

# **Seismicity and Traditional Buildings of Kathmandu Valley, Nepal**

by: Riddhi Pradhan

Himalayan mountain, the youngest mountain range of the world, lies on the northern margin of Indian Plate and Nepal occupies the central part of it between 26° to 30° north and 80° to 88° east. Indian Plate is tectonically very active advancing towards north at about five centimeters a year and sliding underneath the Eurasian Plate. Consequently, the whole of Himalaya including Nepal has become seismically very active. Annually thousands of tremors i.e. earthquakes of various intensities occur in this part of the world.

Until recently Nepal does not have its own seismic station. Only in 1978 it has established the station in collaboration with France.

According to the Gopalrajbamsabali (a fifteenth century chronology) the first recorded devastating earthquake was happened in 1255 A.D. In this earthquake temples were collapsed and one third of the total population (in the Kathmandu Valley) died including king Sri Abhaya malla. Its intensity was estimated at X. Such type of devastating earthquake occurs in a cycle of 75 to 100 years. The last Great Earthquake with the magnitude of 8.3 Richter scale whose epicenter was at Nepal-India border hit the Kathmandu Valley very severely. In that earthquake 4,296 people were perished and 55,739 houses were either fully or partially collapsed and 492 public monuments damaged in the Kathmandu Valley. Recently, in 1988 6.5 magnitude earthquake occurred. Its epicenter was at Udayapur in eastern Nepal. It affected the whole area between the Kathmandu Valley in the west and Ilam in the east, damaging thousand of buildings and more than 700 people killed. In short, Nepal is very sensitive to earthquake or say earthquake prone area.

Nepal is an ancient country. Its settlements are considered as the earliest human habitation in the whole of Himalayan region as Thodung lying between Manang in the east and Mustang in the west is considered as a nucleus landmass of the Himalaya and human settlement in the Mustang Valley dates back to 700 to 800 B.C. Similarly, the settlement in Kapilavastu, the native area of Lord Buddha, in the western Tarai is contemporaneous to the Mustang Valley. But in the Kathmandu Valley settlement with concrete evidence started from the Kirati Period just before

the Christian era. All the masterpieces of stone images like Vishnu Vikranta of Lazimpat, now in the National Museum, Budhaneelkantha at the foothill of Shivapuri and recently discovered Buddha image of Sankhamul, to name a few, belong to the Lichhavi Period (300-900 A.D.). Not a single monument in building structure, whether temple or house of that period exists to-day, either they had been completely modified or reconstructed.

Malla Period (1200-1768 A.D.) is considered as the booming period of Nepalese architecture. The existing three palaces of Kathmandu, Patan and Bhaktapur, almost all the monuments irrespective of types e.g, different tiered roof temples, pati, sattal, monastries, dhungedhara chaityas, viharas, stupas etc and traditional private houses belong to Malla Period which is also called Medieval Period. Each different type of structure has its own distinctive character and utility but is linked with one another by common ties of technique and materials. Even the existing road networks of the core areas of three cities are of that period. All these public monuments and private buildings are constructed with only the locally available construction materials like burnt brick, sun dried bricks clay and timber and stones.

During the early part of Shah Period (1768 A.D.- to date), particularly during the premiership of Bhimsen Thapa (1806-1837A.D.), who first introduced the exotic architecture, particularly European in the Kathmandu Valley. And during the all powerful hereditary Rana premiership (1846-1951 A.D.) large scale neo-classical architecture was introduced. All the existing white stucco palaces belong to that period.

The study conducted by the Department of Town and Regional Planning, Trondheim in 1996 entitled "Urban Ecology-Historical Cities in Asia: The case of Patan, Nepal" has very explicitly described about the characteristics of traditional Newar house as follows:

"The original Newari building has remained relatively unchanged over the centuries up to modern times. Most of the houses kept the same appearance for centuries. This was mainly due to similar building methods and materials, and a steady and uniform way of living. The basic unit is a brick walled rectangle, about six meters in depth and four to eight meters long, divided by a central bearing wall. The house has a saddle roof crowned with tiles, and it is usually three stories tall. Window frames, doors and almost all structural elements are made of wood. In the second floor, just under the overhanging roof, the Sajhya is located. This is a large, wooden

lattice windows that are one of the most recognisable characteristics of the old Newari houses. The Sajhya is always in the centre and it creates therefore a central axis for the symmetry of the Newari facade. The vertical orientation of the building is also striking. All the houses have the same height between the floors (approximately 1,8 meters), and therefore the same height. In that way the roofline creates horizontal continuity and gives the typical uniformity to the Newari town.

