BUREAU OF INDIAN STANDARDS

STATUS REPORT ON STANDARDIZATION EFFORTS IN THE AREA OF MITIGATION OF NATURAL HAZARDS

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India is one of the most disaster prone countries, vulnerable to almost all natural and man made disasters. About 85% area is vulnerable to one or multiple disasters and about 57% area is in high seismic zone including the capital of the country. Disaster prevention involves engineering intervention in buildings and structures to make them strong enough to withstand the impact of natural hazards or to impose restrictions on land use so that the exposure of the society to the hazard situation is avoided or minimized.

Bureau of Indian Standards has rendered invaluable service by producing large number of national standards, which are of direct relevance to the construction industry and some of them particular to the mitigation of disasters. A brief report of the status of standardization efforts by BIS through various technical committees in the area of mitigation of natural hazards is given underneath.

Earthquake Engineering, CED 39

Himalayan-Nagalushai region, Indo-Gangetic plain, Western India and Cutch and Kathiawar regions are geologically unstable parts of the country and some devastating earthquakes of the world have occurred there. A major part of peninsular India has also been visited by strong earthquakes, but these were relatively few in number and had considerably lesser intensity. It has been a long felt need to rationalize the earthquake resistant design and construction of structures taking into account seismic data from studies of these earthquakes.

It is to serve this purpose that standards have been formulated in the field of Design and Construction of Earthquake Resistant Structures and also in the field of measurement and tests connected therewith by the Earthquake Engineering Sectional Committee, CED 39. Following standards have been formulated under this Committee:

IS 1893:1984 Criteria for Earthquake Resistant Design of Structures

This standard deals with earthquake resistant design of structures and is applicable to buildings; elevated structures; bridges; dams etc. It also gives a map which divides the country into five seismic zones based on the seismic intensity.

IS 1893 was initially published in 1962 as 'Recommendations for Earthquake Resistant Design of Structures' and then revised in 1966. As a result of additional seismic data collected in India and further knowledge and experience gained the standard was revised in 1970, 1975 and then in 1984.

Consequent to the publication of this standard on account of earthquakes in various parts of the country including that in Uttar-Kashi and Latur and technological advancement in the field, the sectional committees decided to revise the standard into five parts which deals with different types of structures:

Part 1 : General provisions and Buildings

Part 2 : Liquid retaining Tanks – Elevated and Ground Supported

Part 3 : Bridges and Retaining Walls

Part 4 : Industrial Structures Including Stack Like Structures

Part 5 : Dams and Embankments

IS 1893(Part 1):2002 'Criteria for Earthquake Resistant Design of Structures: Part 1 General provisions and Buildings'

This standard contains provisions that are general in nature and applicable to all structures. Also, it contains provisions that are specific to buildings only. It covers general principles and design criteria, combinations, design spectrum, main attributes of buildings, dynamic analysis, apart from seismic zoning map and seismic coefficients of important towns, map showing epicenters, map showing tectonic features and lithological map of India.

Following are the major and important modifications made in this revision:

a) The seismic zone map is revised with only four zones, instead of five. Erstwhile Zone I has been merged to Zone II and hence Zone I does not appear in the new zoning; only Zones II, III, IV and V do. The Killari area has been included in Zone III and necessary modifications made, keeping in view the probabilistic Hazard Evaluation. The Bellary isolated zone has been removed. The parts of eastern coast area have shown similar hazard to that of the Killari area, the level of Zone II has been enhanced to Zone III and connected with Zone III of Godawari Graben area.

b) This revision adopts the procedure of first calculating the actual force that may be experienced by the structure during the probable maximum earthquake, if it were to remain elastic. Then the concept of response reduction due to ductile deformation or frictional energy dissipation in the cracks is brought into the code explicity, by introducing the 'response reduction factor' in place of the earlier performance factor.

c) The values of seismic zone factors have been changed; these now reflect more realistic values of effective peak ground acceleration considering Maximum Considered

Earthquake (MCE) and service life of structure in each seismic zone.

d) A clause has been introduced to restrict the use of foundations vulnerable to differential settlements in severe seismic zones.

Here it is worthwhile to mention that it is not intended in this standard to lay down regulation so that no structure shall suffer any damage during earthquake of all magnitudes. It has been endeavoured to ensure that as far as, possible structures are able to respond, without structural damage to shocks of moderate intensities and without total collapse to shocks of heavy intensities.

Formulation of revised codes for other parts of IS 1893 are in advance stages.

