6.0 INTRODUCTION
Disaster management model and computer software formulated in the previous chapters provides estimate of damages caused due to earthquake disaster. Quantum of these damages can be used for decision making to deploy resources appropriately or trigger appropriate level of DM set-up to combat the disaster. The DM setup in India operates from the central or national level, state level, district level, block level, right up to the village level. Respective authorities have been assigned specific roles and responsibilities they would discharge during the disaster response besides their routine duties. This chapter provides with a broad outline of the working organisation setup, agencies & NGOs involved in combating disasters. This will help to organise disaster mitigation measures so as to use efficiently and effectively various disaster management resources available at the time of disasters.

6.1 DISASTER MANAGEMENT - GOVERNMENT SETUP
Following governmental setup are put in operations depending on the size and type of disasters.

6.1.1 At the Central Level
Floods, droughts, cyclones, earthquakes, and landslides are some of the major natural disasters that repeatedly and increasingly affect India. The basic responsibility for undertaking rescue, relief, and rehabilitation measures in the event of natural disasters, as practiced, is that of the concerned State Governments. Role of the Central Government is supportive, in terms of supplementation of physical and financial resources and complementary measures in sectors like warning, transport, and inter-state movement of food grains, etc. Various ministries involved in different types of disasters is given in Table 6.1(45) below.
Disaster Management Setup in India: Chapter VI

<table>
<thead>
<tr>
<th>Type of Disaster/ Crisis</th>
<th>Nodal Ministry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air accidents</td>
<td>Ministry of civil aviation</td>
</tr>
<tr>
<td>Civil strike</td>
<td>Ministry of home affairs</td>
</tr>
<tr>
<td>Major breakdown of any of the essential services posing widespread problems</td>
<td>Concerned ministries</td>
</tr>
<tr>
<td>Railway accidents</td>
<td>Ministry of railways</td>
</tr>
<tr>
<td>Chemical disasters</td>
<td>Ministry of Environment</td>
</tr>
<tr>
<td>Biological disaster</td>
<td>Ministry of health</td>
</tr>
<tr>
<td>Nuclear accident inside or outside the country which poses health or other hazards to people in India</td>
<td>Department of atomic energy</td>
</tr>
<tr>
<td>Natural disasters</td>
<td>Ministry of Agriculture</td>
</tr>
</tbody>
</table>

6.1.2 At the State Level

Most of the states in India have special relief commissioners who are in charge of relief and rehabilitation measures in the wake of disasters in their states. The chief secretary is an overall in-charge of relief operations in the State and the Relief Commissioner and Additional Relief Commissioners function under his direction and control. In many States, Secretary Department of Revenue is also in-charge of relief. State Government usually has relief manuals and the districts have contingency plan that is updated once in a year.

6.1.3 At the District Level

The district administration is the focal point for implementation of all government plans and activities. Considerable powers have been vested in the District Collector to carry out relief operations in the shortest possible time. In the event of shortage of funds, he is also empowered to draw money from the district treasury under the emergency powers.

The district administration is also required to prepare an advance Contingency Plan depending on the type of disaster likely to affect the district. The actual day-to-day function of administering relief is the responsibility of the Collector/District Magistrate/ Deputy Commissioner who exercises coordinating and supervising...
powers over all departments at the district levels. There is also a district level Relief Committee consisting of officials and non-officials including the local legislators and members of parliament to review relief measures.

A district is divided into sub-divisions or Tehsils or Talukas. While the head of the sub-division office, the head of the Tehsil is generally known as Tehsildar (Talukdar or Mamletdar in some states). At the Block or Circle level, there is a block development officer (BDO) or Circle officer who looks after relief works. At the village level, the Patwari or the village-level worker remains in contact with the villagers under his charge.

### 6.1.4 National Centre for Disaster Management

The NDM (National Disaster Management) Division, Department of Agriculture and Cooperation, Government of India established the National Centre for Disaster Management in March, 1995. NCDM (National Centre for Disaster Management) functions as a nodal centre in the country for human resource development in the area of disaster management, disaster mitigation and for tackling disasters (web-site www.ncdm-india.org).

The following are the mandate of the centre:

- To prepare an exhaustive information base on damage caused and resources spent on mitigation practices and relief work for various types of natural disasters.
- To establish links with the nodal ministry for natural disasters, technical assistance and service to the national programmes on natural disaster management.
- To assist Southeast Asian and SAARC countries in formulating their polices and developing their capabilities in all aspects of disaster management as and when assigned by the nodal ministry.

### 6.2 HIGH POWERED COMMITTEE REPORT

The High Powered Committee (HPC) on disaster management submitted its report\(^{46}\), which has emphasized on the building-culture of prevention, culture of
strategic thinking, disaster reduction through preparedness and culture of quick response and effective coordination. There have been significant developments in the field of disaster management in our country. India's approach to disaster management has shifted from the response to preparedness and long-term mitigation and prevention. The HPC report has also proposed that India should have a separate ministry for Disaster Management. Fig 6.2(45) gives the proposed structure of the disaster management ministry.

6.2.1 Planning Process

The Government of India has taken vulnerability based planning as the basic approach towards plan preparation: According to this disasters are graded at 3 levels:

- **L1**: A district level disaster, within the capabilities of the district administration to deal with it.
- **L2**: A State Level disaster, which can be effectively handled by the state authorities.
- **L3**: A National level disaster, requiring major direct intervention of the State Government.

In addition to the disaster situations, the following 'peace-time' situation has been identified.

- **LO**: A 'no-disaster' situations. This is the level at which surveillance; preparedness, prevention, and mitigation activities must be focused on.

