

## **SUSTAINABLE RECONSTRUCTION AND REHABILITATION OF TSUNAMI AFFECTED AREAS OF INDIA**

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**ABSTRACT:** In December 04 coastal Tamilnadu experienced one of the worst Tsunami in the history that rocked South East Asia, left behind a totally destructed coastal belt, not less than 7000 human lives were lost with other physical and psychological damages. Apart from losses of valuable assets and public buildings about 0.13 million houses were either collapsed or washed away. A holistic view of "Habitat" is planned - one that links the process of housing with the capacity to make and exercise informed choices with respect to building construction, habitat improvement and economic betterment. The Govt. of Tamilnadu came out with "Technical guidelines for reconstruction of houses affected by Tsunami", for which UNDP contributed from its experience of reconstruction. The entire Indian coastline being vulnerable to multi hazard destruction, the initiatives to be implemented needs to be replicated at national and international level through the medium of experience sharing of best practices and learning techniques.

The paper summarizes the greatest challenges and opportunities identified as follows:

- To ensure incorporation of disaster resistant features in all the new shelters
- Skill up-gradation of construction workers.
- Sourcing building materials, technology and design.
- Bridging the gap in technology know how, transfer of technology, dissemination, setting and maintaining of quality control system.
- Bringing together key stakeholders for building better habitat
- Mainstreaming disaster resistant features and cost optimization through appropriate technology promotion in all state sponsored housing scheme and private and public buildings.

### **1. INTRODUCTION**

Tamil Nadu being located in a highly vulnerable part of Peninsular India - the Deccan Plateau and flanked by the Bay of Bengal and the Arabian Sea, is frequently subjected to overwhelming devastation by natural calamities due to cyclonic storms and flooding in its coastal districts. Records of the past occurrences of cyclonic storms highlight the alarming fact that severe cyclonic storms are more frequent in the Bay of Bengal than in the Arabian Sea and records indicate that from the beginning of this century about 400 cyclonic storms formed in the Bay of Bengal as compared to just 80 in the Arabian Sea. Almost every year on an average, one severe cyclone in the pre-monsoon period and one or two in the post-monsoon period are expected during the Northeast monsoon period in the Bay of Bengal. The area normally affected by cyclones is the entire first line coastal taluks right from Chennai district to Ramanathapuram district. Tamil Nadu is one of the most vulnerable States in the country affected by cyclones.

A very severe earthquake measuring magnitude of 8.9 on Richter Scale struck northern Sumatra, Indonesia at 00:58:50 UTC or 06:28 AM IST. The earthquake driven tsunami was felt widely along the east coast of India. The calamity which struck the Tamil Nadu coast was unprecedented in its suddenness and ferocity. It was also widespread in scale affecting villages and towns all along the coastline. Fig 1 shows the affected areas.

