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## Abstract

The vernacular mud mortar, brick and timber multi-story houses in Kashmir, India are interesting not only because of their architecture, but also because of their seismically resistive construction. The masonry piers and walls are held together at each floor level and above the windows with layers of heavy timber laid directly in the walls.

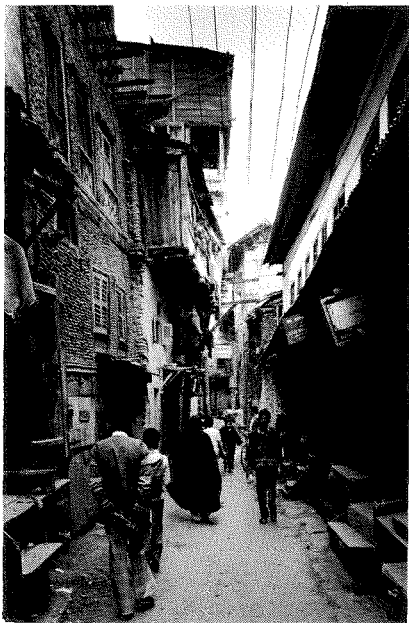
There are two variations, one known locally as *Tag* with horizontal timbers only, and the second with vertical as well as horizontal timbers, known as *Dhajji-Dwari*. Although of weak construction, these buildings have resisted earthquakes because of their flexibility.

Kashmir has been relatively insulated from the West and from the defusion of modern construction technology and ways of life, and thus has preserved this building tradition until very recently. Now, with the money brought by tourism, new reinforced concrete houses are rapidly replacing these traditional mud houses.

## KEYWORDS

Earthquake resistant construction, Mud-brick construction, Mud mortar, Historic Preservation, *Dhajji-Dwari*, *Tag*.

Kashmir, India, Yugoslavia, Greece.



**Above:** A narrow lane in Srinagar which is also one of the city's principal thoroughfares. Now many of these lanes are being widened by demolishing the buildings along one side.

**Upper right:** The Rainawari Canal, Srinagar. Canal boats used to be the main means of transportation through the city. Now one short stretch of this canal is reminiscent of the magical scene which used to exist where an ancient canal once penetrated the densest section of Srinagar until filled in during the 1970's (see p.5.)

## OF TAG AND DHAJJI DWARI

### THE EARTHQUAKE RESISTANT MUD AND BRICK ARCHITECTURE OF KASHMIR

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During recent months the news has been increasingly filled with reports of the conflicts in Kashmir. The images of men in traditional dress standing in front of the timber and brick houses, surrounded by tanks and jeeps, recall the pictures of Afghanistan. Here it is, yet another religious and ethnic conflict which might turn into a civil war. The problem is that such conflicts cannot be easily resolved once they are started, and regardless of the outcome, in their wake often lies the ruination of the traditional culture, way of life, and the fabric of the historic built environment.

Both the traditional architecture and the ways of life are very fragile in Kashmir. It is a land of breathtaking beauty but few resources, a land where the economy depends for basic survival on subsistence farming, traditional handicrafts, and tourism. A protracted conflict will wipe out tourism and thus the market for most handicrafts. This will bring renewed hardship to the population, and has the potential of destroying many buildings in what is one of the most interesting, if not magical, settlements left on the planet.

In this paper I take a closer look at the buildings which make up this city - not the mosques, temples, palaces or other monuments - but the ordinary houses constructed of mud, straw, timber, brick, sod, and (more recently) galvanized steel. These buildings provide an opportunity to study the linkage between traditional construction technology, vernacular design, and a traditional way of life. These particular buildings also are significant because they have an inherent resistance to earthquakes.

#### Srinagar, a "Medieval" City

Entering Srinagar, in Kashmir, is like going back in time. The houses appear to be ancient and timeless, with much evidence of wear and tear. V. S. Naipaul made the observation in 1964:

It was a medieval town, and it might have been medieval Europe. It was a town of smells: of bodies and picturesque costumes...; a town...of disregarded beauty...a town of narrow lanes and dark shops and choked courtyards<sup>[1]</sup>

Srinagar is a densely packed city full of houses. In the oldest portions the residences are mixed together with shops and even small manufacturing industries, such as carpet weaving and metalworking. The view of this dense development and teeming activity is like a scene out of the pages of Dickens or from the canvas of Bruegel. The houses themselves are what form the essential backdrop for this remarkable scene. They appear rickety and insubstantial, almost as if they were deliberately built only as a stage set for the human pageant which takes place around them.

A single house is usually occupied by a joint family, with the grandparents living together with the families of each of their sons. The houses were clustered into small districts, known as *mohallas*. Until the present strife, the families of each *mohalla* formed a tightly knit neighborhood of both Muslim and Hindu families who, regardless of their religious differences, were very close.<sup>[2]</sup> Often a temple, mosque, a *madrassa* (a muslim religious school), a school, and a few shops, form part of the *mohalla*.



