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Performance Analysis of Different Concentric Braced Frame Systems on an Irregular RCC Structure Imperiled to Wind Load

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Abstract – *With the upsurge in the tallness of the structure surges the intensity & effects of Lateral loads comprising of seismic & wind loads. Wind load resistance becomes a governing factor once the structure achieves the description of tall structure due to the inefficiency of rigid or semi rigid frames to control the displacement & deflection thus reducing the strength & stiffness of the structure. Braced frame system is a highly competent & cost-effective method to control the deflections arising due to the fluctuating wind loads. In the present investigation three different types of concentric braced frame systems were analyzed in terms Shear force, bending moment, nodal displacement & reactions by using STAAD.Pro V8i software as per Equivalent static analysis method. An (G+11) irregular high-rise structure was assumed to be situated in Bhuj with Basic wind speed 50m/s*

Key Words: X type bracing, V type bracing, K type bracing, Shear force & node displacement etc.

1.INTRODUCTION

With the incessant growth in urban sprawl & desire to gain maximum profit with minimum investment has enthused the investor to look towards the sky. But with the rise in the height of the structure increases the surface area of the structure exposed to fluctuating wind load which persuades an extensive variety of comebacks in the structure as well as for the inhabitants residing inside it. Different types of lateral load resisting systems are accessible to control the deflections sourced by these wind loads. Braced frame system verified to be highly capable & cost-efficient compared to other wind load resisting systems as the bracing members are connected to form a vertical cantilever truss system which works in axial stress therefore necessitate minimum members to provide lateral stiffness & strength to the structure. Braced frame systems carries all the lateral loads thus, beams & columns are subjected to dead & live load only hence reduces the size & participation of beams & columns in load resisting exertion. Braced frame systems are broadly classified in two categories.

1) Concentric Braced Frame Systems
2) Eccentric Braced Frame Systems

1. Concentric Braced Frame systems – Entails bracing members positioned in the plane of the frame. Both ends of the brace beams connects at the end points of other framing members to form a truss, creating a stir frame.

2. Eccentric Braced Frame System- Entails braces positioned in the plane of the frame where one or both ends of the brace beams does not connects at the end points of other framing members.

1.1 Building Description

For the analytical purpose a twelve storied (G+11) high-rise irregular RCC Structure with 6 bays of 4.2m along x direction & 4 bays of 4.2m along z direction was selected. The storey height of ground floor was taken as 6.48m while all other storeys were designed for 3.15m. The no bays along z direction first reduced after 8th storey & then after 10th storey. The structure was assumed to be located in Bhuj with Basic wind speed 50m/s.

Type of Structure	OMRF
Number of Storeys	12
Type of Building	Residential
Location	Bhuj, Gujrat, India
No of Bays	x-6, z-4
Total Height	41.13
Basic wind speed	50m/s
Terrain Category	2
Class of Structure	B
Bracing Member	ISA 110x110x12
Size of Beam	230x420mm
Size of Column	300x450mm
Grade of Concrete	M-25
Grade of Steel	Fe-415

Table -1: Building Description

2. STRUCTURAL MODELLING & ANALYSIS

A twelve storey high rise irregular RCC structure subjected to wind load is analyzed with & without various braced frame system as per equivalent static analysis method by using STAAD.Pro V8i software. The braced frames analyzed are X type, V type & K type. The results are obtained in terms of Shear force, bending moment, node displacement & reactions. The bracings are provided along both x & y direction. Building is designed as per IS 456-2008 & wind load is applied as per IS 875(iii)-1987. Fixed types of support were provided at the base of the building dispensed at the bottom of the column. Wind load was applied from both x & z direction. Load combinations applied on the design of the structure are as follows:

S.no	Load Combinations
1	1.5 (DL + LL)
2	1.5 (DL + WLX)
3	1.5 (DL – WLX)
4	1.5 (DL + WLZ)
5	1.5 (DL - WLZ)

