PHYSICAL STRATEGIES – NON STRUCTURAL INTERVENTIONS
NON FABRIC INTERVENTIONS

This session was created by Mike Taylor and modified by Claudia Cancino.

ABSTRACT

Intervention strategies for the conservation of earthen architecture, which are selected in response to the identification of specific problems, are numerous and varied. They range from monitoring and taking little action, to intense stabilization or the replacement of portions of the structure's fabric.

Likewise, the conservation resources available for architectural conservators, site/building managers, and homeowners can be simple and inexpensive or complicated and costly. A variety of techniques can be used, based on the variables of the structure. It is important to know when to use what conservation methods, how to combine various conservation methods on the same site, and when to not do anything.

The preservation of earthen architecture in ruins (i.e. in an archaeological site), is dealing with structures in an abnormal state, that is, attempting to prevent the deterioration of an earthen structure without a roof, which it most likely had when it was built.

The majority of exposed earthen archaeological sites are ones that have been excavated fairly recently and have usually suffered from lack of maintenance and exposure to the elements since their excavation. Earthen architecture melts when exposed to rainfall and snow, and suffers the similar types of erosion as does other building materials from such factors as wind, salts, animal and plant infestation, visitor impacts, seismic events, etc. What makes earthen architecture unique to other building types is that, without a good roof and good foundation with proper drainage, the walls will erode faster than stone masonry.

For this reason there are few large monumental edifices of earth that have been exposed to the elements for centuries, with the exception of such sites as Chan Chan in Peru, where rainfall is sparse. Most earthen structures that have been abandoned historically have eroded into archaeological mounds, benefiting from the shroud of its own earth and wind born particles that end up protecting the site until archaeologists unearth the structure. When the structure is abruptly exposed to the elements, it goes first into environmental shock, usually suffering severe cracks from the sudden drying effects of the environment, then suffering from the renewed effects of rain, snow, animals, humans, etc.

Maintenance and monitoring

Maintenance is key to the longevity of any structure, be it in an archaeological setting or a building still in use. An assessment of the maintenance needs, taking into consideration the available personnel and budget, is an important step in weighing options for the treatment of a structure. With a regularly scheduled maintenance cycle in place, concurrent with regular inspections and monitoring, a structure's needs can be met, in many cases. There are instances where this type of maintenance is not feasible.

Historically, owners of historic earthen homes re-plastered their structure on a regular basis. Nowadays in many parts of the world this option is no longer viable, due to the restructuring of the socioeconomic life of a community, which makes it difficult for the members of the household to conduct such maintenance tasks. Along the same lines, managers of archaeological sites may not have the budget and personnel available to sustain a maintenance cycle needed to maintain earthen architecture in ruins, by performing regular re-plastering of the walls, capping, and correction of basal deterioration caused by capillary moisture.

Maintenance can be detrimental in some cases: if the persons doing the work begin to replace portions of the fabric in a piecemeal fashion over a period of many years, the wall may no longer retain its original historic fabric over time. This may be acceptable in many cases on a structure that is still in use where the significance lies in the continued use of the structure as a functioning envelope, but may not be acceptable in an archaeological setting. Regular maintenance can also gradually detrimentally affect the structure from such activities as dragging hoses over walls, spraying walls with too much water, and scraping the surface down prior to applying a new coat of plaster.

Non-fabric Alterations

The basic premise for conserving earthen architecture is to intervene on the physical fabric as little as possible. If techniques are identified that will diminish the deterioration of the structure through minimal impact to the physical fabric of the building, then those should be evaluated and selectively used before any alteration of the physical fabric takes place. Examples of these types of "non-fabric" interventions include: backfilling portions of all exposed earthen architecture on an archaeological site, constructing protective shelters over all or portions of an archaeological site, and altering drainage patterns that have detrimental impacts to a building or site. Often times these types of interventions will solve, or greatly diminish, many of the deteriorative problems from which a structure could be suffering.

