

Phnom Bakheng Progress Report December 2010



Figure 1: Work progressing at the northeast corner

The Phnom Bakheng conservation project focuses on restoration of the east façade of the temple. The first section of this report provides an overview of the work of 2010. The second section of the report provides greater detail and images for primary areas of activity from July to December 2010. Along the northern half of the east façade, reconstruction is underway, as the disassembly necessary for improving stability of the temple and introduction of waterproofing measures has commenced. Extensive work was undertaken in 2010 for the disassembly of wall sections that were structurally unsound; conservation of stone was completed; and work has recently focused on reassembly of the five levels of the east façade and its terraces; when necessary new sandstone was utilized to replace unusable material, which had eroded beyond repair or was missing. Installation of a waterproofing membrane was designed in close collaboration with APSARA National Authority to prevent water infiltration and manage water run off. Water erosion played a significant role in causing decay at the site over time. In the earliest phases of this project, water conditions were carefully studied and the decision to introduce a waterproofing membrane was reviewed with local and international experts. Importantly, research determined there would be no discernable chemical interaction between the membrane and stones. Further, if determined necessary, the membrane could be removed in the future through the same procedure of disassembly. After careful consideration with APSARA, the membrane was determined to be the most reliable method to prevent the reoccurrence of entry of water behind the walls, which causes most of the damage. The waterproofing membrane was laid down over bedrock prior to the reinstallation of pavers and is hidden from view.

The primary focus of the current project is the repair of the northern section of the east elevation of the temple, as this is the most damaged part of the east façade. Since the last

progress report submitted to the US Department of State in July 2010, work at the northern half of the east elevation at Phnom Bakheng has continued. Reassembly at the lowest terrace of the northeast corner is in its final stage and disassembly of upper levels E and D has commenced. During a site visit of the UNESCO Ad Hoc Experts during the last ICC meetings in November 2010, WMF planned the second phase of the Brick Shrine conservation and stabilization workshop, focusing on the surrounding brick shrines at Phnom Bakheng. The first workshop was held in June 2010 and a follow up session is scheduled for February 2011. This second workshop will enable the implementation of conservation treatments on one of the brick shrines. The goal is to develop a comprehensive conservation plan for brick structures at Phnom Bakheng, which will be useful for the conservation and stabilization of brick shrines at other sites within Angkor. These workshops are organized by WMF and include international experts, members of APSARA, and members of the Ad Hoc Experts. WMF has included numerous Cambodian professionals working at Phnom Bakheng in the workshop, so that those implementing the work are participating actively in the analysis and design of solutions.

Archaeological excavation related to the removal of the dirt ramp in front of the south side of the east elevation has been completed. APSARA's archaeological team continues to work with WMF to process data generated from archaeological exploration. APSARA and WMF collaborate on reports to make sure all documentation meets international standards.

The project at Phnom Bakheng has encouraged a wide-ranging dialogue regarding the future management of the site. Several years ago, WMF in collaboration with APSARA conducted an initial site management planning workshop and sessions about the values of the site. Reports resulting from this work can be found on WMF's website:

Phnom Bakheng Conservation Master Plan

http://www.wmf.org/sites/default/files/wmf_publication/Phnom_Bakheng_Conservation_Master_Plan_Vol_1.pdf

Phnom Bakheng Workshop on Public Interpretation

http://www.wmf.org/sites/default/files/wmf_publication/Phnom_Bakheng_Workshop_on_Public_Interpretation.pdf

Work of the last three years has made clear the utility of continuing these conversations and assisting APSARA in assuring effective stewardship of the site. The first session will be held in New York in May. This first session will allow the leadership of APSARA to work with WMF to determine the broad questions to be addressed in the site management plan. Subsequent sessions will be held on specific topics ranging from landscape features, visitor experience, archaeology, and continuing conservation maintenance. In addition to personnel from APSARA, WMF and UNESCO, international experts will be invited to join the discussions to assure broad dialogue. Stewards of Phnom Bakheng, similar to many sites around the world, must balance the physical needs of the site with public enjoyment. Archeology, water management, site erosion, landscaping, site interpretation, and educating international and local tourists are just some of the challenges APSARA faces as it confronts issues of how to protect the site effectively at the conclusion of the conservation program. Managing the tourist experience through circulation planning, analyzing carrying capacity of the site, and identifying vulnerable and fragile areas will be essential elements of the site management process. All of these issues have been discussed fully with APSARA to assist APSARA in selecting participants for the workshops and developing the proper framework for tackling these topics.