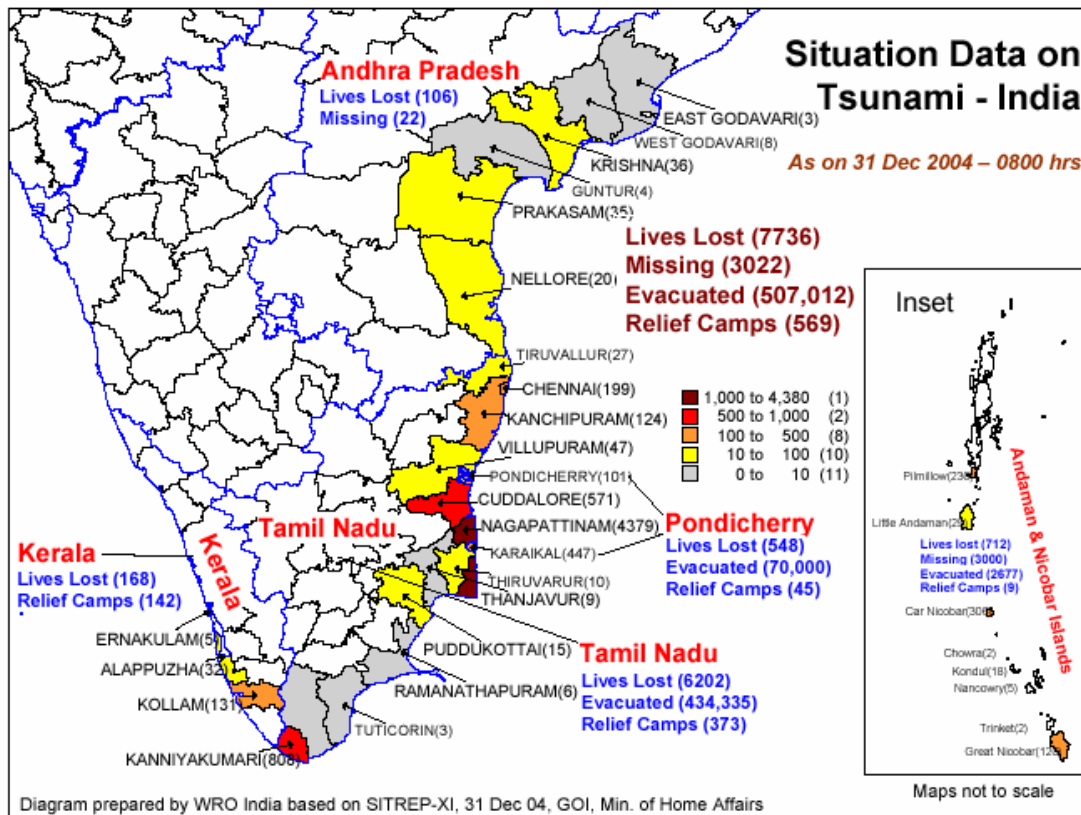


Fig. 1 Areas affected by Tsunami in Coastal Tamil Nadu

The first phase of relief and rescue operations is over in the affected States. The details of action taken, district wise, are shown in Table.1. Apart from losses of valuable assets and public buildings about 0.13 million houses were either collapsed or washed away. Govt., NGOs, International communities and corporate bodies worked actively to restore the normalcy in terms of relief which continued for more than 6 months.

The technology transfer process should and will be able to create building material production and construction based livelihoods. These would serve a variety of purposes: introduce new livelihood opportunities, retain the memory, skills and capacity for improved disaster resistant building systems within the local area in the form of enterprises. These enterprises would continue to build new houses, extend and upgrade old houses in an appropriate manner long after the immediate relief and rehabilitation interventions are over.

It was realized that most of the buildings which had collapsed / damaged due to tsunami were mainly due to poor construction practices without considering the hazard proneness of the area. In order to mitigate such risks in future, it is imperative that all the houses / infrastructure to be constructed in hazard prone areas should incorporate disaster resistant technologies stipulated in Bureau of Indian Standards Codes. The Revenue Administration, Disaster Management and Mitigation Department considered it appropriate to bring out detailed guidelines for construction of houses for the affected people at the relocated sites.

**Table 1 Affected Districts**

Districts	No. of villages / Kuppams affected	No. of families affected	No. of houses / huts damaged	Crop damage (in hec)	No. of Human lives lost	No. of cattle lost	No. of persons injured	No. of persons evacuated	No. of persons in camps
Chennai	24	29144	17722		206	1	9	30000	0
<a href="#">Cuddalore</a>	51	35000	17200	744.00	617	1068	214	61054	900
<a href="#">Kancheepuram</a>	74	10500	9500	336.00	128	5	11	60000	0
<a href="#">Kanyakumari</a>	33	47291	40781	290.00	824	3326	525	46280	2176
<a href="#">Nagapattinam</a>	73	79022	46860	5292.73	6063	5023	1922	196184	19681
<a href="#">Pudukottai</a>	25	6500	1	25.00	15	2	0	4857	0
Ramanathapuram	1	23104	10	104.00	6	0	0	8350	0
<a href="#">Thanjavur</a>	23	6100	100	34.00	30	2	421	4600	0
<a href="#">Thoothukudi</a>	23	19680	1084	323.00	3	15	0	13072	0
<a href="#">Tirunelveli</a>	10	3079	630	37.00	4	0	4	11170	0
<a href="#">Tiruvallur</a>	6	22000	5000	42.00	29	117	0	15600	0
<a href="#">Tiruvarur</a>	0	2568	0	8.00	21	0	0	11295	0
<a href="#">Villupuram</a>	33	16012	11112	64.00	47	0	30	37500	450
<b>Total</b>	376	300000	150000	7299.73	7993	9559	3136	499962	23207