There are a variety of factors to assess while searching for methods to better protect earthen structures that do not involve altering the historic fabric of the structure. They include:

Drainage

Minimizing the amount of water in proximity to the bases of earthen walls is paramount in protecting the structural integrity of the structure. Many times simple alterations can be performed at minimal cost such as establishing a positive slope away from the structure, directing runoff from gutters and downspouts well away from the walls, and proper maintenance of already existing drainage systems by inspecting and clearing these systems on a regular basis.

Surface drainage is favored over subsurface systems because of lower cost, low maintenance and minimal disturbance to archaeological remains. When establishing positive slopes away from ruin walls, equal finish grade levels on both sides of the wall are preferred to avoid the deleterious effects of differential grades that could transfer damaging moisture and salts from one side of the wall through to the other. This should be done with hand labor, since heavy equipment can create vibrations in the architecture, inadvertently knock over a wall, or quickly destroy subsurface archaeological remains if they exist. Hand compaction of the grade is desirable so that moisture can be more readily directed away from the structure instead of seeping below grade through loose fill next to the wall base.

Other types of drainage systems are designed to control water runoff from areas adjacent to or near an archaeological site(s). Many times these systems are installed in association with controlling or slowing down the water velocity in washes, arroyos, streambeds or rivers. They can range from fairly simple, inexpensive systems that are installed in periodic runoff areas near sites; to expensive highly designed systems installed to divert water away from major episodic floods or permanent watercourses.

Some of the more common systems used are:

- Straw bales: installed in a subtle u-shape to stop or reduce the velocity of water. The bales, laid end to end, are partially buried into the soil and stabilized by wooden stakes or rebar placed on the opposite side of where runoff would occur. The ends of the two bales in association with the banks of the wash would be excavated into the wash embankment to obviate runoff from spilling around the ends. This system is not permanent, but can serve to form a quasi-permanent berm against accelerated runoff affecting a site.

- Rip-rap: similar in concept to the straw bale approach of diminishing the flow of water, but more labor intensive, permanent, and costly. Rip-rap consists of stones placed in wire baskets that are tied together to form the configuration cited above for straw bales. These systems are used extensively to control river channels and around culverts in highway construction.

- Geo-webs: similar to the rip-rap system just described, but instead of wire basket, the container is a plastic mesh.

Sub-surface drains are used when surface drainage cannot adequately remove moisture that may be adversely affecting an earthen wall. Even though many varieties of sub-surface drains exist, the following two types of sub-surface drainage systems are widely used:

- French drain: system consisting of a trench excavated at least one meter from walls to a depth even with the bottom of the wall's foundation. In the trench is placed a perforated pipe sloping to an open drain, field or to a dry well. The pipe is surrounded by gravel and the trench filled with gravel to almost grade. The trench sides and top can be covered with a soil filter fabric that will inhibit the passage of soil particles and miscellaneous debris that may clog the system.

- Geo-drain: A less invasive sub-surface system than the "French" drain. A geodrain has a nipple core surrounded by soil filter fabric, which inhibits the entry of soil into the drain. A geo-drain can discharge water with minimal disturbance to the substrate. This can be an important factor in archaeologically sensitive areas. After digging a very narrow trench, normally done with mechanical equipment, the geo-drain is installed. The geo-drain is placed in the trench at a slope to enable gravity-fed discharge into an open drain field or into a dry well.

For Reburial, refer to:

Teuntonico, Jeanne Marie; 'Conclusions and recommendations of the Colloquium Reburial of Archaeological Sites Santa Fe, New Mexico, 17-21 March 2003', *Conservation and Management of Archaeological Sites. Special Issue on Site Reburial,* Vol. 6, Number 3 & 4 (2004) Pages 395-399

For Shelters, refer to:

Avrami, Erica; Barrow, Jake; Jerome, Pamela; Taylor, Michael R. 'Protective shelters for archaeological sites in the southwest USA. A colloquium held a Tumacacori, Arizona, 9-12 January 2001', *Conservation and Management of Archaeological Sites. Special Issue on Protective Shelters,* Vol. 5, Number 1 & 2 (2001) Pages 3-6

OBJECTIVES

As a result of this session, the participant should be able to:

