Effect of Different Bracing Systems to Natural Time Period for Multistorey Building with Bracings

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Abstract - *In Indian standard codes for finding out the natural time period of building does not take into account of the type of the bracing systems. The natural time period is a function of Height of building and the Base dimension of the building. Here in this paper, the attempt is made that natural time period of building is also depends on eccentricity of bracings. Various R.C.C models are made with different height, different plan size and different eccentricity of bracings for L shape building with steel bracings in ETABS 2015 for response spectrum analysis to find effect on natural time period.*

Key Words: *bracings, eccentricity, Response spectrum analysis, natural time period*

1. INTRODUCTION

Bracing is highly capable to resist horizontal forces in a frame structures. Bracing system is efficient because the diagonal members resist force by axial stresses hence require minimum size for resistance in opposition to horizontal shear. Two forms of bracing systems 1) Concentric Braced f Systems and 2) Eccentric Braced Systems. Concentric bracings improve the horizontal stiffness of the structure thus enlarge the frequency (ω) and minimize the lateral storey drift. Eccentric Bracings minimize the horizontal stiffness of the structures and achieve better the energy dissipation capacity.

In this research work, various R.C.C buildings with different steel bracings have been prepared in ETABS 2015. All columns and beams size in each model is same. The height and Plan dimension variation is made to find their effect on natural time period building with bracings. Then, variation in eccentricity of bracings is made. The eccentricity of bracings variation is 0.1 meter. Means in first model storey height is 0.1 meter. In next models, likewise, eccentricity of bracings is 0.1, 0.2, 0.3… 1.4, 1.5. With using ETABS software response spectrum analysis is carried out to find natural time period.

2. BACK GROUND

As per IS 1893 (part -1) [1] the approximate fundamental translational natural time period (T_a) of oscillation, in seconds, of a without infill panels bare MR frame building may be estimated by the expression:

$T = 0.075h^{0.75}$ For RC MRF Building

$= 0.085h^{0.75}$ For steel MRF Building

$= 0.080h^{0.75}$ For RC-steel composite MRF Building

Where

h = Total height of structure, in m. This except the basement, where basement are connected to the ground or connected to the columns. But it contains the basement storeys, when they are disconnected.

The approximate translational natural period (T) of oscillation, for other buildings in seconds, including MR fame buildings with infill panels, be estimated by the expression:

$T = 0.09h/\sqrt{d}$

Where

h= Total Height of building, in m

d= Base Length of the building at the plinth level, in m, along the direction of the horizontal force.

3. PROBLEM FORMULATION

Various L shape building are made in ETABS software. 33 R.C.C. L shape buildings are modelled with steel bracings to have same beam and column size. Bays size is constant 3m x 3m and storey height is 3 m .There are following three cases has been taken to find out effect of bracings on natural time period of building as per response spectrum analysis as per IS 1893:

- Effect of height when plan and eccentricity of bracing is constant, in this height of building increase by one storey.
- Effect of plan when height and eccentricity of bracing is constant, in this bays are increase in both directions and
- Effect of eccentricity of bracing when plan and height is constant, in this minimum eccentricity is provided 0.1 m to maximum eccentricity is half of bay length which is 1.5m.

Geometric data of building:

- Plan dimension: L shape building
  (12m x 12m, 15m x 15m,…33m x 33m)
- Height of building: changes from model to model
  (36m, 39m, 42m,….60m,63m)

- Storey height : 3 m
- No. of bays in X- axis : 4 to 11 nos
- No. of bays in Y- axis : 4 to 11 nos
- Length of each bay in X-direction: 3 m
- Length of each bay in Y-direction: 3 m
- Column size: 700 mm × 700 mm
- Beam size: 300 mm × 600 mm
- Bracing size: ISMB 250
- Eccentricity of bracings: change from model to model (0.1m, 0.2m, 0.3m …. 1.4m, 1.5m)
- Modules of elasticity of concrete: 2 ×105 kN/m3
- Grade of concrete: M-20
- Grade of steel: Fe-415
- Density of concrete: 25 kN/m3
- Floor load: 1.2 kN/m2
- Live load: 3 kN/m2
- Slab thickness: 120 mm

Seismic parameters:

- Seismic zone: III (0.16)
- Soil type: medium (II)
- Response reduction factor: 5
- Importance factor: 1
- Fig shows one sample model shown above with plan dimension (Fig 1) and front face (fig 2).

