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WORK PROFILE

of

Technical Advisory Group

DURING March 2004 – July 2007

under

Government of India - UNDP

DISASTER RISK MANAGEMENT PROGRAMME

National Disaster Management Division
Ministry of Home Affairs
Government of India
New Delhi

24th August, 2007

PREFACE

The GoI-UNDP Disaster Risk Management Programme is the National initiative to reduce vulnerabilities of communities in some of the most hazard prone districts of India. The programme aims to contribute to the social and economic development goals of the National and State Governments, enable them to minimise losses to development gains and to reduce their vulnerability to natural disasters. Under the project one of the major component is development of a techno-legal framework, which broadly outlines the following:

- Orientation for policy makers to enforce legislation for registration and regulation of builders, promoters and real estate developers for creation of safe habitat.
- Creating framework for compulsory certification system for engineers and architects – to set standard levels of competence among all practitioners.
- Developing course curriculum for architects and engineers.
- Developing Guidelines on Disaster Safety aspect.

Based upon this a Technical Advisory Group was established by Ministry of Home Affairs, GoI and United Nations Development Programme under the leadership of **Dr.A.S.Arya**, National Seismic Advisor, MHA in which **Sh.Ankush Agarwal**, Programme Associate (Hazard Vulnerability Reduction), **Sh.Jnananjan Panda**, Ex-Project Officer (Earthquake Mitigation) and **Sh.Anup Karanth**, Ex-Project Co-ordinator (Urban Earthquake Vulnerability reduction Programme) have been the main participants. Additionally, other persons have also been assisting from time to time on different activities as and when initiated.

The present compilation covers the various items of works already accomplished by this Technical Advisory Group. It is being envisaged to place all this material on the websites of MHA-NDM division and United Nations Development Programme

ACKNOWLEDGEMENT

This programme is fully supported by the authorities of UNDP Disaster Risk Management Division and MHA – NDM division. In particular, thanks are due to Sh R.K.Singh, Ex-JS(DM), Sh.Ashim Khurana, Ex-JS(DM), Sh.Saroj Kumar Jha, Ex- ARR (UNDP) & Director (NDM-III) and Sh.M.P.Sajnani, Ex-Advisor (DM) for their constant support. The present team of Sh. O. Ravi, JS (DM), Sh.Rajiv Kumar, Director (NDM-III) and Sh.Sushil Kumar, ARR (UNDP) are always supporting the various technical activities towards disaster risk reduction. The advise of Sh.G.Padmanabhan, Emergency Analyst (UNDP) has always been most timely & useful. The assistance provided by UNDP-DRM project office staff is greatly acknowledged.

Dr.A.S.Arya
National Seismic Advisor

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1. Sensitization Programmes

1.1. Sensitisation Programme for Architects in Disaster Management

There are about 14,000 private practicing architects in the country. Almost all of them are members of IIA. IIA has 17 chapters. IIA had agreed to take up sensitization of architects in earthquake resistant features in different Chapters as and when the meetings of these chapters would be held.

The Ministry has provided financial support for the said Sensitization programme to bear the cost of the resource persons and for the printing of the resource materials to be provided to the participants. The Ministry would also organise resource persons for sensitising the architects for these chapters.

The programme is being closely monitored. **[(*ApK, RI*), JP & ASA]**

STATUS: *A number of sensitisation programme has been organised by Indian Institute of Architects all over India.*

1.2. State Level Sensitisation Programme for the States/UTs Falling in Zone IV & V

As number of activities were being under taken by the Ministry of Home Affairs, GoI, at the national level for earthquake vulnerability reduction, it was felt highly essential that the elected representatives and senior officers of the States should be sensitized about the various initiatives taken up by the Central Government for earthquake risk reduction so that the disaster reduction initiatives are taken forward by the State/UT Govt. in their respective States/UT's.

A one-day sensitization programme on earthquake vulnerability reduction was proposed to be organized in the States/UT's, which are highly vulnerable to earthquake risk (21 States/UT's falling in Seismic Zone IV & V were identified).

[ASA & AA]

STATUS: *The sensitisation programmes has been organised in the States of* ***Arunachal Pradesh, Assam, Meghalaya, Nagaland, Tripura, Mizoram, Manipur, Sikkim, West Bengal, Delhi, Himachal Pradesh*** *and the UT of Chandigarh &* ***Andaman & Nicobar Islands****. The programme is still to be organised in the States of Jammu & Kashmir, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Uttaranchal, Uttar Pradesh and Bihar.*

2. Development of Curriculum and Training Modules

2.1. Development of Chapters on DM for CBSE text book of Class X

Chapter on Disasters have been incorporated in class VIII syllabi which talks about the survival tips and class IX syllabi which talks about the disaster mitigation activities as a set of activities that helps to reduce the impact of disaster and the importance of community as first responder. For class X syllabi one of the chapters "Safe Construction Practices" talks about some important factors to be considered while constructing a building resistant to four natural hazards: earthquake, landslide, flood & cyclone. The idea was to educate the children on the techniques available to mitigate the effects of natural hazards depending on the hazards identified, location, construction type and specific performance requirements for a proposed building.

[ASA, AA & AN]

STATUS: *The book has been introduced in class X syllabi and two day training programmes are being organised by CBSE to train the teachers on the new book introduced.*

2.2. Inclusion of engineering aspects for different types of disasters in the curriculum of technical education prescribed for engineers and architects.

The engineers and architects play an important role in design and construction of built environment and industrial infrastructure. Large scale damage to houses and industrial infrastructure in the past major earthquakes indicate that earthquake resistant features were not incorporated in these buildings. In view of this it was necessary that engineers and architects have adequate knowledge and capacity to design earthquake-resistant structures. So change in engineering and architecture curriculum in Under Graduate courses was felt to be equally important as disaster mitigation aspects were not the part of the then existing curriculum for the engineers and architect. It was therefore necessary to review the then curriculum prescribed for polytechnics, engineering colleges (both at undergraduate and post graduate level) and architecture colleges with a view to include disaster preparedness and mitigation aspects in the curriculum for some the of disasters such as cyclones, earthquakes and fire by adequately including the structural designs, retrofitting of existing buildings and related aspects in the curriculum.

Afterwards, the matter was taken up with the Ministry of Human Resources Development to advise All India Council for Technical Education (AICTE) to set up a group of experts to review the course content and draw up the appropriate syllabi pertaining to disaster mitigation for inclusion in the course content. A small committee of experts was then constituted to review the course content and give adequate coverage to the disaster related aspects.

Subsequently, model course curricula incorporating disaster mitigation aspects were developed for different engineering disciplines: (A) the Compulsory Basic (Foundation) course for students in Electrical, Mechanical and Civil engineering; (B) Compulsory Professional course for students of Civil Engineering; (C) Advanced Elective course for students of Civil Engineering; and (D) Curriculum for the students of Architecture. These modules were then approved by the National Core Group for Earthquake Mitigation and also shared with All India Council for Technical Education (AICTE) and Council of Architecture (CoA) for further perusal with the Universities and Technical Institutions for the adoption and integration of these model curricula.

CoA had sent the model curricula developed for the students of architecture for the for the integration of the same in the main-stream architectural education and proposed to conduct Regional Consensus Workshops for the schools of architecture and universities to facilitate inclusion of the model syllabus in the curriculum. **[ASA, AA & HK]**

STATUS:

1. *For the architecture curriculum, Council of Architecture was entrusted the responsibility to organise regional workshops with different universities and colleges so as to have consensus among all colleges. They have organised six workshops and the final is still awaited.*
2. *For the engineering curriculum, All India Council of Technical Education has been made as the nodal agency to follow up with different universities and colleges.*

2.3. Development of Curriculum for Engineers and Architects in Disaster Management aspect:

2.3.1. For B. Arch. Students

While structural safety is the main focus of Engineers, the structural configurations chosen by Architects control the overall behavior of structures during earthquake. Ensuring structural & operational safety of the buildings would require adequate attention to not only the structural design but also the form and configuration of the building for lateral loads. In this context the role of the architects is crucial in the entire cycle of building construction – concept, form, configuration, construction and provisions of services and non-structural elements.

The syllabi for B.Arch students were revised in consultation with Council of Architecture & Indian Institute of Architects. Two options were prepared to have consensus of different educational institutes imparting architectural education first, One Semester Compulsory Course in B.Arch Curriculum (22 lecture hours and 13 studio hours in a semester) and second, the architecture schools may consider merging the various topics of the syllabus given in the first option in the existing appropriate courses in any semester but ensuring that *all topics* of the proposed compulsory course are fully taken care of. **[ASA, AA]**

2.3.2. For B. E. Students

As most casualties during earthquake are caused by the collapse of structures (both engineered and non-engineered), therefore structural mitigation measures are the key to make a significant impact towards earthquake safety in our country. For successful earthquake mitigation, it has to be ensured that all new constructions in the seismic zones are compliant with BIS Codes. Therefore apart from training PWD, Municipal & practicing engineers there, is a need to incorporate this in the existing curriculum of B.E students.

Two course modules have been designed: first, basic course compulsory for all the B.E. streams (Civil, electrical & mechanical) which is to be introduced in the first year with a total of 21 lectures, and second for advanced professional for civil engineering under graduates only comprising of 21 lectures.

[ASA, DKP, AA]

STATUS: *The curriculum developed has been approved by the National Core Group on Earthquake Mitigation and has also been shared by Council of Architecture and All India Council of Technical Education.*

2.4. Development of Training Modules for Architects and Engineers:

2.4.1. *One Week* training module for the ToT programmes for faculty members in **Architecture** Department of State/UT level Institutes and *One Week* training module for Practising/ Serving Architects.

One week training course for training of architecture teachers to be nominated by States/UT's from their own Institutes was formulated, who will be trained at designated National Resource Institutes. In turn the trained teachers will train the practicing architects at the State Resource Institutes. The module has 29 lecture hours & 13 studio hours in the one week training programme. For the practicing architects, one week training module has 24 lecture hours & 13 studio hours.

[ASA, AA]

2.4.2. *Six Week* training module for the ToT programmes for faculty members in **Civil/ Structural Engineering** Department of State/UT level Institutes and *Two Week* training module for Practising/ Serving Engineers.

A more comprehensive six week training course has been designed to target teaching faculty from State Resource Institutes to be trained at designated National Resource Institutes. The training module has 120 lecture period and each lecture of 1.5 hours. For the practicing & government engineers, the course is of 2 weeks duration with 40 lectures of 1.5 hours duration each.

[ASA, AA]

STATUS: *The training module prepared has been adopted in the National Capacity Building Programmes for the Architects & Engineers.*

2.5. Concept Note on Establishment of <u>Hazard Safety Cell</u>.

Studies on the damage of buildings and other structures during the past earthquakes have clearly brought out the causes of severe damages which include either lack of earthquake resistant design, not following the provisions of the Bureau of Indian Standards Building Codes, and also faulty building practices. To establish proper implementation of the building codes in all future constructions, so as to ensure the safety of buildings and structures in future earthquakes, a note was prepared for establishing Hazard Safety Cells in each State/UT. The Ministry of Home Affairs Govt of India advised the States/UT's for establishment of such cells so as to enhance their competency to review all designs before construction as well as to assess the safety of existing buildings and workout details for retrofitting of weaker ones.

