

° TO BUILD A VILLAGE °

Syed N. Sibtain

The village of Saighanchi in North Afghanistan was completely destroyed by an earthquake in March 1976. Traditional methods of construction in the area have been to make thick mud walls. Architect Syed N. Sibtain has developed a design which combines modern technology with traditional skills, using local or readily available materials. The novelty of the design lies in the fact that, if and when the building is damaged, the building fails in a controlled manner i.e. the walls fall outward, while the dome-shaped roof remains intact. The village, reconstructed on self-help basis as a model for integrated rural development was completed in July, 1979.

New Saighanchi Village →

Saighanchi after the earthquake of 1976 →



On 21 March 1976, an earthquake measuring force 6.8 on the Richter scale struck the Khulm region of northern Afghanistan. Some fifty people died, many thousands were injured and more than a thousand houses were destroyed. The occurrence was no novelty for Afghanistan, where earthquakes are but one of the many hazards of living.

The author is an Australian architect with a First Class Honours degree from NSW Institute of Technology, Sydney, Australia. At present he is doing research in Town Planning for developing countries at the University of Lund, Sweden, in association with the Royal Academy of Arts, Copenhagen, Denmark.

Some countries, such as China, have advanced techniques for earthquake-prediction and systems for evacuation from danger zones. But for countries like Afghanistan, where traditional home ground and farms are so precious and so important, an earthquake is an act of God which must be borne with patience.

For these countries, therefore, the only solution is to provide dwellings which will withstand earthquakes or which (if they do collapse) will not kill people, and which can be easily rebuilt.

Eight months after the earthquake in the Khulm region, I visited the region and came upon a village called Saighanchi which had been totally destroyed. I found the people living in army tents or in the patched-up ruins of their houses. They faced a bleak winter in temperatures which can drop well below zero.

I had just devised a building system for earthquake-resistant housing and my reason for being in Afghanistan was to discover a suitable site for an earthquake-resistant village. Saighanchi proved to be that village. The Government of Afghanistan gave permission for the rebuilding of the village subject to finance being supplied by sources outside Afghanistan. With the finance provided by some Australian aid agencies, the Project Reconstruction Saighanchi began in April 1977.

The objectives of the project reached far beyond the simple reconstruction of a village. These objectives were:

1. to encourage self-reliance through self-help;
2. to enable the peasant farmer to achieve building skills which would help him to become economically self-reliant;
3. to provide a building system which is socially and aesthetically acceptable, thereby ensuring a spreading effect;
4. to provide a model for Integrated Rural Development focussed on health, environment, solar energy resources, community development, nutrition and agriculture;
5. to provide a model for a realistic Disaster Relief programme which the government could adopt for other earthquake-prone regions.

The project took sixteen months to complete. The period was spread over three years, from 1977 to 1979, because it was not possible to work through the winter months. Our team consisted of an architect (myself), a student architect, a participating social anthropologist, and several others who assisted for varying periods.

The work was carried out by the villagers, illiterate peasant farmers with no knowledge of or training in building. Some of them became so skilled in the work that they would put many a qualified artisans to shame.

It soon became clear to us that in a self-help project in a country as poor as Afghanistan it is quite unrealistic to expect people to work all day earning money to support their families and then find the time and energy to work on the project. We therefore devised a system whereby the families were provided with food through a communal kitchen. The food was prepared by the women, in turns, and consumed by the villagers and staff.

communally. Our diet was potatoe soup, bread and tea, but it was satisfying. The health of the people improved and we all had sufficient strength for the work over very long hours!

We were by no means without problems. From the beginning to the end of the project, we faced countless social, organisation and political problems. Besides these, we experienced a Revolution and a Civil War. And yet the project was completed, and the results were greater even than our expectations.

We had found a village which lacked even the basic necessities. The only water supply for drinking, cooking, washing and bathing was the polluted Samangan River. As a result, most people had constant gastric disorders, and eye diseases were also common. Babies died because of the absence of hygiene. The close proximity of farm animals to the living quarters, and the flies they attracted, helped to spread disease.

The new village of Saighanchi has none of these problems. The solution provided was a total solution, taking into account the physical, environmental and social needs of the community. There is nothing dramatically new about this. It is surely the responsibility of any planner/architect who must design for a community to provide nothing less than a total solution.

