Seismic Analysis and Design of Multistoried Building with and without Bracing According to is Code and Euro Code by using ETABS

D. Sirisha[1]
[1]Student, M Tech (SE),
Department of Civil Engineering,
Aditya College of Engineering &Technology, Kakinada

M. Divya Tejaswi[2]
[2]Assistant Professor,
Department of Civil Engineering,
Aditya College of Engineering &Technology, Kakinada

***Abstract*: The construction of multistoried building with increased heights and with usage of light weight, high strength materials leads to flexible structures. Recent earthquakes implies that requirement to estimate the earthquake suitability of structures. Lateral stability is important for the steel structures in the seismic zone, effective way to increase the lateral strength is by means of bracing system. This paper deals with seismic analysis and design of multistoried (G+9)building with and without bracing according to IS code and EURO code by using ETABS 2015 software considering zone II and medium soil condition. The modeling and analysis of the structure have been done by Response Spectrum. The seismic performance of a structure with and without bracing configurations according to IS code and EURO code compared with respect to parameters like storey displacement ,storey drift and storey shear. Diagonal bracings are best bracing system for reducing the storey displacement because of increased stiffness and the structure is proposed to be designed by Limit state method.**

Keywords: Bracing, ETABS 2015 Software, storey displacement, storey drift, storey shear, Response spectrum.

1. INTRODUCTION

For newly constructed structures, Bracing is a system that utilizes a reinforced building structures. Bracing improves seismic performance of building. Braced frame structures are usually considered to resist the lateral forces and also earthquake loads. Braced systems provide due to their strength, stiffness to the structures.

Under gravity load conditions, only beams and columns shall be considered to resist such loads, without taking bracing members into consideration. The diagonals shall be taken into account as follows in an elastic analysis of the structure for the seismic actions.

Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. The advantages of braced buildings are due to bracing of the building, lateral storey displacement storey drift as well as axial force and bending moment in columns reduces to a remarkable level. Braced frame resist the wind and seismic forces, much more than non-braced buildings. Reduction in lateral displacement is a major advantage. Concentric bracing is more effective than the eccentric bracing. Concentrically braced frame are those in which the centerlines of members that meet at joint intersect at a same work point to form a vertical truss system that resist lateral forces.

So overall purpose of bracing is to provide additional safety against the external loads in comparable self- building.

Diagonal bracing can increase a building 'capability to withstand seismic activity. Bracing is important in earthquake resistant buildings because it helps keep a structure standing.

2. STRUCTURAL DETAILS OF MODEL

Plan dimension	16.54x24.18m
Seismic zone	II
Zone factor	0.10
Number of Storey	G+9
Floor height	3m
Thickness of slab	150mm
Size of floor beam	420x230mm
Size of column1	450x300mm
Size of column2	300x450mm
Materials	M30,HYSD500, Fe250(for bracing)
Type of Soil	Medium
Thickness of Wall	230mm
Wall Material	Masonry
Modeling type of wall	Shell thin
Impact factor, I	1
ResponseSpectrumanalysis	Linear Dynamic Analysis
Damping of structure	5
Response ReductionFactor	5
Live load	2kN/m^2
Codes	IS456:2000 IS800:2007 IS875(PartI,II,III) IS1893(Part1):2002 For Earthquake Designing

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3. DIAGONAL BRACING

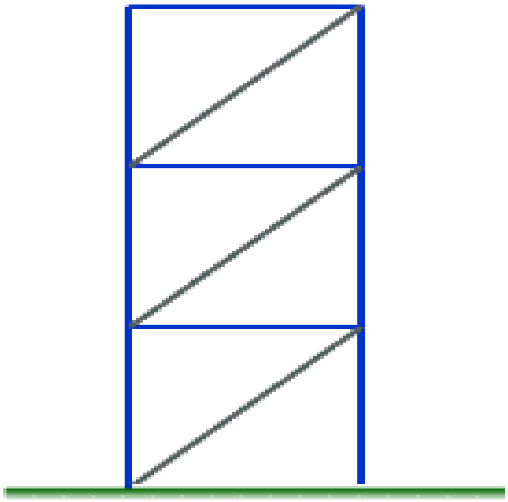

Fig1: Diagonal Bracing

4. MODELLING AND METHODOLOGY

In this paper we considered four types of models with and without bracing according to IS(Indian standard)code and EN(European)code and Diagonal bracing at storey 1 to 10 completely as shown in figures.