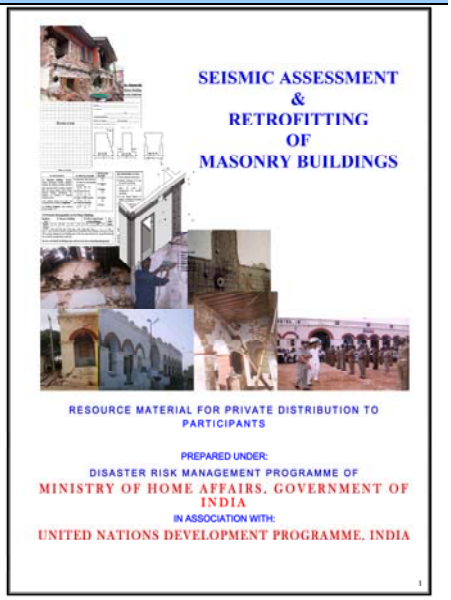
[ASA & HK]

STATUS: *Prepared and shared with all the States/UTs*

3. Preparation of Guidelines

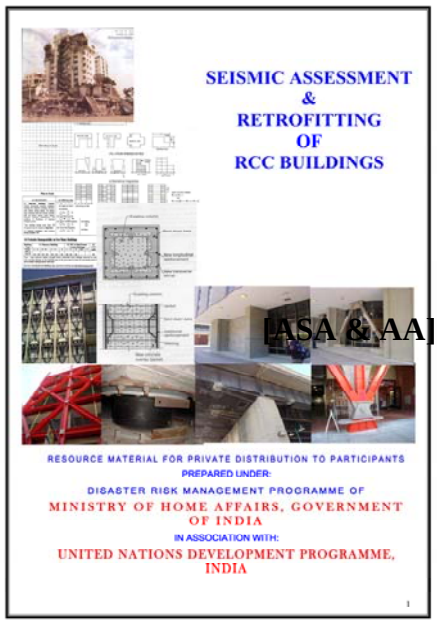
3.1. Rapid Visual Screening of Buildings

For safety from earthquake hazards in future, particularly from destruction and collapse, the seismic resistance of most of the existing buildings will need upgrading by retrofitting procedures. As a first step towards this goal, the *grades of damageability* of the various existing buildings under different *probable earthquake intensities* postulated in the various seismic zones will need to be assessed. The main objective of the guidelines is to provide simple survey forms which could be used by engineers/architects after some training in assessing the damage vulnerability of different building types in India. The most important feature of this procedure is that it permits vulnerability assessment based on walk-around of the building by a trained evaluator and collection of some relevant information from building owners/engineers. With the practical application of survey forms it was felt that there are certain more details which should be added to the survey format. Based on this we have bifurcated it into two:



i. **Rapid Visual Screening of Masonry Buildings.**
ii. **Rapid Visual Screening of RCC Buildings.**

[ASA & AA]

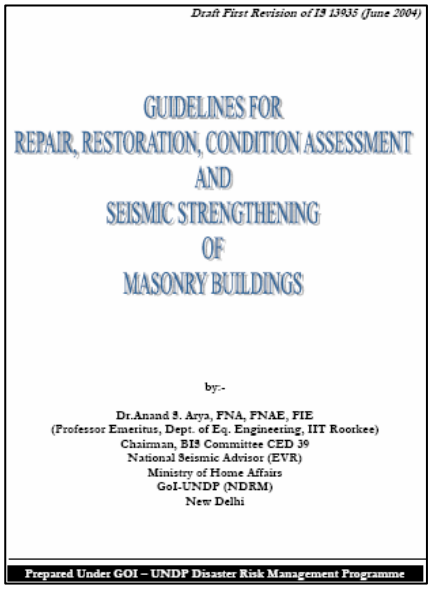


[ASA & AA]

STATUS: *Draft of Masonry building has been included in IS:13935 (First revision) of Bureau of India Standards. Draft on RCC buildings is still under discussion in BIS-CED 39 committee.*

3.2. Amendment of Draft IS 13935 - Repair, Restoration & Retrofitting of Masonry Buildings - Guideline

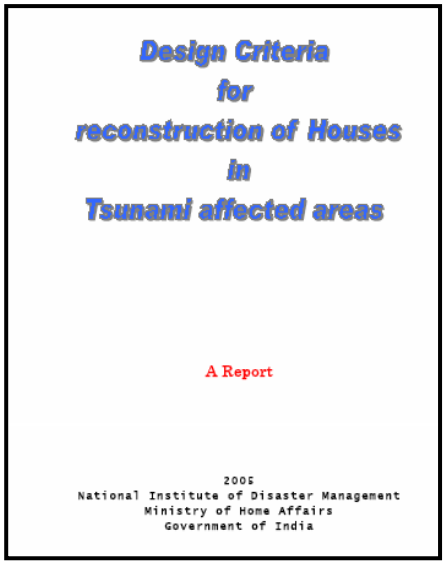
This standard covers the selection of materials and techniques to be used for repair and seismic strengthening of damaged buildings during earthquakes. It also covers the damageability assessment and retrofitting for upgrading of seismic resistance of existing masonry buildings. The repair materials and techniques described herein may be used for all types of masonry buildings. This is a revision of the existing BIS code IS: 13935 in which the retrofitting details developed and widely used in Gujarat have been incorporated. The draft has been submitted to Bureau of India Standards for approval.



[ASA & AA]

STATUS: **The revised code IS:13935 (First revision) f***inal draft has been in Bureau of Indian Standards CED 39, which has been sent out for printing.*

3.3. Design Criteria for Buildings in Tsunami Affected Areas of States/UTs.

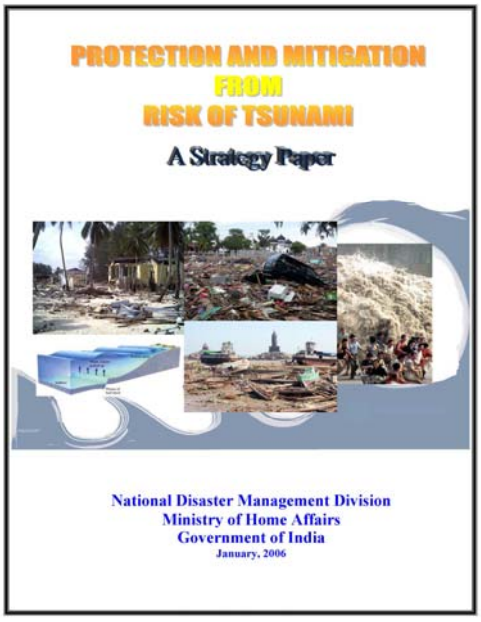


Soon after the tsunami on 26th December, 2004 the biggest challenge for the Govt. was to reconstruct safe houses for thousands of affected people. But the question which was haunting day & night was "what design guidelines should be adopted, so as to minimize the loss of life & property?" A meeting was called at a short notice by Prof. A. S. Arya, National Seismic Advisor, GOI-MHA and Shri Rajarshi Bhattacharya, OSD & Ex officio JS, GOI-MHA to discuss & finalise the design criteria to be adopted for reconstruction of houses in tsunami affected areas of India. The meeting was attended by a number of persons from IIT's & SERC, A & N Administration, MHA & NIDM. During the discussion for reconstruction following parameters were finalized:

- Basis for Design Criteria
- Use importance of the building.
- Performance level desired.
- General design values/factors for coastal States/UT's
- RCC design criteria for all coastal areas.
- And specific recommendations for Andaman & Nicobar Islands.

[ASA, AA & SVRKP]

3.4. Preparation of Strategy Document for Protection and Mitigation from the Risk of Tsunami Disasters.



A concept note was first prepared in the wake of the Tsunami Disaster of Dec. 26th, 2004 covering several countries of North Indian Ocean and various States/UTs of India. It was circulated to various Ministries in Govt. of India and other Line Departments as well as State Governments and revised taking the comments accordingly.

In preparing the final paper as Strategy Paper, the multi-hazard situation prevalent in the Coastal States/UTs, has been taken into consideration. It has been noted that National Cyclone Risk Mitigation program as well as DRM program have already been on going in the States/UTs. Also, that many safety measure against storm surge disasters, like biological shield, wave breakers and

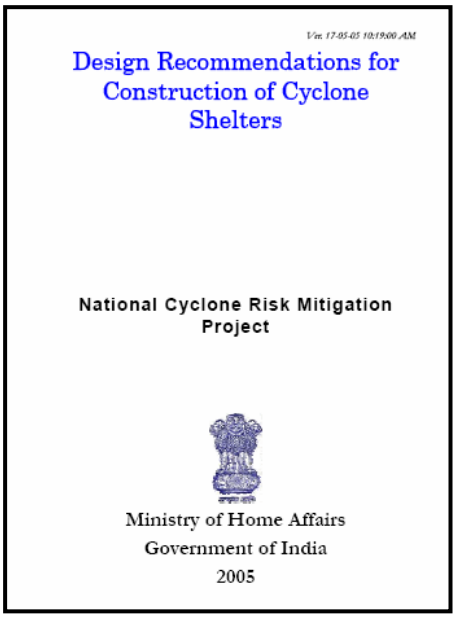
protection walls, high elevation shelters etc as well as warning systems are equally relevant for safety against tsunamis. The Strategy Paper covers the following topics:

- Tsunami Characteristics, Do's & Don'ts in pre, during, and post-tsunami time phases
- Tsunami Risk in India and its Assessment in any given area
- Multi-hazard situation in west and east coast of India and Mitigation Measures
- Specific design solutions against various tsunami effects
- Warning systems and Communication
- Institutional arrangement and design criteria

[ASA & AA]

STATUS: *The strategy document has been widely circulated to all the Ministries and State Governments. The comments received have been incorporated and an Inter-Ministerial meeting is to be convened to finalise the document. The subject has now been taken up by NDMA.*

3.5. Design Guidelines for Construction of Cyclone Shelters



Worldwide, construction of cyclone shelters has been a proven means of preparedness as the vulnerable populations can be evacuated to these structures immediately after receiving the cyclone warning. India too has a 40-year history of construction and maintenance of cyclone shelters, notably from states such as Andhra Pradesh, Orissa and Tamil Nadu. Cyclone shelters constructed in these states proved effective and have become a source of local motivation for preparedness.

The long coast line of India is also vulnerable to various other kinds of natural hazards. It can be noted that the majority of the coastal area falls under the Seismic Zones III and with some parts of Gujarat and the entire Andaman & Nicobar Islands coming under the Seismic Zone V. Hence, it is important that any mitigation and preparedness measures taken up in these coastal areas should also consider the multi-hazard nature of these areas. It is also important to emphasize that the entire coast line is not uniform in terms of intensities of varoius hazards.

