EMERGENCY EARTHQUAKE REPAIRS TO THE TALEJU TEMPLE

FINAL DOCUMENTATION | OCTOBER 2012

SUBMITTED TO

THE PRINCE CLAUS FUND: CULTURAL EMERGENCY RESPONSE PROGRAM

Kathmandu Valley Preservation Trust

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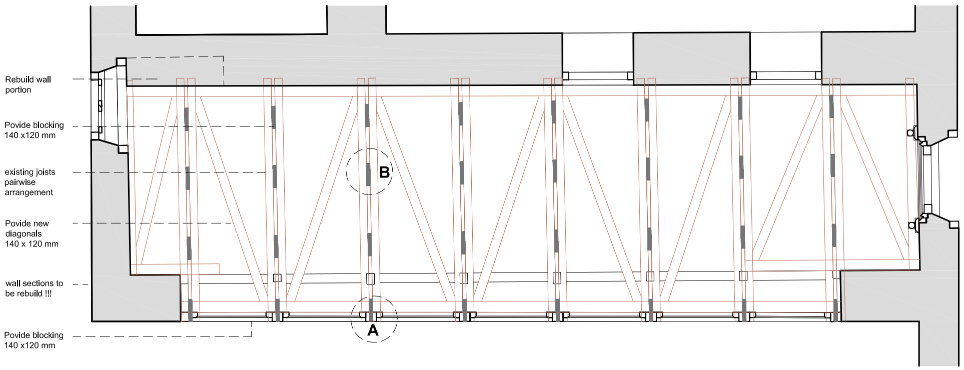
Cover image:
Taleju Temple after restoration | September 2012

Taleju Temple after restoration | October 2012
The small temple in the foreground is also consecrated to Taleju and its structural rehabilitation will be the focus of a future project.

GALLERY LEVEL: DIAGONAL CROSS BRACING WITH STEEL



Gallery level roof: before & after | April, October 2012

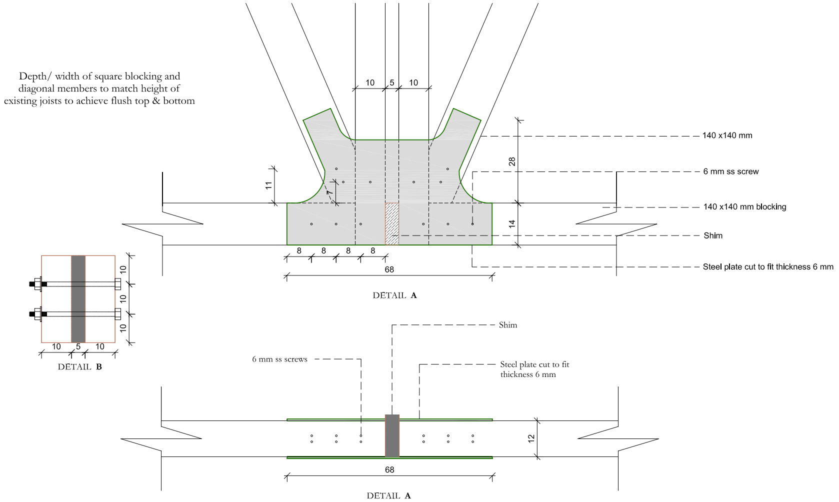
above far left: The east end of the gallery. The roof trusses are spaced widely apart and are not connected to one another. This lack of lateral strength makes them prone to movement in an earthquake and could ultimately lead to the collapse of the whole structure.

above left: Another view of the gallery before restoration.

above: The east end of the gallery level after the installation of steel cross bracing. Diagonal braces effectively tie the horizontal timber beams together, creating a rigid warren truss.

above right: The west end of the gallery level after the installation of steel cross bracing.

left: Drawing detailing the design of the diagonal cross bracing system.



