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REDUCING EARTHQUAKE LOSSES – A Lesson from Kachchh Experience

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ABSTRACT

The Bhuj Earthquake of Jan 26, 2001 occurred on the Republic Day of India when administration, general public, teachers and students in schools were getting busy for the celebrations. Everybody including the Gujarat Government was in a state of unpreparedness to receive and cope with such a terrible earthquake. Hence, the earthquake caused terrible damages to buildings and infrastructures, loss of human and cattle lives. To meet the un-precedent situation, the Gujarat Government established Gujarat State Disaster Management Authority and planned holistic re-construction and rehabilitation policy. The paper presents very briefly the terrible human tragedy, the large affected areas of the state, direct and indirect losses suffered and a unique reconstruction program of the houses through 'owner-driven reconstructions'. For efficiency and effectiveness of the procedures, a large scale capacity building program of masons and engineers was undertaken, along with provision of 'materials banks' to be sourced by the individual house owners. The approach ascertained earthquake resistant measures in all house constructions, achieving 1,80,000 houses within a period of 30 months.

Key words: Bhuj Earthquake, Disaster Relief, Reconstruction Recovery, Disaster Guidelines.

1. INTRODUCTION

The experience during Bhuj Earthquake of Jan 26, 2001 has taught lessons for future as to how to cope with a sudden earthquake tragedy through appropriate government decisions and quick

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and effective actions along with planning for preparedness for future such occurrences (Mishra, 2004). The losses suffered by the state were huge and it is important to note that by appropriate mitigation and preparedness actions the losses could be much reduced. Therefore, a well thought out Disaster Management System has to be instituted. The paper highlights, the immediate and long term actions taken by the government of Gujarat.

2. SALIENT FACTS ABOUT THE BHUJ EARTHQUAKE OF JAN.26, 2001

2.1 VITAL PARAMETERS OF THE BHUJ EARTHQUAKE OF JAN.26, 2001

Magnitude, Mw = 7.7
MSK Intensity, I = VII to X
Number of Persons killed = 13805
Number of Persons Injured = 177000

2.2 THE EARTHQUAKE CREATED A TERRIBLE HUMAN TRAGEDY

- Over 1.1 million homes affected;
- 4 Kachchh towns Bhuj, Rapar, Anjar and Gandhidham in ruins
- Over 5,000 Health units damaged / destroyed (*Bhuj General Hospital collapsed*)
- Over 50,000 School rooms damaged / destroyed (*High School of Dudhai Village*)
- Over 50,000 artisans lost their livelihood.
- Over 10,000 small and medium industrial units went out of production.
- Massive damage to telecom, power, water supply and transport infrastructure.

3. EARTHQUAKE LOSSES – A LARGER PICTURE

3.1 Direct losses (2001,Bhuj earthquake estimate: Rs 153,083 Million)

- Human lives
- Livestock, other animals
- Private property
- Municipal infrastructure
- Power/ telecommunications infrastructure
- Health/ education assets

3.2 Indirect losses (2001,Bhuj earthquake estimate: Rs 30,476 Million)

- Export/ import
- Agricultural output

- Industry/ services output
- Remittance income
- Fall in earning potential (due to disability, trauma etc.)
- Unemployment
- Health hazards

3.3 Tertiary losses (2001,Bhuj earthquake estimate: Rs 100,670 Million)

- Long-term development
- Overall investment climate
- Funds reallocation
- Community migration/ relocation

4. WIDESPREAD IMPACT

- 21 out of 25 Districts.
- 181 out of 225 Talukas
- 7633 Villages
- Area affected - 182,639 sq.km. (Larger than Haryana & Kerala put together)
- Population affected over 30% (Fig. 1)

