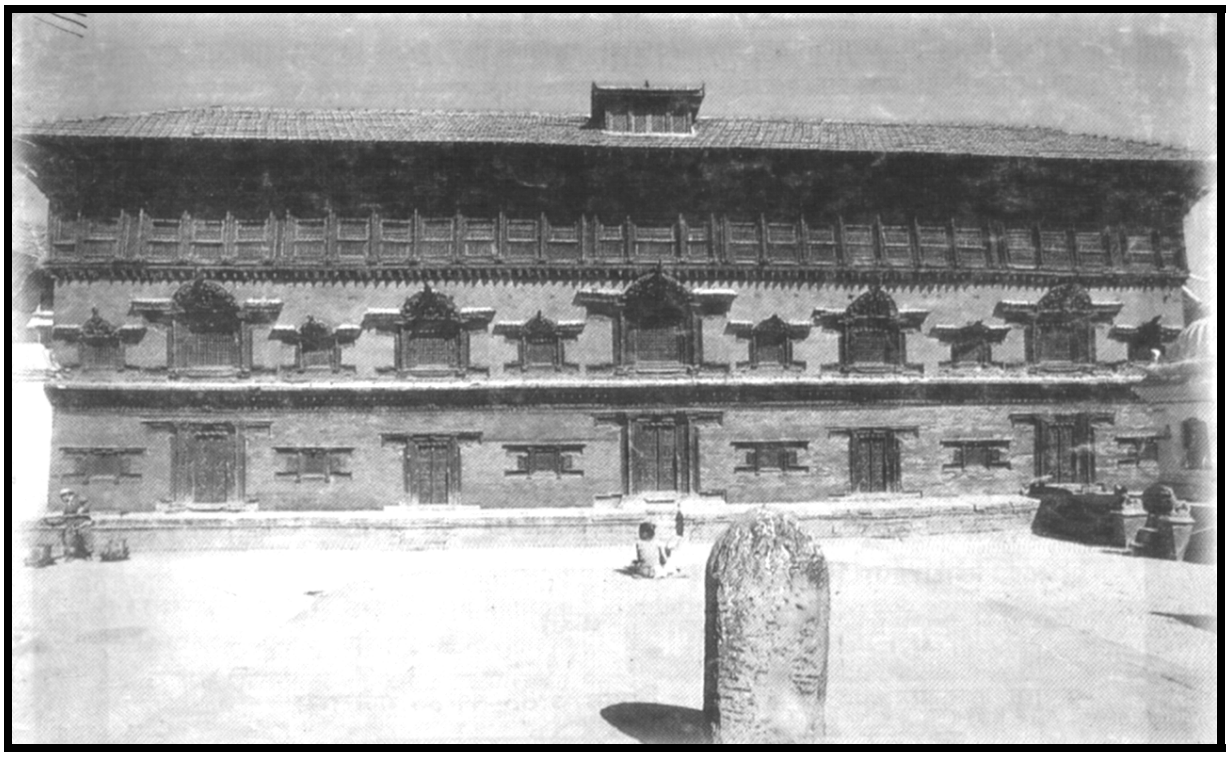
A FINAL REPORT
ON
CONSERVATION OF 55 WINDOWS PALACE

Department of Architectural Restoration and Conservation
Department of Housing Development and Management
Lund University, Sweden
and
Swedish International Development Cooperation Agency (SIDA)



SUBMITTED BY:
AR. RAM GOVINDA SHRESTHA
HERITAGE SECTION
BHAKTAPUR, NEPAL
FEB. 2006

1. INTRODUCTION

The 55 Windows Palace is historically recorded as constructed between 1702 A.D. and 1722 A.D. by the King Bhupatindra Malla. Some historians opine that the foundation stone of the palace was laid during the rule of King Jitamitra Malla, father of King Bhupatindra Malla. However, the construction of the palace is credited to King Bhupatindra Malla, considered to be the champion of the architecture and culture. It is believed that the palace was constructed after an experience of constructing the five storied temple (Nyatapol) which was evidently completed in a very short period. Beside the architecture itself and the carved fifty five windows, the significant contribution of King Bhupatindra Malla is the 'tempera paintings' on the first floor walls of the palace. The tempera paintings representing the rare example of the type depict different Devi (Lordess) dances, social life and culture of the people and include the self-portrait of the king and the queen. The central figure of the painting is dedicated to Lord Shiva Vishworupa. This has been classified as one of the rarest paintings of Nepal. The Palace is considered as the landmark of the Bhaktapur Durbar Square, one of the three famous historian Durbar Squares of Kathmandu Valley which have been listed as World Heritage sites by UNESCO in 1979 A.D.

The Palace, the masterpiece of the medieval period architecture, was built by the local craftsmen and builders using the then local technology in local materials. The load bearing walls of the Palace were built in specially made bricks, such as, Maappa and Dachiappa with mud mortar of high quality. The floors, beams, windows and doors were made of different types of the then available timbers, such as, pine, sal, teak and other types. Special roofing tiles (Jhingate) were used to cover the sloped roofs on timber supports.

