COMPARATIVE ANALYSIS OF HIGHRISE BUILDING WITH VARIOUS CLAUSES OF SEISMIC CODE IS 1893 (PART- 1) 2002 AND SEISMIC CODE IS 1893 (PART- 1) 2016

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Abstract
Safety of building at the time of construction is an important aspect to be considered. India is a nation where earthquakes takes place at higher scales. Hence it becomes essential to engineer the design of building in such a way that it can resist the shaking during an earthquake. In the present work the Comparative analysis of (G + 9) multi-storey R.C. structure as per Seismic Code IS 1893(Part-1) 2002 clauses and Seismic Code IS 1893 (part-1) 2016 clauses. A plan of size 35.90m X 17m and overall height 30 m has been selected. Analysis made for dead load, live load, earthquake load and various load combination are presented. This analysis is made by using computer software STAAD PRO.
Keywords: Staad pro, Multi-storied building, Shear Wall, Compare IS1893(part -1) 2002, IS1893(part -1) 2016.

INTRODUCTION

An earthquake may be defined as wave like motion generated by forces in constant turmoil under the surface layer of the earth, enormous amounts of energy are released. The size and asperity of an earthquake is estimated by two important parameter- intensity and magnitude. The magnitude is a measure amount of energy released, while the intensity is the apparent effect experienced at a specific location. The response of structure to strong earthquake motion are discussed the need of seismic zoning and general principles to be observed in the earthquake resistant design of structure are also discussed. When structure is subjected to ground motion in an earthquake, it provides a response by undergoing vibration comprising the random movement regarding the ground takes place due to earthquake can be settled in any three commonly perpendicular course the two even bearing (X and Y) and the vertical heading (Z).

Civil engineering structures are designed on the basis of two main criteria – strength and stiffness. The strength is related to damageability or ultimate limit state, whereas the stiffness is related to serviceability limit state for the structure displacements must remain limited. In case of earthquake – resistant design, a new criteria, the ductility should also be added. The first two criteria, can be achieved by-(a) specifying severe (or moderate) design earthquake levels, (b) limiting the maximum stresses at internal forces in critical members, and (c) Limiting the story drift ratio. The third criterion, which is prevention of building collapse, is achieved by providing sufficient strength and ductility to ensure that the structure do not collapse in a service earthquake.

In structure building field numerous kinds of programming are available in advertise, as – STAAD PRO, RISA, ETABS, SAFE, TKKLA, and SAP2000. In this venture work staad master programming are utilized to plan and investigation of structure. STAAD PRO is the most mainstream structure building programming item for 3D model age, examination and multi material plan.

Types of Structures

Braced structures

A typical braced frame is shown in fig 1.5. In braced frames the lateral loads like wind earthquake etc, are resisted by special arrangements like shear walls, shear trusses, bracing or special supports. Thus the beam column frames are not subjected to horizontal loads. In other words the sidesway or joint translation is not possible in column. The structure is called a braced structure and columns occurring in such structure are called the braced column.

The shear walls, shear trusses or bracing provided in the building must have stiffness to act as effective bracings. According to SP: 24 the bracing system must provide a total stiffness equal to at least six times the sum of stiffness of all the columns, within the storey. They may become uneconomical for larger height as shear walls are designed as vertical cantilevers from the ground.

Unbraced Structures

A typical unbraced frame is shown in Figure 1.5 where resistance to horizontal loads is provided by bending in the beam and column in that plane. In other words, the sidesway or joint translation do occur in such frames. These structures are called unbraced structures and the columns occurring in such structures are called unbraced columns.

Dual structures

Dual structures are combination of the above two. The resistance to horizontal loads is provided by both, the bending in frames and by shear walls. The frames and shear walls will resist horizontal forces in proportion to their relative stiffness. However, the frame should be designed to carry minimum 25% horizontal shear.

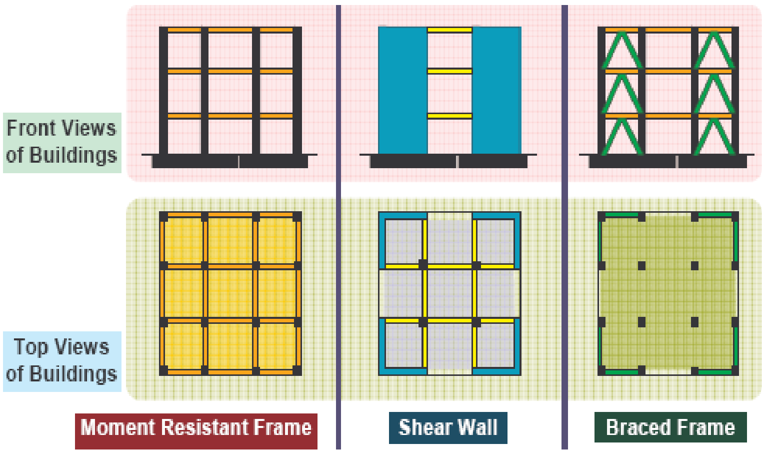

Fig.1: Type Of Structure

Load Combinations

The load which is ever acting on a structure is the dead load which includes the load of partitions also. which may vary in intensity from 0 to 100% of its value , is additive to the effect of the dead load ; as both these loads are gravity or vertical loads .So the structures should be designed by the limit state method for the dead and live load combinations and it is given by the Code [8].

$$U = 1.2 (DL+LL \pm WL \text{ or } EL)$$

For checking over turning live loads in above equation may be made zero and 10% reduction may be made in the dead load to account for any inaccuracy in the calculation of the dead load . This will give the following load combinations for isolated tall structure,

$$U=1.2(0.9DL \pm WL \text{ or } EL)$$

For inclusion of the blast effect in structural design, we consider a load factor of 1.5 for blast loading, as it occurs frequently in the open cast mining areas. So, for such areas the governing load combination, in addition to those given above, is also,

$$U=1.5(D+L+B)$$

Also it is assumed that the worst effect of blast will not take place together with the worst effect of earthquake or wind or temperature.

The notation in equations is explained below:
U= ultimate load
D= dead load
L= live load
W=wind load
E= earthquake load
T=temperature and shrinkage load
B= blast load

Literature Reviews

P.S. Girigosavi, Prof. M. S. Kakamare Apr-2018" STATIC ANALYSIS OF MULTI-STORIED BUILDING AS PER IS 1893-2002 AND IS 1893-2016"[3]: This paper worried about investigation on modification of IS 1893-2016.The static analysis of multi-celebrated structure is finished by utilizing FEM based programming. In present examination, the static analysis is done according to IS 1893-2016 and results, for example, parallel uprooting, base shear, story drift are contrasted and IS1893-2002. This paper manages the examination of configuration powers for multi-celebrated buildings, acquired by utilizing IS 1893-2016 code, with those got by the past IS1893-2002 rendition. From the aftereffects of seismic analysis of buildings it is presumed that the IS1893-2016 is increasingly moderate for tremor analysis of multi-story buildings.

Urunkar S. S., Bogar V. M., Hadkar P. S.(COMPARATIVE STUDY OF CODAL PROVISIONS IN IS 1893 (PART 1): 2002 & IS 1893 (PART 1): 2016) [4]: The conditions gave in seismic code manage the planners to improve the conduct of structures during a quake and withstand against it without critical death toll and property. For India, Indian Standard Criteria for Earthquake Resistant Design of Structures (IS 1893 Part 1) provides the required clauses to structural designers for designing earthquake resistant buildings. Because of nonstop research, picked up information and encounters, the IS 1893 Part 1 has been updated at whatever point required. The relative investigation of codal arrangements is required to be made at whatever point the code is reconsidered. This paper contains the near investigation of an IS 1893 (Part 1):2002 and IS 1893 (Part 1):2016. The paper for the most part centers around the modified codal arrangements in IS 1893 (Part 1):2016.

S. Farrukh Anwar, A. K. Asthana (2013) "Evaluation of Seismic Design Forces of Indian Building Code" [5]: The ongoing fifth modification of Indian Seismic Code, IS: 1893 has been part into five separate parts for various kinds of structures. The new code IS: 1893 (Part-1) 2002 contains arrangements explicit to buildings just, alongside general arrangements appropriate to all structures. This paper manages the examination of seismic plan powers for multi-celebrated buildings, acquired by utilizing the new code, with those got by the past 1984 adaptation. From the aftereffects of seismic analysis of buildings it is reasoned that the new code is increasingly traditionalist for buildings laying on delicate and medium soils.

