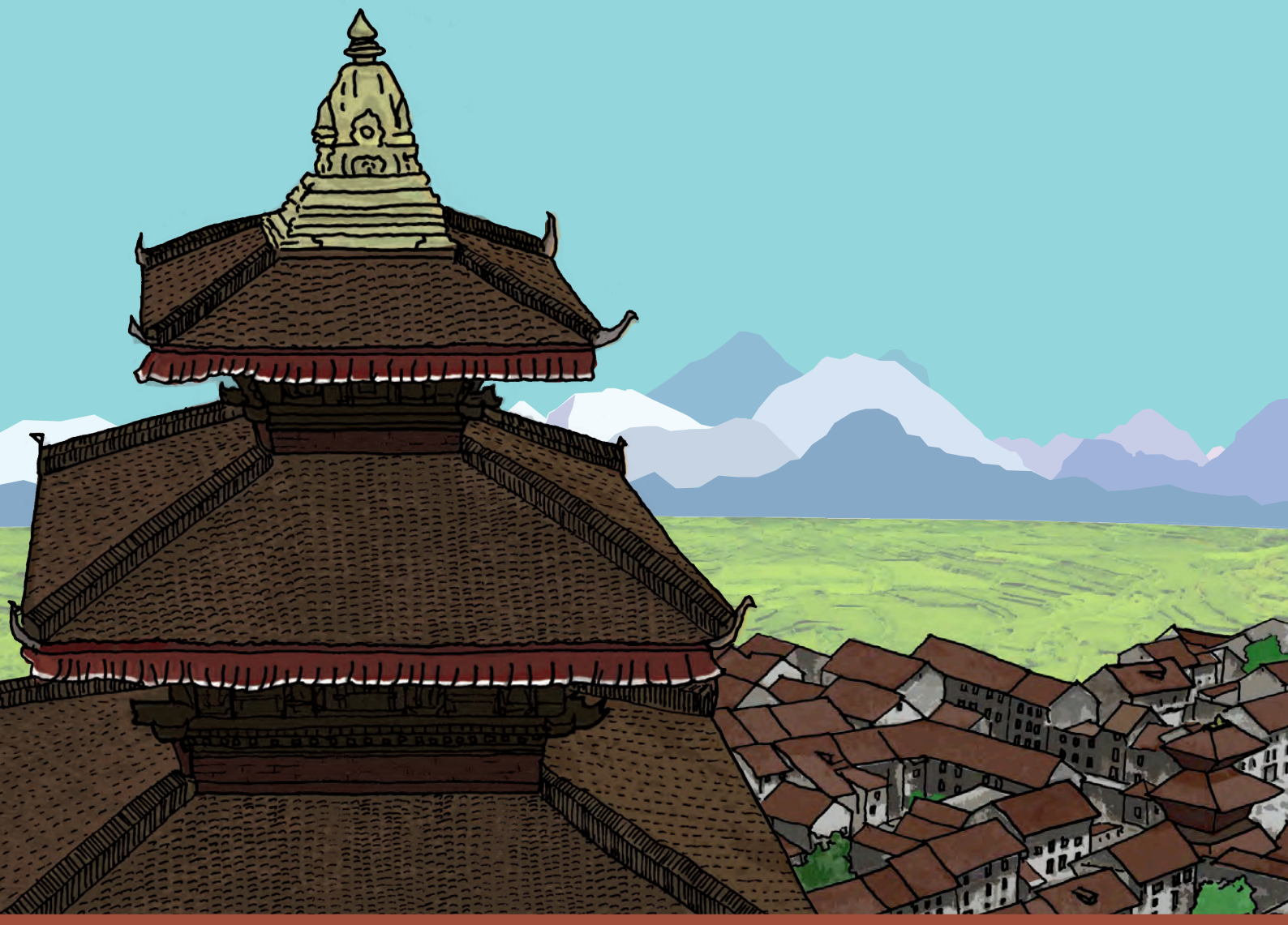
2016 Networking Core Centers for International Cooperation
in the Conservation of Cultural Heritage Project

Technical Assistance for the Protection of Damaged Cultural Heritage in Nepal



Project Report

May 2017

Tokyo National Research Institute for Cultural Properties

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Preface

This report is the outcome of the 'Project of Technical Assistance for the Protection of Damaged Cultural Heritage in Nepal'. The project was commissioned by the Agency for Cultural Affairs of the Japanese government within its scheme of the 'Networking Core Centers for International Cooperation in the Conservation of Cultural Heritage Project, FY 2016' and implemented by the Tokyo National Research Institute for Cultural Properties (TNRICP)

In the fiscal year of 2015, TNRICP was commissioned to implement the 'Project of Investigation of Damage Situation of Cultural Heritage in Nepal' by the Japanese Agency for Cultural Affairs as part of 'Cooperation Project for the Preservation of Cultural Heritage (Expertise Exchange)', with regard to the protection of cultural heritage damaged by the Gorkha Earthquake. TNRICP's investigations and supports thus began. We would like you to make reference to this 2015 Project report uploaded to the following website (http://www.tobunken.go.jp/japanese/publication/pdf/Nepal_NRICPT_2016_ENG_s.pdf).

The current project, which succeeds the results from the last fiscal year, provides the technical assistance regarding the damaged cultural heritage by the earthquake in Nepal, as Nepal's Department of Archaeology (DOA) of the Ministry of Culture, Tourism and Civil Aviation as the local counterpart authority. In collaboration with local governments, experts, and local communities, the professional team organised last year, consisting of researchers from Nippon Institute of Technology, the University of Tokyo, Kagawa University, Tokyo Metropolitan University, as well as external independent experts in cultural heritage conservation continued to conduct investigations of the damaged cultural heritage employing comprehensive viewpoints including fields of architectural history, structural engineering, urban design, restoration technique and intangible cultural heritage. One of the significant outcomes of this fiscal year is how cooperative relationships between Nepal and Japan were further tightened. As for Aganchen Temple in Hanumandhoka Palace in Kathmandu which is one of the target buildings, for example, DOA and the Hanumandhoka Durbar Museum Development Committee (MDC) conducted the emergency stabilisation works according to the plan developed by the professional team mentioned above. During which Japanese experts provided necessary technical advice and guidance to Nepalese experts and craftsmen. Furthermore, we reached out to the Japanese Ministry of Foreign Affairs and the Japan International Cooperation Agency (JICA) in co-operation with UNESCO Japanese Funds-in-Trust, aiming to expand the support scope of the project for the rehabilitation of damaged cultural heritage by the All-Japan team. As a result, at the end of 2016, we finally were able to position one of the expert team members as a restoration technical adviser in DOA in the framework of JICA long-term dispatch system for experts. Moreover, with respect to Aganchen Temple mentioned above, in this emergency situation Nepalese and Japanese governments came into an agreement to make special use of the funds that was made available from Japanese Food Aid grant in the past for the restoration of cultural heritage. We hope this project will encourage the rehabilitation of Nepal with the further development of the cooperation for the preservation of the cultural properties.

Finally, we would like to extend our sincere gratitude to all the experts, Agency for Cultural Affairs of Japanese government, Japanese Embassy in Nepal, DOA, UNESCO office in Kathmandu and other relevant organisasions. Our special appreciation also extends to Mr Besh Narayan Dahal, Director General of DOA; Ms Nabha Basnyat Thapa, Project Coordinator of UNESCO office in Kathmandu; Ms Saraswati Singh, the former Executive Director of MDC; Ms Aruna Nakarmi, the incumbent Executive Director; Dr Bijaya Krishna Shrestha, Professor, Khwopa Engineering College; and the members of the Khokana Reconstruction and Rehabilitation Committee.

Nobuo Kamei

Director General

Tokyo National Research Institute for Cultural Properties

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1. Outline of the Project

1. Outline of the Project

1.1. Project aim

The project, titled 'Technical Assistance for the Protection of Damaged Cultural Heritage in Nepal', was commissioned by Agency for Cultural Affairs of the Japanese government as part of 'Networking Core Centers for International Cooperation in the Conservation of Cultural Heritage Project' of the fiscal year of 2016.

The earthquake occurred on 25 April 2015 in Nepal (hereafter referred to as 'Gorkha Earthquake') and its aftershocks directly affected many of the heritage assets including ancient royal palaces and temples which constitute the World Heritage Site of Kathmandu Valley. The healthy recovery of the whole Nepal is of course hoped for, and the rehabilitation of the historical heritage, which are major tourist destinations of Nepal, is strongly needed in particular not only from the cultural point of view but also from the economical one.

The main purpose of this project is to provide both technical information and actual support work for the rehabilitation of the damaged cultural heritage undertaken by the local authorities such as Department of Archaeology (DOA) of the Ministry of Culture, Tourism and Civil Aviation, based on the outcomes of the 'Project of Investigation of Damage Situation of Cultural Heritage in Nepal' carried out in the fiscal year 2015 within a scheme of 'Cooperation Project for the Preservation of Cultural Heritage (Expertise Exchange)'.

The project in this fiscal year is aimed to take over various surveys conducted since September of 2015 by the interdisciplinary professional team from the fields of architectural history, structural engineering, urban design, restoration technique, and intangible cultural heritage, et. al, continue to work on the more detailed surveys, construct a cordial relationship by sharing information with many disciplines in collaboration with the local authorities in Nepal, and strengthen the system of cultural heritage protection of Nepal transmitting the necessary techniques effectively.

1.2. Duration of the project

The overall duration of the project was twelve months, from 1 April 2016 to 31 March 2017.

1.3. Target area of the survey

Hanumandhoka Durbar Square, one of the component parts within the World Heritage Site of Kathmandu Valley, and Khokana in the areas inscribed on the World Heritage Tentative List were selected as the target areas for the survey.

Within Hanumandhoka Durbar Square, the following buildings were selected for the survey:

1. Aaganchen Temple (Aganchen Mandir/ Aagan temple in UNESCO report 2015) and Sundari Chok, and the west wing of Mohan Chok connected with the Aganchen Temple

<Extent of damage> It seemed no significant damage on three-tiered tower of Aganchen Temple

from the outside, but the pillars located below the Aganchen Temple were inclined significantly, and the outer western walls were heavily damaged. An emergency stabilisation measures followed by an extensive restoration are needed for they may collapse.

2. Shiva Temple (Mahadev Temple)
<Extent of damage> The building was completely collapsed by the earthquake and constituting members were fallen into the adjacent pond. However, the members of this temple are identified and recovered relatively easily because the building was built separately from the fallen members of the collapsed surrounding buildings.

3. Jagannath Temple and Gopinath Temple (Srikrishna Mahavishunu Temple)
<Extent of damage> The outer walls of both temples were cracked by the Gorkha Earthquake. However, due to the structural differences, the damage was concentrated on the upper storey in Jagannath Temple, while on the lower storey in the Gopinath Temple. These buildings are of typical Nepalese multi-tiered tower style architecture, and both had been repaired several times since their reconstruction after the earthquake of 1934. They are target buildings for the restoration by the current UNESCO Japanese Funds-in-Trust project.

Fig.1-1 Location of Nepal and Kathmandu

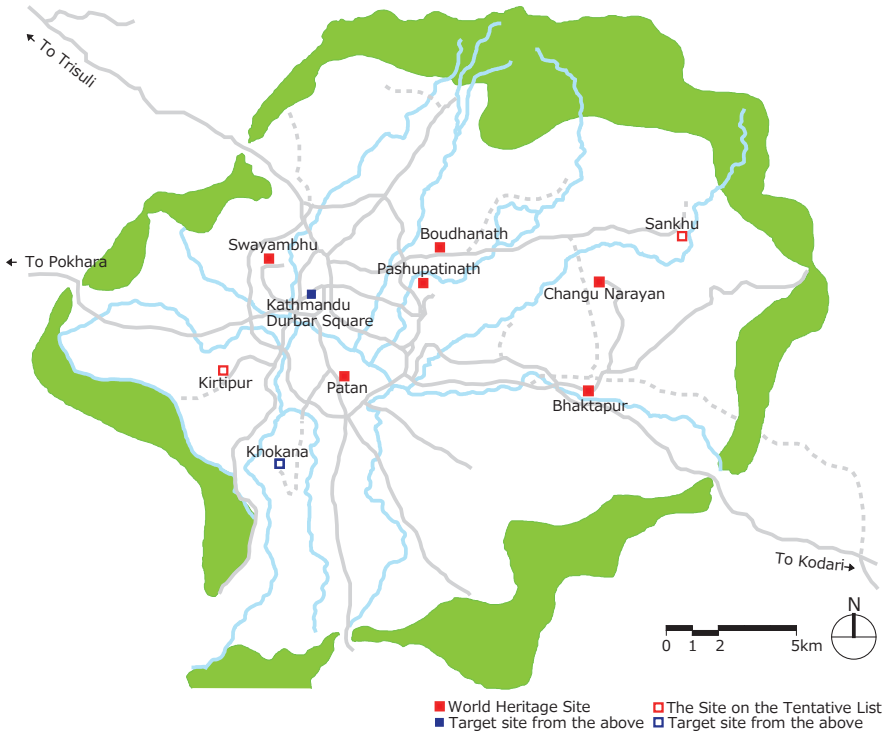
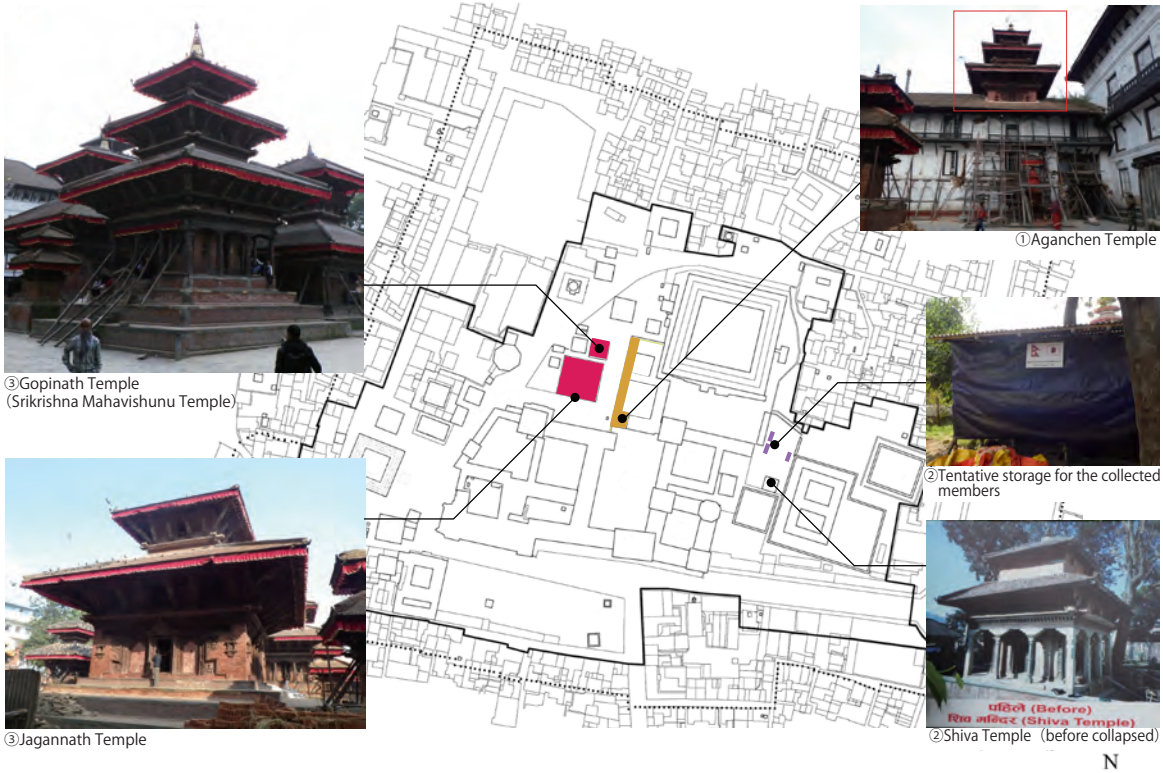


