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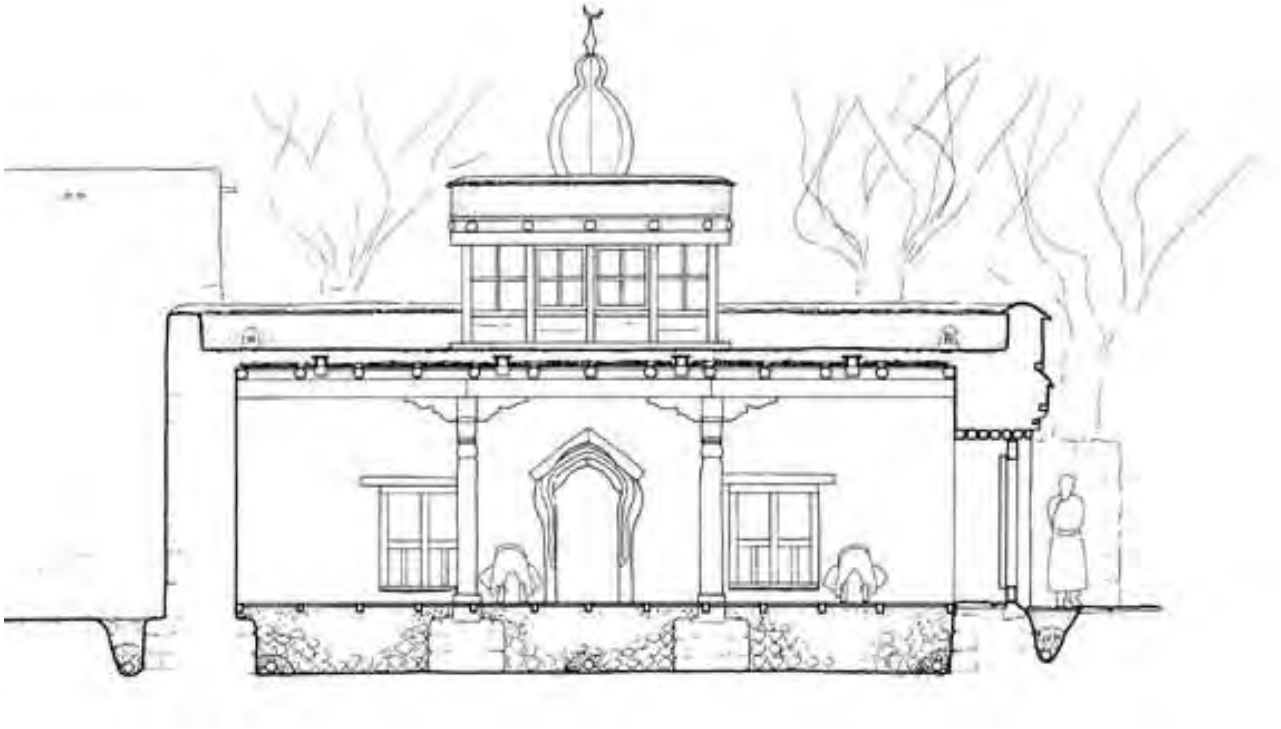


The Restoration of Tsas Soma Mosque, Leh, Ladakh, India

a report by André Alexander and Andreas Catanese

Project supported by Embassy of Finland and Trace Foundation

Location Tsas Soma area (in green).

Satellite image of Leh (courtesy Institute of South Asian Studies, Heidelberg), king Senge Namgyal's royal palace is visible on the hill, with the historic old town below. The Tsas Soma area is the small forested area immediately to the left of the old town.

1.1 Site history

Ladakh has always been a crossroads of different cultures. Permanent Muslim settlements in the Ladakhi capital, Leh, are said to date back to the reign of king Senge Namgyal (r. ca. 1616-1642). At the time, Muslims were given the Tsas Soma ("New Garden") area, immediately to the west of the walled city of Leh. The mother of the King was herself a Muslim princess from neighbouring Baltistan. On the land this land, the traders built the Masjid Sharif mosque, the first in Leh. Both Sunni and Shia Muslims constructed places of worship, which still today stand side by side.

Following the Indian partition 1948 and the 1962 border war with China, Ladakh no longer remained an important crossroads for Central Asian trade. Since that time, the mosque was used as a place of worship by women. It also served as a Madrasah (Koran school). Today, many elderly Leh Muslims still remember how in their childhood they studied here their Holy Scriptures. The small agricultural stream which flows through the area was used to perform the ritual ablutions before prayers. Perhaps because it was built in close vicinity to channels belonging to Leh's water system, and also near to a pool used to store irrigation, water infiltration caused severe damage to the walls and timber frame of the site. Finally it had to be abandoned in the early 1980s.

1.2 Site location

A small foot path leads from Leh's Main Bazaar to the west. After a few meters the Chutayrangtak Street branches off to the north, named after water mills that were once widely used in this area (now replaced by motorized flour mills). A fallen tree, considered sacred to Buddhists and Sikhs, creates a sort of natural gate to the area.

The Anjuman Moin-ul Islam Society and the THF team meet on site to finalize the agreement and the intervention plan.

Masjid Sharif, north elevation (2006).

Interior, showing serious settlement of timber frame and partial roof collapse (2006).

1.3 THF / LOTI involvement

In late 2005, the owner of the Sofi House in old Leh that has just been restored by THF, proposed that we also work on the Masjid Sharif. The Anjuman Moin-ul Islam Society, the official owner of the mosque, then officially proposed to undertake the project in co-financing. In 2006 THF made a survey and developed the intervention plan. Intach J&K were also consulted and supported THF's proposal. The embassy of Finland provided half of the budget, and the Society matched these funds. In 2007 work could begin.

North elevation, showing the entrance, the green wooden door to the left (2007).

