

PATUKVA AGACHE
PATUKVA TOL, PATAN

HISTORIC STRUCTURE REPORT
JUNE, 1994

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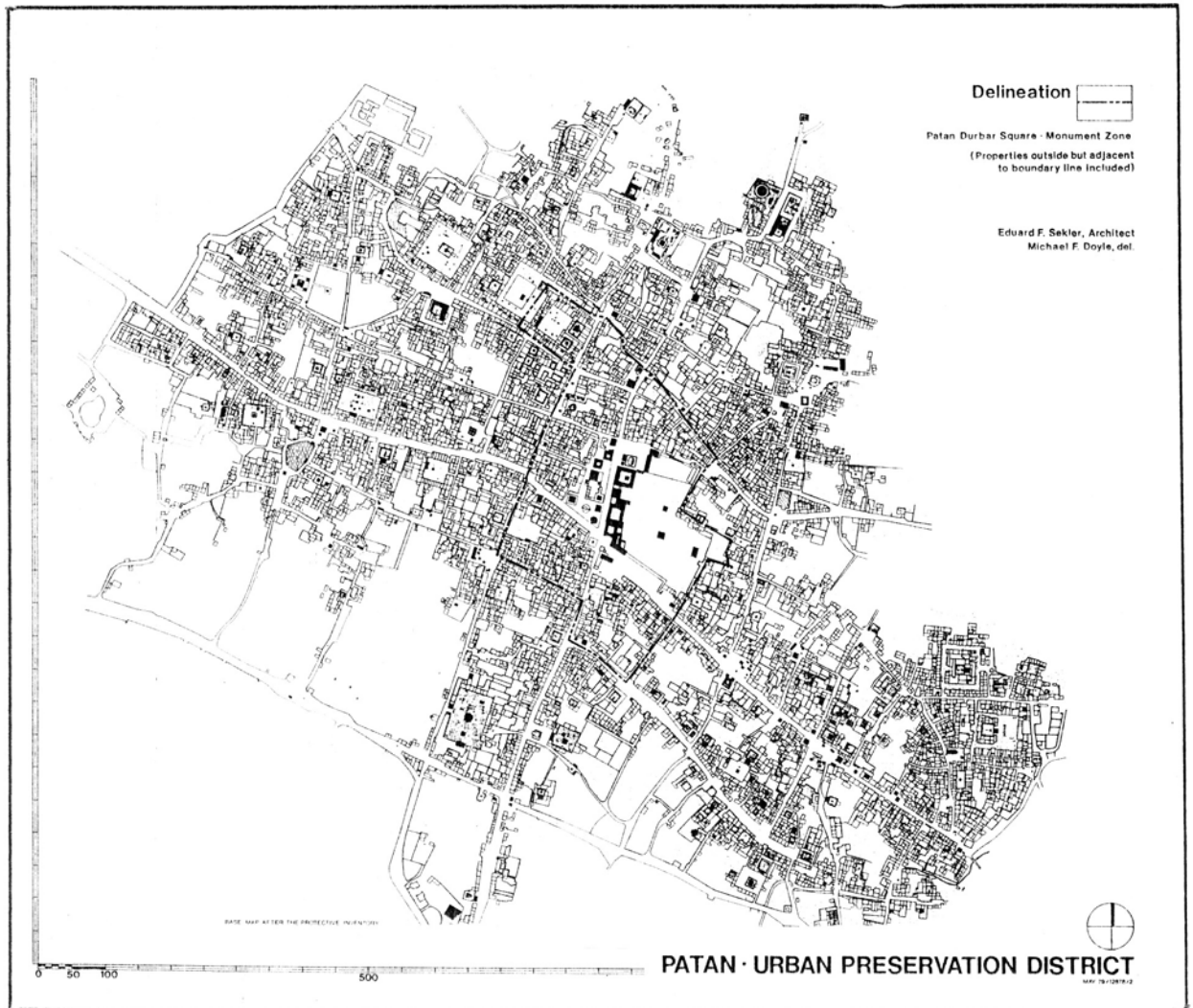
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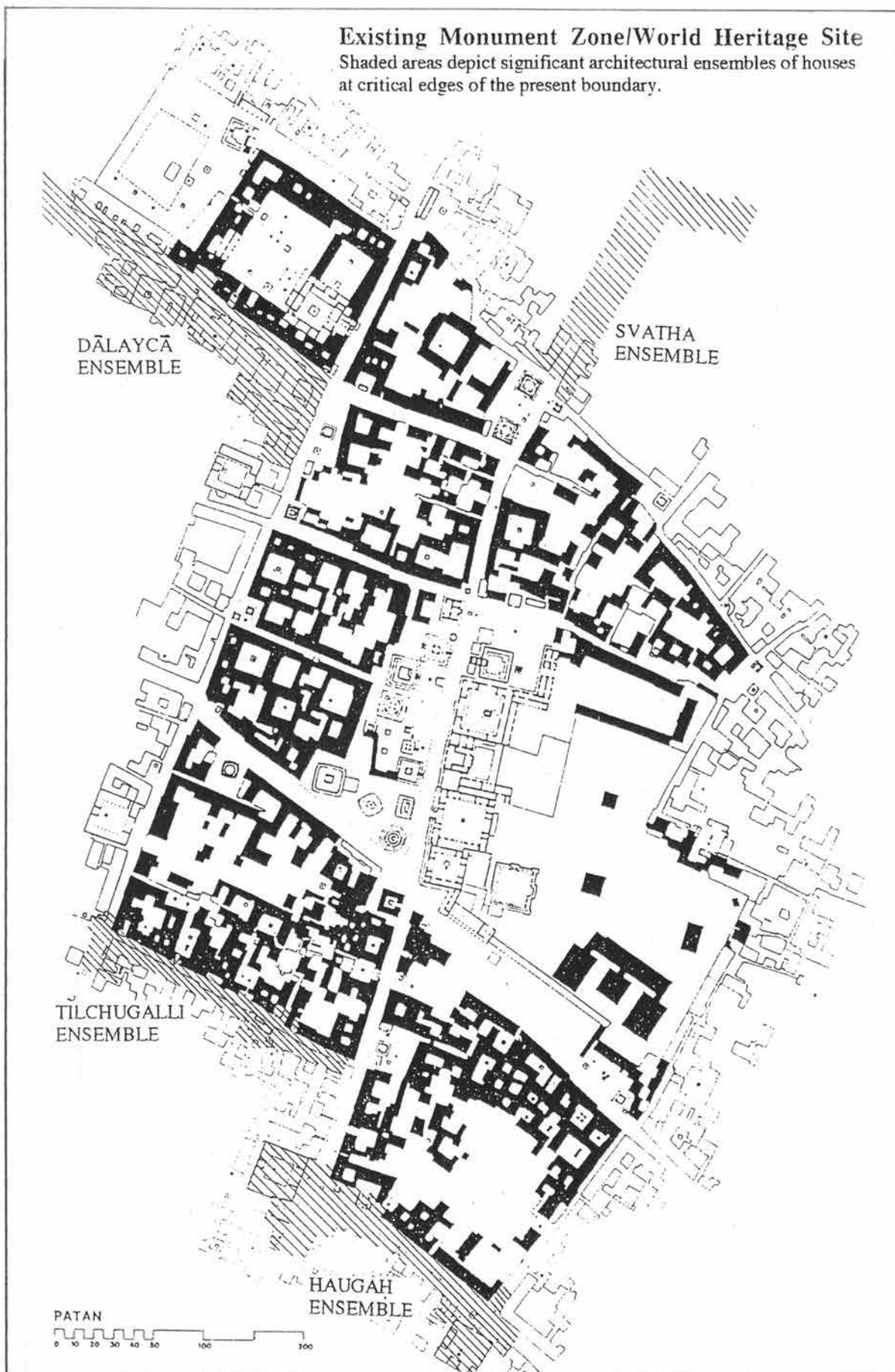
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Above: City map of Patan by E. F. Sekler, 1979.
Below: The Agache seen from the southeast, Spring 1992.





Patan Protected Monument Zone / World Heritage Site as gazetted June 10,1985
Patukva Agache shown in red.

1.0 INTRODUCTION

The Patukva Agache, a rare example of a five-story esoteric shrine house which retains most of its historic features, is a key monument of the Malla era (1400-1769). The seventeenth century structure is composed of a two-story pagoda atop a three-story base, more residential in appearance. In a survey of monuments in and adjacent to the Patan World Heritage Site and in consultation with the Department of Archaeology, the Trust determined this historical structure to be the most threatened monument of significant historical and artistic value. It was proposed as a pilot restoration project to the British Ambassador to Nepal for possible funding by the British Overseas Development Administration with the following background justification:

- (1) In 1989 the working group of the UNESCO Campaign for the Safeguarding of the Cultural Heritage of the Kathmandu Valley identified Patan Darbar as first priority for preservation and restoration efforts among the Valley's seven World Heritage Sites.
- (2) Technically, the Patukva Agache lies within the Patan Darbar World Heritage Site Monument Zone (see E.F. Sekler's Patan Darbar Square Monument Zone/UNESCO Mission January, 1984). There are at present considerable misinterpretations and unclarities about that boundary which may be solved by a ongoing redelineation by the Department of Archaeology. The gazetted legal boundary, according to HMG Ancient Monuments Act, follows the centerlines of streets in the vicinity of the Darbar Square and is interpreted to include all adjacent buildings. In practice, however, only those buildings closest to the Darbar Square, i.e. on one side of the street, have been monitored. Thus, the restoration of the Patukva Agache, which lies on the side of the street *away* from Darbar Square, will help to cement the legal boundary of the Patan Darbar World Heritage Site.
- (3) Thirdly, Patan is a city on the edge, a city whose rich artistic and architectural heritage is threatened daily by the pressures of development and the rapidly deteriorating condition of its monuments. The restoration of Patukva Agache will enhance and be complemented by nearby restoration projects currently in progress including Keshav Narayan Chowk and Iba-Bahi, implemented by the Austrian Government and the Japanese Nippon Institute of Technology, respectively. These projects, in combination with the ongoing German-aided Patan Conservation and Development Programme will focus local and international attention on the urgency of preservation efforts in Patan.
- (4) Lastly and most importantly, there exists a tremendous lack of provisions for maintenance, protection, and restoration of monuments which fall under the semi-private ownership of religious trusts (*guthis*). With the degeneration of the historical guthi system in the last decades, dozens of significant monuments have become threatened. They do not come under the direct jurisdiction of the national agency responsible for conservation of monuments, HMG

Department of Archaeology. The Department of Archaeology, in cooperation with the GTZ/ Patan Conservation and Development Programme, proposes to designate many of those buildings "National Monuments", while establishing the legal framework to monitor and provide technical and financial support for their maintenance. This proposal naturally includes the fine Patukva Agache. International financial assistance for the restoration of such a monument is therefore seen as a critical and necessary precedent for the preservation of the semi-private architectural heritage of Nepal.

(5) The Patukva Guthi, in a show of support of this international effort to restore the building has agreed to donate 250,000 Rs/, a substantial contribution for the local economy, and one which makes this a model collaboration. The legal agreement drafted and included in the appendix A similarly will serve as a model document for the terms on which assistance can be given to a semi-private monuments.

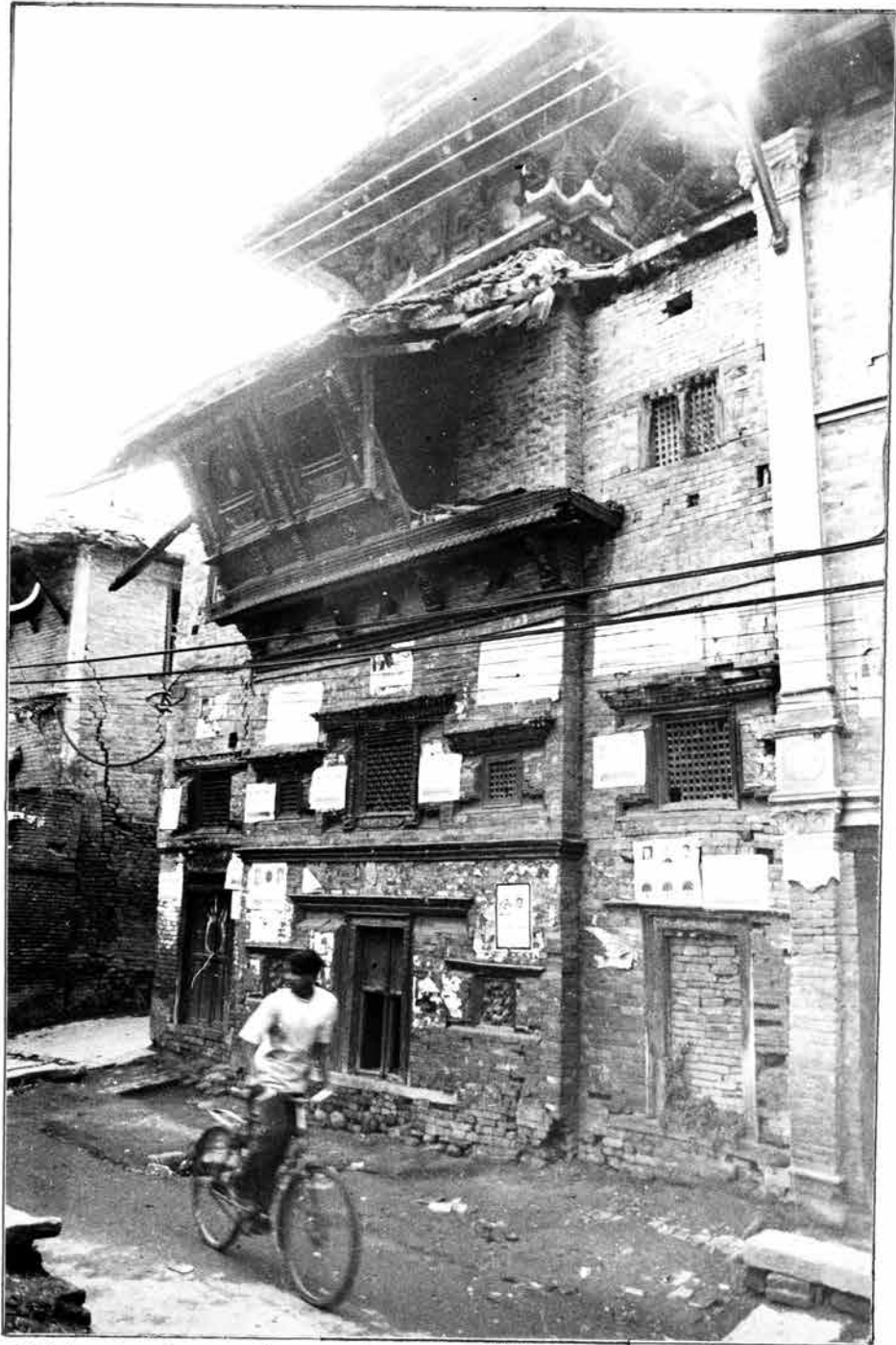


The Agache seen from the southeast, after emergency assistance by K.V.P.T. including tarpaulins on roof to protect building from monsoon rain, Spring 1992.

(6) Lastly, given the intact religious confraternity of the Guthi and their ongoing ritual duties, the building can be rebuilt, restored, and delivered to the owners for its historical use. The only modification of this arrangement, currently under discussion, will be the conversion of part of the ground floor to rentable shop space. This rental income is envisaged to help defray maintenance expenses of the restored building.

2.0 BRIEF HISTORY

For the Patukva Agache no documentary evidence such as manuscripts, *in situ* inscriptions, or photographs have been found to shed light on the building's history. Based on stylistic analysis of the intact carvings of the principal facade, however, the building can be assigned a 17th century date. This places the building in the most active



Patukva Agache, seen from east, summer, 1993.

era of construction in the Patan Darbar Square when a great number of its best-known monuments were constructed including Sundari Chowk in the palace complex, the Viswanath and Bhimsen temples. A seventeenth century date also corresponds to the traditional history of the Guthi which reports that this agache was founded by Biswanath Rajopadhya, son of Gayabajya, the most famous historical and legendary Tantric of Patan. Gayahbajya's residence and esoteric shrine are extant at Sulima Tol, Patan and stylistically appear to be a generation earlier than Patukva.

The Patukva Agache belongs to the Rajopadhya clan, Newar Brahmans of Patan who served as court priests in Malla times (1420-1769). The clan is still resident in the seven courtyards adjacent to the Agache: Hanuman Chowk, Nasa Chowk, Baithak Chowk, Taraghrach Chowk, Saga Chowk, Kahisi Chowk, and Kebaha Chowk. The clan includes some 28 neighbouring families.



Bhuteswar with his Shakti on ground floor

Typical of an agache or esoteric shrine house, the god's name is secret and only referred to among outsiders as *agamaju*, a generic term. The principal esoteric god, a gilded sculpture formerly installed on the second floor, was stolen in 1969. On the ground floor there is also a large stone sculpture of Bhuteswar with his *shakti* worshipped by the neighborhood. Bhuteswara is the god of ghosts (Nepali: *bhut* = ghost) and is associated with tantric worship.

As at other Agache there are various social and religious activities which take place over the course of the year, but the focal activity consists of ritual worship and feasting at *Dashain* in October. At present, these minor religious and social activities are curtailed due to the building's state of ruin.

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 elevation drawings record estimated dates of many small and major changes. Guthi elder Vishnu Jvalananda reports that the building did not suffer any major damage in the major earthquake of 1934.

Most significantly, the building appears to retain most of its original 17th century fabric except for the following:

(1) The upper pagoda structure appears to have been rebuilt in the 19th century based on the poorer finish of the *daci apa* veneer brick and the 1/4" visible mud mortar joints. Interior timber tructure in pine and sal appears too match this date from visual inspection, although dating of interior timber is difficult.

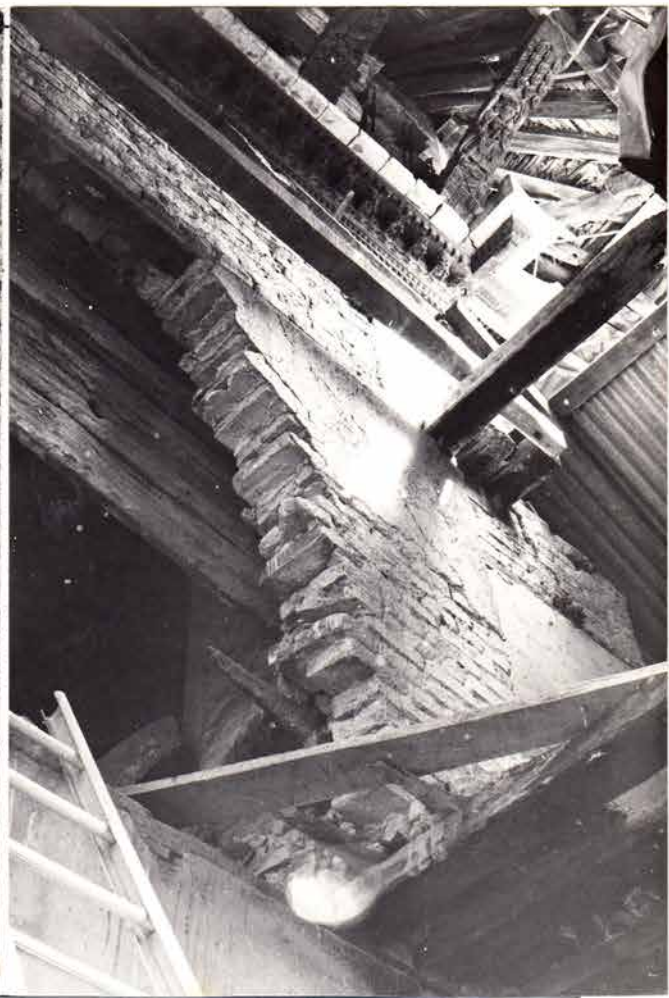
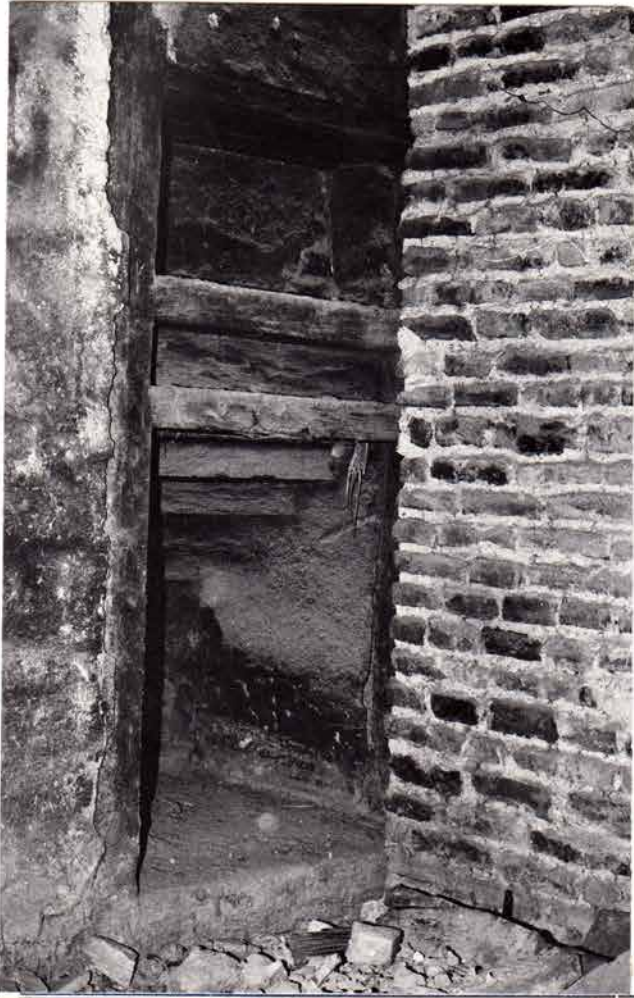


Patukva Agache, south-east corner, 1993.

(2) The struts of the upper pagoda were replaced sometime in the last 100 years- this happened long enough ago that no *guthi* elder recalls the event. This estimated date is based on stylistic analysis.

(3) The southern end wall was sloppily reconstructed in chimney brick in 1977, as reported by the *Guthi*. Historical openings in this elevation were lost; there is no photographic evidence of this elevation in its historical configuration. At the same time most of the base roof above the lower three stories was replaced with zinc sheets.

