Role of Building Codes in Seismic Assessment

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***Abstract*- In previous times the buildings and structures were not planned for the seismic loads. But when high intensity of earthquake comes in India it resulted in destruction and desolation in structures .Therefore to provide safety to buildings Indian standards introduced the building codes to reduce the earthquake impact on the structures. In this paper the role of various building codes has been discussed briefly. For the designing and calculation of earthquake loads IS 1893:2002, (part 1) is used and role of various buildings codes and their provision and guidance is mainly discussed.**

Key words - seismic loads, high intensity of earthquake, safety, building codes

I. INTRODUCTION

In the past 3 centuries over 3 million people have died due to earthquakes and earthquake related disasters. Therefore Indian standard code of practice was published in 1957 for the guidance of civil engineers in designing of buildings. It included the provisions for the basic design loads (dead loads, live loads wind loads seismic loads) in the design of buildings. The main intention of building codes are to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. Building codes offers enhanced protection against the threats of natural disasters to make our buildings more resilient, sustainable and livable for generations to come, which lower the price of mitigation for building owners. IS 1893 was primarily in print in 1962 as `Recommendations for Earthquake Resistant Design of Structures' which provides seismic zone map and specifies seismic design force. This force depends on mass and seismic coefficient of structures. For example, a Building in Bhuj will have 2.25 times the seismic design force of an indistinguishable building in Bombay. In the same way, the seismic coefficient for a single storey Building may have 2.5 times that of a 15-storeyBuilding.

IS1893:2002,(part 1) contain provisions that are universal in nature and those related for buildings [1]. The other four parts of IS 1893 will cover:
IS 1893:2002,(part 2) Liquid-Retaining Tanks, both elevated and ground supported [2];
IS 1893:2002,(part 3) Bridges and Retaining Walls
IS 1893:2002 [3]; (part 4) Industrial Structures [4]
IS 1893:2002,(part 5) Dams and Embankments [5]. These four documents are in preparation. In dissimilarity, the 1984 edition of IS1893 had provisions for all the above structures in a single document. This standard was revised in 1970, 1975 and then in 1984. IS 4326:1993 Earthquake Resistant Design And Construction of Buildings - Code of Practice This standard provides direction in range of materials, special features of design and construction for earthquake resistant buildings together with masonry construction, timber construction, prefabricated construction etc. IS 13827:1993 Improving IS 13828:1993 civilizing Earthquake Resistance of Low Strength Masonry Buildings Earthquake Resistance of Earthen building IS 13920:1993 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic forces.

The main intention of this paper is to revise the building codes for seismic assessment and provide essential improvement in the IS codes for the design of buildings to resist earthquake and seismic loads.

II. METHODOLGY

The principle of building codes is to shelter public health, safety and broad welfare as they relate to the construction and residence of buildings and structures. Building codes offers enhanced protection neighboring to the fear of natural disasters to make our buildings more rough sustainable and inhabitable for generations to come.

IS 1893:1984 Criteria for Earthquake Resistant Design of Structures –This standard deals with earthquake resistant design of structures and is appropriate 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. The revised 2002 edition provisions of the technical committee decided to revise the standard into five parts which deal 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

III. DESIGNING FOR LATERAL LOAD

Calculation of horizontal seismic co-efficient.(Clause 6.4.2, page-14)

$A_{h=ZISa/2Rg}$

A_h= Horizontal seismic coefficient
Z= Zone factor
R=Response factor
I= Importance factor
(Sa/g)=Average response acceleration coefficient

TABLE I. ZONE FACTOR, Z
(Clause 6.4.2)

Seismic Zone	**II**	**III**	**IV**	**V**
Seismic Intensity	Low	Moderate	severe	Very severe
Z	0.10	0.16	0.24	0.36

Importance factor
It is a factor use to obtain the design seismic force depending on the functional apply of the structure, characterized by destructive consequences of its breakdown, its post-earthquake functional need, historic value, or economic significance

TABLE II. IMPORTANCE FACTOR

S.NO	**STRUCTURE**	**IMPORTANCE FACTOR**
1.	Important service and community buildings, such as hospitals; schools; monumental structures; emergency buildings like telephone exchange television stations, radio stations, railway stations, fire station buildings; large community halls like cinemas, assembly halls and subway stations, power stations	1.5
2.	All other buildings	1

Reduction response factor (Table-7)
IS1893:2002 (part-1), table -7, page-23

Fundamental natural (clause 7.6, page-24)
The approximate fundamental natural period of vibration in seconds, of a moment-resisting frame building without brick in. fd panels may be estimated by the empirical expression:

T = 0.075 h075 for RC frame building
T= 0.085 h075 for steel frame building
where
h = Height of building, in m. This excludes the basement storey's, where basement walls are connected with the ground floor deck or fitted between the building columns.
But it comprise the basement storeys, when they are not so linked.

