

Archaeological Conservation of Bagan Ancient Monuments in Myanmar

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Abstract

Bagan covers an area of about 45 - square kilometers along the eastern bank of the Ayeyarwaddy River. The total numbers of Bagan Buddhist monuments were 4446 in the Bagan period. A number of the monuments at Bagan had been destroyed by natural disasters, vandalism, and age. Now there are 3822 monuments of various sizes still standing in Bagan. Conservation, restoration, renovation and rehabilitation works of the ancient monuments at Bagan in Myanmar with the inscriptional evidences have been undertaken from the Bagan period onwards. Archaeological Conservation works have been started during the colonial times. Archaeological Conservation on Bagan monuments carried by the Department of Archaeology and National Museum were identified that are consolidation of walls, strengthening with RCC belts, grouting cracks, binding with steel rods, waterproofing on roofs and terraces, inserting tie beams around the terraces, propping inclining walls with temporary steel structures or other materials, pointing, edging and re-plastering, replacement of brick/stone masonry work, improving drainage and landscaping and chemical conservation of the artistic works on ancient monuments. The 2016 earthquake resulted in the removal of many interventions undertaken in 1996-2012. After the earthquake occurred in 2016, it was proved that the monuments which have been repaired and strengthened suffer no structural damage with some slide damage on nonstructural elements. The monuments which have been repaired and partially strengthened suffer structural damage on not strengthened parts. The monuments which have been only repaired generally suffer more damage with some partially collapse. So the repair and strengthening works should be obligations in the process of rehabilitation, conservations and protections of the ancient monuments.

Keywords: Bagan | Conservation | Monuments in Bagan | Myanmar

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1. Introduction

Bagan covers an area of about 45 - square kilometers along the eastern bank of the Ayeyarwaddy River. The total numbers of Bagan monuments were 4446 in Bagan period. A number of the monuments at Bagan had been destroyed by natural disasters, vandalism, and age. Now there are 3822 monuments of various sizes still standing in Bagan. The art mural paintings, stucco carving, stone carving, gold smith, silver smith, brass smith, black smith, the masonry work, the wood carving, and the glazed ornaments of Bagan period can be observed on Bagan Buddhist monuments, such as mural paintings, stucco.

Before the establishments of the Bagan Kingdom, two different cultural centers existed in Myanmar. They are the Pyu Kingdom in Central Myanmar and the Mon Kingdom in lower Myanmar. Beikthano, Halin, and Srikshetra are major archaeological sites of the Pyu in Myanmar. According to the archaeological evidences, the Pyu settlement dates to early first century A.D. In the early centuries of the Christian era the Mon were settled in the region between the Sittaung and Salween rivers which was known as the Mon Kingdom of Ramanadesa (Myo Nyunt Aung : 2003).

According to the tradition, Bagan was founded in the 2nd century AD by King Thamudayit, a Pyu King. Before King Anawrahta's time in the early 11th century AD, the Buddhist monuments in Bagan are Buphaya, Paukpinya, two encased stupas to the northwest of Gawdawpalin Temple, a stupa on the west side of Taungbi Village, and Ngakywenadaung pagodas, a row of four stupas on the north of Thiripyitsaya palace site, and some inner stupas of the encased Buddhist monuments. The shapes of those stupas are different from the later Myanmar types. The Pyu type of stupas are bulbous in shape (Aung Kyaing : 2007). Nowadays, over three thousand magnificent ancient monuments of Bagan are still existing on the eastern bank of Ayeyarwaddy river in different stages of deterioration.

Upon these general types are evolved various forms of stupas and temples by introducing different architectural and decorative motifs. The architectural types which may be classified are stupas, temples, monasteries, brick pavilions, image houses, brick structures surrounded with wooden buildings, ordination halls, underground caves for meditation purpose, inscribed stone houses, libraries or pitakattaiks, kutis or toilets and guardian houses (Myo Nyunt Aung : 2003).

In Bagan period, Bagan people constructed numerous monuments in an area of 45 square kilometers. in order to gain good merits and to prolong Buddhism for 5000 religious years Kings, royal families, ministers, royal attendants and monks donated money to build temples, stupas and monasteries. A number of religious edifices increased year by year due to the concept of Bagan people that their soul will rest in Nirvana (peace) by building religious monuments. There are many lithic inscriptions which mentioned regarding the donation of slaves to some pagodas to look after the pagodas and to undertake the general maintenance works (Nyein Maung : 1972).

After the fall of Bagan, the Kings of Pinya, Inwa, and Konbaung, Yatanabon period conserved and restored some Buddhist monuments built by their ancestors and added more religious monuments as works of merit in the Bagan area (Pierre Pichard 1992-2001). There are many epigraphic evidences recovered at Bagan temples. That is why over four thousand pagodas cover at the Ancient City of Bagan which measure about 45-square kilometers.

