JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

"REDUCTION OF TORSIONAL EFFECTS ON ASYMMETRIC U-SHAPED HIGH RISE BUILDING WITH SHEAR WALL AND BRACING SYSTEM."

[1]Khushnuma Khatoon, [2]Rajiv Banerjee

[1]Student of M.Tech (Structural Engineering), [2]Associate Professor,
[1] Department of Civil Engineering,
Integral University Lucknow, Uttar Pradesh-India

Abstract : Structures in seismically active regions could sustain significant damage. Structures must endure lateral loads that can cause large strains in addition to gravity loads. Shear walls and steel bracings in R.C. structures are currently the most often used method of preventing lateral loads brought on by earthquakes, wind, blasts, etc. It is discovered that the X type of steel bracing system greatly minimizes the maximum interstorey drift and lateral displacement and increases structural rigidity. Although shear walls are among the best lateral load resisting techniques and are frequently utilized in construction, using steel bracing will be a practical way to increase earthquake resistance. Shear walls are used in construction to sustain gravity loads and resist lateral forces. RC shear walls are very stiff in the plane. The location of the shear wall affects how the building will function as a whole. The placement of the shear wall must be optimum for the building to function effectively and efficiently. In order to determine the effective lateral load system during an earthquake in high seismic zones, computer assisted analysis is performed using E-TABS. Analysis of the RCC shear wall and rigid-bracing framed structure is the primary goal of this study. It also compares top storey displacement variation, cost per panel, and weight of the shear wall and bracing in the building.

The shear wall and braced frame at the centre of the G+10 Storey building are used to analyze it in the current work. Analysis is done, and the outcomes for storey drifts, maximum base shear, storey drift, displacement, and time period are compared and evaluated.

***IndexTerms* - Seismic analysis, Shear wall, X-Bracings, Equivalent static method, Response spectrum method,E-TABS.**

I. INTRODUCTION

This paper's major goal is to identify the shear wall and bracing locations for a building that is being subjected to seismic forces. The structure is analyzed by E-TABS software by Response spectrum method. A structural system known as a dual system resists lateral and gravitational loads. In a dual system, shear walls and frames both resist lateral loads. a collection of columns and beams joined together at rigid connections. RC walls that are projected along the length of the structure from the foundation are known as shear walls. When seismic forces oppose the structure, shear walls reduce the storey displacement.

As a result, if the structure is enclosed by a shear wall all the way around, it might not seem attractive. Bracings are used to lessen wind and lateral forces, and they are simple to retrofit even for existing buildings. Bracings may not be appropriate for low-rise buildings. Shear walls and bracings are combined and installed in various places throughout the structure to help it overcome these conditions.
The current study compares the parameters of Story displacement, Story drift, Time Period, Static Eccentricity and Base Shear, of all 4 models with and without shear walls and Bracing System, which are derived from Response Spectrum Method, in order to determine the most advantageous location for a shear wall and bracing for an irregular U-shaped plan (G+10) store building.

Rigid Frame:-
Rigid refers to the capacity to withstand deformation. In order to withstand the moments that are being generated by the applied load, rigid frame structures are those in which the beams and columns are formed as a single unit. More stability is offered by rigid frame systems. This style of frame constructions more successfully withstands torsion, moment, and shear.

Braced Frame:

A structural system known as a braced frame is primarily made to withstand wind and seismic stresses. A braced frame's members are made to function in both tension and compression. Steel members are almost always used in braced frames. Beams and columns in braced construction are only intended to withstand vertical loads, presuming the bracing system would support all lateral forces..