Details of steel cross-bracing of gallery level roof | October 2012

above left: This detail shows how the steel braces are connected to the original timber trusses by means of joining steel plates and steel bolts.

above: Detail of the steel cross-bracing from below. After the introduction of these steel braces, a rigid diaphragm is created, which will limit movement in the event of an earthquake.

left: Drawing detailing the design of the steel plates used to connect the introduced braces to the existing timber trusses.

THIRD LEVEL, SOUTH SIDE: BEFORE & AFTER

South side of the sanctum before restoration | April 2012
Note the sagging of the rafters and the make-shift columns and beam supporting the roof, part of an inadequate recent intervention.

South side of the sanctum after restoration | October 2012
The uncarved columns (seen in the photo at left) were replaced with historic carved columns provided by the Nepal Government's Department of Archaeology. Although not original to this building, these columns date from the same period and are carved with similar motifs used on other timber elements. Also note the newly built roof with all of the bearing timbers replaced.

South side of the sanctum before restoration | April 2012
Note the strip of light along the top of the sanctum's cornice. This light is entering the third level via the large gap between the roof structure and the sanctum's walls. The chief focus of this seismic upgrade was to improve the structural connection between the inner sanctum's masonry structure and the surrounding roof. Also note the poor condition of the plinth.

South side of the sanctum after restoration | October 2012
Note the improved condition of the masonry plinth, which was completely re-built. A new timber frame on the outer edge acts as a brace against seismic movement. The beam supporting the rafters was moved as close to the sanctum's structure as possible, and was connected to the sanctum with steel bolts and straps.

THIRD LEVEL, NORTH SIDE: REBUILT ROOF STRUCTURE AND SUPPORT COLUMNS

Roof before rebuilding | April 2012
Note the sagging of the rafters and the inadequate timber column support.

Roof after restoration | October 2012
After rebuilding, the roof: no longer sags and rafters are placed more closely together, resulting in better support. New timber columns were made and were set significantly farther back in order to provide more efficient support.

THIRD LEVEL: REMOVAL OF PARTITION WALL AND WINDOW REPAIR

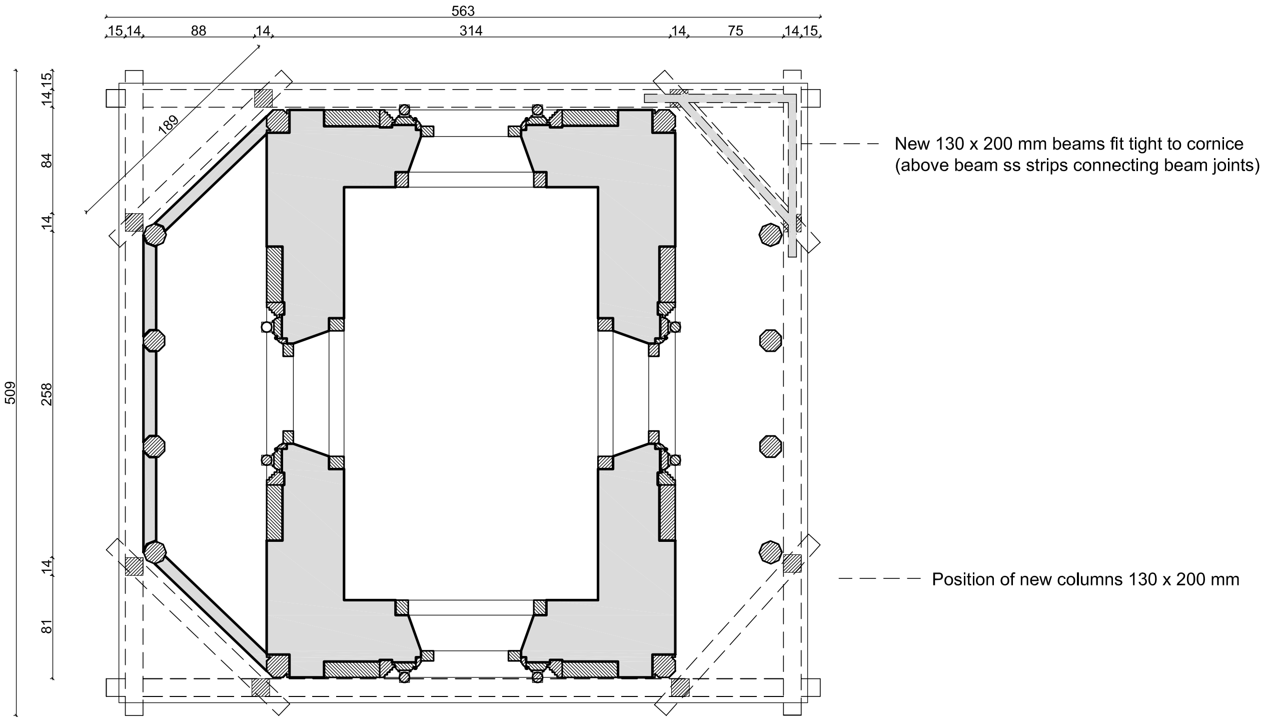
far left (before): The west side of the third level before restoration. Note the presence of a poorly made partition wall which was not original to the building and served no structural purpose.