New Saighanchi consists of the following:

1. Family Houses: 25 dwellings with 2 or 3 rooms, a store room, kitchen etc., with boundary walls and two courtyards. The earthquake-resistant building system is based on a modular building and planning system, ensuring equal floor space area for all.
2. Domestic/Drinking Water Supply System: Amoeba-free clean drinking water is drawn from a deep well through the use of a windmill. The water is continuously pumped into a water storage tank of 8 000 litres capacity, situated at the highest point in the village. From the tower, water is supplied through the pipe-lines to water supply points, toilets, communal bath house and the Mosque.
3. Sanitation: There are banks of toilets in three locations with Septic Tanks which render the faeces harmless. The tanks are emptied twice a year providing the villagers with valuable fertilizer.
4. Cattle-sheds: The cattle-sheds are communal and can accommodate upto 73 cows, 20 donkeys. There are two large milking yards and a special shady and protected area for new born calves. To promote better health, no animals are allowed within the four walls of a dwelling.
5. The Mosque: Unlike the places of worship in other religions, the mosque in Islam is a centre of communal activity beside being a House of God. The mosque is serviced by a Natural Air Conditioning System.
6. School: There are two classrooms, both fully furnished, and can accommodate upto 48 students.
7. Credit Union/Co-op Office: Saighanchi Credit Union was established in 1978 and every family is a member of it. In 1979, a Production Cooperative was also established. The office provided for these activities also doubles as a room for the visitors.

13. Environment: To make the environment softer, an extensive programme of tree-planting was carried out last Spring. The results have been most encouraging. Since the animals are not kept within the yards of the houses, the villagers have planted fruit trees, vegetables and flowers.
14. Landscaping: All streets are paved with limestone aggregate with kerbs formed with large rocks. Along the main street leading to the village, mulberry trees have been planted to provide shade and fruit.

Earthquake-resistant Building System

The earthquake-resistant building system consists of two separate and independent systems, one for the walls and the other for the roof:

Earthquake Bond

In the case of a conventional brick wall, stress can be applied on either side, and failure may occur in either direction. A semi-circular arch, laterally inverted to form a curved wall, resists stresses in one direction only. If a seismic stress is applied to the outer face of a curved wall, the stresses are transferred as in an arch and the wall becomes very much stronger than a conventional wall. Conversely, a seismic stress applied to the inner face results in the failure of the wall, and if the wall fails, it falls outward.

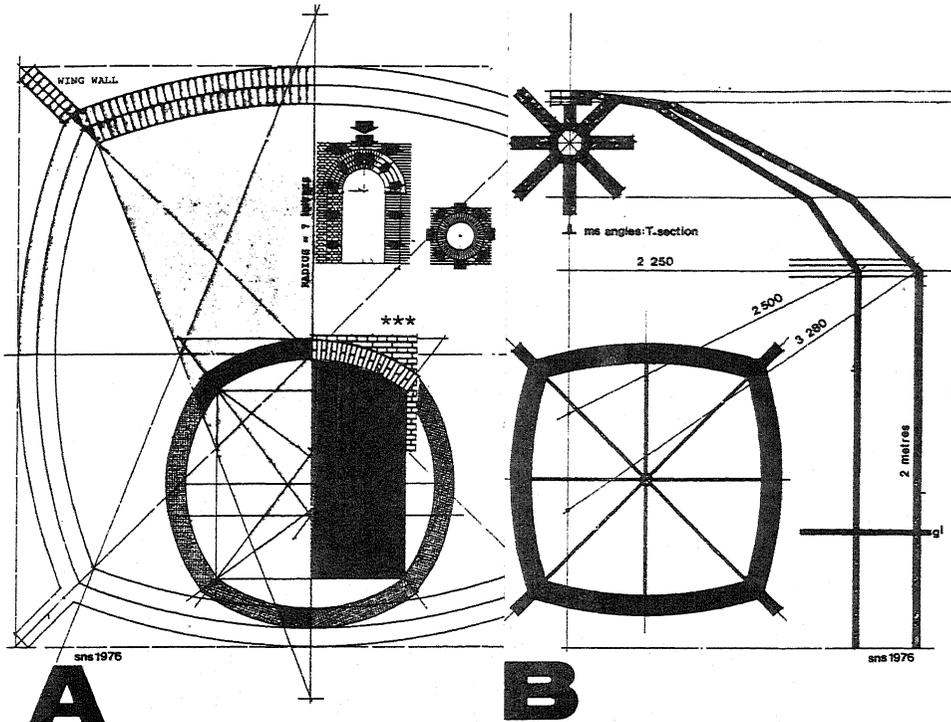
Similarly, in a circular window opening, all stresses are uniformly distributed around the opening which are resisted by the 'arch brick bond', making it one of the strongest way of providing an open space. Based on the same principle, grain stores in the countryside of Australia in the early days were constructed in the same manner. The silos, some of them still in existence but unused, were built underground, with an opening at the ground level, roughly in the shape of an igloo. The stresses exerted by the earth surrounding it, were most efficiently countered by the 'arch-brick-bond' used in the construction.