Shear walls:-

Shear walls are vertical structural components that withstand seismic forces. These are available at various heights to withstand in-plane loads. Seismic and wind loads are the principal stresses experienced by shear walls. In most cases, the diaphragm (the structural element that transverses the lateral load to the vertical resisting parts of a structure) transfers the loads to the walls. These are typically horizontal but occasionally they can be sloping, like a ramp for parking a car.) They may be made of masonry, concrete, or wood. Shear walls are extremely strong and rigid to withstand lateral forces. In high rise buildings in seismically active zones, shear walls are crucial. These shear walls have the ability to lessen lateral movement. Both lateral forces and the structure's own weight (gravity loads) are intended to be resisted by these. Natural disasters (earthquakes, wind forces, etc.) can create a variety of stresses, including shear, tension, and torsion. As a result, the structure may suddenly collapse or endure storey displacement. Shear walls lessen the severity of lateral movement of the structure and signal structural failure.

Shear wall buildings and Bracing with irregularities:-

The structural element of a structure that can withstand lateral forces is referred to as the lateral force-resisting system. Buildings include the lateral load resisting system like shear walls, unique moment resisting frames, and dual bracing systems. . Shear walls are lateral load-resisting systems in a building, and the placement of these systems can have a significant impact on how dynamically the structure responds to earthquake loads.

Ozmen et al. (2014) looked at six different sets of 3D building models with different shear wall placements, storey heights, and axis counts. One storey structures were found to have the highest torsional irregularity coefficients in terms of maximum drift and average drift. The shear walls' proximity to the centre of mass was observed to increase the irregularity coefficients, but floor rotations caused the irregularity coefficients to increase in the other direction. Thus, it was determined that floor rotations, as opposed to torsional irregularity coefficients as suggested by numerous codes, provide an accurate depiction of the torsional behaviour. Based on the wide column method previously described by Arabzadeh and Galal (2017), Arabzadeh and Galal (2018) quantitatively evaluated the non-linear responses of RC shear wall cores with various torsional sensitivity factors. Based on the outcomes of experiments, Heerema et al. (2015) investigated the cyclic behaviour of a reduced size reinforced masonry asymmetric building with shear walls aligned in both orthogonal directions. A two-story reinforced masonry building was put under quasi-static loading, and the individual walls' impact on the structure's torsional response was also assessed.

Torsional Irregularity:-

As per IS 1893-2016 (Part I) “Torsional irregularity as the condition when the maximum horizontal displacement of any floor in the direction of lateral force at one end of the floor is more than 1.5 times its minimum horizontal displacement at the far end of the same floor in that direction”.

- In order to minimize the overall torsion, it is imperatively necessary to reduce the distance between the centre of mass (CM) and centre of rigidity (CR) in the design stage.

Building modeling and analysis:-

The analysis is done using the E-TABS2015 software, which is also utilized to create the 3D model. . In this study, (G+10) storey RC buildings of Shear wall models and X-Braced models are fixed at base. To prevent torsional effects, the building's layout is (50 m × 70 m) in size and symmetric about both X and Y directions. Every floor, including the lowest Floor, has a 3 m storey height. Building is designed in accordance with IS: 456-2008, and seismic loading is implemented in accordance with IS: 1893-2016. Seismic analysis uses the equivalent static method and the response spectrum method. The following seismic parameters were taken into account for this analysis.

Zone factor for seismic zone V = 0.36
Soil site factor for medium soil condition = 2
Importance factor = 1.5
Response reduction factor = 5
Damping ratio = 0.05

The floor finish and live load are assumed to be 3 kN/m2 and 1 kN/m2 accordingly for all models. The application of load combinations follows the advice of Indian standard codes. 25% of the floor live loads are taken into account in seismic weight estimates. Fe415 structural steel is employed, together with M25 grade concrete.

Description of building:-

G+ 10 Building with Bracing & Shear wall Building

Table 1

S.NO.	Structural Part	Dimensin
1.	Length in X-direction	70 m
2.	Length in Y-direction	50 m
3.	No .of bay in X-direction	14No@5 m
4.	No .of bay in X-direction	11No@5 m
5.	Floor to floor height	3 m
6.	Total height of the building	33 m
7.	Slab thickness	150 mm

II. RESULTS AND DISCUSSION

2.1 Response Spectrum Analysis

2.2 Modal Analysis

Designing structures so that they primarily oscillate along their sides. It is preferable to have pure translational modes as the first and second modes of oscillation, and torsional as the third mode of oscillation because modes of oscillations like opening closing, translation along diagonal and dog-tail wagging are not beneficial for the seismic performance of buildings. Shear walls and Bracing can be placed in beneficial areas to control undesirable modes.