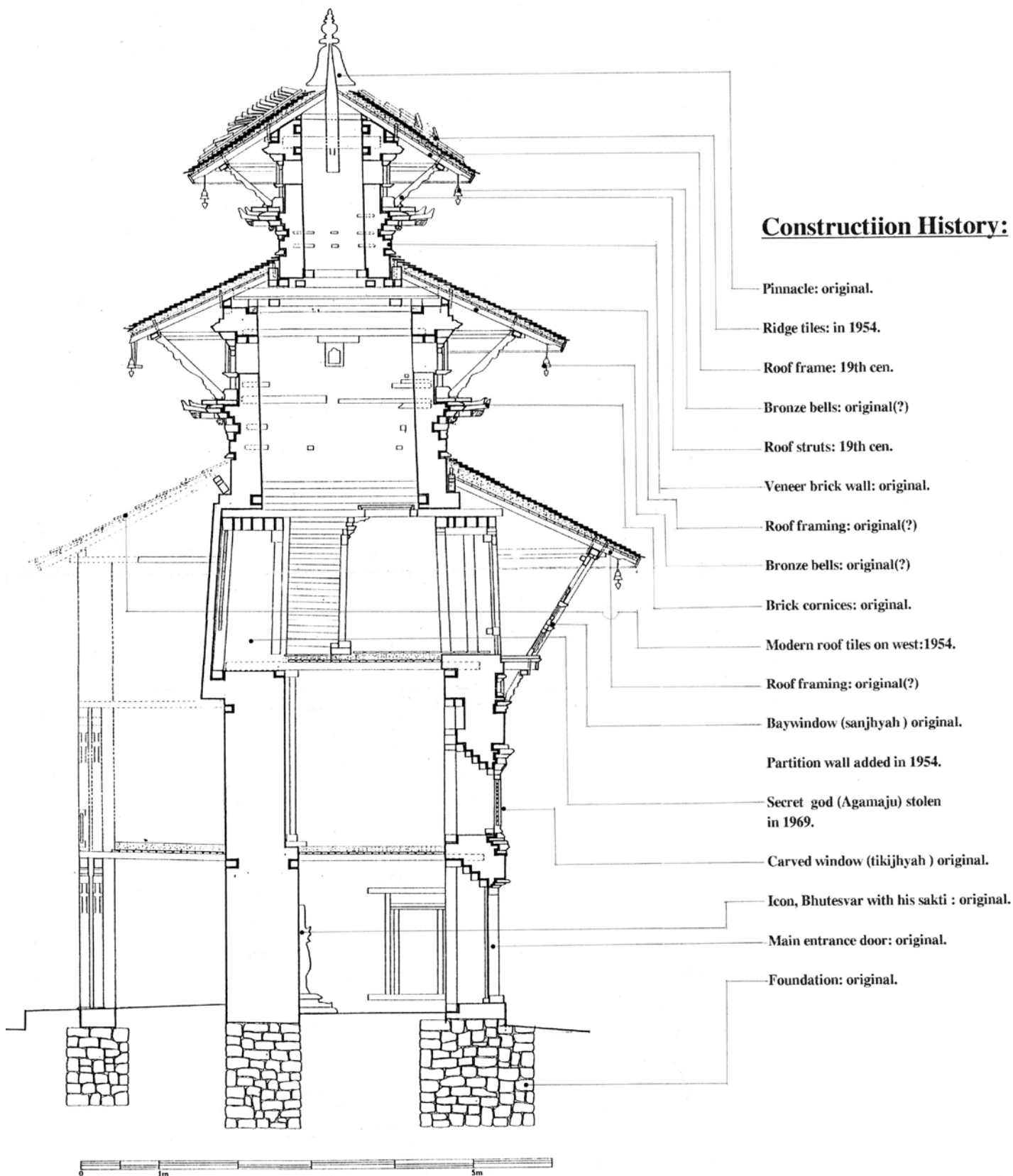
(4) In 1954, as the Guthi reports, two walls were added to the structure, one an additional partition wall on the first floor above ground level. The second, and more critical case, was the addition of a masonry wall at the back of the second story esoteric shrine. This shrine historically was set into the brick wall with



Above left: Partition on first floor (14" thick) wall was added in 1954 and partially blocks the window.

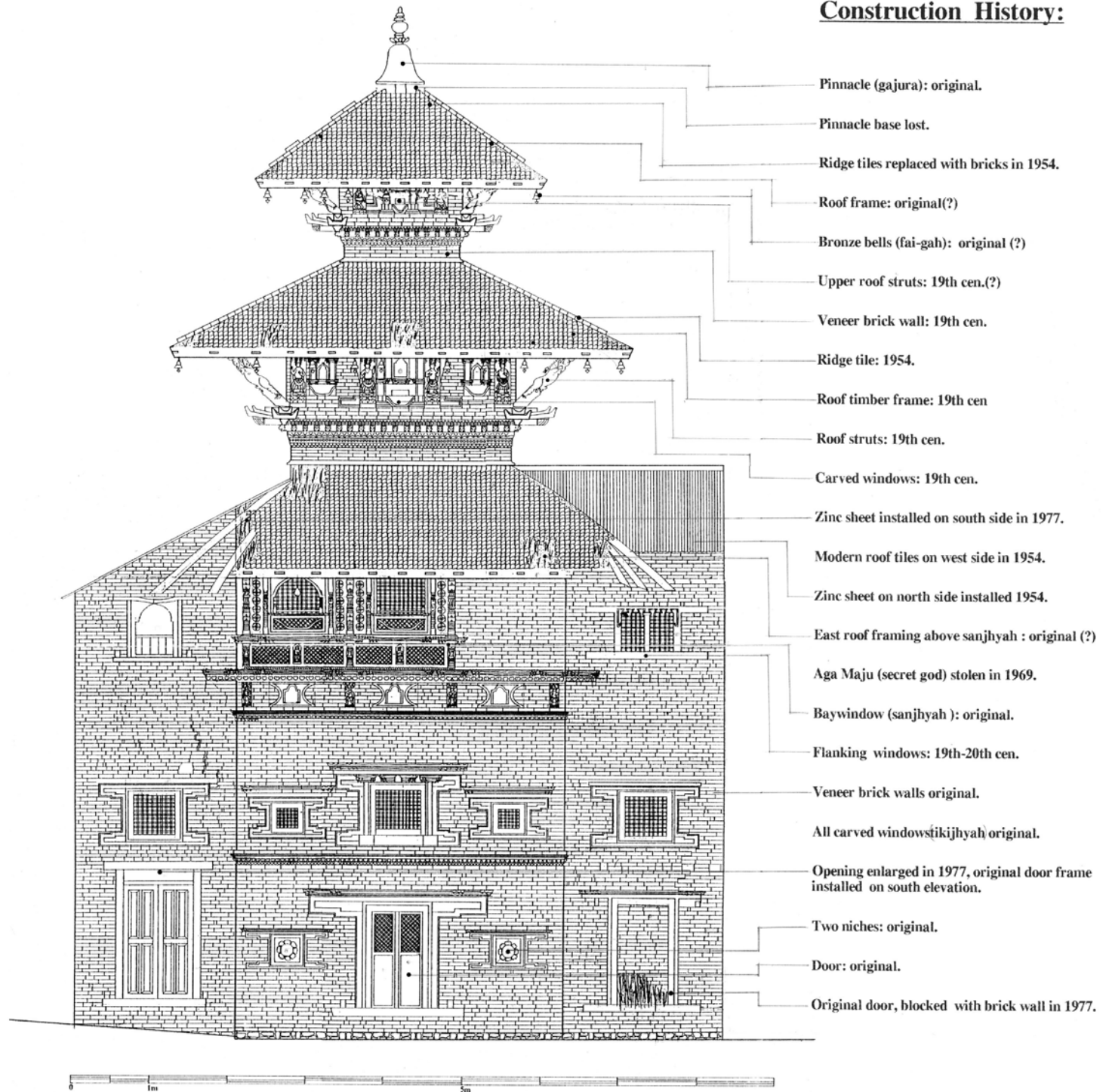
Above right: The masonry wall added in 1954 which led to collapse of joists below and roof above. Seen from below, summer 1993.

Below: Zinc sheet on lower roof south, installed 1977.



PATUKVA AGAM
 PATUKVA TOL, PATAN
 UNESCO WORLD HERITAGE SITE MONUMENT ZONE
 WEST-EAST SECTION: EXISTING CONDITIONS
 KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993

Construction History:



PATUKVA AGAM

PATUKVA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE

PRINCIPAL ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993

only a layer of timber planks closing the niche-like opening at the rear facade. The addition of this improperly supported masonry wall has led in fact to the structural collapse of the rear portion of the building (discussed in detail under 5.0). At the same time, the Guthi repaired portions of the western and northern roofs, replacing the mud bed and traditional *jhingati* tiles with larger tiles. These tiles rest on timber battens instead of the *jhingati*'s mud bed.

(5) Principal facade: 2nd floor windows. Both of these windows replace what was most likely originally a matching pair. The southern window appears to be 50-75 years old based on stylistic comparison; the northern example appears to be nineteenth century.

(6) An intact wall plate on the north side of the pagoda suggests that at some point in the building's early history, the northern roof slope was the mirror image of the southern, that is sloping north and down. Construction of a later building must have necessitated the reconfiguration of the roof to bring the water away from the new adjacent building.

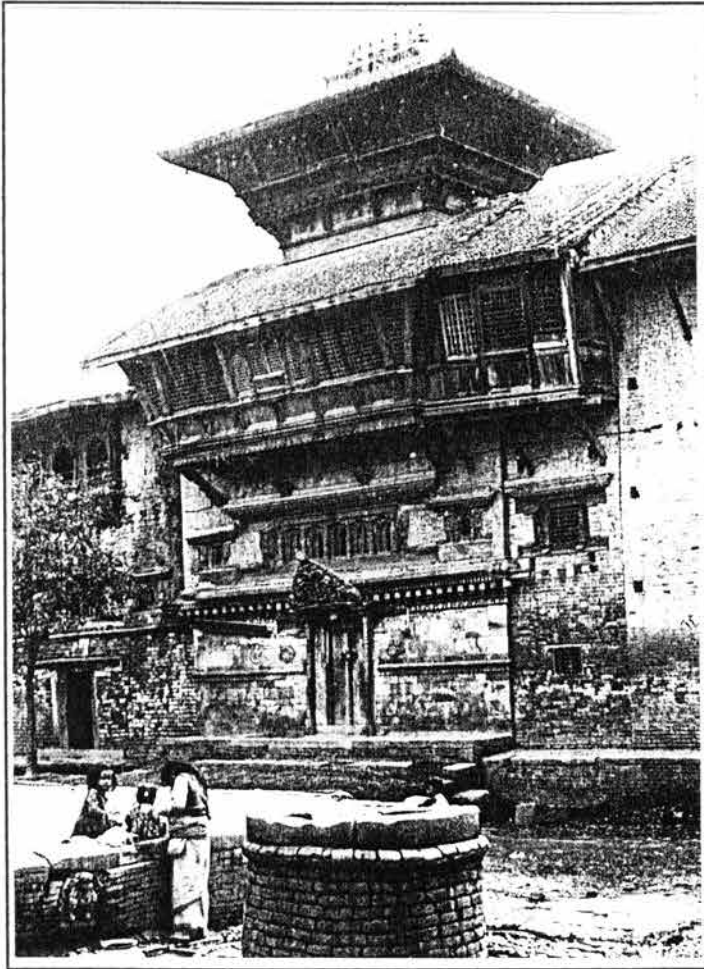
4.0 ARCHITECTURAL DESCRIPTION

General Description.

An *agache* houses the temple of an esoteric god, in this case, a clan god. An *agache* can be a secret chamber (*agakvatha*) in a typical dwelling, or in the case of those more affluent clans, a separate structure exclusively built to house the shrine and its associated activities. These Hindu clan-related *agache* are architecturally similar to Buddhist structures of the same name found in each of the Buddhist quadrangles and housing esoteric Buddhist deities. Both inflect a residential structure with special roofs.



Timber partitioned esoteric shrine, second floor.



Above: Joshi Agache, Sulima Tole,
Patan. 17th century.

Below: Malla King's Agache, Hanuman
Dhoka, 1653.





Above: Joshi Agache, Maru Tole, Kathmandu.

Left: Pradhan Agache, Bhimsensthan, Kathmandu, 17th century,



Above two royal temples, symbolically raised to the rooftop of the palace complex. Below: two private temples built on the rooftop adjacent to Hanuman Dhoka. Clockwise from upper left: Bhagavati Mandir 17th c., Hanuman Dhoka; Degu Taleju, 18th c., Hanuman Dhoka; Private rooftop temple, 18th c., Basantapur; and Narayan private rooftop temple (pinnacle only visible) 19th c., rebuilt 1990.

These composite structures are a significant building type in Nepal: the duo-partite structures composed of a pagoda-like superstructure above a base building more residential in appearance. In this case, a two-tiered pagoda with no functional interior space perches atop a three-story base structure.

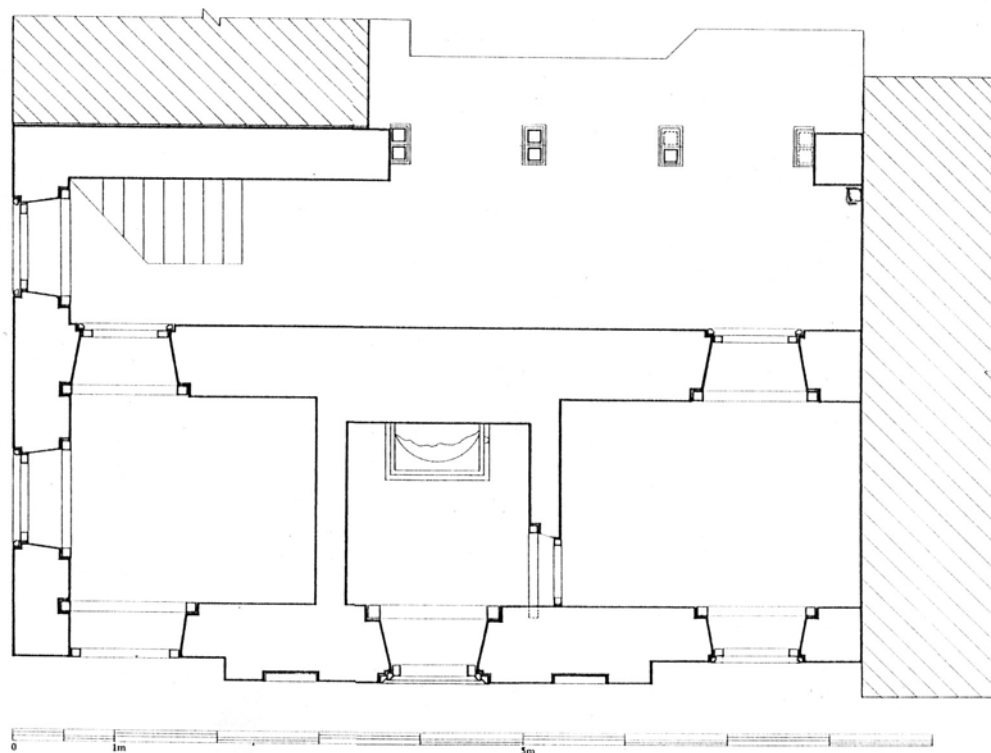
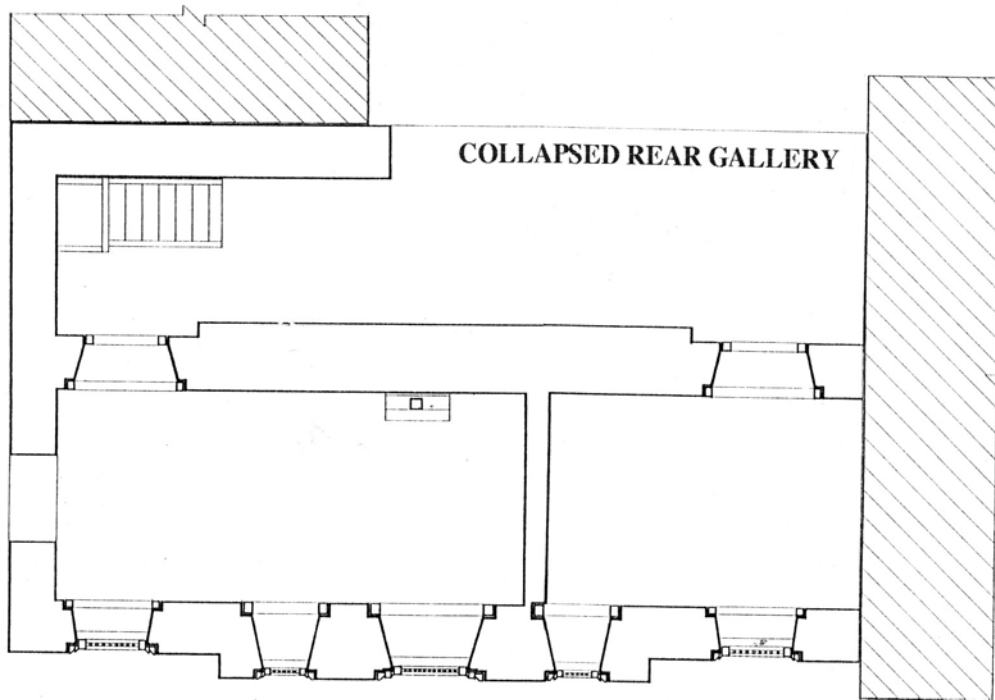
One can locate several similar structures in the Kathmandu Valley including: Joshi Agache in Maru Tole, Kathmandu, (a private shrine belonging to the Joshi family); Pradhan Agache in Binche Bahal, Kathmandu; and the venerable 16th century Joshi Agache of Gayabajya, legendary Tantric, in Sulima Tole, Patan. These are comparable to the royal examples found at the Kathmandu and Patan palace complexes, where three-tier pagoda-like shrines are symbolically sited above the palace itself. The Agam Mandir (1653) at Hanuman Dhoka is of similar 17th century age to that of Patukva Agache.

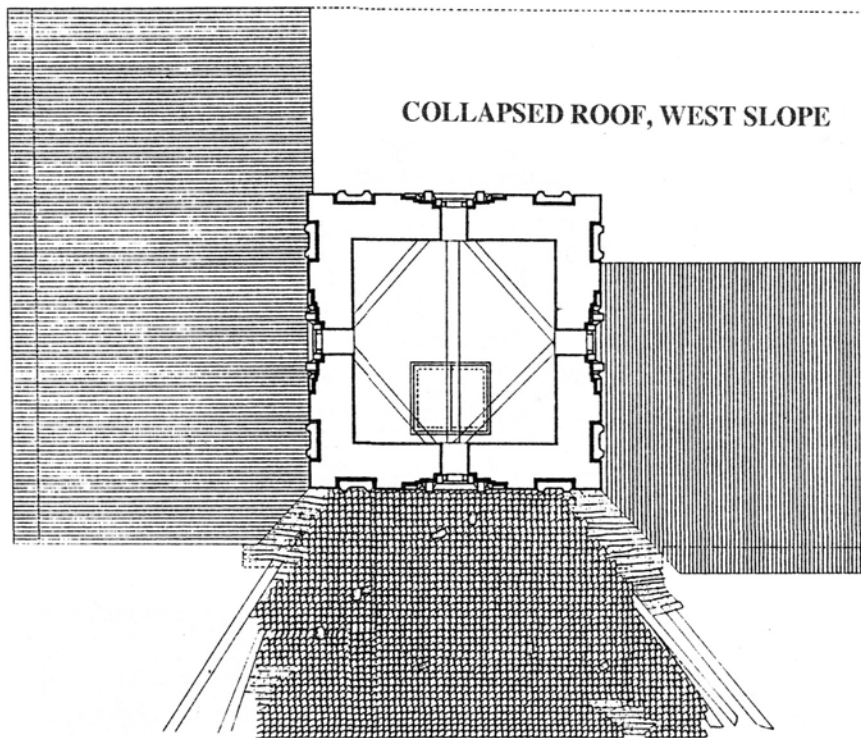
The ground floor plan of Patukva Agache consists of a rectangular brick masonry structure with an interior depth of less than seven feet! This diminuate structure is divided into three rooms at ground level and historically left open at upper levels. The central room at ground level houses a religious icon of *Bhutesvar* with his *Shakti* for local neighborhood worship, The icon rests on a large stone pedestal facing the eastern door.

A rear multi-story open timber gallery (Nepali: *bardali*) almosts doubles the limited floor area,

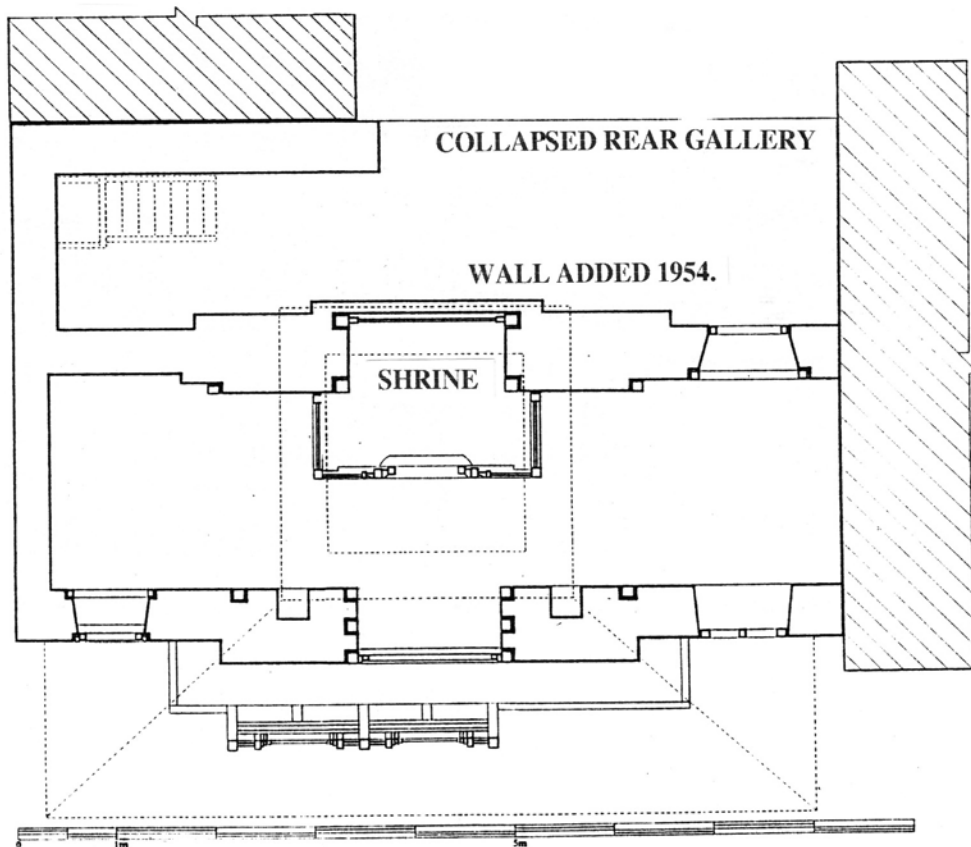


Three pairs of timber columns in front of esoteric shrine, second floor. Summer 1993.

