SEISMIC ANALYSIS OF MULTISTORIED BUILDING OF REGULAR AND IRREGULAR PLAN CONFIGURATION WITH DIFFERENT BRACING SYSTEM USING ETABS

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Abstract- **The goal of this project is to analyze ordinary and vertical irregular homes to understand the reaction of vertically abnormal homes using superior software program together with ETABS. ETABS is an included software program used for static analysis and layout of buildings. This paper deals with the take a look at of of the conduct of buildings when subjected to horizontal loads together with seismic masses. The examine in particular makes a specialty of the effect of the shape of the structure on the resistance to these lateral hundreds. 3 one-of-a-kind configurations are taken into consideration on this look at, particularly: L-form, I-form and rectangular form. The response of vertically abnormal buildings with an everyday building is achieved by using thinking about the simple shear, displacement and bending moment of the buildings. Buildings which have irregular plan will without difficulty be concern to torsional effects because their center of gravity does no longer coincide with the center of gravity, as twisting can be advanced in the building. As for homes that have an abnormal peak and are positioned in seismic zones, it will be difficult to recognize the conduct of such vertically abnormal buildings.**

A viable strategy to growth earthquake resistance is the usage of steel bracing structures with the aid of expanding its stiffness and stability, metallic bracing can growth the shape's resistance to lateral forces. The ability blessings of the usage of metallic braces are their high strength, stiffness, economic system, takes up less space and adds tons much less weight to the present structure. This challenge investigates the structural conduct of ordinary and abnormal building for reinforced and unreinforced situations underneath static and lateral loading. This examine may be used for the layout of latest irregular building systems and for the analysis of existing irregular building.

Keywords- Seismic loads, Configuration, Irregularity, Storey drift, Base shear, Response spectrum analysis, Bracing system.

I. INTRODUCTION

Earthquakes are the most changeable and adverse of all herbal screw ups. Earthquakes have the eventuality to beget the most damage of all natural hazards. Due to the fact earthquake forces are arbitrary and changeable. They no longer handiest beget awesome damage in terms of mortal casualties, however also have a huge profitable effect at the affected area. Organizations approximately seismic pitfalls have brought about a growing mindfulness and call for construction designed to repel seismic forces. While a structure is subordinated to ground actions at some stage in an earthquake, it responds via wobbling. Those floor moves beget the structure to joggle or shake in all 3 directions; the foremost route of shocks is vertical. At some point of an earthquake, structural damage generally starts off evolved at a factor of structural weak point present inside the shape structures. High- upward push RC structures are a special magnificence of systems with their very own special traits and conditions under the condition of earthquake, the behavior of a structure relies upon on several factors, stiffness, sufficient aspect strength, tension, simple and normal configurations. Structures with regular determine, with inconsistently disbursed mass and stiffness in plan and elevations, go through a lot decrease damage as compared to irregular configurations. Earthquake resistant layout of RC structures is an area of exploration as earthquake engineering has started not most effective in India but also in different superior nations. Harm to structures for some purpose or different throughout an earthquake.

Structure configuration can be described as ordinary or abnormal in phrases of structure size and shape, arrangement of structural rudiments and mass. The regular shape configuration is nearly symmetrical in plan and top about the axis and has an indeed distribution of the transverse force of the resisting structure in order that it gives a nonstop cargo path for each graveness and aspect loads. A shape it truly is unsymmetrical and has a discontinuity in figure, mass, or shipment- defying element is known as irregular. These irregularities can beget an unconditional influx of forces and interest of stress. Asymmetric association of mass and stiffness of rudiments can beget a massive torsional force where the center of graveness doesn't coincide with the middle of stiffness. India has witnessed numerous fundamental earthquake failures in the last century. Earthquake is the maximum dangerous and negative motive of destruction of structures and mortal lifestyles due to its unpredictability and enormous pressure. Building structures crumble at some stage in robust earthquakes and beget direct loss of mortal existence. Earthquake is an herbal miracle whose items cannot be unnoticed however can be minimized to a degree through espousing relevant structure designs. The main cause of this paper is to evaluate an everyday shape with an abnormal structure with recognize to earthquake, wind and crumble lading of the shape the usage of ETABS (reaction spectrum method).

