CONSERVATION MANAGEMENT PLAN FOR GOVERNMENT MUSEUM AND ART GALLERY, CHANDIGARH

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Getty Foundation

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Submitted to:
Punjab Engineering College
(Deemed to be University)
Chandigarh

Prepared By:
Development and Research Organisation for Nature, Arts and Heritage

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EXECUTIVE SUMMARY

The Conservation Management Plan (CMP) for the Government Museum and Art Gallery is prepared by DRONAH for the Punjab Engineering College (PEC), with support from the Getty Foundation through its "Keeping It Modern" initiative. The Government Museum and Art Gallery was proposed for the planning grant since it suits the evaluation criteria set by the Getty Foundation. The 'Keeping It Modern' Initiative announced by the Getty Foundation was seen as an advantageous opportunity by the Government Museum and Art Gallery and PEC. The project proposal submitted to the Getty Foundation highlighted the potential of this initiative to raise the profile of this twentieth century heritage as well as develop sound methodologies for its conservation. The PEC was awarded a grant under this scheme in 2017 to develop a research based Conservation Management Plan for the Museum and an MoU was drawn between PEC and DRONAH to prepare the same.

The CMP is an integrated and sustainable plan for the future management of the building, based on extensive background research, testing of materials, and technical analysis by a multidisciplinary team. The project undertook the following phases:

1. Documentation, surveys, background research and establishing significance of Government Museum and Art Gallery
2. Assessment of physical condition and material studies, environmental impact studies on the building material, identification of threats to the building, issues of services, site management and testing of materials
3. Collecting data for Climate Control in various seasons to understand behaviour and impact on the building *(to be undertaken by GCI during 2020-2021 and included in the CMP on completion)*
4. Developing conservation strategies and guidelines
5. Conservation planning and management
6. Training and capacity building of staff
7. Final Conservation Management Plan with implementation and phasing

The statement of significance established for the Government Museum and Art Gallery is as follows:

"The Government Museum and Art Gallery, Chandigarh, is an exceptional national example of modern architecture in India. It simultaneously illustrates formal, technological and material innovation in modernism to reflect post-independence ideals of nation building along with new ideas in museum design. Additionally, it is part of an ensemble of outstanding modern architecture of Chandigarh that marks the transnational exchange of architectural ideas and its subsequent impact on Indian and Western architecture, which lasted for more than three decades. It is an iconic modern museum building designed by Le Corbusier as the final realization of his concept for the Museum of Unlimited Growth"

The conservation of the building seeks to address its cultural, historic and aesthetic significance. The established significance of the museum and detailed assessment has helped in charting out the proposals for building conservation treatments, landscape redevelopment solutions, display exhibition design and risk management plan. All these plans supported by specific policies for each, address specific issues and enhance the overall cultural significance of the site. Detailed technical drawings for the entire site are prepared as a part of the proposed project, after reviewing the on-site conditions. These are presented as a reference set of documents to be used in all implementation works on site.

The proposed building conservation and repair treatments take into account the understanding of possible causes of building decay and extrapolation of how the building may behave in the future. Current conservation techniques for modern materials suitable to the context in which the building is present is proposed to be employed for the Museum building.

The proposals for the use, interpretation and upgradation of the museum intend to remove all earlier conflicts due to alterations and interventions made to the building since its inauguration. The aim of the proposal is to recapture Le Corbusier's vision for the Government Museum and Art Gallery. It also proposes reorganisation of functions of certain spaces that were observed to be in despair or presently inoperative. The decisions to retain or remove elements from the current layout were informed by the understanding and weighing of the values attached to various elements of the building and its design. The choices remain unbiased towards the designers – Le Corbusier as the architect or Ratna Fabri as the interior designer, and also gratify the present and future needs for the wholesome functioning of the Museum.

The report also suggests proposals for security and surveillance equipment, fire extinguisher equipment, and storage of material like compactors, racks, office furniture, proposed for the better management of the Museum.

The implementation of this CMP is envisaged to be undertaken in two phases as outlined below:

S.No.	Description of Work to be Undertaken	PHASE 1	PHASE 2
1	Landscape conservation and redevelopment		
2	Building Conservation		
a.	Concrete repair of terrace elements, drains and other areas requiring immediate attention, Waterproofing, False ceiling		
b.	Cleaning exterior and interior surfaces, Repair flooring, etc.		
3	Interior works and Exhibition design		
4	Visitor Amenities		
5	Lighting and Services		
6	Surveillance and security, Fire safety		
7	Collection storage		
8	Collection conservation		

The implementation of the CMP for the Museum is dependent on the availability of funds from the UT Government. The Museum will also apply for the Museum Upgradation Grant from the Ministry of Culture to support the implementation of the Phase 1. A preliminary estimate was drawn up to source funding for the proposed works at the Government Museum and Art Gallery. The work is estimated at 14 Crore INR.

The identified issues and threats to the building have been detailed in this report. A monitoring schedule indicating parameters which need to be observed by the Museum personnel to ensure the health of the Museum is given below:

ELEMENT OF SIGNIFICANCE	DETERIORATION LEVEL	MONITORING PERIOD	MONITORING AGENCY
LANDSCAPE			
Pools	Low	Per month	UT Engineering/ Architecture Department
Vegetation		Every 6 months	
Piazza			
Urban Furniture			
BUILDING EXTERIOR			
Brick tile cladding	Moderate	Every 6 months	UT Engineering/ Architecture Department
Gargoyles	High	Every 3 months	
Concrete drains			
Clerestory and Fins			
Terrace waterproofing	High	Every 3 months	
BUILDING INTERIOR			
Fibreboard ceiling panel	High	Every 3 months	UT Engineering/ Architecture Department
Terrazzo floor	Moderate	Every 6 months	
COLLECTION			
Museum Collection in galleries	Moderate	Every month	Museum staff
Reserve Collection			
MOVABLE AND IMMOVABLE FIXTURES			
Display furniture	Low	Every 3 months	Museum staff
Furniture			
SERVICES			
Lighting (Original)	Low	Every month	UT Engineering/ Architecture Department
Lighting (New)			
Plumbing	High		

The Conservation Management Plan is a dynamic document which should be reviewed and updated every three years along with proper record and communication of the suggested changes to all concerned parties. All identified issues and threats need to be reviewed periodically, along with adaptations in the primary and secondary plans to accomodate the future growth and changes in site. The next update for this plan should be undertaken after the macroclimate study by the Getty Conservation Institute is completed in 2021.

AMENDMENT SHEET

Date of Amendment	Section Updated
February 2020	CMP submitted.
January 2021	Chapters to be updated by GCI after completion of building environment monitoring and assessment:
	5.7 Lighting
	6.7 Policies for Use and Interpretation
	6.8 Policies for Lighting
	7.3 Use and Interpretation Plan
	7.4 Lighting Plan

1. INTRODUCTION

1.1 Keeping It Modern: The Getty Foundation

Launched in 2014, Keeping It Modern is a grant initiative of the Getty Foundation focused on the conservation of significant twentieth-century architecture worldwide. Grants support the creation of conservation management plans that guide long-term maintenance and conservation policies, the thorough investigation of building conditions, and the testing and analysis of modern materials. As a service to the field, technical reports from grant projects are made freely accessible online on the Foundation's website through the Keeping It Modern Report Library. The Foundation created Keeping It Modern to complement the Getty Conservation Institute's Conserving Modern Architecture Initiative (CMAI).

The Punjab Engineering College applied for a grant under this scheme in 2017 for the conservation management planning of one of India's most iconic museum buildings, the Government Museum and Art Gallery designed by the Modernist master Le Corbusier. The grant was awarded to the Punjab Engineering College in 2017 to develop a research based Conservation Management Plan for the Government Museum and Art Gallery.

Fig. 1: Government Museum and Art Gallery, Chandigarh. Source: DRONAH

The Punjab Engineering College (PEC) University of Technology is a deemed University in India providing undergraduate and post-graduate programmes in various disciplines of engineering and technology and doctorate programmes supporting teaching and research in engineering, science, management, humanities and social sciences. The University's inception dates back to 1921 at Lahore (Pakistan), and later shifted to Chandigarh post-Independence in 1953. The Punjab Engineering College has 9 academic departments and 2 centres of excellence in a campus extending over 146 acres in Sector 12, with its own housing, administration and public facilities. The campus also houses the Chandigarh College of Architecture, which was designed modeled on the Government College of Art which is part of the

Cultural Core of Chandigarh designed by Le Corbusier. The 'Keeping It Modern' Initiative announced by the Getty Foundation was seen as an advantageous opportunity by the Government Museum and Art Gallery and the Punjab Engineering College. An MoU was drawn between the Punjab Engineering College and DRONAH to prepare a Conservation Management Plan for the Government Museum and Art Gallery.

The Government Museum and Art Gallery, inaugurated in 1968, is governed by the Chandigarh Administration and is headed by a government appointed Director to the Museum. The day-to-day running of the museum is taken care of by the Deputy Curator and the Curatorial Assistant. The Museum Librarian is incharge of the library which houses a large collection of books related to history, art, architecture and other related studies.

DRONAH is a multi-disciplinary organization that looks at developing cohesive strategies for conservation, management, adaptive re-use and interpretation for historic sites. DRONAH has had previous experience in large collaborative projects that aim to develop benchmarks in the field.[1] Established in 2003, DRONAH has steered several cultural heritage works at national and international levels for India. Previously, under the Keeping It Modern Initiative, DRONAH has worked with the grant awardee, the Punjab University to develop a Conservation Management Plan for the Gandhi Bhawan in Chandigarh. It has also successfully completed projects funded by the Getty Foundation in the past, namely, the Conservation Master Plan for the City Palace Complex, Udaipur for the Maharana Mewar Charitable Foundation (MMCF), funded in 2007 and then again in 2009 through Architecture Planning Grants of the Foundation.

The Government Museum and Art Gallery was proposed for the planning grant since it suits the evaluation criteria set by the Getty Foundation. It is a heritage building with architectural, scientific and cultural values, as well as being symbolic of the structures that represent the extensive nation building exercise undertaken in the 1950's and 60's in India. The Government Museum and Art Gallery is a building associated with several key historic moments in post–independence history of the country. The project proposal submitted to the Getty Foundation highlighted the potential of this initiative to raise the profile of this twentieth century heritage, as well as develop sound methodologies for its conservation.

This comprehensive Conservation Management Plan for the Government Museum and Art Gallery will serve as a pilot for conservation of modernist architecture in the country. The plan emerges from the combined efforts and expertise of the large inter-disciplinary team from DRONAH, and other associate experts along with the in-house expertise of Punjab Engineering College and the Government Museum and Art Gallery, to ensure a scientific and sustained approach towards conservation of modernist architecture in India.

1. For further details on DRONAH's organizational structure, activities, projects and approaches, please visit www.dronah.org

1.2 Vision, Goals and Objectives of the Conservation Management Plan

The conservation of modern heritage is a recent phenomenon in India and there are precious few examples of conservation of the same in the country. However, the inscription of the Capitol Complex, Chandigarh as a UNESCO World Heritage site, indicates a growing awareness of Modern Heritage and its conservation in India. The conservation of concrete would before long be considered a major discipline to undertake works in modern structures in the near future. The conservation planning of Government Museum and Art Gallery at this stage can serve as a role model for the city and the nation. At the outset of the project, the museum appears to be in good physical and structural condition and has undergone maintenance and repairs in the past to address issues of weathering and aging. However, considering the limited years of concrete life, there are sections of the building that have started showing material deterioration. The conservation planning of Government Museum and Art Gallery at this stage to address its material deterioration, long-term maintenance and appropriate use of interior spaces will be a benchmark initiative in conservation of modern heritage in India. This document will subsequently guide the implementation works to be undertaken.

The vision for Government Museum and Art Gallery is:

"The Government Museum and Art Gallery, Chandigarh, is an exceptional national example of modern architecture in India. It simultaneously illustrates formal, technological and material innovation in modernism to reflect post-independence ideals of nation building along with new ideas in museum design. Additionally, it is part of an ensemble of outstanding modern architecture of Chandigarh that marks the transnational exchange of architectural ideas and its subsequent impact on Indian and Western architecture, which lasted for more than three decades. It is an iconic modern museum building designed by Le Corbusier as the final realization of his concept for the Museum of Unlimited Growth"

The Project is conceptualized in the following stages:

1. Documentation, research and establishing significance of Government Museum and Art Gallery
2. Assessment of physical condition, use, services, management and testing of materials
3. Collecting data on Climate Control in various seasons to understand behavior and impact on building. *(to be undertaken by GCI during 2020-2021 and included in the CMP on completion)*
4. Developing conservation actions and strategies
5. Detailing of individual proposals, secondary plans for the building and site and expanding on the implementation strategy
6. Training and capacity building of staff
7. Submission of plan after consultation with stakeholders and experts on Modern Architecture in India and technical experts on conservation of concrete

1.3 Preparing the Plan: Methodology

The work on conservation planning for the Government Museum and Art Gallery began in November 2017. The Phase 1 of the work plan comprised of historical and archival research, followed by documentation of the building. The team read the design evolution of the museum as intended by Le Corbusier through archival documents received from the Fondation Le Corbusier, Paris. Drawing upon the architectural and landscape history and the history of repairs and alterations to the building, the team traced the evolution of the building to its present. Most of the records were sourced from the Fondation Le Corbusier Paris, Department of Urban Planning- Chandigarh Administration office and the Government Museum office. These included archival photographs, sketches and documentation drawings dated 1957-2006. However, ownership of all original documents lies with the above mentioned sources and access was only limited to their scans and copies. All archival drawings have also been digitized by the team of consultants for later reference.

The initial archival research has assisted in establishing the concept behind site planning, physical setting of the building and its orientation, surface treatment and water management applications as part of the Phase 1 of the Conservation Plan. The position of the museum within the larger framework of Le Corbusier's plan for the city and its component, the Cultural Core, was explored. The team interviewed architect Mr. S.D. Sharma and Mr. S.M. Dhami who worked with Le Corbusier during the execution. They gave valuable insight into the context of the project and the conceptual evolution of the building.

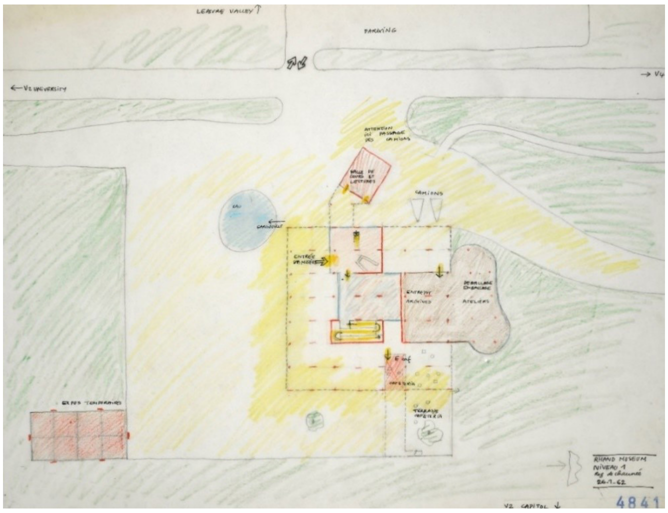


Fig. 2: Archival drawings from 1962 showing development of museum plan. Source: FLC Archive

The participation in the international workshop on Le Corbusier's Three Museums organized by the Getty Conservation Institute in February 2018 initiated dialogues regarding the significance of the ensemble of Modernist buildings and discussed policies regarding governance and funding, site planning and landscape, strategies for building conservation and policies for collection management and archives. The discourse at the workshop has helped inform the Conservation Management Plan process, with regard to establishing significance and preliminary assessment of issues related to the Government Museum and Art Gallery, Chandigarh.

Fig. 3: Laser scanning team on site. Source: PEGS

Site analysis and scientific, historic and architectural survey such as total station surveys, laser scanning, and photographic survey were completed in Phase 1. Laser scanning was employed to create as-built drawings of the building along with developing virtual three-dimensional models.

The Phase 2 involved a detailed assessment of physical threats, structural and surface issues, assessing management issues, maintenance and upkeep lapses and current approaches towards the building use and management. A team of onsite conservation architects and architects carried out exhaustive surveys to confirm visual inspection of the condition of the building and its interiors. This process also included inspection of each concrete panel, brick tile and terrace elements through sound testing. The team of experts from Punjab Engineering College assisted by other consultants conducted scientific testing processes, and sampling of materials for analysis of strength, composition, mechanical and physical behaviour. Assessment of services, landscape and issues of maintenance of exteriors and interiors, furniture and fittings was also reviewed in detail.

Based on visual inspection and initial scientific investigations, it was established that the structure of Government Museum and Art Gallery is in no immediate danger and is showing no visible signs of structural distress. However, the terrace elements and the concrete drains show considerable deterioration requiring immediate conservation intercession. The project team investigated and assessed the building's current conditions, which have been recorded on documentation drawings created by laser scanning. A number of techniques have been adopted including visual and mechanical surveys to identify the issues, which have been translated into drawings and descriptions. A sounding survey was undertaken of all the accessible areas of the building façade and of the terrace elements. This technique involved tapping the surface of a concrete section with a dead blow hammer or a mallet and evaluating the vibrations generated to detect planes of delamination. The differences in the sounds emitted during the percussive investigation enabled the surveyor to determine locations where the concrete is detaching. The conditions were recorded on the schematic elevations produced during laser scanning.

The survey has revealed some patterns that help in understanding the possible causes of decay as well as help in extrapolating how the building might behave in the future. The current conservation techniques for modern materials were analyzed in detail. An overview of these techniques and understanding of probable causes and current conditions will help in recommending treatments for museum building. Further details of the condition assessment are available in Chapter 5 of this plan and the material testing and analysis report is included as Annexure B to this document.

A survey of the building environment is being conducted by the Getty Conservation Institute by installing equipment to monitor the internal climate of the museum galleries and the reserve collection storages since January 2020. The observation and monitoring for relative humidity, temperature fluctuations, air quality, dust etc. undertaken on a regular basis for a period of atleast 12 months can determine the climatic effect on the built fabric as well as the collection housed within. The environmental studies will subsequently inform the implementation works to be undertaken to provide a non-intrusive and compatible condition within the spaces for the benefit of the building and its collections. This aspect and its subsequent findings may be incorporated later in this CMP by 2021.

Critical evaluation and condition assessment studies of the landscape environs of the Government Museum and Art Gallery have been conducted as part of the Conservation Planning project. The basic premise of approaching the condition assessment exercise for the museum was to consider the building as a part of a larger landscape where both the site and its setting lends meaning to the built form and plays an important role in understanding the building in its wider context. The methodology includes appropriate scoping of the studies and understanding the landscape elements of the core site as well as its surroundings in the context of the museum's physical setting within the cultural core of Chandigarh city. Information for condition assessment were collected through site/building plans, archival photographs, visual inspection and inputs on maintenance and repair records. The natural and man-made components of the designed landscape that were identified for the studies were vegetation, water features, landscape services, light sculpture and surrounding concrete flooring.

The Phase 3 involved devising policies and guidelines for the conservation and management of different aspects of the building. The established significance of the Government Museum and Art Gallery and detailed assessment of the building and its surroundings has helped in charting out the policies for future conservation and use of the building. Policies for the conservation of the building envelope and its interiors, landscape, furniture and services were developed. It stresses that the architect's/designer's vision is to be retained in full measure. Policies pertaining to risk management, building use and visitor management were also articulated.

The Phase 4 involved defining specific proposals and action plans for the building conservation, lighting, landscape, environment and climate control, furniture, museum planning, conservation lab, etc. The treatment plans and action strategies along with a monitoring plan was derived, informed by the detailed assessment and testing programme conducted on site. The conservation management plan of Government Museum and Art Gallery includes the following:

1. Conservation Plan for Building and Interiors: Incorporates conservation strategies for the building and further provide specifications for conservation work, detailed conservation and maintenance strategies for the structure, interiors, furniture and finishes. It also provides interior layouts and drawings and feeds the technical drawings for conservation works to determine the level of intervention required in each space.

2. Landscape Plan: Outlines recommendations regarding application of energy efficient methods in lighting, landscaping, and other functions around the building as well as broad recommendations for internal and external environment of the site.

3. Lighting: Outlines recommendations regarding lighting requirements for future use and functionality of the building while considering the aesthetics of the spaces.

4. Use and Interpretation Plan: Provides information regarding future use of spaces and for expansions developed in coherence with the concept for the museum design of unlimited growth. Outlines means for interpretation of building and collection through various media to communicate to all visitors and intends at enhanced visitor experience.

5. Risk Management Plan: Integrates concerns of disaster risk reduction through identification of natural and human induced hazards that may cause risks to the site and provides proposals for reducing and managing risks to both life, collection and the identified values of the site.

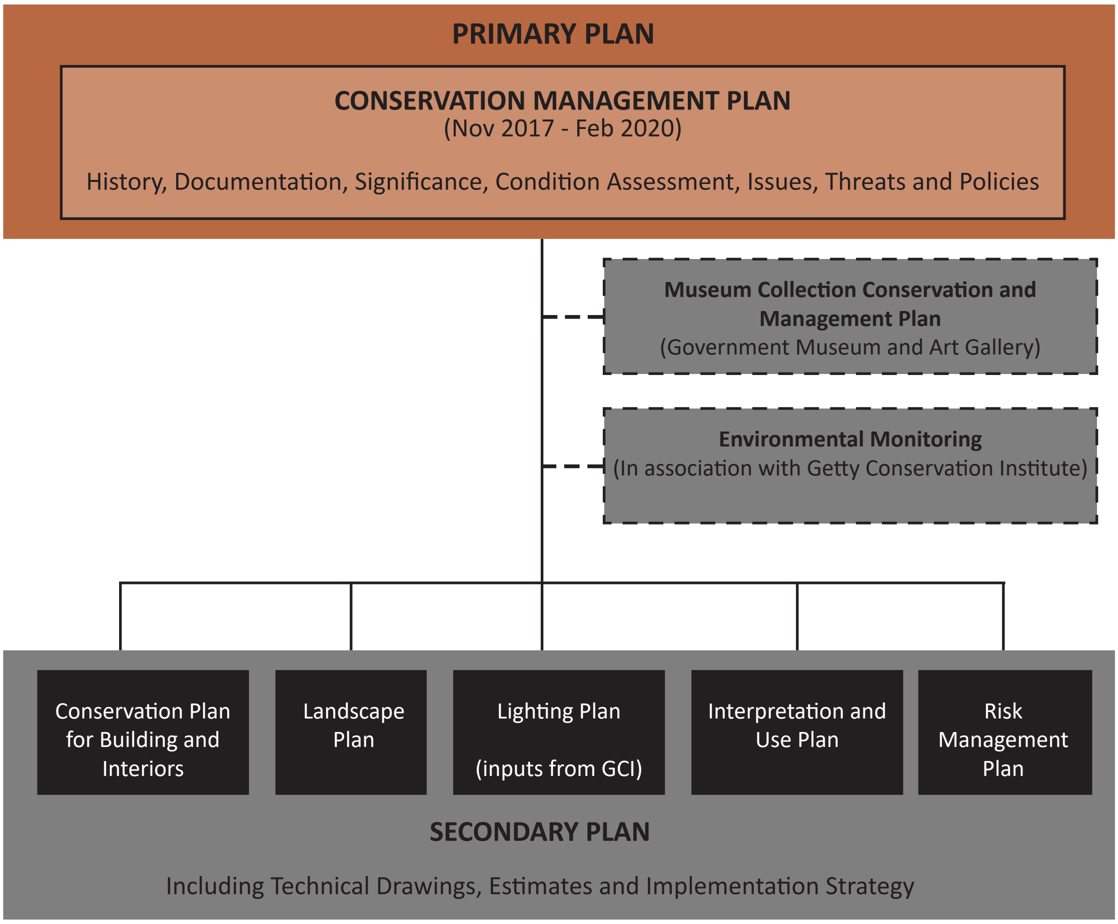


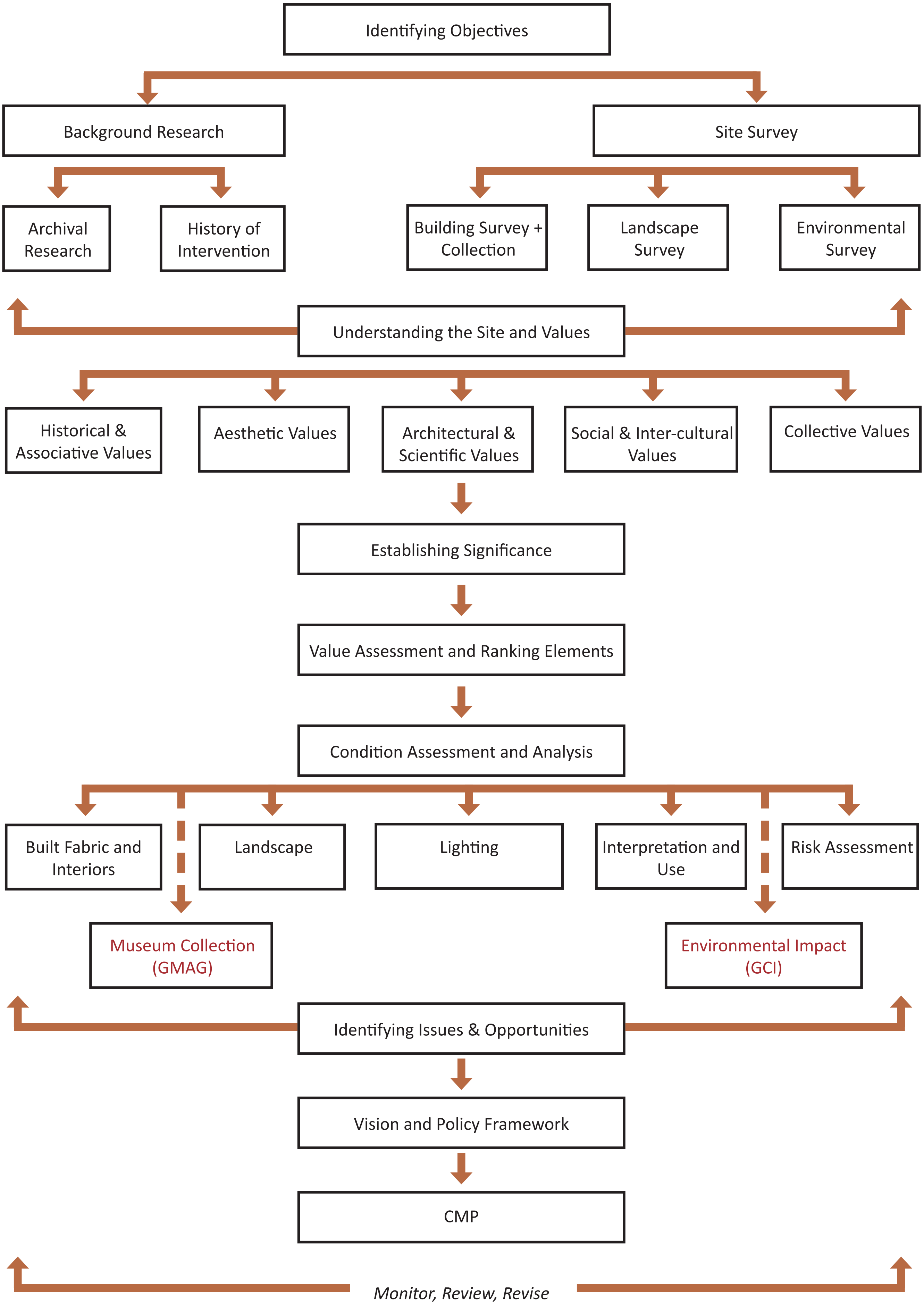
Fig. 4: Components of the Conservation Management Plan for Government Museum and Art Gallery

All these plans address specific issues and enhance the overall cultural significance of the site. These will also serve as important resources for future reference as well as for future fundraising for the building and other structures within the site. The detailed technical drawings for the entire site are prepared as a part of the proposed project, using the documentation in the conservation plan as a base, and reviewing the onsite condition. These are presented as a reference set of documents to be used in all implementation works on site. The models generated through LiDAR scanning was used to prepare rendered views and 3D walk-thru to reflect the proposals for the Museum.

The Phase 5 details out the bill of quantities and estimates prepared as per the technical drawings and will be used for tendering works on site during the implementation stage. It also explores funding opportunities for the implementation of the Conservation Management Plan.

This project intends to go beyond the preparation of a conservation management plan and serve as a pilot case for conservation of Modern architecture and Museums in India promoting aspects of Climate Control and Preventive Conservation. Very little scholarship and scientific data exists on the subject presently and it is expected that the documentation and research that emerges as a result of this project will be widely disseminated in the professional and academic field for future initiatives in the country.

The value-based methodology for the making of the Conservation Management Plan for Government Museum and Art Gallery is demonstrated by the flow chart below.


Identifying Objectives
Background Research
Site Survey
Archival Research
History of Intervention
Building Survey + Collection
Landscape Survey
Environmental Survey
Understanding the Site and Values
Historical & Associative Values
Aesthetic Values
Architectural & Scientific Values
Social & Inter-cultural Values
Collective Values
Establishing Significance
Value Assessment and Ranking Elements
Condition Assessment and Analysis
Built Fabric and Interiors
Landscape
Lighting
Interpretation and Use
Risk Assessment
Museum Collection (GMAG)
Environmental Impact (GCI)
Identifying Issues & Opportunities
Vision and Policy Framework
CMP
Monitor, Review, Revise

2. CONTEXT

2.1 Modernism: A Global Movement

Architectural modernism can be understood to be an architecture conscious of its own modernity and striving for change.[2] The attitude towards the tradition of recycling eclecticism and classicism in architecture started to change in the early 19th century. The dissatisfaction amongst architects, historians and critics led towards creating an architectural style that reflected its age and having avant-garde inclinations. The revolutions in technology and engineering at the end of the 19th century endorsed the breaking away from historical architectural styles to embrace designs that were purely functional. The 20th century philosophy of architecture and design was associated more so with analytical approach to the functionality of building, material technology and structural innovation than focus on the dismissal of ornamentation.

The revolution in materials and engineering allowed to build structures that were lighter and taller. The materials gave the architects the freedom to experiment creating new forms. Reinforced concrete replaced stone and masonry as the primary material for the modern architects. The 19th century also saw the invention of the safety elevator making the construction of skyscrapers practical.

The progressive movements of the late 19th and early 20th centuries radically opposed the prevailing historicist architecture. The Art Nouveau movement of the 1890s was the first attempt to replace the classical system of architecture, drawing inspiration from the preceding Arts and Crafts movement; both of which were outcomes of reforms in the industrial arts. The movement embodied the 'functional dependency of the ornament'[3], where the boundary between ornament and form blurred. Antonio Gaudi integrated crafts like ceramics, stained glass, ironwork and carpentry into the architectural details of his designs. His works were characteristically free of all stylistic conventions and perceived form as sculpture. Scottish modernist architect, Charles Renne Mackintosh influenced the European modernist movement with his own style – a balanced contrast between geometrical forms and right angles, floral-inspired decorative motifs and traditional Scottish architectural elements.

The pioneers of modern architecture moved from stylized ornamentation to a more geometric simplified style of architecture. Otto Wagner, in his published textbook Modern Architecture, states 'new human tasks and views calls for a change or reconstitution of existing forms'. His architectural style reflected the intended function of the building on its exterior. In 1910 the Viennese rationalist architect, Adolf Loos, advocated the modern aesthetic principle approving smooth and clear facades in contrast to ostentatious ornamentations through his essay Ornament and Crime. The modernist industrial movement in Germany saw prominent architects like Peter Behrens, Adolf Meyer and Walter Gropius design buildings without ornament while exposing the construction elements. Frank Lloyd Wright's designs highlighted geometrical forms sans ornaments with strong horizontal lines. His architectural style coordinated design elements so that all components of the building unified. However, concurrently the Art Deco architects such as Auguste Perret and Henri Sauvage continued to practice a combined style, favoring modernist forms with stylized ornaments which were not historical models but representative symbols of modernity.

Post World War I emerged the International Style, characterized by emphasis on volume, use of lightweight, industrially mass produced materials and rejection of decorations. **The dominant figure in the International style of architecture, Le Corbusier promoted functional and pure architecture free**

2. Alan Colquhoun, *Modern Architecture* (Oxford: Oxford University Press, 2002)
3. Ibid.

of decorations. He advocated planned urban cities with identical modular housing for the inhabitants, surrounded by open parkland. Modernist German architect, Walter Gropius also advocated standardization in architecture, promoting mass construction of rationally designed apartments as a solution for mass housing.

The *Congrès Internationaux d'Architecture Moderne* (CIAM) was established in 1927 as an international platform of the Modern Movement. The main focus of their discussions were housing and urbanism with the intention of establishing a common style of design and developing methods to organize modern cities. The Athens Charter published as CIAM's urban doctrine projected a formalized approach to the complex problems of urban cities.

2.2 Modernism: India and Chandigarh

Architects in India were aware of the revolution in the Art and Architectural world in Europe in the early 1900s. Mumbai was the heart of architectural thinking, with many British-headed, as well as Indian architectural practices located there. A gradual modernization of architecture influenced by International Modernism can be seen in some of the works of that period.

The first generation of modernist Indian architects were primarily those who studied architecture overseas under the supervision of internationally renowned Modernist architects. The architects like Habib Rahman, Achyut Kanvinde and Piloo Mody led the way to a new architecture, unified by a desire to bring new approaches to architecture in new India.[4]

After attaining Independence, India looked towards breaking away from the British influence and building a new post-colonial identity. Keeping this in mind, the Government of India invited the famous architects, Le Corbusier in 1955 for designing a new city and Louis Kahn in 1962 for designing the institutional campus for the Indian Institute of Management (IIM). They introduced the modern concept that had begun to find its place in the western world, which preached the abandonment of the classical style; or colonial style in the case of India. Their concepts were completely new in the Indian world where colonial influence had prevailed for many decades.

Jawaharlal Nehru, the first Prime Minister of independent India turned to Le Corbusier to initiate a model portraying industrialized India. The projects included construction of government offices, residential schemes and urban development of the new city of Chandigarh. The planning of Chandigarh highlights characteristic traits of Le Corbusier's design ideology: open plan buildings, concrete structural framework, and often concrete walls, and sculptural elements like the *brise-soleil.*

Louis Kahn sort immediate international recognition for the Indian Institute of Management through its architecture. He employed familiar Indian building material like bricks in his work. His architectural vocabulary was characterized by load bearing exposed brick construction and circular and arched openings.

Le Corbusier and Kahn, through their work, contributed to inspire the Indian architects of their generation. This included the luminaries of modern architecture in India- Charles Correa, Balkrishna Doshi, Raj Rewal and Anant Raje, whose works at the outset clearly displayed the stamps of their

4. Jon Lang, *A Concise History of Modern Architecture in India* (Delhi: Permanent Black, 2002)

respective mentors. However, they later achieved to synthesize ideas transmitted through modernism and traditional Indian architecture to create an Indian contemporary architectural identity. The Indian modernists reinterpreted modern architectural principles ruled by use, by incorporating indigenous philosophies. The modern Indian architecture evolved to express a new architecture reconciled with the historic progression of India's past.

2.3 Modern Museums in the 20th Century

The pioneers of modern museums in the 20th century looked towards redefining museum space design to house modern art collections and raised the paradoxical question: "How can there be a museum (a permanent institution housing the heritage of human civilization) for Modern art (which embodies the ideal of always moving forward and constantly changing)?"[5] Among those thinkers were the architects Adolf Loos and Auguste Perret and curators Richard F. Bach (Metropolitan Museum of Art) and Louis Hautecoeur (Musée du Louvre), who upheld the renunciation of classical architectural styles to focus on the space and its function in order to highlight the collection. They argued that the ornamental richness of classical elements turned the visitor's eyes away from and conflicts with the display exhibited.[6] All this leads to a museum architecture imposing "neutrality, use and function" as described by Nabila Oulebsir (lecturer at Université de Poitiers) in her article "Museum and architecture in France: neutrality or decor, collection or concept?"

The realization of the first modern museum materialized a decade later with the building of the Museum of Modern Art (MoMA) in 1939, by the architects Philip Goodwin and Edward Durell Stone. It was the first example of a museum embodying the precepts of modernism. The simple form of the Museum and the neutrality of its glass curtain facade was in contrast with the decorated streets of the neoclassical and Art Deco New York of the 1930s and claimed a resolutely modern style. The plan showed the services confined in a box, thus releasing the exhibition space which was built as a column-beam structure. A terrace-roof crowned the Museum.

The Musée des Travaux Publics was also established by Auguste Perret in 1939. The museum did not entirely turn down the classical style; demonstrated by his use of bas relief ornamentation on the facade. However, its functional architecture outweighed the classical ornamentation, keeping one's attention focused on the objects exhibited. The bearing structure in raw reinforced concrete, taking advantage of natural lighting, offered bright and flexible exhibition spaces.

Fig. 5: Façade of the Museum of Modern Art.
Source: hereelewhere.com

5. Paul Goldberger, "Architecture View; A Wistful Ode to a Museum That Once Was," *The New York Times*, 11 June 1989
6. Nabila Oulebsir, "Musées et architecture en France: neutralité ou décor, collection ou concept?." (Rencontres du Léman Architecture et quotidian du musée, ICOM, Genève, June 19-21, 2008).

Fig. 6: Musee des Travaux Publics. Source: paris-projet-vandalisme.blogspot.com

In 1931, Le Corbusier proposed the first museum project of 'natural growth', the size of which could be regulated by the importance of the collection. He described his clear intentions in a letter addressed to Mr. Zervos, editor of the journal "Cahiers d'art". The Museum is non-contextual, its architecture is "neutral" or "standardized" to enhance the significance of the collection.[7]

Frank Lloyd Wright was also concerned about the question of growth since the beginning of his career, traces of which can be seen in the houses he built in Chicago. He designed a helical spiralling ramp for Solomon R. Guggenheim Museum in 1959. Ironically, the success of the Wright's model precedes the actualization of Le Corbusier's concept of 'museum of unlimited growth'. Its architecture aimed to be provocative, in contradiction with its built environment, defying New York's skyscrapers skyline.[8]

The common feature of Le Corbusier and Wright's propositions are the exhibition spaces concentrated upon themselves.

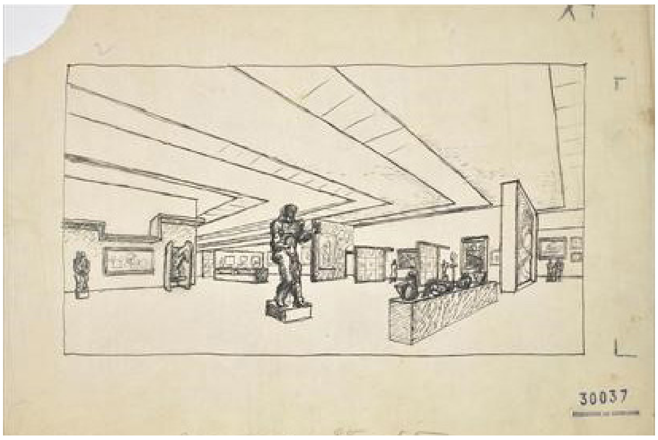


*Fig. 7: Musée d'Art Contemporain, Paris.
Source: FLC Archive*

*Fig. 8: Façade of Guggenheim Museum.
Source: www.guggenheim.org*

7. Fondation Le Corbusier, "Musée d'Art contemporain, Paris, France, 1931," Fondation Le Corbusier
8. Nabila Oulebsir, "Musées et architecture en France: neutralité ou décor, collection ou concept?."

The thought on modern museum took a new turn with the proposal of Mies Van der Rohe for the Neue Nationalgalerie in Berlin in 1968. Through its architecture and building envelope of a thin glass layer, it seemed to open out towards the city.[9] In 1977, Renzo Piano and Richard Rogers followed a similar model of transparent facade for the Centre Pompidou, facing a city square, revealing the exhibition it housed. Like the Guggenheim, its architecture provoked and highlighted the services and techniques as ornamentation in the heart of Hausmannian Paris.[10] The Nationalgalerie and the Centre Pompidou both used metal structures to offer an expansive flexible space, where artists could experience freedom of space to liberate their imagination and integrate the space as a vital element of their art creation. In the case of Pompidou, the structural skeleton, mechanical systems and the vertical circulation elements were exposed on the façade, to give an uninterrupted space within. The museum remained an open plan, sheltered from its environment while housing the required services on the periphery of the built fabric.

During the same period, Louis Kahn shifted away from the international style of Bauhaus and its functionalism. The cycloid vaults of the Kimbell Art Museum[11] (1972) in Fort Worth, Texas, aimed to renew the classical shapes of the past. Regardless of the brutalist movement initiated by Le Corbusier and its sculptural concrete, in Fort Worth we can see an attempt at a resurgence of ‘form’ in architecture. This late modernism period seems to be the premise of the postmodern architecture.

Fig. 9: Façade of Nationalgalerie. Source: afasiaarchzine.com

9. Ibid.
10. Ibid.
11. C. Mileto, F. Vegas, L. Garcia and V. Cristini (Eds.), “Vernacular Architecture: Towards a Sustainable Future” (Proceedings of the International Conference on Vernacular Heritage, Sustainability and Earthen Architecture, Valencia, Spain, September 11-13, 2014).

Fig. 10: Façade of Centre Pompidou. Source: www.centrepompidou.fr

Fig. 11: Kimbell Museum. Source: https://www.archiweb.cz/b/kimbell-art-museum

A look at the history of the art display shows that before the museum revolution of the early 20th century, influenced by the Paris salons, the paintings were stacked on the tapestried walls of the classical building so as to fill any vacant wall space and the floors were covered by a forest of sculptures.[2] Later the artworks were displayed in dense, symmetrical arrangements, allowing better comparison of styles and art movements.[13]

Fig. 12: View of Salon Carré at the Louvre, painting by Alexandre Brun shows the display in the gallery in 1880s.
Source: https://commons.wikimedia.org/wiki/File:Alexandre_Brun_-_View_of_the_Salon_Carr%C3%A9_at_the_Louvre.jpg

However, since its beginning, the modern exhibition display was characterized by neutrality and leaned towards highlighting the artworks. Modern Art was new on the artistic scene and the intent of Alfred Barr, the first curator of the MoMA, was to share knowledge about it.[14] The ground-breaking exhibition of Barr, "Cubism and Abstract Art" was opened in April 1936 with the concept of the "white box"- a display method endorsing an easily regulated white neutral space. The proposal of the exhibition was "a narrative that continues to shape the Museum's presentation of modernism to this day".[15] Barr designed the exhibition to reveal the development of cubism and abstract art by arranging the exhibits in a historic chronology. It showcased the modern collection's style and artistic discipline to address a larger population. The success of the event institutionalized the modern exhibition and anchored it as a museum standard in the academic system.

12. Aurélie Champion, "Expositions des collection, turbulences dans les musées d'art modern," *Marges*, 12|2011, 15 April 2011.
13. Abigail Cain, "How the white cube came to dominate the Art World," *Artsy.net*. January 23, 2017.
14. Ibid.
15. Museum of Modern Art (New York), *Cubism and Abstract Art*, (New York: The Museum of Modern Art, 1936).

Fig. 13: Museum of Modern Art's White Box proposed by Barr.
Source: https://www.artsy.net/article/artsy-editorial-white-cube-dominate-art

Modern, by definition embodies a constant change; it is the idea of moving forward. To promote these ideas, modern museums almost always include a temporary gallery. They differ from a classic gallery, as they are attuned to the future rather than the past.

Barr's academic model remained dominant in the modern museum collection display until the 1990's. In 2000, the Tate Modern in London was the first museum of modern/contemporary art to display its permanent collection according to thematic and multi-disciplinary approaches. Under the influence of Frances Morris (curator of Tate Modern), exhibitions aimed to compare, to oppose, and to balance the artworks by merging permanent and temporary collections in the same exhibition.[16] Concisely, avant-garde curators tried to put forward the history of modernism as an objective and neutral vision, whereas the contemporary curators tried to highlight the subjective dimension of art to develop the visitor's own perception of the artwork.

16. Aurélie Champion, "Expositions des collection, turbulences dans les musées d'art modern."

2.3.1 Le Corbusier's Idea for a Modern Museum

During the course of his career, Le Corbusier attempted to apply rules to architecture. His view “The house is a machine for living in”[17] shows that he believed architecture to be conceived as a machine. To achieve this thought, he developed tools such as the *Dom-ino*, the 5 points of architecture and the *Modulor* and designed his projects with concepts like the “*parcours*” (for house) and the “unlimited growth” (for museum). However, his model of architecture was replicable, accommodating deviations from the core ideas to suit various projects; ironically not everything followed rules. Le Corbusier was also an artist, shaping the space with smooth partitions and sculpting the terraces with gargoyles, ducts and openings. Together, with regularity and irregularity, he produced an architecture which was functional but not emotionless, modern but not neutral.

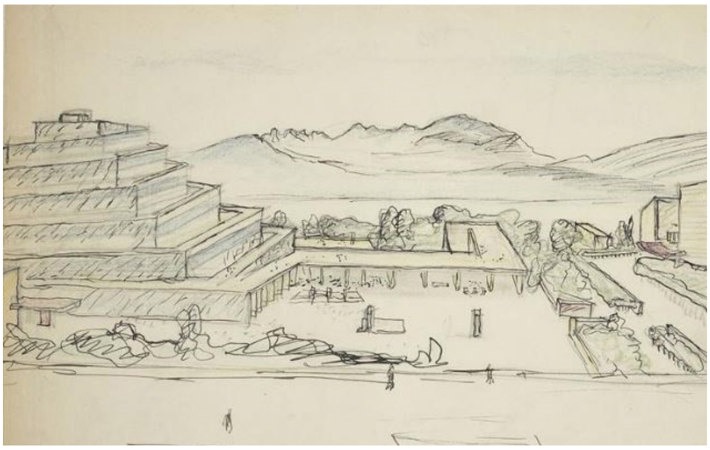


Fig. 14: *Mundaneum, Musée Mondial Geneva. Source: FLC Archive*

The origin of Le Corbusier’s modern museum thought can be traced back to his controversial unrealized project for the Mundaneum in 1929 in Switzerland. The museum, proposed as the cultural element of the Mundaneum, was a pyramidal structure made out of a square spiral. The continuous gallery, showing various stages of civilization in continuous development, began at the top of the pyramid, walking down a ramp until the visitor reached the ground which represented the present.

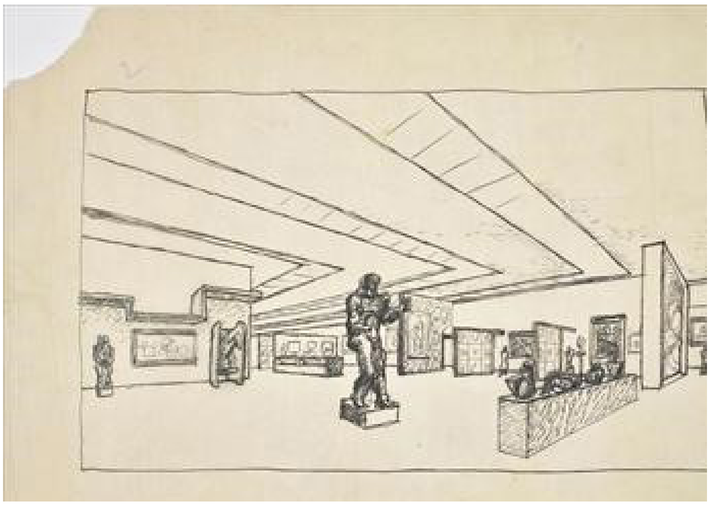


Fig. 15: *Musée d’Art contemporaine, Paris. Source: FLC Archive*

In 1931, Le Corbusier flattened the spiral for his proposal for Museum of Contemporary Art in Paris (Fig.7). It presented a single continuous wall folded into a square spiral to accommodate a linear exhibition space. A few cuts in the walls allowed the visitor to break the fixed path to move in different ways within the building.[18] *”The museum has no façade; the visitor will never see a façade; he will only see the interior of the museum. One enters the heart of the museum by means of an underground passage and the wall opening for the entrance door would, once the museum has reached its full magnificent size, comprise the 9000th meter of the total developed length of the museum.”*[19]

Le Corbusier’s, *Museé a croissance illimitée*, Museum of Unlimited Growth, published in 1931, proposed a series of galleries elevated on pilotis and organized about a square courtyard that would extend infinitely. The project achieved to describe a vision which closely tied architecture to the collection. In addition to the application of the “5 points of architecture” which he formulated in 1927, the concept

17. Le Corbusier, *Towards an Architecture.* Trans. John Goodman, (Los Angeles: Getty Research Institute, 2007).
18. Beatriz Colomina, “The Endless Museum: Le Corbusier and Mies van der Rohe.” *Log*, No. 15, pp. 55-68. 2009.
19. Fondation Le Corbusier, “Musée d’Art contemporain, Paris, France, 1931,” Fondation Le Corbusier.

proposed order-less, face-less, place-less and end-less qualities for an ideal modern museum. It was to become the prototype for the “Three Museums”, later realized by Corbusier in Tokyo, Ahmedabad and Chandigarh.

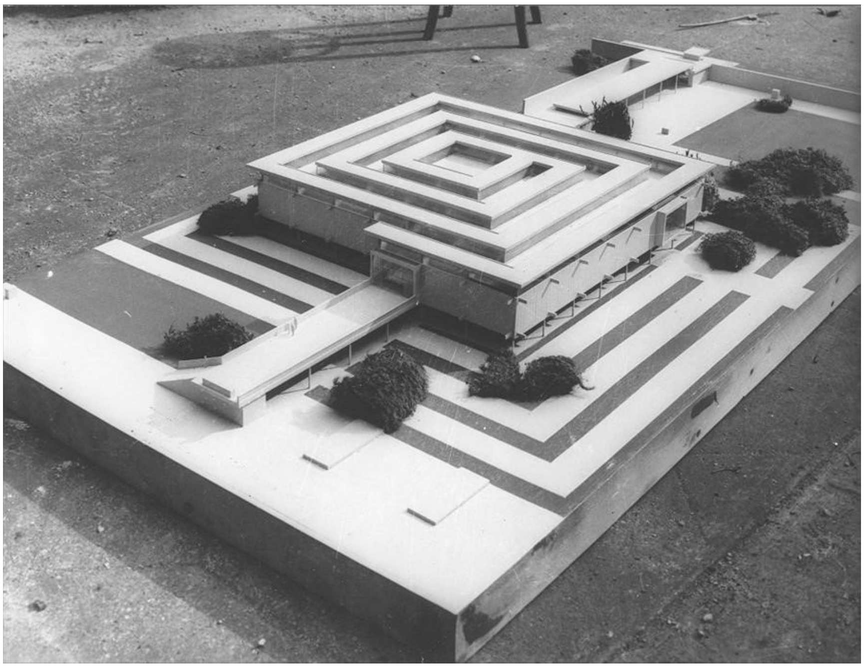


Fig. 16: A project model representing Le Corbusier’s Unlimited Museum. Source: FLC Archive

The Musée opened from within a 14x14 meter square courtyard, and spiraled outward following a 7x7 meter grid. The galleries were to extend incrementally, the museum growing with its collection. The idea subverted previously established elements and concepts of hierarchy in museum space design, to embrace a space for the synthesis of art.

The concept aimed to create an experience in the museum where the art objects speak for themselves and the architecture supports a fluid narrative. The spaces within the museum were configured so as to move along the architectural promenade.

Le Corbusier described his spiral museums as ‘front-less’ in the book *L'atelier de la recherche patiente.* The idea is established in the proposed design, where one would walk straight towards the centre of the spiral without confronting any distinctive façade. A continuous wall unfolding and folding in on itself, the façade is only temporary, as it is destined to become interior partitions in the spiral configuration. The pilotis elevated the building, removing it from its historical and cultural context, allowing it to exist independent of the place. The end-less figure of the spiral allows for absolute continuity and growth.

Le Corbusier seemed to incorporate an endless museum in most of his city plan projects. In 1945, Le Corbusier proposed an endless museum as part of the civic centre of Saint-Dié town plan. **The concept, Museum of Unlimited Growth, was an attempt at an independent architecture, beyond style or traditions, time-less in character, turning the visitor’s attention away from the context within which the museum is set. He realized his vision first through the museum at Ahmedabad in 1957, then in Tokyo in 1959 and finally in Chandigarh in 1965. The prototype of the unlimited museum was adjusted to suit the site and environmental demands of the three museum projects. Using the basic fundamentals of the concept allowed the addition of galleries as the museum’s collection grew.**

In 1963, he proposed a museum near Frankfurt, the International Art Centre at Erlenbach, to be strategically placed at the crossing of the axis Stockholm-Rome and Paris-Vienna-Belgrade-Bucharest. The museum was to be positioned at the key node in a transnational network as a representation of the whole world.[20] Le Corbusier was to build “The Museum of 20th century” in Nanterre in 1965 but his tragic death interrupted the project. The sketches and feasibility survey suggested that he had designed a huge “Unlimited Growth” Museum for Paris.[21]

20. Beatriz Colomina, “The Endless Museum: Le Corbusier and Mies van der Rohe.”
21. Fondation Le Corbusier, “Musée du XXe siècle, Nanterre, 1965,” Fondation Le Corbusier

Furthermore, one can draw similarities between Le Corbusier's proposals for the museum and to that of his earlier designs for private house commissions. When comparing Villa Savoye to the National Museum of Western Art in Tokyo as an example of the endless museum model, although one is smaller and lightweight than the other, they follow a similar basic concept. Both are square boxes suspended off the ground, where one enters through a field of columns and up a ramp to the core of the building. The difference between the two is that as one continues up the ramp, it leads to the interior levels of the house with view to the outside in all directions through ribbon windows. Whereas in the museum the ramp turns into a spiral folding onto itself. The lack of windows in the museum cuts out the relationship between the inside and outside, emphasising the skylight allowing sunlight into the central space.[22]

Fig. 17: (L) Villa Savoye, Poissy; (R) National Museum of Western Art, Tokyo. Source: FLC Archive

The museums of Le Corbusier, by their non-contextual aspect, stand out distinguished from the other museums where implementation looks towards interacting formally with the built environment. Hence, it seems logical that the concept of "unlimited growth", realized in several projects, binds them together through their non-contextual character, thus giving it a collective significance. The "Three Museums" are inestimable witnesses to the museum thought of the 20th century, aiming for a closer relationship between architecture and the collection. The building was no longer considered an independent object but as an extension of the collection, the whole forming a cultural ecosystem. The Sanskar Kendra Museum in Ahmedabad was the first realized museum of modernism by Le Corbusier, which succeeded in conceptualizing a link between architecture and growth of the collection.

2.3.2 Le Corbusier's Three Museums

Le Corbusier imagined Museums of Unlimited Growth for nations across the world – from France to Japan, Switzerland to Africa, Germany to India. Through analysis of the original proposal and subsequent iterations and alterations, there were three projects following Le Corbusier's concept for the Musée that were realized: Sanskar Kendra Museum at Ahmedabad (1953), National Museum of Western Art in Tokyo (1959) and Government Museum and Art Gallery at Chandigarh (1968). The three designs have similar form and plan, but are adapted to the local climate and building materials. The spiral plan of the unlimited museum prototype was reformed to accommodate the specific building functions, providing for multiple entry/exit ways, auditoria, landscape elements and flexible performance spaces. The interior spaces were provided with open air courtyard and clerestories to allow natural light, which worked in conjunction with other systems of artificial lighting. The context under which the three museums were created differs. The museum in Tokyo was designed to exhibit a specific collection – the

22. Beatriz Colomina, "The Endless Museum: Le Corbusier and Mies van der Rohe."

personal collection of Matsukata Kojiro, whereas the Ahmedabad museum was proposed as a museum and cultural centre.[23] The Chandigarh Museum was created as a part of the cultural centre for the city, designed as empty spaces for the display of art.

While drawing parallels between the realised museum projects, it can be noted that Le Corbusier gave emphasis to the urban context for physical site setting. The site setting of the Ahmedabad Museum with its view towards the Sabarmati River shows likeness to the positioning of the Chandigarh Museum facing the stream N.Choe. Le Corbusier's intentions with the Tokyo museum and its positional interaction with the Sumida River is undetermined as the entrance to the site faces away from the river.

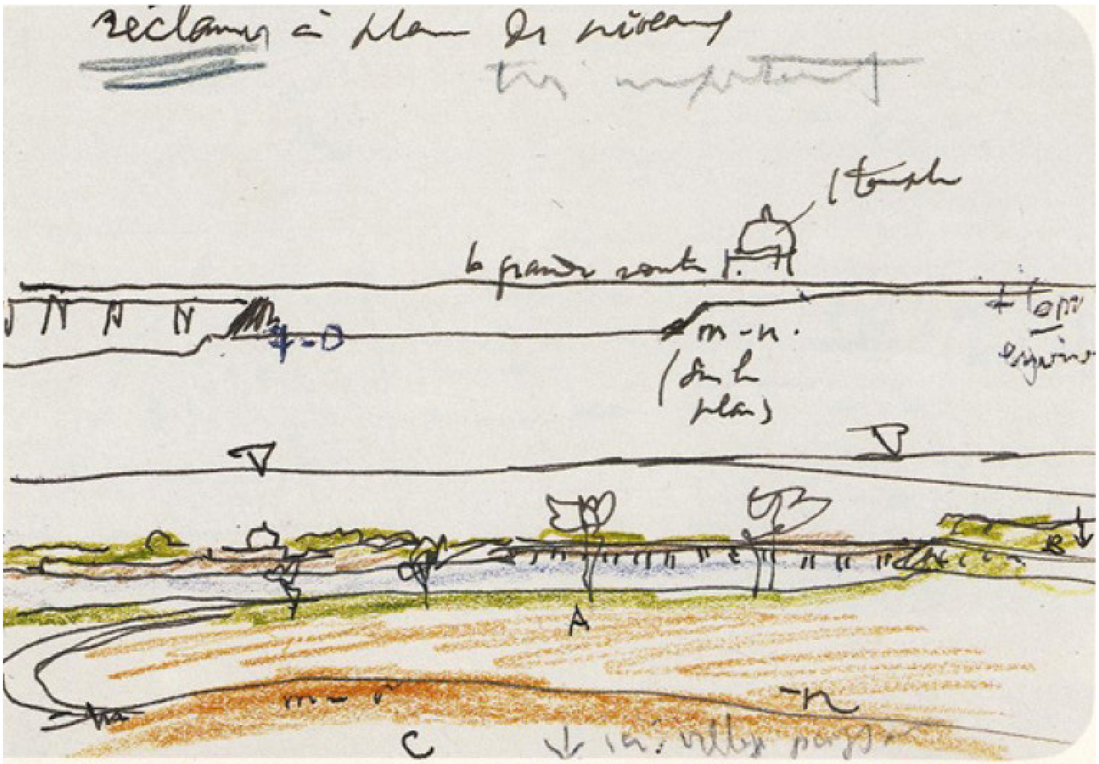


Fig. 18: Sketch by Le Corbusier on site of Ahmedabad Museum. Source: Le Corbusier (1981-82) Le Corbusier Carnets. Vol. 2

When analyzing the design evolution of the projects, it can be observed that Le Corbusier's proposals for the museum within the cultural centre incorporated similar cultural elements - the museum, miracle box and *theatre spontane*, in his designs for both the Ahmedabad[24] and Chandigarh museums. However, in the case of the Ahmedabad Museum only the museum and the theatre got executed, whereas at the Chandigarh Museum only the museum building was retained during execution.

Similarities between the museums can also be drawn on the building form and the extension of annexures from the main cubic body. The spiral circulation within the Ahmedabad Museum transforms into a fylfot or swastika shape, with extending exhibition spaces for archaeology, natural history and anthropology. Whereas, the annexures of the Chandigarh Museum takes on organic (temporary exhibition) as well as regular (guard room) forms. A third annexure, the auditorium, which at one stage of the design phase was an extension of the museum's main body, now stands apart from the main building. However, in the case of the Ahmedabad Museum, the execution of these annexure did not get realized.

23. Shoichiro Sendai, "Realization of the "Museum of Unlimited Growth" Without Façade in Ahmedabad by Le Corbusier," *Journal of Asian Architecture and Building Engineering*, 14:3, pp. 521-528. 2018.
24. Ibid.

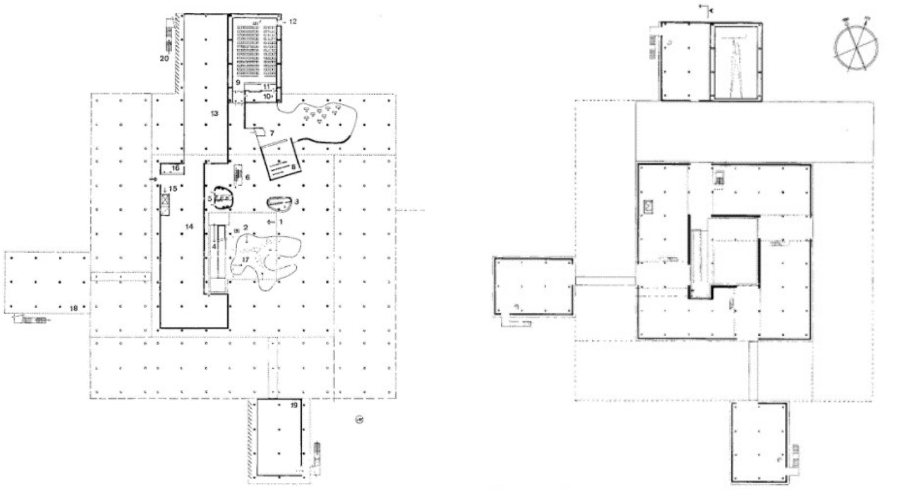


Fig. 19: Floor plans of Sanskar Kendra, Ahmedabad. (L) Ground floor plan, (R) First Floor Plan. Source: https://www.inexhibit.com/mymuseum/sanskar-kendra-city-museum-ahmedabad-le-corbusier/

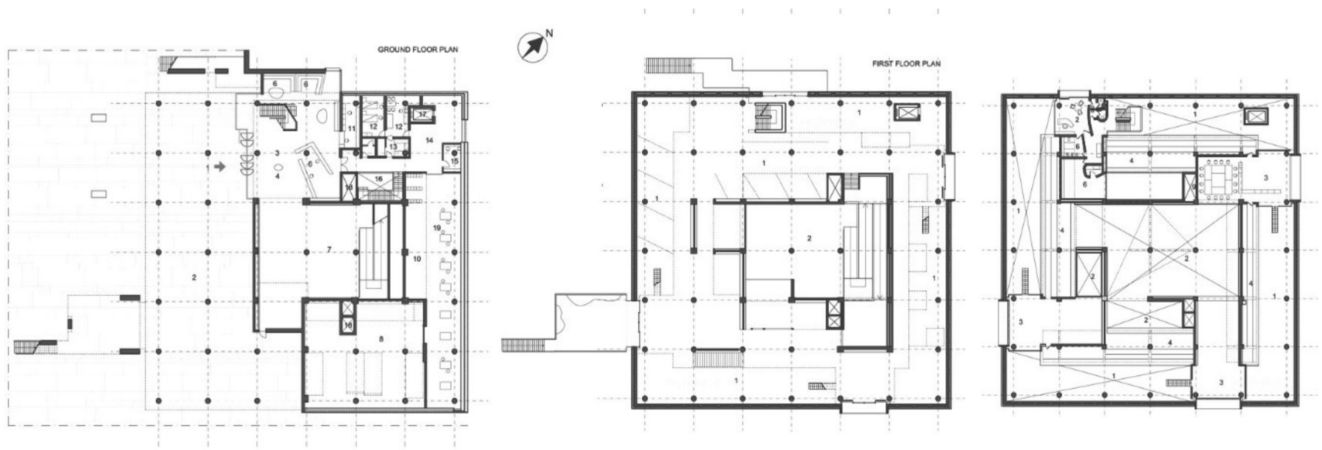


Fig. 20: Floor Plans of National Museum of Western Art, Tokyo. (L) Ground floor plan, (C) First Floor Plan, (R) Second Floor Plan. Source: http://archeyes.com/national-museum-western-art-tokyo-le-corbusier

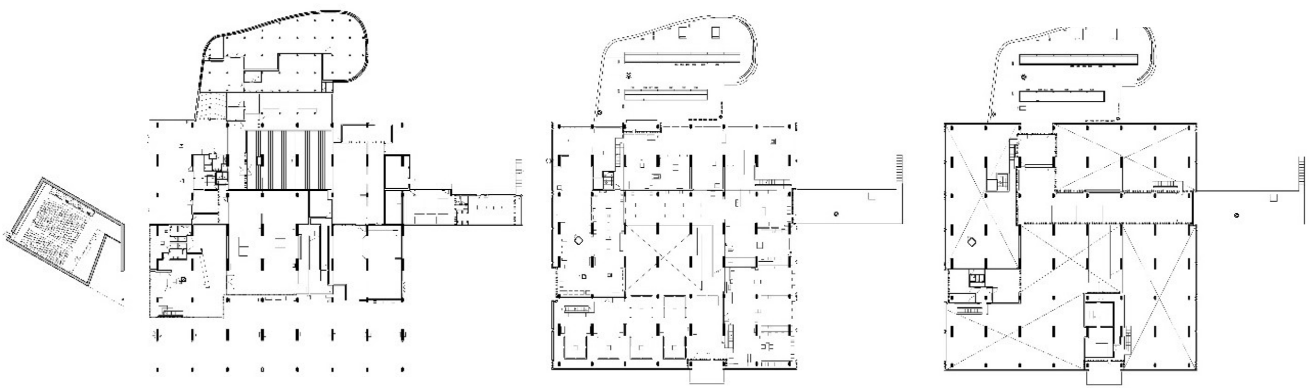


Fig. 21: Floor Plans of Government Museum and Art Gallery, Chandigarh. (L) Ground floor plan, (C) First Floor Plan, (R) Second Floor Plan. Source: DRONAH

At plan level, the museums have a central hall and slope that leads the visitor to the upper exhibition spaces raised up by pilotis. Deviating from the museum prototype, the central hall of the Ahmedabad Museum transforms into an open courtyard with a basin. In the case of the Tokyo museum, the double height of the main hall is illuminated by a glazed pyramid skylight intercepted by crossing concrete beams supported by a single column. In the Chandigarh museum, the double height central gallery is illuminated by a set of overhead clerestorey arranged parallel to each other.

Fig. 22: The central halls of the Three Museums. (L) Ahmedabad, (C) Tokyo, (R) Chandigarh. Source: FLC, DRONAH

While comparing the plans of the museums at Tokyo and Chandigarh, it shows half height spaces at the first floor level which form a swastika-like circulation pattern. At the outer ends of these linear spaces with lowered ceiling there are exits –visual exits through glazed fenestrations or physical exits to balconies. On the second floor they change into independent blocks which are accessed by narrow stairs. These stairs terminate at the second floor, and do not lead to the terrace level.

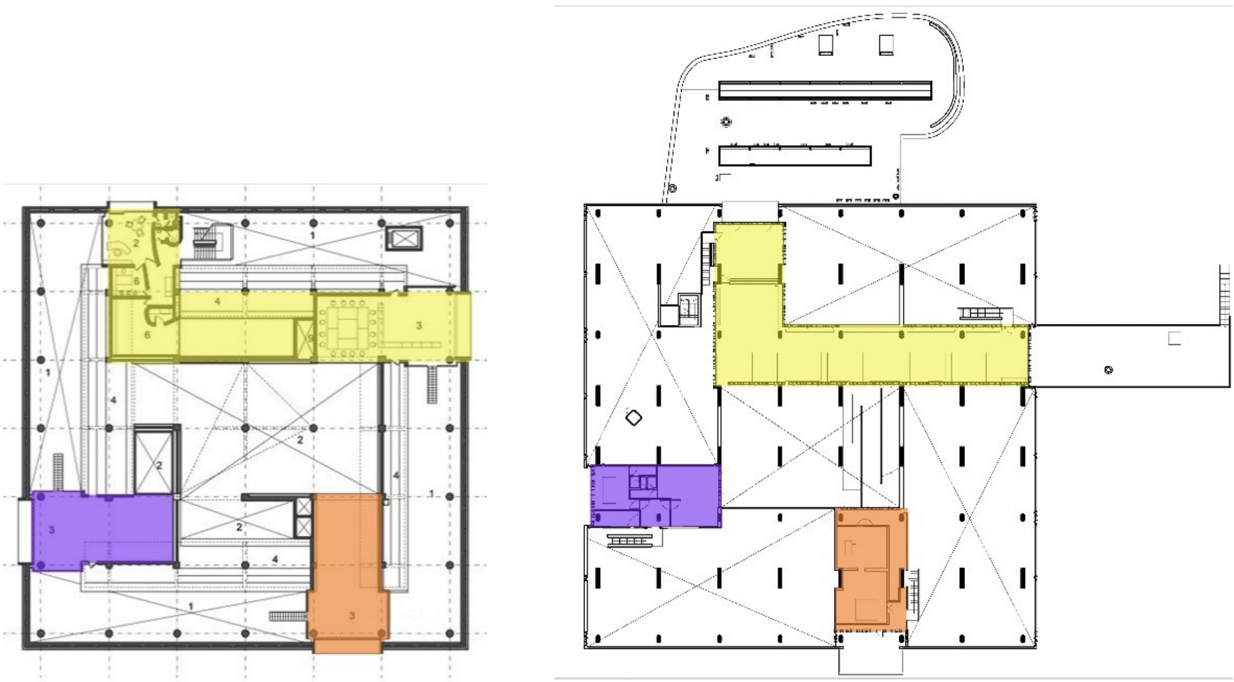


Fig. 23: Second floor plan with half height spaces. (L) NMWA Tokyo, (R) GMAG Chandīgarh. Source: DRONAH

Although serving separate functions, the concrete drains on the facades of the museums at Ahmedabad and Chandigarh seem to share similar design and proportion. The concrete channels at Ahmedabad Museum were designed to be filled with earth for growing vegetation that cover the façade. Whereas in Chandigarh, these channels collect terrace runoff and drains into the water basins at ground level. The sculptural gargoyles are seen in both Ahmedabad and Chandigarh, draining the terrace rainwater into the water basins below. These models for roof drainage seem to be absent in the design for the Tokyo Museum, suggesting that these may have been specific designs to suit the tropical climate of India.

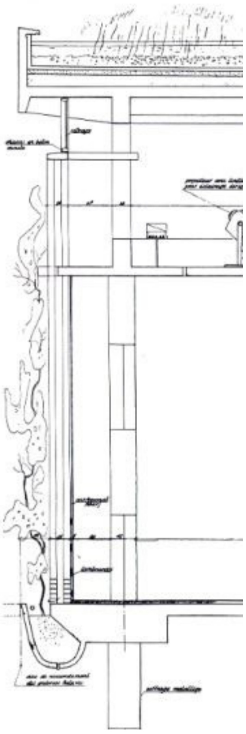



Fig. 24: Concrete channel filled with earth to grow vegetation, Ahmedabad. Source: FLC Archive

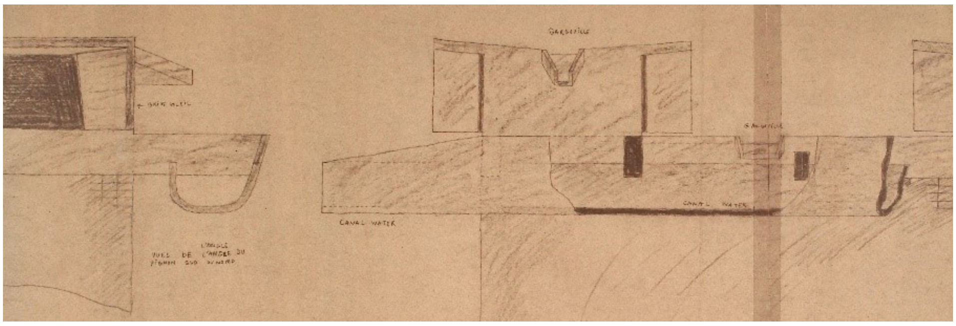



Fig. 25: Concrete channel drains runoff from roof into basin, Chandigarh. Source: FLC, DRONAH

The earlier designs of Ahmedabad Museum (1952-52) show devices for natural lighting on the roof similar to those of the museums at Chandigarh and Tokyo. However, these were abandoned to accommodate a roof garden, calling for the employment of artificial lighting for the interiors which were absent in the museum prototype. Le Corbusier also conceived roof gardens in the Tokyo and Chandigarh museums. However, they were not made functional. The transformation of the prototype also adopted ventilation on the façade. All three museums share similar strip windows for illumination which was an inherent tool from Le Corbusier's design portfolio.

The three museums built on parallel principles show similarities in their architectural details like the staircase railings, pivoting doors, etc. The use of double brick wall with cavity for thermal modulation is seen in both Ahmedabad and Chandigarh museums, again suggesting specific designs to suit the tropical climate of India.

It can be observed that the deviations in the realized projects from the prototype responds to the specificities of the project sites. At the museum in Tokyo, *katsura-hama*, green and grey pebbles were embedded into the concrete of the exterior wall and *himeko-matcu* pine wood grain of the formwork was imprinted on its columns. At the museums in Ahmedabad and Chandigarh local Indian red brick tiles were used for the facade. The unfinished concrete surface bears clean lines formed from the joints of the sheet metal formwork used. They served a more functional purpose than one of aesthetics.[25]

The transformation of the prototype for "Museum of Unlimited growth" as seen in the three museums suggest a balanced relationship between idealization and localization.

2.4 Modern Museums in India

The National Museum in New Delhi established by the Maurice Gwyer Committee in May 1946, began the post-independence modern museum movement in India. The building of the National Museum was designed by the architect Ganesh Bikaji Deolalikar and the foundation stone was laid by Prime Minister Jawaharlal Nehru on May 12, 1955.

The National Gallery of Modern Art in New Delhi was another post-independence initiative of Modern India. The building was designed by Charles G Blomfield and his brother Frances B Blomfield as a residence for the Maharaja of Jaipur in 1936 and was also called the Jaipur House. The butterfly-shaped building with a central dome and red sandstone bands reflects the Indo-British style following precedents set by Lutyens' design for the capital. The second phase of the design commissioned in 1987 to the TEAM architects to design a new wing to the existing gallery saw the application of a vocabulary in direct dialogue with the existing colonial Jaipur House.

At the same time, the Jehangir Art Gallery, designed by Durga Bajpai was inaugurated in 1952. The concrete structure with relief stone cladding has a rather bland façade, except for a large wavy concrete cantilevered canopy at the entrance. The design speaks for the modernist ideas emerging in India at the time.

Charles Correa's National Crafts Museum designed in 1975, displays a revival of the vernacular, while

25. I. Chin, "Le Corbusier's Musée à croissance illimitée: A Limitless Diagram for Museology." (Le Corbusier, 50 years later International Congress, Valencia, Spain, November 18-20, 2015).

Fig. 26: National Gallery of Modern Art.
Source: https://theculturetrip.com/asia/india/articles/the-history-of-the-national-gallery-of-modern-art-in-1-minute/

Fig. 27: New wing of the National Gallery of Modern Art.
Source: http://indianartblog.blogspot.com/2009/03/national-gallery-of-modern-art-delhi.html

Fig. 28: Indira Gandhi National Centre for the Arts.
Source: https://in.pinterest.com/fella_homes/top-20-cultural-and-historical-places-in-delhi/

maintaining a modern concept following an orthogonal grid with lofty internal spaces and open and semi-open passages covered with traditionally tiled roofs. The competition for the design of the Indira Gandhi National Centre for the Arts (IGNCA) was held in 1986. The winning scheme by Ralph Learner which eventually got executed displayed a neo-classical approach.

The development of the modern museums in India demonstrates a preference for architectural style reminiscent of the colonial period. The eventual shift in modernism shows the desire to follow abstraction of traditional forms and adaptation of the modernist ideas to the Indian context.

2.5 Government Museum and Art Gallery, Chandigarh

2.5.1 Context and Physical Setting

The regional context of the Chandigarh city indicates a strong relationship between the natural systems around it and the green corridors woven within its urban fabric, as is evident in the image below. The site chosen for the Museum was additionally endowed with the presence of water in the form of the natural stream, N. Choe flowing down from the forested mountains in the far north-east. The Museum faces the mountains and is positioned on a relatively higher ground that gently slopes towards the stream, creating a beautiful park setting for the Museum – the 'Leisure valley'.

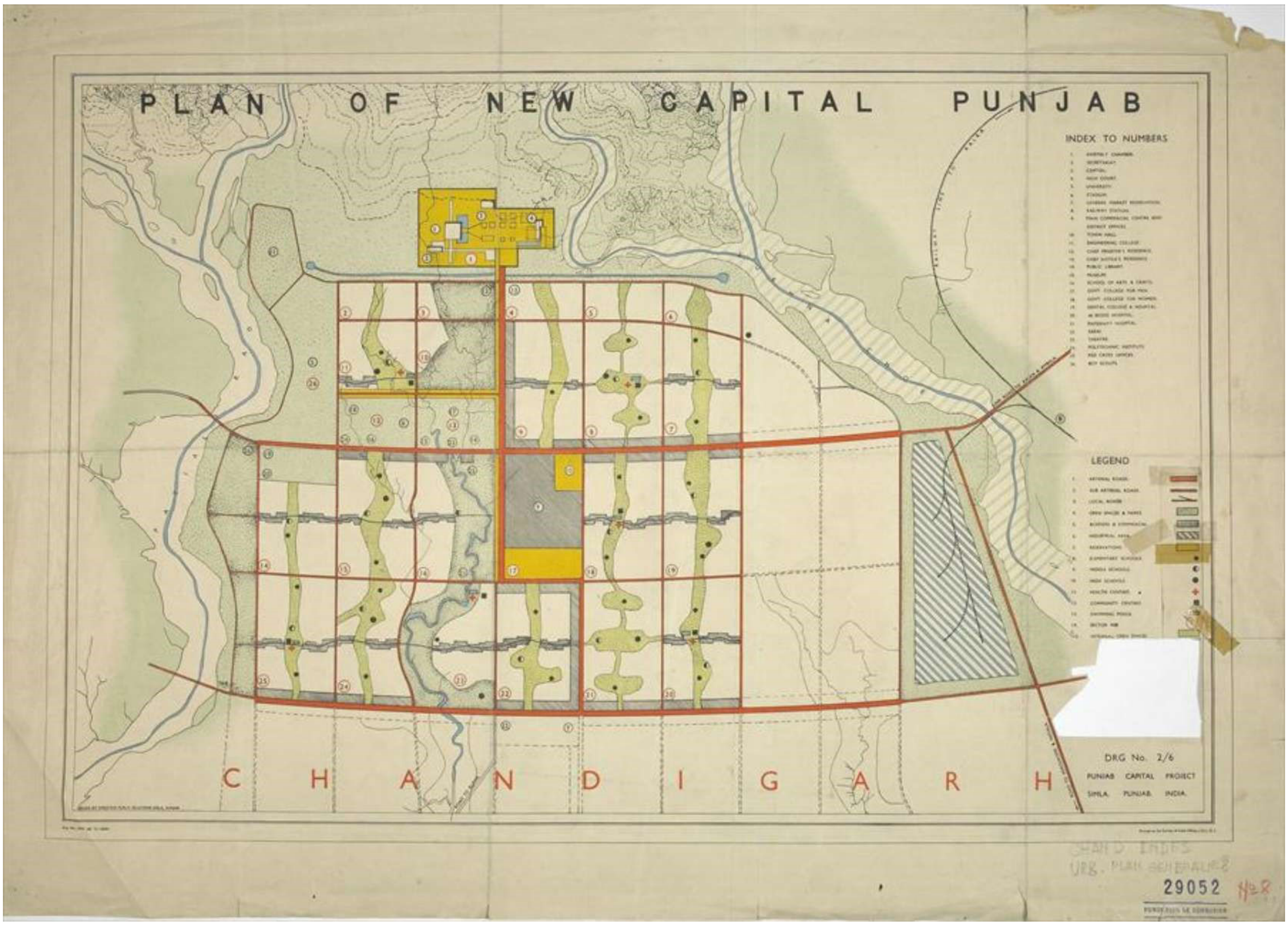


Fig. 29: Proposed plan of Chandigarh. Source: FLC Archives

The Cultural Centre of Chandigarh is spread over a seven-hectare linear strip of land, adjacent to the Leisure valley in Sector 10. The Government Museum and Art Gallery is situated at the centre of this cultural belt.[26] It is located on the Jan Marg (Sector-10) with its entrance from the Leisure Valley side. Defining the Cultural Core of Le Corbusier's plan for the City, the Museum and Art Gallery sits at the cross axis of the Principal V2s The Madhya Marg and the V2 Capitol. The Museum differs from other museums in the country as it is a part of the larger urban project designed by Le Corbusier, and not as a singular object imposed into its cultural landscape.

26. Sarbjit Bahga, Surinder Bahga and Yashinder Bahga, *Modern Architecture in India Post-Independence Perspective*, (New Delhi: Galgotia Publishing Company, 1993).

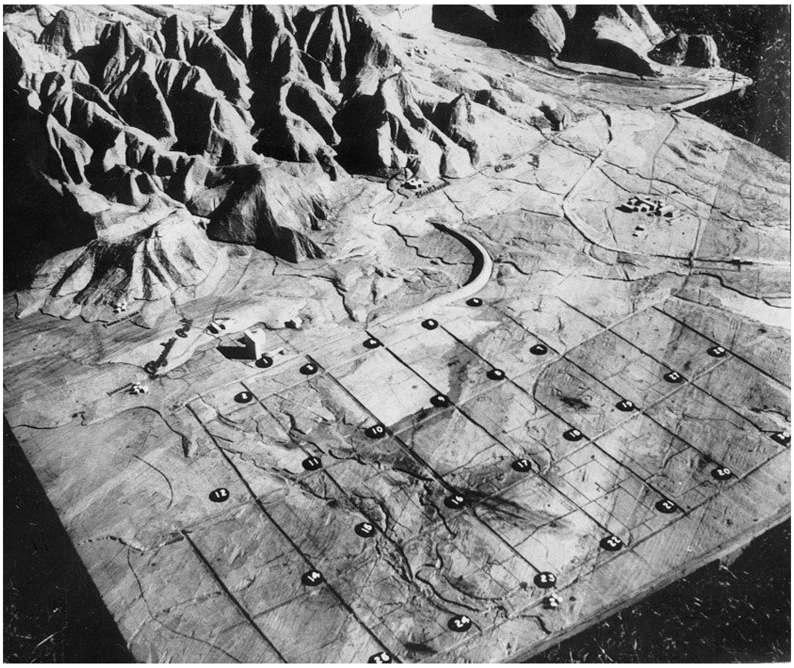


Fig. 30: Model of Chandigarh. Source: FLC Archives

The Museum takes its place in Le Corbusier's global project for a "Cultural Centre" with a – i. "Miracle Box" [currently the Museum of Natural Sciences], ii. Temporary Exhibition [currently Chandigarh Architectural Museum], iii. Museum and Art Gallery, iv. "*Theatre Spontane*" [does not exist on site], and v. School of Art [currently Government College of Art]. Envisaged as a vehicle for transmission of knowledge in the Third Five Year Plan of India and the National Education Policy, the Government Museum and Art gallery continues to serve as a unique cultural and historical resource for the region and beyond.

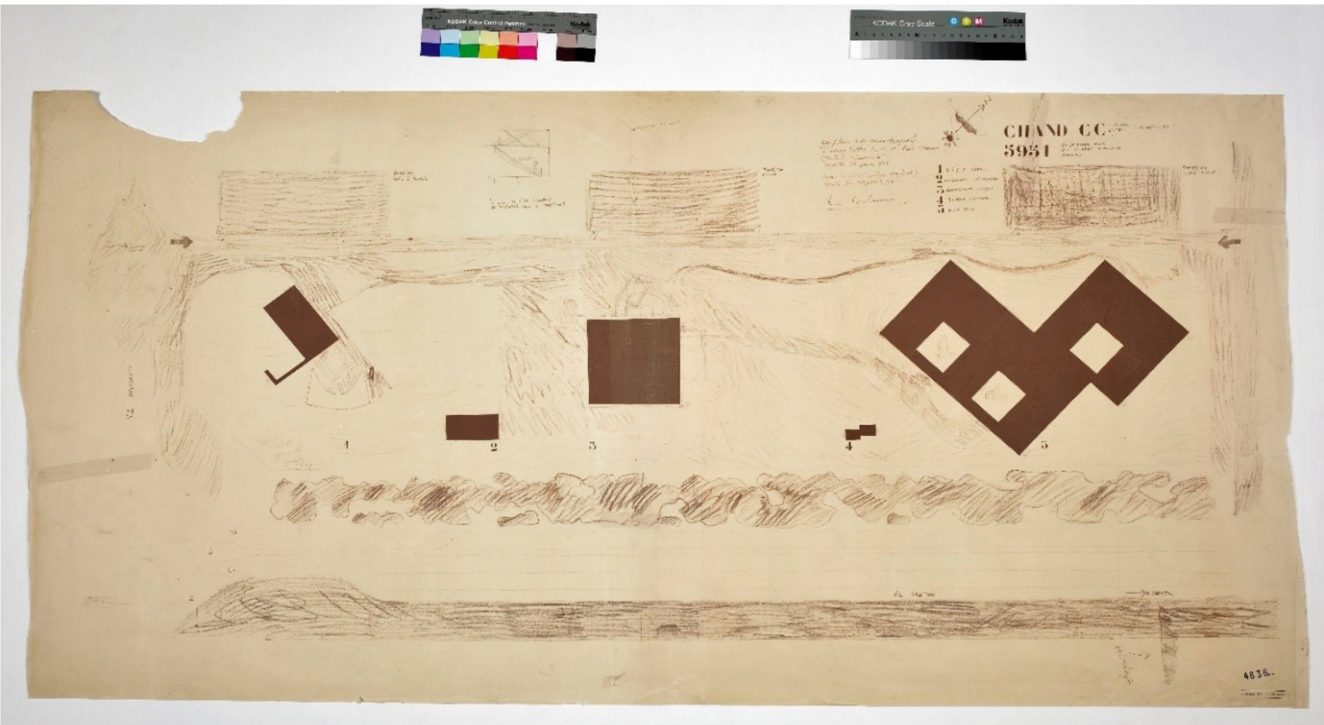


Fig. 31: Cultural Core of Chandigarh City as designed by Le Corbusier. Source: FLC Archives

The Chandigarh Museum, since its initiation, was conceived as a tool for propagating knowledge. It was to provide a glimpse into the history of India in a visual form and was meant to be of educational value as well as art value. Divulging the people to the highest achievements of the past in arts and crafts would integrate progressive thinking within the community. By virtue of the significant building, the important collection, as well as the new type of presentation, the Chandigarh Museum was anticipated to be hailed as an outstanding museum institution. Envisioning the tourism potential of Chandigarh, it was believed that the Museum would add to the city's importance as a tourist attraction. [27]

27. Doc. No. 24, The Chandigarh Museum, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

Le Corbusier was aware of the importance of a museum as means of transmitting knowledge, attracting people and vitalizing the city. In the present-day more than ever, museums aim to have a larger resonance.

2.5.2 Government Museum and Art Gallery

The proposal for the Chandigarh Museum faced many obstructions as early as its design stage. The Government had decided to purchase the Moti Bagh Palace in Patiala in 1957, considering which the Museum at Chandigarh was deemed unnecessary. At one point of time it was also considered that the funds allotted for the Chandigarh Museum can be utilized instead to integrate galleries within the School of Arts.[28] However, the unanimous decision by the High Level Advisory Committee to undertake the construction of a Museum for Chandigarh was taken on 10 May 1960.[29] The design of the building was presented and explained to the High Level Advisory Committee with the help of a wooden model because Dr. Randhawa was convinced that it would be difficult for laymen to appreciate the buildings from mere plans and drawings.[30] The plan of the museum prepared by Le Corbusier was finally approved by the Museum Advisory Committee on 9 November 1962. The building details were prepared by Mr. Pierre Jeanneret and Mr. M.N. Sharma, assisted by Mr. S.D. Sharma. The building was constructed under the guidance of Mr. Kulbir Singh, Chief Engineer Capital Project from 1962 to 1968. He was assisted by Mr. G.S. Toki, Superintendent Engineer, and Mr. Sarvshri Bhagchandani and Mr. Satinder Singh, Executive Engineers.[31]

The construction of the Government Museum and Art Gallery began in 1962. However, the construction of the museum ran into several difficulties at a number of stages. In 1962 an emergency was announced when India was attacked by China, and many construction schemes were put on hold due to lack of funds. The work on site moved at a very slow pace. By February 1964 only the foundation pillars were erected.[32] In 1965 the work progress was impeded owing to acute scarcity of cement, pushing the completion of the project to the end of financial year 1966-67.[33] The construction of the main building was also to include paving the parking area, levelling the site and building the compound wall around the cultural zone.[34] The gate for the museum was made to order at the Nangal Workshop.[35] It was decided from the initiation of the building that the open spaces towards the south-west of the building were not to be converted into rooms, and should instead be used for display of sculptures and for holding exhibitions of sculptures. [36]

In his letter to Dr. Randhawa in 1967, Mr. B.N. Goswami brings to his attention that the museum was being referred to as ‘Chandigarh Museum and Picture Art Gallery’ on road signs, invitations etc. He

28. Doc. No. 468, Memorandum regarding the construction of a Museum and Art Gallery at Chandigarh, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1539A
29. Doc. No. 23, Speech by Mr. M.N. Sharma, Chief Architect at the time of inauguration of the Museum on 06.05.1968, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1621
30. Doc. No. 561, Letter from Dr. M.S. Randhawa to Mr. B. Vohra dated 09.05.1961, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1539A
31. Doc. No. 102, Welcome address by Shri Kulbir Singh, Chief Engineer Capital Project at the inauguration of the Museum on 06.05.1968, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1621
32. Doc. No. 221, Letter from Mr. Kulbir Singh to Dr. Randhawa dated 01.02.1964, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1552
33. Doc. No. 284, Letter from Mr. Kulbir Singh to Dr. Randhawa dated 14.05.1965, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1554
34. Doc. No. 1, Minutes of a Meeting held on 05.11.1966, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
35. Doc. No. 10, Proceedings of the Meeting of Museum Advisory Committee held on 16.01.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
36. Doc. No. 11, Proceedings of the Meeting of Museum Advisory Committee held on 16.01.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

mentions that the expression 'Picture Art Gallery' did not sit well with him and suggests that the museum should be simply called 'Chandigarh Museum' or "Chandigarh Museum and Art Gallery'.[37] Subsequently the museum took the name 'Government Museum and Art Gallery Chandigarh'.

