

RESTORATION AND SEISMIC STRENGTHENING OF THE SOUTH TALEJU TEMPLE

PROGRESS REPORT | MAY 2014

SUBMITTED TO

PRINCE CLAUS FUND FOR CULTURE AND DEVELOPMENT — CULTURAL EMERGENCY RESPONSE

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cover:
Scaffolding | February - April 2014
Extensive scaffolding was built with three ramps running along each of the temple's roofs. The roof cover was removed from all three tiers before restoration work began.

The two Taleju Temples | October 2012
The South Taleju Temple can be seen in the foreground with the Degutale Temple (*left*) and North Taleju Temple (*centre*) in the background. The North Taleju Temple was restored with support from the Prince Claus Fund in 2012. The seismic strengthening of these rooftop temples is of critical importance as the potential collapse of these temples would impact the surrounding structures as well. The restoration included the raising of the roof pitch of the temple's top tier, which had been lowered as a result of shoddy carpentry during the post-earthquake reconstruction in 1935-1938.

OVERVIEW

The restoration and seismic strengthening of the South Taleju Temple is a major component of the Patan Palace Restoration and Conservation Project, KVPT's largest program of works to date. The project, which began in 2005 and is scheduled to be completed in 2015, includes the restoration and conservation of two 17th century palace courtyards, three multi-tiered temples, two Shah-period public buildings, a step-well, and a water tank in the palace gardens. The Sundaricok courtyard and Bhandarkhal gardens were opened to the public for the first time in early 2014 under the management of the Patan Museum.

The present progress report documents ongoing work on the restoration of the South Taleju Temple, supported by the first instalment of the grant from the Prince Claus Fund. The project builds on the technical success of the previous collaboration between KVPT and the Prince Claus Fund in the rehabilitation of the North Taleju Temple. Along with the North Taleju Temple and Degutale Temple, the South Taleju Temple is a focal element of the roofscape and skyline of the palace complex. Though architecturally similar to the North Taleju Temple, it presents its own challenges in restoration and seismic strengthening. The following activities that were carried out during the first reporting period between December 2013 and May 2014 are described in this report:

- Erecting of scaffolding with ramps on each of the three tiers
- Installation of I-Sections to ceiling joists of Mulcok's south wing
- Restoration of the timber base supporting the gilt pinnacle
- Disassembly of roof struture of the third tier
- Reconstruction of the third tier at the correct roof pitch
- Replacement of damaged rafters, wall plates, and timber planking
- Reinforcement of connections between rafters and purlins
- Reinforcement of connections between rafters and wall plates
- Reinforcement of corner lap joints
- Cleaning of struts
- Removal of debris,pigeon's nest and excrement

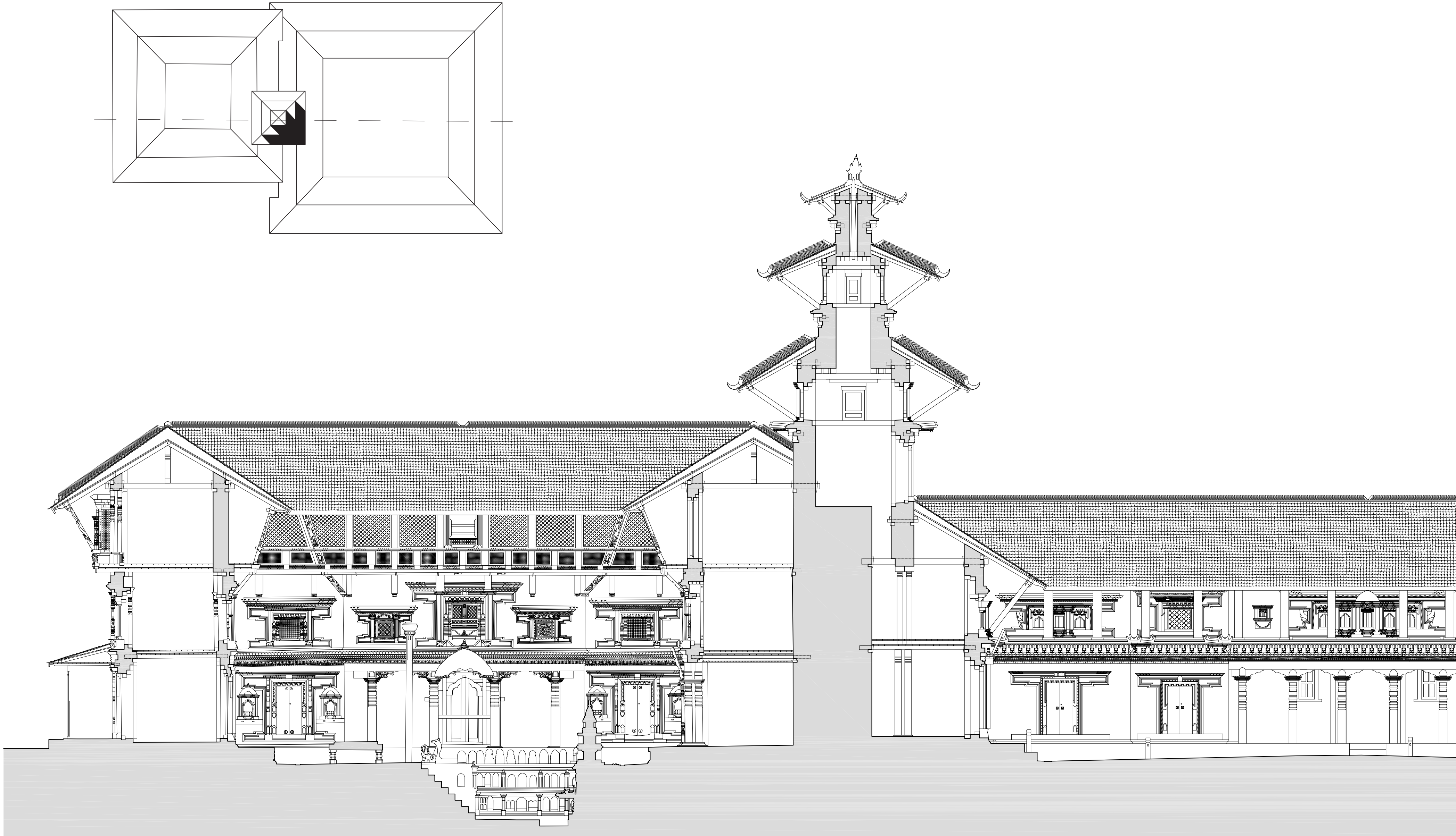
The four-storey courtyard of Keshav Narayancok was left relatively intact.