The Jalli shutters showing, on the left, the remains of the paper attached for winter protection.



The entrance lobby of a typical traditional house showing the timber and mud interior finishes. This front lobby, located at the center of the house, is considered to be the safest place to go to during an earthquake. (Running out of the house is more dangerous.)

The entrance to the typical house would be through a door in a wall separating a small paved private court from the street. The W.C. is usually detached from the house, and set in the corner of the front court, while the bathroom usually consists of a small room next to the hot water tap behind the kitchen stove.

The houses are mostly square in plan, with windows on all sides. In the densest areas, the houses are attached to their neighbors with common walls, but rarely did they line up in even rows. The windows are traditionally closed only with two sets of shutters, the inside set being of solid wood, and the outside with a *jalli* - an open filigree of carved wood. Glass has only recently come into general use in Kashmir. Traditionally oiled newspaper was glued onto the *jalli* shutters to admit light into the houses during the winter.

The living room and the kitchen were always located on the ground floor, with the bedrooms located on the second and third floors. The top level of the house was usually enclosed only with timber. It was usually one single large room with many windows. The family traditionally moved to this room during the summer in order to take advantage of the cool breeze and also, in moist areas, to move away from the mosquitos. This room was also used at times for gatherings and social events. In winter it was used mostly for storage.

Before the recent introduction of corrugated galvanized steel sheeting, the roofs of the houses were most frequently covered with mud laid on an underlayment of bark. In the spring the soil roof became covered with grasses and wildflowers. In the spring, the blossoming of the tulips and lilies on the roofs of the dense mass of houses in Srinagar was famous until most of the mud roofs had disappeared in favor of the corrugated steel.

#### The Aseismic Attributes of Traditional Construction in Kashmir

Earthquakes in Kashmir have occurred with regularity over the centuries, and the Kashmiri houses reflect an adaptation to this threat through the interlacing of heavy timber within the plane of the exterior walls of the masonry buildings.<sup>[3]</sup> In Kashmir, as in most countries, wood and nails are simply too precious to be used for more than what is absolutely necessary, so masonry is the primary building material. Most of the traditional buildings in Srinagar can be divided into two basic systems of construction. The first system, sometimes referred to as "*Taq*,"<sup>[4]</sup> consists of load-bearing masonry piers and infill walls, with wood "runners" at each floor level used to tie the walls together with the floors. The second system, known as *Dhajji-Dewari*<sup>[5]</sup> construction, consists of a braced timber frame with masonry infill.

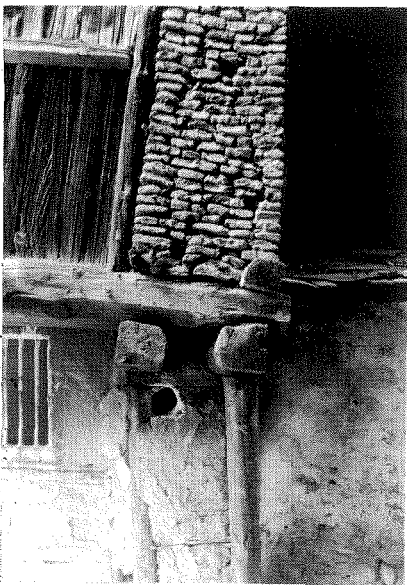
The houses were almost always raised on a plinth made up of stone masonry laced with heavy timbers measuring at least one meter in height. Above this stone the exterior walls were constructed of a mixture of brick and rubble stone set into a thick bed of mud mortar (*Taq*), or with a single layer of modern size brick surrounded by heavy timber (*Dhajji-Dewari*). The *Taq* houses were usually faced with a layer of small, very hard, hand made clinker bricks, known as *Maharaji bricks*, which give the houses their distinctive appearance.<sup>[6]</sup>

The mud, brick and timber construction was usually left uncovered by any plaster on the exterior. The interior was plastered with a mixture of clay, straw, and other ingredients. This layer of mud plaster provided insulation in summer and winter. The internal plaster was renewed by the application of a coat of a thin mixture of clay and water over the existing surface about every two weeks, a process referred to in Kashmiri as *livun*. When this dried, the undulating mud walls were left with an unblemished beige clay surface.