In 1967 Dr. M.S. Randhawa invited Dr. Grace Morley, Adviser on Museums with the Government of India's Ministry of Education, to advise the Museum Committee on hiring staff for running of the museum and suggesting their required qualifications and appropriate remunerations. On her suggestion to providing a trained chemist and assistant for basic preservation of artefacts, Mr. Sunil Sarkar insisted that a dark room and laboratory should be accommodated in the museum's design.[38]

The Chandigarh Museum represents Le Corbusier's most successful museum buildings, in terms of architectural creativity and aesthetic success. However, after the completion of the construction, the museum authorities were presented with the problem of making it work as a museum. The undistinguished spaces of large expanse within the museum posed as a problem for the installation of exhibition. They critiqued that Le Corbusier was thinking primarily of exhibition of large scale paintings and sculptures when designing the spaces. However, now they have in hand some fairly large sculptures, small scale heads in stucco and terracotta and stone architectural fragments which are not large and have small scale details. The miniatures too required closer scrutiny. The inevitable conflict of attention between the importance of the monument and the importance of the collection to be exhibited was also of concern to the museum professionals. The team concerned with setting of the exhibition within the museum believed that the success of the museum would depend on the sensitivity to the material as well as providing them effective presentation while being sensitive to the scale of the building.[39]

The museum was inaugurated officially by Dr. A.M.D. Rozario, Joint Secretary on behalf of the Ministry of Education on 6 May 1968. The canteen was inaugurated later in June 1968. After the inauguration, Dr. Randhawa requested that the Chandigarh Museum should be declared as institution of national importance and should be taken over by the Ministry of Education of the Government of India.[40] However, presently the museum continues to function under the Board of Advisors.

2.5.3 Museum Collection and Provenance

The journey of the museum collection began with the partition of the Indian sub-continent in 1947, when Pakistan was created. All types of assets were divided along with the division of the land. Subsequently, the priceless collection of the central museum at Lahore was also divided. One of the museum's invaluable artefact was a life size, red sandstone Gandhara image of the Buddha in a sitting posture, with his body emaciated due to fasting. Following the division, India received 40% of the museum collection. However, the Gandhara sculpture, and miniatures of the Mughal, Basholi and Kangara schools, the photographs of which were not reproduced, were not divided and hence, went to the Pakistan side of the division. Similarly, finds from the Indus Valley at Mohenjo-daro and Harappa also were not divided since the sites were now within the newly formed Pakistan region. [41]

37. Letter from Mr. B.N. Goswamy to Dr. Randhawa dated 14.10.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
38. Doc. No. 23, Minutes of a Meeting held on 24.02.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
39. Doc. No. 19-20, The Chandigarh Museum, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
40. Doc. No. 127, Letter from Dr. Randhawa to Dr. Rozario, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1621
41. Newspaper article (source unknown)

When India received her share of the collection in 1949, a dedicated storage for the exhibits had not been decided. They were first housed in Amritsar, and then in Shimla, the temporary capital of Punjab. When Chandigarh was declared the new capital of Punjab in 1954, there was still no room for the exhibits. The collection was then housed at the Moti Bagh Palace in Patiala. At this stage, Dr. M.S. Randhawa invited Dr. W.G. Archer, Keeper of the Indian Section at the Victoria and Albert Museum of London, to evaluate the suitability of the Moti Bagh to house the collection. Dr. Archer's report stated that the collection of miniatures is 'one of the greatest' in India and it reveals Punjab's supreme contribution to Indian art. The collection of Gandhara pieces, small-scale stucco and terracotta heads, stone architecture fragments, etc. also represents quality and importance equivalent to the miniature collection. However, Dr. Archer declared the palace unsuitable to house the collection as it was designed as a residence and that the large number of windows and fireplaces severely limited the display surface. Subsequently, the Punjab government decided to provide Chandigarh with a museum building of its own and included it in the III five year plan of Chandigarh Capital Project scheme.[42] In 1962, for an interim period, the collection was installed in improvised studio spaces, corridors and verandahs of the newly completed Government Art College, until the inauguration of the Chandigarh museum in 1968.[43]

The collection at the museum consisted of mainly Gandhara sculptures, around 619 of them, found at various sites in areas now in Pakistan. The museum also had Jain and Hindu sculptures in stone and bronze. A striking image of Hindu god Vishnu in stone was obtained from Fatehpur in Kangra. The museum is still credited for its rich collection of Gandhara sculptures.

Valuable additions were accrued to the Chandigarh Museum from the Patiala Museum's collection of arms. Over the years, Dr. MS Randhawa acquired Pahari miniature paintings still in possession of the Princely rulers of the Punjab Hill states. Some of the finest examples of Basolhi, Kangra, Chamba, Bilaspur, Kulu, Mandi, Guler, Sirmur schools of paintings from the Pahari area were acquired. A rich collection of Rajasthani, Mughal and Persian miniatures were also purchased for the Museum.

A large purchase programme for contemporary art was launched in 1962, which saw the acquisition of paintings, sculptures and works of graphic art to represent the art and artists of the country through the most distinguished examples. A small group of paintings of the Bengal school had come with the collection from Lahore. The works of some of the most eminent artists of India, including Amrita Shergill, S. Roerich, M.F. Hussain, Satish Gujral, Krishen Khanna, N.S. Bendre, Dhanraj Bhagat, K.K. Hebbar and Avinash Chandra were acquired for the museum.[44] By the time the complete collection was displayed in the current building designed by Le Corbusier, it was at par with the leading museums of North India.

2.5.4 Key Players

Discussed below are few individuals who played an important role in contriving the idea for the Government Museum and Art Gallery in Chandigarh, its conceptualization and design, implementation of the construction and its interiors, amassing and composing the museum collection and later continued to be involved in the management of the Museum.

42. Doc. No. 33, Letter from Dr. M.S. Randhawa to Mr. P.N. Kirpal dated 18.04.1967, Personal collection of Dr. M.S. Randhawas gifted to the Museum in 1968, Accession No. 1524
43. Doc. No. 21-23, The Chandigarh Museum, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
44. Doc. No. 174, The Chandigarh Museum, Article written by Mr. B.N. Goswamy for the Tribune, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

Le Corbusier

After decades of promoting his revolutionary architectural ideas to industrialized nations in Europe and America and rendering unsuccessful in his endeavours, India's offer to commission the design of Chandigarh city was for Le Corbusier an opportunity to realize his utopic dream.[45] Le Corbusier's architectural expression of geometrical fundamentalism and peculiar artistic quirk exploded the previously set paradigm of Indian modernism and broke away from the encumbrances of the colonial past. Le Corbusier's architecture for Chandigarh seems to be a global export of all his previously formulated ideas and theories with minimal modifications to respond to the Indian context. Le Corbusier's genius as an architect and planner is mostly interpreted through the adaptation to changing context and by the use of new material technologies laced with traditional or vernacular undertones.

The extent of Le Corbusier's expression has been criticized extensively for being personalized and staunch visions of the planner rather than the user. However, the urbanism promulgated by Le Corbusier's design for Chandigarh became a symbol of the nation's journey to building itself up from the shackles of colonialism. Le Corbusier's contribution to the development of Chandigarh and India was phenomenal and was of colossal historical importance. Dr.MS Randhawa suggested to the then Chief Minister of Punjab, Shri Ram Kishan, that Le Corbusier along with his cousin Jeanneret should be given official recognition for their outstanding work by honouring them with the title of 'Bharat Ratna'.[46]

Ratna Fabri

Ratna Fabri was a display artist and museologist who worked extensively with textile and ceramic mediums. She had worked on many prominent international projects – New York World's Fair 1964 and 1965, Handloom Pavilion 1955 and 1961 in the Indian Industries Fair, where her designs were well received. She was assigned by the Government of India to design and set up the Indian Pavilion for Expo 1967 in Montreal.[47] She was felicitated with the prestigious Padma Shri by the Government of India in 1970 in the Art field for her achievements.

Ratna Fabri sought out Dr. M.S. Randhawa to be involved in setting up the Government Museum and Art Gallery. Even before the work was commissioned to Mrs. Fabri, she insisted that this was serious work and unless one proceeded with proper scheme and designing ideas the project vision could not be achieved. She was greatly inspired by the building and the space, and believed it offered immense possibilities of creativity and full scope for imagination. Being a painter herself, she had great interest in working with the miniature paintings. She also believed that her familial connection to Punjab drew her to this project.[48] She expressed her keenness to work on the museum and showcase her expertise that she had amassed in 10 years of her experience in the respective field.

Ratna Fabri's vast experience in India and abroad gave her realistic insight into the role of modern museums in cultural upliftment of the community. She stated that a modern museum is a centre of civic pride and a vigorous and lively focus around which art and education are built up. World over enormous funds are spent to make museums lively and interesting, and to spread visual education that

45. Mohammed Imran Uddin, "Orientalism, Chandigarh and Le Corbusier" (Research paper, Modern Architectural History, University of Sydney, June 2016).
46. Doc. No. 288, Letter from Dr. M.S. Randhawa to Shri Ram Kishan Ji dated 01.09.1965, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1554
47. Doc. No. 47, Letter from Mrs. Ratna Fabri to Dr. M.S. Randhawa, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
48. Doc. No. 116-117, Letter from Mrs. Ratna Fabri to Dr. M.S. Randhawa dated 06.07.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

schools and colleges cannot impart. Museums assist educational institutions by offering visual demonstrations and lectures which are more valuable. “They are no longer dumping grounds and sleepy old places filled with curios”. She believed her work as the designer for the Museum was to create visual knowledge and try to build up an educational system and presentation for the public to learn.[49]

“There is an old-fashioned idea that a Museum is a dust-laden repository and store-house in old, broken stones, so-called ‘curios’ and other oddities, forgotten and allowed to decay. In fact, a number of reports about the state of Museum in India has emphasized that this is precisely what has been wrong with Indian Museums; whilst in advanced countries museums have become fascinating and thrilling places of visual education and broad cultural uplift.”- **Ratna Fabri**[50]

Ratna Fabri was awarded the project to design the display and exhibition of the Government Museum and Art Gallery in 1967. She provided prototypes of each item of display and furniture that she designed and once they were approved, they were then manufactured in Punjab.[51] She personally supervised all works and assembly of display and furniture by the carpenters. She spent hours on site with her staff to ensure work was done on time and the product was of the highest quality. Ratna Fabri’s work and efforts were highly appreciated and acknowledged at the time of the inauguration. According to Dr. M.S. Randhawa, this was better that the display at the National Museum and stated that Chandigarh now housed the best museum in India.

Dr. M.S. Randhawa

Dr. Randhawa served as the Adviser (Resources) at the Planning Commission, New Delhi and as the Chairman of the Advisory Committee of the Museum and was directly involved in all decisions regarding the Museum since its initiation. In 1966, when Chandigarh became a Union Territory, Dr. Randhawa was appointed as Chief Commissioner of the Union Territory of Chandigarh. Using his powers at the newly appointed post, he was able to push the construction work at the museum, which was at that time struggling to progress. In 1962, when the Indo-China war broke out, the Punjab Government decided to not proceed with the construction of the Museum. However, Dr. Randhawa persuaded the then Chief Minister, Sardar Pratap Singh Kairon that Chandigarh would be incomplete without a museum and will be a crucial blow to the cultural life of the people of Chandigarh. His commitment and dedication to the project, his contribution to the museum and in general for the welfare of the arts industry and artists was invaluable.

Dr. Randhawa was involved in the planning and design of the museum from its initiation. He had always been vocal of his opinions, and clearly told Le Corbusier that he did not like his museum in Ahmedabad. Le Corbusier accepted his criticism and conceded to many modifications suggested by Dr. Randhawa. Throughout the planning process he shared his viewpoints and ensured they were conveyed and incorporated. He also shared with the team references from his many visits to other museums around the world to be considered while designing.

Dr. Randhawa’s contribution in enriching the museum collection is immeasurable. He put in immense

49. Doc. No. 5, Untitled letter signed by Mrs. Ratna Fabri, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1621
50. Doc. No. 116-117, Letter from Mrs. Ratna Fabri to Dr. M.S. Randhawa dated 06.07.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
51. Doc. No. 69, Proceedings of Museum Advisory Committee meeting dated 15.09.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

personal effort in planning and collecting exhibits to augment the museum collection. He researched on Kangra paintings and made numerous tours to the Kangra valley in search of suitable paintings. He also collected Rajasthani and contemporary paintings for the museum. Being the President of the All India Fine Arts and Crafts Society, gave him access to all the exhibitions held in the premises of the society and acquaintance with the leading artists of the time.[52]

His personal intervention and supervision in the setting up of the Museum bore fruit when the museum was well appreciated by all during its inauguration. He took great pride in his efforts and was elated when the Chandigarh museum was appreciated the most in comparison to the three museums by Le Corbusier.

52. Doc. No. 34, Letter from Dr. M.S. Randhawa to Mr. P.N. Kirpal dated 18.04.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

3. CONCEPT

3.1 Vision of Le Corbusier for Government Museum and Art Gallery

"Let us imagine a true museum, one that contained everything, one that could present a complete picture after the passage of time, after the destruction by time (and how well it knows how to destroy! So well, so completely, that almost nothing remains except objects of great show, of great vanity, of great fancy)." - **Le Corbusier**, about "unlimited growth" Museum, 1939[53]

In the design for the Government Museum and Art Gallery, Le Corbusier brings to the table an amalgamation of various architectural design principles and concepts developed by him over the course of his career.

The Government Museum and Art Gallery is one of the last public buildings designed by Le Corbusier for the Chandigarh cultural complex. The Museum was also the last to witness the "unlimited growth" concept developed by him for nearly 35 years. In the last decade of his life, the modernism Master designed the "Three museums"- the first in Ahmedabad, then in Tokyo and last in Chandigarh. They follow similar design essentials that characterize Le Corbusier's *Musée à croissance illimitée*:

- Arrangement of galleries around a central cubic courtyard
- Galleries surrounding the courtyard arranged in a square spiral
- Building rested on pilotis
- Access under the museum from the centre of the spiral
- Museum building without façade - Faceless
- Space articulated within 3 levels
- Skylight illuminating the interior galleries independent of the façade

Ironically, none of the three museums are physically unlimited. However, one can see the concept of spatial arrangement of galleries around a central courtyard reminiscent of the swastika pattern dictating circulation from the central court towards the building perimeter. Of the "Three museums", Chandigarh is certainly the most brutalist one with its sculpted terrace elements. The natural lighting system is also more elaborate than the other two museums designed by Le Corbusier.

Le Corbusier successfully incorporates elements from the "5 points of architecture' in the design for the Museum. The grid of square and round concrete pilotis elevates the mass of the building off the ground. The interior spaces articulated within the three levels are devoid of load-bearing internal partitions, allowing free and unrestrained use of the space. The open plan allows space to flow among the composition of indoor volumes. Bearing in mind the *promenade architecturale*, the sequence of movements takes the visitor up the ramp which bridges the central court to the galleries in the upper level and offers an experiential circulation within the interior spaces.

In the Museum, Le Corbusier applies his *Dom-ino* concept, separating structure from the enclosure with the skeletal concrete framework and infill of brick masonry. The concrete frame construction frees the façade from any structural role, setting the façade free from structural constraints.

53. I. Chin, "Le Corbusier's Musée à croissance illimitée: A Limitless Diagram for Museology."

The ribbon of glass, *fenêtre en longueur,* puncturing the free façade extends across the length of the building. They are set at a level above human eye level, cutting the visitor's contextual connection to the outside, but allows the entry of light into the indoors.

Fig. 32: Brise soleil as fenêtre en longueur along the length of the facade.

For the purpose of achieving sunlight flooded interiors Le Corbusier also implements *pan de verre* as undulatory fenestrations in his design for the Museum. The windows are positioned entirely in the shade – clerestorey set within the *brise soleil* and undulatory windows inside the pilotis area and within recessed walls of the exterior façade.

Fig. 33: Pan de verre represented as undulatory windows.

Le Corbusier's design proposal for the museum (the proposals in 1961 and 1962 both), shows his clear intentions to incorporate balconies overlooking the lawn and the site environs. He incorporated roof gardens in his designs as a compensatory recovery of the green area consumed by the built up area of the building. The 1962 drawings show the terrace of the workshop proposed as a terrace garden with sculptures. Regrettably, only skylights illuminating the galleries exist on the terrace from the original vision.

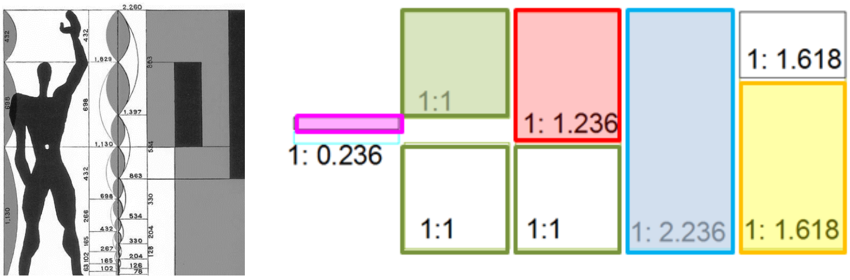


Fig. 34: Graphic representation of the Modulor. Source: https://www.researchgate.net/figure/Figura-4-Modulor-Le-Corbusier-1948-Corbusier-1998_fig1_268221925

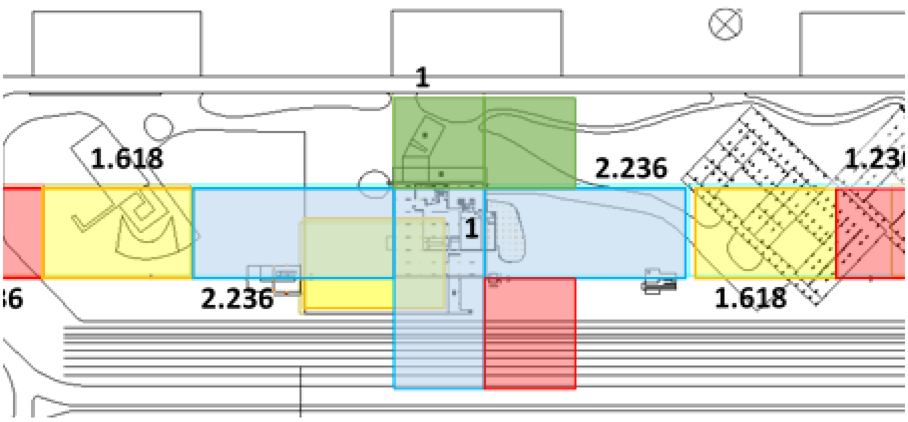


Fig. 35: Application of Modulor in site geometry. Source: DRONAH

Through the use of *Modulor*, Le Corbusier brings ergonomics into the architectural design of the Government Museum and Art Gallery. The anthropometric scale of proportions devised by him has been employed in defining the visual appearance of various design elements in the museum. The flooring pattern of the piazza, the undulatory glazing, the internal heights of the different levels, etc. all are designed as per the proportioning system.

Fig. 36: Application of architectural polychromy in the Museum.

Le Corbusier's work also demonstrates his knowledge about the spatial and psychological effects of colour. He employed architectural polychromy in the Government Museum and Art Gallery to integrate colour harmony as a design tool. The painted wood wool ceiling panels and internal doors in contrasting bold primary colours breaks the monotony of the concrete surface of the ceiling and walls respectively.

Fig. 37: Palette of 63 architectural colours in Le Corbusier's colour system. Source: https://www.lescouleurs.ch/en/the-colours/63-colours/

3.2 Landscape

3.2.1 Site Planning

The Government Museum and Art Gallery was planned as a part of the green belt that was conceived as the lungs of Chandigarh City. The Leisure Valley lies on the eroded bed of a seasonal stream. The Museum is positioned as a macro project for a "Cultural Centre" in the city plan which houses Chandigarh's Cultural Institutions, like the Museum of Architecture, College of Arts and Museum of Natural Sciences. Collectively they form a composition of simple volumes, squares and rectangles along the Leisure Valley.

The Museum sits almost at the centre of the contoured site that gently slopes towards the natural stream N. Choe in the adjoining valley. A close inspection of the site reveals that the highest contour is at 1154* towards the north-east segment of the site (datum is not known) while the lowest is at 1138* on the north-west, with a slope as steep as almost 20%. The natural course of storm water run-off towards the stream is clearly visible in this 'valley' that indeed forms a part of its watershed. The College of Arts is located in this area. However, the extent of grading in the natural landform is difficult to envision now. The museum is located at an elevation of 1150-1149* at around the centre of the site where the slope is gentler and almost plain with an approximate 2% slope. Areas in the immediate vicinity reveals a 3-3.5% slope towards south-west and average 10% slope towards north-west moving away from the building. From hydrology and drainage viewpoint, the positioning of the building certainly qualifies to be an example of best practice in terms of site planning, signifying Le Corbusier's superlative aptitude at site planning.

This penchant for 'order' directs the site planning approach and significantly, indicates the following two layers:

i. The underlying geometry comprising of the applied *Modulor* - 'grid of proportions' that has been used to organize elements on site, particularly the museum block.

ii. The visible spatial articulation giving emphasis to natural elements 'sky, space and trees' as well as mirroring the curvilinear natural flow of the stream in the alignments of the pedestrian walkways within the site.

* Irrespective of units as there is lack of clarity on the units of the mentioned contour levels in the referred archival drawings. Only to be used to understand the concept in principle.

Fig. 38: Cultural Centre of Le Corbusier's Chandigarh City plan. Source: FLC Archives

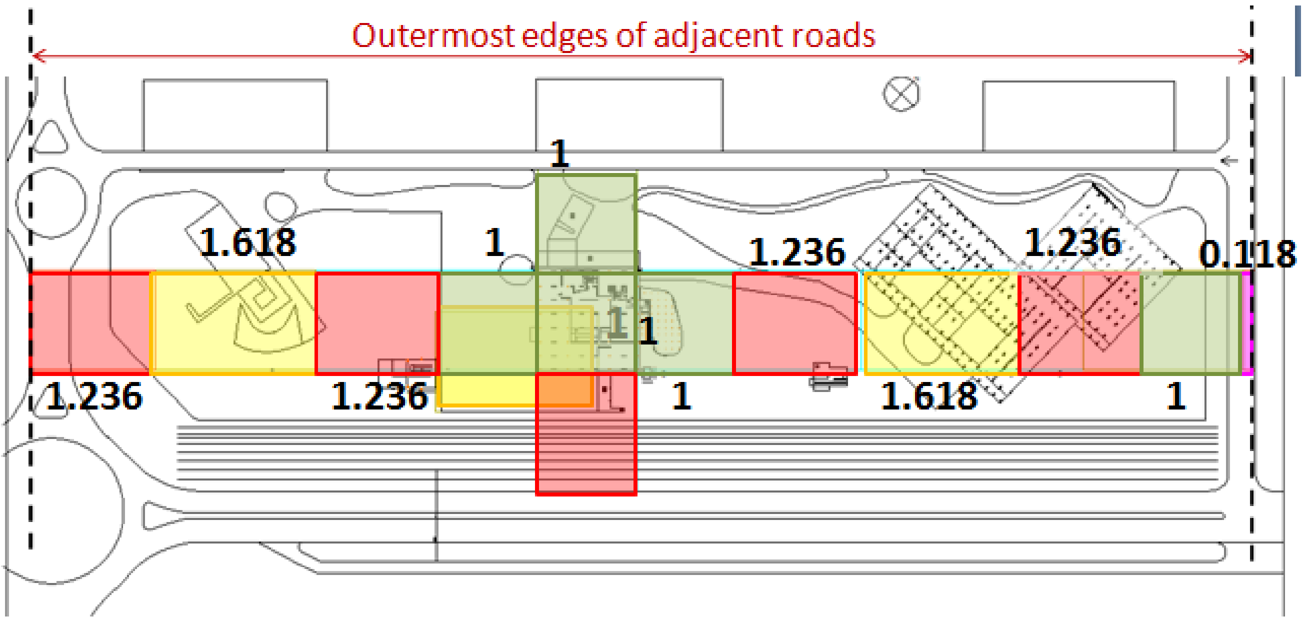


Fig. 39: Incorporating Modulor in site planning

Being an architect-painter, Le Corbusier was driven by the strong passion of finding a common rule that governs art forms and in his own words: "*What is the rule that orders, that connects all things?*"[54]

54. Le Corbusier, *The Modulor A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics*, Trans. Peter de Francia and Anna Bostock (Boston: Birkhäuser Publishers, 2004).

It is also interesting to note that unlike the Miracle Box and the School of Arts, the Museum building is at almost 45 degrees to the north. This ensures that all the surfaces of this building receive ample sunlight. The reason might have some relation to Le Corbusier's passion for playing with light and shade. In the Master's own words: *"Architecture is the masterly, correct and magnificent play of masses brought together in light. Our eyes are made to see forms in light: light and shade reveal these forms."*[55] In fact, Corbusier's thoughts, beliefs and principles expressed in his assertions provide a very useful framework in understanding the design and planning intents behind what we see today. Another pertinent statement of Corbusier that finds resonance in the site plan is: "The materials of city planning are: sky, space, trees, steel and cement; in that order and in that hierarchy".

Fig. 40: South-west façade of the museum photographed around 12 noon in January. Source: DRONAH

The piazza to the south is equal to the museum block in width and is perceived as an unlimited void space delineated by the sky, space, trees, sun and the buildings. The whole composition reads as if the emptiness of the piazza is in an occult balance with the built mass of the Museum block. However, there is also a scientific reason behind having the large open space in the form of the piazza with trees pushed back farther - so that even the lower altitude southern sun of the winter months fails to cast shadows over the S-W facade of the museum during the peak visiting hours.

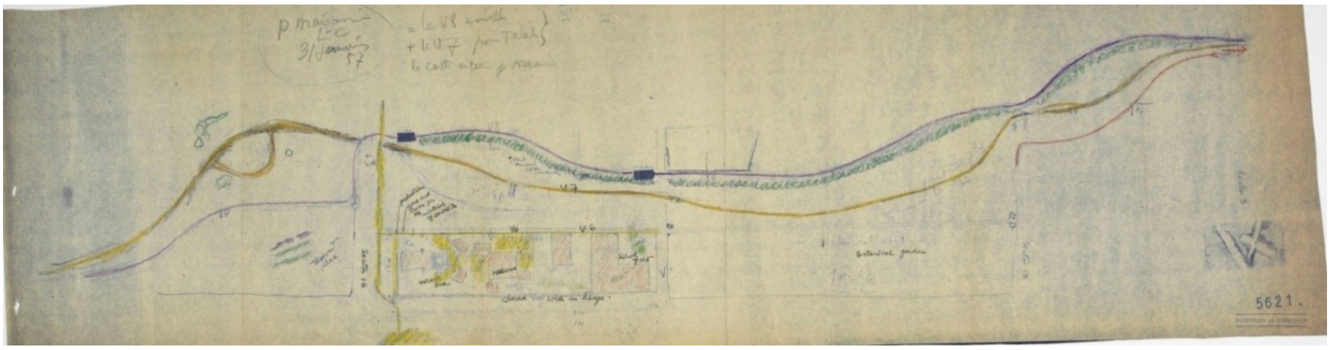


Fig. 41: Sketch showing pedestrian path mirroring the curve of the stream. Source: FLC Archive

It is observed that the pedestrian walkways sketched by the Master Architect mirrors the natural curves of the stream, as if in stark contrast against the rigidity of the machine perfect built form.

3.2.2 Water Pools

The two water basins at the east and west corners of the museum are in a diagonal symmetry. The positioning of the "*patatoïde*" water-basin at the western corner vis-a-vis the square pool at the eastern corner displays a dynamic balance and reminds one of Le Corbusier's love for 'order':

"To create architecture is to put in order. Put what in order? Functions and objects".

55. Le Corbusier, *Towards an Architecture*. Trans. John Goodman.

The two water basins located diagonally opposite to each other to collect rain water from the open concrete drains display this art of 'order' in fulfilling their designated functions. Although of different shapes, these basins are in dynamic balance placed by their respective inlet channels.

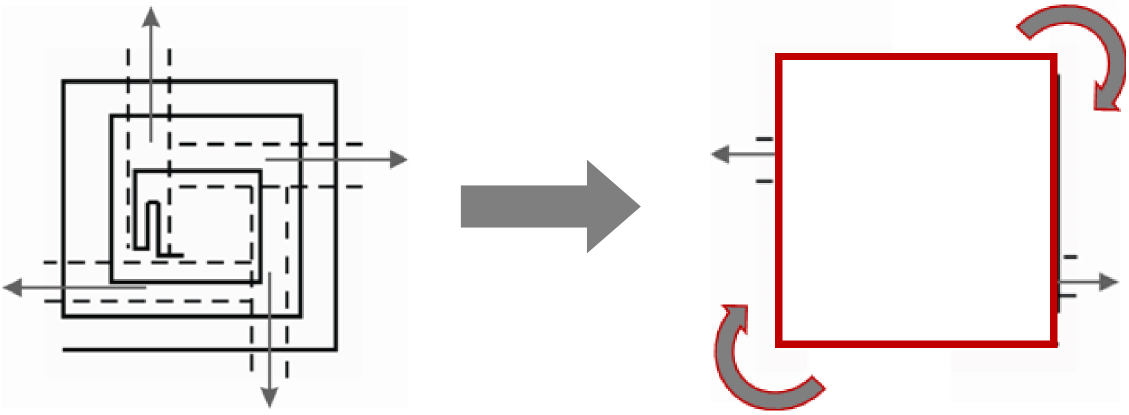


Fig. 42: Position of water basins with respect to the building.

Fig. 43: Patatoïde shaped pool at western corner of the Museum. Source: Museum Archives.

The irregular "*patatoïde*" shape of the pool at the front of the building creates a visual contrast to the rigid form of the Museum, and thus seems to be a part of the sculpture piazza as elaborated in the first sketches of Le Corbusier. This creates an interesting visual contrast between the machine perfect built mass and its surrounding elements that were made to appear natural.

In an attempt to understand if these pools were designed to play far more serious functions in terms of sustainable water management, Rain Water Harvesting quantity check was undertaken and the results were as given below in Table 1.

Table 1: Rain water Collection Rationale

S.No.	ASPECT	MEASURE
1	GMAG Roof area (A)	App. 2500 Sq m
2	Roof surface	Concrete
3	Run-off coefficient (C)	0.8
4	Annual Average rainfall (R)	1048 mm
5	Annual RWH Potential (A x R x C)	2096 Cum
6	Volume of roundish water basin (N-W)	135.3 Cum
7	Volume of square water basin (N-E)	13.7 Cum
8	Total Volume of water basins	149 Cum (app. 7.5 % of the Annual RWH-P)

It is observed that the total volume of the two water bodies fall extremely short of the annual average rainfall of Chandigarh from rain water collection point of view. This indicates that the basins needed to be emptied at regular intervals to prevent flooding of the entire area and harnessing the rain water was, therefore, not the prime motive here.

The treatment of the round pool floor embedded with large gravel, creates a textural contrast to the piazza flooring. One can draw an analogous link to the embankment of the Sukhna Lake, with the pool displaying an iterated effect borrowed from the larger context.

A third rectangular pool is seen towards the south, at the rear of the Auditorium. It is said that a pipe network system connected to the basement of the Auditorium was designed to passively cool the Auditorium. However, the system has not been functional since the museum's initiation.

Fig. 44: Embankment of Sukhna Lake. Source: http://dreamtrails.in/sukhna-lake

3.2.3 Piazza

The piazza acts as a central open space for the museum as well as the cultural centre. It links the other structures within the cultural complex. It enhances a perspective of prominence and monumentalizes the Museum. It provides a perfect foreground to view the Museum and appreciates the interplay of light, shade and shadow on its southern façade.

Fig. 45: Piazza in front of the museum. Source: Museum Archive

The piazza at the entrance to the museum was designed as a temporary/ multi-functional space. The floor tiling of the Piazza is based on the *Modulor*, similar to the one in front of the Tokyo Museum.

3.2.4 Vegetation

Le Corbusier had immense inclination towards nature as he spent his younger days studying trees and the natural order. In his own words[56] : *"From 1900 until 1907, he studied nature under an excellent master; he observed natural phenomena in a place far from city, in the mountains of the High Jura. The call was for a renewal of the decorative elements by the direct study of plants, animals, the changing sky. Nature is order and law, unity and diversity without end, subtlety, harmony and strength: that is the lesson he learnt between the ages of fifteen and twenty".* It may be noted that here Le Corbusier has written in third person singular pronoun and 'he' refers to the Master himself. These five years of close proximity with nature probably made him more sensitive towards plants.

Le Corbusier envisioned a succession of landscape around Chandigarh. His scheme involved different types of plantation for each section of the city. The selection criteria for trees and shrubs included shape, height, density, flowering period and whether they were deciduous or evergreen. Keeping in view the functional imperatives like provision of shade and creation of leisure spaces, the scheme also intended to highlight the purity and elegance of the outlines of the buildings. The implementation of the landscaping scheme was delegated to the botanist Mr. M.S. Randhawa, who was appointed head of the Landscape Advisory Committee created in 1952.[57]

He had suggested the Landscape Committee to prepare a chart showing tree shapes with flower colours and accordingly, a tabulation of trees was done with information on - natural order, botanical name, English and Indian names, flower colours and flowering period, description and gardening notes - that we find in Dr. Randhawa's book and which certainly formed what is today popularly termed as a 'plant palette' for the city.

The archival records shows Le Corbusier's landscape design intentions for the sector 10 and the Cultural Centre (refer Fig.32), with the layout showing pathways and green zones around the museum and a sculpture piazza at the front of the building. A green belt separates the complex from the main road. However, there is no record of any planting plan designed by Le Corbusier or his associates for the museum specifically. Nonetheless, there is absence of vegetation/trees between the buildings of the cultural centre (cf. FLC archives). This may have been in view of providing unobstructed view of the buildings and maintaining their visual dominance.

One can ask if Le Corbusier envisioned an open landscape plan in order to connect the buildings together as a "whole" through perspective. *"Architecture is the masterful, correct, magnificent play of volumes brought together in the light"*.[58] However, in the present scenario, this relation has vanished due to the implementation of the landscaping heedless of Le Corbusier's composition.

According to Dr. Harjeet Singh Dhillon, who served in the Department of Horticulture since August 1975, the tree plantation in the Museum site was not executed as per formal planting plans. Instead it was largely experimental, conceived and supervised by Dr. M.S. Randhawa, the then Chief Commissioner of the UT, Chandigarh. This holds true for the tree avenues on the V2 and V3 roads as well. Based on the concept of Le Corbusier that taller trees are to be planted on north-west to south-east roads for casting long shadows whereas wide canopy trees should be planted along north-east to south-west roads,

56. Le Corbusier, *The Modulor A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics*, Trans. Peter de Francia and Anna Bostock
57. H. Bauchet-Cauquil, Prodhon, F. Prodhon, P. Seguin, M. Roy, J. Tittensor, and J. Harrison, *Le Corbusier, Pierre Jeanneret: Chandigarh, India*, 1951-66 (Paris: Galerie Patrick Seguin, 2014)
58. Le Corbusier, *Towards an Architecture*. Trans. John Goodman.

Dr. Randhawa, a keen botanist himself, went around the country and got saplings of rare species of flowering and other trees.[59]

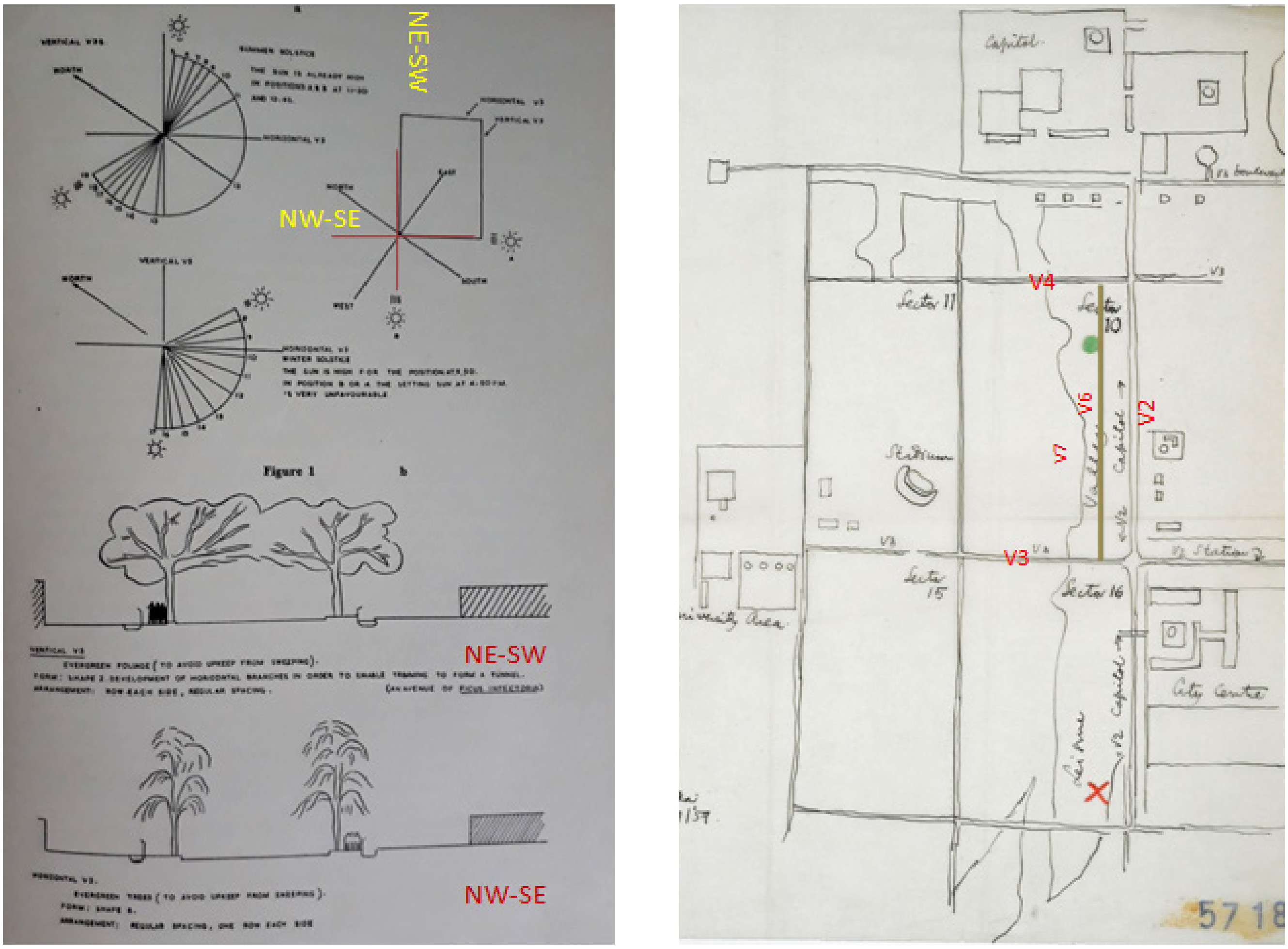


Fig. 46: Study based approach for landscape and tree plantation.
Source: (L) M.S. Randhawa, Beautiful Trees and Gardens; (R) FLC Archive

Dr. Randhawa was instrumental in arboriculture and landscaping of Chandigarh. Interesting cues on the planting philosophy and concept can be obtained from Dr. Randhawa's words as he writes in his book 'Beautiful Trees and Gardens' (chapter 19 titled 'Landscaping Chandigarh'): "*The site of the young city was practically bare with the exception of a few clumps of Mango trees which have been preserved. Chandigarh, like a new-born baby was waiting to be clothed in a mantle of vegetation. The urgency of planting the capital was realized by the State Government, and a Landscape Committee, with the present author as chairman, and engineers and architects of the Chandigarh project as members, was set up to guide the work".*[60]

He further wrote: *"Corbusier, who was one of the members of the Landscape Committee, suggested the preparation of a chart showing shapes of trees and colour of flowers. This simple chart presented a classification of selected, beautiful, ornamental flowering and foliage trees of India which may be called the aristocrats of the plant kingdom, and provided the basis of all tree planting in Chandigarh."*

59. Oral history records of Dr. H.S.Dhillon
60. M.S Randhawa, *Beautiful Trees and Gardens.* (New Delhi: Indian Council of Agricultural Research, 1961)

This led Dr. Randhawa to analyze and classify the elements for the purpose of tree planting into three categories:

i. The urban elements like roads, urban spaces with buildings and free urban spaces
ii. Selection of trees according to the shape of the crown and colour of flowers
iii. The manner and arrangement of trees i.e. the architectural disposition of elements of tree planting.

The Museum site belonged to the first category and here the planting concept revolves around using the trees to unify the whole site and harmonize the heterogeneous structures while ensuring visibility of the iconic buildings.

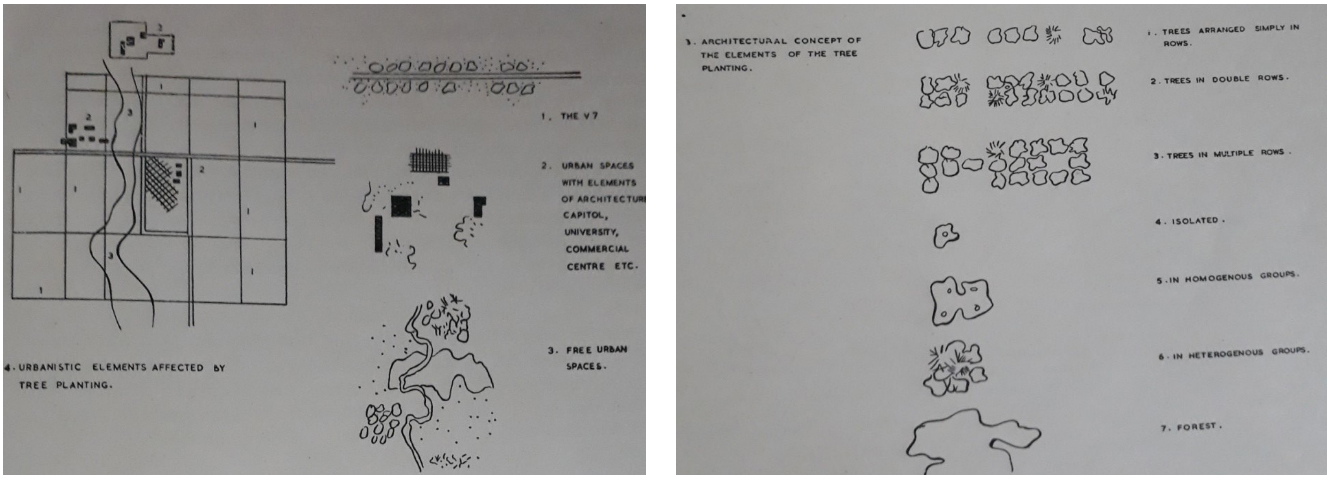


Fig. 47: (L) Urbanistic elements affected by tree planting; (R) Architectural concept of the elements of Tree Planting. Source: M.S. Randhawa, Beautiful Trees and Gardens

Dr. Randhawa explored the articulation of spaces with trees in terms of clustering and grouping of trees and conceptually arrived at seven different types - single row, double row, multiple rows, isolated, homogeneous group, heterogeneous group and forest.

The reflection of these patterns is very well evident in the planting concept of the Museum site.

A study of the tree species originally selected for the site has been carried out based on the book 'Trees of Chandigarh' and in a bid to understand their significance, a comprehensive list of the fourteen mentioned trees along-with an analytical rationale has been presented in the table below:

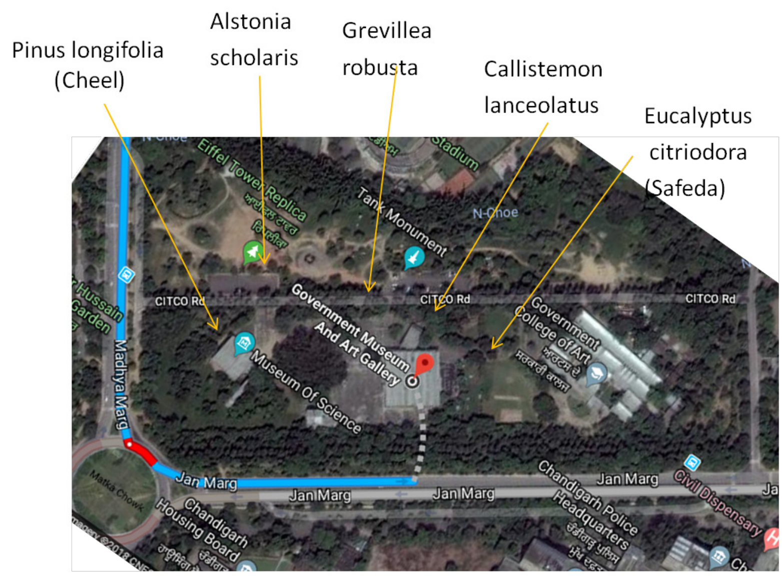


Fig. 48: Tree plantation in Government Museum and Art Gallery

Table 2: Comprehensive Tree Plantation Strategy Undertaken At Museum Site[61]

S.No.	LOCATION	TREE TYPOLOGY	PLANTATION TYPOLOGY	SPECIES	RATIONALE/ SIGNIFICANCE
1	Between buildings	Vertical shape, evergreen	Homogeneous group	*Eucalyptus citriodora* (Safeda)	To unify all the buildings
2	North-western part	Vertical shape, evergreen	Mass	*Pinus longifolia* (Cheel)	To balance Eucalyptus trees at the centre + block low altitude summer setting sun
3	Near Arts College bldg	Vertical shape, flowering deciduous	In group	*Bombax ceiba* (Simal)	To balance Eucalyptus trees at the centre
4	Four entry gates	Drooping, flowering	Homogeneous group	*Callistemon lanceolatus* (Bottlebrush)	To symbolically welcome visitors with their year round flowers
5	Parking area- south and west sides	Evergreen	Single Row	*Alstonia scholaris* (Devil's tree/ Saptaparni)	Shade and balance height of buildings
6	Approach road	Tall conical trees	Row	*Grevillea robusta* (Silver Oak)	To highlight the dominance of the entire area as well as contrast with Bottlebrush
7	Paved piazza, in front of the museum	Specimen trees of low height and round canopies, evergreen species	Groups	*Dalbergia lanceolaria* *Scleichera trijuga* (Kusum) *Putranjiva roxburghii* (Jivaputra)	Act as accents
8	Other locations , including green belt along Jan Marg	Flowering trees, deciduous	Multiple rows + Solitary	*Lagerstroemia flos-reginae* (Queen's flower/ Pride of India) *Lagerstroemia rosea* (Pride of India) *Lagerstroemia thorelli* *Tecoma argentea* *Chorisia speciosa* (Mexican Silk Cotton)	For bright colours of flowers

61. Chhatar Singh, Rajnish Wattas, Harjit Singh Dhillon, Surinder Mohan Dhami. *Trees of Chandigarh* (B.R. Publishing Corporation, Delhi, 2016).

3.2.5 Urban Furniture

The urban landscape of the museum precinct is punctuated by recurring elements from Le Corbusier's repertoire of designed details. This may certainly be viewed as an extension of his artistic vocabulary. Some of these, like the manhole cover with the grid layout of Chandigarh city was designed specifically as part of the city plan, while some others can be seen in many of his earlier urban design project.

Lighting:

Long before present day concepts of indirect lighting, low level built-in concrete lighting fixtures adorned the site. The lighting bollard designed by Le Corbusier can be found in several of his projects in Marseille, Chandigarh and Ahmedabad. It has a mono-block shell of untreated reinforced concrete with a flat base that sits on the ground. The rounded overhang at the upper part conceals the lighting system. The shell retains the imprint of the wooden formwork into which the concrete is poured, giving the untreated skin a tactile texture and the functional sculpture a character of its own.[62]

Fig. 49: Concrete bollard light. Source: Museum Archive

However, barring one, these antique landscape lights no longer exist now in the immediate vicinity of the museum. These low-height built-in concrete bollards provide interesting design statement in meeting lighting requirements of sites, even elsewhere in the city.

Sculptures:

The Museum piazza is dotted with sculptures and installations that efficiently articulate the void and also serve as outdoor exhibits. However, their positions are said to have changed through time and therefore, understanding the original intention in situating these would be difficult.

The contemporary metal art sculptures displayed in the piazza were designed by the artist, Shiv Singh. Other sculptures in stone and concrete by various artists dispersed around the piazza were introduced on site over time.

Fig. 50: Sculptures exhibited in the Piazza. Source: DRONAH

62. H. Bauchet-Cauquil, et al. *Le Corbusier, Pierre Jeanneret: Chandigarh, India,* 1951-66.

Manhole Cover:

The manhole cover for the Chandigarh sanitation system amplifies Le Corbusier's attention to detail.

The cast-iron manhole covers moulded with sand-cast relief bears the impression of the overall plan of Chandigarh as designed by Le Corbusier. They can be found at multiple locations within the site and elsewhere in the city.

Fig. 51: Manhole cover with sectoral grid of Chandigarh city. Source: DRONAH

3.3 Form, Structure and Proportions

3.3.1 Museum Building

Le Corbusier's design for the Cultural Centre of Chandigarh proposed in 1957 shows the Museum as a square plan placed at the centre with the Art College towards the north-east, the Temporary Exhibition to the south and the 'Box of Miracles' to the south-west. A 'wall of trees' obstruct view of the museum building from the V6 at the north-west and from V2 at the south-east. The entrance to the Centre are seen on either side of the sectoral grid towards the Art College and Box of Miracles from the V6. The 'box of miracles' was to be a building housing music, dance, theatre and lectures in the inside and outside. However, this did not materialize probably because the Tagore Theatre already provided a forum for these activities.[63]

The plan of the Government Museum and Art Gallery shows much resemblance to the layout of the National Museum of Western Arts, Tokyo, both of which were at its design stage in 1957. On comparing the 1957 drawing (refer Fig.45) with that proposed in 1962 (refer Fig.32), the overall layout seems to be unchanged except for the inclusion of the '*Theatre Spontane*' in the latter design. The 'wall of trees' on the north-western side is replaced by an additional separate entrance to the Museum. The building orientation of the Art College and the Box of Miracles also seems to have been changed to align along the east-west direction.

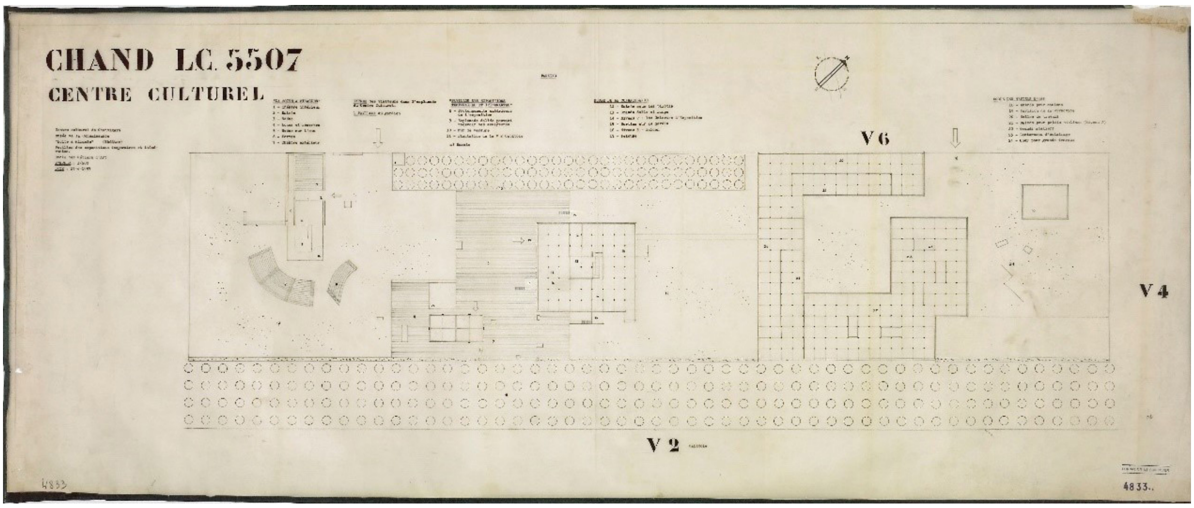
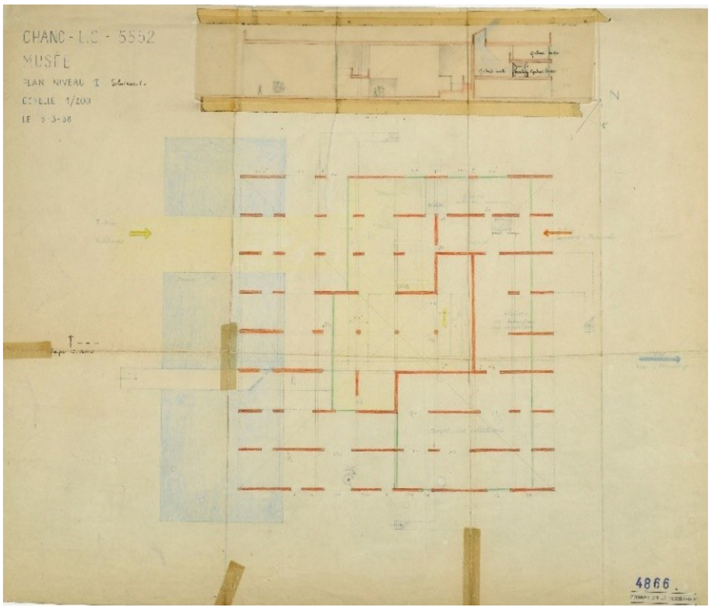
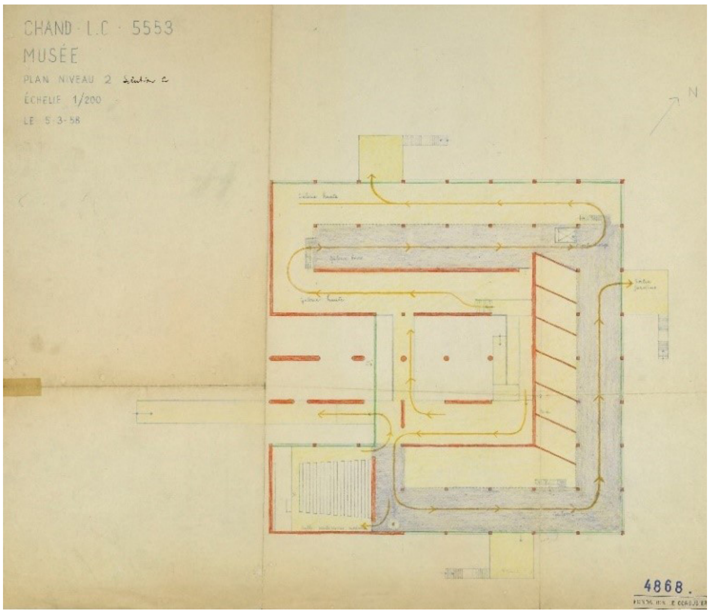


Fig. 52: Archival drawing showing layout of Cultural Centre, 1957. Source: FLC Archive

63. Doc. No. 113, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524





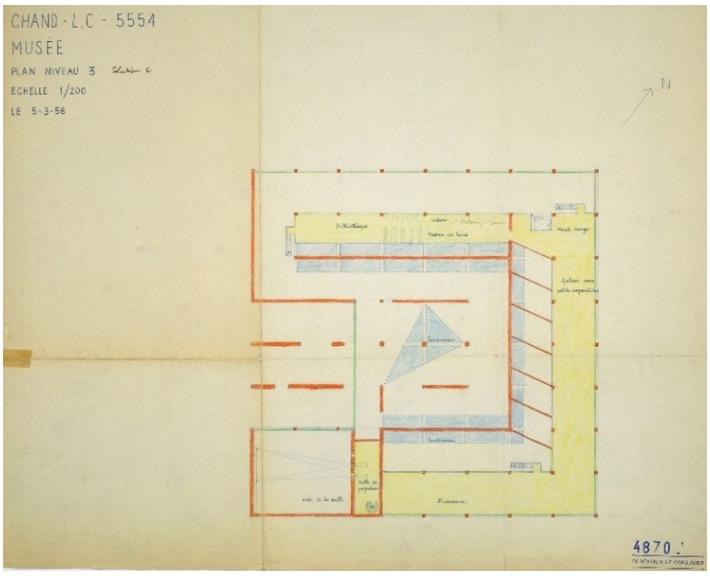


Fig. 53: Archival drawings showing museum design proposed in 1961. Source: FLC Archive

The plans developed for the Government Museum and Art Gallery in 1958 shows a square plan with a water pool along the length of the building on the south-west side of the building. A bridge over the pool acts as the entrance to the museum. A ramp over the pool leads the visitor to the galleries on the first floor. The central hall also houses a ramp that winds up to the first floor, showing similarity to Le Corbusier's plans for the three museum.

The first floor galleries open onto balconies that overlooks onto the exterior and connects the interior to the lawn on the ground floor on all sides except on the south-west façade. An in-house auditorium is seen at the south corner of the building.

The central hall is lit by a conical skylight, showing a similarity to that of the National Museum of Western Art in Tokyo which was designed in]959.

The plans show the configuration of spaces that allows spiral movement within the museum, as propagated by the 'unlimited growth' model.

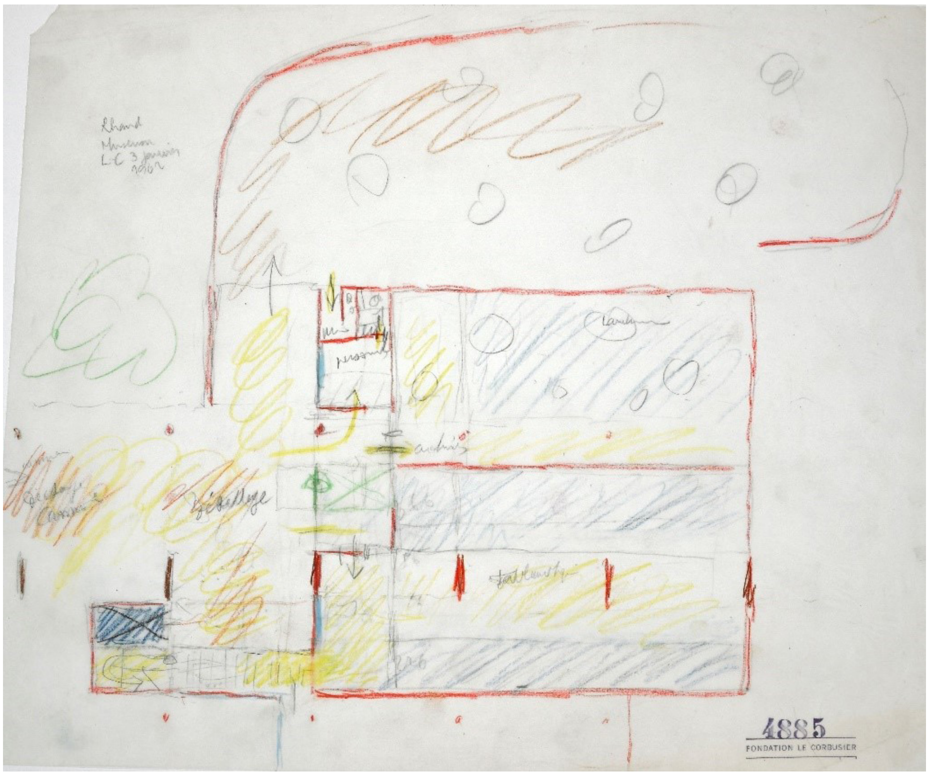


Fig. 54: Sketch of Museum plan, 1962. Source: FLC Archive

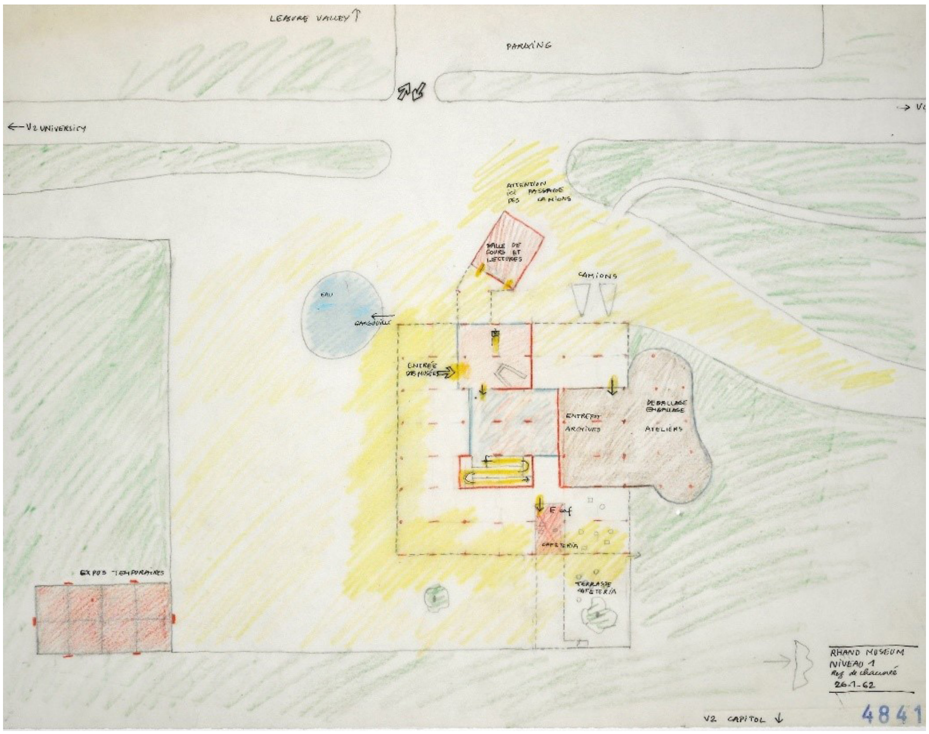


Fig. 55: Archival drawing of Museum plan, 1962. Source: FLC Archive

The 1962 sketch and drawing of the Museum plan shows the evolution of the museum design that included organic and linear extensions from the formerly proposed square plan.

Located at the centre of the cultural belt, the Government Museum and Art Gallery stands out due to its majestic proportions. The perfect square of the museum building integrates well into the composition of simple volumes of squares and rectangles within the cultural complex.

In the model developed in 1962, the building has a 52x52 metres square plan made up of reinforced concrete columns and beams. The structure is vertically divided into three levels, some portions of which have triple and double heights.

The functional cuboid form rests on a forest of pilotis, having the profile of rectangles and rectangles with rounded ends. The museum design based entirely on the Modular have columns oriented NE-SW, parallel to the grid of Chandigarh. The columns maintain a rhythm without disturbing the harmony of the grid of 7x7 metre, similar to Le Corbusier's original model for the Museum of Unlimited Growth.

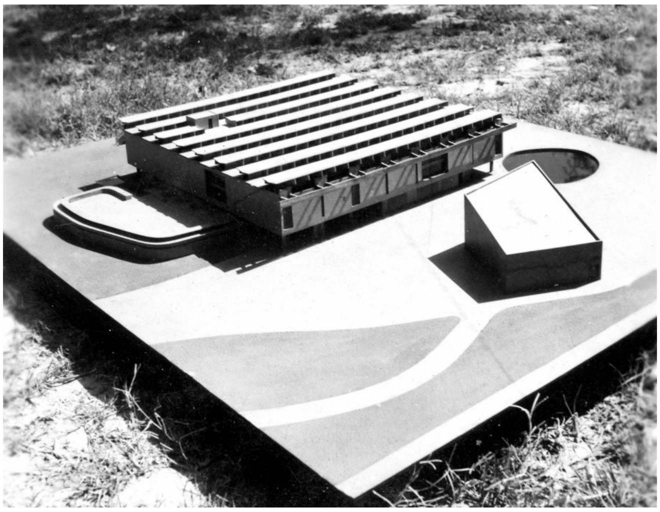


Fig. 56: Model of Chandigarh Museum. Source: Museum Archive

The arrangement of galleries around the central courtyard of the building follows Le Corbusier's Museum of "unlimited growth" concept. A ramp from the triple-height entrance gallery leads to the galleries on the upper floors. Additional provisions for goods lift and service staircases to the different levels were also given in the model developed in 1962.

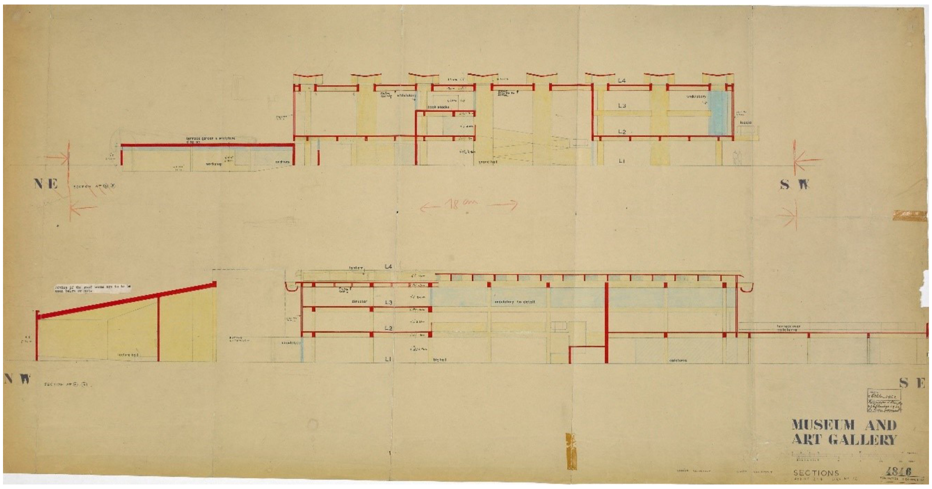


Fig. 57: Archival drawing of proposed Sections for Museum, 1962. Source: FLC Archive

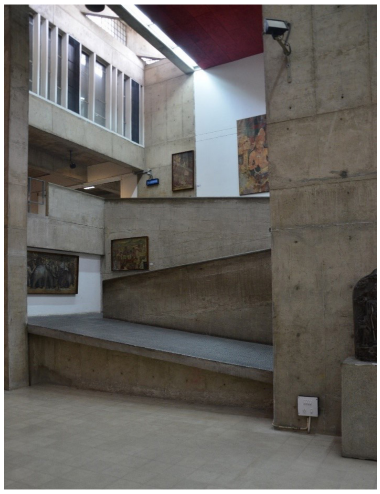
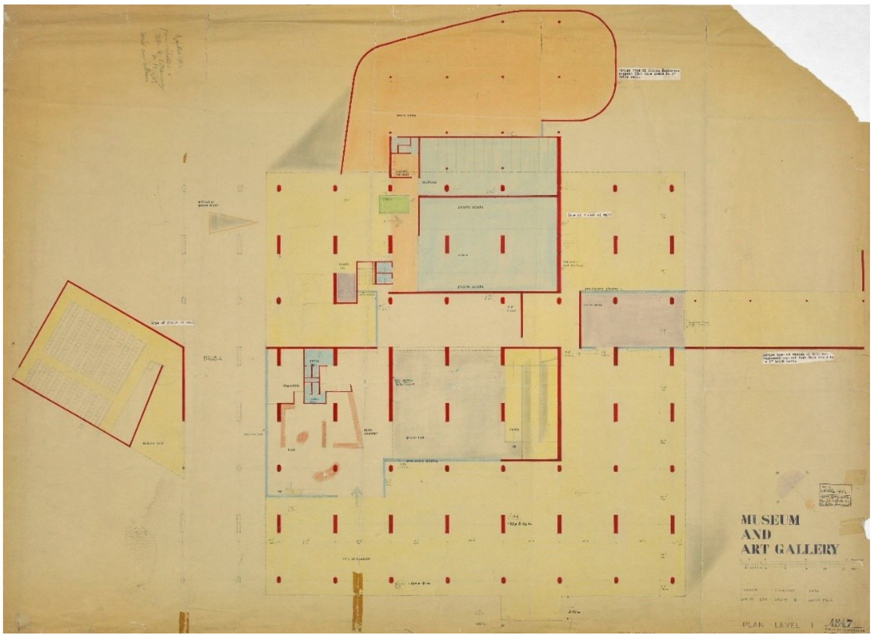


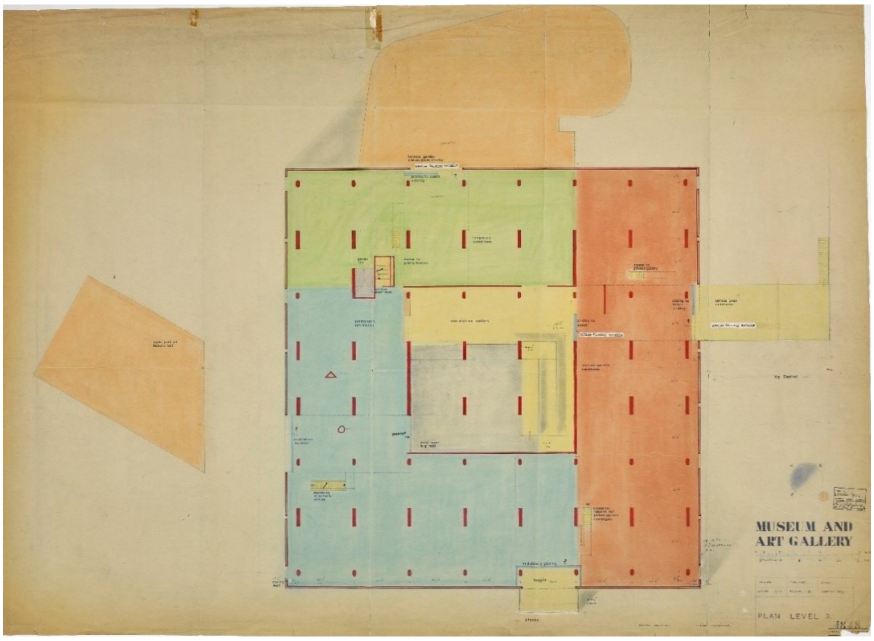
Fig. 58: Ramp leading from ground floor to first floor Bronze Sculpture gallery. Source: DRONAH

The ground floor houses the reception hall, central large hall with a ramp leading to the upper floors, reserve collection storage and conservation laboratory. The central gallery is triple storey high. Apart from the ramp, there are two staircases on the ground floor - one connects the ground floor to the terrace and the other connects the ground floor to the first floor.

The first floor houses the exhibition galleries. The second floor has offices of the curatorial staff, research library and conference room and reserve collection storage.



Ground Floor:
TOTAL FLOOR AREA = 3413.76 SQ.M.



First Floor:
TOTAL FLOOR AREA = 2679.45 SQ.M.

Second Floor:
TOTAL FLOOR AREA = 571.60 SQ.M.

Fig. 59: Archival drawings of proposed Floors for Museum, 1962. Source: FLC Archive

3.3.2 Building Extensions

The "Three Museums" have in common, extensions emerging out of the core square building.

In the case of Chandigarh, they stand out owing to their irregular shape. These "organs"[64] - elements independent of the main structure- follow a compositional logic rather than a pure functional rule, and somehow look independent of the main "skeleton". They embody the concept of "free plan"[65] illustrated in the "5 points of architecture". With its free flowing outline and organic form, this is most explicitly exemplified by the Workshop (now Temporary Exhibition Gallery) at the rear of the Museum. The terrace of the workshop was envisioned as a terrace garden with sculptures.

Fig. 60: Workshop with organic form Source: Museum Archives

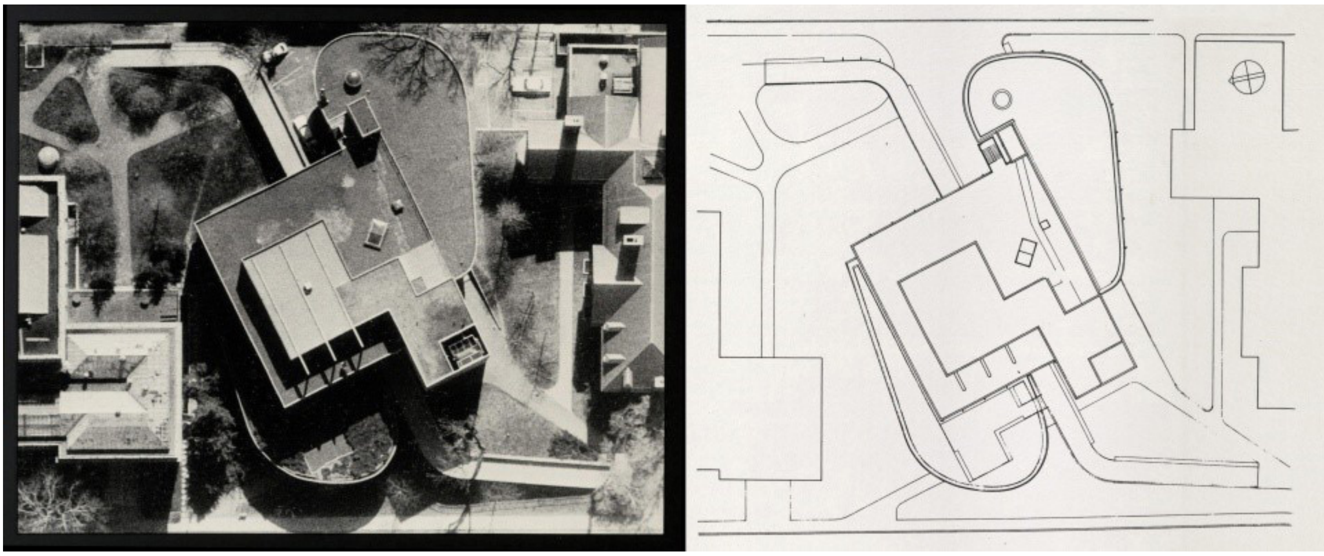


Fig. 61: Organic shaped extensions from the main building in Carpenter Centre for Visual Arts. Source: http://artnewengland.com/ed_picks/looking-back/

The organic form of the temporary exhibition draws similarities with Harvard's Carpenter Centre for Visual Arts, which was designed around the same time as the Chandigarh Museum and was inaugurated in 1963.

The Lecture Hall (now the auditorium) is another extension of notable prominence. The independent hall with its angular front porch, stands against the sedate brick facade of the museum and against the principle of unlimited growth. In the earlier models by Le Corbusier, it was linked to the museum

64. Le Corbusier, *Towards an Architecture.* Trans. John Goodman.
65. Ibid.

without obstructing the potential growth of the museum. However, in the original design, the auditorium was shifted away from the core building.

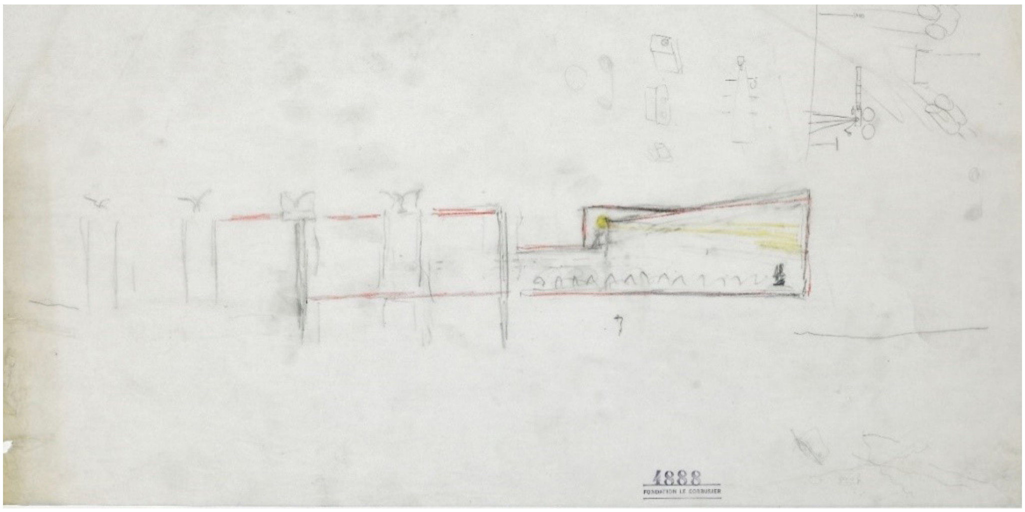


Fig. 62: (L) Sketch showing proposal with lecture hall connected to main museum building. Source: FLC Archives

The distinct rectangular form of the proposed cafeteria project out from the south-eastern façade of the museum building. Presently it houses the AC plants and the guard room. The roof terrace of the structure is accessible by an exterior staircase.

Another glaringly evident extension is the balcony on the front façade projecting out from the otherwise flat façade of the building. Reminiscent of the design proposed in 1961, they may be suggestive of a visual link between the sculptural piazza and the gallery on the first floor. However, because of the protective grills installed after the theft of 1970, the balcony is not accessible anymore, even for the purpose of cleaning.

Fig. 63: Auditorium built as building separate from the Museum. Source: FLC Archives

Fig. 64: South-west elevation with projecting balcony. Source: Museum Archive

The evolution of the core building and its extensions were mapped into a tabular form for better understanding of the changes in the design of the building since its initiation.

Table 3: Design evolution and alterations recorded through archival research

Year	Alterations in the Museum Building	Refer Drawing No.
1958	1. Conceptual proposal with swastika circulation, ramp entrance and pyramid lantern on roof similar to the Tokyo Museum. 2. Spout or drain outlets proposed at a different location as compared to the existing one on the ends. 3. Various designs for clerestory were evolved.	GMAG/OR/P-01-05 GMAG/OR/S-01-02 GMAG/OR/E-01-02
1961	1. Undulatory glazing is proposed on the exterior elevations.	GMAG/OR/P-01-02 GMAG/OR/E-01-02
1962	1. Experiments are further done with the conceptual design and an option with an open plan form is developed. 2. Site extension or future expansion scheme is also proposed in this option, a dialogue in between the architect and the site team is also happening over the proposal. 3. The proposal is then further developed in terms of spatial or functional use which is almost similar to the existing. 4. In the same proposal, future expansion proposal is still retained towards the edge besides Lecture Hall/Auditorium building. 5. On the second floor, the director room and office existed in place of current day store and Randhawa reserve gallery in place of newly added Miniature AC plant respectively. 6. Spout or drain outlets are shifted to the respective ends. 7. A third conceptual proposal which is also of open form exists dating from 1962, which has auditorium connected to the director's room on the second floor and functioning as a terrace to the office. 8. In the same proposal, Le Corbusier has proposed terraces or roof gardens on top of all the extensions, connecting it to the main museum and retaining the continuity. Auditorium and an overhang terrace are proposed as balcony or open extension to Office, workshop terrace to first floor of Museum building and Cafeteria terrace for cafeteria building. 8. Decisions over canal water disposal are taken (whether from one side or both) and finish for the exterior facades is discussed as well.	GMAG/OR/P-01-10 GMAG/OR/S-01-02 GMAG/OR/E-01-03
1963	1. Formwork and material finishes for exterior are recommended like brick tiles similar to that at Ahmedabad Museum, shuttering and patterns.	GMAG/OR/S-01 GMAG/OR/D-02
1964	1. Detail finishes and design for director's room and lavatory are developed.	GMAG/OR/E-01-03
1965	1. Exhaust fans on one side of the clerestories and glass on the other side is proposed which was not implemented and further got developed to glass on both sides. 2. Ramp for the exhibition hall of textile gallery and undulatory glazing was detailed.	GMAG/OR/P-01 GMAG/OR/S-01 GMAG/OR/E-01 GMAG/OR/D-03,08
1987	1. Lighting was proposed for the Henry Moore Exhibition. The spot lights suspended from the ceiling in the Textile gallery are mentioned to be temporarily installed for the exhibition and were supposed to be removed post event. The lights haven't been removed and still exist on site.	GMAG/OR/D-01
2000	1. Grills are proposed to be added to the openings or glazings for security reasons post theft.	GMAG/OR/D-01-02
2002	1. Specifications and detailing of reception counter which includes provision for counter for handicapped, planter and storage shelves.	GMAG/OR/D-01
2006	1. Proposal for replication of the existing undulatory glazing in the Child Art gallery to complete the glazing.	GMAG/OR/D-01
2007	1. Detailing of the Child Art Gallery in the Museum which is in place of the originally conceptualized Cafeteria and pilotis.	GMAG/OR/D-01

Year	Alterations in the Museum Building	Refer Drawing No.
Present	1. Child Art Gallery has been created in place of Cafeteria and pilotis. 2. Office behind souvenir shop, the souvenir shop adjacent to reception, toilets near reserve collection, CCTV room, guard room, storage and AC for reserve collection, City Museum, Miniature and Museum are major alterations which exist in the current day Museum building. 3. Conversion of director and office space into storage and blocking of connections between the galleries has also been done. 4. Addition of conference room within the library is another alteration done to the museum.	GMAG/MD/P-03-06

Year	Alterations in the Temporary Exhibition	Refer Drawing No.
1962	1. Sculptural form was further enhanced into the current day shape of the exhibition hall. (similar to the form of the metal-roofed pavilion for temporary exhibitions at Visual Arts Centre, Harvard University, Cambridge) 2. Column layout was elaborated and detailed for structural stability. 3. Roof was proposed as a sculptural roof garden. 4. Clerestories were added refining the proposed roof garden of the exhibition hall. Profile with opening on the top which would act as skylights. (similar to the design of the skylight of Sainte-Marie de la Tourette)	GMAG/OR/P-01-02 GMAG/OR/P-07-08 GMAG/OR/S-01-02
1963	1. Clerestory profile or design is further developed for the roof with opening being shifted to the side and top surface being at a slope similar to that of the Museum building roof. Reference for the clerestory is remarked as to be referred from the original plan drawing. 2. There is a dialogue regarding material for the walls, beam and slab for the Workshop. It also elaborates sizes of the column, glazing, clerestory and slopes. 3. In 1963, more of decisions on finalizing material finishes and sizes of structural or design elements was done.	GMAG/OR/S-01
1964	1. Further revision of the column layout with addition of 4 more columns and 2 steel pipe columns at locations marked in the drawing. 2 of these are labelled as column of aerator and mirror of the columns on the opposite side. 1 is deviating from the grid cause of lack of space due to form of the structure. Reason for the addition of the 2 Steel pipes needs to be checked. 2. Flooring for the workshop is proposed. 3. Entrance door detail is developed.	GMAG/OR/P-01 GMAG/OR/D-01,04
1965	1. As evident in the drawing, there is an undulatory glazing proposed next to the archives store (current day reserve collection). The glazing doesn't exist at present. 2. Gargoyle for the clerestory of the workshop with two-sided opening is also proposed which is exactly similar to the current day clerestory of the Museum terrace.	GMAG/OR/S-01
1989	1. Conservation lab and a room for Exhibition officer along with reception counter are proposed which reduce down the workshop space. 2. Originally conceptualized and proposed as the workshop, it now functions as exhibition gallery and is also referred to as the same. 3. RCP and display are proposed for the exhibition gallery. 4. As proposed as locker room for staff in the year 1962, the space is converted to a dark room.	GMAG/OR/P-01-02
2011	1. Entrance ramp is shifted towards the edge and steps are proposed along with the ramp. 2. Store is added adjacent to the Conservation lab and the room for the officer along with the partitions proposed for enclosing exhibition space disappear.	GMAG/OR/P-01

Year	Alterations in the Temporary Exhibition	Refer Drawing No.
	3. Reception counter is now proposed at the prior entrance of the lab. The undulatory glazing now converts to an opening and functions as the new entry to the lab and the former entry is to be kept closed as per the proposal. 4. The dark room is further expanded and the toilet for workshop people and staff is converted into an addition to the dark room.	
Current	1. Conservation lab entry is retained to the prior from the exhibition entrance side. Original Undulatory glazing doesn't exist at present and is replaced by a steel glazing. 2. Storage archives functions now as reserve collection with dark room and photo selection room. 3. Store is further extended covering a huge part of the exhibition gallery.	
Undated	1. Window detail of clerestory 2. Aerator detail of Workshop 3. Reproduced plan of LVL.1 (must be from the year 2000-2009 as mentioned in the dates in notes section). Original undulatory in the conservation lab is replaced with steel glazing (as labelled in the dwg.) which exists today.	GMAG/OR/P-03 GMAG/OR/D-02,05

Year	Alterations in the Auditorium	Refer Drawing No.
1962	1. Decisions are being made on the location of the Lecture Hall in respect to the Museum building. 2. Type of finish is requested to be advised in the drawing 3. Museum is proposed in line with the last row of columns which are extended beyond museum for future extension in the particular proposal. 4. Another proposal from 1962 has interconnection to the Museum building and is linked via a proposed terrace to the Directors office on the second level. 5. Advise on whether the beams need to be seen from below or not is requested.	GMAG/OR/P-01-03 GMAG/OR/P-07-09 GMAG/OR/S-01-02 GMAG/OR/E-01
1965	1. Provision for future expansion is still retained.	GMAG/OR/S-01
2004	1. Auditorium (initially referred as Lecture Hall) now exists as an individual structure with no linkage to the Museum building. 2. Fountain with sculpture is proposed in the landscape adjacent to the North façade.	GMAG/OR/P-01
2008	1. Interior details and specifications such as electrical fixtures, ventilation ducts, ramps, materials are worked out. 2. Provision for air curtain above main entrance door is also proposed.	GMAG/OR/P-01
2011	Under upgradation plan proposed following alterations are observed: 1. Addition of control room and glass partition door behind the back row of seats. 2. Additional row of seats is added on the back next to the proposed space for ducts. 3. Arrangement of seats proposed in the particular drawing vary from others prepared earlier. Its unlike the earlier arrangement which is symmetric and aligned. 4. Intermediate beams projecting out on the top (roof level) are proposed. 5. Landscape proposal including provision for steps and ramp along the north and west façade are proposed.	GMAG/OR/P-02 GMAG/OR/S-01
Current	1. Basement and the ventilation ducts are no more in use. 2. Pool adjacent to the North façade exists till date on site but is not functional. 3. New air-conditioning duct has been placed along the basement ramp parapet wall. 4. Currently also 180 seats exist in the Auditorium.	

Year	Alterations in the Auditorium	Refer Drawing No.
Undated	1. Comment on removal of the pool from the north edge of the Museum. There is no mention of the pool apart from this drawing, which exists on site currently. 2. There is a mention of existing number of seats to be 180 on site.	GMAG/OR/P-01-04

Year	Alterations in the Cafeteria Extension	Refer Drawing No.
1962	1. Originally the extension was conceptualized as an extension to the cafeteria. 2. The terrace was proposed as terrace of/over cafeteria. 3. Wall finishing is yet to be advised and is asked by the on-site team (as mentioned on the dwgs).	GMAG/OR/P-01-03 GMAG/OR/P-07-08 GMAG/OR/S-01 GMAG/OR/E-0
1964	1. Pattern of the panels in the front façade is developed.	GMAG/OR/E-01-02
Current	1. The cafeteria doesn't exist on site currently and has been replaced by the Child Art Gallery. 2. The extension has been converted into AC Plant room and security personnel room. 3. The AC plant for the City Museum and a workshop are also accommodated in the original pilotis area.	GMAG/OR/P-01
Undated	1. AC Plant is proposed whose location is suggested next to the cafeteria extension structure. 2. Child Art gallery is proposed which covers the remaining pilotis area apart from the cafeteria.	GMAG/OR/P-03-04 GMAG/OR/S-01

3.4 Materials and Construction Technology

The Government Museum and Art Gallery emerges from the landscape distinct due to its distinguishable structural innovations, exterior finishes and sculptural form. This section discusses the building elements used in the Museum building and their locations and materials.

Table 4: Building elements and their locations

		BUILDING EXTERIOR	BUILDING INTERIOR
MATERIALS	ENVELOPE	Exposed Concrete	Exposed Concrete
		Brick tile cladding	Painted walls
	FLOORING	Concrete Flooring	Concrete Flooring
			Terrazzo Flooring
	CEILING	Pre-cast concrete tiles	Wood wool ceiling panels
DESIGNED ELEMENTS	DOORS AND WINDOWS	Centrally pivoting doors	Internal painted doors
		Undulatory Fenestration	Undulatory Fenestration
		Aerators	
	SPECIAL DETAILS	Clerestory (Fins, Glazing)	Clerestory (Fins, Glazing)
		Terrace Drainage elements (Concrete drain, Gargoyles)	Mild steel handrails

3.4.1 Exterior Envelope

The building envelope of the Government Museum and Art Gallery comprises of exposed concrete columns and beams and brick tile cladding. The contrasting red of the brick against the grey of the concrete gives an appearance of a composite structure. The joints of the shuttering almost forms a pattern that creates a break in the stark façade of the concrete columns and beams. The concrete mix prepared on site followed a very high standard imposed by Le Corbusier.[66]

The brick cladding for the façade was designed specifically for the museum and was handcrafted on site. Le Corbusier insisted that the cladding joints be aligned vertically and horizontally, probably to affirm the facade as non-structural, following the “5 points of architecture” theory. The same is seen on the façade cladding of the Ahmedabad Museum. The envelope of double wall with cavity acts as a thermal barrier providing thermal stability indoors.


