A COMPARATIVE STUDIES ON SEISMIC ANALYSIS OF MULTI-STORY BUILDING USING IS 1893:2002 AND IS 1893:2016

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Sumitted By

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CERTIFICATE

Certified that **HARI SHANKAR** has carried out the research work presented in this project entitled **"**A COMPARATIVE STUDIES ON SEISMIC ANALYSIS OF MULTI-STORY BUILDING USING IS 1893:2002 AND IS 1893:2016**"** for the award of Master of Technology in Structural Engineering from Babu Banarsi Das University, Lucknow under my supervision. This project embodies result of original work and studies carried out by student and the contents of the project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Signature

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DECLARATION

I hereby declare that the project work entitled **“**A COMPARATIVE STUDIES ON SEISMIC ANALYSIS OF MULTI-STORY BUILDING USING IS 1893:2002 AND IS 1893:2016**”** is a record of an original work done by me under the guidance of Department of civil Engineering, **BABU BANARSI DAS UNIVERSITY, and LUCKNOW**. This project work is done in the fulfillment of the requirements for the master’s degree. This is a bona fide work carried out by me and the results provided in this project report have not been copied from any source. The results provided in this have not been submitted to any other University or Institute for the award of any degree or diploma.

Date: 12/09/2019

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ABSTRACT

The purpose of this research work is to compare the behaviour of Multi-storey building using different support conditions for example ogs building, single sturt support, double strut or x support, v support and inverted v support in ground storey for various parameters such as storey drift, stiffness, base shear, max storey displacement, etc. In this paper analysis Multi-storey building is done under seismic loading and the result outcomes are compared using different parameters. Subsequently goal of this investigation is to check which bolster will give better quality and security of the structure during quake and to consider the impact of infill quality and solidness in seismic examination of OGS structures. This structure is examined for time history investigation technique (a) considering infill quality and firmness (open ground story), (b) Not considering infill quality and solidness (Bare casing). The aim of this research paper is to observe the response of multi-storey building under the parameters as per new version of seismic code (IS 1893:2002). This will help us to understand the behaviour of structure as per latest design criteria..

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CHAPTER 1

1.1 INTRODUCTION

Seismic investigation of structure assumes a significant job in the heap examination of any structure, as by and large structures are intended for vertical stacking that is expected to is self weight, live burden, sway load, and so forth. Be that as it may, during seismic tremor dynamic loads particularly unique parallel or flat stacking impacts the structure, which is a significant issue of worry from the purpose of security of structure. The seismic examination have turned out to be increasingly significant in the particularly since ongoing decades particularly after the event of Bhuj Earthquake that happens in 2001 after which numerous flaws and plan lacks were contemplated in the structures that fizzled during the quake. Unfortunately it made a major misfortune to both life and economy. After Bhuj quake old Seismic code was overhauled to IS 1893:2002 which remembers significant adjustments for the Seismic codes for progressively proficient plan of tremor safe structures. It additionally centers around the retrofitting strategies and its necessity for structures. Henceforth we can understand the significance of seismic code and its modification for seismic examination of structures. Another amendment to IS 1893:2002 was done in the year 2016 and the old code was reexamined to IS 1893:2016. This examination work will concentrate on the looking at the conduct of Multi-story building utilizing IS 1893:2002 and IS 1893:2016 for different parameters, for example, story float, solidness, base shear, max story relocation, and so on. This will be finished utilizing ETABS 16.2 and ETABS 17.1 adaptation programming . Along these lines, this paper manages similar investigation of IS 1893-2002 and IS 1893-2016. Two diverse G+14 celebrated private structure models were considered for examination utilizing ETABS programming. This will be finished utilizing ETABS 16.2 and ETABS 17.1 variant programming. ETABS 16.2 depends on IS 1893:2002 and ETABS 17.1 depends on IS 1893:2016. The stature of every story is taken as 3.5 m and base tallness likewise 3.5 m making the absolute tallness of the structure 52.5 meter. Dynamic investigation of the structure is done and results created by programming are analyzed according to IS 1893:2002 and IS 1893-2016.

In upgrading world, superstructure have gotten the inward and today is inescapable to envision's reality without it. Structures produced using concrete is one of the fundamental type of super structure which can be seen all over. Procedure of development of a structure involves diverse office, for example, engineers, structure architect, temporary workers and so forth with all the assistance of these division, building is being created to such an extent that it can withstand relevant vertical loads and ground movement which is the consequence of quakes. Originator must be cautious while considering these powers as meager erroneous conclusions will prompt disappointment of the structure since ground movements, being the perplexing idea, should be examined in a very pore way. Along these lines, the opposition of a structure and its plan according to the rules of seismic codes has become a significant research zone. Once in a while, expansion of individuals other than shafts and segments are required to oppose these delivered parallel powers.

IS: 1893-2016, being the most recent Seismic Indian Code, gives alterations in regards to the plan of the quake safe structure. Various alterations and new rules were presented in this code yet the significant one was identified with the dynamic seismic investigation. It expressed that dynamic seismic investigation will be acknowledged for every one of the structures other than normal structures lower than 15 m in stature in seismic zone II]loads and ground motion which is the result of earthquakes.

1.2 Equivalent Static Seismic Analysis

All plan against seismic burdens must think about the dynamic idea of the heap. In any case, for straightforward normal structures, examination by comparable direct static strategies is frequently adequate. This is allowed in many codes of training for normal, low-to medium-ascent structures. It starts with an estimation of base shear burden and its dispersion on every story determined by utilizing equations given in the code. Proportional static investigation can thusly function admirably for low to medium-ascent structures without noteworthy coupled horizontal torsional modes, in which just the principal mode toward every path is considered. Tall structures (over, state, 75 m), where second and higher modes can be significant, or structures with torsional impacts, are substantially less reasonable for the strategy, and require increasingly complex techniques to be utilized in these conditions

1.3 Dynamic Seismic Analysis

Dynamic analysis may be performed either by response spectrum method or by time history method.

1.3.1 Time History Method

It is an investigation of the dynamic reaction of the structure at every addition of time, when its base is exposed to a particular ground movement time history. On the other hand, recorded ground movements database from past common occasions can be a solid hotspot for time accounts yet they are not recorded in some random site to incorporate every single seismological trademark reasonable for that site. Recorded ground movements are arbitrarily chosen from practically equivalent to greatness, separation and soil condition classification (container); three fundamental parameters in time history age .Adding more limitations to attributes of each canister causes it to be progressively clear and like site qualities notwithstanding, it might put genuine accessibility limit for genuine records in the receptacle. Chosen ground movement reaction range around essential time of the structure can be not the same as target reaction ghastly increasing speeds consented to target range. Never the less very little close understanding between the reaction range of the record and target will be accomplished with basically a solitary factor scaling of the record.

1.3.2 Response Spectrum Method

the portrayal of most extreme reaction of admired single level of opportunity framework having certain period damping during tremor ground movement the greatest reaction plotted against of un-damped normal period and for different damping esteem and can be communicated in the term of most extreme outright speeding up greatest relative speed or most extreme relative uprooting for this reason reaction range instance of examination have been performed by IS 1893

1.4 Definitions

1.4.1 Story: when the multi-story building or the private structure is developed in that when the floor to floor hole will be there that is the story

1.4.2 Soft story: A delicate story is one in which the sidelong solidness is under 70 percent of that in the story above or under 80 percent of normal horizontal firmness of the three story above. The firmness is less when contrasted with the above story due to no in fills at that story level

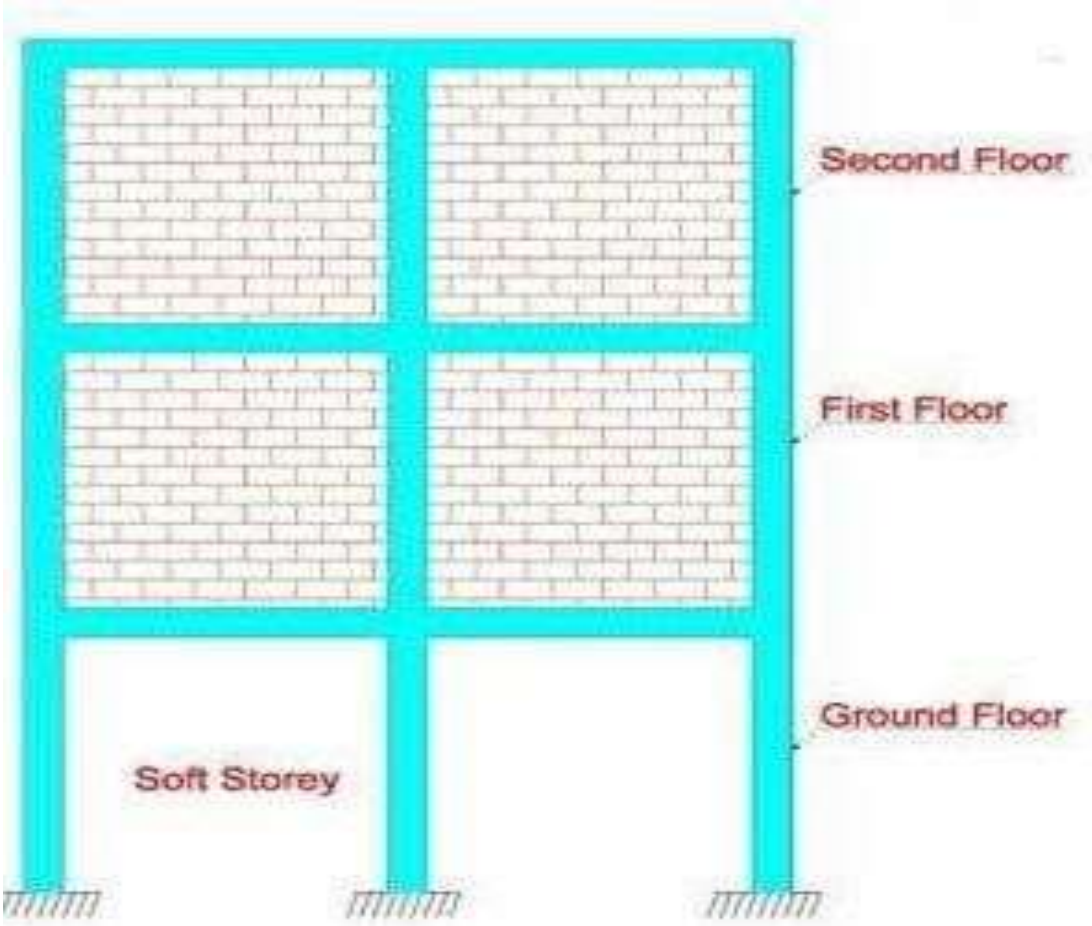


Fig.1.2 Soft Story

1.4.3 Story Drift: it is characterized as the distinction in sidelong diversion between two contiguous stories. During a seismic tremor, huge sidelong powers can be forced on structures; Lateral avoidance and float have three essential consequences for a structure; the development can influence the auxiliary components, (for example, shafts and sections); the developments can influence non-basic components, (for example, the windows and cladding); and the developments can influence neighboring structures. Without appropriate thought during the plan procedure, enormous avoidances and floats can effectsly affect auxiliary components, nonstructural components, and adjoining structure

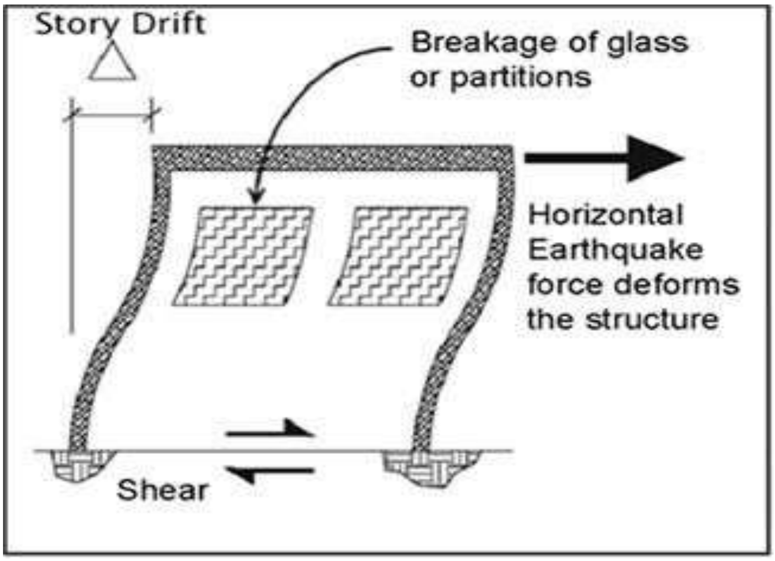


Fig: 1.3 Story Drift

1.5 Base shear: Is a gauge of the greatest expected sidelong power that will happen because of seismic ground movement at the base of a structure

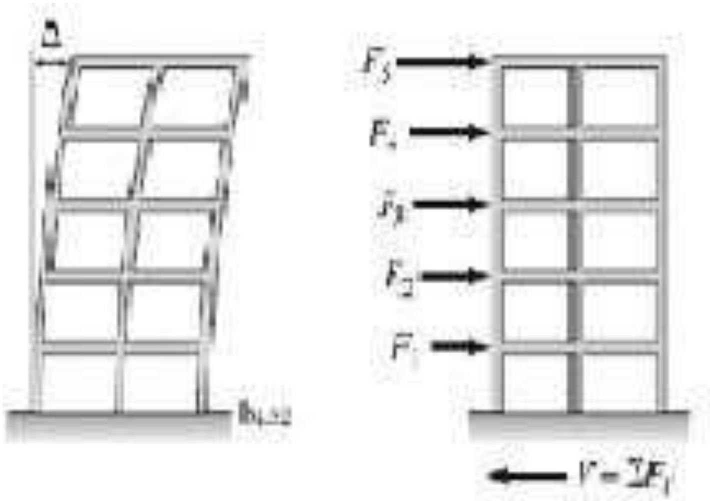


Fig: 1.4 Base Shear

1.6 Structural Analysis By E-TABS

In this examination, conduct of working during quake were considered by the assistance of ETABS programming. ETABS represents Extended Three-dimensional Analysis of Building System. ETABS is an examination and structure programming for breaking down and planning a structure. ETABS is the present day significant plan programming in the market. Numerous originator use this product organizations for their task configuration reason. Along these lines, this exploration paper mostly manages the relative investigation of the outcomes acquired from the examination of a multi story building structure when examinations near examination utilizing ETABS programming independently. For this situation, a 25m x 25m,(G +14) story structure is displayed utilizing ETABS programming. The stature of every story is taken as 3.5 meter making the absolute tallness of the structure 52.5 meter. Examination of the structure is done and afterward the outcomes produced by this product are analyzed utilizing IS 1893:2002 and IS1893:2016

ETABS is building programming for examination and plan of multistory structure. ETABS is being used for a long time and is prepared by Computers and Structures, Inc. (CSI). CSI was established in 1975, is perceived comprehensively as the exploration chief in programming devices for auxiliary and quake designing. Programming from CSI is utilized by a huge number of building organization in more than 160 nations for the plan of chief ventures. CSI likewise gives diverse various items to investigating and planning of various structures as SAP2000, CSiBridge, ETABS, SAFE, PERFORM-3D and CSiCOL

Fig: 1.5 ETABS Software 16.1

Fig: 1.6 ETABS Software 17.1

ETABS is 3D object based displaying and perception programming, blazingly quick straight and nonlinear scientific force, complex and exhaustive plan abilities for a wide-scope of materials, and gives reports, and schematic drawings that permit snappy and simple sightedness of examination and configuration results

ETABS comprised each part of the building configuration process. Making of models in ETABS is simpler - instinctive drawing directions take into account the exceptional age of floor and height encircling. Computer aided design drawings can be adjusted legitimately into ETABS models or utilized as layouts onto which ETABS items might be overlaid. ETABS additionally helps in Design of steel and solid casings (with mechanized advancement), composite pillars, composite sections, steel joists, and cement and brick work shear dividers. Models can be propound , and all outcomes can be seen naturally on the structure. Far reaching and adaptable report is accessible for all investigation and configuration yield, and schematic development drawings of surrounding plans, calendars, subtleties, and cross-segments might be created for cement and steel structures.

