CONSERVATION SPECIFICATIONS

November 2005

"Documentation and Conservation of King Khasekhemwy's Funerary Monument at Abydos"

David O'Connor, Matthew Douglas Adams

with

Anthony Crosby and William Kelly Simpson

Egyptian Antiquities Project

USAID Agreement No. 263-G-00-93-00089-00

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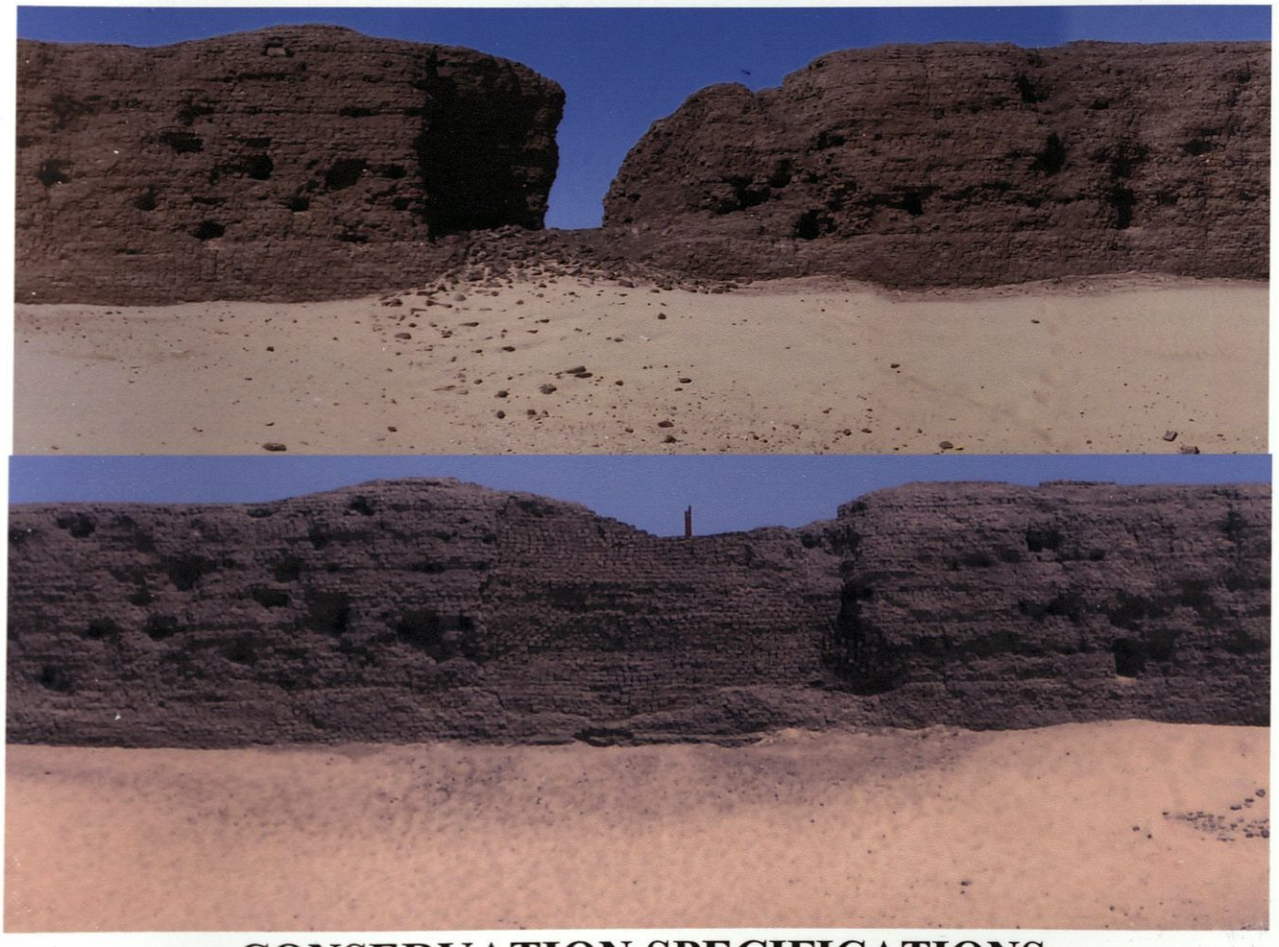
CONSERVATION of the SHUNET el ZEBIB MONUMENT
(c. 2,700 BC) **Abydos, Egypt**



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Shunet el Zebib Archeological Conservation Project
David O'Connor, Project Director, Matthew Adams, Associate Project Director

University of Pennsylvania Museum-Yale University-
Institute of Fine Arts, New York University Abydos Expedition
David O'Connor and William Kelly Simpson, Co-Directors

Revised and Submitted November 2005 by

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This Report was prepared for
The Egyptian Antiquities Project of the American Research Center in Egypt, Inc.(ARCE)
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tel. And fax (20-2) 354-8622, E-Mail: arceeap@internetegypt.com
under USAID Grant No. 263-G-00-93-00089-00 (formerly 263-000-G-00-3089-00)

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INTRODUCTION

The initial conservation report, "Documentation and Conservation of the Shunet el Zebib, Preliminary Field Report No. 1", resulting from field work carried out in January 2000, recorded the conditions, identified the major cause and effect relationships that have in the past and continue to result in decay, and proposed that conservation interventions be undertaken as soon as possible. The three-volume report emphasized the potential for additional loss and the unsafe conditions that presently exist.

The July 2001 Conservation Specifications were the next step in the process of meeting conservation goals. It drew heavily from the initial field report in its approach and in some of the specifics of the interventions, but went much further in detailing specific interventions for the comprehensive range of problems and conditions that existed then. It also specified tools, equipment, and materials that will be needed for the conservation work and how they are to be used.

The November 2005 Conservation Specifications are another step in the process. Several of the specifications remain the same and are identified as such. However, most of been rewritten and others added to respond to the field conditions, but most importantly to the actual conservation work that has been completed over the past three field seasons. After each field season, there has been an editing of the conservation specifications, but they were not reissued as a separate document as is the case with these November 2005 specifications.

Illustrations in these specifications are intended to provide a general understanding of the conditions and the conservation work. The work illustrated is based on sound conservation principles and the success of these approaches at other sites and monuments around the world. This version of the specifications also utilizes many photographs and images from the actual conservation work at the Shuneh. It is recognized that there will continue to be additional needs for which treatments will have to be developed and described, hence this November 2005 version of the specifications will also be revised in the future. However, the general conservation principles will not be changed – the respect for the important values of the Shuneh will not be compromised.

MUD BRICK CONSERVATION
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the general stabilization and conservation approach of the Shunet el Zebib Monument. It includes the general conditions, the project sequencing, the project tools and equipment, the materials needs, as well as examples of the general approaches, detailed in other sections.

A. Mobilization: The area for mobilization for specific components of the conservation project and for the storage for all materials and equipment that is located at the site shall be designated by the Project Director's Representative.

B. Security: The mobilization area and the specific work areas at the Shunet shall be secured at all times, 24 hrs a day and every day during the life of the project. The methodology shall be approved by the Project Director's Representative.

C. Safety: Proper safety precautions are necessary prior to the beginning of all conservation work. Scaffolding shall be erected according to the Occupational Safety and Health Administration, Department of Labor (OSHA) Standard 3124, "Stairways and Ladders", and 3150, "Scaffold Use in Construction Industry". Tools shall be properly stored and used, first aid kits shall be available, and other safety measures shall be put in place to ensure a safe working environment.

D. Materials and Equipment: The mud bricks and the soils are described in detail here and the other materials are listed with their approximate quantities. Following the listing of the materials is a list of the tools and equipment that will be required for the work.

1.2 CONSERVATION APPROACH

For the purposes of this document, the overall approach to the conservation of the Shunet el Zebib monument is to protect the existing form and fabric of the Shunet, and its relationship to its immediate surroundings while reestablishing structural integrity and providing the basic conditions that can be protected into the future by an active and ongoing preventative conservation maintenance program. In addition, the structure and the site are particularly important and valued for the research potential. The conservation interventions completed to date reflect this approach.

The Shuneh has undergone many changes since ca. 2700 BCE, and its present condition and character reflect those changes. The important character to protect is represented by the series of images that are at the end of this Section 04200 (Figures 1 – 4). The most important character is the overall masses and voids of the large mud brick walls that define a basic rectangular form of 75 meters by 135 meters. The general character of the site and a very important character-defining feature is the general relationship of the natural landscape and landforms to the

Shunet. The conservation interventions have and will continue to reflect the significance of this character. Other important character-defining features are the actual texture of the individual courses of mud brick, the differentiation of the difference courses, and the complex texture of the individual bricks. The rhythm established by the pilasters is another important character that provides visual references to the original structure.

1.3 PROJECT SCHEDULE (SEQUENCING)

A. General Project Sequencing: Installation of Bracing, Shoring and Buttressing

A series of sand bag buttresses were installed initially in 2001 and sand bags have been used for buttresses as the work progresses. The existing scaffolding has also been utilized for bracing and shoring and special needs have dictated additional shoring and bracing approaches. The priority consideration for conserving this structure is to first ensure that all the wall bases are structurally sound and that the workers will be safe while on site.

Much like the emergency stabilization, the stabilization phase is emphasizing the repair of the lower portion of the walls, the exposed ends of walls, voids in the mud brick mass and the tops of the walls. Interventions not for conservation purposes shall not be part of this phase of this conservation project.

Prior to any archeological investigations or similar work or studies that occur within 5 meters of the Shunet walls, a thorough investigation of the subject walls shall take place. This investigation shall be for the purpose of identifying all potential safety conditions and mitigating those conditions. No work shall proceed prior to this investigation and resulting mitigation. This is in-addition-to and not in-place-of the installation of appropriate bracing and shoring.

B. Conservation Intervention

1. Reconstruct missing areas of the southeast corner to provide integrity to the corner. Completed in Spring 2005
2. Restore the void and hole through the north end of the West Enclosure Wall. Completed in Fall 2004
3. Restore the south and the north ends at the west gate area of the West Enclosure Wall. Work began in spring 2005 and is underway.
4. Permanently stabilize the lower walls of the East and the West Enclosure Walls. Work has begun on the west enclosure wall.
5. Restore the south end of the north tall section of the East Enclosure Wall. Work is schedule to begin in spring 2006.
6. Restore the major wall cracks of the tall walls: (1) the east end of the North Enclosure Wall; (2) the south and north ends of the north tall section of the East Enclosure Wall; (3) the south and north end cracks

of the south tall section of the East Enclosure Wall; (4) the cracks in the South Enclosure Wall; (5) the cracks near both ends of the south part of the West Enclosure Wall; and the crack near the south end of the north part of the West Enclosure Wall. The repair of the cracks has been undertaken in some areas and will continue after the walls are stable.

7. Restore the large wall voids created by the Coptic cells on the west sides of the West and the East Enclosure Walls, four on the west wall and one on the east (Figures 15 and 16). Two major cells have been completed and work is underway on others. Still other cells will be stabilized in future seasons.
8. Restore the gap in the North Enclosure Wall. This was completed in Spring 2004
9. Restore the lower part of the north side of the South Enclosure wall.
10. Stabilize the tops of all the walls, interior and exterior walls, with the addition of a sacrificial cap where determined necessary. Capping of all the walls will be a lower priority. A section of the east wall was completed in the fall 2004 and capping of the perimeter wall will begin in fall 2005.
11. Reattach pilaster mud bricks and rebury sections. Specific treatment areas will be identified in the field by the Project Director's Representative. Testing continues and two pilasters have been stabilized.
12. Repair and fill all minor holes in the walls, including in some cases, open masonry joints. This will discourage animal activity. This is an ongoing activity and is a part of each field season.

1.4 RELATED WORK

A. SECTION 04210 – MUD BRICK MANUFACTURE

B. SECTION 04220 – SURFACE RENDERING

C. SECTION 04230 – CRACK REPAIR

D. SECTION 04235 – PLASTER STABILIZATION

E. SECTION 04240 – MUD GROUTING

F. SECTION 04250 – MUD BRICK CONSTRUCTION

G. SECTION 04255 – HORNET NEST REMOVAL

H. SECTION 04260 – WALL BASE VOID REPAIR

I. SECTION 04270 – VOID AND HOLE REPAIR

J. SECTION 04280 – MUD BRICK CAPPING

K. SECTION 04290 – PILASTER REATTACHMENT

L. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

M. SECTION 04297 – SAND BAG PROTECTION

1.5 SUBMITTALS

A. No mud brick conservation work shall begin until mud bricks and soil are approved.

1.6 QUALITY ASSURANCE

A. All preparation and conservation work shall conform to the highest international standards for conservation interventions. Techniques developed for conservation and restoration shall be employed to protect the fabric and form of the structure.

B. Do not change basic materials and equipment including scaffolding, mud bricks and soil during the course of the work, without approval.

C. The specific conservation site decisions shall be the responsibility of the Project Director's Representative, who shall have specific training and experience in the field of mud brick conservation and shall rely on the project conservation architectural consolidants and other expertise in making decisions.

D. The progress and the details of the interventions specified here shall be thoroughly documented, and the records resulting from that documentation added to subsequent project report submissions. A documentation plan shall be approved by the Project Director's Representative prior to the beginning of the work. In addition to the conservation interventions, the plan shall include the documentation of architectural and archeological features that are uncovered during the conservation work.

E. Scaffolding, ladders or working platforms required for executing this work shall not be attached directly to the structure unless specifically approved. Scaffolding legs shall have steel plate feet, fixed or adjustable as needed, and each foot shall be supported on one or more layers of continuous, high quality wood planking to distribute load after the ground surface is leveled. Scaffolding shall be approved by the Project Director's Representative.

F. The basic approaches developed for all interventions shall not be approval by the Project Director's Representative.

G. Product Handling: Store cement and lime in safe dry. All materials, including soil, sand and mud bricks are to be are to be kept clean and dry and protected from insects and animals. All water shall be kept clean and potable.

1.7 ENVIRONMENTAL CONDITIONS

A. Wet Weather: Do not mix mortar nor repair tops of walls during rain. Protect holes in tops of walls and cracks during rain.

B. Cold Weather: Do not repair or construct at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

C. Hot weather: If temperatures are above 40 degrees Celsius, or the wind speed is greater than 7 meters/second, protect rendered surfaces and fresh mortar from rapid drying by shading and misting. Continue to test surfaces and mortar during the drying process and treat as needed.

1.8 TEST PANELS

A. The crew, under direction of the architectural consultants, shall prepare "test panels" for each of the conditions of conservation intervention outlined in Sections 04210 – 04297. Test panels for Sections 04270-04290 and part of Section 04230 were prepared in March 2001 and will serve as test panels as applicable. The work undertaken in the previous three field season will serve as approved test panels.

B. All work including test panels shall be reviewed and approved by the Project Director's Representative prior to continuation of the conservation work.

C. The approved test panels and previous work shall be considered a part of the finished work and shall serve as a standard for the remaining work performed under that specification. All test panels shall be adequately documented and identified.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mud Bricks: Mud bricks shall be 9cm X 13cm X 26cm with the project identification stamp "PYIFA" on the 13cm X 26cm top; stamp while wet and no deeper than 1cm. Color shall match the existing Shuneh mud bricks as much as possible (Munsel Color Classification system 2.5Y 6/3, 10YR 6/2, 2.5Y 7/2). The amount of clay for the mud bricks shall not be less than that of the existing Shuneh mud brick, approximately 5% clay, and shall be continually evaluated and changes made in the manufacturing as appropriate. The aggregate in the mud shall not be larger than 1 cm.

B. A supply of mud bricks and mud brickbats for repair shall be kept on hand. The required number of mud bricks shall be not less than 50,000. The mud brickbats shall be collected from the normal breakage of the mud bricks when in use.

C. Store mud bricks by stacking after air died to continue the drying process.

D. Mud for Mortar and Mud Bricks:

1. Soil for mud mortar should have a low clay content, 5-10% by weight, and fine sand and silt and shall be from the same source as the new mud bricks. The mortar will be continually evaluated during use and adjustments made as needed.

2. All soils and mud bricks shall not have organic material in the form of vegetation or decayed vegetable or animal material. It shall be free of alkali, acids, or oils.

E. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair strength.

F. Other Materials: Following is a general list of materials and initial quantities needed for the conservation work on the Shunet, inclusive of those, the mud bricks and soil and water, already mentioned in more detail above.

The delivery and storage of these materials shall be coordinated with the architectural conservation team and shall be adjusted as necessary.

1. Mud bricks – 50,000 (9x13x27 cm)
2. Mud brick soil (for mortar) – 75 meters^3
3. Clay rich soil – 15 meters^3
4. Cement (bags) – 2 (.02 meters^3)
5. Lime (Calcium hydroxide) – 2 bags (.02 meters^3)
6. String (heavy-150 meters) – 20 rolls
7. Construction tape – 500 feet (1500 m.)
8. Fence stakes (for construction tape) – 250
9. Flagging pins – 250
10. Plywood sheets (4x8x 5/8" – equivalent metric) – 10
11. Steel bars (1/4"; 6-8mm)(to be cut in short lengths to attach Tensar Geogrid material across cracks) – 100 meters
12. Cleaning/wiping rags – 20 doz.
13. Lubricating oil & oiler – 5
14. Sand bags – Produced on site as needed
15. Tensar Earth Technologies Biaxial Geogrid (3 x 30 meters roll for horizontal reinforcement).
16. Lumber (2x4s; 2x6s; 2x8s; 1x6s) – 1000 board feet
17. Lumber (random sized pieces 1 meter long) – 100 board feet

18. Nails (steel, common) – 10 kilos of 4" (10 cm); 5 kilos of 3" (7-8 cm)
19. Metal Paint Primer – 10 liters and paint brushes

2.2 TOOLS AND EQUIPMENT:

A. Tools and Equipment: The following is based on approximately 3 conservation crews. Common tools and equipment are listed separately and they are to be used as needed by each of the crews. There is also a separate list of tools and equipment that will be set up for each of 3 crews and will be kept separate from the common tools and are the responsibility of each of the crews.

B. Water – Water to be available in combination of containers and by water hoses from the Dig House.

C. Common Tools and Equipment

1. Steel pry bars (1.5 meters long) – 2
2. Small steel pry bars; ca. 24"X1/2" (look like large screwdrivers and used for raking out deep mortar joints) - 5
3. Wood probe bars (ca 2.5-3.5 cm X 2 meters long – 10
4. Eye syringes – 4
5. Cleaning water (separate ca. 150 l.) – 1
6. Hack saw – 2
7. Hack saw blades – 2 sets
8. Set of hand tools (Vice-grips – curved jaw 175mm & 250mm; 6" slip joint pliers, 10" groove joint pliers; 18, 19 mm crescent wrenches for scaffolding; 175mm cutting pliers; 4" & 6" flat-point screwdrivers; 7 mm wrenches for mechanical ties) – 1 of each
9. Tool bag (small canvas; ca. 14"X19") - 1
10. Ratchet Tie downs (4.9 meters; 1361kg capacity) - 2
11. Mortar boxes; available supplies – 5
12. Grout Bags - 3
13. Plastic hoses for grouting; (ca. 38 mm) – 75 meters
14. Wheel barrow (large) – 15
15. Shovels or hoes - 5
16. Hydraulic jacks (5-ton) – 1
17. Chisels (masonry; ca. 2 ½ inch wide flat blade; all steel)(used for cutting mud brick and cutting out mortar joints – 5
18. Flat steel bars (ca. ¼ X 1 inch and ca. 30 cm long with one pointed end - 10
19. Ladders (wood; ca. 3-4 meters) – 5
20. Ladders (extension-13 meters) – 1
21. Measuring tapes (10 meter) – 3
22. Hand saw – 1
23. Framing square – 1
24. Nylon cord, ¼" (6 mm) for tarp grommets – 150 meters

25. Sledge hammers (large – 5 kilo) – 2
26. Duct tape – 2
27. Bailing wire – 20 meters
28. Water containers; 15-20 liters (drinking) – 2
29. Plastic or metal container with air tight lid (100-130 liters) for lime mixing and storage – 1

D. Conservation Crew Tools; Each of the 3 crews shall have the following:

1. Hand Pump Tank Sprayer – 1
2. Masonry drills (brace and bit - 25-30 cm x 12-15 mm diameter) - 3
3. Plastic Water Container (ca. 20liters) – 1
4. Grout Pan – 1
5. Grout nozzles – 2
6. Rubber Plunger (toilet bowl type) – 2
7. Pointing trowels (6 ¾ X ½ inch; 6 ¾ X ½ inch) – 2 of each
8. Steel bristle brushes – 1
9. Masons trowels (pointed – 11 ½ X 5 inch) – 2
10. Masons line – no. 18 yellow nylon (from USA) – 500 ft. rolls – 1
11. Small trowels (6 X 2 ¾ inch pointed; 5 X 2 inch square) – 5 of each
12. Brooms, whisk – 3
13. Plumb bob – 1
14. Mason's hammer, pointed – 2
15. Rope (ca. 10-15mm hemp-50 feet) – 2
16. Sledge hammers (hand, 3 #) – 1
17. Wide bristle brushes (organic fiber) – 3
18. Nail hammers (medium weight ca. 20 oz.) - 1
19. Brooms, long handles – 2
20. Buckets (for water and mortar; (7 ½ - 10 liters)– 4
21. Water drums (ca. 150 liters; either steel or plastic) – 1
22. Dust masks – 12
23. Gloves, cotton work – 12
24. Eye goggles – 5.
25. Hardhats – 5
26. Levels (1-meter bubble) – 1
27. Measuring tapes (2 meter) – 1

E. Other tools and equipment may be substituted for the above, depending on availability and local uses.

PART 3 EXECUTION

3.1 GENERAL

The execution of all site work shall be consistent with the specific materials and details for each of the conservation interventions in the following Sections 04210 –

04295. The work for each of the specific work elements shall be consistent with the general work ethics and philosophy for the overall conservation of the Shunet found in this Section 04200 and throughout this document. Any apparent conflicts shall be resolved by all parties, with the final decision the responsibility of the Project Director's Representative.

3.2 CREW SIZE

The basic conservation crew consists of approximately 4 to 5 people and will be adjusted for the individual tasks at hand. A professional architectural conservator with at least one, locally trained mason and 1 to 3 local assistants to prepare and supply materials shall initially direct the team. Promising assistants should be encouraged to develop their skills and sensitivities under careful supervision. Highly experienced assistants should be promoted to lead their own teams. It is believed that after careful training, a single professional architectural conservator could supervise the actions of 2 to 3 teams, depending on the complexity of the tasks and the ability of the workmen to be self-motivated and conscientious. No conservation work should be carried out without professional supervision.

The logistics of the project indicate that a total of 3 conservation teams could be efficiently employed at the Shunet under the supervision of a professional architectural conservator. This assumes that all workmen are properly trained and experienced and that all necessary tools and supplies are on hand at the site.

The rate at which the work is carried out will depend directly on the number of experienced and supervised workmen available on site.

3.3 SITE SAFETY

Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to work. No visitors or others not part of the conservation team shall approach to within 20 meters of the work areas. All workmen shall have appropriate eye, head, foot and hand protection equipment.

PART 4 REPRESENTATIVE IMAGES OF SITE CHARACTER AND GENERAL CONSERVATION APPROACH.

4.1 SITE AND STRUCTURE CHARACTER THAT IS TO BE PROTECTED

The general characteristics reflected in Figures 1 through 4 are examples of those characteristics of the Shunet that are to be protected. The important characteristics are identified in Part 1.2 of this section, page 1. Figure 5 and 6 are examples of the work completed that has protected the character.

Figure 1: A view of the interior of the Shunet showing the general relationship between the mud brick walls and the walls to the immediate site environment.

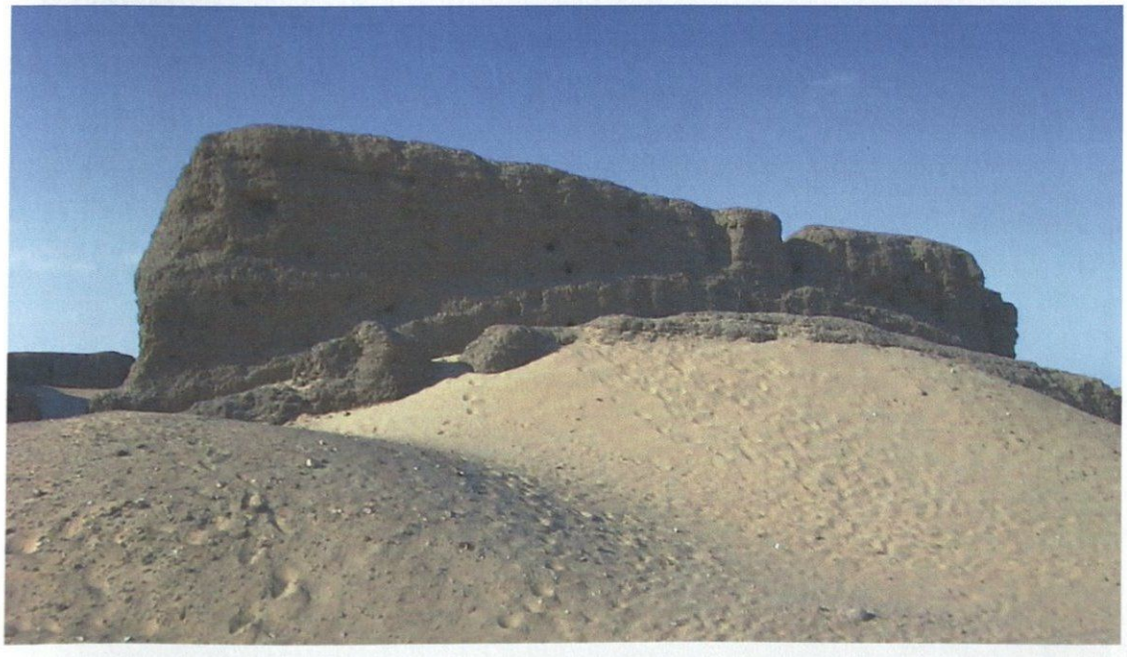

Figure 2: The South Enclosure Wall from the southwest showing the important characteristic of the mass of the mud brick wall and the remaining pilasters on the exterior wall surface.

Figure 3: The characteristic patterns of a typical wall that should also be protected. There will be some changes necessitated by the conservation interventions and will result in the reduction of some of the existing voids, but the conserved wall will retain this general character.

Figure 4: The character of the coursing pattern of the mud bricks is another characteristic that shall be protected during the conservation interventions.

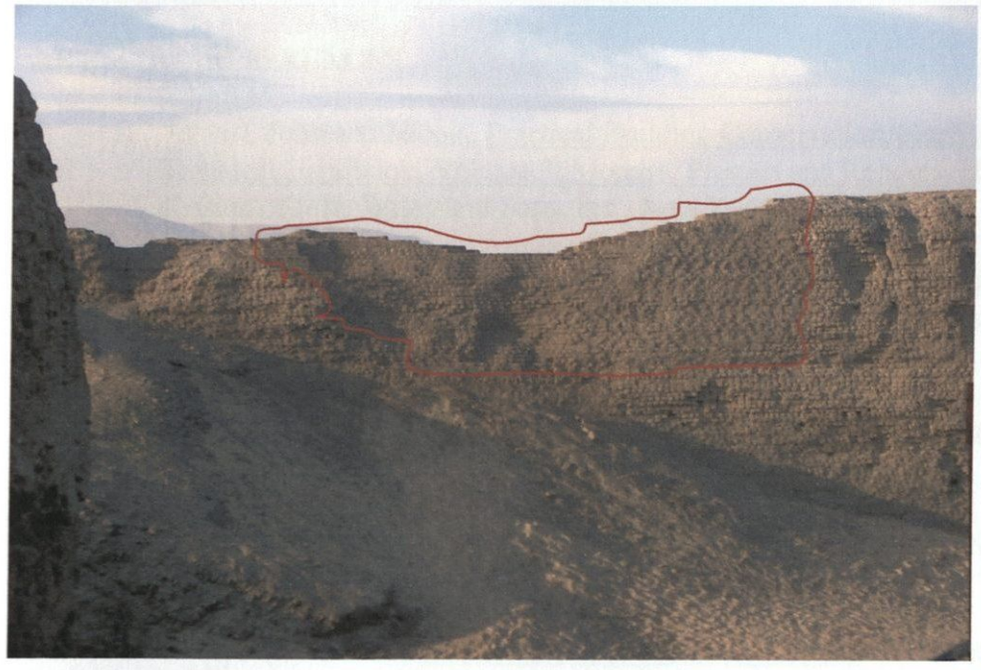

Figure 5: The character of the original walls is reflected in the stabilization of the south end of the west wall. The reconstructed section is in the center of the wall outlined in red.

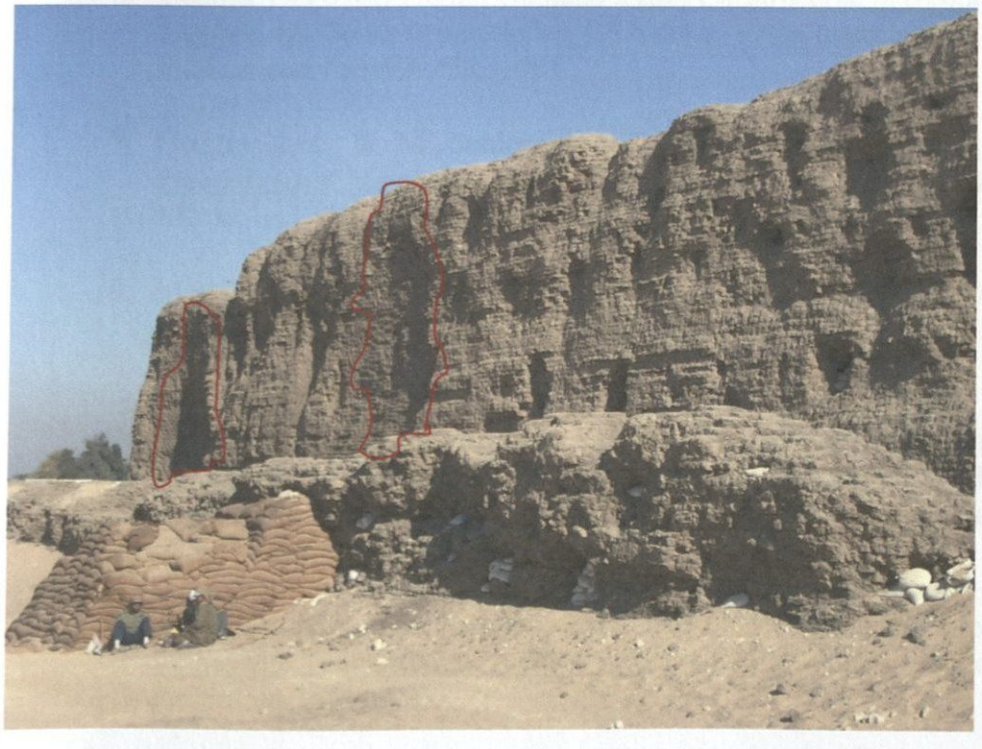

Figure 6: The character of the original walls is reflected in the stabilization of the north end of the west wall in the area where two large Coptic cells were stabilized. The reconstructed sections are outlined in red.