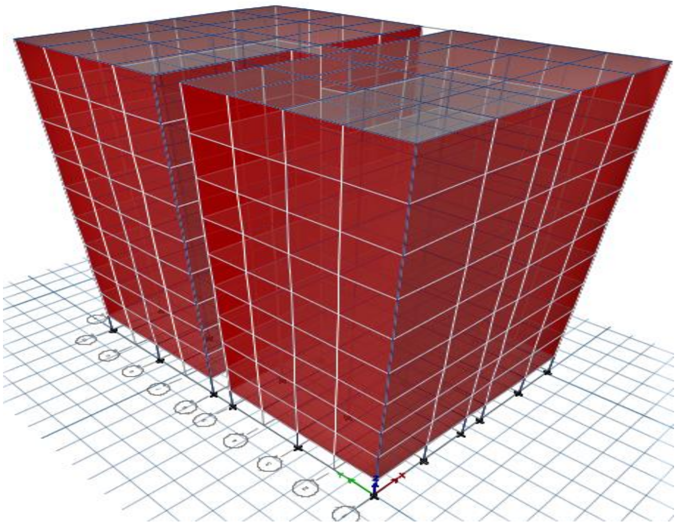

Fig2: 3Dview of model1(G+9)multistoried bare frame building without bracing in IS code

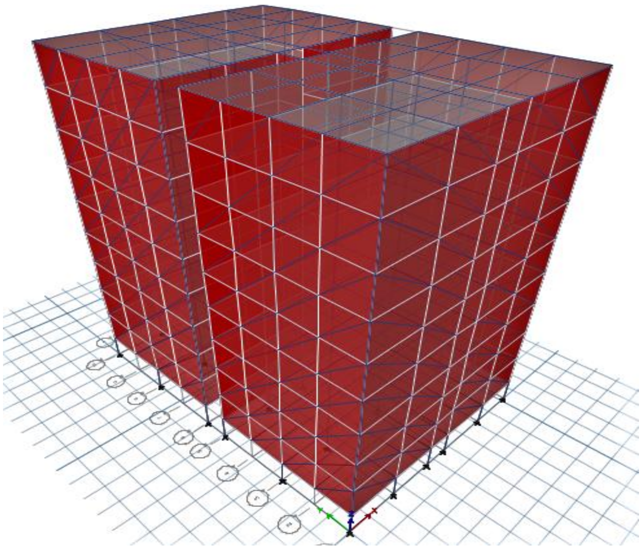

Fig3: 3D view of model2(G+9)multistoried bare frame building with bracing in IS code

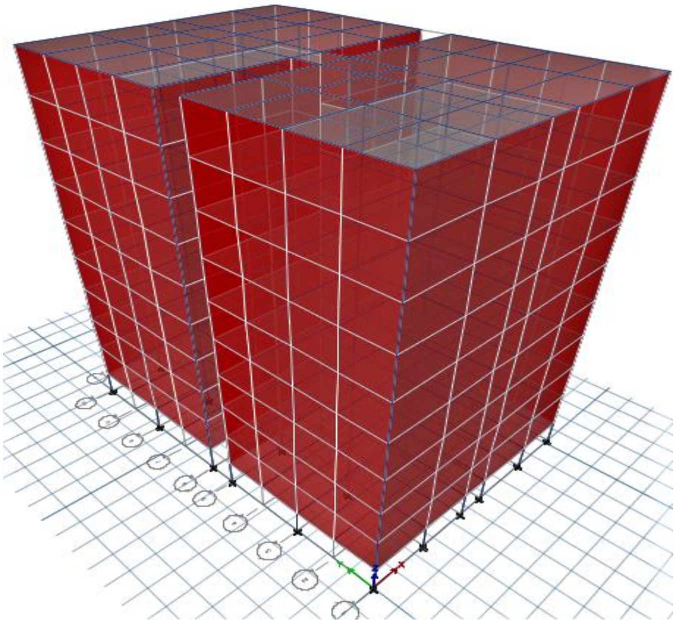

Fig4:3D view of model3(G+9)multistoried bare frame building without bracing in EN code

