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Effectiveness of Steel Bracings in Multistorey Buildings

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***Abstract*—For reinforced concrete buildings, the most crucial aspect is ensuring that a multistory structure is stable against lateral load. Steel bracing is a useful tool in RC frame buildings to transfer or reduce these stresses. Steel bracing's remarkable strength, rigidity, and ability to withstand lateral stresses make it an excellent alternative to other materials for high-rise building lateral support. This study presents the analysis of a G+9 building with four different forms of bracing in a structural system: X, V, Inverted V, and Diagonal bracing, using ETABS software. The result of applying lateral loads is a comparison in multiple parameters. It has been observed that the X bracing system outperforms the other two.**

***Keywords*— Bracing Systems, ETABS, Storey Displacement, Multistorey Building**

I. INTRODUCTION

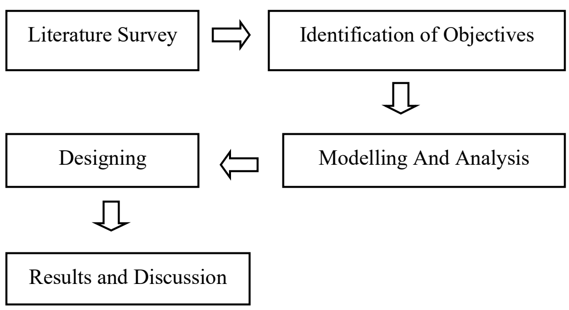
Structural aging is a serious global concern because it negatively impacts structural performance by decreasing the structure's seismic resilience. Because of their ability to maximize land use and support a variety of functions, multistorey structures are becoming essential to contemporary urban development. Tall buildings are particularly vulnerable to lateral pressures like wind and seismic loads that compromise their structural integrity. Bracing systems have become essential components in reducing the effects of lateral forces in order to address this. Steel bracing has several advantages, the main ones being its remarkable strength, stiffness, and affordability. For this a G+9 office building in Panampilly Nagar, Kerala building plan is considered and compared with several parameters. A 50 year old multistorey building having structural decay poses a serious risk to occupants and neighboring properties, necessitating thorough inspections and targeted maintenance. Therefore, steel bracing aids in maintaining the structure's structural integrity. After the steel bracing has been installed, the load in an RCC frame building is carried to the frame and then to the braces, passing through the weak column and obtaining strength. The load is transferred to the frame and then to the braces in an RCC frame building once the steel bracing is installed, passing through the weak column and gaining strength.

II. OBJECTIVE

The main objectives include:

- To analyze the multistorey building using different configuration of steel braces (X, V, Diagonal and Inverted V)
- To determine storey displacement, time period and storey drift for all four bracing system using ETABS.

III. METHODOLOGY



IV. BUILDING MODELLING

A G+9 storey RC frame building is modelled in ETABS software. Model is created with four different types of bracing (X, V, diagonal and Inverted-V bracing). Following properties are considered for modeling the building.

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TABLE 4.1 BUILDING CHARACTERISTICS

Purpose	Office Building
Number of Floors	G+9
Building Shape	Rectangular
Total Building Floor Area	5945.22sq.ft
Occupying Area	2267.23sq.ft
Remaining Area	2970.5sq.ft
Latitude	9°57'31.91'' N
Longitudinal	76°17'44.52''N
Depth and Type of Foundation	45 m, Under reamed piles
Floor to Floor Height	3 m
Ground Floor Height	3.5 m

TABLE 4.2 MEMBER PROPERTIES

Beam	0.5x0.35 m, 0.4x0.3 m
Column	0.59X0.59 m
Slab Thickness	0.15 m

TABLE 4.3 MATERIAL PROPERTIES OF CONCRETE AND STEEL

Column	M 25
Beam	M 25
Slab	M 25
Density of RCC	2500 kg/m^3
Density of PCC	2400 kg/m^3
Main Bars	Fe500
Confinement Bars	Fe415
Density of Steel	7850 kg/m^3
Steel Braces	ISA 200X200X25

V. LOAD CALCULATION

A. Dead Load

The values of the unit weights of the materials are specified in IS 875:1987 (Part-1). The self- weight of structural member auto calculated by software (self-weight multiplier given as 1 in load pattern). The sample manual computation for dead load

Beam 1 = 0.5 x 0.35 x 25
= 4.375 kN/ m^2

Beam 2 = 0.4 x 0.3 x 25
= 3 kN/ m^2

Column = 0.59 x 0.59 x25
= 8.702 kN/ m^2

Slab = 0.15 x 25
= 3.75 kN/ m^2

B. Live Load

The values of the imposed loads depend on the functional requirement of the structure. The standard values are stipulated in IS 875:1987 (Part II) is 2.5 kN/ m^2

C. Seismic Load

The design base shear is computed in accordance with the IS: 1893 (Part-I): 2016

TABLE 5.1 SEISMIC DATA

Seismic Zone	III
Zone Factor	0.16
Importance Factor	1
Response Reduction Factor	5