Fig.1-2 Location of the component parts of the World Heritage Site of 'Kathmandu Valley' and historic settlements on the World Heritage Tentative List



Target buildings and the survey contents in Hanumandhoka Durbar Square

① Aganchen Temple, West wing of the Mohanchok and Sundari Chok
(Measurement survery, architectural survey, planning and technical support for the emergency stabilisation plan)

② Shiva Temple (Storing the collected members from the collapsed building, numbering, photo documentation)

③ Jagannath Temple, Gopinath Temple
(Micro-tremor measurement on the stepped podium, measuring survey of bricks, structural analysis, providing knowledge)

Fig.1-3 Target buildings in Hanumandhoka Durbar Square

1.4. Members of the survey team

The experts participated in this project are shown in Table 1-4-1. Two selected aspects of the project were commissioned to the University of Tokyo. The Mikio Koshihara Laboratory in the Institute of Industrial Science at the University of Tokyo led the 'Structural survey and analysis of the historic buildings', while Yukio Nishimura Laboratory at the Faculty of engineering, the University of Tokyo led the 'Survey for the preservation and rehabilitation of historic settlements'.

Table 1-4-1 Members of the survey team

Working Group	Name	Affiliation
Responsible person	Nobuo KAMEI	Director general, TNRICP
Supervision	Shunsuke NAKAYAMA	Director of Japan Center for International Cooperation in Conservation (JCICC), TNRICP
Survey on emergency protection measures	Masahiko TOMODA	Head of Conservation Design Section, JCICC, TNRICP
	Tadatsugu TAI	Senior Conservation Architect, Cultural Property Center of Wakayama Prefecture Cultural Heritage Advisor (Restoration Technique) (Since 27 December 2016)
Survey on the traditional techniques and cultural value of historic buildings	Takayuki KUROTSU	Professor, Faculty of Engineering, Nippon Institute of Technology
	Shinichi NISHIMOTO	Professor, Faculty of Engineering, Nippon Institute of Technology
	Manabu UEDA	Assistant Professor, Faculty of Engineering, Nippon Institute of Technology
	Sunwook KIM	Research Assistant, JCICC, TNRICP
Survey on the preservation and rehabilitation of historic settlements	Yukio NISHIMURA	Professor, Faculty of engineering, The University of Tokyo
	Tomoko MORI	Assistant Professor, Faculty of Engineering, The University of Tokyo
	Hiroki YAMADA	Associate Fellow, JCICC, TNRICP
	Bijaya Krishna SHRESTHA	Professor, Department of Urbandesign & conservation, Khwopa Engineering College
Structural survey of historic buildings	Mikio KOSHIHARA	Professor, Institute of Industrial Science, The University of Tokyo
	Noriko TAKIYAMA	Associate Professor, Faculty of Urban Environmental Sciences, Tokyo Metropolitan University
	Mitsuhiro MIYAMOTO	Lecturer, Faculty of Engineering, Kagawa University (Associate Professor from 1 February 2017)
	Hiromi SATO	Assistant Professor, Institute of Industrial Science, The University of Tokyo
	Kshitij Charana SHRESTHA	Postdoctoral Fellow, Institute of Industrial Science, The University of Tokyo (Since 16 November 2016)
Survey on intangible heritage	Hiromichi KUBOTA	Head of Intangible Folk Cultural Properties Section, Department of Intangible Cultural Heritage (DICH), TNRICP
	Tomo ISHIMURA	Head of Audio-Visual Documentation Section, DICH, TNRICP

<Assistant>

Survey on the preservation and rehabilitation of historic settlements	Risa KOBAYASHI	First year of master course student, Faculty of Engineering, The University of Tokyo
	Masaya SAMMONJI	Same as above
	Ai HAMADA	Same as above
Structural survey of historic buildings	Tenshin OKIYAMA	Fourth year undergraduate student, Tokyo Metropolitan University
	Takuya SUGAWARA	Same as above
	Tetsuya YAMAZAWA	Fourth year undergraduate student, Kagawa University

1.5. Duration of the on-site surveys

The duration of on-site surveys in this project are shown in Table.1-4-2. We submitted brief reports promptly after the main missions.

Table 1-4-2 Duration of the on-site survey of each expert

Duration of the mission	Participant experts (duration of on-site survey)	Main activities
23-25 April	Masahiko TOMODA △	•Conclusion of Memorandum of Understanding (MOU) with DOA •Preparation for moving the storage for salvage members of Shiva Temple
28 Apr- 07 May	Tadatsugu TAI Hiroki YAMADA Takayuki KUROTSU（02-06 May） Mikio KOSHIHARA（02-05 May） Noriko TAKIYAMA（02-04 May）	•Explanation of the results of the fiscal year 2015 investigation to the local authorities including staff of DOA and UNESCO •Identification of the salvaged members from Shiva Temple •Replacement the storage for the salvaged members of Shiva Temple •Photographic recording of the salvaged members of Shiva Temple •Measurement survey of the surrounding buildings of Aganchen Temple •Investigation for the emergency stabilisaion plan of Aganchen Temple •Meeting for the material testing
29 May- 03 June	Hiroki YAMADA	•Meeting for the emergency stabilisation plan of Aganchen Temple •Survey of materials for stabilisation mentioned above •Measurement survey at the part of below Aganchen Temple
03-09 June	Tomoko MORI △ Risa KOBAYASHI* Masaya SAMMONJI*	•Meeting on the draft report and the activities of fiscal year 2016 with Khokana Reconstruction and Rehabilitation Committee •Interview investigation to inhabitants in Khokana
14-18 June	Masahiko TOMODA △	•Technical support on the Emergency stabilisation plan of Aganchen Temple •Attending meeting of UNESCO Japanese Funds-in-Trust (JFIT) Committee
04-08 July	Hiroki YAMADA	•Providing advice and guidance of the emergency stabilisation plan of Aganchen Temple
1-10 September	Hiroki YAMADA（01-10 Sep） Masahiko TOMODA（04-08 Sep） Mitsuhiro MIYAMOTO（04-06 Sep） Tomoko MORI（02-07 Sep） Risa KOBAYASHI*（02-07 Sep） Ai HAMADA*（02-07 Sep）	•Presentation meeting to explain the results of on-site investigation of the historical settlement of Khokana conducted in the fiscal year 2015 and exchange of opinions with inhabitants •Preparation and pre-meetings for the conference that would be held in November •Investigation of the transition of Aganchen Temple •Providing advise and guidance for the emergency stabilisation of Aganchen Temple •Construction of experimental facility for material testing •On-site survey of the historical settlement of Khokana
10-13 September	Noriko TAKIYAMA	•Preparation for material testing
05-08 October	Hiromichi KUBOTA Tomo ISHIMURA Tomoko MORI △ Masaya SAMMONJI* △	•Survey on intangible cultural heritage of the Shrikali festival
26-31 October	Mitsuhiro MIYAMOTO	•Making specimens for material testing
21 November - 05 December	Noriko TAKIYAMA（21-23 Nov） Tenshin OKIYAMA*（21 Nov-29 Dec） Tetsuya YAMAZAWA*（21 Nov-29 Dec） Hiroki YAMADA（24 Nov-05 Dec） Tomoko MORI（25 Nov-02 Dec） Masaya SAMMONJI*（25 Nov-02 Dec） Risa KOBAYASHI*（25 Nov-02 Dec） Ai HAMADA*（25 Nov-02 Dec） Tadatsugu TAI（26 Nov-05 Dec） Takayuki KUROTSU（26 Nov-05 Dec） Masahiko TOMODA（26 Nov-01 Dec） Sunwook KIM（26 Nov- 01 Dec） Mitsuhiro MIYAMOTO（27 Nov- 01 Dec） Nobuo KAMEI △（27 Nov- 01 Dec） Mikio KOSHIHARA（28 Nov- 03 Dec） Yukio NISHIMURA（29 Nov- 01 Dec）	•Conference on the preservation of Historic Settlements in Kathmandu Valley (on 30 November) •Survey for studying the extent of restoration area surrounding Aganchen Temple in Hanumandhoka Palace and restoration method •Meetings with local authorities •Measurement survey at Hanumandhoka Palace •On-site survey in Khokana •Material testing

20-27 December	Tenshin OKIYAMA* Takuya SUGAWARA* Tetsuya YAMAZAWA* Noriko TAKIYAMA (24-27 Dec)	•Material testing (Compression test of masonry prism, bending test, diagonal compression test, and mortal cylinder compression test)
06-09 January	Mikio KOSHIHARA	•Cooperation for the material testing conducted by UNESCO
15-18 February	Masahiko TOMODA	•Meetings with the experts of JICA and the local authorities including DOA
10-18 March	Takyuki KUROTSU△ Manabu UEDA△	•Measurement survey of Hanumandhoka Palace (at a part of research period)

Members marked with '*' means asistants (students)

Members marked with '△' participated with their external funds

2. Outline of Activities

2. Outline of Activities

2.1. Survey on architectural history

Hanumandhoka Palace and most other monuments of Hanumandhoka Durbar Square in Kathmandu have been repeatedly repaired, renovated or reconstructed due to the damages caused by natural disasters and/or other various reasons. However, very little documentation on transitions of structures and architectural styles, or traditional techniques of each period remains. That also can be said of the details of the repair records in recent years. Thus, this survey on architectural history was conducted for the purpose of clarifying the different architectural styles and techniques of each period, finding out building systems researching the traces of alterations and renovations. Production of measured drawings is also included in the work of this year. This survey was conducted mainly at the west wing of Mohan Chok including Aganchen Temple which is an important building located just next to the main gate of Hanumandhoka Palace (Hanuman gate). We implemented the measuring survey in collaboration with DOA. As for the off-limit spaces to the Japanese for religious reasons, the local staff of DOA surveyed them under the guidance of Japanese experts. A part of the results is attached to this report as appendix 2 'Measured drawings surrounding Aganchen Temple (ver. March 2017)'.

Fig.2-1-1 Survey for previous traces of Hanumandhoka gate

Fig.2-1-2 Measuring the surroundings of Aganchen Temple

2.2. Technical support for the emergency stabilisation work

2.2.1. Technical support for the emergency stabilisation work on the lower storeys of the Aganchen Temple

Although many historic buildings including those at Hanumandhoka palace still stand even after they are damaged by Gorkha Earthquake, but sufficient stabilisation treatments are hardly provided for most of them. Also, many monuments need to be sustained structurally prior to full-scale restorations that will take place because a desirable restoration plan requires ample time for appropriate investigations. We provided technical advice examining structural survey, in collaboration with local relevant organisations.

We proposed and developed an emergency stabilisation plan based on the site investigation and structural analyses after consultation with MDC and DOA. The plan is concerned with the lower storeys of Aganchen Temple because the inclinations in said area are likely to increase which

may result into a collapse in the future. The plan is attached to this report as the appendix 3 ‘The Emergency Stabilisation Plan for Aganchen Temple’. The stabilisation work was implemented under DOA's leadership with funding from MDC (the surplus of restoration budget for Panchamukhi Hanuman Temple mainly from the U.S. Ambassadors Fund for Cultural Preservation). The summary of stabilisation work is as follows:

1. Wooden frames were installed and fixed inside each room on the lower storeys of Aganchen Temple in order to prevent further distortion of the structure.
2. Steel pipes were installed to support the outer wall at the levels of floor joists, from the west side of the west wing of Mohan Chok, in order to prevent the collapse of the outer wall.
3. A metal protective mesh was placed in order to prevent the bricks or the tiles from the damaged walls or the roofs from falling on pedestrians passing through Hanuman gate and worshippers to the Hanuman statue.

In addition to the above measures, the deformed pinnacle of Aganchen Temple was covered with water proof sheets to prevent the water leakage in the rainy season.

During the implementation process, the dispatched experts carried out main activities including drafting of the plan, making sample pieces of metal fittings, selecting materials, making estimates and on-site instructions. The experts submitted the emergency stabilisation plan to DOA on the 26th May, started the stabilisation work on the 17th June after the approval of the plan. On-site instruction work continued during the missions (in June, July, and September) and the stabilisation work ended by the 10th September.