ETABS has an enormous determination of layouts for rapidly beginning another model. At this model format arrange, the client can characterize lattice and matrix dispersing, the quantity of stories. It pursue different global codes which encourages client to break down and plan the structure according to their code. Different sort of various burden can be applied in etabs, for example, Super dead burden, Live burden, Seismic burden, Wind load, and so forth. ETABS gives the help of IS 1893:2002 for seismic examination of a structure and gives the investigation results to different.

1.6.1 Features of ETABS

One Window, Many Views: - ETABS gives a solitary UI to perform: Modeling, Analysis, Design, Detailing, and Reporting.

- Templates: - ETABS has a huge determination of layouts for rapidly beginning another model. The appropriator can characterize framework and lattice separating, the quantity of stories, the default auxiliary framework areas.

- Automated Code Based stacking: - ETABS will naturally make and apply seismic and wind loads dependent on different residential and global codes.

- Load Cases and Combinations: - ETABS takes into account a boundless number of burden cases and blends. Burden blend types.

- Mixed Units: - ETABS gives appropriator full control of the units utilized with every single model datum and showcases brings about the units wanted. Regardless of whether engineering units or investigation results units, you can have any mix of units all through your model.

- Deformed Geometry: - appropriator can show disfigured geometry dependent on any heap or mix of burdens, just as livelinesss of modes.

- Reaction Diagrams: - Support responses can be show graphically on the model either as vectors or as classified plots for chosen response segments.

- Report Generation: - The report generator qualities incorporate a listed chapter by chapter guide, model definition data, and examination and configuration results in classified organization. Reports are visible inside ETABS 2013 with live record route associated with the Model Explorer and legitimately exportable to.

1.6.2 History of ETABS

ETABS is initially development of TABS more than multi year by CSI. The product is applied by a large number of specialists more than 160 nations and is driving device for basic and seismic tremor designing ETABS was applied to make the scientific model of the Burj Khalifa, at present world's tallest structure planned by Skidmore, Owings and Merrill (SOM).ETABS was utilized to break down Taipei 101 Tower in Taiwan, One World Trade Center in New York, the 2008 Olympics Birds Nest Stadium in Beijing, etc.ETABS is regularly used to investigate: Skyscrapers, parking structures, steel and solid structures, low ascent structures, gateway outline structures and elevated structures. Other CSI programming likewise helped in structuring the link stayed Centenario Bridge over the Panama Canal.

1.6.3 Objectives

To consider the conduct of skyscraper RC working during quake.

- To consider Effect of seismic burden on structure because of plan inconsistency.
- To portrayed horizontal power on every level because of seismic power.
- To think about the most extreme passable reaction of structure.
- To think about the conduct of various formed structures in plan during quake.
- described the torsional development in structure because of inconsistency in mass and firmness.
- the product and give fittingly and faster examination results by the utilization of ETABS.

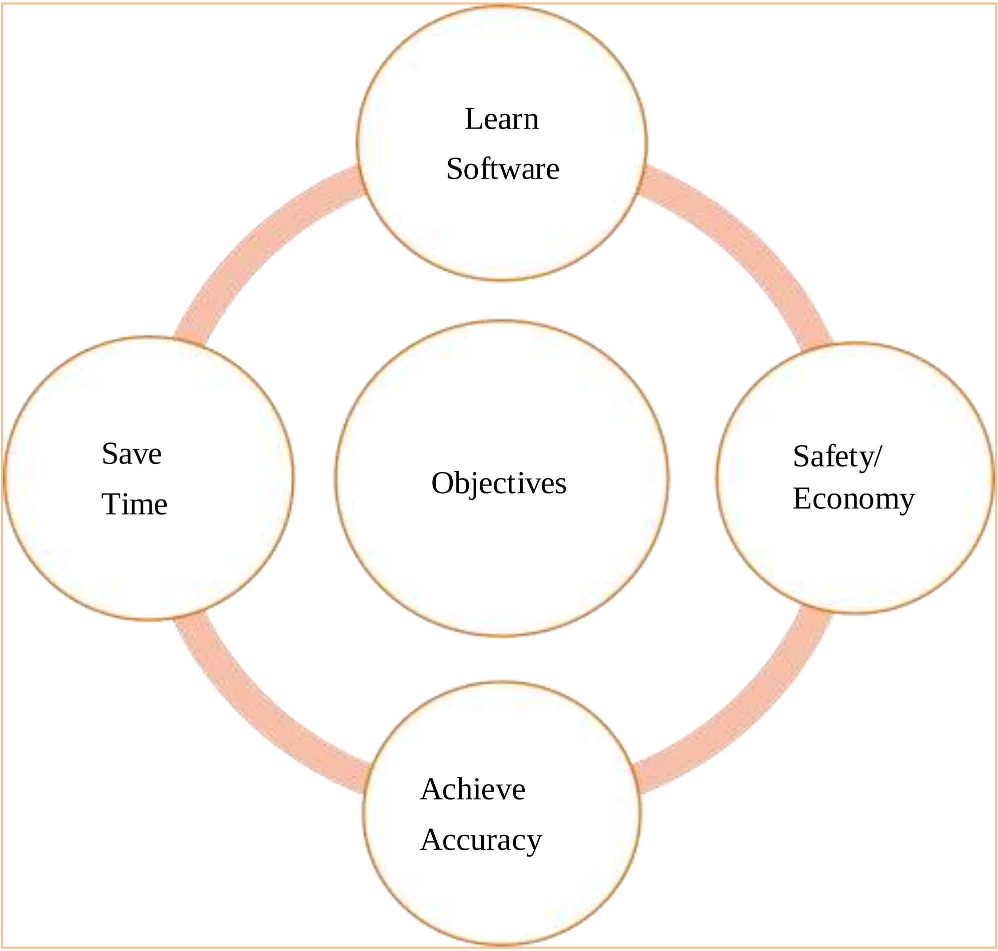


Fig: 1.7 Objective of Software

1.7 COMPARISON OF CODES

[tructure Acceleration Spectrum : cl. 6.4

Old IS-1893-2002 has given one reaction spectra for Equivalent Static Method and Response Spectrum technique in Fig.2. The reaction spectra is given for 4.0 s periods Expressions are given for computing structure increasing speed coefficient

(Sa/g), for Rocky/hard soils, medium soils and delicate soils.

Structure Acceleration Spectrum :

cl. 6.4.2.1

New IS-1893-2016 has given reaction spectra for Equivalent Static Method and Response Spectrum technique independently in Fig.2A and 2B. The reaction spectra are given for 6.0 s periods. Articulations are given for computing structure speeding up coefficient(Sa/g), for Equivalent Static Method and Response Spectrum technique independently for Rocky/hard soils, medium soils and delicate soils.For Equivalent Static strategy, for $T<0.4$ sec, Sa/g=2.5 consistent, however in Response range strategy, Sa/g esteems fluctuates as 1+15T up to 0.10sec.

URM Infill dividers Modeling

Code is quiet about displaying of brick work infill dividers.

Equation for $Ta= 0.09h/\sqrt{d}$ for Buildings with brick work infill dividers is given. Cl.7.6.1

Subsequently, in investigation Ta is taken considering brick work infill, however firmness of infill isn't considered in examination.

RC Framed Building with Unreinforced Masonry Infill dividers: cl. 7.9

This condition has been recently included and examines the figuring of EQ loads when infill are considered.

A detail system for URM infill by Equivalent corner to corner swagger technique has been given in cl.7.9.2.2

Delicate story: cl. 4.20

A delicate story is characterized as the story wherein the horizontal solidness is

- less than 70 % of that in the story above, or
- less than 80 % of the normal sidelong

firmness of the three story above.

Delicate story: cl. 4.20.1

A delicate story is characterized as the story where the parallel solidness is not as much as that in the story above.

Powerless story: cl. 4.25

According to old IS 1893-2002, a powerless story is characterized as the story where the parallel quality is - under 80 % of that in the story above

Powerless story: cl. 4.20.2

According to new IS 1893-2016, a powerless story is characterized as the story wherein the horizontal quality [cumulative plan shear quality of every single basic part other than that of unreinforced workmanship URM in fills]

not as much as that in the story above

Dynamic Analysis Requirement : cl.7.8.1

For Regular Buildings:

Zone-IV, V height>40m

Zone-II, III height>90m

For Irregular Buildings:

Zone-IV, V height>12m

Zone-II, III height>40m

Dynamic Analysis Requirement : cl.7.7.1

Proportionate static investigation will be relevant for normal structures with tallness < 15m in seismic Zone II.

[cl.7.6. what's more, cl.7.7.1]

Proportionate Static strategy ought to be utilized for customary structure with rough normal periods is under 0.4 sec.

[cl.6.4.3]

Snapshot of Inertia (I):

Statement with respect to Moment of Inertia isn't referenced in old code.

Accordingly investigation is made thinking about full Moment of Inertia, for example Uncracked area is considered

Snapshot of Inertia (I): cl.6.4.3.1

The snapshot of dormancy for auxiliary investigation will be taken as given underneath.

For RC and Masonry Structures

Ieq= 0.70 Igross for sections Ieq= 0.35 Igross for shafts

For Steel structures :

Ieq= Igross for bars and sections

This condition of code considers, the broke segment properties.

Torsion anomaly: cl.7.1

Table-4 Torsional anomaly according to old code is

$\Delta 2 > 1.2 (\Delta 1 + \Delta 2)/2$

Torsion anomaly: cl.7.1

Table-5 Torsional anomaly according to

new code is $\Delta max > 1.5 \delta min$. When $\Delta max > (1.5\text{-}2.0) \delta min$ Configuration will be changed

Re-contestant Corners: cl.7.1,Table - 4

According to Old code, For re-contestant corner, A/L > 0.15-0.20

Re-participant Corners:

cl.7.1 Table - 5

According to New code, For re-participant corner A/L > 0.15

In structures with re-participant corners

three dimensional unique examination will be performed

Stomach Discontinuity: (unnecessary patterns) cl.7.1 Table – 4

In old code Flexible or rigid stomach words are not referenced. On the off chance that Ao> 0.5Atotal - it is referenced spasmodic stomach.

Where, Ao= pattern or open territory.

Stomach Discontinuity: (unnecessary patterns)

According to new code, cl.7.1 Table - 5 If Ao > 0.5Atotal

- Flexible stomach If Ao < 0.5Atotal

- Rigid diaphrag

Mass Irregularity: cl.7.1 , Table - 5 according to old code, mass inconsistency is considered to exist when the seismic load of any floor is more than 200 % of that of the floor underneath or above.

Mass Irregularity: cl.7.1 , Table - 6

According to new code, mass anomaly is considered to exist when the seismic load of any floor is more than 150 % of that of the floor beneath.

Wi > 1.5 Wi-1. Wi > 1.5 Wi+1

In structures with mass anomaly and situated in seismic zones III, IV and V dynamic examination will be

Performed.

Vertical Geometric Irregularity: cl. 7.1 , Table - 5

According to old code, the vertical geometric anomaly Shall be considered to exist,

at the point when the flat element of the horizontal power opposing framework in any story is

more than 150 % of the story beneath or above.

A/L >0.15L, L2/L1>1.5.

Vertical Geometric Irregularity: cl. 7.1 , Table - 6

According to new code, the vertical geometric anomaly Shall be considered to exist, when the even element of the parallel power opposing framework in any story is more than 125 % of the story underneath.

A/L >0.125L, L2/L1>1.25

Stomach:

Provision in regards to adaptable or unbending stomach doesn't show up in old code.

Stomach:

cl. 7.6.4

The prerequisites for the floor stomach to be inflexible or adaptable are modified.

When Δmiddle> 1.2δave

- it is viewed as adaptable stomach, else it is inflexible stomach

Generally floor section with plan viewpoint proportion (L/B) under 3 is viewed as inflexible stomach.

Damping proportion:

cl. 7.8.2.1

Damping of 2% was took into consideration steel structures in old code, which is presently 5 %.

Table-3 of old code, duplicating factors for acquiring esteems for other damping.

Damping proportion:

cl. 7.2.4

The estimation of damping will be 5 % of basic damping for figuring Ah, regardless of the material of development (steel, strengthened solid, brick work, and so forth.) of its parallel burden opposing system.The benefit of damping is same (5%) independent of the strategy for examination utilized, in particular, Equivalent Static Method, or Dynamic investigation Method. Table-3 of old code, duplicating factors for getting esteems for other damping has been expelled

Focal point of Mass(CM): cl. 4.4

The old code characterize focus of mass as the point through which the resultant of the majority of a framework demonstrations. It is the focal point of gravity of the

Mass framework.

Focal point of Stiffness :

cl. 4.5

According to old code it is the point through which the resultant of reestablishing powers of a framework demonstrations

Focal point of Mass(CM): cl. 4.4

According to new code the CM is characterized as a point in a story of a structure through which the resultant of the idleness power of the floor demonstrations during ground shaking.

Focal point of Resistance (CR) : cl.4.5

According to new code, for single story building, it is the point on the top of a structure through which when the resultant inertial opposition acts, the structure experiences unadulterated interpretation even way, yet no curve about vertical pivot through the CR. Additionally, CR is likewise characterized for multi story structures, by the new

code.

Increment in reasonable worries in materials. cl.6.3.5.1

When earthquake forces are considered alongside other structure powers, the reasonable worries in materials might be expanded by 33%. For steel having a distinct yield pressure, the pressure be restricted to yield pressure.

For steel without unmistakable yield point, the pressure will be restricted to 80 % of a definitive quality or 0.2 % evidence pressure whichever is smaller

The provision of old code in regards to expanding the worries by 33.0% when EQ loads are acting is evacuated. In this manner fashioner is in a roundabout way compelled to utilize the breaking point state technique.

Increment in suitable soil pressure cl.6.3.5.2

At the point when seismic tremor powers are considered, increment in suitable weight in soils for various kinds of soils (Type-I, II, III) and various sorts of establishments, to be specific, heaps, pontoon, well establishments, and so forth, was given in Table-1 from 25 % to 50 %.

Increment in net weight on soils in structure of establishments cl.6.3.5.2

New code IS 1893-2016, gives rate increment in net bearing weight and skin pressures for soil types A, B, and C as half, 25%, and 0% separately in Table-1.

For delicate soil no expansion in bearing weight will be applied in light of the fact that, settlements can't be limited by expanding bearing weight.]

