

RADHA KRISHNA TEMPLE
SWATHA TOL, PATAN

HISTORIC STRUCTURES REPORT
MARCH, 1992

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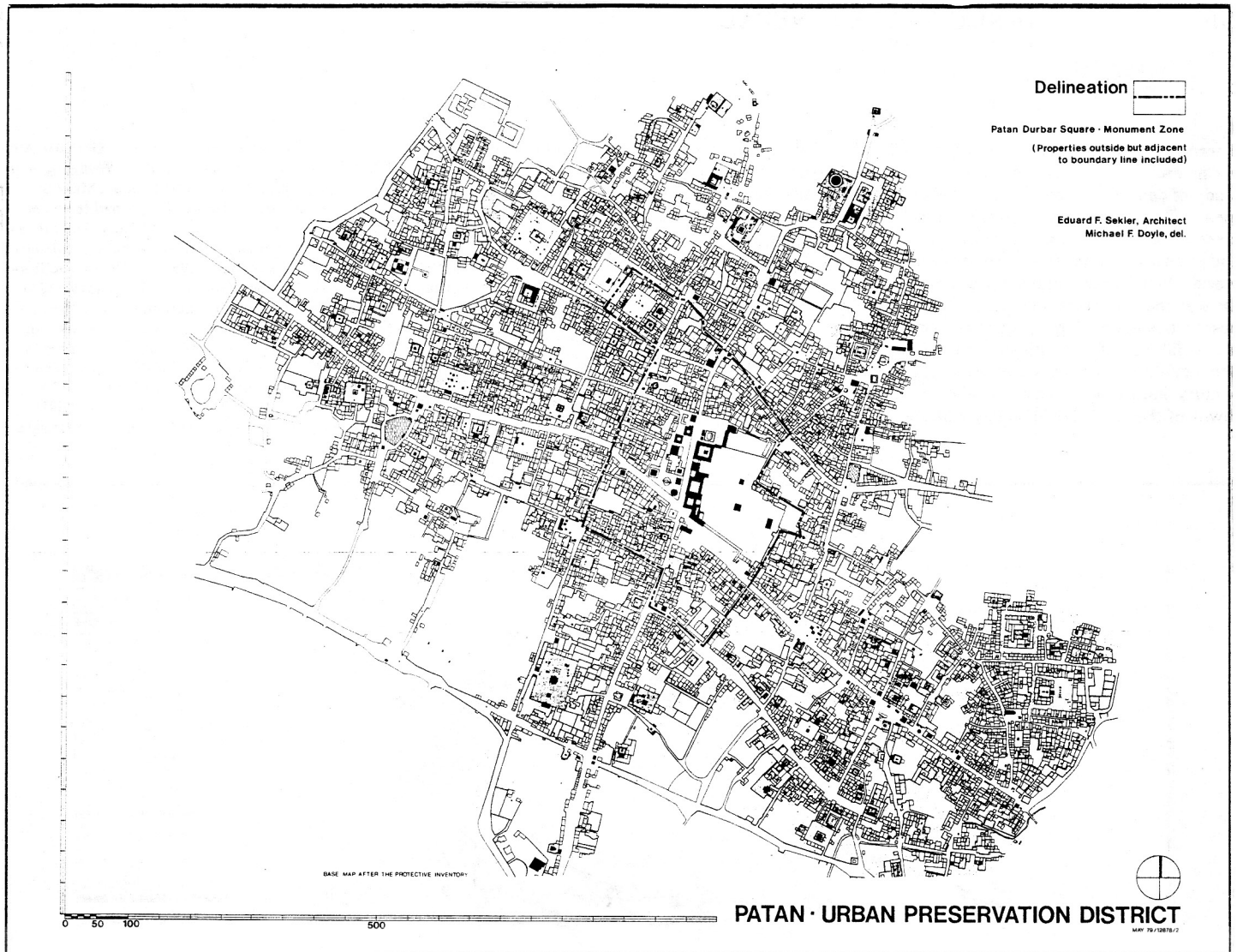
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ABOVE: CITY MAP BY E.F. SEKLER, 1979.
BELOW: THE TEMPLE SEEN FROM THE SOUTHWEST, JANUARY, 1992.

1.0 Introduction

This finely proportioned three-tiered roof brick and timber temple of 1668 is an outstanding example of the Nepalese pagoda style temple built in the era of the Malla kings (1400-1768). Included in the Patan Darbar Square World Heritage Site, the temple to Krishna, an incarnation of Vishnu, and his consort sits on a small harmonious square just north of the Darbar Square.

This square at Svatha Tol retains numerous historical buildings, temples, and small shrines including: (1) a Licchavi period stone *caitya* (6th-9th century) on a later masonry base; (2) the two-tiered Svatha Narayan temple, probably an exact contemporary to the Radha Krishna¹; (3) a 17th century stone *sikhara* temple to Narayan (much altered after the 1934 earthquake); (4) a deep well (Malla period?); (5) a Malla period stone drinking fountain (Newāri-*jahrū*); (6) a one story resthouse or *sat aḥ*, dating from the 19th century; and (7) the stone pavement of a lost miniature shrine with an aniconic Śiva image (keys in the stones indicate this lost superstructure).

The square is defined by some thirteen houses, eleven of which retain their traditional facades dating from the 19th and early 20th centuries. A few earlier carved timber windows of the 17th-18th centuries survive on the Ragubamsi house due west of the temple, both on the square and in two interior courtyards.

Urbanistically, the ensemble at Svatha forms an auxiliary square to the Darbar Square, visible from the royal square and connected by Patan's north-south axial road. The rows of houses between the Darbar and Svatha Squares are notably intact ensembles of traditional 19th and 20th century houses in Patan, while the gentle curve of this lane creates fine views in both directions. Most importantly, the silhouette of the Radha Krishna temple figures prominently in the skyline of the Darbar Square: it punctuates the series of temples which frame the view north to the high mountains from the square, as seen in the 19th century photograph by Gustave LeBon.

Like all buildings in the seismically active Kathmandu Valley, this temple shows many signs of rebuilding and repair over the centuries, but notably retains 18 of 20 original lower roof struts, virtuoso pieces of Nepalese woodcarving. Certain lintel and cornice woodcarvings on the base story are representative of the best of the Malla period as well, although many carved panels and other decorative elements on this and other levels have been lost or stolen. Moreover, the temple appears to retain its original configuration of

¹Gail, p.31.

roofs as it is referred to in a Malla period chronicle as the "three-roofed temple at Svatha"².

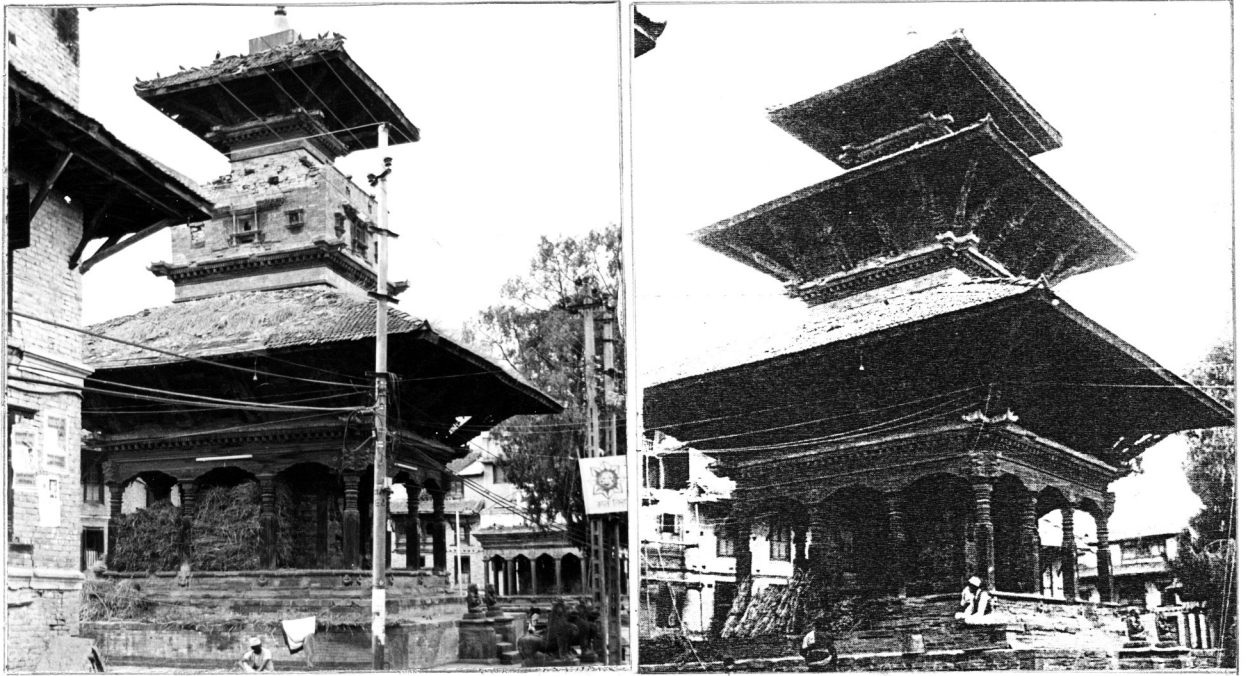
At the beginning of the monsoon of 1989 after several days of continuous light rain, the middle roof of this temple collapsed³ and was subsequently dismantled. The Newar pagoda temples are especially susceptible to roof damage: ineffective historical detailing of the roof cover together with a monsoon climate makes the roof structure with enormous overhangs the Achilles' tendon of these monuments. Although the temple priest (*pujārī*), Dhana Raj Kant Rajupadhya, applied for repair funds from the Guthi Sansthan, a government trust responsible for monument maintenance, funds were not available and further damage caused by water penetration has gone unchecked.

This report is made after a detailed examination of the building December 1991--March 1992 during which time bamboo scaffolding was erected and the damaged tile, mud, and planking cover of the upper and lower roofs was removed to allow inspection of the timber roof and masonry core structures. Inspections were carried out by Constance Stromberg, objects conservator; Manohar Rajbhandari and Prayag Raj Joshi, structural engineers; Nutan Sharma, historian; Mr. B. S. Thapa, Deputy Chief of the Patan Conservation Lab; Niels Gutschow, architect; and Erich Theophile, KVPT project officer. Photographic documentation and measured drawings were prepared by architects Deepak Pant and Rohit Ranjitkar and draftsman Sushil Rajbhandari under the supervision of Erich Theophile. Drawings were prepared in feet and inches according to the working method of the local craftsmen.

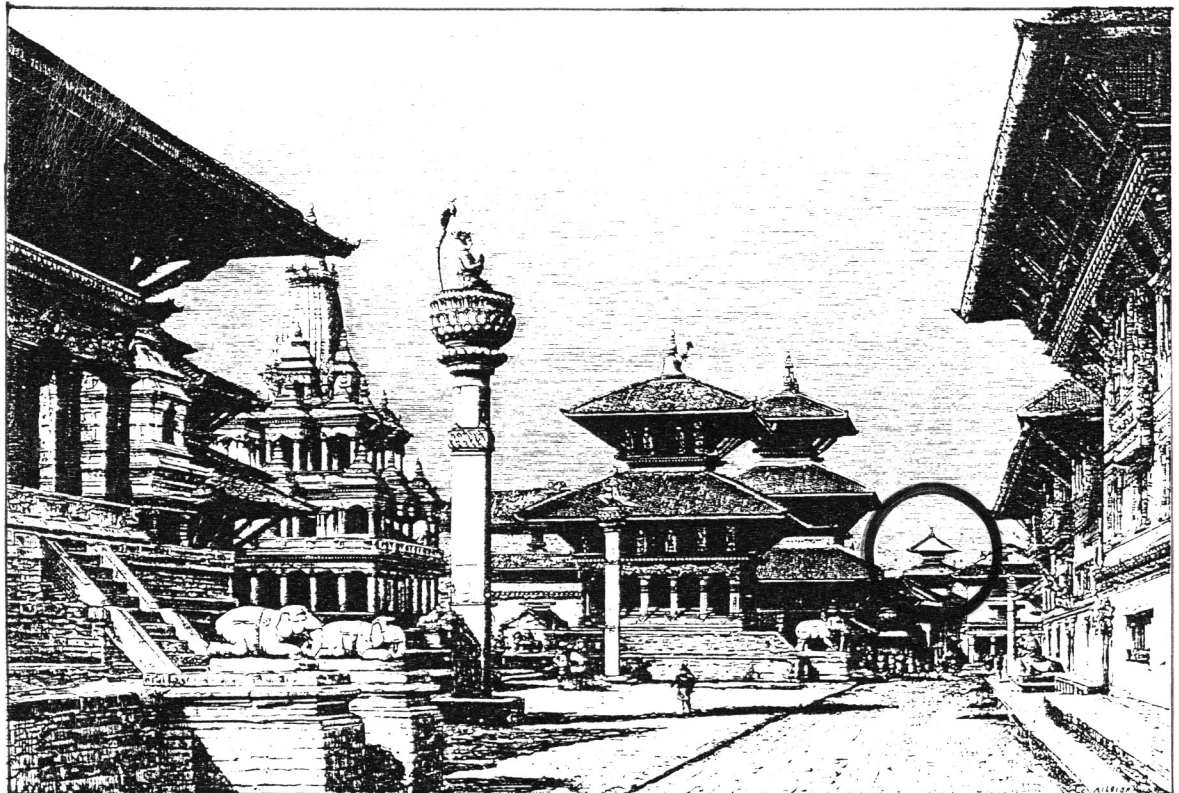
² The only historical mention of the temple found to date attributes the construction of the temple in 1668 (Nepal Samvat 789) to the illegitimate son of Patan's King Siddhi Narsing Malla, Kriti Singh Malla. From *Bhāsā Bhamśāvalī*, translated by Devi Prasad Lasal, rpt. HMG Department of Archaeology B.S. 2023, p. 69.

Some temples in the Kathmandu Valley have acquired additional roofs in later rebuildings such as the Narayan Temple at Cikāmgul, Kathmandu and Panauti's Indresvara Mahadeva.

³ 14th day of Jestha B.S. 2046, May 30, 1989, recorded by the temple priest.



THE TEMPLE FROM THE SOUTHEAST IN 1991 AND 1974,
RESPECTIVELY (1974 PHOTOGRAPH FROM KATHMANDU VALLEY: A PROTECTIVE INVENTORY).



PATAN DARBAR SQUARE LOOKING NORTH.
ENGRAVING AFTER A PHOTOGRAPH BY LEBON (FROM VOYAGE TO NEPAL, 1986 RPT.) RADHA
KRISHNA TEMPLE IS CIRCLED.

2.0 Brief history

In addition to the dating of historical building elements on stylistic grounds, the most common method of dating monuments in the Kathmandu Valley is through *in situ* inscriptions which generally describe the foundation and donors of religious buildings. In the 1975 publication, Kathmandu Valley--The Preservation of Physical Environment and Cultural Heritage, the inscription of the Radha Krishna temple is mentioned, but the date described as illegible⁴. Seventeen years later, the inscription has disappeared as is the case, very curiously, in many of the temples in and around Patan Darbar Square.⁵ Documentation of this lost inscription has not been found.

Local tradition maintains that the temple was the private donation of the prosperous local clan called Raghubamsi⁶ resident in the houses and courtyards west of the temple. The legend purports that the Radha Krishna temple was constructed for a first wife while the adjacent stone Narayan temple was built slightly later for a jealous second wife of the donor.

The fortunate mention of the "three-roofed temple at Svatha" in one of the 18th century chronicles attributes the temple construction to Kriti Singh Malla, the illegitimate son of King Siddhi Narasimha Malla in 1668⁷.

This 17th century dating is consistent with the carving style and detail of the lower roof struts as well as with other intact decorative carvings. A direct comparison can be made between the Radha Krishna Temple at Svatha and the contemporary two story Svatha Narayan temple across the lane: this temple and its intact decorative carvings have been studied and dated to the years 1666-1674, the reign of Srinivasa Malla.⁸ The Radha Krishna carvings are comparable stylistically with those at Svatha Narayan, although it may be mentioned that the larger size and artistic expressiveness of the Radha Krishna elements make them far more impressive.

The verticality of the temple is typical of the 16th through 18th centuries. During this period an historical trend favored multi-tiered temples and raised the buildings on high stepped plinths--symbolic of the ambitions of the Malla kings⁹. These taller structures

⁴Pruscha, v.I p. 235. The temple's inventory # BP 139.

⁵ as documented by Nutan Sharma in ongoing research for the German-funded Patan Conservation and Development Programme.

⁶(Newari: *Raghu* from the Sanskrit *Ragunāth* meaning descendants of Ram, another incarnation of Vishnu; *Bamsi*=clan, Newāri).

⁷*Bhāsā Bhāṣāvalī*, p.69.

⁸Gail, p. 31.

⁹ Niels Gutschow's unpublished documentation of the evolution of Buddhist caityas in the Kathmandu Valley identifies parallel trends in caitya and multi-tiered temple constructions.



LOWER ROOF STRUT #109

THE STRUT, ORIGINAL TO THE TEMPLE (1668) INCLUDES ARMS ADDED IN 1967. DARK PATCH ON LEFT FIGURE IS MILDEW, DISCUSSED UNDER 5.06. PHOTOGRAPH MARCH, 1992.



DETAIL OF 1885 LEBON PHOTOGRAPH
(VOYAGE TO NEPAL, 1986 RPT.), ENLARGED BY PROJECT NOTE PROPORTION OF PINNACLE BASE
(DARK RECTANGLE) DISCUSSED UNDER 5.06.

contrast more squat and massive examples on low plinths of the early Malla period (1400-1650).

Little documentary evidence such as manuscripts or photographs has been found to shed light on the intervening centuries of the temple's history¹⁰. The building fabric of the temple shows signs of at least one renovation in the 19th century (discussed in detail next chapter), while recent repairs in 1967 and 1982 are easily discernable and have been confirmed by interviews with local elders. An early photograph of this building by LeBon in 1886¹¹ (in which the temple is partially visible from the Darbar Square) shows the temple in its present form. A photograph taken just after the 1934 earthquake, again from the Darbar Square, shows the upper roof intact¹².

According to the present *pujārī*, Mr Dhana Raj Kant Rajupadhya, it was during the 1967 renovation by the Guthi Sansthan that the government authority, concerned about the absence of daily worship (*nitya pūjā*) at Radha Krishna, extended his father's responsibilities from the adjacent Svatha Narayan temple to include the Radha Krishna temple¹³. At the same time new stone icons were consecrated in the temple's sanctuary as the originals were missing or damaged. These clothed stone images include Laxmi, the wife of Vishnu, in addition to Vishnu's incarnation, Krishna, and his consort, Radha.

Possibly because of the lack of continuity of patronage, the case of many temples of royal donation in the Malla era, there are no particular seasonal or annual rituals performed at the temple. Notably, a *pūjā* for the anniversary of the temple's founding, celebrated at most temples, is here not performed.

¹⁰ Inquiries have been made at the Kaiser Library, Guthi Sansthan, and the National Archives.

¹¹ LeBon, p. 86.

¹² Samsera, p.224.

¹³ Dhana Raj (b. 1950) assumed these responsibilities after his father's death in 1986. The *nitya puja* was endowed by a payment of 300 Rp. every six months.

3.0 Construction history

Due to the lack of documentary evidence, close study of the age of the building structure and fabric has been made to attempt a description of the building's construction history. Annotated section and elevational drawings record the estimated dates of many small and major changes. Most significantly, certain timber elements, in particular the carved wooden roof struts, suggest that at least one major rebuilding of the upper two storeys took place in the 19th century. The lower story seems intact except for superficial changes made during renovations in 1967 and 1982.

On the two upper storeys three generations of roof struts, that is, of different time periods, are discernable. This analysis is based on stylistic comparison and inspection of the patina by the project team together with two senior woodcarvers (who worked many years on the Hanuman Dhoka restoration) and Hem Raj Sakya, a local historian and scholar. The oldest group of struts (#212, 213, 219, 304, 308) may be original to the temple. The second and predominant group of struts (# 201-206, 208-211, 214-217, 218-220) probably dates from the 19th century. In addition several struts from the 1967 renovation (#207,218) and from other temples (#301,302,305,307,310,311) are found.

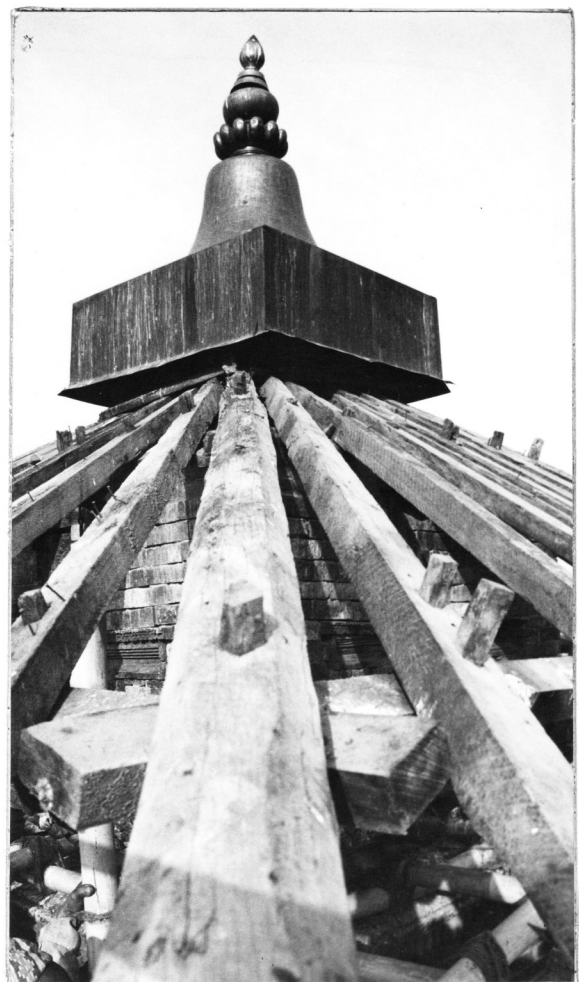
This group of 16 middle roof struts from the 19th century suggests a major rebuilding at that time. This hypothesis is supported by the visual characteristics of the interior timber structural framing of the upper levels, which unlike that of the ground floor ceiling, does not exhibit signs of great age, although it must be added that protected and inaccessible interior timber framing is difficult to date by inspection.

This reconstruction could be hypothesized after one of the several earthquakes which hit Nepal in the early 19th century in the years 1810, 1823, and 1833¹⁴.

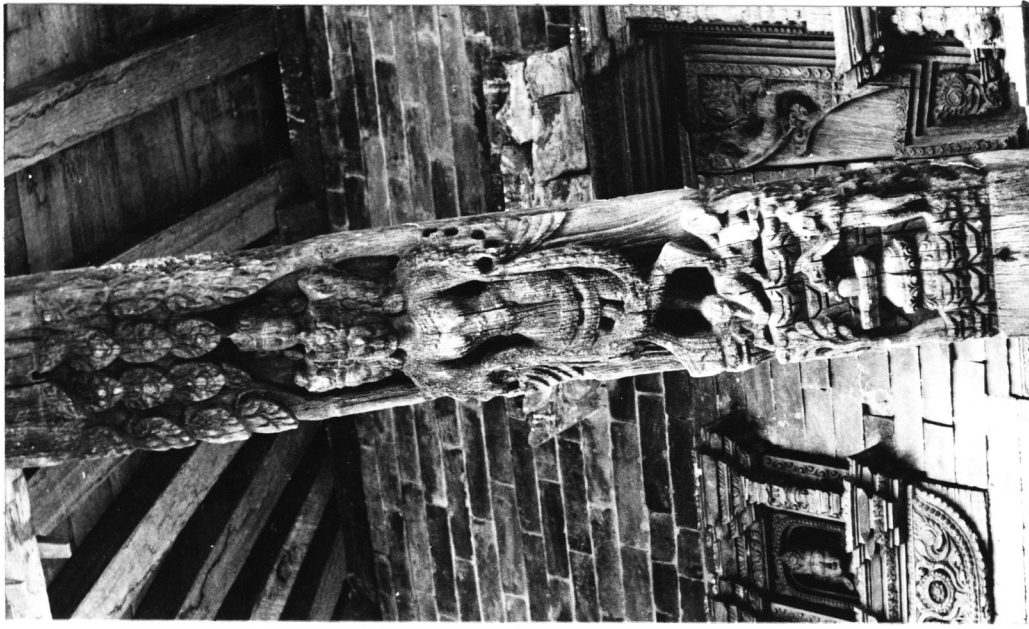
Struts which appear to date from the 20th century are found at corner locations of the upper roof. We have no hypothesis to explain the fitting of these elements. Only two original struts survive at that level (#304, 308), mixed with six struts from other buildings.

The veneer brick (*dachi apā*) of the upper two levels of the temple is consistently of a slightly more reddish color than that of the base story and plinth. This could support the hypothesis of a 19th century reconstruction or could simply be related to different firing qualities of contemporary brick—even in a reconstruction the original brick would have

¹⁴Wright, pp 265, 267, 269. The greatest of which appears to be that of 1833 whose account includes the number of houses and temples damaged or destroyed in the three cities of the Valley including 17 temples in Patan (p 269).



LEFT: VIEW FROM NORTHEAST, JANUARY 1992. **RIGHT:** GILT PINNACLE WITH PLAIN COPPER SHEET BASE ADDED IN 1967, MARCH 1992. DISCUSSED UNDER 5.06.



THREE GENERATIONS OF ROOF STRUTS AT THE MIDDLE LEVEL.
FROM LEFT: STRUTS CIRCA 1967, 19TH C. AND ORIGINAL (1668). (INVENTORY # 207, 201, 213)

probably been reused--as were timber cornices and windows of the upper levels whose surface quality and craftsmanship appear to be original. The brick wall construction at all levels is consistent in jointing and use of mud mortar except for several recent and obvious patches.

Typical minor additions of the last 150 years include iron fretted angles with decorative bird heads at the eave board corners and iron straps connecting rafter heads to eaveboard. Such elements are found on the adjacent residential buildings as well.

The great earthquake of 1934 which destroyed much of the valley architecture seems not to have greatly damaged the Radha Krishna temple. A photograph taken just after the 1934 earthquake, which documents the near ruin of the Darbar Square, demonstrates that at least the upper roof was not damaged on the southern or eastern sides. The lack of damage to the temple has been confirmed by local elders.

The most recent renovation was carried out in 1967. This work was documented in the records of the Guthi Sansthan, although all of the records with the exception of one letter which records construction costs of 31,000 NRps. have been lost. According to locals, an early photograph of the temple from the collection of the Department of Archaeology was used in the 1967 renovation, but has since been lost, perhaps in the great fire of Singha Darbar where many of the Department's collections were housed.

The repairs of 1967 are easily identified and have also been reported by a local craftsman involved in the project. Numerous roof rafters were replaced by machine-sawn members, smaller in section than older although undated adze-hewn (Nep.*basila*) timbers. Planking, mud, and tile cover was redone incorporating many old planks. New upper story blind windows were inserted in historical locations--it is not known if the originals were lost or damaged. Three new struts were carved and inscribed with dates (see inventory). The pinnacle (Nep.*gajūra*) structure was modified to include a plain copper sheet base instead of the traditional layers of carved brick and the upper level of the plinth.

Most recently in 1982 small improvements were made to the temple with funding from the Department of Archaeology. The work consists of pointing of some areas of the lowest story facade and uppermost plinth in a *surkhi* (brick dust-cement-sand) mortar of a typical orange color. At the same time stone paving replaced the historical stone or tile of the base level ambulatory and sanctuary.

4.0 Architectural description

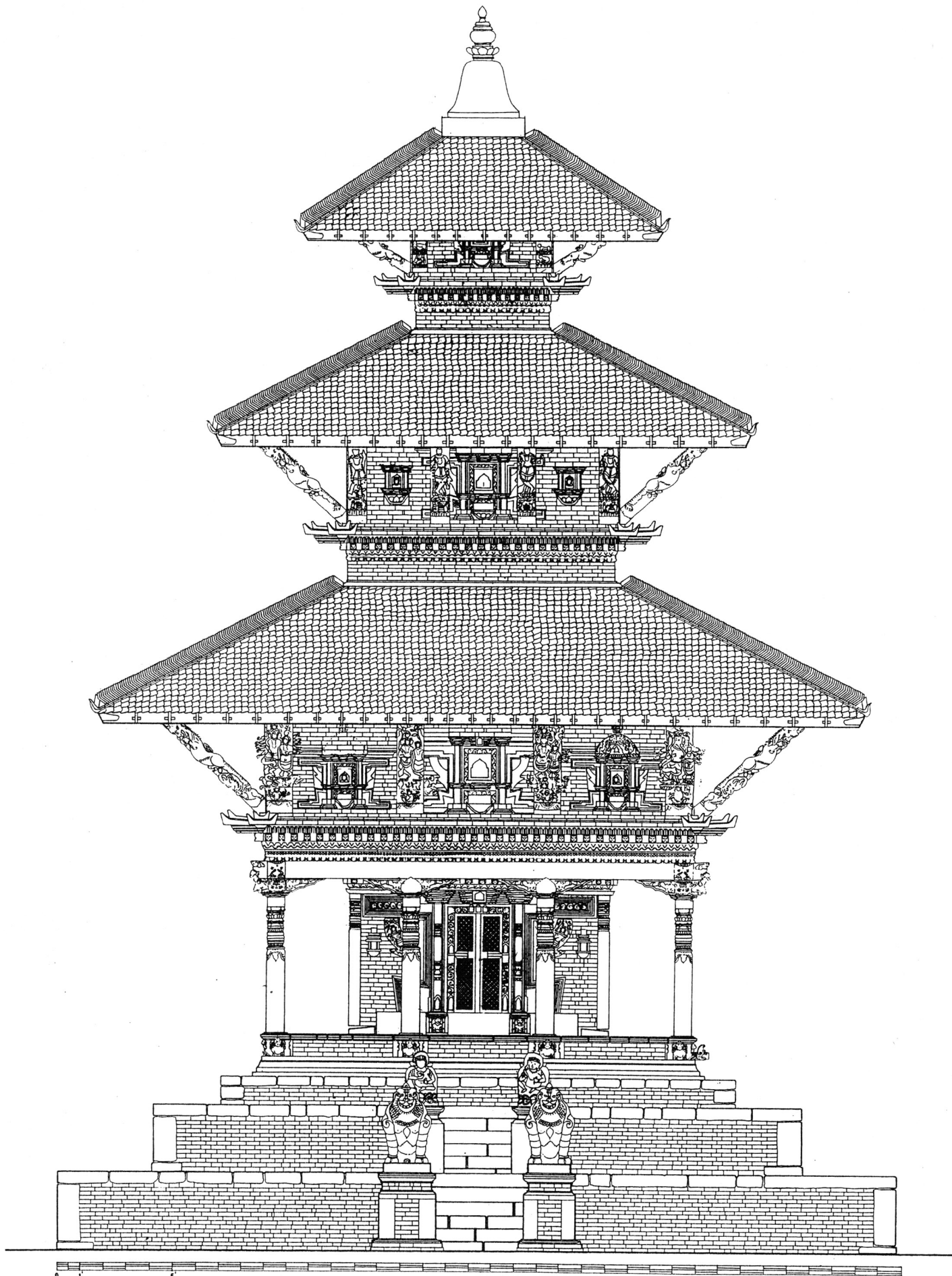
The ground plan of the temple consists of a perfectly symmetrical square brick masonry cella (11'5"x11'5") punctuated by four timber-framed door openings and wrapped by a continuous timber arcade. The cella, the sanctuary of the temple housing its religious icons, and the open air ambulatory which is defined by the timber arcade, sit atop a three-tiered brick and stone-faced plinth. Stone steps and guardian statuary set into the plinth on the east side, define the entrance. The religious icons sit on a large stone pedestal within the sanctuary facing the eastern door; the other three doors are not used.

Above the timber pillars of the ambulatory, a massive timber lintel supports masonry walls of the largest base story (outer dimensions: 18'7" x 18'8-1/2") on which the lowest of three roofs rests. Within this base story is found the only upper floor level consisting of a narrow passage above the ambulatory. This space is accessed by an opening in the floor framing; there is no access into the inner core area above the sanctuary.

The cella forms a masonry structural core of walls 26"-28" thick which extend vertically above the lower roof to support a second and middle roof. The masonry walls of the smallest, uppermost level of the temple, a square cella with outer dimensions of 5'10", rest on timber beams within the volume of the structural core. These walls are thus discontinuous with the lower masonry structure. There are no floor levels in the upper structure.

The visually dominant timber framed roof consists of four-sided pent roofs at each of the three levels with considerable overhangs (7'6", 6'0", and 4'9" from the bottom up) supported by purlins, which are in turn supported by inclined timber struts. The timber struts rest on continuous timber and carved brick cornices which protrude from the wall structure. The entire roof structure is surmounted by a gilt pinnacle (Nepālī: *gajūra*), itself set upon a small copper-sheathed pedestal of recent date. The massive lower roof (outer dimensions at eavesboard 33'3"x 33'5") overhangs, but does not extend beyond the bottom level of the plinth.

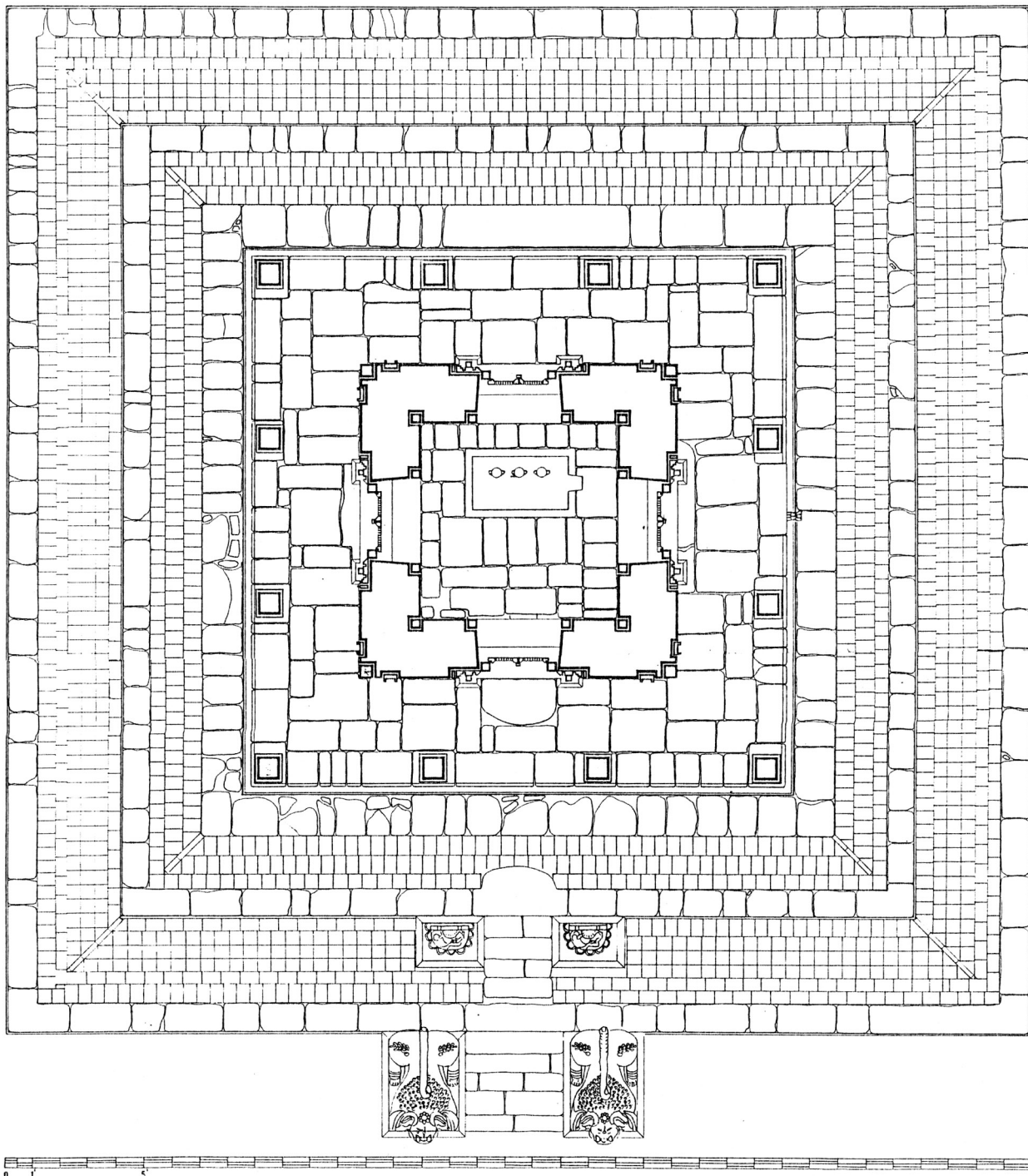
The configuration of timber framed openings is identical on four sides, with axially symmetrical clusters of doors, windows, and niches. Each floor consists of a different configuration of openings. The pattern at each level consists of a central element --door on the ground floor, windows on upper floors-- flanked by pairs of niches and smaller windows, respectively. The roof struts and ground floor pillars read similarly as



RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

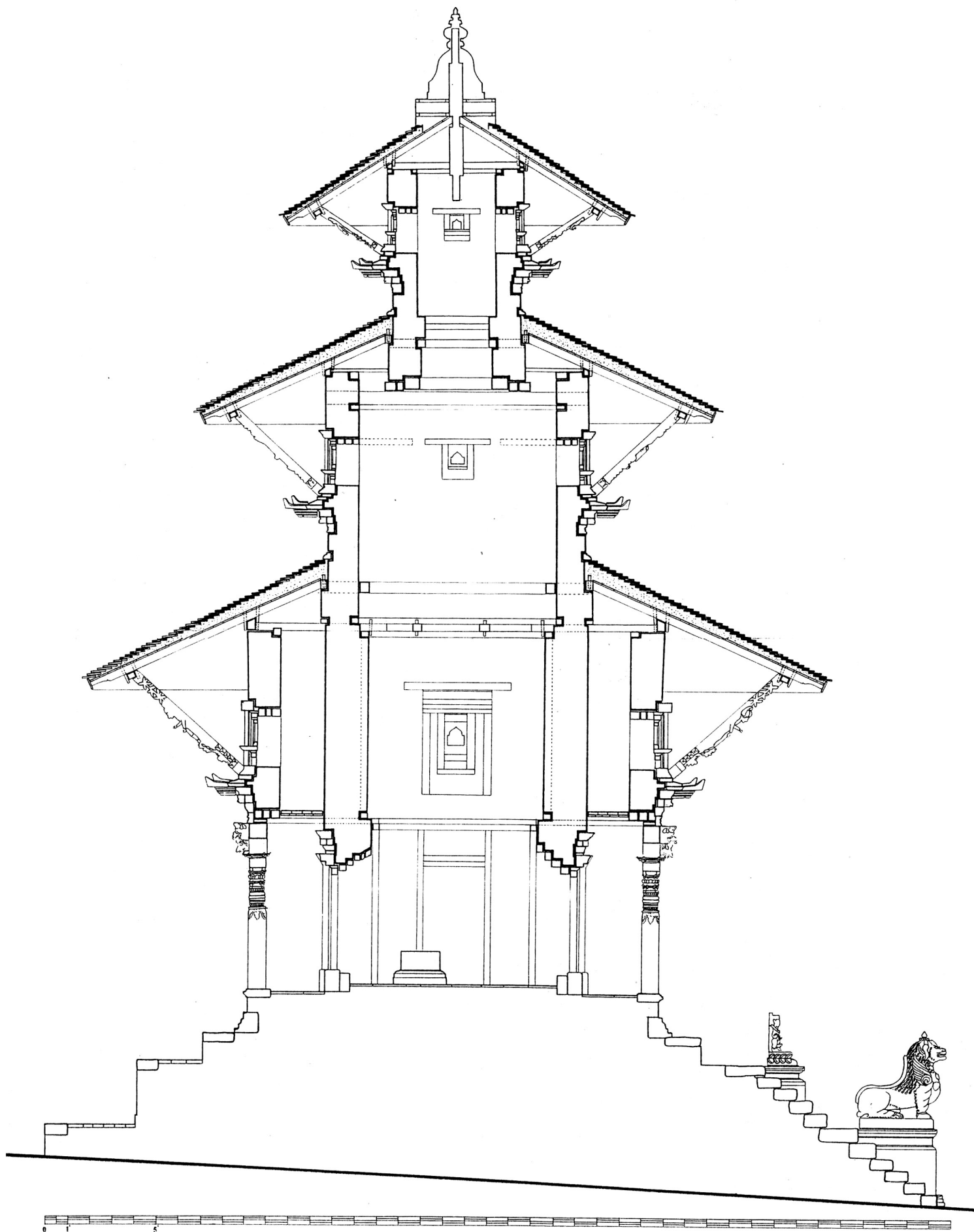
RESTORED PRINCIPAL ELEVATION
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993



RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

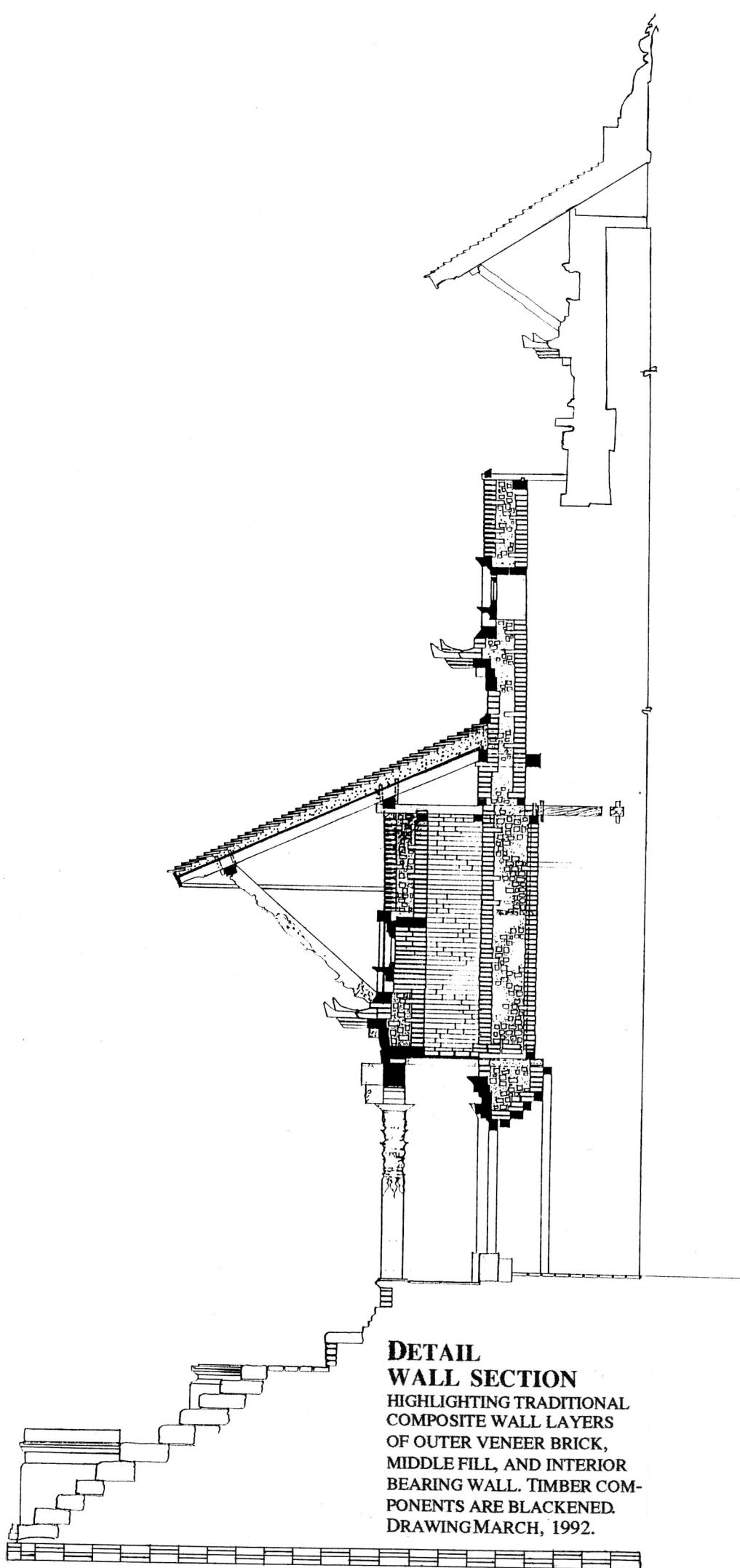
GROUND FLOOR PLAN: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE, MONUMENT ZONE

RESTORED WEST-EAST SECTION
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1993



**DETAIL
WALL SECTION**
HIGHLIGHTING TRADITIONAL
COMPOSITE WALL LAYERS
OF OUTER VENEER BRICK,
MIDDLE FILL, AND INTERIOR
BEARING WALL. TIMBER COM-
PONENTS ARE BLACKENED.
DRAWING MARCH, 1992.

flanking elements around these focal doors and windows. At the uppermost level, the diminished wall area allows only one central window.

The smooth brick wall surfaces are further punctuated by the continuous cornices of composite timber and brick construction which support the roof struts, creating strong horizontal registers. The timber door and window frames and inset panels, cornices, niches, and roof struts provide the field for intricate carvings of iconographic and decorative forms.

The height and breadth of the plinth levels increase as they descend from the ambulatory to create a stepping effect: this echoes that of the graduated roofs above, and raises the temple structure 7'6" above the street level. The height and setback of the ambulatory floor from the top of this massive base (outer dimensions: 36'-5" square) suggests a fourth step. The plinth, faced in brick veneer and paved with brick tile and stone, is most likely a solid fill construction. The depth and configuration of foundations within the plinth are not known.

4.1 Traditional construction techniques

The traditional construction of Radha Krishna employs bearing brick walls laid in yellow clay mortar (Newārī-*mhāsucā*) together with a secondary timber frame construction in which wall plates, corner posts embedded in the walls, tie members, and rafters are connected by timber pegs and lapped joinery.

The brick wall construction consists of three layers with very few cross bonds: an outer facade brick (Newārī-*daciapā*), one course thick; an inner bearing wall of common fired brick (Newari-*mā apā*) two layers thick; and middle fill of brick fragments (Newārī-*dutha apā*). The characteristic facade veneer brick (*daciapā*) tapers in section away from the facade to allow hairline joints on the face with additional mortar behind.

The *daciapā* of the Malla period is an extremely well-fired and dense brick with a finished smooth surface on only one side, excepting corner pieces, which are finished on two sides. The finishing is achieved through the application of a red clay slurry (Newārī-*lācā*) applied after sundrying and before firing. Laid tightly, the lustrous brown crimson *daci apā* provides a fine and smooth background for the sculptural effects of the woodcarvings.

Historically the walls were built of mud mortar and perhaps pointed with a traditional resin mixture of surkhi, lime, molasses, and ghee (Newari-*silāy*). The preparation of

silāy is complicated and expensive¹⁵, and at this time a lost art. There are no traces of this resin pointing on the Radha Krishna, as is the case on all temples inspected to date by the author. In general the construction of masonry walls in the last century has only employed yellow clay for mortar. This clay, when free from rubble and plant material, is a relatively strong and resilient mortar material. No pointing is applied at the flush joints.

The foundation structure of Radha Krishna has not been excavated. One can imagine that it is comparable to other buildings of the period constructed in stone laid again in yellow clay. The plinth is probably built up in fill defined by the temple foundation walls and outer brick walls faced with *daci apā* and stone aprons.

The timber structure of Radha Krishna conforms to the traditional formula of the Newar pagoda temples. Closely spaced rafters (varying center-to-center dimensions 9" to 16") laid on the flat are tied to wall plates and purlins with timber pegs to form the "hanging eaves" (Newari-*kvachupākhā*) of the pagoda's lower roofs.

Sal timber (*shorea robusta*) a local teak is traditionally employed for most structural and virtually all decorative timbers. Pine was used in many 19th and early 20th century reconstructions, but may also have been employed in the Malla period.¹⁶

The integrity of the timber structure of the temple, like many examples in Nepal, has suffered in the many repairs and reconstructions. We do not know how precise the joinery of the original construction was, but later work on the Radha Krishna has been characterized by ill-fitting mortise and tenon joints, over-cut lap joints, and improper placement of timber pegs.

The design and joinery of the elaborate facade openings is, in contrast to extant structural joinery, sophisticated and well executed. Ill-fitting joints in these openings on the Radha Krishna are the result of curing and later seismic activity (discussed later under existing conditions) rather than sloppiness in execution. Stepping timber lintels in the wall thickness expand door and window openings toward the interior, while four interlocking layers of timber frames, both structural and decorative, define the door and window openings in elevation.¹⁷

¹⁵Niels Gutschow, who led the Pujari Math Restoration team, shared this information with me.

¹⁶Hari Ratna Ranjitkar of the Department of Archaeology reports encountering many pine structural timber in his dismantling of portions of structures which appeared intact since Malla times.

¹⁷Discussed at length pp 10-11, 17-18; Gutschow (1985).

The central window of the upper base story, for example, consists of (1) an inner largely concealed structural frame with greatly extending sill (Newari-*kvakhālu*) and lintel (Newari-*mutagaḥ*); (2) a secondary trabeate frame set in front of the first, (3) a forward standing trabeate frame supporting a tympanum (Newari-*toraṇa*) above (now missing); and (4) stylized curving and stepping non-structural frames which wrap the extend the surface of the primary frame, flush with the wall.

4.2 Formal commentary, Directions for further research

A complete formal analysis is beyond the scope of this report, but the following observations can be included.

Typology and structural configuration

There is a wealth of temple typologies, styles, and construction techniques among the temples to Vishnu in Nepal, the temples to the Preserver of the Hindu trinity. It is in fact difficult to make any generalizations about these shrines--within a stone's throw of the Radha Krishna temple are 6 other temples to some incarnation of Vishnu and all completely different in form.

Wolfgang Korn postulated that the arcaded and perfectly symmetrical plan type is generally employed for temples to Śiva¹⁸ (although we find it at the Radha Krishna temple), while those to Vishnu are generally designed as one-sided-- without arcades and with only one door. Research on this subject would be well deserved.

Wiesner hypothesizes in his *Nepalese Temple Architecture* that the three and five tiered temples make a significant departure from earlier two tiered temples with their placement of the diminished uppermost level not on the walls below, continuous vertically with the bearing masonry wall, but on timber beams--forming a kind of inward cantilever. The 1802 construction of the nearby Uma Maheswar temple (currently under restoration by KVPT) employs such an inward cantilever to support the upper level of a scheme which is only two-tiered, however. Research on the development of this inward cantilever would be well deserved, namely to determine if it arose from multiplication of the number of levels (as Wiesner proposes) or if it was also employed for two-tiered schemes, which generally predate the 3 and 5 roof schemes.

The inward cantilever of the much taller Radha Krishna temple is clearly worthy of mention. The absolute daring of setting the considerable mass of the uppermost story

¹⁸ Korn: 1979, p. 71.

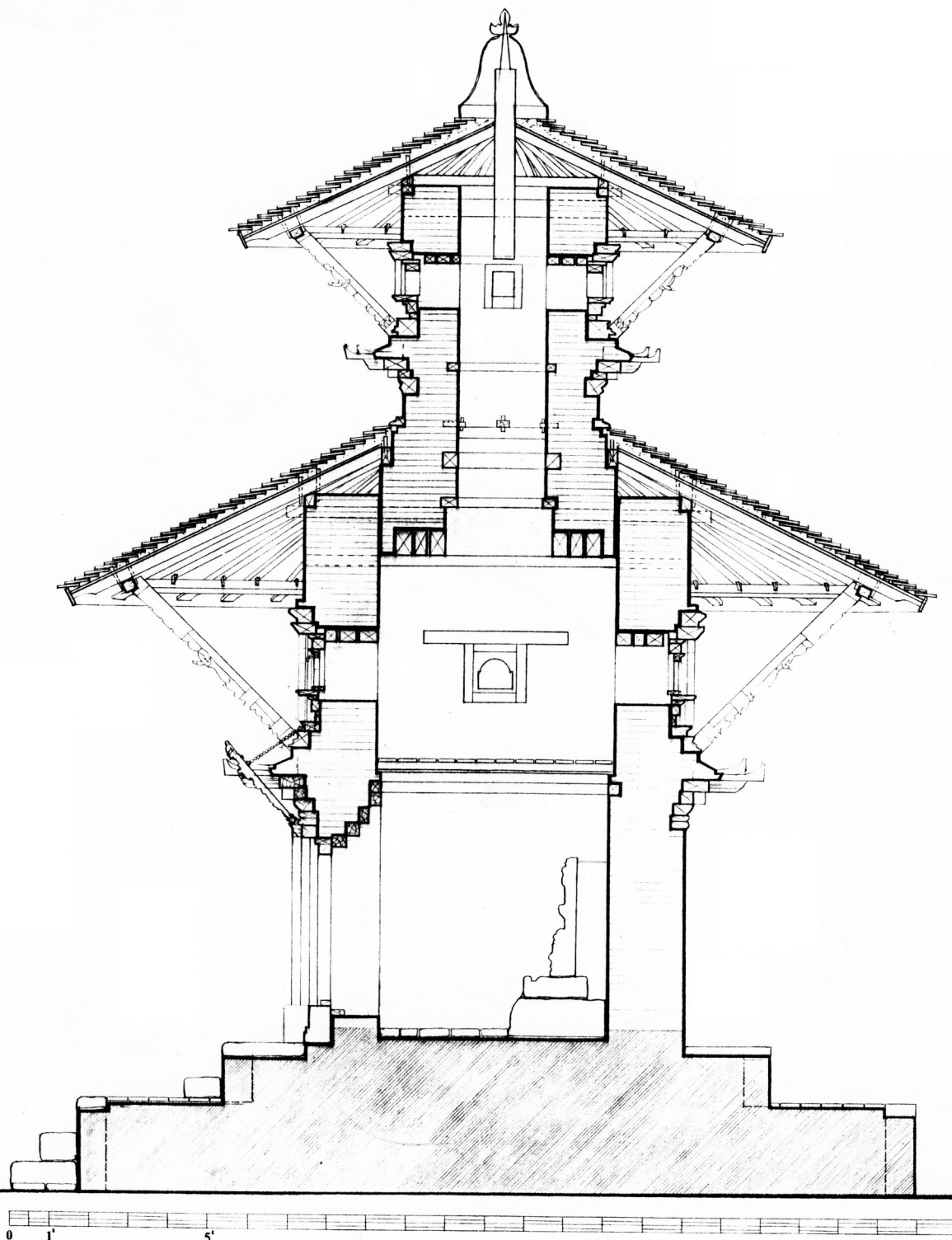
and roof on timber beams 30 feet above the sanctuary floor is testament to the ambitiousness of 17th century building.