2. The previous conservation works of the monuments at Bagan

In the colonial period, the Burma Epigraphic Office was founded in 1902 CE and the Department of Archaeology was opened in 1954 CE. Since colonial times, some of the ruined Buddhist monuments have been conserved and restored by the Epigraphic Office (ASI 1902-1936, ASB 1906-1926). As a result several volumes of Myanmar Inscriptions have been published. The conservation works of Bagan ancient monuments which received very little attention and very small amount of Budget allotment, played a very minor role in those days. Major conservation and large-scale repair works were carried out by special conservation budget while minor repair and maintenance works were carried out by annual conservation budget. In 1901 CE, Lord Curzon, the Viceroy of India visited Bagan and was much impressive by the magnificent monuments at Bagan. On his return to India, he issued orders to establish an archaeological museum and to take conservation measures to Bagan ancient monuments (Nyunt Han: 1989). The conservation works in Bagan during that time, mainly involved the making the access roads to the monuments, the repairs and restorations of the damaged portions, removing and clearing the debris inside the compound of the temples. About forty-eight monuments were declared as “protected ancient monuments” by notification during colonial times (ASB 1906-1926). Before Independence in Myanmar, more attention was paid to epigraphical research in comparison to conservation and excavation. After Independence, the aims and functions of the Department of Archaeology became broader. They considered there activities as important missions namely the excavation at the ancient city of Pyu and contemporary sites to reveal the early ancient culture of Myanmar, the conservation of ancient monuments, collecting and deciphering the lithic inscriptions, collecting the antiquities, and preservation of mural paintings. The average fifteen monuments in Bagan only were conserved and restored by the Department of Archaeology from 1948 CE to 1996 CE (Aung Kyaing : 2008). In 1966 CE, the major conservation works of DOA were handed over to the Public Work Cooperation. The conservation works carried out in Bagan before 1975 CE earthquake was very routine. The routine works involved the general inspection of the ancient monuments, filling and grouting the cracks of the walls inside or outside the temples, topping the cracks appeared on the terraces of the temples, repairing some portions by replacing with bricks, restoring the damaged corner stupas and sikhara of the temples, the enclosure walls, and clearing the debris accumulated inside or at the entrance of the temples (Nyunt Han : 1989).

In 1975 CE, all of the Bagan monuments have been suffered by the severe earthquake and most of the slim stupas, the small corner stupas, and the parts of the sikhara (square tower) have been collapsed. After the earthquake occurred in 1975 CE, an advisory committee included twenty members of the scholars, archaeologists, architects, engineers and technicians were constituted by the Government of Union of Myanmar for the conservation and restoration works of Bagan Buddhist monuments. At the day time, the members of the advisory committee explored and investigated around the ruinous monuments at Bagan for the detailed reports and at the night time, they discussed regarding the conservation and restoration works. And then a special team of construction co-operation was urgently formed by the advisory committee to conserve and restore the monuments in danger at Bagan. At the same time, the conservation team from the Department of Archaeology repaired the small temples which have been badly damaged for the grouting the cracks, reconstructing the vaults to preserve the original mural paintings and stucco carvings, edging for the valuable plaster carvings and pointing between the brick joints and fixing angle blocks in the corners to prevent from the next shocks. Therefore, some ancient monuments in danger could be restored in time before they were totally collapsed. Although Bagan area is situated at the tropical region in central Myanmar, but heavy rains dropped continuously about seven days in some years. At that time some enclosure walls of the monuments, some mural paintings and stucco carvings were fallen while some monuments were partially collapsed and appeared the leakage of rainwater. Some conservation works have been promptly done by the Department of Archaeology such as edging the stucco carvings and mural paintings, grouting the cracks, and substituting the ruinous parts on these.

Because of the severe earthquakes the exterior walls of some temples came outward and slanted so that the drilling machine was used to make the holes into the walls and the iron bars were put into the holes. And then the cement mortar was grouted into the holes by the grouting machine. According to the instructions of the international scholars, experts, and technicians from UNESCO/UNDP, this method had been used for four temples in Bagan. They are Pitakattaik (old library), West Shrine of Shwesandaw Pagoda, Chuswe Temple, and Khemarwara Temple.

Moreover, the angle iron props were supported to the roof of some monuments which were bent down due to the earthquake. Those monuments are Upalithein, Manuha Temple, Nanphaya Temple, kyaukgu Umin Temple, Shinbinthalyaung Temple and Minyeingon Temple. In some monuments, the R.C.C belts were inserted into the walls underneath of the projecting cornice of some temples which slanted and came outward. After digging and inserting the iron bars with the stirrups, the cement concrete mortar was poured into the walls and concealed with the original bricks which have been dug out. They are Alodawpyi Temple, Mongu Temple near Taungbi Village, Ananda Okkyauing, Nanphaya Temple, Kyaukgu Umin Temple.

According to the advice of the advisory committee, three iron bars were bound up on the glazed body of Ngakywenadaung Pagoda to save the wide cracks for the next shocks so that it was not necessary to dig for inserting the iron bars because the beautiful glazed surface could be destroyed if it was dug around the body.

During the earthquake in 1975 CE, the sheer cracks occurred at the sikhara of Ananda Temple. According to the decision of the advisory board, it was necessary to reduce the weight of two hundred tons to strengthen the damaged sikhara. Inside the sikhara was dug from top to bottom and the R.C.C shells with the diaphragms have been supported in it. The R.C.C anchors were also inserted at the basement of sikhara to join with R.C.C shell and R.C.C pillar inside the slim stupa. The R.C.C belts were bound up on the cracks from the upper storey of Thatbyinnyu Temple, which is the highest Temple in Bagan. The sikhara and the slim stupa of Gawdawpalin Temple which was badly damaged during the earthquake have been restored by the Department of Archaeology. The cracks were grouted with the mortar and were bound up with the R.C.C belts around the walls which were badly damaged. Some mural paintings of Lokahteikpan Temple were fallen and collapsed and the wide cracks appeared at the corners of the walls so that the R.C.C belts were bound up on the walls to prevent from the next shocks.