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

Mayur R. Rethaliya Bhavik R. Patel (2018) [1] introduced a relative investigation of seismic loads on four multi-story RC surrounded structures (3 story, 5 story, 7 story and 9 story) according to IS 1893-1984 and IS 1893-2002 codal suggestions. In this paper seismic coefficient, reaction range and modular investigation strategies were embraced to figure the seismic powers on these structures. The end incorporates examination of parallel burden and base shear for each building determined according to both referenced IS codes

Anoj Surwase (2018) [2] mpressive improvement in quake safe structure has been seen in later past. Therefore, Indian seismic code IS: 1893 has likewise been changed in year 2016, following a hole of 14 years. This paper displays the seismic burden estimation for multistorey structures according to Seems to be: 1893-2002 and IS: 1893-2016 proposals. The technique for examination and plan of multi-story (G+4) private structure situated in zone III, IV. The degree behind displaying this undertaking is to learn important Indian standard codes are utilized for plan of different structure component, for example, shaft, section, chunk, establishment and stair case utilizing a product E-tab under the seismic burden and wind load acting the structure. We need to discover the qualities in venture base shear, timespan, greatest story remova

P.S. Girigosavi (2018) [3] this paper stressed over assessment on alteration of IS 1893-2016.The static examination of multi-celebrated structure is done by using FEM based programming. In present assessment, the static examination is finished by IS 1893-2016 and results, for instance, flat dislodging, base shear, story drift are differentiated and IS1893-2002. This paper deals with the connection of design powers for multi-celebrated structures, obtained by using IS 1893-2016 code, with those gotten by the past IS1893-2002 structure. From the outcomes of seismic examination of structures it is gathered that the IS1893-2016 is continuously conventionalist for shake assessment of multi-story structures. IS 1893 (Part 1): 2002 [1] have referenced the strategies, parameters which are required in dissecting and planning of tremor safe structures, particularly structures. IS 1893 (Part 1): 2016 [2] have referenced general arrangements, wordings, examination techniques and structuring parameters for tremor safe structures.

Ravikant Singh and Vinay Kumar Singh (2017) [4] Numerous progressions and improvement in the Earthquake safe plan of structure is done in past ongoing years. It brings about the adjustments in the Indian seismic code IS 1893 which is updated and drafted in year 2016, after a period slipped by of almost 14 years. In this paper we speaks to the seismic burden evaluation for multistory structure according to May be: 1893-2002 and IS: 1893-2016 proposals. Considering and breaking down the four story RC surrounded multistorey structure. It is presumed that such investigation is done on individual RC encircled structure which is planned utilizing before code. To foresee the seismic helplessness of building structure and to check because of modifications and changes in the IS codal arrangements the structure is protected or risky.

Rakesh kumar Gupta (2018) [5] The national construction regulation of India(NBC)2015 was discharged by department of Indian norms during December 2016/january2017. The different areas of this NBC have experienced changes according to most recent advances and client prerequisites. It is important to distinguish the exhibition of the structures to withstand against calamity for both new and existing one. The paper talks about the presentation assessment of RC (Reinforced Concrete) Buildings with different abnormalities. Auxiliary anomalies are significant components which decline the seismic presentation of the structures. This examination in general tries to assess the impact of different anomalies on RC structures utilizing IS 1893:2002 and IS 1893:2016 regarding dynamic attributes.

Urunkar S. S., Bogar V. M. (2018) [6] the statements gave in seismic code control the fashioners to improve the conduct of structures during a quake and withstand against it without huge death toll and property. For India, Indian Standard Criteria for Earthquake Resistant Design of Structures (IS 1893 Part 1) gives the necessary statements to auxiliary fashioners for planning seismic tremor safe structures. Because of consistent research, picked up information and encounters, the IS 1893 Part 1 has been amended at whatever point required. The near investigation of codal arrangements is required to be made at whatever point the code is reexamined. This paper contains the relative investigation of an IS 1893 (Part 1):2002 and IS 1893 (Part 1):2016. The paper chiefly centers around the reexamined codal arrangements in IS 1893 (Part 1):2016

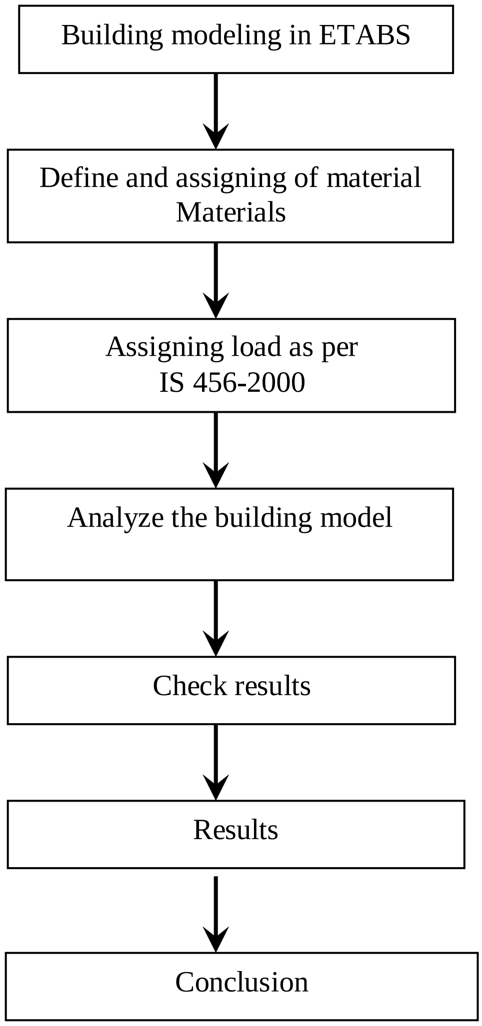
Ajay Kumar (2019) [7] In present investigation, distinctive celebrated structure has been demonstrated utilizing staad.pro programming and dissected with gravity and seismic burdens to think about the consequences of seismic examination according to IS:1893-2002 and IS:1893-2016.The plan has been accomplished for 4 story, 8 story and 11 story structures. The greatest stature of the previously mentioned structures is 39.6m, hence, as indicated by past seismic code (IS:1893-2002) static seismic examination was performed and according to new seismic code (IS:1893-2016) unique seismic investigation was performed. The stacking and all other applicable contemplations are same for different structure. The presentation of the structures has been assessed as far as various basic parameters, for example, hub power, twisting minute, relocation, material amount and so on. Cost investigation has likewise been completed on material (cement and steel). Examination of these outcomes has been done to make the inference of the present investigation. From the ultimate results of the examination, it has been discovered that the absolute expense of the structures planned with dynamic seismic investigation turns out to be 1.06 to 1.1 occasions higher than the structure structured with static seismic examination.

Narayan Malviya, Sumit Pahwa(2015) [8] Proposals gave by seismic codes help the planner to improve the conduct of structures so they may withstand the quake impacts without huge misfortune. Seismic codes are exceptional to a specific district or nation. They consider the nearby seismology, acknowledged degree of seismic hazard, properties of accessible materials, techniques utilized in development and building typologies. Further, they are characteristic of the degree of progress a nation has made in the field of quake building and property. A large portion of the proposals of IS codes depend on perception during past tremors just as test and scientific investigations made by researchers, specialists and seismologists. In India, the main seismic code to be specific IS: 1893 (Criteria for tremor safe plan of structures) was distributed in 1962. As because of Analysis of execution of structures during past seismic occasions and Efforts put by scientists, impressive progression have been made throughout the years in quake safe plan of structures, and seismic plan prerequisites in construction laws have relentlessly improved. In this manner, the seismic code needs correction every once in a while. IS: 1893-2002 has been modified in year 2002 after the hole of 18 years (IS:1893-1984). Presently this is again changed as Seems to be: 1893-2016. The structure planned according to the prior variant of the code might be checked for suggestions made by the amended code. Such examination is to be completed to set up in the case of existing structures planned by before rendition are alright for changed suggestions too. Structures known to have basic lack ought to be retrofitted to withstand expected plan tremor vibrations. Tall structures and structures are currently embraced in India. Many significant urban areas close to the beach front region goes under the live seismic zone, it makes issue for skyscraper multistorey structures. Investigation of such an intricate structure are too riotous and tedious. It is attempted since long time to discover the answer for this issue. Wind and seismic examination of the structures should be possible by the development programming STAAD Pro, SAP or ETABS. Auxiliary Analysis and configuration are prevalent in discovering huge dangers to respectability and strength of a structure. Multi celebrated structures, when planned, are made to satisfy fundamental perspectives and functionality. Since Robustness of structure relies upon loads forced, it is basic. Programming's are grown, for example, STAAD PRO, ETABS and SAFE, and SAP to take care of run of the mill issues easily of utilization. The structure results utilizing programming's can be gotten and looked at. The structure execution under seismic depends fundamentally on its general shape, size and geometry. Seismic tremor safe plan of structures relies on giving the structure quality, firmness and inelastic disfigurement limit. The structure slimness proportion and the structure center size are the key drivers for the proficient auxiliary plan.

Mahesh Patil, Yogesh Sonawane (2015) [9] Seismic Analysis of Multistoried Building The successful plan and the development of quake safe structures have a lot more prominent significance in everywhere throughout the world. In this paper, the tremor reaction of symmetric multistoried structure is examined by manual computation and with the assistance of ETABS 9.7.1 programming. The strategy incorporates seismic coefficient technique as prescribed by IS 1893:2002. The reactions got by manual investigation just as by delicate figuring are analyzed. This paper gives total rule to manual also programming examination of seismic coefficient technique. Seismic examination of structures should be possible by different various strategies. For the investigation Seismic coefficient strategy for examination is utilized as the technique is simple and advantageous. Technique examination is commonly utilized for the structure up to the tallness of 40m (10-12 story).

CHAPTER 3

METHODOLOGY AND MATERIALS USED



The multi-storey building is modeled with G+14 stories with Soft Storey and dynamic analysis has been done by response spectrum Analysis

3.1 Analytical Modeling – ETABS

ETABS writinrformed on ETABS. For the Modeling of the G+14 story RC working with first sensitive story, were consider line part was used for shafts (450mm x 300mm) and segments (300mm x300mm) and strong segment for pieces in the present assessment. The base of structure was totally fixed by convincing all of the degrees of chance. A RC development standard relationship of Indian seismic coad IS 1893:2002 and IS 1893:2016 on medium soil was dismembered and the evacuation, story buoys, and base shear, the mode shapes around the structure due to different weight blends were gotten. Straight one of a kind assessment was performed using response extend procedure

present assessment to make RC diagram Model and to do the examination. Direct one of a kind examination of the structure Models is performed on ETABS. For the Modeling of the G+14 story RC working with first fragile story, were consider line segment was used for columns (450mm x 300mm) and portions (300mm x300mm) and strong segment for segments in the present assessment. The base of structure was totally fixed by convincing all of the degrees of chance. A RC development standard assessment of Indian seismic coad IS 1893:2002 and IS 1893:2016 on medium soil was destitute down and the dislodging, story buoys, and base shear, the mode shapes around the structure in view of different weight mixes were procured. Direct incredible assessment was performed using response run procedureg computer programs is used in the present assessment to make RC plot Model and to do the examination. Straight one of a kind assessment of the structure Models is pe

3.2 Analyzing the data as per IS 1893:2002

Straight powerful examination has been proceeded according to IS 1893 (Part 1): 2002 for each model utilizing ETABS investigation bundle. Parallel burden count and its dispersion along the stature are finished

Table 3.1 Data Relation to the RC Frame Building Models AS Per 1893:2002

Kind of frame Ordinary minute opposing RC outline OMRF) fixed at the base

Seismic zones v

Number of storey 15(G+14storey)

Floor height 3.5 m

Profundity of Slab 150 mm

Size of beam (450× 300) mm

Size of column (300× 300) mm

Separating between outlines in x-direction 5 m

Dividing between outlines in y-direction 5 m

Materials M 30 solid, Fe 500 steel

Thickness of concrete 25KN/m3

Kind of soil Medium soil

Seismic zone As per IS (1893-2002)

Seismic zone factor,(Z) For zone v: 0.36

Significance Factor, (I) 1.5

Reaction range analysis Linear dynamic examination

Plinth tallness over the ground level 3.5 m

Sort of the building OMRF(Ordinary moment opposing RC outline)

3.3 Materials used

Concrete

Concrete with following properties is considered for study.

- Characteristic compressive quality (fck) M = 30 MPa
- Poisons Ratio = 0.2
- Density = 24KN/m3
- Modulus of Elasticity (E) = 5000 x √ fck = 25000 MPa

Steel

Steel with following properties is considered for study.

- Yield Stress (fy) = 500 MPa
- Modulus of Elasticity (E) = 2x105MPa

- Poisons Ratio = 0.15

3.4 Response Spectrum Functions

Table 3.2 - Response Spectrum Function - IS 1893:2002

Name	Period sec	Acceleration	Damping	Z	Soil Type
IS Response	0	0.36	5	0.36	II
IS Response	0.1	0.9	5	0.36	II
IS Response	0.55	0.9	5	0.36	II
IS Response	0.8	0.612	5	0.36	II
IS Response	1	0.4896	5	0.36	II
IS Response	1.2	0.408	5	0.36	II
IS Response	1.4	0.349714	5	0.36	II
IS Response	1.6	0.306	5	0.36	II
IS Response	1.8	0.272	5	0.36	II
IS Response	2	0.2448	5	0.36	II
IS Response	2.5	0.19584	5	0.36	II
IS Response	3	0.1632	5	0.36	II
IS Response	3.5	0.139886	5	0.36	II
IS Response	4	0.1224	5	0.36	II
IS Response	4.5	0.1224	5	0.36	II
IS Response	5	0.1224	5	0.36	II
IS Response	5.5	0.1224	5	0.36	II
IS Response	6	0.1224	5	0.36	II
IS Response	6.5	0.1224	5	0.36	II
IS Response	7	0.1224	5	0.36	II
IS Response	7.5	0.1224	5	0.36	II
IS Response	8	0.1224	5	0.36	II
IS Response	8.5	0.1224	5	0.36	II
IS Response	9	0.1224	5	0.36	II

IS Response	9.5	0.1224	5	0.36	II
IS Response	10	0.1224	5	0.36	II

3.5 Load Case

Table 3.3 - Load Cases - Summary

Name	Type
Dead	Linear Static
Live	Linear Static
Eq x	Linear Static
Eq y	Linear Static
Wind x	Linear Static
Wind y	Linear Static
Response spectrum	Response Spectrum