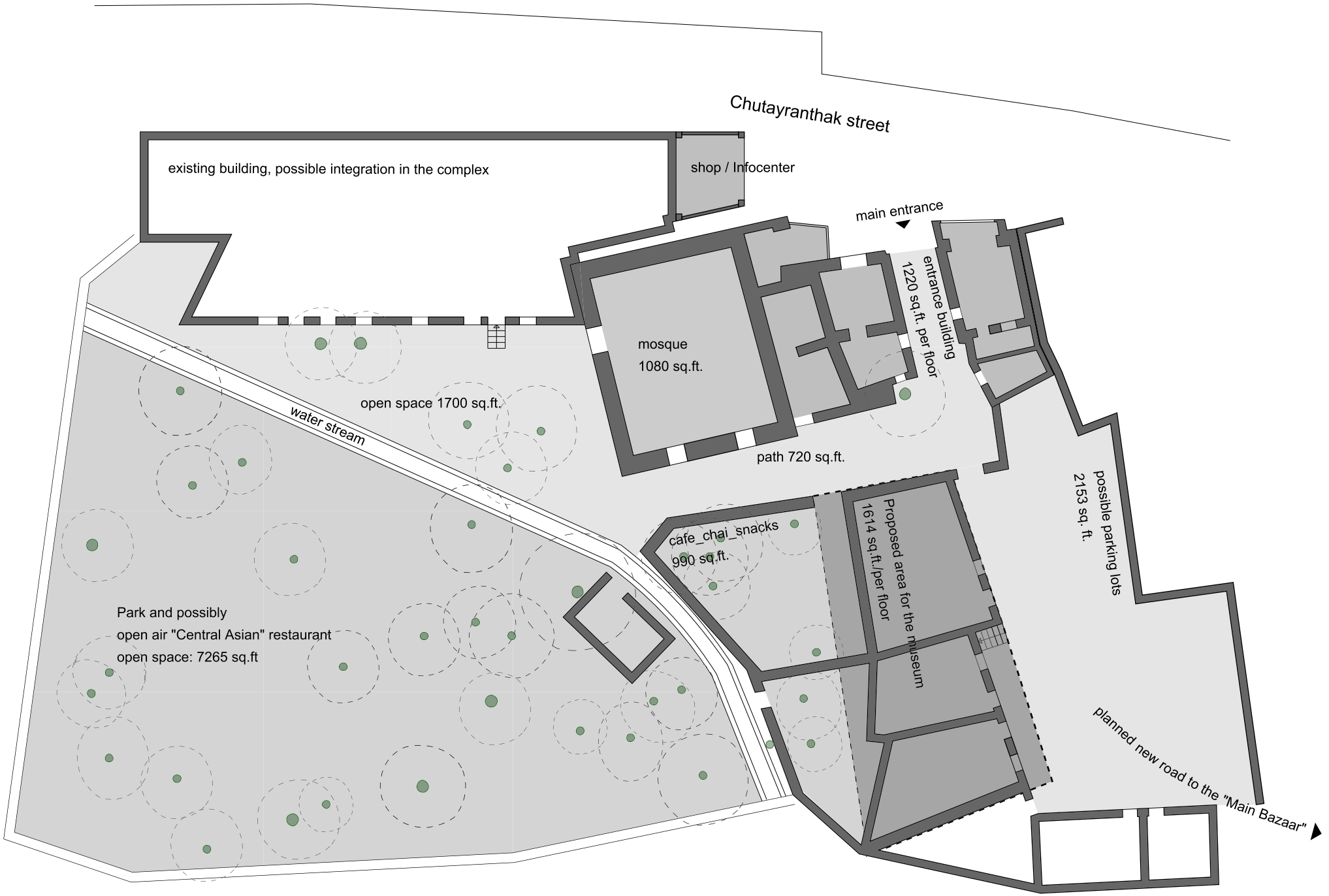
2.1 Intervention principles

The fundamental principles for the restoration work were the use of mostly traditional materials, and the employment of local artisans. To maximize authenticity, as much as possible of the historic building (even if it was ruined) was to be retained, and the original elements and materials would be re-used.

In this way it would be also possible to demonstrate that effective use of the traditional Ladakhi buildings materials, such as mud, timber and stone make most sense in the local environment, and could today be termed eco-friendly. Timber for construction is locally grown and sustainably harvested, for example. The expert use of mud for walls, plaster and insulation gives traditional buildings excellent climatic qualities. In a seismically-active area, Tibetan and Ladakhi buildings have survived earthquakes for many centuries.

Especially in the fragile environment of Ladakh, this aspect of restoration and construction is important. Our experience in working with historic buildings in the Himalayas shows us that the traditional skills and experience, handed down by many generations, is still the most sustainable way to build. For every improvement, we first need to see if it is possible to employ traditional technologies and materials.

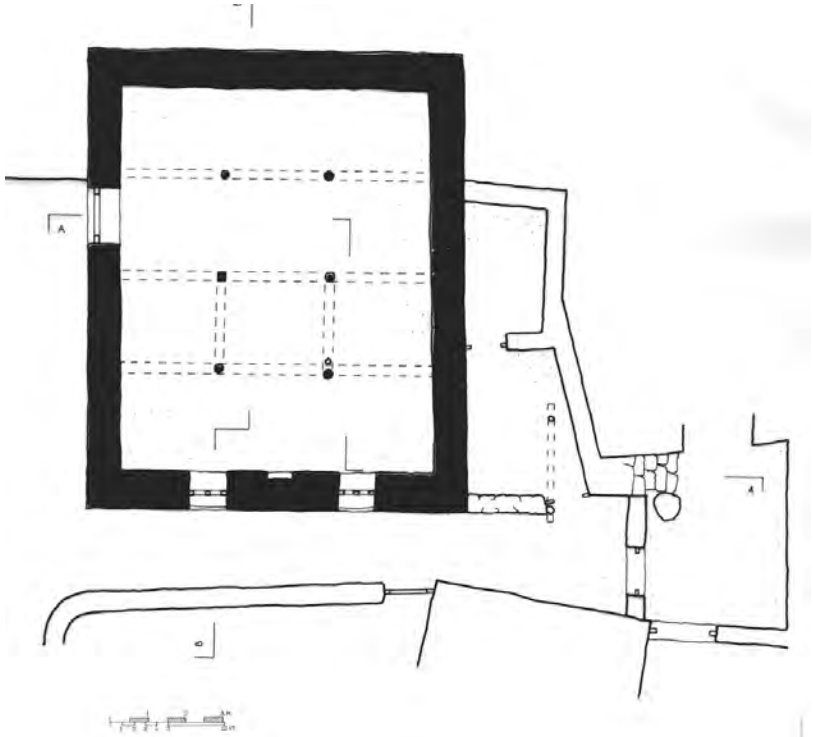
The *mirhab*, the Mecca-facing niche (2007).



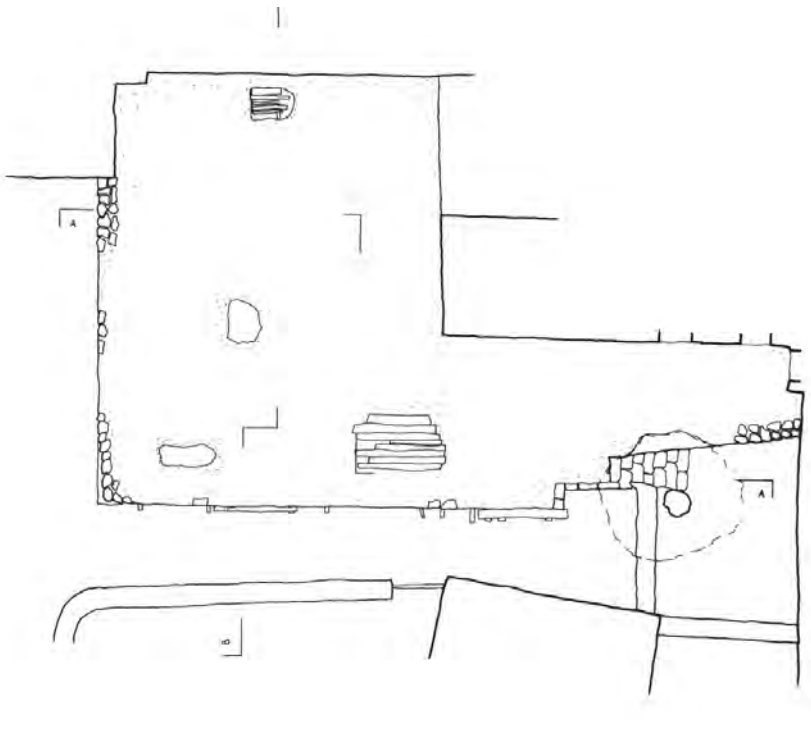
Site plan by THF (2007)

total area
18 105 sq.ft.

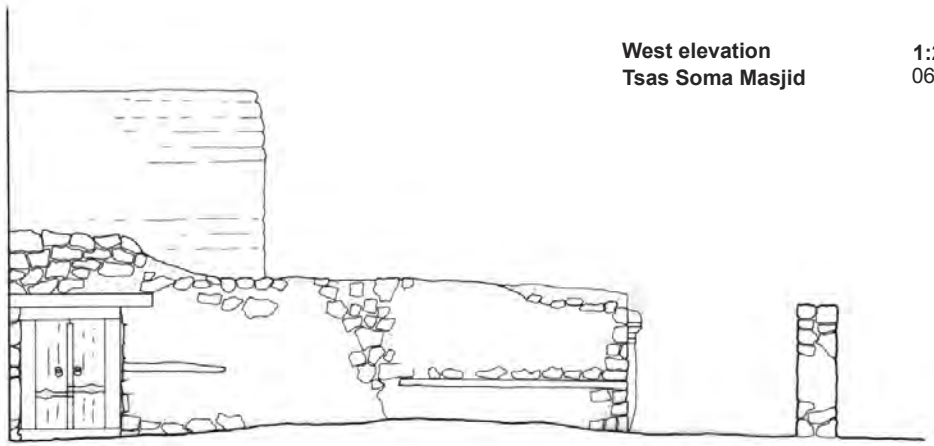
	TIBET HERITAGE FUND LOTI		Leh Old Town Initiative		
Location	Chutay Ranthak	Object	Old Mosque / sideplan		
Survey	A.W. + S.K.	Design	-	Scale	1 : 250
Drawing	A.W. + S.K.	Date	07.07	No.	-