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END OF SECTION 04200

MUD BRICK MANUFACTURING
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the manufacturing of the mud bricks used for the conservation of the Shunet el Zebib Monument. Section 04200 provides the overall conservation guidance and this as well as Sections 04220 – 04297 provide the detail for specific conservation interventions.

A. Mobilization: The mud bricks shall be manufactured off site at the discretion of the contractor as approved by the Project Director's Representative. The mud bricks shall be delivered to the site and stored as indicated in this section in the location approved by the Project Director's Representative, in conjunction with the Conservation Architect.

B. Materials and Equipment: The selection of the appropriate soil for the manufacturing of the mud bricks is described in Section 04200, PART 2, 2.1 MATERIALS.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04240 – MUD GROUTING

C. SECTION 04250 – MUD BRICK CONSTRUCTION

D. SECTION 04260 – WALL BASE VOID REPAIR

E. SECTION 04270 – VOID AND HOLE REPAIR

F. SECTION 04280 – MUD BRICK CAPPING

1.3 SUBMITTALS

A. Submit sample of soil to be used for the mud bricks to the Project Director's Representative prior to manufacturing.

B. Mud brick samples shall be selected and evaluated for compliance with these specifications at the discretion of the Project Director's Representative during the manufacturing process.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for the manufacturing of the mud bricks.

B. Materials and mud bricks shall be consistent in quality and material used.

C. Cracks in mud bricks shall be restricted to surface cracks and shall not be deeper than 1 cm beneath the surface.

D. Breakage shall not exceed 10% of total of the mud bricks delivered to the site.

E. If soil source changes test soil mix by making series of mud bricks and curing to complete final test of soil.

F. Do not add chopped straw or other vegetative materials.

1.5 ENVIRONMENT CONDITIONS

A. Do not manufacture mud bricks at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mud bricks from direct rainfall during the curing process and while stacked on the site during project.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mud bricks shall be manufactured consistent with the material requirements of Section 04200.
B. The standard mud brick size shall be 9cm X 13 cm X 26cm and this standard size shall make up no less than 80% of the total. The remaining 20% shall be in the range of 8-10cm X 11-14cm X 25-27cm.
C. Selection of soil for mud bricks shall conform to Section 04200, PART 2, 2.1 Materials.

PART 3 EXECUTION

3.1 GENERAL

A. Non-natural materials shall not be used in the manufacturing of the mud bricks. Only unamended soils and sand shall be used. Additives that shall not be used include, but are not limited to, cement, lime, asphalt emulsions, synthetic or natural plastisizers, consolidants and water repellents.

B. Forms shall all be the same size, 9cm X 13cm X 26cm; variation in the size of the cured mud bricks shall be limited to variations in curing and material. See 2.1 B. above. Use of single or multiple mud brick forms is acceptable.

3.2 SOIL MIXING

A. Screen soil to remove large debris. Screen shall not allow particles larger than 1 cm to pass.

B. Debris or organic materials that are visually identified shall be removed.

C. Mix soil and water (potable) prior to placement in forms. Mix with minimal amount of water. Making a groove approximately 5 cm deep in the mix indicates proper amount of water; the mud formed by the groove should bulge, but not flow together. Add more dry soil if necessary and remix.

3.3 FORMING

A. Forms for mud bricks shall be smooth and clean. Wet forms between forming. If forms are wood, soak with water prior to next placement of mud.

B. Place forms on level clean ground and place the mud in the forms.

C. Force the mud in the corners of the mold, fill all voids and strike the surplus mud from the top.

D. Strike top surface of brick to avoid "hump-back" brick. Use straight edge to remove the excess mud by pulling the straight edge from one side to the other in a sawing motion.

E. If surface cracks appear immediately, sprinkle water on the top and smooth.

F. Lift the form carefully from the mud bricks and leave them in place on the ground.

G. Stamp project title "PYIFA" on each mud brick after pulling of forms (See Section 04200, Part 2, 2.1 Materials, A. and Figure 1).

3.4 CURING

A. Leave the mud bricks undisturbed for minimal of 3 to 4 days, and then stand them on their edges.

B. Allow the mud bricks to dry on their sides until completely dry (approximately 10 days). Break several to check for dryness.

C. After dry, remove for transport to site.

D. Scrape any loose materials and debris from ground from the bottom of the mud bricks after curing, but before delivery to conservation site.

3.5 STORING / STACKING ON SITE

A. Mud bricks are stacked on site of manufacture after initial curing and cleaning to continue the curing process. Transportation to the Shuneh and delivery on site shall be done carefully to avoid excessive breakage.

B. Mud bricks shall be unloaded by hand and not dumped or thrown from delivery vehicle.

Figure 1: Photograph of a new mud brick stamped with the project title "PYIFA" made in March 2001. Mud brick is 26 cm long.

END OF SECTION 04210

SURFACE RENDERING

November 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes two types surface renderings. One is a mud plaster to protect selected portions of the upper parts of the walls of the Shunet el Zebib. The second is a mud wash for the application on the reconstructed mud bricks to visually blend them into the overall wall mass.

The mud plaster is a sacrificial layer that will protect the original surface from erosion by wind and rain on a limited use basis; it the intent to use only in a relatively few areas and only if needed. It is NOT the intent of this intervention to provide a smooth and flat surface. The finished treatment shall replicate the primary characteristics of the existing surface from a distance of 15 meters including, but not limited to color and texture. The specific areas that are to be plastered will be determined in the field and approved by the Project Director's Representative.

The mud wash is applied sparingly to new mud brick sections solely for the purpose of visual blending.

Section 04200 provides the overall conservation guidance while Sections 04210, 4225 and 4230 – 04297 provide the detail for other specific conservation interventions.

A. Mobilization: The soil to be used for the mud plaster shall be delivered to the site and stored as indicated in this section in the location approved by the Project Director's Representative. The mud for the mud wash will be produced on site from broken mud bricks, both new and original mud bricks.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04250 – MUD BRICK CONSTRUCTION

C. SECTION 04260 – WALL BASE VOID REPAIR

D. SECTION 04270 – VOID AND HOLE REPAIR

E. SECTION 04280 – MUD BRICK CAPPING

1.3 SUBMITTALS

A. Submit samples of the two selected soils for the approval of the Project Director's Representative prior to delivery of the materials to the site.

B. Select broken mud bricks for the purpose of producing the mud wash for the approval of the Project Director's Representative.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements.

B. Soils for the mud plaster shall be consistent in quality and material.

1.5 ENVIRONMENT CONDITIONS

A. Do not apply mud plaster at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mud plaster from direct rainfall during the curing process.

C. Protect mud plaster surfaces from rapid drying and resulting cracking of the surface by shading from sun, by erection of wind screens, and/or by misting surfaces.

D. There is no environmental requirements for the mud wash.

1.6 TEST PANELS

A. The crew under the direction of the architectural consultants shall prepare a test panel for each of the steps in the application of the mud plaster or the mud wash. The test panels shall be 1.5 meters X 1.5 meters square, or of the entire area to be mud washed, if smaller. The panels shall be approved by the Project Director's Representative and shall remain as an example of this treatment throughout the conservation project. The panels will be part of the areas to be treated and not separate areas

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials and Equipment: The selection of the appropriate soil for the mud plaster shall be from the two soil types supplied as described Section 04200, PART 2, 2.1 MATERIALS, D. 1. and 2.

B. Mixture for mud plaster base coat: Base coat should have a higher clay content than the finish coat - approximately 30% clay and silt and the remainder of sand.

C. Mixture for mud plaster finish coat: The finish coat should have less clay than the base coat – approximately 5 – 8% clay and the remainder of silt and sand.

D. Mixture for mud wash: The mud wash will consist of crushed mud bricks and water.

PART 3 EXECUTION

3.1 GENERAL

A. Non-natural materials shall not be used in the soil used for mud plaster or the mud wash. Only unamended soils and sand shall be used. Additives that shall not be used include, but are not limited to, cement, lime, asphalt emulsions, synthetic or natural plastisizers, consolidants and water repellents.

B. Proper safety precautions are necessary prior to the beginning of the actual work. Scaffolding shall be erected and secured where access to work area by scaffolding is required. Protection from falling debris or tools and equipment shall also be in place prior to any construction repair. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

3.2 SOIL MIXING – MUD PLASTER

A. Screen soil to remove large debris. Screen shall not allow particles larger than 7 mm to pass.

B. Debris or organic materials that are visually identified shall be removed.

C. Mix soil and water (potable) prior to use. Mixture with heavy clay soil shall be soaked overnight prior to application. Mix with minimal amount of water. Making a groove approximately 5 cm deep in the mix indicates proper amount of water; the mud formed by the groove should bulge, but not flow together. Add more dry soil if necessary and remix.

3.3 MUD WASH MIXING

A. Select mud bricks to be used and crush. Remove debris and organic materials.

B. Add water and continue to mix until all clumps are broken down.

C. Mix to a consistency that can be applied with a stiff bristle brush.

3.4 PREPARATION OF SURFACES

A. Surfaces to be plastered shall be brushed clean of loose, friable material, animal scat and droppings, and organic materials such as nests.

B. Mist the surfaces lightly with water spray several times in succession as necessary to ensure even penetration. Misting of surfaces should continue as initial mud plaster coat is applied. Do not apply water spray to the extent that it results in the formation of mud drips.

C. Fill holes that remain in mortar joints and mud bricks greater than 5 cm in diameter to within approximately 3 cm of the surface. Do not fill holes flush with the surface. Fill holes with same mud as used for the mud mortar (Section 04200 Part 2, 2.1, D.).

D. Allow the filled holes to dry prior to the application of the mud plaster.

E. Brush loose soil and debris from the surface onto which the mud wash is to be applied.

3.5 APPLICATION – MUD WASH

A. Check the surrounding wall texture prior to application as the wash is to help to blend the new materials with the surrounding original material.

B. Brush the mud wash lightly across the surface to be treated; all the mortar and all the exposed surfaced should not be covered, as a uniform surface is not the intent.

C. Allow the wash to dry before evaluating the results from both a distance of 2 meters and a distance of 15 meters. If more wash is needed it can then be added. If less wash, the wash can then be spot removed (Figure 1).

D. Loose soil may also be used to help with blending. The overall surface may also require some additional texturing.

E. Final effect should be evaluated in different types of light including direct sunlight, raking sunlight, shade, and flat light.

3.6 APPLICATION – MUD PLASTER

A. Throw the mud onto the surface of the damp mud brick wall surface.

B. Force the mud into the surface and the remaining cracks and undulations with the heel of the hand and trowel.

C. Apply this base coat to a thickness of approximately 12 –15 mm thick with a trowel or by hand and shape by hand. Allow to dry completely 1-2 days before continuing. Cracks that form shall be covered by the final coat of mud plaster.

D. Prepare surface as described above in 3.4 Preparation of Surface, A. and B. of this section.

E. Apply the final coat to a thickness of approximately 12 – 15 mm thick with a trowel or by hand and finish by hand. Allow to dry 1-2 days before continuing.

F. The finished surface shall "echo" the undulations of the surface of the original mud brick that is covered. The surface shall not be smooth and shall contain the basic existing wall undulations and texture. See Figure 2.

G. If cracks appear, mist the surface and "work" the surface by hand, or with a sheepskin or sponge until cracks are filled.

3.7 CURING

A. The final coat of mud plaster will cure naturally. Restrict rapid drying of each of the two plaster coats as described above in Part 1, 1.5, D. of this section. Restrict cracking, but if cracks appear, treat as Part 3, 3.4, F of this section.

B. The only curing required of the mud wash is drying.

Figure 1: North cell on west wall with top half treated with mud wash to blend with original wall surface during process of a similar treatment for all the new bricks on this section

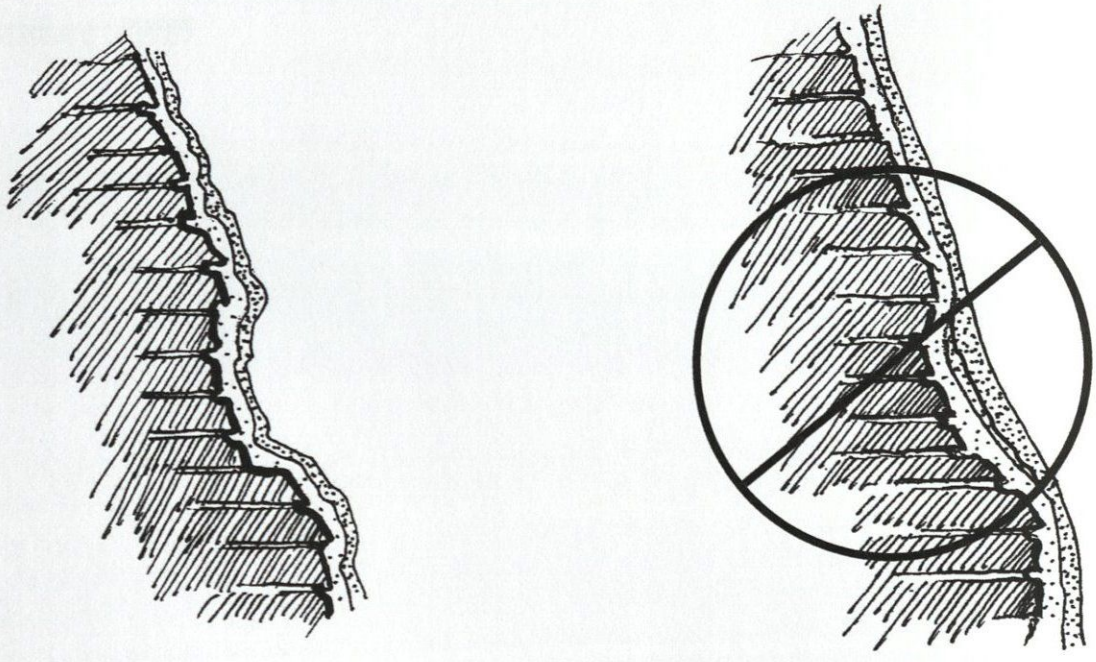


Figure 2: A sketch showing a typical mud brick wall and the application of the rendering. The finish condition on the left is the effect specified; the effect on the right is incorrect as it obscures the wall texture.

END OF SECTION 04220

CRACK REPAIR

November 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes repair of structural cracks in the mud brick walls of the Shunet el Zebib. The structural cracks are primarily described as vertical cracks that extend across sections of mud brick masonry, unrelated to original coursing and horizontal mortar joints. Some of the cracks are perpendicular to the surface and some or parallel to the vertical interior or exterior surfaces. Some of the cracks can be repaired by grouting, Section 04240, and others will require mechanical ties to ensure structural integrity. Still other cracks require that some of the adjacent mud brick masonry be removed and the removed portions replaced with new mud bricks, the new masonry bridging over the crack.

All crack repairs shall be completed in association with structural repairs to the condition of the masonry that caused the cracking. Examples of these structural repairs are the restoration of missing sections of wall, the installation of permanent buttresses and supports and the restoration of the bases and ends of walls. Structural cracks are a result of deformation and unless the cause is mitigated, the crack will return. The intent of the crack repair is to provide an additional level of integrity.

Two specific crack repair methods are described individually below in Part 3 of this section. In reality, the repair of some cracks requires a combination of both basic approaches. The actual specific approach is a field decision and in addition to including these basic approaches will also require variations dictated by conditions. See figures 1 – 3 for examples of cracks.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04240 – MUD GROUTING

E. SECTION 04250 – MUD BRICK CONSTRUCTION

F. SECTION 04280 – MUD BRICK CAPPING

1.3 SUBMITTALS

A. Any substitute materials submitted for the repair of cracks shall be approved by the Project Director's Representative prior to their use in any of the crack repair

procedures. In addition, the specific use of the substitute materials shall be demonstrated in test panels prior to approval.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mud brick masonry from direct rainfall during the curing process.

C. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. A repair for each of the crack repairs shall be prepared and approved by the Project Director's Representative prior to the continuation of those repairs. The test panel shall be part of the original structure and shall remain after approval as the standard for that part of the work. It shall also remain a part of the final conservation treatment. A test panel for 3.4 CRACK FILL REPAIR has been completed and is shown in Figures 5 and 6. A second crack was repaired on the top of the east wall in 2004 and that will also serve as an approved repair.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils and mud bricks for mud brick masonry crack repair shall be consistent with Section 04200, Part 2, 2.1, A. and D., 1. and 2. and all of Section 04210.

B. Tensar Structural Geogrid polypropylene Biaxial BX 1100.

C. Mechanical ties, either Earthanchors or threaded steel rods and toggles, to secure the Tensar geogrid.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to the crack repair. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair.

C. The effect of the repair shall not distract from the existing visual character of the wall where the repair takes place unless the crack repair is to be hidden behind other subsequent repair.

D. Place horizontal and vertical string lines in section of new mud brick repair after the removal of the existing mud bricks to ensure that the repair is consistent with the existing form and mass of the existing masonry.

E. Retain the existing surface profile to the degree possible. Cracks on the top surface of walls will be covered with mud brick caps. See SECTION 4280.

3.2 PREPARATION

A. Remove loose and broken mud bricks and other deteriorated materials prior to the new repair. Take special care not to damage the adjacent original materials (Figure 8 and 9).

B. Prepare mortar joints for installation of lateral reinforcement where it is required. Use thin steel bars to clean joints to maximum depth possible. Remove loose mortar.

C. The specific details of the crack repair shall be determined after loose materials have been removed. The details shall be chosen from the types of repairs specified below.

D. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application. Mix with minimal amount of water and comply with Section 04220, Part 3, 3.2, C. Specific application made dictate more or less water than is specified.

3.3 CONSTRUCTION CRACK REPAIR

A. This method of repair requires the replacement of some of the mud brick masonry that has been damaged by the structural crack. It will include the use of horizontal reinforcement.

B. Remove cracked mud bricks in a "toothed" pattern to the extent that a sound repair is possible (Figure 4).

C. Clean the crack if it continues to extend into the mass masonry and grout with mud mortar. Repair cracks that remain as specified below in 3.4 of this section (Figure 10).

D. Mist surface of new and existing mud bricks lightly with water spray several times in succession as necessary to ensure even penetration. Misting of surface should continue as initial mud plaster coat is applied. Do not apply water spray to the extent that it results in the formation of mud drips.

E. Key new mud bricks in the mud brick masonry mass perpendicular to the wall surface in addition to the "toothed" and stepped pattern parallel to the wall surface. With larger, more extensive cracks, remove additional mud bricks in a stepped pattern on both sides and the top of the crack and restore by installing new mud bricks. With smaller repairs lesser amounts of mud bricks will have to be removed.

F. Place horizontal reinforcement every 5th course. Mechanical ties to secure geogrid may be required. The horizontal reinforcement shall bridge over the crack and extend the length of the new mud brick masonry (Figure 10).

G. Ties shall be laid on a thin bed of fresh mortar and then followed with another thin bed of mortar on top of the tie prior to laying the subsequent course of mud bricks. The total thickness of the mortar joint shall be approximately equal to the thickness of the associated existing mortar joint (Figure 7).

H. Geogrid and mechanical ties shall not be exposed and held approximately 5cm back from exterior surface. Remove all new tool marks with brush.

I. Repair cracks that remain as specified below in 3.4 of this section.

J. Replicate the coursing pattern of the existing exposed surface. Place new mud bricks that are not exposed in an alternating stretcher-header bonding pattern to wall surface or top of wall (Figures 11 and 12).

K. Construct the new mud brick masonry in complete horizontal courses where possible. Do not construct more than 5 courses before allowing masonry to dry.

Allow 1-2 days for drying between 5-course lifts. Lay subsequent mud brick courses on fresh wet mortar. Apply mortar at head joints as well as bed joints and finish one-half the width of the mortar joint below the surface of the mud bricks.

3.4 CRACK FILL REPAIR

A. This method does not involve the removal of mud bricks on either side of the crack that is to be repaired. The void shall be filled with compatible materials to ensure that the future decay and erosion is consistent in the original materials and the new materials used to fill the cracks. This is not a structural repair; it does not include "knitting" the original mud brick masonry (Figures 5 and 6).

B. Clear debris from crack by probing, brushing, and blowing (Figures 7, 8 and 9).

C. Mist surface of new and existing mud bricks lightly with water spray several times in succession as necessary to ensure even penetration. Misting of surface should continue as initial mud mortar is applied. Do not apply water spray to the extent that it results in the formation of mud drips.

D. Force mud mixture into the crack as deep as possible with hands, wood and metal probes. Use as dry a mix as possible, but mix must be thoroughly mixed. Use mud brick batts to fill larger crack voids.

E. Use grout where necessary to ensure mud is forced into smaller/deeper cracks.

F. Fill cracks in a series of applications rather than one large application. Single applications shall not be thicker than 10-12 cm and not thicker than 6 cm if width of fill exceeds 10 cm. Deeper and wider voids are allowed if cured mud brick batts are used in the repair.

G. Final application shall not be flush with the surface, but shall be one-half the width of the crack below the surface. Remove all tool marks with brush.

H. Allow applications to dry one-half to two days before continuing. Exposed mortar shall be thumbprint dry and bricks are firmly set in bed mortar.

I. Protect repairs from rapid drying by misting, shading, protecting from dry winds.

Figure 1: West Enclosure Wall with a major structural near the end of the wall. These type cracks are common near the ends of the tall walls.

Figure 2: A detail of the West Enclosure Wall showing numerous smaller cracks.

Figure 3: Detail of the East Enclosure Wall showing numerous cracks that are structurally related to the critical condition on the opposite side of the wall.

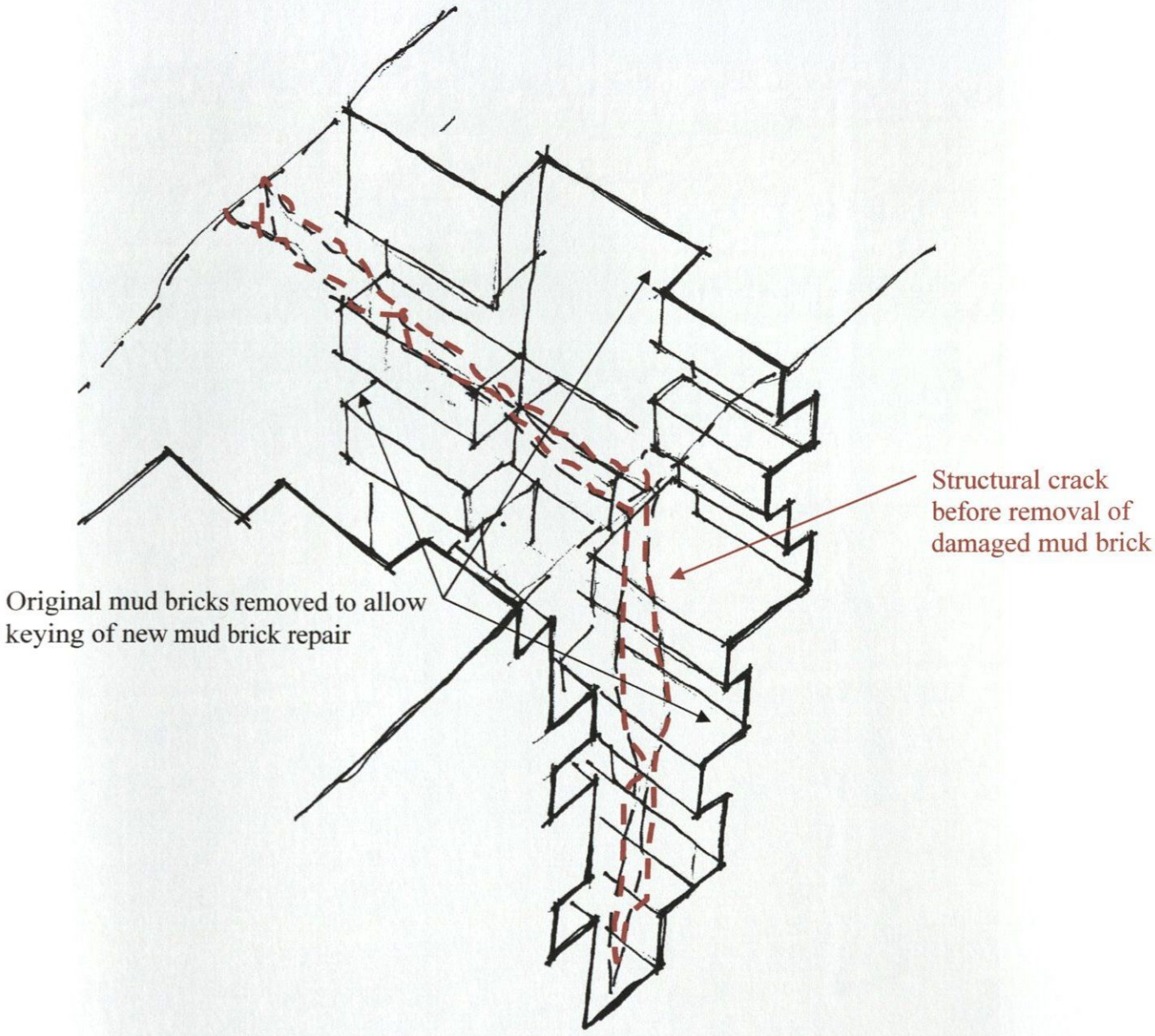


Figure 4: Sketch showing schematic of the removal of section of mud brick masonry at a crack in preparation for the reconstruction of the area with new mud bricks.

Figure 5: Cracks filled on a rear of the east elevation of the East Enclosure Wall that will serve as the approved panel for similar work. This is the same area as Figure 3. See Figure 6 for a detail of the area in red.

Figure 6: Detail of the wall shown in Figure 5 showing a detail of the approved technique for minor crack repair. Note that the still-damp mortar has been textured with a stiff bristle brush to blend better with the original material.

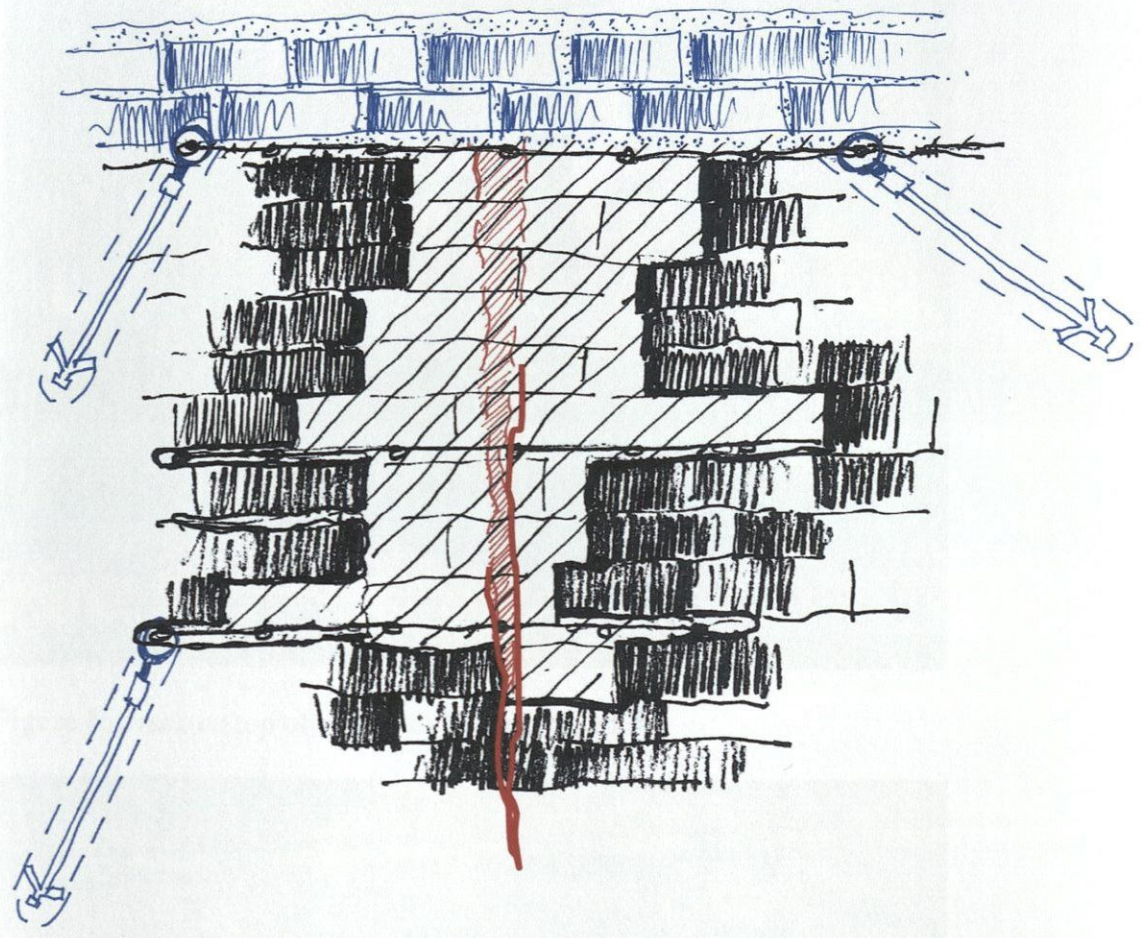


Figure 7: Schematic sketch of wall section showing an area that was removed and horizontal reinforcement and mechanical ties installed prior to the reconstruction of the damaged portion. The red vertical is the location of the existing crack.

Figure 8: Crack on top of east wall being cleaned out

Figure 9: Crack shown in Figure 8 has been cleaned and loose bricks and materials removed.

Figure 10: Detail of crack prepared for grouting and after grouting, bed mortar placed with geogrid.

Figure 11: Mud brick is being laid over crack.

Figure 12: Void created by crack and removal of poor materials is being brought up to original top of wall.

END OF SECTION 04230

PLASTER STABILIZATION
NOVEMBER 2005

PART 1 GENERAL

DESCRIPTION: The work of this section includes stabilization of the remaining plaster on the mud brick walls of the Shunet. The plaster that remains is located on the surfaces of the lower walls on the least eroded parts. The best examples are those most recently exposed by archeological excavations. Figures 1 and 2 show two examples of the plaster. The intent of this section is to provide some degree of protection to the plaster that remains both above and below ground level. Additional plaster exists on many other lower walls that are below existing grade.

Two different approaches are specified here. One is for plaster that remains in place and another when plaster has become completely detached. The latter approach stabilizes the plaster and reattaches it to the mud brick substrate.