Fig. 65: Balanced composition of exposed concrete and brick tile cladding (L); Museum interior lit by skylights (R).
Source: DRONAH

3.4.2 Building Interior

The interior of the museum is composed of walls painted white, with all structural elements- beams and columns- emphasized as unplastered, exposed concrete surfaces. Internally, the south-east wall is painted black and the north-west wall is painted red to highlight the wall as a backdrops for the exhibits. The peripheral walls have large window openings with fixed glazing. The internal walls act as separators to direct visitor movement through the galleries, as well as act as a base for exhibiting museum display. The series of parallelly aligned skylights light up the entire interior space.

3.4.3 Flooring

The external flooring of the Government Museum and Art Gallery is made up of concrete tiles with metal divider strips at the joints. The tiles have non-uniform sizes and are arranged in a pattern that seems to be random, but are linearly arranged.

66. Oral history records of Mr. SD Sharma

The interior flooring of the museum, including the ramp, is finished in terrazzo pre-cast tiles "Ramnik" originally produced in Chandigarh.[67] The gallery floors have light grey terrazzo having a tile size of 24x24cm, with white and light coloured chips. The black terrazzo chequered tiles of the ramp has a size of 20x20cm and have a recessed grid pattern. The flooring for the staircase is cast in situ with a black pigmented terrazzo.

Fig. 66: Black terrazzo tiles with chequered pattern on ramp (L); Black terrazzo cast in-situ on stairs (C); Pre-cast Ramnik terrazzo tiles in galleries (R). Source: DRONAH

3.4.4 Ceiling

The composite material panel for the false/drop ceilings was a model well appreciated by the modern architects in Europe for their acoustic quality, rough design and affordable pricing. It illustrated the principles of modernism and "standardization". The material chosen by Le Corbusier and Pierre Jeanneret for the ceiling panels was a similar composite, but using locally available raw materials. The wood wool panels, also called *Thermofriz*, were probably produced explicitly for the Museum by the local craftsmen. The material for false ceiling panels stands witness to the merging of modernism and tradition.

The ceiling panels are arranged parallelly and alternated with the series of skylights. Each set has 8 rows of uniform panels with a size of 200x50cm. They are finished with colourful paints in the order- 2 sets of yellow painted panels, 2 sets of red painted panels, 1 set of white painted panels and 2 sets of black painted panels, starting from south west to the north east.

Fig. 67: Wood wool ceiling panels painted in brilliant colours. Source: DRONAH

67. Oral history records of Mr. SD Sharma

3.4.5 Doors and Windows

The main entrance door of the museum has a central vertical pivoting system. The painted metal door has a recessed handle in an hourglass shape. The entrance to the temporary exhibition gallery and the auditorium, bear similar design but is made of polished wood panels.

The doors and windows of the Museum displays an extension of Le Corbusier's design vocabulary. They are repetitions of the typical details used in many other modernist buildings in Chandigarh. Similar door design can be seen at the entrance doors of the Legislative Assembly. The Pavilion Le Corbusier in Zurich built around the same period as the Museum (1964-67) also has similar recessed door handles designed by Le Corbusier.

Fig. 68: Centrally pivoting door at Museum entrance.

Fig. 69: Centrally pivoting ventilator shutters.

The interior doors have mild steel shutters painted in contrasting primary colours with frames painted black. Le Corbusier used colours in his designs beyond its aesthetic qualities as an architectural tool to express the transition between indoors and outdoors.[68]

The ventilators shutters that were previously designed for the High Court and Secretary Building,[69] reappears at the Chandigarh Museum. They are vertically pivoting, aluminium encased shutters, with a recessed handle and metal latch to lock when required. Wire gauze mesh set within frames on the exterior prevents the entry of insects and rodents. The design allows to control the micro climate within the galleries, by allowing movement of air while controlling the entry of light.

The undulatory windows set within concrete mullions, have metal frames painted white and with fixed glazing. Here too, the pattern follows the design for windows at the High Court.

Fig. 70: Undulatory fenestration opening internally into the galleries.

68. H. Bauchet-Cauquil, et al, *Le Corbusier, Pierre Jeanneret: Chandigarh, India, 1951-66.*
69. *Ibid.*

3.4.6 Skylights

The terrace level plays an important role in the provision of natural lighting within the museum building. A system of linear skylights embedded in the terrace superstructure provides indirect lighting. The series of oblique fin-like sunshades obscures the direct sunlight, protecting the collection from subsequent light damage. The glass panes are frosted to further allow the diffusion of light. The quality of the light becomes evident in relation to the bright colours of the walls and the ceiling. The archival evidence in Le Corbusier’s drawings confirms that the skylights were not intended to be openable. The clerestory lighting provides for uniform illumination of the space within the museum.

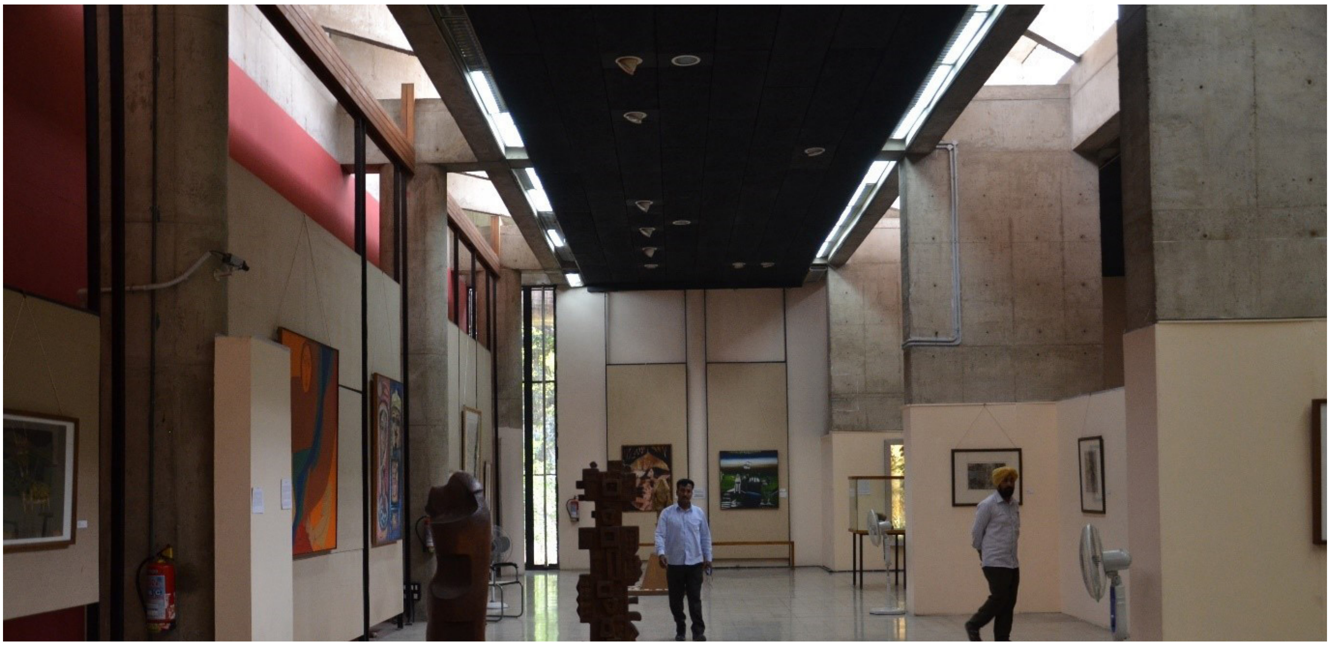


Fig. 71: Gallery space lit by skylight above. Source: DRONAH

3.4.7 Terrace Drainage Elements

The most remarkable design feature of the building is without doubt the roof-terrace and its water drainage system. The rainwater from the terrace drains through sculptural bird-shaped gargoyles onto the heavy raw concrete drains that dominate the upper portion of the façade. These drains channel the collected water into the pools at the entrance piazza and at the rear of the building.

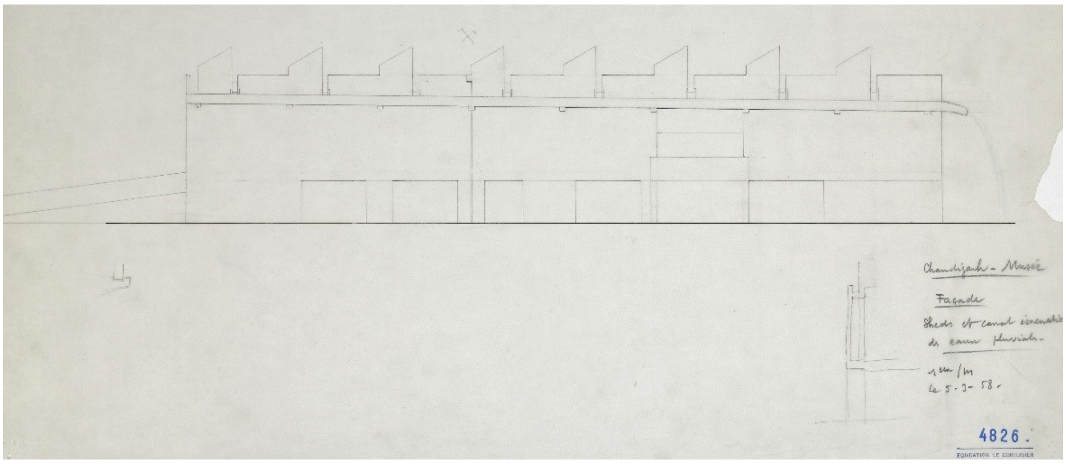
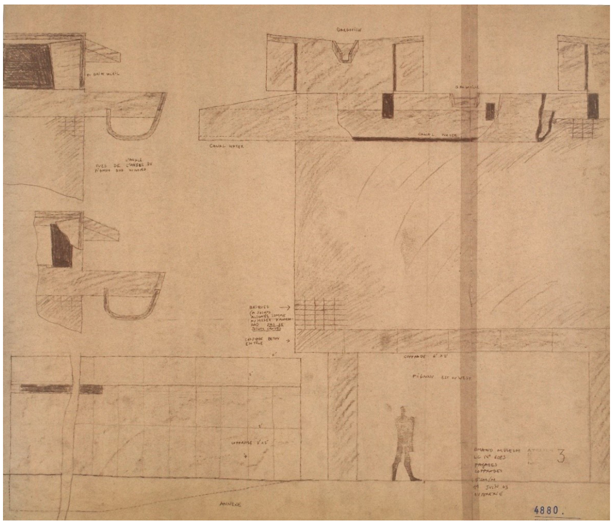


Fig. 72: Sketch showing proposal for water drainage system, 1958. Source: FLC Archive



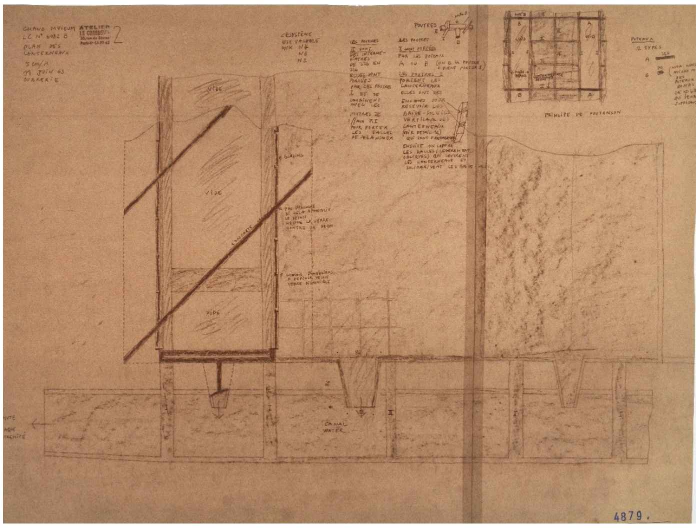


Fig. 73: Archival drawing showing details for terrace draining; (L) Undated, (R) 1953. Source: FLC Archive

Fig. 74: Concrete gargoyles drain terrace runoff into the concrete drains (L); Concrete drain collects terrace runoff and drains into pool below (R). Source: DRONAH

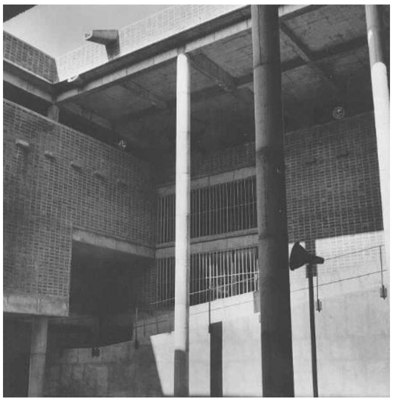


Fig. 75: Concrete gargoyle and splash pool at Chapel of Notre Dame du Haut. Source: https://de.wikipedia.org/wiki/Datei:Notre_Dame_du_Haut_Wasserspeier_und_Becken(ws).jpg (L); Concrete gargoyles at Sanskar Kendra Ahmedabad (C), High Court Chandigarh (R). Source: FLC Archive

The ensemble of terrace elements comprising of gargoyles and splash pools have been used by Le Corbusier in many of his other designs, both international and Indian projects. With the bird shaped gargoyles and the concrete drains, Le Corbusier depicts the relation between nature and the built environment. The sculptural pool remains empty most of the year, filling up only during the monsoons. One can say that through these features, Le Corbusier showcases the climatic features of Chandigarh as a display of the museum.

3.5 Exhibition Display and Furniture

The display of the exhibits at the Government Museum and Art Gallery were planned thoughtfully by a group of individuals,[70] headed by Mr. M.N. Sharma who was the Convenor. They decided that the sculptures and paintings were to be displayed in a chronological manner. They first developed a classification for the exhibits, followed by decision regarding the space it would occupy and the manner in which they were to be displayed. The Chief architect and Mr. S.D. Sharma were authorized to visit galleries of Contemporary Art and the National Museum at Delhi, the Prince of Wales Museum in Bombay and the Calico Museum at Ahmedabad to better understand the various techniques of display. A modeller was also asked to accompany them to prepare copies of the various types of frames that were used.[71]

It is reasonably logical to expect the display in the Government Museum and Art Gallery to relate to Barr's academic model as discussed in Chapter 2. Furthermore, the concept of "unlimited growth" leads the display of the collection to follow a stylistic and chronological model. Evidence from the archival drawings suggest that the purpose of each Gallery was already defined before the construction of the museum, with provision of space for picture galleries, permanent exhibition and temporary exhibition.

The North-East extension was designed as a Workshop to accommodate a functioning art factory- for the generation or execution of artwork. The archival images of the Government Museum and Art Gallery show that the museum display units were crafted in the workshop.

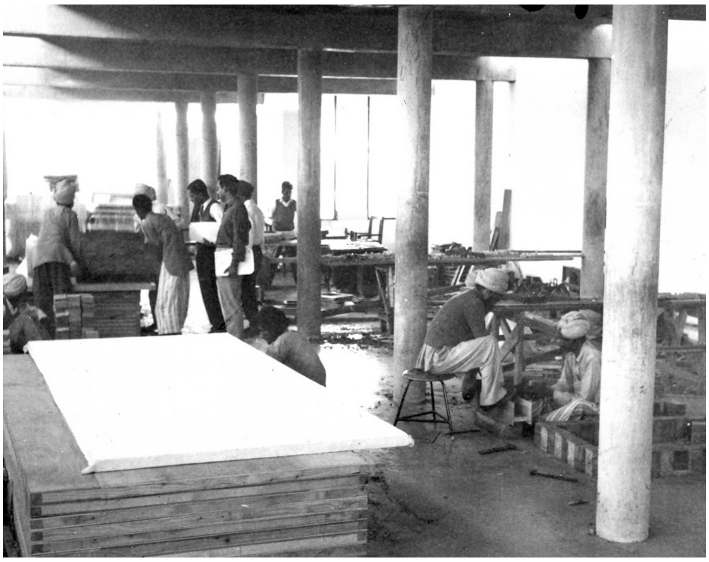


Fig. 76: North-east extension used as workshop during the construction of the Museum. Source: Museum Archives

For the work on designing the museum interior and furnishing, many had shown interest. Although the Advisory Committee appreciated Mr. Shiv Dutt Sharma's interest in completing the interior works[72], the work was eventually commissioned to Mrs. Ratna Fabri. Mrs. Fabri's expertise and education in the field of interior designing with an experience of nearly 15 years, easily made her a suitable candidate to be awarded the project at the museum.

The collection display and most of the furniture were designed in 1967, after the death of Le Corbusier. She designed a high standard modern display, close to Barr's vision and Le Corbusier's design, as it is resolutely modern with simple lines and forms. The ornamentation of the display is minimal to drive the visitor's attention onto the displayed artefact rather than the display itself. However, Ratna Fabri's proposal stands out from the "white box" concept, as she used materials like dark wood, black painted metal and dark coloured fabrics. The strong significance of the raw materials tunes well with the design intentions of Le Corbusier rather than with the MoMA's "white box" influence with her choice of the

70. Group consisted of Mr. M.N. Sharma (Chairman/Convenor), Mr. Sunil Sircar, Mr. S.D. Sharma and Dr. B.N. Goswami
71. Doc. No. 2, Minutes of a Meeting held on 05.11.1966, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
72. Doc. No. 12, Proceedings of the Meeting of Museum Advisory Committee held on 16.01.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

species of wood and materials for furnishings and coverings, etc. Mrs. Fabri was of the opinion that the building should be designed in order to house the exhibits rather than find exhibits to suit the building. She also countered the contention that because it is a modern building, consequently only Modern art should be exhibited. She advocated that all forms of art must be preserved and represented in the museum.[73]

The scheme of interior works for the Chandigarh Museum and the estimate of works was proposed by Ratna Fabri in August 1967. The Indian Miniature gallery was proposed to have short texts describing three major schools of art – Mughal, Kangra and Basohli. 12 paintings of each school were to be mounted in silk, Rajasthani paintings were to be placed in special cases with glass frames and the copies of Ajanta paintings were to be framed in aluminium frames and exhibited in the miniature gallery. The Gandhara Sculpture gallery was proposed to display stucco Gandhara heads, terracotta heads of Akhnoor and Baramulla (Kashmir) and large Gandhara and Hindu stone sculptures on specially designed show cases of different designs. Some modern sculptures, textile art by modern artists and mud wall murals of folk traditions were proposed to be displayed at the entrance hall. All labels and captions were to inform regarding dating, explanation and descriptive matter about the articles.[74] The information for the labels were provided by Dr. Charles Fabri, eminent Indian art critic and husband of Ratna Fabri.

The furniture required in the museum was ordered from Oriental Building and Furnishing Co. Pvt. Ltd. and the textiles were ordered from the Handloom Handicrafts Exports Corporation. The display screens for modern and miniature paintings, frames for miniatures and frames in hessian cloth and teak wood for modern paintings were produced on site. The Niwar chairs and the knitted rope chairs were specially manufactures by the firm TAARU K, Delhi. Special planters and ceramic vases for permanent Indian plants were procured from Government Pottery Works Khurja. Special type refractory clay bases for exhibits were manufactured under Ratna Fabri's supervision at Blue Pottery Factory, Delhi.[75]

The showcases for Gandhara heads were made in sheesham wood and glass and for Gandhara sculptures in cedar wood and glass. The showcases for terracotta and smaller archaeological finds were designed in glass with steel base. Display platforms in sheesham and cedar wood were produced on site as per design. Stone pedestals and slabs in light grey Rajasthani stone were procured from Grey Brog Quarry. For hanging large paintings, large wooden beams between the columns with iron brackets were made. A three partition curtain made of quilted material was proposed between the Gandhara sculptures and miniatures sections. Different types of furniture were designed and manufactured specially for the museum. Easy chairs upholstered in olive green (chairs without arms) and turquoise blue (chairs with arms and benches) material was proposed. Pirhas in Bombay sheesham and lacquered work legs were proposed for the Indian miniatures gallery. Special lighting fixtures in brass and copper were manufactured for the galleries.[76]

The materials used for the design of the display cases and panels are black painted mild steel frames, polished wooden panels, cloth lined backing and base (both light and dark colours) and protective glass. One can identify 6 categories of display units:

73. Doc. No. 117, Letter from Mrs. Ratna Fabri to Dr. Randhawa dated 06.07.1967, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
74. Doc. No. 50, Sample scheme for Chandigarh Museum, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
75. Doc. No. 72,78-81, Estimate or Bill of Quantities, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524
76. Doc. No. 72,84-87, Tentative estimated budget for setting of the exhibits and display at the Chandigarh Museum, Personal collection of Dr. M.S. Randhawa gifted to the Museum in 1968, Accession No. 1524

Display cases:

Fig. 77: Textile display – Polished wooden panels, glass and white fabric lined base (L); Polished wooden panels, glass and white painted display pedestal. Also serves as a partition between the two spaces (R). Source: DRONAH

Fig. 78: Sculpture display – Polished wooden panels, glass and blue fabric lined base. Case is lit by recessed downlight (L) and natural light through the glass top (C); Polished wooden panels, glass, blue fabric lined backing and white painted display pedestals (R). Source: DRONAH

Display cases supported by metal legs:

Fig. 79: Table-like display with fabric lined wooden base supported by black painted metal legs. Glass topped casing allows illumination of the displayed objects by light fixtures or natural light. Source: DRONAH

Wall mounted display cases:

Fig. 80: Wood and glass display case with fabric lined backing and recessed lighting to illuminate exhibits (L); Polished wooden display supported by black painted metal anchors bolted to wall (R). Source: DRONAH

Display pedestals:

Fig. 81: Sculpture display – Series of polished wooden pedestals (L); Buff-colour painted plywood pedestals against black wall.(R). Source: DRONAH

Fig. 82: Sculpture display – Polished wood and Stone display pedestals. Source: DRONAH

Free standing display panels:

Fig. 83: Paintings display – Free standing panels with black painted metal frame and painted plywood backing. Source: DRONAH

Ceiling hung display panels:

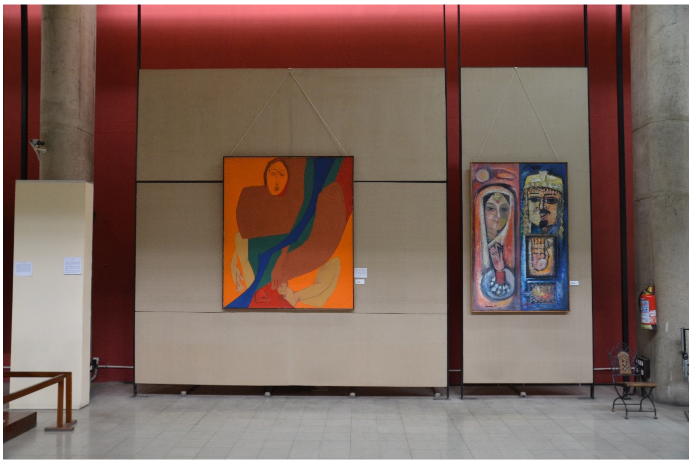


Fig. 84: Paintings display – Black painted metal frame and painted plywood panels hung from channels fixed to the ceiling. Source: DRONAH

The furniture and display units designed by Ratna Fabri, share a comparable simple vocabulary to those employed by Pierre Jeanneret in his designs for Chandigarh's various public buildings.

Fig. 85: Sofa chairs and daybed in museum library (L); Daybed design similar to that of Pierre Jeanneret's design (R). Source: Galerie Patrick Seguin. Le Corbusier Pierre Jeanneret Chandigarh India



Fig. 86: Sofas at the reception - Wooden frame and fabric covered cushions supported by leather straps at the bottom (L); Low stool – Wooden frame and woven jute strap seat (C); Chair – Wooden frame with plastic string seat (R).

3.6 Museum Collection

The collection at the Government Museum and Art Gallery was part of a larger collection of the Lahore Museum, which was divided after the Partition. Around 60% of the collection, along with the Museum and the city went to Pakistan. The remaining 40% portion of the collection was first housed in Simla (the temporary capital of Indian Punjab after the partition) and then in the Moti Bagh Palace in Patiala for an interim period until 1968, from where it was finally shifted to Chandigarh. It consisted primarily of miniatures from the Mughal and Pahari schools and sculptures. A cursory survey by Mr. W.G. Archer, who examined the collection at the palace reported that it held close to three thousand miniatures of the 17th-19th century. The sculptures collection were primarily Gandhara sculptures in stone from sites in Peshawar and Taxila regions belonging to the 2nd-3rd century, small-scale stucco and terracotta heads and stone architectural fragments. The collection was augmented with contemporary Indian paintings, sculptures and graphic art by generous efforts of Mr. MS Randhawa.[77]

The museum space design caters to individual space divisions for the diversity in collection type. Even as one enters the museum, one can see contemporary Indian sculptures scattered along the open piazza and medieval Indian sculptures in the open gallery under pilotis.

Fig. 87: Sculpture at entrance to pilotis. Source: DRONAH

77. Newspaper clipping from Inauguration Album, Government Museum and Art Gallery, Chandigarh

The triple-height central gallery on the ground floor displays phulkari, thanka paintings and other textile art. Going up the ramp to the first floor, leads to the metal sculpture gallery and Gandhara sculpture gallery. The contemporary painting gallery towards the north of the building displays contemporary Indian paintings and graphic prints, etchings, serigraphs, oleographs etc.

The museum houses collections that pertain to eras that span from the early historic and medieval periods to the contemporary period. Miniature paintings, Gandhara sculptures, metal artefacts and contemporary artworks are the fundamental strength of the museum's collection. This multifaceted character of the collection puts forth the museum as an amalgamation of art and knowledge on the same platform. The diversity of the museum artefacts in turn represents the cultural diversity of several regions in the Indian subcontinent. Quantifying the number of artefacts, miniature paintings and numismatics prove to be larger in number. However each artefact within the museum collection brings forth the historical representations of the past and thereby the respective cultural backdrop.

The material compositions of the museum objects extent from a phenomenal number of organic based objects to inorganic ones, due to which the collection requires utmost care and a well devised collection care strategy.

Table 5: Categorized listing of the museum collection

S.No.	COLLECTION TYPOLOGY	NUMBER
1	Gandhara Sculptures	627
2	Miniature paintings	4,267
3	Stone Sculptures	217
4	Metal Sculptures	100
5	Contemporary Paintings	1,300
6	Contemporary Sculptures	167
7	Manuscripts	103
8	Scrolls	8
9	Terracotta	72
10	Textile	259
11	Coins	4,419
12	Glass painting	14
13	Decorative arts (mix-metal, ivory, silver, crystal, wood, bone, papier mache, lacquer, etc.)	199
14	Wasli	34
	TOTAL	**11,786**

***Coins*:**

The Museum has an extensive collection of coins. Majority of the collection are in silver and copper, and a few in alloys like billon and bronze, with a considerable collection of silver punch-mark coins. The numismatic collection holds a large number of Indo Greek coins in silver. A large number of copper coins from the Kushana, Yaudheya and Huns dynasty is housed in the museum. A sizeable number of coins belong to the Sultanate-Slave, Khalji, Tughlaq, Suri and Lodhi dynasties. Mughal coins belonging to the rule of Humayun, Akbar, Jehangir, Shah Jahan, Aurangzeb, Farukhsiyar and Mohamad Shah are also seen. A small collection of coins belonging to the Sikh rule during the period 1835-1878 CE is seen. East India Company coins in copper is also part of the coins collection at the museum.

Terracotta Artefacts:

The terracotta artefacts within the museum collection are one of the oldest among the complete set of collections the museum houses. They display the early historic craftsmanship and artistic flair. The artefacts exhibited belong to the 2nd Century BC and portrays the epitome of craftsmanship during the period.


Fig. 88: Terracotta sculpture of a severed elephant head (L); Remnant of a basal part of human body on a pedestal (R).

Medieval Indian Sculptures:

The collection of Ancient Indian sculptures includes terracotta heads and red sandstone artefacts. The terracotta heads pertain to regions including Akhnoor near Jammu, Ushkar in Kashmir, Sugh in Haryana etc. The red sandstone sculptures include remnants of exquisitely carved railings from a stupa. The ancient Indian sculptures depict the maturing craftsmanship in the early historic period and present the evolving tradition of art and iconolatry.

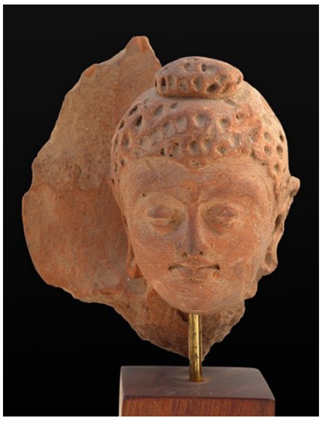



Fig. 89: Stone sculpture - Head of Parvati [7th Century CE, Haryana] (L); Buddha's head with severed halo [4th-5th CE J&K] (R). Source: GMAG

Gandhara Sculptures:

The collection includes a total of 627 Gandhara sculptures, which have exquisite carvings and detailed depictions of Gautama Buddha, Bodhisattvas, Bodhisattva Maitreya, and the life story scenes of the Buddha etc. The Gandhara sculptures stand as a paramount example of aesthetics and artistic craftsmanship during the era of Hellenistic influence in the Gandhara region.

The Gandhara region, being a crossroad of cultural and artistic influences has provided corroborations of the transition of art and tradition in the Buddhist sect and the concomitant Hellenistic impact. This appears to be plausible when in close comparison with the Mathura style of sculptures. Resembling the Hellenistic anthropomorphic forms, the Gandhara art is also referred to as the Graeco – Buddhist School of art. The iconographic representations comprise sculptural portrayal of the Tathagatha in four different Mudras which includes Abhayamudra, Dhyanamudra, Dharmachakramudra and Bhumisparshamudra.

The Gandhara sculptures have been executed mainly on a local variety of schist stone. This also acts as a mode of identifying the style of sculpting and the sect of culture the artefacts pertain to. Being a metamorphic rock, the foliation in schist stone acts as an attribute for the possibilities to carve along its mineral plains thereby accentuating the potentiality of attaining intricate details in the sculptures. A disadvantage here is the susceptibility of the stone if deteriorate when exposed to unstable environmental conditions. This is observed on the artefacts when analyzing the Gandhara sculpture collection, where losses and delamination are observed.

Appraising the cultural backdrop and the theistic evolution, the collection portrays every aspect of Gandhara School of art where the sculptures depicts the path from the aniconic to the iconic depictions of Gautama Buddha. This includes the earliest symbolic depictions of the Buddha in the form of a carved footprint to the iconic representations of Gautama Buddha and other Buddhist deities in several *mudras* and postures.



Fig. 90: Remnant of a Buddha's footprint [aniconic representation] (L); Gandhara sculpture of Gautama Buddha in Dhyanamudra [iconic representation] (C); Sculpture of Bodhisattva Maitreya in abhayamudra [iconic representation] (R). Source: GMAG

Metal Sculptures:

The museum houses about a 100 metal artefacts from the 9th - 20th Century CE. Majority of the metal sculptures in the collection hail from Tibet, and the northern and southern part of India. The collection belongs to a time span of more than a 1000 years, narrating the transition of metal sculpture craftsmanship and the evolution in representations of divine deities. A substantial part of the collection belong to the later medieval era, which corroborates the maturing craftsmanship in metal sculpture making, within several regions of the Indian Subcontinent during the period.

Fig. 91: Bronze sculpture of Bodhisattva Maitreya (L); Source: DRONAH

Analysing the theological backdrop of the collection, the metal artefacts appear to portray sculptures belonging to the Hindu and Buddhist faith. The Hindu sculptures represent various forms of Shiva and Parvathi, avatars of Vishnu, and Devi. The Buddhist sculptures include representations of the Buddha, Bodhisattva and Bodhisattva Maitreya. The collection also includes a series of bronze masks belonging to the medieval era.

Miniature Paintings:

The collection consists of a total of 4267 miniature paintings which includes Mughal, Pahari and Kangra miniatures. The miniature painting collection comes forth as one of the core strength of the museum collection since it encompasses nearly half of the complete collection of the museum.

One of the main schools represented in the miniature collection is of Pahari. The paintings pertaining to a time period of 17th to 19th Century CE, includes nearly all the important Pahari centres of miniature paintings which comprise Basholi, Mankot, Nurpur, Chamba, Kangra, Guler, Mandi and Garhwal and the most prepossessing ones among them being executed by the artist Nainsukh. Nainsukh, being referred to as "one of the most original and brilliant of Indian painters", had executed an immense number of miniature works during his time, and the museum houses a sizeable collection of the artist's works.

Fig. 92: Krishna and Gopala playing with cowherds at the bank of Yamuna-Pahari painting from 1780 CE. Source: GMAG

Apart from the Pahari paintings, Mughal miniature paintings also form a mainstay of the miniature collections. The style of the Mughal School which developed within the royal atelier, illustrated the courts of emperors, the societal backdrop and the classic works of Mughal and Persian literature. The majority of miniatures within the collection are identified to be made with Gouache on paper technique where opaque water colours have been utilized to execute the works. Being used since the early 9th – 10th Century CE in Persian miniatures, the miniatures paintings executed with Gouache technique emphasizes the enduring tradition that spanned until the 19th Century CE.

Fig. 93: Guru Govind Singh on horseback – Pahari painting from 19th Century CE. (L); Portrait of Aurangzeb – 18th Century CE [Gouache on paper] (C); Shiva and family on Mount Kailash – Pahari painting from 1800 – 1810CE (R). Source: GMAG

Contemporary Art:

The museum has a strong contemporary art collection which is diverse in terms of both medium and artists. Artworks including wooden, stone and metal sculptures, oil, watercolour and acrylic paintings, graphic and other types of prints etc., are a part of the permanent collection of the museum. The museum collection also includes artworks by the nine gems of Indian art, the name of whom are provided below:

- Amrita Sher- Gill
- Abhanindranath Tagore
- Gaganendranath Tagore
- Jamini Roy
- Nandalal Bose
- Nicholas Roerich
- Rabridranath Tagore
- Raja Ravi Varma
- Sailoz Mukherjea

The art works by the above given nine artists were declared as national treasures under The Antiquities and Art Treasures Act in the 1970's thus making this a peculiar and exquisite collection for the museum.

Fig. 94: Oil Painting by Amrita Sher-Gil (L); Oil painting on canvas by M.F.Hussain (1961) (C); Aquatint print by Krishna Reddy (R). Source: GMAG

Library:

The museum library situated on the second floor houses an extensive collection of books on art, history and material culture. The collection covers a wide range of topics, from prehistoric art and archaeology to tribal art, religions and cults, music and dance and modern art, sculptures and paintings. It also houses documents relating to collection data and albums with catalogue cards. Dr. Randhawa also presented his personal collection of manuscripts, correspondence on art, books and reprints, totalling more than a thousand. There are portraits of eminent scholars of Indian paintings decorating the walls of the library.

Fig. 95: Library reference collection. Source: DRONAH

Reserve Collection:

Separate reserve collection for miniature painting, contemporary paintings and sculptures are located within the museum. These are under high security surveillance and the doors are sealed daily with hot wax.


Fig. 96: Reserve collection of Contemporary paintings (L); Miniature paintings (R). Source: DRONAH

3.7 Climate Responsive Systems

3.7.1 Integration of Climatic Technique in the Architectural Design

During the first half of the 20th century, research into thermo-regulative response of human body was conducted to inform normalized thermal conditions in working and educational environments to improve the user's performance. During the post-war housing promotion and industrial development, this approach was extended to link climate, indoor atmospheres and human body to develop an ideal environment for the modern society.

André Missenard studied thermo-physiology of comfort and its application to engineering and architecture. In collaboration with Missenard, Le Corbusier's work during the post-war exhibited hydro-thermal control and 'artificial climates'[78]. With the aid of Missenard and Iannis Xenakis, Le Corbusier established the *Programme d'etudes des Conditions Climatiques Optima et des Moyens Architecturaux de correction.*

After the war, as Le Corbusier started to work with tropical countries, he became deeply concerned by climate conditions. Influenced by the French engineer André Missenard, he supported passive and mechanical systems in the context of a growing importance of air conditioning.[79] Missenard thought that architecture should provide an "artificial climate", convenient according to their natural and economic environment and shouldn't homogenize the temperature with air conditioning. Thus, human body will acclimatise to its environment and be more resistant and efficient. For both, the artificial climate of the building must be a result of the architecture itself.

78. Artificial Climate *[Science des climats artificiels]*, create optimal conditions for human life, as well as stimulate a biological reaction that strengthen body and mind making them more resistant and efficient.
79. Ignacio Requena-Ruiz and Daniel Siret, "Experiments on thermal comfort and modern architecture: the contributions of André Missenard and Le Corbusier." (Third EAHN International Meeting, Torino, Italy, June 2014).

Le Corbusier and his team studied carefully the climate of Chandigarh and elaborated what they called a "climatic grid". *It is defined as a material way of visualization allowing to enumerate, coordinate and analyse climate data from a defined location (latitude) in order to guide architectural research towards solutions related to human biology. It is necessary to regulate and to effectively correct the excesses of excessive climates and to create, through architectural devices, the conditions capable of ensuring well-being and comfort.*[80] This chart was divided in 3 parts, which can be loosely translated as "climatic data", "correction to apply" and "architectural solution. Each part is organized under 4 climatic "factors": air temperature, relative humidity, direction and velocity of winds, sunlight and thermal radiation of constructions.

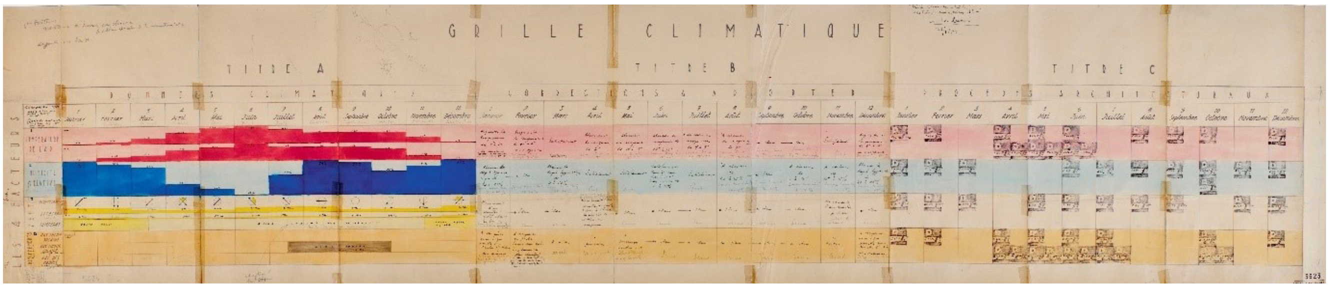


Fig. 97: Grille Climatique or Climatic grid formulated by Le Corbusier. Source: FLC

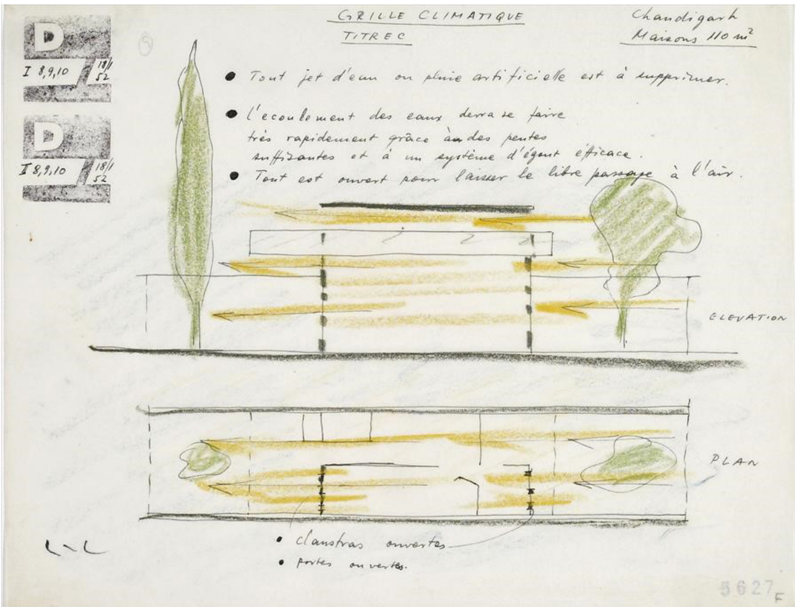


Fig. 98: Sketches showing architectural solution for climate control in a 110m2 house in Chandigarh. Source: FLC Archive

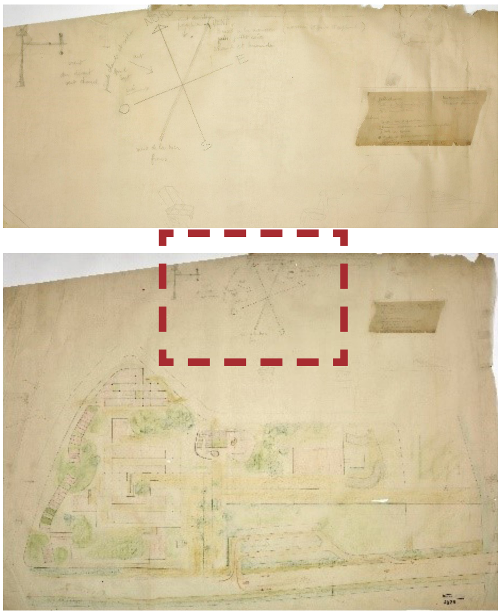


Fig. 99: Archival drawing showing climate study of Chandigarh. Source: FLC Archive

Even though the "architectural solution" of this climatic grid have been designed for a 110m2 house, it points out that Le Corbusier had a clear idea of Chandigarh's climate.

80. Ignacio Requena-Ruiz and Daniel Siret, "Experiments on thermal comfort and modern architecture: the contributions of André Missenard and Le Corbusier."

3.7.2 Climate Responsive Solutions Implemented for Government Museum and Art Gallery

Le Corbusier devised and implemented environmental control devices in his building designs to control the intensity of lighting within the spaces. His interpretation of sun-responsive or heliotherapeutic architecture yielded the façade materialised by reinforced concrete brise-soleil.

"To introduce the sun is the new and most imperative duty of the architect" – **Le Corbusier in The Athens Charter**

Fig. 100: Sketch by Le Corbusier showing cumulative experience of solar heat. Source: http://solarhousehistory.com/blog/2013/10/28/le-corbusier-and-the-sun

The sun protection system in the Government Museum and Art Gallery comprises of oblique concrete fins attached to shelf-like protrusions around the windows of the outer façade across the length of the building. The positioning of these louvres is such that it admits light from the North-east and south-west, to prevent direct rays of the sun from penetrating into the galleries. They are placed at an angle of 135º such that the surface faces the east and west directions, making the facades conditioned to the solar path angles. They cut the direct radiation of the sun from entering the building. Apart from its role as a mechanism for passive energy control, the amorphous covering to the façade also creates visual harmony by means of pattern repetition.

Fig. 101: South-west façade of the building with sun protection system. Source: DRONAH

The mechanisms to promote the building as thermally active proceeds to develop artificial climate within the museum. Le Corbusier proposed counteracting thermal loss and overheating by *"la respiration exacte"* and *"le mur neutralisant".*

The *"respiration exacte"* concept relies on a mechanical ventilation system to guarantee comfortable internal climate conditions. The aluminium aerators or ventilator shutters on the south-east and north-west facades provides for air circulation within the galleries. The narrow proportion of the ventilators ensure cross-ventilation for air renewal and heat dissipation of the spaces, which is essential in achieving ideal atmosphere within the space. The system of shutters on hinges work together to manage air permeability.

The *"mur neutralisant"* idea is based on the mechanical circulation of warm or cold air inside the air gap of a double façade that is only a few centimetres thick. The outer envelope of double brick wall with cavity, acting as a thermal barrier, achieves thermal stability for the museum structure. Subsequently, the high clear height of the spaces also mitigates the heat effect caused by the climate of Chandigarh, perhaps justifying the lack of air conditioning systems within the galleries. The evaporative cooling system, though seasonally, uses the position of the water pools on the western and eastern corners of the building. The movement of winds over the strategically positioned water bodies conducts air cooling.

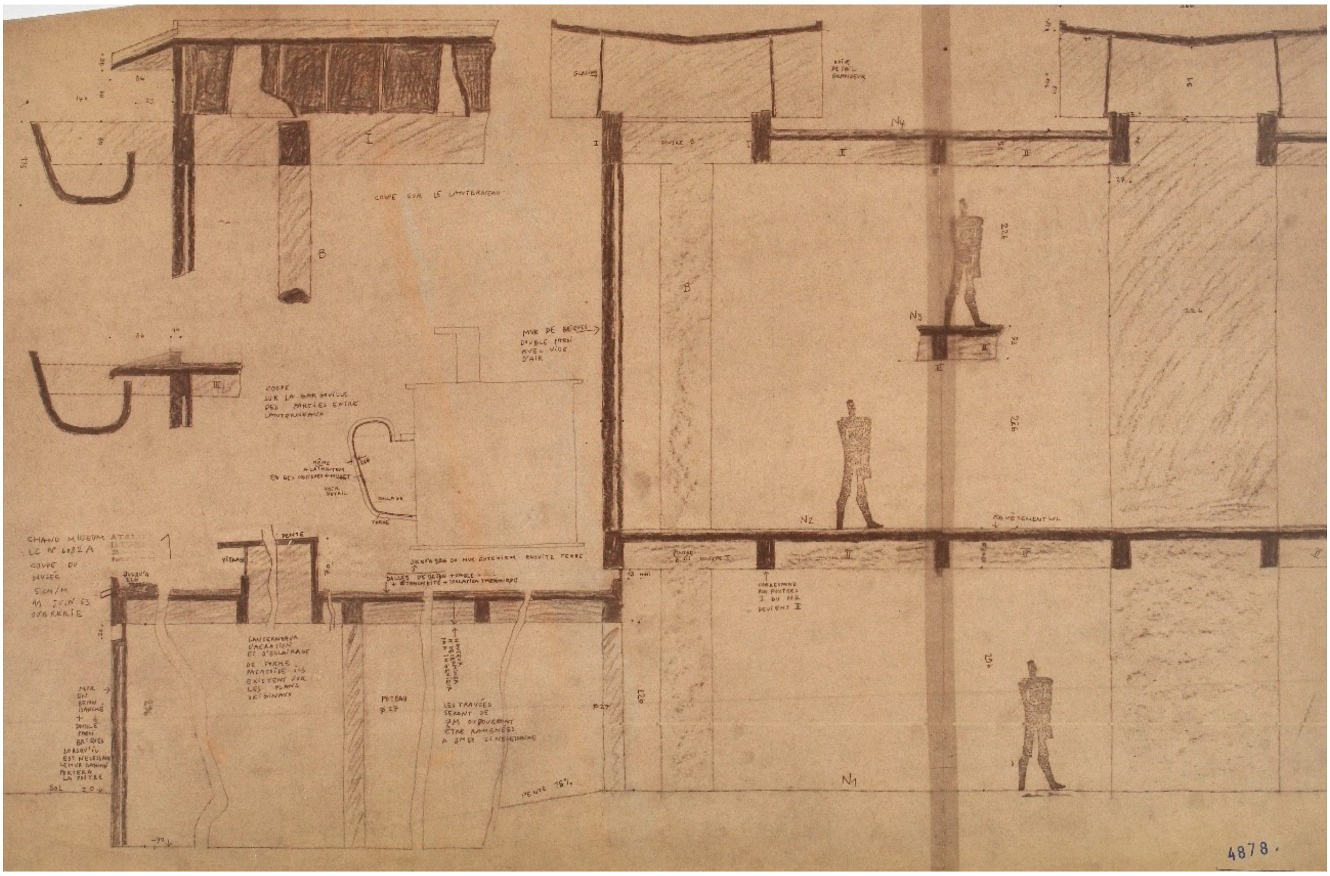


Fig. 102: Archival drawing showing section through double brick wall with cavity. Source: FLC Archive

An air duct connects the pool and the basement of the auditorium. The pipe network system connected to the basement of the Auditorium was evidently designed to passively cool the Auditorium. However, the system has not been functional since the museum's initiation.

Le Corbusier's designs are indicative of the coupling of shade and air movement as a critical response to the context of the building in terms of its climatic environment. They are Le Corbusier's responses to architectural problems related to the composite climate of Chandigarh.

4. ESTABLISHING SIGNIFICANCE

4.1 Recognising Modern Heritage

Since the last two decades, various approaches have been used to evaluate and identify twentieth century cultural heritage through international organizations and established frameworks such as:

- DoCoMoMo, the International Committee for Documentation and Conservation of Buildings, Sites and Neighbourhoods of the Modern Movement
- The Modern Heritage Programme of UNESCO's World Heritage Centre
- ICOMOS-International Scientific Committee on Twentieth-Century Heritage
- Australian National Historic Themes Framework
- English Heritage's thematic approaches to listing twentieth century heritage
- The International Committee for the Conservation of the Industrial Heritage (International Scientific Committee of ICOMOS International) thematic studies on industrial heritage
- The Cultural Landscape Foundation's thematic approaches for the assessment of twentieth century landscapes
- The International Union of Architects' twentieth century Architectural Heritage Repository website

"The Global Strategy of UNESCO is an action programme designed to identify and fill the major gaps in the World Heritage List. It encourages more countries to become States Parties to the World Heritage Convention, relies on regional and thematic definitions and analysis of categories of heritage of Outstanding Universal Value, and promotes the development of nominations of under-represented properties for inscription on the List. During the 1990's several international symposia and conferences took place discussing the dire situation with regard to the recognition of the cultural-historic significance of 20th century architectural heritage, the principal reason why it was lacking any formal protection in many countries. These debates and their recommendations for action certainly helped in raising the awareness of decision makers and the profile of this heritage at the national levels. However, the question that remained concerned the possibilities for a stronger international recognition and protection, in particular through the 1972 World Heritage Convention which had proved to be a powerful organizing tool and platform for advocacy.

In order to examine this question, the International Council on Monuments and Sites (ICOMOS), one of three Advisory Bodies to the World Heritage Committee, commissioned the Working Party for the Documentation and Conservation of buildings, sites and neighbourhoods of the Modern Movement twentieth Century Heritage and World Heritage Programme." (*Van Oers*)

At the start of the Programme in early 2001, the number of properties and sites of Modern Heritage dating to the late 19th and early 20th centuries on the World Heritage List numbered 12. Five years later, at the end of the programming, this had doubled to 23, which demonstrates the programme's remarkable success. In February 2003, when UNESCO's World Heritage Centre held its "Regional Meeting on Modern Heritage, for Asia and the Pacific" in Chandigarh, only one of India's 19 Cultural World Heritage Properties belonged to this period, with none on the Tentative List. Today, the proportion has risen to three Modern Heritage properties in 27 Cultural World Heritage Sites, while another 6 figure on the tentative List. The recent trans-national inscription of the 'Architectural Works of Le Corbusier' jointly by 7 nation states including the Capitol Complex at Chandigarh by India is indeed laudable and most encouraging for Modern Architecture.

The Getty Conservation Institute launched the Conserving Modern Architecture Initiative (CMAI) in 2012 to advance scientific research and development of conservation solutions. To complement the CMAI, the Getty Institute created the Keeping It Modern Initiative in 2014, dedicated to global architecture from the twentieth century. The grant helps custodians of modern sites research the buildings in their care and systematize their conservation processes, leading to optimal sustainable preservation solutions. The Conservation Management Plan for the Government Museum and Art Gallery, Chandigarh is a key project under the Keeping It Modern Initiative.

4.2 Statutory and Policy Frameworks

Despite the above, the cultural significance of Modern heritage in India is not yet fully recognized and conservation architects are still struggling to define the scope of Modern heritage in the country. Considering the vast expanse of unprotected heritage in the country, it is not surprising that very few of the iconic Modern structures in India are protected and even fewer that are being consciously conserved. The national protecting body, the Archaeological Survey of India (ASI) or, its counterparts in the States known as State Archaeology Departments, only protect 'Ancient Monuments and Sites' more than 100 years old. This particular clause in the Heritage Legislation at National and State level in India bars most of the Modern structures to be classified as heritage. However, beginning with a very bold initiative by Mumbai in 1996, several other city governments have undertaken exercises for grading and protecting numerous historic buildings and precincts not considered Ancient Monuments.

The list includes Bhubaneshwar and Chandigarh that were planned after Independence as part of Nation Building and Modernism in India. The Chandigarh Master Plan, in particular, acknowledges the city planning and modern buildings across the city as heritage under three categories of Heritage Zones, Heritage Precincts and Heritage Buildings that are graded and protected as Grade I, II and III based on their historical and cultural significance. The city administration is consciously working towards conservation of various heritage buildings categorized under Grade I, especially so the iconic exposed concrete structures of Le Corbusier's Capitol Complex post its recent inscription on the World Heritage List. All listed heritage zones, precincts and structures require approval of a Special Heritage Committee before any changes/interventions can be undertaken.

The Government Museum and Art Gallery has been recognized as a Grade 1 Heritage building categorized in the Chandigarh Master Plan. As per guidelines under this category, any major intervention/changes in the exterior or interior need to be approved by the Special Heritage Committee of Chandigarh. At the National Level, recently the ASI has also outlined criteria for 'National Cultural Heritage Sites' that identify them of Outstanding National Value. Clearly, GMAG satisfies the criteria that would qualify it under the National Cultural Heritage Sites. However, this listing programme is yet to be made operational.

The proceedings of the Expert Meeting 'Developing a Historic Thematic Framework to Assess the Significance of Twentieth-Century Cultural Heritage: An Initiative of the ICOMOS International Scientific Committee on Twentieth-Century Heritage' held in 2011, identifies various themes or phenomena under which various processes of the twentieth century can be classified and assessed.
Government Museum and Art Gallery is located in two of these frameworks; namely (i) the main theme of 'The role of government and changing approaches to governance', and its sub-theme of 'Education' as well as (ii) the main theme of 'Culture and Society' and its sub-themes 'Museum'.

Besides these two themes that associate the significance of GMAG with two important thematic processes of 20th century India, such as "sharing the knowledge" about (pre-colonial and post-colonial) Indian culture and "building a national identity", the third aspect is that the building belongs to the genre of 'urban architectural ensemble' as part of the 'Cultural Centre', which is a testimony of the intercultural and transnational exchange in Modern architecture at the global level. The Chandigarh museum is a crucial element of the public cultural buildings design by Le Corbusier to provide the city with coherent infrastructure as modern city.

4.3 Establishing Cultural Significance

4.3.1 Identifying and Characterizing Values

Cultural Significance indicates the importance of a site as determined by the aggregate of the values one attributes to it. The assessment and understanding of values inform heritage decisions, regarding what to conserve, how to conserve, where to set priorities and how to handle conflicting interests.

However, the assessment of values are fraught with difficulties stemming from its diverse nature, its tendency to change with time as it is shaped by contextual factors, and the fact that the values sometimes conflict. For the purpose of planning and management, the value assessment follows a systematic process which identifies all values of the heritage, followed by integrating and ranking the different, sometimes conflicting values.[81] The conservation of the asset takes into account all aspects of cultural significance without unwarranted emphasis on any one value at the expense of others.[82]

After thoroughly investigating heritage value typologies devised by various scholars and organizations like Reigl (1982), Lipe (1984), Frey (1997) and English Heritage (1997), an apposite process for assessment of significance of the various elements in the Government Museum and Art Gallery was identified in the Burra Charter (1999) Guidelines under "Other approaches". It states that *"The categorization into aesthetic, historic, scientific and social values is one approach to understanding the concept of cultural significance. However, more precise categories may be developed as understanding of a particular place increases."* Hence, considering the specifics of the site, besides the four specified values in the Burra Charter, further values specifically applicable to the Chandigarh museum were identified to evaluate its significance.

81. Marta de la Torre (Ed.), "Assessing the Values of Cultural Heritage" (Research Report, Los Angeles: Getty Research Institute, 2002)
82. ICOMOS Australia, Australia ICOMOS Charter for Places of Cultural Significance, the Burra Charter, 2013

The values identified for the Government Museum and Art Gallery and their meanings derived in context of cultural significance are discussed below:

Historical and Associative Value:
The historical value stimulates a relation to the past and can increase from the heritage asset's age, association with people or events and from its rarity and uniqueness.

Aesthetic Value:
The aesthetic value encompasses values that refer to the visual qualities and sensory perception of heritage along with experiential qualities. The design and evolution of the building, form, scale, colour, texture and material of the fabric, function of the spaces and other architectural attributes defines the aesthetic value of the asset. It demonstrates creative, spatial, artistic and innovative achievements of the asset.

Architectural and Scientific Value:
The scientific value of an asset provides understanding of the past, contributes as a resource in the present context and offers further substantial information for the future. It includes the potential to yield information on innovative materials and technologies, architectural planning principles, space transformations, changing cultural patterns and traditions.

Social and Inter-cultural Value:
Social values embrace qualities for which the heritage asset becomes a focus of spiritual, political, national or cultural sentiment to a group of people.[83] Political values which can be manifestly symbolic as a contributor to national culture and identity accrue the social value of an asset. It also includes the 'place attachment' aspect of heritage value, which may refer to the social cohesion, stimulation of community identity and feelings of affiliation that social groups, in whichever scale, derive from the asset.[84] Cultural values that build cultural affiliations and inter-cultural exchanges in the present form an integral part of social values. The social value includes the use of the asset for social activities and gatherings, capitalizing on the values of the site.

Collective Value:
Collective value is identified as a distinctive value attributed explicitly to the Government Museum and Art Gallery Chandigarh. It encompasses intangible value that emphasizes its connection to a larger ideology or ensemble.

The characterizing of the values outlined may overlap as they are closely related. For instance, the historic value encompasses the history of aesthetics, science and society, and hence underlies all other values elaborated in this section. However, it is important to understand these as different values because they correspond to different ways of conceptualizing the value of the heritage, to different stakeholder groups, and therefore to different bases for making management or conservation decisions.[85]

83. Ibid.
84. Marta de la Torre (Ed.), "Assessing the Values of Cultural Heritage"
85. Ibid.

4.3.2 Assessing Values and Significance of Government Museum and Art Gallery

Heritage values are not intrinsic, but are the outcome of its interaction with its context. While considering the sociocultural values of the Government Museum and Art Gallery, we delve into the values attached to the building, to its age, architecture and association to the person and events that contributed to the processes of cultural connection.

Historical and Associative Value:
Chandigarh was formed owing to a specific historic context - the partition of India in 1947. Punjab's capital Lahore became a part of the newly formed Pakistan, leaving Punjab without a capital. Jawaharlal Nehru, the first Prime Minister, envisioned the new capital of Punjab to be a modernist symbol to be designed by a significant modern architect.[86] The museum holds value as a symbol of post-colonial national identity.

The historic value of the museum in terms of its association with the partition of India increases when considering the origin of the collection housed within the museum. The museum collection was part of a larger collection of the Lahore Museum, which was subsequently split after the partition of India, hence drawing on associative value. After being transferred around to other cities and museums for over 18 years, the collection found its home in the Chandigarh Museum in 1968. The collection comprises rare, unique and archetypical examples of its type and this adds to the historic value of the museum's collection.

Le Corbusier's association with the promotion of modern India added a new dimension to the Indian architectural experience. His influence on India and the young Indian architects of the time is of great significance, leading to the emergence of a modern architecture movement which were stylistically centered on his design patterns and principles. The museum's association with the Modernist master holds immense associational significance.

Aesthetic Value:
The museum stands symbolic as a significant landmark in the cultural core of the designed urban city of Chandigarh. The built structure of the museum exhibits unique architecture in terms of its form and spatial arrangement. The built form follows Le Corbusier's concern with juxtaposition of pure forms to develop rugged abstract sculptural forms resting on pylons, giving a sense of architectural monumentality. The design uses space, light and volume as basic elements of design. The formal vocabulary of the design also extends from the architecture of built spaces to the urban furniture, street lighting and landscaping. It is the most evolved museum realizing the concept of Open Plan from macro level of the city to the site and building.

The aesthetic significance of the Museum is attributed to the harmonious composition and experiential quality of the built spaces. The building portrays extensive use of reinforced concrete in its natural exposed form to amplify buildings as monumental sculptures, which was distinctively Le Corbusier's work. The unadorned surfaces emphasize the textural quality of exposed reinforced concrete. The bare concrete façade of the museum is only broken by brick panels, stressing on non-decorative aesthetic choices. The museum is an exemplary example of Modern architecture using innovations in materials, technology, colours, texture etc. The building construction also dealt appropriately with the Indian climate and labour intensive construction techniques.

86. Jon Lang, *A Concise History of Modern Architecture in India*

Architectural and Scientific Value:

The museum shows significance as an exemplary contribution to Modernism in its search for one with the 'Idea of a Museum as a Machine'. It intended to be beyond a monument limited to house artefacts, allowing unlimited expansion for exhibiting culture with a human scale within experiential spaces.

The museum also extends value as a prototype for Museum Building Design in Independent India. The building illustrates formal, technological and material innovation in Modernism to reflect post-independence ideals of nation building and Museum Design. It reflects post-independence ideals by sharing the Indian knowledge/culture through an architecture looking forward rather than the past.

The Government Museum is an amalgamation of the various theories and concepts developed by Le Corbusier: the open plan, the Domino, the 5 points of architecture, the *Modulor* and finally the Museum of Unlimited Growth. The Chandigarh museum is last of the three realized projects of Le Corbusier's endless museums.

Although the concept of "unlimited growth" propagates non-contextual design, the application of local materials and their implementation by local craftsmen ironically makes the "Three Museums" relate strongly to their context. In the case of Chandigarh, one can see the amalgamation of two antithetical facets: modernity and native craftsmanship. The fabrication of the unfinished concrete envelope with brick cladding, the fibreboard ceiling panels, or even the collection display demonstrate industrial processes that were executed by the local craftsmen. It produced a type of "handcrafted-standardization", which is paradoxical, but in a very interesting way. It leaves one to wonder if Le Corbusier and Jeanneret intended to merge modernity with tradition in Chandigarh.

Social and Inter-cultural Value:

When India became independent in 1947, Prime Minister Jawaharlal Nehru launched a vast national modernization project. The building of the new capital for Punjab brought a very specific sensibility to Chandigarh, one of national identity. The museum building was projected as part of the educational policy of Independent India to use Museums as Knowledge Centre. The museum as a means to disseminate knowledge reflects the social value of the museum.

Positioned at the core of the cultural centre of the Chandigarh city, the Museum exudes cultural-social value as the cultural hub of the city.

The museum represents the ensemble of outstanding Modern architecture that marks transnational exchange of architectural ideas and its subsequent impact on Indian and western architecture.

Collective Value:

The museum at Chandigarh can be seen as part of an ensemble of three museums designed by Le Corbusier in Asia, which includes the Sanskar Kendra in Ahmedabad and the National Museum of Western Art in Tokyo. Collectively these three Museums form an integral series to represent the realization of Le Corbusier's long thought project for "museum of unlimited growth'. They follow similar modular framework of Modern ideals, the manifesto of 5 points of architecture and material innovations, while providing a diverse interplay of spaces and building technologies adapted contextually to suit the local perspective and programmatic requirement of each. The three museums show the evolution and transformation of the museum prototype to suit the specificities of the project sites. Collectively, the museums presents an interesting interaction between idealization and localization thus exemplifying the pragmatic idealism evident in the constructed sites of Le Corbusier with his extraordinary concept being modulated on site by regional modern architects.

Considering the shared heritage values of the three museums, the participants at the Workshop conducted by GCI in February 2018, recognized the collective cultural significance of the three museums.[87] The series of museums constructed in Ahmedabad, Tokyo, and Chandigarh may be collectively recognized as internationally significant:

I. As exemplars of the interchange of human values internationally in relation to modern architecture.

II. As an exemplary contribution to modernism in its search for a new concept for the museum, this design represents the idea of the "museum as machine, "which breaks with the traditional notion of a museum as a monument designed to house artefacts, and instead provides a non-monumental place for exhibiting culture with a human scale, experiential spaces, and the possibility of unlimited expansion.

III. As an integrated series, these three buildings represent the complete and only realization of Le Corbusier's prototypical Museum of Unlimited Growth. They all demonstrate Le Corbusier's five points of architecture, as well as his modular ideal, and incorporate material innovations and spatial complexity. The series demonstrates the evolution and refinement of the prototype museum concept, as well as its adaptation to local conditions and building technologies to suit the museums 'respective geographic and climatic contexts, and the programmatic requirements of each, thereby demonstrating the interplay of theory and practice developed by Le Corbusier over half a century.

IV. As an interesting interaction between idealization and localization, thus exemplifying the pragmatic idealism evident in the constructed sites of Le Corbusier, with his extraordinary concept being modulated on site by regional modern architects (including B. V. Doshi, M. N. Sharma, and Kunio Maekawa), thus nurturing modernism's Asian diaspora and affirming modernism as the architectural language of the future.

V. As outstanding examples of iconic modern museums that remain in their original use, each plays an important cultural role in the urban life of the city it inhabits: in Tokyo, as a national repository for Western Art; in Chandigarh, as a cultural marker for the new, modernist capital city; and at Ahmedabad, as the museum telling the story of the city as part of a larger cultural space for the expanding community. All are substantially intact in concept, design, and material fabric, and largely retain their settings and relationships with their cities.

4.3.3 Statement of Significance[88]

"The Government Museum and Art Gallery, Chandigarh, is an exceptional national example of modern architecture in India. It simultaneously illustrates formal, technological and material innovation in modernism to reflect post-independence ideals of nation building along with new ideas in museum design. Additionally, it is part of an ensemble of outstanding modern architecture of Chandigarh that marks the transnational exchange of architectural ideas and its subsequent impact on Indian and Western architecture, which lasted for more than three decades. It is an iconic modern museum building designed by Le Corbusier as the final realization of his concept for the Museum of Unlimited Growth."

87. Ana Paulo Arato Gonçalves, Chandler McCoy and Susan Macdonald. "Le Corbusier's Three Museums: A Workshop on Their Care and Conservation" (Meeting Report by the Getty Conservation Institute, Ahmedabad, February 4-6, 2018 and Chandigaarh, February 8, 2018)
88. Ibid.

4.4 Values

In the broader context of the development and evolution of the Government Museum and Art Gallery, Chandigarh, the significance of the museum can be distinctly evaluated as shown in the following chart. It shows the result of a detailed analysis of the attributes of various elements of the Museum: its form, landscape, exterior, interior, materials, furniture, display and collection. The value evaluation will subsequently inform the further assessment and policy formulation.

For a holistic assessment, each value is given equal importance. The ranking of values expressed in the following table is based on the cumulative significance attached to the various categories of the heritage asset.

E - Exceptional Value: For components that meet one or more of the assessment criteria at an exceptional level. These are elements integral to the cultural significance of the heritage asset. They can be replaced only if it is essential due to their compromised condition and should to be replicated to meet their original form, colour, material and texture in totality.

H - High Value: For components that meet one or more of the assessment criteria at an exceptional level. These elements make major contribution to the cultural significance of the heritage asset. If the element has been compromised to some extent, it can be replaced with matching material as and when required, while retaining similar colour and texture.

M - Medium Value: For components that meet one or more of the assessment criteria at a medium level. These elements make an overall contribution to the significance of the heritage asset. The elements can be replaced to accommodate present use, but while ensuring that the interference does not impact other elements of higher value.

L - Low Value: For components that meet one or more of the assessment criteria at a low level. These elements are neutral to the significance of the heritage asset. The elements can be replaced or removed to provide for present use and requirements.

The values derived for the various elements illuminate the conservation and management planning issues and serve as guides for actions to be adopted.

Table 6: Significance matrix for individual elements of the Government Museum and Art Gallery, Chandigarh

ELEMENT	AESTHETIC VALUE	HISTORIC VALUE	SCIENTIFIC VALUE	SOCIAL VALUE	COLLECTIVE VALUE	AUTHENTICITY	OVERALL SIGNIFICANCE
LANDSCAPE							
Pools – Form and Layout	E	H	E	H	E	**H** (Reversible changes)	**Exceptional**
Pools – Surface treatment	E	H	E			**L**	**Exceptional**
Vegetation	H	H	H			**L**	**High**
Piazza	H	H	H			**H**	**High**
Urban Furniture	E	E	H			**L**	**Exceptional**
BUILDING EXTERIOR							
Exposed concrete	E	E	E	H	E	**H**	**Exceptional**
Brick tile cladding	H	E	E			**H** (Some changes)	**Exceptional**
Concrete floor	M	M	H			**H**	**Medium**
Gargoyles	E	E	E			**H**	**Exceptional**
Concrete drains	E	E	E			**H**	**Exceptional**
Clerestory and Fins	E	E	E			**H**	**Exceptional**
Undulatory fenestration	E	E	E			**H** (Reversible changes)	**Exceptional**
Aerators	E	E	E			**H**	**Exceptional**
Pivoting doors	E	E	E			**H**	**Exceptional**
BUILDING INTERIOR							
Exposed concrete	E	E	E	M	E	**H**	**Exceptional**
Painted walls	H	H	M			**H**	**High**
Fibreboard ceiling panel	E	E	E			**H**	**Exceptional**
Terrazzo floor	E	E	E			**H** (Reversible changes- Pilotis)	**Exceptional**
Concrete floor	M	M	H			**H**	**Medium**
Metal doors (Original)	H	E	E			**H**	**Exceptional**
Undulatory fenestration	E	E	E			**H** (Reversible changes)	**Exceptional**
***E** – Exceptional Value; **H** – High Value; **M** – Medium Value; **L** – Low Value*							

ELEMENT	AESTHETIC VALUE	HISTORIC VALUE	SCIENTIFIC VALUE	SOCIAL VALUE	COLLECTIVE VALUE	AUTHENTICITY	OVERALL SIGNIFICANCE
COLLECTION							
Museum Collection	H	E	M	E	E	**H**	**Exceptional**
Library Collection – Books, Photos	M	H	M	L	L	**H**	**Medium**
Library Collection – Randhawa Archive	L	E	E	H	H	**H**	**Exceptional**
Artwork – Mural	E	E	H	L	L	**H**	**Exceptional**
MOVABLE AND IMMOVABLE FIXTURES							
Display furniture	E	E	H	L	L	**H** (Some changes)	**Exceptional**
Furniture	H	H	M			**H** (Some changes)	**High**
SERVICES							
Lighting (Original)	E	E	H	H	H	**H** (Some changes)	**Exceptional**
Lighting (New)	L	M	M	L	L	**L**	**Medium**
Passive cooling system	M	H	E			**H**	**High**
Toilets	L	L	L			**L**	**Low**

***E** – Exceptional Value; **H** – High Value; **M** – Medium Value; **L** – Low Value*

5. SURVEYS AND ASSESSMENTS

5.1 History of Interventions, Repairs and Alterations

The Government Museum and Art Gallery has undergone a few changes over the last 50 years. Alterations can be seen in the configuration of spaces and additions made as part of repairs and maintenance of services and infrastructure. This chapter discusses in detail the changes the building has undergone since its inauguration in 1968 and its effect on the visual and experiential quality of the spaces, structural and spatial performance and the general functionality of the building.

The Museum office has maintained records of minor repairs, upgradation of services and routine maintenance done at the museum over the past years. Some records and drawings were also available at UT Office. However all records are not readily available, and records of some works are missing. A wide range of photographic evidence has also been documented. Oral history was also recorded from staff and other persons involved with the museum. All these have given a comprehensive picture of the changes made to the structure over the last 50 years.

5.1.1 Landscape

The intended visual perspective of the building and its environs as designed by Le Corbusier has changed with the passage of time.

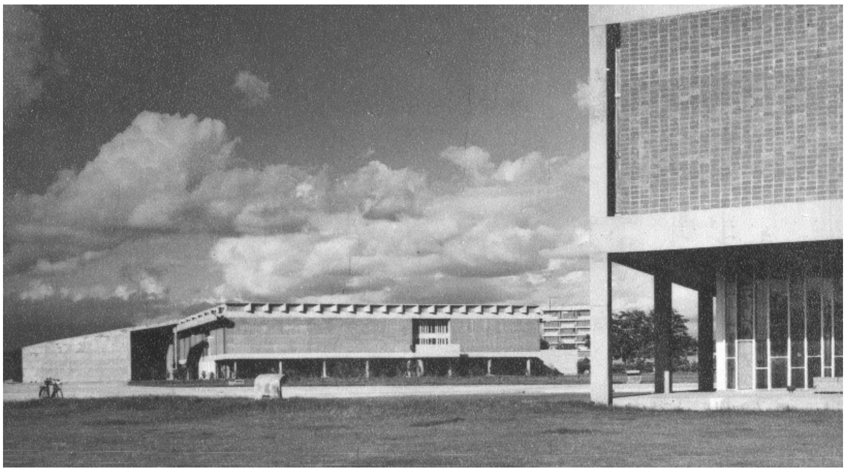


Fig. 103: Trees obstruct the view of the Government Museum building from the Museum of Natural History.

Fig. 104: The Museum building is obscured from view due to the construction of the amphitheatre for the light and sound show as a later addition.

Fig. 105: Addition of fountain and contemporary sculptures to pool (L); Addition of protective grated railing around the rear pool (R)

Fig. 106: Chandigarh is dotted with urban furniture designed by Le Corbusier. However, the position of these within the museum precinct have been changed or have been completely removed.

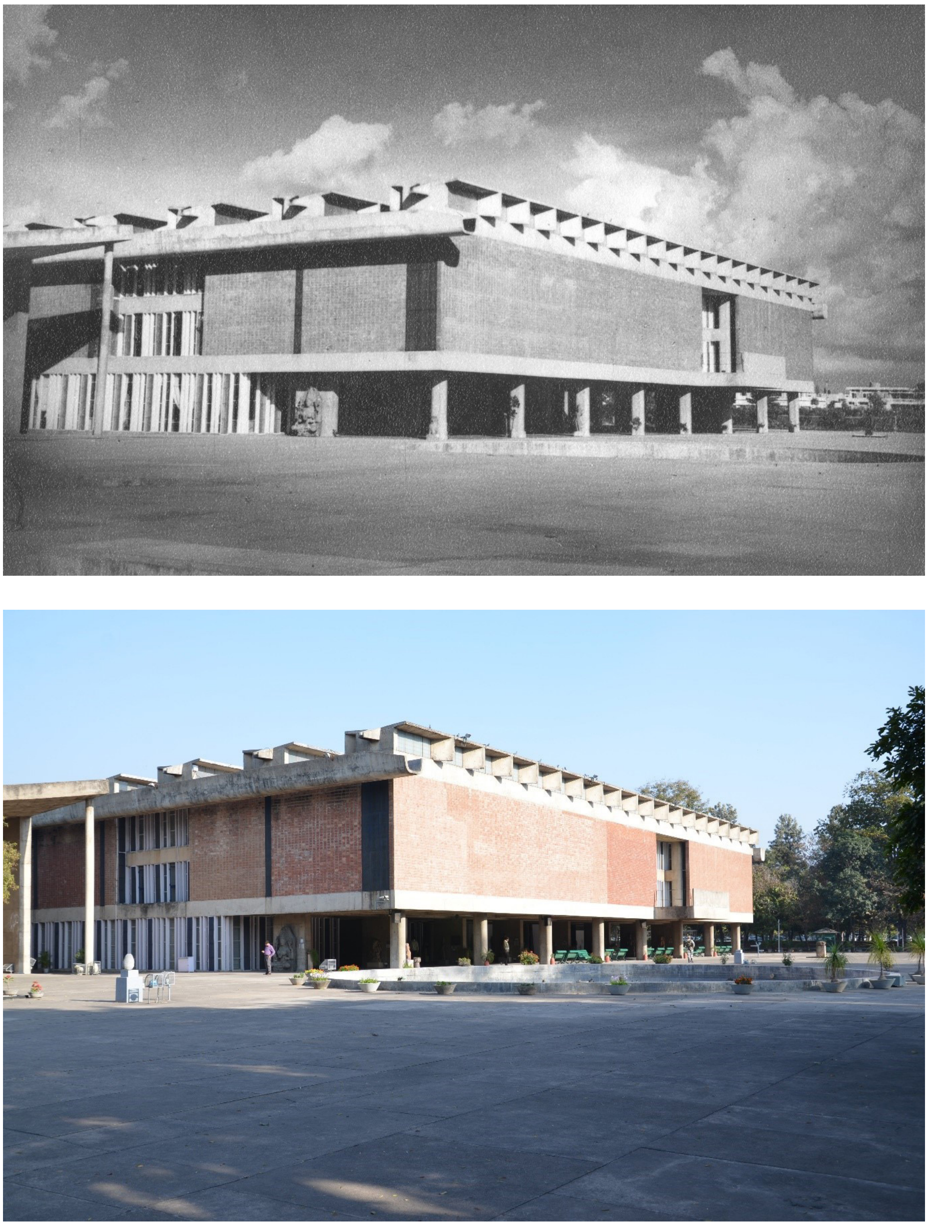


Fig. 107: Addition of a toe wall and the placement of potted plants around the pool at the museum entrance softens the intended starkness of the concrete piazza.

5.1.2 Building Exterior

Alterations to façade:

Many alterations have been made to the building façade in the name of maintenance and repair. However these unsympathetic repairs do not match the original and hence are very clearly differentiable and look visually obtrusive.

Fig. 108: Replacement of brick tiles on exterior façade shows incompatibility in terms of specification and colour.

Fig. 109: Painted mesh over vertical fenestrations as later addition.

Interventions due to change in function:

Interventions have been made to accommodate ancillary functions that were not considered during the original design of the spaces in the museum. The air conditioning units and utility spaces have been provided at the rear of the building using ad-hoc materials. However these have changed the dynamics of the building by altering the openness of the pilotis.

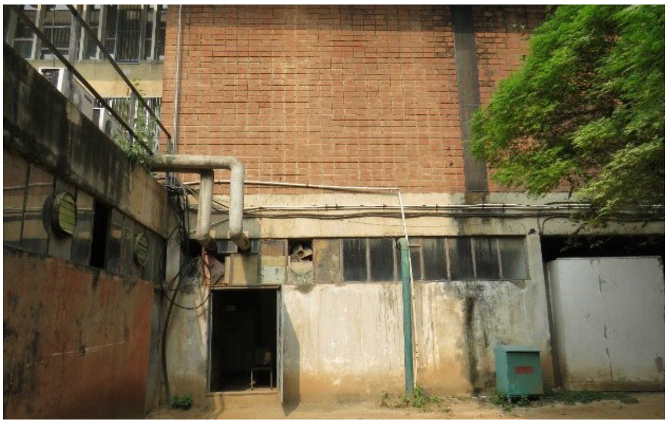



Fig. 110: Additions using permanent and temporary materials to accommodate utility spaces at the rear side of the building.

5.1.3 Building Interiors

Changes in space configuration:


Fig. 111: Addition of glass doors on the ground floor and collapsible grills on the first floor disrupts the flow of spaces physically and visually.

Fig. 112: Addition of collapsible grill at opening to gallery. Channel fixed onto original flooring.

Fig. 113: Addition of air conditioning units has brought down the ceiling level in the gallery dampening the spatial quality.

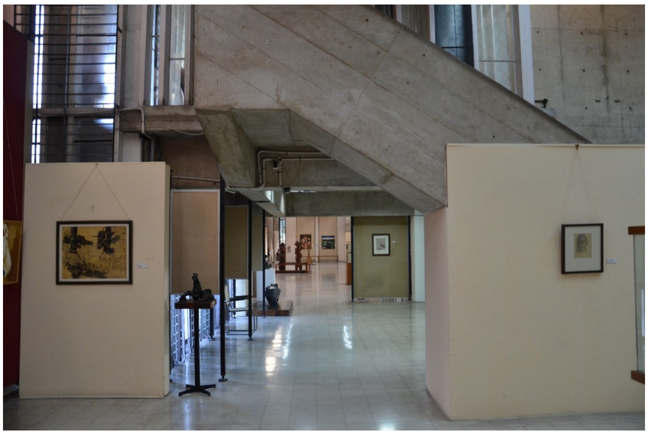
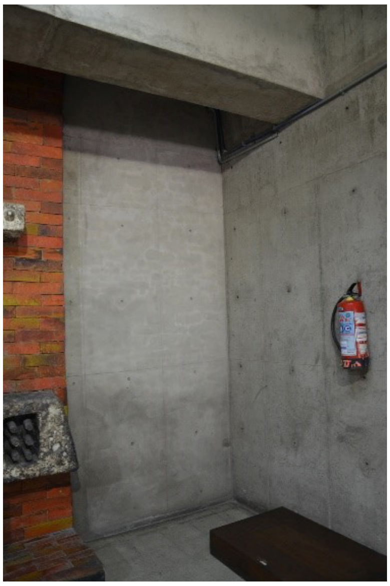


Fig. 114: Partitions that serve as display panels block the window opening.

Alterations to vertical circulation within the museum:

The vertical circulation within the museum has been closed off, leaving only the ramp accessible to the visitors. The elevator openings have been blocked to close off at the ground floor and first floor. The staircase leading to the upper floors and terrace has been blocked with infill wall. The doors leading from the stairwell to the galleries also have been locked and sealed with wax.



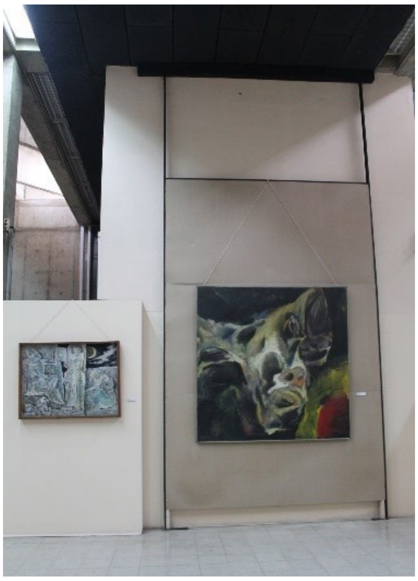


Fig. 115: Elevator and staircase closed off with brick work and plywood respectively.

Interventions due to change in function:

Interventions have been made to accommodate the child art gallery in the area intended as an open pilotis leading to a cafeteria and its service areas.

Fig. 116: Child art gallery incorporated within the pilotis

5.1.4 Doors and Windows

Fig. 117: Addition of curtains to internal windows

Archival photos suggest that the entrance door was painted in bright colours. This however was changed under the instruction of Dr. Randhawa, who suggested that it should have no design and should be painted in plain gold or French blue.

Fig. 118: *Colorfully painted entrance door was later changed.*

Fig. 119: Addition of blinds and safety grill to the undulatory windows have changed the light quality within the gallery.

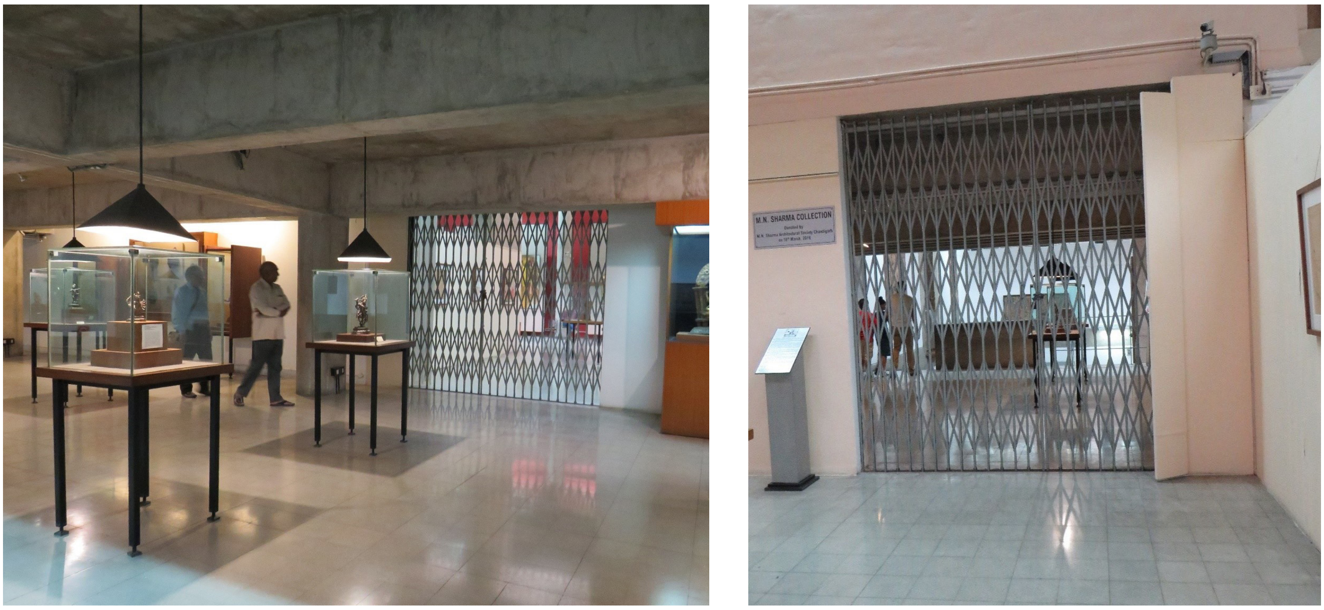


Fig. 120: Collapsible metal grills at opening between galleries restricts visitor movement.

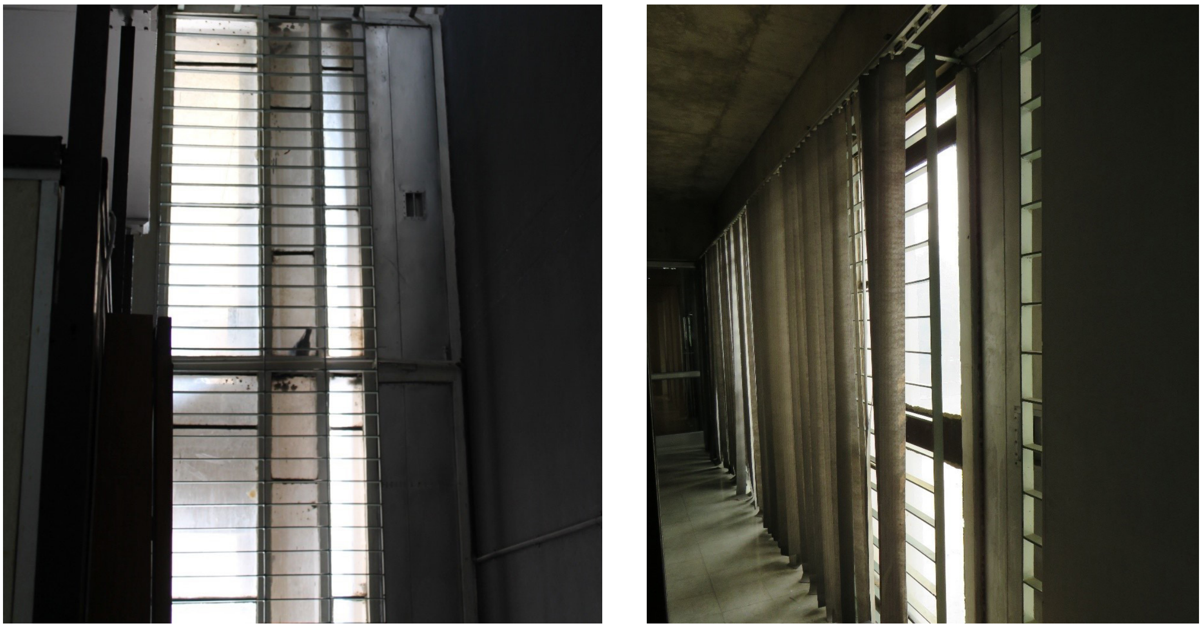


Fig. 121: Protective metal grill and blinds against windows dampens light quality of the gallery.

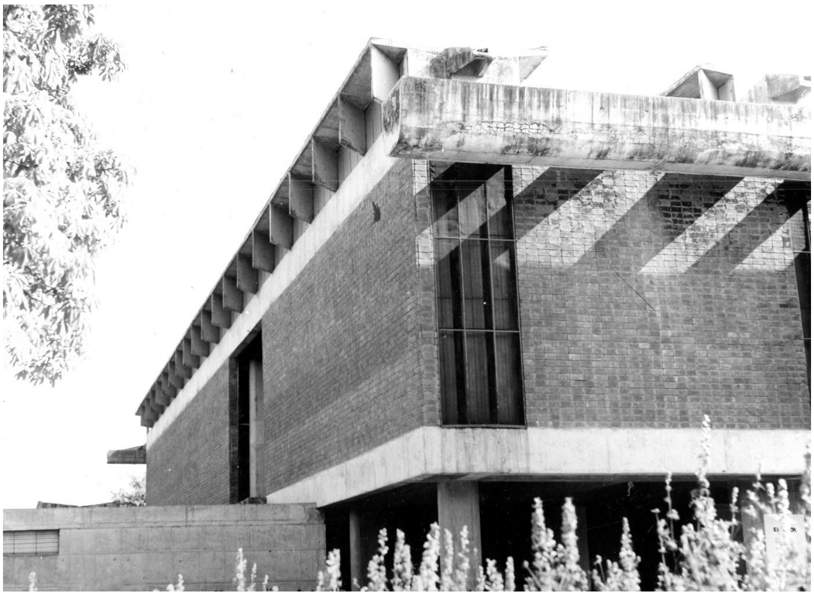


Fig. 122: Addition of painted metal mesh to windows.