Ground floor plan **1:200**
Tsas Soma Masjid 06/2007



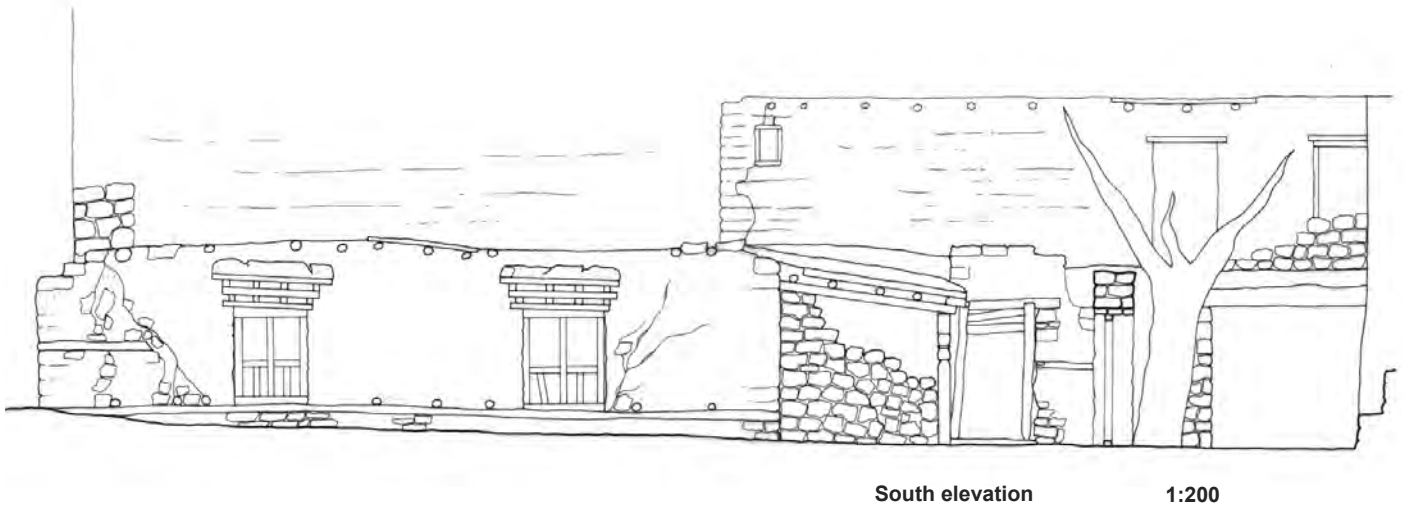
Roof plan **1:200**
Tsas Soma Masjid 06/2007



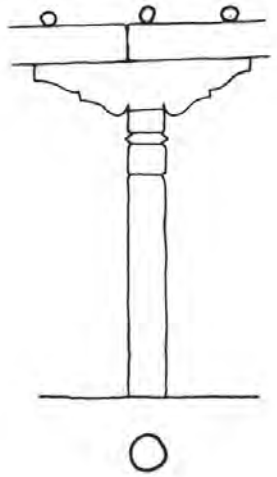
West elevation **1:200**
Tsas Soma Masjid 06/2007

In 2007, further surveys were made prior to actual start of the work.

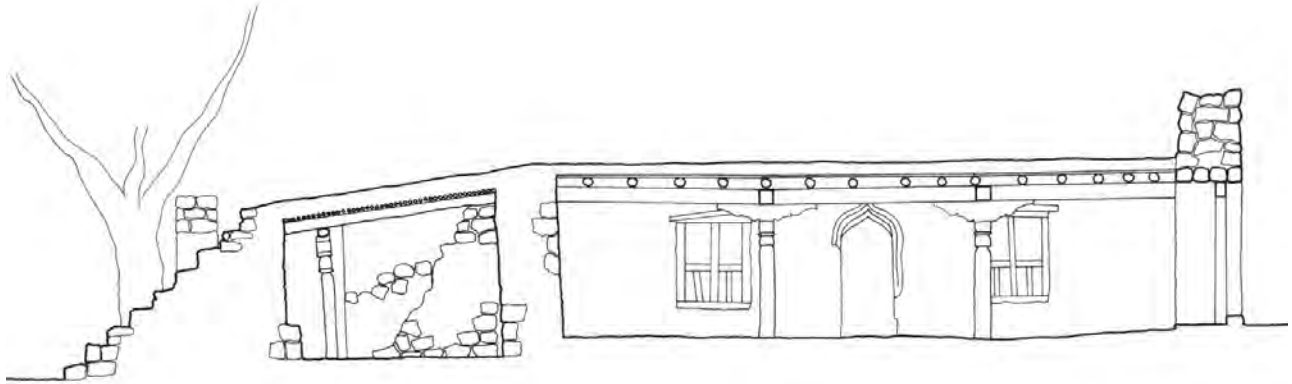
The ground plan reveals the 90cm- thick traditional rubble-stone walls. The timber frame consists of six pillars, most of which were damaged by rot and not suitable for re-use. Poplar and willow have been used. The dome has already been removed decades ago, and after repair apparently fitted at the Shey Mosque.