3.6 Load Combinations

Table 3.4 - Load Combinations

Name	Load Case/Combo	Scale Factor	Type	Auto
DCon1	Dead	1.5	Linear Add	Yes
DCon2	Dead	1.5	Linear Add	Yes
DCon2	Live	1.5		No
DCon3	Dead	1.2	Linear Add	Yes
DCon3	Live	1.2		No
DCon3	Wind x	1.2		No
DCon4	Dead	1.2	Linear Add	Yes
DCon4	Live	1.2		No
DCon4	Wind x	-1.2		No
DCon5	Dead	1.2	Linear Add	Yes
DCon5	Live	1.2		No
DCon5	Windy	1.2		No
DCon6	Dead	1.2	Linear Add	Yes
DCon6	Live	1.2		No
DCon6	Wind y	-1.2		No
DCon7	Dead	1.5	Linear Add	Yes
DCon7	Wind x	1.5		No
DCon8	Dead	1.5	Linear Add	Yes
DCon8	Wind x	-1.5		No
DCon9	Dead	1.5	Linear Add	Yes
DCon9	Wind y	1.5		No
DCon10	Dead	1.5	Linear Add	Yes
DCon10	Wind y	-1.5		No
DCon11	Dead	0.9	Linear Add	Yes
DCon11	Wind x	1.5		No
DCon12	Dead	0.9	Linear Add	Yes
DCon12	Wind x	-1.5		No
DCon13	Dead	0.9	Linear Add	Yes
DCon13	Wind y	1.5		No
DCon14	Dead	0.9	Linear Add	Yes
DCon14	Wind y	-1.5		No
DCon15	Dead	1.2	Linear Add	Yes
DCon15	Live	1.2		No
DCon15	Eq x	1.2		No
DCon16	Dead	1.2	Linear Add	Yes
DCon16	Live	1.2		No
DCon16	Eq x	-1.2		No

DCon17	Dead	1.2	Linear Add	Yes
DCon17	Live	1.2		No
DCon17	Eq y	1.2		No
DCon18	Dead	1.2	Linear Add	Yes
DCon18	Live	1.2		No
DCon18	Eq y	-1.2		No
DCon19	Dead	1.5	Linear Add	Yes
DCon19	Eq x	1.5		No
DCon20	Dead	1.5	Linear Add	Yes
DCon20	Eq x	-1.5		No
DCon21	Dead	1.5	Linear Add	Yes
DCon21	Eq y	1.5		No
DCon22	Dead	1.5	Linear Add	Yes
DCon22	Eq y	-1.5		No
DCon23	Dead	0.9	Linear Add	Yes
DCon23	Eq x	1.5		No
DCon24	Dead	0.9	Linear Add	Yes
DCon24	Eq x	-1.5		No
DCon25	Dead	0.9	Linear Add	Yes
DCon25	Eq y	1.5		No
DCon26	Dead	0.9	Linear Add	Yes
DCon26	Eq y	-1.5		No
DCon27	Dead	1.2	Linear Add	Yes
DCon27	Live	1.2		No
DCon27	Response spectrum	1.2		No
DCon28	Dead	1.5	Linear Add	Yes
DCon28	Response spectrum	1.5		No
DCon29	Dead	0.9	Linear Add	Yes
DCon29	Response spectrum	1.5		No

3.7 Load Patterns

Table 3.5 - Load Patterns

Name	Type	Self Weight Multiplier	Auto Load
Dead	Dead	0	
Live	Live	0	
Eq x	Seismic	0	IS1893 2002
Eq y	Seismic	0	IS1893 2002
Wind x	Wind	0	Indian IS875:1987

3.8 Seismic Coefficient Methods per 1893:2002

The seismic coefficient is most straightforward strategy for figuring of seismic powers on building. In this strategy, first, the plan base shear is determined for the entire structure, and it is then appropriated along the tallness of the structure, as clarified beneath:

3.9 Determination of base shear *:*

The complete plan horizontal power or structure seismic base shear (VB) along any central heading will be controlled by the accompanying articulation:

(IS: 1893 (Part-1) – 2002, Cl. 7.5.3, Pg. 24)

VB = Ah.w

Where,

VB = all out plan parallel power at the base of a structure. Ok = plan level increasing speed range esteem

W = seismic load of the structure

3.10 Seismic weight (w):

Seismic weight of floor system = dead weight of slab + weight of beam + half of the weight of columns above and below the floor + half of the weight of wall above and below the flow.

3.12 Design horizontal seismic coefficient (A_h):

Seismic coefficient is determined according to Seems to be: 1893 (1) - 2002, cl. 6.4.2, pg. 14.

Ok = (Z I Sa/2 R g)

For any structure with T < 0.1 S, the estimation of Ah won't be taken not as much as Z/2 whatever be the estimation of I/R.

Where,

Z = zone factor

I = significance factor

R = reaction decrease factor

Sa/g = normal reaction quickening coefficient

3.13 Zone factor (Z):

Significance factor relies upon the practical utilization of the structures, portrayed by unsafe results of its disappointment, post-quake work need, recorded worth, or financial significance. The estimations of significance factor (I) are given table

Table No. 3.7- Zone Factor (Z) (IS 1893 (Part-1):2002, Cl. 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

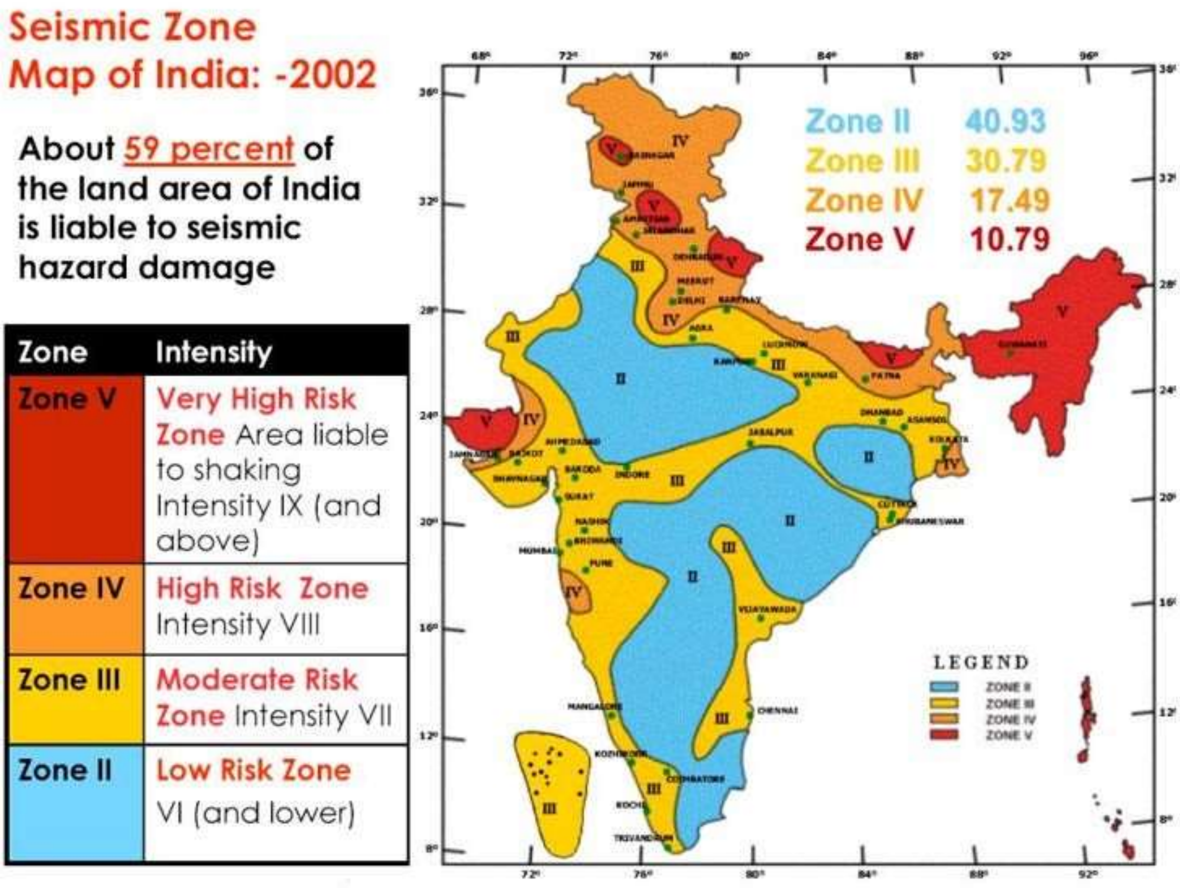


Fig.:3.1 Seismic Zones In INDIA

3.14 Importance factor (I):

Significance factor relies upon the practical utilization of the structures, portrayed by unsafe results of its disappointment, post-quake work need, recorded worth, or financial significance. The estimations of significance factor (I) are given table

Table No. 3.8- Importance Factor, I (IS 1893 (Part-1):2002, Cl. 6.4.2)

SI. NO. (1)	STRUCTURE (2)	Importance Factor (3)
(I)	Importance service and community building, such as hospitals; schools; monumental structures; emergency building like telephone exchange, television stations, radio community halls like cinemas, assembly halls and subway station, power station.	1.5
(ii)	All other building	1.0

3.15 Response reduction factor (R):

It relies upon the apparent seismic harm execution of the structure, portrayed by pliable or fragile disfigurements. In any case, the proportion I/R will not be more noteworthy than I.

Table No. 3.9- Response Reduction Factor, R For Building Systems (IS 1893 (Part-1):2002, Cl 6.4.2)

Sr. no. (1)	Lateral load resisting system (2)	R (3)
(I)	Ordinary RC moment – resisting frame(OMRF)[2]	3.0
(ii)	Special RC moment – resisting frame (SMRF)[3]	5.0

3.16 Average response acceleration coefficient (Sa/g):

It is factors which represent the acceleration response of the structure under earthquake ground vibrations. It depends on the natural period and damping of the structure. For rock or different types of soil the values of Sa/g are given in fig.

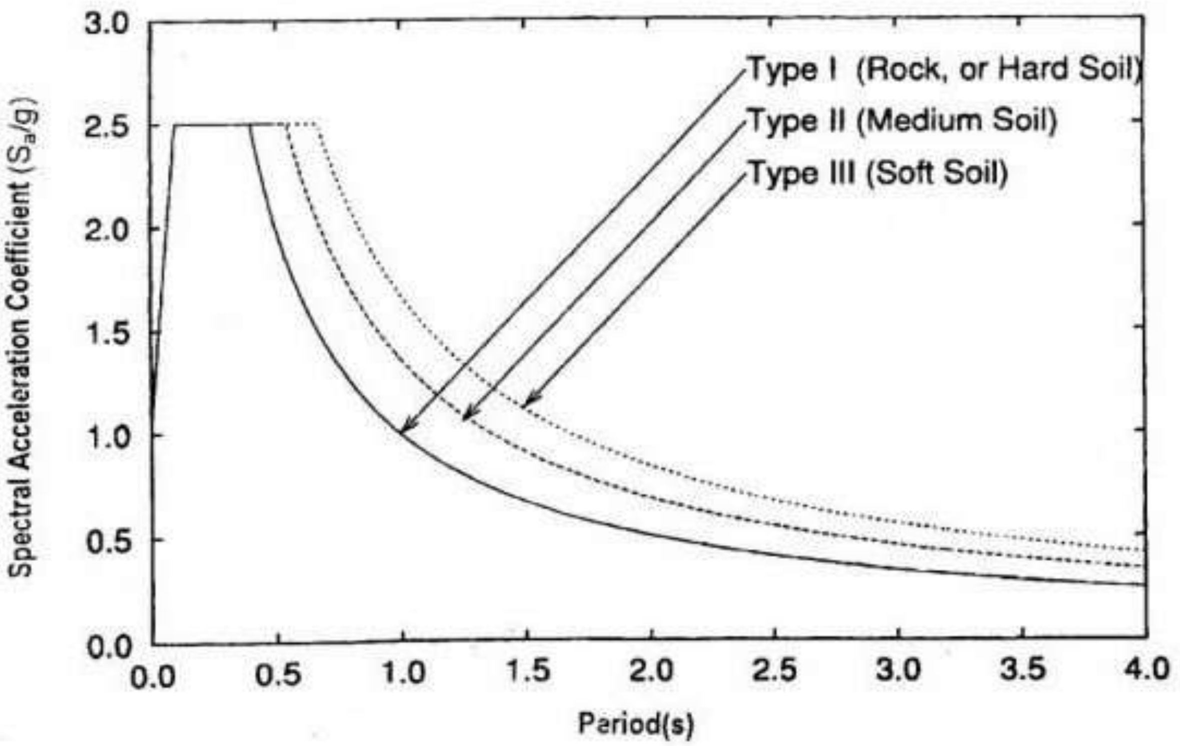


Fig: 3.2- Average Response Acceleration Coefficient- Chart

Multiplying factor for obtaining values for other damping is given in table below.

Table No. 3.10- Damping factor (IS 1893 (Part-1):2002, cl. 6.4.2)

Damping Percent	0	2	5	7	10	15	20	25
Factor	3.20	1.40	1.00	0.90	0.80	0.70	0.60	0.55

3.17 Fundamental characteristic period (Ta):

Ta = 0.075 h0.75 = for minute opposing casing working without block infill board (RC outline).

Ta = 0.085 h0.75 = for minute opposing edge working without block infill board (Steel Panels).

Ta = 0.09 h/√d = for all other structure incorporating minute opposing edge with block infill boards.

Where,

h = stature of building (m)

d = base component of working at the plinth level in m, along the thought about heading of the parallel power.

3.18 Distribution of base shear :

The plan base shear will be circulated along the stature of the structure according to the accompanying articulation

Q = VB (Wi howdy 2/∑ Wi hey 2)

Where,

Q = plan parallel power at floor I, Wi = seismic load of floor I,

howdy = stature of floor I estimated from base, n = number of story

3.19 Analyzing the information according to IS 1893:2016

Direct powerful investigation has been proceeded according to IS 1893 (Part 1): 2016 for each model utilizing ETABS examination bundle. Sidelong burden figuring and its appropriation along the tallness are finished

Table 3.11 Data Relation To The RC Frame Building Models As Per 1893:2016

the base

Seismic zones	v
Number of storey	15(G+14storey)
Floor height 3.5 m	
Profundity of Slab	150 mm
Size of beam	(450× 300) mm
Size of column	(300× 300) mm
Separating between outlines in x-direction	5 m
Dividing between outlines in y-direction	5 m

Materials M 30 solid, Fe 500 steel

Thickness of concrete 25KN/m3

Kind of soil Medium soil

Seismic zone As per IS (1893-2002)

Seismic zone factor,(Z) For zone v: 0.36

Significance Factor, (I) 1.5

Reaction range analysis Linear dynamic examination

Plinth tallness over the ground level 3.5 m

Sort of the building OMRF(Ordinary moment opposing RC outline)

3.20 Materials Used

Concrete

Concrete with following properties is considered for study.

- Characteristic compressive quality (fck) M = 30 MPa

- Poisons Ratio = 0.2
- Density = 24KN/m3
- Modulus of Elasticity (E) = 5000 x √ fck = 25000 MPa

Steel

Steel with following properties is considered for study.