Conduct of structure under seismic loading specially relies upon on simple and normal configuration, irregularity in mass and stiffness, good enough lateral strength and ductility. Regular building configuration is sort of symmetrical in plan and elevation approximately the axis and it provide a continuous load direction for gravity and lateral loads. In irregular building, unconditional float of pressure and strain attention may also occur and the asymmetrical arrangements motive large torsional force. In this examine seismic evaluation of G+25 constructing of ordinary and abnormal plan configuration structure changed into modelled and analyzed by response Spectrum analysis the use of E-tabs software. The reaction of ordinary and abnormal building is completed through considering the base shear, displacement and bending second of the buildings. A viable solution for reinforcing earthquake resistance is the use metallic bracing structures by way of increasing its stiffness and stability, metallic bracings can beautify the resistance of shape towards lateral forces. The capacity benefits of using steel bracing are their excessive strength, stiffness, low-priced, occupies much less area and provides a good deal less weight to the existing structure.

The principal intention of the research was to discover the form of bracing with the intention to motive minimal bottom displacement and for this reason make a contribution to more lateral stiffness of the structure. This challenge investigates the structural conduct of normal and irregular building for bolstered and unreinforced situations underneath static and lateral loading. The analysis methodology turned into presented and mentioned in this record. Ultimately, a comparative look at became provided to assess the first-class structural overall performance of RCC constructing under lateral load. Numerous styles of braces are used for this reason. They may be X bracing, V bracing, Inverted V bracing. The aim of this project is to find out which bracing is more effective in resisting lateral deformation, considering regular (rectangular) and irregular (L and I-shaped) buildings.

II. OBJECTIVES

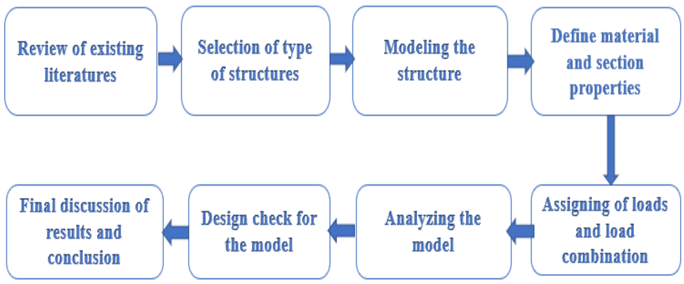
In this study, the seismic analysis of constructing G+25 everyday (square) and irregular (L-shape, I-form) plan shape configuration became modeled and analyzed by using response Spectrum evaluation using E-tabs software program. The response of regular and irregular building is done by considering the base shear, displacement and bending moment of the buildings.

- Develop, design and analyze high rise structure model (G+25) in E-tabs software
- Analyze regular and irregular plan configuration models
- To determine the basic shear, bending moment and displacement of building floors under seismic loading
- To investigate the seismic behavior of multi-storey RC regular and irregular buildings with X, V and inverted V bracing system using response spectrum analysis in Etabs.
- To study the effect of maximum displacement, bending moment and base shear for rectangular building, L and I shaped building with X bracing system.
- Compare base shear, bending moment and story displacement values and graphs.

III. MODELING OF STRUCTURRE AND LOADING CONDITION

G+25 building of rectangular, L-shape and I-shape plan configuration is modeled using Response spectrum analysis in E-tabs software. This model is prepared in E-tabs software which is developed by CSI company and version of the software was 17. The building is modeled by defining various material and section properties. Also, in define menu load pattern, cases and combination is defined according to respective codes. Dead loads are considered based on IS 875 (Part 1)-1987 and IS 875 (Part 2)-1987 for imposed loads. Earthquake loads are taken as per IS 1893 (Part 1): 2002, which is Criteria for Earthquake resistant design of structures.

A. METHODOLOGY



B. MATERIAL PARAMETER

Table 1: Building Description and Material specification

SL.NO	Building Description and Material Specification	
1	Plan Area	768m^2
2	Grid spacing	4m * 4m
3	Storey Height	3.5m
4	Number of storey	25
5	Beam dimension	300mm*500mm
6	Column dimension	800mm*800mm
7	Slab Thickness	175mm
8	Bottom Support Condition	Fixed
9	Grade of Concrete, M-30	f_{ck}= 30N/mm^2
10	Grade of Steel, Fe-415	f_y= 415N/mm^2
11	Density of Concrete	Y_c= 25KN/m^3
12	Density of Brick wall	Y_{brick}= 20KN/m^3

C. SEISMIC PARAMETERS

Table 2: Seismic Parameters

Earthquake zone	V (Z= 0.36)
Response reduction factor	5
Importance factor	1
Damping	5%
Soil type	Soft

D. LOADING CONDITION

Table 3: Loading condition

LOAD TYPE	INTENSITY OF LOAD
Dead load	Wall load- 17.5Kn/m
	Floor load- 6Kn/m^2
Live load	Floor load- 4Kn/m^2
Earthquake load	Floor load- 8Kn/m^2

