# Seismic Analysis of Unsymmetrical Super Structure Using E- tabs for g+11 Building

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***ABSTRACT-****The project provide with static response of Reinforced Cement Concrete (RCC) building under seismic load with unsymmetrical building. Literature survey was carried out to study the seismic behavior of the structures and all the papers gave more information on how the super-structure responds to direct external seismic load., The structure under seismic load and in addition to that mass irregularity was profoundly found in the industrial buildings. Although, in previous studies it was found the analysis on other different irregularities, in residential buildings, so our main focus was mass irregularity and unsymmetrical of the industrial building. The industrial building that was chosen also had vertical irregularity at the first floor, which will enhance the problems and defects at that point. The study was mainly focused and concerned with seismic analysis and hence huge market is available in earthquake prone areas, to save the life.*

## 1. Introduction

Earthquake is a naturally occurring seismic activity. Seismic waves are caused by the release of energy in the crust. In an earthquake, structural failure starts from weak points. It is important to assess the impact of irregularities in structures during an earthquake. The structures can be regular or irregular frames as per design. The irregular structures are susceptible to more damage than regular structures. We have various irregular frames such as mass and vertical irregularities. Our project deals with mass irregularities which are found to be predominant in industrial structures. Mass irregularity is when the weight of any layer is more than 200% of the adjacent layer. For the modelling and analysis purpose, we have used the ETABS.

Earthquakes of severe intensity happen rarely. It is observed that technically conceivable methodologies to build the structures as per the design but outputs have been really not cost effective and it is redundant to do this. Over the years the seismic design philosophy has created to resist for the severe earthquakes with minimum destruction possible, the design philosophy so obtained has been working through years. The objective of the seismic design for any building is to limit the damage of the structure to sustainable level to avoid damage. The structure was designed to have the ability to withstand small levels of earthquakes without serious damage., the structures could withstand moderate levels of any earthquake without significant damage to the industrial structure, having said that, the probability of some structural damage was affected, and the structure could withstand significant levels of ground motion without ultimate state of collapse, but still some of the structural damage were observed in addition nonstructural damage .

### 1.1) Introduction to the etabs software

In this report, we mainly focus on the load analysis of the G + 11 building. The structural analysis method that we will present in this report is done by software (ETABS).

ETABS is software created by Computer and Structural Inc (CSI), a seismic and structural engineering software company. The world's tallest building, Burj Khalifa, was also designed and analyzed in this software. We have chosen ETABS for the following advantages:

- User friendly interface,
- Conforms to Indian standard code
- Flexibility to solve any kind of problem,
- Accurate solution.

ETABS features a modern user interface, powerful visualization, analysis and design tools with advanced finite element and dynamic analysis capabilities. From modeling, analysis and design to visualization and verification of results, ETABS is the choice of professionals for the design of steel, concrete, wood, aluminum and cold-formed steel from low-rise buildings. and at elevations, sewers, petrochemical plants, tunnels, bridges, stakes and more.

## 2. Objectives and Methodology

The study identified the following specific objectives:

- To investigate the behavior of the structure when it is subjected to seismic loads.
- How to conduct seismic tests of buildings.
- Using ETAB Software, compare various analysis results of buildings in zones II, III, IV, and V.
- Determine the type of load acting on these structures.
- To learn how to use the E-tabs programme to understand seismic analysis techniques such as response spectrum analysis and how to apply them.
- The results are interpreted using various seismic zone factor values and their accompanying consequences.
- The study's main purpose is to use ETABS software to assess and design a G+11 building.
- To examine the construction in accordance with IS 1893:2000(part-I) earthquake resistant requirements.
- ETABS was used to create, build, and analyse a high-rise structure model.

