International Conference 2011

“Human Resources Development forTransmission of Traditional Skills: National Approaches and their Application to Stone and Brick”

(6-8 December 2011, Shanghai, CHINA)

Cultural Heritage Protection Cooperation Office,
Asia-Pacific Cultural Centre for UNESCO (ACCU)

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2011 Human Resources Development for the Transmission of Traditional Skills:
National Approaches and their Application to Stone and Brick

Preface

ACCU Nara Office has been holding International Conferences every year, but in this year we are very happy to be able to host this conference together with WHITRAP Shanghai, the World Heritage Institute of Training and Research for the Asia and Pacific Region. Since the establishment of WHITRAP Shanghai in 2007, Professor Zhou Jian has suggested collaboration with ACCU Nara Office. But although we explored various ideas, we were unable to decide what kind of program we could actually work on together.

While considering this issue, we were able to have Professor Zhou attend the International Conference held in Nara in 2010. We had the opportunity on that occasion for a long and friendly conversation. In the course of our discussion, we reached the mutual understanding that as our two institutions both have the task of contributing to the protection of cultural heritage in the Asia and Pacific region, any collaboration towards our shared goal would not only be mutually beneficial for our two institutions, but it should also help protect the Asia and Pacific region's cultural heritage as well.

Then, as a project we could actually undertake together, it was decided to try holding International Conferences as a start. In the last fiscal year, as the first attempt, the International Conference in Nara was held through the cooperation of our institutions' efforts. This conference is the first one to be conducted under joint organisation, that is, through real collaboration between us.

This is also the second time when the International Conference is being held under the general theme of "Human Resources Development for the Transmission of Traditional Skills." In the first conference, we deepened discussion from a comprehensive perspective on tangible and intangible heritage, focusing on how to transmit traditional skills and materials for the future. The topic of the restoration of wooden historic buildings was taken up as the subtheme. This time the focus is on stone and brick. Through lively discussion, we have drawn up a recommendation on the issues and future tasks for regeneration and transmission of traditional skills in stone and brick heritage, as a fruitful result.

Last but not least, I would like to extend special thanks to all those who have given advice and support in regard to holding this conference, beginning with the Agency for Cultural Affairs, Japan (*Bunkacho*); the National Research Institute for Cultural Properties, Tokyo and Nara (Independent Administrative Institution, National Institutes for Cultural Heritage); the JAPAN ICOMOS National Committee; the Japanese Association for Conservation of Architectural Monuments (JACAM); the Nara Prefectural and Municipal Governments; Tongji University and the Shanghai Tongji Urban Planning and Design Institute. Also, special thanks for preparations for the conference are due to all of the staff of the WHITRAP Shanghai.

NISHIMURA Yasushi
Director
ACCU Nara

Preface

On behalf of the World Heritage Institute of Training and Research for the Asia and Pacific Region under the auspices of UNESCO Shanghai (WHITRAP Shanghai), I would like to express my sincere welcome to all participants and professionals.

In July 2010, WHITRAP Shanghai and ACCU Nara signed an official Memorandum of Understanding initiating a series of conferences since 2011 on "Human Resources Development for the Transmission of Traditional Skills". The first session was held in Nara, Japan and focused on woodworking. Stone and brick buildings, materials, decoration and furnishing were to be covered in the following sessions. It is essential for craftspeople to master the traditional skills and implement them in the course of heritage conservation. Meanwhile, traditional skills are facing the threat of extinction due to various impacts. Accordingly, the organizers plan to promote a discussion regarding this topic. Taking this opportunity, professionals from different countries are able to share and learn from one another's experiences. Through the transmission of traditional skills, development of human resources, relevant policy and methods, the appropriate solutions can be sought and combined with practical experience to promote the expansion of cultural diversity.

The year of 2012 marks the 40th anniversary since the World Heritage Convention was approved in 1972. In the past four decades, the number of world heritage sites in the Asia-Pacific region has skyrocketed. At the same time, in parallel to the rapidly developing economy and urbanization in the Asia-Pacific region, the world heritage preservation of these countries is facing new challenges that developed countries have never experienced. Such common problems include gradual loss of traditional skills, breakdown of community due to modernization and urbanization, lack of human resources, poverty, and pressure by commercial growth. Therefore, it is crucial for us to communicate and seek out appropriate solutions while finding a path for mutual improvement. Today is a fresh start. It is obvious that China is dealing with the decline of traditional craftspeople and their successors. Especially in some areas with an advanced economy, the number of traditional stonemasons and artisans is declining. The young generation is not willing to learn these skills. These talented craftspeople can only be found in underdeveloped areas. In my opinion, one of the most fundamental reasons is that there is a shortage of supportive policy to protect and transmit traditional skills. On the other hand, experts like us should further study how to improve old-fashioned talents as they attempt to meet the needs of modern society, and how to promote them for extensive use.

I hope this academic conference can be a new channel of communication and cooperation for regional heritage conservation. We can all share experiences and lessons from others presentations and ideas focusing on the theme of "Human Resources Development for the Transmission of Traditional Skills".

Last but not least, I would like to express my sincere appreciation to Mr. NISHIMURA Yasushi and his team for their efforts. I hope the conference will be a success and the cooperation between ACCU Nara and WHITRAP Shanghai will become closer and closer.

ZHOU Jian
Director
WHITRAP Shanghai

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I. Keynote Speeches

Tapping Stone and Brick: In Search of Traditional Skills and their Continuity (redefining traditions of heritage)

Gamini WIJESURIYA
Project Manager
ICCROM

Introduction

When speaking about traditional skills, the general trend is to refer to skills used by craftsmen to fix or deal with material. These skills are being considered useful by the conservation professionals in their work. The purpose of this paper is to offer a broader definition to traditional skills, which may encompass knowledge. I propose to discuss the traditional knowledge systems linked to brick and stone monuments as a useful tool for better understanding, and for the conservation of brick and stone monuments.

For this purpose, I plan to 'tap' the knowledge systems surrounding the brick and stone monuments. My conviction (or thesis if you wish) is that these monuments are broader than simply sources of traditional skills in their definition mentioned above. What I mean by traditional skills is not just the building techniques practiced by craftsmen but the compendium of knowledge systems including a variety of people involved in different functions from the time of their establishment. This compendium often include all elements of continuity (continuity of use, traditional systems etc.) that I will elaborate later. Understanding, application and transmission of traditional skills or the knowledge systems defined in this manner, in the end, become the responsibility of all those engaged in heritage conservation, which is also something I wish to highlight at the end of my presentation.

Heritage of Brick and Stone

Asia is undoubtedly one of the richest regions in heritage buildings made of stone and brick. Buddhist stupas built of brick in Sri Lanka to epic proportions (height going up to 400 feet) from the 2nd century BC are the largest brick structures built in the ancient world in terms of their scale and so are the gigantic monastic complexes surrounding them, now in ruins. According to the visiting Chinese Buddhist monk Fa Hishen, one such complex had 5,000 Buddhist monks in the 5th century AD and all of them were sheltered in edifices built mainly of brick. Further, an approximate assessment shows that Jetavana stupa constructed in the 3rd AD used 62 million ancient size bricks and Abhayagiri stupa built in the 1st BC has used 54 million bricks. Monastic complexes of Ayutthaya, in Thailand and Bagan in Myanmar or Polonnaruwa in Sri Lanka are some of the added testimonies to this grand tradition of building monastic buildings utilizing brick as the basic unit of construction.

Jetavana Stupa In Sri Lanka: 3rd century AD

Hindu temples in India, Buddhist/Hindu monuments in Cambodia and Buddhist monuments in Indonesia on the other hand were built mainly of stone, and have no parallels elsewhere in the world.

Angor Vat, Cambodia

Rock cut caves in Ajanta in India to those numerous grottos in China are unparallel manifestations of how our ancestors have elaborately carved natural rocks to create massive monastic complexes. Gigantic rock cut Buddha figures from Afghanistan to Sri Lanka to China are among the most magnificent sculptures ever created by mankind. So are the numerous sculptures and carvings associated with Hindu temples.

Buddha Statue from Sri Lanka: 6th century AD

Female Deity from Patna Museum, India

The questions we need to ask are: Are they only grand?; Beautiful?; Strong?; Old? Are they heaps of brick and stone only? Or are they manifestations of many facets of our cultures? This is what I wish to deliberate further.

Cultural Meaning

Classical written work of Stella Kramrisch intended to 'depict the Hindu temple as not merely a heap of brick, stone or wood but a visible symbol of aspirations of pious men and women, the throbbing of their hearts in religious fervor and their endeavors for the attainment of salvation'. The volumes highlight that the 'Hindu temple- its structure is rooted in vedic tradition, and primeval modes of building have contributed their shapes. The principles are given in the sacred books of India and structural rules in the treatise on architecture. . . . The purpose of the Hindu temple is shown by its form. It is the concrete symbol of Reintegration and coheres with the rhythm of the thought imaged in its carvings and laid out in its proportions. Their perfection is a celebration of all the rites enacted during the building of the temple, from the ground to its pinnacle. Nothing that is seen on the temple is left unsaid in the verbal tradition nor is any of the detail arbitrary or superfluous. Each has a definite place and is part of the whole'.

This indeed is a dazzling introduction to heritage under deliberation, in this seminar. Like the Hindu temples, gigantic stupas mentioned above are not mere heaps of bricks stacked one over the other, in millions. From whatever the origin, they have been developed to epic proportions representing the lord Buddha himself but more importantly depicting and symbolizing the Buddhist world view for the followers of Buddhism to be used and inspired.

Sculptures of Buddhist and Hindu traditions associated with these edifices numerously and in diverse scales out of stone (or built in brick in lesser numbers) are meant to symbolize and satisfy the spirituality of the followers. Coomaraswamy was right when he stressed: Buddha statues were made not because there was a demand for art but as an icon of worship.

Samadhi Buddha statue in Sri Lanka, created in the 6th century AD, is one of the finest sculptures where Buddhist iconography is concerned. Sri Javerhar Lal Nehru, when visited the sculpture not only had tears in his eyes but also considered it to be an eternal inspiration for him, which reflected the qualities of the Buddha. In his autobiography, he mentions that while in the Dehradun prison, whenever he was troubled or stressed, it was the reminder of this sculpture that brought him salvation.

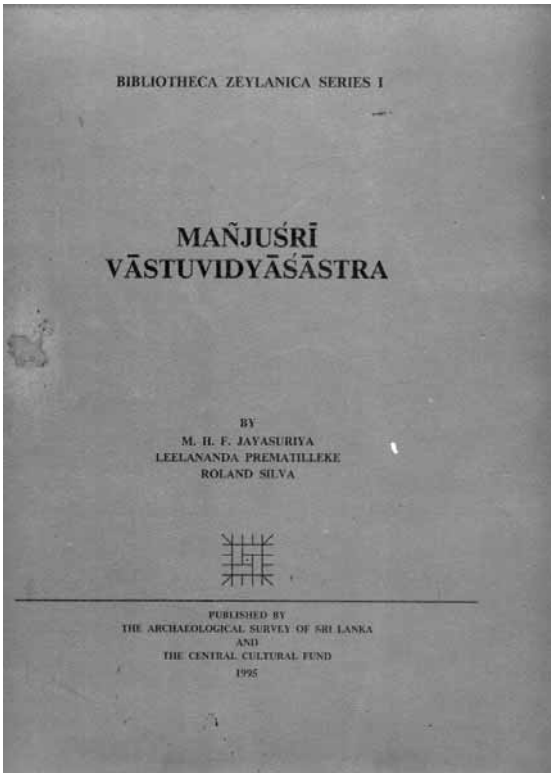
Deeply rooted meanings of the creations of brick and stone are reflected in every aspect of these edifices. The moonstone is the stepping stone to any religion edifice in Buddhist monastic complexes in Sri Lanka. Some of them are functional and are hardly with any decorations, while others are highly decorated. One would argue that the decorative elements are for mere aesthetic purposes, but others think that they symbolizes the cycle of life one has to pass through, to attain final salvation or nibbana.

Even the urinal stone from a meditation monastery of the 10th century in Sri Lanka that you see in the picture would have a deeper meaning than mere decoration.

The purpose of this quick overview was to show that these edifices are not just brick and stone as we the conservators often try to embrace, but manifestations of ingenuity of the people in skilful exploitation of the nature to depict their social or religious aspirations. Let me elaborate this further.

Knowledge

There were large knowledge systems that contributed to the creation of these edifices which I would like to highlight and bring to this discussion. They existed in diverse forms and were transmitted in oral traditions through generations. Later on, numerous silpa texts of Vastu sastra known as the science of architecture emerged. I would need a separate presentation of this nature to talk about numerous text books that are available in the region which guided the construction of not only monuments but also the villages, towns and even sculptures. To name a few, Visnudharamottara, Manasara, Mayamatha and Manjusri vastu vidya sastra.



Ancient text on architecture

These texts suggest the level of knowledge that should exist amongst those who were responsible for building these edifices and it is worth quoting here. “The architect of the temple was not only a master of the ‘ocean of the science of architecture’. Balanced himself in body and mind, he had to be versed in the

traditional science (sastra) in its various branches, and as much in the knowledge of rhythms, mathematics, and astronomy as in the conditions of different places, etc…The various arts and sciences had to be known for one and the same purpose, so that he could apply them in his work which was to be an image an reconstitution of the universe".

Indeed, the texts are very clear and harsh on unqualified persons. One text says 'he who begins to work as an architect without knowing the science of architecture and proud with false knowledge must be put to death by the King …'. It continues to say that 'he who is expert only in his workmanship, but unable to understand the meaning of the traditional science, will like a blind man be misled by anyone'.

The texts go further and say 'for immediate intuition, a readiness of judgment in contingencies, and ability to fuse them into the requirements of the whole, are the distinctions of a true architect… It is then, that the builder himself, once his work is completed, is struck with wonder and exclaims: 'Oh how was it that I built it'. Isn't it the same feeling that we have today when we see these creations?

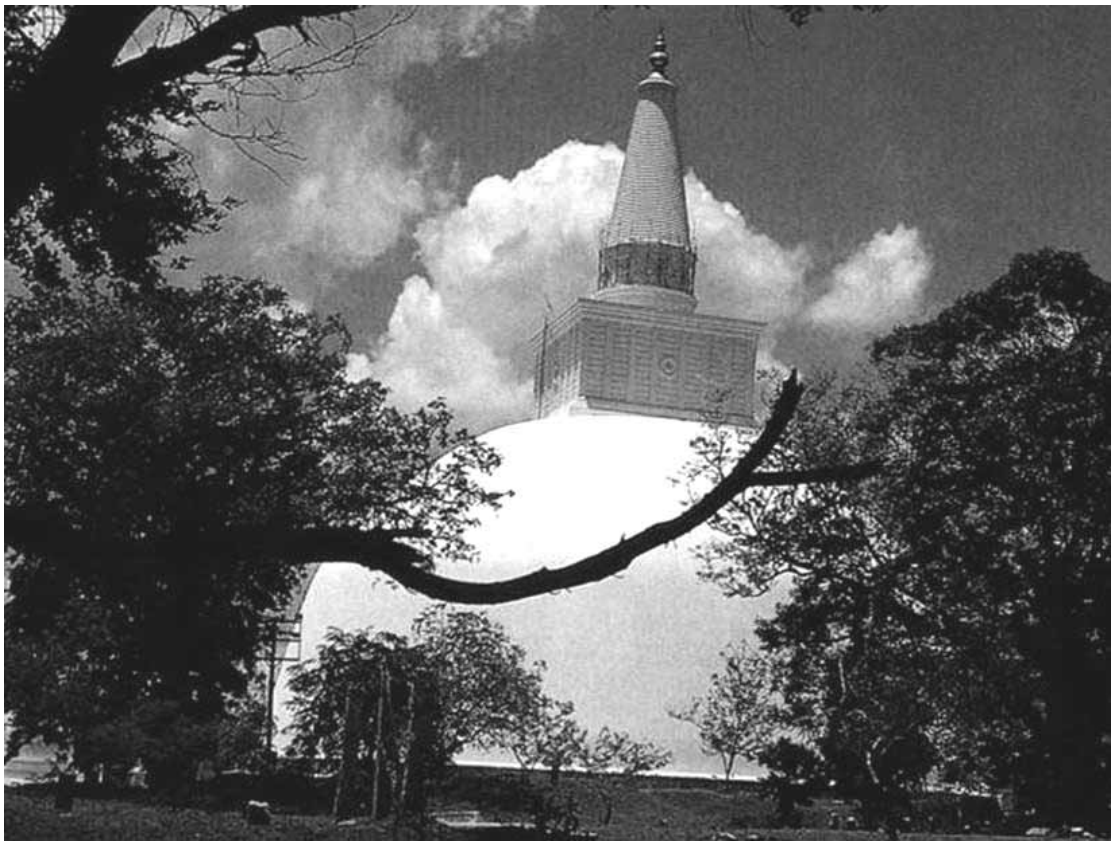
These texts also provide numerous technical details and even minute details such as making quality bricks. Mayamatha for instance, describes of methods to make quality bricks.

> 'instructs that soil free from gravel, stones, roots, bones and clods should be selected, having fine sand, of uniform colour and pleasant to touch. First one should throw a lump of earth into knee-deep water, and then stir and knead it repeatedly forty times with one's feet. One should wet it with waters of Ksira (pine), Kadamba, Amra (Mango) and Abhayaksa tree bark and the water of the 3 fruits (Amalaka= emblic myrobalan, Bahela and Haritaka) and go on kneading it for a month.
> ……..
> The bricks must be freshly made and all other building materials too must be hewn or quarried in due time, and used exclusively for the building for which they are destined'.

Such is the level of sophisticated knowledge and experience that have gone into the creations of these edifices and associated elements. The existence of edifices under discussion in this seminar which are in perfect condition even after thousands of years, is witness to this.

We have many examples to prove the existence of such deep rooted and detailed knowledge. Let me give you several examples.

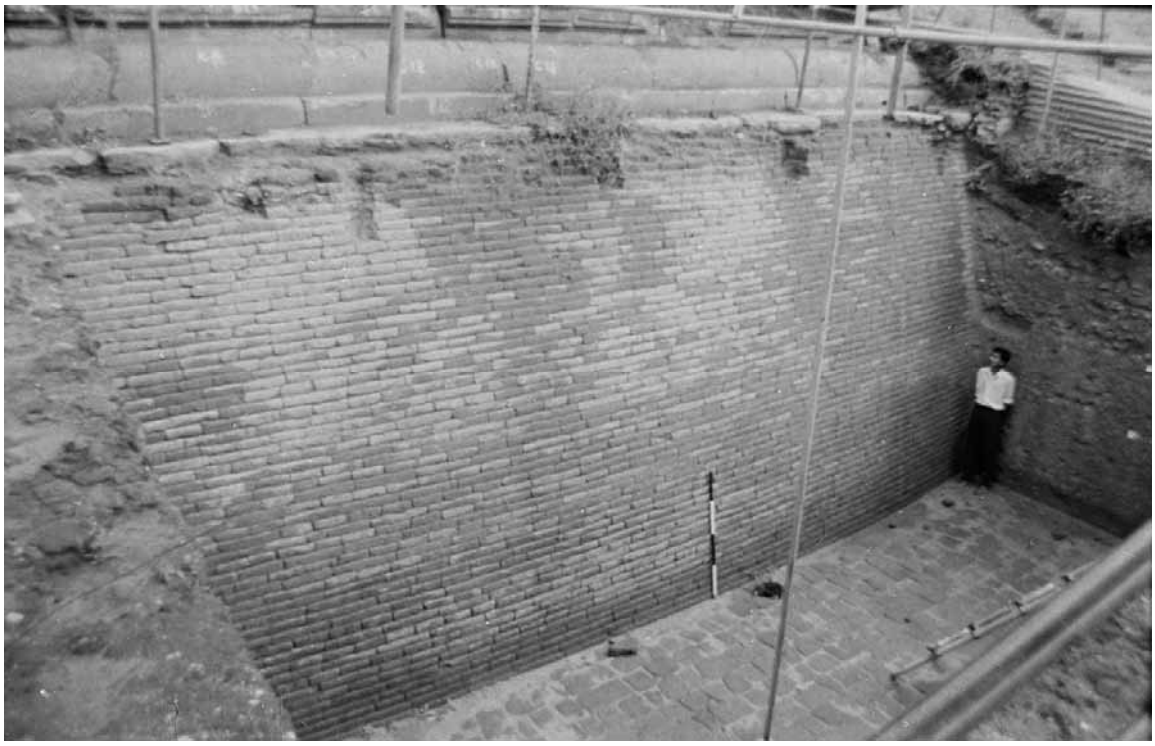
Vinayapitaka, Buddhist text on discipline, provides a fascinating prescription of the cankamanaghara or the meditation hall. Archaeological remains prove beyond doubt as to why such prescriptions are necessary for the building and functioning of them properly and also to sustain against conditions of the surroundings and weather.



Mahathupa, Sri Lanka: origin 1st BC

When the King of Sri Lanka in the first century BC had the desire to build a stupa, he consulted a priest who himself was the architect, according to the Mahavamsa, the great chronicle of Sri Lanka. He provided the form and shape of the stupa and much more advice. Mahavamsa provides a beautiful description of how the King selected a contractor for making bricks for the stupa through public announcement. The contract was awarded to the one who described the way to achieve the best quality product. It required at least 40 million bricks at that time and the importance attached to the quality of bricks receiving the royal attention is therefore not surprising. In order to hold such a huge mass of bricks, the King and the builders understood the importance of the foundations and it is in this context that we can still read how they prepared the foundation. The King 'had the place for the stupa dug out to a depth of seven cubits (16 feet) to make it firm in every way. Round stones that he commanded his soldiers to bring hither did he caused to be broken with hammers, … command that the crushed stone, to make the ground firmer, he stamped down by great elephants whose feet were bound with leather'.

I have no better example than the details of the excavated foundation of the largest stupa in Sri Lanka which is Jetavana, projecting up to 400 feet. Excavations revealed (see the picture below) that even the bottom most layers of brick carrying 62 million for over 2,000 years is in perfect conditions. Builders knew the strength required on the bottom most layers of brick in order not to be crushed under self load carrying millions of them.



Foundation of Jetavana stupa

I believe, our colleagues from Angkor will provide fascinating examples of knowledge on stone work as depicted in carvings.

Sculpture from Angkor depicting stone work

Knowledge for Care

Books dedicated to science of building contain chapters on principles of continuous care of heritage. In addition, chronicles and inscriptions provide numerous references on attempts to care and maintain heritage. Whether this is the same conservation we talk about today can be a doubt for some, but I will not open that discussion now. A closer look at some of the principles reveals that they in fact are quite comparable to what we have been advocating today, if not advanced, in some cases.

Literary sources reveal all types of terminology to suit different interventions and some of them are as follows from Pali and Sanskrit literature:

- '***patisankharam***' – Restortaion
- '***puna karayi'-*** '**renovation'** of a section to its original form
- '***navakamma***'- '**replaced anew'**
- '***pinnasankari'*** and '***navamkamankaryi***' as **'replacing sections that have been decayed'**
- '***parkathika***"- **'replacement of unit as it was previously'**

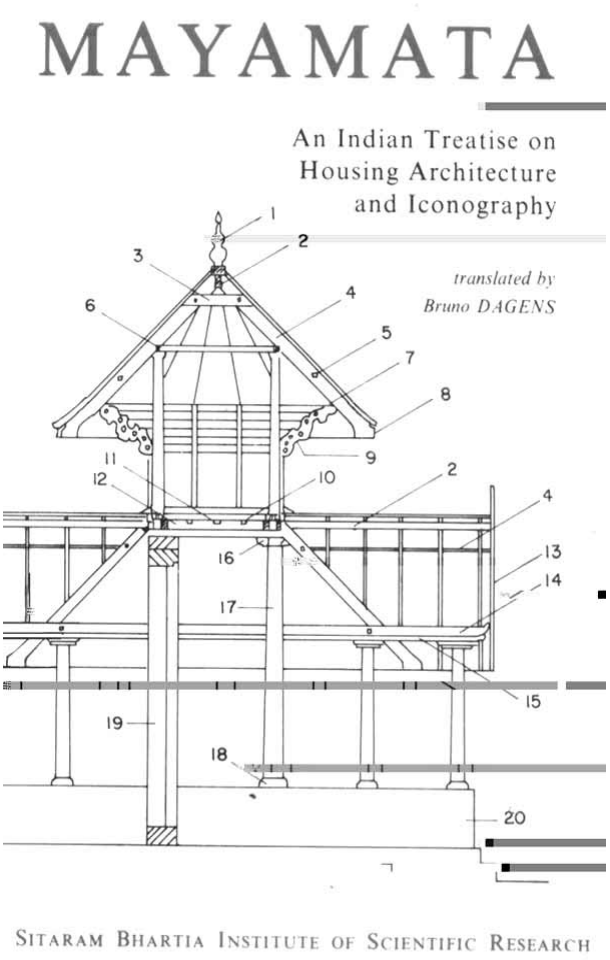
Mayamatha has devoted one chapter for renewal work. These are also to be guided by the wise men and those who have specialized knowledge on care. What appears below is an excerpt from the chapter:

Those (temples) whose characteristics are still perceptible in their principal and secondary elements (are to be renovated) with their own materials.

If they are lacking in anything or have some similar type of flaw, the sage wishing to restore them, (must proceed in such a way that) they regain their integrity and that they are pleasantly arranged (anew);

this (is to be done) with the dimensions - height and width – which were theirs, with decorations consisting of corner, elongated and other aedicule, without anything being added (to what originally existed)

and always in conformity with the advice of the knowledgeable



A 12th century inscription in Sri Lanka refers to an officer assigned by the royalty in charge of restoration:

> "Thereafter he (the King) placed in charge 'Loke Arakmena'… he gave him unlimited wealth and.. and thus beautified the city as it was in former time, like the city of gods".

The post of the officer 'Loke Arakmena' has been translated as 'Chief Conservator of Monuments' in present day context.

The high level of respect and regard shown to the skilled men are clearly explained in this 9th century inscription from Sri Lanka. For the masons and carpenters in charge of temple renewal, there had been a separate village set apart.

- **[There shall be] clever stone-cutters and skilful carpenters in the village devoted to the work of [temple] renewal.**
- **They all… shall be experts in their [respective] work.**
- **….shall be granted to the officer who superintends work.**
- **…his respective duties, shall be recorded in the register.**
- **…….they alone shall be answerable for its correctness.**
- **The limit [of time] for the completion of work is two months and five days.**
- **Blame [shall be attributed to] … who do not perform it according to arrangement.**

The stone column you see in the picture (which are in large numbers) is the evidence of grants given to monasteries at the time of their establishment for their continuous maintenance. Grants are mainly land which generates income and were exempted from taxes etc.

With such a vast knowledge about construction and also continuous care of heritage, the next natural question is who in fact were these builders who indeed were geniuses?

Skilled People

The knowledge and skills described above are inextricably linked to a group of people who were responsible for creating these edifices and indeed are an integral part of the heritage. According to ancient texts in Hindu traditions, the work of these edifices is a collective effort guided by priests. Here we need to recognize the significant role played by religious leaders in shaping this knowledge and providing the metaphysical foundation to build these edifices. The priest would be supported by the architect (sthapati) whose

qualifications I have mentioned above. . Architects followed this guidance and were not only familiar with the religious knowledge but also the science of building. Disciple or son of Sthapati, competent in their work is known as Sutragrahin. Also mentioned is taksaka who is an expert in cuttings and carvings. There may also be a Vardhakin who gives the final touches to the work of the above. Of course there are many variations and no conformity between the texts, but the important thing to note is the fact that the building and long-term care of these edifices were a collective effort. All their knowledge and skills were gained through contemporary scientific understanding or through trial and error. It is this group who were finally responsible for guiding the creation of these magnificent edifices.

The varieties of people involved are depicted in numerous texts, one such reference is as follows: 'The king ordered the building of the city of Yapahu Nuvara was begun on the rock called Sundaragiriparvata, after which the city was named. That king commanded that it should be constructed of stone only, and the following workman should be engaged: 120 lacs of masons, 100 chief blacksmiths, 250 hangidi (foremen), 3,000 painters 400 carvers….'

These were people well versed in knowledge, required skills and dedication to their work. One Indian text enjoins meditation upon the sculpture 'In order that form of an image may be brought fully and clearly before the mind, the imager should meditate; and his success will be proportionate to his meditation. No other way- not indeed seeing the object itself- will achieve his purpose'. This explains the level of spirituality that they are engaged in while working in addition to possessing the required competencies. The reference in the above quoted inscription that 'they shall be experts in their respective work' further proves this.

This particular reference, I have quoted from Coomaraswamy, suggests the level of respect and appreciation placed on the craftsmen who were engaged in making statues. 'The sound of the tools that are raising the image of Buddha, let it reverberate in Heaven' by Empress Komyo of Japan.

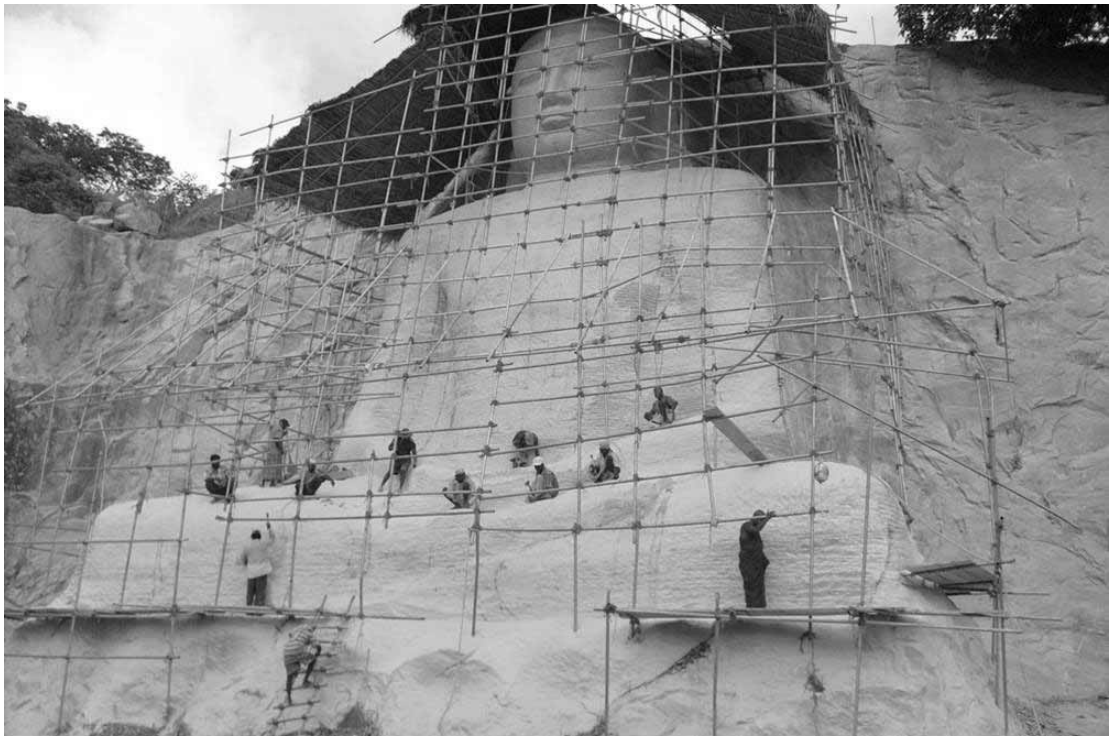
It was also out of respect for the workman, that the King who commissioned the Mahathupa of Sri Lanka in the 1st century ordered that the 'Work shall not be done without wages...'

In the recent past, when the temple of the Tooth Relic of the Buddha in Sri Lanka (a World Heritage site) was bombed by terrorists which led to the destruction of a large number of decorative elements made out of stone, finding skilled men for making replicas was one of the major challenges. Importing skilled men from India was considered as an option but vehemently opposed by the monk community, who considered, skills and the people with knowledge were a part of the heritage. I had the task of searching for families who still retained the skills to make necessary replicas of the damaged sculptures. A thorough countrywide search made us realise that skilled people have almost disappeared but fortunately were able to trace a smaller number of families who could help. After testing their skills through making samples, we were able to revive the tradition and make replicas of the destroyed stone elements.

There is another aspect to this heritage which is 'continuity', relevant to my discussion.

Continuity

Above all, much of this heritage still continues to perform original functions for which they were established, and also plays a major role in the lives of the contemporary society. This is why we identify them as living heritage. While some of this heritage is being used for the religious purposes, others are being celebrated. Associated traditions, festivals, rituals are being continued to this day. Some places continue to maintain skills and mange them in their own traditional way. We also have to recognize that this type of heritage is still being created utilizing the traditional knowledge systems.



New Sculptures being made in Sri Lanka

When the continuity of the original function occurs in a heritage place, there are three other interrelated aspects of continuity: continuity of the connected community, continuity of the traditions and continuity of tangible and intangible expressions. We cannot separate these from most of our heritage, although there is always a tendency among the conservation community to disassociate from this important point and focus only on the material aspects. While this may also largely depend on the local and national socio-political context, it is important for us to engage in studying these aspects if we are to understand these places better. For instance, continuity of traditions and traditional management systems will be an important aspect we need to recognize in our effort to better conserve and manage heritage.

Concern for continuity was one of the key elements missing in the conventional conservation approach. Indeed, it believes that the traditional continuity between the past and the present is always broken, and that

heritage can be frozen in space and time. This is based on many assumptions and also on the basis that time is considered as liner in the western world though it is not universal. Indeed, even strong advocates of the conventional conservation approach, such as Paul Philippot agreed that continuity is an important factor in some instances and such heritage needs new definitions. This was a subject of a long inquiry of ICCROM and there is ongoing debate for a new definition for heritage in which continuity is a dominant character.

Human resources development

In terms of developing human resources on traditional skills, thinking of craftsmen would not be sufficient. This is where we now talk about capacity development which focuses on: strengthening the ability of larger and changing audiences and considering 'knowledge acquisition' instead of 'knowledge transfer' while taking into account new learning environments for more effective conservation of heritage. In this context, we need to understand where the capacity resides and the respective audiences, as given below;

Where capacities reside	Associated audiences
Practitioners	Those with direct responsibilities for heritage
Institutions	Decision-and-policy-makers
Communities & networks	All those who have a legitimate interest in heritage

We have to identify tasks related to different audiences in propagating the importance, recognition and implementing issues related to traditional skills. Linking with communities could be a very useful approach in this process.

Conclusions

In conclusion, I would like to stress that traditional skills should not be looked at or considered in isolation from all the aspects mentioned above. Traditional skills should be considered as the sum of all knowledge, skills and people that have contributed to the final results that we see as heritage today, reflected in both tangible and intangible forms. It also includes all elements related to continuity mentioned above. This would mean that traditional skills as defined above should form an integral part of the entire conservation disclosure at appropriate levels. For this, new research, changes of attitudes, new procedures will be required. Ideally, it is through this that we have to address the issues of human resource development.

Let's reflect what we have done so far as a profession?

- We ignored the traditional approaches as not part of the modern discourse.
- We develop principles, ethics and education for professionals, ignoring other players and the knowledge systems.
- How many charters make reference to traditional skills?

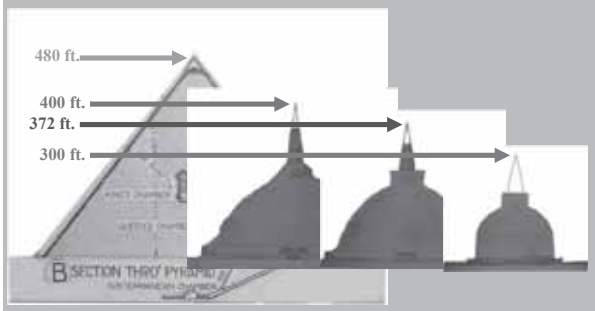
Is it now the right time to rethink?

While recognizing that we have a challenging task, if we are to develop human resources to promote transmission of traditional skills, I am optimistic. Many countries particularly in this region as we would hear from presentations, will bring to light many examples that would strengthen our effort to develop Human Resources for the Transmission of Traditional Skills.

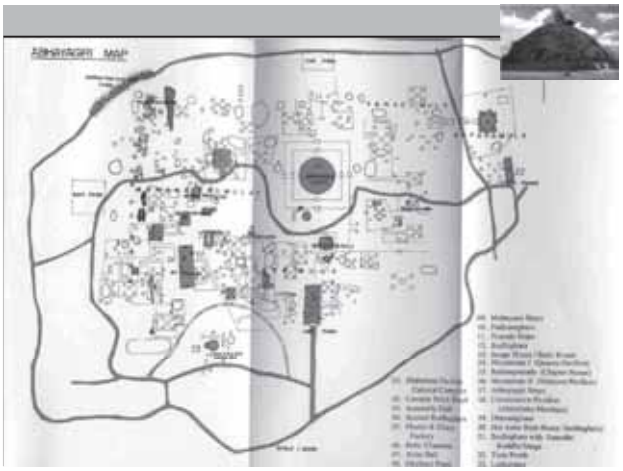
Seminar on "Human Resources Development for the Transmission of Traditional Skills: National Approaches and their Application to Stone and Brick
Shanghai Dec. 2011

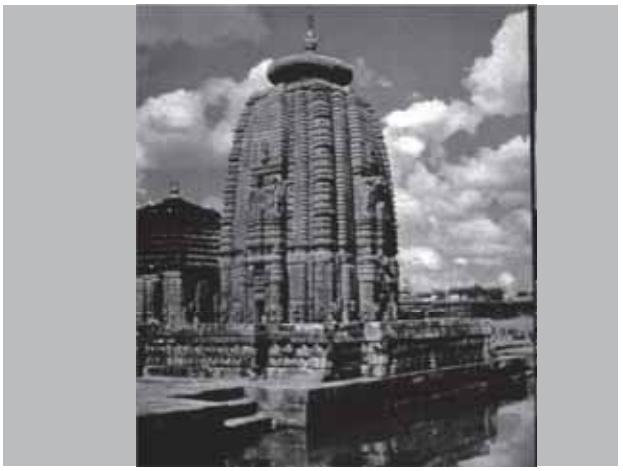
Tapping Stone and Brick: In search of Traditional Skills and their Continuity
(redefining traditions of heritage)

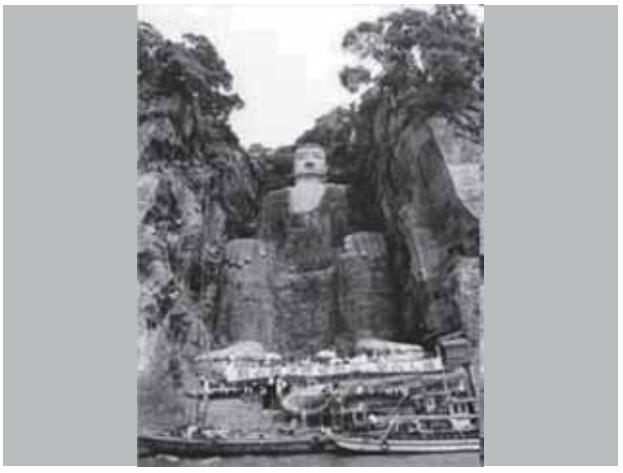
Gamini Wijesuriya
ICCROM

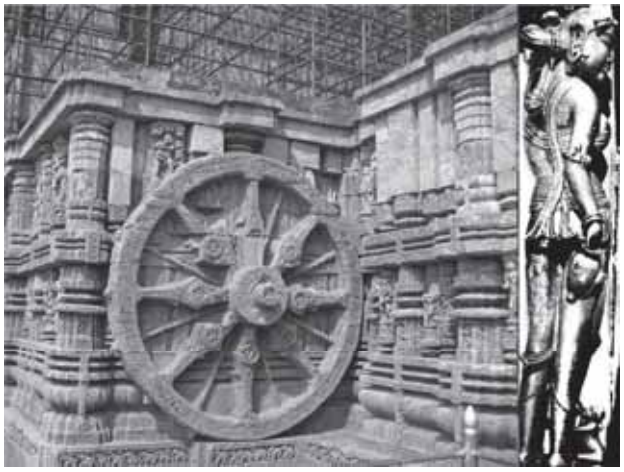


The Three Major Stupas at Anuradhapura in relation to the largest of the Three Pyramids of Egypt









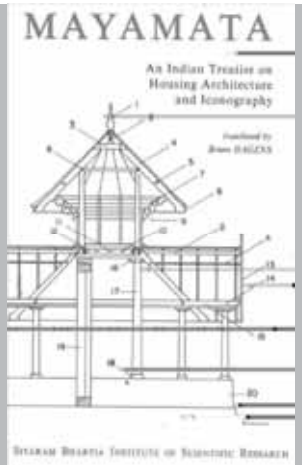
Symbols

Symbols

- Hindu temple as not merely a heap of brick, stone or wood but a visible symbol of aspirations of pious men and women, the throbbing of their hearts in religious fervor and their endeavors for the attainment of salvation'

Coomaraswamy

- "Buddha statues were made not because there was a demand for art but because there was a need of an icon to worship"



Architect

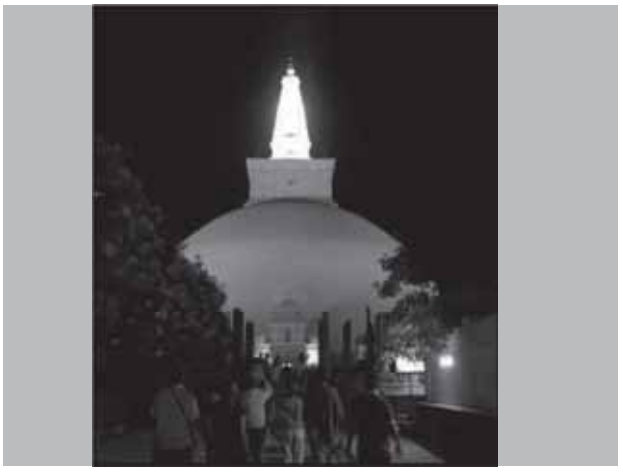
- '…The architect of the temple was not only a master of the 'ocean of the science of architecture'. Balanced himself in body and mind, he had to be versed in the traditional science (sastra) in its various branches, and as much in the knowledge of rhythms, mathematics, and astronomy as in the conditions of different places, etc…The various arts and sciences had to be known for one and the same purpose, so that he could apply them in his work which was to be an image an reconstitution of the universe.'

Brick making

- ' instructs that soil free from gravel, stones, roots, bones and clods should be selected, having fine sand, of uniform colour and pleasant to touch. First one should throw a lump of earth into knee-deep water, and then stir and knead it repeatedly forty times with one's feet. …….
- The bricks must be freshly made and all other building materials too must be hewn or quarried in due time, and used exclusively for the building for which they are destined'.

Cankamana- Walking meditation

- Avoid
  - Hard and uneven surface
  - Trees inside
  - Covered by thicket
  - Too narrow
  - Too wide…….when one walks on a cankamana which is too wide , one's mind roams about, one does not obtain concentreation.
- Have
  - a roof over….
- Build
  - Slightly above ground



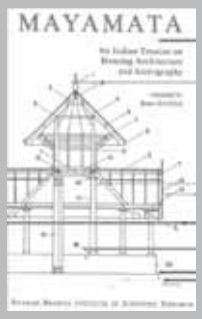
- The King ' had the place for the stupa dug out to a depth of seven cubits (16 feet) to make it firm in every way. Round stones that he commanded his soldiers to bring hither did he caused to be broken with hammers, … command that the crushed stone, to make the ground firmer, he stamped down by great elephants whose feet were bound with leather'.

– '***patisankharam***' – Restortaion
– '***puna karayi'-*** '**renovation'** of a section to its original form
– '***navakamma***'- '**replaced anew'**
– '***pinnasankari***' and '***navamkamankaryi***' as **'replacing sections that have been decayed'**
– '***parkathika***"- **'replacement of unit as it was previously'**

Conservation principles

Those (temples) whose characteristics are still perceptible in their principal and secondary elements (are to be renovated) with their own materials, regain their integrity, with the dimensions - height and width – without anything being added (to what originally existed)

always in conformity with the advice of the knowledgeable



- 12th century inscription:
- ' Thereafter he (the King) placed in charge 'Loke Arakmena'…….he gave him unlimited wealth and.. and thus beautified the city as it was in former time, like the city of gods' (Ez Vol.11, 83).
- The post of the officer 'Loke Arakmena' has been translated as 'Chief Conservator of Monuments' in present day context.

Traditional Conservation

9TH AD INSCRIPTION

- **[There shall be] clever stone-cutters and skilful carpenters in the village devoted to the work of [temple] renewal.**
- **They all… shall be experts in their [respective] work.**
- **….shall be granted to the officer who superintends work.**
- **…his respective duties, shall be recorded in the register.**
- **…….they alone shall be answerable for its correctness.**
- **The limit [of time] for the completion of work is two months and five days.**
- **Blame [shall be attributed to] … who do not perform it according to arrangement.**

- **Donation of a property for the maintenance of a newly built monastery**
- To the villages, royal officers and irrigation officers shall not enter. Those of the archery department, the tax officers (melassi), headmen in charge of districts and of provinces shall not enter. The employees at the two offices, deruvana, perelaki (function not known), archers, guards, and those of the paid services shall not enter. Carts, oxen, labourers, imposts of cooked and raw rice, and periodical gifts of milk and oil should not be taken..... having forbidden the entry of the aforesaid persons, we, two of us (the two officers who planted the pillar), have given to these villages the immunities (sanctioned by) the Council. (Ez Vol.3, 105).

The team

- According to ancient texts in Hindu traditions, the work of these edifices is a collective effort
  - guided by Priests
  - supported by the architect (Sthapati)
  - disciple or son of Sthapati, competent in their work is known as Sutragrahin.
  - taksaka who is an expert in cuttings and carvings.
  - Vardhakin who gives the final touches to the work of the above.

- 'In order that form of an image may be brought fully and clearly before the mind, the imager should meditate; and his success will be proportionate to his meditation. No other way- not indeed seeing the object itself- will achieve his purpose'.

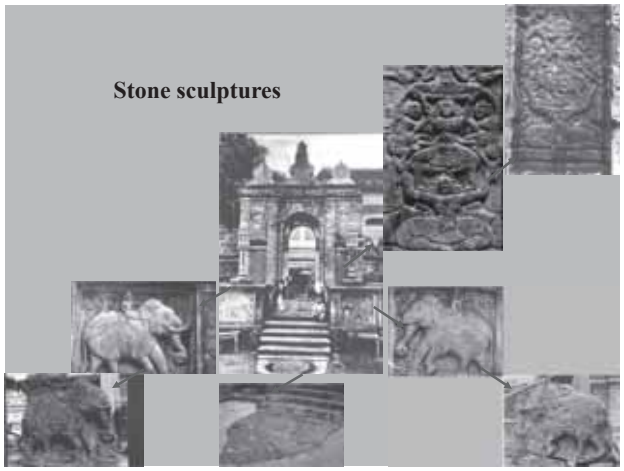
- 'The sound of the tools that are raising the image of Buddha, let it reverberate in Heaven'
  - Empress Komio of Japan.

- 'Work shall not be done without wages….'
  - King of Sri Lanka (1st century BC)

Temple of the Tooth Relic

January 1998

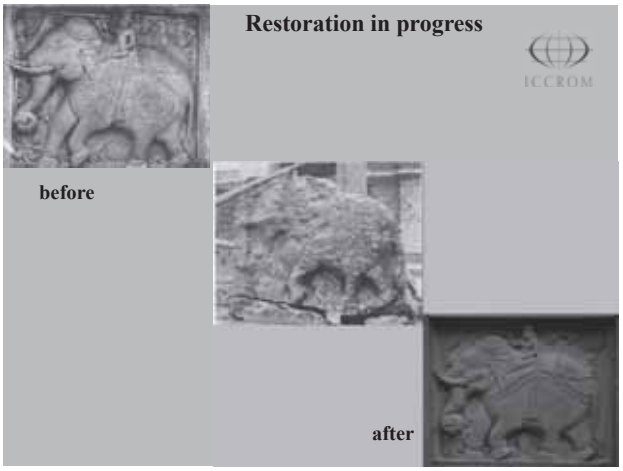
Stone sculptures



Restoration in progress

ICCROM

before



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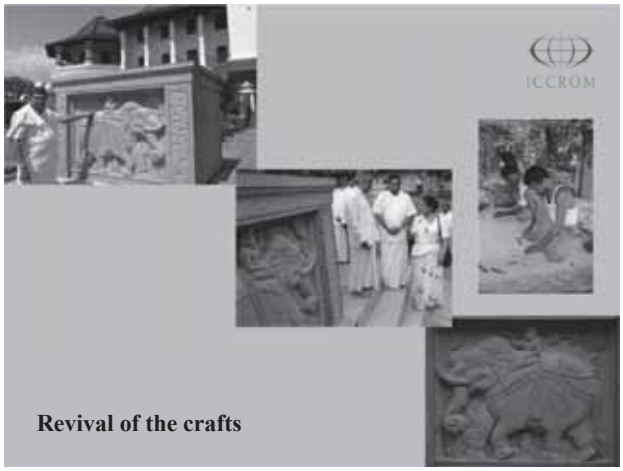
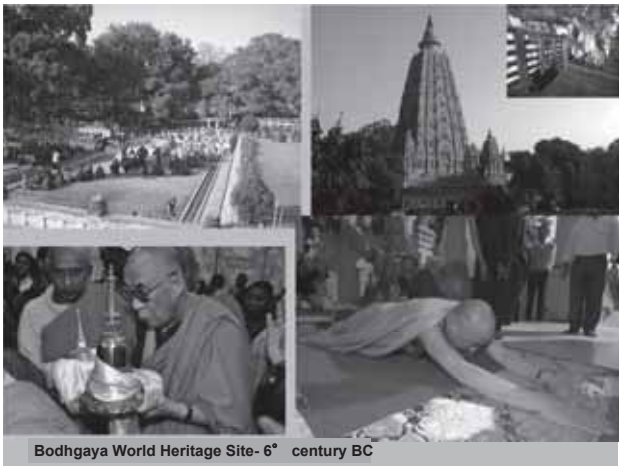
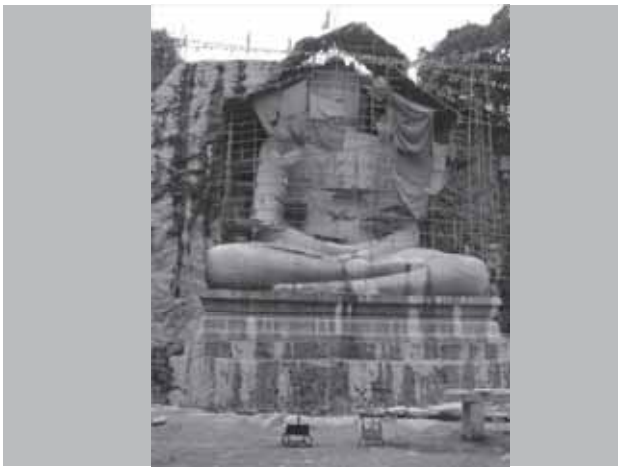
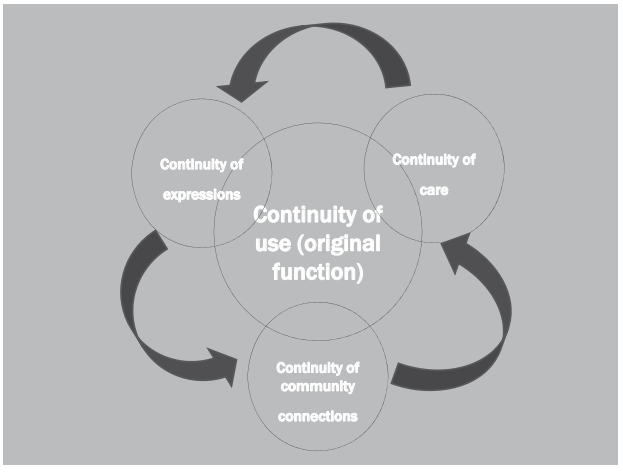



Bodhgaya World Heritage Site- 6° century BC





- Need for a new definition
- "a concern for the conservation of the particular values of a historically transmitted and still living milieu… indeed requires a new definition of the object to be restored; this definition will have to be broader and more comprehensive than the traditional one." Paul Philippot

Where capacities reside:	*Associated Audiences*
Practitioners	Those with direct responsibilities for heritage
Institutions	Decision-and policy-makers
Communities & networks	All those who have a legitimate interest in heritage

Introduction to Ancient Brick and Stone Buildings and its Conservation Restoration in China

HOU Weidong
Vice-Director / Chief Engineer
Chinese Academy of Cultural Heritage

Outline

PART ONE
Remains and Categories of Ancient Stone and Brick Buildings in China

1.1 History and Categories of Ancient Stone and Brick Buildings in China.

1. History of Brick Structures

Brick and tile are one of the earliest artificial building materials, which had been used as floor covering since the Western Zhou Dynasty. Stone and brick buildings are significant components of ancient buildings in China, and the Development and decline of them were connected closely. Stone and brick buildings, being discussed here, are buildings and constructions built with certain structures, not including grotto temples and carvings with natural stone by Chinese ancients. Although many Chinese Grotto Temples did imitate wooden architecture form, their spatial principles (excavating space in rocks) are opposite to artificial construction space (constructing boundary and outline for existing space), so grotto temples are creating spaces while buildings are constructing entities. As we are talking about the physical buildings, the limits of discussion are defined in stone and brick buildings with structures and constructions. Stone and brick have a long history in China and the Chinese word QINZHUAN HANWA, which means the bricks in Qin Dynasty and tiles in Han Dynasty is one type of the adjectives to describe historic buildings.

The predecessor to brick is pottery which is calcined with clay and has a history of over 6000 years. The history of clay bricks and tiles (about 3000 years) is shorter than containers, so there is plenty of pottery in the field of architecture in the Spring and Autumn Period and the Warring States Period, such as clay channels, hollow bricks decorating the ground and wall, tile roof used in significant buildings. During that time, pottery products are rare and precious.

Using tiles on the roof can be seen in the sectional tile types, at the sites of the Epang Palace in Qin Dynasty and the entire roofs of residential sites at Sanyang village (Anyang City, Henan Province) in Han Dynasty.

The earliest example of brick wall dates back to the Warring States period, the face of the smelting ventilated well in Xinzheng Town, Henan province.

The function of standard clay narrow brick broadened in Han Dynasty, such as at the bottom of buildings, Lining walls of well, channel and graves. The Graves remaining until now are mostly built with brick, with Corbelled Arches and Arches had being used adroitly.

There had been plenty of brick buildings and constructions during Wei, Jin and the Southern and Northern Dynasties, including brick stupas and graves such as the Songyue Pagoda and the Yongling Mausoleum.