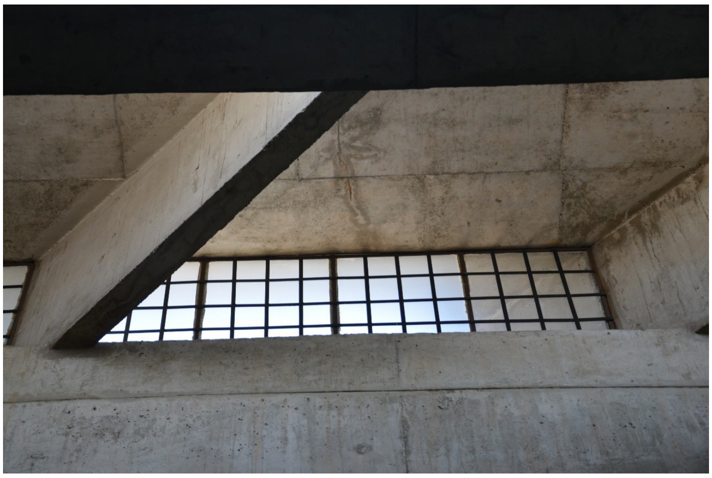


Fig. 123: Protective Addition of protective grills to clerestory windows. The window pane is replaced with glass that do not match the original tinted glass.

5.1.5 Terrace Drainage Elements

Fig. 124: Patch repair of concrete drains

Fig. 125: Inefficient patch repair of terrace waterproofing

The documents accessed from the Museum office and the Chandigarh UT Office shows correspondence between the offices and architecture teams with regard to repairs, routine maintenance and upgradation of services within the Museum. The review of these documents helped in drawing up a timeline of activities and events as described in the table below.

Table 7: Timeline of Interventions, Repairs and Alterations

PERIOD	ALTERATION / ADDITIONS	REFERENCE
Oct 1953-April 1954	Conceptualization of building plans and landscaping by Le Corbusier	
July 1954	Received the budget programme from the government for the project.	
Aug 1954	Proposal for location and concept of the offices at the museum building.	
Feb 1955	Approval of building of offices at the museum.	
March 1955	Construction of offices deferred and shift to a new location outside the museum premises.	
1956	Finalization of the site for Government Museum and Art Gallery.	
May 1958	Construction of museum deferred due to lack of funds and relocation of artefacts at Punjab Museum from Lahore to Moti Bagh Patiala.	
July 1958	Meeting held to reconsider the need of construction of Government Museum and Art Gallery at sector 10 Chandigarh.	Archival documents from UT office and Museum office
1968	Inauguration of Government Museum and Art Gallery	
Jan 1982	Proposal for providing garbage bins at the museum	Archival drawings
Feb 1982	Discussion on provision of irrigation facilities in the museum campus.	Archival documents from UT office and Museum office
Oct 1983	Meeting discussion points: 1. Construction of exhibition hall cum admin block: Cons. Under litigation with the contractor in the court 2. Repair of boundary wall close to the admin cum exhibition hall	Archival documents from UT office and Museum office
Dec 1985	Drawings prepared by UT for fumigation chamber, case for coin display, movable display screens.	Archival drawings
July 1987	Aluminium light track with ceiling spot lights and temporary spot lighting installed for Henry Moore exhibition. These lights have not been removed since.	Archival drawings
Sept 1988	1. Providing security lights in all locations in the site 2. Exhibition hall cum Admin block converted to City museum therefore it's conversion into sculpture gallery was dropped.	Archival documents from UT office and Museum office
1988	INTACH Report: Establishing of the museum souvenir shop.	Archival documents from UT office and Museum office
Feb 1989	Conservation lab and room for exhibition officer proposed within the temporary exhibition gallery. Drawings prepared by UT for display panels along wall and aluminium guide track with spot lighting on ceiling of temporary exhibition gallery	Archival drawings
Feb 2000	Provision of grills for skylight. Drawings prepared by UT for display cases.	Archival drawings
May 2000	Drawings prepared by UT for provision of glazed aluminium partitions in Miniature painting gallery	Archival drawings
June 2000	Improvement of lighting system in the museum building.	Archival documents from UT office and Museum office

PERIOD	ALTERATION / ADDITIONS	REFERENCE
Sept 2000	Meeting discussion pointers: 1. The existing Cycle stand was considered to be converted into a Museum Shop and Exhibition hall but rejected, keeping in view the inadequate head room available. 2. Strengthening of Security: a. Providing suitable campus lighting and close circuit cameras; b. segregation of more ancient, priceless and rare works of art with grill gates; c. providing strong iron grills (aesthetically designed) in the window panes of GF museum; The grills on the windows on the g+1 and the sky lights only provide notional resistance to unauthorised entry, it needs to strengthen.	Archival documents from UT office and Museum office
Oct 2000	Drawings prepared by UT for provision of grills for undulatory windows.	Archival drawings
Jan 2002	Drawings prepared by UT for provision of granite cladding of reception counter and cabinets below the counter.	Archival drawings
April 2002	Repair work of all the M.S. grills for the skylights.	Archival documents from UT office and Museum office
Nov 2002	Repair of the brick tiles on the outside walls of the main building of the Govt. Museum and Art Gallery.	Archival documents from UT office and Museum office
2002-2003	1. Fire sensing equipment's 2. Generator for Govt. Museum 3. Landscaping of Museum Campus 4. Repair/Renovation of Cycle Stand 5. Repair/Renovation of Guard Room 6. Reopening of the section of philately	Archival documents from UT office and Museum office
Jan 2002	Proposal of Air Conditioning with location finalization	Archival documents from UT office and Museum office
	Providing Diesel Generator Set in the outside Drg no .14 Job no. 536	Archival documents from UT office and Museum office
	Museum Shop Cabinets drawn Drg no. 98 Job no. 294	Archival documents from UT office and Museum office
Feb 2002	Meeting discussion points: 1. Strengthening of security system in Govt museum and art gallery: The barbed wire boundary wall was being dismantled and a brick boundary wall was being prepared according to meeting held in 2nd week Dec 2001. Finally, Barbered wire fencing with hedge/creeper was decided. 2. Points raised by Dr. V.H. Bedekar: Ultra violet films provided on the glazed windows in the Indian miniature painting section of the museum to cut the effect of ultra violet rays.	Archival documents from UT office and Museum office
	Detail of Proposed AC Plant room and detailed drawings of AHU room on the mezzanine floor of Miniature Painting Section, Gallery of Air Conditioning.	Archival documents from UT office and Museum office

PERIOD	ALTERATION / ADDITIONS	REFERENCE
	Meeting Discussion pointers: 1. Air conditioning of Indian Miniature Painting section be completed within 2001-2002 session 2. Strengthening of Security: The proposed brick wall between Govt. College of Art and Govt. Museum and Art Gallery will create visual hindrance therefore, some green foliage and flowering plants be planted along with the barbed wire also beautifying the entrance.	Archival documents from UT office and Museum office
June 2002	Removal of wooden structures and paintings for the installation of the AC Unit	Archival documents from UT office and Museum office
July 2002	As per discussion at site on 18/6/2002 the proposed suspended ceiling to cover the air conditioning duct is to be maintained at a uniform level as per existing ceiling. Same materials and design is to be adopted for the ceiling at the resultant lower level and along with that existing lighting fixtures have also been removed and fixed.	Archival documents from UT office and Museum office
Sept 2002	Meeting Discussion pointers: 1. Air conditioning work of the Indian Miniature Paintings section under process 2. Strengthening of Security: Close Circuit cameras installed 3. Landscaping for museum campus: Creepers planted along the barbed wire fencing 4. Conversion of Cycle Stand into Child Art Gallery: There was a Child Art Gallery in the Exhibition-cum-Administrative block which has been converted into City museum. It is proposed that the works of art removed from the Exhibition Hall-cum-Administrative Block building may be accommodated in the Cycle Stand after its conversion to Child Art Gallery.	Archival documents from UT office and Museum office
March 2003	Meeting Discussion pointers: 1. Review of Air conditioning on next meeting; the feasibility/desirability of introducing an air conditioning to be sought first, with respect to the months and hours during which the air conditioning should be on.	Archival documents from UT office and Museum office
April 2003	Pre-Planning Meeting Discussion pointers: 1. Work in Progress: a. Prov. and fixing of translate (done) b. Dismantling and re-fixing of canopies in manitone pointing section c. Prov. Of AC in the miniature painting section (80% done) 2. Work in Approval/Planning Stage: a. Repair/Renovation of Guard Room b. Providing of ceiling and exhaust fans c. Providing generator set d. Landscaping of museum Campus e. Replacement of 2 window types AC in Committee room/ Library f. Renovation of toilets g. Prov. Fire sensing equipment h. Providing Touch screen kiosks in important sections i. Stoppage of leakage of main art Gallery building j. Conversion of Cycle Stand into Child Art Gallery k. Repair of rain water tunnels l. Prov. And laying 25mm thick semi dense bituminous concrete on approach road and parking	Archival documents from UT office and Museum office

PERIOD	ALTERATION / ADDITIONS	REFERENCE
May 2003	The evaporating unit of split AC type air-conditioning will be hung from the beam on the skylights of the library and no projection on the floor will be utilised therefore not affecting the ambience and efficiency of the museum Gallery	Archival documents from UT office and Museum office
Aug 2003	Provision of air conditioning to the miniature paintings section hall.	Archival documents from UT office and Museum office
Oct 2003	White wash of the curatorial staff room situated at the 2nd floor.	Archival documents from UT office and Museum office
Nov 2003	Meeting Discussion pointers: 1. Prov. and fixing of translate (done) 2. Dismantling and re-fixing of canopies in manitone pointing section (done by 30/11/2003) 3. Prov. Of AC in the miniature painting section (done by 30/11/2003) 4. Providing of ceiling and exhaust fans (estimate to be framed) 5. Providing generator set (estimate to be framed) 6. Replacement of 2 window types AC in Committee room/ Library (Estimate submitted, admin approval awaited) 7. Renovation of toilets (estimate to be framed) 8. Providing Touch screen kiosks in important sections (delayed) 9. Stoppage of leakage of main art Gallery building (director pointed it as general problem and ordered necessary action) 10. Conversion of Cycle Stand into Child Art Gallery (estimate to be framed) 11. Repair of rain water tunnels (need to be looked over) 12. Prov. And laying 25mm thick semi dense bituminous concrete on approach road and parking (estimate to be framed)	Archival documents from UT office and Museum office
Dec 2003	Grinding of the floor of Harappan Section in the main Art Gallery.	Archival documents from UT office and Museum office
March 2004	Request for allocation of AC substation in the building	Archival documents from UT office and Museum office
April 2004	Request for supplying drawings of Fibre Glass shed proposed above the Cycle Stand for stopping the rain from entering, and changing the grill gate to iron gate.	Archival documents from UT office and Museum office
	The basement Cycle Stand is non-habitable, as per building bye-laws and cannot be used as Child Art Gallery.	Archival documents from UT office and Museum office
Aug 2004	Laying of 25mm thick semi dense bituminous concrete on the roads of parking.	Archival documents from UT office and Museum office
	Removal of Barbered wire for a basketball court's provision in the govt. college of art	Archival documents from UT office and Museum office
	Drawings prepared by UT for landscaping of museum entrance	Archival drawings

PERIOD	ALTERATION / ADDITIONS	REFERENCE
Oct-Nov 2004	Removal of barbed wire fencing between Govt. College and Art Museum	Archival documents from UT office and Museum office
Nov 2004	Meeting Discussion pointers: 1. 200KVA Generator Set installation in museum 2. Provision of Ceiling and exhaust fans 3. Electricity Connection for AC plant in Indian Miniature painting section 4. Teak Wood showcases and fixing of metal screens in Art Gallery 5. Laying of 25mm thick bituminous concrete on road parking of museum	Archival documents from UT office and Museum office
	Letter from Director to JE: 1. Increase in capacity of overhead water tanks 2. Need of booster pumps to counter low pressure 3. Water tank provision in Police Guard toilets 4. Shanks of conservation lab to be replaced 5. Renovation of Public Toilets	Archival documents from UT office and Museum office
	The cycle Stand to convert into Child Art Gallery	Archival documents from UT office and Museum office
	Alterations in the blind gate walls of Govt. Museum and Art Gallery and Natural History Museum	Archival documents from UT office and Museum office
	Renovation of toilet and improvements in related services	Archival documents from UT office and Museum office
Dec 2004	Grinding and polishing of floors of Govt. Museum and Art Gallery.	Archival documents from UT office and Museum office
	Beautification of abandoned AC pond in the premise. Drawings requested for the same	Archival documents from UT office and Museum office
2005	1. Opening of the epigraphy and numismatics section. 2. Provision of air conditioning in the gallery of contemporary art.	Archival documents from UT office and Museum office
Jan 2005	Request from Governor to make gallery of Contemporary Arts Air Conditioned	Archival documents from UT office and Museum office
	Conversion of Dry Pond into Lotus Lily Pond	Archival documents from UT office and Museum office
Feb 2005	Landscaping of the museum campus	Archival documents from UT office and Museum office
June 2005	Request of Installation of shadow Tube Well	Archival documents from UT office and Museum office
	Request for removal of cement concrete and creating green pathways and plant shrubs and lower plants	Archival documents from UT office and Museum office
	Development of Pond parapet	Archival documents from UT office and Museum office

PERIOD	ALTERATION / ADDITIONS	REFERENCE
July 2005	1. Providing Aluminium glazed door in main building and renovation thereof. 2. Renovation of Reception counter	Archival documents from UT office and Museum office
	Letter Referring: Inauguration of City Museum on 17/12/1997 1. Admin office shifted to Natural History Museum 2. Temporary exhibition made near conservation lab 3. General Store made in the museum canteen 4. Dismantled objects of Child Art Gallery along with showcases, screens temporarily shifted in cycle stand which was to be changed to Child Art Gallery	Archival documents from UT office and Museum office
Sept 2005	Conversion of scooter stand into general store, providing shelves in the cycle stand	Archival documents from UT office and Museum office
Oct 2005	Drawings prepared by UT for converting cycle stand into general store	Archival documents from UT office and Museum office
	Issue of drawings of Museum Campus for provision of Sound and Light show by Citco	Archival documents from UT office and Museum office
Dec 2005	Shifting of National Gallery of portraits from Sec 17	Archival documents from UT office and Museum office
	Providing and installing 60 Ton AC plant in City Museum	Archival documents from UT office and Museum office
Jan 2006	Drawings prepared by UT for undulatory glazing in child art gallery	Archival drawing
March 2007	Drawings prepared by UT for proposed exhibition display in child art gallery	Archival drawing
Feb 2011	Drawings prepared by UT for renovation of temporary exhibition gallery and upgradation of Auditorium	Archival documents from UT office and Museum office

5.2 Landscape Condition Assessment

5.2.1 Water Pools

Front Pool:

The storm-water run-off from the roof has been directed to the pool and this gets ‘activated’ as and when there is rainfall. The original slope of the pool is towards the central pit from where it drains out to the main rainwater outlet pipe running outside the premises towards Leisure valley. Thus the pool acted as a stop-gap solution between the roof-top drainage and the final disposal of the storm-water, briefly animating the setting with the water gushing out from a height.

Later interventions included the following:

i. addition of small stone sculptures in the pool bed,
ii. raising of its sides with a toe wall
iii. creation of more pits within the pool, thus loss of original flooring
iv. putting up of a fountain with plumbing network at the centre
v. under-water light fixtures for night-time illumination


Fig. 126: Pool filled with water during the monsoons (L); Makeshift arrangements of water management inside pool (R).

Rear Pool:

i. Removal of original plantation around the edge of the pool
ii. Addition of fence around the pool
iii. Other utilities like plumbing networks, sink etc.

Auditorium pool:

i. Addition of metal fence around the pool
ii. Cracks and deterioration of the concrete


Fig. 127: Addition of metal railing around - Rear pool (L); Auditorium pool (R)

5.2.2 Piazza, Flooring, Paving


Fig. 128: Condition of piazza flooring- water-logging at places, discoloration of concrete surface


Fig. 129: Damaged litterbin and cluster of uplighters near auditorium (L); Inefficient signage and other utilities

5.2.3 Vegetation

Two major phases of planting have been identified so far – the first phase was led by Dr. Randhawa and focussed on plantations based on climatic-cum-design principles such as sun and shade, harmony, balance, contrast and accents as well as ‘architectural concepts’ or plantation typologies like solitary/groups, rows etc. The trees of this genre are *Alstonia scholaris* (shade; row), *Eucalyptus citriodora* (harmony; group), *Callistemon lanceolatus* (accent; group) and *Pinus longifolia* (balance; group). The post-1975 second phase[89] saw tree plantations that included *Dalbergia lanceolaria, Lagerstroemia spp*., specimen and flowering trees like *Bombax ceiba, Chorisia speciosa, Scleichera trijuga* etc. as well as shrubs and herbaceous plants. A survey of plantations, comprising mostly of trees, at the Museum site was carried out and an Inventory has been prepared mentioning the flower colours of some of the trees that must have played important role in their selection, as given in Table L-3.

89. Oral history records of Dr. H.S. Dhillon

Table 8: Inventory of Existing Plants in Government Museum and Art Gallery

S.NO.	BOTANICAL NAME	COMMON NAME	QUANTITY AT SITE	FLOWERING PERIOD IN CHANDIGARH[90]	KNOWN FOR FLOWER / FRUIT/ FOLIAGE
TREES					
1.	*Aegle marmelos*	Bael/ Wood Apple tree	2		Fruit
2.	*Annona squamosa*	Shareefa/ Custard Apple tree	1		Fruit
3.	*Alstonia scholaris*	Devil's Tree/ Saptaparni	10	December to March	Flower- greenish white Fragrant
4.	*Anthocephalus cadamba*	Kadam	4	July to September	Flower- yellowish white
5.	*Aurocaria cookii*	Christmas tree	2		Foliage
6.	*Azadirachta indica*	Neem	9	April to May	Foliage
7.	*Bombax ceiba*	Simal/ Silk Cotton Tree	1	February to March	Flower- Scarlet Red
8.	*Callistemon lanceolatus*	Bottlebrush	21	March to August	Flower- Crimson Red
9.	*Cassia fistula*	Amaltas	5	May to July	Flower- Yellow
10.	*Cassia javanica*	Java Cassia	1	May to July	Flower- Pink
11.	*Cassia siamea*	Siamese Cassia/ Kassod tree	4	November-December	Flower- Yellow
12.	*Chorisia speciosa*	Mexican Silk Cotton Tree	2	October-November	Flower- Pink
13.	*Dalbergia lanceolaria*	Takoli	2	March-May	Foliage
14.	*Delonix regia*	Gulmohar	4	April-August	Flower- Red
15.	*Eucalyptus citriodora*	Eucalyptus	28	April-May (generally)	Foliage
16.	*Eugenia cuspidata*	Jamoah	2		Fruit
17.	*Eugenia jambolana*	Jamun	6	April-June	Fruit
18.	*Ficus benghalensis*	Banyan	1	Throughout the year	Keystone species
19.	*Ficus nuda*	Weeping Fig	1		Foliage
20.	*Ficus racemosa*	Gular	1		Foliage
21.	*Ficus religiosa*	Peepal	1		Foliage
22.	*Grevillea robusta*	Silver Oak		April-May	Foliage
23.	*Jacaranda mimosaefolia*	Nili Gulmohar	3	April-May	Flower- bluish mauve
24.	*Lagerstroemia spp.*	Pride of India/ Crepe Myrtle	27	April-June; May-Oct./Nov.	Flower- Pink, mauve
25.	*Madhuca longifolia*	Mahua	1	April-May	Flower- cream fragrant
26.	*Melia azedarach*	Bakain	3	March -April [91]	Flower-Lavender

90. R.K. Kohli, H.P. Singh and Daizy R. Batish. "An Inventory of Multipurpose Avenue Trees of Urban Chandigarh India," in Integrated Tools for Natural Resources Inventories in the 21st Century, ed. Mark Hanson and Thomas Burk (IUFRO Conference, Boise, Idaho, USA, August 16-20, 1998)
91. M.S. Randhawa, *Beautiful Trees and Gardens.*

S.NO.	BOTANICAL NAME	COMMON NAME	QUANTITY AT SITE	FLOWERING PERIOD IN CHANDIGARH	KNOWN FOR FLOWER / FRUIT/ FOLIAGE
27.	*Mangifera indica*	Mango	13	March -April	Fruit
28.	*Millingtonia hortensis*	Tree Jasmine, Indian cork tree	1	September -November	Flower- white
29.	*Morus alba*	Shehtoot, Mulberry	4		
30.	*Nyctanthes arbortrystis*	Sheuli, Parijat	1		Flower- white
31.	*Psidium guajava*	Guava	1		Fruit
32.	*Schleichera trijuga*	Kusum	4	April-May	Foliage
33.	*Terminalia bellirica*	Bahera	5	May to June	Fruit
PALM					
1.	*Livistona chinensis*	China Palm	8		Foliage
SHRUBS					
1.	*Artabotrys hexapetalus*	Harichampa	4	July-August8	Flower- greenish white
2.	*Caesalpinia pulcherrima*	Peacock Flower plant	27		Flower- scarlet
3.	*Tabernaemontana coronaria*	Chandni/ Tagar	2		Flower- white
CACTUS					
1.	--	Kiora	1		

It is indeed very interesting to note that in his book ‘Flowering Trees in India’, Dr. Randhawa classified trees on the basis of their form and flower colours, as advised by Le Corbusier himself, shown in the chart below. As previously mentioned, he called these plants ‘aristocrats of the plant kingdom’ and revealed that this formed the basis of the city’s arboriculture. When the choice of trees in the Museum site is examined against this chart, a good mix of form-colour combination is observed where the representative ‘aristocrats’ from almost all categories is found to be present in the Museum site.

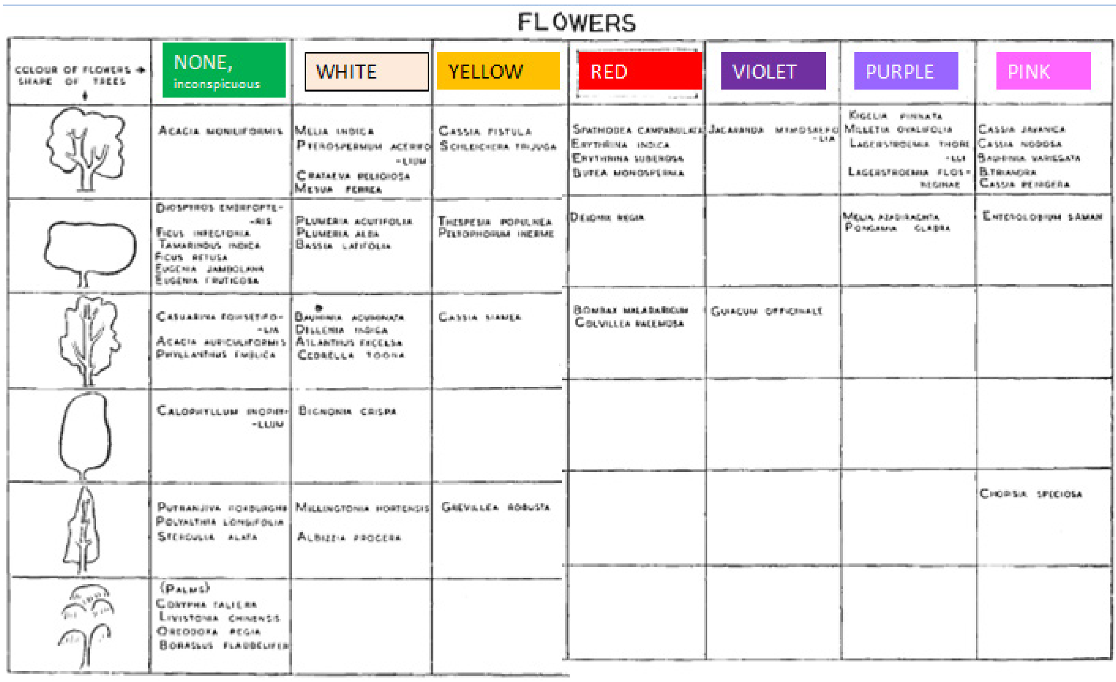
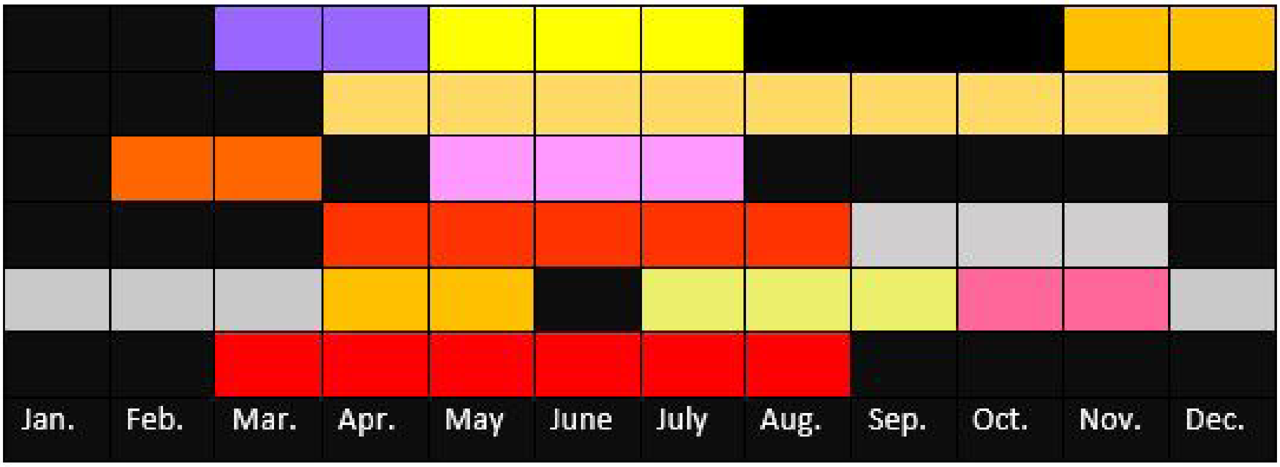


Fig. 130: Classificatin of trees based on form and colour of flowers

An in-depth analysis of the existing flowering trees and the seasonal distribution of their flowers' colours has been presented in Table L-4.

Table 9: Seasonal distribution of Colour of flowering trees in the Landscape



As evident from the above Table 9, it is seen that three to four tree species in the landscape are always in flowering state during most part of the year, with the spring and summer months contributing to the most colourful sight, when six to seven trees flower simultaneously. Thus the planting palette reveals a well-thought out concept and strong rationale in selection and positioning of the trees in the museum landscape, further corroborated through the Figure 131(L), where it is seen that 56% of the trees present in the Museum site are flowering trees, of which 51% are of bright colours. The percentage distribution of different colours of this tree category is given in Figure 131(R), that indicates a high preference towards red and allied colours, which constitutes nearly 50% of the flowering trees, distantly followed by those with purple hues and further with the yellow ones.

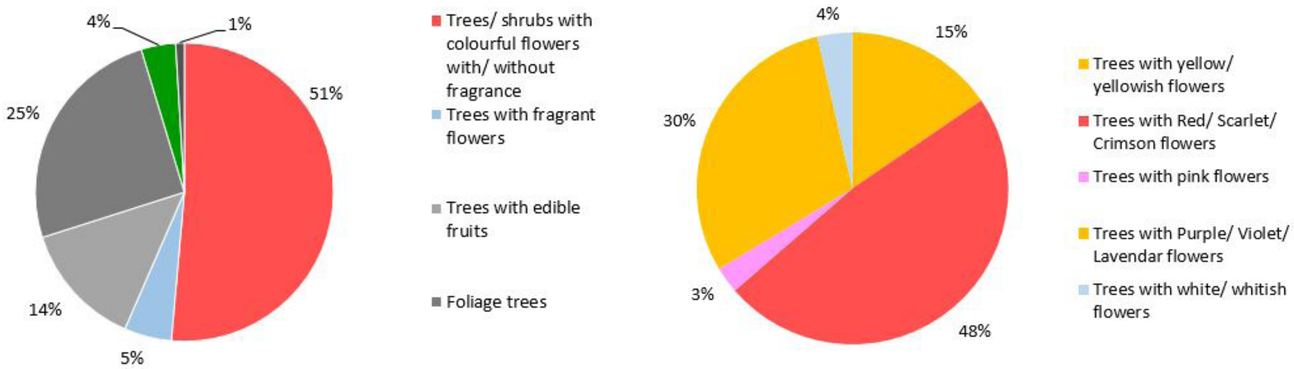


Fig. 131: Tree composition and categorization of Museum site (L); Percentage colour distribution of flowering trees in the site (R)

Landscape plans from the Archives:

Undated landscape drawings obtained from the office of the UT, Chandigarh indicate that several landscape and horticultural schemes were prepared from time to time, that proposed several interventions including fountains, grass mounds, steps/ramps and different types of plant materials, especially near the gate and the southwest part of the museum.

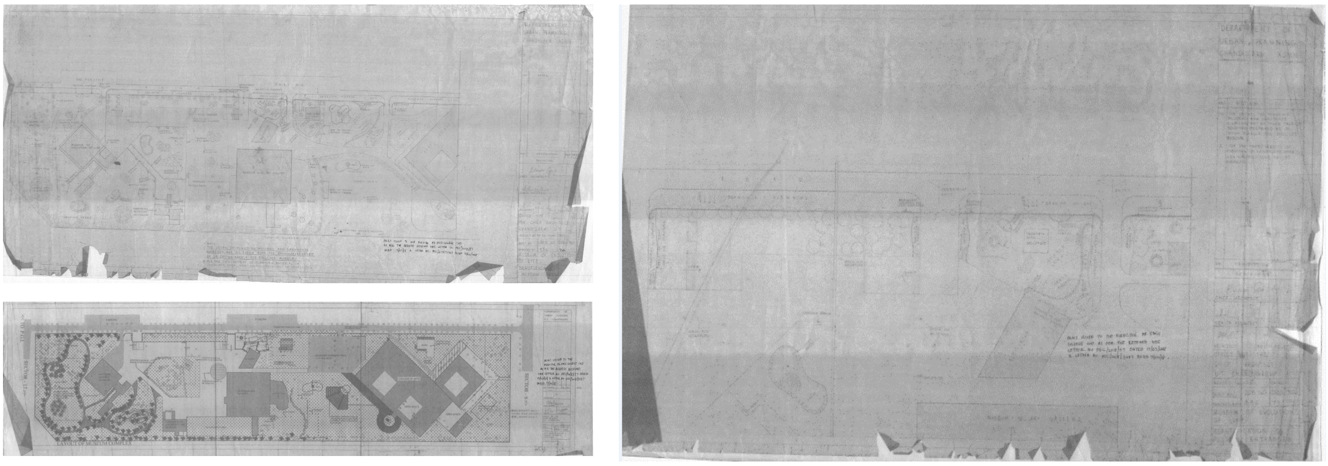


Fig. 132: Undated drawings showing landscape proposals. Source: UT Office Chandigarh

Some of these proposals seem to have been implemented on site, while the rest probably evolved with the changing needs of the site.

5.2.4 Gate, Access and Urban Furniture

Fig. 133: Inside View of main access area: Introduction of potted plants to control movement (L); Addition of fountain in pool and art installations in the piazza

Some of the original art installations have been removed from the entry piazza and currently new art installations have been displayed. There is no information displayed about these artworks, not even the artist's name or the date of creation.

Built-in concrete bollards:

As mentioned earlier, only one of such lighting fixture exists on site.

Utilities:

As is normal with any site, several utilities have got added due to technological upgradation like the electrical transformer and the Diesel Generator to the north-east side near the rear pool. New plantations are made around these additions and the solid-void dynamics has undergone changes.

Fig. 134: Air Conditioning outdoor units at the rear side of the auditorium (L); Trees have been heavily pruned in the utility areas (C); The DG set within a rather unkempt landscape, hidden from the public view, but with garden benches (R)

5.3 Building Condition Assessment

The Government Museum and Art Gallery shows signs of weathering due to age and exposure to the elements of nature. There are also issues arising due to unsympathetic repairs and alterations made to the built structure. Some of the pertinent issues of building failure have been discussed in this section of the document. A detailed set of condition assessment drawings and a visual glossary compiled as a result of the documentation and analysis process can be found in Annexure B of this document.

5.3.1 Building Exterior

The structural system of concrete columns and beams infilled with brick walls are in good condition. There are no signs of structural instability. However, there are signs of deterioration related to failure of the roof and water disposal system. All the elements of the building exterior have been discussed below:

***Exposed Concrete Elements** (Façade and Terrace elements):*

As mentioned in chapter 3, the exterior façade is composed of exposed concrete at the base of the building as well as the top, with brick cladding in the portion between the two concrete bands. The upper band also supports the clerestory placed right above it with fixed glazed openings and exposed concrete fins. The condition of these two bands along with the projecting fins at the upper level appears to be in a fairly good condition. The roof-terrace and its water drainage system are also constructed in exposed concrete, and is now showing a number of issues that require immediate attention.

The concrete strength seems to be in a good range as shown by scientific tests. Through phenolphthalein tests, the PH of the concrete was found to be between 5 and 6. This low number indicated that the concrete is carbonated and the matrix is acidic. The acidic environment is not able to provide protection to the embedded reinforcement from corrosion.[92] [93] Due to corrosion the rust starts to accumulate on the rebars, increasing its size. The expanded size of rebars due to rust causes stress of the concrete and causes the concrete to crack and spall. Through investigations it was also found that the minimum cover over the reinforcement is only 9mm which is extremely low. These two factors, may together explain the cracks, spalling, delamination and corrosion that is explained in detail below:

- *Cracks:*

Minor cracks have been observed on most of the concrete surfaces of the building but there are some critical structural cracks which can be observed mostly on the upper beam on the façade and clerestory part of the south-east facade, possibly due to varying daily weather conditions. Other than the exterior envelope of the main museum building, structural cracks can be seen on the exterior façade of the temporary exhibition gallery. Moderate or non-structural cracks which are not severe can also be seen in the elevation.

Fig. 135: Cracks due to repairs made in the interior of the temporary exhibition gallery

At the terrace level, there are a large number of structural cracks at the edges of the south-west fins as they are more exposed to fluctuating weather. Other than fins, soffit of the clerestory and gargoyle also have structural cracks. The cracks generally occur in concrete when the rebars are corroded and exert pressure on the concrete. The testing confirms that these cracks are due to corrosion of reinforcement.

- *Delamination and Spalling:*

The concrete surfaces in the Museum building are delaminated in many areas. Delamination occurs when the layers of concrete start to separate from the main body. The condition is especially seen in the fins and soffit of the clerestory as well as the drainage elements on the roof. Both the north-west and south-east elevations show delaminated concrete on the underside of the drains, spout ends of gargoyles and in upper beam.

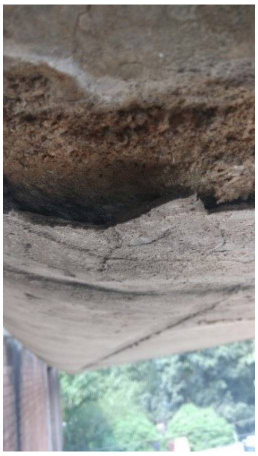


Fig. 136: Spalling leading to loss of material and exposed rebars along the outer edges of fins(L); Concrete spall at the underside of concrete drains (C)

92. John P. Broomfield, *Corrosion of Steel in Concrete Understanding, investigation and repair* (New York: Taylor & Francis, 2007).
93. Paul Gaudette and Ann Harrer. "Assessment of Historic Concrete Structures," (APT Bulletin: The Journal of Preservation Technology, Vol. 48, No. 4, Special Issue on Documentation, pp. 29-36, 2017)

When the water gets inside the delaminated surfaces, the rebars get corroded and expand. Alternatively, if the concrete is carbonated it doesn't provide enough protection to the rebars and hence the rebars start to corrode. The rust starts to settle on the corroded rebars and expands. This stress of expansion causes the concrete to spall or simply loss of concrete around the reinforcement, which is clearly a big issue to address at the roof level. Concrete spalls are visible and recorded in several locations in the museum building, especially the vertical surfaces of fins, clerestory soffit and underside of the concrete drains that drains the water out from the roof level. The concrete gargoyles also shows extensive damage on the outer edges. The waterproofing membrane seems to be missing or damaged in some places.

- *Exposed rebar:*

In many locations throughout the building the embedded rebars are slightly exposed on the concrete surface and are visible as small spots. This could be due to a small or missing concrete cover over the rebar. Exposed rebars can be observed on concrete surfaces on all the elevations, with a higher concentration on the pilotis columns of the north-west elevation and upper beams of north-east elevations.

Rebars are severely exposed in large areas on the clerestory and its assembly including soffits and fins that are present on the roof. A large number of exposed rebars are seen on these elements. This is primarily due to spalling of delaminated concrete exposing the rebars, both attributed to carbonation of concrete and small depth of cover.

Fig. 137: Exposed rebars of terrace elements

- *Surface deterioration:*

Concrete surface deterioration is mainly a result of exposure to the weather or of poor concrete mix. The upper layer of the concrete surface erodes, which is either not strong enough or due to weather and exposes the aggregate. Surface deterioration of concrete is present on almost 50 percent of the exterior concrete surface of the museum building. Out of this, 21% is seen on the South- West elevation and 19% on North-West elevation, mostly on the upper beam of both elevations. On the terrace level, fins have significant surface deterioration on North- East direction. The surface deterioration is seen due to exposed aggregate and loss of binding material.


Fig. 138: Surface deterioration and soiling on concrete surface.

- *Seepage (water stains) and Soiling:*

The clerestory soffits show water stains overall. This is mostly due to failing drip course, which have been lost due to spalling. Almost all the fins show surface deterioration and staining due to water seepage. Seepage has also been observed due to stagnant water in the concrete drain which leaks through the detached area.

Concrete surface soiling is seen on almost 52% of the exterior envelope of the building, out of which 44% is seen on the South-East elevation. This is mainly atmospheric soiling with pollutants and dirt due to the weather. Maximum soiling has been observed on the upper beams of the façade and the connectors joining the drain to the building. This is mainly due to water seepage from the detached areas of the concrete drain. Soiling is also observed on the fins because of seepage, detachment and surface deterioration.

The concrete drains were found to be in precarious condition. Some of the issues observed was the stagnation of water in the drain leading to growth of vegetation and algae on the drain floor. Water seepage and rust stains were also seen on the façade, especially under the windows due to water washing over the rusted metal mesh at the window openings.

Fig. 139: Rust stains on concrete beam due to water washing over rusted metal mesh at the window openings


Fig. 140: Water stains at the bottom surface of connectors (L); Staining under beams (R)

- *Previous repairs:*

The concrete patch repairs made to the underside of the drain are failing. Large chunks of spalling concrete can be observed, leaving exposed rebars. The drain accumulates dirt and debris during non-rainy season and when they get fed by water from the entire roof and its elements the passage of water gets obstructed and leads to stagnation. Over time, the standing water has induced deterioration of the concrete and leading to its failure. These signs are clearly visible and have been recorded.

Fig. 141: Failing patch repairs (L); Water stagnation inducing vegetation growth within concrete drain (R)

***Exposed Concrete Elements** (Flooring):*

The concrete flooring of the pilotis area shows surface abrasion and stains due to constant use of the space. The addition of light fixtures directly onto original flooring indicates loss of original flooring material and irreversible damage to the concrete tiles. Patch repair of concrete floor is also seen in several locations, which do not match the existing.

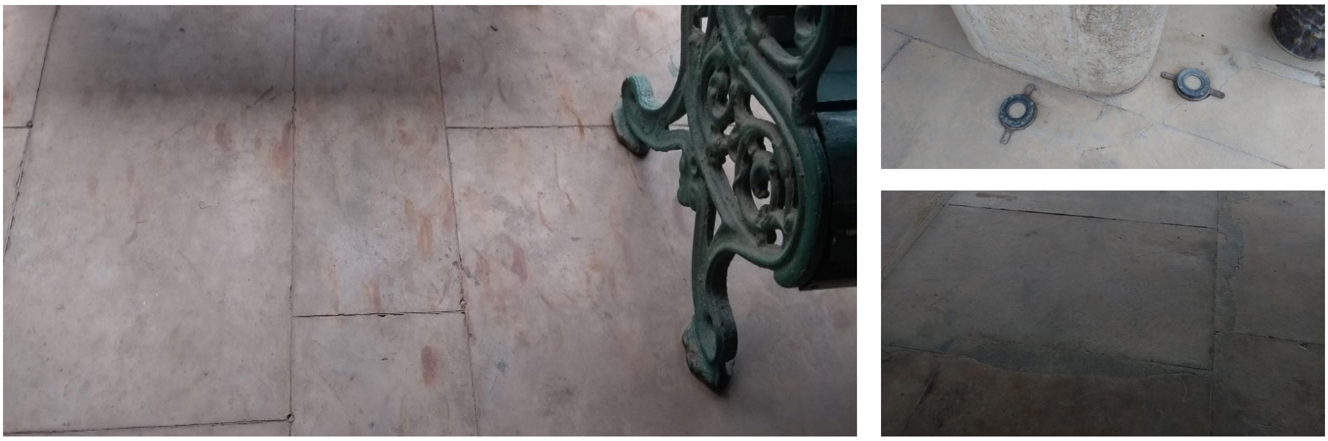


Fig. 142: Surface abrasions and rust stains (L); Alterations and repairs made on concrete flooring in pilotis (R)

***Exposed Concrete Elements** (Ceiling):*

The predominant conditions observed in the ceiling of the pilotis area is water stains on the external beams and small areas of exposed rebars. The rebars are usually visible due to less concrete cover or the loss of it due to deterioration of the concrete surface.

Fig. 143: Rust staining and exposed rebars due to loss of concrete cover

Brick tile cladding:

The brick tile cladding on the building façade seems to be in a good condition. The cladding has been replaced in the past and appears to be maintained well. However, even with regular maintenance there are some issues related to the present cladding. The joints have not been regularly pointed and it has been observed that the open joints between the brick tiles have caused water ingress, leading to further damage to the bricks causing damp patches and algal growth to appear on the bricks. The replaced brick tiles show discoloration and deterioration as they do not match the composition of the original. Attempts have been made to match the brick to the original by means of chemical treatments and painting.

Horizontal metal strips are observed between the courses of the brick tiles, embedded within the joints. The south-west elevation has had minimum interventions in the past and can be considered to have retained original brick cladding. The metal strips were found along the entire height of cladding on this facade. However, the intervals between the metal strips show an uneven pattern ranging from 3 to 20 brick tiles. On the south-east elevation, where brick cladding has been replaced in the past, some metal strips were found. The distribution of metal strips are uneven, which could suggest that they may have been removed during replacement of brick tiles.

Fig. 144: Metal strips between brick tile cladding

It was observed that in some areas the mortar at the joints are missing and has exposed the metal strips. They show signs of corrosion, which could exacerbate in the future leading to the damage of existing brick cladding. Repointing with cement was also observed in some areas. The other two elevation were not studied in detail for metal strips due to inaccessibility.

The visual examination included examination for size, colour, hardness and texture for physical appearance and properties. Amongst the brick tiles that were reviewed, it is clear that none of the bricks are the same colour, texture or hardness though the colour range is similar for the original ones. This shows that they were mainly handmade without any control or guidelines. Some bricks have been replaced and these brick tiles show discoloration and deterioration as they do not match the original. Attempts have been made to match the brick to the original by means of chemical treatments and painting. Currently the original has variations with the same range but the replacements are very clearly distinguishable. Many factors contribute to this like the original manufacturing, location in the building and exposure to weathering.

Instrumental analysis through EDS was employed to identify composition of original brick samples. The results clearly show Silica as the major component which is primarily the clay.
Several peaks for Aluminium, Iron, Potassium, Magnesium and sodium most of which are the primary constituents of a brick with an exception of sodium. Sodium indicates contamination or efflorescence, it could be potentially harmful to the brick. Presence of iron is evident though the colour and appears to be in moderate quantity since the colour of the brick is in the regular range and not too dark. The elements from tests are similar to the soils of the area. Therefore it is possible that the brick tiles are mostly from alluvial soils from the area itself. Were mostly made from site or from areas around.

- *Dislodging:*

Of all the elevations with brick cladding on the exterior envelope, about 24% of the cladding is dislodged or dislocated from its location. This is mainly observed on north-west elevation and some on the North-East elevation. This could be a potential life threatening condition and should be addressed immediately. This dislodging could also be due to corroding metal strips embedded within the brick courses.

- *Open Joints:*

The joints between the cladding tiles are pointed and secured with mortar to make them water-tight. The current mortar is deteriorated and is missing in some locations causing the joints to be open. It has been observed that the open joints are letting the water penetrate into the cladding.

- *Seepage:*

Main problem of seepage on the brick cladding is due to the presence of the concrete drains on the northwest and south east elevations. The drains are fed through gargoyles located higher than the drain and when the water comes down from the gargoyles into the drain, the water splashes cause the adjacent areas to become wet. These wet patches can be easily located on the elevations.

- *Bio growth:*

The constant seepage on the façades have led to bio-growth. This is mostly seen on the North-West elevation since the auditorium blocks the sunlight that would have otherwise allowed the surface to dry.

- *Discoloration:*

The replaced brick shows discoloration as they do not match the composition of the original. Almost one fourth of the South-West façade has discoloured brick cladding. This occurs on the other elevations as well. Attempts have been made to match the brick to the original by means of chemical treatment and painting.

- *Soiling:*

Soiling can also be observed of about 12% of South-East elevation may be because it is exposed more to sun than any other elevation.

Fig. 145: Brickwork damaged due to water seepage (L); Discoloration of replaced bricks (C); Algal growth on brick tile surface under gargoyle (R)

Doors and Windows:

It is observed that the clerestory windows have frosted glass panes as the original material. However, they are replaced by non-tinted plain glass in a few windows. A few glass panes are also broken. The putty is failing on all clerestory windows.

The external windows of the museum do not show any deterioration, most likely due to routine maintenance and repainting of the frames. Deposits of paint splashes on the window panes and loss of putty around the glass is seen widely throughout the building. Termite infestation was noticed on the frames of the windows. Bird droppings are also seen along the windows of the upper floors.

Fig. 146: Glass panes replaced with un-tinted glass (L); Painted metal mesh over the external windows allows water into the galleries during the rain (R)

The painted metal mesh over the external windows allows water into the galleries during the rain and has damaged display cases and furniture. The water also gets trapped at the bottom of the opening, which then flow over the concrete beam and leaves rust stain on the concrete surface.

The entrance door of the museum shows damage due to the daily routine of sealing the lock with wax. It was also observed that there is flaking of paint at the door handle and on few panels of the door.

Fig. 147: Wearing of entrance door and handle

Roof:

The roofing membrane seems to have been applied in the recent past. This membrane is not properly installed and is letting the water in through the joints. It has not been laid in a proper slope there also causing the water to stagnate on the roof. The roofing membrane also has a number of joints which let water in. It has also led to the growth of plants in between the membrane and roof at various locations.

5.3.2 Building Interior

Exposed Concrete Elements:

The exposed concrete interior walls of the museum seem to be in an overall good condition.

The bottom surface of walls show discoloration and staining due to daily swabbing of the floors.

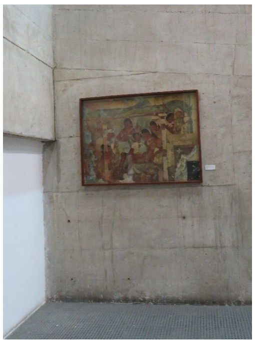


Fig. 148: Discoloration due to daily swabbing

It was observed that there is water seepage from the clerestory leaving damp stains on the upper portions of some columns. Water leakage from air conditioning pipes have also been seen in the library showing damage of the concrete wall.

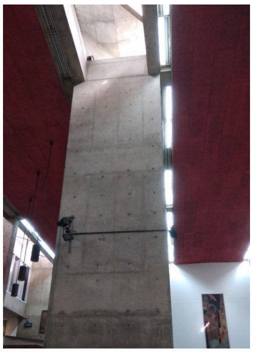


Fig. 149: Water seepage from clerestory windows (L); Failing air conditioning pipes (C)(R)

Staining was also seen along the concrete handrails of the ramp due to weathering. The metal railing on the ramp is finished with a bluish-grey enamel paint. When observed cross sectionally under the microscope, it shows two thin layers of dark blackish coating. One layer of red colour is visible as the outermost layer under reflected light. However, it seems that the original paint finish may have been black.

Fig. 150: Stratigraphy of paint sourced from metal railing on ramp (L); Staining on concrete handrail due to weathering (R)

Plastered Walls:

The plastered interior walls have been painted over multiple times and hence is in a good condition. They seem to be well maintained.

Flooring:

Two types of terrazzo are present in the building- white and black. Instrumental analysis was carried out for both the types. The elements found in the white terrazzo are Calcium, Carbon, Silicon, Aluminum, Sulfur while the black terrazzo has Calcium, Carbon, Silicon, Aluminum. Sulphur was missing in the black terrazzo sample but is present in white terrazzo sample, indicative of vitrification. The presence of calcium indicates the chips present from marble and similar material. It could also indicate the presence of lime, but lime was not prevalent during this period. The micro-structure of both types of terrazzo is very similar. The scans revealed that there is very little differences in the morphology and the matrix appeared to be dense and devoid of pores, indicating its durability.

Fig. 151: Terrazzo sample taken for analysis. Black terrazzo (L); White terrazzo (R)

The terrazzo flooring of the museum interior shows general weathering of the surface. A few cracked tiles in the first floor galleries have also been observed.

Fig. 152: Broken terrazzo tiles in gallery (L); The replaced and repaired tiles seem to be different from the original terrazzo tiles in colour and composition

Fig. 153: Modern alterations damaging original terrazzo floor tiles

The visual survey also shows damage of original tiles due to alterations and repairs made to the flooring. The channels for collapsible grills at openings and fixtures for glass and aluminium partitions are fixed directly onto flooring indicating loss of original material and irreversible damage to the terrazzo tiles. The replaced tiles after the damage are very clearly differentiable and look visually obtrusive.

Fig. 154: Tile damage due to water dripping from roof

Terrazzo flooring of the first floor galleries also show staining due to water damage. Water seepage from the terrace slabs during the monsoons have left dark circular spots due to continuously dripping over a long period of time.

Wood-wool Ceiling Panelled:

The main concern for the condition of the ceiling is water seepage during the monsoon. The points where water drips into the gallery changes seasonally. When the point of water seepage is repaired, the water trapped under the waterproofing membrane during the next monsoon channels away to find another weak spot in the slab, causing dripping from a new point. The condition of the slab under the waterproofing layer should be investigated to understand the extent of damage and solutions for repair.

It was found by cross-sectional imaging that the sample is organic in nature with synthetic binding matrix (matrix). The imaging ruled out the possibility of coir which was popular during the period. Presence of bast fibre, from the inner bark of hardwood trees was detected. So the fibreboard is composed of wood derivatives.

Fig. 155: Fibreboard sample taken for analysis (L); Water damage of fibreboard ceiling panels is also seen.

The fibreboard ceiling panels on the exterior of the building show deterioration due to exposure to weather. Several panels have come loose and show displacement. The replaced panels do not match the original material.

Fig. 156: Damaged fibre board on the building exterior

Doors and Windows:

Most of the doors of the museum are painted in bright colours. These coloured surfaces are studied for stratigraphy's and showed accumulation of similar colours of past layers under the microscope. Two doors had different layers under the current paint campaigns.

The door at the Shaft in the Coin Gallery shows plaster, followed by ground layer, then a layer of red paint and following layers of white.

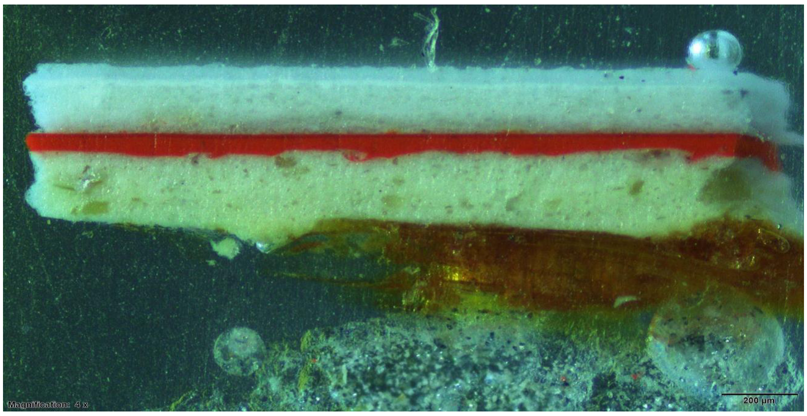


Fig. 157: Stratigraphy of paint sourced from duct door

Gallery door at interior stairwell (entry to FF) shows that there are four layers of paint over plaster - one green and three red. Green could have been the original colour scheme.

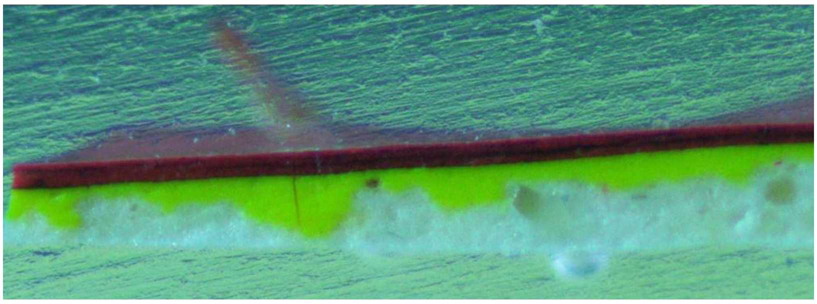


Fig. 158: Stratigraphy of paint sourced from gallery door at interior stairwell

The doors and windows of the museum show signs of wear and tear, loss of polish, scratches on surface and in some cases weathered laminates. The internal metal doors that are sealed daily shows deposits of seal wax on the shutters.

The structures built as interventions to the building are made up of make shift and temporary materials.

Fig. 159: Worn door corners (L); Ad hoc additions (R)

Fig. 160: Damaged door fixtures, concrete sill and rusting grills.

5.3.3 Testing Programme

A testing programme was formulated for the building materials of Corbusier museum based on the visual and sounding survey. All building materials shows signs of distress and need repairs in the future and some possible replacement. It was pertinent to perform these tests so that the building materials are characterized and analyzed to understand the basic properties before undertaking any interventions or carrying out any corrective measures so that the causes are rectified and the repairs are compatible.

A number of investigations were carried out based on available standards for field and laboratory testing methods which can help to define the properties and causes for visual defects. A combination of methods were employed in order to get the required information. Once the samples are tested and analyzed it will help in understanding the issues and causes, and help in selection of compatible repair and replacement materials.

Table 10: Testing Programme for different building materials found at the Museum

NO	TEST	PURPOSE	NO. OF SAMPLES	RESULT	INFERENCE	RECOMMENDATIONS
CONCRETE						
1	Rebound Hammer test	Measure surface hardness of concrete. Assessing variations of strength within a structure.	11	Average relative strength of concrete varies from 7 N/mm2 to 24.76 N/mm2 corresponding to the rebound hammer test.	Concrete average to strong	No action required
2	Ultrasonic pulse velocity	Establish homogeneity of concrete and corrosion prone locations	4	Concrete quality grading: Medium in one location. Poor/ Doubtful at 3 locations	Shows average strength	No action required
3	Compressive strength test	Compressive strength of concrete	3	Average relative strength of concrete : 22.19-30.31 N/mm2	All cores show good strength	No action required
4	Carbonation test	pH value of concrete	8	PH value : 5-6 (pH value of fresh concrete: 12-13)	Inferred as acidic nature of concrete due to carbonation. Responsible for corrosion of reinforcement	SERIOUS: carbonation needs to be retarded or slowed otherwise concrete spalls will lead to large scale damages especially at terrace level. A coating could be applied to the concrete to protect from further carbonation, (details in proposals) that will act like a protective barrier
5	Chemical test	Chloride (water-soluble and acid-soluble) and Sulphate content in concrete.	16	Sulphates and Chlorides within permissible limits	Sulphates and Chlorides within permissible limits	No action required
6	Ferro scanning	Depth of cover	19	Min. 9mm. cover Reinforcement exposed in some locations.	Very small cover, or no cover; exposing reinforcement to corrosion.	Patch repair design to consider the small cover and consider provision for better protection.
7	Ratio of cement concrete	Ratio of Cement: Combined aggregates	16	M20 grade concrete	Average to good concrete – prevalent during the period of construction	No action required
BRICK TILE						
8	FESEM	Composition	2			Could be conveniently remade with colour matching mock ups. Efflorescence to be removed with poulticing.
9	EDS	Quantity of chemical constituents	2	Detected traces of: Oxygen, Silicon, Aluminum, Iron, Potassium, Magnesium, Sodium	Regular constituents, except sodium indicating water seepage or efflorescence	

NO	TEST	PURPOSE	NO. OF SAMPLES	RESULT	INFERENCE	RECOMMENDATIONS
10	Metal Detector	Distribution of metal strips	2 sample areas with original brick work. 2 sample areas with replaced brick work.	Inconsistent distribution of metal strips, intervals ranging between 3-20 brick tiles	No definite pattern of metal strip distribution was established. Difficult to comprehend the exact use but appears to be provided for strengthening of the tiles to prevent them from detaching.	Should be cleaned (shot blasting) and coated and left in place. Pulling out may damage the adjacent tiles. This should be done when the whole façade is repointed.
WHITE TERRAZZO						
11	FESEM	Study of composition	1	Matrix is dense and devoid of pores indicating durability.	The small sized capillary pores can make the material more susceptible to salt crystallization	No issues with composition or structure. No actions required. Could be replicated through mock ups.
12	EDS	Quantity of chemical constituents	1	Detected traces of: Calcium, Oxygen, Carbon, Silicon, Aluminium, Sulphur	Sulphur indicating vitrification. Calcium indicates the chips present from marble and similar material.	
13	XRD	Quantity of chemical constituents on top layer	1			
BLACK TERRAZZO						
14	FESEM	Study of composition	1	Matrix appears to be dense and devoid of pores	Indicate durability.	No issues with composition or structure. No actions required. Could be replicated through mock ups.
15	EDS	Quantity of chemical constituents	1	Detected traces of: Calcium, Oxygen, Carbon, Silicon, Aluminum	Elements typical of terrazzo are found.	
FIBRE BOARD						
16	Light microscopy (LM) & Polarized light microscopy (PLM).	Study of composition and structure	1	Sample is organic in nature with synthetic binding matrix. Presence of bast fiber, from the inner bark of hardwood trees was detected.	The fibreboard are composed of wood derivatives	Replacement boards should be of wood derivative similar to the existing, whether custom made or factory made.
PAINT ANALYSIS						
17	Stratigraphy	Cross section analysis of paint layers	17			All surfaces had accumulation of similar colours of past layers. Two doors and a railing have different layers under the current paint campaigns.

Sampling:

Most of the issues with concrete which were identified through surveys indicate issues primarily at the terrace levels and the façade of the auditorium. Therefore, the cores were extracted from these locations as well as some non-destructive (NDT) tests were performed.

7 fins on terrace were identified for taking samples for testing. All 7 fins were scanned with Ferro Scanner to mark the steel on the surface to determine the position for core cutting. Core cutting and sample collection from the RCC fins in clerestory at the terrace was carried out. A total of 8 samples were collected from the fins after examining fins all around the terrace. 3 cores were cut, which were good condition concrete samples and 5 samples of 1kg approx/sample were pulled out with hand from the deteriorated/damaged fins.

2 samples of brick tiles were pulled out with the help of hammer and chisel from the south-east facade of the Museum building. One sample each of black and white terrazzo tiles were also removed from the flooring of first floor. Scraping of paint samples were removed from multiple locations within the building. A sample of fibreboard ceiling panel which was removed during an earlier repair work was used for testing purpose. The details of the location of each sample has been attached in Annexure B.

Fig. 161: Ferroscanner to locate rebars before locating sites for core cutting

Fig. 162: Core cutting in progress and samples collected

Tests for Concrete:

A. *Compressive Strength: Rebound Hammer*

Aim is to determine the compressive strength of the concrete by relating the rebound index and the compressive strength; to assess the uniformity of the concrete; to assess the quality of the concrete based on the standard specifications.

In order to ascertain the compressive strength of Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring controlled mass that slides on a plunger within a tubular housing.

Fig. 163: Core Rebound Hammer testing

B. *Depth of cover: Ultra Sonic pulse device*

Aim of this test is to identify the depth and of the reinforced bars from the surface of the concrete.

Measuring the concrete cover is an essential procedure because when analyzed with the carbonation depth it will determine if the concrete surrounding the steel is providing the necessary protection against corrosion. A thinner cover indicates areas where corrosion will start sooner. An USP equipment was obtained in a portable format, where a hand-held transducer is connected to a data reader for results.

Fig. 164: Ultra sonic pulse test

C. *Carbonation or Phenolphthalein Test*

Aim of this test if to find out whether the concrete has carbonated and to what depth. Carbonation of concrete is associated with the corrosion of steel reinforcement and with shrinkage. Carbonation progresses it decreases the permeability of the concrete cover. The permeability decrease causes the carbonation rate to drop. A solution of phenolphthalein can be used as a qualitative test to indicate depth of carbonation in concrete elements.

Within a few hours, or a day or two at most, the surface of fresh concrete will have reacted with $CO2$ from the air. Gradually, the process penetrates deeper into the concrete at a rate proportional to the square root of time. After a year or so it may typically have reached a depth of perhaps 1 mm for dense concrete of low permeability made with a low water/cement ratio, or up to 5 mm or more for more porous and permeable concrete made using a high water/cement ratio.

Process: To test for depth of carbonation into a concrete surface, a solution of phenolphthalein indicator was being applied. Un-carbonated concrete is indicated as a pink colouration i.e. the pH is greater than ~9.

Fig. 165: Carbonation test

D. *Chloride/sulphate*

Aim of this test is to identify the presence of Cholride or sulphate in the concrete. Chloride ions can damage reinforced concrete if they are present in the pore solution of the concrete surrounding the reinforcement and once they reach critical concentration. Current techniques for measuring chloride concentration in concrete have to be performed in a laboratory with samples extracted from the building.

E. *Chemical analysis*

Aim of the test is to determine the composition of the concrete and type and content of cement

Tests for Brick Tiles:

A. *SEM/EDS (Scanning Electron Microscopy)*

Aim of this test is to identify morphological features and to see elemental composition and differences across the samples as well as features like pores. Scanning Electron Microscopy (SEM) is an imaging technique that magnifies a sample up to 50,000x; 1,000x is common in conservation. At this magnification one is able to characterize the surface of a material, detect elemental differences across a sample, and measuring small features. This is a technique used to precisely describe the morphological features of a brick. The output one receives is a magnified image of the sample, at a much higher resolution than is offered by a light microscope. SEM is often used in combination with EDS, which identifies the elemental composition of a sample in a scanning electron microscope, heavier than boron. EDS output is in the form of a peaked spectra or X-ray mapping. EDS in combination with SEM is a powerful tool.

B. *Metal Detector*

Aim of this test is to identify the distribution of metal strips between the brick tiles. This is carried out with a hand held metal detector.

Tests for Terrazzo Tiles:

A. *SEM/EDS (Scanning Electron Microscopy)*

Aim of this test is to identify morphological features and to see elemental composition and differences across the samples as well as features like pores.

B. *XRD (X-ray diffraction)*

Aim of this test is to identify minerals of clay used in bricks. X-ray diffraction or XRD which is an analytical technique was employed to identify minerals of clays in 16 brick samples as clay minerals are crystalline in nature. X-Ray Diffraction (XRD) is used to identify single-phase, (i.e. minerals, ceramics) or multi-phase material, (i.e. micro-crystalline mixtures like stone). This technique is used to identify crystallography of a material as well as identify minerals and chemical compounds.

Tests for Fibre Board:

A. *Examination through Light Microscope and Polarized Light Microscope*

The result report of all tests conducted for the building materials have been attached as Annexure B of this document.

Tests for Paint Analysis:

A. *Stratigraphy*

Aim of this test is to determine the number of paint layers present in the paint sample.

5.4 Use and Interpretation

The Government Museum and Art Gallery is open to visitors throughout the year from Tuesday to Sunday, except on the National Holidays. The footfall of the museum was about 68500 during the year 2018 with about 4000-8700 visitors per month. This shows an increase from the 4000-7500 per month record of 2017. The visitors include 78 percent general public, 18 percent school children and about 4 percent foreign tourists. The museum is frequented by students from the art and architectural colleges of the city. Occasional student groups from the local schools visit as a study tour, enabling the museum's vision of transmitting knowledge. Apart from the local crowd, the museum also receives a good number of foreign tourists, many of whom are interested in Le Corbusier's design. The main benefactors of the museum, apart from the local and national visitors and international tourists, are the students, scholars, schools and institutions of Chandigarh.

The Auditorium adjoining the Museum is actively used to hold seminars and conferences. It is also rented out as venue for musical concerts. The pilotis area towards the north corner of the building serves as pre-function area or as area for catering service during events held at the auditorium or temporary gallery.

The Museum provides a platform for local artists to display their work. The exhibitions are frequently held at the temporary exhibition gallery of the museum. The proximity of the Museum to the Government Art College has also proved advantageous to the students for visiting as well as using the temporary exhibition gallery.

The library of the Government Museum and Art Gallery is well equipped with books catering to a multitude of fields related to art, architecture, history, religious studies and more. The reference section is frequented by local researchers and academicians.

The museum also used to conduct a light and sound show showing the history of the Chandigarh city. However, this has be discontinued for the last few years. Some of the equipment for the broadcast are also dysfunctional.

Fig. 166: Activities at the Government Museum and Art Gallery, Chandigarh

5.5 Display and Furniture

The original display and furniture of the Government Museum and Art Gallery has remained largely intact and are generally in a good condition. The newer furniture which are replicas of the original design seem to not match in terms of its materials and colour. A visual assessment of the display cases and furniture were conducted on site.


Fig. 167: The bottom surface of the display shows discoloration due to daily floor swabbing.


Fig. 168: Reception sofas have been repaired with leather straps that do not match the colour of the original straps.(L): Jute strings of the low stool hanging loose (R)


Fig. 169: Loss of polish and dust accumulation at bottom of the table and chair legs

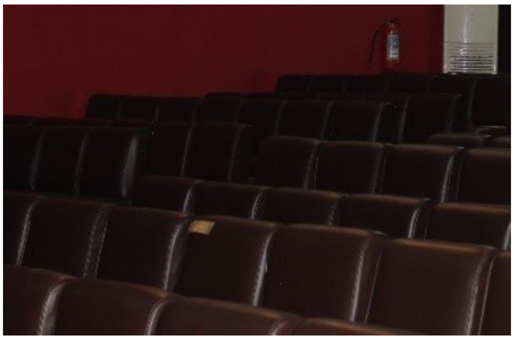



Fig. 170: Patch repair of Auditorium chair upholstery (L); Mural at the reception by the artist Satish Gujral show accumulation of dust

5.6 Museum Collection

This section of the document gives a result of a visual analysis of the museum collection in the galleries and the reserve collection. The museum environment maintains a micro-climate that is easily susceptible to the varying outer environmental conditions. The conditions of inorganic artefacts are considerably good. These include terracotta artefacts, coins, metal sculptures, porcelain artefacts and stone artefacts which comprise the Gandharan sculptures, the early and late Indian medieval sculptures. The susceptibility of the museum micro-climate to the exterior environment contributes to an enormous level in the deterioration of the organic artefacts. Organic artefacts comprising a sizeable number of miniature paintings, manuscripts, contemporary paintings and sculptures, patua paintings and textile artefacts are at a deteriorating state and require well organized conservation treatments to ensure its prolonged sustenance. Stone sculptures that are highly deteriorated are displayed in the exposed environment that can further steer the way to its degradation. Below is a brief regarding the present status of the museum collection, which are either on display or in the storage:

- The sculpture of Hindu mythological animal, Nandi, is displayed in the open, thereby exposing it to the direct environmental scenario. This has led to the delamination, deformation and discoloration of the stone structure.

- Staining of the stone artefacts due to seepage from the roof and also as an aftermath of improper conservation treatments have been observed.

- Paintings and prints have been exhibited on panels placed near the undulatory windows, which apart from blocking natural lighting, also creates difficulty for the visitors in viewing the artworks.

- The miniature paintings, even though they have been mounted in a satisfying way, are being hung with the use of thumb pins and do not contain individual glass protected frames to provide a buffer from the unsought environment. This can elevate the possibilities of environmental as well as human threat to the paintings.

- At present large casing are employed to enclose multiple miniature paintings within them thereby providing protection.

- The panels used for the display of miniature paintings has accumulated dust and dirt depositions.

- Currently the storage furniture and equipment cover nearly 80% of the storage area. The storage equipment space must be limited to a maximum of 40%, thereby increasing the circulation space to meet the Universal standards where any and every object can be identified and accessed within 3 minutes without moving more than 1 object.

- The objects within the storage area are placed on the floor, thereby increasing chances of its deterioration in the eventuation of natural or manmade risks.

- The coins are displayed vertically by sandwiching the objects between transparent acrylic sheets. This helps to display both the sides of the coins and provides the visitors with appreciable knowledge on the details and inscriptions on the coins. However, the drawback here is the use chemical adhesives to adhere the coins to the acrylic sheets. With continued exposure, the chemicals can react with the coins, leading to further deterioration. Furthermore, the chemical adhesives visible as semi-transparent films are visually obtrusive.

Textile Exhibits:

Fig. 171: Loss of material observed on textile

Metal Sculpture Exhibits:

Fig. 172: Corrosion and calcareous deposits on metal artefacts

Stone Sculpture Exhibits:

Fig. 173: (L-R) Deteriorations including deformation, detachment and discoloration observed on the sculpture; Display pedestal with visible evidences of water stains; Sculpture mounted on a pedestal towards the edge; Bird activity observed in galleries

Painting Exhibits:

Fig. 174: Flaking of paint layers observed on artworks

Fig. 175: Bird dropping on painting

Fig. 176: Waviness observed on the tempera paintings

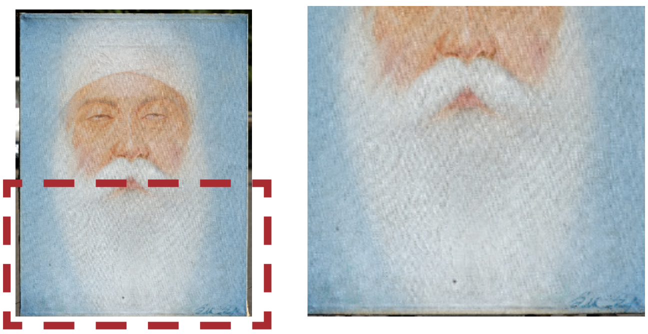
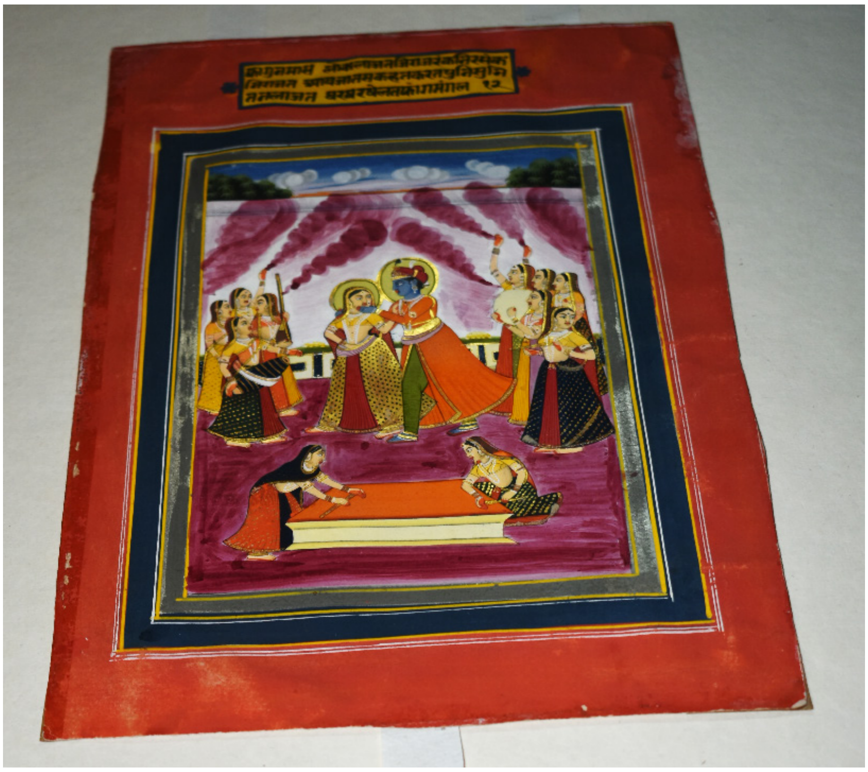


Fig. 177: Craquelure observed on paint layers in painting

Coin Exhibits:

Fig. 178: Patination and bronze disease observed on bronze coins (L); Vertical display of coins with lighting from the top. This reduces the visibility of the coins displayed towards the lower parts of the display unit (R)

Miniature Paintings [Reserve Collection]:



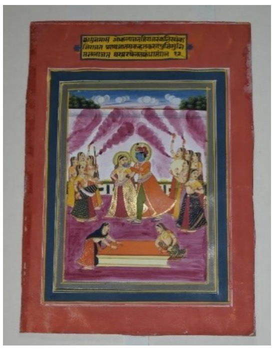


Fig. 179: Stains, fold marks, fading and loss of material observed on miniature paintings

Photographs [Library Collection]:

Fig. 180: Blooming and stains observed on photographs

Reserve Collection:

Fig. 181: Objects placed on the floor within the storage

5.7 Lighting

The infrastructure and services at the Government Museum and Art Gallery including piping systems, electrical works and lighting require maintenance and replacement considering its future use and functionality. Some of the later additions like the air conditioning system are major interventions that disturb the intended visual quality and aesthetics of the space.

Fig. 182: Objects Exposed electrical wiring and conduit casing disfiguring the building façade

Fig. 183: Inappropriate light and fan fixtures

Fig. 184: Inadequately and inappropriately lit spaces – Staircase to terrace (L), Miniature gallery (R)

Fig. 185: Air conditioning units alters the gallery height

The preliminary observations on lighting and other services will be expanded upon after completion of monitoring and assessment of the building environment by GCI.

Fig. 186: Water leakage due to damaged pipework under floor of entrance lobby (L); Main water supply has been temporarily blocked to check the leakage (R)

The main water supply line lie underneath the floor and goes up the duct in the entrance lobby. Over the years, extensive corrosion and rusting of the metal pipes had led to leakage through the joints of the terrazzo flooring. The main water supply pipeline was replaced at some portions on the exterior of the building. The 1" pipes were replaced with 2' pipes. However, the pipework below the museum floor was not replaced. The increase in pressure on the 1" pipe could also be the reason for the failure of the pipeline. The extent of damage cannot be determined without employing a scanning programme or physically removing the original flooring.

5.8 Risk Assessment

Disasters cause great damage or loss of life and property. This situation becomes even more critical when the buildings involved have heritage significance. The risk to museums becomes a complex process since it includes the rescue of artefacts and exhibits along with the human life.

Museums are the institutions charged with conserving; protecting and displaying artefacts from our past and thus preserving our rich heritage which might otherwise be lost. Also, here the risk is not only about the human lives and building but very critically about the artefacts that is a resource which once lost can't be retrieved. Considering that this building is also a site of high heritage significance, risk assessment at building level is also very critical. A preliminary study of this complex does show gaps in the building in terms of risk assessment. The risk includes structural as well as at management level. The existing systems if available are not in compliance with those required for such a building.

The survey takes into consideration the fact that key risks to the collections may result from their characteristics in terms of material and size, nature of display and storage, location in the building, the vulnerability of the building itself and also its immediate surroundings. Such comprehensive risk analysis helps in identifying ways of significantly reducing risks through simple improvements in maintenance and monitoring systems. A summary of hazards and vulnerabilities of the collections located in various display and storage areas that contribute to risks form a major content of this chapter. In addition to the wear and tear over time and the duration and location exposure to cumulative hazards that normally endanger museum collections, larger scale hazards such as fire and earthquake can have a major impact on the collections as well as the building. The chapter summarizes some of the key hazards to which valuable collections in the galleries and storage are exposed and key vulnerability factors associated with them. It outlines the approach that was followed in carrying out the risk assessment and provides a basis for identifying various risks to the collections, visitors, buildings, infrastructure and services.

However, the field work and analysis conducted comes with limitations. The risks to collections have been assessed mainly through visual observations of the collections, their display and storage, building, ancillary areas and surroundings. In some cases, assumptions have been made for some of the risks because of the nature of the impact on its surroundings. In some cases detailed investigation from specialists such as structural engineer, fire strategist may be required to understand the exact nature of the problem and decide further course of action.

The risks to the collection were identified first by analysing the condition of various types of collections kept in various display and storage areas, and identifying the key agents of deterioration if any and the underlying causes for the same. Based on this analysis of present condition, potential hazards/hazards and vulnerability factors for the collections are assessed.

The level of risks to each type of collection located in various areas is subsequently analysed based on the probability of hazard and the severity of impact. At a broader level of museum complex, the risks to collections from building and open areas are analyzed. The complex level assessment also provides a broader understanding of the risks that prevail in the area surrounding the museum. Besides site observations, risk assessment has also been undertaken through the study of documents and interviews and evaluation of existing management systems by understanding the existing organizational structure, the assessment of existing roles and responsibilities and procedures based on site observations and interviews with various stakeholders such as administrative staff of the museum, security officers, guards, maintenance personals etc.

5.8.1 Risk Identification

Catastrophic Hazards:

- *Fire:*

Loss of collections in museums can be significant during a fire. Visual site observation and information from staff was used to assess the current condition of electrical systems in the museum complex. Faulty electrical wiring in the galleries, storage and other ancillary areas was studied. As told to us by a museum employee, there have been some minor incidents of short circuiting in the past years. Though we do not find any apparent electrical issues inside the building, the pilotis area shows many cables converging at a point which has seen incidents of short circuit in the past. Hence these areas needs to be identified and checked for safety.

The electrical panels have been housed in a very narrow aisle area with the air conditioning systems accessed through the same aisle. This could be hazardous at the times of any short circuiting or sparking in the area as they will not remain accessible. Also this area is not locked at all times and though there are security guards patrolling the area, it needs to have some check on the access.

Existing fire management systems: The existing system includes hand-held Dry Powder (stored pressure) fire extinguishers and sand buckets placed in the exhibit areas. This includes 35 in the exhibit area, 7 in the library and conference room and 6 in the pilotis. All fire extinguishers are type B except one in the miniature art gallery which falls in type A. An international guideline for fire safety mentions that the distance between any two fire extinguishers should not be more than 75'. Though the museum has a reasonable number of extinguishers, this distance needs to be rectified. There are some units which are lying on the steps of the unused staircase in the reception foyer. Also the placement has not been done with any understanding of its need and accessibility at times of hazards. It was also noted that as on the date of the assessment work (31.07.18), the service date was overdue by a month (13-06-18). There are also some sand buckets that are lying totally out of view and also used for waste disposal. The exhibit area does not have any smoke detector that is very critical for help during the early stages of a hazard.

Fig. 187: (L-R) Area of past incident; Type B extinguisher; Units stored on the staircase; Fire extinguishers hidden away behind exhibits

Due to theft incident in the past and for directive movement in the galleries, partitions in form of collapsible gates have been installed at various levels. Also two of the staircase have been closed and are not accessible. This has increased the distance from any point to exit as more than 30 m which is prescribed by the NBC codes. This can result in panic and accidents leading to secondary hazard situation during event of fire.

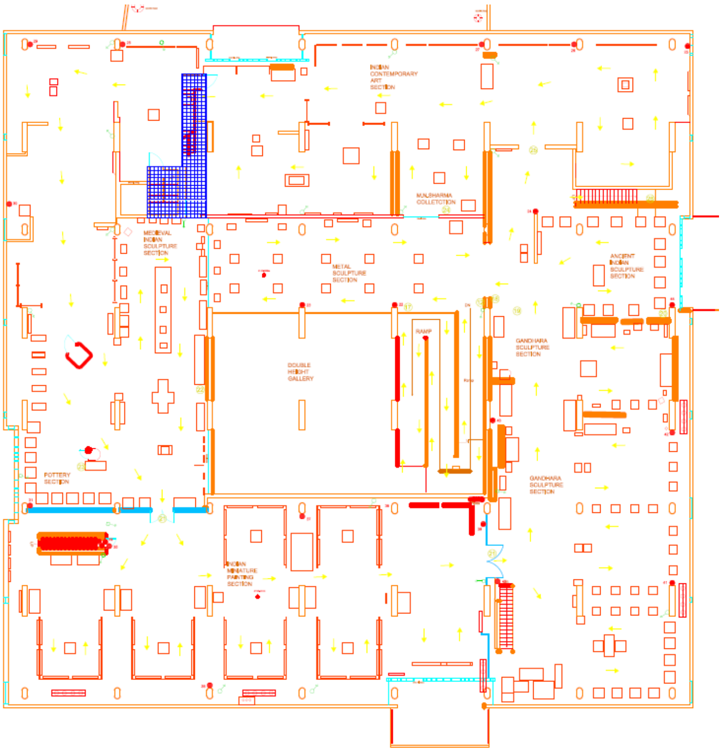


Fig. 188: Blue highlights the location of collapsible gates restricting the exit

- *Vandalism:*

There is no major historical account of any event with regards to vandalism, but with the presence of the museum in a very centralized zone within the complex of an arts college, it makes it sensitive to such activities in the future and care will need to be taken to take this risk into consideration.

There have been few incidences of vandalism in the gallery. The vandalism has been more ignorant in the gallery. As shown by the museum staff, someone has drawn a small part on one of the paintings in the contemporary art gallery.

Fig. 189: Graffiti in paint on fins at terrace level (L); on external columns (R)

Though nothing more has happened, as told by the staff, it is difficult to guard the paintings especially in the modern art section as the visitors at times get too close to it. According to them, the act of taking selfie also becomes a big issue. In name of taking selfies, the visitors at times also in groups get very close to the artefacts and put them at risk.

But there is lot of graffiti seen on the columns on the entrance of the building. Also one can find some paint marks that might have been done by children who come for the workshops in the children's gallery.

- *Earthquake:*

The Chandigarh city comes under IV seismic Zone which is considered severe and capable of wreaking real havoc. There is no history of major event in the past with respect to the earthquake hazard. As mentioned by one of the old staff that one sculpture was damaged in the earthquake that came in 70's but there is no proof to substantiate the narrative.

Several areas within the museum showed signs of decay over time. The reasons could be a combination of - improper interventions, weakening structure, type of usage etc. The building shows more apparent damage on the external façade than the internal. On the external façade the maximum damage can be noticed at the two ducts on the two sides that accumulate the water from the terrace and take it down. They show biological growth and major cracks at various levels.

Fig. 190: Vegetation growth in concrete duct (L); Exposed reinforcement bars and major cracks seen on beams connecting the concrete drains to the building (C)(R)

- *Theft:*

The museum has a history of major theft of precious paintings. This led to adding aluminium grills all along the external glazing. Considering that this museum houses a very precious miniature painting collection along with much other important collection, security is very important. As mentioned earlier, all the glazing has been covered by aluminium grills. But there are major security issues at the entrance level. The same has been discussed in the security and visitor management part.

Slow and Cumulative Hazards:

- *Pollutants:*

The museum is nestled within a surrounding of tress. Hence though it is also at risk to regular pollutants of the air, the scale would not be very high.

- *Dampness:*

Many areas of the museum show leakage of water from the ceiling. The dampness can be divided into external façade and internal. The external façade shows dampness at many places. Some of the area on the brick façade has also got algae growth due to continuing dampness.

Fig. 191: Dampness seen on external wall (L); Discoloration of ceiling due to water seepage (C); Marks on interior floor tiles due to water dripping from the roof in the past (R)

In the interior galleries, there seem to develop small outlets from which water drip from the ceiling. Some of the previous seepage points that have been repaired show water stains on the floor. As per the staff, new spots develop every monsoon season. This includes the galleries and the library where a bucket had to be kept for collecting the dripping water. As told by the staff, the waterproofing of the terrace has been done many times but considering that it has been done in phases and not homogeneously, the waterproofing layers open up at joints leading to such seepage below the membranes. A cabinet in the Gandhara section shows the ply of the display unit damaged due to water seepage. This has happened mainly due to the water that comes in through the aerators during the rains.

The false ceiling in the miniature gallery also shows stain and discoloration of the fibre boards. This could be due to water seepage from the roof above but can only be verified after proper survey of the false panelling system. So far, though no major damage has been reported on the exhibits, the structure shows surface deterioration due to this.

Fig. 192: Damp stains on false ceiling (L); Water seepage through aerators (C); Sculpture wrapped to protect from seepage (R)

- *Light:*

Light is a common cause of damage to collections-textiles, manuscripts, photographs, paintings. While textiles are vulnerable to fading from prolonged exposure to light, manuscripts exposed to light can cause bleaching, yellowing and embrittlement etc. It can also cause pigments/paints to fade or change colour.

Light damage is cumulative and irreversible. Our observation found that none of the galleries had any special lighting for the collections. As informed, there was no UV filter or orange filter to prevent for any of the lighting except for a part area in the textile gallery. Some of the art works are exposed to sunlight at specific locations such as at the ramp level, galleries of miniature art and contemporary art.

Most of the exposure is from the skylight above. Even though this exposure is mainly in peak summer and at specific time, continuous exposure would be harmful for the art works and The miniature paintings have too little light to appreciate the art work.

- *Termites:*

The external windows show many points of termite growth. Apparent study shows no such growth in the internal building but more through checking needs to be undertaken at every level.

Fig. 193: Paintings in Miniature gallery (L) and Contemporary gallery (R) exposed to light from skylight

Fig. 194: Termite growth seen on window frames in the pilotis area

Other Miscellaneous Hazards:

Other than the vulnerabilities as mentioned within individual hazards, the exhibits also undergo wear and tear over the years. There is a major collection of stone sculptures in the entrance foyer of the museum. They have been mounted on stone base. Vulnerabilities would include dust and regular weathering over the years. Most of the artefacts including the precious manuscripts have been exhibited in case made of wood covered by glass on top. Though the system is efficient, exposure to dust over the years cannot be avoided.

Past Interventions:

The museum has undergone many interventions in the past years since its making. Waterproofing layer was replaced over several parts of the palace. Previous instances of dampness have resulted in water stains in the galleries. Some of the major interventions include collapsible grills, closing of ducts and stairs.

Planning Issues:

Though the building is a masterpiece by Corbusier, it has some architectural elements that do not meet the compliance of today's safety guidelines and can be risk to people.

a. Railing: The railing of the design is such that it can be prone to someone falling through especially kids. In fact the same has been closed with a collapsible grill shutters on the 1st floor.
b. Ramp: Though the slope of the ramp meets the required gradient and is comfortable, absence of safety barrier in form of a railing can be risk to movement especially considering that the place is visited by school children where the density of the place increases.
c. The building as of now has only single entry and exit. This is also due to some interventions such as closing of stairs at first floor level.
d. Also as told to us, two of the exits that open into the terraces have been sealed by locks and no one has the keys since many years. Being a government institution, opening the locks is also a difficult procedure that has not been attempted so far.

5.8.2 Other Observations

Security and Visitor Management:

The security is divided into guards in the exterior of the museum and the museum attendants inside the building. Outside the museum, on the front side, the area is manned by 3 personnel from the ITBP (Indo Tibetan border police) police force. Rest of the area is supposed to be guarded by 4 security guards and one at the gate, but our observations found only one at the gate and one more around. As for the entire complex, a total of 13 security guards from private agency have been deputed. The ITBP police force is changed every three months. Within the building, there are 14 attendants stationed in various galleries. Even though there is a checkpoint for the visitors when they enter/exit the gallery, there are no regulations on the number of visitors allowed at one time. No bags are allowed inside the museum and lockers are provided for those who need it. There is no physical or machine backed checking of the visitors. Other than that CCTV cameras have been deputed at various locations as shown in the drawing. As for the building, there is a single entry-exit point from the main museum. The circulation is also controlled by additions of collapsible shutters at various levels. Two of the exits to the balcony have got sealed locks which have not been opened since many years with no one having knowledge of the keys. But there is a narrow entry, camouflaged as a partition to the one of the stairs in the first gallery that leads to the terrace. The terrace is also locked and the keys with the staff personnel.

The routine closing of the museum includes a bell at 4.00 p.m. for the visitors to vacate the museum. This also has the Deputy curator with a staff taking a round at 4.00 o'clock around the entire museum to check each gallery personally. After this routine, the museum door is locked and also sealed with wax every day. There are no exit signage at any point of the circulation area. Also there are no possibility of curtail the regular round by the visitor in case of any emergency. The option is only to complete the round or go back the entire way. There are no bottlenecks as such in the museum considering the general density of visitors at any given time in this building.

The entire building has jail of strong MS section. Though this is a strong deterrent for theft, considering the single entry-exit of the building, it can also be an issue in case of any emergency evacuation required from the museum.

