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Comparative Study of High-Rise Building on Sloping Ground with Using Steel and RCC Bracing

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ABSTRACT

Extinct earthquakes events demonstrate that, a building with irregularity is vulnerable to earthquake damages. So, as it's essential to spot the seismic response of the structure even in high seismic zones to cut back the seismic damages in buildings. Objective: The most important objective of this study is to grasp the behaviour of the structure in high seismic zone III and also to evaluate Storey overturning moment, Storey Drift, Lateral Displacement, Design lateral forces. During this purpose a 14 storey-high building on four totally different shapes like Rectangular, sloping ground, sloping ground with bracing in steel , and sloping ground with bracing in RCC are used as a comparison. The complete models were analysed with the assistance of STAAD Pro 2015 version. In the present study, Comparative Dynamic Analysis for all four cases have been investigated to evaluate the deformation of the structure. Results & Conclusion: The results indicates that, building with severe irregularity produces more deformation than those with less irregularity particularly in high seismic zones. And conjointly the storey overturning moment varies inversely with height of the storey. The storey base shear for regular building is highest compare to irregular shape buildings.

Keyword: - Rectangular Building, sloping ground, sloping ground with bracing in steel, and sloping ground with bracing in RCC Static Force and Seismic Force, Bending Moment, Lateral Displacement, Story Drift.

1.0 INTRODUCTION

1.1 High Rise Building with Bracing and Sloping Ground

A braced frame is a really strong structural system commonly used in structures subject to lateral load such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both intension and compression.

The beams and columns that form the frame carry vertical load in the bracing system carries the lateral loads. The positioning of braces, however, can be problematic as they can interfere with the design of the façade and the position of openings. Buildings adopting high-tech or post-modern is tstyle shave responded to this by expressing bracing as an internal or external design feature.

A steel frame can be strengthened in various types to resist lateral forces. These systems are moment resisting beam-column connections, braced frames with moment-resisting connections, braced frames with pin jointed connections and braced frames with both pinpointed and moment-resisting connections. In steel buildings the most widely used method of constructing lateral load resisting system is braced frames. Hence, the main concern is to select the appropriate bracing model and to decide the suitable connection type. Bracing systems are used in structures in order to resist lateral forces. Diagonal structural members are inserted into the rectangular areas so that triangulation is formed. These systems help the structure to reduce the bending of columns and beams and the stiffness of the system is increased. There are lots of advantages of the bracing systems so that they are widely used.

When a tall building is subjected to lateral or torsional deflections under the action of fluctuating earthquake loads, the resulting oscillatory movement can induce a wide range of responses in the building's occupants from mild discomfort to acute nausea. As far as the ultimate limit state is concerned, lateral deflections must be limited to prevent second order delta effect due to gravity loading being of such a magnitude which may be sufficient to precipitate collapse. To satisfy strength and serviceability limit stares, lateral stiffness is a major consideration in the design of tall buildings. The simple parameter that is used to estimate the lateral stiffness of a building is the drift index defined as the ratio of them maximum deflections at the top of the building to the total height. Different structural forms of tall buildings can be used to improve the lateral stiffness and to reduce the drift index. In this research the study is conducted for braced frame structures. Bracing is a highly efficient and economical method to laterally stiffen the frame structures against lateral loads. A braced bent consists of usual columns and girders whose primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that total set of members forms a vertical cantilever truss to resist the horizontal forces. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member.

