"Parametric Study of Integral Setback Building using Steel Structure"

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Abstract: Nowadays, due to the increase in construction of high-rise structures, the need for selecting a proper resistant structural system against earthquake and wind has increased meaningfully. A good example of a highly efficient system in high-rise buildings can be specified is the Setback structure system. An appropriate key to resolve this delicate is using a braced system. Combination of the braced with the Setback is more well-organized. This study focuses on the behavior of the system of structure with bracing and Setback structure. To this aim, buildings is modeled and analyzed with different types of bracing and Different position of bracing at structural systems in ETABS software.

The present-day work focuses on the effect of 20 storey Setback structure connected by a common Bracings. It is found from the studies that steel bracing and steel setback structure can impose significant differential restraint on the walls displaces under lateral loads. In this study the implementation of Bracings, in different configuration at the corner, center and combinations of center side on the building is discussed. The analysis was carried out by using ETABS 19 software, by implementing the response spectrum method and nonlinear dynamic analysis (time-history) method. The parameters under study are lateral deflection, storey drift, base shear and shear reversals in structure.

Keywords: ETABS software, Setback structure, Outrigger system at different position.

INTRODUCTION:

In multi storied framed buildings, damage from earthquake ground motion generally initiates at locations of structural softness present in the lateral load resisting frames. This performance of multi-storey framed buildings during strong earthquake motions depends on the distribution of mass, stiffness, and strength in both the horizontal and vertical planes of buildings.

A common type of vertical geometrical irregularity in building structures arises is the presence of setbacks, i.e., the presence of abrupt reduction of the lateral dimension of the building at specific levels of the elevation. This building category is known as 'setback building'.

Literature Review:-

1. Study on Seismic Response of Multi storey RC Building with setback and Re-entrant corner irregularities.

Fasil Neguse et al(2018); Reentrant corner and Vertical Irregularity – setback Irregularity model as compared to regular buildings. Two types of irregularities namely setback irregularity and re-entrant were considered with different plan area for G+11 stories. The effect of irregular setback on fundamental time period the percentage of setback increases, the fundamental time period decreases. The effect of re-entrant corner irregularity on fundamental period of building is larger than effect of vertical setback irregularities. They concluded that the re-entrant corner irregularities were more sensitive than to setback irregularities

2. Influence of Bracings on the Seismic Behavior of RC Framed Irregular Structures

Shridevi S. Angadi et al(2017); The performance of the structure by response spectrum method and modal period, storey shear, displacement and drift. The parameters considered in the time history method are base shear, joint displacement and column force. From the analysis, use of X bracing to all models is found more effective compared to V bracing and K bracing. Displacement and storey drift increases as the amount of irregularity present in the building increases.

3. Nonlinear Static Seismic Analysis of Vertically Irregular Building Frames with Different Outrigger System

Aswathy S Kumar et al(2019); This paper studies the efficient use of outrigger systems subjected to earth quake load in regular and irregular building with and without outrigger systems. The location of outrigger beam has critical influence on the lateral behavior of structure under earthquake load. The optimum location with outrigger system is providing at top, 3/4th height, middle and at 1/4th height shows the maximum reduction in lateral deflection in the three models. Comparing the virtual outrigger system with conventional outrigger with x bracing gives good result.

4. Seismic Analysis of Step back and Setback- Step back Buildings

Prince Adani et al(2018); Step back configuration is found more susceptible to seismic forces. From Results it has been concluded that the maximum displacement in both the direction in Step Back Building for given storey was more than that of in Step Back and Set Back Building. In Step Back-Set Back Building when Shear wall is introduced in X and XY both direction max. Displacement reduces by 60-80% in X-Dir. For Step Back Building Max. Displacement in X-Dir. reduces to 80-90%

and in Y-Dir. it reduces to 50-80% for all cases. When Shear wall was introduced in all type of configuration support connected to Shear Wall bears highest reaction. For same number storey Step Back buildings showed higher value of Storey drift and also of maximum displacement than Step-back Set-Back buildings hence they are more vulnerable to Earthquake.

5. Study on earthquake resistant buildings on ground surface by using ETABS

S. Kusuma et al(2016); It can be concluded that the stiffness of the building is getting reduced where length of the columns is higher relative to the other extreme end. The maximum variation in storey shear is about 55%. The variation in bending moment between long column and short column is about 22%. The variation of torsion moments in Step back buildings is 2% higher compared to set back buildings. Step back Set back buildings are found to be less vulnerable than Step back building against seismic ground motion. It is observed that extreme left column at ground level which are short are the worst affected. The Setback buildings on plain ground attract less action forces as compared to Step back Set back buildings.