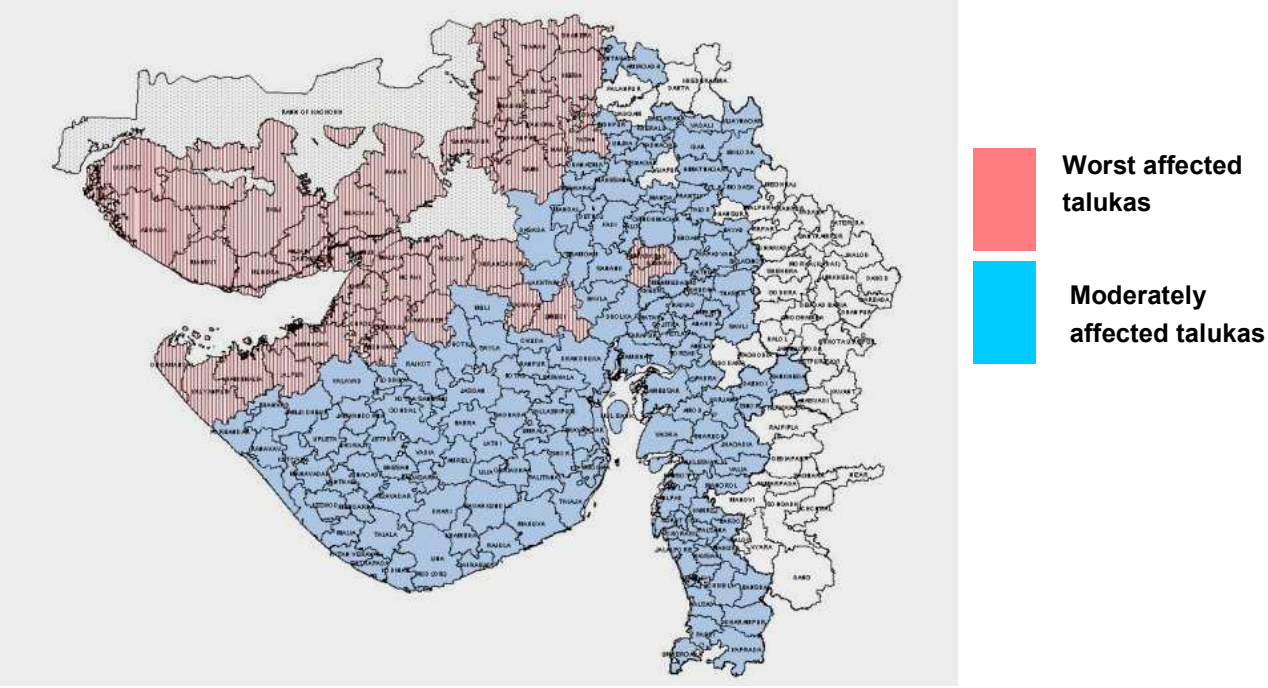

Figure 1. Map showing affected talukas due to Bhuj 2001 earthquake.

5. Earthquake Hazard Map of Gujarat

Seismic Zoning Map of India prepared by Bureau of Indian Standards in 2000 divides India in zones II,III, IV and V having potential of earthquake intensities VI (M5), VII (M6), VIII (M7) and ≥IX (M≥8), respectively. This map is prepared on the basis of intensities experienced at places and their tectonic belts. Gujarat is the only state outside Himalaya-Andaman belt which has high seismic hazard with Kachchh having hazard of level V i.e. magnitude 8 (Fig. 2). About 60 km wide zone surrounding it may experience intensity VIII covering some areas of northern Saurashtra like Jamnagar. Rest of the Saurashtra peninsula in the south and the mainland in the east have hazard of M6 (intensity VII) or less. The Cambay rift has shown seismicity confined to its southern part and to M5.7 level. Narmada rift zone has experienced shocks of magnitude 6 or so and has a maximum potential of earthquake of M6.5.