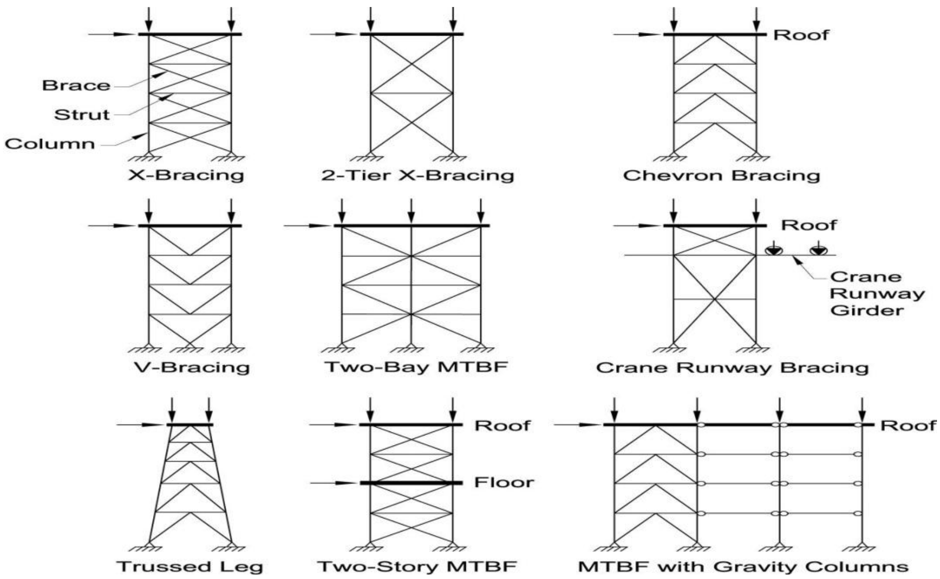

Figure No. 1.1 Different Types of Bracing in High-Rise Building Ware House

2.0 DESIGN PHILOSOPHIES AND ASSUMPUTION

The principle of earthquake resistance design is to evolve safe and economical design of structures to withstand possible future earthquake. This can be achieved by proper provisions of adequate strength, stiffness and ductility in the structure. Besides, this earthquake resistance of structure can be increased by careful planning, design and constructions.

The design of tall buildings essentially involves a conceptual design, approximate analysis, preliminary design and optimization, to safely carry gravity and lateral loads. The design criteria are, strength, serviceability, stability and human comfort. The strength is satisfied by limit stresses, while serviceability is satisfied by drift limits in the range of H/500 to H/1000. Stability is satisfied by sufficient factor of safety against buckling and P-Delta effects.

2.1 Damping

In order for a building to stop swaying after being excited, the vibration energy needs tube converted into thermal energy which is achieved with damping.

3.0 MODEL DESCRIPTION AND SOFTWARE ANALYSIS

In this part we discussed about model description and present work of software analysis and gives other model pictures with normal building and sloping ground, it contains a discussion on the load-displacement positions along the slope represented.

3.1 Problem Formulation

The object of the present work is to compare the behaviour of high-Rise buildings with vertical irregularities having shear wall with and without shear walls under seismic forces. Also, different shape of building. For this purpose, a high-Rise building of 15 storey's is considered. To reduce lateral displacement and storey drift shear walls have been provided.

The structure is 18m in x-direction & 21m in y-direction with columns spaced at 3m from centre to centre. The storey height is kept as 3.0m. Basically model consists of multiple bay 15 storey building, each bay having width of 4m. The storey height between two floors is 3.0m with beam and column sizes of 600x600m respectively and also the slab thickness is taken as 0. 125m.Shape of the building for all the cases is shown in figure.

To study the behaviour the response parameters selected are lateral displacement and storey drift. Building is assumed to be located in seismic zone III. All the building models are analysed with and without shear wall. Gives four model following are below shown in figure.

For this purpose, 4 models of 15 storeys for zone III, considered:

1. Rectangular building without any changes

2. Rectangular building with sloping ground
3. Rectangular building with sloping ground and also bracing using (RCC) beam 500X500mm
4. Rectangular building with sloping ground and also bracing using (STEEL) I section Beam MB400