1.1 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04220 – SURFACE RENDERING

C. SECTION 04240 – MUD GROUTING

D. SECTION 04260 – WALL BASE VOID REPAIR

E. SECTION 04297 – SAND BAG PROTECTION

1.2 SUBMITTALS

A. Any substitute materials submitted for the stabilization of plaster shall be approved by the Project Director's Representative prior to their use in any of the plaster stabilization procedures. In addition, the specific use of the substitute materials shall be demonstrated in tests prior to approval.

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section.

1.4 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect wall surfaces and detached plaster from potential rainfall, direct sun and human and animal traffic until cured.

C. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.5 TEST PANELS

A. The stabilization of the attached plaster shall be prepared and approved by the Project Director's Representative prior to the continuation of the stabilization. The test panel shall be part of the original structure and shall remain after approval as the standard for that part of the work. It shall also remain a part of the final conservation treatment. A sample test was undertaken in March 2001 on the east side of the East Enclosure Wall at the area of a crack repair. See test panel for Section 04230, Part 3.4 CRACK FILL REPAIR for location.

B. The stabilization and reattachment of the detached plasters shall be prepared and approved by the Project Director's Representative prior to the continuation of the treatment. Most of this plaster will be covered by backfill materials after it has been conserved. The examples that remain above ground and exposed will serve as the test panels.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Soils for plaster stabilization shall be consistent with Section 04200, Part 2, 2.1, A. and D., 1. and 2.

B. Syringe and needles with diameter of approximately 2-3 mm.

C. Small sand bags

D. Wood or metal panels to be used as flat smooth working surface.

E. High strength absorptive Japanese paper.

F. Hand water mister.

G. Small trowels, pipettes, scapulas and spatulas.

H. Tensar Biaxial Geogrid, BX 1100.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding should not be required for access. Protection from falling debris shall be in place prior to the stabilization. All visitors and others not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the stabilization.

C. The effect of the stabilization shall not distract from the existing visual character of the wall where the stabilization takes place.

3.2 DETACHED PLASTER

A. Identify areas of detached by probing, sounding and by visual observations Figure 3).

B. Secure detached plaster in place with flat working surfaces and sand bags prior to actual conservation treatment.

C. Salvage detached in largest possible fragments and arrange on flat working surface with the exposed surface facing down (Figure 4).

D. Plaster that is not detached completely shall be removed by inserting a flat working surface in contact with exposed surface and removing.

E. Once plaster is secure on a horizontal working surface, face down, mist repeatedly with water the mud brick and mud and mud plaster attached to the rear of the finish plaster. Allow the moisture to penetrate and loosen the mud backing and begin scraping. The object is to remove the mud plaster and any attached substrate leaving the surface or finish gray plaster (Figure 5).

F. Mist gray plaster and apply a thin coat of mud plaster, followed by a layer of geogrid, BX 1100, which has been cut to fit. Immediately apply another thin coat of mud plaster over the geogrid, and allow to dry (Figure 6).

G. Prepare mud brick by removing all loose materials. Remove enough of the existing mud brick surface where the plaster will be reattached to allow for the added thickness of the mud plaster and geogrid backing plus a layer of mud plaster applied to the mud bricks.

H. Dampen the surface of the mud brick substrate and apply mud plaster. This mud plaster will serve to reattach the detached plaster. Some experimentation will be necessary in order to assure the proper mix with the proper thickness (Figure 7).

I. Transfer the geogrid reinforced plaster carefully to its former location on the wall by means of the flat working surface. Press gently but firmly back in place (Figure 8).

J. Secure the working surface with sand bags and allow to dry.

K. Continue setting smaller pieces of plaster back in place in the wall plane.

L. Begin injecting or packing the edges of the reattached plaster with additional mud plaster until no more mud plaster can be forced between the plaster and the mud brick substrate without displacing the plaster or breaking the bond forming between the plaster and the mud brick (Figure 9). Repeat process after allowing mud to cure until all edges are filled and secure.

M. Finish edges with mud plaster to an angle of approximately 30-45 degrees.

N. After fully cured, remove sand bag supports and flat working board (Figure 10).

3.3 ATTACHED PLASTER

A. Mix soil and water (potable) prior to use. Mix shall be determined for each application on the site and approved after successful application on a test panel. Mix with minimal amount of water and comply with Section 04220, Part 3, 3.2, C. Specific application made dictate more or less water than is specified.

B. Using a gentle mist, spray the area of plaster to be stabilized. Do not apply water to the degree that it stands or beads on the surface.

C. Gently place the Japanese paper over the section of plaster to be stabilized. Using a pipette, apply small amounts of water to the paper, not directly to the plaster allowing the water that soaks through the paper to pull the paper against the surface of the plaster.

D. Carefully clean area adjacent to plaster by gentle air pressure generated by blowing through a small tube and by gently picking with small scapulas.

E. Gently press the paper onto the surface with hand and finger pressure only. The paper will protect the actual surface. The pressure will slightly consolidate the surface.

F. With the paper in place, build up the edges of the plaster with mud mortar at an angle of approximate 30% to the surface of the substrate (Figure 3). Work the mud grout under exposed edges.

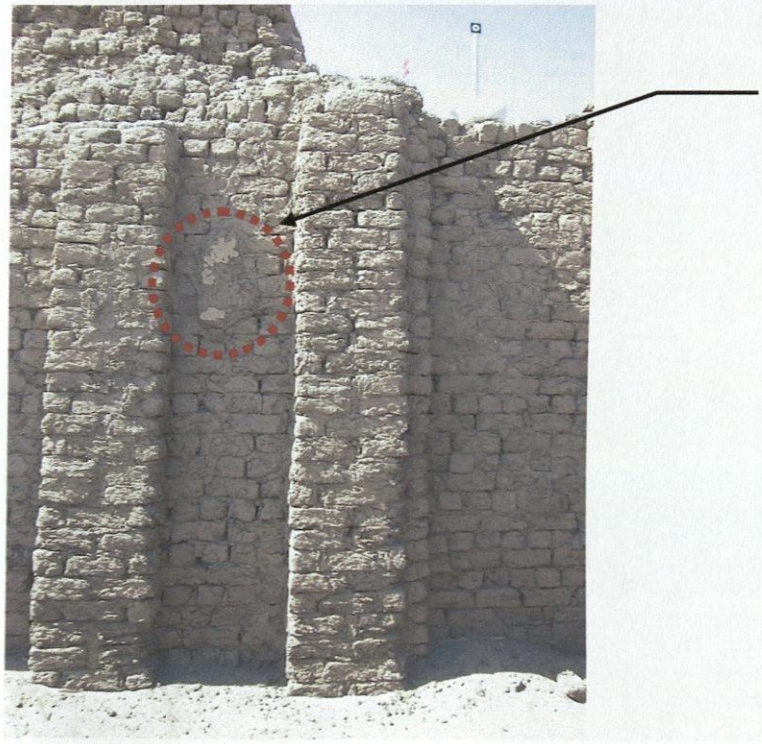
G. Apply gentle pressure to the surface of the plaster through the Japanese paper as pressure is applied to the mud mortar edge. Continue to press during the drying process if edge cracking exists.

H. Keep the paper only wet enough to keep it in place by gentle misting. The paper will also help in the curing process.

I. When the area is cured, and the paper is completely dry, remove the paper.

J. Figure 11 is a sketch of the general process.

Figure 1: Plaster remains on the lower part of the east side of the East Enclosure Wall, near the north end.



Typical area of original plaster that remains on the surface of the East Enclosure Wall. The white is the remains of the finish plaster, but mud plaster the color of the walls is beneath and around it.

Figure 2: Plaster remains between pilasters on the East Enclosure Wall, east side.

Figure 3: Detached plaster prior to removal from wall.

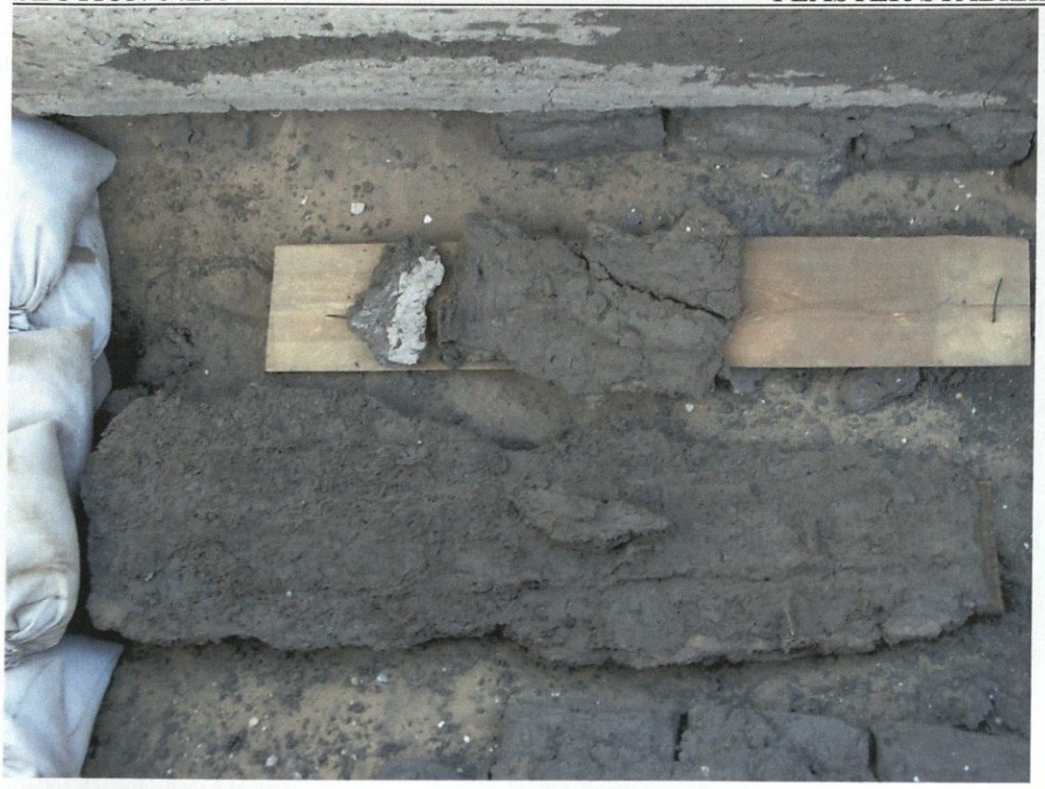


Figure 4: Large piece of intact plaster after removal from wall on flat working surface.

Figure 5: Large piece of plaster with partial removal of the mud plaster substrate.

Figure 6: Detached plaster with geogrid being attached to the back with mud plaster.

Figure 7: Mud plaster being applied to mud brick substrate for reattaching the plaster.

Figure 8: Plaster is being pressed back into place on the mud brick wall.

Figure 9: Packing mud along the edges and behind the plaster.

Figure 10: The reattached plaster in place after it has cured and the sand bag supports have been removed.

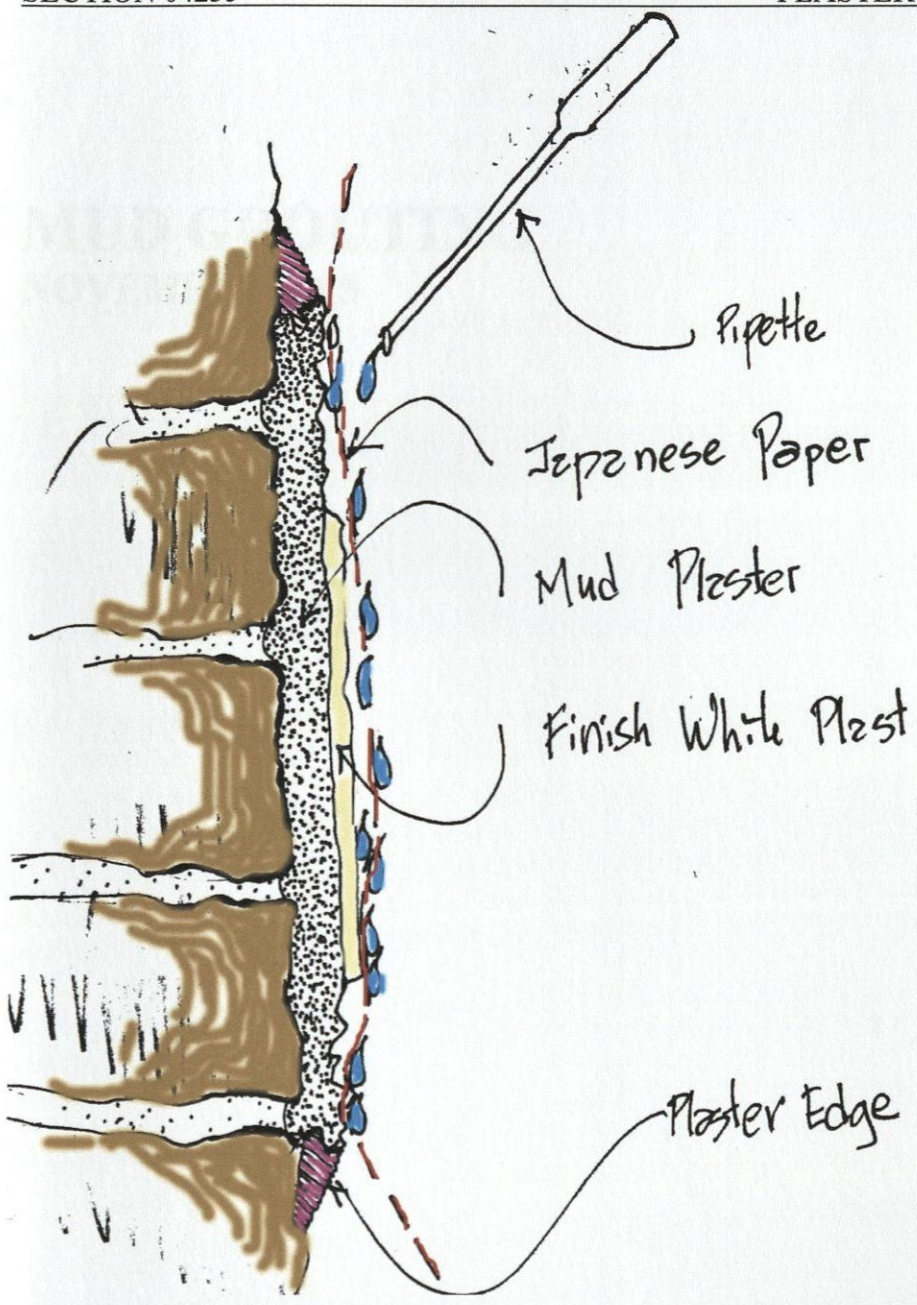


Figure 11: Sketch section showing basic relationship between plaster, paper and mud mortar edge.

END OF SECTION 04235

MUD GROUTING
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the use of mud grout to fill crack and voids and replacement of mortar joints of existing mud brick masonry. The specific grouting of cracks, voids, and mortar joints are described below in Part 3 of this section.

The types of cracks and voids include horizontal detachment cracks, vertical structural cracks, cracked and missing mortar joints, deep, narrow holes that are the result of animal and insect activity, small voids and cracks resulting from shifting and movement of individual mud bricks and wall sections, and small cracks and crevices between existing mud brick masonry and new conservation treatment masonry.

Grouting techniques are utilized when it is difficult or impossible to access voids with mortar and hand tools (trowels, etc.).

Figures 1 and 2 are examples of the type of cracks that will be repaired by the specifications in this section.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04220 – SURFACE RENDERING

C. SECTION 04230 – CRACK REPAIR

D. SECTION 04250 – MUD BRICK CONSTRUCTION

E. SECTION 04270 – VOID AND HOLE REPAIR

F. SECTION 04280 – MUD BRICK CAPPING

1.3 SUBMITTALS

A. The material for grout shall be unamended mud, unless a condition arises in the field that another material such as lime has to be added to increase the workability of the material. That special condition and the use of other materials shall be approved by the Project Director's Representative prior to use.

B. Any substitute materials submitted for use shall be approved by the Project Director's Representative prior to their use in any of the grouting procedures. In addition, the specific use of the substitute materials shall be demonstrated in test areas prior to approval.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

C. Additives that are considered for use shall comply with provisions of Section 04200, Part 1, 1.5, A. and B.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying grout from direct rainfall during the curing process.

C. Protect grout from rapid drying from temperature, sun, and wind by shades and wind breaks.

D. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. Grouting techniques shall be worked out and demonstrated on site and approved by the Project Director's Representative prior to the continuation of the related repairs. The test area shall remain a part of the final conservation treatment.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of grout shall be consistent with Section 04200, Part 2, 2.1, A. and D., 1. and 2. and all of Section 04210. Sand and soil to be used for hand-held grout bags may need to be dry-sieved more finely than specified above if grout clogs the grout bag nozzles. Revise the material preparation as necessary.

B. Lime (calcium hydroxide)

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. All workmen shall have appropriate eye, head, foot and hand protection. Protection from falling debris shall also be in place prior to the crack repair. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The use of additives for the basic soil mix shall be used only if required to enhance flow characteristics and shrinkage.

C. Cracks and holes may have to be further cleared by drilling into the crack or void with a hand operated brace and bit.

D. The removal and the loss of original fabric shall be minimized during the repair.

E. The effect of the repair shall not distract from the existing visual character of the wall where the repair takes place unless the crack repair is to be hidden behind other subsequent repair.

3.2 PREPARATION

A. Select site location for conducting the testing of the grout mixes.

B. Test grout mixes prior to actual use for shrinkage and flow characteristics.

1. Pour grout samples in a series of molds of equal size and allow sample to dry. Sections of pipes of approximately 10 cm diameter or cans with the tops and bottoms removed can be used for the molds.
2. Allow the samples to dry thoroughly. Evaluate each sample for relative strength and shrinkage.
3. Place grout between two mud bricks as a bed mortar and allow to dry thoroughly. Compare the relative adhesive quality of the various grouts by the force required to pull the two mud bricks apart. Moisten the sides of the mud brick that are in contact with the grout prior to placement of the grout and shade to prevent rapid drying.
4. Test the flow characteristics in use demonstration of both the grout bags and the gravity flow systems.
5. The characteristics of each grout shall be determined at least 24 hours prior to the actual use on the monument.

C. Remove loose and deteriorated materials prior to the new repair by scraping, brushing, probing and blowing the voids and cracks where the grouting is used.

D. Prepare lime putty, if required, prior to addition to basic mud mix.

1. Fill plastic barrel 1/3 full of potable water, and then slowly add lime (calcium hydroxide) to the water slowly mixing until the mix is the consistency of thick pudding.
2. Continue slowly adding water and lime and mixing thoroughly until the barrel is 2/3 full. Seal barrel and allow to stand a minimum of 48 hours prior to use.
3. Keep barrels sealed. Add water to ensure that there is a minimum of 5 cm of water standing on the top of the putty at all times.

E. Mix soil and water (potable) prior to use. Mix with heavy clay soil should be soaked overnight prior to application. Additives such as lime or cement shall not be mixed into the basic mud grout until immediate before use. Mix only amount that can be used for any specific application in amounts that can be used prior to initial dehydration of the mix. The actual time that the grout can stand before being discarded shall be determined in the field based on temperature, exposure, relative humidity and wind.

F. There is no restriction on the re-tempering or time limit on the use of unamended grouts.

G. Anticipated lime added to the mix is approximately 3-5%, if required.

3.3 GROUT REPAIR

A. Mist materials that will be in contact with the new grout with water; repeat misting or dashing water into cracks or voids with brushes and brooms. Do not apply water spray to the extent that it results in the formation of mud drips.

B. When grouting is done in association with crack repair, Section 04230, the sequencing shall be determined for each specific case.

C. The pressure of flow is directly related to the height of the grout pan above the area grouted. A pressure of approximately 10-15 psi results from the placement of the pan approximately 3 – 5 meters above. All grouting shall be done with relatively low pressures.

D. Pressure using grout bags is individually controlled.

E. Depending on the position and the specifics of the cracks and voids to be grouted, prevent overflow by packing lower areas with wet newspapers, burlap strips or similar materials.

F. Protect wall surfaces from mud drips. Clean mud drips from wall surface immediately.

G. Repair holes that remain as described in Part 3, 3.4 of Section 04230.

H. Horizontal cracks:

1. Support brick courses prior to grouting.
2. Temporary shoring and bracing may be required.
3. In a series of horizontal cracks, begin with the lower one and work toward the upper cracks (Figure 3).
4. The horizontal cracks are at mortar joints.
5. Grout the deepest voids first and then proceed toward the surface after initial curing of the deeper grout.
6. Extensions on the grout nozzles may be required.
7. Extreme care shall be taken in "packing" the grout.
8. Temporary supports shall be left in place until the grout is fully cured.

D. Vertical cracks and voids:

1. The same general descriptions apply as to E. above with the following additions.
2. Vertical cracks exist along vertical "stacked" mortar joints, end joints of headers, and through mud bricks.
3. Grouting will be in association with other structural crack repair methods specified in Section 4230. Grouting is a supplement of more structural crack repair methods.

E. Holes and voids, missing mortar:

1. Structural support is normally not required, as the voids do not reflect structural damage.
2. Prepare as with other grouting methods.
3. Complete filing of identified voids is not as critical as with the Horizontal and vertical cracks (E. and F. above).

F. Use of both grout bags and gravity grouting in combination for the repair of most cracks and voids is expected.

G. Grout Bags:

1. Wet grout bags with water prior to filling with grout.
2. Clean grout bags regularly during use. Often the grout will have to be removed and re-tempered with water for continuing use.
3. Clean grout bags thoroughly after use and set aside to dry.
4. Fill grout bags approximately half full when grouting.
5. Pressure is applied by continually rolling the open end of the bag.

H. Gravity Grouting:

1. Wet group pans and hoses and nozzles prior to filling with grout.
2. Clean all apparatus regularly during use.
3. Clean apparatus thoroughly after use or at the end of the day.
4. Grout pan and apparatus are located at a level above the point of introduction of grout into the wall. See Figure 4 for schematic sketch of operation.
5. Two men located at the grout pan to regulate flow and to mix grout for continuous operation.
6. Nozzle operator will be able to control the flow at the nozzle with a cut off valve or plunger.

Figure 1: Detail of crack in the East Enclosure Wall. This is a large structural crack that will require grouting because of the depth of the crack.

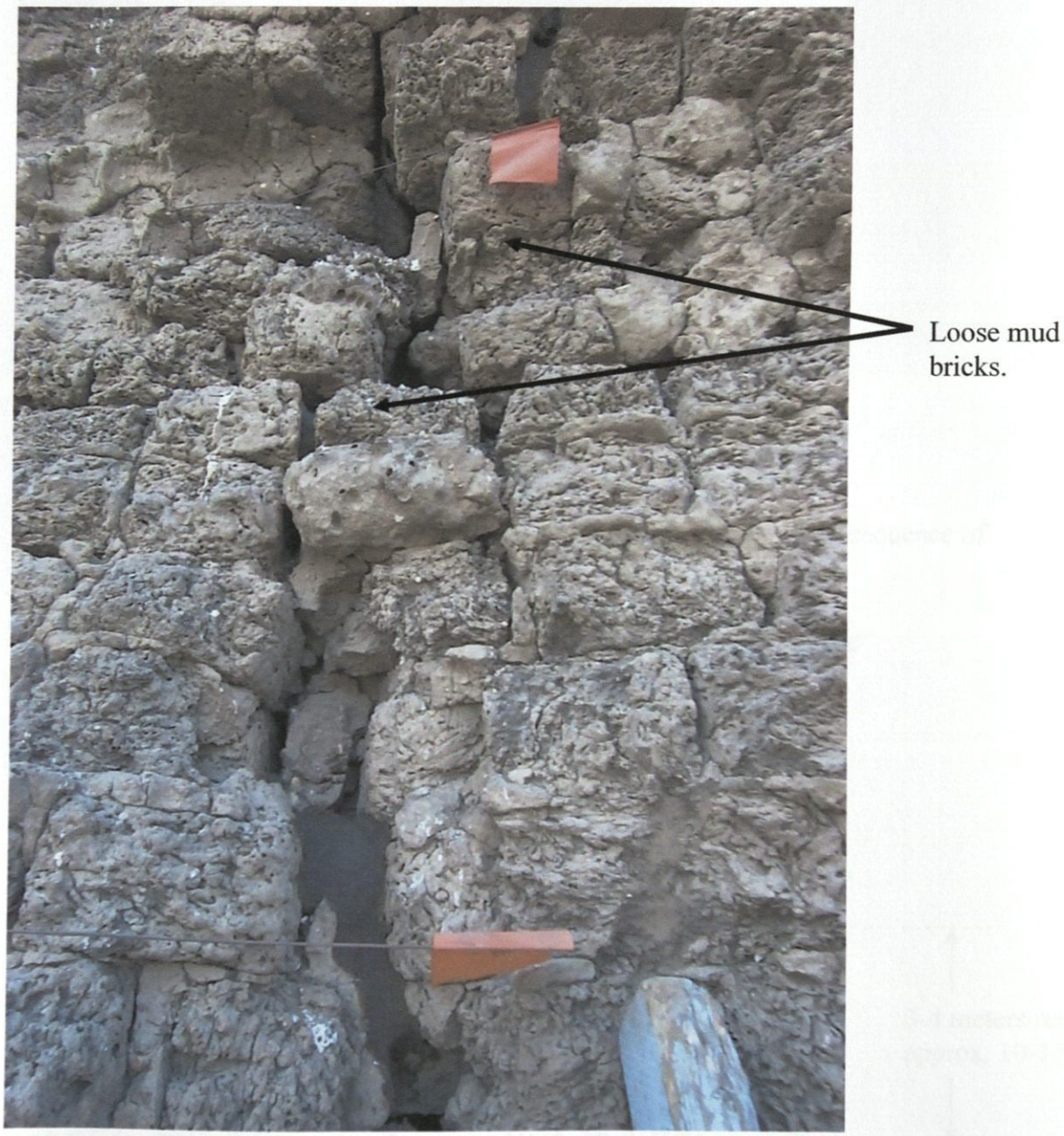


Figure 2: Another large structural crack in the West Enclosure Wall that extends down from the top of the wall and is completely through the wall. A combination of grouting, structural ties and new mud bricks will be required to repair this crack.

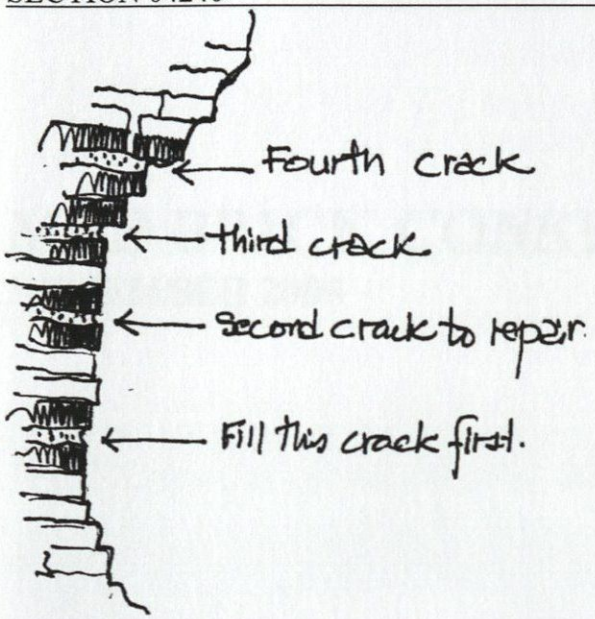


Figure 3: Sketch of wall section with multiple horizontal cracks showing sequence of crack repair.

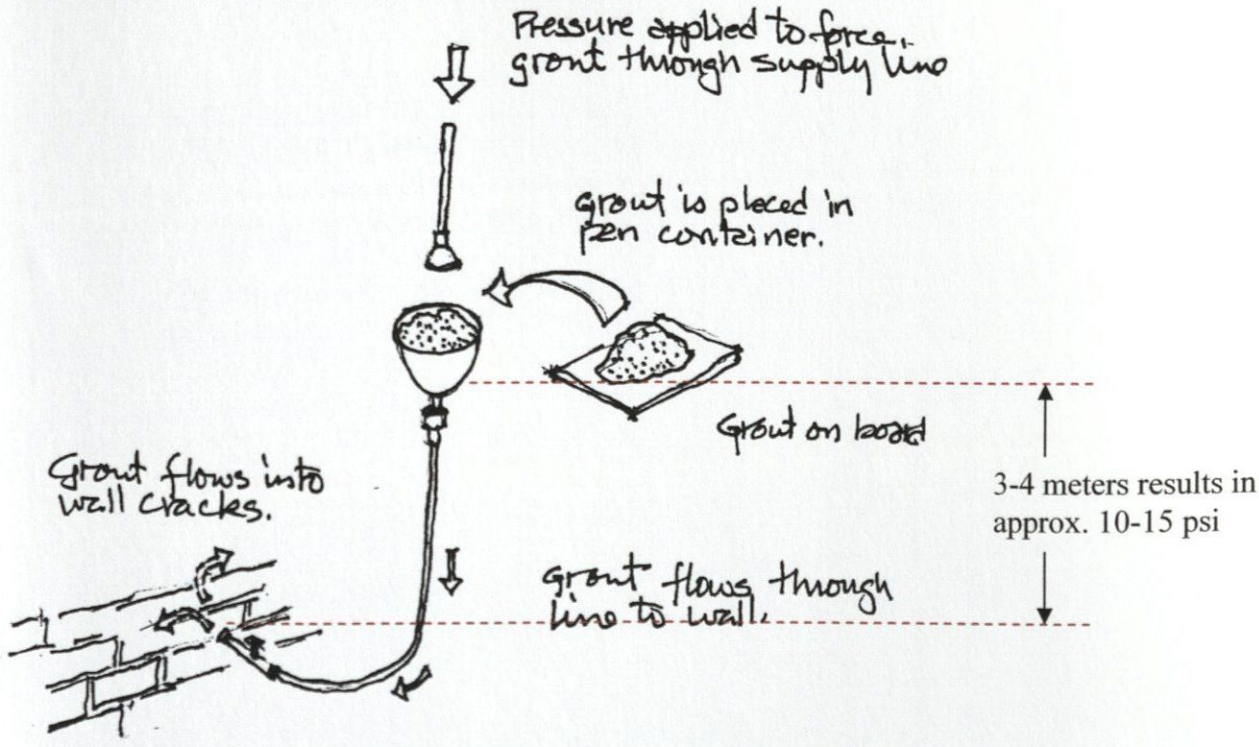


Figure 4: Schematic sketch showing the basic process of the gravity grout system.