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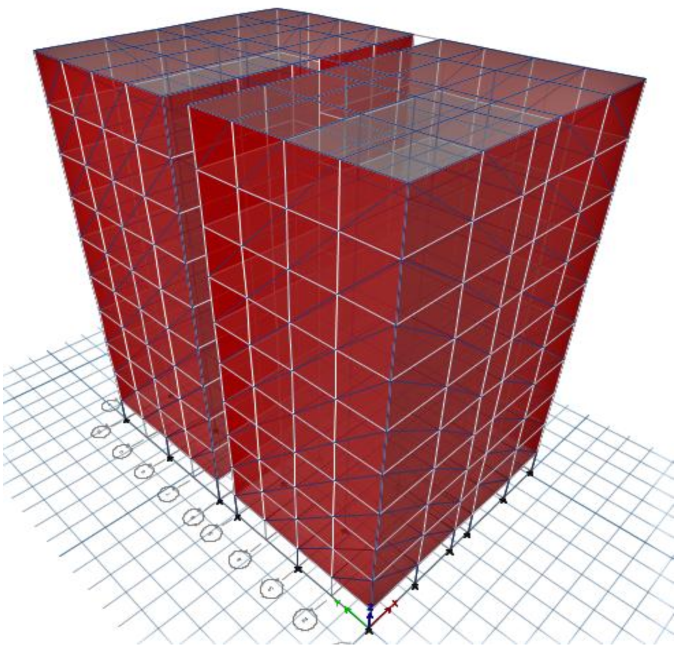

Fig5:3Dview of model4 (G+9) multistoried bare frame building with bracing in EN code

5. DESIGN

1. Beam design:

As per IS456:2000 by limit state method

Grade of concrete $f_{ck=}$30N/mm^2

Grade of steel $f_{y=}$500N/mm^2

Clear span l=3.65mm

Width of beam B=230mm

Depth of beam D=420mm

Clear cover=20mm

Total load W=7.75 kN/m^2

Factor load W_u=11.62 kN/m^2

Ultimate moments:

M_X=6.76 kN-m

M_Y=4.89kN-m

Depth check:

M_{ulim}=62.63 kN-m

Slab is safe against moment

A_{st}= 126.53mm^2

Dia of bars=8mm

Provide Spacing of 8mm# bars @ 300 mm c/c

Effective depth d=395mm

Clear cover=25mm

Ultimate moment

M_u=143.1kN-m (singly Reinforced beam)

Provide A_{st}=402mm^2

Dia of bars =16mm

No of bars=2

Deflection check=ok

Shear force V_u=79kN

Shear check=ok

Provide Spacing 2 legged vertical stirrups16mm#bars at 296mm center to center

Hence Beam is safe

2. Slab design:

Size of slab=3.5x4.34m

L_y/L_x=1.23<2

Two way Slab

Grade of concrete f_{ck}=30N/mm^2

Grade of steel f_y=500N/mm^2

Overall Depth of slab D=150mm

Effective depth d=125mm

Shear force V_u=14.69 kN

Shear check:

Nominal shear stress $\tau_v=V_u/bd$ = 0.118N/mm^2

Design shear strength τ_c=0.33N/mm^2

$\tau_{c\,max}$= 1.7N/mm^2

$\tau_v<\tau_c<\tau_{c\,max}$

Hence shear Reinforcement is not required.

3. Footings design:

Size of column (lxb)=400x300mm

Grade of concrete f_{ck}=30N/mm^2

Grade of steel f_y=500N/mm^2

Load P_u=800kN

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SBC of soil=200kN/m^2

Area of footing A=4.4m^2

Size provided B=3m

Soil Reaction q_u=0.267N/mm^2

Depth of footing:

From shear consideration, IS456:2000

Length between edge of footing to edge of column

L'=1.35m

Critical shear stress τ_c=0.32N/mm^2

Depth d=600mm

Overall depth D=650mm

Bending moment:

$M_u$lim=216.4kN-m

Two way shear:

Critical section at d/2=300mm

Perimeter of section p=3600mm

Area of section a=2160000mm^2

Upward pressure=985230N

Two way shear stress=0.456N/mm^2

Maximum shear=0.25$\sqrt{f_{ck}}$=1.369N/mm^2

Hence depth is sufficient

Area of Reinforcement:

In long direction :

Moment M_u=364955625Nmm

A_{st}=1436.51mm^2

Spacing S_v=180mm

Provide Reinforcement of bars 16mm@180mm c/c

In short direction:

B'=0.6m

Moment M_u=144180000Nmm

A_{st}=570.65mm^2

Spacing S_v=250mm

Provide reinforcement of bars16mm@250mmc/c

4. column design:

Size of column=400x300mm

Grade of concrete f_{ck}=30N/mm^2

Grade of steel f_y=500N/mm^2

P_u=1200kN

Factored load=1800kN

M_u=66.66kN

Factored Moment=100kN-m

d'=50mm

d'/D = 50/500= 0.10

From IS 456, chart no36

y=0.36

x=0.04

P_{SC}=0.4%

A_{sc}=1000 mm^2

No of bars=9

Provide transfer reinforcement of bars:8mm

Pitch :

a)Least lateral dimension = 500

b)16 times the smallest diameter of the longitudinal reinforcement bar =16*12=192mm

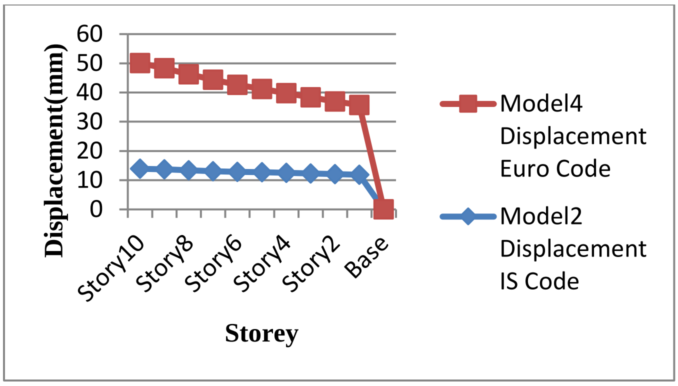
c)300mm

Provide 8mm#@192mmc/c

6. RESULTS:

Table1: Storey Displacement with bracing

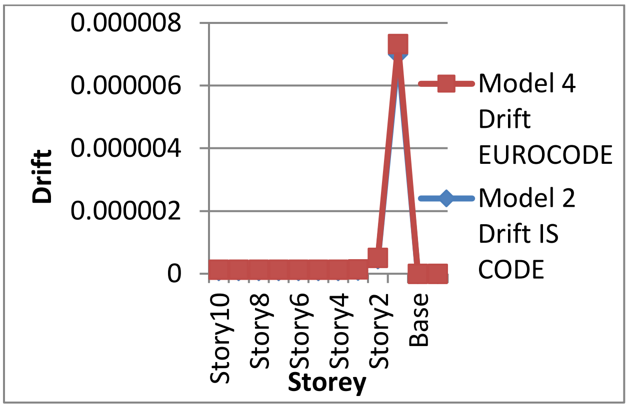
Storey	IS code	EURO code
Storey10	13.9	36.2
Storey9	13.7	34.6
Storey8	13.4	32.9
Storey7	13.1	31.3
Storey6	12.9	29.7
Storey5	12.7	28.5
Storey4	12.5	27.3
Storey3	12.3	26.1
Storey2	12.1	24.9
Storey1	11.9	23.8
Base	0	0



Graph1: Comparison of Storey Displacement with bracing IS&EURO codes.