In nutshell, the design of cyclone shelters should consider cyclone, flood and earthquake hazards of the area, elevation of the place, population density, and socio-economic conditions of the area, connectivity, and proximity of the human settlement on the sea and river mouth.

A one day workshop was called at NIDM, which was attended by the Relief Commissioners of all the coastal States/UT's as well some renowned architects and engineers were also called.

The Design recommendations on the following items were finalized:

- Sustainable Use
- Building
- Accommodation Capacity
- Location
- Height of the Cyclone Shelter

- Inner Design
- Structural Specifications
- Staircases
- Material Selection
- Water Supply
- Toilets and Sewerage
- Construction of Earthen Mounds (Killas)
- Other Considerations
- Provision for Helipads

The document has been circulated to all the members and comments are still awaited.

[ASA, AA & SVRKP]

STATUS: *The Design Recommendations has been circulated to all the concerned Ministries and State Governments for their suggestions and comments obtained have been incorporated.*

3.6. Preparation of Sample Design for unit houses supported by *Indira Awaas Yojana*

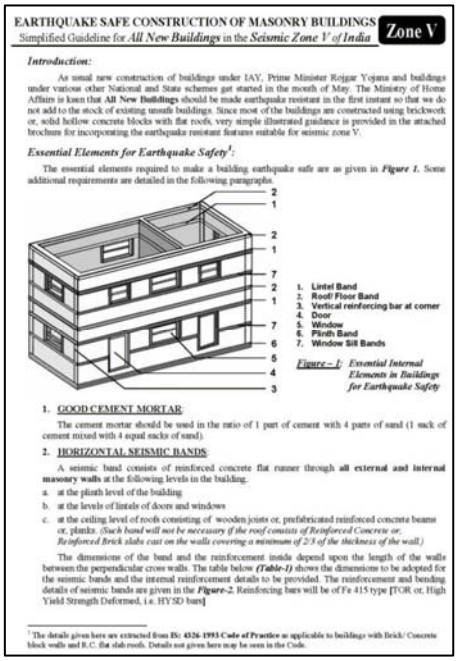
As different government departments are coming up with different construction projects like Indra Awas Yojana etc. where in it is necessary to capture it at the initial phase and incorporate earthquake resistant details, so that where ever the building under this project is constructed the earthquake resistant features are incorporated into it. Keeping this in view certain alternate design drawings for residential buildings were prepared incorporating earthquake resistant features into it.

[ASA, AA & AN]

STATUS: *The Design Recommendations has been circulated to the concerned Ministry*

3.7. Earthquake Safe Construction Of Masonry Buildings [*Simplified Guideline for All New Buildings in the Seismic Zone III,IV & V of India*]

As is known India is an earthquake prone country and the major portion of construction is based on Masonry. Usually new construction of buildings under IAY, Prime Minister Rojgar Yojana and buildings under various other National and State schemes get started in the month of May. The Ministry of Home Affairs is keen that All New Buildings should be made earthquake resistant in the first instant so that we do not add to the stock of existing unsafe buildings. Very simple illustrated guidance is provided in the brochure for incorporating the earthquake resistant features suitable for seismic zone III, IV & V and all information in the brochures are based on the Indian


EARTHQUAKE SAFE CONSTRUCTION OF MASONRY BUILDINGS
Simplified Guideline for *All New Buildings* in the *Seismic Zone V of India*
Zone V

Introduction:

As usual new construction of buildings under IAY, Prime Minister Rojgar Yojana and buildings under various other National and State schemes get started in the month of May. The Ministry of Home Affairs is keen that **All New Buildings** should be made earthquake resistant in the first instant so that we do not add to the stock of existing unsafe buildings. Since most of the buildings are constructed using brickwork or, solid hollow concrete blocks with flat roofs, very simple illustrated guidance is provided in the attached brochure for incorporating the earthquake resistant features suitable for seismic zone V.

Essential Elements for Earthquake Safety[1]:

The essential elements required to make a building earthquake safe are as given in ***Figure 1.*** Some additional requirements are detailed in the following paragraphs.

1. Lintel Band
2. Roof/ Floor Band
3. Vertical reinforcing bar at corner
4. Door
5. Window
6. Plinth Band
7. Window Sill Bands

Figure – 1: Essential Internal Elements in Buildings for Earthquake Safety

1. GOOD CEMENT MORTAR:

The cement mortar should be used in the ratio of 1 part of cement with 4 parts of sand (1 sack of cement mixed with 4 equal sacks of sand).

2. HORIZONTAL SEISMIC BANDS:

A seismic band consists of reinforced concrete flat runner through **all external and internal masonry walls** at the following levels in the building.

a. at the plinth level of the building
b. at the levels of lintels of doors and windows
c. at the ceiling level of roofs consisting of wooden joists or, prefabricated reinforced concrete beams or, planks. *(Such band will not be necessary if the roof consists of Reinforced Concrete or, Reinforced Brick slabs cast on the walls covering a minimum of 2/3 of the thickness of the wall.)*

The dimensions of the band and the reinforcement inside depend upon the length of the walls between the perpendicular cross walls. The table below ***(Table-1)*** shows the dimensions to be adopted for the seismic bands and the internal reinforcement details to be provided. The reinforcement and bending details of seismic bands are given in the ***Figure-2***. Reinforcing bars will be of Fe 415 type [TOR or, High Yield Strength Deformed, i.e. HYSD bars]

[1] The details given here are extracted from **IS: 4326-1993 Code of Practice** as applicable to buildings with Brick/ Concrete block walls and R.C. flat slab roofs. Details not given here may be seen in the Code.

Standard Code IS 4326.

The following points have been discussed in the brochures according the zones with illustrated diagrams to explain the principles in an effective way:

- **i.** Cement mortar to be used in the new constructions.
- **ii.** The reinforcements to be used in the horizontal bands which will depend on the length of the walls as well as the type of occupancy of the buildings.
- **iii.** The reinforcements to be used in the vertical bands which will depend on the number of storeys as well as the type of occupancy of the buildings.
- **iv.** Vertical reinforcement at jambs of openings.
- **v.** Foundation details.

These guidelines will act as a ready reference for any engineer or, building owners at the district level finally contributing towards the earthquake safe construction in the country.

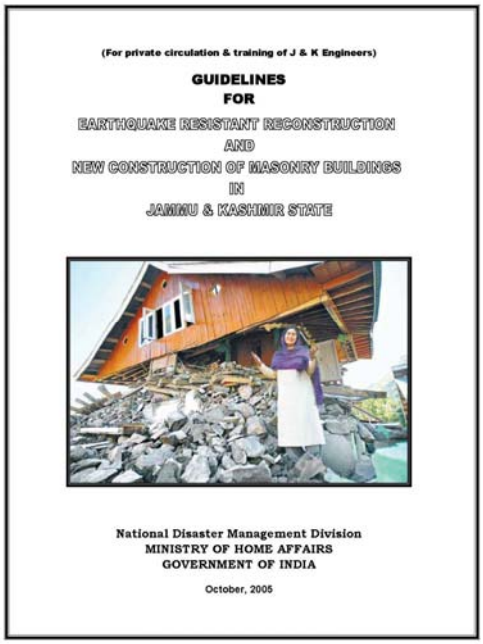
These guidelines were distributed to District Collectors of all districts lying in seismic zone III, IV & V throughout the country.

[ASA & JP]

STATUS: *These have been shared with all District Collectors in Seismic Zones III, IV & V of India during 2006. The hindi translation have also been prepared.*

3.8 Guideline for Earthquake Resistant Reconstruction and New Construction of Masonry Buildings in Jammu & Kashmir State

A strong earthquake of magnitude 7.4 occurred on 8th October 2005 at 9.20.38 AM (IST) with epicentre at 34.432°N, 73.537°E in Muzaffarabad Region of POK. The shaking caused massive destruction to houses, public buildings and communication network in Pakistan as well as Jammu & Kashmir.



Most damaged/destroyed buildings in J & K were constructed using random rubble masonry and bricks laid in clay mud mortar. Most of them had corrugated galvanized iron sheet roofing. No earthquake resisting measures were used.

Such buildings are destroyed in a severe earthquake on account of weakness of the mortar used, absence of bond stones across the thickness of the stone wall resulting into delamination of the inner and outer walls, and separation of the walls at the corners. These finally result into the total collapse of the buildings.

In view of above this Guideline is prepared which details out those earthquake resistant techniques and procedures for reconstruction and construction of new buildings using the available materials which will make them safe. Using good quality *cement mortar* in the construction of stone and brick masonry walls is one of the important requirements. However, if *mud mortar* is desired to be used for any reason, reasonable earthquake resistance can be achieved by using appropriate measures. The Guidelines, therefore, cover both *'masonry in mud*

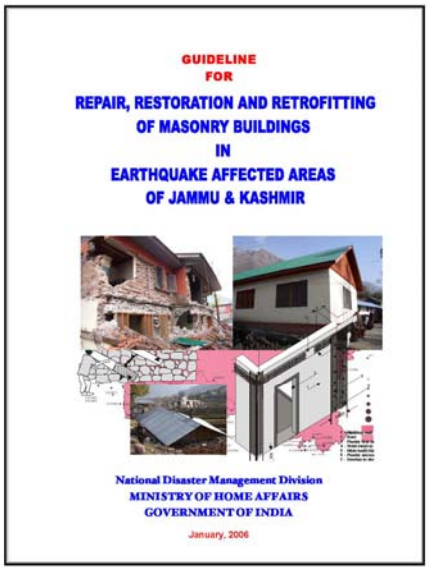
mortar' and *'masonry in cement mortar'*. Similarly seismic bands made of *reinforced concrete* or using available *wooden elements* are both covered and use of *concrete blocks* (solid and/or hollow) may also be made laying the masonry in cement mortar. Another element added to this guideline keeping in view the use of wooden elements in construction of houses in Jammu & Kashmir is the earthquake resistant design of wood framed walls.

It is hoped that with the help of this guideline the house owners and the supervising Engineers will take full care in using all necessary safety elements in the new construction whether for housing or for important buildings for Schools, Public health or Community congregations.

[ASA & AA]

STATUS: *The guideline have been shared with Government of J & K and were used for training of engineers and masons. These have been placed on the website of NDM division, Ministry of Home Affairs, GoI.*

3.9 Guideline for Repair, Restoration and Retrofitting of masonry Buildings in Earthquake Affected areas of Jammu & Kashmir



The earthquake on 8th October, 2005 in Jammu & Kashmir State with Richter Magnitude 7.4 caused large-scale damage and destruction to residential and community buildings. In addition to buildings that collapsed, a number of buildings were damaged to varying grades of damage. Such buildings will need minor and major repairs. Needless to say that simple and superficial repair to buildings will not restore the lost strength; it will only hide the cracks, leaving the building in a weakened state. Such buildings become vulnerable to the next earthquake, even with lesser Magnitude. Consequently, it is necessary, especially in the earthquake prone districts lying in Seismic Zone IV & V, that people take appropriate actions in order to achieve not only the restoration of the lost structural strength to pre-disaster level, but also to upgrade the earthquake resistance by retrofitting to the level envisaged by the Building Codes.