E. LOAD COMBINATIONS

1. DL
2. DL + LL
3. 1.5(DL+ LL)
4. 1.2(DL + LL + EQX)
5. 1.2(DL + LL + EQY)
6. 1.2(DL + LL - EQX)
7. 1.2(DL + LL - EQY)
8. 1.5(DL + EQX)
9. 1.5(DL + EQY)
10. 1.5(DL – EQX)
11. 1.5(DL – EQY)
12. 0.9DL + 1.5EQX
13. 0.9DL + 1.5EQY
14. 0.9DL – 1.5EQX
15. 0.9DL – 1.5EQY

F. MODELING OF BUILDING FRAMES

An RCC structure is in particular an assembly of Beams, Columns, Slabs and basis inter-related to every other as a single unit. Generally, the switch of load in these systems is from slab to beam, from beam to column and eventually column to basis which in flip transfers the whole load to the soil. In this study, we've got followed three cases through assuming one-of-a-kind shapes (Rectangular, L-shape and I-shape) for the structure modelled using Etabs.

a. MODELING OF BUILDING (WITHOUT BRACING)

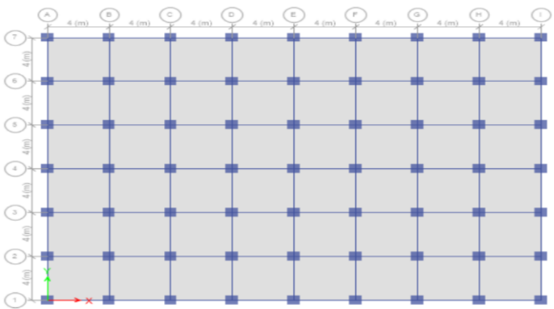


Fig 1: Plan of rectangular building

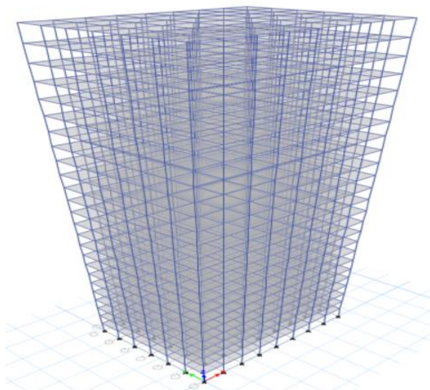


Fig 2: 3D view of rectangular building

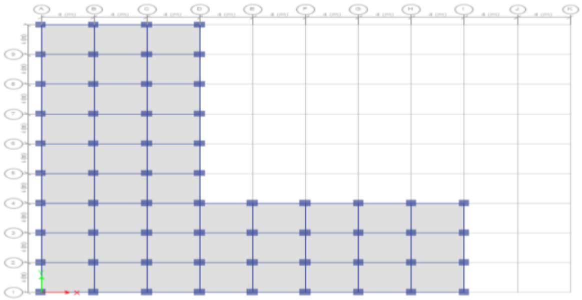


Fig 3: Plan of L-shape building

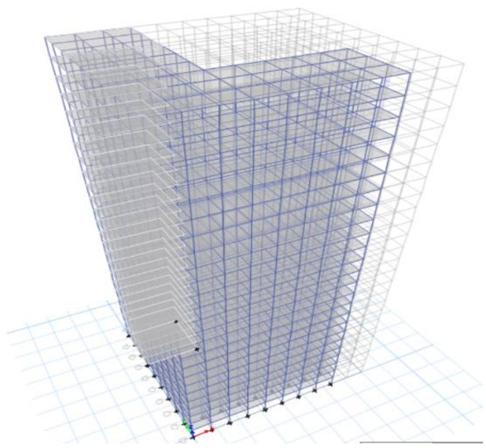


Fig 4: 3D view of L-shape building

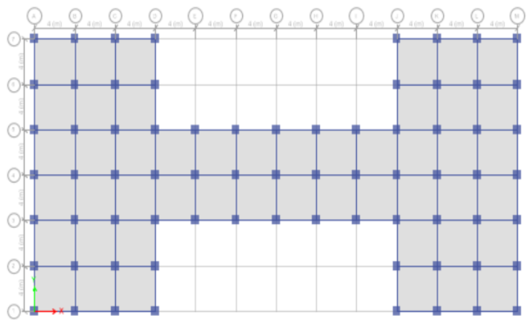


Fig 5: Plan of I-shape building

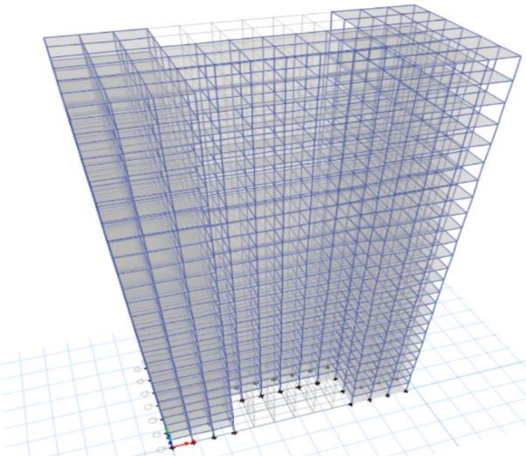


Fig 6: 3D view of I-shape building

b. MODELING OF BUILDING WITH BRACINGS

The most appropriate alternatives in development of reinforcement concrete systems against lateral loading is to provide steel bracing gadget. Those diagonal contributors deliver the lateral loads and transfers the axial hundreds to the vertical member i.e., columns, which is a powerful structural member. The usage of steel bracing has capability gain over other scheme like higher energy and stiffness, within your budget, occupies less area, adds a lot much less weight to current shape. The manipulate of the dynamic response of the multi-storey constructing may be carried out by growing stiffness via the use of bracing gadget. In this take a look at, the analysis of a bolstered concrete every day and irregular constructing with extraordinary types of bracing (X type, V kind, inverted V type) is accomplished with the aid of using ETABS software. ISMB 500 section is used for providing X-type bracing along the periphery and the interior bays of building.