6.3 State Disaster Management Authorities

6.3.1 Setting up of OSDMA

The OSDMA (Orissa State Disaster Mitigation Authority) in Orissa was set up following the 1999 super cyclone (web-site www.osdma.org). It has two wings, one dealing with disaster mitigation and the other with project management. The Disaster Management Unit deals with:

- Planning
- Capacity building
- Preparedness
Disaster Management Setup in India: Chapter VI

Social development
- Documentation
- Awareness raising and public education
- Inter organizational coordination and partnership.

The Project Management wing deals with various construction projects aimed at reducing disaster risk and vulnerability. The Managing Director, the executive head of the organization coordinates all activities. The Chief Secretary of Orissa is the chairperson of the Governing Body of OSDMA, which is constituted by senior Government functionaries, representatives from UN agencies, and civil society. The major focus of OSDMA's activities is response and preparedness planning for various disasters. Disaster management plans prepared by OSDMA in collaboration with different agencies include:
- Disaster Management Framework for the State
- Draft Disaster Management Policy for the State
- Draft Disaster Management Plan

6.3.2 Setting up of the GSDMA

After the ravages of the Gujarat earthquake "The Gujarat State Disaster Management Authority" (GSDMA) was set up on the 8th February 2001 with the chief minister as the chairperson and ten other members (web-site www.gsdma.org).

The main objectives of the GSDMA are the following:
- To undertake social and economical activities for rehabilitation and resettlement of the affected people that would include new Housing, Infrastructure, Economics Rehabilitation, social Rehabilitation, and other related programmes.
- To prepare programmes and plans to mitigate the losses on account of disasters as a strategy for long term disaster preparedness.
- To undertake research and study regarding causes for losses on account of natural disaster and to suggest remedial measures for minimizing the same.
To manage Gujarat Earthquake Rehabilitation and Reconstruction Fund.

- To act as a nodal agency and to co-ordinate various issues relating to the deserving victims out of the funds, either directly or through a common fund created for these purpose in any other feasible mode.
- To develop approach, philosophy, policy guidelines and action plan and other relevant aspects for meeting out disaster of any kind.

Thus with the establishment of the Gujarat and Orissa state Disaster Management Authorities a Central authority has been created at the state level to work in coordination with the relief commissioners and that will take up social and economic activities for rehabilitation and resettlement of the affected people in the shortest possible time.

In some other states, National Centres for Disaster Management and Special Cells on Disaster Management in each Administrative Training Institutions have been set up to co-ordinate disaster management activities and capacity building. YASHADA set-up by Government of Maharashtra is described in brief in the next para. Thus it would be seen that many institutions are now involved in the field of disaster management. All these institutions are having varied experience for effective disaster management; there is need for experience sharing among all these agencies and states.

6.3.3 YASHADA

Yashwantrao Chavan Academy of Development Administration (YASHADA) Pune, (www.yashada.org) is the apex training institute of the Government of Maharashtra. YASHADA is an autonomous body, funded by the central and state governments. The academy plays roles of Administrative Training Institute (ATI), State Institute of Rural Development (SIRD), and State Institute of Urban Development (SIUD).

Objectives:
- To impart training in development administration to public administrator, managers of public sector undertakings, officials and non-officials of local
self-government bodies and executives of non-government organization etc.
- To carry out public policy-oriented and operational research.
- To provide consultancy services in development and public administration.
- To serve as the apex institute for the collection and dissemination of information regarding development administration and
- To function as the nodal level training institute in the field of development administration.

Activities:
The major thrust areas identified by the academy include Good Governance, Sustainable Rural Development, Effective Urban Management, Capacity Building, Effective of Panchayati Raj Institutions and Other Local Self Government Bodies, Watershed Development, Micro-regional Environment planning, Disaster Management, Gender Equity, Human Rights, Social Justice, Old age Care Services, Effective Financial and Project management, turn-around Strategies for PSUs, HRD Strategies, TQM, Information Technology and training methodology, etc. The substance and scope of the training, research, consultancy and publications related activities are determined by the thrust areas.

6.4 ROLE OF PRIVATE SECTOR IN DISASTER MANAGEMENT
Huge resources in terms of communications resources, heavy machinery, cutting equipments, tents, tarpaulins, vehicles are available with corporate sectors, which can be mobilized to assist the district administration to minimize damages when a disaster strikes. Most of the corporate houses have their own on-site emergency preparedness plans and they also conduct regular mock drills. Their assistance can help the district administration and respond to the disaster in a faster and systematic manner.

Gujarat is the second most industrialized state in the country and the response of the corporate sector in the Gujarat earthquake (January, 2001), was very positive. Besides other agencies, corporate sector has played a greater and important role in disaster management by mobilizing and developing materials and trained
manpower as part of the Corporate Social Responsibility in the past disasters. Table 6.2\(^{(47)}\) below gives a list of corporates involved in the Gujarat earthquake response.

