DYNAMIC ANALYSIS OF SETBACK STEEL MOMENT RESISTING FRAME ON SLOPING GROUND WITH DIFFERENT TYPES OF BRACING SYSTEM

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Abstract - Structure are exceedingly helpless to serve harms in tremor situation, so picking a suitable supporting frameworks will significantly affect execution of the structure. So this present investigation is done for assessing and contrasting different sorts of steel bracings for setback building on slanting ground .In this paper, an endeavor has been made to assess the seismic execution of setback building laying on sloping ground. The investigation has been performed in two individual techniques i.e by equivalent static analysis and time history method .For this 4 sorts of supporting frameworks like X-Bracing, Diagonal bracing, V-bracing and transformed V bracing are considered. The models are analysed for various aspects such as storey displacement,time period and storey shear, the structure is examined for seismic zone V and medium soil condition according to IS 1893:2002 utilizing ETABS software.Based on the results it can be concluded that due to irregularity on ground surface,the structures on sloping ground are more vulnerable to earthquake.

Key Words: Setback, Sloping ground, Equivalent static analysis, Time history method,ETABS

1. INTRODUCTION

Because of industrial revolution, in the present decade the improvements in the urban groups have been on rise in the sloping ground. The lack of plain topography is a normal issue in various urban zones, thus developers are building multistory structures to suit this rising population on inclining grounds. However, with such arrangements increment in self weight and live load along with seismic tremor powers will increment and influence the structures relying upon many components like quality of materials utilized, sort of soil surface, measure of mass and firmness of structural and non structural members, levels of workmanship etc. Consequently there is an need to do a seismic evaluation of the present structure in most urban region which comes under higher seismic zones.

1.1 SETBACK STRUCTURE

Set back structures are portrayed by astounding diminishments in floor zone along with drops in mass, quality and robustness.Due to the assorted configurations of buildings in sloping ground, these buildings become irregular and asymmetric .The changes in strength and mass render the dynamic properties of these structures not the same as the "standard" building. The developing number of damages after seismic ground advancement has given certification that setback structures show deficient conduct however they were designed by current seismic codes.

1.2 OBJECTIVES

1. To study the behaviour of high rise steel frames building resting on slant grounds with bracings under the action of earthquake load.
2. To identify best sort of bracing in setback SMRF on slant ground for resisting earthquake.
3. Load Analysis is done for varying slanting ground angles i.e 10,15,25 degrees.
4. The variation of time period, base shear, storey displacements, peak displacemet, peak acceleration for sloping setback steel moment resisting frame with and without bracing system are compared.

1.3 METHODOLOGY

1. Setback steel moment resisting frame of 25 stories resting on inclining ground is considered in the present investigation.
2. Sloping ground having three varying slants i.e., 10, 15 and 25 degrees are considered.
3. Five sorts of steel frames laying on slanting ground i.e., one without bracings and other 4 sorts of bracings are considered. X, diagonal, Inverted V and V bracings are incorporated in outer pheripherals of structure.
4. Lateral loads are applied in the form of earthquake forces and for the modelled structure equivalent static and time history analysis is carried out.
5. Behaviour of steel structure under varying inclined ground with various sorts of bracings are studied.

2. MODELLING AND ANALYSIS

Following types of models are considered in this study. Total fifteen models are considered in the present study

With 10 degree slope

- Model 1 : Steel Set back MRF on inclining ground.
- Model 2 : Steel Set back MRF on inclining ground with V sort bracing system on exterior part of building.
- Model 3 : Steel Set back MRF on inclining ground with X sort bracing system on exterior part of building.
- Model 4 : Steel Set back MRF on inclining ground with single diagnol sort bracing system on exterior part of building.
- Model 5: Steel Set back MRF on inclining ground with inverted V sort bracing system on exterior part of building.

With 15 Degree slope

- Model 1 : Steel Set back MRF on inclining ground.
- Model 2 : Steel Set back MRF on inclining ground with inverted V sort bracing system on exterior part of building.
- Model 3 : Steel Set back MRF on inclining ground with X sort bracing system on exterior part of building.
- Model 4 : Steel Set back MRF on inclining ground with single diagnol sort bracing system on exterior part of building.
- Model 5: Steel Set back MRF on inclining ground with V sort bracing system on exterior part of building.

With 25 Degree slope

- Model 1 : Steel Set back MRF on inclining ground.
- Model 2 : Steel Set back MRF on inclining ground with inverted V sort bracing system on exterior part of building.
- Model 3 : Steel Set back MRF on inclining ground with X sort bracing system on exterior part of building.
- Model 4 : Steel Set back MRF on inclining ground with single diagnol sort bracing system on exterior part of building.
- Model 5: Steel Set back MRF on inclining ground with V sort bracing system on exterior part of building.