- Buildings should be able to withstand large earthquakes without collapsing

2.1. Scope of work

- Studies commonly used to determine the scope to which seismic behavior changes of RC building models can be performed.
- Buildings constructed with RC framing are built first for gravity loads, then for seismic stresses.
- The number of structures has increased significantly. Therefore, the influence of lateral loads such as seismic pressure becomes more and more important, and it is faced by almost all designers.
- The research focuses on the influence of the factors of the seismic area in different regions, such as Zone II, Zone III, Zone IV and Zone V. These factors are considered when evaluating the seismic behavior of buildings.
- In general, ETABS software is used to run all key element modeling, analysis and design processes of any model.

## 2.1 Equilateral load method

The forces that drive this dynamic reaction are lateral in nature, and shear is the ruling factor. As a result, the inertia forces induced by the EQ can be characterised as equal static lateral forces as a practical method. This approach is applicable to structures that meet specified criteria.

Vibrations in the structure are caused by earthquake motion, resulting in inertia forces. As a result, a structure must be capable of securely transmitting the horizontal & vertical inertia forces created in the superstructure to the ground via the foundation. As a result, earthquake-resistant design for most ordinary structures necessitates ensuring that the structure has appropriate lateral load carrying capacity.

The seismic code will guide designers to safely design structures in accordance with their intended purpose.

1. Dynamic analysis

I. Response spectrum method

II. Time history method

2.3 Dynamic Analysis

For the following buildings, a dynamic analysis will be performed to determine the design seismic force and its distribution in different levels along the height of the building, as well as in various lateral load resisting elements.

I. Regular buildings

Those buildings over 40m high in zones 4 and 5, over 90m high in zones 2 and 3.

II. Irregular buildings

All frame buildings are over 12 meters high in zones IV and V, and over 40 meters in zones II and III. Dynamic analysis models of buildings with a typical configurations must fully model the anomalies that exist in the building configuration. TIME HISTORY METHOD or RESPONSE SPECTRUM METHOD can be used to perform dynamic analysis. In all cases, the design fundamental shear force VB shall be compared with the basic shear force Vb calculated according to the fundamental period Ta. All reactive quantities must be multiplied by VB/Vb when VB is less than VB. For the purpose of dynamic analysis of steel and reinforced concrete buildings, damping values of 2 and 5% of the critical limit can be used.

## 2.4 Time History Method

This method must be used on a suitable ground motion and must be carried out according to known dynamics principles. In this procedure, the mathematical model of the building receives accelerations derived from seismic records that indicate the expected earthquakes from the foundation of the structure.

2.5 Response Spectrum Method

In engineering, the term spectrum refers to a graph that summarizes the response of buildings over different time periods. For structures manufactured at the project site, this process is done using either the design spectrum described in the code or the site-specific design spectrum. For the dynamics of steel and reinforced concrete buildings, damping values of 2 and 5% of the critical value can be used. Inelastic response is expected in most buildings during large earthquakes, which means inelastic analysis is much suitable for design. However, although non-linear inelastic programs can be used, they are not used in common design practices for the following reasons:

1. Their proper application requires an understanding of their basic operations and philosophies.

2. The output is difficult to decode and is subject to standard design criteria.

3. The necessary calculations are very costly.

Accordingly, linear elastic processes based on response spectroscopy are commonly used in practice. Because it is easier to use, response spectrum analysis method is the preferred method.

TABLE-1:BUILDING CONFIGURATION

| STRUCTURE | CONCRETE |
|---|---|
| No.of story | G+11 |
| Height of structure above GL | 38.4m |
| Storey height | 3.2m |
| Grade of Concrete (fck) | M25, M30 |
| Grade of reinforcement steel | HYSD 500 |
| Column | 600*600MM |
| Beam | 300*600MM |
| Slab | 175MM |
| Plus shape | 300*600MM |
| L-shape | 300*600MM |
| T-shape | 300*600MM |
| Wall load | 14.6KN/m |
| Floor finish | 1.5 KN/m2 |
| Typical live load | 1.5 KN/m2 |
| Roof live load | 1 KN/m2 |
| Earth quake zone | Zone -2, Zone-3 ,Zone-4, Zone-5 |
| Typical of soil | Medium |