Proximity of the store to the gallery is vital for collections as it minimizes any risks arising during moving the collections from one place to another. Two storage areas are located at the back of the main museum. The entry to the storage area from the museum which had existed has been closed. So now there is no connection between the two. There is no special security for the storage areas though we found staff present due to the presence of a pantry next to these storage. As told to us by the deputy curator, the storage is opened every 3-4 months. They have locked doors at two levels and they are also sealed with wax after every opening. There are no CCTV cameras inside the storage. Though there is a camera on the collapsible shutter before entering the storage area, it does not have clear vision.

Fig. 195: Blurred vision of the camera outside the storage area

Condition of the display cases:

Most display and storage cases in the galleries were found to be adequate and in proper condition in accordance to standard conservation guidelines. Most of the stone sculptures have been anchored by nuts to m.s sections. Some of the display units though do have a weak structure and could be risk in case of any vibrations. Also the glass display cases can be opened by simple screws from the top. This can make them prone to risk of theft.

Condition of the Storage Area:

The museum consists of two storage areas, for contemporary art and antiquities. As informed, the storage areas open once in three to four months. They have doors at two levels with the collapsible shutter closing the veranda before the storage. As per our study, the storage of contemporary art is over occupied and does have not much space. Some of the paintings are also lying on the floor.

As for antiquities, the miniature paintings have been put in wooden cases. As told by the deputy curator, wooden boxes are not good storage options as they release fumes and can damage works over the years. The museum has also procured steel storage systems from Godrej, but here also wooden boxes have been used within for the individual storing which had continued the risk. Also large art works that do not fit into the cabinets have been rolled up into the cupboard which is damaging for them. The same needs to be stored on rollers.

Fig. 196: (L-R) Overcrowded racks for storage of Contemporary paintings; Paintings on the floor due to lack of space; Large size objects rolled up in wooden cupboards; Miniature paintings stored in wooden boxes

Major dampness has been seen in the storage of antiquities. Though the stain seemed to have dried out, no repair work had been done at the point. Due to air conditioning work in the past, the common wall between the two storage areas was broken down near the floor. Though the HVAC work is completed the broken wall has been left unfinished. Also there are useless ducts lying around which could act as breeding are for rodents. As informed, they do have issue of rodents in this area. Also the entrance wall shows major cracks in the wall.

Fig. 197: Damp walls and ceiling in storage areas (L)(C); Unfinished construction between two storage areas (R)

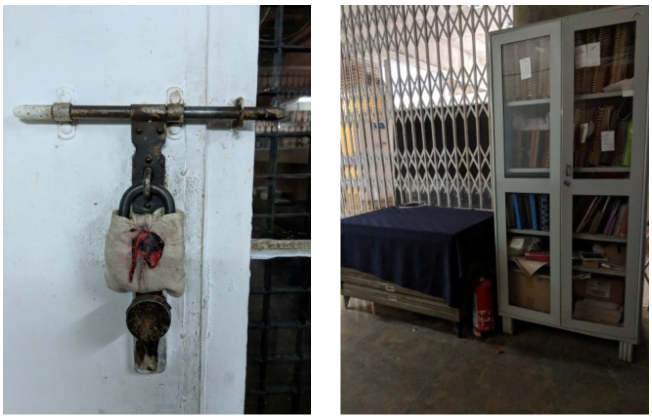


Fig. 198: Lock sealed with wax (L); Fire extinguishers hidden between cabinets (R)

There are no smoke detectors in the storage areas. Four fire extinguishers are found hidden between the two storage cabinets just outside the storage areas.

Electrical and AC Unit:

A new air-conditioning unit added some years back for the air conditioning of the storage areas has a very narrow entry point. That area includes electrical controls of the building as well as the unit at the end of a narrow lane. Any human working in this area can be at great risk in case of any fire at the electrical panel at the mouth of the narrow corridor. Also this area is not locked open and can be accessed by anyone. The electrical transformer at the back shows water flooding on its platform with algae growing around it.

Fig. 199: Water logging at the base of electrical transformer

CCTV Cameras:

There are a total of 56 cameras in the museum. They were put in 2009. They have a recording at the back of the main museum and the entry is separate from the main building. If they work well, it has a history recording possibility of 10 hours. From that 16 are outside. Of the 56 cameras, 25 are not working. The CCTV staff says they have complained but nothing has been done for the same. Earlier there was an AMC but nothing has been done since last 3 years.

2 attendants are on constant duty to monitor it. This time is only during the working hours of the museum. Most incidents for use of CCTV include when visitors are getting too close to the exhibits. The staff goes directly to the floor concerned and warns them. They said that other than warning them not to get close or touch these exhibits they also request them not to do so in any other museums also. Also in case of a visitor forgetting their belonging in the museum.

Security check:

There is no proper security check at the entrance. Most of the times, the visitors are asked to leave their bags at the reception table but the rule is not strictly followed. Also there is no check for the people themselves.

Staff:

The staff consists of permanent staff and contract staff. The permanent staff has been employed by the administration while the contract people are from an agency. There is a total of 16 contract staff, one at the reception, two guides and 13 attendants in galleries. All keys are with the Deputy Curator.

It can be concluded that the museum is exposed to various risks that can be a threat to the collection as well as the building which is also a major work of the Le Corbusier. The museum lacks a basic management plan to address the plan of action in case of emergencies- fire, theft or terrorist attack. It was observed that safety and functioning of the museum has manual dependency - heavily depending on the staff, security and attendants. Although, some of the security surveillance systems exist, many parts of the complex areas are not covered or the cameras do not function, thus increasing the window of hazards. The survey shows that risk due to fire are severe, apart from conservation and organizational issues and that threaten the individual collections. The risks to collections have been assessed based on the condition of its surroundings and a visual condition of the object itself. In some cases, assumptions have been made for some of the risks because of the nature of the impact on its surroundings.

5.9 Environmental Impact on the Building

As discussed in Chapter 3.7 of the document, Le Corbusier introduced climate responsive systems in his design for the Government Museum and Art Gallery. The mechanisms of ventilation control and environmental thermal inertia was directed at regulating and maintaining a sound indoor environment.

A survey of the building's thermal response to solar radiation suggests large variations in indoor temperature and luminance, depending on the daylight hours and the outside temperature. The result also changes seasonally; during the monsoons it is observed that there is lower light influx and lower temperature as compared to during peak summers. The use of tinted glass panes for the skylight brings in diffused sunlight, thereby reducing the heat gain within the building. The indicators of thermal comfort- temperature and relative humidity, provide indirect indication for potential organic and biological contamination. However, no signs of bio-contamination was found within the building during the visual survey conducted by the team.

The role of aerators introduced as mechanisms to respond to air permeability and cross ventilation indoors seems to be non-functional, as most of them are usually kept closed during the working hours of the museum. Electric fans installed at different locations within the gallery give temporary respite in terms of air movement. The air conditioned galleries seem to have a reduced overall circulation of air. A balance between natural ventilation and mechanically controlled environment is yet to be achieved.

Chemical contaminants originating from materials used in the repair works within the museum or even from different materials of the collection (paints, polishes, etc.) are to be explored. The impact of urban climate and outdoor air pollution, measurements of CO2 and VOC indoors effecting the indoor air quality, built fabric and the museum collection are also still unexplored. However, dust accumulation on artwork, display and built fabric has been observed during the survey, requiring regular dusting and cleaning of the spaces. Their sources should thereby be identified in order to remedy or reduce the dust generation.

A scientific survey of the environmental impact on the building is being conducted by the Getty Conservation Institute in 2019-2020. Devices recording relative humidity, temperature fluctuations, air quality, dust etc. have been installed to monitor the internal climate of the museum in December 2019. They will be monitored regularly over a period of minimum one year to determine the climatic effect on the built fabric as well as the collection housed within the Government Museum and Art Gallery. The environmental studies will subsequently inform the implementation works to be undertaken to maintain an ideal indoor environment for the durability and performance of the building and its collections. This aspect and its subsequent findings may be incorporated later in this CMP by 2021.

6. POLICIES

6.1 Overarching Objectives

Conservation actions for the Government Museum and Art Gallery shall be based on rigorous documentation and research on various aspects of the building as well as a broader understanding of its geographical, historical and architectural context while also taking into account its present and future operational requirements.

The objectives for outlining conservation, use and management policies for the Government Museum and Art Gallery are:

OBJ 1 The mission of the Conservation Master Plan is to maintain the authenticity and integrity of the modernist views of the designers and patrons of the Government Museum and Art Gallery. The policies will strive to protect and enhance the significance of the Museum to a wider public audience as well as professionals and academicians.

OBJ 2 The conservation policies shall ensure that all preservation and restoration work shall follow an integrated approach for modern scientific techniques and standard building practices to retain the authenticity of the original design and materials.

OBJ 3 Policies concerning conservation activity or future intervention shall take into account the authenticity of the form, design, built fabric, furniture, fixtures and finishes, and shall strive to enhance and sustain its cultural significance. Interventions shall be undertaken after establishing clear limits for ‘acceptable change’, ensuring that these are sensitive to the values and preserve the significance of the Government Museum and Art Gallery.

OBJ 4 Conservation policies for the Museum are based on thorough research and understanding of the historic layers on site and the present and future needs of the site. The conservation, use and management of the Government Museum and Art Gallery shall respects the original vision of its designers. The authenticity of the structure and the historic fabric will be maintained, while integrating the evolving needs of the users in a sensitive manner with minimal intervention.

OBJ 5 Use and interpretation policies for the Museum should be based on the intended usage of spaces and the interpretation and presentation of the vision of the architect.

OBJ 6 Management policies should ensure safety, protection, disaster management along with routine maintenance of the Museum and its environs. Specific policies monitoring the maintenance should also be outlined.

6.2 Policies to Retain Architect’s Vision

Le Corbusier’s design for the Government Museum and Art Gallery is the product of the unification of various architectural design principles and concepts designed by him over the course of his career. Le Corbusier’s vison and conceptual approach to the form, symbolism and innovative construction technology applied in the building shall override any approach towards the conservation, use and interpretation of the Government Museum and Art Gallery, as well as any future interventions introduced in the building.

V 1 The relationship and dynamic interaction of the Museum with its immediate surrounding landscape as well as its setting in the city of Chandigarh contributes to its distinct character. The conservation plan for the Museum should ensure maintaining the building’s integrity and uphold the wholeness of its existence. The proposals shall preserve the architectural identity of the museum and its place in the modern city, while concurrently enhancing its vitality.

V 2 All conservation, use and interpretation proposals for the Museum shall be mindful of its sculptural form and physical fabric as conceptualized by Le Corbusier and his team. The open plan design of the museum shall be kept intact, allowing no alterations or interventions to disrupt the flow pf spaces as designed by the architect.

V 3 The pilotis, envisaged as an uninterrupted expanse of columns by Le Corbusier, should reflect the original quality of the space. All alterations and additions that disrupt the free circulation space of the pilotis should be removed.

V 4 The visual appearance of the museum is regulated by the *modulor* and highlighted by architectural polychromy as designed by Le Corbusier. All aspects of the building, interiors, landscape, fittings and fixtures that positively contribute to its significance should be handled with caution.

V 5 The configuration of spaces and the sequence of movement within Le Corbusier’s Museum influences the visitor experience within the spaces. No additions or subtractions may be permitted in the structure or its setting that could diminish its intended configuration in any manner or cause discontinuity in the intended flow of visitor circulation.

V 6 The narrow proportions of the aerators, proportions of the undulatory and tinted glazing of the clerestory that contribute to the air renewal and passive energy control within the building should be revived. No alterations shall be made to the environment control devices and sun protection systems devised by Le Corbusier that may compromise the thermal comfort within the spaces. Maintaining the authenticity of the Museum and all its attributes should spearhead any physical intervention.

V 7 The authenticity of the use and function of the museum spaces should be maintained at the core of the conservation plan for the Government Museum and Art Gallery. The use and interpretation of the Museum shall respect the original intentions of the designer.

V 8 While developing the Interpretation plan all associated stakeholders, particularly the local community, shall be at the core of the entire process.

6.3 General Conservation Policies

(Source: Meeting Report, Le Corbusier's Three Museums: A Workshop on Their Care and Conservation, Getty Conservation Institute)

Considering the shared heritage values of the three museums, the Workshop participants identified conservation recommendations resonating their collective cultural significance. The following recommendations were recognized as important for the care and conservation of the Government Museum and Art Gallery:

CON 1 Understand the significance of the relationship between the buildings and their collections. Conserve and maintain the buildings as well as the collections, including securing access to resources to operate them effectively.

CON 2 Engage expert staff and ensure that the staff structure is adequate to guide future stewardship and conservation of the buildings and their collections.

CON 3 Ensure that the conservation of the building dictates its use and what happens within it. Recognize that the building is the principle exhibit and its careful conservation must drive any proposals for changes arising from or related to collection care and exhibit needs. Consider opportunities to interpret the building through museum programming.

CON 4 Plan interventions to the building only after detailed investigations, research, and design work have been completed. Implement interventions using only contractors with skill and knowledge of modern buildings.

CON 5 Establish and sustain a network with other Le Corbusier designed museums.

6.4 Site Planning and Landscape Conservation Policies

LAN 1 The water pools within the museum site are integral to the museum building. Any intervention or physical obstructions like railings, utility fixtures etc. that visually impacts the Museum structure and its relation to the pool should be strictly avoided. However, concerns of physical safety, if any, may be considered suitably.

LAN 2 The "*patatoïde*" water-basin at the western corner is the most important water element envisaged at the site. The raised edges, fountain with its plumbing system, lighting installations and other stone sculptures implemented so far should be removed and the pool should be restored to its original state as much as possible. However, rainwater spill around the pool during its fall from the drain above may need to be addressed through appropriate design intervention.

LAN 3 Appropriate physical repair works, as may be required, should be undertaken for restoring the pool conditions as well as amending the physical deterioration of the pool, along with transparent waterproofing membrane on the pool surface to retain the material texture.

LAN 4 The Piazza, conceptualized as a foreground to view and appreciate the museum should not be visually interrupted by sculptures, signboards, etc. barring the existing ones.

LAN 5 The flooring pattern of the piazza designed by Le Corbusier based on the *Modulor* should not be changed or altered in terms of the tile size and proportions. Introduction of outdoor sculptures or other installations, if unavoidable, should be judiciously and carefully placed.

LAN 6 The tree plantation policy at the Government Museum and Art Gallery was devised by Dr. Randhawa taking into account the tree forms and flower colours, based on the advice of Le Corbusier. Any future proposal for tree planting should follow the original planting principle centered on the unification of the whole site and harmonization of the heterogeneous structures while ensuring visibility of the iconic buildings. For shrubs, ground covers and climbers, a planting strategy plan shall be put in place in the basis of location, climatic, functional and aesthetic factors.

LAN 7 Other landscape interventions like grass mounds or stepped seating may be avoided in the vicinity of the Museum building, especially near the access points to the premises.

LAN 8 Original urban furniture like the built-in concrete lighting fixture, of which currently only one exists on site, may be added at positions based on archival photographic references. These may also be provided at other locations to meet the illumination requirement of the site.

LAN 9 The current parking facility is unplanned. All four/two-wheeler parking shall be relocated to the outside parking area. Demarcation of parking space for both two and four wheelers should be provided.

LAN 10 The open space on the eastern side of the museum that is currently being used as a service yard needs to be organized and articulated in sync with the museum use and interpretation plan. The northern as well as north-western part of the site, especially around the cycle stand, need to be augmented with more user-friendly landscape intervention.

LAN 11 A regular maintenance regime for the landscape may be devised to include tree pruning work to avoid interference of the branches of large trees with the museum building and/or its openings.

LAN 12 Interface of landscape with other services must be sensitively dealt with. This is particularly important for landscape and risk management plan involving emergency escape routes/ firefighting tank location etc.

6.5 Conservation Policies for Building Exterior

BE 1 The exterior form of the structure should be retained in its original form. There should not be any new intervention that impacts the visual, structural or material integrity of Government Museum's existing structure.

BE 2 The authenticity of the brick panels on the building façade should be maintained in terms of its composition, size and material. The original panels should be retained as far as possible. All incompatible repairs or interventions should be restored with that matching the original panels. Any future repairs/ fixing should be based on a detailed analysis and material testing to match with the original material, texture and composition. Mock-ups for the brick panels are essential to determine the precise approach for fixing of the panels.

BE 3 The exterior of the building parts with exposed concrete appear to be in original state with exception of some areas where repairs have been undertaken. In future, any repairs to be done should be duly approved and the properties of the new materials should match the existing.

BE 4 For all repairs to exterior concrete floor tiles, concrete matching the original mix and finish should be used. The repairs must also keep in mind the tile sizes designed as per modulor proportions by Le Corbusier.

BE 5 The roof form of Government Museum and Art Gallery which is its key architectural feature should not be tampered with in any manner that may disturb its form or alter the appearance and skyline. All repairs to the roof elements like the concrete drains, gargoyles, etc. should be done with concrete matching the composition and finish of the original.

BE 6 The elements forming the terrace drainage system should be maintained on a regular basis to achieve longevity. The parts that dispose off water should be cleaned regularly to prevent water accumulation and penetration into the building.

BE 7 The waterproofing of the roof must be constantly monitored for seepage. Since the surface of the roof has low authenticity, it can be re-surfaced if and when required to ensure protection of inner spaces from damage through seepage and dampness. The new surface protection should be re-laid with proper care and with maintaining slopes.

BE 8 All doors and windows of Government Museum and Art Gallery are to be retained as per original design and should be cleaned and monitored for any damage in the future. The original paint colour on these fenestrations should be analyzed for any future paintwork. The size, shape and design of these openings should never be compromised in any manner during any future intervention.

6.6 Conservation Policies for Building Interior

BI 1 The interior layout of spaces should be retained as originally designed. Any later changes that impact the original configuration of spaces need to be reversed to attain its original form as intended by the architect.

BI 2 The interior walls finished as exposed concrete and plaster with coloured paint should not be altered. The existing layers of paint need to be tested in each space and archival records/ photographs need to be studied for material specifications and colours to make informed decision on the final paint specifications to match the original.

BI 3 All past repairs or interventions made to the ceiling panels of interior galleries should be reversed and should be replaced with that matching the original panels. For any future repairs, detailed analysis and material testing has to be done to determine the original material, texture and composition. The paint colours used should match the sequence followed in the original design.

BI 4 Owning to its uniqueness and difficulty in reproducing, utmost care should be taken to protect and maintain the terrazzo flooring of the interior of the Museum. For places where it has been modified or damaged, mock-ups of matching terrazzo should be prepared. A rigorous cycle of testing needs to be taken up before any changes are made to the original flooring.

BI 5 All doors and windows of Government Museum and Art Gallery are to be retained as original and should be cleaned and monitored for any damage in the future. The metal doors painted as per the colour palette designed by Le Corbusier should be retained as intended. Any interventions or additions to the fenestrations that diminish the integrity of the interior spaces in any manner should be avoided.

BI 6 Unsympathetic additions like safety grills, curtains and blinds and replacement of tinted glass of clerestory windows with clear glass should be reversed. Any interventions or additions to the doors and windows that diminish the integrity of the interior spaces, alter the visual continuity as well as the quality of light within the spaces in any manner should be avoided. All security related issues should be resolved with appropriate solutions that do not adversely affect the building.

6.7 Policies for Use and Interpretation

The use and interpretation policy for the Government Museum and Art Gallery shall direct the ways in which it will link and showcase the information and artefacts for the purpose of study, awareness and entertainment. It shall function as an umbrella under which public events and exhibitions shall be conceived, designed and delivered focusing primarily on betterment of the visitor experience.

USE 1 While framing interpretation and re-use policies, the original design intent and visions of Le Corbusier for the Museum building should be retained as much as possible, as well as consider its current function and demands of the museum.

USE 2 Any intervention which is visually intrusive and compromises the Museum’s significance shall not be recommended. The addition of Child Art Gallery covering the original pilotis area which alters the architect’s open plan design and the building’s configuration should be reversed. Alternate solutions to accommodate these functions should be provided.

USE 3 All alterations made to the original layout of the Museum should be reversed. The cafeteria which was part of the original design should be reinstated.

USE 4 While aiming to retain the original use and function of the spaces within the museum as well as accommodating increasing collections at the museum, there is need for additional space. A support building or structure separate from the present building might be required to accommodate future needs of the museum. Decisions for the same would need to be taken by the UT Administration and the Museum Committee to allocate additional building in the vicinity of the Museum.

USE 5 In the Government Museum and Art Gallery distinct strategies for exhibition, public oriented programs, education and publication should be established which emphasises on effective interpretation. It shall not only convey factual data but also add meaning to the objects on display.

USE 6 An orientation space shall be incorporated in the re-use and interpretation plan for introducing the Museum and its significance to the visitors. Stressing upon the Museum's inter-cultural association with Le Corbusier's three museums, it should be interpreted on a wider platform and communicated to the visitors as well.

USE 7 Interactive and digital display techniques shall be adopted for engaging the visitors more actively and increasing the experiential quality of the Museum.

USE 8 Signage scheme for the entire museum needs to be improvised and implemented.

USE 9 The sound and light show which narrates the story of the City Beautiful - Chandigarh and its modern heritage shall be redeveloped in terms of content and technology. It should be advertised and promoted effectively at a larger platform. It should aim to attract the local people of the city as well as the tourists to the museum.

USE 10 There is lack of adequate public amenities in the Museum. Additional public toilets should be introduced elsewhere in the campus to reduce the pressure on the main toilets within the building. Absence of drinking water facility and cafeteria is a major inconvenience for the visitors. The same shall be made available.

USE 11 Regular maintenance of the building exteriors, interiors and the pool should include daily, monthly and annual activities, extending beyond standard cleaning practices to regular inspection of the spaces, surfaces, services, fittings and furniture. Continual and appropriate maintenance and periodic inspection is consistently the best conservation action for architectural heritage and reduces long-term repair costs.

USE 12 The interpretation plan devised for the Museum shall be subject to review every 2-3 years to evaluate the various outreach and interpretation events, budgeting for the annual events, themes and target audience for the programs in the museum, etc.

6.8 Conservation Policies for Exhibition Display, Furniture and In-situ Artworks

EX 1 All repairs and re-upholstering works of original furniture and display cases should follow detailed inventory of the original furniture, along with condition assessment. All future treatment should ensure they use similar design, pattern and materials as the original. The original colour schemes and fabric composition should be reinstated after confirmation through research into archival documents and specifications.

Mock-ups for repairing the same should be mandatory along with material testing and paint analysis.

EX 2 Any future furniture requirement should be met with those which follow the form, scale, proportion, material, texture and finish of the original and should be recorded properly to distinguish them from the original.

EX 3 Any future reproduction of such furniture, if required, should be done with proper research and documentation to match the original. Archival records and original drawings should be referred for this purpose.

EX 4 The mural at the museum reception should be restored to its original state through technically appropriate processes of cleaning and retained with the highest regard for its authenticity in terms of composition, textures and colour.

EX 5 No display should be hung directly onto the wall using nails and brackets or by other methods that may cause mechanical distress to the built structure. All artwork to be exhibited shall be either pinned onto the original display panel (upholstered board) or suspended from the ceiling from the wooden batten and channel system design for the very purpose.

EX 6 Timely maintenance and cleaning/dusting of the artwork (including sculptures), pedestals and display furniture should be part of the museum upkeep and management schedule.

6.9 Conservation Policies for Museum Collection

The preventative conservation and care of collections objects is an essential function of the ongoing work of the Museum, in that these activities preserve the Museum's raison d'etre. As a consequence of the high standard of care, the Museum requires responsible and disciplined handling, storage, and display of collections via a rigorous adherence to the following principles:

COL 1 The Museum shall control the physical, chemical, and biological factors that can result in deterioration of the valuable Museum collections.

COL 2 The Museum shall preserve collection records and any other documentary materials that support the use and preservation of collections items.

COL 3 The Museum, and its staff (principally the Curator of Collections), shall be responsible for developing and implementing technical standards, preservation strategies and policies that respect the diverse nature of its collections, while providing useful access to those collections.

COL 4 The Museum shall provide the necessary preservation, protection, and security for all collections acquired, borrowed, and in the custody of the Museum (inclusive of their associated information).

COL 5 The Museum shall balance current research and educational use with the preservation requirements of collection items to ensure that collections are maintained for future generations and rightfully serve their intended purpose.

COL 6 The Museum and volunteer staff shall at all times, be aware of their responsibility to preserve and protect collections objects, and shall act accordingly.

COL 7 The Museum shall ensure that collections and their associated information are cared for and maintained in conditions that preserve and extend their physical and intellectual integrity for use in exhibition, research, and education.

COL 8 Collections activities shall be predicated upon a concerted preventative conservation program, which advocates: minimal intervention, providing environmental conditions that minimize harm, permitting handling only by trained personnel and under strict guidelines, use of non-deleterious (i.e. inert, acid-free) materials for storage, packing, and exhibition of collections material, condition assessment and lucrative procedures for new acquisitions (where appropriate), and reversibility of conservation treatments.

COL 9 All physical aspects of the facility affecting the ambient environmental conditions of the collection (i.e. light, temperature, relative humidity, infestation, and air pollutants) shall ideally be monitored weekly by the Curator of Collections and/or his/her designee (at the discretion of the Curator of Collections).

COL 10 The Curator of Collections shall prepare a written condition report (replete with photographic documentation) where appropriate, for objects in the permanent collections requiring treatment, or objects on loan or in temporary custody when necessary, producing a baseline record from which the condition of collections objects can be monitored.

COL 11 The Curator of Collections (or his/her staff designee) shall make weekly inspections of objects on exhibit and in storage areas.

COL 12 Changes in the ambient environment or in conditions that affect objects in the Museum's collections or on loan to the Museum must immediately be brought to the attention of the Curator of Collections, and/or the Director, who shall collaboratively take the necessary actions to rectify the situation.

COL 13 Any damage to or change in condition of Museum collection or loan objects must be reported immediately to the Curator of Collections, who will notify the appropriate staff members and the Director.

COL 14 A Collections entering the Museum via new acquisition, current loan, or current exhibition shall be given top priority for the purposes of digitization and record keeping in a collections management database.

COL 15 A clear Do's and Don'ts policy specifying monthly, quarterly, half -yearly and annual task of maintenance works should be charted out. A regime armed with knowledge of traditional materials and building practices should be created.

6.10 Policies for Lighting

LI 1 The sculptural elements and details of the Government Museum and Art Gallery designed by Le Corbusier and Ratna Fabri should be retained in their original form. Any later interventions which are not in the same spirit, must be reversed. In addition, any future proposals should incorporate the original Modernist idiom of design without impacting the original design strategy.

LI 2 All sensitive upgradation and repairs made to the infrastructure, electrical wiring, plumbing and drainage of the structure should be considered as acceptable change. Any future intervention should be discreet and should not disrupt the aesthetics of the exteriors and interiors in any manner, as well as diminish its significance.

LI 3 Defunct services such as electrical wiring and fittings should be removed or replaced. Outdated fixtures should be replaced with those matching the original lighting fixtures or should provide sustainable alternatives that do not detract from the original design.

LI 4 For any new wiring requirement, the most feasible option may be introduced with minimum damage to the heritage building. In no case, should the flooring be compromised for any wiring purposes since the terrazzo flooring is of much higher significance and authenticity. All the wiring for ceiling lights originally ran through the wooden casings on the walls and ceiling, which could be used for new wiring by retrofitting or replicating the same design of wooden casing as per requirement.

LI 5 Any future requirements for air conditioning, CCTV, projection systems and other advanced contemporary technologies required for improved functioning of the Museum needs to be introduced sensitively to ensure that they do not impact any interior or exterior elements of significance.

LI 6 The original general lighting was designed to be very subtle so as to give more importance to the natural light from the clerestory. The same should be restored to keep the light quality within the galleries as intended.

LI 7 The light quality in the Miniature Painting Gallery has been compromised because of the addition of AC ducting bringing down the ceiling level and blocking the lighting filtering in from the clerestory. All future additions to the services within the galleries should be mindful of the quality of space intended by the designer through his design for the built space.

LI 8 Focused lights in the original lighting scheme meant for the Sculptures and other wall hung paintings were originally suspended from the ceiling or placed on the floor. Introduction of new track lights has led to increase in the overall lumen intensity for the display lighting. The defunct original display lights should be repaired and retrofitted with more efficient and eco-friendly fixtures.

LI 9 HVAC services have been upgraded and also added over the years as per requirement. In some areas this intervention has caused a major impact to the building, both in the exterior and interior. The need for air conditioning shall be determined through weather monitoring and less intrusive measures shall be adopted to provide the services.

LI 10 Façade illumination systems are set up very often during major events at the museum. Permanent lighting for façade illumination could be introduced. This should be executed with minimum physical impact on the building and should reverse all past interventions.

6.11 Policies for Archival Resources

AR 1 In case there is availability of records in the various offices of the UT Department pertaining to the project proposal, construction, interventions and repairs of the Government Museum and Art Gallery, including original office records and drawings, all such original files, records, drawings, models, etc. should be located and collected. They should be carefully restored (if damaged), digitized, catalogued and documented properly for future reference.

AR 2 The original documents should be safeguarded from future weathering and secured from vandalism and misuse.

AR 3 All archival material should be stored in appropriate storage such as compactors/ rooms with dehumidifiers and data-loggers, etc. as prescribed by material conservators.

6.12 Policies for Risk Management

RM 1 The risks to the site and its management systems should be regularly assessed and suitable actions taken to mitigate the risks. The building exterior currently poses threat to the visitors, due to loosening of brick tiles and disintegration of the concrete drains. There are also structural issues in the ancillary buildings such as the conservation lab and HVAC area. Immediate precautionary action and structural conservation works should be undertaken to minimize the risks. In the future these conditions may evolve and/or reoccur and it is imperative that a continuous monitoring system is set up for the Museum.

RM 2 Defunct services such as electrical wiring and plumbing and drainage lines should be removed or replaced as necessary to minimize risk to the built fabric. The existing electrical wiring should be checked and any wiring prone to accidents, such as those seen in the pilotis area should to be rectified.

RM 3 A security system should be implemented to safeguard the Museum property, especially with respect to its movable furniture and collections that are housed within the building. It should also enable monitoring of the precinct for potential vandalism or anti-social activities. The existing CCTV cameras need to be replaced with improved systems which has better visual clarity. The security system should also include metal detection system for visitors to be installed at the museum entrance. CCTV cameras installation should be such that all spaces within the museum and immediate surroundings is covered. The systems should integrate on-site personnel management with off-site monitoring to ensure protection of the site at all times. The technology based security systems should be monitored and updated at regular intervals. Contemporary issues such as damage to the art work due to selfie phenomenon also will need to be addressed in the exhibit galleries.

RM 4 The entire site should follow safety and fire-fighting norms. Emergency preparedness planning in response to fire, accidents and overcrowding inside the museum is essential. The site should identify emergency evacuation routes and protocols for emergency response and these should be clearly communicated to visitors through signage and other communicative media.

RM 5 Capacity building and training should form an integral part of risk management for the Museum (and other structures in the area). It should be undertaken as a mandatory regular exercise.

RM 6 Fire Audits, security audits and structural audits should be scheduled in the maintenance and upkeep roster of the building.

RM 7 The exhibits and exhibition systems are the most important part of this building and they need to be checked and corrected for providing better preservation environment of the artefacts.

RM 8 Proper storage of the art works is very critical for their long term sustainability and this need to be given critical attention.

RM 9 Climatic issues for the art works such as exposure to sun light and water leakage should be addressed and checked at regular intervals.

7. CONSERVATION MANAGEMENT

7.1 Landscape Conservation Plan

The Museum building can be considered as part of a larger landscape where both the site and its setting lends meaning to the built form and plays an important role in understanding the building in its wider context. The proposals for the conservation of the landscape around the Museum keeps this in mind as its underlying principle and values the landscape elements of the core site as well as its surroundings in the context of the museum's physical setting within the cultural core of Chandigarh city.

Water Pools:

All obstructions around the rain water collection/drainage tanks are proposed to be removed. In the case of concerns of physical safety, Mild Steel railings of simple, unobtrusive and period design may be introduced around the pools at the rear of the building.

The "*patatoïde*" water-basin located near the entry acts as an accent and identity for the site and hence, has been proposed to be restored to its original state. However, since wetting of the hardscape around the pool during monsoon creates undesirable environment along with concerns of physical safety, especially for school children visiting the museum, a glass barrier has been proposed along the inner edge of the pool based on the following design basis and rationale:

Table 11: Proposals for Water Pools

S. NO.	PREFERRED CHARACTERISTICS OF THE BARRIER	POSSIBLE SOLUTION	FINAL PROPOSITION
1.	Physically strong	Custom-made toughened clear glass with minimum numbers of SS mullions fixed to the inner edge.	Glass barrier of varying height with maximum height as 1.5 m towards the rainwater fall and minimum 0.3 m on the opposite side to allow service access inside the pool. Three SS mullions for fixing the glass in place.
2.	Visually non-obtrusive		
3.	Reversible		
4.	Configuration similar to 'modern' design language		
5.	Allow service access inside the pool		

The provision of the glass railing is optional and may be installed as per requirement of the museum.

Piazza:

Metal tree gratings proposed at the base of the two large trees to the north of the auditorium, removing the dislocated guard wall around the trees. Similar treatment can be applied to any/other tree(s) with root systems dislodging the surrounding concrete paving.

Vegetation:

No new trees have been proposed since the site already has a good number of well-planned trees. Some trees (*Polyalthia longifolia var. pendula*) have already been planted near the stepped seating, which do not seem to be coherent with the original planning, but may be retained.

Since the site lacks under-planting with exposed earth in many areas, causing loose soil to get eroded during monsoon, a number of additional shrubs, ground covers and climbers need to be planted in such areas. A planting strategy plan has been put in place on the basis of location, climatic, functional and aesthetic factors, suggesting broad typologies for selection of specific plants.

Proper pruning of trees involving cutting of branches less than 4 inches diameter is proposed as part of annual tree maintenance regime, which may be brought under Annual Maintenance Contract, if required.

Landscape Illumination:

The original built-in concrete lighting fixture, designed by Le Corbusier, which exists on the site is proposed to be made operational with LED strip light. Additional light fixtures of same design are proposed all along the piazza as well as on the northern side to meet the illumination need of the site.

Site Landscape Redevelopment:

New intervention in landscape design is proposed at the northern side of the museum to be in sync with the museum use and interpretation plan. All the haphazardly located water tanks, generator etc. have been physically linked with a service pathway along-with a proposed firefighting tank. The rest of the area is proposed to be cleared of junk and is to be put under grass cover. Peripheral pathway with stepping stones is proposed on the extreme northern limit to soft-mark the edge and provide access to the sculptures as well as for service. Hardscape may be introduced in the cycle stand area, especially in the tree shaded area with appropriate landscape furniture.

7.2 Building Conservation Plan

The Government Museum and Art Gallery is a very significant 20th century heritage building. All conservation works on the building are designed keeping in mind the significance and character of this building.

- Conservation materials should match original materials as far as possible.
- Mock-ups should be done so that the repairs are of the expected standards and ensure a long term performance of the same.
- All the building works should be executed by skilled craftsperson/contractors with experience in repairing the 20th century buildings.

Based on the detailed on-site surveys and assessments of the building discussed in Chapter 5 of this document, the treatment for the conservation of the exterior and interior of the building are proposed. The treatments have been proposed based on the problems identified during the survey and its severity and threat to the building fabric or to the life safety of the people. The proposed treatment for the various conditions observed on site have been classified based on the element and material type. Conditions have been grouped based on severity and priorities for intervention:

P1: *HIGH*
These include conditions which require immediate attention and could be a threat to life safety if not addressed in a timely (urgent) manner.

P2: *MEDIUM*
These include conditions which could cause the material fabric to deteriorate and result in failure of materials and could become severe. These should be addressed after the urgent conditions have been taken care of.

P3: *LOW*
Conditions that do not need urgent intervention and can be planned for and appropriate time in the future. If left unaddressed these may further the deterioration that has already set in.

P4: *AESTHETIC*
This includes conditions that affects the appearance but not the integrity or performance of the material. It also includes conditions that have been addressed in the past but still require intervention either due to failure or due to aesthetic concerns.

Exposed Concrete Elements:

A major part of the building is made up of exposed concrete. All the structural elements, columns and beams and an extensive area of the flooring and ceiling are exposed concrete. The terrace elements including the concrete drain, gargoyles, connectors, fins etc. are also exposed concrete elements. All treatments should be carried out as per conservation planning drawings and detailed specifications document attached as Annexure D of this document:

CONDITION	RECOMMENDATION	Location	PRIORITY
GENERAL	All concrete surfaces are to be cleaned to remove dirt, paint splashes, accretion, bird droppings, etc.		P4
GENERAL	Surface cleaning using mild detergent and water or steam		P4
Cracks	Clean the cracks and inject with grout	All locations	P2
Structural or wide cracks*	The crack should be cleaned and routed. The crack should be grouted and then patched with specified mortar.	All locations	P2
Failing patch repairs*	Carefully remove failing patch repairs. Clean the rebar (shot blasting) and coat with corrosion inhibitor. Provide a new patch as specified and designed to accommodate the small depth of cover.	Drain	P1
		Gargolyles	P2
		Fins	P2
Delamination and Spalling*	Loose concrete should be removed. For spalls, a patch repair with specified material should be provided. If the rebars are exposed then it should be cleaned (shot blasting) and a coating of corrosion inhibitor should be applied. Then provide a patch as specified and designed to accommodate the small depth of cover.	Drain	P1
		Gargolyles	P2
		Fins	P2
		Connector	P2
EXPOSED REBARS	Clean (shot blasting) and apply corrosion inhibitor. Provide repair patch as needed.		P3

Brick Tile Cladding:

The brick tile cladding seen on the building façade is arranged horizontally in rows.

All the treatments should be carried out as per conservation planning drawings and detailed specifications document:

CONDITION	RECOMMENDATION	Location	PRIORITY
GENERAL	All brick surfaces are to be cleaned with a soft brush and mild detergent to remove dirt, paint splashes, accretion, bird droppings, etc.		P4
GENERAL	All the joints should be repointed		P3
Dislodged or displaced	All dislodged, brick tiles should be removed carefully and re-secured.	Elevation	P1
Exposed Rebar/ metal strip	Exposed metal strip should be cleaned and primed. Joints to be filled with mortar.	Elevation	P2
Damaged	Damaged brick tiles should be replaced with new tiles as specified to match the original.	Elevation	P2
Replaced tiles	All previously replaced brick tiles with tiles that do not match the original composition are to be removed carefully. These should be replaced with new tiles of appropriate shape, size, colour, width.	Elevation	P4

Ceiling Panels:

The wood-wool ceiling panels seen in the museum building are painted in vibrant colours. The auditorium has fibreboard ceiling panels painted in white.

All the treatments should be carried out as per conservation planning drawings and detailed specifications document:

CONDITION	RECOMMENDATION	Location	PRIORITY
GENERAL	Panels should be cleaned to remove efflorescence		P3
GENERAL	All fibreboard panels should be repainted to match the original colour		P3
Dislodged	All dislodged panels should be removed carefully and re-secured back in position		P1
Seepage	Damaged panels should be replaced with new panels as specified. Panels may be salvaged from areas to be demolished may be reused.	All locations	P3
Damaged	Repair damaged or cracked panels are to be patch repaired with composite material matching original composition.	All locations	P3
Past Repair	For repairs less than 25% of board area, incompatible patches should be removed and new ones provided with composite material as specified. If the previous patches are more than 25% of board area then it should be replaced with anew as specified.	All locations	P3

Acoustic Panels:

The acoustic panels in the auditorium is made up of a composite material, with perforated surface and finished with a brown paint.

- All damaged, cracked or broken panels are to be replaced with acoustic panel matching original.
- All dislodged, detached or loose panels should be removed carefully and re-secured back in position.
- All acoustic panels should be repainted to match the original colour, after conducting paint pigment test to determine colour shade, specifications, etc.

Terrazzo:

The interior flooring of the museum is mainly made up of terrazzo tiles. The ramp has a different terrazzo tile in black colour. All staircases in the building have terrazzo floor cast in-situ. The toilets on the second floor level of the building has terrazzo cast in-situ on the wall and floor.

All the treatments should be carried out as per conservation planning drawings and detailed specifications document:

CONDITION	RECOMMENDATION	Location	PRIORITY
GENERAL	The pointing at all tile joints should be removed and repointed		P3
GENERAL	Clean and scrub all the terrazzo surfaces to be cleaned with mild detergent.		P4
Weathered Tile/ Loss	Weathered tile should be replaced with tile matching original composition and colour. These are factory made and could be bulk ordered after sampling.	Ramp	P2
Damaged	Damaged tiles (more than 25%) should be replaced with tile matching original composition and colour. These are factory made and could be bulk ordered after sampling. Damage less than 25% should be repaired using matching material as specified.		P2
Cracks	Repair cracks by cleaning and injecting with grout and polishing.		P2
Past Repair	Remove inappropriate existing repair material and provide new to match the existing if the patch is smaller than 25% of the tile area.	Ramp	P3, P4
Detachment	Dislodged or displaced tiles should be re-secured back in position.		P2
Wooden Inserts	In areas where there are wooden inserts in more than 25% of the tile area, the complete tile should be replaced with tile matching original composition and colour. These are factory made and could be bulk ordered after sampling.		P3
	If the wooden insert cover less than 25% of tile area, they should be removed and repaired with patch of terrazzo matching original composition and colour.		P3

Glass:

The doors and windows have clear glass panes fixed within concrete and mild steel mullions with putty. The clerestory windows have frosted glass panes.

All the treatments should be carried out as per conservation planning drawings and detailed specifications document:

CONDITION	RECOMMENDATION	PRIORITY
GENERAL	Clean all surfaces with gentle detergent and water to remove dirt, paint splashes, accretion, bird droppings, etc.	P3
GENERAL	Clean paint spatter and other deposits from glass surfaces and surrounds	P3
GENERAL	Remove all deteriorated putty and install new putty	P3
GENERAL	Make all the hardware operable	P3
GENERAL	Monitor damaged concrete around doors and windows	P3
GENERAL	Provide new glass pane where missing or damaged	P2
GENERAL	Replace severely damaged door with similar	P3
GENERAL	All tinted glass should be removed and provided with glass panes matching original.	P3

Metal:

The doors have bright painted metal shutter within black painted metal frames. The aluminium encased aerators have protective grills made up of mild steel flats and is covered from the exterior with metal wire mesh with paint finish.

- All metal surfaces should be cleaned by scraping off old, damaged paint and rust, followed by application of rust coating. The surface should be finished with paint of appropriate shade matching original.

Coloured paint on doors and railing:

Presently, all the doors are painted in bright colours. The paint analysis revealed almost similar colours of past paint layers below the present ones. Two doors had different layers under the current paint campaigns. Based on confirmation of colours through exposure and archival research, these elements could be brought back to the original colour scheme.

The door at the Shaft of Coin Gallery shows plaster, followed by ground layer, then red paint and following layers of white. Red may have been one of the early campaigns.

Recommendation - It needs to be analyzed further by exposure at some spots and other methods and for establishing original color of the paint on the wall.

Gallery door at interior stairwell (entry to FF) shows that there are four layers of paint over plaster - one green and three red. Green could have been the original colour scheme.

Recommendation - It needs to be analyzed further by exposure at some spots and other methods and for establishing original color of the paint on the wall.

The paint sample from ramp railing under microscope shows two thin layers of dark blackish coating visible. One layer of red colour is visible as the outermost layer under reflected light. It appears that the original colour may have been black.

Recommendation - It needs to be analyzed further by exposure at some spots and other methods and for establishing original color of the paint on the wall.

7.3 Use and Interpretation Plan

The Use Plan for the Museum is based on the value assessment outlined in Chapter 4 of this CMP. The aim is to recapture Le Corbusier's vision for the Government Museum and Art Gallery. The proposed Use Plan also intends to remove all earlier alterations and interventions made to the building that impact the values.

Among the three primary components – (i) the museum building and architecture by Le Corbusier, (ii) the museum collection for display, and (iii) the interior display designed by Ratna Fabri, the assessment reveals that the values of (i) and (ii) supersedes that of (iii).

Hence, the proposals for use and interpretation of the museum focuses on:

(a) Retaining the original character of the Museum building as envisioned by Le Corbusier

(b) Display of the collections conducive to its long term safety and management

(c) Retention of later historic layers such as MS Randhawa interventions or Ratna Fabri's interiors (if they do not conflict with the above two points)

The historic significance of Ratna Fabri's design efforts for the museum and its prominent influence on the modern museum movement in India cannot be ignored even though it is of lesser priority as per CMP value assessment. Hence, a dedicated gallery displaying the furniture designed by Ratna Fabri for the Chandigarh Museum is proposed. The cases will be reused for the display of coins and porcelain collection. Any remaining units will be reused elsewhere as appropriate or stored with care.

The only exception is the display panels with white plywood canopy designed for the miniature gallery. The museum presently holds 6 units of this display type. The issues related to maintenance of these display cases designed by Ratna Fabri were also highlighted in discussion with the stakeholders, due to which it was considered not to use these pieces in other galleries of this museum:

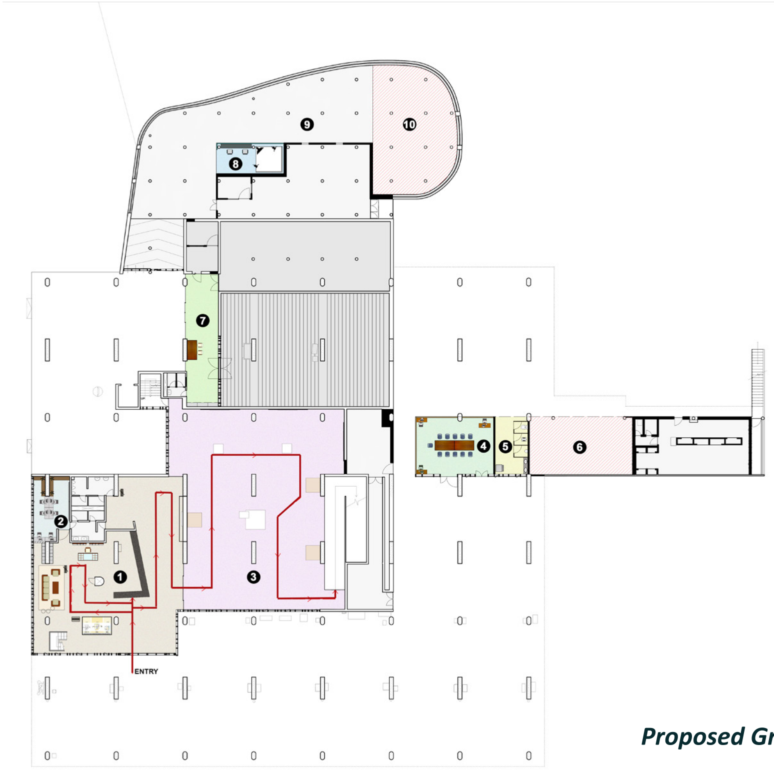
1. The height of the display unit cuts down the scale of the gallery, deterring from Le Corbusier's vision of open plan with free flowing spaces.

2. The original design intent was to provide diffused light where the central light fixture throws light onto the white painted plywood canopy which then reflects the light onto the paintings. However, the light fixtures are not turned on daily due to incidents of short circuiting in the past. For security purposes, the miniature paintings are now placed within heavy wooden frame glass boxes hung on the panel. The reflected light fails to illuminate the paintings.

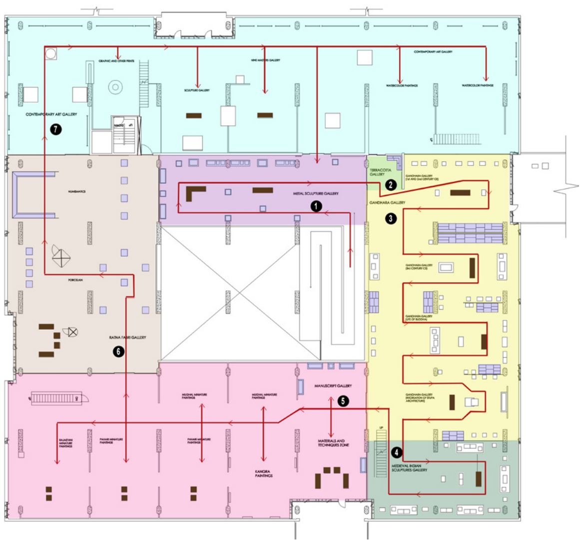
3. The canopy collects dust as it is inaccessible for routine cleaning. This may be detrimental to the condition of the museum collection in the long run.

4. The arrangement of these display units also generate negative spaces (between the units and the walls), which are presently misused to store housekeeping and cleaning tools.

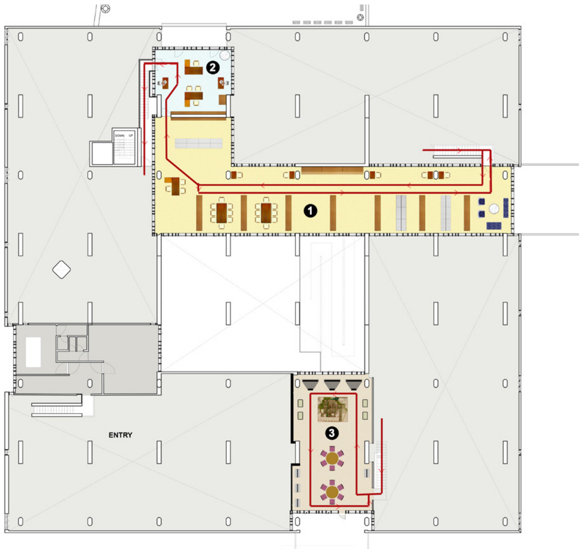
The proposed Use Plan with circulation within galleries is shown below:



Proposed Ground Floor



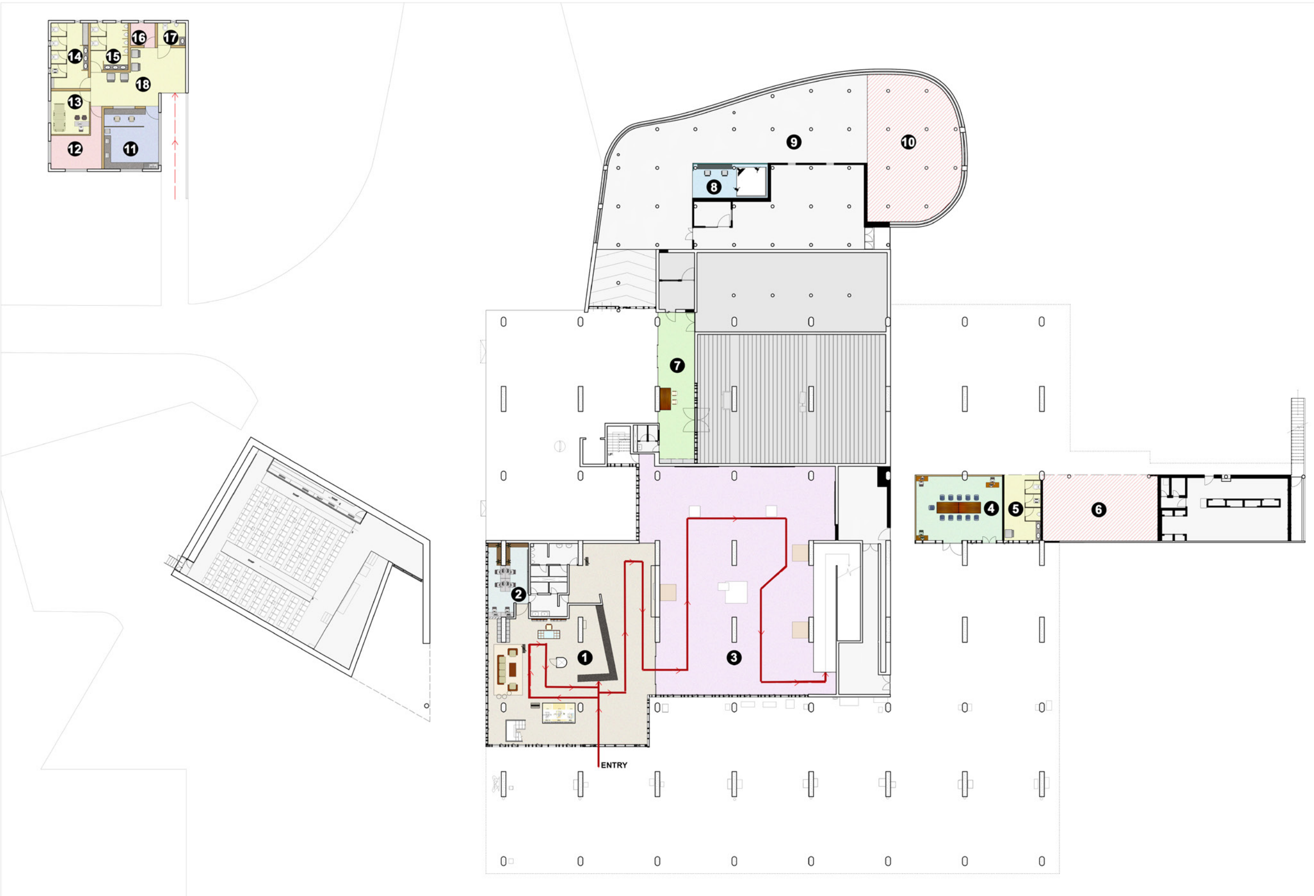
Proposed First Floor



Proposed Second Floor

Fig. 200: Proposed Use Plan for Government Museum and Art Gallery

7.3.1 Ground Floor



1. **Orientation (Reception) Gallery**

Orientation and History of Museum Panel, Transformation of Museum display, Souvenir Shop, Interactive touchscreens displays, Waiting lobby, Visitor and staff lockers.

2. **CCTV room**
3. **Central Gallery**

Gallery is proposed to hold grand exhibitions on temporary basis. On regular basis it will showcase art installations (hung from ceiling) and 7 sculptures and 3 paintings.

4. **Conference cum Workshop Hall**
5. **Visitor Facilties for Conference Hall**
6. **Storage (Phase II after removal of AC Plant)**
7. **Lobby for Reserve Collections**
8. **Photography Studio**
9. **Temporary Exhibtion Gallery**
10. **Visual Storage (For scultpures in the reserve collection)**
11. **Cafeteria Kitchen**
12. **Artists Workshop cum storage**
13. **Medical Room**
14. **Female Toilet for visitors**
15. **Male Toilet for visitors**
16. **Store**
17. **Toilet for the Differently-abled**
18. **Drinking water kiosks 4nos. (4taps / unit)**

LEGENDS

Facilties for visitors or staff (Toilets, Drinking water kiosks and Medical room

Reserve Collections
Later interventions (walls) removed to enlarge the existing storage

Existing Building Use

- Conservation Lab facade to be made in Translucent Concrete

- Toilet for staff in the Reserve Collection area to be renovated (interiors)

- AC plant for Reserve to be compartmentalized as proposed for fire safety

- Guard room interiors to be redone

Fig. 201: Proposed layout for reuse and interpretation of Ground Floor

Orientation Gallery:

An orientation gallery is proposed at the reception hall. This will include a display table at the entrance of the museum describing the evolution the Government Museum and Art Gallery. A floor plate model of the museum is proposed to be suspended from the ceiling above the display table.

An assembly of original museum furniture arranged as it was during the inauguration of the museum is proposed to be used as the lobby waiting area.

A movable display is proposed on the wall adjacent to the Satish Gujral mural, with panels about Le Corbusier's Museum of Unlimited Growth concept, the Chandigarh museum, Le Corbusier, Ratna Fabri, Dr. Randhawa and Pierre Jeanneret. Photographs and details about the three museums, the museum building features and museum collection will also be presented. The display will also have two digital touch screens with information about the museum, galleries and collection.

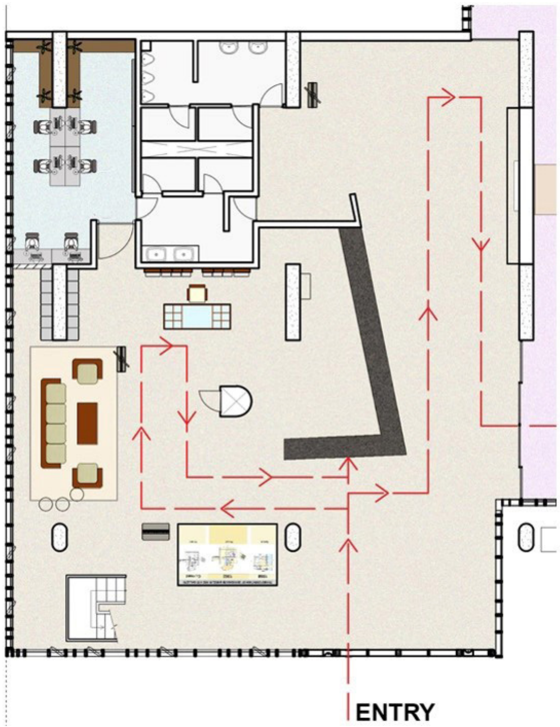


Fig. 202: Proposed layout of Orientation Gallery on the Ground Floor of the Museum

A CCTV and surveillance room is proposed behind the toilet block. Lockers for visitors and staff is also provided in the orientation room.

Fig. 203: Proposed views of Orientation Gallery. Existing (T), Proposed (B)

Pilotis:

The exhibit typology displayed in the pilotis and the exterior premise of the museum is based on the susceptibility of the objects to deterioration when exposed to environmental conditions. The main stone types used for the sculptures at the museum are schist, red sandstone and black granite. The sculptures which are of granite stone have minimal absolute and effective porosity compared to the other types and does not easily undergo weathering or salt damage. This makes the granite stones which are of igneous origin apt to be exhibited in the exterior areas. The sculptures in the pilotis are exhibited against the columns so that there is minimum obstruction in the visitor's path.

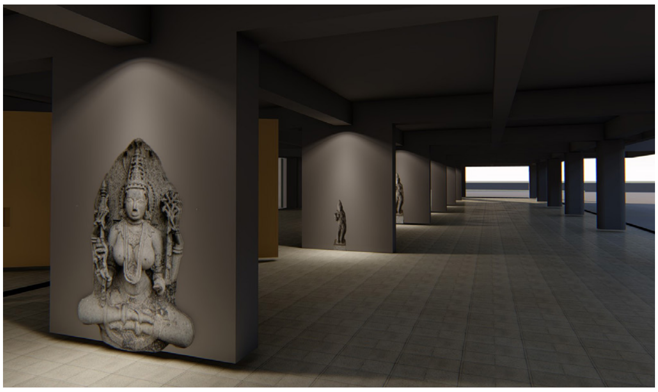


Fig. 204: Sculpture display in pilotis. Existing (L), Proposed (R)

Central Gallery:

The museum is for the first time planning to bring in International exhibition of antiquities. The museum proposal has outlined the central hall on the ground floor of the museum as temporary exhibition of international antiquities and installations by artists. Contemporary painting and sculptures on easily movable pedestals will be displayed here temporarily, which can be shifted during the events and exhibitions.

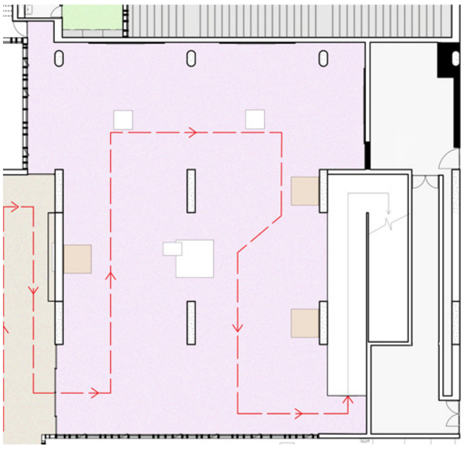
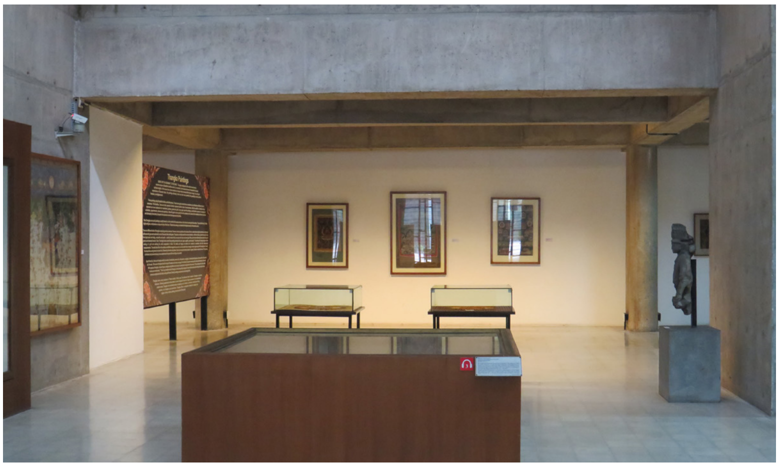


Fig. 205: Proposed layout of Central Gallery



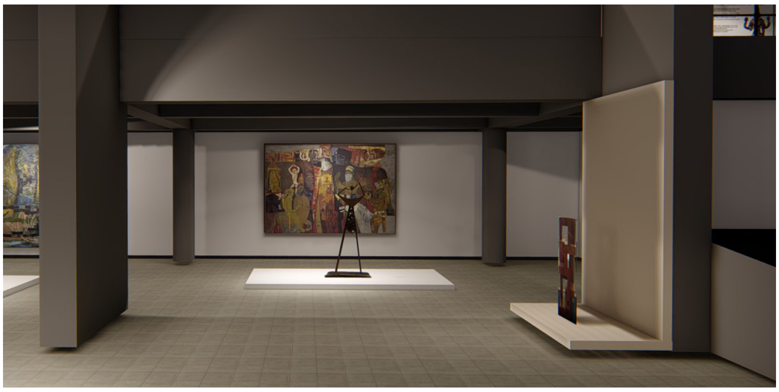


Fig. 206: Proposed views of Central Gallery. Existing (T), Proposed (B)

Conference Room:

The upgradation proposal for the museum includes removing all ad hoc structures and ancillary functions that are present at the rear of the museum building. The room that is presently used as the air conditioning unit is proposed to be freed up, to convert the space into a conference room for the museum staff. The original furniture from the museum is proposed to be reused for the conference room.

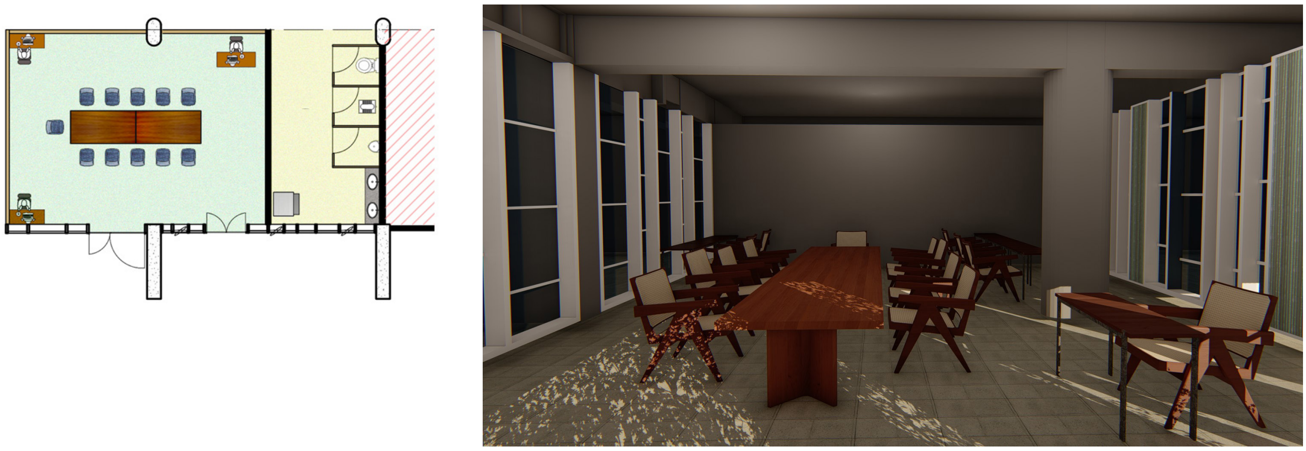


Fig. 207: Proposed layout (L) and view (R) of Conference Room on the ground floor of the Museum

7.3.2 First Floor

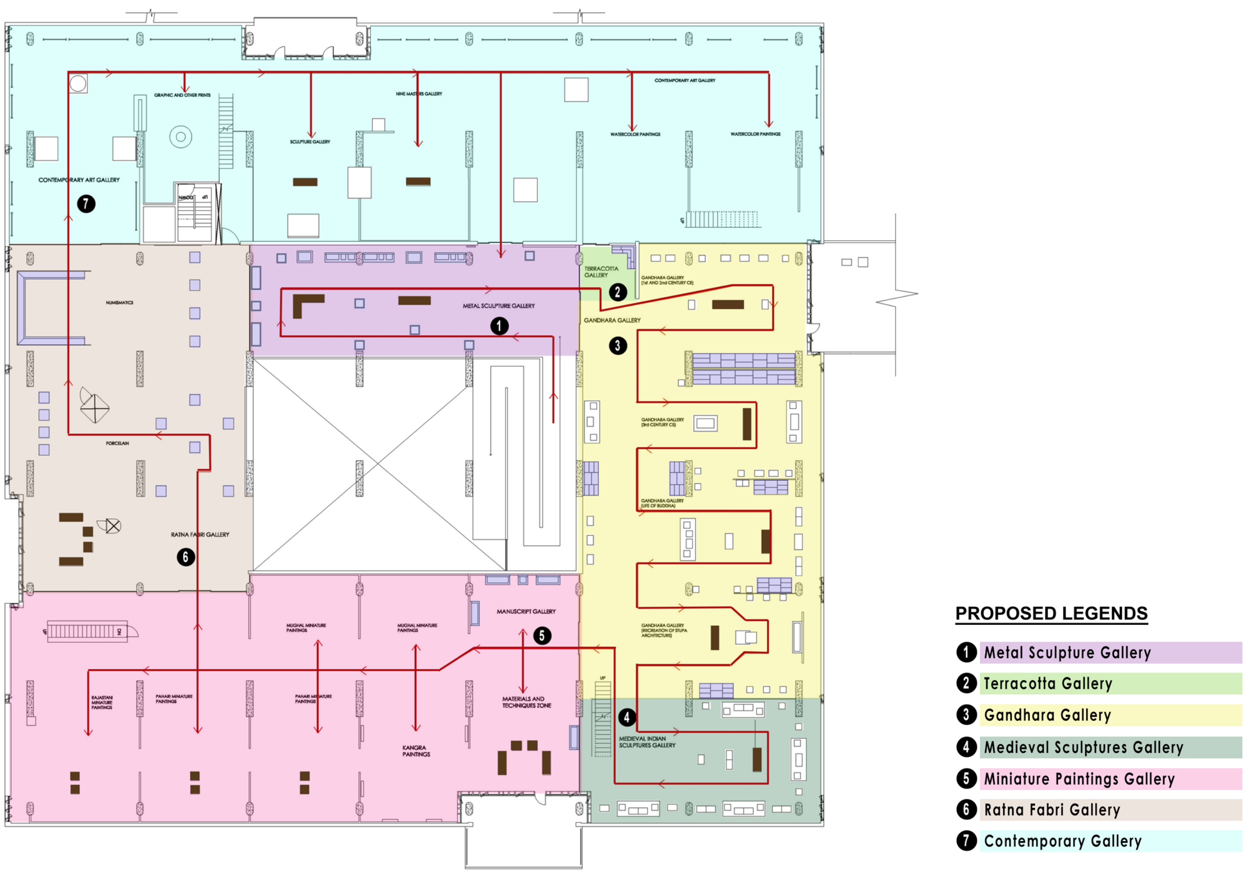


Fig. 208: Proposed layout for reuse and interpretation of First Floor

Metal Sculpture Gallery:

The metal sculpture gallery exhibits sculptures from the 9th century CE to the 20th century CE. The collection includes artefacts mainly in bronze and a few in other metals like copper, brass, iron, silver and alloys. The display describes the ancient alloy making technique prevalent in the northern and southern parts of India, Nepal and Tibet. While the visitor moves through the sculptures from 9th to 20th century CE, the gallery narrates the technological advancements evident in the artefacts and the details that have evolved.

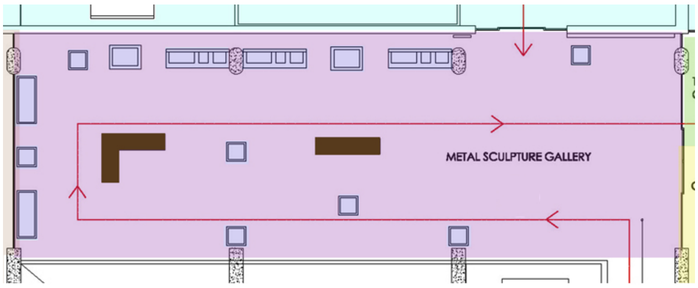


Fig. 209: Proposed layout of Metal Sculpture Gallery on the First Floor of the Museum

Fig. 210: Proposed views of Metal Sculpture Gallery. Existing (T), Proposed (B)

The proposal provides an unobstructed open layout. The alterations at the rear is replaced with a glass wall to give a transparent through and through view across the gallery as intended by Le Corbusier's design.

Gandhara Sculpture Gallery:

The Gandhara sculpture gallery exhibits artefacts dated from the 1st century CE to the 4th century CE. The exhibits comprise Gandharan Buddhist era artefacts that are exquisitely carved and detailed with depictions of Gautama Buddha, Bodhisattva, Bodhisattva Maitreya and life story scenes of the Buddha etc. The display is executed on the backdrop of the life story of Buddha, with regard to Jataka tales and other historical references. The chronological layout followed is in the order of Bodhisattva, the one who followed the Buddha's path and Maitreya who is the future Buddha, thereby bringing the Buddhist narratives into the exhibit spaces through display methodology.

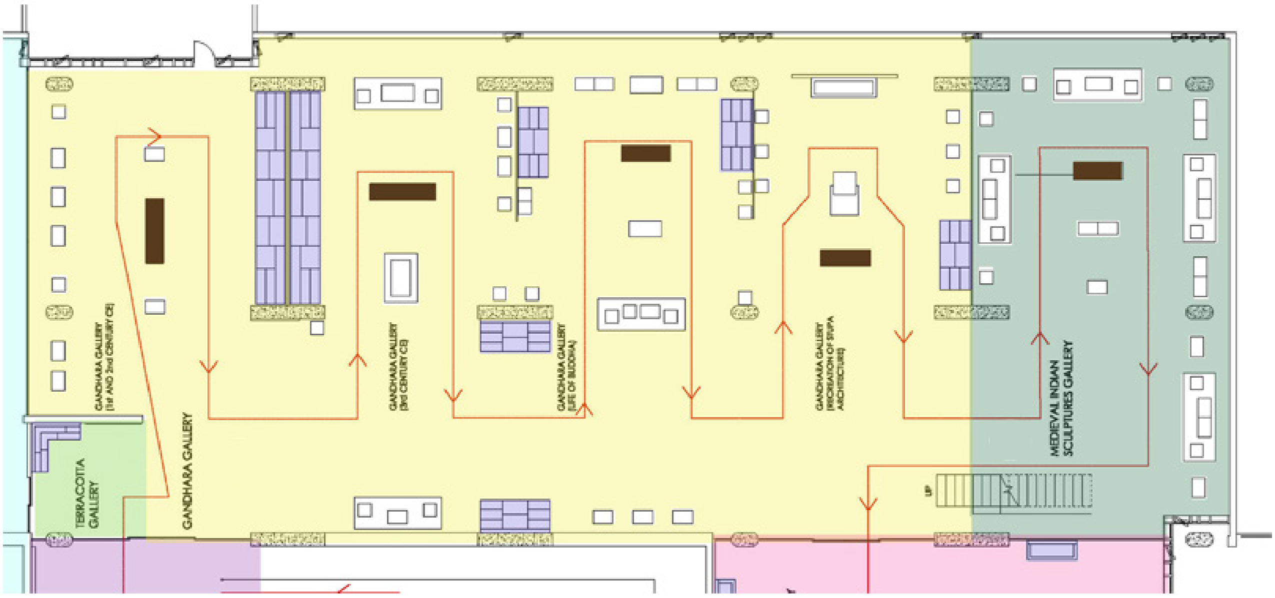


Fig. 211: Proposed layout of Gandhara Gallery on the First floor

The display further orients itself by the correlation of various representational figures in the gallery that are connected to various Buddhist tales. An example is the display of Hariti and two other Yakshis, exhibited equivalently to the sculptures of the Buddha, Bodhisattva and Maitreya within the same gallery space, which brings forth the historical tale of Hariti being referred to as Bhumata (mother of demons) in the Vinaya Pitaka of the Sarvastivada school. The tale speaks of Buddha's inimical relation with Hariti.

A reconstruction of a stupa is also executed within the gallery using artefacts in the museum collection and through representational images of the context. Railing fragments of a stupa made of red sandstone from the North-Western part of India, remnants of a chattra and a votive stupa have been used to assemble the stupa installation.

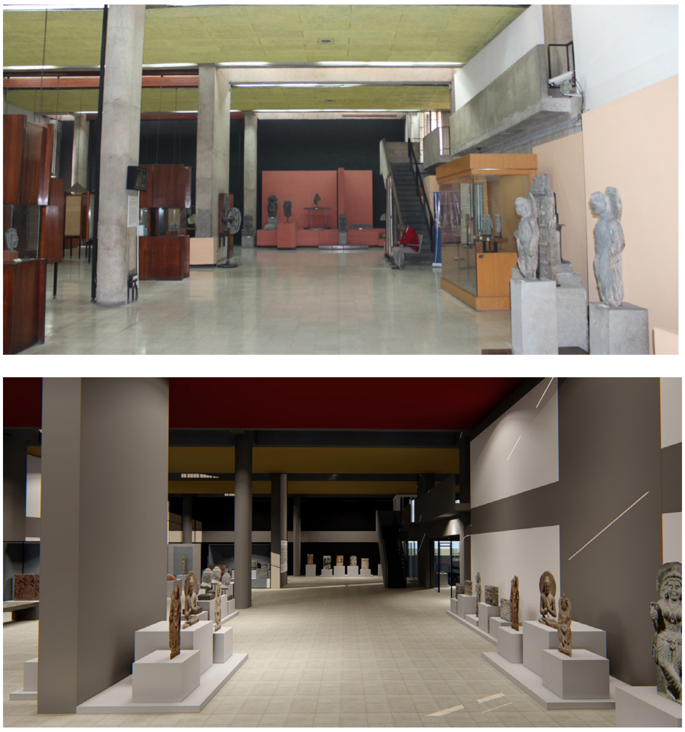


Fig. 212: Proposed views of Gandhara Sculpture Gallery. Existing (T), Proposed (B)

Fig. 213: Proposed view of Gandhara Sculpture Gallery.

Medieval Indian Sculptures Gallery:

The gallery displays Hindu, Jain and Buddhist themed stone sculptures belonging to 7th to 16th century CE. The display describes the tradition of Indian art and iconolatry.

Fig. 214: Proposed views of Medieval Indian Sculpture Gallery on the first floor of the Museum

Terracotta Gallery:

The terracotta gallery is designed as a dedicated space at the beginning of the Gandhara sculpture gallery due to small collection. The artefacts belong to the period between 2nd century BCE to 9th century CE.

Miniature Paintings Gallery:

The miniature gallery commences with the introduction of the materials and techniques used in miniature paintings and writing manuscripts. Materials such as pigments and tools used in the art form are exhibited. This section displays miniature paintings that depict the artistic flair of the virtuoso during the post medieval era. The miniature collection is one of the main strengths of the museum collection. The miniature paintings from the Mughal and Pahari context hail from the 17th to the 19th century. The display of the paintings begins from a section displaying a small collection of manuscripts, followed by the miniature paintings from the Kangra, Pahari, Rajasthani and Mughal schools.

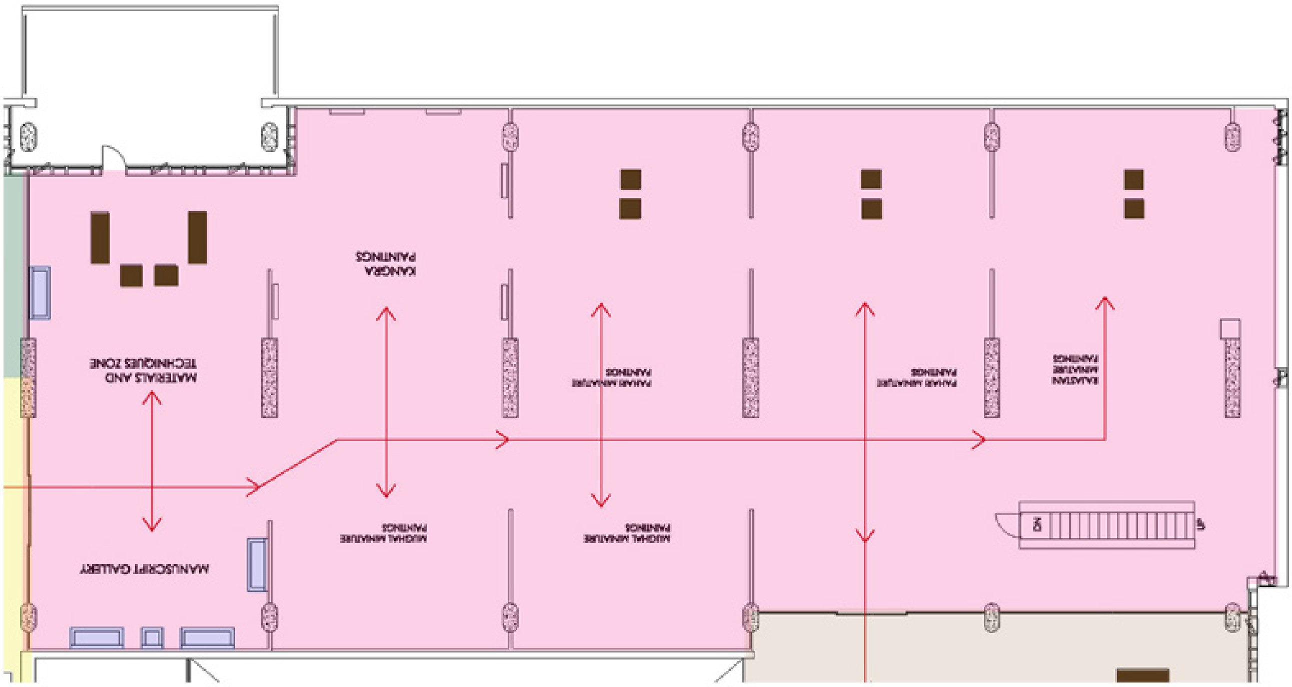


Fig. 215: Proposed layout of Miniature Gallery on the First floor

Fig. 216: Proposed views for Materials and Techniques (L) and Manuscript Gallery (R) section of Miniature Gallery on the First Floor of the Museum

At one end of the gallery, an interactive display is proposed. This will give a better understanding to the visitor regarding the different schools of miniature paintings, their styles, materials used, etc. The proposal keeps in mind the museum's fundamental vision of creating a centre for the study of Pahari miniature paintings.

The original display panels in the Miniature Gallery designed by Ratna Fabri is proposed to be replaced with metal framed panels with negative spaces. The panels, designed in the spirit of Le Corbusier's vision, intends to give a transparent view along the length of the gallery.

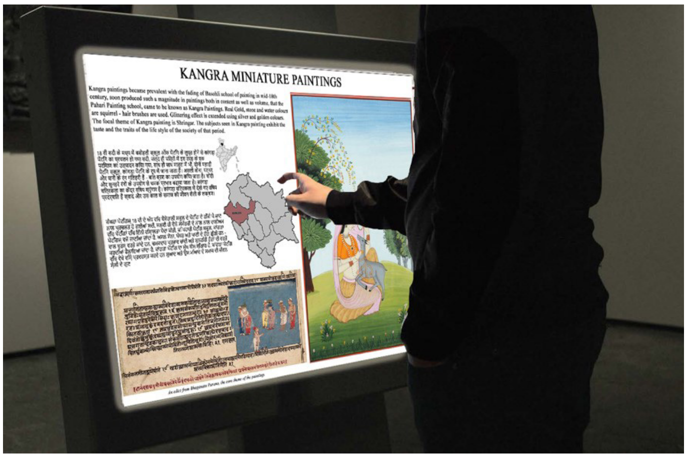


Fig. 217: Proposed view of interactive display in Miniature Gallery

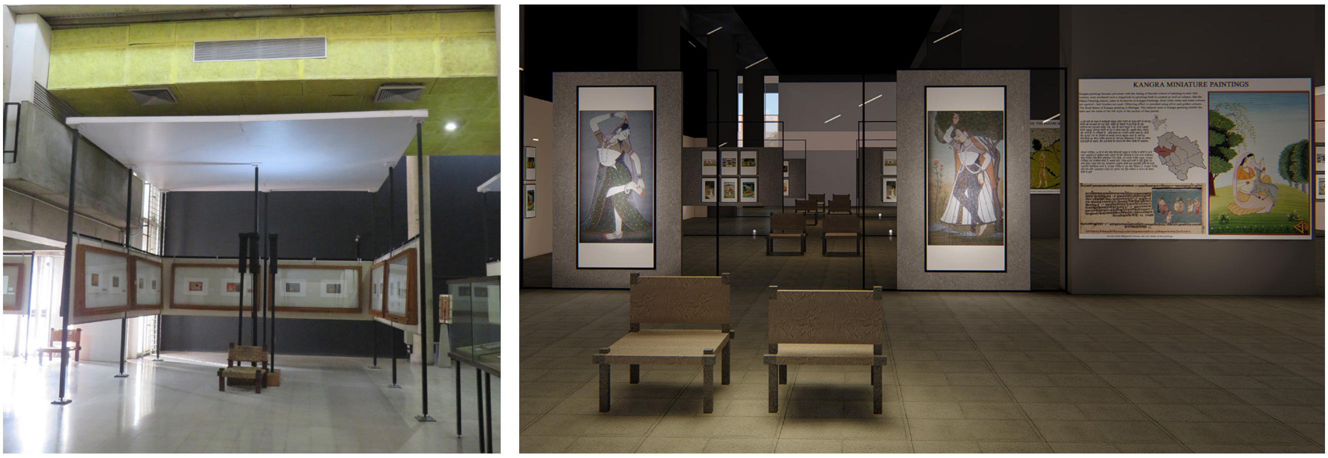


Fig. 218: Proposed view of Miniature Paintings Gallery. Existing (T), Proposed (B)

Ratna Fabri Gallery:

A dedicated gallery exclusive to the Government Museum and Art Gallery has been proposed, which will display the furniture designed by Ratna Fabri for the Chandigarh Museum. Along with the invaluable artefacts, the display cases designed by Padma Shri awardee Ratna Fabri also stand akin as a historical pillar and speaks of the initial movements in the design of museums in the early 1950s in India. Considering its significance and giving them their due, the display cases that have been replaced in the upgraded proposed galleries are showcased here.

The Ratna Fabri gallery showcases numismatics and porcelain artefacts which are part of the museum collection. The collection of coins are displayed as per their typologies – Ancient Indian coins, Sultanate period coins, Mughal period coins, South Indian dynasty coins and British India coins.

An assembly of original museum furniture designed by Pierre Jeanneret is also arranged adjacent to the undulatory, and is proposed to be used as seating area for visitors.

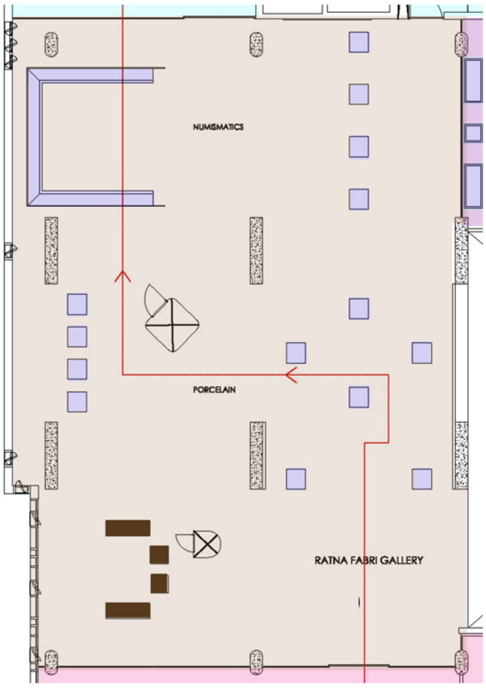


Fig. 219: Proposed plan of Ratna Fabri Gallery on the First floor of the Museum

Fig. 220: Proposed view of Porcelain artefacts and Numismatics section in Ratna Fabri Gallery on the first floor

Fig. 221: Proposed view of Numismatics section of Ratna Fabri Gallery on the first floor

Contemporary Art Gallery:

The contemporary art gallery is segregated into various genres on the basis of materials used, techniques employed and the prominent artists. The primary segregation is based on the material typology such as watercolours, oil paintings, graphic prints and sculptures. When considering the susceptibility to deterioration, sculptures are placed towards locations where the daylight moves into the building since the deterioration caused on sculptures by natural light is much less when compared to paintings.

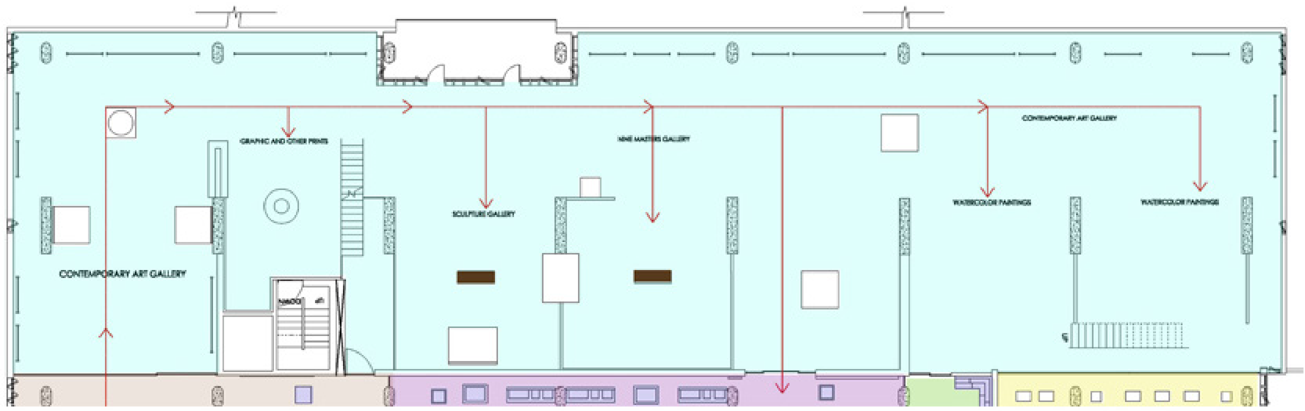


Fig. 222: Proposed plan of Contemporary Art Gallery on the First floor

A specific section within the gallery design is fabricated for the display of the nine masters of Indian art. These artists include: Amrita Sher- Gill, Abhanindranath Tagore, Gaganendranath Tagore, Jamini Roy, Nandalal Bose, Nicholas Roerich, Rabridranath Tagore, Raja Ravi Varma and Sailoz Mukherjea. The art works by the nine artists were declared as national treasures under The Antiquities and Art Treasures Act in the 1970's, thus making this an important component of the museum collection. This legitimizes the proposal to exhibit these artworks as one of the focal points in the contemporary gallery.

The other sections dedicated to water colour paintings and graphics and other prints have also been incorporated into the design.