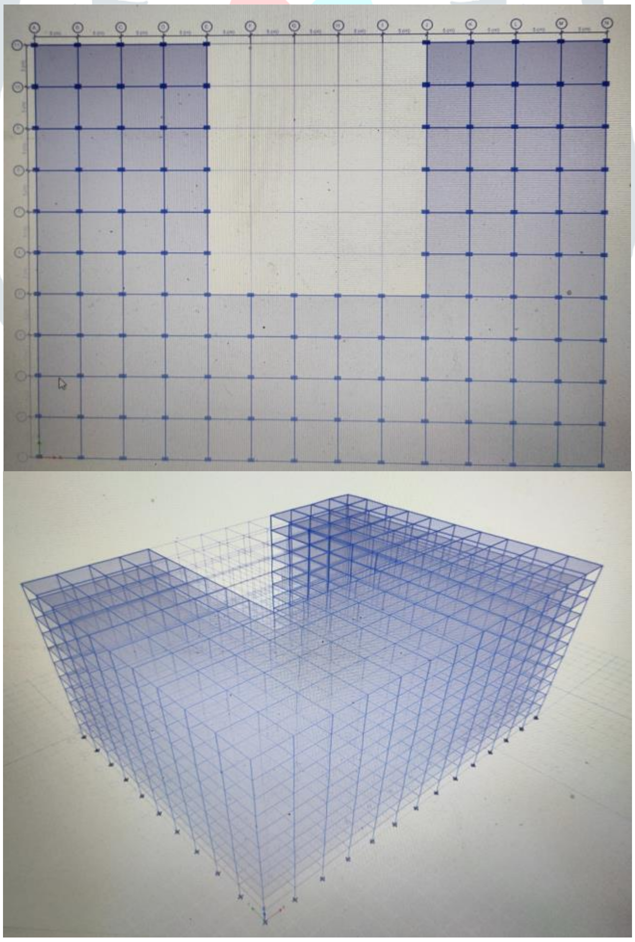

Fig1:-Plan and 3-d View of G+10 Building (Bare Model)

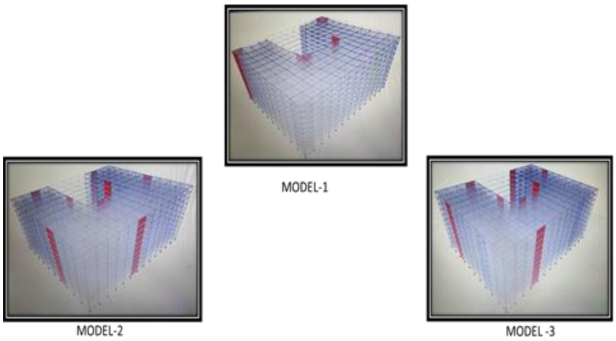

Fig2:-3-D view of G+10 building for different models (bracing & shear wall)

Storey Displacement:-

H/250 provides the maximum permitted displacement as per Eurocode-819.where H is the building's overall height above ground. The maximum allowable displacement, as determined by the formula H/250, is 132 mm. Figure 2 displays the storey displacement of several models along with the corresponding data. Following the dynamic analysis from ETABS, the test models' Storey Displacement along X- and Y-direction was assessed.