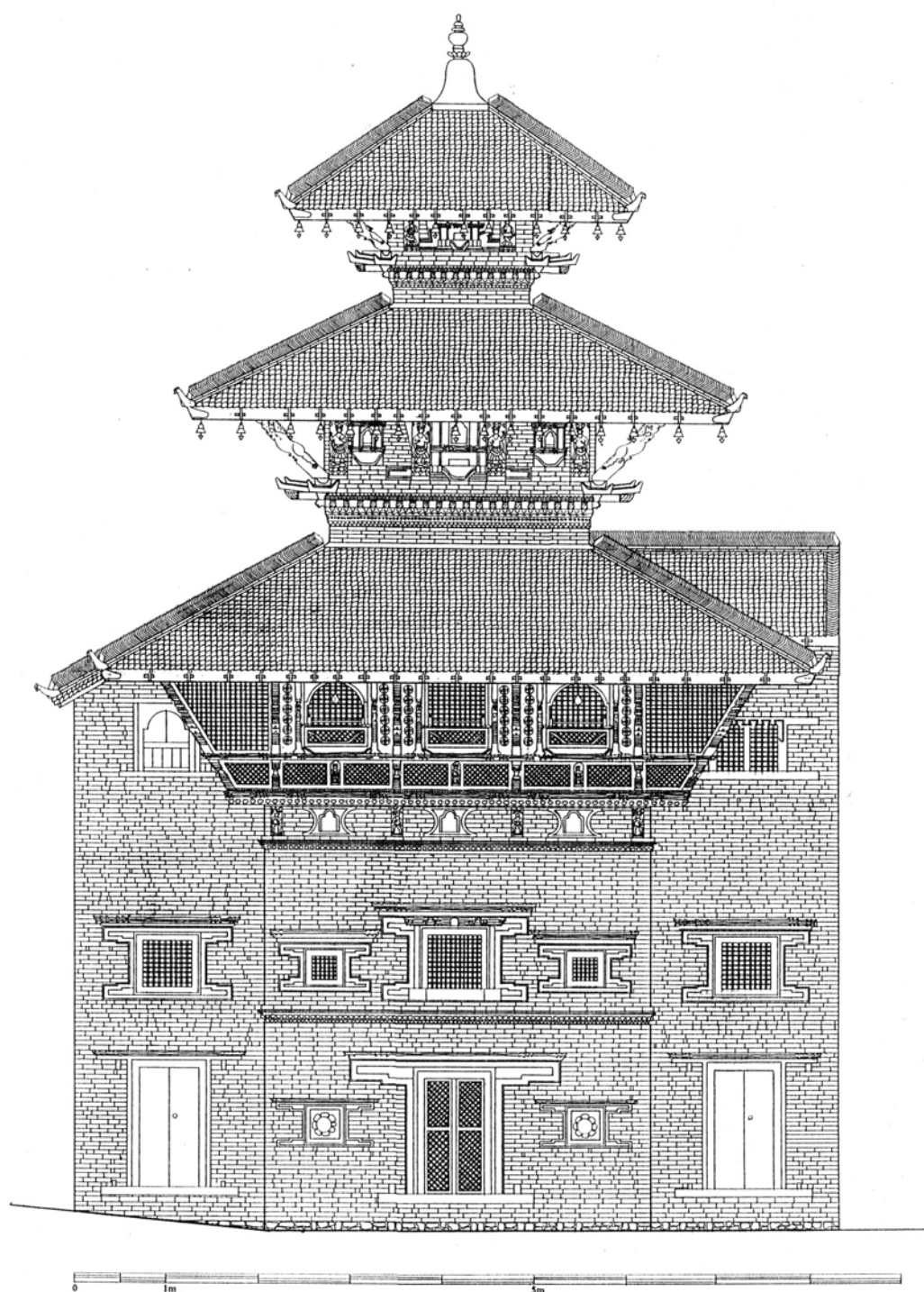




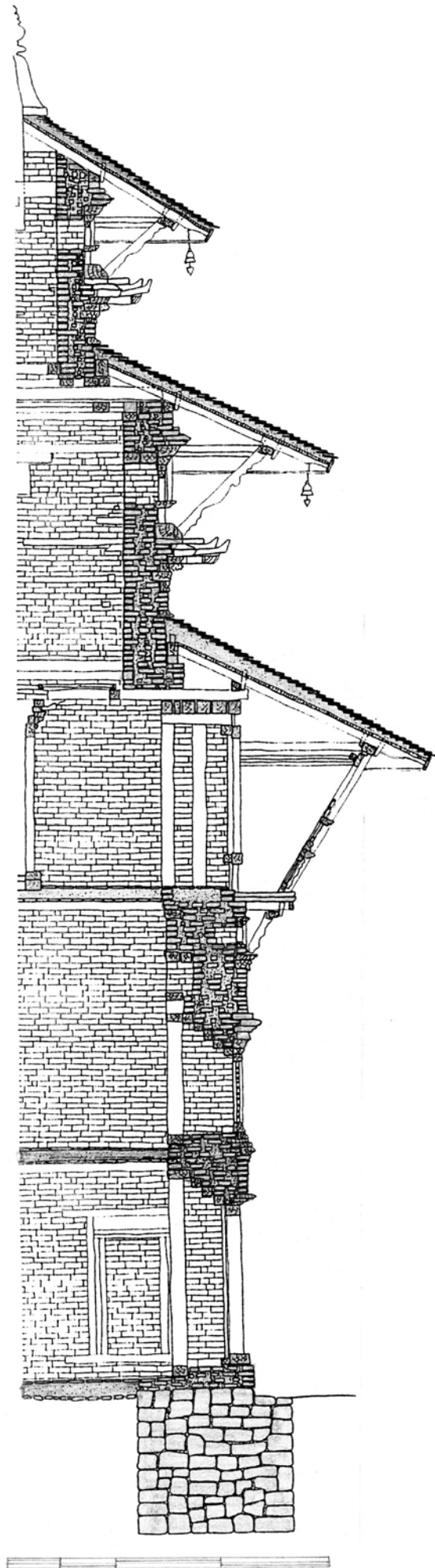
PATUKVA AGACHE
Third floor plan : Existing condition



PATUKVA AGACHE
Second floor plan : Existing condition

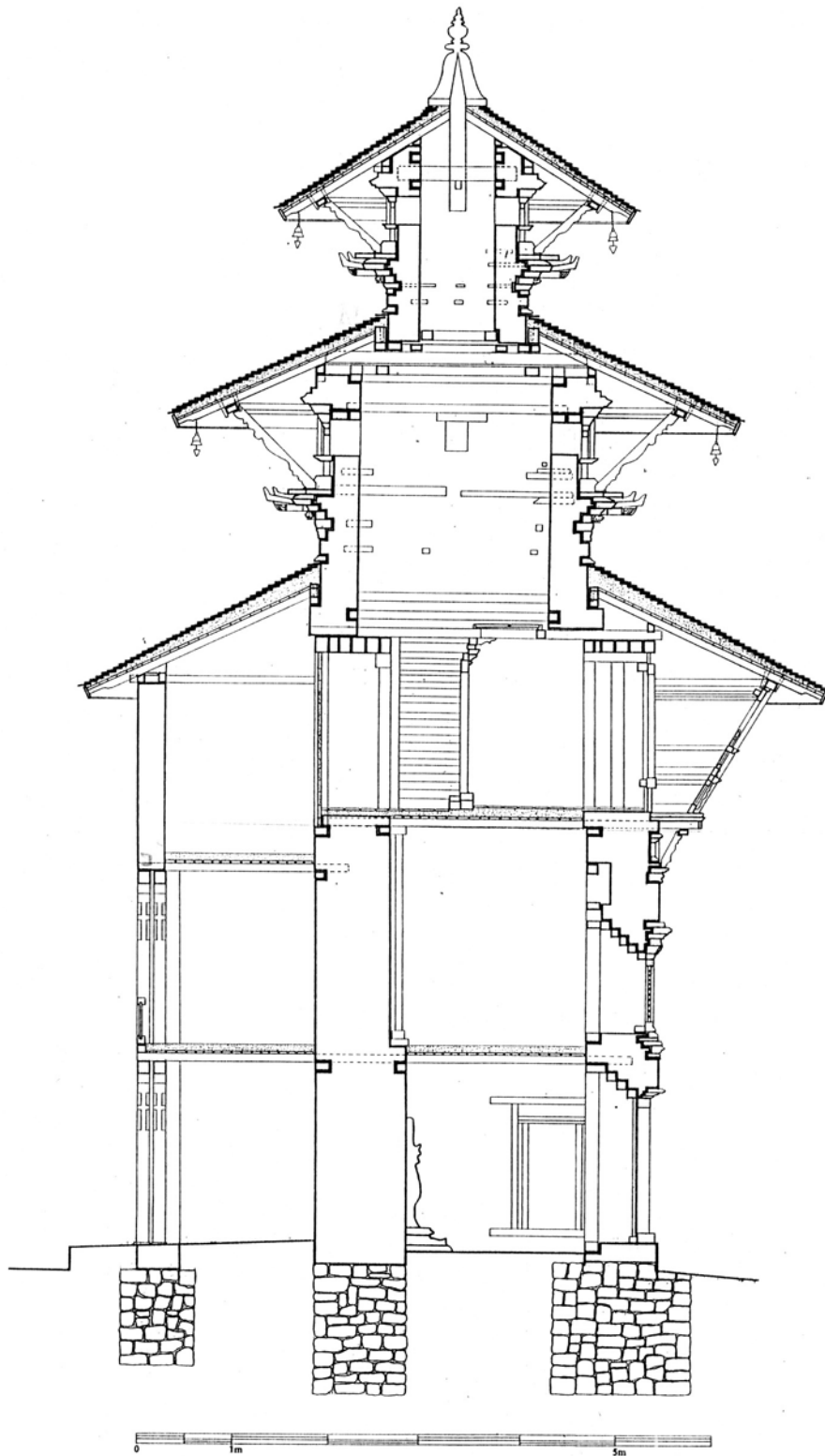


PATUKVA AGACHE
 Restored principal elevation

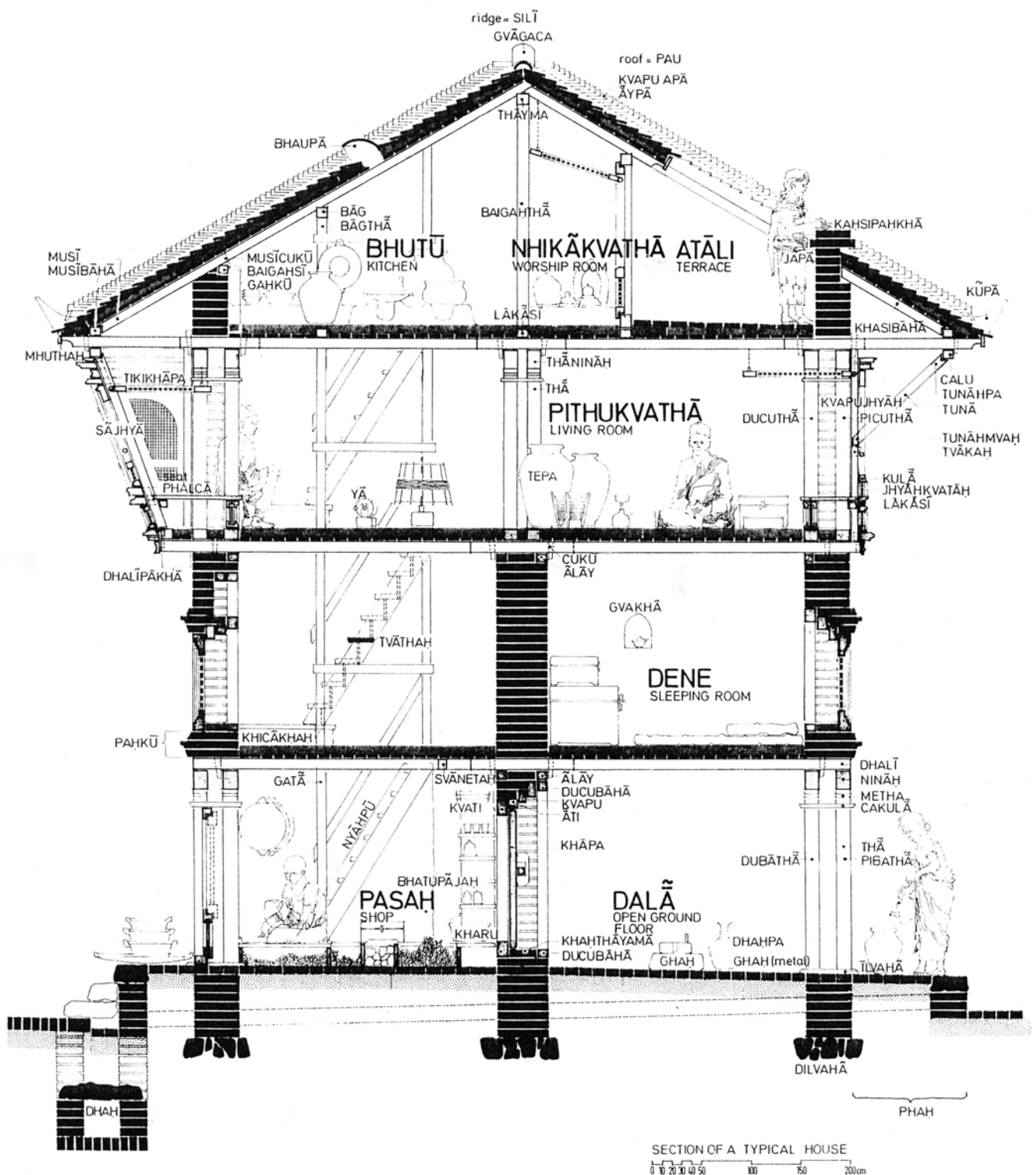


Detail wall section

Traditional composite wall layers of
outer veneer brick, middle fill and
interior bearing wall. Sept. 1993



PATUKVA AGACHE
Restored West-East section



Section of a typical Newar house from N. Gutschow Newar Towns and Buildings. Compare with Patukva section opposite: the lower portion of the agache is comparable to a dwelling house.

providing circulation space and ladder-like stairs. It is possible that the lowest stair, the only run executed in masonry, is not original. One can hypothesize that the historical configuration of adjacent residences may have provided access to the *agache* at first floor level, making this staircase a later addition. If this was the case, the historical arrangement would have resembled present circulation arrangements at Agam Mandir at Hanuman Dhoka, where there is no direct access from ground level to an upper level esoteric shrine.

On the first floor, the historically undivided room has been used for preparation of feasts and occasionally for accommodation of guthi members during mourning periods, when seclusion is necessary. The second floor houses the most important principal shrine. On this level, a small semi-enclosed shrine is located on axis with a projecting bay window (Newari: *sahjhya*). The shrine of the secret god (*agamaju*) is thus expressed architecturally by the surmounting pagoda in plan, and by the multi-bay window in elevation. This multi-bay window creates ambiguity in the reading of the composite facade: it simultaneously suggests a base to the pagoda and a crown to the lower facade.



Front facade, lower two stories. April 1993

The interior of the pagoda superstorey consists only of one floor level above the shrine, accessible by an opening in the ceiling joists of the shrine itself. The exterior of the pagoda is arranged identically on four sides with a single central window opening flanked by blind windows. At the uppermost level, the diminished wall size allows only one central window.

The visually dominant timber framed roof consists of a four-sided pent roof at each of two levels with generous overhangs (5'6" and 4'0" lower and upper levels) supported by purlins. The purlins are in turn supported by twelve inclined carved timber struts. There are four corner struts and two additional struts per side, these pairs suggest flanking elements at each of the windows. The timber struts rest on a continuous timber and carved brick cornices which protrude from the wall structure. The entire roof structure is surmounted by a gilt pinnacle (Nepali: *gajura*).

The lower facade is organized by a central and focal bay which projects one brick thickness in front of the adjacent wall areas. Typical of the Newar architectural vocabulary, larger focal elements-- a door at ground level and a window above-- are flanked by minor blind and latticed openings. The axial symmetry is made more complex by the additional windows and doors of the side bays. These openings are slightly smaller than those of the central bay, reinforcing the pattern of flanking axial symmetry, yet at the same time they are large enough to suggest that the central window is repeating. At the top and second level of the lower facade the focal bay window is flanked by two individual windows.

In addition to the complex pattern of openings, the brick facade is further punctuated by a timber cornice in the central bay. This cornice above the ground floor does not continue across the side bays, emphasizing the focal quality of the central bay. On the upper pagoda, continuous composite timber and brick cornices carry struts at two levels. The timber door and windows and inset panels, cornices, niches, blind windows and roof struts provide the field for intricate carrying of iconographic and decorative forms.

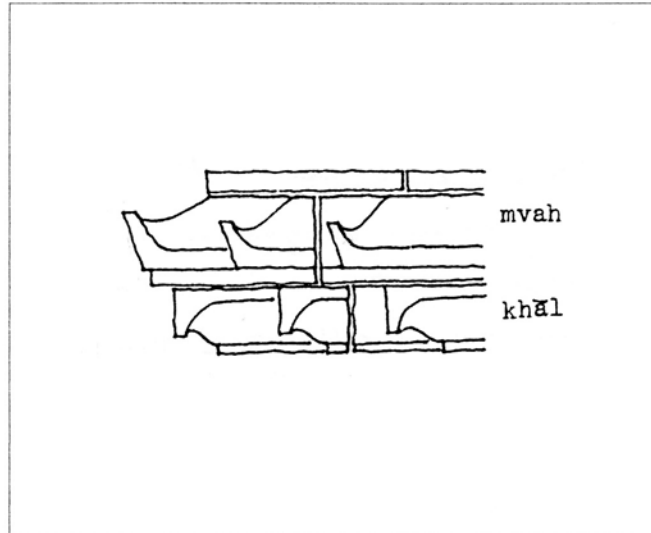
In section, the building is quite curious. While the rear gallery suggests a symmetry between front and back of the building, the slight displacement of the upper pagoda, that is, slightly off center with the lower masonry core, creates a blatant eccentricity. Put another way, the back wall of the pagoda is continuous with three levels of masonry walls below, while the front wall of the pagoda is supported by timber beams.

4.1 Traditional construction techniques

The traditional construction of Patukva Agache employs bearing brick walls laid in yellow mud mortar (Newari: *mhasula*) together with a secondary timber frame construction wall whose plates, door frames, tie members, joists and rafters are connected by timber pegs and lapped joinery.

The foundation of Patukva Agache consists of a 8-12 layers of natural stone, above which and at ground level begins the brick wall construction. There is no damp-proofing course or layer, typical of traditional construction practice here.

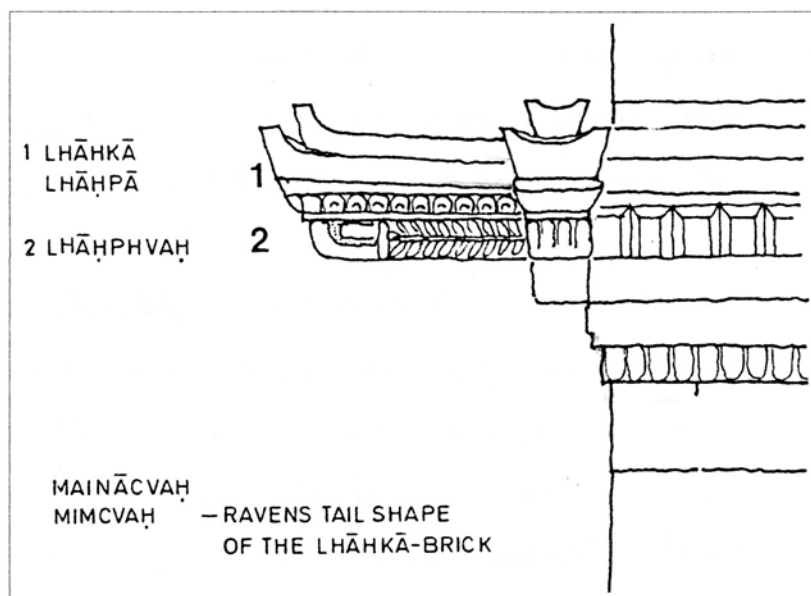
Masonry bearing wall construction consists of three layers with very few cross bonds: an outer facade brick (Newari: *daci apa*) one course thick; an inner bearing wall of common fired brick (Newari: *ma apa*) two layers thick; and a middle fill of brick fragments (Newari: *dathu apa*). The characteristic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

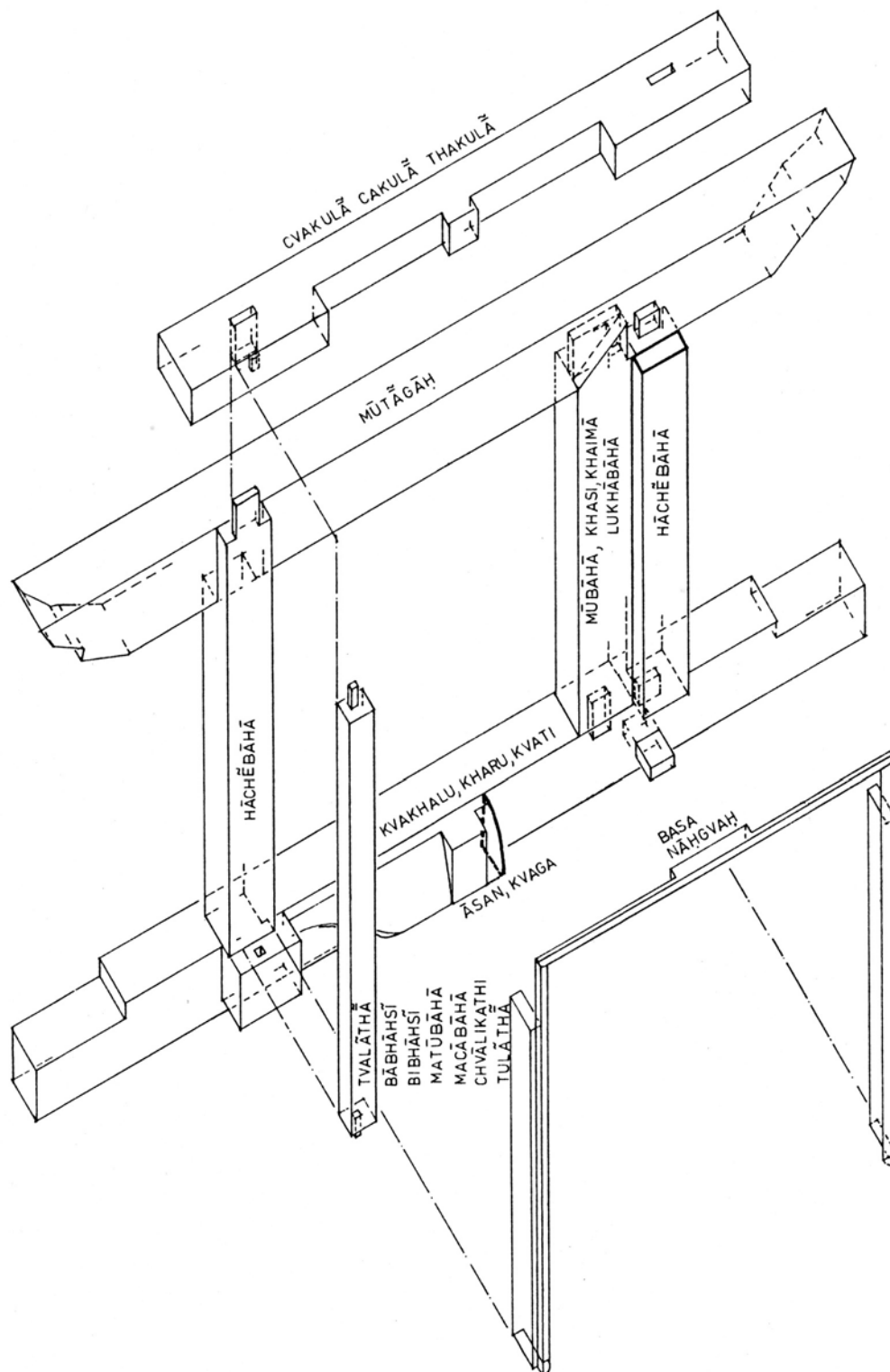


The *daci apa* of the Malla period (and well up to the turn of this century) is extremely well-fired and dense with a finished surface on only one side. Only on corner bricks is the smooth finishing rendered on two sides. Finishing is achieved through the application of a red clay slurry (Newari: *laca*) applied after sun drying and before firing. Laid tightly, the lustrous brown crimson *daci apa* provides a fine and smooth background for the sculptural effects of the wood carvings.