- Yield Stress (fy) = 500 MPa
- Modulus of Elasticity (E) = 2x105MPa
- Poisons Ratio = 0.15

3.21 Response Spectrum Functions

Table 3.12- Response Spectrum Function - Is 1893:2016

Name	Period sec	Acceleration	Damping	Seismic Zone	Z	Soil Class	I	R
IS Response	0	0.0432	5	V	0.36	II	1.2	5
IS Response	0.1	0.108	5	V	0.36	II	1.2	5
IS Response	0.55	0.108	5	V	0.36	II	1.2	5
IS Response	0.8	0.07344	5	V	0.36	II	1.2	5
IS Response	1	0.058752	5	V	0.36	II	1.2	5
IS Response	1.2	0.04896	5	V	0.36	II	1.2	5
IS Response	1.4	0.041966	5	V	0.36	II	1.2	5
IS Response	1.6	0.03672	5	V	0.36	II	1.2	5
IS Response	1.8	0.03264	5	V	0.36	II	1.2	5
IS Response	2	0.029376	5	V	0.36	II	1.2	5
IS Response	2.5	0.023501	5	V	0.36	II	1.2	5
IS Response	3	0.019584	5	V	0.36	II	1.2	5
IS Response	3.5	0.016786	5	V	0.36	II	1.2	5
IS Response	4	0.014688	5	V	0.36	II	1.2	5

IS Response	4.5	0.014688	5	V	0.36	II	1.2	5
IS Response	5	0.014688	5	V	0.36	II	1.2	5
IS Response	5.5	0.014688	5	V	0.36	II	1.2	5
IS Response	6	0.014688	5	V	0.36	II	1.2	5
IS Response	6.5	0.014688	5	V	0.36	II	1.2	5
IS Response	7	0.014688	5	V	0.36	II	1.2	5
IS Response	7.5	0.014688	5	V	0.36	II	1.2	5
IS Response	8	0.014688	5	V	0.36	II	1.2	5
IS Response	8.5	0.014688	5	V	0.36	II	1.2	5
IS Response	9	0.014688	5	V	0.36	II	1.2	5
IS Response	9.5	0.014688	5	V	0.36	II	1.2	5
IS Response	10	0.014688	5	V	0.36	II	1.2	5

3.22 Load Cases

Table 3.13 - Load Cases - Summary

Name	Type
Dead	Linear Static
Live	Linear Static
EQ x	Linear Static
EQ y	Linear Static
Wind x	Linear Static
Wind x	Linear Static
Wind y	Linear Static
Response spectrum	Response Spectrum

3.23 Load Combination

Table 3.14 - Load Combinations

Name	Load Case/Combo	Scale Factor	Type	Auto
DCon1	Dead	1.5	Linear Add	Yes
DCon2	Dead	1.5	Linear Add	Yes
DCon2	Live	1.5		No
DCon3	Dead	1.2	Linear Add	Yes
DCon3	Live	1.2		No
DCon3	Wind x	1.2		No
DCon4	Dead	1.2	Linear Add	Yes
DCon4	Live	1.2		No
DCon4	Wind x	-1.2		No
DCon5	Dead	1.2	Linear Add	Yes
DCon5	Live	1.2		No
DCon5	Wind x	1.2		No
DCon6	Dead	1.2	Linear Add	Yes
DCon6	Live	1.2		No
DCon6	Wind x	-1.2		No
DCon7	Dead	1.2	Linear Add	Yes
DCon7	Live	1.2		No
DCon7	Wind y	1.2		No
DCon8	Dead	1.2	Linear Add	Yes
DCon8	Live	1.2		No
DCon8	Wind y	-1.2		No
DCon9	Dead	1.5	Linear Add	Yes
DCon9	Wind x	1.5		No
DCon10	Dead	1.5	Linear Add	Yes
DCon10	Wind x	-1.5		No
DCon11	Dead	1.5	Linear Add	Yes
DCon11	Wind x	1.5		No
DCon12	Dead	1.5	Linear Add	Yes
DCon12	Wind x	-1.5		No

DCon13	Dead	1.5	Linear Add	Yes
DCon13	Wind y	1.5		No
DCon14	Dead	1.5	Linear Add	Yes
DCon14	Wind y	-1.5		No
DCon15	Dead	0.9	Linear Add	Yes
DCon15	Wind x	1.5		No
DCon16	Dead	0.9	Linear Add	Yes
DCon16	Wind x	-1.5		No
DCon17	Dead	0.9	Linear Add	Yes
DCon17	Wind x	1.5		No
DCon18	Dead	0.9	Linear Add	Yes
DCon18	Wind x	-1.5		No
DCon19	Dead	0.9	Linear Add	Yes
DCon19	Wind y	1.5		No
DCon20	Dead	0.9	Linear Add	Yes
DCon20	Wind y	-1.5		No
DCon21	Dead	1.2	Linear Add	Yes
DCon21	Live	1.2		No
DCon21	EQ x	1.2		No
DCon22	Dead	1.2	Linear Add	Yes
DCon22	Live	1.2		No
DCon22	EQ x	-1.2		No
DCon23	Dead	1.2	Linear Add	Yes
DCon23	Live	1.2		No
DCon23	EQ y	1.2		No
DCon24	Dead	1.2	Linear Add	Yes
DCon24	Live	1.2		No
DCon24	EQ y	-1.2		No
DCon25	Dead	1.5	Linear Add	Yes
DCon25	EQ x	1.5		No
DCon26	Dead	1.5	Linear Add	Yes
DCon26	EQ x	-1.5		No

DCon27	Dead	1.5	Linear Add	Yes
DCon27	EQ y	1.5		No
DCon28	Dead	1.5	Linear Add	Yes
DCon28	EQ y	-1.5		No
DCon29	Dead	0.9	Linear Add	Yes
DCon29	EQ x	1.5		No
DCon30	Dead	0.9	Linear Add	Yes
DCon30	EQ x	-1.5		No
DCon31	Dead	0.9	Linear Add	Yes
DCon31	EQ y	1.5		No
DCon32	Dead	0.9	Linear Add	Yes
DCon32	EQ y	-1.5		No
DCon33	Dead	1.2	Linear Add	Yes
DCon33	Live	1.2		No
DCon33	Response spectrum	1.2		No
DCon34	Dead	1.5	Linear Add	Yes
DCon34	Response spectrum	1.5		No
DCon35	Dead	0.9	Linear Add	Yes
DCon35	Response spectrum	1.5		No

3.24 Load Patterns

Table 3.15 - Load Patterns

Name	Type	Self Weight Multiplier	Auto Load
Dead	Dead	0	
Live	Live	0	
EQx	Seismic	0	IS 1893:2016
EQy	Seismic	0	IS 1893:2016
Windx	Wind	0	Indian IS875:1987
Windy	Wind	0	Indian IS875:1987

3.29 Design horizontal seismic coefficient (Ah):

Seismic coefficient is determined according to May be: 1893 (1) - 2016, cl. 6.4.2, pg. 9.

Ok = (Z I Sa/2 R g)

For any structure with T < 0.1 S, the estimation of Ah won't be taken not as much as Z/2 whatever be the estimation of I/R.

Where,

Z = zone factor

I = significance factor

R = reaction decrease factor

Sa/g = normal reaction quickening coefficient

3.30 Zone factor (Z):

Seismic zoning assesses the maximum severity of shaking that is anticipated in particular region. The zone factor ,thus is defined as a factor to obtain design spectrum depending on the perceived maximum seismic risk characterized by maximum considered earthquake in the zone in which the structure is located the basic zone factor included in IS Code are reasonable estimate of effective peak ground acceleration.

Table No. 3.17- Zone Factor (Z) (Is 1893 (Part-1):2016, Cl. 6.4.2)

Seismic zone	**II**	**III**	**IV**	**V**
Seismic Intensity	low	Moderate	severe	Very sever

Z	0.10	0.16	0.24	0.36

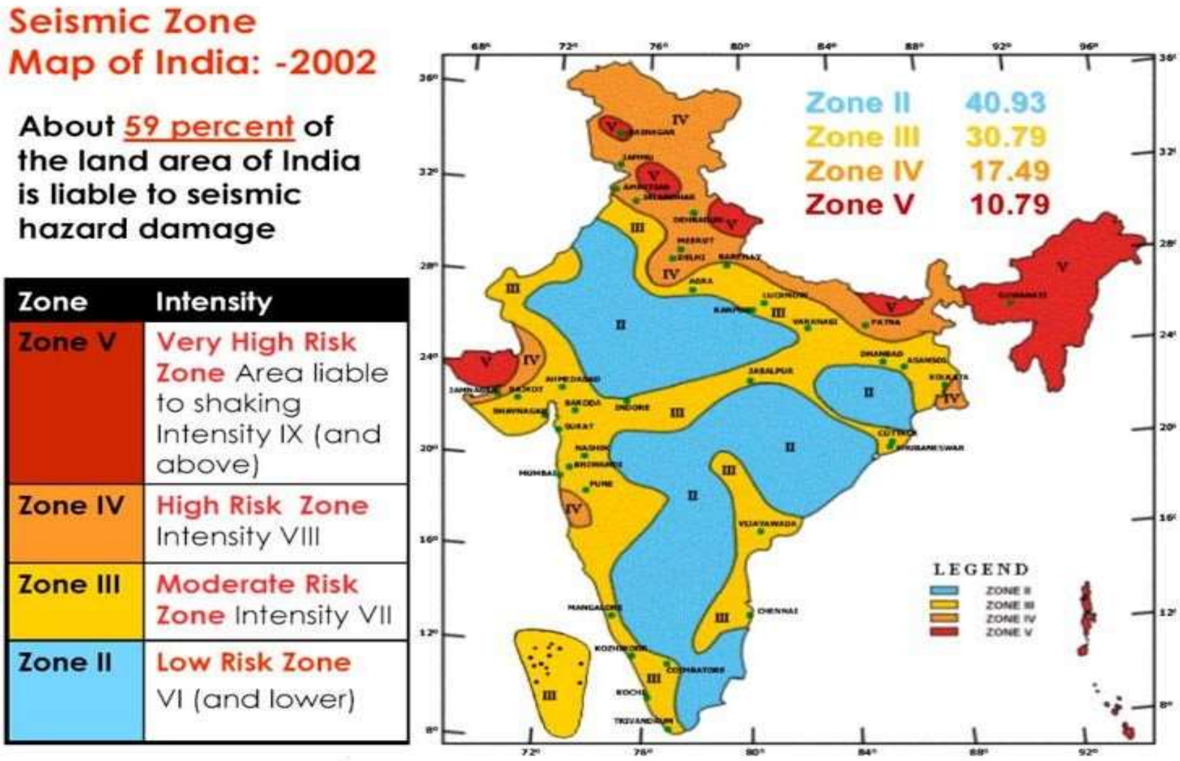


Fig: 3.3 Seismic Zones in INDIA

3.31 Importance factor (I):

It is a factor are use to gain the arrangement seismic force dependent upon the valuable use of the structure, depicted by hazardous consequences of its failure, its post-tremor work need, vital worth, or money related essentialness. The estimations of centrality factor (I) are given in table.

Table No. 3.18- Importance Factor, I (IS 1893 (Part-1):2016 Cl7.2.3 Pg.19

SI. NO. (1)	STRUCTURE (2)	Importance Factor (3)
(I)	For Residential or commercial buildings, with occupancy more than 200 persons importance factor 1.2 has been assigned, in new code , Table-8	1.2

3.32 Response reduction factor (R):

. It relies upon the apparent seismic harm execution of the structure, described by pliable or fragile distortions. In any case, the proportion I/R will not be more noteworthy than I.

Table No. 3.19- Response Reduction Factor, R For Building Systems (Is 1893 (Part-1):2016, Cl 7.2.6)

Sr. no. **(1)**	**Lateral load resisting system** **(2)**	**R** **(3)**
(I)	Ordinary RC moment – resisting frame(OMRF)[2]	3.0
(ii)	Special RC moment – resisting frame (SMRF)[3]	5.0

3.33 Average response acceleration coefficient (Sa/g):

It is a factor which speaks to the speeding up reaction of the structure under tremor ground vibrations. It relies upon the characteristic time frame and damping of the structure. For rock or various sorts of soil the estimations of Sa/g are given in fig

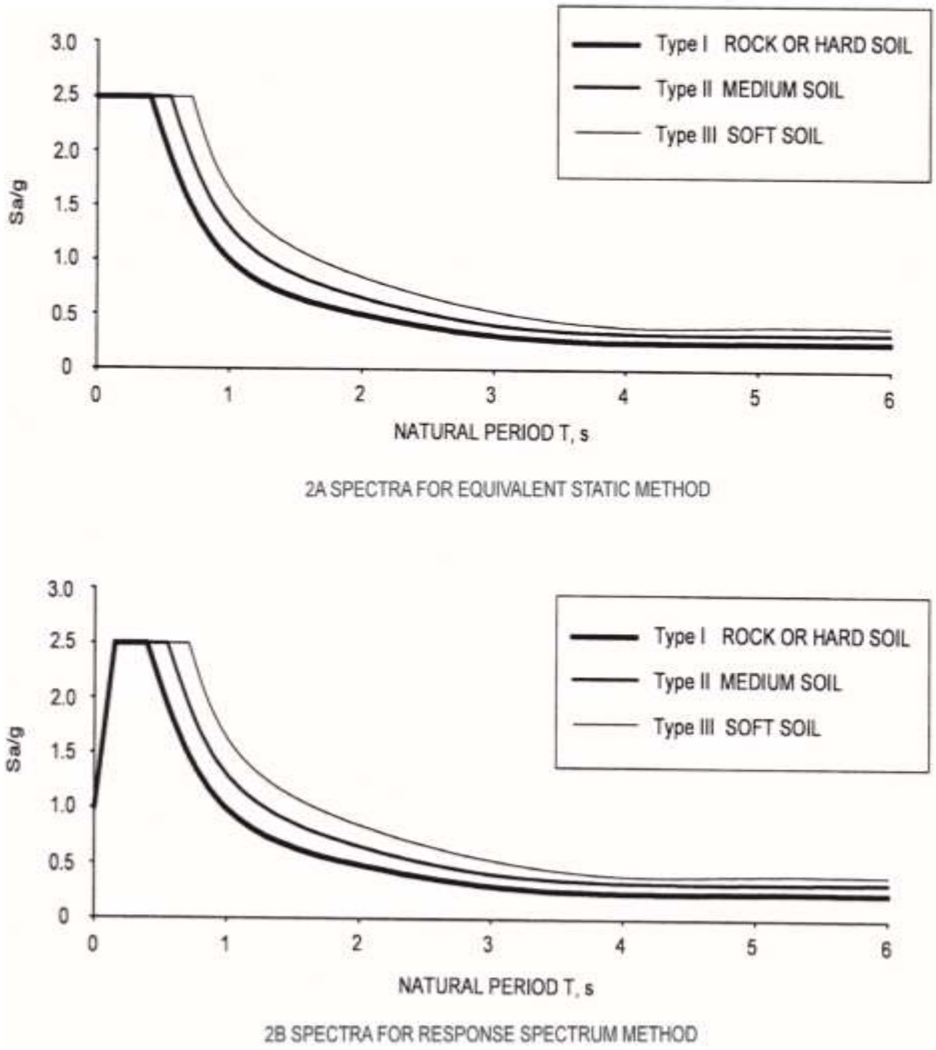


Fig- 3.4: Design Acceleration Coefficient Sa/G Corresponding To 5 Percent Damping

3.34 Fundamental characteristic period (Ta):

Ta = 0.075 h0.75 = for minute opposing casing working without block infill board (RC outline).

Ta = 0.085 h0.75 = for minute opposing casing working without block infill board (Steel

Panels).

Ta = 0.09 h/√d = for all other structure incorporating minute opposing casing with block infill boards.

Where,

h = tallness of building (m)

d = base element of working at the plinth level in m, along the thought about course of the parallel power.

3.35 Distribution of base shear :

The plan base shear will be circulated along the tallness of the structure according to the accompanying articulation:

Q = VB (Wi hello 2/∑ Wi howdy 2)

Where,

Q = Design Lateral Force At Floor I, Wi = Seismic Weight Of Floor I,

hello = Height Of Floor I Measured From Base, n = Number Of Story

CHAPTER 4

RESULTS

4.1 IS1893:2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern This computation exhibits the consequently created parallel seismic burdens for load design Eq x as indicated by IS1893 2002, as determined by ETABS.