Classroom Lecture:
- Understand the difference between structural and non-structural interventions
- Identify and understand the various interventions that can be implemented on an earthen archaeological sites which do not directly impact the site physical fabric
- Present the positive and negative impacts for each type of intervention
- Explain when non-fabric interventions are preferable to fabric intervention
- Rationalize when it is better not to do anything

Field Exercise:
- Gain familiarity with materials and techniques used to install drainage systems or rebury archaeological sites
- Understand the inter-relationship of designing and installing drainage systems in association with a reburial program
- Be aware that the drainage systems installed during the exercises can be used in applications with archaeological sites or extant historic buildings

CONTENT

Classroom Lecture – Overview of non-structural interventions:

The lecture will be extensively illustrated with examples of such treatments from different parts of the world and from regional sites as well. This lecture will be followed by field exercises in separate sessions on reburial and drainage techniques.

In addition to presenting examples of sites and conditions in various parts of the world, it is important that the instructor present examples of situations within the region where the participants live and work. This will focus on the specific types of environmental conditions (i.e. precipitation, freeze/thaw, proximity to a coastline, humidity, etc.) that the students generally have to contend with when assessing which techniques might have a positive impact on retarding the erosional rates at their sites.

The non-fabric interventions to be illustrated through images in the classroom will include the following:

- Partial or total reburial of exposed earthen architecture on archaeological sites
- Construction of protective shelters over all or portions of an archaeological site
- Alteration of drainage patterns that have detrimental impacts to a building or site

Participants will be able to assess the efficacy of these types of interventions through the class lecture illustrated by examples. Time will be allotted for classroom discussion on how these techniques can diminish many of the deteriorative processes caused by exposure to the elements at earthen archeological sites.

In support of the objectives of this section, the instructor will:

- Present the classroom lecture in a way that builds on information presented in earlier sessions addressing the implementation of non-structural interventions

- Demonstrate that each response stems from the analysis of the physical and social conditions at a given site.

The instructor will present information and stimulate discussions on the following non-fabric interventions:

Drainage

- Surface
  - Rip-rap
  - Geo-webs
  - Straw bales
- Subsurface
  - French drain
  - Geo-drain

Site reburial

- General issues, current research
- Types of soils
- Local conditions
- Importance of not disturbing archaeological deposits
- Freeze/thaw effects
- Wet/dry effects
- Rodents and insects
- Documentation/stabilization prior to backfilling
- Seismic effects
- Equipment considerations (when to use heavy equipment)
- Use of geo textiles
- Using backfill interventions to improve drainage on site
- Importance of not introducing salts, seeds that could prove damaging
- Seismic vibrations of heavy equipment in proximity to walls
- Levels of compaction
- Re-vegetation by broadcasting, raking, then mulching grass seed
- Positive effects:
  - Seismic effects dampened
  - Reduction in amount of maintenance needed on site
  - Discourages vandalism
  - Removes resource from direct impacts of weather
- Negative impacts:
  - Hides the resource from view to visitors, researchers
  - Potential introduction of damaging salts and vegetation
  - Potential damage from heavy equipment

Protective shelters

- Aesthetics
- Drainage
- Materials used for shelter construction (availability, cost)
- Surface and sub-surface anchoring
- Maintenance
- Positive impacts:
  - Removes resource from falling damp if designed correctly
  - Diminishes maintenance to the resource

- Negative impacts:
  - Aesthetics
  - Cost for construction
  - Potential disturbance to archaeological deposits
  - Provides shelters for animals, insects
  - Potential creation of destructive wind turbulence
  - Potential creation of damaging micro-environments

Field Exercise:

This is a workshop activity with demonstrations by the instructor and assistants, then hands-on exercises by the participants who will be divided into teams. The first half of the exercise will involve demonstrations and participant installation of drainage systems. The second half of the exercise will involve demonstration and installation of reburial techniques.

It is important to emphasize throughout the exercises that any technique used will need to be based on previous sound planning and analysis of the conditions at any given site.

The field exercise will be undertaken at either ten new test walls (one meter high by one meter long) built for this exercise, or at historic earthen walls at an archaeological site.