The traditional Newari house can be separated into three main types due to when they are built and the finish of the facade. The oldest, medieval style is characterized by a horizontal window style with square latticed openings. This is called the Malla style. About two hundred years ago the window design started to change towards a more vertical form, and the Sajhya became less ornamented. This is known as the Shah style. Before the end of the century the trend towards lighter and larger windows was introduced. These windows are called French windows and they are almost one story high. The lattice work disappeared and so did the Sajhya. This style is called the Rana style".

This paper deals specially on the traditional private buildings. Still the large number of private buildings in the core area of Kathmandu, Lalitpur and Bhaktapur cities have traditional architecture coming down from the Malla period.

The average houses are constructed in rectangular design they are in general, about 6 meters depths and its length is governed by the size and availability of materials. The lengths range from minimum of 1.5 metre up to 15 meters although 4 to 8 meters is the norm.

Generally, the buildings are three stories high but two and four are not uncommon. In the core area with better economic standard contains four storeyed houses while in the fringe with poorer economy have two story buildings. In the core area for space reasons or security the buildings coalesced each others forming a courtyard called Chuka in Newari and Chowk in Nepali with at least one house providing access to the street through a gateway on the ground floor. And in case of rich people they have their own independent courtyards having a strong wooden gate for entrance.

The quality of front facade also depends upon economic condition of the occupants. The rich people have profusely carved wooden elements e.g. doors, windows, and cornices with glazed brick wall.

The ground floor is the most uncared part of the whole building as this part is unfit for human habitation. This part is affected by dampness. Its windows are very small and less ventilated. The first floor contains latticed windows with central one is bigger than its side windows and either they are horizontal or square in shape.

In the three story houses the third story (top story) is usually an attic directly under the slopped roof and is used mainly as kitchen and eating room. When there is a fourth story the second and third floors serve as living areas with the cooking and eating areas in the attic as previously described, externally the living area is marked by a special window "San Jhya" consisting of either three or five bays. These windows can be of two different but standard patterns; one of them being a canted projecting bays the other being a projecting but vertical bay of odd numbers (three or five) and on the more important buildings these two standard patterns are combined vertically to form a very impressive and imposing central axis of the building.

In case of four story between third and fourth stories are separated by skirt-roof below which the San Jhya occupies the central position. The skirt-roof continues as symmetry with adjoining third storey building.

The street front ground floor is used for commercial purpose either shop or workshop and the back-side is used for cowshed or store room or keeps empty space called 'Dalan'. The front side and back side is separated by spinal wall or "Dathu Anga" in Newari. Matan or first floor is used as sleeping rooms. Ground floor and first floor is connected by a narrow wooden staircase. Generally buildings are of three stories and the second floor "Chota" is for both purposes living as well as family gathering area. Its central wall is supported by a series of wooden columns making the area more spacious decorative and well ventilated.

The third floor "Pyata" is used for family gathering or sub-divided in rooms. The attic is always occupied by kitchen and shrine. Both are considered as private. No strangers and low castes are allowed. The houses do not have water connection system. Wells and public spouts "Dhuga Dhara" are the main source of water, and because there is no drainage system, the house does not contain a latrine.

In contrast with the well documented description of religious buildings, the historical information concerning private dwellings is almost non-existent. Father Giuseppe who visited Nepal more than 200 years ago has written probably the best known and earliest description of dwellings. "The houses are constructed of bricks and three or four stories high; their apartments are not lofty; they have doors and windows of wood, well worked and arranged with great regularity" this statement to a large extent was valid till the first half of the present century.

The construction characteristics of traditional buildings in relation to seismicity.