### TABLE 6.2
Some Examples of the Corporate Participation in the Past

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Industry</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reliance</td>
<td>Rescue and Relief responsibility for Anjar, more than 3000 reliance staffers worked around the clock for rescue and relief work at Anjar.</td>
</tr>
<tr>
<td>2</td>
<td>Tata Group</td>
<td>Providing relief supplies and funds. Constituted a relief committee to ensure that contributions reach only the deserving. Pressed into service &quot;Lifeline Express&quot; a mobile hospital train.</td>
</tr>
<tr>
<td>3</td>
<td>Larsen and Toubro</td>
<td>Rs five crore for construction activities. Studying quakeproof designs. To assist Maharashtra Government in reconstructing Bhachau.</td>
</tr>
<tr>
<td>4</td>
<td>GNFC</td>
<td>Installed VSATs at Bhuj and Anjar to provide telecommunication facilities.</td>
</tr>
<tr>
<td>5</td>
<td>Zydus Cadila</td>
<td>Set up a 24 hour control room for free medical aid.</td>
</tr>
<tr>
<td>6</td>
<td>Indian Airlines</td>
<td>Contributed Rs. Two crore including Rs. One crore from employees.</td>
</tr>
<tr>
<td>7</td>
<td>FICCI-CARE</td>
<td>To provide temporary shelter, water/sanitation/electricity, quake resistant housing, construction of permanent social infrastructure (Schools, clinics, anganwadis, tube well), help small business establishments and craftsmen.</td>
</tr>
<tr>
<td>8</td>
<td>Confederation of Indian Industry (CII)</td>
<td>Provided relief material and to build infrastructure (physical and social)</td>
</tr>
<tr>
<td>9</td>
<td>Kandla Port Trust</td>
<td>Have created a corpus of Rs. 30 crore. Rs nine crore given for improvement of road network in Gandhidham-Kandla area. Giving assistance for infrastructure development, schools and other institutions.</td>
</tr>
<tr>
<td>10</td>
<td>Birla AT &amp; T</td>
<td>Provided a mobile phone link-up in the quake-hit area.</td>
</tr>
<tr>
<td>11</td>
<td>Fascel</td>
<td>Offered free lines to those involved in rescue operations.</td>
</tr>
<tr>
<td>12</td>
<td>Shipping Corporation of India (SCI)</td>
<td>Vessel M V Kabirdas reached Kandla Port from Mumbai on January 31, 2001, transporting three cranes of 35 tonnes each to help and assist in relief operations.</td>
</tr>
<tr>
<td>13</td>
<td>TCI</td>
<td>Sent 18 truckloads of medicines, clothes, food grains, water pouches and other relief material to Bhuj, Bachao, Morvi and Kutch from Rajasthan.</td>
</tr>
</tbody>
</table>
Disaster Management Setup in India: Chapter VI

Sr. | Industry | Contribution
--- | --- | ---
14 | Mahindra Gujarat Tractors Ltd | In Baroda, has provided the local authorities with 16 tractors and tippers and seven Voyager ambulances. In addition, the control room established by them in the said city, has already set up tents, which can accommodate around 2000 people.

15 | BSES Limited | Rushed a team of technical experts to assist Gujarat Electricity Board for restoration of electric supply in Bhuj and Anjar.

16 | NTPC | Sent five DG sets, two cranes and civil and electrical assistance for repairing badly damaged sub-stations.

17 | The Power Grid Corporation | Sent 50 engineers to help restore the sub transmission facilities in Kutch district, especially in Bhuj. Also sent nine DG sets, tenting material and ready-to-eat foodstuff for the survivors.

6.4.1 Need for a platform

As non governmental agencies and commercial entities like Corporate become more centrally involved in dealing with the crisis arising out of natural disasters, they have numerous experiences to share with the outside world about their contribution and the strategy they have adopted and would adopt in future in fulfilling their responsibility in the larger interest of the society. The need for a common platform for the Corporate has been felt in order to come together to share their experiences and deliberate over the lessons for the future.

The High Powered Committee has also recognized the valuable role played by various public sector undertakings and corporate groups in the aftermath of the recent major disasters including the Orissa super cyclone and the Gujarat earthquake. The role of private sector is still emerging one and though a major role was played by a number of corporate organizations in disaster situations, not much has documented or is available in a consolidated form in this area. The HPC does realize the potential of this sector and feels the need for its inclusion in the plans, particularly at local levels.

It was felt that the Corporates with their managerial skills can certainly improve the effectiveness of the aid process, as the Gujarat experience goes on to show.
The response of Corporate sector to Gujarat earthquake was spontaneous and at the same time overwhelming. It was directly involved in rescue, relief and rehabilitation work.

And last but not the least, Corporates involved in Gujarat earthquake response felt, their contribution to relief and rehabilitation process is part of protecting their self interest and has also opened up new opportunities for business innovation. Their earnest desire to share the burden of rebuilding Gujarat is certainly a part of 'enlightened self interest'.

6.4.2 NGO Involvement in Disaster Management
Non-Government Organizations (NGOs) have emerged as an integral part of the institutional structure for addressing poverty as well as rural development, gender equality, environmental conservation, disaster management, human rights and other social issues. NGO's can be innovative, rooted to the ground and participatory in their approach.

Non-governmental organizations have often played an important relief role in disasters. Some evaluations of past involvement of non-governmental organizations during disasters have shown that non-governmental involvement has generally been positive. This is not to say that all community committees worked well. Some have been more successful than others. Conflicts between government and non-governmental organizations, and between community groups, can arise, delaying and hampering disaster management activities. They supplement government initiatives by acting as a conduit between development programmes and beneficiaries, informing and sensitizing people about their rights and entitlements.

The linkages between government and NGOs are of vital importance to effective disaster Management. NGOs can serve three essential roles in disaster management. First, national NGOs can help communication between government and local communities. Second, the recent trend for the donor international governments has made it imperative that governments effectively integrate NGOs
into all levels of the national structure. Third, NGOs can significantly assist to promote community awareness and preparedness.

6.5 NGO's in India

Some of the active NGOs in the field of disaster management working in India are discussed in brief.

6.5.1 Indian Red Cross:

The Indian Red Cross Society was established in 1920 (Web-site www.indianredcross.org). The IRCS has State / Union Territory Branches in 32 of them with 650 district and sub district branches. The IRCS's programmes are grouped into four main core areas: promoting humanitarian principles and values; disaster response; disaster preparedness; and health and care in the community.