Some monuments were situated on the bank of the Ayeyarwaddy River in Bagan. They are temple No.1166 to the north of Kyaukmyatmaw Pagoda, Temple No.136 to the northwest of Chaukphayahla Temple, and Yan Aung Myin Pagoda to the east of Shwezigon Pagoda. In those Temples the embankments were constructed to prevent from the water erosion.

Dr. Pirre Pichard was an international co-ordinator from UNESCO to assist the restoration and conservation works for Bagan ancient monuments damaged by the earthquake in 1975 CE. He joined with some chemists and architects from ICCROM who were sent to Bagan. The archaeological experts and chemists worked at Gubaukyi Temple near Myinkaba Village, Abeyadanar Temple, Nagayon Temple, and Lokahteikpan Temple from 1987 to 1994 to clean the mural paintings treated with the chemicals and tubular scaffoldings supplied by UNESCO/UNDP. Thirty local people from the Department of Archaeology have been trained by the chemists and experts from ICCROM how to apply the chemical treatments and how to clean mural paintings to last for a long time. Dr. Pirre Pichard also wrote, eight volumes of books entitled Inventory of Monuments at Pagan published by UNESCO/UNDP, written by Japanese Government likewise assisted six trucks and 300 pipes of various sizes using for water supply of the conservation and restoration works in Bagan. It is the responsibility of the Department of Archaeology and National Museum (DANM) to carry out conservation works at all these ancient cities and sites with a view to safeguard the ancient monuments or cultural heritage sites of Myanmar. One hundred twenty this amount three monuments were? completed for conservation and restoration works from 1975 to 1980 (Aung Kyaing : 2008).

Bagan architecture mainly consists of two which are solid types and hollow types. The solid type is a stupa and the hollow type is usually a temple, however different architectural typologies can be classified in detail. There are what is this amount and stupas, 431 monasteries, and 54 other type of monuments, such as ordination halls, caves, and what is the difference between sample and image house?, While 1592 excavated mounds are still remaining in Bagan. Many had been destroyed by the natural disaster, seasonal effects, long life span, rain water, vegetation, animals and insect effects, wind attack, and vandalism. There are over three thousand monuments still exist in Bagan region. The 892 mounds at Bagan were systematically excavated by the DANM and different architectural typologies of the monuments such as what is the difference inscribed houses, guardian houses were uncovered after the excavation of those mounds in 1995 CE. A number of Bagan monuments have been restored and reconstructed by the DANM with the public donations, NGOs, INGOs, foreigners and the governmental budgets from 1996 CE to 2012 CE. Most Myanmar people are the Buddhists so that they would like to reconstruct all Buddhist monuments with the completed decorations as original styles (Soe Soe Lin : 2016).

3. The present state of conservation at Bagan

After 2012 CE, the conservation works of Bagan monuments were only allowed by the DANM in order to maintain the integrity and authenticity of Bagan ancient monuments. The numerous monuments at Bagan have been measured by the conservation works such as digital recording/drawing, consolidation for walling and curving, strengthening with RCC belts, grouting into the cracks, binding with steel rods, water proofing on the roofs and terraces with consideration of evaporation, providing for tie beam around the terraces, propping the inclining wall with temporary steel structure or other materials, providing for pointing , edging and re-plastering, drainage system, replacement of brick/stone masonry work, landscaping, road and communication.

Unfortunately the severe earthquake was occurred in Bagan on 24 August 2016 and 389 monuments at Bagan were affected by the earthquake. Advisory and Technical Expert teams were urgently formed by the Ministry of Religious Affairs and Culture and were approved by the President Office on 19 September 2016. The team included scholars from DANM, UNESCO Consultant, professors from MTU (Mandalay Technological University) and YTU (Yangon Technological University), architects from AMA (Association for Myanmar Architect), engineers from MES (Myanmar Engineer Society), president of BHT (Bagan Heritage Trust), members of the National Earthquake Committee, and officers from the Department of Metrology and Hydrology. According to the discussion and decision by the Technical Expert Team, three priority lists of the affected

monuments were classified. Among 389 monuments affected by the earthquake, 36, 53, and 300 monuments are the first, the second and of the third priority, respectively, listed by the DANM for conservation and rehabilitation. After the earthquake occurred in 2016, emergency response has been undertaken by DANM. such as roofing for protection from rain water, removing debris, site cleaning, providing the scaffolding, belting the cracked monuments, topping on upper parts of the monuments, and propping with wooden buttresses as a temporary support the inclined walls. With the help of UNESCO Consultants, the Rapid Condition Assessment Cards such as Structure Condition Assessment Cards and Decoration Condition Assessment Cards have been carried out for the earthquake affected monuments in collaboration with DANM, Local Communities and Volunteers (Soe Soe Lin : 2016).

The inventory of Bagan monuments has been digitized and the rapid monument survey have been undertaking for eleven parts by the DANM in participation with UNESCO Consultants. The pilot project on conservation works at Phyat-Sa-Shwe-Gu Temple (Monument No.1249) have been undertaken by the DANM in collaboration with UNESCO Consultants. There are two conservation projects at Bagan in collaboration and coordination with the Archaeological Survey of India and Japan University. Those temples are Ananda Temple with ASI and Mei Daw Yat Temple (Monument No. 1258) with Japan University. Some information regarding the emergency conservation measure for monuments in danger were collected from the security team and watchmen team of DANM and tourist guides.

According to the strength of Bagan Branch Office, there are one Deputy Director, one Assistant Director, one Staff Officer (Engineer), one Staff Officer (Chemist), four conservators and twenty-six staffs at the conservation section of Bagan Branch Office. There are eleven parts with the supervision of engineers on each site divided by DANM to be conserved, restored, monitored and rehabilitated ? (Soe Soe Lin : 2016).