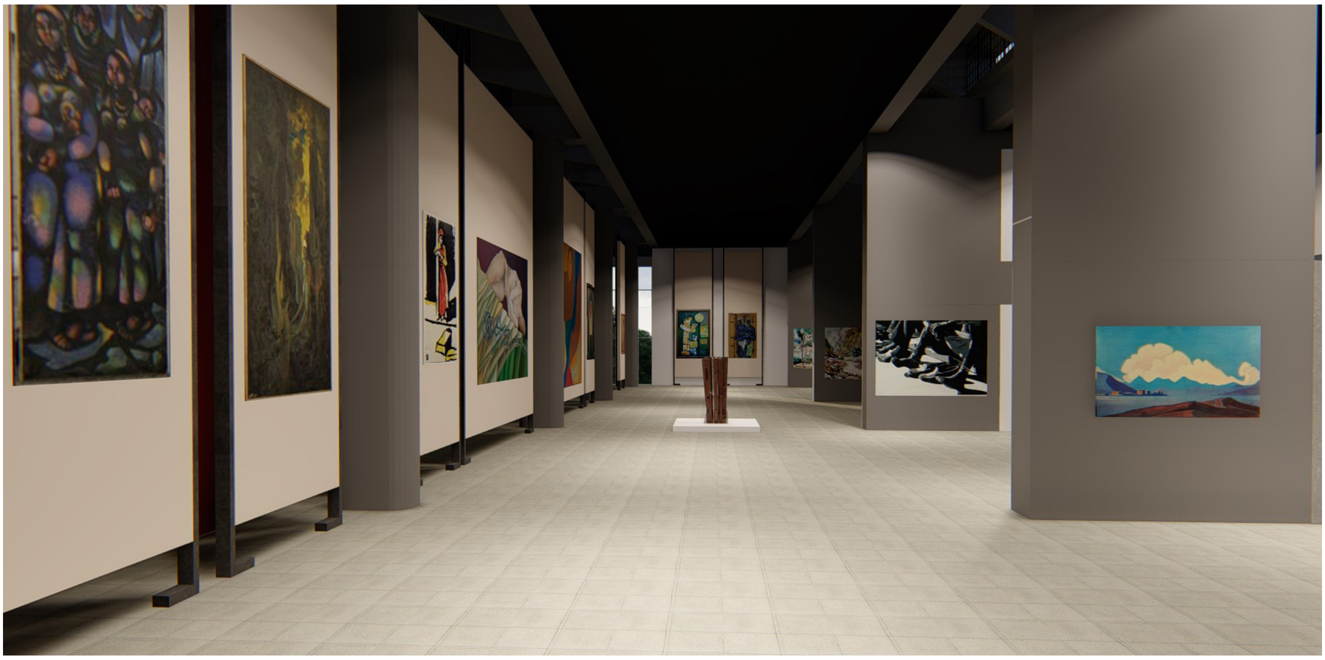


Fig. 223: Proposed views of Contemporary Art Gallery on the first floor of the Museum

7.3.3 Second Floor

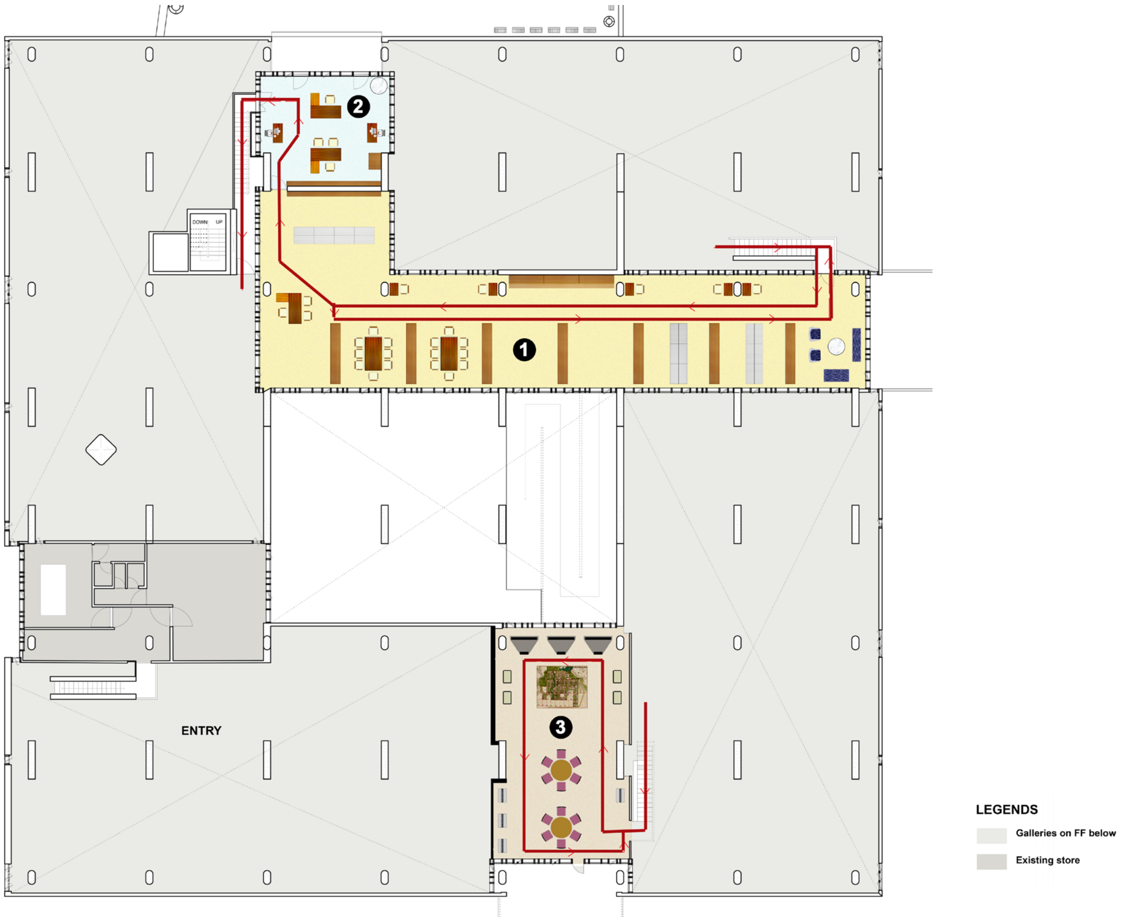


Fig. 224: Proposed layout of reuse and interpretation of Second Floor

Museum Library:

The upgradation proposal for the museum library includes reorganization of the furniture to clear up the view from the undulatory windows. The conference room at the end of the library is proposed to be used as office for the museum staff.

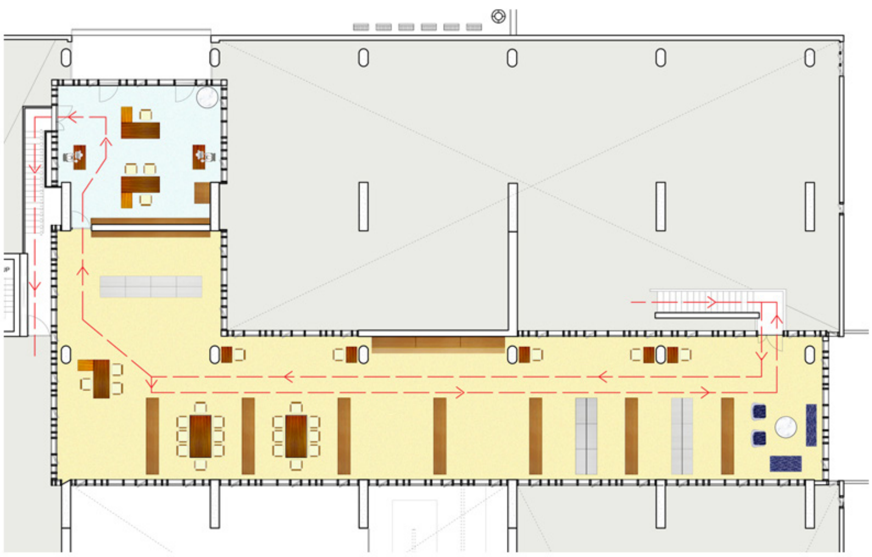


Fig. 225: Proposed layout of Museum Library with Staff Office at the rear on the Second floor

Fig. 226: Proposed views of Museum Library. Existing (L), Proposed (R)

Kid's Play Area:

The proposal also indicates removal of the AC units on the second floor in order to install a more wholesome and sustainable system like geothermal cooling. On removing the units, a kid's play area is proposed on this floor.

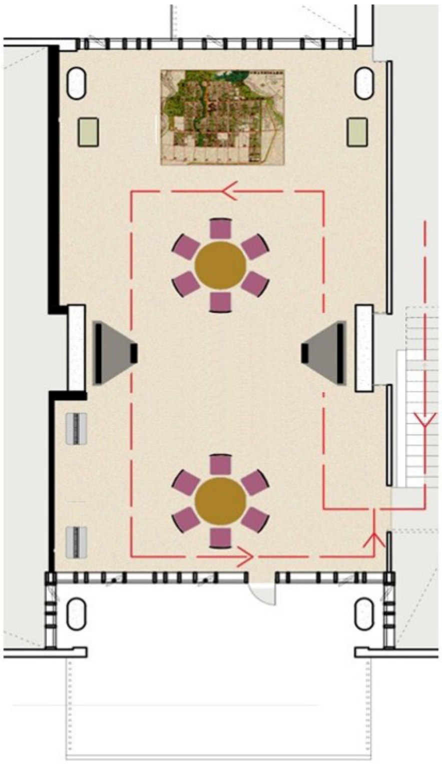


Fig. 227: Proposed view (L) and layout (R) of Kid's play area on the Second floor

Signage:

The proposal for signage aims to provide clear, concise information which is informative, aesthetically pleasing and consistent for all areas. This will help promote a unified and attractive appearance for all facilities and eliminate inconsistent, ineffective and unnecessary signs.

Fig. 228: Reference image for directional signage

Directional signage is proposed along the trails for comprehensive visitor movement within galleries. These signage are to be placed inside and outside the museum.

Interpretation signage is proposed to be placed at the main entrance and other strategic locations within the building. In the orientation gallery, the design for the proposed signage is inspired by the centrally pivoting door at the museum entrance. The gallery name signage of the Museum is proposed to be etched on the glass separating the various galleries in order to maintain transparency and flow of spaces as intended in the original design of the building. Informational signage for all exhibits are to be placed adjacent to the exhibit.

Fig. 229: Proposed signage for gallery name etched on glass partition

The general recommendations for signage are that letters and numbers are to be Sans Serif using lowercase lettering and Arabic numerals. The text should have a width to height ratio of between 3:5 and 1:1 and have a stroke width to height ratio between 1:5 and 1:10 (preferably between 1:6 to 1:8). The character spacing should be such that the horizontal spacing between characters should be 25-50% of the characters width and 75-100% between words. The vertical spacing between lines should be at least 50% of character height. It is essential that the characters on signage should contrast with the background of the sign. All signage will be multi-lingual to cater to a wide range of visitors. The signage will have details in 3 languages: Gurmukhi, Hindi and English.

Usually a light coloured lettering on a dark background is preferred. All signage should have a matte finish, not glossy one, and should be well and evenly lit with uniform lighting over the surface of the sign of between 100 and 300 lux.

Storage Facilities:

The use of compactors has been proposed for the storage of the artefacts. It consists of mobile units with shelves, which function on the mechanism of Chain and Sprocket arrangement incorporated within the front panel provided to the unit. Each mobile unit will be provided with Mechanical Synchronized Drive Mechanism for smooth and effortless movement.

Fig. 230: Reference images of compactors for storage of artefacts in museum

Visible storage is also proposed to enhance the visitor experience and maximizing the visitor's access to the museum collection. The visual storage is proposed within the temporary exhibition gallery.

Fig. 231: Reference images of visible storage in museum

Visitor Facilities:

i. Souvenir Shop -

The souvenir shop that is presently in the reception hall of the museum is proposed to be upgraded. It is proposed to be relocated to a better position within the reception hall so that it is easily visible to the visitors as they enter and leave the museum.

The souvenir shop will sell replicas of sculptures, prints of artworks, books on Gandhara, miniatures and contemporary art, and books about the museum, Chandigarh and Le Corbusier.

ii. Toilets –

A toilet block is proposed to be built within the cycle stand. The ramp at the entrance makes it easily accessible for elderly and differently abled visitors.

iii. Cafeteria –

A cafeteria is proposed on the terrace of the cycle stand, with spill-over seating on the garden space around it. The details for arbours with seating which is proposed around the cycle stand is provided in Annexure D. The kitchen and ancillary facilities will be provided within the cycle stand.

7.4 Lighting

The proposal for the upgradation of the Government Museum and Art Gallery intends to rework the service equipment available presently. The design incorporates the requirements of the museum as deduced from the building assessment and discussions with the museum personnel. There was no complete drawing of existing services available for the museum. While services have been mapped as part of the condition assessment and issues with existing museum lighting are flagged, the Lighting Plan will need to be prepared with involvement of experts after the complete studies by Getty Conservation Institute are completed by 2021. It is beyond the scope of this CMP.

7.5 Risk Management Plan

Management of historical buildings which also house museum should aim at achieving maximum competency within their premises in dealing with emergencies and in recognizing potential sources of danger, independent of outside assistance.

Some of the measures include:

- Staff training (prevention and intervention)
- Provision of alarm and emergency plans
- Periodic maintenance and checking of firefighting equipment
- Keeping escape routes accessible and unobstructed

Risk management guidelines and mitigation measures for the Government Museum and Art gallery were formulated based on the comprehensive risk assessment. These guidelines articulate strategies for mitigating risks and for emergency preparedness and response in case of any disaster.

Fire:

i. Electrical wiring - The pilotis shows many cables converging at a point which has seen incidents of short circuit in the past. Such area need to be identified and checked for safety. The electrical panels have been housed in a narrow aisle adjacent to air conditioning systems and share a common access. This could be hazardous at the event of a short circuit or sparking in the area and will making it inaccessible. This area is not locked at all times and though there are security guards patrolling the area, it requires to have some check at the access. An optional partition in glass could be considered on the side of the front pilotis. This would enable any incident of spark etc. to be noticed by the security as well as people moving in this area. This have been included in the risk management drawings (attached as Annexure D). Also a comprehensive electrical risk assessment needs to be carried out by experts in electrical field.

ii. Fire Detection - For museums, detection of fire at the earliest is of utmost importance to prevent damage to the artefacts and archival materials. Considering most exhibit areas have large height, Optimal Beam detectors would be a good option. ASD (Aspirating Smoke Detection) option can be looked at for the museum. This is a system that consists of a central detection unit which draws air through a network of pipes to detect smoke and is suitable for environments where a highly sensitive rapid smoke detection capability is required.

iii. An acoustic alarm system should be considered to warn people during potential danger. In the case of a historical building or museum three distinct target groups are addressed: Visitors for whom a hazardous situation has been detected, staff who should coordinate the evacuation, and the people who should deal with the fire. The integrated system should also include fire detection system that must activate the installed alarm devices and transmit the alarm signal to the fire department.

iv. Firefighting systems - A system employing a combination of gas and water mist can provide an effective solution for archives and storage vaults in which documents, manuscripts, books or paintings are exhibited or stored. The type A and B extinguishers currently present in the museum will need to be reconsidered with context of the exhibit and equipment experts.

An international guideline for fire safety mentions that the distance between any two fire extinguishers should not be more than 75’. The existing extinguishers will need to be re located as per the above norm, for easy accessibility at the time of emergency. Regular maintenance of the extinguishers on yearly basis should be also undertaken. The sand buckets currently present in the museum should be cleared of all garbage and placed in the line of vision in case of emergency. Considering the importance of the building, possibility of adding hydrants at the site level needs to be considered. Alternatively, a feasibility study for sprinklers should be carried out before finalization of the systems.

v. Planning considerations - Due to the theft incident in the past and for directive movement in the galleries, partitions in form of collapsible gates have been installed at various levels. Two of the staircase have also been closed and are not accessible. This has increased the distance from any point in the gallery to the exit to more than 30m which is prescribed by the NBC codes. This can result in panic and accidents leading to secondary hazard situations during the event of a fire. Hence, changes in this system will need to be done with reference to the evacuation routes considered. Suggestion for better circulation has been proposed in the drawings (attached as Annexure D). Compartmentalization of the entire area into various zones separated by fire rating EI partitions with 90 minutes minimum rating should be incorporated so that in case of any incident, fire can be contained within that zone.

vi. Signage and evacuation map - Signage and evacuation map needs to be put up at strategic points within galleries.

vii. Fire exit doors - Exit doors in the case of fire should be considered. The same have been proposed in the drawings (attached as Annexure D).

Vandalism:

CCTVs will be required to give complete coverage of all areas. This measure can prevent visitors from making graffiti on the columns in the pilotis area and on artefacts in the galleries. The artworks in the galleries require a separator to keep a distance between the viewer and the exhibit.

Considering the possible damage due to people coming too close to the paintings, dividers/railing are to be provided 1m away from the wall displaying the works.

These measures can also act as a deterrent for the possible damage to the art work by contemporary issues such as the selfie phenomenon in the exhibit areas.

Fig. 232: Reference image for railing options to keep visitors at a distance from the exhibits. Railing option for painting (left); Free standing flexible system (right). Source: Google

Fig. 233: Reference image for railing options to keep visitors at a distance from the exhibits. Railing with details at a comfortable reading distance for visitors. Source: Google

Earthquake:

i. External façade: The two water drains at the terrace level show major issues of damage. They need to be retrofitted as per the structural analysis done to curb their vulnerability in the event of an earthquake. Also some parts of the facades have deteriorated due to water seepage. The root cause will have to be identified and the façade repaired as required.

ii. Exhibit systems: Some display stands are very weak and may fall even with minor shaking during hazards like earthquake. Also, with crowds of people visiting the museum, such exhibits can be vulnerable to fall. These delicate exhibit systems should be replaced.

iii. Regular monitoring of all cracks in the building need to be carried out.

Rain and Water Leakage:

i. Water Seepage: All points identified in the museum having water leaking from the skylight above should be repaired. Leakage at some places in the galleries as seen from the discoloration of fibre boards ceiling panels needs to be investigated to check the root cause.

ii. Water percolating from the jails on the external walls should be corrected.

iii. Major dampness has been seen from a past seepage in the storage of antiquities. This needs to be repaired to avoid similar incidents in the future.

Light:

All points identified as receiving direct light from the skylight will need be checked to avoid direct sunlight falling on exhibits. The exhibition design should consider this aspect while reorganizing the display.

Termites:

Termite infestation has been observed on the external fenestrations in the pilotis area. This will need to be treated to avoid further damage.

Regular through inspection should be taken up for avoiding damage in the future.

Storage:

There is inadequate area for the storage of artefacts in both miniature and contemporary art collections. Either additional place will need to be made or some art works need to be shifted to optional places.

Wooden storage boxes for the miniatures are detrimental for the art works. Hence should be replaced with Steel storage options. Also roller kind of storage required for the long fabric artworks.

Theft:

Of the CCTV cameras currently in the museum, 25 out of 56 cameras are not working. This will need to be rectified. Also the old units need to be replaced by cameras that have better clarity of vision.

Both the exhibit storages requires to have independent cameras inside the areas.

The security at the entrance needs to be planned for more vigilance and security check

Surveillance and Security System for Building:

Considering the value of the museum artefacts and issues with reliability of technology driven systems in terms of working and maintenance, we do not recommend removal of existing grills from the external window and glass facades and replaced by surveillance security systems. Alternatively, the design of the protective grills can be altered for better aesthetics.

In case of provision of access routes in case of emergency, the above typology of system will need to be used only at the designated egress location as marked in the drawings.

Other Issues:

There are some issue with the design of some of the architectural elements, which do not meet the safety compliance for visitors and users. For the safe use of the space in the museum building the following have been proposed:

i. Considering the heritage significance of the existing railings in the building, these cannot be changed. However, it may be retrofitted with glass and appropriate design for safety.

ii. Railing should be provided along the open edge of the ramp. The design should follow the design of the original railing, with circular section for easy grasping.

iii. The slope of the ramp is not compliant to regulations. Hence provision such as wheelchair stair lift will need to be considered.

Fig. 234: *Open edge of the ramp should be provided with railing*

Closed Circuit Television System (CCTV):

i. Camera Unit - Cameras with visibility upto 30 meters and high clarity should be considered. Maximum of 120 degrees should be considered for the viewing zone. Considering the above, location for cameras have been proposed in the drawings.

ii. Observation room - The placement of the room should be closer to the reception area to help with overall co-ordination during risk. Also, a room that can accommodate upto 10 screens should be designated. This is critical for comfortable viewing by the personnel. The same has been proposed in the plan.

iii. Staff - As a guideline, a single person should not be on this job for more than two hours and hence the duty should be shared turn-wise by 2-3 numbers of staff.

Security at Entry Point:

Security checking with the system of metal detectors should be installed. Also conveyor belt bag screening system is also a necessity at the entrance. Provision of lockers for visitors to keep their belongings should be added.

Enforcement of Good Housekeeping Rules:

i. The staff should be well trained to follow certain basic procedures to ascertain risk free routine of the museum.
ii. Correct storage of flammable materials used for cleaning or restoration work should be considered
iii. Electrical appliances should be switched off as soon as it's no longer in use
iv. No portable heating equipment should be permitted
v. No smoking in any part of the building or in the immediate vicinity should be allowed.
vi. All the essential equipment required for emergency response should be kept where they can be easily accessible during emergency. For search and rescue, safety jackets, safety helmets, fire/heat resistant safety gloves, masks, emergency lamps/battery operated torches, ropes, CSI tape (for Cordoning), stretcher and a well-equipped First Aid kit (to be identified with the help of a medical professional) should be kept handy. For salvaging collections during an emergency, apart from these items, aprons, illuminated jackets (for working in the dark), special rubber gloves for handling collections, foldable tents (Gazebo), polythene (plastic) sheets approximately 40 inches wide, bubble wrap, plastic baskets and blotting paper should be made available at an easily accessible location.

Essential Equipment for Emergency Response:

All the below mentioned items should be kept such that it can be easily accessible during emergency.
For Search and Rescue:

- Safety Jacket
- Safety Helmet
- Safety Gloves (fire/heat resistant)
- Masks
- Emergency Light / Battery Operated Torches
- Ropes
- SI Tape (for Cordoning)

- Stretcher
- First Aid Kit (to be identified with the help of a medical professional)

For Salvaging Collections:

- Aprons
- Illuminated Jackets (for working in the dark)
- Safety Helmets
- Special rubber gloves for handling collections
- Emergency Light/Batter Operated torches
- Foldable Tent (Gazebo)
- Polythene (plastic) Sheets approximately 40 inches wide.
- Masks
- Bubble Wrap
- Plastic baskets
- Blotting paper
- CSI Tape for cordoning

Emergency Team and its Responsibilities:

A team consisting of the internal staff of the museum should be prepared, who is supposed to be the first responder to any emergency situation, so that it does not turn into a bigger disaster. The team will coordination for effective relief, rescue of visitors / staff and salvage of objects.

The rescue team would be made up of:

- Building and Infrastructure Team
- Administration and Supplies Team
- Objects Salvage Team
- Communications Team

Their key tasks would be:

- To undertake first response actions before external emergency services arrive.
- To assist external emergency services when they reach the site
- To undertake key measures to facilitate recovery of the building and objects after external emergency services leave the site

General Guidelines:

- The staff should be given roles to perform in emergencies according to their expertise in the field they work with proper command structure.
- The entire staff should know appropriate responses and their roles in an emergency situation.
- Each emergency team should divide responsibilities among itself and should not concentrate in one activity or location. For example, while some members of collections team may salvage the collections, others may stay back to take care of prepare their temporary storage area. However the team should be ready to plan for the unexpected.
- Emergency response should involve activating all emergency teams and services and following necessary procedures by coordinating among various teams.
- Coordination with nearest fire office, police station, hospital and other line departments should

be established beforehand so that they are aware of the shortest route to the site and have sufficient knowledge of the layout of site.

- The emergency team should hold regular meetings of various team heads for general review the activities and the status of plan. Each team leader should also convene the meeting of its respective team members on regular basis to practice and review the responsibilities of the team.
- Each emergency team leader should have a back-up in case the designated leader is unable to discharge his or her function due to unforeseen circumstances.
- Procedures should be established for the notification of an emergency, which is understood by all the staff.
- All the staff members especially the emergency team members should be well versed with all the areas in the site. They should know the main evacuation routes as well as the emergency signage.
- The staff members also to be made aware of the areas that are demarcated for refuge as well as temporary storage of salvaged collections.
- Special public areas should be demarcated for stationing of emergency services such as fire, police and ambulance during an emergency situation. Such areas should be declared as 'No Parking Areas' and easily accessibility to these areas should be ensured all the time.
- It is crucial that each emergency team member is equipped with wireless device for internal communication. Communication with all the team members should be feasible through mobile. It is important to check their connectivity.
- Recovery process should commence only when all safety aspects have been taken into consideration following a disaster and when the incident has been declared safe by the proper authorities like police, fire, electricity, building control etc.
- Response procedures should be for both during and outside business hours, alerting chain of command including other organizational departments e.g. security.

Composition of Emergency Team:

- Rescue Team
- Building and Infrastructure Team
- Administration and Supplies Team
- Objects Salvage Team
- Communications Team

Objectives of the Emergency Drill:

- To identify existing strengths and shortcomings in emergency response in Government Museum and Art gallery.
- To familiarize the participants with the response procedures (actions, duration and sequence and communication channels) and create an emergency team
- To test proposed emergency preparedness measures (effectiveness of signage, proposed evacuation routes in terms of movement, time needed).
- To test the emergency communication and coordination with external agencies such as fire, police, hospital, media etc.
-

Disaster Scenario and Responsibilities of Emergency Team Members :- (TO BE EXECUTED)

Emergency Evacuation Plan (As proposed in the drawings): Emergency Contacts would consist of the following. The tentative list of team consisting of the staff from the museum has been put down after consultation with Museum Curator Ms. Seema Gera:-

S. No	Team member designate	Museum staff	Contact number
1	Emergency Team Coordinator	Seema Gera (Curator, Museum)	+0091 97791 29129
2	Assistant Security Officer (PU) Head of Rescue team	Sunil l Kumar	+0091 9872207479
3	Head of Building and infrastructure team	Ravindra Kumar	+0091 9872823366
	Head of Administration	Vijay Kumar	+0091 9878220815
4	Head of Objects salvage team	D. K Ghavri (Conservator) Megha Kulkarni (Curator assistant)	+0091 9888902278 +0091 8087572732
5	Head of Communications Team	Director Museum	
6	Chief Medical officer, PU	Not designated so far	
7	Electricity Officer, PU	JE(on call) Sunil	+0091 9780240978
8	Water Supply Officer, PU	Trilokchan	+0091 9988211415
9	Fire Tenders	Sector 11	0172 274 7820 (Source: Google)
10	Police station	Sector 11	0172 274 7066 (Source: Google)
11	General hospital	Sector 16	0172 275 2042 (Source: Google)

Guidelines for Salvage of Heritage Objects:

- Enter the site only if declared safe
- Prepare all relevant information before
- Document the incident
- Prioritize collections to be salvaged and protected in-situ based on their value and vulnerability.
- Evacuate only if required and if another space is available
- Work in pairs, use safety gear
- Observe minimal intervention
- Debrief and report

8. IMPLEMENTATION AND PHASING

8.1 Implementation and Phasing

The Conservation Management Plan for the Government Museum and Art Gallery provides a framework for an integrated conservation planning, addressing all issues related to the building and its surroundings.

The table below shows a tentative timeline of the execution of the proposed works to be undertaken for the upgradation of the Government Museum and Art Gallery.

Table 12: Implementation Timeline

S.NO.	Description of Work to be Undertaken	PHASE 1	PHASE 2
1	Landscape conservation and redevelopment		
2	Building Conservation		
a.	Concrete repair of terrace elements, drains and other areas requiring immediate attention, Waterproofing, False ceiling		
b.	Cleaning exterior and interior surfaces, Repair flooring, etc.		
3	Interior works and Exhibition design		
4	Visitor Amenities		
5	Lighting		
6	Surveillance and security, Fire safety		
7	Collection storage		
8	Collection conservation		

8.2 Budgeting and Funding Opportunities for Government Museum and Art Gallery

The implementation of the CMP for the Museum is dependent on the availability of funds from the UT Government. The Museum has also applied for the Museum Upgradation Grant from the Ministry of Culture to support the implementation of the Phase 1. All significant and immediate works to be undertaken at the Museum has been translated into a Design Project Report for immediate perusal. A preliminary estimate was drawn up to source funding for the proposed works at the Government Museum and Art Gallery. The work is estimated at 14 Crore INR.

8.3 Monitoring Indicators

Following monitoring parameters need to be observed by the Museum personnel to ensure the health of all essential components of the Museum:

I. Concrete drains and terrace elements - to be inspected on a quarterly basis for any signs of cracks/ exposed rebars/ detachment and other conditions.
II. Interiors, furniture and artwork – Interiors including furniture and artwork conditions should be inspected on a quarterly basis for any wear and tear and appropriate measures to be undertaken as per policy guidelines in the CMP.

III. Interpretation and Use – After the installation of orientation gallery and exhibition display as proposed in the CMP, monthly record of visitors and their response/feedback is essential to ensure the success or improvements required in this area. The Museum should also chart out an annual calendar of outreach activities/events to be carried out in the building and keep a record of all such activities.
IV. Services – All services of the Museum needs to be checked on a monthly basis or as per need basis for complete efficiency and functionality.

Table 13: Monitoring Schedule

ELEMENT OF SIGNIFICANCE	DETERIORATION LEVEL	MONITORING PERIOD	MONITORING AGENCY
LANDSCAPE			
Pools	Low	Per month	UT Engineering/ Architecture Department
Vegetation		Every 6 months	
Piazza			
Urban Furniture			
BUILDING EXTERIOR			
Brick tile cladding	Moderate	Every 6 months	UT Engineering/ Architecture Department
Gargoyles	High	Every 3 months	
Concrete drains			
Clerestory and Fins			
Terrace waterproofing	High	Every 3 months	
BUILDING INTERIOR			
Fibreboard ceiling panel	High	Every 3 months	UT Engineering/ Architecture Department
Terrazzo floor	Moderate	Every 6 months	
COLLECTION			
Museum Collection in galleries	Moderate	Every month	Museum staff
Reserve Collection			
MOVABLE AND IMMOVABLE FIXTURES			
Display furniture	Low	Every 3 months	Museum staff
Furniture			
SERVICES			
Lighting (Original)	Low	Every month	UT Engineering/ Architecture Department
Lighting (New)			
Plumbing	High		

8.4 Phasing and Updating the Plan

The Conservation Management Plan of the Government Museum and Art Gallery needs to be a dynamic document and should be updated on an annual basis, recording the works carried out every year as per plan. It should include any new aspects associated with the conservation and management of the building. The next update for this plan should be undertaken after the macroclimate study by the Getty Conservation Institute is completed in 2021.

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ANNEXURE

A: Oral History

A.1 Oral History Records of Ar. S.D. Sharma, Architect On-Site

How were you involved in the Museum Project and how was the project realized from its conceptual stage to the implementation on ground?

The building was, as we know, designed by Corbusier. He used to send the designs and drawings from Paris to the Architect Office here in Chandigarh, where Jeanneret used to be the Chief Architect. The job for us Indian Architects, was to translate those Metric drawings into Imperial system i.e. Feet- Inches and making working drawings of the same. The drawings which were sent by Corbusier were only conceptual sketches with all dimensions in metric units but, without the details. The details were given by Corbusier when he visited Chandigarh. The conceptual drawings by Corbusier are not available here in Chandigarh now. However, I remember seeing a few coloured drawings of the Museum at the Gandhi Bhawan Exhibition a few years back when Maristella was here.

Corbusier used to visit Chandigarh twice a year for a period of one month. During this period, he would call all the Architects on the team one by one. Whenever my turn came, I remember he used to look at all the working drawings prepared by us and check them against the drawings he supplied earlier. Of course, these drawings were initially checked by Jeanneret first and then rechecked by Corbusier.

I was responsible for making the drawings and details for the Auditorium, the furniture for the library and display objects, working directly with Mr. Randhawa. We both used to sit together and share ideas. He was majorly involved in the conception of Chandigarh and its landscape and was also awarded for the same.

Amongst the archival drawings from the Fondation Le Corbusier we found traces of the proposal to extend the Museum according to the "unlimited growth" concept. Did this idea exist even during the construction phase?

The future extension was not considered during the construction of the building, because the gargoyle would obstruct the extension towards the sides. The space between the auditorium and the museum building was very beautifully composed. When you walk through this space, it reveals a very grand picture. Maybe the extension was initially thought of by Corbusier or someone else, but was never discussed with the execution team. I believe, the theory of unlimited growth is only applicable for modern art galleries.

Was there a landscape design intended for the cultural centre, linking it to the museum?

A landscape scheme was never proposed and the complex was never landscaped. Although Corbusier had something in mind for the same, Mr. Randhawa was interested in building a science museum instead. This was built later in the campus in the place of a miracle box as shown in the layout plan of the cultural centre. The landscape which exists today divides the Arts College and Science museum with visual barriers, which is in contradiction with the concept of "Unlimited Growth".

What kind of shuttering was used for casting the concrete panels of the Museum? Was it metal or wood shuttering? And what kind of concrete and shuttering was used for the Auditorium hall next to the Museum, as they both appear to be different in nature?

The shuttering used was a two feet by four feet steel grate. In Chandigarh, it was a common practice to use steel shuttering rather than wood, because wooden shuttering gives a very random pattern as compared to the uniform pattern of steel shuttering. For this the contractors probably charged more. The waves and patterns created in the concrete walls of the Auditorium were not intentional. They formed naturally with flaws in the shuttering and aging of the building. Intentions can be shown in very strong shuttering pattern only. Either we can put it diagonally or any other way.

Do you have any idea about the underground ventilation system in the auditorium? Was it ever functional?

The reservoir at the rear of the auditorium and the basement were meant for a passive cooling system, but it was never put to use. As far as the shafts under the seats are concerned, auditoriums generally have an underground tunnel which connects the projection system on the back side of the seats to the front stage and it also accommodates all the other wires for speakers etc. So it must be there for the same purpose in this auditorium. But to my knowledge it was never functional as a cooling system, although it was made for the same purpose and further tunnels connecting the basement were to be made which would bring in the conditioned air. I was responsible for the conception of the auditorium, but I really don't remember this aspect of design.

Do you remember the names of the Engineers involved in the construction of the project and how did the Architects and Engineers work together?

The Chief Engineer was Mr. Kulbir Singh at the time. Engineers and Architect met quite often. They used to visit our office and discuss any changes to be made or get any problems sorted there and then. Please excuse my memory but, I really can't remember the names of any other engineers on the project.

Was it common to use brick cladding before Le Corbusier? Were they specially designed for the Museum?

The buildings in the Capitol Complex are monumental. In a smaller building like the Museum concrete may not show very well. So, looking at the climate, height of the building and the nature of the structure both in Ahmadabad and Chandigarh, it was decided to use the Brick tile cladding as it gives a very warm and planet oriented expression. The brick tiles used are different from normal bricks. They are much thinner and baked at higher temperatures which makes their surface very hard so that they do not peel off easily. These brick tiles were clad to the surface as is usually practiced. Right at the bottom of the clad wall, there is beam which is slightly protruded outwards which acts as a resting base for the brick tiles. Also, there are some metal strips grouted between every 4 to 5 courses to divide the load and hold the cladding to the surface.

Through the archives it's evident that the terrace of the temporary gallery (previously workshop) was supposed to be accessible from the Museum and was to function as a sculptural terrace exhibiting artworks. Was this idea still present during the construction phase? Why wasn't it implemented on site?

Yes, it was a part of the scheme but never executed. The terrace of the workshop and Guard's room were supposed to be accessible from the inside of the museum, to serve as a stimulating space or an emergency exit in case of a fire. Corbusier passed away when the structure was built up-to 6 feet above the ground, after which Dr. Randhawa took over. He was the main guide and the only one who could get the funds for the project even in the worse situation of Indo-China war. After 1965 Jeanneret left Chandigarh and Mr. Randhawa continued the project along with Kulbir Singh (Chief Engineer) and Ar. M.N. Sharma who was a Senior Architect from Patiala. They were responsible for the completion of the project. It is possible that all the ideas of Corbusier could not be executed by them.

Who decided the colour palette for the museum, Le Corbusier or Ratna Fabri? Did Le Corbusier chose the colour for the ceiling panels and the red and black colour walls of the galleries?

The colour scheme was definitely given by Le Corbusier. Each colour was chosen to distinguish between the different galleries. During the time of Corbusier, there were no display items. The collection - Gandhara, coins, miniature paintings and other statues were brought from the Lahore Museum after the partition with an arrangement of 60-40 division. 60% remained with Pakistan and 40% came to India. They were shifted between Shimla, Amritsar and Patiala until the Museum in Chandigarh was built as their permanent house. So, all the display scheme was done later when the artefacts arrived. Apart from this, the fixed furniture in the Auditorium and its interior details were done by me. Upholstery of the chairs was leatherette which might have been changed over time but the colour was almost the same. All remaining parts of the auditorium interiors like the wall panelling, ceiling, lighting and audio system etc. are original.

After Corbusier's death we had to get the whole scheme executed in the spirit of his vision. He had given us all the details and colour schemes but he never planned for the kind of display which would be exhibited. He was mostly oriented towards modern art and exhibits like large scale paintings.

The wood wool ceiling panels were appreciated a lot by the modern architects in Europe because they were cheap, had good acoustic quality, they have rough design and so on. But I guess it was quite new in India. Who decided to use these panels for the false ceiling in the museum- Corbusier or Jeanneret? Also, we were informed on site that these panels were handcrafted by local artisans. Is it true?

The ceiling panels were called thermophrasers and it was quite a new thing in India at the time. It had acoustic values as it is rough in texture. There were companies which made these back then and was available in grey colour. They were painted as per the colour scheme provided by Corbusier. Also I can't remember these ceiling panels being installed in the balconies as it would not stand the weather outside the building. There was no need of this. I just can't recall this detail being planned or executed.

Was the exhibition display and the furniture entirely designed by Ratna Fabri? Who designed the lighting?

The interior display was designed by Ratna Fabri, especially the Gandhara and miniature painting section where you can see the glass boxes and the indirect upward lighting. The library furniture, book shelves and Randhawa's sculpture display were designed by me. Apart from these, there were some basic display items like the canon, for which I designed the stand. Ratna Fabri was commissioned for the overall museum display and interior design. Lighting for the exhibits was designed in such a way that the natural light and artificial light looked like they were coming from the same source, in tune with Corbusier's scheme. However, I think the lighting has been re-done now which does not look very good.

Were there any exhaust fans or ventilators planned in the skylights as shown in some of the archival drawings?

No, I do not recall this ever being planned or executed. Actually, the air conditioning was not done at one consistent speed and these exhaust fans are very noisy to be put in a museum. It may have been thought of by somebody but the idea was not executed. I remember we raised a question to Corbusier that there was no ventilation system in the building design, but he did not answer to that right away. I have written about this in my book. The next morning he came back with a solution. He decided to put ventilators behind the columns against the outer walls in the galleries. Probably then the idea of exhaust system in the skylights may have been dropped which I am not sure about. These ventilators were also covered with wire mesh from the outside to avoid birds and insects from entering the galleries.

What do u think about the design of the gargoyle? Are you happy with the way it functions? When the wind blows, it splashes water onto the facade and triggers the growth of algae or creates water stains on the surface.

It is a natural process and water will splash around in strong winds. With time, bacterial growth or staining takes place. Initially, the engineers did not agree to make such a long gargoyle on either sides of facade because they had never made such a thing. They questioned Corbusier about its functioning and wanted to adopt a common method using pipes for drainage. But, Corbusier said that water is not like grain, it will find its own way and asked them not to worry about it.

What do you think about the interventions made to the building over time? Were you ever consulted by the Museum authorities regarding any proposed changes to be made?

A lot of time has passed and over time many people came up with different ideas proposing various changes. Like the adulatory glazing was painted in the auditorium entrance, installation of the grill against the windows and the tar (bitumen) on the terrace etc. The surface of brick cladding was painted for projection show on the front facade. I am really concerned about that, and I am eager to see what the conservation Architects will do about that. I left the UT office in 1973 and from then on I have had no connection with any decision making or changes to be made in the building.

How often did Le Corbusier visit the museum site? Did he get to see the starting of the construction? What was Jeanneret's involvement?

I think he only came to the site once to see the location and check the conditions. The work was allotted to a Calcutta based company, though I don't remember it now. Jeanneret did not visit this building. He was busy with the capitol complex mostly. He was a very loaded person with maximum amount of work and so many duties.

A.2 Oral History Records of Dr. Harjeet Singh Dhillon, Retd. Executive Engineer, Horticulture Dept. Chandigarh

What might have been the selection criteria of the trees in Chandigarh and particularly in the Sector 10 Cultural Belt?

Whenever we choose a tree species for plantation, we consider three to four factors. The first factor would be that, if the climate of the area is suitable for the species or not; if not the tree won't grow. The second factor would be the importance or type of the building around which the plantation is to be done. Whether it is a monumental building, a religious building, a residential area or just road side plantation. Here the height of the building and the available space is taken into consideration, because trees come in various shapes and heights. Some trees grow vertically, others have a wide spread and some have horizontal branches, others have drooping branches.

The Cultural Complex of Sector 10 has a number of very important buildings, like the Govt. College of Arts which is a low height building, the Govt. Museum which is a square building and the Museum of Evolution. The tree plantation was done with respect to the forms of all these buildings in the complex.

The cultural complex has a great number of visitors from over the world. In order to receive these visitors there are trees like Bottle Brush having drooping branches and leaves which have been planted along the inner side of the front boundary wall as a sign of welcome. The front approach road running parallel to the site has been planted with an avenue of *Grevillea robusta* which is a vertical tree, in order to create dominance. On the other hand the plantation on the inner side of the site is focused towards camouflaging the buildings, softening the hard concrete forms of the buildings and bifurcating the spaces around the buildings in order to provide an individual atmosphere to every building in the complex. Eucalyptus trees divide the space between the Museum of history and Museum of Science. On the south-west side of the site, Pine trees have been planted along the Madhya-Marg which have an average height of 40 to 50 feet. These tall trees filter the horizontal rays of setting sun, which gives a beautiful shadow on the grass, paved areas and the building as well. The south-eastern side of the site also has a row of tall Pine trees along the boundary wall on the outer side and to contrast these tall green trees, a row of *lagerstroemia*, which is a flowering tree, has been provided in the front along the Jan-Marg. Throughout the summers this flowering tree is in full bloom from April to August which adds to the colourful charm of the area. Apart from this there are some specimen trees planted in the complex, *Dalbergia lanceolatus* for example, which has very shiny leaves and spherical foliage. Similarly, there is Kusum (Scientific name - *Schleichera trijuga*), which is also a specimen tree. Although, it is not a flowering tree, its leaves turn colourful in the months of March-April. These specimen trees have been planted in groups of 3 to 4 in the paved plaza in front of the History museum and they create focus in the landscape, acting like a sculpture. The College of Arts has been surrounded by trees which provide shade and flowers during summers in order to camouflage the low height building.

When was the landscape design or the plantation plan prepared and by whom?

As far as I remember, Dr. Randhawa (Chief Administrator) along with Mr. Johal (XEN Horticulture) executed the landscape plan of Museum and Art Gallery in 1958-59. I read the autobiography of Dr. Randhawa. He wrote it in "Punjabi". He talks about his childhood, how he studied and when he came to Chandigarh for higher studies. He also wrote about the Indo-Pak partition, about the migrating people and what was his role in rehabilitating them. There is one chapter on the Museum and Art Gallery in his autobiography. He was the first Chief Commissioner of Chandigarh. He was a lover of art, environment and he had a Masters degree in Botany which gave him knowledge of plants and trees. During his official visits to other states or abroad, he used to discuss with dignitaries or experts about plants or tree species and visited the nurseries. He used to bring back seeds and plants with him to Chandigarh which was under development and he played a major role in its development. Though there is no written evidence about how Dr. Randhawa prepared the plantation scheme for the Museum and Art gallery, being a landscapist myself, I could read his mind and studied the existing landscape to write about the justification of the plantation scheme in the book.

Le Corbusier who designed Chandigarh, gave the concept of tree plantation, which type of trees should be planted on North-West to South-East roads, North-East to South-West roads and types of trees to be planted in VIP houses with acres of garden spaces. Dr. Randhawa being a lover of Art, wrote in his autobiography that he always had the idea of making a Museum and Art Gallery for Chandigarh in his mind. So, he went to Delhi and got this project approved in a single day, although it takes years to get such projects approved. He considered himself lucky enough that the secretary approved the project in such short time. Le Corbusier along with Dr. Randhawa had thought of making 7 to 8 major buildings in the city like the high court, Assembly, secretariat etc. and the Museum and Art Gallery was also one of them. For all these buildings they designed the landscape based on "Purity". The overall concept was given by Corbusier and the plantation scheme developed by Dr. Randhawa. The basic planning consisted of types of trees to be planted on the approach road for welcoming, another type for domination and flowering trees for adding colour to the landscape and so on. All the tree species were brought from other states, majorly South Indian states. Chandigarh was being developed as a modern city at the time, and it was an opportunity to develop an exotic and unseen landscape. So, the local trees of Punjab were planted in minimal quantity.

Tree Directory of Chandigarh mentions the types and number of trees in the city and its different areas. How accurate is that information today and what does the directory say about the cultural belt of Sector 10?

The tree directory talks about all the types and species of trees planted in Chandigarh, whether they are on road side, in the gardens or any other areas. There are some roads on which there are 20 to 25 species of trees planted on a single road alone. This may be due to the negligence or due to non-availability of one particular species to be planted on road side. So, the concept given by Corbusier has been violated in some areas. We limited the list of trees to very important ones in the directory so that the volume does not become too big. I have myself identified 225 species of ornamental trees in Chandigarh and it is on record.

There is another book, which is going to be published by the Forest Department on the heritage trees of Chandigarh. We have prepared a list of 31 very old heritage trees which is going to be featured in this book. All the heritage trees in Chandigarh have been preserved and protected by the administration. Very old trees like

Peepal, Neem, Banyan and orchards of Mango trees in local villages were preserved. The Sher Shah Suri road which crossed through the region had mango and Khajur trees along the road, which also have been preserved. Wherever the old trees were found, either the planning was altered or such spaces were converted into parks. Sector 37 Model School layout was changed because there were three very old mango trees on the site. Another example is the UT Guest house in Sector 6, which had a very old Peepal tree. Orders were given to cut away the tree but, when the case went to the Advisor, he visited the site himself and dismissed the orders to cut the tree, as it was a heritage tree. Thereafter the design and location of the building within the site had to be changed by the Architecture Department. It is the duty of the Advisor along with XEN Horticulture, to take up all the cases of tree removal requests from 3pm to 5pm on Friday. Only after his permission is granted, the tree is allowed to be cut. Every heritage tree in the city is being labelled and information boards are being erected in front of these trees, which are also in the shape of a tree. The boards will contain the size and age of the tree along with the name of the village which it belonged to and the written interview of the local people who are related to that particular tree. As far as the cultural belt of sector 10 is concerned I don't think there is any old tree with a heritage status in the area.

What do you think about the Landscape Design and Site selection for the Museum and Art Gallery as it is situated on a higher ground within the complex?

The idea of placing the building on a higher ground within a site is called "Transition". Transition means treating the site terrace wise and gradually moving towards lower levels. Take Secretariat in Sector 1 for example. The height of the Secretariat building is having a height of 150 ft. approx. In order to counter the visual imbalance in the area, the Geometric hill was made. The hill is covered with shrubs and trees of round shape, so that the great height of the building is visually reduced and the round shaped foliage softens the straight and bold lines of the concrete structure. In the Govt. Museum and Art gallery building the plantation is done in such a way that it camouflages the building and gives a visual softness to the concrete and brick structure. The *Alstonia* trees in the parking and near the vehicular entrance, which is generally a low height species, gained height due to close plantation and pruning countering the height of the Museum and Auditorium building and its green leaves are in contrast with the grey concrete.

When did you join the Department and what is your experience at the Dept. of Horticulture U.T. and with the Govt. Museum and Art Gallery and the landscape of the city?

I joined the Department of Horticulture in August 1975. Working in the U.T. Office, with few months of experience, the senior officials sent me to Dehradun in Jan 1976 to find and buy new species of trees and plants. I was supposed to visit 2 to 3 nurseries in Dehradun. I was also guided to visit Forest Research Institute in Dehradun and collect a list of rare plants and trees from there. I got a list of 50 rare trees and plants which had never been planted in Chandigarh before. So, I chose the different species from the list in the nurseries and as per our XEN's directions, I placed the order and returned back. We created a garden of unusual trees and plants in sec36 leisure valley where we planted these 50 species and they grew very well

The building and its landscape was already in place and completed. Over the years, I have observed that Govt. Museum and Art gallery is a very important building but, the same importance has not been given to the landscape around it. First of all the maintenance is very poor. Secondly, general public and tourists are not aware of the vast variety of trees we have in our city. Even the Govt. staff are not able to identify the tree species, and if one cannot identify, how can they choose a tree species. A couple of times I have stressed on this agenda of spreading awareness about trees to the "Society of Trees" of Chandigarh. It is important to educate people and making it easier for them to identify the trees in their surroundings. I believe, that all the tourist spots in Chandigarh like the Sukhna Lake, Sector 17 Plaza, Govt. Museum and Art Gallery, all the main roads, Panjab University Rose garden and Leisure valley should have labels on the trees with their respective Common name, Botanical name and Family name. I remember once I met a couple from New Delhi sitting in the Rose Garden just across the road to the Museum and Art gallery. They had a book of regional trees and they were trying to identify the trees in the Garden with the help of the book but, failed to do so. Right then I promised them that whenever you come again next time, you will find all the trees labelled with their names and the same year after the Rose festival, I got 65 tree species identified and labelled. Every month with the help of Tree Lover Society we organize tree walks in Chandigarh, where students from school, colleges and nature lovers and citizens participate and learn the names, value, benefits and other properties of various trees.

Talking about the plantation of Museum and Art gallery complex, I remember that Eucalyptus trees, *Alstonia* on the entry gate, bottle brush along boundary wall and Pine trees on the main road were already there before I joined in 1975. Plantation is generally started simultaneously when the construction of the building begins. But, other trees like *Delbergia lenculatus, Lagerstroemia*, other specimen trees and flowering trees were added after 1975 during my service. Even shrubs and flower pots have been added over time.

What could have been the selection criteria for tree species by Dr. Randhawa?

The tree selection was purely experimental. Some of the main selected species were flowering trees. Gulmohar, Cacius, Kachnar etc. These trees belong to humid climate or coastal areas where they flourish and have long age. But, in Chandigarh their age was found to limited. After 25 to 30 years of age, they start declining. Reasons for this age reduction could be the widening of roads, which lead to cutting of roots. Due to cutting of roots, the trees went in shock. Second reason is the decreased water level of the area. The third factor is the increase in pollution levels due to which the trees could not withstand the air change.

While selecting the trees factors like climate suitability would have been considered. Apart from that personal preference also might have played a major role, because every person demands a flowering tree as it is aesthetically appealing. Although the Concept of plantation tells a different story. The flowering trees bloom only for 1 or 2 months in a year, rest of the year it remains with only leaves. Also the canopy of flowering trees is small so, they are not fit for main roads. Main roads must have vertical, spreading and evergreen trees with long lives. Chukrasia for example which is the most successful tree on road sides, Toona, Mahogany, Arjan and Imli. Another factor is to create buffer, just like outside the rear boundary of the site parallel to Jan Marg has been provided with a buffer of 5 rows of trees like Chukrasia, *Grevillea robusta*, Siris, Pilkhan etc. to create a complete buffer from the road traffic. While on the inner side of the boundary flowering trees have been grown to contrast the buffer.

How should the maintenance works be carried out for landscape of the complex?

The maintenance responsibility mainly lies with the Horticulture Dept. But the horticulture Dept. has limited resources as they have to maintain the complete city. During my tenure, there was no maintenance scheme for the Museum but, the horticulture staff was called on requirement basis by the Museum authorities. The Director Museum and Art gallery shall take interest and appoint separate staff to take care of the complex landscape with the guidance of the Horticulture Dept. U.T. There have to 8 to 10 permanent gardeners and one head of staff appointed along with machines for pruning, mowing or cleaning etc. Regular maintenance schedule must be followed. Trees need care only when they are growing, but after a few years depending on species to species they hardly require special care. They shed leaves which needs cleaning and they may also get out of shape, for which their pruning needs to be done from time to time in order to maintain a defined shape. Also, looking at the tourist influx year round, there must be flowerbeds, shrubs planted for beautification which need regular care along with timely mowing of grass. There is also a major lacking of landscape furniture for people to site and enjoy the place. The sitting furniture shall be planned as per requirement for a single person, a couple, a family with kids or for old people rather than just randomly placing benches in the landscape.

As per your study, what design language has been followed in the landscape of the Museum Complex?

For instance, Eucalyptus trees in the Museum complex are used to unify the respective spaces of the buildings and to balance them *Pinus longifolia* trees have been planted. Moreover all the tall tree species in the complex, like Eucalyptus, *Bambik ciba* and *Pinus longifolia* balance out each other in terms of height. The design principles of landscape include Emphasis which in this case is created by the Building itself. So, the landscape design can be used to either strengthen the emphasis, if the building is of human scale or weaken the emphasis if the building is of monumental scale. Secondly there is Rhythm which can be created by repetition of plants or trees after intervals, reminding the viewer of the same species. The third principle is "Contrast" which can be in texture, shape and colour. If we have to give a spacious feel to a small area, trees with very small/thin leaves with fine texture are planted and vice-versa. Fourth principle is "transition" as mentioned earlier. This is done in order to either camouflage or to break monotony of the building.

The green belts spreading from sector to sector which also touches the South-eastern side of the site was originally made for the pedestrians or cyclists. It also gave a linearity to the road avoid heavy traffic noise into the site. The plantation of green belt is generally done by throwing seeds randomly or we group them into rows of single, three, five or seven trees.

The sculptures have been added to the landscape of the Museum Complex over time. What role do they play in the landscape?

During my tenure in the UT Horticulture Dept. I gave a concept of 13 gardens especially for the southern sectors of Chandigarh, out of which the sculpture garden was proposed in the sector 10 Leisure valley in front of the Museum and Art Gallery complex. Sculptures made by the students of College of Arts are marvelous, which were then dumped or haphazardly displayed behind the arts college building due to which they didn't get recognition. By displaying these sculptures in the open leisure valley, not only the students will be motivated but also their work will be recognized, people will appreciate the art and it will add to the beauty of the landscape. Although this proposal hasn't been completely implemented yet but, some of these sculptures now add to the beauty of the Museum complex itself. Eucalyptus and *Pinus longifolio* are used for massing; *Bambic ciba*, Jivaputra and *Delbergia lenculatus* are a Specimen trees; *Alstonia* is used for low height massing; *Grevilia robusta* is used for Dominance; *Schleichera trijugga* is a Specimen tree which changes colour with season; Pride of India, *Lagestroemia, Tecoma argentea* and *Chorisia speciosa* are used to add colour

What do think about the storm water and water supply management of the site?

The Architect took care of the storm water from the roof by collecting them in gutters and using it as a natural waterfall which falls onto the randomly placed stones in the circular pool in the front paved area. From here it goes into the drains. This not only adds to the beauty of the landscape but, the splash of the water also gives a cooling effect to the people sitting around. Back then there was no rain water harvesting schemes available. However, Le Corbusier decided to use this water in some way, instead of just letting it go directly into the drains. Now, you can see that a fountain has been added to the water body, which is an artificial method of creating splash, which is not as per the original idea of the Architect. Apart form that, air conditioning units have been added on the Eastern side of the building and to camouflage or hide that new plantation has been done around it.

A.3 Oral History Records of Dr. B.N. Goswami, Member Museum Advisory Committee

Since when have you been associated with the Govt. Museum and Art gallery and in what capacity?

My association with the Govt. Museum and Art gallery has been close to 40 years long but not in a formal way, I never held a position here. But, I have been associated as a member of several committees over the years, one after another. Art purchase committee, advisory committee and book purchase committee for example. I am an academician and used to teach at the University and held the position of Director for the University museum. So, in this capacity I used to come here at the Museum and worked here with all the people here.

Please share some of your memories with us from the times when the museum was being constructed or after the inauguration of the building.

I never saw the Museum during its construction; I saw it soon after the building was complete. The Chief Commissioner at the time was Dr. M. S. Randhawa, who was a very legendary name in the region. The Museum exists due to his contributions. He himself used to get all the works done here, supervision of the museum, collection of art, etc. He was senior to me but, we were very good friends. There were times we used walk around together and see the work happening in the museum. So, when I say that I have been associated with the museum since 40 years, I may be wrong, it should be close to 50 years.

Dr. Randhawa had his own way of working and somehow I enjoyed that. He did not believe in roadblocks in the way of his works and he also held a top position where he could make things happen. He has contributed a lot in making this museum. I got a chance to assist him in the collection of art but, not much otherwise. He used to take our advice at all times. The original setup of Museum galleries was done by Prof. Mathur's sister, Ratna Fabri who was married to Charles Fabri. Professor Mathur was also a member of faculty in Panjab University of Arts and a dear friend of mine. While Ratna Fabri was designing the setup, we used to debate on how to do and what to do. For instance, there was a very tall wall hanging made of jute, so we discussed how to display it in the best possible way, and more preliminary level discussions while setting up the museum. I would not take any credit for it, but yes we kept working.

Who played the main role in designing the Museum setup and who were the key persons involved in making approvals and taking decisions?

Ratna Fabri was given the responsibility for the designing the setup, but there were some inputs from Dr. Randhawa and a very few from me. The building as you already know was designed by Corbusier and S.D. Sharma was involved in the construction. One thing was very clear that the decisions were taken in an informal way. There were no minor hiccups which lingered in the work. Real work happens better in an informal setup only. Dr. Randhawa had an amazing capacity to override conventions or bend the rules. Since his heart was in the right place and he really thought for the city, all the decisions he took were for the betterment of the museum. Ratna was also responsible for the lighting design along with the display. She must have had a technical expert in her team who helped her with such aspects.

What do you understand about Le Corbusier's concept of "unlimited growth" which he kept in mind while designing the Three Museums?

Corbusier thought of his building as a sculpture on a large scale. The concept of "unlimited growth" is a general concept. It doesn't apply to a particular building. It could be about the city or a complex. It can't be applied to a single building. He was an open minded person with a vision. He was not rigid in his thoughts but yes, he was rigid in some things or we can say he was particular when he took inspiration from the things he saw. No human is complete in himself, and one tends to take ideas from everywhere. He also took ideas and used them in his own way.

This building we already know about, but Sanskar Kendra in Ahmadabad, which is structurally similar to this building, have some problems. For example, ingress of air in the interiors of the building. These minor issues are germane to architecture. Nothing is created like "Minerva from the head of Jove". Only by using a building for a time or couple of season changes, you will be able to tell about the shortcomings and flaws in it. Similarly, architecture is never complete in itself. One has to make modifications, gaps have to be filled in, and infirmities have to be removed.

Who do you think decided the colors of the walls and ceiling panels in the galleries?

Le Corbusier used to work with concrete in most of his buildings. And exposed concrete is not an attractive material to look at; but it does not catch the eye. Human eye stops only where there is highlighting. Corbusier was very conscious of this idea. I am very uneducated about him, I haven't read any book about him.

Have there been any changes done to the original display over the years? If yes, by whom?

There haven't been many changes in the display since the beginning. But, over the years whenever a senior officer from the Administration visited or a bureaucrat became the Director, who is not conscious about Art and Architecture, they would ask for some changes as per their desire which would be hard to resist. So, minor tinkering did take place, but the basic structure of the galleries remained the same. Approximately 10% display has been increased from the original. Gandhara sculptures have increased and coin display was added later.

What do you remember about the theft which occurred in 1970 and what changes were made to the museum after that? According to you, how did those changes affect the Building?

The theft in 1970 created a great stir in the museum. And due to that many areas were blocked. The staircase in the reception area for example. Earlier it was used by the staff members to access the office on the 2nd level. Similarly many other changes were done, which were not well thought of or discussed properly.

What do you think about the museum setup today? Are there any changes you would want to do for the betterment of the museum and which help retaining the original idea of the Architect?

I feel we can move the sculptures which are lying outside in the corridor indoors because they are hardly seen by the visitors. Only the Jain Goddess and Ganapati sculpture which are in the way to the main door get the attention of the people. So, they could be placed in the galleries for the people to see. There was a canteen at the back side, which was a very important aspect of the museum. Not exactly a canteen but, a café should be there in the museum. Although, I hardly visited the cafe in earlier times. It didn't have the atmosphere of a café, it was more like a glorified Dhaba.

After Corbusier's death, who took over the project and who were the key persons responsible for the building as per the original design by Corbusier? Were any changes were made by someone as per requirement?

Ar. M.N. Sharma who was the Chief Architect at that time and Ar. S.D. Sharma, the Assistant Architect were certainly involved in completing the project. I saw M.N. Sharma many times on site. I have also seen Euli Chaudhary a few times. Though, she was not formally appointed, but her suggestions must have been taken. I wasn't a daily visitor to the museum, so I do not know as much as the people who were regularly appointed. Sometimes I was called upon, sometimes I came myself to read or to meet people working here.

Was the Auditorium in place when you first came here or was it being constructed at the time?

I remember having a discussion with Dr. Randhawa about the Auditorium, whether it should be made or not. I am not sure but, it may have been left out of the original plan or it wasn't sanctioned initially. But, I insisted that the Auditorium should be made. A museum cannot function without an Auditorium. Eventually, Dr. Randhawa decided to make it.

Did it ever occur to you that while making his paintings in the Capitol Complex buildings or the tapestries , Corbusier might have painted the form and shape of the Museum based on his concept of unlimited growth, inspired from the shell of a mollusc?

Corbusier was an heir to the European tradition. All these basic forms and shapes are from the time of Plato. If you read about Plato, he says that there are basic forms derived from the nature which humans have made- cube, pyramid, etc. So, Corbusier might have had all this in his mind. When he came to India, he might have absorbed the local scene form whatever he saw. To be able to absorb is a gift, one should not be scared of it and Corbusier was a brave man, who clearly reflected his ideas and inspirations in his paintings. So, yes it very possible that he might have made the form of the museum in the tapestry.

If the Museum is brought back to its original state, what are your recommendations for the adaptive reuse and modern security systems to be adopted without disturbing the original design and look of the building?

Looking at the displayed items in the museum, we can't even guess the true value of art and artefacts. I believe the value would be equal to the infrastructure of the complete sector in Chandigarh. So, while reversing the changes done to the museum after the theft, one has to think out of the box so that the security of these invaluable items is not compromised. Times have changed now and we are living in a dangerous world, but something can be done for sure to strike a balance between the security measures and the look of the museum.

A.4 Oral History Records of Mr. C.K. Sharma, Museum Superintendent

Could you tell us a little bit about the Mural in the entrance lobby? And what changes do you see in the lobby over time?

Mr. Satish Gujral made this mural. And I remember there was a door next to it which has been closed now. He used to come here to make this mural himself and his wife accompanied him. He was not able to speak, so he explained everything to his wife and she conveyed it further. It wasn't here during the inauguration; it was made a bit later. Dr. Randhawa commissioned it to Mr. Satish Gujral. Dr. Randhawa had a special place in his heart for this museum. All the collections of paintings, sculptures and artefacts in the museum were done by him. It would be safe to say that the museum exists today only due to Dr. M.S. Randhawa.

Another change in the entrance lobby is the staircase going upwards, which was blocked after the theft due to security reasons. Otherwise we went up to our office using this staircase. The room for the curator behind the lobby was also made later. It was all open earlier and we could look outside through this wide glazing. The column like shaft next to the reception counter used to be exposed concrete finish, which has been painted white now. Even the door on the shaft was either red or yellow in colour.

Please tell us about yourself when you joined the Museum and share your memories from that time. Also can you remember anything about the theft which took place in the museum?

I joined here as a clerk on 14th February 1967 and retired in the year 2005. The museum was in the Arts College building at that time. We had a small office there. Mr. Mohan Singh, who was a curator from Punjab was with us in the office. Later, Surinder Kaur Dosanjh joined as an assistant curator. In 1968 when this building was inaugurated, we shifted our office to the upper floor. We used to stay inside the museum and oversee everything. Artists used to come here to work; I have seen the famous artist Sobha Singh coming here to finish an incomplete painting of Guru Gobind Singhji. There is another painting of Guru Nanak Devji made by him, in which he has painted his own reflection. One needs to keenly observe the painting to find resemblance of the face of Guru Nanak Devji with Sobha Singh. So, whenever someone extraordinary used to come here or some event used to take place in the museum, me and my colleagues used to come down from our office to see it. Mr. R.S. Madaan was one of my colleagues at that time.

Mr. O.P. Kapoor who was Superintendent here is another important name, someone who has made a huge contribution in establishing this museum. We all used to work so passionately, even upto 10.00pm in the night under his leadership. We were not aware of the term "overtime" at then. All we knew was that we have to establish this museum as quickly as possible. With full enthusiasm we played our part in correspondence and writing letters to various companies and departments.

Later, when the theft took place, we realized that it wasn't safe to work late at the museum. The technical staff used to lock down the museum from outside and slide the keys in from under the door, while we used to work inside. After finishing our work, we slipped the key out from under the door, and the guard used to unlock and let us out and lock the door again. Things were not so unsafe back then.

People were not aware of the great value of the things inside the museum and neither were we. But, after the theft we learned the true value of the things kept here. I am not sure but, it was the night of 23rd-24th July 1970 when the theft took place. I was in New Delhi for a wedding that night and I remember we came to the museum the next morning; I saw all the employees and guards of the museum were being beaten up and thrashed so badly. They all were lined up and were being interrogated. But, those poor people were all innocent. Nobody had even dreamt of a theft at the museum. We stood up for our staff and requested the police to leave the staff alone, as we knew in our hearts that they could not do such a thing. People were honest back then and we had trust in each other. The security guards from the police department deputed here were beaten very badly too, as the theft happened under their noses. Later our office was shifted to the City Museum building.

You will be surprised to know that a while after the theft when things started getting back to normal; we received a parcel from Lucknow. Mr. O.P. Kapoor saw that there was no name on the parcel. The moment he opened the parcel, we were shocked to see that it had the stolen paintings in it. We checked the back side of the paintings to see the stamp of the museum and it was confirmed that those paintings belonged to the museum. Immediately, Mr. Kapoor called the police to inform about the parcel. The police took over and kept the parcel with them and the investigation went on for long at a very high level. Later it was discovered that some foreigners were involved in the theft and it was all very meticulously planned.

Earlier the security of the museum was managed by the Chandigarh police and the guards appointed by UT Administration. After the theft, many changes were made here, like the grills were installed against all the windows. Currently the security is also managed by the ITBP (Indo-Tibetan Border Police). The Engineering Department made all the changes here and every decision was taken at a higher level, although approvals may have been taken forcefully from architecture department too. All the extra doors in the galleries were closed down with masonry and openings were closed with doors.

As per the current status of the Museum, what are the changes you see have been made from the time you were here?

At our time, it was a very strict rule that even if a nail has to put on the wall we had to take permission from the Architecture Department. But, after the theft there were many major changes made to the museum as we have discussed earlier.

Did you see this building during its construction? If yes, have you seen Le Corbusier coming here anytime?

I haven’t seen Corbusier but I have seen M.N. Sharma and S.D. Sharma ji here many times. I saw this building closely only when it was complete. The museum was in the Arts College when the construction was going on. Actually, the site of the museum was a water pond originally so, the foundations of the building were made quite deep. The building is so strong that it can withstand an earthquake easily.

What do you remember about Ratna Fabri, the designer of the interior setup?

As we can see in the double height gallery, there is a tall woven hanging made of jute. Ratna Fabri decided to cover the high ceiling area of the first gallery with such tall hangings. Although now it has been hung against the wall; originally it was in the centre along with the column and there was another full height hand-woven carpet. It was a challenge to use the tall height of this room, so she thought of filling up this space with full height artistic designer hangings. We used to be seated in the office on the third level, but we came down to see how the gallery was being decorated. There were many decorative hangings, but with time they needed to be changed as they might have been eaten by insects or some other reason.

What about the lighting scheme, is it the same as original, or do you see any changes now in the lights or any other things?

There were no ceiling lights in the reception area. I remember it used to be dark here. The architect didn’t allow us to put lights here but they were added later during my tenure. The lighting in the false ceiling is the same as original. But, these hanging lights in the double height gallery were added later when an artist named Henry Moore from U.K. had his exhibition here. The lights above the window in the textile gallery were put later. It was observed that the lights being too high could not illuminate the area properly. But, Mr. Randhawa wanted the lights to be away from the sculptures and artefacts, so that it does not affect them in any way. Even the lights in the ceiling panels have been added later. The colour of the light was same as now. Only white tube lights were installed. The continuous running lights running along the false ceiling is the only original lighting design. It used to have a transparent plastic mesh covering, which is not there now. The mesh used to fall down because it was so poorly installed. Either pigeons or other birds which entered the museum used to hit these lights while flying and the mesh kept falling down at some place or the other. We used to run behind the birds to push them out of the building, but the poor birds could not find a way out. They usually entered from the main gate as it remained open throughout the day. The curtains against the window in the textile gallery were also not there as far as I remember. The flooring of the ramp is the same. There was a huge painting of Ajanta- Ellora on the wall adjacent to the ramp, although it may have been removed due to damage.

As we can see the openings in the upper galleries have been blocked with collapsible M.S gates. Has this change affected the circulation and accessibility?

The system of circulation was the same as it is now. The entries were closed keeping in mind the circulation pattern of the visitors. First one enters the Gandhara section and then the miniature painting section and so on.

What changes do you see in the upper galleries?

There are many changes, like these showcases were smaller and now I see quite bigger ones. The curtains on the windows of Director's cabin have been added later. They were not there originally. The shaft in the gallery was also in exposed concrete with a coloured door. It has been painted white now and the door has been hidden behind the display panel. The entrance to the lift has also been closed with display panels. The lift might be of no use now to the museum, although it was used to bring heavy sculptures initially. The painting of Guru Nanak Devji used to be in the modern painting section. The paintings are usually taken to the lab for conservation whenever required, and when they are displayed again, the location might have been changed. The curtains in the library also have been added later.

The terrace of Guard's room was supposed to be designed as a terrace garden as per Corbusier plan and maybe an emergency exit too, but it was never used. The grills on the windows were added immediately after the theft, but I think these grills in the clerestory have been added later to make sure all glass panes are secured with fixed iron grills. All the galleries were open and interconnected, but now these glass doors have been added as they needed to air condition the gallery. The glass panes in the clerestory also seemed to be changed. Originally, translucent glass was used. The colour of ceiling panels in the library seemed to be changed now. It wasn't white originally, although I don't remember exactly but it would have been red, yellow or black. It used to be really hot in the library even at those times, otherwise rest of the building was fine. The sofa in the library is original but the upholstery has been changed now. Dr. Randhawa used to come and sit here in the Director's room. The seating arrangement was different from what it is now. These curtains were not there in the Director's room and one used to get a very nice view of the Art college and the Shivalik hills in the backdrop from here. The clerestory here in the Director's room was closed with this acrylic sheet in the same way, but it was transparent. It used to catch dust which was visible from the transparent sheet, due to which they might have made it opaque.

Was it revealed after the investigation where the thieves entered the building to execute their plan?

Yes, we came to know about this in full detail. They entered from the door in the north-west facade on the 2nd level, which opens to the terrace of the temporary exhibition gallery. After the museum was closed in the evening, one of the thieves stayed hiding inside. Back then we did not check properly. The security guard would just call out if anybody is still there before locking. Late at night that man loosened the screws of the door lock from inside and opened the door to let the other men who were waiting on the terrace of the temporary exhibition gallery inside.

The showcases of the miniature paintings were of a special design earlier, although it is different now as they were changed. The thieves with complete ease spent the full night and opened the frames. It wasn't an easy job to open the frames of these paintings. They must have acquired knowledge to do it. Only Gurdev Singh knew how to open these frames. He had come from Patiala museum on deputation. He was a carpenter and promoted to the post of caretaker (*tehbildar*). Only due to this reason he was very badly beaten up and tortured but he was a very honest man. They stacked up the frames properly at a side and packed the paintings only. Then they left from the same place where they entered from. Those frames are now kept away in storage somewhere as they were replaced with new frames.

The full detail of investigation was also published in the newspaper. You can find it in Tribune from the 1970. Some of the stolen paintings were sold to a lady in France. She had seen it in the news that such paintings have been stolen from Chandigarh Museum because the incident went viral all around the world. She bought the paintings and informed the police that this person sold the paintings to me. She did a good job in getting that person caught but she was never given credit for it and neither was she paid back for the paintings; even this thing kept coming in the news. Afterwards rest of the paintings came back in an unnamed parcel.

Was the staircase in the reception to the miniature section used by people?

We used this staircase to come up to our office here at the third level, which has been converted into a room for the Holy Scriptures now. It was our office only until the theft happened and then we were shifted to the City

Museum building. The staircase was never meant for visitor access. The coloured door of the staircase used to remain open However, now it has been closed permanently and covered with display panels. The wood panelling on the staircase going up to the office has been done later. It was exposed concrete earlier. These changes were made after we shifted to the City museum building, which was still under construction at that time.

Was the guard room in the extended single story block the same as it was originally?

Yes it used to be a guard room then too, but it did not have toilets. They have been added much later. The guards used to sleep outside on *charpoys* as it was hot inside the room. If you look at the north east façade of the extension block, you can see that it used to be half veranda and half guard room. Later it must been closed to accommodate the toilets and AC plant. Even the corridor spaces under the building was covered and converted into store rooms with wooden partitions. All this was done during the term of director V.N. Singh.

What can you tell us about the water body at the front of the building?

I can tell you about the story behind the small stone like sculptures in the water body. We had here Gyan Singh, who was an attendant from a local village. Mr. N. Deva Sahaye was our Director at that time and he wanted to decorate the pool in some way. This attendant brought a stone from a river to show it to the director, which might have taken its natural sculpture-like shape due to the flow of water. Mr. Sahaye really liked it and went along with him to the river and collected some more such pieces. They were brought down to the museum and installed in the pool with cement. He later became a curator at the Museum. Before him, Mr. Sarkar who was the principal of Art's College had an additional charge of directorship at the Museum too. The water body was also filled up with water later in order to plant water lily. This was done by Mr. K.K. Sharma who was an environmentalist. But now I see there is no water stored in it and fountains have been added, probably for the sound and light show. I also remember that the water body was surrounded by an M.S railing some time later. This has been removed now and a brick parapet has been made. This might have been done by CITCO when the sound and light show was introduced.

Were these sculptures in the outside corridor initially planned as they are now?

Originally only two sculptures were kept in the corridor. One was the statue of Lord Ganesh and the Jain Devi. Rest all have been added later over time. Maybe some have been brought out from the inner galleries. The statue of Jain Devi was very heavy and was installed here with the help of a crane.

Do you remember anything about the Auditorium? Have you seen it under construction?

As far as I remember, when I came here the building of the auditorium was complete but the interiors were being done. The basement in the auditorium was meant for the air conditioning system and the vents under seats released cold air into the auditorium. It was all designed as per the latest/advanced technology available. The cooling system was used for a while back then and the water body behind the auditorium was meant for the cooling plant only. It was filled up with water and used to have fountains too. The acoustic panels have been painted later I guess. Originally they were without paint and with the natural finish of hard board. The ceiling is still the same as it is now in white color. The upholstery of the seats was bluish-grey leatherette. They may have been changed later to brown leatherette after the original wore out. The older version of projection system was manually operated, so the back entry was used by the projectionist to run that. The window above the entrance door of the auditorium had transparent glass which has been painted white now. It used to have maroon coloured curtains initially. These faded paintings on the exterior wall of the auditorium were done by an artist quite later. But initially it was not allowed. The concrete surface was supposed to be kept untouched.

Was the underground cycle stand ever used?

It wasn't initially planned, but later on it was made as a necessity. We all used to come on our cycles but there wasn't any designated parking for cycles available. It was used for a couple of years but, due to the problem of water ingress, it was abandoned and converted into a scrap store.

What differences are there in the landscape from the beginning?

There is not much difference in the landscape but the trees used to be smaller in size and everything was visible from faraway distance. One could see everything around the museum too. All the sign boards you see now have been added later. The oldest trees here in the campus were the eucalyptus trees between the science museum and Govt. Museum. Rest all were planted after the inauguration. The trees along the boundary wall were very small as I remember.

What was the locking procedure for the museum originally? Was it done in the same way as it is done now?

Earlier it was just locked with a key without any seal. The wax seal method was only adopted after the theft in 1970. This method is damaging the gate and it also gets stuck at times. Many times the lock smith had to be called to repair it. This issue was brought up several times that the lock should be changed but, it cannot be changed because it's an original design by Le Corbusier. In the evening 15 minutes before the closing time a hand held bell/gong was rung by the caretaker to announce the closing time and to make sure that all visitors come out of the museum. This has been replaced by an electric bell. No checking was done before the theft. Now, after ringing the bell the complete museum is thoroughly checked to ensure nobody is left inside.

What can you tell us about the canteen area? When was this area covered and converted into a child art gallery?

The canteen was there until I retired in 2005, but I remember that Mr. V.N. Singh had hired artists and given the canteen area to them after closing down the canteen. They used to sit here and paint on canvases.

Well, I have never seen this area closed. Today is the first time I am looking at these walls which have closed the corridor space. This all used to be open when I was here. It's quite surprising that one can't even see the canteen now. Otherwise the glazing of the canteen was visible from here and it had curtains inside. I remember there used to be Security in-charge's office (SHO) in this space under the ramp. The canteen was run by the Hospitality Dept. and it was economic to have refreshment here. It also had furniture in it which was very strong and well made. I remember a person who had come from France. He saw the furniture and he wished to buy the tables in the canteen. The tables were designed by Corbusier I think, but the chairs were different, they were foldable chairs. There was no heavy cooking done in the canteen's kitchen. Only tea was made here and rest all came packed from the Hospitality Dept. We all used to have a tea break here in the canteen. I am not happy to see this area being converted into a gallery. They could have made the gallery somewhere else, and this should have remained as it was. I feel, this intervention has dampened the beauty of the building.

What do you remember about the plaza area?

It used to be empty in the beginning. But, slowly it was decorated with these sculptures. Sculptures were bought under the annual purchase and some of these sculptures were made by artist Shiv Singh. The boundary was of the same height. The barbed wires was added later because the height was too small and people used to jump over the wall to come in. The director V.N. Singh requested the Engineering Dept. to get this done. The railings in the paved area were added by CITCO when the sound and light show was introduced. However, the paving is original and no changes have been made to it. I remember the inauguration ceremony was held here in this plaza. Tents were setup here; it was a very grand event. Many ministers of Punjab and eminent personalities came for the event. I miss my colleagues from those days and it makes me happy remembering those incidents.

Do you have any memories of the City Museum building?

Originally this building was designed as an administrative block cum exhibition hall. The bottom floor was exhibition hall and upper floor was the administrative block. We used have our office here for a couple of years. Exhibitions were held on the ground floor. Bureaucratic officer who visited wished to make changes and eventually it was converted into Architecture Museum. The terrace floor used to have a food stall when it was converted into the Architecture Museum.

Since the time P.C.S. officers have been appointed Directors, they have been doing as they desire and they do not consult the Architecture Dept. Earlier it was mandatory to consult the Architecture Dept. and nobody could change anything without their consent. All the works used to happen in-house by the Engineering Dept. Now it is tendered out to private contractors and consultants. Engineering Dept. used to do high quality work themselves, but trends have changed now and the quality of work has degraded.

Since you have been associated with the museum from the beginning and for such a long time, what are you recommendations for the betterment of the museum?

I started my career with the museum and retired from here in 2005. I gave my whole life to the museum. It is very funny and you won't believe me when I say that I see the museum even in my dreams. One thing I would like to recommend is that the museum should be expanded. Art purchase is made every year and the collection has increased over the years. However, instead of putting them on display, it has been kept in the store due to shortage of space. Also, the lock system of the main gate should be changed. As far as the security is concerned, the grill shall not be removed because in today's world there are high chances of criminal activities. Right from the beginning, we all have faced the problem of high temperature inside the museum, especially the third level. It was very hard for us to sit here in the summers. So we always wished there was air conditioning in the building.

A.5 Oral History Records of Mr. Janak Raj, Museum Caretaker

Since when have you been associated with the Govt. Museum and Art gallery and in what capacity?

I joined the museum as a "*chaukidaar*" (Guard) on 4th September 1986. The post of "*chaukidaar*" is such that he has to become a caretaker after 5.00pm. Especially at the museum he has to take care and guard the invaluable things kept in the building. I do my duty with full dedication and I remember where each and every artefact has been placed in the museum.

What changes do you see have been made in the museum over time?

The sitting area in the reception is still the same but there was no souvenir shop here. There were a few books related to the museum which were sold on the reception table itself. The metal grill against the windows of the ground floor were added after I joined the museum. It was added around the year 1990 as far as I can remember, which is almost 20 years after the theft. Prior to this, the grill was already added in the windows of first floor. For the skylight, double grills have been installed both on the inside and outside. Earlier it was a single layer, the second one was added later in 2004. This has made the cleaning or changing of the glass difficult. There are some broken glass panes, but it is impossible to replace it with the grill in place. There were no curtains against the ground floor windows, giving a clear view of the outside. These curtains have been added recently in 2002 -03. There was no office for the curator behind the reception. Instead it was an empty space which was meant for the projectionist to sit and he was provided with a storage cupboard. A temporary partition with a steel door was put to enclose the space.

What changes were done to the toilets and the reception area?

The flooring was terrazzo tile initially. Later it was changed twice, first in 2000-01 and later it was renovated again in 2016 when the exhibition of fossils was put up. The French President and Indian Prime minister visited the exhibition. During the same time, the false ceiling in the Curator's office near the toilet block was done. The toilets had one wash basin each and two WC's. The Gent's toilet had the same no. of urinals as now. This shaft in the reception area was painted white in 1989 when an exhibition was put up by the Post Office Dept. The reception area was also used for the exhibition, so the shaft and walls were painted white to suit the exhibition setup. There used to be a passage adjacent to the mural as my seniors used to tell me, but I have never seen it opened. However, it may have been permanently closed after the theft. The aluminium-glass door at the entrance to the central gallery was added in 2000. It was installed to prevent the birds from entering the galleries.

What changes were done here in the central gallery?

The lights above the windows were added around 1998. There used be blinds here installed in 2000, which were recently replaced with curtains in 2016. The hanging lights have been here before I joined the museum. The partition near the staircase going to the terrace was added in 2002 and the furniture store was made in 2004-05. Earlier the light used to come in from the glazing and one could look outside from within the gallery. All the furniture in the store is the damaged furniture of the galleries. This gallery used to have three to four tall embroidered wall hangings which were suspended from the ceiling between the columns. The door leading towards the child art gallery was already closed before I joined here. The child art gallery was made in 2006. The display was different earlier. There used to be stone pedestals and sculptures in this gallery or wooden pedestals for other lighter artefacts. Later the display was changed when Governor Jacob came in 1995-96. Everything was encased in box type display units.

How often were the interior walls painted in the museum?

Earlier the white wash on the walls was redone every 3 years. But, now it's not done regularly. It has been almost 6 years now since the walls were painted last. Similarly the coloured walls in the upper galleries also have been painted many times, however the colour has been kept the same as original. Even the ceiling panels have been painted twice under my watch. The mechanical ladder from the Electrical Dept. was used for painting these high walls and ceilings.

What routine was practiced to close the museum when you joined the museum?

The same routine was performed as it is practiced now. But instead of an electric bell, a hand held bell was rung at 4.30 pm, which meant that the visitors had another 10 minutes left. Then a second bell was rung at 4.40 pm and the receptionist along with the curator and care taker took a round of the galleries to thoroughly check everything. At 5.00 pm all the staff members gathered outside and the main door was locked and sealed with the stamp of the museum in-charge. The electric bell was installed in 1994 or 1996, I don't remember exactly.

What changes have been made to the metal gallery?

The CCTV cameras were firstly installed in 1995 or 96 but they were quite less in number. Then in 1998 the number was increased. There were no cameras outside the building but only in the galleries. The wiring and conduiting along the ceiling was done for the CCTV cameras. Earlier there was only one conduit clamped to the ceiling but, in 2008-09 the system was upgraded and more conduits were added. The big switches and the track lights were installed in 1997-98 and they have been repaired and replaced a few times. The hanging metal light fixtures are original design. The collapsible doors were also added later after my joining.

When was the air conditioning of the miniature gallery done?

The AC plant was installed in the miniature gallery under my watch in the year 2000 or 2002. The false ceiling height was reduced to accommodate the HVAC ducts. During the same time, the aluminium-glass partition was also added to enclose the miniature painting gallery. The AC unit was installed in the third level above the miniature painting gallery. These pipes from the AC plant go to the cooling unit in the extended block near guard’s room. To accommodate these vents the ceiling was punctured and they go down into the front corridor space.

The Holy Scriptures that are kept at the third level now, where were they kept earlier?

The holy scriptures of Sikh religion were on display in the Natural History Museum. Later it was brought to the main museum and kept in the room on the third level which was earlier the office for museum staff. This room was not being used as the office was shifted to the City Museum after the theft took place. The room was initially meant to be used by the Director, but it was used by the Curator and Assistant Curator. I never saw that room being used as an office since I joined.

What was the original plan of lighting in the museum?

The lights running along the ceiling panels had a plastic jaali covering which broke and fell down due to pigeons hitting against them. Then it was changed with translucent plastic sheets which can be still be seen in the Holy Scripture room. But, that too didn’t prove to be durable enough. Much later, the complete fixture was changed with one that had metal grating.

Do you have any information about the structure of the building?

I have been told by my seniors who worked here during the construction of the buildings, that the foundation of this museum is as deep as half the height of the building above ground.

Was the cafeteria functioning when you joined the museum? Do you have any memories of the cafeteria?

The canteen had wooden furniture and metal folding chairs. There was a big counter made in concrete and finished in terrazzo. Later, it was converted into the child art gallery by making wooden partitions. AC plant next to the guard’s room was installed recently in 2008-09. To accommodate the AC plant the open veranda was enclosed with a brick wall. Only the guard room was originally enclosed, rest of it was open from the northern side. The entrance to the guard room was through the covered veranda where the AC plant has been placed. The glazing of the cafeteria and the verandah in the extended block had space in between to cross by, so that all three verandas around the cafeteria were connected.

When was the terrace waterproofing repaired or changed?

It has been repaired several times under my watch and I remember it was last done in 2008-09.

What about the toilets near the temporary exhibition area?

Those toilets were already there when I joined the museum. The original toilets behind them were not being used at the time, since they were too small. Their access was through the secured area in front of the reserve collection area, so they had to be closed down. They were never meant for the public use. The newer toilets have also been renovated twice during my term here at the Museum.

When was the conservation lab setup in the museum?

The conservation lab was made in the year 1987 or 88, just a couple of years after I joined. Earlier the entire space was an exhibition hall. There was also a toilet in that area, where the photo lab has been setup now. It was meant for the visitors of the exhibition area.

What can you tell about the cooling system under the auditorium?

The cooling system used to work when I joined here. There were big machines in the basement which used to run with a belt and roll system. The water tank was connected to it and water came in with pressure and cooled the air. Even the AC plant for the reserve collection used to be the same mechanism. Later with newer technology, the updated machines have been placed in the same spaces now.

Was the lift ever used during your time?

I have never seen the lift being used. But, I have been told by senior employees that it was used to bring the sculptures to the upper floor galleries.

What recommendations do you have for the functioning of the Museum and any other changes?

Firstly, the issue of maintenance is to be noted. For example, the pedestals for the sculptures have never been painted or cleaned on my watch. The security of the museum is very poor and it needs to be improved as per international standards. Basic systems like metal detectors, general security-check of visitors should be done. A cloak room should be provided for the bags and luggage of the visitors. All this should be provided outside at the entrance veranda. The CCTV system is very poor and unreliable. Infrared cameras should be installed for surveillance during the night also.

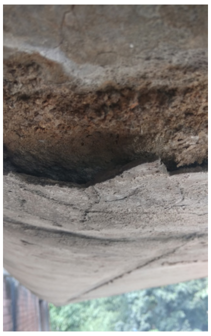
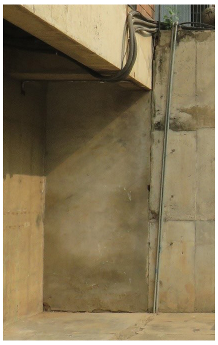
The number of permanent staff is also decreasing every year, who are a major support for the management of the museum. Positions are not being filled at the moment. Temporary staff cannot develop a sense of ownership and responsibility towards the museum unlike a permanent staff. This museum is a place of national importance and we have visitors visiting from world over on a daily basis. But there is no place for them to sit, relax or to have some refreshment in the museum complex. Moreover there is no basic facility like drinking water available here. One has to drink water from a tap near the boundary wall, which is an embarrassment for the visitors and staff both. Even the toilets do not match the standard of the museum. The toilets are not clean most of the time and they always stink. The cycle stand can be used as a cafeteria, because it is being used as a scrap dump. It can also house a public toilet and a souvenir shop.