Research Gap:-

From Literature review, it is found that researches have been done in following areas:

- To analyse model on steel setback structure.
- Compare steel setback structure with steel setback structure with bracing, steel setback structure with simple frame setback system and steel setback structure with bracing.
- Perform nonlinear dynamic analysis on the model.
- Steel dampers are not provided in structure to reduce the external forces generated at story.
- Use of steel bracing as vibration control for steel setback building is not studied
- Compare steel setback structure with simple frame setback structure and steel setback structure with bracing.

Methodology:

List of steps used to carry out the investigation are as follows:

❑ **10** models were prepared

- Model 1- Steel setback structure without Bracings
- Model 2- Steel Frame setback structure with V bracing at only off-centre
- Model 3- Steel Frame setback structure with Diagonal bracing at only off-centre
- Model 4- Steel Frame setback structure with X bracing at only off-centre
- Model 5- Steel Frame setback structure with V bracing at only centre
- Model 6- Steel Frame setback structure with Diagonal bracing at only centre
- Model 7- Steel Frame setback structure with X bracing at only centre
- Model 8- Steel Frame setback structure with V bracing at both centre & side
- Model 9- Steel Frame setback structure with Diagonal bracing at both centre & side
- Model 10- Steel Frame setback structure with X bracing at both centre & side

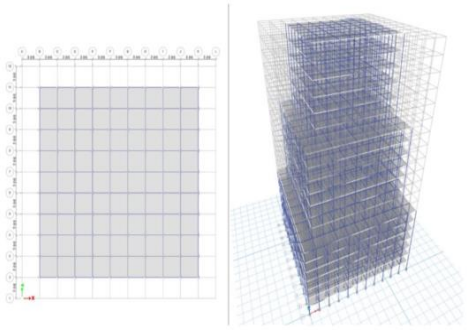
❑ **Structural property & Member size models for analysis**

Specification	Size
Building type	20 story setback building with steel bracing
Building area	36m x 36m
Column size	1-7 Storey – 550mm x 32mm 8-14 Storey – 550mm x 28mm 15-20Storey – 450mm x 25mm
Bracing (I section)	650mm x 250mm x 12mm x 20mm
Beam size	700mm x 300mm x 12mm x 25mm
Slab	250mm
Span length	3m
Floor to floor height	3m

Building Loading Data and Material Property	
Live Load	Each floor 3 KN/m^2
Wall Load	12 KN/m^2
Floor Finish	1 kN/m^2
Load Combination	As per IS 1893-2016
Unit Wt. of Concrete	25 kN/m^2
Grade of steel	500

Seismic Design Data	
Soil Type	II (medium)
Response Reduction Factor	5
Importance Factor (I)	1
Damping	5 %
Earthquake for NLTHM	ELCENTRO Earthquake

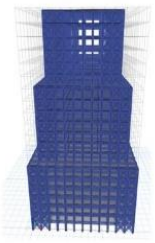
Model work



Simple model without bracing

V bracings at side

Diagonal bracings at side



X Bracings at side

V Bracings at Centre

Diagonal Bracings at Centre

X Bracings at Centre

V bracing at Centre + side

Diagonal bracing at Centre + Side

X bracing at Centre + side

OBJECTIVE & SCOPE OF WORK:-

Objective:-

Analyzing the Behavior of Steel Tubular structure System with different Braced Belt Truss configuration by checking parameter like,

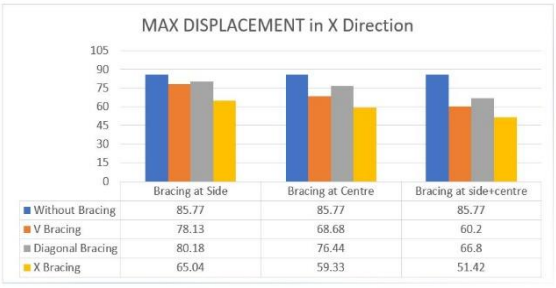
- Displacement
- Storey drift
- Storey Shear
- Method to be used is, Nonlinear Dynamic Analysis (Time History Analysis) is performed on the structure.