South elevation and entrance section **1:200** 06/2007

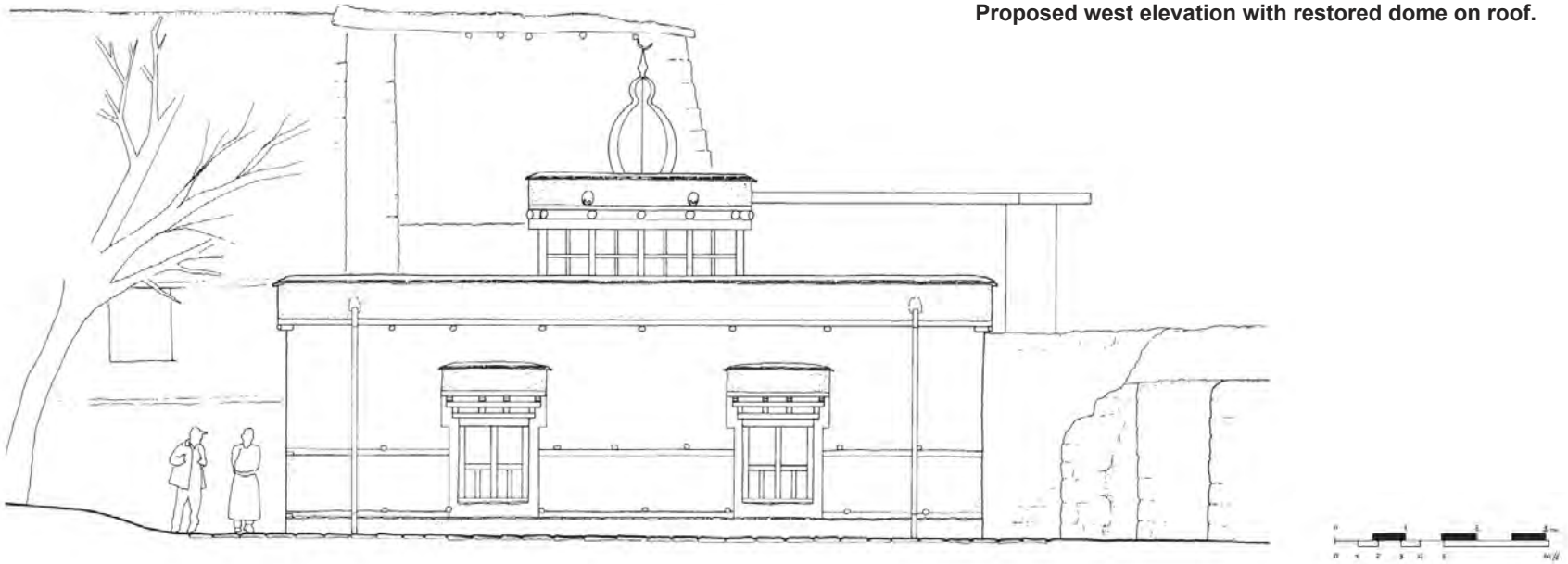


Detail, timber frame Tsas Soma Masjid **1:40** 06/2007

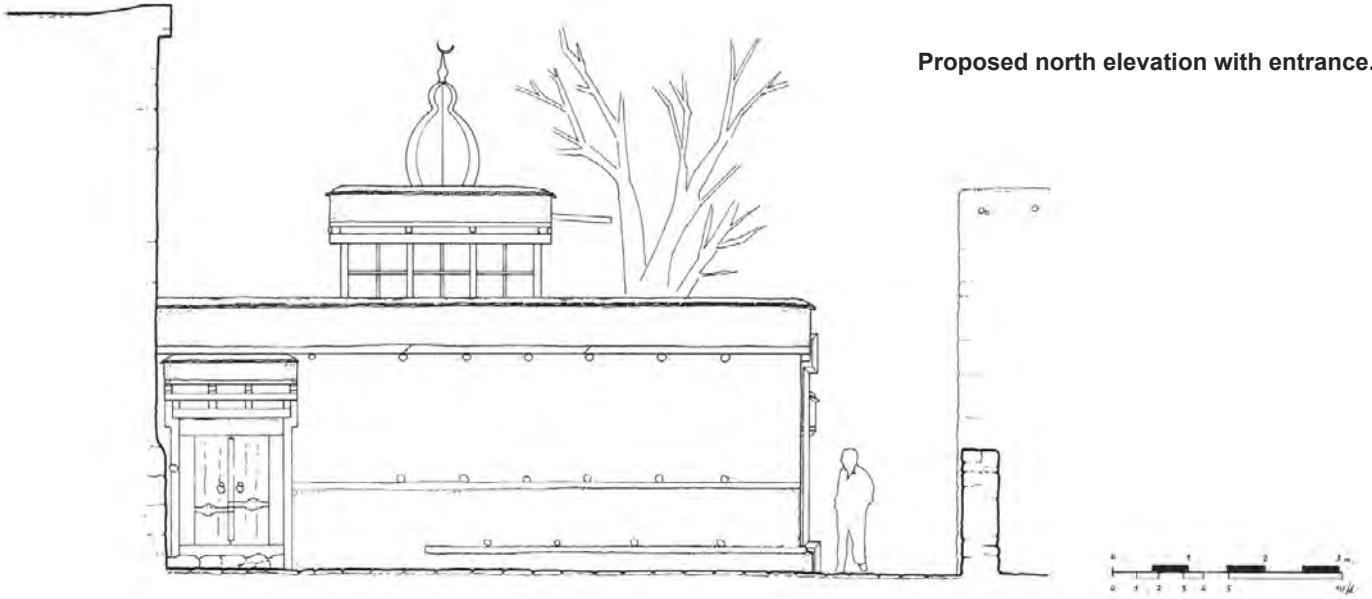


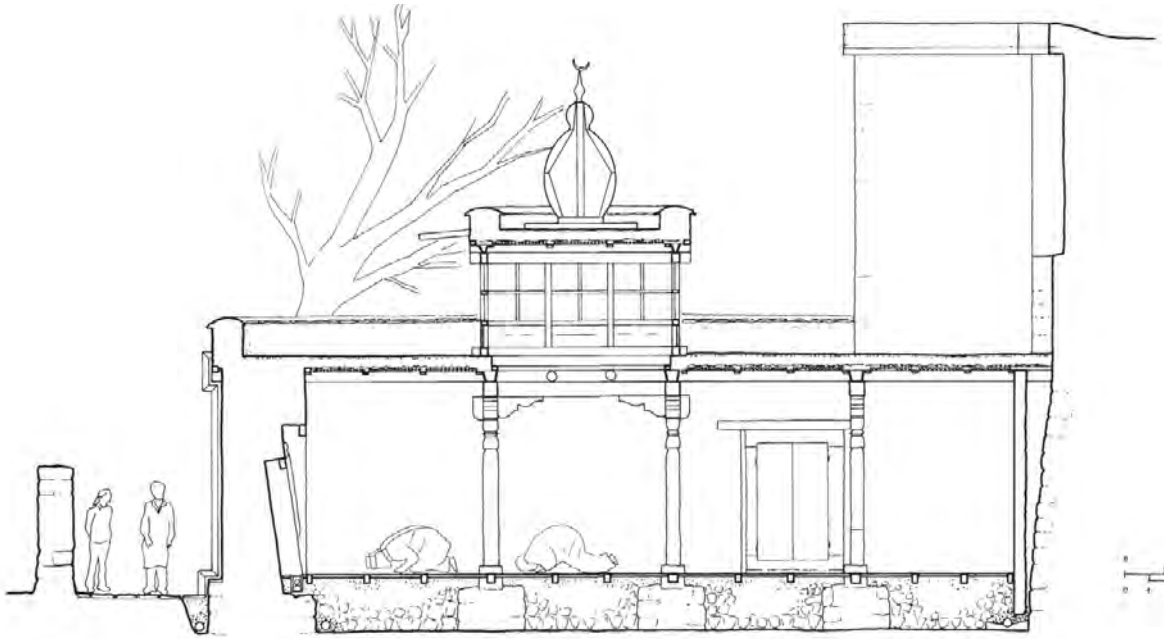
west-east section Tsas Soma Masjid **1:200** 06/2007

Proposed west elevation with restored dome on roof.

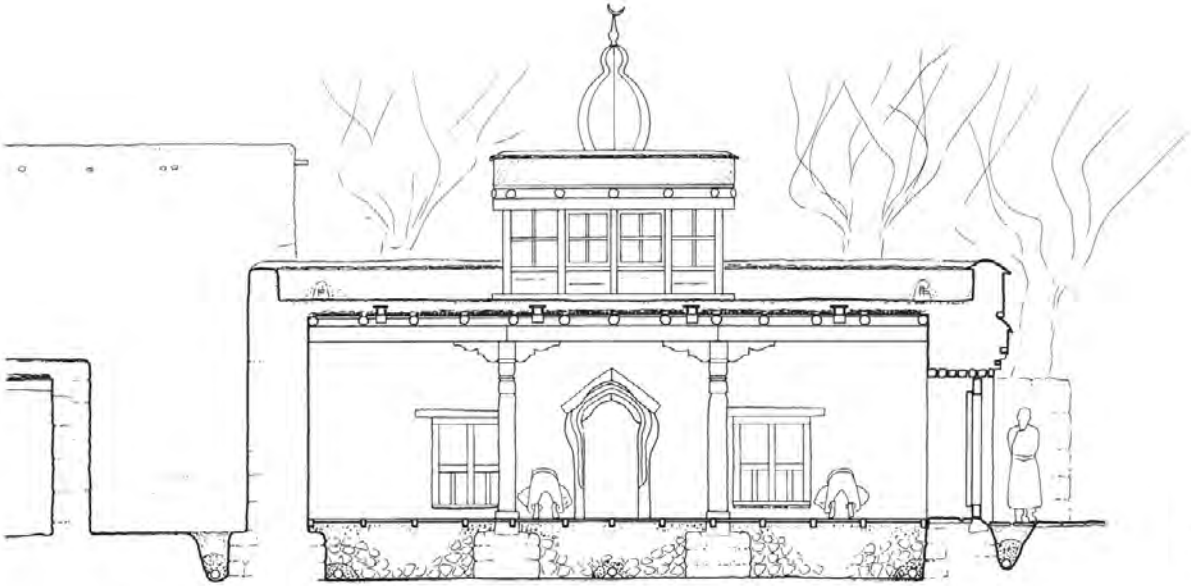


Proposed north elevation with entrance.