## 2. Modelling

The ETABS software was used to model the structure. For this proposal, an commercial building frame with UG+G+11 storeys of different shaped structure is choosen like plus shape, L-shape, T-shape. Figure 2 ,3 and 4 depicts a modelled frame of a G+11-story building. The building frame was designed using ETABS, and the materials were thought to have low characteristics while the seismic zone are ZONE II, ZONE III, ZONE IV , ZONE V. The soil type is consider to be medium. The zone factor are 0.1,.0.16,0.25,0.36. Importance factore will be 1, response reduction will be 3 for all different typed structure

### 3.1 DETAILS OF BUILDING:

#### 1. PLUS SHAPE

The details of a UG+G+11 building with 55m×55m plan area are as follows-

a. Type of structure- Commercial Building
b. Span along X- direction- 55m
c. Span along Y-direction- 55m

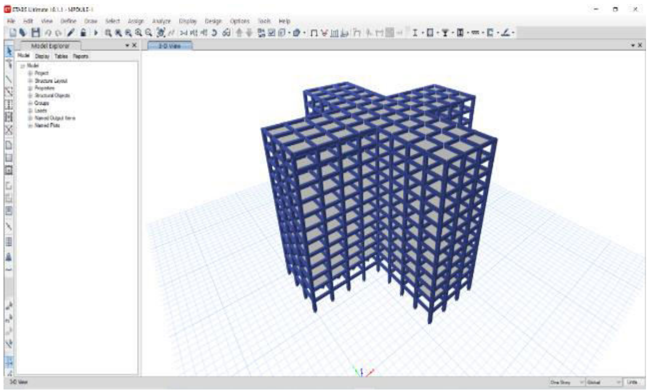

FIG 2: PLUS SHAPED STRUCTURE

#### 2. T-SHAPE:

The details of a UG+G+11 building with 50m×45m plan area are as follows-

a. Type of structure- Commercial Building
b. Span along X- direction- 50m
c. Span along Y-direction- 45m

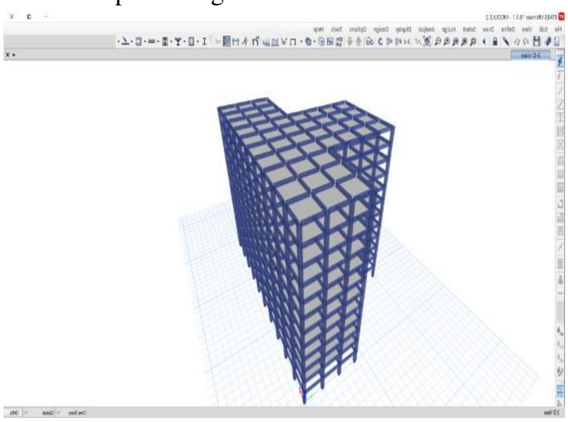

FIG 3: T-SHAPED STRUCTURE

### 3. L-SHAPE:

The details of a UG+G+11 building with 50m×45m plan area are as follows-

a. Type of structure- Commercial Building
b. Span along X- direction- 50m
c. Span along Y-direction- 45m

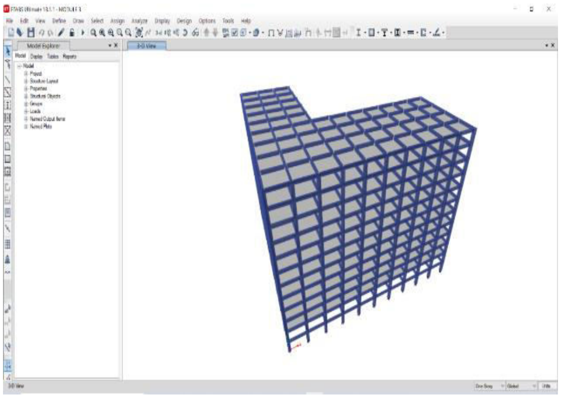

FIG 4 : L- SHAPED STRUCTURE

3.2 LOAD COMBINATIONS

I. 1.5(DL)+1.5(LL)
II. 1.5(DL)+1.5(EQX)
III. 1.5(DL)-1.5(EQX)
IV. 1.5(DL)+1.5(EQY)
V. 1.5(DL) -1.5(EQY)
VI. 1.2(DL)+1.2(LL)+1.2(EQX)
VII. 1.2(DL)+1.2(LL)+1.2(EQY)
VIII. 1.2(DL)+1.2(LL)-1.2(EQX)
IX. 1.2(DL)+1.2(LL)-1.2(EQY)

