

# Study on Shear Wall and Bracing in Irregular Structure and Regular Structure by Providing Expansion Joint

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**Abstract** - Earthquakes are caused generally by rupture of geological faults inside the earth, but also by other events such as volcanic movement, landslides, mine blasts, and atomic tests. Major causalities in the earthquakes around the world are due to the structural collapses. The major structures that collapse are mainly due to their irregularities horizontally and vertically. In these modern days, most of the structures are involved with architectural importance and with Irregular shapes. Hence, achieving ultimate performance even with a poor configuration by providing expansion joint and make it to good configuration.

In the present work, it is focused to study Behaviour of the Buildings with Plan Irregularities under Earthquake loads. frames with unsymmetrical plan configuration of L shape is taken and G+15 storey building is modelled in ETABS 2016 software with seismic zone V and Medium soil type, and that irregular structure to be converted to regular structure with the provision of expansion joint. Where three case to be considered one with Bare Frame Sections with and without Expansion Joint, Shear Wall Frame Sections with and without Expansion Joint and Shear Wall and Bracing Frame Sections with and without Expansion Joint these models are analysed under response spectrum method.

The comparison between the structure with and without Expansion joint was made for all three cases for base shear, storey drift, storey displacement, storey forces and storey stiffness.

**Key Words:** Earthquake loads, Shear wall, Storey displacement, Base shear, Storey displacement, Expansion joint, Storey stiffness and ETABS.

## 1. INTRODUCTION

Earthquake is a passage of different vibrations from ground. Earthquake is unpredictable and occurs irrespective of time and location and our country has experienced many earthquake resulting in severe damage to structure and loss of life. Hence the design engineers has to design the building in order to make it resistible for damages caused due to effects of seismic actions. These experiences have demonstrated the new developments in building up the resistance towards seismic actions and their execution must be proper to protect against seismic damages. Present days RC framed buildings have become the type of constructions

commonly seen. Generally, the purpose of structure is to transfer the primary gravity loads like dead load and live load safely. Depend on the terrain category the structure should withstand the lateral forces by earth quake and wind. The lateral loads produce sway moments and induce high stresses, thus reduces the stability of the structure. In order to resist lateral loads the structure stiffness is more important parameter than strength. Earthquake induces lateral forces which transfer through the beams and columns forming the lateral load resisting system of structure. The lateral load resisting systems that are widely used are rigid frame, shear wall, diagrid structural system, wall frame, braced tube system, outrigger system and tubular system. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous in many structural engineering applications. Lateral bracing systems are economical and also provides stiffness and stability to the structure.

### 1.1 Shear Walls

Shear walls are vertical members that resist seismic forces. The in-plane loads are resisted by providing shear wall along the height of the structure. Shear wall mainly experience the seismic and wind loads. Shear walls have high strength and stiffness to resist the lateral forces. Shear wall are very important in high rise buildings in the seismic prone areas. Shear wall can reduces the lateral displacements. These are designed to resist both self weight of the structure and lateral forces. Natural calamities force causes several kinds of stresses such as shear, tension, and etc., the structure may experience Storey displacement or may collapse suddenly. The failure of the structure and the lateral displacement of the structure are reduced by shear walls.

### 1.2 Bracings

Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. The lateral stiffness and capacity of frames under seismic performance increased by the provision of bracings.

Through the addition of the bracing system, load could be transferred out of the frame and into the braces, by passing the weak columns while increasing strength. Steel-braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel-bracing systems for retrofitting reinforced-concrete frames with inadequate lateral resistance is attractive.

### 1.3 Expansion Joints

Joints provided to accommodate the expansion of adjacent building parts on Building shapes L,T, etc, and others and relieve compressive stresses that may otherwise develop, Expansion joints essentially provide a space between the parts and may sometimes be provided with the load transmitting devices between the parts and generally filled with expansion joint filler which is compressible enough to accommodate the expansion of adjacent parts, and when pressure is released the filler having the ability to regain 75 percent of the original size. The rubber shock absorbing material with gap size provides economical and effective design that could reduce the impact force response.

### 1.4 Construction of Expansion Joint

The expansion joint is to be provided from the foundation to the top floor of the building. Required gap to be given according to the codal provision and The one side of the expansion joint is first constructed to desired level, and outer side are constructed after the sponge rubber sheet are placed at the place of expansion joint. The fiber board is sealed with sealing compounds. Thus the whole construction of the building is done.