3.2 Details of Building for All Types

Table No. 3.1 Details of Model Applicable for All Model

SR. NO.	Elements Of Building Dimension
1	Length x width: 18m X 21m
2	Number of stories:14
3	Support conditions: Fixed
4	Storey height: 3.m
5	Grade of concrete: M25
6	Grade of steel: Fe500
7	Size of columns from 1-14storey: 600mm x 600mm
8	Size of beams: 300mm x 500mm
9	Depth of foundation: 3 m
10	Seismic zones-III (0.16)
11	Importance factor I: 1.0
12	Response reduction factor: 5.0
13	Damping ratio: 0.05
14	Soil type medium: 2
15	Height of parapet wall: 1 m
16	Thickness of main wall: 230mm
17	Thickness of parapet wall: 230mm
18	Wall load: 0.230x20x(3.00-0.500) = 11.5 kN/m
19	Parapet wall: 0.230x20x1= 4.6 kN/m
20	Slab weight: 0.125x25x1 = 4 kN/m
21	Live load: 3 KN/m^2
22	Floor finishing :1.5 KN/m^2

4.3 LOADINGS CONSIDERED

1. Dead Load- floor load, Wall load, Parapet Load as per to IS 875 (part1).
2. Live Load- 2 kN/m_2 on all the floors.
3. Earthquake Load- As per IS 1893 (part-I):2002.

5.0 RESULT AND DISCUSSION

5.1 Result Parameters

The performance of bracing and sloping ground is assessed for High rise building with different materials 16 storey building in common earthquake zones III. The results obtained from analysis are given in various tables and figures are as follows:

5.2 Calculation of Maximum Bending Moment and Maximum Shear Force

For All Loads in All Building LOAD COMBINATION (1.2 (DL+LL+EQ Z1)

Table No. 5.1 Maximum Bending Moment and Shear Force for All Building

Max B.M. And Shear Force of Beam				
Force	**Rectangular with no changes**	**Rectangular with sloping ground**	**Rectangular with sloping ground and RCC bracing**	**Rectangular with sloping ground and MS steel bracing**
B.M. My	1.423	12.294	24.498	26.556
B.M. Mz	93.823	112.654	119.715	122.835
Shear Force Fy	99.098	105.830	111.030	115.173
Max B.M. And Shear Force of Column				
Forces	**Rectangular with no changes**	**rectangular with sloping ground**	**rectangular with sloping ground and RCC bracing**	**rectangular with sloping ground and MBS steel bracing**
Axial Force Fx	4090.963	4681.729	4672.529	4663.488
Shear Force Fy	37.440	70.987	70.514	70.125
Shear Force Fz	36.969	54.879	121.123	136.794
B.M. My	58.557	119.454	202.152	228.306
B.M. Mz	59.148	177.132	179.839	177.599