4. Archaeological conservation measures undertaken at the Ancient City of Bagan

There are many unexcavated archaeological sites and a few archaeological mounds in the property of Bagan. In order to maintain the integrity of identified those sites and mounds, the principal conservation measure is the maintenance of existing vegetation cover in order to prevent erosion. There is also a need to control the type of vegetation on identified sites since deep-penetrating tree roots, including those from newly introduced tree crops, can cause damage to archaeological deposits.

The conservation measures consist of the removal of vegetation growth, which can be dense after the annual rainy season, and the drainage of standing water from the excavated

archaeological sites with the exposed structures. Constant and routine maintenance is also required at all excavated archaeological sites and exposed structures, to control deterioration caused by the infiltration of rainwater into the exposed brick structures, absorption of ground water into the structures' foundations, and the growth of vegetation. These preventive conservation measures are not sufficient to ensure the continued physical integrity of the structures at some exposed archaeological sites and monuments, more aggressive conservation intervention are required, such as the construction of shelters over the exposed features and artifacts, or the removal of some moveable artifacts into the Bagan Archaeological Museum. Some exposed structures need to be provided for consolidation, strengthening, pointing, edging, water proofing, and grouting.

The overall state of the conservation of Bagan can be considered as good, and is constantly improving, as it is fitting for archaeological property of national and world significance.

The particular challenges of the conservation of the physical remains of the Bagan are due to their antiquity and by the pressures placed on the religious and ceremonial use of the still-venerated monuments by local residents and pilgrims. The serious threat to the integrity of the still-buried archaeological remains of some places nominated property comes from the recent change, by a few of the local farmers, from traditional shallow-draft to modern deep-draft agriculture plowing technology employed in farming. It is a threat to the continued authenticity of the historic land-use of the property. Besides there may be pressure from public demand and supported by the sangha (monk body) for the renovation of the most venerated stupas, in keeping with traditional religious practice. In light of these above-mentioned threats to the continued integrity and authenticity of the property, as well as to respond to the need to ensure incremental, but ever-increasing, levels of site maintenance and preventive conservation at all ancient archaeological sites, as the ancient structures continue to age and suffer from the negative effects of weathering, the principal needs ensuring the still-venerated religious monuments, the excavated and unexcavated archaeology, and the historic conservation of the character-defining attributes of the Ancient City of Bagan, including the landscape and land use need to be undertaken. There are needing to be carried out by DANM to control of land use within the property, which ones ? what factors to be consolidated and maintained of the standing and exposed ancient physical remains and to educate the public awareness as to the significance of the property and the value of its preservation to all concerned.

The threats to the Outstanding Universal Value of Bagan are mainly due to the residual effects of poor conservation work undertaken in the past. In particular, the use of cement mortars to conserve the brick structural remains has unfortunately resulted in hastening their deterioration, rather than helping. Another problem ensuing and enduring from past attempts at

conservation of some Buddhist monuments is the over-loading of the structurally weak ancient brick features with modern brick layers, added with the good intension to protect the ancient features. This has put undue structural stress on the fragile ancient materials leading to collapse of entire sections of the ancient structure, together with the modern additions bonded to the old with cement. However DANM is now taking measures to correct these past mistakes, and is in the process of removing the earlier added brick as well as the cement mortar used in earlier conservation works and is replacing the cement with a traditional mortar consisting of lime and brick dust.

There are two towns and ten villages in the property. According to the Archaeological Law, the residential areas are not allowed to extend outside the demarcated boundaries of the property so that some Bagan people faced many problems expanding population from Bagan to settle inside the property in the future. The existing plots in the urban areas are very expensive to buy for poor families so that the government urgently need to replace for new settlement areas outside the buffer zone. In Bagan, the rapid expansion of cement construction in the vicinity of the property as Bagan expands has increased the demand for sand and gravel, which is conveniently mined from ancient streambeds, a practice which also contributes to the distortion of the historic landscape. There are many hotels, motels and guest houses in the property. A few of them are located in the monumental zone while some of them are situated in the urban areas. Some of the hotels located nearby the historic monuments in the monumental zone and ancient site zone distorted to the original historic landscape.

5. Archaeological conservation of some monuments at Bagan

Most of the monuments at Bagan were built between 11th and 13th Century AD but a few of them were built before 11th century AD. Ngakywenadaung Stupa (Monument No. 1603) located to the west of Thatbyinnyu was built before 11th Century AD. It is a stupa surmounted with bulbous in shape as well as a double encased stupa in Bagan. It is one of the Pyu type stupas (Aung Kyaing : 2007). When it was earthquake in 1975 CE, the huge vertical cracks appeared on the surface of the stupa. According to the advice of the advisory board, three iron bars were bound up on the glazed body of Ngakywenadaung stupa to save the wide cracks for the next shocks. It was not necessary to dig for inserting the iron bars because the beautiful glazed surface could be destroyed if it was dug around the body. After the earthquake in 1975 CE, toppings, pointing, strengthening and consolidation works on necessary areas and replacements of the brick masonry works have been done by the DANM. After 1996 CE, a finial of the stupa have been reconstructed as an original shape and the pointing into the brick joints and the brick masonry works have been carried by the DANM with the individual public donation funds.

