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Comparative Study of G+7 Building with and without X Bracing System by Using STAAD.Pro

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ABSTRACT

In India the provision of bracing system in RCC structures is very rare feature. This feature is very much desirable in structures built in seismic areas. This study gives a solution to eliminate or reduce the effects of earthquakes caused due to seismic loads. Bracing is a highly economic and efficient method of resisting lateral forces. X Bracing system is more efficient and safe at the time of earthquakes when compared to remaining bracing system. This study aim is to compare the normal building and building with X bracing system. For this purpose, the G+7 building model is used with X bracing systems. The parameters which will be considered for comparing the seismic effect of buildings are Combined stress, base shear and maximum displacement in different seismic zones. In this study, analysis of RCC building with X steel bracings is carried out by using STAAD Pro. All mentioned data for RCC building is analyzed as per IS:456-2000 and the load combinations and frame model are analysed as per IS:1893-2000. In this project we will prove the importance of bracing system in order to resist horizontal forces such as earthquake and wind. Conclusions are drawn based on the tables and graphs obtained.

KEYWORDS: *Bracings, Combined stress, Base shear, Maximum displacement, STAAD.Pro.*

I. INTRODUCTION

1.1. GENERAL

STAAD PRO is a powerful design software licence ID by Bentley. Staad stands for structural analysis and design Programme. Design phase is designing the type of materials and its dimensions to resist the load. This we do after the analysis. To calculate Shear force, bending moment diagram of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very important software which can complete the project within hours. Most of the high rise building are designed by Staad pro which makes compulsory for every Civil Engineer. This software can be used to design various types of RCC works, steel bridges, truss, etc. According to various country codes. Earthquake's where tremors observed on earth's surface, are characterized movements of the ground that's created by force which are termed as seismic forces. The tremors cause vibration inside the building structures making a gentle to extreme harms to the structures prompting loss of human life

1.2. OBJECTIVES OF STUDY:

1. To study the role of bracing systems in RCC structures.
2. To determine whether steel bracing system is superior in higher earthquake zones.

3. To determine which structure is superior to another in higher earthquake zones.
4. To investigate efficiency of bracing systems by following point of view:
   a) Maximum displacement
   b) Combined stress
   c) Base shear
5. To reduce the Combined stress and Maximum displacement during earthquakes in seismic zones.
6. To reduce the base shear at bottom of building during earth quakes.

II. LITERATURE REVIEWS

Tejas D. Joshi (2013) studied on bracing systems on high rise steel structures. For this investigation, G+15 storied steel frame structure models with same sections and different bracing arrangements like X bracing, double X bracing, Single diagonal, K bracing and V bracings are used. STAAD Pro V8i software is used for the seismic analysis and comparison is done with different parameters. The reduction in displacement is higher in case of V bracing and K bracing compared to un-braced building due to irregularity in shape of the building. Storey drifts may increase or decrease in braced building compared to un-braced building structure.

Young Kelly et al. (2016). Basic times of eccentrically braced frame (EBF) structures of no. in 12 with changing geometric abnormalities were planned and dissected. From factual examination it was presumed that 3-variable power model was better fit to the Rayleigh information than conditions which were reliant on stature just).

Rashmi sakalle et. al. (2015) studied the effect of bracings at different position of the structure and compared it with rigid diaphragm structure under dynamic loading, using analysis tool staad.pro and concluded that rigid diaphragm is comparatively more effective in reducing lateral forces also making the structure cost effective in terms of reinforcement steel.

D.K. Paul et. al. (2012) presented a practical implementation on an earthquake resistance building to resist nonlinear (pushover) lateral seismic forces. Retrofitting is introduced in which chevron bracing and aluminum shear link as a beam is introduced to improve its performance and concluded that with the use of bracing and shear link building becomes more responsive and capable of bearing lateral forces.

III. METHODOLOGY

The earthquake zoning map of India divided India into four major seismic zones (zone II, III, IV, V). Zone V has highest level of seismic effect whereas zone II subjected to less amount of seismic effect when compared to zone V.