## 2. BACKGROUND GENERAL DEVELOPMENT PERSPECTIVE

It is realized that most of the houses damaged or collapsed either due to poor construction practices or inability of the victim to construct a relatively safe structure. Govt of TamilNadu and other aid agencies came forward to detail out a comprehensive rehabilitation strategy, on which shelter construction and livelihood restoration are major challenges. The Govt. of TamilNadu came out with “Technical guidelines for reconstruction of houses affected by Tsunami”, for which UNDP also contributed from its experience of reconstruction in Orissa supercyclone and Gujrat earthquake. UNDP has come out with a statement on CRZ Coastal Regulation notification and post tsunami reconstruction in TamilNadu.

These guidelines have been specifically framed for the reconstruction of houses considering multi hazard perspective, for the communities which have been affected by the tsunami of 26 th December 2004 in coastal districts of Tamil Nadu. These guidelines will also be helpful for the construction of houses in other districts apart from the coastal districts, which are prone to cyclones and earthquakes. The entire Indian coastline being vulnerable to multi hazard destruction, the initiatives to be implemented needs to be replicated at national and international level through medium of experience sharing forums, best practices and learning techniques.

At present the vulnerable communities are still staying in the temporary shelters. In most of the areas semi permanent houses are built for an interim stay arrangement initiated by Government and NGOs. The Government estimated to build 0.15 million houses in phases. In first phase in 5 most affected districts (Nagapattinam, Chennai, Kanyakumari, Kancheepuram, Cuddalore) 60,000 houses will be built in Ist phase. In some areas the construction of permanent houses are started

Now the greatest challenges and opportunities identified are:

- To ensure incorporation of disaster resistant features in all the new shelters

- Skill up-gradation of construction workers.
- Sourcing building materials, technology and design.
- Bridging the gap in technology know how, transfer of technology, dissemination, setting and maintaining of quality control system.
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A network among other Tsunami affected states / nations for sharing of experience, learning and knowledge platform to be created which will impart and improve on guidelines, set up community processes, technology dissemination and disaster preparedness as a whole to solve the larger environmental issues. As a first step by UNDP in this regard the TNTRC (Tamil Nadu Tsunami Resource Center) is already in function in partnership with Government and other aid agencies (the website can be visited [www.tntrc.org](http://www.tntrc.org))

### 3. GENERAL GUIDELINES

With respect to Site selection the following essential requirements were formulated:

1. During very high velocity winds, the coastal areas suffer due to storm surge where huge loss of property takes place. Site selection should avoid areas likely to be submerged. It is desirable to locate the site such that it is
  - a. At least 500m from the shore and
  - b. +5m above Mean Sea Level
2. The sites need to be close to the present settlement. It should preferably be within a distance of one km from the present settlement so as to facilitate the fishers to carry out their economic activities easily.
3. Building should be located on stable foundation on soil strata having no susceptibility for liquefaction.
4. Terrain category and topography of the site should be assessed and based on these correct orientations of the buildings should be finalized.

The area behind a mound or a hillock (Fig.2) or behind casuarinas plantation should be preferred in order to provide natural shielding (Fig.3).

