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Seismic Analysis of the RC Structure with Different Bracing System

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Abstract - *In this paper, we applied the different type of bracing system in the RC building. We created five RC structure have same dimension and property but provide the different type of the bracing. The model-01 have an X-bracing system of the steel which having Fe250 grade, model-02 having V- bracing system in the RC structure, model-03 having an inverted V-Bracing system in the RC stricture, model-04 having eccentric forward bracing, and model-05 having eccentric backward bracing in the RC structure. There all five models are created by the ETABS software, and the method used for the analysis of these models is Dynamic Analysis with the help of the Time History Method. We used some Indian Standard Code such as IS456:2000, IS1893 part-1:2016, IS 875 part-1, part-2. These models compared seismic analysis parameter to each other, to check the stability and safety of the structure. The seismic parameter is base shear, natural time, storey displacement, drift, storey overturning moment, joint drift, column force, and storey acceleration.*

Key Words: RC Structure, Time History Analysis, Linear Analysis, Bracing System, ETABS.

1. INTRODUCTION

Structures are built to facilitate the performance of various activities connected with residence, office, education, healthcare, sports and recreation transportation, storage, power generation, etc. All the structures should sustain the loads coming on them during their service life by possessing adequate strength and also limit the deformation by possessing enough stiffness. The strength of a structure depends on the characteristics of the material with which it constructed and Stiffness depends upon the cross-sectional and geometrical property of the structure. The tall building or multi-storied building defined as the virtue of its height (more than 30 m), is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. Structural analysis deals with the mechanism of regeneration of loads applied on the system into local element force, using various theories and theorems enunciated by eminent engineers and investigators. It also deals with the computation of deformations these members suffer under the action of induced forces.

The essential work of members of a framed structure is to transfers the gravity loads and lateral loads to the the foundation of structure and then to the earth. The main loads that come in the structure are gravity loads consists dead load, live loads and some service loads. Besides this structure is probable may undergo lateral forces caused due to seismic activity, wind forces, fire, and blasts etc. Here the columns and beams of the structures are used to transfers the major portion of the gravity loads and some portion of lateral loads but that is not significant to the stability of the structure. So we provide bracing systems, shear walls, dampers etc to resist or transfer these lateral forces to the structure uniformly without affecting the stability and strength of the structure.

1.1 Types of Steel Bracing

There are different types of the Bracing system, which are given below:

1) Horizontal Bracing System
2) Vertical Bracing System

1.1.1 Horizontal Bracing System

This consists of bracing at each floor in the horizontal planes thus providing load paths so that the horizontal forces can be transferred to the planes of vertical bracing.

1.1.2 Vertical Bracing System

In vertical planes, there are bracing between column lines which provide load paths that are used to transfer horizontal forces to ground level. This system aims to transfer horizontal loads to the foundations and withstanding the overall sway of the structure. These are the bracings placed between two lines of columns.

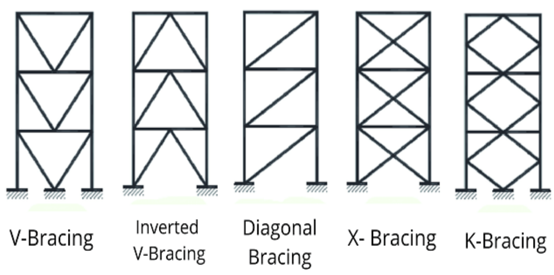

Fig -1: Type of Vertical Bracing System

2. DETAILS OF THE MODELS

In the details of the models, we will know the details of the models, such as the materials, frame section, slab details, load parameter, type of the bracing system, and view of the models,

2.1 Material Parameter

In this research paper, for the creating and analysis of the models, we used the following material:

Table-1: Material Parameter

S.No	Material	Grade
1	Concrete	M30
2	Longitudinal Reinforcement	Fe500
3	Transverse Reinforcement	Fe250
4	Steel for Bracing	Mild Steel (Fe250)

2.2 Type of Bracing in the Models

In the RC structure, we used the following types of bracing in the RC building, which is given below:

1. Model-01- X-Bracing System in RC Structure
2. Model-02- V-Bracing System in RC Structure
3. Model-03- Inverted V-Bracing System in RC Structure
4. Model-04- Eccentric Forward Bracing System in RC Structure
5. Model-05-Eccentric Backward Bracing System in RC Structure

2.3 Load Parameter

We used the following loads on the RC structure according to the Indian standard code, which is given below:

Table-2: Load Parameter

S.No	Load	Value
1	Live Load	$3KN/m^2$
2	Partition wall load	7 KN/m
3	Load Bearing Wall	14 KN/m