## 2. OBJECTIVES

1. The analysis of a multi-storeyed RC building having G+15 Storey in high seismic zone.
2. To Model regular model with expansion joint and irregular building model in ETABS Software.
3. To analyse the regular and irregular building models by shear wall and bracings with Response Spectrum method in high seismic zone.
4. To compare the responses of regular with expansion joint and irregular configuration structures for base shear, storey drift, storey displacement and storey stiffness.
5. Study gap between adjacent buildings.
6. Find the suitable way to reduce the seismic effect on building.

## 3. MODELLING AND ANALYSIS

The modelling and the analysis of the structure is carried out using ETABS software. Response Spectrum Method is used for the analysis of structure.

### 3.1 Response Spectrum Method

Linear dynamic analysis popularly known as response spectrum analysis. The building is modelled as a multi degree of freedom system with a linear elastic stiffness matrix and an equivalent viscous damping matrix. Through eigen value analysis the natural frequencies and mode shapes are computed. The coupled equations of motion are then decoupled by modal transformation where in the principle of orthogonality of the mode shapes with respect to mass, damping and stiffness matrices is applied. Each decoupled equation signifies the motion of a single degree of freedom system for which the response is obtained through the use of elastic response spectra. Using appropriate modal combination rules the peak responses of the significant modes are combined. The linear dynamic procedure is superior to the linear static procedure because higher modes are considered in the linear dynamic procedure while only the first mode is considered in the linear static procedure. However, since both of these procedures are based on linear elastic response.

### 3.2 Building details and plan

- Number of stories = G+15
- C/C distance between columns in X-direction = 5m
- C/C distance between columns in Y-direction = 5m
- Foundation level to ground level = 3m
- Floor to floor height = 3m
- Expansion joint gap = 25 mm
- Sponge rubber = 25 mm
- Live load on all floors = 3 kN/m<sup>2</sup>
- Live Load on Roof = 2 kN/m<sup>2</sup>
- Floor Finish = 1.5 kN/m<sup>2</sup>
- Wall Load on beams = 11.5 kN/m<sup>2</sup>
- Parapet Load on Roof = 3 kN/m<sup>2</sup>
- Concrete = M25
- Steel = Fe 415 and Fe500
- Size of column = 550x550mm

- Size of beam = 230x500mm
- Shear Wall = 150mm
- Bracing = ISMB 150x150
- Depth of slab = 150mm
- Soil Type = Medium

- 2) Case 2- Shear Wall Frame Sections with and without Expansion Joint.
- 3) Case 3- Shear Wall and Bracing Frame Sections with and without Expansion Joint.

### 3.3 Plan and 3D Elevation of Model

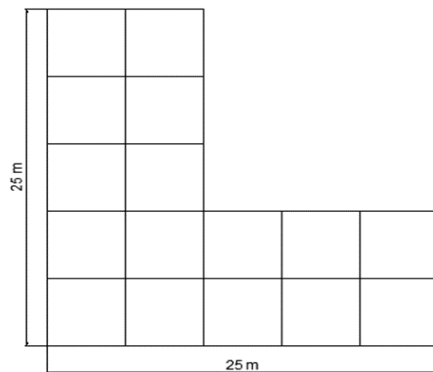


Fig 3.3.1: Plan without Expansion Joint

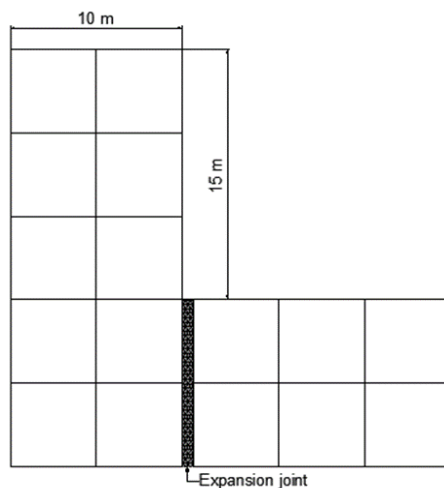


Fig 3.3.2: Plan with Expansion Joint

### 3.4 Models considered for Analysis

A total of three cases are considered for the analysis, and all the frame sections are analysed with the provision of expansion joint and without expansion joint.

- 1) Case 1- Bare Frame Sections with and without Expansion Joint.