Only the lowest tier of the three-tiered North Taleju Temple survived the 1934 earthquake. The Degutale Temple was reduced to rubble.

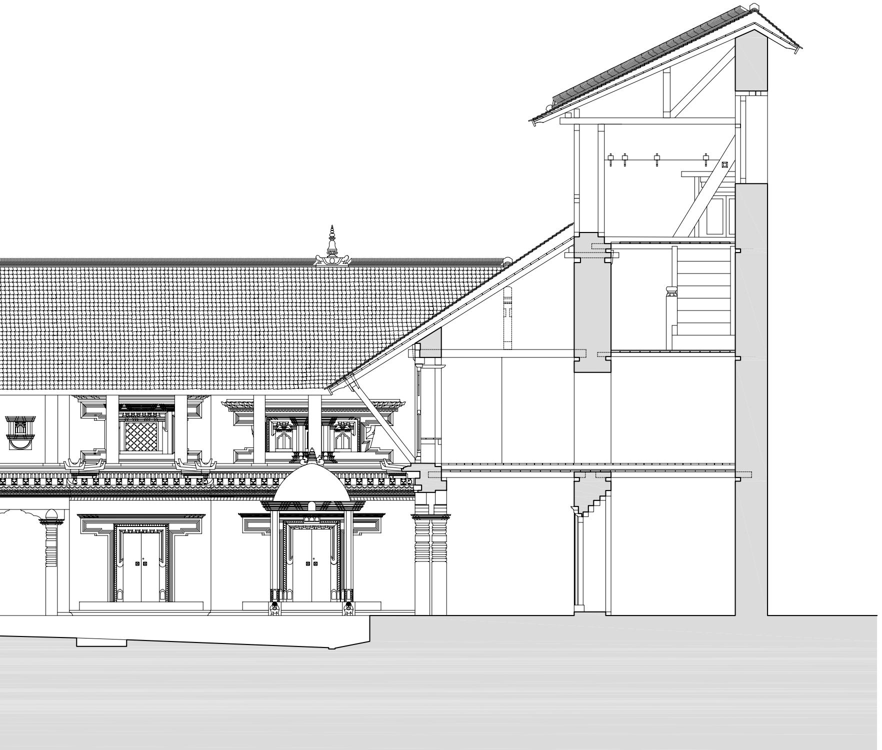
Patan Darbar after the earthquake | View from the Northwest, 1934
This photograph shows the extent and type of damage after the 1934 Bihar-Nepal earthquake. The collapse of the four "floating" Taleju temples caused extensive damage to the relatively stable courtyard buildings upon which they stood.

Position of South Taleju Temple, which completely collapsed and was later rebuilt (1935-1938)

Patan Darbar after the earthquake | View from the West, 1934
Three of the four temples were rebuilt in 1935-1938 using mostly salvaged materials collected from the rubble. Since the reconstruction occured