**The *Taq* System.** The timber beams in the *Taq* buildings do not constitute complete frames. Instead, large timbers "runners" rest along the load bearing masonry walls, with the floor beams and the "runners" for the cross walls lapping over them. The wood serves to tie the walls of the structure together with the floors. The weight of the masonry serves to "prestress" the wall, contributing to its resistance to lateral forces.<sup>[7]</sup>

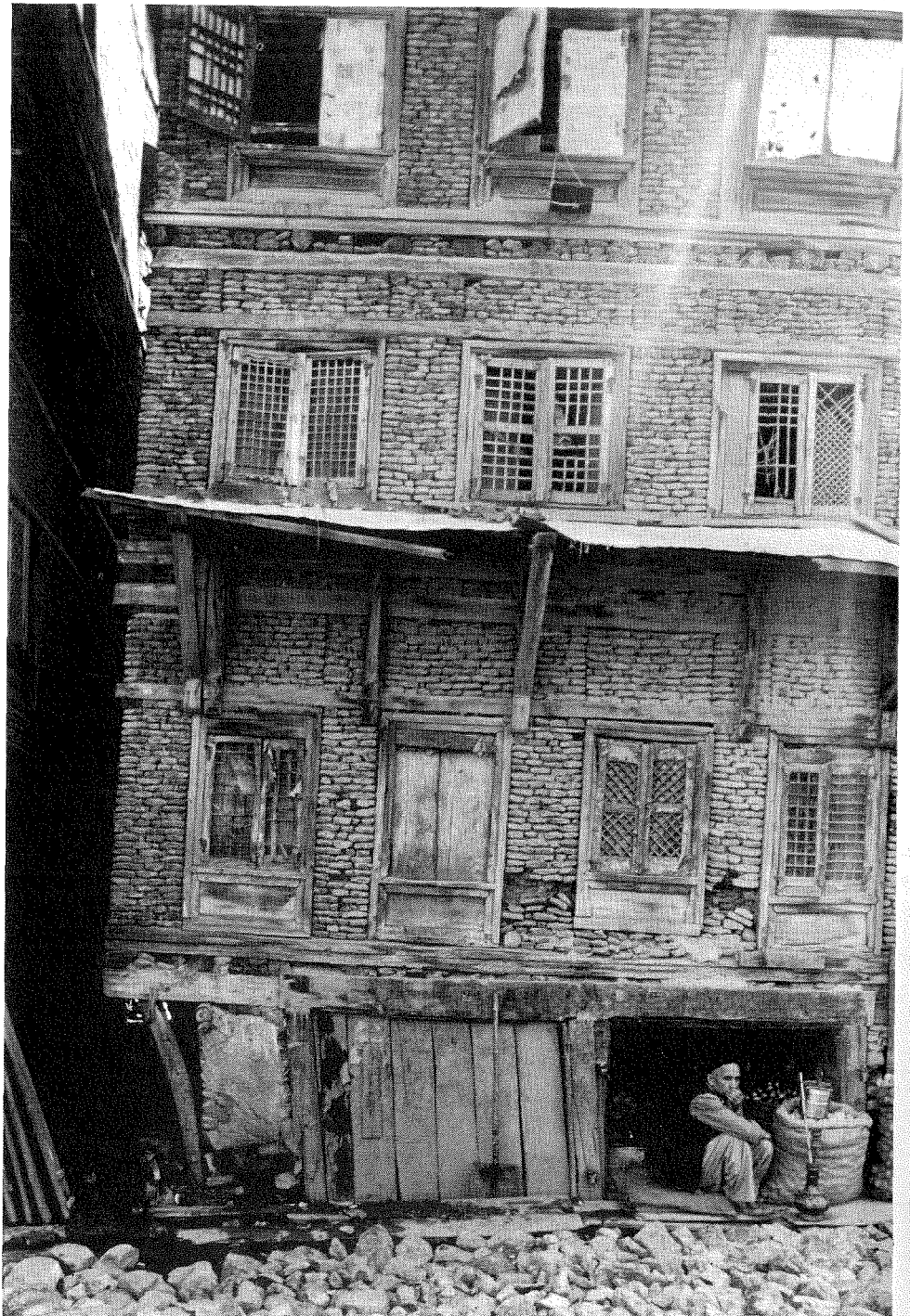
The construction practices used for these buildings in Kashmir which stand in contrast to the codes and commonly accepted practices today, include (1) the use of mortar of negligible strength, (2) the lack of any bonding between the infill walls and the piers, (3) the weakness of the bond between the wythes of the masonry in the walls, and (4) the frequent (historical) use of heavy sod roofs. It is just such buildings that were observed almost a century earlier by Arthur Neve, a British visitor to Kashmir who witnessed the 1885 Kashmir earthquake:

To a European traveler, the city of Srinagar looks tumbledown and dilapidated to a degree; very many of the houses are out of the perpendicular, and others, semi-ruinous. But the general construction in the city of Srinagar is suitable for an earthquake country; wood is freely used, and well jointed; clay is employed instead of mortar, and gives a somewhat elastic bonding to the bricks, which are often arranged in thick square pillars, with thinner filling in. If well built in this style the whole house, even if three or four stories high, sways together, whereas more heavy rigid buildings would split and fall...Part of the Palace and some other massive old buildings collapsed...[but] it was remarkable how few houses fell....<sup>[8]</sup>



**Above:** A masonry pier resting on a timber cantilever bracket on a ca. 18th century house. The beams extend across the width of the house, tying it together, while the weight of the masonry holds the wood in place in an earthquake.