The 55 Windows Palace was badly damaged in the Great Earthquake of 1934 (Reichter Scale 8.3). The gallery of the second storey with the 55 Windows was collapsed nearly by ninety-five percent. Fig. 1 ,Fig.2,Fig.3and Fig.4 respectively show the frontal view and east view of the Palace before 1934 earthquake and the Palace in ruined in 1934. Second and attic floor of the Palace were damaged. However, the first floor of the Palace with the valuable

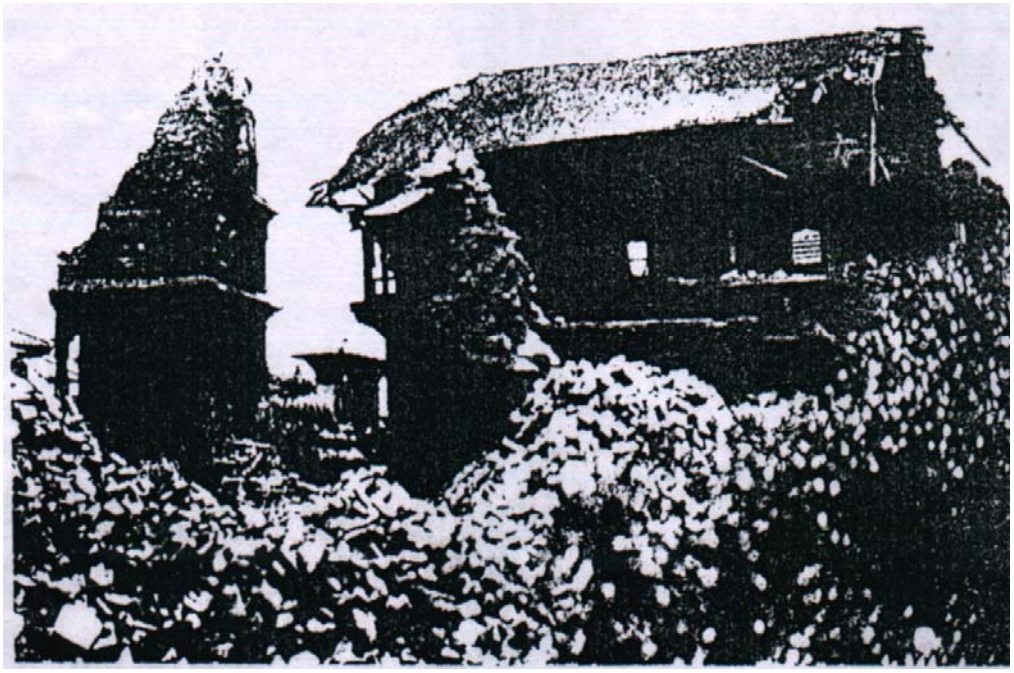
tempera paintings was not visibly harmed. The 55 Windows Palace was the most affected Palace among the three historical palaces of the Kathmandu Valley, obviously it was so in the case of overall damage in the city of Bhaktapur.

FRESCO ON THE WALL O F FIRST FLOOR OF THE PALACE

DIFFERENT PORTION OF THE PORTION

SOUTH-EAST VIEW OF 55 WINDOWS PALACE BEFORE 1934 EARTHQAKE

DURBAR SQUARE WITH 55 WINDOWS PALACE BEFORE 1934 EARTHQAKE



EAST VIEW OF 55 WINDOWS PALACE AFTER 1934 EARTHQUAKE

EAST VIEW OF 55 WINDOWS PALACE AFTER 1934 EARTHQUAKE

Subsequent to the event of the earthquake, in the process of rehabilitation the Palace was reconstructed with construction materials salvaged from the earthquake. The reconstruction work of the palace was done in a very short span of time, and as the need was to restore the palace as soon as possible, apparently less cure was given to the original style, and also appropriate consideration of detailing could not be taken care of. Evidently the post earthquake reconstruction was marked by the financial and time constraints. If it had to be rebuilt in a shortest possible time even without consideration of technical aspects, another constraint was the necessity of using the salvaged materials. For instance, during the earthquake, the joists of second floor projected by about 45cm (below the series of 55 Windows), must have been broken (obviously the overhang part is most prone to damage during earthquake) and the joists salvaged from the earthquake became shorter by the same length. The reconstruction of the floor using the salvaged joists of shorter length has resulted into the setback of the windows. It is also believed that the spine wall and front wall were out of the plumb during the reconstruction which would have caused the leaning and cracks in the walls. It is assumed that important details of construction were either written off or could not be restored, and structural members like wall plates were not restored in structurally strategic places during the reconstruction works.

55 WINDOWS PALACE BEFORE RENOVATION

Beside the above mentioned deficiency in the post earthquake reconstruction, a number of other activities related with repair works in isolation must have aggravated the structural condition of the palace. The addition and removal of various structural elements in course of

time to suit the then occupancy of the palace is another major important parameter. In the Rana's regime, the then magistrate removed the southern cross wall to make the ground floor more spacious for his official purpose, and in late seventies (1978) the western cross wall was removed for the purpose of Museum. Such removals were done without proper study of the importance of the cross wall in the structural performance of the building.

The palace building has been, in course of time, used for different occupancy like, office, residence and museum. Various alterations were carried out to suit the occupancy at various periods.

Until it was stopped some ten years back, the Durbar Square used to be a main thorough fare route for transportation of daily use. The traffic had been imparting a vibration to the building.