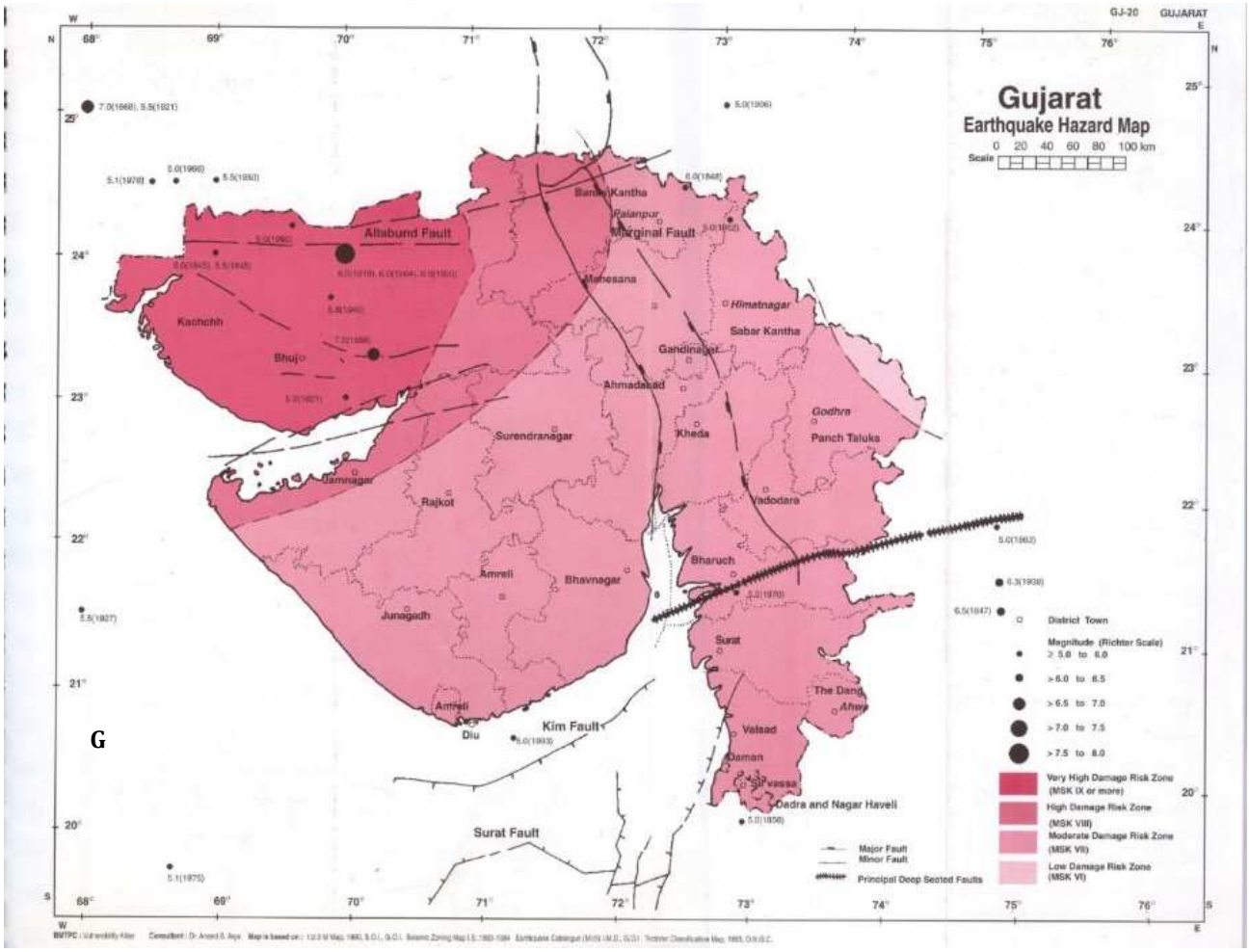

Figure 2. Zoomed Gujarat portion of the Seismic Zoning Map of India which also corresponds to realistic Intensity distribution during Bhuj 2001 earthquake . Locations of some past earthquakes are shown.

6. GOVERNMENT OF GUJARAT POLICY FOR DISASTER RELIEF, RECONSTRUCTION RECOVERY AND FUTURE PREPAREDNESS

The holistic reconstruction and recovery program was designed to address the needs of beneficiaries comprehensively (Fig. 3).