i. WITH X BRACING

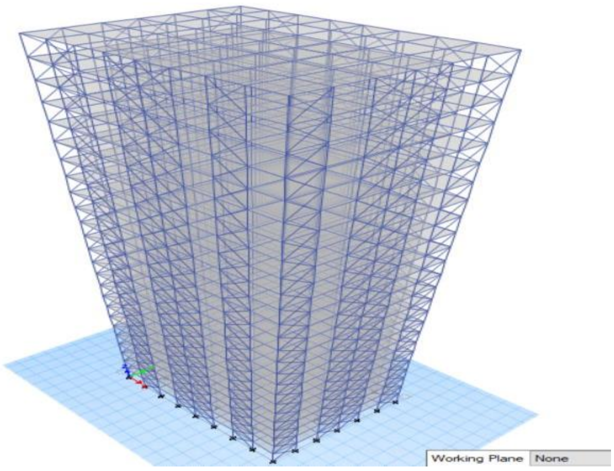


Fig 7: Elevational view of Rectangular shaped X braced building

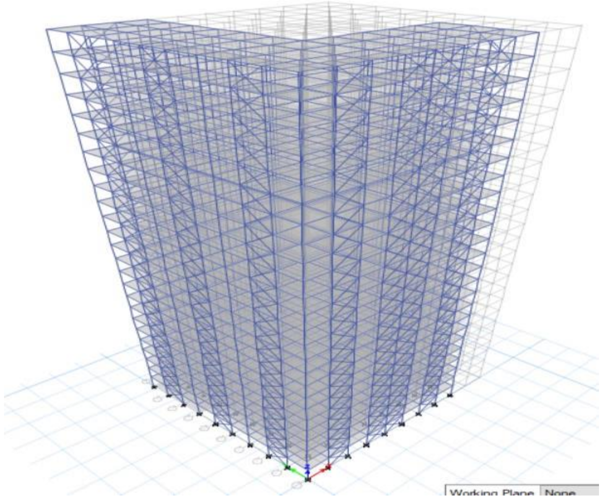


Fig 8: Elevational view of L-shaped X bracing building

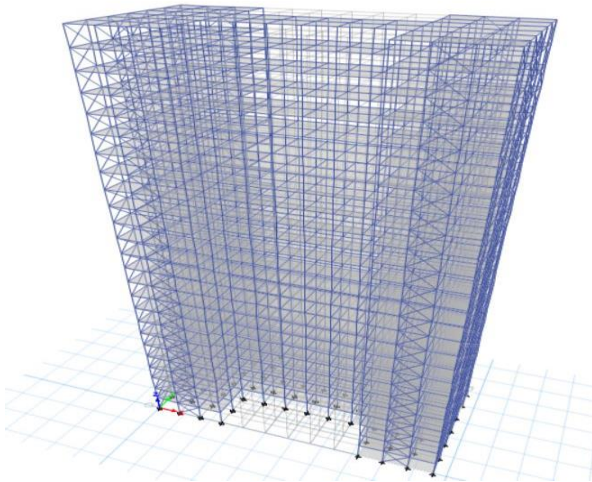


Fig 9: Elevational view of I-shaped X bracing building

ii. WITH V-TYPE BRACING

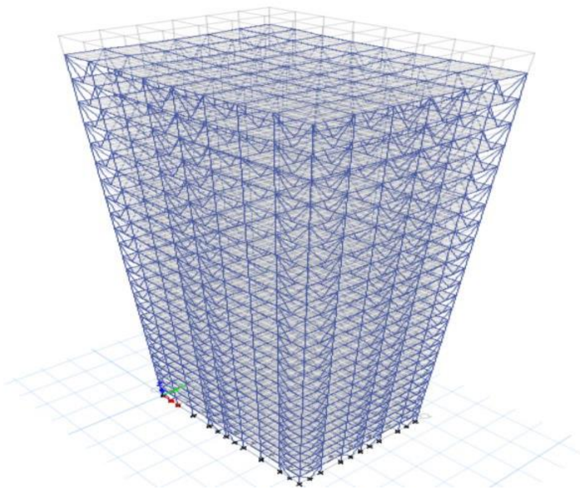


Fig 10: Elevational view of Rectangular V-type braced building

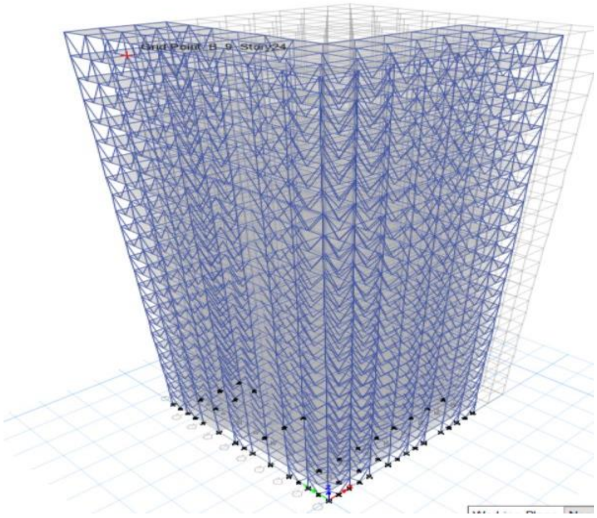


Fig 11: Elevational view of L-shaped V-type braced building

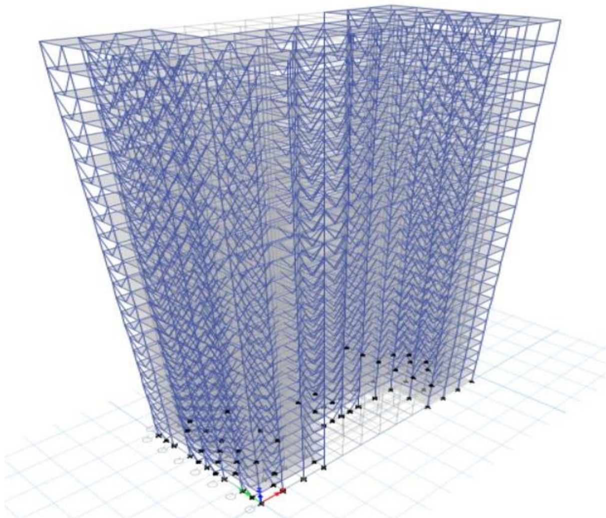


Fig 12: Elevational view of I-shaped V-type braced building

iii. WITH INVERTED V-TYPE BRACING

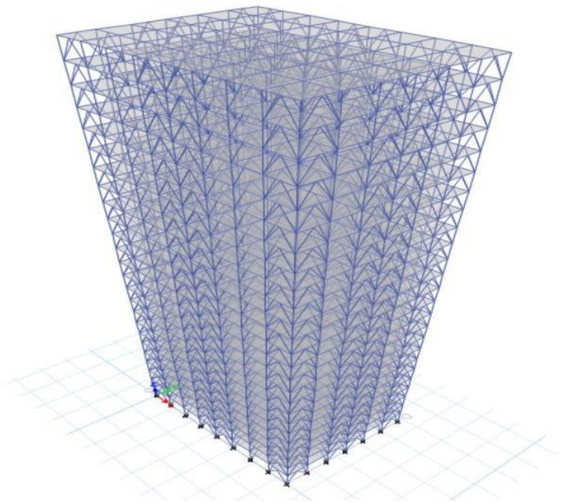


Fig 13: Elevational view of Rectangular Inverted V-type braced building

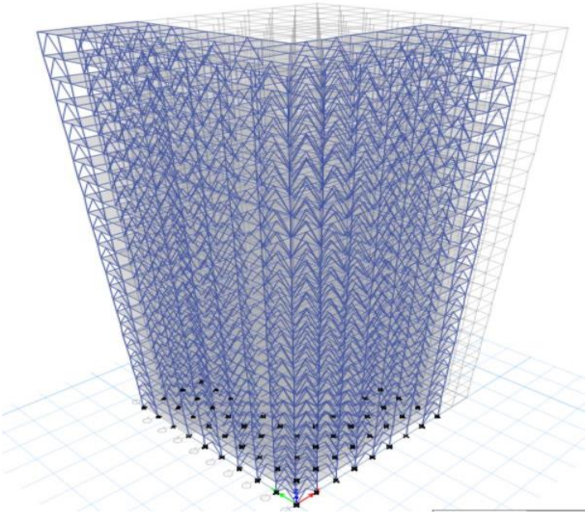


Fig 14: Elevational view of L- shaped Inverted V-type braced building