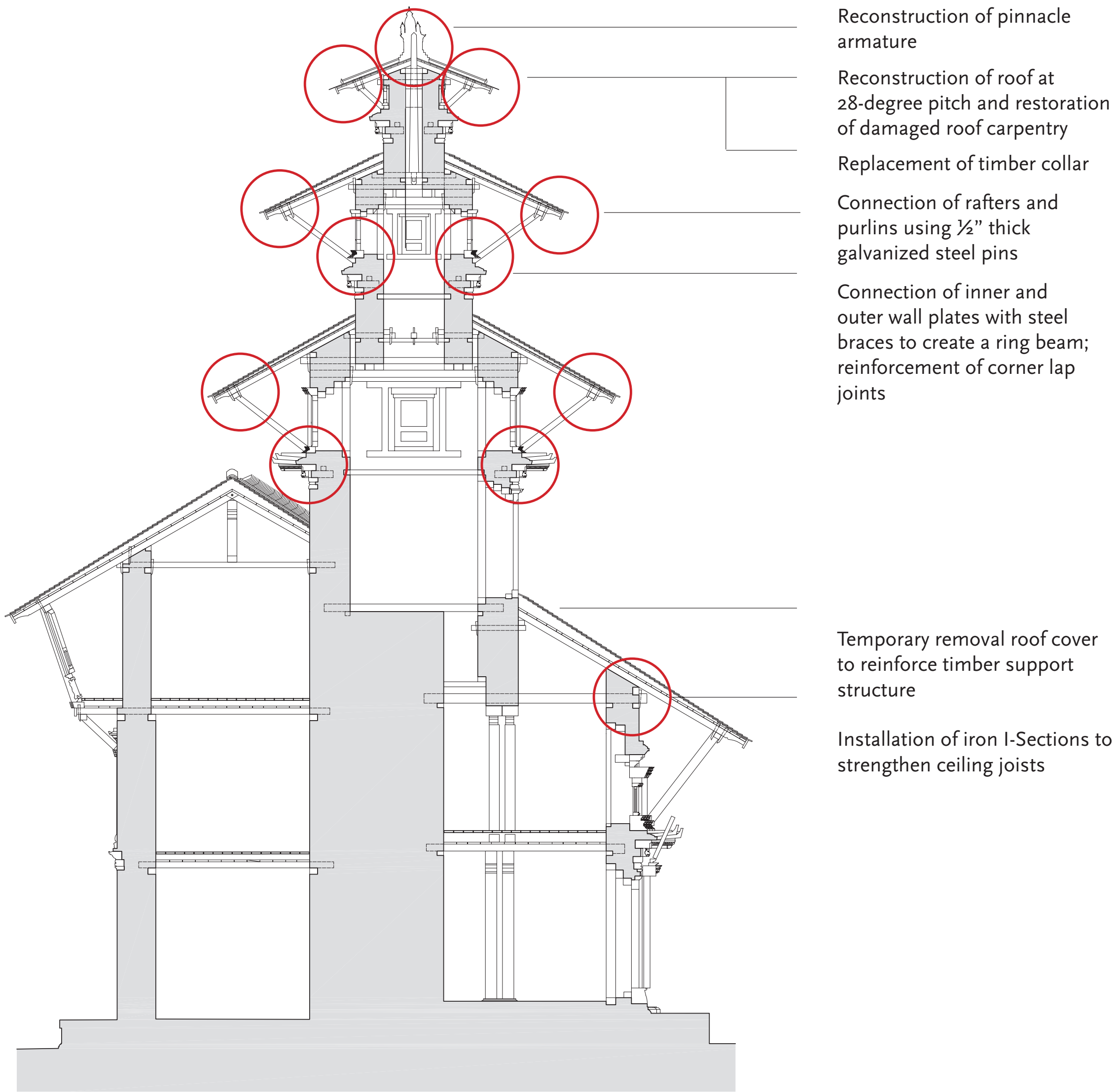


MULCOK, SUNDARICOK, & SOUTH TALEJU TEMPLE | **SOUTH-NORTH SECTION**



left:
Section drawing | 2013
This drawing shows how the temple is made to float above the roofs of Sundaricok and Mulcok. The load of the temple is supported by a masonry core between the two courtyards and timber columns extending into the interior of Mulcok. The roof joists of Mulcok were reinforced with iron I-Sections to strengthen this support structure.

bottom:
Aerial view of Patan Darbar | 2006
This aerial photograph shows the roofscape of Patan Darbar and the temples on the adjoining square. The smallest of the three rooftop temples, the South Taleju Temple occupies a central position between Mulcok and Sundaricok.



SOUTH TALEJU TEMPLE | **SOUTH-NORTH SECTION**

Location of structural interventions | January 2014
The drawing shows the locations of the ongoing structural interventions. The work implemented during the current reporting period was focused primarily on the third tier of the temple.

left:
View through Mulcok | June 2010
This photograph taken during the reconstruction of the south wing of Mulcok shows the masonry core and load-bearing system of timber columns and joists supporting the temple.

right:
Installation of I-Sections | December 2013
As an emergency stabilization measure, iron I-Sections and newly fabricated timber tie-beams were added to the existing ceiling joists to strengthen the rigidity of this crucial support structure.

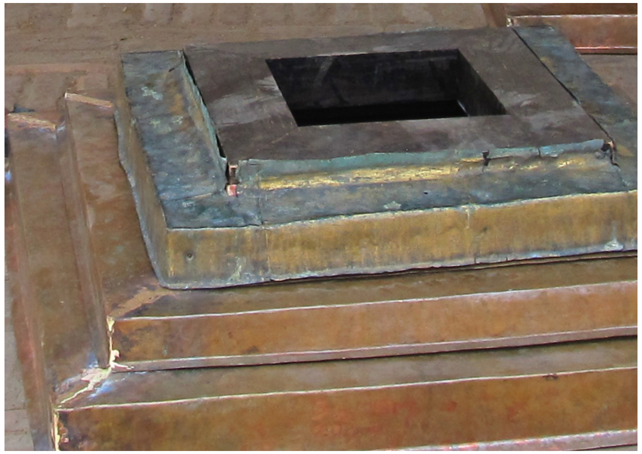
RESTORATION OF THE PINNACLE BASE

Removal of historic gilt sheeting | March 2014
The gilt sheeting was found to be extensively damaged with several holes allowing water to enter the timber structure.