Spectral Acceleration co-efficient (clause 6.4.5, page-16
Sa/g,
It depends upon the soil condition and fundamental natural period.

Refer IS1893:2002 part-1(clause 6.4.5, page-16)

Calculation of Seismic weight:-
It is the total dead load plus proper amounts of specified imposed load.

SEISMIC WEIGHT= DEAD LOAD+ LIVE LOAD

DEAD LOAD

DEAD LOAD on floor =$W_1+W_2+W_3+W_4+W_5+W_6$

DEAD LOAD on Roof =$W_1+(W_2/2)+\{(W_3+W_4)/2\}+W_5+W_6+W_7+W_8$

W_1=Weight of Slab

W_2= Weight of Column

W_3= Weight of Wall in X direction

W_4= Weight of Wall in Y direction

W_5= Weight of Beam in X direction

W_6= Weight of Beam in Y direction

W_7= Weight of Parapet wall in X direction

W_8= Weight of Parapet wall in Y direction

IMPOSED LOAD

TABLE III. IMPOSED LOAD

Imposed Uniformity Distributed Floor Loads (kN/ m^2)	Percentage of Imposed Load
Upto and including 3.0	25
Above 3.0	50

Base shear
Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. Calculations of base shear depend on the soil conditions at the site, immediacy to potential sources of seismic activity (such as geological faults), the probability of noteworthy seismic ground motion, the level of ductility and over strength associated with various structural configurations and the total weight of the structure and the fundamental (natural) period of vibration of the structure when subjected to dynamic loading.

$V_B = A_h W$
where
Ah =Design horizontal acceleration spectrum value as per 6.4.2, using the fundamental natural period T,as per 7.6 in the considered direction of vibration, and

W=Seismic weight of the building as per 7.4.2
Earthquake load (Clause 7.7,page 24)

$$Q_I = V_B \frac{Wh^2}{\sum_{j=1}^{n} Wh^2}$$

Qi= lateral force
W= Seismic Weight of floor
h= Height of floor from Base
V_B= Base shear

IS 4326:1993 Earthquake Resistant Design and Construction of Buildings [6] - Code of Practice This standard provide regulation in selection of materials, special features of design and structure for earth quake opposed to buildings including masonry construction, timber construction, prefabricated construction etc. In this standard, it is projected to cover the specified features of design and construction for earthquake resistance of buildings of conventional types. The general principles to be practical in the construction of such earth quake resistant buildings as exacting in this standard are Lightness, Continuity of Construction, avoiding/reinforcing Projecting and suspended parts, Building configuration, strength in a variety of directions, stable foundations, Ductility of structure, link to non-structural parts and fire safety of structures. It also cover up 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 particulars for vacant block masonry, flooring/roofing with precast components and timber construction.

IS 13827:1993 Improving Earthquake Resistances of Earthen Buildings – As per the rule given in this code deal with the Design and construction methods for improving Earthquake resistance of earthen houses, without the Use of stabilizers such as lime, cement, asphalt, etc. As per the provisions of this code which area appropriate for Seismic zones III, IV and V. No special provisions are considered necessary in Zone II. It is suggested the buildings should be light, single storied and of easy rectangular plan. Qualitative tests for the correctness of soil have been completed and adopted.

IS 13828:1993 Improving Earthquake Resistances of Low Strength Masonry Buildings – Guidelines This standard code cover the some scrupulous features of designing and construction of low-strength masonry for improving earthquake resistance of buildings. The provisions of this standard code are relevant for all Seismic zones. No particular requirements are measured essential for buildings in seismic zone II if cement-sand mortar is not leaner then 1:6 is used in masonry and by stones and bonding elements can be used in stone walls.