In addition to the *daciapa* other specialty bricks are found in Patukva Agache. Moulded bricks, for example, are found incorporated at the cornices above individual openings, artfully integrated with the timber

Above: 3 course of moulded cornice brick (Newari: *cvalaku*) above first floor windows. Below: the oversized corner pieces are supported by timbers in the shapes of hands (*lhahphvah*) at corners of upper pagoda cornice.





Structural elements of a traditional window, from Niels Gutschow: Newar Towns and Buildings.

cornice. The larger scale building cornices, which support the lower ends of inclined roof struts, are similarly formed by different projecting carved timbers and two layers of projecting moulded brick. . At the corners, the overlap generates a projecting element (Newari: *lhahka*).

Another characteristic terracotta product are the floor tiles (Newari: *cika-apa*, size approximately 6"x 6"). Their smooth and convex top surface is finished with slurry in the same manner as the *daci apa*.

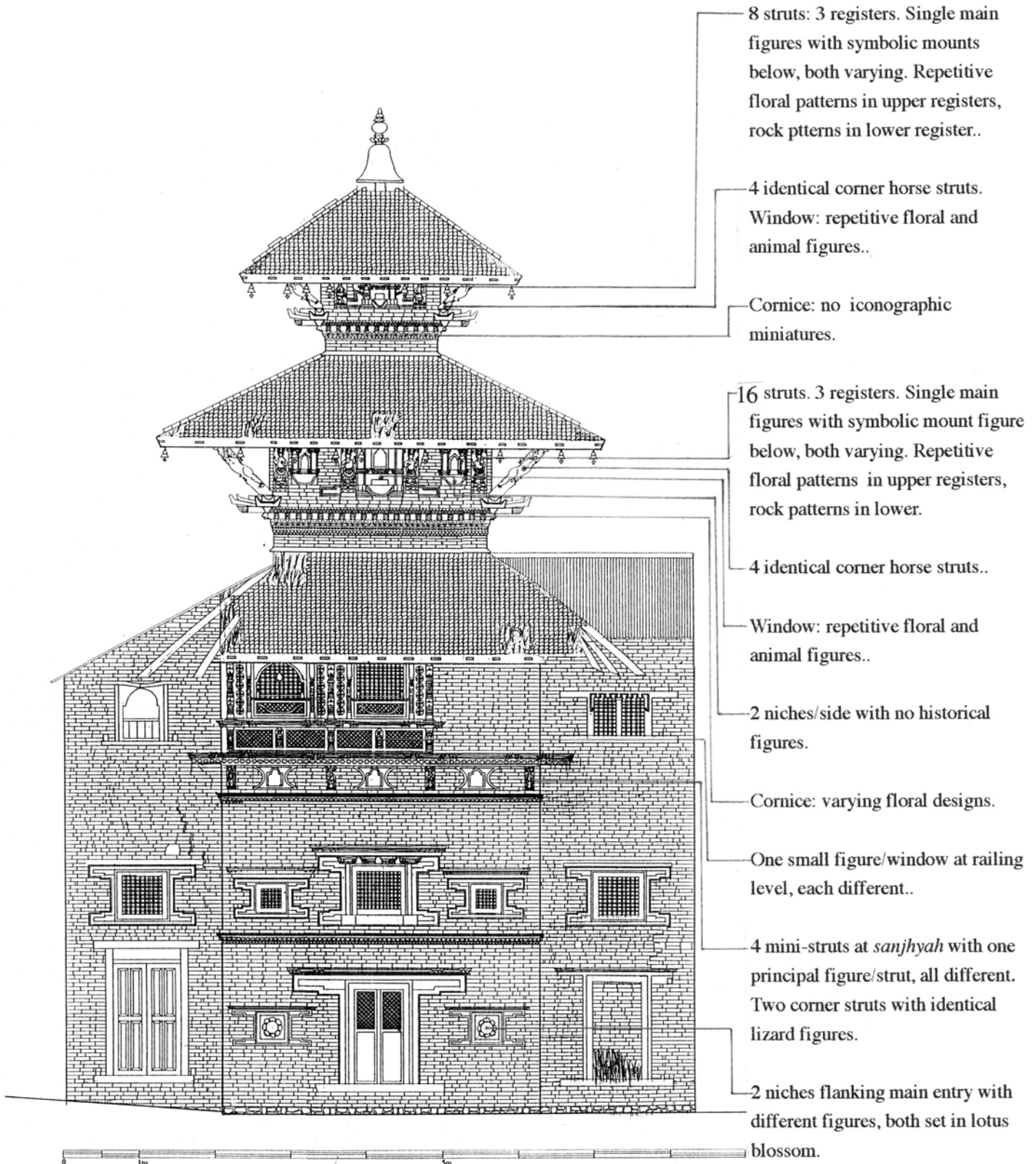
The timber structure of Patukva Agache conforms to the traditional formula of both the typical Newar house and the pagoda temple. Closely-spaced joists (varying centre to centre dimensions 9" to 12") and rafters (varying centre to centre dimensions 9" to 16") laid on flat and tied to wall plates with timber pegs (Newari: *cuku*; Nepali: *chukul*). The rafters, wall plates, and purlins at Patukva are assembled to create "hanging eaves" (Newari: *kvachupakha*), a local term describing roof configuration and indicating the lack of horizontal members linking eaveboard and wall.

Sal timber (*Shorea robusta*) a local species related to Malaysian teaks, is traditionally employed in Nepal for most structural and virtually all decorative applications. Pine is found in many 19th and early 20th century reconstructions; it may also have been employed often in the Malla period for structural framing. The Patukva Agam conforms to these formulas of interior structural timber for the most part in pine and all exterior timber and carved elements in sal. In particular one finds many examples of pine lintels in facade locations where long lengths are needed. Timber door blades are made of magnolia, a timber used traditionally because it is not prone to cracking.

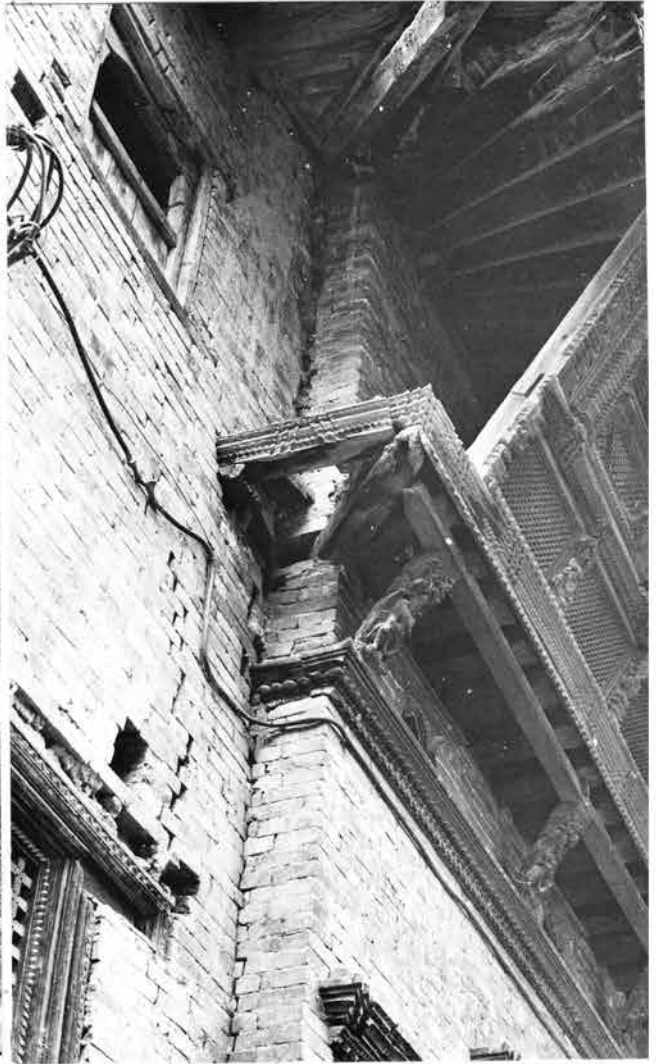
The sophisticated design and joinery of elaborate facade openings contrast interior structural joinery. Stepping timber lintels in the wall thickness expand door and window openings toward the interior, while four interlocking layers of timber frames, both structural and decorative, define the door and window openings in elevation. The central window of second level, for example, consists of

- (i) an inner largely concealed structural frame with extending sill (Newari: *kvakhalu*), lintel (Newari: *mutagah*) and main vertical support (Newari: *mubaha*);
- (ii) a secondary trabeate frame set in front of the first (Newari: *hachebaha*); and
- (iii) stylized curving and non-structural frames which wrap the extended surface of the primary frame, flush with the wall.

Iconographic programme

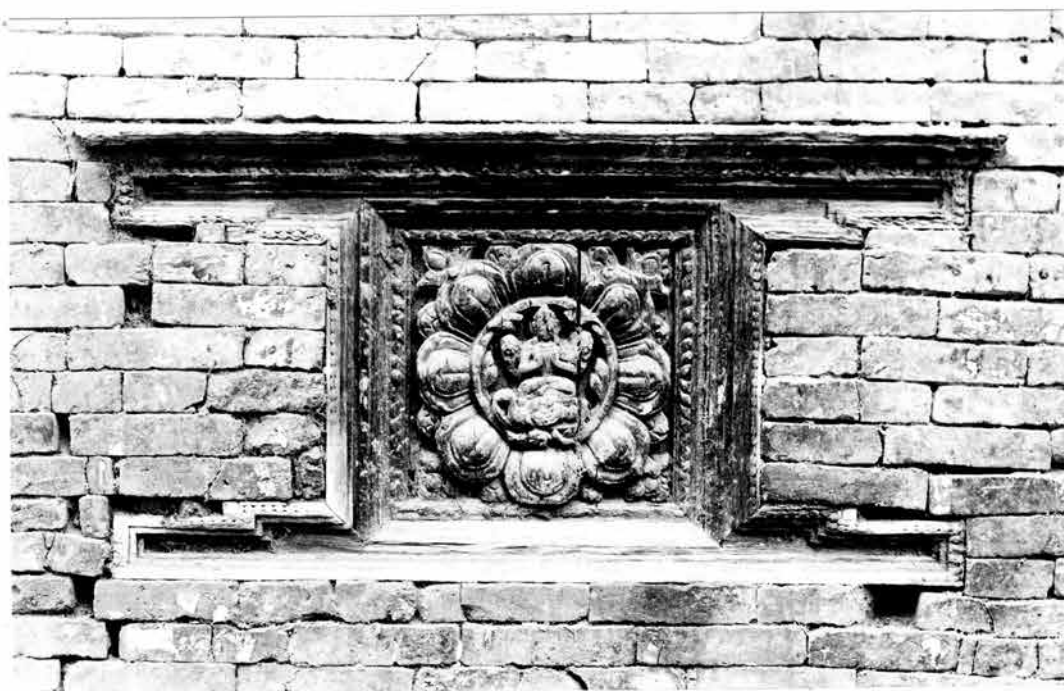


PATUKVA AGAM
 PATUKVA TOL, PATAN
 UNESCO WORLD HERITAGE SITE MONUMENT ZONE
 PRINCIPAL ELEVATION: EXISTING CONDITIONS
 KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993



Left : Lower roof strut on back (west) facade of upper pagoda.

Right : Mini- struts below *sanjhya*; corner struts with lizards are in storage.



Blind windows of entrance ensemble
Above, left of entrance; Below, right.
Figures are unidentifiable.

4.2 Iconography - General Description.

One of the richest and most characteristic expressions of Newar art is found in the conception and execution of woodcarving which adorn the building. Thousands of images-- many of them unique and unrepeated in other comparable locations on the building - contribute to a complex often inscrutable iconographical program. This iconographical program is fundamental to the conception and religiosity of the Hindu temple: the constellation of religious symbols and deities reconstructs a cosmological diagram, a mandala, and is integral to the architectural structure, itself holy in Hindu thought.

Among the Newar pagoda temple or shrine houses one finds variations in the iconographic programs, even of temples or shrine houses 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.

The figurative carvings of the Patukva Agache's architecture consist of:

- (1) Roof struts on two levels of the upper pagoda
- (2) Miniature struts below the bay window (*sanjhyah*)
- (3) Blind windows at entrance ensemble.

In general, the iconographic program has fewer images than a pagoda of the same age; the esoteric and Tantric nature of the images makes precise identification of images very difficult. The doors and windows are notably plain without iconographic material, they utilize stylized decorative elements.

Pagoda Roof Struts

Excepting the horse designs of corner struts (Newari: *kunsas*), repeated at both levels, all struts are articulated in three registers. A principal female figure dominates each strut with foliage register above and rock register below. The foliage register consists of four rows of four leaves each, total sixteen leaves. The base register of 4 leaves across, middle portion of the struts; below are symbolic mounts.

Sanjhya

Four different female figures are located beneath the vertical of the leaning bay window. At the corners the miniature struts are rendered as lizard figures.

Blind windows

Two different figures flank the entrance door to the ground floor shrine. The figures are unidentifiable female figures set in lotus blossoms.

5.0 EXISTING CONDITIONS

5.01 Foundations/walls: structural

5.02 Wall fabrics

5.03 Wall openings and decorative elements

5.04 Roof Structure

5.05 Roof Cover and decorative elements

5.06 Timber floor structure

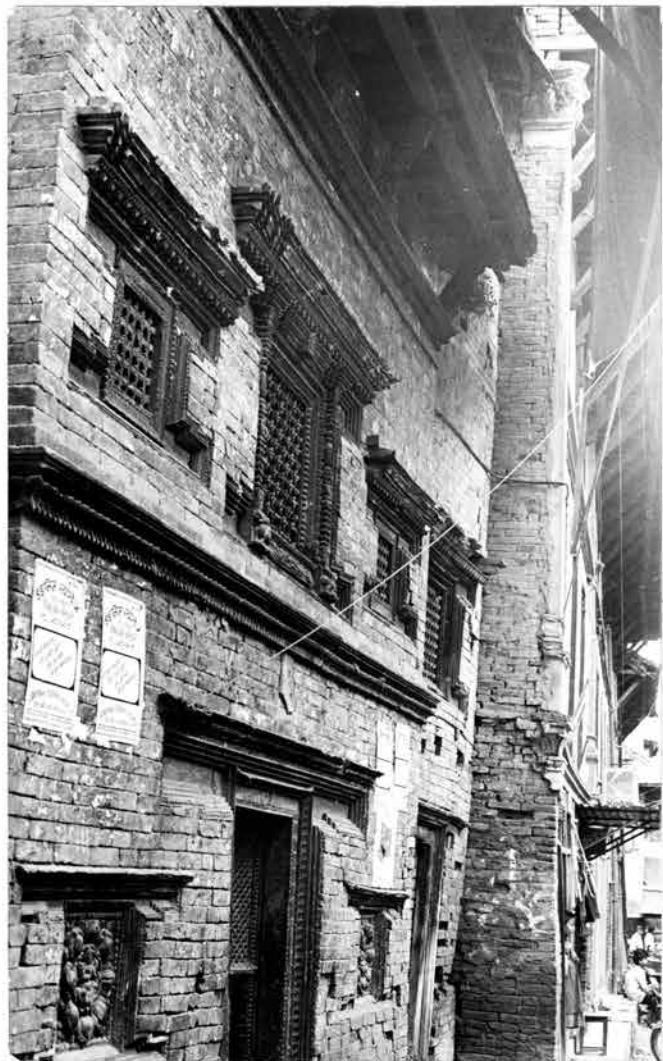
5.07 Interior

5.01 Foundations / Walls structural

Summary

While the masonry walls of the upper pagoda and their timber supports are structurally sound, the lower base structure approaches ruin. The rear masonry bearing wall of the lower structure has buckled out on the lower two stories (below the shrine) to create a cavernous hole approximately eight feet square. This wall has also settled as much as 7" in its central portion under the tower. The rear gallery timber structure has disappeared but for the lower two levels, which are heavily damaged. Roof cover over the entire base structure has been minimal for the last five years: unchecked rain damage has rotted out most timber structural members. The principal facade of the lower facade is not damaged, although serious cracks and movement are found to both sides.

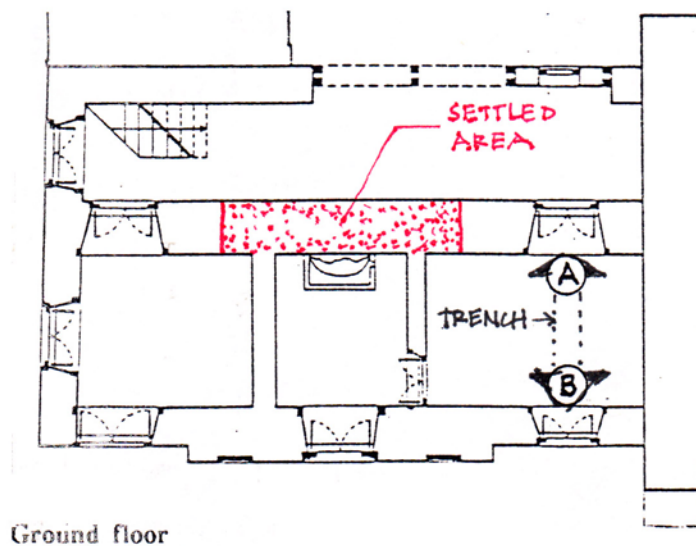
In general, the traditional masonry wall construction is structurally deficient because of minimal through-bonding between three distinct layers and settlement of the middle fill layer (see 4.1).



One brick projection of central bay of the principal facade.



The foundation of the building appears to be in excellent condition, consisting of river stones laid in mud mortar total height 5'-1" to ground level. Excavation summer 1993. It is unclear why significant settlement of up to 6" has taken place in the tower area of the N-S wall facing back courtyard (called middle wall in text).



Ground floor

5.01 Foundation

Excavation in two locations during summer 1993 determined the composition and condition of the foundation: it's height is exactly 5'0" from the bottom of the bricks above (ground level) to the bottom of the lowest stone below. The construction is of river stone (varying sizes approximately 9-12" diameter oval) laid in mud mortar, thickness of the stone foundation wall varies (front eastern wall: 4'3-1/2"; rear wall: 2'6"). Excavation has not been undertaken at the timber posts of the rear gallery in order to preserve adjacent historical tile pavement.

Settlement of the middle masonry wall has occurred only under the tower section of the building. Settlement varies from 7" maximum in the middle to 5" under the tower's north and south walls. No settlement is found at the end of this wall (outside central tower area). Settlement has been determined by comparative study of the wall plate levels.

No settlement is found on the front principal facade. Minor settlement of 1-2-1/2" is found in the stone bases of the rear timber gallery (from north to south: column 1: no settlement; column 2: 2-1/2" settlement; column 3: 2" settlement; column 4: 1"). These settlements were determined with a pipe level.

Lower base structure

The most significant failure of the structure consists of the buckling out and collapse of a later added masonry wall directly behind the 2nd floor shrine. This 9" thick wall appears to have been added as a security precaution for the shrine (otherwise closed only by timber planking at this level). Because of insufficient support by the historical floor joists, this wall led to the collapse not only of the joists it sat on, but also of the rafters above and portions of the original middle masonry wall.

There is a major void in this same bearing wall directly below the northern interior-gallery door. This void measuring 4'2" x 2'7" x 4-1/2" (one brick layer deep) appears to have been caused by unchecked water damage after roof loss over the gallery.

On the principal facade (south side, above first floor window) is found a structural crack 16 courses tall spreading two feet to the south with maximum gaps of 2-1/4" both inside and out. This crack again appears to result from water damage from the lost roof above, exacerbated by poor bonding at this the intersection of the old principal facade and 14 year old south wall.

A smaller crack is found on the northern side bay of the principal facade (above first story

window, six course high, maximum gap 1", no cracking inside. Another separation crack is found between the Agache building and its neighbor to the north. This crack is 3" wide at its maximum and extends from first floor to second floor height (approximately 6'0" height).

Above the second floor southern window of the principal facade, a failed timber lintel has resulted in the deflection of several masonry courses above. This failure has been caused by water damage allowed by the poor roof condition.

Notably, at the northern bearing and party wall of the agache is found only a 4" (one layer) brick wall connecting front and middle longitudinal walls. This lack of critical structural wall has resulted from an historical encroachment by the northern neighbor.

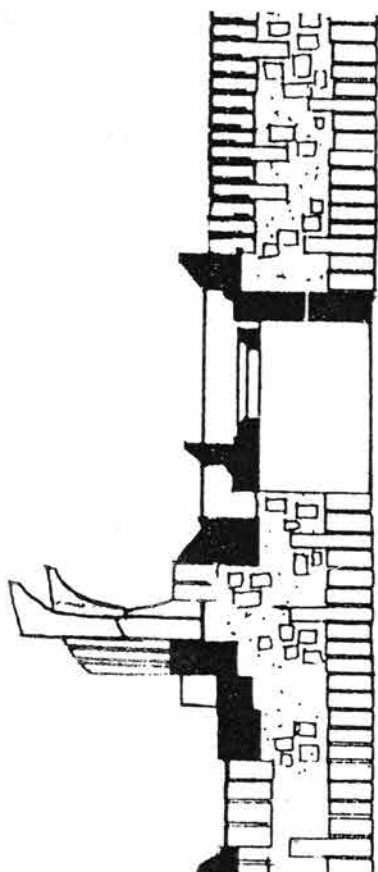
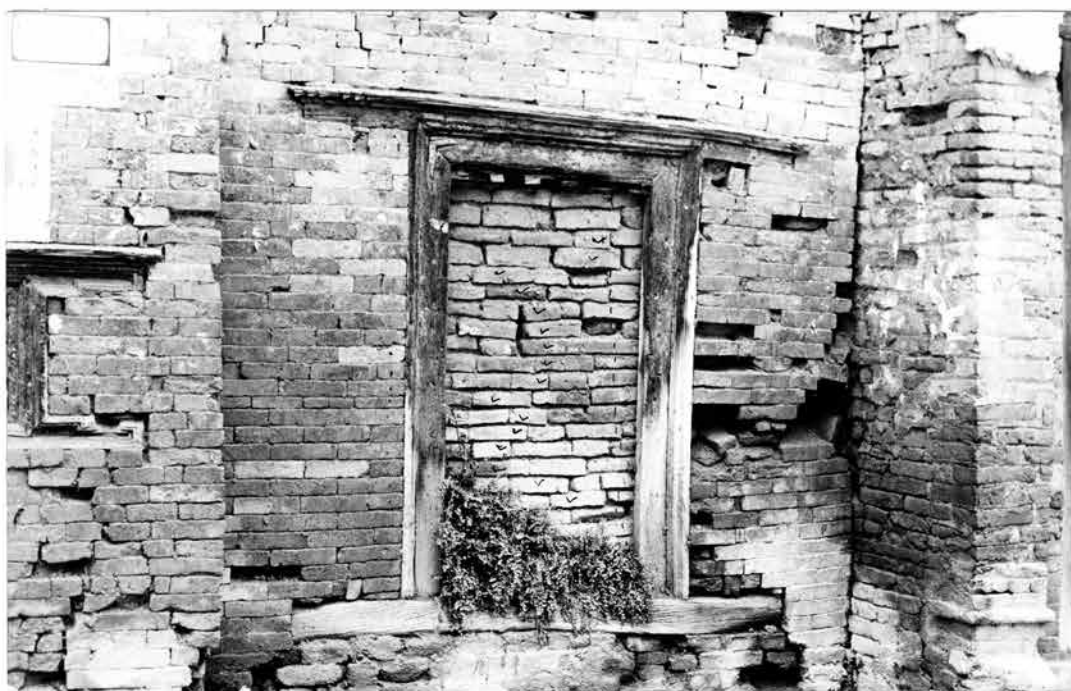
Lastly, the masonry wall in the stair area (west wall and party wall) is constructed in sun-dried brick above the ground floor. This wall shows signs of movement away from its neighboring structure of maximum 2" resulting from rain damage. All other brick construction in the building uses fired brick of mixed sizes (range 8"x 4-1/2"x 2-1/2" to 8" x 4"x 1-3/4").

