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ENHANCING SEISMIC PERFORMANCE THROUGH THE IMPLEMENTATION OF SHEAR WALL AT RE-ENTRANT CORNER IN BUILDING WITH PLAN IRREGULARITIES

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ABSTRACT:
This research is done to find the seismic performance of multistory building with asymmetrical plan. Now days L & T Shape Structure is widely seen in the city so at re-entrant corner maximum damage is occur during earthquake. So we are going to find the better solution for the re-entrant Corner providing shear wall at re-entrant corner in the buildings.
A G+10 L & T Shape building having plan Asymmetry is modeled in response spectrum analysis using ETABS. Comparable study is done between two Model 1st model in which we have not provided the shear wall at the corner and 2nd model we have provided the shear wall at the corner of the Buildings for two of the L & T shape building to find the best solution for it. Accidental torsional load is applied with reference to 1893(part-1) - 2016.
Keywords: Re entrant corner, shear wall, Response spectrum analysis, accidental torsional load, ETABS, etc.

1. INTRODUCTION

Earthquake Engineering is most important field in the structural engineering research field. Traditionally structures were analyzed for the gravity loading and designed accordingly. The destruction caused by earthquakes to such structures gave rise to a thought of designing such a structure that would safely withstand and resist earthquakes which are expected to occur during the design life time of the structure. Earthquake analysis utilizes the basics of the Structural dynamics. Several simplified methods are available to evaluate the seismic Performance of the building.
Indian code for seismic resistant design of buildings, IS 1893 (PART 1) classifies the whole of India into four seismic zones. The considered building models have been studied for all the seismic zones. There are two major problems associated with re - entrant corners. One is torsion and another is that they tend to produce differential motion between different wings of the building leading to local stress concentration at the re - entrant corner. Re - entrant corner arises in case of plans in H, I, T, L, C, U shapes.

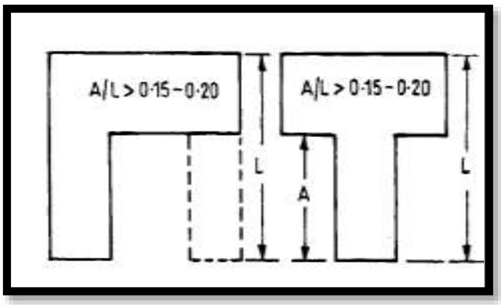

Figure 1 Examples of Building with Plan Irregularities

In figure 1 shows differential motion between different parts of building, resulting local stress concentration at the notch of the re-entrant corners.(Placeholder1)

2. LITERATURE REVIEW

Sachin G. Maske, Dr.P.S.Pajgade(2013) "Torsional Behavior of Asymmetrical Building" International Journal of Modern Engineering Research (IJMER), Vol.3 (2), 1146-1149:(Maske 2013)

This research paper has studied on the torsional behavior of multi-storey buildings with different structural irregularities. Such as plan irregularity and vertical irregularity. This paper represents a review about the investigation done on torsional behavior of multi-storey buildings with plan as well as vertical irregularities. It also focuses on codal provision made for torsion. This paper concludes that torsion is the most critical factor leading to major damage or completes collapse of building; therefore it is necessary that symmetric buildings should also be analyzed for torsion. While designing the building design eccentricity and accidental eccentricity should be considered. It was observed that the irregular profile buildings got larger forces and displacement as compared to symmetrical buildings.

Suryawanshi, et al. (2014) "Torsional Behaviour of Asymmetrical Buildings in Plan under Seismic Forces"International Journal of Emerging Engineering Research and Technology, Vol.2 (4), PP 170-176 :

This research paper has studied on the torsional behavior of asymmetric building subjected to ground motion using Response Spectrum method .Then he used the non-linear push over analysis has been used to find the structural description. In this paper the gravity load analysis & lateral load analysis as per the seismic code IS 1893(part-1):2002 is carried out for three building one is symmetric and other two are asymmetric in plan for variation in building height. Determining the torsional moment, Base shear, displacement & time period by Response spectrum method & there capacity & demand is equivalent using non-linear push over analysis.