### 3.4 ASSUMPTIONS

- Wind load is assumed to be not acting.
- The structure is assumed to be isolated, with lateral and vertical forces acting.
- The masses are placed on slabs and separate columns act as springs, to reduce it to a mathematical model.
- The live load is assumed to be uniform throughout the slab.
- Mass irregularity is across a different set of columns.
- Deformation due to the structure is small and cannot change the original design of the structure.

## 4. RESULTS:

4.1) DISPLACEMENT

The maximum value of the displacement is tabulated by comparing the X and Y directions. Displacement values for different models can be obtained by considering the case showing the maximum displacement across the model response spectrum analysis.

4.2) BASE SHEAR

Foundation shear is a measure of the highest expected lateral force due to seismic motion at the bottom of the structure. Since the foundation shear value is proportional to the weight of the building, the load-bearing capacity of the traditional model is lower than that of other models. The calculation of soil shear force depends on the soil conditions in the area and its suitability for possible sources of seismic activity.

4.3) STORY DRIFT

Story drift is the relative displacement of one story to another.. The importance of story drift is in design of partitions and curtain wall. The story drift ratio as required by the code has to be checked under earthquake against the limit of 2.0%.

4.4) STORY SHEAR

The story shear graph shows how much lateral load there is on each floor, whether it is wind or earthquake. The lower you go, the greater the shear force.

**ZONE-2**

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 08 | Aug - 2021 ISSN: 2582-3930