END OF SECTION 04240

MUD BRICK CONSTRUCTION
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: This is the primary section for the actual construction or restoration of missing elements of the structural and architectural systems. It includes the basic principles that the following sections, 04260 Wall Base Repair, 04270 Void and Hole Repair, and 04280 Mud Brick Capping adhere to with the more specific details included in those sections. It is also closely related to parts of Section 04230 Crack Repair, which involves the bridging of severe structural cracks.

The intent of this conservation intervention is to provide structural integrity to portions of the wall masses that lack that integrity. Portions of missing architectural elements or features shall not be constructed except for that purpose. There are no current guidelines that allow the construction of missing features for interpretive purposes only and that activity is beyond the scope of this phase of this project.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04240 – MUD GROUTING

F. SECTION 04255 – HORNET NEST REMOVAL

G. SECTION 04260 – WALL BASE VOID REPAIR

H. SECTION 04270 – VOID AND HOLE REPAIR

I. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

J. SECTION 04297 – SAND BAG PROTECTION

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mortar from direct rainfall during the curing process.

C. Protect mortar from rapid drying from temperature, sun, and wind by shades and wind breaks.

D. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. Specific coursing of mud bricks shall be developed for each specific application location and approved prior to the continuation of the work. The actual integration of the new masonry and the existing shall also be developed and approved prior to continuing. The sections constructed for approval by the Project Director's Representative shall be part of the final work when approved.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

C. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

D. Steel rods, threaded, stainless ¼ inch diameter, 24 inches long.

E. Stainless steel toggle bolts, ¼ inch.

F. Earth anchors, Foresight Products, Commerce City Colorado; #40 and #68.

G. Tensar Biaxial Geogrid.

H. Tensar Boykin rods.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated repair.

C. Repairs are to be structurally integrated with the existing mass of mud brick masonry to the greatest extent possible by excavating unsound material and establishing a sound base for the new material.

D. Use Tensar Geogrid and mechanical ties to integrate new construction with original. The mechanical ties are the Earthanchors and threaded steel rods.

E. The effect of the construction repair shall not distract from the existing visual character of the wall where the repair takes place.

F. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the construction prior to beginning the repair and the amount of original materials that will have to be removed. The specific details

of the construction repair shall be determined after loose materials have been removed.

B. Remove loose and deteriorated materials prior to the new repair by removal of existing mud bricks, scraping, brushing, probing and blowing the areas where the repair will take place. The removal of existing insect mud nests will be determined on site. Remove all remaining hornet nests. See Section 04255.

C. Prepare mortar joints for installation of Tensar Geogrid for horizontal reinforcement. Use thin steel bars to clean joints to maximum depth possible. Remove loose mortar.

D. Prepare a flat, horizontal base on the existing mud brick construction for the first courses of new mud brick. The base will likely not be continuously flat but stepped in areas where mud bricks are sound (Figure 1).

E. Dampen contact areas of existing and new mud brick masonry prior to setting new mud bricks and mortar.

F. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application.

G. There is no restriction on the re-tempering or time limit on the use of unamended mortars.

3.3 CONSTRUCTION REPAIR

A. Re-dampen materials according to 3.2, E. above of this section if required. Misting or spraying is allowed, but the water spray shall not be applied to the extent that it results in the formation of puddles.

B. Key new material to existing by setting new mud bricks in a "toothed" pattern keyed into the original mud brick masonry or with mechanical ties as determined in the field (Figure 2).

C. Replicate the coursing pattern of the existing exposed surface including the thickness of the mortar bed joints. Place new mud bricks that are not exposed in a pattern of one course of hearers and the subsequent course of stretchers. New bricks that are exposed shall replicate the bonding pattern of the original wall fabric. If the new mud bricks are on the original wall plane, the pattern shall be that of the original

D. Vary bed mortar joint thickness only to ensure level mud bricks.

E. Set bricks on bed mortar and place bricks with some head joint mortar as well. Every approximately 6-9 courses, or at the end of each day, or when the horizontal reinforcement is to be placed, point all joints completely (Figure 3).

F. Construct the new mud brick masonry in complete horizontal courses where possible. Do not construct more than 10 – 12 courses before allowing masonry to dry. Allow 5-7 days for drying between 10 – 12 course lifts. Lay subsequent mud brick courses on fresh wet mortar.

G. Large voids may be filled with sand bags filled with soil cement.

1. Three approaches shall be field tested for the actual wetting of the soil cement sand bags. The soil cement filled bags shall be either set in place dry and then wetted; partially wetted before set in place and then further wetted in place; or completely wetted prior to setting in place.
2. The bags shall be packed on a firm base as tightly as possible; the contact areas of the existing mud brick shall be prepared as described for mud brick Part 3, 3.2, D, and 3.3 A of this section.
3. Pre-wetted or completely wetted soil cement bags shall be used within approximately 10 minutes of wetting and shall not be rewetted. The exact time depends on the specific weather conditions and shall be determined from field trials.

H. Place horizontal reinforcement every approximate 6-9 courses. Geogrid can be laid in one contiguous piece or in pieces connected by Boykin rods (Figure 4).

I. Remove all tool marks from mortar by brushing, or other means to achieve the effect necessary to reflect the character of the surrounding wall surfaces. This may include but not be limited to the additional texturing of the surface, tuck pointing, the removal of some mortar joints and the application of a mud wash on the exposed surface (Figure 5).

J. The finished wall surface shall evoke the texture of the adjacent wall surface.

K. The new mud brick material in the Coptic cells shall be recessed to reflect their existence. The recess will be to a depth of approximately 1- 1 ½ meters, but the specific depth will be determined on site. The new mud brick masonry shall be set flush with the existing wall plane at the contact zone and shall taper back to the desired depth.

L. Use mechanical ties with Tensar Geogrid reinforcement when horizontal stress between existing and new masonry is excessive (Figure 6).

M. Figure 7 shows a wall section before and after the additional new mud brick construction. Figure 8 shows a typical area that has been reconstructed and Figure 9 is of an unstable area that was stabilized by adding the masonry as indicated.

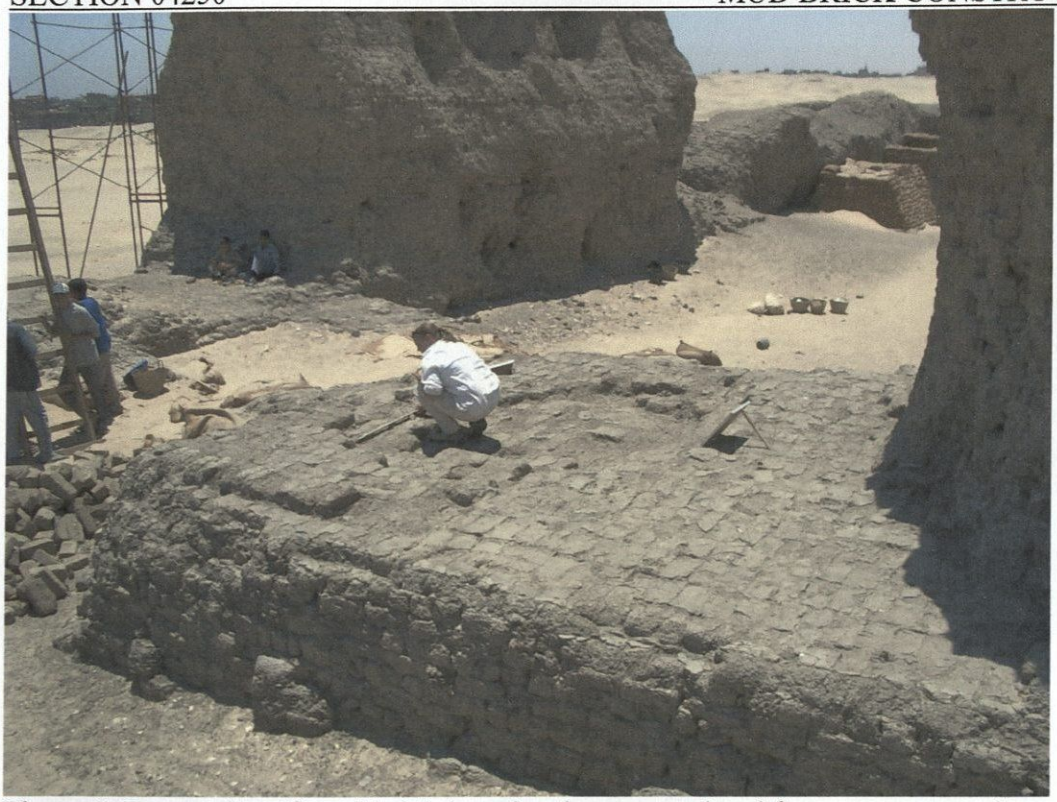


Figure 1: Preparation of mud brick base has been completed for new construction. Documentation of the base is underway.

Figure 2: Integration of existing mud brick construction with new construction by the creation of a "toothing" pattern.

Figure 3: Comprehensive pointing of a course of mud bricks prior to the installation of horizontal reinforcement.

Figure 4: Geogrid horizontal reinforcement installed.

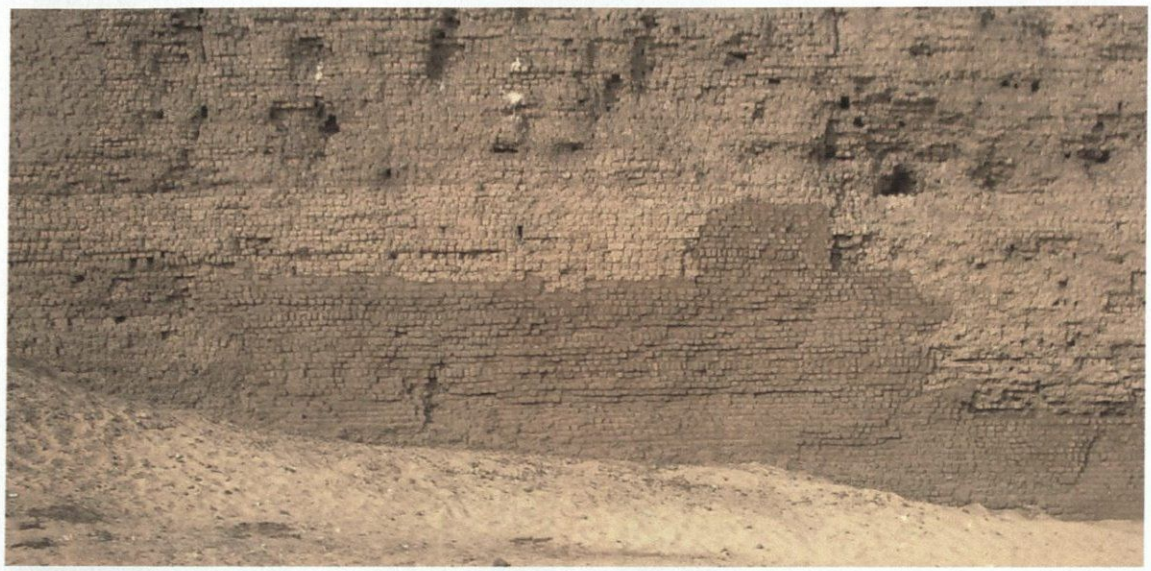


Figure 5: An example of a section of new mud bricks that has been textured to blend with the surrounding wall surface.

Figure 6: Mechanical ties used to connect horizontal reinforcement and new mud brick construction to existing.

Figure 7: South end of the West Enclosure wall on the north side of the west gateway. Before condition on the left and after partial reconstruction on the right.

Figure 8: West wall with stabilized north Coptic cells with new masonry textured and washed

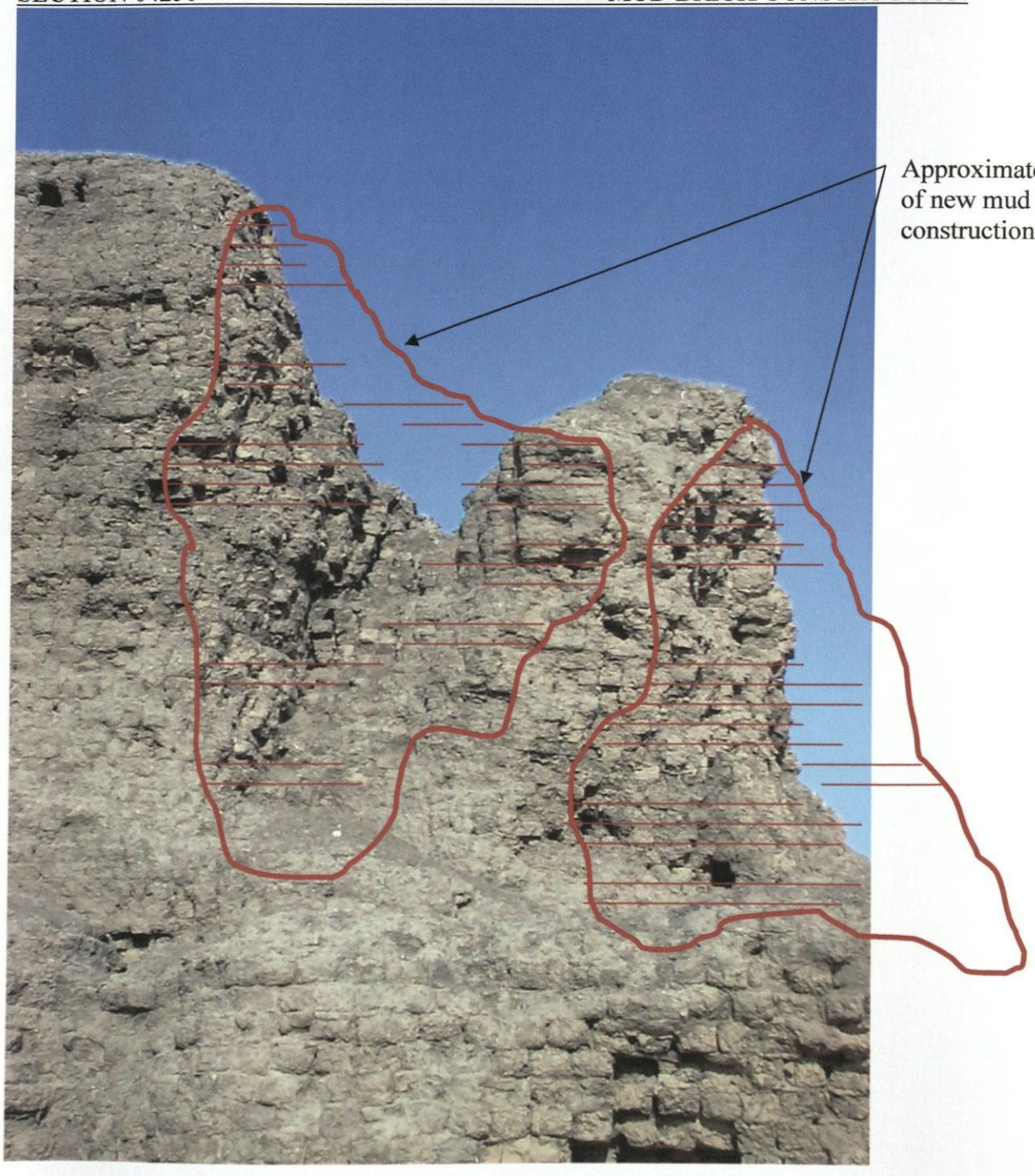


Figure 9: Detail of an area of missing wall mass at the southeast corner. The missing sections were reconstructed in 2005.

END OF SECTION 04250

WEST DOORWAY RESTORATION
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes all work associated with the restoration of the west doorway of the Shuneh, not limited to any material or construction system type. The primary sections of these conservation specifications are those addressing mud brick construction and wall base repair. This section, section 04252 also includes the construction steel reinforced concrete lintels for the doorway.

The intent of the partial restoration of the west doorway of the Shuneh is to first provide structural integrity to the large west enclosure walls, which will continue to deteriorate, resulting in periodic substantial loss of the mud brick masonry on the two exposed and facing end walls. Figure 1 shows the west doorway and the missing part prior to the beginning of the stabilization and partial restoration that began during the spring 2005 season. In order to provide structural stability with a partial reconstruction of the missing walls, the entire doorway will have to be enclosed. The dotted red lines on Figure 1 show the extent of the necessary reconstruction. Rather than simply close off the entire area, eliminating an important entrance into the Shuneh, it has been decided that the opening will be restored.

Consistent with the overall conservation approach of the Shuneh, the partial restoration of the west doorway shall reflect the overall character of the Shuneh as a ruin, and shall reflect the existing colors and textures and general massing of the structure. Because it is a partial restoration, there will be reconstructed elements here that have not been necessary in the other conservation work of the structure. The main features that have or will be restored are parts of the existing pilasters and the entrance way lintels.

This specification addresses work that has already been completed. Because of the extensive work that has already been completed on the west doorway, the restoration approach has effectively been made. Figure 2 is a view of the west doorway as it exists after the work completed in April 2005.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04235 – PLASTER STABILIZATION

F. SECTION 04250 – MUD BRICK CONSTRUCTION

G. SECTION 04280 – MUD BRICK CAPPING

H. SECTION 04290 – PILASTER REATTACHMENT

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

B. All repairs as specified in this section have been and shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

C. The Project Director's Representative shall directly approve the specific work details described above.

D. All areas shall be made safe for the workmen. These areas were excavated and documented according to professional archeological practices. Conservation work proceeded after the archeological investigations were completed.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at ambient temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours. If the

location is well protected from winds and the actual temperature of the mud brick mass where the repair will take place is greater than 10 degrees Celsius, the repair can continue.

B. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. The actual integration of the new masonry and the existing was developed and approved prior to continuing. The sections constructed for approval by the Project Director's Representative shall be part of the final work when approved.

B. The existing partial reconstruction of the pilasters on the west side of the doorway shall serve as test panels for the continuing work. Modifications will continue to be made as necessary.

C. The specific alternative materials and methodology shall continue to be developed for each specific repair after field investigation and verification of the field conditions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

C. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

D. Steel bars: Steel bars to conform to descriptions in Section 04200, Part 2.

E. Tensar Biaxial Geogrid reinforcement (#15 in 2.1, F. of Section 04200).

F. Portland Cement

G. Concrete color stain and dyes as available locally and/or Quikrete Cement Color.

H. Metal Paint Primer available locally.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. Structural support of the walls in the areas of the base wall void repairs shall be installed prior to the actual conservation work of this section. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated repair.

C. Repairs are to be structurally integrated with the existing mass of mud brick masonry to the greatest extent possible by excavating unsound material and establishing a sound base for the new material.

D. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the construction prior to beginning the repair and the amount of original materials that will have to be removed. Specifically determine the depth and the extent of the repair. The specific details of the construction repair shall be determined after loose materials have been removed.

B. Remove loose and deteriorated materials prior to the new repair by removal of existing mud bricks, scraping, brushing, probing and blowing the areas where the repair will take place. This includes loose mortars and mud bricks, organic matter, and wind blown sand. It is anticipated that some of the voids contain animal nests and these shall also be removed.

C. Entire west doorway area was excavated utilizing appropriate archeological procedures and documented prior to and after the archeological work was completed.

3.3 PROTECTION OF ORIINAL DOORWAY FLOOR

A. Once the floor of the doorway was excavated, cleaned and documented the floor level was protected with a layer of sand and from 1 to 3 courses of mud bricks.

The floor sloped from west to east 30 cm and the mud brick capping retained the approximate same slope.

B. The base of the wall on the west side was in poor condition and had to be stabilized (Figure #). Exposed limestone feature was temporarily protected with sand bags as the work progressed.

3.4 WALL BASE REPAIR

A. See section 4260, Wall Base Repair for details of this part of the work (Figure 3).

C. New material keyed to existing by setting new mud bricks in a "toothed" pattern keyed into the original mud brick masonry.

D. Replicate the coursing pattern of the existing exposed surface including the thickness of the mortar bed joints.

E. New mud brick repair shall not appear as new construction, but shall replicate the general character of surrounding wall surfaces.

F. Remove all tool marks from mortar by brushing and "stipple" with stiff bristle brush.

3.5 MUD BRICK CONSTRUCTION

A. See section 4250, Mud Brick Construction for details of this part of the work.

3.6 PILASTER RESTORATION

A. Stabilize existing pilasters as described in Section 04290 Pilaster Reattachment.

B. Restoration of pilasters consists of extending the height with new mud brick construction. New extensions shall be integral with the mud brick masonry and shall not be applied to the surface of the mud brick mass.

C. Determine slope of existing pilasters and conform to slope and size. Establish plumb lines and other guides to insure continuity and accuracy.

D. The extent and design shall be determined prior to beginning the work. Any changes shall be approved by the Project Director's Representative.

E. Horizontal reinforcement shall extend into the pilaster at the level where it is placed on the mud brick construction. Geogrid shall be held back ca. 5 cm from surface of pilaster.

F. Pilasters at the door shall extend up above the lintel level before gradually reduced in thickness and definition. Pilasters more distant from the actual door opening shall be shorter, less defined and less finished (Figures 4 and 5).

G. Pilasters shall not be restored or reconstructed where the bases or other portions no longer exist.

3.7 LINTEL RECONSTRUCTION

A. New lintels shall be placed at a height that corresponds to a 3:1 slenderness ration of the door. The exposed finish height will vary because the slope of the floor through the door way and the reburial of the lower part of the walls.

B. The approach for the reconstruction of the lintels shall be based on the approach of the reconstructed lintels at Saqqara (Figure 6). However, the original of the Shuneh were probably originally of timber.

C. The reconstructed lintels shall replicate the general form of exposed timbers, but shall not replicate timber color and texture, exactly, but rather the general character.

D. Final color and texture shall be approved by Project Director's Representative after testing prior to actual fabrication of lintels.

E. Lintels shall be fabricated of reinforced concrete, tinted to blend with the color of the mud bricks. Forms made on site shall echo a grainy and rough surface to the finished visible surface of the lintel.

F. Finished exterior plane of lintels shall be recessed approximately 5 cm from finished wall surface at that point. The exact location shall be made in the field.

G. Lintels shall be fabricated in the half round with the rounded half exposed as the soffit. See Figure 7 for a sketch detail of the general shape of the lintels. All dimensions shall be field verified prior to fabrication.

H. Half round portion to extend beyond face of doorway approximately

I. Use 4 - #3 steel rebars or equivalent for each lintel, with minimum of 4 cm coverage. Clean, prep and paint steel before fabrication.

I. Each fabricated lintel shall be butted against the side of another, which leaves a gap of approximately 12 mm between each half round (Figure 7).

Figure 1: The west doorway prior to beginning the structural stabilization and partial restoration. The dashed red lines indicate the approximate extent of the mud brick construction necessary to establish structural integrity.

Figure 2: West doorway from the east at the end of the spring 2005 field season.

Figure 3: Detail of the base of the west side of the door showing deteriorated and missing lower wall. This part of the base had to be comprehensively stabilized by reconstructing this part of the base.

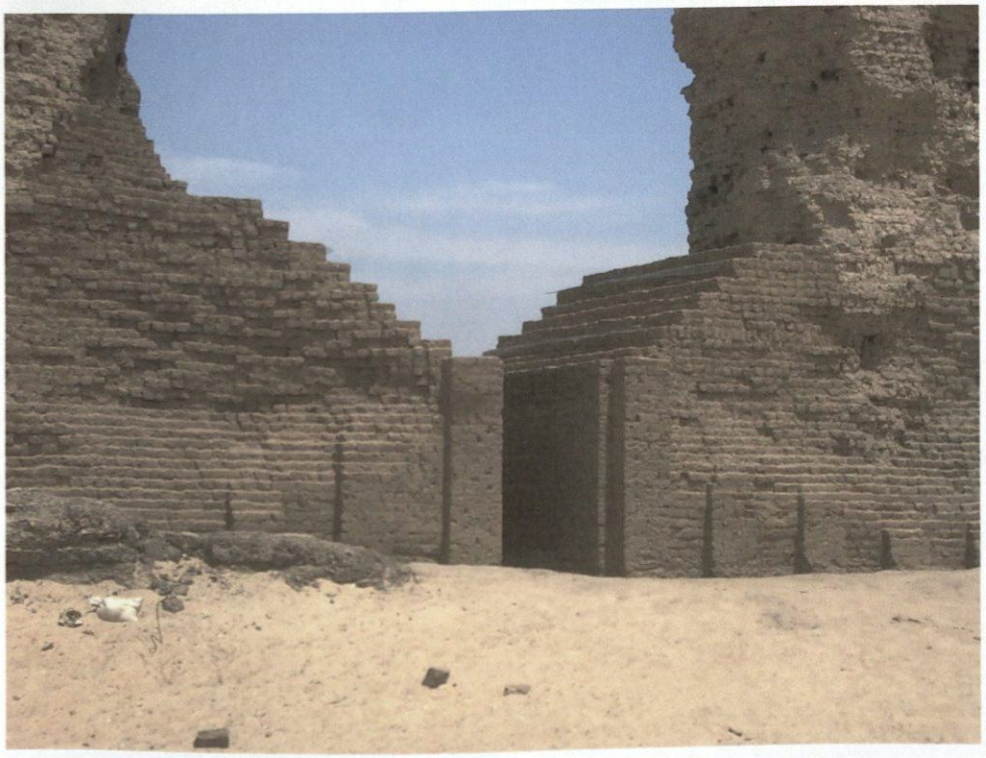


Figure 4: West doorway from the east showing the extent of the restored pilasters.

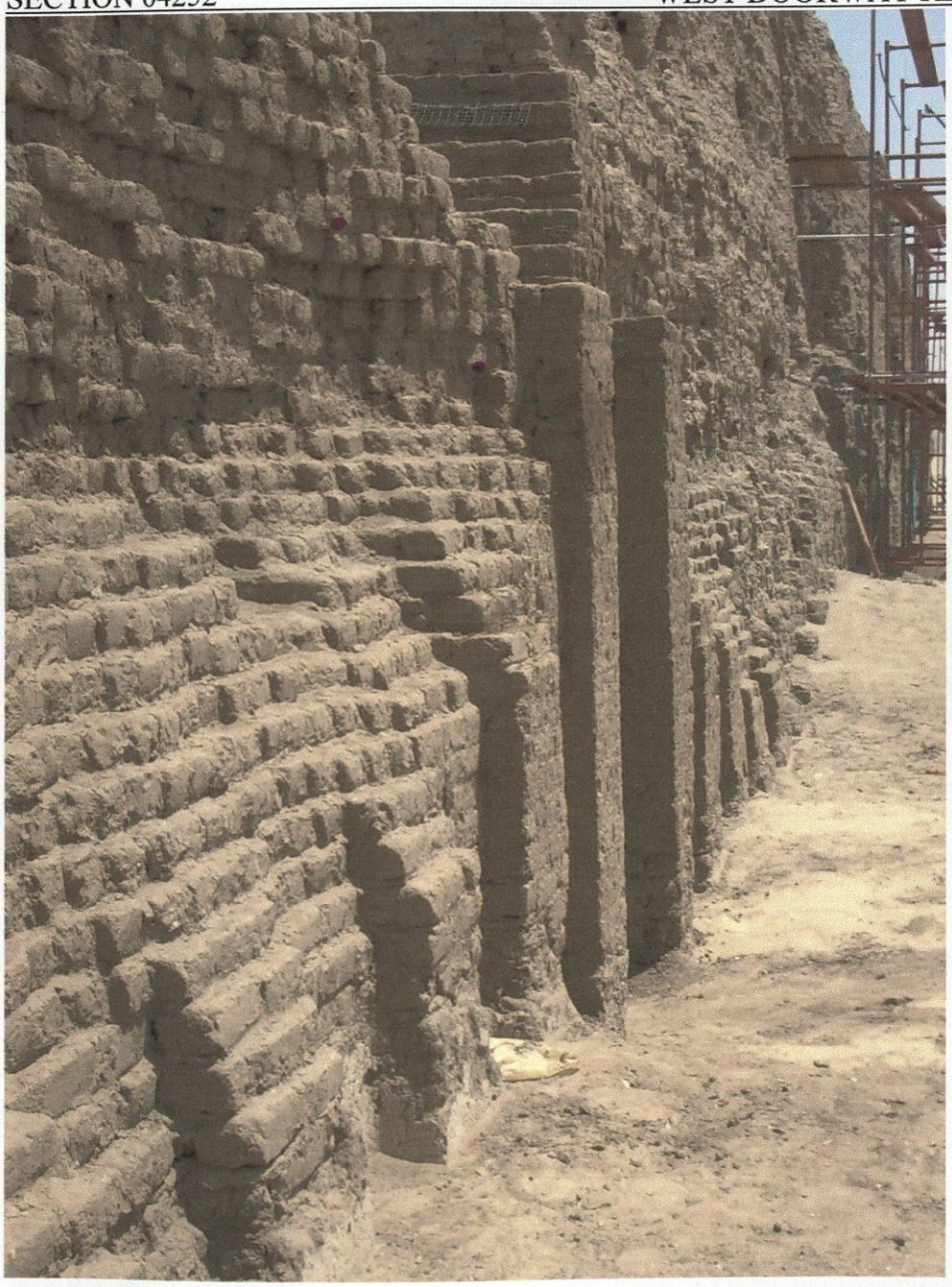


Figure 5: Oblique view of the west doorway pilasters. Note the relative heights associated with the location of the restored door.

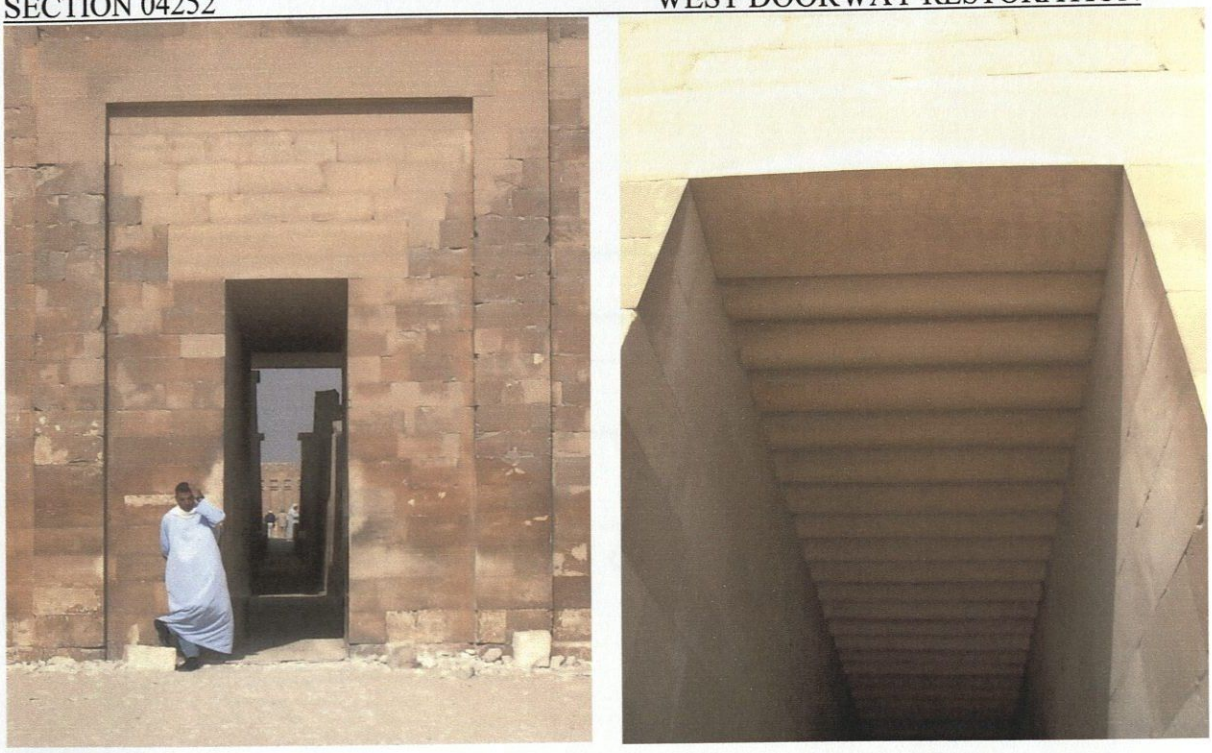


Figure 6: Elevation and detail of the door and lintels at Saqqara. The reconstructed stone lintels visually replicate timber lintels.