The multiple level plinths of Newar temples, which are found on only the most important temples of the 16th century, but then increase in size and are more commonly found on 17th and 18th century temples, reiterate the stepping of the roofs above. In comparison to early Malla examples and to the pagoda temples of the Far East, which both sit close to the ground, the later Newar temples make a more dramatic transition from earth to sky. They first gather up the great mass of the the earth in the stepped plinth, boldly punctuated by the deep shadow at the base story of the lowest and largest roof overhang, and then dematerialize into the sky through diminishing roof size.

The eaveboards of the diminishing roofs can generally be connected by a straight line which terminates at the top of the gilt pinnacle (*gajūra*). At the Radha Krishna temple, the simplicity of this silhouette unites the composition which, at the same time, is made more complex by unidentical roof angles. The upper roof angle is 3 degrees steeper than those below. The steeper pitch of the top roof seems to be the result of a past reconstruction, although it cannot be ruled out as original based on present knowledge. The silhouette is similarly made more complex by the traditional thickening of the clay bed beneath the tiles closer to the masonry core. Contemporary craftsmen explain this feature as a traditional attempt to counterweight the great overhangs of the projecting roofs.

Visual characteristics

Similar to the elegant juxtaposition of smooth, flush jointed *daci apa* and rich woodcarvings, one finds an interesting contrast between the plain adze-hewn beams (sans fascia) and the elaborately carved columns on which they sit. Such contrasts are also found between the multiple plain square-edged borders and the inner carvings of the door and window frames. Although in some of the most ambitious structures of royal patronage (as at Biswanath and Hari Shankar Temples, Patan Darbar Square) very few surfaces are left unelaborated, one recognizes in the Malla art a great sensitivity to restraint--an ability to bring out the beauty of a carving through juxtaposition with a plainer element. This sensitivity has unfortunately been lost by a great number of contemporary woodcarvers whose technical skills are limited by artistic judgement. The norm in current woodcarving tends toward a western and Victorian fear of leaving anything plain.



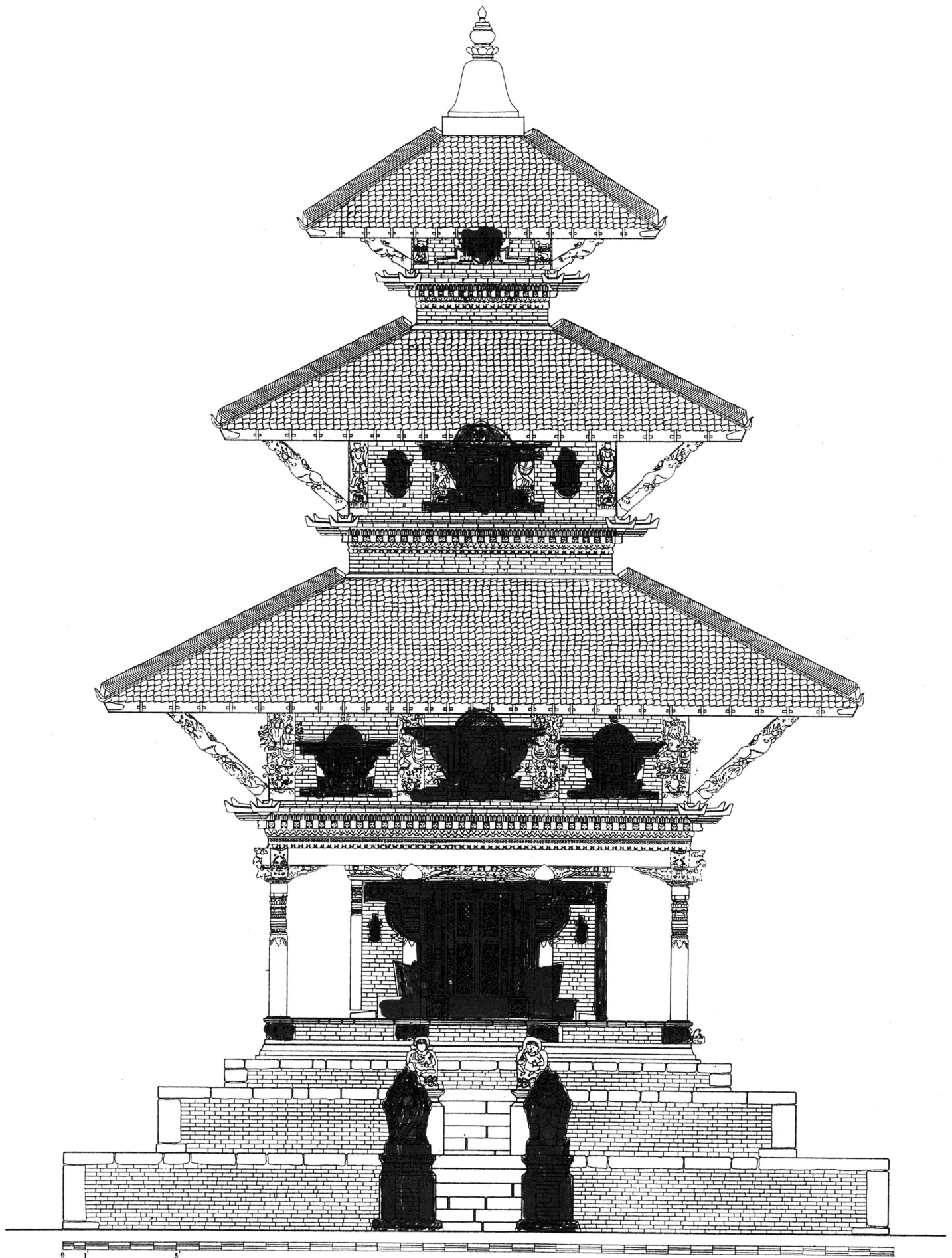
UMA MAHESWAR TEMPLE

KWALKHU TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

SECTION WEST-EAST : EXISTING CONDITIONS

KATHIMANDU VALLEY PRESERVATION TRUST, MARCH 1992

A NEARBY TEMPLE DATED 1802 (AND UNDER RESTORATION BY KVPT) RAISES QUESTIONS ABOUT THE HYPOTHESIS THAT INWARD CANTILEVER SUPPORT OF UPPER LEVELS IS DIRECTLY RELATED TO THREE AND FIVE ROOF SCHEMES. HERE, THE SAME TIMBER SUPPORTS INSIDE OF THE TEMPLE CORE ARE USED TO CARRY THE UPPER LEVEL, ALTHOUGH THE SCHEME IS ONLY TWO-TIERED.



RADHA KRISHNA MANDIR

LAYERED AXIAL SYMMETRY.

MAJOR FACADE ELEMENTS ARE HIGHLIGHTED TO DEMONSTRATE VARIATION ON EACH LEVEL AND LACK OF ALIGNMENT. THE CONFIGURATION SUGGESTS IRREDUCEABLE "FACES".

Ordering systems of the facade

The arrangement of facade elements can be described as a very sophisticated permutation of axial symmetry, an ordering system typical of both Newar religious and secular architecture. In what could be termed "layered axial symmetry", odd numbers of major facade elements such as doors and windows are arranged symmetrically, the odd number guaranteeing that one element falls on the centerline of the building. The number, type, spacing, and size of these elements is allowed to vary by floor, however, so that the resulting composition of superimposed different floors or "layers" achieves a remarkable complexity. Different elements on different floors rarely align (except at their centerlines) to suggest a regular grid or bay system. They seem to cluster instead forming an irreducible and often face-like patterns, conjoined by common central axes. This complexity of facade arrangement, best demonstrated by the non-alignment of facade element frames is a key feature of Nepalese traditional architecture.

If, as Stella Kramrisch writes, the architectural evolution of the Hindu temple in India can be understood as an elaboration in the facade of the central axis to manifest the power of the god within¹⁹, then the layered axial symmetry of the Newars suggests a great power, a power able to conjoin the diverse and complex constellations of each floor through its central axis.

One can hypothesize that such arrangements grew naturally from the constraints of a stepping pagoda structure, where diminishing wall areas encourage variations on each floor, buffered by large intervening roofs. Yet far Eastern counterparts show little of this predisposition to complexity in facade composition, while even the essentially flat and simple rectangles of Newar palace, monastery, and residential facades are often composed of similarly complex, non-aligning layers. Hypothetically these arrangements, these ordering systems symbolize a deep theme in Hindu cosmology, a world of flexible and multi-fold, if not overlapping constellations of gods united by an ultimate power. Traditional architectural treatises of the Subcontinent furthermore indicate that all religious structures are considered built diagrams of the universe, *maṇḍala*.

¹⁹ Kramrisch: 1976, p. 180.

4.3 Iconography-general description

One of the richest and most characteristic expressions of Newar art is found in the conception and execution of woodcarvings which adorn the temple²⁰. Thousands of images--many of them unique and not repeated in other comparable locations on the building--contribute to a complex perhaps inscrutable iconographical program. This iconographic program is fundamental to the conception and religiosity of the Hindu temple: the constellation of religious symbols and deities reconstructs a cosmological diagram, a *maṇḍala*, and is integral to the architectural structure, itself holy in Hindu thought.

Among the Newar pagoda temples, one finds some variation in the iconographic programs, even of temples dedicated to the same god or goddess. These variations may be understood as reflections of local sacred geography, mythology concerning the particular deity to be housed, the artistic inventiveness of individual carvers, wishes of the donor, or certain programmatic or stylistic conventions, which can be observed by city or period in the Kathmandu Valley. ²¹

The principal figurative carvings of the Radha Krishna's architecture consist of:

(1) Roof struts on three levels.

Excepting the single full-height horse designs of corner struts (Newari-*kūnsal*), repeated at all levels, all other struts are articulated in three registers. A principal figure (or figures) dominates the largest middle portion of the strut atop symbolic mount(s). Below the main figure(s) are found subsidiary panels depicting narrative scenes; above are stylized foliage designs. Only on the largest and most elaborate lower roof struts are small animal and human figures rendered in these foliage areas.

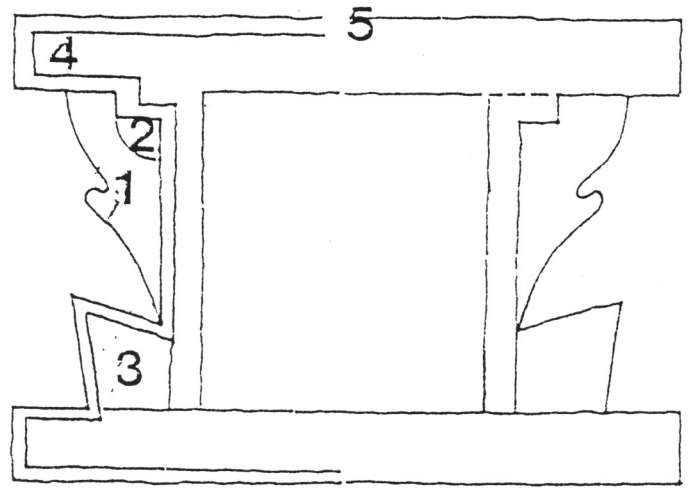
²⁰Very few comprehensive iconographic or stylistic studies have been made on the woodcarved art of Nepal (Rau 1985). Work by Gail on nearby Vaisnavit and Saivite temples in Patan focuses only on ground floor elements (Gail 1984). Mary Slusser's work on Panauti's Indresvara Mahadeva deals primarily with roof struts (Slusser 1979). Gutschow's "dictionary" describes the complex construction and symbolic elements of windows, doors, columns, pillars, cornices (Gutschow, 1987). Koelver's work puts forth a holistic analysis of iconographic elements related to architectural form, etc., not for a Buddhist monument, the stupa at Svayambunath (Koelver, 1992).

²¹ Niels Gutschow's documentation and analysis of the 1500 year evolution of the Buddhist *caityas* of the Kathmandu Valley provides the most comprehensive illustration of these points. Unpublished manuscript, 1992.



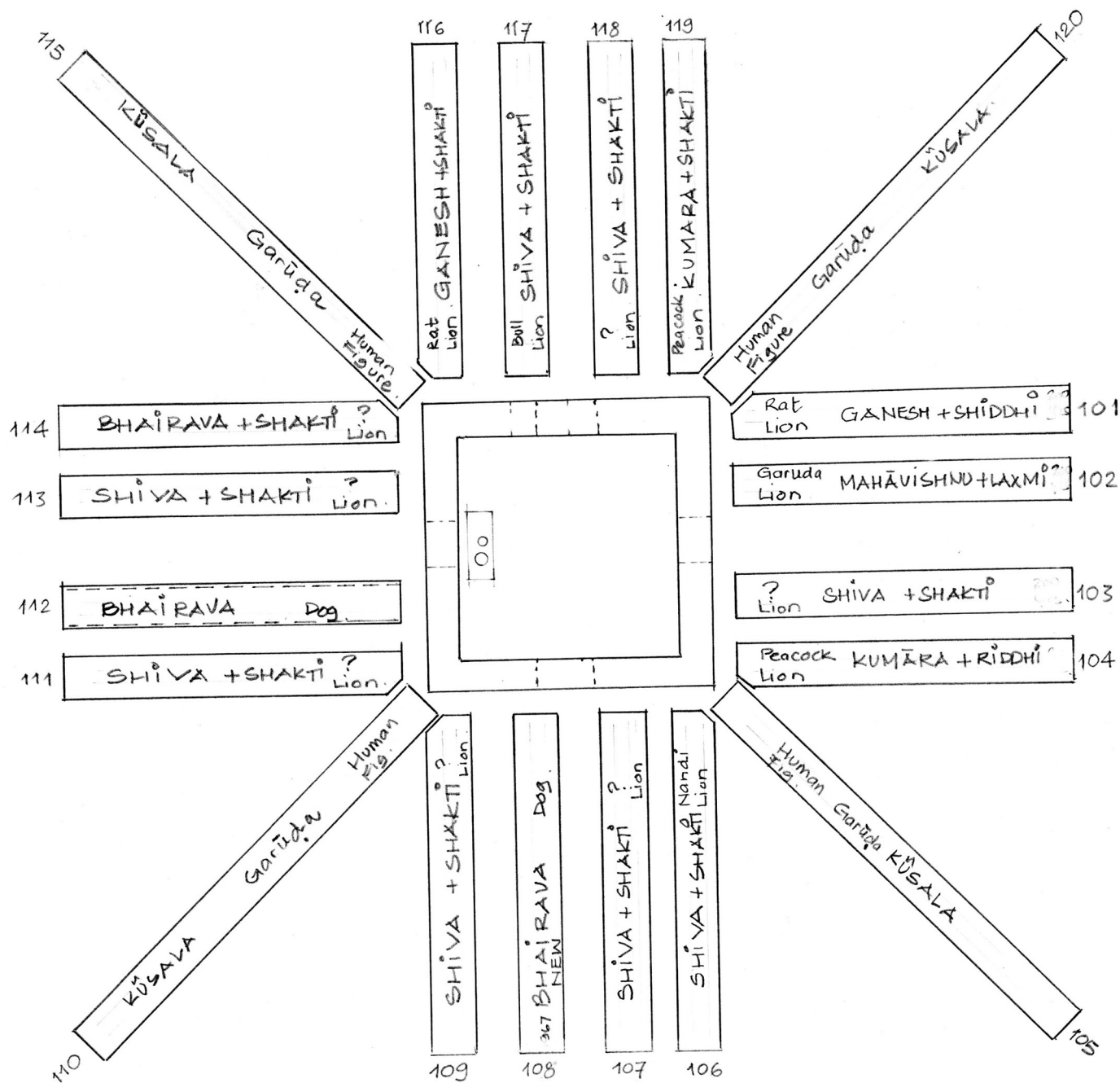
LEFT: ONE OF TWO SURVIVING ORIGINAL STRUTS DEPICTING AṢṬA MĀTR KĀ. (#304)
 RIGHT: DETAIL LOWER ROOF STRUT (#101) DEPICTING FIVE-HEADED GANESH.

1. gvāgahkva - wail bracket with kāyṇvā (makara) and Gaṅgā/Yamunā or phaikuḷā (mythic animal) design
2. debikva - medallion of wail bracket with Candra/Sūrya, Aṣṭamātrkā or flower design
3. bhailahkva
bhailahkuti - panel above the sill with Bhairava design
4. lapu
licva
lācva - projecting end of sill or lintel
5. purātva - decorative beading around the whole frame



ICONOGRAPHIC PANELS AT DOORS

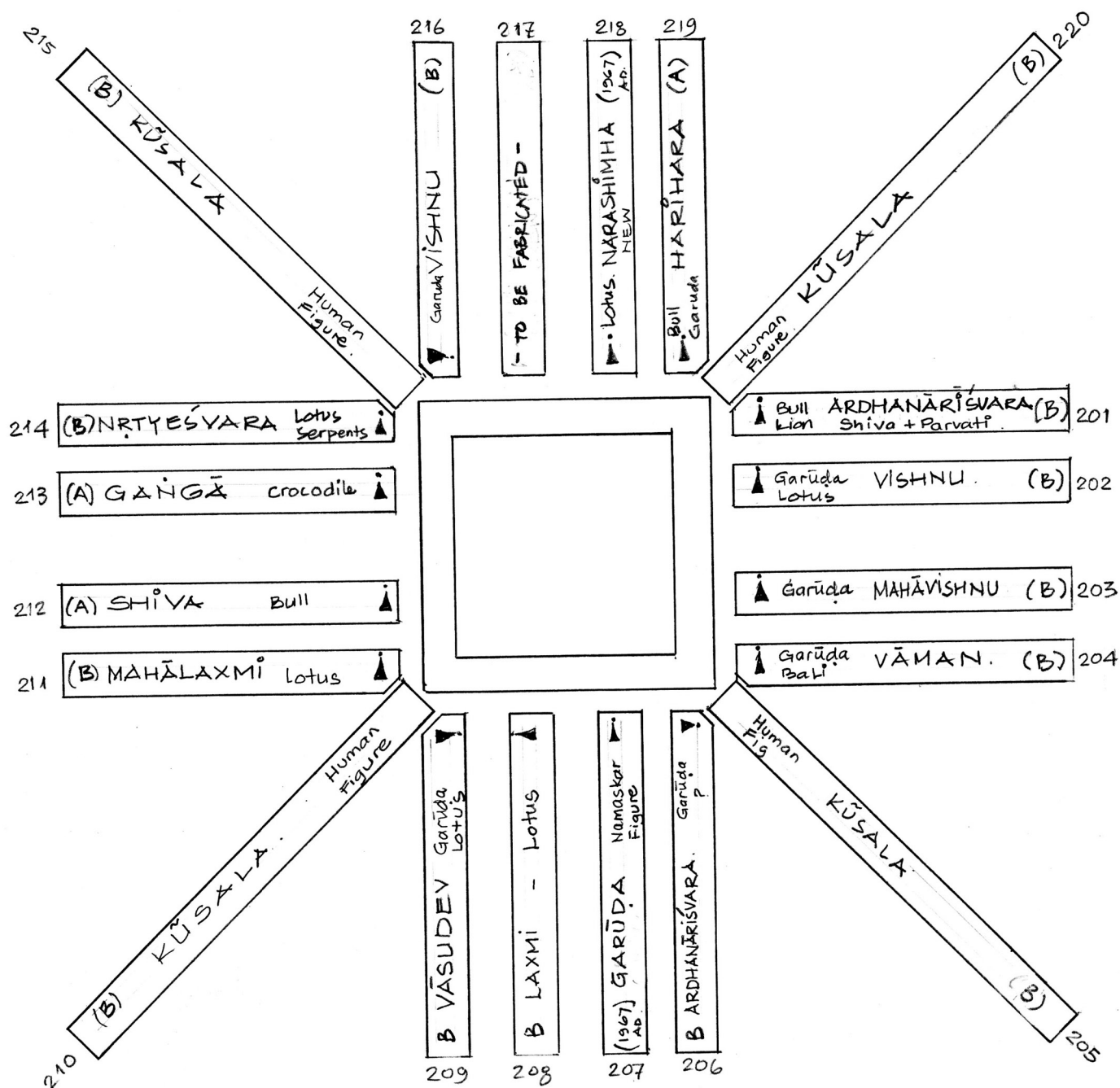
ABOVE: IDENTIFICATION OF ELEMENTS FROM N. GUTSCHOW, NEWAR TOWNS AND BUILDINGS, 1987. BELOW LEFT: THE EAST ELEVATION OF RADHA-KRSNA SHOWING LOST ASTAMATRIKA PANEL AND ADJACENT NICHE, JANUARY, 1992. RIGHT: ONLY ON THE RIGHT SIDE OF THE SOUTH ELEVATION WERE ALL ICONOGRAPHIC FEATURES INTACT.



STRUTS: LOWER ROOF

LAYOUT OF STRUTS INDICATING PRINCIPAL FIGURES AND MOUNTS. STRUT 108 DATES FROM THE 1967 RENOVATION. STRUT 112 HAS BEEN RECOVERED FROM A NEARBY COURTYARD.

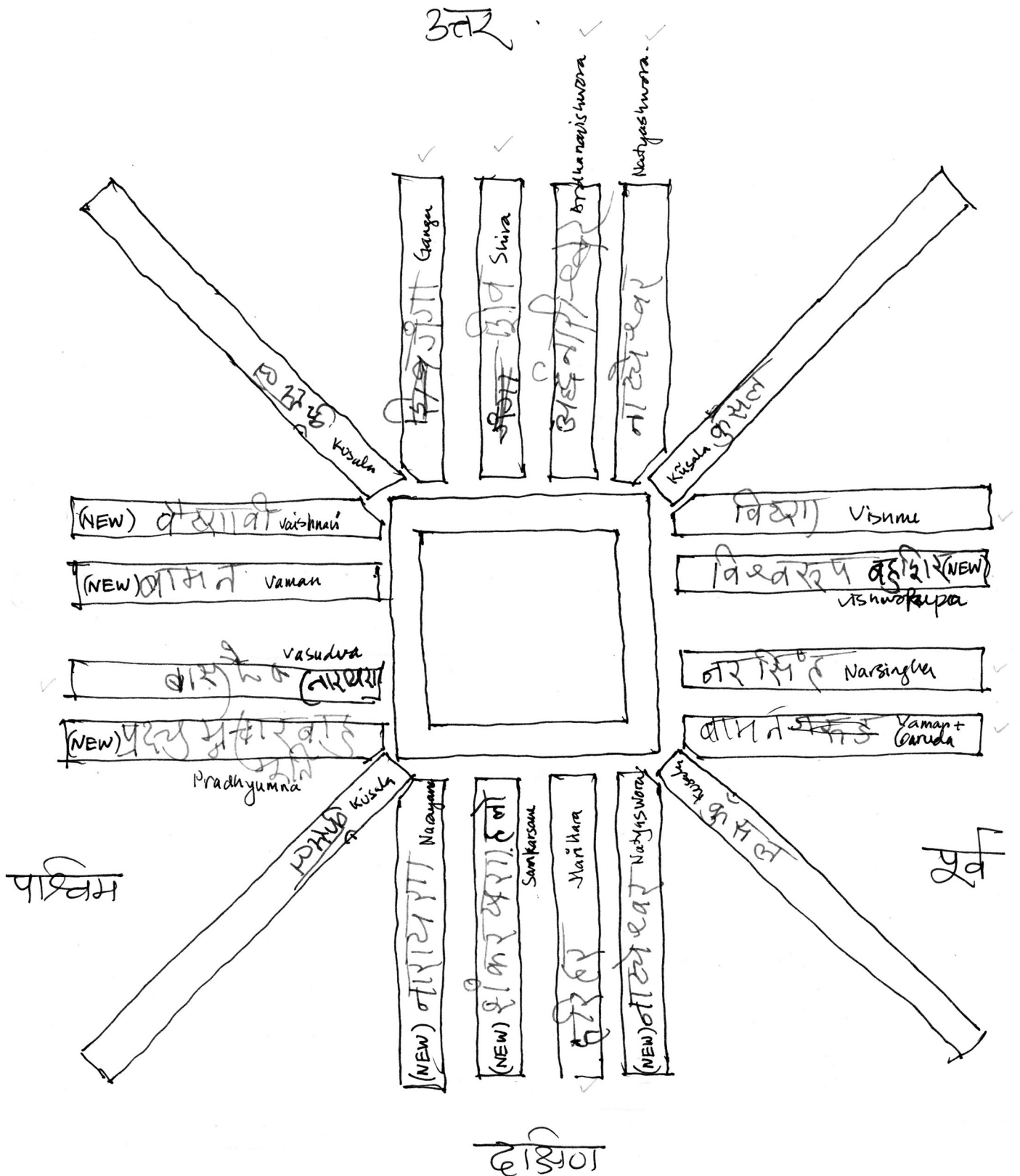




STRUTS: MIDDLE ROOF

PROPOSED LAYOUT OF STRUTS WITH PRINCIPAL DEITIES AND MOUNTS FOR THE LOST MIDDLE ROOF. DARKENED TRIANGLES INDICATE THE DIRECTION OF THE SUBSIDIARY SCENE SIVALINGA.
STRUT AGE: A = ORIGINAL 1668; B = 19TH CENTURY. STRUT 207 & 218 DATES FROM 1967 RENOVATION.
217 IS LOST.

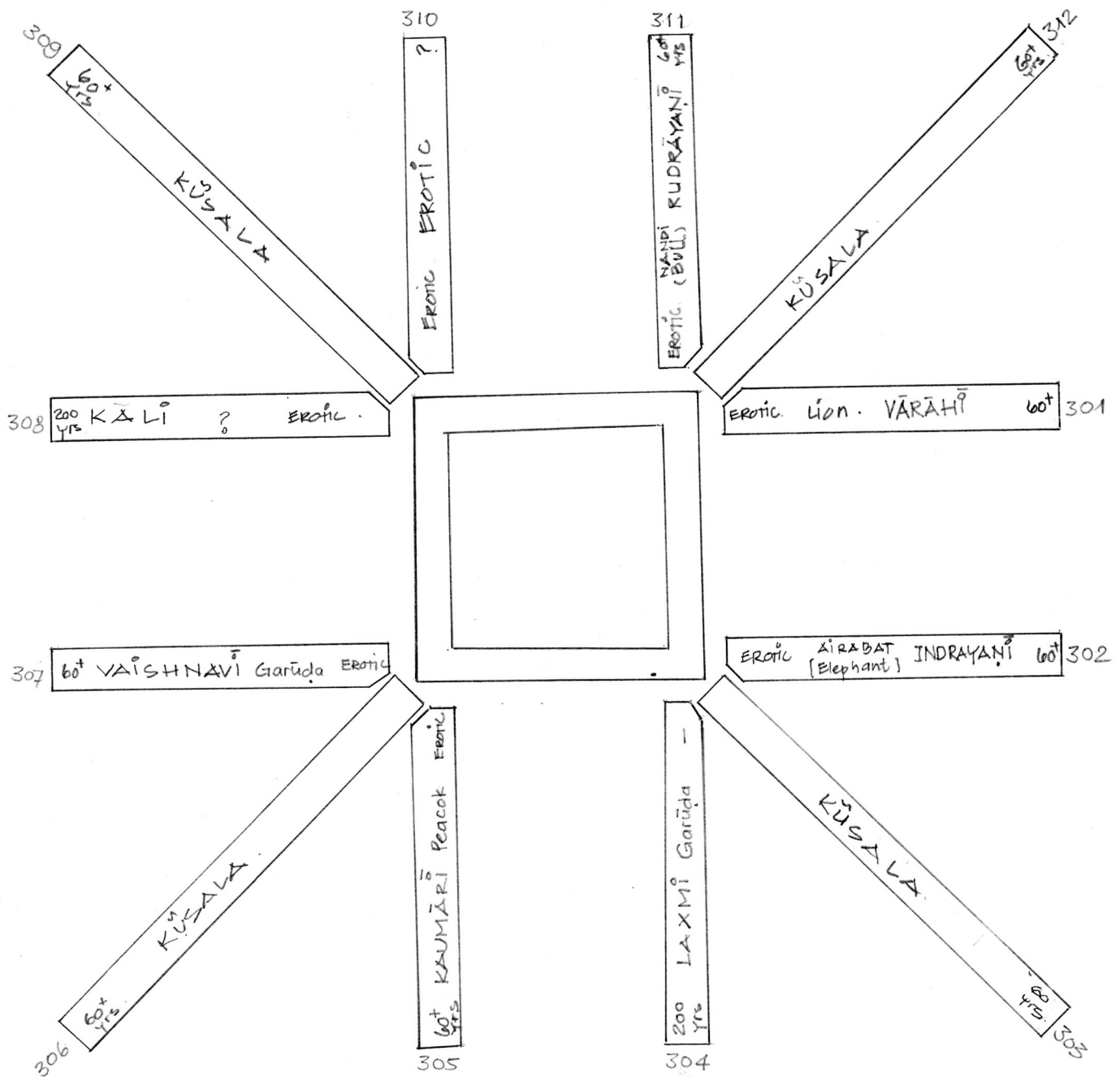




STRUTS: MIDDLE ROOF

PROPOSED LAYOUT OF STRUTS WITH PRINCIPAL DEITIES BY MADHAN MOHAN MISHRA, HISTORIAN. MISHRA PROPOSED 7 STRUTS AT THIS LEVEL BE NEWLY MADE TO CREATE THIS "IDEAL" LAYOUT OF DIFFERENT INCARNATIONS OF VISHNU.





STRUTS: TOP ROOF

EXISTING LAYOUT OF STRUTS WITH PRINCIPAL DEITIES AND SUBSIDIARY SCENES. ONLY THE FOUR 20TH CENTURY CORNER STRUTS AND #304 AND 308 ARE ORIGINAL TO THE TEMPLE.



(2) Ground floor door frames

Figurative carvings are elaborated in many locations including:

(a) Extended door frames just above sill level (Newārī-*bhailahkvā*)

house Bhairav figures. (There are eight such panels, two per door on four sides.) The surviving original figures show that each Bhairav figure is rendered similarly, but with varying symbolic attributes to depict the eight Bhairavs (Newārī-*Aṣṭ abhairav*).

(b) Curvilinear panels (suggesting inset brackets, Newārī-*gvāgaḥkvā*) flank each of the four doors and are carved to depict female figures--*Sālabhañjikā*-- atop a crocodile (*makara*). All eight figures are identical. The ancient and archaic *Sālabhañjikā* type, consists of a maiden standing beneath a tree, with one arm above the head grasping the foliage²².

(c) Quarter-round panels (Newārī-*debikvā*) within the curve of the *gvāgaḥkva* are rendered with the eight Mother Goddesses (Newari--*Aṣṭamāṭṛ kā*). The *Aṣṭamāṭṛ kā* are present in many locations on the temple --and on all temples in the Valley--their location here is a typical variant. According to Gutschow, this medallion is also used to depict Sūrya, Candra, or flower designs²³.

Again, each of the surviving historical panels is a unique rendering of one of the Mother Goddesses corresponding to the orientation of each location.²⁴

(d) Projecting lintels include miniature panels depicting Viṣṇu atop his mount Garuda with two auxiliary figures. This composition repeats in all inner lintel areas on all sides; the mounts below this scene, however, are different in each location depicting different groups of animals and floral motifs.

In the outer lintel areas are found different carvings by side. On the principal east elevation eight additional gods and goddesses are rendered (four per side). On other elevations are found the eight auspicious symbols (Newārī-*Aṣṭamaṅgala*), mythical animals, and floral designs.

(e) Forward standing columns

In the base areas of these columns and surrounds are rendered additional deities, probably *Devīs*, as the Mother Goddesses are generally referred to. On the principal

²² Rau (1985: 143) discusses the *Salabhanjika* motif, "as ancient as the tradition of art in Southeast Asia". The *Sālabhañjikā*'s juxtaposition of a figure in nature is clearly echoed in the general rendering of virtually all woodcarved struts in Nepal which include foliage above and suggestion of rock cut earth imagery below.

²³Gutschow, 1987:259)

²⁴See Gail (1984) for extensive discussion of correspondence between god and orientation.

elevation, the column base includes figures on three sides; on all other sides a single figure is found on the front of the column base; floral motifs replace the side figures.

(f) Door surrounds include carved deities are found at the bases of two layers of the surrounding door frames, probably Devīs, but possibly Viṣṇu.

Above the door opening a miniature set into the architectural mouldings depicts one of four different incarnations of Viṣṇu above each door. Below this, a tryptich niche repeats identically on all sides with central Viṣṇu flanked by Ganesh on his right, and Sarasvatī on his left.

(3) Pairs of niches (in the shape of miniature blind windows; Newārī- gaḥjhyāḥ) flank each of the ground floor doors. Formally they read as a united composition with the extended door frames, although separated by masonry wall. A repetitive architectural frame houses different incarnations of Visnu.

(4) Small round-topped carved panels attached above the pillar capitals against the plain main beam (none of these survive). The author has not been able to find comparable panels on any other temples in the Valley.

(5) Upper windows (gaḥjhyāḥ) are constructed in the form of openings with panels below (Newari-kvasvahjyah). Both central and auxiliary flanking windows support tympanum (Newārī-toraṇa) with repetitive animal-filled frames surrounding various deities including (in the two surviving examples) the dancers and musicians of heaven.

Central windows receive more elaborate carvings and more symbolic figures. In the auxiliary flanking windows carvings of deities (which vary in each location of the central windows) are replaced by repetitive animal and floral figures.

The most elaborate central upper base story windows depict deities in the following locations:

(a) In the wall brackets (*gvāgaḥkṣā*) are found *Sālabhañjikā*.

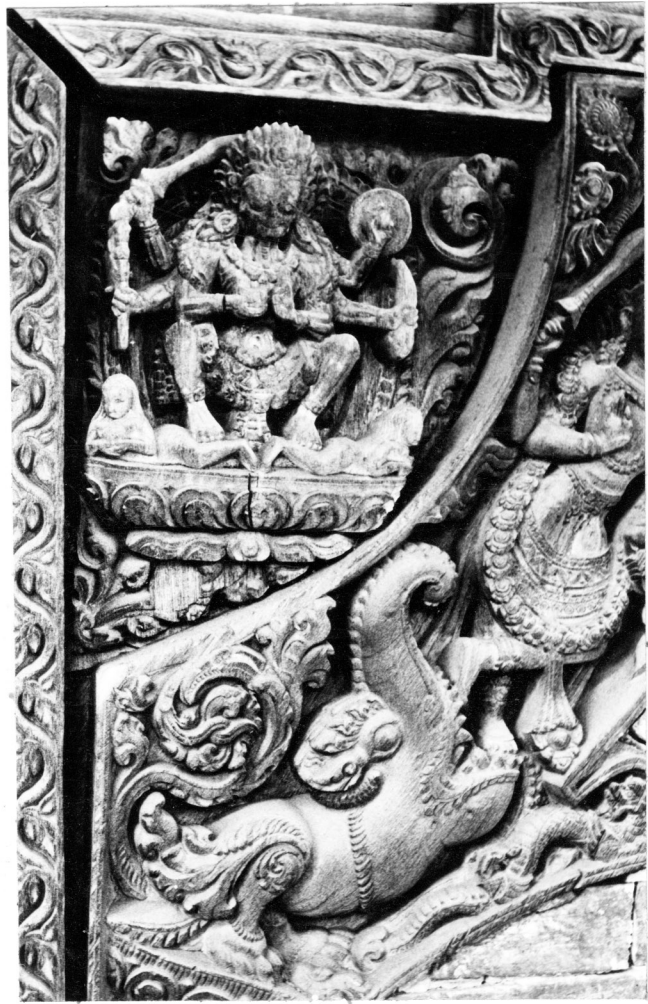
(b) Single miniature niches set into the architectural moulding of the window frame above the opening depicts various incarnations of Viṣṇu.

On central windows, figurative carvings are elaborated in 3 locations. None of these *toraṇa* survive.

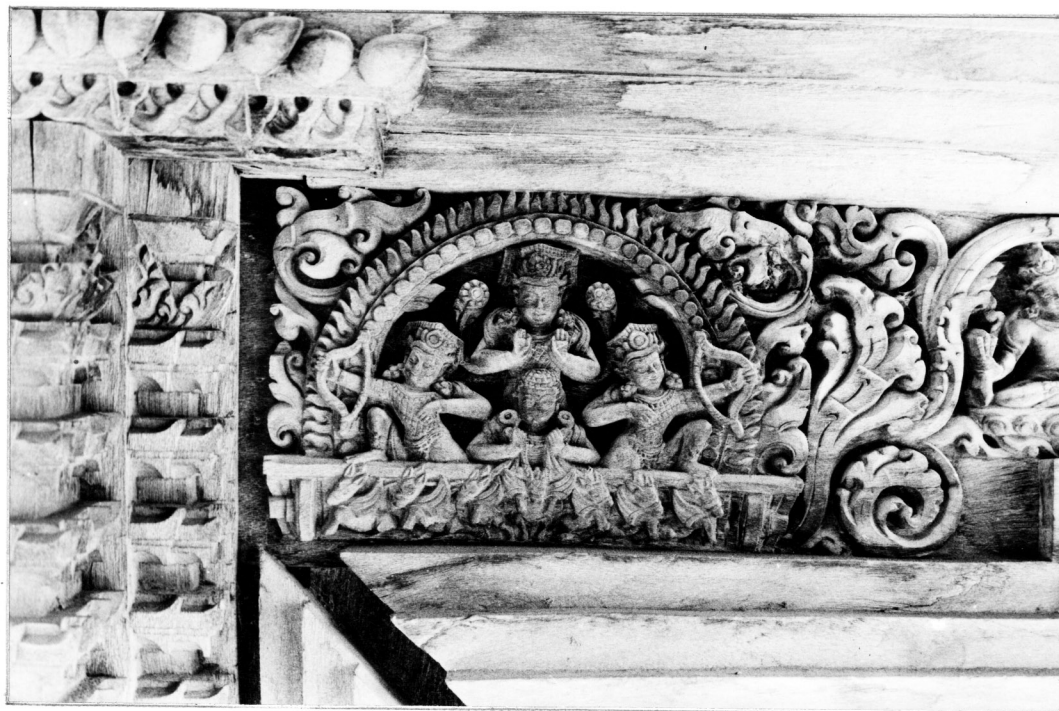
(c) Repetitive guardian *Dvārpāl* figures are found in curvilinear sill panels.



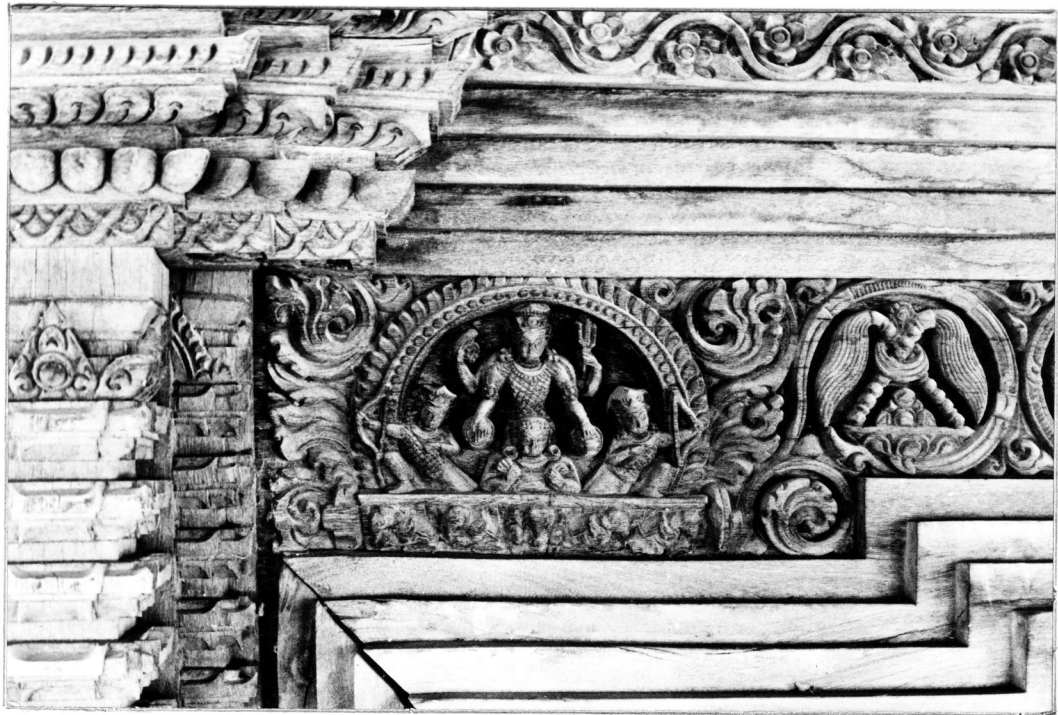
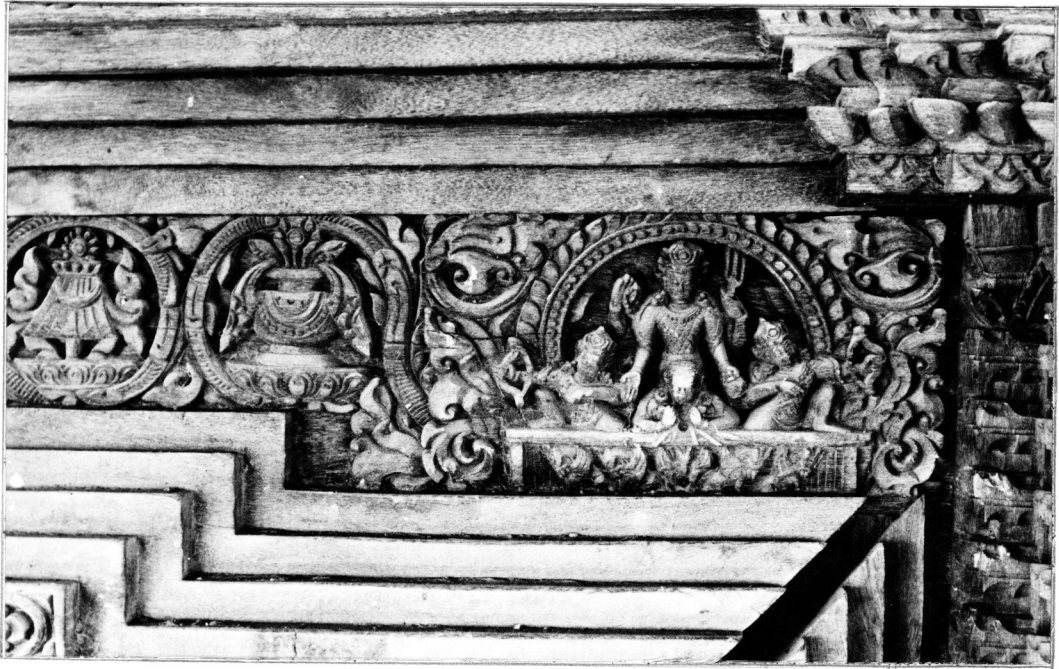
BASE STORY CARVINGS AT DOORS.
THREE SURVIVING BHAIRAV PANELS
(ABOVE DOOR SILLS). ABOVE: EAST ELEVATION
LEFT AND RIGHT. BELOW: SOUTH ELEVATION,
RIGHT.



BASE STORY CARVINGS AT DOORS.
THREE SURVIVING PANELS WITH AṢṬAMĀTRĀ KĀ
JUST BELOW DOOR LINTELS. ABOVE NORTH
ELEVATION LEFT AND RIGHT. BELOW: SOUTH
ELEVATION, RIGHT.



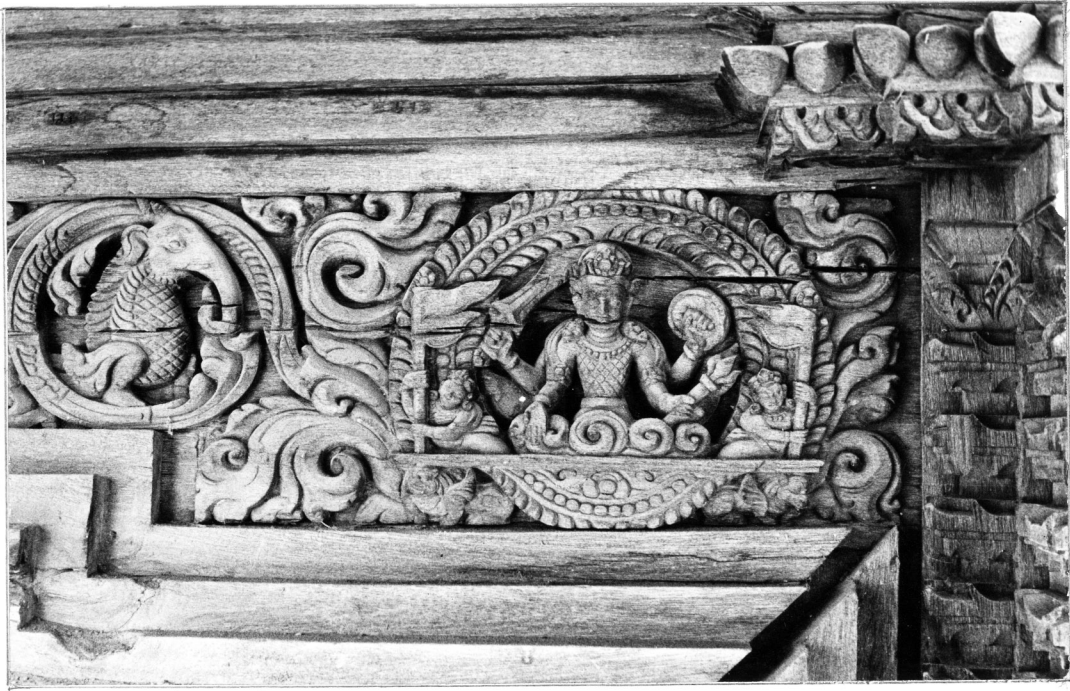
BASE STORY CARVINGS AT DOORS.
REPRESENTATIONS OF VISNU IN EXTENDED DOOR LINTELS. EAST ELEVATION.



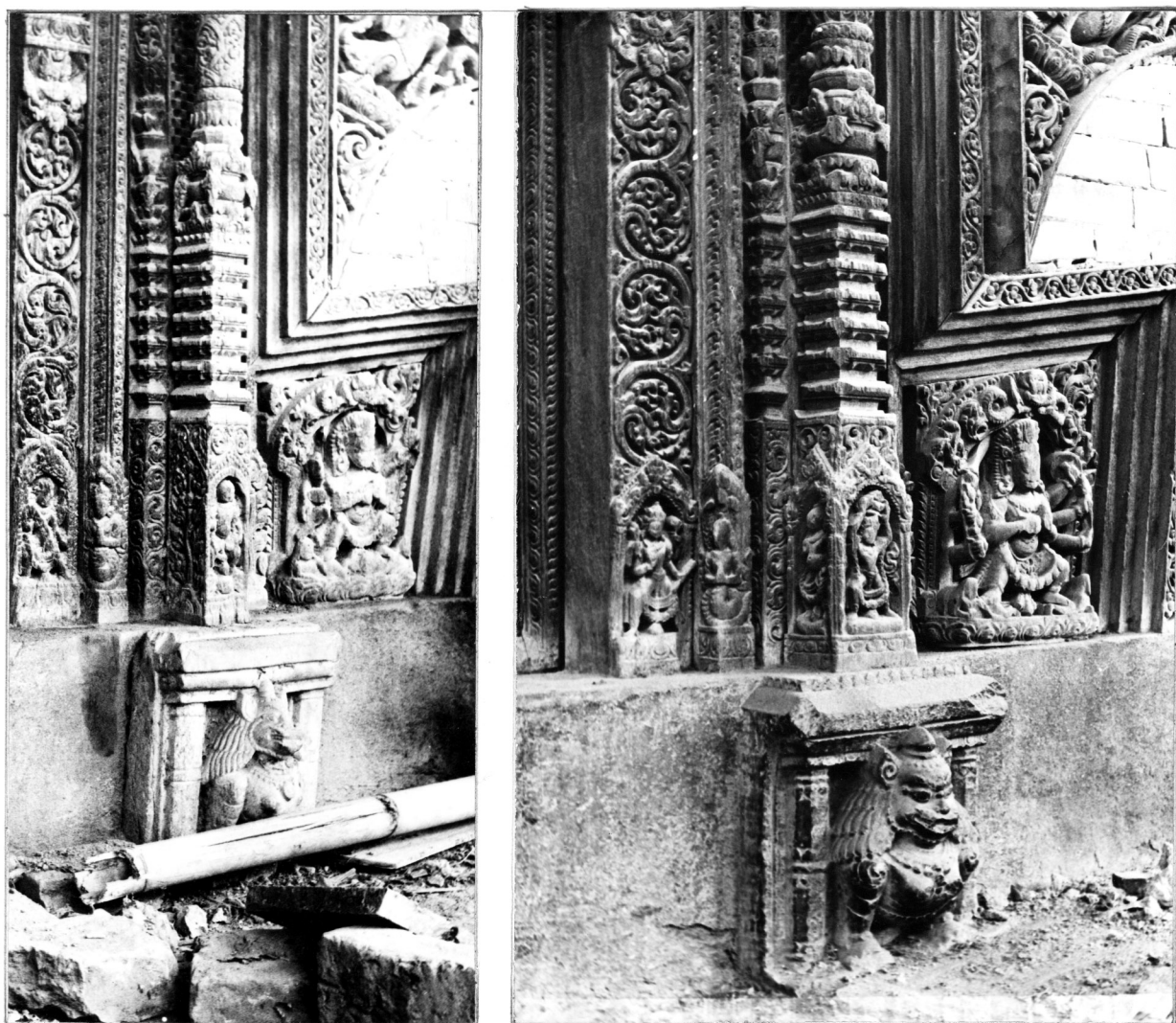
BASE STORY CARVINGS AT DOORS.
REPRESENTATIONS OF VISNU IN EXTENDED DOOR LINTELS. WEST ELEVATION.



BASE STORY CARVINGS AT DOORS.
REPRESENTATIONS OF VISNU IN EXTENDED DOOR LINTELS. SOUTH ELEVATION.

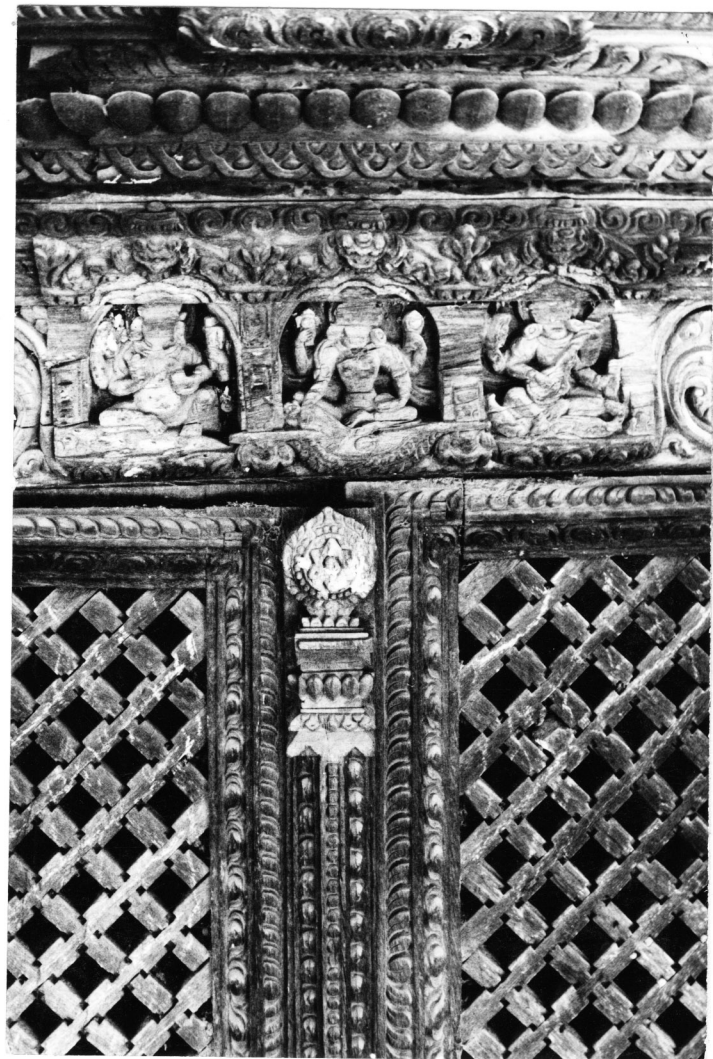


BASE STORY CARVINGS AT DOORS.
REPRESENTATIONS OF VISNU IN EXTENDED DOOR LINTELS. NORTH ELEVATION.