S.K. Ahirwar, S.K. Jain and M. M. Pande (2008) "earthquake loads on multistorey buildings as per is: 1893- 1984 and is: 1893-2002: a comparative study" [6]: Accordingly Indian seismic code Seems to be: 1893 has likewise been amended in year 2002.This paper shows the seismic burden estimation for multi-story buildings according to May be: 1893-1984 and IS: 1893-2002 proposals. Four multistorey RC encircled buildings going from three celebrated to nine celebrated are considered and broke down. The procedure gives a lot of five individual analysis successions for each building and the outcomes are utilized to think about the seismic reaction viz. story shear and base shear registered according to the two adaptations of seismic code. The seismic powers, processed by IS: 1893-2002 are seen as essentially higher, the distinction fluctuates with structure properties. It is reasoned that such examination should be done for singular structure to foresee seismic helplessness of RC confined buildings that were planned utilizing before code and because of updates in the codal arrangements may have rendered perilous.

Dr. H. SudarsanaRao [9]: thought about lateral powers determined according to the arrangements of IS 1893-1984 and IS 1893-2002 for two buildings, one is of 12 stories in region which was in zone I yet later on moved up to zone II, and another structure is of 11 stories arranged in zone II. The STAAD Pro programming was utilized for analysis of both contextual investigations. Creator inferred that the powers determined according to IS 1893-2002 gave higher qualities than the past rendition of working in zone I moved up to zone II. The perception made that the base shear an incentive according to amended IS 1893-2002 is higher for structures in zone II.

AnojSurwase, Dr. Sanjay K. Kulkarni , Prof. Manoj Deosarkar(2018) [10]:"Seismic Analysis and Comparison of IS 1893(Part-1) 2002 and 2016 of (G+4) Regular and Irregular Building": Considerable improvement in tremor safe structure has been seen in later past. Thus, Indian seismic code IS: 1893 has additionally been reconsidered in year 2016, following a hole of 14 years. This paper displays the seismic burden estimation for multistorey buildings according to May be: 1893-2002 and IS: 1893-2016 proposals. The strategy for analysis and structure of multi-story (G+4) private structure situated in zone III, IV. The extension behind exhibiting this task is to learn applicable Indian standard codes are utilized for plan of different structure component, for example, shaft, segment, section, 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, most extreme story removal.

Methodology

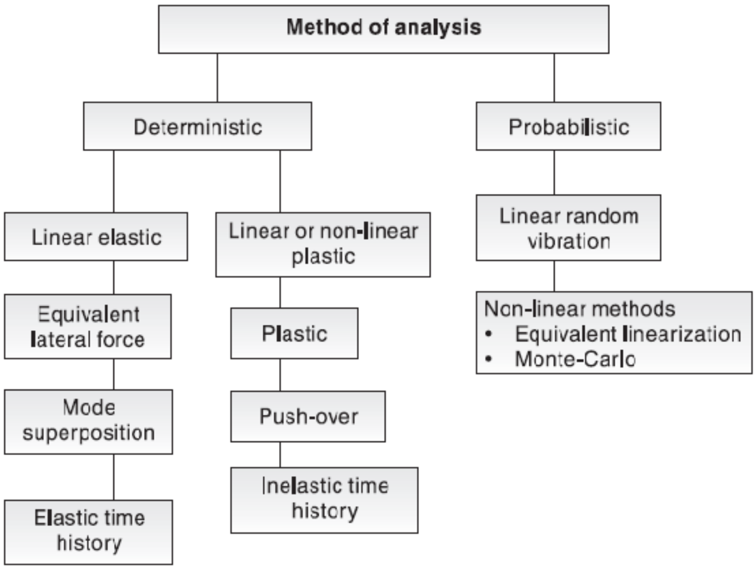

Fig. 2: Method of Analysis

Analysis by using staad pro

STAAD.PRO is the most famous basic building programming item for 3D model age, examination and multi-material plan. It has a natural, easy to understand GUI, representation devices, ground-breaking examination and plan offices and consistent coordination to a few other displaying and structure programming items.

For static or dynamic investigation of extensions, control structures, implanted structures (passages and ducts), pipe racks, steel, solid, aluminum or timber structures, transmission towers, arenas or some other basic or complex structure, STAAD.PRO has been the decision of plan experts around the globe for their particular examination needs.

Load Acts on the structure

In my analysis three type of load was consider which is given below:

- Dead load
- Live load
- Seismic load As Per IS: 1893-2002 (Part-1), IS 1893-2016 (Part 1).

Table 1: Seismic Definition as per IS 1893 (Part-1) 2002 Clauses

Parameters	**Value**
Zone (II)	0.10
Response Reduction Factor (RF)	5
Importance Factor (I)	1
Rock and soil site factor (SS)	1
Type Of Structure (ST)	1
Damping ratio (DM)	0.05
Period in X direction (PX)	0.45 [(0.09 X h)/√dx] [(0.09 X 30)/√35.90 = 0.45 s]
Period in Z direction (PZ)	0.65 [(0.09 X h)/√dz] [(0.09 X 30)/√17.00 = 0.65 s]
Depth of Foundation (DT)	1.8

Table 2: Seismic definition as per IS 1893 (Part-1) 2016 clauses

Parameters	**Value**
Zone (II)	0.10
Response Reduction Factor (RF)	5
Importance Factor (I)	1.2
Rock and soil site factor (SS)	1
Type Of Structure (ST)	1
Damping ratio (DM)	0.05
Period in X direction (PX)	0.45 [(0.09 X h)/√dx] [(0.09 X 30)/√35.90 = 0.45 s]
Period in Z direction (PZ)	0.65 [(0.09 X h)/√dz] [(0.09 X 30)/√17.00 = 0.65 s]
Depth of Foundation (DT)	1.8