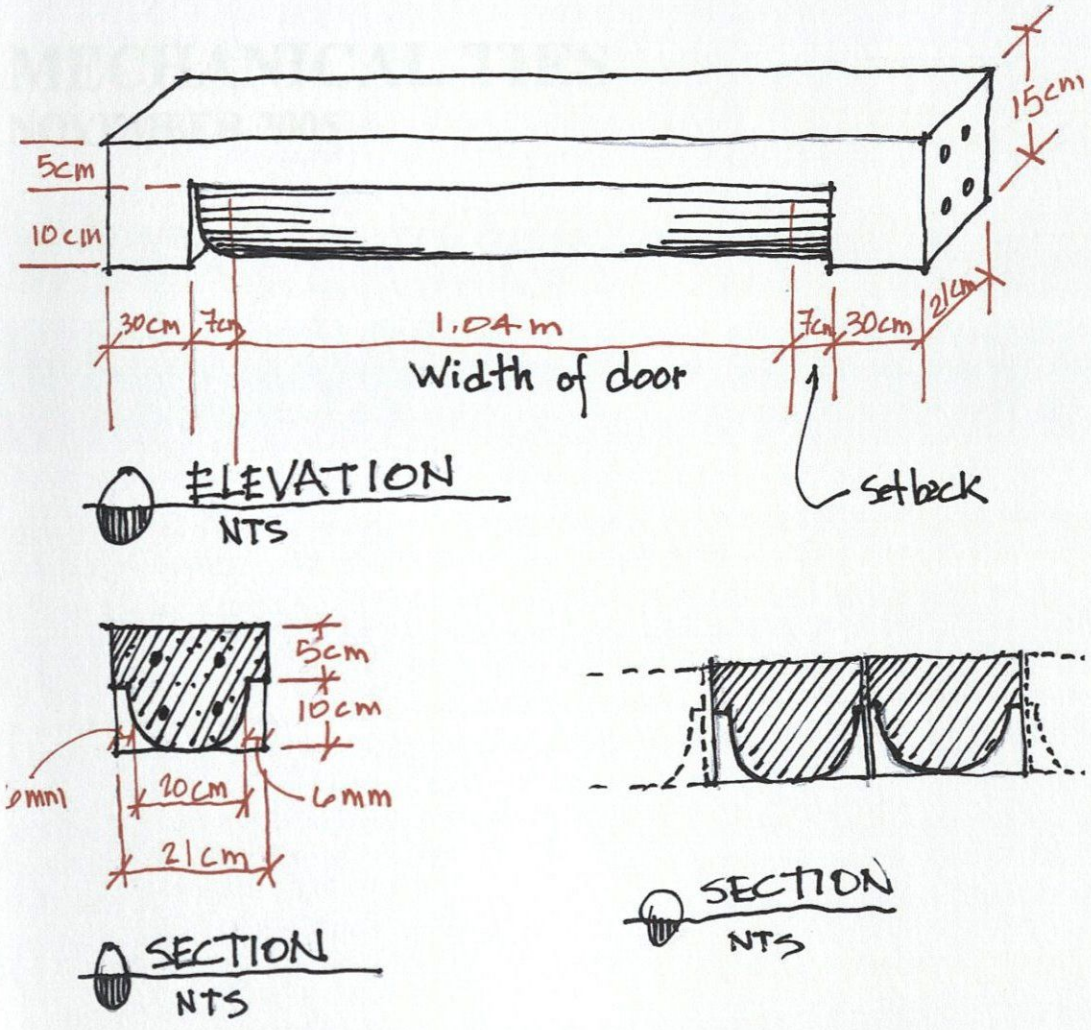


Figure 7: Sketch of reinforced concrete lintel. Secondary sketch shows lintels butted against one another.

MECHANICAL TIES
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes mechanical ties used to attach the new mud brick masonry to the existing mass mud brick masonry of the Shuneh walls. The mechanical ties actually connect to the Tensar Biaxial geogrid, which is used as horizontal reinforcement in the new mud brick masonry construction. The sections attached are usually relatively thin sections of new masonry, primarily because of the construction of relative thin sections of new masonry. The ties shall be used only in cases where additional attachment is necessary and when it cannot be achieved by conventional masonry coursing approaches.

There are two types of mechanical ties. One consists of a threaded steel rod attached to a spring loaded toggle that opens, when not compressed. The steel rod is attached by a couple to a steel eye bolt. The second type consists of a steel wedge on the end of a steel cable that is driven into a drilled hole with a driving rod. When the steel cable is pulled tight, the steel rod rotates from being in –line with the drill hole to perpendicular to the hole. In both cases, the rod and the cable cannot be pulled from the drill hole. Both devices can be connected directly to the geogrid horizontal reinforcement by the eye bolt in one case and a loop in the steel cable in the other case (Figure 1).

The work of this section is closely associated with the work of Sections 04250 Mud Brick Construction. It is also closely related to parts of Section 04230 Crack Repair that involve the bridging of severe structural cracks. This section does not replace any other specification and is limited to the mechanical ties alone.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04230 – CRACK REPAIR

C. SECTION 04250 – MUD BRICK CONSTRUCTION

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials

that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200.

C. Safety conditions are specified in Sections 4250, Mud Brick Construction.

1.4 ENVIRONMENT CONDITIONS

A. Do not install mechanical ties at ambient temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours. If the location is well protected from winds and the actual temperature of the mud brick mass where the repair will take place is greater than 10 degrees Celsius, the repair can continue.

B. Protect drying mortar and mud bricks from direct rainfall during the curing process.

C. Protect materials from rainfall or night humidity.

1.5 TEST PANELS

A. There are no "test panels" as such as the repair is completely covered by mud brick masonry as soon as the mechanical ties have been installed.

PART 2 PRODUCTS

2.1 MATERIALS AND TOOLS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Gravel collected locally.

C. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

D. Steel rods, threaded, stainless ¼ inch diameter, 24 inches long, nuts, eye bolts and couples.

E. Stainless steel toggle bolts, ¼ inch.

F. Earth anchors, Foresight Products, Commerce City Colorado; #40 and #68 and associated clamps and connectors.

G. Tensar Biaxial Geogrid and Tensar Boykin rods.

H. Brace and bit (hand operated); Hammer drill (non-battery powered) and ½ ", 18 inch long masonry bits.

I. Portable generator, transformer and electrical extension cords.

J. Assorted steel and wood probes, pliers, wrenches, and a masonry hammer.

PART 3 EXECUTION

3.1 GENERAL

A. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated repair.

B. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Remove loose construction materials, debris, and deteriorated materials prior to selecting the exact locations for the ties.

B. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application.

C. There is no restriction on the re-tempering or time limit on the use of unamended mortars.

3.3 INSTALLATION OF MECHANICAL TIES

A. Locate where holes will be drilled for the installation of the ties along the entire length of the section of wall that will be mechanically attached to the existing mud brick masonry.

B. Drill hole to a depth of approximately 30 cm or equal to the length of the steel rod or steel cable. The holes are drilled at an angle of 30-45% from horizontal. Holes should be between ½ inch and 1 inch (25-50 mm) (Figure 2).

C. Clean loose debris and soil from drilled hole by scooping, brushing, backward drilling with brace and bit. It may be necessary to add water to the hole to aid in the extraction.

D. Insert steel rods or earth anchors into the holes. The earth anchors are simply driven to resistance. The steel rods and toggles are inserted and maneuvered until the toggle opens. Both devices are then pulled to resistance.

E. The drilled holes are filled with mud mortar. The moisture content of the mortar will vary but should be as dry as possible. The mud, along with large gravel is placed into the holes in small quantities and packed as tightly as possible with steel and wood rods. The process is repeated until no more mortar can be forced into the holes. The only part of the tie that remains visible is the steel eye bolt or the steel cable loop, which will connect to the geogrid (Figure 3 and 4).

F. The geogrid is cut and put in place. The connecting Boykin rod is woven through the geogrid and the eye bolt or cable loop (Figure 5).

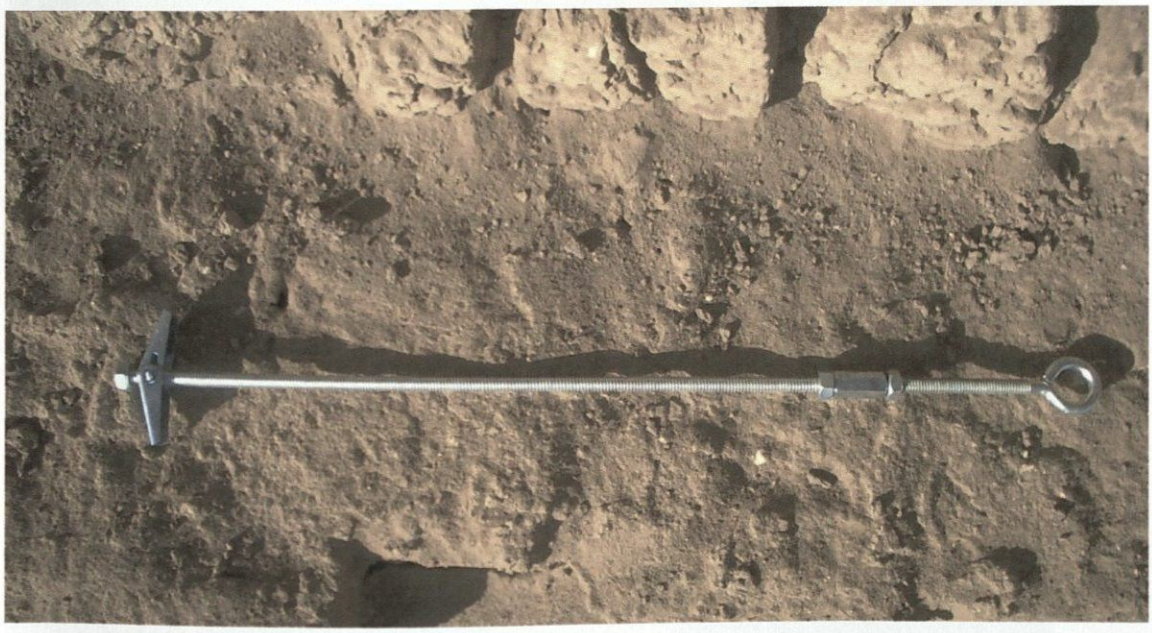


Figure 1: The threaded steel rod, toggle and eye bolt assembled near where it will be set into the drilled hole in the mud brick masonry.

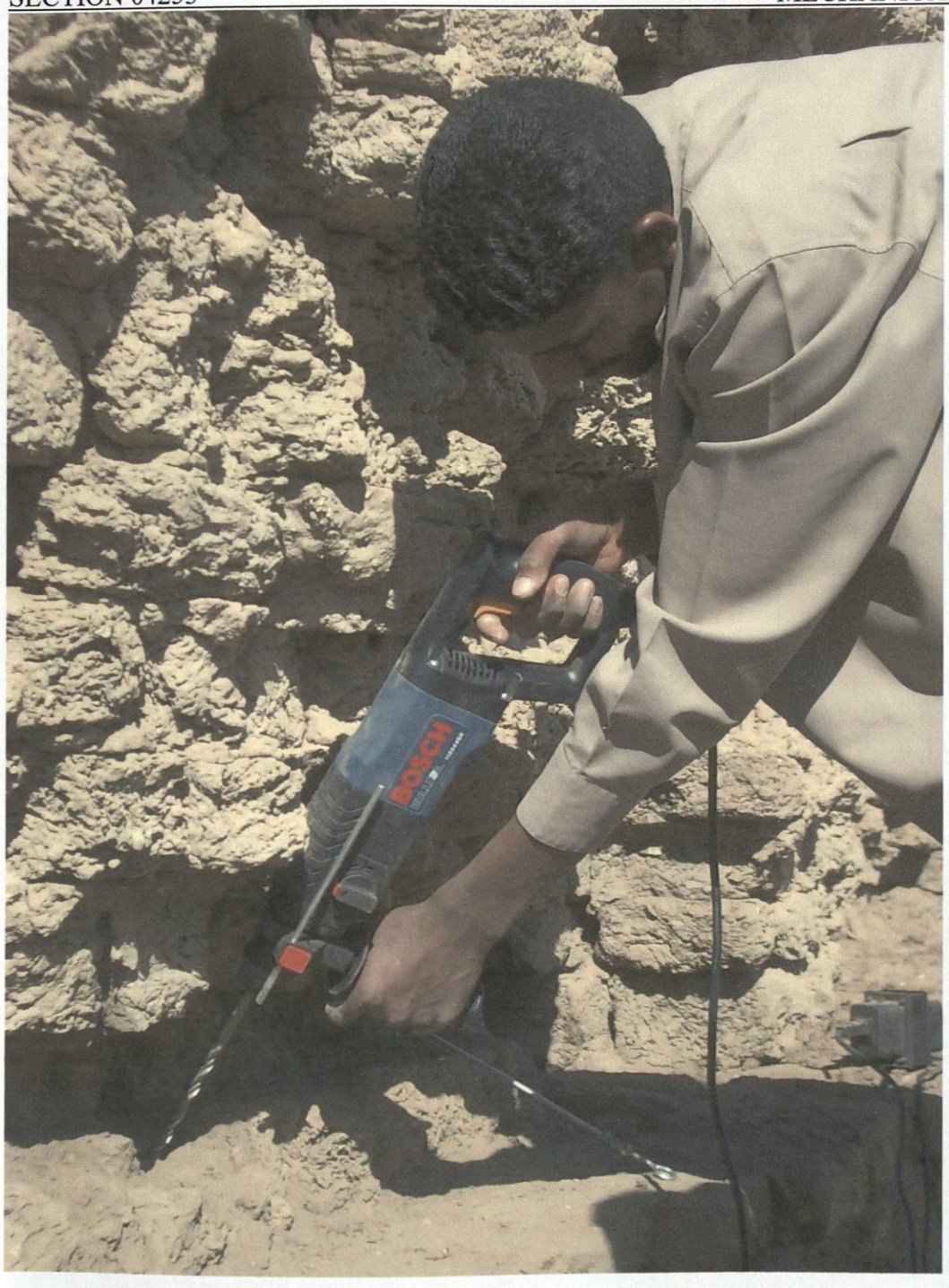


Figure 2: Holes are drilled at an angle of approximately 30-45% from horizontal.

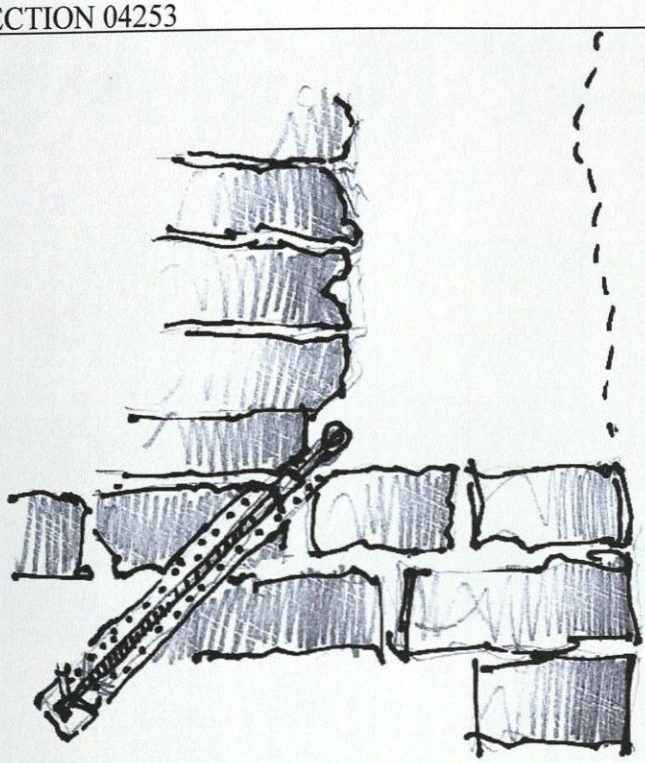


Figure 3: Field sketch of section detail at wall showing steel rod and toggle assemblage set into the mud brick wall.

Figure 4: Eye bolts are the only part of the mechanical tie that is visible after set in the wall. These are set approximately 1 meter apart.

Figure 5: The mechanical ties connected to the geogrid.

END OF SECTION 04253

COPTIC CELL PROTECTION

NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the protection of the remains of the Coptic cells when they present a structural threat to the surrounding mud brick masonry and new supporting masonry has to be constructed. This section does not include the protection of the cells during and after the excavation and documentation process – for that see sections 04225, 04295, and 04296. Most of the large cells have significant remains of the fine plaster floors and some remnants of wall plasters. Because the reason for reconstructing the mud brick masonry is to provide structural stability to adjacent wall mass, there is no anticipation that the new mud brick masonry will ever be removed. Figures 1 – 4 show examples of the remains of the cells after they have been excavated, cleaned and documented.

The work of this section is closely associated with the work of Sections 04250 Mud Brick Construction.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04235 – PLASTER STABILIZATION

C. SECTION 04240 – MUD GROUTING

D. SECTION 04250 – MUD BRICK CONSTRUCTION

E. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

F. SECTION 04297 – SAND BAG PROTECTION

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials

that are utilized in the repairs. The Project Director's Representative shall directly approve the specific work details in each of these critical wall bases described above and shall approve modifications and/or changes to the specifics of this section.

C. Prior to any removal of the existing debris in the cells, the areas shall be made safe for the workmen. These areas shall be excavated and documented according to professional archeological practices. Conservation work can only proceed after the archeological investigations are completed.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at ambient temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours. If the location is well protected from winds and the actual temperature of the mud brick mass where the repair will take place is greater than 10 degrees Celsius, the repair can continue.

B. Protect cell features from direct rainfall and blowing sand and dust.

C. Protect treated features from rapid drying from temperature, sun, and wind by shades and wind breaks.

D. Protect repair area during the night by covering previous work and protecting from low night temperatures and night winds if appropriate.

1.6 TEST PANELS

A. Specific treatments shall be modified for each specific application location, if necessary, and approved prior to the continuation of the work. The sections constructed for approval by the Project Director's Representative shall be part of the final work when approved.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Fine shifted sand, free of organic materials and gravel larger than 5 mm.

C. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

D. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

E. Acryloid B-72 or equal consolidant at 5% solids.

F. Lime, calcium hydroxide, available locally

G. Sand bags and fill sand.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual treatment. Protection from falling debris shall also be in place prior to any construction repair. Structural support of adjacent mud brick walls in the areas of treatment shall be installed prior to the actual conservation work of this section. Persons that are not part of the conservation team shall not approach to within 3 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated repair.

C. The effect of the treatment of the Coptic cell features is to protect them from damage when mud brick masonry is added that bears directly on the individual features.

D. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the treatment and the treatment area prior to beginning the treatment and the amount of original materials that will have to be removed. The specific details of the treatment shall be determined after loose materials have been removed. Carefully inspect all exposed features and identify where treatment is needed.

B. Remove loose and deteriorated materials prior to the new repair by removal of existing mud bricks, scraping, brushing, probing and blowing the areas where the repair will take place. This includes loose mortars and mud bricks, organic matter, and wind blown sand. It is anticipated that some of the voids contain animal nests and these shall also be removed.

C. Carefully clean all exposed surfaces of cell features with soft brush prior to beginning the treatment procedures.

D. Dampen contact areas of existing and new mud brick masonry prior to setting new mud bricks and mortar. The depth of the dampening shall be between approximately 2-3 mm and 6 mm deep; it shall not exceed 6 mm deep.

E. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application.

F. Determine specific proportions of the soil//lime or lime plaster mix used for stabilizing the existing plaster edges in the field. The appropriate mix will depend on the soil or sand available. See section 04235, PLASTER STABILIZATION for the details of plaster edge treatment.

G. Do not retemper plaster that has lime as an additive.

3.3 COPTIC CELL PROTECTION

A. Stabilize edges of plaster with consolidant if necessary prior to the application of plaster edging.

B. Build up contact surface of existing plaster and substrate where needed and allow to dry.

C. Fill missing mud brick sections up to the level of the cell features (Figures 5 and 6).

D. Protect the features while extending the level of the mud brick masonry to approximately one course above the feature (Figures 7 and 8).

E. Once the surrounding mud brick feature is above the features, add fine sand up to the level of the mud brick. Compact by dampening and tamping the sand (Figures 9 and 10.

F. Vertical features such as wall plaster will be protected by building up the mud brick leaving a space between the feature and the mud brick – the space is then filled with fine sand (Figure 11)

G. Continue constructing the mud brick masonry until the cell features are completely encased by the new masonry (Figure 12).

H. Document the process during the protection treatment as well at the end of each day.

Figure 1: Coptic cell floor with temporary support in place.

Figure 2: The Coptic cell in the east wall in an area where the missing wall will be reconstructed in the spring of 2006.

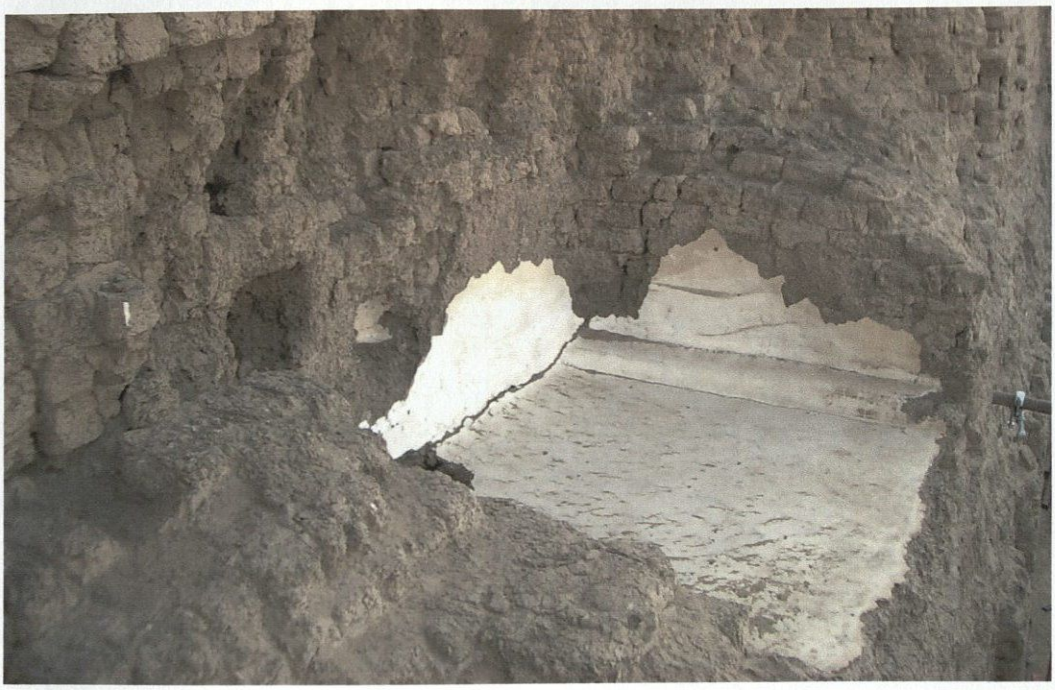


Figure 3: The remains of a floor and bench in one of the cells in the west wall, west side.

Figure 4: A cell with niches and mud plaster remaining on wall surface.

Figure 5: Coptic cell cleaned as mud brick base is being brought up to cell level.

Figure 6: A second view of the mud brick base being raised to cell level.

Figure 7: Mud brick has been raised to one course above cell floor.

Figure 8: Mud brick masonry placed to best advantage in protecting the cell features.

Figure 9: Sand fill added to floor of cell.

Figure 10: Sand being sifted as it is being placed on cell plaster.

Figure 11: Sand is being added to space between mud brick and vertical plaster.

Figure 12: Protective sand has been added and compacted and mud bricks are being placed over entire area.

END OF SECTION 04254

HORNET NEST REMOVAL

JULY 2001

Anthony Crosby, Architectural Conservation
For International Preservation Associates, Inc.

July 2001

PART 1 GENERAL

DESCRIPTION: This section includes the removal of existing insect mud nests, both for the purpose of removing the threat to the deterioration of the original mud brick fabric as well as being necessary for the actual completion of the conservation interventions of these sections. This section does not include the cyclic control of the insects necessary to prevent the re-infestation in the future. Nests located inside areas and voids that shall be filled should be left in place and keyed into as necessary in order to achieve a sound structural repair.

Safety precautions shall conform to Section 04200, Part 1, C.

1.1 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04235 – PLASTER STABILIZATION

F. SECTION 04240 – MUD GROUTING

G. SECTION 04250 – MUD BRICK CONSTRUCTION

H. SECTION 04260 – WALL BASE VOID REPAIR

I. SECTION 04270 – VOID AND HOLE REPAIR

J. SECTION 04280 – MUD BRICK CAPPING

K. SECTION 04290 – PILASTER REATTACHMENT

L. SECTION 04295 – SAND BAD BUTTRESS CONSTRUCTION

M. SECTION 04297- SAND BAG PROTECTION

1.2 SUBMITTALS

A. The manufacturer's safety data sheets and application instructions for insecticide application that may be necessary to provide a safe work place shall be submitted and approved by the Project Director's Representative prior to use.

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project.

B. The action as specified in this section has been tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. Any change in conditions may require a modification to the specifications. The Project Director's Representative shall approve any modification and/or changes to this section prior to the work. The test area is on the north elevation of the South Enclosure Wall (Figures 1 and 2). No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.4 ENVIRONMENT CONDITIONS

A. There are no restrictive environmental conditions. The environmental conditions may affect the activity of the insects and that should be considered when planning the work.

1.5 TEST PANELS

A. Test area was prepared in March 2001 on the north elevation of the South Enclosure Wall and shall be the standard to meet when removing insect nests.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel bars and chisels, hammers, brushes, ladders and scaffolding to conform to descriptions in Section 04200, Part 2, 2.2 C. and D. Safety equipment such as goggles, gloves, dust masts, and hard hats are essential.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. All visitors shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the removal of the nests, although some existing materials will have to be removed in order to execute a satisfactory removal.

C. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the conservation treatments that require the removal of the nests prior to beginning the work.

B. Have all tools available prior to beginning the work.

C. Determine the process of removal, i.e., from left to right, right to left, bottom to top, or a combination and tentatively mark the individual parts of the nest to be removed and the sequence with a steel chisel. See Figure 1.

D. Determine the activity pattern of the insects and, if possible, remove the nests when the insects are not active. Insects were observed to be quite active after the sun warmed the surface temperatures ca. 0800 hours in January 2000. Insect activity lessened close to 1200 hours until mid-afternoon. For unknown reasons, the insects were not active during any time of the day in March 2001.

3.3 REMOVAL

A. The insect nests are extremely dense and well attached to the mud brick. The removal of the nest in relative large pieces was not possible

B. Cut through parts of the nest with a steel chisel and remove sections of the nest that can easily be handled. The cuts through the nest should be approximately 5-10 cm apart.

C. Restrict beating on the nest with large hammers, as it will do more damage to the mud brick on which the nest is attached. Do not hit the actual nest with a hammer, use the hammer and chisel to cut the nest.

D. Cut through the nest perpendicular to the wall plane first and then cut through the section of the nest parallel to the wall plane and remove the separated section.

E. Reduce the weight of the hammer blows as the sections immediately attached to the wall are cut.

F. Clean the mud bricks of the last remaining parts of the nest, but it is not necessary to remove every part of a nest. The removal of some parts of nest may cause more damage to the mud bricks than if that small part was left in place.

G. Continue to monitor and evaluate the condition and the stability of the mud brick to which the nests are attached.

H. Determine the approximate volume of the nest that is removed. The test area nest, approximately .05 meter^3, required approximately 45 minutes to remove.

Figure 1: A large insect nest on the lower part of the north side of the South Enclosure Wall prior to the removal that is specified in this section. The red dotted vertical lines are the approximate locations of the chisel cuts into the nest.

Figure 2: The insect nest after the removal test is complete. See Figure 3 for a detail of this area.

Figure 3: A detail of the area where the insect nest was removed

END OF SECTION 04255

WALL BASE REPAIR
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the structural repair of the bases of walls for which the structural integrity has been compromised by the removal of significant portions of the walls. This includes additional foundation stabilization that may be required. It also includes the extensive voids at ground level, primarily on the west side of the East Enclosure Wall and the east side of the West Enclosure Wall. Figures 1, 2 and 3 show examples of the conditions for which this specification is applicable.

The work of this section is closely associated with the work of Sections 04250 Mud Brick Construction and Section 04270 Void and Hole Repair. It is also closely related to parts of Section 04230 Crack Repair that involve the bridging of severe structural cracks.

The intent of the construction is only for the purpose of providing structural integrity to the lower walls. Portions of missing architectural elements or features shall not be constructed except for that purpose.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04230 – CRACK REPAIR

C. SECTION 04250 – MUD BRICK CONSTRUCTION

D. SECTION 04270 – VOID AND HOLE REPAIR

E. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

F. SECTION 04297 – SAND BAG PROTECTION

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall directly approve the specific work details in each of these critical wall bases and modifications and/or changes to the specifics of this section.

C. Prior to any removal of the existing debris and unstable mud bricks each specific area shall be inspected for its safety and steps taken to provide a safe work environment. This includes, but not limited to the construction of sand bag buttresses and supports, temporary bracing and shoring, and personal safety equipment. Each area shall be excavated and documented according to professional archeological practices. Conservation work can only proceed after the archeological investigations are completed.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at ambient temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours. If the location is well protected from winds and the actual temperature of the mud brick mass where the repair will take place is greater than 10 degrees Celsius, the repair can continue.