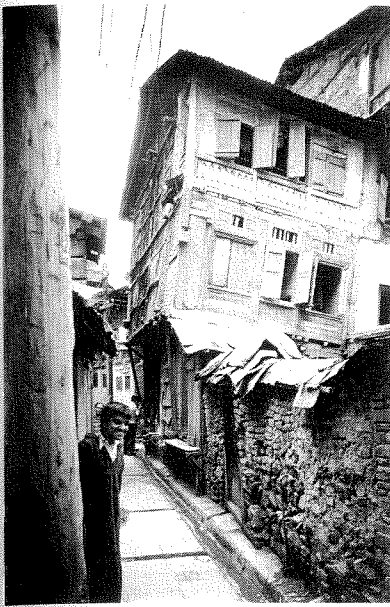
**Upper right:** A ca. 18th century Taq system house showing the horizontal runner beams and the masonry piers between the windows. Notice that in this unusual case the piers do not even line up.



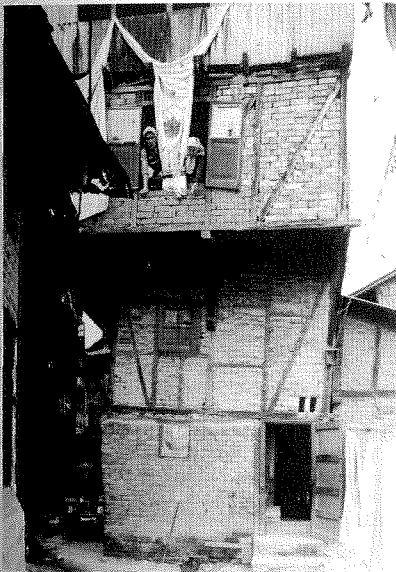
Prior to this earthquake, another British traveler to the Kashmir, Frederick Drew noted that these houses were locally recognized for their aseismic attributes, "these mixed modes of construction are said to be better as against earthquakes (which in this country occur with severity) than more solid masonry, which would crack." [9] More recently, two Indian engineers, N. Gosain and A. S. Arya ascribed the damage from a 1967 earthquake to the different types of traditional and modern construction in Kashmir:

The timber runners...tie the short wall to the long wall and also bind the pier and the infill to some extent. Perhaps the greatest advantage gained from such runners is that they impart ductility to an otherwise very brittle structure. An increase in ductility augments the energy absorbing capacity of the structure, thereby increasing its chances of survival during the course of an earthquake shock. This was substantiated by the observation that "*dhajji-dwaris*" [sic] in which a larger volume of timber was used were comparatively safer. [10]

Gosain and Arya note that during the 1967 Kashmir earthquake buildings of three to five stories survived relatively undamaged. According to Arya, one of the most important reasons for this was the damping of the motion of the building caused by the friction induced in the masonry of the Taq walls when it begins to crack and move along the mortar joints. Internal damping "may be in the order of 20%, compared to 4% in uncracked modern masonry (brick with Portland cement mortar) and 6%-7% after the masonry has cracked." His explanation for this is that "there are many more planes of cracking in the *Dhajji-Dewari* compared to the modern masonry." It is this distribution of the forces throughout a large area of the wall, preventing destructive cracking in one



Many of the houses in Srinagar remain radically askew from weak soil and past earthquakes.



An example of Dhajji Dewari construction.

area, that leads to a much greater level of energy dissipation than would otherwise be possible. As a result, even though the mortar is extremely weak, causing the wall to yield under a much smaller load, the masonry continues to have a good chance of holding together. The timber runner beams and floor diaphragms keep the individual piers from separating, which would cause the house to break apart. In Kashmir, rigidity carries the potential for destruction. The more rigid a building is, the stronger it must be in order to avoid fracture. Because the primitive materials and means of construction used in Kashmir did not provide strength, flexibility was essential.

A similar form of construction can be found in Afghanistan but not in Nepal. The cultural context in which it developed extends to include Yugoslavia, Turkey, Iran and Iraq, all once part of the Ottoman Empire. [11] Houses found in parts of Greece affected by earthquakes also have horizontal wood members, but in the buildings seen by this author, the walls are far more massive. The use of horizontal wood ties is also common in seismic areas of Turkey, with less use in nonseismic areas, thus supporting the claim that they were used deliberately for earthquake resistance. [12] The bond beams in Turkey are credited with "incorporating ductility to the adobe walls, substantially increasing their earthquake resistant qualities." [13]

**The Dhajji-Dewari.** The half-timber, brick-nogged type, known as the *Dhajji-Dewari*, exists side-by-side with the *Taq* in Kashmir. Half timbered construction continues to provide an efficient and economical use of materials. The use of wood, while kept to a minimum, nonetheless enables the thin masonry walls to resist out-of-plane collapse, while also restraining the in-plane movement of the masonry.