5.3 Comparison between all types of building in Graphical Representation

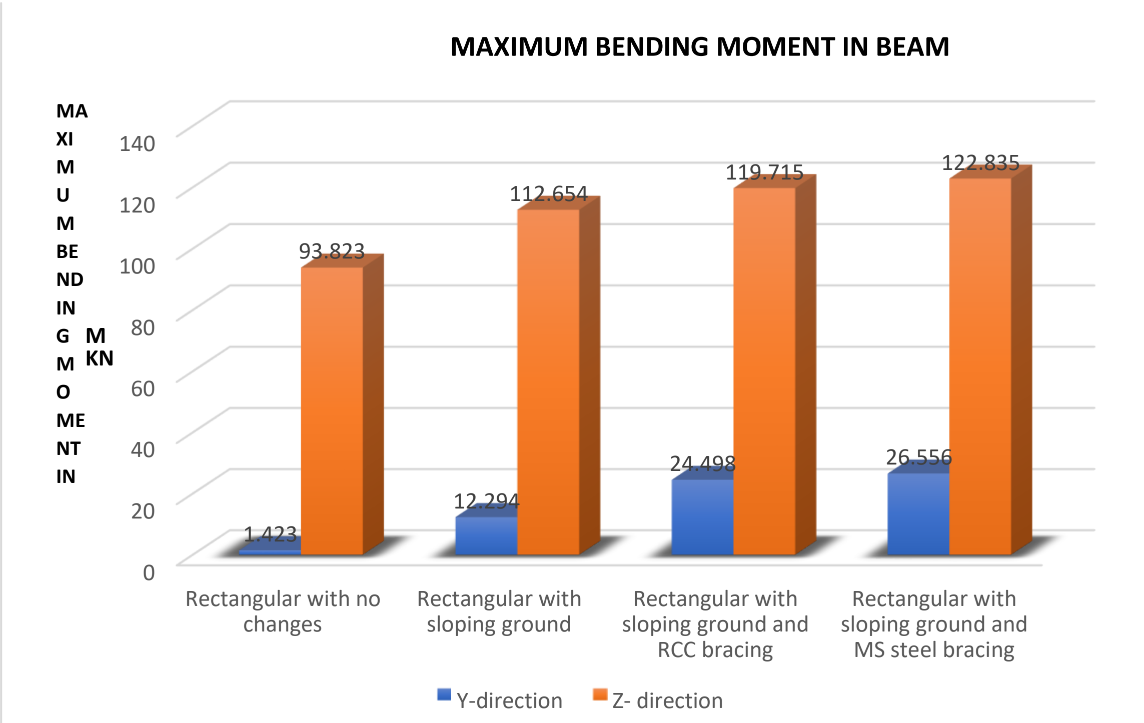

Figure No 5.1 Maximum Bending Moment in Beam

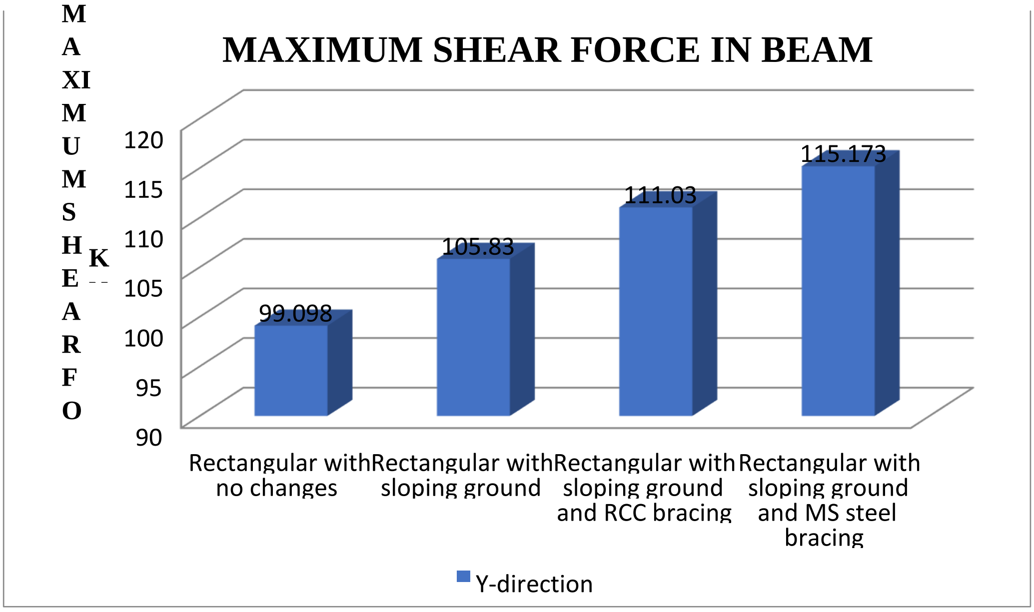

Figure No 5.2 Maximum Shear Force In Beam

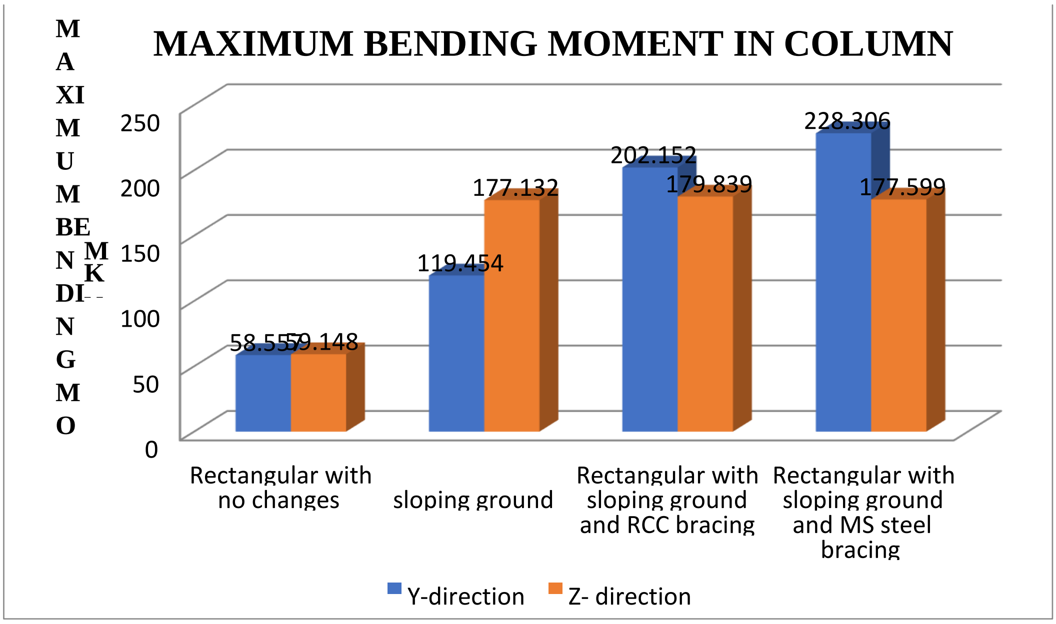