The present Guidelines on ***Repair, Restoration and Retrofitting of Masonry Buildings in Earthquake Affected Areas of Jammu & Kashmir*** will provide the much needed information to Engineers, NGOs and house owners so as to enable them to ensure long-time safety of rehabilitated houses and community buildings.

This Guideline covers all three aspects as applicable to all types of *masonry buildings* as well as Dhajji Diwari constructions whether used for housing or community activities. It is suggested that the three types of action are taken in the following order:

First, restore the building structurally
Next, retrofit the building for upgrading seismic resistance
Last, repair the building architecturally.

[ASA & AA]

STATUS: *The guideline have been shared with Government of J & K and were used for training of engineers and masons. These have been placed on the website of NDM division, Ministry of Home Affairs, GoI.*

3.10 Seismic safety of non-structural elements and contents of Hospital Building

After any large scale earthquake disaster the demands on the hospitals are increased many folds including small, medium and severe injuries to people requiring various treatment from first aid to serious operations. During the Kachchh earthquake of 26th January, 2001, 1,77,000 persons got injured besides 13,800 persons killed. The only large civil hospital at Bhuj got completely demolished during the earthquake killing more than 200 persons including doctors, nurses, patients, visitors and hospital staffs. More than 17,000 operations were performed in tents with make shift arrangements. To prevent the total collapse of hospital buildings structural assessment as well as retrofitting is to be carried out. In Delhi GTB hospital in east Delhi and the All India Medical Institute have been studied towards this objective and retrofitting details are being worked out.

However there is another equally important issue to be addressed. Even under smaller intensity earthquakes in which the buildings will not be affected, the non-structural building components and particularly the furnishings and equipments in the hospital can be badly shaken as a result of which they can overturn or slide crashing down on the floor and hitting people to cause injuries. The hospital can thus become non-functional. The Olive View hospital in California got destroyed during San Fernando earthquake of 1971 and was reconstructed with stronger specifications. During the Northridge earthquake of 1994 this hospital building was not damaged but there was so much non-structural damage to the contents, particularly to hospital equipments, that it became non-functional when it was needed the most.

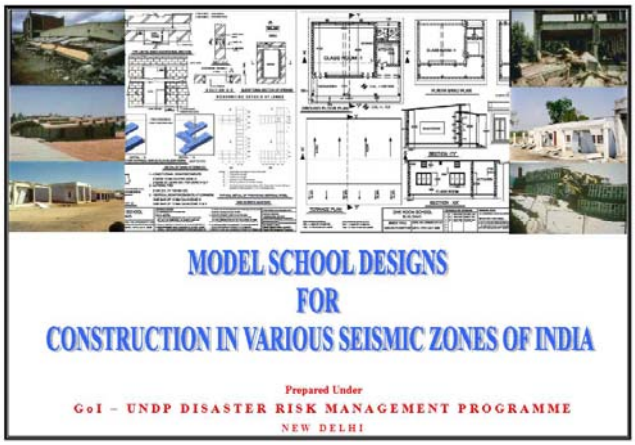
Delhi can have a large earthquake with magnitude 6.7 or MSK intensity VIII but at large intervals of time, whereas smaller earthquake causing MSK intensity VI – VII can occur more frequently which may not be able to cause structural damage but can impact the hospital contents adversely stopping the functioning of hospital as well as causing large scale economic loss since the hospital contents may even account for 80% – 90% of the total hospital cost. The objective of this guide is to indicate how the non-structural hazards can be quickly estimated by the hospital staff and how the same can be prevented at very small cost.

The Guide was issued as the first draft and presented to the large number of medical doctors from Delhi hospitals in a workshop organized by Delhi government. Comments and suggestions of the readers are solicited to improve it, so as to make it adequately useful for safety in hospitals.

[ASA & AA]

STATUS: *Has been shared with Government of Delhi and Ministry of Home Affairs, GoI.*

3.11 Model School Designs for Construction in Various Seismic Zones of India



Amongst all the public facilities children in schools are the most vulnerable during an earthquake disaster. A large number of schools managed by the education departments of the States as well as by private organizations operate in various urban and rural centers. Experience shows that rarely the school buildings are designed to be resistant to earthquake impacts. In the earthquake of 26th January, 2001 in Gujarat, more than 20000 school rooms were destroyed or severally damaged showing the inherent seismic weakness of the school buildings. Thousands of children perished due to collapse of the schools in this earthquake. In the recent earthquake which occurred in Jammu & Kashmir in 2005, more than 200 students & teachers lost their lives in the collapse of only one school building.

School buildings, wherever found safe either in earthquake, cyclone or flood disaster, are used for accommodating the homeless persons as temporary shelters. After the Kobe earthquake in Japan, the Ministry of Construction adopted a policy of upgrading all the school buildings to be used as shelters by retrofitting the unsafe buildings and upgrading their kitchen and drinking water facilities for that purpose.

We, in the Ministry of Home Affairs, had an opportunity of reviewing the primary school building designs of the Uttar Pradesh Government. None of the drawings indicated the provision of any earthquake resisting features. On our recommendations and details furnished, the UP Government has now modified all the school designs incorporating the seismic resisting features and upgrading the cost estimates so that *all new buildings* in the State in seismic Zones IV & III will have the earthquake safety built in the first instance.

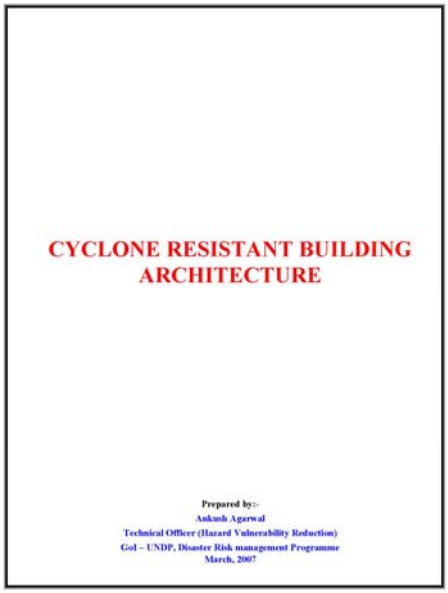
Using the school plans of UP as the base, we have now prepared school building plans of one room, two rooms and four rooms in which further improvements have been incorporated such as two doors in every room and provision of toilets. Further more, we have incorporated the standard planning norms recommended in the National Building Code, 2005. It is hoped that these building plans along with all structural details, if adopted in all States & UT's in the various seismic zones will be a big forward step in creating a culture of prevention in the society, since, the primary schools, which are the closest to the community, may also be used as Technology Demonstration Units for the community which they can simulate in the construction of their own housing units.

The details of earthquake resisting elements furnished in these sample drawings can also be incorporated in other school plans which may have been developed by the States in their school building programmes.

[ASA & AA]

STATUS: *Has been shared with Ministry of Human Resource & Development, GoI and Ministry of Home Affairs, GoI to be adopted for construction of school buildings under Sarva Shiksha Abhiyan.*

3.12 Cyclone Resistant Building Architecture



The vulnerability of a human settlement to a cyclone is determined by its siting, the probability that a cyclone will occur, and the degree to which its structures can be damaged by it. Buildings are considered vulnerable if they cannot withstand the forces of high winds. Generally those most vulnerable to cyclones are light-weight structures with wood frames, especially older buildings where wood has deteriorated and weakened the walls. Houses made of unreinforced or poorly-constructed concrete block are also vulnerable.

Urban and rural communities on low islands or in unprotected, low- lying coastal areas or river floodplains are considered vulnerable to cyclones. Furthermore, the degree of exposure of land and buildings will affect the velocity of the cyclone wind at ground level, with open country, seashore areas and rolling plains being the most vulnerable. Certain settlement patterns may create a "funnel effect" that increases the wind speed between buildings, leading to even greater damage.

This guide has been prepared to give a complete idea on the effect of cyclone on wrong siting of buildings as well the effects on each components of the building followed by the procedure to be adopted to make a house safe from cyclonic winds.

[ASA & AA]

STATUS: *Has been shared with UNDP-NIDM for uploading on the India Disaster Knowledge Network (IDKN) portal.*

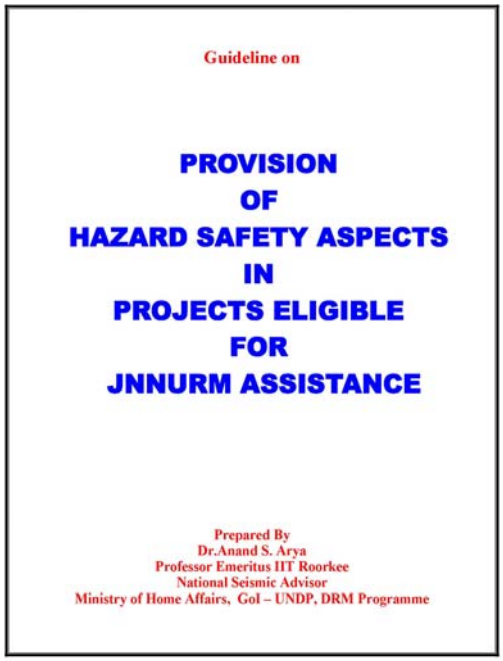
3.13 Self Assessment Guide for Buildings Situated in Seismic Zone IV of India

As almost 85% of the houses constructed in India are in brick & stone masonry which are highly vulnerable to earthquake forces. Keeping this in mind a self assessment guide has been prepared for dissemination to the general public with limited technical know how. Using this individual can assess the level of damageability of his building by filling a few simple data in the questionnaire framed in the guide. But before filling the data, an individual should go through the guideline for better understanding of their building and the earthquake behavior of such buildings.

[ASA & AA]

STATUS: *Has been shared with Delhi Govt. & Ministry of Home Affairs, GoI.*

3.14 Provision of Hazard Safety Aspects in Projects Eligible for JNNURM Assistance



The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) envisages an investment of Rs.55,000/= crores covering 63 cities consisting of 7 major cities, 28 one million plus cities, and 28 other identified cities with less than one million population. It is found that 8 cities are situated in *Seismic Zone V* of the seismic zoning map of India, 2002 with *very high damage risk*, where the highest *Intensity of MSK IX or higher* may occur in future earthquakes, 14 cities are in *Seismic Zone IV* considered in *high damage risk zone with MSK intensity VIII* considered probable. Another 24 cities fall in *Seismic Zone III*, i.e. *moderate damage risk zone with MSK Intensity VII* postulated to occur. The other 17 cities are in *Seismic Zone II with low damage risk zone*. Seven of the sixty three cities are located in the coastal area, which may be affected by very high cyclonic wind velocities causing severe damage to tall, flexible and sheeted residential and industrial buildings. Ten of the total cities are located in *severe to high landslide prone areas*, which incidentally are in seismic zones V and IV and may therefore, be badly affected by landslides due to the occurrence of a major earthquake. Some of the cities are liable to flooding due to heavy rainfall combined with choking of drains or high tide in the sea.

