

CODAL COMPARISON OF IS-1893 (PART 1)2002 AND IS-1893 (PART 1) 2016 FOR SIESMIC ANALYSIS OF HIGH RISE BUILDING WITH RAFT FOUNDATION USING ETABS AND SAFE SOFTWARE

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Abstract - In India IS 1893 (Part1) Criteria for Earthquake Resistant Design of Structures is used as code of practice for analysis & designing of earthquake resistant buildings. The sixth revision of IS 1893 (Part 1) 2016, "Criteria for Earthquake Resistant Design of Structures" have been published by Bureau of Indian Standards recently in December 2016. Main intention of present work to compare the behavior of building when applied with seismic load as per the code IS 1893 (Part 1) 2002 and IS 1893 (part 1)2016 and seismic analysis of high rise building i.e. G+12 storey in ETABS. The loads are applied separately based on code IS 1893 (part 1) 2002 and IS 1893 (part 1) 2016 and analysis of super structure is done in ETABS software then results are compared. With the help of super structure axial load the footing is designed i.e. the sub-structure of the building is analyzed in SAFE software by considering the load from super structure.

revised Indian code i.e. IS 1893(part1) 2016 for seismic analysis of tall or high rise structures in FEM based software and results are compared using both code provision. In this paper 12 storey building is modelled and analysed in ETABS software, height of each storey is 3m the city selected for seismic analysis is "CHENNAI" having seismic zone III for medium soil type. The foundation is most important element in the structure which carries out any type of superstructure load and transmits the loads including its self-weight to the underlying soil strata. The Analysis of Raft or Mat Foundation for 12 story high rise building of 23x20m² using SAFE software. This report shows soil pressure and deformed shapes of the Mat foundation when subjected to Static load to that of Dynamic load.

2. Comparison of codes i.e. IS 1893 (part 1) 2002 and IS 1893 (part1) 2016:

A comprehensive study of various clauses of New IS 1893 (Part 1):2016 and Old IS 1893 (Part 1):2002 has been made. Many clauses of old IS 1893-2002 has been revised in new IS 1893-2016. The revisions in major clauses have been presented in the table below with critical comments on that.

Key Words: Equivalent static analysis, Response spectrum analysis, Base shear, Storey drift, Displacement, High rise building, IS-875 (part 3) 1987, IS-875 (part 3) 2015, Raft or Mat Foundation , Punching shear.

1. INTRODUCTION

Earthquake is most unpredictable and devastating of all natural disasters. Effect is not only on the human casualties but also have a tremendous economic impact on effected area. An earthquake can be defined as the sudden and violent shaking of the ground surface layer of the earth (lithosphere) which travels through the earth's crust. In other word it can also be defined as the vibration or sometimes violent of earth surface due to sudden release, which causes a sudden dislocation of crust element, volcanic eruption etc. Seismic waves are formed in dislocation process which is caused due to vibration. These seismic waves travel out from origin of earthquake point at various speeds. Vibrations on the surface of the earth is created due to seismic activity which converts in to Dynamic loads that causes more ground vibration and also anything which attached to it in a complicated manner and makes a very damage to the structure's or other buildings. This paper presents comparison of IS-1893(part 1) 2002 and the

SL. NO	IS 1893 (PART 1) 2002	IS 1893 (PART 1) 2016
1	<u>Importance Factor (I):</u> Importance factor 1.5 was for Important structures and 1.0 for all other buildings, Table-6.	<u>Importance Factor (I):</u> For Residential or commercial Buildings, with occupancy more than 200 persons importance factor 1.2 has been assigned in new code, table 8.
2	<u>Moment of Inertia (I):</u> Clause regarding Moment of Inertia is not mentioned in old code. Thus analysis is made considering full Moment of Inertia, i.e. Un cracked section is considered.	<u>Moment of Inertia (I):</u> The moment of inertia for structural analysis shall be taken as given below. For RC and Masonry Structures : Ieq= 70% for columns Ieq= 35% for beams

3. METHODOLOGY

For design and analysis of high rise building on seismic load following methods are adopted

- 1) Static Method.
 - i. Equivalent Static Method.
- 2) Dynamic Methods.
 - i. Response Spectrum Method.
- 3) After completion of modelling and analysis of building in ETABS software the result for both codal standards are compared.
- 4) Using the lodes from the superstructure the substructure is designed and analysed using SAFE software.