All other masonry wall locations are in good condition with no visible signs of damage or movement.

Upper pagoda

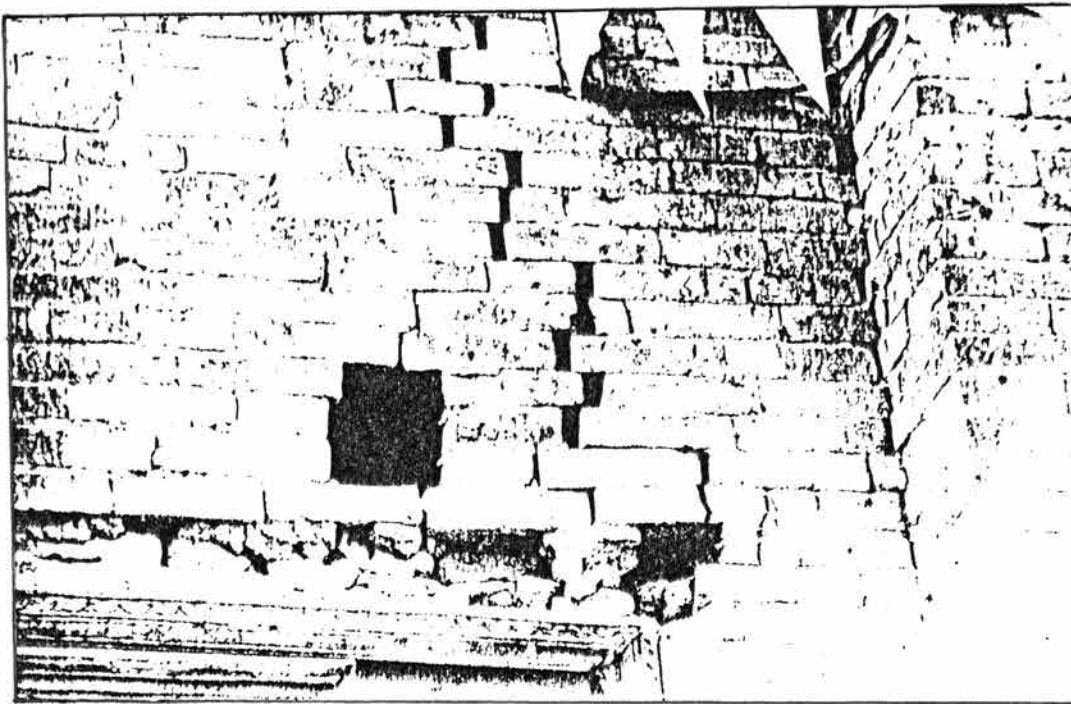
The upper pagoda structure, like many temple buildings in Nepal, rests atop timber beams and is thus discontinuous with the lower masonry wall structure. These timber beams in sal have been carefully inspected and found to be in excellent condition, although some historical deflection (maximum 1-1/2") is evident at centerspan.

There is no damage to the two levels of masonry walls which form the pagoda: there are no cracks; slight outward displacement of the walls from the roof thrust is recorded at 1- 1-3/4" at the four corners.



Above : Right (northern) door of principal facade: adjacent area with missing bricks.

Below : Section through wall at upper base storey windows shows typical construction: inner and outer layers with few headers and rubble fill between. This accounts for failure in veneer brick..



Above : Settlement of brick work above the second floor window resulting from roof damage and water penetration. August 1993.

Below : Wall crack above the first floor lattice window, south side principal facade. August 1993.

5.02 Wall fabric

Summary

The veneer brick (*daci apa*) of the principal facade of the lower structure and all sides of the upper pagoda tower is in good condition with a few exceptions.

Base story: principal facade

The building plinth (Nepali: *peti*; Newari: *fa*) of the principal facade is lost, exposing several layers of common brick (*ma apa*) and in some locations the foundation stones as well. Above, the highly fired veneer brick (*daci apa*) is of a deep crimson color and smooth finish typical of brick more than a hundred years old.

Damaged bricks are found in a register across the facade and three feet in height from ground level. Some 25 bricks show signs of spalling; adjacent to these damaged bricks, others have



Southeast corner: notice later patch at corner at plinth level. August, 1993.

been pulled out leaving several gaps, notably one to the right of the northern door 2'2" wide by 4 courses high. The spalling is a result of the lack of damp proof course.

Separations between the bricks are discussed in the previous section 5.01.

The decorative cornice bricks (*kopu apa*, lit. lintel brick) are lost above the first floor south window and damaged and 50% lost above the first floor window to the north.

During the reconstruction of the south wall 17 years ago, the left bay of the principal facade was modified to include a quarter round cornice (just above the timber cornice of the central bay of this facade). Above this simple cornice, the face of the re-used brick was shifted some 3-4" forward. A small patched area is found at the southeast corner (see photo).

South elevation

This reconstructed facade in chimney brick and mud mortar is in good condition except for the scouring of joints. Lack of roof protection has allowed the yellow mud mortar (thicknesses 3/8"-1/2") to be washed out. Some 5-10 bricks show signs of spalling from lack of damp-proofing in the lowest registers.

The raised ground level in the small lane defined by this elevation most probably resulted from debris from the 1934 earthquake. It can be hypothesized that this raised ground level combined with rising ground dampness did enough damage to necessitate this wall's reconstruction.

Rear elevation

Outside of the areas where major structural damage has occurred, the historical common brick and/or mud plaster is in good condition.

Upper pagoda

These *dacia apa* walls are in excellent condition, although the finish of the brick and tightness of joints does not compare favorably with the lower principal elevation. Here, visible yellow mud mortar (thickness $\pm 1/4"$) are typical. Decorative brick and timber cornices are intact.

At the corners above the timber cornices are found two levels of overlapping and projecting decorative corner bricks (Newari: *lhahka*). Their considerable cantilever is supported by projecting timbers, are also decoratively rendered. At these two upper most levels all *Lhahka* are intact, but chipped.



Upper level of rooftop pagoda shows dacia apa framed by timber cornice pieces. Below common fired brick with visible mud mortar joints. All in excellent condition.

5.03 Walls openings, decorative elements

Principal facade

The very fine second-story leaning bay window (*san jhya*) has partially collapsed due to water damage from missing and damaged roofs. The right-hand of three principal bays, together with the two triangular corner bays, have fallen down in the last three years. Some of these damaged components have been secured by the project team. The remaining bay element are in good condition. The entire assembly is constructed in sal timber.

Flanking the *san jhya* on the second floor are two additional windows. The left window lintel has collapsed due to water damage. The right hand window is in fair condition with some superficial wet rot, having suffered in its high location susceptible to rain water.

On the first floor, openings are in good condition except for missing brick cornice discussed under 5.02. Lattice work in the central and northern windows is damaged, approximately 6"x4" and 4"x4", respectively.

On the ground floor, the southern historical door has been replaced by a modern and larger opening. The historical door frame has been installed in the reconstructed south facade. The latticework of the central door is largely damaged or lost; the northern door has lost its shutters, replaced with brick infill.

The timber cornice of this facade's central bay is intact. The side bays appear never to have had a cornice.

South elevation

There is no historical evidence of the original configuration of this facade. Two doors have been installed in the 1977 rebuilding, one of which was originally found on the principal facade. Both doors are damaged by wet rot in the lower 18" of the frame. Historical shutters of the right (eastern) door are intact with damaged sections from wet rot; the left door has been blocked with brick infill.

Rear courtyard elevation

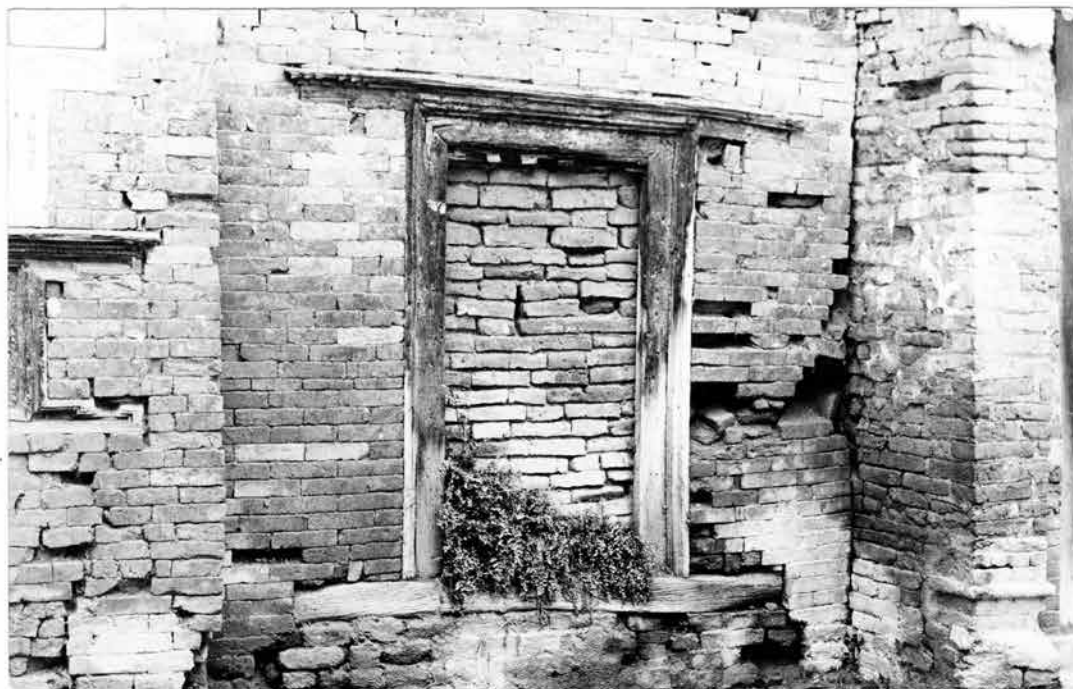
Five timber door openings on this elevation have all lost their shutters. All five door frames are damaged by wet rot in the lower third (approximately 18"). Timber lintels and inner frames also largely damaged by wet rot. This facade has been the most exposed to rain since roof was lost/damaged.

Seven of 16 historical columns survive, all damaged in the lower half by wet rot. Stone bases survive; one of four is cracked.



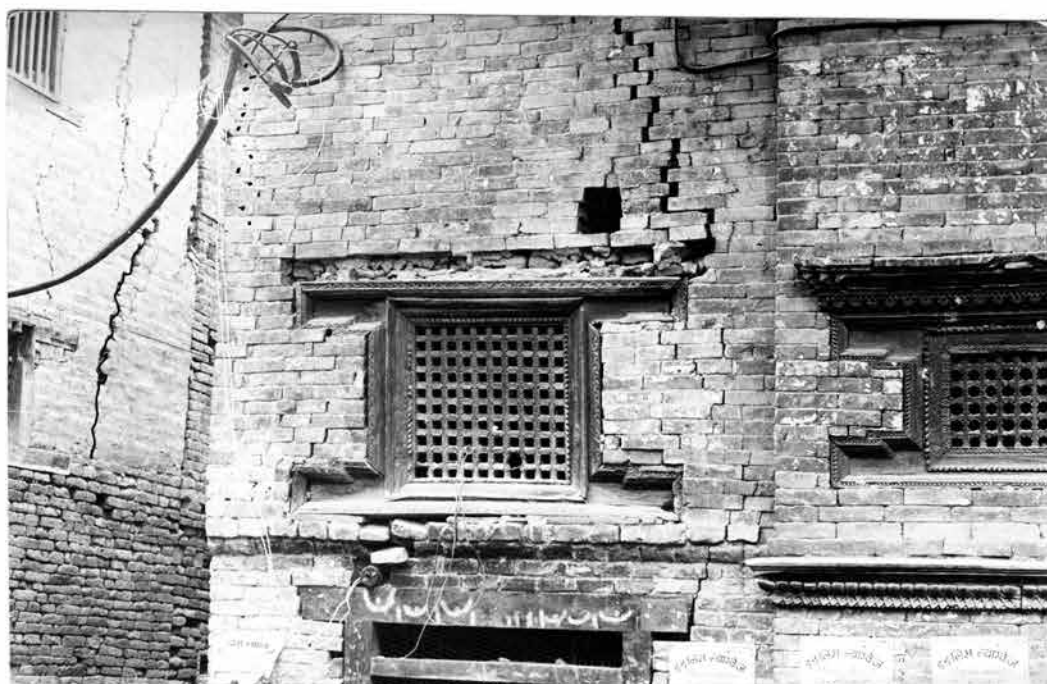
Left : Wall opening on South facade blocked by brick wall in 1977 repair.

Right : South facade: original door re-installed here from principal facade..

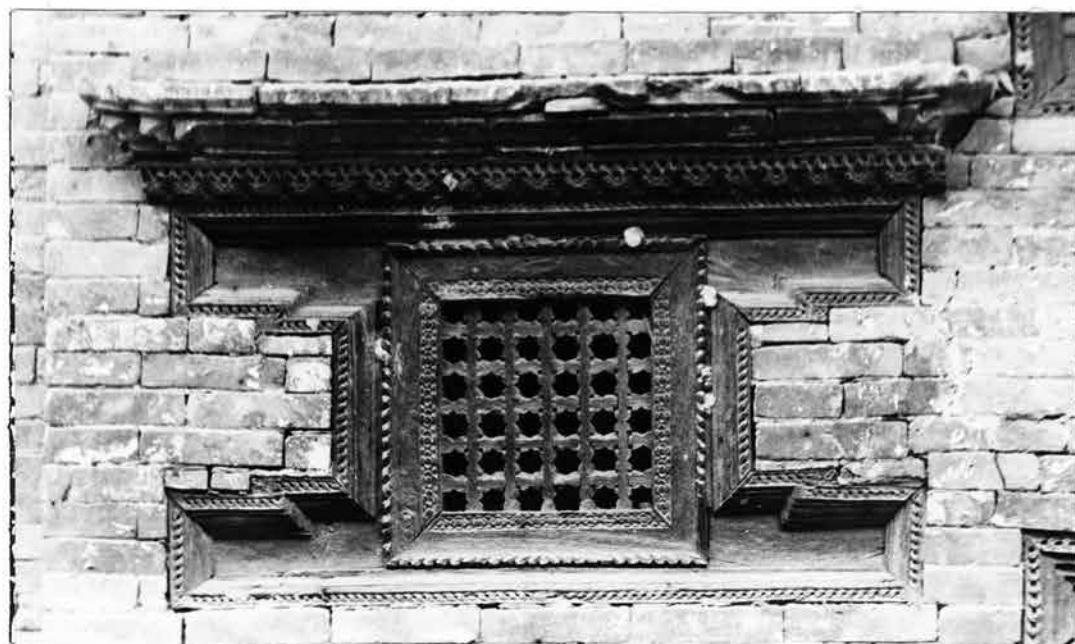
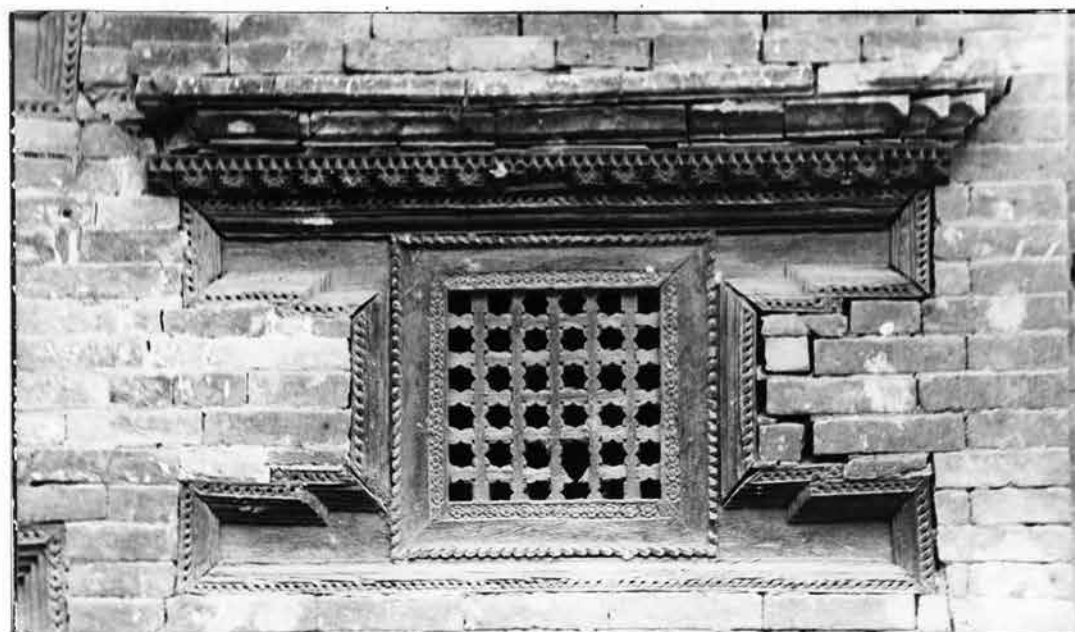
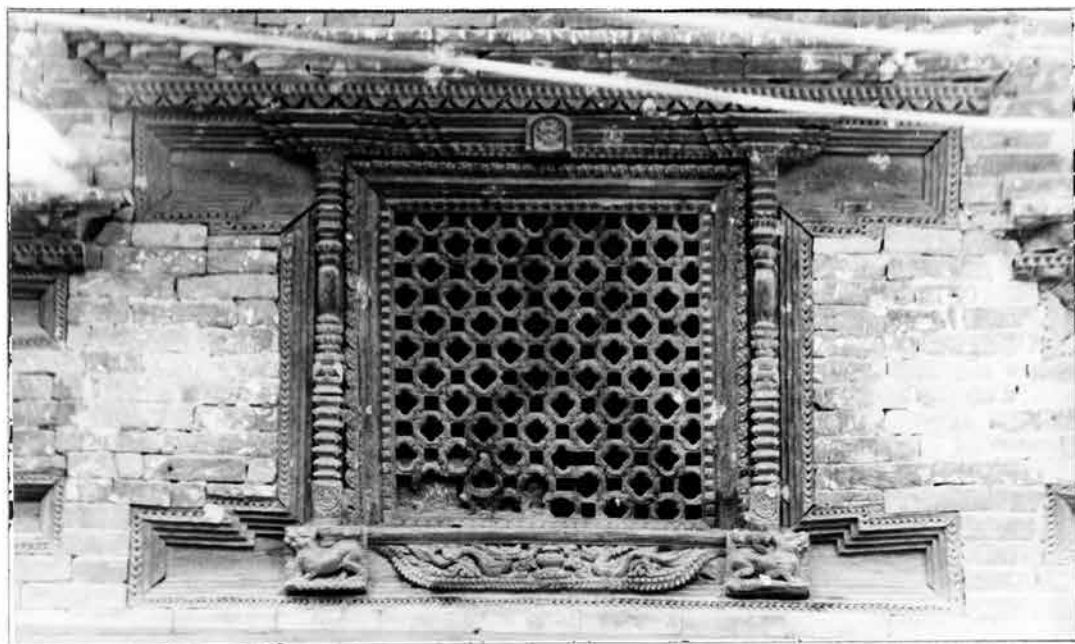


Above : New opening front facade left, from 1977 repairs.

Below : Historical door, principal facade north, blocked by brick in 1977 repairs.



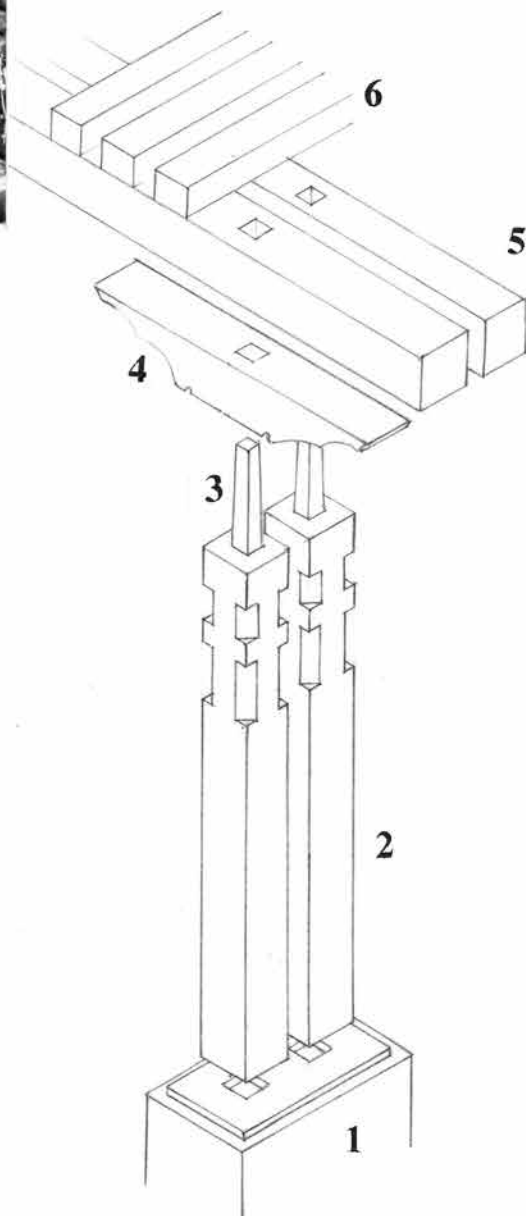
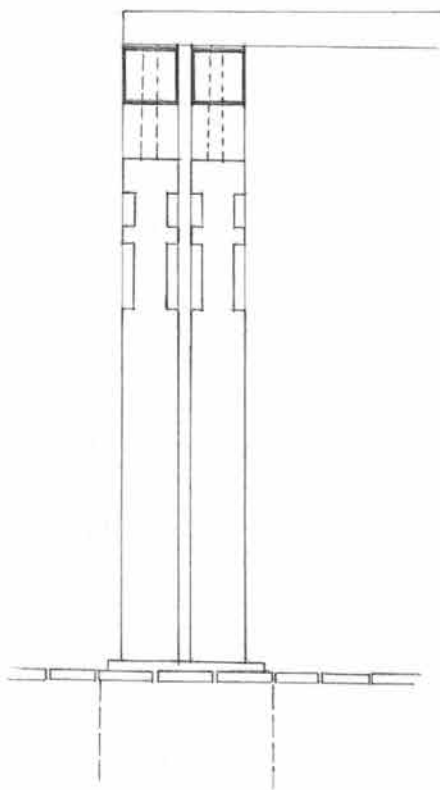
This page: First floor windows north and south ends. Opposite page: central window first floor. above with north and south flanking units below, respectively.