IS 4326:1993 Earthquake Resistant Design and Construction of Buildings-Code of Practice

This standard provides guidance in selection of materials, special features of design and construction for earthquake resistant buildings including masonry construction, timber construction, prefabricated construction etc. In this standard, it is intended to cover the specified features of design and construction for earthquake resistance of buildings of conventional types. The general principles to be observed in the construction of such earthquake resistant buildings as specified in this standard are Lightness, Continuity of Construction, avoiding/reinforcing Projecting and suspended parts, Building configuration, strength in various directions, stable foundations, Ductility of structure, Connection to non-structural parts and fire safety of structures.

Special Construction Features like Separation of Adjoining Structures, Crumple Section, Foundation design, Roofs and Floors and Staircases have been elaborated in the standard. It also covers the details pertaining to the type of construction, masonry construction with rectangular masonry units, masonry bearing walls, openings in bearing walls, seismic strengthening arrangements, framing of thin load bearing walls, reinforcing details for hollow block masonry, flooring/roofing with precast components and timber construction.

IS 13827:1993 Improving Earthquake Resistance of Earthen Buildings – Guidelines

The guidelines covered in this standard deal with the design and construction aspects for improving earthquake resistance of earthen houses, without the use of stabilizers such as lime, cement, asphalt, etc.

The provisions of this standard are applicable for seismic zones III, IV and V. No special provisions

are considered necessary in Zone II. However, considering inherent weakness of earthen buildings against water and earthquake, such buildings should preferably be avoided in flood prone, high rainfall areas and seismic zones IV and V.

It has been recommended that such buildings should be light, single storeyed and of simple rectangular plan. Qualitative tests for the suitability of soil have been suggested.

Guidelines for Block or Adobe Construction, Rammed earth construction, Seismic strengthening of bearing wall buildings, Internal bracing in earthen houses and earthen constructions with wood or cane structures have heen elaborated in this standard.

IS 13828:1993 Improving Earthquake Resistance of Low Strength Masonry Buildings – Guidelines

This standard covers the special features of design and construction for improving earthquake resistance of buildings of low-strength masonry.

The provisions of this standard are applicable in all seismic zones. No special provisions are considered necessary for buildings in seismic zone II if cement-sand mortar not leaner than 1:6 is used in masonry and through stones or bonding elements are used in stone walls.

The various provisions of IS 4326:1993 regarding general principles, special construction features, types of construction, categories of buildings and masonry construction with rectangular masonry buildings of low strength dealt with in this standard. There are however certain restrictions, exceptions and additional details which are specifically included herein.

IS 13920:1993 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – Code of Practice

This standard covers the requirements for designing and detailing of monolithic reinforced concrete buildings so as to give them adequate toughness and ductility to resist severe earthquake shocks without collapse.

The provisions for reinforced concrete construction given in this standard apply specifically to monolithic reinforced concrete construction. Precast and/or prestressed concrete members may be used only if they can provide the same level of ductility as that of a monolithic reinforced concrete construction during or after an earthquake.

Provisions on minimum and maximum reinforcement have been elaborated which includes the requirements for beams at longitudinal reinforcement in beams at joint face, splices and anchorage requirements. Provisions have been included for calculation of design shear force and for detailing of transverse reinforcement in beams.

Material specifications are indicated for lateral force resisting elements of frames. The provisions are also given for detailing of reinforcement in the wall web, boundary elements, coupling beams, around openings, at construction joints, and for the development, splicing and anchorage of reinforcement.

IS 13935:1993 Repair and Seismic Strengthening of Buildings – Guidelines

This standard covers the selection of materials and techniques to be used for repair and seismic strengthening of damaged buildings during earthquakes and retrofitting for upgrading of seismic resistance of existing buildings.

The provisions of this standard are applicable for buildings in seismic zones III to V of IS 1893:1984, which are based on damaging seismic intensities VII and more on MSK Scales.

The buildings affected by earthquake may suffer both non-structural and structural damages. This standard lays down guidelines for non-structural/architectural as well as structural repairs, seismic strengthening and seismic retrofitting of existing buildings. Guidelines have been given for selection of materials for repair work such as cement, steel, epoxy resins, epoxy mortar, quick setting cement mortar and special techniques such as shotcrete, mechanical anchorage etc. Seismic Strengthening techniques for the modification of roofs or floors, inserting new walls, strengthening existing walls, masonry arches, random rubble masonry walls, strengthening long walls, strengthening reinforced concrete members and strengthening of foundations have been elaborated in detail.