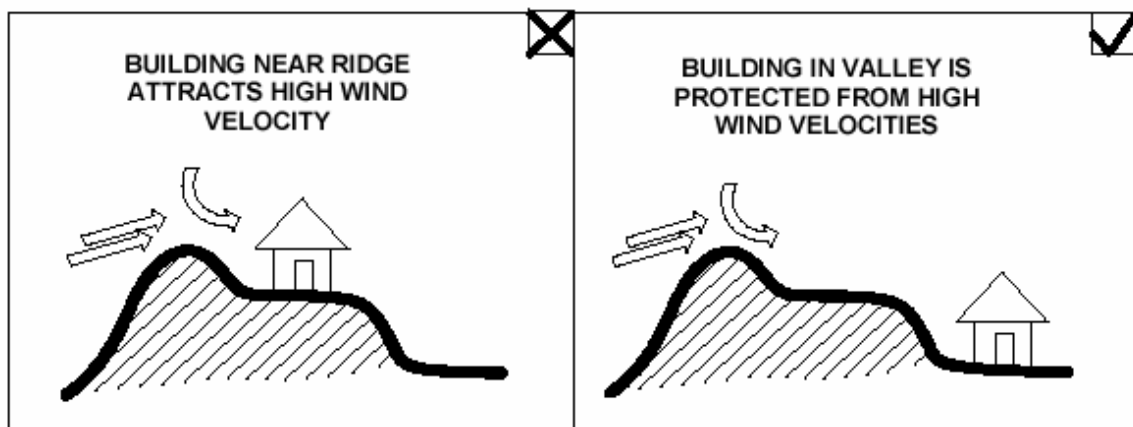
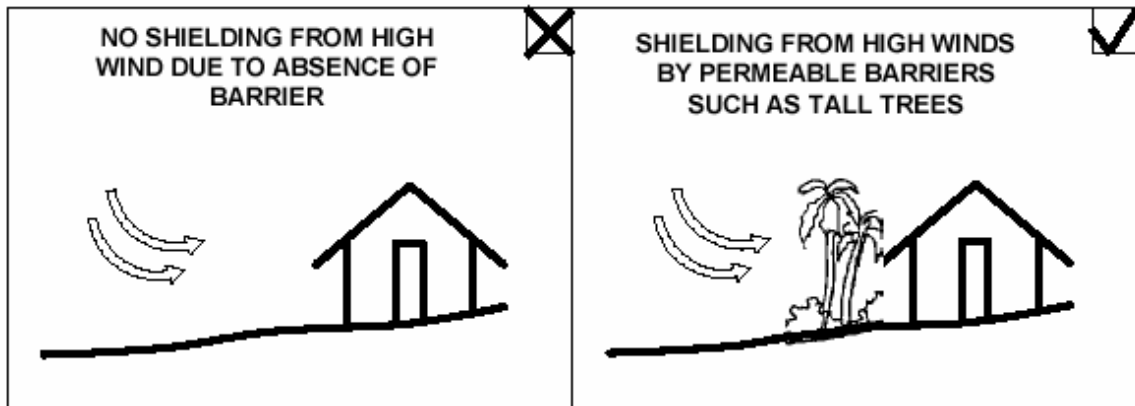


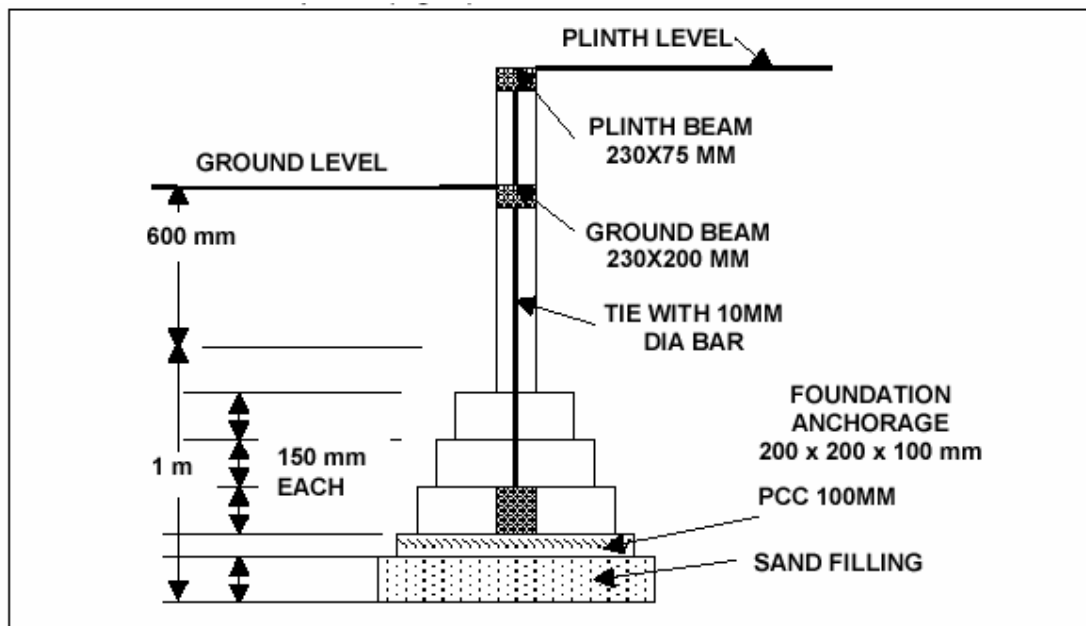
Fig.2 Area behind a hillock

It will be desirable to connect the individual reinforced concrete column footings by means of RC beams below natural ground level. These bands will be intersecting at right angles and form an integral housing unit. The ground beam should be in one level and be connected continuously.