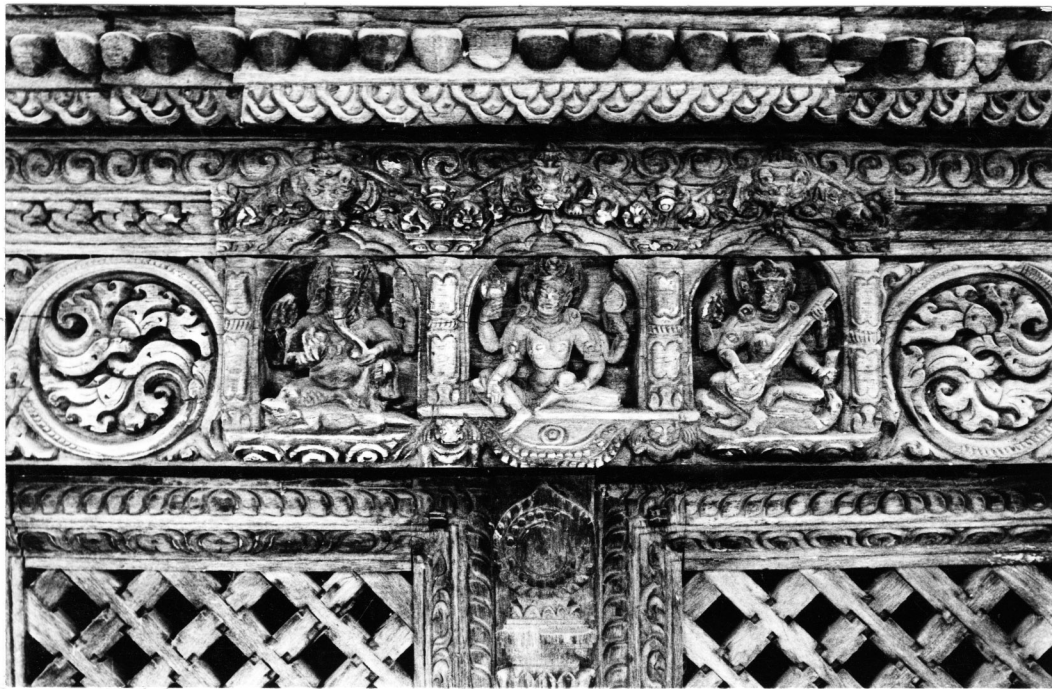


BASE STORY CARVINGS AT DOORS.

FORWARD-STANDING COLUMNS: ON THE PRINCIPAL EAST ELEVATION (RIGHT) THREE FIGURES ARE FOUND ON FRONT AND SIDES OF COLUMN BASE. ON THE SOUTH ELEVATION (LEFT), SIDE FIGURES ARE REPLACED BY FLORAL MOTIFS.



BASE STORY CARVINGS AT DOORS.
TRYPTICH IN DOOR SURROUND. ABOVE WEST ELEVATION; BELOW, SOUTH.



BASE STORY CARVINGS AT DOORS.
TRYPTICH IN DOOR SURROUND. ABOVE NORTH ELEVATION; BELOW, EAST.



BASE STORY CARVINGS AT DOORS.
NICHE IN DOOR SURROUND. ABOVE EAST ELEVATION; BELOW, SOUTH



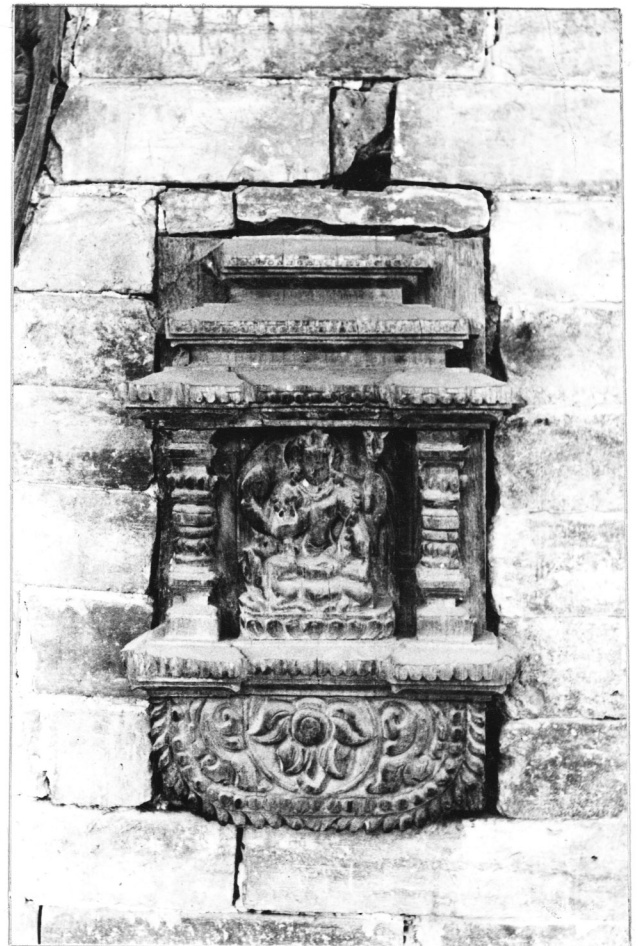


BASE STORY CARVINGS AT DOORS.
TRYPTICH IN DOOR SURROUND. ABOVE WEST ELEVATION; BELOW, NORTH.





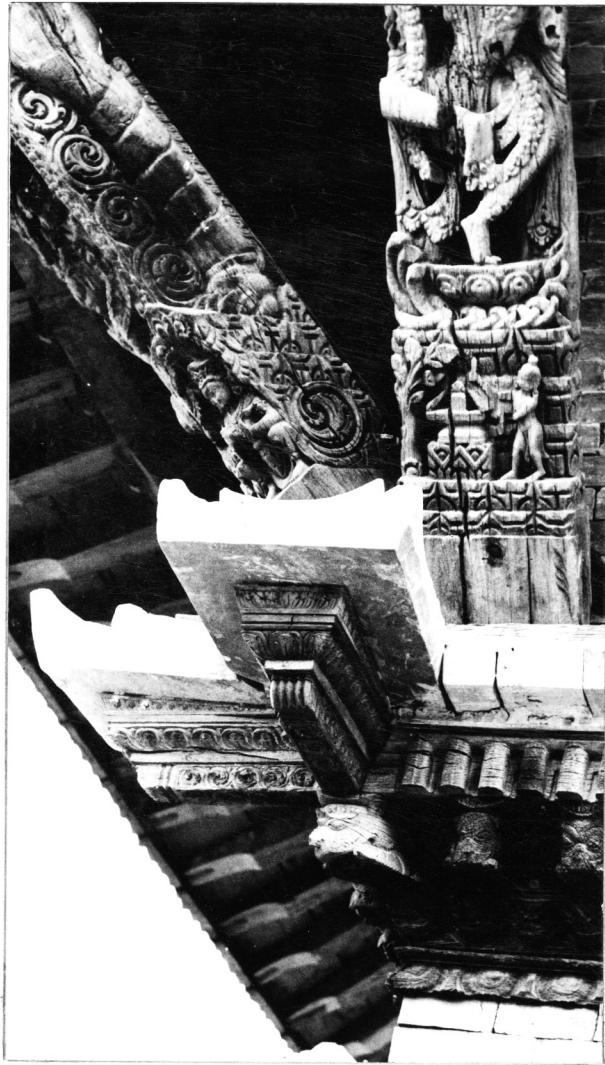
BASE STORY CARVINGS AT DOORS.
SURVIVING NICHES FLANKING DOORS. CLOCKWISE
FROM OPPOSITE LEFT : EAST ELEVATION, LEFT AND
RIGHT; SOUTH ELEVATION, RIGHT; NORTH ELEVATION,
LEFT AND RIGHT.





UPPER WINDOWS

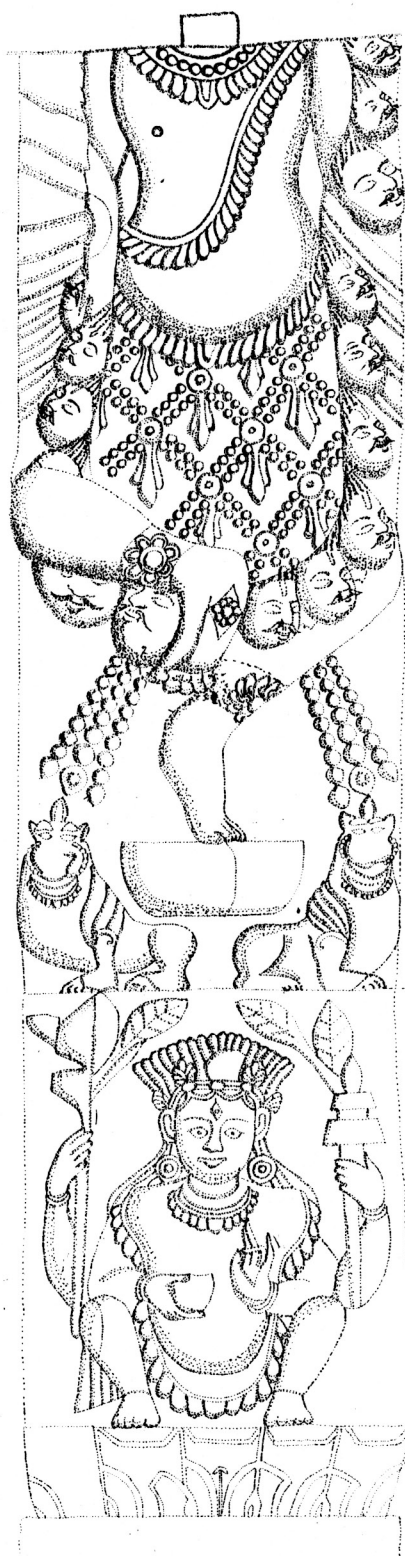
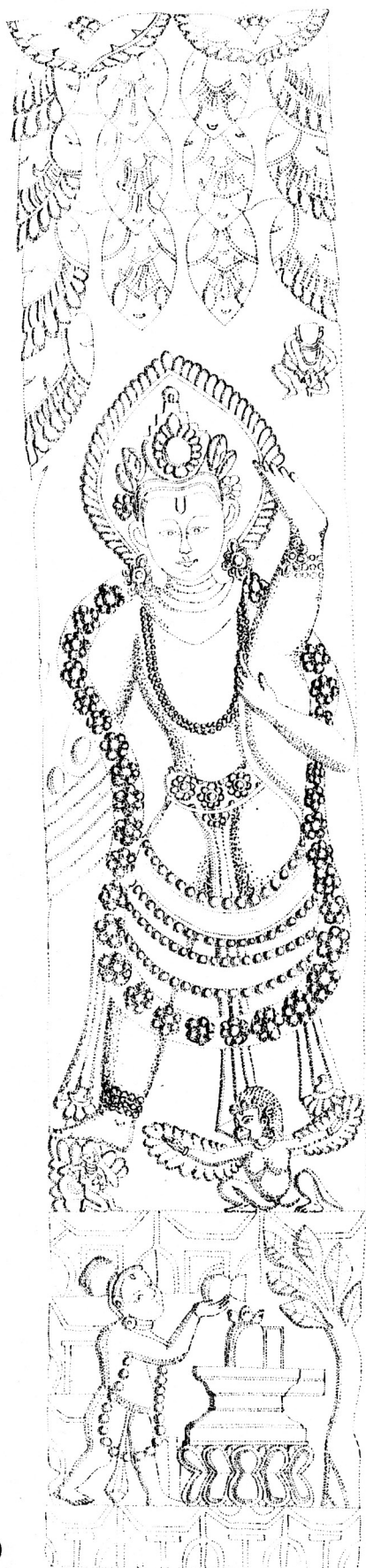
ABOVE : MIDDLE LEVEL CENTRAL WINDOW AND FLANKING BLIND NICHE, SANS TORANA BELOW: UPPER BASE STORY SIDE WINDOW WITH 1967 HANUMAN FACE



ARCHITECTURAL CARVINGS
PROJECTING BRICKS, *LHĀKĀ*, WITH TIMBER
SUPPORTS. RIGHT: BASE STORY CORNICE AT
NORTHWEST CORNER.

REPRESENTATIVE STRUTS

LEFT TO RIGHT: MIDDLE ROOF (#204); LOWER ROOF FRAGMENT (#112); UPPER ROOF (#311).



Further reductions occur at the middle and upper stories of the temple, where carvings are more shallowly rendered and all figural locations depict repetitive animal and floral motifs. The flanking niches depict identical images of Ghandarva, singer of the heavens inside an architectural frame.

(6) Cornice miniatures

Miniatures between the carved lion heads in the cornice just above the ambulatory depict images of Visnu (above the principal entrance), floral motifs, and the eight auspicious symbols (Newari-*Aṣṭamaṅgal*).

(9) Stone guardian statuary

Flanking the entry stair are a pair of male and female lions, reiterating the male-female theme of Tantrism.

Architectural carvings

Additional more architectural carvings are found which although formulaic have some symbolic content²⁵ and are typical of the local architectural canon. These include:

- (1) Carved lions on base stones below ambulatory pillars, at plinth corners, and beneath the sills of all door and window frames.
- (2) Pillar and capital carvings, varying only in floral motifs.
- (3) Elaboration of crossing beam heads (at the corners) with griffin heads
- (4) Elaboration of crossing timbers below projecting corner bricks (Newari-*lhākā*) to suggest cupped hands supporting the bricks.
- (5) Timber cornices at three levels

Lower struts:

Principal figures (all male-female/Śiva-Śakti pairs except for two single Bhairav figures—one modern, one historical) stand upon symbolic mounts. They are surmounted by an upper panel of foliage into which small animal and human figures are integrated. Lower registers depict varying individual and groups of gods, demons, and humans with a general theme of the victory of good over evil.

The predominance of Siva rather than Visnu figures is unusual according to local iconographer and researcher, Hem Raj Sakya. Typical, however, is the location of Ganesh (#101) and Kumār (104) on the principal elevation flanking Mahāviṣṇu (#102) just above and right of the entrance. The original Bhairav strut (#112) on the west

²⁵Gutschow's dictionary (1987) identifies the names and symbolic content of hundreds of mouldings, motifs, and profiles.

elevation corresponds to the traditional belief that evil spirits and demons come from the west. Such a single Bhairav figure is often found on the lower roof of many pagoda structures, although not always on the west side. The copy of this Bhairav strut added to the south elevation in 1967 (#108) does not conform to a local practice of one protective Bhairav strut/lower roof.

The pairing of figures is critical to the Tantric belief of power coming from the male-female union. It is echoed in the lion-lioness pair of guardian statuary as well as the male and female icons within the sanctuary. An extension of this theme may also be seen in the complementary predominantly *male* figures of the middle roof struts and *female* figures of the top roof as well.

Corner horses. On this and the upper two levels, the larger corner struts are elaborated as massive flying horse figures (Newārī-*kūṃśal*). These animal figures are typical of all pagoda temples and are found with minor variations. The erect genitalia of these struts suggests Tantric themes.

Middle struts

(1) The principal figures are male gods, most of which are different forms of Vishnu. The upper foliage register is not elaborated with any figures. In the lower register are depicted various scenes of a priest (Newārī-*pujārī*) worshipping a *śiva liṅga*. The orientation of the *liṅga* suggests an orientation and strut location. The spout should always point north, i.e. on the north elevation the spout would be seen head on.

Upper struts

Those two struts which are original to the temple render the principal figures as one of the eight mothergoddesses or *Aṣṭa Mātṛ kā*. Foliage above does not include any figures. Symbolic vehicle animals serve as mount. Struts from other buildings include erotic scenes which traditional mythology maintains encode the holy message (*mantra*) of the temple.

4.4 Iconographic commentary

The following are preliminary observations.

Tantric themes

The pairing of figures is quite significant--it is one of the many iterations of the Tantric conception of the temple, a program in which the male god realizes his powers (*siddhi*) through union with his female counterpart (*sakti*). Thus, this Tantric sect temple is dedicated to an incarnation of Vishnu, Krishna, with his consort, Radha. The themes of

male and female union are found in the conception and placement of a majority of the struts: male-female (*Śiva-śakti*) pairs supporting the bottom roof; single male figures (Vishnu, Bhairav) the middle; and single females (*Aṣṭa amāṭṛ kā*) the top. Not by accident several struts which have found their way over the centuries to support the top roof of the Radha Krishna temple from other temples also depict erotic scenes associated with the *Siva-sakti* union. It can be noted that such organizing principles in Newar cosmology are rarely executed without some apparent contradiction--that is, to the western mind. Thus, at the middle primarily "male" level, for example, several female figures are also found (#208, 211, 213). Studies of Newar iconography that both these deviations and the general patterns which they seem to contradict are typical of the local cosmology and the traditional artistic license of the maker²⁶.

Typical elements

Several other conventions of the iconographical typical of many temples in Nepal should be mentioned. First, above all doorways a tiny tryptich is carved in the door frame depicting the god of the temple as well as two companion gods, in this case Ganesh, the elephant god of good fortune and Saraswati, the goddess of wisdom. In upper story blind windows the faces of the singer (Gandarva) or dancer (Kinnara) of the heavens are found, beckoning the faithful to the otherworld. The stone guardian statuary of lions and dwarves (*yaḥsas*) flanking the plinth steps shows signs of Chinese influence via Tibet.

Complexity

Among temples of the Malla period one can distinguish different levels of elaboration and complexity of the decorative iconographical program. The more complex examples, whose workmanship is also typically more sophisticated, consist of many more "layers" of iconographic images. The facade is developed with more locations for iconographic images at niches, extended door and window frames, roof strut panels, and cornice friezes. The images found at similar locations on the facade--sometimes diverse and sometimes repetitive--form a kind of subset of iconographical images. As one would expect, the more elaborate temples are composed of more complex subsets. These subsets include different members of a particular group (such as the eight identifiable Mothergoddesses found in the pairs of niches which flank the door on each elevation of Radha Krishna) or those which transform an icon in different locations (such as the Bhairav image repeated on every threshold, but in each position displaying a different hand gesture (*mudrā*). Conversely, on less sophisticated temples, one finds fewer images and simple repetitions of images at comparable locations. At the nearby Uma

²⁶Unpublished manuscript "The Nepalese Caitya", Niels Gutschow.

ICONOGRAPHIC PROGRAM

Struts(8): 3 registers. Single main figures (Mothergoddesses) with subsidiary narrative panels. Both registers varying with repetitive floral patterns above.

4 identical corner horse struts.

Window: repetitive animal and floral figures. Central torana figures: varying(?) x 4 sides, with repetitive frames (?).

Cornice: no inset miniatures

8 struts: 3 registers. Varying single deities, main register. Varying subsidiary narrative panels below. Repetitive floral designs above.

4 identical corner horse struts.

Niches: 2 deities/ elevation, repeated on 4 sides.

Windows/torana: repetitive pairs of animal figures in 2 locations x 4 sides. Central torana figures: varying(?) x 4 sides with repetitive frames (?).

Cornice: no inset miniatures.

16 struts: 3 registers, all varying. Principal figures are pairs of gods; narrative panels below, floral designs include animal, human, and deities.

4 identical corner horse struts.

12 windows with torana: different deities in 6 locations x 4 sides. Repetitive animal and guardian figures.

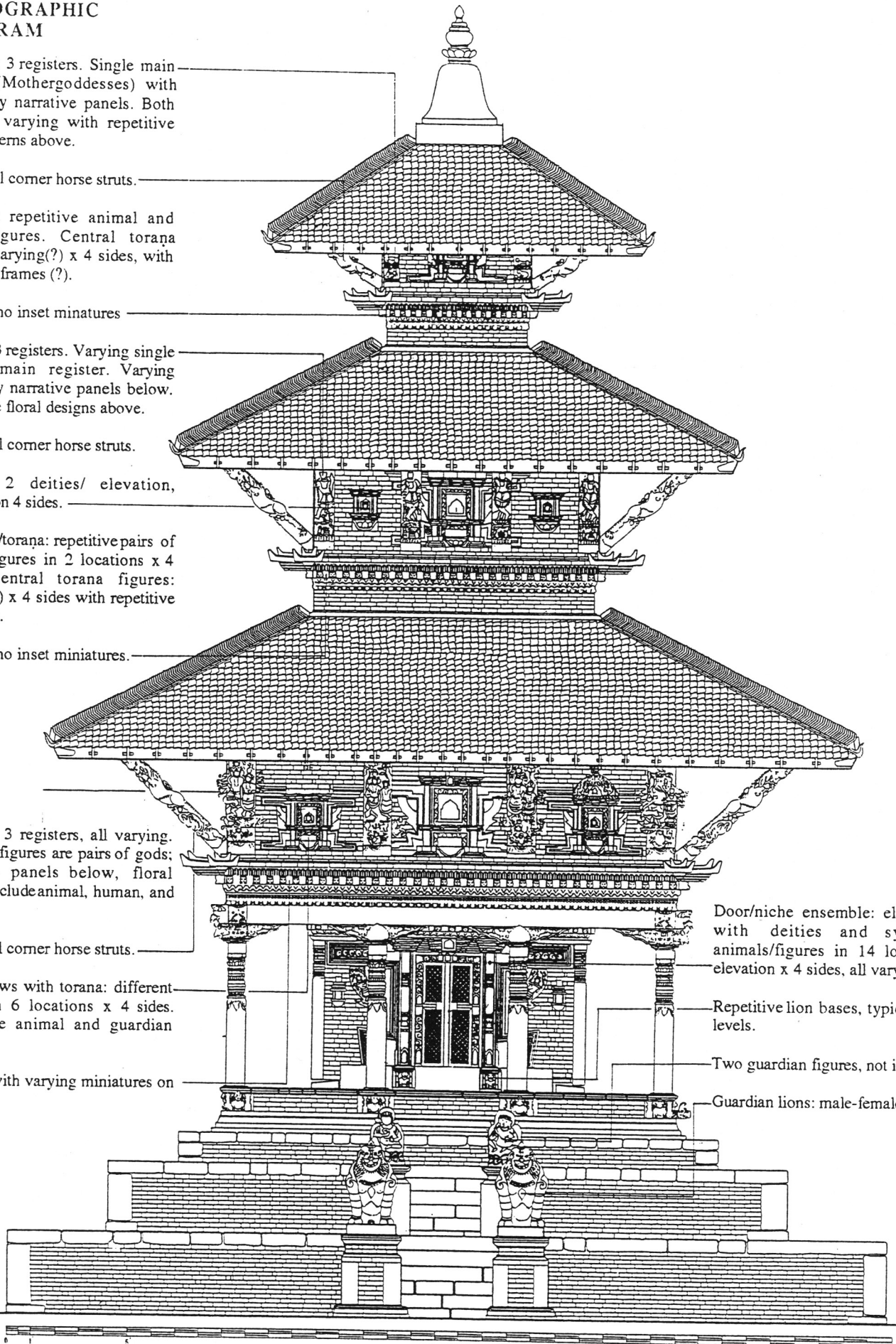
Cornice with varying miniatures on all sides.

Door/niche ensemble: elaborated with deities and symbolic animals/figures in 14 locations/ elevation x 4 sides, all varying.

Repetitive lion bases, typical at all levels.

Two guardian figures, not identical.

Guardian lions: male-female.



RADHA KRISHNA MANDIR

SWATHA TOL., PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

RESTORED PRINCIPAL ELEVATION
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993

ICONOGRAPHIC PROGRAM

8 struts: 3 registers. Single main figures (Mothergoddesses) and subsidiary narrative panels, both varying, with repetitive floral patterns above.

4 identical corner horse struts.

Window: repetitive floral and animal figures.

Cornice: no miniatures.

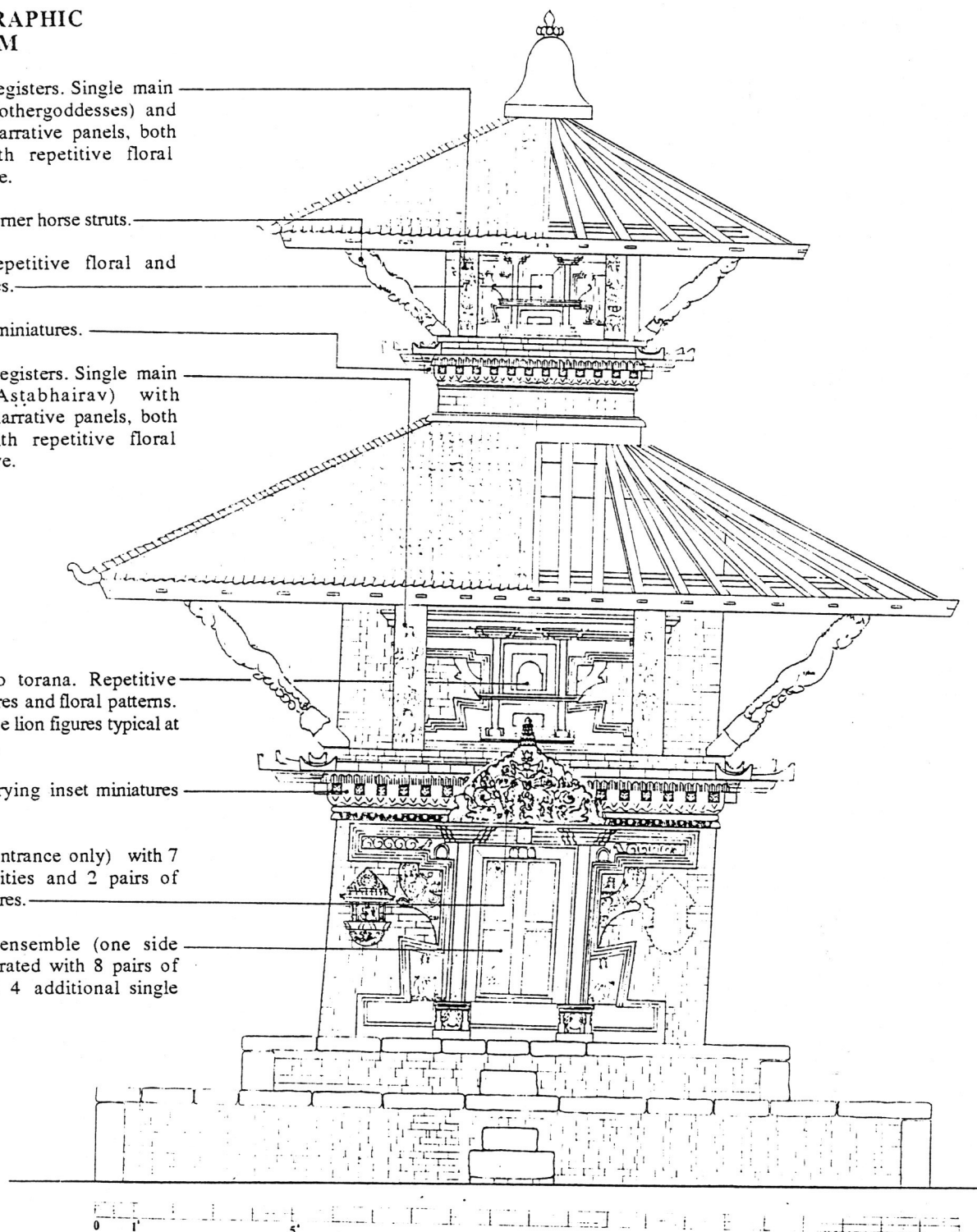
8 struts: 3 registers. Single main figures (Aṣṭabhairav) with subsidiary narrative panels, both varying, with repetitive floral patterns above.

Window: no torana. Repetitive animal figures and floral patterns. Repeated base lion figures typical at all openings.

Cornice: varying inset miniatures on all sides.

Torana (at entrance only) with 7 different deities and 2 pairs of guardian figures.

Door/niche ensemble (one side only): elaborated with 8 pairs of deities and 4 additional single deities.



UMA MAHESWAR TEMPLE

KWALKHU TOL, PALAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

PRINCIPAL EAST ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992

Mahewar temple, for example, niches with Mothergoddesses flank the single doorway, but are mirror images of the same generalized image.

The Radha Krishna temple displays a relatively elaborate program of iconographic woodcarving, one which is comparable to the greatest monuments of the Malla period for both its artistic execution and level of complexity.

There is great variation in the figures and forms of these carvings--almost no two elements are identical on the temple in spite of the number of repetitive elements and identical facade configurations. For example, even the timber pillars of the ambulatory reveal variations in the floral carvings of their capitals upon close inspection.

Even numbers of minor elements such as niches, guardian statuary, and roof struts gather symmetrically at the sides of the doors and windows to provide another hierarchical layer in the axial symmetry within each floor.

Hierarchy, focus

There are virtually no "repeats" in the many layers of iconographical woodcarving. Hierarchies of orientation and level direct the variation and transformation of iconographical material. The east and principal elevation at base and entrance level is the key zone. For example here one finds the eight Mothergoddesses (*Aṣṭ amātṛ kā*) carved in the lintel above the door, while on southern and northern sides floral designs fill this position. The only representation of Mahavishnu, Vishnu in his supreme form, is found on the strut just above the door to the right, balanced by another unidentified form of Vishnu. Kumar and Ganesh, gods who because of their association with good fortune are included on a majority of temples in Nepal, flank these struts of Vishnu, acting as further keys to the entrance side. Lastly, the strut figures on this side include an additional fifth head (carved on the back of the struts) to reinforce the importance of the entry side.

As one looks up the temple, the iconographic program becomes simpler: there are fewer iconographic images than below --floral motifs inhabit the niches of gods found on the lower floors. Paired male and female figures (*Śiva-śakti*) on the bottom roof struts are replaced by single male and female images on middle and upper roof struts, respectively. The importance of the east elevation remains, however, as seen in the auxiliary figures at the first floor window. These depict Vishnu, while on the other sides his female devotees are found. One can draw a parallel between the layers of

iconographical material and the organizing principles of "layered" symmetry discussed above.

The western elevation follows in importance: here above the door lintel the eight auspicious Buddhist symbols (*Aṣṭamaṅgala*) correspond to the eight Mothergoddesses found on the principal elevation, while the terrific and most powerful manifestation of Śiva, Bhairava, is found on a bottom roof strut guarding from evil spirits which, according to local tradition, come from the west.



LEFT: DETAIL LOWER ROOF STRUT (#103) THE SIXTH HEAD ON THE BACK OF THE STRUT.
RIGHT: CORNER HORSE STRUT, SOUTHEAST CORNER.



VARYING FLORAL MOTIFS
ON TWO ADJACENT PILLAR CAPITALS: NORTHWEST CORNER.

5.00 Existing conditions

The following numbered outline is used to organize descriptive material about the existing conditions of the monument and is repeated in the following section for proposed repair and restoration work. Thus, for example, proposed work under section 6.04 refers to existing conditions described under 5.04, etc.

Existing conditions described below correspond to annotated elevation and section drawings.

- 5.01 Foundations/walls structural
- 5.02 Walls: fabric
- 5.03 Walls: openings, decorative elements
- 5.04 Roof structure
- 5.05 Roof cover
- 5.06 Roof decorative elements
- 5.07 Interior
- 5.08 Plinth

5.01 Foundations/walls structural

Summary

Excepting the collapsed areas just beneath the missing middle roof, which have deteriorated since the removal of the roof cover, the masonry wall structure of Rādhā Krishna is in good condition. The interior bearing wall layer of common brick (Newārī-mā apā) laid in mud mortar shows no signs of cracking, movement, or settlement. The exterior veneer wall of *daci apā* on both plinth and walls is relatively intact except for several areas discussed below. Vertical posts of sal wood set in the wall, which together with interior wall plates and cross ties at three levels create a kind of timber framework, are in good condition showing no signs of wet rot or insect infestation.

A serious structural problem is found at the two levels of timber beams which support the uppermost temple walls and roof. Here, deflection of the undersized historical timber members and deterioration by wet rot (brought on by the missing roof cover) threaten future collapse.

5.01.1 Plinth/foundation

The condition of the foundation is indeterminable in such a structure without excavation of the plinth. As the temple shows no signs of settling or problems resulting from rising ground dampness, further investigation was not undertaken. Lack of settlement was determined by pipe level readings at the wall plate of the bottom roof.

5.01.2 Base story

At the base story of the temple, i.e. ambulatory level, just above the plinth, the walls have developed a curious pattern of deformation. This movement is most visible in the spaces of 1/2 to 1-1/2" inches which have developed in the joints of the timber door frames and between door frames and masonry wall. There are similar gaps between the exterior corner posts of the building and the brick wall.

Documentation of the width and location of cracks does not suggest a single cause for this deformation (see ground floor elevations). Certainly the typical²⁷ use of unseasoned timber in the original construction of the temple may cause such gaps through their shrinkage and warping. The size of the gaps, however, suggests additional forces at work on the temple such as the lateral thrust of seismic activity or settlement. As there are no other signs of settlement in the temple structure, it appears that these deformations, found only at the base level where seismic forces would be strongest, may result from past earthquakes.

Consulting structural engineer Prayag Raj Joshi's appraisal of these gaps in the timber joints and between timber elements and walls is that they do not pose structural problems as there is sufficient timber interlock remaining in the joinery.

Upper base story

The wall structure shows some signs of outward displacement resulting from the great thrust of the largest roof which it supports. In an area approximately 6 feet in height and on all sides of the temple just below the lower roof wall plate, the wall has been pushed out, tapering from below to a maximum distance of between 1 and 2 inches at the top.

East elevation

The only damage on this elevation consists of a 1/2" separation between bricks close to the upper and north corner of the elevation. The pattern repeats that of the south elevation (starting one brick in from the corner and stepping down almost vertically), but only extends through the seven uppermost courses of brick.

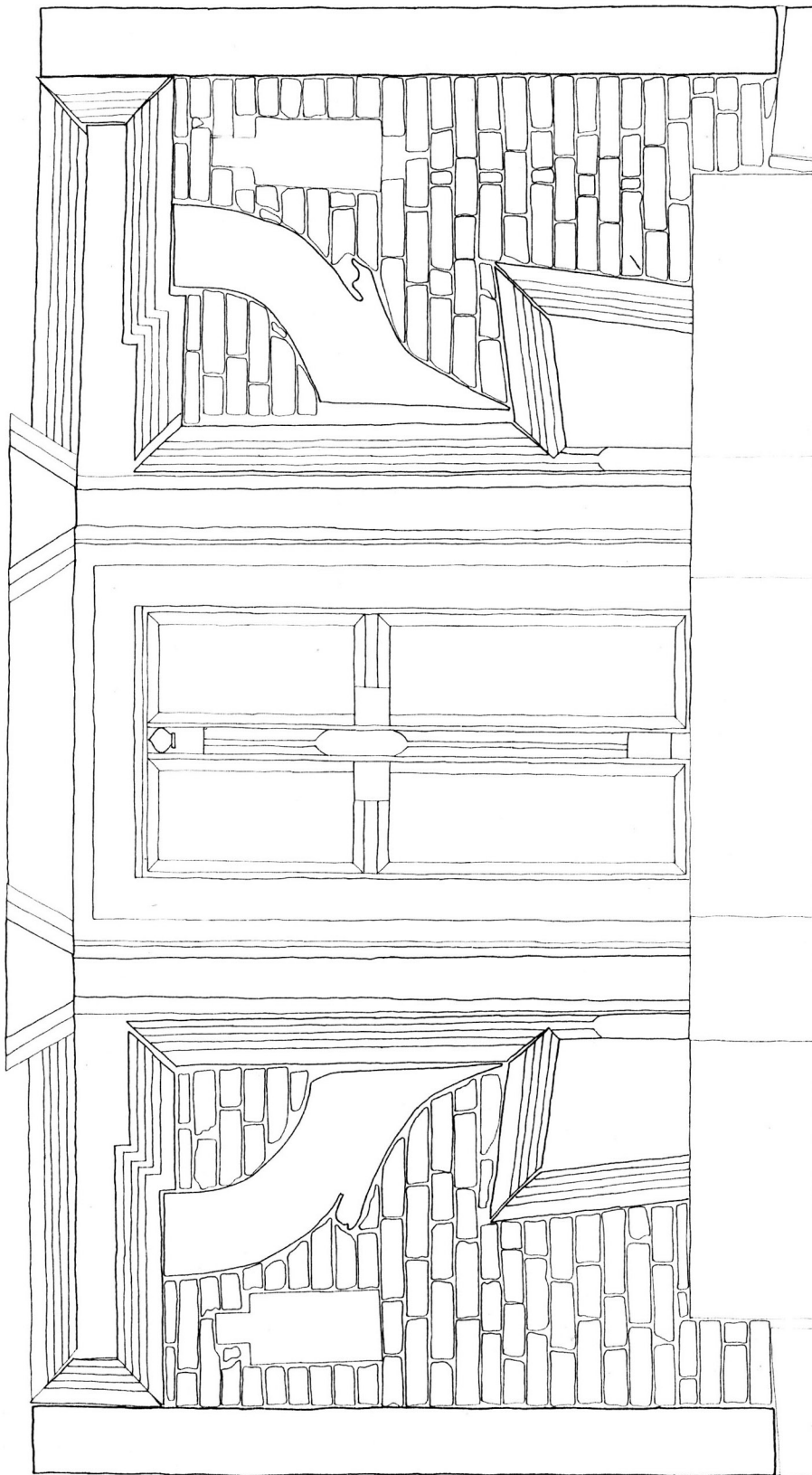
South elevation

At east and west corners, the bonds of the corner bricks have remained intact, while spaces have developed just inside (one, two, and three bricks in from the corner) as a consequence of the outward displacement discussed above. On the east side a separation of 1" begins one brick in from the corner at the top and travels almost vertically down to

²⁷Niels Gutschow discussed this point in a recent lecture to the Institute of Engineering.



SPREAD TIMBER JOINTS AT BASE STORY.
 LEFT: NORTH ELEVATION, LEFT SIDE. RIGHT:
 CORNICE AT NORTHWEST CORNER.



SURKHI (CEMENT) POINTING
LOST CARVING
SPREAD TIMBER JOINT (>1")

RADHA KRISHNA MANDIR

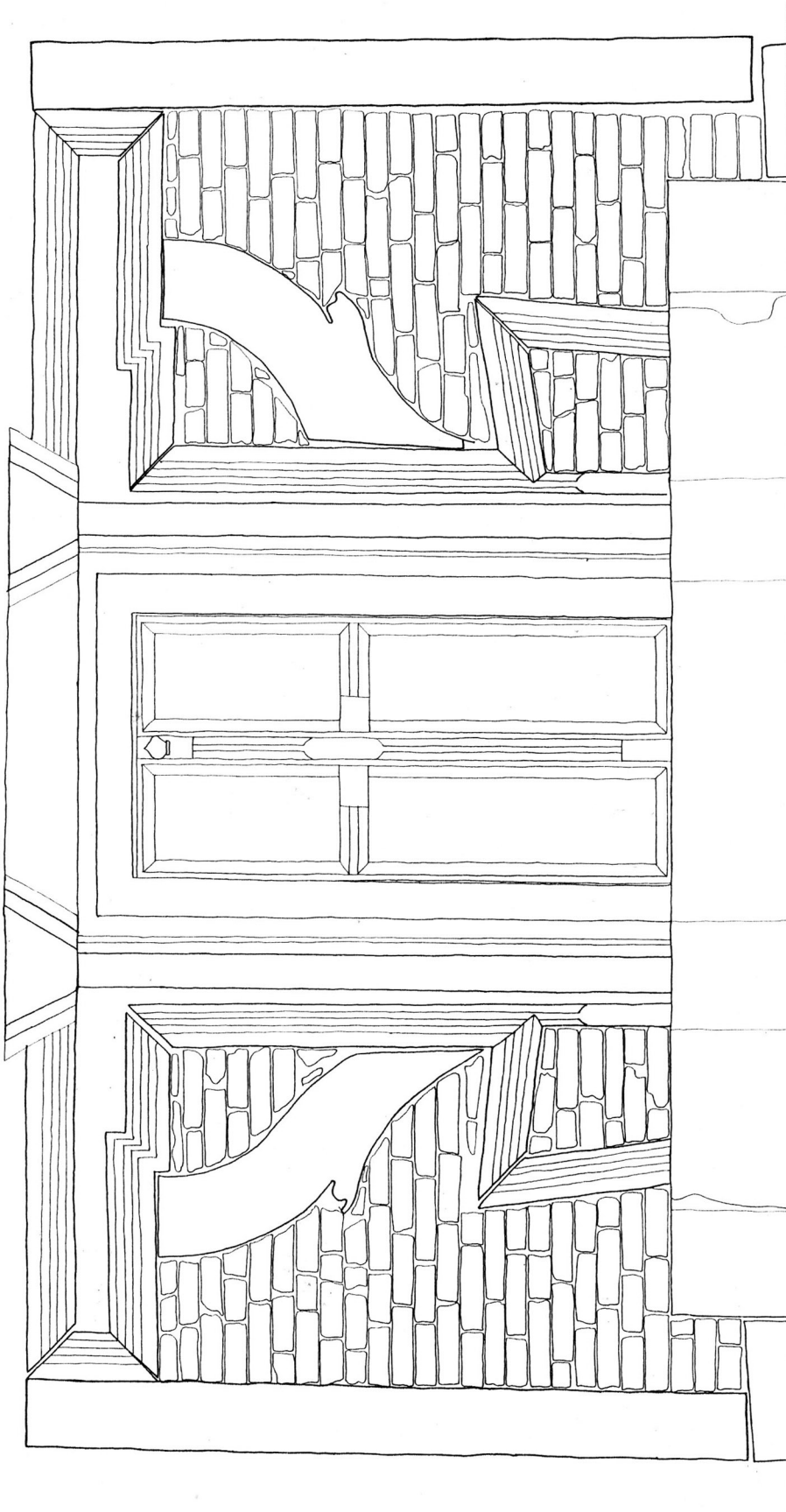
PATAN DARBAR WORLD HERITAGE SITE

EXISTING CONDITIONS: FEBRUARY, 1992
GROUND FLOOR EAST ELEVATION

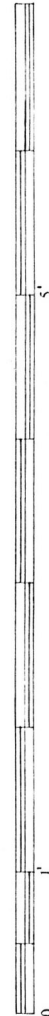


SURKHI (CEMENT) POINTING
LOST CARVING
SPREAD TIMBER JOINT (>1")

RADHA KRISHNA MANDIR
PATAN DARBAR WORLD HERITAGE SITE
EXISTING CONDITIONS: FEBRUARY, 1992
GROUND FLOOR SOUTH ELEVATION



SURKHI (CEMENT) POINTING
LOST CARVING
SPREAD TIMBER JOINT (>1")

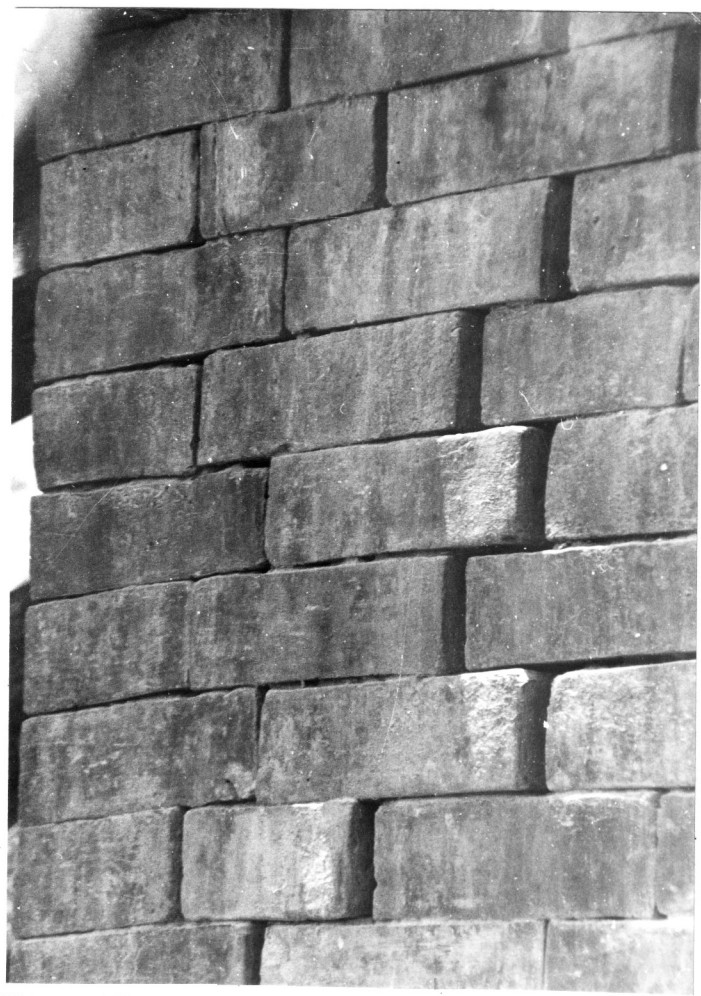


RADHA KRISHNA MANDIR
PATAN DARBAR WORLD HERITAGE SITE
EXISTING CONDITIONS: FEBRUARY, 1992
GROUND FLOOR WEST ELEVATION



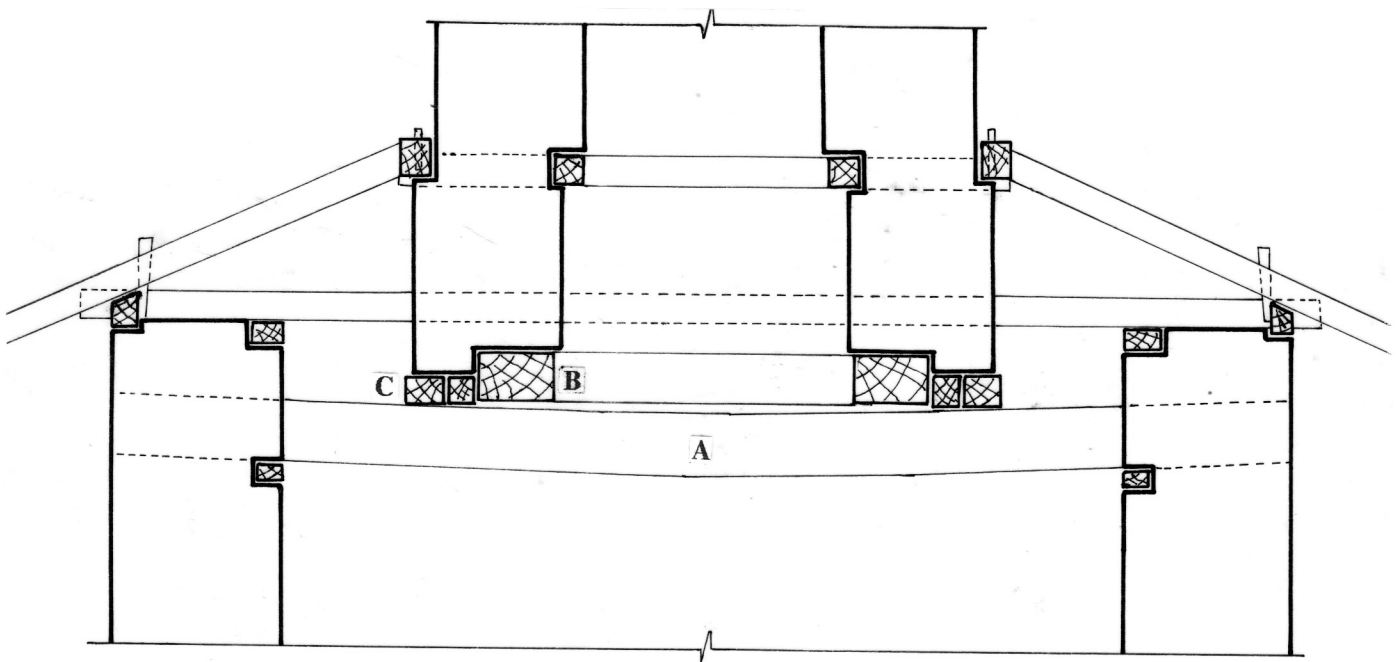
SURKHI (CEMENT) POINTING
LOST CARVING
SPREAD TIMBER JOINT (>1")

RADHA KRISHNA MANDIR PATAN DARBAR WORLD HERITAGE SITE EXISTING CONDITIONS: FEBRUARY, 1992 GROUND FLOOR NORTH ELEVATION



WALL CRACKS

LEFT: SOUTH ELEVATION UPPER BASE STORY, RIGHT SIDE. RIGHT: DETAIL OF MIRROR IMAGE CRACK, SOUTH ELEVATION, LEFT SIDE.



SECTION DETAIL: EXISTING

DEFLECTION AT SUPPORT OF UPPER LEVEL

A - 13"X7" SAL MAIN BEAMS, 2" DEFLECTION

B - 9" X6" PINE SECONDARY BEAMS, GOOD CONDITION

C - 4"X3" SAL TIMBERS SPANNING MAIN BEAMS, GOOD CONDITION



the level of the timber cornice above the arcade. The separation is only 1/2" at the lower end. On the western side, the same pattern is found in mirror image, but slightly smaller (3/4" at the top and 1/2" at the bottom). Additionally the top 5 courses of bricks on this elevation bulge outward with a maximum displacement of 3" in the middle. This area is 5'0" long and exactly in the middle of the elevation. This bulging is found primarily in the veneer layer, typical of almost all historical buildings here where few cross bonds are incorporated between the three layers of the walls. In this location, the displacement seems to have resulted from weakened joints in the *daci apā* wall caused by water seepage from the damaged roof above.

Hairline cracks have developed on the inside bearing wall behind these areas, demonstrating both the relative independence of the inner and outer walls and the greater vulnerability of the veneer layer.

West elevation

The upper portion of this wall was rebuilt in 1967 of common brick of laid in cement mortar with surkhi pointing. This area consists of the top ten courses of brick at the corners growing to 14 courses of brick in the center. Other areas retain historical *daciapā* and are in good condition.

North elevation

Excellent condition except for one separating crack on the east side. This separation begins one brick in from the corner and travels 6 courses down, maximum width 3/4".

5.01.3 Middle story

The considerable deterioration in the top 9 courses of brick (on all but the east elevation) has resulted from the removal of the middle roof. As water has penetrated the mud mortar and fill area between structural and veneer wall layers, the wall has literally fallen down brick by brick. Other areas of the middle wall are in good condition, showing no signs of movement and retaining the historical *daciapā* laid in mud mortar with no pointing.

The most serious structural problem of the temple is found where the great load of the uppermost temple level is carried by two layers of timber beams. This construction consists of two main beams of sal timber below (dimensions: 13"x 7") and two perpendicular secondary pine beams above (dimensions: 9"x 6"). The upper pine beams do not rest on the lower sal beams and thus distribute upper loads to all four walls. This construction may date from the 19th century (as discussed in section 3.0).

The lower sal members show signs of wet rot on their upper surfaces in exposed areas, in this case the 18" length between inner and outer walls. A pen knife penetrates

between one and two inches in these areas. Furthermore these members show signs of deflection, measured at 1-3/4" and 2" in the center. There are no signs of deterioration or wet rot in other areas of these sal beams or in the pine beams above, demonstrating that the rot has been caused by the lost roof. It should be mentioned that it is not possible to inspect the upper surfaces of the pine beams as the upper walls rests directly on them.

5.01.4 Upper story

In excellent condition, these walls show no signs of cracking, movement or deformation.

5.02 Walls- fabric

Summary

The surface condition is excellent. The highly fired historical *daciapā* is both smooth and of a beautiful dark crimson hue. The color of the upper two storys is slightly more reddish in color than the lower wall areas. Except in a few locations where repairs and patches have been made or damage has occurred, the *daci apā* is laid in its characteristic way, that is, so tightly that only a maximum of 1/8" mud mortar is visible 1/4" behind the surface of the brick.

5.02.1 Plinth

Spalling of the *daciapā* veneer brick is found only at the skirt below the ambulatory, where complete rebuilding in cement mortar with *surkhi* pointing was done in 1982. Some new *daciapā* of more orange color, but identical in size to the historical brick, were also incorporated in this repair. This spalling, which has affected some 30% of the wall surface at this level, results from water penetration which has brought salts from the cement mortar to the surface, where upon crystallization, the face of the brick is damaged .