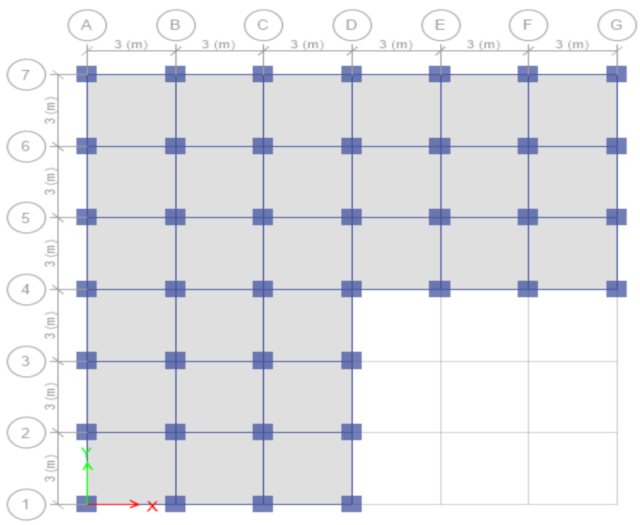

Figure 1 plan of a sample model

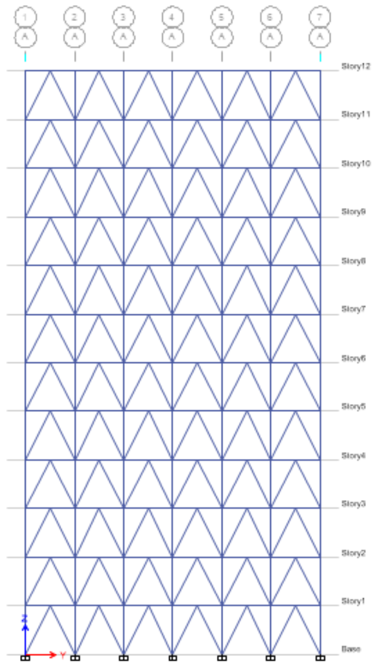

Figure 2 Front face of a model

4. RESULTS

For height variation with maximum eccentricity of bracing and same plan size of building by response spectrum analysis in ETABS software.

Table 1 Effect of height on Time period

H (m)	E (m)	b(m)	d(m)	bay size (m)	T (sec)
63	1.5	18	18	3	1.846
60	1.5	18	18	3	1.733
57	1.5	18	18	3	1.623
54	1.5	18	18	3	1.515
51	1.5	18	18	3	1.409
48	1.5	18	18	3	1.306
45	1.5	18	18	3	1.163
42	1.5	18	18	3	1.107
39	1.5	18	18	3	1.012
36	1.5	18	18	3	0.918

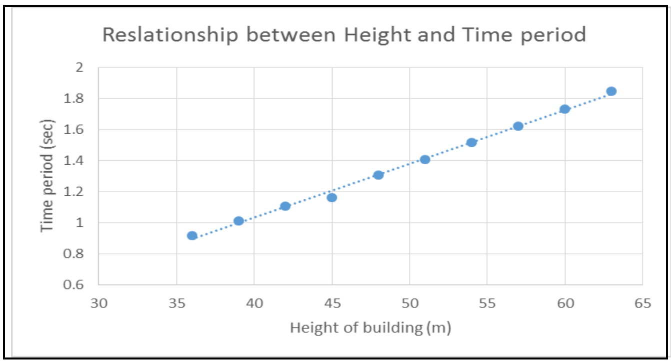

Figure 3 Relation between Time period (T) and height (h)

For variation of eccentricity of bracing with same plan size and same height of building by response spectrum analysis.