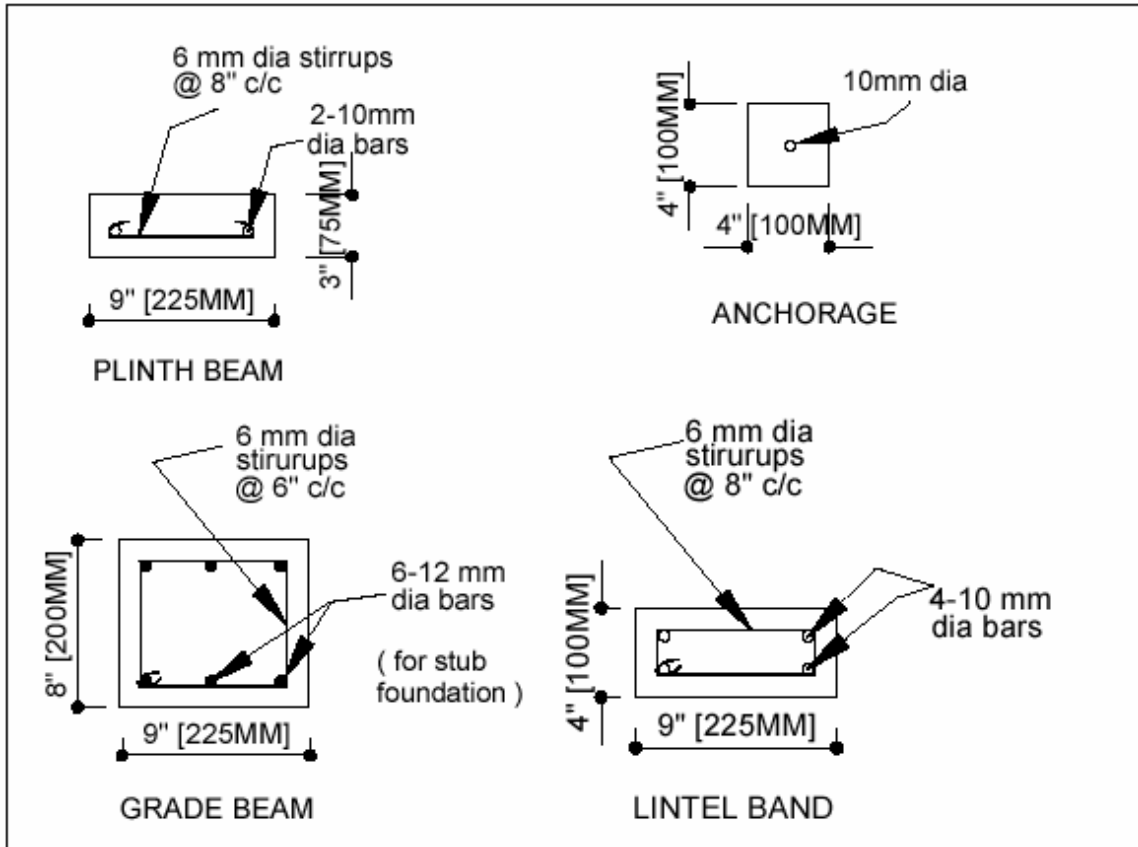
**Fig.3 Natural shielding**

The vertical reinforcement at corners and jambs of doors and windows should emanate from ground level beam. Horizontal beam at ground level or plinth level must be provided. It is desirable to provide the same at both the places (Fig.4)