1. Structural repair of the northeast corner

Reassembly of the lowest level at the northeast corner is reaching completion. Prior to reinstallation of the wall units and new pavers the bedrock has been cleaned and all deteriorated material was removed. The bedrock was found to be in very poor condition. To improve site conditions, stainless steel rock bolts and infill of new laterite blocks were installed. Sandstone was used as part of the fill to provide necessary load bearing stability. Gravel has been used to fill in areas where it can act as natural drainage. There are also weep holes hidden in the walls to facilitate drainage and improve the movement and evaporation of water to keep areas as dry as possible where moisture would erode the foundation and stability of the monument. In a humid environment such as Angkor and given the heavy seasonal rains, conduction of water and prevention of pooling and standing water are significant factors in long term protection of the condition of the monument. The bedrock surface has been leveled where needed and cracks and depressions were filled with laterite and small gravel to create a homogeneous slope to facilitate proper water flow. Where the wall does not bear directly on the bedrock, deteriorated laterite is replaced and the wall reassembled with the use of reinforced structural fiber pins.



Figure 2: Condition of bedrock at northeast corner level F



Figure 3: Detail of bedrock repair

Original and new sandstone units were installed as part of the reassembly process. Thus far about 500 new laterite blocks and 300 new sandstone units have been prepared and installed at the lowest level at the northeast corner. The team is preparing new stone pavers to install at the lowest level. In February 2011, the waterproofing membrane will be laid and the crew will be trained to implement the technical details of this procedure. Reassembly of the lowest level with new pavement and water proofing membrane will be completed by the end of February 2011.



Fig 4: Reassembly of northeast corner level F - pavement



Fig 5: Reassembly of northeast corner – northern wall

Work on this section of the façade has served to refine the methods and materials proposed and to obtain final approvals by the International Co-coordinating Committee for the Safeguarding of the Historic Site of Angkor and APSARA National Authority.



Figure 6: In-fill condition before repair



Figure 7: Condition after repair

Disassembly of the second and third levels at the N\theast corner has begun. The wall has been dismantled to levels that were found to be in structurally sound condition. Stones that were originally in these locations but were scattered as a result of an earlier collapse have been moved to safe locations and the original stone pavers have been cleaned and moved to storage or the workshop for documentation and stone conservation. The bedrock at level E was found to be in similarly bad condition as the bedrock at the lowest level F. Thus, it will require structural repair by installation of rock bolts and replacement of deteriorated portions with new stone as described earlier in this report. Unstable areas of bedrock are currently being supported by scaffolding that WMF installed. The documentation team is conducting condition surveys of the bedrock in preparation for the repair of this section.



Figure 8: Northeast corner level E during disassembly



Figure 9: Northeast corner level E terrace cleaning of original pavement

To continue work at level E partial disassembly of the next upper level D will be required. This will include the disassembly of unstable wall sections and the remains of a sandstone shrine. There will be extensive documentation of this area prior to dismantling. Recording of conditions, dimensions, and other data will include wall sections, remains of a corner sandstone shrine on the terrace of level D, and existing original pavement. The documentation entails photographs of existing conditions of all sections of the wall and the existing stone pavers, graphic documentation and condition surveys, stone numbering, searching for fallen stone units to be returned to their original locations, and the design of new stone units for areas that require replacement.



Figure 10: Northeast corner level E bedrock condition



Figure 11: Northeast corner level D existing condition

2. Conservation and preparation of new laterite and stone units

Stone conservation measures include, documentation, cleaning, desalination, structural consolidation of broken blocks, and reattachment of fragments using adhesives. Work is progressing to repair original stone blocks to be returned to the temple structure. Final surface finishing of the stones including mortar repairs will be executed after the wall has been reassembled. The team continues to prepare new laterite and sandstone units for the repair of the walls and terrace pavers. WMF has installed a system of pneumatic stone carving chisels in order to increase production for the preparation of new stone units required for the repair of the temple and the preparation of the supporting bedrock. Training for this system has been completed and the team is effectively working on the stones.



Figure 12: Documentation and condition assessment



Fig 13: Preparation of laterite with pneumatic chisels

WMF has received approval from APSARA and the ICC to reuse some original stone blocks that are scattered around the site and in the surrounding vegetation. As a result of ancient modifications of the temple during a Buddhist period and the removal of these additions during a previous restoration campaign, a tremendous number of stone blocks are now located on the hillside adjacent to the temple. In collaboration with APSARA these stone blocks will be documented, inventoried, and categorized. Blocks that can be identified or bear carvings indicating their original locations in the temple will be returned to the temple. Others than can be utilized appropriately will be incorporated into the conservation process. Blocks that cannot be identified and are in good condition will be cut to be reused for repair of temple walls and pavements. All decisions will be made in collaboration with APSARA and all reuse of older stones reclaimed from the hillside and vegetation will be carefully documented. While the goal is to have these stones harmonize visually, it will be possible for APSARA and future conservators at the site to identify the replacement stones utilizing the documentation from this project.