2.1 MATERIAL AND FRAME SECTION PROPERTIES

- Grade of structural steel is taken as FE 500, having yield stress of 500 N/mm^2.
- Grade of concrete for deck: M25
- Column : ISWB 600
- Structural Beam : ISMB 250
- Deck : Steel-concrete composite deck of 200 mm thickness
- Bracings :ISMB 250

2.2 MODEL GEOMETRY

The Building is a 25-storied, 6 bays along X-direction and 5 bays along Y- direction, Steel frame with properties as specified below. The floors are modeled as rigid deck section. The live load on the floor is taken as 4 kN/m^2,dead load as 1.5 kN/m^2,glazing load as 2 kN/m.

Number of stories = 25.

Number of bays along X Dir. = 6 Bays, Y-Dir. = 5 Bays

Each Storey height = 3.5 meters

Dimension of building=20m x 20m

2.3 PLAN VIEW OF BUIDLING

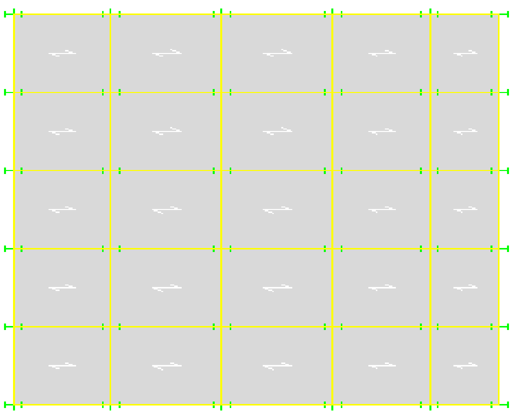

Figure1: Plan View of Building

2.4 BUILDING ELEVATION VIEW

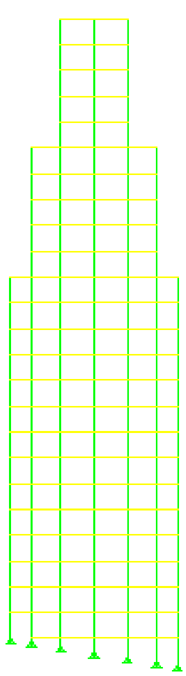

Fig 2: Setback steel frame on 10 degree sloping ground

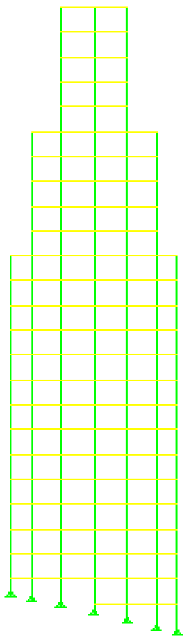

Fig 3: Setback steel frame on 15 degree sloping ground

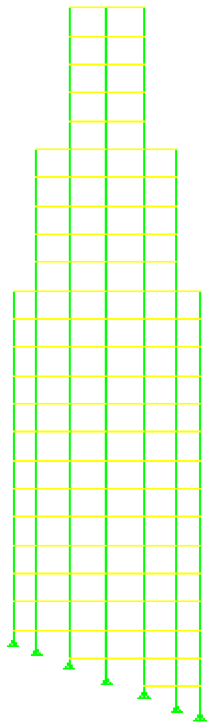

Fig 4: Setback steel frame on 25 degree sloping ground

3. RESULTS

3.1 EQUIVALENT STATIC ANALYSIS RESULT

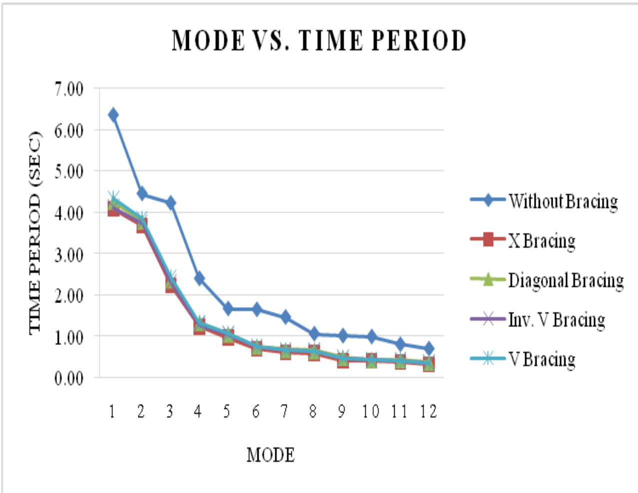

Fig 5: Mode vs. Time Period (Sloping ground 10°)