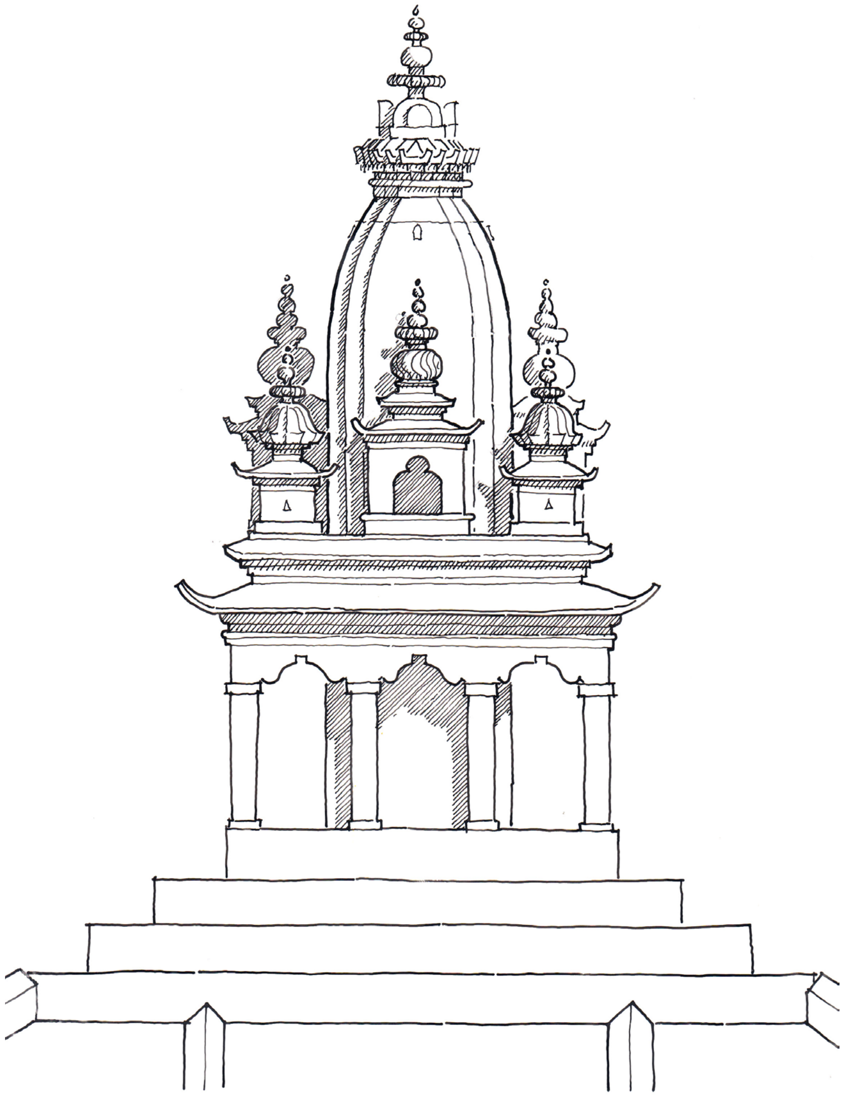
Reconstruction of timber structure | April 2014
Carpenters constructed a new timber structure for the stepped plinth of the miniature *sikhara* temple on the pinnacle.

Sealing with protective copper sheet | April 2014
This protective copper sheet will prevent water infiltration into the timber structure.

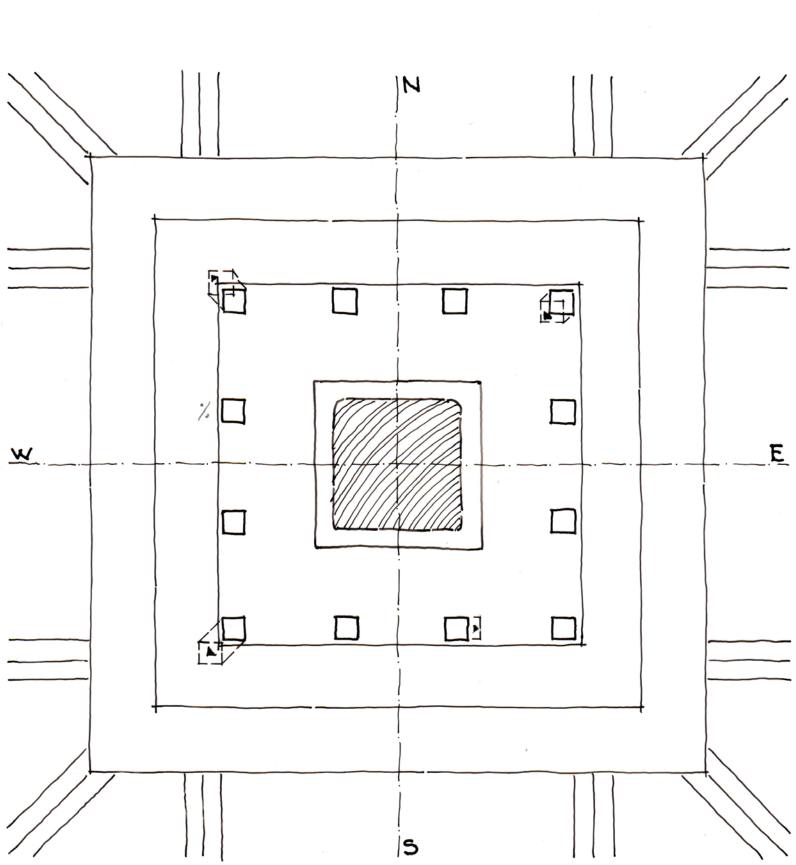
Sealing with protective copper sheet | April 2014



Reassembly of historic gilt sheeting | April 2014
The historic gilt sheet was installed over the new protective copper sheet. This original sheet was left intact since any restoration effort would risk damaging the gilt surface.



PINNACLE | **PROPOSED ELEVATION**



PINNACLE | **PROPOSED PLAN**

Disassembly of damaged roof structure (third tier)

Removal of existing roof cover | April 18, 2014
The removal of the roof cover revealed heavily damaged timber planking.

