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POST-EARTHQUAKE RECONSTRUCTION IN MAHARASHTRA, INDIA

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ABSTRACT

The experience gained in after-earthquake reconstruction in Maharashtra State of India is described herein. The items mainly presented are: the total rehabilitation program involving relocation of villages and reconstruction in-situ, damage assessment methodology, construction technology options, and level and nature of aid to the affected people. Some issues are also discussed: relocation versus in-situ construction, appropriateness of technology to be adopted, suitable type and level of aid for reconstruction, role of NGO's and voluntary agencies and coordination with the governmental afforts. Lessons are drawn towards suitable time frame and reconstruction approach for developing countries such as India especially for the disastrous damage in rural areas.

KEYWORDS

Earthquake, reconstruction, relocation, rehabilitation, Indian earthquakes.

INTRODUCTION

In the earthquake of Sept. 30, 1993 in Marathwada area of Maharashtra, India, though of moderate Magnitude of 6.4 on Richter Scale, huge devastation occurred including complete destruction or collapse of 28771 stone houses reulting in about 9000 deaths and minor to heavy damage in 169841 stone houses. Besides, severe damages occurred to schools, health centres, other public buildings, and infrastructure. These houses were mainly built using field stone laid in clay mud mortar, with very thick walls and heavy clay roofs. After the first phase of these relief operations, the Government of Maharashtra (GOM) lanuched a comprehensive rehabilitation program 'Maharashtra Emergency Earthquake Rehabilitation Program (MEERP)' which aims

at not only the reconstruction of villages, housing, infrastructure and community services, but also the social, economic, and psychological rehabilitation of victims to install in them a sense of dignity and self-confidence. The rehabilition program includes a marginal upgrading of the infrastructure also, and includes the largest reconstruction program taken in hand in India after a natural disaster, which involves a financial outlay of Rs. 10233.6 Millions (U.S. Dollars 328.6 Million at 1994 prices) by GOM and the donors (REF. 6, 1994).

THE REHABILITATION PROGRAM - MAJOR COMPONENTS

The major components of the rehabilitation include (Ref. 6, 1994) construction of 25000 houses in 50 relocated villages; reconstruction of 30000 houses in-situ on old foundations; construction of 500 model houses and buildings to illustrate economical earthquake resisting techniques using appropriate materials; repair and seismic retrofitting of 200000 houses; seismic retrofitting of 5000 undamaged houses of various types in 12 districts around the epicentre to serve as examples to the house owners; and other items of repair and reconstruction of community buildings, besides economic and social rehabilitation. A high level Advisory Committee with the author as one of its members was appointed by Government of India who submitted its report on Dec. 8, 1993 and made a number of recommendations regarding relocation of villages, selection of new village sites, building materials and plans, new houses at existing sites, repair and strengthening of damaged buildings, strengthening of vulnerable housing stock, upgrading of earthquake monitoring and project management (Ref. 7, 1993). A set of performance criteria' were also developed for the new houses which included: the plan types to suit the socio-cultural needs of the village people; the thermal performance of roofs and walls; the minimum earthquake safety measures, and the foundations. Besides, preferred specifications for walls, roofs and foundations were also brought out which would mostly use available building materials as well as skills, though in some cases, requiring additional training of the skilled artisans.

A number of donor organizations, industries, etc, came forward very soon to construct houses in relacated villages at their own cost and under their own management. They were the first to undertake the new house constructions under direction of the Government using the covered area ceiling of 23m for a house on the plots provided by the Government. They were all required to provide seismic safety for MSK Intensity VIII as per Indian Stardards 1893-1984 and 4326-1993. Their contribution has covered a total of 6500 houses in the chosen relocated villages.

For funding the overall program, GOM sought the assistance from the World Bank, which took time to mature by about June 1994, that is, about 9 months time to complete various formalities. Under the conditions, the program has hired more than 14 consultants whose charges will amount to more than 100 million Indian Rupees.

Some of the problems and issues asising out of the above rehabilitation program are presented and discussed herebelow.