left (after): The partition wall has been removed, allowing a continuous walkway around the inner sanctum. Also note the new roof timbers and the carved support column.

far left (before): The east-facing wall and the three-bay window prior to restoration. Note the extreme bowing of the beam above the window frame, as it could not support the load of the roof.

left (after): Now the cross beam receives additional support from the window frame and pillars. The structure was additionally secured against movement by the introduction of stainless steel pins securing the rafters to both the cross beam and window frame.

INNER SANCTUM: FORCE-FIT TRANSITION BETWEEN ROOF AND SANCTUM CORNICE



COLUMN AND BEAM DETAIL
TALEJU TEMPLE

New timber support system | Sep 2012
This drawing shows the new timber column and beam support system installed around the inner sanctum. The new position of the columns allows the support beams to be directly joined to the historic wooden cornice and therefore provides a strong tie between inner sanctum walls and roof structure.

Southeast corner of the inner sanctum before rehabilitation | April 2012
The uncarved column in the foreground is not original to the building but was a later addition installed to support the roof.

Southeast corner of the inner sanctum after rehabilitation | October 2012
For the new roof support system historic carved columns were used.
To compensate for the room height, the columns were extended. These columns were strategically placed much closer to the inner structure for maximum support.

Inner sanctum exposed | August 2012
After the dismantling of the third level walls and roof, the inner sanctum stands exposed. Here, work on the rebuilding of the plinth is ongoing.

Installation of new timber support system | August 2012
One of the new horizontal beams which runs along the face of the carved cornice is carefully moved to its position. This beam will serve as the force-fit connection between the roof and the inner sanctum. This will securely connect the roof structure to the inner sanctum core.

Placement of crossbeam atop historic columns | August 2012
As was planned in the original seismic report, the new system of columns and beams was installed around the inner sanctum. Historic columns were used, and were strategically placed before each corner column of the sanctum.

Frontal view of timber support system | August 2012
This photo shows the newly installed columns, capitals, and cross beam along the sanctum's south-facing side.

Corner view of the timber support system | September 2012
This view shows how the cross beams meet at the sanctum's southeast corner. Note that the newly installed system no longer has a column at the plinth's corner.

Inner sanctum after wall re-building | September 2012
Taken from the same perspective as the previous photo, this shows the southeast corner after the walls and roof were re-built. Here the roof rafters are all connected to the new timber cross beam, which is itself connected to the inner sanctum's cornice, uniting all components of the third level: walls, roof and inner sanctum.

INNER SANCTUM: FORCE-FIT TRANSITION BETWEEN ROOF AND CORNICE

far left (before): A detailed view of the roof where it joins the inner sanctum. Note how the gap between the roof and the sanctum has been filled with scraps of wood arranged in a haphazard manner.

left (after): Taken from the same angle, this photograph shows how the roof structure is now properly tied to the inner sanctum. Note how the rafters are directly secured to the inner roof beam, and there are no gaps between the sanctum and the roof.

far left (before): A detail of the gap that originally existed between the carved cornice and the roof structure.

left (after): A detail of the inner roof beam and the carved cornice. The gap that once existed is no longer present as the inner roof beam has been installed directly along the cornice, providing a force-fit transition between the roof and the inner sanctum. The cornice, although now obscured, has not been damaged.