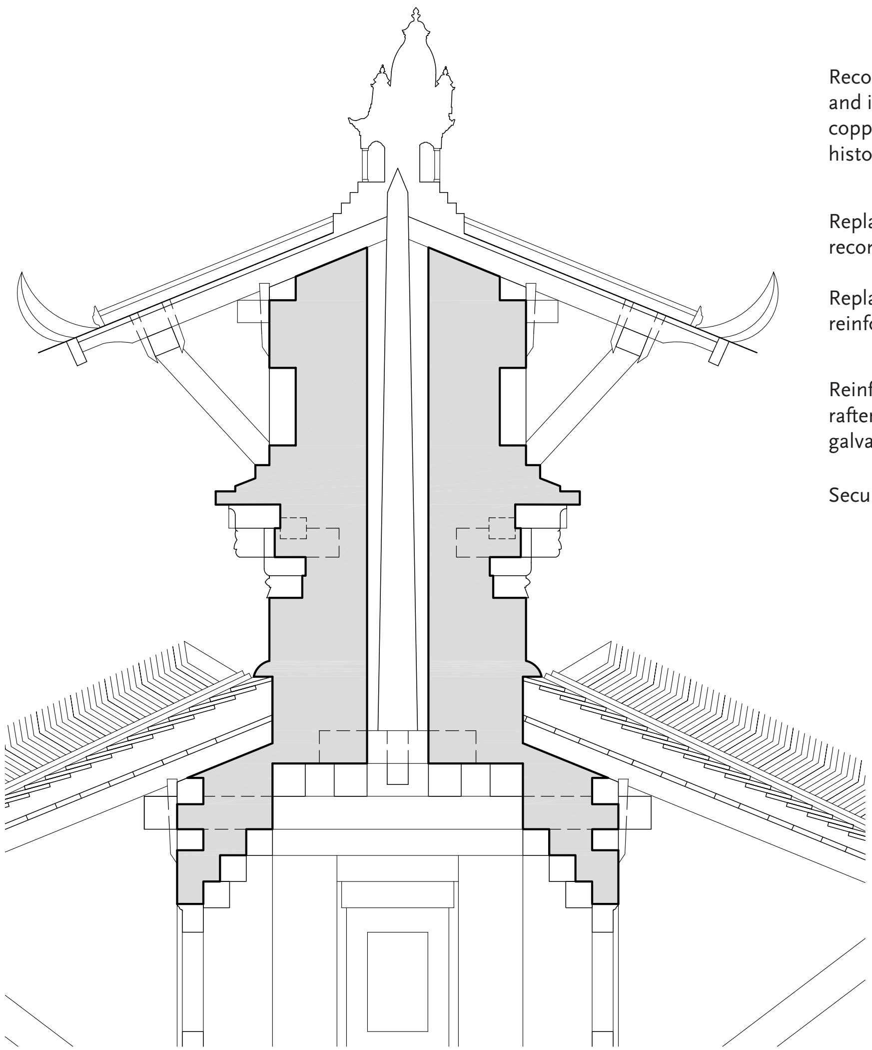
Removal of timber planking | April 22, 2014
The quality of the existing timber varied considerably: relatively new rafters were supported by rotten wall plates.

Inspection of existing rafters | April 22, 2014
All of the rafters were found to be unuseable.

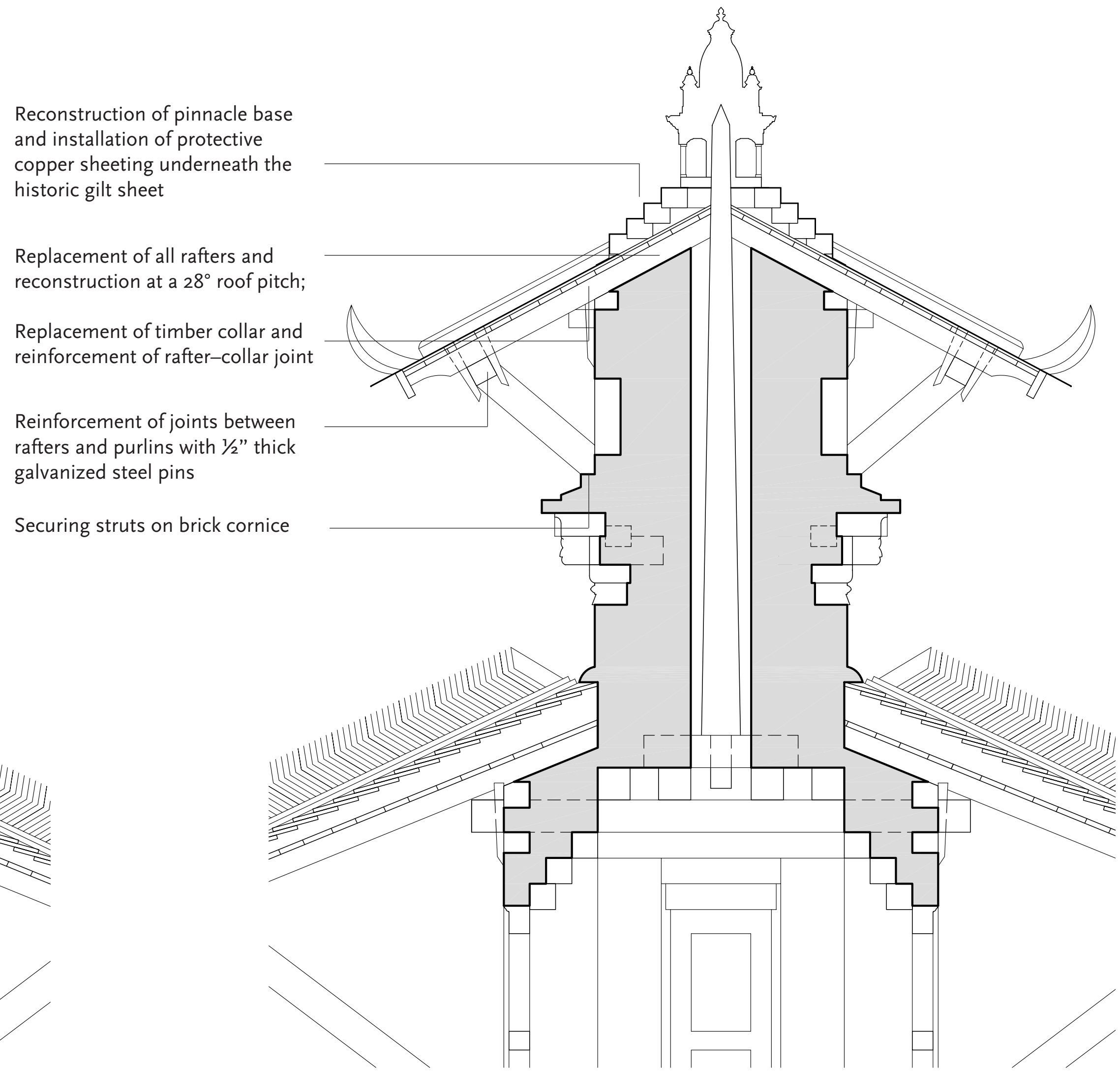
Removal of common rafters | April 22, 2014