IS 6922:1973 Criteria for Safety and Design of Structures Subject to Underground Blasts

This standard deals with the safety of structures during underground blasting and is applicable to normal structures like buildings, elevated structures, bridges, retaining walls, concrete and masonry dams constructed in materials like brickwork, stone masonry and concrete.

As underground blasting operations have become almost a must for excavation purposes, this standard lays down criteria for safety of such structures from cracking and also specifies the effective accelerations for their design in certain cases.

IS 4991:1968 Criteria for Blast Resistant Design of Structures for Explosions Above Ground

This standard covers the criteria for design of structures for blast effects of explosions above ground excluding blast effects of nuclear explosions.

IS 4967:1968 Recommendations for Seismic Instrumentation for River Valley Projects

This standard covers recommendations for instrumentation for investigation of seismicity, study of microtremors and predominant period of a dam site and permanent installation of instruments in the dam and appurtenant structures and in surrounding areas.

These standards endeavour to provide a guideline in designing and repairing of buildings under seismic forces.

CYCLONE RESISTANT STRUCTURES, CED 57

Large parts of India, particularly the coastal regions are prone to cyclones and large scale devastation has occurred causing loss of life and property. The coastal regions of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal on east coast and Gujarat on west coast are cyclone prone.

At the instance of Ministry of Urban Development and Ministry of Science and Technology, Bureau of Indian Standards set up a Sectional Committee on Cyclone Resistant Structure, CED 57 with the following scope :

> 'Formulation of Indian Standards Guidelines and Recommendations for planning, design and construction of Cyclone Resistant Structures and Buildings : Cyclone Protection and post Cyclone Rehabilitation Measures'.

BIS has recently published two standards pertaining to Guidelines for Cyclone Resistance :

1) IS 15498:2004 'Guidelines for improving the cyclonic resistance of low rise houses and other buildings/structures'

   Damage of houses due to cyclones is most responsible for loss of life and thus the need to have greater emphasis on the safety of houses. Due to this, need has been felt to evolve national standard for design and construction of cyclone resistant structures so as to ensure desirable level of safety. The provisions given in this standard are intended to reduce the damage to buildings and structures in the event of a cyclone.

This standard covers the guidelines regarding planning, design and construction aspects for improving the cyclonic resistance of low rise houses and other buildings/structures.

2) IS 15499:2004 'Guidelines for survey of housing and building typology in cyclone prone areas for assessment of vulnerability of regions and post cyclone damage estimation'

Considering that the existing housing stock needs retrofitting to enhance its cyclonic resistance, this standard lays down the guidelines and proformae for survey of existing houses their typology and carrying out post cyclone damage evaluation in buildings. The information collected will help in compilation of database, which will be very useful for assessment of vulnerability of regions against cyclonic occurrences.

FLOODS

The work of formulation of Indian Standards in the field of planning, irrigation, management and evaluation of river valley projects is carried out by Water Resources Plannings, Management and Evaluation Sectional Committee, WRD 6.

Occurrence of flood damages is a natural phenomenon and man has to cope with floods situations from the very beginning. Floods have ravaged portions of India from time immemorial even before the population of India grew and economic activities developed. Earlier, the flood water spread over the flood plains, flowed back to the stream/river and emptied into the sea in course of time without causing much of problems. However, as human settlements started growing close to the river banks and with increased population pressure and greater economic development, more and more of the flood plains got occupied leading to adverse flood effect being felt in an acute manner by people. Flood hazard is thus a dynamic quantity as it changes in response both to the magnitude of the flood event and to the nature and scale of the development on the flood plain. Seeing the importance of the subject, one effort in this direction was publication of IS 13739:1993 'Guidelines for estimation of flood damages'. The standard lays down a detailed scientific procedure for collection of flood damages (other than loss of human life) data under various categories and also methods of translating them to monetary terms. It also recommends methods by which indirect flood.

LANDSLIDES

The problems involved in the development of seismic prone hill areas are entirely different from those in plains, as was evident from the recent catastrophe in Uttar Kashi. Depending upon the terrain, availability of local materials and the risks involved, the practices followed are way apart. Due to this, a need was felt to give due consideration to Civil Engineering activities in the hilly region which may

be technically and economically viable. Bureau of Indian Standards thus, constituted a new Hill Area Development Sectional Committee, CED 56 which deals with the standardization in the field of Developmental Activities of Hilly Area such as Landslide Analysis, Site Evaluation for Human Settlement and Safe Design Selection of Building Materials & Mode of Construction Suitable for Hilly Area.