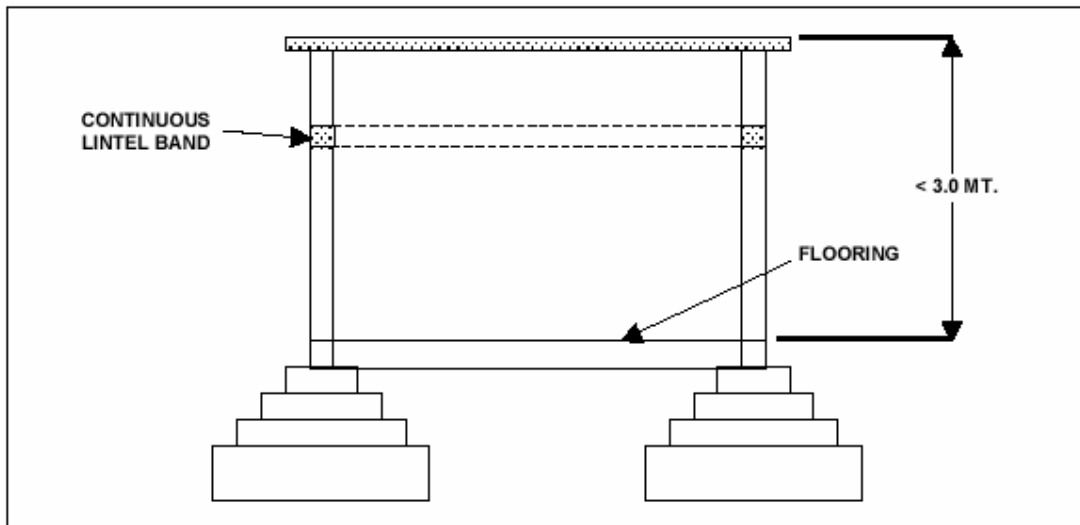
**Fig.4 Foundation details**

It is necessary to reinforce walls by means of horizontal reinforced concrete bands and vertical reinforcing tie members having reinforcing bars as suggested for earthquake resistance. This will make the building act as an integral unit under lateral forces (Fig.5). All external walls or wall panels must be designed to resist the out of plane lateral pressures adequately. For this, the walls should be sufficiently buttressed by the transverse walls or pilasters. The lateral load due to wind/ tidal surge/ tsunami should finally be resisted either by walls lying parallel to the lateral force direction (by shear wall action) or by RC frames to which the panel walls are fixed using appropriate Reinforcement such as Seismic Bands at window sill and lintel level. This will avoid collapse due to out of plane forces.



**Fig.5 Seismic bands**

Continuous lintel has to be provided for the partition wall also and height of floor should be less than 3000mm (Fig.6)



**Fig.6 Partition wall details**

The rainwater should not be allowed to weaken the foundation due to water logging problems. It is preferable to provide an apron around the building. The wastewater from kitchen and bath should be disposed off properly through the drain. Roof top rainwater harvesting system is to be provided. The construction as well as curing should be done only with good quality of water. The PCC in foundation of 1:4:8 should be made over well-compacted soil.

#### **4. TECHNICAL GUIDELINES**

From the results of studies on the performance of buildings during past disasters the following recommendations emerge:

Certain building types, such as, earthen houses, random rubble masonry as well as brickwork in clay mud/mortar, should be ruled out in severe disaster prone zones, costal zones vulnerable for cyclone and Tsunami. Rich mortars involving cement and lime should be used in fired brick and/or coursed stone masonry. Required steel reinforcement should be introduced in the walls in both directions of the building. Light roofs should be properly anchored.

A building is to be designed and constructed in such a way that even in the event of the probable earthquake or cyclone in the region, an ordinary building should not suffer total or partial collapse.

It should not suffer such irreparable damage which would require demolishing and rebuilding

It may sustain such damage, which could be repaired quickly, and the building put back to its usual service.

The damage to an important building should even be less so that the functioning of the activities during post-emergency period may continue unhampered and this will enable the community buildings to be used as temporary shelters for the affected people.

The present state of knowledge indicates that the above structural safety can be achieved by adopting appropriate design and construction details involving only small extra expenditure.

#### **5. STRATEGY TO BE ADOPTED**

The aspects of appropriate technology, local capacity building, creation of sustainable livelihood, outreaching to maximum community invites Partnership processes among key stakeholders which essentially

1. Networking with professionals / agencies working the field of disaster resistant technology and Resource centers.
2. Partnership with community level organisation like Self Help Group (SHG), Civil Society Organisations(CSO) and local Government
3. Identifying potential masons / technicians / supervisors / engineers for skill up-gradation.
4. Capacity building of the society for safe shelter and better habitation for human life.