Brick buildings have increased significantly since Tang and Song Dynasties. Besides the original wooden pagodas which were converted to brick pagodas, the key position of main circumvallation for urban defense was built using bricks as well. As a result, the production and use of bricks in Ming Dynasty were more general, not only in palaces and mansions, but also in common residences, whereas the most general use should be the circumvallation as seen in the Great Wall or enceinte.

2. Categories of ancient brick structure buildings

The ancient brick buildings in China can be divided into brick graves, brick pagodas, brick circumvallation, brick arch bridges, brick caves, brick palaces without beams, etc, according to functions.

They can also been divided into beam slab structures, arch structures, fornix structures, narrow brick structures, etc., according to structural forms.

Applying hollow brick as beam columns and decorated with carving or paintings, the beam slab structure was usually used at the gates of graves, such as a large number of graves with painted bricks in Northern Shaanxi.

The arch structure was usually applied at the tops of graves and used as a circular arch. There were also corbelled arches which were built with layers of narrow bricks overhanging and it could be changed to fornix top.

Narrow brick structures were applied widely in walls of buildings, bodies of pagodas and circumvallation. Several of them are brick cylindrical structures, such as the brick walls of wells. The brick pagoda is the key symbol for the technical development of Chinese historical architecture.

Reviewing the development of brick structures, there are two peaks.

Han dynasty: Different building methods of brick walls came into being, the certain scales of bricks appeared and the top structures had been made as well.

Ming dynasty: Brick making technology developed, brick building skill advanced and mortar was used widely.

1.2 History and Categories of Stone Buildings.

Stone building, which refers to certain structures built with stone, is a component of ancient Chinese buildings.

Categories

Stone graves: A great amount of stone graves were built in Tang Dynasty with stone walls and roofs and even decorations. The materials and structures of these stone graves were solid and resistant.

Stone constructions: There are few structures in China built with stone exclusively. Except for several stone pagodas, most stone buildings are palaces with limited rooms or structures like stone Jing Chuang, monumental archways, Screen walls and Ornamental Pillars, which were built with certain structures and can be counted as one category of Chinese stone buildings.

Large-scale stone constructions:

Bridges: there are a variety of stone bridges in China, including stone arch bridges and large stone girder bridges.

The Stone Sea wall, which is a great project stretching hundreds of kilometers in China for the sake of the people's well-being, was built with a regular boulder strip in Ming and Qing Dynasties to protect farmland from back-flow tide.

The histories of stone and brick buildings are roughly the same and their developments are almost synchronous.

PART TWO

The Conservation and Restoration of Historic Buildings in China

2.1 The Damage Types of Stone and brick Buildings.

Environmental damage: earthquake, geohydrologic environment
Structural damage: stone buildings
Material damage

1. Damaging factors of the environment.

Every construction is exposed to its environment and has suffered from certain geological hazards such as earthquakes, long-term immersion, Landslides, cracks, subsidence, etc. In recent years, not only had the frequent earthquakes brought about huge damage to human life and economy, but it had lead to the destruction of cultural heritage. During the Wenchuan earthquake, the stone pagoda was a type of

construction receiving serious damage. The vulnerability of stone and brick buildings is much greater compared to wooden buildings during earthquakes. (collapse, cracking, frangibility, etc.)

Surface floods and groundwater are also major factors influencing stone buildings. Long-term and short-term immersion affects stone and brick building themselves and their foundations. For underground constructions like stone and brick graves, flow on their bodies caused by long-term leaching water will damage the structures of stone materials.

Geological hazards (landslides, large scale ground subsidence, ground fissure, etc.) can also damage carriers of stone and brick buildings, resulting in their destruction. Take the historic buildings on seismic belt in Xi'an for example: their walls and foundations had suffered varying degrees of cracking. Some subsidence even threatens the survival of the stone and brick buildings directly. For instance, several historic buildings in China had to be moved as a result of landslides caused by precipitation recently.

2. Damaging factors of stone and brick structure.

When stone and brick buildings work as the structure, it also faces other problems: It needs to handle pressure, bending moment and shear force as a supporting object, and when this structure has a certain height, it faces stability problems.

Stone and brick structures have two kinds of stresses: One is the vertical stress such as columns, piers, tables, walls, etc; the other is transverse stress by arch, corbel, beam, etc. The object under vertical stresses may disintegrate and collapse once overloaded or bent, and the object with transverse stress may disintegrate as well.

3. Damaging factors of stone and brick materials

The material is prone to deterioration and air slaking in the air. The geometric brick which is a result of the shaping and calcining of clay is also an oxidation process of raw soil under high temperatures. Chinese brick has experienced another step--- quenching, so it is called black brick. The producing process of early Chinese brick is quite meticulous, including the choice of soil, watering, shaping，airing, calcining and quenching, so the brick is smooth and endurable. It can be seen from the bricks excavated from the graves of the Han Dynasty which still have a good appearance and texture. For brick materials, the deteriorating process is inevitable and its strength will decline as well.

In addition to natural deterioration, the damage of brick materials is due to the following reasons:

Load: Long-term load will damage the structure of the brick itself. For instance, a brick pagoda with thousands of years of history can exist for a long time without interference, but once it is touched, it may break easily.

Moisture movement: Moisture can dissolve minerals and salt in different extents and carry them out as moving in the brick, which can damage the components of molecules in brick.

Freezing and thawing process: When entering the brick material, water molecules are converted to crystal and inflate. This process will damage the structures of soil molecules and the brick will become fragile.

As the stone is a completely natural material, its strength and compactness are higher than the artificial materials, so the deterioration process turns out to be slow. At the same time, there is a great deal of difference among the stone materials, so their damage factors are not exactly same. Usually, stone components have two kinds of patterns, dressed stone (being manually crafted) and cobblestone or schist (keeping the natural form). These two both can be used as buildings and structures: The dressed stone are used to build exterior walls and the cobblestone or schist can be used to construct slope protection and other structures. Of course, there are also stone components like columns, Girders, the foundation stones, doors ,windows and roofing, most of which become artwork in buildings and have to be preserved properly.

Damage of stone components is similar to clay brick, just differing in extents.

2.2 Preserving and Restoring Methods of Stone and Brick Structures.

1. The Treatment of Environmental Damage

The first thing that should be taken into account is the potential natural disaster such as the earthquake or the mountain torrent which cannot be controlled by humans and have to be prevented and prepared to conceivable extent.

The geological disaster can be reinforced using anchoring methods to prevent and treat landslides. The impact to groundwater can be adjusted as well.

2. Reinforcement and restoration of masonry

Crack: For cracked masonry, the first thing should be confirmed is whether the crack is still continuing. And if it is continuing, we have to find out the reason and deal with it. Generally speaking, if the crack is small (less than 10 mm), it can be treated with partial grouting. And if it is too large, reinforcing bricks are needed.

Hollowing: Hollow parts of the masonry should been reinforced by grouting and removing according to its causes.

Incline: For inclined stone and brick structure, the foundation should be surveyed firstly and then treated if there is sedimentation. After the stabilizing measure of foundation, the stability and basic impression of structure should be checked. If it is mostly stable and has little impact on the architectural form visually, it can maintain status-quo, and if it is not, some rectification measures can be taken.

Fragility: It is caused mainly by strong external forces or long-term over-loading. The bond between the bricks and stones is weak and the overall strength is declining, leading to insufficiency of bearing capacity. In this case the overall structure should be reinforced by grouting.

Partial damage: The damaged parts of stone and brick bodies should been restored depending on circumstances with raw materials and crafts in principle and the location of patches should be labeled.

Besides the reinforcement of stone and brick buildings, new structures can be added as well through structural strengthening methods, buttress strengthening methods, unbounded steel-encasing strengthening methods, carboform strengthening methods and strengthening methods with pre-stressed bracing bars.

The other key element of masonry is the mortar material.

Stone and brick buildings have different practices in different periods. Mortar was not used to build masonries until the Tang and Song Dynasties (Yellow slurry was used widely at that time), and lime mortar had been used since the Ming Dynasty. There were several kinds of mortar developed from lime mortar, such as sticky rice mortar, brown sugar mortar and putty mortar, which are components of historic buildings. The conservation of these mortars has two meanings, including the mortar itself and its cohesive function. The study of mortar of traditional stone and brick buildings is presently underway. In principle, the use of original mortar is advocated, but modest reform can be accepted as well and it may fit the stone and brick buildings better in some cases.

4. External Weathering of Stone and Brick Materials

The chemical strengthening method is usually used to treat the External weathering of stone and brick materials.

PART THREE

Case Study of Conservation and Restoration

3.1 Environmental Improvement

1. Post-quake foundation stabilization for buildings in Wenchuan of Sichuan Province

Hillside stabilization for Mt Erwang in Doujiang Weir

2. Ground and foundation sinking caused by changes in the surrounding environment

Wenchang Pavilion, which was built in Bianliang in Northern Song Dynasty, has been 2.5 meters below its surroundings on account of the rise of the surrounding ground. To solve this, the foundation was raised 3 meters and the whole building was raised as well. The same method was used in Kunming Pagodas in Yunnan Province.

3. Isolation of detrimental water in surrounding environment

Wang Jian Tomb in Chengdu of Sichuan Province is the site of a masonry grave which was built during Former Shu Dynasty and was treated with waterproofing work to prevent the permeation of moisture. This was done because the masonry grave was covered with rammed earth and has suffered the permeation of surface water for a long time, which may change the temperature in the brick structures and damage the buildings.

4. Foundation stabilization for declining stone and brick buildings.

If the foundation of buildings suffered external forces or immergence, they will subside asymmetrically and the top-out will decline. A number of stone and brick pagodas have been leaning in certain degrees. Take the brick pagoda in Mei County of Shaanxi Province for example. It once inclined at an angle of 6 degrees and was in danger of destruction. Through the improvements, the foundation was restored to balance and the incline was eased.

5. Foundation replacement without moving the building

In front of the Great Buddhist Temple of the Tang Dynasty in Bin County of Shaanxi Province, there is a platform tower with a wooden pavilion. Due to long-term humidity on the buried part, the bricks were heavily weathered and in danger. To solve this security problem, the foundation was replaced without moving the building.

3.2 Conservation, Reinforcement and Restoration of Stone and Brick Structures

In Reinforcement of masonry, overall grouting methods should be taken to respond to the frangibility caused by a long history of overload. Some assisting constructions can also be used such as adding concrete spar frames or draw knots with external metallic structures.

The brick pagoda in Famen Temple of Shaanxi province, which was built in the Tang Dynasty and rebuilt in the Ming Dynasty has used the reinforced concrete tube structure in the middle of the pagoda in restoration, and the exterior was built following the original masonry method.

Longhu Dagoba in Sichuan Province suffered serious damages during the Wenchuan earthquake (fragility, cracking, partial collapse, etc). After supporting with draw knots to external metallic structures and timber frames, it can now resist strong aftershocks successfully.

Masonry crack receives a new grouting method.

Hollowing stone and brick partially dismantled with a laying method and grouting method.

3.3 Structural components strengthening

Stone memorial arch reinforced with Carboform bolt.

Stone memorial arch in Xiyue Temple

Seal and protection for the surfaces of seriously weathered brick

3.4 Conservation of stone bridges

3.5 Conservation of stone memorial arch and watchtower of the Han dynasty

3.6 Dam engineering

2011上海砖石建筑保护国际研讨会

SUMMARY OF CHINESE ANCIENT MASONRY REPAIR AND CONSERVATION

中国古代砖石建筑及其保护修复概述

中国文化遗产研究院　侯卫东
HOU WEIDONG
CHINESE ACADEMY OF CULTURAL HERITAGE

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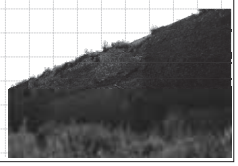
1 砖石结构建筑发展简述

砖瓦是最早的人工建筑材料。铺地砖和瓦在西周时期已经出现。砖石建筑是中国古代建筑的重要组成部分，他的历史与中国建筑的历史兴衰密切相关。

我们所说的砖石建筑是指利用砖石材料以一定的结构形式砌筑的建筑物或构筑物。

我们这里讨论的是物质的建筑，因此，我们本次讨论的界限界定在具有结构和构造的砖石建筑。



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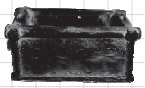
三、砖石结构保护修复的主要方法
四、保护修复案例

砖石的历史很悠久，一般形容秦砖、汉瓦，就是一种对建筑古老的形容词。
砖的前身是陶，一种粘土焙烧后的物体，陶器的烧制在中国有超过6千年的历史。而陶砖瓦的历史要比容器短，大概有3千年左右，春秋和战国时期已大量在建筑领域使用陶器，如陶制水道、用于装饰地面和墙面的空心砖、在重要的建筑上使用瓦屋面，这时候陶制品由于稀少而珍贵。



一、中国古代砖石建筑历史及类型简述
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三、砖石结构保护修复的主要方法
四、保护修复案例

屋面使用瓦见于完整实物的有秦阿房宫前殿遗址的拼排瓦样和河南安阳三杨庄汉代居住遗址的完整屋面。

秦阿房宫前殿遗址的拼排瓦样

河南安阳三杨庄汉代居住遗址的完整屋面

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汉代

- 成规格的砌制条砖使用范围增大，如建筑的底部、村井壁，水道，墓葬等。留存至今较多的是砖砌的墓室，已经能熟练运用叠涩拱及券拱。

魏晋、南北朝时期

- 已经有用砖砌筑的建筑物或构筑物，如砖砌佛塔，砖墓等。如北魏嵩岳寺塔、成都永陵墓室等。

唐、宋以后

- 砖结构建筑物明显增加，除大量原来木造的佛塔改建为砖塔外，在城市防卫的主体-城墙的关键部位也开始以砖石包砌

及至明朝

- 砖的生产和使用更为普遍，不仅用砖砌筑宫殿府第，民间宅院也不少用砖建造，但最大量使用的应该是城墙，不论是边塞长城还是城郭的围墙。

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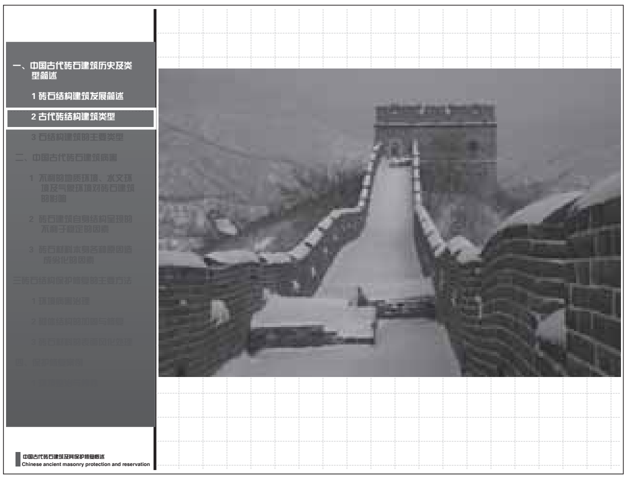
四、保护修复案例

中国古代砖建筑按使用类型可分为：

- 砖墓室
- 砖塔
- 砖城墙
- 砖拱桥
- 砖窑洞
- 砖砌无梁殿

HOU Weidong


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
曹 操 高 陵
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
四川石塔
定县开元寺砖塔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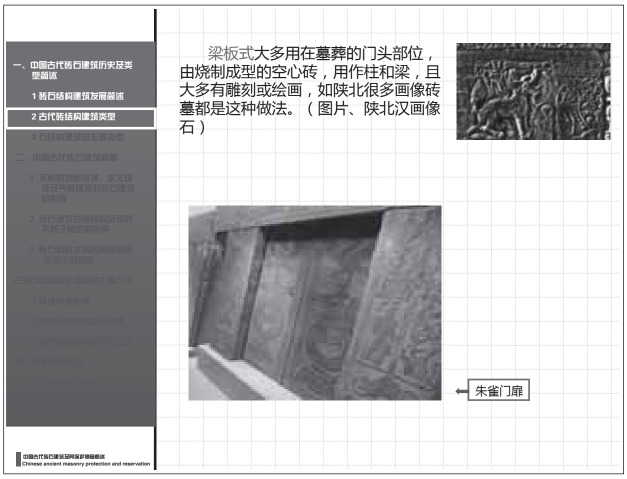
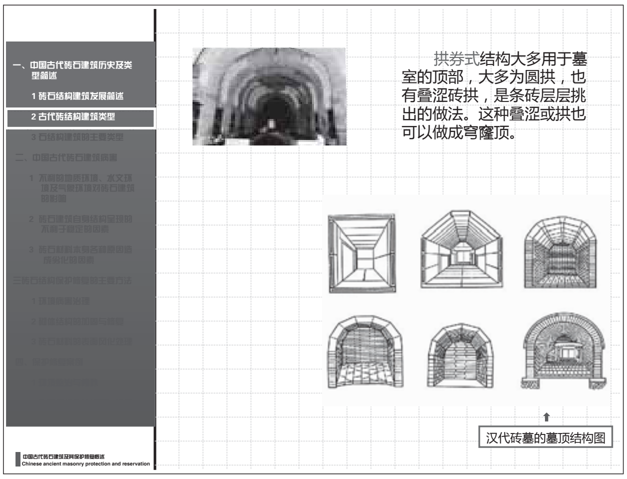
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
中国古代砖建筑按结构形式可分为：
穹窿结构
条砖砌体结构
拱券结构
梁板结构
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
梁板式大多用在墓葬的门头部位，由烧制成型的空心砖，用作柱和梁，且大多有雕刻或绘画，如陕北很多画像砖墓都是这种做法。（图片、陕北汉画像石）
朱雀门扉
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
拱券式结构大多用于墓室的顶部，大多为圆拱，也有叠涩砖拱，是条砖层层挑出的做法。这种叠涩或拱也可以做成穹窿顶。
汉代砖墓的墓顶结构图
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
1 砖石结构建筑发展概述
2 古代砖结构建筑类型
条砖承重墙如建筑物的墙体、砖塔的塔身、城墙的墙身等，个别也有砖筒式结构，如砖井壁等。
其中砖塔是中国古代建筑技术发展的一个重要标志。
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型概述
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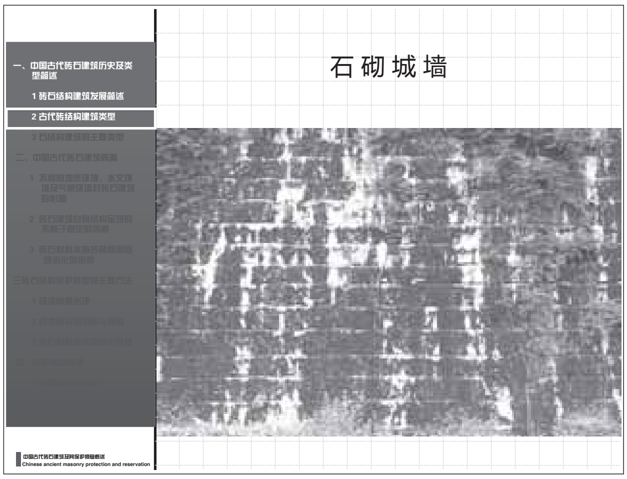
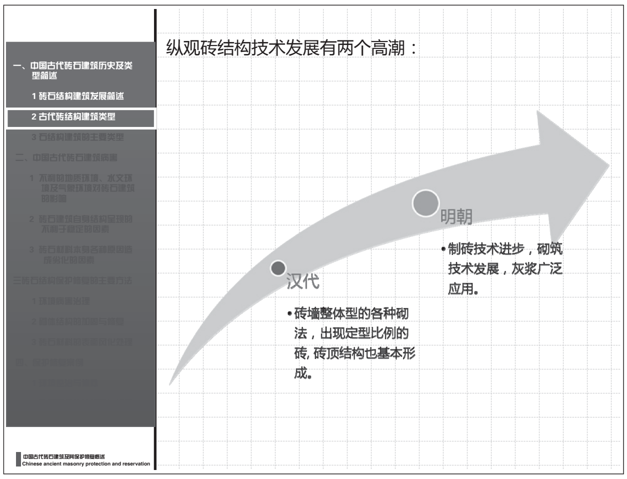
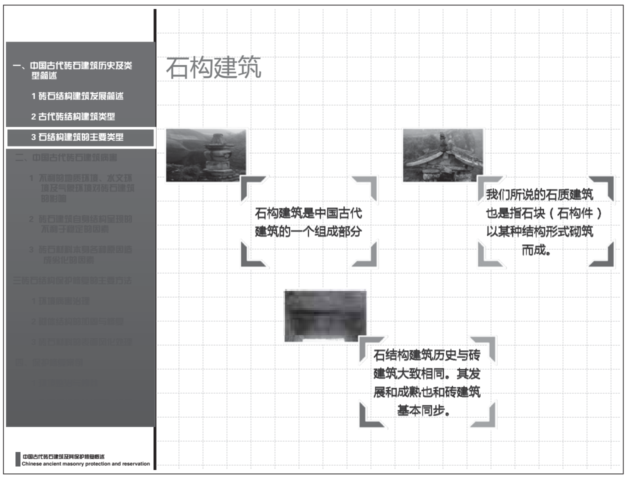
2 古代砖结构建筑类型
蔡氏古民居建筑群
Chinese ancient masonry protection and reservation


一、中国古代砖石建筑历史及类型简述
1 砖石结构建筑发展简述
2 古代砖结构建筑类型
石 砌 城 墙


一、中国古代砖石建筑历史及类型简述
1 砖石结构建筑发展简述
2 古代砖结构建筑类型
唐同光禅师塔


一、中国古代砖石建筑历史及类型简述
1 砖石结构建筑发展简述
2 古代砖结构建筑类型
纵观砖结构技术发展有两个高潮：
明朝
•制砖技术进步，砌筑技术发展，灰浆广泛应用。
汉代
•砖墙整体型的各种砌法，出现定型比例的砖, 砖顶结构也基本形成。


一、中国古代砖石建筑历史及类型简述
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2 古代砖结构建筑类型
3 石结构建筑的主要类型
石构建筑
石构建筑是中国古代建筑的一个组成部分
我们所说的石质建筑也是指石块（石构件）以某种结构形式砌筑而成。
石结构建筑历史与砖建筑大致相同。其发展和成熟也和砖建筑基本同步。


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3 石结构建筑的主要类型
1.石室墓。
中国汉唐时期建造了很多石造的墓室，这些墓室以成型石块砌筑墙体及屋顶，甚至装饰部分都选用石材雕凿而成。这些石室墓材料和结构均很坚固耐久。（图片东汉画像石墓）


一、中国古代砖石建筑历史及类型简述
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2 古代砖结构建筑类型
明　代　王　陵


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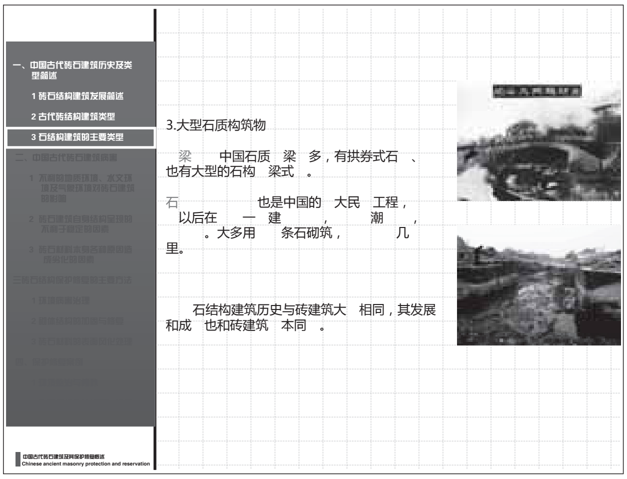
3 石结构建筑的主要类型
2.石质建筑物
中国完全按照石材修筑的建筑物很少，除几处石塔外，其他并无大型石质建筑，大多是一些间数不多的石殿，但石经幢，石牌坊，石照壁，石华表等建筑小品较多。这些建筑小品也都由某种结构而成，也可以算作中国石质建筑的一个门类。
青石殿
开元寺双石塔
县汉


一、中国古代砖石建筑历史及类型简述
1 砖石结构建筑发展简述
2 古代砖结构建筑类型
3 石结构建筑的主要类型
3.大型石质构筑物
梁　中国石质　梁　多，有拱券式石　、也有大型的石构　梁式　。
石　也是中国的　大民　工程，以后在　一　建　，　潮　，　。大多用　条石砌筑，　几里。
石结构建筑历史与砖建筑大　相同，其发展和成　也和砖建筑　本同　。

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2 古代砖结构建筑类型
3 石结构建筑的主要类型
二、中国古代砖石建筑病害
1 不利的地质环境、水文环境及气候环境对砖石建筑的影响
2 砖石建筑自身结构呈现的不利于稳定的因素
三、砖石结构保护修复的主要方法

2 中国古代砖石建筑保护修复

砖石建筑的　　分为几类

第一类　砖石的环境病害，如地质环境、水文环境存在不安全形态造成的砖石建筑的破坏。

第二类　结构性病害，指砖石建筑的结构体存在的不安全形态。

第三类　砖石的材料病害，指砖石材料本身由于劣化造成的破坏。

建筑物都处于　定的区域和　定的地质　，　条的限制。

因

地震　长期浸泡　地下渗水　地质破坏

- 滑坡
- 裂缝
- 沉陷

年　地　发，除　人类及经　造成重大　外，　遗　的　也是　要　对的　要　砖石建筑物较　结构　容　造成　。在　年的　地　中、砖石塔是　较　重的一类、如　后　、　后开　、　等。

地　后的　塔群

地表水　和地　水也是　　砖石建筑的　要因

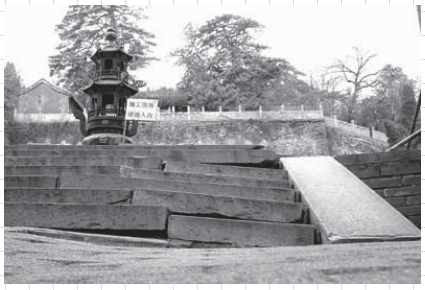
影响砖石建筑本身或其地基与基础

- 长期浸泡
- 短期淹没

对于砖石拱等处于地下的建筑

- 长期下渗水对砖石砌体造成水份的流动
- 从而破坏砖石类的材料结构

地质　也　　砖石建筑所处的　体、如　、大面　的地面　、地　等　　而　建筑物　。如一些位于地　上的古建筑 其墙体、　都　了不同程　的开　。一些　甚至　　砖石建筑的　。如　期多处因　造成的　体　、古建筑甚至　　。

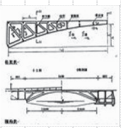


北　寺　体

当砖块和石块砌筑成结构体时，它所面临的问题就成为另外一类，

当砖石结构作为一个支撑体存在时

- 它需面临荷载带来的压力、弯矩、剪力等
- 当这个结构体具有一定的高度后，它又面临稳定问题。



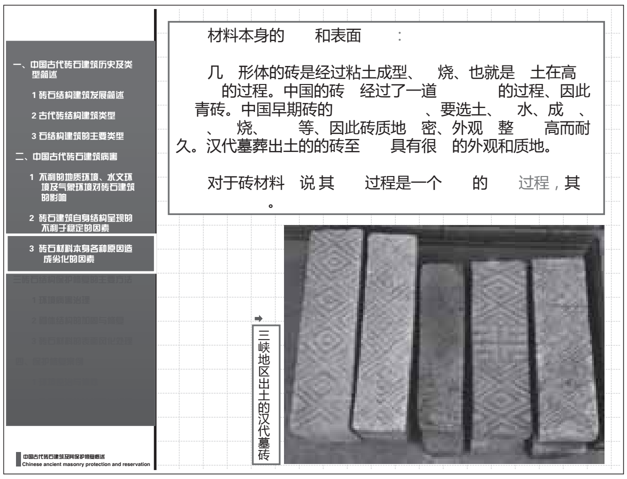
砖石结构的　一般是两类

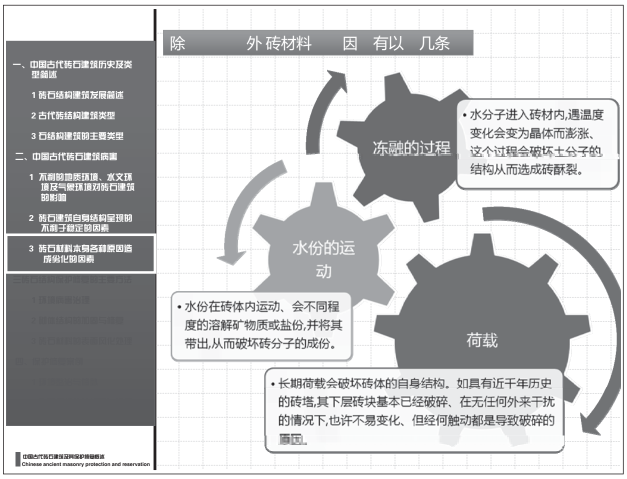
一种是竖向传力的柱、墩、台、墙等

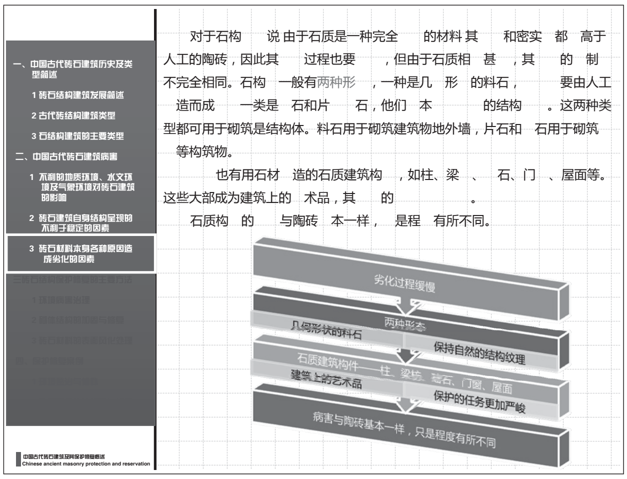
- 对于竖向受力的砌体，会由于受压碎裂、受剪和受弯开裂、会由于横向推力失稳等

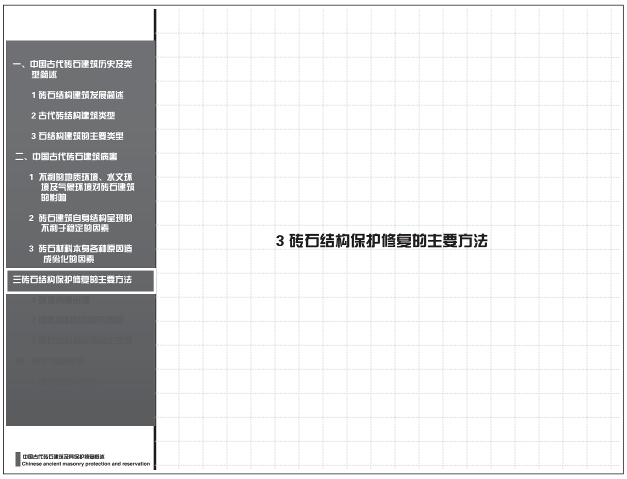
一种是横向传力的拱、券、叠涩、横梁等

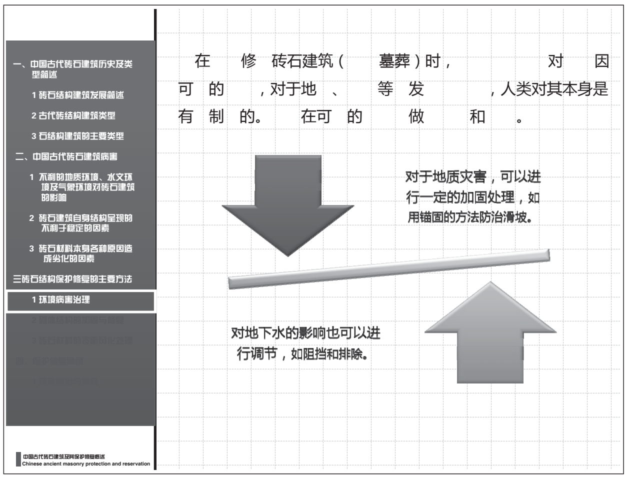
- 对于横向受力构件，也会发生开裂、局部碎裂等并可导致失稳等破坏。

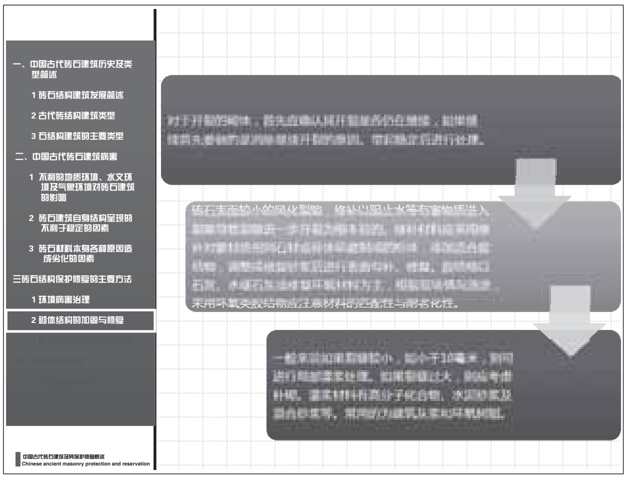

材料本身的　　和表面　　：
几　形体的砖是经过粘土成型、　烧、也就是　土在高　　的过程。中国的砖　经过了一道　　　　的过程，因此　青砖。中国早期砖的　　　　　、要选土、　水、成　、　　、烧、　　等、因此砖质地　密、外观　整　　高而耐久。汉代墓葬出土的的砖至　　具有很　的外观和质地。
对于砖材料　说其　　过程是一个　　的　过程，其　　。
三峡地区出土的汉代墓砖

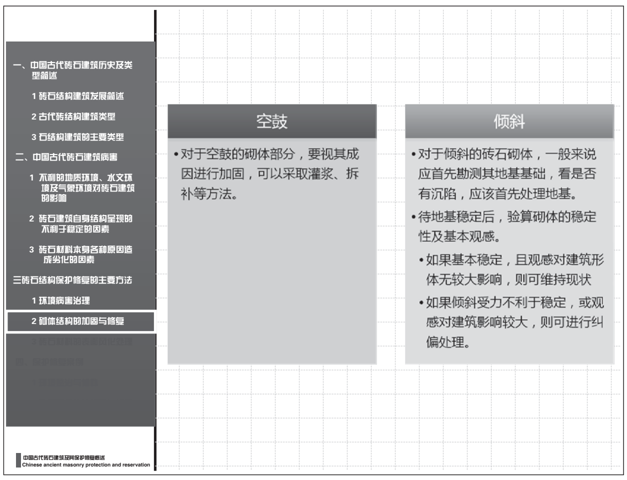

除　　　外砖材料　　因　有以　几条
冻融的过程
•水分子进入砖材内,遇温度变化会变为晶体而膨胀、这个过程会破坏土分子的结构从而造成砖酥裂。
水份的运动
•水份在砖体内运动、会不同程度的溶解矿物质或盐份,并将其带出,从而破坏砖分子的成份。
荷载
•长期荷载会破坏砖体的自身结构。如具有近千年历史的砖塔,其下层砖块基本已经破碎、在无任何外来干扰的情况下,也许不易变化、但经何触动都是导致破碎的原因。

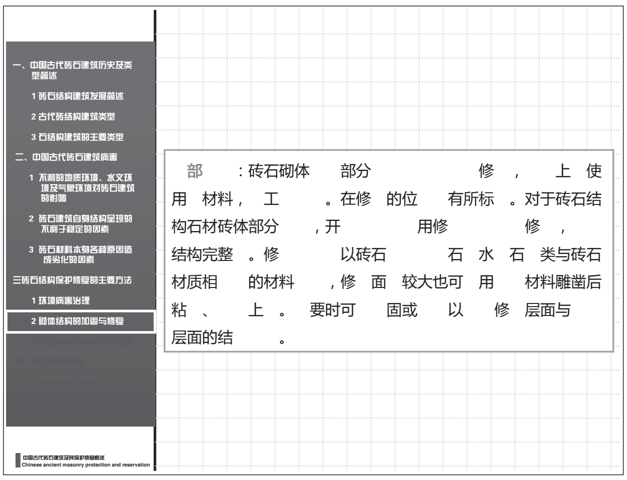

对于石构　　说由于石质是一种完全　　的材料其　　和密实　都　高于人工的陶砖，因此其　　过程也要　　，但由于石质相　甚　，其　　的　制不完全相同。石构　一般有两种形　　，一种是几　形　的料石，　　要由人工　造而成　　一类是　石和片　　石，他们　本　　　的结构　　。这两种类型都可用于砌筑是结构体。料石用于砌筑建筑物地外墙，片石和　石用于砌筑　等构筑物。
也有用石材　造的石质建筑构　，如柱、梁　、　石、门　、屋面等。这些大部成为建筑上的　术品，其　　的　　　　　。
石质构　的　　与陶砖　本一样，　是程　有所不同。
劣化过程缓慢
两种形态
几何形状的料石
保持自然的结构纹理
石质建筑构件——柱、梁枋、础石、门楣、屋面
建筑上的艺术品
保护的任务更加严峻
病害与陶砖基本一样，只是程度有所不同


3 砖石结构保护修复的主要方法


在　修　砖石建筑（　　墓葬）时，　　　　　对　　因　可　的　　，对于地　、　　等　发　　　，人类对其本身是　有　制　的。　在可　的　　做　　和　　。
对于地质灾害，可以进行一定的加固处理，如用锚固的方法防治滑坡。
对地下水的影响也可以进行调节，如阻挡和排除。




空鼓
•对于空鼓的砌体部分，要视其成因进行加固，可以采取灌浆、拆补等方法。
倾斜
•对于倾斜的砖石砌体，一般来说应首先勘测其地基基础，看是否有沉陷，应首先处理地基。
•待地基稳定后，验算砌体的稳定性及基本观感。
•如果基本稳定，且观感对建筑形体无较大影响，则可维持现状
•如果倾斜受力不利于稳定，或观感对建筑影响较大，则可进行纠偏处理。


部　　：砖石砌体　　部分　　　　　　修　，　上　使用　材料，　工　　。在修　的位　　有所标　。对于砖石结构石材砖体部分　　，开　　　　用修　　　修　，　结构完整　。修　　　以砖石　　　石　水　石　类与砖石材质相　　的材料　　，修　面　较大也可　用　　材料雕凿后粘　、　　上　。　要时可　　固或　以　　修　层面与　层面的结　　　。

HOU Weidong

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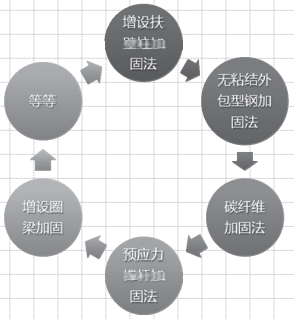
1 环境整治与修缮

除了砌体身的 和修 外，对于 不 要 的，可 的结构 ，如结构体 固：



砖石结构砌体 固修 的 一个关 是 的粘结 材料。

中国的砖石砌体在各个时代有不同的做法

唐宋以前的砖石砌体基本不用灰浆，或者用黄泥浆灌封。

明代以后基本用石灰浆作为砖砌体的灰浆。

在石灰浆的基础上还发展出很多特别的灰浆
- 糯米灰浆
- 南方的红糖沙灰浆
- 腻子灰浆等。

这些 是古建筑的组成部分， 的 有两层 ，身和其粘结 。 前对 砖石建筑的 也在 ， 上，我们 使用 类型于 建筑，但也可对 一定的 造，使其 砖石建筑的 。

喷淋渗透

嵌缝补强

补缺补强

灌浆加固

对于砖石材料的表面 ，一般 用 固的 法不同砖石材料 质， ，用的 材料是不同的。

前使用材料：

无机类：	有机类：
• 如PS材料（碱性硅酸盐） • 纳米材料	• 有机硅类 • 丙烯酸聚合物 • 有机氟聚合物 • 其他的人工合成材料（如人工生物模板草酸钙）

清洗主要工作目的：
- 清除砖石表面污染物恢复其艺术价值；
- 去除砖石材料表面的有害物质，减缓或去除不良病害发生；
- 为后期的加固修复工作提供条件。

砖石文物建筑清洗技术包括两大类型
- 物理清洗
- 化学清洗

其中常用的清洗技术包括
- 水洗(含蒸汽清洗)
- 化学清洗
- 微粒子喷射清洗
- 激光物理清洗等

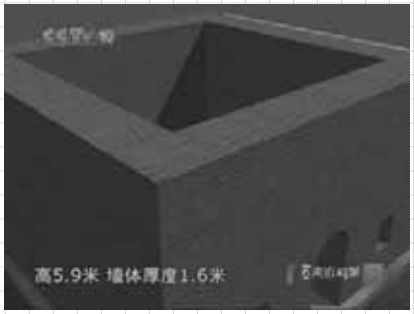
4 保护修复案例

建筑整体

河南开 观 建于 ，由于周 地 不 高，其地面 于周 2. 。建筑 期 地 水 。为了这一 ， 高3 ，建筑 整体 。

河南开 观 整体 工程现场

：



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相同的 有 南

南 工程现场

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古代砖石塔的纠偏：

建筑物的地 由于 外 或 水 ， 造成不均 ，造成上部建筑物的 ，如很多砖石塔都有一定的 。如陕西眉县的唐代砖塔，一 6 ，造成建筑物地 ， 过对 和地 的处 ，是的地 于 ，使过大的 以 。

眉县净光寺塔纠偏工程现场

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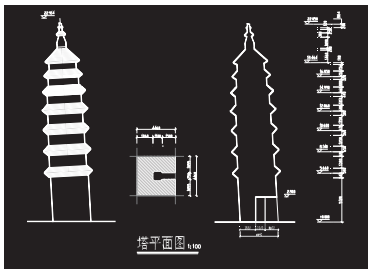

– 净光寺塔 式 层 砖塔， 层有塔室可 。塔 面 形， 层 .6 ， 现 有 地 面 塔 高 22. ， 层塔体 重。1 年 塔体 北偏东 . 2 ， .3 ，塔 中心偏 1.66 ， 北 偏 1.62 。

• 由于塔体 使塔 北 外 砌体

塔体纠偏

- **塔体加固**
- 为 高塔纠偏过程中的 及 ，对塔体一层、 层及三层以 、 板及 了时 固， 层 固2道。对 固 在塔体纠偏过程中的 实 了全过程 。

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建 水 ：

成都王建墓是一处建于地上的砖石结构墓葬，建造于前 时期，由于砖结构的墓室由 土 ，地表水 期由顶部 砖石体 ，造成砖结构体的 ，对建筑造成 ，为 水的 ，在砖结构与土体 间做了水处 ， 了砖石体的 ， 了 墓室建筑的 的。

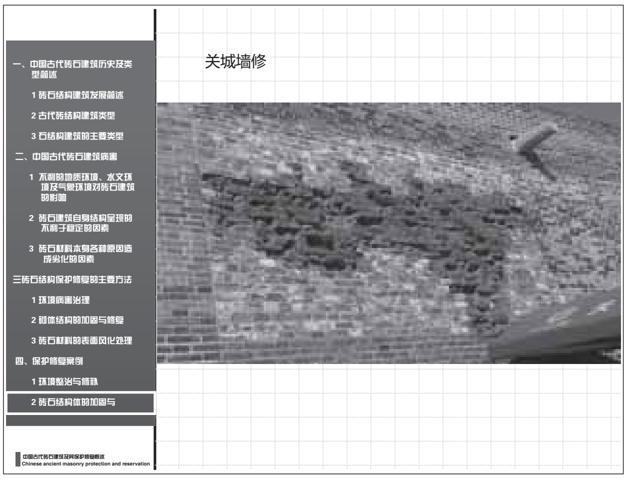
王建墓

HOU Weidong

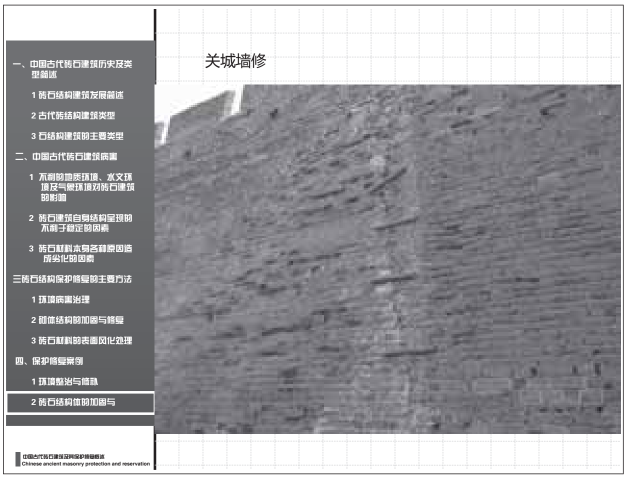

王建墓砖石墓

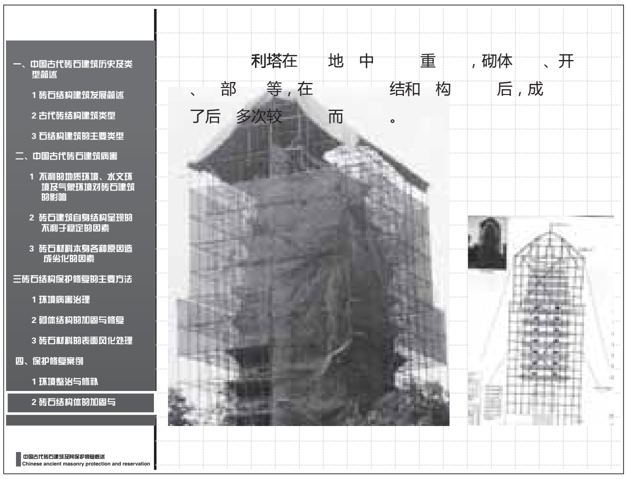

王建墓防水
王建墓砖室

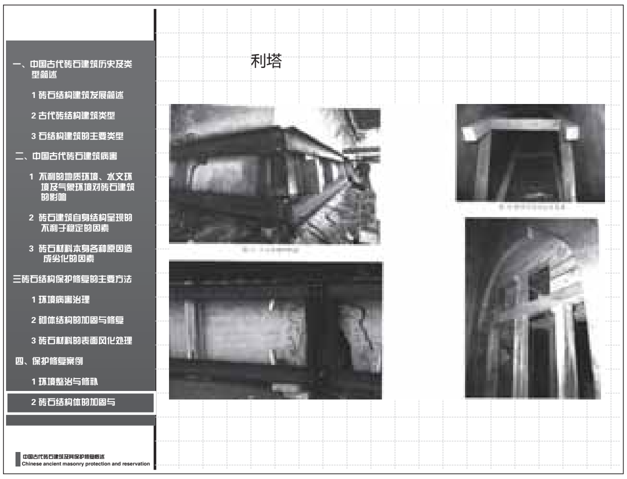

砖墙（砖砌体）的 固
对于砌体年久 或 在过量 的 ， 整体
固的 法。也可 结构，如在其体
土梁 ，或 在外部用 结构 结。如河北
关城墙， 了大 的 修，其中 了 固、 部
等 法。
关城墙


关城墙修


关城墙修

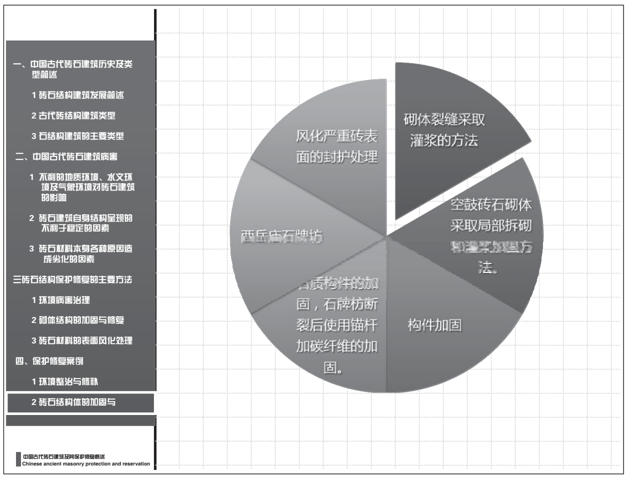

关城墙修


利塔在 地 中 重 ，砌体 、开
、 部 等，在 结和 构 后，成
了后 多次较 而 。

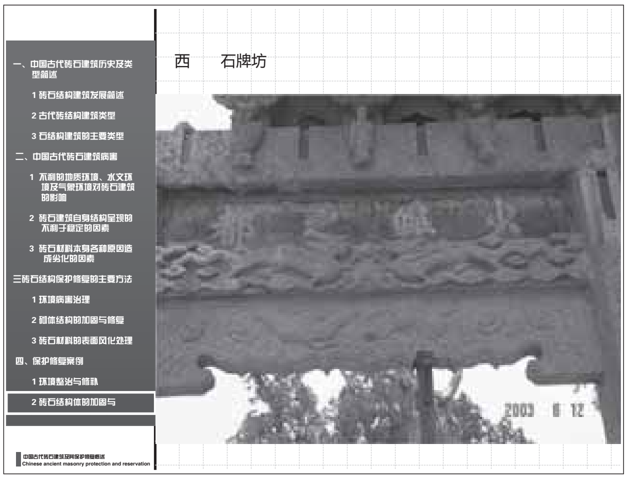

利塔


利塔


利塔


砌体裂缝采取灌浆的方法
空鼓砖石砌体采取局部拆砌
构件加固
固，石牌坊断裂后使用锚杆加碳纤维的加固。
风化严重砖表面的封护处理


西　石牌坊


西　石牌坊
2003 6 12


西　石牌坊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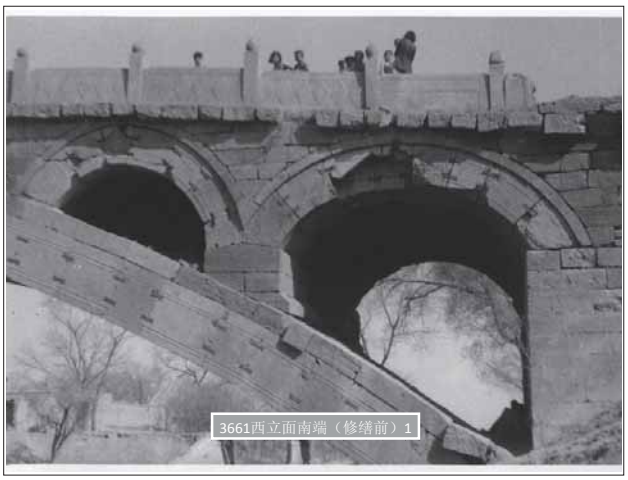
石 与石牌坊的
是中国 的古代 梁，上 了 修，
修的 法

石栏板及望柱	东面石 大部无 ，代以砖砌墙，西面石 小有 。	全部 用 石料雕作安装
石桥面	有 面 不 ， 中心 人 道，一条 后 作。	面石 修 ， 作 土板， 。
空撞券四孔	券石大部 ，券 石均有 。	券石全部 安，石 用 土造。
大券	东 三道无 ，两道 ，其券石间有 处。	东 处 ， 处 安，其 券石 ，过甚 。 石 用 土造（南北 空 券部分 用 石）


3661西立面南端（修缮前）1


3836主券券缝清洗干净


3883主券压力注浆


4027亚麻布层


24542望柱加工

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汉
要 是表面的 ， 修 法 用 材料 ，
等。


喷淋渗透


嵌缝补强


补缺补强


灌浆加固

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重 房 、 物 工程。

The Japanese Protection System for Preservation Technique for Traditional Stone Wall

MOTONAKA Makoto
Chief Senior Specialist for Cultural Properties
Agency for Cultural Affairs, Japan (*Bunkacho*)

Many Japanese cities have grown out of castle towns constructed between the 16th and 19th centuries. Since pre-modern castle towns were designed to meet the needs of defense, logistics, housing and economic activities, houses and various other facilities were strategically located around the castle, which was the political and administrative center of the respective domain. After the Meiji Restoration (1868), however, the feudal lords who had formerly resided in such castles now chose to live elsewhere, so during the latter half of the 19th century many uninhabited castles were demolished and their moats filled in. The sites of such castles were then used for the sites of schools and military facilities. During Japan's high economic growth period (1955 –1973), many cities redeveloped their districts by expanding street width and replacing wooden structures with more robust concrete structures. Although such redevelopment projects involved castle sites, many cities managed to retain at least part of their historic structures, which continued to retain the atmosphere of former times. Currently, many such cities plan to enhance their attractive features through effective use of historic assets. Under such plans, the primary focus is on maintaining/restoring the moats and stone walls that once comprised essential elements of castles and castle towns.

This article introduces initiatives taken by the Japanese government to ensure that stone wall maintenance/renovation techniqueologies, techniqueologies essential for preserving the intrinsic value of pre-modern castles and castle towns, are handed down to future generations.

1. Japanese Systems for Protecting Cultural Properties

Under the Law for the Protection of Cultural Property, Japan, these of cultural properties are divided into the following six categories (Article 2).

1. Tangible Cultural Property
   Buildings, pictures, sculptures, applied crafts, calligraphic works, classical books, ancient documents, and other tangible cultural products that are of significant historical or artistic value to Japan (including lands and other objects which are combined with these objects to create such value): archaeological and other historical resources of significant scientific value.
2. Intangible Cultural Properties
   Drama, music, applied art, and other intangible cultural products that are of significant historical or artistic value to Japan.

3. Folk Cultural Property
   Manners and customs related to food, clothing and housing, to occupation, to religious faith, and to annual festivals, etc.: folk performing arts: folk skills: clothes, utensils, houses and other objects used therefor, which are indispensable to the understanding of changes in the mode of life of Japan.
4. Monuments
   Shell mounds, tumuli, sites of fortified capitals, sites of castles, monument houses and other sites, which are of significant historical or scientific value to Japan: gardens, bridges, gorges, sea-shores, mountains, and other places of scenic beauty, which are of significant artistic or aesthetic value to Japan: animals (including their habitat, breeding areas and trails), plants (including their self-seeded areas), and geological features and minerals (including the areas where peculiar natural phenomena are recognizable), which are of significant scientific value to Japan.
5. Cultural Landscapes
   Landscapes that have been created by people's lives or occupations in their community as well as by the climate prevailing in such community, and which are indispensable to the understanding of the mode of life or occupation of Japan.
6. Groups of Traditional Buildings
   Groups of traditional buildings of high value, which form a certain historic configuration in combination with their environments

In addition to six categories, the following two are also placed as objects of cultural property to be protected by the Law for the Protection of Cultural Property, Japan.

1. Treasure Trove
   An object of cultural property which is buried (Article 92)
2. Selected Preservation Technique
   Traditional techniques or craftsmanship that are indispensable to the preservation of cultural property and for which preservation measures shall be taken (Article 147)

Of the various castle structures, including moats and stone walls, the Japanese government designates those with high historical or academic value as historic sites, so as to ensure their protection under the relevant law. To ensure the preservation of stone walls, which comprise the essential framework of castles, the Ministerry of Education, Culture, Sports, Science and Technology (MEXT) has collectively specified various stone wall preservation techniqueologies as a Selected Preservation Technique Technology that is indispensable to preservation of cultural propertyies, and has authorized the Stone Wall Preservation Techniqueology Council as the official organization responsible for preserving stone walls that have been designated as cultural properties.