THIRD LEVEL: RE-BUILDING OF SANCTUM PLINTH

far left: The south east corner of the plinth prior to restoration. Note the broken brick and the timber column's precarious placement.

left: The plinth after it has been re-built with new brick and mortar. Here, a carpenter is installing steel corner braces tied with bolts to the timber frame of the plinth. This strong ring beam provides additional strength to the structure and also acts as a solid base for the roof support columns.

far left: The plinth being tiled with traditional terra cotta, *telia*, tile.

left: The southeast corner of the plinth after restoration.

THIRD LEVEL: RE-BUILDING OF WALLS, FLOORS, AND ROOFS

far left: The east-facing wall was beyond in-situ repair after it was badly damaged by the 2011 earthquake. Here the wall is being dismantled.

left: The east wall after dismantling.

left: Continued re-building of the east-facing wall. Note the proper integration of the timber window frame into the masonry.

far left: Re-building of the south-facing wall after repair of the floor joists below.

left: The south-facing wall being rebuilt with new brick in an interlocking arrangement to ensure both the south and east walls are sufficiently tied together.

far left: Though difficult to see, note the timber wall plates joined at the corner with a steel plate for added reinforcement.

left: The east-facing wall being built around the new window frame. The timber frame was properly integrated into the surrounding masonry.

far left: Installation of the repaired and strengthened five-bay window in the south-facing wall.

THIRD LEVEL: COMPLETE RE-BUILDING OF ROOF STRUCTURE

far left: Setting of the first rafters. Note how the rafters are connected to the newly installed inner roof beam, running along the sanctum's cornice.

left: After all the rafters were installed the eaves boards were fitted with through mortise and tenon joints. Traditionally in Newar architecture timber pegs are employed to secure the rafters to the eaves beams, however for additional strength rafters were also pinned with stainless steel rods.

far left: Hardwood planking is being nailed over the rafters. Note the use of stainless steel nails.

left: The continued installation of planking over the roof rafters.

far left: As was done with the floor, plyboard is installed over the roof planking to create a rigid diaphragm.

left: Completed installation of plyboard.

far left: The waterproof membrane is installed over the plyboard. This will protect the timber against any future water infiltration, and acts as a waterproof layer.

left: The traditional terra cotta *jhingati* tiles were installed on traditional yellow mud. In order to reduce the load of the roof structure, the mud bed was kept to the minimum thickness.

THIRD LEVEL: FLOOR FINISHING

far left: A carpenter nails planking over the newly installed and repaired floor joists.

left: A carpenter installs planking over the repaired joists on the south side of the sanctum.

far left: The plywood is installed in a staggered arrangement to create a rigid diaphragm, and is joined to the planking below with the use of stainless steel nails.

left: Brick soling being laid over the plyboard layer.

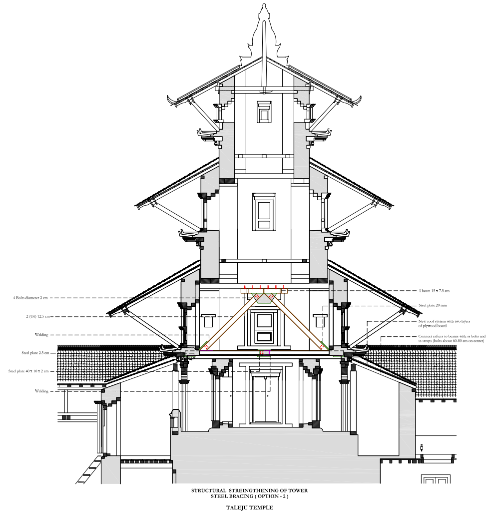
far left: Brick soling being laid in the north west corner of the third level.

left: Traditional terra cotta floor tile *(telia)* is installed over the soling with the use of a traditional lime and brick dust mortar (*surkhi*).

far left: *Telia* floor tile being installed over the soling on the east side of the third level.

left: A view of the south side of the third level after floor tiling was completed.

