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Seismic Analysis of Vertically Irregular RC framed Structure using X- Bracing and Bundle Tube in Various Zones using STAAD Pro Software

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***Abstract*:- The concept of tall structures comes in mind due to the increasing population. Due to advancement in civil technology the concept is being successful now a day. The height of the structures with the number of floor is decided by engineers. Earthquake is the one which is the main phenomena causing damage to the structure. As the height of the structure increases it absorbs large seismic forces. If structure is regular in its elevation strength distribution will be uniform. If there is irregularity there will be breakages in strength which is the main cause for failure. To overcome this there are several lateral load resisting systems, among which the brace and tube system is used. In this project the structure is analysed with X Brace and bundle tube. This is compared with the structure without brace and bundle tube. The structure is analysed in Zone III, IV and V. Type of soil strata is hard soil. G+ 20 structures is used for the analysis. The plan dimension is 48x21 meters at top and 16x21 meters at base. The structure is irregular in elevation with irregularity towards downward. The study shows the behaviour of the structure in various zones . The height of each floor is 3m. The parameters calculated are base shear and displacement. From the results obtained it is found that Zone III and IV gives maximum results. So it can be said that structure in Zone III and IV gives maximum strength and stiffness and causes less damage to the structure compared to V during the earthquake.**

Key Words:* *Bundled tube, X-bracing, vertically irregular, base shear and displacement.

1. INTRODUCTION

1.1 BUNDLE TUBE

This form used is in great demand for the high raised structures because it is used in the world tallest building 'Sears Tower in Chicago'. It is efficient system against resisting of the lateral and the wind load. This form was introduced by 'Fazlur Rahman Khan', engineer from Bangladesh. The design he made was the 'Dewitt Chestnut apartment in Chicago', consisting of the number tubes interconnected to form a major tube resisting the shear developed by the lateral force. Though it is not highly economical, innovative in formulation of the architectural space

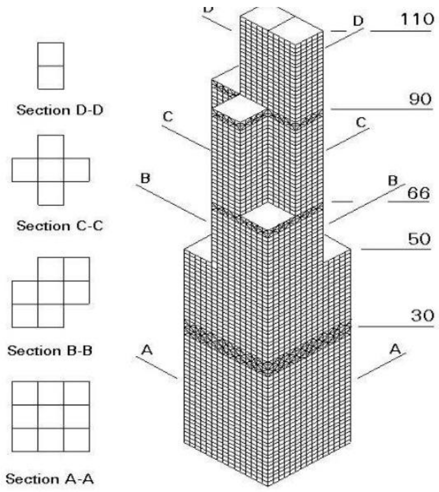

FIG.1.1 MODULAR FLOOR CONFIGURATION

1.2 BRACED FRAME STRUCTURES

A system used in structures subjected to loads (seismic and pressure). These members are generally made up of steel, able to work under both tension and compression. The horizontal and vertical elements of the structure carry vertical loads while bracing the lateral loads. It is important in earthquake resistant structures. The placing of the bracing can be problematic, as they make problem in design aspects. The resistance to horizontal forces is given by vertical and horizontal bracings.

1.2.1 TYPES OF BRACINGS ARE

1. Single diagonal
2. Cross bracing
3. K- bracing
4. V bracing

2. OBECTIVES

1. To study the effect of the vertical irregularity of the structure with performance level.
2. Comparison between conventional building with the building having X bracing and bundle tube on the basis of base shear, displacement and storey drift.

3. Obtaining the performance in Zone III, IV and V using hard soil.
4. The structure used for the analysis is G+20 vertically irregular in its elevation.
5. To find in which zone the analysed RC framed structure obtains the maximum strength to resists the lateral seismic forces
6. The irregularities are to be found out at ground, 9th, 15th and the 20th floor.
7. The software to be used for the analysis is STAAD PRO.