This paper concludes that time period and base shear calculation by using equivalent static method is approximately equal with response spectrum method in SAP. It also concluded that torsional moment is more in the asymmetry building so beam and column are necessary to design considering torsional moment. The base shear and roof displacement of asymmetry building is more than symmetrical building. By using push over analysis performance of symmetrical building is better than asymmetrical building.

Wakchaure, et al. (2013) "Effect Of Torsion Consideration In Analysis Of Multi Storey Frame"", International Journal of Engineering Research and Applications, Vol.3(4), 1828-1832:(wakchaure 2013)

This research paper has studied on the influence of the torsion effects on the behavior of structure is done. In this paper two building are considered one is without considering torsion and other is considering the torsion. The building is analyzed and design using method and as per IS1893 (part1):2002.the result are compared in terms % Act in column. This paper concluded that In the asymmetric building second building, that is without considering torsion, it was observed that the area of steel in the beams at critical stage are much smaller than those obtained in the case of first building, that is with considering torsion. The bottom bars should be more critical, because they seem to be subjected to more tension than the top bars therefore torsional behavior of asymmetric building is one of the most frequent source of structural damage and failure during strong ground motions. He also concluded that the torsion is the most critical factor causes damage in building, so the irregular buildings are analyzed for torsion.

Bensalah, et al. (2012) "Assessment of The Torsion Effect In Asymmetric Buildings Under Seismic Load"15 WCEE, LISBOA: (bensalah 2012)

Has presented the influences of torsional effect on the behavior of the structure. In this paper two buildings are considered one symmetrical and other un-symmetrical building in terms of rigidity. Some parameters such as displacement, ductility, reduction factor and dynamic non accidental eccentricity are focused in this paper. This paper concludes that lateral yielding strength in terms of capacity of asymmetric structure is higher than symmetrical structure. The ductility increases with increasing input motion (Arias intensity) and decrease with increasing predominant period with significant variation in asymmetrical structure than those symmetrical structures. The reduction factor decreases when the dominant period of the earthquake increases. Unlike the reduction factor increase with decreasing input motions.

Nehe P. Modakwar and Sangita S. Meshram:

Have tried to understand different irregularity and torsional response due to plan and vertical irregularity and to analyze cross shape and L shape building while earthquake forces and to calculate additional shear due to torsion in the columns. It was found that the Re-entrant corner columns are needed to be stiffened for shear force in the horizontal direction perpendicular to it as significant variation is seen in these forces. Significant variation in moments, especially for the higher floors about axis parallel to earthquake direction, care is needed in design of members near re-entrant corners. From the torsion point of view the re-entrant corner columns must be strengthen at lower floor levels and top two floor levels and from the analysis it is observed that behavior of torsion is same for all zones.

3. OBJECTIVE OF PRESENT STUDY

The objective of this study is to investigate and propose a solution for enhancing the seismic performance of buildings with re-entrant corner irregularities through the implementation of -

- **Model Creation:** create a Response spectrum analysis model using ETABS software to accurately represent a G+10 L & T-shaped building with plan asymmetry.
- **Comparative Study:** Create two models for comparison: a) Model 1: A representation of the building without shear walls at the re-entrant corner. b) Model 2: Incorporation of shear walls at the re-entrant corner.
- **Seismic Performance Assessment**: Apply an accidental torsional load to both models, following the guidelines outlined in 1893(part-1)-2016.
- **Analysis and Comparison:** determine and analyze the response of the two models in terms of: a) Structural displacement and drift b) Story shear forces c) Modal frequency.

4. ANALYSIS OF T & L SHAPE OF BUILDING

General

Building is situated in Srinagar. There are two Re-entrant configuration of Building has been taken T & L shape of 10 Storey. At corner we have provide the shear wall to reduce the stresses at the corner side of the structure.

Building Configuration

In this research, it is assumed that the structure under consideration is a residential building with a design for importance factor 1.0 Building dimension in plane for T & L shape is 106m x 60m. & base to plinth height is taken as 3m, Plinth to ground floor height is 3m, & height of typical floor as 3 m.