Figure No 5.2 Maximum Bending Moment in Column My and Mz Direction 5.17

5.4 Now Compares Between Height Vs Drift

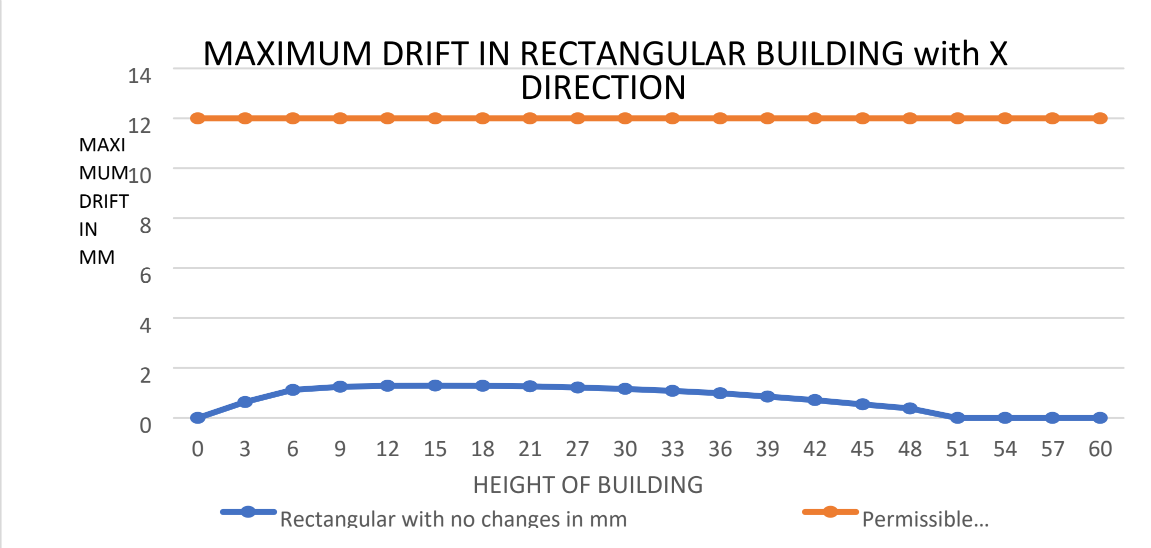

Figure No 5.3 Drift Vs. Height of Rectangular Building X Direction

5.5 Now Compares displacement between all types of building in graphically represented in both direction x and z direction