This skirt area is defined top and bottom by decorative stone courses, which have been largely replaced in 1982 by crude copies of the original in an inferior limestone. Under the ambulatory pillars, historical limestone slabs rendered as lions are intact and demonstrate the difference between their intact architectural profiles and those of the new. In two locations on the south elevation the lower stone base elements were replaced with bricks.

On the lower vertical surfaces of the plinth approximately 80% of the wall area has been pointed with *surkhi* mortar in 1982. These walls were not rebuilt but retain the historical *daciapā* in good condition. The edging of large stones of these plinth levels has been

sloppily pointed with cement mortar; voids and crack in the stones have been filled with cement mortar as well.

Pavement

At ambulatory and all plinth levels the pavement was replaced in 1982. At ambulatory level, traditional telia tiles (Newārī- *cikā apā*) were replaced with stone tiles laid in cement mortar. On the horizontal surfaces of the plinths, traditional tiles were laid in a regular pattern mixed with courses of common brick, all pointed in a *surkhi* mixture. This ahistorical pavement is in excellent condition.

5.02.2 Base story

Ground floor elevations document the extensive patching of the veneer brick at this level which also includes the filling up of lost carved timber decorative panels with brick. All of this work, executed in 1982, uses *daci apā* of historical size but less fired and more orange in color. These patches are laid in cement mortar with *surkhi* pointing-- grout lines average 1/4" thickness. The orange color and cement-like rough texture of this pointing as well as the large size of the joints is visually distracting at this most visible level.

5.02.2 Upper base story

All irregularities of the veneer brick have been described above under structural conditions.

At the corners above the timber cornices are found two levels of overlapping and projecting decorative corner bricks (Newari-*lhaka*). Their considerable cantilever is supported by projecting timbers, are also decoratively rendered. At this level all *lhaka* are intact, but chipped in many locations.

5.02.3 Middle story

Excepting damaged portions below the missing roof discussed above, the wall surface is in excellent condition. *Surkhi* pointing has not been applied.

Projecting decorative corner bricks above the timber cornice (*lhaka*) are intact except at the northwest corner where one upper and one lower brick (both on the west side are missing. The projecting timbers below the *lhaka* at this corner are in poor condition: they are weakened by wet rot and overcut lapjoints. The deflection of these projecting timbers is 2" below horizontal.

5.02.4 Upper story

The wall surface is in excellent condition. *Surkhi* pointing has not been applied.

Projecting decorative corner bricks above the timber cornice (*lhaka*) are intact except at the northeast corner where the lower brick on the east side is lost. The projecting timber below the missing *lhaka* on the northeast corner has broken off. On the northwest corner these projecting timbers are weakened by water damage and have deflected 2" below horizontal.

5.03 Walls: timber elements

The carved timber wall elements--doors, windows, tympanum, niches, and decorative panels are in good condition, exhibiting no signs of rot, fungal decay, or insect infestation. Many elements have been lost, however, as documented by the existing conditions elevations. These lost elements include 25 of the 28 historical tympanum-like *torana* above windows and niches; 10 of 16 decorative panels which fit into the extended frames of the ground floor door frames; 3 of 8 small niches on the ground floor; and 3 of 8 niches at the middle level. Missing elements are documented on individual elevation drawings.

All three levels of historical timber cornice are intact except for one patch of 4' length matching the historical design and made in 1967 on the uppermost level south elevation .

5.04 Roof structure

Summary

All of the roofs were completely rebuilt in 1967 incorporating some historical members. Among the rafters of the extant lower and upper roofs, one-fifth of the rafters pre-date the 1967 repair. The middle roof was dismantled after partial collapse in 1989. The following remarks can be made:

All timbers introduced in 1967 are machine sawn sal timbers, average size 4"x 3" laid on flat. (Traditional construction methods consistently employ timber beams and joists in their structurally inefficient orientation on flat in Nepal.) The older rafters of unknown date are all pine, adze hewn, and of average size 5" x 4". Older wall plates and purlins are all adze-hewn in both sal and pine.

All of the pine timbers show some signs of past insect infestation, namely the very tiny flight holes (1-2mm) flight holes of the furniture or powder post beetle, *Anobium Punctatum* or *Lyctus*, respectively. The flight holes are widely spaced and show no signs of recent infestation. The weakened structural integrity of almost all the pine

members results from water damage and development of wet rot rather than insect infestation.

In general the sal timber (*shorea robusta*) retains its structural integrity even in locations where damaged roof cover has allowed water penetration over the last two years, while all unprotected pine timbers have deteriorated rapidly due to wet rot, losing all structural integrity in the same time period. This damage is often only detectable from the top side of the rafter---inspection from below (before dismantling of the roof cover) is often misleading, as even when the bottom three surface appear sound, a pen knife from above will penetrate 2 inches.

The traditional connection between rafter and wall plate and between rafter and purlin consists of two timber pegs inserted to brace the rafter against the horizontal member. At approximately 60% of these peg locations, water penetration had caused deterioration of the peg, enlargement of the peg hole, and deterioration of the surrounding area on the rafter of 3" square on average.

The most important conclusion of the detailed study of the roof structure is that the traditional wooden peg (Nepālī-*cukul*, Newārī-*c ukū*) inserted as a key at the wall plate and purlin is the principal entry point for water into the structural timbers. The traditional detail uses the peg as a key in the mud layer above the planking. Thus any damage to or movement of the rather loose roof tile (*jhingāṭi*) allows water to reach the mud and then penetrate to the cross grain of the rafter through this wooden peg. Moreover, when the small timber peg deteriorates, there is nothing to prevent the heavy rafters from sliding off the masonry core structure. This scenario describes the majority of roof failures in Newar buildings. See further discussion in appendix article.

5.04.2 Bottom roof

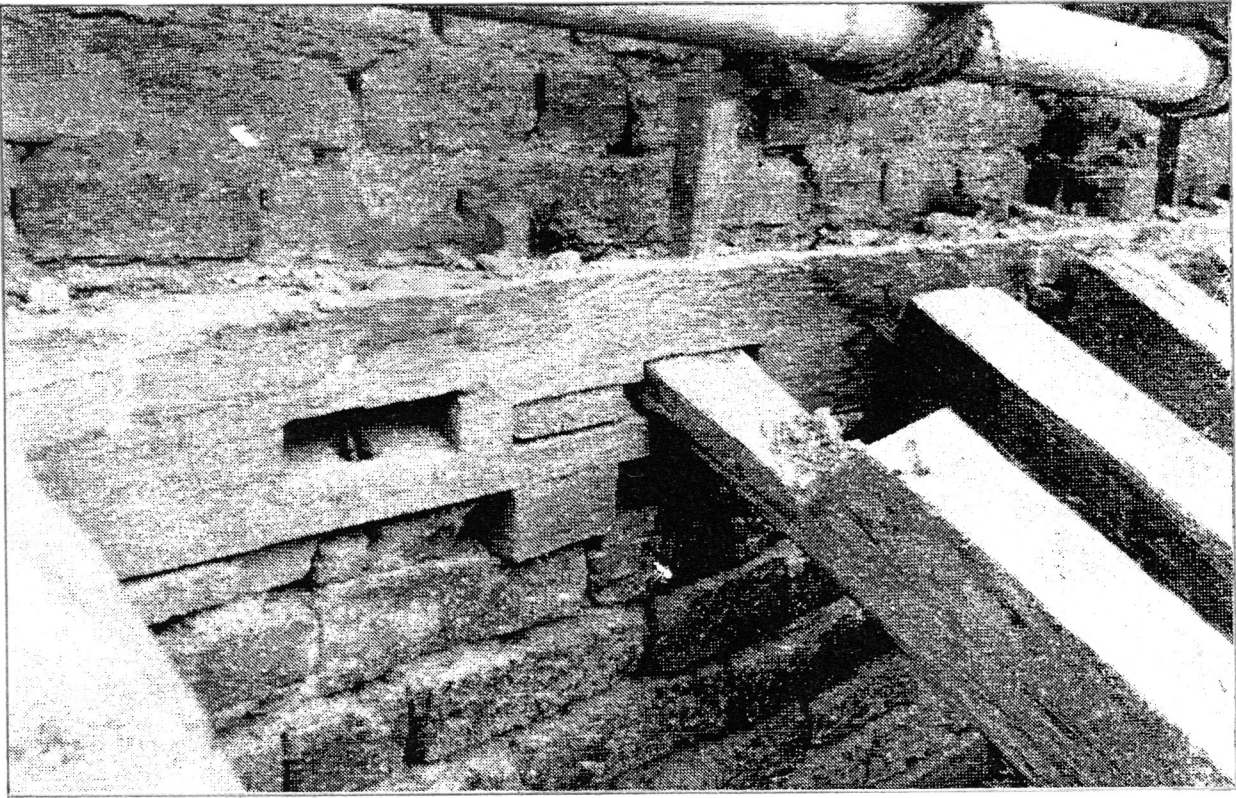
At the lower roof, the joinery of the 1967 rebuilding is notably sloppy and structurally unsound. The upper ends of the lower roof rafters are consistently and drastically overcut where tenons notch into a vertically mounted wall plate. The upper ends of these rafters lose their structural integrity, reduced to as little as 1-1/2" height in section for lengths of 7" to 12". In 10 locations where rafters are joined from two timbers, the lapped joint is made in the reverse of its structurally sound configuration. Lastly, the main wall plate beneath these rafters (above the base story) has been structurally reduced where rafters have been notched into the wall plate. This notched cut reduces the wall plate to as little as 1" height in section in some 20 rafter locations.

Condition of roof structural timber

(by elevation and level, 1 =lower roof, 2 =middle, 3 =top.)

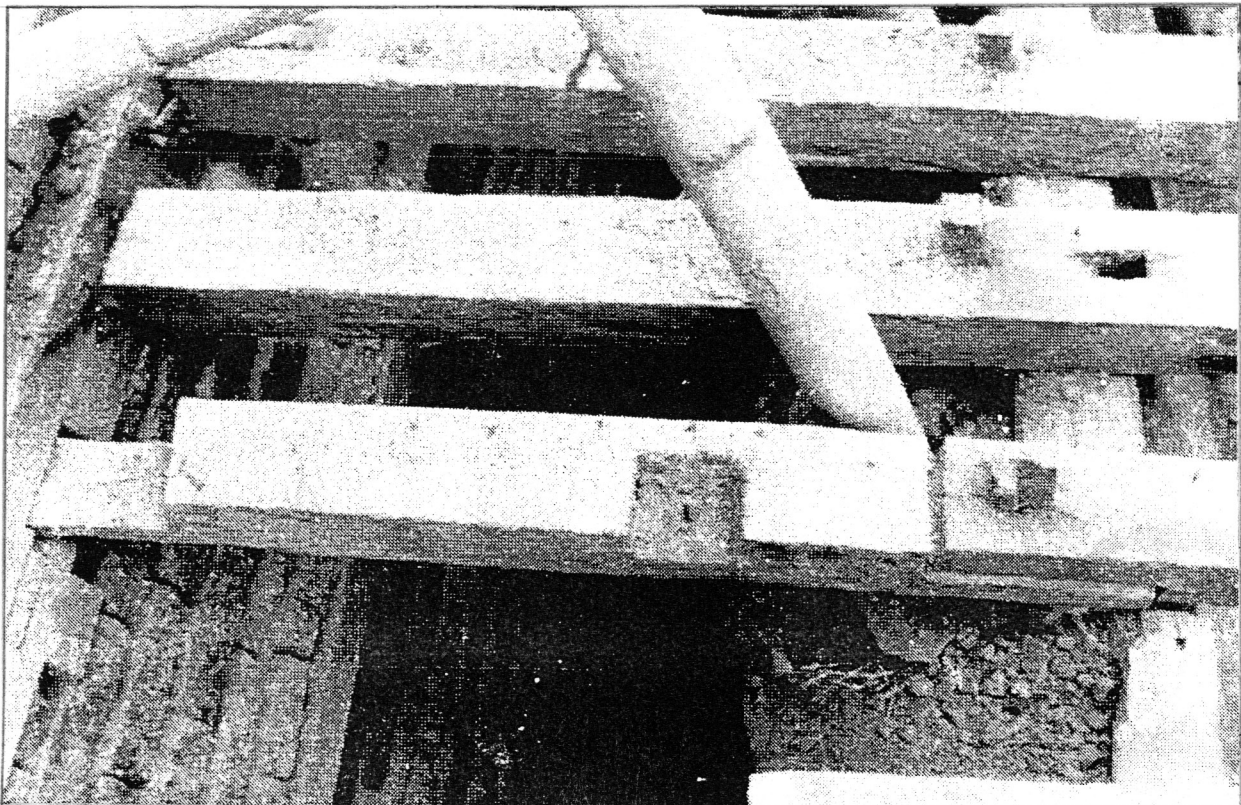
Location	Rafters	Purlin	Wallplates
East 1	# 1, 4, 6, 8-18, 21-23, 25-27: 1967 sal. Good except for damage @ pegs. # 2, 3, 5, 7, 19, 20, 24: older pine: severely rotted.	1967 sal: severely rotted.	Inner wallplate: older pine in good condition; outer: older pine severely rotted and overcut by 1967 renovation.
East 2	Lost	Lost	Older pine: severely rotted.
East 3	13 Rafters all 1967 sal, damage @ pegs, 50% reusable	Good	1967 sal: good condition .
South 1	1967 sal: # 1-3, 5, 10-12, 14-18, 21, 22, 24, 28. # 15-18, 21, 22 severely rotted. All others damaged @pegs. Older pine: # 4, 6-9, 13, 19, 20, 25-27. All pine rafter severely rotted. # 23 missing.	1967 sal: severely rotted.	Older pine: severely rotted.
South 2	Lost	Lost	Lost
South 3	13 rafters: all 1967 sal damaged @pegs.	1967 sal: good condition	1967 sal: severely rotted.

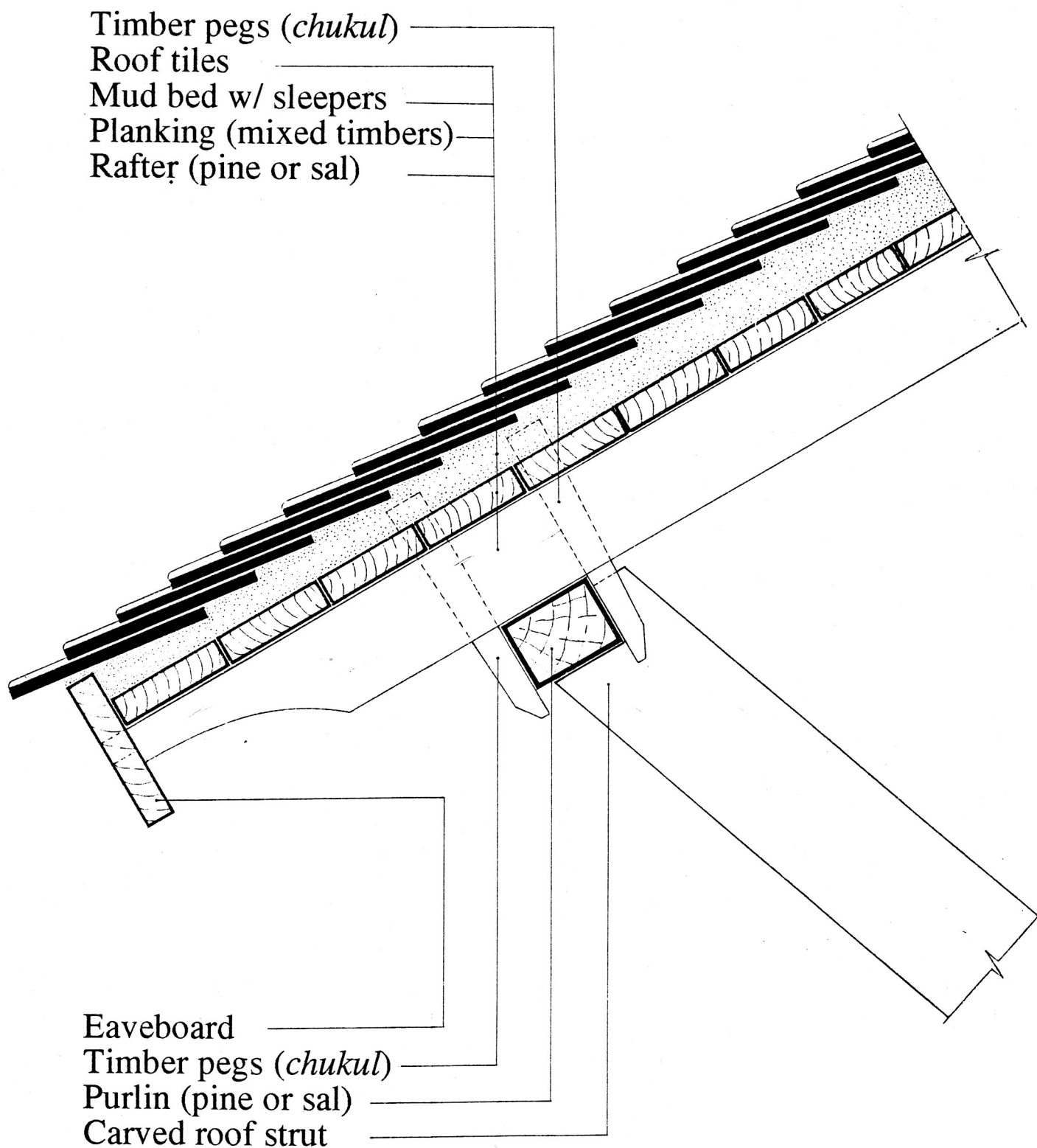
Location	Rafters	Purlin	Wallplates
West 1	1967 sal: # 2, 4, 8-18, 19, 21-23, 25. # 6-18 severely rotted, others damage at pegs. Older pine: # 1, 3, 5, 24. All severely rotted. # 6, 7, 20 missing.	1967 sal: severely rotted.	Older pine: severely rotted.
West 2	Lost	Lost	Lost
West 3	13 Rafters all sal by 1967 50% usable.	1967 sal: good condition.	1967 sal: severely rotted.
North 1	1967 sal: # 1, 7, 9, 11, 12, 14-19, 22-27. All sal rafters are good except for damage @ pegs. Older pine: # 2-5, 13, 20. All severely rotted.	1967 sal: severely rotted.	Older pine: severely rotted.
North 2	Lost: # 6, 8, 10, 21. Lost	Lost	Lost
North 3	13 Rafters all sal 1967, 60% severely rotted, others damaged at pegs.	1967 sal: good condition.	Older pine: good condition.



Timber joinery from 1967 repairs at Radha Krsna Temple.

Sloppy repairs and rebuilding in the last century have endangered many buildings. Above: where rafters meet upper walls of the temple, tenons have been drastically undercut, rendering the joint useless. Below: rafters (often made up of two lengths) are joined in a structurally irrational configuration: the lap joint is reversed, so that the lower length of rafter is held in place only by the small timber peg.





THE "KEY" PROBLEM

*Section at roof overhang:
as traditionally detailed*

This overcutting of the wall plate may result from the following scenario. During the 1967 fitting of new rafters, cutting of the wall plate would have allowed new and relatively straight rafters to meet the eavesboard level of older, deflected members. This deflection is especially apparent at the highly loaded corner rafters where, for example, at the northeast corner a deflection of 4" has been measured. This rebuilding to fit a lowered eavesboard level is also suggested by the cutting of six lower roof struts. It can be hypothesized that repairs were made *in situ* and that when these struts were removed to make repairs, they could not be fit back in without shortening of some 3" at their uncarved bases.

Similarly, the historical sal eavesboards (1"x 5") at both upper and lower roof levels have been structurally weakened by the 1967 repairs. The refitting of the rafters did not consistently use the historical notched holes for rafter heads, but rather introduced new holes, most oversized so that a proper connection could not be made. All eavesboards at all levels are made structurally unsound by these holes as well as from exposure to water. The 1967 rebuilding employed different numbers of rafters on each side of the roof. Not including corner rafters, the number of members per side is 27, 28, 25, and 27 for east, south, west, and north sides, respectively.

5.04.2 Middle roof

Dismantled after partial collapse in 1989, only the wall plates on the east side are intact, although structurally damaged by exposure to water and consequent wet rot.

5.04.3 Upper roof

The much smaller upper roof structure, in contrast to the lower roof, does not suffer from deficiencies in joinery. Moreover, the historical tie structure at wall plate level, partially rebuilt in 1967, is adequately designed not only to carry rafter loads, but also to act as an anti-seismic ring beam. This tie structure consists of three continuous wall plates, lap jointed to each other at the corners and to two perpendicular sets of crossing tie beams.

Deterioration at timber peg locations is again noticeable.

5.05 Roof cover

The roof cover consists of planking over rafters with a clay bed above to receive the tiles.

Planking

The random width timber planking was entirely replaced in 1967 in plank sizes from 1" x 3" to 1" x 6". 80% of the planking on the intact upper and lower roofs is structurally denatured from exposure to water and wet rot.

Roof tiles *jhingaṭi*

The roof tile cover laid in clay is largely intact only on the southern side of the bottom roof and on the upper roof all sides. Vegetable growth is visible in all locations between tiles and has dislocated many tiles. In several locations the planking is visible below dislocated tile areas. A large portion of the tiles are covered with moss. The condition of the roof tiles and amount of vegetable growth is slightly better on the north and east sides of the lower roof.

Only 25% of the traditional ridge tiles which are stacked vertically along the hips of the roofs remain. The lost tiles have been knocked off --traditionally they are not attached.

Only two of eight corner aviform tiles of the two extant roofs remain, both on the lower roof.

5.06 Roof decorative elements

Metalwork

On the lower roof eavesboard (northeast corner), survives only one iron corner plate, decoratively elaborated in the form of a bird (Newāri-*kūpātā*). It is in good condition with limited surface rust. On the upper roof one plain iron corner plate survives in good condition on the northwest corner of the eavesboards.

One inch wide metal straps with triangular points are found with nails connecting all rafter heads at their penetration of the eaveboards of bottom and top roofs. Their 1 mm thickness has allowed them to rust through in all locations.

5.06.1 Roof struts bottom story

Please refer to appended inventory of struts.

The 15 original and finest struts, although structurally sound, are discolored dramatically by mildew which gives the appearance of smoke staining. These black areas, which rub off to the touch, are not continuous and form large patches on the sal wood struts. In addition on all of these struts at least 50% of the surface is covered by an eight inch thick residue, beige colored and in linear strand formation, parallel to the wood grain, the result of wet rot, structurally damaging in places. There are no signs of dry rot.

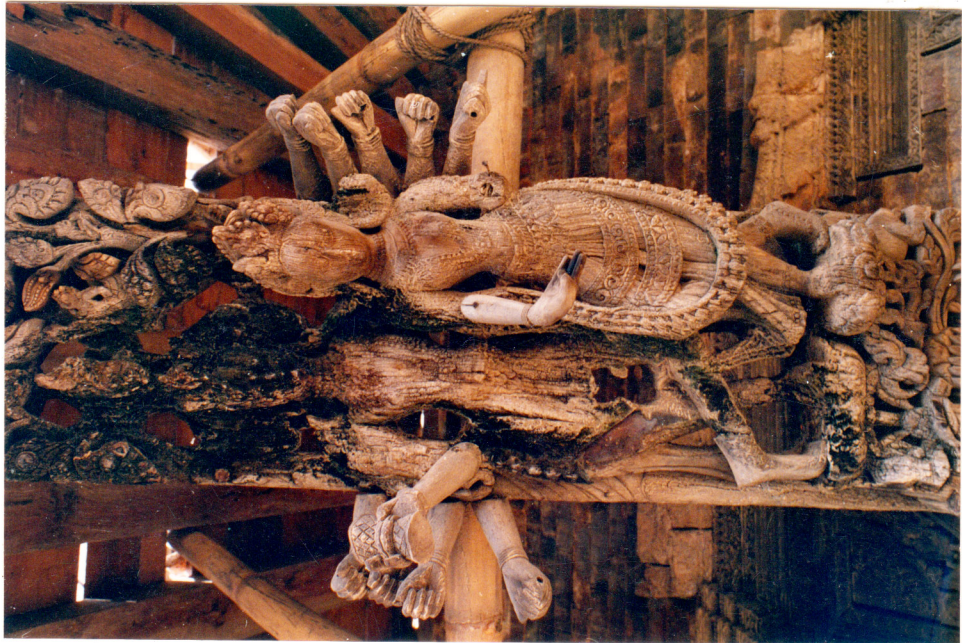
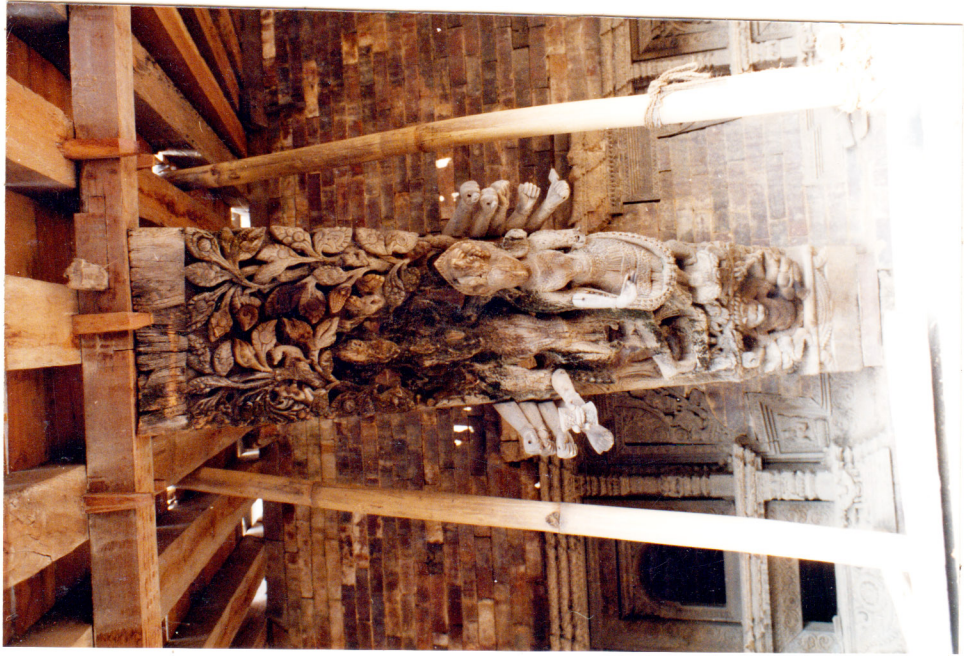
The number of arms and drapery locations can be determined by studying notches on the sides of the strut. The pairs of figures depicted on these struts have lost almost all of their original arms displaying symbolic objects and most of their drapery and mount elements, all of these being made of separate pieces of timber fitted into the main timber. During 1967 repairs, new and crudely fashioned replacements of the hands were nailed to the struts, not employing the notches in the side of the struts where the original features had fit, but instead nailing into the front surface of the strut. In some locations, older and more finely carved hands have been re-fitted with nails.

One lost strut from the west elevation (#112) has been recovered from a neighbor's attic, the upper one quarter of the strut is missing. Several struts require structural consolidation (#107,112,113, 114, 117); all are from locations directly below roof damage.

Many of the struts have been cut some 3-4" at their bases. This is discussed under existing conditions of roof structure 5.04.1.

5.06.2 Middle roof struts

The struts from the missing roof have been stored in the temple since dismantling. Of 20 struts only one has been lost and another (#219) survives in several fragments. These fragments were recovered from the rubble heaped in the upper passage of the building. Five struts have deteriorated from wet rot to a degree that they will require structural consolidation (#208, 212, 213,216,219). All struts suffer from mildew and wet rot staining and deterioration similar to the bottom roof struts. This rot is characterized by linear ruts parallel with the grain of the wood and beige residue, although the residue is less evident on these struts, the result of limited advance of the rot since interior storage. Black mildew stains many of the pieces although to a lesser extent than the bottom roof struts.



LOWER ROOF STRUT 107: DOCUMENTATION OF MILDEW AND WET ROT, MARCH, 1992.

The subsidiary panels carved on these struts depicts a scene with a *śiva liṅga*. In Hindu cosmology the spout of the base of the *śiva liṅga* must always face north. The different views of the *śiva liṅga*--head-on, side, spout concealed, etc., therefore, provide clues to the original locations of these struts. For example a strut which shows the spout head-on should be located on the north side, while one with a side view (with spout right, pointing north) should have been on the east elevation. Additional clues to original location are provided by a notching pattern on the strut bases which identifies central, right, and left-hand locations. Working in this manner, all of the struts could be assigned an historical location, although at certain locations several struts fit, while at others none fit. (This may have come about from the common practice of copying extant struts to replace lost elements--in these cases even inappropriate notch locations and *śiva liṅga* orientations were copied.) By giving priority to older struts, i.e. putting them in their proper location, while putting newer copies in the remaining locations a final configuration was determined.

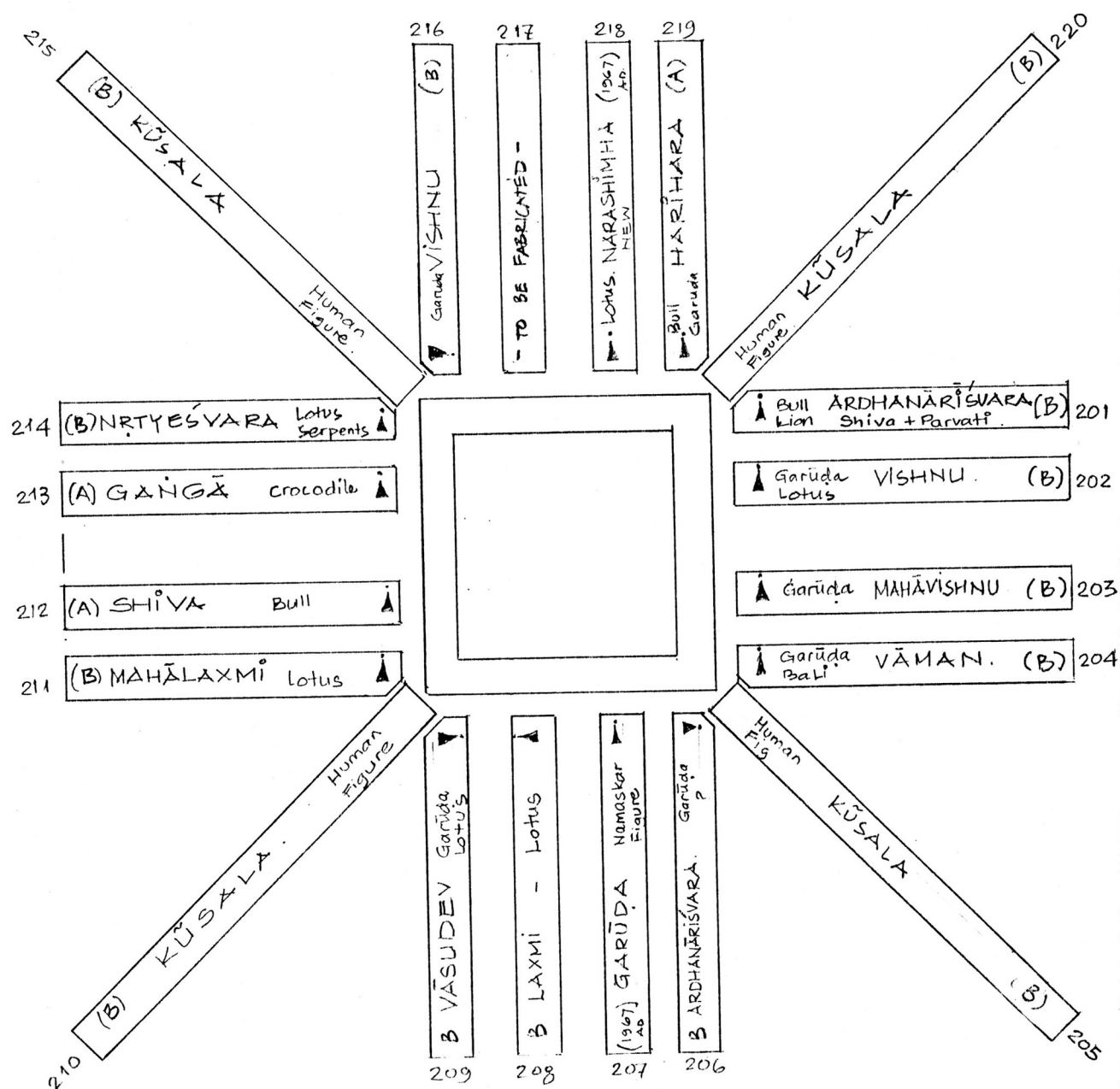
Most historical arms of these single figure struts have been lost. A few were replaced crudely in 1967.

5.06.3 Top roof struts

Similar evidence of fungal and mildew attack is found, although to a lesser degree than on the other roofs due to the better condition of the roof cover. Six struts can be identified as belonging to another temple because of their shorter lengths and different composition, one of these even appears to be a leaning window element rather than a strut because of the structural notches in its side. Where pieces of wood have been added to fit these struts on the Radha Krishna temple, wet rot deterioration is evident. The two struts, which appear to be original to the temple, have lost some sculptural detail from water and wind action, but are otherwise in excellent condition.

5.07 Interior

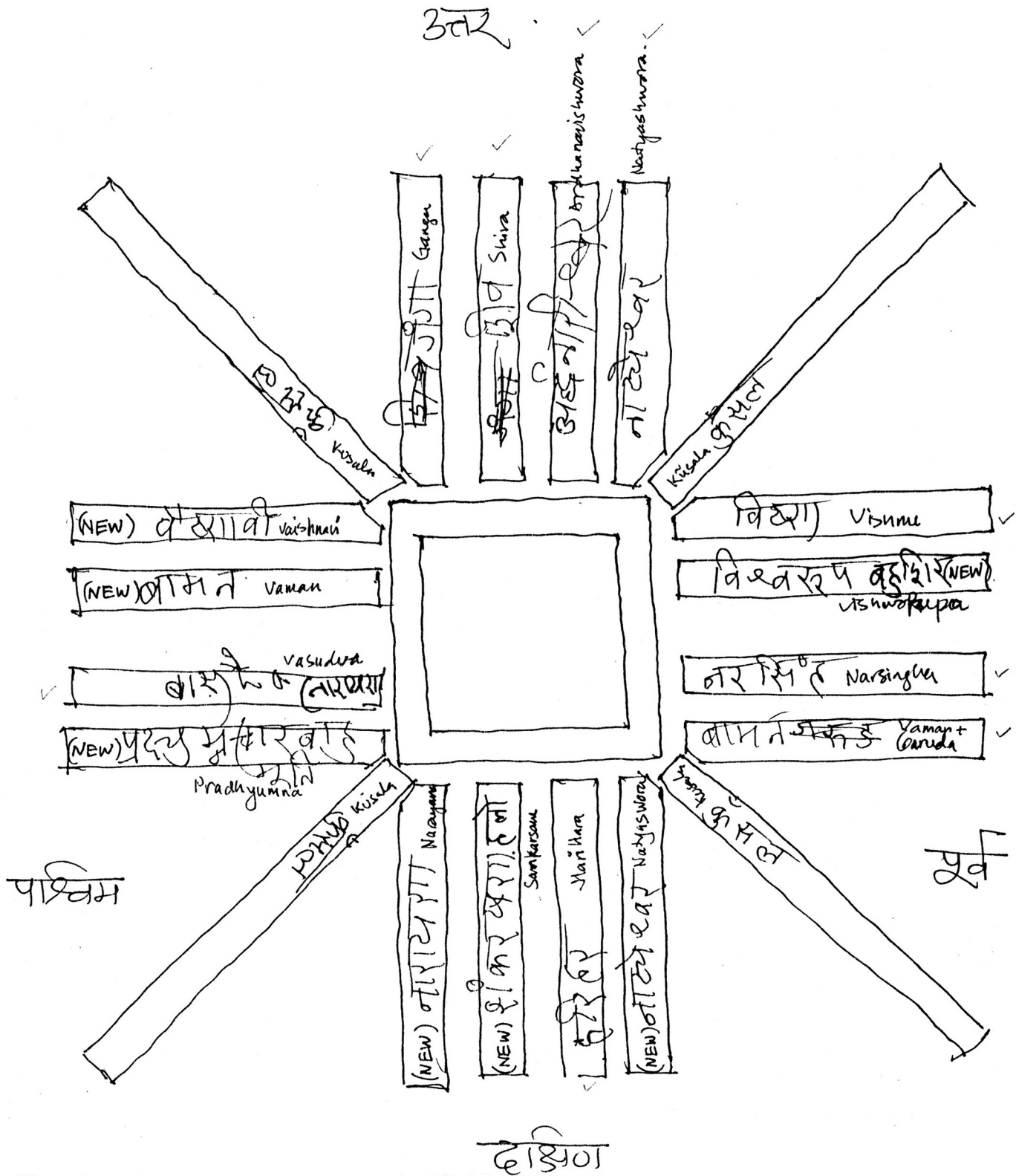
Excepting structural issues discussed under 5.01 there are no surface or structural defects in the interior. The original telia tile floor was replaced in 1967 with stone tiles. The upper ambulatory level was filled with trash 18" deep remaining from the 1967 renovation. When cleared out fragments of one damaged middle roof strut were found.



STRUTS: MIDDLE ROOF

PROPOSED LAYOUT OF STRUTS WITH PRINCIPAL DEITIES AND MOUNTS FOR THE LOST MIDDLE ROOF. DARKENED TRIANGLES INDICATE THE DIRECTION OF THE SUBSIDIARY SCENE SIVALINGA. STRUT AGE: A = ORIGINAL 1668; B = 19TH CENTURY. STRUT 207 & 218 DATES FROM 1967 RENOVATION. 217 IS LOST.





STRUTS: MIDDLE ROOF

PROPOSED LAYOUT OF STRUTS WITH PRINCIPAL DEITIES BY MADHAN MOHAN MISHRA, HISTORIAN. MISHRA PROPOSED 7 STRUTS AT THIS LEVEL BE NEWLY MADE TO CREATE THIS "IDEAL" LAYOUT OF DIFFERENT INCARNATIONS OF VISHNU.



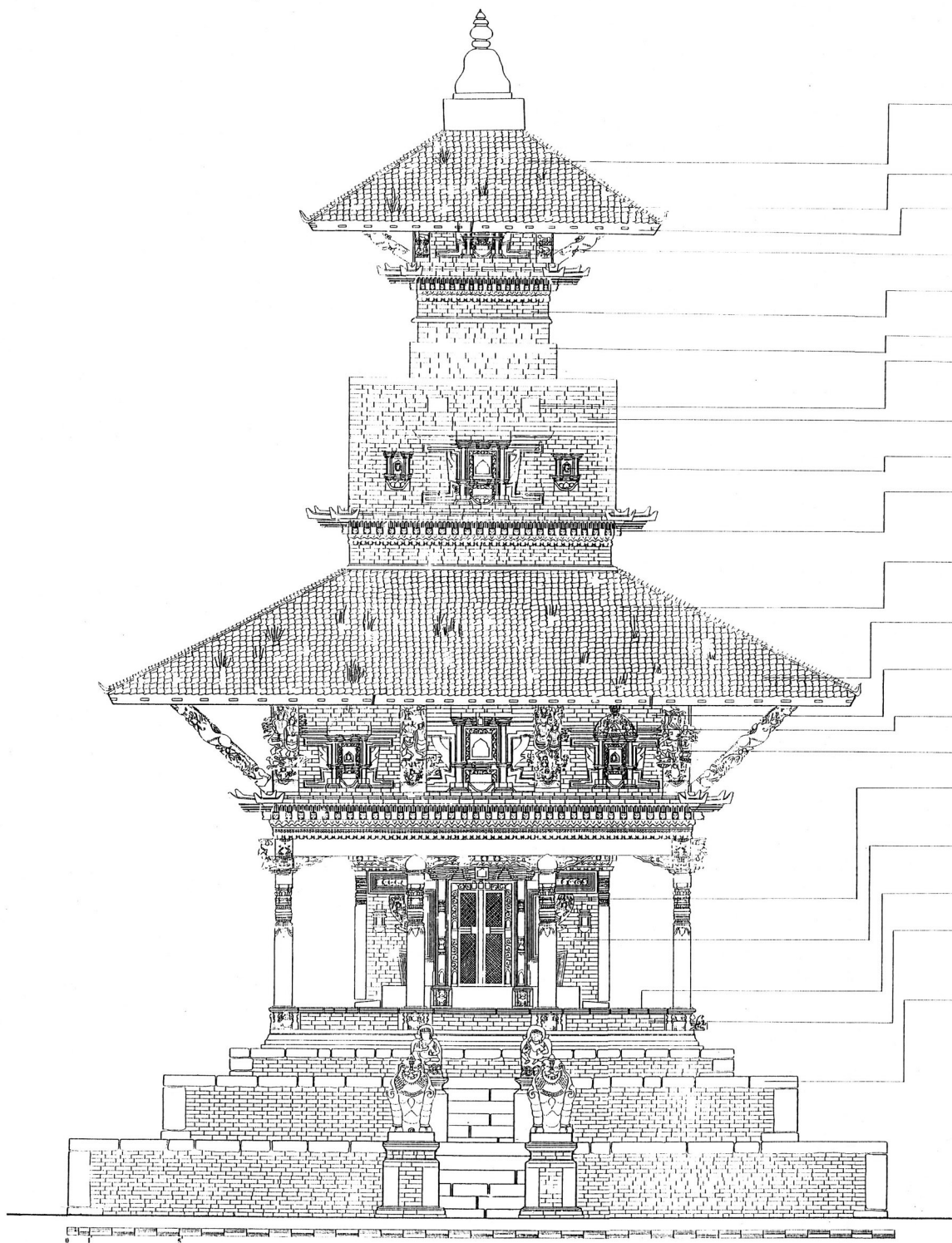
5.08 Plinth

5.08.1 Guardian statuary

The limestone figures which flank the entry stair clearly demonstrate the importance of protective covering in the monsoon climate. The lower lions, not covered by the bottom roof, are scoured by 1/8-1/4 inch grooves created by and showing signs of ongoing lichen growth in rain-driven patterns. The upper guardian figures, under roof cover, are perfectly smooth and show no signs of lichen growth.



GUARDIAN LION (LEFT):
LICHEN GROWTH, FEBRUARY, 1992.



East
EXISTING
CONDITIONS

Rafters: 1967 sal members reusable with repairs at *chukul* locations. All older pine rafters rotted.

Inner wall plates sound; outer wall plates rotted and overcut in 1967. Sal purlins (1967) sound. Sal eavesboard rotted.

Struts need cleaning, but structurally sound.

Upper wall: excellent condition. Missing *torana* above window.

Upper wall plate lost.

Timber beams supporting upper level damaged by wet rot and deflected 2".

Middle wall intact, wall plates intact, but rotted.

Blind windows intact, all 3 *torana* lost.

Timber and brick cornice in good condition except for chipped projecting corner bricks, *haka*.

Rafters: 1967 Sal (20 rafters) damaged at *chukul* locations. Older pine (7 rafters) rotted.

Sal purlins rotted. Pine inner wall plates, sound; outer rotted.

Vertical separation between bricks at upper right corner.

All *toranas* but one (right window) lost.

Severe mildew and wet rot on all struts.

Missing *Asta Matrika* panels, all other carvings intact at door/niche ensemble.

Historical brick veneer and mud mortar wall intact at base level.

Plioth pavement 1982: excellent condition.

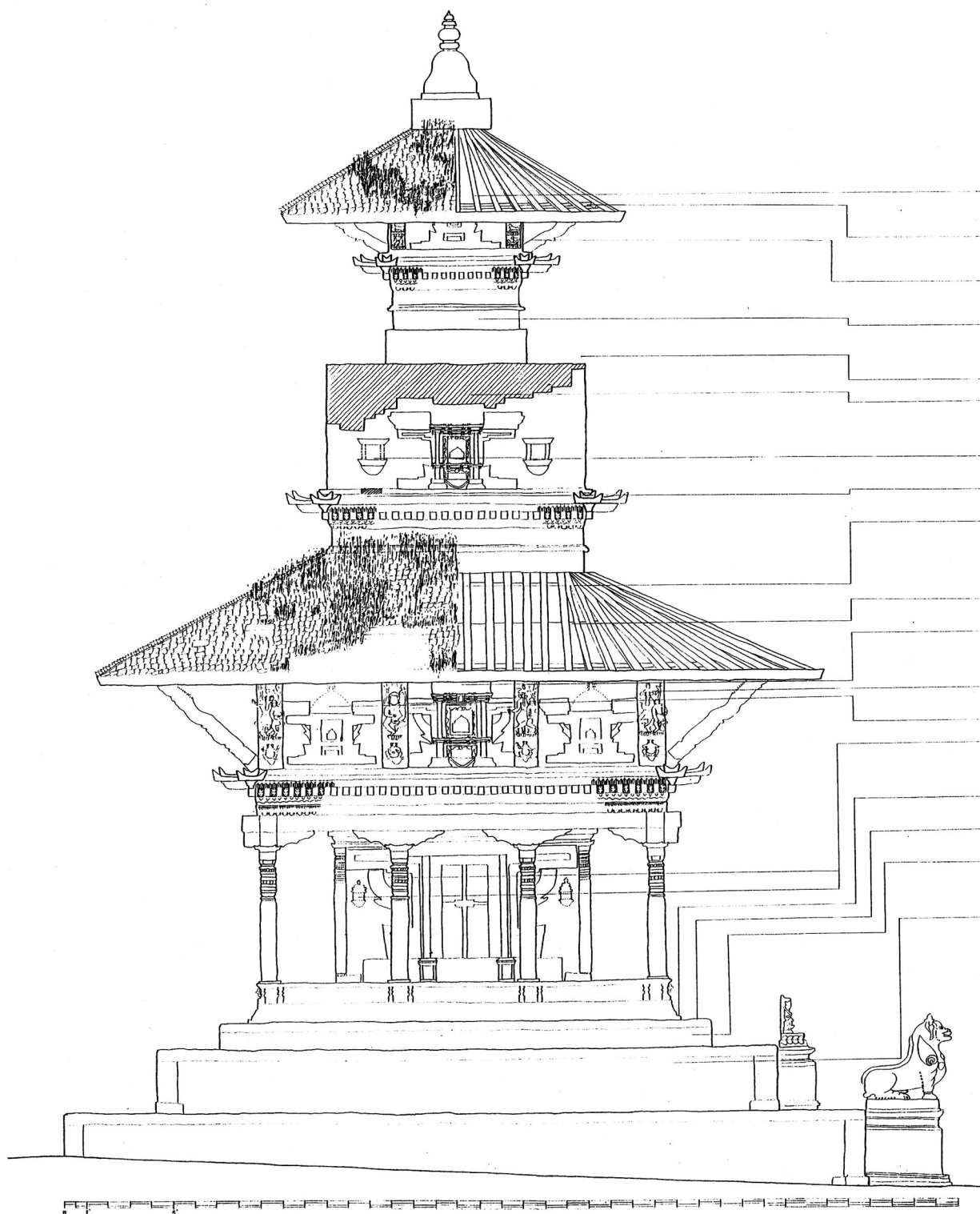
Plioth brick veneer, upper level: salt stains and spalling from 1982 rebuilding in cement mortar.

Plioth brick veneer: historical brick and stone edging with 1982 cement and *surkhi* pointing. Good condition.

RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

PRINCIPAL ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



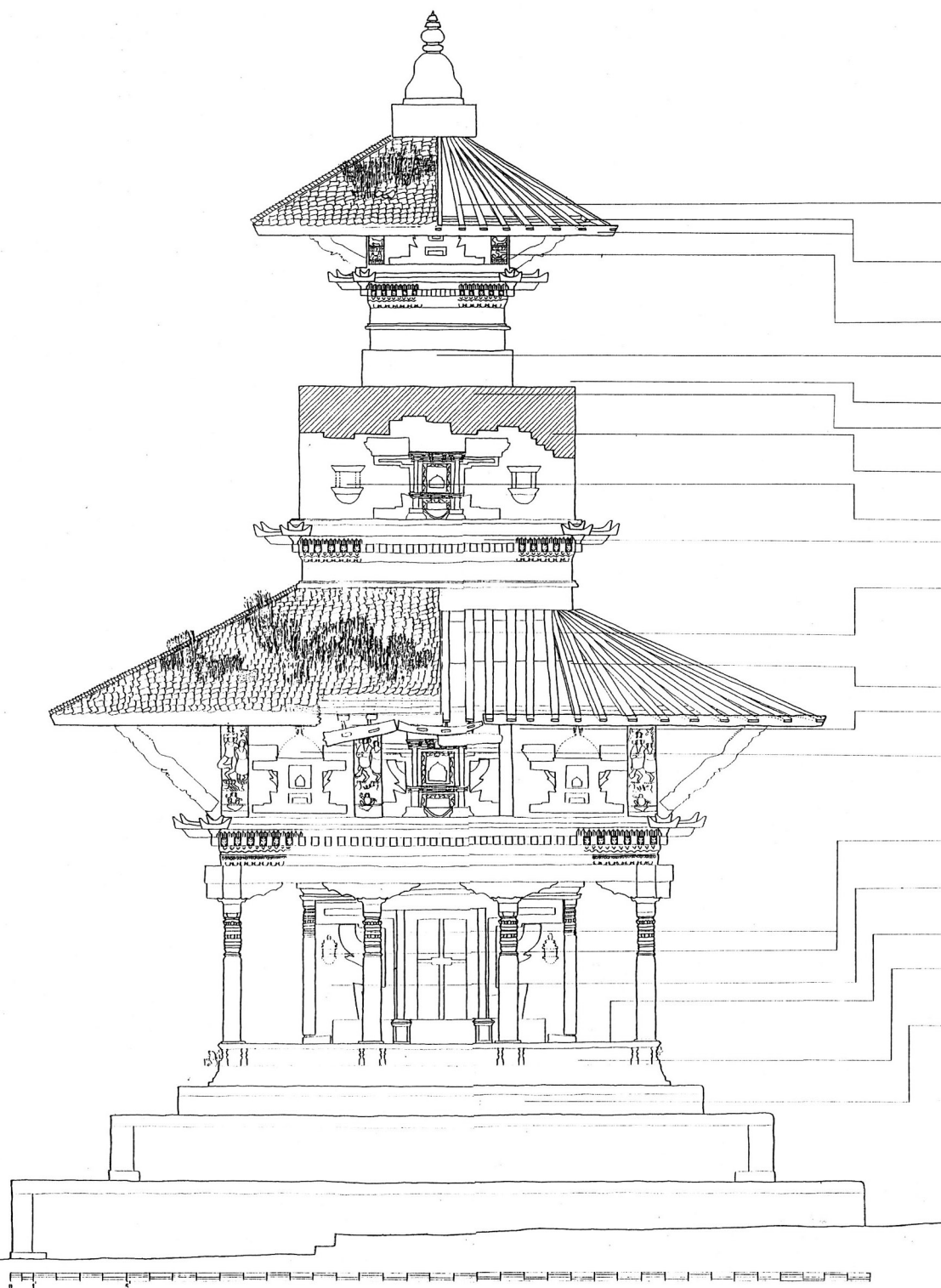
EXISTING CONDITIONS:

- Upper rafters: all 1967 sal with damage at *chukul* locations.
- Wall plates severely rotted. Sal purlins in good condition. Eavesboard rotted.
- One of two original upper roof struts (center right): excellent condition.
- Upper wall: excellent condition with 1967 timber cornice patch matching historical design.
- Upper wall plate missing.
- Wall deteriorated since roof dismantling. Wall plates lost.
- Roof struts in storage.
- All *korana* missing. Left niche lost.
- Broken brick cornice, one location.
- Lower rafters. 1967 sal (# 1-3, 5, 10-12, 14-18, 21, 22, 24, 28) damaged at *chukul* locations. Pine (#4, 6-9, 13, 19, 20, 25-7) severely rotted. #23 missing.
- Wall plates in good condition. Purlin and eavesboard rotted.
- Bulging of upper wall (4") in center. Vertical separations between bricks close to both corners left and right.
- Severe mildew and wet rot on all struts.
- Missing torana.
- Niche, *Astramatrika*, and *Bhairav* carving lost on left side only. Cement mortar wall patches.
- Brick patches of stone base moulding.
- Plinth pavement (1982): excellent condition.
- Plinth brick veneer, upper level: salt stains and spalling from 1982 rebuilding in cement mortar.
- Plinth brick veneer: historical brick and stone edging with 1982 cement and *surkhi* pointing. Good condition.

RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

SOUTH ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



EXISTING CONDITIONS:

Rafters: 1967 sal members reusable with repairs at *chukul* locations. All older pine rafters rotted.

Inner wall plates sound; outer wall plates rotted and overcut in 1967. Sal purlins (1967) sound. Sal eavesboard rotted.

Right strut needs structural consolidation.

Upper wall: excellent condition. Missing *torana* above window.

Upper wall plate lost.