D. Wind Load

As per IS 875 Part III-2015, wind load is determined using following parameters

Basic wind speed in Kerala= 39m/s

Risk factor k1= 1

Topography factor k3=1

Terrain category= 3

Value of k2 varies as per building height, k2 = 1.062

Design wind speed, $VZ = Vb \times k1 \times k2 \times k3$

Design wind pressure, $Pz = 0.6VZ^2$

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TABLE 5.2 WIND PRESSURE

Height (m)	Vb	*k1*	*k2*	*k3*	*Vz (m/s)*	Wind Pressure
30.7	39	1	1.062	1	41.418	1029.270

VI. LOAD COMBINATION

Various load combinations as per the partial safety factors given in IS 456:2000 and IS 1893 (Part I) 2016 stipulates the combination of the loads to be considered in the design of the structures.

1. 1 DL
2. 1.5 (DL+LL)
3. 1.5 (DL+EQX)
4. 1.5 (DL+EQY)
5. 1.5 (DL+EQ-X)
6. 1.5 (DL+EQ-Y)
7. 1.5 (DL+WLX)
8. 1.5 (DL+WLY)
9. 1.5 (DL+WL-X)
10. 1.5 (DL+WL-Y)
11. 1.2 (DL+LL+EQX)
12. 1.2 (DL+LL+EQY)
13. 1.2 (DL+LL+EQ-X)
14. 1.2 (DL+LL+EQ-Y)
15. 1.2 (DL+LL+WLX)
16. 1.2 (DL+LL+WLY)
17. 1.2 (DL+LL+WL-X)
18. 1.2 (DL+LL+WL-Y)
19. 0.9DL+1.5EQX
20. 0.9DL+1.5EQY
21. 0.9DL+1.5EQ-X
22. 0.9DL+1.5EQ-Y
23. 0.9DL+1.5WLX
24. 0.9DL+1.5WLY
25. 0.9DL+1.5EQ-X
26. 0.9DL+1.5EQ-Y

All these load combinations are built in ETABS. Analysis result from the critical load combinations are used for the design of structural members.