3. Brick Shrine Stabilization and Conservation Workshop

To address the immediate conservation issues of the brick structures at Phnom Bakheng, WMF and APSARA conducted a Brick Shrine Stabilization and Conservation Workshop in June 2010. This Workshop was held in Siem Reap and was attended by leading experts in the field. Some sessions were held at the Center for Khmer Studies and others were held on site so all participants could benefit from discussing site conditions in situ. Extensive discussions were held to evaluate current conditions and typical solutions for brick conservation methods in southeast Asia, as well as in other parts of the world. The group also analyzed interventions that have been made over the years on brick structures in Angkor. The Workshop participants visited a number of sites in Angkor Archaeological Park to benefit from expertise gained over the years by various international conservation and engineering teams. There was also a visit to the brick kilns at Dam Dek where manufacturing methods were observed and discussed with local craftsmen. The final session allowed the group to review a variety of methodologies in light of local traditions, regional practice, and international expertise. The group wished to find a solution that was sustainable, relatively low-tech, and accomplished with as much local expertise as possible.

On the occasion of the November 2010 Plenary Session of the ICC, the Ad Hoc Experts visited Phnom Bakheng and reviewed with WMF the results of the Brick Shrine Workshop. Following this site visit, it was decided to prepare a test of the various methods and materials proposed during the workshop in June 2010. The on-site exercise will commence in February 2011 when international experts will work with local craftsmen to evaluate several methods and materials to determine their applicability and effectiveness. The goal for the Brick Shrines is to find conservation solutions for:

1. Foundation Consolidation
2. Brick Masonry Consolidation
3. Structural Consolidation
4. Formulation of Conservation Plan
5. Presentation of Proposed Solution for APSARA's approval

Based on evaluation of the on-site tests during the pilot project at brick shrine G10 it will be possible to develop a full conservation plan and program for the brick shrines. As a result of these efforts to stabilize and conserve the brick shrines at Phnom Bakheng, WMF and APSARA hope it will be possible to develop conservation guidelines for the consolidation of similar brick shrines at other temple sites within Angkor. The Ad Hoc Experts noted more than a year ago that numerous Brick Shrines in Angkor Archaeological Park are in need of greater attention. At the completion of the February 2011 fieldwork, WMF will publish on its website the results of the June 2010 workshop and related subsequent fieldwork.

4. Archeological Excavation and Condition Surveys of the hill and plateau

The archeological excavation in the field in front of the south side of the east elevation in collaboration with the APSARA has been completed. Data is being processed and final documentation is underway. This work is anticipated to be completed by June 2011. In preparation for the site management workshop planned for May 2011, WMF and APSARA conducted condition surveys of the bedrock level of the entire plateau at Phnom Bakheng. APSARA has requested that this work be extended to include detailed documentation of the existing conditions of the eastern laterite stairs that lead up the hill at Phnom Bakheng. This survey entails preparation of detailed drawings including cross-sections and plan views. Data from this research is expected to inform the conservation plan for the site and will be useful in discussions at the upcoming site management workshop related to site maintenance, water management, and visitor management.

5. Site Management Workshop

During initial meetings with the APSARA National Authority, it was agreed that the site management workshop will be held in phases. The first phase will take place in New York in May 2011 with senior management representatives of WMF and APSARA. The group will include representatives of various divisions at APSARA concerned with the protection of the site and representatives of the Ministry of Tourism, Ministry of Culture, UNESCO Phnom Penh, and the Standing Secretariat of the ICC. The meeting will define major issues and challenges that are faced at Phnom Bakheng. This initial meeting will establish a framework for setting goals for the site management process. The participatory nature of the site management process will assure that all topics are given proper consideration. While Tourist Management, Site Security, Large Scale Water Management, Landscape Features, Site Interpretation, and Long-Term Sustainable Stewardship are overarching topics to be addressed, subsequent workshops will allow each of these topics to be explored in greater depth. The process will allow a variety of viewpoints to be heard. It is not just the physical concerns that must be reviewed. The historical, cultural, and religious meanings of the site must be acknowledged, as well identifying key themes that will allow visitors to understand best what they are seeing when they visit the site.

After successful completion of the first phase which is expected to result in a set of comprehensive recommendations that outline major objectives, topics to be discussed in depth during the second phase, and assistance required by international experts, the second phase of the workshop is planned to take place in coordination with the 20th Technical Session of the ICC meetings set for June 2011. WMF is currently preparing a small handbook for this workshop that will be made available to all participants prior to the phase one in February 2011.