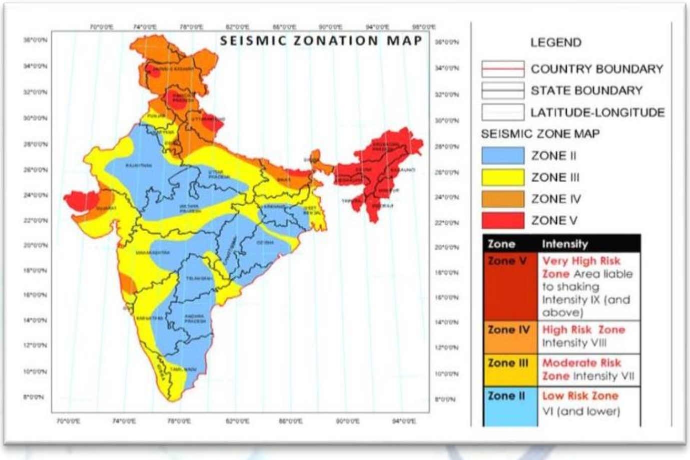


Fig. 3.1 Earthquake zones

ZONE II: This region is liable to MSK VI or less and is classified as the low damage risk zone. The IS Code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration)

ZONE III: The Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as moderate damage risk zone which is liable to MSK VII and also 7.8. The IS code assigns zone factor of 0.16 for zone 3.

ZONE IV: This zone is called the high damage risk zone and covers areas liable to MSK VIII, The IS code assigns zone factor of 0.24 for zone 4. The Indo Gangetic basin, Jammu and Kashmir fall in zone 4. In Maharashtra, the Patan area (koyananagar) is also in zone 4. In Bihar the northern part of the state like Raksaul, near the border of India and Nepal is also in zone 4.

ZONE V: This zone covers the area with highest risks zone that suffers earthquakes of intensity MSK IX or greater. The IS code assigns zone factor of 0.36 for zone 5. Structural designers use this factor for earthquake resistant design of structures in zone 5. The zone factor of 0.36 is indicative of effective level of earthquake in this zone

IV. BRACING SYSTEMS

A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression. Braced frames are a very common form of construction, being economic to construct and simple to analyse. Economy comes from the pinned connections between beams and columns. Bracing, which provides stability and resists lateral loads, may be from diagonal steel members or, from a concrete 'core'. In braced construction, beams and columns are designed under vertical load only, assuming the bracing system carries all lateral loads. The beams and columns that form the frame carry vertical loads, and the bracing system carries the lateral loads.

4.1. TYPES OF BRACINGS:

1) *Inverted V bracing*
2) *Single bracing*
3) *Cross bracing*
4) *K bracing*
5) *V bracing*

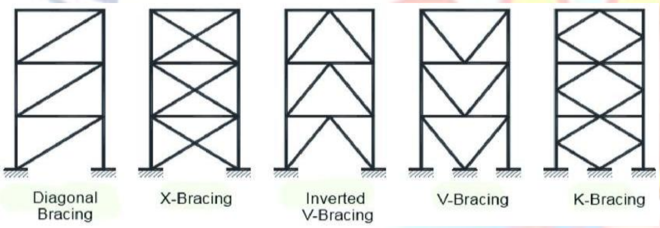


Fig. 4.1 Types of bracing

4.1 (a) CHEVRON OR INVERTED V BRACING: Chevron or inverted-chevron bracing (inverted V- or V- bracing) has intersecting brace connections.

4.1 (b) SINGLE DIAGONAL BRACING: Trussing, or triangulation, is formed by inserting diagonal structural members into rectangular areas of a structural frame, helping to stabilize the frame. If a single brace is used, it must be sufficiently resistant to tension and compression.

4.1 (c) CROSS BRACING OR X BRACING: Cross-bracing (or X-bracing) uses two diagonal members crossing each other. Steel cables can also be used for cross-bracing. However, cross bracing on the outside face of a building can interfere with the positioning and functioning of window openings

4.1 (d) K-BRACING: K-braces connect to the column at mid-height. This frame has more flexibility for the provision of openings in the facade and results in the least bending in floor beams. Bracing is generally discouraged in seismic regions because of the potential for column failure if the compression brace buckles.

4.1 (e) V BRACING: Two diagonal members forming a V-shape extend downwards from the top two corners of a horizontal member and meet at a centre point on the lower horizontal member.