Timber beams supporting upper level damaged by wet rot and deflected 2".

Wall deteriorated since dismantling of roof. Wall plates lost.

Lost blind window.

Timber and brick cornice in good condition except projecting corner bricks.

Rafters: 1967 Sal (# 2,4,8-18, 19, 21-23, 25). Pine (#1, 3, 5,

24). Lost: (# 6, 7, 20). #6-18 and all pine totally rotted. Others sound except at *chukul* locations.

Wall plates: pine, rotted.

Upper 9 courses of wall rebuilt in 1967 in common brick and cement mortar.

All *toranas* lost. Strut center right replaced with plain timber, 2/3 of historical member found nearby. Severe mildew and wet rot on all struts.

Missing auxiliary niches, Bhairav, and *Astramatrika* panels.

Cement mortar patches in historical wall. 1"-2" deformation of door frame.

Plinth pavement (1982): excellent condition.

Plinth brick veneer, upper level: salt stains and spalling from 1982 rebuilding in cement mortar.

Plinth brick veneer: historical brick and stone edging with 1982 cement and *sarkhi* pointing. Good condition.

RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

WEST ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



NORTH EXISTING CONDITIONS

Rafters: 1967 sal members reusable with repairs at *chukul* locations. All older pine rafters rotted.

Inner wall plates sound; outer wall plates rotted and overcut in 1967. Sal purlins (1967) sound. Sal eavesboard rotted.

Struts need cleaning, but structurally sound.

Upper wall: excellent condition. Missing *torana* above window.

Upper wall plate lost.

Timber beams supporting upper level damaged by wet rot and deflected 2".

Middle roof struts: 18 of 20 historical members in storage. Considerable mildew and rot damage.

Middle wall deteriorated since loss of middle roof; wall plates lost.

Blind windows lost except for left base portion; all 3 *torana* lost.

Timber and brick cornice in good condition except projecting corner bricks: right *thuka* lost.

Rafters: 1967 Sal (13 rafters) damaged at *chukul* locations; older pine (6 rafters) rotted. 4 rafters lost.

Sal purlins rotted. Pine inner wall plates, sound; outer rotted. Central *torana* lost; two side *toranas* intact.

Two Bhairav panels lost; other carvings intact at door/niche ensemble.

Base story wall veneer brick intact; no pointing.

Plinth pavement 1982: excellent condition.

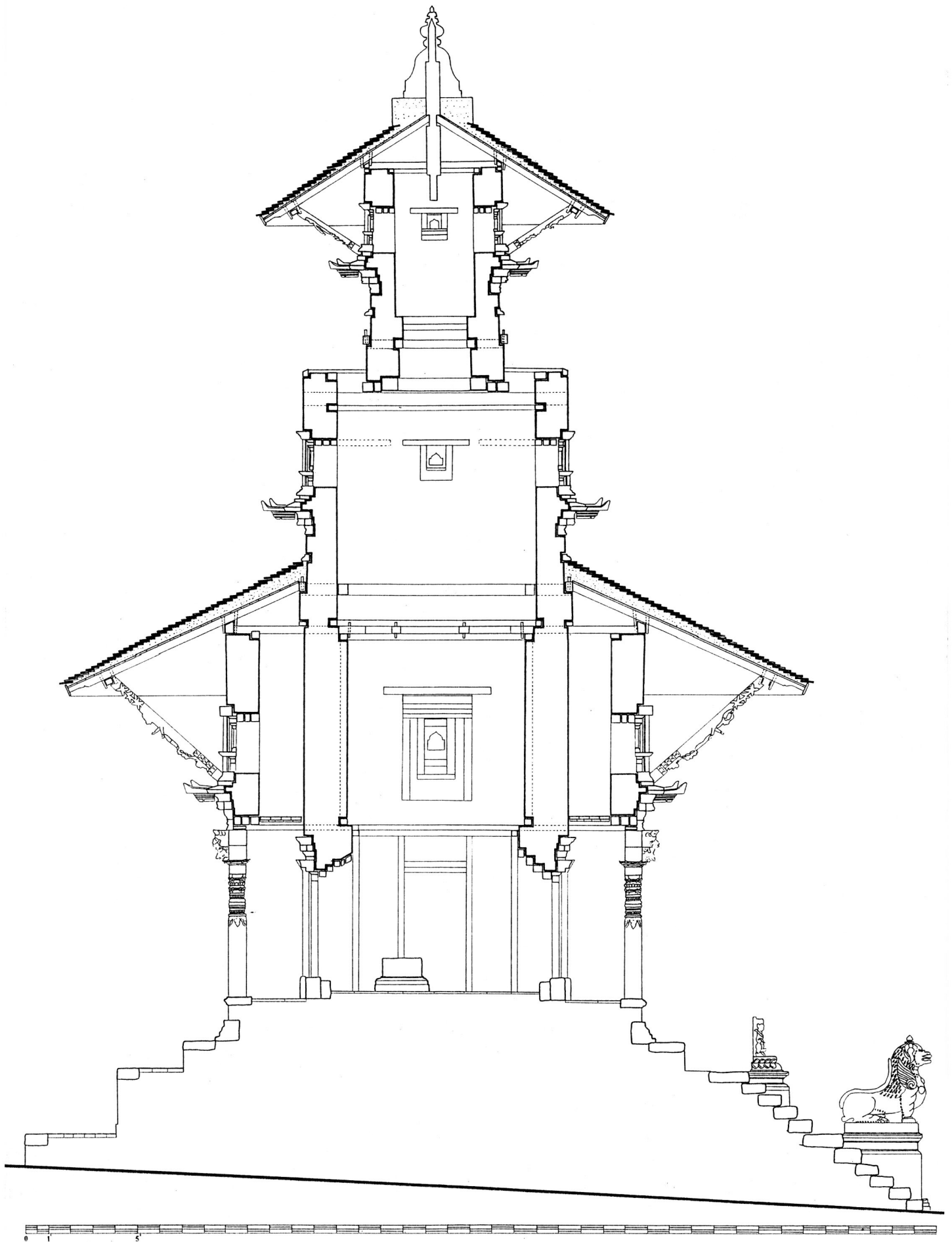
Plinth brick veneer, upper level: salt stains and spalling from 1982 rebuilding in cement mortar.

Plinth brick veneer: historical brick and stone edging with 1982 cement and *sarkhi* pointing. Good condition.

RADHA KRISHNA MANDIR

SWATHA TOL, PALAN
UNESCO WORLD HERITAGE SITE MUMUKSHU ZONE

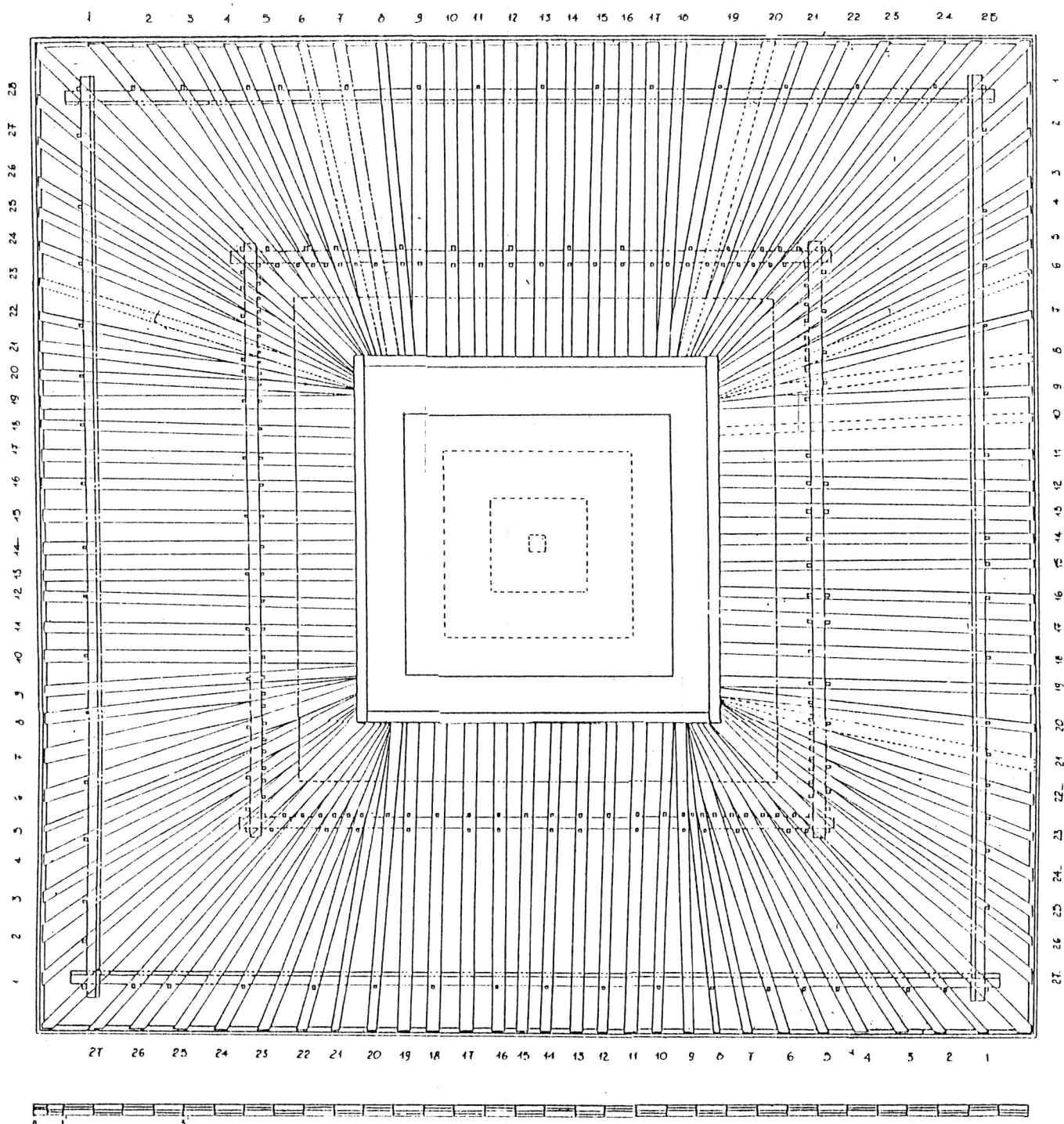
NORTH ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



RADHA KRISHNA MANDIR

SWATHA TOL., PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

WEST-EAST SECTION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992



RADHA KRISHNA MANDIR

SWATHA TOL., PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

LOWER ROOF PLAN: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1992

6.0 Recommendations for repair and restoration

6.01 Foundations/walls structural

General-seismic reinforcement issues

Given the seismic activity of Nepal, any restoration project must consider both the reinforcement of existing structure and the introduction of new structural members to withstand earthquakes. Structural characteristics in the historical design of Radha Krishna Temple which affect performance in an earthquake can be summarized.

*The lack of vertical structural continuities, both (1) between the upper temple level and lower bearing walls and (2) between the base story timber arcade and bearing wall above put the temple at risk to withstand the lateral forces of an earthquake.

*This deficiency is exacerbated by the "top-heaviness" of the structure created by the great mass of the roofs and (4) the ambulatory at base level, in seismic terms a "soft ground floor".

*Furthermore, (5) the general looseness of the structure resulting from (a) poor through-wall bonding; (b) sloppy and structurally deficient timber joinery; and (c) traditional timber pegged joints, rigid in only one direction, detract from performance in an earthquake.

The mud mortar construction of the temple, on the other hand, would improve performance in an earthquake because of its damping effect--the mud is able to absorb shocks without fracturing adjacent bricks and/or wall areas. Preliminary investigations by the author also suggest a possible connection between the massive stepping plinths of some pagoda temples and greater resistance to earthquakes. This massive plinth could act as a huge shock absorber or damper between the earth's movement and the temple mass above. This "shock absorber", able to absorb forces because of its mud mortar and massive construction, depends on the great weight of the temple structure as well to resist lateral forces. This preliminary conjecture deserves further investigation: it may help explain why such tall pagoda structures as Nyātopola in Bhaktapur or the Radha Krishna did not suffer great damages in the 1934 earthquake.

The challenge of restoration of such a monument is to arrive at a thoughtful compromise between full structural consolidation and preservation of historical appearance and fabric. Concealed horizontal tie members are relatively easy to insert at wall plate levels, a technique developed by the UNESCO project at Hanuman Dhoka in Nepal, but to tie the structure together vertically is more difficult. For example, it would be technically impossible in Nepal at this time to drill and insert vertically-continuous reinforcement

SEISMIC CHARACTERISTICS Rādhā-Kṛṣṇa & Umā Maheśvara Temples

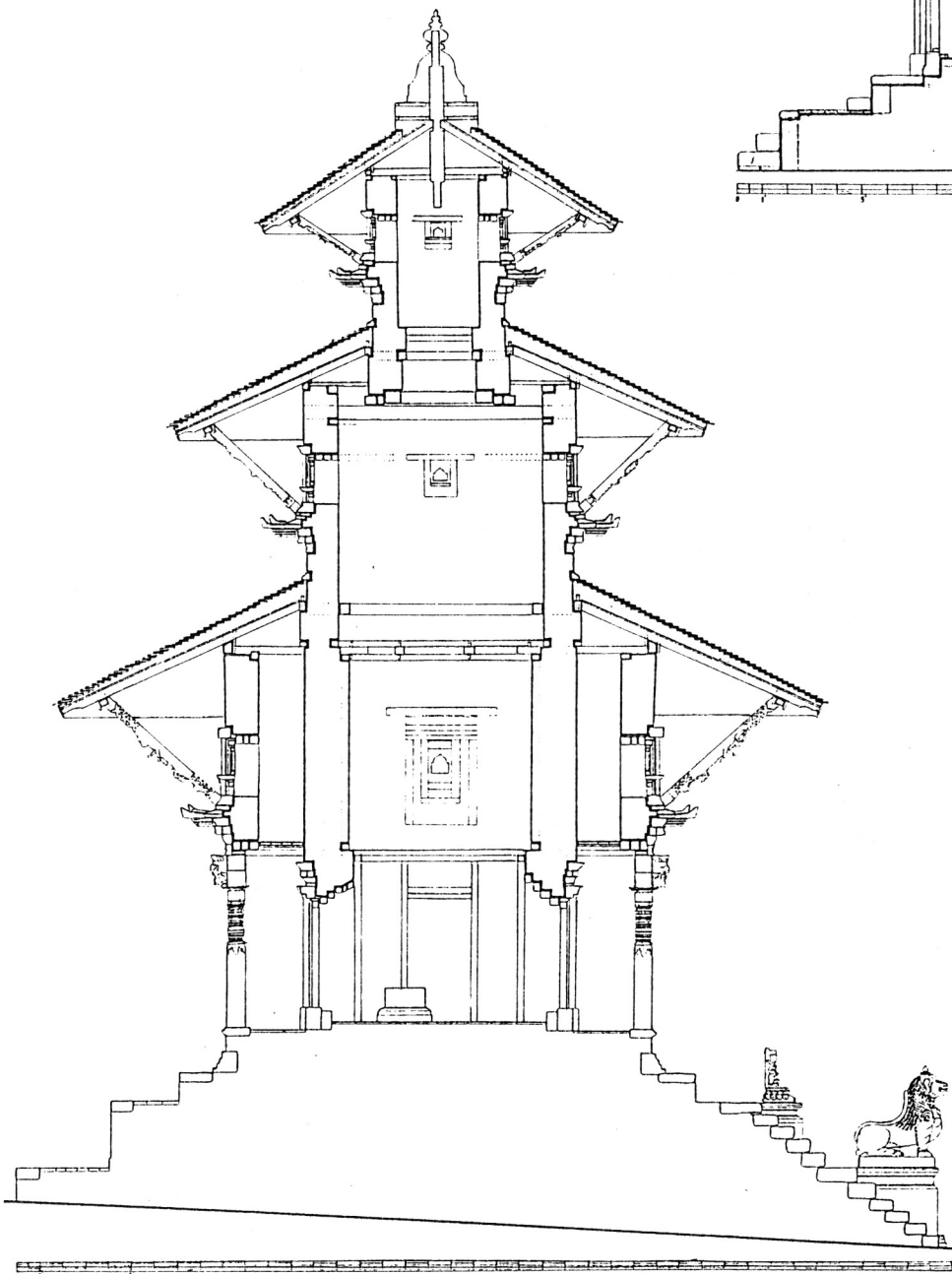
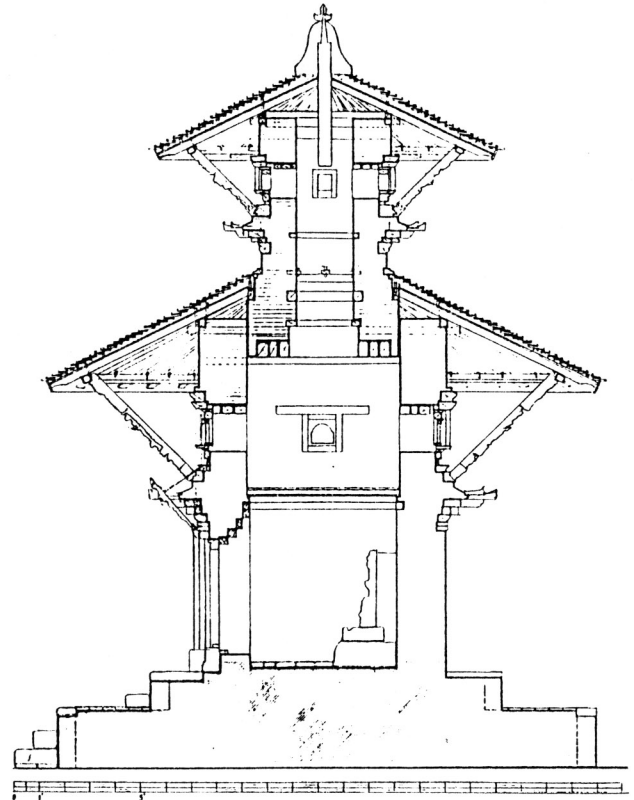
Umā Maheśvara Temple (1802)

Overall proportions more compact.

Top-heavy due to great roof overhangs and heavy mud/tile cover.

Vertical discontinuity is lessened because upper walls abut lower walls. Historical timber tie structure adequate to reinforce.

Foundations?



Rādhā-Kṛṣṇa Temple (1668)

Top-heavy due to great roof overhangs and heavy mud/tile cover.

Taller overall proportions increase risk.

Vertical discontinuity. Historical timber tie structure inadequate to reinforce.

Lack of bracing between inner and outer walls. Historical timber tie structure inadequate to reinforce.

Symmetrical placement (in plan) and small size of openings are more resistant.

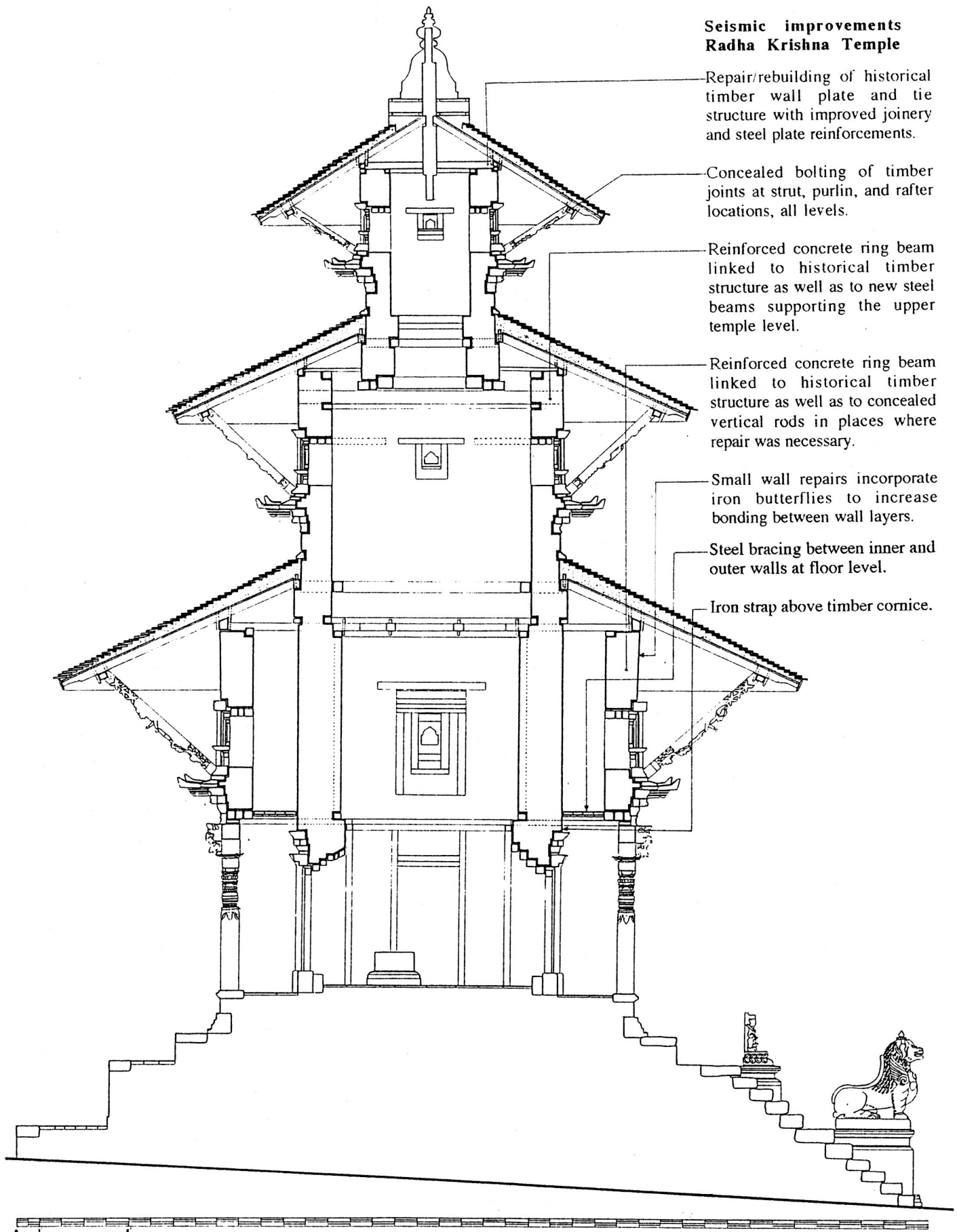
Lack of bracing between two wall layers

Soft ground floor: continuous timber arcade.

Plinth: massive shock absorber?

Foundations?

Seismic improvements Radha Krishna Temple



RADHA KRISHNA MANDIR

SWATHA TOL, PATAN
UNESCO WORLD HERITAGE SITE, MONUMENT ZONE

RESTORED WEST-EAST SECTION
KATHMANDU VALLEY PRESERVATION TRUST, MARCH 1993

channels in the wall structure, while any structure added to the interior or exterior surfaces could not be concealed. Opening up of the walls to build in such continuous vertical reinforcement would destroy a large volume of historical building material.

Thus, insertion of reinforced concrete tie beams was considered for the three wall plate levels of the temple under each of the roofs. It should be mentioned that current retrofitting of historical buildings for seismic reinforcement often employs reinforced concrete floor slabs at upper levels. The vertically open interior structure of the Radha Krishna temple did not, however, invite this solution.

In general, the construction of a reinforced concrete beam is accomplished more easily than the insertion of long steel beams, which are difficult to position between *in situ* rafters.

The structural integrity of the historical timber tie structure at the top roof together with the small size of the upper cella at that location led us early on to consider ring beam insertion necessary only under the two lower roofs. This was confirmed by local engineers' assessments.

Directly above the base story timber arcade, the passage floor level was identified as another location where horizontal bracing could easily be inserted. Steel cross bracing, laid on the floor in "X" patterns, can be used to brace inner and outer temple walls to provide another layer of lateral reinforcement. As this passage is only used for storage, it was decided an unobtrusive and necessary proposed intervention.

Parallel work on the nearby Uma Maheswar temple, a much smaller temple where calculations had confirmed the appropriateness of steel reinforcement of the existing timber tie beam and roof structure for seismic improvements, opened the project teams' eyes to a program of smaller interventions which could enhance the effect of the new reinforced concrete ring beams. In the Uma Maheswar temple, concealed bolting and steel angles were used not only to strengthen the tie beams and wall plates, but also to *extend* structural connections vertically through linkage, in this case, between the new ring beam and rafters and corner posts.

At the Radha Krishna temple, several locations where wall reconstruction is necessary (just below the wall plate/ring beam level of the lower and middle stories) will allow the insertion of vertical reinforcement rods up to 3 feet long tied to the ring beam. Some improvements in structural vertical connections can thus be achieved. At the same time,

interior timber corner posts in the wall, tie beams, rafters, and wall plates can be structurally linked to the ring beam by attaching a steel angle which becomes integral with the reinforced concrete ring beam. Combined with concealed bolting of the roof struts to their purlins and consoles, the ring beam will, in effect, tie together more of the building in the vertical direction than has been the norm in recent restoration projects.

Below the uppermost level of the temple, new steel beams to support the load presently carried by damaged and undersized timber elements can similarly be connected to the ring beam above. All of the work proposed can and will be concealed and requires little destruction of historical fabric.

6.01.1 Plinth

No structural work necessary.

6.01.2 Base story

The deformations at this level pose no structural problems. Work will only be undertaken to remove the *surkhi* pointed brick (discussed under 6.02.2) which necessitates rebuilding. During this rebuilding, which will incorporate as many historical bricks as possible, tighter fitting of the spread timber joints in some locations will be possible. Insertion of iron butterflies to make through-wall links is not necessary at this level where the masonry wall area is so small.

Upper base story

Insertion of a new reinforced concrete beam at this level will prevent further outward movement of the walls. Given the small size of the existing outward displacement (1"-2") and the difficulty in reproducing the tight surface joints at corners, consolidation in the existing wall location is proposed.

South, north, and east elevations

In separated areas close to the corners of the building, small cut bricks (with lean cement mortar packed in behind) can be pieced in. Old bricks of similar color will be used.

West elevation

The upper 10-14 course of new common brick in cement mortar will be dismantled and replaced with new *daciapā*, identical to the historical *daci apā* in size, and laid in mud mortar. Iron butterflies to make through-wall connections will be inserted packed in lean (1:4 cement:sand) mortar. It should be mentioned that convention to describe cement ratios have been rendered inaccurate by the inconsistent quality of cement made in

Nepal. Testing on site with varying proportions of cement must be made to achieve a mortar not stronger than the brick but of adequate strength.

Spacing of the iron butterflies will be 3' on center every two courses, locations to be staggered.

6.01.3 Middle story

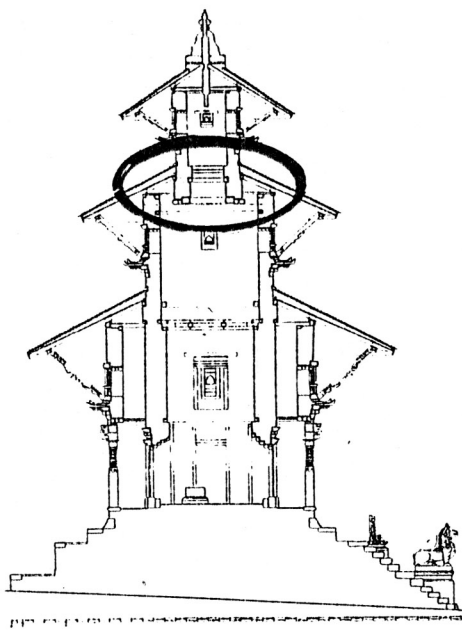
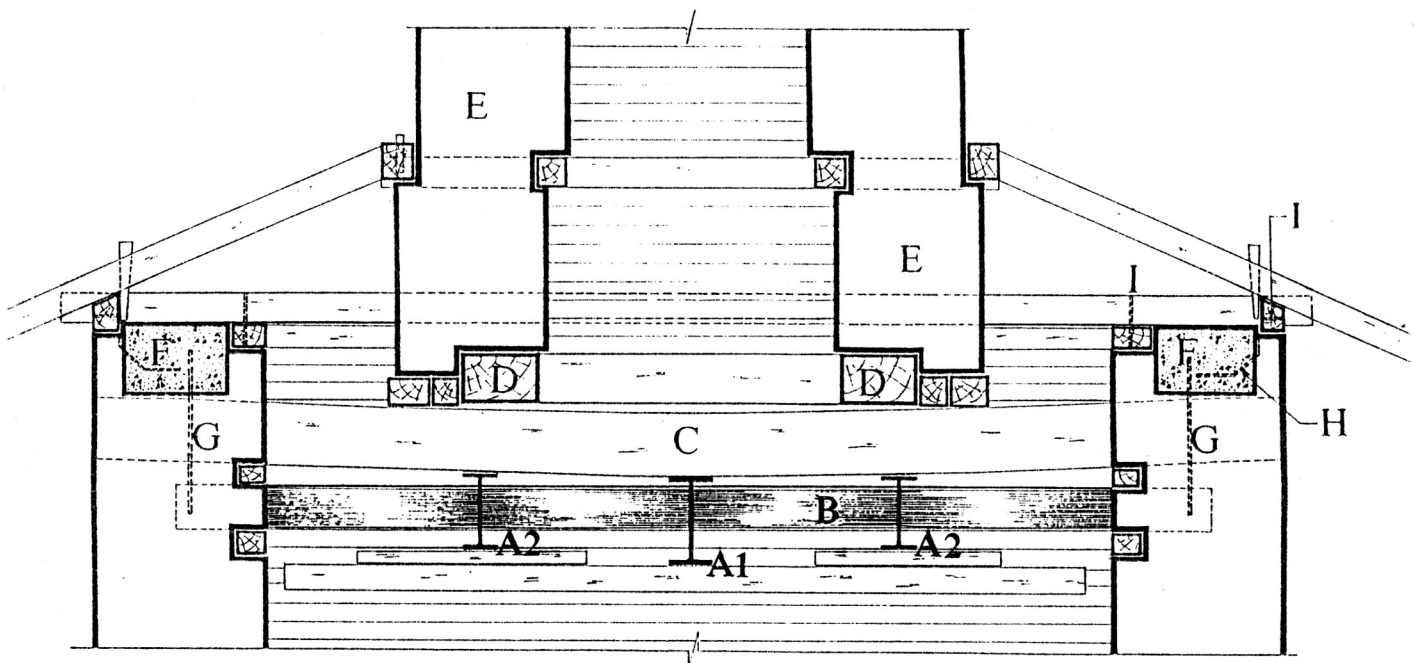
A ring beam at wall plate level, designed to take the horizontal thrust of the roof load, will arrest further outward displacement of the wall at this level while introducing necessary seismic reinforcement discussed below. A reinforced concrete beam is easily inserted at this level where the damaged upper portions of the walls must be rebuilt and roof structure is already dismantled.

The damaged and undersized timber supports of the uppermost level are to be reinforced by the insertion of new steel I sections. Reinforcement of the existing timber beams only by steel plates bolted to the existing timbers was preferable for conservation reasons, but considered unfeasible by Engineer Rajbhandari given the great shear stress of the timber beams, which would not allow drilling.

An initial proposal by Engineer Rajbhandari was rejected because the simple insertion of two new steel sections (just underneath and perpendicular to the main beams) would modify the historical and *positive* structural configuration which transfers upper wall loads to all four sides of the lower structure. Thus, with the assistance of Engineer Joshi, an alternative two-directional *grid* of steel sections was developed, whose six members maintain this historical and structural feature.

The new steel sections are to be inserted flush to the lower surface of the timber beams-- they will thus only carry loads upon further deflection. The new steel structure is sized to carry the entire upper load. Jacking up of the timber structure was considered not only unnecessary, but also dangerous to the upper wall structure. This new grid structure consists of 3 principal sections (2 @ 8"; 1 @ 10") in the north-south direction. Six inch sections in the east-west direction will then be pieced in and welded to create this grid. New timber plates of full wall length will be inserted to transfer these loads to the wall structure.

At all twelve locations where the new steel sections are inserted in to the wall, concealed vertical connections in reinforced concrete will be made to the ring beam above. Proposed is bolting of the steel beam ends to allow connection of 16 mm. rebar in approximately 12"x12" lean cement mortar.



- A New steel beams to carry top level walls/roof
- B New steel cross beams
- C Existing principal timber beams
- D Existing secondary timberbeams
- E Uppermost temple level walls
- F Reinforced concrete ring beam
- G Steel rods connecting new steel frame and new ring beam
- H Steel plates connecting timber wall plates to new ring beam
- I Concealed bolting at timber joints

INDIAN STEEL SPECS

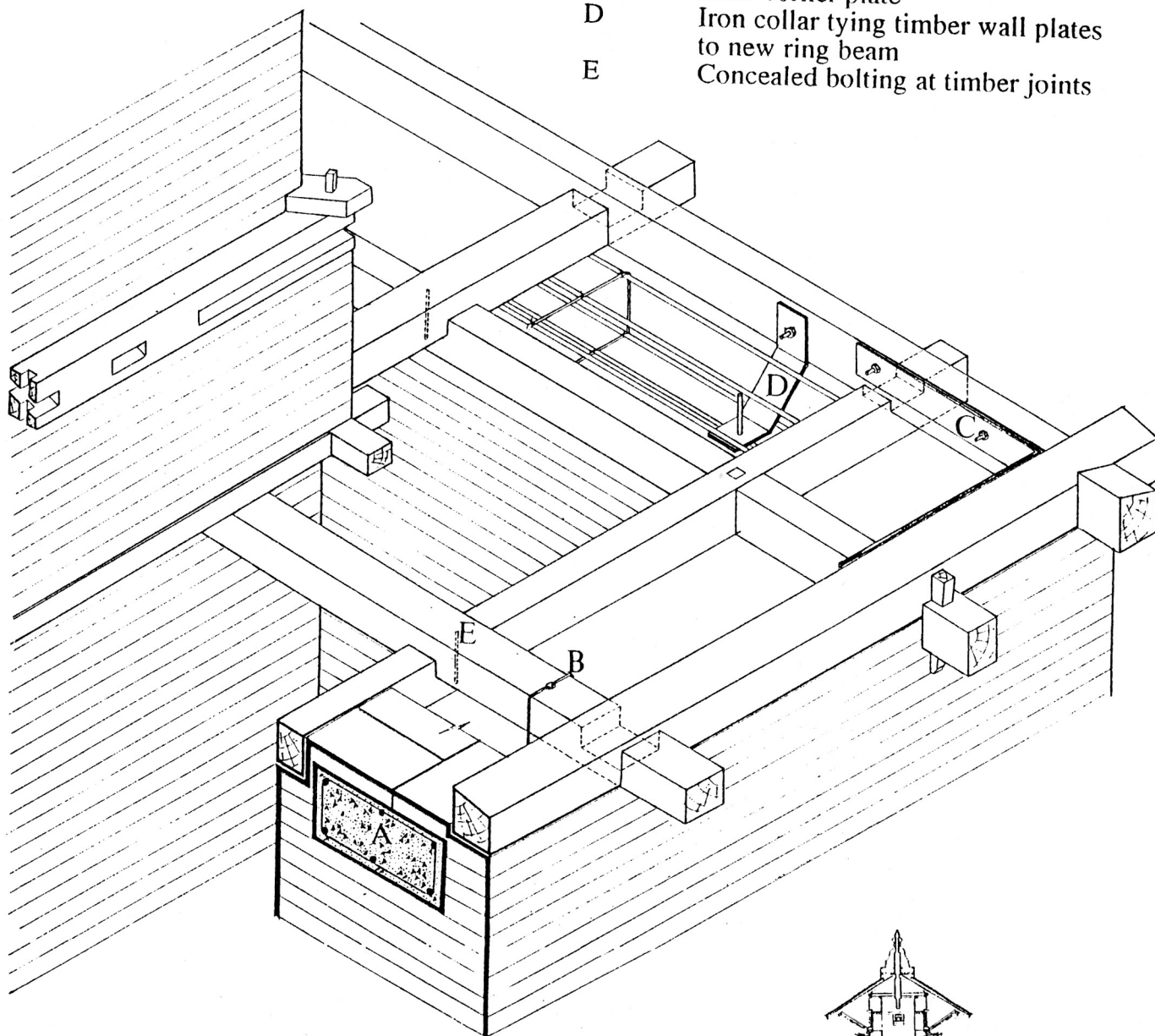
A1 = IS LB 250
A2 = IS MB 200
B = IS LB 125

RĀDHĀ-KṚṢṆA TEMPLE: REINFORCEMENTS BELOW UPPER TEMPLE LEVEL

Section detail at wall plate level below the middle roof rafters.

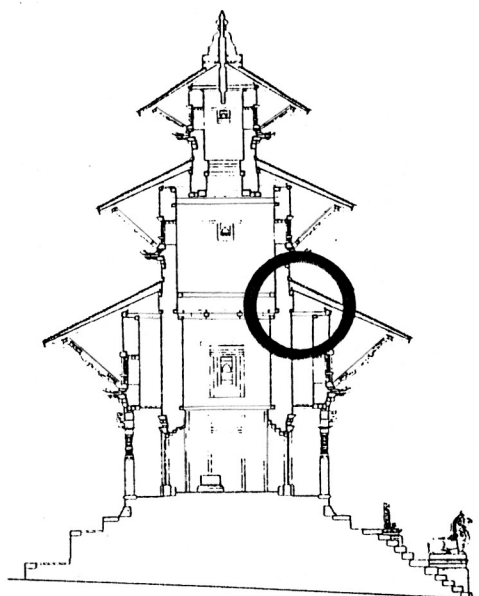
Drawing: R. Ranjitkar, June 1992.

- A Continuous reinforced concrete ring beam
- B Steel connections from tie joists to new ring beam
- C Steel corner plate
- D Iron collar tying timber wall plates to new ring beam
- E Concealed bolting at timber joints



**RĀDHĀ-KṚṢṆA TEMPLE:
CONNECTIONS TO NEW R.C.C. RING BEAM**

Axonometric view at wall plate level below the lower roof rafters.
Drawing: R. Ranjitkar, June 1992.



6. 02 Walls : fabric

Summary

The damaged, rebuilt, or patched surface areas mentioned under sections 5.02.1-3 are to be refitted with new *daci apā* custom ordered to the same size (8" x 4-1/2"x 2") as the historical brick. Iron butterflies packed in lean cement mortar will be inserted in rebuilt areas to connect the inner and outer layers of the masonry wall. A lean cement mortar (1:4) will be employed to consolidate areas in the middle rubble-like layer of the wall, while the *dachi apa* will be laid in mud mortar, the historical mortar material. It should be mentioned that convention to describe cement ratios have been rendered inaccurate by the inconsistent quality of cement made in Nepal. Testing on site with varying proportions of cement must be made to achieve a mortar not stronger than the brick but of adequate strength.

The contemporary practice of pointing *daci apā* with orange colored *surkhi* (brick powder-cement) must be condemned. It is important to note that where such pointing has been done on the monument, the pointing cannot be removed without damaging the brick surface. Removal of pointing thus means rebuilding and loss of historical materials. It is therefore not recommended to remove the *surkhi* pointing in the large areas of the plinth in good condition, and where dust conceals the ahistorical color and texture. At the ambulatory level, however, the small and most visible areas of *surkhi* pointed wall will be rebuilt to consolidate visually this wall. It will also allow tighter fitting of the spread timber joints of the door frames.

The removal of pointing and bricks will be attempted with the utmost effort to prevent damage to the historical bricks. Where new bricks are necessary, old bricks of identical size and similar color will be found and used.

The clay and firing quality of custom ordered brick can come fairly close to the historical, although consistency in size is difficult to achieve. Unlike the historical brick, new brick varies in height by as much as 3/16th of an inch, making the very tight joints (1/16") of the historical walls nearly impossible. In upper less visible areas, the new brick will be laid as tightly as possible. At the ambulatory level, the *daci apā* will be cut with a radial saw to identical size to allow flush joints.

6.02.1 Plinth

To remove *surkhi* pointing generally means rebuilding and replacement of the bricks as they are largely damaged when trying to remove the pointing. Thus, given the otherwise good condition of the large plinth area and the extant historical brick, removal of the pointing is not recommended.

Only at the skirt below the ambulatory, where in addition to the *surkhi* pointing, rebuilding in cement mortar construction has created spalling of the new brick, will rebuilding be attempted. The rebuilding will incorporate as many possible historical bricks laid tightly in mud mortar.

Missing pieces of the the limestone base below this skirt will be replaced with stone of similar color detailed to match the historical sections extant under the pillars. Limestone of appropriate hardness and color is difficult to find in the Kathmandu valley and will necessitate scouting trips to the Sunkosi River east of the Valley.

The cement mortar pointing and filling of plinth edge stones is not easy to correct. Because many of these joints are as large as 3", removal of the cement mortar would necessitate piecing in of new stones or replacement with larger stones. Given the difficulty of procuring stone of similar size, hardness, and color it is proposed that the now flush cement mortar joints be cut back a minimum of 1/2" from the surface of the stone. Within a month, dust will collect to conceal the cement.

6.02.2 Base story

Through work on the nearby Uma Maheswar temple, the project team has devised an effective but time-consuming method of grinding down the new *daci apa* bricks to an identical size which allows the traditional hairline joints. At the Radha Krishna temple the most visible wall areas at arcade level will be repaired using such custom-worked bricks, while the small and less visible areas on upper walls will be rebuilt with the slightly larger (1/8"-1/4") mortar joints necessitated by unmodified *daci apa* brick.

Slightly damaged decorative corner bricks (*lhāhpā*, *lhāhpahā*) will be retained as the chipped surfaces of the historical elements are preferable to custom ordered replacement pieces which can not match the originals in color or durability. Where the *lhāhpā* is lost, a reproduction will be fabricated and installed, while reinforcing the timber supports beneath with concealed steel plates.

6.02.3 Middle story

Slightly damaged decorative corner bricks (*lhāḥpā, lhāḥphvaḥ*) will be retained as the chipped surfaces of the historical elements are preferable to custom ordered replacement pieces which can not match the originals in color or durability.

6.03 Walls : decorative elements

Summary

All timber elements will be cleaned with soft brushes with a mild liquid detergent, Extrann, followed by a dilute solution of ammonia (1:8). Given the excellent condition of these elements and the absence of signs of insect or fungal attack, the application of the expensive and imported preservative is not recommended.

Plain timbers will replace the crude brick patching where decorative panels have been lost as the details of such designs are indeterminable.

The many missing tympana (*torāṇa*) detract greatly from the overall facade composition and merit careful consideration for replacement. Although the central images of such torana are indeterminable, the repetitive motif of the *torāṇa* frame can be reproduced. Only examples of the upper base story auxiliary window torana are extant. Thus, only these repetitive frames will be reproduced. Their fitting on this most visible level of the facade will reproduce to a large extent the historical effect while not introducing ahistorical iconographic material.

6.04 Roof structure

Summary

All repairs and replacement of timbers will be accomplished piece by piece, with extant upper and lower reusable roof structure *in situ*, to preserve the historical position of the roof structure and struts. All extant timbers--both the older and larger pine members and more recent sal rafters will be conserved and reused wherever possible. In some cases, longer damaged timbers from the lower roof can be cut and reused for shorter upper roof locations. All new wood to be used will be sal wood.

Although the roof structure as seen from below is extremely heterogeneous, it was decided to replace defective members with new sal wood (1) of the historical size (5"x4" in comparison with 4"x3" sized members from the 1967 renovation which are visually undersized) and (2) sawn by machine to reduce timber consumption, but

rendered lightly on the three visible surfaces with an adze to approximate the historical appearance.

Where possible, defective rafters can be repaired by splicing in new short lengths of timber using a scarfed joint. In the many locations on the bottom roof where multiple locations of decay make repair unfeasible, undamaged timber can be cut out and fitted on the much smaller top roof.

To enhance the vertical continuity of new ring beams, concealed non-corrosive bolts and angles will be added to timber joints where possible.

The durable sal wood does not require costly treatment with a wood preservative.

6.05 Roof cover

Summary

The same roof cover details as developed by the Hanuman Dhoka and Bhaktapur Development Projects will be employed with several additional refinements discussed below.

Planking

Existing planking will be reused wherever possible, although it seems unlikely that more than 20% of the sal planking is structurally sound. In most cases, the existing timbers will have to be shortened or narrowed to eliminate deteriorated areas. New planking will be in random widths, 1" thickness, and nailed to the rafters with galvanized nails.

Moisture barrier

As at Hanuman Dhoka, two layers of highest quality (Indian standard III grade 1) layers of tarfelt will be introduced above the planking layer. Heated bitumen (Indian standard 85/25 meaning at 85 degrees, 25 drops/minute) will be coated on the planking, between tar felt layers, and as a final coat above the bitumen. Small sal wood timber battens in angled positions (to allow water to run down their length as horizontal orientation would not allow) will be nailed into the tar felt with rubber washers to prevent water penetration. Such battens are necessary to prevent slippage of the mud.

Mud bed

The traditional mud bed into which the jhingati are laid must use the more cohesive black mud available in the valley and must be dug from depths greater than one meter to

minimize organic material content. The mud will then be mixed with a herbicide per manufacturer's directions.

The herbicide Karmex has been used extensively in the valley over the last years with mixed results. Our discussions with project personnel at various sites suggests that the American-manufactured product performs better than an Indian product of the same name. Moreover, the care taken in the mixing of the herbicide with the mud appears to be critical. At Hanuman Dhoka, the chemical has not proven foolproof, but has certainly inhibited vegetal growth for at least 15 years according to supervising engineer Hari Ratna Ranjitkar. The American Karmex will be used for proposed work, which will be closely supervised.

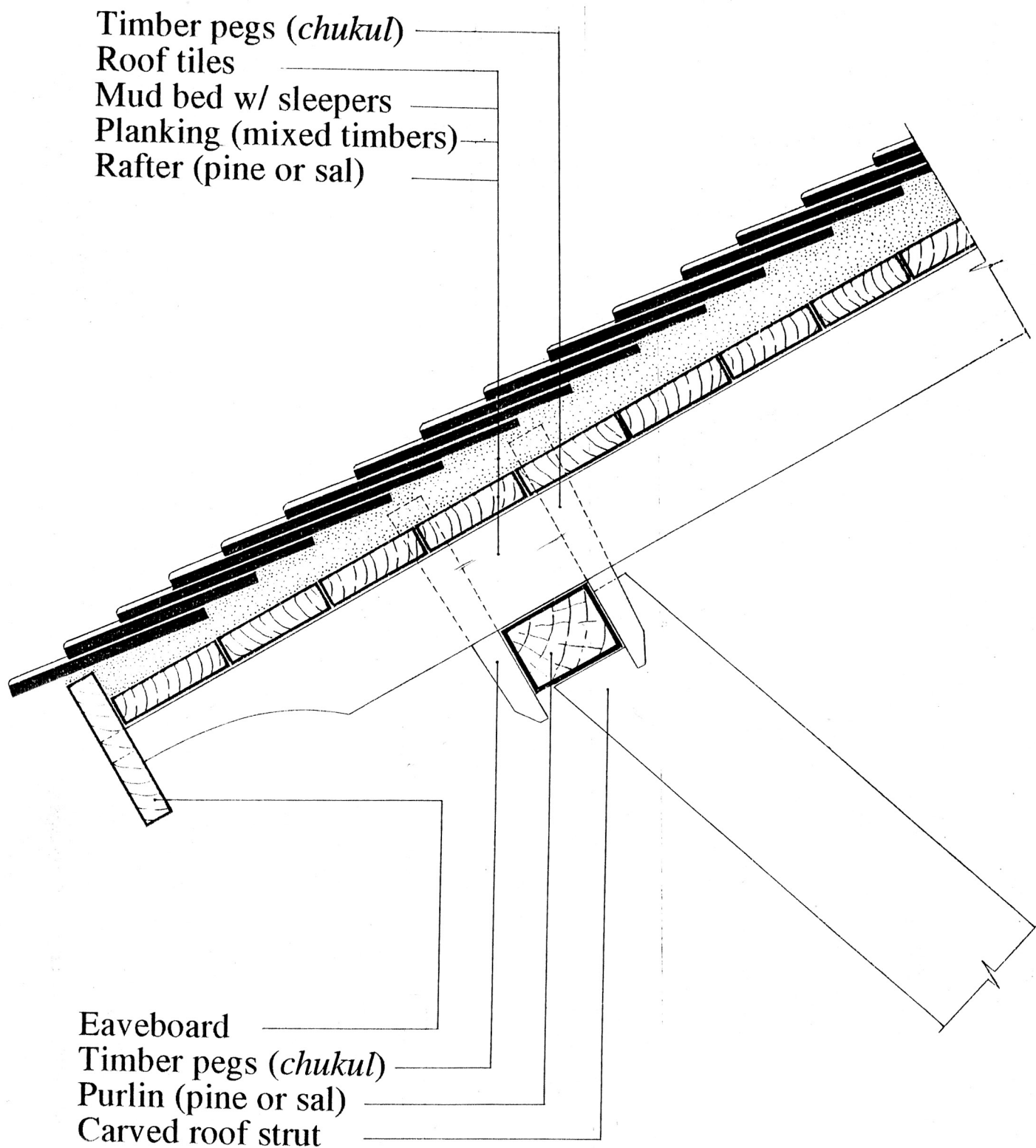
At the thickened mud bed locations closer to the structural core, the substitution of over-burned bricks (inexpensive and lighter) is proposed to reduce the great weight of the roof cover.

Jhingati

As newly produced *jhingati* are of inferior color, strength, and porosity, the project will procure old *jhingati* for replacement tiles (approximately 40%). These older more durable tiles are not difficult to find given the present rate of destruction of historical structures in the Kathmandu Valley. The old tiles will be scrubbed with mild detergent and water.

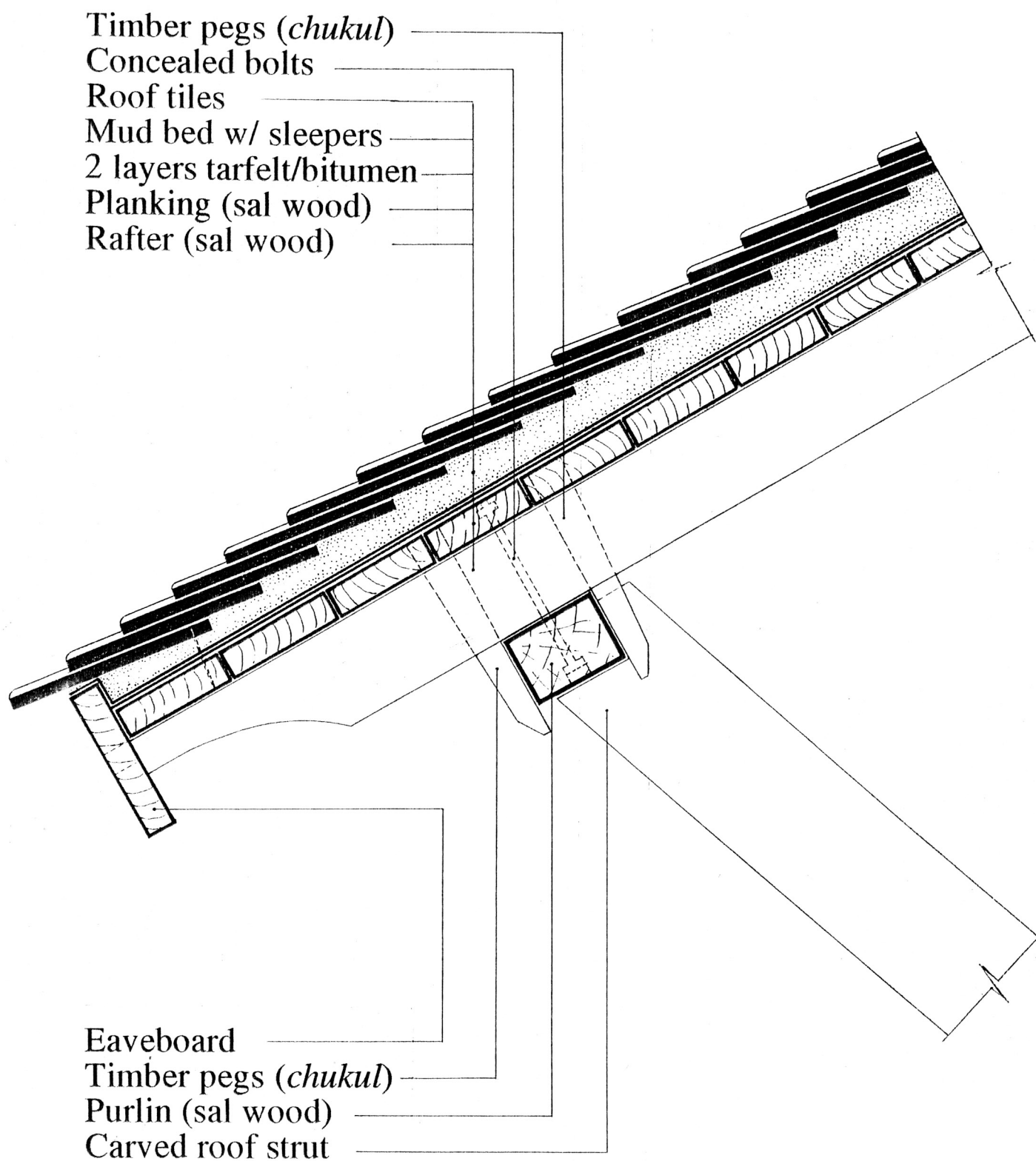
Tiles will then be soaked in silicate solution per manufacturer's directions to reduce their absorbency. The effectiveness of this treatment is clearly illustrated on the recently rebuilt Cyasilin Mandap in Bhaktapur, where samples of treated and untreated tiles (new tiles) have weathered very differently. In just two years, the untreated tiles have become covered with moss, while treated bricks are moss-free. The poor performance of the new untreated tiles contrasts greatly with those of ten years ago, installed by the Bhaktapur Development Project. Those tiles were also not treated, but remain moss free to date because of their more highly-fired and moisture-resistant composition.