During the reconstruction of the Palace after 1934 earthquake, the roofing was done in CGI sheets. Later (1963) in course of repair works, the Corrugated Galvanized Iron sheets were replaced by roofing tiles. Beside using the heavier material without improving the supporting wall, excess tiles (thousands in number each weighing 4 kg.) were stored in the western side of the attic floor.

As a part of repair, outer skins of the internal walls of ground floor were repaired with new machine made bricks later.

2. Data about property

Designation of the property

The palace is own as public monument. Specially most of the residential buildings are owned by private. The local government owns all open public space roads and public building in the city. Math, temples *Sattals* are the property of *Guthi* that is also private or government.

Most of the monuments are preserved & conserved by the department of Archeology but in the case of Bhaktapur, Bhaktapur Municipality is being sustainable due to tourist income, Bhaktapur Municipality self determine that monuments which lies in the area of its boundary is need to monitor and clean preserve so from last decade its also started to conserved historical monuments.

In the case of conservation of 55 windows palace, Department of Archeology and Bhaktapur municipality jointly work together even though it should be conserved by DOA.

Usage

The palace building has been, in course of time, used for different occupancy like, office, residence and museum. In present time it is useD as museum. It is proposed to use the Palace as same purpose but final decision will be taken by Bhaktapur Municipality and DOA.

3. Values

The '55 Windows Palace', the focal mark of Bhaktapur Durbar Square completed in a very short period. Beside the architecture itself and the carved fifty five windows, the significant contribution of King Bhupatindra Malla is the 'tempera paintings' on the first floor walls of the palace. The tempera paintings representing the rare example of the type depict different Devi (Lordess) dances, social life and culture of the people and include the self-portrait of the king and the queen. The central figure of the painting is dedicated to Lord Shiva Vishworupa. This has been classified as one of the rarest paintings of Nepal. The Palace is considered as the landmark of the Bhaktapur Durbar Square, one of the three famous historian Durbar Squares of Kathmandu Valley which have been listed as World Heritage sites by UNESCO in 1979 A.D.

The Palace, the masterpiece of the medieval period architecture, was built by the local craftsmen and builders using the then local technology in local materials. The load bearing walls of the Palace were built in specially made bricks, such as, Maappa and Dachiappa with mud mortar of high quality. The floors, beams, windows and doors were made of different types of the then available timbers, such as, pine, sal, teak and other types. Special roofing tiles (Jhingate) were used to cover the sloped roofs on timber supports is in need of a long term conservation plan. Due to want of such a transparent plan, and the lack of regular maintenance and various other reasons, different important structural elements have started exhibiting their weaknesses affecting the overall performance of the Palace. It has jeopardized(harmed) the heritage of paramount importance(more important than anything). The outward leaning in transverse direction (out of plane) of the southern longitudinal wall with the precious mural paintings has called for need of immediate renovation, and is the most crucial problem of urgent nature. This visible defect (damage) in itself is the result of the overdue repair and maintenance of other structural elements of the palace building. The repair of the wall, on one hand, has been a matter of primary importance, on the other, such repair of the wall or any other structural

members in isolation may be difficult to carryout and will not achieve the goal of conservation.

Recognizing the importance of the building and the need for conservation of it, various conservation plans and proposals have been prepared and presented at various times. Each of these proposals is significant in terms of its contents. However, a general approach, based on the current status of the palace, satisfying the conservation principles and engineering requirement is felt in need. The Department of Archaeology, HMG, Nepal and the Bhaktapur Municipality, the two organizations concerned with the conservation of the palace wanted to arrive at a general consensus on the adoption of a conservation approach. In this connection, an assessment of the present status of the materials and structural elements as well as that of the building became important to identify the causes of the damage and to evaluate the capacity of the building to withstand various loads including the lateral one. The preliminary assessment of the structural condition of the building will be a sound base for determining the rational approach of the long term conservation of the palace.

In view of the need, the March 1998 Mission of UNESCO decided to conduct the study "An Assessment of the Structural Condition of 55 Windows Palace" before developing a strategy for the rational conservation approach. It was envisaged that the findings of the study would facilitate in development of a long term strategy for a comprehensive conservation plan and programme, which will be applicable to the palace building and other monumental structures of similar characteristics.

4.1 Investigation Team

The March Mission of UNESCO, a meeting was called on March 26, 1998 at Kathmandu. The meeting unanimously decided to form an Investigation Team, comprising of representatives from the Department of Archaeology and Bhaktapur Municipality with Prof. P. N. Maskey as the Coordinator of the Team. On consultation with Bhaktapur Municipality and in agreement with the Department of Archaeology, an Investigation Team was officially Department of Archaeology and Bhaktapur Municipality with Prof. P. N. Maskey as the Coordinator of the Team. On consultation with Bhaktapur Municipality and in agreement with the Department of Archaeology, an Investigation Team was officially.

4.2 Terms of Reference

The Terms of Reference (TOR) for the Investigation Team formulated by the meeting of March 26, 1998 consist of the following objectives and scope:

4.2.1 Objectives of the Study :

In general, the objective of the study is to prepare all the requisite information pertinent to the structural condition of the palace building to facilitate in working out a rational strategy for the conservation of the palace. The study is aimed specifically to

(I) collect and prepare information, in terms of drawings, details and description, related with the form, system, elements of the palace.