B. Protect drying mortar and mud bricks from direct rainfall during the curing process.

C. Protect mortar from rapid drying from temperature, sun, and wind by shades and wind breaks.

D. Protect repair area during the night by covering previous work and protecting from low night temperatures and night winds.

E. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. Specific coursing of mud bricks shall be developed for each specific application location and approved prior to the continuation of the work. The actual integration of the new masonry and the existing shall also be developed and approved prior to continuing. The sections constructed for approval by the Project Director's Representative shall be part of the final work when approved.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

C. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

D. Steel bars: Steel bars to conform to descriptions in Section 04200, Part 2, 2.1, F., 13.

E. Steel rods, threaded, stainless ¼ inch diameter, 24 inches long.

F. Stainless steel toggle bolts, ¼ inch; nuts and couples.

G. Earth anchors, Foresight Products, Commerce City Colorado; #40 and #68.

H. Tensar Biaxial Geogrid reinforcement, BX 1100, or equivalent.

I. Sand bags and fill sand.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. Structural support of the walls in the areas of the base wall void repairs shall be installed prior to the actual conservation work of this section. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated repair.

C. Repairs are to be structurally integrated with the existing mass of mud brick masonry to the greatest extent possible by excavating unsound material and establishing a sound base for the new material.

D. The effect of the base wall repair shall provide structural integrity to the bases of the walls.

E. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Remove loose mud bricks, loose sand and debris and clean area of new base.

B. Determine the specific extent of the construction prior to beginning the repair and the amount of original materials that will have to be removed. Specifically determine the depth and the extent of the repair. The specific details of the construction repair shall be determined after loose materials have been removed.

C. Excavate loose sand below lowest course of mud brick to firm compacted sand. Compact new sand used as fill by alternately wetting and tamping (Figure 3). It may be necessary to contain the sand while it is compacted (Figure 4).

D. Establish extent of base, which may project out from original wall line in order to provide a more stable wall base (Finish ground shall cover any base projection by a minimum of 30 cm) (Figures 5 and 6).

E. Place horizontal and vertical string lines in section of new mud brick masonry after removal of any damaged existing mud bricks to ensure that the repair is consistent with the form and mass of the existing masonry.

F. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application.

3.3 WALL BASE WALL REPAIR

A. Place geogrid on compacted sand and set with mud mortar. Lay first course of bricks on geogrid and bed mortar to the full horizontal extent necessary (Figures 7 and 8).

B. Step back subsequent courses to the original wall plane (Figure 9).

C. Key new material to existing by setting new mud bricks in a "toothed" pattern keyed into the original mud brick masonry. Pack new mud bricks and mortar to the maximum extent possible (Figure 10).

D. Replicate the coursing pattern of the existing exposed surface including the thickness of the mortar bed joints.

E. Construct the new mud brick masonry in complete horizontal courses where possible. Set new bricks with head joint mortar as well as bed mortar.

F. New mud brick repair shall not appear as new construction, but shall replicate the general character of surrounding wall surfaces.

G. Mortar should be thoroughly wet and in a plastic state but as dry as possible. The specific moisture content of the mortar will vary depending on the specific use.

H. Protect the repairs from rapid drying by misting, shading and protection from dry winds.

I. Figure 11 shows the completed construction of a wall base.

Figure 1: Base of wall that has collapsed and will have to be reconstructed to provide structural integrity.

Figure 2: Another example of a wall base that will have to be stabilized. This large section of wall is at the southwest corner of the enclosure wall.

Figure 3: Unstable base of west enclosure wall, east side, along the south portion.

Figure 4: A separate feature has been constructed to retain the sand during compaction and placement of new mud bricks.

Figure 4: Loose materials have been removed and sand base is being compacted.

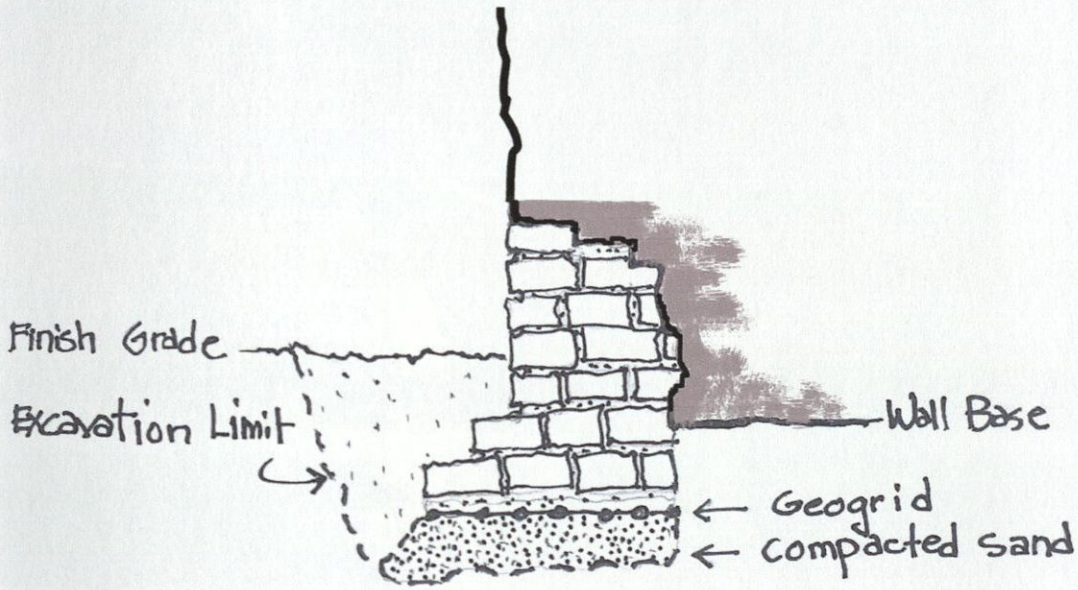


Figure 5: Sketch of typical wall base showing the construction of a new base, which projects beyond the wall face.

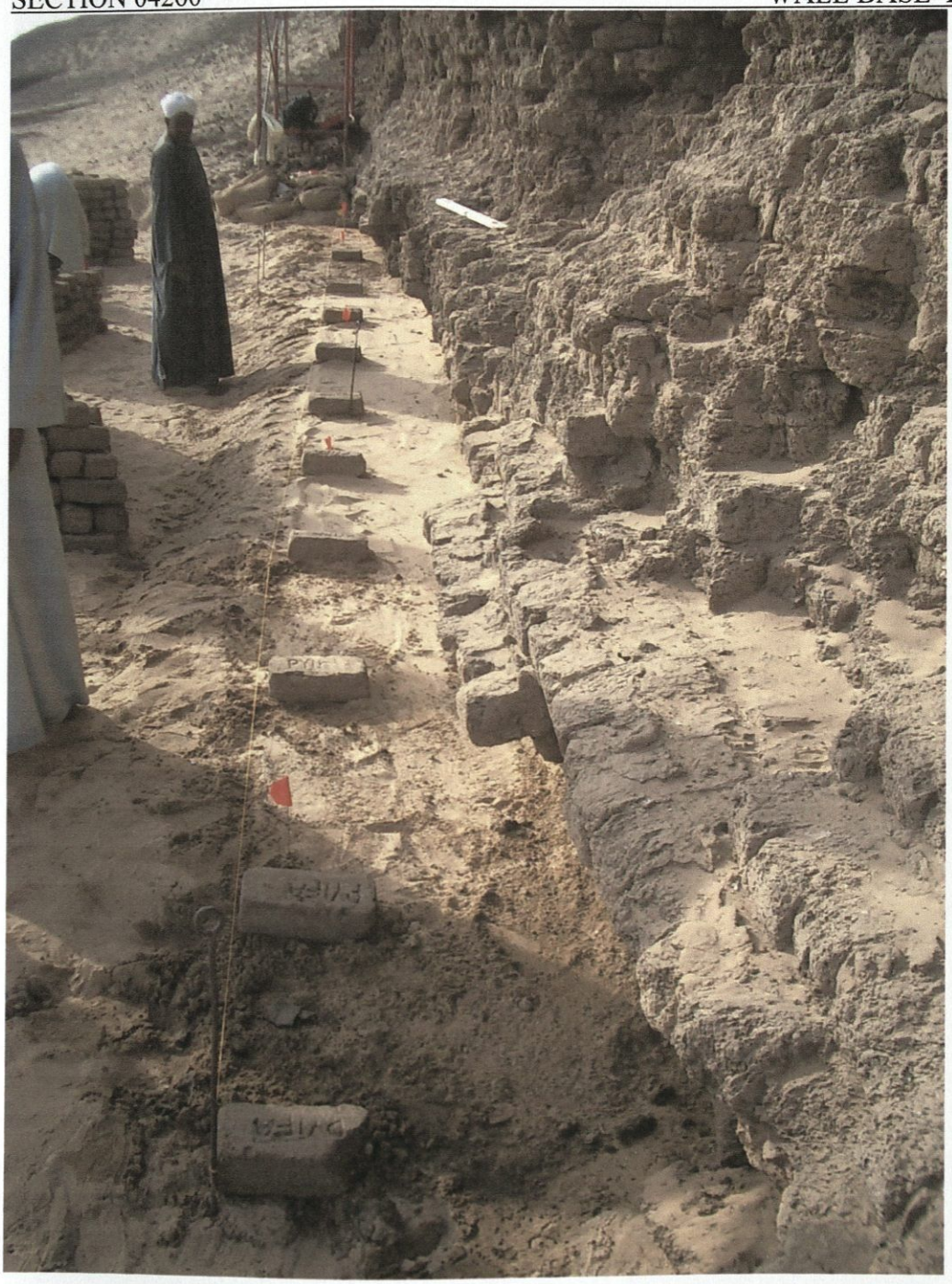


Figure 6: Establishing the extent of the base. The red flags indicate the original wall surface.

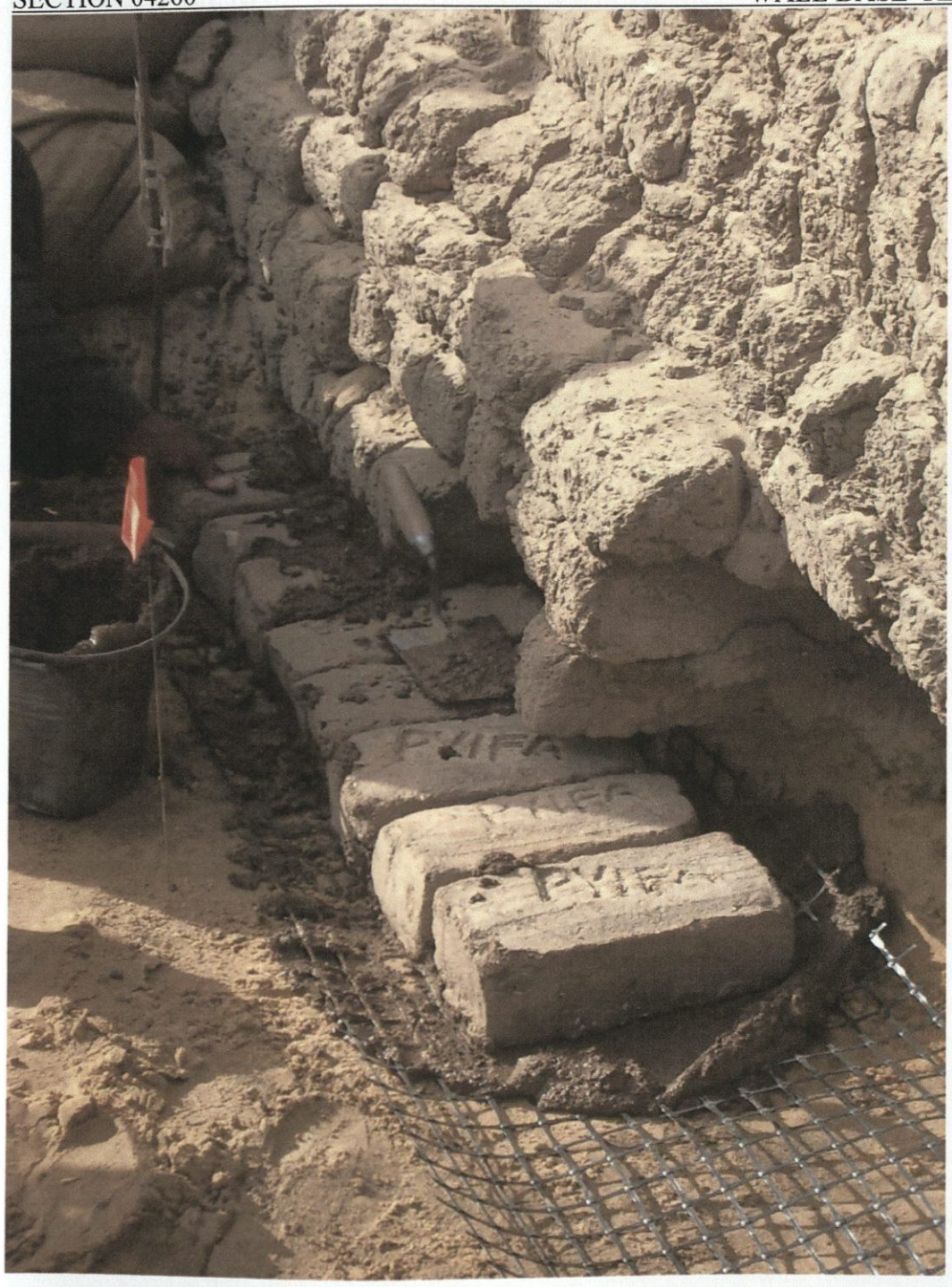


Figure 7: Laying the first course of mud bricks on a base of compacted sand and geogrid.

Figure 8: One complete course of base mud brick masonry. The red flags are on the line of the original wall face.

Figure 9: Mud brick masonry is being stepped back to the original wall face.

Figure 10: The wall base is being completed masonry packed and wedged in as much as possible. Note small white rocks used to reduce settlement as mortar dries.

Figure 11: The completed construction of a wall base. The lower part of the wall will be covered with fill sand.

END OF SECTION 04260

VOID AND HOLE REPAIR
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the repair of voids and holes in the mud brick walls that are not included in the structural repairs specified in Sections 04250 and 04260. The repairs of this section are not structural and the intent of the repair is to eliminate holes and voids that provide habitat for animals and insects and possible access to the mud brick mass of water and wind that further erode these same holes and voids. The repair of the holes and voids will also eliminate existing deep shadows in the wall surfaces.

The repair of this section will result in undulations in the wall surface similar to that which exists. The repaired sections shall not be flat, but rather set to create the textures and shadows consistent with the texture and character of the original mud brick walls. The repairs shall also replicate the coursing patterns as much as possible. Figures 1 – 3 show some of the typical areas of voids that are the subjects of the work covered by this specification.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04240 – MUD GROUTING

E. SECTION 04250 – MUD BRICK CONSTRUCTION

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04250.

B. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be

consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at ambient temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours. If the location is well protected from winds and the actual temperature of the mud brick mass where the repair will take place is greater than 10 degrees Celsius, the repair can continue beyond the limits of the minimum low temperatures above.

B. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. Two test areas that represent the two extremes of void and hole repair, large and small voids shall be selected. One example was completed in March 2001 and shall serve as a test area (Figures 5, 6, and 7). Future repairs shall replicate the general character of the test repair in the east side of the West Enclosure wall as well as other repairs that are completed and approved. The additional test sections shall be approved by the Project Director's Representative.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

C. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

D. Tensar Biaxial Geogrid.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. Proper safety precautions are necessary prior to the

beginning of the actual work. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory repair.

C. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of repair prior to beginning the work. The specific details of the repair shall be determined after loose materials have been removed.

B. Each area shall be documented photographically by the project documentation team prior to any preparations of the specific areas. After preparation the areas shall be re-documented prior to the undertaking of the actual repair.

C. Check for the presence of hornet nests and treat with an approved insecticide if necessary.

D. Remove loose and deteriorated materials prior to the new repair by removal of loose debris, sand, soil, and insects nests. Loose mud bricks can be removed to reset later, but removal is not necessary. Report all cultural materials and objects to Project Director's Representative Remove loose materials by scraping, brushing, probing and blowing the voids and holes where the repair will take place.

E. Establish the overall repair approach and the final surface plane of the repair prior to the work. Temporary placement of dry laid mud bricks in the larger holes and repairs can be used to approximate the visual effect of the final repair.

F. Use thin steel bars to clean joints to maximum depth possible. Remove loose mortar.

G. Dampen contact areas of existing and new mud brick masonry prior to setting new mud bricks and mortar. The depth of the dampening shall be between approximately 2-3 mm and 6 mm deep; it shall not exceed 6 mm deep.

H. Mix soil and water (potable) prior to use. Do not use the clay rich soil.

I. There is no restriction on the re-tempering or time limit on the use of unamended mortars.

3.3 VOID AND HOLE REPAIR

A. Re-dampen materials according to 3.2, E. above of this section if required. Misting or spraying is allowed, but the water spray shall not be applied to the extent that it results in the formation of mud drips.

B. Place full size mud bricks in the holes and voids where possible. Fill voids around the placed mud bricks with mud brick bats and mud mortar. Particularly deep voids may require the use grouting as specified in Section 04240. See Figure 4.

C. Replicate the coursing pattern of the existing exposed surface including the thickness of the mortar bed joints where the voids and holes have the required surface area. The actual coursing pattern of the new mud bricks is not important except at the finish surface of the repair.

D. Set new bricks with head joint mortar as well as bed mortar.

E. Fill all voids by throwing mortar into the voids. The new mud bricks and mud brick bats shall be placed into the voids with as much pressure as possible.

F. Mortar should be dry as possible but the mortar for grouting will be quite wet. Grout shall be restricted to the filling of only small voids in the actual repair after the repair material has initially set. The mud grout shall set completely (thumbprint dry) prior to the subsequent step of repair. Grouting shall be limited.

G. Specific depth of each repair step shall be determined in the field for each specific case. In some cases where deep and large voids exist, it may be necessary to complete the repairs in a series of steps. See Figure 4.

H. Use Tensar Biaxial Geogrid in particular large voids to provide horizontal reinforcement. In rare cases it may also be necessary to mechanically connect the geogrid to the existing wall mass. See Section 04253 of these specifications.

I. New mud bricks shall not extend beyond the existing surface of the mud brick walls. In some cases it will be necessary to corbel out mud bricks to establish a base for repairs higher in the wall.

J. The repair shall replicate the general texture of the surrounding mud brick wall surface (Figures 5 and 8).

K. Remove all tool marks from mortar.

L. The application of a mud wash will complete the repairs. See Section 4220 for surface rendering.

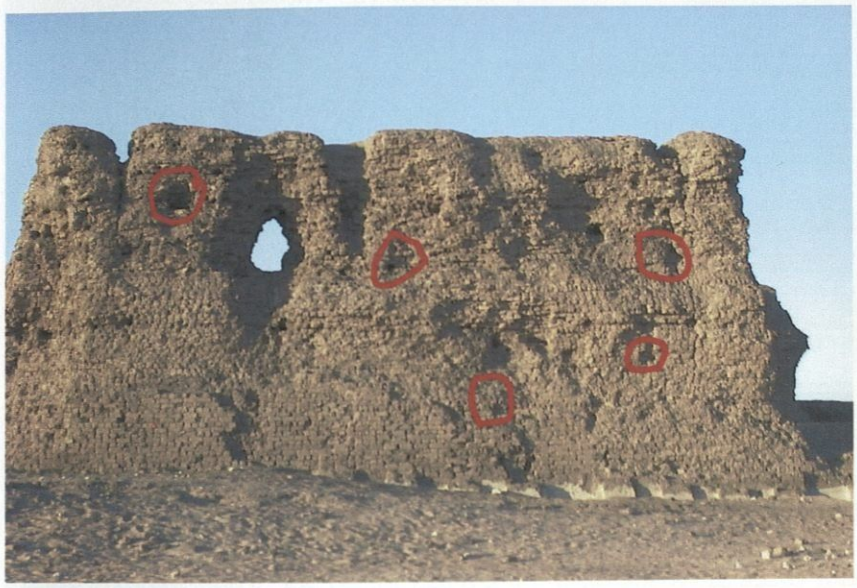


Figure 1: East Enclosure Wall showing a few of the numerous holes and voids that are typical of the areas that will be included in the work of this section.

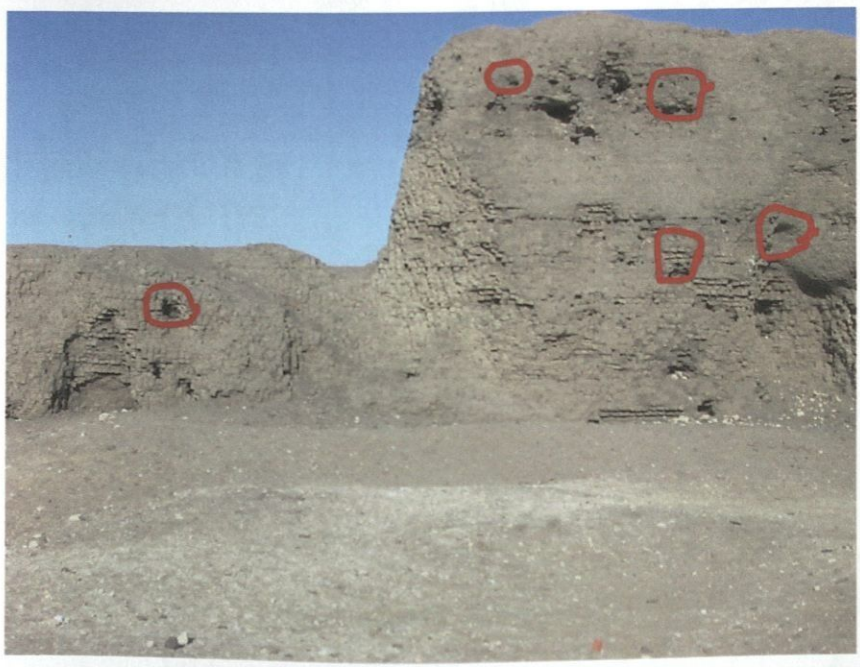


Figure 2: Another view of the East Enclosure Wall with a few of the typical holes and voids indicated.

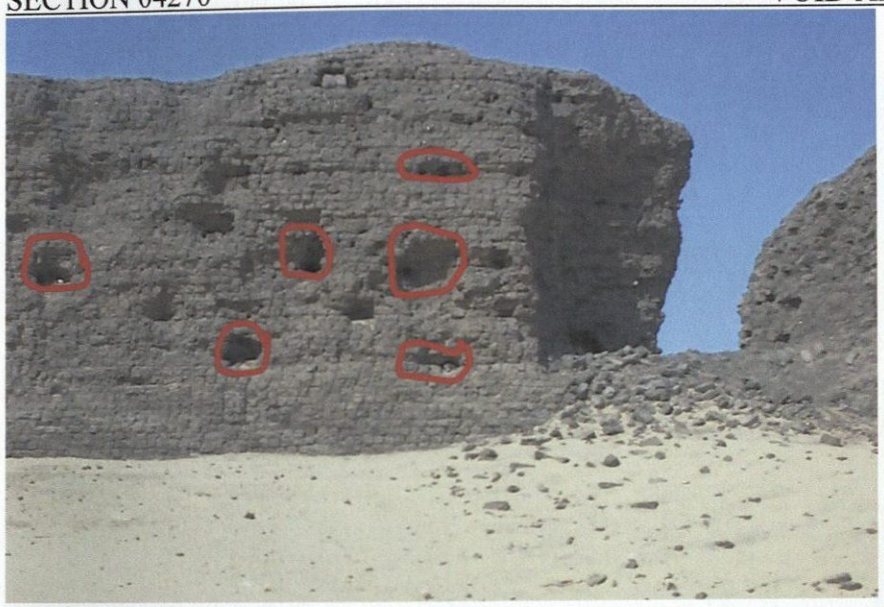


Figure 3: South side of the North Enclosure Wall showing some holes and voids that shall be repaired.

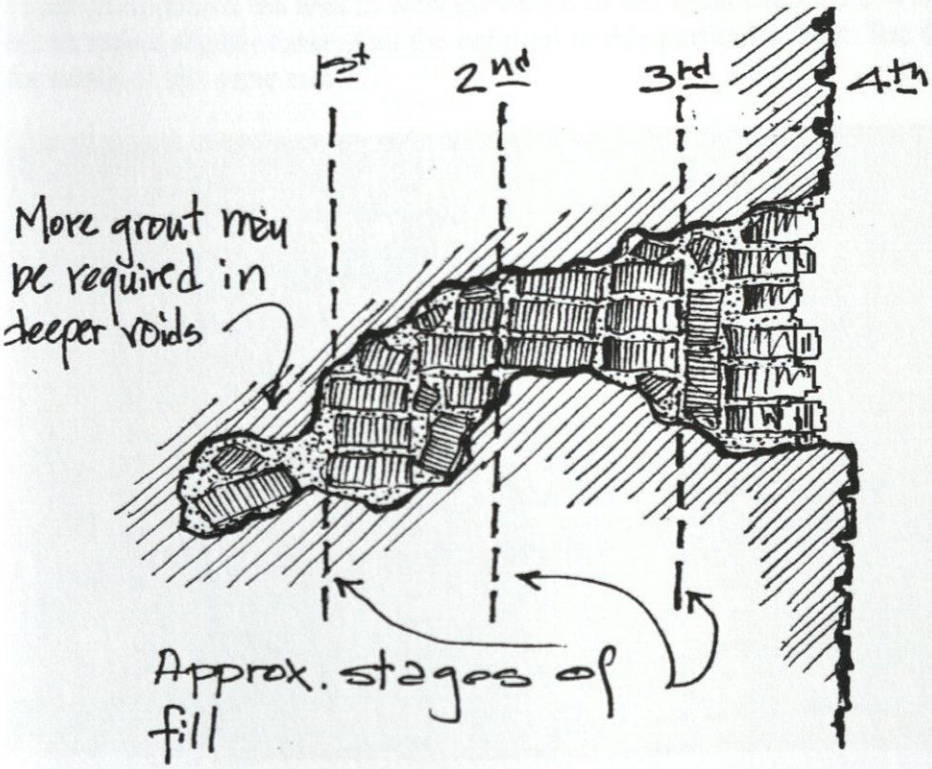


Figure 4: Sketch partial section through a typical void showing basic repair with mud bricks and mud brick bats.

Figure 5: Approved test area in west elevation of the West Enclosure Wall. The new mud bricks appear slightly darker that the original in this particular light. See figures 7 and 8 for details of this same area.

Figure 6: Detail of the void repair in the West Enclosure Wall. The new mud bricks are stepped to support the unsupported mud bricks above, and set to replicate the characteristic of the surrounding mud brick wall.

Figure 7: Detail from below of the repair to the West Enclosure Wall. Note repair is corbelled to support mud brick above.

Figure 8: An example of a completed void repair.

END OF SECTION 04270

MUD BRICK CAPPING

NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the protection of the tops of walls by the installation of mud brick caps. It is the intent of the work of this section to install caps to the tops of all walls to protect the existing (original) fabric. The new mud brick caps will compose a sacrificial layer and are expected to erode. Over time the cap will be replaced by other mud bricks to continue the protection of the tops of walls. Protection is necessary as decayed mud bricks no longer withstand even the most minor decay mechanisms. The new mud brick caps will provide greater protection to continual human-caused erosion by walking, climbing, etc, and from the less destructive forces of nature in the form of wind and rain. It includes the basic principles that the Section 04250 Mud Brick Construction. It is also closely related to parts of Section 04230 Crack Repair that involve the bridging of severe structural cracks.

The intent of the mud brick capping is only for the purpose of providing a sacrificial layer to protect underlying fabric. It shall not significantly change the overall massing of the existing walls and shall follow the existing wall undulations to the degree possible by adding one to two courses to every exposed brick. Figures 1 and 2 show typical tops of walls and other horizontal wall surfaces to be capped.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04230 – CRACK REPAIR

D. SECTION 04240 – MUD GROUTING

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mortar from direct rainfall during the curing process.

C. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. A test panel was constructed in March 2001 and approved for use for low wall capping. Before and after photographs are included as Figures 3 and 4. Other selected areas shall represent different wall conditions and panels shall be prepared for approval by the Project Director's Representative. The sections constructed and approved shall be part of the final work and shall serve as the standard until the work of this section is complete. The additional test areas shall replicate the general techniques of the approved area on the east perimeter wall.

B. A portion of the top of the east enclosure and the west enclosure was also capped in 2004 and those two will also serve as test panels.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar shall be consistent with Section 04200, Part 2, 2.1, D., 1. and 2.

B. Soils for mud plaster shall be consistent with Section 04220 Surface Rendering Part 2, 2.1, C. and D.

C. Mud bricks for mud brick masonry construction shall be consistent with Section 04200, Part 2, 2.1, A., 1., 2 and 3.

D. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair strength.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to repair area by scaffolding is required. Protection from falling debris shall also be in place prior to any construction repair. Proper safety precautions are necessary prior to the beginning of the actual work. Persons that are not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials will have to be removed in order to execute a satisfactory and integrated cap. Compare Figures 1 and 2 and the left photograph of Figure 9.

C. The mud brick caps are to be integrated with the existing mass of mud brick masonry to the greatest extent possible, but the complete removal of all unsound materials is not normally required.

D. The effect of the mud brick cap shall not distract from the existing visual character of the wall where the repair takes place.

E. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the construction prior to beginning the repair and the amount of original materials that will have to be removed. Do not remove loose material from the top of a wall if the mud cap is not to be installed within 5 workdays.

B. Remove loose and deteriorated materials in the form of friable and powdery surface prior to the new repair by scraping, brushing, and blowing the areas where the repair will take place. Remove loose mortar and repoint prior to the installation of the mud brick cap. See Figures 3 and 5.

C. Mortar joints are harder and denser than the original mud bricks. Mortar may have to be broken and removed for preparation of base for the bed mortar.

D. Dampen contact areas of existing and new mud bricks prior to setting new mud bricks and mortar cap. The depth of the dampening shall be between approximately 2-3 mm and 6 mm deep; it shall not exceed 6 mm deep.

E. Mix soil and water (potable) prior to use. Mix with clay soil should be soaked overnight prior to application.

F. There is no restriction on the re-tempering or time limit on the use of unamended mortars.

G. Mixing of mud for mud plaster and mud washes shall be as specified in Section 04220.

3.3 CONSTRUCTION REPAIR

A. Re-dampen materials according to 3.2, D. above of this section if required. Misting or spraying is allowed, but the water spray shall not be applied to the extent that it results in the formation of mud drips.