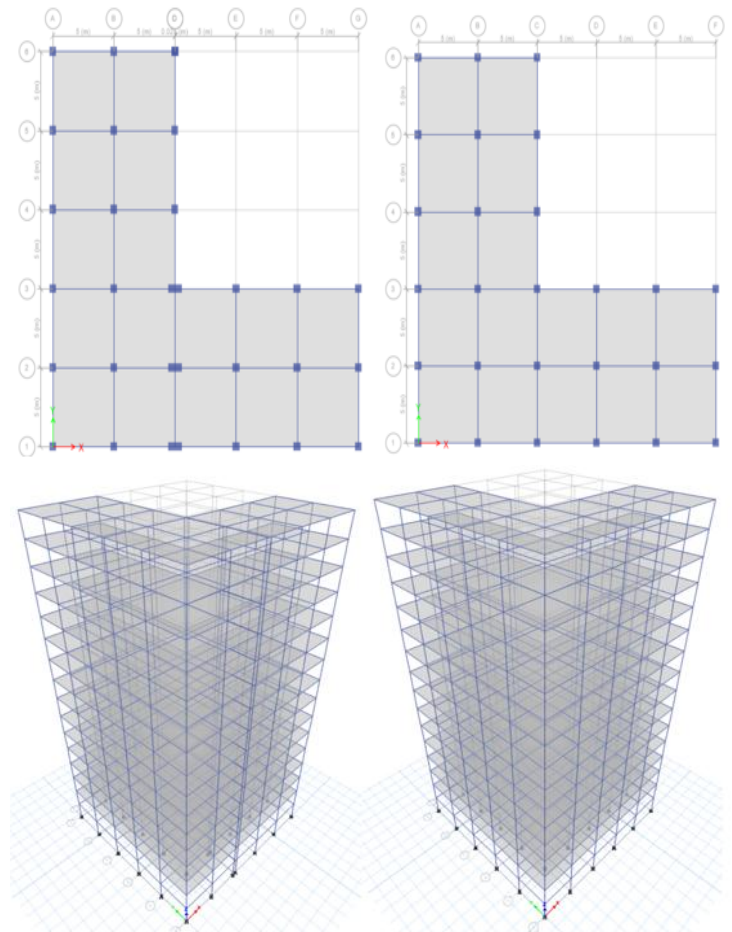
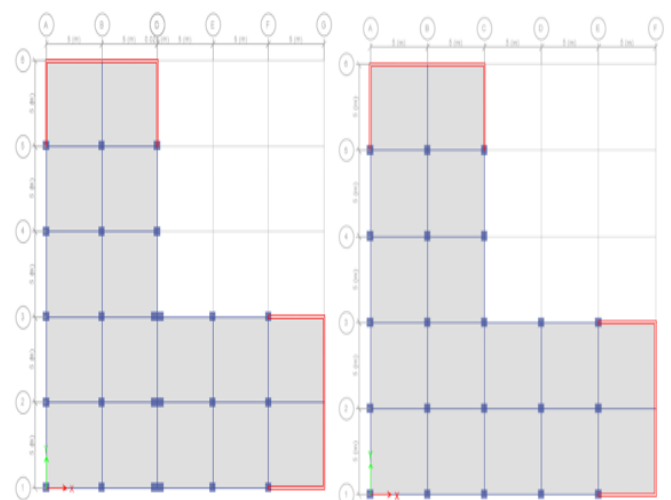


Fig 3.4.1: (Case 1) Plan and 3D model of Bare Frame Sections with and without Expansion Joint



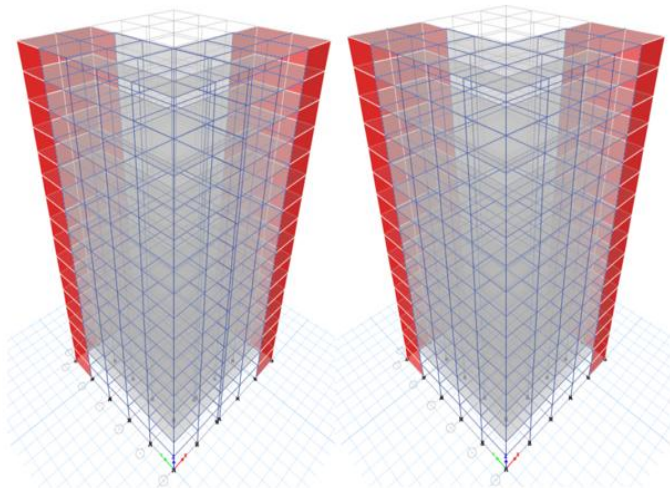


Fig 3.4.2: (Case 2) Plan and 3D model of Shear Wall Frame Sections with and without Expansion Joint