3. LITERATURE REVIEW

3.1 RUPESH R. PAWADE, M. N. MANGULKAR. (2017) [1]

Stiffness, strength and mass in both horizontal and direction perpendicular to the base of the structure that is high rise buildings is due to the strong earthquake motion. Their are various types of plan and vertical irregularity as per IS 1983(part1) - 2002.

In the paper mentioned the study is related to G+16 storey's analysis using pushover analysis. To know the structural performance parameters used are Base shear, Storey drift and Displacement. Under dynamic loading for the collapse of the structure irregularities are responsible. Types of 5 building geometry are taken compared it with the regular building. The software SAP 2000 is used. It was been that the level of performance the structure is been reduced due to irregularity of the structure. Equivalent static method is used in Zone V and the soil type 2.

By comparing the regular and the irregular frame, the regulared frame structures has more load capacity than the irregular frame. Vertical irregularity decreases the flexure and the shear demand. The regular building frames has less shear compared to the irregular frames.

3.2 KARTHIK .K. M, VIDYASHREE. D (2015) [2]

Most threatening natural hazard is the earthquake, which is very destructive in nature. It causes the shaking of the earthquake. Due to the damage to the structures, the structures should be designed to resist the earthquake forces, to increase the life span of the structures. Structures have less stiffness and strength in the irregular framed structures. To overcome this systems resisting lateral load are introduced. The types of the bracing used are X type, V type, inverted V type. Among these X bracing is found most suitably to improve the stability of the structures.

In this study G+5 storey buildings analysed using ETABS 9.7 software. Grade of concrete used is M30 with Fe415 grade steel. The plan dimensions used is 15m*15m. The analysis is being carried out to find the parameters like base shear, displacement and storey drift.

From the analysis it was found that irregularities in the buildings affect the performance of the buildings. The amount of the lateral stiffness and storey drift increases in the amount of the vertical irregularity. Compared to regular building the base shear will be less of the irregular structures Addition of bracing to the frames shows reduction in displacement and storey drift.

4. METHODOLOGY

The structure analysed is G+20 RC framed structure. Structure is RC framed structure. Seismic analysis is carried out using code IS 1893(part-1)-2002. The structure is regular in its plan and irregular in its elevation. The plan dimension is 16mx21m at base. The spacing of the grid in X direction is 4m centre to centre and in Z direction is 4.5m centre to centre. The height of each storey is 3m, with overall height of 60m

Steel X- bracing and bundle tube is used in the structure resists the lateral loads of 0.1m width and 0.1 thickness. The codes used in analysis are IS 875 Part I,II and V. Parameters obtained are time period, base shear, displacement and storey drift. Analysis is carried out for the structures in Zone III, IV and V and the performance is studied. With the Zones the structure is analysed in comparison with the conventional type of building.

TABLE-4.1.1 PRIMARY DATA

SEISMIC DETAILS	
Soil type	Hard soil
Importance factor (I) IS 1893(part-1) 2002	1.5
Reduction factor (R) IS 1893(part-1) 2002	5
Zone factor IS 1893(part-1) 2002	Zone III- 0.16 Zone IV-0.24 Zone V -0.36

TABLE-4.1.2 PROPERTIES OF STRUCTURES

Column size	1000mmX1000mm
Beam size	700X600mm(**From ground floor to 10th floor**) 700X600mm (**from 11th to 15th floor)** 600X500mm **(17th to 20th floor)** 800X600mm **(10th and 16th floor)**
Cross beams	1000X1000mm
Bracing and Bundled tube thickness	100X100mm
Wall thickness	300mm
Slab depth	150mm
f_{ck}	30N/mm^2
f_y	500N/mm^2