2.4 Building Geometry

In the building geometry, we will know the dimension of the beam, dimension of the column, the thickness of the slab, the dimension I section, these details are given below:

Table-3: Building Geometry

S.No	Building parameter	Value
1	RCC Beam	500mm*350mm
2	RCC Column	600mm*500mm
3	Slab	160 mm
4	Beam Span	3m
5	Height of ground floor	3m
6	Height of floor	3m
7	Plan Area	18m*15m
8	I Section for Bracing	Total depth= 350mm, Web thickness= 13mm, Flange width =100mm, flange thickness = 20mm
9	Total Height of Building	51m

2.5 Seismic Parameter

In the seismic parameter, we will know the all seismic parameter which provided in the models for analysis, there parameters are given below:

Table-4: Seismic Parameter

S.No	Seismic Parameter	value
1	Importance Factor (I)	1.2
2	Response Reduction Factor (R)	5
3	Zone Factor (z)	0.16
4	Type of the Soil	2nd
5	Eccentric ratio	0.05
6	Magnitude	6.9
7	Time history data	EL CENTRO

3. DETAILS VIEW OF MODELS

In the detailed view of the models, we will see the plan, elevation, and 3D View of each model, which are given below:

3.1 Details View of Model-01: RC Structure with X-Bracing System

The plan, elevation, and 3D view of the model-01 given below:

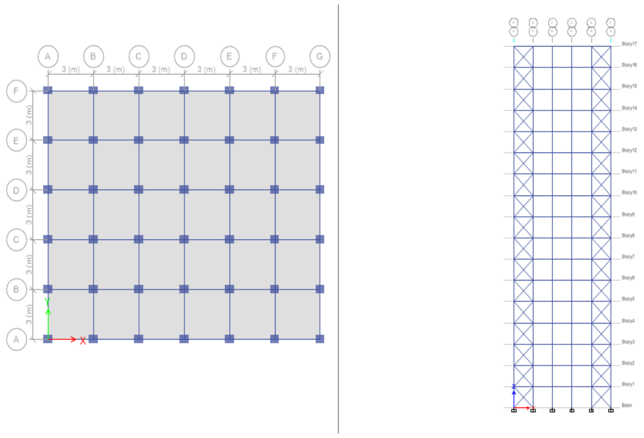

Fig -2: Plan and Elevation of Model-01

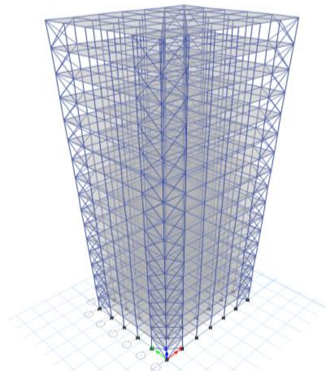

Fig -3: 3D View of Model-01

3.2 Details View of Model-02: RC Structure with V-Bracing System

The elevation and 3D view of the model-02 given below:

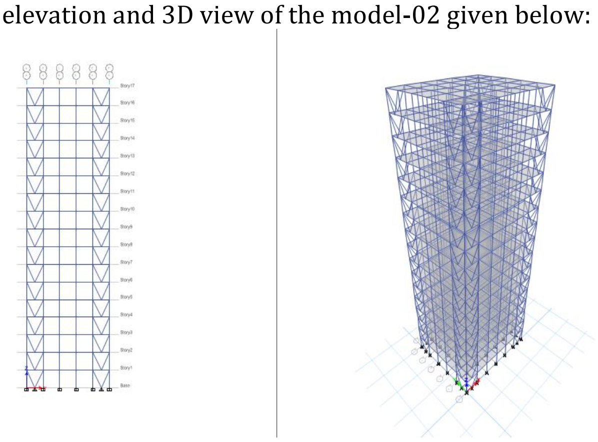

Fig -4: Elevation and 3D View of Model-02

3.3 Details View of Model-03: RC Structure with Inverted V-Bracing System

The elevation and 3D view of the model-03 given below:

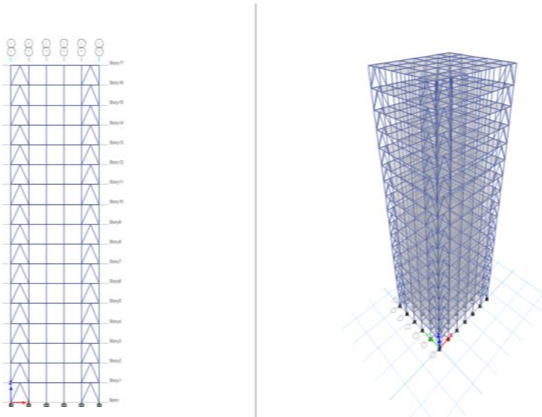

Fig -5: Elevation and 3D View of Model-03

3.4 Details View of Model-04: RC Structure with Eccentric Forward Bracing System

The elevation and 3D view of the model-04 given below:

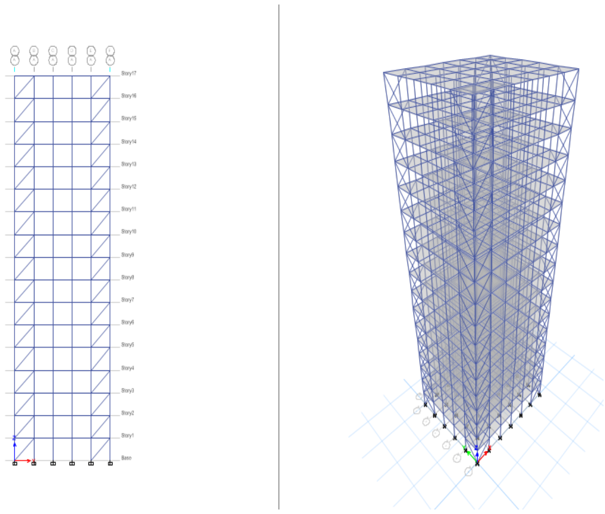

Fig -6: Elevation and 3D View of Model-04

3.5 Details View of Model-05: RC Structure with Eccentric Backward Bracing System

The elevation and 3D view of the model-05 given below:

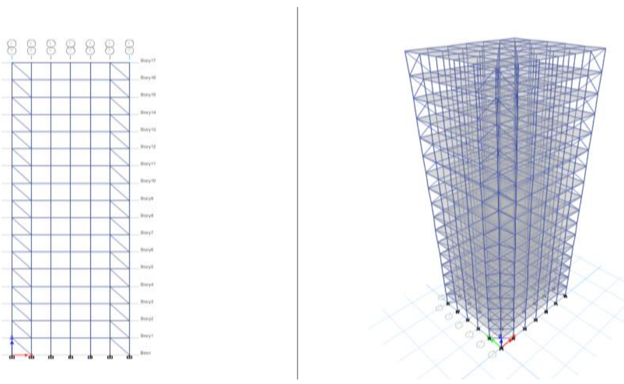

Fig -7: Elevation and 3D View of Model-05

4. CALCULATION AND RESULT

In this chapter, we analyze the result which came after analysis of this entire model, we have taken some parameter of the seismic such as natural period, base shear, storey displacement, storey stiffness, storey drift, etc. based on this parameter we will check that which types of the bracing system is more suitable and stable concerning other models.

4.1 Natural Period

From clause 3.18 from Indian Standard Code 1893 part-1:2016, the natural period in the mode of oscillation is defined as the time (in a sec) taken by structure to complete one rotation of the oscillation in its natural mode of wavering. The following graph represents the variation of the natural period:

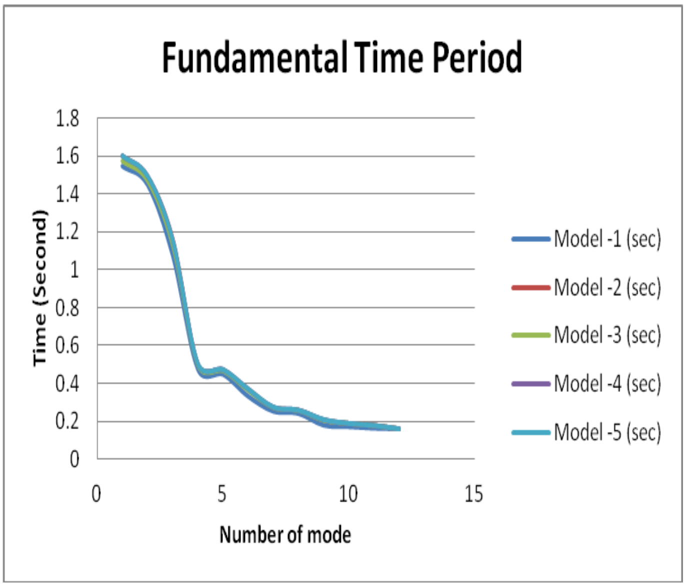

Chart -1: Natural period

Concerning the Indian Standradrad code 1893 part-1:2016, the natural period of RCC structure should exist in 0.05 to 2.00 second.