2. Maintenance of Stone Walls and Selected Preservation Techniqueology

Stone wall preservation is essential for maintaining the intrinsic value of a castle site. To maintain stone

walls, it is imperative to select the most suitable techniqueologies and to pass their heritage for future generations.

Through government subsidies, the Agency for Cultural Affairs ("Agency") has assisted the stone wall preservation projects of local governments that have been certified as either the owners or operators of castle sites. Also, from diverse approaches, the Agency for Cultural Affairs has provided assistance and suggestions regarding [1] initiatives for selecting suitable stone wall maintenance techniqueologies and sharing related information among related parties, and [2] initiatives for specifying optimal ways of transmitting various basic techniqueologies that support stone wall maintenance techniqueologies, and to ensure that they are handed down to future generations. Specifically, the Agency for Cultural Affairs has carried out the following programs:

(1) Promoting the sharing of information among parties engaged in stone wall maintenance and renovation

1) Preparing the *Guidebook on the Maintenance of Historic Sites*

The *Guidebook on the Maintenance of Historic Sites* ("Guidebook") was issued in 2004 under the initiative of the Agency for Cultural Affairs. Regarding the preparation of stone wall maintenance plans and the application of maintenance techniqueologies, the Guidebook indicates desirable approaches and techniques, thus providing basic guidelines for the maintenance and effective use of historic sites and other monuments.

2) Establishing the Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts, and organizing its annual meetings

Although the Guidebook stipulates principles concerning the maintenance and improvement of castle sites, it does not illustrate concrete stone wall maintenance/renovation processes or detailed techniques. Moreover, stone wall maintenance entails a completely different approach from that used to preserve buried historic sites. In the latter, structures representing original forms are sometimes built after backfilling the remains discovered underground, for their preservation. In contrast, since most stone walls remain on castle sites, maintenance operators, rather than build new structures, must work on existing historic assets of intrinsic value, sometimes rebuilding them after demolition. To that end, it is essential that masonry engineers share more detailed information regarding maintenance and renovation techniqueologies and approaches. With this in mind, in 2005 the Agency for Cultural Affairs began to organize annual January meetings of the Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts ("Research Organization"), in joint efforts with the municipalities that host the events. The annual meetings were effective in developing closer communication among municipal staff responsible for maintaining and renovating castle sites. By sharing related information, they have begun to improve the accuracy of maintenance and renovation works.

3) Compiling an official report of the Research Organization

As shown in the Attachment, at the fifth annual meeting of the Research Organization, held in 2008,

participants reviewed previous discussions held at all the five meetings that had been organized up to that time, and adopted an official report that stipulates several important tasks that must be fulfilled. These tasks include [1] taking initiatives to receive and pass on traditional stone wall maintenance techniqueologies and [2] preparing a new guidebook to facilitate the sharing of relevant techniqueologies. Regarding the first task, the participants agreed that in order to encourage technicians and engineers to engage in stone wall maintenance projects, it is essential that stone wall maintenance techniqueologies be selecdesignated **as** a Selected Preservation Techniqueology in compliance with Article 147 of the Law for the Protection of Cultural Propertyies, and that a council comprising such technicians and engineers be established at the earliest possible time.

(2) Passing on stone wall maintenance techniqueologies and fostering technicians and engineers

1) Growing demand for measures to protect stone wall preservation techniqueologies

In parallel with efforts to compile a report on the part of staff of relevant municipalities, groups of frontline technicians and engineers, particularly those dealing with masonry, have also begun to demand measures that address the critical situation regarding traditional techniqueology bequeathal.

2) Characteristics of stone wall preservation techniqueologies

The techniqueologies necessary for preserving stone walls that have been designated as cultural properties include techniques for dismantlingdemolishing and rebuilding stone walls at castle sites and other places designated historic sites. To restore stone walls to their original state, it is essential to correctly analyze their present state, accurately specify the range of dismantlingdemolition and carefully plan necessary processes, from dismantlingdemolition to masonry work. In addition, when stones must be replaced, new materials must be quarried, carved and finished. To carry out all these processes, workers must have exceptional sensitivity, advanced techniqueology and a wealth of experience.

To pass valuable historic assets on to future generations, stone walls of castle sites and other historic sites must be well- maintained. Since preservation entails particular expertise and high technological skill levels, it is essential to provide workers with high-level technological training. It is also important to study and revive traditional stone wall preservation techniqueologies that is are no longer in use today.

3) Establishing the Stone wall Preservation Techniqueology Council

In consideration of the unique characteristics of stone wall preservation techniqueologies, along with the tasks stipulated in the agreement concluded at the fifth meeting of the Research Organization, related parties established the Stone Wall Preservation Techniqueology Council (“Council”) in April 2008. The major objectives were to preserve related techniqueologies and foster human resources to engage in maintaining and preserving stone walls. The Council comprises technicians and engineers engaged in stone wall preservation projects at castles and other historic sites throughout the country. In partnership with researchers specializing in traditional stone walls and stonework, the Council organizes seminars, comprising both lectures and practical training programs. In addition, the Council issues newsletters to

disseminate the outcome of its activities.

4) Selecting preservation techniqueologies and authorizing a preservation organization in compliance with the Law for the Protection of Cultural Propertyies

On 2 September 2009, in recognition of the Council's achievements, the Ministerry of Education, Culture, Sports, Science and Technology (MEXT) specified stone wall preservation techniqueologies as Selected Preservation Techniqueology and recognized authorized the Stone Wall Preservation Techniqueology Council as the preservation bodyofficial organization responsible for preserving such stone wallscultural properties.

3. Future Tasks

At present, the Council has its office in the Japan Castle Research Center (established by Himeji City), which is located within the precincts of Himeji Castle, a World Heritage Ssite listed in 1993. The Council offers systematic technological training to about 70 technicians and engineers, who are members of the Council.

Since the technicians and engineers have diverse views and take different approaches to the maintenance of stone walls, the first task of the Council was to build a network and partnerships among its members by overcoming such differences in views and approaches. Following selectiondesignation as a Selected Preservation Techniqueology and recognitionauthorization of the Council as a competent preservation body in compliance with the Law for the Protection of Cultural Propertyies, the organization is expected to proceed to the next stage in order to achieve the goal of its establishment. At this moment, however, it seems the Council must go a long way to reach the goal. The Agency for Cultural Affairs believes that the Council should continue its efforts to unify its members, reinforce training programs and polish up the members' skills and techniqueologies. Moreover, the Agency expects that the Council will share information more closely with the Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts, and reinforce their partnerships toward preparation of a new guidebook on the maintenance of stone walls.

Attachment

To Hand Down the Intrinsic Value of Stone Walls to Future Generations

18 January 2008
Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts

On 22 January 2004, the Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts ("Research Organization") was established with the aims of inheriting *traditional techniqueologies* for maintaining stone walls, handing down such techniqueologies to future generations, and building common recognition among related parties regarding technicalological and administrative obstacles that can arise in preserving historic sites, particularly stone walls and stonework at castle sites. The *traditional techniqueologies* stipulated herein include masonry techniqueologies adopted at the time of initial construction, more recent maintenance techniqueologies employed up to date, and present-day maintenance and renovation techniqueologies that hasve been developed to ensure the preservation of valuable stone walls, stonework and other remaining structures of pre-modern castles that have been designated historic sites, monuments or other cultural properties. The first Research Organization meeting was held at the site of Himeji Castle (designated as a special historic site under the Law for the Protection of Cultural Property) by the organizing committee, comprising staff of the Agency for Cultural Affairs, Himeji City Board of Education and Hyogo Prefecturale Board of Education. Following the first meeting, it was decided that subsequent meetings be held through joint efforts of the Agency for Cultural Affairs, the Board of Education of the host municipality (seat of a castle) and the Board of Education of the host prefecture.

At subsequent annual meetings of the Research Organization, lively discussions concerned a wide variety of topics relating to stone wall maintenance, through reference to the castles of the respective host cities. The topics include ways to foster technicians and engineers who can engage in stone wall maintenance, coordination of traditional and present-day maintenance techniqueologies, and preparation of a new guidebook covering various related techniqueologies. At the fourth meeting, held at the Kanazawa Castle site from January 18 to 20, 2007, it was decided that at the next (fifth) meeting, which would be held at the Kumamoto Castle site (designated as a special historic site), on the basis of discussions held at all five meetings participants would compile an official report on important issues and initiatives to be addressed in regard to bequeathing the intrinsic value of stone walls to future generations.

In line with this decision, the Agency for Cultural Affairs decided to establish a Taskforce for the Development and Succession of Stone Wall Maintenance Techniqueologies for Castle Sites and Other Historic Sites ("Taskforce"). Membership in this Taskforce comprises researchers of stone wall maintenance techniqueologies and officials of municipalities that have hosted the meetings of the Research Organization. (Members' list is provided in the Supplementary Note.) On 17 December 2007, the Taskforce completed a draft of a report and submitted it to the fifth annual meeting.

The Research Organization analyzed the draft of the report prepared by the Taskforce. Having confirmed

that the draft contained issues essential for carrying out stone wall maintenance projects (items listed below), the Research Organization unanimously decided to adopt the draft.

1. Annual Meetings and Their Agendas

The outline and agendas of the annual meetings of the Research Organization are as follows:

(1) The first meeting: 22–24 January 2004 at Himeji Castle site (designated as a special historic site, Hyogo Prefecture)

In addition to confirming the purpose of establishing the Research Organization, participants discussed various challenges involved in stone wall maintenance projects. In addition, presentations were held on case studies of stone wall maintenance projects conducted at Himeji Castle site (special historic site) and other castle sites in Hyogo Prefecture. Since this was the first meeting, many individuals participated in the event, including staff members of various municipalities, technicians and engineers engaged in stone wall projects, and lay citizens.

(2) The second meeting: 20–22 January 2005 at Hizen Nagoya Castle site and Its Surrounding the site of forts (designated as a special historic sites, Saga Prefecture)

At Hizen Nagoya Castle site and the site of forts (special historic sites), stone wall renovation projects have been conducted over the past 20 years. Based on these experiences, discussions were held concerning challenges at various stages of the projects, ranging from order placement to masonry work, from the viewpoints of [1] the specialists who are members of the stone wall maintenance and improvement committee, comprising specialists, [2] members of the municipalities that place orders of the projects, [3] design consultants and surveying technicians, [4] project managers and [5] masons.

(3) The third meeting: 26–28 January 2006 at Sendai Castle site (historic site, Miyagi Prefecture)

Discussions were focused on methods of surveying and recording the present state of stone walls. After discussing the importance of analyzing the present state of stone walls, participants actually had an opportunity for surveyinged and evaluatinged a stone wall together and comparinged different results of the evaluation from person to person. This led to deeper discussions about the methods for evaluation methods and maintenance of the stone wallstechnologies.

(4) The fourth meeting: 18–20 January 2007 at Kanazawa Castle site (Ishikawa Prefecture)

In-depth discussions were held concerning problems and tasks that had been pointed out at previous meetings. Participants also discussed the processes of maintenance/renovation projects, issues to notice, and related problems, stipulated in the *Guidebook on the Maintenance of Historic Sites* (issued in March 2004 under supervision of the Agency for Cultural Affairs). Regarding the main theme “reviving and succeeding traditional techniqueologies,” participants discussed [1] significance of survey and research in stone wall maintenance programs (excavation, studies of remaining structures and studies of historical documents), [2] extent to which existing stone walls should be preserved, extent to which stone wall renovation/reconstruction and processing of original stones should be permitted, and [3] extent to which

modern construction methods should be permitted so as to enhance the safety of the structures.

Participants agreed that at the next meeting (the fifth meeting), they would compile a report on the outcomes of the five meetings. To analyze important issues and tasks to perform, the Agency for Cultural Affairs decided to establish the Taskforce for Development and Succession of Stone Wall Maintenance Techniqueologies for Castle Sites and Other Historic Sites.

(5) The fifth meeting: 17–19 January 2008 at Kumamoto Castle site (designated as a special historic site, Kumamoto Prefecture)

Since discussions at previous meetings focused on technological aspects of stone wall maintenance programs, at this meeting, participants discussed challenges involved in coordinating stone wall maintenance and reconstruction of theother castle buildings that had been disappearedstructures, roles expected of castle sites as vast open public spaces in urban districts, and the significance of stone wall maintenance in fulfilling those roles.

2. Analysis of Contentions at Research Organization Meetings

The Taskforce analyzed various issues that were discussed at the previous five annual meetings. These included:

(1) General issues

A. In addition to the techniqueologies used to maintain stone walls of castles that have been designated as historic sites, techniqueologies used to maintain other stone walls and stonework constructed in other sites of cultural properties should be included as targets of protection.

B. Major tasks of the Research Organization should include [1] fostering human resources to engage in stone wall maintenance projects and building appropriate systems/organizations, [2] ensuring stable supply of stone materials, [3] securing constant employment for masonry technicians and engineers, and [4] coordinating traditional and present-day technologies.

C. A new guidebook should be prepared that focuses on stone wall maintenance projects at castle sites. In preparing the new guidebook, it is important to refer to the processes of maintenance/renovation projects, issues to notice, and related problems stipulated in the *Guidebook on the Maintenance of Historic Sites* (issued in March 2004 under the supervision of the Agency for Cultural Affairs).

(2) Fostering technicians/engineers and establishing relevant systems/organizations

A. Appropriate initiatives should be taken to foster technicians and engineers to engage in stone wall maintenance projects.

B. To improve the quality of stone wall maintenance projects, it is essential to constantly maintain related techniqueologies at satisfactory levels. To that end, objective evaluation criteria should be established.

C. Since stone wall maintenance projects are conducted incessantly over long periods, staff of local governments that outsource the projects must have the competency to evaluate project quality and

workers' skill levels, and to offer suggestions and advice regarding various processes. To develop staff with such competency, seminars should be provided to improve their professional knowledge levels.

D. In this relation, seminars and training programs should also be provided to technicians and engineers.

E. In conducting stone wall maintenance projects, decision-making in each respective process should be carried out with the utmost transparency. To ensure transparent decision-making, close and thorough communication must be maintained among the following seven parties concerned: members of the maintenance/renovation committee, comprising specialists; local governments that outsource projects; survey and research organizations; design firms; surveying agents; construction companies; and masons. At seminars and other occasions, these parties are encouraged to exchange views and promote mutual understanding, so as to align the direction of their efforts.

F. Meetings of the Research Organization should be held at castle sites where maintenance/renovation projects are actually under way, so that participants can observe the project sites and exchange their views with reference to specific cases.

G. Stone wall maintenance projects should involve local community members, so that the projects may foster residents' pride in their hometowns and inspire them to participate in community development. All stakeholders, including residents, should deepen their understanding of the effects of the projects on community development.

H. A new guidebook—*Guidebook on the Maintenance of Stone Walls at Castle Sites*—should be prepared and issued. The guidebook should stipulate minimum requirements concerning roles of respective organizations/individuals in stone wall maintenance projects, and ways to maintain close communication and coordination among related parties.

I. An organization should be established that will gather information concerning stone wall maintenance/renovation and that will function as a nationwide network hub. It is desirable that the office of such an organization be located within a castle site, where the maintenance/renovation projects of castle buildings and stone walls can be conducted jointly.

J. In the Japanese construction industry, the term *gijutsusha* (engineer) is traditionally defined as an individual engaged in design and management, while *ginosha* (technician) designates craftworkers, including masons. However, the definitions and classification of the two terms should be reviewed and redefined.

(3) Enabling appropriate stone wall maintenance/restoration processes

A. Since most of the quarries that are expected to supply new stone materials may also have historical value, it is essential to seek an optimal balance between their preservation as historic sites and their effective use in supplying new materials.

B. Although most imported stone materials are less expensive than Japanese materials and convenient to use, it must be remembered that in most cases the finishing processes of stones have been completed in their respective countries.

C. It is neededThe Research Organization is expected to indicate its views regarding the extent to which restoration to the original state should be pursued. In consideration of the costs of stone processing, it is also needed to the Organization must also indicate its views regarding the extent to which traditional

techniqueology should be employed in stone processing.

D. It is also needed to The Organization must also indicate its strategies for securing stone materials.

E. In consideration of the unique characteristics of stone wall maintenance projects, items that must be included in the detailed technical specifications of maintenance/renovation must be clearly illustrated in various documents, including the *Guidebook on the Maintenance of Stone Walls at Castle Sites*.

F. Basic maintenance/renovation construction processes of the stone walls and important issues in the respective processes should also be indicated in various documents, including the *Guidebook on the Maintenance of Stone Walls at Castle Sites*.

G. In preparing the detailed technical specifications, responsible persons for this task should remember [1] what they must do, [2] what they must not do, and [3] what they must know when they engage in stone wall maintenance projects. Detailed information concerning these issues must be stipulated in various documents, including the *Guidebook on the Maintenance of Stone Walls at Castle Sites*.

H. It is important to determine the extent to which restoration to the original state should be pursued in maintenance/renovation projects. Since most techniqueologies used in the beginning of the Early Modern Period (the 16th century) have disappeared, it is important to study methods for reviving them. To that end, it is imperative that existing stone walls be thoroughly observed and surveyed.

I. Preparation of stone wall charts is encouraged, since by means of this process, staff members of local governments who are responsible for stone wall maintenance can carefully observe stone walls and understand their present state. In actuality, however, many such staff members outsource this task to external agents. Accordingly, measures should be taken to rectify this trend.

J. Definitions of *dento gijutsu* (traditional techniqueology) and *dento gino* (traditional skills) must be reviewed. Whereas *gijutsu* (techniqueology) is generally understood as a conceptual oneproperty shared by contemporary people of a given epoch, *gino* (skills) is interpreted as belonging to a specific individual. Definitions of these terms, however, have not been firmly established; further efforts should be made to foster common recognition regarding their definitions.

(4) Coordinating traditional technologies with present-day construction methods

A. In parallel with the efforts to compile a report on the outcomes of the meetings, the Research Organization must decide and manifest the manner in which it will inherit and hand down traditional technologies. In doing so, the Organization should discuss these topics with design staff and masons. At the same time, appropriate procedures should be followed in order to seek governmental selection designation of stone wall maintenance techniqueologies as a Selected Preservation Techniqueology that is indispensable to the preservation of stone wallsfor cultural properties.

B. Since stone walls are civil engineering structures, their maintenance/renovation projects must place the utmost priority on safety and stability. The useadoption of newly modern present-day construction methods must be decided in consideration of structural safety and security. If the use of such modern present-day construction methods is deemed necessary, it is required to the Organization should clarify in advance the extent to which such use will be permitted.

C. Before deciding upon the use of newly modern present-day construction methods, the responsible parties must review the outcomes of surveys and researches conducted in advance. The final decision should be

made only when the parties furnish to the authority the necessary applications for approval of modifications to the present states of historic sites.

D. The applicability of newly modern present-day construction methods depends upon the respective processes, ranging from of stone material processing to laying stones in walls. It also depends upon whether the process involves *maintenance* of historic stone walls or their *reconstruction*. Since traditional construction methods of earlier times (pre-Edo Period [1603 – 1868]) have once vanished, the approaches and principles of present-day masons differ from those of their pre-modern counterparts. Present-day masons sometimes find techniques used in original stonework that they themselves consider to be taboo. Accordingly, before engaging in stone wall maintenance projects, masons must be taught that they should review their own concept of what is taboo.

E. When present-day masons find that some stones are not arranged "correctly" in original stonework, they tend to "rectify" them. For instance, when they find *sakaishi* (lit.: inverse stone; where a heavier stone is placed upon a lighter stone), which is regarded as taboo by present-day masons, they tend to rearrange the stones. Regarding these issues, thorough discussions should be held in order to seek the optimal balance between the present-day and traditional masonry approaches.

3. Future Direction

Based on analysis of the items mentioned above, the Research Organization has decided to focus its efforts on the four tasks listed below. Since these tasks should be fulfilled through joint efforts with related parties, the Research Organization asks the generous cooperation of such parties.

A. Stone wall maintenance techniqueologies isare essential for passing on the intrinsic value of stone walls at castle sites and other historic sites. Accordingly, it is imperative to protect theose techniqueologies, through its selection by the Minister of Education, Culture, Sports, Science and Technology their designation as Selected Preservation Techniqueology in compliance with Article 147 of the Law for the Protection of Cultural Propertyies. Moreover, an organization responsible for preserving the techniqueologies should be established at the earliest possible occasion. This organization, to be titled the Stone Wall Preservation Techniqueology Council ("Council"), should primarily comprise engineers and technicians engaged in stone wall maintenance.

B. As the organization responsible for preserving stone wall maintenance techniqueologies, the Council should establish objective criteria for evaluating the technological skill levels of its members, and should create appropriate evaluation systems so as to ensure maintenance of high technological skill levels.

C. In seeking cooperation from the Agency for Cultural Affairs and local governments that outsource stone wall maintenance projects, the Council should provide regular seminars and training programs for engineers, technicians and other individuals that engage in stone wall maintenance, so as to improve their technological skill levels.

D. The Council should take an active part in compiling the *Guidebook on the Maintenance of Stone Walls at Castle Sites*. In so doing, through various activities of the Research Organization the Council should seek cooperation from specialists and researchers of stone wall maintenance, as well as from staff of the Agency for Cultural Affairs and related local governments.

Even after the predicted establishment of the Council and an appropriate system for ensuring continued succession of stone wall maintenance techniqueologies, the local governments responsible for stone wall maintenance projects should continue to fulfill their roles as leading players. In partnership with the Council, the local governments should work to reinforce related systems and promote communication and sharing of information among related parties, so as to facilitate project operation and improve its reliability. At the same time, the Agency for Cultural Affairs is expected to offer advice to the Council and local governments concerned, from diverse viewpoints.

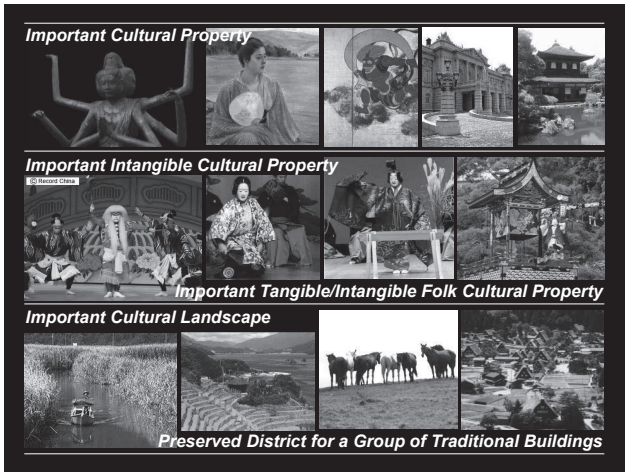
[Supplementary Note]

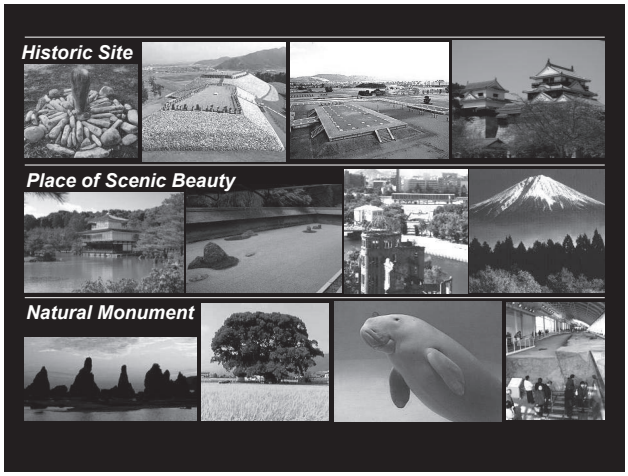
Members of the Taskforce for Development and Succession of Stone Wall Maintenance Techniqueologies for Castle Sites and Other Historic Sites

Yasutaka Kanamori	Manager, Sendai Castle Site Survey Office, Department of Cultural Properties, Sendai City Board of Education
Soichiro Kitagaki	Former Pprofessor, Higashiosaka Junior College
Tetsuro Takase	Chief Curator, Saga Prefectural Nagoya Castle Museum
Tetsuo Tanaka	Professor, Tohoku University of Art & Design
Wakio Tomita	Researcher, Kanazawa Castle Survey Office, Department of Cultural Properties, Ishikawa Prefecturale Board of Education
Kimio Nishikawa	Chief Engineer, Improvement & Promotion Section, Kumamoto Castle Office, Kumamoto City Government
Hirotoshi Yamamoto	Chief Researcher of Cultural Properties, Himeji City Research Office of Castles and Forts, Division of Life-long Education, Himeji City Board of Education

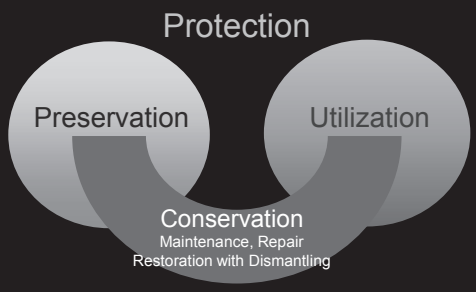
"An Object of Cultural Property" defined in the Law for the Protection of Cultural Property

- **Cultural Property**
  - **Tangible Cultural Property** (Important Cultural Properties)
  - **Intangible Cultural Property** (Important Intangible Cultural Properties)
  - **Folk Cultural Property** (Important Tangible/Intangible Cultural Properties)
  - **Monuments** (Historic Site, Place of Scenic Beauty, Natural Monument)
  - **Cultural Landscape** (Important Cultural Landscape)
  - **Group of Traditional Buildings** (Preserved District for a Group of Traditional Buildings)
- **Treasure Trove**
- **Preservation Techniques for Cultural Property**

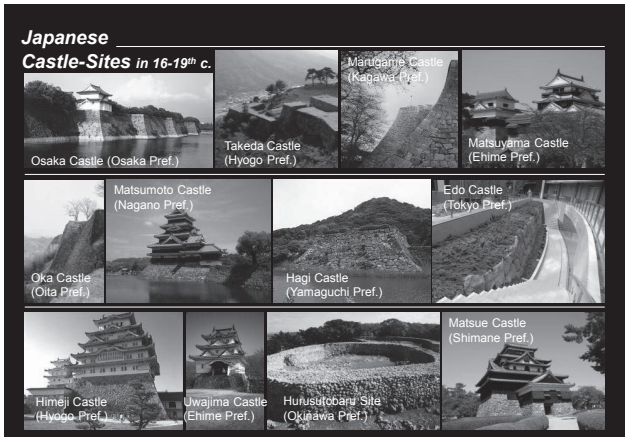


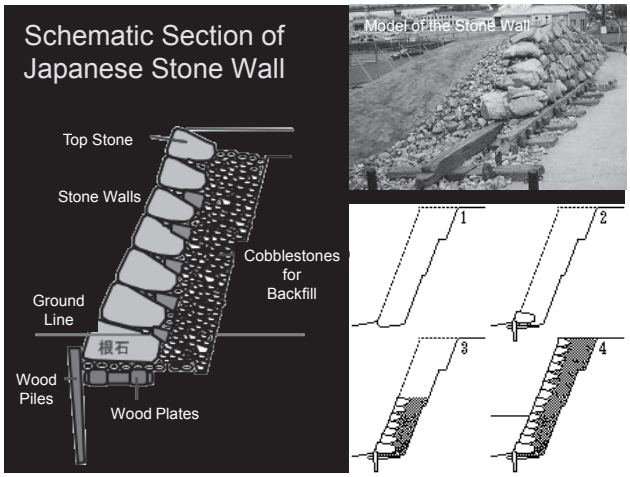


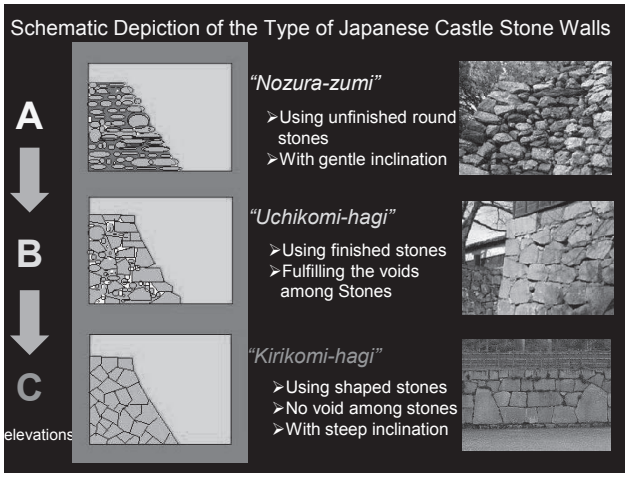
◆Protection – Preservation and Utilization –



Definition in the Article 1 of the Law for the Protection of Cultural Property







Process of Restoration with Dismantling


1
State before works of restoration with dismantling of the stone walls affected by roots of trees.


2
Numbering each stone included in the scope for dismantling. Survey.


3
Drawing up the plans, elevations and sections of the stone walls concerned.


4
Collecting the information of each stone through survey during dismantling.


5
Placing dismantled stones in order in the working lot.


6
Investigating during dismantling the original way of construction, the state of backfilling of the stone walls and causes of the state of loose.

Nakatsu Castle Site (Oita Pref.)


7
Removal of the roots of trees affecting negative impacts upon the stone walls


8
Setting the frame indicating the inclination to be followed, and starting rockworks.


9
Placing stones in its original locations respectively.


10
Completion of restoration with dismantling.

Nakatsu Castle Site (Oita Pref.) http://www.city-nakatsu.jp/digitalcontent

Maintenance of Castle Stone Walls

- Law for the Preservation of Historic Buildings of Temples and Shrines (1897)
  - Crisis to preservation of the temple buildings caused by the movement to abolish Buddhism
- Law for the Preservation for Historic Site, Place of Scenic Beauty and Natural Monument (1919)
  - Crisis to preservation of moats of ancient tombs and castle stone walls of castles caused by the Meiji enlightenment
- Law for the Protection of Cultural Property (1950)
  - Maintenance and renovation works of the stone walls of Himeji Castle started.

Succession of the Intrinsic Value of the Stone Walls as Cultural Properties

- Being stacked up should be of value.
  - Special attention should be paid to the value of stone walls as not only an archeological site but also a structure.
- The value of the stone walls can be succeeded through restoration with dismantling
  - To restore stone walls to their original state, it is essential to correctly analyze their present state, accurately specify the range of dismantling and carefully plan necessary processes, from dismantling to masonry work.
  - When stones must be replaced, new materials must be quarried, carved and finished.
  - According to the circumstance, it is needed to choose restoration method with dismantling the whole.
  - Restoration with dismantling always causes destruction of archaeological remains, especially affects on those of buildings remained on the top of the stone walls

How the Contradiction be Resolved?

- How much could the traditional techniques possibly be followed?
  - Need to respect traditional techniques that inherited for more than 400 years.
- How much could the newly modern technologies be permitted?
  - Need to ensure the safety for the visitors of the castle site.

Programs Carried out by the Agency for Cultural Affairs for Protection of Stone Wall Preservation Projects

1. Agency for Cultural Affairs has assisted the stone wall preservation projects of local governments with subsidies that have been certified as either the owners or custodial bodies of castle sites.
2. Agency for Cultural Affairs has provided assistance and suggestions regarding
   - initiatives for selecting suitable stone wall maintenance technique and sharing related information among related parties, and
   - initiatives for specifying optimal ways of transmitting basic technique that support stone wall maintenance, and to ensure that they are handed down to future generations.

A) Promoting exchange of information among parties engaged in stone wall maintenance and renovation

1. **Preparing the "*Guidebook on the Maintenance of Historic Sites*"**
2. **Establishing the *"Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts"*, and organizing its annual meetings at each castle**
3. **Compiling an official report of the "Research Organization"**

B) Passing on stone wall maintenance technique and fostering technicians and engineers

1. **Growing demand for measures to protect stone wall preservation technique**
2. **Developing Considerations to the characteristics of stone wall preservation technique**
3. **Establishing the *"Stone wall Preservation Technique Council"***
4. **Selecting preservation technique and recognizing a preservation body in compliance with the Law for the Protection of Cultural Property**

"Guidebook on the Maintenance of Historic Sites"

- Agency for Cultural Affairs established the "Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts" in 1998, and published, in cooperation with the "Organization", the "Guidebook on Maintenance of Historic Sites" in 2004.
- "Guidebook" indicated principles and measures for planning for conservation and management and applying proper techniques for maintenance of historic sites.
- Items included in the "Guidebook" has become the guideline for conservation projects for historic sites that are implemented by the municipalities concerned.

"Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts"

- In 2004, Agency for Cultural Affairs established "Survey and Research Organization for the Maintenance of Stone Walls of Castles and Forts" and started organizing annual meeting in cooperation with the municipalities that hosts it.
- It aims at close exchange among the members of the municipalities that implements projects for maintenance and repair of the castle stone walls
- The special report approved at the 5th meeting in 2008 included;
- Summary of the items discussed in the previous five meetings,
  - In order to train technicians and stonemasons in the young generations, technique for preservation of stone walls should be selected under Article 147 of the Law for the Protection of Cultural Property,
  - Specific organization consisting of technicians and stonemasons who participates at the projects of maintenance and restoration of castle stone walls should be established as soon as possible.
  - New guidebook for maintenance and restoration of castle stone walls should be issued.

"Stone Wall Preservation Technique Council"

- Established in April, 2008.
- Consisting of technicians and design stuff who are in charge of maintenance, renovation and restoration of castle stone walls designated as historic sites under the domestic Law.
- Organizing practical training courses for technicians in cooperation with researches and other experts.
- Disseminating the information on the activities of the "Council" through publishing annual bulletin.
- Of which secretariat is placed in the "Japan Castle Research Center" (established by Himeji City)

Law for the Protection of Cultural Property

- Article 147 Selection of Preservation Technique

The minister of Education, Culture, Sports, Science and Technology may select such preservation technique as traditional techniques or craftsmanship that are indispensable to the preservation of cultural property and for which preservation measures shall taken.

Law for the Protection of Cultural Property

- Article 147 Selection of Preservation Technique

2. In making the selection under the provision of the preceding paragraph, the Minister of Education, Culture, Sports Science and Technology shall recognize a bearer or a preservation body (*i.e.* a body (including a foundation) that primarily aims at preserving 'Selected Preservation Techniques' and has its representative or manager appointed by their own statutes; hireinafter, the same applies) of the 'Selected Preservation Techniques'.

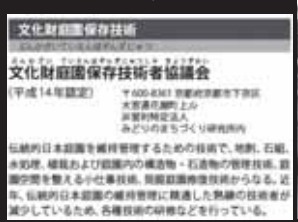
The Number of the Selected Preservation Techniques

as Traditional Techniques or Craftsmanship that are Indispensable to the Preservation of;

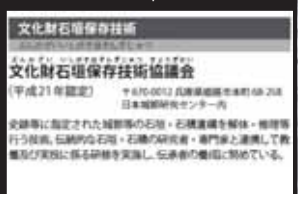
Buildings	19
Artistic Products	16
Performing Arts	15
Applied Arts	20
Folk Cultural Properties	1
Monuments	2
Total	73

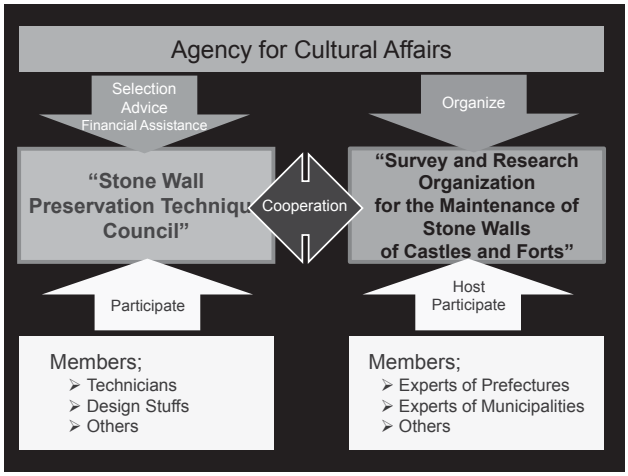
In the year of 2011

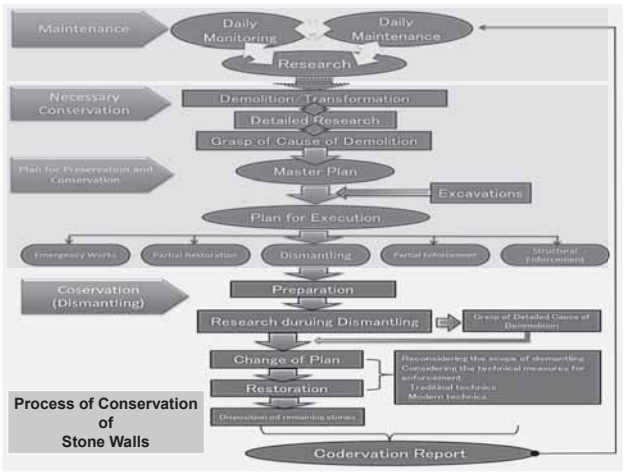
Selected Preservation Techniques for **Gardens**



Selected Preservation Techniques for **Stone Walls**







Process of Conservation of Stone Walls

Building Database for Stone Walls

◆Monitoring through "Chart" for the state of stone walls.

Below items should be undertaken while drawing up the "Chart".

- Photography of each side of stone walls
- Measurement of height and inclinations of the stone walls
- Reflection of all information regarding the stone walls concerned on the chart.
- Grasp of the type of each stone comprising stone walls.
- Identification of the traces and evidences of former restoration, and their verification/comparison with the documents at the time of the former restoration.
- Comparison with the old illustrations, drawings and pictures etc.
- Determination of the minimum necessary parts that possibly collapse in the near future.

◆"Reading the face of the stone walls by staff's own eyes" automatically deepens understanding their characteristics and value.

Important Items during the Restoration with Dismantling includes;

◆ **Identification of the Scope for Restoration with Dismantling**
- ◆ It is Important to minimize the scope for restoration with dismantling.
- ◆ It is needed to remain the base stone as the original state.
- ◆ It is appropriate to determine the scope with high risk of collapse through periodical monitoring and undertake restoration with dismantling.

◆ **Chart for individual stones**
- ◆ Photography of individual dismantled stones.
- ◆ Measurement of width, height and length of individual stones.
- ◆ Confirmation of specific marks on each side of individual stones.
- ◆ Identification of the grit of individual stones.

◆ **Grasp of the process of stone wall formation**
- ◆ "Restoration with dismantling" equals to "Archaeological Excavation".
- ◆ It is Important to share information on the process of excavation and restoration between archaeological experts and technicians (stonemason).

◆ **Measures for change and replacement of original stones**
- ◆ Measures for procuring of new stones for replacement
- ◆ Measures for distinction between original stones and new stones.

II. Papers by Participants

Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Arnulfo F. DADO
Museum Curator II / Chief Architect
Restoration and Engineering Division
National Museum of the Philippines

Abstract

The paper delves on the current issues and future tasks for the conservation of stone and brick structures in the Philippines, mainly our National Cultural Treasures and National Historical Landmarks. An overview of Philippine architectural heritage built in stone and brick is presented. Case studies on the conservation and restoration of the Philippine Baroque Churches (World Cultural Heritage Site) revealed the significance and value of the church heritage structure to the community and the need to preserve it. From the standpoint of building conservation, the state of preservation of stone and brick heritage structures reflect the value accorded by the national government, the Church, and the local community to built heritage and local building traditions that sustain their conservation.

Keywords: Conservation, heritage, brick, stone

An overview of stone and brick heritage in the Philippines

The protection and conservation of the country's built heritage, as embodied in our Constitution and mandated by law such as the National Cultural Heritage Act of 2009 (Republic Act No. 10066), rests mainly upon three government cultural agencies: National Historical Commission of the Philippines (NHCP), National Museum, and National Commission for Culture and the Arts (NCCA). Since 1973 the NHCP (formerly the National Historical Institute) and the National Museum have identified and declared numerous immovable cultural properties worthy of preservation. To date the NHCP has declared 201 sites and structures as either a National Historical Shrine, National Historical Monument, or National Historical Landmark. The National Museum has declared 58 immovable cultural properties as either a National Cultural Treasure or an Important Cultural Property. Six of these immovable cultural properties have been inscribed in the UNESCO List of World Heritage Sites. Such a National Cultural Treasure is defined by law as "a unique cultural property found locally, possessing outstanding historical, cultural, artistic and/or scientific value which is highly significant and important to this country and nation, and officially declared as such by pertinent cultural agency" (RA 10066). Cultural properties which have been singled out from among the innumerable cultural properties as "having exceptional cultural, artistic, and historical significance to the Philippines," (RA 10066) as shall be determined by the National Museum and/or the NHCP, are designated as Important Cultural Properties. Other categories of immovable cultural properties

are National Historical Shrine, National Historical Monument, and National Historical Landmark as determined by the NHCP. The categories of cultural properties guide the government in determining priority funding for protection, conservation and restoration.

In line with the policies and objectives of R.A. 10066, the government has formulated a program for the conservation of built heritage. Through the NCCA, the program provides assistance to structures declared as National Cultural Treasures and/or inscribed in the list of UNESCO World Heritage Sites. Currently, the main beneficiaries of the program are the 36 Spanish colonial period churches located in the 11 regions of the country. In the last three years (2008 - 2010), NCCA provided financial grants in the amount of P46,745,437.00 to 28 restoration projects for churches declared as National Cultural Treasures (National Commission for Culture and the Arts [NCCA] 2011). In 2001, the National Museum declared and designated the 26 Philippine colonial churches[i] as National Cultural Treasures. These colonial churches considered as the best examples of our Philippine architectural heritage constitute the greater part of the cultural heritage of the Philippines.

The Philippine colonial churches are mainly built of stone and masonry. An understanding of these historic masonry structures in relation to the tropical and seismic environment facilitates an appropriate line of conservation action that includes preventive conservation and building maintenance. Spanish missionaries introduced masonry in the country during the late-16th century and made masonry popular by the turn of 17th century (Jose 1991; National Historical Institute [NHI] 2005). Geologically, the country has an abundant source of materials like tuff and other volcanic rock, coral stone, sandstone, limestone, lime and clay. The local people learned how to work with stone, brick and lime. Structures were built of rubble, cut stones or bricks, held together by traditional lime-based mortars. Thick walls, buttresses, arches and vaults characterize the masonry construction of the heritage churches. The stonework or brickwork of church facades was often articulated with ornamental reliefs or sculptures.

The decay of masonry can be attributed to natural conditions such as humidity, rain, deposits of soil, presence of water and temperature extremes. Other causes are inadequate protective measures such as roofs, drainage pipes and plastering. Structural damage to masonry-built historic structures can also be attributed to natural phenomena like earthquakes and typhoons. To prevent or slow down the decay process of masonry as material, preventive and remedial actions are necessary. As part of building maintenance, varying degrees of interventions on the surface of the structure, at the base of the structure, and inside the structure, are introduced (Croci 1998). Periodic maintenance is best undertaken at regular intervals in a collaborative effort among all the stakeholders of the heritage structure.

Restoration and Conservation of Stone and Brick Heritage:
Philippine Colonial Churches

While the prevailing approach in conservation still favors the curative rather than the preventive, recent government-funded projects emphasize the importance of disaster-sensitivity (Dado 2011). Restoration projects concerning our National Cultural Treasures were recipients of grants from NCCA. In keeping with risk-preparedness for our heritage structures, the government strengthens its advocacies for preventive conservation measures as priority interventions. Walls have to be cleaned and kept structurally stable. Roof trusses and framework have to be structurally retrofitted to improve tensile resistance. Wind-and-water-tight

roofs are essential for heritage structures that lie along the path of strong typhoons. Adequate fire protection shall be integrated in the building system. The National Museum, as mandated by law, supervises all activities relating to the conservation, restoration and preservation of Philippine colonial churches as National Cultural Treasures.

The San Agustin Church in Intramuros, Manila was declared a National Cultural Treasure in 1973 and was included among the four Philippine Baroque Churches inscribed in the list of UNESCO World Heritage Sites in 1993. The structure was built mainly of volcanic tuff (locally known as *adobe*). The structure is considered the oldest stone church in the Philippines. The structure was damaged by fire in 1605 and 1923; war bombing in 1945; and earthquakes in 1771, 1852, 1863, 1880, and 1937 (with negligible effects). The structure's plasters were removed (1969-1970) to expose the masonry units. In 1995, the cement-adobe layer applied in 1970 was removed, and the façade were replastered with new lime cement layer. The Detailed Engineering Studies (DES) for the structure revealed the need for the re-plastering of the exterior masonry walls, and the repair of doors and windows (Schema Konsult, Inc., 2002). The corrective repairs and restoration were implemented in two phases, in 2007 and 2009. Both phases of the restoration and conservation works were implemented through a building contractor. In the first phase of the project the contractor's manpower were given orientation and brief training on-site by the National Museum team on the proper procedures of masonry cleaning, limewashing, consolidation and replastering. They were taught how to prepare the specified lime-base mortar mixture. The first phase was completed at a cost of P3,546,888.00 for a duration of 210 calendar days (from December 18, 2006 to May 31, 2007). The second phase was completed at a cost of P4,188,449.83 for a duration of 185 calendar days (from September 27, 2008 to June 30, 2009). The exterior walls of the inner courtyard and the church facade involving more than 5,174 square meters were applied with the lime-based *paletada* (plaster). A colored mineral pigment was tested and applied as part of the plaster and yielded acceptable results (National Museum 2009). The restoration projects were supervised by the National Museum through its team of architects and conservators.

The Miagao Church in Miagao, Iloilo was declared as a National Historical Landmark in 1975 and was included among the four Philippine Baroque Churches inscribed in the list of UNESCO World Heritage Sites in 1993. The church structure was built mainly from carbonaceous limestone. The structure was built from 1786-1797. The structure was burned twice (during the revolution against Spanish, and during the Japanese Occupation); and was reconstructed from 1945-59. The restoration of the structure was under the jurisdiction of the National Historical Institute (now referred to as NHCP) since 1975 until it was assigned under the jurisdiction of National Museum in 2005. The DES for the present church structure specified the need for the cleaning of the exterior masonry walls (EJR Construction & Dev't. Corp., n.d.). The initial restoration work involving about 4,030 square meters of the exterior masonry walls was completed in 2010 at a cost of P1,988,897.46 for a duration of 150 calendar days (from September 18, 2009 to February 28, 2010). A total exterior wall surface area of about 4030 square meters was cleaned by mechanical and chemical means. Bryophytes and pteridophytes were removed by gently uprooting, while surface deposits were removed and cleaned using stiff bristle brush, followed by water washing at low pressure (National Museum 2010). Woody plants were treated with appropriate herbicides, Round-up by Mosanto (National Museum 2010). The restoration project was supervised by the National Museum through its team of architects and conservators.

Current Issues on Restoration and Conservation of Stone and Brick Heritage

The government supports training programs for conservation professionals and skilled workers with the aim of sustaining the conservation of Philippine built heritage. As part of the government's capacity and capability building, cultural workers of government cultural agencies are encouraged to acquire relevant international and local trainings in heritage conservation. Architects drawn to further studies and specializations in heritage conservation acquire relevant training through the courses offered in the academe or through seminars as part of the continuing professional development.

Since 2008, the NCCA, through the National Museum, organized and conducted a series of seminars and training workshops to increase awareness and enhance the skills of communities in the risk-preparedness for cultural heritage. These seminars included a module on disaster response strategies and building maintenance.

Early this year, the First UST-UAP Certified Heritage Building Conservation Specialist Course was held from 15 January – 19 March 2011. The certificate program offered by the University of Santo Tomas - Center for Continuing Professional Education and Development, and the United Architects of the Philippines was "intended to provide continuing professional education to architects, contractors, restoration workers and other professionals who want to enhance their skills in the art of heritage preservation, rehabilitation, and restoration of heritage buildings and sites."

Another notable training program is offered by the *Escuela Taller*. The *Escuela Taller* in Manila was established in 2008, as a collaboration among Agencia Española de Cooperación Internacionál para el Desarrollo, NCCA, Intramuros Administration, Technical Education and Skills Development Authority (Tesda), and the Department of Social Welfare and Development (Villalon 2011). The 1½ -year training course provides skills in traditional construction technology which includes, among others, that of stone sculpture, traditional stone and masonry. The training course aims to equip the selected out-of-school youths or trainees with skills, and develop human resource for heritage building conservation (Villalon 2011). An encouraging policy introduced by NCCA (in its Res. No. 2010-390), intends to give privileges to persons who have completed relevant courses at *Escuela Taller* or equivalent institution to be given priority in the selection of workers for restoration projects (NCCA 2011).

The prevailing mode in the implementation of restoration projects is in compliance with the Government Procurement Reform Act (RA 9184) concerning government infrastructure projects. The services of a building contractor with the technical, financial and legal capacity will be considered for the project. The technical supervision of restoration projects is either under the NHCP or the National Museum. Normally contractors hire local manpower whenever the skilled people are available especially for projects in communities far from the contractor's company base. Policies are yet to be fully implemented to ensure that for the restoration of built heritage in a certain community, the required competencies and skills are made accessible and available, and that contractors employ competent professionals and skilled workers from the local community.

As part of the collaborative conservation program for the Church of San Agustin in Paoay, Ilocos Norte, the NHCP and the Municipality of Paoay undertook the scientific documentation and cleaning of the masonry walls from 2003-2004. A component of the project involved the orientation-training of the local people as manpower resource prior to implementing the cleaning of the walls. Under the guidance of NHCP

team, workers were taught how to properly clean the stone and masonry walls by mechanical and chemical means. With the disruption of preventive maintenance for about six years, the regrowth of vegetation on the same masonry surfaces were evident. The planned sustaining corrective maintenance works - involving the eradication of moss, soiling and bird droppings as well as necessary treatment of herbicides for the large woody plants or trees - were not implemented in the summer months as prescribed (NHI 2004). Masonry consolidation has been formulated in the plans - which include the reassembling of dislocated stones, as well as re-pointing and re-plastering to sustainably address the problems of bio-deterioration and masonry decay - yet these plans were deferred for reasons that are attributed to lack of funds (NHI 2004). Financial grant from the NCCA is requested by NHCP to consolidate the masonry walls in 2012. This could be an opportunity for another collaborative undertaking among the national governmental cultural agencies, the Church community, and the Municipality of Paoay. This could likewise be the stepping stone to build up on the government training program initiatives, by integrating skilled workers (such as people trained at *Escuela Taller*) in developing the community's human resource that will implement the restoration agenda for Paoay Church.

Discussion and Conclusion

One strong significance of the Philippine colonial church as an architectural treasure is its contribution to the development of a local building tradition adapting the use of indigenous materials such as stone and brick. We should learn from these building traditions and reintegrate them in maintaining our heritage churches.

The national government has limited financial resource. Priorities should remain focused on our outstanding National Cultural Treasures and in keeping with the risk-preparedness for our heritage structures. The involvement of the local community should be strengthened by providing them with appropriate training programs, geared towards the safeguarding of traditional skills and developing human resource that can augment the government initiatives in the conservation of stone and brick heritage. Competent people in the local community could be tasked with responsibilities vital in the maintenance of heritages structures. Traditional building practices are important resources that could benefit a building maintenance program and disaster response. Local masons and craftspeople have the practical knowledge and adaptable skills that can be rediscovered or revived. Local people's skills and industry complemented by the competence of trained local professionals are potent resources that should be developed intensively.

We should focus on how we can develop the community's human resource, and how such intangible resource can best sustain the conservation of our Philippine built heritage.

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Author's Note

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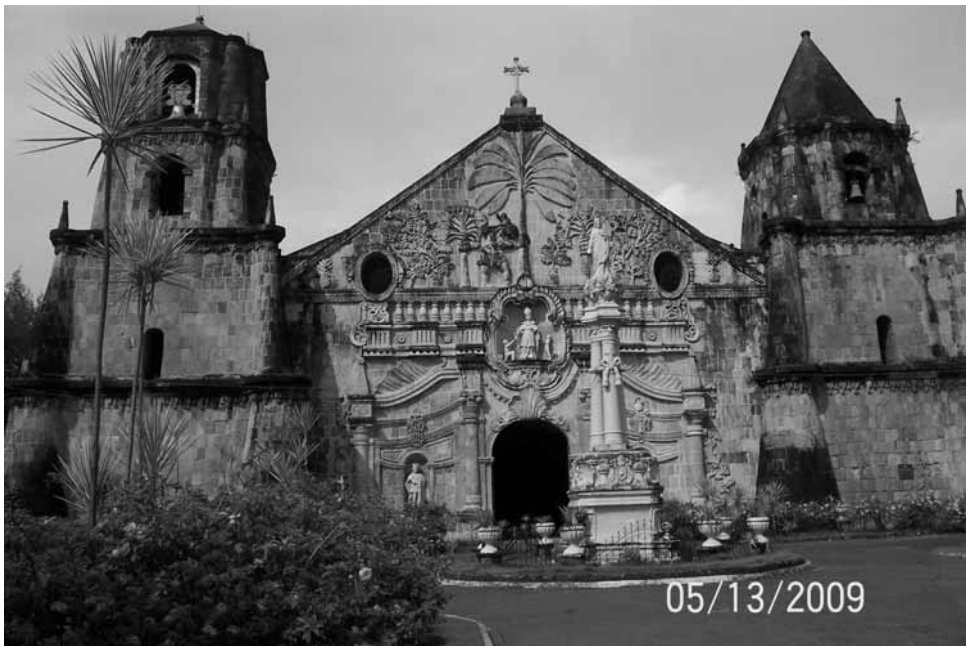
[i] Letter of declaration dated July 31, 2001.