Plan of Structure

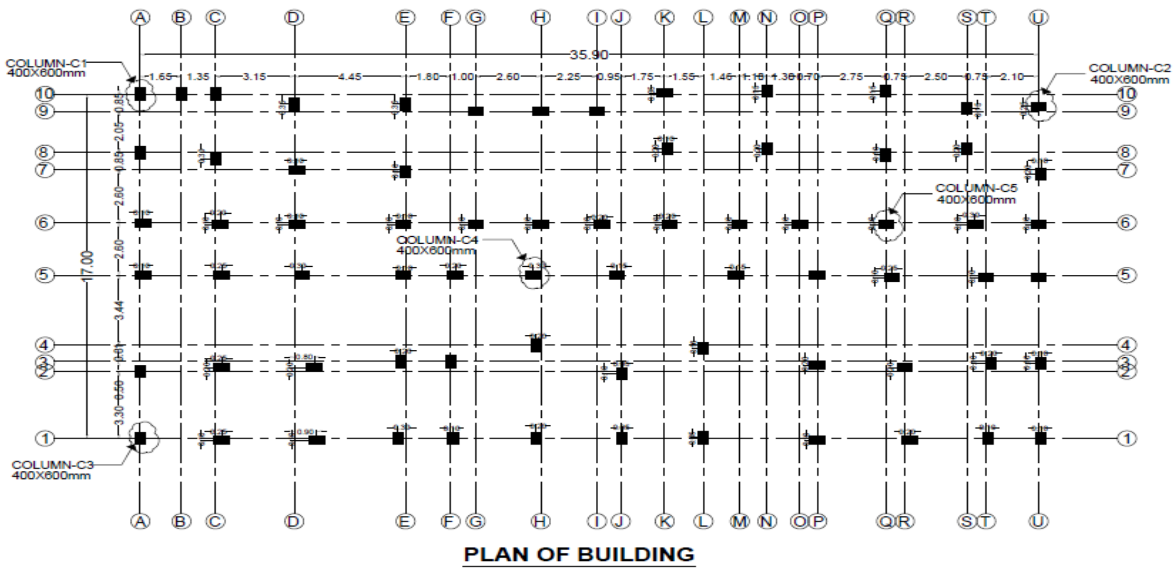

Fig. 3: Plan Of Building

Plan of Structure With shear wall

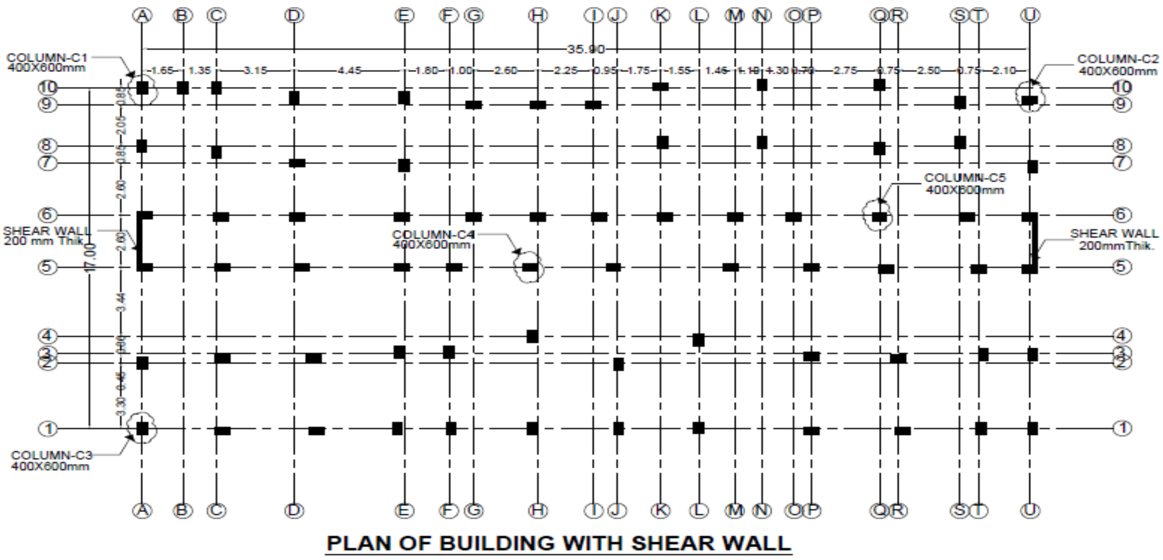

Fig. 4: Plan Of Building With Shear Wall

Height of structure

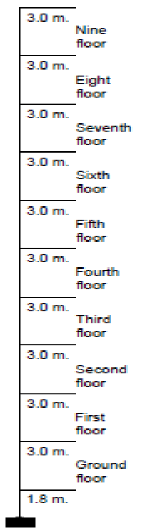

Fig. 5: Height Of Structure

Loading Combination used for analysis

Table 3: Table Caption in Title Case.

I	1.5 (DL+LL)
II	1.2 ($DL+LL+EL_Z$)
III	1.2 ($DL+LL-EL_Z$)
IV	1.2 ($DL+LL+EL_x$)
V	1.2 ($DL+LL-EL_x$)
VI	1.5 ($DL+EL_Z$)
VII	1.5 ($DL-EL_Z$)
VIII	1.5 ($DL+EL_x$)
IX	1.5 ($DL-EL_x$)
X	0.9 DL +$1.5EL_Z$
XI	0.9 DL -$1.5EL_Z$
XII	0.9 DL +$1.5EL_x$
XIII	0.9 DL -$1.5EL_x$

Modelling Of Structure

Table 4: Table Caption in Title Case.