Table2 Storey Drift with bracing

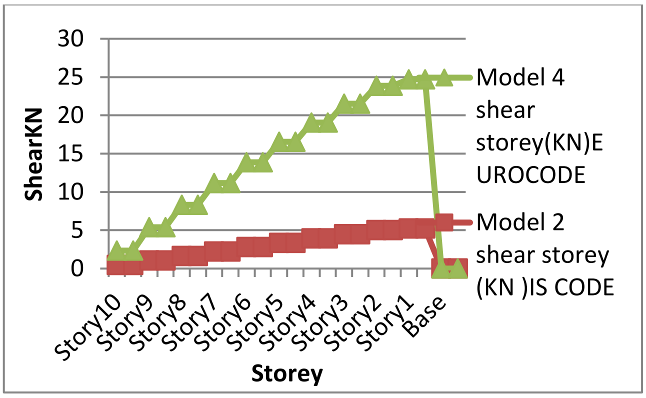
Storey	IS code	EURO code
Storey10	8.816E-08	4.548E-08
Storey9	8.817E-08	4.542E-08
Storey8	8.823E-08	4.537E-08
Storey7	8.831E-08	4.528E-08
Storey6	8.84E-08	4.514E-08
Storey5	8.849E-08	4.496E-08
Storey4	8.859E-08	4.482E-08
Storey3	1.009E-07	4.489E-08
Storey2	4.638E-07	4.452E-08
Storey1	0.000007	3.324E-07
Base	0	0



Graph2: Comparison of Storey Drift with bracing IS&EURO codes.

Table3: Storey shear with bracing

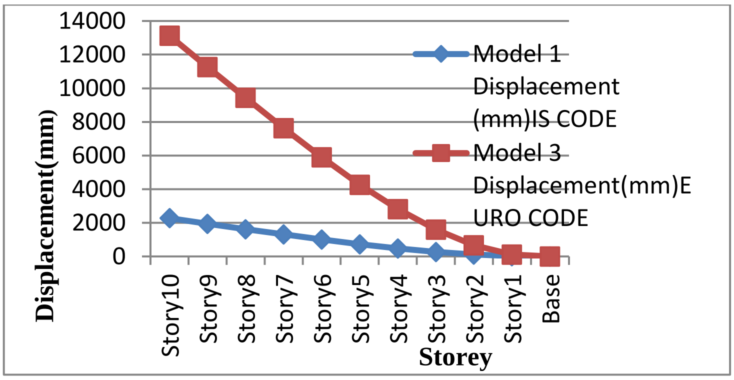
Storey	Location	IS code	EURO code
Storey10	Top	0.4534	1.8946
	Bottom	0.4534	1.8946
Storey9	Top	1.0506	4.3292
	Bottom	1.0506	4.3292
Storey8	Top	1.6398	6.6753
	Bottom	1.6398	6.6753
Storey7	Top	2.2209	8.9325
	Bottom	2.2209	8.9325
Storey6	Top	2.7939	11.0985
	Bottom	2.7939	11.0985
Storey5	Top	3.359	13.1732
	Bottom	3.359	13.1732
Storey4	Top	3.916	15.1571
	Bottom	3.916	15.1571
Storey3	Top	4.4649	17.0494
	Bottom	4.4649	17.0494
Storey2	Top	5.0051	18.8423
	Bottom	5.0051	18.8423
Storey1	Top	5.2148	19.4971
	Bottom	5.2148	19.4971
Base	Top	0	0
	Bottom	0	0



Graph3: Comparison of storey shear with bracing IS&EURO codes.

Table4: Storey Displacement without bracing

Storey	IS code	EURO code
Storey10	2276	13122.5
Storey9	1950.3	11274.5
Storey8	1626.9	9436.9
Storey7	1310.2	7631.8
Storey6	1006.8	5894
Storey5	725.3	4269.7
Storey4	475.1	2814
Storey3	266.8	1590.2
Storey2	111.3	667.4
Storey1	19.8	119.6
Base	0	0



Graph4: Comparison of Storey Displacement without bracing IS&EURO codes.

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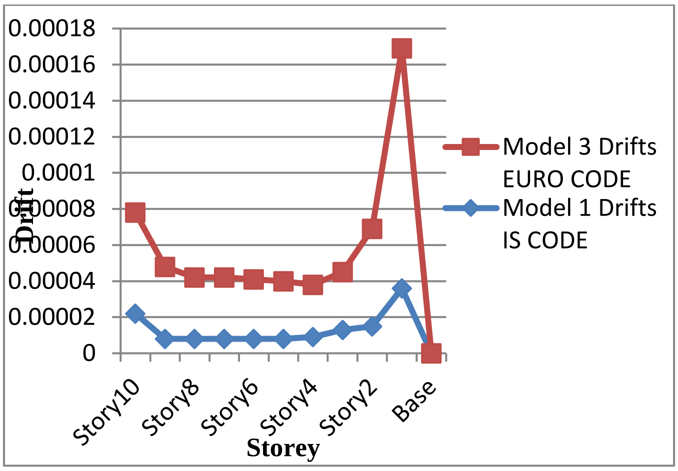
Table5: Storey Drift without bracing