Fig.2-2-1 Presentation of emergency stabilisation plan of Aganchen Temple to Mr Bhesh Narayan Dahal, Director General of DOA

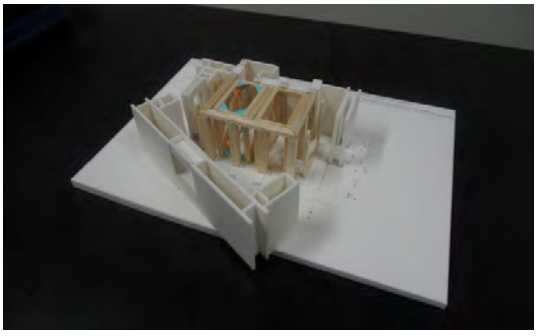


Fig.2-2-2 Presentation of the model for the emergency stabilisation plan

Fig.2-2-3 Waterproofing work of the pinnacle of the Aganchen Temple

Fig.2-2-4 Before the stabilisation work (May 2016)

Fig.2-2-5 The stabilisation work of inner space on the first storey (the ground floor) below Aganchen Temple: Wood-processing work (June 2016)

Fig.2-2-6 The stabilisation work of inner space the first storey below Aganchen Temple: Metal fitting installation (June 2016)

Fig.2-2-7 The stabilisation work of inner space on the first storey below Aganchen Temple: Installation of wooden frame (June 2016)

Fig.2-2-8 The stabilisation work of the exterior below Aganchen Temple: Addition and replacement of steel pipes (June 2016)

Fig.2-2-9 During the stabilisation work (July 2016)

Fig.2-2-10 The stabilisation work of the inner space, below Aganchen Temple: Bracing with a wire and turnbuckles (September 2016)

Fig.2-2-11 Completion of the stabilisation work: General view (September 2016)

Fig.2-2-12 Completion of work: Gate front was organised (September 2016)

2.2.2. Survey on the salvaged members of Shiva Temple

As for the restoration of collapsed or partially damaged historic buildings, it is necessary to prevent damaged or fallen building materials from dispersing. The purpose is not only to secure reusable materials as much as possible but also to learn and re-evaluate the buildings' cultural and historic value from the materials. For the monuments with insufficient historic building records before the Gorkha Earthquake, findings of the investigation of salvaged building members can become an important evidence for drafting a restoration plan.

While a large number of members were salvaged from the rubble after the Gorkha Earthquake, non-decorative members tend to be dispersed and members of different buildings are mixed in here and there even in the World Heritage Site. Classification of salvaged members from the damaged or collapsed monuments had just begun when this project started. As a continuation of the project of the last fiscal year, we have conducted a pilot case study to construct an investigation method from studying building materials to design a restoration plan with the salvaged members of Shiva Temple collapsed in Hanumandhoka Palace. The pilot project is considered as part of the support project for rehabilitation of historical monuments, sustaining the value and its authenticity as cultural heritage.

We reviewed the salvaged items that were temporary classified and stored in the storageduring the project of the last fiscal year of 2015 and documented with identification numbers and photographs. . As for window frames and some other structural members, we tried to assemble them temporarily supposing the original composition, examining their traces including original markings (chiseled marks). Data of each salvaged member was recorded on each formatted investigation sheet. These sheets were made expecting that the local engineers would utilize them in a different site in the future as a sample of documentation technique of recording historic buildings.

During the mission of May 2016, we carried out a cross-reference investigation of decorative members of Shiva temple for the purpose of possible periodisation based on characteristics of the decorative carving technique, processing trace of tools, extent of weathering, and qualities of wood. As a result of the investigation, we could classify large sized, decorative struts with deep carvings together with the verification of photographs into the following four categories based on their technical characteristics.

① 2 members: This type of struts have deep and detailed engravings lively expressed with curvy lines. Their sides and backsides are also carved deeply to express three-dimensionally. We considered they are the oldest strut type judging from the extent of the surface erosion (Fig.2-2-17).

② 4 members: This type of struts is carved deeply and carefully in detail, but they are less expressive in comparison with type ① . Their backsides are usually flat (Fig.2-2-18).

③ Unknown numbers: According to the pictures taken before the disaster of Gorkha Earthquake, 5 struts without carving are used at least on the south side and west side. As weathering had not appeared on brick walls of the upper storey, we considered that these members were added during the large-scale restoration modified into a relatively simple form in the later years (Fig.2-2-20).

④ 8 members: This type of struts is carved roughly and monotonously as a whole. We can see these members are added recently considering the extent of weathering. Their backsides have no carving but have traces of mechanical band saw. A series of the above-mentioned pictures includes pictures of dismantling roof tiles. Some struts that appear in those pictures do not exist. Therefore, we consider this type of struts are replaced members in place of type ③ and damaged ones after the restoration mentioned in ③ above (Fig.2-2-19)

Fig.2-2-13 Identification and numbering of the salvaged items

Fig.2-2-14 Example of temporary assemblies of window frame members

Fig.2-2-15 Photographic recording of a salvaged item

Fig.2-2-16 Example of the investigation sheet

Fig.2-2-17 Strut ① (Left)

Fig.2-2-18 Strut ② (Center)

Fig.2-2-19 Strut ④ (Right)

Fig.2-2-20 Photograph of the Shiva Temple during dismantling of the roof (Taken on 12 Feb. 2014, provided by ERCO)

Fig.2-2-21 Partially assembled corner members ① with two types of chiseled marks

Fig.2-2-22 Partially assembled corner members ②

According to the above analysis, we considered that the latest Shiva Temple is constituted with members of at least four periods and the temple has been restored more than three times providing that the original members belong to the 17th century remain.

Considering the situation of processing traces, we estimate that members of ③ were added after the Earthquake in 1988, and ④ were added during the restoration in 2014.

In regard to the edge carvings, we can see members belong to a different period are mixed in and used judging from the characteristic of engravings and materials. However, we were not able to classify them because it was too difficult to clarify the difference of carving techniques in small pieces and the extents of weathering are so different one another.

On the other hand, regarding the corner members, we found that the matching chiseled marks are placed on the top surface of the materials, which became a key to reassemble two complete sets partially (Fig.2-2-21, 22). A corner consists of 5 members basically, but each corner joint is different from another. On both corner sets of chiseled marks were placed on the diagonal member and at the end of the member located first from the corner. In the corner set of ① , the pattern marking that is different from the one at the end, made by a different tool appeared at the tip of the member located first from the corner. We know that members of both first and second from the corner are set into the diagonal member with a mitre butt joint in the corner set of ① . There are 7 in total members same as the one located at first from the corner, among which two pieces found in the set ② are the only ones that set not in a mitre joint. The reason for that is not known, however, this could be because of different craftsmanship at the same period, but also could be the works of different periods. This result is important evidence indicating that members of the same type were also processed for specific positions.

Many markings can be seen on members of window frames. They might be largely classified into two categories by the characteristics of patterns and the tool marks, but further inspection and analysis are necessary to prove this hypothesis because there are combinations of members and re-used materials of different periods.

Also, we identified the same kind of markings in the pillars and joint members inside the walls of the first storey. These are important findings to understand the situation of positioning members and interior structure of completely destroyed Shiva Temple whose general plans do not exist. In addition, they would become important factors of conservation of authenticity for restoration.

We also identified similar markings in the pillars and window frames, which are considered to be original members, of the Vishvanāth Temple (1626), currently under restoration in the Patan Durbar Square. Since such findings could become important indicators in periodisation of members or buildings as characteristic of construction in the 17th century, further investigations and studies including comparative analysis are necessary.

(Section authors: Tadatsugu Tai and Hiroki Yamada)

2.3. Structural survey

It is necessary to obtain the data of physical properties of the building materials (mainly brick and mortar) in order to evaluate the structural performance of historical monuments. At first, we supposed to conduct sampling from damaged buildings and laboratory test on material characteristics in collaboration with Nepalese engineers and researchers, in cooperation with the UNESCO Japanese Funds-in-Trust (JFIT) project, using an existing laboratory in Kathmandu to transfer the technical knowledge on material testing of historic buildings.

However, due to the difficulties in scheduling and other local conditions, the Japanese participating experts could neither attend the laboratory test nor offer lacking testing machines. The appropriate laboratory test was not conducted and not enough data was collected under the initiative of the Nepalese engineers.

The expert team from Japan set up a temporary laboratory and conducted material testing with their machines because it was in urgent necessity to obtain the data of material characteristics on which the structural analysis is based. The detail of testing will be reported as a separate document.

Since January 2017, we have lent the measuring instruments and provided technical guidance so that Nepalese engineers could conduct the material testing more accurately for the UNESCO project. Concerning two temples in the Hanumandhoka Durbar Square (Jagannath Temple and Gopinath Temples) which were objectives of the project by the UNESCO Japanese Funds-in-Trust, we provided technical assistance on structural aspects based on the results of the project 2015.

Also, the structural experts team conducted the invitation and interchange activities with Nepalese experts (Refer to the section 2.5.1.).

(Section authors: Noriko Takiyama and Mitsuhiro Miyamoto)

Fig.2-3-1 Making specimens for structural material testing

Fig.2-3-2 Material testing (Uniaxial compression test of masonry prism)

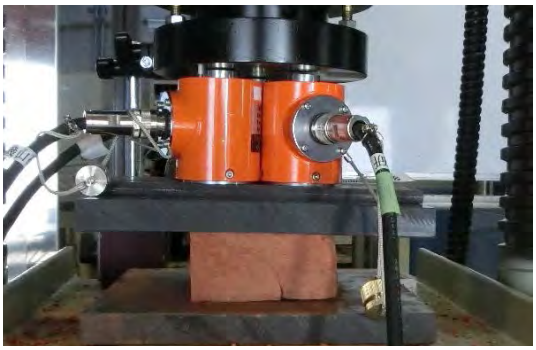


Fig.2-3-3 Material testing (Uniaxial compression test of old brick)

Fig.2-3-4 Meeting with local structural experts

2.4. Support for the preservation and rehabilitation of historic settlements

All the historic settlements suffered from the Gorkha Earthquake face difficult problems of securing safe and comfortable space for inhabitants during rehabilitation while developing sustainable communities by keeping historical and cultural values of their townscapes and spatial structure. A continuous survey from the last fiscal year on the historic settlement of Khokana, inscribed on the World Heritage Tentative List, was conducted mainly by Nishimura laboratory, the University of Tokyo, as a pilot case study on the rehabilitation of damaged historic settlements.

2.4.1. Survey of urban design

Urban design laboratory, the University of Tokyo conducted the continuous survey from the last fiscal year on the historic settlement of Khokana regarding 1) the present situation of rehabilitation and conservation and 2) examination of design guideline on façades of buildings for rebuilding and renovation. A field survey and interviews, as development processes of drafting a plan for the preservation and rehabilitation of historic settlements, were conducted in collaboration with local experts and inhabitants for the purpose of transferring technical knowledge of research method. Along with the clarification of issues for the realisation of preservation and rehabilitation of townscape reflecting the current condition of each settlement, through the development of plans for the Khokana settlement, issues on the institutional design were examined. Then, investigations were finally carried out taking into consideration its application to other historic settlements in Kathmandu Valley inscribed on the World Heritage Tentative List including Sankhu and Kirtipur.

(1) Field survey on rehabilitation and preservation

As the investigation of the last fiscal year focused mainly on the exhaustive visual investigation on the damage situation of façades, we were not able to grasp the current state of the use of the buildings with traditional construction method, which were main targets for the preservation of urban design, and the future prospects of owners. During the project of this fiscal year, we observed changes in the exterior and the current use of the buildings built with traditional construction methods that were surveyed last fiscal year. Moreover, we attempted to comprehend the current situation on rehabilitation and preservation of the settlement conducting the exhaustive interview with residents on current residences and their future plans. Surveys were carried out from the 2nd to 7th September and from the 26th to 29th November in total for 10 days by Tomoko Mori with a local resident as an interpreter and assistant. For analysing changes on exterior we employed visual comparative analysis comparing pictures taken last fiscal year to the ones of the current situation. As for the current living situation and how they are using their damaged buildings, we interviewed owners of the targeted buildings. In case owners were absent, we interviewed neighborhood inhabitants as an alternative. As a result of the investigation on the exterior changes, out of the records on the 268 buildings of traditional construction method obtained this year (as compared to the 347 records obtained last fiscal year) the exterior changes of 59 buildings were observed. These records were classified into 5 patterns depending on their extent of changes: 1 (small scale repair), 2 (temporary construction of corrugated gavalnised iron (CGI) roofing after the dismantlement of roof and upper floors), 3 (demolition and removal), 4 (rebuilding with a traditional construction method) and 5 (rebuilding with a non-traditional construction method). As we mapped the result, we found that the changes made in damaged buildings with a traditional construction method tend to gather in groups and forming a certain group. The townscape has been certainly changed in the 2 years since the earthquake disaster.

Because for all reconstruction of traditional buildings until today, people used a reinforced concrete structure instead of traditional ones. Most of the inhabitants use their original houses whose roofs and upper floors were demolished and temporary covered with CGI roofing as storages or kitchens and sleep in the temporary shelter. They have plans for rebuilding their houses on the former site after the complete demolition of original houses, when economically viable. Buildings with a traditional construction method are easily assumed to disappear in the future since people tend to prefer reinforced concrete structure for a seismic safety reason. Some inhabitants, however, want to examine the reconstruction methods according to the opinions of neighborhoods or to the administrative rules. We understood that the way of thinking of the old regional society respecting community rather than individual is still deepl rooted.

The total number of interviews reached 338 cases. Regarding the buildings divided into multiple owners due to inheritance, we interviewed each owner about the current state of use and current living condition separately and counted as a separate case. In the 338 cases in 2016, 16% were used as a permanent residences, 54% were as storages, kitchen or temporary living spaces during the daytime, about 20% has become vacant houses and about 10% were dismantled and removed. Regarding buildings used as a residence, their roofs were repaired but only with emergency measures. Some inhabitants take the risk of living in the damaged houses because they cannot bear long-term living conditions in temporary shelter. In the above-mentioned situation, it could be said that almost all buildings of traditional construction method need to be repaired because of the damages and deteriorations.