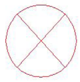
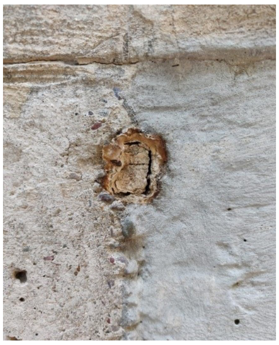
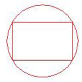
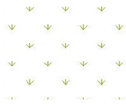
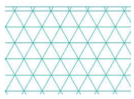
ANNEXURE
B: Assessments and Material Testing

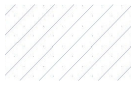
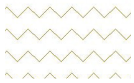
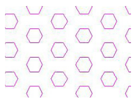
B.1 Glossary of Conditions for Building Assessment

B.1.1 Glossary of Condition for Exterior Concrete

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
MAJOR CRACKS		Condition resulting from separation of one part from another, more than 4 mm wide.	
MODERATE CRACKS		Surface cracks / prominent cracks which may become severe in the future	
EXPOSED REBAR	 	Reinforcement bars visible due to loss of cover, possibly due to deterioration of surface.	
LOSS OF MATERIAL		Loss of concrete material creating a void, either by erosion , water or mechanical damage	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
SPALLING	 	Loss of cohesion resulting in separation from the base.	
PAST REPAIRS AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *(Patch filling due to loss of material or filling of cracks or pointing)*	
PAST INTERVENTIONS (NEW ADDITION)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions Addition of railings, panels, partitions, etc.	
BIRD DROPPINGS		Deposits of bird droppings	
INFESTATION		Insect nests (yellow wasps, termites , beehives	

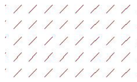
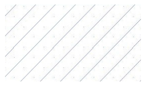
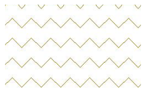
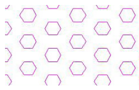
CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
EXPOSED METAL ANCHORS / NAILS/ CLAMPS	 	Presence of screws, nails, rods or metal anchors on concrete wall surface	
WOOD INSERTS		Presence of wooden pegs in holes on concrete wall surface	
BIO GROWTH		Presence of micro-organisms such as bacteria, algae, fungi and lichen On concrete surface	
VEGETATION		Growth of small vegetation plants with roots penetrating into structure	
SURFACE DETERIORATION		Surface erosion or loss of original finished surface. Areas with exposed coarse aggregate missing binding material	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
SOILING		Accumulation of materials including dirt on the surface due to action of water, pollution or any other external factors. Dry/ inactive algae leaving black stains.	
RUST STAINS	 	Reddish brown stains due to presence of iron oxides	
SEEPAGE/ DAMP PATCHES/ WATER STAINS		Active ingress of water in the form of stains (dry / active)	
EFFLORESCENCE		Presence of whitish, powdery substance on the surface composed of salts.	
DEPOSITS		Accumulation of extrinsic material on concrete surface, like paint, cement splashes, residues from repairs, graffiti	

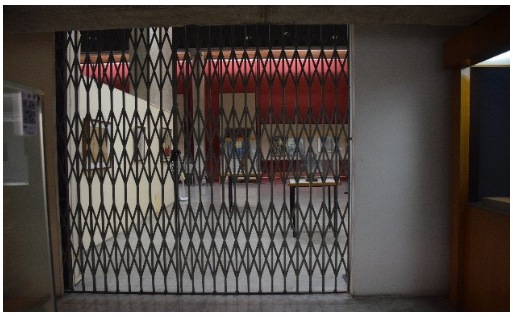
B.1.2 Glossary of Condition for Exterior Brick Tiles

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
EXPOSED REBAR		Reinforcement bars visible due to loss of cover, possibly due to deterioration of surface.	
DAMAGED BRICKS		Damage due to mechanical action or impact	
OPEN JOINTS		Loss of pointing mortar from the joints	
DETACHMENT		Loss of cohesion resulting in separation of material from its base.	
DEFORMATION OR DISPLACEMENT (out of plumb)		Slight shift or change of brick tile from its original location	+ -

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
PAST REPAIR AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *(Patch filling due to loss of material or filling of cracks or pointing)*	
EXPOSED METAL ANCHORS / NAILS/ CLAMPS		Presence of screws, nails, rods or metal anchors on concrete wall surface	
BIO GROWTH		Presence of micro-organisms such as bacteria, algae, fungi and lichen.	
SOILING/ staining (all black stains)		Accumulation of materials including dirt on the surface due to action of water, pollution or any other external factors. Dry/ inactive algae leaving black stains.	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DISCOLORATION		Change in original color of material due to weathering or change in composition of material	
SEEPAGE		Active ingress of water in form of stains (dry / active)	
EFFLORESCENCE		Presence of whitish, powdery substance on the surface composed of salts.	
DEPOSITS		Accumulation of extrinsic material like paint & cement splashes, residues from repairs	

B.1.3 Glossary of Condition for Metal

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DAMAGED MATERIAL	 	Damaged due to mechanical action or impact. Dents and bulges on metal surface.	
PAST REPAIRS AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *[Welded joints between metal door panels]*	
PAST INTERVENTIONS (NEW MATERIAL)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions. Addition of grills, wire mesh on doors and windows and addition of collapsible door to create partition.	
BIRD DROPPINGS		Deposits of bird droppings	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
LOSS OF FINISH		Loss of paint, polish and exposing the inner layer due to mechanical damage, scratches, wear and weathering	
RUST STAINS		Reddish brown stains due presence of iron oxides	
DEPOSITS		Accumulation of extrinsic material like paint, seal wax and cement splashes, residues from repairs, graffiti	

B.1.4 Glossary of Condition for Terrazzo

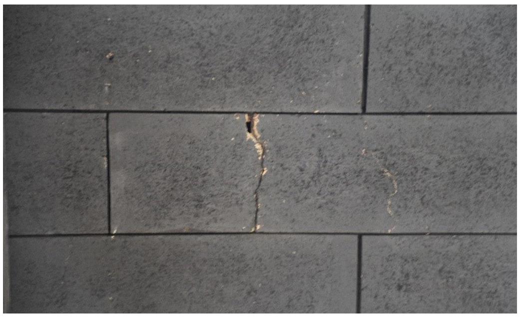
CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
MODERATE CRACK		Surface cracks / prominent cracks which may become severe in the future	
LOSS OF MATERIAL		Loss of compositional material creating a void, either by erosion , water or mechanical damage *[Loss of grid pattern in terrazzo tile on ramp making its surface flat]*	
DAMAGED MATERIAL		Damaged due to mechanical action or impact	
OPEN JOINT		Loss of pointing mortar between the joints	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DETACHMENT		Loss of cohesion resulting in separation of material from its base.	
PAST REPAIRS AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *(Addition of similar tiles with different composition of material)*	
PAST INTERVENTIONS (NEW MATERIAL)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions *[Addition of new tiles in child art gallery]*	
SURFACE DETERIORATION		Surface erosion or loss of original finished surface.	
SOILING		Generally, accumulation of materials including dirt on the surface due to action of water, pollution or any other external factors	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
RUST STAINS		Reddish brown stains due to presence of iron oxides	
SEEPAGE/ DAMP PATCHES/ WATER STAINS		Active ingress of water in form of stains (dry / active)	
DEPOSITS		Accumulation of extrinsic material like paint, seal wax and cement splashes, residues from repairs, graffiti	

B.1.5 Glossary of Condition for Fibreboard

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
LOSS OF MATERIAL		Loss of compositional material creating a void, either by erosion , water or mechanical damage	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DAMAGED MATERIAL		Damaged due to mechanical action or impact	
DEFORMATION/ DISPLACEMENT/ DISLODGED		Slight shift or change of fiberboard panel from its original location *[Sagging fiberboard panels]*	+ -
PAST REPAIRS AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *(Addition of ply board instead of fibreboard panel)*	
PAST INTERVENTIONS (NEW MATERIAL)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions *[Addition of new fibreboard for installation of air conditioners]*	
SEEPAGE/ DAMP PATCHES/ WATER STAINS		Active ingress of water in form of stains (dry/ active)	

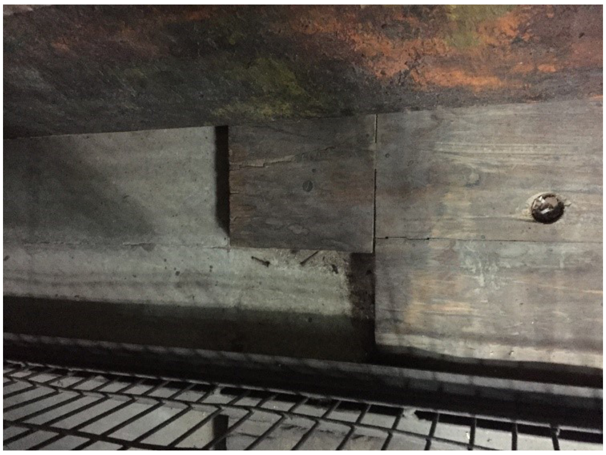
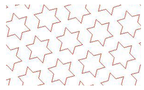
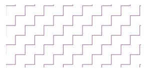
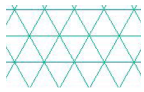
CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
EFFLOROSENCE		Presence of whitish, powdery substance on the surface composed of salts.	

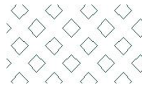
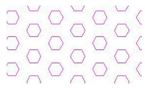
B.1.6 Glossary of Condition for Glass

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DAMAGED MATERIAL	 	Damaged due to mechanical action or impact *[Cracked or broken glass]*	
MISSING MATERIAL		Missing glass panes	
OPEN JOINT		Loss of pointing mortar from the joints *[Loss of putty around glass panes]*	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
DEFORMATION/ DISPLACEMENT/ DISLODGED		Slight shift or change of brick tile from its original location	+ -
PAST REPAIRS AND MAINTENANCE		Interventions undertaken in the past to repair or modify that have altered original character and are sometimes carried out with incompatible materials *(Addition of clear glass instead of tinted glass)*	
PAST INTERVENTIONS (NEW MATERIAL)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions *[Addition of new glass in undulatory windows]*	
BIRD DROPPINGS		Deposits of bird droppings	
DEPOSITS		Accumulation of extrinsic material like paint and cement splashes, residues from repairs, graffiti	

B.1.7 Glossary of Condition for Wood

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
LOSS OF MATERIAL		Loss of compositional material creating a void, either by erosion , water or mechanical damage	
DAMAGED MATERIAL		Damaged due to mechanical action or impact *[cracked or broken wooden door shutters]*	
DPAST INTERVENTIONS (NEW MATERIAL)		Addition of new material to replace original. May include demolition/ removal of original to incorporate new additions *[Addition of new wooden casing around staircase railing]*	
SURFACE DETERIORATION		Surface erosion or loss of original finished surface	

CONDITIONS	REPRESENTATIVE PHOTO	DEFINITION	LEGEND
LOSS OF FINISH		Loss of paint, polish and exposing the inner layer	
DEPOSITS		Accumulation of extrinsic material like paint and cement splashes, residues from repairs, graffiti	

B.2 Sample Location for Material Testing

Sample for testing of white terrazzo was extracted from the Miniature art gallery on the first floor. The black terrazzo sample was taken from the main staircase leading to the terrace. A fibreboard ceiling panel which had been removed previously during repair work was taken as sample for testing.

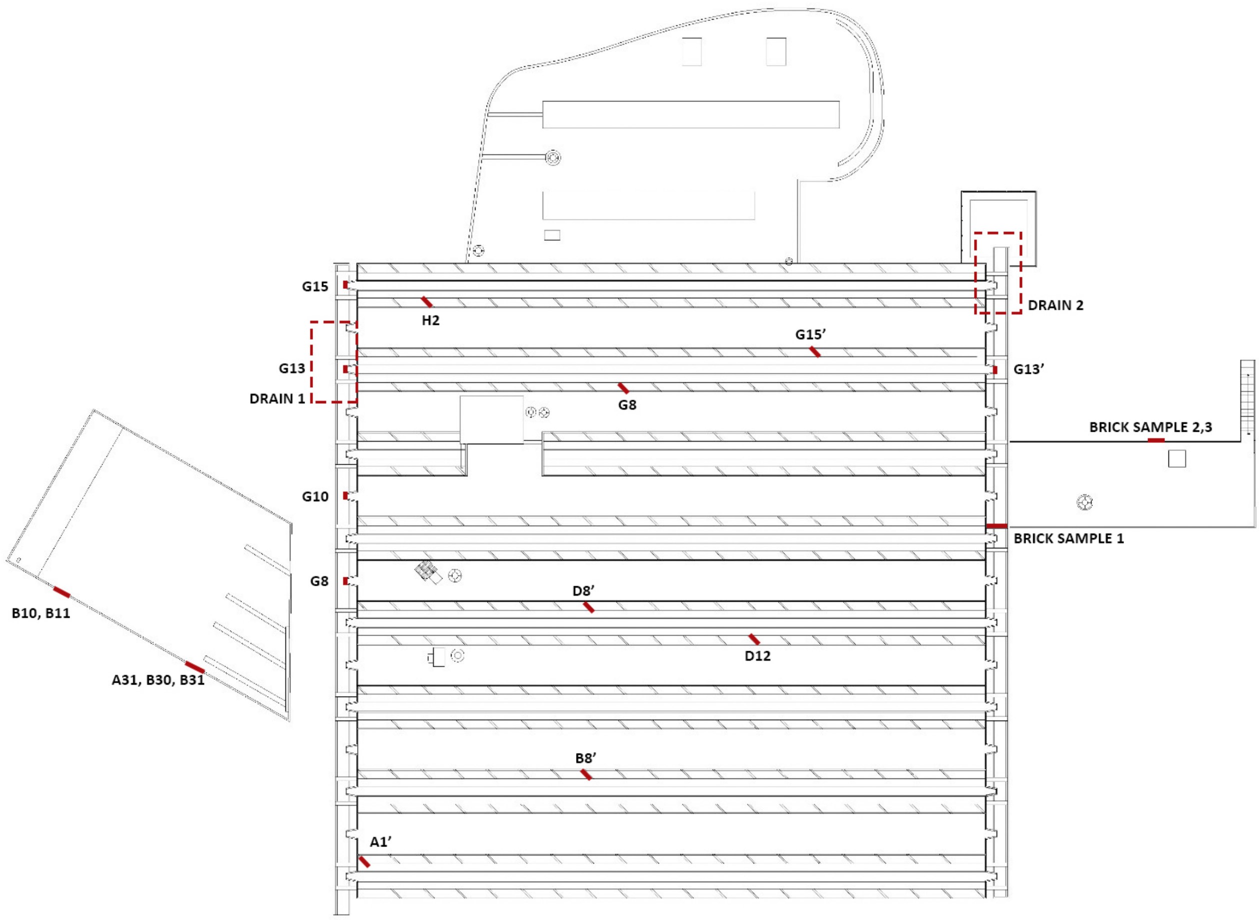


Fig. 231: Sample location for material testing of Concrete and Brick - Terrace level

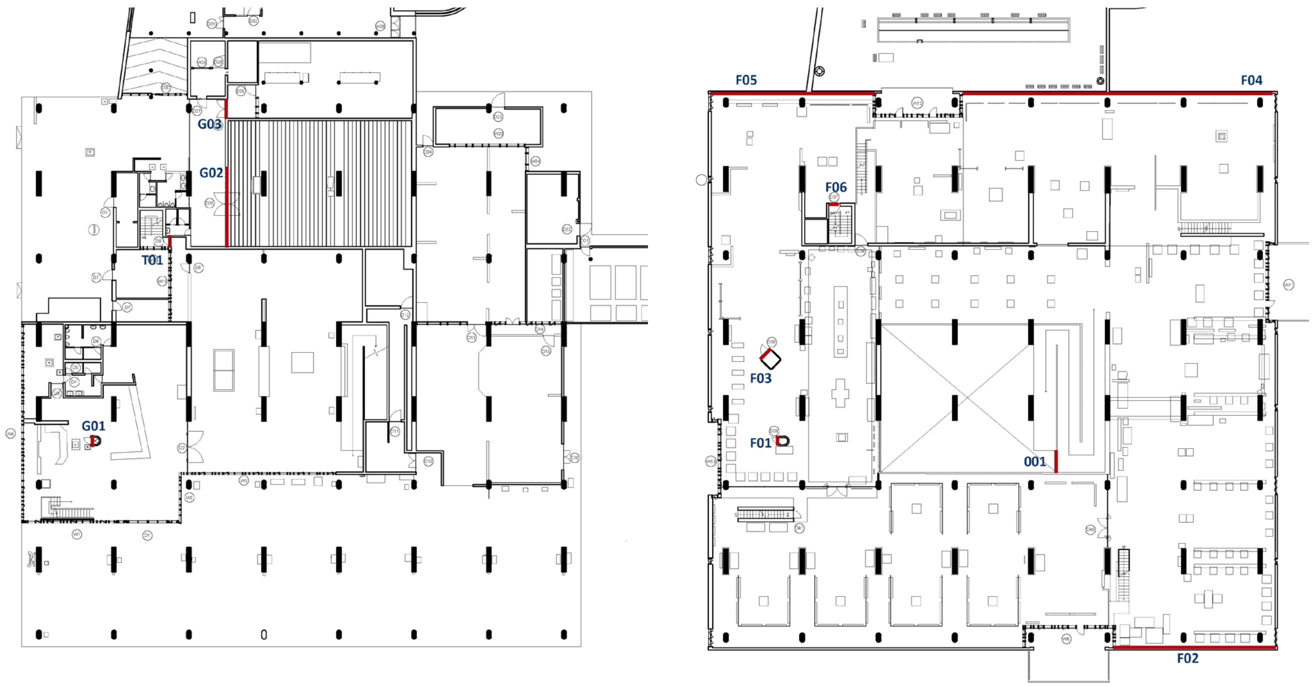


Fig. 232: Sample location for material testing of Paint - Ground Floor (L); First Floor (R)

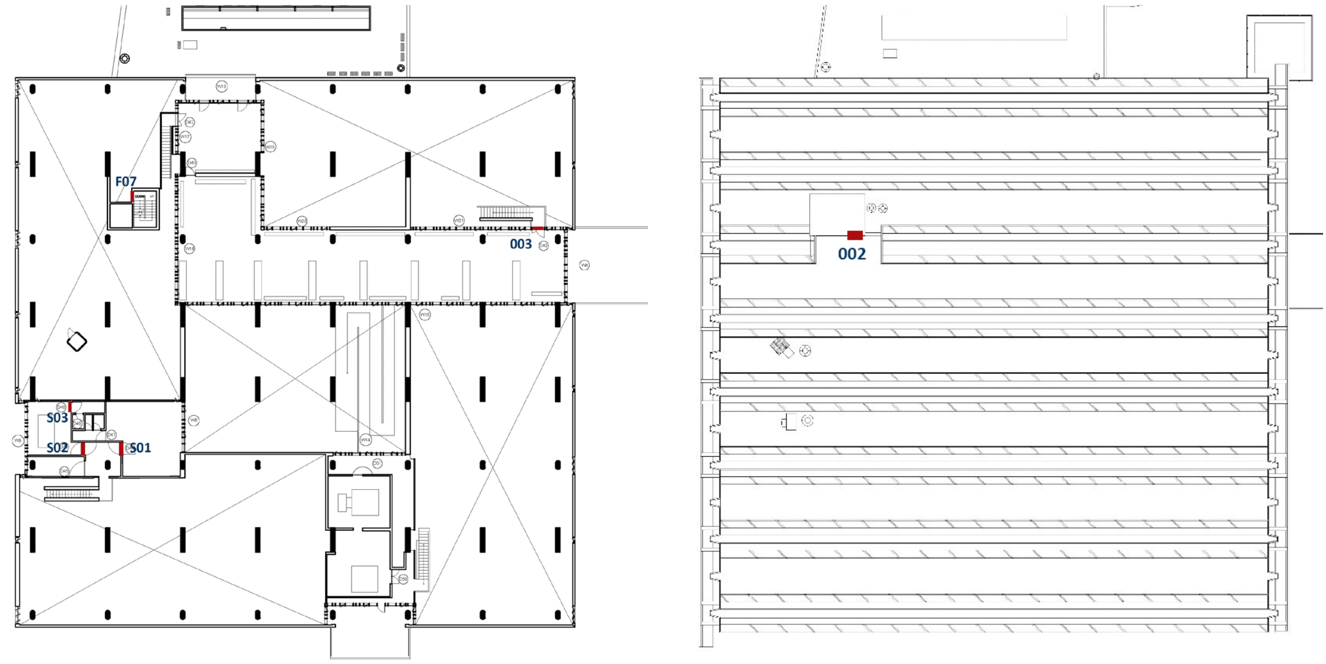


Fig. 233: Sample location for material testing of Paint - Second Floor (L); Terrace Level (R)

B.3 Schedule of Material Tests

B.3.1 Tests for Concrete

Sampling of concrete to be done using:
ASTM C1324: Standard Test Method for Examination and Analysis of Hardened Masonry Mortar.

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
1.	Core cutting	Chloride, sulphates, Compressive strength, ratio test, carbonation.	Minimum 3" dia. cylindrical core	Clerestory Fin H2, G15', G8	3
2.	Compressive strength : Rebound hammer	To determine the compressive strength	IS 13311.1.1992; IS 13311.2.1992	Clerestory Fin -H2, G15',G8 South-West Façade of Auditorium wall -Panel No. B31,B30,A31,B10,B11 Gargoyle -G10, G13, G15 Drain outer wall near G13, Drain floor edge near G15’	13
3.	Phenolphthalein test	Carbonation depth	No standards	Clerestory Fin -H2, G15', G8, D12, A1’,D8’, B8’ Gargoyle -G8,G13,G13’ South-West Façade of Auditorium wall -Panel No. B31,B30,A31,B10,B11	15
4.	Chemical Analysis	Chloride & Sulphates concentration	RILEM TC 178-TMC	Clerestory Fin -H2, G15', G8, D12, A1’,D8’, B8’ Gargoyle -G8,G13,G13’	10

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
5.	Depth of cover	To determine the depth of cover or location of rebar	No standards	South-West Façade of Auditorium wall -Panel No. B31, B30, B11 Clerestory Fin -H2, G15', G8 5 other random locations	11
6.	Ratio analysis	Composition of the concrete and type and content of cement		Clerestory Fin -H2, G15', G8, D12, A1’,D8’, B8’ Gargoyle -G8, G13, G13’ South-West Façade of Auditorium wall- Panel No. B31, B30, A31, B10, B11	15

B.3.2 Tests for Brick Tiles

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
	Brick removal			South-East Facade above extension block North-East Facade of guard room	2
1.	FESEM/EDS	To study composition, type and constituents		Brick sample 1,2	
2.	Metal detector	Distribution of metal strips	No standards	3 sample areas on South east facade 1 sample areas on South west facade	4

B.3.3 Tests for Terrazzo

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
	Terrazzo removal			White terrazzo (WT): First floor – Miniature paintings gallery floor tile Black terrazzo (BT) : Service staircase flooring	1 each
1.	FESEM/EDS	To study composition, type and constituents		WT1, BT1	
2.	XRD	To study composition, type and constituents		WT1	

B.3.4 Tests for Fibre Board

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
1.	Light microscopy (LM) & Polarized light microscopy (PLM).	Study of composition and structure			1

B.3.5 Tests for Paint Analysis

S.NO.	TEST	PURPOSE	STANDARD	SAMPLES LOCATION	NO. OF SAMPLES
1.	Stratigraphy	Cross sectional analysis of paint layers			17

B.4 Material Test Results

B.4.1 The report of the tests conducted by Absolute Testing and Consultants is below:

REPORT OF CONDITION ASSESSMENT

REBOUND HAMMER, ULTRASONIC PULSE VELOCITY TESTS, FERROSCANNING, CARBONATION AND CHEMICAL ANALYSIS
FOR

Government Museum and Art Gallery, Chandigarh

ABSOLUTE TESTING & CONSULTANTS

1. INTRODUCTION

There is Government Museum and Art Gallery, Chandigarh at sector 10 Chandigarh. The building was completed approximately in 1968. Absolute Testing & Consultants has given the work to conduct non destructive testing of concrete element along with condition survey to assess the quality of concrete by using non destructive testing methods ie ultrasonic technique and Hammer rebound method. The details of reinforcement were obtained by using Ferro scanning and Carbonation Test was conducted with Phenolphthalein based rainbow indicator. The visual examination was carried to find out/ locate the dampness, cracks and other defects in the buildings. The Building is multi-storied frame structure. The general health of building is good.

1.1 Objective

The study involves determination of in-situ strength of building under investigation. The buildings are being used for museum purposes.

The specific objectives of the study are to know:
- The present strength of concrete.
- The present quality of concrete.
- Visual inspection

NDT tests to assess the quality of concrete structures.
- To assess the existing quality and allowable characteristic strength of concrete elements, so that the same can be utilized for overall structural safety appraisal of the structure if required.
- To diagnose the causes of the distress so as to undertake suitable remedial measures for rehabilitation of the structure taking account of the causes

2. ASSESSMENT OF INTEGRITY OF STRUCTURES

Despite the high durability of concrete as construction material, there are occasions when a structure shows signs of deterioration. Damage may occur from a variety of causes: accidental overloading, foundation settlement, or (construction faults / poor detailing) poor workmanship. An even more common cause of damage is corrosion of reinforcement, which leads to cracking and spalling of the concrete cover.

Concrete structures that are in use under severe conditions need to be specifically inspected to determine the extent of damage and assess Integrity of structures. Several techniques and methods are available for assessing the condition of such structures.

The first step in successful integrating testing is to carry out a thorough investigation. It is essential to determine if the major portion of the structure is of suitable quality. In addition, knowledge of the intensity and extent of damage is required for executing an appropriate repair scheme. The aim of the investigation should be:

- ♦ To identify the cause of the damage and the source of the problem;
- ♦ To determine the extent of damage;
- ♦ To determine material properties;
- ♦ To assess the safety and serviceability of the structure;
- ♦ To provide recommendations on remedial and preventive measures;

- To estimate the cost of repair or replacement.

A typical investigation involves the following processes:-

- Inspecting the site, with special attention to potential safety hazards;
- Studying the design, construction details, and loading history of the structure;
- Planning a condition survey;
- Executing the condition survey;
- Laboratory testing of material samples secured from the structure;
- Analyzing and interpreting the acquired data;
- Load testing individual members, if necessary.

The different methods for inspecting concrete structures may be simply classified as:

- Visual
- Mechanical / physical inspection
- Chemical analysis, and
- Electrochemical testing

2.1 Initial Visual Inspection

Visual examination is the starting point of inspection. Cracks, rust staining, and spalling are the most obvious defects which can be identified. Often the location of these can give a good indication of the cause of the problem, but an open mind must be kept at this stage until further investigation is undertaken to confirm the root cause. If visual inspection of a structure suggests that a problem may be present, an in-depth examination should be carried out.

The purpose of the site inspection is to identify the type and age of construction, gravity and lateral load resisting systems, and to make a preliminary assessment of the existing condition of the structure. Visual defects may be related to poor workmanship or material deterioration. These show up as excessive deflection and flexural cracking, while foundation movements may cause diagonal cracks. Material deterioration is normally indicated by cracking and spalling. It is particularly important to differentiate between the various types of cracks found. Examination of crack patterns often suggests the most probable cause of the problem.

Access facilities are usually minimal, so the extent of examination is limited. Hammer- tapping (to locate hollowness or delamination), and the use of the Schmidt Hammer, cover meter, or crack width gauge are often helpful. Potential problems associated with cracking, excessive deflections, water permeability, and evidence of corrosion should be specially noted. By observing the site and examining pertinent drawings and records, the probable causes of damage are deduced, and the areas of serious concern are located. It is often possible to judge whether the damage is corrosion related and this is useful in planning the subsequent detailed survey.

2.2 Condition Survey

The purpose of the survey is to collect sufficient data to pinpoint the cause and source of the problem and to determine the extent of the damage. Depending on the probable cause of the damage, the site work involves a combination of the following processes:

- Detailed visual inspection;
- Survey of cracks, spalls, steel pitting and other defects;
- Potential mapping with half cell potentiometer, or similar instrument, that identifies zones of high corrosion risk;
- Drilling holes or mini-cores for carbonation test and chloride content analysis;
- Coring of concrete for determination of strength and petrography examination;
- Measurement of concrete cover and reinforcing bar spacing with cover meter;
- Schmidt hammer test for Delamination or compressive strength (comparison only);
- Ultrasonic test for honeycombing depth of cracks, or compressive strength (comparison only);
- Assessment of depth of discoloration (in the damage) with hammer and chisel.

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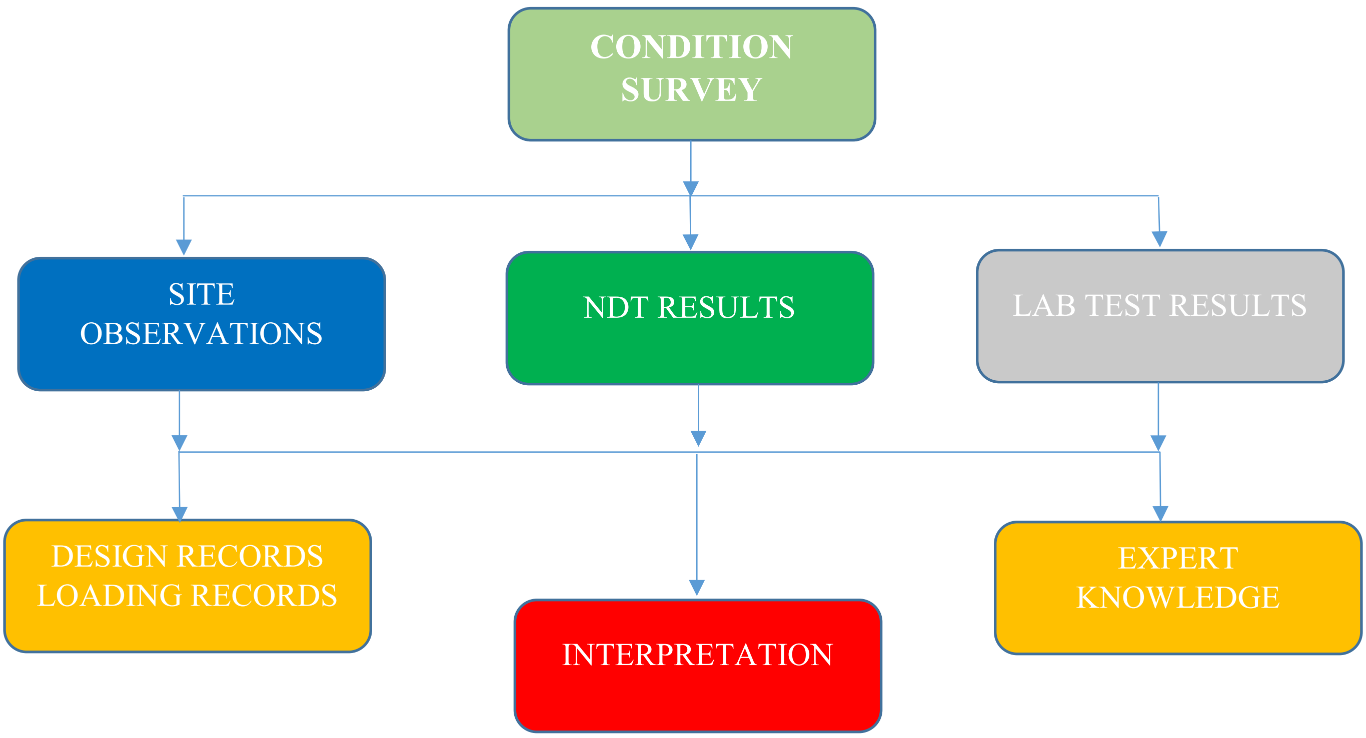


2.3 Physical and Mechanical Inspection

This comprises of a series of tests conducted physically on the structure to assess its condition. This covers the range of nondestructive tests and semi destructive tests, conducted in-situ. The various tests conducted are as follows:

(a) Simple Hammer

A simple hammer can be effectively utilized to get an idea about the nature and extent of damage in a distressed structure. The sound heard on tapping the surface indicates the qualitative nature. A metallic sound indicates undamaged area while a dull thud indicates delaminated areas. This simple instrument can throw light on the following aspects:

- Delamination of cover concrete
- Presence of honeycombs
- Sulphate attack

(b) Strength tests

The strength, integrity of concrete, presence of cracks and delamination are determined by the following tests.

(i) Rebound Hammer Test:-

Purpose:-

This test gives a measure of the surface hardness of the concrete surface. Although there is no direct relationship between this measurement of surface hardness and strength, an empirical relationship exists.

Rebound hammer is the best known methods of comparing the concrete in different parts of a structure and indirectly assessing concrete strength. The rebound hammer should be considered as a means of assessing variations of strength within a structure rather than an accurate means of assessing the strength.

Objective of testing:-

Rebound hammer test is performed to determine the following:

a. Surface hardness
b. Uniformity of concrete over the structure
c. Grade of concrete
d. Estimated strength which is derived from establishing a relationship between in-situ core strength and rebound number.

References:-

- ✓ BS 6089:1981 and BS 1881:Part 202,
- ✓ IS13311(Part2):1992
- ✓ ASTM C 805-02

Influencing factors:-

Rebound hammer test results are considerably influenced by these factors:

- ✓ Size, shape and rigidity of the specimen
- ✓ Age of test specimen
- ✓ Smoothness of surface and internal moisture condition of the concrete
- ✓ Carbonation of concrete surface

Testing Method:-

According to ASTM C 805-02 clause 7.1 the concrete members to be tested shall be at least 100mm thick and fixed within a structure. Towelled surfaces generally exhibit high rebound numbers than screed or formed finishes. Do not compare the test results if the form material against which the concrete is placed is not similar.

Heavily textured, soft or surfaces with loose mortar shall be ground flat with abrasive stone. Smooth formed or towelled surfaces do not have to be ground prior to testing.

Also this test is not conducted directly over the reinforcing bars having cover less than 20mm. The surface under test should be clean and smooth because rough surfaces cannot be tested as they do not give reliable results. Dirt or other loose material on the surface can be removed using a grinding stone prior to test

(ii) Ultrasonic Pulse Velocity Tests

2.1 Ultrasonic Pulse Velocity

Purpose

Although there is no fundamental relationship between pulse velocity and strength, an estimation of strength can be obtained by correlation. The method has perhaps a greater potential for comparing known sound concrete with affected concrete.

Ultrasonic pulse velocity is a means of assessing variations in the apparent strength of concrete.

The quality gradation of concrete can be appraised at best qualitatively as `excellent', `good', `medium' or `doubtful'. The meanings of the term `excellent', `good', `medium' and `doubtful' are based on ultra sonic pulse velocity measured at site and are as per the nomenclature of IS 13311(part-1): 1992.

Objective of testing:-

Ultrasonic pulse velocity test is used to establish the following:

- ✓ Homogeneity of concrete
- ✓ Presence of cracks voids, honeycombing and other imperfections
- ✓ Changes in the structure of concrete which may occur with time.
- ✓ Quality of one element of concrete in relation to another i.e. comparative quality analysis and gradation of concrete.
- ✓ The values of dynamic elastic modulus of the concrete.

References:-

- ✓ BS 6089:1981 and BS 1881:Part203
- ✓ IS 13311:Part1:1992
- ✓ ASTM: C597-83.

Influencing factors:-

The velocity of a pulse of ultrasonic energy in concrete is influenced by the stiffness and mechanical strength of the concrete

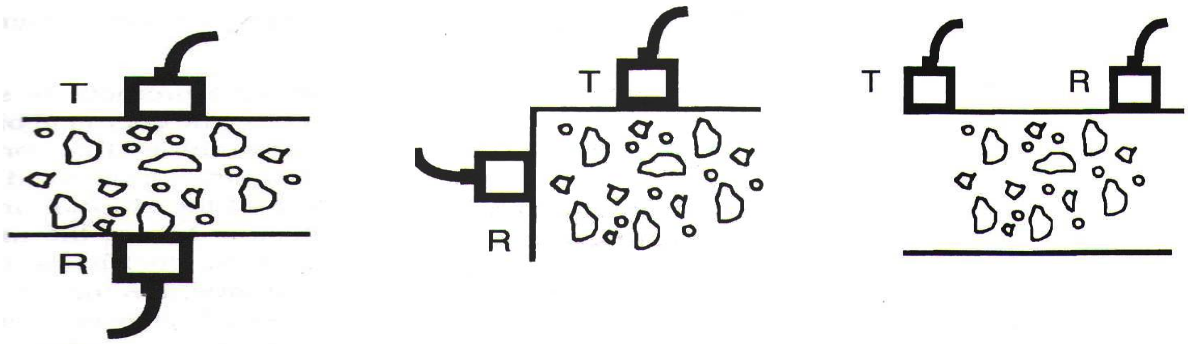
- ✓ Moisture content: The moisture content of the concrete have a small effect in the velocity and can increase the pulse velocity by 2%.
- ✓ Surface condition: The testing surface should be smooth any roughness cannot provide reliable readings because of gap between transducers and testing surface.
- ✓ **Temperature:** Ideal Temperature is between 5^0C and 30^0C; Temperature between 30^0C to 60^0C can reduce the pulse velocity up to 5%; below freezing temperature results in an increase the pulse velocity up to 7.5%.
- ✓ Stress: When concrete is subjected to a stress which is abnormally high for a quality of concrete, the pulse velocity may be reduced due to development of micro-cracks.
- ✓ Reinforcing bars: The velocity measured in reinforced concrete in the vicinity of reinforcing bars is usually higher than in plain concrete because pulse velocity in steel is 1.2-1.9 times the velocity in plain concrete. Wherever possible, measurements should be made in such a way that steel does not lie in the path of the pulse.

Testing method:-

According to IS 13311(Part1):1992 clause 5.2 transducers with a frequency of 50 to 60 kHz are useful for most all round applications, and as per IS 13311(Part1):1992 clause 6.2 the path length should be long enough not to be significantly influenced by the heterogeneous nature of concrete. This test requires a flat surface generally only appropriate for un-spalled surfaces.

In view of inherent variability in the test results, sufficient number of readings should be taken by dividing the entire structure in suitable grid of markings 30x30 cm or even smaller. Each junction point of the grid becomes a point of observation.

There are three possible methods of testing according to the type of surface:



(a) Direct measurement (c) Semi-direct measurement (b) Indirect measurement

Table 1: Velocity Criterion for Concrete Quality Grading
[Ref: IS13311 (part-1)]

Sr. No.	USPV by Cross Probing (km/sec)	Concrete Quality Grading.
1.	**Above 4.5**	**Excellent**

2.	**3.5 - 4.5**	**Good**
3.	**3.0 - 3.5**	**Medium**
4.	**Below 3.0**	**Doubtful**

TABLE - 2
IDENTIFICATION OF CORROSION PRONE LOCATIONS BASED ON UPV AND HAMMER READINGS (IS: 13311 PART 1: 1992)

S.No	Test Result	Interpretation
1.	High UPV values, high impact hammer number	Not corrosion prone
2.	Medium range UPV values, low impact	Surface delamination, low quality of hammer numbers. Surface concrete corrosion prone
3.	Low UPV high impact hammer numbers	Not corrosion prone, however, to be confirmed by chemical tests, carbonation, pH and Phenolphthalein test values
4.	Low UPV values, low impact hammer numbers	Corrosion prone - requires chemical and electrochemical tests

(iv) The compressive strength of core samples extracted from the RCC members.

Test Procedure for Concrete Core:
Conditions & Calculation for Core Strength

1. The diameter of core size: - The general rule adopted for fixing the core size, besides the H/D ratio, is the nominal size of stone aggregate and the diameter should be not less than 3 times the maximum size of stone aggregate. **Reference ASTM C-42 article clause number 6.1 and part 4 of IS: 1199-1959.**

2. **L/d ratio**: Its value should be minimum 0.95 and maximum 2 (without capping but after trimming). A higher ratio would cause a reduction in strength. L/d of the extracted core after capping should be 1 < L/d <2. Capping size should be 0.5% of core diameter. Capping thickness can't be fixed it depends upon the diameter of the core. **Reference code:- IS 516: 1959 Article clause number 4.3 and ASTM C-42 article clause number 6.1 and 6.5**

3. Drilling operations: The strength of cores is generally less than that of standard cylinders, partly as a consequence of disturbance due to vibrations during drilling operations. It disturbs the microstructure of the concrete core (body centred cubic) so it affects the bonding between aggregate to aggregate (direct strength of concrete). Whatever best precautions are taken during drilling; there is always a risk of slight damage.**Reference code:- ASTM C-42 Article clause number:- 4.1.1**

4. The position of sample: - Core sample should be taken from near the middle of a unit of RCC section. It should not be taken near fronted joint or obvious edge of a unit of deposit. A concrete core taken from cover depth gives very lower strength because it mainly contains cement slurry. **Reference code: - ASTM C- 42 article clause number 4.2**

5. Method of strength calculation: - Apply the compression load over the core sample at140 kg/sq cm/min rate of loading.

A. Cylindrical compressive strength (MPa) = Failure load (kN)/ Loading surface area ($m^2 = \Pi.d^2/4$)
B. Correction factor = IS Code 516:1959 Page no 12 fig 1
C. Equivalent cube strength (MPa) = Cylindrical compressive strength×1.25
D. **Interpretation Methodology and acceptance criteria: -** Concrete construction should be considered structurally adequate if the average of three cores from the questionable region is equal to or exceed the 85% of specified strength as per ACI 318. IS 456: 2000 Sec 17.4.3 provides the below following acceptance criteria for core strength:

Average equivalent cube strength of the core > 85% of Grade of concrete. The least value of individual equivalent cube strength of the core > 75% of Grade of concrete.

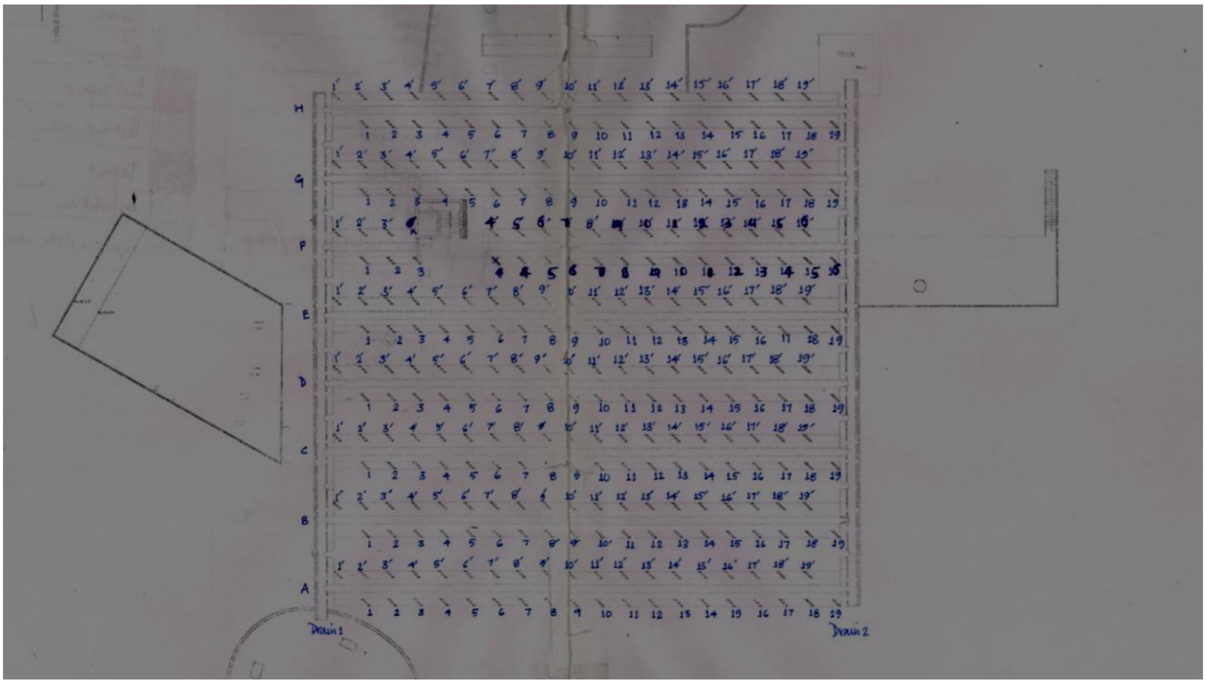


Figure 1 Government Museum and Art Gallery, Chandigarh

(v) Carbonation test

Concrete is alkaline in nature. The pH value of concrete at the time of construction is around 12.5. During the course of time; carbon-di-oxide from external environment enters inside the concrete. Because of the chemical action of carbon-di-oxide on calcium carbonate, the alkaline environment changes to acidic environment. This is one of the necessary conditions for corrosion. This change can be detected by phenolphthalein test. A solution of phenolphthalein in dilute alcohol is usually used because it has a very strong dark blue colour that is easily visible on any kind of concrete surface, which has retained its alkalinity. But it changes its colour on the concrete surface which no longer remains alkaline due to the action of carbon-di-oxide, thus paving the way for the corrosion of steel rebars. The change in colour of phenolphthalein takes place as pH value changes from 12.5 towards lower pH. Once the pH value reduces below 10, passive layer in the rebar is broken. The freshly broken concrete surface is sprayed with phenolphthalein indicator solution. The outer most part of the freshly broken concrete surface will be carbonated and will not be stained. The inner part of concrete will not be carbonated. The boundary of color stain will clearly show how far carbonation has penetrated into the concrete. The position of steel reinforcement at that zone is determined. If carbonation has penetrated up to the steel reinforcement and beyond, the rusting is slow. When concrete is alternatively wet and dry, the steel starts rusting rapidly. In case of salty environment, the change of alkalinity and the presence of chloride fasten the rusting of steel. Measuring the depth of carbonation into the concrete is a test, which can give warning of rusting before serious damage will occur. A rainbow indicator gives the value of pH

TABLE- 3

PH RANGE OF CONCRETE WITH RESPECT TO COLOUR

Sr. No	Colour	pH
1.	orange	5-6
2.	Yellow	7-8
3.	Green	9-10
4.	Violet	11-12
5.	Dark Blue	13

(vi) Chlorides and Sulphate Content Test:

DETERMINATION OF WATER SOLUBLE AND ACID SOLUBLE CHLORIDES IN HARDENED CONCRETE

INTRODUCTION:

Whenever there is chloride in concrete there is an increased risk of corrosion of embedded metal. The higher the chloride content, or if subsequently exposed to warm moist conditions, the greater the risk of corrosion. Chlorides in the concrete could be drawn from different sources like aggregates, mix water, admixtures and cement and could lead to durability problems namely, corrosion of reinforcing steel in concrete, if present in sufficient quantity. Chlorides could be present in different degrees of binding in the concrete matrix and could be determined as water soluble and acid soluble chlorides.

PREPARATION OF SAMPLE:

Sample is broken into smaller pieces by hammering carefully to avoid loss of smaller pieces. Particles are crushed to less than 25 mm in maximum dimensions; care is taken to restrict negligible levels of loss of fine particles. Crushed sample is sieved through 850 micron IS

Sieve. Thoroughly blend the material by transferring it from one glazed paper to another at least 10 times.

DETERMENATION OF SULPHATE CONTENT IN HARDENED CONCRETE

INTRODUCTION

Sulphates are present in most cements and in some aggregates; Exposure of concrete made with Portland cement to sulphate salts can cause damage due to an expansive reaction between the cement and the sulphate salt to form crystals of ettringite. Given adequate space to form, the ettringite forms needle like crystals, causes an expansive reaction.

PREPARATION OF SAMPLE:

Sample is broken into smaller pieces by hammering carefully to avoid loss of smaller pieces. Particles are crushed to less than 25 mm in maximum dimensions; care is taken to restrict negligible levels of loss of fine particles. Crushed sample is sieved through 850 micron IS Sieve. Thoroughly blend the material by transferring it from one glazed paper to another at least 10 times.

As per IS-456(2000)The Permissible limit of chloride contents by weight of cement is 0.6% and 0.15% is enough for onset of corrosion and permissible limit of sulphate contents by weight of cement is 4%.

Figure 2 Extended fins at roof top of the building.


Figure 3 Ferro scanning of the fins.

Figure 4 Rebound hammer Test at wall of Gargwell (rainwater drain at roof).

Figure 5 Rebound hammer test of extended channel for pouring of rain water from roofslab into the Gargwell (rainwater drain)

Figure 6 Carbonation test showing red colour over the concrete surface.

Figure 7 loose concrete fallen down just by light tamping with hammer

Figure 8 Exposed reinforcement bar leads to corrosion of reinforcement, resulting in cracks & spalling of concrete.

TABLE 4:
CLASSIFICATION OF STRUCTURAL DAMAGE

S.NO.	Intensity	Visual damage
1.	Light	Final crack (<1mm) light spalling at isolated spots

2.	Moderate	Medium cracks (1-2mm) light spalling
3.	Severe	Wide cracks (<2mm) at different locations
4.	Very severe	Wide cracks

Planning the condition survey includes selection of the most appropriate tests, the **extent or number of test points to reflect the existing conditions** of the structural members, and the location of these test points. It is good practice to obtain sufficient test **result to make a statistical analysis**. However, the number of test points adopted is usually a compromise between reliability, time, cost, and damage. Sometimes the survey is carried out in two stages: **first, a preliminary survey with a few test points to establish the necessity for repair**; and second, a thorough survey to allow a repair scheme to be designed and cost estimated.

While a condition survey may begin with a definite plan, modifications often become necessary as work proceeds and the initial test data becomes available. If the results deviate significantly from expectation, the scope and nature of the survey should be modified accordingly. Assessment of material strengths normally forms part of the condition survey. This part of the work is essential if structural adequately is in doubt.

The concrete strength is determined by non-destructive testing on site. It is important to distinguish between the concrete strength in general and the concrete strength of a particular member. For general assessment, the sampling locations should be randomly chosen, and a sufficient number of samples taken to arrive at a reliable indication of the average strength and the degree of variation. Reinforcement corrosion has been recognized as one of the serious problems in concrete structures as it contributes to substantial damage in a structure exposed to aggressive environments. Corrosion results in the reduction of effective cross sectional area of reinforcing steel and also results in cracking, spalling-delamination of cover concrete finally leading to total failure of the structure.

FACTORS INFLUENCING CORROSION

The principal factors, which influence corrosion, are:

- **pH value of concrete**: The pH value of the fresh concrete is normally about 12-13 & thus providing an alkaline environment to inhibit corrosion. This alkaline environment is largely due to the generation of $Ca(OH)_2$, which is formed during the hydration of cement. If this pH value reduces, the alkalinity reduces making the steel vulnerable to corrosion.
- **Carbonation:** Carbonation occurs when CO_2 from air finds its way into the body of concrete through its pores in presence of moisture & water forms carbonic acid which neutralizes the $Ca(OH)_2$ formed due to the reaction during setting of concrete thus reducing the alkalinity of concrete. This process continues and destroys the passivation layer on steel. Carbonation is dependent on humidity of environment & porosity or permeability of the concrete.
- **Chloride:** The penetration of salt containing chlorides activates corrosion & destroys the passivation. The sources for chlorides could be water used for concreting & curing or the aggregates which may be contaminated with chlorides. Even chlorine gas from the environment may enter through the pores in concrete. These chloride ions tend to destroy the passivating film on steel making the surface activated locally forming a small anode while the rest of passive surface serves as the cathode. Since the latter (cathode) is much

larger, the dissolution of iron in the anode is highly localized and a pit is formed. The chloride ions combine with water forming hydrogen chloride & hydroxyl ions. The hydrogen chloride further prolongs the corrosion causing an increase in the pit depth leading to pitting corrosion.

- **Moisture:** Corrosion is essentially an electrochemical reaction setting in galvanic cells & difference in potential. This cell activity is aided by moisture content, which makes the galvanic cell conductive.
- **Oxygen:** Oxygen plays a significant role in accelerating corrosion. The penetration of oxygen in differential concentrations at different places causes formation of differential aeration cells, which in turn produces potential difference, and flow of current. The oxygen ingress depends on permeability, cracks, and cover thickness and water cement ratio.
- **Permeability:** The permeability (K) of concrete is one of the primary factors affecting the rate at which salts, oxygen, moisture, etc. can penetrate into concrete and also influences the behaviour of both steel & concrete. The permeability depends on factors like cement content, water cement ratio, degree of compaction, age & curing of concrete.
- **Cover:** The cover thickness is also an important factor affecting corrosion, as the cover thickness is the path through which salts, oxygen, moisture etc. penetrate to reach the steel surface.

2.3 Mechanism and Principles of Corrosion

The alkaline environment of concrete protects the embedded reinforcement against corrosion. Good quality concrete with low water cement ratio lowers the permeability minimizing the penetration of chloride ion, carbon dioxide, oxygen and water. Chloride ions in the paste tend to destroy the protective field formed on the steel by the alkaline environment. Higher the chloride ion concentration, lower is the toleration of corrosion. This concept is also used while protecting the concrete from corrosion depending upon the degree of aggressive environment.

It is well recognized that the corrosion of base metals in aqueous environs follows an electrochemical mechanism. The corroding metal functions as a mixed electrode on which anodic and cathodic sites are formed and corresponding reactions take place. Corrosion occurs at anodic sites where the metal atoms pass into solution as positively charged hydrated ions (anodic oxidation) and the excess free electrons flow through the metal to cathodic sites where an electron acceptor, such as hydrogen ion or dissolved oxygen is available to consume them (cathodic reduction).

Corrosion process of iron

The essential features of the process are:

1 A reactive metal which will oxide anodic ally to form soluble ions.
2. A reducible substance, which provides the cathodic reactant.
3. An electrolyte, which allows ions to move between anodic and cathodic sites.

The electrochemical behaviour of corroding metal implies the formation of electrolyte cell and consequent current flow extensive of potential difference between local anodic and cathodic sites.

Corrosion process of steel in concrete

Corrosion is an electrochemical process and most common form of corrosion in concrete is in an aqueous medium. The corrosion process is similar to the action, which takes places in a dry cell battery. In the presence of aqueous medium, which acts as an electrical conductor, anode is formed where the electrochemical oxidation takes place and cathode is formed where electrochemical reduction occurs. Therefore at cathode the reduction takes place lowering the size and therefore the structural ability to carry the stresses. Availability of oxygen, water and chloride ions is the basic requirements for corrosion. There are five states of corrosion that may occur in steel rebars in concrete. These are:

(a) Passive state

(b) The State of Pitting Corrosion

(c) State of General corrosion

(d) The state of active low potential corrosion

(e) Time dependence of corrosion states

a) Passive state

Cement concrete when dense and not contamination by carbonation, maintains a high alkaline (pH 13) environment within the pore solutions of the hardened cement matrix. The high alkaline environment is due to the availability of calcium, potassium, and sodium hydroxides resulting from the reactions of the hydration process, in the presence of dissolved oxygen in the pore- water.

In reinforced concrete members protection to steel rebar is imparted through quality concrete and adequate cover thickness. However aggressive substances, either mixed in concrete or from environments can penetrate into concrete and alter the pore- water composition thus endangering the passive state of the concrete. The passivity break down occurs due to ingress of chloride- ions (or presence of chloride- ions) and the corrosion mechanism follows an electrochemical process in which the most concrete serves as the electrolyte. It is interesting to note that penetration of chloride to the steel surface does not necessarily destroy passivity. A zone of perfect passivity can exist at high levels of chloride concentration, and it is possible to control the corrosion by maintaining a potential corresponding to this zone.

The electrochemical process considers reaction at anodic and cathodic sites of corroding steel and the current flow between these two sites. These reactions can be expressed as given below:

$Fe \rightarrow 2e + Fe^{++} \rightarrow Fe\,(OH)_2$ (ANODE)

$1/2\ O_2 + H_2\,O + 2e^- \rightarrow 2\,(OH^-)$ (CATHODE)

$4\,Fe\,(OH)_2 + 2\,H_2O + O_2 \rightarrow 4Fe(OH)_3$ (RED RUST)

$3\,Fe + 8\,OH^- \rightarrow Fe_3\,O_4 + 8e^- + 4\,H_2\,O$ (BLACK RUST)

(c) The State of Pitting Corrosion

The passivity of steel in an alkaline environment may be destroyed by the presence of chloride ions. Pitting corrosion is therefore likely to occur in reinforced concrete containing significant levels of chloride salts, derived either form the service environment or from the use of contaminated mix materials. This corrosion state is characterized by galvanic action between relatively large areas of passive steel acting as cathode and small anodic pits where the local environment, within the pits, develops a high chloride concentration and a depressed pH value. For pitting to be sustained, it is necessary that a sufficient concentration of oxygen should be available to cause polarization of the anodes to potentials more noble than the pitting (break down) potential characteristic of the particular environment. **State of General corrosion**

The passivity of steel in non- buffered alkaline electrolytes requires a minimum pH value of about 11.5 to be maintained. In concrete, general loss of passivity can, therefore, arise if the pH value of pore- water at the depth of the reinforcement becomes substantially reduced from its initial, high level. This can happen as a result of carbonation, which involves penetration into the material of acidic gases (CO_2 etc.) from the surrounding air and it gives rise to general corrosion of the steel. More or less general corrosion may also be observed in reinforced concrete, which has become contaminated with chloride ions to such an excessive level as to cause virtually complete destruction of the passive film.

(c) The state of active low potential corrosion

In environments where the availability of oxygen is extremely limited, as is sometimes the case for fully submerged or buried reinforced concrete, the limiting cathodic current density may eventually become insufficient to maintain the passive film on steel. Under these circumstances, the metal behaves 'actively' in the highly alkaline environment undergoing uniform dissolution to form soluble $Fe(OH)_2^-$ ions. The corrosion potential is extremely low owing to the restricted availability of the cathodic reactant.

(d) Time dependence of corrosion states

The state of corrosion of steel in concrete may be expected to change as a function of time. In attempts to model this time dependent corrosion behaviour, it is convenient to distinguish the following states:

The imitation period, during which the metal, having been embedded in concrete remains passive whilst, within the concrete, environmental changes are taking place that, may ultimately terminate passivity. The corrosion period, which begins at the moment of de-passivation and involves the propagation of corrosion at a significant rate until a final state is reached when the structure is no longer considered acceptable on grounds of structural integrity, serviceability, or appearance?

TABLE- 5
CLASSIFICATION OF CORROSION

S.No	Intensity	Cracking	Spalling	Carbonation of concrete cover
1.	Light	Hairline cracks (0.1mm) without rust stain	Not apparent	Partial

2.	Moderate	Fine cracks (<0.2mm) with or without rust stain	At isolated spots	Partial
3.	Severe	Extensive with rust stain	Extensive corroded steel visible	Complete
4.	Very severe	Extensive and wide with rust stain	Extensive; substantial steel pitting visible	Complete

3. CONCRETE DETERIORATION:

Concrete is a strong, versatile building material that has found favor with Architects, Engineers as well as Builders due to the ease of production and capability of being moulded into any shape and size. Its quality, performance and behavior however depend on a number of factors. These are mainly related to the constituents and the method of production. In the earlier times the period when most of the old RCC structures were built, the emphasis was on primarily the 28 days strength of concrete. Little was known about the long-term behavior of concrete because IS 456 of 1964 (Code of Practice for Plain & Reinforced Cement Concrete), which was in vogue, then was silent on this aspect. The general belief was that good quality concrete was expected to last for at least a century. Though environmental factors were known to cause damage to concrete but environmental factors were not considered of any major consequence. It was therefore considered that concrete needed no protective coating or covering and so to provide a unique character and also to ensure good quality concrete the formulators of the specifications at that time decided to provide shutter finished RCC with no coating or plaster to be provided over it for the sake of uniformity.

As time passed the concrete technologists realized the importance of durability and the effect of the environmental factors on the performance of concrete. IS 456 of 1978 introduced for the first time the aspect of 'Limit State' of Design for Concrete Structures.' Among the various Limit States that were set out to be satisfied, one of the important ones was the Limit State of 'Durability'. However even this revision of the Code linked the durability to the 'Condition of Exposure' to which the structure was to be exposed and a minimum content of cement to be used was specified. This lead to over use of cement in may cases with no control on the water cement ratio. The high cement content leads to high heat of hydration, which results in high initial cracking. This coupled with uncontrolled water cement ratio lead to increased pores in the body of the concrete. The formulators of IS 456 then realized the importance of deterioration of concrete by the process of 'Carbonation' and hence the Fourth Revision issued in the year 2000. This revision has now laid down the limits of minimum cement content as well as the corresponding maximum water cement ratio for different conditions of exposure of concrete. This has been made possible with the advent of the water reducing admixtures for concrete.

3.1. The Importance of Cover

Concrete is heterogeneous material and, therefore, non-homogenous. Such in homogeneity occurs both at macro and micro levels. The cover has many non-visible micro cracks and these acts as avenues for water and gas penetration. The cover, therefore, should be of proper quality, depth and Bar Spacers could be incorporated to maintain even cover depths. It is observed that when the permeability form work is uncontrolled, the water cement ratio needed is 0.10 more and the cement content gets reduced by about 45 kg/m^3 compared to the original concrete mix and therefore, the cover becomes most vulnerable to attacks.

3.2. Carbonation of Concrete

Under pure solution of pH values of up to 12.5, the reinforcement in the concrete remains in passivating conditions and does not initiate the process of corrosion. Carbonation is the effect of CO_2 from the atmosphere reacting with alkaline component in concrete $Ca(OH)_2$ in the presence of moisture thereby converting the calcium hydroxide to Calcium Carbonate. The pH value of the pore water is reduced to less than 9.5, the reinforcement is no longer in the passivating range and corrosion occurs.

3. RESULTS, ANALYSIS AND DISCUSSION

Visual Inspection:

- In some of the fins at roof the rusting and spalling has been observed. On tamping with hammer hollow sound was also observed. This hollow sound indicates the cover is detached from its parent concrete member.
- At some locations reinforcement bars were exposed and getting rusted as shown in figure-8.
- At roof the roof treatment was damaged at various locations due to this water stagnation takes place at the roof slab of the building.
- At some locations Plantation growth on the roof slab and in rainwater drain (gargwell) was also observed.

TABLE-6

REBOUND HAMMER TEST RESULTS of Block-A

Sr. No.	Location	Rebound Number	Average Rebound Number	Compressive strength N/mm^2	pH of concrete	Corrected Compressive Strength N/mm^2
West elevation						
1.	B-31	51.5,56,45,52,53,54.5,53,53	52.3	34.09	**5-6**	**20.45**
2.	B-30	52,53.5,47,57.5,50,58,50,49.5,46.5,53	51.7	33.13	**5-6**	**19.87**
3.	A-31	51,44.5,54.5,49,52,55,37,39,51	50.3	30.97	**5-6**	**18.58**

4.	B-10 (Near crack)	39.5.45.48.41.42.5.46.42.43.5.	43.4	22.24	**5-6**	**13.34**
5.	B-11	52,50,54.5,43,52,52.5,55	51.4	32.16	**5-6**	**19.92**
6.	G-10 destress location (Roof cutout gargwall)	50,36,31.5,48,31.5,32.5,42.5,56	47.5	27.08	**5-6**	**16.24**
7.	G-10 sound location (Roof cutout gargwall)	56,52,57,51,50.5,56.5,62.5,60.5	55.75	40.23	**5-6**	**24.13**
8.	G-13	19.5,10.5,15,14,19.5,25	19.6	7.08	**5-6**	**7.08**
9.	G-13	46.5,53,54,55,42.5,46,40,47	48.1	27.87	**5-6**	**16.77**
10	G-13 (opposite wall drain)	60,53.5,52,54.5,44,45,54,56.5	56.3	41.31	**5-6**	
11	G-13'	43.5,33.5,50,45,30.5,37.5	35.4	15.15	**5-6**	**24.76**

Table-7
Ultrasonic Pulse Velocity Test Results of Block –A

Sr. No.	**Location**	**UPV**	**Method of Testing**	**Final UPV Results Direct Proportionate Velocity (IS, 5.4.1 13311 part)**	**Quality**
1.	B-31	**2895**	Indirect	3329	Medium
2.	B-30	**2028**	Indirect	2332	Doubtful
3.	B-10 (Over the crack)	**1265**	Indirect	1454	Doubtful
4.	Between B10 & B-11	**2623**	Indirect	3016	Doubtful

Table-8

Concrete Cores Compressive Strength Test results.

Sr. No.	Location/ Mark	Dia (mm)	Area (mm^2)	The overall height of Test Core with Capping (in mm)	H/D Ratio	Maximum Load in (KN)	Measured Compressive Strength of the specimen (Maximum Load/Cross-Sectional Area) (N/mm^2)	Correction factor after Capping from Fig 1 of IS:516	Corrected Compressive Strength of the specimen = measured compressive strength x Correction Factor (N/mm^2)	Equivalent cube strength of the concrete determined by multiplying the Corrected Cylinder Strength by 5/4 as per Clause 5.6.1 of IS 516 (N/mm^2)
1.	G15	68.40	3676.0	117.59	1,72	92.1	25.05	0.968	24.25	30.31
2.	G-8	68.40	3676.0	87.28	1.28	90.3	24.56	0.922	22.64	28.30
3.	H-2	68.40	3676.0	102.24	1.49	69.1	18.80	0.944	17.75	22.19

Table-9
DEPTH OF COVER (FERRO SCANNING)

		Vertical		Horizontal	
Sr. No.	Location	Minimum (mm)	Maximum (mm)	Minimum (mm)	Maximum (mm)
1	Point 1 front	39	54	43	64
2	Point 1 Back	12	60	14	30
3	Point 2 front	19	25	49	20
4	Point 2 Back	14	25	18	56
5	Point 3 front	13	43	38	59
6	Point 3 Back	11	22	11	19
7	Point 4 front	11	32	15	49
8	Point 4 Back	9	14	15	45
9	Point 5 front	13	39	13	53
10	Point 5 Back	23	35	12	71
11	Point 6 front	17	21	16	32

12	Point 6 Back	15	36	15	34
13	Point 7 front	12	25	22	33
14	Point 7 Back	31	60	20	29
15	Point 8 front	14	57	50	68
16	Point 8 Back	11	38	19	33
Auditorium					
17	B-31 panel	34	45		
18	B-30	65	80		
19	B-11	90	95		

TABLE-10

Carbonation test Results of Block-A

Sr. No.	Location	pH of concrete
1.	**D-12**	**5-6**
2.	**A-1’**	**5-6**
3.	**D-8’**	**5-6**
4.	**G-8’**	**5-6**
5.	**G-13**	**5-6**
6.	**G13’**	**5-6**
7.	**B-8’**	**5-6**
8.	**C-16**	**5-6**

Table- 4 chemical test results of concrete samples

S No.	Name of Sample	Sulphates (%)	Chlorides (%)
1	A1	1.22	AS-0.0185 WS-0.0488
2	Drain 1	0.88	AS-0.0248 WS-0.0392
3	Drain	1.246	AS-0.0176 WS-0.0296
4	C-16	2.97	AS-0.028 WS-0.0392
5	B8	1.20	AS-0.0214 WS-0.0427
6	D8	1.41	AS-0.0124 WS-0.0279
7	G13	0.74	AS-0.021

			WS-0.0199
8	UNKNOWN	0.29	AS-0.0149 WS-0.0210
9	D13	1.40	AS-0.0188 WS-0.0314
10	D12	1.42	AS-0.0198 WS-0.0248
11	MORTAR	1.20	AS-0.0196 WS-0.0389
12	C16	2.82	AS-0.0289 WS-0.0464
13	G8	0.69	AS-0.0172 WS-0.0272
14	G8	1.064	WS- 0.0322 AS-0.0118
15	H2	1.10	WS-0.0282 AS-0.0146
16	G15	1.14	AS-0.0188 WS-0.0138

Test Method: IS 14959 (Part 2) 2001RA 2016 & IS 2317 1975 RA 2015

Table- 11
Ratio of cement concrete samples.

S No.	Name of Sample	Result(cement: combined aggregates)
1	A1	1:2.2
2	Drain 1	1:3.43
3	Drain	1:3.28
4	C-16	1:129
5	B8	1:3.29
6	D8	1:1.90
7	G13	1:37
8	UNKNOWN	1:3.5
9	D13	1:3.32
10	D12	1:3.2
11	MORTAR	1:56
12	C16	1:90
13	G8	1:3.30
14	G8	1:2.05
15	H2	1:2.39
16	G15	1:1.90

6.1 RESULTS & DISCUSSION

Based on the investigation & study carried out on various members, the following conclusions are drawn.

i. The average relative strength of concrete varies from 7 N/mm^2 to 24.76 N/mm^2 corresponding to the rebound hammer test.

ii. The average relative strength of concrete varies from 22.19 N/mm2 to 30.31 N/mm2 corresponding to the core compressive strength test.

iii. The general quality of concrete is in the range of medium at one location & Poor/doubtful at 3 locations where the tests were conducted corresponding to the Ultrasonic Pulse Velocity test.

iv. The Ultrasonic Pulse Velocity Tests are conducted by direct and Indirect Method, as per the IS-13311(Part-I) the indirect velocity is invariably lower than the direct velocity on the same concrete element. This difference may vary from 5 to 20 percent depending largely on the quality of the concrete under test.

v. The sulphates & chlorides are within the permissible limits.

vi. The minimum cover over the reinforcement is just only 9mm and at some locations the reinforcement is exposed also.

vii. In buildings some of the fins show the cracks, on investigation of these cracks it was found that these cracks are due to corrosion of reinforcement.

viii. The pH of concrete is decreased to 5-6 as shown in figure-6.

ix. The carbonation depth is increasing with the age of the structure. The rate of carbonation is more than the normal concrete of sound quality. The variation is due to deficiency in field practice and also the temperature and relative humidity in Chandigarh are suitable for carbonation. And also the improper maintenance is one of the reasons for more carbonation than normal.

x. Carbonation test result shows the pH of concrete is severely decreased towards acidic side from its actual alkaline nature (12.5pH). This acidic environment of concrete is responsible for the corrosion of steel reinforcement embedded in the concrete. Due to corrosion the rust starts depositing over the steel reinforcement and starts increasing its size, which results in development of internal stresses in the RCC member and hence the cracks starts appearing over the concrete members. Further this process continues and results in spalling of concrete and corrosion of reinforcement.

xi. The corrosion observed is more, where the cover is minimum and where the carbonation is reached up to rebar level. And also local corrosion observed where the bars are exposed. As the ingress of moisture increases, the corrosion also increases. Because of fluctuations in temperature and relative humidity, exposed members are more prone to corrosion.

xii. From the results of above study, it was concluded that the deterioration in structures is due to carbonation, acidic environment in building, deficiency in field practice, improper maintenance etc. Further pollution level, fluctuations in temp and humidity accelerated the above deterioration.

xiii. It was further concluded that, even though deterioration has taken place, the deflection is not observed, if the deterioration is further continued, the structures may not serve for its desired life.

xiv. To maintain the life of structure for its desired life, the deterioration should be controlled.

xv. Lack of maintenance makes the external member more prone to cracking and disintegration. In many fins vertical thin to wide cracks, drying shrinkage cracks and disintegration observed indicate likely corrosion in the members.

CONCLUSIONS

The overall stability of various structures was found to be good. The major problem is the reinforcement is getting corroded due to carbonation in the concrete. The level of corrosion is high in some members and low in certain members depending upon the exposure conditions. The defects identified are to be repaired in order to prevent further deterioration as soon as possible.

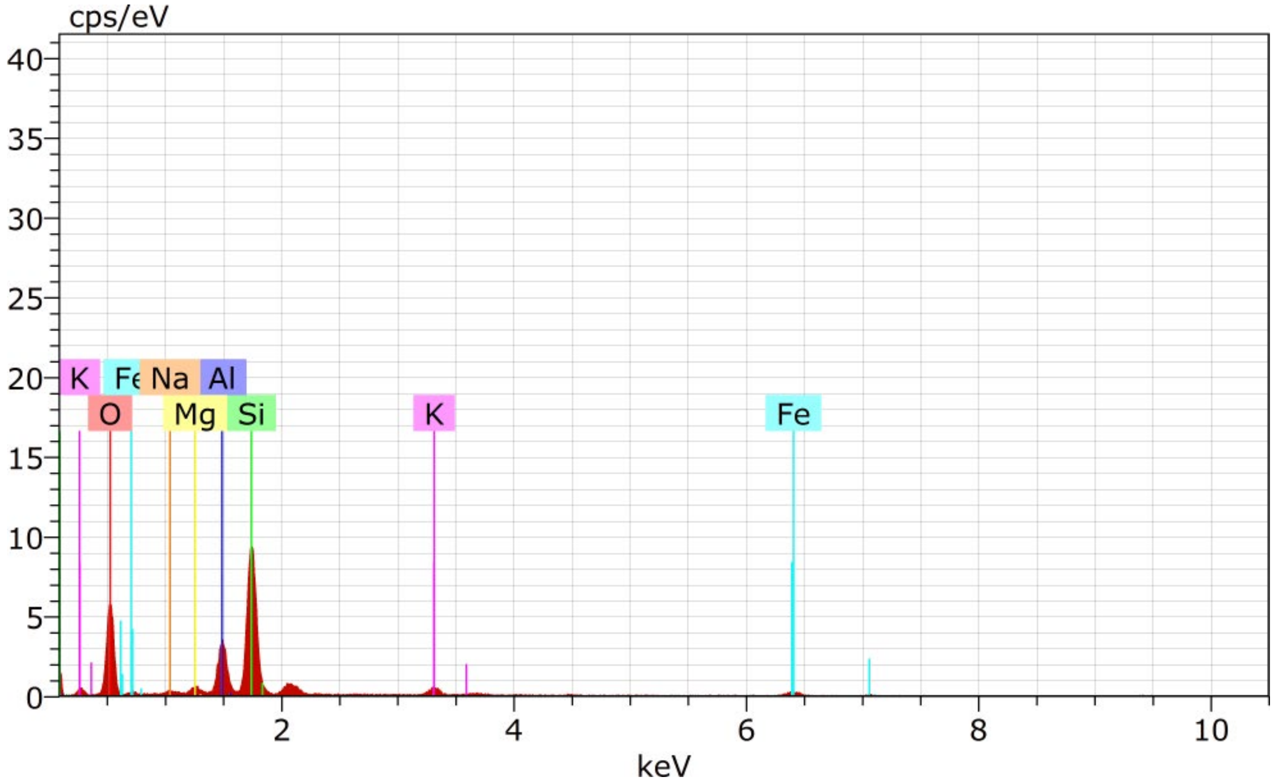
Er. Ashish Kapoor
Chartered Engineer
AM1803681

B.4.2 The report of the tests conducted by Sophisticated Analytical Instrumentation Facility at Punjab University is below:

EDS Test of Brick Tile sample

BRUKER

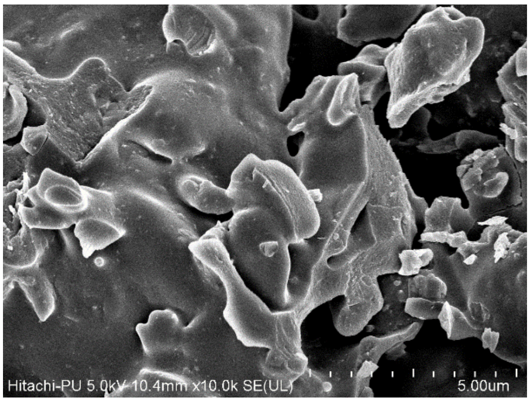
Application Note

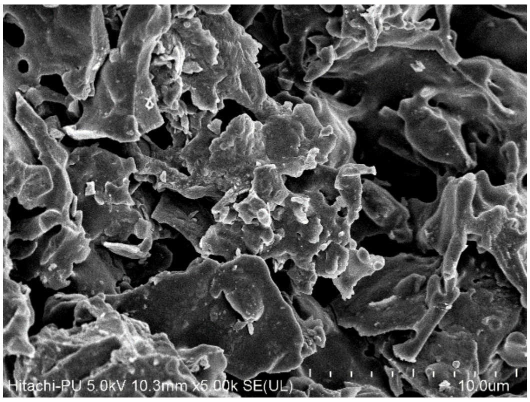


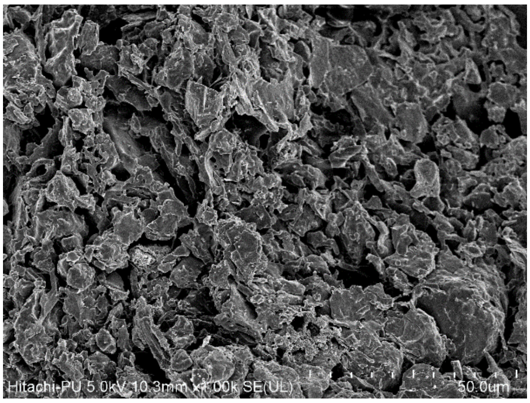
Spectrum: test 5213

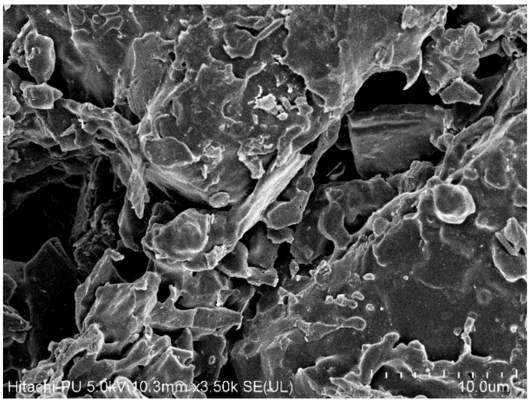
Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Oxygen	K-series	27.64	45.04	60.77	11.41
Silicon	K-series	19.98	32.56	25.03	2.62
Aluminium	K-series	6.21	10.12	8.10	0.99
Iron	K-series	4.76	7.75	3.00	0.71
Potassium	K-series	1.73	2.82	1.56	0.30
Magnesium	K-series	0.72	1.18	1.05	0.23
Sodium	K-series	0.33	0.53	0.50	0.18
	Total:	61.38	100.00	100.00	

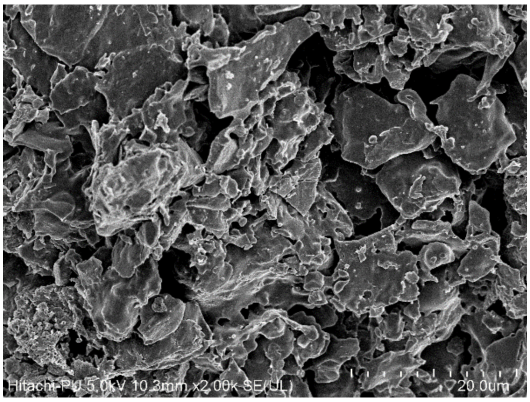
FESEM Test of Brick Tile sample

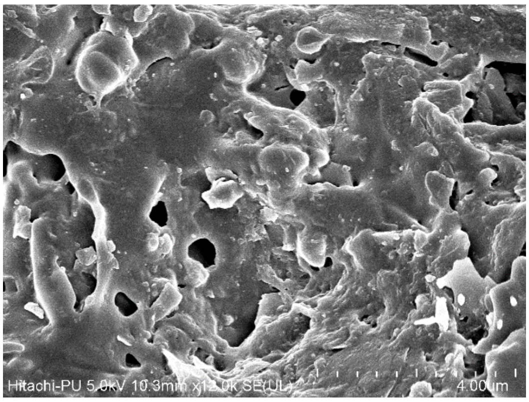


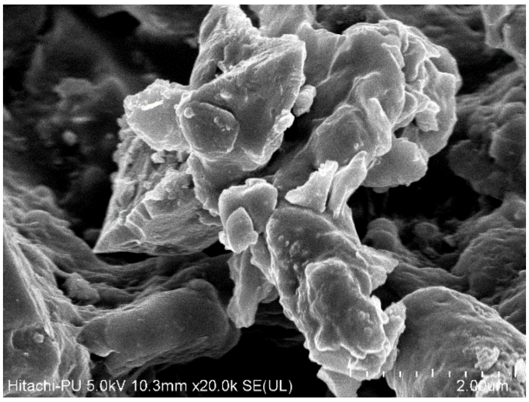


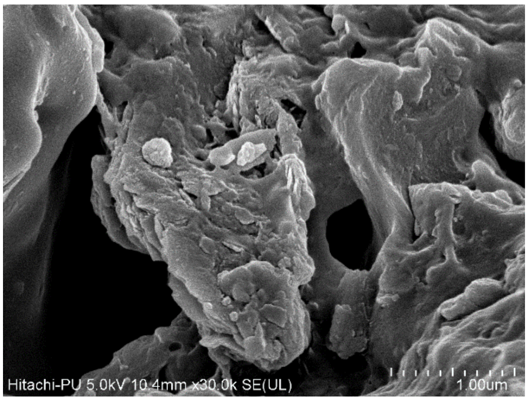






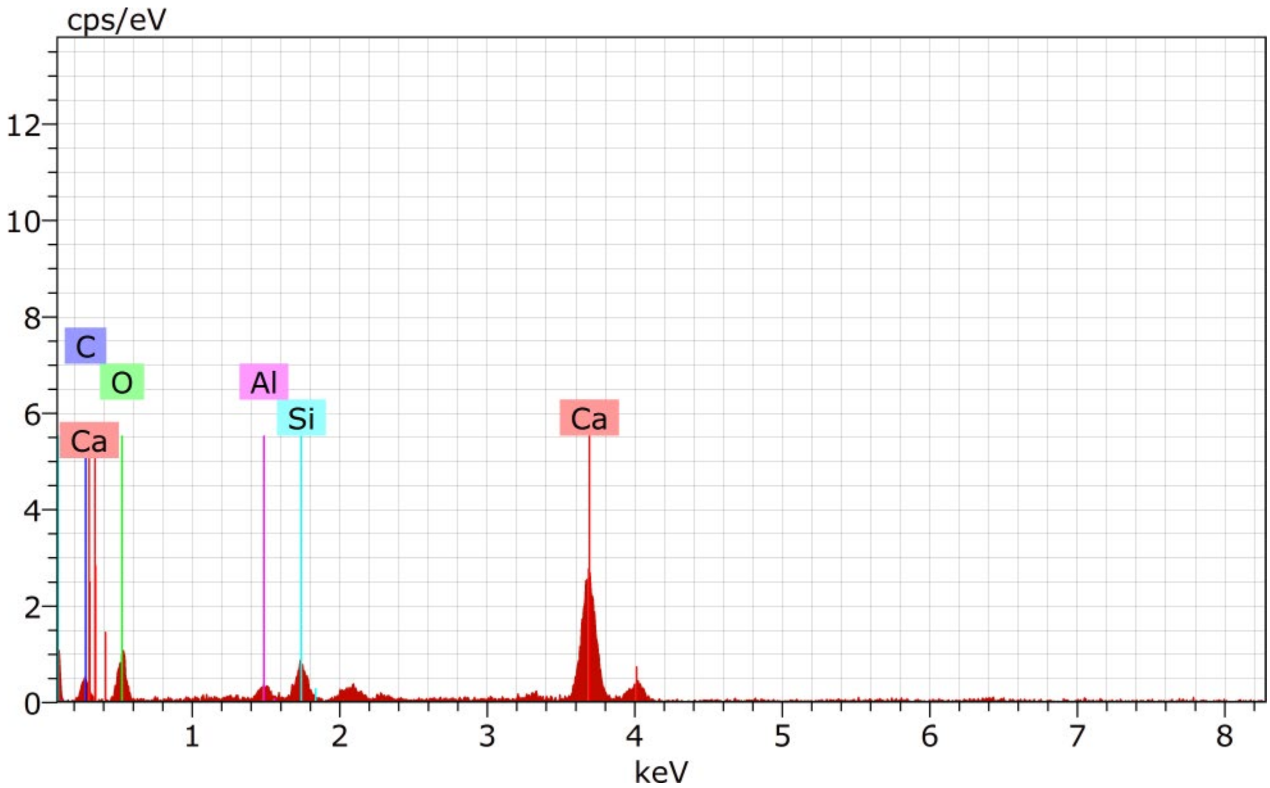






EDS Test of Black Terrazzo Tile sample

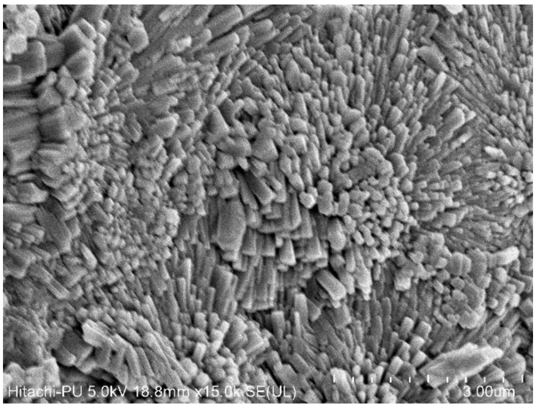
Application Note

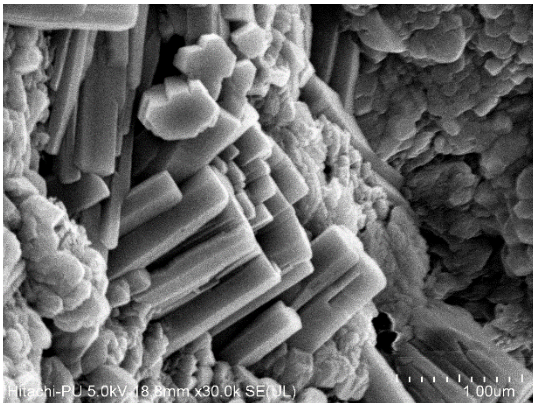


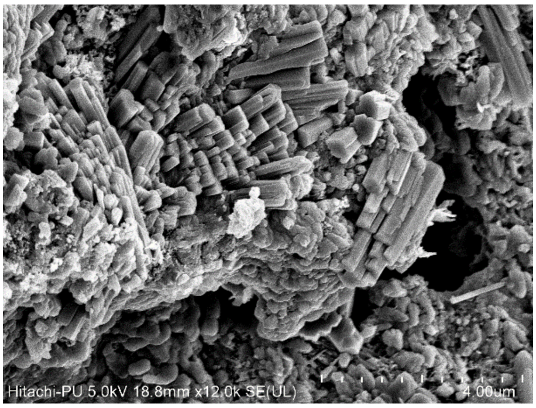
Spectrum: test 5205

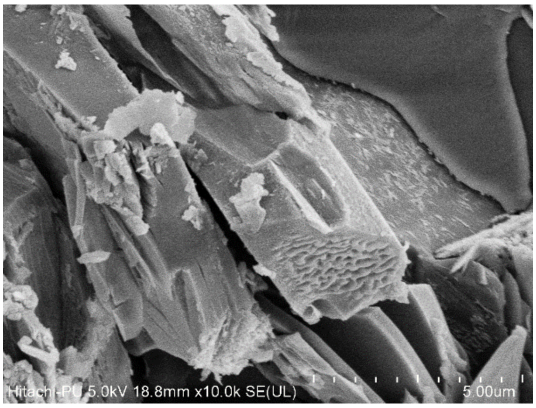
Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Calcium	K-series	23.56	43.81	23.37	2.51
Oxygen	K-series	21.68	40.31	53.87	15.09
Carbon	K-series	5.61	10.44	18.58	5.22
Silicon	K-series	2.29	4.26	3.24	0.50
Aluminium	K-series	0.64	1.19	0.94	0.26
	Total:	53.77	100.00	100.00	

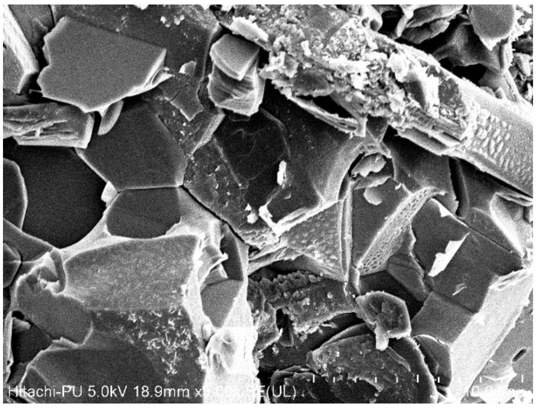
FESEM Test of Black Terrazzo Tile sample

