PHYSICAL STRATEGIES – STRUCTURAL ANALYSIS AND INTERVENTIONS

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ABSTRACT

Structural intervention is an important concept in most interventions to historical earthen buildings and structures. An intervention that is structurally integrated allows the structural system to continue to function in the way that it was intended; or, in some cases, extends or adds to the original structural system to protect the heritage structure from forces and threats that the original was not capable of withstanding. Whether as a replacement for a missing or failed component of an original system, or as an additional system component, the intervention works as an integral part of the structural system.

An original structural system of a wall minimally consists of the wall itself and a base on which it transfers forces to the ground. It may also consist of intersecting walls that provided some degree of rigidity and resistance to flexure and overturning. The original wall thickness may have been adequate, but erosion may have reduced the thickness to a critical level. An original wall that was perfectly vertical at one time may be leaning to a critical degree because of the failure of the foundation. Structural cracks made have effectively isolated various components of the structural system resulting in separate components, which then act alone and are structurally incomplete. In these cases interventions are directed toward the restoration of the missing or failed part of the system.

In some cases, threats may not have been anticipated and the structural system was simply not designed to address them, such as the movement of the earth from the impact of heavy modern construction equipment. In other cases, while a threat may have been known, the technology to adequately resist the threat was not; or even if known, may have not been employed because of a reason lost through the passing of time. In these cases interventions may add components that did not exist previously.

Threats may be the result of a change in the use of a structural element or of an entire structure. A habitation intended for human use may not be adequate for storing manufacturing equipment. Defensive walls may not adequately resist the decay caused by extended exposure to human use. Interventions may consist of the addition of structural components or the treatment of parts of the original to make it more resistant to decay brought on by the new uses. When evaluating the need for intervention, it is also important to consider that changes in use may have also reduced the causes of deterioration and it may not be necessary to restore the original system.

Archeological sites and associated structures often face all of the conditions and scenarios previously mentioned. The remaining structures are normally performing a different functional use than intended, they have lost come critical components of their structural systems, and they are exposed to threats that were not anticipated.

This session will introduce a range of interventions. These will address interventions at the base of an earthen structure, to structural cracks that have altered the performance of the structural system, to the replacement of missing walls and portions of walls, and interventions required to provide resistance to earth movement in a seismic event. Several of the interventions introduced during the lecture will be addressed in more detail during the field exercise that follows. The purpose of the field exercise is to provide an opportunity for the students to undertake some of the interventions themselves. The interventions will take place on new walls, constructed for this purpose and are designed with the exercise in mind.

It will be emphasized that the primary goal is not to design the best system of intervention to address the concerns of new uses, the failure of original structural components, and previously unanticipated threats. The primary goal is to protect the heritage structure by intervening as little as possible. This can best be accomplished by simply eliminating the threats; if completely successful, interventions of any type would not be necessary. The elimination of the threats is the first goal of the conservator. However, when the threats cannot be eliminated, conservation interventions are necessary.

OBJECTIVES

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

Classroom Lecture:

- Describe basic repair approaches.
- Understand the basic concepts that will be used during the field exercise to follow.
- Describe the concept of incompatibility of materials and systems and give examples of each.
- Describe and give examples of structural non-seismic integration.

Field Exercise:

- Demonstrate knowledge of appropriate reintegration methods.
- Describe a range of solutions for a common reintegration issue.
- Demonstrate an understanding of the process stable condition-failure-reintegration.

CONTENT

Classroom Lecture:

The classroom lecture will introduce the subject of structural intervention, the methodology, and provide examples of actual case cases. The field exercise will demonstrate some of the methods described in the lecture. Because of the shortness of the lecture, the major subjects will be summarized.

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

- Introduction
    1. The session activities for the day and the responsibility of the instructors.
    2. The relationship between this session with the previous sessions and particularly with the sessions that are to follow.

- Intervention – Inappropriate examples
    1. Incompatible materials
        a. Important soil characteristics
        b. Examples
    2. Non-Structural
        a. Inappropriate examples of basal erosion repair
        b. Inappropriate crack repairs and introduction of replacement material that does not act cohesively with the original materials
        c. Case study example and coverage of basic concepts
    3. Excessive Structural Intervention
        a. Examples of reinforced concrete interventions, etc.
    4. Infrastructure Problems
        a. Inappropriate drainage systems, excavations, adaptive reuse.

- Lower Wall Repair
    1. Basic review of previous session on basal repair
    2. Examples

- Lower Wall Replacement
    1. Lower wall decay in historic building.
    2. Examples showing support of upper wall by pinning.
    3. Use of existing or new foundation.
    4. Support of upper wall by wood compressive plates and banding.

- Upper Wall Repair
    1. Major erosion rills, and voids.
    2. Examples of repair using both mud bricks and rammed earth.

- Vertical Cracks
    1. Critical at corners.
    2. Repair of crack in a single wall plane
    3. Repair of crack by structural knitting at a corner when thecrack extends around the corner

- Wall Replacement
    1. New wall construction in historic structure.
    2. Replacement of large section of wall needed to reintroduce structural integrity to the system.
    3. Show examples

Field Exercise:

The field exercise will be undertaken at the constructions used earlier to demonstrate failure patterns. The five groups will each work on a separate construction and each group will be given a specific reintegration assignment, in addition to a common exercise for all of the participants. The common assignment will be the stitching together of two portions of an adobe wall separated by a structural crack.

Figure 5.3.1 (left) and 5.3.2 (right)
Left: View of field exercise walls to be repaired
Right: PAT instructor discusses the damage and proposed solutions to PAT students
PAT course, 1999 © J. Paul Getty Trust

Prior to the exercise the session coordinator and assistant instructors will modify the constructions for the specific exercise. It is anticipated that several hours will be required, depending on the results and the condition of the constructions after the failure exercise.

- Exercise Introduction
    1. Each group will be given the specific group assignment.
    2. The general time frame for the exercises will be explained.

- Groups will all begin by stitching together a crack
    1. Assistant and collaborating instructors will be available for each group.
    2. Each group will perform a quick evaluation of their wall condition and review conditions with the assistant instructors
    3. After a brief discussion about the solution the group will begin the repair

- The second part of the exercise will begin at a predetermined time, regardless of whether or not the stitching repair has been completed
    1. Groups A and B will pin a wall and begin repair on the lower portion of the wall with the wood pins supporting the upper portion.
    2. Groups C and D will construct a missing portion of a wall effectively reintegrating two portions of the wall.
    3. Group E will reintegrate a wall by a small-scale seismic banding system utilizing ropes and bands to restore the ductility of the system.
    4. Each group will again evaluate their specific project and in collaboration with the assistant instructors will develop a plan for the reintegration.

- Each group will describe their specific assignment and present their approach, describe what they think they did correctly and what they would do differently.

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