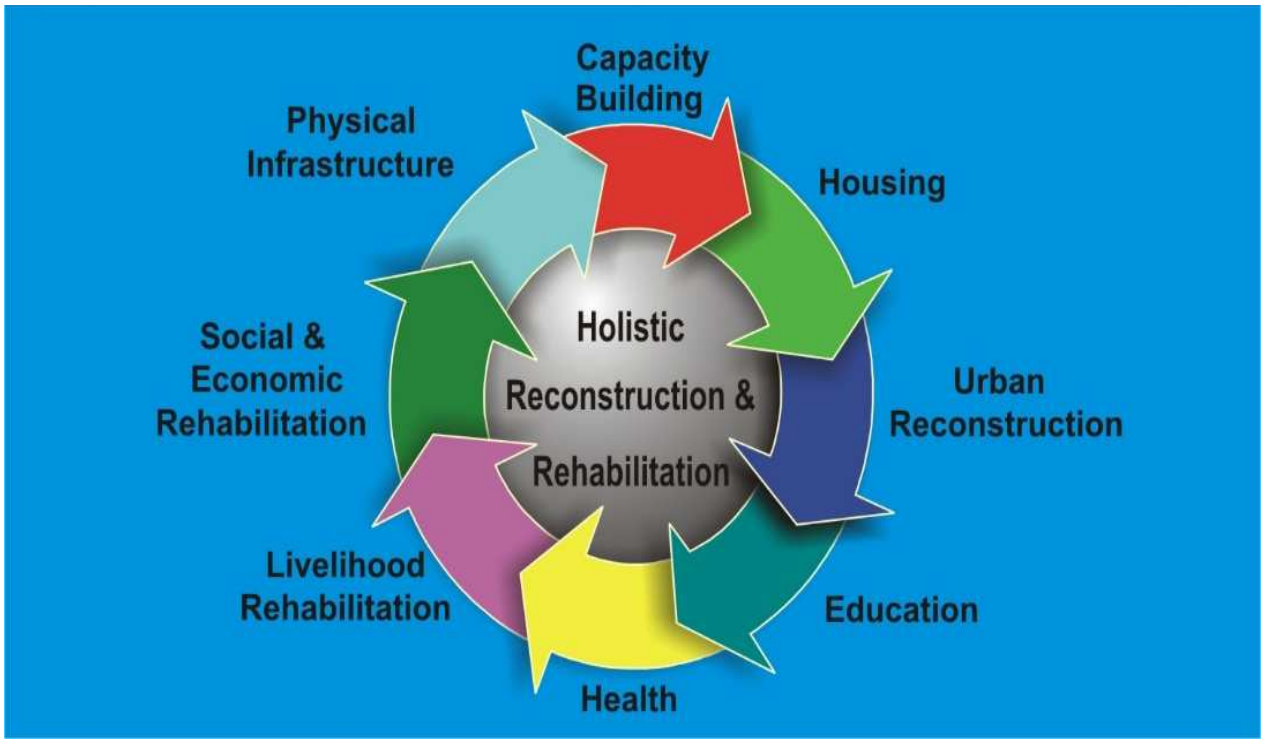

Figure 3. Reconstruction and recovery program that was followed by state after the 2001 Bhuj earthquake

One of the most distinguishing features of the reconstruction program was the focused attention on capacity building, community participation and long-term disaster management. A number of initiatives have been taken in this regard. Varied activities such as the preparation of numerous pamphlets and booklets, training programmes, workshops and sophisticated studies were undertaken.

For efficiency and effectiveness of the procedures, a large scale capacity building program of masons and engineers was undertaken, along with provision of 'materials banks' to be sourced by the individual house owners. The basic approach was owner-driven reconstruction. People reconstruct their houses themselves, with the assistance and facilitation of the government. In addition, NGOs have undertaken construction of some houses under the public-private partnership programme. The approach ascertained earthquake resistant measures in all house constructions, achieving 1,80,000 houses within a period of 30 months.

The approach of the Government of Gujarat and the GSDMA to urban reconstruction was systematic and scientific. The School of Architecture at the CEPT, Ahmedabad undertook, a study on the nature of the damage and approach to reconstruction/relocation in respect of some urban areas, particularly the inner city of Bhuj and made a number of suggestions including:

(i) Improving layout of settlements and urban infrastructure.
(ii) Setting up of a local authority at Bhuj to offer technical assistance for appropriate construction and monitoring of reconstruction.
(iii) Finalizing an approach to preparation of a development plan.
(iv) Adoption of a Town Planning Scheme for re-development of the inner city.
(v) Widening of roads to facilitate movement of vehicles at the time of crisis and development of a hierarchy of streets.
(vi) Some reorganization of plots of land in order to widen the roads; acquisition of plots that are cut more than 75 per cent.

It was realized that training of the practising engineers alone would not be adequate for capacity building on a sustainable basis, so all the engineering colleges and polytechnics of Gujarat subsequently incorporated seismic engineering in their curriculum. The GSDMA organized training programmes for teachers of technical institutions. Short-term and medium-term courses were designed for the purpose.
Buildings in the health sector affected by the earthquake were rebuilt, retrofitted, and repaired through the application of earthquake-resistant technology. Health support was provided to the people injured by the earthquake on a long-term basis along with psychological counseling for the people traumatized by the disaster. The Bhuj civil hospital which had collapsed has been reconstructed, with the assistance of the Prime Minister's Relief Fund, at a cost of about Rs 114 crores. The new building for the Bhuj hospital adopted the base isolation technology that was developed in New Zealand. Isolators were provided by M/s Robinson Seismic Ltd., a New Zealand-based company. 6 CHCs, 24 PHCs, 184 sub-centres, nine dispensaries and 183 anganwadis, have been constructed.