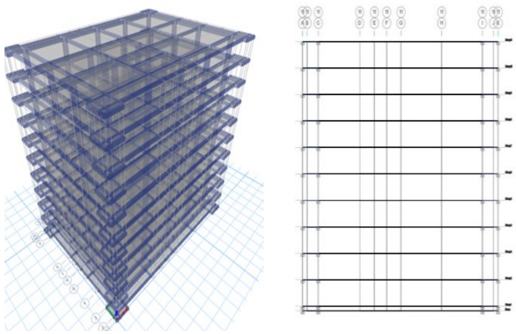

Fig 6.1 Unbraced Frame

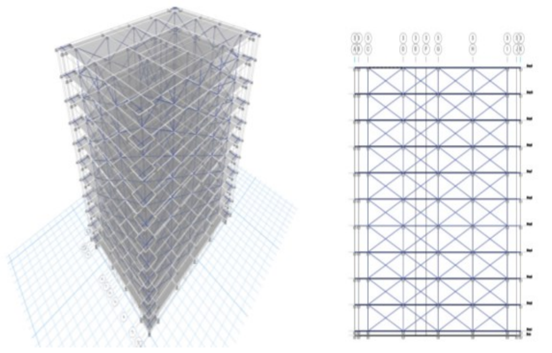

Fig 6.2 X Braced Frame

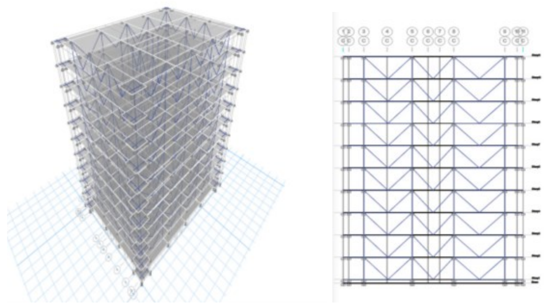

Fig 6.3 V Braced Frame

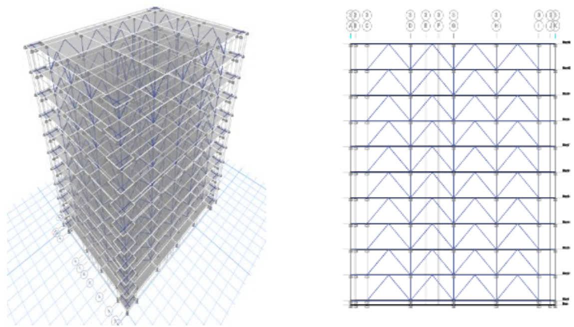

Fig 6.4 Inverted V Braced Frame

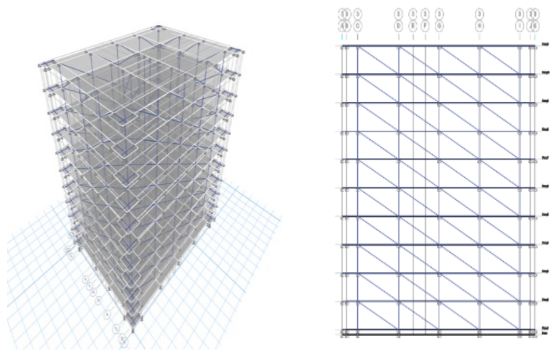

Fig 6.5 Diagonal Braced Frame

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VII. RESULTS AND DISCUSSION

After analysis of G+9 storey building in ETABS software. Results are in form of Storey displacement, storey drift and time period . Storey drift and displacement were determined for each building separately in every instance. The parameters obtained for the unbraced system are compared to the bracing systems of the X, V, Inverted V, and diagonal braced frames. Upon comparing all of these systems, it is found that when the steel bracing system is modeled, there is the least amount of building drift. Storey displacement decreased as well when steel bracing was installed. Find out that the X braced frames are most effective one by comparing all of the data to resist the lateral load caused by the seismic load. Below are graphs and tables for each of the several scenarios

A. Storey Displacement

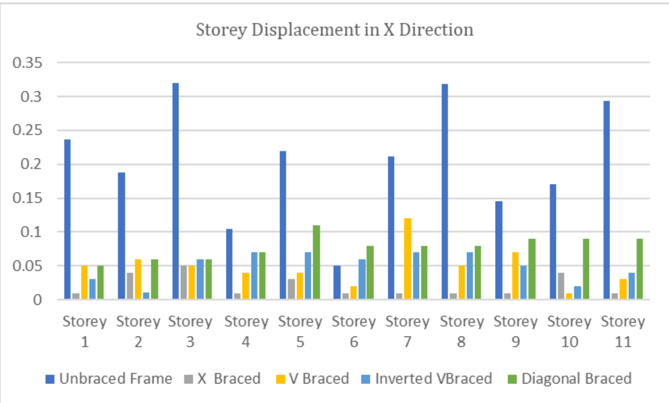

Fig 7.1 Storey Displacement in X Direction

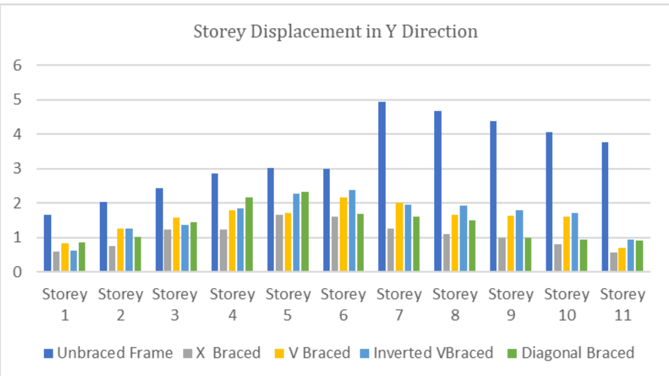

Fig 7.2 Storey Displacement in Y Direction

B. Storey Drift

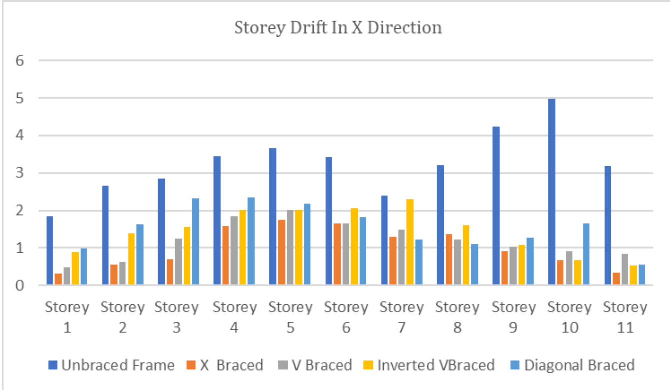

Fig 7.3 Storey Drift in X Direction

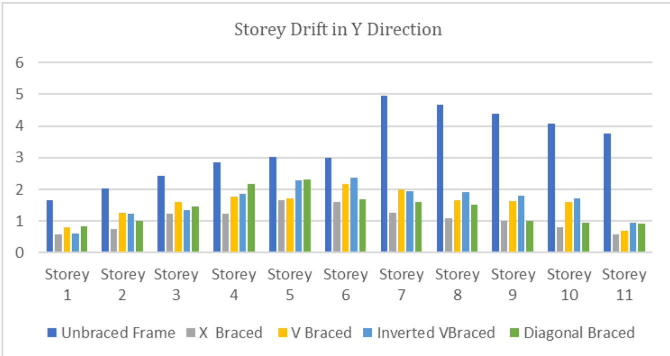

Fig 7.4 Storey Drift in Y Direction

C. Time Period

TABLE 7.1 TIME PERIOD

Model	EQX(Seconds)	EQY(Seconds)
Unbraced Frame	0.014	0.029
X Braced	0.003	0.004
V Braced	0.003	0.004
Inverted V Braced	0.003	0.004
Diagonal Braced	0.003	0.003

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