SEISMIC ANALYSIS OF BUILDINGS RESTING ON SLOPED GROUND AND CONSIDERING BRACING SYSTEM USING ETABS

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Abstract : Most of the constructions in hilly regions are constrained by local topography which results in the adoption of either a step back or step back &set back configuration. Due to this the structure is irregular by virtue of varying column heights leading to torsion and increased shear during seismic ground motion. The dynamic analysis is carried out using response spectrum method to the step back and step back & set back building frames. The dynamic response i.e. fundamental time period, storey displacement & drift, and base shear action induced in columns have been studied for buildings of different heights. These results show that the performance of step back & set back building frames are more suitable in comparison with step back building frames. But after considering bracings to the step back building frames, a better performance can be observed when compared with step back & set back building frames. In the present study the effect bracings in high rise RC structures sited in different types of earthquake zones (Z-II &V) and type of soils(S-II) using ETABS 2013 is done.

1 INTRODUCTION

The economic growth & rapid urbanization in hilly region has accelerated the real estate development. Due to this, population density in the hilly region has increased enormously. The adobe burnt brick, stone masonry & dressed stone masonry buildings are generally made over level ground in hilly regions. Since level land in hilly regions is very limited, there is a pressing demand to construct buildings on hill slope. Hence construction of multi-storey R.C .Frame buildings on hill slope is the only feasible choice to accommodate increasing demand of residential & commercial activities.Seismic analysis is a method to carry out the response of the building structure during ground motions. It is a part of process structural design, which includes seismic assessments of the buildings and also the retrofitting measures to strengthen the retaining structure in the seismic regions. In recent days the buildings with irregular configurations in both plan and elevation are common. These buildings asymmetry will suffer severely during earthquakes and undergo coupled torsion and lateral motions. A building can be designed to be earthquake proof for a rare but strong earthquake proof, but such buildings will be more expensive. The most logical approach to seismic design problem is to accept the uncertainty of the seismic phenomenon.

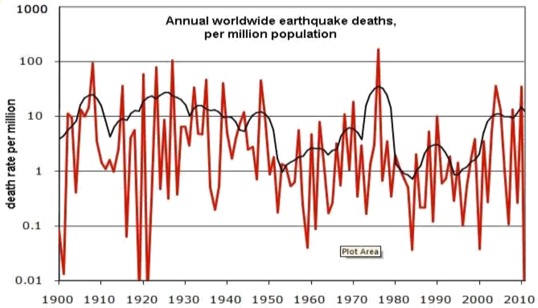


Fig 1: Worldwide earthquake Deaths

The Indian Standard IS: 13920-1993 for ductile detailing of RC structures requires special confining reinforcement to be provided over the full height of columns that are likely to sustain short column effect. The special confining reinforcement (i.e., closely spaced closed ties) must extend beyond the short column into the columns vertically above and below by a certain distance. In existing buildings with short columns, different retrofit solutions can be employed to avoid damage in future earthquakes. Where walls of partial height are present, the simplest solution is to close the openings by building a wall of full height - this will eliminate the short column effect

2 LATERAL LOAD RESISTING SYSTEMS

The horizontal and vertical sub-systems of a structural system interact and jointly resist both gravity loads and lateral loads. Lateral load effects (due to wind and earthquake) predominate in tall buildings, and govern the selection of the structural system. There are three basic types of lateral load resisting systems there are moment-resisting frames, shear walls, and braced frames. Generally, shear walls are the most rigid, that is, they deflect the least when subject to a given load. Braced frames are usually less rigid than shear walls, and moment-resisting frames are the least rigid. Lateral load resisting systems of reinforced concrete buildings generally consist of one of the following Frames These are generally composed of columns and beams [Their ability to resist lateral loads is entirely due to the rigidities of the beam-column connections and the moment-resisting capacities of the individual members. They are often (albeit mistakenly) called 'rigid frames', because the ends of the various members framing into a joint are 'rigidly'