The approach to livelihood restoration was three pronged: immediate restoration of livelihood; enhancing the skills of artisans; and empowering the artisans to market their skills. In addition, schemes for small-scale industries and agriculture were introduced. The assistance included free distribution of kits, financial assistance for damaged structures, working capital assistance, loans at subsidized interests, marketing linkages, training and farm input kits.

Measures were taken to rehabilitate orphans, widows, the aged and handicapped who were adversely affected by the earthquake. Such measures included financial assistance, residential facilities, skill upgradation, medical aid, therapy and counselling. A scheme of foster parents was introduced so that orphans could be taken care of by their relatives. Pensions were provided for the aged and for widow.

6.1 TYPES OF CONSTRUCTION

Non-engineered buildings are those which are spontaneously and informally constructed in the traditional manner without any or little intervention by qualified architects and engineers in their design.

Engineered constructions include reinforced concrete buildings and structures used for various purposes normally designed by Architects and Engineers working in various Govt. departments or consulting organization.

Both types were damaged and destroyed due to bad quality of design and construction.

6.2 GUIDELINES PUBLISHED BY GUJARAT STATE DISASTER MANAGEMENT (BY A.S.ARYA)

i. Reconstruction and New Construction of Houses in Kachchh Earthquake Affected Areas of Gujarat, first printing June 2001 and 2nd printing in January 2002.
ii. Control on Quality of Construction in Earthquake Affected Areas of Gujarat, printed in June 2001.
iii. Guidelines for Construction of Compressed Stabilised Earthen Wall Buildings, printed in December 2001.
iv. Guidelines for Cyclone Resistant Construction of Buildings in Gujarat, printed in December 2002.
v. Restoration and Retrofitting of Masonry Buildings in Bhuj Earthquake Affected Areas of Gujarat, printed in March 2002.

6.3 GOVT POLICY-- OWNER-DRIVEN RECONSTRUCTION

Houses were to be constructed by the owners themselves.

Design of 20 model houses were displayed to the public to choose from with an option to have one's own design.

It ensured that the designs of the houses are determined by the owners themselves, as per their needs and preferences.

Also it was ensured that instead of being uniform, the houses reconstructed are of different patterns as found in case of organic evolution of the common villages.

Approach ensured `Technology Transfer' to the community and subsequently the sustainability of program.

Financial, technical & material assistance was provided by the government.

The material assistance was provided through 1082 material banks (cement bags and other materials provided at subsidized rates).

More than 180 public consultations were held for town planning.

6.4 AWARENESS CREATION

It involved various approaches and actions:
Publications.
Public Displays.
Demonstrations.
Audio-Visual and Capacity Building Trainings and Workshops.
Exhibitions.
4 Shake Table Demonstrations and video shows.
Messages displayed on hazard resistant construction on 600 state transport buses in five worst affected districts.
Seven types of hoardings at strategic locations were displayed in the state.
Disaster management was taken as a permanent agenda in 18000 Gram Sabhas conducted during a period from 12th Jan'03 to 24th Jan'03 and in May '03.

6.5 EXTRA COST OF EARTHQUAKE SAFETY

For buildings constructed using the Indian Standard Codes and Masonry Building

Seismic Zone III	2-3%
Seismic Zone IV	3-4%
Most severe seismic Zone V	4-6%

Reinforced concrete buildings of 4 – 8 storeys

Seismic Zone III	2.6-3.2%
Seismic Zone IV	3.2-4%
Seismic Zone V	5-6%

(in each case, including about 0.7% only for ductile detailing)
Retrofitting of buildings, not initially designed for earthquake will cost: 2 to 3 times as much as the above mentioned extra costs.

6.7 ACHIEVEMENTS

180,000 houses were built in 2.5 years (30,000 in Latur and 30,000 in Kobe in 4 years each). A unique achievement of Gujarat reconstruction program has been training of more than 6,000 engineers and about 30,000 masons in the skill development towards earthquake safe building construction.