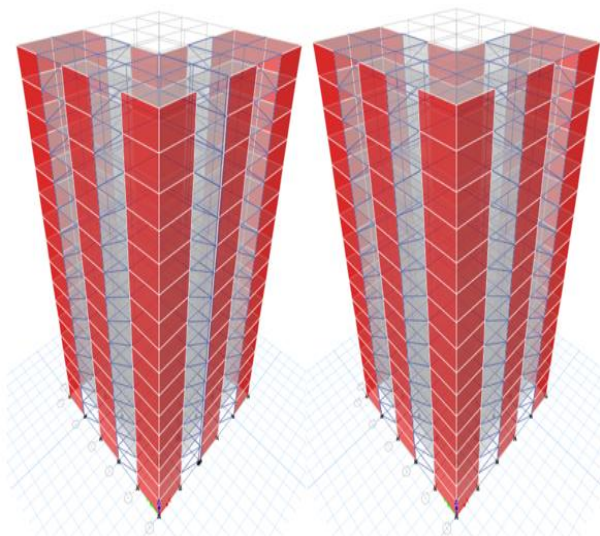
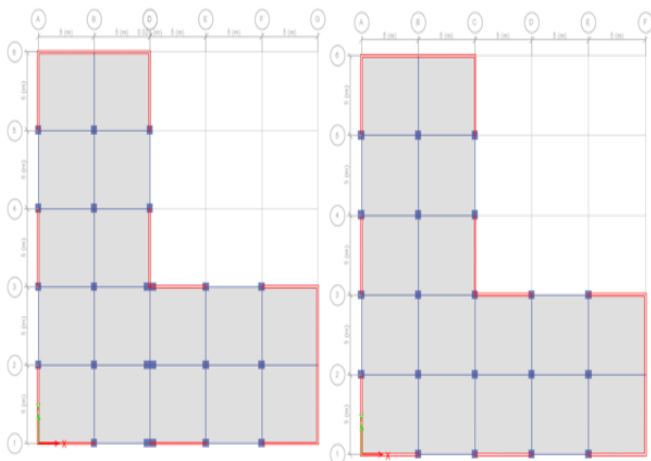
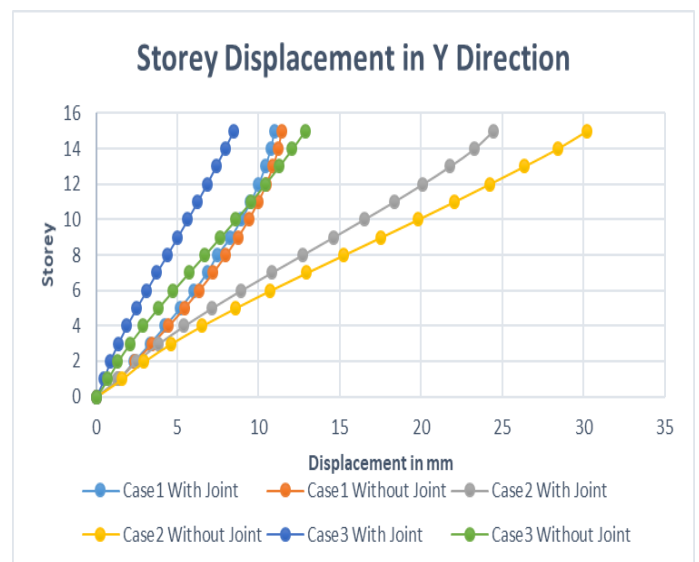


Fig 3.4.3: (Case 3) Plan and 3D model of Shear Wall and Bracing Frame Sections with and without Expansion Joint

#### 4. RESULTS AND DISCUSSION

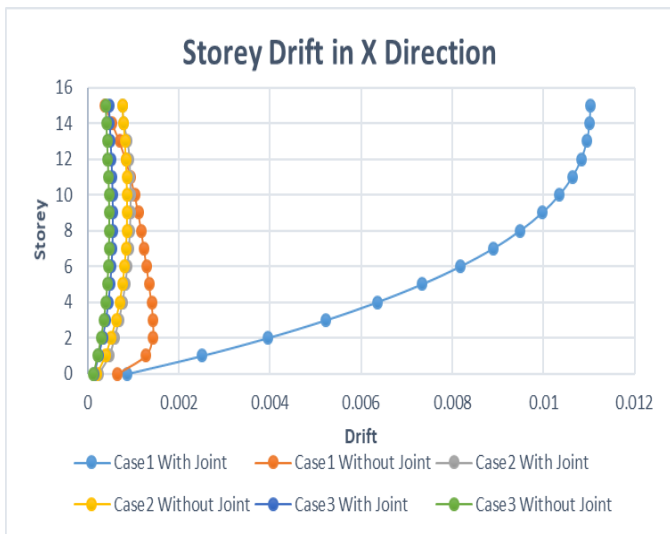
Discussions are made based on following parameters