As at Hanuman Dhoka, the bottom roof tiles (above the eavesboard) will be drilled and nailed in place as they are highly susceptible to being knocked off. They will be attached with headless nails, however, as the Hanuman Dhoka installation with regular nails necessitated removal of one square feet of adjacent tiles to replace one bottom *jhingati*. The top tiles will also be drilled and nailed into the mud bed, as this layer of tiles is vulnerable to dislocation by pigeons.



THE "KEY" PROBLEM

*Section at roof overhang:
as traditionally detailed*



THE "KEY" PROBLEM

*Section at roof overhang:
Improved detailed*

As it is difficult to find old ridge tiles (Newārī-nyākūcā) or corner aviform tiles, the project will custom order necessary new tiles (75%) to match historical size and shape. The exact size of the missing upper roof aviform tiles will be extrapolated by the proportional relationships seen on many historical buildings (smaller roof-smaller corner tile). Project personnel will monitor production of these tiles to assure the best possible quality. They will be soaked in siltrate solution per manufacturer's directions.

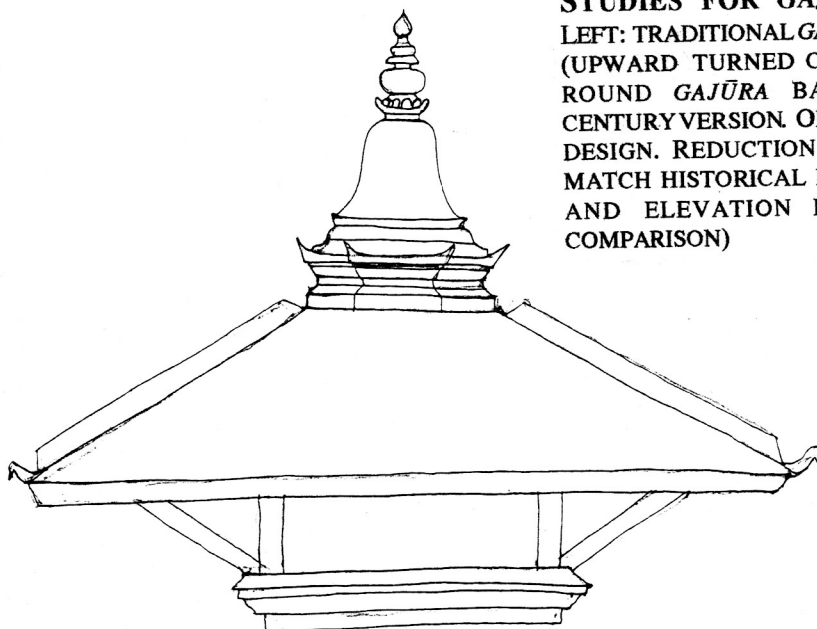
The stacked lower ridge tiles will be held from slipping by the introduction of a steel angle beneath the lowest 16 tiles as introduced by the Hanuman Dhoka Project. The "L" form literally hooks the bottom-most tile and is held in place by the weight of the upper tiles. It is concealed by the tile traditional placed at the bottom tilted in the opposite direction.

6.06 Roof decorative elements

Gilt pinnacle (*gajūra*)

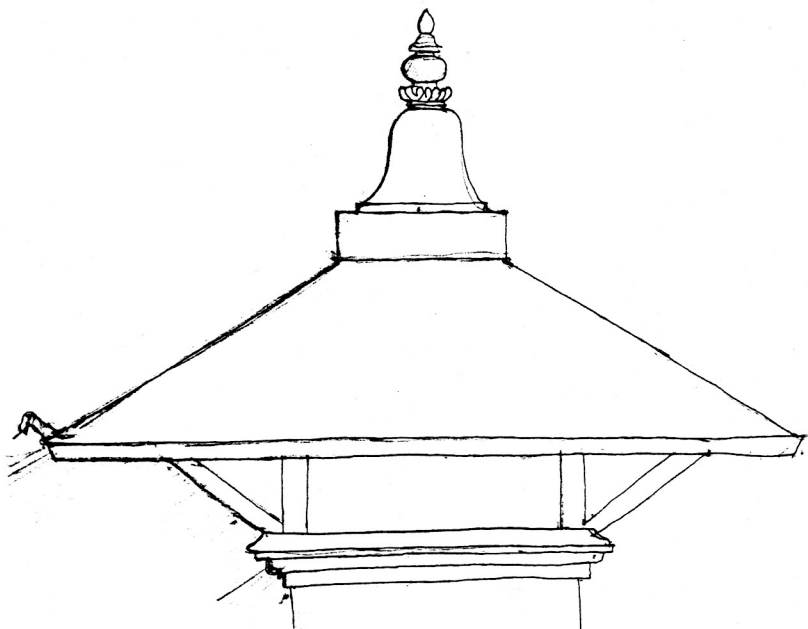
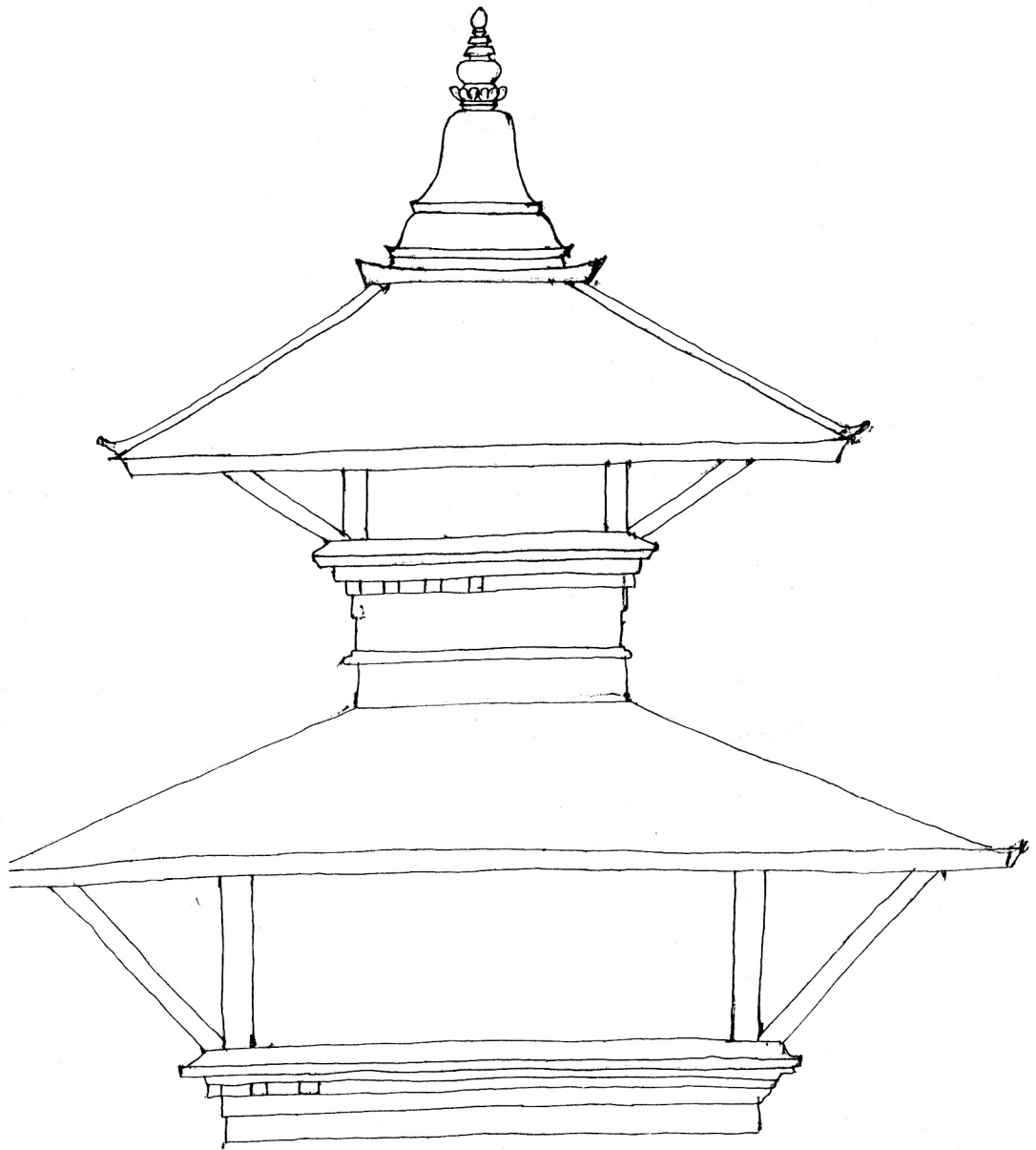
As the material (brick or repoussee?) and details of the pre-1934 earthquake *gajūra* are not determinable, it is proposed that the existing plain copper sheathed box (installed in 1967) simply be cut down some 9" to approximate the proportions of the historical feature, visible in LeBon's photograph. The taller proportions and plain silhouette of this metal box detract from the temple's silhouette.

During work on this upper roof level, the historical gilt *gajūra* will be stored in the Archaeological Garden for safekeeping.



STUDIES FOR GAJURA IMPROVEMENT

LEFT: TRADITIONAL GAJURA BASE WITH KULA MOTIF (UPWARD TURNED CORNERS). OPPOSITE ABOVE: ROUND GAJURA BASE, A TRADITIONAL 19TH CENTURY VERSION. OPPOSITE BELOW: COMPROMISE DESIGN. REDUCTION OF EXISTING PLAIN BOX TO MATCH HISTORICAL PROPORTIONS. (SEE PAGES 8 AND ELEVATION FOLLOWING PAGE 10 FOR COMPARISON)



Roof struts

As the details of the missing elements of the struts--arms, hand gestures (*mudrā*), symbolic objects, and mount figures are indeterminable, the historical struts will be conserved without the introduction of new carved elements. The modern arms on the struts will be retained as an historical layer (1967) which, although crude, provides a memory of the historical spread of the struts. Removal of these modern replacements would give a naked appearance to the struts.

One new replacement strut will have to be fabricated. Although one could argue that the new strut replacements should be simple uncarved timbers, the stark contrast of such uncarved elements may detract from the texture of the historical facade. Furthermore, the opportunity to give work to the local woodcarvers helps to preserve that craft in the Valley.

Based on the documented local historical tradition of copying another extant historical strut from another location²⁸ (when the iconography and details of the lost member are indeterminate), the project proposes to reproduce historical examples on the temple. The local tradition of inscribing the date of a strut at its base will prevent misinterpretation of these new members as historical.

A cleaning program accomplished *in situ* is proposed for all struts of the top and bottom roofs which do not need structural consolidation. This *in situ* treatment program will necessitate additional platform cover and reinforcement of the somewhat flexible bamboo scaffolding to accomodate conservation workers.

The cleaning program for all struts to combat fungal and mildew attack includes: (1) cleaning with soft brushes and liquid detergent followed by dilute (1:8) ammonia solution (2) treatment one week later with a solution of zinc-silico flouride. Cleaning is followed by (3) treatment with the French wood preservative Xylophene mixed with 3 parts kerosene and 2 parts linseed oil. Such a cleaning and treatment program (not including the zinc-silico flouride treatment aimed at the extensive mildew) has been used successfully employed in the UNESCO Hanuman Dhoka and Japanese Ibaha Bahi projects.

The current norm in Nepal for structural consolidation of timber elements (Hanuman Dhoka, French project at Brahmayani, Panauti, and Department of Archaeology projects) employs steel painted with anti-corrosive paint. At the Brahmayani temple, the reinforcements consist of a "U" shaped member which wraps the back of the strut and is visible from below. "T" shaped members are proposed for all reinforcements which will be structurally sound, and invisible from below. This project proposes the investigation of several alternatives including (1) locally available nickel-plating steel and iron (2) testing of custom galvanizing, available in the Terai region, though generally of very poor quality, (3) use of imported stainless steel and (4) imported two-component epoxy anti-rust paints.

The fitting of these consolidating members must be designed according to each strut composition to allow through-bolting in uncarved areas. Bolt locations will be concealed with timber plugs. The nickel plated "T" section mounted on the back of the strut will be invisible from the street and can be concealed with small timber planks so that it is not seen from adjacent buildings' upper story windows.

²⁸Unpublished research, Nutan Sharma.

STRUT REINFORCEMENTS
DETAIL OF FLAT STEEL REINFORCEMENT AT
BISWNATH TEMPLE, 1990. RIGHT: VISIBLE "U"
SECTION REINFORCEMENT AT BRAHMAYANI
TEMPLE, PANAUTI, PHOTO 1991.



On several of the most deteriorated struts (#208, 213, and 118) the injection of a consolidating but irreversible epoxy resin must be considered.

6.07 Interior

No work proposed.

6.08 Plinth

A treatment program for the lichen growth on the limestone lions will employ cleaning with a mild detergent followed by close monitoring to check reoccurrence.

7.00 Recommended maintenance program

Maintenance in Nepal is a challenging question with no easy answers. Theoretically any future work on this temple will have to be approved by the Department of Archaeology, although in practice government authorities are not even able to control demolition of historic structures in the World Heritage Site, let alone specify maintenance practices. Thus, the first job of the conservation architect in Nepal is to build not only the Department's technical resources, but also the public awareness that old buildings need care and professional expertise.

The following is an outline of what recommendations the Department could issue to persons wishing to maintain an historical building.

(1) Roof maintenance. Roof damage must be corrected as soon as possible to prevent related timber and structural damage. During repairs of the traditional tile roofs, great care must be taken not to damage other tiles. We recommend that only tilelayers (Newārī-awāḥ) be used for *any* work on the roof--even removal of vegetation--as only they have the sensitivity to realize when a tile has been broken when stepped on. And they can repair it on the spot.

(2) Timber carved elements. No paint, varnish, or treatments other than the traditional linseed oil. Current fashion is to paint everything black.

(3) Wall repairs. NO cement mortar anywhere. As demonstrated in the study of proposed restoration work, the problem with cement and *surkhi* mortars is that they are largely irreversible, i.e. while removing them the bricks or stones are generally broken. The salt content of cement mortar reduces the life of these traditional building materials.

(4) Brick walls. No paint, mud wash, or lime wash. Clean with soft bristled brushes.

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APPENDIX A

ENGINEERS' REPORTS

1. Structural report by Engineer Prayag Joshi
2. Ring beam/ upper reinforcement design
final design by P.R. Joshi, engineer
3. Ring beam/ upper reinforcement: alternative
design by M. Rajbhandari, engineer

DR. JOSHI: FINAL DESIGN P.1 OF 7
TO BE IMPLEMENTED

STRUCTURAL DESIGN REPORT OF RADHA KRISNA TEMPLE

The structural design of Radha Krishna Temple has been carried out in following stages:

Observation

Before carrying the design work, an observation of the temple has been made from plinth level to upper roof level. As a result of the observation following things have been noticed:

- The existing main timber beams holding loads from upper roof and wall have been found deflected by 4 cm in the center and deteriorate from fungal attack. Any more deflection will subject beams to cracking, endangering entire upper structure.
- Existing double layer of timber wall plates at top wall plate level and tie members in two directions are enough to take horizontal force, not necessitating the RCC ring beam at this level.

Design Work

A. Structure Design

After the inspection of the temple, it is concluded that the timer main beams should be either replaced or reinforced with the insertion of steel beams (I-section) under these timber beams to take all the loads from upper roof and wall. But, the replacement of these timber beams will involve huge volume of works and shall be expensive. Hence, insertion of steel beams has been decided and designed accordingly.

Secondary steel beams have been also designed and proposed to place at the same level as of main beams. These secondary beams shall help to uniformly transfer the loads from upper roof and wall to main steel beams through timber beams.

The joints between main and secondary beams have been carefully specified.

Followings are the design parameters:

Design Load	: 33.60 KN/m
Max. Bending Moment	: 46.73 KN-m
Maximum Shear Force	: 44.59 KN
Average Shear Stress	: 29.23 MPa
Calculated Deflection:	0.31 cm

B. Seismic Reinforcement

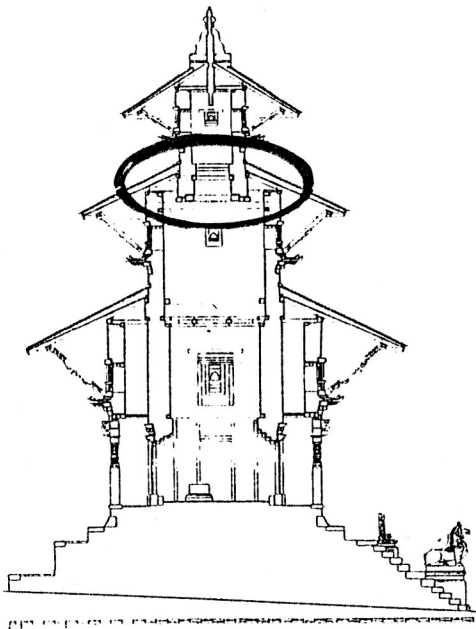
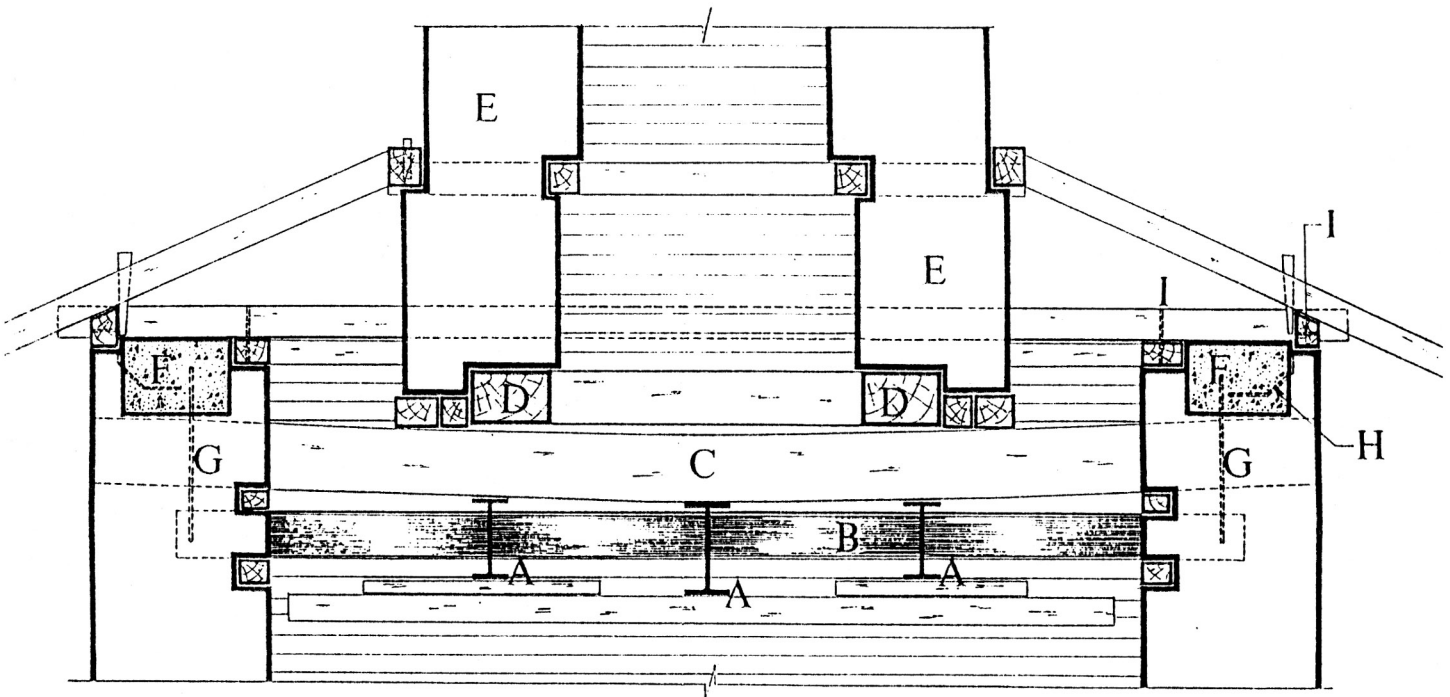
Design of seismic reinforcements ia largely limited to insertion of RCC ring beams as installation of vertical reinforcement is not allowed by the historical structure i.e. would necessitate extensive dismantling of the structures. The simplest (least destructive) location for ring beam insertion is at the wall plate level.

Thus, it is proposed to insert RCC ring beams at wall plate levels of middle and lower roofs to resist horizontal forces of seismic activities.

A seismic coefficient of 0.12 has been adopted for the calculation of seismic load and subsequently, the size and steel of RCC ring beams.

Project Architect Rohit Ranjitkar's proposal for the vertical continuities with the ring beam with steel plate connectors to wall plates, rafters and tie beams is advisable.

As there are no signs of settlement further investigation of foundation is not undertaken. Pipe level inspection of heights confirms lack of settlement.



- A New steel beams to carry top level walls/roof
- B New steel cross beams
- C Existing principal timber beams
- D Existing secondary timber beams
- E Uppermost temple level walls
- F Reinforced concrete ring beam
- G Steel rods connecting new steel frame and new ring beam
- H Steel plates connecting timber wall plates to new ring beam
- I Concealed bolting at timber joints

STRUCTURAL DESIGN OF RADHA KRISNA TEMPLE

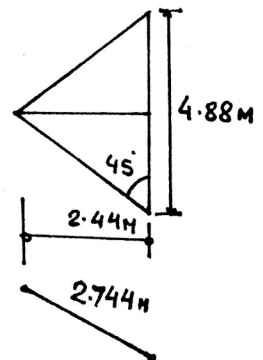
CONCEPT - 1 (USE SAME GRID BEAM IN TWO DIRECTION)

Loads:

$$\text{Dead Load of Gajur} = 8 \text{ kg}$$

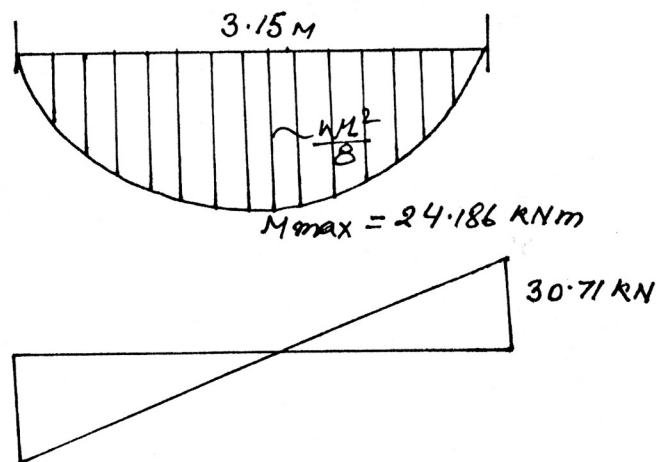
$$\text{Dead Load of Roof} = 6.70 \times 300 = 2010 \text{ kg}$$

$$\begin{aligned} \text{Dead Load of Wall} &= 1.90 \times 0.35 \times 3 \times 1920 \\ &= 3830 \text{ kg} \end{aligned}$$



$$\begin{aligned} \text{live load} &= 75 - 2 \times 22.5 = 30 \text{ kg/m}^2 \times 6.7 \\ &= 201 \text{ kg} \end{aligned}$$

$$\text{Total load} = 8 + 2010 + 3830 + 201 = 6049 \text{ kg}$$



$$\text{UDL from above mentioned load} = 1920 \text{ kg/m}$$

$$\text{UDL from self load of timber and Iron beams} = 30 \text{ kg/m}$$

$$\text{Total} = 1950 \text{ kg/m}$$

$$Z \geq \frac{M}{\sigma_{bt}} = \frac{24.186 \times 10^3}{165 \times 10^3} \times 10^3 = 147 \times 10^6 \text{ mm}^3$$

$$\text{Try ISLB 200 @ } 19.8 \text{ kg/m}$$

$$Z_x = 169.7, a = 25.27 \text{ cm}^2, L = 200, t_w = 5.4 \text{ mm}$$

$$I_x = 1696.60 \text{ cm}^4$$

Check for Shear:

$$\text{Max. Shear force} = 30.71 \text{ kN}$$

$$\text{Average shear stress} = \tau_{va} = \frac{30.71 \times 10^3}{200 \times 5.4} = 28.44 \text{ MPa} < 100 \text{ MPa}$$

Check for deflection:

$$\text{Max. deflection } \delta = K \times \frac{W \times l^3}{E \times I_x}$$

$$K = \frac{5}{384} = 0.013$$

$$W = 19.50 \times 3.15 = 61.425 \text{ kN}$$

$$l = 3.15$$

$$E = 2 \times 10^4 \text{ kN/cm}^2$$

$$I_x = 1696.5 \text{ cm}^4$$

$$\delta = 0.013 \times \frac{61.425 \times 3.15^3 \times 10^6}{2 \times 10^4 \times 1696.5} = 0.74 \text{ cm}$$

$$\text{Allowable deflection } \delta = \frac{l}{325} = \frac{3.15}{325} = 0.97 > 0.74 \text{ cm.}$$

which is safe.

Check for Web Creeppling:

$$\text{Bearing stress at support} = \frac{R}{t_n(a + h_2 \sqrt{3})}$$

$$R = 30.71 \quad h_2 = 17.15 \quad \left(\begin{array}{l} \text{Bearing length} = 350 \\ d = 200 \\ a = 200 \end{array} \right)$$

$$= \frac{30.71 \times 10^3}{5.4(200 + 17.15 \sqrt{3})} = 24.75 \text{ MPa} < 187.5 \text{ MPa}$$

which is safe.

Check for web buckling:

$$\text{Slenderness ratio for web} = \frac{k_1}{t_n} \sqrt{3}$$

$$= \frac{165.3}{5.4} \sqrt{3} = 53.02$$

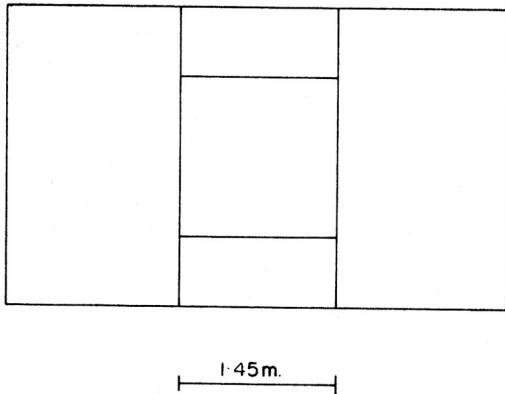
$$\sigma_{ac} = 129$$

Load carrying capacity of the web under

$$\text{concentrated load} = \sigma_{ac} \times t_n \times B = \frac{129 \times 5.4 (100 + 50)}{1000} = 104 > 30.7 \text{ kN.}$$

Hence provide ISLB - 200 in both direction

CONCEPT - 2 (USE SECONDARY BEAM & MAIN BEAM)



Secondary Beam

Dead load of Gajra = 8 kg

Dead load of Roof = 2010 kg

Dead load of wall = $1.066 \times 0.35 \times 3 \times 1920 = 2028 \text{ kg}$

Live load = 30 kg/m^2 ; Total load = 4046 kg

UDL = 2790 kg say, $2800 \text{ kg/m} = 28 \text{ kN/m}$

With this load,

$$\text{Max. bending moment} = \frac{wl^2}{8} = \frac{28 \times 1.45^2}{8} = 7.36 \text{ kNm}$$

$$\text{and Reaction} = \frac{wl}{2} = 2023 \text{ kg}$$

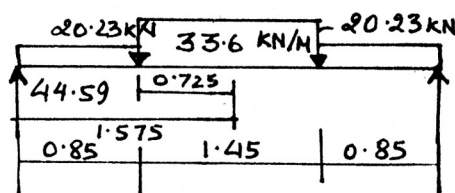
$$Z = \frac{7.36 \times 10^6}{165 \times 10^3} = 44.60 \text{ mm}^3$$

Provide ISLB - 125

Main Beam

Total load = 6049 kg (Please ref. the 1st case)

and, UDL within wall = 3360 kg/m



Maximum bending moment = 46.73 kNm

and shear force = 44.59 kN

$$Z \gg \frac{M}{\sigma_{bt}} = \frac{46.73 \times 10^3}{165} = 283.21$$

try ISMB 200 @ 25.4 kg/m

$$\begin{aligned} I_x &= 223.50 \text{ cm}^3 & t_w &= 5.7 \text{ mm} & T &= 10.8 \text{ mm} \\ a &= 32.33 \text{ cm}^2 & I_x &= 2235.40 \text{ cm}^4 \\ h &= 200 \text{ mm} & b &= 100 \text{ mm} \end{aligned}$$

$$\frac{T}{t_w} = \frac{10.8}{5.7} = 1.89 < 2$$

$$\frac{d_1}{d_w} = \frac{200 - 2 \times T}{t_w} = \frac{200 - 2 \times 10.8}{5.7} = 31.30 < 85$$

$$l/r = \frac{1.45 \times 100}{8.32} = 17.43$$

$$D/T = \frac{200}{10.8} = 18.52 \quad \sigma_{bc} = 165 \text{ MPa}$$

Hence, the section is safe.

$$\text{Max. shear force} = 44.59 \text{ kN}$$

$$\tau_{va} = \frac{44.59 \times 10^3}{200 \times 5.7} = 39.11 < 100 \text{ MPa}$$

Check for deflection

$$\delta = \frac{5}{384} \times \frac{38.6 \times 3.15^3 \times 10^6}{2 \times 10^4 \times 2235.40} = 0.31 \text{ cm} < \frac{3.15}{325} = 0.96 \text{ cm}$$

which is safe

DESIGN OF TIE BEAM

$$\text{Dead load of roof} = 308 \text{ kg/m}^2$$

$$\text{Area of roof} = 24.50 \text{ sq.m}$$

$$\text{Live load} = 30 \text{ kg/m}^2$$

$$\text{Upper roof load} = (30+308) \times 24.50 = 8281 \text{ kg}$$

$$\text{Upper wall load} = 7.87 \times 1800 = 14164 \text{ kg}$$

$$\begin{aligned} \text{Lower half load of wall} &= (3.65^2 - 2.74^2) \times \frac{3.42}{2} \times 1800 \\ &= 17,898 \text{ kg} \end{aligned}$$

$$\text{Middle roof load} = 338 \times 52.25 = 17661 \text{ kg}$$

$$\text{Total load} = 58004 \text{ kg}$$

$$\text{UDL load on metre length of wall} = \frac{58004}{4 \times 3.15} = 4603 \text{ (N)}$$

$$\text{Seismic coefficient assumed} = 0.12 (k_e)$$

Horizontal load due to earthquake

$$= W \times k_e$$

$$= 4603 \times 0.12 = 55236 \text{ kg/m (W}_s\text{)}$$

Moment due to this load

$$= \frac{W_s l^2}{10} = \frac{55236 \times 3.15^2}{10}$$

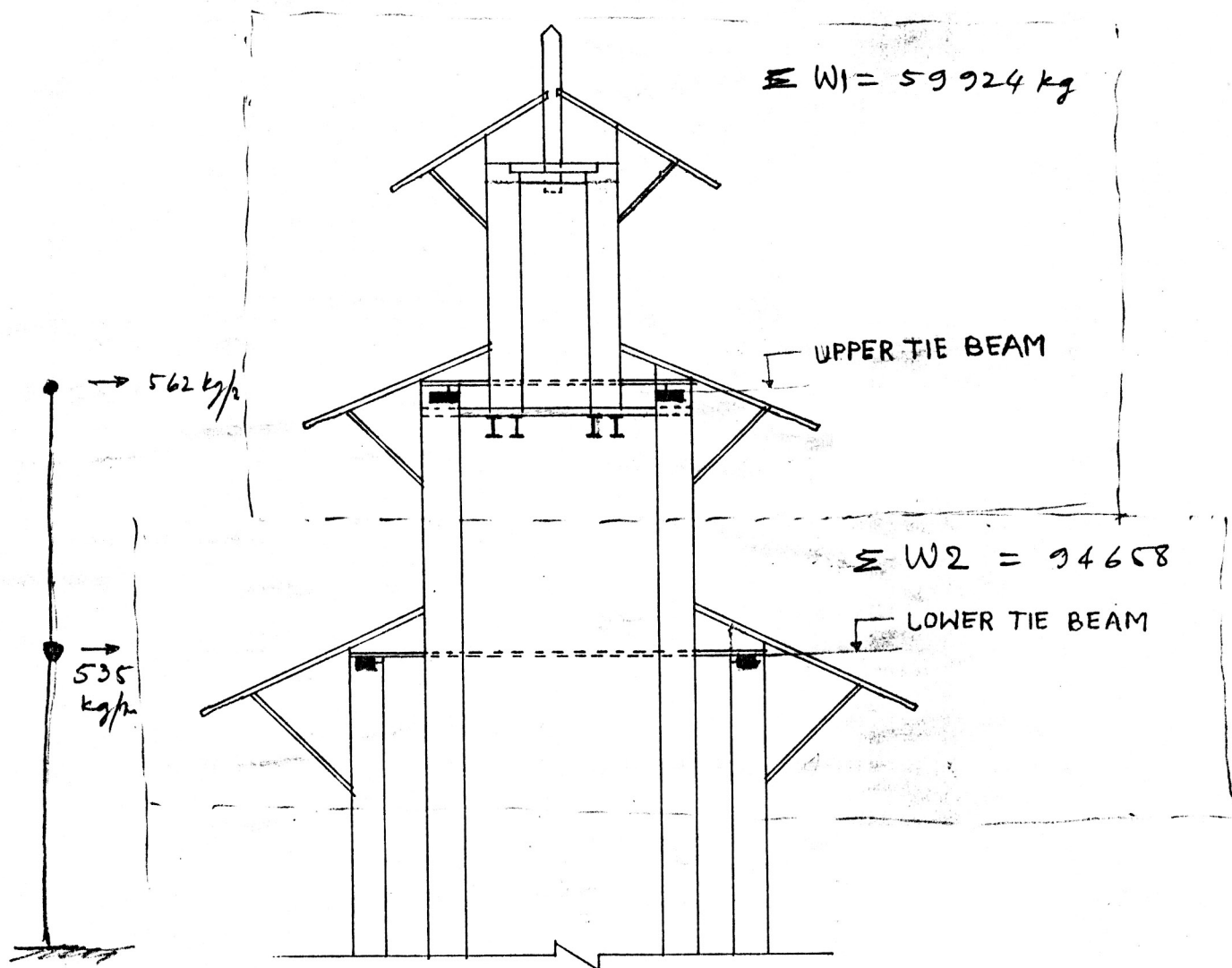
$$= 548 \text{ kgm}$$

$$\text{Shear force} = \frac{552.36 \times 3.15}{2} = 870 \text{ kg}$$

Let us take the value of effective depth as - 34.6 cm
(total depth = 38 cm)

$$\begin{aligned} \text{Area of steel} &= \frac{M}{\sigma \times d} = \frac{548 \times 100}{1.333 \times 2300 \times 34.6} \\ &= 0.576 \text{ cm}^2 \end{aligned}$$

However provide 4 nos 12 mm ϕ with corner overlapping and 6 mm ϕ stirrups at 20 cm c/c
 $A = 4 \times 1.13 = 4.52 \text{ cm}^2 > \text{min. steel area} = 3.06 \text{ cm}^2$



DESIGN CALCULATION: RADHA KRISHNA TEMPLE

1. UPPER TIE BEAM LOADING

DEAD LOAD

CLAY JHINGTEE TILE	- 25 kg/m ²
TIMBER PLANK	25 kg/m ²
4" MUD PACKING	160 "
TIMBER BEAM	100 "
TOTAL DEAD LOAD	<u>310 kg/m²</u>

LIVE LOAD

SLOPE OF ROOF - 22°

BASIC LIVE LOAD FOR SLOPING ROOF IS 75 kg/m²
FOR SLOPE ABOVE 10° FOR EACH ANGLE
2 kg/m² CAN BE REDUCED.

$$\text{LIVE LOAD } 75 - 2 \times 12 = 51 \text{ kg/m}^2$$

$$\text{TOTAL LOAD (LIVE + DEAD)} = 361 \text{ kg/m}^2$$

$$\text{AREA OF UPPER ROOF} = 263.55 \text{ ft}^2 = 24.485 \text{ m}^2$$

$$\begin{aligned}\text{UPPER ROOF LOAD} &= 24.485 \times 361 \\ &= \underline{8839 \text{ kg}}\end{aligned}$$

WALL LOAD RESTING ON
TIMBER BEAM

$$\begin{aligned}\text{WALL VOLUME} &= (6.25^2 - 3.25^2) \times 9.75 \\ &= 277.88 \text{ ft}^3 \\ &= 7.87 \text{ m}^3\end{aligned}$$

$$\text{WALL LOAD} = 7.87 \times 1800 = \underline{14164 \text{ kg}}$$

LOWER WALL LOAD (ONLY HALF OF THIS WALL LOAD WILL BE EFFECTIVE IN DESIGN OF UPPER TIE BEAM)

$$= \frac{(12^2 - 9^2) \times \frac{11.25}{2} \times \frac{1}{35.313} \times 1800}{2}$$

$$= 18063 \text{ kg}$$

MIDDLE ROOF LOAD

$$= \frac{562.3 \times 361}{10.76} = 18,857.6 \text{ kg}$$

$$\text{TOTAL LOAD} = 59,924 \text{ kg}$$

$$W, \text{ LOAD/m OF WALL} = \frac{59,924}{4 \times 10.5 \times 3048} = 4681$$

SEISMIC COEFF. ASSUMED

$$\alpha_k = 0.12$$

HORIZONTAL LOAD DUE TO EARTHQUAKE

$$= \alpha_k \times W = 0.12 \times 4681$$

$$W_k = 562 \text{ kg/m} \rightarrow L = 10.5'$$

MOMENT DUE TO HORIZONTAL COMPONENT OF SEISMIC LOAD

$$\text{MOMENT, } M = W_k \times \frac{L^2}{10} = 562 \times \frac{(10.5 \times 3048)^2}{10}$$

$$= 575 \text{ kgm}$$

$$\text{SHEAR, } V = \frac{562 \times 10.5 \times 3048}{2} = 877 \text{ kg}$$

SECTION OF TIE BEAM

$$D \times D = 7" \times 15" = 17.78 \text{ cm} \times 38.1$$

$$\text{effective } d = 34.6 \text{ cm}$$

$$\text{Allowable stress in Steel} = 1.333 \times 2300$$

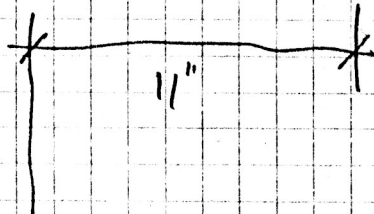
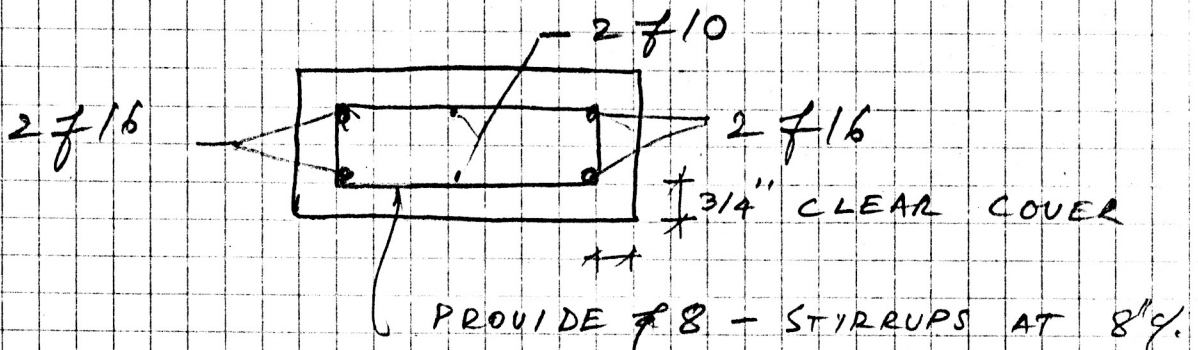
Steel Reinforcement area reqd

$$A_{st} = \frac{M}{f_y \times l} = \frac{575.34 \times 100}{1.333 \times 2300 \times 34.6} = 0.542 \text{ cm}^2$$

$$\text{minimum steel area} = 0.5\%$$

$$A_{st} = 0.5 \times \frac{17.78 \times 38.1}{100} = 3.065 \text{ cm}^2$$

PROVIDE 2#16 (4.02 cm²)
2#10 at center.



2. LOWER TIE BEAM

WALL LOAD FROM ABOVE = 18063

WALL LOAD FROM BELOW

$$\begin{aligned}\text{WALL VOLUME} &= \frac{8.5}{2} (19^2 - 15.834^2) + (12^2 - 8^2) \\ &= 808.8 \text{ cft} \\ &= 22.9 \text{ m}^3\end{aligned}$$

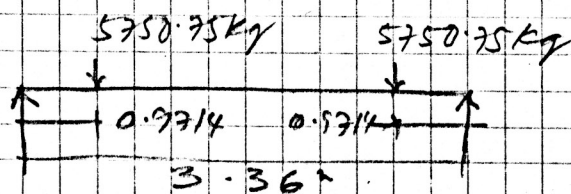
$$\begin{aligned}\text{WALL LOAD} &= 22.9 \times 1800 \\ &= 41,222 \text{ kg}\end{aligned}$$

3. STEEL BEAM DESIGN

$$\begin{aligned}\text{TOTAL LOAD RESTING ON TIMBER} \\ \text{BEAMS} &= 8839 + 14164 \\ &= 23003\end{aligned}$$

$$\text{LOAD ON ONE SIDE} = \frac{23003}{2} = 11501.5$$

$$\text{LOAD ON EACH POINT} = \frac{11501.5}{2} = 5750.75$$



$$\text{BENDING MOMENT } M = 5750.75 \times 0.9714 + 50 \times \frac{3.36^2}{8}$$

$$\text{SHEAR } V = 5750.75 + 50 \times \frac{3.36}{2} = 5834.75 \text{ kg}$$

$$\text{REQD. SECTION MODULUS } Z = \frac{M}{f_b}$$

f_b = ALLOWABLE BENDING STRESS IN

$$\begin{aligned}\text{I-SECTION} \\ &= 1650 \text{ kg/cm}^2\end{aligned}$$

$$\begin{aligned}Z &= \frac{5656.9 \times 100}{1650} = 342.9 \text{ cm}^3 \\ &= 2 \times 171.45\end{aligned}$$

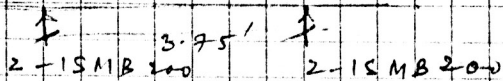
PROVIDE TWO NUMBER OF ISMB-200

$$Z_{22} = 223.5 \text{ cm}^3 > 171.45 \text{ cm}^3$$

SHEAR CAPACITY

$$= 14,400 \text{ kg} > \frac{5834.75}{2} \text{ hence safe.}$$

4 STEEL PLATE REINFORCEMENT FOR EXISTING TIMBER BEAM



$$\text{SPAN } L = \text{SPACING BETWEEN 2-15MB 200} \\ = 3'2.5 + 1.5 = 3.75'$$

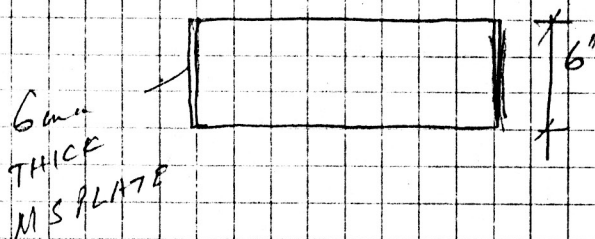
$$\text{LOAD } W = 4681 \text{ kg/m}$$

$$\text{Moment } M = 4681 \times \frac{(3.75 \times 0.3048)^2}{8} \\ = 764.5 \text{ kgm}$$

$$\text{SECTION MODULUS REQD} = \frac{M}{f_b} = \frac{764.5 \times 100}{1650} \\ Z = 46.33 \\ = 2 \times 23.16$$

$$\frac{bd^2}{6} = 23.16, \quad d = 15.24$$

$$b = 0.6 \text{ cm} \quad \text{PROVIDE } 6 \text{ mm} \times 15.24 \text{ PLATE}$$



Steel Reinforcement area

$$\begin{aligned} \text{reqd} &= \frac{3091.5 \times 100}{1.333 \times 2300 \times 24.64} \\ &= 4.11 \text{ cm}^2 \end{aligned}$$

PROVIDE SAME REINFORCEMENT
AS IN UPPER TIE BEAM.

$$\begin{aligned}\text{AREA OF LOWER ROOF} &= 1055 \text{ ft}^2 \\ &= 28 \text{ m}^2\end{aligned}$$

$$\text{Roof LOAD} = 28 \times 361 = 35373$$

$$\text{TOTAL LOAD} = 94658$$

$$\begin{aligned}\text{LOAD / m} &= \frac{94658}{4 \times 17.4166 \times 3048} \\ &= 4457.8\end{aligned}$$

HORIZONTAL LOAD

$$\begin{aligned}\text{DUE TO EARTHQUAKE} &= K_1 \cdot W \\ &= 0.12 \times 4457.8 \\ &= 535 \text{ kg} \rightarrow\end{aligned}$$

TOTAL HORIZONTAL

$$\text{LOAD} = 562 + 535 = 1097 \text{ kg}$$

MOMENT DUE TO HORIZONTAL

$$\begin{aligned}\text{LOAD} &= 1097 \times \frac{(17.4166 \times 3048)^2}{10} \\ &= 3091.5 \text{ kgm}\end{aligned}$$

$$\begin{aligned}\text{SHEAR } V &= \frac{1097 \times 17.4166 \times 3048}{2} \\ &= 2911.8 \text{ kg}\end{aligned}$$

$$D \times D = 17.78 \text{ m} \times 27.94 \text{ m} (7" \times 11")$$

QUANTITY SHEET

S. No.:

DATE:

PROJECT.....RADHA KRISHNA.....
.....TEMPLE, PATAN.....

JOB CODE.....STEEL BEAM.....
.....4 STEEL PLATE.....

Item No.	Description	Nos.	Length	Total Length	Breadth	Height	Quantity	Remark
1.	ISMB - 200	4	11'-7"	46'-4"			359 kg	
2	MS PLATE 6 mm x 6"	2	11'-7"	23'-2"				
		2	11'-7"	23'-2"				
				46'-4"			102 kg	
							461 kg	

QUANTITY SHEET

S. No.:

DATE:

PROJECT.....RADHA KRISHNA.....
.....TEMPLE, PATAN.....

JOB CODE.....1-UPPER TIE.....
.....BEAM.....

Item No.	Description	Nos.	Length	Total Length	Breadth	Height	Quantity	Remark
1.	CEMENT CONCRETE FOR UPPER TIE BEAM (MIX 1:2:4)			$(11.583^2 - 9.0833^2) \times \frac{7}{12}$			30.2	cft
2.	TORSTEEL FOR REINFORCEMENT							
		16mm DIA	135'-4" + 148'				283'-4"	
							136.3 kg	
		10mm DIA	67'-8" + 74' = 141'-8"				26.7 kg	
		8mm DIA	182'				21.9 18.4 kg	
						TOTAL	184.9 kg	
				+ 15% WASTAGE			213 kg	
3.	FORMWORK			$4 \times (11.583 + 9.0833) \times \frac{7}{12}$			48.3	SFT

QUANTITY SHEET

S. No.:

DATE:

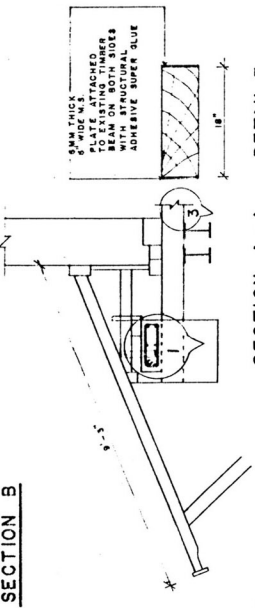
PROJECT.....R.A.DHA...K.RISHNA.....
.....T.E.MPLE.....P.A.TAN.....

JOB CODE...2...LOWER TIE.....
.....BEAM.....

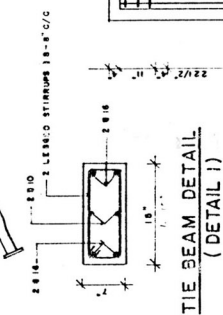
Item No.	Description	Nos.	Length	Total Length	Breadth	Height	Quantity	Remark
1.	CEMENT CONCRETE FOR LOWER TIE BEAM (MIX 1:2:4)			$(19.25^2 - 17.4166^2) \times \frac{7}{12}$			39.2 cft.	
2.	TORSTEEL FOR REINFORCEMENT	16 ^{mm} DIA.	135' 4" + 288'	423.67'			203.8 kg	
		10 ^{mm} DIA.	67' 8" + 134'	201.667'			37.9 kg	
		8 ^{mm} DIA	283.83'				34.1	
							2758 kg	
				+ 15% WASTAGE			318 kg	
3.	FORM WORK			$4 \times (19.25 + 17.4166) \times \frac{7}{12}$			85.6 SFT.	



SECTION B



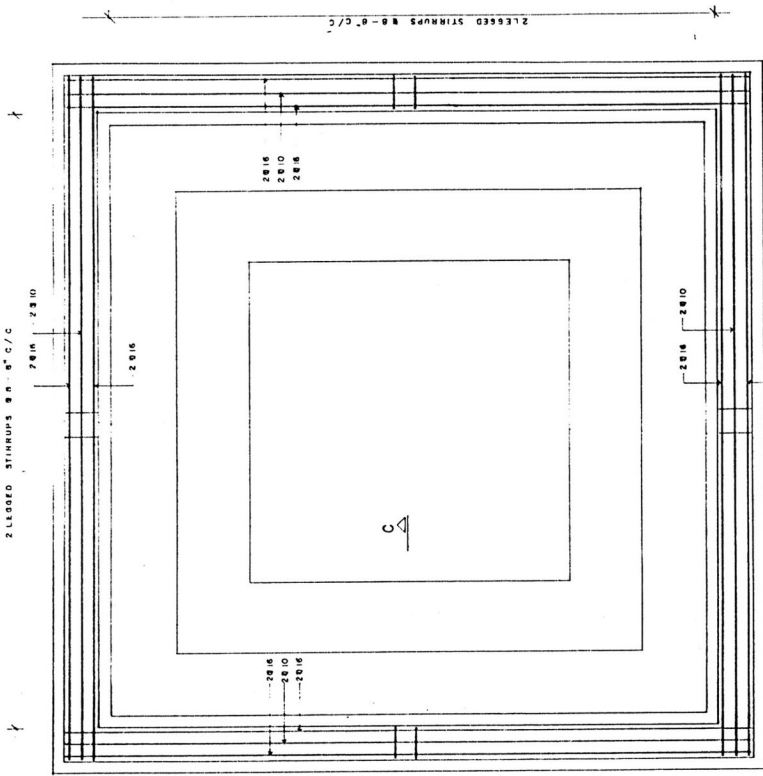
SECTION A-A



TIE BEAM DETAIL (DETAIL 1)

SECTION C-C

TIE BEAM DETAIL (DETAIL 2)



UPPER TIE BEAM

LOWER TIE BEAM

BENDING SHAPE	DIA.	NOS	LENGTH	TOTAL LEN.
1/4"	1/8"	16	8'-5 1/2"	135'-4"
1/4"	1/8"	8	8'-5 1/2"	67'-8"
1/4"	1/8"	16	9'-3"	148'-0"
1/4"	1/8"	8	9'-3"	74'-0"
1/4"	1/8"	52	3'-8"	182'-0"

BENDING SHAPE	DIA.	NOS	LENGTH	TOTAL LEN.
1/4"	1/8"	16	8'-5 1/2"	135'-4"
1/4"	1/8"	8	8'-5 1/2"	67'-8"
1/4"	1/8"	16	15'-9"	268'-0"
1/4"	1/8"	8	15'-9"	134'-0"
1/4"	1/8"	100	2'-10"	283'-4"

TIE BEAM DETAIL OF
RADHA KRISHNA TEMPLE
CHECKED - 11-07/02-11-08
SCALE - 1/4" = 1'-0"
DATE - 10-08-2008
M.R.B. & ASSOCIATES
GYANESHORE, KATIMANDU, NEPAL TEL - 41081

APPENDIX B

ROOF STRUT INVENTORY

**BOTTOM ROOF
ELEVATION: EAST
STRUT: 101
AGE: ORIGINAL (1668)**

PRINCIPAL FIGURE

FIGURE: "Panchamukhi" (five-headed) Ganesh with his Sakti (Siddhi). Ganesh with 12 hands and is guarded by seven Snakes as a crown, Sakti Siddhi ; one-headed with two original hands.