Bearing and Eccentricity

Bearing = X

Basic Period

Period Calculation Method = Program Calculated

Variables and Coefficients

Seismic Zone Factor, Z [IS Table 2] Z=0.36

Reaction Reduction Factor, R [IS Table 7] R=5

Significance Factor, I [IS Table 6] I=1.5

Site Type [IS Table 1] = II

Seismic Response

Unearthly Acceleration Coefficient, Sa/g [IS 6.4.5] S_a/g=0.34 S_a/g=0.34

Identical Lateral Forces

Seismic Coefficient, Ah [IS 6.4.2]   A_h=(ZI S_a/g)/2R   ]Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2]

$$A_h = \frac{ZI\frac{S_a}{g}}{2R}$$

Calculated Base Shear

Table 4.1 Base Shear as per IS 1893:2002

Direction	**Period Used (sec)**	**W (kN)**	**V_b (kN)**
X	5.578	147187.5	2702.3625

4.2 IS 1893:2016 Auto Seismic Load Calculation

This computation exhibits the consequently created parallel seismic burdens for load design Eq x as indicated by IS1893 2002, as determined by ETABS.

Bearing and Eccentricity

Bearing = X

Basic Period

Period Calculation Method = Program Calculated

Variables and Coefficients

Seismic Zone Factor, Z [IS Table 2] Z=0.36

Reaction Reduction Factor, R [IS Table 7]   R=5

Significance Factor, I [IS Table 6]   I=1.5

Site Type [IS Table 1] = II

Seismic Response

Unearthly Acceleration Coefficient, Sa/g [IS 6.4.5] S_a/g=0.34 S_a/g=0.34

Identical Lateral Forces

Seismic Coefficient, Ah [IS 6.4.2] A_h=(ZI S_a/g)/2R]

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2]

$$A_h = \frac{ZI \frac{S_a}{g}}{2R}$$

Calculated Base Shear

Table 4.2 Base Shear as per IS 1893:2016

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	5.578	147187.5	2161.89

4.3 Base shear:

Table 4.3 Comparison of Base shear in X- Direction as per IS 1893:2002 and IS 1893:2016

Sr. N	IS CODE	A_h	W (kN)	V_b X-Direction
1	IS 1893:2002	0.01836	147187.5	2702.36
2	IS 1893:2016	0.01468	147187.5	2161.89

3	% decrease	20	0	20

- As per modification of importance factor in new code(IS 1893:2002), its value changes from 1.5 to 1.2 for Residential or commercial buildings, with occupancy more than 200 persons, the same will significantly changes the horizontal seismic coefficient A_h and due to change in horizontal seismic coefficient, the value for the base shear and lateral load distribution will change.

4.4 Lateral load distribution:

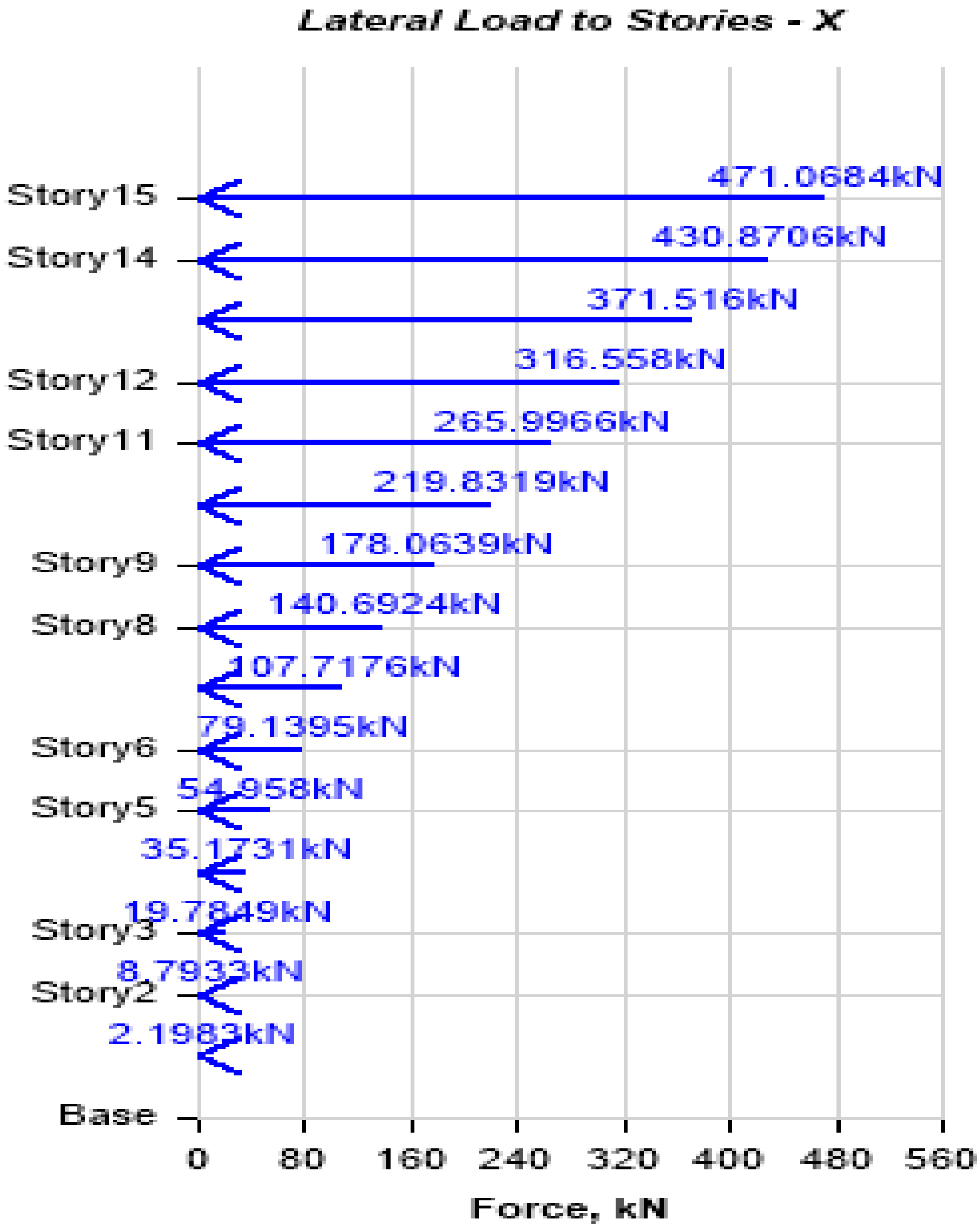


Fig-4.1: Lateral load for different stories x and y direction as per IS 1893:2002

Table 4.4 Lateral load for different stories x direction as per IS 1893:2002

Story	**Elevation** **m**	**X-Dir** **kN**
Story15	52.5	471.0684
Story14	49	430.8706
Story13	45.5	371.516
Story12	42	316.558
Story11	38.5	265.9966
Story10	35	219.8319
Story9	31.5	178.0639
Story8	28	140.6924
Story7	24.5	107.7176
Story6	21	79.1395
Story5	17.5	54.958
Story4	14	35.1731
Story3	10.5	19.7849
Story2	7	8.7933
Story1	3.5	2.1983
Base	0	0

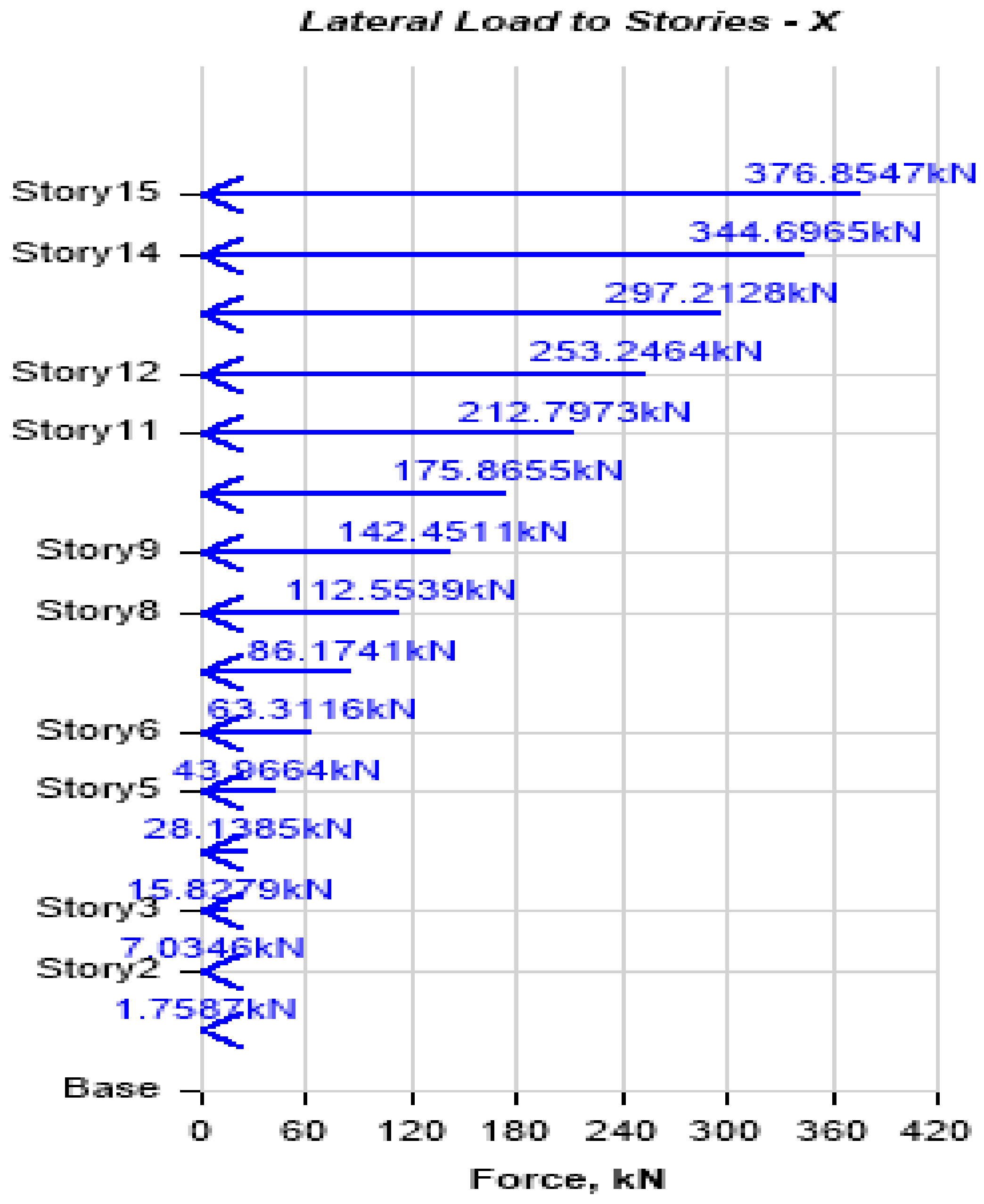


Fig-4.2: Lateral load for different stories x and y direction as per IS 1893:2016

Table 4.5 Lateral load for different stories x direction IS 1893:2016

Story	Elevation m	X-Dir kN
Story15	52.5	376.8547
Story14	49	344.6965
Story13	45.5	297.2128
Story12	42	253.2464
Story11	38.5	212.7973
Story10	35	175.8655
Story9	31.5	142.4511
Story8	28	112.5539
Story7	24.5	86.1741
Story6	21	63.3116
Story5	17.5	43.9664
Story4	14	28.1385
Story3	10.5	15.8279
Story2	7	7.0346
Story1	3.5	1.7587
Base	0	0

Table 4.6 Maximum and Minimum Lateral load for different stories x-Direction as per IS 1893:2002

Lateral load IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X-Direction (kN)**
Story 15(max)	52.5	Top	471.06
Story 1 (min)	3.5	Top	2.1983

Table 4.7 Maximum and Minimum Lateral load for different stories x- Direction as per IS 1893:2016

Lateral load IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	376.85
Story 1 (min)	3.5	Top	1.758

- Comparison of Lateral load distribution as per IS 1893:2002 and IS 1893:2016 the value found to be decreased by 19%.

4.5 Maximum Story displacement:

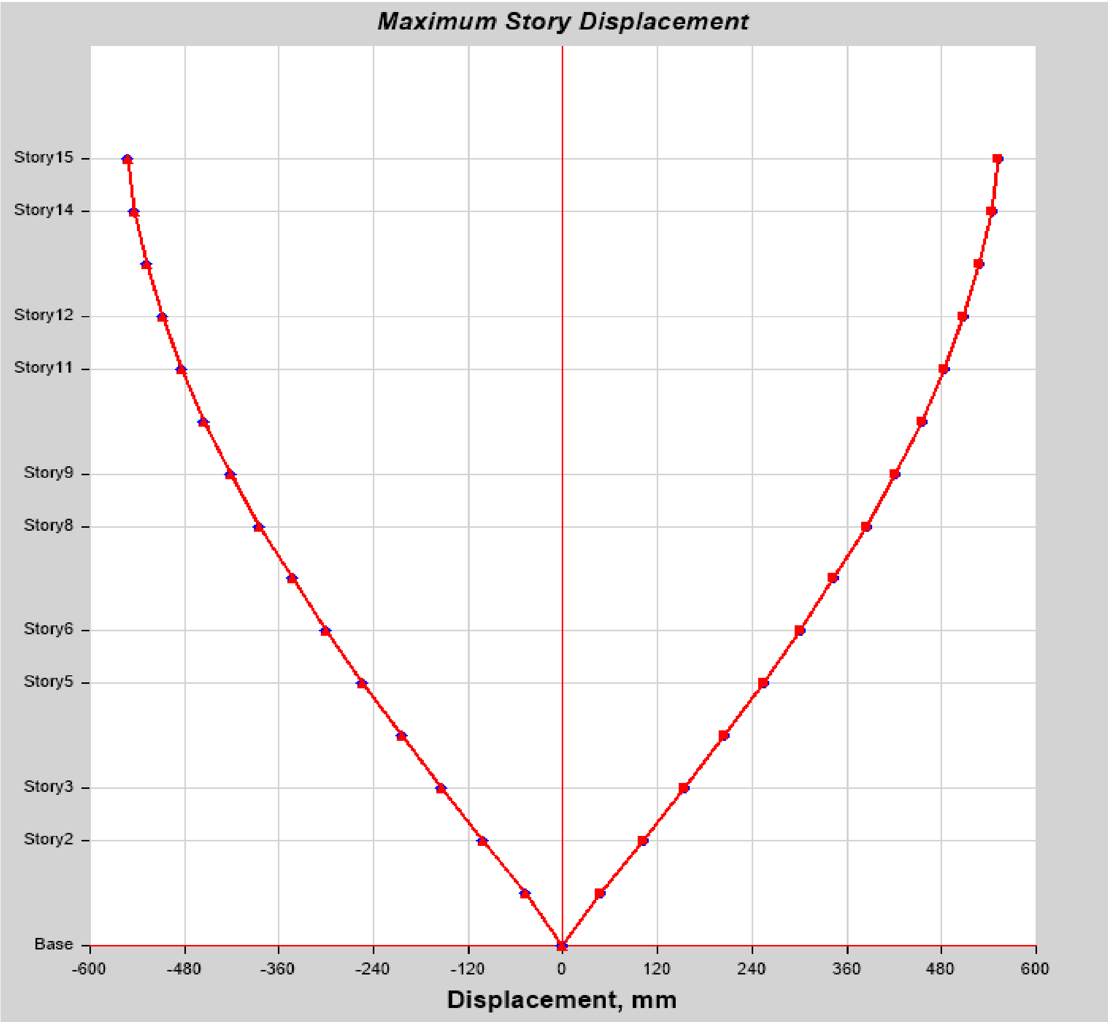


Fig-4.3: Maximum Story Displacement Due To Load Combination 28 As Per IS 1893:2002