DAMAGE ASSESSMENT

Proper decisions to be taken regarding relocation of a village, demolition and reconstruction in-situ, or repair and strengthening, require a careful assessment of nature and extent of damage to the buildings under consideration. The first available man-power consisted of the staff of the Revenue Department, who are not trained in building damage assessment. Naturally the first damage reports were of very general nature, but good enough to bring to the notice of the Government, the names of affected villages and idea of number of damaged and destrayed/

collapsed houses. This assessment was done very quickly by the revenue staff as best as they could. It helped in the assessment of relief and sheltering requirements but, it was not sufficient for reconstruction planning.

A second assessment was carried out by the junior level engineers of the Public Works Department (PWD), after they were given a quick training by the author regarding the five categories of damage under MSK Intensity Scale (IS: 1893-1984). It is important to mention that as a result of this assessment, the number of houses earlier declared as 'fully damaged' category came down drastically inspite of large scale vandalism of the unoccupied buildings in the elapsed time. The decisions taken by the Government regarding rehabilitation of the buildings are based on the second assessment. For quantifying the damage to each building a scheme was devised (Ref.1, 1994) in which symbols were chosen to indicate the type of damage and its extent. This scheme is very helpful in assessing the repairability of the building or otherwise.

RELOCATED VILLAGES

Relocation of villages involves several issues like selection of the site, layout of the new village, design of the new houses and community buildings etc. The site should be on stable ground, as close to the old village and farm lands as possible, should have adequate drinking water soruces as well as effective drainage possibility. The village layout should be such that it facilitates local living pattern which is 'neighbourliness' prevailing in the villages through cluster housing. Opportunity of improving the community facilities in the village should be utilized in reconstruction. In the new house designs, the living pattern of the affected people, who in the present case are mostly farmers or those in trades related to farming, should be respected. In the planning excercises, participation of the affected communities could ensure the acceptability of the final layout and the buildings.

All these points were realized quite early in the high level Advisory Committee and were recommended strongly. However, due to the natural haste to start reconstruction work as early as possible, political pressures of various kinds, and insensitivity of urban decision makers to the rural context, what actually happened is not fully satisfactory. In order to avoid foundations on 'black-cotton' soils (expansive clayee soils), some of the villages were sited quite far away from the old village agricultural areas, causing permanent inconvenience to the residents. In most cases, 'grid' pattern (the modern city plan) of houses has been used instead of the rural 'cluster' pattern. The house designs adopted are not the 'inward looking' courtyard type but the outward looking rectangular block type. The few villages, such as Tapse Chincholi where the life style of the villages has been expressed in the layout (Fig. 1) and house designs (Fig.2), are the ones most liked by the allottees who had been fully involved during the planning process.

In fact, an important issue arises: should 'relocation' have been considered at all for the villages inspite of some of them having been fully demolished. Since no foundation failures or subsidence had occurred in the earthquake, the walls could be raisedon old foundations, and incorporating the earthquake resisting measures such as reinforced concrete bands (seismic belts or ring beam). That would have kept the villages and the life styles intact, without causing some of the social problems in the villages, which have arisen in the process of site selection, allotment of houses etc leading to division of communities. Some villages have been split into two or more parts, more or less on communal and caste lines. At some places, the new village and the farm lands have become many kilometers apart (even 7 km) compelling them to walk or cycle or tractor down these distances almost daily for their farming activities.