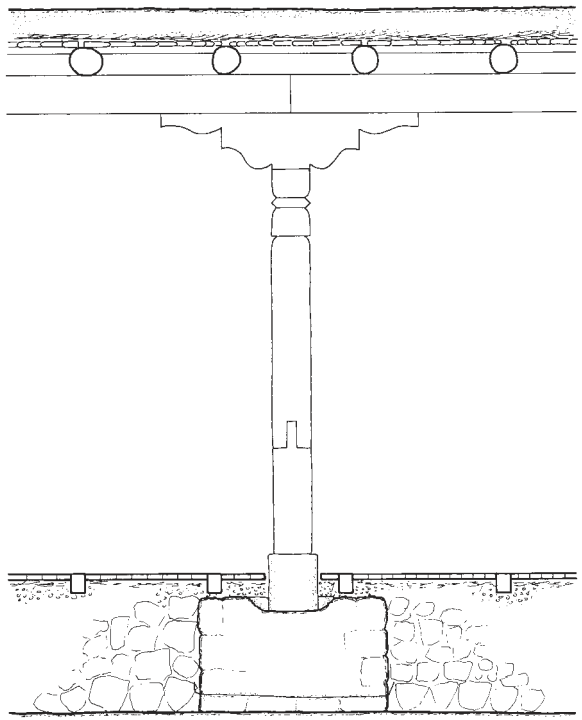




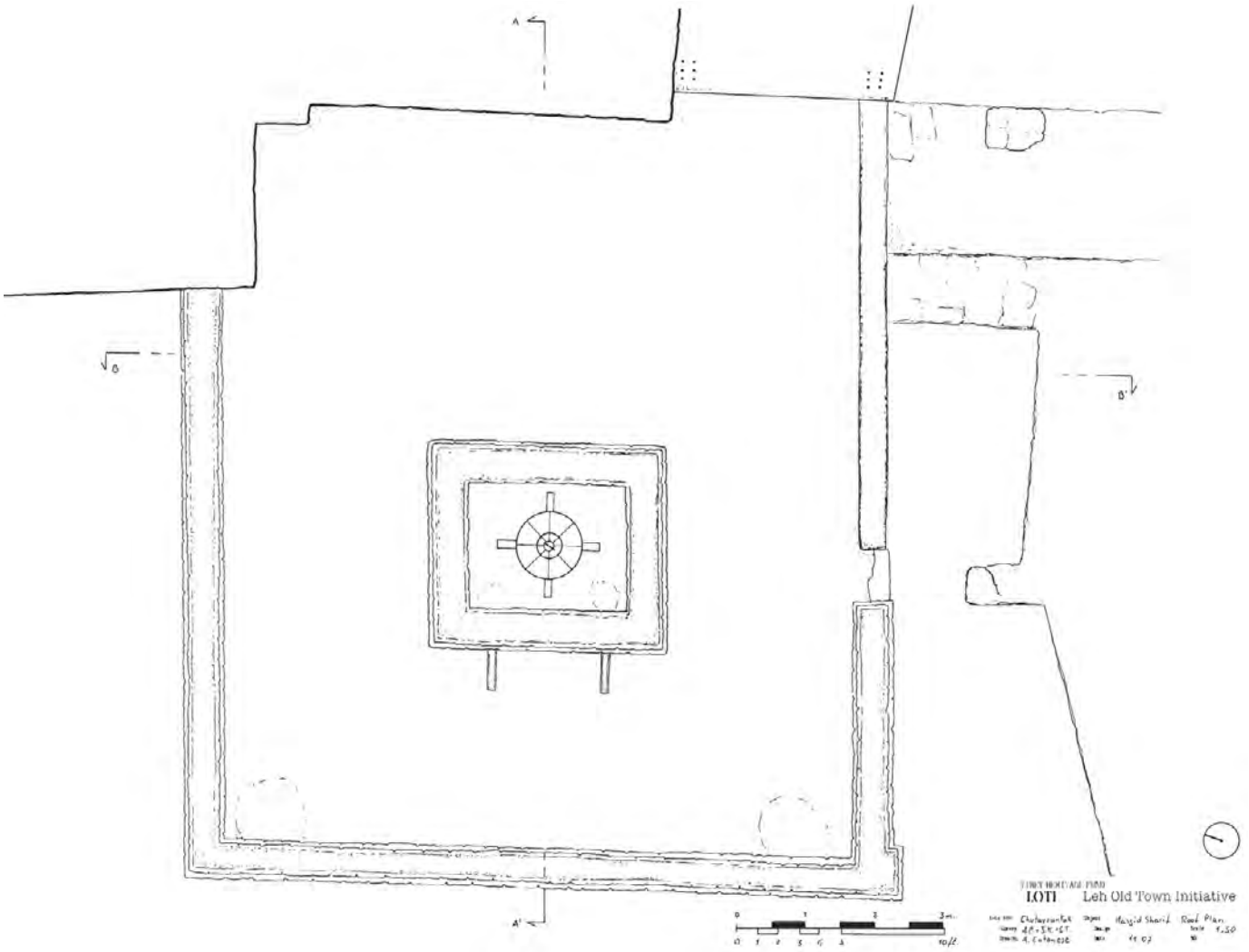
East-west section, looking north, showing the ‘sunken’ mirhab on the left.



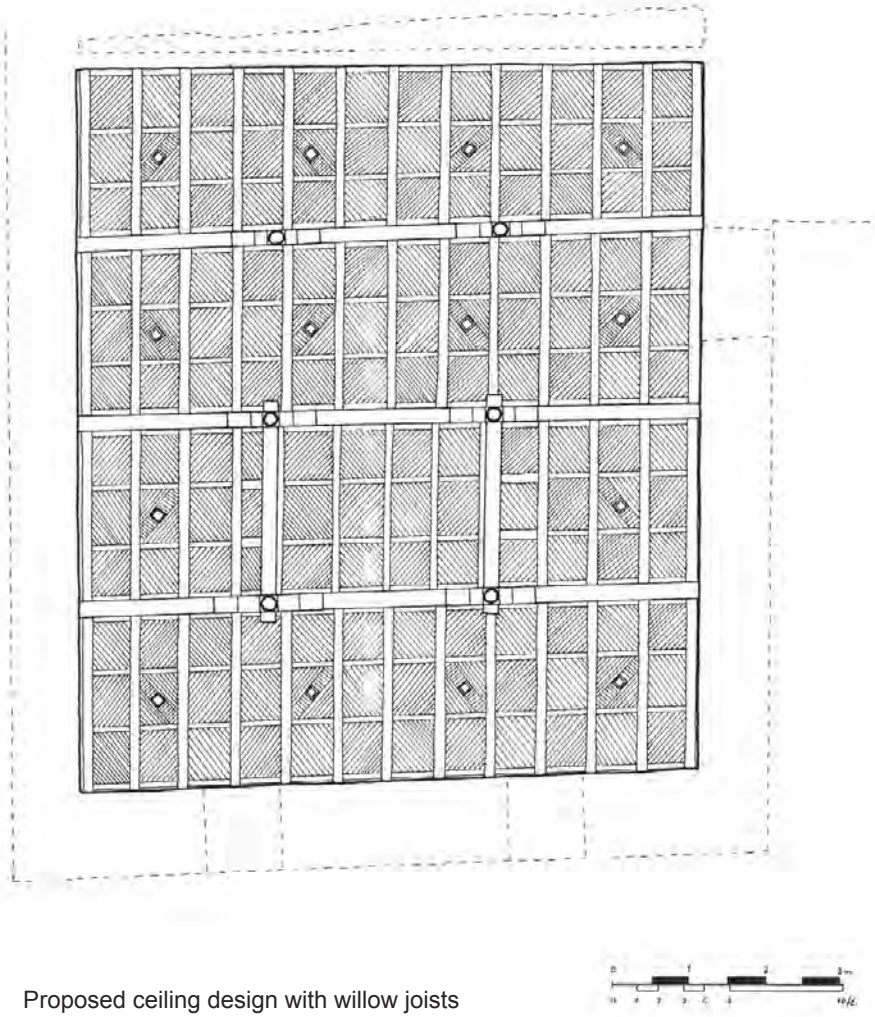
South-north section, looking west, mirhab in center.