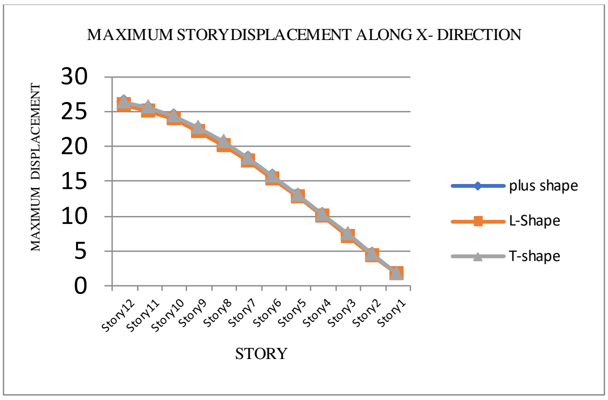


FIG:1 MAXIMUM STORY DISPLACEMENT ALONG X- DIRECTION

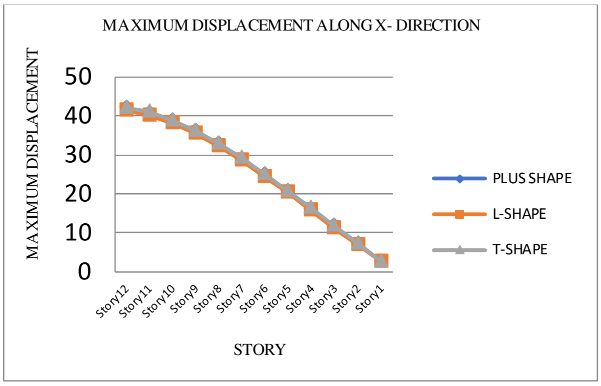


FIG:4 MAXIMUM STORY DISPLACEMENT ALONG X- DIRECTION

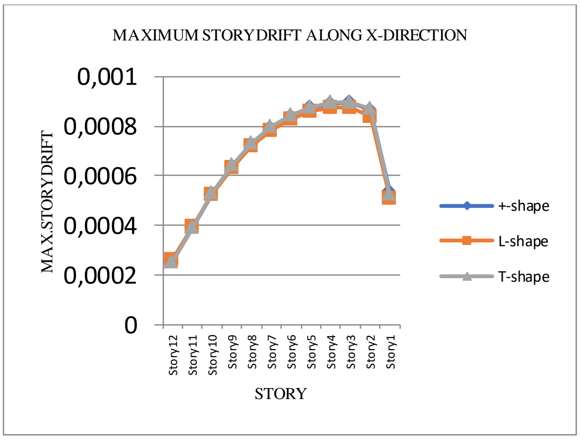


FIG 2: MAXIMUM STORY DRIFT ALONG X-DIRECTION

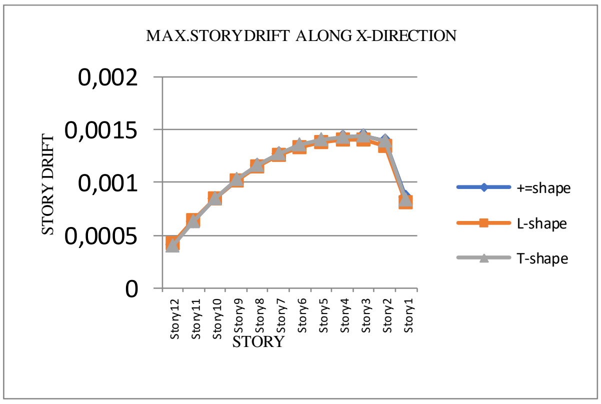


FIG 5: MAXIMUM STORY DRIFT ALONG X-DIRECTION

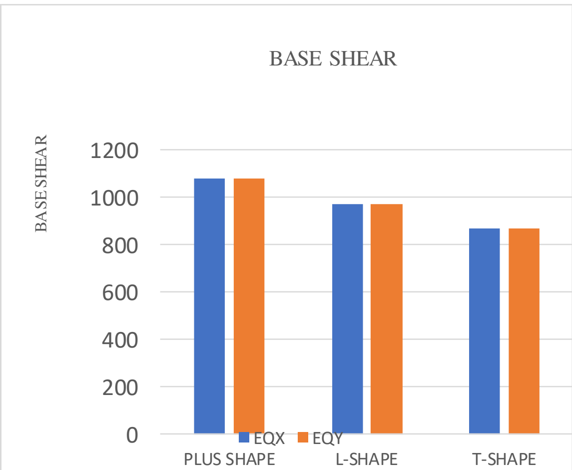


FIG 3: BASE SHEAR ALONG X-Y DIRECTION

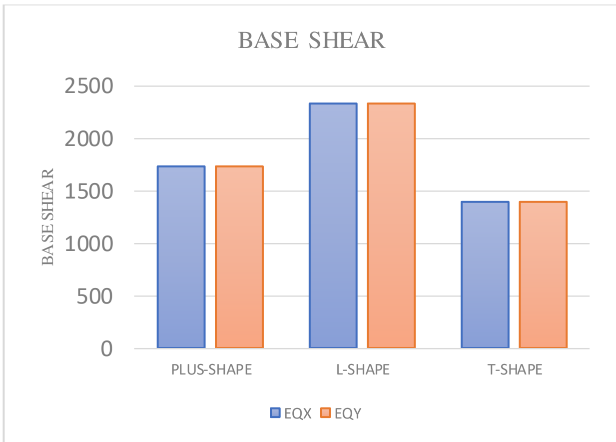


FIG 6: BASE SHEAR ALONG X-Y DIRECTION

**ZONE-3**

**ZONE-4**

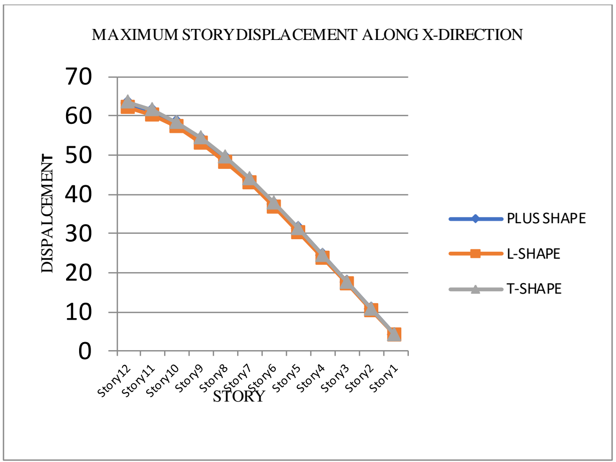


FIG:7 MAXIMUM STORY DISPLACEMENT ALONG X- DIRECTION

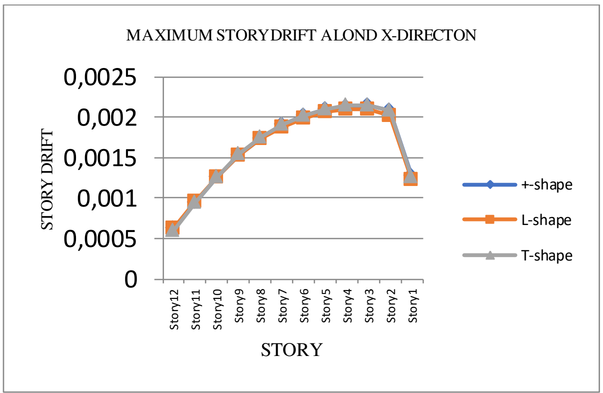


FIG 8: MAXIMUM STORY DRIFT ALONG X-DIRECTION

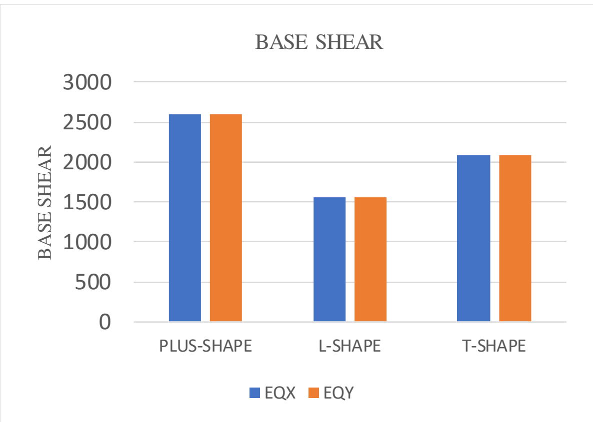


FIG 9: BASE SHEAR ALONG X-Y DIRECTION

**ZONE-5**

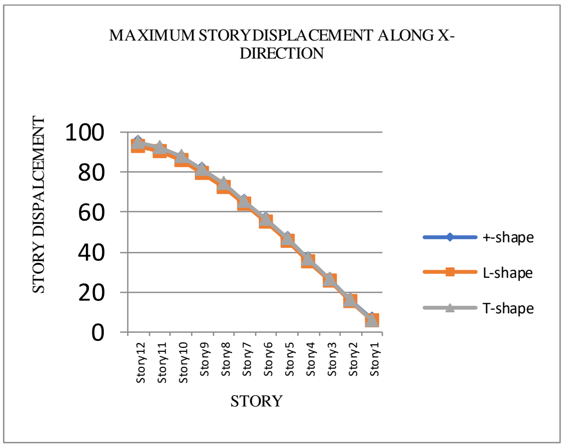


FIG:11 MAXIMUM STORY DISPLACEMENT ALONG X- DIRECTION