Table 2

Model Name	**X-direction in (mm)**	**Y-direction in (mm)**
Bare model	98.3596	99.03
Model 1	64.1617	62.93
Model 2	75.9279	76.0154
Model 3	78.6984	78.7415

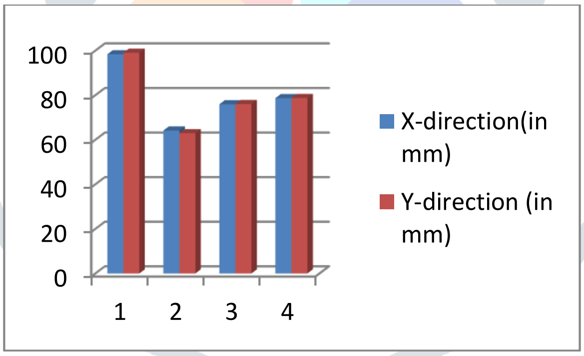

Fig3:- Storey displacement

This can be seen in Fig. 3, where the bare models' storey displacement in the X- and Y-directions is 98.3596 mm and 99.03 mm, respectively.

Shear wall addition significantly minimizes storey displacement. The table shows that Model 1 has the least amount of storey displacement out of the three T-T-R models (Model 1). Model 1 has a displacement of 64.1617 mm in the X direction and 62.93 mm in the Y direction.

Storey Drift:-

According to IS 1893:2016 (Part-I) (clause 7.11.1)2 determined permitted drift as per the aforementioned code (0.004x3000 = 12 mm), story drift shall not exceed 0.004 times of storey height. After evaluating the test models' Storey Drift in X and Y directions using the dynamic analysis from ETABS.

The storey drift for the Bare Model is seen in Fig.4 to be 0.003723mm and 0.00479 mm respectively. These values are within acceptable bounds. With the inclusion of a shear wall in a suitable position, these values are further decreased. In the X and Y-directions, Model 1 exhibits 0.002379 mm and 0.002269 mm, respectively. Model 2 values are around one-third those of the Bare Model.

Table 3

Model Name	X-direction in (mm)	Y-direction in (mm)
Bare model	0.003723	0.00479
Model 1	0.002379	0.002269
Model 2	0.003246	0.00319
Model 3	0.003435	0.003452

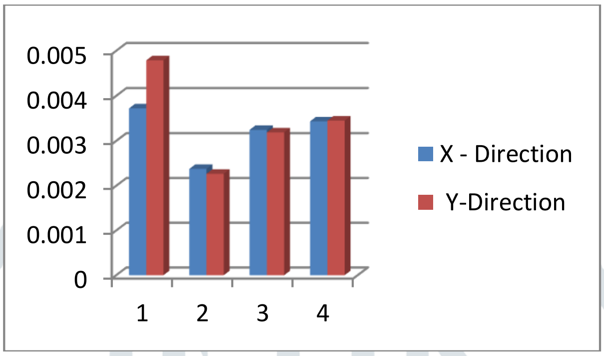

Fig4:-Storey Drift in X and Y-direction.

Base Shear:-

When seismic ground motion occurs, the maximum lateral force that can be expected at the base of the building is referred to as base shear. Base shears for all models are displayed here following the dynamic analysis by ETABS. Base Shear for the Bare Model in Fig. 5 is 10100.831 kN and 10129.932 kN, respectively, in the X and Y directions. Model 1 is seen to have values of 11624.3305 kN and 11541.284 kN in the X and Y directions, respectively. Among the T-T-R showing models, it is the highest. In light of this, Model 1 shear wall and bracing position may be ideal for this kind of building.

Table 4

Model Name	X-direction in (mm)	Y-direction in (mm)
Bare model	10100.8317	10129.932
Model 1	11624.3305	11541.284
Model 2	11225.8215	11025.993
Model 3	10807.0929	10567.837

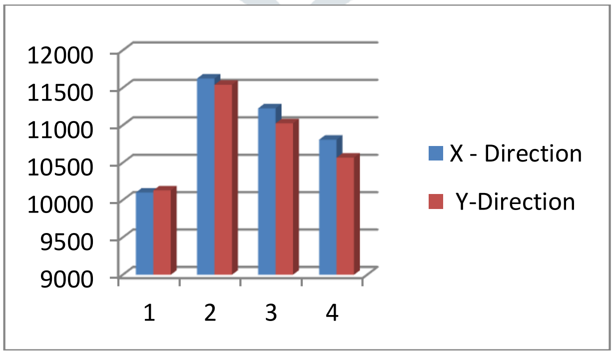

Fig 5 :- — Base Shear in X and Y-direction.