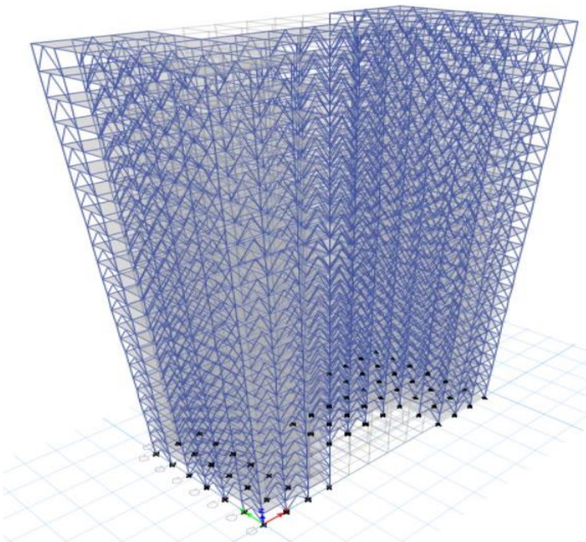


Fig 15: Elevational view of I- shaped Inverted V-type braced building

IV. RESULT AND DISCUSSION

a. RESULTS OF BUILDING WITHOUT BRACINGS

After the analysis results obtained for maximum displacement, maximum bending moment and base shear for the rectangular, L-shape and I-shape building without bracings are shown in the table below:

Table 4: Results obtained for building without bracing

MAXIMUM DISPLACEMENT		
	X-direction (mm)	Y-direction (mm)
Rectangular	315	70

L-shape	519	410
I-shape	286	52.31
MAXIMUM BENDING MOMENT		
	X-direction (kNm)	Y-direction (kNm)
Rectangular	72.32	1360
L-shape	195.26	1620
I-shape	54.21	1020
BASE SHEAR		
Rectangular	17241 kN	
L-shape	17951 kN	
I-shape	17850 kN	

The variation of maximum displacement, maximum bending moment and base shear in rectangular, L-shape and I-shape building in X and Y direction is given below:

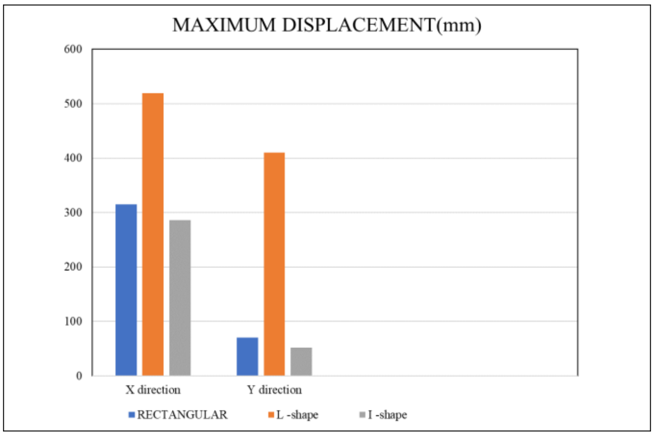


Fig 16: Variation of maximum displacement values

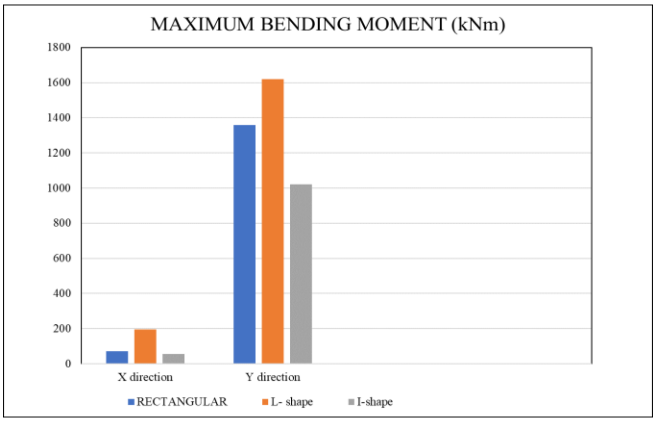


Fig 17: Variation of maximum bending moment values

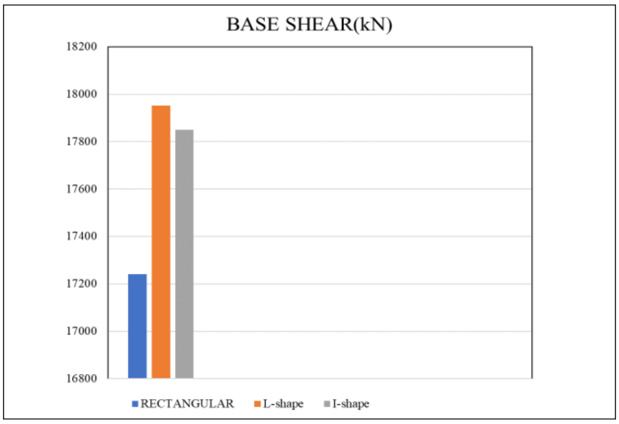


Fig 18: Variation of base shear values

b. RESULTS OF BUILDING WITH BRACINGS

The results obtained by using different bracings like X, V-type and inverted V-type bracings for the 3 building models are given in the table below:

i. WITH X BRACING

Table 5: Results obtained for building with X bracing

MAXIMUM DISPLACEMENT		
	X-direction (mm)	Y-direction (mm)
Rectangular	235	40
L-shape	382	274
I-shape	225	12.24
MAXIMUM BENDING MOMENT		
	X-direction (kNm)	Y-direction (kNm)
Rectangular	35.65	1002.25
L-shape	82.65	1382
I-shape	19.25	805.64
BASE SHEAR		
Rectangular	15850 kN	
L-shape	15892 kN	
I-shape	15998 kN	

ii. WITH V-TYPE BRACING

Table 6: Results obtained for building with V-type bracing

MAXIMUM DISPLACEMENT		
	X-direction (mm)	Y-direction (mm)