(II) Determine the condition of various structural elements carrying out necessary tests and observations, particularly the wooden members and the brick masonry elements.

(III) Monitor the further development of defects, especially, transverse displacement of the longitudinal walls in the period of the investigation.

(IV) Report the overall condition of the palace including information on other defects and blemishes.

In order to achieve the above mentioned objectives, the Investigation Team detailed the scope of the study as follows:

4.2.2 Scope of the Study :

1. To collect and review all available documents including reports and proposals on the conservation of the Palace.

2. To review the available drawings of the Palace. Measure and verify the dimensions of the building. Prepare all necessary measured drawings and details.

3. To collect and review the history of the Palace in terms of its construction, past repairs/renovation, and alterations of the building components and occupancy of the Palace.

4. To carry out timber drilling tests on various wooden elements of the Palace to determine their conditions.

5. To investigate the conditions of the brick masonry walls of the palace, particularly to inspect the inner core of the walls including with the aid of the boroscope.

6. To monitor the further development of defects and blemishes, particularly the lateral displacement of the leaning longitudinal walls for the period of next three months.

7. To investigate and record other defects of the structural members of the Palace.

8. To prepare and present the findings of the investigation study in the form of a report at the end of the study.

9. Prepare and plan for a workshop, after submission of the report, on the conservation approach for the palace.

4.3 Principles and Working Strategy

To carry out the investigation work in 4 stages as follows:

Stage I	-	Collection and review of available documents;
Stage II	-	Physical verification and preparation of measured drawings;
Stage III	-	Exploration and tests of structural members; and
Stage IV	-	Analysis of the findings and preparation of the report.

5. METHODOLOGY

With an aim to achieve the objectives of the study, the Investigation Team adopted the following methods and procedures in the specific activities.

Stage I

In this stage, all the documents and information related with 55 Windows Palace were collected from various organizations.

Stage II

A complete set of drawings for the Palace was not available. The available partial drawings and details were either incomplete in terms of dimensions or they did not always show construction in sufficient detail. A complete set of drawing were prepared.

Stage III

The Stage III of the study basically involves the exploration and testing works. In this stage various structural members, such as the timber elements, walls were investigated and tested, and exploration of foundation condition was carried out. Main emphasis was given to the tests of wooden members and brick masonry walls, the main materials constituting the structural system of the Palace.

5.4 Timber Drilling Test on Various Wooden Members

As timber of different quality, in different forms, is extensively used in the building, its current condition has become necessary to find out to arrive at the structural condition of the Palace. Beside inspecting the surfaces visually, the condition of the wooden members: joists, rafters, posts, wall plates, lintels, beams, windows and door frames were tested with the help of the timber drill test machine made available by the Department of Archaeology.

In the method of the drill test, a small hole is drilled through the depth of the timber and measurements in terms of plotting of lines at some spacing are recorded. The spacing of the lines represents the resistance to the penetration of the drill. The decay or weakness of the wooden member is indicated by a large spacing of plotted lines, which in its turn signifies a low drilling resistance. The spacing of the plot lines is compared with the same of the test on a normal new wooden sample of the same quality to arrive at a relative condition (resistance to drill) of the tested member.

The purpose of the drill test is to determine indirectly the strength or density of the wooden member with respect to the same of the fully strong wooden sample. The result is indicated by lines (almost parallel) plotted on a paper with vertical grid lines spaces at 10mm. The result linesvaries as the density (in its turn the strength condition) of the

wooden member; nearer the spacing, better the strength condition. The average spacing of the plotted lines is determined for the wooden members, and compared with the average spacing of the plot lines of the test on the new sample of the timber of the respective type. The floor joists of all the floors were tested, by testing each out of five joists in series. Each of such joists was tested at both of its ends nearer to the supports (masonry walls).

The number of wooden members by tested are as given below.

S.No.	Wooden Members	Members
1.	Joists	67
2.	Wall Plates	16
3.	Cornices	17
4.	Lattice Windows	24
5.	Doors	15
6.	Posts	31
7.	Beams	13

5.5 Investigation of the Brick Masonry Walls

The brick masonry walls of considerable thickness and made of traditional bricks in mud mortar, constitute the main supporting system of the Palace. The overall condition of these walls directly influence the structural condition of the whole building. Beside general inspection of the exposed surfaces, it has become important to investigate the inner core of the wall. In view of the tilting of the longitudinal walls in the first floor, and visible cracks and gaps at places, and the type of construction of the walls with the thinner facing veneer with a thicker internal core, the inspection of the inner core was carried out to check for separation, cavity or any other type of gap.

At places of interest some walls from the inner surface were opened up and inspected the status of bricks, mortar and layers. Such openings of about 450mm x 450mm x 230mm size were inspected at 6 places and the observations were recorded. The purpose of such inspection is just to assess the status of the inner core.

In order to inspect any cavities, gap or other sources of weakness inside the wall which cannot be done by just opening up the surface, boroscope was used to observe and photograph the inner condition.

5.6 Monitoring of the Lateral Displacement Of the Walls

With a purpose to determine the remedial measures as well as to determine the type and cause of the displacement, it was planned to monitor the possible further movement of the leaning walls. To determine the further displacement, if any, of the whole wall or of the external face (veneer) relative to the inner core, two ways of monitoring the displacement were adopted. The displacements of the wall from inside and from outside were determined by measuring the positions of various points on the wall periodically.