1. Wall thickness:- Its thickness is maximum at the ground floor, 45 centimetres. Thickness decreases with succeeding upper floors. As the horizontal thrust at the ground level develops highest at the time of earthquake in a building the greater thickness reduces the shear failure at that time.
2. Mud mortar:- Generally in all structures mud is used as mortar in between bricks, Mud is very weak in strength as compared to the strength of brick and timber. In case of greater thrust the mud mortar cracks and helps to displace wall thus absorbing the thrust. This causes partial collapse preventing total collapse of the building.
3. Wooden elements:- Traditional houses have many timber components like beams, joists, lintels, beautifully carved doors, windows and pillars. The wooden members tie the brick walls making them work as single unit. It prevents the distortion or displacement of walls in case of earthquake. The flexibility of wooden members can absorb some external forces by bending itself and comes to its original shape after the force is released. It helps from breaking the wall. Even in case of breaking, the timber components prevent from total collapse, i.e. partial collapse takes place.
4. House plan:- The plan of traditional houses are generally rectangular, some are even square, which is very good from the earthquake safety point of view. The ratio of length to breadth is generally less than 2.
5. Height: The height of traditional buildings are generally three and half story. The ratio of height to breadth of house is less than or equal to 2.

6. Use of traditional materials: It has an additional benefit that even in case of total collapse most of the materials are reusable where as in case of concrete it is not possible.
7. Partial repair: In case of the damage to the building, partial repair can be done.

On the basis of the above mentioned traditional technology we can say that our ancestors have learned a lot about the earthquake safety construction techniques although they did not know the complex calculation of modern earthquake safety designs. They had learned from thier own experiences.

Traditional buildings are a part of living heritage of the country. Traditional buildings or architecture were intact before the first half of the 20<sup>th</sup> century. After the construction of modern highway in late 1950s the Kathmandu Valley was exposed to the outside world coupled with the fast development of communication rapid population growth and improvement in the economic condition of the middle class people of the city core either they have shifted outside the city in the modern style buildings or started interfering the traditional architecture. The traditional architecture is considered as low height, less ventilated, insufficient light and dampness. Hence, they are against in situ restoration. As a result, there are great change of city scape in the city core.

The government is taking all the possible efforts to project and preserve the traditional houses in the Protected Monument Zones for which it is amending the Ancient Monument preservation Act, 1956 with the demand of time. But from the part of the public with the improved economic condition are hesitant to endorse fully its regulation. They are complaining the shortcomings of vernacular buildings which are low height, less ventilation, poor light and dampness. In addition, compared with modern building its cost of maintenance is relatively high, without convincing and making more aware of the importance of vernacular architecture people will not fully cooperate.

But with the increasing flow of tourists, they have started thinking the other way round. Tourists come here either to enjoy natural or cultural heritage, but definitely come here not to see concrete jungle. Age long

traditional architecture is also a part of living cultural heritage of the country. On the other hand, after listing the Kathmandu Valley in the World Heritage List in 1979, it has become more imperative to maintain cultural heritage as it is. Tourism booming and the UNESCO's encouragement have supported to retain the remaining cultural heritage intact. Keeping in view of the importance of traditional buildings the government had made amendment of the Ancient Monument Preservation Act, 1956 fifth times. Under this amendment for demolition of traditional private houses in the Protected Monument Zones require prior approval from the government. To protect the historical environment as well as the privately owned traditional buildings of the Projected Monument Zones, the government has introduced a special conservation and maintenance guidelines. Those who follow the government regulation will be provided financial incentive like exemption of house/land taxes, exemption of royalty and other taxes in timber, ten percent grant of the total cost of the construction/restoration of building. Further, the monuments have been proposed for the classification into three categories: internationally, nationally and locally important ones. And also special Heritage Fund has been created for the conservation and restoration of the internally and nationally important monuments.

Since last few years there are increasing awareness in the field of heritage conservation. NGO, INGO, private Guthi and individuals are participating in restoration and conservation of cultural heritage. As a result, these activities are putting great demand for wood carving and traditional bricks. And to make more awareness the government has recently introduced the courses on cultural heritage the school curriculum.

As mentioned above Nepal in general and the Kathmandu Valley in particular are very susceptible to earthquake. The vernacular house is made of clay, brick, timber and stone, which are very weak. The past earthquakes have proved that it can withstand in general, up to magnitude 6 in Richter scale. But magnitude above 6 is not uncommon. Keeping in view the importance of traditional architecture as it is a part of the living heritage, it is imperative to make it more earthquake resistant by applying, if possible, the new technology without interfering its original architecture.

Hence, I appeal to the eminent scholars of this august gathering for the suggestion of this technical problems.