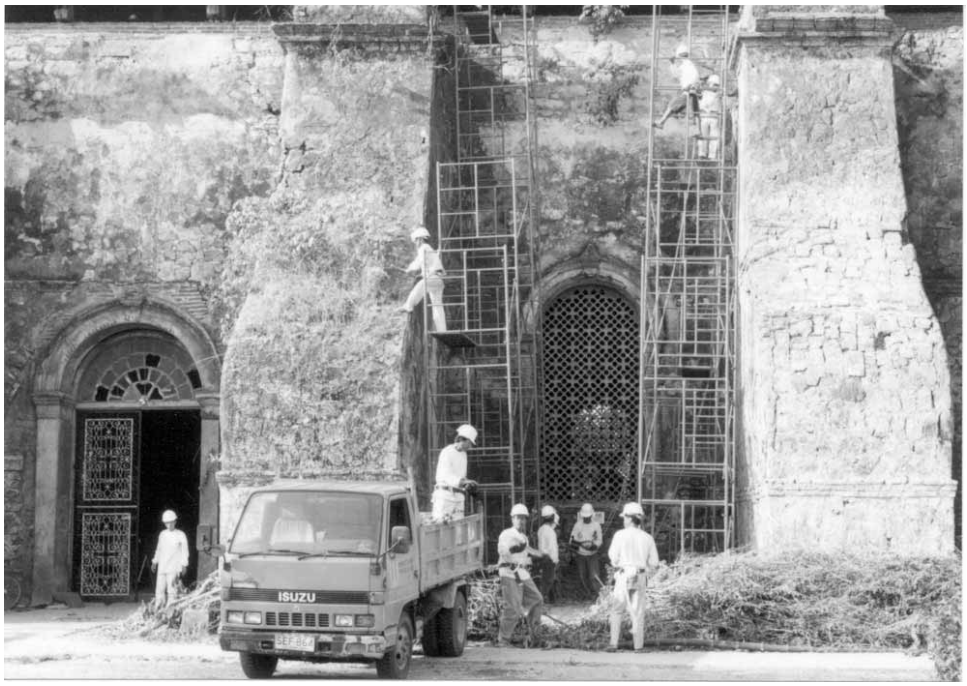
San Agustin Church before restoration (2008) and after the restoration of its façade (2009) (National Museum 2009)



Miagao Church before the restoration (2009) and after the restoration (2010)

(National Museum 2010)

Paoay Church before the cleaning of the walls in 2003 (NHI 2004)



Paoay Church during the cleaning of the walls in 2003 (NHI 2004)

The local workers trained and involved as manpower resource of Paoay Church Restoration Project in 2004 (NHI 2004)

Paoay Church in Paoay Ilocos Norte

INTERNATIONAL CONFERENCE ON *HUMAN SKILLS RESOURCE DEVELOPMENT FOR THE TRANSMISSION OF TRADITIONAL SKILLS: NATIONAL APPROACHES AND THEIR APPLICATION TO STONE AND BRICK*
SHANGHAI, DECEMBER 6-8, 2011

Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

ARNULFO FAJARDO DADO . 06 December 2011

Overview of stone and brick heritage in the Philippines

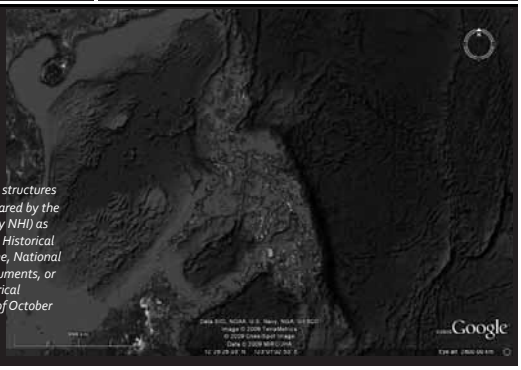
The Cultural Heritage Act of 2009 (RA 10066)

1. *Protect, preserve, conserve and promote the nation's cultural heritage, its property and histories, and the ethnicity of local communities;*
2. *Establish and strengthen cultural institutions; and*
3. *Protect cultural workers and ensure their professional development and well-being*

NHI NM NCCA

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

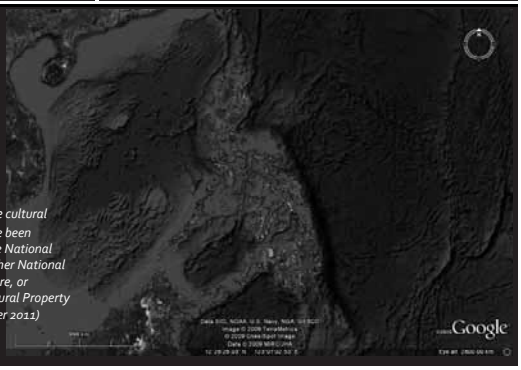
Overview of stone and brick heritage in the Philippines



***201** sites and structures have been declared by the NHCP (formerly NHI) as either National Historical Historical Shrine, National Historical Monuments, or National Historical Landmark (as of October 2011)*

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines



***58** immovable cultural properties have been declared by the National Museum as either National Cultural Treasure, or Important Cultural Property (as of November 2011)*

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

Program for the conservation of Philippine built heritage

Intended primarily to provide assistance to structures declared as National Cultural Treasures, and UNESCO World Heritage Sites.

*Primary beneficiaries are **36** Catholic churches in 11 regions.*

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

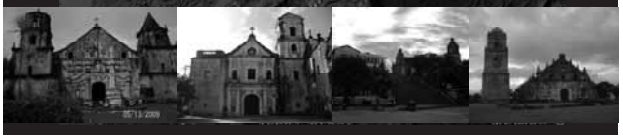
Overview of stone and brick heritage in the Philippines

World Heritage Sites

Some of our National Cultural Treasures have been inscribed in the UNESCO List of World Cultural Heritage Sites.

6

(After Heritage City of Vigan)



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

National Cultural Treasure

A unique cultural property found locally, possessing outstanding historical, cultural, artistic and/or scientific value which is highly significant and important to the country and nation.

(RA 10066)

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

Important Cultural Property

A cultural property having exceptional cultural, artistic, and historical significance to the Philippines (RA 10066).

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

National Historical Shrine

Historical sites or structures hollowed and revered for their history or association (RA 10066)

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

National Historical Monuments

Structures that honor illustrious persons or commemorate events of historical value (RA 10066)

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

National Historical Landmark

Sites or structures that are associated with events or achievements significant to Philippine history (RA 10066)

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

Program for the conservation of Philippine built heritage

3

P46,745,437.00

28

In the last three years (2008-2010), the NCCA provided financial grants in the amount of P46,745,437.00 to 28 restoration projects for Spanish colonial period churches declared as National Cultural Treasures.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

Philippine colonial churches are the best examples of our architectural heritage.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

Geologically the Philippines has abundant sources of stones and clay.

Heritage structures are mainly built of stone and masonry.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

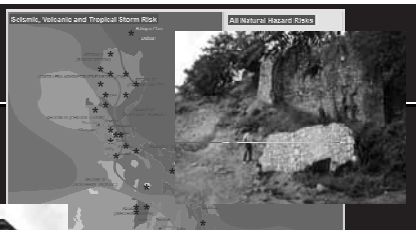
Overview of stone and brick heritage in the Philippines

Stonework of church facades

Ornamental reliefs and sculptures

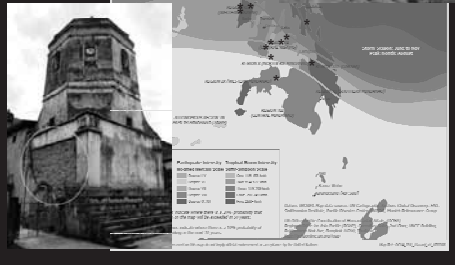
Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

36 PHILIPPINE COLONIAL CHURCHES DECLARED AS NATIONAL CULTURAL TREASURES



EARTHQUAKE
FIRE

TYPHOON
FLOOD
EROSION



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

DISASTER-SENSITIVITY

KEEPING THE WALLS CLEAN AND STABLE.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

Damaged by fire 1605 & 1923; war bombing in 1945; and earthquakes in 1771, 1852, 1863, 1880, & 1937 (with negligible effects).

1969-1970 - Plasters were removed to expose masonry units (Angel Nakpil)

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

1995 - Removal of cement-adobe layer applied in 1970; and replastered with new lime-cement layer .

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

A study revealed the need for the re-plastering of the exterior masonry walls, and the repair of doors and windows.

Built mainly of volcanic tuff

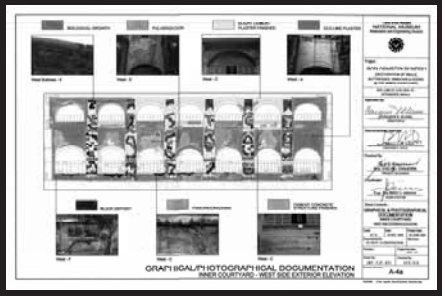
Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

San Agustin in Intramuros, Manila

Deposits on the stone surfaces: black deposits, biological growth, moss, lichens, algae.

Structural condition: pulverization, fissuring/cracking, open joints



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

Orientation training of contractor's manpower on :

1. Masonry cleaning and removal surface deposits/ previous cement plaster.
2. Consolidation, limewashing, repointing masonry joints.
3. Replastering of exterior wall surfaces & buttresses.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

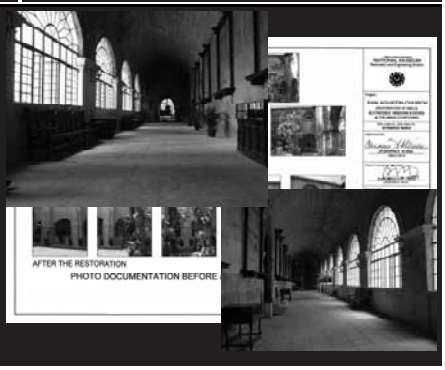
Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

Repointed masonry joints;

Replastered about 2630 sq. m of the courtyard's exterior wall

Replastered 260 sq m of the interior corridor's wall



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

San Agustin in Intramuros, Manila

Restoration works on the walls at the inner courtyard was done by a building contractor, at a cost of P3,546,888.00 for a duration of 210 calendar days. Work started December 18, 2006 and was completed May 31, 2007.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

1. Masonry cleaning
2. Removal surface deposits /previous cement plaster.
3. Consolidation
4. Replastering of exterior wall surfaces .

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Overview of stone and brick heritage in the Philippines

San Agustin in Intramuros, Manila

Restoration works of the façade was done by a building contractor , at a cost of P4,188,449.83 for a duration of 185 calendar days. Work started September 27, 2008 and was completed June 30, 2009.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

San Agustin Church in Intramuros, Manila

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

Constructed in 1787-97, as a fortress. Damaged by fire twice – during the revolution against Spain in 1898, and in World War II; and the earthquake in 1948.

Rebuilt 1945-1959.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

A study for the present church structure specified the need for the cleaning of the exterior masonry walls

Built mainly of carbonaceous limestone.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

Deposits on the stone surfaces: dark deposits, botanical growth, moss, lichens, algae.

Structural condition: pulverization, fissuring/cracking, open joints

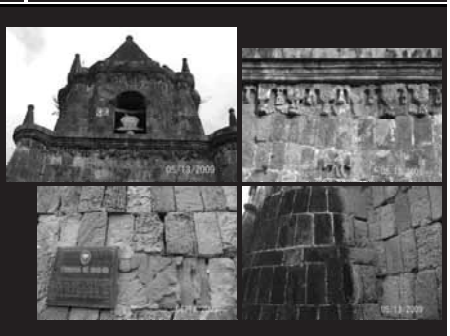
Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

Deposits on the stone surfaces: dark deposits, botanical growth, moss, lichens, algae.

Structural condition: pulverization, fissuring/cracking, open joints, scaling

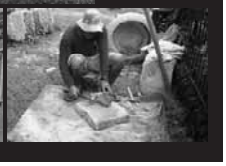


Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

1. Masonry cleaning (by mechanical and chemical means)
2. Removal surface deposits.
3. Consolidation
4. Repointing

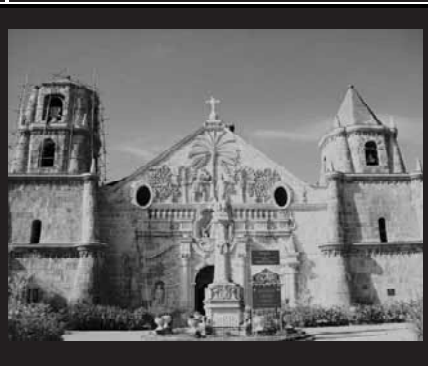


Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

1. Cleaned masonry walls;
2. Removed surface deposits (by mechanical & chemical means)
3. Consolidated stones & repointed masonry joints



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

Restoration work of the exterior walls was done by a building contractor , at a cost of P1,988,897.46 for a duration of 150 calendar days. Work started September 18, 2009 and was completed February 28, 2010.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Restoration and conservation of Philippine colonial churches

Miagao Church in Miagao, Iloilo

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Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

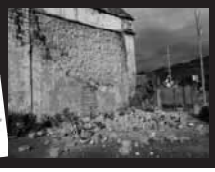
Current issues

TRAINING PROGRAMS

Since 2008, series of seminars and trainings, enhancing the awareness and skills of communities in risk preparedness for cultural heritage.

1st UST-UAP Certified Heritage Building Conservation Specialist Course (15 January – 19 March 2011)

The Escuela Taller de Intramuros



Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Current issues

BUILDING HUMAN RESOURCES

implementing a restoration project by a building contractor.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Current issues

BUILDING HUMAN RESOURCES

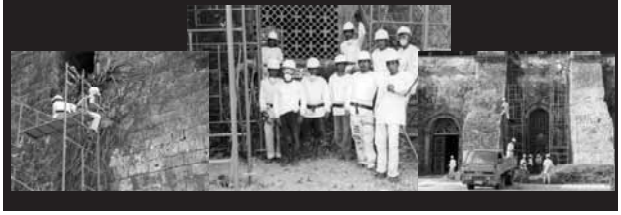
implementing a restoration project by administration.

Dado, A.F. (2011)
Current Issues and Future Tasks for Conservation of Stone and Brick Structures in the Philippines

Current issues

BUILDING HUMAN RESOURCES

implementing a restoration project by administration.



Conclusion

Traditional building practices could benefit a building maintenance program .

INVOLVE THE COMMUNITY
TRAIN PEOPLE
BUILD HUMAN RESOURCES

Thank you .

afdado@gmail.com
wishes to acknowledge the NM, NHCP and NCCA.

Problems and Solutions of Cultural Heritage Made from Bricks Conservation in Indonesia

Soeroso

Senior Staff

Directorate General of Archaeology and Museum

Ministry of Education and Culture

Abstract

Cultural heritage in Indonesia made from various materials such as andesitic stone, brick, and wood. Brick is the main element that is used for building construction and made of soil or various mixtures of other ingredients, then baked to make it strong and not easily broken even if exposed to rain or soaked into water.

There are many different shapes and sizes of brick made in Indonesia, some are sharp, geometric or other shapes adapted to the shape of the building of the cultural heritage.

The architecture of cultural heritage made from bricks in Indonesia are varied, from the influence of Hindu / Buddhist until the colonial period. Cultural heritages made of bricks that come from the kingdom of Hindu / Buddhist is mostly not shielded by the roof, thus directly affected by the rain and heat of sun. While the heritages that come from the colonial period has been partially protected by the roof construction. This condition causes various damages and weathering of cultural heritage made of bricks in Indonesia.

Old bricks have properties that are very sensitive to the threat of damaging factors both biological and physical nature. One of the factors that could cause problems of brick conservation is water. Water can cause damage in biological, chemical, and physical aspect on the surface of the brick. The most severe consequences caused by water are the growth of microorganisms, salinity, and the fragility of brick.

One effective way to overcome this problem is to create a waterproof layer horizontally to prevent capillary movement of water from the ground and the application of *masonceal* water repellent to reduce the amount of water that enters the brick material. Studies on the cultural heritage conservation should continue to be developed in Indonesia. One obstacle in the cultural heritage study especially on conservation aspect is the number of experts who are dedicated to the preservation of cultural heritage and the laboratory facilities are still inadequate compared to the number and variety of cultural heritage in Indonesia, especially the cultural heritage made from bricks.

CULTURAL HERITAGE MADE FROM BRICKS CONSERVATION PROBLEMS AND SOLUTIONS

Soeroso
Directorate for Archaeological Heritage
Directorate General of History and Archaeology
Ministry of Tourism and Creative Economy
Republic of Indonesia

International Conference 2011
Human Resources Development for the Transmission of Traditional Skills: National Approaches and their Application to Stone and Brick
Shanghai, 6-8 December 2011

Objectives

- To exchange and share of knowledge and experience on community based conservation development of cultural heritage
- To inventory the issues encountered
- To formulate recommendation and action plan to be jointly implemented
- To discuss models of implementation and development on community based conservation of cultural property

Scope

- **Aims and Objectives**
- **Background and Justification**
- **Cultural heritage: definition, material,and ownership**
- **Problem encountered: cultural heritage, community, and human resources**
- **Policy and Strategy of Implementation**
- **Case study: community based development**

What is CULTURAL HERITAGE PROPERTY?

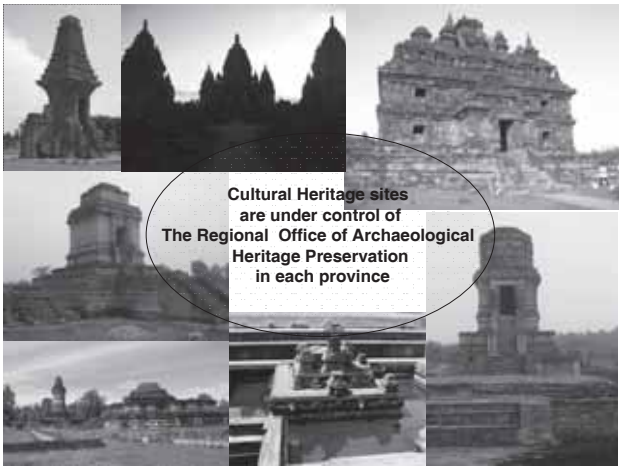
According to Law of Cultural Heritage Number 11 year 2010:

Cultural Heritage Property is the tangible cultural heritage in the form of:
Cultural Heritage Object , Cultural Heritage Building, Cultural Heritage Structure , Cultural Heritage Site , Cultural Heritage Area located on land and / or under water that needs to be preserved because it has important value for the history, science, education, religion, and / or culture through the process of judgment

Management of Cultural Heritage is Regulated by:

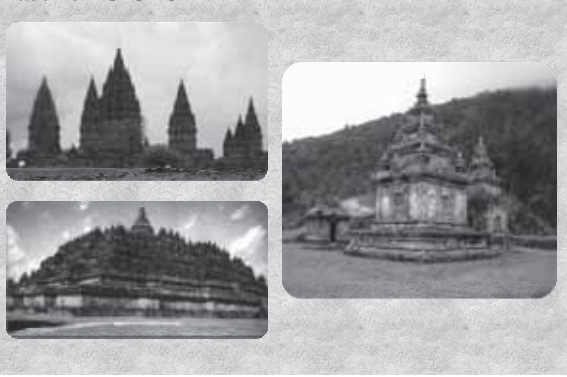
- Law of The Government of Republic of Indonesia Number 11, Year 2010 about Cultural Heritage
- Law of The Government of Republic of Indonesia Number 28, Year 2002 about Buildings
- Law of The Government of Republic of Indonesia Number 32, Year 2004 about Local Otonomi Government
- Law of The Government of Republic of Indonesia Number 26, Year 2007 about Spatial Arrangement
- Joint Regulation of Minister of Home Affairs and Minister of Culture and Tourism Number 040 and 042 Year 2009
- Government's Regulation Number 14, Year 1993
- Some others related regulations,.

Maimun Palace, North Sumatera

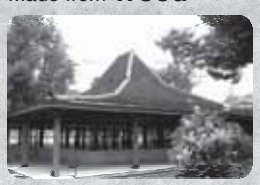


TYPES OF MATERIAL CULTURAL HERITAGE RESERVES IN INDONESIA

Cultural Heritage in Indonesia
Made from **Stone**



Cultural Heritage in Indonesia
Made from **Wood**



Cultural Heritage in Indonesia
Made from **Bricks**



Brick is the main element that is used for building construction and made of soil or various mixtures of other component, then combusted to make it strong and not easily broken, even if exposed to rain or soaked into water.

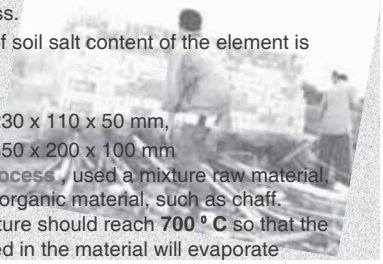
The process of bricks making from soil mine process mixed with water and other materials, until the shaping of the bricks all are done by hand.

BRICKS ANALYSIS

- Shape
- Material Composition(sand and clay)
- Colour
- Compressive strength
- Water content
- Temperature of Combustion
- Destructive dissolved salt

Technique of Bricks Making

1. **Quality of raw material**
   High quality soil as a raw material is a type of *lempung padas* (rock-clay). If the material contains too much clay , it will be easily broken at the time of the drying process, when too much sand , it will be brittle. Ratio between clay and sand contained in the material needs special experience in the manufacturing process.
   Laboratory analysis of soil salt content of the element is needed.
2. **Brick size :**
   - present = 230 x 110 x 50 mm,
   - ancient = 350 x 200 x 100 mm
3. **For combustion process**, used a mixture raw material, usually composed of organic material, such as chaff. Combustion temperature should reach **700 º C** so that the water particles trapped in the material will evaporate



Agent of Damage and Deterioration of Cultural Heritage made from Bricks :

1. **Moist**
2. **Water**
3. **Microorganism**
4. **Quality of brick replacement**
5. **Bricklaying technique**
6. **Cement use**
7. **Organic Acid**
8. **Sun heat**
9. **Wind**
10. **Vandalism**

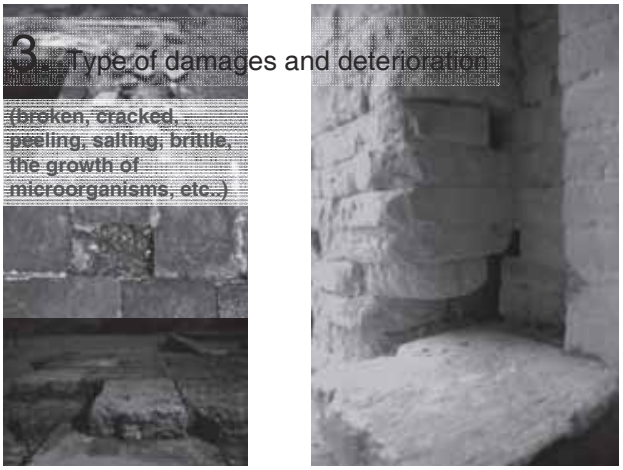
TECHNICAL STUDY PRECEDING TO CONSERVATION

OBSERVATION	IDENTIFICATION	PLANNING AND ACTION
❑**Method and technique of the building process;** ❑**Damage and deterioration (broken, cracked, peeled, salting, brittle, the growth of microorganisms, *etc.*);** ❑ **Analysis of environment microclimate such as temperature, moist, wind speed, etc**	❑**Analysis of the physical characteristics of cultural heritage materials, petrography, and chemical;** ❑**Analysis of damage and weathering of cultural heritage material microbiologically;** ❑**Test in the effectiveness of treatment materials and their impact on the Cultural heritage**	❑**Method and technique;** ❑**Equipments and materials;** ❑**Human resources;** ❑**Cost;** ❑***Etc.***


Case Study:
Conservation Technical Study
BAHAL TEMPLE, Padang Lawas, North Sumatera


1. Field Observation


2. Positioning and measurement
Using GPS and manual ruler


3. Type of damages and deterioration
(broken, cracked, peeling, salting, brittle, the growth of microorganisms, etc..)


4. Sampling and microclimate analysis
Sample will be examined in the laboratory to find out the mineral content, chemical substance, and its characteristic
Analysis of environment microclimate such as temperature, moist, wind speed, etc.


5. Microorganism and other organisms analysis
Algae, lichen, moss, grass, insect, birds, etc.


6. Vegetation
Dominant vegetation and its influence to the temple existence


7. Economy and Social
Visitors and people surrounding, wether influence the existence of the temple or not.

Conservation Action

Mechanical Cleaning

Target:	Material:	Equipments :
Dust accumulation, soil, moss, and brittled clay	Water if necessary	brush toothbrushes, vacuum cleaners, needles, knives or spatulas, buckets, masks, gloves

Chemical Cleaning

Target:	Materials:	Equipments:
paintstain, markers, oil, lichens, algae, and salt deposits	Water, AC-322, Alkohol, Toluol, Xylol, Thinner, Acetone, Ethyl Asetat, Paint Remover, Hyvar-XL, Hyamin	brush, brush fibers, toothbrushes, needles, knives or spatulas, wooden stirrers, buckets, masks, gloves

... Chemical Cleaning

Paint stain, markers, and oil

- Use of organic solvents such as alcohol, toluol, Xylol. The way the cleaning is applied by using a cotton swab dipped in an organic solvent, then rub on the stain repeatedly until clean.

Lichens

- Lichens cleaning process can use the AC-322 on the surface of brick covered with lichen, left for 24 hours and closed with plastic. After that, brick must be washed with water until its pH becomes neutral.

Algae

- Cleaning algae with by combating algae using Hyvar-XL levels of 1 to 1.5% with a sprayer or brush. Then wash with water and scrub gently by using a brush fibers.

Salt Deposits

- Hard salt deposits (carbonate) cleaned with 0.1 N citric acid by scrubbing the bricks, left for 24 hours and then washed with water.

Physical Cleaning

Target :	Materials :	Equipments :
Salt deposits	Straw paper, water	buckets, wooden stirrer, masks, gloves.

Gluing/bonding and splicing

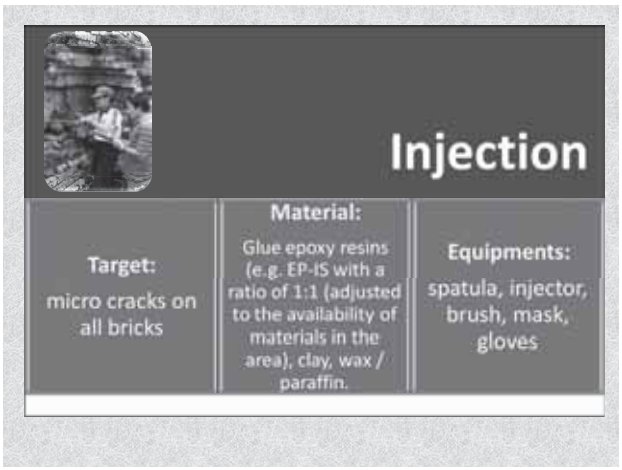
Target:	Materials:	Equpiments:
Broken or cracked original bricks	Epoxy resin glue e.g. Euroland FK20, Araldite AW-106/HV-953U (adjusted to the availability of materials in the area)	spatula, trays, brushes, mask, gloves

Holes Filling

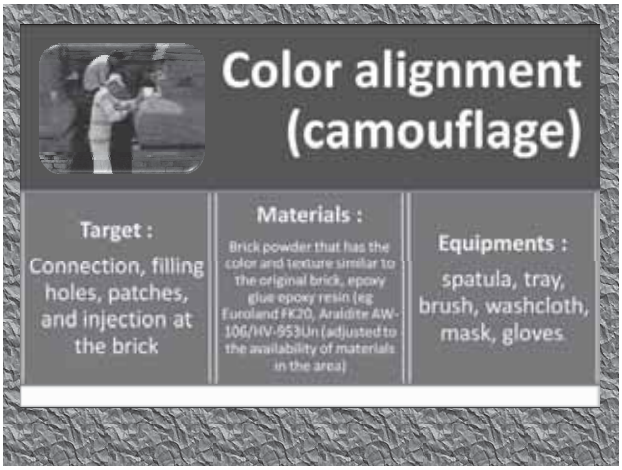
Target :	Materials :	Equipments :
Perforated, cracked, or chipped bricks	Epoxy resin glue e.g. Euroland FK20, Araldite AW-106/HV-953U (adjusted to the availability of materials in the area), brick powder	spatula, trays, brushes, mask, gloves

Patching

Target:	Materials:	Equipments :
The eroded original bricks / fragile part	Epoxy resin glue e.g. Euroland FK20, Araldite AW-106/HV-953U (adjusted to the availability of materials in the area) brick powder, brick replacement	spatula, trays, brushes, mask, gloves

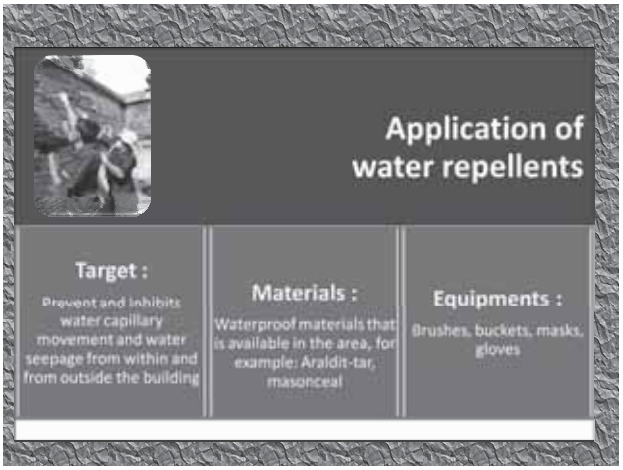

Injection
Target:
micro cracks on all bricks
Material:
Glue epoxy resins (e.g. EP-IS with a ratio of 1:1 (adjusted to the availability of materials in the area), clay, wax / paraffin.
Equipments:
spatula, injector, brush, mask, gloves

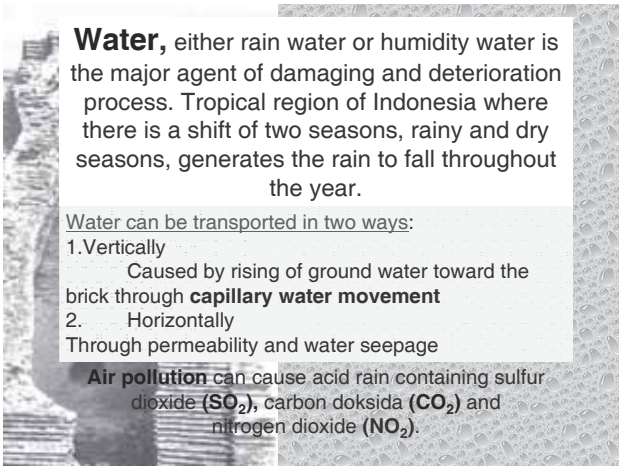

New Bricks Replacement
Target :
Missing part or damaged brick (technically can't be maintained)
Materials :
Glue epoxy resins (eg EP-IS with a ratio of 1:1 (adjusted to the availability of materials in the area), clay, wax / paraffin
Equipments:
gloves, masks, and mason equipment

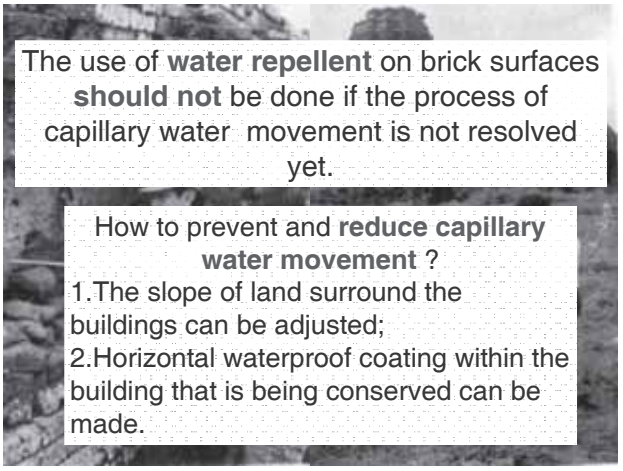

Color alignment (camouflage)
Target :
Connection, filling holes, patches, and injection at the brick
Materials :
Brick powder that has the color and texture similar to the original brick, epoxy glue epoxy resin (eg Furoland FKJ0, Araldite AW-106/HV-953Un (adjusted to the availability of materials in the area)
Equipments :
spatula, tray, brush, washcloth, mask, gloves

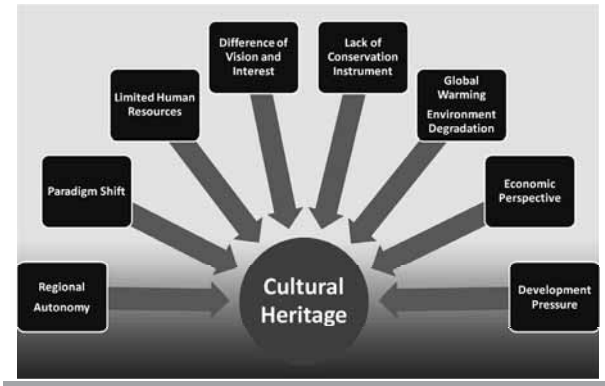

Consolidation
Target :
Fragility on brick
Materials :
Paraloid B-72, Chlorotene/ethyl as a solvent
Equipments :
injector, brush, baker glass


Preservation
Target :
All bricks, especially bricks overgrown by algae, fungi, and grass.
Materials :
Pesticides such as algisida, fungicides, and herbicides, as well as water repellent material (silicone resin)
Equipments :
Beaker glass, stirre glass, bucket.


Application of water repellents
Target :
Prevent and inhibits water capillary movement and water seepage from within and from outside the building
Materials :
Waterproof materials that is available in the area, for example: Araldit-tar, masonceal
Equipments :
Brushes, buckets, masks, gloves


Water, either rain water or humidity water is the major agent of damaging and deterioration process. Tropical region of Indonesia where there is a shift of two seasons, rainy and dry seasons, generates the rain to fall throughout the year.
Water can be transported in two ways:
1.Vertically
Caused by rising of ground water toward the brick through **capillary water movement**
2. Horizontally
Through permeability and water seepage
Air pollution can cause acid rain containing sulfur dioxide **(SO_2),** carbon doksida **(CO_2)** and nitrogen dioxide **(NO_2)**.


The use of **water repellent** on brick surfaces **should not** be done if the process of capillary water movement is not resolved yet.
How to prevent and **reduce capillary water movement** ?
1.The slope of land surround the buildings can be adjusted;
2.Horizontal waterproof coating within the building that is being conserved can be made.



Challenges on Cultural Heritage Conservation in Indonesia

PROBLEM ENCOUNTERED

A. Cultural Property

- Most of the cultural property has been deteriorated
- Cultural information system has not been so developed yet as it is
- Conflict of interest between conservation and development

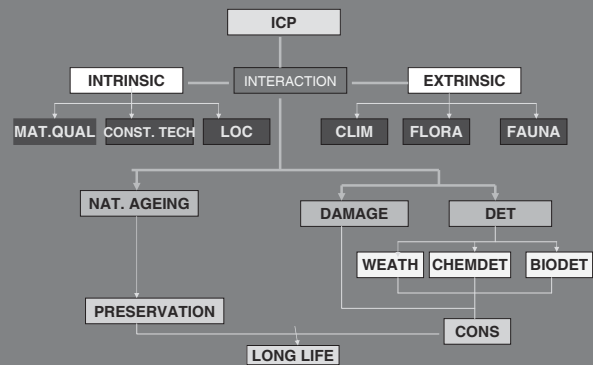
B. Community

- Less in public awareness of the community for the nation building.
- Lack in understanding of history value, including local history.
- Less in public awareness in conservation, protection, utilization, and development of sustainable preservation efforts of the cultural heritage

C. Human Resource

- Limited qualified and professional human resources in the field of conservation and preservation

Degradation Problem of Item Culture Properties



Community Development

- **Carry out scientific studies on the existing social economic condition and the capability as well as readiness of the local population, especially topics related to tourism and economic development**
- **Involving the local population in the management of the cultural heritage through their representatives in the structure of organizing body**
- **Carry out cultural exchange programmes in research and cultural exhibition to promote and strengthen cultural identity among the countries**

Community Participation in Preserving Nation's Cultural Heritage

- Community have active role in day to day management in preserving and utilizing the cultural heritage within the area.
- Train and educate to raise awareness to preserve and avoid any development that might ruin the cultural heritage site

FUTURE PLAN

- Increase cooperation in preserving of Culture Heritage
- Exchange Program and technical training program for Capacity building in the field of conservation
- Joint exhibition program to promote diverse of movable and immovable culture heritage
- Developing information network system
- Establish cooperation for preservation and promotion of tangible and intangible heritage

All the program will be successful if the government together with the communities and all stakeholder commit to support this program. Finally, the future development on preserving our cultural heritage is our responsibility.

SOEROSO

Practical Experiences and Thoughts during the Protection of Shanghai Historic Buildings

WANG Anshi

Deputy Director

Expert Committee of Shanghai Architecture Academy of Historic Buildings Conservation

The history of Shanghai dates back to over 700 years ago. Since its development into a trading port in 1843, more than 100 years have passed. Due to special political, religious, economical and cultural reasons, Shanghai has been enriched by the essence of Chinese and foreign cultures in both ancient and modern times, and the "International Expo of Architectures" on the Bund has been widely recognized as the pearl of Chinese and global contemporary architectures. In Shanghai, there are now 26 national key cultural relics protection units, 163 municipal cultural relics protection units and 381 district cultural relics protection units. Since 1989, 632 units, which include 2138 constructions totaling 4,300,000 m^2, have been listed in four batches by Shanghai municipal government as excellent historical architectures under protection. A large amount of contemporary architectures in Shanghai are residences, of which a total of 12,180,000m^2's constructions are worthy of protection, including 1,470,000 m^2 of garden houses, 1,470,000 m^2 of apartments, 3,350,000 m^2 of new lanes, and 6,170,000 m^2 of old lanes such as Shikumen. According to incomplete statistics, 58% of the constructions worthy of protection are damaged or severely damaged ones. The restoration and protection of historical constructions in Shanghai has a long and tough way to go.

Ⅰ. To proceed from actual conditions and choose appropriate ways of restoration and protection

With the principles of unified planning, classified management, effective protection, rational use, and use subordinate to protection, an overall and systematic protection plan should be worked out on the basis of investigation, historical value and architectural features. The plan must be implemented step by step and in light of conditions such as the raising of capital, technical requirements and processes. Ways usually adopted include:

1. Preservation. To conserve the original appearance is the most important way of restoring historical architectures. Styles, materials and processes should be consistent with the original.
2. Restoration. For severe damage or badly-worn materials and structures, restoration should be implemented on the whole or partly on a case by case basis. "Authenticity" is the rule. Locations, dimensions, styles, materials and processes should be consistent with the original and original parts and decorations should be used as much as possible.
3. Renovation. After renovation, non-protected constructions should be in harmony with protected ones. The

upgrade of functions should help in the long-term protection. The exterior could be conserved and the interior upgraded. Another method of renovation is to keep old constructions together with the new. The appearance of the old constructions could be completely conserved and turned into a functional area of new constructions.

Ⅱ. Elements to be adhered to in the renovation and protection of historical architecture

1. To properly handle the relationship between protection and use, and pay attention to the structural safety of historical architecture.

There are three principles. 1). In general: while ensuring safety, try not to harm the existing structure and appearance. 2). In particular: in the case that common technical specifications cannot be applied, a particular specification should be made, and the standard is that the structural safety after restoration should be better than before. 3). Suitability: The ways to secure structures should suit function and use. Structural safety should be appraised so that proper structural systems can be selected. On the premise of achieving specifications and ensuring safety, it should be attempted to meet the demands of design in its space layout and decoration so that the original appearances and functions can be reproduced.

2. To correctly abide by the principle of "authenticity", and reproduce the original appearance of historical architecture.

As there may be several phases of restoration or renovation during the continuous use of contemporary architecture in history, it's hard to completely restore them to their original conditions. So time should be taken into consideration when we say "original appearance", which means not only the original appearance upon completion of architectures but also the appearance during different periods in history. The measuring sticks are: whether their architectural styles are consistent with the original, whether local features are embodied, whether there are major changes of functions in their history, and whether they are recognized by most people. The design drawings of some historical architecture may look different from their original appearance. In this case, we should, on the basis of investigation, respect history and try to protect the original appearance rather than blindly follow the design drawings and build fake antiques.

3. To carefully conserve the traces of history on architecture.

The majority of historical architecture in Shanghai were built in the early 20th century, with a history of over 70 or 80 years. Most of them were built with drywall on the exterior and natural stone walls plastered with cement or pumice stones. Colors are plain but elegant and textures are coarse but modest. Traces of natural erosion on walls are so full of history. To extend these distinctive units to streets, the most eye-catching part is the exterior of walls. From details to the whole, history is conveyed and inherited. So it is one of the most important elements in building a historical atmosphere and cannot be replaced. The selection of paint is significant to the protection of facades and historic traces. The paint should be colorless, transparent, hard to

decompose, impervious, aerated, stain-resistant, self-cleaning, surface strengthening, etc. “哈德罗”, an inorganic infiltrating crystal protective paint from Japan, has all these functions.

4. To pay attention to identifiability and reversibility during restoration and protection.
Restored or newly-built constructions should be harmonious and consistent with the original ones. Never make them indistinguishable from the original ones. The traces of history contain different phases and should be identifiable. When necessary, a few temporary constructions or additional facilities are allowed to be built on historical architecture, but the premise is it won’t do any harm to the protection and reversible technical measures must be taken.

Besides high buildings and a flourishing economy, the highlights of Shanghai as a famous historical and cultural city should also include its profound history and culture. Both tangible and intangible cultural heritage are wealth that cannot be substituted. The “International Expo of Architecture” on the Bund showcases the personality of Shanghai and makes it identifiable. While protecting historical architectures, we should proceed from the perspective of history, follow innovative thought and adopt modern means so as to restore the past glamour and reproduce the charms of history!

(Author: Wang Anshi, a member of the specialists committee for the protection of the areas with historical cultural features and excellent historical buildings of Shanghai, president of the Website on Architectural Conservation, vice chief engineer of Shanghai Municipal Housing and Land Resources Administration and director of its Historical Buildings Protection Office)

上海历史建筑保护的实践和思考

Shanghai excellent historical building protection practice and thinking

王安石

Wang An-Shi

- 上海建城七百多年,自1843年开埠，也已历经百余年，由于特殊的政治、宗教、经济与文化的发展机遇，西方文化的输入和上海本土以及中国的传统文化和地域文化相互之间的并存,冲撞,排斥,认同,适应,移植,追求与转化,使上海揉和了古今中外文化的精粹,其万国建筑博览成为中国乃至世界现代建筑文化的明珠。
- The city of Shanghai was setup over 7 hundred years ago. It has also over one hundred years since 1843 when it was open to the overseas trading. Due to particular political, religious and economical as well as cultural development opportunities, Shanghai became the bright pearl of China as well as of the contemporary world architecture, after the western culture came in and the shanghai local culture had collision, exclusion, identity, adaptation, migration, transformation and the seeking with them, and finally it mixed the best of all different culture and had cultivated the international architectural exhibition here.

一、上海优秀历史建筑概况和保护现状

Shanghai excellent overview of historic buildings and conservation status

上海现有全国重点文物保护单位26处,市级文物保护单位163处,区级文物保护单位381处.上海市政府分四批公布，列为保护的优秀历史建筑共有632处 （2138栋），约430万㎡，其中61处（140幢）属市级文物保护单位。同时，上海市还先后公布了中心城区和郊区历史文化风貌区共44片，总面积为41平方公里。

Shanghai now has 26 units of national cultural heritage, 163 units of Shanghai city level cultural heritage and 381 units of district level of cultural heritage. Shanghai government has listed four batches of preserved historic buildings, which are totally 632 places with 2138 buildings and 4.3 million ㎡ ,including 61 places with 140 buildings in the level of municipal relics preserved units. Meanwhile, 44 historic culture landscape areas in urban and suburb districts have been listed with total area of 41 k㎡ .

12个历史文化风貌区（中心城区），总面积达到27平方公里。

12 historical cultural preserved areas (in urban districts) , with total sites coverage of 27 KM² .

- 具体名单为：the name list
- 外滩 Bund
- 人民广场 People's Square
- 老城厢 Old Shanghai Town
- 南京西路 Nanjing Road West
- 衡山路-复兴路 Hengshan Rd-Fuxing Rd
- 愚园路 Yuyuan Road
- 虹桥路 Hongqiao Road
- 山阴路 Shanying Road
- 提蓝桥 Tilan Qiao
- 龙华 Longhua
- 新华路 Xinhua Road
- 江湾 Jiangwan

郊区32片郊区历史文化风貌区，总面积约为14平方公里。

32 historical cultural preserved areas in suburb , with total site coverage of 14 KM².

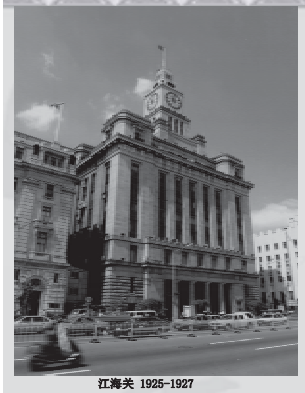
南汇新场古镇
XinChang Old Town

朱家角古镇
Zhu Jia Jiao Old Town

- 从建筑功能分类看有官方建筑、商业建筑 、娱乐建筑、公共建筑、居住建筑、工业建筑等六类；
- Concerning building function, historic buildings are classified into 6 categories: office building, commercial building, recreation building, public building, residential building and industrial building.

陈氏住宅-申康宾馆 1930
Chen's Residence – Shen Kang Hostel

（长海医院）飞机楼中国航空协会 1935
(Chang Hai Hospital) Airplane Building of China Aviation Association



江海关 1925-1927
Customs House

（1）官方建筑
Official Buildings

英国领事馆 1872
British Consulate

大新公司 1936 Sun Co.

（2）商业建筑
Commercial Buildings

大陆商场 1933
The Continental Emporium Building

大世界游乐场 1924 Great World

（3）娱乐建筑
Recreation Buildings

兰心剧院 1929-1931
Lyceum Theatre

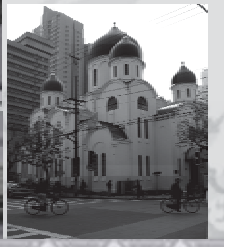
（4）公共建筑
Public Buildings

左侧图为淮海路小学，1920。A primary school on Huaihai Road,1920

右侧上图为大田路教堂内景

Catholic Church of St. Teresa of the Child Jesus, Lisieux

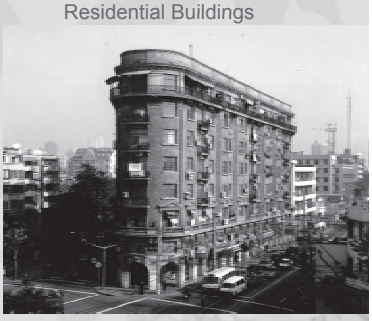
右侧下图为新乐路原东正教堂
(1932-1934)，Russian Orthodox Mission Church 1932-1934



花园住宅，孔祥熙住宅 1936
Residence of H.H.Kung

新式里弄，安亭路新里住宅 1930
New style Lilong house on Anting Road

（5）居住建筑
Residential Buildings



公寓，诺曼底大楼 1924 Normandie Apartments

杨树浦水厂 1901-1927
Shanghai Water Works

原中央造币厂 1922
Shanghai Central Mint

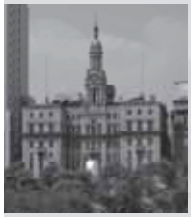
（6）工业建筑
Industrial Buildings

从建筑风格式样上看，有哥特式、文艺复兴、巴洛克、新古典主义等西方古典建筑风格，也有西班牙、伊斯兰、俄罗斯等地域建筑式样，还有早期现代和中西合璧式，装饰艺术派建筑在上海的保护建筑中有167幢。

The historical buildings in Shanghai have various architectural styles not only western classical such as Gothic, Renaissance, Baroque and new classical, but also regional styles like Spanish, Islamic and Russian, as well as the modern time and combination of Chinese and western styles, especially 167 Art Deco buildings in the preserved list in Shanghai.

太原别墅，1928年
Taiyuan Villa

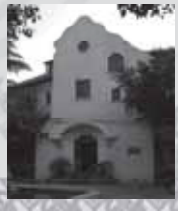
原荣氏花园住宅，1939
Former Mr.Rong's residence



金门饭店，1926
Golden Gate Hotel

原东正教堂，1934
St.Nicholas Russian Orthodox Church

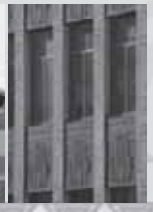
原市图书馆，1935
Former Shanghai Library



原海关副总税务司住宅，1933 Former Custom Official's residence

装饰艺术派建筑
Art Deco Architecture

南昌大楼外貌、尖塔 1933
Appearance of Nanchang Mansion, Spare Tower



电力大楼外貌 1929
Appearance of Electricity Power Building

上海在建国以前建成的居住类建筑中约有1218万平方米具有保护保留价值。 Approximately 12.18 million ㎡ of residential buildings in Shanghai built before 1949, are worth of preserving.

花园住宅147万平方米
villa 1.47 million ㎡

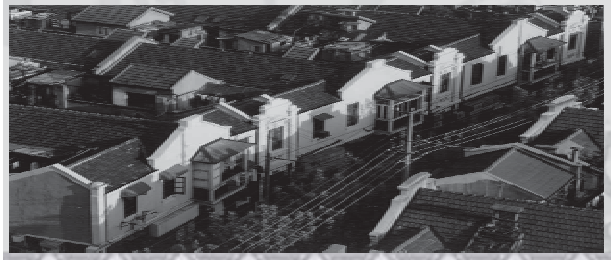
公寓大楼119万平方米
Apartment 1.19 million ㎡

新式里弄335万平方米
New terraced housing3.35 million ㎡

石库门等老式里弄617万平方米
Old terraced housing 6.17 million ㎡

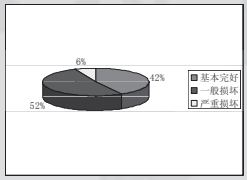
对第二批、第三批337处优秀历史建筑普查报告，有170处（124.9万 ㎡）为一般损坏，23处（15.1万 ㎡）为严重损坏，一般损坏和严重损坏占总数的58%。

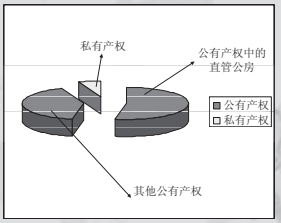
The survey reported that the 2nd and 3rd batch lists of 337 historic buildings which have 170 places with 1.249 million ㎡of general damage, 23 places with 0.151 million ㎡of serious damage, both of them possess 58% of total.



保护建筑产权情况分析，约90%属公有建筑，其中国有直管的房产超过70%。

By analysis of preserved building's ownership, 90% are state-owned, in which more than 70% are directly managed by the government.





二、从实际出发选择好修缮保护的方式

In practice, it selected sound measures to repair and protect

上海历史建筑建成至今仅百余年，且普遍处于使用之中。上海把保护类别划分为四类，其中约三分之二以上保护建筑为三类或四类保护要求，保护的重点在外貌，内部空间具有较大更新、利用的可能性。

Historic buildings were built in Shanghai more than 100 years, which are still on use. The preservation is classified into 4 grades, more than 2/3 preserved buildings are in grade 3 or grade 4, which mainly protects the façade, interior space has the possibility to upgrade and reuse.

信托大楼（北京东路190号）保护类别三类 重点保护外立面
Credit Mansion (190 Beijing road E) Grade 3, the key preserved part is facade

室内有特色的柱帽
featured column cap inside of building

1、保存修缮 Remain and repair

历史建筑最重要的修缮方法是保存原貌原状。在修缮时确保式样、材料、工艺等的一致。The predominate repair method of historic building is to keep the original state. Ensuring the consistent in pattern, material and technique when repairing.

海关大楼Custom House

海关大楼入口立柱Gate columns

海关大楼巨大的底座石块Stone base

塔楼的南立面 south elevation

塔楼的东立面局部 part of east elevation

石材外墙变旧，显示的是历史沧桑，汇丰银行石材塔楼保护的选择了保存方式。 Due to time running, the stone façade becoming deterioration, the dome of HK - Shanghai Bank protection adopted restoring preservation.

这些细部不妨碍使用的“变旧”修缮时不一定 “出新”，保护的方式应选择保存。图为工会大楼门厅楼梯扶手。

The protection method for details can be preserved the “old” impression. Picture shows the coppery handle of stair in Trade Union Building.

工会大楼大厅水磨石图案地坪，予以保存。

Floor finishing of the lobby in Trade Union Building was preserved.

卢湾区思南路成片保护整治试点项目，规划占地面积5公顷，地上总建筑面积为5.7万平方米，其中保留保护老建筑49幢，近3万平方米，以保护地区整体历史风貌为出发点，延续城市肌理，尊重街巷尺度，完善空间形态，补充新鲜功能，增强社区活力，提高开放品质。

Si Nan Road preserved area in Luwan district has the site space of 5 ha, 57 thousand ㎡building space, including 49 preserved buildings with 30 thousand ㎡. The project aimed to preserve integrate historic scene of the area, continue its urban structure, respect street dimension, add new function and vigor, promote its opening quality.

思南路有41栋花园住宅是最大的特色，重点是保护外墙这张“脸面”，修缮恢复其历史上的卵石饰面。

41 detached houses along Si Nan road become major feature in the area, to keep the façade is a key, so that it restored pebble façade as its original.

修旧如故 repaired as its original

周公馆外墙
Façade of Premier Zhou Enlai' s residence

2、恢复重建 Restoration and redevelopment

一些历史建筑因外力作用造成损坏严重，或材料、结构使用寿命已到，可按保护内容部分或全部复建。西藏路的沐恩堂五十年代曾遭遇大火，烧毁的部分建筑和装饰就是按历史的原样重建的。

Some historical buildings' preserved can be partly or wholly rebuilt due to serious damage caused by force, or material and structure 's life span are finished. Memorial Church was burned in 1950s, the burned part structures and decorations were restored according to original.

沐恩堂，1931年建造，1958按原样修复。曾损坏严重的室内装饰，现已恢复。

Memorial Church built in 1931,was repaired in 1958,the decoration damaged seriously has been restored now.

静安区“涌泉坊”里弄环境优雅、布局合理、设计讲究，其外墙上镶嵌的12幅小孩吹号的立体雕塑墙砖，采用传统工艺，按实物翻样制模修复。

Yong Quan Neighborhood in Jingan district has elegant lane environment, good layout and design daintily. 12 sculpture tiles with little trumping boys studded on façade, which were restored by using traditional technique.

涌泉坊
Yong Quan Neighborhood

修复前的雕塑
Stored sculpture

修复后的雕塑
Restored sculpture

徐汇区石库门里弄“建业里”保护改造方案中就是完整保留西弄，把其改变成石库门宾馆，拆除东弄、中弄，在完成地下配套设施后按原样复建。

“Jian Ye Li” stone gate lane in Xuhui district in preserving proposal. is to preserve West Lane completely and alternate it into a hotel; demolish East and Middle Lanes, rebuild them as original shape after finishing underground facilities.

建业里西弄 1930年 West Lane of Jian Ye Li

3、改建更新 Renovation and upgrade

改建与保护内容协调，功能更新利于长久保护

Renovation mixed with preservation, upgrading its function, which benefit the long term preservation.

原工部局宰牲场为英国建筑设计大师巴尔弗斯设计，现世界上仅存这一栋，修缮改建中该建筑两个核心筒之间连接着千姿百态的楼梯被完整地保留了。

Former Shanghai Sanitary Butchery Co. Building was designed by English master architect Mr. Balvers, which is only one building existed in the world. After repairing, divers stairs connected two cores of the building were preserved completely.

“新天地” 外貌保留了上海传统民居“石库门”的 “里弄”空间特征，而内部更新改造为适合旅游休闲的空间功能。

The appearance of “Xin Tiandi” remained space feature of “shi Ku Men” Shanghai traditional housing, interior upgrading to fit the space function of tourism leisure.