Number of Nodes	3945
Number Of Beam	7853
Number Of Support	71

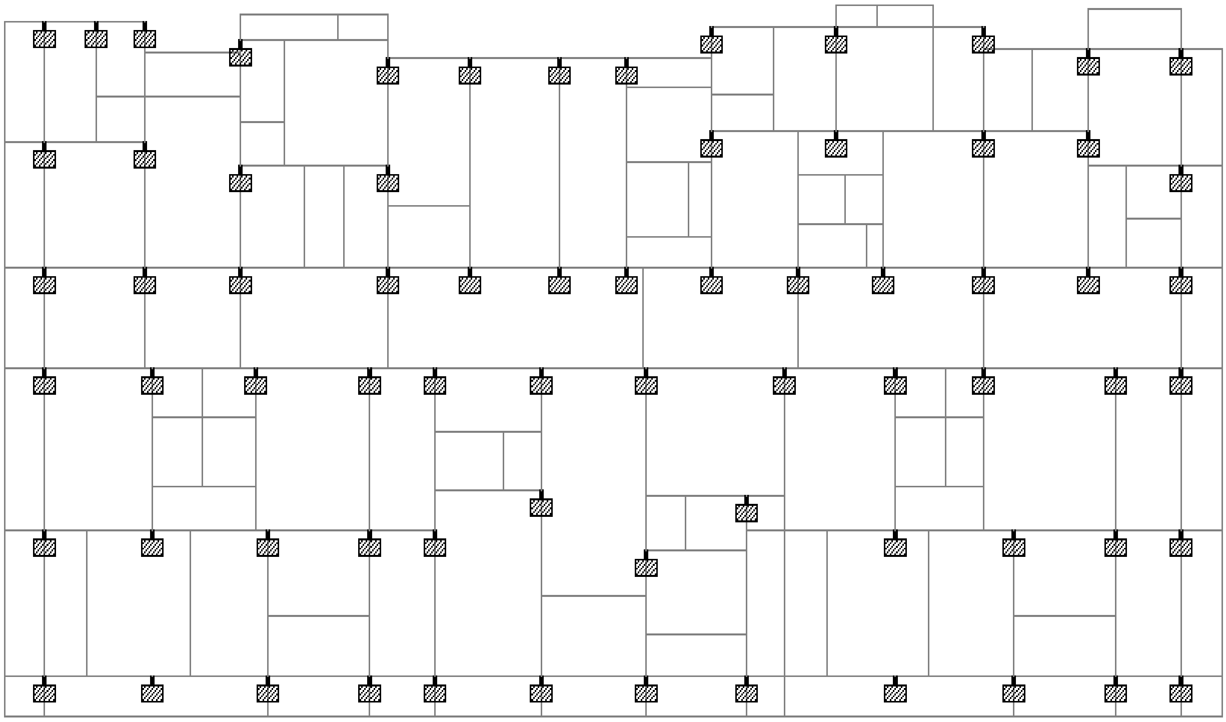

Fig. 6: Plan of structure

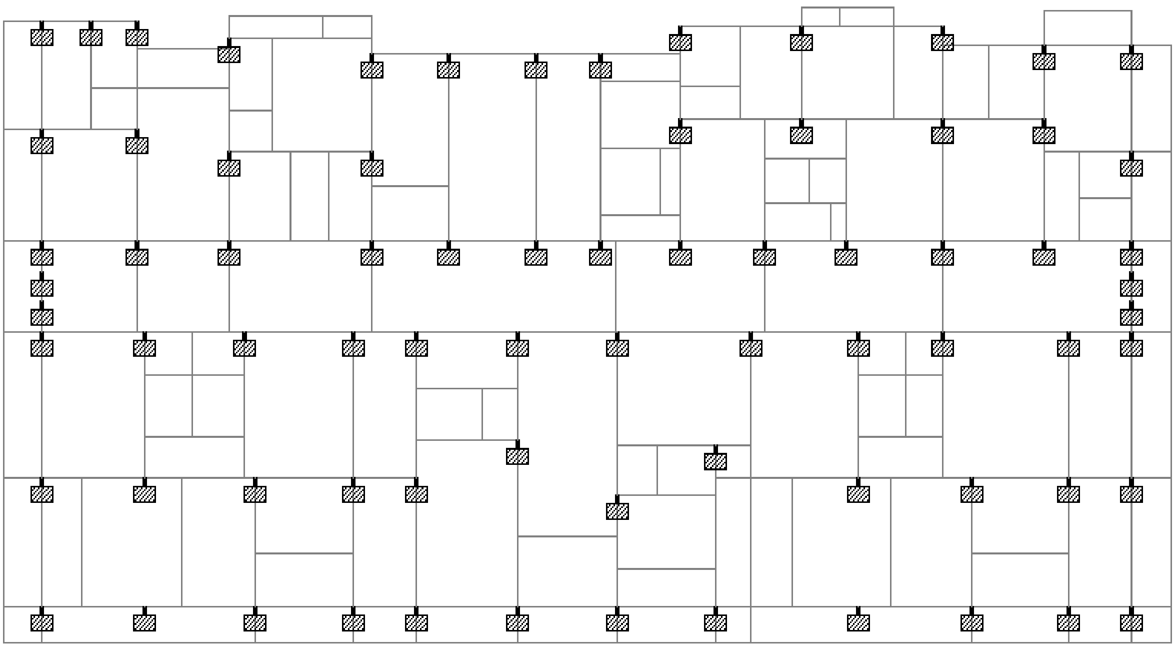

Fig. 7: Plan of structure with shear wall

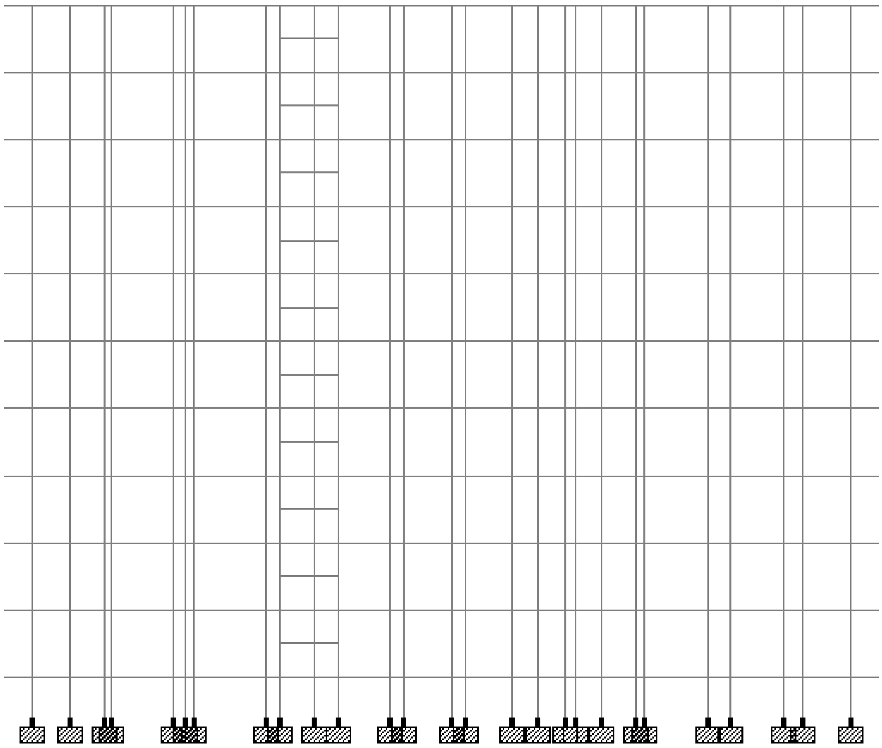

Fig. 8:elevation

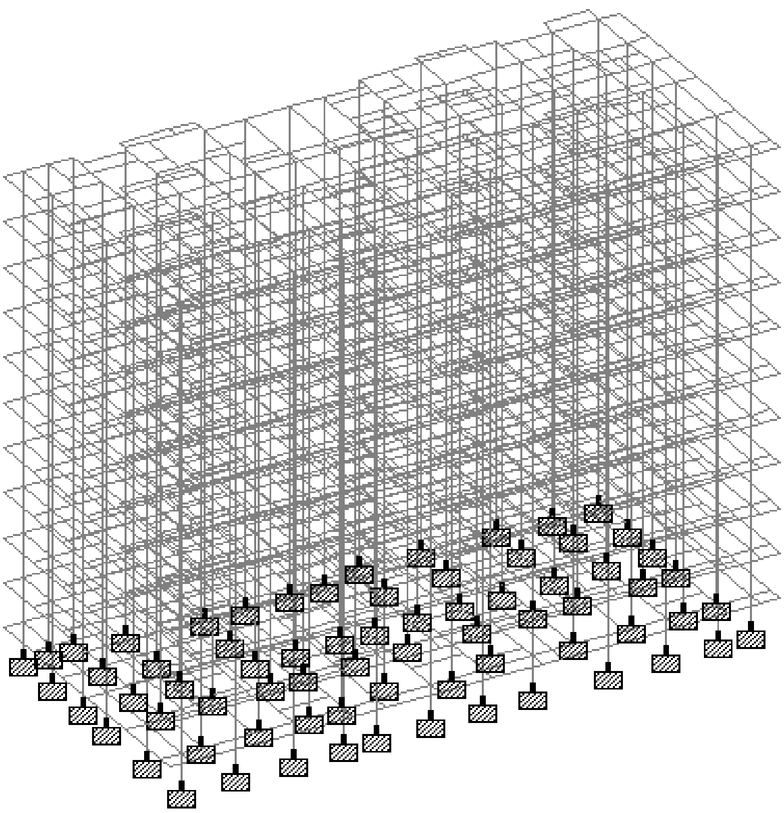

Fig. 9:3D view

Results

Comparison of base shear when structure is analyzed as per Seismic code IS 1893(Part-1) 2002 Clauses and as per Seismic code IS 1893(Part-1)2016 Clauses.

Table 5: Comparison Base shear

IS Code	Base shear Direction - X	Base shear Direction - Z
IS 1893-2002	3306.13	2253.23
IS 1893-2016	3963.13	2705

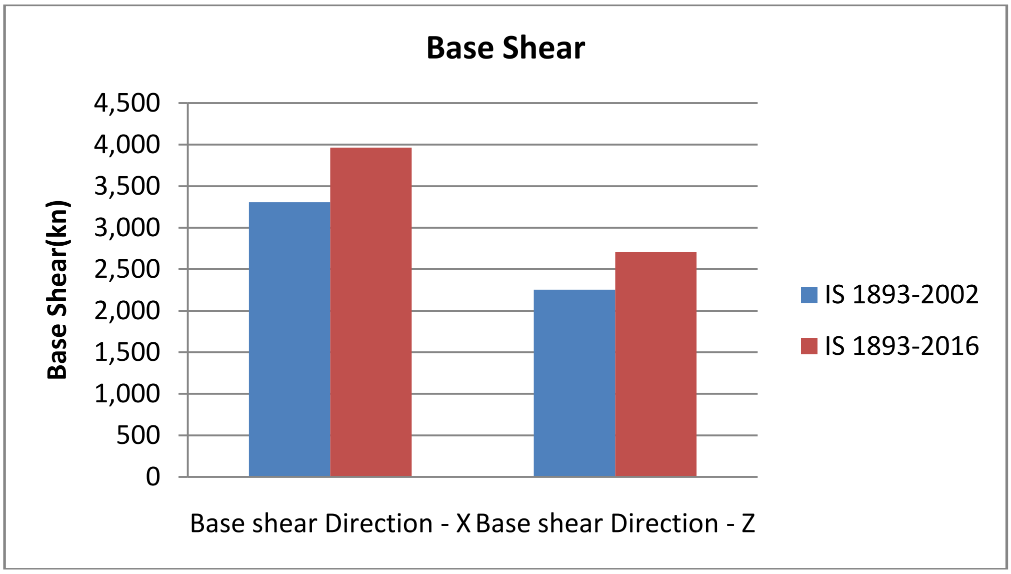

Fig.20: Comparison Base shear

Parameter 3. Comparison of nodal displacement when structure is analyzed as per Seismic code IS 1893(Part-1) 2002 Clauses and as per Seismic code IS 1893(Part -1)2016 Clauses.