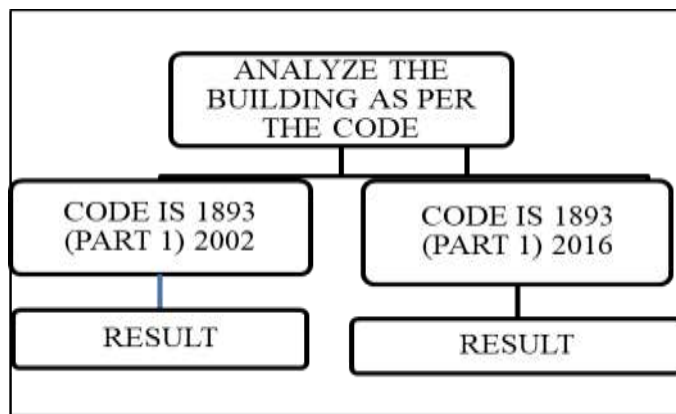


FIG 1: Flow chart

4. DESIGN PARAMETER

ZONE FACTOR (Z)	0.16
CITY	CHENNAI
SOIL TYPE	MEDIUM SOIL
ZONE	III

5. MODEL

The Finite Element Model is created using ETABS software, for performing structural analysis.

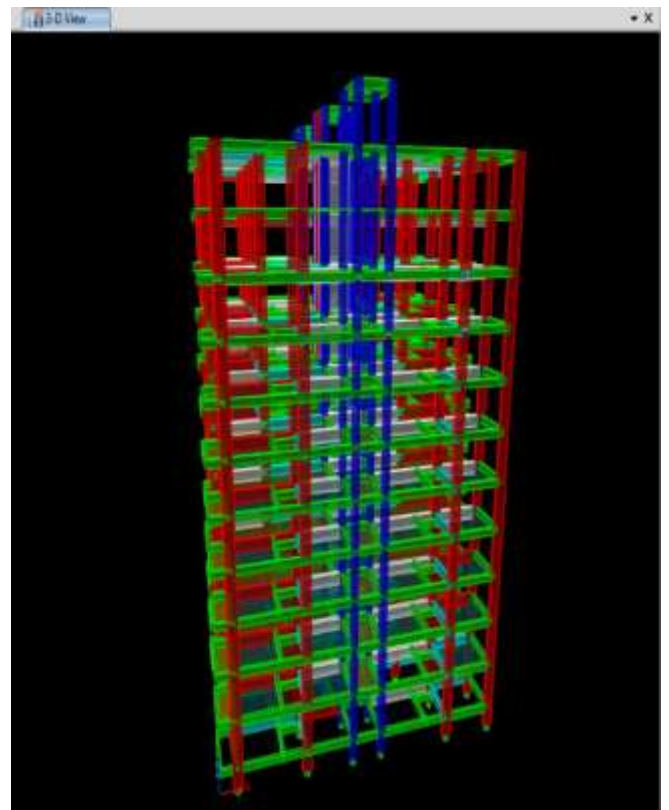


FIG 2: 3D model of 12 storey building.

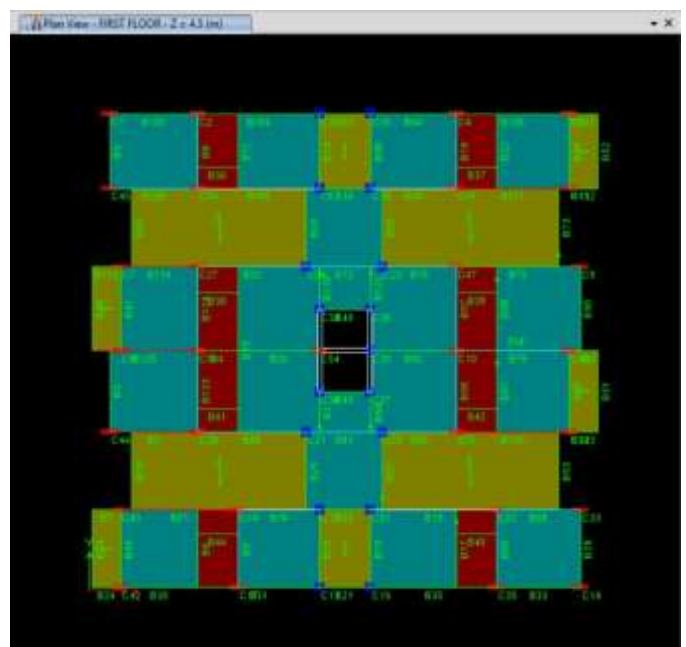


FIG 3: Plan of the building.