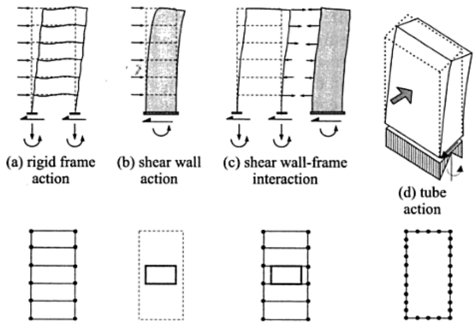


Fig 2 : Behavior of components if EQ load acts

Types of Braces

Braced frames may be grouped into two categories, as either concentric frames (CBF) or eccentric braced frames (EBF), depending on their geometric characteristics. In CBFs, the axes of all members –i.e., columns, beams and braces –intersect at a common point such that the member forces are axial. EBFs utilize axis offsets to deliberately introduce flexure and shear into framing beams. The primary goal is to increase ductility. The CBFs can be configured in various forms, some of which are shown in Fig 18. Depending on the magnitude of force, length, required stiffness, and clearances, the diagonal member can be made of double angles, channels, T-sections, tubes or wide flange shapes. Besides performance, the shape of the diagonal is often based on connection considerations. The least objectional locations for braces are around service cores and elevators, where frame diagonals may be enclosed within permanent walls. The braces can be jointed together to form a closed or partially closed three-dimensional cell for effectively resisting torsional loads.

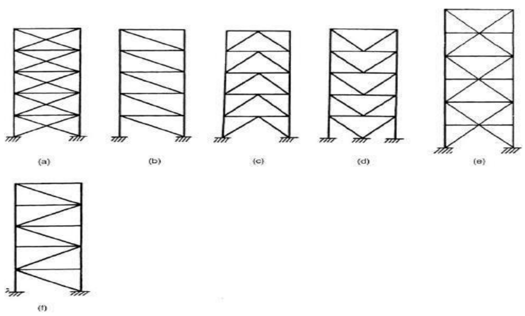


Figure 3 Typical concentric braced frame (CBF) configurations: (a) One-storey X-bracing; (b) Single-diagonal bracing; (c) and (d) Chevron bracings; (e) two-storey X-bracings; (f) Single-diagonal alternate-direction bracing.

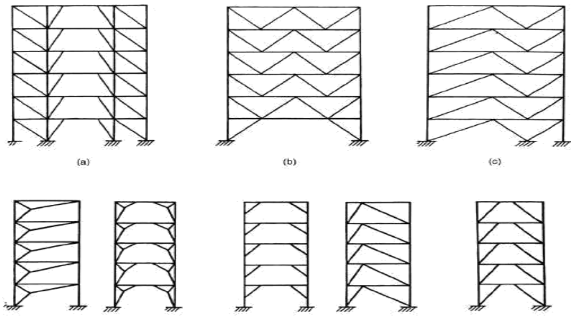


Figure 4 Brace configuration that allows for door-size openings in interior space layouts.

3 NUMERICAL MODELLING

Geometrical Properties :

1	Height of typical storey	3 m
2	Height of ground storey	3.5m
3	Length of the building	56m
4	Width of the building	8 m
5	Height of the building	45 m
6	Number of stores	15
7	Wall thickness	230 mm
8	Slab Thickness	115 mm
9	Grade of the concrete	M20
10	Grade of the steel	Fe415
11	Support	fixed
12	Column sizes	0.53m X 0.53 m
13	Beam Sizes	0.45m X 0.45 m

Loads

1. Live load

Live load from 1^{st} floor to 15^{th} floor = 3.5 kN/m^2

2. Dead load

Dead load is taken as prescribe by the IS: 875 -1987 (Part-I) [3] Code of Practice Design Loads (other than earthquake) for Buildings and structure.