Disaster response continues to represent the largest portion of their work, with assistance to millions people annually ranging from refugees to victims of natural disasters. This programme includes their emergency response units and to devote more attention to disaster preparedness activities.

Their emergency phase of a relief operation aims to provide life-saving assistance; shelter, water, food and basic health care as the immediate needs; along with a sense of humanity and a sign that someone cares. Subsequent needs include reconstruction and rehabilitation.

They have put tremendous efforts in institutional strengthening, training and knowledge sharing through the establishment of a Disaster Management structure.

6.5.2 BAPS:

The Bochasanwasi Akshar Purushottam Swaminarayan Sanstha (BAPS), a socio-spiritual organization with its roots in the Vedas, has been involved regularly in disaster relief (Web-site www.swaminarayan-baps.org). The major activities being providing relief material, food to villagers as well as volunteers, medical aid, agricultural aid, and reconstruction work.
During the 1999 super cyclone in Orissa, BAPS started concentrating on a long-term rehabilitation of the neediest and most vulnerable in the Erasama Block of Jagatsinghpur. The Sanstha’s team of sadhus (Holy Men) and qualified engineers decided to construct 100 cyclone proof houses, measuring 16 x 16 with kitchen and bathroom. The houses are especially designed to withstand future cyclones of similar magnitudes.

During the Gujarat earthquake, BAPS sadhus (Holy Men) and volunteers provided shelter, food, and medicines for victims and rescue workers in Bhuj, Amdavad, Bhadra, Surendranagar. Relief kitchens were operated for about 45 days. They have helped in the economic rehabilitation of the villagers.

6.5.3 Abhiyan:
Abhiyan is a network of local NGO’s in Gujarat formed for better coordination and to avoid duplication of efforts. During the Gujarat earthquake, Abhiyan had set up 2 key logistics coordination depots at Bhujodi and Samkhialyari and 16 sub-depots to provide services to remote and most affected villages. It also set up a control room at Ahmedabad to coordinate efforts of 200 NGOs for effective channelisation of relief materials and resources. A "NGO desk" was set up at the district collectorate and the Bhuj airport. The HAM radio units were made operational at Ahmedabad, Samkhialy and Bhuj. Volunteers were drawn from diverse technical fields ranging from engineers, planners, social workers, database experts, communication designers, medical experts, rehabilitation experts etc. Their cumulative experience & expertise was assimilated, shared extensively and relayed to the policy level body of the district and the state administration.

6.5.4 CARE:
CARE began work in India in 1950 (Web-site www.care.org), after an INDO-CARE agreement was signed with the Government of India. CARE’s projects in India are currently in the sectors of health, nutrition, and population, girl’s education, small economic activity development, urban development, tribal empowerment, agriculture and natural resources and emergency preparedness and relief and rehabilitation.
CARE responds to natural disaster that cause human suffering and the loss of support systems and livelihood such as infrastructure, property, crops and livestock. Following the massive earthquake that stuck Gujarat on 26th Jan 2001, CARE partnered with the Federation of Indian Chambers of Commerce and Industry (FICCI) to rebuild homes, community infrastructure and restore livelihoods.

CARE has not restricted its activities to merely the provision of relief. It has also been actively involved in programmes pertaining to disaster preparedness, rehabilitation and development during the post disaster phase. In Andhra Pradesh CARE is also a member of the committee constituted by the State Government responsible for all rehabilitation and reconstruction projects in East Godavari District.

In India, CARE works in collaboration with central and state governments, International and local NGO's, corporations and project participants.

6.5.5 Unnati:
Unnati is a voluntary nonprofit organization. It was set up in 1990 to provide educational support to developmental initiatives at the grass root, on issues of basic rights and livelihood. All promotional activities like educational events, training, research and documentation are carried out in partnership with community based organizations (CBOs), local voluntary development organization (VDOs) and government institutions. They derive their relevance by enhancing their outreach on a variety of issues at the grass root level.

6.5.6 SEEDS:
SEEDS was formed in 1994 as an informal group of students from the School of Planning and Architecture, New Delhi, whose common interests brought them together and made them carry human habitat environment related exercises beyond set academic targets (Web-site www.seedsindia.org).

During the Gujarat earthquake SEEDS was involved in immediate relief activities. For example: SEEDS carried out Relief distribution in Patan in immediate
aftermath of the earthquake. Besides relief, SEEDS is also involved in Participatory planning workshops with village communities in Patan to develop action plans for rehabilitation, Construction of demonstration units to disseminate information on safe building construction, Rehabilitation program in Patanka, a village of about 250 families, etc. The Present focus is on house reconstruction and retrofitting.

6.6 NEED FOR GO-NGO COLLABORATION

*Replicating micro-level initiatives:* The community-focused approach, which is the main strength of NGOs, can be a limitation without conscious efforts to replicate successful micro-level initiatives for wider impact. This can be achieved only through continuous dialogue and engagement between state and NGOs, which would create greater understanding amongst them and facilitate policy changes for replication of micro-level experiments.

*Check Overlapping, Duplication, & Confusion:* Timely response to natural disasters remains a difficult task in India, where a majority of people live in dispersed rural settlements with inadequate communication facilities. Involvement of multiple actors like NGO's, private sectors, etc makes it possible for humanitarian aid to reach marooned victims and initiating restoration work in cut-off zones. However, without coordination, such engagement of multiple actors could result in duplication, overlapping, and confusion. Adequate coordination of efforts made by govt. and NGOs can only ensure proper sharing of responsibility in the disaster response process.