In the first method, vertical threads were fixed on the ceiling at a regular interval along the periphery of the rooms (large painted room and small room on the first floor). In each vertical thread five levels along the height were marked as reference points from where the distances of the marked points (five along the height of the wall) were measured periodically. The change in the measured distance in the period would indicate the magnitude of the further displacement at the particular point of the wall. With the help of these observations, the overall inclination increment (if any) of the wall at the specific points along the length of the wall would be determined. The position of vertical thread lines in plan is depicted and the points along the height (vertical) indicated in the section,

In the second method, the displacement was periodically measured with the help of a theodolite stationed in front of the Palace. Various points along 2 horizontal lines at different levels were fixed on the front facade for observations. A reference point was chosen in front of the Palace building, and two stations for the instrument were chosen with respect to the reference point. The observations in terms of vertical and horizontal angles of individual test points were taken from both the stations. Such observations were repeated periodically.

Besides monitoring the further displacement as mentioned above, the width of the cracks at various levels at the gaps between the longitudinal wall and the partition wall normal to it were periodically measured. The distance of the wooden peg on the joist from the adjacent wall also was measured periodically to monitor the further lateral displacement.

5.7 Investigation and Record of Other Defects Of the Structural Members of the Palace

It was envisaged, in course of the available documents including the available plan of the building, that there would have been cross walls in the ground floor at three places adjacent to the south west corner of the Palace. To determine their existence and also the condition of foundation, if any, the ground floor was excavated upto a depth of 1500mm at three places .The ground floor detail and the status of the foundation were recorded during the excavation.

The condition of wooden members, apart from the drill test, was assessed in terms of other defects such as distortion of beam connections, buckling and twisting of posts, distortion of longitudinal lines of window frames.

Damages and defects in the walls including opening of wide cracks, leakage resulting blemishes, moisture movement, lack of ties at the joints were studied and recorded.

Stage IV

This stage of the work is basically related with the analysis, formulation of the results obtained in terms of data and observations and organization of them in a form of report for presentation.

5.8 Preparation of the Report

All the outcomes of the activities mentioned in the above paragraphs were processed and reviewed. All data of the tests were analyzed and used for determination of expected values. From the obtained values and observations, the conclusion of the study was drawn and an executive summary was prepared. The final report of the Investigation Team on "An Assessment of the Structural Condition of 55 Windows Palace" was prepared for submission to the concerned agencies.

5.9 Plan and Preparation for the Proposed Workshop

The Investigation Team also planned a 2 day workshop to deliberate on the conservation approach applicable to 55 Windows Palace.

6. Plan and Preparation for the conservation of 55

Windows Palace.

In view of the present condition of the structural members and the structural system of the palace it is envisaged that the following works, classified as minimum urgent works shall be carried out as soon as possible:

(i) Repair of the longitudinal walls of the first floor (wall paintings) simultaneously preserving the wall paintings.
(ii) Replacement of all floor joist and wall plates in all floors with additional wall plates where they are missing.
(iii) Repair of second floor walls, where separation of wall junction has taken palace.
(iv)Correction and realignment of the inner parts (sill platforms, posts, planks and beams with connections) of the assembly of
55 Windows.
(v) Minor repairs in the roof and terrace including sealing for protection from rain water leakage.

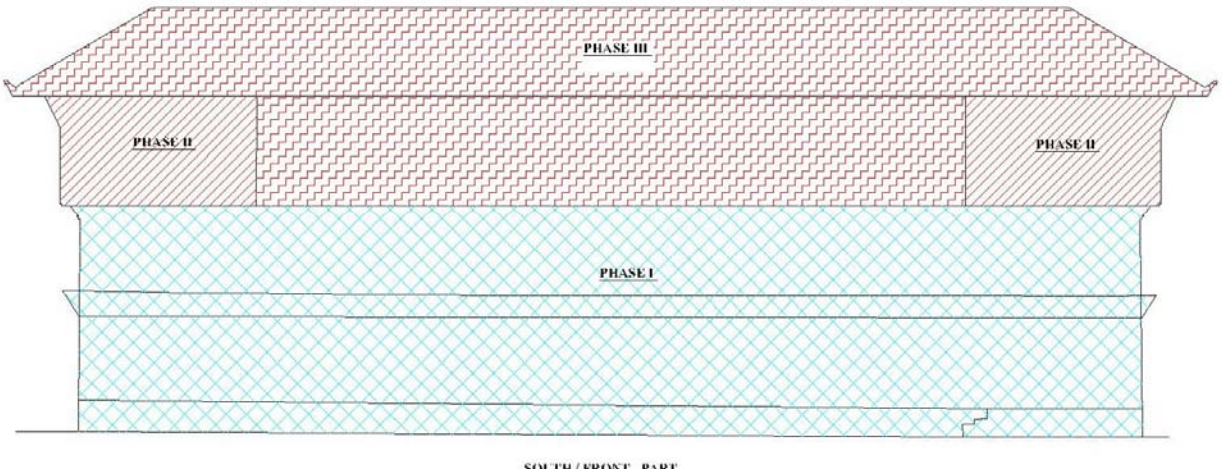
The above group of works includes only the minimum works which shall be carried out urgently, unless and until a renovation work plan in broad sense, as a part of conservation strategy is worked out.