6. RESULTS AND DISCUSSION OF SUPERSTRUCTURE USING ETABS SOFTWARE.

Results and discussions of different parameter such as Base shear, Storey Drift and displacement are shown with the help of graphs.

Storey drift:

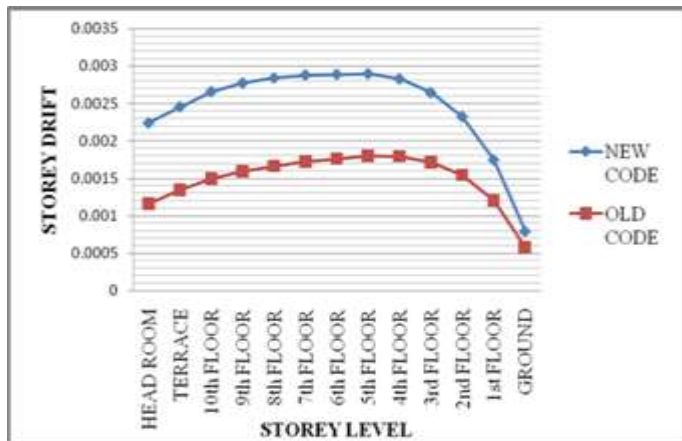


FIG 4: Variance in storey drift along "X" direction.

The ratio of displacement of two consecutive storeys to height of that storey is called storey drift. Storey drift is increased in new code when compared with the old code. Peak storey drift in old code along "X" direction is 0.002239mm and in new code along "X" direction is 0.001163mm. FIG 4: shows the variation in storey drift along "X" direction.

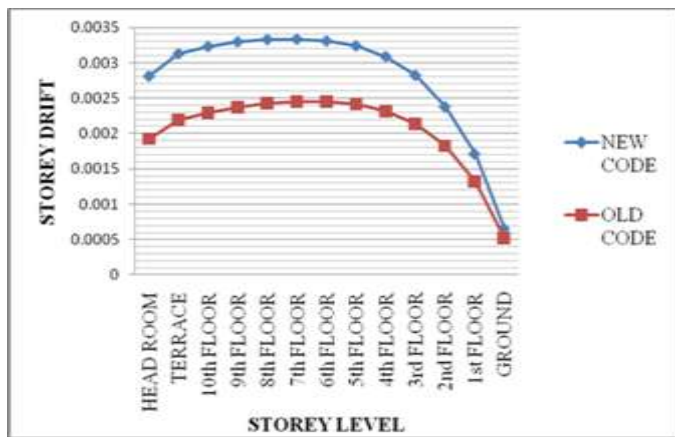


FIG 5: Variance in storey drift along "Y" direction.

The ratio of displacement of two consecutive storeys to height of that storey is called storey drift. Storey drift is increased in new code when compared with the old code. Peak storey drift in old code along "Y" direction is 0.002809mm and in new code along "Y" direction is 0.001921mm. FIG 5: shows the variation in storey drift along "Y" direction.

Storey displacement:

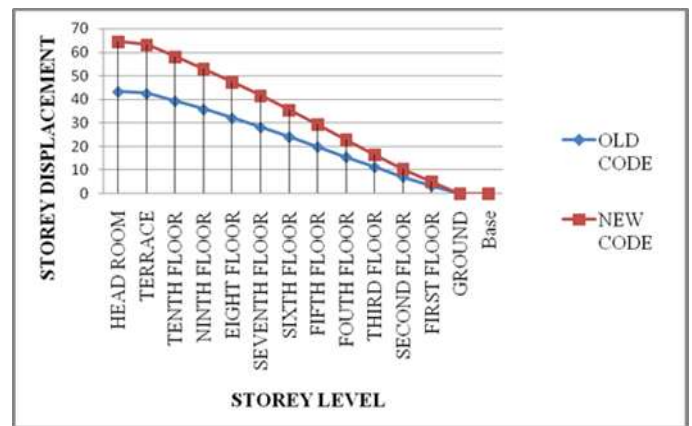


FIG 6: Variance in storey displacement along "X" direction.