Removal of corner rafters and timber collar | April 24, 2014
The existing timber collar beams were found to be rotten.

Reconstruction of masonry walls | April 25, 2014
The masonry wall was raised in preparation for the installation of the newly constructed hardwood collar (*see page 19*)



THIRD TIER | **EXISTING SECTION**

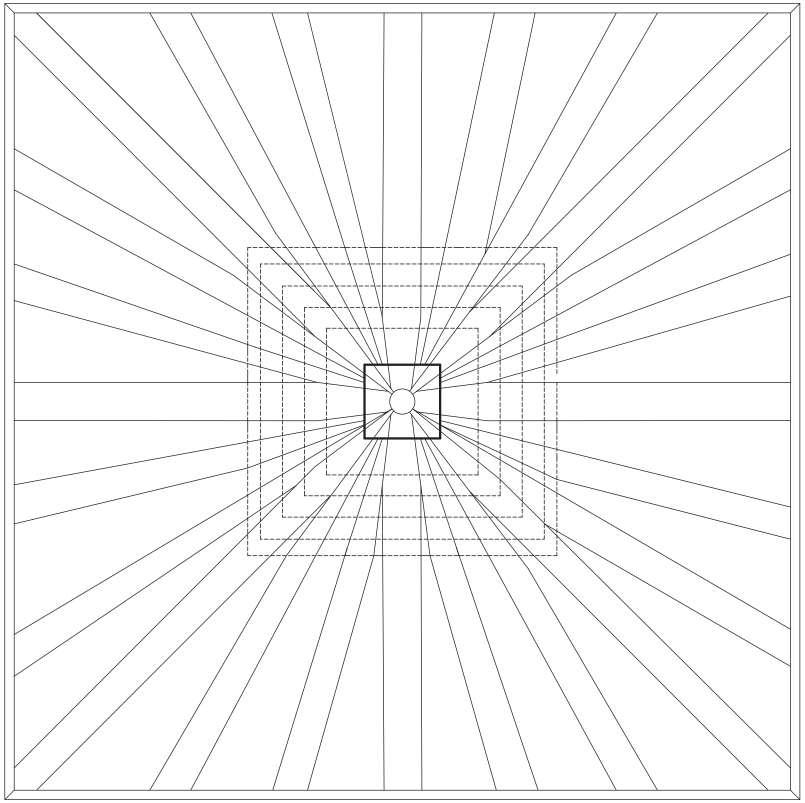


THIRD TIER | **PROPOSED SECTION**

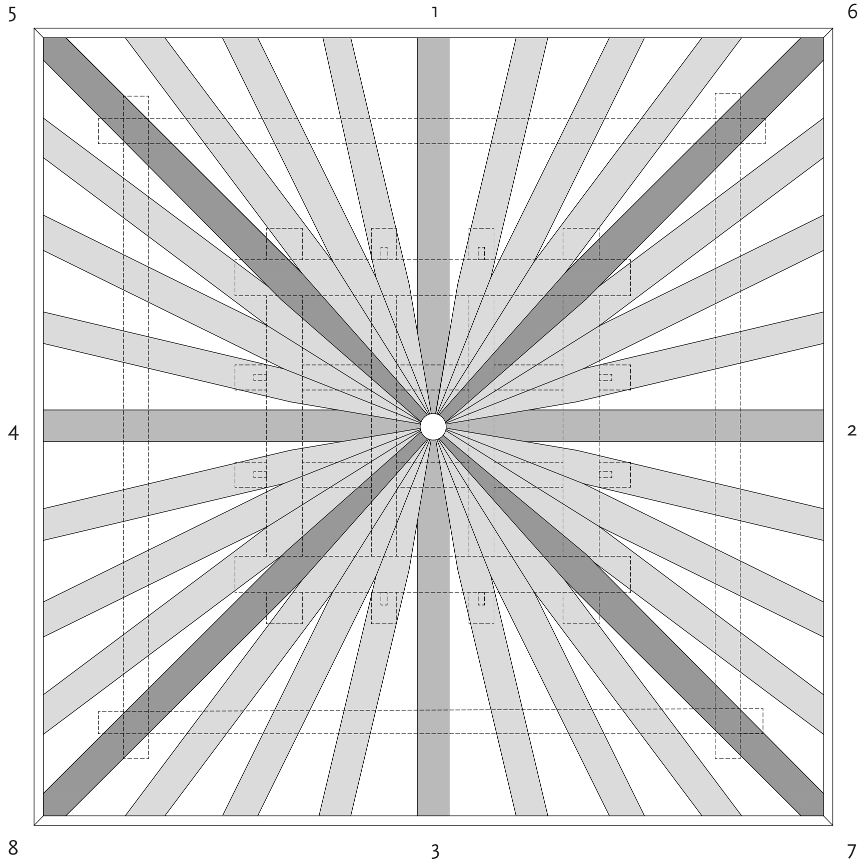


Existing conditions of roof carpentry | April 22, 2014
The roof structure was examined more closely after the removal of rafters. There was considerable variation in the quality of the structural timbers, with several rotten timbers connected to relatively new ones. Some of the timber elements date to the 1938 reconstruction while others were likely added in the 1970s. Up to 75% of the structural timbers were affected by dry rot and in need of replacement. Parts of the interior timber frame have been damaged by water and rising damp. Brick and timber surfaces had also been affected by the acidity of pigeon excrement. The four pigeon nests that were found beneath the rafters were removed.

Rebuilding masonry on the third tier | April 25, 2014
Mud mortar was transported to the top of the temple using a pulley through the gap between the roofs of Mulcok and Sundaricok. The masonry was raised to support the new roof structure. Traditional mud mortar is preferred as it is a flexible bonding material with shock absorbent properties.



THIRD TIER | **EXISTING RAFTER PLAN**



THIRD TIER | **PROPOSED RAFTER PLAN**

Design drawings for rafter assembly | April 2014
The total number of rafters was increased from 24 to 32 to achieve a traditional configuration of closely spaced rafters for improved support. The drawing of the proposed rafter plan indicates the numbered sequence in which the central and corner rafters were installed. Central and corner rafters were made from Sal tree (*Shorea robusta*) wood, a locally available hardwood that is traditionally preferred for its strength and durability. Pine was used for the common rafters.