Table 2 Effect of eccentricity on Time period

H(m)	e(m)	b(m)	d(m)	bay size (m)	T (sec)
45	0.1	18	18	3	1.441
45	0.2	18	18	3	1.433
45	0.3	18	18	3	1.423
45	0.4	18	18	3	1.414
45	0.5	18	18	3	1.404
45	0.6	18	18	3	1.391
45	0.7	18	18	3	1.372
45	0.8	18	18	3	1.352
45	0.9	18	18	3	1.329
45	1	18	18	3	1.302
45	1.1	18	18	3	1.271
45	1.2	18	18	3	1.24
45	1.3	18	18	3	1.212
45	1.4	18	18	3	1.185
45	1.5	18	18	3	1.163

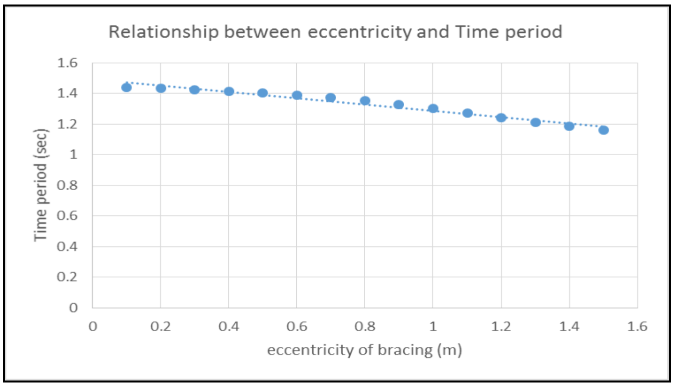

Figure 4 Relation between Time period (T) and eccentricity (e)

For plan variation (different compare to b/b_1 ratio and d/d_1 ratio) with same eccentricity of bracing and same height of building by response spectrum analysis.

Table 3 Effect of smaller plan dimension (d) on Time period (T)

H(m)	e(m)	b(m)	d(m)	Bay size (m)	T (sec)
45	1.5	15	15	3	1.139
45	1.5	18	18	3	1.163
45	1.5	21	21	3	1.183
45	1.5	24	24	3	1.202
45	1.5	27	27	3	1.218
45	1.5	30	30	3	1.234
45	1.5	33	33	3	1.248

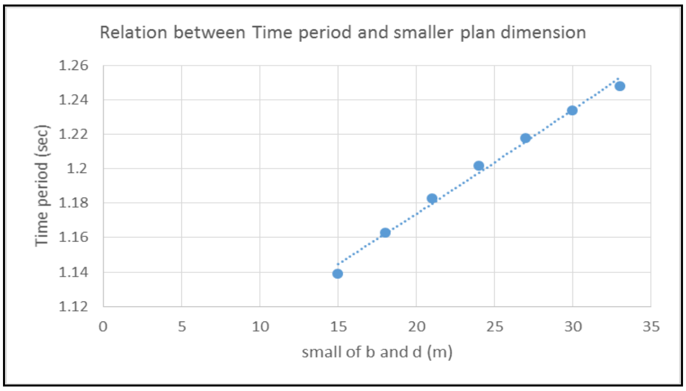

Figure 5 Relation between Time period (T) and smaller plan dimension

5. CONCLUSIONS

From the above results it can be observed that out of three parameters which is height, smaller plan dimension and eccentricity of bracings, if anyone of the parameter is different which will cause the change in natural time period of building.

1. Keeping eccentricity of bracing and smaller plan dimension of buildings constant it can be observed that natural time period increases as height increases which is incorporated in Indian code 1893 part-I.
2. Keeping Height and smaller plan dimension of buildings constant it can be observed that natural time period decreases as eccentricity of bracing increases.
3. Keeping eccentricity of bracing and height of buildings constant it can be observed that natural time period increases as smaller plan dimension increases which is opposing Indian code 1893 part-I because bay size is kept constant so increases in stiffness and mass.

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