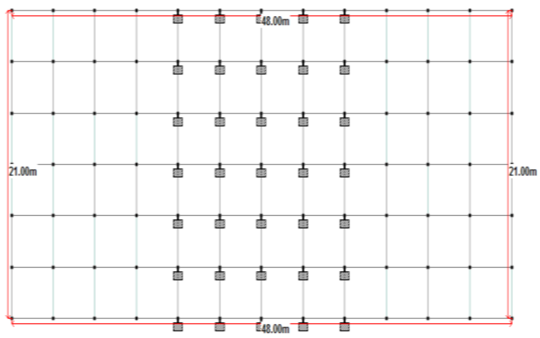

FIG.4.1 PLAN OF THE STRUCTURE

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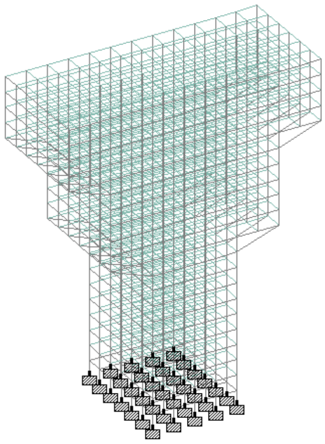

FIG.4.2 MODEL OF THE STRUCTURE

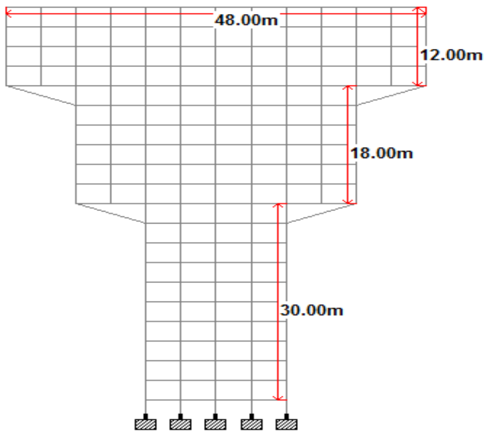

FIG.4.3 ELEVATION OF THE STRUCTURE WITHOUT BRACING AND BUNDLE TUBE

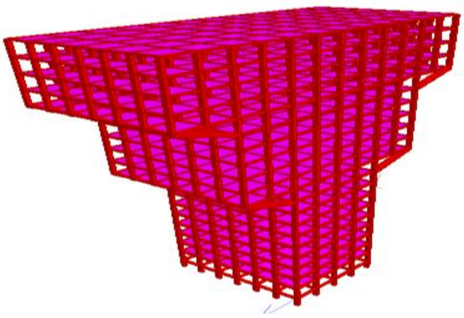

FIG.4.4 ISOMETRIC VIEW OF STRUCTURE WITHOUT BRACING AND BUNDLE TUBE

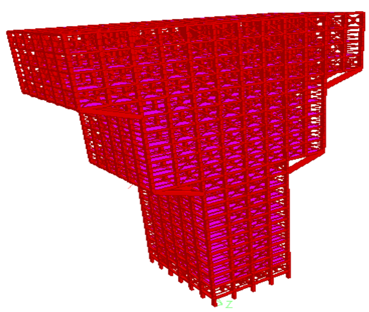

FIG.4.5 ISOMETRIC VEIW OF THE STRUCTURE WITH BRACING AND BUNDLE TUBE

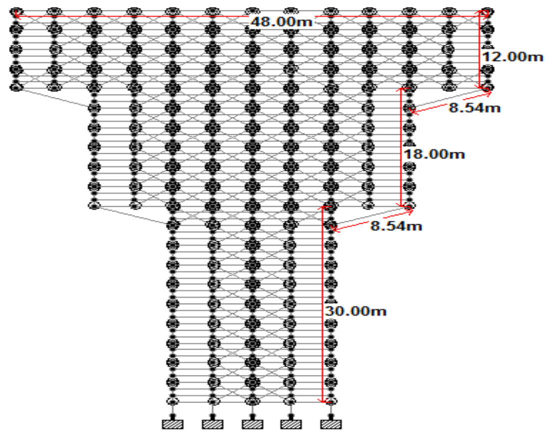

FIG.4.6 ELEVATION OF THE STRUCTURE WITH BRACING AND BUNDLE TUBE WITH PINNED CONNECTION

4.2 LOADINGS

4.2.1 DEAD LOAD: (IS 875 PART 1)

Self weight of the structure= 1 kN/m^2

Floor load (with floor finish) = 2 kN/m^2

Wall load (Beam size= 700X600mm) = 13.8 kN/m

Wall load (Beam size= 600X500mm) = 14.8 kN/m

Wall load (Beam size= 800X600mm) = 13.2 kN/m

4.2.2 LIVE LOAD: (IS 875 PART 2)

Floor load (with floor finish) = 3 KN/m^2

LOAD COMBINATIONS (IS 875 PART 5)