Fig.1 Cluster plan of village Tapse Chincholi

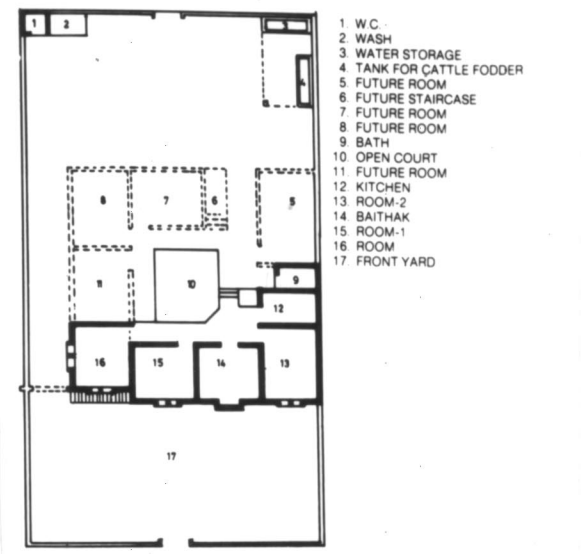

Fig.2. House plan showing present construction and future extension (with inner courtyard)

RECONSTRUCTION IN-SITU

In constrast to relocation, village Tembhi of 77 households is being reconstructed at old site on existing foundations (Fig. 3). The external walls are constructed using stone from the demolished house, but using earthquake resisting features: (i) Cement mortar instead of clay mud, (ii) 350 mm thickness using 'through' stones instead of original 600 to 900 mm thickness 'without' the'through' stones, (iii) reinforced conccrete 'bands' at plinth and lintel levels, and (iv) vertical steel bars at corners and junctions of walls going from foundation into the roof slab. The internal walls are constructed using solid concrete blocks of 200 mm width. The coarse aggregate used in the blocks is obtained from the demolished stones. The internal and external walls are integrated by physical penetration and dowels at intervals besides the 'bands'. Opportunity has been utilized to improve architectural planning and internal detailing. As a results of thinner walls, the rooms have become larger than before and the earlier narrow streets have been widened. The original external facade of stone has been maintained (Joglekar and Das, 1994). The village is thus 'reborn' keeping the originality of hundreds of years (Fig. 4)!

The reconstruction at original site has offered the advantages: (i) direct participation of the house holder in decision making during planning and execution, (ii) use of material available at site, (iii) use of local construction skills, (iv) economy in cost, and (v) maintaining socio-cultural continuity of the community. It may be mentioned that the cost of these houses per unit area (excluding the cost of acquiring land for relocation of villages) has worked out to about 50 percent only as compared with the construction in relocated villages, under the conditionthat the construction agency and the consultant (the author) are the same in both cases.