Therefore, this urban renewal mission provides a great opportunity for improving the safety of the cities with respect to natural hazards, which will otherwise have the potential of causing disastrous situation in the cities as experienced in the past earthquakes such as the Kachchh earthquake of 26th January, 2001 or the super cyclone of 1998 in Orissa or the recent floods in the cities of Mumbai and Surat. It may also be mentioned that the Disaster Mitigation and Management Act, promulgated by Central Government in 2005, emphasizes to consider disaster mitigation measures as an integral part of all development activities, specifically *section 11 (3) (b) state that the National Plan shall include measures to be taken for the integration of mitigation measures in the development plans; and enjoins in section 23 (4) (c) that the State plan shall include the manner in which the mitigation measures shall be integrated with the development plans and projects.*

This paper attempts to discuss the appropriate measures to be adopted while developing the projects for assistance under JNNURM in the nine sectors considered for assistance in the renewal schemes of the cities. These include the redevelopment of inner old city areas, water supply, sewerage and solid waste management, storm water drains, urban transportation, parking lots, heritage areas, prevention of soil erosion and landslides and preservation of water bodies. Two important issues in the impact of the proposed developments are specifically discussed:

(a) How the elements of the proposed project would be adversely impacted by any one or more of the natural hazards and how to safeguard the proposed development?

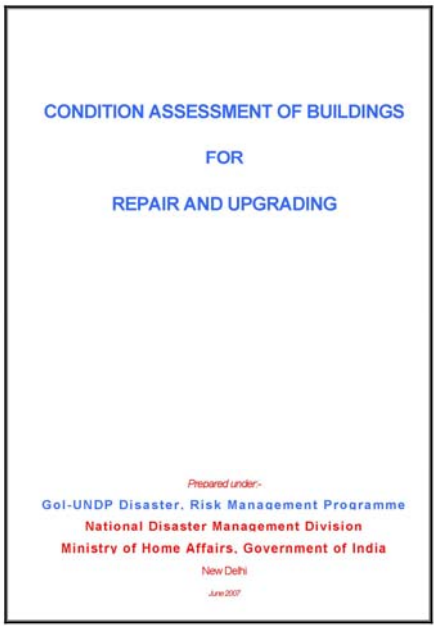
(b) *Whether the proposed projects will have adverse effect in enhancing the hazard proneness of the city and if so, then how to eliminate the features that may cause such an adverse impact?*

Finally, recommendations are made for proper coverage of the disastrous impacts and mitigation measures in the project planning, review and approvals.

[ASA & AA]

STATUS: *Has been shared with Ministry of Urban Development, GoI and Ministry of Home Affairs, GoI to be adopted for preparation of projects under JNNURM.*

3.15 Condition Assessment of buildings for repair and upgrading



The importance and need for condition assessment and evaluation of safety of existing buildings and foundations in disaster prone areas have been highlighted in this guideline. This will determine whether or not a distressed building should be demolished to build back better or whether it will be cost-effective to either repair or retrofit it, in the context of overall safety. Safety evaluation forms the basis for designing and carrying out retrofitting/strengthening of buildings to satisfy the safety and performance standards as per the extant building codes. An overview of the procedures and different investigations including tests involved in condition assessment and evaluation of safety is presented in a simple format. It can be seen that detailed visual inspection and Non Destructive Testing (NDT) plays an important role in condition assessment of existing buildings. It may be emphasized here that a great deal of expertise is required for interpretation of field observations and test results to make a proper assessment of the condition as well as for analyzing and evaluating safety.

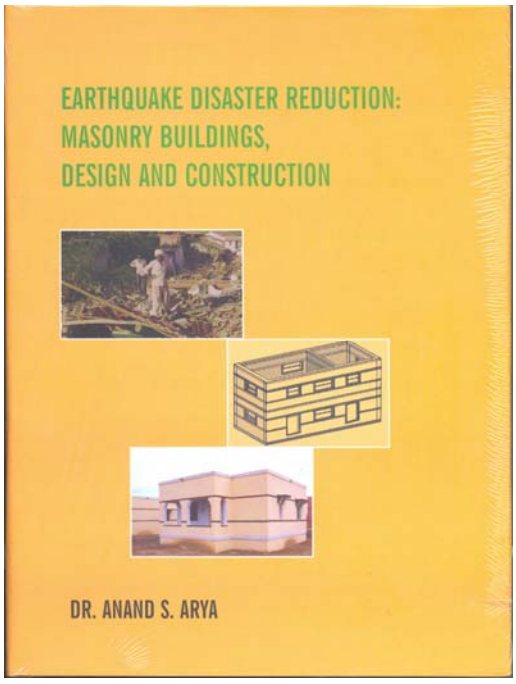
[ASA & AA]

STATUS: *Final Draft is ready and will be shared with the Ministry of Home Affairs, GoI.*

3.16 Earthquake Disaster Reduction: Masonry Buildings, Design & Construction

During the earthquake occurrences in the last century in India and the neighboring countries as well as the most recent earthquakes in 2001 in Gujarat and 2005 in Jammu & Kashmir, the most extensive damage has occurred in masonry buildings of different types, which has resulted in massive loss of lives besides the loss of dwellings. The problem about the *safety of masonry* buildings was one of the most important issues taken up for research and development work at University of Roorkee in 1960. The author started working towards establishing appropriate design and construction standards for masonry buildings. This effort based on extensive analysis and some laboratory testing, was able to produce the Code of Practice IS: 4326 in 1967, in which guidelines for the design of brick, stone and wooden buildings were given in detail.

The book has been planned so as to include the author's published research papers as chapters, placed in a logical way. First, it covers the following basic topics:- *Earthquake hazard mapping in India, The principles of earthquake resistant design of structures, Rational seismic coefficients, understanding the behavior of objects which are subjected to sliding and overturning under earthquakes, Concepts and techniques for seismic base isolation of structures, Vulnerability and risk of damage to masonry buildings in India, Behavior of buildings and foundations during earthquakes, Basic analysis and design of seismic elements, namely, seismic bands and vertical reinforcement at critical points, and, Construction of small buildings of masonry or wood or tubular frames*. Then a number of experimental studies conducted by the author and his associates at University of Roorkee are given in which various parameters were varied to study their effects on seismic performance. The new principles of base isolation applied to masonry buildings through sliding joint were also tested. An economical brick building system with desired earthquake resistance was also developed. Finally a procedure for developing damage scenario in future earthquake has been developed and the problem of safety of existing buildings by retrofitting has been attended to.



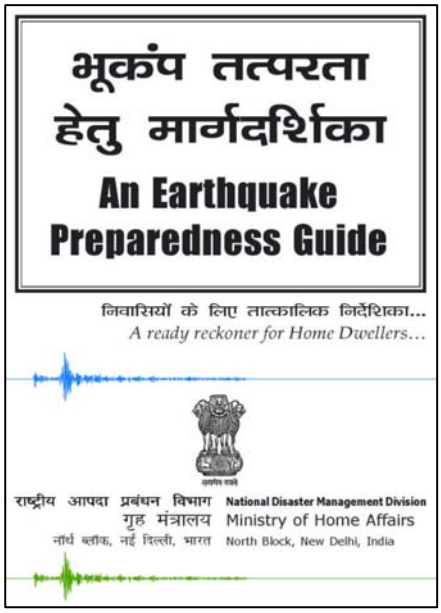
It is hoped that the information and guidance provided in the book will help the readers including senior and junior engineering personnel, disaster managers as well as the general public to learn about the weaknesses in common masonry buildings and how to safeguard against damage in future probable earthquakes by incorporating earthquake resisting elements in the new constructions or by taking retrofitting action in the post-construction life of the buildings.

[ASA & AA]

STATUS: *The book was released by the Prime Minister of India Sh,Manmohan Singh during the inauguration of First India Disaster Management Congress in November, 2006.*

4. Preparation of documents on awareness generation for Disaster Management

4.1. Earthquake Preparedness Guide



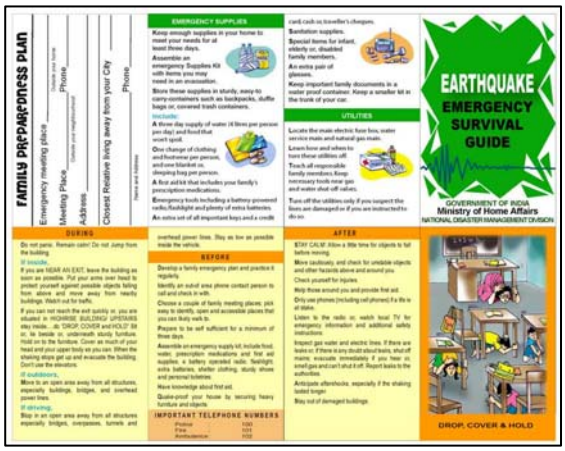
Past earthquakes in the country have brought home the harsh reality that earthquakes don't kill people but the unsafe buildings do. About 57% of the land area of our country is susceptible to damaging levels of seismic hazard. We can't avoid future earthquakes, but preparedness and safe building construction practices can certainly reduce the extent of damage and loss. To take necessary action it is mandatory for every citizen to have elementary knowledge of what is an earthquake, forces acting on structures, remedial measures to be taken for structural safety and knowledge of what to do before, during and after an earthquake.

This guide has been designed to serve as a reference tool to sensitise citizens about the issues concerning preparedness measures for an earthquake.

Around 20,000 copies of this guide have been printed so far. This has been sent to all the States and UTs for wider dissemination. The Guide has also been translated into other languages in India. **[JP, AK & ASA]**

STATUS: *Has been printed and sent to all the State/ UTs.*

4.2. Earthquake Emergency Survival Pocket Guide



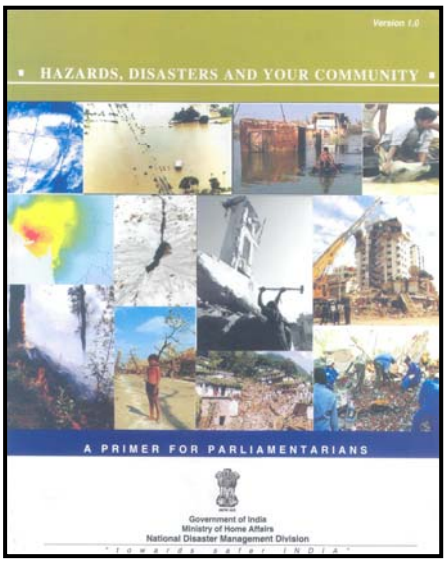
Being prepared for a disaster is often the key to surviving one. Some of the things you can do to prepare for the unexpected, such as making an emergency supply kit and developing a family communications plan, are the same for both a natural or, man-made emergency. However, there are important differences among natural disasters that will impact the decisions you make and the actions you take. Planning what to do in advance is an important part of being prepared.

This pocket guide is a resource that helps citizens and communities prepare for catastrophic events such as earthquake disasters. The information provided in that can help citizens respond appropriately before, during and after an earthquake, no matter where they happen to be when it occurs.