1. 1.5(DL+LL)
2. **1.2(DL+LL+ELX)**
3. **1.2(DL+LL-ELX)**
4. **1.2(DL+LL+ELZ)**
5. **1.2(DL+LL-ELZ)**
6. 1.5(DL+ELX)
7. 1.5(DL-ELX)
8. 1.5(DL+ELZ)
9. 1.5(DL-ELZ)
10. 0.9DL+1.5ELX
11. 0.9DL-1.5ELX
12. 0.9DL+1.5ELZ
13. 0.9DL-1.5ELZ

1. The load combinations accounted for the design [As per 1893(part-1)-2002]

1. 1.5(DL+LL)
2. **1.2(DL+LL+EL)**
3. **1.2(DL+LL-EL)**
4. 1.5(DL+EL)
5. 1.5(DL-EL)
6. 0.9DL+1.5EL
7. 0.9DL-1.5EL

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5 RESULTS

5.1 BASE SHEAR

The base shear is calculated at ground floor, 9th, 15th and 20th floor, comparing between conventional building and the building with bracing and bundle tube

5.1.1 Percentage increase in base shear

The percentage of increased base shear

Considering

A= base shear of conventional building in (Kilonewton)

B= displacement of building with X-bracing and Bundle tube

Percentage of reduction

= (A-B)/A*100................ (5.1.1.a)

LOAD COMBINATION USED

1.2 [DL+LL+EQ+X]

TABLE-5.1.1.1 RESULTS OF THE BASE SHEAR FOR TIME PERIOD Tn=1.35 seconds

FLOORS	ZONES		
	III	IV	V
20TH	10.61%	33.72%	10.22%
15TH	11.82%	33.22%	10.01%
9TH	9%	26.25%	10.36%
Ground	15.54%	38.95%	13.77%

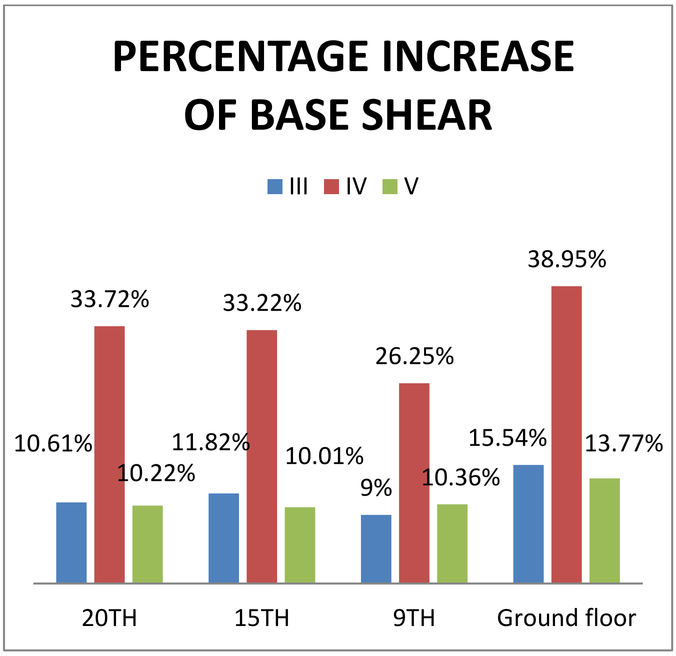


FIG.5.1.1.1 MAXIMUM BASE SHEAR RESULT LOAD COMBINATION USED

1.2 [DL+LL+EQ+X]