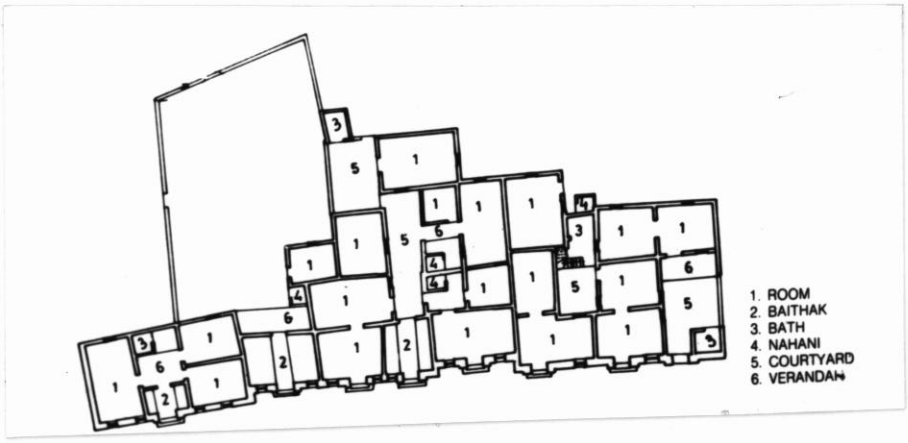

Fig.3. Part plan of village Tembhi

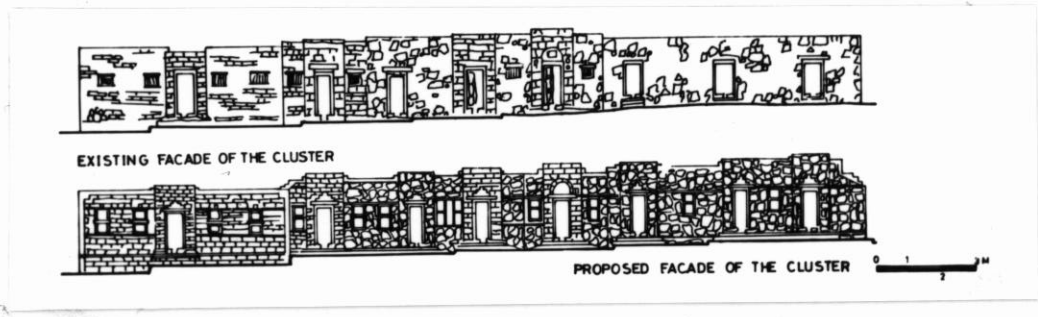

Fig.4. Existing and proposed facade of Tembhi

BUILDING MATERIALS AND CONSTRUCTION TECHNOLOGIES

In view of the volume of construction program (about 25000 new houses at new (free) sites involving about Rupees 2000 million and community buildings of about Rs 500 million, a large number of innovative technology options were offered by prospective contractors. These varied from (a) earthquake resistant bearing wall types including Adobe, fired brick, solid concrete block, hollow concrete block, stone masonry, cast-in-situ reinforced concrete wall, prefabricated reinforced concrete panel walls, Bison panels, etc, to (b) framed construction using reinforced concrete columns and beams or prefabricated light steel columns and beams with various types of filler wall panels. To select the materials and technolgies, a few economic constraints and performance criteria had to be met, as the following

1) Three types of houses will be constructed having floor areas as C=23.2 sq.m, B=37.2 sq.m and A=68.1 sq.m.

2) The houses will be constructed within aceiling of plinth area rate of Rs 1950.00 per sq. m.

3) The seismic resistance will meet the requirements laid down in Indian Standards IS: 1893-1984 and IS: 4326-1993.

4) The thermal performance index (TPI) will at most be equal to that of 200 mm solid concrete block walls and not more than 100 for roofs (requiring about 200 mm overall solid thickness or equivalent using an insulation layer.

5) Since the house areas to be constructed at present are small which may require extension by the occupants later at their own cost, the construction should be replicable and extension of reinforcement and walls or frames should form part of the technology.

6) Foundations will be appropriate to the site soil condition - rocky, murrum or black-cotton (expansive clay) soil.

In the mean time many voluntary agencies offered to adopt one or more villages and construct homes through donations. They were permitted to do so on the lands acquired by the Government for the relocated sites with minimum supervision and intervention. This brought in a variety of house layouts and designs, which in most cases used the 'grid' pattern in village layout, violated the thermal performance index criterion and did not provide for extendability and replicability. Variation can also be seen in the area provided, comforts built, the quality of construction and the finishing specification followed. Donors' contribution is very great in as much as about 6000 houses have already been built in this way while the others taken up by Government under World Bank loan are still far away from completion. However, the variable quality and comforts have become a source of discontent among the people of different villages.

From the view points of availability of materials and skills along with the considerations of cost, replicability and extendability, the construction technology using solid and hollow concrete block walls with stone-in-cement strip foundation, reinforced concrete slab roof and seismic reinforcing with R.C. bands and vertical bars at junctions and corners of walls, has turned out to be the most appropriate for one storey housing in the area.

To transfer the block making technology a number of Building Centres have been established by the Government in the area with the financial and technical assistance from Housing and Urban Development Corporation (HUDCO), Government of India. Thus this technology will remain available in the area even when the after-earthquake reconstruction project is completed.