In brief, without proper collaboration between these multiple agencies, initiatives in disaster response, mitigation, and reduction will not bear any fruit. There is always a strong co-relationship between successful project implementation and effective collaborations.

6.7 SUGGESTED MODEL FOR DISASTER MANAGEMENT

Disaster Mitigation measures and implementation of disaster relief plans are executed by revenue departments under control of district collector at district level.
As suggested by the High Power Committee four levels structure for combating the disasters involving from district level to national level administrations to deal with disasters of various quantum. In this structure triggering mechanism is not effective for national level disasters, for sake of approvals/sanctions and directions from the concerned authorities. It takes longer time to put the relief measures in place, on the other hand if these measures are forced in action in time, could avoid or minimise the losses due to disaster.

It is proposed to setup in place organisation structure parallel to general assembly election process followed in India. India is one of the biggest democratic country to elect its leaders from the public with the voting system by the general public. In this election organisation from lowest level 'police patili', tahsildar, Block Development Officer (BDO), district collector up to election commissioner are involved to conduct general election poles. In the election process area is divided into Booths, Zones and areas headed by presiding officer (PO), zonal officers (ZO) and returning officers (RO) respectively. RO reports to the election commissioner. Role of various members of the booth are given to the teachers of public schools of same area, police patil, talathi. Role of the ZOs are assigned to senior officers of the public organisations of that area. Tahsildar normally act as a assistant returning officer (ARO) for the collector, who is the RO. Police and revenue department work hand-to-hand for smooth and peaceful conduct of the election.

As this structure is in place, to conduct elections almost at the interval of every 2-3 years. Same structure can be oriented, trained to function in the event of any disasters. As in case of election set-up, authorities, powers and responsibilities are vested with election officer at State level, in DM set-up Relief commissioner is to be powered at State level. At district level District Magistrate/ Collector works as Returning Officer (RO), same is also responsible and authorised to handle any kind and type of disaster in the district. All the administrative and financial powers and responsibilities are with collector/District magistrate to plan, monitor, control and organise activities related with disasters.
District Collector is assisted by revenue personnel – Tahsildhars, BDOs, Circle Officers, Chief Engineer of planning department of Municipals, Police and NGOs. All these works in tandem to combat the disaster in shortest possible time. They work at a level of ARO/ZO of election organisation.

Engineers from the near-by engineering colleges/institutes, technical staff of PWD or selected practitioner engineers are required to carry-out Rapid Damage Assessment or take the help of the proposed damage estimation model to quickly estimate the various types of damages & losses due to earthquake disaster. This team will conduct detailed assessment of damages and co-ordinate with the planning chief engineer of municipals (as he have detailed information of the constructed structures in his region). Data may be cross verified or updated as the realities may be.

Tahsildhars and Talathies are requested for verification and certifications of documents, ownership of land etc. from land records. As per the detailed assessment the relief compensation package distribution task is to be executed through BDOs and Tahsildhars. NGO are involved for rehabilitations (Temporary/permanent), repairs and provides various resources required during disaster management like equipment, machineries or manpower/volunteers in disaster management.

In case of national disaster, where concerned personnel may be affected by the disaster, in such case adjoining taluka/district personnel of the same state may be deployed for the disaster relief plan. Tahsildar or BDO may be authorised to organise helps coming from the NGOs.

For more effective disaster reduction, numerous sectors should be involved in the activities to fill in the gaps in the disaster reduction cycle. Networking among governments, NGOs, regional/international organizations, communities, and private sector is essential in achieving a holistic approach to disaster reduction. Networking can facilitate investment and also information sharing, best practices,
expertise, volunteers and critical resources for disaster reduction activities such as an early warning system, flood control and relief operations.

In this system list of personnel required, disaster mitigation resources, list of NGOs, experts can be maintained as a ready-reckoner and put in operation as need arises. This will reduce the time required for detailing the resources for disaster management. In this structure also there will be constraints of approvals of financial sanctions as this involves huge expenditures. Proposed DM organisation structure chart is given in Fig. 6.3.

6.8 CONCLUDING REMARKS
All the authorities and responsibilities are vested with the governments to plan and carry-out all the activities in the state. Government is the owner of all the resources, manpower of the state. Hence ultimate responsibility is with state government. In this chapter brief elaboration on the organisation setup used for disaster management at various levels of administration in India is discussed. Chapter also explains role of NGOs and collaboration required between GO & NGOs. Next chapter is dedicated for technical aspects required to restore the damaged houses or technical details needed during construction of houses in earthquake proven areas.
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Fig 6.1: Operational Functions of Disaster Response
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Fig 6.2: Structure for the National Disaster Management System
Fig: 6.3 Proposed Organisation Set-up for Disaster Management
Chapter VII
EARTHQUAKE RESISTANT DESIGN AND CONSTRUCTION

7.0 INTRODUCTION

In the previous chapter various organisations involved during disaster management operations are discussed. Other element to reduce the damages/losses during the disasters is technical know-how of the structures. If structures are strong enough to take the forces generated during earthquake, in such cases collapse of properties and/or damages/losses will be minimal. This chapter deals with the basic concepts involved in achieving appropriate earthquake resistance of buildings such as load bearing masonry wall buildings, stud-wall and brick-house constructions in wood, and composite constructions using combinations of load bearing walls and piers in masonry, reinforced concrete, steel or wood, and the like. This chapter will be of importance to suggest measures to be taken to strengthen or retrofit the structures.

The important buildings and structures such as schools, hospitals, water tanks, emergency buildings like telephone exchanges and fire brigades, large assembly structures etc. should have higher strengthening provisions; sustain less damage than ordinary ones in an earthquake occurrence.