Setting out the objectives

1. Public awareness is created to incorporate “Disaster resistant features” in all buildings to be built in the Tsunami reconstruction and practiced for rest of the state on the basis of multi-hazard mapping, practiced at implementer and user level.
2. Looking at the huge demand of building materials and resources, good practices incorporating “appropriate building elements and construction system” is adapted and scaled up.
3. Quality assurance system is set up across the state so that user~ implementer link is established for better control over shelter and infrastructure development and planning.
4. Infrastructure development takes place with user-executor relationship for upgraded quality of life
  - rural infrastructure development
  - proper habitat planning
  - resource leverage in development
5. Building construction being one major source of livelihood, production and construction of appropriate building elements by local entrepreneurship and SHG groups will invite ensure livelihood for a section of people. Housing and public shelters being one of the major challenges for entire State, trained masons, supervisors and village level entrepreneurs and institution will continue to be involved in building better shelters and contribute in better services for the improved habitat.

## **6. ACTIONS**

1. Training of Masons, Engineers, Supervisors, Shags, - Conduct 1 Day / 2 day and 5 days training programme
2. Construction of TDU's involving masons, engineers, supervisors, UNV engineers
3. Preparation of "model" village resettlement plans
4. Construction of Technology Demonstration Units (TDUs) (2 to 4 units in each district) in most affected districts. Spread out to moderately affected districts and other vulnerable districts as a risk reduction measures.
5. Collaboration with Development organizations, Academic Institution and professionals
6. Supporting Government and NGOs involved for setting up of quality control standards and awareness generation towards achieving quality – at user and executor level
7. Support Resource centers and Government bodies for creation of shelter and habitat related datas / information (GIS/ MIS).
8. Documentation of best practices and dissemination through print and web media for better decision making and transparency.
9. Model Habitat planning at the village platform involving the community representatives, executing agency. Creation of "Community level" habitat services group.
10. Organising design and process workshops to detail out guidelines for multipurpose Cyclone shelters.
11. Periodic workshops at State and District level for improvement and sharing of knowledge for shelter and habitat related interventions.

## **7. CAPACITY BUILDING THROUGH TRAINING AND DEMONSTRATION**

UNDP will organize periodic training and orientation of trainers, masons, engineers, supervisors across the tsunami affected belt for skill up-gradation and application in the reconstruction phase. These training will be organized in cooperation with local Government, TNTRC, District level Resource centers and strategic partners.

Strategic partners will be identified with respect to their institutional background and individual background on the strengths on promotion of different technology options, disaster resistant designs. At present functional building centers of Government of TamilNadu, Auroville Earth Institute, COSTFORD, TamilNadu Slum Clearance Board are being contacted to play a complimentary role as Strategic partners. Training and orientation programmers are being planned at regular interval at State, District and reconstruction site with infrastructure and training support.

Information, education and communication being one major source of disseminating information, material will be prepared as per the training needs for masons. Hand book / manual in English and local language will be prepared on technology, disaster resistant features involving technical and social experts. Visual documentation of best practices will be made and telecast in local television channel for public education.

Construction of Technology Demonstration Units will be taken up initially in the worst affected districts and gradually to be spread out to other vulnerable districts. The Technology Demonstration Unit will impact the general mass in adopting the appropriate technology and educate them application of disaster resistant features.

## **8. NETWORKING**

Shelter and habitat being one of the major interventions by all developmental actors, UN will play a lead role in creating, facilitating and leading shelter forums at State and district level to address issues during implementation, consistently try to mainstream the noble efforts in regular development programs undertaken by Government. Play a proactive and supportive role for networking among the Civil Societies and local Government. UN played a lead role in formation of a State level resource center TNTRC and linking with District level Resource Centers for better coordination in reconstruction effort. Shelter & Habitat initiative will use these platforms to outreach to the implementing agencies and public.

This programme will support for a web based dynamic shelter portal for collecting / compiling and availing shelter data, information and documentation in Resource Center websites.

## **9. SUMMARY**

In summary, the following are aimed to be achieved:

1. Community participation
2. Play a role of complimentary role and support Government and CSOs for effective implementation of reconstruction programme.
3. Linking disaster to development.

## **10. REFERENCES**

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