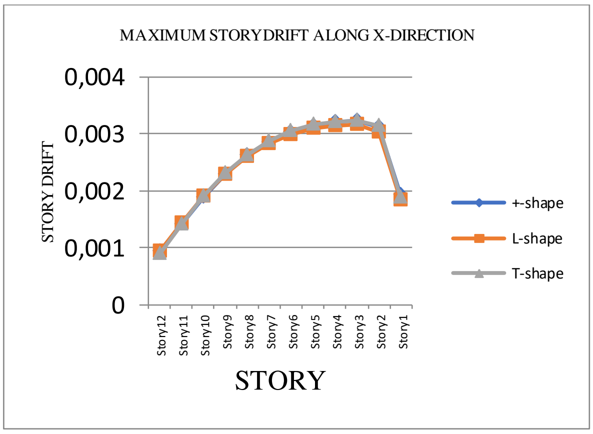


FIG 11: MAXIMUM STORY DRIFT ALONG X-DIRECTION

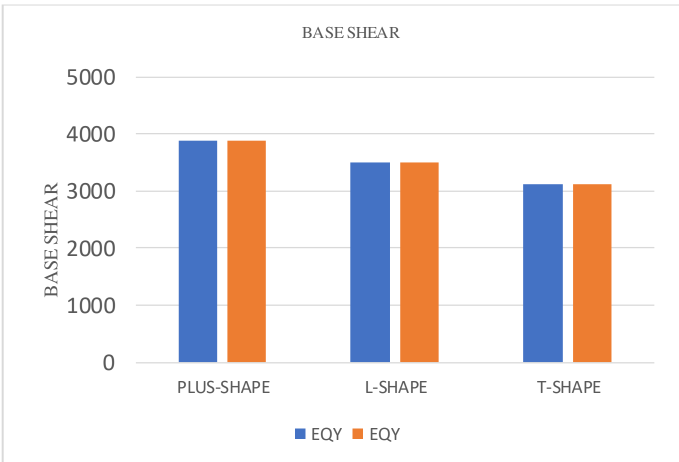

FIG 12: BASE SHEAR ALONG X-Y DIRECTION

## TIME HISTORY FUNCTION

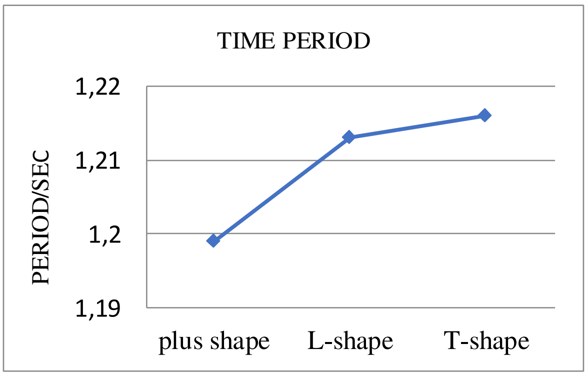


FIG:13 TIME HISTORY FUNCTION

## Conclusion

1. Use ETABS software for seismic analysis, and manually verify it according to IS 1893-2002.
2. ETABS can also be used for rough evaluation of structural seismic reliability.
3. This also shows that the behavior of a plane symmetrical building is different from that of a plane symmetrical building.
4. The entire Failed Beam List can be obtained, and the software also provides Best Section.
5. Details of each and every members can be obtaining using ETABS.
6 .To get detailed information about each member. The graphs of the models were compared with each other and the behaviors were studied, but no significant changes were observed, except for the increase in amplitude in different areas.
7. An asymmetric analysis of superstructures was carried out for all areas.
8. Regarding the load of the designed section, the reinforced structure is safe in zone 2 and zone 3, and unsafe in zone 4 and zone 5.
9. L-shaped fabric is safe in zone2 and zone3, and not safe for design section loading in zone4 and zone5.
10. The T-frame is safe in zone 2 and zone 3, and is not safe for design section loading in zone 4 and zone 5.
11. The response spectrum method can clearly understand the contribution of different modes of vibration.
12. The plane configuration of the structure has a significant impact on the seismic response of the structure in terms of displacement, floor displacement, and floor shear
13. The frequency of the "L" shape is the largest and the frequency of the plus sign is the most small.

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