*Dhajji-Dewari* comes from Persian and literally means "patch quilt wall." This method of construction appears to have emerged into common usage alongside of the *Taq* system during the late nineteenth century when bricks of a more standard large size became available. This larger size brick (65mm X 115mm X 230mm) [14] set into the timber frame enabled the construction of one-wythe-thick brick wall. *Dhajji-Dewari* buildings constructed with unfired mud bricks also were common, especially in the villages.

Variations of the brick-nogged type were common historically in many areas not affected by earthquakes, such as medieval England and Europe, where bricks provided an alternative infill to wattle and daub. It even extended into North America, where the German *Fachwork* tradition gave root to a number of vernacular buildings with masonry infill in the United States. Since much of this construction was far from earthquake country, it is not possible to ascribe its continued use in Kashmir solely to the incidence of earthquakes. It is clear, however, that the almost universal use of either timber restraint system is a logical response to both the incidence of earthquakes and the instability of the soils. Variations on this system have proved especially suitable in seismically active regions such as Yugoslavia, Greece, and Turkey, and it is probably from this region that the Kashmiri system developed.

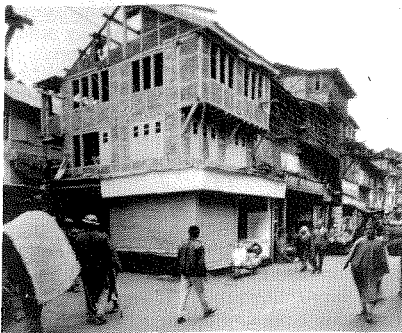
In a survey of the damage caused by the 1963 Skopje, Yugoslavia, Earthquake, a London engineer, N.N. Ambraseys, reports that the "old adobe construction, particularly those with timber bracing, resisted the shock with some damage, but behaved far better than the [modern] brick or the hybrid [reinforced concrete with brick infill] construction." Many of the modern reinforced concrete buildings, which ranged from 3 to 6 stories in height, were seriously damaged or destroyed, while the less substantial adobe buildings survived. [15]

In Kashmir there are many examples of houses where both the *Taq* and the *Dhajji-Dewari* are used side by side in the same structure. The *Dhajji-Dewari* is frequently found used for the party walls between buildings, whereas the *Taq* is used for the front walls. In principle, the *Dhajji Dwari* is lighter in weight, allowing for its use on walls which are cantilevered over the street. The brick-nogged type of construction also is found in Greece, where it is sometimes used for the upper part of the houses - where masonry would be less stable because of the lack of the precompressive force provided by the weight of the building above. In Kashmir, the top floors of the houses were frequently made only of timber, probably for the same reason.

This construction type has shown enough resistance to earthquakes when compared to plain masonry structures, whether of fired brick or adobe block, that in some of these areas where earthen or brick buildings continue to be built it is encouraged by the local building codes. [16] A. S. Arya reports that it has formed the basis for the current Indian Standard Building Code #4326. 17

#### Present-day Construction

Over the course of the last twenty years, construction practices have changed dramatically in the Kashmir Valley. Now, most of the new buildings are of reinforced concrete. Brick is still used, but only for infill walls between reinforced concrete floor slabs. Considering the world-wide trend towards concrete or steel construction, this is not surprising. In Kashmir, however, it does represent a major shift in the nature and the cost of construction. In addition, much of the building which is done in reinforced concrete is neither well engineered nor carefully constructed. Concrete in Kashmir, as in most of the Third World, is not treated as a sophisticated material requiring careful quality control. It is mixed by hand, dumped by the basket-full, and retempered if necessary. In addition, much of the construction is not engineered for earthquake forces. Instead, it must rely on the infill masonry for most of its lateral strength. The timber runner beams and *Dhajji-Dewari* frames have been abandoned as unwanted vestiges of the pre-modern way of life.



A Dhajji Dewari house being reconstructed using the traditional materials, including mud mortar. All of the exterior walls were reconstructed while the family continued to live in the house.

This author did come across one project involving the reconstruction of a house in Srinagar where the *Dhajji-Dewari* system was still being used. In this particular construction project it was observed that the mortar in which the brick infill was laid was made from mud mixed with straw. A man was mixing this mortar with his bare feet. Next to this pile was another made up of cement and sand. In response to the inquiry as to why both materials were being used for mortar on the same project, the mason pointed out that the mud was used for the brick infill, while the cement mortar was being used for a brick wall behind the structure which did not have the timber surrounds.

While the mason could not fully explain in English why it was done this way, it was clear that he understood that the use of cement for the infill bricks would be a mistake. It is possible that the higher cost of the cement contributed to the decision, but wood is even more expensive. Mud was being used because cement would not have withstood the movement of the timber frame without cracking. Like many traditional systems, the *Dhajji-Dewari* system is an almost organic balance in the economical use of locally available natural materials. Once one part of it is changed, the whole system necessarily must change.