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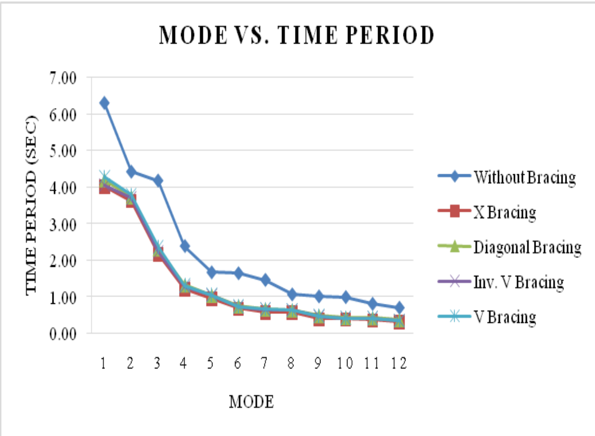

Fig 6: Mode vs. Time Period (Sloping ground 15°)

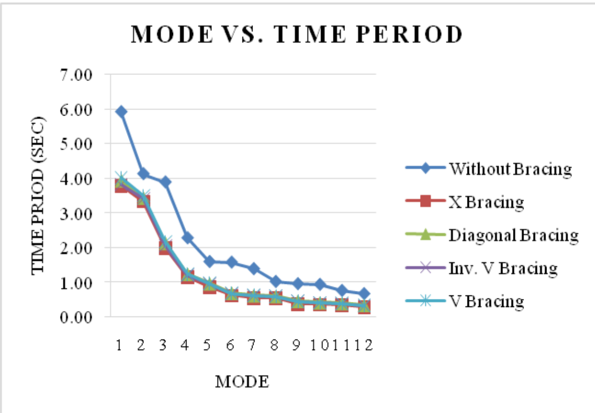

Fig 7: Mode vs. Time Period (Sloping ground 15°)

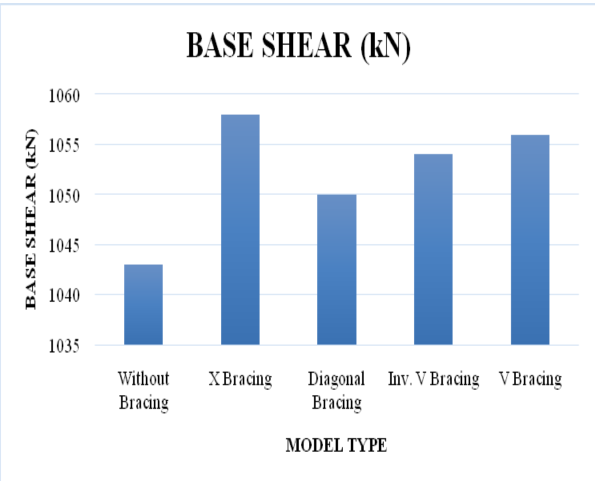

Fig 8: Storey Shears (Sloping ground 10°)

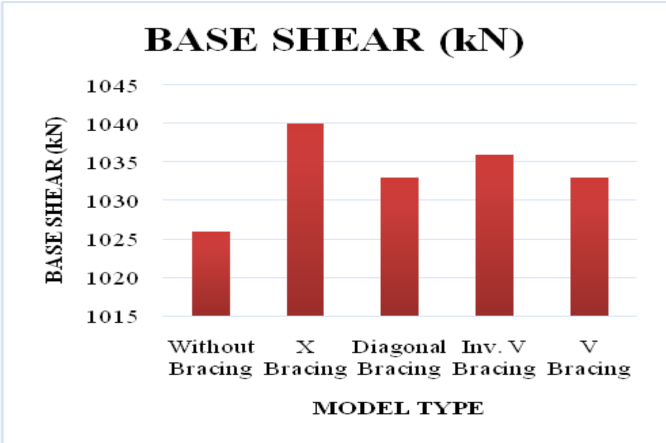

Fig 9: Storey Shear (Sloping ground 15°)