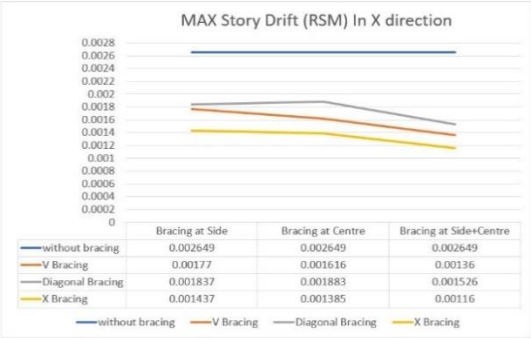
Scope of the Work:-

- To validate the model with reference.
- To prepare models of steel structure with Braced System.
- Perform Nonlinear Dynamic analysis on the structure.
- Comparison with provided elementary structural form.
- Representing the obtained result in the graphical form.
- Derive conclusion based on obtained results.

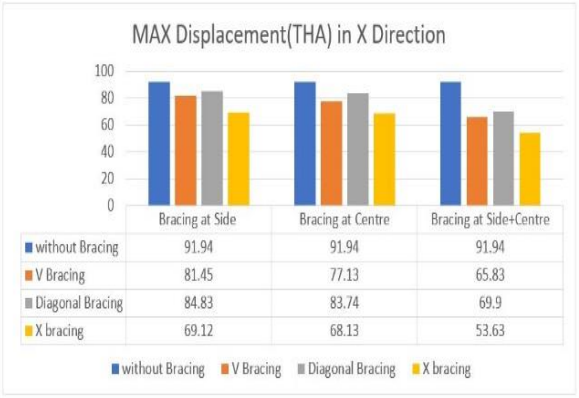
Result & Discussion:-

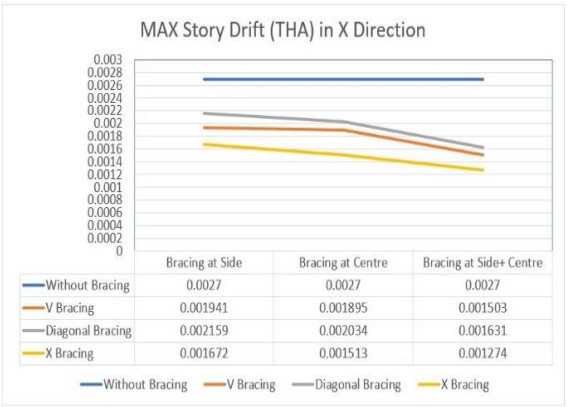
1. Response spectrum method

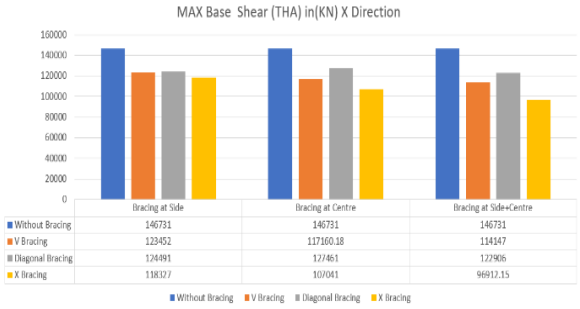




2. Time History Analysis







Conclusion:-

In this study the implementation of outrigger system provided at the side, center and both center & side of the building of the setback structure withthe varying position on structure is studied. The analysis was carried out by using ETABS 19 software, by implementing the response spectrum method and nonlinear dynamic analysis (time-history) method. And study the parameters like storey displacement, storey drift and base shear.

❑ **Result comparison with and without bracing:-**

- Inclusions of Bracing reduced the response of structure.
- Bracing systems are used to resist horizontal forces or lateral forces and to transmit to the foundation.
- Bracing minimises the displacement and provide Stability to the structure.
- Bracings gives batter results as compare to structure without bracings.
- Bracings decrease 10% response of structure as compare to without bracing.

❑ **Result comparison with deferent Bracings:-**

- In case of different type of bracings V, Diagonal and X bracing X Bracings gives better results.
- In the V and Diagonal Bracings gives more response to structure as compare to X bracings in both (x and y directions).
- Inclusion of bracing at only side and only centre of the structure reduced 10 to 15% response of the structure.
- Inclusion of bracings at centre pulse side on the structures can reduced 25% response of structure.