The construction of ten test walls (5 for the drainage exercise and 5 for the reburial exercise) could serve earlier exercises on building techniques and traditions if needed to expose participants to hands-on construction techniques. If a test wall plot is used as the venue for the exercises, such a plot should have dimensions large enough to accommodate five teams of participants with at least ten small walls.

Figure 5.1.1 (left) and 5.1.2 (right)
View of exercise walls with instructor discussing the field exercise to PAT students
PAT course, 1999 © J. Paul Getty Trust

If using historic earthen walls at an archaeological site, analysis and proper planning should identify needs, such as a particular drainage or reburial intervention. Any disturbance to archaeological fill material in association with the walls will need to be mitigated by a qualified archaeologist. For the drainage exercises, if buildings have been identified through proper analysis and planning for installation of a geo-drain or a French drain, these buildings can be used instead of newly built test walls.

Drainage exercise

Demonstration

With a flip chart available to illustrate any points of the demonstration to the whole group, the instructor will demonstrate (with the help of the assistant instructors) the installation of three drainage techniques:

Surface drainage (with positive slopes): The instructor will stress that surface drainage with positive slopes leading away from walls is the preferred and easiest drainage solution. The instructor and assistants can easily demonstrate this with shovel and rake. Also, compaction of any disturbed fill next to the wall can be demonstrated by foot stamping, a hand tamping tool, and/or a roller drum filled with water. If simple positive drainage contoured away from walls is not possible, or will not solve the moisture problem because of, for example, differential fill, great quantities of water collecting at the bases of walls, etc., then more invasive systems can be installed such as a French drain or a geo-drain which are described in the session abstract.

Hands-on exercises:

Given a hypothetical group of 20 participants, the group will be divided into five teams of four participants each, with an assistant instructor for each team.

Each team will work on installing drainage systems on five walls. Each team will install a French drain on one side of the wall and a geodrain on the other side of the wall. Before the exercise assistants will have already excavated trenches for these installations.

Once the systems are installed, water will be introduced to the base of the walls to demonstrate the efficacy of the drainage systems. Each team will record any observations.

Figure 5.1.3
View of French drain instalation
PAT course, 1999 © J. Paul Getty Trust


Figure 5.1.4 (left) and 5.1.5 (right)
PAT students working on different drainage installation systems at test walls
PAT course, 1999 © J. Paul Getty Trust

Reburial exercise

Demonstration

With a flip chart available to illustrate any points of the demonstration, the instructor will demonstrate (with the help of the assistant instructors):

- Total reburial of a wall using hand equipment
- Partial reburial of a wall using hand equipment
- Total reburial of a wall using heavy equipment (i.e. bobcat)
- Total reburial of a wall using a conveyor belt system fed by bobcat in the hopper

For each type of demonstration, the instructor will:

- Estimate amount of fill needed
- Discuss selection of soil type to be used for backfilling
- Install geo fabric material, with discussion of various types available
- Place fill material in levels, with tamping or rolling at each level
- Place of final level of fill, with proper grade requirements

Hands-on exercise:

Given a hypothetical group of 20 participants, the group will be divided into five teams of four participants each, with an assistant instructor for each team.

Each group will then rotate among five walls that will receive one of the various reburials treatments outlined above.

Teaching Tips

It is important to be flexible with this exercise. If the instructor feels that other drainage systems that are used in the region would be more applicable for the exercises, then they can be added to or substituted with the exercises presented here. Also, if the instructor feels that the actual hands-on exercises are much more of a physical workout with good cardio-vascular benefits than actual didactic lessons, the amount of shovel and tamping time can be reduced. It is important, however, to have at least one wall completely backfilled with enough soil fill over the top of the wall (at least ½ meter), the various fill levels tamped, and surface drainage contours established on the finished product.

It is also important to have all the supplies, materials, and tools needed for the exercises close at hand so that there is minimal down time for the participants. For example have the backfill dirt placed next to the walls to be backfilled to minimize time and effort needed to backfill the walls. Have hoses already available for use when systems are to be tested.

Figure 5.1.6 (left) and 5.1.7 (right)
PAT instructor, Mike Taylor, demonstrating reburial of a test wall with high relieves.
PAT course, 1999 © J. Paul Getty Trust

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🕮 = Essential reading material

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