In this particular case not only was the internal core of an existing house conserved while all of the exterior walls were being reconstructed, but the family continued to live in the house as the work was being done. Such was probably the rule rather than the exception in Kashmir, until the recent introduction of Western-style building technology. When asked the age of the Kashmiri houses, earthquake engineer Anand Arya responded by telling the story of a barber who passed his razor on to his son, saying that it was precious because "it had been in the family for three generations." This barber went on to say, "My father replaced the blade, and I replaced the handle." His point was that these changes made in the course of its use did not erase the time honored significance of the artifact, and "the Kashmiri houses are the same as that razor." They are ancient, regardless of whether the physical fabric had been replaced in time, simply because they represent the embodiment of a tradition. The timeless quality of the buildings in Srinagar is undoubtedly a product of the fact that they have been rebuilt in fragments whenever needs changed or deterioration required it over many generations. This probably explains why the travel diaries from the nineteenth century describe a typical Srinagar scene to be one of rickety falling down houses, which look every bit the same as their late twentieth Century counterparts.

#### The "Modernization" of Srinagar: The Destruction of the Old City

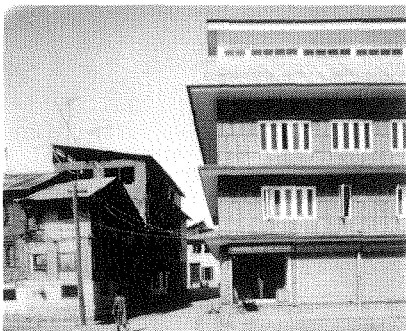
On every level, from the scale of the individual dwelling to the scale of urban and regional planning, Kashmir's reach for modernity threatens to be a disaster. The tragedy is all the greater, because this fragile place is also one of the most unique and beautiful places in the world. For one hundred years, it has been the beauty and character of Srinagar's natural and human environment that has been the region's primary "export." It is this same beauty that is threatened with destruction in the current efforts to "modernize" it.

The least recognized but most important issue is the tremendous aesthetic and cultural loss that inevitably would accompany the rebuilding of Srinagar and other cities that have similar pre-modern vernacular buildings. Total replacement of these structures with buildings of a new reinforced concrete technology destroys that continuity. The work is taken out of the hands of the people who had traditionally done it and put into the hands of specialists trained in a new way. An alien form thus makes its appearance on the landscape. What is needed is a combination of traditional vernacular construction techniques with a modest and compatible introduction of some modern materials and technology.

The problems in Kashmir are not entirely the fault of the shift towards reinforced concrete construction. The desire to have a concrete house is emblematic of the desire to be modern, especially when modernization is actually confused with Westernization. If it were only people wishing to renew their houses in a new material, the change would be gradual, and the culture and way of life would remain intact. However, Srinagar itself is being rapidly eroded by a town planning scheme designed to modernize the city by widening the narrow streets in order to carry auto and truck traffic. In the eight years between this author's first visit in 1981 and his most recent visit in 1989, many of the narrow lanes had been widened into major traffic ways. The buildings along one side had been demolished and replaced with a continuous stream of buses, trucks, and motor rickshaws, with horns blasting. Rarely were sidewalks constructed, as people have always walked in the street. Now they must compete with the motor traffic, and residents frequently get run over.

The Chief Town Planner, M.L. Chaku explained that before they had built the roads "the center was dead." It was clear that his conception of city "life" was incompatible with the traditional life of the walking pace, the mule carts, the small shops facing directly onto the lanes, and the residences mixed together with the shops. The main new street has the shops lined up like bunkers, and few of these new shops appear to support the kind of activities and industries as the older ones.

The local desire for modernization presents a real social dilemma. To recommend a maintenance of the old houses and narrow streets because they are picturesque is unsupportable. Reasons for preservation must be founded in a broadened understanding of how the buildings can continue to support the health and quality of life of the people in the future. Ironically the technology of these houses, although traditional in execution, is still "modern" in concept.



The clash between old and new in the historic part of Srinagar. Buildings, like the one on the right, threaten the coherence, scale and character of the historic center of Srinagar.



The new road constructed during the 1970's which replaced the picturesque 14th century Mar Canal which used to penetrate the heart of Srinagar. The sewerage line which was supposed to replace the canal was deleted in a budget cut, so now the sewerage which used to flow out of the city through the canal now backs up into Dal Lake.



Above: A house in ruins shows the timbers imbedded at each floor level in the Taq System masonry wall.

Above right: A Taq system house undermined by the river shows the remarkable flexibility and strength of this timber/masonry system (and the fearlessness of the workers.)



Modernity should not only be constructed on a Western model, and in this case the blind pursuit of the Western model portends disaster. It is a disaster not only because of the major cultural loss that the destruction of the historic environment would cause, but also because, except for the most wealthy, the comfort and quality of life of the people will most likely be diminished by the changes.