Table 6: Comparison Nodal Displacement

Floor Level	Column C1			
	Displacement (mm)			
	IS 1893(Part 1)-2002		IS 1893(Part 1)-2016	
	X-Direction	Z- Direction	X-Direction	Z-Direction
N.F.	24.652	0.928	58.965	22.732
E.F.	23.678	0.920	57.208	22.169
S.F.	22.100	0.901	54.447	21.155
S.F.	20.153	0.855	50.568	19.674
F.F.	17.802	0.784	45.623	17.764
F.F.	15.140	0.690	39.694	15.485
T.F.	12.259	0.578	32.927	12.87
S.S.	9.246	0.451	25.551	9.979
F.F.	6.189	0.310	17.712	6.875
G.F.	3.209	0.162	9.551	3.644
P.L.	0.618	0.032	1.873	0.707

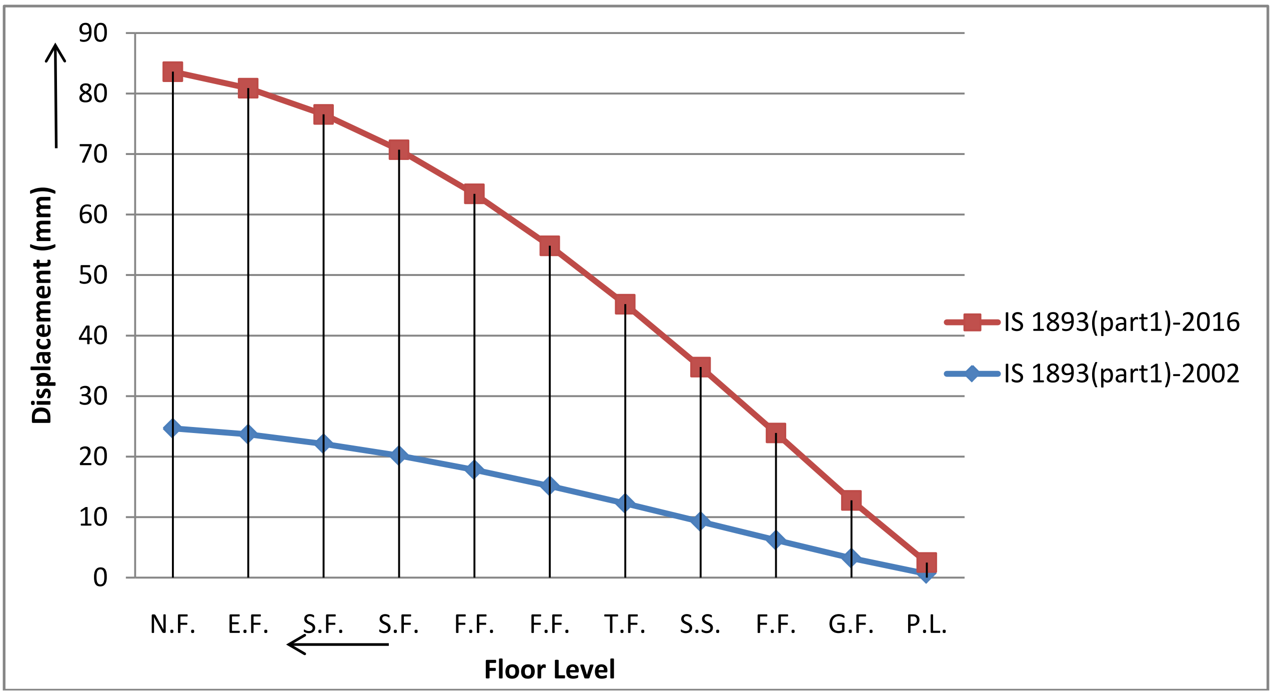

Fig.31:C1 Column Displacement (mm)- X Direction

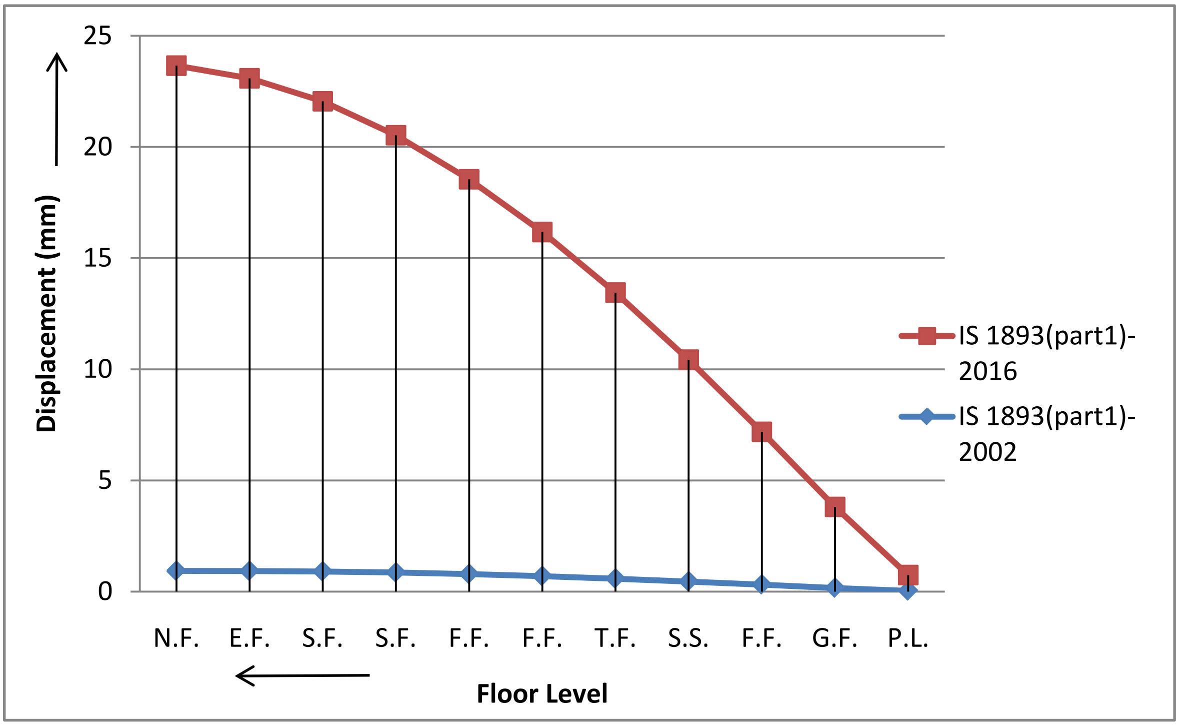

Fig.42:C1 Column Displacement (mm) - Z Direction

Parameter 4. Comparison of storey drift when structure is analyzed as per Seismic code IS 1893(Part-1) 2002 Clauses and as per Seismic code IS 1893(part-1)2016 Clauses.

Table 7: Comparison Storey Drift

Floor Level	Column C1			
	Storey Drift (mm)			
	IS 1893(Part 1)-2002		IS 1893(Part 1)-2016	
	X- Direction	Z- Direction	X- Direction	Z- Direction
N.F.	0.974	0.008	1.757	0.563
E.F.	1.578	0.019	2.761	1.014
S.F.	1.947	0.046	3.879	1.481
S.F.	2.351	0.071	4.945	1.910
F.F.	2.662	0.094	5.929	2.279
F.F.	2.881	0.112	6.767	2.615
T.F.	3.013	0.127	7.376	2.891
S.S.	3.057	0.141	7.839	3.104
F.F.	2.980	0.148	8.161	3.231
G.F.	2.591	0.130	7.678	2.937
P.L.	0.618	0.032	1.873	0.707