At the back elevation upper two floors (first and second floor) collapsed some five years back after several years of water penetration. Now only seven of the ground floor timber posts remain.

1. Base stone (*I Lohan*)
2. Timber column (*Than*)
3. Tenon (*Sa*)
4. Bracket (*Meth*)
5. Beam (*Nina*)
6. Joist (*Dalin*)



5.04 Timber roof structure

Summary

Little of the Patukva Agache's historical timber roof framing survives 1977 repairs which replaced historical pine members with new members in a jerry-built configuration to carry zinc sheets. Elders report that removed damaged roof frame members were pine has been confirmed by inspection of certain re-used elements, cut down and used for the metal roof supports. Extant historical interior floor joists are similarly of pine, contrasting exterior components like carved doors, cornices, and windows in sal. The distinction is here emphasized because of the common misconception that all historical applications used only sal, when in fact it is only the restoration and repair projects of the last two decades which have used sal exclusively. The general condition of the new roof frame is poor, damaged by wet rot, because the 1977 metal roof was not installed properly. The only extant historical portion of roof framing is found over the bay window of the principal elevation.

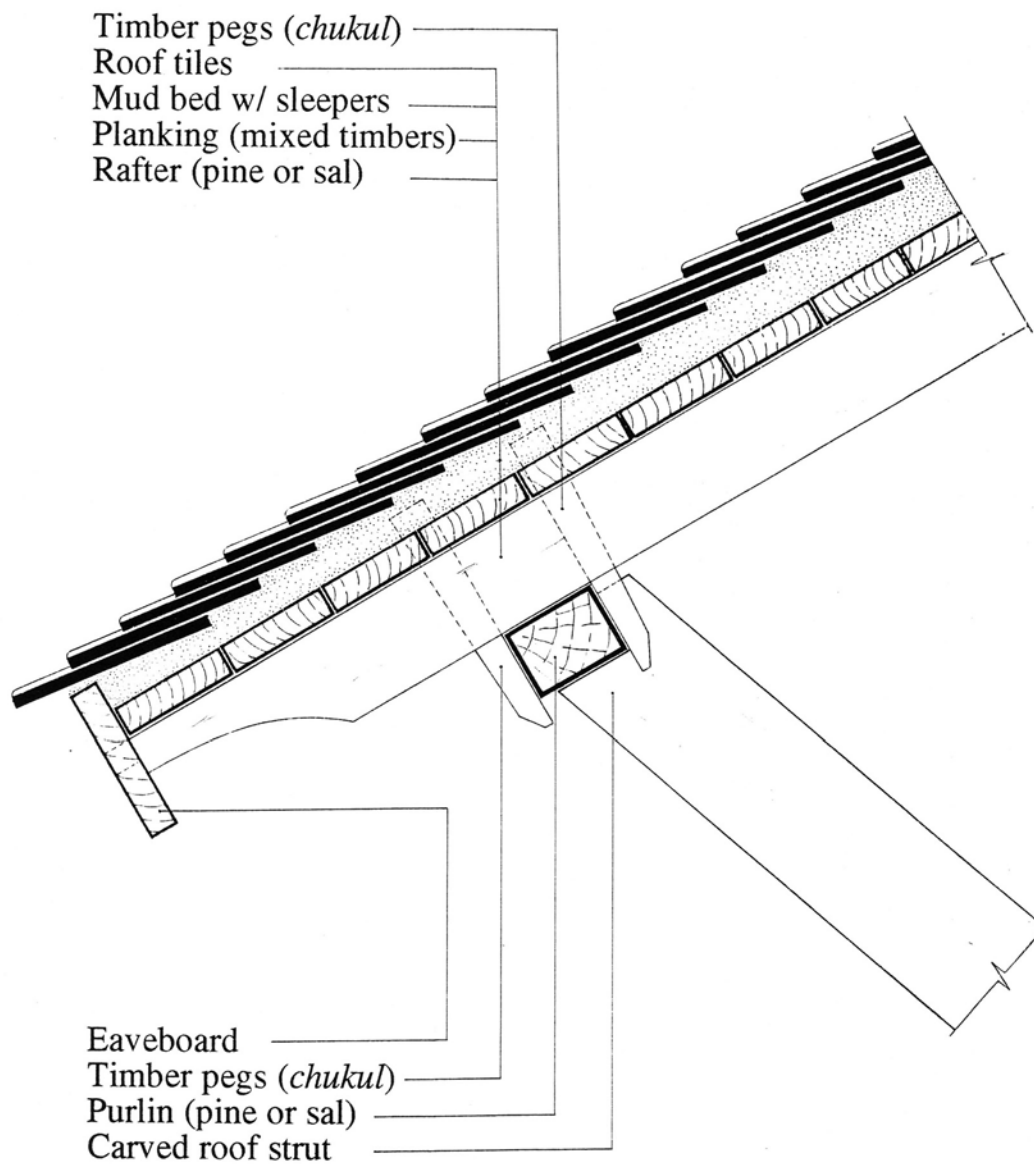
All pine and rafters in this extant portion show minor signs of past insect infestation (as do the interior historical pine floor joists). These bore holes, approximately 1 mm in diameter are found in irregular patterns and do not threaten the structural integrity of the members.

An important conclusion after detailed study of the extant roof structure is that the traditional wooden peg (Newari: *cuku*, Nepali: *chukul*) inserted as a key at wall plate and purlin is a principal entry point for water into the structural timbers. The traditional detail uses the peg as a key into the mud layer above. Thus any damage to or movement of the rather loose roof tile (Newari: *Jhingati*) allows water to reach the mud and then penetrate into 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 is especially critical at purlin locations.

At almost all (approximately 90%) of these peg locations, structural deterioration and in particular enlarged holes of these pegs to as much as 3" square (300%) has led to structural failure of the joints. This failure pattern is exacerbated by general dampness transmitted by the timber lath beneath the mud bed. This scenario describes the loss of rafters above the bay window here as well as the majority of roof failures in Newar buildings, and in particular at our other recent projects, Radha Krishna and Uma Maheswar Temples.

Lower Roof

Except for the front part above the bay window, this roof has been completely rebuilt with metal sheet roofs (north and south slopes), while the courtyard slope (west) was rebuilt with big tiles. These substitutions of lighter roof cover have allowed the Guthi to completely dismantle the historical pine roof framing, replacing it with an undersized ahistorical sal frame.



THE "KEY" PROBLEM

*Section at roof overhang:
as traditionally detailed*



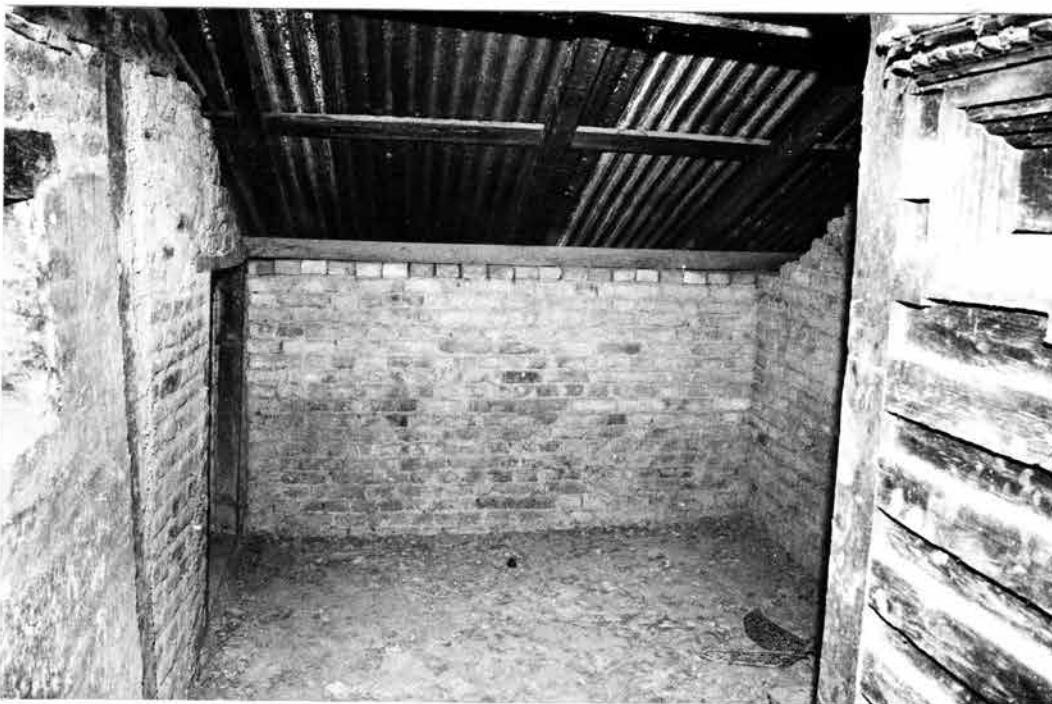
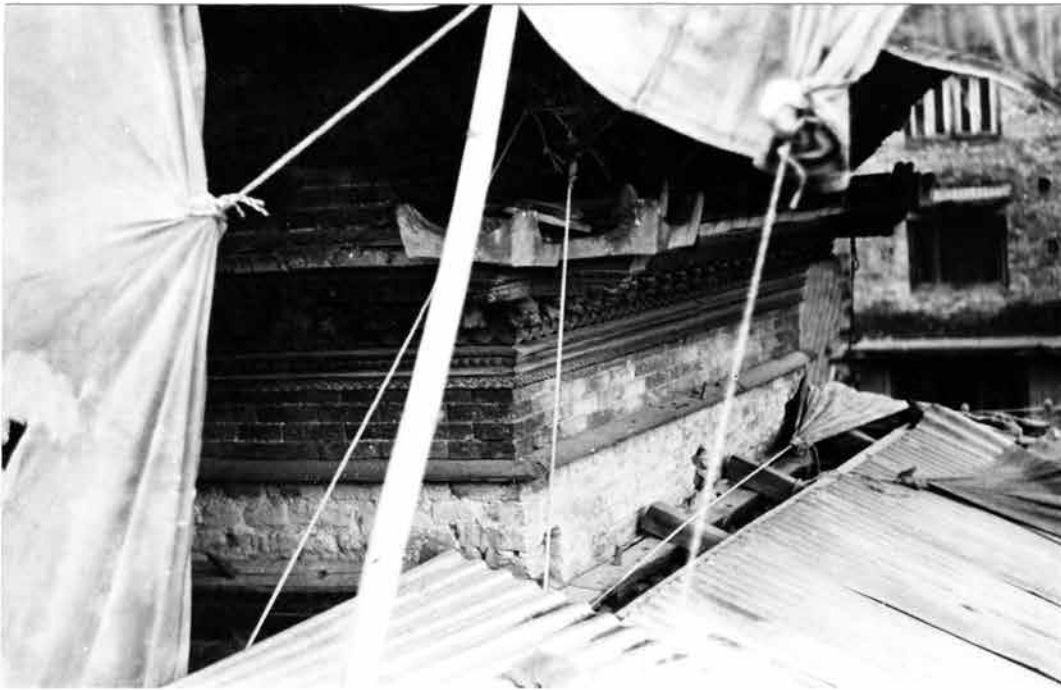
Timber lath above pine rafters has transmitted dampness from mud to rafter. Principal facade, August 1993.

The condition of these machine sawed sal members is good, although their reduced size does not correspond with the historical members (4"x 3" cf. 5"x 3"). The members have been fixed with an inappropriately shallow pitch and with insufficient overhang.

Elders report that the front (east) roof above the bay window was not rebuilt after the 1934 earthquake; it retains pine rafters, closely spaced (14" o.c.) with lath above. Most of these rafters are structurally damaged, from *chukul* or dampness transmitted by the lath.

Upper Pagoda Roofs

The upper roof has also not been repaired since before the 1934 earthquake, as reported by Guthi elders. All of the rafters and purlins are pine (5"x 4" on average, spacing 12" o.c. at eavesboard) and in very poor condition. Several pieces of the sal eavesboards are missing, surviving portions are in poor condition. All damage is related to wet rot caused by water penetration. Source of the problem, as at other roof locations, consists of water entry via *chukuls* and general dampness transmission from mud bed to rafter via lath under the mud.



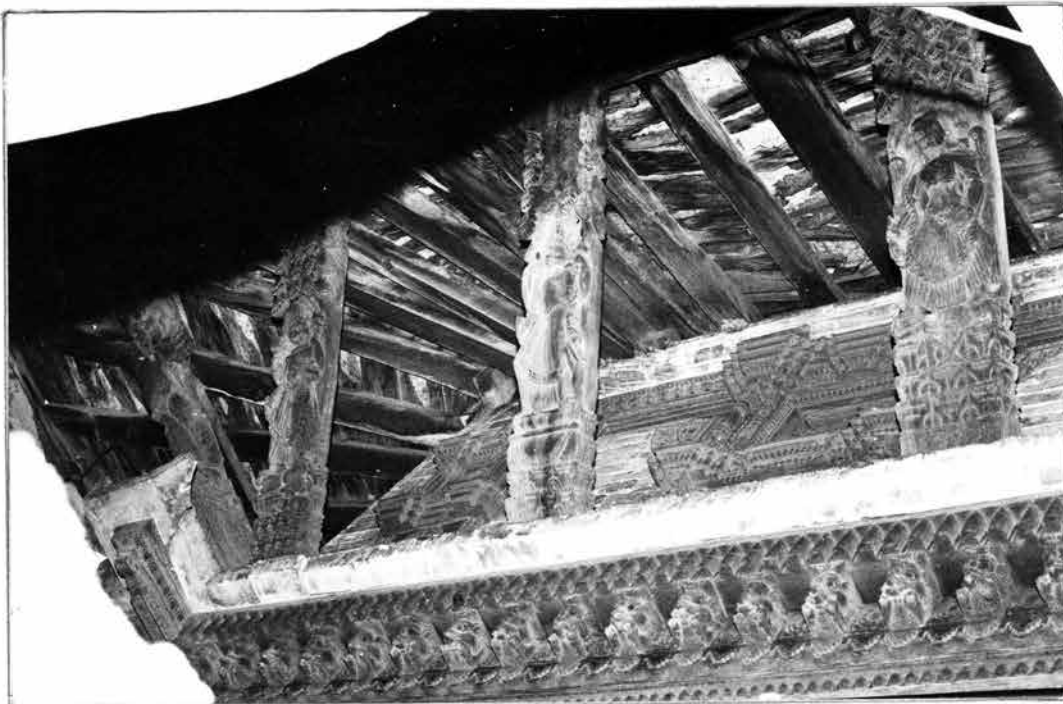
Above: Zinc roof on south side of building from 1977 repairs. Although zinc sheet is relatively easy to fix (especially in comparison with *Jhingati*), nevertheless, improperly executed repairs with zinc sheets have allowed water to enter the building.

Below: Replacement with zinc sheets allowed minimally rebuilt roof frame (rafter spacing +/- 3'7" o.c.).

Right: Eavesboard already lost and rafter ends rotted off, Upper pagoda(lower of two roofs) , south elevation. August 1993.

Below: Only a few metal strips hold a damaged eavesboard on west facade, upper pagoda (lower of two roofs).August 1993.





**Above : Uppermost pagoda roof from west shows broken eaves on North-West corner.
August 1993.**

**Below : Middle roof shows timber lath above pine rafters, typical of upper and lower pagoda roofs.
August 1993.**

5.05 Roof cover and decorative elements

Summary

On the lower roof, a traditional roof cover of lath on rafters with a clay bed above to receive the tiles is intact only above the bay window ,i.e. the eastern slope. The upper pagoda roofs similarly retain this traditional treatment with lath, a convention that has been in general replaced in all repairs and renovations of the last two decades, The norm during these years has been to substitute more water-resistant sal planking. Lower roof areas have been recovered in zinc sheets or larger tiles, laid dry.

Roof Tiles *Jhingati*

The roof tile cover laid in clay is largely intact on the two pagoda roofs, although many individual tiles have been displaced. All the ridge tiles have been replaced by two layers of brick laid in mud mortar from the 1977 repair. On the lower roof above the bay window even this later ridge in brick has been lost. Not a single corner aviform tile survives on any of the three roofs. These aviform tiles are the traditional corner treatment which give the roofs a slight *upswept* effect.

Metal work

One inch wide metal strips with triangular points are found with nails connecting all rafter heads at their penetration of the eaves boards of bottom, middle and top roof. Their 1 mm thickness has allowed them to rust through in all locations.

Roof Struts

All roof struts are in place. Based on stylistic grounds and visible lack of texturing by wind and rain, they appear to be not more than 100 years old. All the struts are sal and structurally sound showing no damage by fungi or insects. Historical cracks from the wood's seasoning are visible on several components, but pose no structural threats. Some struts have been discolored by water and mud running off the damaged roofs above.

See inventory.

Pinnacle (*Gajura*)

Rafters of the topmost roof meet to carry a central kingpost in sal wood. This kingpost supports the gilt copper pinnacle of traditional bell shape. The pinnacle appears to be original: it is nicely proportioned and undamaged. A 6" gap between the bottom of the pinnacle and the roof tiles below is found where such pinnacles would normally have a rectilinear base. Elders report that some thirty + years ago a masonry base existed, but since was lost. Many traditional buildings in the Kathmandu Valley have lost this base, which can be of masonry, but is more often in gilt or ungilt copper.

5.06 Timber floor structure

Base structure

Extensive water penetration over the last five years has induced wet rot and severely damaged at least 60% of the interior timber joist framing. The historical timber joists are of pine in sizes averging 5"x 4" (laid on flat, 12-14" on center according to local convention). Ten new joists in undersized machine sawn sal replaced damaged members in the 1977 repairs.

The wall plates are also of pine. Their long lengths (north-south) are made of up 3-4 pieces per side and lap jointed. In the western or middle wall, wall plates and opening lintels are in very poor condition, all damaged from years of rain pouring in. On the front facade there is less damage to wall plates because of limited roof cover. Surface probes suggested that between 30 and 50% of wall plate lengths are still structurally sound.

Upper pagoda

The beams which rest at wall plate level to carry the upper pagoda are the only interior structural members in the more durable and strong sal. They are in excellent condition despite what appears to be an historical deflection of 1-2" in the center.

Interior framing in the upper pagoda is intact and in good condition. It consists of joist like framing (although without floor cover) just above the principal econd story shrine. Above this tie members brace the structure at 45 degrees at the corners. Crossing members at the centerpoint support the pinnacle's kingpost. The kingpost of sal is in good condition; its pine supports are completely decayed from wet rot, especially in the central portions where pieces of timber 4"x 5"x12" have actually crumbled away.

TIMBER CONDITION

Ground floor ceiling joist

Location	Size	wood Type	Age	Condition	Remarks
Back Dalan (South-North)					
01.	11x8	Pine	19th cen	1/3 part damage rotten	Reuse
02.	8 1/2x5	Pine	19th cen.	Normal	Use
03.	10x10	Pine	14 year old	Rotten	Replace
04.	8x9	Pine	14 year old	Rotten	Replace
05.	10x10	Pine	14 year old	1/2 rotten	Replace
06.	11x7	Pine	14 year old	1/3 rotten	Replace
07.	14x8	Pine	14 year old	Centre rotten	Replace.
08.	16x8	Pine	14 year old	Seen face rotten	Replace
09.	13x10	Pine	?	1/2 thick rotten	Replace
10.	13x8	Pine	?	1/2 rotten	Replace
11.	15x9 1/2	Pine	?	1/2 rotten	Replace
12.	13x10	Pine	?	1/2 rotten	Replace
13.	10x9	Pine	19th cen.	1/2 rotten	Replace
14.	-----	-----	-----	-----	Missing
15.	-----	-----	-----	-----	Missing
16.	13 1/2x7	Pine	19th cen	1/2 rotten	Replace
17.	13 1/2x9	Pine	19th cen.	1/2 rotten	Replace
18-26	-----	-----	-----	-----	All missing
27.	10x4	Pine	19th cen.	Fully rotten	Replace
28.	8x9	Pine	19th cen.	End rotten	Replace

Ground Floor ceiling joist

Location	Size	Type wood	Age	Condition	Remarks
Front wing (South-North)					
01.	13x8	Pine	14 year old	Fully rotten	Remove
02.	13x10	Pine	14 year old	Surface rotten	Remove
03.	10x7	Sal	14 year old	Good	Usable
04.	12x10	Pine	19th cen.	Bad	Replace
05.	13x10	Pine	19th cen.	Normal	Use
06.	13x10	Pine	19th cen.	Normal	Use
07.	16x10	Pine	19th cen.	Half missing	Replace
08.	13x10	Pine	19th cen.	Surface rotten	Use
09.	13x10	-----	-----	-----	Missing
10.	13x10	Pine	14 year old	Side rotten	Usable
11.	14x10	Pine	19th cen.	Normal	Usable
12.	11x10	Pine	19th cen.	Normal	Usable
13.	15x10	Pine	19th cen.	Normal	Usable
14.	14x10	Pine	19th cen.	Normal	Usable
15.	14 1/2x9	Pine	19th cen.	Normal	Usable
16.	16x9	Pine	19th cen.	Normal	Usable
17.	14x10	Pine	19th cen.	Bad	Replace
18.	11x10	Pine	19th cen.	Bad	Replace
19.	16x9	Pine	19th cen.	End rotten	1/2 can use
20.	13x10	Pine	19th cen.	Surface rotten	Replace
21.	12x8	Pine	19th cen.	Surface rotten	Can use
22.	Variable	Pine	19th cen.	Bad	Can use
23-28	-----	-----	-----	-----	All missing

First Floor ceiling joist

Location	Size	wood Type	Age	Condition	Remarks
Front wing (South-North)					
01-05.	-----	-----	-----	-----	All missing
06.	12x8	Pine	?	surface rotten	Replace
07.	11x8	Pine	?	surface rotten	Usable
08.	10x7	Pine	19th cen.	surface rotten	Usable
09.	10x7	Pine	19th cen.	surface rotten	Usable
10.	12x9	Pine	19th cen.	surface rotten	Remove
11.	12x9	Pine	19th cen.	1/2 surface rotten	Remove
12.	12x8	Pine	19th cen.	1/4 surface rotten	Reusable
13.	14x8	Pine	19th cen.	1/4 surface rotten	Reusable
14.	15x8	Pine	19th cen.	1/4 surface rotten	Reusable
15.	16x8	Pine	19th cen.	Rotten	Replace
16.	16x8	Pine	19th cen.	Rotten	Replace
17-26.	-----	-----	-----	-----	All missing
27.	12x8	Pine	19th cen.	Rotten	Replace

First Floor ceiling joist

Location	Size	Type wood	Age	Condition	Remarks
Back wing (south north)					
01.	14x8	Pine	19th cen.	Rotten	Replace
02.	12x8	Pine	19th cen.	Rotten	Replace
03.	12x7	Pine	19th cen.	1/2 rotten	Replace
04.	10x8	Pine	?	Bad	Replace
05.		?	?	Bad	Replace
06.	16x8	Pine	?	Bad	Replace
07.	14x7	Pine	?	Bad	Replace
08-27.	-----	-----	-----	-----	All missing

5.07 Interior

Because of damaged and missing floor joists, the structure has been uninhabitable for almost a decade.