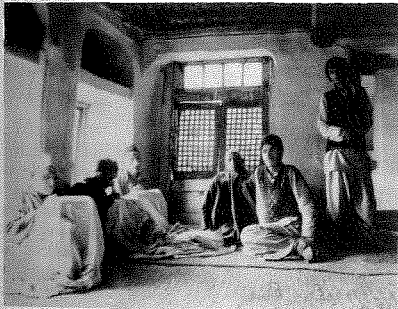
For example, by abandoning the soft restraints of the timber beams, while failing to provide the strong restraints of good engineering and quality control in the construction, the new concrete houses are potentially far more dangerous in earthquakes than the traditional timber and masonry ones. With reinforced concrete, a greater degree of life safety can be promised, but, as seen in Armenia, not necessarily delivered. Perhaps by forgetting the unwritten knowledge of past generations, in preference for the seeming certainty of an imported industrialized alternative, a greater risk may result.

Another shortcoming exists in the overall thermal comfort provided by the concrete houses. These houses usually have many large windows, but central heating is practically nonexistent in Kashmir, and most Kashmiris would not be able to afford the fuel it would require anyway. An additional disadvantage is that the concrete has a much greater thermal conductivity than does the mud, timber, and brick making the new houses impossible to heat with primitive stoves. Some of the better traditional homes even had a room, called a "hamam", constructed with its floor slabs above a wood fire box which allowed the hot gasses to heat the floor. When interviewed in 1989, many people commented that in winter the newer houses were much colder even than those mud houses which lacked the hamam.

Even the sanitary arrangements of the new houses in the old city fail to fit the local conditions. The new houses usually have bathrooms with flush toilets, but the government has yet to install a modern sewerage system in Srinagar, spending its money on new roads instead. As a result, the flush toilets only serve to transport its contents to a ditch in the middle of the public footpath! In the past, the "night soil" had been gathered by workers on a daily basis and taken to the fields, but as of 1989, there were no provisions for the removal of either liquid or solid waste, other than allowing it to migrate slowly to the river in the open gutters.

In other words, modernization has come to Kashmir from the wrong end first. The home appliances and visible trappings of a consumer society are beginning to be accumulated, before the infrastructure is in place. The results are devastating, and these changes have substantially eroded the ecological balance which traditionally existed in the valley. In addition, the removal of the people from some of the older neighborhoods has upset the human ecology as well, because Muslims and the Hindus have moved to separate areas in the new colonies which tends to aggravate the sense of difference and distance between the two communities. As one member of the Legislative Council, Sadiq Ali, observed, in the older neighborhoods the two groups had traditionally lived close together in harmony.

What is ironic is that all of this planning effort begins with the desire to improve the quality of life of the people and to repair the environmental damage that has already occurred. The problem is that in an area like Kashmir, First World industrialized solutions just will not work. With foreign aid, facilities such as water treatment plants can be constructed, but they will not work unless the local community has the money and technological know-how to



Embroidery craftsmen in the living room of a Taq System house. The traditional Kashmiri house has no chairs and few tables. The Kashmiris are accustomed to sitting on the floor.

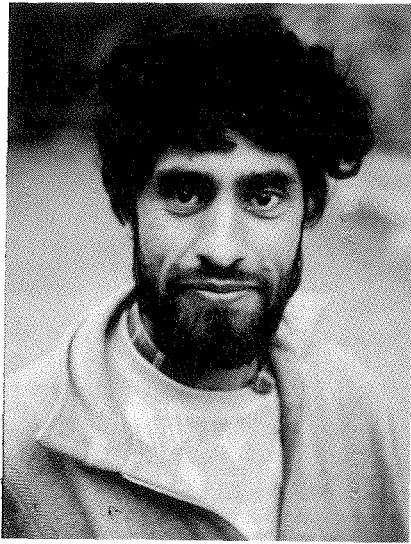


A Kashmiri family in front of their Dhajji Dewari home.

operate them.<sup>[18]</sup> Solutions must be in sympathy with the existing society and economy of the region. Kashmir could have a lot to teach the world about life in balance with nature, but first it must rediscover the value of its own traditions. The place to begin is to rediscover the advantages of the timber and mud houses - not in order to return to the past but to bring this technology into the future as an essential step in the effort to return intrinsic wealth to the people in the form of affordability, comfort, family closeness, and social compatibility.

The possibility that this approach might be viable was made poignantly clear when the head of one family living in a traditional mud and brick house, Fayaz Bhat, reported in an interview that for years he believed that he would have "to build a new [modern concrete] house" like that of his neighbors, to replace his house originally constructed by his grandfather. He said that when he was traveling in central India, he met an English couple and was struck by how they were always interested in the old things. He said that it was only then that he realized that, when he returned to Kashmir, he "did not have to tear down his grandfather's house." As T. S. Eliot said in *Little Gidding*: "We shall not cease from exploration, and the end of all our exploration will be to arrive where we started and know the place for the first time."