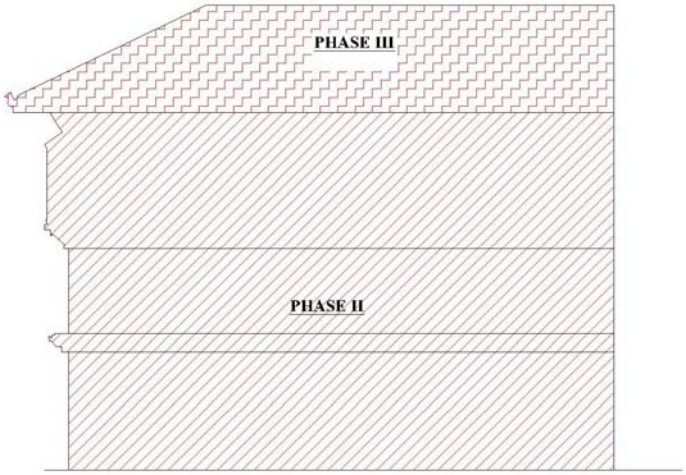
The conservation of the 55 Windows palace in long term basis is a matter of great concern to all. Mere remedy of the defects presently encountered will not serve the purpose of making the monumental structure long lasting.
It would be desirable, at this stage, better than never, to work out a conservation strategy for the palace, which would also be applied to the conservation of other monumental structures of importance.

In view of the present situation it would have been ideal to formulate an overall conservation strategy specific to the '55windows palace ' under the initiative of the concerned organisations including the Department of Archaeology, HMG, Nepal and Bhaktapur Municipality. Long term conservation of the 55 windows palace will step by as follow:
A. Preparation of purposed set of drawing.
B. Preparation of cost estimate and division of work as follows:
1 First Phase

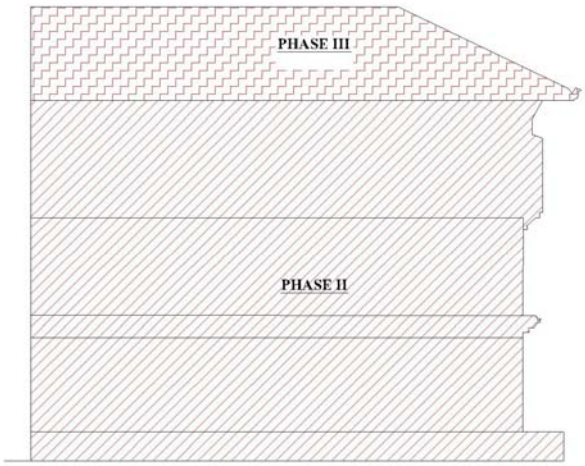
2 Second Phase

3 Third Phase





EAST PART



WEST PART

Schematic view of Phases

First Phase

In this phase, the Conservation work has been done on south-long part of Palace from ground floor to 2nd floor level. The work has been done as follows:

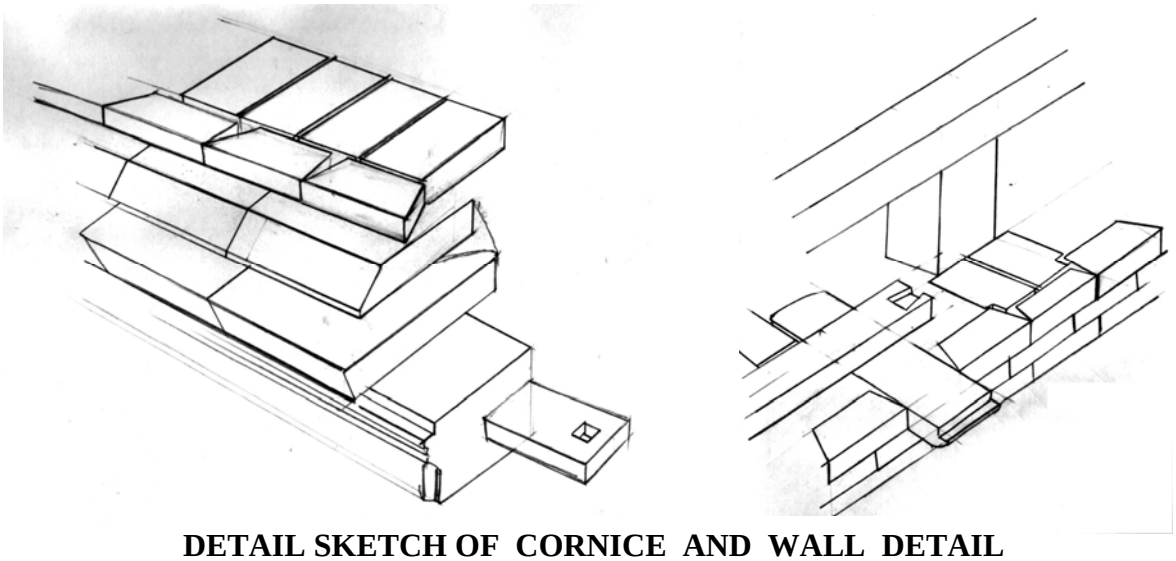
a. Dismantle ground floor's north and south wall and rebuild.
b. To build southern wall in plum up to 2nd floor level.
c. Inserting biteplate, beam and upright post into built up wall.
d. Replaced old decayed ceilings
e. Replaced lattice windows, doors and repairs.
f. Protect Fresco painting
g. Strengthen wall by providing wall plate.
h. Replaced decayed wooden cornice.
i. Remake floor.
j. Remake gallery of courtyard.
k. Build interconnection wall between south and north wall (4Nos).
l. Replaced base of struts.