Ananda Temple (Monument No. 2171) is the finest and most venerated temple in Bagan. Not like other monuments, it has four vestibules and two corridors. It was built by the King Kyansittha in 1091CE (Khin Maung Nyunt : 1986). There are ink inscriptional evidences with mural paintings in this temple regarding the repair and restoration works. After the Bagan period, the successive Myanmar Kings repaired and repainted again to this temple. During colonial times, it was repaired and three causeways on the west, north, and south sides were constructed by the individual donations. Only the eastern vestibule without a causeway can be viewed as an original view of the Bagan period. After the earthquake in 1975 CE, the sheer cracks occurred at the sikhara of Ananda Temple. According the decision of the advisory board, it was necessary to reduce the weight of two hundred tons to strengthen the damaged sikhara. Inside the sikhara was dug from top to bottom and the R.C.C shells with the diaphragms have been supported in it. The R.C.C anchors were also inserted at the basement of sikhara to join with R.C.C shell. The consolidation works, the strengthening works, pointing, edgings, the replacements of the brick masonry works and the grouting works have been carried out by the special construction cooperation team after the earthquake occurred in 1975 CE (Aung Kyaing : 2008). Subsequently general repairs have been done by the Ananda Pagoda Trustee Office with the supervision of DANM. There are a big project regarding the restoration and conservation works undertaken by the Archaeological Survey of India in collaboration with the DANM and the project have been started since 2012 CE. The fifth-year project have been recently completed for conservation works at Ananda Temple. The chemical conservations at Ananda temple for cleaning the mural paintings, the stucco carvings, stone carvings, wood carvings, glazed decorations and floorings in the corridors and outside the temple. The replacement of the brick masonry works for the damaged parts and landscaping of the eastern part in the precinct have been done during the five-year project. The conservation and restoration work of Shwe Chan Thar Temple and Tha Gya Pya Temple have been already carried out during the project. The original stone sculptures in the niches after consolidation with chemicals, have been done and covered with the glass windows. When it was earthquake in 2016 CE, a part of the finial and some corner stupas have been affected by the recent earthquake and some cracks were appeared on upper parts. Some original plasters on the ceiling of the corridors were flaked off and the consolidation and strengthening works, grouting with mortars into the cracks and aging for the plaster carvings have been carried out by the ASI in collaboration with DANM.

Thatbyinnyu Temple (Monument No. 1597) is a tallest temple in Bagan and it is 201 feet in height. It consists of four storeys and seven terraces. It was built by the King Alaungsithu in the 12th Century AD. Original mural paintings with the footprints of the Lord Buddha can be

viewed on the ceiling only at the western porch (Aung Kyaing : 2007). In 1975 CE, the top finial with the sikhara and the corner stupas, the main Buddha image on the third stories have been damaged by the earthquake. Some vertical cracks measuring 9 inches in width appearing at the corner of the exterior walls on the third storey of Thatbyinnyu Temple. The strengthening works have been carried out for all cracked areas on the walls by the DANM. strengthening and consolidation works, replacement of the brick masonry works including the brick Buddha image on the third floor, crowning the umbrellas on a top finial including the corner stupas, water proofing on the terraces, and pointing and edgings on all necessary Other tasks also such as (Aung Kyaing : 2008). In 2006 CE, the water proofing to prevent from the rain water leakage on the floor of terraces and donation for gilding of the finial of corner stupas have been undertaken by the Pagoda Trustee Board of Thatbyinnyu Temple. When the earthquake was occurred in 2016 CE, many horizontal and vertical cracks were appeared on all corridors and stories of Thatbyinnyu Temple. Some original plasters on upper parts were flaked off and the eastern parts of the brick masonry works at the bottom of the sikhara measuring 4 ft x 12 ft were immediately damaged during the raining time after the earthquake in 2016 CE. The DANM in collaboration with the Pagoda Trustee Board have taken care of the grouting works with mortars into the cracks, consolidation works, pointing, edgings, supporting with wooden buttresses to the inclined walls on upper terraces, and the replacement of the brick masonry works on the damaged parts A.

Saytanagyi Stupa (Monument No.987) is one of the biggest Sinhalese type monuments in Bagan. It was built by King Htilominlo or King Nadaungmya in the 13th Century AD and is located on the southern end of new Bagan area. There are five receding terraces of which are one circular terrace, one octagonal terrace and three-square terraces with corner stupas enshrining the standing Buddha images. Along the base are thirty nine elephants and forty kalasa pots which are alternately arranged on each side (Aung Kyaing : 2007). In 1964 CE, some figures of the elephants, parapets, kalasa pots, some parts of the hemispherical dome and the inner enclosure walls have been repaired by the DANM. In 1975 CE, some parts of the projecting cornice and parapet were damaged, and the damaged parts have been conserved by the DANM after the earthquake occurred in 1975 CE. In 1997 CE, the top finial including the concentric rings and all corner stupas have been repaired and all of them have been crowned by the umbrellas. The sandstone floors at the southern side of the stupa were laid in 2011 CE. The eastern gateway and the inner enclosure walls were repaired in 2013 CE. While in 2014 CE., the DANM repaired water proofing on all terraces, grouting works into the cracks for strengthening, pointing into the brick joints including the original brick floors, edging at the edge of the plaster carvings and the replacement of the brick works on the damaged parts of the stupas, and the inner and outer

enclosure walls and four gateways. Some parts of the original brick floors have been covered with glass and wood to be viewed and researched from the outside. During the earthquake occurred in 2016 CE, the main finial including the reconstructed concentric rings, some of the corner stupas, some parts of the receding terraces with parapets have been collapsed. After the earthquake in 2016 CE, strengthening and consolidation works on necessary areas, toppings on finial, replacement of the brick masonry works on damaged parts have been undertaken by the DANM with UNESCO consultants.