Today understanding earthquake forces is the key to good earthquake design and that quality of design and its execution has such a profound influence on the performance of structures during earthquakes & therefore development control rules & regulations will inspire Architects, Engineers, Contractors and owners to provide safe and yet economical constructions. Some of the codes to be adhered to during design and construction of new structures are given below:

I.S. 875-1987 part I to V for design loads
I.S. 1893-2002 for earthquake resistant design of structures
I.S. 4326-1993 for earthquake resistant design & construction of buildings
National Building Code of India S.P.-22 & 34.
IS 1893: 2002 Criteria for Earthquake Resistant Design of Structures: In the fifth revision with a view to keep abreast with the rapid development and extensive research that has been carried out in the field of earthquake resistance design of various structures, the committee had decided to cover the provisions of different types of structures in five parts.

It is an unfortunate part of our system of new construction approval by the planning dept of the Municipal Corporations. Most of the Municipal Corporations sanction building construction based on the development control rules (DCR). These DCRs do not consider design and strength aspects of the buildings and quality of construction. Poor design & construction are causes of failure of the buildings rather than architectural planning of the buildings. Following para suggest some of the consideration to be taken into account during planning of the buildings.

7.1 SEISMIC CONSIDERATIONS IN PLANNING AND DESIGN

YASHADA Pune had organised a workshop during Feb 10-12, 2003 and Institute of Engineers Pune on Oct 29, 2003, to draft building bye-laws for the Municipal Corporations to take account of structural design and construction as per earthquake resistant construction. Some of the recommendations suggested during above mentioned workshop as per Indian standard code provisions are listed below:

7.1.1 Building

The plan of the building should be simple, symmetrical in both directions, as stated in I.S. code 4326 – 1993. For irregular shape of building the methodology explained in this code for simplifying these shapes should be adopted. After such simplifications if at least one of the conditions stated in Table 4 & 5 of I.S. code 1893 (Part I) 2002 is applicable, such building or its part shall be treated as irregular configuration. While carrying out analysis & design of building, the importance factor and the response reduction factor should be considered as per Table 6 & 7 of I.S. 1893 (Part I): 2002. It is advisable to provide shear walls, and
should be well distributed in plan along the principal axis, symmetrical. And as far as possible, shear wall concentration at one place in plan is to be avoided.

7.1.2 Loads
In structural analysis & design dead load, imposed load, wind load, forces due to earthquake should be considered. If applicable shrinkage, temperature and creep effect should also be considered. Other forces and effects, if they are liable to affect the safety also need to be considered in analysis and design like; foundation movement, soil & fluid pressures, elastic axial shortening, fatigue, vibration, impact, erection loads, stress concentration effect due to point load, loads during construction. Combination of loads should be considered as per I.S. 875 (Part 5) and in case of forces due to earthquake as clauses 6.3 of I.S. 1893 (Part I) : 2002.
The stability of structure should be ensured as per clause 20 of I.S. 456 – 2000.

The design and construction of load bearing structure in general shall be governed by I.S. 1905 – 1987 and I.S. 2212 – 1991. The design and construction of load bearing walls, openings for doors and windows, their location in plan and elevation, should be as per I.S. 4326 – 1993. The seismic strengthening arrangements e.g. lintel band, roof or floor and, vertical steel (at corners, junctions of walls jambs of opening) etc. should be as per I.S. 4326 – 1993.

7.1.3 Foundations
- Founding of new buildings on strata vulnerable to significant differential settlement due to ground shaking shall be avoided in seismic zones III & IV
- If the ascertained SBC of foundation strata less than 100 kN/sqm – Irrespective of type of building stated above, if the assumed SBC of foundation is less than 100 kN/sqm, the value of permissible settlement and precise value of SBC should be confirmed after laboratory tests or field tests by approved agencies and the copy of these test results should be enclosed at the time of plinth checking certificate.
- If the ascertained SBC of foundation strata > 100 kN/sqm - The appointed structural consultant should state clearly the ascertained SBC of foundation strata and foundation system proposed.

- If the foundation strata is susceptible to liquefaction, before ascertaining safe bearing capacity, method of stabilization should be carefully selected.

7.1.4 Frame Analysis

Frame Analysis should be carried out using manual calculations or using software platform. Frame Analysis may be plane frame analysis or space frame analysis. The Building frame height is measured from foundation top to roof slab top in running meters.

For Structures in Zone IV: For all the buildings the forces due to earthquake should be considered for analysis and design of structural members considering worst load combinations. For buildings having irregular configuration and frame height more than 12.0 m, and also for buildings having regular configuration and frame height more than 40.0 m, Dynamic Analysis by any method is mandatory.

7.1.5 Miscellaneous

i. Columns

- If the unsupported length of column is more than 4 M, or c/c distance of beams is more than 5.0 M then least lateral dimension of column should not be less than 300 mm, irrespective of grade of concrete & steel.

- If the unsupported length of column is less than 4 M, then least lateral dimension of column should not be less than 200 mm, irrespective of grade of concrete & type of steel.

- The unsupported length of frame column should be greater than Four times the longer side of column section, otherwise, the shear strength of the column shall be checked.

- It is suggested that strong column weak beam concept should be followed.