B. In most cases the mud brick cap shall be two courses thick, although there may be some conditions that require only one course of mud bricks (Figure 6).

C. Coursing pattern shall replicate the existing bonding pattern when possible. Alternate patterns and the use of partial mud bricks will be necessary to cover the original bricks most efficiently (Figure 7).

D. New mud bricks shall be set in bed mortar following the basic existing contour. Thickness of bed mortar shall be approximately 15-25 mm thick.

E. Do not allow bed mortar to dry prior to setting mud bricks. Mud bricks shall be placed on mud mortar immediately after placement of mortar.

F. Second course can be added immediately with no time allowed for the drying of the first course.

G. Mud brick cap shall follow the general wall surface profile or step back several cm if the wall surface is plumb (Figures 8 and 9).

H. Remove sharp edges from the new mud bricks prior to setting. Additional removal of sharp edges may be necessary during the final treatment.

I. Remove all tool marks from mortar by brushing and by stippling mortar joints with stiff bristle brush.

J. Allow 1-2 days for drying after placement of second course of mud bricks. Repoint mortar joints to ensure complete closure where necessary.

K. Dampen surface and brush with a wire brush to further blend with original material.

L. A very light mud wash shall be added if the color contrast between the new and the original mud bricks is objectionable.

M. Field dirt may also be applied to the finished capping to further reduce strong shadow lines and sharp edges (Figure 9).

N. See Figure 9 for another before and after comparison.

Figure 1: A section of the east enclosure wall with eroded mud bricks on the top of the wall.

Figure 2: Another typical example on the East Enclosure Wall.

Figure 3: The low section of the East Perimeter Wall that was selected for one capping examples prior to treatment. The basic tools used are shown at the base of the wall.

Figure 4: The same low East Perimeter Wall after the cap was constructed in March 2001.

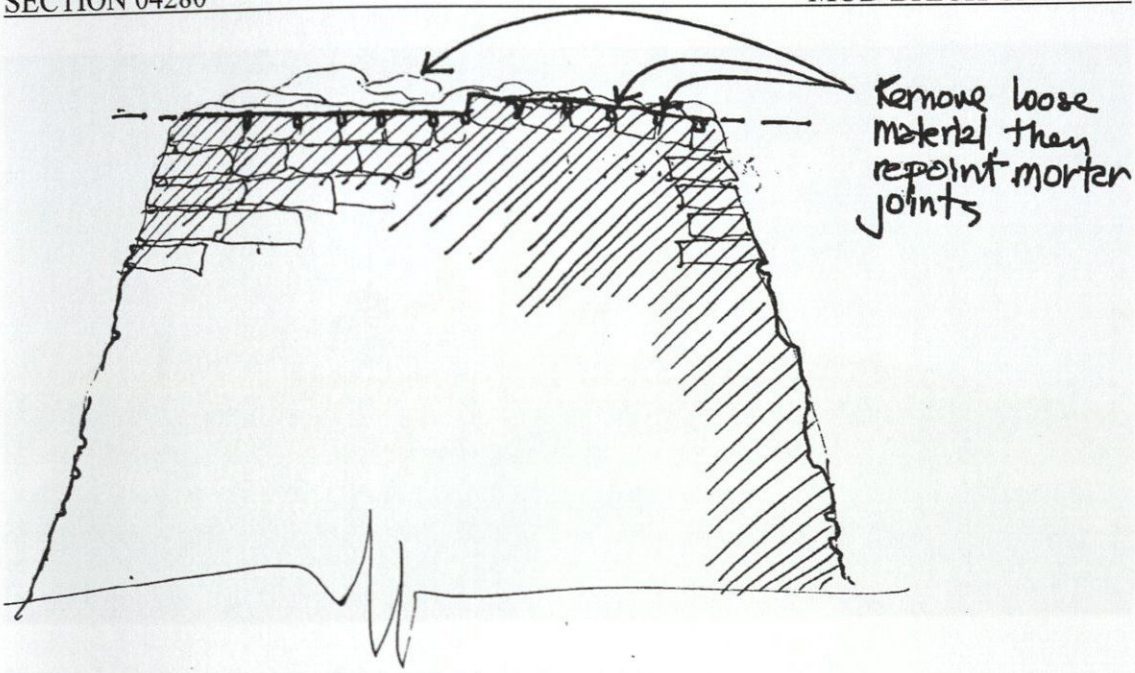


Figure 5: Sketch of the top of a wall showing the preparation prior to the construction of a mud brick cap.

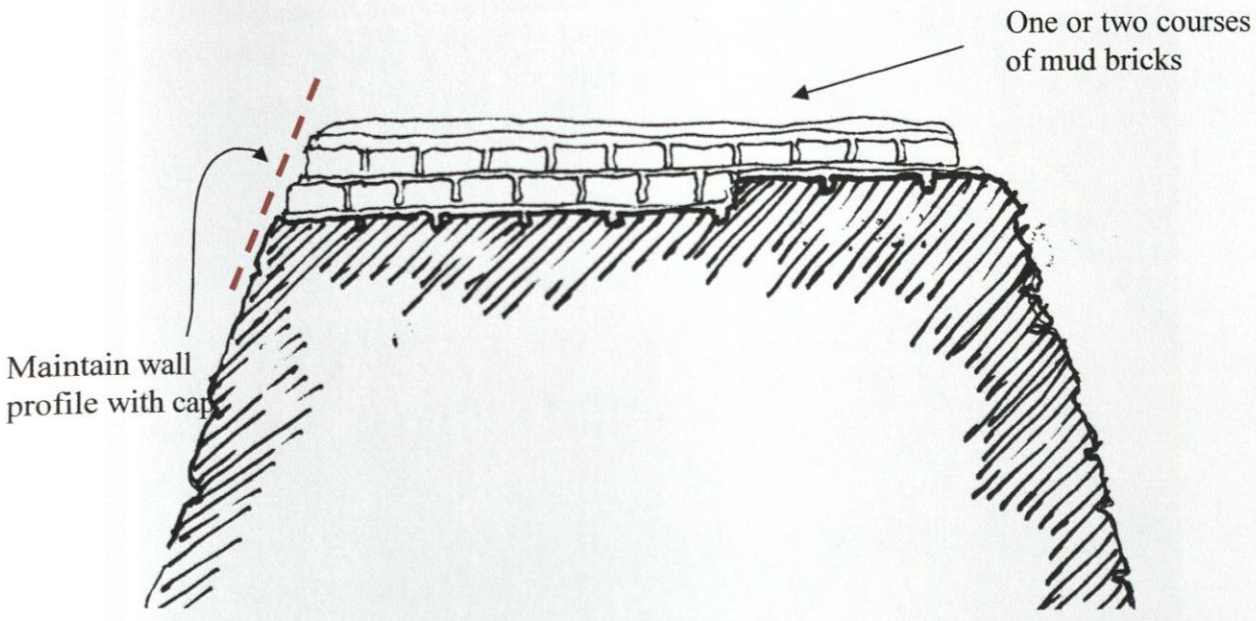


Figure 6: Sketch of a partial with a typical wall cap construction.

Figure 7: Capping the top of the east enclosure wall.

Figure 8: Capping while reflecting the general contours of the existing.

Figure 9: Another before and after comparison of the wall capping. The before on the left is after the wall was cleaned and debris and deteriorated mud bricks were removed.

END OF SECTION 04280

PILASTER REATTACHMENT

JULY 2001

Anthony Crosby, Architectural Conservation
For International Preservation Associates, Inc.

July 2001

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section is the reattachment of the pilasters on the exterior surfaces of the interior enclosure walls that are currently exposed and which may be exposed during future archeological excavations. It does not include any reconstruction of any missing or partially missing pilasters. There are no current guidelines that allow the construction of missing features for interpretive purposes only and is beyond the scope of this phase of this project.

The exposed pilasters are detaching as individual mud bricks or in some cases sections of mud bricks. The original construction attachment consisted of an occasional mud brick key that is set into the adjacent mud brick wall mass. The original surface plaster also provided some additional support for the pilasters and it also served to protect the pilaster mud bricks from wind and water erosion. While the original construction technique was adequate with the additional protection of the plaster, exposed pilasters will continue to erode and become detached. The original attachment is not adequate to support the pilasters in their present exposed condition. See Figures 1 - 7 for examples of detached and deteriorated pilasters.

The treatments specified in this section are considered as a temporary repair while long-term solutions are developed. One alternative long-term solution is the reburial of the pilaster in situ. If they are to remain exposed into the future, another treatment alternative will be to replaster those portions of the walls. Still a third alternative will be to selectively replaster the pilasters themselves. There are other alternative as well such as consolidation and reattachment mechanical means, but any of the alternatives will require additional field and laboratory research and based on comprehensive guidelines as to the long-term protection and approach for the presentation of the structure.

1.2 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04235 – PLASTER SATBILIZATION

F. SECTION 04240 – MUD GROUTING

G. SECTION 04250 – MUD BRICK CONSTRUCTION

H. SECTION O4255 – HORNET NEST REMOVAL

I. SECTION 04260 – WALL BASE VOID REPAIR

J. SECTION 04270 – VOID AND HOLE REPAIR

K. SECTION 04280 – MUD BRICK CAPPING

L. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

M. SECTION 04297 – SAND BAG PROTECTION

1.3 SUBMITTALS

A. Submittals for the basic materials of mud brick and mortar shall conform to Part 1, 1.3, Section 04210.

1.4 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. All repairs as specified in this section shall be tested on site to ensure that the specifics of this section are compatible with the site conditions and the materials that are utilized in the repairs. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section and all modifications and/or changes shall be consistent with the general intent as stated in Section 04200, Part 1, 1.6 and to this section, Part 1, 1.1 above.

C. The prioritization of the pilasters to be treated will be a field decision based on the conditions of the pilasters at the time of the conservation project. The decision will be approved by the Project Director's Representative.

1.5 ENVIRONMENT CONDITIONS

A. Do not repair at temperatures less than 5 degrees Celsius, or if temperatures are expected to be less than 0 degrees Celsius within 24 hours.

B. Protect drying mortar from direct rainfall during the curing process.

C. Protect mortar from rapid drying from temperature, sun, and wind by shades and wind breaks.

D. See Section 04200, Part 1, 1.7 Environmental Conditions for general restrictions.

1.6 TEST PANELS

A. Pilasters shall be selected and after the specific treatment approaches are refined in the field, the pilasters shall be reattached. After the work is approved by the Project Director's Representative, they shall be part of the final work and shall serve as controls for all work included under this section. If different mortar types or used, work with each type shall be approved.

B. One pilaster on the east elevation of the East Enclosure Wall was stabilized by grouting and repointing as an example of stabilization by minimal intervention. It is one of the approved approaches (Figure 10).

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils for preparation of mortar and grout shall be consistent with Section 04200, Part 2, 2.1, A. and D., 1. and 2. and all of Section 04210.

B. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, and acids, organic impurities and other deleterious materials, which might impair bond or strength.

C. Lime (Calcium Carbonate)

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual repair. Scaffolding shall be erected and secured where access to work area by scaffolding is required. Protection from falling debris or tools and equipment shall also be in place prior to any construction repair. All visitors and others not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair.

C. The effect of the reattachment shall not distract from the existing visual character of the wall and the pilaster where the repair takes place.

D. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

3.2 PREPARATION

A. Determine the specific extent of the reattachment and the specific procedure for each pilaster prior to beginning the repair.

B. Remove loose and deteriorated materials prior to the new repair by removal of debris, friable loose materials in cracks and between the pilaster mud bricks and the mud brick substrate by brushing, probing and blowing the areas where the repair will take place.

C. Protect the wall in the area of the repair to prevent the drip of mortar.

D. Dampen contact areas of existing and new mud brick masonry prior to setting new mud bricks and mortar. The depth of the dampening shall be determined at the time of the repair for each pilaster condition, but shall not exceed 6 mm deep.

E. Mix soil and water (potable) prior to use. Mix with heavy clay soil should be soaked overnight prior to application. Additives such as lime or cement shall not be mixed into the basic mud grout until immediate before use. Mix only amount that can be used for any specific application in amounts that can be used prior to initial dehydration of the mix. The actual time that the grout can stand before being discarded shall be determined in the field based on temperature, exposure, relative humidity and wind.

F. Do not re-temper any grout that has lime as an additive.

G. There is no restriction on the re-tempering or time limit on the use of unamended mortars.

H. Anticipated cement or lime added to the mix is approximately 3-5%.

3.3 REATTACH PILASTERS

A. Re-dampen materials according to 3.2, D. above of this section if required. Misting or spraying is allowed, but the water spray shall not be applied to the extent that it results in the formation of mud drips.

B. Cracks or gaps that exist between the pilaster mud bricks and the mud brick substrate, or in the pilaster keys shall be repaired. Loose pilaster mud bricks shall also be repaired.

C. Repair cracks by first dampening the two surfaces on either side of the crack. Depending on the width of the crack, mortar or grout is placed in the crack and before dry, the fractured parts are gently pushed together if completely separated. Temporary supports shall be installed where necessary until the repair dries. See Figure 8.

D. Mortar or grout shall also be placed in mortar joints surrounding any loose pilaster mud bricks.

E. Repoint all loose or missing mortar joints after cracks have been repaired.

F. Mortar beads shall be placed at the contact between the unstable pilaster mud bricks and the mud brick substrate. The beads shall extend out from both surfaces approximately 1 – 2 cm, forming a 45-degree angle between the perpendicular faces. See Figure 9.

G. Protect the repairs from rapid drying by misting, shading and protection from dry winds.

H. Remove all tool marks from mortar by brushing and stipple with stiff bristle brush.

I. The use of mechanical ties is not anticipated at this time, because of the temporary nature of the repair. In certain cases their use may be necessary. Any use of mechanical ties will be specifically approved by the Project Director's Representative prior to their use.

Figure 1: An area on the East Enclosure Wall showing three deteriorated pilasters.

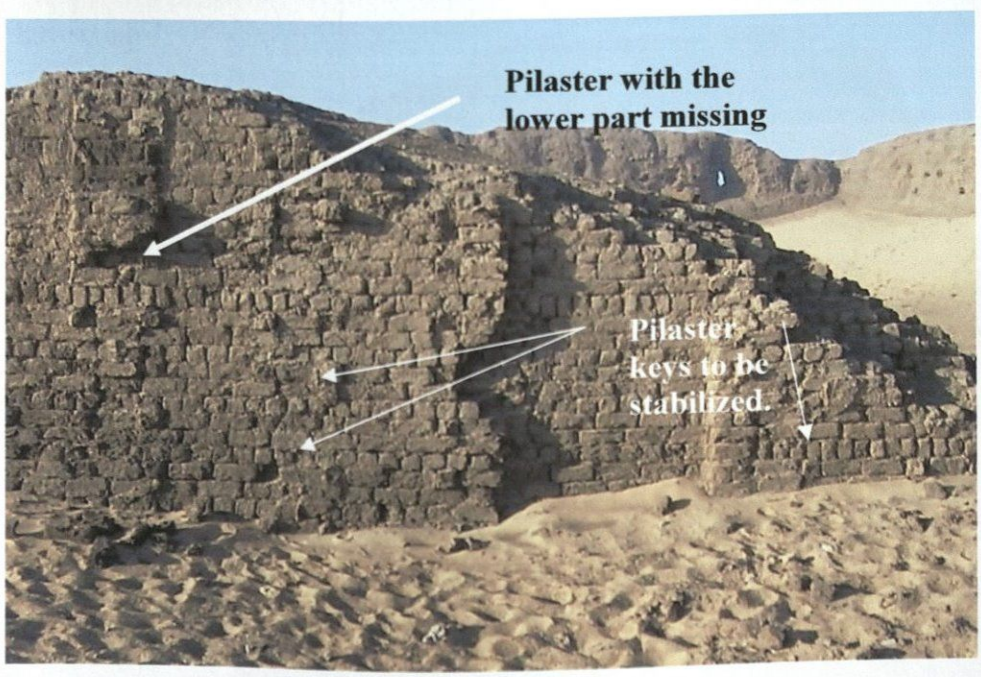


Figure 2: Remains of pilasters on the east side of the East Enclosure Wall. Pilaster keys project beyond the face of the mud brick wall in several areas here.

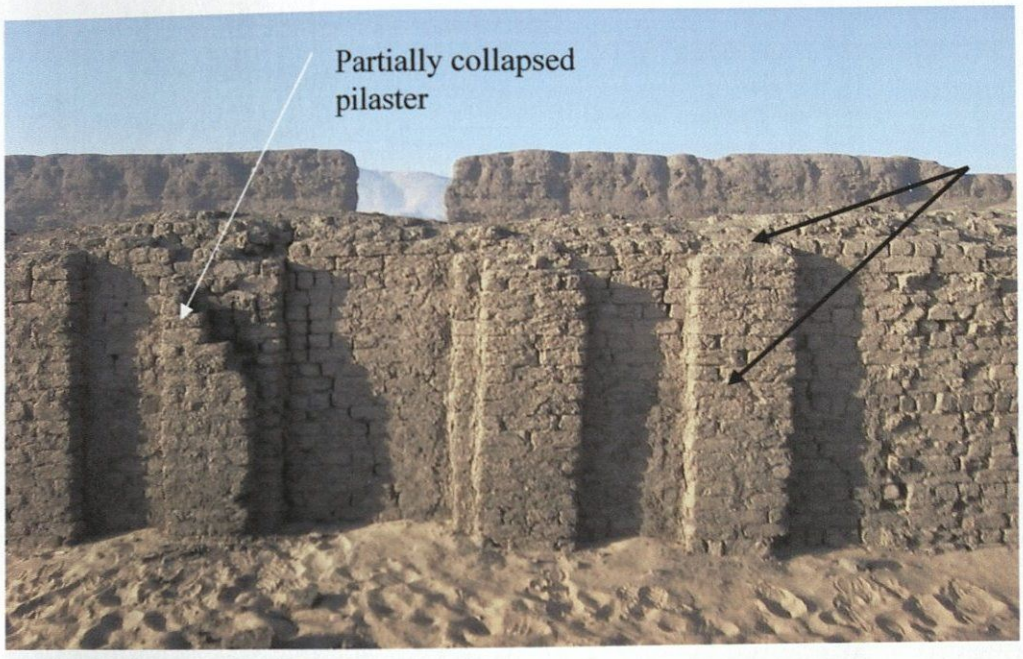


Figure 3: Pilasters in various stages of decay. However, all of them require conservation treatment

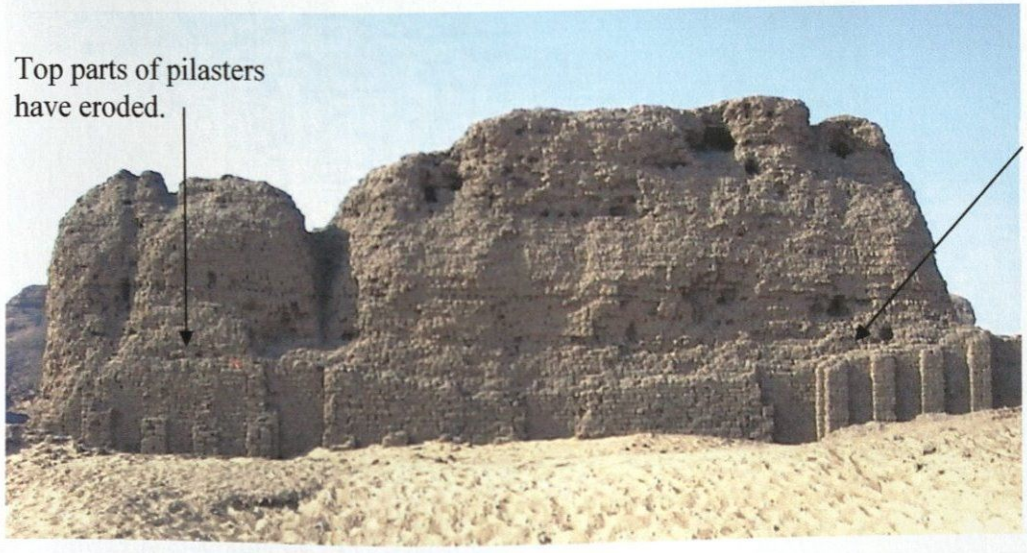


Figure 5: Part of the east side of the East Enclosure Wall showing a range of pilaster conditions.

Figure 6: Deteriorated pilaster with recent fall of mud bricks and fragments.

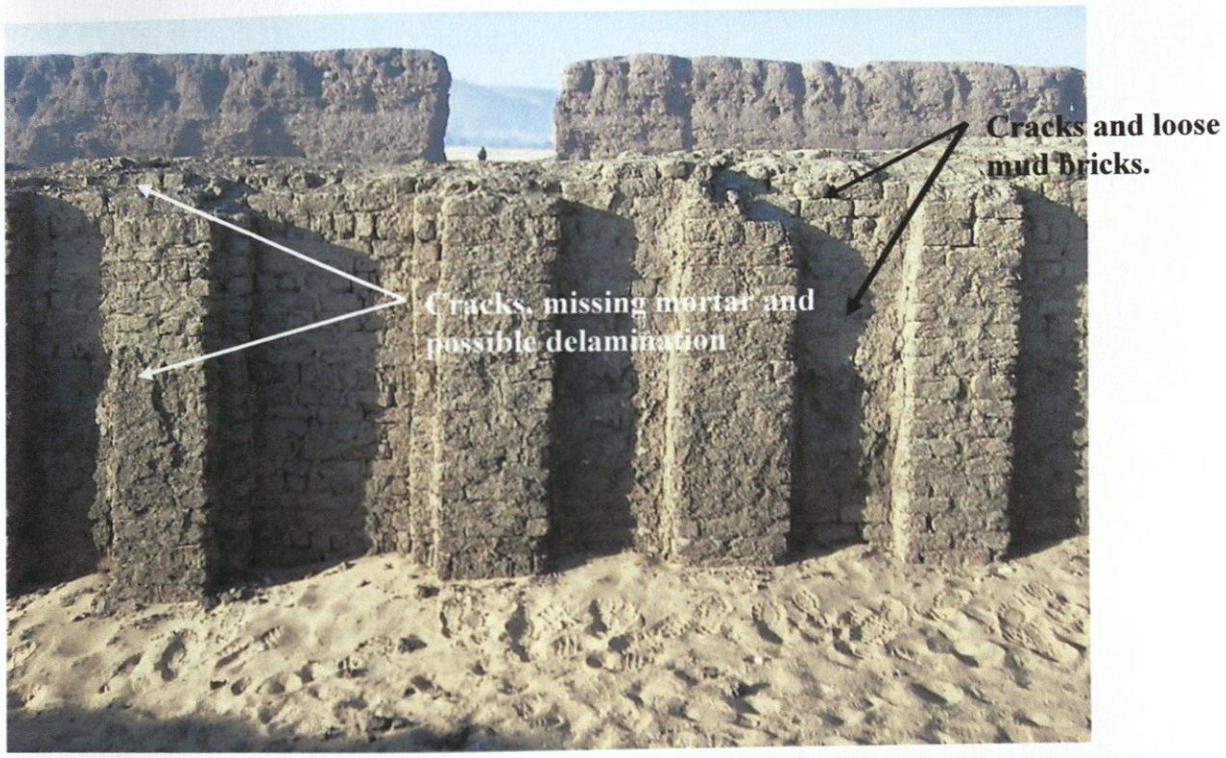


Figure 7: Other pilasters on the East Enclosure Wall looking to the west.

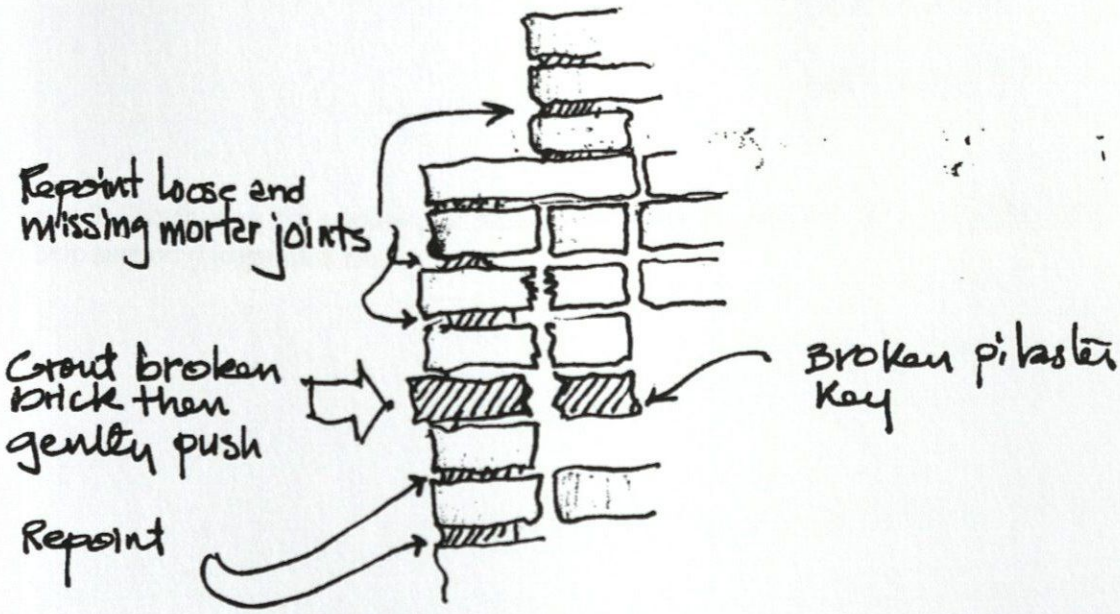


Figure 8: Sketch of partial section at a pilaster showing a broken key and mortar joints, which that are to be repaired.

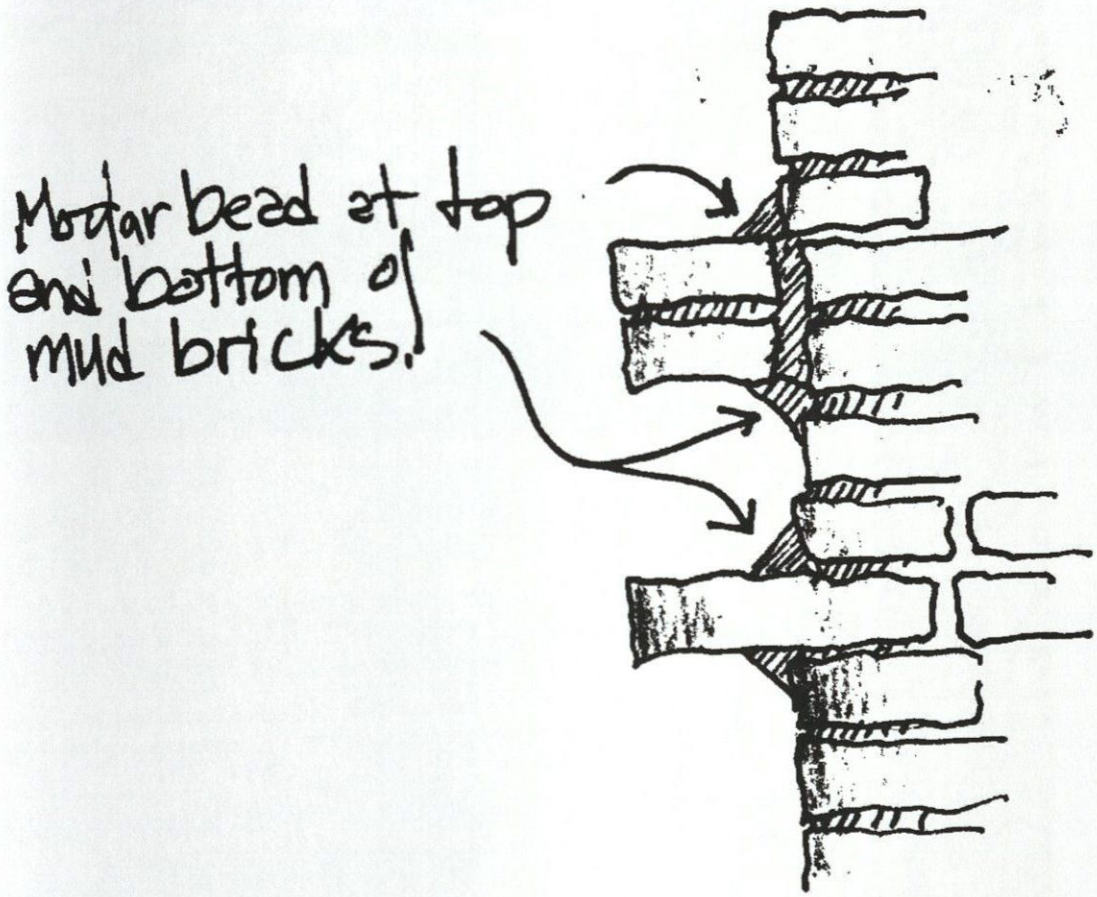


Figure 9: Sketch of partial section at a pilaster showing the application of a mortar bead to help support pilaster mud bricks.

Figure 10: Pilaster on east elevation of East Enclosure Wall that was stabilized by repointing and grouting in March 2001. The dark mortar joints are still damp.

END OF SECTION 04290

SAND BAG BUTTRESS CONSTRUCTION

JULY 2001

Anthony Crosby, Architectural Conservation
For International Preservation Associates, Inc.

July 2001

PART 1 GENERAL

DESCRIPTION: The work of this section is the construction of buttresses of sand bags for the support of potentially endangered mud brick walls. The buttresses are not intended as a permanent solution, although in some minor examples they may be. Sand bags shall be used to provide support large sections of walls such as those that currently exist along the west side of the East Enclosure Wall in conjunction with other methods of shoring and bracing; they are one part of a comprehensive system, all parts of which are essential. Sand bag buttresses require the least amount of resource investment and technical skill and shall be considered an important part of the protection of the resources and health and safety during the process of conservation as well as during the archeological investigations and shall be available on the site at all times.

The sand bags are intended to protect the original walls and human health and safety prior to the stabilization or restoration of the critical feature component that will restore structural integrity.

1.1 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04235 - -PLASTER STABILIZATION

F. SECTION 04240 – MUD GROUTING

G. SECTION 04250 – MUD BRICK CONSTRUCTION

H. SECTION 04255 – HORNET NEST REMOVAL

I. SECTION 04260 – WALL BASE VOID REPAIR

J. SECTION 04270 – VOID AND HOLE REPAIR

K. SECTION 04280 – MUD BRICK CAPPING

L. SECTION 04290 – PILASTER REATTACHMENT

M. SECTION 04297 – SAND BAG PROTECTION

1.2 SUBMITTALS

A. Sand bags shall be submitted for approval in advance of any specific project. Material can vary, but for relatively long-term use (greater than one year) they should be constructed of burlap. Bags of non-natural fiber, such as polypropylene, can be used for emergency and short-term use and where they are not exposed to sunlight.