Finishes

The floors and walls are finished with mud plaster. This traditional plaster is made with mud, cow dung, molasses, and rice husk. This plaster is impressively durable and intact in many wall locations, approximately 40%.

Floor plaster is generally never removed, but simply added to in order to repair. The thickness of extant mud floors is between 4 and 8 inches. The mud floors rest on a mixture of timber lath and small bamboo stalks, a local variety of diameters less than 1/2" called *nigalo*.

Services

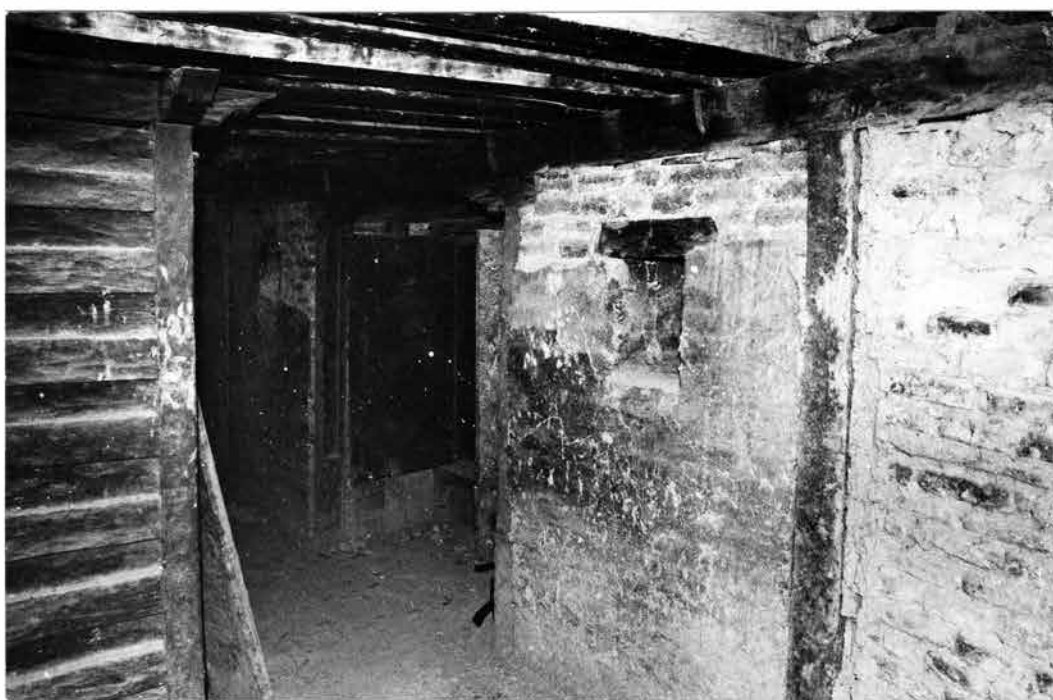
The building has never been electrified or fitted with running water or toilet.



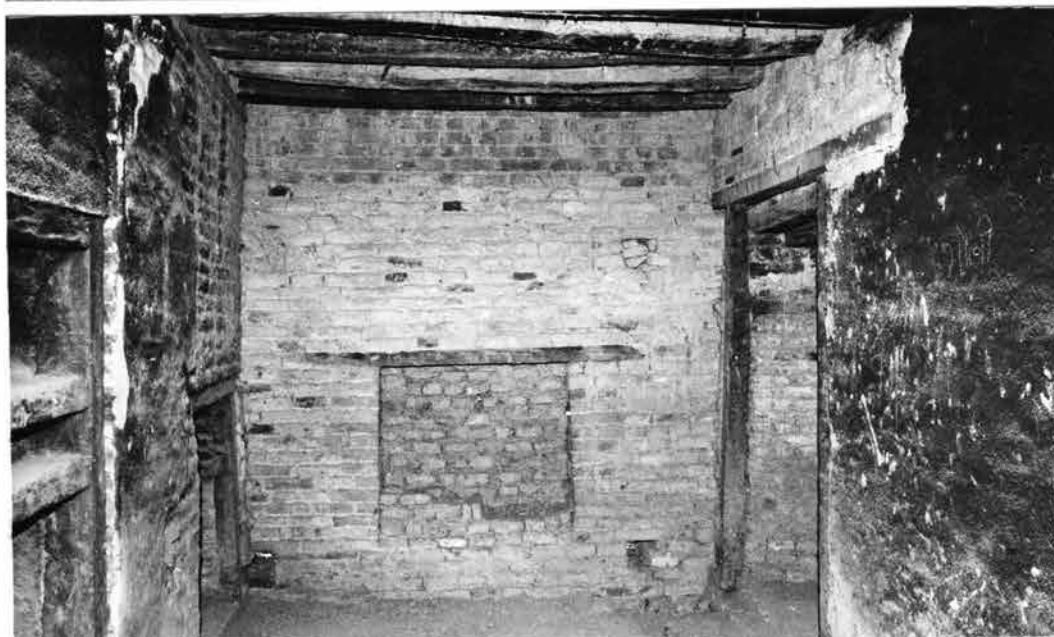
Left : Gap between bottom of pinnacle and roof tiles. August 1993.

Below : Inside timber structure of upper pagoda showing damaged tie in center and corner bracing, perhaps added in 19th c. reconstruction. August 1993.

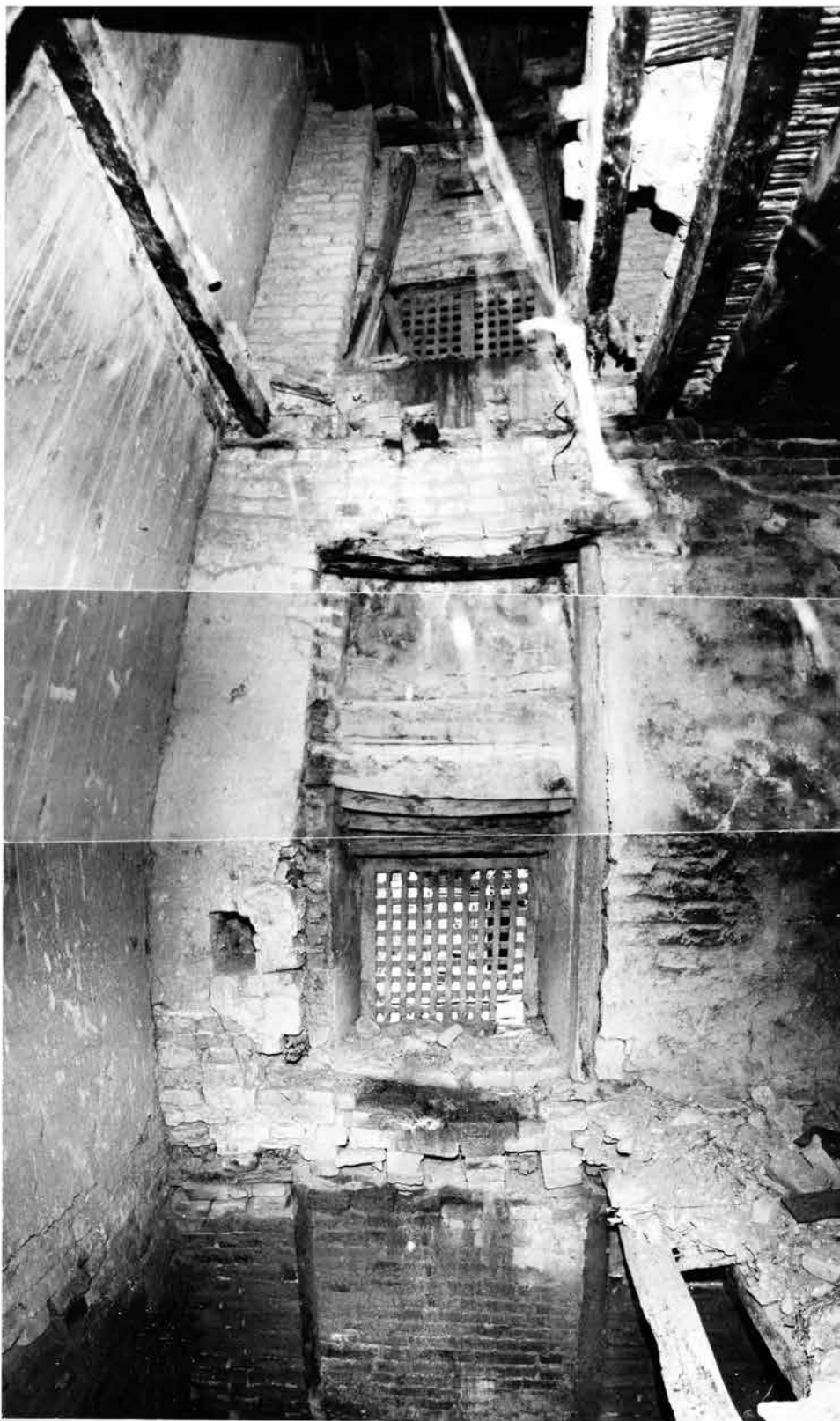




Above : Partition of esoteric shrine, second floor. Below: view towards *san jhya* with esoteric shrine left.
August 1993.



Above: Detail above south window first floor showing intact mud plaster and common brick beneath. Middle: First floor south face of 1954 partition left, central and south windows of principle facade right. Bottom: First floor looking south to blocked window.



Composite photo view looking east. The three northern openings of the principle facade (blocked door below) are visible as is collapse of all floor joist in this area.

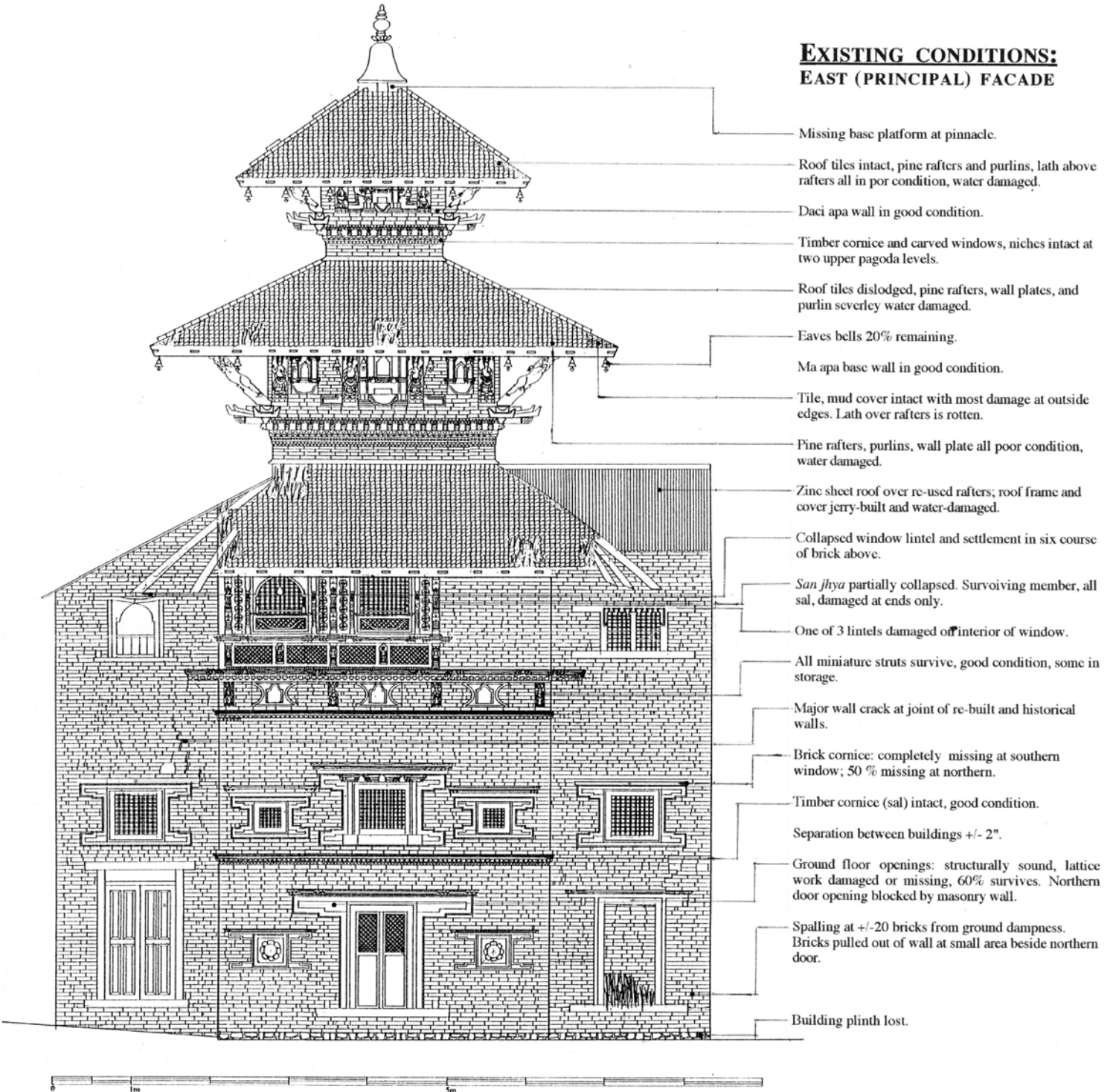


Above: Back of main building ("middle wall") showing second floor shrine location where masonry wall added behind timber partition led to structural collapse of rear gallery. Summary 1993. Below: First floor of rear gallery showing missing joist and partially collapsed adjacent masonry wall (left).

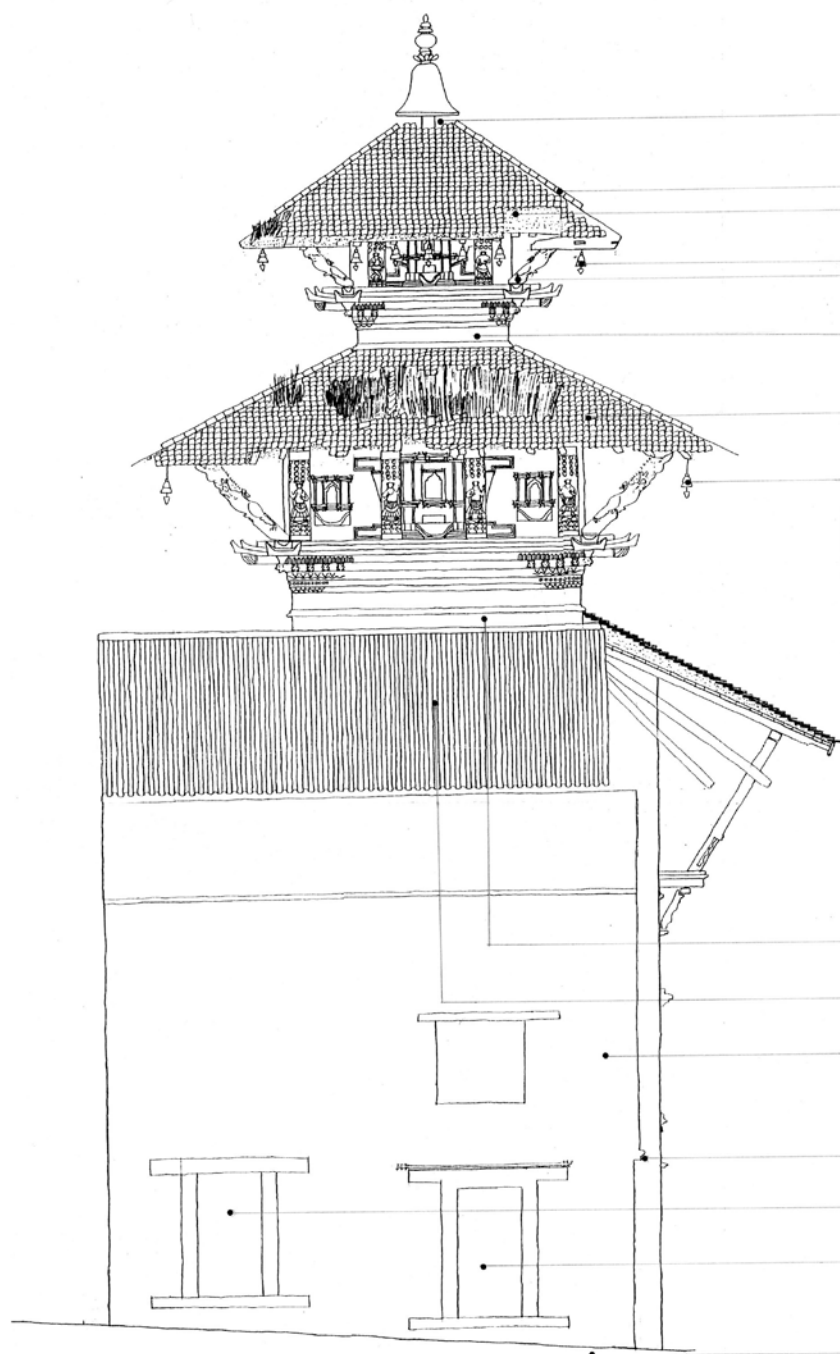


Above left: Back of esoteric shrine, second floor, showing original planking partition as well as later added and partially collapsed masonry wall behind, summer 1993. Above right: first floor level at back wing looking south to stair ladder. Below: Ground floor at back wing looking south, showing masonry stair middle, and gallery timber pier right.

EXISTING CONDITIONS: EAST (PRINCIPAL) FACADE



PATUKVA AGAM
PATUKVA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE
PRINCIPAL ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993



Existing Conditions

South Facade

Missing base platform of pinnacle

Roof tiles broken in west-south and south-east corner, ridge tiles replaced by brick.

All pine rafters, wall plates, and purlins and sal eavesboard in poor condition, water damaged.

60 % of bronze bells at eaves missing.

Sal struts and cornices in good condition at upper pagoda two levels.

Daci apa walls in excellent condition at upper pagoda two levels.

Roof: damaged pine rafters, purlins, wall plates; timber lath-poor condition, small holes in cover, esp. at outer edges; missing eavesboard. Ridge tiles replaced by bricks.

85 % of bronze bells at eaves missing.

Ma apa base wall in good condition.

Jerry-built sal roof frame, zinc roof sheets.

1977 chimney brick facade (south) in good condition, joints scoured.

Wall rebuilt above ground floor cantilevering 4" forward of ground floor.

Left opening blocked by brick wall.

Right door lintel and frame water damaged from raised ground level.

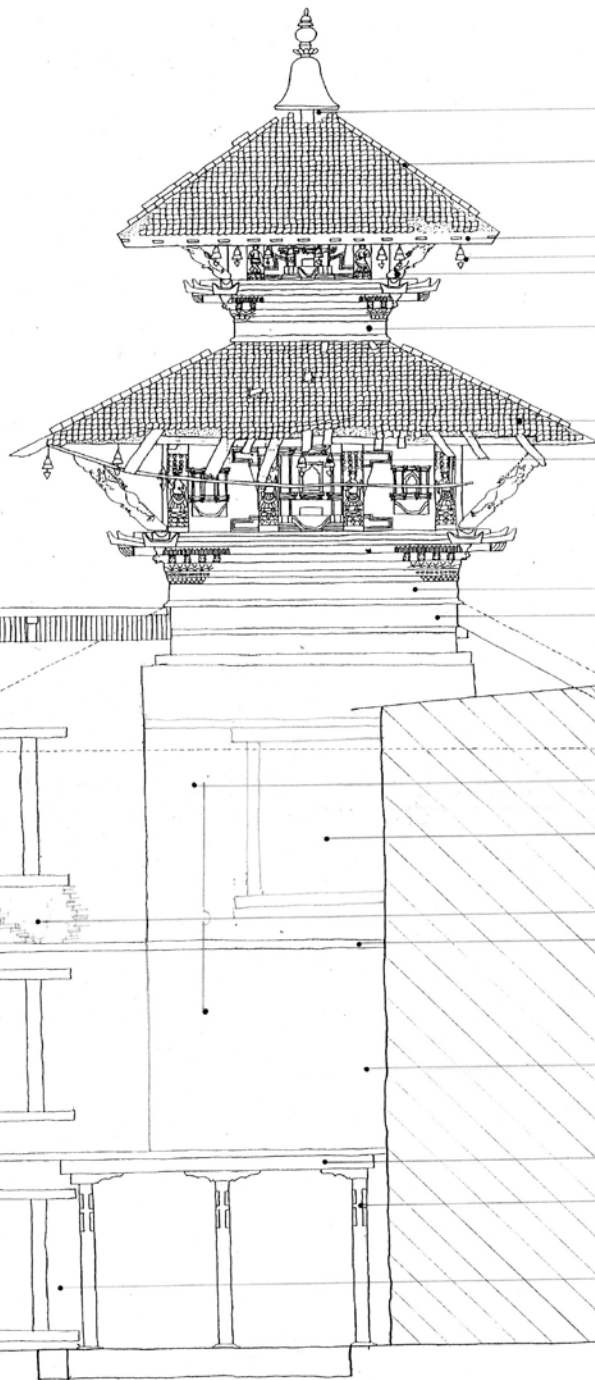
Missing plinth



PATUKVA AGAM

PATUKVA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE
SOUTH ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993

Existing Conditions West Facade



Missing base platform of pinnacle

Roof tile intact, ridge tiles replaced by brick.

All pine rafters, wall plates, and purlins and sal eavesboard in poor condition.

65% of bronze bells missing.

Sal struts in good condition.

Upper walls in excellent condition.

Roof damaged (broken rafters, small holes, and collapsed eavesboard); ridge tiles replaced by bricks

80% of bronze bells missing.

Dachi apa wall in good condition.

Ma apa base wall in good condition.

Lower roof: rafters, purlins collapsed.

First and second floor rear gallery collapsed.

Timber partition at the back of esoteric shrine broken in many places.

Wall (middle wall facing courtyard) damaged in many places esp. large collapsed areas at second floor level.

Pine wall plates: poor condition, water damaged.

Wall cracks in several places (min. 1/2", max. 1 1/2").

Pine wood beams: poor condition, water damaged.

Sal timber columns, surviving 8 of 16 are all water-damaged in lower 1/3.

Left (north) bay of gallery, which had been rebuilt in masonry, collapsed.

PATUKVA AGAM

PATUKVA TOL, PATAN
UNESCO WORLD HERITAGE SITE MONUMENT ZONE
WEST ELEVATION: EXISTING CONDITIONS
KATHMANDU VALLEY PRESERVATION TRUST, APRIL 1993

6.0 RECOMMENDATIONS FOR REPAIR

6.01 Foundations/walls: structural

6.02 Wall fabric

6.03 Wall openings and decorative elements

6.04 Roof structure

6.05 Roof cover and decorative elements

6.06 Floor structure

6.07 Interior

6.01 Foundations/walls structural

Introduction--seismic reinforcement

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 help withstand earthquakes. Structural characteristics in the historical design and present conditions of the Patukva Agache which affect performance in an earthquake can be summarized.

*The lack of vertical structural continuities in the mud mortar wall is not good for performance in earthquakes. Typical of Nepalese buildings, the discontinuity of masonry walls at the base of the upper pagoda is especially noteworthy. At this location, the loads of the upper pagoda are carried by timber beams.

*The general looseness of the walls is a major problem in Nepalese historical buildings. Insufficient or non-existent through-bonding (to connect three distinct layers) greatly diminishes the strength of the walls. The exterior veneer has little to restrain it from movement out.