V. METHODOLOGY

DESCRIPTION OF MODELS:

G+7 Building without bracing in zone III
G+7 Building without bracing in zone IV
G+7 Building without bracing in zone V
G+7 Building with X bracing in zone III
G+7 Building with X bracing in zone IV
G+7 Building with X bracing in zone V

5.1 SPECIFICATIONS USED IN MODELS:

Table 5.1 specifications used in models

S. NO	PARAMETERS	DIMENSIONS
1	Plan dimension	16m x 16 m
2	Number of stories	G+7
3	Total height of building	24m
4	Height of each storey	3m
5	No of bays in length	4
6	No of bays in height	8
7	No of bays in width	4
8	Column size	400mm×400 mm
9	Beam size	400mm×300 mm
10	Grade of concrete	M30
11	Grade of steel	Fe415
12	Dead load	17.58 KN/m^2
13	Live load	2 KN/m^2
14	Thickness Floor finish	50mm
15	Plaster thickness external	16mm
16	Plaster thickness Internal	12 mm
17	Slab thickness	150mm
18	Unit weights of Concrete	25 KN/m^3

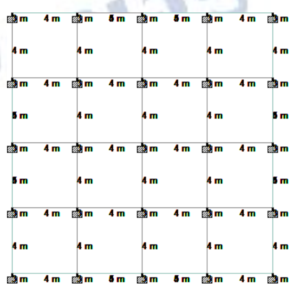


Fig. 5.1 Plan

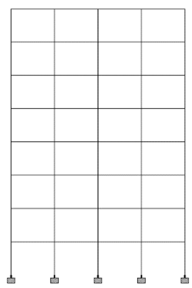


Fig. 5.2 front view

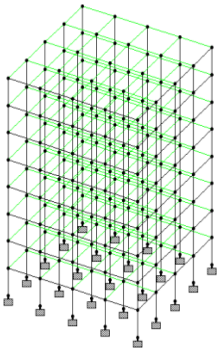


Fig. 5.3 Isometric view