NO of Models has been prepared for the studying the Results

1. T shape With SW at the Corners of 10 storey.
2. T shape Without SW at the Corners of 10 storey.
3. L shape with SW at the Corners of 10 storey.
4. L shape without SW at the Corners of 10 storey.

Load combinations:

Following primary load cases are considered for design of building.

1. Dead Load(DL)
2. Live Load(LL)
3. Floor Finish
4. Wall load

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5. Static Earthquake Load along X direction (EL-x)
6. Static Earthquake Load along Y direction (EL-y)
7. Dynamic Earthquake Load along X direction (RSA-x)
8. Dynamic Earthquake Load along Y direction (RSA-y)

Along with the above cases, following load combination are considered for design of structural elements as per IS 1893:2016 and IS 456:2000.

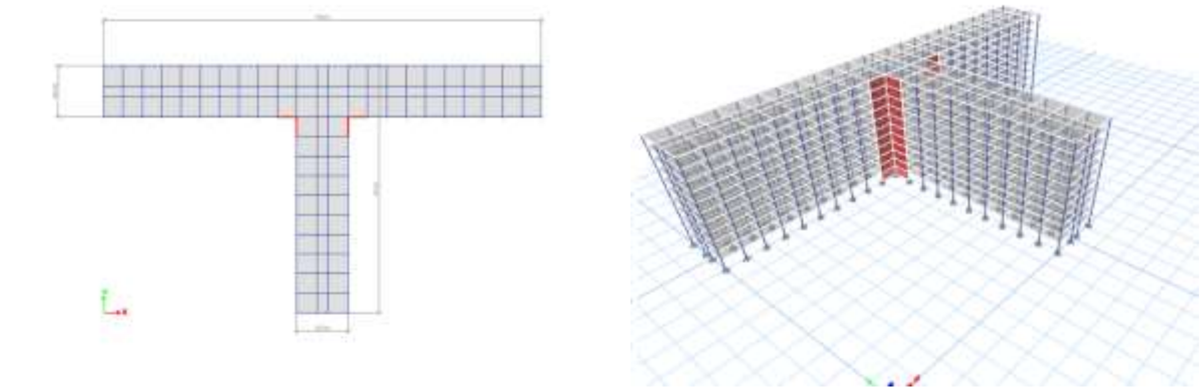

Fig 2. T Shape with SW

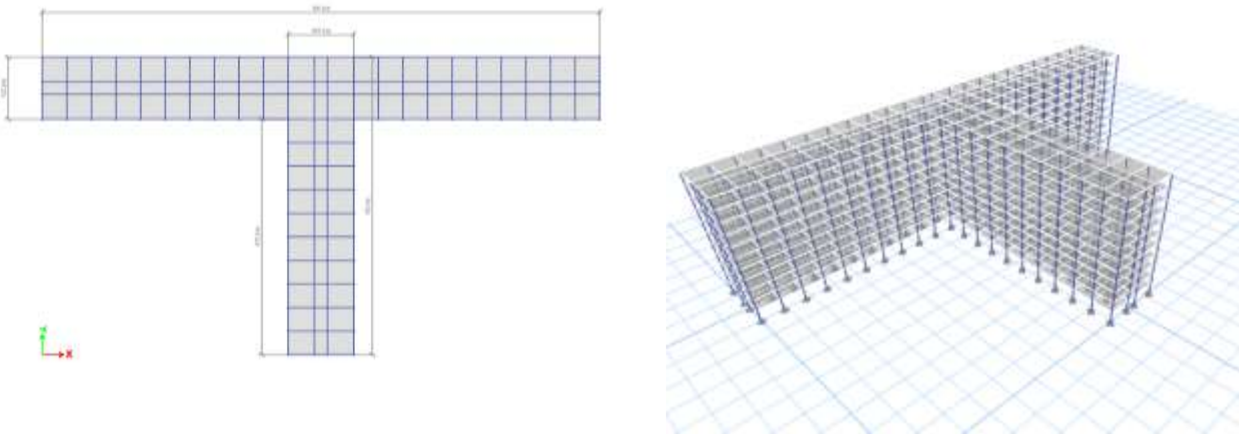

Fig 3.-T Shape without SW

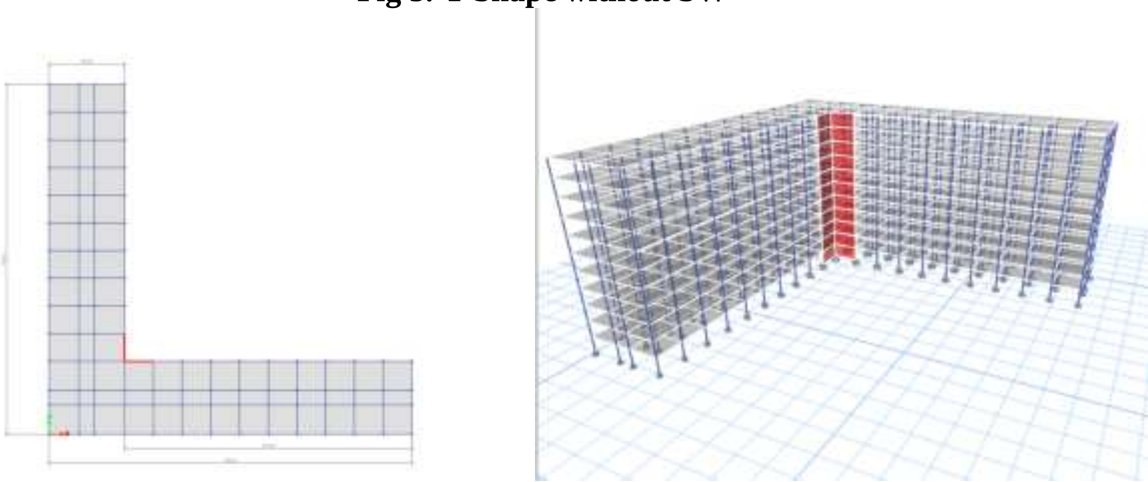

Fig. 4. L SHAPE WITH SW

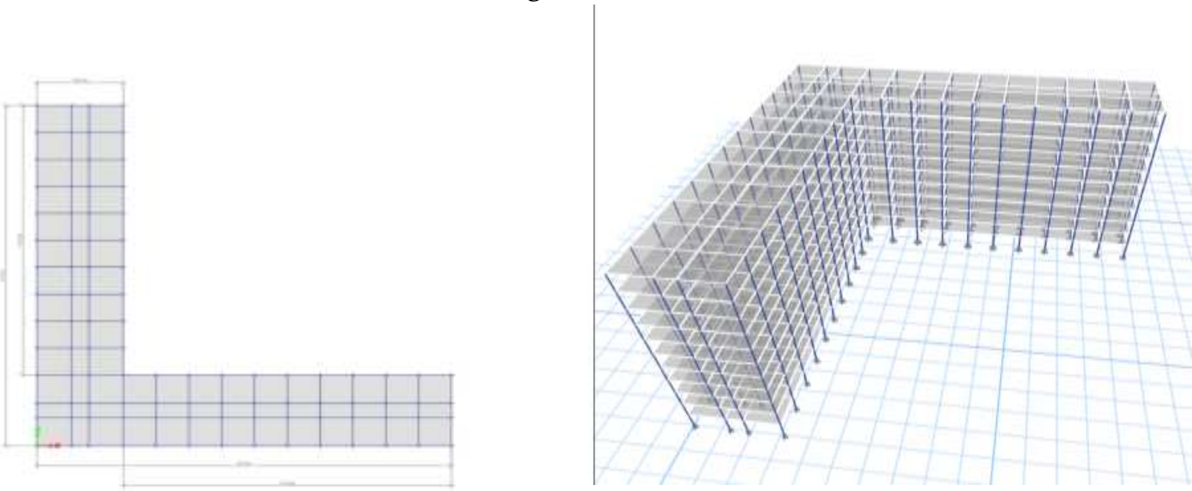

Fig.5. L SHAPE WITHOUT SW

5. Building design

Building is design and response spectrum analysis is carried out using computer program Etabs. For finding the torsion irregularities Member size of the 10 storey building, after analysis and design are as below:

Details of Modeling:

Model 1 with shear wall at corner & model 2 without shear wall at corner

Concrete grade for beam & slab M25
Concrete grade for column & shear wall M30
Rebar grade HYSD 550
Beam size 450 x 200
Column size 400 x 400
Slab thickness 150mm
Shear wall thickness 150mm
Ex.wall thickness 200mm
In.wall thickness 100mm
Parapet wall thickness 150mm
Storey G+10
Storey height 3m
Zone V
Zone factor 0.36
Important factor 1
Response reduction factor[smrf] 5
Live load 5kn/m^2
Floor finish 2kn/m^2
External wall load 10.8kn/m
Internal wall load 5.4 kn/m
Parapet wall load 2.43kn/m
Corridor load 3kn/m^2
Joint support- fix support

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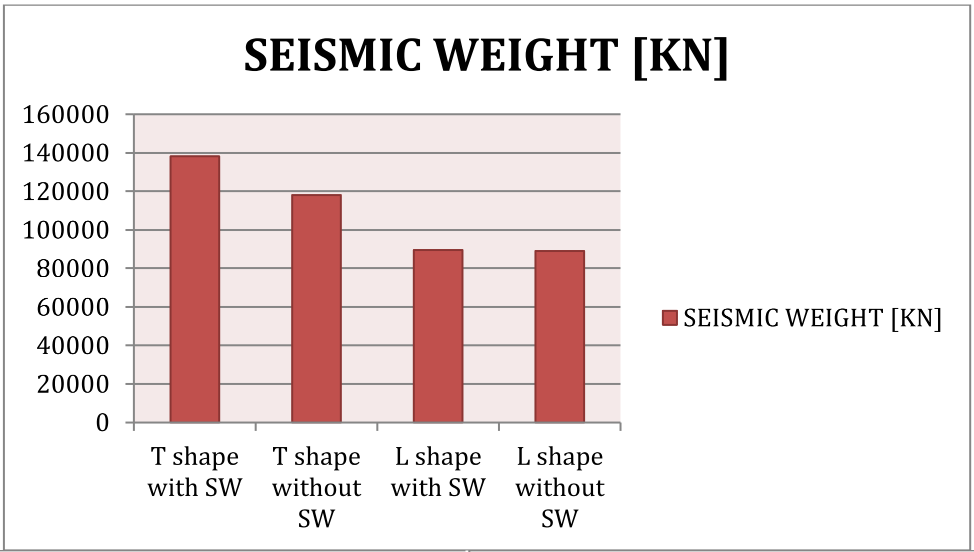
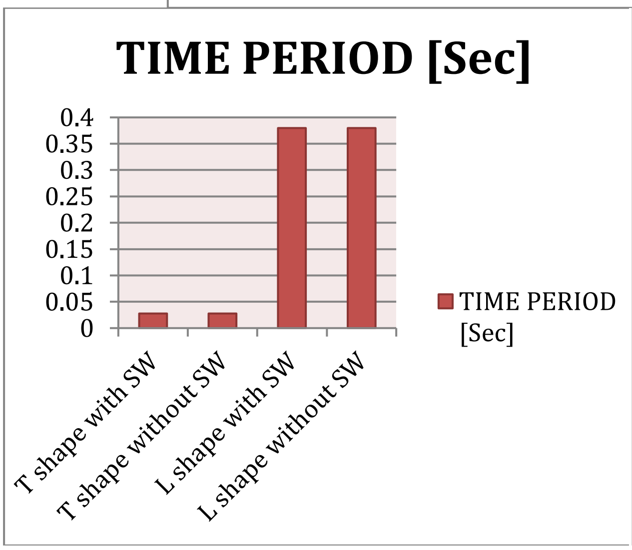
6.RESULT AND DISCUSSION