- The detailing of ties and vertical reinforcement and laps, splices should be as per I.S. 13920 – 1993.
ii. **Cantilever Projections (Vertical)**

Tower, tanks, parapets, smoke stacks (chimneys) and other vertical cantilever projections attached to buildings and projecting above the roof, shall be designed and checked for stability for five times the design horizontal seismic coefficient $A_h$ specified in clause 6.4.2. of I.S. 1983 (Part I): 2002. In the analysis of the building, the weight of these projecting elements will be lumped with the roof weight.

iii. **Cantilever Projections (Horizontal)**

It is advisable to avoid cantilever projections like balconies, canopies, car porches, stair landing and terraces as structural cantilever elements misbehave in resisting earthquake forces. It is permitted as per requirements of structural consultant to provide R.C.C. columns and beams as a part of structural frame at the tip of such cantilevers. In any case of earthquake force on cantilever portions should be as per I.S. 1893 (Part I): 2002. If the cantilever projections are unavoidable they should be analysed as per clause no 7.12.2.2 & 7.12.2.3 of I.S. 1893 (Part I) 2002.

iv. **Quality Assurance**

Quality provided is the foremost amongst the most important element in the seismic behaviour of the building. Therefore, buildings shall be carefully supervised so as to ensure the assumptions about required quality of various items in the design are achieved as reality in the construction. The quality of material to be used in construction shall be as per relevant Indian Standard Codes & National Building Code of India.

The owner in consultation with Architect has to appoint qualified and experienced construction supervisor and or contractor to supervise the construction on day to day basis and this supervisor / contractor in turn to take responsibility regarding providing acceptable quality and workmanship of R.C.C. steel, masonry, in-fill works and other ingredients as per I.S. specifications and guidelines. The Supervisor / Contractor should follow sampling and testing requirements stated in I.S. code 456 – 2000.
Many manuals/guidelines are published by various institutes/organisations like, NICEE**(50), BMTPC**(10).**22*, IEER, CECR, etc. for the earthquake resistant constructions. In the present dissertation scope, detailed discussion of the different earthquake resistant structures is not included. In the following para only selected technical details of Brick Building**(47)* and Earthen Buildings**(47)* are listed.

### 7.2 BUILDINGS IN FIRED-BRICK AND OTHER MASONRY UNITS

The buildings in fired bricks; solid concrete blocks and hollow concrete or mortar blocks are dealt with in this para. The general principles and most details of earthquake resistant design and construction of brick-buildings are applicable to those using other rectangular masonry units such as solid blocks of mortar, concrete or stabilized soil or hollow blocks of mortar or concrete having adequate compressive strength. Some construction details only differ for hollow blocks, which have also been dealt.

#### 7.2.1 General Construction Aspects

i. **Mortar**: Since tensile and shear strength are important for seismic resistance of masonry walls, use of mud or very lean mortars will be unsuitable. Mortar mix cement sand equal to 1:6 by volume or equivalent in strength should be the minimum. Appropriate mixes for various categories of construction are recommended**(50)* in Table 7.1. Use of a rich mortar in narrow piers between openings will be desirable even if a lean mix is used for walls in general.

<table>
<thead>
<tr>
<th>Category of Construction</th>
<th>Proportion of Cement-Lime-Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cement-sand 1:4 or cement-lime-sand 1:1:6 or richer</td>
</tr>
<tr>
<td>II</td>
<td>Cement-Lime-Sand 1:2:9 or richer</td>
</tr>
<tr>
<td>III</td>
<td>Cement-sand 1:6 or richer</td>
</tr>
<tr>
<td>IV</td>
<td>Cement-sand 1:6 or Lime-Cinder* 1:3 or richer</td>
</tr>
</tbody>
</table>

* In this case some other puzzolonic material like Trass (Indonesia) and SurKhi (burnt brick fine powder in India) may be used in place of cinder.

ii. **Wall Enclosure**: In load bearing wall construction, the wall thickness 't' should not be kept less than 190mm, wall height not more than 20t and wall length
between cross-walls not more than 40t. If longer rooms are required, either the wall thickness is to be increased, or buttresses of full height should be provided at 20t or less apart. The minimum dimensions of the buttress shall be as thickness and top width equal to 't' and bottom width equal to one sixth the wall height.

iii. Openings in Walls: Studies carried out on the effect of openings on the strength of walls indicate that they should be small in size and centrally located. The following are the guidelines on the size and position of openings:

- Openings to be located away from the inside corner by a clear distance equal to at least 1/4 of the height of openings but not less than 60cm.

- The total length of openings not to exceed 50% of the length of the wall between consecutive cross walls in single storey construction, 42% in two storey construction and 33% in three storey buildings.

- The horizontal distance (pier width) between two openings to be not less than 1/2. the height of the shorter opening but not less than 60cm.

- The vertical distance from an opening to an opening directly above it not to be less than 60cm or less than 1/2 of the width of the smaller opening.

- When the openings do not comply with above requirements, they should either be boxed in reinforced concrete around or reinforcing bars provided at the jambs through the Masonry as shown in figure 7.1.

iv. Masonry Bond: For achieving full strength of masonry the usual bonds specified for masonry should be followed so that the vertical joints are broken properly from course to course. The following deserves special mention.

- Vertical Joint between Perpendicular Walls

For convenience of constructions, builders prefer to make a toothed joint which is many times left hollow and weak. To obtain full bond it is necessary to make a sloping (stepped) joint by making the corners first to a height of 600mm and then building the wall in between them. otherwise, the toothed joint should be made in both the walls alternately in lifts of about 45cm.
v. Horizontal Reinforcement in Walls: Horizontal reinforcing of walls is required for imparting to them horizontal bending strength against plate action for out of plane inertia load and for tying the perpendicular walls together. In the partition walls, horizontal reinforcement helps preventing Shrinkage and temperature cracks. The following reinforcing arrangements are necessary.