REASSEMBLY OF RESTORED ROOF CARPENTRY (THIRD TIER)

Reconstruction of timber collar | April 24, 2014
Carpenters fabricated a new timber collar using sal wood. The four timber elements were half-lapped to form a ring anchor.

Installation of timber collar | April 27 2014
The new timber collar was installed on top of the raised masonry on four cross pieces, optimizing the bond of the timber structure to the masonry.

Fixing of rafters | April 27, 2014
A new joint was created 1' above the existing joint to fix the rafters to the existing central timber post.

Fabrication of new rafters | April 28, 2014
New rafters were fabricated by carpenters with reference to the new roof design using both sal wood and pine.

Fixing of central rafters | April 28, 2014
The new rafters were joined to the existing central timber armature.

Assembly of central and corner rafters | April 28, 2014
The central and corner rafters (sal wood) were placed in an alternating sequence before assembly of the common rafters (pine).

left:

Assembly of new rafters | April 28, 2014
The central and corner rafters (Sal wood) were joined to the purlins using traditional timber pegs. In this photograph, common rafters (pine) are being fixed in place before being cut to size.

right:

Reinforcement of rafter–purlin joints | April 30, 2014
½" thick galvanized steel bolts were fixed to alternate rafters to strongly connect them to the purlin.

Rafter–purlin joint | April 30, 2014
Traditional joinery uses timber pegs (*chukul*) to connect rafters to purlins. These joints must be reinforced with steel to provide additional rigidity in the event of seismic movement. In this photograph, a carpenter fixes a ½" thick galvanized steel bolt on alternate rafters on the third tier.

Purlin (sal wood)

Collar (sal wood)

Corner rafters (sal wood)

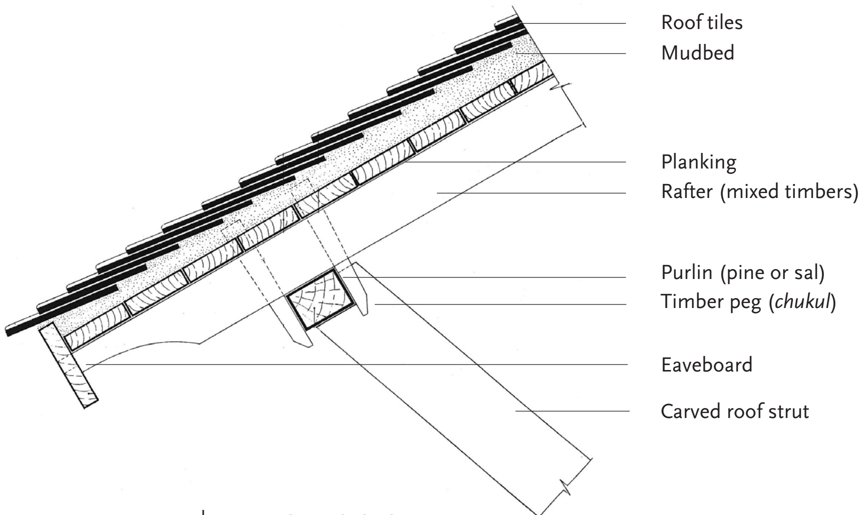
Common rafters (pine)

Central rafters (sal wood)