B. Sample sandbags in the required size and fabric shall be approved by the Project Director's representative prior to the placement of a substantial order well in advance of a specific need and a proposed field season.

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section.

1.4 ENVIRONMENT CONDITIONS

A. There are no restrictions on the manufacturing/filing of the bags and the construction of the buttresses, except those that might affect human health and safety.

1.5 TEST PANELS

A. The existing buttresses can be considered as approved examples with the exceptions pointed out in the drawings and the photographs of this section (Figure 1).

B. Additional small-scale examples shall be constructed and approved prior to the construction of large-scale buttresses. These examples shall be approximately 4 meters long, two meters wide and 2 meters high.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand for the sand bags shall be the archeologically cleared sand from excavations. If sand bags are fabricated separate from an excavation, site sand can be used as well, if it is archeologically cleared.

B. Sand bags shall be constructed of untreated burlap, approximately 35-45 cm wide (14-18") and 75-90 cm long (30-36"). Larger bags are too large to handle.

C. Polypropylene sand bags can be used in emergency, for short-term use (less than one year) and for bulk areas where they are not exposed to sunlight. They should be the same approximate size as the burlap bags.

D. Natural fiber sand bags with tighter weave than the burlap can also be used for small-scale application. Light cotton or similar natural fiber material can be used for smaller bags. The size should be approximately 25-30 cm wide (10-12") and 40-45 cm long (16-18").

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual construction of the buttresses. Other shoring and bracing and scaffolding shall be erected and secured as required to provide a safe working environment and protection to the resources. Protection from falling debris shall also be in place prior to any construction repair. All personnel not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the repair, although some existing materials may have to be removed in order to execute a satisfactory construction – the removal of fabric shall be restricted to the absolute minimum. Little removal is anticipated.

C. Sand bags shall be filled on the site and there shall be a minimum number for emergency use of 100 filled burlap bags and 100 smaller filler bags.

D. Sand bag buttresses are used to support portions of the walls that are unstable or potentially unstable. They are not intended to correct a problem but to prevent structural movement that could result in structural failure and loss of material.

3.2 PREPARATION

A. Determine the specific extent of the construction prior to beginning. The specific details of the construction shall be determined prior to the beginning of construction. Set steel stakes at the corners of the buttress and connect stakes with construction tape or cord as guidelines.

B. Filling sandbags: Filling sand bags is a two-person operation, one holding the bag and the other filling. The most effective way is to use a rounded point shovel to fill the bags. The bags should be filled approximately 1/3 full. The method of tying the bags will determine if the bags can be filled more than 1/3.

C. Tying sand bags: Sandbags shall be sealed by either tying with steel wire, with heavy cord, or by stitching the open end. The most effective method is tying with wire (Figure 2).

D. Clean area of buttress of debris and loose sand; remove surface sand to firm packed sand. Loose sand will shift and the sand bags could also shift.

3.3 CONSTRUCT BUTTRESS

A. Excavate a bonding trench near the toe of the buttress. The trench shall be between 2 and 4 sacks deep, extending the width of the buttress, and 1/5 the total length of the buttress, but never less than 2 sacks wide. Example: a buttress that is 2 meters wide and 5 meters long should have a bonding trench that is 2 meter long and one meter wide (Figure 5).

B. Place the bags parallel to the wall being supported; place succeeding bags on top, offsetting by one-half (½) the length of the previous bag (Figures 3 and 4).

C. Place bags level or slightly inclined toward the wall. Stamp each individual bag in place once it is placed.

D. Begin building up the buttress on the rear 1/2 to 2/3 and at the same time begin building against the wall to be supported. Continue construction until the full desired height is reached.

E. The last step is to fill in the wedge-shape space between (Figures 5 and 6).

Figure 1: Three buttresses being constructed during the Spring 2001 Campaign. Note the vertical or near vertical end of the buttress; reducing the angle would be a correct modification.

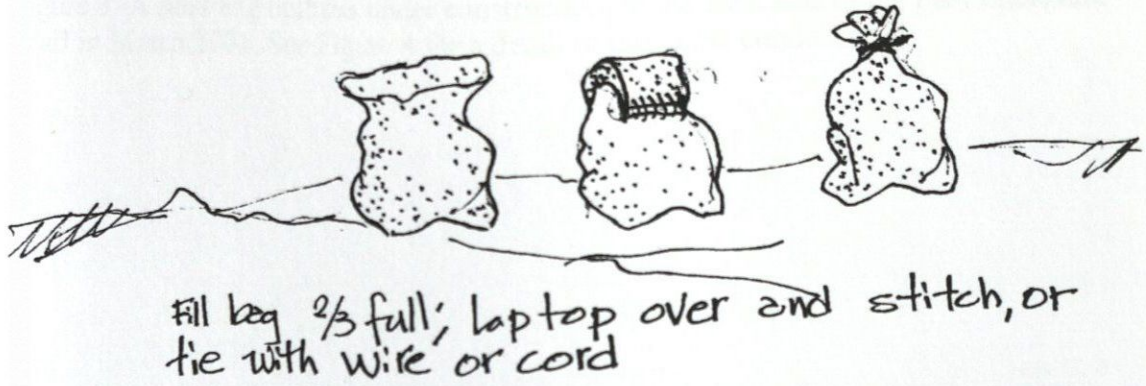


Figure 2: Filling the sand bags. Bags are filled and then either stitched or tied.

Figure 3: A sand bag buttress under construction on the west side of the East Enclosure Wall in March 2001. See Figure 4 for a detail of this same condition.

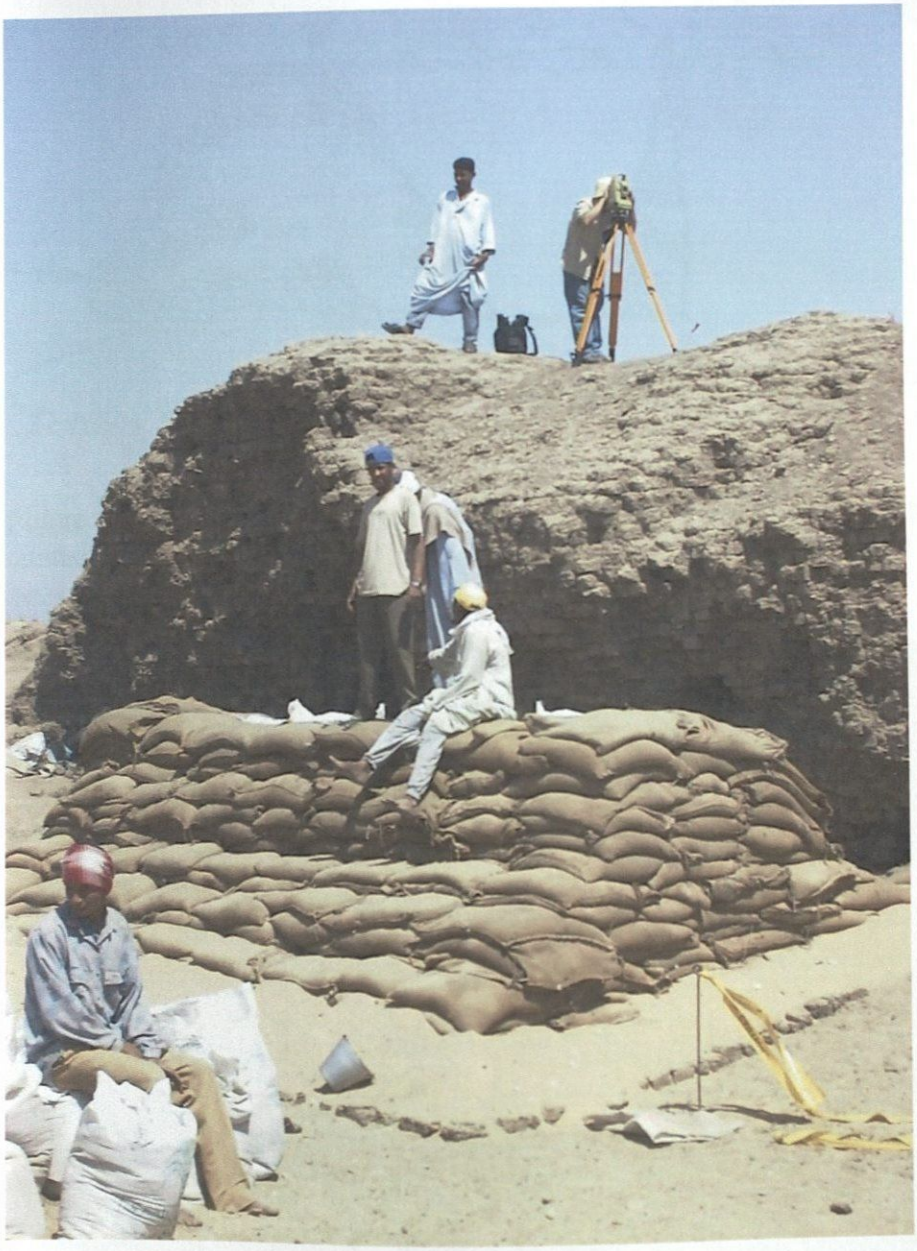


Figure 4: Detail of the sand bag buttress in Figure 3 under construction at the Shunet during the Spring 2001 Campaign. This is a view of the end of the buttress under construction – it precedes the construction of the remainder of the buttress. A bonding trench was constructed after the area was cleared of loose sand.

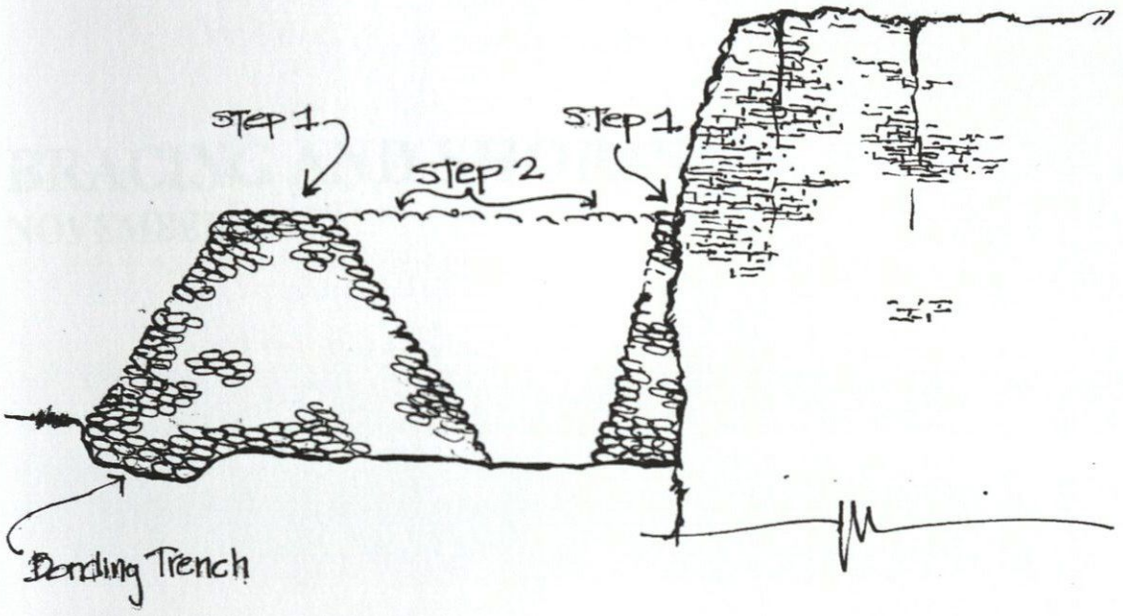


Figure 5: Sketch showing the construction of the end of the buttress and the part that is in contact with the wall as the first step. The second step is constructing the "wedge" between the two.

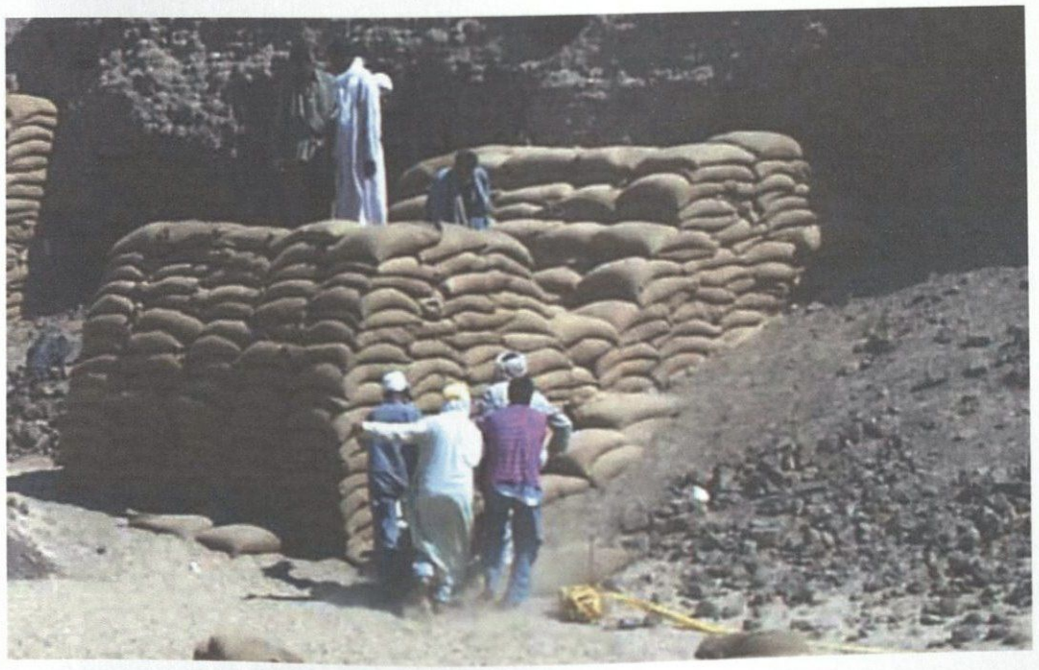


Figure 6: Construction of a buttress at the second stage as the center "wedge" is placed. This is a detail of the buttress on the East Enclosure Wall shown in Figure 1.

END OF SECTION 04295

BRACING AND SHORING
NOVEMBER 2005

PART 1 GENERAL

1.1 DESCRIPTION: The work of this section includes the structural bracing and shoring during archeological excavations. The system utilizes existing supplies and materials at Abydos and is based on components of the scaffolding system in use there. The scaffolding is very versatile as various pasts of the systems can be used in a multitude of ways to create support for both vertical and lateral loading. One particular use is described here, supporting vertical walls and partial vaults from collapsing during excavations, but it also demonstrates how adaptable the system is.

The intent of the bracing system is to provide temporary support during the excavation process, or to meet emergency needs. The following sections of the conservation specifications are only related as they may address directly some of the repairs associated with the structural failures that lead to the need for the shoring and bracing.

1.2 RELATED WORK

A. SECTION 04230 – CRACK REPAIR

B. SECTION 04270 – VOID AND HOLE REPAIR

C. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

D. SECTION 04297 – SAND BAG PROTECTION

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. The specific use of the bracing and shoring system should be reviewed prior to and during its use by the Project Director's Representative and that person shall approve modifications and/or changes to the specifics of this section.

C. The Project Director's Representative , or the person responsible for installing the system shall work directly with the site archeologist in charge so that the system responds best to the archeological needs as well as protecting both the archeological features and the health of the archeological crew members.

1.4 ENVIRONMENT CONDITIONS

A. There are no specific environmental restrictions to when this work can be undertaken. The nature of the work is often responding to an emergency regardless of the environmental conditions.

PART 2 PRODUCTS

2.1 MATERIALS AND TOOLS

A. Steel pipes of approximately 2 inches or 50 cm in diameter to fit the multi directional couples that connect the various parts of the system. The actual lengths will be determined by the specifics of the support needs, but shall consist of a minimal of two pipes that are 4 – 5 meters long and 6 pieces that are 2 – 3 meters long.

B. Multi-directional couples – minimal of 6 couples for each section of bracing.

C. Adjustable scaffolding feet, a minimum of two for each section of bracing.

D. Wedges and shims of various thicknesses and lengths.

E. Lumber of various lengths, 2 inches, 50 cm, and 25 cm thickness

F. Nails and a hammer

G. 19 mm crescent wrench

H. Pipe cutter (hack saw, etc.)

I. Tie wire and pliers and wire cutters.

J. Sand bags and fill sand.

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual installation. Sand bags and temporary bracing may be needed to safely install the system. Protection from falling debris may also be necessary.

B. The removal and the loss of original fabric shall be minimized during the installation.

C. Utilize tools and equipment that are most appropriate to limit the degree of intervention and loss of existing fabric.

D. Figure 1 shows the general condition where this example of the brace is necessary.

3.2 PREPARATION

A. Determine the specific extent of the problem and develop a preliminary design that addresses the problem. Collect the needed materials as need for the bracing design.

B. Plan access and working conditions that minimizes damage to the site features.

C. Install sand bags or temporary bracing as needed.

3.3 EMERGENCY BRACING AND SHORING

A. Collect system components and adjust sizes and lengths as necessary for the specifics of the task (Figure 2).

B. Set horizontal steel pipes in place, which will support the system components, connect securely and secure in place with sand bags (Figure 3).

C. Connect vertical members with the support pipes with couples and tighten temporarily.

D. Arrange horizontal pipes with adjustable feet (screw jacks) that will supply the bracing for the lateral loading of the walls. Continue to add to the basic system as needed to supply the support necessary.

E. Add pressure plate against the walls to be supported and snug in place with screw jacks (Figure 4).

F. As the system is designed to allow excavations beneath, the components are supported from above leaving the floor free.

G. One support will require lateral support perpendicular to the brace. This support can be removed when the second and subsequent braces are installed and connected to each other.

Figure 1: A partially excavated collapsed vault that requires additional excavation, but walls are unsafe as they exist.

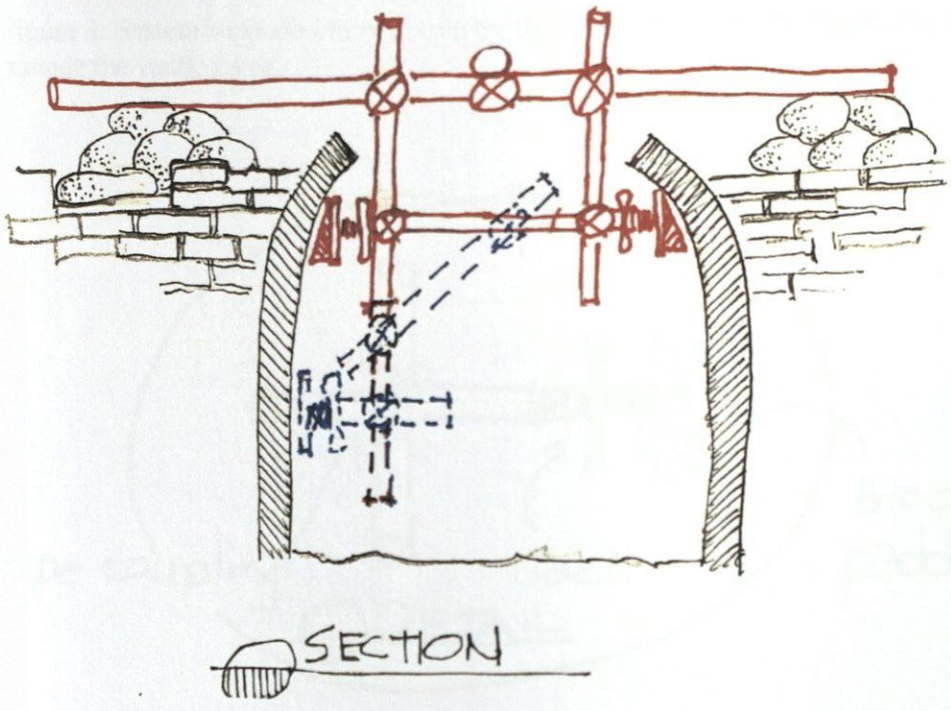


Figure 2: A field sketch of the basic concept of the support constructed of pipes and couples, standard components of the scaffolding system. Components in red represent the basic system; components in blue are features that are added as necessary.

Figure 3: System supported from above by the horizontal pipe that bears on a stable area outside the vaulted area.

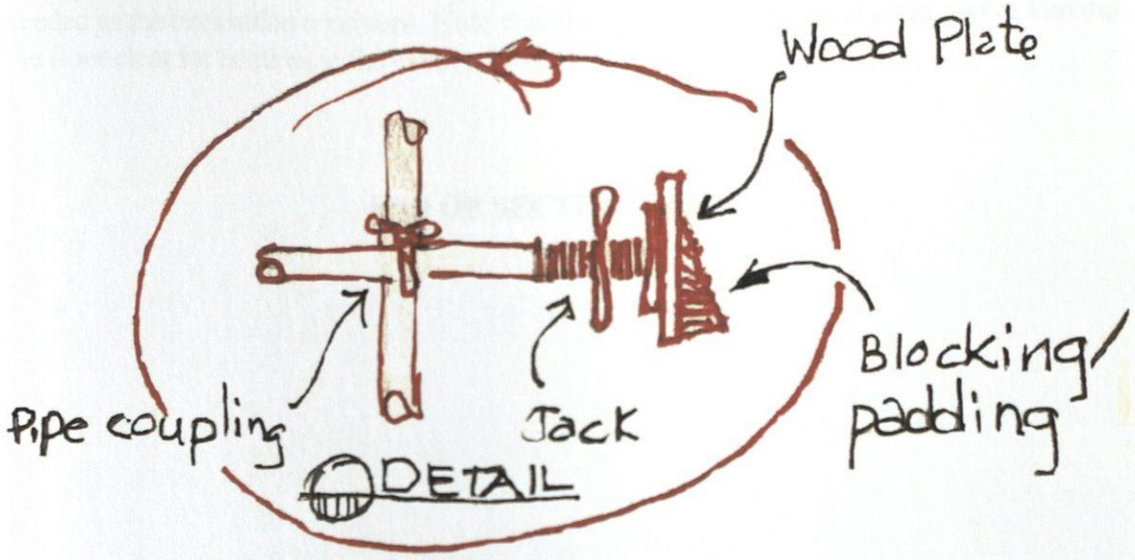


Figure 4: Field sketch of the adjustable compression feature that supports the side walls.

Figure 5: one brace or one bay of the system installed. Additional bays can be added as needed as the excavation continues. Note that the system is supported from above leaving the floor clear for continuing the excavations.

END OF SECTION 04296

SAND BAG PROTECTION

JULY 2001

Anthony Crosby, Architectural Conservation
For International Preservation Associates, Inc.

July 2001

PART 1 GENERAL

DESCRIPTION: The work of this section is the placement of sand bags to protect the low walls and features that are exposed to accelerated deterioration primarily because of foot traffic on the site. The deterioration is particularly bad when there is a lot of activity on the site such as this past Spring 2001 Archeological Campaign. The sand bags are intended to cover the areas that are susceptible to wear and take the actual force of the traffic. The materials are exactly the same as the sand bags used for the sand bag buttresses, Section 04295. Sand bag protection represents the least amount of resource investment and technical skill and shall be considered an important part of the protection of the resources during the process of conservation as well as during the archeological investigations. Sand bags shall be available on the site at all times.

1.1 RELATED WORK

A. SECTION 04200 – MUD BRICK CONSERVATION

B. SECTION 04210 – MUD BRICK MANUFACTURING

C. SECTION 04220 – SURFACE RENDERING

D. SECTION 04230 – CRACK REPAIR

E. SECTION 04235 - -PLASTER STABILIZATION

F. SECTION 04240 – MUD GROUTING

G. SECTION 04250 – MUD BRICK CONSTRUCTION

H. SECTION 04255 – HORNET NEST REMOVAL

I. SECTION 04260 – WALL BASE VOID REPAIR

J. SECTION 04270 – VOID AND HOLE REPAIR

K. SECTION 04280 – MUD BRICK CAPPING

L. SECTION 04290 – PILASTER REATTACHMENT

M. SECTION 04295 – SAND BAG BUTTRESS CONSTRUCTION

1.2 SUBMITTALS

A. Sand bags shall be submitted for approval in advance of any specific project. Material can vary, but for relatively long-term use (greater than one year) they should be constructed of burlap. Bags of non-natural fiber, such as polypropylene, can be used for emergency and short-term use and where they are not exposed to sunlight.

B. Sample sandbags in the required size and fabric shall be approved by the Project Director's representative prior to the placement of a substantial order well in advance of a specific need and a proposed field season.

1.3 QUALITY ASSURANCE

A. See Section 04200 Part 1, 1.6 for the general requirements of the conservation project and the specific requirements related to the selection of materials and the handling of the materials for general conservation requirements in Sections 04210 and 04230.

B. The Project Director's Representative shall approve modifications and/or changes to the specifics of this section. No modifications or changes shall be made to the general intent of this section.

1.4 ENVIRONMENT CONDITIONS

A. There are no restrictions on the manufacturing/filing of the bags and the construction of the buttresses, except those that might affect human health and safety.

1.5 TEST PANELS

A. The east side of the East Enclosure Wall, tall north portion, has sand bags in place to protect the lower part of the wall in the area of the exposed pilasters. This is one site example of how sand bags can be used; they were placed in March 2001.

B. A second test panel is located east of the southern end of the tall northern section of the East Enclosure Wall where approximately 6 meters of the exposed top of the East Perimeter Wall was protected in March 2001.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand for the sand bags shall be the archeologically cleared sand from excavations with the addition of local loam. The best material for the sand bags is a sandy loam. If sand bags are fabricated separate from an excavation, site sand can be used as well, if it is archeologically cleared. Final material selection shall be approved by the Project Director's Representative.

B. Sand bags shall be constructed of untreated burlap, approximately 35-45 cm wide (14-18") and 75-90 cm long (30-36"). Larger bags are too large to handle.

C. Polypropylene sand bags can be used in emergency, for short-term use (less than one year) and for bulk areas where they are not exposed to sunlight. They should be the same approximate size as the burlap bags.

D. Natural fiber sand bags with tighter weave than the burlap can also be used for small-scale application. Light cotton or similar natural fiber material can be used for smaller bags. The size should be approximately 25-30 cm wide (10-12") and 40-45 cm long (16-18").

PART 3 EXECUTION

3.1 GENERAL

A. Proper safety precautions are necessary prior to the beginning of the actual placement of the sand bags. Protection from falling debris shall also be in place prior to any work. All personnel not part of the conservation team shall not approach to within 20 meters of the work areas.

B. The removal and the loss of original fabric shall be minimized during the placement of the bags. Little removal is anticipated.

C. There shall be a minimum number for emergency use of 100 filled burlap bags and 100 smaller filled bags.

3.2 PREPARATION

A. Determine the specific extent of the need and establish a priority for sand bag protection; the highest priorities should be in the area of the greatest amount of human foot traffic. The specific details of the bag placement shall be determined prior to the beginning of construction.

B. Filling sandbags: Filling sand bags is a two-person operation, one holding the bag and the other filling. The most effective way is to use a rounded point shovel to fill the bags. The bags should be filled approximately 1/3 full. The method of tying the bags will determine if the bags can be filled more than 1/3.

C. Tying sand bags: Sandbags shall be tied or sealed by either tying with steel wire, with heavy cord, or by stitching the open end. The most effect is tying with wire.

D. It is not necessary to clean area of loose sand before the sand bags can be placed.

3.3 PLACE SAND BAGS

A. Place sand bags to prevent food traffic abrasion as well as to prevent the force of people walking dislodging walls, mud bricks or features. It is difficult to use too many sand bags. Sand bags should be a minimal of two bags thick in heavy traffic areas. Figures 1 and 2 are typical areas where sand bags should be placed.

B. Place the sand bags 5-10 cm from the wall surfaces. Fill the space between the sand bags and the feature with sand to serve as a separation (Figure 3).

C. Place the bags parallel to the wall or feature being supported; place succeeding bags on top, offsetting by one-half (½) the length of the previous bag. It may be necessary to form steps of the bags for easier human access.

D. Place bags level or slightly inclined toward the wall. Stamp each individual bag in place once it is placed.

E. It may be necessary to place the sand bags so that human access is restricted by making it difficult to step over the bags.

F. Monitor the effectiveness of sand bags and replace and add additional ones as necessary.

G. Sand bag protection should be supplemented by restricting use to some areas by the installation of stakes and construction tape, or construction fencing.

Figure 1: This area in the southeast corner of the Shunet should be backfilled, but until it is, the exposed mud brick walls should be protected with sandbags.

Figure 2: An exposed mud brick feature that should be protected by covering with sand bags. Sand bags should be placed at the base of the feature and up to the top and then over the feature. This is not a high traffic area, although the footprints and the wear on the top of the wall are obvious.

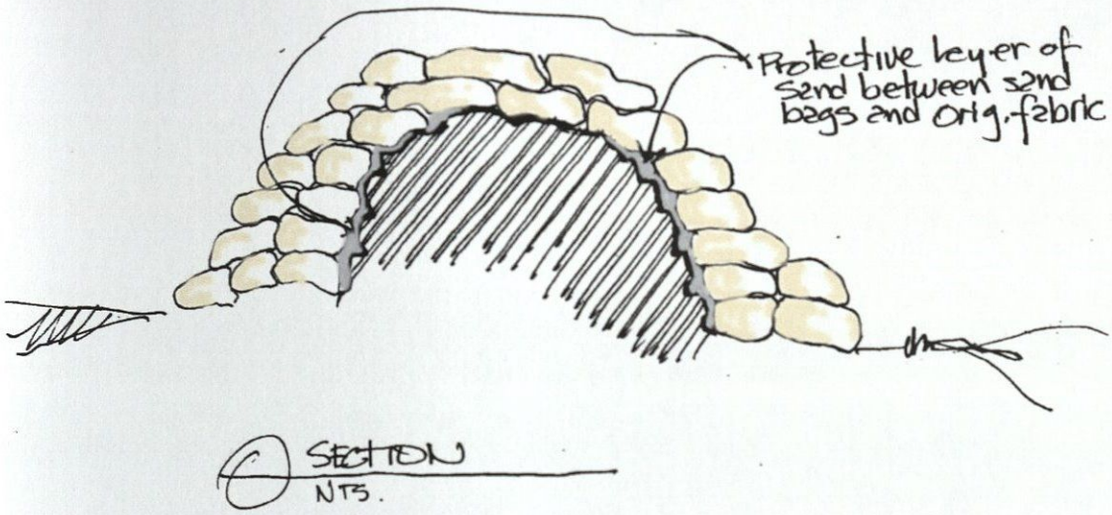


Figure 3: A sketch of a low wall showing the use of sand bags to protect it. This wall would be similar to the walls of Figure 1.

END OF SECTION 04297