As for the owners' current living locations and conditions, it became clear that most of the owners still live in the Khokana settlement and more than a half of them live in the temporary shelter. 30% is living in the buildings of non-traditional construction method such as reinforced concrete structure constructed before the earthquake disaster in their backyards or around the bus park. These buildings were mainly constructed due to the increase of family members, but some of them were built for rental purpose before the earthquake disaster. 8 families are living in such rental properties of reinforced concrete structure after the earthquake disaster. In additionary, it also became clear that 28 families moved outside of the Khokana settlement before the earthquake disaster. Among these buildings belong to those families who left the settlement, some are temporarily used during ritual occasions, and some became completely vacant.

We found that the owners of the buildings of traditional construction method live within the Khokana settlement either in their damaged houses, using temporary shelter, or the houses of reinforced concrete structure which their family own corresponding to each current situation.

Fig.2-4-1 Interview with local governments (November)

Fig.2-4-2 Interview survey at Shikali festival

(2) Examination of design guideline on façades of buildings in the case of rebuilding and renovation

After understanding typologies of private houses in Khokana based on literature documentation, a field study was conducted for private houses built with traditional construction methods and those with non-traditional construction methods. Based on the study, a suggestion for development of a design guideline was prepared. Additionally, a block design guideline was developed in order to avoid undesirable crowding in backyard spaces taking current situation into consideration.

Accoding to the initial research plan, at first, technical methods of structural reinforcement and preservation for partially destroyed historic buildings were planned to be examined in collaboration with the structural expert team. However the plan was not materialized this year due to the limitation in the implementation system. We would like to examine them in the fiscal year of 2017.

The details of above-mentioned investigations, suggestions and the draft of design guidelines will be published as a separate document later.

(Section author: Tomoko Mori)

2.4.2. Survey on intangible cultural heritage

Survey on Shikali festival was conducted as intangible cultural heritage study in Khokana settlement (inscribed on the World Heritage Tentative List) for the project of the fiscal year 2016. The purpose is to investigate how cultural space is used in the actual situation in the villages and their outskirts and to collect data that contribute to the drafting of a preservation and rehabilitation plan of the historic settlements, considering that intangible cultural heritage is important for preservation and rehabilitation of the historic settlements. Along with this investigation, we interviewed the representatives of the local community and shared the result with them.

The Shikali festival targeted in the survey is especially large-scale and important among festivals in the Khokana settlement. It is performed in the same period as Dasain festival performed in the whole land of Nepal; however, it has many unique aspects in comparison with other festivals in other areas. This is a festival for the goddess dedicated to the Rudrayani Temple, located in the center of the Khokana settlement and performed in Khokana settlement and in suburban Shikali Khyo Temple. The most important event in this festival is called "Shikali Jatra" performed on the 5th day. The portable shrine carrying the goddess statue which normally is stored in the Shree Rudrayani Temple parade to the Shikali Khyo Temple during the daytime and from the evening it goes around the Khokana settlement. It became clear that the route of the portable shrine is an important element that constitutes the cultural space shared in the Khokana settlement and the surroundings. The festival is closely related to the city planning.

As the result of this investigation, we were able to collect basic data of the cultural space in conjunction with the festival.

This data can contribute to drafting a plan concerning preservation and rehabilitation of Khokana settlement. Furthermore, it can be utilized as a reference or a case study for investigation of the other historic settlements.

(Section authors: Hiromichi Kubota and Tomo Ishimura)

Fig.2-4-3 Dance of the goddess at the Shikali Khyo Temple

Fig.2-4-4 Portable shrine of the goddess going around Khokana

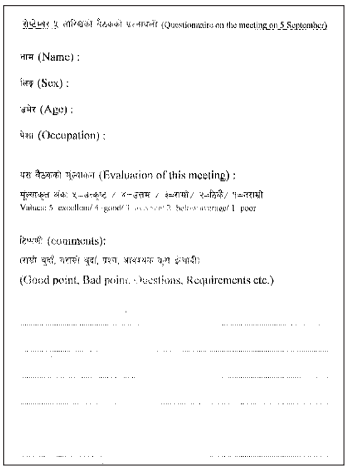
2.4.3. Local meeting sharing the result of the 2015 project to the inhabitants of Khokana

The Meeting for sharing the project result of 2015 was organized for the members of the Khokana Reconstruction and Rehabilitation Committee and inhabitants of Khokana on the 5th September 2016 in order to get feedback on the rehabilitation guideline from inhabitants by sharing the outcome.

A total of 91 people were listed as participants. We received some questions and opinions during Q&A session in addition to some opinions obtained through the questionnaires (Fig.2-4-7) distributed to the inhabitants and related people at the end of the session (38 responses). Although some people demanded the concrete measures to solve the problems and future directions, most of the responses evaluated the investigation of the project 2015 positively (as shown in Fig.2-4-8).

Fig.2-4-5 Meeting sharing the result of the project 2015 at Khokana

Fig.2-4-6 Q&A session: an inhabitant states an opinion



नाम (Name) :

लिङ्ग (Sex) :

उमेर (Age) :

पेशा (Occupation) :

यस बैठकको मूल्याङ्कन (Evaluation of this meeting) :

टिप्पणी (comments):

(Good point, Bad point, Questions, Requirements etc.)

Fig.2-4-7 Questionnaire concerned with the meeting

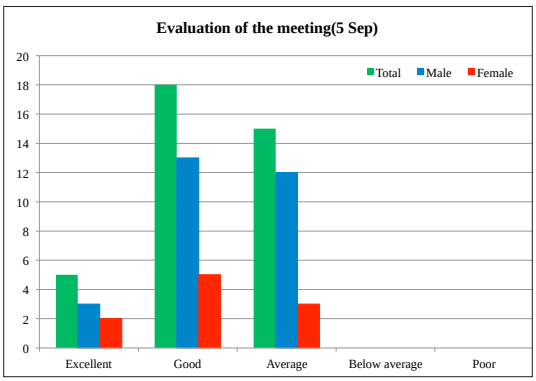


Fig.2-4-8 Evaluation of the meeting (38 responses)

2.4.4. Conference on the preservation of the historic settlements in Kathmandu Valley

Concerning historic settlements of Khokana, surveys of the historical townscape, structural survey on damaged buildings and survey on the intangible cultural heritage were conducted. Through these activities, we found that the institutional frames for the preservation of the historic settlements itself have not yet developed in Nepal. Also, we recognized that the role of the local governments who directly contact with the inhabitants is important. We understood that such issue as to strengthen the role of the local government must be tackled with wider perspectives as a universal administrative issue for making an improvement to the actual situation.

After we consulted with four municipalities (Karyabinayak, Shankharapur, Panauti and Kirtipur) which have jurisdiction over the settlements inscribed on the World Heritage Tentative List and two municipalities (Lalitpur sub-Metropolitan city and Bhaktapur) which contain the areas inscribed on the World Heritage List, we organised 'the Conference on the Preservation of Historic Settlements in Kathmandu Valley' on 30 November 2016. 35 people participated in this conference, including Mr Besh Narayan Dahal, Director General of DOA, and the members of the relevant organisations such as UNESCO etc. The details of this conference will be included in the proceedings of 'The Conference on the Preservation of Historic Settlements in Kathmandu Valley on 30 November 2016'.

Fig.2-4-9 Conference

Fig.2-4-10 Conference participants

2.5. Invitation and interchange activities

2.5.1. Invitation of experts on structural engineering

We invited the following two Nepalese structural engineers to Japan from 21st to 27th February.

(1) Dr Prem Nath Maskey

(Professor of Civil Engineering, Institute of Civil Engineering, Tribhuvan University)

(2) Dr Santosh Shrestha (Engineering consultant, UNESCO Office in Kathmandu)

We made a site visit with the above experts to the restoration site of National Treasure West Cocoon Warehouse of Tomioka Silk Mill. Issues on restoration of brick-built monuments in Japan were discussed on site. We also organized the workshop for seismic performance evaluation of brick monuments in Nepal at the Institute of Industrial Science (IIS), the University of Tokyo, on 24th February. Both Japanese and Nepalese experts shared knowledge and discussed on the future issues.

Fig.2-5-1 Site visit of Tomioka Silk Mill

Fig.2-5-2 Workshop on seismic performance evaluation of historical brick masonry monuments in Nepal

2.5.2. Invitation of experts concerning preservation of historic settlements

8 Nepalese experts and officers who are locally in charge of the preservation of historic settlements were invited by TNRICP from 4th to 12th March 2017. All the following visitors played important role at the 'Conference on the Preservation of Historic Settlements in Kathmandu Valley' in November.

(1) Dr Bijaya Krishna Shrestha (Professor, Department of Urban design & Conservation, Khwopa Engineering College)
(2) Dr Suresh Suras Shrestha (Under Secretary (CAO), Head, World Heritage Conservation Section, Department of Archaeology)
(3) Ms Barsha Shrestha (Engineer, Karyabinayak Municipality)
(4) Mr Krishna Bhola Maharjan (Engineer, Planning and Technical Section, Kirtipur Municipality)
(5) Mr Prem Kumar Somname (Engineer, Panauti Municipality)
(6) Mr Bal Krishna Manandhar (Engineer, Heritage Section, Shankharapur Municipality)
(7) Mr Ram Govinda Shrestha (Chief, Heritage Section, Bhaktapur Municipality)
(8) Ms Chandra Shova Shakya (Chief, Heritage Conservation Section, Lalitpur Sub-metropolitan City Office)

The purpose of this invitation programme is to introduce measures and methods of conservation and enhancement of traditional townscape in Japan. We visited the important preservation districts for groups of traditional buildings in the Chubu region and received presentations from the local administration officers and the local residents. All participants compared present issues and conditions of those districts with the historic settlements or areas in Nepal which they manage and exchanged opinions with the locals.

Fig.2-5-3 Lecture at Kanazawa University

Fig.2-5-4 Site visit Ainokura village in Nanto city

Fig.2-5-5 Workshop at TNRICP

Fig.2-5-6 Invitees for this study tour

2.6. Related activities

2.6.1. Meeting for sharing the result of the project 2015 on 2nd May

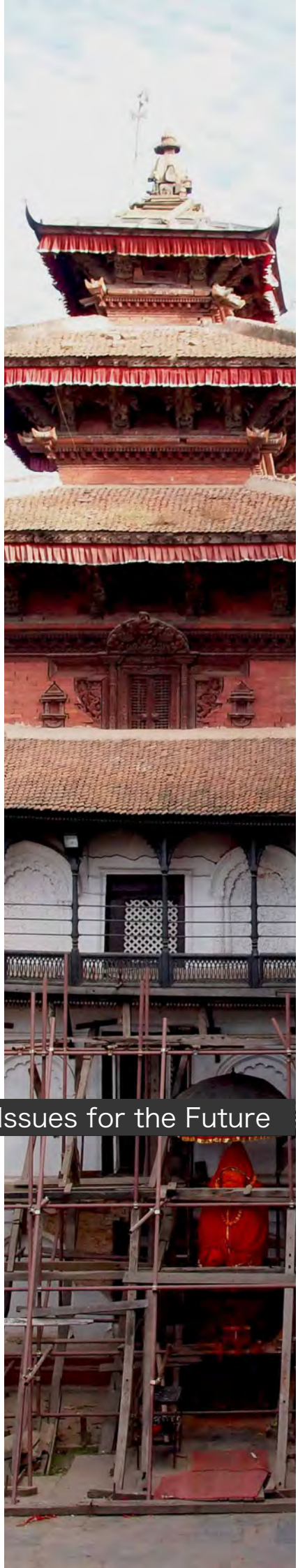
The meeting for sharing the result of the project 2015 with the members of DOA and UNESCO was organized on 2nd May 2016, at the DOA meeting room and about 35 people participated. The project report 2015 was submitted to Mr Besh Narayan Dahal, Director General of DOA.

Fig.2-6-1 Submission of the report to Mr Besh Narayan Dahal, Director General of DOA

Fig.2-6-2 Meeting for sharing the results of the project 2015

2.6.2. Cooperation for the UNESCO Japanese Funds-in-Trust Project

Concerning Jagannath and Gopinath Temple, in Hanumandhoka Durbar Square in Kathmandu, which are target buildings of the UNESCO Japanese Funds-in-Trust project, Ms Setsuko Yokochi, a certificated conservation architect specializing in cultural property buildings, visited there as UNESCO consultant on the examination of the restoration plans in June 2016. Together with Nepalese relevant organisations and individuals we discussed the contents of the work required for developing the restoration plan with Ms Yokochi. Regarding the project, we have continuously exchanged information with the UNESCO office in Kathmandu in coordination with the Japanese Ministry of Foreign Affairs so that the project would proceed smoothly.



3. Summary of the Project Outcomes and Issues for the Future

3. Summary of the Project Outcomes and Issues for the Future

3.1. Issues and prospects of restoration and reconstruction of historical monuments in Hanumandhoka Palace

3.1.1. Acquired knowledge from measurement survey of Aganchen Temple

(1) Architectural features of Aganchen Temple

Aganchen Temple is a three-tiered tower standing on top of the southwest corner of Mohan Chok. Its appearance consists of inclined timber roofs with deep eaves, brick walls, windows with carved wooden frames, struts decorated with statues of gods and a rooftop pinnacle in Shikhara style '*gaju*' (Fig. 3-1-1). The brickwork of outer walls has a three-storey composition and the length of one side of the first layer is 4.2m. The height of tower body is 11.3m measured by 3D scanning measurement and laser range finder (from the top of the floor joist of the first storey to the top of the pinnacle).

While investigation on the inside of the tower is left for the future, we found that sections of its outer walls are stepped where the brick wall of each layer (two pieces and a half of thickness in the first storey) recedes as the wall goes up in order to make progressive size reduction possible. The brick walls are raised directly on top of the beams, which were lined up to the same width of the wall. The inside of the tower seems to be hollow because there might be no floor in the second and the third storeys.

Aganchen Temple experienced restoration works up to today. As considerable modifications are not observed in the three-tiered tower itself, it seems to have kept its original architectural style since its erection. Concerning the detailed specifications, the following modifications are observed from outside.