FOURTH LEVEL: INSTALLATION OF TIMBER A-FRAME BRACES



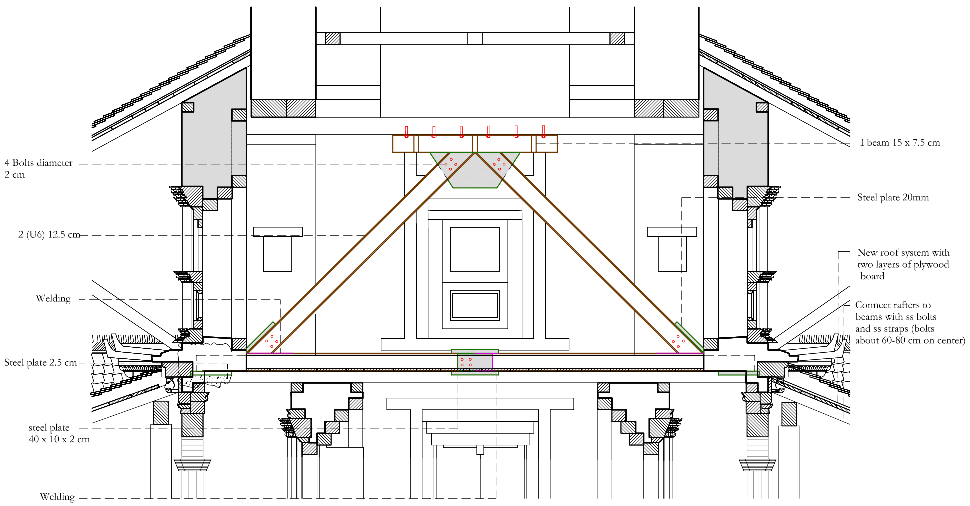
Timber A-frames installed in fourth level | September 2012

above left: A carpenter installs the steel corner braces onto the timber A-frame. These braces serve to strengthen timber joints, and unite all of the timber pieces in the event of seismic movement.

above center: The installed timber A frame at the west end of the fourth level

above right: A thumbnail of the drawing for the timber A-frame installation, showing the A-frames's strategic placement in the fourth level to support the weight of the three roof tiers above.

left: Detail of the timber A-frame drawing



BUDGET OVERVIEW

As is illustrated in the comparative budget overview at right, all originally anticipated and planned activities could be accomplished with only minor variations on the original cost estimate submitted to the Prince Claus Fund in February 2012.

However, only after the structural engineer had carried out a thorough on-site investigation in April 2012 after access to the temple was allowed by the priests, did the need for additional interventions and more extensive re-building became apparent. Two additional major construction components that were not part of the original estimate turned out to be necessary. These included the extensive rebuilding of walls around the third level, and the complete rebuilding of the roof structure. Ensuring such a comprehensive rehabilitation of the structure required additional funding.