Story Displacement is the total displacement of ith storey with respect to ground. Storey displacement is increased in new code when compared with the old code. Peak storey displacement in old code along "X" direction is 43.3mm and in new code along "X" direction is 64.5mm. FIG 6: shows the variation in storey displacement along "X" direction

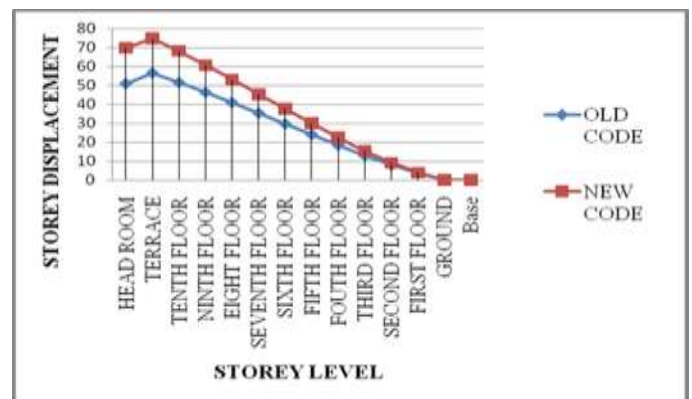


FIG 7: Variance in storey displacement along "Y" direction.

Story Displacement is the total displacement of ith storey with respect to ground. Storey displacement is increased in new code when compared with the old code. Peak storey displacement in old code along "Y" direction is 51mm and in new code along "Y" direction is 69.7mm.

FIG 7: shows the variation in storey displacement along "Y" direction.

Base shear:

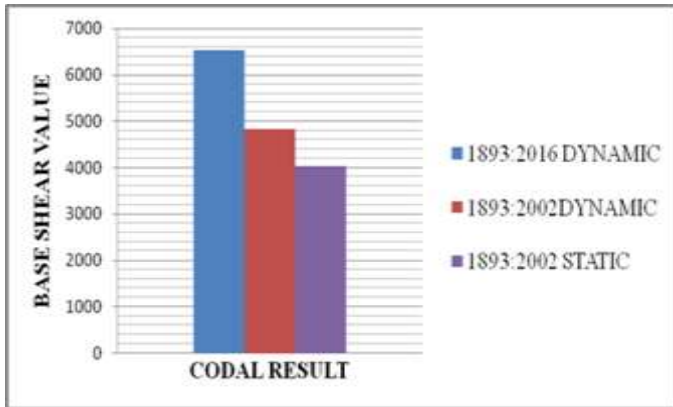


FIG 8: Variance in base shear along "X" direction.

Base shear for 12 storey building along "X" direction is 6535.6767kN for new code along x direction and for old code is 4828.8177kN; the percentage increased in base shear in new code is 35.34% when compared to old code along "X" direction, where base shear for static analysis along "X" direction is 4023.333kN. Therefore base shear has been increased in new code when compared with the old code.

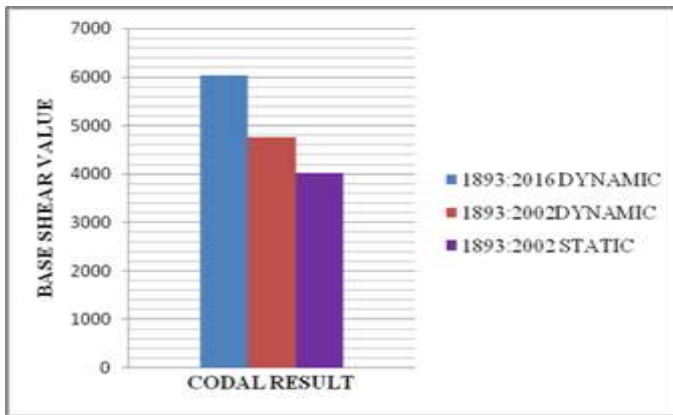


FIG 9 Variance in base shear along "Y" direction.

Base shear for 12 storey building along Y direction for dynamic analysis is 6037.27kN for new code along "Y" direction and for old code is 4750.3571kN; the percentage increased in base shear in new code is 27.09% when compared to old code along "Y" direction, where base shear for static analysis along "Y" direction is 4023.333kN. Therefore base shear has been increased in new code when compared with the old code.

7. METHOD OF MODELLING OF RAFT FOUNDATION USING SAFE SOFTWARE

The Raft or mat foundation is modeled in SAFE software for the loads analyzed. All analysis and design are based on the IS 456-2000 for the following parameters and some of the views are shown below.