Table 4.8: Maximum Story displacement as per IS 1893:2002

Story Response Values

Story	Elevation m	Location	X-Dir Max mm
Story15	52.5	Top	552.694
Story14	49	Top	543.171
Story13	45.5	Top	528.303
Story12	42	Top	508.326
Story11	38.5	Top	483.59
Story10	35	Top	454.404
Story9	31.5	Top	421.106
Story8	28	Top	384.051
Story7	24.5	Top	343.552
Story6	21	Top	299.91
Story5	17.5	Top	253.493
Story4	14	Top	204.68
Story3	10.5	Top	153.73
Story2	7	Top	100.832
Story1	3.5	Top	46.634
Base	0	Top	0

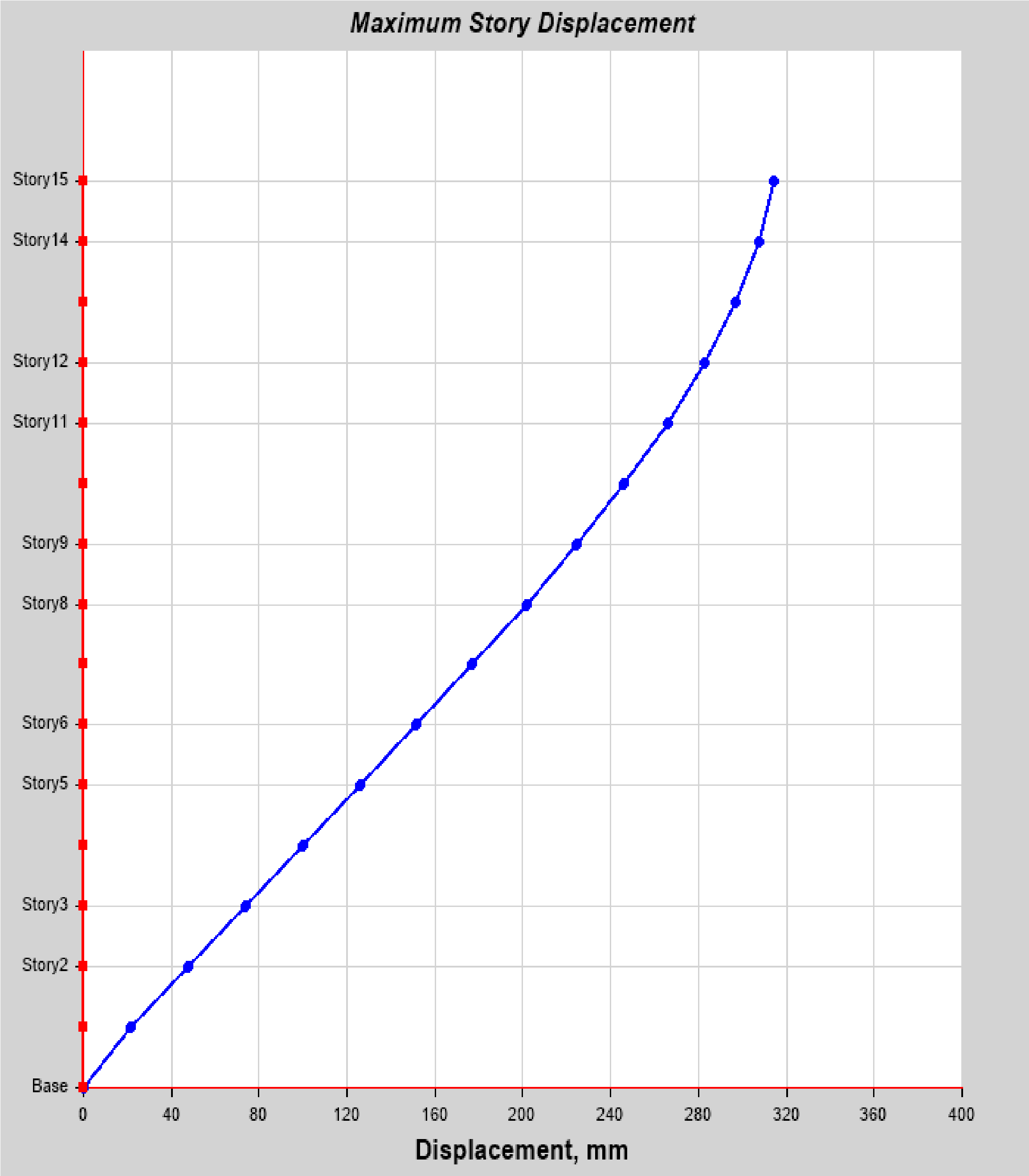


Fig-4.4: Maximum Story Displacement Due To Load Combination 28 As Per IS 1893:2016

Table 4.9: Maximum Story displacement as per IS 1893:2016

Story Response Values

Story	Elevation m	Location	X-Dir mm
Story15	52.5	Top	314.57
Story14	49	Top	307.781
Story13	45.5	Top	297.075
Story12	42	Top	282.893
Story11	38.5	Top	265.76
Story10	35	Top	246.165
Story9	31.5	Top	224.564
Story8	28	Top	201.374
Story7	24.5	Top	176.974
Story6	21	Top	151.705
Story5	17.5	Top	125.87
Story4	14	Top	99.731
Story3	10.5	Top	73.513
Story2	7	Top	47.405
Story1	3.5	Top	21.651
Base	0	Top	0

Table 4.10 Maximum And Minimum Story Displacement Due To Load Combination 29 As Per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	552.694
Story 1 (min)	3.5	Top	46.634

Table 4.11 Maximum And Minimum Story Displacement Due To Load Combination 29 As Per IS 1893:2016

maximum Story displacement IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(max)	52.5	Top	314.57
Story 1 (min)	3.5	Top	21.651

- Comparison of Story displacement due to Load combination 1.5 (DL + Response spectrum) was found maximum at story 15 as per IS 1893:2002 and for load combination (0.9 DL + 1.5 EQ_x) found the maximum story displacement at story 15 as per IS 1893:2016.

- Story displacement due to Load combination 1.5 (DL + Response spectrum) was found minimum at story 1 as per IS 1893:2002 and for load combination (0.9 DL + 1.5 EQ_x) Story displacement was found at story 1 as per IS 1893:2016. The value was found to be decreased by 43% for story 15 (max) and 53.56% for story 1 (min).

4.6 Story stiffness due to response spectrum:

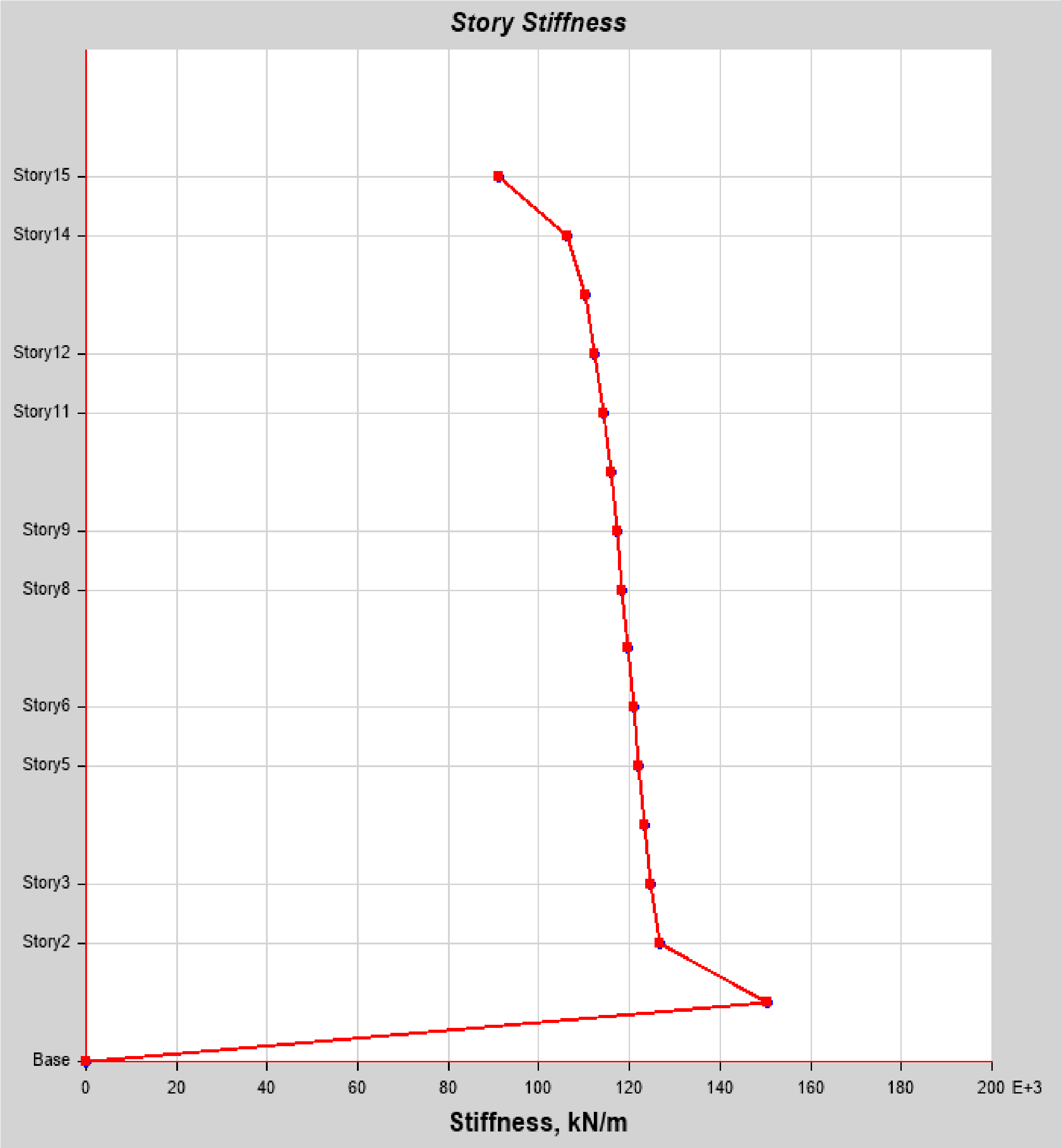


Fig-4.5: Story stiffness due to response spectrum as per IS 1893:2002

Table 4.12 Story Stiffness Due To Response Spectrum As Per IS 1893:2002

Story Response Values

Story	Elevation m	Location	X-Dir KN/m
Story15	52.5	Top	91007.427
Story14	49	Top	106107.029
Story13	45.5	Top	110256.393
Story12	42	Top	112281.27
Story11	38.5	Top	114093.794
Story10	35	Top	115809.13
Story9	31.5	Top	117195.26
Story8	28	Top	118375.13
Story7	24.5	Top	119588.711
Story6	21	Top	120846.756
Story5	17.5	Top	122045.74
Story4	14	Top	123234.574
Story3	10.5	Top	124591.38
Story2	7	Top	126571.637
Story1	3.5	Top	150461.623
Base	0	Top	0

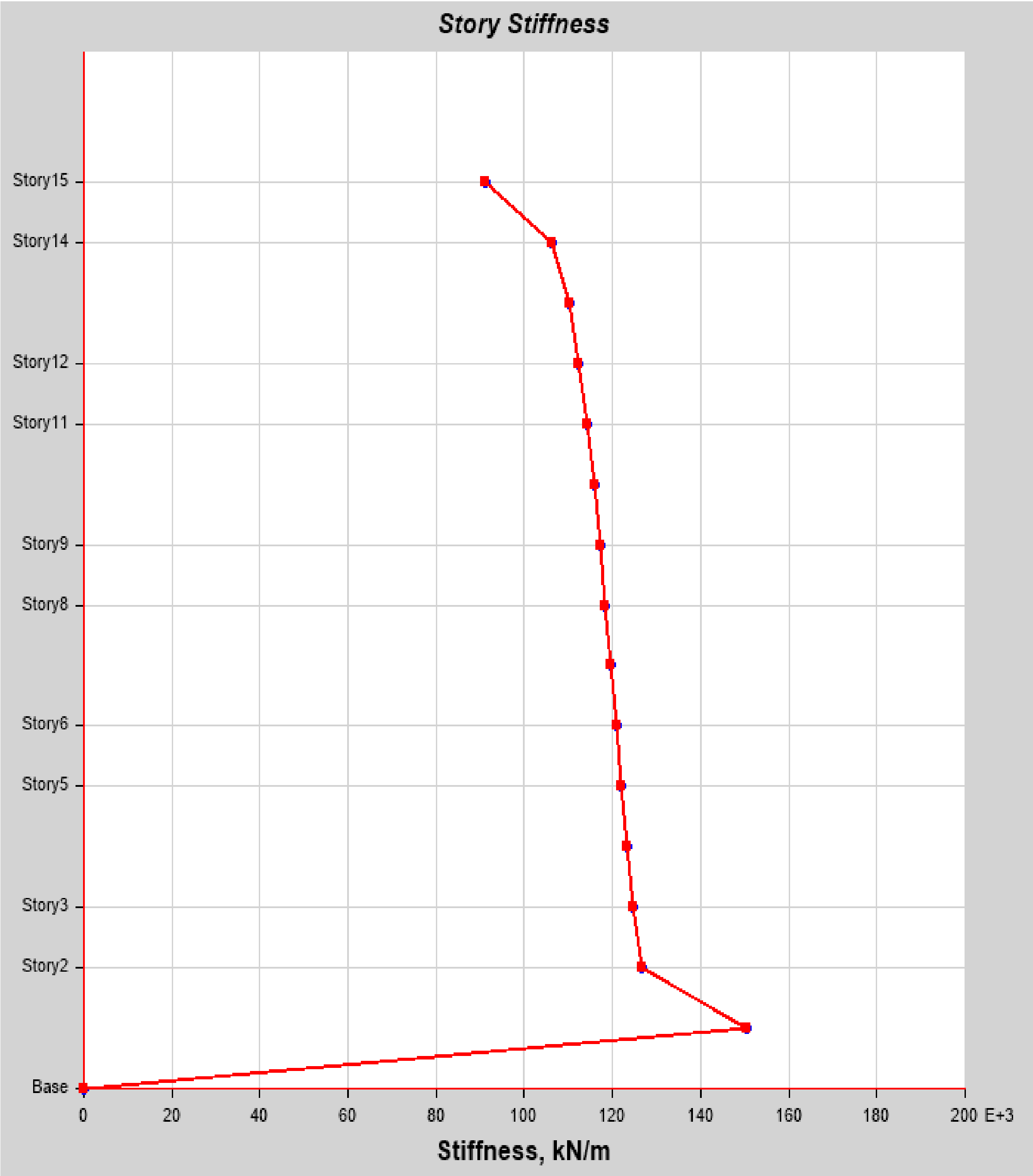


Fig-4.6: Story Stiffness Due To Response Spectrum As Per IS 1893:2016

Table 4.13 Story Stiffness Due To Response Spectrum As Per IS 1893:2016 Story Response Values

Story	Elevation m	Location	X-Dir kN/m
Story15	52.5	Top	91007.374
Story14	49	Top	106107.024
Story13	45.5	Top	110256.415
Story12	42	Top	112281.268
Story11	38.5	Top	114093.797
Story10	35	Top	115809.129
Story9	31.5	Top	117195.258
Story8	28	Top	118375.13
Story7	24.5	Top	119588.712
Story6	21	Top	120846.756
Story5	17.5	Top	122045.743
Story4	14	Top	123234.572
Story3	10.5	Top	124591.38
Story2	7	Top	126571.635
Story1	3.5	Top	150461.625
Base	0	Top	0

Table 4.14 Maximum And Minimum Story Stiffness Due To Response Spectrum As Per IS 1893:2002

stiffness due to response spectrum IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(min)	52.5	Top	91007.427
Story 1 (max)	3.5	Top	150461.623

Table 4.15 Maximum And Minimum Story Stiffness Due To Response Spectrum As Per IS 1893:2016

stiffness due to response spectrum IS 1893:2016			
Story	**Elevation (m)**	**Location**	**X Direction (kN)**
Story 15(min)	52.5	Top	91007.374
Story 15(max)	3.5	Top	150461.625

- On Comparing the stiffness of two models due to response spectrum as per IS 1893:2002 and IS 1893:2016 the stiffness was found to be decreased by very small values for the respective stories of the two models, example for story 15 (0.0000026%) and story 1 (0.0000023%).