Unit weight of R.C.C. = 25 kN/m^3

Unit weight of brick masonry = 19 kN/m^3

Floor finish = 1.5 kN/m^2

Wall load = 13.8 kN/m on all floors

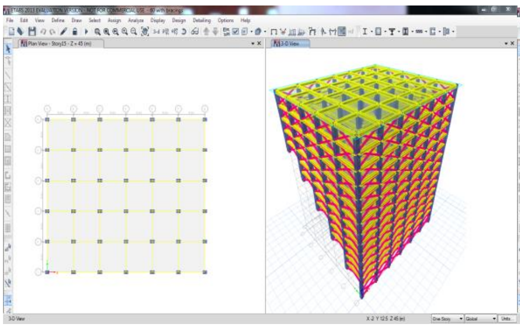


Fig:5 3D View of 20 Degree Sloped ground building

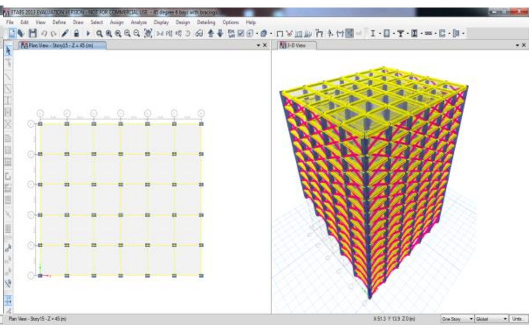


Fig 5.4: 3D View of 45 Degree Sloped ground building

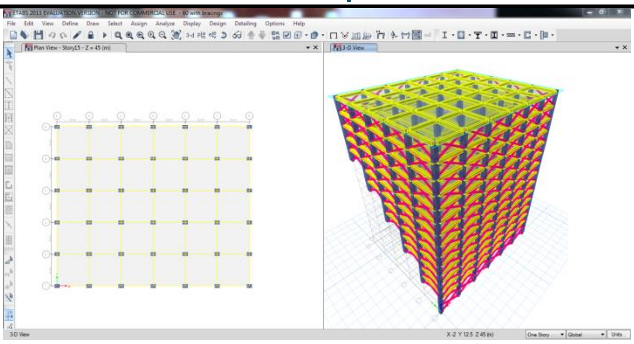
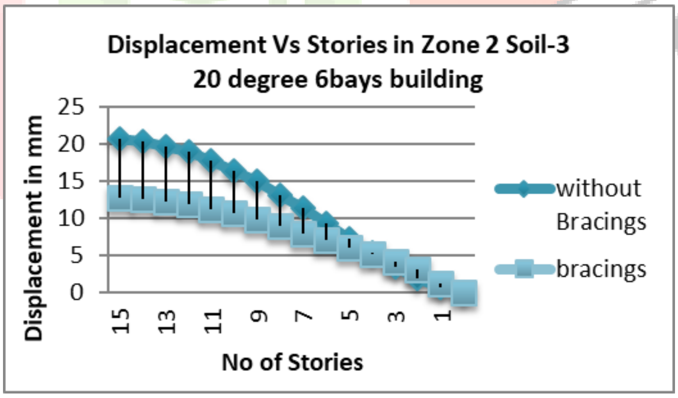


Fig 5.4: 3D View of 60 Degree Sloped ground building

Table 1 Comparative values of displacement of 6bays high-rise building in zone-2 soil-3in 20 degree.

Storey	without Bracings	bracings
15	20.7	12.7
14	20.3	12.5
13	19.7	12.2
12	18.9	11.8
11	17.8	11.2
10	16.4	10.6
9	14.9	9.8
8	13.1	8.9
7	11.3	8
6	9.3	7.1
5	7.3	6.1
4	5.3	5.1
3	3.4	4.1
2	1.9	3.1
1	0.7	1.3
Base	0	0

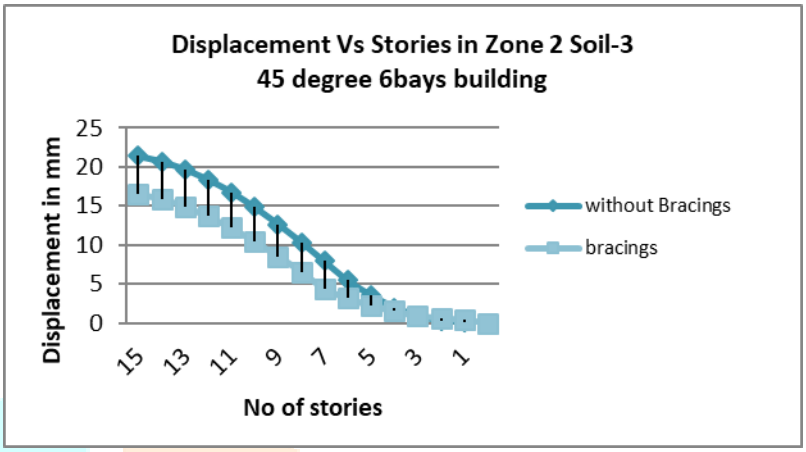


Graph:1 Variation of displacement zone-2 soil-3in 20 degree high-rise building.