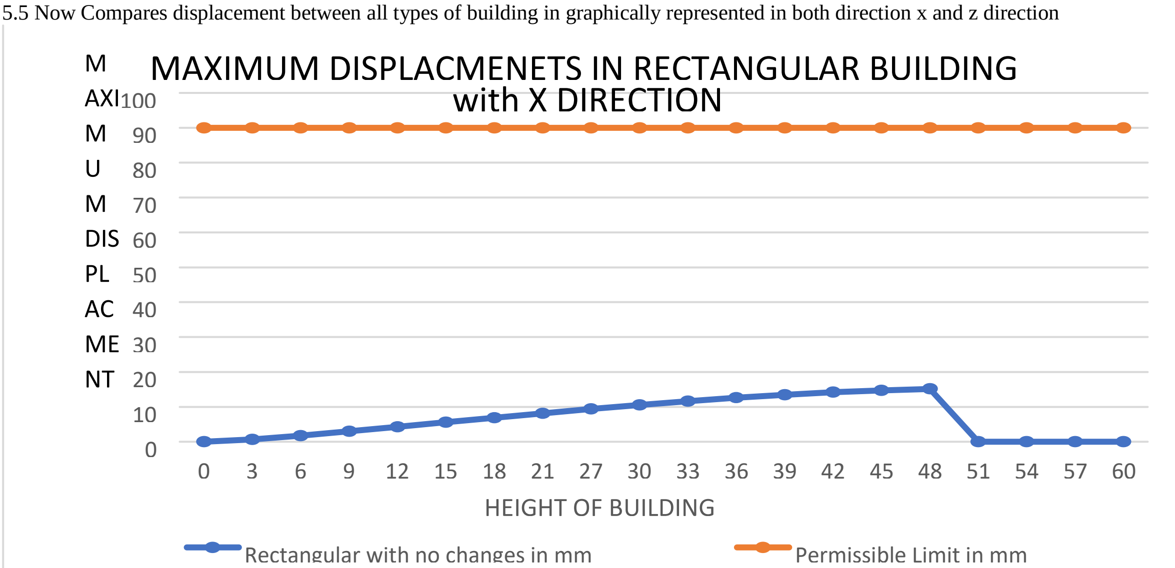

Figure No 5.4 Displacements Vs. Height of Rectangular Building X Direction

6.0 CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1) Bracing Structures gives more resistance to lateral deflection and also it suitable in earthquake prone areas
2) The bracing system effectively reduces the lateral displacement and drift for the A bracing of the structure compared to other bracings
3) By using A bracing it is possible to adopt openings for windows and doors which are critical in XBS because X-bracings run across the entire wall area
4) The X braced system give a well performance as compared to normal building.
5) In case of bending moment and shear force of beam increasing model 1 to model 4 but we can see that bending moment and shear force hold from M3 to M4 model.
6) But In case of bending moment and shear force of column just apposite of beam decreasing value of BM and SF of column to model 1 to model 4 but we can see that bending moment and shear force decreasing from M3 to M4 model.
7) The Storey Displacement is reduced in buildings after providing a bracing system.

8) The storey force changes with the shape of the building even though the lateral displacement and the storey drift change
9) Maximum Bending Moment in Column Mz and My Direction. Mz is maximum in rectangular building 59.148 kN-m and other three model M2, M3 and M3 where M3 is maximum 177.599 kN-m
10) Maximum Bending Moment in Column Mz and My Direction. where prefer the rectangular building with Sloping ground and bracing increasing bending moment
11) Maximum Axial Force In column 4681.729kN in rectangular building where prefer the rectangular building with sloping ground like M1, M3 and M4.
12) After analysis we find that storey displacement is considerably increased after provision of bracing.

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