4.2 Base Shear

From clause 7.2.1, from Indian Standard code 1893 part-1: 2016, the base shear is defined as the lateral forces which act at every storey due to seismic effect on the structure.
The following graph represents the base shear (lateral forces) of all models in the Y direction due to applying seismic effect in the Y direction:

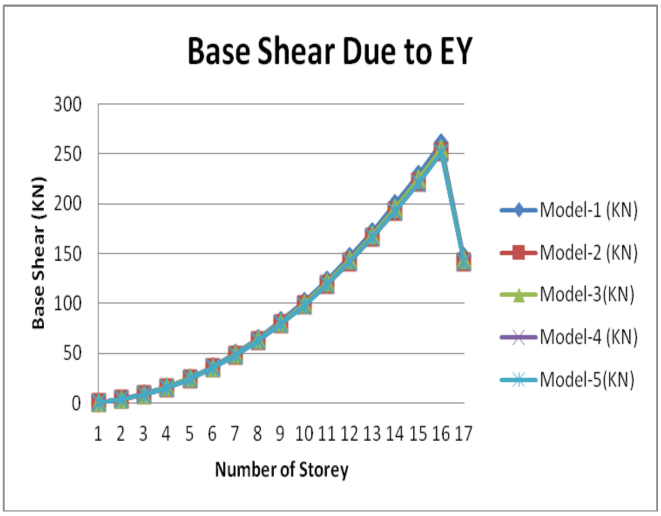

Chart -2: Base Shear Due to EY

From the above graph, the maximum value of the base shear is in models-01 and same in the model-04 and model-05.

4.3 Maximum Storey Displacement

It is defined as the displacement of every storey concerning the ground which is developed due to the effect of the seismic forces on the structure

The graph of the maximum storey displacement is given below of all models:

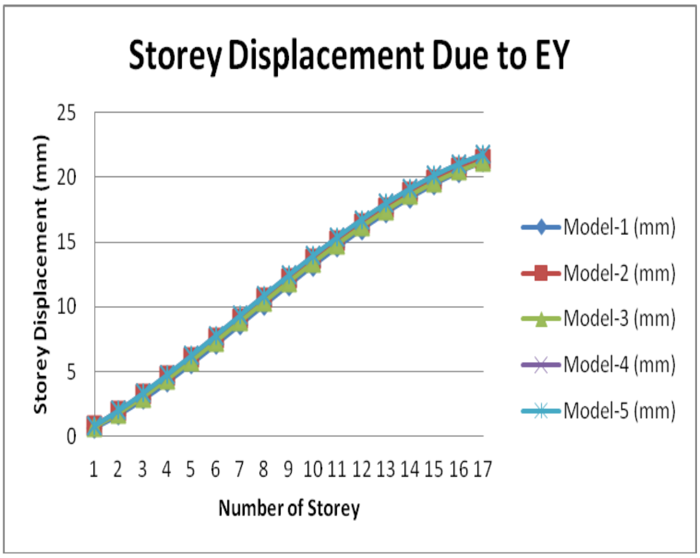

Chart -3: Maximum Storey Displacement

From the above graph, we can see that the value of maximum storey displacement in model-04 and model-05.

4.4 Storey Drift

Storey Drift is defined as the relative displacement of the storey concerning the top or below the storey. Storey drift does not calculate concerning the ground surface.

The graph of the storey drift of all models is given in the form of the graph:

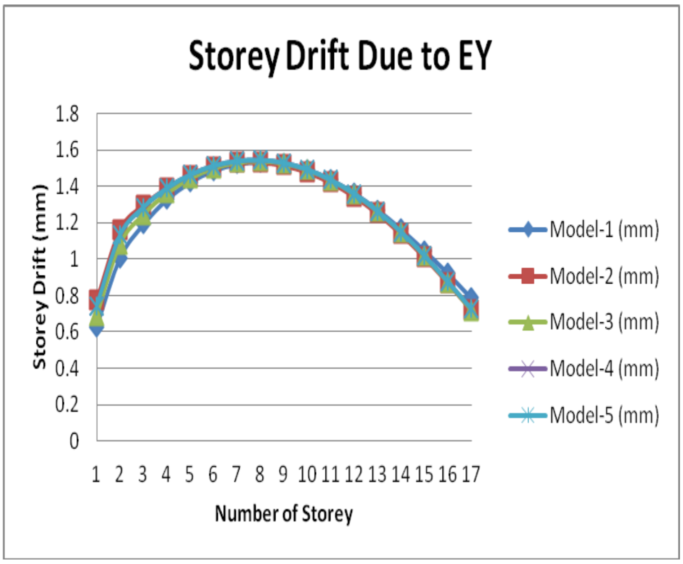

Chart -4: Storey Drift

Concerning the Indian Standard code, the value of the storey drift should not be exceeding than 0.004 height of the floor

4.5 Storey Stiffness

Storey stiffness is defined as by Indian standard code 1893 part-1:2016, it is the ratio of the storey shear to the storey drift.