TABLE-5.1.1.2 RESULTS OF THE BASE SHEAR FOR TIME PERIOD Tn=1.17 seconds

FLOORS	ZONES		
	III	IV	V
20TH	10.03%	10.41%	29.73%
15TH	11.83%	33.22%	10.01%
9TH	11.84%	26.25%	8.98%
Ground	15.88%	38.94%	12.42%

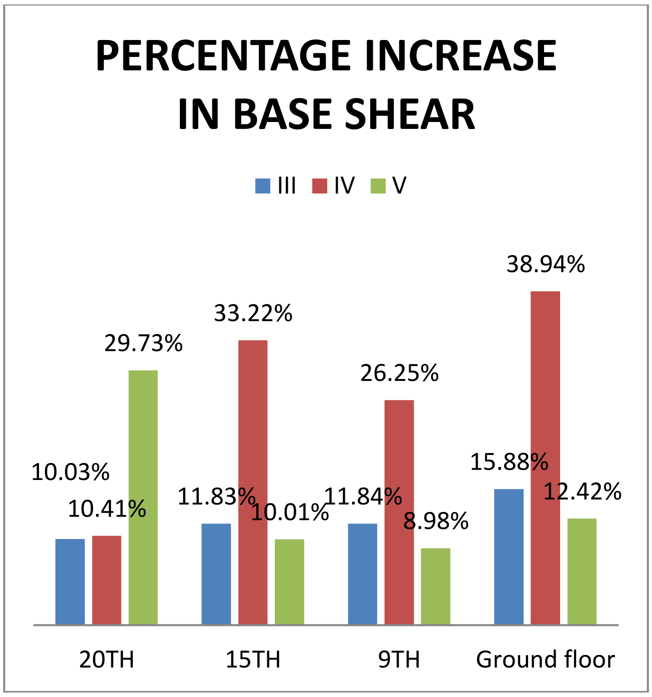
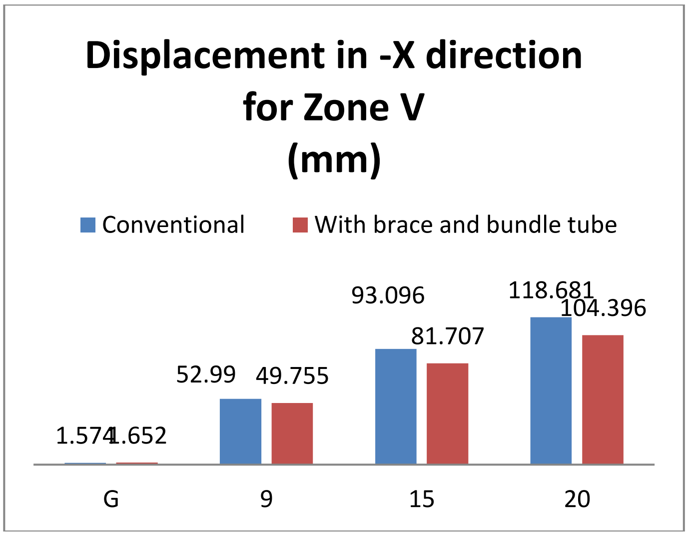


FIG.5.1.1.2 MAXIMUM BASE SHEAR RESULT

5.2 DISPLACEMENTS

5.2.1 Maximum displacement of the structure in comparison with Conventional building in Zone V

Floors	Node Number	-X Direction	
		Conventional **(mm)**	With brace and bundle tube **(mm)**
G	30	1.574	1.652
9	380	52.990	49.755
15	730	93.096	81.707
20	1157	118.681	104.39



5.2.1 FOR THE TOP 20TH FLOOR OF THE STRUCTURE THE DISPLACEMENT RESULTS ARE ANALYSED

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LOAD COMBINATION USED

1.2 [DL+LL+EQ+X]
1.2 [DL+LL+EQ-X]
1.2 [DL+LL+EQ+Z]
1.2 [DL+LL+EQ-Z]