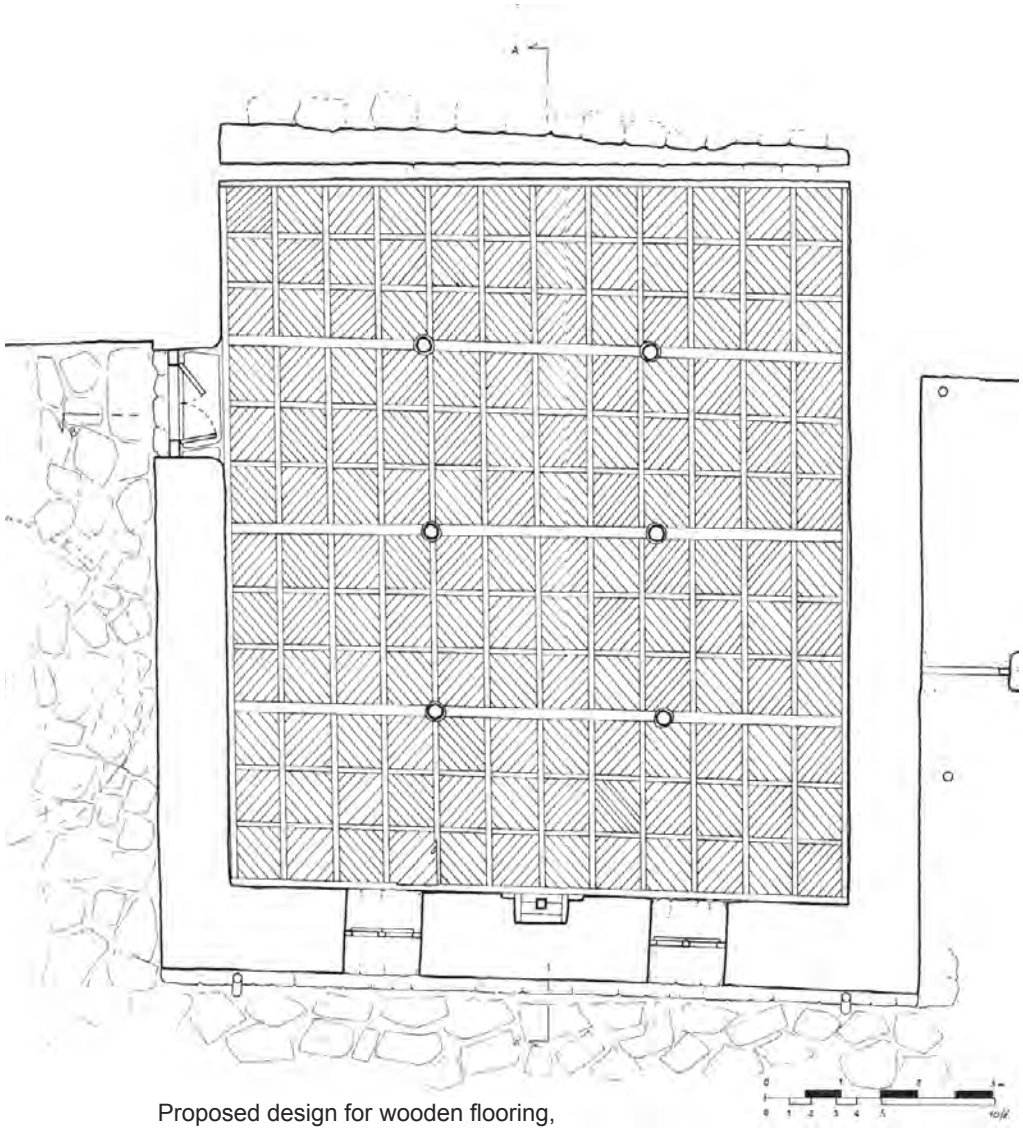
Detail showing restored timber frame and section through floor, showing gravel layer and pillar base stone to prevent water infiltration.



Proposed roof plan, with reconstructed parapets and dome.



Proposed ceiling design with willow joists arranged in traditional Ladakhi pattern.



Proposed design for wooden flooring, arranged to match the ceiling pattern.

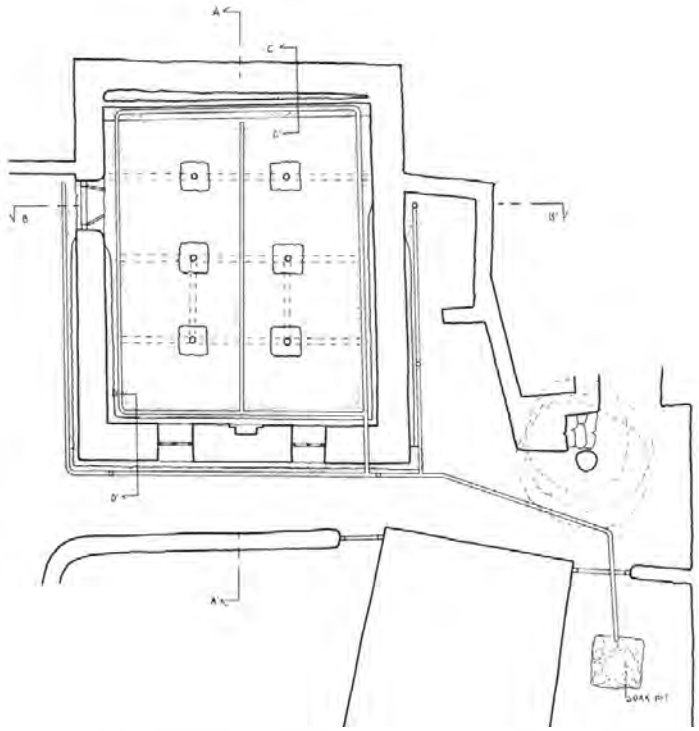
Top: Anjuman Committee members on site.
Bottom: A. Catanese surveys the site.

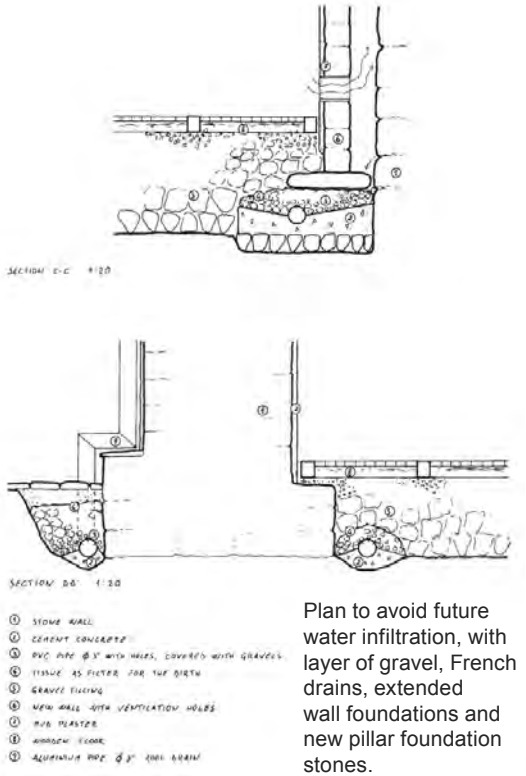
2.2 Intervention planning

To understand the present condition of the building, we had to identify the causes of the damages, and solve these.
Water is the traditional enemy of mud houses, and in our case there was extreme infiltration from the ground below. This could be explained by the presence of a plethora of underground irrigation channels as well as a storage pond nearby. It is also possible that the mosque was built on marshy grounds in the first place, as proper ground for construction has historically been very scarce in Leh.
We have decided to remove the wet soil, and lay a bed of gravel to keep away the moisture. French drains (half-open pipes) were laid below the gravel, collecting water and leading it away. The foundations of the walls would be extended, and all timber elements places on long stones. The east side is today located beneath the Chutayrangtak alleyway level, and so particularly susceptible to infiltration from an irrigation channel below that street. Following a request from the Anjuman Committee, the channel was sealed with concrete lining by the government. From our side, we built a second wall next to the one that is partly below ground, to have a layer of ventilation.