*These deficiencies of the wall structure are exacerbated by the “top-heaviness” of the overall building created by the rooftop pagoda and more generally by the great mass of the roofs. The mud bed of the roof tiles together with the significant projecting overhang of the roofs create unusually heavy roof loads.

*Furthermore, the general looseness of the timber structure resulting from traditional timber pegged joints, rigid in only one direction, detracts from performance in an earthquake.

*The mud mortar construction of the structure, 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.

* The present condition of the building threatens the monument: timber floor and roof structure are greatly compromised by water damage and, to a lesser extent, by careless rebuilding. A critical end wall to the north has been lost by encroachment.

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. Several alternative design solutions for seismic strengthening of the building have been pursued.

Key features of proposed seismic reinforcements are:

- (1) Rebuilding of the floors with double layer planking at 45 degree angles to create rigid plates at two levels. A perimeter beam frames this floor system.
- (2) Introduction of a timber frame on the interior of the building designed to carry floor and tower loads in the event of severe damage to the walls. Connections to repaired and renewed historical timber structure are maximized; this frame or skeleton also compensates for the critical missing end wall (north) of the building. Post locations (eight per floor) correspond to building interior corners and most critical locations beneath the upper pagoda's masonry walls.
- (3) General strengthening of timber structural connections (rafter-wall plate; rafter-purlin; post-beam) during repair and rebuilding work.
- (4) Reinforcement of the timber beams which carry the upper pagoda by insertion of two additional beams underneath and perpendicular to the historical members.
- (5) Introduction of new diagonal timber bracing in the upper pagoda interior.

An important development in the design process for the above was the conception of the new timber frame as an *auxiliary* skeleton, rather than as a framework inserted into the wall. This was suggested by Engineer Guy Nordenson and has several important benefits. Mr. Nordenson maintains that given the extreme structural deficiencies of the historical walls, it will be safer to construct a new auxiliary or *back-up* reinforcement than to attempt to improve the old walls. At the same time, the solution is critical for the project's conservation philosophy as it allows a minimum intervention to the historical walls and proposes a solution which is reversable, i.e one could theoretically remove it without doing damage to the historical structure. The independent timber skeleton is sympathetic visually to the historical interior while also being clearly distinguishable from the historical timbers.

Philosophically, it is in keeping with many historical structures in Nepal where later repair and rebuildings have introduced additional (sometimes inelegant) timber reinforcements (Kwa Baha and Vabaha towers are two examples where distinct 19th and 20th century layers of timber reinforcement are recognizable).

In all but two ground floor locations introduction of the new posts and beams does not necessitate any destruction of historical walls. The new skeleton will be executed in the most durable sal timber and will contrast the extant, repaired, and rebuilt historical timber framing in pine. Because of this design solution, research and design work to develop (a) stranded metal tensile strength reinforcements and (b) metal rods for general wall reinforcement have been suspended (see Technical update 2/94 in the appendix.)

(1) Stiffening plates

(a) Concurrent design work by the project team for the Palace of 55 Windows with international seismic engineer Walther Mann employed the strategy of inserting rigid plates, in this project, reinforced concrete slabs above floor joists in the historic structure. This process is relatively uninvasive as the floors generally must be rebuilt in historical structures in the Kathmandu Valley. The principal alternative would be the insertion of perimeter ring beams.

(b) We adopt this strategy of stiffening plates at floor levels for general lateral reinforcement. Given the small size of the Agam, it will be structurally feasible and aesthetically preferable to use two layers of timber planking as this stiffening plate (laid at 45 degrees to the walls, the two layers perpendicular and nailed to each other).

(c) The timber plate has the advantage of being more compatible with the mud, brick, and timber structure into which it is being inserted. This substitution of timber planking for r.c.c. was suggested by Sir Bernard Feilden.

(d) Planking is two layers of one inch thickness sal planking. The planking is framed by a sal perimeter beam 5"x 3".

(2) Timber auxiliary frame

(a) The new timber skeleton is designed to carry floor and tower loads in the event of wall collapse, but it also provides critical reinforcement to the masonry walls, acting as a brace. Post locations directly under the masonry walls of the upper pagoda increase critical vertical continuity.

(b) Using the intact and impressive timber tie structure of the structure's upper pagoda as a starting point for the design, the introduction of timber members to increase the vertical structural continuity seems logical and aesthetically unintrusive. Timber has the clear advantage of being more compatible with the existing mud mortar walls (in terms of mass, flexibility, and strength) than steel and reinforced concrete alternatives.

(c) To achieve sufficient strength (while maintaining a size for the new timber members which will not interfere with head clearance and be similar in proportions to historical framing)

a two pile solution was developed, that is 3 posts across in cross-section. Posts are inserted against the east and west walls of the principal interior rooms and against the masonry wall of the rear gallery.

(d) Post sizes are 11 cm. by 11 cm. Locations correspond to the upper pagoda wall locations and interior corners of the building.

(e) The skeleton is made stiff laterally by the rigid plate of angled planking nailed to it. The planking system has allowed calculation of frame sizes based on the lower floors skeleton having "locked" or rigid joints. The skeleton is linked to wall plates, joists, and rafters with bolted connections.

(3) General improvement of structural connections

(a) The introduction of timber posts in eight locations per floor will be joined to the extant and replaced tie members (at wall plate level) with mortise and tenon joinery (where possible) or with concealed steel plates.

(b) The rebuilding of the rear timber gallery will incorporate the following structural improvement: every 3-5' (and wherever possible) floor joists will be made longer to allow connections to the wall plates and/or vertical posts of the main building. In effect this gallery structure will act as a buttressing structure.

(4) Additional reinforcements-pagoda beams

(a) At the meeting of the upper and lower structures, strengthening of critical timber joints with steel angles is recommended where the upper pagoda is carried on timber beams. Given this interior location use of steel with anti-corrosive paint is acceptable.

(b) Given two inch deflection of the principal beams carrying the upper pagoda, precautionary reinforcement with beams just beneath and perpendicular to these beams is recommended.

(5) Additional reinforcements-upper pagoda

(a) In the interior of the uppermost pagoda, diagonal bracing in timber will be introduced as a precautionary measure. This portion of the interior is not habitable and little visible, accessible only via a hatch near the second floor shrine.

Introduction: *in situ* repairs and damp-proofing

As a model for ongoing and future conservation work in Nepal, the project team opts for the most conservative of strategies to maximize retention of historical fabric. Key strategies and techniques to this end include:

- (1) Repair and rebuilding will be done in very small areas at a time to minimize dismantling. It is believed that many floor joists can be left *in situ* if great care is taken. Similarly, with a few notable exceptions (discussed specifically under structural wall damage 5.01), little of the intact masonry wall area will have to be dismantled.
- (2) Seismic reinforcement (discussed above) consisting primarily of an interior timber skeleton, a distinct and reversible structural layer.
- (3) This seismic skeleton's bracing of the masonry walls are used instead of invasive reinforcements installed inside the wall.
- (4) A new damp-proofing course will not be inserted based on the following considerations. It appears structural damage caused by this insertion of such a course in copper or reinforced concrete (to name two alternatives considered by the project team) may be greater than the very minor surface damage to bricks caused by lack of protection over the last three hundred years. It is clear rising ground-dampness is not a critical problem in this location and structure.

Foundation

Engineer Joshi's inspection of the excavated foundation found it sufficient for the building loads. Six inch settlement recorded in the middle longitudinal wall is historical and shows no signs of recent movement. This settlement has not been explained, but poses no present threat to the building.

No repair or rebuilding work is proposed for the foundation.

Lower base structure

The major structural collapse of the middle wall will be remedied in the following way. First, the remaining portion of the wall which was added (behind the 2nd floor shrine and which caused the structural collapse) will be dismantled. Removal of this wall will reduce the risk of further deterioration or collapse.

Once emergency roof cover is secured, the damaged portion of the wall will be rebuilt in matching materials, fired common brick and mud mortar, with great attention to bonding with undamaged adjacent wall areas.

Structural cracks on the principal facade

From the exterior brick fragments will be pieced in order to maintain adjacent historical bricks.

From the inside these serious cracks merit dismantling of an area one foot to each side of the opening to allow sufficient interlock of rebuilt patches with adjacent undamaged areas. In all cases, historical materials will be matched.

Rebuilding of the small area of masonry wall (approximately 3'x3') above the collapsed lintel of the south window, second story window will be necessary.

At the two locations where spaces have developed between the project building and adjacent buildings (north edge of principal facade, eastern boundary of wall adjacent to stair) these cracks will be filled, as rebuilding to achieve plumb and matching walls will necessitate major rebuilding. In the wall area adjacent to the stair hall damaged sundried brick will be replaced with more durable fired common brick.

Upper pagoda

The wall is in excellent condition; slight outward displacement of the walls poses no structural threat and will be maintained.

6.02 Wall fabric

Summary

Where patches are necessary to the historical *daci apa* surface of the principal facade (about 20-30 bricks), historical brick of identical size and similar color will be scouted to match historical patina. They will be fitted in using yellow mud mortar to match the existing.

In an effort to preserve rather than restore, the 17 year old projection of the southern bay of the principal facade will not be dismantled and rebuilt flush with the historical facade, nor will the southern facade of the same age in chimney brick be rebuilt. The original southern facade may have been *daci apa*, but probably was in common brick more carefully laid than the present construction. Scoured joints in this facade will be pointed with yellow mud mortar; the repaired roof will prevent future scouring.

Missing cornice bricks will be custom ordered from a local brick factory. This production will be closely monitored by the project team in order to control quality, particularly in length of firing. Chipped historical corner cornice bricks (*lhahka*) will be maintained rather than replaced as new replacements would be of much inferior quality.

Upper pagoda

No work necessary.

6.03 Wall openings and decorative elements

Repairs will be made to the extant historical timber components to allow maximum conservation of historical material. In the case of the damaged latticework or *jhali*, for example, new pieces will be fitted in to match while retaining any historical material possible.

The focal element, *san jhya* 70 %. New pieces in *sal*

South elevation

The original door of the principal facade will be removed from this elevation and re-installed in its historical location with repairs. A door of similar design, with details reduced, will be fabricated for this location to provide access to the ground floor rental space proposed by the Guthi. No signage or non-historical openings will be allowed on the principal facade.

A blocked and damaged timber-framed opening in the 17 year old south facade, first floor, will be replaced with new window of simplified historical design. This window was requested by the Guthi on this floor and the floor above. Given the lack of historicity on this facade, as well as its side alley location, these changes to make the building more liveable (all other windows are latticed!) was judged acceptable.

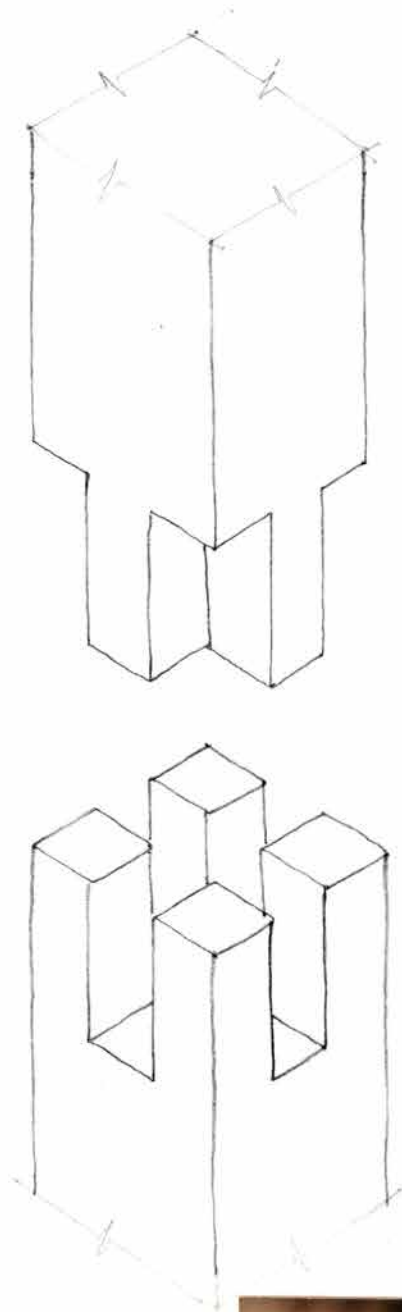
Rear courtyard elevation

Repair will be made to the five damaged timber-framed openings. On all of these openings, the lower third of the structural frame and lintels are damaged by wet rot. These damaged areas and elements will be repaired or replaced while maintaining the sound areas of the timbers.

Columns will be repaired in a similar way, cutting off the lowest damaged portions and joining new timber feet to the historical elements. Jointing between new and old timbers are shown below. The restored rear gallery will require new railings. Working from extant examples of similar age, and with approval from the Department of Archaeology, new visually appropriate elements will be designed and installed.

Timber treatment

All *sal* timber openings and decorative elements will not be treated with preservative per the recommendations of the 1992 ICOMOS Wood Conservation Mission to Kathmandu. During that mission the following factors were discussed: (a) the great durability of *sal* wood; (b) the limited penetration of preservative-- even when soaked; and (c) the necessity to repeat every five years. These arguments recommended against *a priori* treatment with preservative unless clear justification could be found.



Proposed joinery detail of new feet for damaged timber columns uses "cross" design to transfer column loads efficiently. Photo of sample joint, May 1994, and sketch by R. Ranjitkar.



6.04 Timber roof structure

Lower roof

In an effort to restore both the historical configuration and materials of the roof, a roof frame in pine and matching the spacing and sizes of the surviving extant portions will be rebuilt. Only in several critical locations, where additional strength and durability are required, will sal members be used. These locations include: the corner rafters (which carry increased loads) and the purlins, which due to their exposed location are more susceptible to damage and which are especially critical to roof bracing (see related discussion of *chukuls* and roof failure under 5.04). Eavesboards will also be in sal, as are all historical and extant examples.

Local traditional joinery techniques for rafter fixing are limited to peg or *chukul* insertion. To improve structural integrity of the roof frame, which must carry considerable loads (300 kg/sq.meter), rebuilt rafters will be notched to the wall plate. Additionally, every third rafter will be conceal bolted to the wall plate.

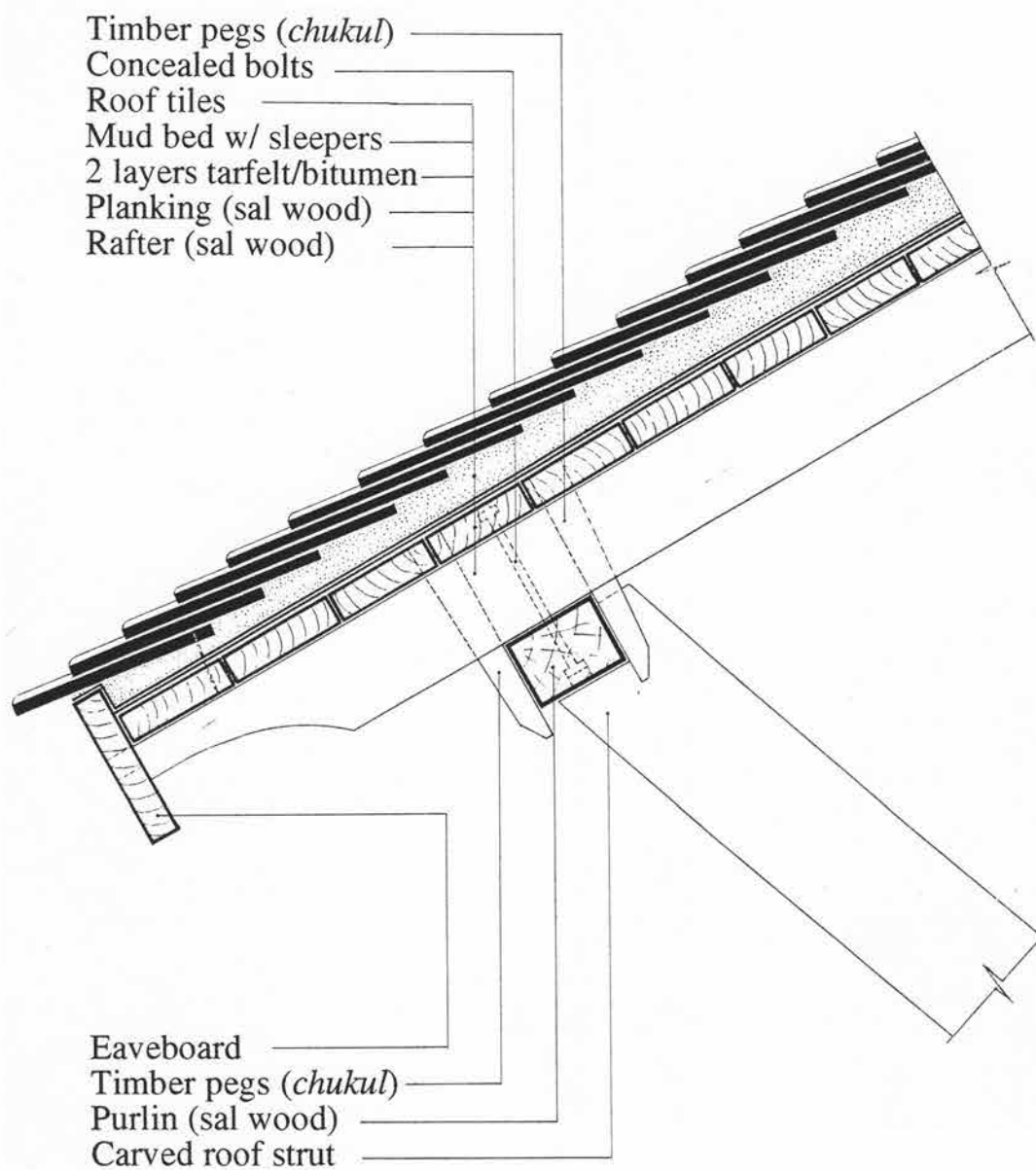
Upper pagoda

The universally damaged rafters will be taken out one at a time, repaired (where possible) and refitted in an effort to maintain the existing angle and level of the roof. This solution requires additional scaffolding and supports (to keep the struts in situ), but has proven successful at the recently completed Radha Krishna Temple.

As on the lower roof, new timbers will match the historical in type, size and finish, that is, pine, 5"x3 on average, and adze finished, respectively.

Timber treatment

Based on the advice of visiting timber conservation expert David Michelmores, the treatment of all pine timber with Wykamol Permetheryn preservative will be undertaken according to manufacturer's recommended application. This recommendation is based on numerous examples in the Kathmandu Valley of termite attack to pine including the principal *sattal* buildings at Pasupatinath and the Ayaguthi Sattal at Patan Darabar Square. At the Pasupatinath example, termites passed over sal columns, leaving them undamaged, to attack and destroy pine lintels.



THE "KEY" PROBLEM

*Section at roof overhang:
Improved detailed*

6.05 Roof cover and decorative elements

Roof tiles/*Jhingati*

Past project experience has demonstrated that the quality of new tiles is so inferior to the old, that scouting of old tiles is worth the effort of hunting as well as cleaning. All used tiles will be first soaked in water and then cleaned with wire brushes. Given their saturation over the years, these old tiles do not need siltrate treatment, which reduces absorption.

Ridge and aviform tiles will have to be custom ordered due to unavailability of historical pieces. The shorter life of these new products can be extended by treatment with siltrate. Tiles are immersed in the siltrate solution for several hours and then allowed to dry before installation per manufacturer's instructions.

As the stacking tiles which run along the ridge and down the ends of the roof are quite vulnerable to slippage, a concealed iron rod with a bend on the end will be inserted underneath, as per techniques first developed at Hanuman Dhoka.

Several details for the attachment of roof tiles, as developed by the project team in the Radha Krishna Restoration Project, will be repeated. First, lowermost tiles are pre-drilled and then attached to the eavesboard with a nail; the trick is to cut the head off of the nail to allow future replacements of broken edge tiles without removal of upper tiles. Another critical location to attach tiles is at the uppermost row adjacent to the tower structure, where pigeons are prone to roost. Here the tiles are pre-drilled and the nail is set in the mud, traditionally thickest (9-11") at this location.

Cover above rafters: lath

As a critical demonstration, the project will undertake to restore the upper pagoda roofs and lower structure roof using lath above the rafters, a traditional practice at least as old as the 19th century layer and probably much older. In order to accomplish this, an alternative waterproof membrane detail will have to be developed, namely, a solution to create a smooth surface above the lath which receives the membrane. In general all historical lath cover has been eliminated in repairs and restoration work of the last two decades.

Battens

An additional goal of the project will be to develop a detail for the fixing of battens (to hold the mud), which does not necessitate piercing of the planned waterproof membrane. In all restoration work in Nepal since the 1972 Hanuman Dhoka project, timber batten keys for the mud bed have been nailed through to the timber planking below the waterproof membrane, generally tar felt. An alternative design under development proposes to hang the battens off of the ridge line using a corrosive resistant wire. This would provide the necessary key for the mud bed, while eliminating the necessity to nail through the waterproof membrane.

Waterproof membrane

Ongoing monitoring of historical buildings by the Trust has identifies current use of tar felt for the waterproof membrane as the potential weak link in the rebuilt roof cover. This thesis is based on consideration of the life of the highest quality Indian tarfelt which is less than fifteen years. As an alternative, the Trust will seek to identify specialty membranes with longer life. Such products include man-made pond lining materials joined at the seams with resin or heat guns. Searches for appropriate products are underway. Drawbacks to this solution include the great cost of the membrane (\$10/sq. ft) and unavoidable difficulties to import.

Mud bed

Supervision of the digging of the yellow mud and treatment with the herbicide Karmex will be critical to the success of the effort to control vegetal growth. Digging of the mud from more than a meter and a half depth assures lack of vegetal material in the mud; treatment with Karmex, a French product should be done carefully according to manufacturer's instructions. We have been warned that Indian manufactured Karmex has not proven as effective as the original French product.

In an attempt to reduce the top-heaviness of the structure (vis-a-vis earthquake performance), the thicker mud layer towards the upper part of the roofs will be lightened by the substitution of over-fired bricks wherever possible. The thickness of the upper end of the mud bed can easily be determined by the historical cornice location and will be matched. The cornice lies directly above the top layer of tiles, its overhang protecting the joint between top-most tile and building from water penetration.

6.06 Interior floor structure

Wherever possible, intact or partially damaged floor joists will be left *in situ* while being repaired. Careful investigation of each timber will maximize retention or reuse of historical material. New timbers will match historical members in timber type, pine, and finish, that is, rendered with the traditional adze or *basila*. Traditional pegging will be carried out to match visually with extant portions of the structure, while concealed bolting will increase the strength of critical joints.

Every third joist on the second floor floor framing will run continuously through the middle wall, enhancing the anti-seismic skeleton. The floor will of course be enhanced structurally by the angled planking and perimeter beam conceived as part of the seismic strengthening scheme.

Floor planking details are described under seismic reinforcements, section 6.01.

6.07 Interior

Wherever intact, existing mud plaster will be retained necessitating protective measures during construction.

Provide concealed electrical outlet and lighting locations per owner needs. A toilet will be provided under the existing lowest run of stair, easily partitioned off and the standard location in old buildings here.

As the building is used by neighbors all with running water, provision of plumbing lines in the building is not considered necessary.

All new mud plaster will be whitewashed with a traditional lime mixture. Interior timbers will be oiled with linseed oil, another traditional practice.

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