IS 13920:1993 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – This standard code cover the fundamental requirements for designing and Detailing of reinforced concrete buildings so as to give them sufficient toughness and ductility to oppose severe earthquake shocks and vibrations without genuine collapse. The provisions in the code for RCC are given in this ordinary code which applies particularly to reinforced concrete construction. Precast and/or pre stressed concrete members may be use only if it can present the same state of ductility during or after an earth quake. The provisions are also specified for detailing of reinforcement in the wall web, boundary elements, coupling beams, around openings, at construction joints, and for the development, splicing .

IS 6922:1973 Criteria for Safety and Design of Structures Subject to Underground Blasts - This standard code agreement with the security of structures During the underground blasting and vibration and is applicable to normal structures like buildings, elevated Structures, bridges, retaining walls, concrete And masonry dams constructed in materials of Brickwork, stone masonry and concrete. As underground blasting operations have be converted into a must for excavation Purposes, this standard lay down criteria for Safety of such structures from cracking and also specifies the effectual accelerations for their Design in certain cases.

IS 13935:2009 Repair and Seismic Strengthening of Buildings – This standard code agreement with the range of materials and methods to be used for repair and seismic strengthening of damaged buildings during earthquakes and retro fitting for improvement of seismic resistance of existing buildings. The provisions of this standard are applicable for buildings in seismic zones III to V of IS1893:1984, which are based on destructive seismic intensities VII and more. The structures affected by earthquake may suffer non structure land structural damages. This standard lay down guidelines for non-structural/architectural in addition to structural repairs, Seismic Strengthening. Methods for the modification of roofs or floors, inserting new walls, strengthening existing walls, masonry arches, and random rubble masonry walls, strengthening long walls, strengthening reinforced concrete members and strengthening of foundations have been elaborated in briefly.

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Fig I. Seismic Zone Map of India showing four seismic zones - over 60% of India’s land under seismic zones III, IV and V

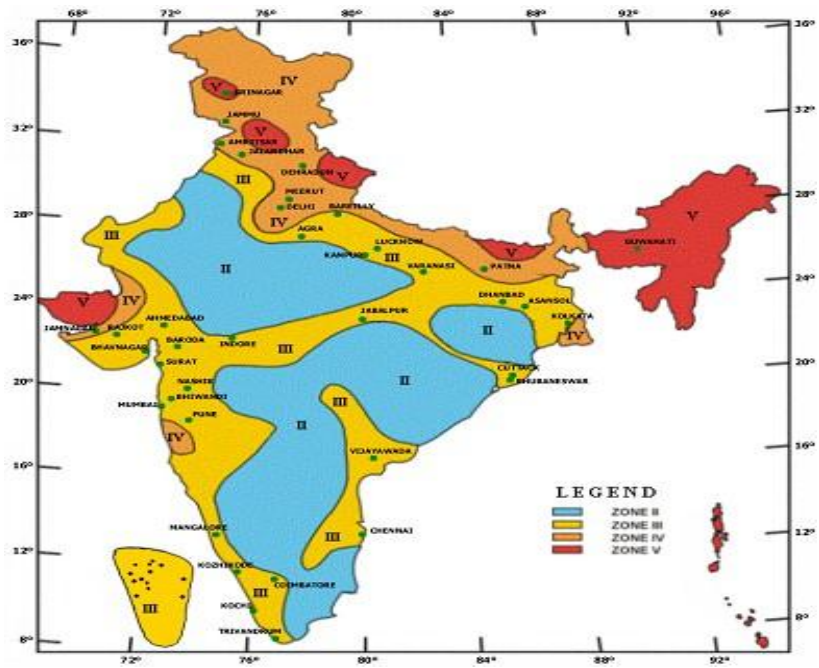

Figure 1 Earthquake Zones of India

III. CONCLUSION

The IS 1893(Part 1): 2002deal with measurement of seismic loads on different structures and earth quake defiant design of buildings. Its fundamental provisions are appropriate to buildings; elevated structures; industrial and stack like structures; bridges; concrete masonry and earth dams; embankments and retaining walls and other structures. Earthquake construction resources implementation of seismic design to permit building and non-building structures to live through the anticipated earthquake exposure up to the Expectations and in discharge with the appropriate Buildings codes .In universal earthquake construction is a process that consists of the building, retrofitting or accumulate of infrastructure particular the construction materials are obtainable.

REFERENCE

[1] IS 1893:2002, (part 1) contains provisions that are general in nature and those applicable for buildings.
[2] IS 1893:2002, (part 2) Liquid-Retaining Tanks, both elevated and ground supported
[3] IS 1893:2002, (part 3) Bridges and Retaining Walls
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