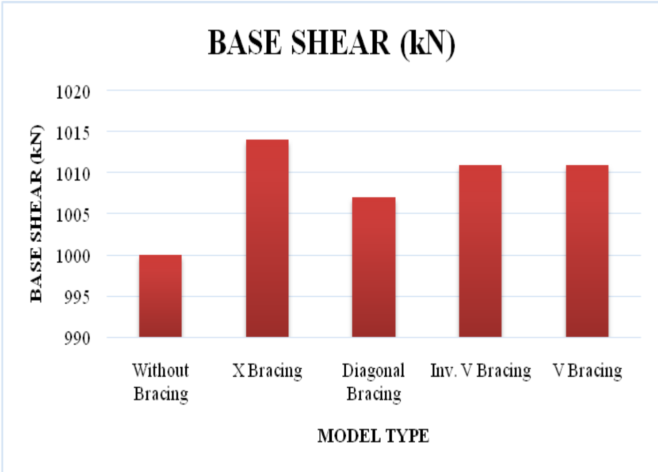

Fig 10: Storey Shears (Sloping ground 25°)

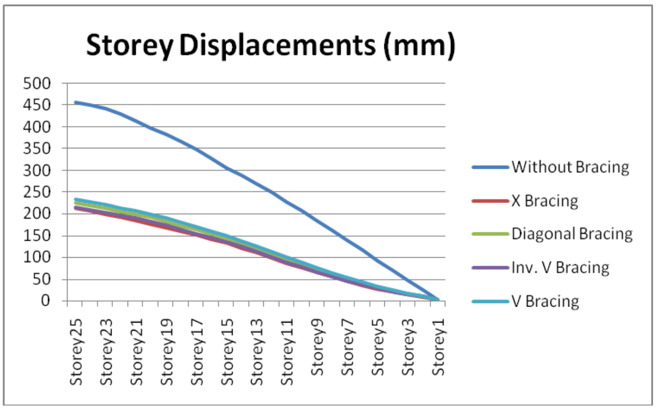

Fig 11: Storey vs. Displacements (Sloping ground 10°)

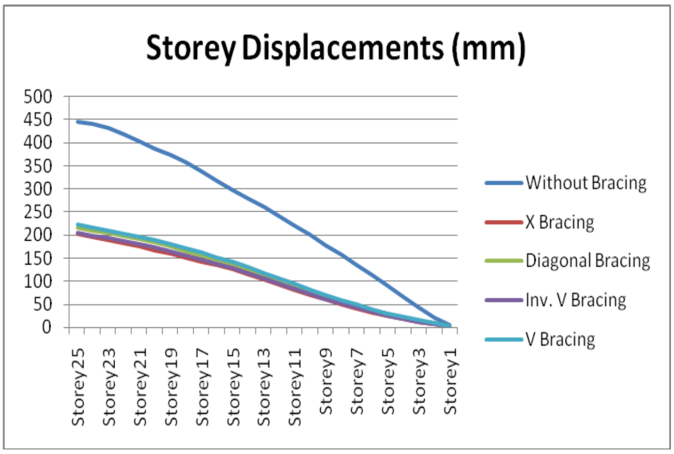

Fig 12: Storey vs. Displacements (Sloping ground 15°)

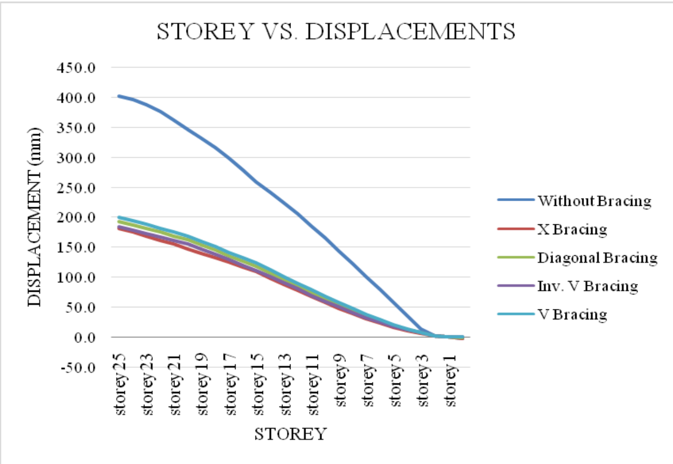

Fig13: Storey vs. Displacements (Sloping ground 25°)

3.2 TIME HISTORY ANALYSIS RESULT

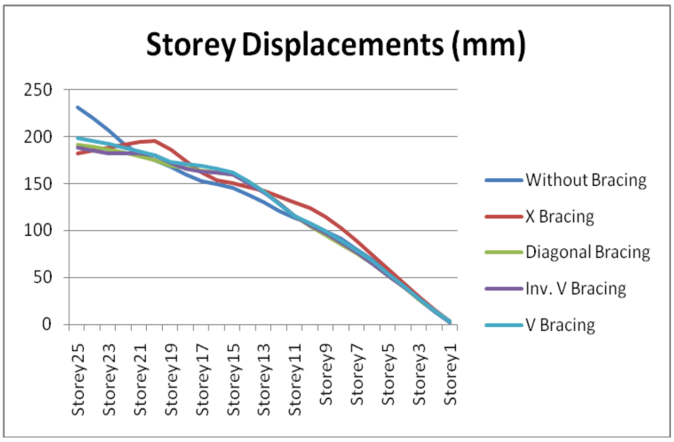

Fig 14: Storey vs. Displacements (Sloping ground 10°)