改建更新的另一种方式是新老建筑的共存共荣，完整保留老建筑的外观，使其成为新建筑的一个功能区。

Another way of renovation is to mix new and old construction, wholly preserving the appearance of old building, let it become a function part of new building.

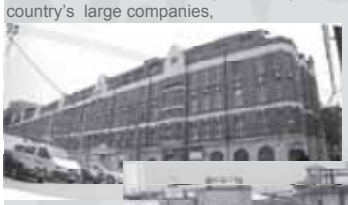
1989年建成的五星级花园饭店，其裙房大堂公共部分由原法国总会（ 1926年建造）改建而成。
Garden Hotel, a 5-stars hotel built in 1989, the front building as lobby was Cercle Sportif Francais built in 1926

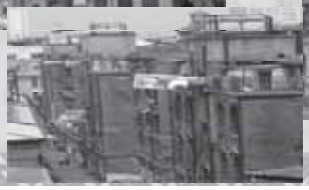
原法公董局，1909年建造，现改建更新为中环广场购物空间。

Former Council Building of French Concession built in 1909,now it is shopping area of Central Plaza.

北京东路81号益丰洋行，拟和国际大公司合作，改建成世界顶级百货商场。

No. 81 Beijing East Road, Yick Fung Matheson, would consider to be planned to convert it into the world's top class department store with the co-operation of the country's large companies,





益丰洋行现状
Today's Yick Fung Matheson,

效果图一

益丰大厦方案设计

三、走出修缮保护中的误区，切实保存好建筑的历史痕迹

Get rid of fault of repairing and preserving, really keeping the historical path of buildings

1. 处理好“保护利用”的关系，注重历史建筑的结构安全

To balance with the "protection and use" relationship, focusing on the structural safety of historical buildings

结构安全隐患
structural safety risks

处理原则： Principles of handling the structural safety risks

（1）兼顾的原则：保证基本“安全”的前提下，尽可能不破坏结构和外观。

The principle of balance: to ensure a basic "safety" of the premise and avoid damaging the structure and appearance by all means

（2）特殊的原则：不能完全适用一般的新建或修缮技术规范，应有特殊规定，标准为：修缮后安全性能比原来有所改善和提高。

Special rule: can't be fully applicable to the general technical specifications of new or repaired, there should be special provisions and criteria: safety is to be enhanced and it is to be better than the original after restoration has been completed.

（3）适用的原则：加固方法多种，关键是适合功能使用。

The applicable principle: when there are available of a variety of reinforcement methods, the key is to be suitable for functional use.

荣家老宅（1918年）
Old house of Rong's Family.

处理程序：Procedure of handling:

（1）结构安全性鉴定：这是进行保护修缮方案设计的依据。

Identification of structural safety: This is a program designed to protect the repair basis

（2）选择合理结构受力体系： choose the structure of the force system:

a：完全利用原结构受力承，进行适当的加固；

Full use of the original structure of the force commitment, and add appropriate reinforcement;

b：原结构加固，增加新的结构承，新老结构共同承载；

Reinforcement of the original structure, adding new structures bearing, to let the new and old structure share equally the load;

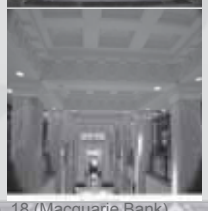
c：完全脱离原结构，由新结构受力承载

Completely stay out of the original structure and let new structure to take the load.

（3）设计方案的优化：在满足设计规范和建筑安全的前提下，尽量满足装饰设计所需要的空间布局和装饰效果，使其重现风貌，重塑功能。

Design optimization: to meet the design specifications and construction under the premise of safety, try to meet the space required for the decorative layout of the design and decorative effect, so as to reproduce the style remodeling function.

外滩十八号（麦加利银行）
1922年



Wai tan No. 18 (Macquarie Bank)

结构加固主要技术方法：

Structural reinforcement of the main technological approaches:

（1）钢结构加固： 外包钢加固法、粘钢加固法、套箍加固法。

Steel reinforcement : external steel reinforcement method, bonding steel reinforcement method, hoop reinforcement method.

（2）混凝土加固： 增大截面加固法、植筋锚固加固法

Concrete reinforcement: increasing cross-section reinforcement method, anchorage reinforcement method

（3）碳纤维加固： 受拉受剪增强法。

Carbon fiber reinforcement: tensile shear enhancement method.

（4）喷射砼加固： 喷射混凝土加固法、喷射环氧砂浆加固法。
Reinforcement of spray concrete: reinforced shotcrete method, Reinforced shotcrete method, spray eoxy mortar reinforcement method

（5）预应力加固： 局部预应力后张加固法。
Pre-stressed reinforcement: partial pre-stressed post-tensioned reinforcement method.

（6）抗震加固：抗震摩擦阻尼器加固法和加设抗震柱和剪力墙加固法。
Seismic retrofit: seismic reinforcement method and processing friction damper set up columns and shear seismic reinforcement method.

（7）化学加固：采用乙基硅酸盐固结法加固石料散屑、化学灌浆加固法。
Chemical reinforcement: Reinforcement of the use of ethyl silicate consolidation of stone scattered debris, chemical grouting method.

2、坚持“原真性”，修旧如旧，修旧如故，真实地展现建筑的历史原貌
Adhere to the "authenticity", repairing the old as old, and repair as before, show the true history of the original appearance of the building

申康公寓 Shen Kang apartment

室内壁画
Indoor wall painting

原东正教堂
Former Orthodox Church

室内壁画
Indoor wall painting

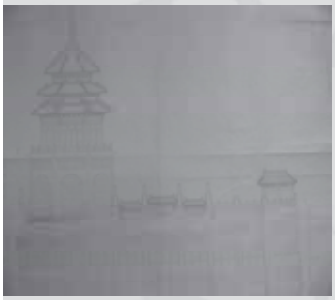
恢复到某一历史阶段的面貌。判断的标准是，建筑风格特色是否一致，是否反映了地域的特点，历史上是否因使用功能调整有过重大变化，是否为大多数人所认可。

Restoring appearance of certain historic period. The judge criteria : whether the building style and character are consistent, whether it features regional character, whether the function has been major changed in history, whether it is accepted by majority.

为1936年形态
State in 1936

外滩6号 1893年始建
Wai tan NO. 6 1893 buliding

尊重历史的真实，保护好历史的原建，而不应该盲目地按图纸再去新建，造成假古董。
Respect for real history, protect original building, which should not rebuild false antique by copying the drawings.



历史图纸 南京西路立面
Old drawing elevation of Nanjing Road (w)

原杨廷宝设计方案 南京西路立面
Yang Tingbao's design proposal elevation of Nanjing Road (w)

现状 南京西路立面
Existing the elevation of Nanjing road (w)

修复方案 南京西路立面
Restoring proposal the elevation of Nanjing road (w)

3、保护好历史建筑的表皮 preserving historical building's appearance

上海的历史建筑主体多为清水外墙，天然石材墙面，水泥或汰石子粉刷，色彩淡雅而真实，质感粗糙而朴素。由于年代悠久，墙面留下各种被自然环境侵蚀的痕迹，有一种故旧沧桑感。

The historical buildings in Shanghai are mainly exposed brick, natural stone, cement or washed carpolite façades, which have light color and real, roughness and simplicity features. It remains all kinds of mark by natural environment corrodes, making the sense of old and profound.

山阴69弄住宅修缮;
repairing the house in Lane 69 Shanyin Road

霍山路住宅修缮 repairing the house in Huoshan Road.




原工部局宰牲场去除暗红色涂料后恢复清水混凝土外墙和花饰
Former Shanghai Sanitary Butchery Co. Building, after cleaning up red colored wall painting, restored its exposed concrete wall and decoration .

保护历史建筑的表皮，其中很重要的一个环节是要用好防水保护剂。

选择的原则是：

External protection of historic building: one of the most important aspect is to use a good waterproof protection agent. Selection principle is:

1、能保持原建筑立面的形态色彩，没有复盖作用；

Can maintain the original color of the shape of building facades, no cover role;

2、表面防水，但又具透气功能；

Surface water proof, but with ventilation;

3、涂刷的表面不易沾染灰尘及污物，具自净功能；

Brushed surface is not easy to catch the dust and dirt, with self-cleaning function

4、能对建筑表面的强化起到一定作用。

Can play a role to strengthen the building's surface.

上海目前主要使用的防水涂料

he mainly used waterproof coating in Srhanghai now

- **进口的有：** 日本哈德罗　美国永凝液（DPS）
  德国德赛堡（碧林）　德国雷马士；
- **国内的有：** TF　三瑞 等。

Imported are: Japan HadeLuo，United States Wing condensate (DPS), Germany Fort Desai(Tahitian)，Germany Lei Mashi;
The China made has: TF, 三瑞

哈德罗是无机质渗透结晶型防水（保护）剂，是从无机质溶液和高反应催化剂中提取的一种强碱金属盐+硅酸化合物的防水（保护）剂，它完全能够达到上述选择的四个要求。

Hade Luo is inorganic capillary crystalline waterproofing (Protection) agents, from inorganic catalyst solution and extract high-alkali metal salts of a compound of the water + silica (Protection) agent, it is fully able to meet the above selection of the four requirements

哈德罗在外墙上的应用

Hade Luo outside wallapplications


武康大楼修缮后
After renovation of the Wu Kang Building


武康大楼修缮前
Before renovation of the Wu Kang Building


南昌大楼修缮后
After renovation of the Nan Chang Building


东风饭店修缮后
After renovation of the Dond Feng Hotel

建筑上的门窗、阳台的围栏、墙面的花饰都是展示外立面形象的重要元素，修缮中应尽可能保留或恢复原样。

Windows and doors, balcony rail and wall decoration are the key components to show façade image, so it is possible to remain or restore its original in repairing.




东平路9号　按原样恢复的门窗五金件、灯具及楼梯转角玻璃窗
9 Dong Ping road restored windows and doors' hardware, lights and windows of turning staircases.

4、必须注意修缮保护中的可识别性和可逆性

It should care about identification and recoverable in repairing and preserving

复建或新建的建筑应和原建筑保持协调、统一，体现整体风貌，但决不要仿制得以假乱真。历史痕迹也具有阶段性，要让人能够识别。

Building restoration or reconstruction should be matched with old buildings integrated, the imitation never be made like the original. Let people identify periodic history.


修缮保护方案中六层保留，但与原建筑有明显差别
The repair drawing is obviously different from the orignial

德邻公寓现状图
Existing situation of De Lin apartment

在找不到历史依据的情况下，还是保持原貌为好。

If can't find historical clue, it should keep the original appearance.


摩西会堂一层马赛克地坪修复后现状
The ground mosaic floor after repair, Morse hall


二层南外廊
South corridor of second floor


摩西会堂 Morse hall

历史建筑由于使用功能调整的需要，会出现一些临时搭建或加建设施设备，在不严重影响建筑保护的前提下，可允许建设，但必须保证不损害建筑保护，并采用可逆的技术措施。

Due to functional readjust for historic buildings, it occurs some temporary extension or added facilities, it is permitted under the condition of un-affecting building preservation, but it mustn't damage the building preservation, it should adopt recoverable technical measures.


黄浦剧场 Huang Pu Theater


百乐门 Parliament Dancing Hall

结论：Conclusion

上海作为历史文化名城，其闪光点绝不局限于高楼大厦、发达经济，而是深厚的历史文化积淀。物质的和非物质文化遗产是不可替代的宝贵财富，万国建筑博览彰显上海城市的个性，使她具有可识别性。我们必须用历史的观念、创新的思路、现代的手段去保护好遗存的光辉，契而不舍修旧如故，让历史风貌再现！

Shanghai as a historic cultural city, the highlighted attractions are not limited to towers and developed economy, but profound historic cultural accumulation. Physical and non-physical cultural heritages are un-replaceable treasure. The reputation of world architecture museum shows the characters of Shanghai, making it recognized. We must preserve heritages well by using historical concept, creative ideas and modern means, insisting on repairing as its original state, recurring historic landscape.

Conservation of World Heritage Site of Humayun's Tomb, New Delhi

Sangeeta BAIS
Programme Officer, Conservation Works
Aga Khan Trust for Culture

The presented case study is a part of the larger "project Humayun's Tomb – Sundar Nursery – Nizamuddin Basti Urban Renewal project" initiated AKTC and which includes the conservation of over 40 monuments.

The Aga Khan Trust for Culture, following a MoU signed on 11 July 2007 with several governments of India agencies in undertaking a major urban renewal project spread over 200 acres area of Humayun's tomb complex, Sunder Nursery and Nizamuddin Basti. The vision of the project is to conserve and develop the three presently segregated albeit historically connected sites of Humayun's Tomb, Nizamuddin Basti and Sunder Nursery into one cohesive and integrated complex. The urban renewal initiative includes the conservation of monuments using traditional tools and building techniques, renewal of the surrounding spaces and environment, and sustainable socio-economic development to improve the quality of life of the resident community. Upon completion, the complex will offer a vast area of green space housing the restored monuments, supplemented by excellent visitor facilities and improved quality of life for local communities. It is working to preserve Delhi's glorious built and cultural heritage in a setting worthy of its rich, historical past.

Since its considered auspicious to be buried near a Saints grave, the project area has seen over seven centuries of tomb building and with over a 100 monuments standing within or adjoining the project zone, it could well be the densest ensemble of medieval Islamic buildings in India. This area was chosen for a potential project by AKTC on account of the possibility of building on the successfully completed Garden restoration at Humayun's Tomb, high number of significant buildings in the area, potential of the conservation initiative to be coupled with a socio-economic development programme that would benefit a resident population, the importance of a 'living culture' showcasing exemplary religious tolerance within a prominent location in the capital.

The presented case study will describe the major conservation works were carried on the World heritage site of Humayun's tomb complex. The tomb of the second Mughal Emperor, Humayun, is a red sandstone and white marble structure of monumental proportions standing in a garden landscaped in the classic chahar bagh (four part paradise garden) pattern. The earliest existing example of the Mughal garden tomb in India, Humayun's Tomb, a UNESCO World Heritage Site, was the first of the grand imperial mausoleums that

became the hallmark of the Mughal dynasty. Humayun's tomb inspired and is a precursor of the Taj Mahal. The imposing mausoleum of Emperor Humayun's took nearly a decade to complete, from the time it was commissioned in 1565 AD. Influenced by Persian architecture, the 47m high structure stands on a 120 sq m platform. The emperor's final resting place is at the centre of the elevated plinth in a chamber under the dome. The central chamber is surrounded by ancillary rooms housing other royal graves. Entirely paved in blocks of Delhi quartzite, the plinth's façade is embellished with a series of arched recesses on all four sides. Built of rubble masonry, the mausoleum is amongst the first to use red sandstone and white marble in such quantities. Conservation work on the restoration of the mausoleum, the gateways, pavilions and tomb structures began in April 2008. Preparatory work prior to conservation included exhaustive archival research, documentation using state-of-art laser scanning technology, condition assessment and structural analysis. Major works carried out during the project period includes:

Conservation of lower plinth- The lower plinth of the mausoleum is an important interface between the garden and main building. It is a central platform paved with large blocks of Delhi quartzite stone standing 1m above garden level. The entire 12,000 sqm area was covered with concrete in 1956, possibly to compensate for unequal settling of the paving. Following the removal of the recent concrete layer, a rigorous exercise was carried out to lift and reset the stone paving below, requiring almost 80% of the stone blocks, some weighing over 2000 kilos to be manually lifted and reset.

Conservation of upper plinth- Due to replacement and partial repairs carried out in the 20th century portions of the plinth were facing water logging thus causing serious structural cracks in the ceilings of the cells below. In order to ensure easy rainwater disposal from the pacing to stop the further deterioration, conservation works were carried out on the plinth to provide appropriate slopes and to restore the original pattern.

Terrace repair works- Conservation work on the terrace of the mausoleums roof entailed the removal of 1 million kilos of concrete laid in several layers through 20th century, followed by re- terracing of the floor to its original level. Removal of approximately 40cm thick layer of concrete exposed hidden architectural elements eased the extra load on the structure and now ensures swift disposal of rainwater ñ the seepage of which has caused severe deterioration to the stonework over the years. Concrete on the roof was manually removed by meticulous chiselling. Concrete was also removed from the roof of the four roof pavilions with the underlying sandstone slabs then replaced or repaired depending on the state of the stones. Finally, the floor of the main terrace and of the pavilions were laid with a 10 cm thick layer of lime concrete as per original slopes identified by meticulous research and documentation.

Conservation of the chamber at the lower and the upper cells

Chambers of 68 lower cells was severely decayed due to water seepage from the upper plinth which is now repaired and re-plastered as per original details. Chambers of the upper plinth were cement plastered in 1960s which are also restored using lime mortar finished with punning.

Dome repair works

With the prime objective to ensure no water seeped into the dome through the joints the entire surface of the dome was cleansed of dust and grime and 20th century additions of white cement. Marble joints were painstakingly raked with precision tools by skilled craftsmen to rid them of all accumulation. Clean cavities and joints were grouted and filled with lime slurry mixed with traditional additives to consolidate the inner masonry layer. Masonry joints were finally re- pointed with lime mortar mixed with white marble dust. Inner layer of brick masonry cleaned
and lime plastered.

Stone repair works

Facade stone were decayed due to various reasons which now repaired which include partial and complete replacement of decayed stones, inappropriately repaired stones, cleaning and refixing of loose stones.

Glazed tile works

The tradition of using glazed tiles is a long standing one in Islamic architecture with roots in Persian crafts and aesthetics. The colour palette and style of tile work at Humayunís Tomb reflects the very distinctive Timurid Persian influence similar to those found in contemporary buildings in Central Asia.

The eight small canopies on the roof of Humayunís Tomb were originally decoratively clad in glazed ceramic tiles in lapis lazuli blue, turquoise blue, green, white and yellow, the preferred colour montage seen in many Timurid Persian buildings. The brilliant tile work added a clever design component to a stately mausoleum, one that stood in sharp contrast to the pristine white dome. On the basis of a study of existing tile work the original patterns were determined. A detailed microscopic documentation of the tile work was carried out to analyse the tiles prior to determining appropriate conservation strategy to restore the tile work. It was followed by condition assessment based on condition mapping, photographic documentation, digitization and scientific investigations. On site studies were coupled with archival research and scientific analysis of the physical and chemical properties of Mughal period tiles at ASI labs and in universities in Roorkee (India), Oxford (UK) and Barcelona (Spain). A team of three craftsmen from Uzbekistan were worked with the Indian team for six months to establish the process of glazed tile production. Now Indian team is working to produce the final tiles for the monuments.

Training programs

As an integral part of the ongoing conservation initiative, several training programmes and workshops have been jointly organised by **ASI and AKTC.** Over 170 officers of the ASI, from all parts of India, have attended training in the preparation and use of lime mortar and high definition survey of historic buildings using 3-D Laser scanning technology. These workshops also give an opportunity to participants to understand mutual problems and concerns and learn from solutions used in varying context. The project has also been used as a platform for training of conservation professionals and craftsmen.

The project ensures that conservation standards and process are established through the works being undertaken on the monuments in Humayun's Tomb- Nizamuddin Basti-Sunder Nursery by adhering to established Indian and international conservation philosophy and principles. It stringently maintains authenticity of the original design in both form and material substance by employing hundreds of master craftsmen working with traditional building materials. All conservation work is supervised by the multi-disciplinary ASI-AKTC team and preceded by archival research, high definition surveys, and structural assessments and peer review. The Conservation Plan for the project includes a Statement of Significance and conservation philosophy, stakeholder discussion with local residents and independent experts from agencies such as UNESCO, ICOMOS and INTACH. Based on onsite requirements and conservation work in specific areas, the project has revived and re-developed expertise on application and treatment of near-extinct crafts, materials and techniques through training modules, seminars and workshops.

Human Resources Development for the Transmission of Traditional Skills: National Approaches and their Application to Stone and Brick
6-8 December 2011, shanghai, china

Presentation by:

NATIONAL [illegible] MEETING

Sangeeta Bais
Programme Officer, Conservation works

HUMAYUN'S TOMB
NIZAMUDDIN BASTI
SUNDER NURSERY

urban renewal initiative

A Public-Private Partnership initiative of Archaeological Survey of India
Municipal Corporation of Delhi – Central Public Works Department
Aga Khan Foundation-Aga Khan Trust for Culture

Humayun's Tomb – Sunder Nursery – Hazrat Nizamuddin Basti
PROJECT AREA

Archaeological Survey of India

Aga Khan Trust for Culture

Conservation and restoration works on the monuments in the project area

Municipal Corporation of Delhi

Aga Khan Trust for Culture

Aga Khan Foundation

Health, education and urban development initiatives in Nizamuddin Basti

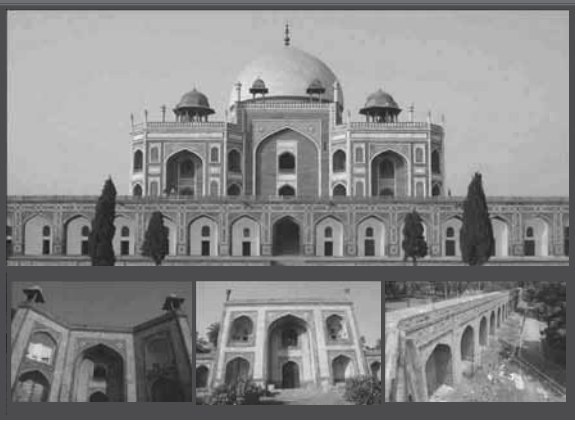
Public Works Department

Aga Khan Trust for Culture

Environmental development in Sundar Nursery

Historical buildings in the project area

World heritage site of Humayun's tomb

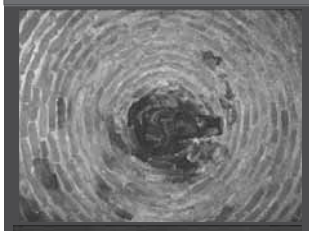


World heritage site of Humayun's tomb

World heritage site of Humayun's tomb

Walls- inner core with rough stone masonry
Red sand stone cladding
Red sand Flooring
Marble used in flooring for decorative purpose
Arches with red sand stones
Slate (black) for borders
Dholpur sand stones for panels

World heritage site of Humayun's tomb



Dome and vaults
Inner core constructed with Stone masonry and brick masonry

Externally cladded with white marble, internally lime plastered

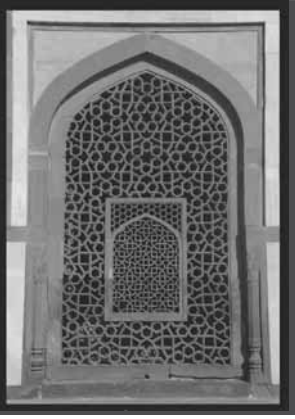
External half dome are cladded with red sand stone

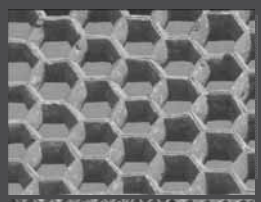
World heritage site of Humayun's tomb

Decorative forms in stones
Brackets
Star patterns
Columns
Lattice screens

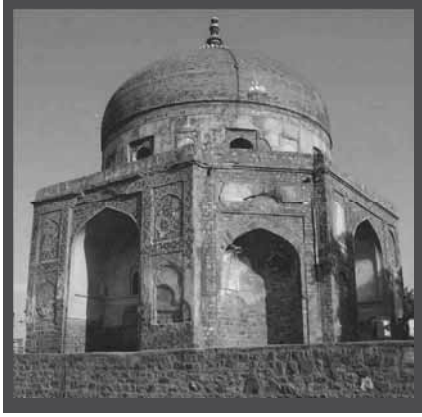
Lime plasterworks
Plain plaster with lime punning
Decorative patterns

World heritage site of Humayun's tomb





World heritage site of Humayun's tomb



Nila Gumbad
(blue dome)

16th Century monument
Constructed with Quartzite stone rough Ashlar masonry

Lime plastered

North façade and dome external surface are covered with Mughal glazed tiles

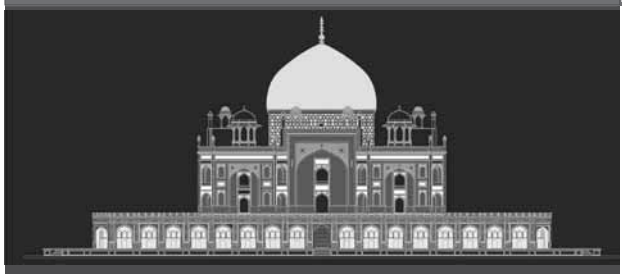
World heritage site of Humayun's tomb

Water features for the garden
Red sand stone used for the water channel, tanks , chadars fountains and street funriniture

Water bodies in the project area
Wells
Step wells
Constructed with Delhi Quartzite stone which is resistant to water related problems

Conservation works

Conservation works



LOWER PLINTH | UPPER PLATFORM | DECORATIVE STONE WORKS | CLADDDING | MASONRY WORKS

Humayun's Tomb Complex
Methodology for the conservation works

Documentation using 3D laser scanning of individual stones

Detailed condition mapping of individual stones

Identifying matching materials such as stones, lime etc for the repairs and replacement and marking them on site

Discussion with the core committee of the project to finalize the materials as well as the process for the conservation works

Identification of the craftsman to execute the work

Petro logical studies to find out quarries for the matching stones

Procuring matching stones for the conservation works

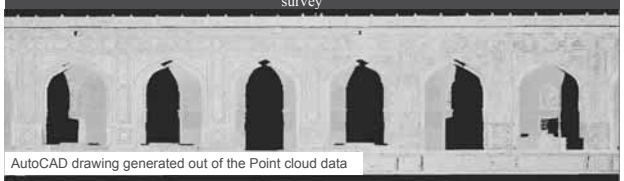
Evacuating on site details such as surface finishes, tools rerquired

Preparing 1: 1 drawings for the details
Preparing sample pieces or repair works

Preparing 1: 1 drawings for the details
Preparing sample pieces or repair works for the approval before execution

Humayun's Tomb Complex
HIGH DEFINITION SURVEY

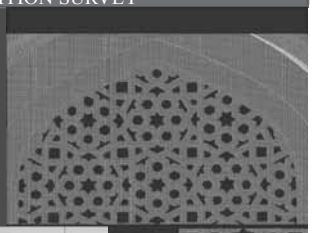
Each surface measured, each stone documented using high definition survey

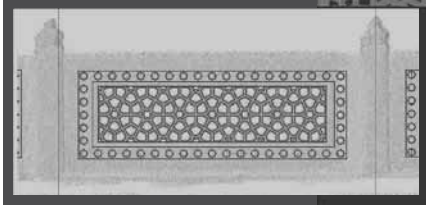


AutoCAD drawing generated out of the Point cloud data

Humayun's Tomb Complex
HIGH DEFINITION SURVEY

- Intricate patterns such as lattice screen, carving details, flower details scanned and drafted on a cad
- Scale drawings were prepared for transferring details on the stones and wall surfaces
- Finalizing the stone sizes and sectional details to procure keeping in mind the section to be chiseled and wastage

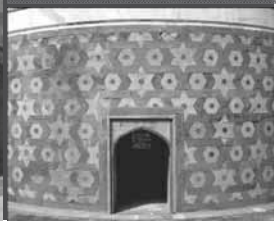




Western facade Jali
Point Cloud Data showing Geometric Form

Humayun's Tomb Complex
CONDITION MAPPING

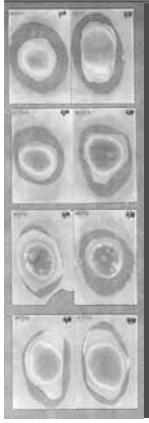
- Condition of each stone was marked on the drawings and images
- Stones were identified for conservation works :
  - Stone replacement- partial and complete
  - Replacing rusted iron dowel
  - Cleaning of the surface



Humayun's Tomb Complex
Procuring matching stones for the conservation works

- Peterological analysis of sandstone used at Humayun's tomb
- Stone samples were collected from over 50 quarries in bansi paharpur, karoli, Dhaulpur region etc for the detailed study
- A team of engineers and craftsmen visited to various quarries to find out suitable stones

Humayun's Tomb Complex
Procuring matching stones for the conservation works



1. 23 samples were shortlisted based on the visual characteristics for the detailed peterologocal studies
2. After the studies, ten samples identified for the conservation works
3. The study was carried out by the geologist

To establish the correlation between the sand stone samples collected from different quarry and the monument sandstone on the basis of colour and texture, which will direct the ensure use of matching sandstone for the conservation work.

Humayun's Tomb Complex
Procuring matching stones for the conservation works

- Stones of various sizes as per required procured from the finalized quarries
- Each stone numbered as per the size and location to be used
- Craftsmen starts the getting required tools ready on site
- Basic chiseling and cutting starts on site using had tools
- Works carried out under supervision of master craftsman and site architect

Humayun's Tomb Complex
Procuring matching stones for the conservation works

1. Delhi quartzite not available due to closing of the quarries due to environmental reasons
2. Old quartzite stones were procured from other resources such as roads
3. Stones were cleaned to remove dust and color deposits before using

Humayun's Tomb Complex
Conservation of Lower plinth

Archival images showing the original paving pattern, laying concrete over that in 1956 and revealing the paving during conservation works in 2008.

1. The removal of the present concrete flooring, first laid in the 1960's.Lifting of underlying quartzite stone blocks and replacing missing portions with matching stone.
2. DQ flooring of all the four sides of the lower plinth have been restored to the original pattern.
3. Heavy DQ stones , weighting up to 1000 kgs were lifted up manually using belts and hand tools . These stones were chiseled and dressed as required for the appropriate finish and levels
4. Raised red sand stone edging was removed and refixed as per the original levels.

Humayun's Tomb Complex
Conservation of Lower plinth

- Concrete layers form the dq floor of the plinth have been removed
- Stones were reset in position as per the original pattern using lime mortar.
- Flooring of all the four sides of the lower plinth have been restored to the original pattern.

Humayun's Tomb Complex
Conservation of Lower plinth

Stone pieces were chiseled to give appropriate profile

Stones were chiseled using hand tools

Final pointing was carried out with lime mortar

Humayun's Tomb Complex
Conservation of Lower plinth

Humayun's Tomb Complex
Conservation of Lower plinth

Restoration of the original character of this plinth which is a significant interface between the mausoleum and the garden.

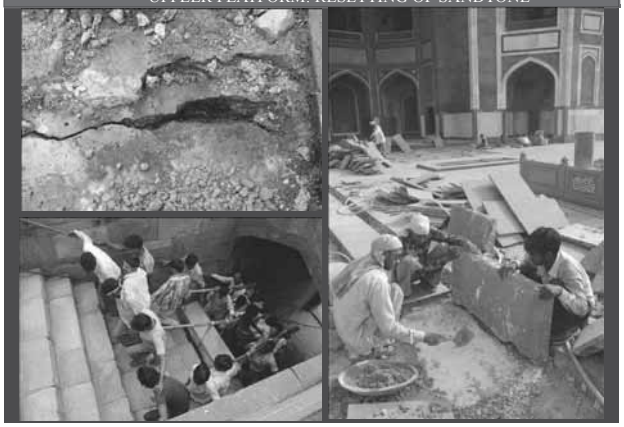
Humayun's Tomb Complex
Conservation of Lower plinth

Humayun's Tomb Complex
UPPLER PLATFORM: RESETTING OF SANDTONE

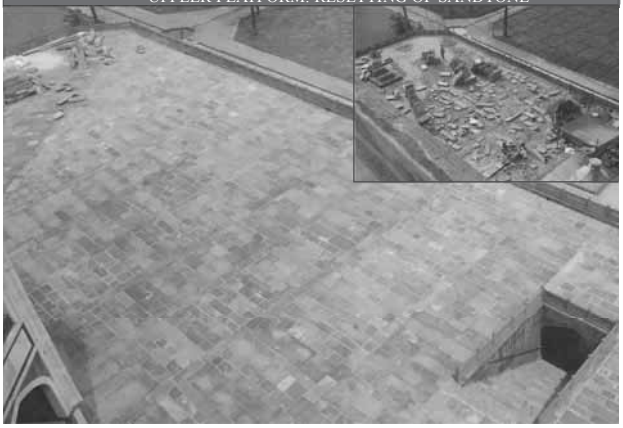
Final dressing of the stone was carried out on site as per site requirement before fixing in position

- Inappropriate slopes
- Water logging and deterioration of materials in the lower chambers
- Lost original architectural pattern due to inappropriate repair works

Humayun's Tomb Complex
UPPLER PLATFORM: RESETTING OF SANDTONE



Humayun's Tomb Complex
UPPLER PLATFORM: RESETTING OF SANDTONE

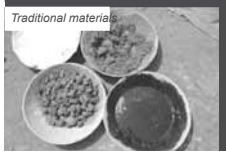


Humayun's Tomb Complex
TERRACE REAPIR WORKS

During Conservation

After Conservation

Traditional materials



- In 2008 and early 2009 over a million kilos of concrete were removed from the terrace
- A 10 cm thick layer of Lime concrete laid on the terrace with appropriate slopes
- Existing water spouts were cleaned and repaired.

Humayun's Tomb Complex
TERRACE REAPIR WORKS

August 2007

NOW

December

Humayun's Tomb Complex
CHMABER REPAIR WORKS

Before Conservation

After Conservation

During Conservation

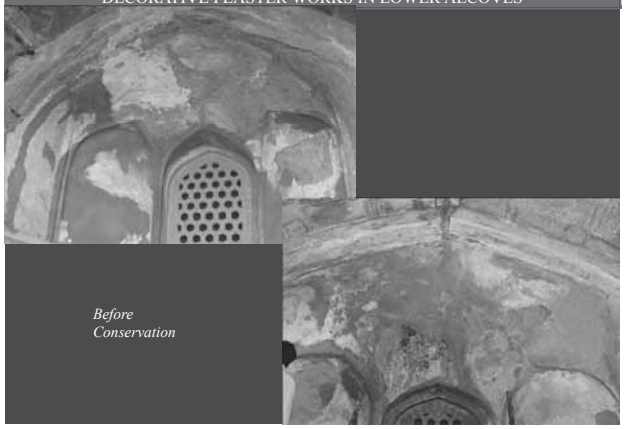
1. Lime plaster was decayed and disintegrated due to sever water seepage from the terrace
2. Decayed plaster replaced with new lime plastering with a finish of lime punning
3. Lime concrete flooring was provided

Humayun's Tomb Complex
CHAMBER REPAIR WORKS

During Conservation

During Conservation

Humayun's Tomb Complex
DECORATIVE PLASTER WORKS IN LOWER ALCOVES



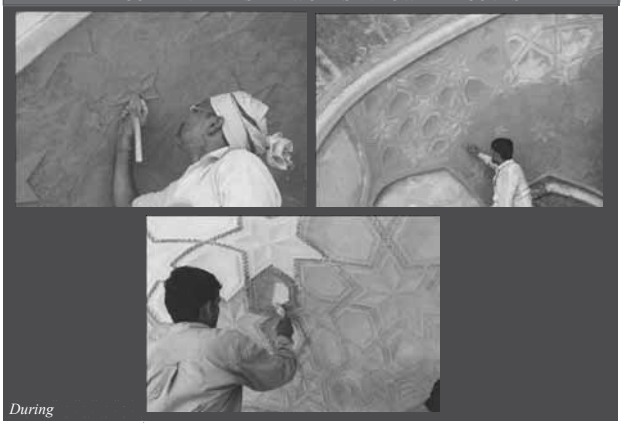
Before Conservation

Humayun's Tomb Complex
DECORATIVE PLASTER WORKS IN LOWER ALCOVES

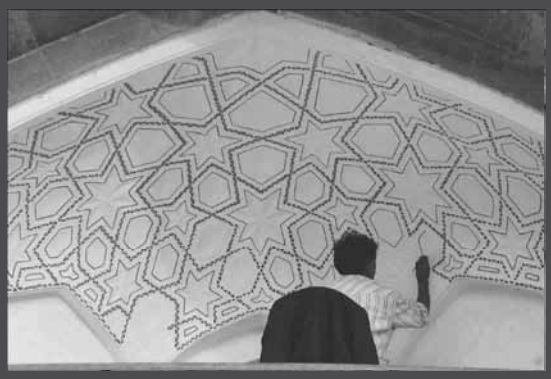
Before

Humayun's Tomb Complex
DECORATIVE PLASTER WORKS IN LOWER ALCOVES

Humayun's Tomb Complex
DECORATIVE PLASTER WORKS IN LOWER ALCOVES

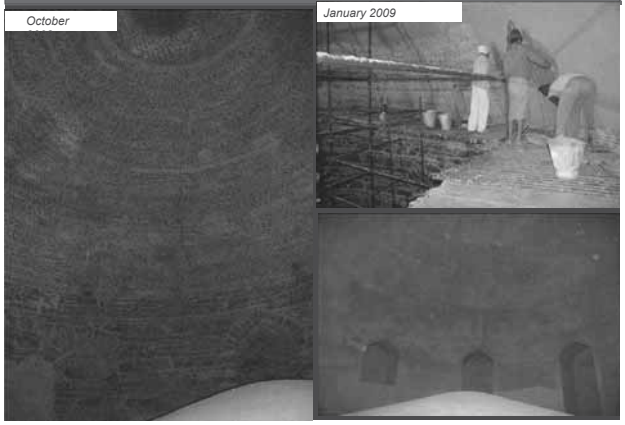


Humayun's Tomb Complex
DECORATIVE PLASTER WORKS IN LOWER ALCOVES



Humayun's Tomb
DOME –REPAIR WORKS

Humayun's Tomb
DOME –REPAIR WORKS



Humayun's Tomb
EXTERNAL FAÇADE REPAIR WORKS

Condition of the stones:

De-lamination
Erosion
Bursting
Splitting of the columns
Inappropriate previous repair works
•stones of different geological characteristics
•Replacement with multiple stones
•Wrong sectional details
•Filled with mortars

Humayun's Tomb
EXTERNAL FAÇADE REPAIR WORKS

Major works on façade includes:

- partial and complete replacement
- stone were prepared individually by the craftsmen
- All the stone replacement is done by using matching stones with same geological specification, sectional details as per original stones after applying hand chiselled finish.
- It took long time and efforts due to intricate constructional details

Humayun's Tomb
STONE PILASTERS

Stone columns:

- Stone columns WERE identified which have lost their integrity due to loss of architectural features
- Details of the existing original columns were studied and analyzed
- New stones columns are prepared by the master craftsmen as per original design
- Prepared columns are kept in open air since last one year for natural weathering to match with the original columns

KNOWLEDGE OF THE ARCHITECT AND THE STONE CRAFTSMAN CREATED THE LOST ARCHIETCTURAL DETAILS

Humayun's Tomb
ENCLSOURE WALL

It Includes:

•Restoration of the missing arches of the enclosure wall
•Consolidation of the inner masonry which is weak and fragile
•Repairing and completing the missing passage of the wall running along the Mughal garden

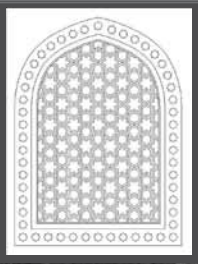
Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

TOOLS

- Traditional tools used for all types of works
- Tools are prepared on site by the craftsman
- All tools shape and sizes are made according to use

Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION



Original lattice screens studied and drafted

Pattern was transferred from paper to stone by making frame.

Jalies were crafted on red sand stone using traditional stone carving tools.

Over a 100 stone craftsmen are presently employed by the project.

Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

Lime mortar have been used in all the historic buildings of the project areas for various purpose:

1.Stone masonry
2.Terracing and flooring
3.Plastering
4.Decorative plaster works

Conservation works

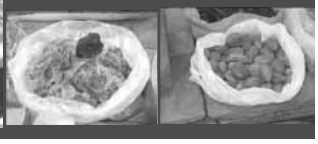
1.Lime mortar used using traditional chakki
2.matching proportions used for the lime mortar
3.Sand, sunkhi (brick dust) and quick lime is the main composition of the lime mortar

Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

Lime mortars comprised of:

Lime putty- Non Hydraulic lime
Sand
Pozollana
Organic additives such as Bel fruit, Jaggery, Jute fibers, Pulses, Egg white

These additives used as per the lime mortar specification and function

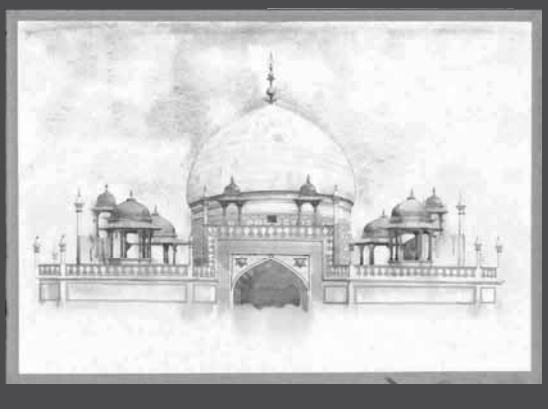


Humayun's Tomb
USE OF TRADITIONAL KNOWLEDGE IN CONSERVATION

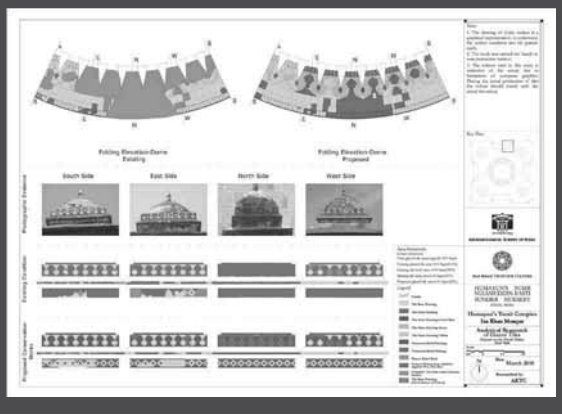
Traditional craftsmen identified for the various types of works to execute the conservation works:

•Stone and brick masonry- masons
•Stone dressing after quarrying
•Stone chiseling- finishing
•Stone carving-decorative patterns
•Stone lattice screen works
•lime plastering works- plain works, decorative works

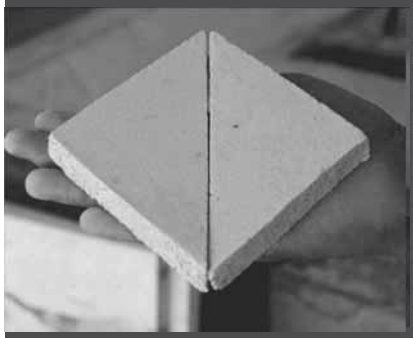
Humayun's Tomb
GLAZED TILE WORKS



Humayun's Tomb
GLAZED TILE WORKS



Humayun's Tomb
GLAZED TILE WORKS



1. Electrical kilns constructed on site for tiles
2. Chemical and raw materials procured from the India and tested for required results
3. More than 20 types of local clay and quartz was used for experimentation to matching tile bodies
4. Craftsman from Uzbekistan worked closely with Indian craftsmen , extensive training was carried out
5. After training , they worked under strict supervision of the master craftsmen
6. Several types of tile bodies were prepared and

Humayun's Tomb
GLAZED TILE WORKS

1. Original proportions were worked out using scientific testing
2. Copper, iron, cobalt and antimony oxides are the main colorant
3. Proportions varied milligram by mailgram to reach the final results
4. More than 1500 experiments carried out to prepare the five original glazed colors

Humayun's Tomb Complex
Lime training program

Till now 16 lime workshops have been completed

More than 170 ASI officials and conservation professional have attended and trained

Humayun's Tomb Complex
Lime training program

Workshops with ASI officials have been held in 2009-10-11

Humayun's Tomb Complex
HIGH DEFINITION SURVEY

- Introduce the advance 3-D laser scanning technology in INDIA for the first time jointly with ASI and LEICA.
- Document the main mausoleum with the help of advance 3-D laser scanning technologies.
- Two-week training for 9 ASI officers and 5 AKTC's officers was conducted in December 2008.

Humayun's Tomb Complex
STONE CRAFTSMEN TRAINNING

- Set up a training programme for youth to develop craftsman skills and ensure traditional building skills are continued to be practiced.
- To ensure availability of high quality craftsmanship and generate employment opportunities.

Current Issues of and Future Tasks for Conservation of Brick and Stone Structures in Sri Lanka

Jude Nilan COORAY
Architect / Assistant Secretary General,
National Trust, Sri Lanka

Introduction

As in many other countries and territories with a long standing history, Sri Lanka also inherent a rich heritage in both brick and stone construction. The indigenous technology using sun-dried bricks to construct the village dwellings was in practice from a very early date. It is still being continued in some parts of Sri Lanka, where a timber framework which supports the roof is held by sun-dried brickwork. The brickwork in this instance is not load bearing and serves only as a screen wall. The earliest reference to the use of sun-dried bricks for the construction of substantial structures was however, during the 3rd century BC, where chronicle *Mahawamsa* records that 'lumps of dry clay' has been used for the construction of Thuparama stupa at Anuradhapura, the first Buddhist stupa to be built after the formal introduction of Buddhism to Sri Lanka from the mainland India during the 3rd century BC. As evident from the colossal stupas at Anuradhapura dating from the 2nd century BC, burnt clay bricks, which is the next phase of maturity in the evolution brick technology, were also widely in used in the Island by the 2nd century BC. With regard to stone construction, the oldest surviving examples are the rubble masonry associated with monastic cave dwellings of the Buddhist monks ranging from the 3rd / 2nd century BC up to 1st century AC.

Types and scale of brick and stone constructions

Brick structures

Sri Lanka's historic brick structures could be broadly categorized into several types based on the technique of construction.

(a) Framed construction

This is, no doubt, a continuation of the technique associated with the sun-dried bricks, where a wooden framework is embedded into the walls to reinforce the brick masonry to support the roof or the structural timber work of the upper floors. The post-holes of the gate houses on the eastern entrance to the ancient royal city of Anuradhapura (Ca. 8th century AC) are among the oldest surviving evidence of this technique of construction (Silva 1991). The stone posts embedded in to the brick masonry walls of the later historic structures show that wooden reinforcements were subsequently replaced with granite, which is a durable material against dampness, termite attacks etc. However the 12th century AC royal palaces and structures at Polonnaruva and Panduvasnuvara display the continuity of the wooden reinforcements within brick masonry walls. The positioning of the wooden or stone posts in a single row at the middle of each brick masonry wall was the usual practice. But the brick masonry walls associated with the central area of the Parakkramabahu Palace at Polonnaruva displays that wooden posts are positioned as a double row with the wide space

in between filled up with brick masonry to form immensely thick walls. The vertical crevices of the thick brick masonry walls and stone spur stones at the base of such crevices indicate where these timber posts once stood. The outer surfaces of the wooden posts in this instance are flushed with the brick work to be covered by the lime plaster of the brick wall. The cavities left in the brickwork due to the decay of timber posts indicates that dressed wooden posts had been used and their lower and upper parts were square and octagonal respectively in cross section. This was a multi-storey structure and according to the chronicle *Culavamsa,* it was originally seven storeys high.

Parakkramabahu Palace, Polonnaruva (12th century AC). Note the vertical crevices and the holes of the brickwork indicates the vertical wooden reinforcements and the horizontal floor beams respectively.

(b) Solid construction

The city walls of massive thickness and extending several kilometres and the colossal stupas at the ancient capitals of Anuradhapura and Polonnaruva are the best representations of this construction technique. There are two variants in this technique, viz., the bricks laid course upon course as solid brickwork and, the brickwork only as a skin with earth and brick bats in the core. The stupas at Anuradhapura are the examples of the first variant, while the city walls and some stupas at Polonnaruva are the examples of the second.

Ruvanvaliseya (2nd century BC; original height 96 meters approx.), Abhayagiri Stupa (1st century BC and enlarged 1st century AC; original height 106 meters approx.) and Jetavana Stupa (3rd – 4th century AC; original height 120 meters approx.) at Anuradhapura are not only the largest brick monuments in the entire Buddhist tradition, but still the tallest brick structures in the entire world, even rivaling the stone-built great pyramids of Egypt in height and volume. The profile of the dome of these colossal stupas conforms to the traditional paddy heap shape (ellipsoid for Jetavana and paraboloid for Abhayagiriya) suggesting that the dome has been designed to a very sophisticated mathematical formula (Nanayakkara 1982, Dampegama 2001, Silva 1990). Such a profile having a gradient equal to the angle of repose is the most stable form from a structural point of view, as it gives no tension in the dome

under self weight (Ranaweera 1998). The foundation of these stupas rest on the bed rock and that of Jetavana stupa is about 8 meters deep. The burnt clay bricks used for the construction of these stupas are of high quality with a compressive strength of more than 4 N/m^2 and their dimensions being 450x225x5 mm. It is estimated that Jetavana and Abhayagiri stupas contain approximately 62 and 54 million bricks respectively (Silva 1991). In order to keep the solid built masonry of brickwork intact, slurry type butter clay had been used as the mortar mixture, which is perfectly pliable and compatible with the clay bricks. Therefore this binding medium had made the whole structure a homogeneous mass which is flexible as a three dimensional plain, in order to provide for internal movement of these immense masses due to settlement, expansion and other physical forces. The mortar joints are deliberately made absolutely thinner; almost the bricks on the upper course sit on those of the lower course to transfer the vertical gravitational weight from one layer of bricks to the other, instead of it being made to traverse through the medium of clay mortar, which is weak in compression. Another interesting aspect of these stupas is the verticality of the free standing solid brickwork of the spire of slender proportions (for instance, the height of the spire of Jetavana stupa is about 48 meters) which rose above the square structure of these stupas that withstood the high wind pressure at high elevations.

Jetavana Stupa at Anuradhapura, the world's tallest brick structure (4th century AC)

Rankotvehera at Polonnaruva (12th century AC; height 48meters) suggests that the superstructure of this stupa rests on a brick tower and the space between this tower and the brick skin of the dome is filled with compacted earth and brick bats (Prematilleke and Karunaratne 1993:102).

Other notable solid brick constructions are the tall and slender 12th century AC Buddha images of Lankatillake (original height 15.1meters) and Tivanka image houses at Polonnaruva. However, these images have been constructed not as free standing structures, but are buttressed with brick masonry work at the back. Other significant structures of this type are the massive brick built retaining walls at the royal palace complex on the rock summit of Sigiriya (5th century AC), reaching a height of about 12 meters,.

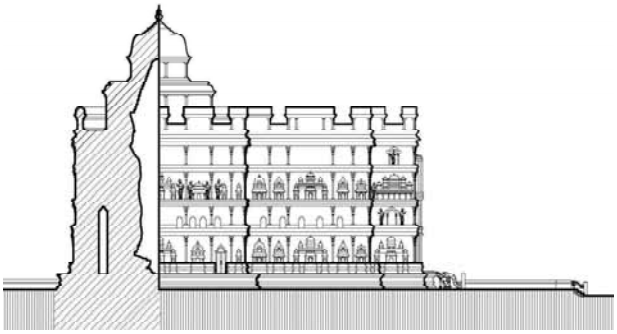
Brick-built colossal Buddha images of Lankatillake and Tivanka at Polonnaruva (12th century AC)

(c) Hollow construction

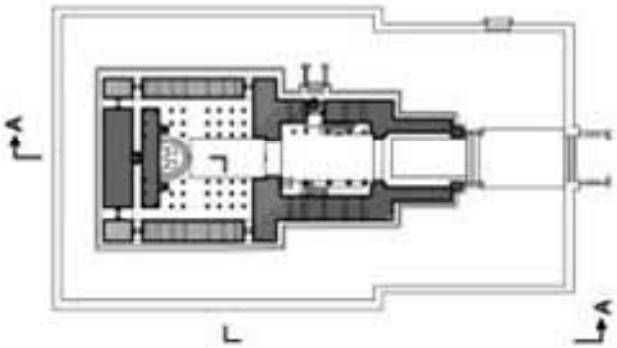
Called '*gedige*' in Sri Lanka, the foundation, walls and the roof of these structures are constructed out of masonry work with hollow space inside. One of the earliest surviving structures of this type was probably the 'Lion-Staircase-House' constructed against the vertical rock face of Sigiriya in the form of a fore part of a colossal lion. Although the massive fore paws and the central passage with flight of steps leading to its possible mouth have survived, the remnants of the brick masonry and the crevices for the timber posts to reinforce the brickwork suggests that it could be a hollow construction of grand scale datable to the 5th century AC.

The best structures representing this technique are the brick built image houses at Anuradhapura and Polonnaruva. As seen at Thuparama, Lankatillake and Tivanka image houses at Polonnaruva (12th century AC), they utilize the

arch for the openings (for access and ventilation) while vault and dome to form the interior spaces. These structures eloquently display that the builders have used both the corbel and circular technique to form the arch, vault and the dome (Silva 1991). In some instances a combination of corbel and circular techniques are also used, where the arch, vault and the dome commence with the corbel technique up to a certain height to give way to the circular technique to complete the upper circular part. Another notable feature of the circular form of the arch, vault and the dome is that the ancient Sri Lankan builders have opted the Sassanian technique of construction to construct the circular arch, vault and the dome, where the headers of the bricks are laid in the same direction of the circular profile, which is markedly different to the Roman technique of construction, where the headers are laid perpendicular to the circular profile. The Lankatillake image house at Polonnaruva, which has a ground floor area of about 890 square meters and an original height of about 27 meters, is the largest of this type, while Thuparama image house, also at Polonnaruva, is the well preserved example of this type.

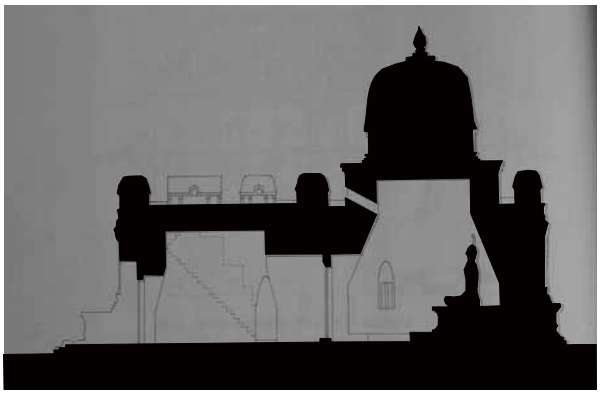


Sectional Elevation AA



Plan

Lankatillake image house at Polonnaruva (12th century AC)



Thuparama image house at Polonnaruva (12th century AC): general view and longitudinal cross-section

Stone structures

Sri Lanka's historic stone structures could be basically divided into two types, viz., monolithic and assembled structures.

(a) Monolithic structures

The cultural properties ranging from sculpture and decorative elements to artificial caves (such as the one at Galvihara, Polonnaruva) fall in to this type. Buduruvagala (15.4 meters high), carved in relief, Avukana (11.8 meters), carved all round but connected to the mother rock, Maligavila (12.7 meters), which is carved as a free standing sculpture are the tallest Buddha images of this type.