- Both *māapā* and *dātiapā* are used for brick walls and *dātiapā* are used as finishing material only in the outer walls. *Dātiapā* relatively large in size are seen here and there. Issues such as the remaining ratio of the original bricks used since the erection of the temple and the regularity of stacking bricks, require further examination in the future through more detailed investigations. In a picture taken after the 1934 earthquake (Fig.3-1-2), the outer western wall of the first storey is covered with plaster. As well as the structure below Aganchen Temple (the southwest

Fig.3-1-1 Western external view of Aganchen Temple

Fig.3-1-2 Aganchen Temple in the back after the 1934 Earthquake
Source: *'The Ranas of Nepal'* 2003

corner of Mohan Chok), the western façade was once covered with white plaster. Therefore, we cannot deny the possibility that most of *dātiapā* might be the materials employed later for the restoration.

- Concerning the roof, that of the third tier is covered with copper-ribbed seam roofing, while those of the first and the second tiers are covered with brick roofing tiles called *jhīgatī.* Pictures taken before 1967 show those roofs of both the first and the second tiers are covered with metal sheets. The gap between *jhīgatī* and the brick wall is filled with plaster and the stacked corner ridge tiles with their small ends on top are fixed with plaster, which prevents the movement of tiles. Both works are for the purpose of the maintenance repair to protect from rain leaking and falling of tiles. Incidentally, there was the time when Mohan Chok was roofed with the tiles larger than *jhīgatī*.

(2) Architectural features of building below Aganchen Temple (the southwest corner of Mohan Chok)

The part below Aganchen Temple is located at the southwest corner of Mohan Chok. Mohan Chok is a three-storey building with an inner courtyard and it consists of inclined timber roofs with shallow eaves, brick walls coated with plaster, a faux-window in India–Islam style, wooden doors and balconies (Fig. 3-1-3). The western façade has a three-storey composition. We can consider that these works were introduced in the Rana period but some traces of bricks and the wooden frames from earlier periods are left in parts just under Aganchen Temple. Therefore, these traces would become a clue concerning the past renovations or transformation process.

Its structure consists of brick masonry walls and horizontal wooden members. Firstly, brick walls are erected and joists span between the walls in order to make spaces. Joists laid horizontally are aligned closely. The floorboards are laid on joists, and the flooring is made of compressed clay. The spaces on the upper floors also consist of units of the same section with a horizontal earthen floor and brick walls piled up together. Each floor height is between 2.2m and 2.3m (from the top of flooring to the top of the floor joists). The openings are few and there is a vertical long window in the middle of the west façade of each floor. The doors are the entrances to adjacent rooms.

The part below Aganchen Temple belongs to Mohan Chok. But there is little structural continuity between this part and the south wing of Mohan Chok even though the former connects to the latter

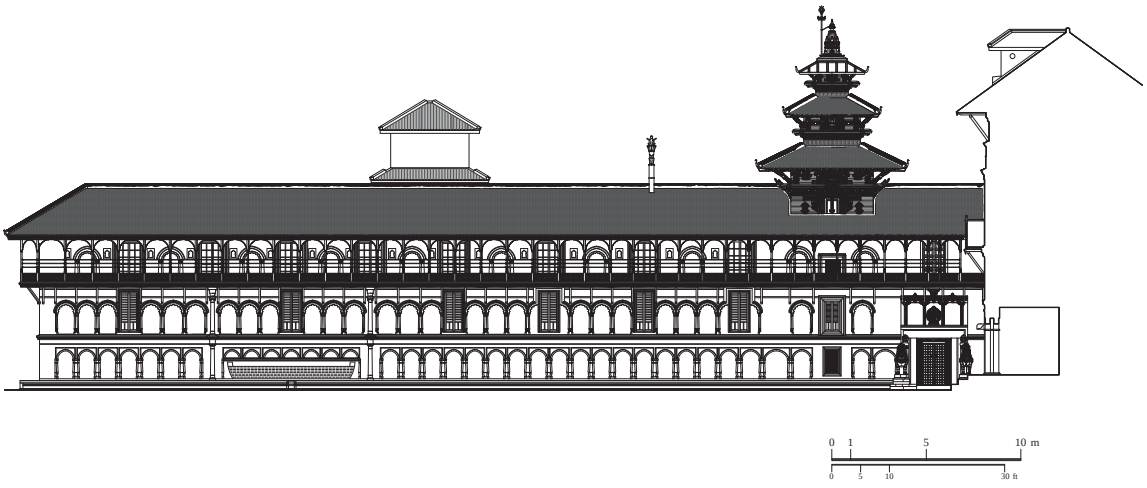


Fig.3-1-3 Hanumandokha Palace, west elevation (drawn by Takeshi Ohara)
(From right; Hanuman gate, Aganchen temple, Mohan Chok, Sundari Chok)

through the stair hall. The part below Aganchen Temple and the west wing of Mohan Chok continue in their floor plans, but from the difference of their floor levels and connection between brick walls, their structural relation is weak. The west wing was added later to the north side of the part below Aganchen Temple.

Aganchen Temple has been often repaired up to the present day but considerable modifications are not observed from our personal view. As for the extent of the modifications of the part below Aganchen Temple, the following aspects can be pointed out in the specifications of the details related to the transition process.

- The outer western wall

The plaster finishing is used for final coating of the *māapā* brickwork but the *dātiapā* brickwork on the first storey (the first floor) is hidden under the plastered wall. That explains that there was a time when the finishing bricks *dātiapā* were used on the outer western wall. Also, *dātiapā* brick wall on the first storey is piled up on top of the engraving cornices (Fig.3-1-4) and the northern external corner of the outer western wall is located 7,282mm to the north from the southern external corner of the outer western wall of the part below Aganchen Temple. As the edge of cornice is cut diagonally, the miter joint is adopted, and the end surface (north side) is engraved, the cornice is thought to have gone around the northern external corner. That is, we consider that the western wall below Aganchen Temple stuck out approximately for end surface of brick from the western wall of west wing of Mohan Chok which extends toward the north.

-The outer southern wall

The southern brick wall below Aganchen Temple connects to the main gate of Hanumandhoka Palace (hereafter referred to as 'Hanuman gate'). Hanuman gate is the three-storey building and has rooms on the second and the third storeys, which were installed later. *Dātiapā* bricks are left at the southern external corner of the outer wall below Aganchen Temple. The outer southern wall of the second and third storeys serves as the northern partition wall of Hanuman gate. The cornice located at the upper part of the door frame and a wall cornice are left on the first storey, and a medium-height window in the architectural style of the Malla period remained on the third storey of the wall (Fig.3-1-5). The surfaces of these wooden members are weathered, suggesting that at least the southern wall on the third storey was exposed to the outside at one point in time.

-The openings

There is an opening in the shape of the vertical long window on the west side in the middle of the room on the third storey. Four thin pillars with engraving also remain on this wall (Fig.3-1-6). Since the two of them on both sides were wall pilasters, this room might have had with three multiple windows with a waist-height inner bench. The door location on the southern side of the first storey has a trace of remodeling. Together with the doors on the second and the third storeys, a further investigation is necessary in the area connecting to Hanuman gate.

-The direction of floor joists

Floor joists of the second and the third storeys change their directions in the middle of the rooms. They run in the north-south direction on the south side and in the east-west direction on the north side. Floor joists of the attic space (above the third storey) run in the east-west direction without purlins in the middle of the room, and this direction is the shorter direction of the building which surrounds the courtyard. It is necessary to consider it as a subject for future analysis whether the south wing of

Mohan Chok was originally connected to the part directly below Aganchen Temple on the first and the second storeys.

-The room directly below Aganchen Temple

Aganchen Temple (three-tiered tower) stands on the outer western wall of the part below of Aganchen temple For religious reason, entering to the inside of this temple is strictly prohibited. When entering from the ceiling access door of the third storey of the room below Aganchen Temple, a space of 600mm in height is observed but there is no connection pathway to the inside of the Temple above it. The use of this room is unknown. We would like to pay attention to this space whether it is related with the past modifications or for the height adjustment by the scrambles of roof surface of Mohan Chok and the openings of Aganchen Temple.

-Later addition of pillars

The later addition of pillars was mentioned in the report of the last fiscal year and the following new discoveries were confirmed in relation to the pillars during this project. All of the 10 later added pillars stand directly on the stone floor of the first storey and there is no trace of molded base stones. The bottom part of the pillars is repaired. 11 later added pillars on the first and the second storeys stand directly from the tread board on the floors joists and there is no wooden plinth. Each of those pillars is made from square timbers(*agrākh*) with a section of 140×140mm put together. Wooden cotters to tie members together are not observed. There are engravings on the surface of pillars and their compositions and styles are almost the same. The time of the installation of these pillars might date back to earlier than the 1934 earthquake.

Fig.3-1-4 Cornice at the northern external corner of outer western wall on the second storey below Aganchen Temple

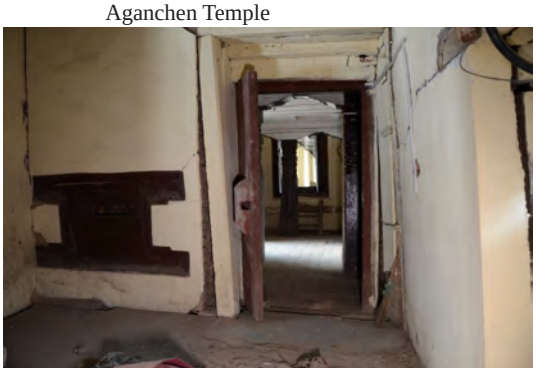


Fig.3-1-5 External south wall on the third storey below Aganchen Temple (seen from the room above Hanuman gate)

Fig.3-1-6 Western pillar and a remaining pilaster on the third storey below Aganchen Temple

Three later added pillars on the north side of the first storey are noteworthy. The free standing pillars usually have engraving strips wrapping all four sides, except these three pillars that do not have engravings on their northern face. They are wall pilasters and it is suggested that a partition wall ran along these three pillars. The location is directly under the northern wall of Aganchen Temple but there are no partition walls on the first and third storeys at the same location. Among later added pillars on the first storey, corners of 5 pillars are rounded. This processing work was to improve to the use of the interior space to acquire smooth pathway to the adjoining room, which suggests that this room was used as living space.

3) Further subjects to be studied

One of the historical evidences indicating the original construction period is an inscription. According to the inscription board on the first storey of the north wing of Mohan Chok, Aganchen Temple was erected in 1649 (Fig. 3-1-7). In addition, there is an engraving on the stone pillar standing on the attic floor of the south wing and another carving indicating era in Newari archaic language at the western window on the first storey of the part below Aganchen Temple. It has already been known to the experts that both of them were built at the time of King Pratap Malla and there are inscriptions of their identification. We would like to study further by translating the original text.

The author focused on the measuring and record-keeping for documenting existing condition of Aganchen Temple during the investigation of this fiscal year. Measurement survey of the second and the third storeys of Mohan Chok is not completed, even though these areas are included in the targeted area because some spaces are prohibited for us due to religious reasons. However, as mentioned before, we gradually gained more knowledge on the traces of modifications and the structure of buildings so that the result of a certain level on this project seems to be expected. I would like to go on the analysis works with advancing field studies in collaboration with the persons concerned such as officers of DOA.

(Section author: Takayuki Kurotsu)

Fig.3-1-7 Inscription board indicating the data of erection of the Temple

3.1.2. Issues of emergency stabilisation work

The emergency stabilisation work conducted in the fiscal year 2016 at the part below Aganchen Temple became the first construction work carried out in collaboration with DOA. As we could not use this project budget to execute construction works, we began discussion from securing the fund source for the work. The work was finally carried out with the fund from MDC, using the surplus of the different restoration project budget mainly from the U.S. Ambassadors Fund for Cultural Preservation.

It took us a longer time than we expected, to learn and understand the Nepalese system of procurement of materials, estimation, ordering and establishing logistics that were new to us. At first, we planned to manage directly all the work including material procurement, but due to traditional customs in executing contracting work in Nepal, we couldn't do by ourselves. Therefore, quality control of material supplies had some limitations. For example, a metal fitting manufacturer whom we selected could not be contracted and another manufacturer that the contractor chose produced and supplied uneven sets of metal reinforcement. As for construction supervision, some stabilisation works are done differently from the plan just because Nepalese constructors did not understand the prepared drawings. Furthermore, the local workers needed to be supervised throughly because their attention to the precision on leveling the horizontal and keeping the vertical were often inaccurate. We, therefore, felt a strong need for Nepalese collaborators who understand the requirements of Japanese experts. Among the advice for the site, we strongly asked workers not to smoke on site using woodwork through the directors of MDC and DOA. On top of such difficult situation, construction works are interrupted frequently whenever Japanese experts left the site. The implementation of emergency stabilisation work which was initially assumed to be completed in two weeks, took more than three months instead.

Through these experiences during the emergency stabilisation work, some problems on cost estimation, ordering system and supervision on site were revealed. For future investigations and restoration work, not only the permanent staff of the Japanese engineers for restoration, it is necessary to secure local administrative staff who can assist with various duties such as ordering. We are pleased that such an team mentioned above is going to be established under the direction of JICA expert as a technical advisor to DOA.

The group of historic buildings including Aganchen Temple is structurally secured for now. Its appearances has been improved with the completion of the emergency stabilisation work, for both tourists and pilgrims of Hanuman statue. Now that the safety circumstance for investigation is prepared, we hope to accelerate necessary surveys for the restoration work based on the cordial relationship with the Nepalese established through experience up until now.

(Section author: Hiroki Yamada)

3.1.3. Acquired knowledge from the survey of salvaged members of Shiva Temple

As mentioned in the section 2.2.2, we clarified that the points that would become indicators to identify constructed period through the close inspection of the engraving of the salvaged members. For example, chisel marks (Fig.3-1-8) seem to be a practice that was only used during a specific period. We therefore considered that it would become one of the periodisation indicators as well as a key to specify the combination and locating positions before the disasters.