Obviously the same system can be applied to structures above the ground (as in a brick chimney of a factory), replacing stresses by the earth surrounding an underground grain store, with seismic stresses. But, it is not very practical to live in a space completely circular in shape, a radical departure from the traditional way of living. Therefore, a compromise had to be reached. I decided to use the profile of a shallow arch, making use of its load-bearing characteristics.

To test the relative strength of the shallow arched wall, two brick walls of equal length and height were built to a 1:5 scale with one return end on each. The first of these walls was built in the conventional way and the other with a shallow arch-like bond, renamed as the Earthquake Bond. Both walls were simultaneously subjected to a simulated earthquake and the results studied.

The wall constructed like a shallow arch, with Earthquake Bond, withstood seismic oscillations four to five times longer than a conventional wall and it fell in the direction predicted.

By constructing these arches as walls it becomes a simple matter to form an enclosure - see illustration 'A' for graphic explanation. The corners can be strengthened by means of a wing wall or cement mortar in voids, which behave in a manner similar to a keystone in an arch. Using this configuration, fairly large-sized enclosures can be formed. Even if the walls are not constructed like arches, slightly curved walls of irregular configuration can be constructed using the Earthquake Bond, which gives the designer a free hand to form an infinite range of earthquake-resistant structures - limitation being that the roof has to be of a different shape but still independently supported. Even if the roof is conventionally built with components supported by the walls, the building is four to 5 times stronger against earthquakes provided the Earthquake Bond is used for the walls.



Development of
EARTHQUAKE BOND

Development of
STRUCTURAL COMPONENTS

***Elevation of an Arch laterally inverted and developed into the Plan of a room.

The Roofing System

It is comforting to know that in the event of an earthquake the walls are stronger than conventional walls, and if they do fall, they fall

outward. But what about the roof? Obviously the roof will need to be independently supported in such a way that it will remain standing even after the walls have fallen down. Beside that, there were other criteria to be considered. The roof had to be light with its components easy to fabricate and handle without much skill. In short, all structural components had to be designed in such a way that stress imposed at any point were quickly distributed amongst other elements.

To solve the problem it was necessary for me to go back in time to search for a solution which fulfilled traditional and aesthetic needs. The answer was found in a Turkoman's tent called Yurt, alacheeq in Iran, khair gah in Afghanistan.

The roof had to be dome-shaped for two reasons: Because the dome is socially and aesthetically acceptable in northern Afghanistan (as well as in Iran and other Middle East countries) and because it is most suitable for countries with a climate ranging from very hot to very cold.

Scarcity of timber in these regions also had to be considered and since the steel sections are commonly used to form lintels for the support of pseudo-arches, doors, gates, etc., it was decided to utilize skill. Consequently, a modular system came into being: mild steel angles were joined together to form a T-section, heated and bent to the shapes required. As can be seen, there are only three components, two roof-supporting members and a tension ring. Using all three or any one of the components, different shapes and sizes in structures, with an infinite variation of spaces, can be achieved - for mosques, schools, animal-sheds, hospitals and traditional covered bazaars.

The components are put together in such a way that the roof structure looks like an inverted basket when used for small structures such as houses. At the springing point of the roof, there are four 3mm wires, joining together the structural components to share the stress applied by earthquakes. The dome-shaped roof can be covered by wood joists and boards, mats or reeds and then covered with Kah-gil, a mixture of mud and straw to provide a surface impervious to rain and snow.

The structural components can also be fabricated in wood where good quality timber is easily and economically available.



Walls and roofs without final render - note structural steel members in the background on the left.