TYPE AND LEVEL OF AID TO BENEFICIARIES

The policy of Government of India for relief after any disaster, natural or technological, includes ex-gratia cash compensation (i) for death and injuries at different levels, (ii) for building houses 'destroyed' and 'damaged' one sat different scales, and also provides for paying lost belongings. There is hardly any insurance cover available and the Government works as the biggest benevolent insurer using certain laid down norms. In major tragedies, such as the earthquake in Maharashtra, special consideration is made by the State concerned for providing not only relief and temporary sheltering but also for permanent housing to be built to a higher level of assistance. There are two examples of different approaches used by two States in India in the last five years for after-earthquake reconstruction with different results. The approach used in Maharashtra, as described above, is to build houses for the beneficiaries, at relocation sites or the original sites and deliver to them. Each one will get a house plot of land, a plinth area of 23.2 sq.m built as free aid and, those entitled to types B and A will get the additional built area as loan to be paid back later in instalments. On the other hand, the state of Uttar Pradesh adopted a different approach after the Uttarkashi earthquake of 1991 as described below:

Uttarkashi Earthquake of 1991 (Ref. 2, 1994)

This earthquake of M=6.6 occurred in the Himalayas near Uttarkashi in U.P. State on Oct. 20, 1991 and caused severe loss of life and property: 715 human lives were lost with 4774 persons injured, 20212 stone houses were destroyed and other 44643 houses damaged in 2093 mountain villages. Other losses included damage to roads, bridges, water supply, electricity supply and public buildings of various Government departments including schools and hospitals. An extensive relief operation was mounted which included,besides food and health measures, supply of 520000 (C.G.I.) corrugated galvanized iron sheets, 131000 blankets and 42500 tarpolin tents. As usual, ex-gratia payments were made for deaths and injuries and house supplies. The reconstruction program included a total payment of Rs. 42000 per family house [consisting of supply of building materials like C.G.I sheets, timber, steel reinforcement and cement costing Rs 10000 and cash Rs 10000 as grants; loan of Rs 15000, retrieved material and labour component worth Rs 7000 to be provided by the beneficiary]. Team of engineering personnel was established to guide the villagers in reconstruction of earthquake resistant houses, but the construction was left to the beneficiary himself.

This approach is quite different than the approach in Maharashtra adopted after 1993 earthquake. A visit to the devastated area two years after the earthquake showed a variety of scenarios from village to village (Swami, 1993). In some villages, houses have been reconstructed either by the people or partly by people and partly by donor agencies.

But in some villages, houses have still not been reconstructed for various reasons inspite of supply of materials as well as cash.

So far as public buildings are concerned, the government is repairing, retrofitting or reconstructing either through its own resources or using a World Bank loan employing the normal channel of Public Works Department.

COMPARISON

Comparing the two approaches described above, both seem to have strong and weak points. In the Maharashtra approach, every affected family is likely to get a new and better constructed house, sooner or later. But the socio cultural structure of the village communities will be broken altogether or severely strained in most of the relocated villages due to urban type layout, little participation of local communities, lottery allotment of new houses etc. Discontentment is quite apparent as seen from various reviews brought out in the newspapers and voluntary organizations reports. In Uttarkashi, although the village communites have remained intact as before, the reconstruction has not been carried out satisfactorly, inspite of money and materials having been supplied to the affected people. One thing is, however, common in both cases - too much dependence created on aid provided by the government, NGO or voluntary organizations.

CONCLUSIONS

From the Indian experience of post-earthquake reconstructions, the following lessons could be drawn:

1) Planning of reconstruction after a severe damaging earthquake requires a very careful

consideration of the local socio-cultural living ways and the economic trades of the affected people for which appropriate surveys need to be carried out. The people's participation is crucial.

2) A minimum lead time of 6 to 9 months may be necessary for finalizing such plans. There is no magical way to do it overnight whatever the political bosses may think or announce.

3) Relocation of villages raises many problems and should be resorted to only in minimum unavoidable cases and not as a liberal policy. Insitu reconstruction will offer many advantages when carried out with the participation of the beneficiaries at all stages.

4) Building technologies based on local materials and skills with suitable modification or upgradation will offer the best opportunity for employment of the affected population, replicability and appropriate incremental constructions in future and adoption in later new constructions.

5) Besides the government, the NGO's and voluntary orgainzations of various types can play an effective role if properly coordinated, otherwise they can pull in different directions, causing difficulties and dissatisfaction.

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