Htilominlo Temple (Monument No. 1812) is located on the south of Bagan-Nyaung Oo Road. It was built by the King Htilominlo or Nadaungmya or Zeyatheinkha in th 13th Century AD. King Nadaungmya was mentioned in many stone inscriptions in the Bagan period. It is one of the three stories temples at Bagan. Some original mural paintings, stucco carvings, stone and brick masonry works and glazed decorations still remain in this temple (Aung Kyaing : 2007). The earthquake occurred in 1975 CE, some corner stupas, some plaster carvings were damaged, and the vertical and horizontal cracks were appeared on upper parts. After the earthquake in 1975 CE, the northeast corner stupa has been repaired and pointing into the brick joints and edgings at the edge of the stucco and mural paintings have been carried out by the DANM. In 1978 CE, the main Buddha image on the ground floor was repaired and the main flaming like arch-pediments on the ground floor, some archways and gateways of the enclosure walls have been conserved in 1979 CE. The new floors, the pointing on the arches, the installing of the glazed gutters on upper terraces, edgings have been undertaken by the DANM in 1980 CE. The water proofing on the damaged floors of terraces, grouting into the cracked floors and edgings on the original plaster carvings in 1992 CE. In 1997 CE., the DANM did reconstruction of the top finial, the repair of four Buddha images, edgings on mural paintings and stucco carvings, killing and uprooting of the banyan trees with chemicals, pointing around the bottom of the monument, the replacement of the figures of stone guardian Nats in the niches, and water proofing over the outer enclosure walls. There is a Pagoda Trustee Board who takes care of the general maintenance of Htilominlo Temple. The replacement of the brick masonry works on the projecting cornices and around the monuments on the damaged parts in 2015 CE. This temple was affected by the recent earthquake occurred in 2016 CE. The top finial, some corner stupas, some arch-pediments and parapets have been damaged and some original plasters and mural paintings were flaked off in 2016 CE. After the earthquake in 2016 CE, the stabilization, the strengthening, the consolidation, the replacement of the brick masonry works, water proofing, pointing and edgings have been done by the DANM in collaboration with the Pagoda Trustee Board of this temple.

Hsin Phyu Shin Monastic Complex (Monument No. 697) is located to the northwest of the Minnanthu village in the Bagan Cultural Heritage Region. Hsin Phyu Shin Complex is a group of buildings which consisted of a temple, a stupa, an ordination hall, a chief priest of Maha Thera monastery, 19 various sizes of brick monasteries, a rectangular brick water tank, a well, and an inscribed house. This complex was built in the 14th century AD. The rectangular and square brick monasteries were built between inner and outer enclosure walls. There were 8 monuments and one brick water tank inside the inner enclosure walls and 19 monuments between inner and outer enclosure walls totally 27 monuments. These monuments were suffered by the weathering, the server earthquakes, the vandalism, the old age throughout the historical periods. Before 2002 CE, out of 45 monuments, 18 monuments had been already collapsed and now existing in the form of mounds. Similarly, many monuments were existing in the different stages of deterioration. During the Bagan period, the monastic complexes were very famous monuments where the chief priest (Maha Thera) resided and taught the Buddhist canons (Tripitakas) to the young monks and novices. These monastic complexes are the centre of the Buddhistic studies in those days. The stone inscription found at the Hsin Phyu Shin Monastic Complex mentioned that King Thihathu called King Tasishin Thihathu (the possessor of a white elephant) built this monastic complex in 1312 CE. Later this monastic complex called as Hsin Phyu Shin complex meaning the monastic complex of a king who owned a white elephant. Among the monastic complexes located in Bagan, Hsin Phyu Shin Monastic Complex survived a fair state of preservation while the rest monastic complexes suffered much deterioration. It is a good example of a Buddhist learning centre of the Bagan period with a view to show the visitors how the Buddhist monks resided and learned the Buddhist scriptures (Tripitakas) for the development and propagation of the Buddhism in the Bagan period. Between 2002-2003 CE, the DANM did the excavations of 26 brick mounds, the conservations of 26 excavated mounds, the conservation of the damaged monuments between the inner and outer enclosure walls, the brick water tanks, the reconstruction of 18 brick monasteries, two Dhammasala buildings and one ancient well, the excavation of the two ancient ponds, the reconstruction of three gateways and 2827 feets measuring outer enclosure walls, landscaping in the complex, the reconstruction of the ancient interior roads and foot-paths, site cleaning and leveling (Myo Nyunt : 2004). The top finial of the main temple and some brick monuments in the complex are affected and some original stucco carvings and mural paintings were flaked off by the recent earthquake occurred in 2016 CE. After the earthquake, the DANM wim UNESCO Consultants did. the reducing the weights on upper parts, the replacements of the brick masonry works on necessary damaged areas, pointing and edgings, water proofing on the upper terraces and grouting into the cracks