(b) Assembled structures

The structures constructed using several blocks or slabs of stone fall in to this type. Except the rubble work, where clay or lime mortar is used, here, the dry wall construction is mainly used in this type. The stone blocks made to different shapes to interlock with each other, the tenon and mortise joints together with their self weight are used to keep the stone blocks in position. These could be either solid constructions or even a stone facing to a core of earth and brick bats. Corbelling technique has been used to reduce the spans of the domical roofs. The Buddha image house (Gedige) at Nalanda (8th -10th century AC), Hindu shrines at Polonnaruva (12th century AC), the Buddha image houses at Ridi Vihara (14th century AC) and Gadaladeniya (14th century AC) are significant examples in this regard. Compared to the scale of brick monuments in Sri Lanka, the stone monuments are, however, less significant.

Nalanda Gedige (8 – 10th centuries AC)

Siva Devales No. 1and 2 at Polonnaruva (12th century AC)

Image Houses at Ridivihara and Gadaladeniya near Kandy (14th century AC)

Conservation

What is attempted below is not to provide an account of the conservation work carried out with regard to numerous brick and stone structures in Sri Lanka, but to present some of the current issues of and future tasks for conservation of brick and stone structures through selected examples.

Conservation of brick-built Jetavana and Abhayagiriya stupas at Anuradhapura

Due to the neglect and disrepair for about four centuries, both these colossal stupas were deteriorated almost identically, at the time the Central Cultural Fund (CCF) under took the conservation work in 1980's. The dome of each monument was totally overgrown with thick vegetation; except at the very bottom and the top of the dome, the lime plaster covering the brickwork has disappeared; brickwork of the dome has eroded considerably allowing infiltration of rain water to the body of the stupa; walls of the square structure sitting upon the dome have either collapsed or developed severe cracks; and the upper portion of the spire has broken. The detail investigation of these monuments suggested that the deterioration process had taken place in the following sequence after the stupas were neglected for about four centuries.

- Cracking of the plaster and the brick surface due to thermal stresses and to minor structural adjustments
- Rain water infiltration to the body of the stupa and the washing and, or detaching of the lime plaster from the brick work.
- Vegetation growth in cracks and joints on the exposed brick surfaces
- Formation of local failures and creation of gullies on the brick surfaces as a result of erosion due to rain water runoff and to root pull-out from the falling trees
- Long term fabric deterioration, specially on the shoulder of the domes, resulting the cracking and collapsing of the walls of the square structure

Jetavana and Abhayagiri stupas at Anuradhapura (before conservation)

Significance assessment (overall importance determined through an analysis of all of the values attributed) of both these stupas are as follows:

- Final evolution of a stupa design of specific type as reflected through its architectural design (ARCHITECTURAL & HISTORICAL VALUE)
- Symbol of spiritual well being of a society in the 1st millennium AC as reflected by the immense scale and positioning in relation to its overall city plan and individual monastic plan (SYMBOLIC & PLANNING VALUE)
- Exceptional organizational capabilities and technical knowledge of a civilization, which is unparallel in the Buddhist world as reflected by the construction technology, brick masonry technique, shape of the dome's profile, etc. (TECHNOLOGICAL VALUE)
- Still being worshiped by the Buddhists as reflected by the continued use and function (FUNCTIONAL VALUE)

Conservation policy adapted for the conservation of these stupas is as follows:

- to restore the monument for its structural stability
- to preserve the architectural fabric
- to facilitate the spiritual needs of the devotees
- without losing historical/ archaeological character

Since the bricks used for the stupas are of special size (450x225x50 mm), which is very much larger than the modern engineering bricks (212x106x56 mm) that are commonly used in the present construction industry, it was apparent that the modern engineering bricks are not suitable for conservation due to following reasons:

- since the thickness of the engineering brick do not match with that of the ancient bricks it does not allow to maintain a uniform thickness of the brick courses, which will in turn create issues regarding the homogeneity of the overall brick mass
- the length and the breadth of the engineering bricks that are very much less than that of the ancient bricks is not harmonious with the existing character of the brickwork in bonding, width of mortar joints, etc.
- compressive strength of the engineering brick is very much less and the rate of water absorption is very much higher than those of the ancient bricks

Therefore one of the challenges faced in the conservation of these stupas was to manufacture the bricks that are compatible with those of the ancient bricks. In order to derive specifications for the new bricks, laboratory tests were carried out with regard to the ancient bricks (Siritunge 1982, Silva 1991), and the results are as follows:

- average compressive strength is 600 psi (4 N/m^2) and the average water absorption rate is 12%.
- average ratio of sand and clay composition is 1:1

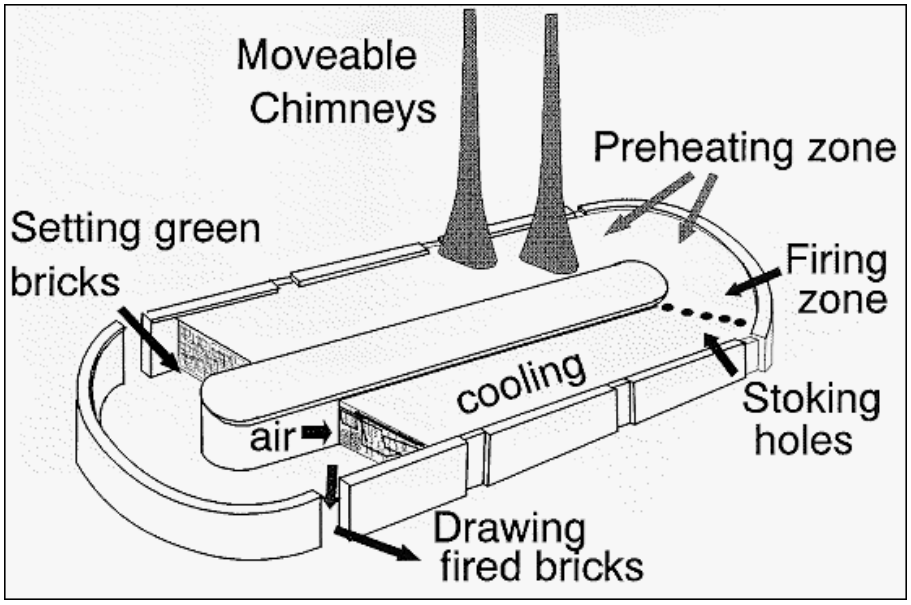
- with regard to sand component, only the silt (below 1/16 mm) and very fine sand (between 1/16 – 1/8 mm) to the ratio of 1:1 has been used

The specifications derived for the new bricks to be manufactured based on the above investigations are as follows:

- dimensions: 450x225x50 mm
- compressive strength: 400 psi (2.65 N/m^2)
- water absorption rate: 15% to 18%
- clay and sand ratio to be roughly 1:1 with the sand component (below 1/16 mm and between 1/16 – 1/8 mm) to be approximately 1:1
- Efflorescence: nil
- Method of production: hand made
- Similar in color and texture to the ancient bricks
- regular in shape with sharp and clean edges, uniform in color, free from cracks and flaws, reasonably uniform texture in the cross-section and free from black core and any signs of being imperfectly burnt, free from pebbles and expansive particles etc.

Although several attempts were made to produce the bricks to meet the above specifications, initially through traditional brick makers who use traditional clamp kilns to produce engineering bricks, they all failed due to the inadequate firing levels of these kilns. On the other hand, the amount of bricks needed for the conservation of stupas were several millions, which needed a steady supply of burnt bricks and an enormous quantity of fuel in the form of fire wood to meet this demand. The CCF, therefore had many discussions with the National Building Research Organization (NBRO) regarding these issues and their advice, based on the research carried out by them was to establish a traditional brick kiln (commonly called the Bull's Trench Kiln), which is widely used in countries like India, Bangladesh, Pakistan, Myanmar etc. to produce these bricks to overcome these issues. These type of kilns involve low cost of construction and is of comparatively low energy consumption (reduces the fuel consumption by more than 50% of the other types). Moreover, they are continuous kilns where bricks could be burnt without interruption to meet the demand of the conservation work. The temperature level of the kiln is 800^o – 1000^o C. As an experiment, a scaled down sample kiln was initially established and the green bricks burnt were found to be most successful in terms of quality. An officer was thereafter sent to India to study the firing process and other technicalities involved in the process. On his return to the Island, he trained other officers and firemen. In the mean time the NBRO investigated the suitable sites to obtain the best clay deposits close to the work sites at Anuradhapura to locate the new kiln. After selecting a suitable site which is about 12 km away from the work sites within the flood plains of Malvatu Oya (stream), a kiln was constructed as per the design of the traditional kilns of this kind with a stacking capacity of 80,000 ancient sized bricks, with an output of 7000 bricks per day. The areas around the kiln, where the clay deposits are found were assigned to the traditional brick makers of the locality to produce and supply the green bricks for firing. Through this system, the CCF was successful in producing quality bricks required for the conservation of these two colossal stupas.

Through this process it was possible to revive the traditional skills in producing large sized quality bricks, which has been lost after the 12th century AC in Sri Lanka. This is considered one of the success stories and a landmark achievement in the annals of heritage conservation in Sri Lanka.



Traditional brick kiln (Bull's Trench Kiln)

Process of preparing green bricks

The brick kiln established to produce the ancient sized bricks)

Stacking of green bricks for firing

Stacked green bricks showing the gaps created for the movement of heat

Fired bricks

Since the conservation policy was not to cover the brickwork of the stupas with a new lime plaster, but to finish as exposed brickwork, the use of clay mortar, which is the original mortar, would not guarantee the durability of the exposed brickwork. Therefore, the other issue with regard to the conservation of these stupas was to find a mixture which is compatible with that of the clay mortar. The CCF together with the NBRO carried out research on traditional ways of preparing non-cement based mortar mixtures, and was successful in developing a special mortar (1 slaked lime: 1 paddy husk ash: 2 ant hill clay: 2 tile powder) that is compatible with the original clay mortar and at the same time with an increased setting time to conserve the Abhayagiriya stupa. This is the first time in the history of heritage conservation in Sri Lanka, where a mortar mixture without Portland cement is being used for the conservation work of this magnitude.

When recruiting general masons for conservation activities, special training is always given to them on traditional brick conservation techniques.

Conservation work in progress: Jatavana and Abhayagiri stupas

Conservation of stone structures

The general principals followed for the conservation of stone structures in Sri Lanka, specially with regard to the voids and missing stone works are as follows (Silva 1979: 305-309):

- such areas to be filled with new stones that are identical to the geological type and similar in size, color and texture to the ancient stones
- character of the new stonework should harmonize with the old in bonding, width of joints, texture etc.
- if the use of new stones are not practical, such areas to be filled with brickwork bonded as stretcher courses and pointed
- if brick in-fills are numerous and if these contrast conspicuously with the original work such in-fills to be plastered with a mixture to imitate the stonework

Due to the lack of skilled craftsmen and the high cost of stone carving work, the use of new stone for conservation is extremely rare in Sri Lanka. The reproduction of stone carvings of the Temple of the sacred Tooth Relic at the World Heritage Site of Kandy using traditional craftsmen, after the terrorist bomb attack, is an exception.

With regard to the missing decorative stone works, such as those of the frontispieces (*ayake*) of the stupas, due to the lack of skilled craftsmen to reproduce these decorative works to match the old, the usual practice is to fill such missing voids with brickwork, as it is also difficult to imitate the original decorative work with plaster work. But the brick filling in such voids gives a contrasting effect with the original work.

Stone frontispieces of Jetavana stupa showing the filling of voids and missing stone work with brick work

But on the other hand, there is also a tendency to use machine-cut stone for conservation of stone work. Use of machine-cut stone slabs to fill the voids of the stone paved terrace of Mirisaveti stupa at Anuradhapura shows that new stone slabs do not at all match with the size, color, texture, etc. of the ancient stone work and not harmonize the ancient stone work in bonding, width of joints etc.

Stone paved terrace of Mirisaveti stupa showing the filling of voids and missing stone work with machine-cut stones

At the same time there are also attempts (such as the conservation work at the precinct of the sacred Bodhi-tree of Anuradhapura) to get the services of the companies involved in granite work using mechanized systems to reproduce stone work to match the characteristics of the old stone work. However the lack of artistic sensitivity of the machine operators and the limitations offered by the mechanized systems in reproducing ancient decorative works are evident through their products.

On the other hand the CCF has also initiated a training program for the youth in reproducing stone carvings to encourage the young artists to keep up with this rare and valuable field of arts as a profession and income generation avenue, and thereby to safeguard the traditional skills in stone carving. A combination of traditional methods (manual systems based on artistic sensitivity) and mechanized tools are employed during the training program. The reproductions through this system show promising results and offers better scope for stone conservation in Sri Lanka.

The above examples show that the approach to materials, mixtures, workmanship etc. related to stone and brick conservation in Sri Lanka is basically a combination of traditional skills / knowledge and modern technology, and it has shown positive results. It also points out that the traditional skills /knowledge exists with the traditional craftsmen and at the same time is stored within the monuments themselves. It therefore underlines the importance of conducting scientific research on monuments to unearth such skills /knowledge with regard to:

- techniques of construction
- techniques of brick making / stone finishing and carving
- techniques of brick laying (including mixtures, bonding systems, laying techniques etc.)
- techniques of stone fixing (joinery etc.)

Conservation of the stone retaining walls of the terraces of the sacred Bodhi-tree at Anuradhapura. The upper section of the retaining wall is restored using stone work reproduced with mechanized-systems.

Reproduced stone work using mechanized systems


Reproduced stone work using a combination of traditional methods and mechanized tools



Young craftsmen at work using a combination of traditional methods and mechanized tools

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International Conference

Human Resources Development for the Transmission of Traditional Skills:
National Approaches and their Application to Stone and Brick

Current Issues of and Future Tasks for
Conservation of Brick and Stone Structures in Sri Lanka

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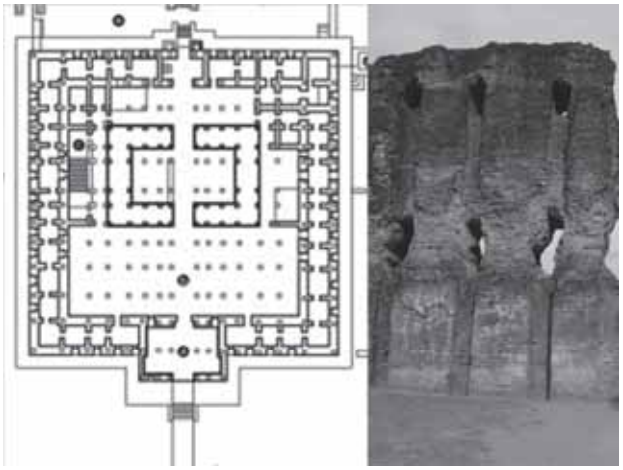
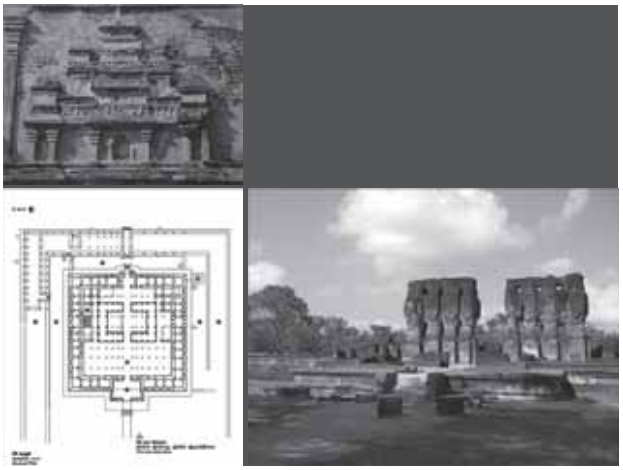
Types and scale of constructions : Brick Structures

(a) Framed Constructions

Timber framed brickwork
(continuation of the wattle-and-daub construction)

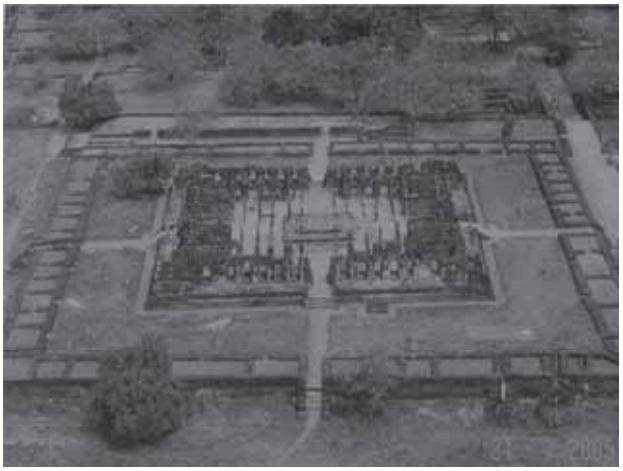
Royal Palace, Polonnaruva (12th century AC)



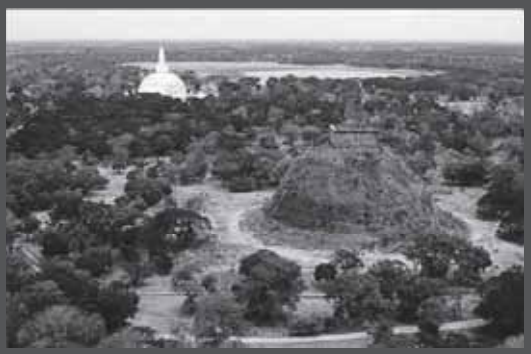


Stone framed brickwork

Buddha Image House, Manik Vehera, Polonnaruva (12th century AC)



(b) Solid Constructions



Ruwanveli and Jetavana Stupas, Anuradhapura, 2nd century BC and 4thcentury AC

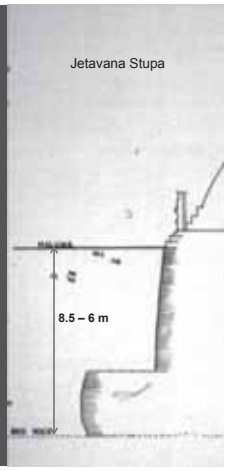
Characteristics of Mega Stupas at Anuradhapura

- Solid Brickwork in clay mortar
  (Bricks laid course upon course)

- Utilization of millions of large sized bricks: 450x225x50 mm
  (more than 90 million bricks for Jetavana and more than 54 million bricks for Abhayagiriya)

Technical Characteristics of Mega Stupas at Anuradhapura

Jetavana Stupa

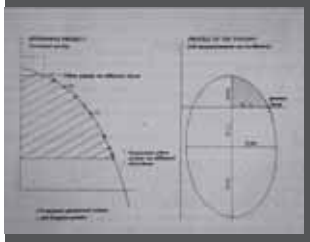


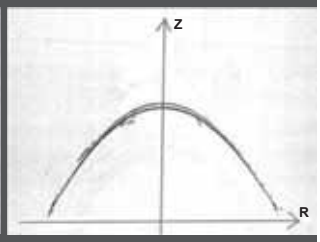
- Deep foundation resting on the bed-rock

Technical Characteristics of Mega Stupas at Anuradhapura

- Profile of the dome

Conforms to the traditional paddy heap shape: a sophisticated mathematical formula





Ellipsoid for Jetavana Stupa

Paraboloid for Abhayagiri Stupa

$Z = -0.019566R^2 - 0.001548R + 50.77112$

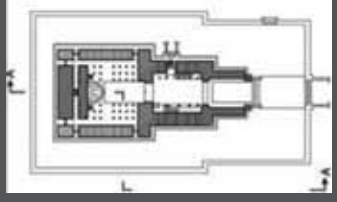
Gradient equal to the angle of repose, most stable form from a structural point of view,
(no tension in the dome under self weight)

Lankatillake Buddha image 15.1 m

Tivanka Buddha image

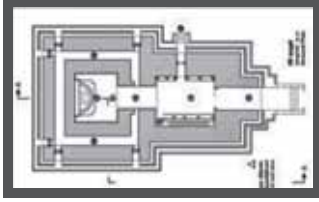
(c) Hollow Constructions

Thuparama
Buddha Image House,
Polonnaruva
12th century AC



Lankatillake Buddha Image House
Polonnaruva, 12th century AC

Tivanka Buddha Image House, Polonnaruva, 12th century AC

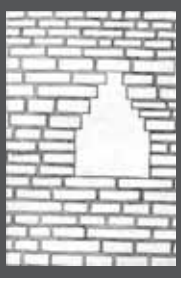


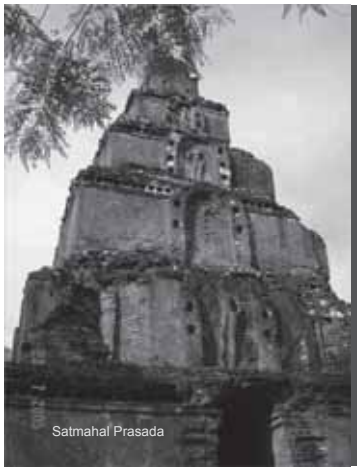
Techniques of Construction:

(c) Hollow Constructions

c. 1. ARCH

Corbelled Arch





Satmahal Prasada

Circular Arch

Pidurangala

Corbelled and Circular Arch

Techniques of Construction:

(c) Hollow Constructions

c. 2. VAULT

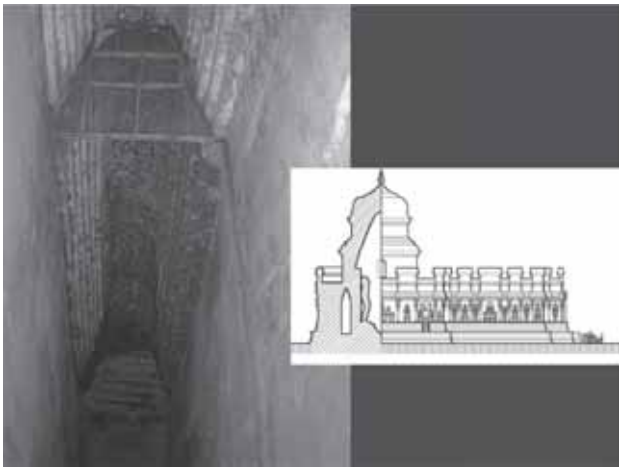
Corbelled Vault

Techniques of Construction:

(c) Hollow Constructions

c. 2. VAULT

Corbelled and Circular Vault

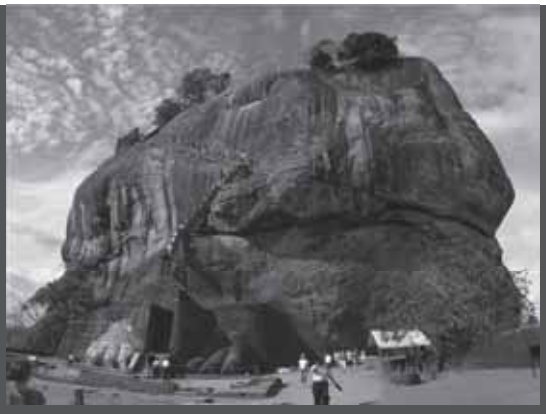


Techniques of Construction:

(c) Hollow Constructions

c. 3. DOME

Corbelled Dome



Lion-Staircase-House, Sigiriya,5th century AC

Stone Structures (ranging from 8th -12th century AC)

Nalanda Gedige
(8 – 10th centuries AC)

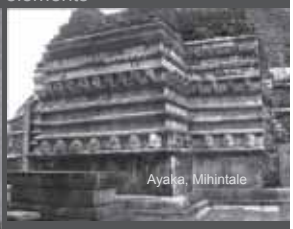
Siva Devale No. 1at Polonnaruva
(12th century AC)

Yapahuva (13th century AC)

Buddha Image Houses at Ridivihara and Gadaladeniya (14th century AC)

Architectural elements

Ayaka, Ruvanveli



Ayaka, Mihintale

Stone Railing, Jetavana

Architectural decorations

Brick Conservation

Conservation of mega stupas

Production of ancient sized bricks for conservation

Comparison of ancient brick (450x225x50 mm) with modern brick (212x106x56 mm)

Properties of ancient bricks used for the mega stupas

(a) Mineralogy ratio

Quarts (Sand)	50 - 60%
Clay	35 – 45%
Voids	3 – 8%

(b) Sand size analysis and the ratio used

Silt (below 1/16 mm.)	48.5%
Very fine sand (1/16 – 1/8 mm.)	48.5%
Fine sand (1/8 – ¼ mm.)	---
Medium sand (1/4 – ½ mm.)	1.9%
Common Sand (1/2 – 1 mm.)	1.1%
Very common sand (1 – 2 mm.)	---

(c) Average Compressive strength — 621 psi (4.28 N/m2)

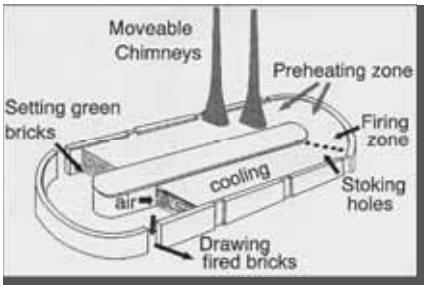
(d) Average water absorption rate — 12%

Specifications for the new bricks to be manufactured:

- dimensions: 450x225x50 mm
- compressive strength: 400 psi (2.65 N/m^2)
- water absorption rate: 15% to 18%
- clay and sand ratio to be 1:1 with the sand component (below 1/16 mm and between 1/16 – 1/8 mm) to be 1:1
- efflorescence: nil
- method of production: hand made
- Similar in color and texture to the ancient bricks

Traditional Clamp Kiln

- Used to manufacture small sized bricks (212x106x56 mm)
- Inadequacy of firing level
- No steady supply of burnt bricks
- Requires enormous quantity of firewood



Traditional brick kiln (commonly called the Bull's Trench Kiln), widely used in countries like India, Bangladesh, Pakistan, Myanmar etc

- involve low cost of construction
- temperature level of the kiln is 800^0 – 1000^{0}C.
- comparatively low energy consumption (reduces the fuel consumption by more than 50% of the other type).
- a continuous kiln (bricks could be burnt without interruption to meet the demand of the conservation work)

- located in the best clay deposits close to the work sites
- stacking capacity: 80,000 bks.
- out put: 7000 bks. per day
- clay deposits around the kiln were assigned to traditional brick makers to produce green bricks
- training of staff and other support staff (firemen)

Process of producing green bricks

- Revival of traditional skills in producing large sized quality bricks
- A landmark achievement in the annals of heritage conservation in Sri Lanka

Mixture

Research on a mixture compatible for the bricks and clay mortar-

1 slaked lime:
1 paddy husk ash:
2 ant hill clay:
2 tile powder

(first time in the history of conservation in Sri Lanka that a mortar mixture without Portland cement is used for a conservation work of this magnitude)

Training programs for general masons on brick conservation techniques

Stone Conservation

- if the use of new stones are not practical / economical, the voids and other missing areas:
  - be filled with brickwork and pointed
  - such in-fills to be plastered with a mixture to imitate the stonework

Use of machine-cut stone slabs:

Stone paved terrace, Mirisaveti Stupa, Anuradhapura

…… do not match with the size, color, texture, character etc. of the ancient stone work and not harmonize the ancient stone work in bonding, width of joints etc.

Use of mechanized systems to reproduce stone work

Stone retaining walls of the terraces of the sacred Bodhi-tree at Anuradhapura.

CCF's training program for the youth in reproducing stone carvings:

- to safeguard the traditional skills in stone carving.
- to encourage the young artists to keep up with this rare and valuable field of arts as a profession and income generation avenue
- A combination of traditional methods (manual systems based on artistic sensitivity) and mechanized tools

Reproduced stone work using a combination of traditional methods and mechanized tools

Approach to materials, mixtures, workmanship etc. related to stone and brick conservation in Sri Lanka:

- basically a combination of traditional skills / knowledge and modern technology
- traditional skills / knowledge exists with the traditional craftsmen and at the same time is stored within the monuments themselves (therefore underlines the importance of conducting scientific research on monuments)

Underlines the importance of :

- documenting the skills / knowledge of traditional craftsmen
- conducting scientific research on monuments

with regards to:

- techniques of construction
- techniques of brick making / stone finishing and carving
- techniques of brick laying (mixtures, bonding, laying techniques, etc.)
- techniques of stone fixing (joints etc.)
- preventive conservation

Current Issues of and Future Tasks for Conservation of Stone and Brick Cultural Heritages and Traditional Techniques in Korea

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1. Cultural overview of stone and brick

There are various kinds of cultural heritage in Korea. Those made of stone were produced from prehistoric time to present. They are dispersed nationally and most of them were made of granite. Manufacture of stone heritages has deep relationship with notion of life and death. Ancestors of Korean has made house for living of wood which have life and death like people. But stone and brick, as its invariant characteristic, has been used in construction of pagoda, stupa, grotto, and foundation of structure.

2. Heritage classification of Korea and intangible heritages

Categories of designated heritage are as bellows;

- State-designated heritage[1]: national treasures[2], treasures, historic sites, scenic sites, natural monuments, important intangible cultural heritages, important folklore materials
- City/province-designated heritage[3]: tangible cultural heritage, intangible cultural heritage, monuments, folklore materials, cultural heritage materials
- Registered cultural heritage[4]: cultural heritage of early modern times
- Undesignated cultural heritage[5]

At present in Korea, 553 stone structures are designated as state-designated cultural heritages which designated as national treasure, treasure and historic sites. The Mireuksaji seoktap (stone pagoda of Mireuksa temple site) designated as national treasure no. 11 was built in early A.D. 7th century. Most cases of stone structures were made before Joseon dynasty (A.D. 1392~1910), and brick was used after mid Joseon

1 Designated by the administrator of Cultural Heritage Administration pursuant to the Cultural Heritage Protection Act after deliberation by the Cultural Heritage Committee

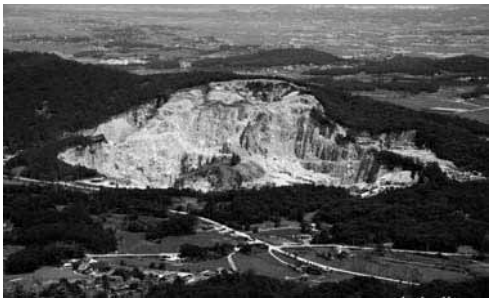
2 Heritage of a rare and significant value in terms of human culture and with an equivalent value to treasures

3 Among the non-state designated heritages, those in need of preservation are designated as City- or Province-designated Heritage by the mayor and the governor respectively, based on the municipal or provincial regulations.

4 The Registered Cultural Heritage refers to architectural structures or monumental facilities of early modern or modern times that have significant values and thus need to be preserved.

5 The Undesignated Cultural Heritage refers to the cultural heritage that needs to be preserved even though it is not designated as State-, City- or Province-designated Heritage.

dynasty when started to affect by western culture. The representative type of stone cultural heritage is stone pagoda. Techniques of quarrying and sculpture have been established since prehistoric age. Dolmens which represent Bronze Age have capstones and their weight varies from 4or 5 to dozens tons.

Though capstone comes from natural stone but in many cases, they were cut from rock bed. And it means there were already techniques of quarrying and sculpture since Bronze Age. Also, most of mountain fortress walls which constructed during A.D. 4–7th century were made of stone. Mountain fortress walls are also a kind of structure needs various techniques such as quarrying, carving, building, etc. Constructions of these kinds of stone structures have been done by Seok-jang (a stone artisan).[6]

According to related law, CHA designate important intangible heritages among intangible heritages which has outstanding value. After designation of important intangible heritage, CHA should certify a holder or holding group which can actualize those techniques or arts. At present there are 178 holders and 58 holding group of important intangible heritages. Seok-jang was designated as an important intangible heritage in Sep. 2007. A reason of designation as below;

"As time goes by, because of such reason like introduction of machinery, traditional skills of stone structure faced a serious crisis of disappearance. So, to conserve and hand down traditional skills and techniques of stone structure, now we designate the Seok-jang as an important intangible heritage."

Generally, a designation of important intangible heritage has a various procedures, such as on-site inspection by specialist, consideration by heritage committee. Most important principle is technical power, will and circumstance of inheritance of holder (or holding group). Inheritance steps are consisted as honorary holder – holder - assistant of inheritance teaching - trainee. Through these steps we try to guide inheritance between generations smoothly, and national government subsidizes basic expenses to maintain these steps. If one holder could not carry out education because of one's ripe age or disease, we certify current holder as honorary holder and fill up the vacancy.

Two stone artisans had learned stone techniques from the age of 15 by inducement of kindred and had spent 3 to 10 years as an apprentice. Now, their sons are learning stone techniques from their father as a scholarship student of inheritance.

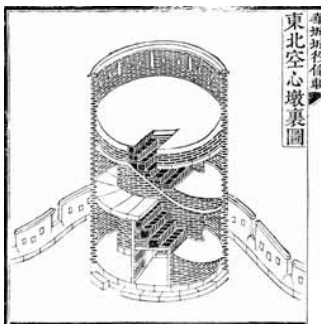
6 One of an old historical record about stone artisan was found in record of sarira in stone stupa which was built in 8th century. There was a name of stone artisan 'Shin-no' on that record.

3. Various type of stone and brick structure

The Mireuksaji Seoktap (a stone pagoda of Mireuksa temple site) is a representative stone structure and it was made of granite which quarried in local quarry. Because this stone pagoda was built in transition period of material from wood to stone, it has a characteristic of wooden pagoda. Gameunsaji Seoktap (a stone pagoda of Gameunsa temple site) which was made of tuff of andesite descent is relatively smaller than Mireuksaji Seoktap. But its formative beauty and construction method are very impressive. Over 200 mountain fortress wall dispersed nationwide, and they are conserved and restored by local government. Seoul municipal authority also has established total restoration plan of its fortress wall.




Hwaseong (Hwaseong fortress), built in late 18th century, is the representative structure using brick and stone. Of course, there are so many structures using brick or brick-like stone, and Bunhwangsa Seoktap (a stone brick pagoda of Bunhwangsa temple) which is built in A.D 634 is representative. But it did not use real brick but brick-like stone. After this, lots of brick pagodas were constructed along rivers because riverside have a good condition for brick making. A brick structure has been constructed generally after 17th century because people understood its merits. Finally, technical powers of brick structure in late 18th century concentrated on construction of Hwaseong fortress.

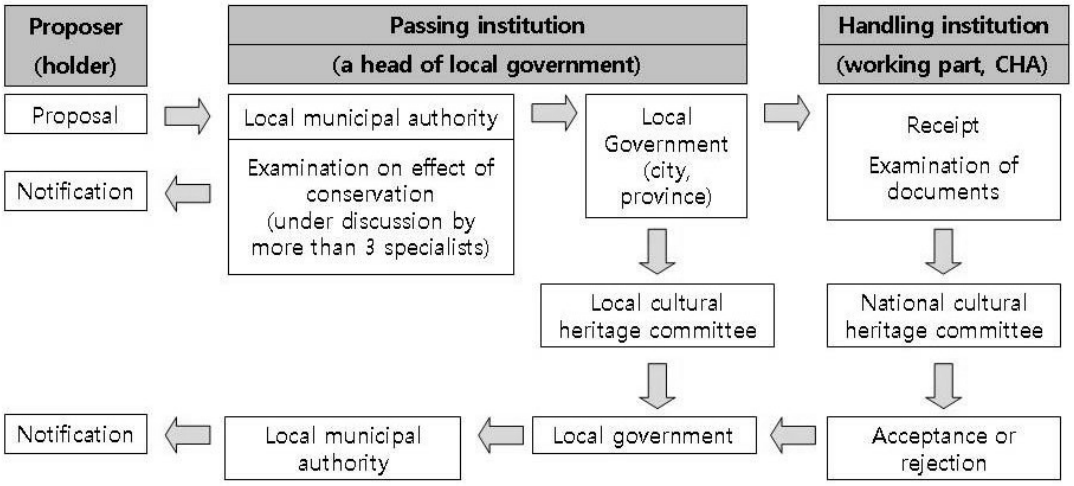



Especially called Gongsimdon which means empty and functions as a guard post succeed to create quite different space compare to that of Korean architecture. After construction of Hwaseong fortress, brick structure has broadened its usage as a living building. Anyway, with cultural spreading of Christianity and Catholicism, religious building such as cathedral started to be constructed. Myeongdong seongdang (Myeongdong seongdang cathedral) which is designated as historic site and other cathedrals were built in late 19th century or early 20th century. But planning of these brick structure was done by Christian missionary or priest and Chinese artisan took a part in making brick and construction. On this article, I have concentrated on stone structure.



4. Phase of conservation/preservation project implementation

Conservation/preservation or restoration project of cultural heritage is carried by local government and its workflow is as below;



In case of general conservation/preservation project on state-designated cultural heritage, national and local government arrange budge plan at the ratio of 3 to 7. On the other side, in case of project on city (or province) designated cultural heritage, its ratio is 5 to 5. In some cases, holder share expenses but its ratio is irregular. In each case of budget subsidy, inspection of current state, records of processes, and publication of report on total process are mandatory. But quality and quantity of report is different according to scale of project, supervisor, career of writer, scale of budget, etc.

Recently, CHA set intra network system. Through this system, a person in charge of cultural heritage in local government can input data and information by online such as photos, drawings, manuscripts, etc. In planning of each project, local government took total progress of project, and CHA took part in decision making and establishment of conservational method. Also, opinion of specialist such as cultural heritage committee member is very important criterion of decision. In all conservation/preservation or restoration of designated cultural heritage, person in charge of local government and CHA supervise total process, but not reside always.

5. Education of specialist and inheritance of technique

All projects are carried by 2 different specialist, repair technician[7] who control the whole process and repair craftsman[8] who operate each conservation processes. At present, the number of technician is 1382, and craftsman 5854. Its qualification examination is carried out by HRD Korea (Human Resources Development service of Korea) and their licenses are managed by CHA. Recently, CHA arranged mandatory regulation about education, and everyone have license should take part in educational program of CHA once in a 5 year.

A standard salary of technician is not fixed, but daily pay of craftsman is written in standard repair specification of cultural heritage as CHA's regulation. For example, those of craftsman related with stone structure are as below;

Index	Traditional mason		Deujabi	Stone sculptor
	Carving	Construction		
Daily pay	144,386 won (approx. $120)		151,579 (approx. $126)	156,098 (approx. $130)

Both repair technician and craftsman should belong to a company and the company can take a chance to take part in conservation/preservation projects ordered from local or national government. Occasionally, technician is a kind of project specialist and makes delicate decision and controls craftsman. There are 371 companies that can carry out conservation or preservation project of cultural heritage and they are obliged to register to their local government. Also, they can be divided as two type of businesses, one is overall repair business that can take part in all kind of project and the other is special repair business that can charge project of each specialized repair. In case of former, one can acquire its registration in condition of employment more than 4 technicians (including 2 technicians of general repair and 1 of traditional painting) and 6 craftsmen (including 1 craftsman of Daemok, 1 of traditional surface finishing, 1 of tile roofing and more than 3 of Deujabi or traditional painter or traditional mason or Somok). Also if one' representative is a corporate body, it need a capital more than 2 hundred million won (approx. 0.16 million dollar) and in case of personal registration, one need its double of corporate body. Office room is mandatory, too.

7 There are 7 different qualifications; General repair, Survey and planning, Traditional landscape architecture, Conservation science, Vegetation protection, Supervision, Traditional painting.

8 There are 22 different qualifications; Carving mason, Daemok (a master carpenter), Plater, Deujabi (a craftsman can rectify a wrong part of stone and wooden structure without dismantling), Wood sculptor, Mounting and making specimen, Tile roofing, Conservational treatment, Stone sculptor, Cleansing, Somok (a carpenter making wood furniture such as window, door, chest, etc), Vegetation protection, Survey and planning support, Construction mason, Roof tile maker, Traditional landscape architecture, Ironware, Painting (lacquering, varnishing), Papering, Traditional surface finishing, Traditional painter, Fumigation.

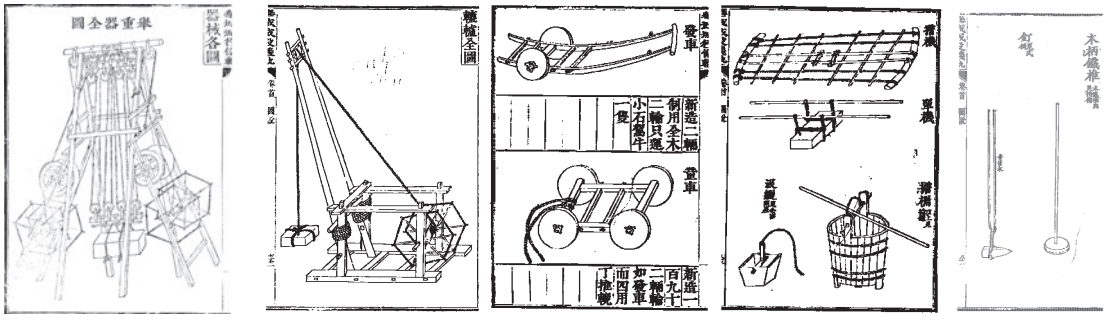
6. Traditional technique and tool of stone structure

1) Material

Techniques of stone in Korea have been developed through mass construction such as Royal palaces, fortresses and Buddhist temples. Among quarried stone materials, 90% of these are granite. Representative quarry is Pocheon area which locates near Seoul, and granite from Pocheon has a gray color. The granite of Hwangdong area which Mireuksaji located, have a gray-white color. The granite has characteristics of good strength and durability, low absorption force. But this is weak at heat of high temperature and can not be used in delicate sculpture. The marble can be used in detailed sculpture but can not endure acid rain. The sandstone is still quarried and it is mainly used as material of an ink slab or a tombstone.


2) Traditional technique

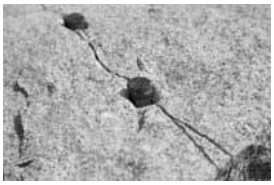
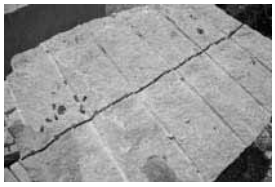
Ancient document which have a record about technique of stone structure is not exist. But in ‘Hwaseong seongyeok Uigwe’ [9] which have a record about construction process of Hwaseong in late 18th century, there are six hundreds names of stone artisans and their tasks. Also there are records about tools used in transportation, pounding, split, etc. For example, Geojunggi (a crane that handled by 30 men. It can lift 7.2 ton), Nokro(a crane which raise and move stone), Gupan (a tool used in moving stone in short distance), Jeong (a big chisel or burin used in shaping stone) are depicted. Also, in some genre painting drawn in 18 ~ 19th centuries, we can see an image of hammering to split stone.



9 Uigwe is record of Royal Protocols in the court of Joseon dynasty. Generally it refers to the collection of documents that record and prescribe in prose and illustration all the procedures, protocols, formalities and requirements needed to conduct important ceremonies, events, rites and rituals performed by and for the royal family of Joseon dynasty.

Traditional stone split start from Seok-jang, a stone artisan. First, he inspects exposed bedrock in natural state, and then splits severely weathered or cracked part. Secondly, he chooses being quarried part and makes small holes along grain of rock. And then he drives a wedge in those holes and hammers them repeatedly. Finally a stone material is being split.



Finishing of trimming is divided in six steps; Me-dadeum (trimming using a hammer), Jeong-dadeum (trimming using a small hammer), Jul-dadeum (trimming in slight pattern of line), Dodeurak-dadeum (trimming using a multi-pointed hammer) and Jan-dadeum (trimming surface almost in flat).

In Stacking/construction of stone embankment or fortress wall, it inclines to inner way as it goes up. A put-off degree between stones of upper and lower is about 5 to 10 millimeters. In case of vertical move of stone, we use a Gin-pole, which is consisted by two long wooden timbers and a pulley. According to the length of wood, its range and distances are changed.



In case of construction of stone structure, balance of each member is so important. Geuraengyi, a representative traditional technique, is making out with a gauge for chiseling according to the shape or line of former-settled member. For example, in case of wooden structure, a master carpenter would carve bottom of column according to the shape of base stone. And in case of stone structure, a stone artisan would chisel upper stone according to the shape of lower stone. If he wants to correct a slight unbalance, he generally uses clay, mud, wood chip, or a piece of lead/iron.

3) Traditional tools

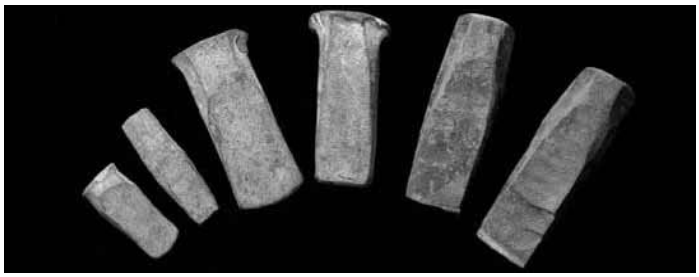
When a stone artisan makes a stone structure, he uses tools like a ruler, a wedge, an inking liner, an inking spatula, a brush, a me (a sledgehammer or hammer), a teolyigae, a dodeurak-mangchi (a hammer or mallet),

a Jeong(a chisel).

Materials of a ruler are an iron or wood and basic unit of it is 1 cheok (approx. 30.3cm). Its shape is basically a line shape, and its size varies from 2.3meters to 0.3meters according to its purpose. Also there is a Gokja (a '∟' shaped ruler) and Yeongwija (a '∠' shaped ruler which used in miter joint or acute angle joint).

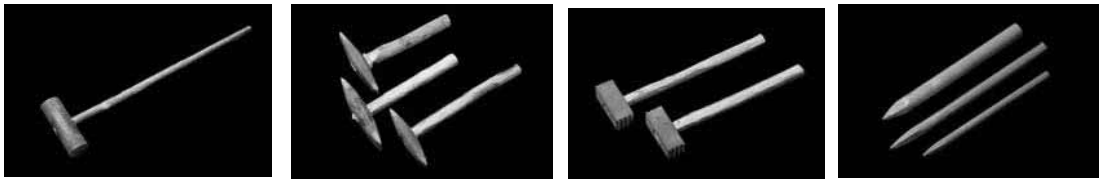
There are two types of a wedge, wood and iron. Before the Iron Age, ancient Korean stone artisan used wood wedge, but it was not suitable to split stone precisely and it needed long time in split. In case of split of big stone material, a stone artisan uses size of 16cm, 10cm, 7cm, 4cm wedges. When he makes a delicate stone sculpture, he uses size of 9cm, 7cm, 4.5cm wedge.

An ink liner is a tool of making line on stone. It is consisted of a small ink barrel, a thread and a small nail, and when a thread with a nail comes out of liner, it wears ink. An inking spatula which is made of bamboo has a cracked and sharpened edge. When use it, one would soak its edge and ink would soak in between cracks, and then draw or mark on surface of stone material. Its general length and width is 1 cheok (approx. 30.3cm) by 4 puns (approx. 1.2cm). And its length is differs from 37.5 to 20cm. A brush is used in case of delicate depiction such as a Buddhist statue.



A me is a kind of sledgehammer and its head is made of iron or wood. In case of wood, its species of trees have a characteristic of rigid nature such as an oak or a birch. According to its size, there is big, middle and small me. In case of big one, length of its head is about 30cm, and is used in quarry. That of middle one is about 17cm, and is used in split. That of small one is about 6 ~ 9 cm. In case of big one which a stone artisan uses, its length of grip is 73cm. Also that of head it is 26cm, and width of edge is 5cm.

A teolyigae has a similar look with a me, but its shape of head is edged only in one end. It is used in split an unnecessary part. In case of big one, its length of grip is 19cm, and that of head is 6cm. And in case of small one, its length of grip is 14cm, and that of head is 3cm. A dodeurak-mangchi (a hammer or mallet) is used to make surfaces looks fair or almost flat. In one end of head, there are lots of peaks. According to the number of peaks, this hammer is divided as 25 peaks, 64 peaks and 100 peaks. The length of its grip is around 10cm. A jeong (a chisel) has various types. In case of a chisel used in split, its length is about 20 ~ 40cm, and for sculpture, its length is 25 ~ 28cm, and its thickness is 1.5 ~ 2.5cm.



4) Case study about usage of traditional technique and tool: Repair of Sungnyemun gate and restoration of fortress wall Sungnyemun gate, designated as national treasure no. 1 in 1962, was damaged by arson in Feb. 2008, and is now under restoring by CHA.[10] At this time, two stone artisans designated as an important intangible heritage work for this project and one is specialized in sculpture and the other is specialized in construction. As this site is located in the heart of city, site area is relatively small, so they could not use traditional tools like Nokro or Gin pole. But for safety of worker, they use cranes and a hoist in moving of stone materials.

Once carried in that site area, all stone material should pass through traditional handwork in every process. Generally, the size of stone from quarry has 2 meter in width, 1.5 meter in height and 1.2m in depth. As split process repeated, every stone material gets a larger volume than that of final process. Its degree differs in case by case but generally is around 30%. In every process, masons use traditional tools and techniques such as a chisel for split. The size of stone for fortress wall is divided as large, middle, and small. In case of large one, its size is 1.2 ~ 1.5m in width, 0.48~0.65m in height. And in case of middle one, its size is 0.9 ~ 1.2m in width, 0.3 ~ 0.45m in height. In case of small one, its size is 0.5 ~ 0.9m in width, 0.13 ~ 0.28m in height. The depth of each stone differs from 0.6m in minimum to 1.8m in maximum. Therefore the size of stone for fortress wall differs case by case. Inner part of fortress wall is filled with rough broken stone or rubble. On the other side, that of foundation of pavilion is filled with stone and rubble mixed by limestone. Especially in case of part where footstone will be set, we reinforce that area by big rough stones and stacking it orderly.

10 Fortunately, CHA carried out a delicate survey in 2005, and documents of dismantle and repair in 1963 were remained in a report and drawings. Also, two years ago, CHA found on-site records about dismantle written in 1962. On the basis of these records, CHA carry out conservation project now. As Sungnyemun gate is a representative of cultural heritage, the whole process of project is supervised by CHA.

In this case, one of foot stone has been weathered and replace by new one. Supporting stones of footstone are engaged with facial stone. And their lower part is consisted of rough rectangular stones, which are stacked orderly like '#' shape. A base stone of column shaped stone located at the lower end of stair's side also changed.

Tool such as chisel, as it keep going to use, its end goes dull. So CHA made a small blacksmith beside of mason's rest place, and they fix their chisel's end sharpen. These kinds of usage of traditional techniques and tools are only adjusted in this project.

5) Case study of repair of stone structure with new material

Recently, the repair of cultural heritage has been affected by high-tech material and progress of science. To obtain a perfect balance of stone structure, stone artisans have used wood chip or iron, but today, they use plastic, copper, lead, titanium plate. Especially in case of copper, as one of the Korean coins was made of compound metal with copper, some of them used coin to obtain balance.

In repair project for Gameunsaji-seoktap which has been done in 2007 by NRICH[11], a special structure made of titanium was used. As I have already mentioned, this pagoda was made of tuff of andesite descent, and this kind of stone is capable at carving, but its organization is relatively weak. At that times, each corner of upper part of the body stone of 3rd story were weathered, and it was impossible to reassemble upper stones. So NRICH decided to use support structure made of titanium and then succeed in reassembling.



A Buddha statue in Gwancheoksa temple has a large plate-shaped stone on its cap. A few years ago, a serious crack occurred in that stone and there was no alternative idea except reinforcement of it. So CHA also decided to use support structure made of titanium, and it stands in safety still today.

7. Current status and issues on stone and brick heritage

Changes of techniques and tools related with cultural heritage caused by modernization and industrialization would be a worldwide problem. The stone itself does not change, but the brick is in different situation, because its production method has been changed. For example, Myeongdongseongdang cathedral constructed in 1898, and it has been designed by Father Coste and constructed by Chinese brick artisans and their technique. A few years ago, this building has been repaired and the owner has wanted to use same brick in preservation process, but it was not so easy. In Korea, the history of brick structure is relatively short, so we did not have systemic repair process or apprentice institution. Fortunately, artisans or initiators still know or use same techniques or tools of one hundred years ago. But we are now faced some problems as bellows;

The first problem is a systemic one. We already have a support system of initiation of important intangible heritage, but its financial subsidy is insignificant. Though he or she is designated as an important intangible heritage, he or she cannot live on its financial subsidy and he or she needs additional means of living. Presently, CHA subsidize expenses that required in demonstration (twice per one year) and training course to all important intangible heritages. Also assistant of inheritance teaching and trainee get a regular expense from CHA. In Korea, there are so many artisans and intangible heritages designated by local

11 NRICH is National Research Institute of Cultural Heritage of KOREA, a sub body of CHA.

government. They earn money by participation in constructions, repair projects ordered from company, temple or local government. Also they live with incomes from selling sculptures or handicrafts. To produce high qualified handicrafts, artisans need enough time and manpower. But in consideration of economic profit, they have no choice but to increase proportion of machine and use electric power. And this is a big obstacle in inheritance of traditional culture. So, the scale of economic subsidy should be broadened. To achieve this purpose, CHA tries institutional supplementation such as enactment of related laws, establishment of center for intangible heritages, reinforcement of subsidy system, etc. Additionally, it is needed to revitalize and expand intangible heritage's scope for movement. An expansion of systemic method and promotion of participation could be one solution for this. And this would be the best way to achieve high qualified result of conservation or repair projects and also to help intangible heritages.

Secondly, we need a various education system. In CHA, there is a national university specialized with departments of traditional cultures and annexed training institute for training of specialists. They have good condition in inheritance of technique, but as located in same place, there is a possibility of disappearance of regional characteristics. Accordingly, we need to increase the number of training institute. And in case of items that has low social demand and are unfamiliar to public, its inheritance could be obtained only through family initiation[12]. To improve this situation, we should transfer these kinds of family initiations to department of university or institutional system, and national government or CHA should confirm financial support. Once this kind of system is settled, we can protect a craft or skill on crisis of vanishing. Furthermore, going side by side with education of design, brand and patent, it will make a good effect to intangible heritages.

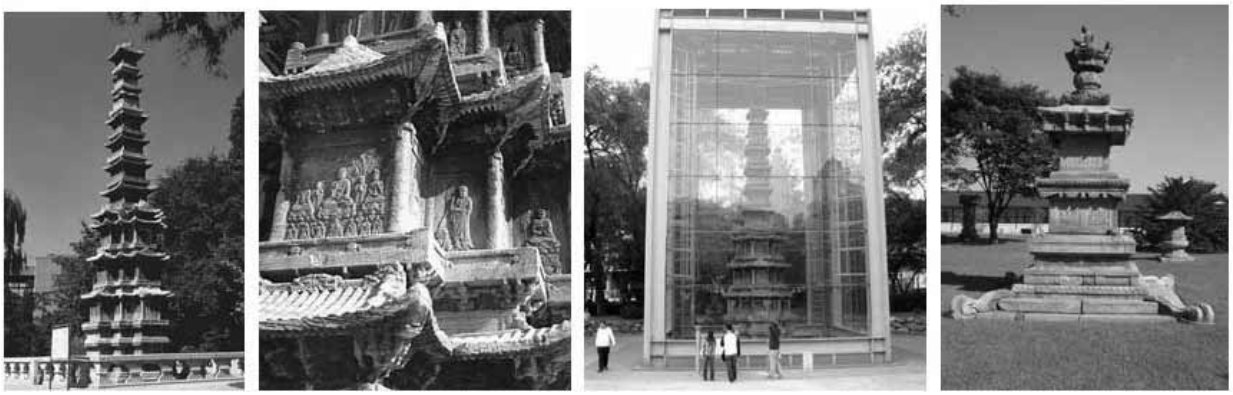
A research on traditional material and tool is important, too. As you know, cultural heritage generally uses materials from its located area. When we consider a climate change, we can easily think about a change of materials. So we need research about producing area, supply and demand system and security of alternative material, etc. Also systemic record about traditional tool and intangible heritage is necessary. In Korea, there are designated items has no holder or holding body and they are facing serious crisis of disappearance. So, we should record everything about traditional technique and tools of holder or holding body through making movie or drawings, images, interviews, etc.