Rectangular	245	59
L-shape	386.75	296.23
I-shape	228.5	18.65
MAXIMUM BENDING MOMENT		
	X-direction (kNm)	Y-direction (kNm)
Rectangular	38.695	1038.54
L-shape	95.23	1386
I-shape	23.68	830.12
BASE SHEAR		
Rectangular	15900 kN	
L-shape	16010 kN	
I-shape	16030 kN	

iii. WITH INVERTED V-TYPE BRACING

Table 7: Results obtained for building with inverted V-type bracing

MAXIMUM DISPLACEMENT		
	X-direction (mm)	Y-direction (mm)
Rectangular	246.2	59
L-shape	387.15	295.64
I-shape	229.8	18.32
MAXIMUM BENDING MOMENT		
	X-direction (kNm)	Y-direction (kNm)
Rectangular	38.6	1038.56
L-shape	94.23	1387.12
I-shape	23	833.21

BASE SHEAR	
Rectangular	15900.25 kN
L-shape	16010.25 kN
I-shape	16032.21 kN

c. COMPARISON OF RESULTS

The correlation of results obtained for the 3 building models (rectangular, L-shape and I-shape) without bracings and with bracings (X, V and INVERTED V) where shown in the below diagrams:

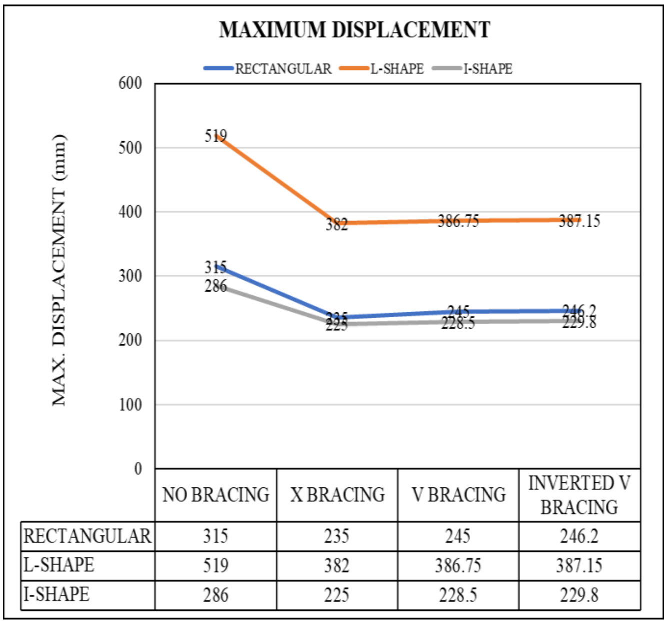
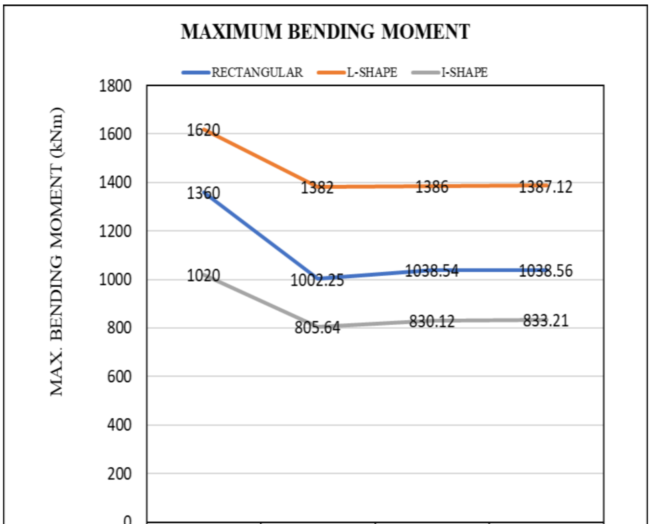


