Conservation project on Nandin Hall monument at Vat Phou Archaeological Site (Laos PDR)

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**Introduction**
After a long gap of research due to the political events occurred in Laos, in 1992 the Italian Archaeological Mission (Fondazione Ing. C.M. Lerici of Politecnico di Milano) started its studies in Vat Phou (Laos PDR). In almost thirty years, different competences have interacted with one another. At the beginning they were focused in systematic territorial analysis and field surveys in order to identify the process of Khmer Kingdom formation before the foundation of Angkor (Cambodia).

In 1997 the Fondazione Lerici started a tight collaboration with UNESCO and the Lao government which has put in practice the project “Capacity building in cultural resource management through the preparation and implementation of Conservation and Management Master Plan, for the preservation of Vat Phou and surrounding archaeological landscape within a framework of Sustainable of Champasak, Lao PDR” to draw up the Master Plan of the area. The Vat Phou archaeological site was designated World heritage Site in 2001.
Among several activities carried out over the years in the area, the Italian Archaeological Mission had drawn up the site plan, and had mapped the archaeological risks for one of the two cities discovered during the archaeological surveys and excavations.
Since 2006, a project is running for the preservation of one of the stone building in the complex: the Nandin Hall monument.

**Conservation Project**
The Conservation Project has been running with the coordinating conjunction of Fondazione Ing. C.M. Lerici (Rome-Italy) and Politecnico di Milano (Milan-Italy), together with Laotian Ministry of Information, Culture and Tourism, for the preservation of one building in Vat Phou complex: the Nandin Hall monument. The project is financed and supported by Italian Ministry of Foreign Affairs and Global Heritage Fund (USA).
This working project is the continuation of the first degrees of difficulty conservation project carried out in 2004 and 2005: the preservation of the Ceremonial Road which runs from the great basin for sacred ablutions to the upper temple along the West-East axis with the purpose to build the capacity up of local architects and engineers, technicians and workers, in view of Nandin Hall project. The work on Ceremonial Road has been a “field school” about archaeological investigations, stones restoration, and conservation knowledge. The first part of the road has been excavated, the stone pillars restored, and the stone slabs, which lost their original position, re-placed in the correct levelling. The conservation of the second part has been carried out by the trained local staff of Vat Phou World Heritage Management Office.
The choice of Nandin Hall monument is belonging to its state of art: its condi-
tion was not so dramatic so that this has allowed training local officials, technicians and workers on a building with low degrees of difficulty.

Before the present restoration project, a preparatory study about Khmer construction techniques and characteristics of original and new materials employed was undertaken by Department for Architectural Design and Department of Structural Engineering of Politecnico di Milano in order to avoid possible new material and techniques incompatibilities which can decrease the durability of the structures and affect the original material.

1. Description of the temple: materials, construction techniques, state of art

The monumental complex covers an area of three square kilometers and it is composed by several buildings typical of the Hindu architecture: shrines, gateways, libraries, assembly halls, ceremonial road, artificial ponds, etc.

The monument known as Nandin Hall is located on the first terrace South of the Ceremonial Road, and West of the South Palace. Its name is belonging to a sculpture of Nandi found by French at the beginning of XX century, nearby the building. Due to this discovery French archeologists think that Nandin Hall is a temple dedicated to Nandi. In reality is not clear the precise function of this type of building, even if from the South side of Vat Phou starts a circa 200km long road going to Angkor. So that Nandin Hall building could be the South secondary entrance of the sanctuary complex that introduced the worshippers from the "Royal Road" to the ceremonial causeway. On the northern side, in a symmetrical position, there is a similar but not complete structure placed in correspondence of another road running from the northern side of Vat Phou that could bolstered this hypothesis.

The main structure of Nandin Hall stands on a rectangular platform of 25m long and 7.5m wide elongated on the north-south axis, and it is composed of a base, a central room, north and south entrance rooms, and two pillared porches at both ends. The whole building is therefore constituted by five successive sections with a double symmetry longitudinal as well as transversal.

Each room have one window facing east with five baluster colonnette. The building has four doors to enter into the three rooms, but only the south and north room doors had double wooden wings.