8. MATERIAL PROPERTIES OF RAFT OR MAT

PARAMETERS	VALUE
Mat Thickness	600mm
Concrete grade	M40
Steel grade	Fe500
Bearing capacity of soil	200kN/m ²

8. RAFT OR MAT FOUNDATION 3D MODEL IN SAFE SOFTWARE:

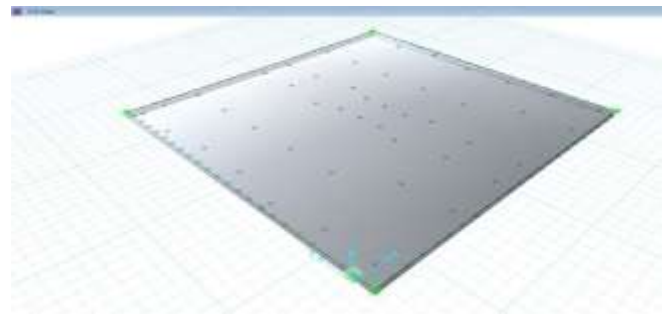


FIG 10: 3D model of Raft or Mat Foundation

9. RESULTS AND DISCUSSION FOR RAFT OR MAT FOUNDATION

Punching shear:

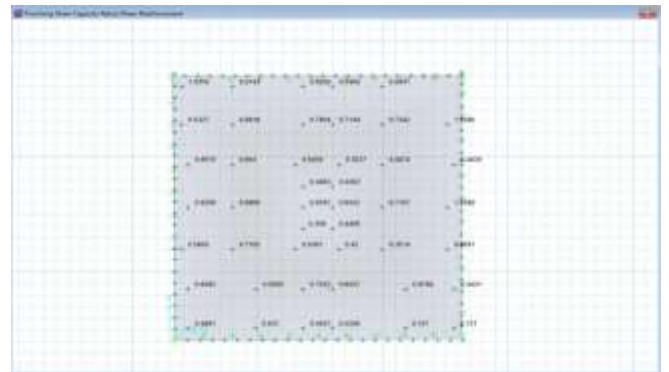


FIG 11: Punching shear value for Raft or mat foundation.

The raft footing is analyzed and designed for 12 storey residential building resting on soil having 200kN/m² bearing capacity of soil using SAFE software. In the above figure 12, the punching shear value for mat foundation should not exceed 1kN/m². If it exceeds increase the thickness of the foundation at that particular loading point.

Displacement:

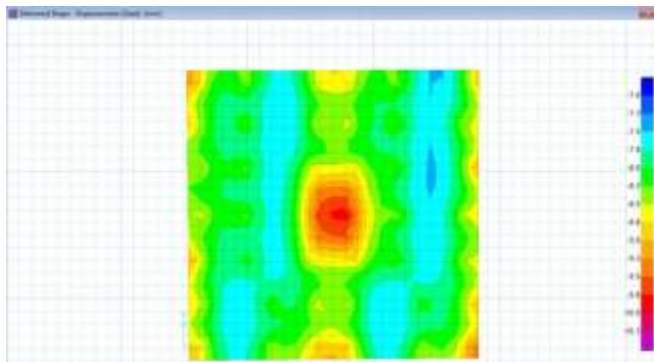


FIG 12: Displacement for mat foundation

The Raft footing is analyzed and designed for 12 storey residential building resting on soil having 200kN/m² bearing capacity of soil using SAFE software. When the mat foundation is subjected to axial and lateral loads, soil pressure is exerted on the mat at the interaction of soil and mat in upward direction. There for causing the displacement in the mat. The resultant displacements are as follows.

Displacement	value (mm)
Corner of the slab	-8.43429
Edge of the slab	-9.290575
Middle of the slab	-9.775356

10. CONCLUSIONS

From the obtained results we can concluded that:

- Story drift** value for dynamic analysis as per is 1893:2016 show high value due to reduction of Moment of Inertia (I)
- Displacement** is increased in the new code [IS-1893 (part 1) 2016], when compared with the old code [IS-1893 (part 1) 2002]. The displacement in the peak storey for 12 storey building is 64.5mm in "X" direction and 69.7mm in "Y" direction for new code and 43.3mm in "X" direction and 51mm in "Y" direction for old code.
- Base shear** has been increased for 35.34% in "X" direction and 27.09% in "Y" direction for IS 1893:2016 compared with per IS 1893:2002.
- Punching shear** value for raft or mat foundation should not exceed 1kN/m². If it exceeds increase the thickness of the foundation at that particular loading point
- Displacement** of the raft or mat foundation is analysis and designed for 12 storey residential building resting on soil having bearing capacity of soil as 100kN/m². Displacement of raft or mat foundation at corner is -8.43429mm, at edge displacement is -9.2905mm and at the middle the displacement is -9.7753.
- From the above result it can be concluded that new code [IS-1893 (part 1) 2016] is more safe for seismic design than the old code [IS-1893 (part 1) 2002].

7. SAFE software is easier to import model loads from ETABS.

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