PHOTOS RELATED TO FIRST PHASE OF CONSERVATION WORK

Second Phase

In this phase, the Conservation work will be done by renovating of east long and west long upto attic floor level. The work will done as follows:

a. Dismantle of work from roof to plinth level.
b. Inserting base plate, beam and upright post into built up wall.
c. Replaced old decayed ceilings
d. Replaced lattice windows, doors and repairs.
e. Strengthen wall by providing wall plate.
f. Replaced decayed wooden cornice.
g. Remake floor.
h. Remake gallery of courtyard.
i. Build interconnection wall between east and west wall (2Nos).
j. Replaced base of struts.
k. Repair old sinkhwa, sardule and making new sinkhwa and sardule for cantilever decoration.



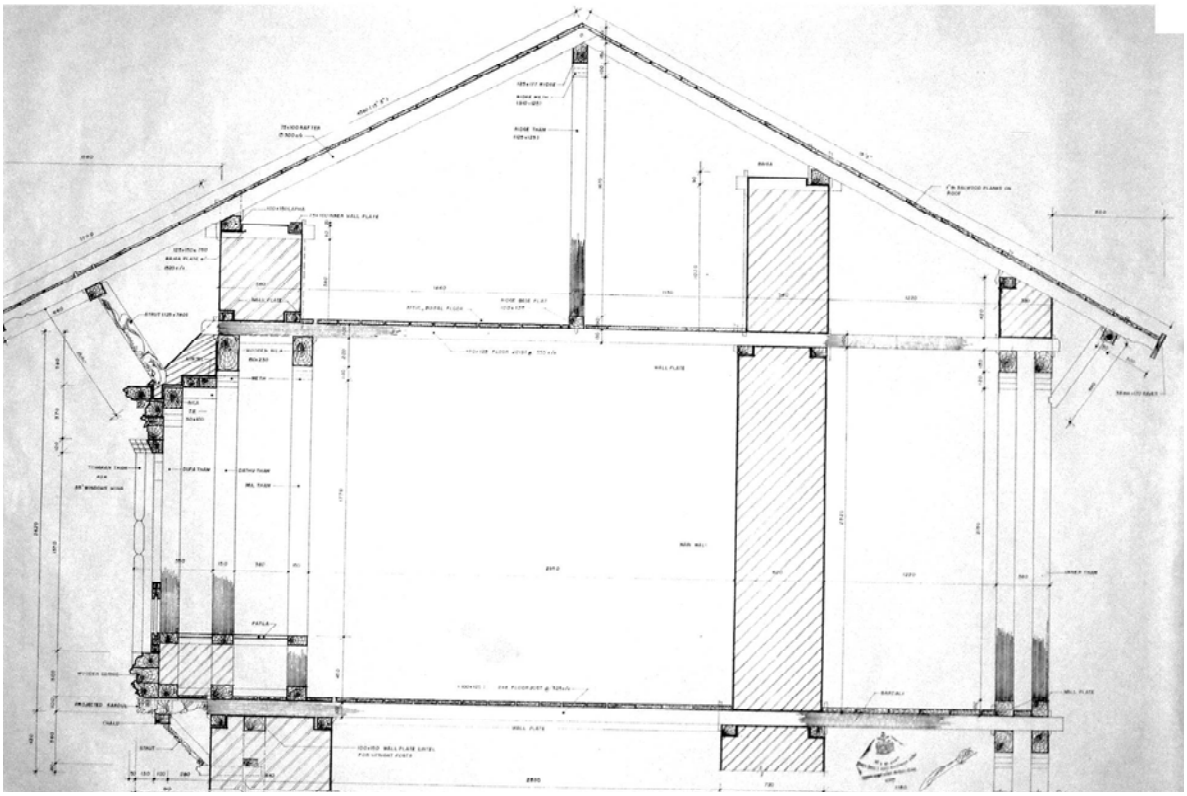
DETAIL SKETCH OF CORNICE AND WALL DETAIL