The shape of this monument is unique in Vat Phou but conformed to Khmer buildings as the libraries in Angkor.

The structure is a dry masonry composed by sandstone blocks of different sizes, very precisely adjusted so as not to leave any gap between adjacent blocks. In addition laterite blocks are used in foundation and for the filling of the basement, under the floors, and of the platform.

The monument has been built on an artificial refilling about (max detected) two meters dept. The area was prepared by a general re-fill, made by scattered natural sandstone mixed with soil and sporadic brick fragments. The ancient builder had to obtain a regular surface being the irregular original ground surface of the first terrace sloping where new structures had to be built. Once the topography of the area was uniform, only the overall dimensions of the
structures was reinforced with a preparation made by silt, sand, pebbles and natural rock fragments, directly under the foundation stone blocks. The platform is composed by two layers of laterite blocks and two of sandstone. The first three layers composing the platform are at the level of the foundation of the building; the fourth one is a kind of pavement around the building and the first step of the two stairs on the northern and southern sides. When the building, or probably when the platform, was completed, the foundation blocks were covered by a layer of about one meter of compacted soil, today washed off on the south and east side. This is in fact the difference in height between the present day ground level and the first step of south porch staircase. The ancient ground surface was inclined eastwards to convey the water flow into a laterite canal, as shown after the excavation carried out in 1997 by the Italian Archaeological Mission.

The courses have been assembled placing the blocks starting from the corners, and continuing towards the center. The upper stone has the function of key-stone, well recognizable from its trapezoidal shape and from its smaller dimension. In order to connect the blocks composing the masonry they originally put on a system of dap joints and grooving which can lock the stone blocks and the courses each others, instead of bonder or metal devices.

A wooden beam was placed on the top of doors and windows heads to better distribute the loads from the upper masonry.

The Nandin Hall roofing was composed of five parts three-stepped gable roof. The highest was placed on the central room and the lowest covered the porches. A wooden framework was covered by tiles; at the edge of the eaves on the eastern and western sides, sandstone blocks carved as false roof edge tiles are on the top of the central and entrance rooms walls. The slots of the wooden trusses are still visible on the upper part of western and eastern walls. At present the building is unroofed, and both the wooden framework and the roof tiles are lost. Fragments of roof tiles were found scattered around the building.

The first cause of stones collapse has been the wooden roof structure breakdown. After roof collapsing, two main events affected the monument: the rainwater infiltration inside the structure, and the erosion of the soil covering the foundation. The concomitance of this two agent factors have caused the horizontal translation toward outer of the foundation blocks, and the consequent upper structure movement. The lack of regular maintenance and the uncontrolled vegetation growth among the stone blocks then accelerated the movement of the blocks. The structural decay of the building was due to these stone movements: the three windows were completely free on three sides, and the frames not anymore well connected with each others; the same problem has been noticed on the four doors and this fact has caused the break of some stone element; the five floors were sunken; and the perimetrical wall were inclined inwards.

The most degraded side of the building was the southern one where the soil has been washed out of about one meter, and all the stone blocks composed the porch were disconnected and/or collapsed.
2. Conservation work

The work of a conservator includes study of the history of the period which the structure was built to try to give the chronological sequence of the events in its life. Research about previous study and intervention, archaeological inspection and excavation, need also to reach these results, and to obtain data about environment context and surrounding of the building. Its construction techniques and materials must be studied in order to achieve an adequate approach to realize an appropriate conservation project. Diagnostic about structure and material decays and its causes need also to be studied to prevent future decay degeneration.

Conservation involves making interventions at different scales and levels of intensity which are determined by the physical condition of the monument. For the monument restoration, the method of partially dismantled and remounted has been adopted, and the principles of conservation have been followed to establish planning decisions.

To achieve the maximum result also in terms of respect of competence with Lao colleagues, the project is involving the active participation of local officials appointed in Ministry of Information and Culture, and in Vat Phou Conservation Unit. In the same time local architects, engineers, technicians and manpower have been trained in order to build up their capacity.

The northern and central sides of the building have been accomplished during the previous first working seasons; the dismantling and the partial reassembling of the southern part have been carried out during the 2011-2012 season. The record of the work is here reported as the description of the working phases: dismantling, documentation, supply of new materials, stone repairing, drainage system setting up, reassembling.