Table -2: Load Combinations

Building frame with the above specified dimension & properties were considered for analysis of 3 different types of Braced frame systems which are: -

Model 1 Bare Frame

Model 2 K Braced Frame

Model 3 X Braced Frame

Model 4 V Braced Frame

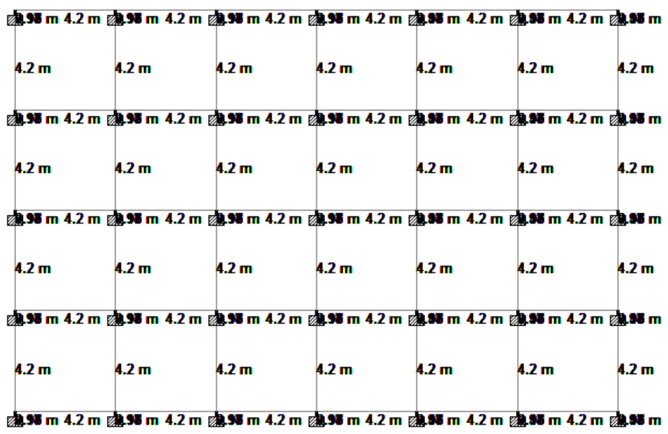

Fig -1: Plan of Proposed Frame

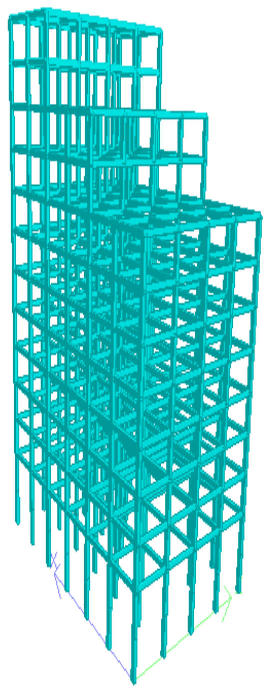

Fig -2: Model1

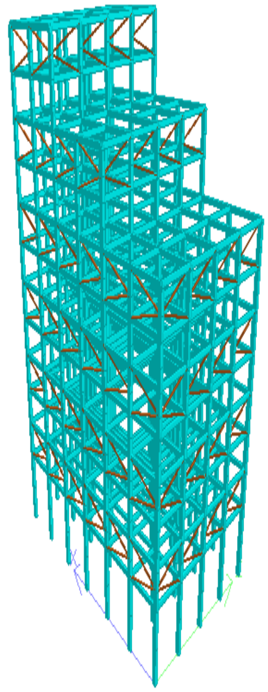

Fig -3: Model2

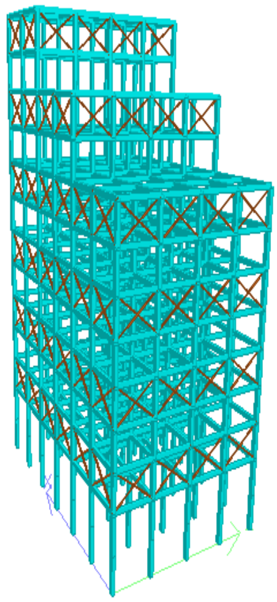

Fig -4: Model3

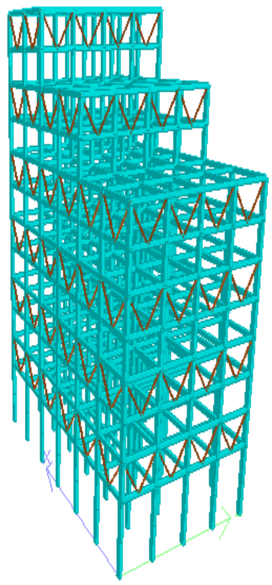

Fig -5: Model4

1. RESULT

Results of analyzed frame are presented in the form of comparison tables, graphs & their discussions.