Table 2 Comparative values of displacement of 6bays high-rise building in zone-2 soil-3in 45 degree.

Storey	without Bracings	bracings
15	21.4	16.5
14	20.7	15.9
13	19.7	14.9
12	18.4	13.7
11	16.7	12.2
10	14.8	10.4
9	12.6	8.5
8	10.3	6.5

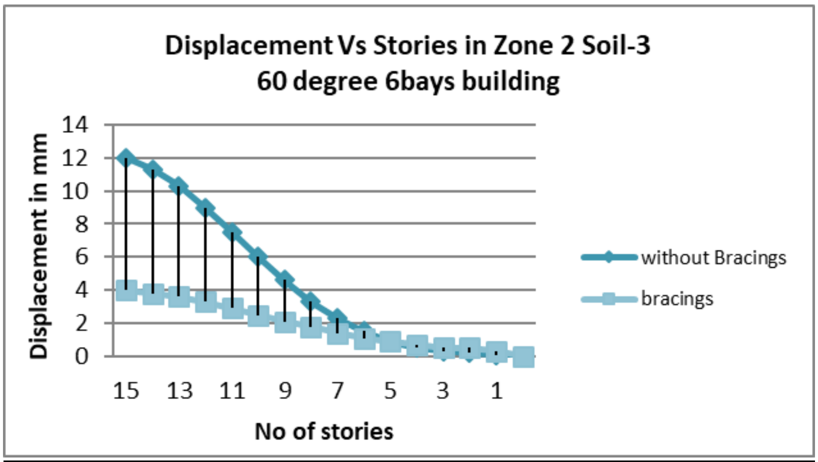
7	7.9	4.3
6	5.5	3.2
5	3.5	2.2
4	1.9	1.5
3	0.9	0.9
2	0.3	0.6
1	0.1	0.4
Base	0	0



Graph:2 Variation of displacement zone-2 soil-3in 45 degree high-rise building.

Table 3 Comparative values of displacement of 6bays high-rise building in zone-2 soil-3in 60 degree.

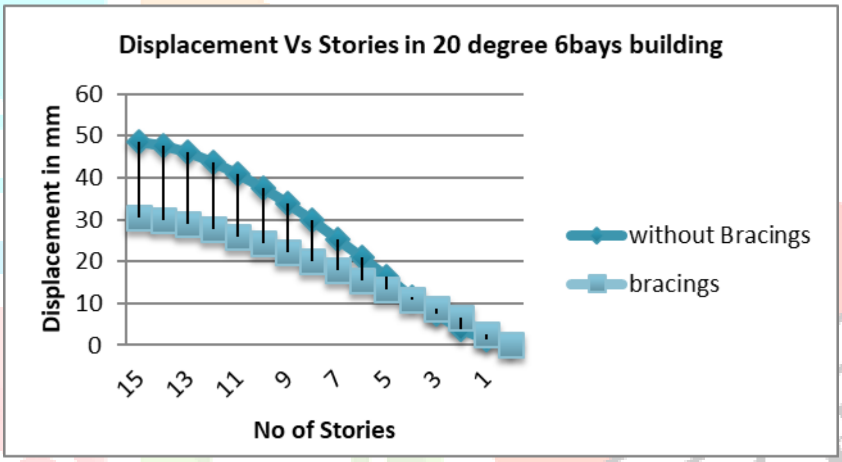
Storey	without Bracings	bracings
15	12	4
14	11.3	3.8
13	10.3	3.6
12	9	3.3
11	7.5	2.9
10	6	2.5
9	4.6	2.1
8	3.3	1.8
7	2.3	1.4
6	1.5	1.1
5	0.9	0.9
4	0.5	0.7
3	0.3	0.5
2	0.2	0.5
1	0.1	0.3
Base	0	0



Graph:3 Variation of displacement zone-2 soil-3in 60 degree high-rise building.

Table 4 Comparative values of displacement of 6bays high-rise building in zone-5 soil-3in 20 degree.