[JP, AK & ASA]

4.3. Primer for Parliamentarians

With the initiation of State level sensitization programme in the States it was felt that apart from the resource materials distributed, there was a need to develop a handbook specifically for the parliamentarians briefing them about different natural & man made hazards, their onset type, warning, causes, elements at risk, zonation, main mitigation strategies and community based mitigation strategies to be adopted for that particular hazard. Apart from this, chapters on effects of hazards on economy & development and role of policy makers in disaster mitigation were also added so that they can understand the financial intricacies related to a disaster and how best can they help in mitigating those disasters.



[ASA, AA & AK]

STATUS: *Primer is being widely distributed in all the State Level Sensitisation Programmes.*

4.4. Self Assessment of Earthquake Damageability of residential brick Building in NCT of Delhi

During last few months people in Delhi & NCR have been hearing through various media that Delhi lies in Seismic Zone IV of the Seismic Zoning map of India. But what is seismic zone IV and how will it affect your residential house, if the postulated earthquake ever happens? The purpose of this 2 page pamphlet is to make the people aware of what could happen to there building in such an earthquake and by what simple technique they can assess the earthquake damageability of their residential brick buildings. The pamphlet has also been converted into Hindi for mass circulation.

SELF ASSESSMENT OF EARTHQUAKE DAMAGEABILITY OF RESIDENTIAL BRICK BUILDINGS IN NCT OF DELHI (also in NCR)

Dear Citizen of Delhi State,

You have been hearing through various media that Delhi lies in Seismic Zone IV of the Seismic Zoning map of India. But what is seismic zone IV and how will it affect your residential house, if the postulated earthquake ever happens? The purpose of this communication is to make you aware of what could happen to your building in such an earthquake.

In seismic zone IV a maximum earthquake Intensity of VIII on MSK Intensity Scale is likely to occur. In terms of building damage, Intensity VIII is stated to cause the following types of damage:-

Areas of Uttarakhand and many areas in Saurashtra are also placed in Seismic Zone IV where MSK Intensity VIII has actually occurred during 1991 Uttarkashi earthquake, 1999 Chamoli earthquake and the 2001 Kachchh earthquake resulting in wide spread loss of life and property due to collapse of masonry buildings.

In Delhi State, as per 2001 census, there are 1.2 lakh *kutcha* houses and 31 lakh brick masonry buildings. Those buildings which are in East Delhi constructed on old Yamuna bed may be shaken more heavily and suffer larger damage.

MSK Intensity VIII

Most kutcha buildings constructed using clay walls may be totally destroyed. Most masonry buildings constructed using brick walls with *mud* mortar may also be destroyed. But those constructed using good cement mortar may only have heavy cracking.

Buildings constructed in sandy soil with high water table are liable to more severe damage than in other areas

From the above you could get a general idea of behavior of your building during a future probable earthquake. However, if you want to have more specific information about your brick building you can do the assessment yourself as explained below:-

- A single or two storeyed building using one brick (9 inch.) thick walls will be relatively safer than the three storeyed building. The fourth storey, if added, will be very unsafe, and will make the lower storeys also more vulnerable.
- Use of half – brick (4½ inch.) thick load bearing walls will make the storey very unsafe and, if used in 3rd or 4th storey, it may have a catastrophic failure.
- Too many window openings in a wall make it weaker, and use of smaller size piers less than 18 inches (45 cm) between them will increase the damageability even higher. To check this aspect, you should measure the combined width of all the openings in a wall and compare with the length of the wall. In a three or four storey building, the combined width of the openings should be less than one third the length of the wall, in two storeyed less than 42% and in one storey not more than 50%. The width of the brick pier between two consecutive openings should be more than two brick length or 18 inches (45 cm).

Fig.:- Essential elements for earthquake safety of masonry buildings

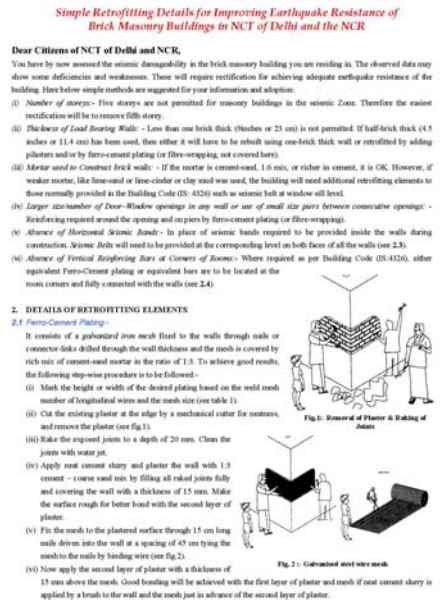
- The earthquake safety of the building depends upon the strength of the mortar used, stronger the mortar safer the building. Minimum mortar specified for safety is 1:6 cement-sand mortar (1 part cement by 6 parts of sand). Lime-Surkhi or lime –cinder mortar is much weaker.

[ASA & AA]

STATUS: *Has been shared with the Govt. of Delhi as well as Ministry of Home Affairs, GoI.*

4.5. Simple Retrofitting Details for Improving Earthquake resistance of Brick Masonry Building in NCT of Delhi and the NCR

Now comparing what actually exists with the guideline description provided above, one can judge the whole building as well as their unit house in the building whether during MSK



Simple Retrofitting Details for Improving Earthquake Resistance of Brick Masonry Buildings in NCT of Delhi and the NCR

Dear Citizens of NCT of Delhi and NCR,

You have by now assessed the seismic damageability in the brick masonry building you are residing in. The observed data may show some deficiencies and weaknesses. These will require rectification for achieving adequate earthquake resistance of the building. Here below simple methods are suggested for your information and adoption:

(i) *Number of storeys:-* Five storeys are not permitted for masonry buildings in the seismic Zone. Therefore the easiest rectification will be to remove fifth storey.

(ii) *Thickness of Load Bearing Walls:* - Less than one brick thick (9inches or 23 cm) is not permitted. If half-brick thick (4.5 inches or 11.4 cm) has been used, then either it will have to be rebuilt using one-brick thick wall or retrofitted by adding pilasters and/or by ferro-cement plating (or fibre-wrapping, not covered here).

(iii) *Mortar used to Construct brick walls:* - If the mortar is cement-sand, 1:6 mix, or richer in cement, it is OK. However, if weaker mortar, like lime-sand or lime-cinder or clay mud was used, the building will need additional retrofitting elements to those normally provided in the Building Code (IS: 4326) such as seismic belt at window sill level.

(iv) *Larger size/number of Door–Window openings in any wall or use of small size piers between consecutive openings:* - Reinforcing required around the opening and on piers by ferro-cement plating (or fibre-wrapping).

(v) *Absence of Horizontal Seismic Bands:*- In place of seismic bands required to be provided inside the walls during construction, *Seismic Belts* will need to be provided at the corresponding level on both faces of all the walls (see 2.3).

(vi) *Absence of Vertical Reinforcing Bars at Corners of Rooms:*- Where required as per Building Code (IS:4326), either equivalent Ferro-Cement plating or equivalent bars are to be located at the room corners and fully connected with the walls (see 2.4).

2. DETAILS OF RETROFITTING ELEMENTS

2.1 Ferro-Cement Plating:-

It consists of a *galvanized iron mesh* fixed to the walls through nails or connector-links drilled through the wall thickness and the mesh is covered by rich mix of cement-sand mortar in the ratio of 1:3. To achieve good results, the following step-wise procedure is to be followed:-

(i) Mark the height or width of the desired plating based on the weld mesh number of longitudinal wires and the mesh size (see table 1).

(ii) Cut the existing plaster at the edge by a mechanical cutter for neatness, and remove the plaster (see fig.1).

(iii) Rake the exposed joints to a depth of 20 mm. Clean the joints with water jet.

(iv) Apply neat cement slurry and plaster the wall with 1:3 cement – coarse sand mix by filling all raked joints fully and covering the wall with a thickness of 15 mm. Make the surface rough for better bond with the second layer of plaster.

(v) Fix the mesh to the plastered surface through 15 cm long nails driven into the wall at a spacing of 45 cm tying the mesh to the nails by binding wire (see fig.2).

(vi) Now apply the second layer of plaster with a thickness of 15 mm above the mesh. Good bonding will be achieved with the first layer of plaster and mesh if neat cement slurry is applied by a brush to the wall and the mesh just in advance of the second layer of plaster.

Fig.1:- Removal of Plaster & Raking of Joints

Fig. 2 :- Galvanized steel wire mesh

VIII earthquake; it could be subjected to *destructive damage* or *heavy cracking* or *minor* damage.

If one finds that the conditions in the building are of a type where destruction or heavy damage will be likely to occur, they can should proceed to strengthen (retrofit) the building for earthquake safety, for which this simple and understandable four page pamphlet has been prepared with the help of which one can retrofit their building or can even take the help of a qualified Structural Engineer.

[ASA & AA]

STATUS: *Has been shared with the Govt. of Delhi as well as Ministry of Home Affairs, GoI.*

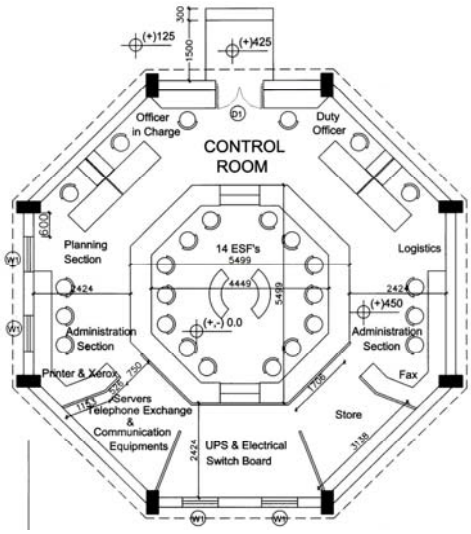
5. Projects on Earthquake Risk Management

5.1. Emergency Operation Centres

One of the major focuses of the programme is towards strengthening of Emergency Operations Centres (EOC) in order to enable them to disseminate accurate warning for advance action. The EOC is established to act as a state of the art resource centre for emergency response in the event of any disaster. It would be provided with work stations and communications equipment for management of emergencies.

5.1.1. State Emergency Operation Centre

<u>Building Design of the State EOC</u>



The EOC buildings have been planned in four separate blocks which could be arranged by the States in the pattern most suitable for the available area. The Toilet block & Generator room have been combined into one block.