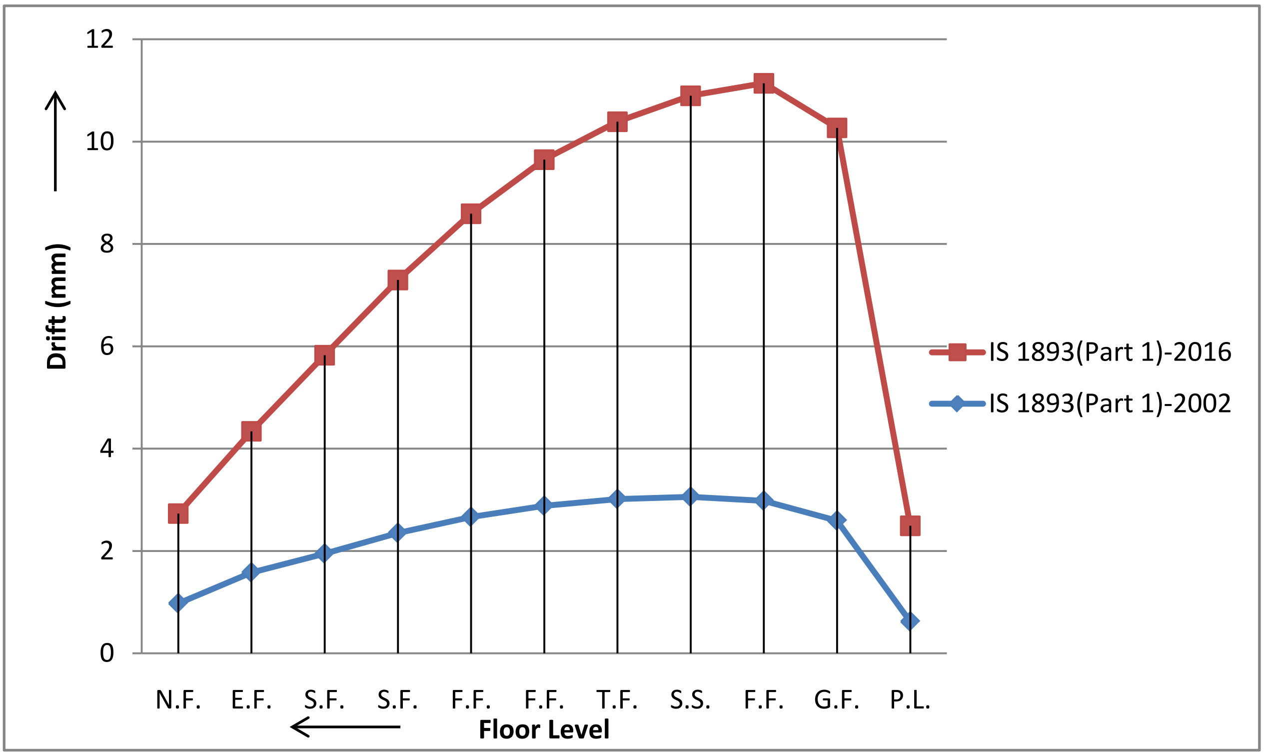

Fig. 13:C1 Column Storey Drift(mm)- X Direction

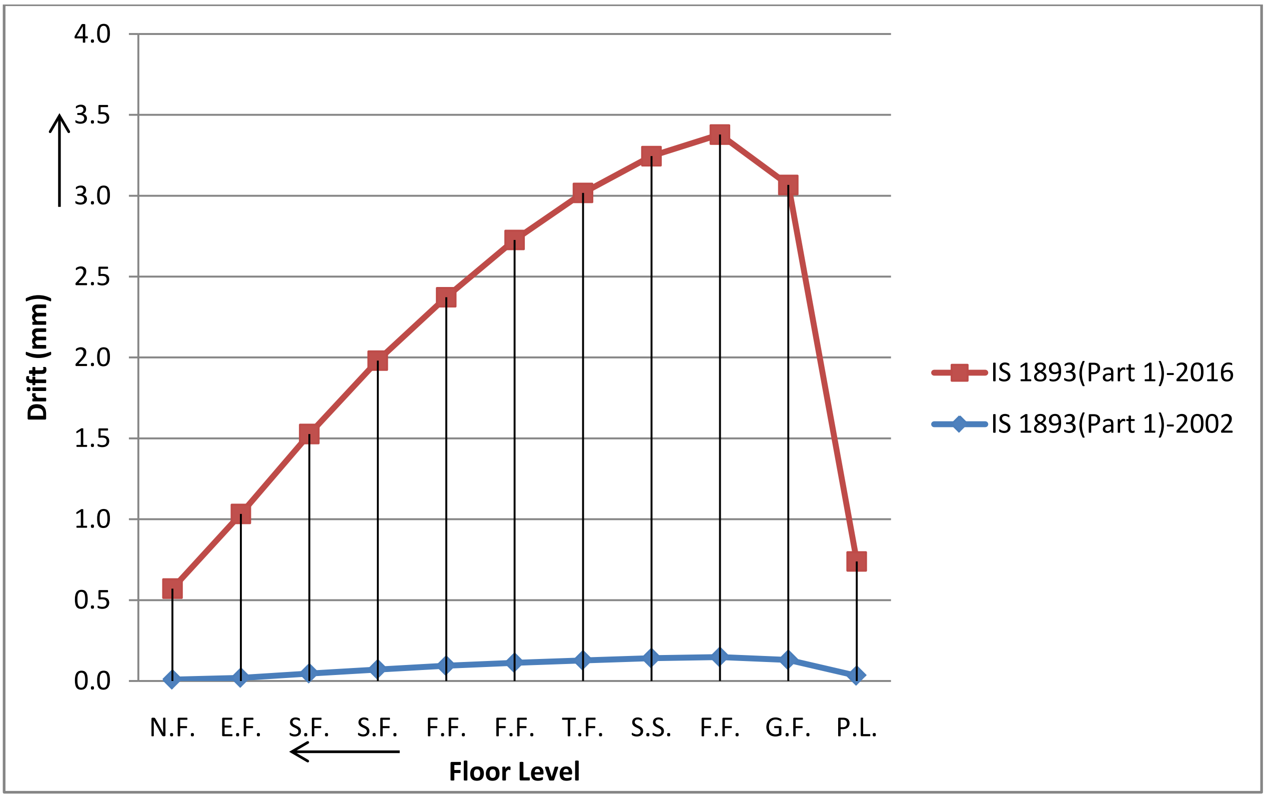

Fig. 14:C1 Column Storey Drift(mm)- Z Direction

Parameter 5. Comparison of nodal displacement when structure is analyzed with shear wall and without shear wall as per Seismic code IS 1893(part-1)2016 Clauses.

Table 8: Comparison nodal displacement

	Column C1			
Floor Level	Displacement (mm) as per IS 1893 (Part-1)2016			
	Without Shear wall		With Shear wall	
	X- Direction	Z- Direction	X- Direction	Z- Direction
N.F.	58.965	22.732	45.079	6.089
E.F.	57.208	22.169	43.504	5.762
S.F.	54.447	21.155	41.29	5.366
S.F.	50.568	19.674	38.286	4.882
F.F.	45.623	17.764	34.512	4.3
F.F.	39.694	15.485	30.026	3.625
T.F.	32.927	12.87	24.911	2.875
S.S.	25.551	9.979	19.257	2.082
F.F.	17.712	6.875	13.175	1.298
G.F.	9.551	3.644	6.923	0.603
P.L.	1.873	0.707	1.339	0.112