CORNICE ABOVE WINDOW

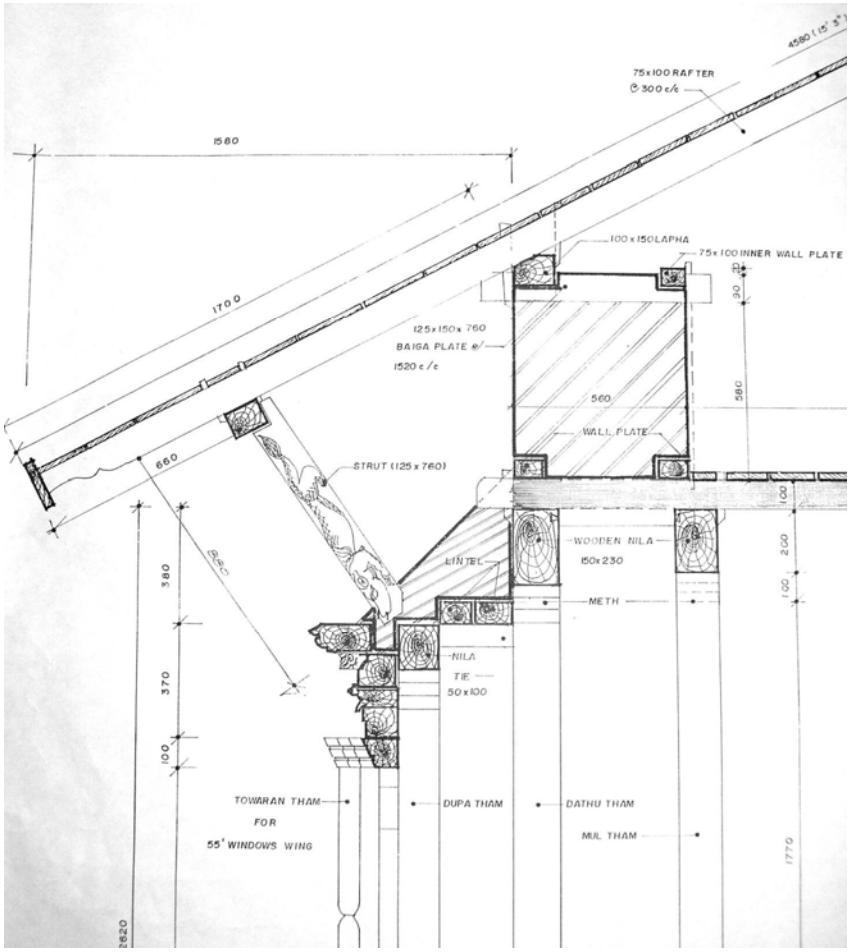
Third Phase

In this phase, the Conservation work will do renovation of south long second floor to roof and renovation of east and west long attic floor to roof. The work will do as follow:

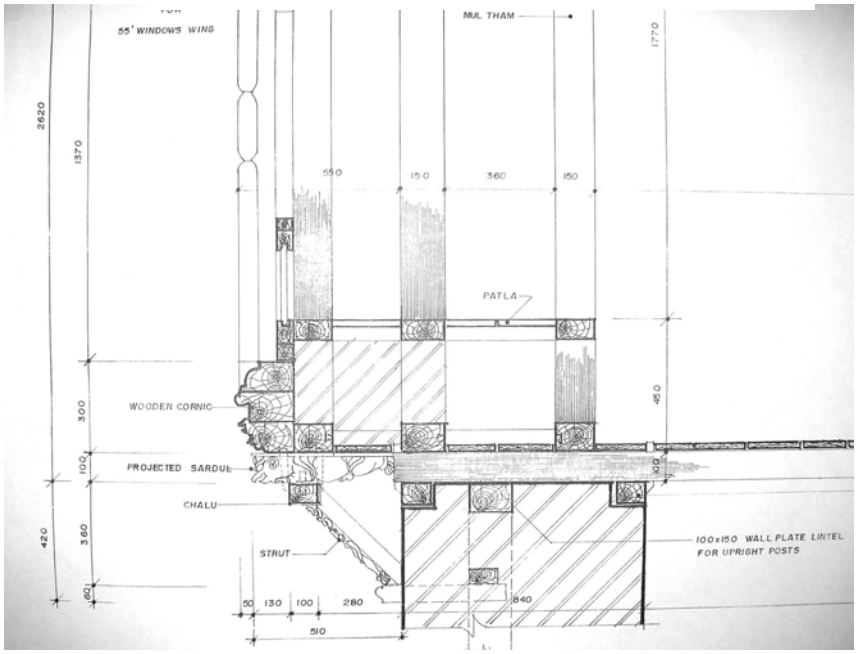
- Dismantle of work from roof to 2nd floor level in south long.
- Replaced basepalte, beam and decorated post and *meth*.
- Replaced old decayed ceilings by new.
- Replaced bay windows of 55 , doors and repairs.
- Strengthen wall by providing wall Plate
- Replaced ceiling.
- Remake attic floor.
- Remake gallery of courtyard.
- Build interconnection wall between east and west wall (2Nos).
- Replaced base of struts.
- Repair old *sinkhwa*, *sardule* and making new *sinkhwa* and *sardule* for cornice over the 55 windows.
- Cantilever decoration.



SECTION OF ROOF ALONG NORTH- SOUTH



ROOF DETAIL ABOVE 55 WINDOWS BAY



BASE DETAIL OF 55 WINDOWS BAY

CONSERVATION WORK OF PALACE TOWARDS THIRD PHASE

Conclusion

In this way conservation of 55 Windows palace is going on for the sole purpose of preserving the Malla period architecture, traditional construction technology and also preserved world's valuable fresco painting art by the king Bhupatindra Malla himself.

So, it believes, this conservation work will be the example and reference for future conservation work of Nepal and It will helps to promote our own technology, labor, skills and craftsmanship in conservation of Heritages of Nepal.

By:
Ar. Ram Govinda Shrestha
Co-cooridinator
55 Windows Palace Conservation Project
Heritage Section, Bhaktapur Municipality
Bhaktapur, Nepal