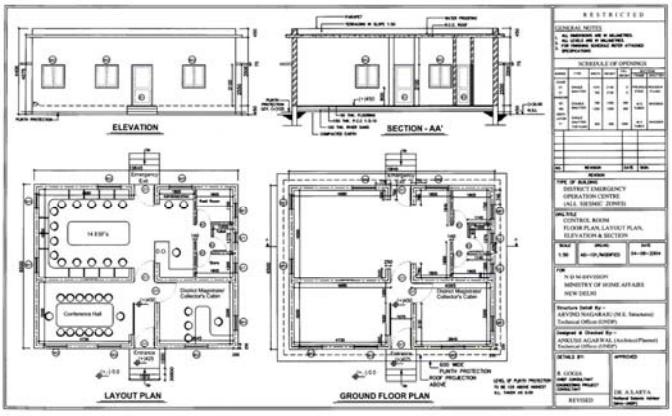
The control room, the conference room & the resting room are designed as reinforced concrete frames, for twice the seismic force for which residential buildings are normally designed in each zone so that the EOC buildings will have much higher factor of safety against probable earthquakes in the respective areas. By this design, the buildings will not only be safe against collapse will should also remain functional after the hazard occurrence.

5.1.2. District Emergency Operation Centre

<u>Building Design of District EOC</u>

The District EOC is planned as a single block in which areas for different activities have been earmarked. The district EOC has a DC's room, a conference hall and a control room. Apart from this it has a small rest room, toilet and one store. A number of options to suit different terrains all over India have been prepared for building design:

i. Single storey load bearing structure with flat roof.
ii. Single storey framed structure with sloping roof.
iii. Double storey framed structure with flat roof.
iv. Double storey framed structure with sloping roof.



Apart from the building design, complete structural details for different seismic zones along with their bill of quantities & estimates have been prepared.

[ASA, JR, AA & AN]

STATUS: *Drawings and estimates for State & District Emergency Operation Centres prepared by MHA has been shared with all the States/UTs. Construction has commenced in many States and Districts.*

5.2. Implementation of National Capacity Building Programmes

Unfortunately, this was not reflected in the **undergraduate engineering /architectural curriculum** and most graduates in Civil Engineering/Architecture from our universities would not have acquired the capacities to carry out seismic design/ construction. Considering the increased construction activity throughout the country, this effectively results in the construction of buildings and structures with low earthquake resistance and an exponential increase in the vulnerability of our built environment.

Therefore two key programmes were initiated and are under implementation towards sustainable earthquake risk reduction. They are:

On account of its geo-climatic conditions, the Indian sub-continent is highly prone to multiple natural hazards including earthquakes- one of the most destructive natural hazards with the potential of inflicting huge losses to lives and property. Earthquakes pose a real threat to India with 57% of its geographical area vulnerable to seismic disturbances of varying intensities including the capital city of the country.

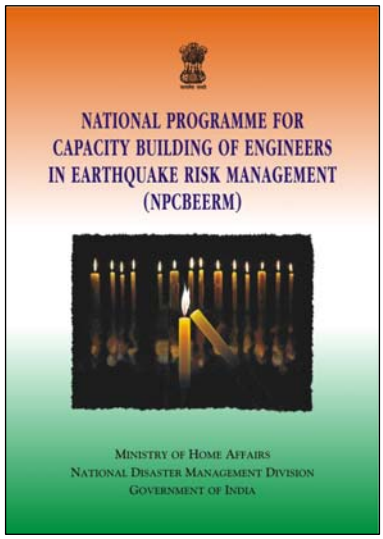
Every State and UT in the country have regions in the moderate (Zone III), high (Zone IV) or, severe (Zone V) earthquake hazard zone. Almost the entire northeast region, northern Bihar, Himachal Pradesh, Jammu & Kashmir and some parts of Kutch are in seismic zone V, while Delhi, the entire Gangetic plain and some parts of Rajasthan are in seismic zone IV. It has been observed that an average of three earthquakes of magnitude 6.0 or more occur in India every year. India is thus among the most earthquake prone countries in the world and in the last 15 years, we have experienced six earthquakes of moderate to severe intensity.

5.2.1. National Programme for Capacity Building of Engineers in Earthquake Risk Management (NPCBEERM)

National Programme for Capacity Building of Engineers in Earthquake Risk Management (NPCBEERM). [The programme envisages the development of capacities of 10,000 serving and practising engineers all over the country through leading Engineering Institutions at the National level (National Resource Institutions-N.R.Is) and State level (State Resource Institutions-S.R.Is).]

[(*RNG, HK*), JP & ASA]

STATUS: ***Ten*** *training programmes have been completed and* ***137*** ***engineers*** *have been trained so far out of a target of 420 trainer engineers from the Civil Engineering Departments of the SRIs.. A training programme for 19 trainer engineers is now going on at IIT Delhi for the State of Gujarat and NCT of Delhi. Training of all the trainer engineers is likely to be completed by June, 2006. IIT Madras, SERC Chennai, IIT Kharagpur, IIT Guwahati and IIT Roorkee are organising 6 week ToT programmes in the month of February, March and April 2006 (to be updated)*

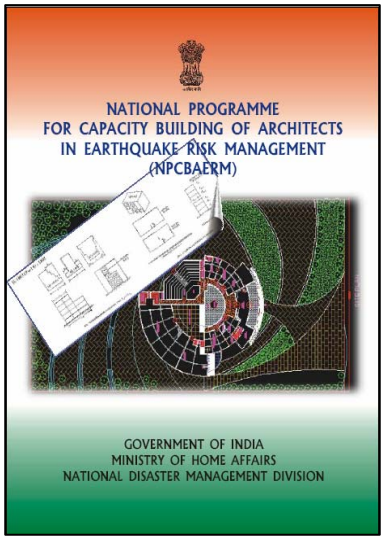


5.2.2. National Programme for Capacity Building of Architects in Earthquake Risk Management (NPCBAERM)

National Programme for Capacity Building of Architects in Earthquake Risk Management (NPCBAERM). [The programme envisages the development of capacities of 10,000 serving and practising architects all over the country through

leading Architectural Institutions at the National level (National Resource Institutions-N.R.Is) and State level (State Resource Institutions-S.R.Is).] **[(*RNG, HK*) JP & ASA]**

STATUS: ***Seven*** *training programmes have been completed and* ***99*** ***architects*** *have been trained so far out of a target of 250 trainer architects from the Architecture Departments of the SRIs. The ToT programmes for the trainer architects are being organised at different NRIs (CEPT Ahmedabad, IIT Roorkee, IIT Kharagpur, JNTU Hyderabad, MANIT Bhopal, MIT Manipal and SPA Delhi) during January to March 2006. The remaining faculty members are expected to complete their training in the above mentioned training programmes(to be updated).*



The resource material for training of trainers and practising professionals for both the training programmes i.e. NPCBAERM & NPCBEERM has been prepared by IIT Roorkee under the guidance of Dr.A.S.Arya and been shared with all National as well as State Resource Institute for their suggestions as well as incorporation.

5.2.3. Constitution of Hazard Safety Cells in States and UTs and Capacity Building of members of the Hazard Safety Cell from the States/UTs

It is well known that more than 57% of the land area in India is liable to damage & destruction of buildings under Seismic Intensities 'VII & higher'. The coastal belt in a width of about 50 km is liable to cyclonic winds along with storm surge effects. Not as spectacular though, fires in buildings also have been taking a large toll of life and properties. During the last fifteen years several damaging earthquakes in different parts of India, highly damaging cyclones on the east as well as west coast, as well as several major fires have clearly brought out the inadequacies of building design & construction practices. It was therefore considered essential that the various State Government & UT Administration put in place suitable Hazard Safety Cells so as to mitigate the impact of these disasters in all buildings in general & Government buildings in particular. The HSC will perform the following functions.

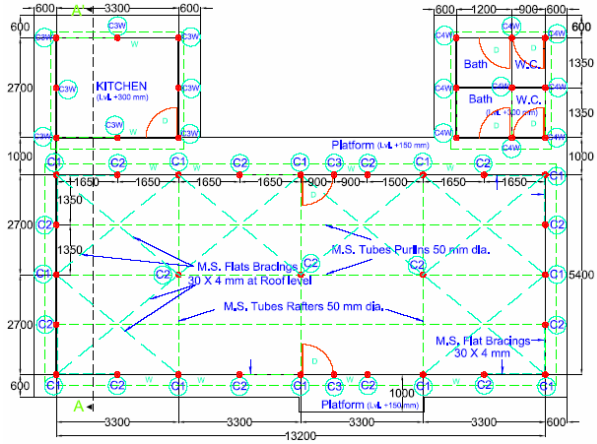
- To achieve competence in Hazard Resistant Design of Buildings and Structures as well as in Restoration & Retrofitting of Buildings and Structures through training, acquisition of published books and documents, building codes, guidelines and manuals, documentaries and films etc. on the subjects of disasters.
- To review the architectural and structural designs of all RCC, Steel and Masonry Buildings and Structures from the point of view of safety under earthquakes, cyclones, floods, landslides and fire, and to prepare checklists for quick review of the new designs to be adopted for buildings and structures to be constructed in the state.
- Carry out safety review of All Government Buildings of Various Departments including Panchayats, and Standard or, type designs etc. & including:
  i. Important Service and Community Buildings with an Importance factor (I) of 1.5 or, higher
  ii. All buildings of over G + 2 including apartment buildings, shopping complexes etc.

- ***To provide suitable checklists for regulatory authorities in local bodies who carry out the initial screening of designs.***
- ***To act as an advisory Cell to the State Government on the different aspects of building safety against the hazards.***
- To act as a consultant to the State Government for retrofitting of government buildings and lifeline structures.

The Ministry of Home Affairs is supporting the State Governments/ UTs in training of the functionaries of the Hazard Safety Cells on all aspects of hazard safety engineering with the help of CPWD National Training Institute (a National Resource Institution for the training of members of HSC). **[(*ASA & HK*), ASA]**

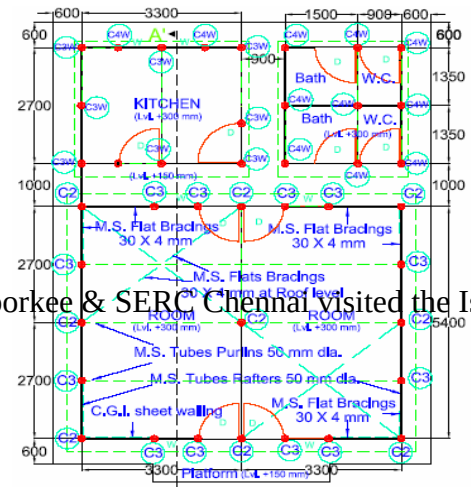
STATUS: *The States/UTs of* ***Assam, Bihar, Chattisgarh, Dadra & Nagar Haveli, Delhi, Goa, Gujarat, Haryana, Jharkand, Karnataka, Lakshadweep Islands, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Orissa, Pondicherry, Rajasthan, Tamil Nadu, Tripura, Uttaranchal*** *and* ***West Bengal*** *have already constituted Hazard Safety Cells. 117 members (3 from each State and Union Territories; Delhi is an exception, where 5 Hazard Safety Cells have been planned to be formed, 3 of which have been constituted) were planned to be trained in 5 training programmes, which were organised at CPWD National Training Center, Ghaziabad.* ***91*** *members of the HSCs from* ***32*** *States/UTs have participated in the 4 training programmes which are already over. The remaining members will be trained in the fifth batch of the training programmes, which is proposed to be held during 16th to 20th January 2006 at the said training institute.* ***(to be updated)***

5.3. Design of Intermediate Shelters for Andaman &Nicobar Islands



Andaman & Nicobar Islands were worst affected by tsunami and the reconstruction there had major constraints mentioned below:

- The monsoon in Andaman & Nicobar starts from 15 May and lasts for seven months.
- The Shelters proposed should have earthquake & cyclone resistant features.
- There are serious constraints on the availability of the construction material in the A & N.
- As number of jetties got damaged, therefore loading & unloading of material will be a big challenge.
- As majority of the shelters were to be constructed for tribal people. Therefore reconstruction should ensure acceptability to the people so that people feel involved as owners in the reconstruction programme.