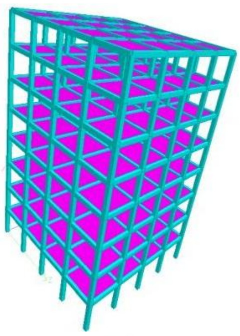


Fig. 5.4 Render view

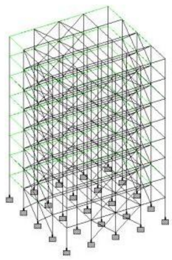


Fig. 5.7 Isometric view

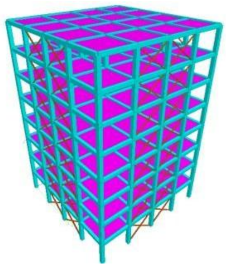


Fig. 5.8 Render view

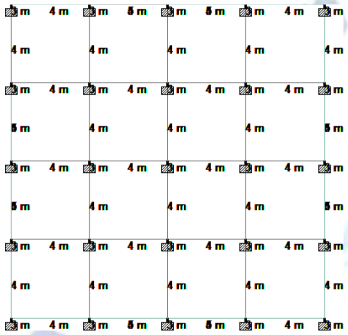


Fig. 5.5 Plan

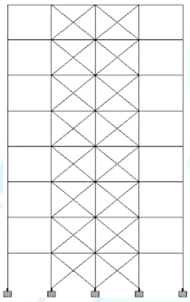


Fig. 5.6 Front view

5.3. LOADING DATA:

1 Total Member load = 12.63KN/m.

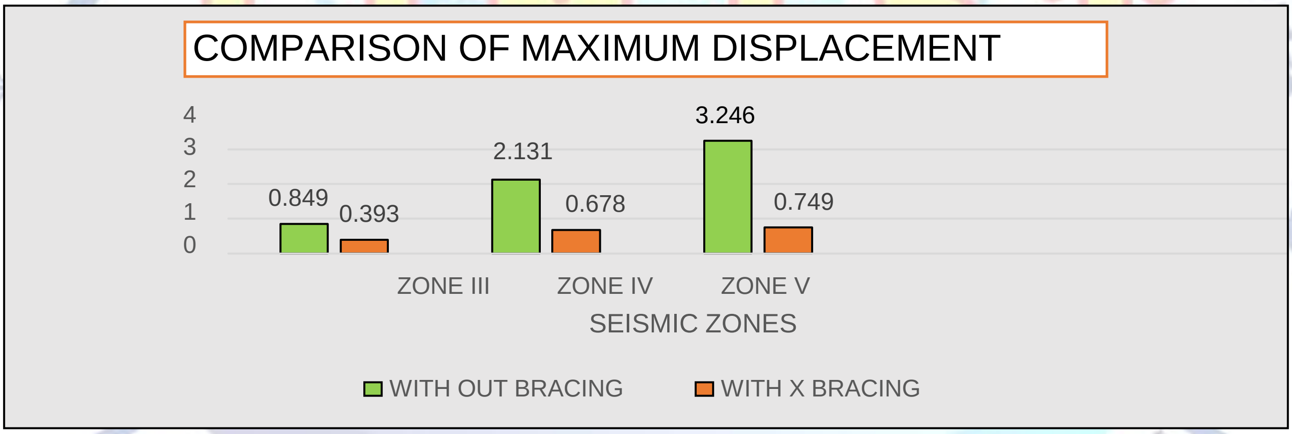
2. Total floor load = 4.95KN/m.

VI. RESULTS AND DISCUSSIONS

6.1. MAXIMUM DISPLACEMENT (mm):

Table 6.1 comparison of maximum displacement

S.NO	MODEL NAME	MAXIMUM DISPLACEMENT (mm)		
		ZONE III	ZONE IV	ZONE V
1.	Building without bracing	0.849	2.131	3.246
2.	Building with X bracing	0.393	0.678	0.749



Graph 6.1 comparison of maximum displacement

ZONE III: The displacement of building with X bracing is 53.3% less than the displacement of building without bracing.

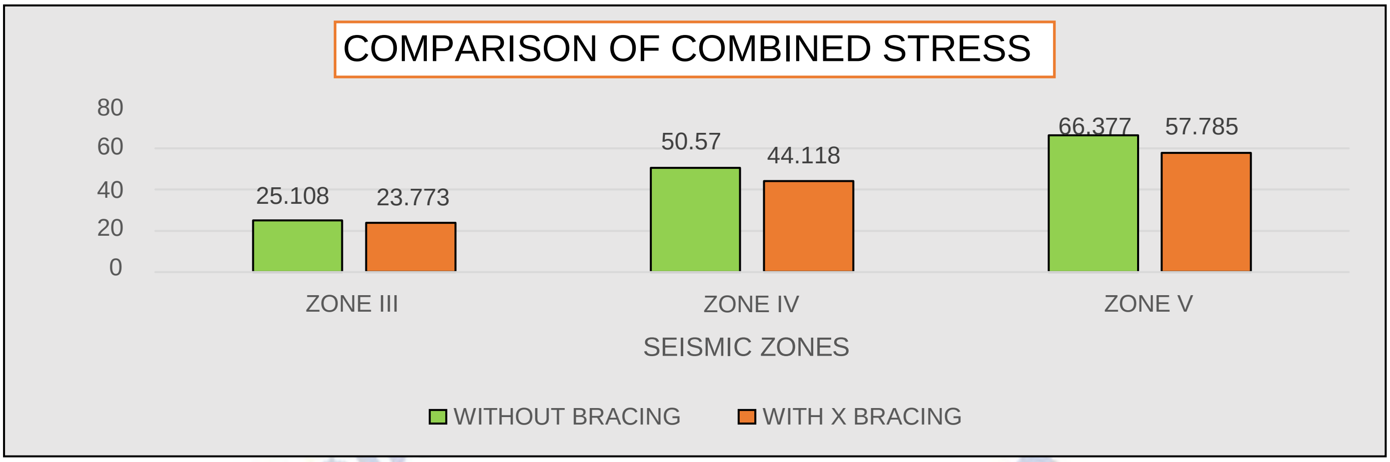
ZONE IV: The displacement of building with X bracing is 68.18% less than the displacement of building without bracing.