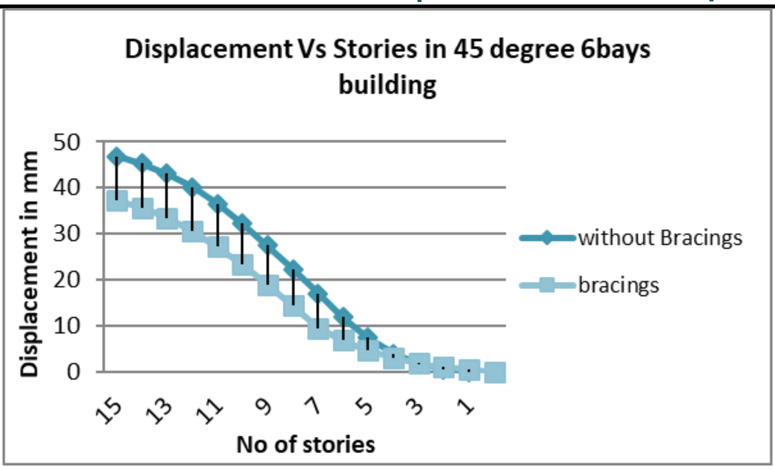
Storey	without Bracings	bracings
15	48.7	30.5
14	47.6	29.8
13	46	28.8
12	43.7	27.6
11	40.9	26
10	37.6	24.2
9	33.9	22.3
8	29.8	20.2
7	25.4	17.9
6	20.9	15.6
5	16.3	13.2
4	11.6	10.9
3	7.4	8.7
2	3.9	6.5
1	1.3	2.6
Base	0	0



Graph:4 Variation of displacement zone 5soil-3in 20 degree high-rise building.

Table 5 Comparative values of displacement of 6bays high-rise building in zone-5 soil-3in 45 degree.

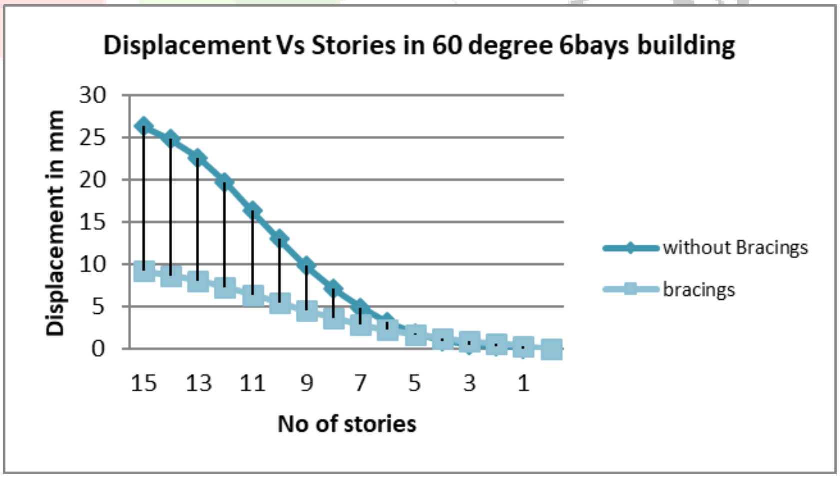
Storey	without Bracings	bracings
15	46.9	37.3
14	45.3	35.7
13	43.1	33.5
12	40.1	30.6
11	36.5	27.2
10	32.2	23.3
9	27.5	19
8	22.4	14.4
7	17.1	9.5
6	11.9	6.9
5	7.4	4.7
4	4	3.1
3	1.8	1.9
2	0.6	1.1
1	0.1	0.6
Base	0	0



Graph:5 Variation of displacement zone 5soil-3in 45 degree high-rise building.

Table 6 Comparative values of displacement of 6bays high-rise building in zone-5 soil-3in 60 degree.

Storey	without Bracings	bracings
15	26.3	9.2
14	24.8	8.7
13	22.6	8.1
12	19.7	7.3
11	16.3	6.4
10	13	5.5
9	9.8	4.5
8	7.1	3.7
7	4.9	2.9
6	3.2	2.3
5	1.9	1.7
4	1	1.3
3	0.5	0.9
2	0.3	0.7
1	0.1	0.4
Base	0	0



Graph:6 Variation of displacement zone 5soil-3in 60 degree high-rise building.

4 CONCLUSIONS

The structural performance is analyzed in different angles i.e 20 degree, 45 degree,60 degree building Without bracings, With X Bracing, the displacement of 45% is reduced when lateral systems are provided. By providing lateral systems in the framed structures the reduction in the displacement, shear, thereby increasing the stiffness of the structure for resisting lateral loads due to earth quakes.

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