- **Shear Force**

S. F	Fx	Fy	Fz
BF	4721.638	150.422	9.52
K	4660.393	395.35	238.889
X	4465.007	406.556	258.156
V	4504.014	378.446	144.57

Table -3: Comparison of SF

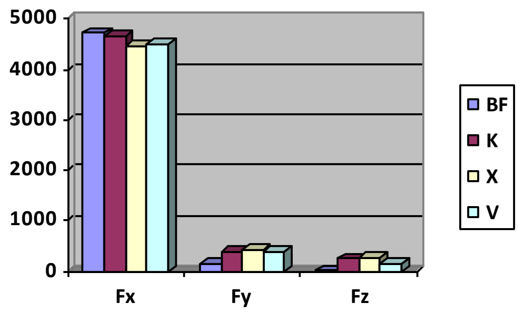

Chart -1: Comparison of SF

X type Braced frame was found to be most efficient to reduce S.F

- **Bending Moment**

B.M	Mx	My	Mz
BF	9.547	501.017	516.018
K	16.3333	475.775	585.007
X	18.755	469.399	621.139
V	17.116	461.416	608.56

Table -4: Comparison of SF

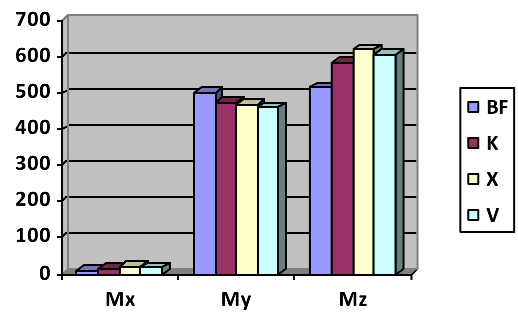

Chart -2: Comparison of BM

The B.M increased marginally about 3 %

- **Node Displacement**

N. D	X	Y	Z
BF	255.214	2.857	406.714
K	187.332	15.614	371.506
X	170.566	3.256	350.412
V	177.713	3.417	354.052

Table -5: Comparison of ND

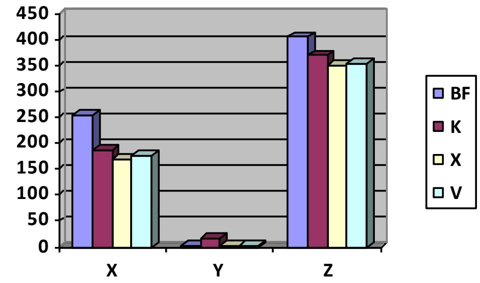

Chart -3: Comparison of ND

X type Braced frame was found to be most efficient to reduce N.D

- **Reactions**

REACTIONS	Fx	Fy	Fz
BF	1.019	4721.638	0.724
K	1.536	4660.393	1.653
X	1.249	4465.007	0.704
V	1.072	4504.0144	0.873

Table -6: Comparison of Reactions

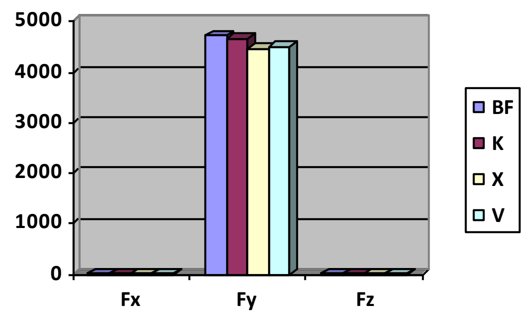

Chart -4: Comparison of Reactions

X type Braced frame was found to be most efficient to reduce S.F

2. CONCLUSION

- It has been observed that the performance of the structure enhanced with the provision of Braced frame system in terms of Shear force, Nodal displacement & Reactions.
- Bending moment however increased marginally by the addition of Braced Frame system.
- Model 3: X Braced Frame [Refer Fig:4] was found to be most efficient in terms SF, ND & Reaction.
- Model 3 X braced frame reduced SF by 5%, ND by 33% & Reactions by 5%.
- The weight of the structure increased up to 3% after the application of Braced frame system.

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