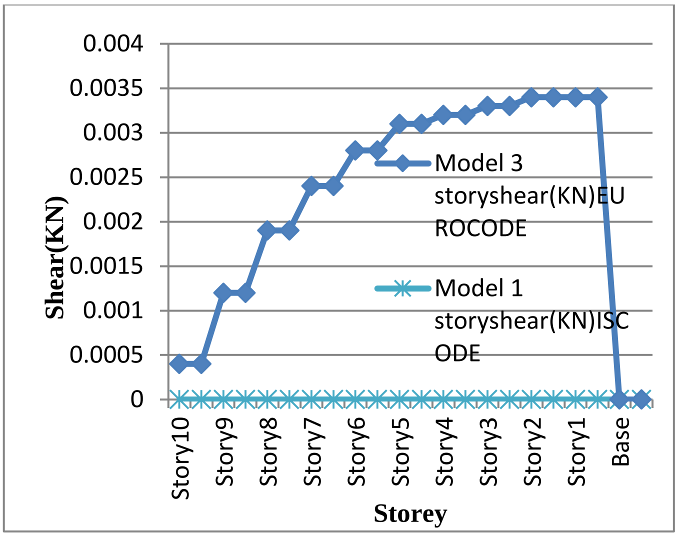
Storey	IS code	EURO code
Storey10	0.000022	0.000056
Storey9	0.000008	0.00004
Storey8	0.000008	0.000034
Storey7	0.000008	0.000034
Storey6	0.000008	0.000033
Storey5	0.000008	0.000032
Storey4	0.000009	0.000029
Storey3	0.000013	0.000032
Storey2	0.000015	0.000054
Storey1	0.000036	0.000133
Base	0	0



Graph5: Comparison of storey Drift without bracing IS&EURO codes.

Table6: Storey shear without bracing

Storey	Location	IS code	EURO code
Storey10	Top	0	0.0004
	Bottom	0	0.0004
Storey9	Top	0	0.0012
	Bottom	0	0.0012
Storey8	Top	0	0.0019
	Bottom	0	0.0019
Storey7	Top	0	0.0024
	Bottom	0	0.0024
Storey6	Top	0	0.0028
	Bottom	0	0.0028
Storey5	Top	0	0.0031
	Bottom	0	0.0031
Storey4	Top	0	0.0032
	Bottom	0	0.0032
Storey3	Top	0	0.0033
	Bottom	0	0.0033
Storey2	Top	0	0.0034
	Bottom	0	0.0034
Storey1	Top	0	0.0034
	Bottom	0	0.0034
Base	Top	0	0
	Bottom	0	0



Graph6: Comparison of storey shear without bracing IS&EURO codes.

CONCLUSION:

1. Bracings are the most critical members for the structure. To have a good control over the forces and displacements.

2.It is observed that the presence of bracing influences the overall behavior of structures when subjected to lateral displacements are reduced about 40%to89%in plan.

3. The presence of diagonal bracing subjected to storey displacement and storey drift are increased about 20% and base shear reduces to 60%

4. From present work it has been identified that storey drift of a structure with bracing is more compare to normal building.by providing bracing to a structure storey drift reduces to about 40%.

5. Storey drift are consideringly increased about 10to25%, base shear is consideringly reduced about 50%.than base shear is reduced when diagonal bracing is added to building.

6. It is observed that base shear is reduced to about 45%when compared to a building with bracing.

7. It is observed that by providing bracing at center of building, all parameters like base shear, lateral displacement and storey drift is consideringly reduced when compared to without bracing.

8. In Displacement EURO code is more compared to IS code in model 3&4

9. Drift is more occurring in storey 1in IS&EURO codes.

10. In EURO code displacement graph is randomly increase. Compare to IS code, so less displacement structure has more stiffness.

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