6.8 DISASTER MANAGEMENT COMPONENTS

Disaster Management Components envisaged from the lessons learnt, for the future establishment of proper Disaster Management System in each state and major cities before the next Hazard occurrence are shown in Figure 4.

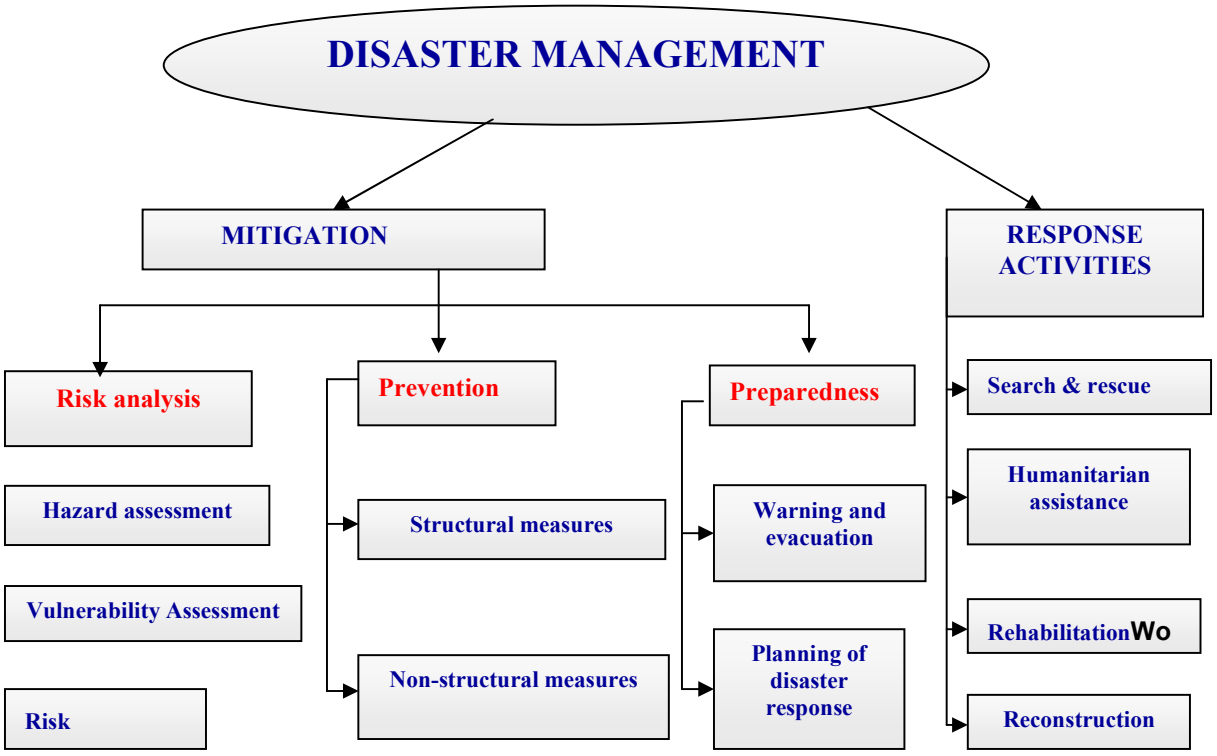

Figure 4. Reconstruction and recovery program followed by state after earthquake.

7. CONCLUSION

To reduce losses we have to save Buildings from future earthquakes. An earthquake risk arises mainly due to unsafe constructions.

- For meaningful earthquake risk mitigation, the country has to embark on two initiatives in a pre-decided time frame:

  (i) First to ensure that all new constructions must have earthquake resisting measures.

  (ii) Second, the critically important existing buildings should be identified, assessed and retrofitted as found necessary, (for example China retrofitted 12million m^2 of floor area in 10 years after Tangshan earthquake).

- To sensitize all stake holders from policy makers, administrators to the common public regarding earthquake prone areas and preparedness and mitigation measures.
- To establish techno-legal and techno-financial regimes in the states.
- To build capacity of architects, engineers and masons by appropriate training in various earthquake prone states

References

Mishra, P. K. (2004), The Kutch Earthquake 2001-Recollections, Lessons and Insights, Report NIDM, ISBN 81-8347-000-9, PP 235.