But most important thing is a change of recognition and attitudes about cultural heritage.[13] Especially in case of stone structure, as most of them are located outside, their owner or management group must understand their characteristics and should take appropriate conservational treatment. Lots of stone structures

12 At present, an age group of workers or apprentices of stone structure is attached weight to fifties, and an age group of twenties or thirties is relatively rare. Most of them started learning as apprentice not by one's own will but by a kinship or relationship.

13 An arson, which set fire to Sungnyemun gate, was 70 years old. He had dissatisfied at his compensation for expropriated land, and on the purpose of telling to the public about his situation, he had set fire. During inspection on motive of arson, he had said 'There is no problem, because a cultural heritage though it may be destroyed, it can be restored easily'. Anyway, a fire of Sungnyemun gate has changed recognition of the public on conservation and protection of cultural heritage.

designated as state- designated heritage are owned by a state. A continuous management and arrangement of budget to conserve or manage are duties of local government. But when the owner of city/province-designated heritage or registered cultural heritage is a person or a group, it is not easy to obtain management expense from state or local government. So, until now, to take a preventable treatment through continuous concern is a reasonable action. In the long term, a state should establish enough storage facilities of national dimension. An environmental change such as air pollution or acid rain affect to conservation of stone structure on the outside, so we should build shelter or move it inside of building. Wongaksaji-seoktap (ten storied stone pagoda of Wongaksa temple site) is a case of shelter installed on the outside. Beopcheonsa-jigwangguksa-hyeonmyo-tap (stupa of national preceptor Jiwang in Beopcheonsa temple) has detailed images on surface of body stone, and through those images we can get lots of information about traditional wooden building style of 700 years ago. For this reason, this stupa is a very important state-designated cultural heritage. But it still stands on the outside in corner of Gyeongbokgung palace and sooner or later it should be moved to exhibition hall of museum.



Current issues of and future tasks for conservation of stone and brick cultural heritages and traditional techniques in Korea

Dec. 6 – 8, 2011

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Research Associate,
Preservation Technology Division, Cultural Heritage Administration (CHA),
Historical and technical researcher, Sungnyemun-gate restoration project

1. Cultural overview of stone and brick

- Stone structure were constructed from prehistoric time to present.
- Manufacture of stone heritages has deep relationship with notion of life and death.
- Ancestors of Korean has made house for living of wood which have life and death like people.
- A stone and brick has been used in construction of pagoda, stupa, grotto, and foundation of structure


Stone ice storage in Cheongdo


Seven storied brick pagoda in Sinse-dong


Daeungjeon hall of Gaeamsa temple, wooden architecture

2. Heritage classification of Korea and intangible heritages

- Categories of designated heritage
  - State-designated heritage: national treasures, treasures, historic sites, scenic sites, natural monuments, important intangible cultural heritages, important folklore materials
  - City/province-designated heritage: tangible cultural heritage, intangible cultural heritage, monuments, folklore materials, cultural heritage materials
  - Registered cultural heritage: cultural heritage of early modern times
  - Undesignated cultural heritage
- Those heritages are designated by the administrator of Cultural Heritage Administration pursuant to the Cultural Heritage Protection Act after deliberation by the Cultural Heritage Committee

2. Heritage classification of Korea and intangible heritages


Dolmen site, hwasun, Korea


A quarry site, Iksan, Korea

- 553 stone structures are designated as state-designated cultural heritages which designated as national treasure, treasure and historic sites.
- Most cases of stone structures were made before Joseon dynasty (A.D 1392 ~ 1910), and brick was used after mid-Joseon dynasty when started to affect by western culture.
- Techniques of quarrying and sculpture have been established since prehistoric age. Dolmens which represent Bronze Age have capstones and their weight varies from 4or 5 to dozens tons.

2. Heritage classification of Korea and intangible heritages

- CHA designate important intangible heritages among intangible heritages which has outstanding value.
- There are 178 holders and 58 holding group of important intangible heritages. Seok-jang (stone artisan) was designated as an important intangible heritage in Sep. 2007. A reason of designation as below
  - As time goes by, because of such reason like introduction of machinery, traditional skills of stone structure faced a serious crisis of disappearance. To conserve and hand down traditional skills and techniques of stone structure, now we designate the Seok-jang as an important intangible heritage.
- Most important principle is technical power, will and circumstance of inheritance of holder (or holding group). Inheritance steps are consisted as honorary holder – holder - assistant of inheritance teaching - trainee. Two stone artisans had learned stone techniques from the age of 15 by inducement of kindred and had spent 3 to 10 years as an apprentice.

3. Various type of stone and brick structure

- Mireuksaji seoktap (a stone pagoda of Mireuksa temple site) is a representative stone structure and it was made of granite which quarried in local quarry.
- Gameunsaji Seoktap (a stone pagoda of Gameunsa temple site) which was made of tuff of andesite descent is relatively smaller than Mireuksaji seoktap. But its formative beauty and construction method are very impressive.
- Over 200 mountain fortress wall dispersed nationwide


Mireuksaji-seoktap (stone pagoda of Mireuksa temple site, national treasure no.11)


Gameunsaji samcheung -seoktap (3-storied stone pagoda of Gameunsa temple site, N.T. no.112)


Gyeongju-cheomseongdae (Observatory in Gyeongju. N.T. no 31)


Sangdang-sanseong (Fortress, Cheongju. Historic site no. 212)

3. Various type of stone and brick structure

- There are so many structures using brick or brick-like stone, and Bunhwangsa seoktap built in A.D 634 is representative.
- Hwaseong (Hwaseong fortress), built in late 18th century, is the representative structure using brick and stone
- Brick structure has been constructed after 17th century.


Bunhwangsa-seoktap (Stone pagoda of Bunhwangsa temple, N.T. no 30)


Perspective of Hwaseong (from Hwaseong seongyeok uigwe, a royal record of construction)


Up : perspective of Gongsimdon (a part of Hwaseong fortress)
Below : Gongsimdon, at present

3. Various type of stone and brick structure

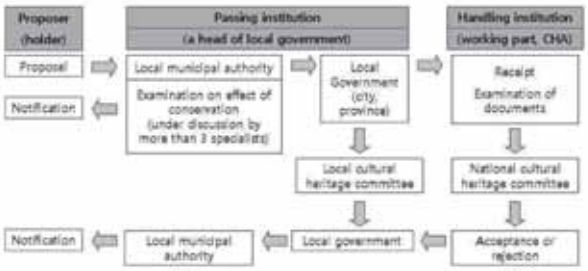
- After construction of Hwaseong fortress, brick structure has broadened its usage as a living building.
- Religious building such as cathedral started to be constructed in late 19th century.
- Planning of these brick structure was done by Christian missionary or priest and Chinese artisan took a part in making brick and construction,


Myeongdong-seongdang (Cathedral in Myeongdong, Seoul, Historic site no. 258)


Left: Façade of Seonhyangjae (a study building of Youngyeongdang. Changdeokgung, Seoul. Historic site no. 122).
Right: A detail of its side. By using brick, a brick artisan has imitated a gable of wooden architecture.

4. Phase of conservation/preservation project implementation

- Conservation/preservation or restoration project of cultural heritage is carried by local government



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- Its qualification examination is carried out by HRD Korea (Human Resources Development service of Korea) and their licenses are managed by CHA.
- CHA arranged mandatory regulation about education, and everyone have license should take part in educational program of CHA once in a 5 year.
- Daily pay of craftsman is written in Standard Repair Specification of cultural heritage as CHA's regulation. Those of craftsman related with stone structure are as below

Index	Traditional mason		Deujabi	Stone sculptor
	Carving	Construction		
Daily pay	144,386 won (approx. $120)		151,579 (approx. $126)	156,098 (approx. $130)

※ Deujabi: craftsman can rectify wrong parts of stone or wooden building without dismantling.

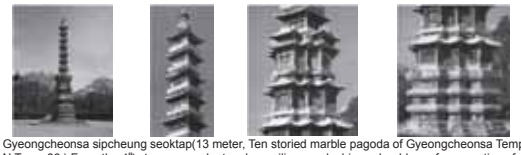
5. Education of specialist and inheritance of technique

- Repair technician and craftsman should belong to a company and the company can take a chance to take part in conservation/preservation projects order from local or national government.
- There are 371 companies that can carry out conservation or preservation project of cultural heritage and they are obliged to register to their local government.
- Companies can be divided as two type of businesses, one is overall repair business that can take part in all kind of project and the other is special repair business that can charge project of each specialized repair.
- The former can acquire its registration in condition of employment more than 4 technicians and 6 craftsmen. Also it is a corporate body, it need a capital more than 2 hundred million won (approx. 0.16 million dollar) and in case of personal registration, one need its double of corporate body. Office room is mandatory, too.

6. Traditional technique and tool of stone structure

1) Material

- Techniques of stone in Korea have been developed through mass construction such as Royal palaces, fortresses and Buddhist temples. Among quarried stone materials, 90% of these are granite.
- **Granite** has characteristics of good strength and durability, low absorption force. It is weak at heat of high temperature and incapable of delicate sculpture.
- **Marble** can be used in detailed sculpture but weak at acid rain. **Sandstone** is still quarried and it is mainly used as material of an ink slab or a tombstone.

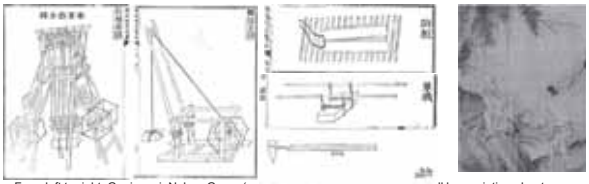


Gyeongcheonsa sipcheung seoktap(13 meter, Ten storied marble pagoda of Gyeongcheonsa Temple, N.T. no. 86.) From the 4th story up, each story has railings and a hip-and-gable roof, suggestive of a wooden architecture with a tiled roof. It stands out as one of the finest examples of Korean pagodas.

6. Traditional technique and tool of stone structure

2) Traditional technique

- Hwaseong seongyeok Uigwe have a record about construction process of Hwaseong in late 18th century, there are six hundreds names of stone artisans and their tasks, records about tools used in transportation, pounding, split, etc.
- Geojunggi (a crane that handled by 30 men. It can lift 7.2 ton), Nokro (a crane which raise and move stone), Gupan (a tool used in moving stone in short distance), Jeong (a big chisel or burin used in shaping stone) are depicted.

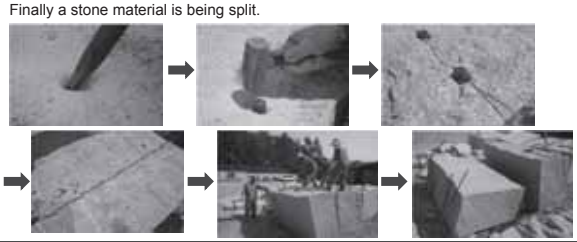


From left to right: Geojunggi, Nokro, Gupan(up), Dankı(below), Jeong(chisel), Folklore painting about mason

6. Traditional technique and tool of stone structure

2) Traditional technique

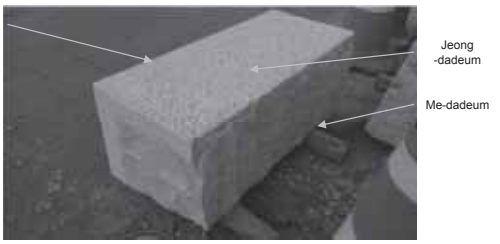
- Stone artisan inspects exposed bedrock in natural state, and then splits severely weathered or cracked part.
- Secondly, he chooses being quarried part and makes small holes along grain of rock. And then he drives a wedge in those holes and hammers them repeatedly. Finally a stone material is being split.



6. Traditional technique and tool of stone structure

2) Traditional technique

- Finishing of trimming is divided in six steps; Me-dadeum (trimming using a hammer), Jeong-dadeum (trimming using a small hammer), Jul-dadeum (trimming in slight pattern of line), Dodeurak-dadeum (trimming using a multi-pointed hammer) and Jan-dadeum (trimming surface almost in flat).



6. Traditional technique and tool of stone structure

2) Traditional technique

- In stacking/construction of stone embankment or fortress wall, it inclines to inner way as it goes up. A put-off degree between stones of upper and lower is about 5 to 10 millimeters.
- In case of vertical move of stone, we use a Gin-pole, which is consisted by two long wooden timbers and a pulley. According to the length of wood, its range and distances are changed


Put-off degree is 5~10mm


A section view of fortress wall, restoration project of Sungnyemun-gate and its fortress wall

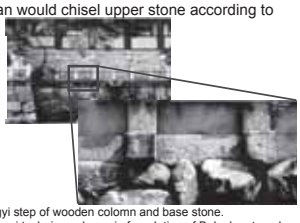

A view of using a Gin-pole to raise stone


A view of using a Gin-pole to construct a stone arch

6. Traditional technique and tool of stone structure

2) Traditional technique

- Geuraengyi, a representative traditional technique, is making out with a gauge for chiseling according to the shape or line of former-settled member.
- In case of wooden structure, a master carpenter would carve bottom of column according to the shape of base stone.
- In case of stone structure, a stone artisan would chisel upper stone according to the shape of lower stone.

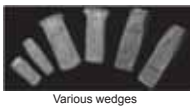


Left: a geuraengyi step of wooden colomn and base stone.
Right: a geuraengyi technique shown in foundation of Bulguksa-temple

6. Traditional technique and tool of stone structure

3) Traditional tools

- When a stone artisan makes a stone structure, he uses tools like a ruler, a wedge, an inking liner, an inking spatula, a brush, a me (a sledgehammer or hammer), a teolyigae, a dodeurak-mangchi (a hammer or mallet), a Jeong(a chisel).


Various wedges


End of dodeurak-mangchi


Various chisels


Stone artisan use a me to trim unnecessary part


A mason draw line on stone with inking spatula

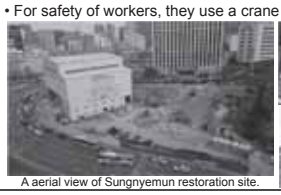

Teolyigae and Mangchi

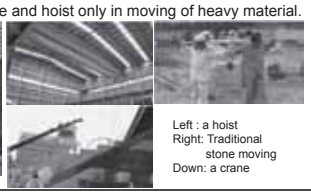

Inking spatula

6. Traditional technique and tool of stone structure

4) Case study about usage of traditional technique and tool: Repair of Sungnyemun gate and restoration of fortress wall

- Sungnyemun gate, designated as national treasure no. 1 in 1962, was damaged by arson in Feb. 2008, and is now under restoring by CHA.
- Two stone artisans designated as an important intangible heritage work
- One is specialized in sculpture and the other is specialized in construction.
- As its area is small, so they can not use traditional tools like Nokro or Gin pole.
- For safety of workers, they use a crane and hoist only in moving of heavy material.


A aerial view of Sungnyemun restoration site.


Left : a hoist
Right: Traditional stone moving
Down: a crane

6. Traditional technique and tool of stone structure

4) Case study about usage of traditional technique and tool: Repair of Sungnyemun gate and restoration of fortress wall

- Once carried in site area, all stone are trimmed by traditional handwork
- The size of stone from quarry has 2 meter in width, 1.5 meter in height and 1.2m in depth.
- The size of stone for fortress wall is divided as large, middle, and small. The depth of each stone differs from 0.6m in min. to 1.8m in max.
- Inner part of fortress wall is filled with rough broken stone or rubble. That of foundation of pavilion is filled with stone and rubble mixed by limestone.


Inner part of foundation of pavillion


Reinforcement for safe supporting of stone column which located at low-end of stairway


Footstone's lower part is consisitde of rectangular stones

6. Traditional technique and tool of stone structure

4) Case study about usage of traditional technique and tool: Repair of Sungnyemun gate and restoration of fortress wall

- Tool such as chisel, as it keep going to use, its end goes dull.
- CHA made a small blacksmith beside of mason's rest place, and they make their chisel's end as sharply.


Inside of smithy and kiln


A mason makes his chisel's end as sharply


Sharpened chisels

6. Traditional technique and tool of stone structure

5) Case study of repair of stone structure with new material

- To obtain a perfect balance of stone structure, stone artisans have used wood chip or iron, but today, they use plastic, copper, lead, titanium plate.
- In repair project for Gameunsaji-seoktap which has been done in 2007 by NRICH, and another project for Buddha statue in Gwancheoksa temple, special structures made of titanium was used.


Left: view of Buddha statue
Right: titanium frame and detail of cap stone

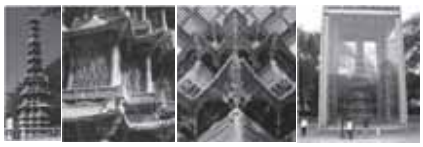
Gwancheoksa

7. Current status and issues on stone and brick heritage

- Changes of techniques and tools related with cultural heritage caused by modernization and industrialization would be a worldwide problem.
- The first problem is a systemic one. We already have a support system of initiation of important intangible heritage, but its financial subsidy is insignificant. So, the scale of economic subsidy should be broadened.
- Secondly, we need a various education system. We need to increase the number of training institute.
- A research on traditional material and tool is important. we need research about producing area, supply and demand system and security of alternative material. Also systemic record about traditional tool and intangible heritage is necessary.
- Most important thing is a change of recognition and attitudes about cultural heritage. A preventable treatment through continuous concern is a reasonable action. In the long term, a state should establish enough storage facilities.

7. Current status and issues on stone and brick heritage

- An environmental change such as air pollution or acid rain affect to conservation of stone structure on the outside, so we should build shelter or move it inside of building.
- Wongaksaji-seoktap is a case of shelter installed on the outside.
- Beopcheonsa-jigwangguksa-hyeonmyo-tap has detailed images on surface of body stone, and through those images we can get lots of information about traditional wooden building style of 700 years ago.



Whole and detail view of Wongaksaji-seoktap.

Installed shelter

Current view of Beopcheonsa-jigwangguksa-hyeonmyo-tap

Thank you for listening

50th Anniversary of CHA

Outline of a Project to Repair a Brick Building in Japan: The Challenges of Reproducing Traditional Engineering and Structural Reinforcement

KIMURA Kazuo
Senior Conservation Architect / Head
Management Division
The Japanese Association for Conservation of Architectural Monuments (JACAM)

1. Introduction

Brick building engineering was first introduced in Japanese architecture, in which buildings were traditionally made mainly of wood, in the 1850s before modernization. As modernization progressed, structural reinforcement measures were progressively introduced to adapt brick buildings to earthquake-prone Japan. Various reinforcement methods were attempted, and records of that time and existing brick buildings reveal the hard work of the architects in those days. However, modern structural diagnoses have confirmed that all of these structures would probably suffer serious damage or collapse in a major earthquake.

This paper outlines a project to repair Yamaguchi Prefecture's Old Prefectural Assembly Building, which is designated as an important cultural property. The large-scale repair project received a subsidy from the Agency for Cultural Affairs, and cost 1.24 billion yen and 75 months to complete, from 1998 to 2004.

Restoring the brick structure, part of which had been dismantled or modified by later repairs, to its original state constructed in 1916 required not only reproduction of the original design but also a safe design to withstand a major earthquake and construction in compliance with the design standard. The successful resolution of two conflicting factors, reproducing traditional engineering and providing structural reinforcement by modern engineering, is described below.

2. Overview of the Building

Name: Yamaguchi Prefecture's Old Prefectural Assembly Building designated as an important cultural property
Location: 1-1, Taki-machi, Yamaguchi, Yamaguchi Prefecture
Type of building: Assembly reference library
Year of construction: 1916
Structural type: Brick construction, two-story, slate roofing
Plane area: 776.252 m^2
Total floor area: 1,279.214 m^2

Photo 1: Appearance of completed front (south side)

Photo 2: Inside view of completed Assembly

Photo 3: Appearance of northeast side before repair work

Photo 4: Appearance of completed northeast side

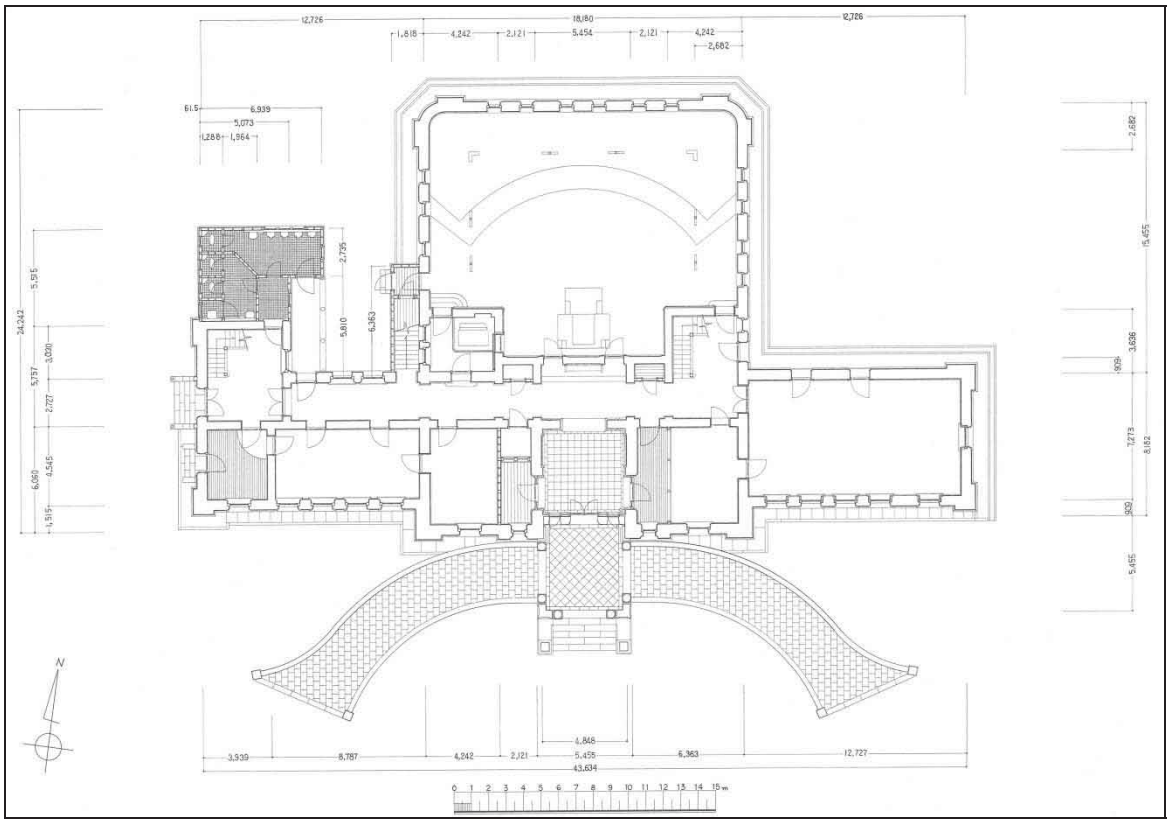


Fig. 1: Plan of first floor before repair work

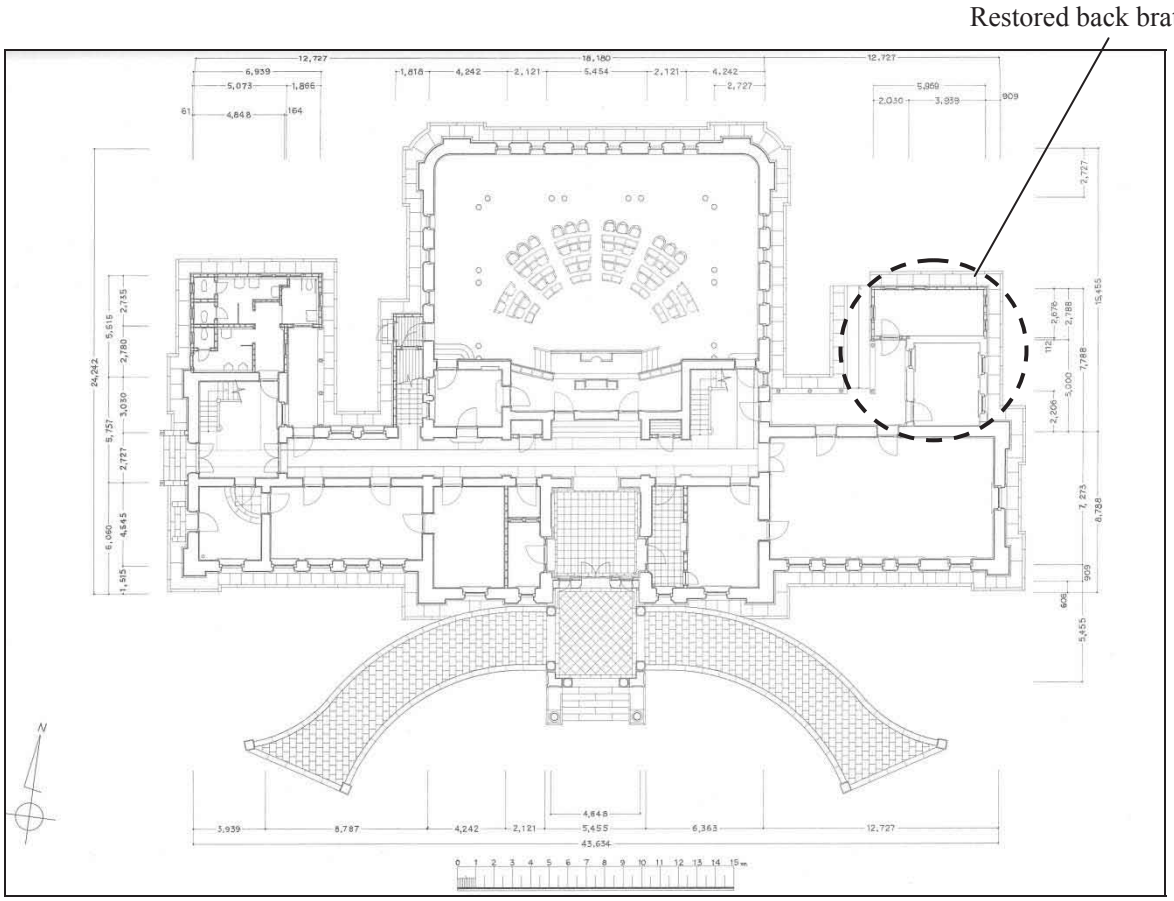


Fig. 2: Plan of completed first floor

3. Flow of the Repair Work for Preservation

Investigation of current conditions

⇩ General survey on damage, specifications, and history, structural diagnosis, preparation of current condition drawings

Basic design (overall)

⇩ Review by the Repair Experts Committee, formulation of a plan for utilization, application to the Agency for Cultural Affairs

Design for execution (first-half work)

⇩ Preparation of design documents for temporary work and dismantlement work

Launch of temporary work and dismantlement work

⇩ Supervision of temporary work and dismantlement work, detailed survey on damage, specifications, and history, structural reinforcement design

Review of repair policy

⇩ Review by the Repair Experts Committee, reassessment of the budget and work period, application for modification to the Agency for Cultural Affairs

Design of execution (second-half work)

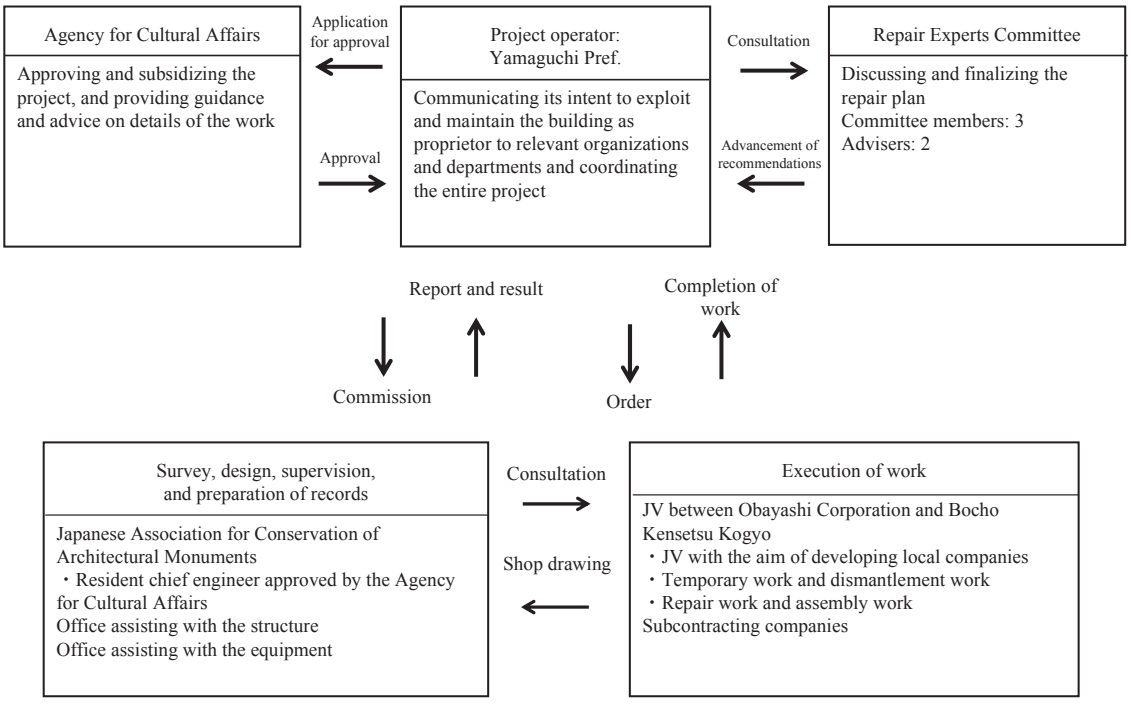
⇩ Preparation of design documents for repair work and assembly work

Launch of repair work and assembly work

⇩ Supervision of repair work and assembly work, preparation of a repair work report

Completion, opening to the public

4. Project Organization



5. Determination of Surveys and Repair Policy

This building was designed in 1911 by the same design team that was set up to construct the existing Diet Building in Tokyo, which was designed and constructed later. Twenty-three design drawings and some photos of the completed Assembly Building are still available as records of that time.

The building was used as the Assembly Building until 1974, with various repairs and modifications made to it over the years. Then, in 1978, it was opened to the public as an assembly reference library because the new Assembly Building was being constructed behind it.

As rain leakage, deterioration of exterior walls, and damage to the interior worsened, various surveys began to examine the condition of the building in 1996. The Repair Experts Committee repeatedly discussed the survey results and finally decided to restore the building to its former glory of 1916. The reason the Committee decided to restore the building to the original appearance was that some materials and finishes used at the time of its construction were still available and various surveys also confirmed that the lost techniques applied to modified portions could be reproduced.

Based on this repair policy, a decision was made to restore the back brattice that had been lost in later modifications. Although the portions above ground had been lost, excavation surveys revealed that most of the brick foundation remained in its original state underground. In the excavation surveys, chipping marks on the bricks to which the brattice had been attached appeared upon carefully removing portions of exterior wall mortar that had been applied in later years. Those marks showed the shape and cross section of the plane, and the clarification of techniques through detailed surveys on the existing brick structure made it possible to reproduce the brick-laying technique used to construct the building in 1916.

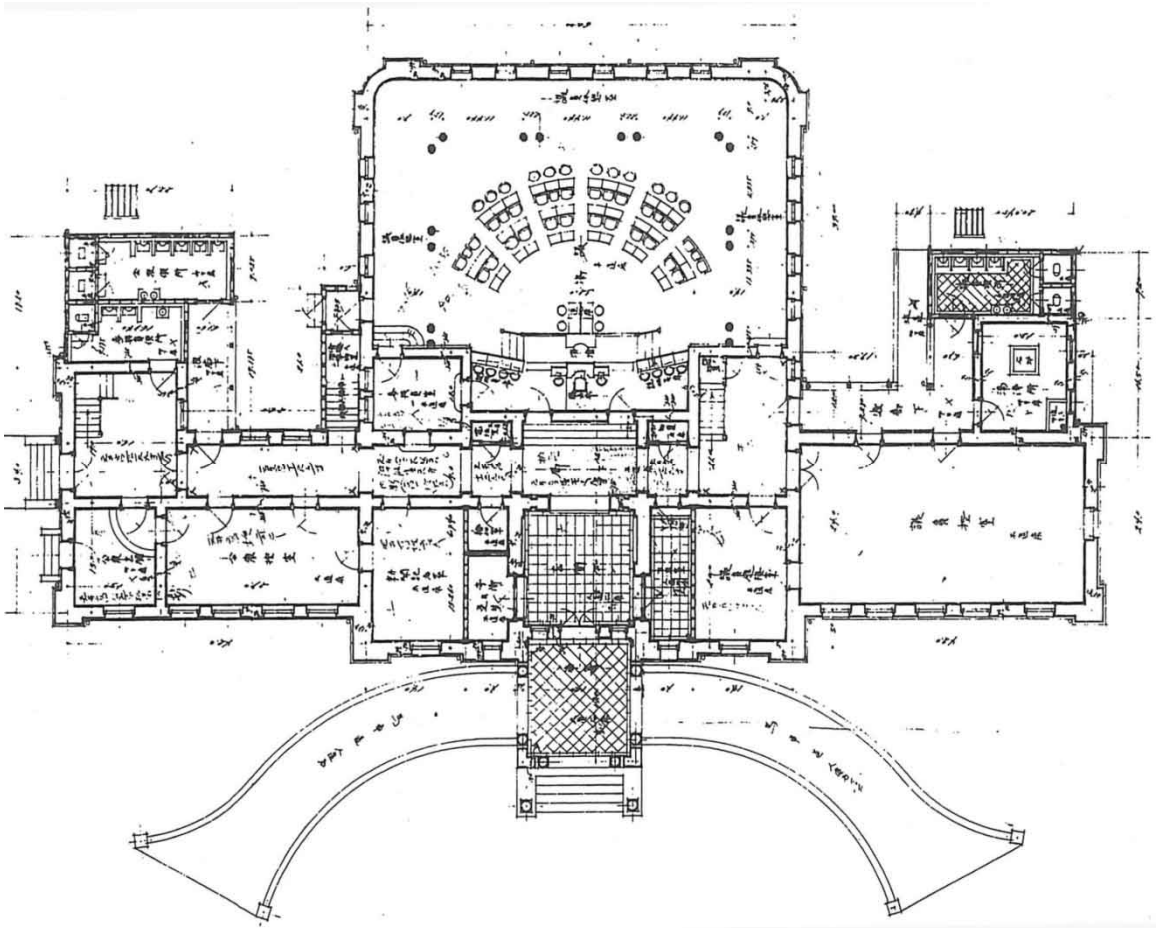


Fig. 3: Plan of first floor in 1916, when the Assembly Building was constructed

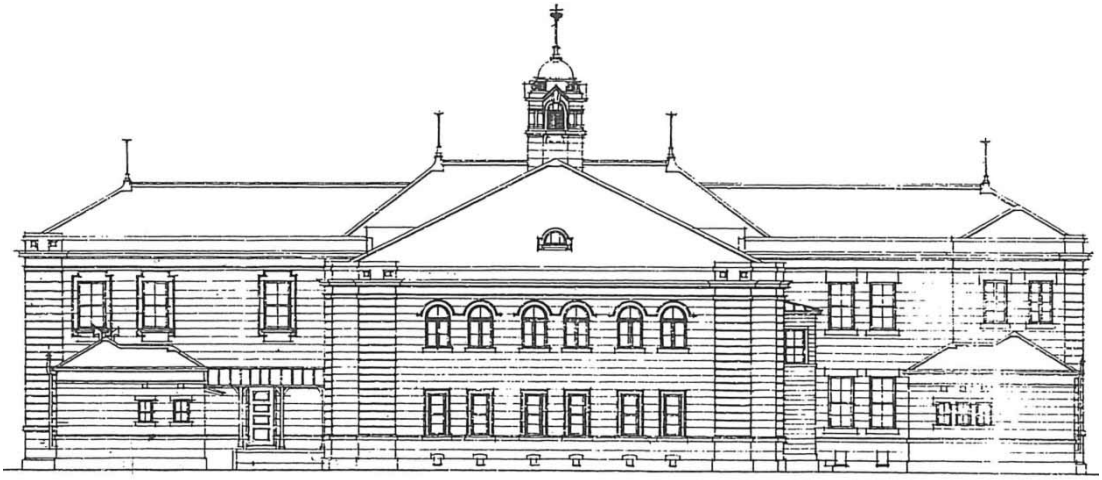


Fig. 4: Elevation of north side in 1916, when the Assembly Building was constructed (back side)

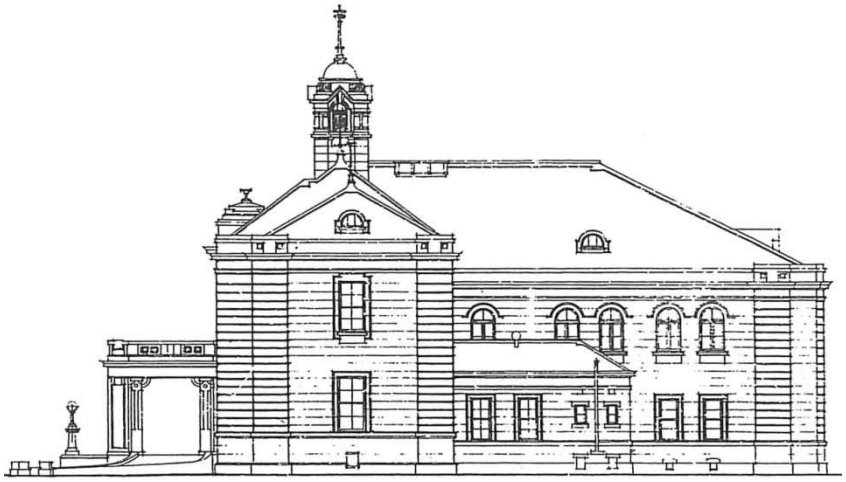


Fig. 5: Elevation of east side in 1916, when the Assembly Building was constructed (side)

Fig. 6: Cross section of east approach in 1916, when the Assembly Building was constructed

Photo 5: Brick foundation of back brattice found in excavation survey

6. Structural Diagnosis and Determination of Reinforcement Method

The main part of the building was made of brick. Varied physical tests were conducted on the bricks and joints of the building while confirming the techniques through surveys of the brick structure. In addition, estimations were conducted by mixing joint mortar and measuring the compressive strength and tensile strength of bricks, the compressive strength of joints and bricks, the adhesive strength of joints, and the shear strength of joints.

A structural diagnosis of the brick structure carried out based on these test results disclosed that the structure would suffer serious damage in case of a major earthquake (approx. 400 gal). Therefore, it was

decided that structural reinforcement was necessary to maintain the building, and several reinforcement methods were studied.

Of the reinforcement methods considered, all of which had been adopted for other buildings designated as important cultural properties, the method of incorporating reinforcing bars and steel frames into the brick structure was selected as the main scheme, as well as reinforcement of the foundation surface with stainless panels and reinforced concrete. The reinforcement work was carried out carefully so as to avoid damaging the interior and exterior of the building with reinforcing materials and to minimize damage to the existing materials.

An order was placed for custom-made bricks with equivalent strength to that identified by the test results. Brick-layered samples were prepared and combined with joints of different mix proportions as brick wall models, which were subjected to bending tests to check the strength of the reinforcing materials.

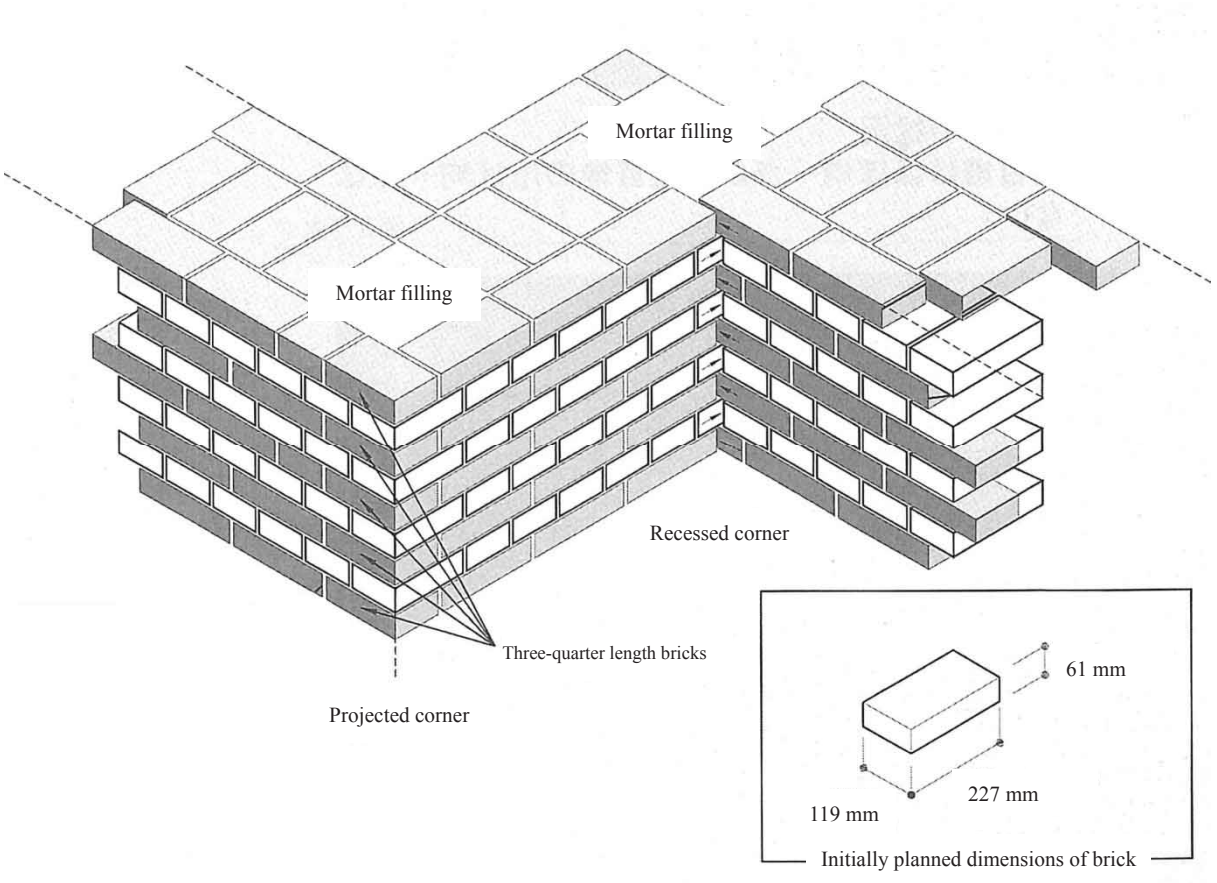


Fig. 7: Pattern diagram of identified bricklaying method

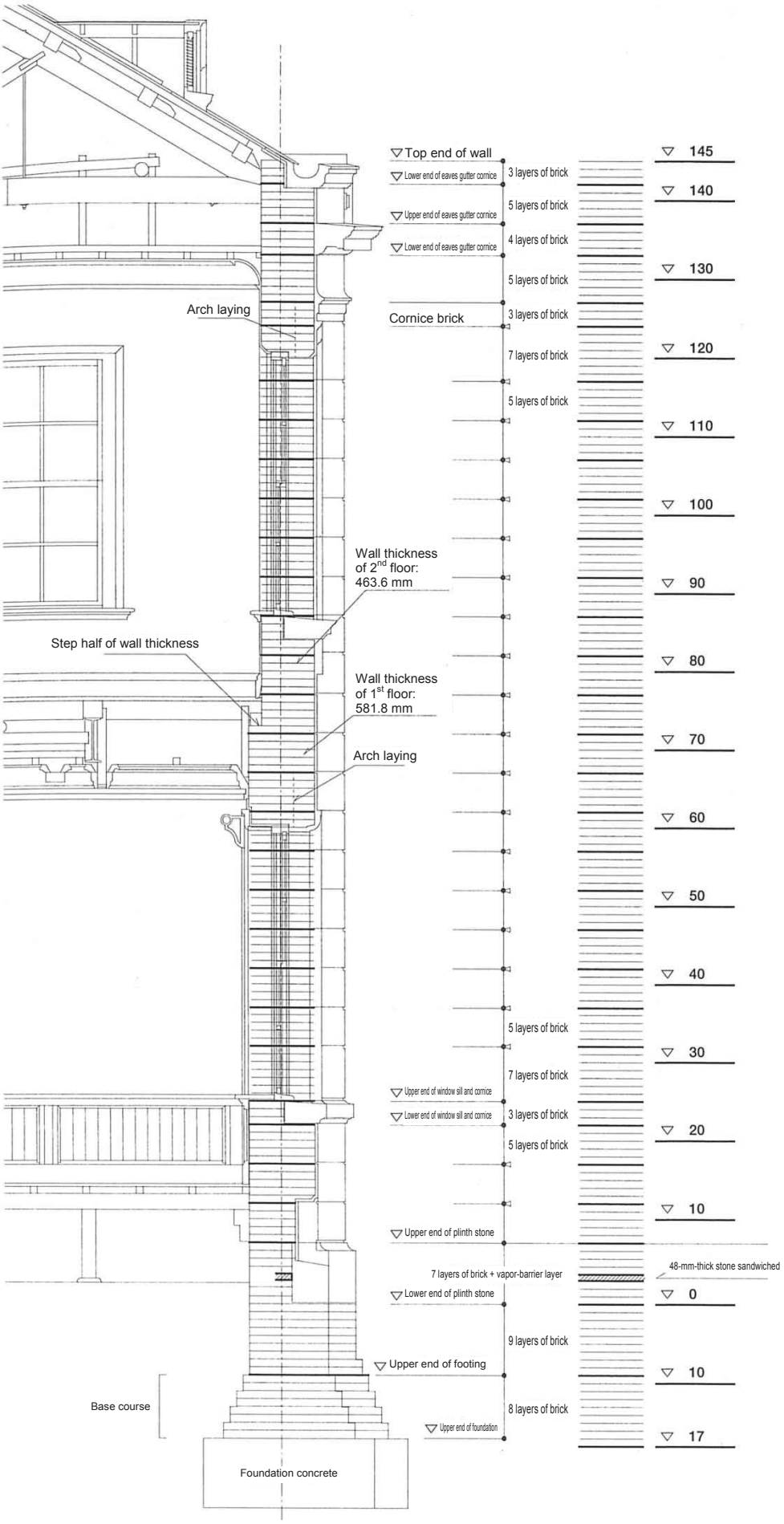


Fig. 8: Cross section plan drawing of brick laying

7. Reproduction of Traditional Techniques and Structural Reinforcement

To restore the lost back brattice, the bricks remaining as chipping marks on the existing back brick wall surface were carefully removed by hand. Efforts were made to retain as much of the remaining brick foundation as possible, and cracked and partly remaining bricks were removed by hand. This approach was required in order to reproduce the building as faithfully as possible using the techniques of 1916 and also to effectively preserve the materials used at that time.

With regard to bricks and joints, on the other hand, the original shapes and dimensions in 1916 were exactly reproduced by the techniques applied at the time of construction. However, the strength of the bricks and the mix proportion of joint mortar complied with present-day standards. This approach was intended to ensure that the brick structure of the brattice to be made by laying bricks in layers would have sufficient strength and safety.

However, the structural safety standards could not be met even by using bricks and joints complying with current standards, so it was necessary to reinforce the structure by incorporating reinforcing bars at the stage of laying the brick structure and placing circumferential girders on the tops of the walls of the brick structure.

Planning and design were conducted so that these conflicting factors would be resolved, the plans were correctly communicated to engineering personnel responsible for brick laying, and the work was executed under careful supervision.

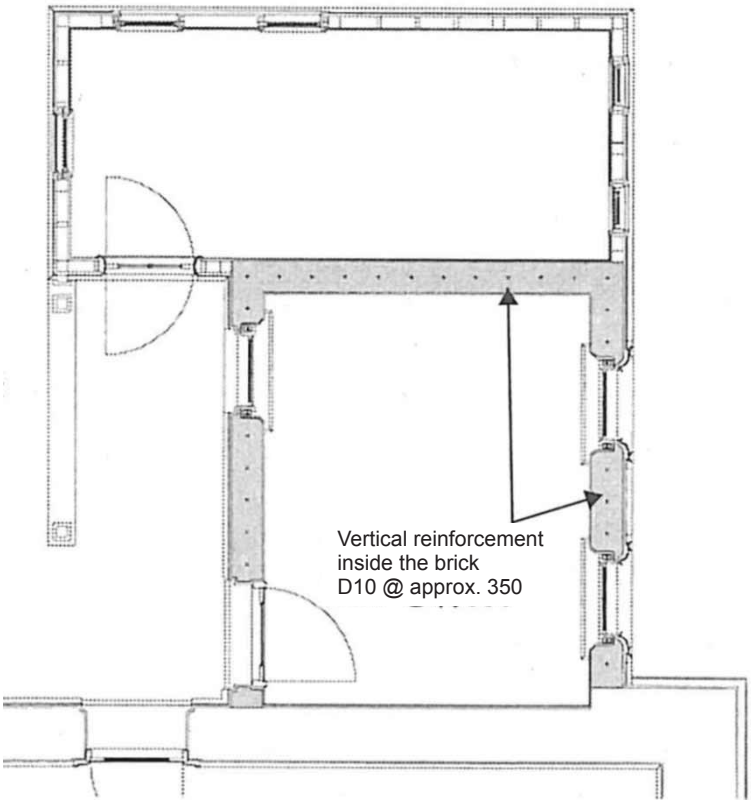


Fig. 9: Plan of back brattice to be restored

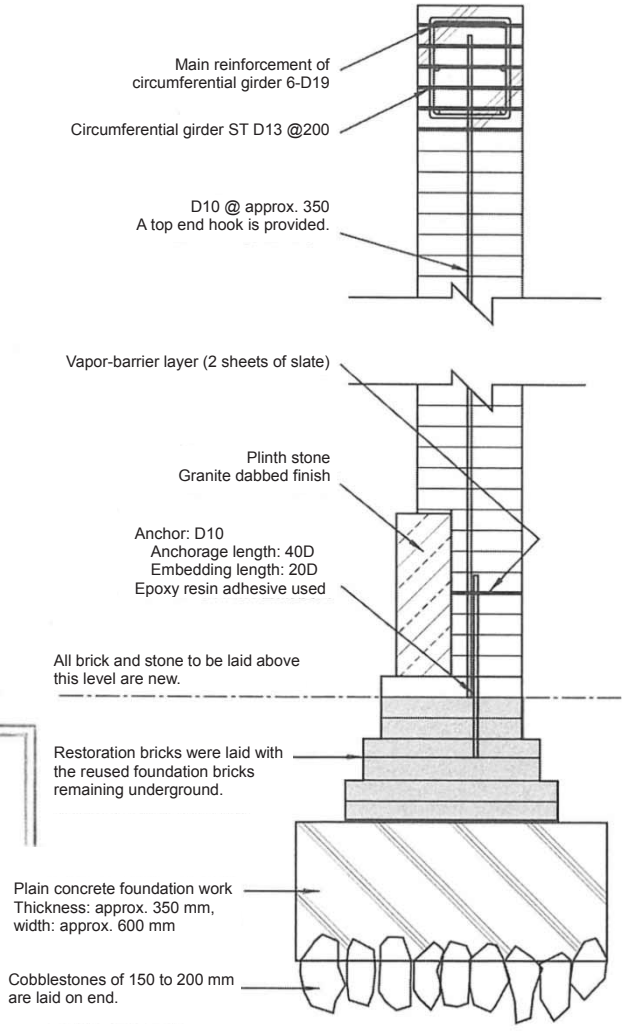


Fig. 10: Detailed cross-sectional drawing of brick wall of back brattice to be restored

8. Conclusion

This repair work successfully repaired and restored a lost brick structure, which is of great significance and shows that brick-making and brick layer techniques still exist in Japan.

The custom-made bricks for the work were manufactured by a brick manufacturer operating in Hiroshima Prefecture, adjacent to Yamaguchi Prefecture. Today, demand for bricks is decreasing, and manufactured bricks do not provide the functional main structure of buildings. They are manufactured as materials chiefly for pavement, gardens, and interior and exterior materials for buildings.

The profession “brick-layer” is no longer used by brick-laying craftsmen. Brick-laying techniques are inherited only through “concrete block masonry.”

The future demand for constructing large-scale brick structures is expected to be extremely low, and bricks are seldom used in repair work on important cultural properties like the Assembly Building. The restored back brattice of Yamaguchi Prefecture’s Old Prefectural Assembly Building was smaller than 20 m^2. Nevertheless, the experience obtained from the difficult work of assimilating the techniques adopted in 1916 with modern structural reinforcement techniques will be useful for many years to come.

Photo 6: The inside of the restored back brattice is used as an anteroom and hot water service room.

Photo 7: The north part of the restored back brattice is used as a depository.

Outline of a Project to Repair a Brick Building in Japan

– The Challenges of Reproducing Traditional Engineering and Structural Reinforcement –

Yamaguchi Prefecture

Yamaguchi Prefecture's Old Prefectural Assembly Building, which is designated as an important cultural property, on the premises of Yamaguchi Prefectural Office

1. Introduction

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Plane area: 776.252 m^2
Total floor area: 1,279.214 m^2

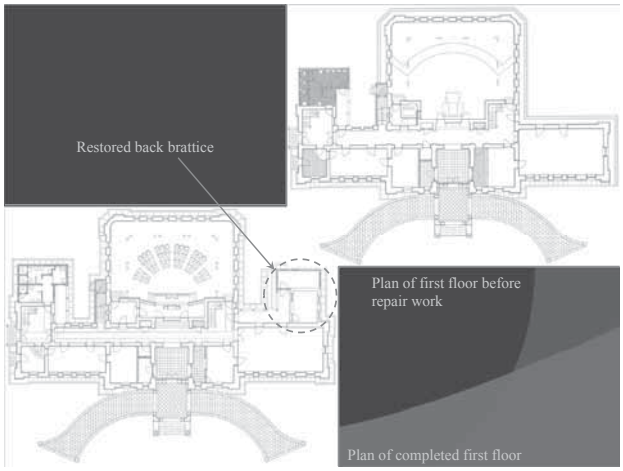
Appearance of completed front side and inside of assembly hall

The lost back brattice was restored.