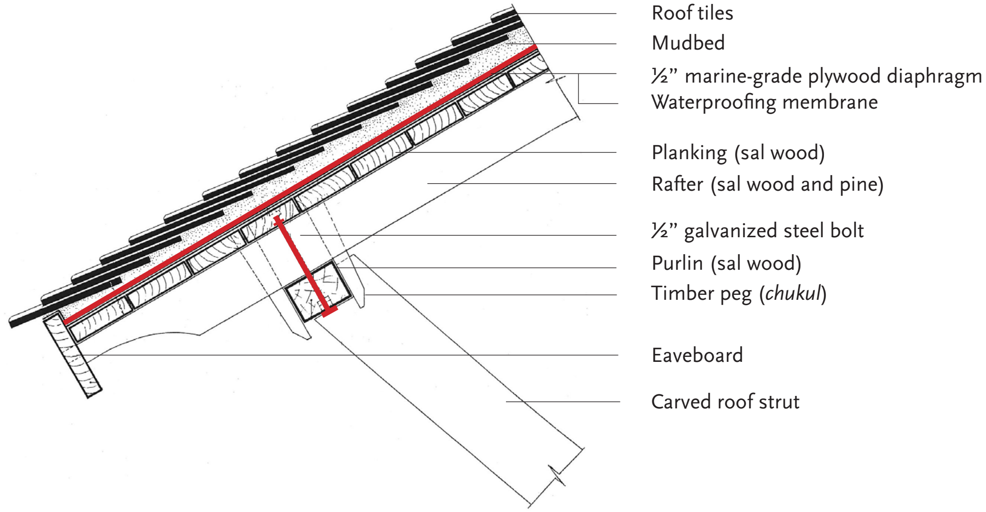
3/8” steel pin

1/2” galvanized steel bolt

Rafter–collar (wall plate) joint | April 30, 2014
In traditional structures the rafters are not notched to the wall plates. This is not sufficient to resist the impact of seismic motion. In this photograph, 3/8” stainless steel pins are being used to join the rafters to the timber collar of the third tier. This will firmly pin the rafter to the plate and thus prevent any downward sliding movement of the rafters.

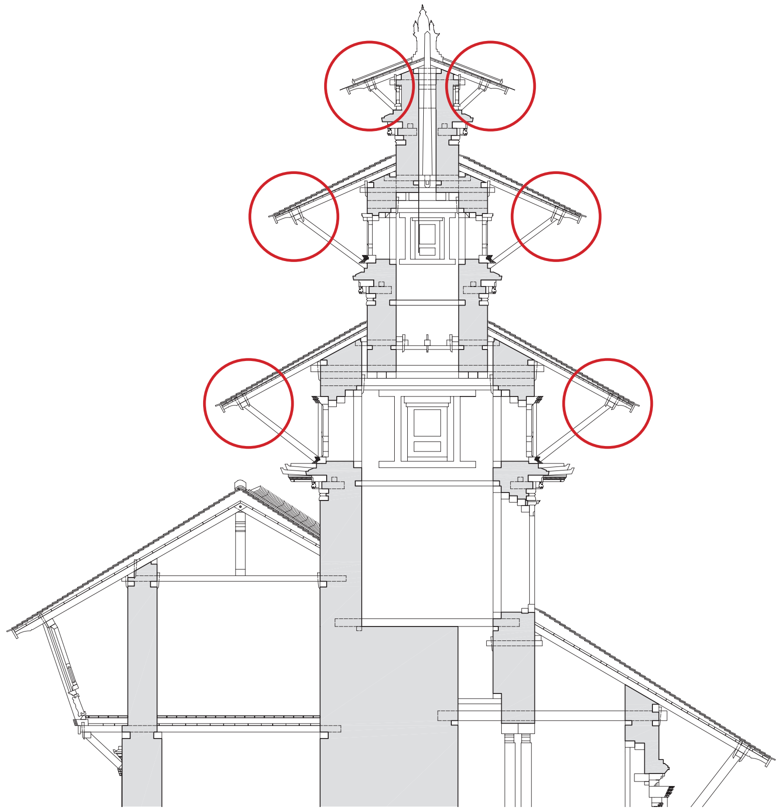


RAFTER–PURLIN JOINT | **TRADITIONAL SECTION**



RAFTER–PURLIN JOINT | **IMPROVED SECTION**

Proposed rafter–purlin joints
During the next reporting period, steel reinforcements will be added to the first and second tiers. The connection of rafters and purlins using steel bolts will prevent the potential separation of the joint during seismic movement. A layer of ½" marine-grade plywood diaphragm will be added on top of the rafters. On the first and second tiers, terracotta roof tiles (*jhingati*) will be placed in mud mortar above plywood diaphragm and waterproofing membrane. On the third tier, the gilt roof cover will be placed directly above the waterproofing membrane.



Second and third tiers | May 2013
This photograph shows the condition of the struts, rafters, and purlins of the second tier. ome of the struts depict Tantric divinities, while others feature various manifestations of Bhairabs and Matrikas. The 6 plain struts dating to 1994 were left intact.

REMOVAL & CLEANING OF DECORATIVE ELEMENTS



Removal of struts from the second tier | March 2014
The carved struts on the second tier were carefully removed. As per the project proposal, no changes were made to the existing collection of struts except for cleaning and removal of paint.



Cleaning of struts and gilt copper sheet | March 2014
The removal of the water-soluble polychrome paint, which dates to King Mahendra's royal coronation in 1956, makes the relief carvings on the struts much more legible. The copper sheet of the third tier was carefully cleaned with plain water and brushes.

left:
Pre-monsoon rainfall | April 30, 2014
During frequent pre-monsoon rains, work was halted and the temple was covered with a tarpaulin sheet. The scaffolding is popular with local crows.

right:
Rato Machendranath procession | May 5, 2014
The Rato Machendranath and Minnath chariots pass through Patan in the early monsoon as an offering to Machendranath, the god of rain. South Taleju Temple can be seen on the top left.