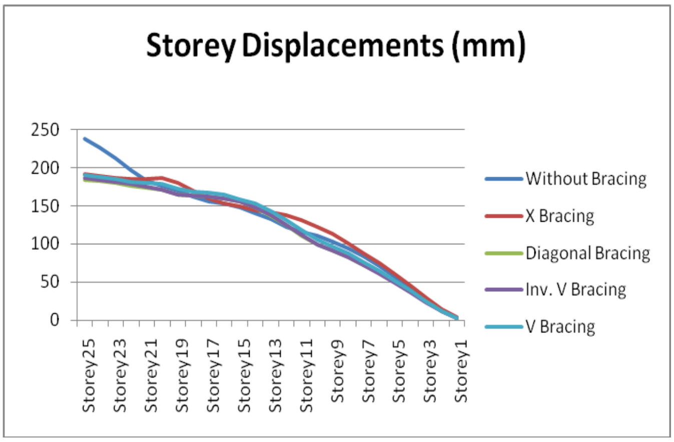

Fig 15: Storey vs. Displacements (Sloping ground 15°)

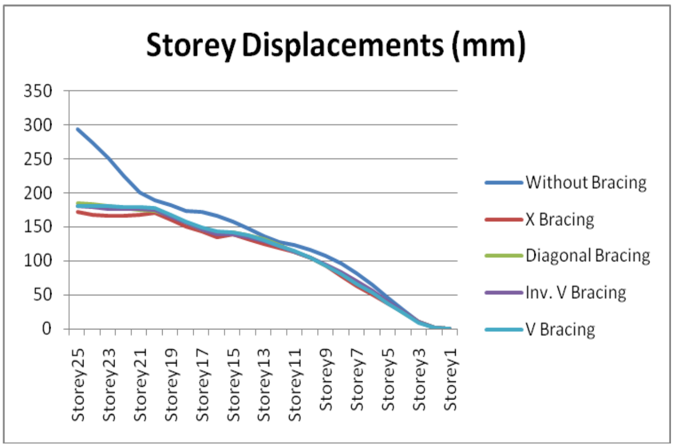

Fig 16: Storey vs. Displacements (Sloping ground 25°)

Table 1: Peak Displacement summary (mm)

Sloping Ground	Without Bracing	X Bracing	Diagonal Bracing	Inverted V Bracing	V Bracing
10 Degree	230.9	182.8	191.3	188.2	198.9
15 Degree	237.5	192.1	184.4	186.8	190.0
25 Degree	293.7	171.7	184.4	179.9	180.1

Table 2: Peak acceleration summary (m/s²)

Sloping Ground	Without Bracing	X Bracing	Diagonal Bracing	Inverted V Bracing	V Bracing
10 Degree	4.12	7.07	4.10	3.68	4.05
15 Degree	4.12	7.09	4.09	3.56	3.73
25 Degree	4.27	7.91	4.35	4.48	4.01

4. RESULTS

1. Time period has less effect on change in slope angle of ground from 10 to 15 degrees, but a decrease in time period of 6% is found from 10 to 25 degrees. Hence only substantial change in slope angle has an effect on time period of the steel setback building.

2. Presence of bracings causes decrease in time period of about 36% due to the increase in stiffness of the steel structure, hence increases the frequency of the building. Maximum decrease in time period is observed in setback frame on inclining ground with X bracing.

3. Effect of storey shear due to change in slope of the ground is very less which is underneath 5%. Also there is little variation due to change in type of bracing system.

4. Sloping ground has an effect on variation of displacements, with the increase in slope angle a decrease in displacements is found which is about 12%. Also presence of bracings plays a major role in reducing the displacements up to 54% using X bracings respectively, in all type of slope angle. Inverted V bracings also shows a better performance in decreasing the displacements next to X bracing.

5. In case of time history analysis, X bracings shows good resistance in 10 and 25 degree which reduces displacement about 21% and 42% respectively.

6. Due the large stiffness in X braced steel structure, peak acceleration is found to be highest which is found to be 7.91 m/sec^2 in 25 degree.

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