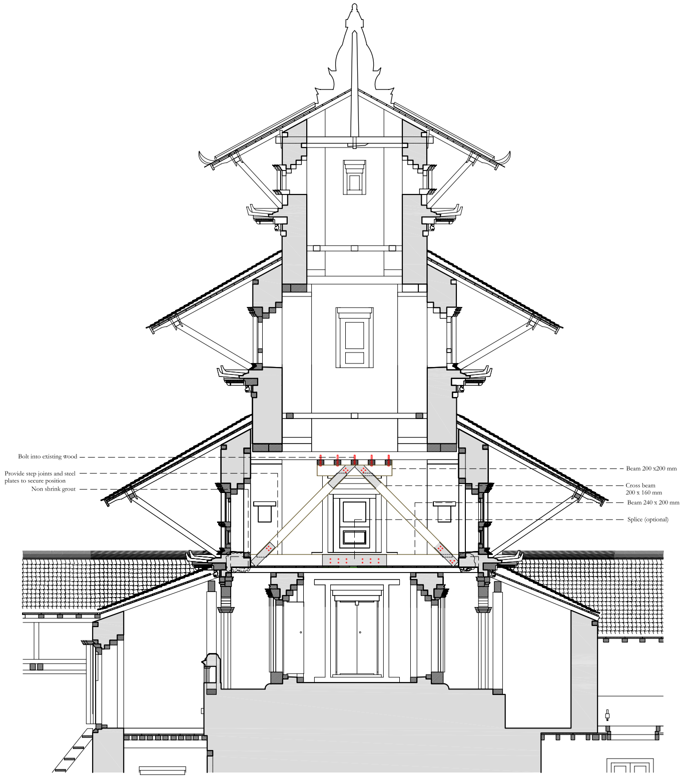
As described in the Final Report to Prince Claus, issues of structurally tying the roof to the inner sanctum required further evaluation and resulted in a revised work plan. The entire roof was found to be far more unstable than initially anticipated, with timbers in poor condition and a complete lack of connections to inner and outer walls. After the structural engineer's final analysis, it became obvious and prudent that rather than retrofit the existing roof structure, the roof would be entirely re-built. This reconstructed roof could be more effectively tied to the inner sanctum and could more easily incorporate additional strengthening measures such as a rigid plywood diaphragm.

The Trust was able to secure additional funding to carry out these important additional measures to the highest possible standards. The temple now benefits from an extremely well built and strong roof that provides additional resistance in the case of seismic movement. The Trust was able to use the Prince Claus Fund award as intended for emergency repairs and seismic strengthening upgrades, and as catalyst funding to more thoroughly upgrade and safeguard the temple.

THE REHABILITATION OF TALEJU TEMPLE: TOTAL PROJECT EXPENSES

Oct 28, 2012

S.n.	Description of Works		Estimated Amount in $	Actual expenses in US $
	Construction cost based on original estimate			
1	Scaffolding and shoring		1,500.00	1,425.63
2	Removal of heavy mud floors and rotten timber componenets		1,250.00	1,267.08
3	Disassembly of serious damaged wall fabric and re-building with historic brick		2,650.00	2,886.58
4	Repair of doors and windows		1,500.00	2,317.24
5	Replacement of damaged wooden joists		3,800.00	3,776.79
6	Hard wood planking above joists		2,300.00	2,179.29
7	Water proof plyboards above planking for horizontal rigidity		1,400.00	595.00
8	Water proofing membrane in flooring on main shrine room		600.00	1,073.21
9	Floor tile (6"x6") finishing above brick soling on lime mortar		900.00	747.56
10	Seismic strengthening and anchoring of walls by means of stainless steel ties and braces		1,500.00	1,395.76
11	Strengthening of timber joinery (roof struts, purlins, wall plates) with stainless steel plates and braces		1,250.00	1,365.32
12	Installation of concealed drainage system		1,350.00	1,470.06
13	Trash disposal/ site clearance		1,500.00	1,523.81
		Total:	**21,500.00**	**22,023.33**
	New roof - additional construction cost incurred			
1	Pine rafters			2,845.57
2	Hard wood planking roof			2,558.93
3	Marine grade plywood			1,050.00
4	Water proofing membrane			1,705.95
5	Yellow mud			916.67
6	40% replacement of jingati roof tiles (materials)			714.29
7	Installation of traditional roof tile (labor)			1,485.95
		Total:		**11,277.36**
				-
	Implementation Team			-
1	Documentation		1,800.00	1,652.00
2	Structural engineer		3,000.00	5,000.00
3	Architect 7 days @ $200/days		1,400.00	1,400.00
4	Site supervision 3 mm @ $350/month		1,050.00	1,050.00
		Total:	**7,250.00**	**9,102.00**
		US $ Grand Total:	**$28,750.00**	**$42,402.69**
		Euro Grand Total:	**€ 22,115.38**	**€ 32,617.45**



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