Ventilation

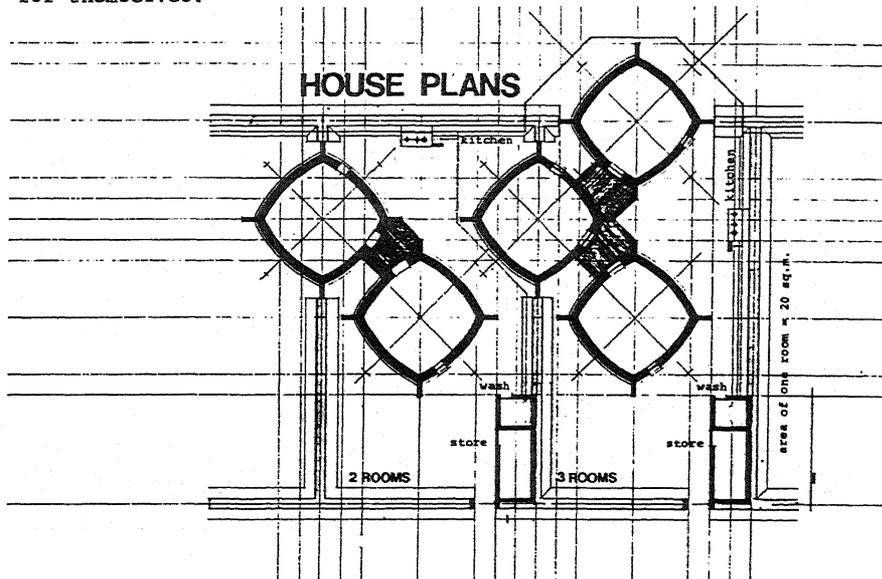
The windows are small in width, only 300mm wide, but are designed in such a way as not to weaken the structure against earthquakes. The windows are also designed to provide adequate ventilation when required: for instance, in summer, top and bottom sashes can be opened; the air-changes assisted by the opening in the roof, take place rapidly.

During the winter, the smoke can be removed from the upper layers of the space by opening the top sash only without losing much heat at the floor level.

It is worth noting that in traditional dome-shaped houses, usually there are no windows at all, only an opening at the apex.

According to the test carried out under simulated earthquake conditions, the walls fail only partially and fall outward, while the remainder of the structure remains intact. The model tested in Australia withstood seismic forces greater than any yet recorded anywhere in the world, and the forces had to be increased beyond Richter's Scale 10 to achieve partial failure of the building.

It is a great feeling to know that the rural populations living in earthquake-prone zones can live there without the fear of being killed inside their houses. The security provided by the Earthquake-resistant Building System, is at present, enjoyed only by the villagers of Saighanchi and two families in Khulm; but it is hoped that the system would be universally accepted in due course. At least in Afghanistan, the spreading-effects of the technologies introduced to Afghanistan through Project Reconstruction Saighanchi are assured of success. The government, through a change in the Disaster Relief Policy, has ensured that in the future the victims of earthquakes will be helped (through food and materials for building) to build earthquake-resistant houses for themselves.



8. Teacher's House: A house, similar to all the other houses, is provided for the resident teacher and his family.
9. Communal Bath House: A traditional institution in Afghanistan, the bath house in Saighanchi has a capacity for about 20 persons. The water is heated through the use of Solar Energy.
10. Workshop: A fully equipped workshop and a store have been built to ensure that the villagers trained in various technologies can pursue their interests. It is expected that the Solar Absorbers and the structural components for houses will be fabricated by the villagers during the idle winter months. The facilities also ensure spreading of the skills and building techniques throughout the region.
11. Land Reclamation and Irrigation: About four hectares of waste land reclaimed for agriculture, is irrigated with underground water. The irrigation system consists of a well, a windmill, a high capacity four litre pump, and a pipe-line about 1 000m long.
12. Production Co-operative: The land reclaimed for agriculture is controlled by the Village Credit Union (as a landlord) of which every family in the village is a member. If less than five members cultivate the land, the proceeds are equally divided between the landlord and the sharecroppers. If more than five members join together to cultivate the land, the proceeds are divided 9:1 (one share for the Credit Union). The income of the Credit Union is used for the upkeep of the village as well as for the acquisition of farming tools for the use of every family in the village.