- Horizontal Bands or Ring Beams
The most important horizontal reinforcing is through reinforced concrete bands provided continuously through all load bearing longitudinal and transverse walls at plinth, lintel, and roof-eave levels, also at top of gables according to requirements as stated hereunder:
Plinth band: This should be provided in those cases where the soil is soft or uneven in their properties as it usually happens in hill tracts. It will also serve as damp proof course. This band is not too critical.
Lintel band: This is the most important band and will incorporate in itself all door and window lintels the reinforcement of which should be extra to the lintel band steel.
Roof band: This band will be required at eave level of trussed roofs and also below or in level with such floors, which consist of joists and covering elements so as to properly integrate them at ends and fix into the walls.
Gable band: Masonry gable ends must have the triangular portion of masonry enclosed in a band, the horizontal part will be continuous with the eave level band on longitudinal walls.

- Dowels at Corners and Junctions
As a supplement to the bands described above, steel dowel bars may be used at corners and T-junctions to integrate the box action of walls. Dowels as shown in Figure 7.2 a, b & c. are placed in every fourth course or at about 50cm intervals and taken into the walls to sufficient length so as to provide the full bond strength.
Wooden dowels can also be used instead of steel. However, the dowels do not serve to reinforce the walls in horizontal bending except near the junctions.
vi. **Vertical Reinforcement in Walls**

The critical sections are the jambs of openings and the corners of walls. The amount of vertical reinforcing steel will depend upon several factors like the number of storeys, storey heights, the effective seismic coefficient based on seismic zone, importance of building and soil foundation type. The steel bars are to be installed at the critical sections that is the corners of walls and jambs of doors right, from the foundation concrete and covered with cement concrete in cavities made around them during masonry construction. This concrete mix should be kept 1:2:4 by volume or richer. Typical arrangements of placing the vertical steel in brick work are shown in Figure 7.3.

The jamb steel of window openings will be easiest to provide in box form around it. The vertical steel of opening may be stopped by embedding it into the lintel band but the vertical steel at corners and junctions of walls must be taken into the floor and roof slabs or roof band.

### 7.3 EARTHEN BUILDINGS

Earthquake experience shows that earthen buildings may be cracked at MSK Intensity VI, wide cracks and even partial collapse may occur at MSK VII and collapses are widespread under MSK VIII. Damage is always much more severe in two storeyed buildings than in one storeyed ones. Some typical damages are shown in Figure 7.4 However, single storeyed houses with flat roofs constructed in good clay have been found to be undamaged in Intensity VIII zone whereas at the same location two storeyed houses were completely ruined. The main courses of failure of earthen buildings in earthquakes are graphically summarised in Fig. 7.5.

#### 7.3.1 General Recommendations for Seismic Areas

i. **Walls**

- The height of the adobe building should be restricted to one story plus attic only in seismic zones A, B and to two storeys in zone C.

- The length of a wall, between two consecutive walls at right angles to it, should not be greater than 10 times the wall thickness 't' nor greater than $64t^2/h$ where $h$ is the height of wall.
When a longer wall is required, the walls should be strengthened by intermediate vertical buttresses.
- The height of wall should not be greater than 8 times its thickness.
- The width of an opening should not be greater than 1.20m.
- The distance between an outside corner and the opening should be not less than 1.20m.
- The sum of the widths of openings in a wall should not exceed one-third of the total wall length in seismic zone A, 40 percent in zones B and C.
- The bearing length (embedding) of lintels on each side of an opening should not be less than 50cm.
- Hand-formed walls could preferably be made tapering upwards keeping the minimum thickness 30cm at top and increasing it with a batter of 1:12 at bottom.
- Providing outside pillasters at all corners and junctions of walls will increase the seismic stability of the buildings a great deal as shown in figure 7.6.

ii. Control on openings in bearing walls
- The width of a window or door opening should not exceed 1.2m.
- The distance between an outside corner and edge of opening or between two openings should not be less than 1.2m.
- The top level of windows and doors should be kept at the same level, say at 1.8 m above the plinth/floor level so as to have a continuous band.

7.4 CONCLUDING REMARKS
Civil engineers play major role in construction, retrofitting and rehabilitation activities. If the design and construction is done considering the effect of earthquake forces, may help in reducing the damages and hence saving the state funds. Therefore in this chapter only few selected tips on earthquake resistant design and construction are discussed. This subject of earthquake resistant is very vast, what is discussed here is just highlighted features and needs to be design and executed under expertise guidance.
Figure 7.1 Strengthening of masonry around openings

- Diameter d, W - Window, V - Vertical Reinforcing Bar
- Thickness of wall (minimum 1 brick length), t
- Minimum thickness 75mm, L - Length of brick unit

Details at Z.
Figure 7.2 (a) Corner-Strengthening by Dowel Reinforcement Placed in One Joint.
Figure 7.2 (b) Corner-Strengthening by Dowel Reinforcement Placed in Two Consecutive Joints.

1 - Wall thicknesses, 1 - cross links, 2 - thicker joints to receive bars.
Figure 7.2(c) T-Junction - Strengthening by Dowel Reinforcements

Figure 7.2 (d) Strengthening by Wire fabric at junction and corner
Corner junction details for one brick wall for providing vertical steel.

Corner junction details for one and a half brick wall for providing vertical steel.

T. Junction details for one and a half brick wall for providing vertical steel.

1/4, 1/2 and 1 indicate:

1/4 brick wide, 1/2 brick wide, 1 brick long etc.

* = Vertical bar

Figure 7.3 Vertical reinforcement in walls
**Figure 7.4** Typical damages and collapse of earthen buildings

**Figure 7.5** Graphic Summary of causes of failure
Figure 7.6 Pilasters at Corners