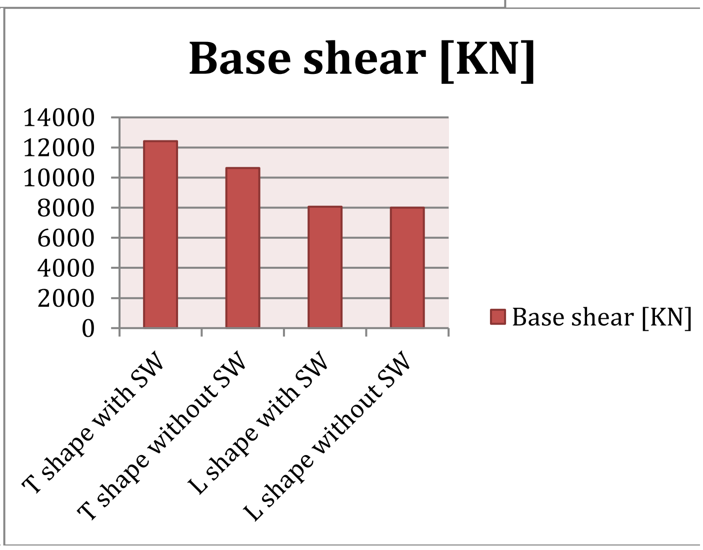
Result and Discussion of L and T shape 10 Storey Buildings

T & L Shape Building

By using software ETABS Response Spectrum Method	Seismic weight (KN)	Time Period(Sec)	Base Shear(KN)
T Shape With SW at Corner	138129	0.028	12431
T Shape Without SW at Corner	118151	0.028	10633
L Shape with SW at Corners	89541	0.38	8058
L Shape without SW at corner	89001	0.38	8010







L & T SHAPE BUILDING DEFLECTION

By using software ETABS Response spectrum method	Max storey displacement[RSAx]	Max storey displacement[RSAy]
T Shape With SW at corner	526mm	603mm
T Shape Without SW at corner	679mm	723mm
L Shape with SW at corner	651mm	651mm

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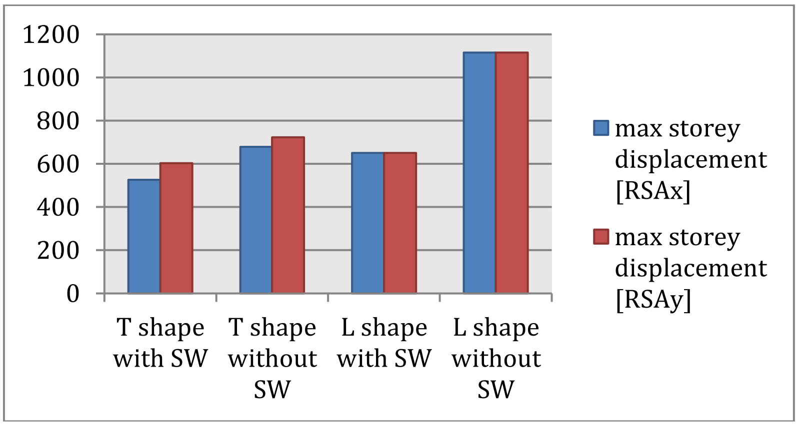
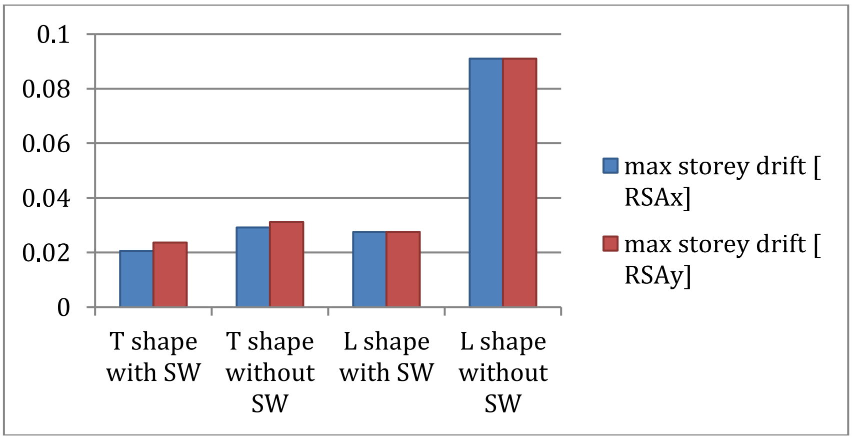
L Shape without SW at corner	1115mm	1115mm