Back side before repair work

Completed back side

Restored back brattice



Plan of first floor before repair work

Plan of completed first floor

3. Flow of the Repair Work for Preservation

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- Basic design (overall)
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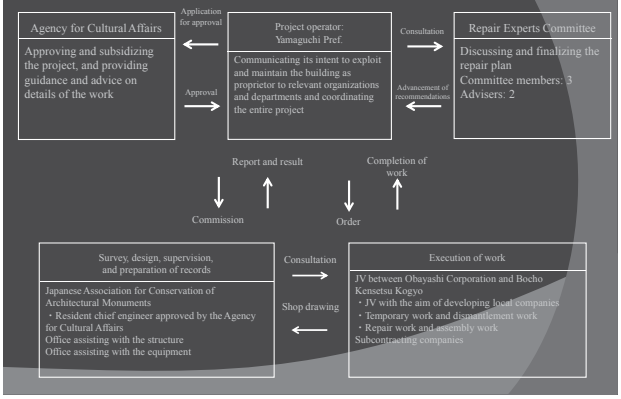
  - Preparation of design documents for repair work and assembly work
- Launch of repair work and assembly work
  - Supervision of repair work and assembly work, preparation of a repair work report
- Completion, opening to the public

4. Project Organization



5. Determination of Surveys and Repair Policy

Various surveys began to examine the condition of the building in 1996. The Repair Experts Committee repeatedly discussed the survey results and finally decided to restore the building to its former glory of 1916. The reason the Committee decided to restore the building to the original appearance was that some materials and finishes used at the time of its construction were still available and various surveys also confirmed that the lost techniques applied to modified portions could be reproduced.

Based on this repair policy, a decision was made to restore the back brattice that had been lost in later modifications. Although the portions above ground had been lost, excavation surveys revealed that most of the brick foundation remained in its original state underground. In the excavation surveys, chipping marks on the bricks to which the brattice had been attached appeared upon carefully removing portions of exterior wall mortar that had been applied in later years. Those marks showed the shape and cross section of the plane, and the clarification of techniques through detailed surveys on the existing brick structure made it possible to reproduce the brick-laying technique used to construct the building in 1916.

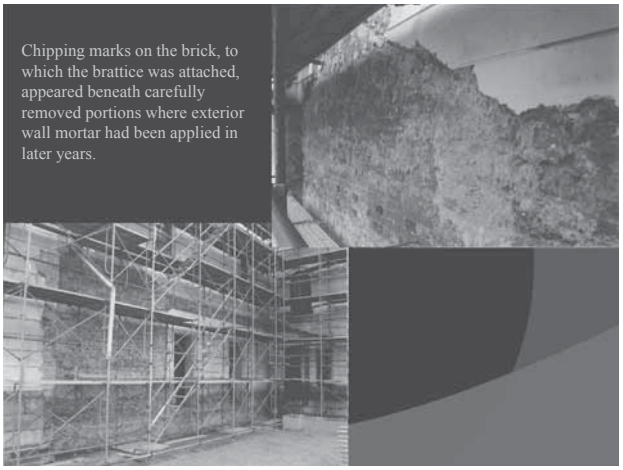
Back side before repair work

Part of brick foundation found in ground excavation

Entire brick foundation found in ground excavation

Marks of building remaining on exterior wall

Chipping marks on the brick, to which the brattice was attached, appeared beneath carefully removed portions where exterior wall mortar had been applied in later years.



6. Structural Diagnosis and Determination of Reinforcement Method

The main part of the building was made of brick. Varied physical tests were conducted on the bricks and joints of the building while confirming the techniques through surveys of the brick structure.
A structural diagnosis of the brick structure carried out based on these test results disclosed that the structure would suffer serious damage in case of a major earthquake (approx. 400 gal). Therefore, it was decided that structural reinforcement was necessary to maintain the building, and several reinforcement methods were studied.

Of the reinforcement methods considered, all of which had been adopted for other buildings designated as important cultural properties, the method of incorporating reinforcing bars and steel frames into the brick structure was selected as the main scheme, as well as reinforcement of the foundation surface with stainless panels and reinforced concrete. The reinforcement work was carried out carefully so as to avoid damaging the interior and exterior of the building with reinforcing materials and to minimize damage to the existing materials.
An order was placed for custom-made bricks with equivalent strength to that identified by the test results. Brick-layered samples were prepared and combined with joints of different mix proportions as brick wall models, which were subjected to bending tests to check the strength of the reinforcing materials.

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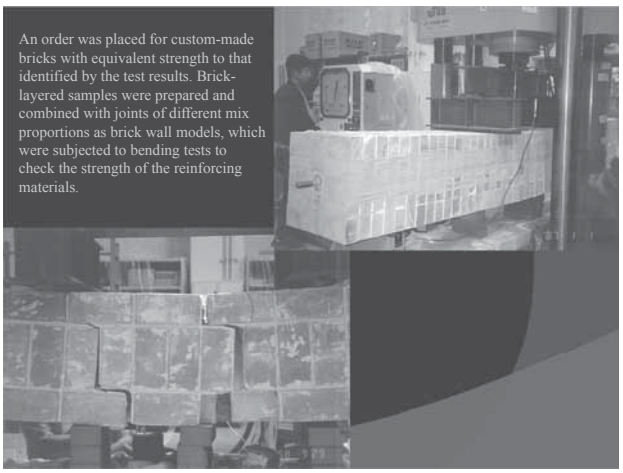


7. Reproduction of Traditional Techniques and Structural Reinforcement

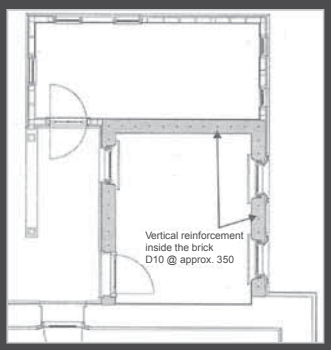
To restore the lost back brattice, the bricks remaining as chipping marks on the existing back brick wall surface were carefully removed by hand. Efforts were made to retain as much of the remaining brick foundation as possible, and cracked and partly remaining bricks were removed by hand. This approach was required in order to reproduce the building as faithfully as possible using the techniques of 1916 and also to effectively preserve the materials used at that time.

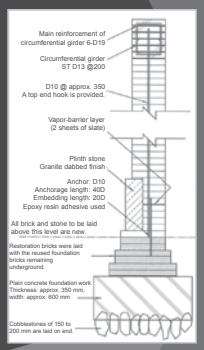
With regard to bricks and joints, on the other hand, the original shapes and dimensions in 1916 were exactly reproduced by the techniques applied at the time of construction. However, the strength of the bricks and the mix proportion of joint mortar complied with present-day standards. This approach was intended to ensure that the brick structure of the brattice to be made by laying bricks in layers would have sufficient strength and safety.

However, the structural safety standards could not be met even by using bricks and joints complying with current standards, so it was necessary to reinforce the structure by incorporating reinforcing bars at the stage of laying the brick structure and placing circumferential girders on the tops of the walls of the brick structure.

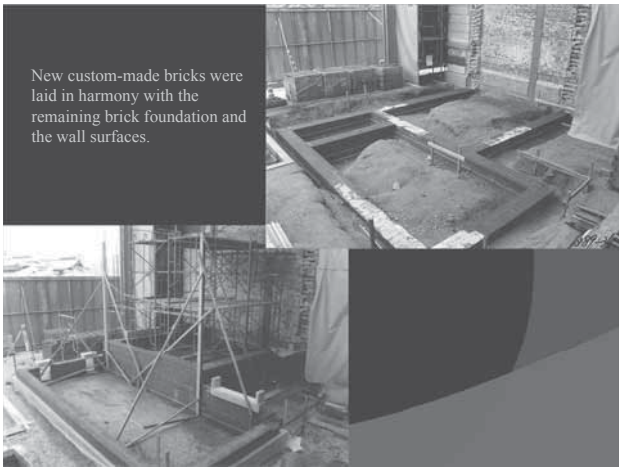
Planning and design were conducted so that these conflicting factors would be resolved, the plans were correctly communicated to engineering personnel responsible for brick laying, and the work was executed under careful supervision.

Detailed cross-sectional drawing of brick wall of back brattice to be restored

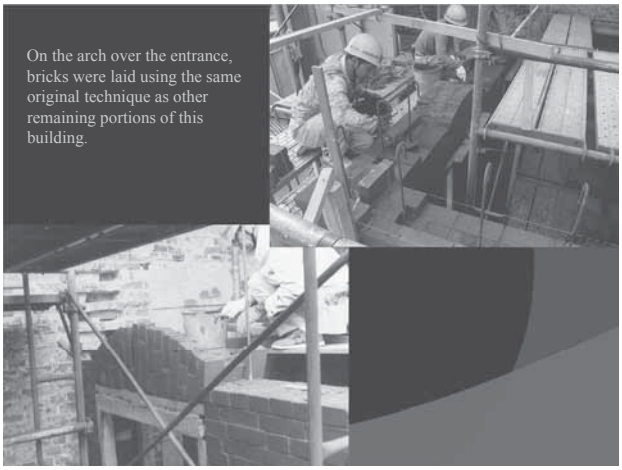




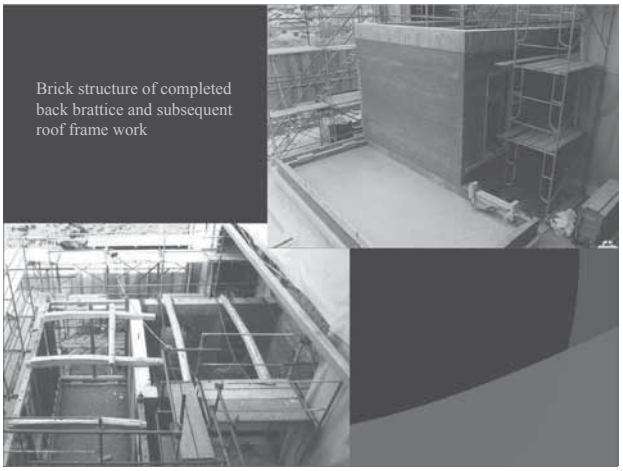
New custom-made bricks were laid in harmony with the remaining brick foundation and the wall surfaces.



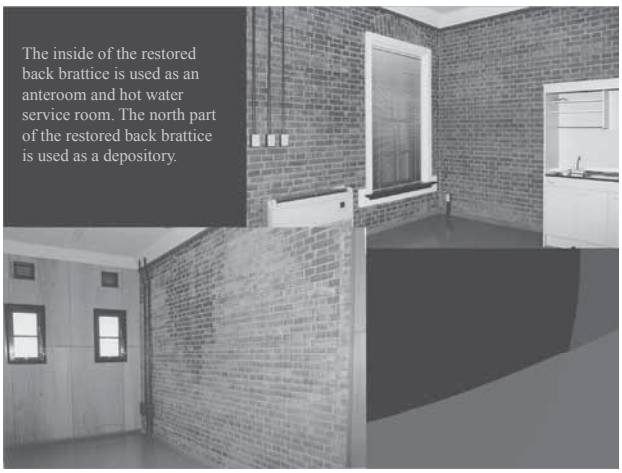
On the arch over the entrance, bricks were laid using the same original technique as other remaining portions of this building.



Brick structure of completed back brattice and subsequent roof frame work



The inside of the restored back brattice is used as an anteroom and hot water service room. The north part of the restored back brattice is used as a depository.



8. Conclusion

This repair work successfully repaired and restored a lost brick structure, which is of great significance and shows that brick-making and brick layer techniques still exist in Japan.

The future demand for constructing large-scale brick structures is expected to be extremely low, and bricks are seldom used in repair work on important cultural properties like the Assembly Building. The restored back brattice of Yamaguchi Prefecture's Old Prefectural Assembly Building was smaller than 20 m^2. Nevertheless, the experience obtained from the difficult work of assimilating the techniques adopted in 1916 with modern structural reinforcement techniques will be useful for many years to come.

Structural reinforcement performed at this time to maintain the brick structure

The foundation was reinforced by forming a 30-cm-thick concrete slab.

Holes were drilled from the top of the brick exterior walls, which are 57 cm and 46 cm in thickness on the first floor and the second floor, respectively, then 10-meter-high, 25-mm-diameter reinforcing bars were inserted, and shrinkage-compensating mortar was poured into the holes.

The existing wooden parts were removed intact from the inside of the brick walls, and the horizontal surface was reinforced by fastening steel materials with bolts.

The brick walls of the assembly hall were reinforced by fastening 3-mm-thick stainless steel panels with bolts.

The corridor floor surface of the second floor was reinforced by embedding 3-mm-thick box-formed stainless steel frames.

This building is no longer used as the Assembly Building but is open to the public as the assembly reference library after the repair work.
It is also used for lectures and various other purposes.

Restoration of Historic Natural Stones in the Past Decade in China – Case Study

DAI Shibing

Professor / Director

College of Architecture and Urban Planning, Tongji University

Conservation Centre of Architectural Heritage

1. Introduction

Natural stones are one of the most important construction materials worldwide, same as in China. They include grottoes, monuments, commercial buildings as well as bridges etc. Some of monuments and historic architecture in China have been restored in the last decade with different technology and materials. 3 typical cases will be reported in this paper, they are Monument Zhang Peijue, Chongqing, West China. Clock Tower of Custom House Bund No 13 in Shanghai and Golden Bridge Tiananmen Square in Beijing.

2. Case 1: Restoration of Monument Zhang Peijue, Chongqing, West China

2.1 Martyr Zhang Peijue

Zhang Peijue（1876－1915），borne in Rongchan Chongqing was revolutionist. In April 1915 he was killed in Tianjin by Yuan Shikai. To commemorate his achievements to establish the Republic of China, the Kuomintang Central Executive Committee decided to build a "monument Zhang Pei Jue" in Chongqing Battery Street (now Chongqing Chang Bai Road). In July 1944, the monument was completed.

2.2 Defects

The monument is made from sandstone and marble. It suffered severe damages after over 50 years exposure to weathering.

Fig. 1: Monument Zhang Peijue (from left to right: (1)before restoration in 1999, during restoration in 2000, (3) 10 years after restoration; (4) new restoration in Summer 2011)

In 1999 the local cultural administration decided to restore the monument. Based on visual inspection, following defects of sandstone have been found: crust formin, sanding, discoloration, algae growth, etc. But only surface solving has been found on the marble.

2.3 Restoration implementation in 2000

Based on the restoration plan done by former China National Institute for Cultural Properties in Beijing, following workflow was specified: remove delaminated stone; surface cleaning with water jet; consolidation with ethyl silicate to the entire old stone surface; surface reprofile with restoration mortar (off-white) from Germany; surface colour-matching with restoration mortar mixed with old sandstone particles. After curing of the restoration mortar, all surfaces (both old sand stone and new mortar) were consolidated with ethyl silicate. As final coat the solvent-based clear siloxane was applied to make the entire surface water repelling. The water absorption was tested after completion of the entire restoration.

2.4. Inspection after 10 years exposure

After 10 years, the restored monument was visually inspected and found, the surface of both old and new materials are intact. Especially no further weathering was identified in the contact area between new mortar and old stone. However the color of the surface was turning into off-white (restoration mortar's color). Algae were found on top of the monuments.

Fig. 2: restoration details after 10 years exposure (taken in 2010, left) and new staining (taken in 2011)

2.5 Maintenance in 2011/11/18

To celebrate the Revolution of 1911 (the Chinese bourgeois democratic revolution led by Dr, Sun Yat-sen which overthrew the Qing Dynasty), in summer 2011 the monument was desalinated, consolidated and stained into green color, similar to revolution's colour 100years ago.

3. Case 2: Restoration of the clock tower of Shanghai Customs House

(Bund No. 13, Shanghai)

Shanghai Customs House (Bund No.13) was built in 1927, it is originally named Jianghai Custom House. It is considered as one of the symbols of the Bund in Shanghai. It is topped by a clock tower, which is 11 storeys or 90 meters tall, which represents Shanghai geographically. The façade of the clock tower is surfaced in granite and Shanghai plaster.

In 2006 because of leakage, the clock tower was restored with following methods:

(1) cleaning with high pressure water jet to remove dust;
(2) cut and vacuum the open joint;
(3) reprofile the delaminated granite with restoration mortar formulated with granite particle; Craftsman surface treatment with historic technique to reach a similar texture as original;
(4) the joints were prefilled with traditional mixture of lime, TUNG oil and hemp fibre;
(5) as finishing, the joints were pointed with lime-based mortar;
(6) solvent-based siloxane was applied to the entire façade especially the joint to improve the rain water tightness.

After 6 years exposure, the lime-based mortar joints are still rain water-tight.

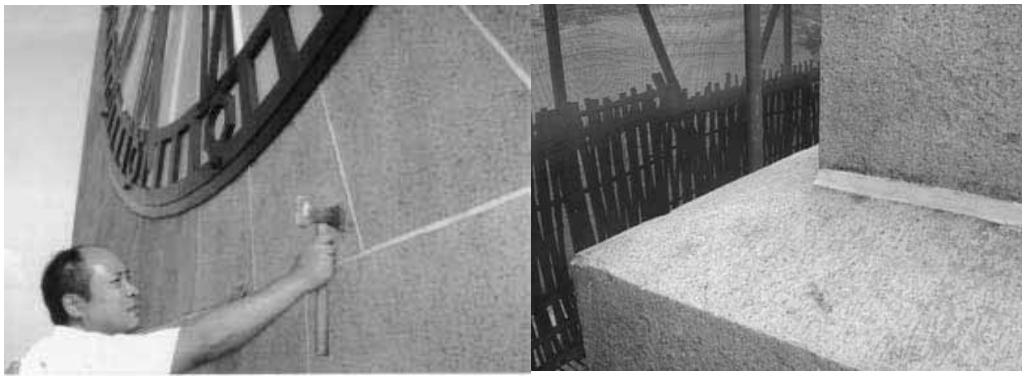


Fig. 3: craftsman surface treatment with historic technique (left) and details after restoration (right)

Fig. 4: The clock tower of Custom House Bund No 13, Shanghai (Before 2006 and after restoration 2008)

4. Case 3: Restoration of the Golden Bridge, Tiananmen Square in Beijing

4.1 History

The Forbidden City was the Chinese imperial palace from the Ming Dynasty to the end of the Qing Dynasty. It is located in the middle of Beijing, China, and now houses the Palace Museum. For almost 500 years, it served as the home of emperors and their households, as well as the ceremonial and political center of Chinese government. The Forbidden City was declared a World Heritage Site in 1987, and is listed by UNESCO as the largest collection of preserved ancient wooden structures in the world. Built in 1417, the golden bridge was the pathway to the Forbidden City. Historically there were totally 7 bridges, but only 5 are preserved. white-grey marble from were laid on top of clay brick sub ground, all open joints were historically filled with lime milk.

4.2 Causes of Defects

Before restoration, the marble stone was damaged by many factors. Because of inhomogeneous properties of expansion and shrinking of calcite mineral (main component of marble stone) the marble turns to become fragile under changes of daily temperature.

However severest damages of marble were caused by wrong restoration done a few years ago. The huge pieces of delaminated marble were replaced with concrete and all open joints were filled with cement mortar. The high strength of concrete and water-soluble salts in cement accelerated the delamination.

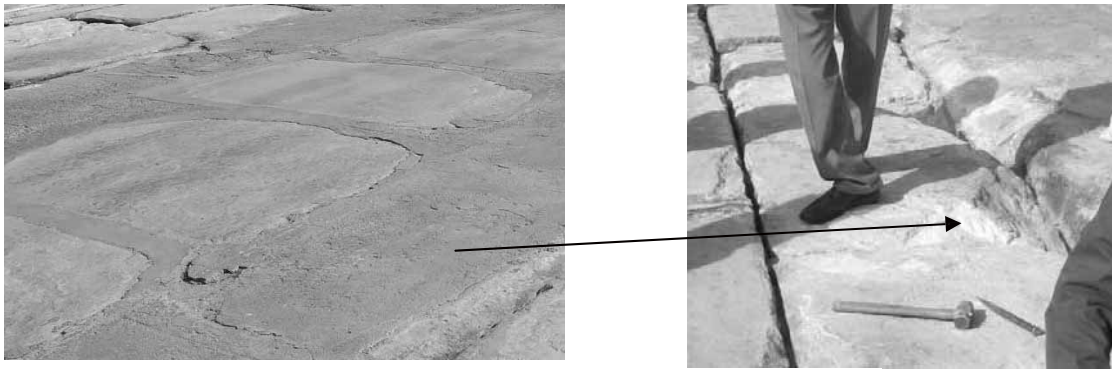


Fig.5: Cement mortar damages historic marble stone

4.3 Specification

To prepare 70th anniversary celebration of the PR China, the bridges were decided to be restored.

Fig.6: Methods to restoration (from left to right: replacement, piece-in and re-profile)

All old cement mortars and concrete were removed. Where the marble was heavily damaged, replaced by new marble from the same mine as original. Piece-in technique was also used to preserve as much as possible historic materials. For the re-profile, a new natural hydraulic lime-based mortar with marble aggregate had been developed. All open joints were filled with lime mortar.

Fig. 7: Yulu Qiao (Emperor Bridge) before, during and after restoration

5. Comments and Prospects

The Monument of case 1 was restored with modernist materials of 20th century from Germany and applied as a trial project to test if the modern technology can save guard stone monument. The preliminary inspection after 10 years proves it's success, however if the colour of the restoration mortar would have been adjusted to original sandstone, it could have become a perfect restoration project.

The case 2 shows the combination of traditional skills, traditional materials and modern technology can improve the durability of architectural heritage.

The case 3 is the first application case of natural hydraulic lime (NHL) as binder for restoration of natural stones in China. Today lime is becoming one of the dominant materials for conservation and restoration of our architectural heritage.

Today, more efforts have been given to investigate the real causes of defects and monitor of environments. Nondestructive technology like desalination will be more applied in future.

Fig. 8: Documentation, Monitoring, Diagnosis, Intervention Guia Chapel Macao

Fig. 9: Desalination before restoration in Shanghai

中国历史石材修复十年 – 案例分析

Restoration of historic natural stones in the past decade in China – case study

戴仕炳， 德国自然科学博士， 教授
By Prof. Dr. rer.nat. DAI Shibing
同济大学建筑城规学院 CAUP Tongji Univrsity
历史建筑保护中心 主任

内容提要 Content -New

1. Transmission of Traditional Skills: Tongji Approaches-Research Projects, Conference, Seminar, Workshops etc. 同济团队在传统技艺方面的工作
2. Architecture Conservation Laboratory of Tongji University同济大学历史建筑保护技术中心介绍
3. Case Studies 案例分析

Transmission of Traditional Skills: Tongji Approaches-Conference, Seminar, Workshops 同济团队在传统技艺方面的工作

- **Research Program科研： “低技术保护”Low Tech和“科学性保护”** 结合High-Tech
  e. g. National R& D fund project: System of Low Tech for Heritage Architecture: Conservation and New Construction
- **Seminars, Workshops, e. g. 2011年亚太地区古建筑保护与修复技术高级人才培训班**

组织的重要国际会议 Training Activities 2008-2011

第一届“历史建筑可持续性改建与建筑物理技术2008”国际研讨会 International Conference on Sustainable Building Restoration And Building Physics in 2008

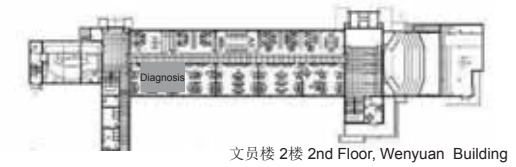
“近现代历史建筑修缮技术研讨班”2009 1st Workshop on Building restoration in 2009

2011年 亚太地区古建筑保护与修复技术高级人才培训班 Adv. Workshop for Conservation and Restoration of Heritage Architecture in 2011

Photo: Traditional Limes

Location位置

文员楼 1楼 Ground Floor, Wenyuan Building



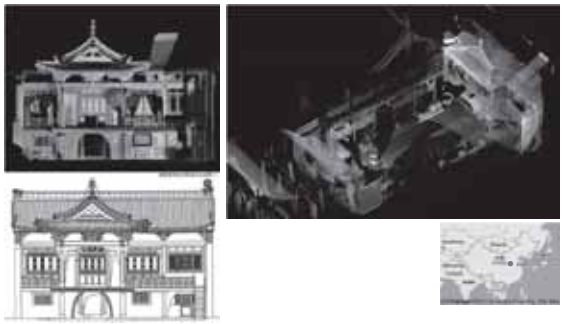
文员楼 2楼 2nd Floor, Wenyuan Building

■ **实录、诊断与材料研发设备、仪器等Instruments and Tools**

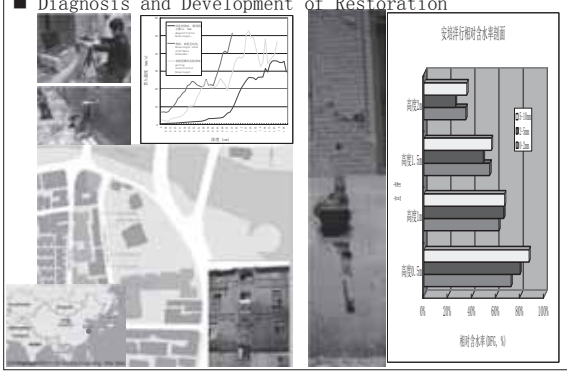
实录、诊断与材料研发设备： 拥有三维激光扫描（Leica C10）、钻入阻力仪、离子色谱仪、热红外成像仪等30余台高端设备

实录 Documentation　诊断 Diagnosis　研发 Development

■ 三维激光扫描技术应用研究—以平遥文庙为例
3D Scanning of Historic Architecture



■ 材料检测、病害诊断与修复技术—以上海市黄浦区174街坊为例
■ Diagnosis and Development of Restoration



Architecture Conservation Laboratory/CAUP Tongji University
同济大学历史建筑保护实验中心介绍

■材料检测、病害诊断与修复技术—以海口骑楼老街灰塑为例
■Investigation of Lime Plaster in Haikou

Architecture Conservation Laboratory/CAUP Tongji University
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■ 特色 - 建筑石灰技术
Unique Technology - Lime

材料与工艺开发

石灰砌筑　石灰修复材料　石灰粘结材料　桐油石灰　纸筋灰　水硬性石灰

建筑石灰网站website for lime technology: www.china-limes.com

Architecture Conservation Laboratory/CAUP Tongji University
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■ 建筑石灰技术应用：
天安门广场金水桥石材修复
■ Application of lime technology

特色材料： 石灰基(NHL) 汉白玉修复剂

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■ 建筑石灰技术应用：平遥城墙修复2008
■ Application of Lime technology in Pingyao City Wall
■ Development of traditional skills to maintain historic architecture

筛分　加灰　搅拌

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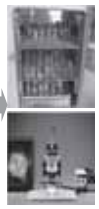
■ 特色 - 盐病害定量诊断与修复技术研发
■ Evaluation of Salts- Diagnosis and Conservation



取样　观察制样　离子色谱测试　评估　无损技术研究

Architecture Conservation Laboratory/CAUP Tongji University
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■ 澳门特别行政区文化局委托：
世界文化遗产大炮台围墙保护研究
■ Macao: Lime plaster

Architecture Conservation Laboratory/CAUP Tongji University
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■ 澳门特别行政区文化局委托：
世界文化遗产澳门圣母雪地殿-大中华地区最古老的湿壁画
■Most Valuable Fresco in Great China

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同济大学历史建筑保护实验中心介绍

研究单位Organizer：

同济大学-建筑与城规学院
同济大学-机械学院
Tongji University

协作单位Cooperation Partner ：

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Uni for Applied Sci & Arts Hildesheim

实录 Documentation→病害机理Diagnosis→干预Intervention→监测Monitoring

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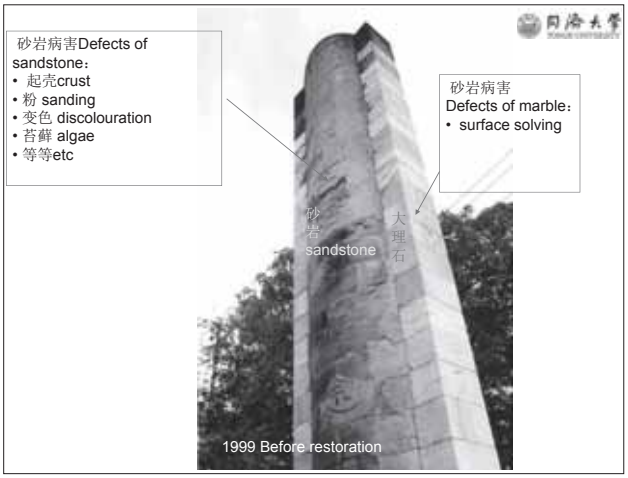
武夷山世界文化遗产摩崖石刻现状实录技术及描字材料技术研究

inscriptions on precipices, World Heritage Wuyishan

张培爵（1876—1915），字列五，重庆荣昌人。辛亥革命家。1915年4月，密谋讨伐袁世凯，严厉拒绝袁世凯的利诱，被杀于天津。1944年7月，由国民党中央执委会决定修建的“张烈士培爵纪念碑”在重庆炮台街（今重庆市沧白路）竣工落成，以纪念张培爵为建立民国立下的功绩。

Borne in Rongchan Chongqing, revolutionist. In April 1915 was killed in Tianjin by Yuan Shikai.

July 1944, the Kuomintang Central Executive Committee decided to build a "monument Zhang Pei Jue" in Chongqing Battery Street (now Chongqing Chang Bai Road) were completed, to commemorate his Achievements to establish the Republic of China Zhang Pei Jue.

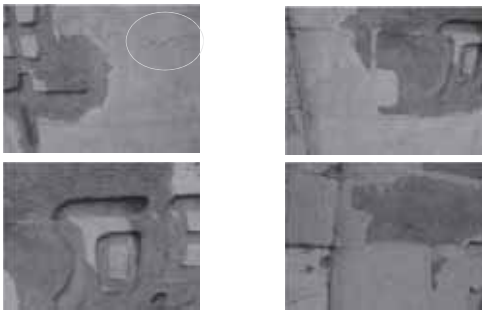


修复工艺restoration

• 剔除开裂， 粉化石材remove delaminated stone
•表面杀菌，清洁surface cleaning
• 硅酸乙酯增强consolidation with ethyl silicate
• 缺损部分修复surface reprofile with restoration mortar
砂浆从德国进口， 灰白色(off-white) from Germany
• 表面加砂岩粉作色surface colour-matching with mortar + sandstone particle
•硅酸乙酯增强consolidation with ethyl silicate
• 有机硅憎水处理water repelling impregnation with siloxane

10年后10years later-2010年

10年后的细部
details between old and new after 10years



纪念辛亥革命100周年
-2011年整修 Maintenance in 2011

2011年9 月

DAI Shibing

案例2：上海海关钟楼 - 2006年

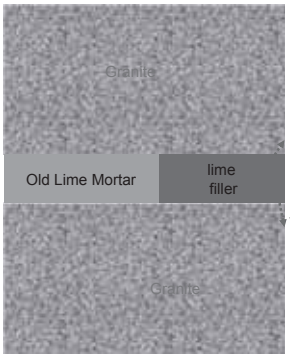
- 上海海关大楼是1891年拆除旧屋，于1893年建成一座英国建筑师设计、浦东川沙匠人杨斯盛主持建造的3层砖木结构的英国哥特式楼房。1925年又拆除旧屋重建，于1927年底落成，即现大楼，与雍容典雅的汇丰银行大齐肩并列，相得益彰，被称为汇丰银行的“姐妹楼”。
- 钟楼旗杆位置在地理坐标东经121° 29′ 0.02″，北纬31° 14′ 20.38″，为上海地理位置的标志点，同时也外滩建筑中上最气派最大者。钟楼则为歌特式，有十层楼高，是仿美国国会大厦的大钟制造，在美国造好后运到上海组装。据说花了白银2千多两，是亚洲第一大钟，也是世界著名大钟之一。海关大楼巍然屹立在浦江之滨，它那铿锵、激昂的钟声象征着庄严，象征着使命。
- Shanghai Customs House (Bund No.13) was built in 1927, it is originally named Jianghai Custom House. It is considered as one of the symbols of the Bund in Shanghai It is topped by a clock tower, which is 11 storeys or 90 meters tall. The façade of the clock tower is surfaced in granite and Shanghai plaster.

材质分析 – 金山石
Material testing: typical granite from Suzhou

Restored granite stone
修复的花岗石

历史工艺
Traditional skill
To reach the historic surface

Traditional cross section profile of Joints, Clock Tower Custom House, Shanghai



Composition of Lime Filler:
Slaked Lime
+Tung Oil
+ Hemp Fiber

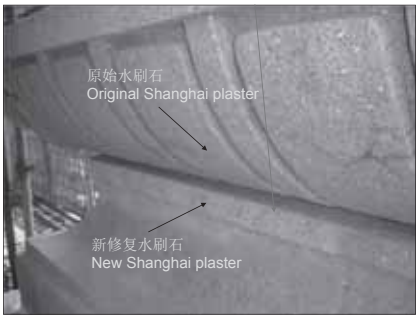
Stain of TUNG Oil

Modernized cross section profile of Joints, Clock Tower Custom House, Shanghai

Siloxane Impregnation

Advantage:
-New lime filler will cure very slow, work as rubber
- clean surface
- rain water tight even under Horicon

水刷石修缮效果
Restored Shanghai-plaster



上海海关修缮保护前后对比
Bell Tower before and after restoration

Case案例3：
天安门金水桥汉白玉修复
restoration of golden bridge of Tiananmen Square, 2009

设计单位：北京古建研究所
Archt: Beijing Inst Anc. Architecture
施工单位：北京怀建集团

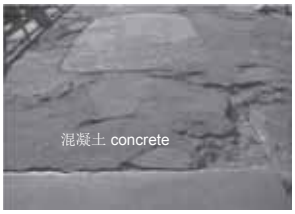
材料研发：同济大学历史建筑保护技术实验室

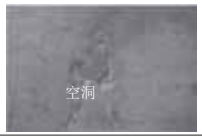
材料供应：上海德赛堡公司

历史沿革History

- 七座桥在建制使用对象上各有不同。正中的一座最为宽阔宏大，为皇帝一人专用，称为“御路桥”；御路桥左右的叫“王公桥”，是宗室亲王们通行的；王公桥外侧的桥较窄叫“品级桥”，是三品以上的文武官员们走的；在太庙（劳动人民文化宫）和社稷坛（中山公园）门前的两座桥比品级桥还窄，叫“公生桥”，供四品以下官员、兵弁、夫役来往使用的。现在人们看到的这两座桥已不是昔日的“公生桥”，面是解放后扩建，桥身加宽为11.8米。
- 天安门位于北京市中心，原为明、清两朝皇城的正门。始建于明永乐十五年（1417年），原名“承天门”，清顺治八年（1615年）改建后称“天安门”。
- Built in 1417, the golden bridge was the pathway to the Forbidden City. Historically there were totally 7 bridges, but only 5 are preserved. Constructionally, white-grey marble were laid on top of clay brick, all open joints were historically filled with lime milk.

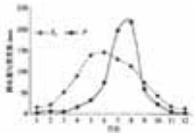
桥面的破坏程度Defects of the bridge surface before restoration





汉白玉病害原因
Damage causes

- 自然Natural：
  汉白玉的化学、物理
- 人为Anthropological：
  错误的修复方法



无机矿物不同方向的膨胀及导热系数
Heat and expansion coefficient

	热膨胀系数 Heat expansion coef.（x10⁻⁶K）		导热系数 Heat conductive co	
	平行// C轴	垂直+ C轴	平行// C重轴	垂直+C轴
石英Quartz	7.8	14.3	11.3	6.5
方解石 calcite	**23.3**	**-5.2**	**5.0**	**4.2**
白云石 dolomite	19.9	3.8	4.3	4.7
铜cupper			406.1	
食盐 NaCl	39.6	39.6		

（引自Dreyer,W.,1974）

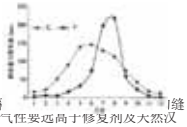
采用的手段-北京古建研究所
Technique of marble stone restoration

1：丙烯酸类材料
2：缝填实-水泥

1：快速 - 2个月施工时间
2： 高强 – 2吨红旗
3：填缝， 整体-便于游客行走

同济大学修复材料技术设计
Technical specification for restoration mortar

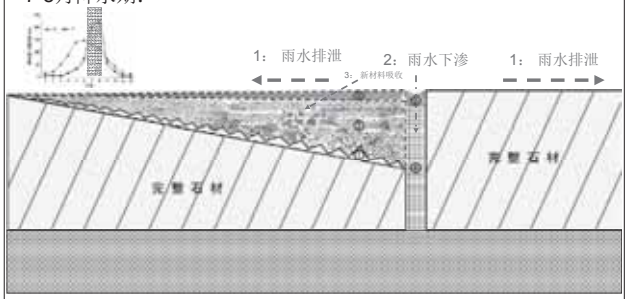
- **强度：**修复材料必须达到一定的强度，以满足行人交通，特别是能够承载60周年大庆时胡主席检阅车。但是，强度不易太高，要求是汉白玉修复材料完全固话后略低于已经发生风化的汉白玉的强度。根据经验，汉白玉修复剂的抗压强度控制在2～10MPa之间。
- Strength: 2～10MPa
- **吸水性：**原始汉白玉是需要重点保护对象，而水，特别是受污染的大气降水是汉白玉破坏的最重要因素，因此，要求修复材料的吸水性能要高于汉白玉，使得如桥面有少量积水时，这些水会很快被新的修复材料吸收掉，以保全历史材料。
- Watr absorption: shall absorb water more than marble
- **透气性：**由于北京地区除7～8月份外，
  蒸发量均大于降水量，
  使桥体里的水汽在蒸发时，
  优先选择缝及新修的修复材料。



- Damp diffusion: permeable
- **勾缝材料：吸水，透气，**除汉白玉修复剂外，必须对缝材料的强度要远低于修复剂，抗压强度<1MPa为易，透气性要远高于修复剂及大然汉白玉。
- Joint: lime

天然水硬性石灰/火山灰修缮材料及对修缮材料技术要求

7-8月降水期：

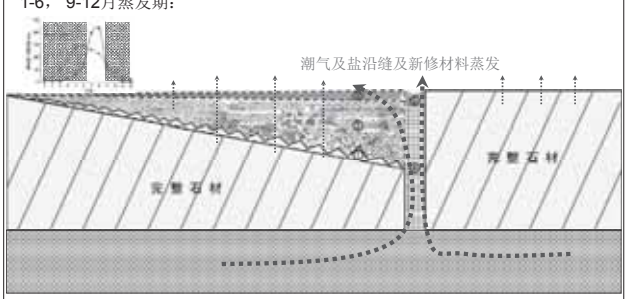


1. 抹底料（汉白玉界面剂）
2. 抹汉白玉修复剂-中间层
3. 做汉白玉修复剂-面层
4. 注浆: 石灰浆
5. 勾缝: 传统石灰勾缝
6. 增强: 正硅酸乙酯增强, 增加表面耐磨

强度: 修复材料低于已经风化的石材
吸水率: 修复材料大与已经风化的石材
透气性: 修复材料大于已经风化的石材
勾缝: 留出原有的缝, 采用石灰材料, 强度低于修复剂

天然水硬性石灰/火山灰修缮材料及对修缮材料技术要求

1-6， 9-12月蒸发期：

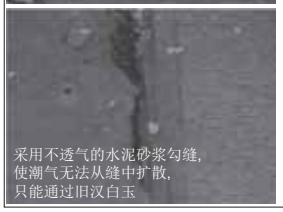


1. 抹底料（汉白玉界面剂）
2. 抹汉白玉修复剂-中间层
3. 做汉白玉修复剂-面层
4. 注浆: 石灰浆
5. 勾缝: 传统石灰勾缝
6. 增强: 正硅酸乙酯增强, 增加表面耐磨

强度: 修复材料低于已经风化的石材
吸水率: 修复材料大与已经风化的石材
透气性: 修复材料大于已经风化的石材
勾缝: 留出原有的缝, 采用石灰材料, 强度低于修复剂

采用北京某公司研发并
部分施工的丙烯酸材料

采用丙烯酸树脂修复剂不透气，
在修复面层与原有石材之间的霉变



采用不透气的水泥砂浆勾缝，
使潮气无法从缝中扩散，
只能通过旧汉白玉

采用同济大学历史建筑保护技术实验室
研究的材料及工艺试验面-20090325

采用天然水硬性石灰修复剂透气，
在修复面层与原有石材之间干燥

新旧界面之间无潮气

试验性施工
started phase 1, March 2009

现场勘查及最终方案的确定
During application

全面修复During restoration

修复后After restoration

结论与讨论
Comments and Prospects

- 科学的修复需要进行科学的诊断，利用多学科的技术成果
- 历史材料与工艺：尊重与科学应用， 如石灰技术
- 材料与工艺： 具体问题具体分析
- **经验**在成功修复中起重要作用
- The Monument of case 1 was restored with modernist materials of 20th centry from Germany and applied as a trial case to test if the modern technology can save guard stone monument. The preliminary inspection after 10 years proves it's success, however if the colour of the restoration mortar would have been adjusted to original sandstone, it could have become a perfect restoration project.
- The case 2 shows the combination of traditional skills materials and modern technology can improve the durability of architectural heritage.
- The case 3 is the first application case of natural hydraulic lime (NHL) as binder for restoration of natural stones. Today lime is becoming dominant material for conservation and restoration.

展望Prospects

- Today, more efforts have been given to investigate the real causes of defects and monitoring of environments. Nondestructive technology like desalination will be more applied in future. 未来更多研究病害的科学机理，监测环境，采用无损的、少干预措施保护
- Today, more efforts have been also given to understand the scientifical background of traditional skills and materials to transmit them scientifically
- Maintenance program more important than restoration 日程维护比大规模修复更重要
- More time is needed to carry out more perfect restoration projects.好的修复需要时间
- 低技术与高技术结合Low tech (Lime, Earth) + High tech (Building Physics)

Efflorences on the surface of marble of Golden Bridge, lack of time to carry out desalination金水桥桥面泛碱， 没有时间进行排盐

谢谢!

Thank you for your attention!
欢迎参观指导！
文远楼Room113（砖石灰土stone brick）/
文远楼Room105（木材修复保护wood）
电话：021-65982265，
www.tongji-acl.org
www.china-limes.com

DAI
Shibing

III. Recommendation

Recommendations of International Conference 2011

"Human Resources Development for the Transmission of Traditional Skills: National Approaches and their Application to Stone and Brick"

1. Nature of Cultural Heritage in Stone and Brick

- Cultural heritage in stone and brick in Asia, although considered very durable because of the nature of the material, transmits rich knowledge on traditional skills that need to be considered for their conservation.
- Conservation approaches for cultural heritage can be classified on the basis of its scientific understanding and various values identified in local context. Moreover these should take into consideration the hybrid/composite nature of these structures as they utilize various materials and techniques besides stone or brick.
- Each of the two broad categories calls for special consideration of authenticity of material, design, usage, workmanship and conservation interventions (including protection, repair, restoration and reconstruction).
- Cultural heritage in stone and brick is specific to its local context representing cultural diversity of the people. However it should be noted that exchange of ideas have added to the cultural diversity in Asia especially in the case of 20th century/modern heritage.
- Cultural heritage in stone should be seen as a process consisting of selection of appropriate type of stone from quarries, their cutting, laying, pointing and carving. In case of brick, it should be seen as a process that ranges from brick manufacturing including selection and mixture of appropriate types of clay and sand in correct proportions, molding, and traditional facilities such as kilns fired at specific temperature as well as brick laying and pointing. In many cases, each task is specialized by craftspeople. This process needs to be properly understood for deciding appropriate interventions for conservation, repair and restoration
- There is a close link between tangible heritage values (product=building) and intangible values (process = skills and workmanship) in stone and brick cultural heritage.
- Therefore cultural heritage should be seen as a compendium of traditional knowledge systems on construction as well as care and maintenance of buildings. This knowledge is orally transmitted among generations and is sufficiently documented in historic texts and material evidences manifested in

heritage itself. It is possessed by various kinds of people including craftspeople, architects and religious leaders. Moreover it is characterized by continuity of use, community relationships, care and expressions.

2. Threats to Traditional Skills in Stone and Brick

- Traditional craftspeople are leaving their profession in search of other sources of livelihood since there is not enough market for their skills. This is partly due to larger impact of globalization and economic development. This has especially resulted in gradual loss of traditional knowledge in (re)construction, maintenance and repair.
- Loss of craftspeople is also attributed to their low social and economic status in various regions of Asia.
- Although in most parts of Asia, stone craftspeople are still available, there is greater emphasis on quantity at the cost of the quality of workmanship. On the other hand, master craftspeople are very few and expensive to employ.
- In many cases, cultural heritage in stone and brick is also confronted with issues of safety especially against natural disasters such as earthquakes. This may be due to their vulnerability resulting from higher requirements in the contemporary society as well as inherent problems in construction and lack of maintenance.
- Vernacular constructions in brick and stone in rural and urban areas are generally not recognized as cultural heritage to be protected and thus are being gradually replaced with contemporary constructions that are insensitive to local context.
- Lack of resources and policies in traditional building skills in stone and brick is one of critical challenges.

3. Principles of Conservation, Repair and Restoration

- Depending on the nature of heritage (archaeological/monumental or living heritage), appropriate interventions should be considered; ranging from cleaning and consolidation to repair, restoration and rebuilding of heritage buildings with emphasis on material as well as structure by utilizing traditional skills. The former would require research and practice in conservation science that seeks to protect the original fabric while the latter seeks continuity of skills while incorporating changing needs of inhabitants.

- It is important to record and document the entire conservation/repair/restoration process rather than merely the final product (structure).

- It is important to consider viability of high quality of workmanship in restoration based on appropriate evidence-based scientific research by analyzing the authenticity in terms of materials, tools and skills. The extent of their application would be dependent on the nature of heritage.

- Various measures should be adopted to upgrade living heritage buildings to enable lower energy consumption for ecological considerations.

- Upgrading vernacular housing to meet contemporary needs with minimal compromise of values should be encouraged.

- Optimum safety requirements should not be compromised for the protection of values. Therefore risk reduction measures should be integrated in conservation, repair and restoration of cultural heritage.

4. Recommendations for Regeneration and Transmission of Traditional Skills in Stone and Brick

- Conservation of urban cultural heritage in stone and brick needs to be integrated with planning policies and guidelines to encourage its regeneration through adaptive reuse.

- To ensure the transmission of traditional techniques, intellectual property rights of craftspeople should be considered through appropriate laws and regulations.

- Professional education in the fields of engineering and architecture should include construction, repair, restoration and retrofitting techniques in traditional stone and brick buildings.

- Vocational training in traditional material and construction techniques in brick and stone should be imparted to the younger generation.

- Research on traditional materials and tools should be promoted by recording living crafts/skills, historic texts as well as through physical evidences in buildings. Applied research for development of physically, socially and economically appropriate materials and techniques for conservation, repair and restoration of cultural heritage in brick and stone should be encouraged.

- Older craftspeople should be encouraged to transfer their skills to younger generation. To support livelihoods of traditional craftspeople, subsidies should be provided by the government. Other appropriate measures for increasing livelihood opportunities for craftspeople especially younger

generation should be considered

- It is important to build capacities of practitioners (those with direct responsibilities of heritage), institutions (decision and policy makers) as well as community networks. Administrators should especially be made aware of the importance of conserving and restoring cultural heritage.
- Adaptation of traditional techniques in brick and stone should be encouraged for contemporary constructions to ensure their sustainability and viability. Where possible and appropriate, combination of traditional and contemporary materials and technology should be encouraged for new constructions.
- Considering the similarity of traditional materials and techniques and various regional influences, international cooperation especially among academic and research institutions for conservation, repair and restoration of stone and brick heritage should be strengthened while respecting the diversity of cultural heritage
- An integrated team consisting not only professionals and experts but also craftspeople should be established for undertaking conservation works.
- Awareness about traditional materials and constructions and their appropriateness for local environment should be raised among general public.

IV. Appendix

1. General Information of the Conference

International Conference 2011
"Human Resources Development for the Transmission of Traditional Skills: National Approaches and their Application to Stone and Brick"
(6 – 8 December 2011, Shanghai, China)

1. Organisers

This conference is jointly organised by Agency for Cultural Affairs, Japan (*Bunkacho*); the Asia-Pacific Cultural Centre for UNESCO; the National Institutes for Cultural Heritage, National Research Institute for Cultural Properties, Nara and Tokyo; WHITRAP Shanghai; Tongji University; and Shanghai Tongji Urban Planning & Design Institute in cooperation with the JAPAN ICOMOS National Committee, the Japanese Association for Conservation of Architectural Monuments (JACAM).

2. Background and Objective

The International Conference 2011 is the second in a series, held once each fiscal year and expected to continue for several years, under the general theme of "Human Resources Development for the Transmission of Traditional Skills".

The first conference aimed at a common understanding of the theme's current status by presenting different national approaches to the restoration of historic buildings. It also highlighted ways of posting experts on sites to guide and supervise the repair work, examples of different legislation and measures for training conservation experts with traditional skills and for procuring traditional materials, and the actual operations at work sites. We also deepened discussion on how to transmit traditional skills and materials for restoration, while taking a comprehensive view of both tangible and intangible cultural heritage. The subtheme of the first conference was woodworking, and practical aspects of the repair work were discussed in detail.

Following up on the first conference, the subtheme of the second will be stone and brick, as seen in structures such as stone monuments, stone walls, building foundations, bridges, retaining walls and brick buildings. Case studies of repair work using traditional techniques and materials will be examined from each country in the Asia-Pacific region, while aiming to share information on the latest scientific technology for use in making judgments at the stage of preliminary investigation, and on methods for assessing the current condition of the properties.

3. Dates and Venues

Dates: From Tuesday, 6 to Thursday, 8 December 2011
Venues: Tongji Urban Planning Conference Center, Tongji University (Shanghai), etc.

4. Provisional Schedule

Day 1 (Tuesday, 6 December)

09:00 ~ Opening Session
09:30 ~ Keynote Speech I〜III
13:50 ~ Case Study Report I – IV

Day 2 (Wednesday, 7 December)

10:00~15:00 Participants will visit to three restored historic buildings in Shanghai under the guidance of Mr WANG Anshi.

Day 3 (Thursday, 8 December)

09:30 ~ Presentation of Case Study Report V-VIII
13:10 ~ General Discussion
16:00 ~ Closing Session

5. Working Language

The working language of the conference is English. Simultaneous interpretation between English and Chinese (or Japanese) will be provided when necessary.

6. Financial Arrangement

Organisers will provide each of the participants with:

1. Travel expenses: A round trip air ticket (economy class) designated by organisers between the international airport nearest to the participant's residence and Pudong (Shanghai) Airport.
2. Accommodation and meals during conference session.

7. Correspondence

All enquiries and correspondence concerning the Conference should be addressed to:

❖ **ACCU Nara**

Cultural Heritage Protection Cooperation Office,
Asia-Pacific Cultural Centre for UNESCO (ACCU)
575 Horen-cho, Nara 630-8113 JAPAN
Tel: (+81) 742-20-5001 Fax: (+81) 742-20-5701
e-mail: nara@accu.or.jp

❖ **WHITR-AP (Shanghai)**

World Heritage Institute of Training and Research for the Asia and
the Pacific Region under the Auspices of UNESCO (Shanghai)
3F Wen Yuan Building, Tongji University
No. 1239 Siping Road, Shanghai 200092 P.R. CHINA
Tel & Fax: (+86) 21 6598 7687
e-mail: whapshanghai@gmail.com

2. Schedule of the Conference

Day 1 (Tuesday, 6 December)

09:00- 09:30 Opening Session

Welcome addresses by organisers and guests: Mr ZHOU Jian, Director of WHITRAP (Shanghai); Mr NISHIMURA Yasushi, Director of ACCU Nara; Mr WU Jiang, Vice-President of Tongji University; Mr MOTONAKA Makoto, Chief Senior Specialist for Cultural Properties, Agency for Cultural Affairs, Japan; Mr HOU Weidong, Vice-Director & Chief Engineer, Chinese Academy of Cultural Heritage.

09:30 -10:15 Keynote Speech I: Mr Gamini WIJESURIYA (ICCROM)
"Tapping Stone and Brick: In Search of Traditional Skills and their Continuity"
11:00-11:45 Keynote Speech II: Mr HOU Weidong (China)
"Introduction to Ancient Brick and Stone Buildings and its Conservation Restoration in China"
11:45-12:30 Keynote Speech III: Mr MOTONAKA Makoto (Japan)
"The Japanese Protection System for Preservation Technique for Traditional Stone Wall"

13:50-14:25 Case Study Report I: Mr Arnulfo DADO (Philippines)
"Current Issues and Future Tasks for Conservation of Stone and Brick Structures in Philippines"
14:25-15:00 Case Study Report II: Mr Soeroso (Indonesia)
"Problems and Solutions of Cultural Heritage Made from Bricks Conservation in Indonesia"
15:20-15:55 Case Study Report III: Mr WANG Anshi (China)
"Practical Experiences and Thoughts during the Protection of Shanghai Historic Buildings"
15:55-16:30 Case Study Report IV: Ms Sangeeta BAIS (India)
"Conservation of World Heritage Site of Humayun's Tomb, New Delhi"
18:00-20:00 Reception

Day 2 (Wednesday, 7 December)

Excursion: Participants visited four restored historic buildings in Shanghai under the guidance of Mr Anshi Wang, Mr ZHANG Lai'en (Yifeng Bank), Mr HOU Jianshe (Bund 18), Mr LIU Shen (Sinan Mansion) and Mr BU Jianmin (Yong Quan Fang).

Day 3 (Thursday, 8 December)

09:30-10:05 Case Study Report V: Mr Jude Nilan COORAY (Sri Lanka)
"Current Issues of and Future Tasks for Conservation of Stone and Brick Structures in Sri Lanka"
10:05-10:40 Case Study Report VI: Mr JO Sangsun (Rep. of Korea)
"Current Issues of and Future Tasks for Conservation of Stone and Brick Cultural Heritages and Traditional Techniques in Korea"
11:00-11:35 Case Study Report VII: Mr KIMURA Kazuo (Japan)
"Outline of a Project to Repair a Brick Building in Japan: The Challenges of Reproducing Traditional Engineering and Structural Reinforcement"
11:35-12:10 Case Study Report VIII**:** Mr DAI Shibing (China)
"Restoration of Historic Natural Stones in the Past Decade in China – Case Study"
13:10-16:00 General Discussion: All participants
"Human Resources Development for the Transmission of Traditional Skills"
16:00- Closing Session

3. List of Participants

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《Opening Ceremony》

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