Several wall-sections have historic clay mouldings on the interior: the *mirhab* prayer niche and a lamp stand. Our aim was to preserve these.

The Committee requested to increase the height of the building. The original size barely allows a man to stand upright. This is a common problem of very old buildings in Ladakh, as large pieces of timber have always been expensive. Since we would be placing the restored timber frame on new stone foundation stones, it would be easy to raise the ceiling height. The roof composition of willow stick joists and soil layers would be improved, according to our experience. Additional layers of pure clay help to water-proof the roof, and a layer of straw mats prevents dust from falling through the joists.
The missing dome would be placed on a traditional skylight to make the room more light. Together with the committee, the new dome would be designed based on the Kashmiri style, which is the oldest in the region. Parts of the old dome were apparently used when a mosque in Shey village near Leh was restored some years ago, and we went to study that dome on site. However, its scale indicates that it was not the original Tsas Soma dome.





Plan to avoid future water infiltration, with layer of gravel, French drains, extended wall foundations and new pillar foundation stones.

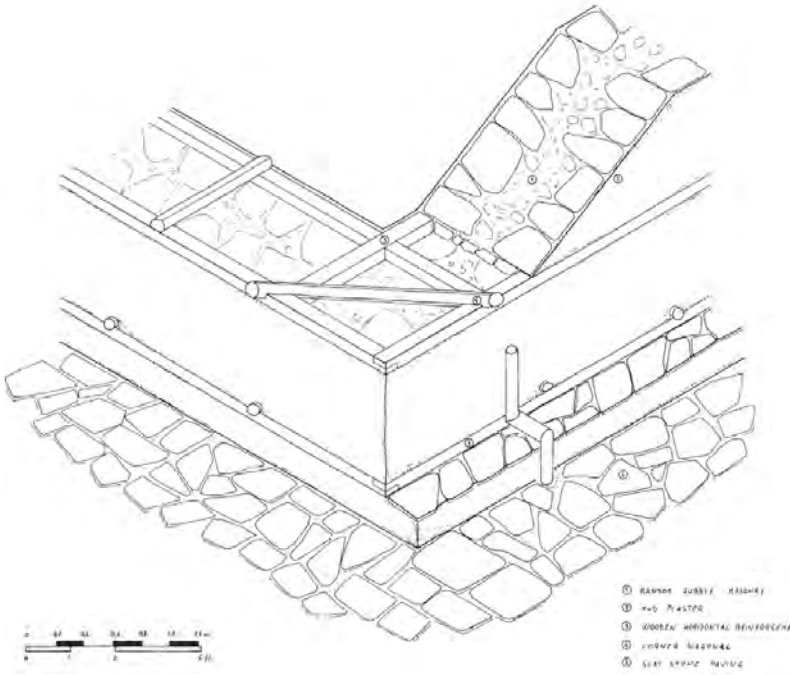
3. Description of the intervention

After the planning and preparation had been completed, the first work done was to dismantle the roof and timber frame. The materials which we could reuse were stored nearby. Unfortunately almost all the beams and rafters were rotten except for 2 pillars, 4 capitals and 2 beams. In some of them the damage was so huge that another collapse appeared to be imminent. Because the mud mortar in the walls had been washed out, the walls were held together only by the weight of the roof. Once it was dismantled entire portions of the walls collapsed.

We then dug out the soil about 2 feet deep until we found firm ground. At this point we could see directly where the moisture came from, water from the Chutayrangtak channel pouring through the east wall of the mosque and soaking into the ground.

We choose to collect the water and let it flow away from the building.

We laid a net of perforated PVC pipes on the ground, some 60 cm lower than the final floor level. The pipes were covered with old cloth to prevent the dirt from going inside and rubble stones. These were then buried under the 2 feet layer of fine gravel.



Detail showing Ladakh's traditional earthquake-damage-preventive technology of wooden bracketing inside the walls. In 2007 the UNESCO office Delhi supported a THF workshop with local artisans to explore this traditional technology, which was then used for the Masjid restoration.

Where the walls had been dismantled, new stone foundations were built (1.5 times the wall thickness). For the remaining historic wall sections we reinforced the foundations by adding stones around them.

To prevent moisture from rising up in the masonry, we laid a layer of bitumen sheet between the foundations and the masonry. Above that the first wooden horizontal reinforcement element was placed. Traditional masonry is build with two layers of stones, outside and inside, in between the filling is done with mud and smaller stones. The wooden horizontal reinforcement elements hold the masonry together and in case of earthquake the wood absorbs the vibrations reducing the damages.

Left from top:
historic wall section with *mirhab*;
the team has dismantled the wall section to the left of the *mirhab* and secures it with temporary support;
the new wall section is joined to the *mirhab* wall section with iron rods.

Center: section view of the historic wall section, *mirhab* wooden support is visible.

Right from top:
after completion of the left side, the right side wall section was dismantled;
rebuilding the right side wall section, here the window frame had to be replaced, modelled on the surviving frame on the left side;
the two wall sections are joined and the old *mirhab* has been saved.

A particular challenge was to preserve the old *mirhab* despite the serious structural problems. Neither the Anjuman Committee members nor most of our artisans believed it could be saved, as the wall on which it was located was severely dilapidated, but THF's experience with similar cases in Tibet helped.

To prevent the collapse of the weakened wall section on which it was located, a wooden support was fixed on the site. Then portions of the neighbouring and even outer sections of the wall were carefully dismantled. Most of the mud mortar had been washed out, so that we found only empty spaces between stones, and whole sections of the wall fell easily when touched. During their reconstruction of the walls on both sides of the prayer niche steel bars were used to stabilize the old structure and to hold the entire wall together. Once it was strong enough to bear the loads of the leaning *mirhab* the wall on the outer part was completed.
With all the walls restored or rebuilt we could start to re-erect the timber frame.

Only two pillars, four capitals and two beams could be re-used (all made from poplar wood), the replacements were made from the same wood and in same design, the different colour of the aged and new wood makes it possible to distinguish between original and replacement.

3.2 Structural rehabilitation

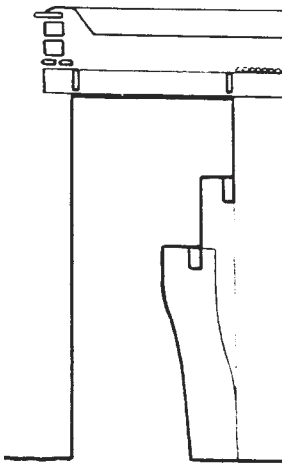
Decades, probably centuries of water infiltration have taken their toll on the walls and timber elements. Therefore 80% of the walls were rebuilt on new foundations. The new foundations are about 60 cm deeper than the originals and their thickness about 1.5 times wider than the original (following guidelines for constructions on marshy ground).
Many elements of the internal timber frame had to be replaced, some elements could be partly re-used through grafting. All the discarded old wood was cut into boards and used for the wooden floor.

The roof of Ladakhi traditional buildings is composed of different layers. Each layer has different functions and capacities, so that the traditional roof works best if all the layers are deployed.