The percentage of reduced displacement

Considering A= displacement of conventional building
B= displacement of building with X-bracing and Bundle tube

Percentage of reduction= (A-B)/A *100............................. (5.1.7.a)

TABLE-5.2.1.1 PERCENTAGE REDUCTION OF DISPLACEMENT TABLE

Directions	**+X**	**-X**	**+Z**	**-Z**
Zone III	27%	30.81%	28.82%	26%
Zone IV	32.93%	39.94%	18.95%	25.55%
Zone V	12.03%	12.03%	17.18%	17.19%

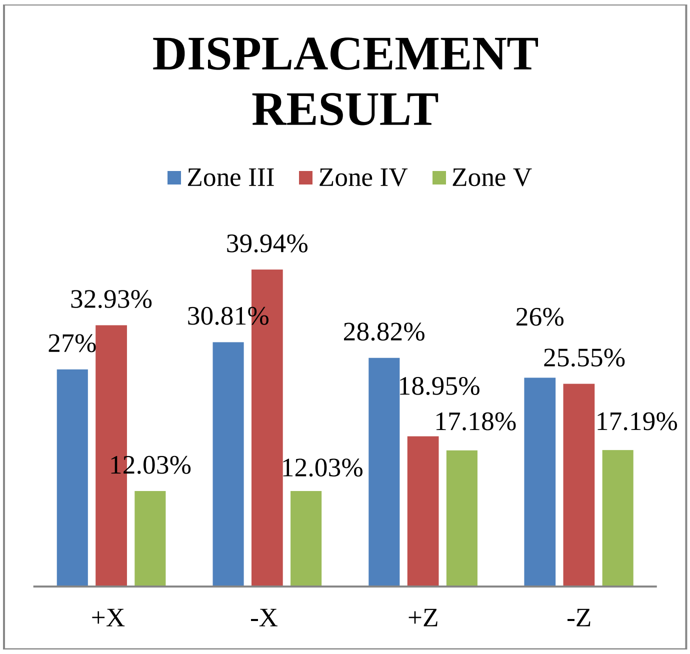

FIG..5.2.1.1 DIPLACEMENTS RESULTS PERCENTAGE

6. CONCLUSION

6.1 BASE SHEAR

1 The base shear gives the maximum result in zone IV at the base compared to III and V zones.
2 With time period Tn= 1.35 seconds, It is increased by 38.95% compared to conventional building i.e is without bracing and bundle tube.
3 And is less increased in zone III by 9% compared to zone IV and V.
4 With time period Tn= 1.17 seconds, It is increased by 38.94% compared to conventional building i.e is without bracing and bundle tube.
5 And is less increased in zone V by 8.98% compared to zone IV and V.

6.2 DISPLACEMENT

1 It is estimated with the top floor
2 The maximum lateral displacement is 120mm and the displacements are within limit with highest of 118.68mm in Zone V in –X direction
3 Displacement is reduced by 39.94% in –X direction for IV with reference to other zones

Comparing the results the base shear is maximum in zone IV and displacement is maximum in zone IV, hence the structure analysed can be constructed in Zone IV efficiently with maximum strength and stiffness.

7. REFERENCES

[1] Rupesh R Pawade, M. N Mangulkar (2016), "Influence of combine vertical irregularity in the response of the earthquake resistance RC structure" in IRJET.
[2] Karthik. K. N, Vidyashree D (2015), "Effects of the steel bracing on vertically irregular RCC building frames under the seismic loading".
[3] Hojat Allah Ghasemi (2016), "Optimal design of high rise bundle tubed structural systems". Research Paper in "Advances in Science and Technology Journel".
[4] .IS 1893(Part1)-2002 code, "Earthquake resistant design of structures".
[5] **5.**Dr.Vinod Hosur, A text book "Earthquake resistant design of building structures".
[6] Bryan Stafford Smith, Alex Coull, A text book "tall Building structures"