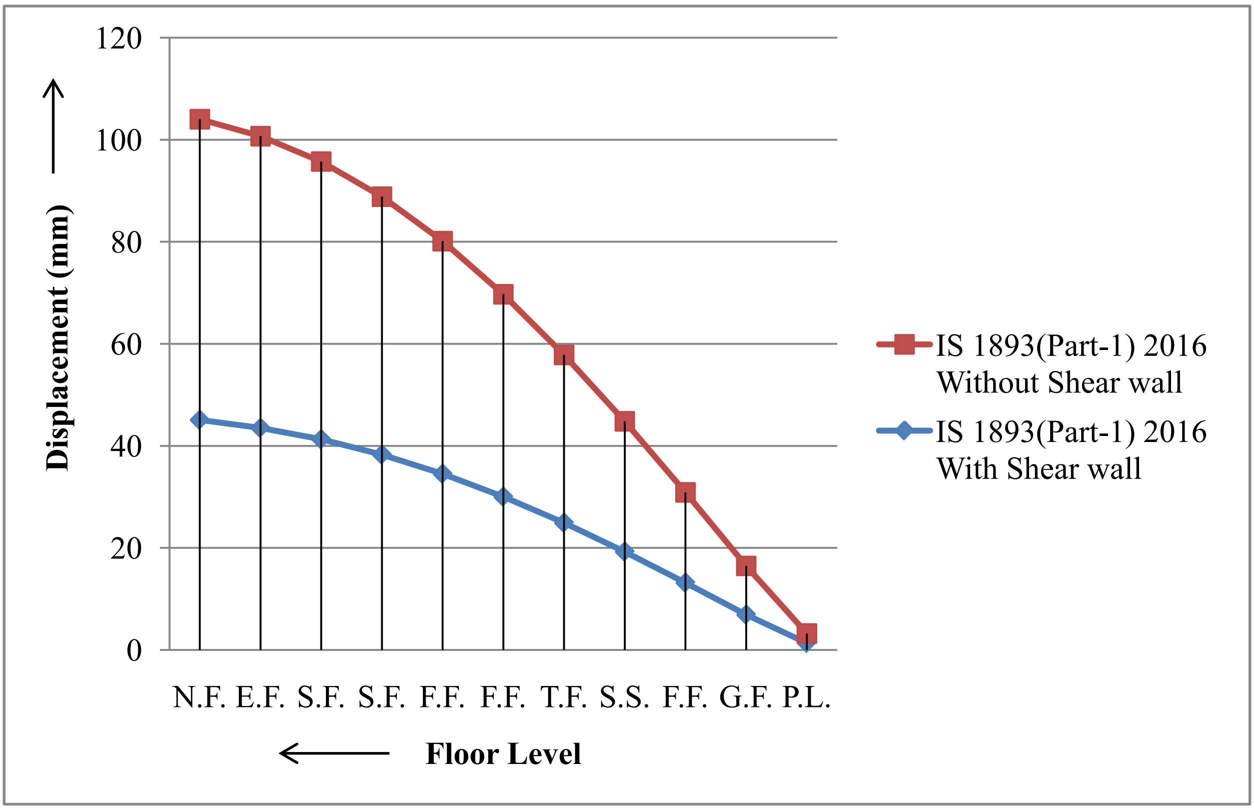

Fig.15 : C1 Column Displacement (mm)- X Direction

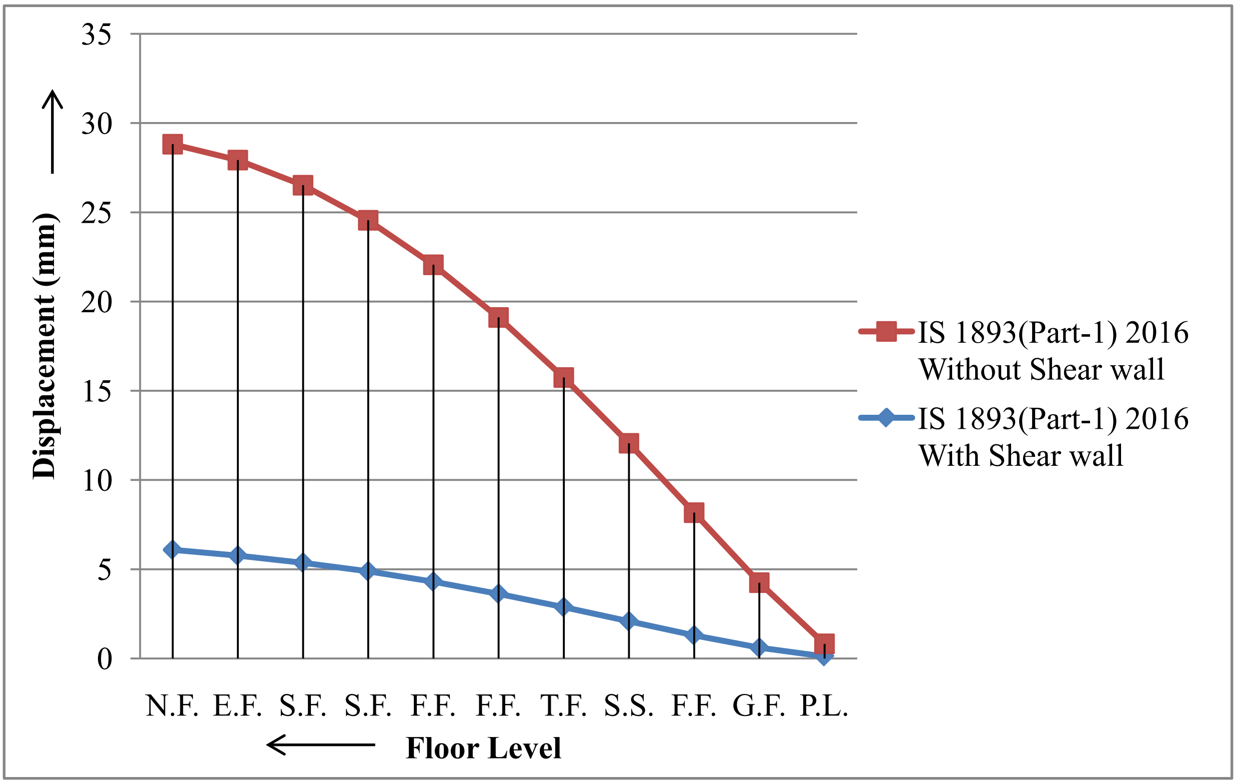

Fig.16 : C1 Column Displacement (mm) - Z Direction

Parameter 6. Comparison of Storey Drift when structure is analyzed with shear wall and without shear wall as per Seismic code IS 1893(part-1)2016 Clauses .

Table9 : Comparison Storey Drift

Floor Level	Column C1			
	Storey Drift (mm) as per IS 1893 (Part-1)2016			
	Without Shear wall		With Shear wall	
	X- Direction	Z- Direction	X- Direction	Z- Direction
N.F.	1.757	0.563	1.575	0.327
E.F.	2.761	1.014	2.214	0.396
S.F.	3.879	1.481	3.004	0.484
S.F.	4.945	1.910	3.774	0.582
F.F.	5.929	2.279	4.486	0.675
F.F.	6.767	2.615	5.115	0.750
T.F.	7.376	2.891	5.654	0.793
S.S.	7.839	3.104	6.082	0.784
F.F.	8.161	3.231	6.252	0.695
G.F.	7.678	2.937	5.584	0.491
P.L.	1.873	0.707	1.339	0.112