- As per the tables data of each story the value of lateral stiffness is almost same for both the models (as per IS1893:2002 & IS 1893:2016). As per modification made in 1893:2016 only definition for soft storey is change.

- It means there is no criteria changing hence the value for all story will be same by analysing using both codes.

- Only the parameter to decide the soft story changes in term of lateral stiffness.

4.7 Maximum Story drift*:*

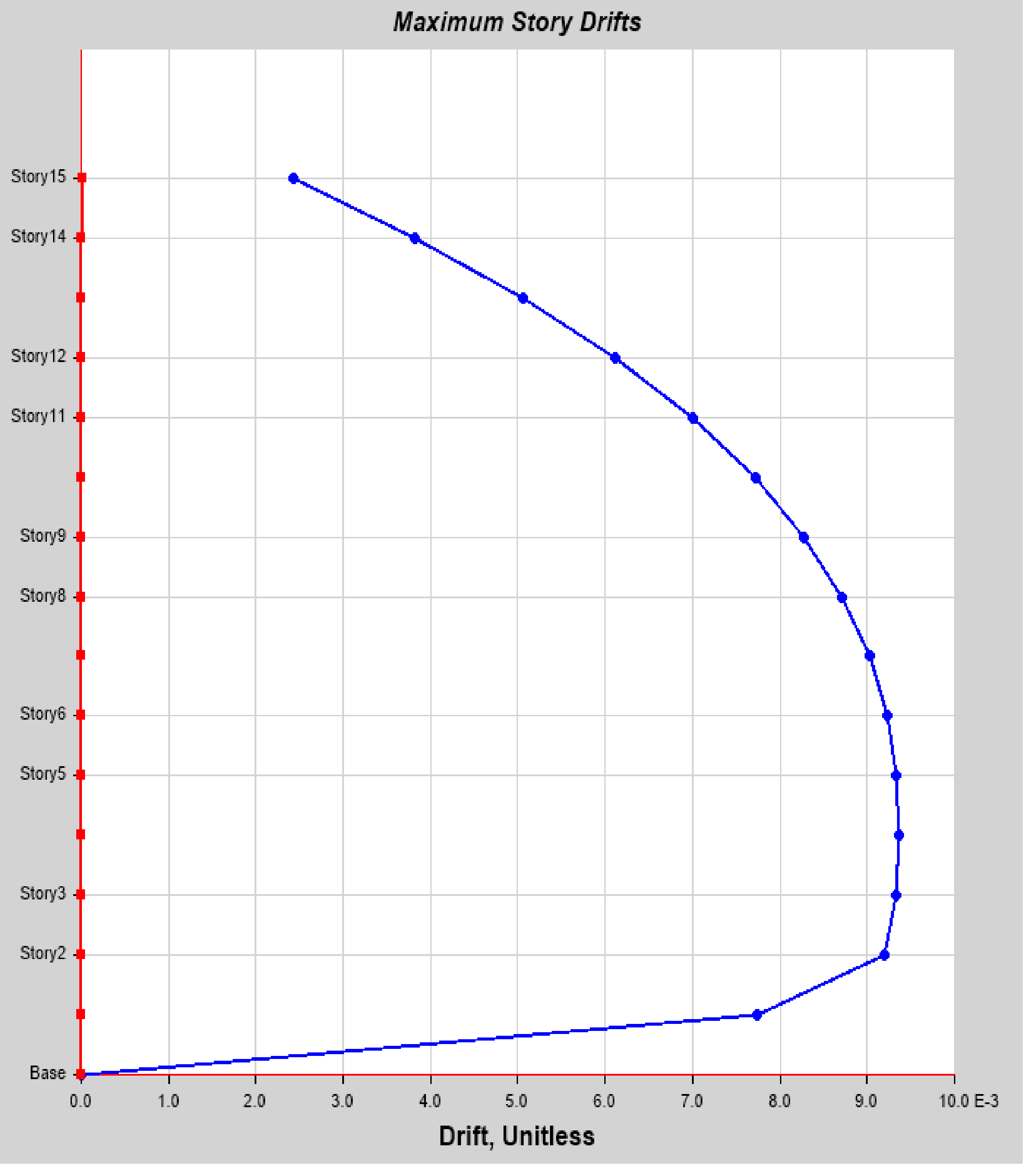


Fig-4.7: Maximum Story Displacement Due To Load Combination 20, 1.5(DL - Eq_x) As Per IS 1893:2002

Table 4.16 Maximum Story Drift As Per IS 1893:2002

Story Response Values

Story	Elevation m	Location	X-Direction
Story15	52.5	Top	0.002435
Story14	49	Top	0.003825
Story13	45.5	Top	0.005065
Story12	42	Top	0.006119
Story11	38.5	Top	0.006998
Story10	35	Top	0.007715
Story9	31.5	Top	0.008282
Story8	28	Top	0.008715
Story7	24.5	Top	0.009025
Story6	21	Top	0.009227
Story5	17.5	Top	0.009336
Story4	14	Top	0.009364
Story3	10.5	Top	0.009324
Story2	7	Top	0.009204
Story1	3.5	Top	0.007733
Base	0	Top	0

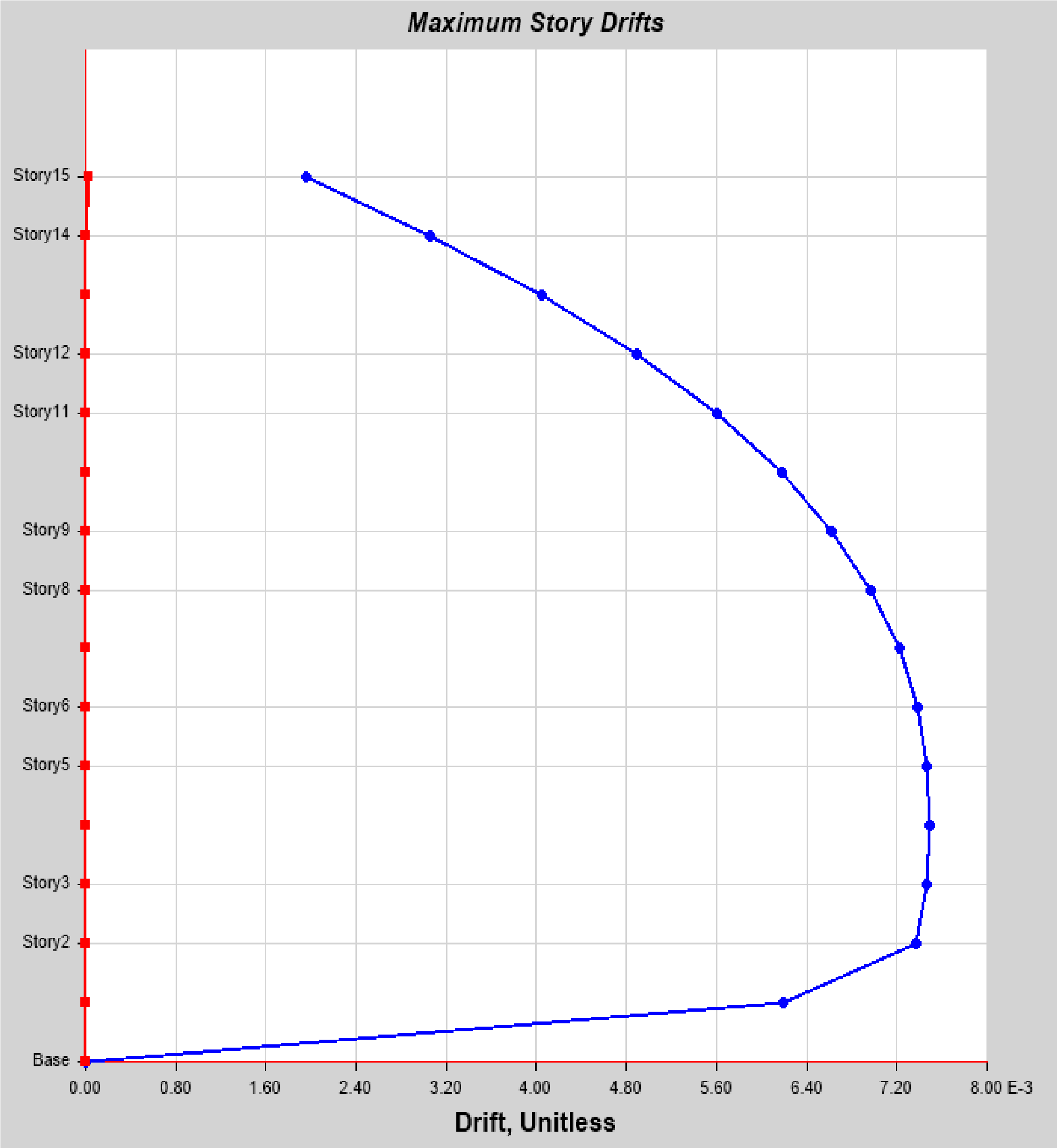


Fig-4.8: Maximum Story Displacement Due To Load Combination 25, 1.5 (DL+Eq_x) As Per IS 1893:2002

Table 4.17 Maximum Story Drift As Per IS 1893:2016

Story Response Values

Story	Elevation m	Location	X-Dir
Story15	52.5	Top	0.001953
Story14	49	Top	0.00306
Story13	45.5	Top	0.004052
Story12	42	Top	0.004895
Story11	38.5	Top	0.005599
Story10	35	Top	0.006172
Story9	31.5	Top	0.006626
Story8	28	Top	0.006972
Story7	24.5	Top	0.00722
Story6	21	Top	0.007382
Story5	17.5	Top	0.007468
Story4	14	Top	0.007491
Story3	10.5	Top	0.00746
Story2	7	Top	0.007363
Story1	3.5	Top	0.006187
Base	0	Top	0

Table 4.18 Maximum And Minimum Story Displacement Due To Load Combination 20, 1.5 (DL - Eqx) As Per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction**
Story 15(min)	52.5	Top	0.00243
Story 1 (max)	3.5	Top	0.00773

Table 4.19 Maximum And Minimum Story Displacement Due To Load Combination 25, 1.5 (DL + Eqx) As Per IS 1893:2002

maximum Story displacement IS 1893:2002			
Story	**Elevation (m)**	**Location**	**X Direction**
Story 15(min)	52.5	Top	0.001953
Story 1 (max)	3.5	Top	0.006187

- Comparison of Story drift due to Load combination 1.5 (DL - EQ_x) was found minimum at story 15 as per IS 1893:2002 and for load combination 1.5 (DL + EQ_x) was found the minimum story drift at story 15 as per IS 1893:2016 .

- For maximum Story drift due to Load combination 1.5 (DL - EQ_x) was found maximum at story 1 as per IS 1893:2002 and for load combination 1.5 (DL+ EQ_x) was found the maximum story drift at story 1 as per IS 1893:2016 the value found decrease story 15 (min) 19% for story 1 (max) value decrease 19% compare of both code parameter.

CHAPTER 5
CONCLUSION

1. As per modification of importance factor in new code(IS 1893:2002), its value changes from 1.5 to 1.2 for Residential or commercial buildings, with occupancy more than 200 persons, the same will significantly changes the horizontal seismic coefficient A_h and due to change in horizontal seismic coefficient, the value for the base shear and lateral load distribution will change.
2. Comparison of Base Shear as per IS 1893:2002 and IS 1893:2016 the value found to be decreased by 20%.
3. Comparison of Lateral load distribution as per IS 1893:2002 and IS 1893:2016 the value found to be decreased 19%.
4. On Comparing the stiffness of two models due to response spectrum as per IS 1893:2002 and IS 1893:2016 the stiffness was found to be decreased by very small values for the respective stories of the two models, example for story 15 (0.0000026%) and story 1 (0.0000023%).As per the tables data of each story the value of lateral stiffness is almost same for both the models (as per IS1893:2002 & IS 1893:2016). As per modification made in 1893:2016 only definition for soft storey is change. It means there is no criteria changing hence the value for all story will be same by analysing using both codes. Only the parameter to decide the soft story changes in term of lateral stiffness.
5. Comparison of Story displacement due to Load combination 1.5 (DL + Response spectrum) was found maximum at story 15 as per IS 1893:2002 and for load combination (0.9 DL+1.5 EQ_x) found the maximum story displacement at story 15 as per IS 1893:2016. Story displacement due to Load combination 1.5 (DL + Response spectrum) was found minimum at story 1 as per IS 1893:2002 and for load combination (0.9 DL + 1.5 EQ_x) Story displacement was found at story 1 as per IS 1893:2016. The value was found to be decreased by 43% for story 15 (max) and 53.56% for story 1 (min).

6. Comparison of Story drift due to Load combination 1.5(DL - EQ_x) was found minimum at story 15 as per IS 1893:2002 and for load combination 1.5 (DL + EQ_x) was found the minimum story drift at story 15 as per IS 1893:2016.For maximum Story drift due to Load combination 1.5 (DL - EQ_x) was found maximum at story 1 as per IS 1893:2002 and for load combination 1.5 (DL + EQ_x) was found the maximum story drift at story 1 as per IS 1893:2016 the value found decrease story 15 (min) 19% for story 1 (max) value decrease 19% compare of both code parameter.

FUTURE SCOPE

1. It is normal that this investigation will be a point of reference to other RC multi story structures far and wide.

2. This will assist us with understanding the conduct of structure according to most recent plan criteria and codal values.

3. The comparative methodology can be taken for standard and sporadic structures having distinctive tallness at various story , it will expand the firmness and float of the structure.