Landslides are being increasingly viewed as natural hazards. The concern regarding landslide problem can be understood in the light of the fact that a majority of the landslides are triggered by natural causes including substantial rainfalls, cloud bursts, earthquakes etc and as such are difficult to predict. Landslides problem has increased in magnitude immensely due to man made activities as well. The need for study and understanding of the landslide phenomenon, landslide correction techniques, their evaluation and the need to adopt more effective correction measures has been felt and BIS has taken up standardization in this area and following standards have been formulated :

1) IS 14496 (Part 2):1998 Guidelines for preparation of landslide – Hazard zonation maps in mountainous terrain : Part 2 Macro Zonation

   Other parts for Micro Regional and Mega Regional Hazard zonation Maps are under preparation. These Maps will be useful in planning the development scheme, selection of geo-environmentally soundsites which may pose minimum hazards of stability.

2) IS 14458 Guidelines for Retaining Wall for Hill Areas

   Part 1 Selection of Type of Walls

   Part 2 Design of retaining/breast walls

   Part 3 Construction of Dry stone walls

3) IS 14680:1999 Guidelines for Landslide Control

4) IS 14804:2000 Guidelines for Siting, Design and Selection of Materials for residential buildings in Hilly Areas

FIRE PROTECTION

Fire Fighting Sectional Committee, CED 22 of BIS is engaged in formulation of Indian Standards on Fire Fighting equipments/extinguishers using water, carbondioxide, foam, dry powder and halon as extinguishing agents. In view of the phasing out of halons as per Montreal Protocol, BIS has recently published various standards on halon alternatives. These are intended for use by the Fire brigades and other organizations. BIS has formulated more than 100 standards on fire fighting including standards on various type of fire tenders, fire engines, trailer pumps, high capacity portable pumpsets etc.

Modern forest fire techniques in the suppression of fires are being introduced in the country. Some of the important equipments which are required are relating to hand tools, water handling equipment etc. On the request of Ministry of Environment and Forest, Indian Standards covering specification for some of the important tools have been formulated so that on the basis of the same, these could be indigenously manufactured in the country and also users could procure these tools of proper specification.

Safety of the occupants of the buildings is the fundamental requirement that the owner and the professionals involved endeavor to achieve. Fire Safety Sectional Committee, CED 36 of BIS has formulated a series of Indian Standards pertaining to General requirements and specific to various buildings & industries. Some of the important standards formulated by this Committee are as follows

IS 1641:1988	Code of practice for fire safety of buildings (general) : General principles office grading and classification (*first revision*)
IS 1642:1989	Code of practice for fire safety of buildings (general) : Details of construction (*first revision*)
IS 1643:1988	Code of practice for fire safety of buildings (general) : Exposure hazard (*first revision*)
IS 1644:1988	Code of practice for fire safety of buildings (general) : Exit requirements and personal hazard (*first revision*)
IS 1646:1997	Code of practice for fire safety of buildings (general) : Electrical installations (*second revision*)
IS 3034:1993	Code of practice for fire safety of industrial buildings : Electrical generating and distributing stations (*second revision*)
IS 3079:1990	Code of practice for fire safety of industrial buildings : Cotton textile mills (*first revision*)
IS 8758:1993	Recommendations for fire precautionary measures in the construction of temporary structures and pandals (*first revision*)
IS 11457(Part 1):1985	Code of practice for fire safety of chemical industries : Part 1 Rubber and plastic
IS 11460:1985	Code of practice for fire safety of libraries and archives buildings
IS 12456:1988	Code of practice for fire protection of electronic data processing installation
IS 13694:1993	Code of practice for fire safety in iron and steel industries
IS 13716:1993	Code of practice for fire safety of hotels
IS 14435:1997	Code of practice for fire safety in educational institutions

National Building Code (Part 4) – Fire Protection

As a major development, BIS has published NBC (Part 4) Fire Protection which includes comprehensive recommendation of minimum standards of fire protection. It specifies the demarcation of fire zones, restrictions on construction of buildings in each fire zone, classification of buildings based on occupancy, types of building construction according to fire resistance of the structural and non-structural components and other restrictions and requirements necessary to minimize danger to life from fire, smoke, fumes or panic before the building can be evacuated. The Code recognizes that safety of life is more than a matter of means of exits and accordingly deals with various matters which are considered essential to the safety of life.

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