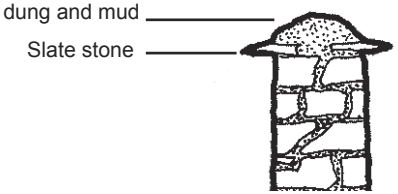
The structure is post-lintel construction. The pillars, called "*ka*", support an intermediate bracket between pillar and beam, called "*kazhu*". Its function is not only decorative, it distributes the load and reduces the span between the pillars. Above the main beams, called "*madung*" ('mother beam'), lie the rafters (called "*dungmas*"). A layer of joists called "*taloo*" completes the wooden roof truss.

Top: straw mats are placed above willow sticks.
Left: *markalag* is applied on top of the first soil layer. Left to soak in water overnight, it is best applied as a sticky mass.

Traditionally, grass, roots or willow bark are used to create a division between wooden structures and mud layers, and to create a stopgap protection from rain infiltration. For the latter, these materials are not very effective, and they also do not prevent dust from the soil layers coming through the ceiling into the rooms below.
Therefore for some time now we are adding a layer of tightly-woven straw mats on top of the taloo sticks to keep the dust out.
On this the first layer of mud is applied, consisting of ordinary soil mixed with water. This stabilizes the joist layer, and creates a uniform smooth layer. This also the layer where the final slope of the roof is formed. Into this first mud layer we have placed the PVC pipes for powersupply, and wooden boxes are placed for installing light bulbs later on. It was our concept to show that one can fit planned electric supply in a traditional structure, without showing the wires, the bulb holders, the switches and so on.
Waterproofing of the roof is done by using a clay called "*markalag*" ("butter-mud"). This material is an extremely hardened clay stone, which melts and expands in contact with water. It is available at low cost around Leh town. The *mar-kalag* clay is applied over the first soil layer, as a paste about 5 cm thick. It shrinks during drying out, and the cracks are then filled with mar-kalag powder to create a uniform layer. When the mar-kalag comes in contact with water it expands again, creating a waterproof layer. The water at this point is drained via the slight slope of the roof to the spouts.
This system is an improvement of the best available local method for waterproofing the flat roofs of traditional Ladakhi architecture. Traditionally only a thin layer of *markalag* was used. Due to the heavy rains for the last several years the traditional thin layer is not capable anymore to keep the water away from the roof structures. To prevent further damages and to waterproof the roof of the houses, owners needed to place more soil on their roofs every year. This helps in the short-term, but over the years the soil accumulates and the timber frame distorts due to the extra weight. We have found excessive soil layers of up to a meter thick on many old buildings.



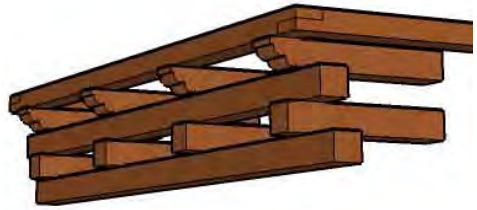
Top: the restored mosque is being plastered from the outside. The parapet is an overhang construction, designed to protect the walls from rainwater.
Left: section through the west wall, showing the “sunken” *mirhab* and the parapet construction.
Below: parapet section.



As in many buildings, the weakest part of the roof is the joint between the roof itself and the walls or parapets, as well as the spots were water flows into the wooden spouts. For the joints, we have used a layer of bitumen sheets, fixed in L shape and plastered over. The wooden spouts are fixed with cement, so that water cannot seep underneath the spouts and create damage.

A important detail of Ladakhi / Tibetan architecture is the parapet, built from a variety of materials and decorated in a variety of forms and colours to reflect regional tradition and function of the building (for example, one can always tell a Buddhist temple from far by its parapet). The parapet creates a slight protrusion that protects the outside walls from rain water. Two layers of slate stone are placed on both sides along the entire length of the parapet (i.e. all around the building). These are held in place by the ‘fish-back’ (*nya-gyab*), a topping layer of mud. After several experiments in other buildings, we stabilized this mud with donkey dung and coated it with oil. The donkey dung gives to the mud better hardness, and the oil soaking into the mud waterproofs it.

Top: bitumen is applied as protective layer between parapet and roof.
Below: rendering of the *shing-tsak*, the traditional wooden overhang above the mosque windows (THF/Nyandak).



Left: detail, construction of parapet with slate stone

3.3 Finishes & Details

The Masjid project shows the intention of both the owners and the restoration team to achieve the a high standard of quality by choice of materials and techniques. Together with the Muslim Association, we decided that wood, even if costly, would be the most appropriate flooring material for a place of worship (even more since it is an important landmark in the Ladakhi history). The Muslim Association had a good supply of wood in their storerooms. The design of the floors follows the design of the ceiling. Where on the ceiling are the main beams on the floor, long struts are being laid on the floor. In the fields that the struts are forming ceiling boards are laid diagonally, mirroring the arrangement of the taloo sticks in the ceiling.

The missing dome will be placed on a traditional skylight to make the room more light. Together with the committee, the dome was designed based on the Kashmiri style, which is the oldest in the region. Parts of the dome were apparently used when a mosque in Shey village near Leh was restored some years ago, and we went to study that dome on site.

Detail of the floor structure: struts are placed on the gravel bed, forming a grid. The squares are filled with sawdust for insulation, and then closed with diagonally-arranged boards (see right).

Completed exterior, with drain pipes and new paving.

Electric supply system hidden in floor boards, and switchboard.

We placed a green spotlight inside the Mirhab. Green is the colour of Islam; at night when the mosque is dark the spotlight highlights the prayer niche.

Light system, the lamps are made from traditional hand-made Ladakhi paper.

The walls are plastered with three layers of mud plasters. The first layer, locally called "*shaskalag*" is a mixture of normal mud and grass. It is used to cover the imperfections of the walls and to create a rough surface for a better adherence of the 2nd layer. Added grass prevents cracks while the mud dries out and shrinks. The second coat, called "*jala*", is carried out in a mixture of soil with a high clay percentage, to lean the mixture river sand is add. It creates a smooth surface on which the third layer can be applied.
The last layer, called "*gubri*", is carried out in river sand and *markalag* mixture. The *gubri* surface is gray in color and is very smooth. We white-washed it with natural color for a pleasant bright feeling in the room.

The wood of the old windows was rotten, partly. So the windows were restored using some new wood. New glazed shutters were added to the historic frames.
The entrance door was kept as original, with some minor repairs. We found that historically the door and windows were painted green, so we applied green pigment mixed with linseed oil, which also protects the wood from exposure.

On the outside, the outlines of the doors and windows were plastered according to local tradition and painted in green as well, in this case with green pigment mixed with *markalag* and water. The other parts of the wall exteriors were whitewashed with *markalag* and water - the clay in the *markalag* gives a pleasant natural colour and protects the walls from rain water infiltration.

Re-consecration and first prayer on 13 November 2007,
with the senior imam of the Leh Sunni community leading the prayers.
















4. Credits

This report by André Alexander and Andreas Catanese

Planning and site supervision: André Alexander, Andreas Catanese
Architectural survey: Andreas Catanese, Stanzin Tundup
Further surveys and site documentation: Anna Wozniak, Steffen Klein, André Alexander
Engineering consultant: John Niewoehner
Logistics management: Konchok Rafstan
Accountant: Stanzin Dolker
Food: Rigzin, coffee: Lala.
Head mason: Bashir Ahmed
Head carpenter: Tsering Dorjey
Other workers: Jamyang Tarchin (mason and carpenter), Shaffi Mohammed (mason), Tsering Dorjey (mason), Sri Lal (plasterer), Hare Krishna (plasterer), Punchok Angdu (carpenter), Sangay Punchok (carpenter), Feroz Ullah (carpenter), Jaan Mohammed (carpenter), Vijay Kumar (electrician), Parvez Kahn, Manzoor, Gulam Nabi, Farooq, Tashi Dolma, Tsering Dolma, Rigzin Yandol, Diskit Tsomo, Yangskit (labour).