Fig 16: Comparison of maximum displacement

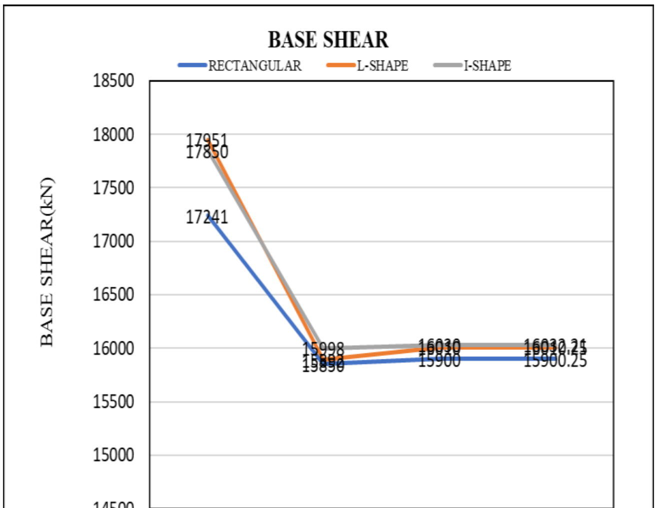
The results indicate that the maximum displacement gets reduced by using bracings. Highest displacement is observed in L-shape building and lowest for I-shape which implies least damage under lateral loads. Among the results X bracing shows least value of displacement. By the use of X bracing in L-shape building the maximum displacement value reduced by 27% and about 25% by using V and inverted V-type bracing. In rectangular building by using X bracing the value reduced by 25% and in I-shape it is about 22%.



	NO BRACING	X BRACING	V BRACING	INVERTED V BRACING
RECTANGULAR	1360	1002.25	1038.54	1038.56
L-SHAPE	1620	1382	1386	1387.12
I-SHAPE	1020	805.64	830.12	833.21

Fig 17: Comparison of maximum bending moment

Results show that maximum bending moment values decreased by using bracings. Also, I-shape building shows least values of bending moment imply high resistance under lateral loads. L-shape building shows higher values of bending moment in all cases. The minimum value of bending moment is when X bracing is used. By the use of X bracing in rectangular building the maximum bending moment value reduced by 26% and about 24% by using V and inverted V-type bracing. In L-shape building by using X bracing the value reduced by 15% and in I-shape it is about 21%.



	NO BRACING	X BRACING	V BRACING	INVERTED V BRACING
RECTANGULAR	17241	15850	15900	15900.25
L-SHAPE	17951	15892	16010	16010.25
I-SHAPE	17850	15998	16030	16032.21

Fig 18: Comparison of base shear

Base shear gets reduced by using different bracings. Regular and irregular buildings without bracings show high values of base shear under lateral loads. Base shear is lowest for rectangular building and high for L-shape building. Use of X bracing show the lowest values of base shear. By the use of X bracing in L-shape building the base shear value reduced from 17951 kN to 15892 kN.

V. CONCLUSION

Considering the analysis of regular and irregular structures in zone V soft soil, it is concluded that regular geometry shows much less force and perform properly for the duration of the earthquake. Analysis proves that irregularities are dangerous and it's far essential to have ordinary shapes of frames in addition to uniform load distribution across the constructing. Regular type buildings display more protection whilst built in earthquake prone zones. Consequently, as some distance as feasible irregularities in a building need to be avoided. With the installation of bracings in buildings the maximum value of displacement, bending moment and base shear get reduced. Building with X- bracing is found to be more effective among the different bracings.

VI. REFERENCE

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