A group comprising of members from MHA, CPWD, IIT Roorkee & SERC Chennai visited the Island to hav the construction material was not available locally, so it had to be shipped from mainland. The material selection was done keeping in mind its durability as it had to be used

in the coastal area and secondly availability in bulk, therefore corrugated galvanised iron sheets were identified as the material to be used in roof & walls and tubular iron section of different diameter for making the pillars, rafters & purlins. The designs were so prepared that once the fabrication work is done at the workshop the members could be easily transported, bolted & tied together. The biggest advantage was that the structure could be dismantled and shifted wherever required.

[AA & ASA]

5.4. Preparation of Layouts for Construction of Intermediate Shelters

As time was a major constraint in erecting the intermediate shelters, A & N Administration requested Ministry of Home Affairs to deputy 6 architect/planners who will assist the administration in preparation of layout drawings with community facilities, demarcation at site and also in supervising the construction work. A team of 6 architects/planners were deputed under the leadership of Dr. Arya. These architects were posted at different islands where in they conducted PRA (Participatory Rural Appraisal) exercise and the layouts were prepared accordingly so that the tribal can have ownership of the whole reconstruction activity carried out. Visit to different islands was also made Dr. Arya, wherein he gave his suggestions to the problems faced by the executing agency. He also conducted training programmes for the engineers, so that they are completely acquainted with the design drawings of the intermediate shelters sent by MHA. The target of constructing 10100 intermediate shelters was completed well in time i.e. before the onset of monsoon.

[AA, JP, SP & ODTF]

5.5. Retrofitting of five Lifeline Buildings in Delhi: A Pilot Project

The Ministry of Home Affairs, GoI and the National Capital Territory of Delhi (NCTD), established a program through which NCTD agencies identified 5 lifeline buildings to evaluate & retrofit. This is a project for developing and piloting a "Model Program for Seismic Evaluation and Retrofitting of Lifeline Buildings in Delhi". The initiative is supported by the United States Agency for International Development (USAID) within the National Disaster Management framework of Govt. of India. In Delhi, the project is led by the Office of Divisional Commissioner, Govt. of N.C.T. of Delhi the Delhi Disaster Management Authority (DDMA) and is being assisted by US based non-profit organization – Geo-Hazards International (GHI), along with Delhi based non-governmental organization – SEEDS. The objectives laid down under the program are:

- To provide technical advice for seismic safety of 5 identified lifeline buildings.
- To transfer and exchange seismic safety knowledge from US experts to select Indian experts.
- To raise awareness on seismic safety of stakeholders in health & education sectors.

These interventions will include structural as well as non-structural seismic safety measures towards making a holistic seismic safety programs.

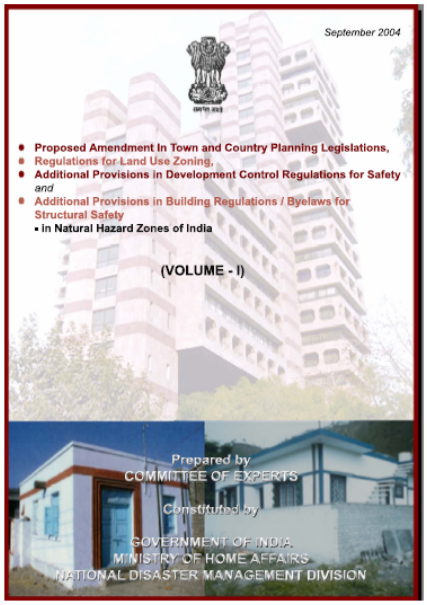
[ASA]

STATUS: *Assessment and analysis of building is complete. Actual retrofitting will soon start.*

6. Work done by different Expert Groups constituted by MHA for Disaster Risk Management

6.1. Model Building Bye-laws

First step towards the implementation of an earthquake mitigation strategy will be to put in place an appropriate techno-legal regime. Building bylaws had to be amended to incorporate the BIS codes for seismically safe construction. Keeping this in view the National Core Group on Earthquake Mitigation constituted a Committee under the chairmanship of Dr.A.S.Arya to prepare Model Building Bylaws based upon which the States can make amendments in their existing bylaws. The Core Group was of the opinion that a mere reference to the BIS code is not sufficient and as such it was considered necessary to make essential elements of the code a part of the building bylaws, the committee took note of this and prepared structural design basis report (SDBR) in which the designer has to provide all the information required for preparing the structural design of the building (The SDBR format was prepared for masonry, RCC and steel structures). Apart from this a concept of proof checking & quality audit was also recommended for important buildings.



The core group was also of the view that apart from the building bylaws State Town & Country Planning Acts as well as Land Zoning Regulations would need to be reviewed, so as to ensure that these codes were in conformity with the hazard mitigation requirements.

[ASA, JKP & AA]

STATUS:

1. *Copy of the Model Bylaws has been forwarded to all States/UTs with a request to constitute a committee for incorpation of proposed regulations in the existing system.*
2. *Building Materials & Technology Promotion Council has been entrusted with the responsibility to organise workshops in 8 North Eastern States and 12 Non NE States. Till date they have organised the workshops in the States of Tamil Nadu & Pondicherry, Chattisgarh, Bihar, Assam, Tripura, Meghalaya and Uttar Pradesh*

6.2. Revision of Vulnerability Atlas of India

Recognising the paradigm shift in the policy of the Government in dealing with natural disasters and in keeping with the objectives of Yokohama strategy focusing on pro-active action rather than post disaster response, the Vulnerability Atlas of India was brought out by BMTPC as formulated by Expert Group Constituted by the Ministry of Urban Development, GoI under the chairmanship of Dr. A. S. Arya. In response to the invaluable feedback on the Atlas since its publication to date, the new knowledge has been generated and significant changes have taken place during the intervening period in terms of number of new States and Districts, demographical changes and typology of housing brought out of Census 2001. In view of these

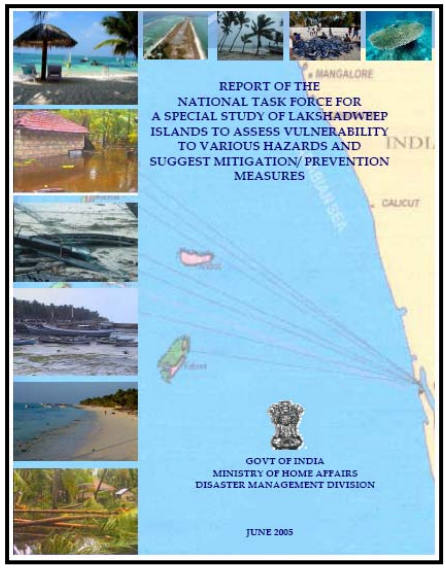
significant changes there is a growing demand for updating and revising the Vulnerability Atlas of India released in 1997.

To update the Vulnerability Atlas of India in GIS platform, the Ministry of Urban Affairs & Employment constituted a Peer Group comprising of experts from different disciplines under the chairmanship of Dr.A.S.Arya. The Atlas would include hazard maps of States/UT's right upto Taluka level indicating vulnerable areas and district wise and taluka wise risk levels of existing house types. The Group would also make recommendations on nature of Techno-legal regimes to be established and necessary technical guidelines for disaster resistant construction methods, for construction, reconstruction and retrofitting of housing and buildings so that pro-active programme of strengthening the existing stock can be formulated and implemented.

[ASA, AA & JKP]

STATUS: *Revised Vulnerability Atlas 2006, published.*

6.3. Vulnerability Assessment of Lakshadweep Islands



In view of the recent tsunami disaster in Andaman & Nicobar Islands, Ministry of Home Affairs expressed an urgent need to put in place the entire gamut of prevention, mitigation and preparation measures to effectively overcome eventualities arising out of natural disasters if and when striking the Lakshadweep Islands. The objective of the study was to study the hazard & vulnerability of the Islands to develop a road map to list out explicitly the modalities for responding to such emergency situations, so as to ensure that in an event of a natural disaster striking Lakshadweep Islands, there would be adequate provisions for connectivity as well as emergency supplies, with the overall objective of reducing the impact of the natural disaster. Therefore, the special study for the Lakshadweep Islands needs to address inter alia the issues listed below:

- Prevention and mitigation measures to minimize damages to all the infrastructural facilities;
- Steps required for preparedness to meet the eventualities arising out of natural disasters; and
- To ensure adequate provisions for connectivity and emergency supplies under all circumstances.

A National Task Force was constituted under the chairmanship of Dr.A.S.Arya, wherein representatives from different departments namely: IMD, DOD, GSI, SoI MoEF, CWC, NRSA, DST, IIT Chennai, DoS, BMTPC and Lakshadweep administration were made as members. A visit to Lakshadweep Islands was made by some of the members soon after which a copy of the draft report was shared with the Ministry and was also circulated to all the members for their comments. Recently a one day workshop was called to discuss & incorporate the suggestions given by the members. The report of the Task force is under finalization.

[ASA, EVM, JKP & AA]

STATUS: *Expert group report has been submitted to the Ministry of Home Affairs for consideration and necessary action.*

Abbreviations:

AA: Ankush Agarwal, Programme Associate (Hazards Vulnerability Reduction)
AK: Anup Karanth, *Ex-Programme Coordinator,* UEVRP
ApK: Aparna Kanda, *Ex-Programme Associate (DM)*
AN: Arvind Nagaraju, *Ex-Technical Officer (DM)*
ASA: Dr. Anand Swarup Arya, *National Seismic Advisor*, Ministry of Home Affairs
DKP: Dr. D. K. Paul, Professor, *Earthquake Engineering*, IIT Roorkee
EVM: Dr. E. V. Muley, *Ex-Advisor (NCRM Project)*
HK: Hari Kumar, *Ex-Programme Associate (DM)*
JKP: J. K.Prasad, Chief (Building Materials), BMTPC
JP: Jnananjan Panda, *Ex-Project Officer*, Earthquake Mitigation
JR: Joydeep Roy, Ex-NUNV Architect
ODTF: Orissa Development Technocrats' Forum
RI: Rajeev Issar, *Programme Associate (DM)*
RNG: Rabi Narayan Gauda, *Ex-Programme Associate (DM)*
SP: Satya Narayan Padhiari, Shelter Team, Orissa
SVRKP: S.V.R.K. Prabhakar, *Ex-Programme Associate (DM)*