The graph of the storey stiffness of all models is given below:

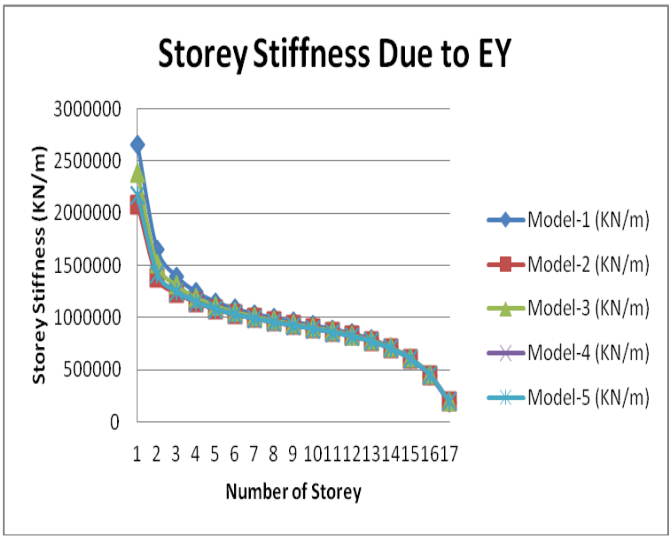

Chart -5: Storey Stiffness

From the above graph, we can see that the value of the story stiffness is high in the H model-01 on the first floor.

4.6 Maximum Storey Overturning Moment Due to EY

It is defined as the product of the base shear and perpendicular distance or height (height of the buildings.). The graph of the storey overturning moment is given below due to seismic force in the Y-direction.

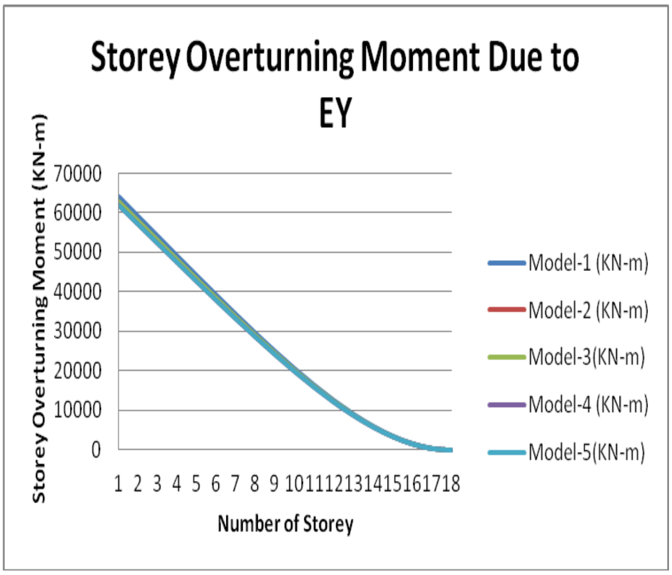

Chart -6: Storey Overturning Moment

The maximum value of the storey overturning moment is in model-01, its because the value of the base shear in model-01 is high as compared to the all other four models.

5. CONCLUSIONS

After analyzing these five models of the RC Structure with a different type of bracing system in it, we found some conclusion related to the seismic analysis:

I. According to the Indian Standard Code 1893 part-1:2016, the fundamental period of the G+20 RC structure is from 0.05 second to 2.0second. from this point of view, our all models have a fundamental period less than 2.0, so we can say that these models safe in the fundamental period. The fundamental period of model-02 has little high as compared to all fours models.

II. Concerning the graph of the base shear due to EY, we found that the maximum base shear in model-01. Model-02 have 3.49% less, model-03 have 1.92% less, model-04 have 3.64%less than model-01 at the top floor of the RC structure.

III. According to IS 1893 part-1:2016, the maximum storey displacement of the RC structure should not be greater than H/250, where H represents the total height o the structure. Here the total height of the RC structure is 51000mm, so the maximum storey displacement should not be greater than 204mm, but in the models, the maximum storey displacement is less than 204mm. The maximum storey displacement occurs in the model-04 and models which is 21.779mm

IV. According to the IS 1893 part-1: 2016, the value of the storey drift should not be greater than be 0.004h, where h represents the height of the floor. So maximum value of the storey drift should not be greater than 12mm. All models have the value of the storey drift less than 12mm. So all models are in a safe condition after providing the bracing system.

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