T & L SHAPE MAX STOREY DRIFT

By using software ETABS Response Spectrum Method	**Max Story Drift (RSAx)**	**Max Story Drift (RSAy)**
T Shape With SW at Corner	0.020653	0.023732
T Shape Without SW at Corner	0.029133	0.031132
L Shape with SW at corner	0.027596	0.027596
L Shape without SW at corner	0.091091	0.091091



7. Discussion:

1. The displacement & Stresses of the structure reduced drastically when we have provided the shear wall at the corner.
2. The drift of the structure reduced drastically when we provided the shear wall at the corner.
3. The T shape & L shape both of the structure shows the Good response by providing the shear wall at the corner.
4. We have analysis G+10 building to see the difference of the response of the structure.

5. Building with the reentrant corner will be lead to the failure of the structure & more damage is seen in that case.
6. The torsional moments of the building has been reduced in the when we have provided the shear wall at the corner.

8. CONCLUSION:-

In this research modeling of multistoried building with plan irregularity is done.

In accordance with IS1893-2016 for simulation purpose response spectrum analysis ETABS is used following conclusions are formed after studying T-shape and L-shape Building with Providing the Architectural Relief in form of Shear Wall at the Corner of the Building.

1. Providing the Shear Wall at the Corner decreases the relative displacement & stress at re-entrant corners.
2. Architectural Relief is given for T-Shape & L-Shape building relatively considerable decrease in displacement and also decrease in stresses at re-entrant corners.
3. A T-shape building with shear wall and without shear wall at corner is analyzed and it is observed that nodal displacement and stresses reduced at re-entrant corners.
4. In T- shape& L-Shape building shear wall must be provided at re-entrant corners.
5. There is reduced in drift of the building when we have provided the shear wall at the corner of the buildings.
6. Architectural Relief is the better solution on the re-entrant corner on which maximum earthquake damage is done.
7. The torsional moment is reduced in when we have provided the Shear wall at the corner of the Building.
8. We analyzed the G+10 building and found the same response and the reentrant corner will more damage in earthquake.
9. In G+10 by providing the shear wall at the corner the best architectural relief.
10. We can finally conclude that providing the shear wall at the corner is the better solution of the reentrant corner and we have seen this thing in G + 10 of the case of the building.

9. Future Scope:

Some possible areas of future scope include:

•Experimental Validation:

While this study may include some experimental validation, further research can be conducted to validate the effectiveness of corner shear walls through extensive physical testing. This can provide more comprehensive and realistic data to validate the seismic performance improvement achieved through corner shear walls.

• Advanced Analytical Methods:

Future research can explore the use of advanced analytical method. These methods can provide more detailed information on structural response, stress distribution, and dynamic interactions, allowing for a more accurate assessment of seismic performance.

•Optimization Techniques:

Optimization techniques can be employed to determine the optimal design parameters and configurations for corner shear walls in buildings with re-entrant corners. This can involve exploring different wall heights, locations, and reinforcement patterns to maximize the effectiveness of corner shear walls in reducing structural vulnerabilities and enhancing seismic resilience.

•Performance-Based Design:

The topic of performance-based design can be explored further, focusing on buildings with re-

entrant corners. This can lead to more targeted and effective design strategies for architects and engineers working on projects with re-entrant corner irregularities.
By exploring these future research directions, the understanding of re-entrant corner irregularities and the efficacy of corner shear walls can be further enhanced, leading to improved design practices, retrofitting strategies, and seismic resilience in buildings with re-entrant corners.

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