have been undertaken by the DANM with UNESCO Consultants after the earthquake in 2016 CE. Mya Taung Brick Monastery (Monument No. 225) is located to the southwest of Shwezigon Stupa. There was an original stone inscription regarding the history of this monastery written in 15th Century AD, which is now erected inside the inscribed house. It is three stories building belonging 15th Century AD. It consists of staircases to be climbed, the perforated windows for lighting and ventilation. Originally there was a wooden preaching hall attached to the main building, which were decorated with the stucco carvings on the exterior walls and the mural paintings on the interior walls. Some of them remain in this monument, Stone plinth, stone stairways, stone sockets to be erected for the timber posts are still visible. In 1965 CE, the DANM took care Repaired all staircases, the bottom of the monument, the corbelled arches over the staircase of the third storey, northern and eastern interior walls in the corridor of the third storey and the northwest and the southwest vaults of the second storey the propping with the brick buttresses at the bottom of the southeast corner, replacements of the brick masonry works of the damaged parts of parapets, installing the iron door on the roof floor, the ruined windows on the southern exterior wall, and pointing and edgings on the vault of the second. The pointing and edgings on necessary areas, the windows on the northern and western exterior walls have been repaired in 1989 CE. The recent earthquake in 2016 CE, the vertical and diagonal cracks on the northern and western exterior walls, the horizontal cracks on the floors and vaults of the second storey and roof floors were appeared and the corbelled vaults on the northern corridor of the third storey have been totally collapsed. After the earthquake in 2016 CE, the belting the cracked and ruined areas, pointing and edgings on the exterior and interior walls, the stabilization, the strengthening, consolidation works have been carried out by the DANM (Soe Soe Lin : 2016).

Ananda Okkaung Monastery (Monument No.2162) is located to the north of Ananda Temple. It was built in the eighteenth century in the Konbaung Period. The brilliant mural paintings illustrating the scenes of some previous lifes of the Gotama Buddha can be viewed in this monument. There are very valuable ink inscriptions inscribed on the interior walls. It was mentioned that the name of the builder, when it was built, the started date and the completed date for constructional period, the cost of the detailed constructional materials and the exact cost of the monuments are recorded on the walls. It is a medium sized and two storey monastery on a platform with stairways on north and south sides. There are ground floor, square central cell and corridor around, internal staircase in west wall and tiered sloping roof with crenellations in this monument. In 1964-65 CE, the replacement of the brick masonry works on plinth, the pointing into the brick joints, edgings at the edge of the damaged mural paintings and water proofing on

terraces have been carried out by the DANM. A reinforced concrete ring beam was inserted into the walls of the ground floor and into the first floor for reinforcement and strengthening works in 1982 CE (Aung Kyaing : 2008) . Some original mural paintings on the ceilings were flaked off and some horizontal and vertical cracks were appeared on the ceilings of the upper storey in the recent earthquake in 2016 CE. After the earthquake in 2016 CE, the supporting works on the vaults, the pointing into the brick joints, edgings at the edge of the mural and stucco carvings and grouting into the cracks have been done by the DANM.

Bagan city wall s? pural? with moat s? pural?

The city wall of Bagan is nearly suggested as irregular rectangular in shape with the length of east-west is longer than north-south generally. But the existing of three city gates are respectively seen in each side except west for river erosion. The northwestern portion of the city had been eroded and washed away into the Ayeyarwaddy river. Nowadays the length of the city wall are existing; 540 meters on the north, 1170 meters on the east and 1250 meters. on the south. The walled area has 106.80 The city originally was enclosed by water moat after city wall, it is today already dried up. The moats might have been brick walled construction to prevent erosion and maintaining water with the different widths. East and southeast areas of moats have a wider space with 37-52 meters width and 3-4 meter. deep, northwest and southwest areas with less than 30- meters width and averagely 3- meters deep (Win Kyaing : 2016).

Local people and archaeologists of Bagan pointed out the drainage system in this area starts from Myakan when it was over filled by Naletaw Chaung. Then the drains and channels continue towards northwest flowing through out Alampagan, Alekan, Minnanthu Kan, Nyunlet-taphet Kan, Ywahaung-gyi Kan and finally to water moat of walled city. This is present situation how the city-moat and the storage tanks of monastery complex receives water during the heavy rain. Originally there are twelve gateways in this city wall. Tharabha Gate which is situated at the centre of the eastern wall is a well preserve gateway in Bagan. The city wall and moat have been excavated by DANM in 1990 CE (Aung Kyaing : 1991).

Bagan Palaces

Tradition said that Bagan started with 19 Pyu villages communities from the Bagan plain and the sided areas of Tuyin Hill range. On the ancient hydrological point of view the early villages of Bagan mainly depended on Ayeyawaddy River and hinter lands of dry streams. For instance, the most important cluster of ancient city area, spotted with the villages of Nyaung U, Nagakyit, Nagabo, Anuradha and Thiripyitsaya were easy to access water resource from the river and dry streams. Bagan period lasted 1262 years from 107 CE to 1369 CE. There are five palaces

in Bagan. Two of them have been excavated by DANM and the rest are unexcavated sites but all of them have been tested by the non-invasive method in September 2016 (Kyaw Khaing : 2016). Some archaeological remains and structures have been uncovered by this method so that it need to be excavated in the future.