Time Period:-

A building's time period is the length of time needed to complete one oscillation cycle. The key factors affecting time are the structure's mass and flexibility. The time period would be longer the more flexible the requirements. Less time is preferred for better performance.

The time periods for Bare modal, Model 1 , model 2 and model 3 are 3.778 seconds, 0.792 seconds 0.818

and 0.849seconds, respectively, according to the Fig. 6 above. When showing T-T-R (Translation - Translation - Rotation) modal behaviour in the first three modes of vibration, Model 1 exhibits the shortest time period of all the models. In terms of shear wall and bracing position, Model 1 can therefore be regarded as the best model.

Table 5

Model Name	Time Interval (in sec)
Bare model	3.778
Model 1	0.792
Model 2	0.818
Model 3	0.849

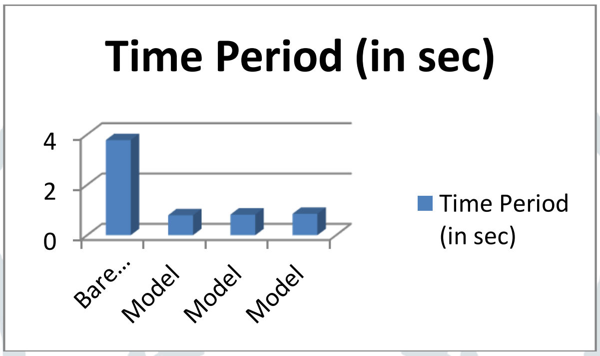

Fig. 6 — Time interval (sec).

Static Eccentricity:-

Shear walls' placement and number have an impact on C_m (Centre of Mass) and C_R (Centre of Rigidity). As shown in Figure 7, the structure is symmetrical along the Y-axis; hence the static eccentricity along the Y-direction has no effect on torsion.

It is noted that the maximum eccentricity of the bare model is 1.0349 m, and that eccentricity rapidly decreases with the addition of shear walls and bracing in suitable locations. It is found that Model 2 has got an eccentricity of 0.249m. This is the lowest value among the models. So arrangement of shear wall as per Model 2 may be considered as best.

Table 6

Model Name	Y-direction in(m)
Bare model	2.7349
Model 1	0.4561
Model 2	1.0117
Model3	0.4934