As for the features of engraving techniques, identification of construction period of three-dimensional engravings as seen in struts should be examined in comparison with those of other buildings whose restoration records have already been clarified. If it were investigated along with the history of engraving motifs and carpenters' tools identified by processing traces, it would become a significant clue to understand the history of each historic buildings in Nepal that have been repeatedly suffered from earthquakes and restored.

With regard to the current preservation and restoration projects of historical monuments in Nepal, except for some projects carried out with technical assistances of foreign countries including Japan, there is no custom of keeping records on the extent of restoration, details of survey and restoration work of historic buildings even in the World Heritage Site. In some cases,even basic drawings of buildings do not exsist. Due to lack of documents such as accurate drawings, the buildings completely destroyed by the Gorkha Earthquake had to be reconstructed depending on their images on photographs. On the other hand, DOA needs to supervice that the reconstruction of buildings based only on the images of photographs is insufficient to retain the authenticity as the World Heritage Site. Thus, the restoration method preserving authenticity becomes an important issue.

As for Shiva Temple, several old bird's-eye view pictures (Fig.3-1-9) of Hanumandhoka Palace from south-east (Bhimsen Tower) taken before 1934 were found. Many DOA experts suggest that Shiva Temple had a shape different from the one before the last disaster and it should be reconstructed to the original state as in the images of the old pictures. However, it is clear that the location of the indicated building in old pictures is different from current location of Shiva Temple according to the site plan of Hanumandhoka Palace. This fact reveals that inspection work on historical documents was still deficient.

In regard to completely destroyed buildings, it is possible to reconstruct them as to the state before the disaster with a certatin information if the remaining members and the foundations would be well examined of to collect information of the building before the disaster. As regard to the future preservation of cultural assets in Nepal as well as the restoration after the disaster, it would be necessary to work together with the DOA engineers and deepen their understandings through these works.

(Section author: Tadatsugu Tai)

Fig.3-1-8 Chisel marks

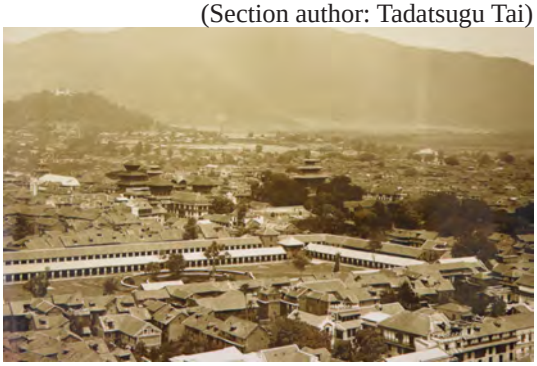


Fig.3-1-9 Bird's-eye view picture taken from Bhimsen Tower provided by Dirghaman & Ganeshman Chitrakar Art Foundation

3.1.4. The extent of restoration of Aganchen Temple and provisional restoration policy

(1) The extent of damage and deformation

Aganchen Temple is located on the top of the southwest corner of the building group which surrounds Mohan Chok whose south side Hanuman gate is connected to (Fig.3-1-10). The extent of damage and deformation observed in these buildings are as follows.

- Three-tiered tower of Aganchen Temple

From the outside, there is no significant damage. Simple observation reveals inclination of the pinnacle on the top, displacement of roof tiles, and partial slackening of the brick joints around the corner wall. No significant inclination of the whole tower can be observed (Fig.3-1-11). We have not yet conducted an investigation of this tower entering inside due to religious reasons but this investigation is indispensable to evaluate its structural soundness accurately.

-The part below Aganchen temple (Southwest corner of Mohan Chok)

The entire section of the building is seriously inclined toward the west, and the inclination is more remarkable on the lower storeys. The degree of inclination reaches one-eighth on the first storey (Fig.3-1-12). The part of the outer western wall, around the openings on the first storey collapsed significantly and many cracks are evident on the upper storeys. Its northwest corner part is especially unstable with a significant gap in the wall surface (Fig.3-1-13). The emergency stabilisation work was conducted in the last fiscal year by installing pipe frames and the timber supports inside and outside of the building in order to prevent further inclination. In the balcony of the third storey, distortions occurred in many parts that are causing serious damage. (Fig.3-1-14) A gap of approximately 15cm has appeared between the east side of Aganchen Temple and the west end of the south wing of Mohan Chok at the attic space floor level, where both sections are supposed to be adjoined (Fig.3-1-15).

- The south wing of Mohan Chok

This is one of the buildings that earliest restoration and repairing works took place and finished after the Gorkha Earthquake but the colonnade of the corridor, at the northern side of the building on the first storey, incline towards the west looking from the inside of Mohan Chok (Fig.3-1-16). One pillar which did not exist originally has been added at the west end of the wooden beam above this colonnade so that the beam would not come out from the wall of the east side of the building below Aganchen Temple (Fig.3-1-17).

- The west wing of Mohan Chok

Both of the eastern and western walls are twisted along with the inclination of the building below Aganchen Temple and their angle of inclination is steeper on the south side (Fig.3-1-18). Many shear cracks are observed on the wall especially at the south end and there is a gap between the floor and the outer western wall on the third storey. Also, some struts of the east side balcony of the third storey facing the courtyard came off at the south end, suggesting that the balcony is in danger of collapse (Fig.3-1-19).

-Hanuman gate and its upper part

This building also twists and the angle of the inclination of the outer western wall is steeper on the north side under the influence of the inclination of the part right below Aganchen Temple. The northern pillar of Hanuman gate slants forward as well (Fig.3-1-20, 21). There is a gap between the west edge of the second floor (the floor of the third storey) and the wall (Fig.3-1-22). The RC

Fig.3-1-10 General view of Aganchen Temple

Fig.3-1-11 Three-tiered tower of Aganchen Temple (East side)

Fig.3-1-13 Gap on the outer western wall of the building below Aganchen Temple

Fig.3-1-12 Interior view of the room on the first storey below Aganchen Temple

Fig.3-1-14 Damaged condition of the west balcony on the third storey of the west wing of Mohan Chok

Fig.3-1-15 Gap between the south wing of Mohan Chok (Left) and the Aganchen Temple (Right)

slab supposed to have provided horizontal stiffness was added later on the second floor, but it only increases the floor load without working as a structural support because it never joined to the wall. The gaps of the roof tiles are also remarkable and we can observe the tiles fallen off from the edge of the eaves on the protection net installed as an emergency measure (Fig.3-1-23).

-Additional remarks

Judging from the observation of the past restoration works, most of the damages and deformations seem to have occurred a long time ago and they turned worse by the Gorkha Earthquake. On the other hand, the uneven settlement is not observed around any building and it is hard to consider that the inclinations of buildings are caused by the troubles of the foundations or the supporting soil at the moment.

Fig.3-1-16 The colonnade at the north side of the south wing of Mohan Chok on the first storey

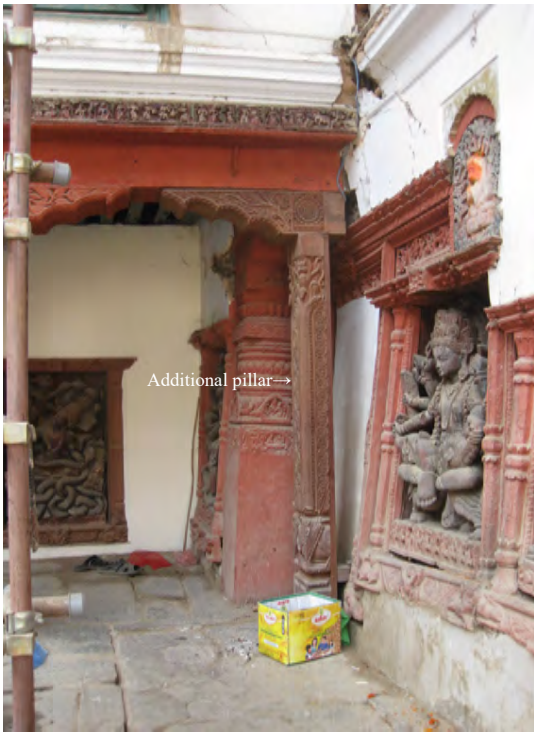


Fig.3-1-17 The column added at the western end of the north side of the south wing of Mohan Chok

Fig.3-1-18 Deformation condition of the east side of the west wing of Mohan Chok

Fig.3-1-19 Balcony of the north side of south wing of Mohan Chok, view from below

(2) Proposal of the basic restoration policy

Observing international charters and recommendations such as the Venice Charter for the Conservation and Restoration of Monuments and Sites or the 1994 Nara Document on Authenticity is the major premise for the restoration policy for these historic buildings which constitute a component of the World Heritage Site. The principle is to reuse old materials as much as possible while adding necessary new members for replacement employing similar technique to the traditional fashion.

Concerning the target buildings for restoration, it is clear from the past investigations that the repeated extensions and renovation works including partial rebuilding were carried out since their erections until today. However, as for the limited historical documents to understand the past architectural styles, it would be very difficult to clarify the details of the extension and renovation history even though we conduct existing physical condition survey thoroughly after this including the restoration work process. The scope of the restoration project is limited to some parts of the

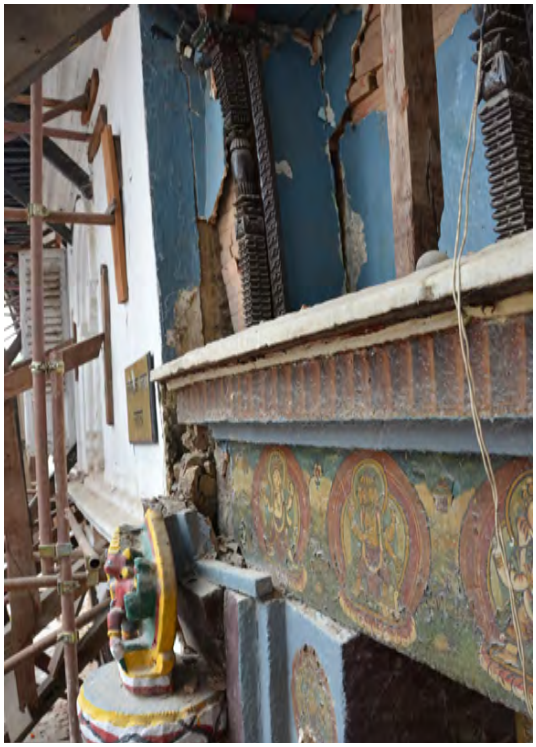


Fig.3-1-20 Damage condition of the upper part of Hanuman gate

Fig.3-1-21 Inclined north gatepost of Hanuman gate

Fig.3-1-22 Gap between the second floor of Hanuman gate and the outer western wall

Fig.3-1-23 Tiles felled from the roof above Hanuman gate

building group constituting Hanumandhoka Palace but all of them experienced a more or less similar complicated transformation history up to the present day. Therefore, we consider in case of this cultural heritage of the Royal Palace multilayered historical transformation itself takes an important factor to constitute its cultural value. It is thus appropriate to leave the traces of past restoration works of the target buildings rather than to reconstruct bringing back to the original state even if the past architectural forms could be clarified from documents or traces. This, however, shall not apply when original building values were spoiled by temporary repair or when existing conditions are considered to be inappropriate from the viewpoint of maintaining soundness. In case that new members are added for the purpose of structural reinforcement, the work should be conducted in a reversible manner as much as possible so that the added members can be removed for future restoration work when a more desirable technique is developed.

A series of judgments during the process of developing the restoration plan should be backed by well-grounded scientific studies. In addition, the decision-making process and the execution details along with the details of discoveries through investigations must be documented and published for the future reference.

(3) The extent of restoration and examination of applied techniques

The damages and deformations extended almost to the entire Royal Palace buildings. That is also the case of buildings connected to these targeted buildings for restoration this time. Therefore, it is desirable to repair the deformations of the Royal Palace holistically but that is not realistic from various aspects. Moreover, the restoration work of the south wing of Mohan Chok had already finished last year, leaving some deformed parts unrepaired. In order to recover the soundness of Aganchen Temple as built monument and its structural stability, it is necessary, at least, to correct the inclination of the walls and recover its verticality. To achieve such state without causing disassociation of the roofs and the walls to adjacent buildings, we made an approximation for the scope of restoration work as the area from the southern end of Hanuman gate to the northern end of the west wing of Mohan Chok (extended line of south side of the north wing of Mohan Chok to the west). We also decided not to touch the south wing of Mohan Chok except its connection to the part below Aganchen Temple at the western end.

All the upper part of the Hanuman gate is to be dismantled and repaired because its damage and deformation are severe. As Hanuman gate is the front gate to the Royal Palace and is mainly used as an entrance for visitors, closing period by the construction should be minimized.

The damage and deformation of the part right below Aganchen Temple (southwest corner of Mohan Chok) is also severe. The brick walls, however, may contain the important information about the past transformation processes, we examine the construction method for the preservation of the existing wall with the minimum intervention, while the roofs and balconies are to be dismantled and repaired.

As for the three-tiered tower of Aganchen Temple, we decided to repair partially including the roof and some severely damaged parts without touching its main structure unless serious defects are revealed in the coming investigations. In order to correct the position of the building, we will detach the Temple once from the three-storey building below, which is the part right underneath the Temple, and move parallelly while restoration works take place in the section underneath and revert it back to reunite the building afterward.