ZONE V: The displacement of building with X bracing is 76.92% less than the displacement of building without bracing

6.2. COMBINED STRESS (N/mm^2)

Table 6.2 comparison of combined stress

S.NO	MODEL NAME	COMBINED STRESS (N/mm^2)		
		ZONE III	ZONE IV	ZONE V
1.	Building without bracing	25.108	50.570	66.377
2.	Building with X bracing	23.773	44.118	57.785



Graph:6.2 comparison of combined stress

ZONE III: The Combined stress of building with X bracing is 5.31% less than the Combined stress of building without bracing.

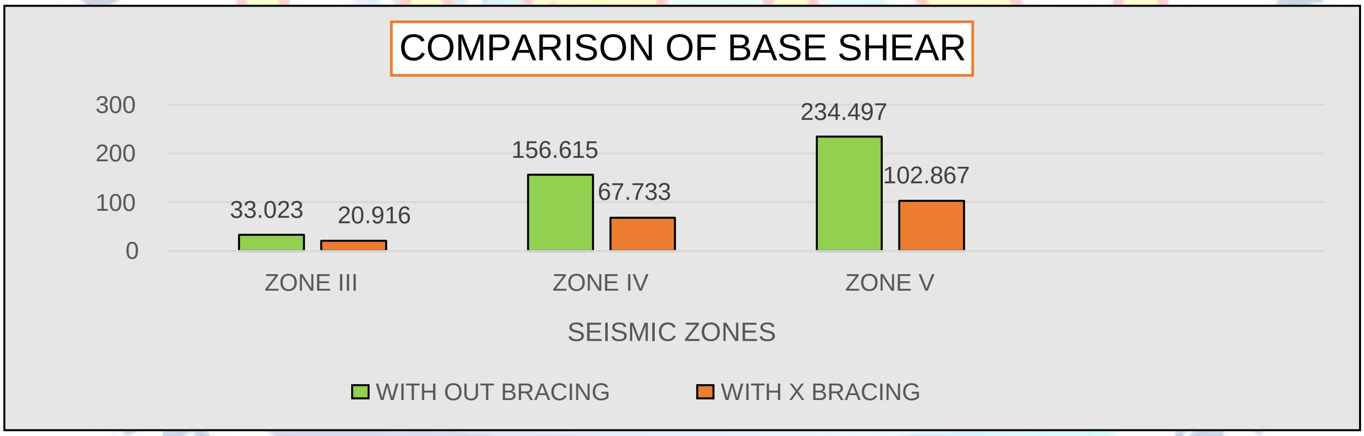
ZONE IV: The Combined stress of building with X bracing is 12.7% less than the Combined stress of building without bracing.

ZONE V: The Combined stress of building with X bracing is 12.94% less than the Combined stress of building without bracing.

6.3. BASE SHEAR (KN):

Table 6.3 comparison of base shear

S.NO	MODEL NAME	BASE SHEAR (KN)		
		ZONE III	ZONE IV	ZONE V
1.	Building without bracing	33.023	156.615	234.497
2.	Building with X bracing	20.916	67.733	102.867



Graph:6.3 comparison of base shear

ZONE III: The Base shear of building with X bracing is 36% less than the Base shear of building without bracing.

ZONE IV: The Base shear of building with X bracing is 57% less than the Base shear of building without bracing.

ZONE V: The Base shear of building with X bracing is 56% less than the Base shear of building without bracing.

VII. CONCLUSIONS

1. Steel bracing system shows the efficient and economical measures for RC multistory buildings located in high seismicregion.
2. Building with X bracing system provides more efficiency than building without bracing system in higher earthquake zones.
3. The Maximum Displacement is reduced in building by 76.92% in higher risk zone (zone V) after providing X bracing system.
4. The Combined stress is reduced in buildings by 12.94% in higher risk zone (zone V) after providing X bracing system.
5. The Base shear is reduced in building by 56% in higher risk zone (zone V) after providing X bracing system

FUTURE SCOPE:

1. We can do the same project using ETABS Software.
2. We can do the same project by changing the type of bracing systems.
3. We can do the same project by changing the location of bracing systems
4. We can do the same project by changing the storey heights.
5. We can do the same project by changing the number of bays in length, height, width.
6. We can do the same project by changing the various types of load combinations.

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