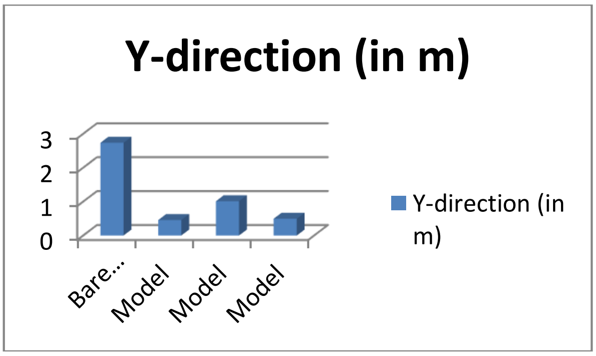

Fig. 7:- Static Eccentricity in y- direction

Conclusion:-

- It is ideal for the building to have higher performance against seismic force. The first two vibration modes are controlled by the translational mode, and the third vibration mode is controlled by torsion.
- All building models are symmetrical about the Y axis, and shear walls are positioned so that the centers of mass (C_m) and rigidity (C_R) of each structure lie along the Y axis. Static eccentricity should be kept to a minimum to minimize the torsional effect it causes. The construction with the best shear wall and bracing location indicates how close together the centers of mass and rigidity will be.
- Eccentricity is decreased by 16% in y-direction dual system (Shear wall and Bracing) when compared to normal building.
- The addition of shear wall and bracing at different location in models results decrease in the time period. Model 1 decrease in Time Period compared to bare model. Model 1 shows minimum Time Period among all Models that satisfy Translation-Translation-Rotation (T-T-R) mode of vibration.
- Base shear of Model 1 with bracing and Shear wall is found to be maximum (11624.3305 KN) where as Base Shear for Bare model is least and is found to be 10100.831 KN.
- In the case of structure with Shear wall and bracing eccentricity is found to be least for Model 1 (0.792) where as for bare model eccentricity is 1.0349.
- Displacement is decreased by 63% and 42% in x- direction and y-direction dual system when compared to normal building.
- Storey Drift is decreased by 63% and 47% in x- direction and y-direction dual system (Shear wall and Bracing) when compared to normal building.
- Time period for model 1 is 0.749 sec which is lesser than that of bare model (3.778 sec).Time period is decreased by 20% in dual system (Shear wall and Bracing) when compared to normal building.

II. ACKNOWLEDGMENT

The delight and thrill on completing a project successfully would be lacking if I didn't acknowledge the people who made it possible and whose ongoing guidance and support gave my effort a successful ending. Additionally, I would like to take this opportunity to express my sincere gratitude to Mr. Rajiv Banerjee, Associate Professor Associate Professor in the Department of Civil Engineering at Integral University in Lucknow, who served as my dissertation advisor and provided me with invaluable advice at important turning points as well as throughout the entire process. I want to thank Dr. Syed Aqeel Ahmad, a professor and the head of Integral University's civil engineering department in Lucknow, for his help, wise observations, and provision of the lab materials required for the project work. I also want to express my gratitude to Integral University's Civil Engineering Department for providing the project with a perfect environment and support.

REFERENCES

[1] K.G. VISWANATH K.B. PRAKASH AND ANENT DESAI, "SEISMIC ANALYSIS OF STEEL BRACED REINFORCED CONCRETE FRAMES", INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING VOLUME 1, NO 1, 2010 ISSN 0976 – 4399.

[2] COMPARATIVE STUDY OF STRENGTH OF RC SHEAR WALL AT DIFFERENT LOCATIONS BY VARSHA R. HARNE INTERNATIONAL JOURNAL OF CIVIL ENGINEERING RESEARCH).

[3] Miss.S.A. Ghadge, Prof. S.S. Patil, Prof. C.G. Konapure, " Equivalent Static Analysis of High-Rise Building with Different Lateral Load Resisting Systems" , International Journal of Engineering Research & Technology (IJERT) , Vol. 2 Issue 1, January- 2013

[4] I.S. 1893 (Part 1)-2016, Criteria for earthquake resistant design of structure, general provision and building, Bureau of Indian standards, New Delhi. 2002.

[5] Software used ETABS.

[6] IS 456-2000 "Code of practice for plain and reinforced concrete".

[7] IS 875 Part 1 "unit weight of materials "

[8] IS 13920-193, "Earthquake resistant design and construction of buildings – code of practice.

[9] Anil Baral, Dr.Yajdani SK., "Seismic Analysis of RC Framed Building for Different Position of Shear Wall", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 5, May 2015.

[10] Chandurkar P. P., Dr. Pajgade P. S., "Seismic Analysis of RCC Building with and without Shear Wall", International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue. 3, May - June 2013 pp-1805-1810. Second revision)

[11] Heerema, P., Shedid, M. and Dakhakhni, W.E. (2015). ―Seismic response analysis of a reinforced concrete block shears wall asymmetric building.‖ Journal of Structural Engineering, ASCE, 141(7), 04014178 1-12.

[12] Arabzadeh, H. and Galal, K. (2018). ―Seismic-response analysis of RC C-shaped core walls subjected to combined flexure, shear, and torsion. Journal of Structural Engineering, ASCE, 144(10), 040181651-18.

[13] Arabzadeh, H., and Galal, K. (2017). ―Seismic collapse risk assessment and FRP retrofitting of RC coupled C-shaped core walls using the FEMA P695 methodology.‖ Journal of Structural Engineering, ASCE, 143 (9), 04017096