With regard to the west wing of Mohan Chok, the wooden parts such as the roof, floors, and balconies (except for the floor joists) will be dismantled and the southern end of brick wall will also

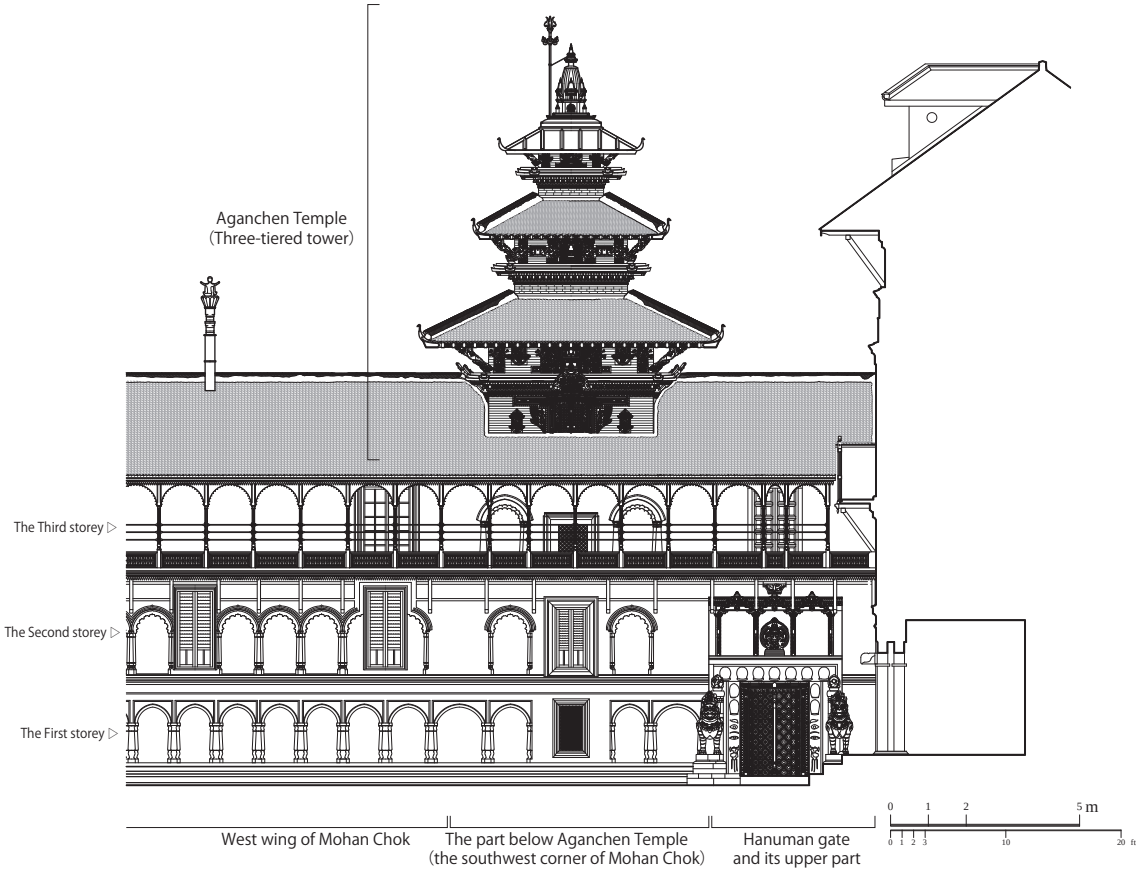


Fig.3-1-24 Names of Aganchen Temple and surrounding buildings

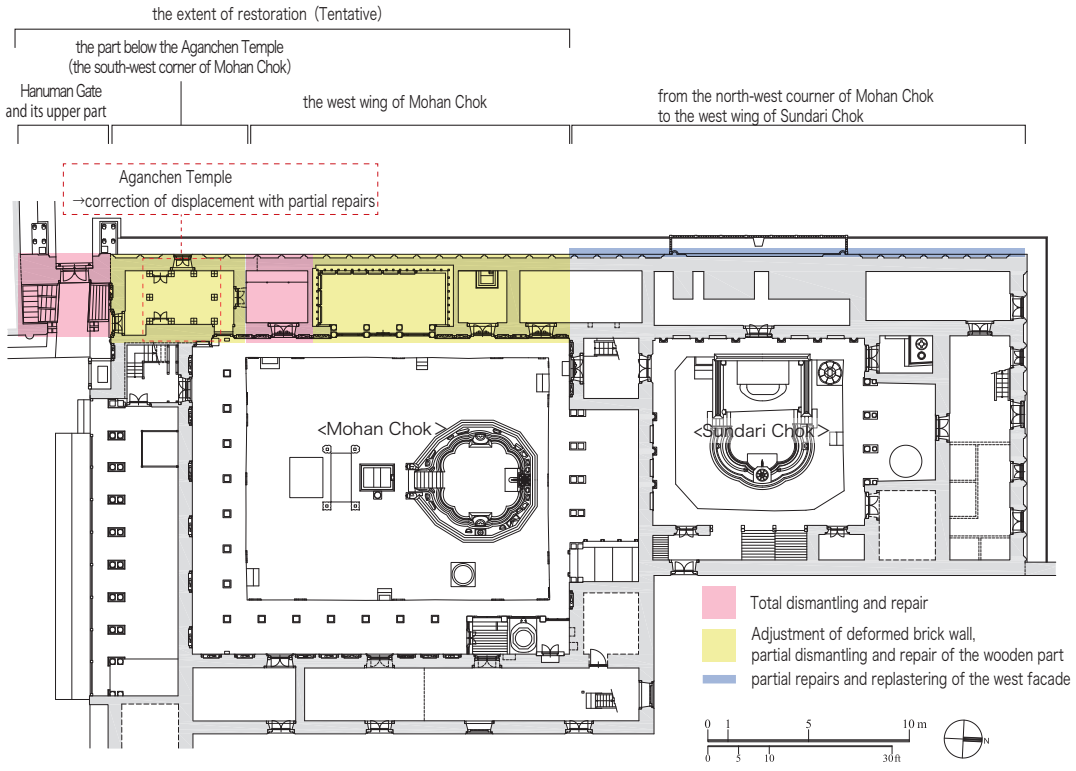


Fig.3-1-25 Provisional scope and policy for restoration

be partially dismantled for the above mentioned detachment work. As for the rest of the wall, we will examine the construction methodology that does not interfere with position correction work using jack that we may perform on the wall.

The work order concerning the above-mentioned buildings, we will first complete the wall adjustment, then conduct the works on reassembly where the areas were dismantled including repair work of the damaged parts, which will be followed by the repair and rebuilding of the wooden parts and the roofs. Also, we are going to conduct the necessary reinforcement work for securing the integrity of the brick walls along with making improvements of their seismic performances.

As for the outer western wall facing the Hanumandhoka Durbar Square, the facade part running from the south to the north end of the west wing of Sundari Chok retains one continuity. Consequently, we are going to clarify the original specifications about the outer wall plasterwork and then, replaster and repaint the entire surface of the facade following these specifications.

(4) Current issues in the investigations

-Investigation of structural configuration

It is necessary to enter into Aganchen Temple three-tiered tower and clarify the structural configuration of wooden parts with the measurement. The construction methodology of the foundation and internal composition of the wall structure of the part below the Temple should be clarified.

-Investigation of techniques

It is necessary to comprehend the techniques and specifications used at the time of the erection or the renovation/restorations. Also, the possibility of reproducing following such specification in present condition should be examined considering the availability of material production and the state of craftsmanship.

-Investigation on damages

It is necessary to tear the plaster off partially or entirely from the wall so as to examine the existing damage condition of the walls. As for the checking of the wooden members, it will be done basically after dismantlement. In the area where buildings including Aganchen Temple are not dismantled, it is necessary to investigate closely for decays and extent of damages of the wooden members in advance.

-Sociological survey

Many of the original uses or the religious significances of the rooms in the target buildings are not yet known. We need to collect more information and conduct document research because they are related to future examination of utilisation and setting of the safety performance.

-Investigation on structural performance

In order to obtain the information about the strength and features of foundation and supporting soil, the excavation investigation and geological boring survey are to be conducted. Along with the survey on the internal structures of the brick wall, brick and mortar are sampled and the simulation tests about the structural strength and behavioral characteristics during an earthquake are to be conducted based on the data of material properties. Concerning the pros and cons of joining between each building and the stiffness reinforcement, we require particularly careful examination.

-Investigation on construction method

Theoretical viability is not beneficial when an ideal restoration plan cannot be carried out in Nepal or even difficult to do so. Feasibility in the present conditions of Nepal in consideration of appropriate techniques and methodologies on site is required in the development of the restoration plan.

-Transfer of techniques

Training Nepalese engineers is needed, through all processes from plan development to the execution of restoration work. As for the transfer of research techniques particularly, it is necessary to promote Nepalese independent participation.

(Section author: Masahiko Tomoda)

3.1.5. Prospects for the project of the fiscal year of 2017

For the final development of the restoration general plan in regard to Aganchen Temple, experts of corresponding fields including researchers of architectural history and structural engineers as well as conservation architects will discuss the extent of restoration and its provisional policy reported in section 3.1.4.

Along with the examinations mentioned above, investigations of damage and techniques used in Aganchen Temple and Hanuman gate as well as each wing of Mohan Chok are going to be conducted.

As for the damage investigation, we intend to make a close observation looking at the existing condition of inclination, swelling, cracks, delamination, degradation of masonry joints, decays, breakage and missing of wooden members. Inclination and unevenness of overall structure are to be investigated at the same time for the comprehension of the damage situation. The restoration plan is then to be developed suitable for the monument that constitutes World Heritage Site.

As for the investigation of techniques, we will dismantle a portion of brick wall surface partially in order to clarify the details of damage where the plaster coating prevents from verifying specifications and structural members employed. Then, based on the result of the investigation of construction and restoration history of each wall, the restoration plan of an individual part will be examined in consideration of significance to preserve the present condition and other factors.

Concerning wooden members, connections and fitting state such as joinery are to be examined carefully to understand the original structural performances of the buildings. If necessary, the seismic stabilisation measures are to be examined making use of structural features of the wooden frames. Construction techniques at the time of erection or later modification will be further researched through the close investigation of old traces and the narrow spaces below Aganchen Temple. These results are to be reflected on the scope of the restoration work of this time and construction methods.

Along with the coordination with DOA and relevant religious people, the investigation inside of Aganchen Temple (three-tiered tower) will be carried out for verifying and confirming its historic value, the extent of damage and the structural features of the whole building, which are to be reflected on the restoration plan.

In addition to the examination mentioned above, connection and fitting state where two buildings are joined, the gaps caused by the inclination of each building are to be investigated further to decide the extent of repairing of the connection and fitting this time.

The results of above-mentioned investigations as well as the restoration general plan are the subject of the information disclosure. Taking that into an account, the documenting methodology including drafting processes of the plan is considered as part of transferring techniques.

The necessary temporary construction and temporary stabilisation for the investigation and the partial dismantling work are to be carried out considering the security and safety for the survey work and visitors. Also, temporary construction plan and work orders are to be prepared for the full-scale repair construction, considering the accessibility and ample space for festivals and visitors.

This project is aimed to transfer techniques so that the counterpart continues to preserve other buildings respecting their authenticy as part of a World Heritage Site. Therefore, in principle, the repairing works of the project are carried out with appropriate techniques using materials and machines that can be supplied on site. However, the decisions for selecting the extent of the brickwork dismantlement require more attention because unlike wood construction where members can be restored back to the original position even after the dismantlement, brickworks must be reconstructed eventually after the dismantlement. For the purpose of minimizing the extent of dismantlement and repair to retain authenticity as much as possible, traditional Japanese restoration techniques such as a repair through jacking-up and correction of verticality and horizontality in situ must be carefully employed.

(Section author: Tadatsugu Tai)

3.2. Issues and prospects of seismic performance evaluation of historic buildings

3.2.1. Acquired knowledge from the material testing

For the material testing performed locally this fiscal year, we used the jigs and tools that can be maneuvered manually which were designed and produced particularly for this purpose. Testings performed were the material strength testing for units of bricks and joints, the compression test of masonry prism, the diagonal compression test and the bending test.

Firstly, a series of compression strength tests was carried out for two kinds of bricks, one of which is new bricks purchased from a factory and the other is an aged brick of approximately 100 years collected in Katmandu city from a private house.

The elastic modulus of new bricks was higher than the old ones, while the compressive strength of the old bricks was higher than the new ones (Fig.3-2-1).

Regarding mortar for masonry joint, the tests were carried out concerning the following four kinds of materials:

(1) Yellow Mud collected from the paddy field

(2) (3) 2 different compounding ratios of Lime Surkhi: A mixture of ① Slacked lime on the market, ② Surkhi (powdered materials of a brick finely crashed) and ③ sand (Ratio of (2) 1:1:1 and Ratio of (3) 1:1:3)

(4) Cement mortar

(Fig.3-2-1 shows the result of cylinder compression test)

The compressive strength and elastic modulus of the cement mortar are much higher than others. Among other three materials, Yellow Mud is the lowest and Lime Surkhi of less sand ratio (2) showed higher strength.

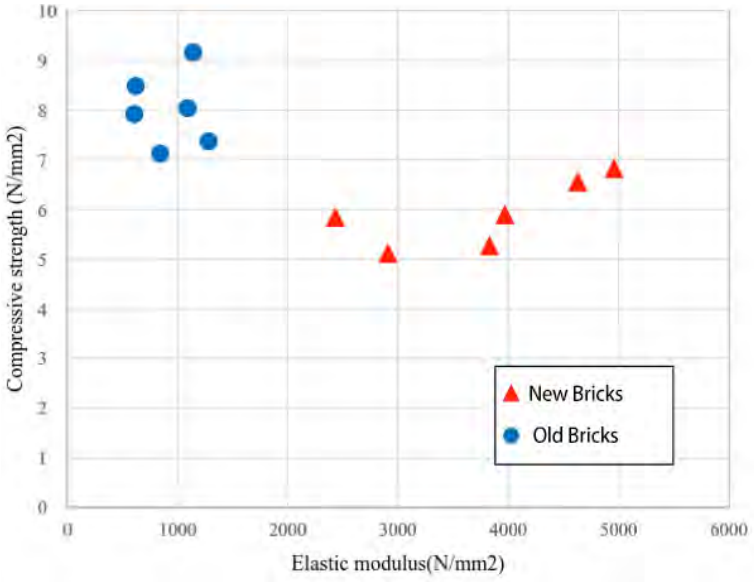


Fig.3-2-1 Compressive strength- elastic modulus graph (red triangle: new bricks, blue circle: old bricks)

Fig.3-2-2 Cylinder compression test

Fig.3-2-3 Compression test

Fig.3-2-4 Diagonal compression test

Fig.3-2-5 Bending test

After making brick prism specimens combining the above-mentioned 2 kinds of bricks and 4 kinds of mortar, a compression test (Fig.3-2-3) a diagonal compression test (Fig.3-2-4) and a bending test (Fig.3-2-5) were performed. The compressive strength of cement mortar masonry joint is the highest, followed by Yellow Mud, then by Lime Surkhi of the lesser sand ratio. However, the excessive strength of mortar joint caused the destruction mode in which bricks were damaged. Therefore, we need to pay attention for the choice of the material strength to be combined so that bricks will not be damaged. The results of the diagonal compression test vary widely and many specimens whose masonry joints would be peeled by the weight of the specimens themselves were observed. The results of bending test also vary widely but the bending tensile strength of masonry joint of cement mortar is the highest and Yellow Mud is the lowest. Between 2 kinds of Lime Surkhi, the bending tensile strength of the one of lesser sand ratio is higher.