These old structures possess something which no architect can put into a new design - the visible manifestation of *time*. Most of all, these structures already belong to the people. They are their houses, their businesses, their parents and ancestor's houses. They carry the unspoken history of generations. They are not just good design; they are an inextricable part of a way of life which defines the character of Kashmir. Their destruction will do no less than destroy this relationship, and thus diminish the cultural heritage which can be a source of Kashmir's pride. It is a loss which no amount of money or material goods can recoup, and it is not the tourists who will suffer most when the loss takes place. It will be the Kashmiris themselves.



Fayaz Bhat, when interviewed in 1989.

<sup>1</sup>V. S. Naipaul, *An Area of Darkness*, London, 1964, p123.

<sup>2</sup>With the recent fundamentalist-inspired conflicts, most of the Kashmiri Hindus have been forced to leave Kashmir.

<sup>3</sup>Seismicity of 8-9 on the Modified Mercalli scale (Arya, interview)

<sup>4</sup>This system, sometimes incorrectly identified as "Dhajji-Dewari," actually has no specific name in Kashmiri to identify the construction method. The closest name identified by local experts to describe it is "Taq." "Taq" refers to the modular layout of the piers and window bays, ie: a 5 taq house is 5 bays wide. The piers are almost always 11/2 -2 feet square, and the bays are approximately 31/2 feet in width. This traditional system with the piers and horizontal wooden runner beams was in common usage before the Dhajji-Dewari came into use. The bricks commonly used were small size, rough surfaced, and hard fired. They are known as "Maharaji Bricks." The reason for the name is unknown. Bricks of this type can be found in the Mogul Period buildings as early as the 16th Century, but the houses which survive date from the 18th and 19th centuries.

<sup>5</sup>*Dhajji-Dewari* comes from Persian and literally means "patchquilt wall." This method of construction appears to have emerged into common usage alongside of the *Taq* system during the late nineteenth century when bricks of a more standard large size became available. This larger size brick (21/2"x41/2"x9") set into the timber frame enabled the construction of one-wy-thick brick wall. *Dhajji-Dewari* buildings constructed with sun-dried mud bricks were also common, especially in the villages. The brick-nogged type of construction is common throughout many parts of Europe from the middle ages, including some of the half timber construction in England and the *Fachwerk* in Germany. Examples originating from these traditions can be found also in the United States. Since most of these areas were far from earthquake country, it is not possible to ascribe its continued use in Kashmir fully to the incidence of earthquakes. It is, however, clear that the almost universal use of either timber restraint system is a logical response to both the incidence of earthquakes, and the existence of soils subject to differential settlement.

<sup>6</sup>As folk lore has it, the hard-fired brick technology was imported to the valley by the Maharaja. The date for this is uncertain.

<sup>7</sup>Gosain, N. and A.S. Arya, 1967. "A Report on Anantnag Earthquake of February 20, 1967.", *Bulletin of the Indian Society of Earthquake Technology*, Vol 4, # 3, September, 1967.

<sup>8</sup>Arthur Neve, *Thirty Years in Kashmir*, London, 1913, p38

<sup>9</sup>Frederick Drew, *The Jummoo and Kashmir Territories*, Edward Stanford, London, 1875, p184.

<sup>10</sup>Gosain & Arya, "Anantnag," p. 29 (italics added). In this case the authors are referring to the *Taq* system. (The English spelling of *Dhajji-Dewari* varies.)

<sup>11</sup>A.S. Arya, interview, August, 1988.

<sup>12</sup>Gurpinar, et al, "Siting and Structural Aspects of Adobe Buildings in Seismic Areas," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 145.

<sup>13</sup>Alkut Aytun, "Earthen Buildings in Seismic Areas of Turkey," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 352.

<sup>14</sup>21/2"x 41/2"x 9"

<sup>15</sup>Ambraseys, N.N., 1965. *An Earthquake Engineering Viewpoint of the Skopje Earthquake*, July 26, 1963.

<sup>16</sup>For example see: Panayotis Carydis, "The Extent of the Problem of Earthen Buildings in Greece," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 120. (The buildings constructed "have withstood the various earthquakes quite well.") Also Arya reports that India encourages the use of this system.

<sup>17</sup>Arya, interview, August, 1988. (Arya participated in the preparation of this code.) Note that the comparison here is with other forms of masonry construction which are still commonly used in India. Neither this nor the Dhajji-Dewari are as resistive to seismic forces as properly constructed steel and reinforced concrete buildings.

<sup>18</sup>For example, when the new tourist and convention hotel, the Centaur Hotel, designed by an American and an Indian architect, was approved, it was promised to have a sophisticated sewerage treatment plant. It is reported that this plant has broken, and has not operated for years. The hotel is right on the edge of Dal Lake, into which its sewerage now flows.