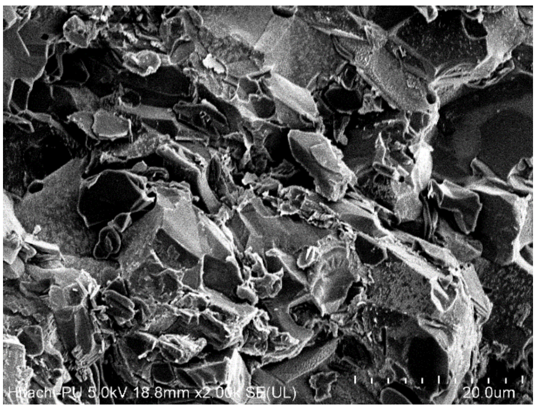






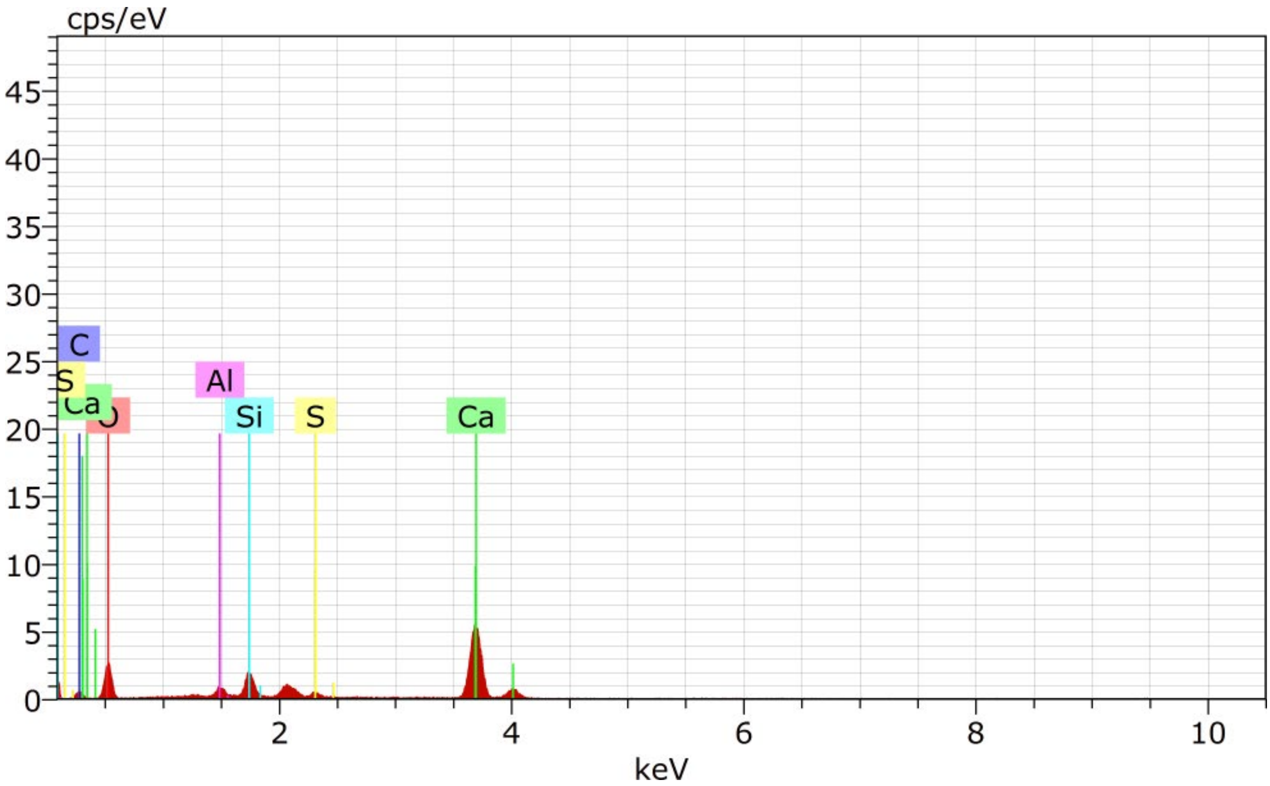






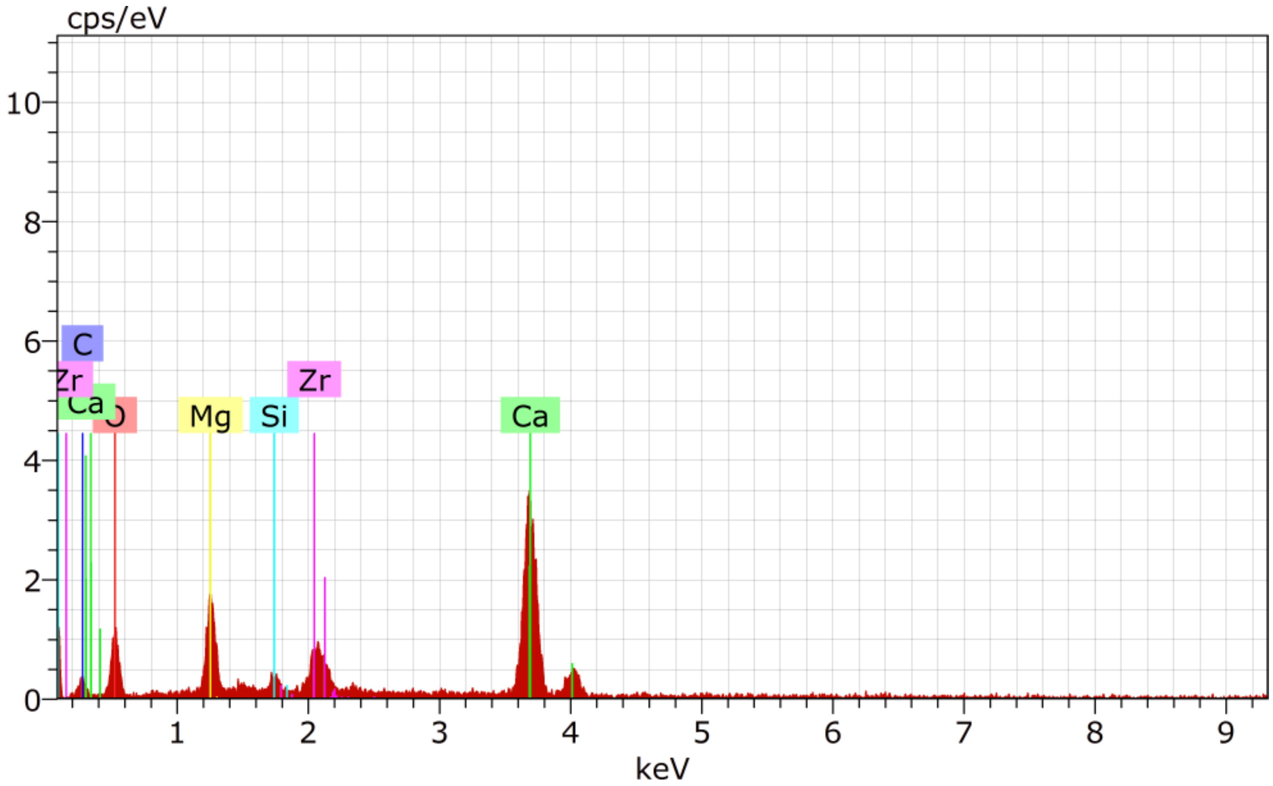
EDS Test of White Terrazzo Tile sample

Application Note



Spectrum: test 5203

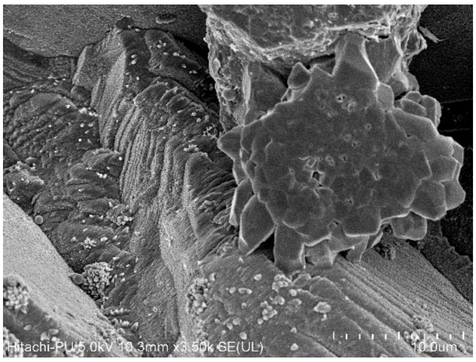
Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Oxygen	K-series	29.74	44.95	61.27	14.24
Calcium	K-series	27.41	41.43	22.54	2.63
Carbon	K-series	3.60	5.44	9.89	2.79
Silicon	K-series	3.50	5.29	4.10	0.57
Aluminium	K-series	1.23	1.86	1.50	0.30
Sulfur	K-series	0.68	1.02	0.69	0.19
	Total:	66.17	100.00	100.00	

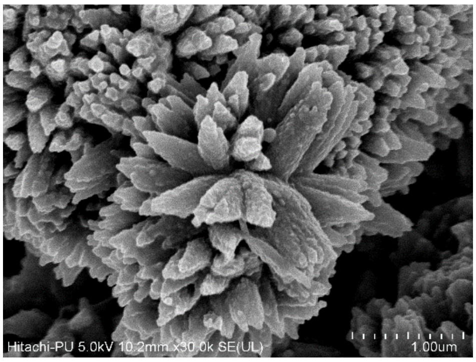


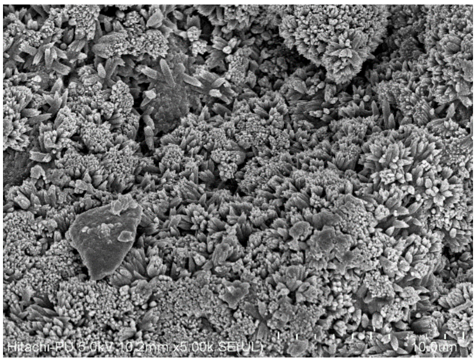
Spectrum: test 5204

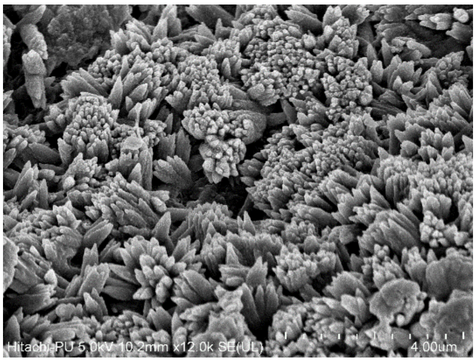
Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Oxygen	K-series	19.36	33.12	50.59	13.69
Calcium	K-series	24.66	42.17	25.72	2.61
Carbon	K-series	3.46	5.93	12.06	4.17
Silicon	K-series	0.41	0.70	0.61	0.21
Zirconium	L-series	5.68	9.71	2.60	0.96
Magnesium	K-series	4.90	8.38	8.43	1.04
	Total:	58.47	100.00	100.00	

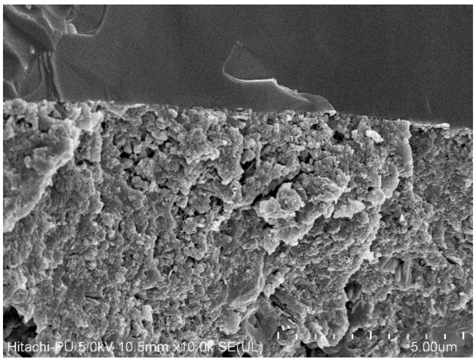
<u>FESEM Test of White Terrazzo Tile sample</u>

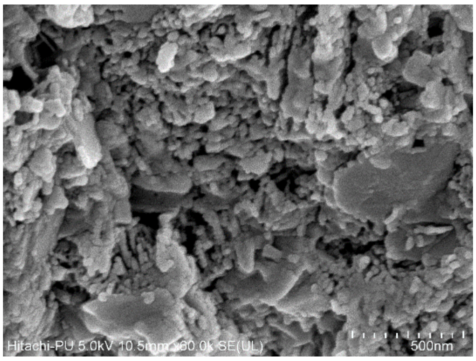


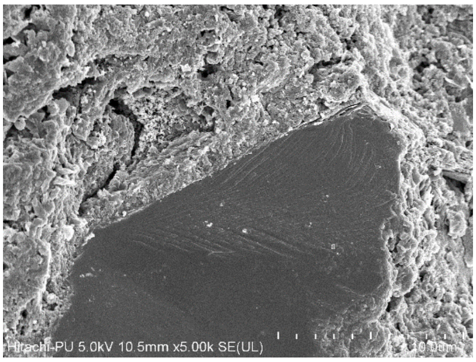




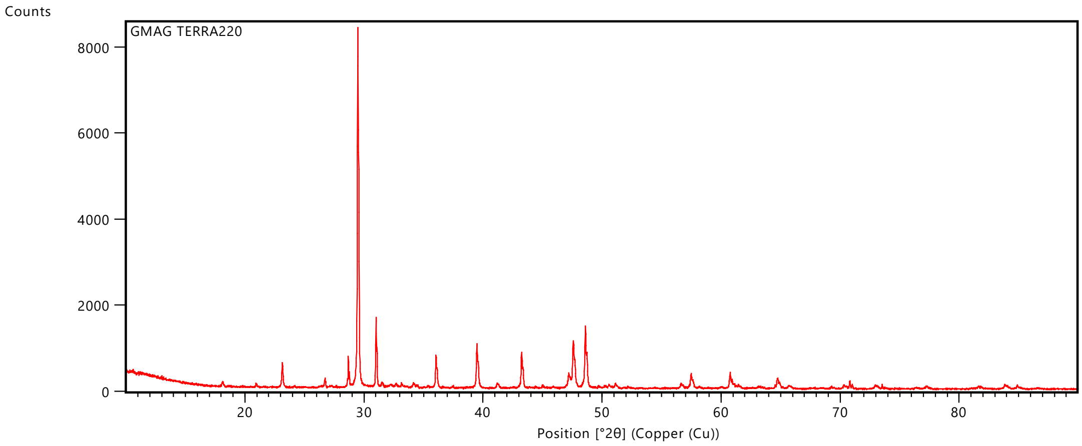








XRD Test of Top layer of White Terrazzo Tile sample



Measurement Conditions: (Bookmark 1)

Dataset Name GMAG TERRA220

File name C:\XRD Data\October2019\GMAG TERRA220.xrdml

Sample Identification GMAG TERRA220

Comment Configuration=Reflection Spinner Stage, Owner=User-1, Creation date=20-09-2016 16:48:22

Goniometer=PW3050/60 (Theta/Theta); Minimum step size 2Theta:0.001; Minimum step size Omega:0.001

Sample stage=Spinner PW3064

Diffractometer system=XPERT-PRO

Measurement program=C:\PANalytical\Data Collector\Programs\10°-90°.xrdmp, Identifier={50DFF4F9-B737-43FA-A617-FA0883B94F1C}

Batch program=C:\PANalytical\Data Collector\Programs\GENERAL.xrdmp, Identifier={B0748876-7E9E-4232-9E0C-A5B1EDFA04A4}

PHD Lower Level = 6.52 (keV), PHD Upper Level = 12.80 (keV)

Measurement Start Date/Time 29-10-2019 11:41:47

Operator User

Raw Data Origin XRD measurement (*.XRDML)

Scan Axis Gonio

Start Position [°2θ]	10.0084
End Position [°2θ]	89.9934
Step Size [°2θ]	0.0170
Scan Step Time [s]	29.2100
Scan Type	Continuous
PSD Mode	Scanning
PSD Length [°2θ]	2.12
Offset [°2θ]	0.0000
Divergence Slit Type	Fixed
Divergence Slit Size [°]	0.4354
Specimen Length [mm]	10.00
Measurement Temperature [°C]	25.00
Anode Material	Cu
K-Alpha1 [Å]	1.54060
Generator Settings	40 mA, 45 kV
Diffractometer Type	0000000011023505
Diffractometer Number	0
Goniometer Radius [mm]	240.00
Dist. Focus-Diverg. Slit [mm]	100.00
Incident Beam Monochromator	No
Spinning	Yes

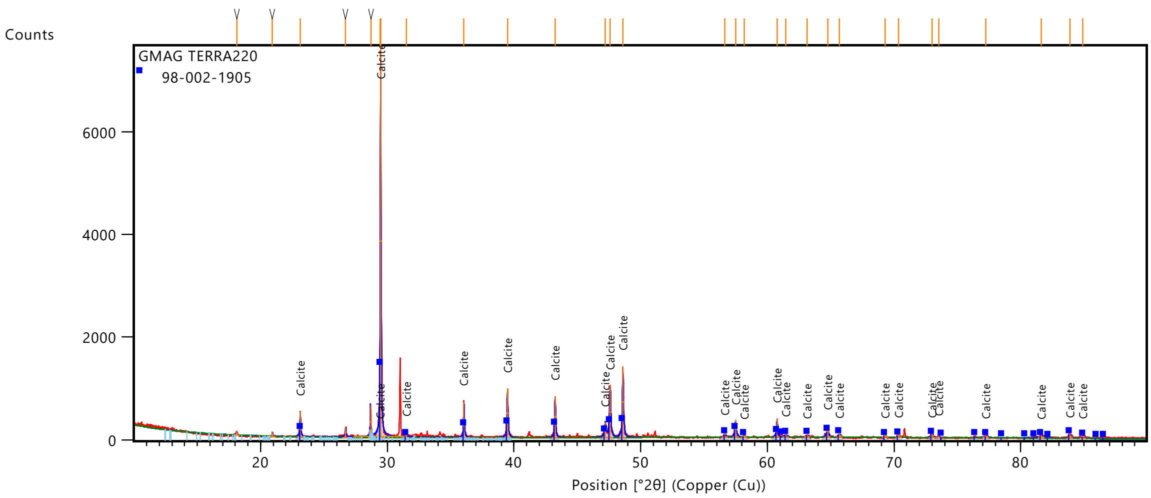
Main Graphics, Analyze View: (Bookmark 2)

Peak List: (Bookmark 3)

Pos. [°2θ]	FWHM Total [°2θ]	d-spacing [Å]	Rel. Int. [%]	Area [cts*°2θ]
18.1116	0.1011	4.89401	0.65	5.30
20.9396	0.0717	4.23900	0.91	5.30
23.1333	0.0842	3.84174	6.32	65.54

26.7129	0.0785	3.33450	2.33	23.40
28.6927	0.0431	3.10877	8.16	45.57
29.4191	4.1658	3.03364	0.56	374.55
29.4843	0.0792	3.02708	100.00	882.71
31.0139	0.0626	2.88118	21.10	137.39
31.5111	0.0929	2.83685	1.25	15.46
32.6808	0.5679	2.73793	0.79	72.45
34.1651	0.1997	2.62230	0.93	28.03
35.3815	0.1278	2.53489	0.47	8.81
36.0518	0.0883	2.48927	9.09	91.48
37.6611	6.1261	2.38652	0.23	227.08
39.4939	0.0982	2.27989	12.27	142.42
41.2020	0.1168	2.18923	1.41	20.47
43.2470	0.0865	2.09033	10.44	109.66
45.0321	2.5997	2.01153	0.25	99.30
47.2061	0.1301	1.92383	3.71	64.87
47.5894	0.1204	1.90923	13.02	182.74
48.6028	0.1056	1.87176	17.98	228.29
49.6982	0.0762	1.83304	0.88	7.21
50.5766	0.3280	1.80325	0.81	42.72
51.1277	0.1197	1.78510	1.20	11.59
52.1752	0.0920	1.75170	0.49	5.73
56.6500	0.1392	1.62348	1.41	21.14
57.4899	0.1303	1.60175	4.08	66.07
58.1842	0.1608	1.58428	0.39	5.64
60.0291	0.2299	1.53992	0.27	4.97
60.7633	0.1124	1.52306	4.57	60.15
61.4607	0.1382	1.50744	0.91	20.33
63.1548	0.1596	1.47102	0.53	12.48
64.7520	0.1449	1.43854	2.86	52.62
65.7044	0.2349	1.41997	0.69	13.10

69.2899	0.0685	1.35499	0.75	6.99
70.3443	0.2053	1.33724	0.89	14.77
70.8178	0.0903	1.32946	2.29	21.57
72.9925	0.2608	1.29512	0.81	17.14
73.5425	0.0587	1.28679	1.36	8.62
77.2618	0.2520	1.23386	0.69	24.18
81.6343	0.3412	1.17846	0.63	34.67
83.8830	0.2509	1.15250	1.04	27.03
84.9014	0.1870	1.14126	0.77	17.67
88.7615	10.4364	1.10133	0.31	257.74



B.4.3 The report of the tests conducted by INTACH is below:

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INTACH CONSERVATION INSTITUTES

RESEARCH WING

71, Lodhi Estate, K.K. Birla Lane, Delhi-110003

Phone: 011-24642172, E-mail Id: intachiciresearch@gmail.com

SAMPLE ANALYSIS SHEET UNDER LM/PLM

SAMPLE: Composite (Fiberboard) **SOURCE OF SAMPLE:** Corbusier Museum, Chandigarh

OBJECTIVES OF ANALYSIS : To know about nature and morphology of the sample.

TESTING AND COMPARISONS:

- The sample is examine using Light microscopy (LM) & Polarized light microscopy (PLM).
- The imaging is done under the reflected (4X, 10X, 20X, 40X) and transmitted light (20X).
- Sample was compared with different species of wood.
- The burning test is done under controlled conditions.

FINDINGS:

1. The sample is organic in nature.
2. The binding medium is synthetic in nature (matrix).
3. The sample does not contain coir.
4. The transverse section is showing straight cubical pattern of pores.
5. The radial section is showing parallel longitudinal fibers resembling bast fibers. Bast fibers are long thick-walled cells harvested from the inner bark of hardwood trees. Flax and hemp are some examples of bast fibers and are harvested from the stems. Salient features used to identify bast fibers are thick walls, dislocations (also called kinks), long length, tapered ends and presence of lumens (cavities).

CONCLUSIONS:

The sample is organic and is most probably a bast fiber board. Bast fibre reinforced boards are bio-composites made of natural fibres such as kenaf, jute, flax, hemp, sisal, corn stalk, bagasse or other grasses are embedded in a matrix.

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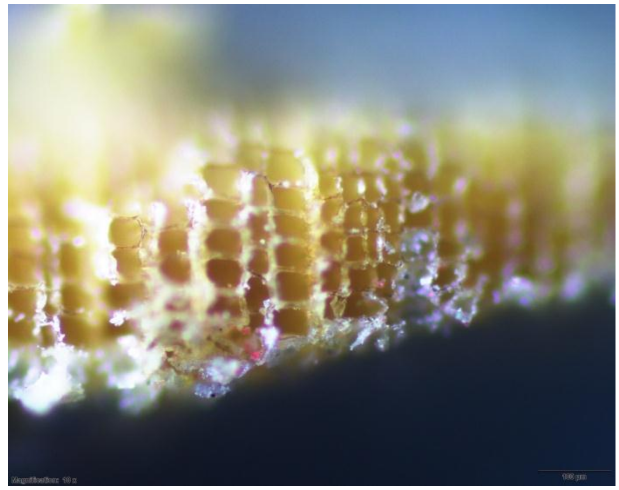
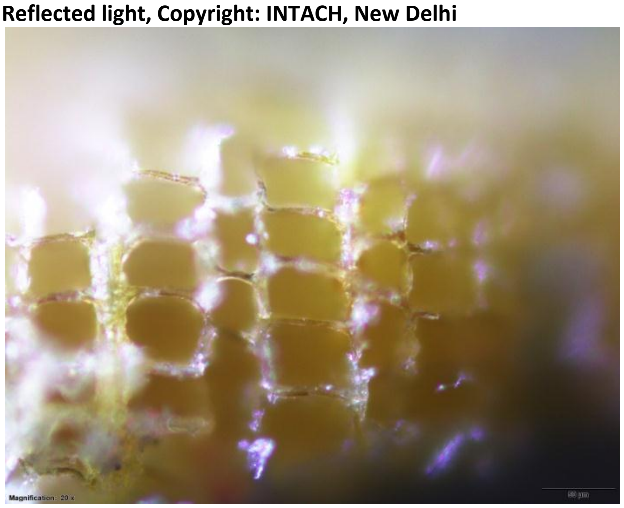
Cross-sectional Imaging

Micrograph showing transverse section

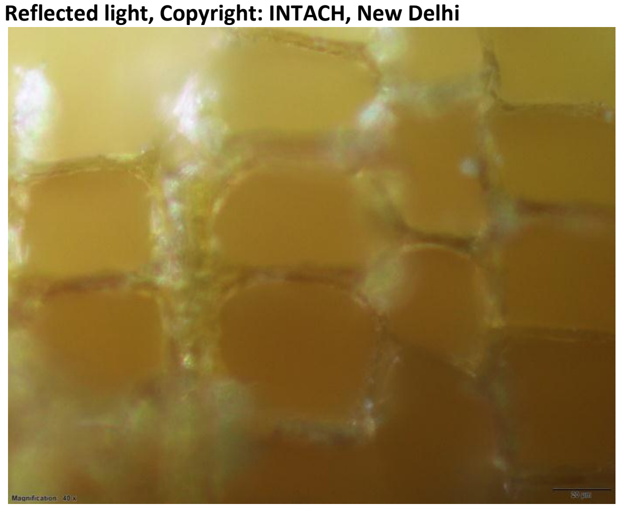
Micrograph showing transverse section of sample, 4X, Reflected light, Copyright: INTACH, New Delhi



Micrograph showing transverse section of sample, 10X, Reflected light, Copyright: INTACH, New Delhi



Micrograph showing transverse section of sample, 20X, Reflected light, Copyright: INTACH, New Delhi



Micrograph showing transverse section of sample, 40X, Reflected light, Copyright: INTACH, New Delhi

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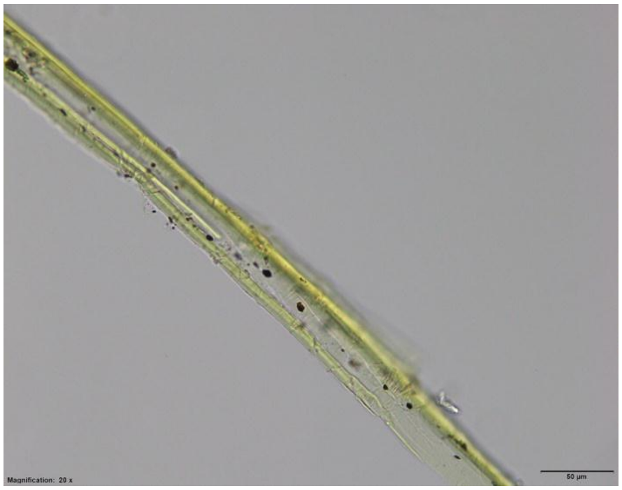
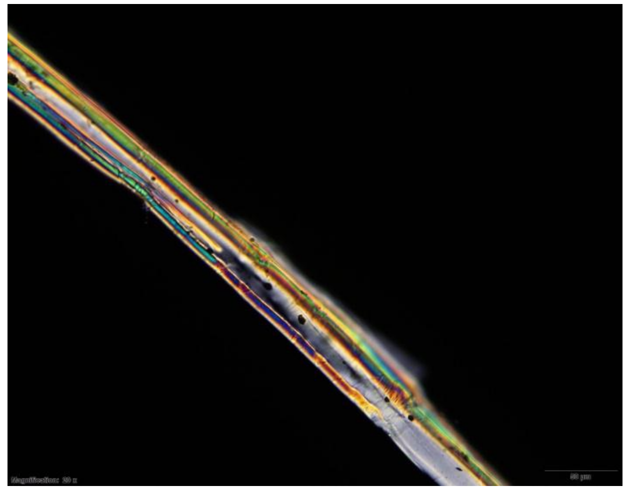
Micrograph showing radial section



Micrograph showing radial section of sample, 20X, Transmitted light(PPL), Copyright: INTACH, New Delhi



Micrograph showing radial section of sample, 20X, Transmitted light(XPL), Copyright: INTACH, New Delhi

Garima S Raghav
Research wing
Art & Material Heritage Division
INTACH

Date: 25/11/2019

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INTACH

Slide No.: **0110-0123**

INTACH CONSERVATION INSTITUTES

RESEARCH WING

71, Lodhi Estate, K.K. birla Lane, Delhi-110003

Phone: 011-24642172, E-mail Id: intachiciresearch@gmail.com

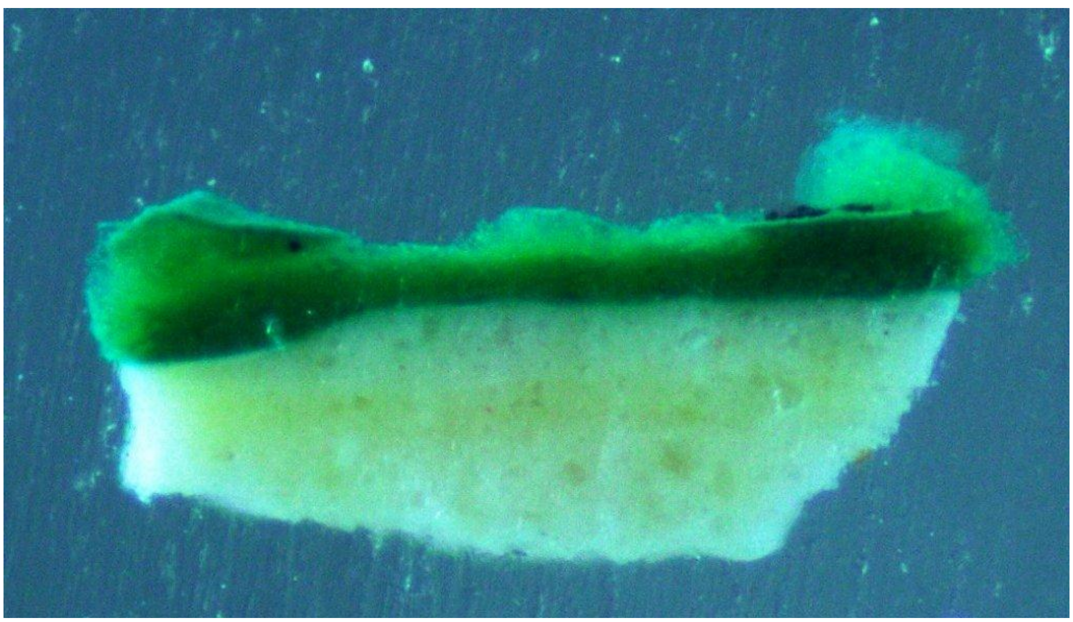
CROSS-SECTION SAMPLE ANALYSIS SHEET

SAMPLE: Composite (WOOD/PLASTER) **SOURCE OF SAMPLES:** Corbusier Museum, Chandigarh

OBJECTIVES OF ANALYSIS: Stratigraphy to determine the number of paint layers present on each sample.

SAMPLE NO.: S01 (Location: Next to granth sahib room- Old curator Room-Level 2)

REFLECTED LIGHT: 4x



CONCLUSION:

- Three distinct layers of plaster are visible under reflected light.
- There two paint layers (greenish black) distinctly visible.

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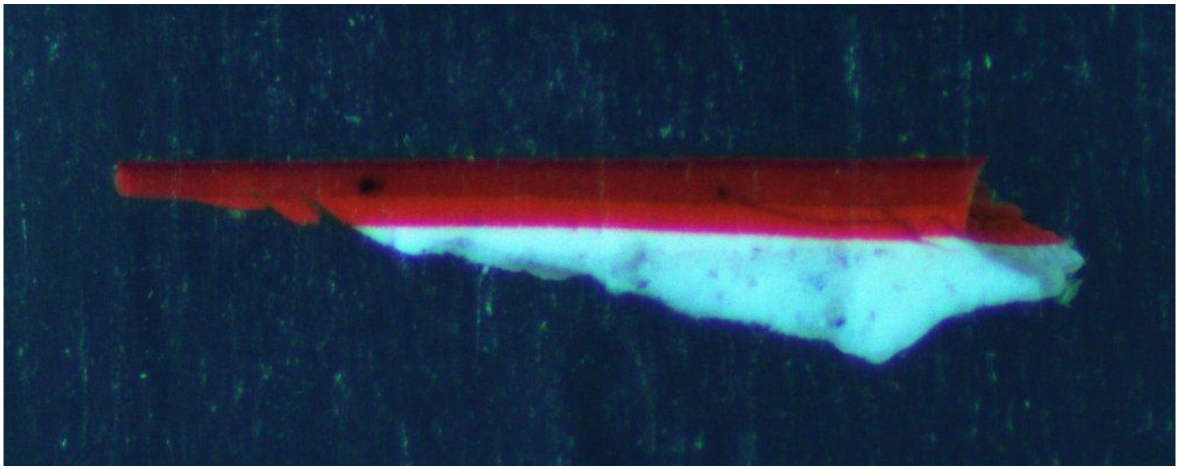
SAMPLE NO.: S02 (Location: Guru granth sahib room-Level 3)

REFLECTED LIGHT: 4x

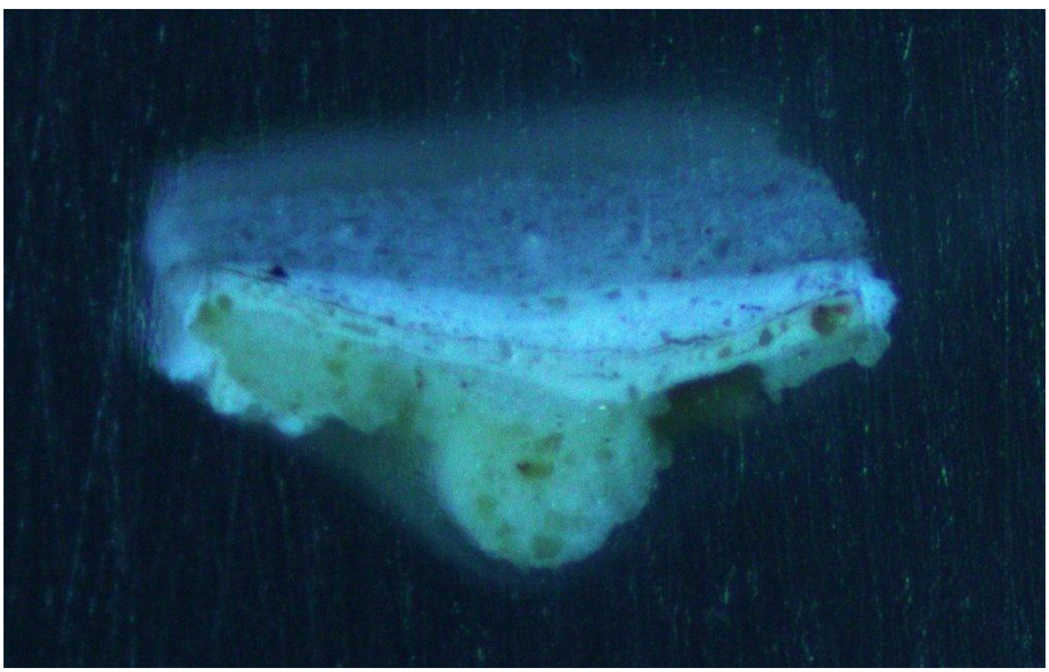


CONCLUSION:

- Two layers of plaster are visible under reflected light. One layer could be ground.
- Two layers of red paint (light and dark) are visible under reflected light.

SAMPLE NO.: S03 (Location: Guru Granth Sahib room- Toilet)

REFLECTED LIGHT: 4x

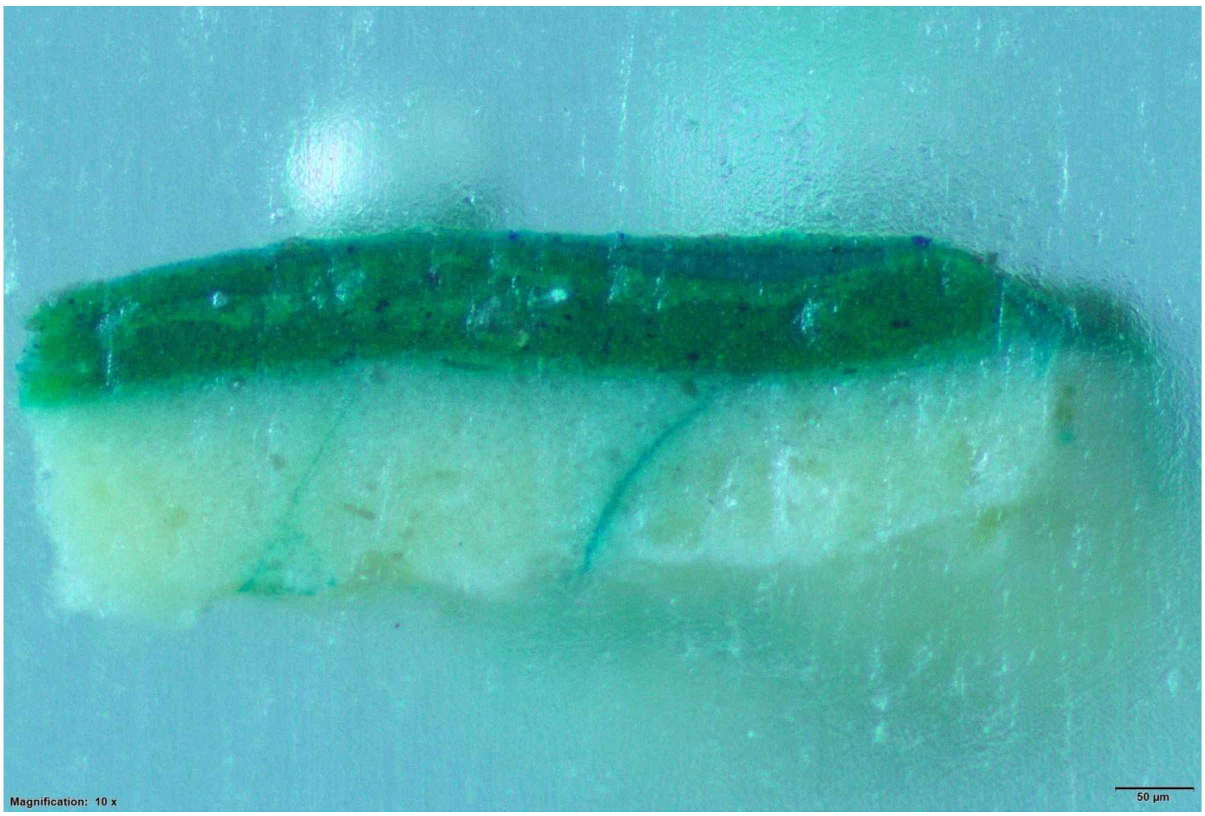


CONCLUSION:

- Three layers of plaster are visible under reflected light.
- Three layers of bluish white paint are clearly visible under reflected light.

SAMPLE NO.: T01 (Location: Staircase to Terrace)

REFLECTED LIGHT: 4x



CONCLUSION:

- Only one thick layer of plaster is visible under reflected light.
- Four layers of green paint (different tones) can be distinguished in reflected light image.

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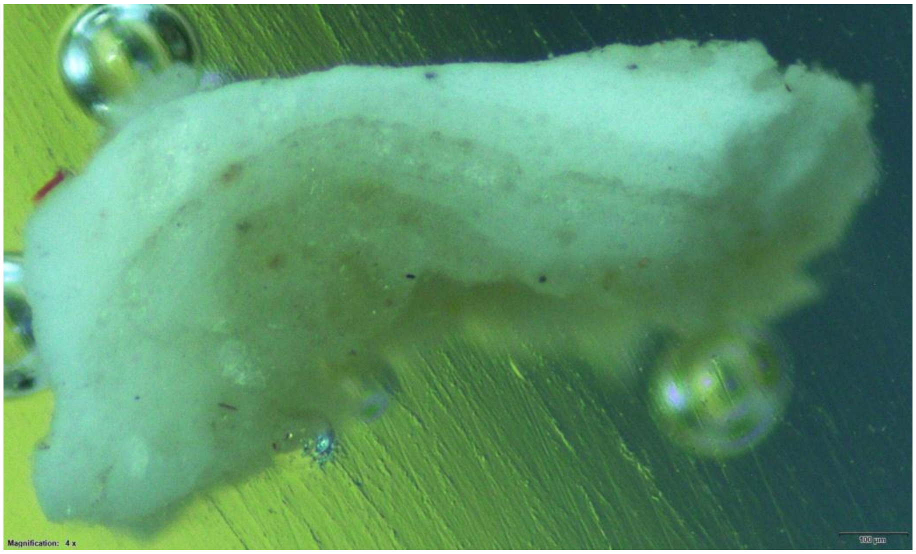
SAMPLE NO.: G01 (Location: Shaft Entrance)

REFLECTED LIGHT: 4x

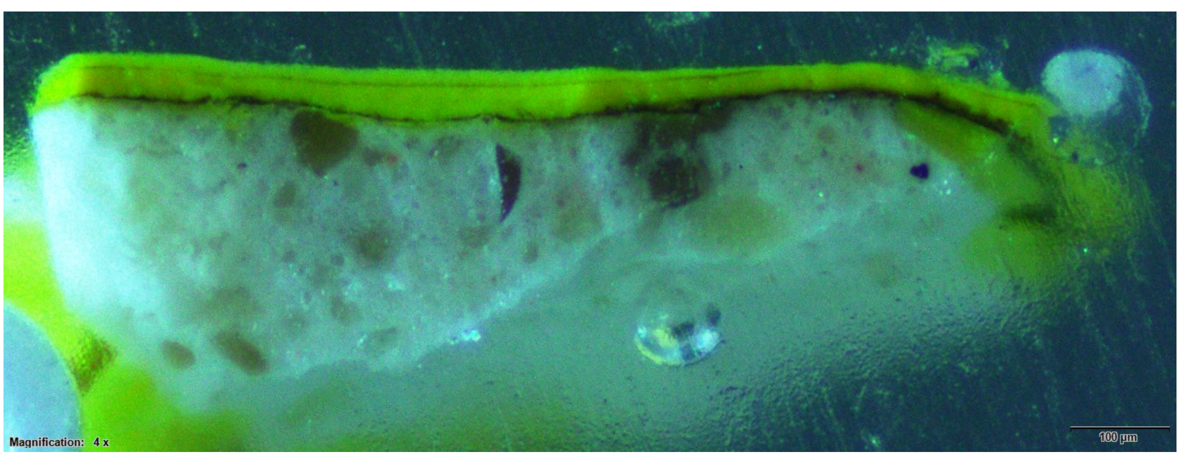


CONCLUSION:

- Three white layers are visible under reflected light.
- These could be plaster, ground and paint or ground with two layers of paint.

SAMPLE NO.: G02 (Location: Reserve Gallery- Ground Floor)

REFLECTED LIGHT: 4x



CONCLUSION:

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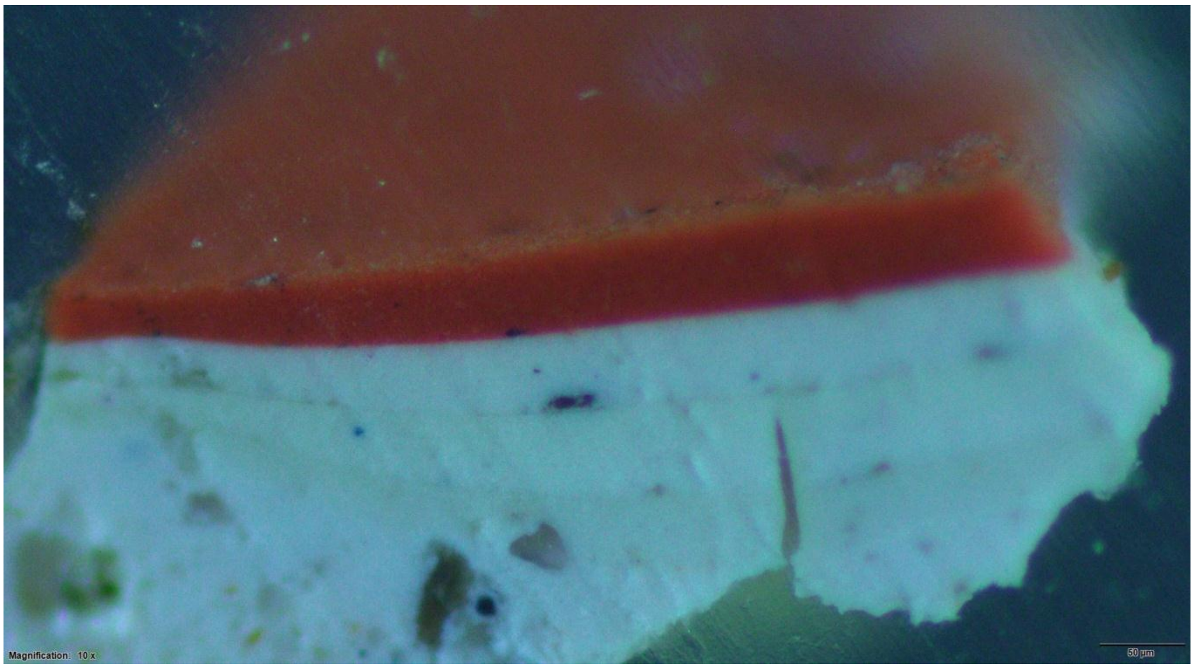
- A single layer of plaster is clearly visible under reflected light.
- A thin layer of black (could be dust and dirt) is present over the plaster layer.
- Two layers of green paint are visible in reflected light with a thin layer of probably dust in between. This may indicate painting a second coating without cleaning.

SAMPLE NO.: G03 (Location: Reserve Gallery Miniature- Ground floor)

REFLECTED LIGHT: 10X



CONCLUSION:

- Three layers of white are visible under reflected light. These could be the plaster layers (two) and a ground layer.
- One layer of red paint is visible in reflected light image.

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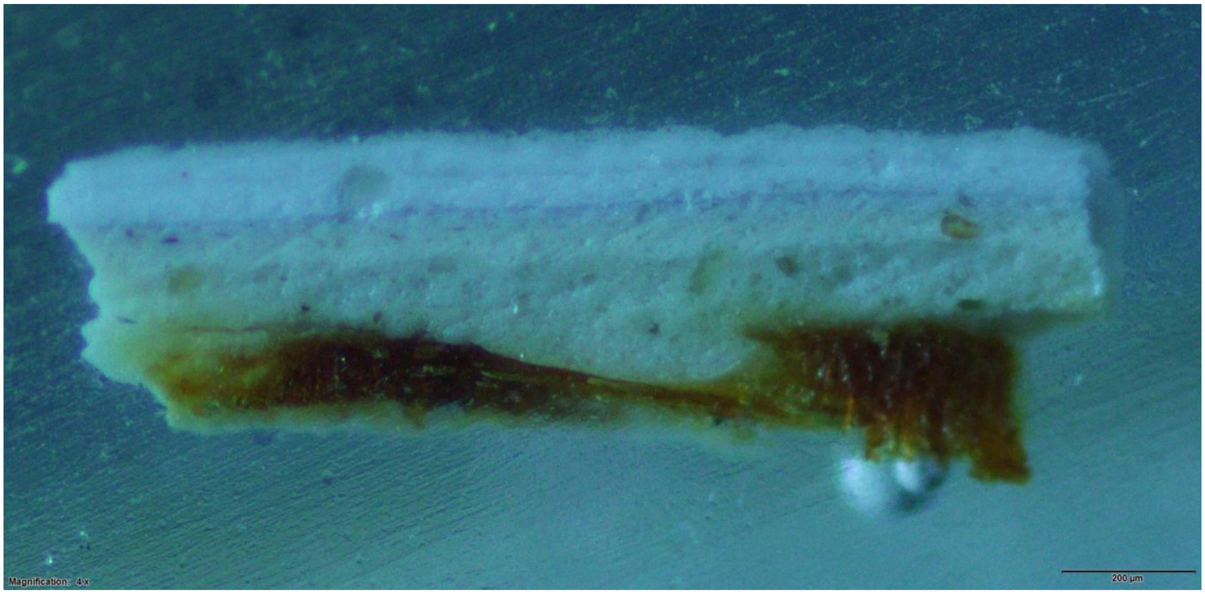
Slide No.: **0110-0123**

SAMPLE NO.: F01 (Location: Shaft Door- pottery section-First floor)

REFLECTED LIGHT: 4x



CONCLUSION:

- Two layers of plaster clearly visible under reflected light. These may be a ground layer over plaster.
- Two layers of white paint are distinctly visible.
- Wooden support is visible below the plaster layer.

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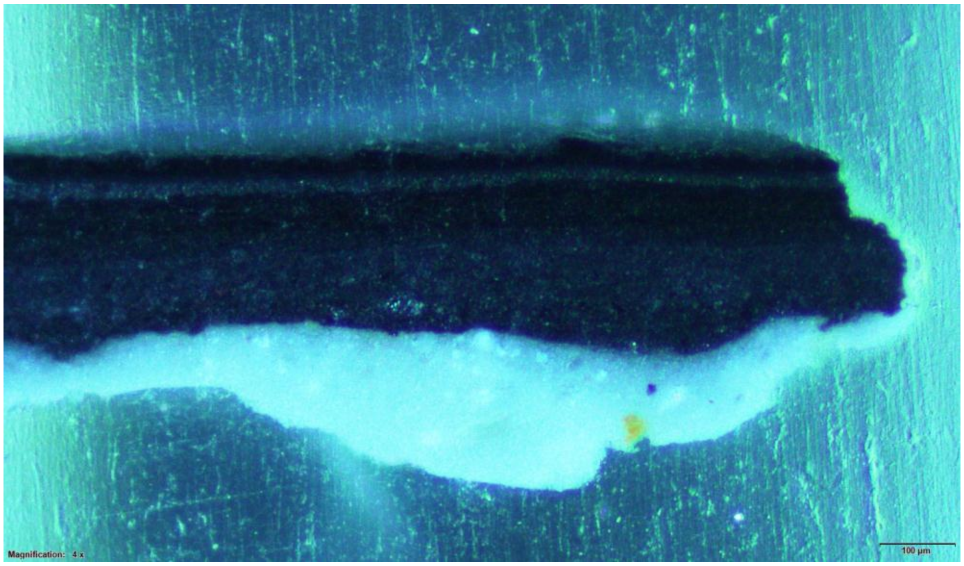
SAMPLE NO.: F02 (Location: Gandhara Gallery)

REFLECTED LIGHT: 4x

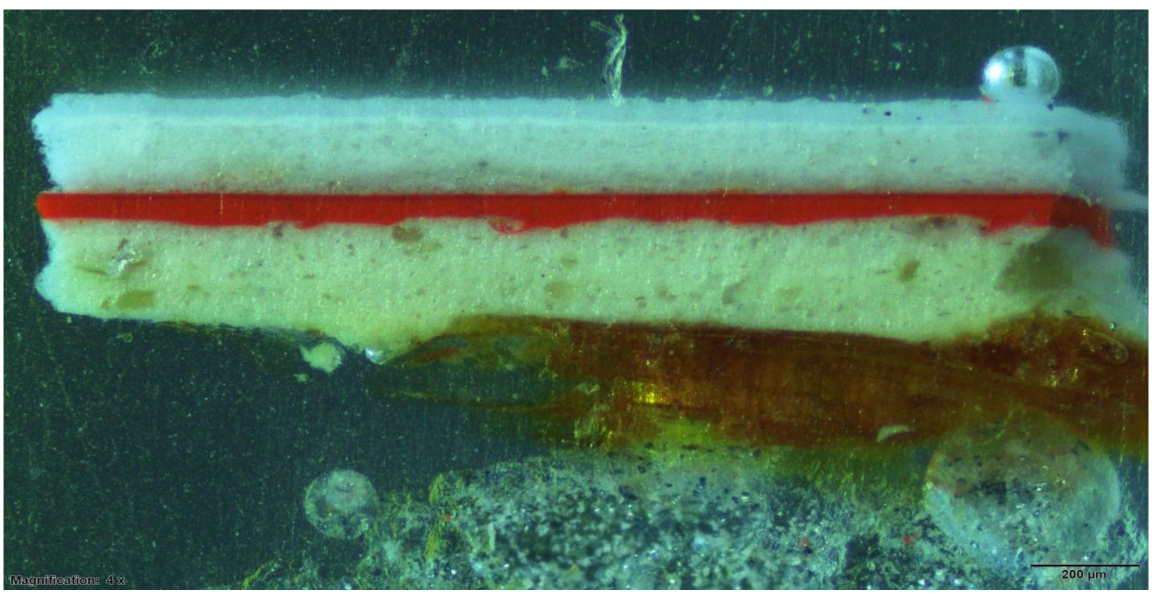


CONCLUSION:

- A single ground/plaster layer is visible under reflected light.
- Four layers of dark paint (different tones) can be distinguished under reflected light.

SAMPLE NO.: F03 (Location: Shaft Door-Coin Gallery)

REFLECTED LIGHT: 4x



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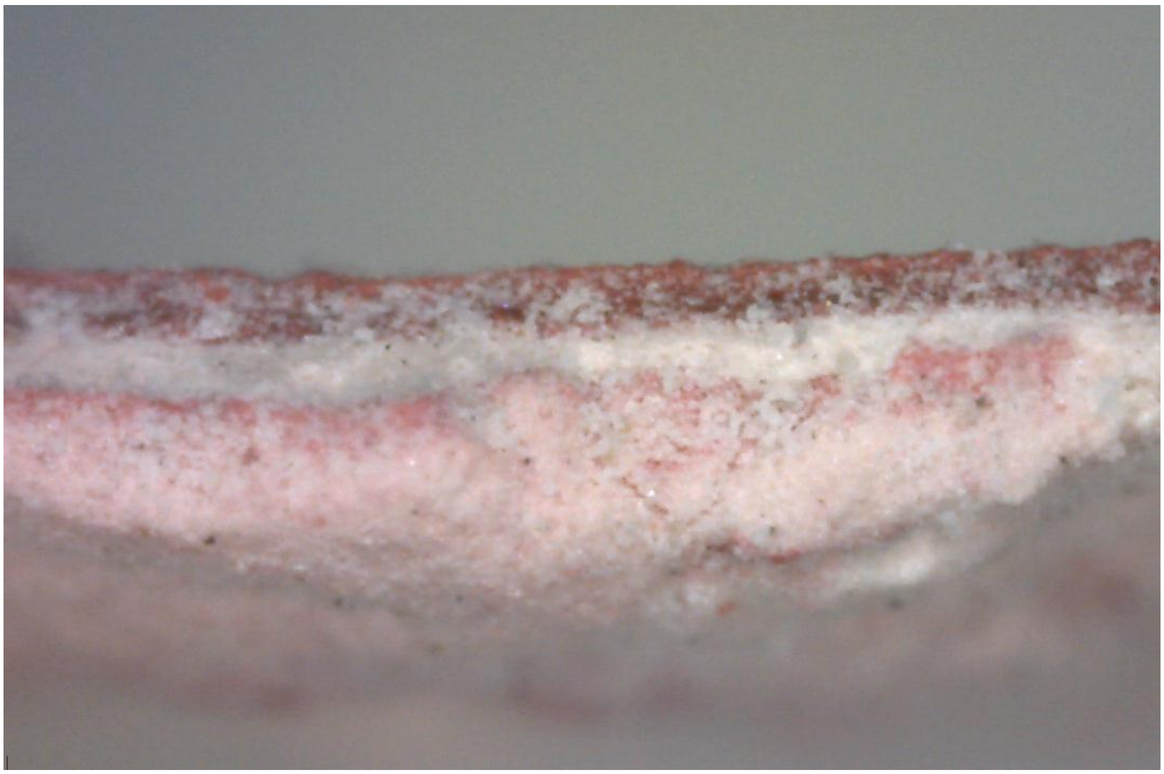
CONCLUSION:

- This sample shows that a red painted area is painted over with white.
- One layer of plaster, followed by ground and red paint is visible.
- Then a ground layer is present over the red paint layer.
- Two white layers are visible over the ground layer.

SAMPLE NO.: F04 (Location- Contemporary Gallery)

REFLECTED LIGHT: 4x



CONCLUSION:

- One layer of red coloured layer can be seen under reflected light.
- One layer of plaster is visible under reflected light.
- One layer of ground between paint and plaster layer is visible under reflected light.

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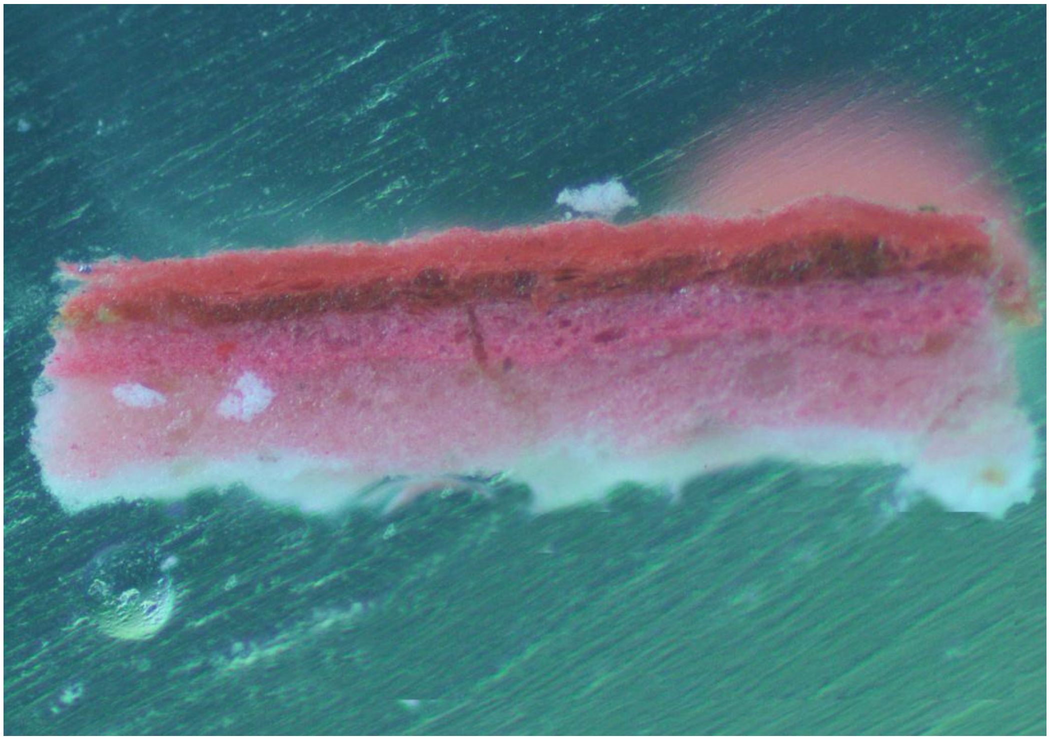
Slide No.: **0110-0123**

SAMPLE NO.: F05 (Location: Shobha Singh Gallery-First floor)

REFLECTED LIGHT: 10x



CONCLUSION:

- Three layers of plaster are visible under reflected light.
- Two layers of paint are distinctly visible under reflected light.

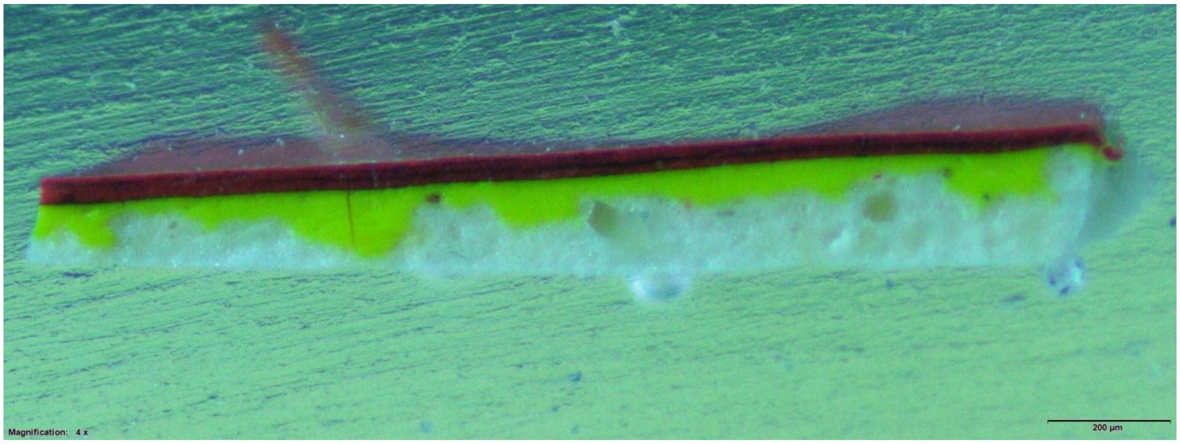
****This is an examination report only and in no way can be treated as a statement of authenticity/ confirmation.**

INTACH

Slide No.: **0110-0123**

SAMPLE NO.: F06

REFLECTED LIGHT: 4x

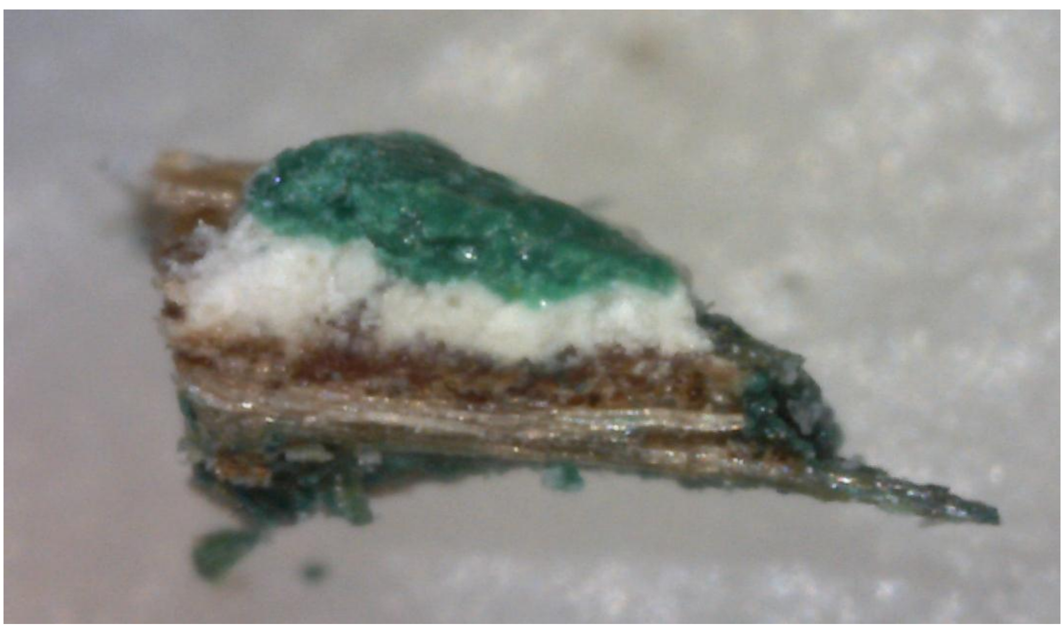


CONCLUSION:

- One layer of plaster is visible under reflected light.
- Four layers of paint, one green and three red, are visible under reflected light.

SAMPLE NO.: F07 (Location: Lift Door in stairwell- First floor)

REFLECTED LIGHT: 4x



****This is an examination report only and in no way can be treated as a statement of authenticity/ confirmation.**

INTACH

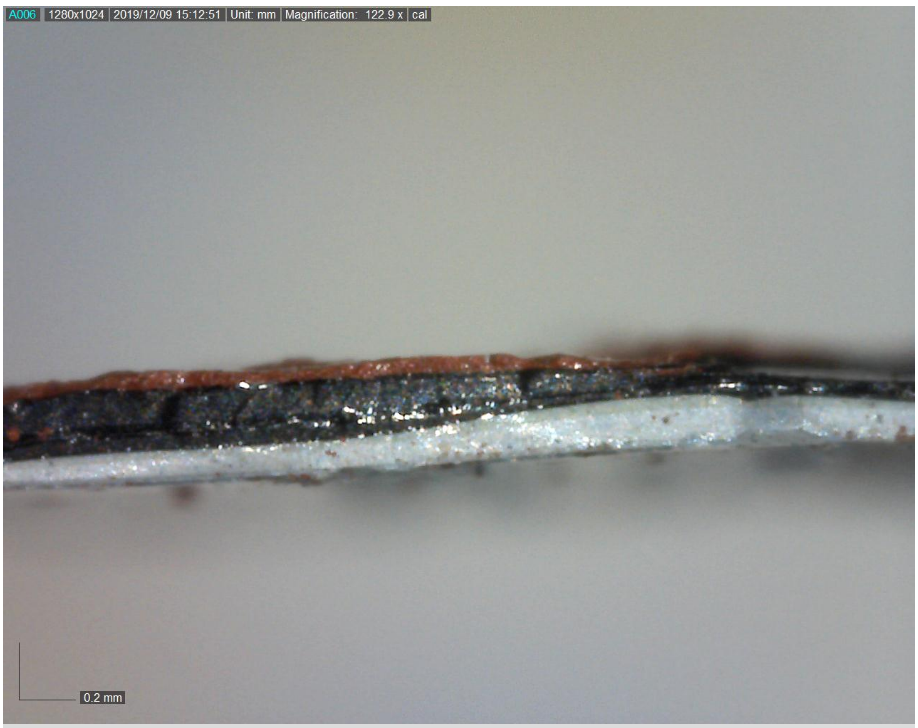
Slide No.: **0110-0123**

CONCLUSION:

- Single layers of plaster is evidently visible with the wood support under reflected light.
- One layer of green paint is visible under reflected.

SAMPLE NO.: 001 (Location: Ramp railing)

REFLECTED LIGHT: 4x



CONCLUSION:

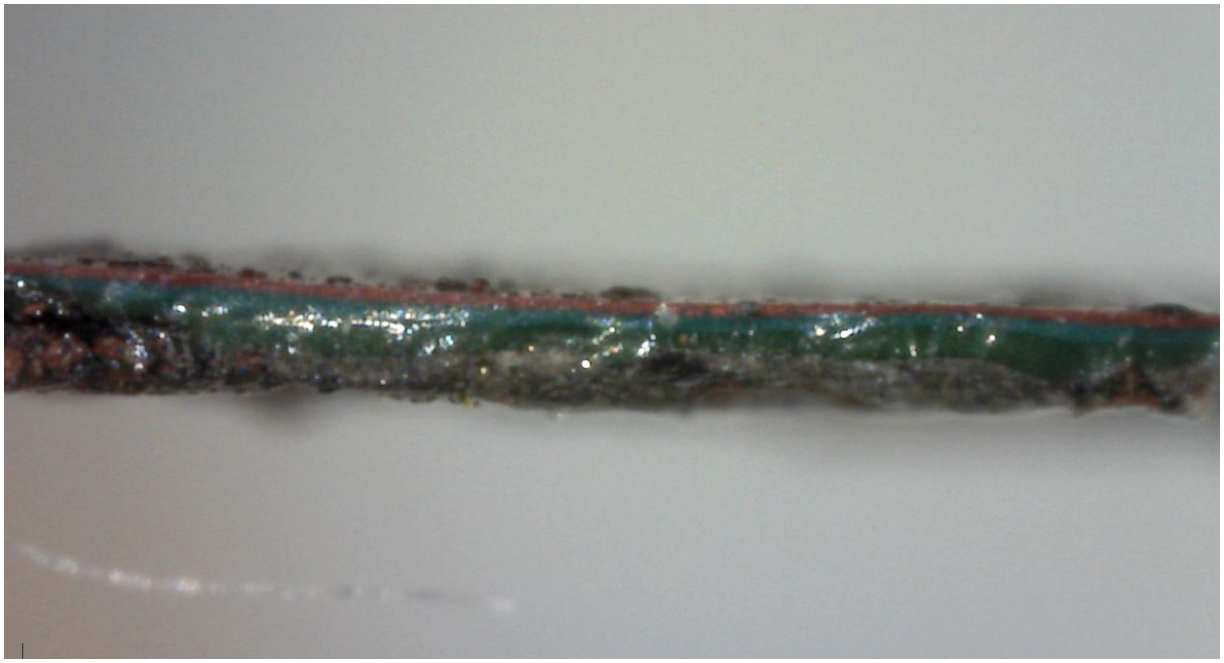
- On the metal surface two thin layers of dark blackish coating visible
- One layer of red colour is visible as the outermost layer under reflected light.

****This is an examination report only and in no way can be treated as a statement of authenticity/ confirmation.**

Slide No.: **0110-0123**

SAMPLE NO.: 002 (Location: Mumpty door)

REFLECTED LIGHT: 4x



CONCLUSION:

- On the metal surface two thin layers of greenish bluish colour are visible.
- One layer of red colour is visible as the outermost layer under reflected light.

SAMPLE NO.: 002 (Location: Library Main Door)

REFLECTED LIGHT: 4x

INTACH

Slide No.: **0110-0123**

CONCLUSION:

- The metal surface is not visible.
- The paint flake sample has two distinct red layers.

Garima S Raghav

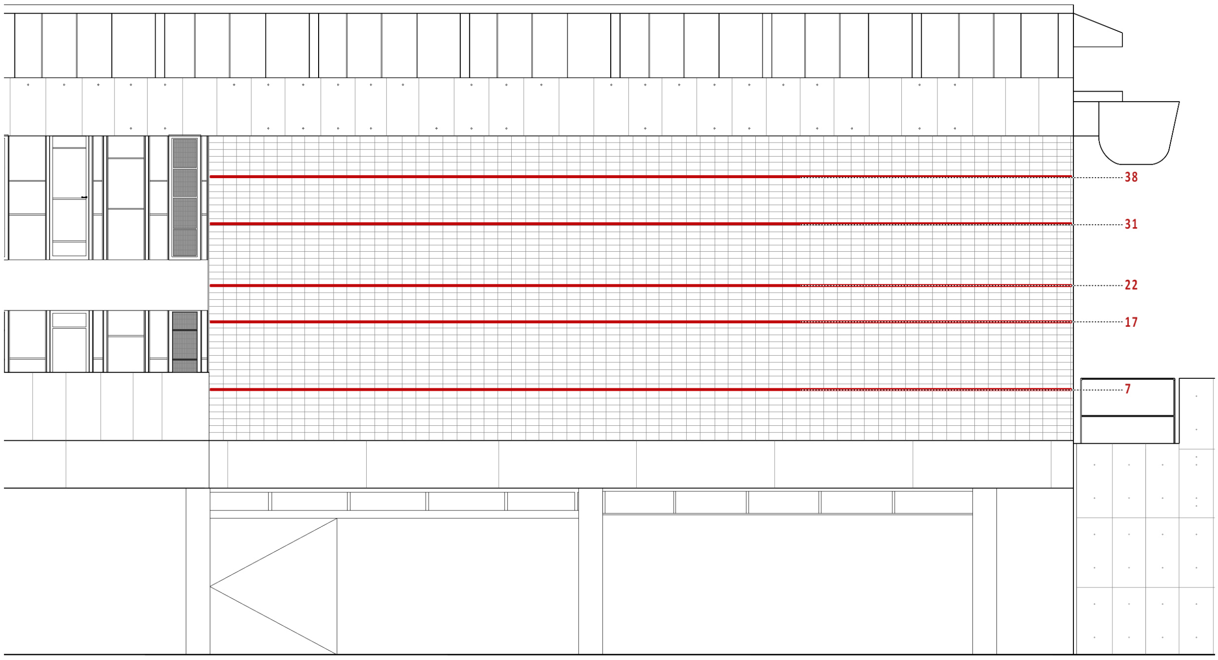
Conservator

Art & Material Heritage Division

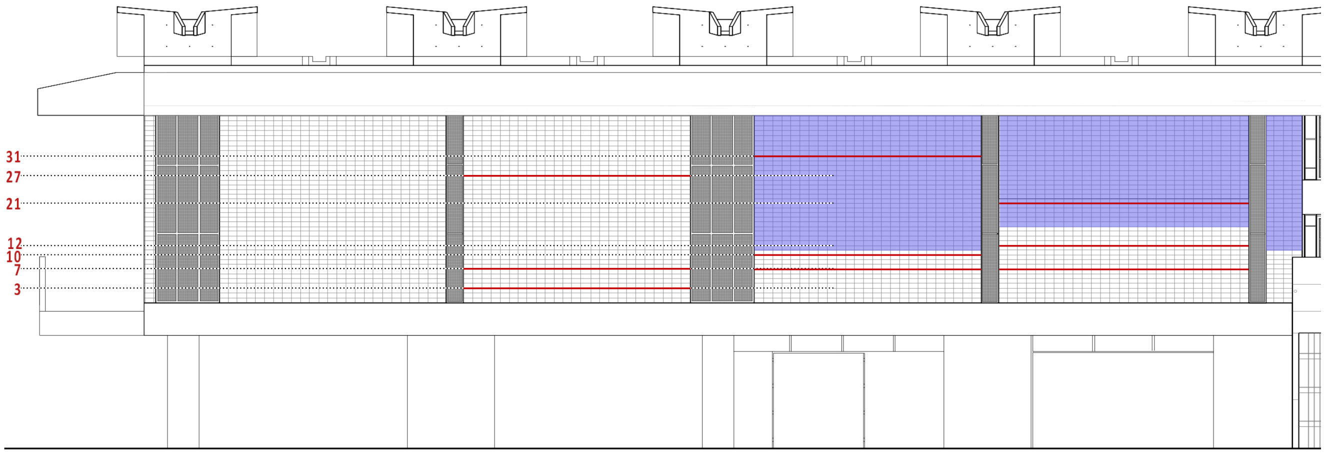
INTACH

 This is an examination report only and in no way can be treated as a statement of authenticity/ confirmation.

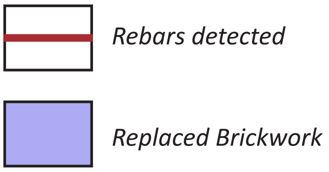
B.4.4 The report of the test conducted by Metal Detector is below:



South-West Elevation



South-East Elevation



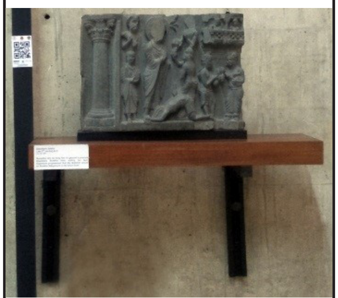
B.5 Inventory of Original Museum Furniture

A basic inventory showing the types and number of original furniture in the Government Museum and Art Gallery is given below:

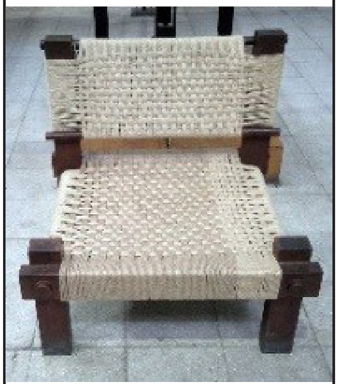
S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
1.	Sofa chair with arms		**2**	D.C Room
2.	Junior officer table		**2** GM/OT-10 GM/lib/OT/2	D.C. Room Library
3.	V-leg chair with arms		**17**	4- Art Gallery reception 1- Metal Sec. 1-Gandhara Sec 2- Library 2- Child art Gall 2- Cont. Reserve collection 5 – Antiquity Reserve collection
4.	Chair arm-less		**7**	1-Miniature sec. 1-Contemp. sec 1-Child Art Gall. 2- Common Room- GCE46 1- Library C.Ed. 87 1- Cont. Sect. 163/8/
5.	Study table		**6+1 =7** 6 No's [thick] 1 No's [thin]	Library
6.	Easy sofa chair with arms		**12** GM/LH/CU.C- 1 GM/LH/CU.C- 2 GM/LH/CU.C- 3 GM/LH/CU.C- 4 GM/LH/CU.C- 5 GM/LH/CU.C- 6 GM/FCH - 1 GM/FCH - 2 GM/FCH - 3 502 2 without nos.	Library – Chairman Room

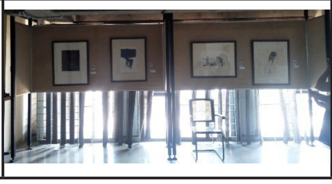
S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
7.	Senior Officer table		**1** GM/Lib/OT-1	Library – Chairman Room
8.	Easy Sofa Chair with arms		5 + 2 broken	Common Room
9.	Wooden chair with square legs and woven cane seat		**8** GM/CH/72 GM/AG/c 5 GM/CH/51 GM/CH/54 GM/AG/c 17 GM/CH/59	Common Room
10.	Wooden chair with woven cane seat		**3** GM/CH/10 GM/CH/CS- IO/ WC[c]9	Common Room
11.	Cross leg wooden Chair		**2**	Common Room
12.	Junior officer table		2 No's broken GM/OT/9	Common Room
13.	Table with file racks		**2**	1 - Common Room 1- contemporary reserve collection

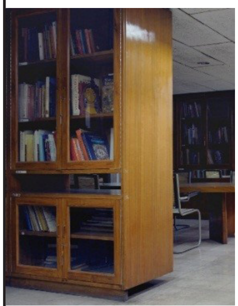
S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
14.	Wooden center table		**2 + 2 + 6 = 10**	2-Contemporary reserve collection 2- Antiquity reserve collection 6- Store [exhibition hall]
15.	Glass show-case		10 GM/SC-1 TO 10	Metal Gallery
16.	Glass Show-case		**3**	Metal Gallery
17.	Display stand (Stone)		**1 + 5=6**	1 Metal Gallery+ 5 miniature section
18.	Glass Show-case		**13**	Gandhara Section

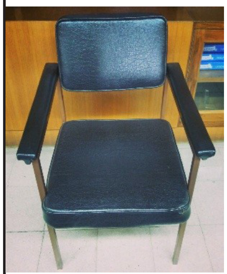
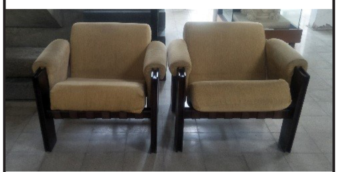
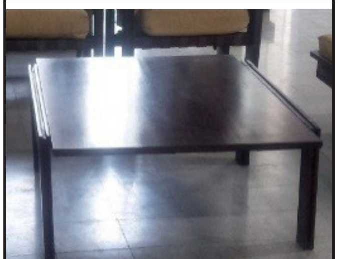
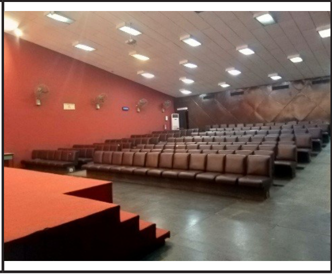
S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
19.	Glass Show-case		18	Gandhara Section (16 display +1 behind screen +1 under Library stairs)
20.	Write-ups boards		**3+1+3 = 7**	(3 Gandhara Section + 1 Cont. Section + 3 Miniature Section)
21.	Pedestal fixed on wall		**3**	Gandhara Section
22.	Pedestal stand		**3**	Gandhara section (2 in glass show-case)
23.	Iron Pedestal (3legs)		**2**	Gandhara Section (1 in glass show-case)

S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
24.	Stone Pedestal		**1** (Round)	Gandhara Section
25.	Wooden Pedestal (Rectangular 18x9 blocks)		3+2+3=8	3 Gandhara Section +2 Contemporary Section +3 Textile section
26.	Wooden Pedestal (Rectangular blocks)		1	Store [exhibition hall]
27.	Wooden Pedestal (Rectangular 24x9 blocks)		**2+1=3 (2 inside glass show-case + 1 outside show case)**	Gandhara Section
28.	Wooden Pedestal (Square 12 x12 blocks)		1 + 1 =2	1 Gandhara section + 1 Textile Gallery
29.	Wooden Pedestal (Square 9 x 9 blocks)		1+3=4	1 Gandhara section + 3 Textile Gallery

S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
30.	Iron- Pedestal		**1**	Gandhara Section
31.	Peedhas		6 + 7 =13	6 Miniature + 6 Contemporary +1 Coins Gallery
32.	Vertical display glass rack		6	Miniature
33.	Glass Show-case		**2 (small) +1 (Big) =3**	Miniature
34.	Glass Show-case		2	Miniature

S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
35.	Screens		42	Miniature
36.	Wooden-stand		**1(Round)**	Contemporary Section
37.	Fixed hanging Screens (Vertical)		16	Contemporary Section
38.	Fixed hanging Screens (Horizontal)		**2**	Contemporary Section
39.	Moveable Vertical Screens		23	Contemporary Section (1 17 Display + 3 under chairman room stairs + 2 under library stairs + 1 back side of Brahm gallery)
40.	Horizontal Screens with side stand (Half, small)		2	Contemporary Section

S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
41.	Horizontal Screens without stand (Half, Big)		**3**	Contemporary Section
42.	Wooden pedestal with Iron stand		**3+1+5+7 +5 =21**	3 -Contemporary gallery 1-Textile gallery 5- Contemp. Reserve collection 7- Store [exhibition hall] 5- Gandhara Gallery(2 in show-case)
43.	2 Setees + 2 Chairs		2 +2= 4 Long setee - GM/SS.2 Broad setee -GM/ SS.2	Library
44.	Book- Racks		**18** **GM/BS – 1 to GM/BS -12 , GM/Lib/ BS - 25 to 30**	Library
45.	Show- Case		1 (GM/B.S. -13)	Library
46.	Wooden Rack		GM/CB-2	Library
47.	Fixed Book Rack (Dr. Randhawa section)		**6 GM/B.S. 14 to 19)**	Library

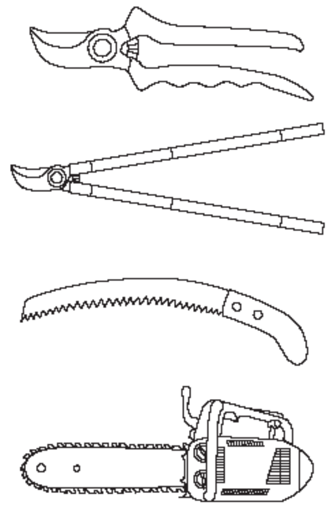
S.NO.	NAME	PHOTOGRAPH	QUANTITY	LOCATION
48.	Fixed Book Rack		3 (GM/Lib/ B.S.-21 to 23)	Library – Chairman Room
49.	Fixed Book Rack		3	Library - Chairman Room
50.	Leatherite Chair		**1 GM/Lib/OC-1**	Chairman Room
51.	Settee		**1 GM/SS.3**	Near Reception
52.	Sofa- Chairs		**2 GM/SS.4**	Near Reception
53.	Sofa		1 GM/SS.4	Near Reception
54.	Table		**1 GM/CT-3**	Near Reception
55.	Glass show-case (Square)		**7**	Child Art Gallery
56.	Auditorium Chairs		**180**	Auditorium

ANNEXURE
C: Proposed Strategies

C.1 Recommended Strategies for Tree Pruning [94 95 96]

1. Tree pruning exercise should take place as per the instructions/ directions of a Certified Arborist/ Horticulturist under direct supervision of a Garden Supervisor during his duty hours.
2. The various aspects and procedure for correct pruning practice with diagram is shown below:

C.1.1 Tools



- Hand pruning for small branches, up to about ½ -inch diameter.
- Loppers or a saw for larger branches or for species with hardwood.
- Long-handled loppers to remove larger-diameter branches, but precise cuts are more difficult to make.
- Newer blade designs are able to cut large and small diameter branches quickly and cleanly. Pruning saws are available with fixed or folding blades, or mounted on a pole. Larger pruning saws are sometimes used by professionals.
- Chainsaws are not recommended for general pruning, except by professionals as a time saver.

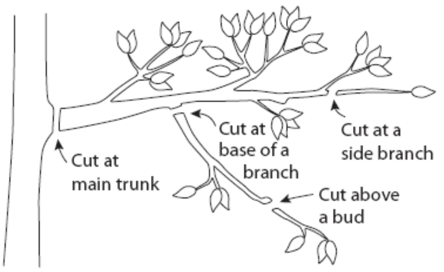
C.1.2 Timing

- To minimize damage and synchronize with the natural growth cycle, winter pruning is recommended (January, February).
- Heavy pruning in early spring (April, May) should be avoided as tree energy reserves are low.
- Timing for light pruning is less critical.
- For maximum display of spring flowering species, pruning after bloom (June or later) is better.
- Dead limbs and branches can be pruned at any time.

	J	F	M	A	M	J	J	A	S	O	N	D
BEST TIME	■	■										■
WORST TIME				■	■							
LIGHT PRUNING	■	■	■			■	■	■	■	■	■	■

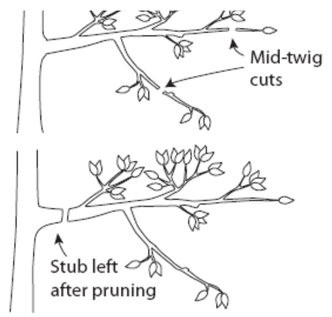
C.1.3 Hierarchy of cutting

YES



Always cut back to the main trunk, base of a branch or above a bud. This technique respects natural growth patterns.

NO

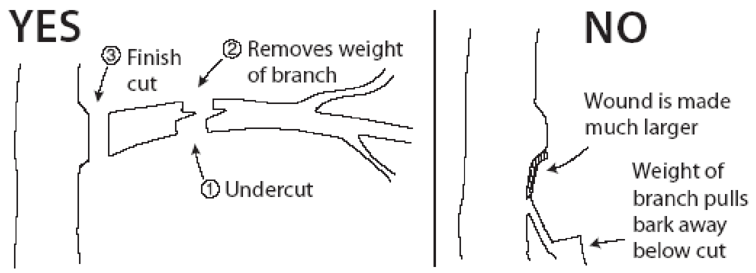


Do not leave a stub. Do not cut in the middle of a branch or twig. Pruning in this manner creates entry points for decay and pests.

94. Basic Pruning Guidelines, Missouri Dept. of Conservation
95. http://www.peterborough.gov.uk/pdf/env_PruningTechniques.pdf
96. http://www.tlcfortrees.info/pruning_specifications.htm

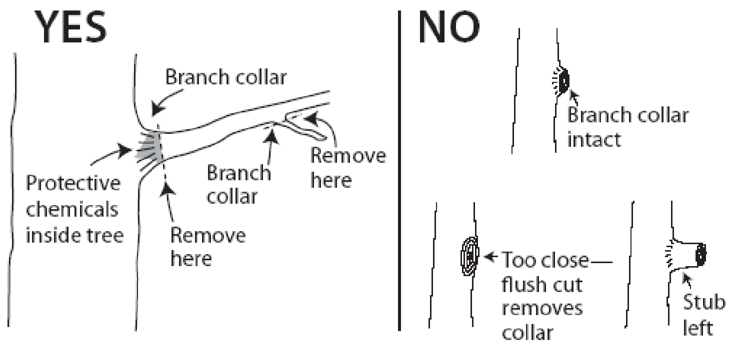
C.1.4 Applying the three-cut method for larger diameter branches

• Branches 1” (25.4 mm) in diameter or larger generally should be removed in a series of three cuts. This will prevent bark attached to the base of the cut branch from stripping away bark on the trunk as it falls.



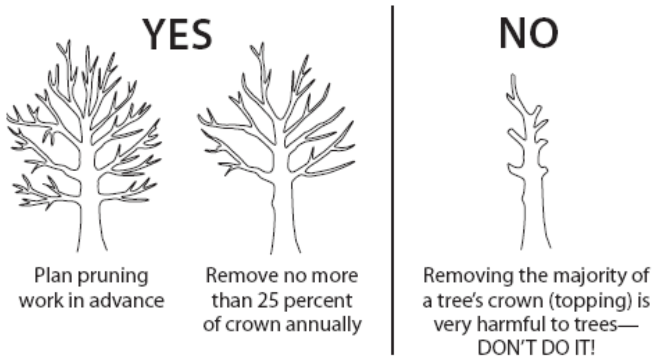
C.1.5 Saving branch collars

• Trees produce natural chemicals to prevent decay from entering the tree at the base of each branch or limb.
• To preserve this chemical zone, pruning should spare the slight swelling or branch collar, at the branch base. The resulting wound will be smaller than if the branch were cut flush. This rule applies to large limbs and small branches.



C.1.6 Degree of pruning

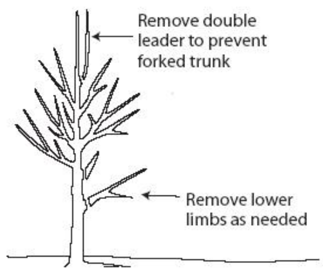
• An important principle to remember is that a tree can recover from several small pruning wounds faster than from one large wound.
• Only a small percentage of the live part of a tree may be removed at one time - a maximum of 25% in one year for healthy, vigorous trees.



• The older and larger a tree becomes, the less energy it has in reserve to close wounds and defend against decay or insect attack. The pruning of large mature trees should be limited to removal of dead or potentially hazardous limbs.
• Weak or declining trees should be pruned still lesser.
• Severe pruning is absolutely undesirable as it may stimulate undesirable sprouting from the stem or roots.
• Pruning more than 25 percent of the live crown annually of any tree two years in succession should be strictly avoided.

C.1.7 Pruning for young trees to avoid future problems

• Simple hand-pruning tools can be used when a tree is young to prevent future growth problems as well as inconveniences and the need to remove large limbs later in its life.
• Young trees should be checked for any abnormality like forked tops (double leaders) or low level branches, which should be gently removed.



C.1.8 General 'DO'-s & 'DON'T-s' to be followed

• Established and maturing trees should be inspected every 2-3 years for pruning and maintenance needs. The main concerns for pruning middle-aged and mature trees are: Removing the 'Five D's (Dead, Dying, Damaged, Diseased and Deformed limbs).
• A Certified Arborist/ Horticulturist should review the bids for contract before they are made public to contractors.
• Only contractors with a Certified Arborist/ Horticulturist on staff or retainer should be considered for award of the pruning work. That Certified Arborist would be expected to make regular site visits (at least weekly) for supervision.
• Only rope and saddle climbing gear without climbing spurs or spikes should be allowed for pruning live trees (spurs and spikes wound trunks and allow decay organisms to enter the trunk, or they may transfer diseases from tree to tree).
• All crewmembers should wear the appropriate safety gear: hard hats, eye protection, approved boots etc.
• Pruning large trees can be dangerous. Hiring the services of a professional arborist is strongly recommended, who will determine the type of pruning necessary to improve the health, appearance, and safety of the trees. A professional arborist can provide the services of a trained crew, with all of the required safety equipment and liability insurance.

C.2 Building Conservation Proposal Matrix

The tags given in the table below have been used in the Conservation Proposal drawings (Annexure D) to identify the condition and its corresponding treatment proposed for the building.

Legend for Concrete:			
CODE	CONDITION	TREATMENT	TAG
CO- RC	CRACKS	• Clean grout • Fill the crack	CO-RC
C0- P1	LOSS OF MATERIAL	• Provide/install patch	CO-P1
CO- P2	EXPOSED REBARS (more than X mm long)	• Clean Rebar • Remove loose concrete • Provide/install patch	CO-P2
CO- P3	PAST REPAIRS	• Remove old patch • Clean the rebar • Coat the rebar • Provide/install patch	CO-P3
CO- P4	DETACHMENT	• Remove loose concrete • Clean the rebar • Coat the rebar • Provide/install patch	CO-P4
Legend for Brick Tiles:			
CODE	CONDITION	TREATMENT	TAG
Remove pointing and re-point all joints for brick cladding			
BT-RE	Dislodged/Deformation/ Detachment/ Displaced	Re-secure Brick	BT-RE
BT- RR	Exposed Rebar/metal strip	Clean and prime metal surface and repoint joints	BT-RR

Legend for Terrazzo:			
CODE	**CONDITION**	**TREATMENT**	**TAG**
Remove pointing and re-point all joints for terrazzo tiles			
TZ- NT1	Weathered Tile/ Loss of Material	Replace weathered tiles with new	TZ-NT1
TZ- NT2	Past Repair	Replace improper tiles with new matching tiles	TZ-NT2
TZ- NT3	Damaged Material	Replace damaged tiles with new tiles	TZ-NT3
TZ- RC	Cracks	Repair cracks by filling and refinishing the surface	TZ-RC
TZ- RE	Detachment	Re-secure detached tile	TZ-RE
TZ- W1	Wooden Inserts - 1	Remove wooden Inserts and in-stall patch for area less than 25% area	TZ-W1
TZ- W2	Wooden Inserts - 2	For more than 25 % area remove and install new tiles	TZ-W2
Legend for Fibreboard:			
CODE	**CONDITION**	**TREATMENT**	**TAG**
FB-NB1	Seepage	Replace damaged boards with new boards (or salvaged from the areas under demolition)	FB-NB1
FB-NB2	Past Repair	For past patches more than 25% replace the board with new and paint	FB-NB2
FB- P1	Past Repair	Provide patch of composite material for past repairs less than 25%	FB-P1
FB- P2	Damaged Material	Provide patch of composite material where the fiber board has cracks or is damaged	FB-P2
FB- CP	Efflorescence	Clean and paint	FB-CP
FB- RE	Dislodged/ De-formed Material	Re-secure dislodged or loose fibre boards	FB-RE
Legend for Acoustical Panels:			
CODE	**CONDITION**	**TREATMENT**	**TAG**
AP- RE	Dislodged/ De-formed Material	Re-secure dislodged or loose acoustical panels	AP-RE
AP- RP	Loss of material	Replace damaged panels with new panels	AP-RP