(Section author: Noriko Takiyama)

3.2.2. Prospects for the target setting of the seismic performance of historical monuments

Regarding technical support for restoration of Jagannath Temple and Gopinath Temple, preparation for the structural analysis such as measuring survey, drafting plans, or load calculation are in process. Final structural analysis cannot be concluded at this time because the necessary data of material characteristics (bricks and masonry joints) for analysis are not sufficient. It is important to collect the material characteristics data urgently by testing bricks, masonry joints, and woods of existing buildings and of the ones considered to be used as an intervention material for the repair. The clarification of objective performance is needed on the repairing and reinforcement of buildings. The consultation on criteria of presumed earthquake vibration, deformation and damages is required as well. In the examination, it is necessary to survey on presumed earthquake vibrant of other restored architectural monuments.

As for Aganchen Temple, the structure of multi-tiered section is unexplained. It is necessary to collect more data with three dimensional analysis models that can be made either by actual measuring or making estimation of the frames.

Also, regarding the local human resource development for technical transfer, it is important to secure the staff who continuously takes charge of experiments, analyses and other studies.

(Section author: Mikio Koshihara)

3.2.3. Toward the establishment of seismic performance evaluation methodology of traditional houses

Regarding the rehabilitation support of people's houses in Nepal, we can mention 'The Project on Rehabilitation and Recovery from Nepal Earthquake' conducted by JICA. Several types of housing models are proposed as public rehabilitation housing and establish the specifications of each model in this project. Structural analysis was carried out at the time of the planning, and it is possible to construct seismically reinforced masonry houses with a traditional construction method. The rehabilitation support for the completely destroyed houses goes well on one hand, the investigations on the repairing methods and reinforcement techniques for partially destroyed houses have not progressed on the other hand. As the examination of reusable possibility by structural reinforcement of partially destroyed traditional houses is not progressed especially, the number of cases that partially destroyed houses are replaced by reinforced concrete houses has increased in the settlements where many traditional houses still exist such as Khokana. The townscape of traditional settlements would disappear because the current building law permits new construction of masonry houses only to 2 storeys.

For the establishment of seismic performance evaluation of traditional houses, the classification of Nepalese traditional houses in types and the structural analysis of several representative housing types are needed. Together with data of the material characteristics (bricks and masonry joints) conducted in other investigation programmes and seismic diagnostic criteria used in other countries we need to examine the seismic performance evaluation of traditional houses and their reinforcement methods.

(Section author: Mitsuhiro Miyamoto)

3.3. Issues and prospects of preservation and rehabilitation of historic settlements

3.3.1. Summary of investigation of this fiscal year

3.3.1.1. Issues of investigation of the last fiscal year and its current situation

In the project of the last fiscal year, along with the necessity of refurbishing legislation as the most urgent issue, we pointed out the necessity of the establishment of the rules for the reconstruction of damaged private houses of traditional construction method, development of the restoration and stabilisation techniques of partially destroyed houses, and establishment of a design guideline of private houses of non-traditional construction methods.

In the project of this fiscal year, a design guideline for private houses of traditional construction method, that for the private houses of non-traditional construction method, and a guideline draft of a block design were prepared. The remaining issue is to examine how to bring about the efficacy of the rules after discussions with the inhabitants and the local authorities. Review of the legislation is a continuing issue, while the issue on the restoration and stabilisation techniques of partially destroyed houses is an important one but has not yet started.

3.3.1.2. Issues of investigation of this fiscal year

In this fiscal year, continued investigation on Khokana settlement was carried out. This focused mainly on 1) the comprehension of present situation for rehabilitation and preservation, and 2) the examination of developing design guidelines for private houses of traditional construction method and of non-traditional construction method, and for the block plans, through the series of interviews with the inhabitants. Also, during the survey, several terms that are applied to the spatial structures of settlements were organized for better comprehension. The actural meaning of *tole*, expressing the minimum unit of the community was grasped during these works.

The fact that there hardly are any local researchers or experts who would develop the preservation plan considering the spatial characteristics of the importance of the spaces in historic settlements was recognized as an issue during the investigation of this fiscal year. These settlements are not merely a townscape but are shared spaces constructed by the local communities over a long period of time. Systematic academic researches on private houses which are the main constituents of townscapes are not developed. The fact that academic research of this field in Nepal is behind leads into the stagnation of the Nepalese cultural heritage protection administration whose criterion is simply described as ‘old’. Consequently, discussions cannot be reached to the point where to draw a line between traditional buildings and others as seen in the preservation district system for groups of traditional buildings in Japan. This discussion on distinction is to manifest the value evaluation of cultural heritage in the present townscape. If we broaden our outlook, most of the settlements in Kathmandu Valley called as historic settlements, underwent complete changes. 53 ‘historic settlements’ considered to exist in Kathmandu Valley are controlled at once, without exhaustive survey, in the ‘Preservation of Heritage Settlements and Building Construction bylaws 2073’, based on the documents prepared in about the 1970s. Regarding the effectiveness and details, the bylaws need more consideration.

3.3.1.3. Prospects of the projects from the fiscal year of 2017

The case that private houses of traditional construction methods suffered from the earthquake are demolished and replaced with houses of reinforced concrete has increased rapidly since the beginning of 2017. The rehabilitation of the living environment has been pushed forward based only on

individual judgments at the present even after two years since the earthquake disaster. It seems natural that the inhabitants demolish private houses of traditional construction methods and reconstruct reinforced concrete houses because even Khokana Reconstruction and Rehabilitation Committee has not yet proposed the effective alternatives and the structural reinforcement techniques of existing private houses of traditional construction methods have not yet examined.

In that situation, though, our goal of the project in the fiscal year of 2017 is to discuss with the inhabitants and the local authorities about these design guidelines proposed this fiscal year and to complete these guidelines as practical tools.

As mentioned earlier, it is necessary to promote fundamental researches on the private houses and settlements further as the mid- and long-term goal. But we might be able to propose its framework. The exhaustive survey on the current situation of historic settlements in Kathmandu Valley seems to be the opportunity for us to examine that framework.

(Section author: Tomoko Mori)

3.3.2. Prospect on establishing an appropriate preservation system for the historic settlements

3.3.2.1. Summary of the activities concerning the preservation system for the historic settlements

Our investigation of Khokana in the fiscal year of 2015 revealed that the laws or systems related to the preservation of historic towns in Nepal remain inadequate. To contribute to the rehabilitation and reconstruction process by using the results of investigation, the regulatory and administrative assistance to improve the preservation system is necessary. Issues related to the preservation of historic settlements need to be clarified and then shared with local authorities. Acknowledging these needs, a conference on the preservation of historic settlements was organised in November to realise the cooperative relationship (Historic settlements Network) among local municipalities, which have jurisdiction over the historic settlements in the Kathmandu Valley.

Prior to the conference, we visited four municipal offices (Karyabinayak, Kirtipur, Panauti and Shankharapur) and interviewed the municipal Chief Exective Officers(CEOs) and the responsible officers regarding the existing cultural heritage preservation system in each municipality. These four municipalities have historic settlements already inscribed on the World Heritage Tentative List (WHTL). Two other municipalities, Lalitpur Sub-Metropolitan City and Bhaktapur Municipality, which are preserving the World Heritage Sites (WHSs) that fall within their jurisdiction, were also consulted on the preservation of WHS. In addition, the Kathmandu office staffs of UNESCO and UN-Habitat were asked about their works in the preservation of historic settlements. In these activities, Dr Bijaya K. Shrestha from the Post Graduate Department of Urban Design and Conservation at the Khwopa Engineering College provided an invaluable assistance, particularly during interviews and discussions. A summary of the situation and issues associated with the preservation of the historic settlements in Nepal and prospects for the future is as follows.

3.3.2.2. Principal Issues on the preservation of historic settlements in Kathmandu Valley

According to the interviews with the local government officials, it has become clear that the following three issues regarding the preservation of historic settlements in Nepal need to be resolved:

(1) The historic settlements and (private) traditional houses are not legally designated as cultural

assets.

(2) The incentive and penalty mechanisms, which some municipalities already enforced for individual house construction, are not effective enough for promoting the preservation. Moreover, such measures are yet to be established for the settlement as a whole.

(3) Traditional brick masonry (with mud mortar) houses in three to four storeys, which constitute the main parts of the historic townscape, do not comply with the current National Building Code (NBC) requirements; consequently, it is substantially impossible to reconstruct them or newly build buildings in the traditional form and style.

3.3.2.3. Prospects for the preservation of historic settlements and expectation for the future cooperation

This fiscal year of 2016, issues regarding the preservation of historic settlements were discussed with the local authorities; the conference held in last November facilitated the exchange of opinions between the Japanese experts and the municipal officers. In this fiscal year of 2017, we envisions the following cooperative activities:

(1) Formation of the Historic Settlements Network

With respect to the preservation of historic environments, each municipality faces a different situation and each preservation system is different as well. Therefore, it is required for these municipalities first to share the information about their approaches for and knowledge about the preservation. It is also important that the local authorities cooperate with each other, to reflect their experiences on to the laws and system at the national level.

The Historic Settlements Network which this project proposed is expected to establish direct relationship among the officers of all the six municipalities. In future, such a network could include chief executive officers and local community members, other municipalities which manage the historic settlements also. Engineers should act as the key persons of this network. It would be beneficial to organise mutual site visits and exchange views and ideas among the reconstruction and rehabilitation committees of different settlements. Such networking among municipal staff and local communities across different historic settlements is expected to ultimately promote preservation activities.

(2) Assessment of historic settlements

The new chapter on ‘Special Provisions for the Heritage Settlements’ inserted as part of the first revision to the ‘Basic construction bylaws related to settlement development, city planning and building construction 2015 (2072)’ regulates the construction of private, individual houses inside the 53 historic settlements in the Kathmandu Valley. However, these provisions alone cannot preserve the historic settlements in their entirety. Each settlement must be investigated, its history delineated, its intangible cultural heritages noted, and its values determined; then, the traditional houses and elements worth preserving and protecting must be identified. Some investigations have already been carried out on an individual basis. However, at present, there is no organisation or system to unify such fragmented information.

The system in Japan that designates the historic settlements and districts to be preserved has already been in use for more than 40 years. The criteria and survey methods for the selection of

settlements are well established. However, it is difficult for Japanese experts to conduct by themselves the necessary investigations for establish preservation plan even a single historic settlement in Nepal. On the other hand, Nepalese experts may have an advantage over the Japanese ones of having a better, more pertinent understanding of the backgrounds and, hence, may be better able to explore the settlements.

However, the findings of any investigation on the traditional townscape and intangible cultural heritage of Khokana which we have carried out as a pilot project would be extremely meaningful. The investigation method, techniques, and content structure may be used as a framework and applied to other historic settlements in the Valley.

We need to contribute to the localisation of the investigation of historic settlements as follows: 1) share the survey method used in Khokana at the meetings of the historic settlements network; 2) compare, classify, and categorise the 53 historic settlements in the Kathmandu Valley; and 3) propose the investigation guidelines for the cultural assets designation of historic settlements and traditional houses.

(3) Stabilisation and reconstruction of traditional houses

It is difficult to adapt traditional houses and monuments, which constitute historic settlements, to the current building standards including NBC directly. In Japan, structural strength and fire resistance performance has been verified through research and repeated experiments before improving preservation techniques and systems. Currently, the NBC of Nepal substantially prohibits the reconstruction of houses using traditional construction methods, and this situation has accelerated the removal of damaged houses, as well as their replacement by reinforced concrete houses. Seismic performance evaluation methods for traditional houses as well as simple and low-cost stabilisation techniques should be explored. Henceforth, we will somehow tackle this issue, propose a roadmap for the establishment of such techniques, and further the investigations on the seismic performance evaluation methods for existing traditional houses (brick masonry in mud mortar houses with three to four stories).

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3.4. Issues and prospects of preservation of intangible cultural heritage

3.4.1. Summary of the activities in this fiscal year

Investigation on Shikali festival in Khokana settlement was conducted for the project of this fiscal year. As the result, we found that the festival as an intangible cultural heritage is an important factor in constituting cultural spaces of the settlement and its surroundings. In general, the investigation for tangible cultural heritage such as buildings or urban facilities and that for intangible cultural heritage such as festivals or customs are conducted independently and their outcomes are rarely shared. In this project, however, they were conducted in collaboration of urban design survey and intangible cultural heritage survey from the beginning so as to prevent conventional adverse effects. Furthermore, we found that, through the investigation, regarding the cultural heritage in Nepal, the tangible factors and intangible ones are closely tied together in this country. Especially the cultural spaces used for festivals and the inhabitants' everyday life include both tangible and intangible aspects. The experience of this project is pioneering in that sense and the project provided an advanced result.

3.4.2. Prospects for the next fiscal year project

From the fiscal year of 2017, the investigation, which contributes to protect and utilize both the tangible and intangible cultural heritage, would be conducted for the rehabilitation of cultural heritage in Nepal, based on the result of this year. Specifically, as the collection of basic data was intensively carried out this fiscal year, the attempt to share that result with the local authorities and the inhabitants would be carried out for the project of the fiscal year of 2017. As this attempt, workshops in Nepal and the development and distribution of publications such as pamphlets are planned.

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