Dismantling

According to the principles of conservation, the building was not dismantled until the foundation blocks of laterite to preserve as much as possible the original layout, even though all the blocks composed the construction underwent vertical and horizontal translation and rotation movement, except for the SE corner where the laterite foundation lost completely its original settlement. The monument has worst deformation in the south and north side, so that only few blocks of the central room have been removed in order to give back the asset
to the central room openings.

**Documentation**
The documentation is the most important step of a restoration and conservation work because it records data concerning the monument in its present condition, the Khmer’s construction techniques, and it gives the possibility to reassemble the stone blocks in the original position layer by layer. Complete recording is essential before, during and after any phase. To ensure the maximum survival of cultural property, future conservators must know and understand what has occurred in the past as well. For these reasons, every phase of work has been photographed and described; every plan has been drew; every level taken; every dismantled block has been permanently numbered, photographed, sketched, measured, and described by the use of inventory cards, in order to have the complete history not only of the monument, but of each stone blocks.

**Supply of new materials**
New stone has been employed when the original material was lost, cracked off, too much deteriorated or practically none existing, or when necessary for structural condition. A very important point is to employ material as much as similar to the ancient one. Past archaeological surveys carried out by the Italian Archaeological Mission, for the archaeological cartography of the area, showed different sources of ancient Khmer quarries both for laterite and sandstone.
Fig. 5 – NE view of Nandin Hall monument before intervention

Fig. 6 – NE view of Nandin Hall monument after intervention
Laterite - The main and large laterite quarry is located at 38 km along 13 road, close to Ban Lak. The area is covering about 12 ha and it is located between the river courses of Huay Touay and Houay Tomo. All the process of ancient laterite mining is still preserved from the extraction until the shaping of final blocks. The north part of the quarry, close to the main road, has been in recent past disturbed by local works, and the blocks have been displaced by their original location. The material supplied for Nandin Hall has been taken only where blocks have no scientific value. By one medium size block it is possible to obtain two new dressed blocks. To distinguish the replaced blocks from the original ones a fiber glass dowel of 5 cm long and 16 mm of diameter has been centred on the stone, used as marker.

Sandstone - There are several places close to Vat Phou where it is possible to have a supply of sandstone. All the hills close to the area are composed by sandstone, and were quarried during ancient time. A large quarry is located 2 km south from Vat Phou, just outside the Lingapura ancient city, in a locality called Pha Phet. But also close to the monumental complex, is possible founding scattered large natural blocks some of which shows on surface sign of cutting. During our work, natural sandstone blocks found close to Vat Phou near the south canal have been dressed an employed on monument.

Stone repairing
The stone repairing has been carried out by the technical unit of Vat Phou Management Office, trained in previous 2004-2005 Lao-Italian-UNESCO Project by the stone expert Mr. P. Pagnin.

This job includes the connection of two or more stone fragments by Epoxy resin and fibre glass, the joint of two or more small stone fragment to the main stone by Epoxy resin, and the consolidation of cracks with injection of Epoxy resin.

Drainage system
The drainage system has been necessary to avoid the rain water reaching the inner core of the building, and originate the same decay process to the structure. Part of the inner laterite core and filling soil have been removed in order to set up the drainage, and to performe the correct gradient able to flow off the water. According with the principle to employ materials as much as similar to the original used in the past, the slopes have been made by the same technique of the ancient one and with compatible material. Brick powder and lime have been added to the soil and stone fragment mixture to ensure a longer durability, and to avoid new vegetation growing to the original filling. A PVC pipe line of 150 mm in diameter (previously cut every 50 mm in alternate slits of 120°) has been placed along the length of the floor with a trend able to discharge the water out from the building. The pipeline has been covered by a layer of gravel, and the floor slabs have been reassembled.

Reassembling
The building has a slope forwards south detected on the first basement moulding. The basement of central room has been not interested of any inter-
vention so that the monument has been reassembled following as much as possible this incline.
The foundations, the platform, the northern porch, the northern room, the central room, and their floorings, windows and doors have been reassembled. Future intervention is the complete reassembling of the southern porch and southern room.

References
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