MOUNT: Male: mouse; Female: lion (?)

PEDESTAL : Siddhi on lotus; Ganesh is on snake's tail above mouse.

MUDRA: Ganesh is in a dancing posture where- as his counterpart "Siddhi" is feeding "modaka" (sweets) to him.

BASE SCENE:

God (Bhairav-like) killing three demons.

UPPER FOLIAGE:

- Tree with leaves peacock and tiny monkey figure at top and the floral patterns like a necklace at the base.

CONDITION:

- Almost in an original state except for two arms added in 1967.
- Mildew has quite significantly covered the strut e.g. on leaves, crown, face of female figure, chest of male figure body of the lower figures. (nearly 4 sq. feet)
- Female figure in good condition, only mildew at right hand and on face.
- Male figure: two right hands are original , two 1967 replacements are fitted w/nails; two are lost; on the left, five hands are original, two lost.
- Drapery is intact.
- This is the most intact strut of the temple.



NOTE MARCH 1993:

MOST PHOTOS OF STRUTS WERE TAKEN DECEMBER 1991-MARCH 1992. SOME BETTER QUALITY PHOTOS (TAKEN IN DECEMBER 1992 AFTER NEW ROOF WORK, BUT BEFORE STRUT TREATMENT *IN SITU*) HAVE BEEN SUBSTITUTED.

**BOTTOM ROOF
ELEVATION: EAST
STRUT:102
AGE: ORIGINAL (1668)**

MAIN FIGURE:

MAHA VISHNU with his **SHAKTI LAXMI**.
VISHNU: five heads and ten hands; Laxmi: a normal single head and two hands.

MOUNT: Vishnu is directly mounted on his mount Garuda. His Laxmi on a lion which looks special than the other female mounts.

PEDESTAL: Lotus for Laxmi.

MUDRA: Both figures crossed leg standing posture.

BASE SCENE:

God killing the two demons at the base.

UPPER REGISTER:

A tiny monkey, peacock, gandharva and tree with leaves at the top and floral patterns like a necklace at the bottom.

CONDITION:

- Structural condition good.
- Hands, Male: right 1 hand original, figures are broken on original hands; left 4 hands misfitted, 1 lost; Female: both lost.
- Weapons in hands are lost.
- Wetrot on upper leaves and at the right side head. (App.2 sq.ft.)
- Mildew problem on lower figure (App.60sq.in.)



**BOTTOM ROOF
STRUT: 103
ELEVATION: EAST
AGE: ORIGINAL (1668)**

MAIN FIGURE:

SHIVA with his SHAKTI.

SHIVA: five heads on front, one on back; 12 hands. Shakti : single head and two hands.

MOUNT: Lost for male and a lion for the female.

PEDESTAL: Lotus for both.

MUDRA: Crossed leg standing posture (both figureS).

BASE SCENE:

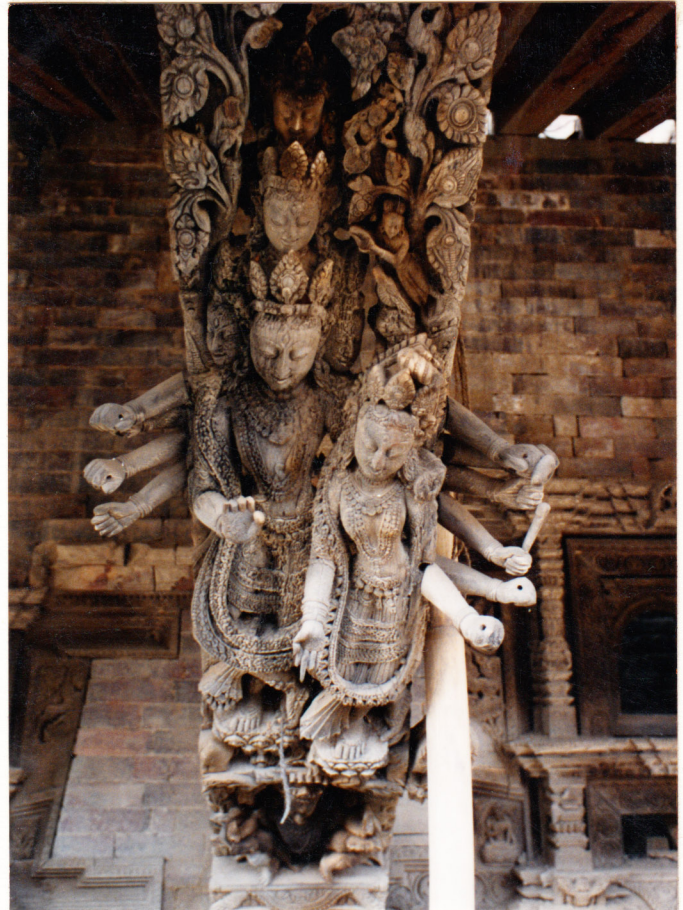
God killing two demons at the base.

UPPER REGISTER:

Tree with leavers at the top and floral pattern like a necklace at the base. A peacock, two monkeys and three gandharva one with water pouring on upper most head of God, one playing musical instrument and one with Sankha on leaves.

CONDITION:

- Hands : Male: Right 1 hand original, 3 misfitted, 2 lost; Left: 1 original, 5 misfitted;
- Female: Right 1 hand original; Left misfitted.
- Weapons of hands lost.
- Structurally o.k.
- Mildew problem is mainly on the lower figures and upper most head (App. 36sq. in.)
- Green mould is seen in some part of the male figures and uncarved top of the strut. App.80sq.in.
- Drapery is lost.
- Some 1"x 3"x 8" piece is broken off at top-most end of the strut.



**BOTTOM ROOF
STRUT: 104
ELEVATION: EAST
AGE: ORIGINAL (1668)**

MAIN FIGURE:

KUMARA with his SHAKTI RIDDHI.

KUMARA: five heads come at back and 12 arms, Shakti; a normal single head and two hands.

MOUNT: Kumara on peacock and Riddhi on lion.

PEDESTAL: Lotus for both.

MUDRA: Kumara is in dancing posture and Riddhi is in crossed leg standing posture.

BASE SCENE:

- Hanumana killing two demons at the base.

UPPER REGISTER:

- Tree branches with leaves and two tiny monkeys, a peacock and a gandharva at the top and the floral pattern like a necklace at the bottom.

CONDITION:

- Structural condition is good.
- Mildew problems on leaves, tiny monkey, on female face ornaments of female figure as well as on the base scene. (App.1sq.ft.)
- Hands- Male-Right; 2 original hands, 3 misfitted, 1 lost; Left; 5 original hands, 1 misfitted. Female- both original, fingers are broken on both hands.
- Right side drapery is lost, left intact.
- Male figure's right leg is loose, because of timber shrinkage.



BOTTOM ROOF
STRUT: 106
ELEVATION: SOUTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA with SHAKTI.

SHIVA: four heads, ten hands; Shakti: has got a head and two hands.

MOUNT: Lost for male and female.

PEDESTAL: Lotus for both.

MUDRA: Nritya a Tandab by male and Lasya by the female. (7 historical hands intact).

BASE SCENE:

- Bull-headed god (Nandi) killing two demons.

UPPER REGISTER:

-Peacock, 3 monkeys, one human figure; Tree branches with leaves at the top of the strut and a floral patterns like a necklace at its bottom.

CONDITION:

- Surface of the figure crumbling from wet rot, probed depth 1".

- Auxiliary faces of Shiva show signs of wetrot, but timber is still hard to the touch. (Total affected area 6sq.inches).

- Four hands misfitted (1967).

- Ayudh (weapons) at hands have been lost.

- Mildew on leaves, on the crown face and on the drapery, on god's face as well as and on the base of the bull. (1sq.ft.mildew area.)



BOTTOM ROOF
STRUT: 107
ELEVATION: SOUTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA with SHAKTI pair.

SHIVA: four heads, ten hands; Shakti: one head and two hands.

MOUNT: Mount is lost for male and female.

PEDESTAL: Lotus for both figures.

MUDRA: Lost. (Ten new hands misfitted 1967)

BASE SCENE:

- Bhairava-like, God killing 2 demons.

UPPER REGISTER:

-1 peacock and 1 monkey.

CONDITION:

- Face and figure of the male as well as adjacent areas have been deteriorated by wet rot, knife probe penetrates 1/4"-1/2" in these areas. This is one of the three most affected struts.
- Outer surface layer and the figures have started to crumble.
- Hands misfitted (new).
- 'AYUDH' (weapon) in hands lost.
- Mildew problem is partially on the base scene.
- Green mould in all parts.
- Structural condition is good.



**BOTTOM ROOF
STRUT: 108
ELEVATION: SOUTH
AGE: 1967**

MAIN FIGURE:

BHAIRAVA: with single head and ten hands
without female counterpart.

MOUNT: Dog.

PEDESTAL: Lotus.

MUDRA: Nritya (dancing).

BASE SCENE:

- God killing demons at the base.

UPPER REGISTER:

- Tree with leaves at the top.

INSCRIPTION:

- (Written at the back) Made by "Patan
Audhogik Kshetra". (Patan Industrial Centre,
2024 V.S.)

CONDITION:

- Mildew on leaves, faces of the Bhairava and
on base scene. (Area 1sq.ft.)

- Structural condition is good.



**BOTTOM ROOF
STRUT: 109
ELEVATION: SOUTH
AGE: ORIGINAL (1668)**

MAIN FIGURE:

SHIVA with SHAKTI pair.

SHIVA: has four heads and ten hands and his
Shakti has a normal single head and two hands.

MOUNT: Lotus Petal for male and a Lion
for the female.

PEDESTAL: Lotus for both figures.

MUDRA: 'Nritya' (dancing) by the both.

BASE SCENE:

- Garuda killing demons at the base.

UPPER REGISTER:

- Tree branches with leaves and a tiny monkey
at the top and the floral pattern like a necklace
at the base.

CONDITION:

- Strut in very good condition, no signs of wet rot.
- Eight new hands misfitted with nails in 1967. All weapons lost
- Mildew on upper foliage, and on the base scene.



**BOTTOM ROOF
STRUT: 111
ELEVATION: WEST
AGE: ORIGINAL (1668)**

MAIN FIGRUE:

SHIVA with SHAKTI pair.

SHIVA: four headS and ten hands; Shakti: a normal single head and two hands.

MOUNT: Mount has lost for male and female.

PDESTAL: Lotus for both figures.

MUDRA: Crossed legs standing posture by both.

BASE SCENE:

- Garuda killing two demons at the base.

UPPER REGISTER:

- Tree branches with leaves at the top and the floral pattern like a necklace at the bottom. 3 tiny monekys are on leaves. Head of all the monkeys are broken.

CONDITION:

- Weapons in hands lost.
- Hands- Male-Right: All new hands (1967); Left: 3 original hands, 2 new (1967); Female: both lost.
- Mildew problem partially on leaves, body and ornaments of the female figure. On face and arm in male figure (total mildew app.81sq.in.)
- Drapery lost on both sides.
- Structural condition is good.



BOTTOM ROOF
STRUT: 112
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:

Bhairav. (This strut had been removed from the roof, its upper portion lost. Study of the body, and Naramuda male (human skull garland) identifies it as Bhairava. In place of this strut, was fixed a plain timber strut, probably after 1967.

MOUNT:

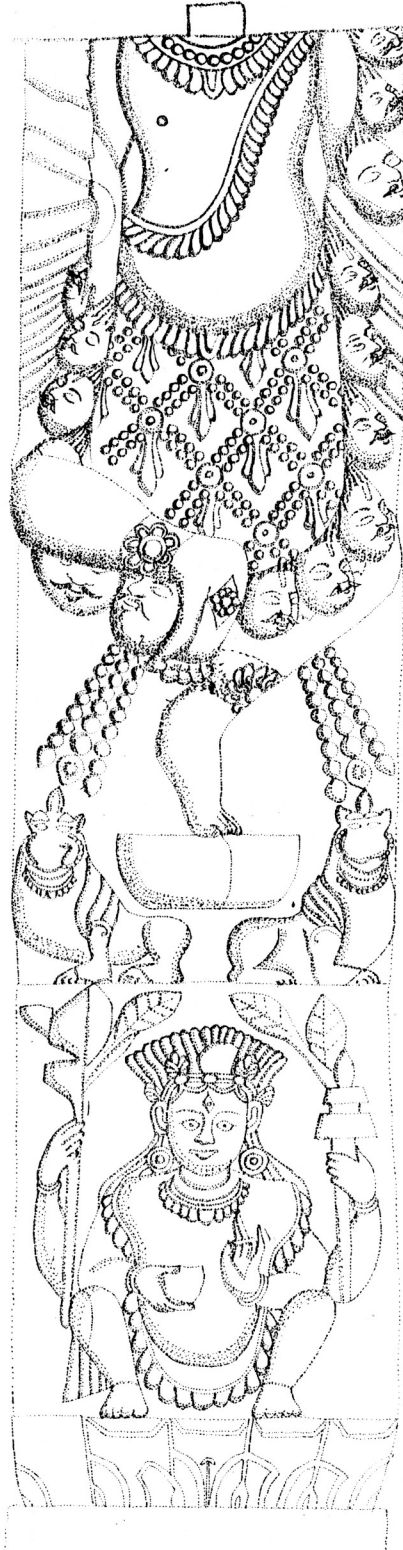
2 lions.

BASE SCENE:

- A God with joined hands.

CONDITION:

- Head, hands, weapons, and drapery are lost. (Above head all the part are lost, 29" upper portion is lost.)
- Strut has been stored on the ground at the back of Sattal beside Swatha Narayan Temple.
- Structurally condition needs closer study to determine how extensive denaturing from wet rot has penetrated.



BOTTOM ROOF
STRUT: 113
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:
SHIVA with SHAKTI.

MOUNT: Mount has lost for male and lion for a female.

PEDESTAL: Lotus for both.

MUDRA: Crossed legs standing posture.

BASE SCENE:

- God (with sheep's head) killing two demons at the base.

UPPER REGISTER:

- Tree branches with leaves at the top and a floral patterns like a necklace at the base. Two gandharvas just above male figure's head on leaves.

CONDITION:

- Outer surface layer of the male figure is deteriorated due to wet rot, a knife probe in this area is up to 1/2" deep.

- Hands: Male-right, 2 new hand (1967), 3 lost; left- all lost. Female: both lost.

- Structurally fair: it has been reinforced by a wooden plank on the back of the strut in 1967.

- Mildew problem partially on leaves, on the body of base scene and on crown and garland of the female figure (App. 36 sq. in.).

- Draperies are lost.



BOTTOM ROOF
STRUT: 114
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA with SHAKTI pair.

SHIVA: four heads and ten hands; Shakti: a normal single head and two hands.

MOUNT: Mount has lost for male. In males mount 1/2 part of human figure is remaining and lower part is lost. And lion for the female.

PEDESTAL: Lotus for the both.

MUDRA: "Nritya" (dancing) by both.

BASE SCENE:

- God (Elephant-headed) killing two demons at the base.

UPPER REGISTER:

- Trees and leaves at the top and floral patterns. A monkey on the top most part of strut in centre, one monkey looking out from leaves and a gandharva above top head of Shiva.

CONDITION:

- Seasoning cracks on face and up the sides of the strut.

- One big crack from top to middle of strut, apparently from seasoning of the timber after carving.

- Extant example of the drapery (left), right is lost.

- Mildew problems, partially on leaves and the face of the male figure and on the ornaments of the female figure. And on pedestal of female figure (App.25sq. in.).

HAND: Male- Right, 4 new hands (1967), 1 lost; Left-all five new hands. Female: right hand original (integral with main strut timber); left, new.

- There is a hole (2" dia. 5" deep in neck of male figure, caused by insect infestation.

- Tiny holes on left head face of male figure and above female figure's head, from past insect infestation.

- Right foot is lost on male figure.

- Structural condition is fair.



BOTTOM ROOF
STRUT:116
ELEVATION: NORTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

Four headed GANESH, with SHAKTI.

MOUNT: Lion for male and (?) for female lost.

PEDESTAL: Lotus for both.

MUDRA: Male, ordinary standing posture and female crossed leg standing posture.

BASE SCENE:

Garuda killing two demons at the base.

UPPER REGISTER:

Trees and leaves at the top and floral pattern like a neckless at the base. A peacock, monkey and a gandharva with flower on leaves.

CONDITION:

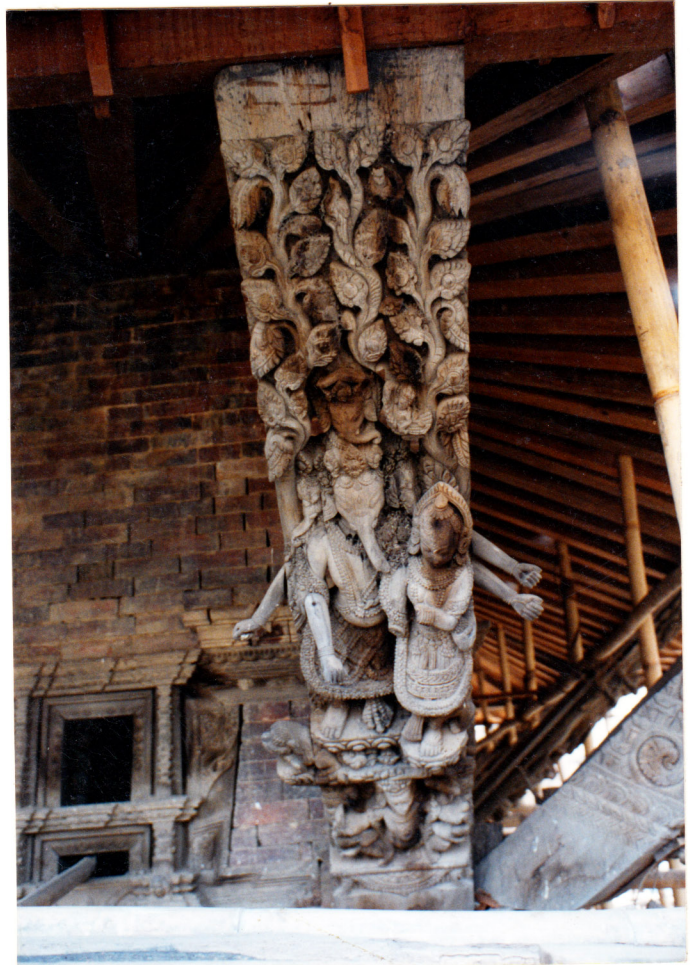
HANDS: Male- Right; one new hand (1967) 4 lost; Left; one new, one old, 3 lost. Female: Right lost, left broken.

- Draperies lost.

- Mildew area partially on leaves, faces, ornaments and on the mounts.

- Tusk of main head is broken.

- Structural condition is good.



BOTTOM ROOF
STRUT: 117
ELEVATION: NORTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA, with his SHAKTI.

SHIVA: five heads and ten hands and his

Shakti: a normal single head and two hands.

MOUNT: Lost for both.

PEDESTAL: Lotus for both.

MUDRA: Crossed legs standing posture.

BASE SCENE:

Garuda killing two demons at the base.

UPPER REGISTER:

Tree branches with leaves and two tiny monkeys, one gandharva with flower at the top of the strut and a floral pattern like a necklace at the bottom of the strut.

CONDITION:

-HANDS: Male ; Right- 3 new, 2 lost; Left- 3 new ,1 old, one lost; Female: both lost.

- Figure are seriously affected by wetrot, a knife probe in many areas is 1-1/2" deep.

- Small pieces (1/4"x1/2"x1") crumble to the touch.

- Green mould are mainly on body of both, and left side upper leaves figures and on the pedested. Extensive mould on two side heads of male figure.(3sq.in.)

- Mildew mainly on upper most face of male figure, on monkey (App. 45 sq.in.).

- Draperies are lost.

- Structural condition is fair.

BOTTOM ROOF
STRUT:118
ELEVATION : NORTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA, with SHAKTI pair.

SHIVA: five heads and ten hands; Shakti: a normal single head and two hands.

MOUT: Mount is lost for male and female.

PEDESTAL: Lotus for both figures.

MUDRA: "Tribhanga" (crossed leg) on both figures.

BASE SCENE:

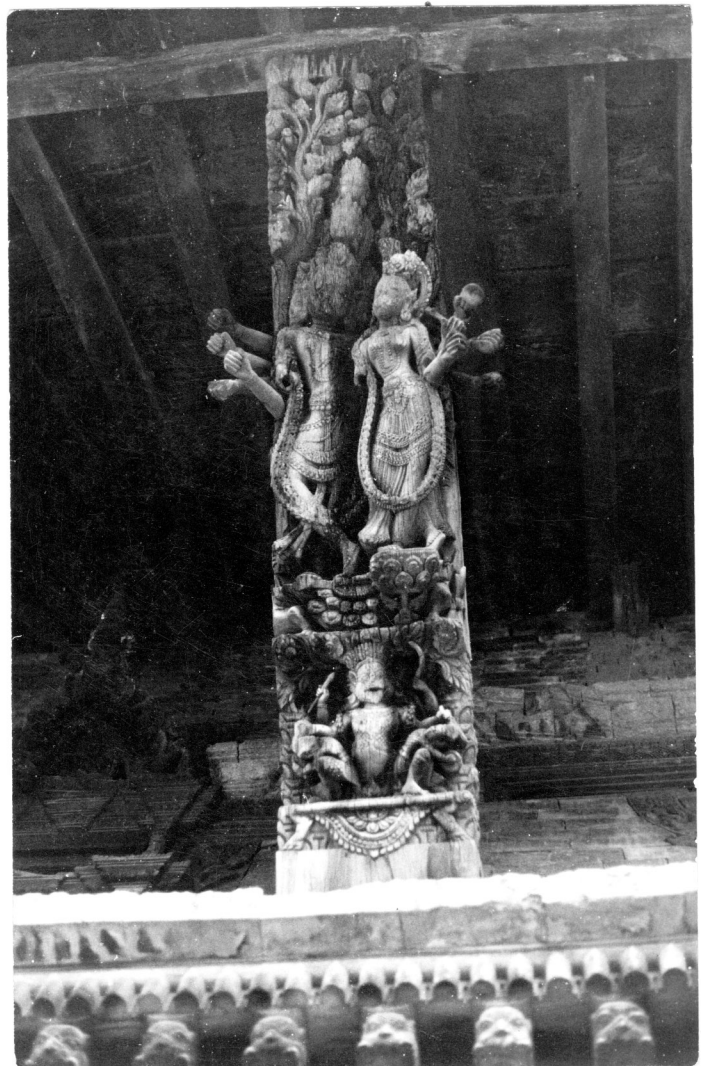
Garuda killing two demons at the base.

UPPER REGISTER:

Tree branches with leaves and a tiny monkey figure, the floral pattern like necklace at the base and a gandharva.

CONDITION:

- Face and left side of body of the male figure is deteriorated by water allowed by roof damage above.
- Hands: Male: Right- 2 new, 3 lost; Left- 2 new, 3 lost. Female: right lost, left new.
- Weapons at hands lost.
- Mildew problem on leaves.
- Green mould on leaves and in left side of the male figure.(App.1sq.ft.)
- Structural condition is good.



BOTTOM ROOF
STRUT:119
ELEVATION: NORTH
AGE: ORIGINAL (1668)

MAIN FIGURE: KUMARA, with his SHAKTI.

KUMARA: Single head and ten hands
Shakti: a normal single head and two hands.

MOUNT: Both lost.

PEDESTAL: Lotus for the both.

BASE SCENE:

Three headed god killing two demons. (This is the only strut where three heads are given to a base scene.)

UPPER REGISTER:

Tree branch with leaves at the top and a floral patterns like a necklace at the base. A monkey, a peacock and a gandharva on flower.

CONDITION:

HANDS: Male-Right; all new, left 4 new, 1 old. Female: Right old, left lost.

- Weapons in hands lost.

- Mildew problems, partially on leaves, crowns and on the body of base scene. And right side of face on male's figure (MILDEW 50sq. in.)

- Wetrot on the top of strut in centre.(24sq.in.)

- Draperies lost.

- Structural condition good.



**BOTTOM ROOF
CORNER STRUTS:
105, 110, 115, 120
AGE: ORIGINAL (1668)**

MAIN FIGURE:
KUSALA (Flying horse).

MOUNT: Garuda.

BASE SCENE:
Human figure at the base.

CONDITION:

- All four corner struts are structurally sound.
- Mildew problems mainly on the base scene with few patches on the body of the main figures and on the Garuda mounts.



**MIDDLE ROOF
STRUT: 201
ELEVATION: EAST
AGE: 19th C.**

MAIN FIGURE:
ARDHANARISVARA,

MOUNT: Bull and lion.
PEDESTAL: Lotus.
MUDRA: Crossed legs standing.

BASE SCENE:
A Shivalingam mounted on lotus petals, with
a devotee at the side.

CONDITION:
-HANDS: eight hands (all lost).
- Mildew problem on leaves, crown and face.
- Structurally o.k.
- All hands lost.
- Draperies also lost.



**MIDDLE ROOF
STRUT: 202
ELEVATION: EAST
AGE: 19th CENTURY**

MAIN FIGURE: VISHNU, with eight
hands (a lost)
MOUNT: Garuda.
PEDESTAL: Lotus
MUDRA: Crossed legs standing posture.

BASE SCENE:
A Shivalingam mounted on lotus petals, with
a devotee at the side.

CONDITION:
- Mildew problems on leaves and face.
- Structurally o.k.
- All hands are lost.
- Drapery also lost.



MIDDLE ROOF
STRUT: 203
ELEVATION: EAST
AGE: 19th CENTURY.

MAIN FIGURE:

VISHWARUPA, with eight hands (a lost).

MOUNT: Garuda.

PEDESTAL: Lotus.

MUDRA: Crossed legs standing posture.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Surface decoration and ornaments have been removed.
- One portion has broken off (App.3"x 6"x 2") at the top of strut, but not structurally threatening.
- All the hands lost.
- Draperies also lost.



MIDDLE ROOF
STRUT: 204
ELEVATION: EAST
AGE: 19th CENTURY

MAIN FIGURE: VAMAN, with eight hands (a lost).

MOUNT: King Bali and Garuda.

PEDESTAL: ?

MUDRA: Lord Vishnu's most stretchable form by which his first and second step covered the whole earth and the sky then there was no place except the king Bali's head for his remaining third step.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Structural condition is good.
- All hands lost except one which is not joined hand.
- Draperies are also lost.



**MIDDLE ROOF
STRUT: 206
ELEVATION: SOUTH
AGE: 19th CENTURY**

MAIN FIGURE:

ARDHANARISVARA with eight lost hands.

MOUNT: Tortoise and Garuda.

PEDESTAL: Lotus

MUDRA: Crossed legs standing posture.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Structurally good.
- Mildew problems on leaves and face.
- All hands are lost.
- Draperies are also lost.



**MIDDLE ROOF
STRUT: 207
SOUTH: ELEVATION
AGE: 1967**

MAIN FIGURE:

"GARUDA" with eight hands and human skull garland.

MOUNT: Human figure in "Namaskar" posture.

PEDESTAL: Lotus.

MUDRA: Standing.

BASE SCENE:

Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Dated 1967 AD. by Guthi construction and renovation committee.
- Structurally sound.
- Mildew problems on leaves and face.
- All hands are lost. After 1967 new hands were misfitted by nailing.



MIDDLE ROOF
STRUT: 208
ELEVATION: SOUTH
AGE: 19th CENTURY

MAIN FIGURE:

LAXMI, with eight hands. (all lost)

MOUNT: Not recognizable.

PEDESTAL: Lotus.

MUDRA: Crossed leg.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- The strut has been turned black as if burnt by mildew.
- Structurally weak due to wetrot deterioration.
- All hands are lost.
- Draperies also lost.
- Surface layer badly damaged by wet rot, flakes to touch.



MIDDLE ROOF
ELEVATION: SOUTH
STRUT: 209
AGE: 19th CENTURY

MAIN FIGURE : VASUDEVA with eight hands (all lost).

MOUNT: Garuda

PEDESTAL: Lotus

MUDRA: Trivangam

BASE SCENE:

- A Shivalingam mounted on lotus petals, with a devotee at the side.

UPPER REGISTER:

Foliage

REMARKS:

- Structurally o.k.
- Mildew problems on leaves and crown.
- All hands are lost.
- Draperies lost



MIDDLE ROOF
STRUT: 211
AGE: 19th CENTURY.

MAIN FIGURE:

MAHALAXMI, with eight hands (all lost).

MOUNT: Lotus.

PEDESTAL: Lotus.

MUDRA: Crossed legs standing.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Structurally o.k.
- Mildew problem on leaves.
- All hands are lost.
- Draperies also lost.



MIDDLE ROOF
STRUT: 212
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:

SHIVA, with three hands.

MOUNT: Bull

PEDESTAL: Lotus

MUDRA: Crossed legs standing.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Ornaments and surface decoration have deteriorated due to wet rot.
- Left head is badly damaged by wet rot.
- Structurally not sound.
- All hands are lost.
- Draperies are also lost.



MIDDLE ROOF
STRUT: 213
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:

GANGA with ten hands, and four heads.(Three heads on one level and one above).

MOUNT: Half human-half crocodile

PEDESTAL: Lotus

MUDRA: Crossed legs standing.

BASE SCENE:

A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Outer layer crumbling (3/4" max depth) due to wetrot in many locations.
- Burnt like effect due to heavy mildew problem.
- Structurally weak.
- All hands and draperies lost.

COMMENTS:

- Only strut with ten hands middle roof.



MIDDLE ROOF
STRUT: 214
ELEVATION: WEST
AGE: 19th CENTURY

MAIN FIGURE:

NRITYESVARA with eight hands.

Mount: Lotus and serpents (snakes).

Pedestal: Lotus.

Mudra: Dancing.

BASE SCENE:

- A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Right leg has been broken near the ankle.
- Mildew problem at the face and leaves.
- Structurally o.k.
- All hands and draperies are lost.
- A small seasoning crack (1/8") from top to bottom.



**MIDDLE ROOF
STRUT: 216
ELEVATION: NORTH
AGE: 19th CENTURY**

MAIN FIGURE:

VISHNU with eight hands.

- Mount: Garuda.
- Pedestal: Lotus.
- Mudra: Dancing poture.

BASE SCENE:

- A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Right ankle broken.
- Surface decorations by storage in bad place.
- Structurally poor.
- All hands and draperies lost

(Note: 217 LOST)



**MIDDLE ROOF
STRUT: 218
ELEVATION: NORTH
AGE: 1967**

MAIN FIGURE:

NARASIMHA, with eight hands.

- Mount: Lotus
- Pedestal: Lotus
- Mudra: Standing

BASE SCENE:

- A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- Dated 1967.
- Structurally o.k.
- Mildew problems on face and base.
- All hands lost.



MIDDLE ROOF
STRUT: 219
ELEVATION: NORTH
AGE: ORIGINAL (1668)

MAIN FIGURE:

HARIHARA eight hands (all lost).

- Mount : Garuda for Hari and Bull for Hara.
- Pedestal: Lotus.
- Mudra: Crossed legs

BASE SCENE:

- A Shivalingam mounted on lotus petals, with a devotee at the side.

CONDITION:

- The main figure was recovered from the rubble in the upper story left by 1967 renovation. The strut is broken into two pieces and severely affected by wet rot.
- All hands are lost
- Draperies also lost



MIDDLE ROOF
CORNER STRUTS:
205, 210, 215, 220
AGE: 19th C.

MAIN FIGURE:

KUSULA (Flying horse).

MOUNT:

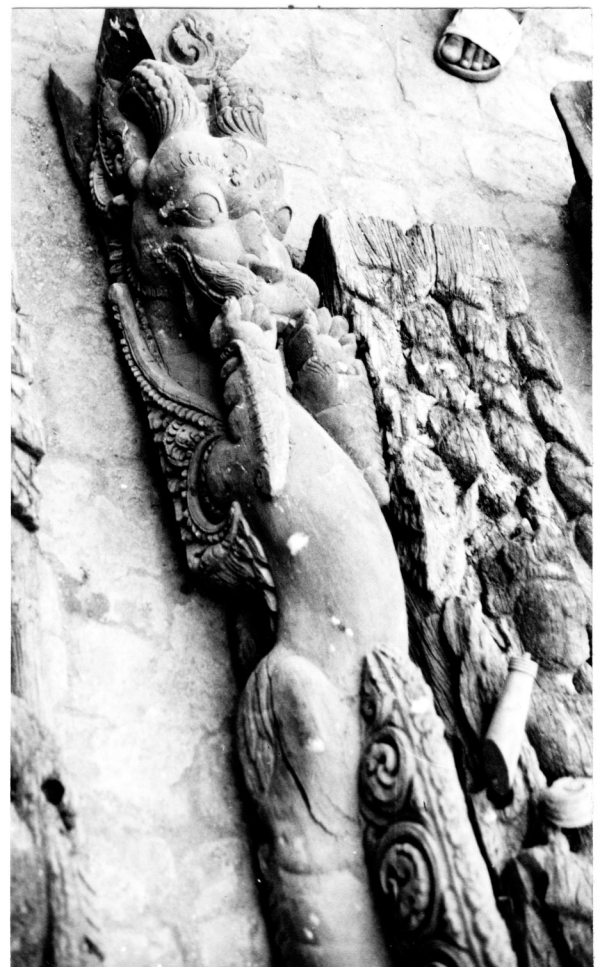
PEDESTAL:

BASE SCENE:

Human figure at the base.

CONDITION:

- All corner struts are structurally sound except 205 in which a vertical crack has been developed from top to bottom at one side.
- Patches of mildew are seen generally on top and on the base.
- 215 has been used as firewood (witnessed by the author some 2 years ago), superficially burned at middle portion.



**TOP ROOF
STRUT: 301
ELEVATION: EAST
FROM ANOTHER TEMPLE
AGE: 19th C.**

MAIN FIGURE:

Varahi, with three hands.

MOUNT: unclear

PEDESTAL: Lotus

MUDRA: Dancing.

BASE SCENE:

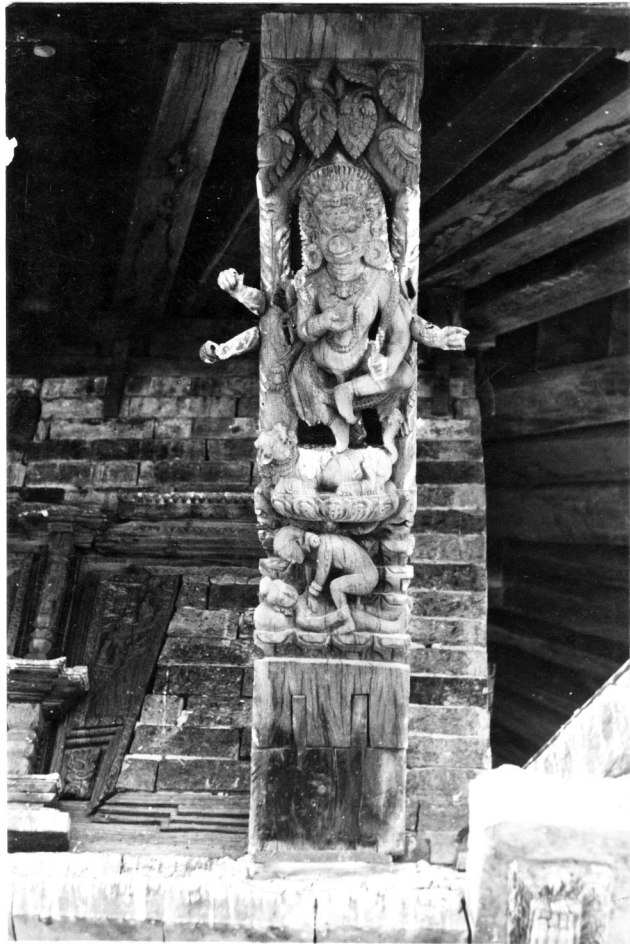
Copulating couple.

CONDITION:

- Structurally sound.
- Two hands, one arm lost.
- Stained by pigeon guano.

REMARKS:

-Additional timber added at base to fit this element on the temple, typical of all "borrowed" struts at this level. As added timbers, format, and carving style are similar (#301, 302, 305, 307, 308), they appear to come from the same temple. Floral patterns in upper register differ, however.



**TOP ROOF
STRUT: 302
ELEVATION: EAST
FROM ANOTHER TEMPLE
AGE: 19th C.**

MAIN FIGURE:

Indrayani

MOUNT: Elephant

PEDESTAL: Lotus

MUDRA: Dancing.

BASE SCENE:

Copulating couple.

CONDITION:

- Structurally sound.
- All hands are lost.
- Stained by pigeon guano.



**TOP ROOF
STRUT: 304
ELEVATION: EAST**

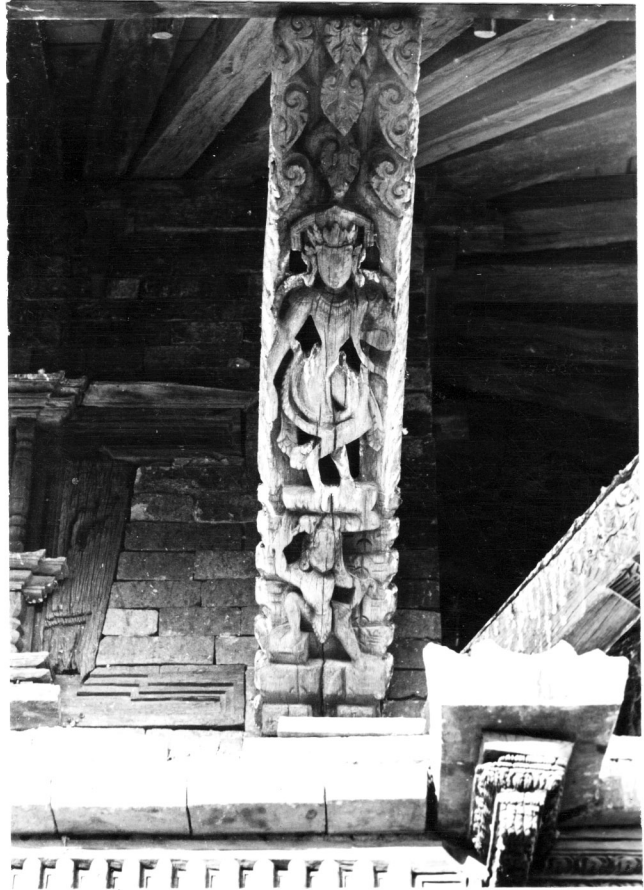
AGE: ORIGINAL (1668)

MAIN FIGURE:
LAXMI

PEDESTAL: Lotus
MUDRA: ?

BASE SCENE/MOUNT:
GARUDA

CONDITION:
- Structurally sound.
- Scoured by wind and rain.
- All hands are lost.
- Stained by pigeon guano, scoured at back as well. Typical of all upper roof struts.



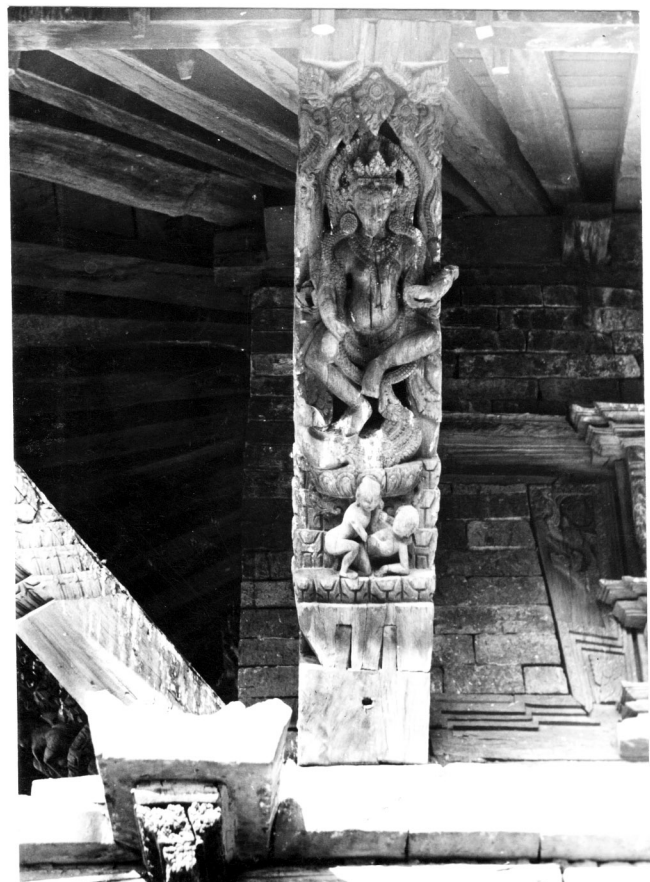
**TOP ROOF
STRUT: 305
ELEVATION: SOUTH
FROM ANOTHER TEMPLE
AGE: 19th C.**

MAIN FIGURE:
KUMARI, Shaktirupa of Kumara

MOUNT: Peacock
PEDESTAL: Lotus
MUDRA: Dancing.

BASE SCENE:
Copulating couple.

CONDITION:
- Structurally sound.
- All hands are lost.
- Stained by pigeon guano.
- Added timber at base. See notes #301.



TOP ROOF
STRUT: 307
ELEVATION: WEST
FROM ANOTHER TEMPLE
AGE: 19th C.

MAIN FIGURE:
VAISHNAVI, Shaktirupa of Vishnu

MOUNT: Garuda
PEDESTAL: Lotus
MUDRA: Dancing.

BASE SCENE:
Copulating couple.

CONDITION:
- Structurally sound.
- Seasoning crack (vertical) lower 2/3 of strut.
- All hands are lost.
- Stained by pigeon guano.
- Added timber at base. See notes #301.



TOP ROOF
STRUT: 308
ELEVATION: WEST
AGE: ORIGINAL (1668)

MAIN FIGURE:
RUDRAYANI

PEDESTAL:
MUDRA: Dancing

BASE SCENE/MOUNT:

CONDITION:
- Structurally damaged by wet rot.
- Scoured by wind and rain.
- All hands are lost.
- Stained by pigeon guano.

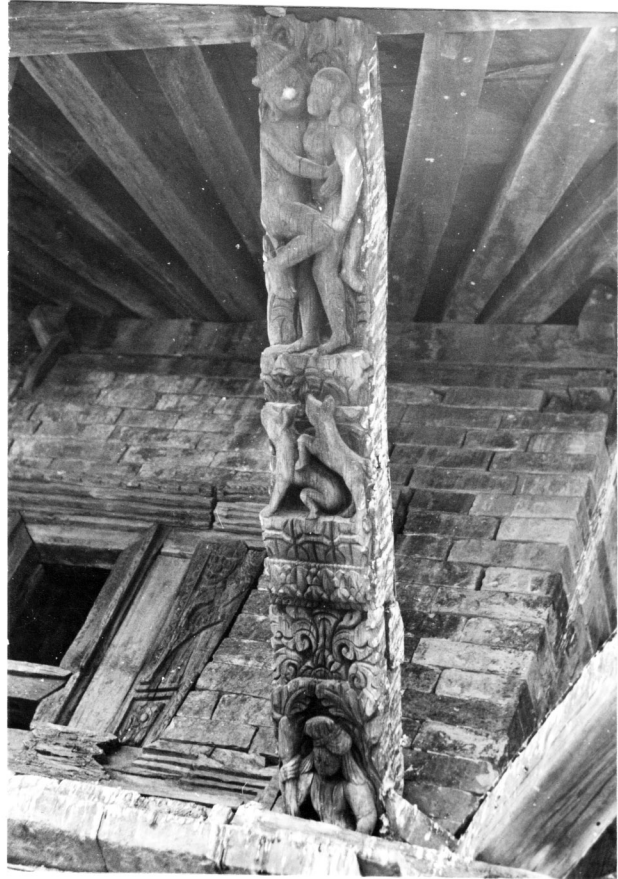
TOP ROOF
STRUT: 310
ELEVATION: NORTH
FROM A LEANING WINDOW
AGE: 20 C.

MAIN FIGURE:
 COPULATING COUPLE

MOUNT: Copulating dogs
PEDESTAL: Lotus

BASE SCENE:
 Female figure, partially cut off at bottom.

CONDITION:
 - Structurally o.k.
 - Oversized window element, cut to fit temple.
 Notches for horizontal window frame elements
 in sides of member.
 - Stained by pigeon guano.



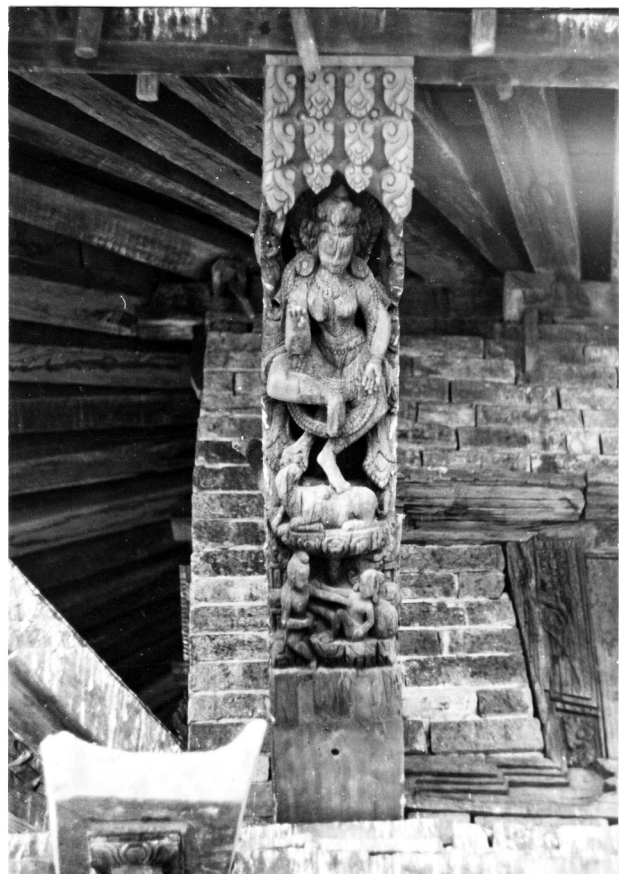
TOP ROOF
STRUT: 311
ELEVATION: NORTH
FROM ANOTHER TEMPLE
AGE: 19th C.

MAIN FIGURE:
 KALI, Shaktirupa of Vishnu

MOUNT: ?
PEDESTAL: Lotus
MUDRA: Dancing.

BASE SCENE:
 Copulating couple.

CONDITION:
 - Structurally damaged by wetrot. Knife probe
 to 2"-3".
 -
 - Stained by pigeon guano.
 - Added timber at base. See notes #301.



**TOP ROOF
CORNER STRUTS:
303, 306, 309, 312**

AGE: 20th C.

MAIN FIGURE:
FLYING HORSE *Kunsala*

CONDITION:
- All corner struts in excellent condition with
limited mildew.



APPENDIX C

PRODUCT INFORMATION

CIBA-GEIGY TOOLING RESINS

Master model paste - An epoxy resin system containing a non-abrasive filler

(R) Araldite SV 427
Hardener HV 427

Applications Machinable surface layers for master models and patterns
Large models (in combination with wood)
Barrier layer in sandwich structures

Method of application Manual, using a spatula

Features Simple 1:1 resin-to-hardener mix ratio
Does not sag on vertical surfaces even when applied in layers up to 20 mm thick
Slow curing

Properties High dimensional stability
Good mechanical properties
Easy to machine (contains no abrasive fillers)

Product data Araldite SV 427

As-supplied form	amber, thixotropic paste
Density at 25°C g/cm ³	0.60-0.65
Flash point (Pensky-Martens) °C	>200
Shelf life at 18-25°C	1 year

Hardener HV 427

As-supplied form	brown, thixotropic paste
Density at 25°C g/cm ³	0.60-0.65
Flash point (Pensky-Martens) °C	170
Shelf life at 18-25°C	1 year

Processing Mix ratio

	parts by weight
Araldite SV 427	100
Hardener HV 427	100

The resin and hardener should be mixed with a spatula on a clean, dry surface (metal, wood, etc.) and in the prescribed ratio until they form a homogeneous compound.

It is normally advisable not to mix large batches but, if this has to be done, the mix should be spread relatively thin to maximize its pot life.

At ambient temperatures of 20-25°C all the mix should be used up within 25 to 35 minutes. At temperatures above 25°C its pot life will be correspondingly shorter.

The cured paste can be cut and shaped with any regular woodworking tool. Unlike wood, it exhibits no internal stresses and its physical and mechanical properties are identical throughout and in any orientation.

Properties

Resin/hardener mix at 25°C

			Araldite SV 427
			Hardener HV 427
Visual appearance			brown, thixotropic paste
Pot life (1000 g batch)	min		25-35
Demouldable after	h		14-24
Minimum cure time	h		24

After curing for 7 days at 20-25°C

Density		g/cm ³	0.6
Compressive strength	ISO 604	N/mm ²	10-20
Flexural strength	ISO 178	N/mm ²	10-20
Deflection		mm	3-4
Impact resistance	ISO 179	kJ/m ²	1-2
Deflection temperature	ISO 75	°C	50-55
Cold water absorption			
10 days	ISO 62	%	5.8
Boiling water absorption			
30 min	ISO 117	%	-
60 min		%	6.9
Linear shrinkage			
(900x75x20 mm plaque)	CIBA-GEIGY	°/°	0.3-0.4
Thermal conductivity	DIN 52612	W/(m.K)	0.1
Coefficient of thermal expansion (linear)	VDE 0304	mm K.10 ⁻⁶	60-65

Page three

Storage	The products described in this publication have the shelf lives shown when stored in a dry place at 18-25°C in sealed containers, preferably those in which they were supplied.
Handling Precautions	Epoxy resins and hardeners are chemicals. The mandatory and/or recommended industrial hygiene procedures should always be followed when they are being handled. For details, please consult "Hygienic precautions for handling plastics products of CIBA-GEIGY" (Publication No.24264/e).
First aid	Contamination of the eyes by resin, hardener or mix, should be treated immediately by bathing with clean, running water for 10 to 15 minutes. A doctor should then be consulted. Material smeared on the skin should be dabbed off, and the contaminated area then washed and treated with cleansing cream. A doctor should be consulted in the event of severe irritation or burns. Contaminated clothing should be changed without delay. Anyone taken ill after inhaling vapours should be moved out of doors immediately and medical assistance should be called for. In all cases of doubt call for medical assistance.

CIBA-GEIGY

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The information given in this publication is based on the present state of our knowledge but any conclusions and recommendations are made without liability on our part. Buyers and users should make their own assessment of our products under their own conditions and for their own requirements.

Publ.No.24864/1/e
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DU PONT AGRICHEMICALS

PRODUCT INFORMATION DATA

KARMEX* WEEDKILLER

A wettable powder containing 80% Diuron for long-term control of weeds in non-crop areas. Approved by Agricultural Chemicals Approval Scheme under Approval No. 1793.

Toxicological Data

Acute LD₅₀ for rats 3400 mg/kg body weight

Karmex can be irritating to eyes, skin and respiratory system.

Product Properties

Karmex is a residual herbicide which will control a wide range of annual grasses and shallow rooted broad leaved weeds. Rain soon after application is essential to carry Karmex into the root-zone of germinating weeds. The product is absorbed through the roots and inhibits photosynthesis within the plant. Karmex may be applied to most soil types but length of residual weed control may be reduced on heavy soils or soils high in organic matter.

Karmex is non-corrosive to equipment, non-flammable and non-volatile.

Weed Control Properties

Karmex may be used pre-emergence or shortly before weed growth begins, at any time of the year except when ground is frozen. Provided adequate moisture is supplied by rainfall to activate the herbicide.

Rate of use

The amount of Karmex required for satisfactory control will depend on the type of weeds to be controlled, the soil type, the weather conditions and the time of year.

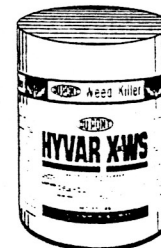
For control of weeds in non-crop areas, apply 100 g of Karmex per 100 m² of area.

IMPORTANT FACTS ABOUT DU PONT WEED AND BRUSH KILLERS

A. SOIL STERILANTS

1. **HYVAR® X** bromacil weed killer . . . is especially suited for control of hard-to-kill perennial weeds and grasses on industrial sites. It is a wettable powder containing 80% bromacil (5-bromo-3-sec-butyl-6-methyluracil). It is highly active against a broad spectrum of broadleaf weeds and grasses. "Hyvar" X may be mixed in either water or a herbicidal oil and sprayed to the surface of the ground where it is carried by rainfall into the soil and is taken up by the roots of weeds. Depending upon the rate applied, "Hyvar" X persists in the soil for an extended period of time and gives long-lasting control of weeds.