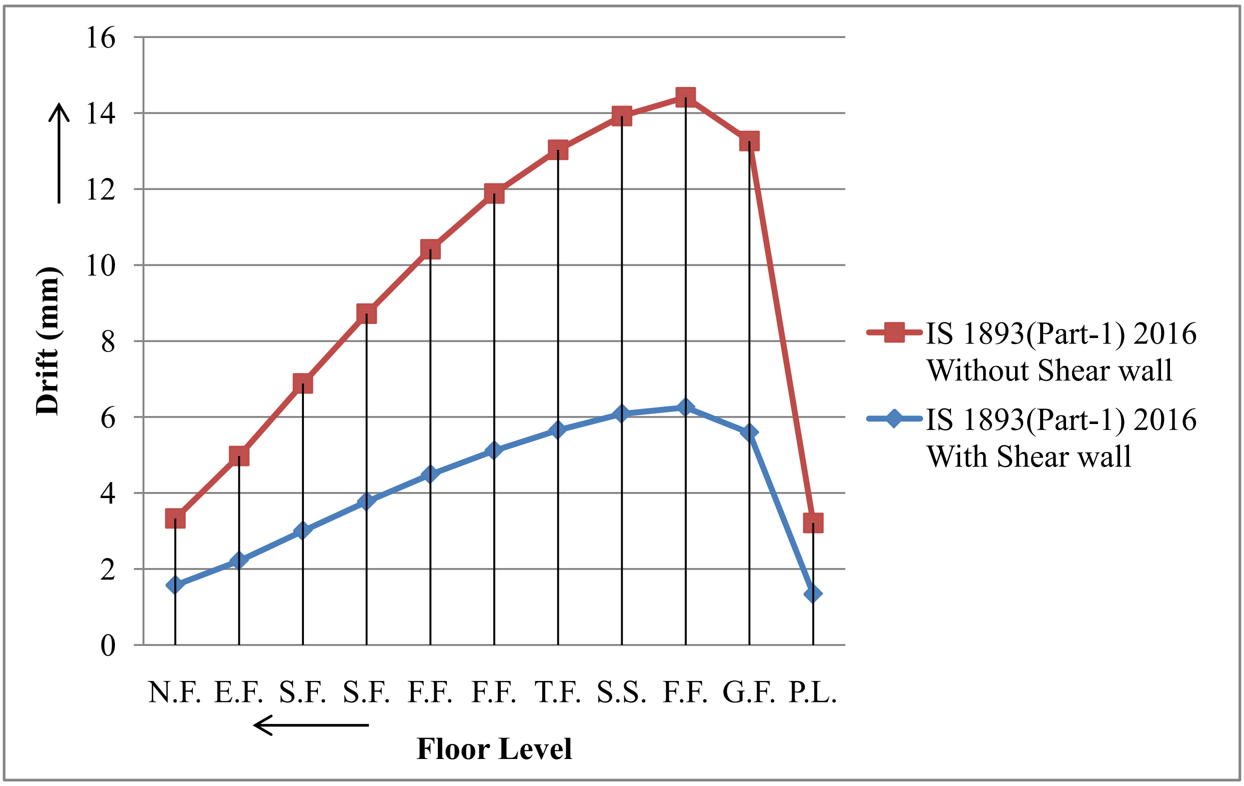

Fig. 17 :C1 Column Storey Drift (mm)- X Direction

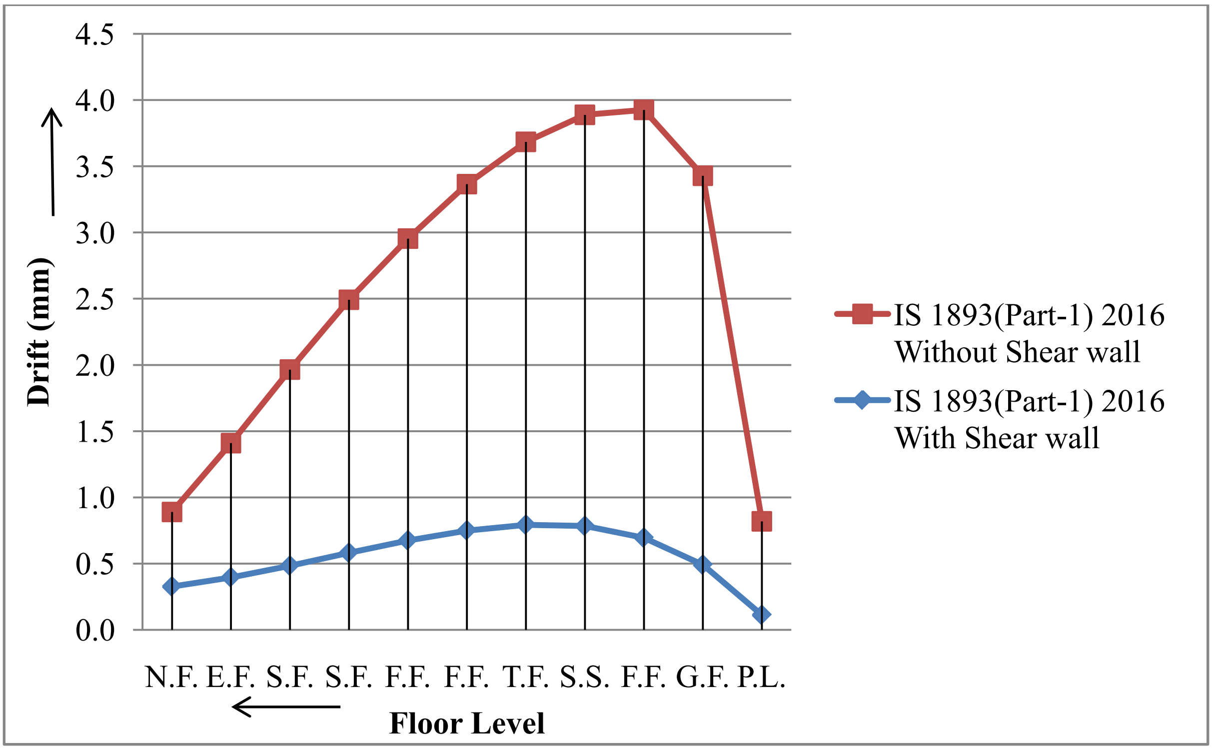

Fig.18 :C1 Column Storey Drift (mm)- Z Direction

Conclusions

In the present work the Seismic investigation of (G + 9) multi-story R.C. structure according to Seismic Code IS 1893(Part-1) 2002 statements and Seismic Code IS 1893 (section 1) 2016 provisions. An arrangement of size 35.90m X 17m and generally speaking tallness 30 m has been chosen. Examination made for dead burden, live burden ,seismic tremor load and different burden mix are displayed. This investigation is made by utilizing PC programming STAAD PRO.

The structure is broke down for Six diverse Parameter and results are produced for these Six Parameter. First Parameter includes examination of Seismic code IS 1893(Part-1) 2002 Clauses and Seismic code IS 1893(Part-1) 2016 Clauses.

Second Parameter includes correlation of Base shear when structure is examined according to Seismic code IS 1893(Part-1) 2002 Clauses and Seismic code IS 1893(Part-1) 2016 Clauses. For this Parameter results dependent on correlation of Base shear are introduced in unthinkable structure and thought about by charts.

Third Parameter includes correlation of Nodal Displacement when structure is examined according to Seismic code IS 1893(Part-1) 2002 Clauses and Seismic code IS 1893(Part-1) 2016 Clauses. For this Parameter results dependent on examination of Nodal Displacement are introduced in unthinkable structure and thought about by diagrams.

Fourth Parameter includes examination of Story Drift when structure is broke down according to Seismic code IS 1893(Part-1) 2002 Clauses and Seismic code IS 1893(Part-1) 2016 Clauses. For this Parameter results dependent on examination of Story Drift are exhibited in unthinkable structure and thought about by charts.

Fifth Parameter includes Comparison of nodal dislodging when structure is broke down with shear divider and without shear divider according to Seismic code IS 1893(section 1)2016 Clauses . For this Parameter results dependent on correlation of nodal relocation are displayed in unthinkable structure what's more, looked at by charts.

6th Parameter includes Comparison of Story Drift when structure is dissected with shear divider and without shear divider according to Seismic code IS 1893(section 1)2016 Clauses . For this Parameter results dependent on correlation of Story Drift are displayed in unthinkable structure and thought about by diagrams.

In this section we characterize the correlation of code and after examination of code provisions float ,removal and base shear esteem is higher in X and Z bearing in Parameter 2, Parameter 3 and Parameter 4 as indicated by Seismic code IS 1893 (part-1)2016 statements as contrast with Seismic code IS 1893 (section 1) 2002 provisos.

The explanation of base shear esteem is higher as I (Importance factor) as indicated by old code provisions: 6.4.2 significance factor(I) 1.0 for every single other structure however now in new code conditions 7.2.3 for private or business working with inhabitance in excess of 200 people significance factor 1.2 has been appointed. After a progressions an incentive As I increment ,Ah will increment and in this manner base shear VB will increment.

This may prompt increment in measure of sidelong loads on the structure and in the end increment the size of the parallel burden opposing individuals and fortification. eventually structure cost may increment however in a similar time the auxiliary quality is likewise increase.to ward the seismic tremor load. float and dislodging esteem is higher in Case of snapshot of Inertia (I), this conditions is included for security and post-quake impact. In Seismic code IS 1893 (Part-1) 2002 full area, full M.I. of segment and pillar considered. In Seismic code IS 1893(Part-1) 2016, split segment with 70 % MI of Columns and 35 % MI of Beam is considered. As concrete is appear to be broken segment record-breaking, one can't consider the full MI of RC segment for examination. Full MI of RC individuals makes make structure solid thus the redirection at top story, float of story, Lateral removal of story and so forth assessed wrongly as littler qualities. Then again by thinking about the broke snapshot of idleness horizontal redirection, floats and so on will increment and to control one ought to need to expand the size of parallel burden opposing individuals which eventually cause wellbeing of structure. Thus for wellbeing it is increasingly sensible to consider broken area properties in investigation.

Diminishing the higher estimation of float and dislodging factor, we giving the shear divider framework in this structure according to Seismic code IS 1893 (section 1) 2016 provisions. Think about the outcomes without shear divider and with shear divider framework in Parameter 5 and Parameter 6 according to Seismic code IS 1893 (Part-1) 2016 provisions. After contrast the parameter and the assistance of shear divider and without shear divider framework in seismic code IS 1893(Part-1) 2016,Drift and Displacement esteem is lessen in X and Z bearing.

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