❑ **Result comparison by different Parameters:-**

- In correspond to the parameters like displacement, story drift and base shear X bracings gives batter results as compare.
- Implementation of X steel bracings at the center pulse side periphery of the building reduces the storey displacement and drift by 10 to 15 % as compared to other bracings.
- In correspond to base shear, on an average 10 % increases occurs in both directions.
- According to the model analysis in all model in x direction and y directions have minor change because of symmetrically setback structure so it is negligible so here y direction's figures not shown.

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References:-

[1] HuzefaSarangkhedawala, Rajesh Chaturvedi (2018), "Study on Seismic Response OF Multi storey RC Building with setback and Re-entrant corner irregularities", International Journal of Engineering Applied Sciences and Technology

[2]Fasil Neguse, Gashaw Tesfaye,(2017) "Aerodynamic Modification and Shape Optimization of Tall Buildings", University Of Gondar - IOT, CE

[3]Shiv Kumar Deshmukh, Nitesh Kushwaha, Firoja Alam& Shree Prakash,(2020)"Study on Residential Building of Constant Area and Different Shape Using ETABS", International Journal of Scientific Research in Civil Engineering.

[4]Akshatha Rathod, Shridevi. S. Angadi (2017), "Influence of Bracings on the Seismic Behavior of RC Framed Irregular Structures", International Research Journal of Engineering and Technology.

[5]Aswathy S Kumar, M.V.Varkey, (2019) "Non Linear Static Seismic Analysis of Vertically Irregular Building Frames With Different Outrigger System", International Research Journal of Engineering and Technology.

[6]Ms. Ameena M Ansary, Mr. M V Varkey, (2017) "Aerodynamic Modification and Shape Optimization of Tall Buildings", International Research Journal of Engineering and Technology.

[7]Firoja Alam, Shree Prakash,(2017)"Effect Of Setback On fundamental period of RC framed Buildings", International Journal of Engineering Sciences & Research Technology.

[8]Seema V, Mrs.B.R Shilpa,(2018) "Dynamic Analysis of Adjacent RCC Buildings for Pounding Effect", International Research Journal of Engineering and Technology

[9]HanSu Yin win, Kyaw Lin Htat,(2019) "Study on Effects of Opening Patterns in Shear wall on Setback building", International Journal of Science and Engineering Applications,

[10]ZaidMohammada, Abdul Baqi,(2017) "Seismic Response of RC Framed Buildings Resting on Hill Slopes", ELSEVIER.

[11]Prince Adani, Maulik Prajapati, Vasu Patel,(2018)"Seismic Analysis of Step back and Setback-StepbackBuildings",Parul University International Conference on Engineering & Technology.

[12]Jyotsna Joseph , Prof. N. P. Phadtare,(2017)"Seismic Analysis of Step back-Set back building on Sloping ground with Bracing systems "Imperial Journal of Interdisciplinary Research.

[13]J. Shaikh Sameer, S. B. Shinde,(2016)"Seismic Response of vertically irregular RC frame with mass Irregularity", International Journal of Civil Engineering and Technology.

[14]Mohiuddin Ahmed, Subrata Roy, Md. Hasan Imam,(2018) "Seismic Response of Setback RCC Buildings under Revised BNBC Code by Pushover Analysis" Journal of Mechanical and Civil Engineering

[15]Qudsia Bhavikatti ,Swapnil B. Cholekar,(2017) "Soil structure interaction effect for a building resting on sloping ground including in fill subjected to seismic analysis", international Research Journal of Engineering and Technology.

[16]Rahul Kumar, Shivanand,(2017)" Study of vertical irregularity of tall RC structure under lateral load", International Research Journal of Engineering and Technology

[17]S.Kusuma, CH.Rambabu,(2016)"Study on earthquake resistant buildings on ground surface by using ETABS", International Research Journal of Engineering and Technology.

[18]Nyein Nyein Thant, Tin Yadanar Kyaw,(2019) "Study on the Effect of Response Spectrum Analysis and Construction Sequence Analysis on Setback Steel Structure", International Journal of Trend in Scientific Research and Development.

[19]Mr Ashwin Hardiya, Mr Arpit Chawda,(2018)"Using time History Analysis of vertical Irregular Buildings using ETABS" International Journal of Engineering Sciences & Research Technology.

[20]Rahul Ghosh, Rama Debbarma,(2017)"Performance evaluation of setback buildings with open ground storey on plain and sloping ground under earthquake loadings and mitigation of failure".

- https://scholar.google.com/
- https://www.sciencedirect.com/