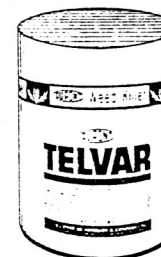
"Hyvar" X is non-flammable, non-volatile, non-corrosive and low in toxicity to man and animals when used as directed. "Hyvar" X has two particular advantages as a soil sterilant. First, it is activated with a very small amount of rainfall—as little as 1/2 inch. Second, its breakdown by heat and light is negligible so that it will persist on the soil surface and become active when rainfall occurs.



2. **HYVAR® X-WS** bromacil weed killer . . . is a 50% active bromacil water soluble formulation which performs identically to "Hyvar" X on a pound-for-pound active ingredient basis. It dissolves completely in water with slight agitation.



3. **KARMEX®** diuron weed killer . . . is a substituted urea compound formulated as a wettable powder containing 80% diuron, 3-(3,4-dichlorophenyl)-1,1-dimethylurea. It is applied as a spray to the surface of the ground for weed and grass control. It is a versatile and effective weed killer giving weed control at low rates of use, and, because it is only slightly soluble in water, it persists in the soil to give long-term weed control, particularly under conditions of high rainfall. The product is non-flammable, non-volatile, non-corrosive and is low in toxicity to humans and animals under recommended conditions of use.



4. **TELVAR®** monuron weed killer . . . another member of the family of substituted urea herbicides is formulated as wettable powder containing 80% monuron, 3-(p-chlorophenyl)-1,1-dimethylurea. Its weed and grass control activity is much the same as that of "Karmex", but the product is more soluble. Because of this, it is preferred primarily in areas of lower rainfall or for late season use. It, too, is non-flammable, non-volatile, non-corrosive and is low in toxicity to humans and animals under recommended conditions of use.

B. PERENNIAL VINE CONTROL CHEMICALS

1. **ZOBAR® WEED KILLER** — A solution containing 4 lbs. of chlorinated benzoic acids per gal. to be diluted in water for use as a spray for non-select selective control of certain undesirable broadleaf weeds and certain species of woody plants. It is absorbed by foliage and leaches into the soil to be taken up by the roots. It controls perennial vines such as bindweed, smilax, and trumpet vine and perennial weeds such as Canada thistle, leafy spurge, blueweed, and Russian knapweed.

2. **TRYSBEN® 200** weed killer . . . a water solution of the dimethylamine salts of trichlorobenzoic acids, "Trysben" 200 is intended to be diluted further with water and applied as a spray to the weeds and surface of the ground where it is both absorbed by foliage and leaches into the soil to be taken up by roots. "Trysben" 200 is especially useful for control of many deep-rooted perennial broadleaved weeds, such as bindweed, and woody vines such as smilax and trumpet vine. It will persist in the soil for extended periods of time depending on the amount applied.



C. BRUSH KILLERS

1. Foliage Spray

AMMATE® X weed and brush killer . . . is soluble in water and is non-flammable, non-volatile, and low in toxicity to man and animals under recommended conditions of use. Because of its lack of volatility, it is the preferred foliage-applied brush killer for use along rights-of-way adjacent to agricultural crop areas. When applied as a foliage spray, it is recognized as one of the most effective compounds for the control of woody brush. It may also be used to treat stumps following cutting, and can be applied in frills, notches, and cups to control unwanted trees. "Ammate" X may be applied easily with spray equipment. It may be applied in solution with water plus Du Pont Surfactant WK or Du Pont Spreader Sticker, or in an oil-water emulsion.



"Ammate" Weed and Brush Killer Solution, a concentrated solution of ammonium sulfamate in water, is available in tank car quantities from Du Pont.

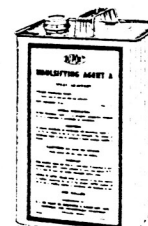
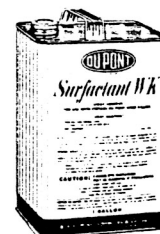
2. Soil applied

DYBAR® fenuron weed and brush killer . . . is formulated as a dry pellet containing 25% fenuron (3-phenyl-1,1-dimethylurea). The 1/8 inch cylindrical pellets are applied just as they come from the container to the surface of the ground beneath the brush. With no sprayer or heavy equipment needed, application is extremely easy. "Dybar" is non-volatile, non-corrosive, non-flammable, and low in toxicity to humans and animals.



D. ADDITIVES THAT IMPROVE PERFORMANCE OF CERTAIN WEED AND BRUSH KILLERS

1. **DU PONT SURFACTANT WK** . . . improves weed and brush control results when used with "Hyvar" X, "Hyvar" X-WS, "Karmex", "Telvar", "Ammate" X, Sodium TCA, and Sodium Chlorate. It increases the solubility of some chemicals that are low in solubility and gives better kill on some tough-to-kill species. Surfactants improve wetting and spreading of chemicals for better control on vegetation, especially when temperatures are above 85°F and soil is dry and humidity low.
2. **DU PONT EMULSIFYING AGENT A** . . . an emulsifying agent that is used in preparing oil-water emulsions of "Ammate". The use of this mixture in general enhances performance of "Ammate" and minimizes corrosion on metal surfaces.



FACTORS WHICH MAY AFFECT RESULTS OF WEED CONTROL APPLICATIONS

A. INTRODUCTION

Weed control in non-crop areas of industry often means controlling all vegetation for an extended period, (a growing season or longer). The needs of the industry usually determines the degree of control desired. But weeds should be controlled before becoming too well established in the spring so that the dead plants will not remain as a fire hazard.

There are many variables in nature and with the chemicals which are factors in obtaining these different degrees of vegetation control. The most important are discussed below.

B. TYPE OF CHEMICAL

Chemicals are usually classified as follows:

1. **Contact types** — Detrimental to plant tissues and destroy the plant shortly after application. They produce plant kill within a few hours, are favored by good plant conditions and leave no residual action.

Contact chemicals are often added to soil sterilants to enhance results.

2. **Foliage Translocated Chemicals**

These materials are absorbed by foliage and other green plant tissues, are transported throughout the plant, and interfere with plant growing processes. They usually require several days for toxic effects to show, generally have a short residual action in the soil, and are specific in that they will control certain types or species of plants. Their application results in short term control and repeat applications are necessary for continued control. Also, their specificity requires that mixtures of chemicals be used if broad spectrum control is desired.

3. **Root Absorbed Chemicals**

These chemicals are of the soil sterilant or residual type ("Hyvar" X, "Hyvar" X-WS, "Karmex" or "Telvar"). When applied at high rates, complete control of all vegetation is obtained. One application usually lasts a growing season.

These materials should be applied to the surface of the soil. Water is required to dissolve and activate the material. The chemical is picked up by the roots of vegetation and translocated throughout the plant where toxic symptoms begin to show. Plant control is a matter of time. They should be applied just prior to or shortly after emergence of vegetation in the spring. In late spring and summer applications, they should be combined with contact or foliage translocated type chemicals to speed up results.

C. TYPES OF CHEMICAL VEGETATION CONTROL

1. **Soil Sterilization (Where Bare Ground is Desired)**

The application of residual type herbicides gives complete control of all vegetation. This is desired in areas where weed and grass growth creates serious risks such as fire hazards, decreased maintenance efficiency, or where maintaining bare ground economically is desired. Initially high rates are required but retreatments at 1/2 to 1/3 of the initial rate is usually recommended.

2. **Abatement Vegetation Control**

This term denotes the use of a chemical (or combination of chemicals) at rates which result in knockdown of existing vegetation and retarda-

tion of regrowth. One to three applications may be necessary depending on the length of the growing season and the chemical combination used. It is designed for areas where bare ground is not necessary.

3 Selective Weeding

Selective weeding means selectively controlling certain plants without injury to a stand of desired vegetation with a chemical or combination of chemicals. These chemicals may be applied either as pre or post-emergence treatments.

4. Chemical Trimming & Pruning

Denotes the use of contact chemicals to knockdown vegetation in close proximity to valuable plants. Weeds and grasses under fences, along the base of buildings, under shrubbery, etc. may be controlled by treating the foliage of the undesired plants.

Limbs of trees that overhang on a right-of-way may be controlled by directing the spray to those limbs. This is accomplished without material damage to the tree.

5. Brush Control

- a. **Summer Foliage Treatment** (applicable to medium or dense stands of brush) — The application of chemicals to leaves and stems of brush during the active growing season. Complete wetting of the plant to the point of runoff is necessary for effective control.
- b. **Basal Applications** (to light or scattered stands of brush) — Dry pelleted products such as "Dybar" may be applied to the soil at the base of individual stems or clumps of brush in late winter to early summer to clean up these infestations. Also, 2,4-D — 2,4,5-T or 2,4,5-T LV Esters in diesel fuel may be applied to the lower 18 inches of a plant anytime during the year.
- c. **Stump Treatments** — The application of "Ammate" or 2,4-D — 2,4,5-T to the freshly cut surface (within 24 hours) of a stump to prevent it from resprouting.
- d. **Dormant Cane Treatment** — The application of 2,4-D — 2,4,5-T or 2,4,5-T in diesel fuel to dormant vegetation in the winter for its control. Eight to 16 lbs. active ingredient in 100 - 200 gallons of diesel fuel per acre is usually used.
- e. **Aerial application** — The use of fixed wing aircraft or helicopter to apply weed and brush control chemicals.

D. TYPE OF PLANT

The type or species of vegetation influences the selection of the chemical or treatment. **Annual and biannual type** weeds and grass originate from seeds in the surface of the soil and can be controlled with low rates of residual type herbicides applied prior to emergence or with combinations of soil sterilants and contact materials after emergence.

Perennial type vegetation have root systems which live from year to year. They require specific translocated herbicides or soil sterilant type chemicals at high dosages for their control.

In general, a broad spectrum soil sterilant such as "Hyvar" X or "Hyvar" X-WS, and "Karmex" is capable of controlling most vegetation for a year or more. Resistant weeds or grasses should be spot treated with a specific material or retreated at initial rates.

E. THE SOIL

Soil type affects the dosage required to control plants. In light soils, herbicides are more active due to less adsorption so that lower rates are required. Soils which are high in organic matter or clay are adsorptive,

requiring higher rates to kill the weeds and more rainfall to wash the herbicides down into plant root zones. In heavy soils, "Hyvar" X and "Hyvar" X-WS will perform better and faster than "Karmex" or "Telvar".

The organic content of a soil also determines the population of soil micro-organisms such as bacteria or fungi. These micro-organisms may destroy some of the organic herbicides and shorten their duration of activity. The bromacil compounds ("Hyvar" X, "Hyvar" X-WS) are not as effected as "Telvar", "Karmex" and "Dybar".

F. RAINFALL

Water is important in chemical weed control. It acts as a vehicle for application, the soil sterilant type chemicals must be in solution in water before they can enter the root systems of plants, and excessive water can leach the chemicals out of the soil to reduce their effectiveness. Water is also a necessary ingredient for growth of plants, thereby affecting growth rate and performance of contact or foliage translocated herbicides.

The rate of rainfall is an important factor in determining which soil sterilant should be recommended in a given area. In high rainfall areas a lower solubility chemical such as "Karmex" is suggested whereas in the semi-arid to arid areas higher solubility materials such as the "Hyvar" products are recommended.

G. THE APPLICATION

Proper application is the key to success of any herbicide treatment. Soil sterilants should be applied evenly to the surface of the soil at the recommended rate. Contact materials must be distributed evenly to the foliage of vegetation when atmospheric conditions are conducive for good control. And with foliage translocated herbicides, proper timing and good coverage are essential for performance.

H. SURVEYING THE SITUATION

Only through a survey can the problem be critically analyzed and proper steps be taken to get the best possible control (commensurate with the need). In such a survey, the following factors are important:

1. **The Type of Weeds** — It is critical that the various kinds of weeds be identified in order to select the proper weed killer and amount needed for the job.
2. **The Objective** — The selection of the chemical or combinations of chemicals to be used will depend on the results desired.
3. **Soil Type** — Is the soil sandy, heavy clay, or highly organic? Higher rates are needed for the clay and organic soils and more rain necessary.
4. **Climatic Factors** — How much rainfall is expected? Is it evenly distributed over the year or seasonal? Rainfall patterns usually dictate the timing of applications as well as the proper material and quantity.

I. SURFACTANTS

The use of a good surfactant such as DuPont WK has improved weed control results obtained with such compounds as "Karmex", "Hyvar" X, "Hyvar" X-WS, TCA, Dalapon, MSMA, and DSMA. This is particularly true when spraying established vegetation, which is under-going drought stress or other adverse growing conditions, and temperatures are above 80° F.

APPENDIX D
CANADA FUND PROPOSAL
Application for funding July, 1993



The Restoration of the Radha Krishna Temple
Kathmandu Valley Preservation Trust
June, 1991

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Canada Fund Project Proposal

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Kathmandu Valley Preservation Trust: Articles of Incorporation	Appendix A
Bylaws	Appendix B
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Attachments

Kathmandu Valley Preservation Trust: information package, working draft
Radha Krishna Temple: 1/4" scale elevation and plan

Canadian Embassy to Nepal
New Delhi
File #

Canadian Cooperation Office
Kathmandu
File #

CANADA FUND
Project Proposal Form

I. General information

Project title:

Radha Krishna Temple: the restoration of a living monument in the Patan Darbar Monument Zone, a UNESCO World Heritage Site.

Implementing organization:

The Kathmandu Valley Preservation Trust
24 Quincy Street
Cambridge, Massachusetts 02138 USA
tel. (617) 659-1883 fax (617) 659-2409

Contact person: (Kathmandu)

Lisa Choegyal, Director, Kathmandu Valley Preservation Trust
Tigertops
Darbar Marg, Kathmandu
tel. (w) 414073 (h) 414218 (fax) 414075

Project location:

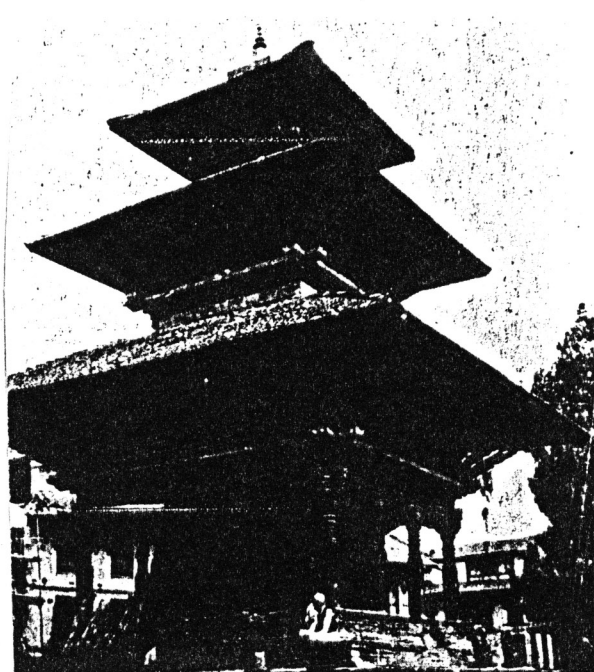
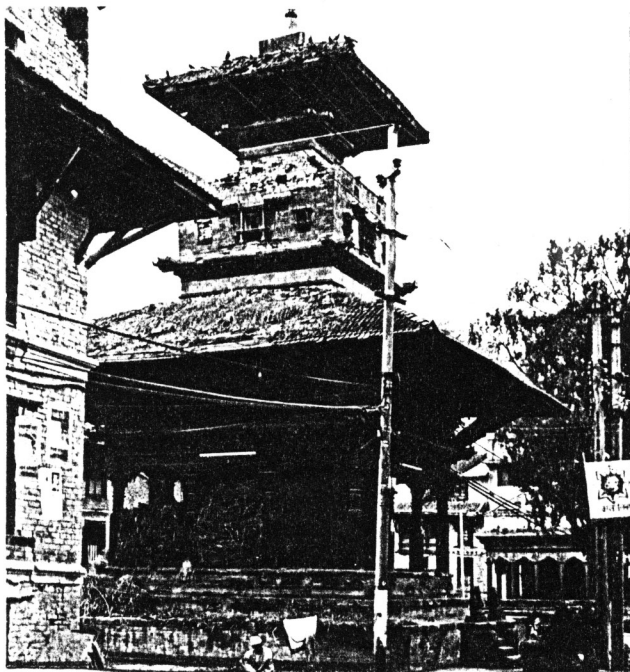
Swatha Tol, Patan. Ward 14

Project beneficiaries:

The Radha Krishna Guthi and the inhabitants of Swatha Tol, Patan

Implementation time:

Nine months
October 1991-June 1992



Radha Krishna Temple, Swatha Tol. Left 1990; right 1977.

II. Budget Information

Budget Summary:

<u>Item</u>	<u>Amount NRps.</u>	<u>Total NRps.</u>
1. Local/organization contribution:		
The local community will secure project office and materials storage space rent-free. 8 months @ NRps.8,000/month	64,000	
Kathmandu Valley Preservation Trust has funded project identification and development by architectural and conservation consultants.	28,000	
Kathmandu Valley Preservation Trust will provide technical project reviews by Dr. Eduard Sekler & Michael Doyle, architectural conservation experts, together with an appropriate outside expert.	70,000	
The Kathmandu Valley Preservation Trust will fund the difference between total project costs and Canada Fund grant.	101,420	
HMG Department of Archaeology will provide use of the Patan Conservation Lab and office furniture for project office.	10,000	
HMG Department of Archaeology is negotiating with the Department of Electricity to fund temporary relocation of high tension power line to facilitate construction.	18,000	287,420
2. Other contributions:		
The New York architectural firm of Mr. Doyle will reimburse all international communication costs (courier, telephone, fax) for project duration.	15,000	<u>15,000</u>
Total other contributions:		302,420
Total project costs:		1,974,084
(Other contributions represent 15% of total project costs.)		

Budget Summary: (continued)

<u>Item</u>	<u>Amount Nrps.</u>	<u>Total NRps.</u>
3. Contribution requested:		
Equipment:	---	
Construction:	1,215,050	
Services:	395,580	
Administrative costs:	36,000	
Other:	<u>25,000</u>	
Total contribution requested:		1,671,630
Total project costs:		1,974,084

Disbursement schedule:

1st: upon approval	250,000	
2nd: September 1, 1991	500,000	
3rd: November 1, 1991	600,000	
4th: February 1, 1991	<u>321,630</u>	
Total:		1,671,630*

* based on July 3, 1991 exchange rates: CAN \$ 50,000 x .8752 =
US \$ 43,760. US \$ 43,760 x 38.2 = NRps. 1,671,630.

The Kathmandu Valley Preservation Trust is willing to supply an independently audited financial statement to show how funds have been disbursed. During the project, the Trust will make available updated construction cost estimates as well as detailed construction bids by local subcontractors.

Detailed budget for contribution requested:

Item	Unit price	Amount	Total
	(all prices in NRps.)		
1. Equipment:			
No expenditures for equipment are anticipated as all construction work will be subcontracted; office equipment will be supplied by Dept. of Archaeology and KVPT Nepal office.			

2. Construction:			
See attachment for materials quantities and construction cost estimates.			1,215,050
3. Services:			
Local technical support:			
Consulting engineer	flat fee		40,000
Site supervisor	5500/mo.	9 mos.	49,500
Architect apprentice (half-time)	2500/mo.	9 mos.	22,500
Draftsman	5000/mo.	2 mos.	10,000
Subtotal			122,000
Foreign experts:			
Restoration architect and project coordinator. Fee is calculated as approximately 21% of total project excluding foreign experts. See page 14 for discussion of fees and job description.			
	flat fee		300,000
Objects conservator (15 days @ US \$130/day)	5000/day	15 days	75,000
Subtotal			375,000
Total services:			497,000
less KVPT contribution (see page 3)			- 101,420
Total services requested:			395,580
4. Administrative costs:			
Project bookkeeper/secretary	3500/mo.	9 mos.	31,500
Office supplies		4500	4,500
Total administrative costs:			36,000
5. Other costs:			
Project documentation: reprographics and photographic expenses			
		15000	15,000
Fees: building permits, pujas, etc.		10000	10,000
Total other costs:			25,000
TOTAL CONTRIBUTION REQUESTED:			1,671,630*

* based on July 3, 1991 exchange rates: CAN \$ 50,000 x .8752 =
US \$ 43,760. US \$ 43,760 x 38.2 = NRps. 1,671,630.

III. Information on the organization

1. Purpose and structure of the organization:

The Kathmandu Valley Preservation Trust was founded to help identify and save endangered architectural monuments and other cultural heritage in Nepal through publicizing, fundraising for, and implementing the most urgent projects--both large and small--in collaboration with His Majesty's Government Department of Archaeology. In support of the ongoing UNESCO International Campaign to Safeguard the Kathmandu Valley, the Trust, as a private, non-profit organization is intended to provide a means and a model for preservation efforts in Nepal, including, where feasible, a training component.

The Trust is governed by a Board of Directors, the majority of which are experts in some aspect of Nepalese cultural heritage. Two of seven board members are women.

2. Date of founding and registration details:

The Kathmandu Valley Preservation Trust was incorporated as a Massachusetts charitable organization in April, 1989. The Trust was granted non-profit, tax-free status by the United States Internal Revenue Service in December, 1990 and by the Commonwealth of Massachusetts in March, 1991. The Trust's tax identification number is 223063050.

The Trust is in the process of applying for registration with His Majesty's Government of Nepal as a private, non-government organization. The Department of Archaeology has advised the Trust that registration in Nepal is not mandatory for project implementation, as demonstrated by the Trust's current work at the Gokarna Mahadeva Temple Complex.

3. Annual operating budget:

The Trust's annual operating budget was \$3650. in 1989-1990 and \$4165. in 1990-1991.

4. Organization's normal funding sources:

To date, the Trust's activities have been funded by private contributions. The Trust's present fundraising activities solicit: individuals with an interest in the cultural heritage of Nepal; donor agencies with a focus on architectural preservation and Asian art and architecture; and companies doing business in Nepal.

5. Relevant experience and activities undertaken to date:

The Trust has successfully raised money for and completed 85% of the work to restore the Parvati Temple at the Gokarna Mahadeva Temple Complex outside Kathmandu. (see project sheet 1, information package; attachments) Construction will be completed this month including the rebuilding of the roof structure, replacement of the traditional tile roof, repair of masonry walls, and excavation of the adjacent plaza to the original courtyard paving with new provisions for drainage. The project was executed by the Department of Archaeology and completed under the supervision of project

III. Information on the organization (continued)

officer Erich Theophile. The Trust provided 75% of construction costs and all architectural supervision services, matched by His Majesty's Government contribution of 25% of construction costs.

Although the Trust is young in years, its governing directors have many years of experience in restoration, research, and planning projects in Nepal. Most notably, Chairman Eduard Sekler was responsible for the 1977 UNESCO Masterplan for the Conservation of the Cultural Heritage of the Kathmandu Valley and at present is the foreign expert member of the UNESCO International Campaign for the Safeguarding the Kathmandu Valley. Architect Erich Theophile, who will be project officer for the Radha Krishna restoration, has been resident in Kathmandu for three years and has done restoration work and preservation planning with other foreign experts and the Department of Archaeology at four of Nepal's World Heritage Sites.

IV. Project Information

1. Background analysis and justification:

In 1989 the working group for the UNESCO Campaign for Safeguarding the Kathmandu Valley identified the Patan Darbar Monument Zone as first priority for preservation efforts at the valley's seven World Heritage Sites. Patan is a city on the edge: its enormously rich cultural and architectural heritage is in danger of being lost if immediate actions are not taken to repair damaged buildings and monuments and control rapid urban growth. A forthcoming German-aided masterplan for Patan's urban planning and historic preservation describes the city's deteriorating historic core as denigrating the residents' quality of life while endangering the rich historical fabric and monuments. The Trust in consultation with the Department of Archaeology, the German Patan Masterplan Team, and other foreign experts has identified the restoration of the Radha Krishna Temple from its near state of ruin as the most critical emergency project in the Patan Darbar Monument Zone.

The Trust believes the restored Radha Krishna Temple will enhance and be complemented by other restoration projects currently under construction in the Monument Zone. These include the Biswanath Temple, the Keshav Narayan Chowk Palace, and the Ibaha Bahi Monastery all being executed by the Department of Archaeology in cooperation with UNESCO, the Austrian Government, and the Japanese Nippon Institute of Technology, respectively.

The 18th century Radha Krishna Temple is a fine example of the Newar pagoda or multi-tiered roof religious architecture. Before the collapse of its roof, the brick and timber structure exhibited a particularly beautiful sense of balance---standing tall on its multi-level building plinth, yet in repose. The finely carved wooden roof struts are notable for their unusual pairing of figures, which refers back to the pair of Gods housed in the sanctuary, Krishna, an incarnation of the Brahmanical God, Vishnu, and Radha,

IV. Project Information (continued)

his female consort. The temple is still the center of active worship and, as a shrine to Krishna, plays an important role in the religious life of Patan, also known as the city of Krishna. Urbanistically the temple figures prominently in the principal and most dramatic view of the Patan Darbar Square--the view looking north which sets successive temple silhouettes against the snow-capped Himalaya.

Although repairs to the temple were made as late as 1967, the Newar pagoda style temples are highly susceptible to roof damage because of the roof's deep projection and the great weight of the mud and tile covering. Deteriorated timber structural members were responsible for the collapse of the middle of three tiers of roofs in the 1989 monsoon season. Water damage to the building's structural core has since gone unchecked. Although the temple priest has applied to the Guthi Sansthan for repair funds and the Department of Archaeology has prepared estimates for the work, funds have not been forthcoming.

2. Immediate objectives:

The Kathmandu Valley Preservation Trust will restore the monument to its historical appearance and conserve the monument according to international standards of preservation. The main components of the restoration include the repair and reconstruction of the damaged masonry core structure; the cleaning and conservation of the temple's fine woodcarvings; and the reconstruction of the temple's three roofs.

After completing an historic structure report and detailed conservation methods study, conservation measures will clean, repair, structurally consolidate, and preserve all historical components of the monument. Most importantly, the superb woodcarvings of the roof struts and door and window surrounds will carefully be brought back to their original beauty, inserting concealed structural reinforcements where necessary. To cope with the great seismic activity of the Kathmandu Valley, new and concealed earthquake-resistant ring beams will be introduced inside and around the upper levels of the masonry core. These continuous perimeter beams consolidate the top-heavy structure, serving to buttress the temple against the lateral stresses of an earthquake. In keeping with the International Charter of Venice, historical building elements will be reused wherever possible; where necessary, new components matching the historical or appropriate to the period building conventions will be inserted.

The current description of project work has been developed to allow all critical and sequential conservation tasks to be completed within the budget constraints of the Canada Fund grant and other existing contributions. The work does not include the cleaning and conservation of the four stone sculptures which flank the principal stair, a task which is not pressing and can easily be done at a later date. The Trust has made a commitment to raise funds (approximately NRps. 180,000) for this work.

IV. Project information (continued)

3. Planned results:

The restoration of the Radha Krishna Temple, together with the three other foreign-aided restoration projects in the Patan Darbar Monument Zone, will focus local as well as international attention on the urgency of preservation efforts in Patan

Executing the project on a turn-key basis, the Trust will:

- provide employment to neighborhood residents, who will be given priority in hiring process
- support and augment the skills of traditional craftsmen including woodcarvers, carpenters, brick makers, and masons
- develop technical skills related to restoration among the private sector professionals included on the project team-- architect, engineer, site supervisor, and draftsman
- provide on-site demonstrations and seminars to the staff and professionals of the Department of Archaeology on relevant technical issues.

4. Implementation plan:

A 30 week construction schedule will be executed over 9 months or 36 weeks to accommodate the high proportion of holidays in the Nepalese calendar.

Pre-project planning (July-September, 1991)

- Fundraising for related stone sculpture conservation project.
- Negotiations by Department of Archaeology with the Department of Electricity to relocate temporarily the adjacent high tension lines. Work cannot begin until these lines have been moved.
- Assembly of the local project committee which will approve all work by the Trust.

Phase I (October-November, 1991) 6 weeks

- First meeting of local project committee.
- Relocation of high tension electrical lines.
- Construction of bamboo scaffolding to facilitate documentation and historic structures report of the temple.
- Preparation of historic structure report including complete documentation of the monument in drawings and photographs; documentation and analysis of the condition of the historical building fabric; development of conservation methods and strategies including sample testing; and documentation of the iconographical program of the wood and stone carvings.
- Review and approval of historic structure report by Dr. Eduard Sekler and Michael Doyle, architecture conservation experts.
- Development of project work description including construction drawings, structural details, and specifications.
- Scouting of subcontractors
- Provision of timber and brick. Timber scarcity and the production schedule for custom manufacturing of high quality brick and tile necessitate ordering these materials at the beginning of the project.

IV. Project information (continued)

Phase II (November-December) 3 weeks

- Tendering of bids from subcontractors and materials suppliers.

Phase III (December-March, 1992) 14 weeks

- Dismantle roof structure saving all reusable elements.
- Dismantle masonry wall structure where damaged and at new ring beam locations.
- Insert ring beam. Patch and rebuild masonry walls as necessary.
- Clean, repair, structurally consolidate, and preserve all timber components. This work can be done in parallel with other Phase III tasks described above.
- Reconstruct roof structure with new and historical timber elements.

Phase IV (April-June, 1992) 13 weeks

- Install roof planking, protective membrane, mud, and tile covering.
- In situ cleaning, repair and preserving of timber door, window, and cornice elements.
- Cleaning of brick and stone facade surface and decorative elements.
- Repointing of facade as necessary.
- Site cleaning.

5. Factors affecting project implementation:

The Radha Krishna Temple restoration project has been conceived as a turn-key project to avoid the delays typical of working through a government bureaucracy. Factors which could affect project implementation include further damage to the temple brought on by the present monsoon rains and delays in the relocation of electrical lines to begin work. The Kathmandu Valley Preservation Trust is committed to raising or appropriating necessary additional funds to cover unforeseen work or the private relocation of electrical lines.

6. Beneficiary participation:

In response to and in support of the Kathmandu Valley Preservation Trust's proposal to restore the Radha Krishna Temple on a turn-key basis, the Department of Archaeology, which is responsible for all UNESCO World Heritage Monument Zones, has suggested that a local project committee be formed to represent:

- the local community at Swatha Tol, Patan
- the Radha Krishna Guthi
- the Guthi Sansthan, a national Trust for monuments
- the local government administrative office of the Chief District Officer and
- the Department of Archaeology.

This local project committee will approve all proposed and completed work on the temple. The Trust's project team will meet with the com-

IV. Project information (continued)

mittee during the first phase of implementation in order to integrate the committee's suggestions into the project work description and schedule.

The Trust will employ Erich Theophile, architect and secretary of the Trust, as project officer. Mr. Theophile will assemble the project team and direct all project activities.

The Trust could invite voluntary laborers from the neighborhood, but the nature and scale and great significance of the work involved raise several counter-arguments. Conservation work such as the cleaning of fragile woodcarvings demands a level of attention which is difficult to maintain with a volunteer work force. Furthermore, given the scale of the potential savings, the project work is better seen as an opportunity to provide employment to neighborhood residents, particularly women, who traditionally are used to clean and treat woodcarvings. In order to involve the community in the project, the Trust has negotiated their provision of storage and project office space adjacent to the monument.

A significant component of the project is the involvement of local private-sector professionals in the project team. These engineers, architects, draftsmen, and site supervisors constitute a huge potential resource in the development of local preservation expertise.

7. Contribution from the organization:

The Members of the Board of the Kathmandu Valley Preservation Trust have donated US \$800 to support project development including measured drawings, preliminary work descriptions, and cost estimates. The Trust will also provide technical project appraisals by Dr. Eduard Sekler and Michael Doyle, board members and architectural conservation experts. Finally, in order to execute the comprehensive restoration of the Radha Krishna Temple has allocated US \$ 2655 (NRps. 101,420) from pledged contributions to make up the difference between total project costs and the Canada Fund grant and other contributions.

8. Involvement of women:

Given the aims of the Canada Fund, the Trust will encourage the selection of women in the formation of the local project committee. Implementation of the project will involve restoration consultant Mrs. Shobha Shrestha, officer of the Department of Archaeology responsible for all foreign-aided projects, and a female senior technician in the Department of Archaeology Conservation Lab in Patan. Traditional division of labor will provide employment (800 man-days estimated) in the cleaning and treatment of the historical woodcarved temple components.

It is anticipated that Mrs. Constance Stromberg, an American objects conservator resident in Kathmandu since 1987, will serve as conservation consultant to the project team.

IV. Project information (continued)

9. Project ownership:

The Nepalese national trust, Guthi Sansthan, is the legal owner of the Radha Krishna Temple. The Kathmandu Valley Preservation Trust will implement the project on a turn-key basis, subcontracting local craftsmen, laborers, materials suppliers, and technical consultants under the direction of Trust secretary Erich Theophile. Funds will be disbursed from the Trust's Boston headquarters to a project bank account in Kathmandu. All payments and requests for payments will be approved by Mr. Theophile and the chairman and treasurer of the Trust.

10. Project maintenance:

Ongoing maintenance of monuments--even after restoration-- is a complex problem in the third world. Generally the cost of necessary labor and materials is quite small, but professional supervision is critical. As the Department of Archaeology does not have sufficient manpower to inspect regularly already completed projects and supervise maintenance and repair works, the Kathmandu Valley Preservation Trust proposes to fund the monitoring and maintenance of the Radha Krishna Temple as part of a small-scale emergency and maintenance fund, the "band-aid fund". A recent pledge from a private donor will make this emergency fund operable by December, 1991.

11. Monitoring/evaluation and reporting:

The property will remain under the ownership of the Guthi Sansthan. A technical project appraisal will be made by Dr. Eduard Sekler and Michael Doyle, experts in architectural conservation during phase I of implementation as well as at the end of the project when an outside expert will be included. Mr. Theophile and the project team will provide regular reports of project work and expenditures during implementation.

ABSTRACT OF COSTS

Restoration of Radha Krishna Temple, Swatha Tol, Patan

No.	Description	Qt.	Unit	Rate* Mat'l/labor	Amount
Item numbers refer to materials and quantities estimates on following pages. All prices in NRps. based on July 1, 1991 exchange rate of US \$1 = NRps. 38.2.					
1	Bamboo scaffolding mat'ls				44,170
2	Scaffolding labor				9,000
3	Dismantle wall + roofs	2360	cu.ft.	2.80	6,608
4	Site clearance				8,000
5	Masonry reconstruction	780	cu.ft.	55	42,900
6	Facade veneer brick	310	sq.ft.	50	15,500
7	Seismic ring beam	82.6	cu.ft.	620	51,212
8	Rebuilding of timber structure	333	cu.ft.	700	233,100
	Wood seasoning charge				25,000
9	<u>Cleaning, treatment of 42 roof struts & other woodcarvings</u>	800	manday	50	40,000
10	Conservation materials				30,000
11	<u>Repair of struts, replacement of carving</u>	96	manday	250	24,000
12	Structural consolidation of struts with stainless steel	8	struts	6000	48,000
13	<u>New carved struts to match historical</u>	6	struts	15000	90,000
14	<u>New carved windows to match historical</u>	3	units	6000	18,000
15	Timber roof planking	2084	sq.ft.	42.50	88,570
16	Protective roof membrane (two layers)	2084	sq.ft.	34	70,856
17	Jhinghati roof tile with siltrate treatment	2084	sq.ft.	30	62,520
18	Ridge tile	116	lin.ft.	84	9,744
19	Pointing of plinth	2398	sq.ft.	2.46	5,900
20	Cleaning of facade	60	manday	60	3,600
21	Site cleaning				8,000
SUBTOTAL					934,680
30% contingency allowance for restoration work and inflation					280,404
TOTAL CONSTRUCTION COSTS					1,215,084
Local technical services (description p.4)					122,000
Administrative costs (description p.4)					36,000
Other costs (description p.4)					25,000
TOTAL LOCAL PROJECT COSTS					1,398,084

*All construction rates are based on current government rates where applicable.

Underlined items: generous allowances are made for restoration of woodcarving, which promotes local artisans and employment of women.

Date:—

Prepared by:— S.H.

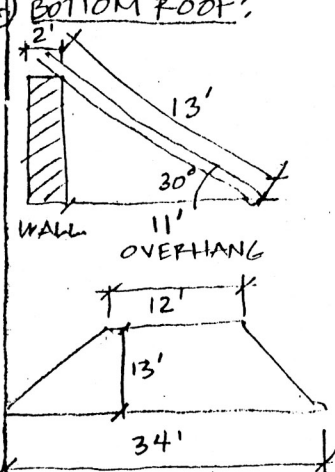
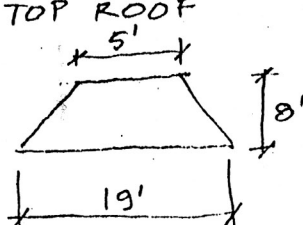
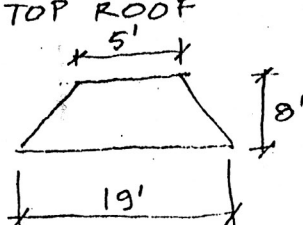
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KATHMANDU VALLEY PRESERVATION TRUST

DETAILED ESTIMATE PAGE 2

Site:— RADHA KRISHNA

Date:— JUNE 1991

No.	Description	No.	Length	Breadth	Height	Quantity	Remark
3.	AREA VOLUME DISMANTLING						
(A)	BOTTOM ROOF: 						
	AREA/ONE SIDE = $13 \left(\frac{12 + 34}{2} \right) = 299 \text{ SQ. FT.}$ BOTTOM ROOF AREA BOTTOM ROOF VOLUME	4 (SIDES)				1196 SQ. FT. $1196 \text{ SQ. FT} \times 1'-0" \text{ THICKNESS} = 1196 \text{ CU. FT.}$	
(B)	WALL ABOVE BOTTOM ROOF 	4	10'	1'-8" THICKNESS	11'-8"	780 CU. FT.	
(C)	TOP ROOF 						
	AREA (ONE SIDE) = $8 \left(\frac{19 + 5}{2} \right) = 96 \text{ SQ. FT.}$ TOP ROOF AREA TOP ROOF VOLUME TOTAL (MAXIMUM) VOLUME DISMANTLED =	4 (SIDES)				384 SQ. FT. $384 \text{ SQ. FT} \times 1'-0" \text{ THICKNESS} = 384 \text{ CU. FT.}$ 1196 CU. FT. 780 CU. FT. 384 CU. FT. 2360 CU. FT.	

Prepared by:— S.H.

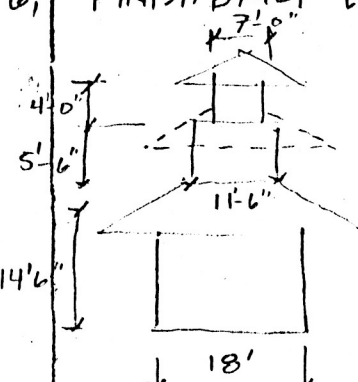
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KATHMANDU VALLEY PRESERVATION TRUST

DETAILED ESTIMATE PAGE 3

Site:—

Date:—

No.	Description	No.	Length	Breadth	Height	Quantity	Remark
5,	MASONRY RECONSTRUCTION (SEE 3-B, PAGE 2)					768	CU FT.
6,	FINISH BRICK (DACHI-APA)						
							
	TOTAL AREA/SIDE = $(18 \times 14.5) + (5.5 \times 11.5) + (4 \times 7) =$ $297 + 63 + 28 = 388$ SQ FT						
	50% WALL SURFACE BRICK $.5 \times 388 = 194$ SQ FT						
	194 SQ FT $\times 4$ SIDES = 776 SQ FT						
	MAX. 40% TO BE REPLACED $.4 \times 776 = 310$ SQ FT.						
7,	SEISMIC RING BEAM						
	WALL PERIMETER @ BOTTOM ROOF = $4 (18') =$				72 FT.		
	" @ MIDDLE ROOF = $4 (11'6") =$				46 FT		
					= 118 FT		
	TOTAL PERIMETER						
	EST'D CROSS SECTION IN RCC = $9" \times 11" = 99$ SQ IN = $.7$ SQ FT/L.F						
	VOLUME = $118' \times .7$ SQ FT/ = 82.6						

Prepared by:— S.H.

Checked by:— *67+*

KATHMANDU VALLEY PRESERVATION TRUST

DETAILED ESTIMATE PAGE 4

Site: — RADHA KRISHNA

Date: — JUNE 1991

No.	Description	No.	Length	Breadth	Height	Quantity	Remark
B.	3" STRUCTURAL WOOD						
A.	BOTTOM ROOF RAFTERS 4 SIDES X 28	115	15'	3"	4"	140	CU FT.
B.	BEAMS CARRYING WALL ABOVE	4	12'	1 1/2"	1'-0"	72	CU FT.
C.	WALL PLATES	4	12'	5"	3"	5	CU FT.
D.	EAVE BOARD	4	34'	1"	8"	7.67	CU FT.
E.	BEAM ABOVE STRUTS (TYING RAFTERS)	4	34'	3"	4"	17.33	CU FT.
	SUBTOTAL					236	CU FT.
	MIDDLE ROOF						
A.	RAFTERS 4 SIDES X 20	20	9'-2"	3"	4"	61.62	CU FT.
B.	BEAMS CARRYING WALL ABOVE	4	12'	1 1/2"	1'-0"	72	CU FT.
C.	WALL PLATES	4	12'	3"	4"	4	CU FT.
D.	EAVE BOARD	4	24'	1"	8"	5.3	CU FT.
E.	BEAMS ABOVE STRUTS	4	24'	3"	4"	8	CU FT.
	SUBTOTAL					152	CU FT.
	TOP ROOF						
A.	RAFTERS 4 SIDES X 16	16	8'	3"	4"	42.7	CU FT.
B.	BEAMS CARRYING PINNACLE	4	6'	8"	8'	21.7	CU FT.
C.	WALL PLATES	4	4'	3"	4"	1.4	CU FT.
D.	EAVES BOARD	4	18'	1"	8'	4	CU FT.
E.	BEAMS ABOVE STRUTS	4	18'	3"	4'	6	CU FT.
	SUBTOTAL					57	CU FT.
TOTAL: 445 CU FT.							
MINIMUM 25% OF EXISTING TIMBER CAN BE REUSED, MAX. NEW TIMBER 75% OF 445							
= 333 CU FT.							

50
152
30
232
8
1056.00

Prepared by: — S.H.

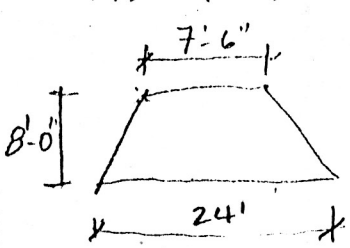
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KATHMANDU VALLEY PRESERVATION TRUST

DETAILED ESTIMATE PAGE 5

Site:—

Date:—

No.	Description	No.	Length	Breadth	Height	Quantity	Remark
9.	ROOF STRUTS						
	CLEANING/TREATMENT	16	MANDAYS/STRUT	42	STRUTS	= 672	MANDAYS
	CLEANING/TREATMENT OF OTHER DECORATIVE CARVINGS (CORNICHE, DOOR + WINDOW FRAMES) IN SITU					130	MAN DAYS
11.	REPLACEMENT OF MISSING CARVINGS ON STRUTS						
		8	CARVER MANDAYS/STRUT	12	DAMAGED STRUTS	= 96	MAN DAYS
15.	ROOF PLANKING AREA.						
	FROM ABOVE 3A, 3C. (PAGE 2)						
	AREA BOTTOM ROOF:					1196	SQ FT
	AREA TOP ROOF:					384	SQ FT.
	AREA MIDDLE ROOF						
							
	$A = 8 \left(\frac{7.5 + 24}{2} \right) = 126 \times 4 \text{ SIDES} =$					504	SQ FT.
	TOTAL ROOFING AREA (3 ROOFS)					2084	SQ FT.
18.	RIDGE TILE LENGTHS:						
	BOTTOM ROOF	4	10.8'	43.2	lft.		
	MIDDLE ROOF	4	9.6'	38.4	lft.		
	TOP ROOF	4	8.4'	33.6	lft.		
				116	linear feet.		

Prepared by:— S.A.

Checked by:— 69T

KATHMANDU VALLEY PRESERVATION TRUST

DETAILED ESTIMATE PAGE 6

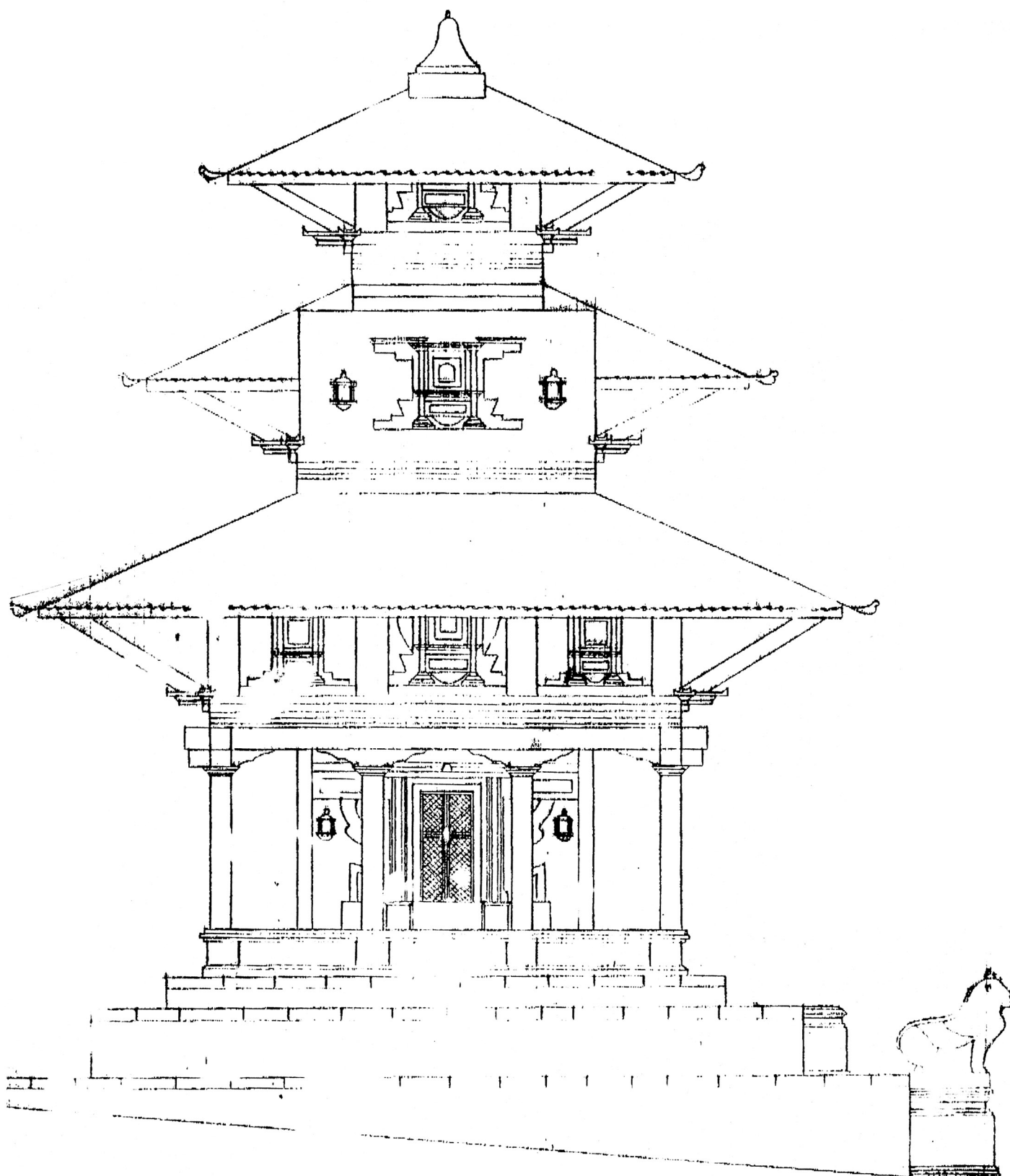
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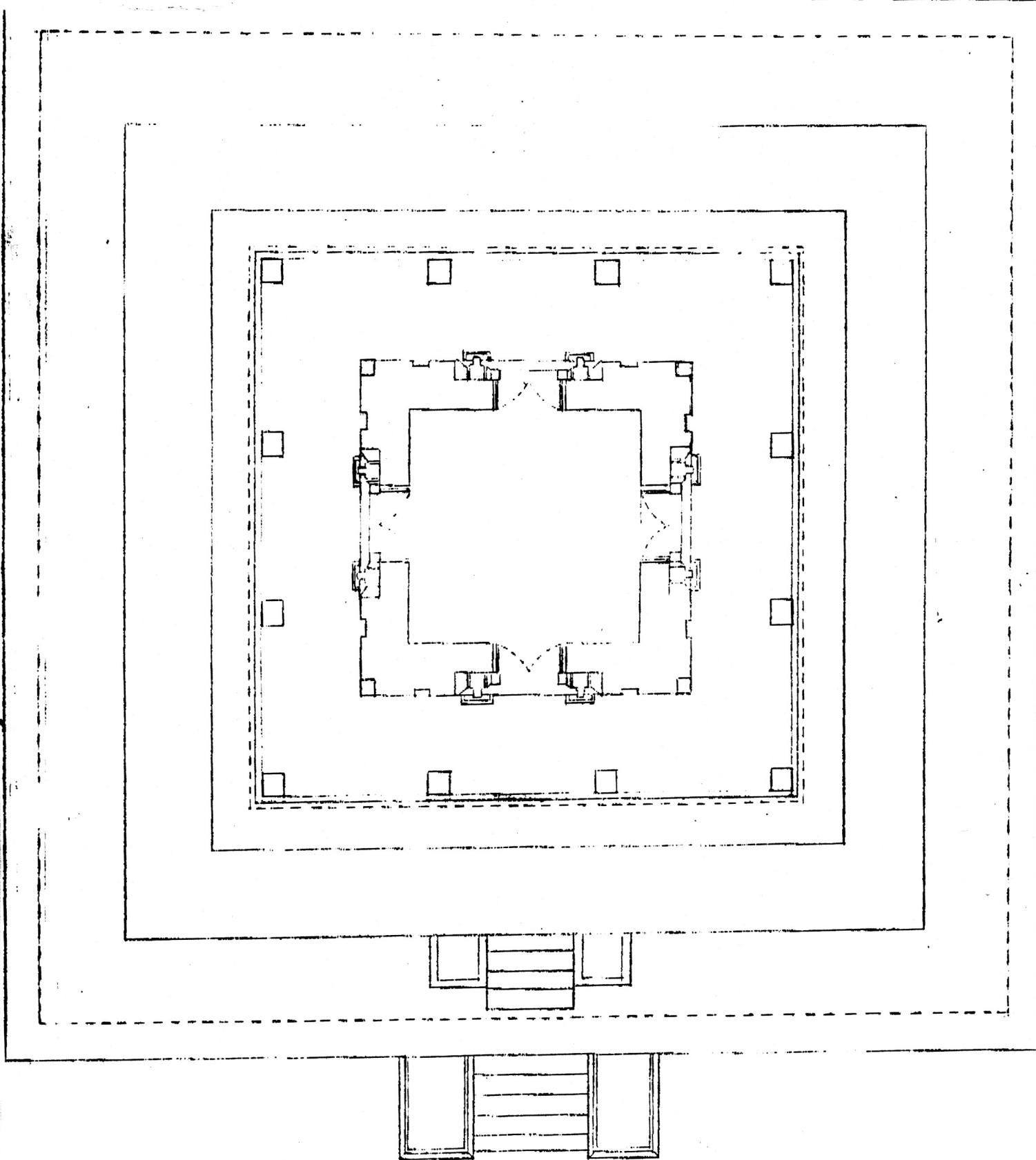
No.	Description	No.	Length	Breadth	Height	Quantity	Remark
19.	PLINTH SURFACE AREA						
	1ST STEP (SIDES)						
	HORIZONTAL	4	36'-6"	3'-3"	—	474.5	SQ FT.
	VERTICAL	4	36'-6"	4'-1"	—	596.2	SQ FT.
	2ND STEP						
	HORIZONTAL	4	28'-4"	2'-9"	—	311.6	SQ FT.
	VERTICAL	4	28'-4"	2'-9"	—	311.6	SQ FT.
	3RD STEP						
	HORIZONTAL	4	22'-8"	1'-6"	—	136.1	SQ FT.
	VERTICAL	4	22'-8"	1'-4"	—	120.6	SQ FT.
	4TH STEP						
	HORIZONTAL	4	19'-6"	3'-9"	—	292.5	SQ FT.
	VERTICAL	4	19'-6"	2'-0"	—	156	SQ FT.
	TOTAL AREA:					2398	SQ FT.

Prepared by:— J. D.

Checked by:— E. A.



Radha Krishna Temple: South elevation.
One inch equals 4'10".



Radha Krishna Temple: Ground plan
Scale: one inch equals 4'-0"



Project location: the Radha Krishna Temple is highlighted in this map of Swatha Tol from the 1975 Kathmandu Valley: The Preservation of Physical Environment and Cultural Heritage, a Protective Inventory.



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