The Bagan Dynasty was started with King Thamudarit by organizing the nineteen Pyu villages located around Yon-hlut- Kyun-an island surrounded by a creek flowing from Mt. Popa into the Ayeyarwaddy river. The first palace was built in Yon-hlut-Kyun located to the east of Turintaung mountain range and six kings ruled there. It was excavated by Dr. Bob Hudson and U Nyein Lwin in collaboration with the DANM in 1999-2000 CE. A rectangular brick compound and associated structural ruins were discovered at Yon Hlut Kyu located in the eastern hinterland of Bagan. The excavation program resulted in two discoveries, an abandoned habitation site and a three-sided 60 by 60 use American spelling rectangular structure made from sun-dried or low-fired brick with remnants of roof tiles, iron nails, a pivot-stone from a doorway and earth-ware pottery fragments that included ritual sprinkler pots. The brick structure is located on the eastern approach to the city from Mount Popa, a major pilgrimage site. This is also the route to the Samon/Panlaung Valley and the Bagan period rice-growing area of Kyaukse (Hudson & Nyein Lwin 1999; Hudson 2000a; Hudson, Nyein Lwin & Win Maung 2002; Hudson 2003b). After the excavation of this site, some documents in details had been recorded by the excavators and a watchman was appointed by the DANM to take care of this site since 1999 CE. The land covering this site was purchased by the DANM.

The Myanmar Chronicles said that during the reign of King Thin-li gyaung in 4th century AD, the palace was transferred to the second palace site named Thiripyitsaya to the southwest of new Bagan. From King Thi-li gyaung to King Thaik-taing, altogether five kings ruled there till to 6th century AD. This is a systematically unexcavated site, but non-invasive method has been carried out for this site by the DANM in 2016 CE.

The 12th King Thaik-taing transferred his palace site to Tampawaddy, near Phwa saw village and twenty-two kings ruled there till to 9th century A.D. The 34th King Pyinbya finally moved his palace to the existing palace site and built pural? city pural? and pural? (Aung Kyaing : 2007). There are included such famous monuments of Thatbyinnyu, Gawdawpalin, Mahabodhi, Shwegugyi, Mimalaung Kyaung, Nathlaung Kyaung Temple, Bupaya, Atwinsigon, Ngakwenadaung Stupa, Palace site, Archaeological Museum and other monuments, all together about 100 ancient monuments in the fourth palace site. There were palaces of King Pyin Bya, King Anawrahta and King Kyansittha at the fourth palace sites inside the city pural? and pural?. King Kyansittha Palace site was excavated by the DANM in 1990-94 CE. The numerous brick post holes with stone slabs,

a well with brick masonry works, brick walls, a burned brick wall, terracotta roof tiles, the different typologies of potteries and potsherds, a long brick paths and a rectangular brick temple belonging in the 14th century AD were recovered in this site (Aung Kyaing : 2004).

The excavation of King Pyinbya Palace site located to the south of Atwinzigon Stupa have been undertaken by DANM in 2001-2002 CE. According to the parabaik in the 18th century AD, the city and palace form a rectangle within a rectangle. An area of 40 by 20 metre outside the south wall of the Atwinzigon complex was excavated and brick walls and floors were uncovered in this site (Nay Naing Tun : 2002).

The excavation of the King Anawrahta palace site have been carried out by DANM in 2003 CE. Two big brick buildings, two small brick buildings, an 85-meter brick wall stretching south and north, two 40-metre long brick wall stretching east and west, brick floors, posts, the drain of Bagan period, the site assumed to be the west gatehouse of the palace of King Anawrahta, earthen pots and broken earthen pots, 53 earthen pots, 73 earthen ear-plugs, utensils including earthen potsherds and earthen beads were unearthed in this site. The structural conservation and the chemical conservation with the consolidation have been done by the DANM for the exposed structures and the excavated finds after the excavation of this site.

There was Kyauksagar Palace site located between new Bagan and Saytanagyi Stupa in the property. Two enclosure walls which were made of wood fossil, sandstone, a huge gravel bed were found in this site. Two small scale areas for the test pits on the southwest corner of the inner enclosure walls have been excavated by the DANM in 2005 CE (Myo Nyunt Aung : 2005). A part of the outer northern enclosure wall was exposed at the southern end of new Bagan area. Some scholars consider that this site might be second palace site of Bagan founded by the King Thamudarit after the first palace site called Yon Hlut Kyun. There are four palace sites which have been tested by the non-invasive method by the Field School of Archaeology in 2016 CE. They are Thiripyitsaya, Kyaksagar site, Tampawaddy site and Yon Hlut Kyun palace sites. All of the areas covering 53500 square meter have been measured with Geomagnetic Prospecting and Topographic Surveying. The rectangular structures on each site were uncovered by this method (Kyaw Khaing : 2016). The excavation of the Bagan palace sites should be systematically carried out by the DANM in the future.

6. Conclusion

In 2015-17, with the collaboration of UNESCO, the task of updating the inventory of monuments was conducted. As result of this work, the range of conservation measures on Bagan monuments were identified that are consolidation of walls, strengthening with RCC belts, grouting cracks, binding with steel rods, waterproofing on roofs and terraces, inserting tie beams around

the terraces, propping inclining walls with temporary steel structures or other materials, pointing, edging and re-plastering, replacement of brick/stone masonry work and improving drainage and landscaping.

The 2016 earthquake resulted in the removal of many interventions undertaken in 1996-2012. Almost all monuments in Bagan are considered strong enough, in fair condition, and not likely to suffer sudden collapse. Further conservation work is being undertaken in Bagan. After the earthquake occurred in 2016, it was proved that the monuments which have been repaired and strengthened suffer no structural damage with some slide damage on nonstructural elements. The monuments which have been repaired and partially strengthened suffer structural damage on not strengthened parts. The monuments which have been only repaired generally suffer more damage with some partially collapse. The monuments which have been treated at all suffer heavy damage with partial or total collapse. So the repair and strengthening works should be obligations in the process of rehabilitation, conservations and protections of the ancient monuments (Predrag GAVRILOVIC, Pierre PICHARD, Christophe POTTIER : 2016).

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