1. Storey Displacement
2. Storey drift
3. Storey forces
4. Storey Stiffness
5. Base Shear

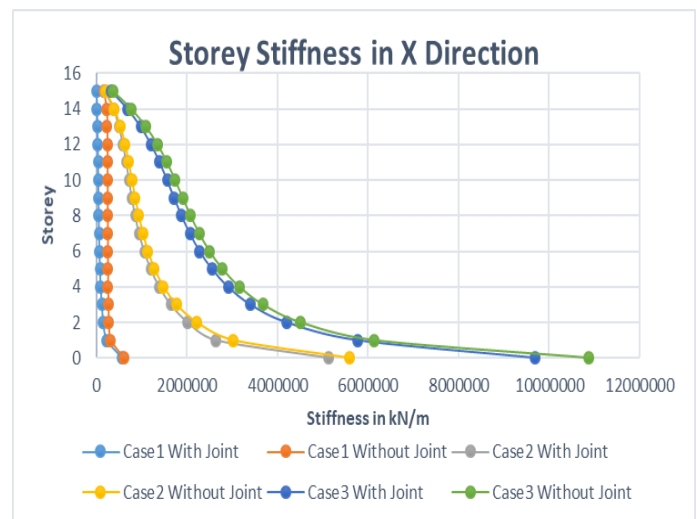
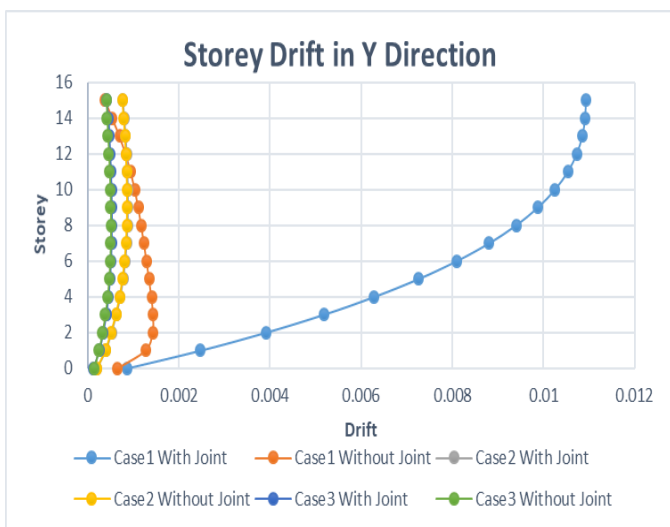


Graph 4.1: Storey Displacement in mm of all three cases with and without Expansion Joint in X and Y Direction

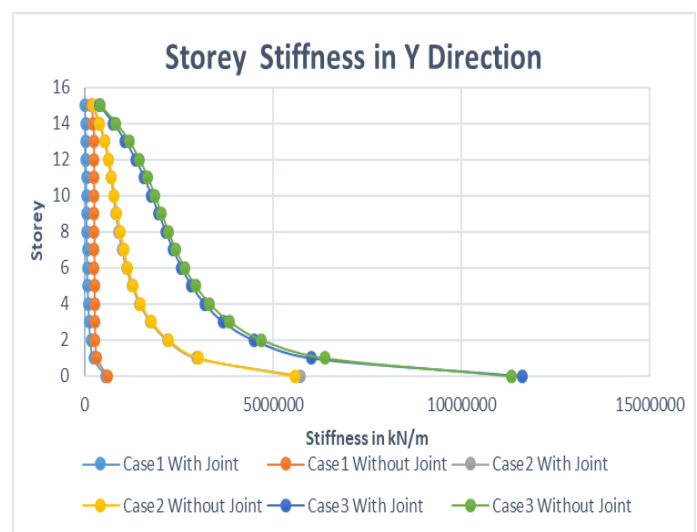




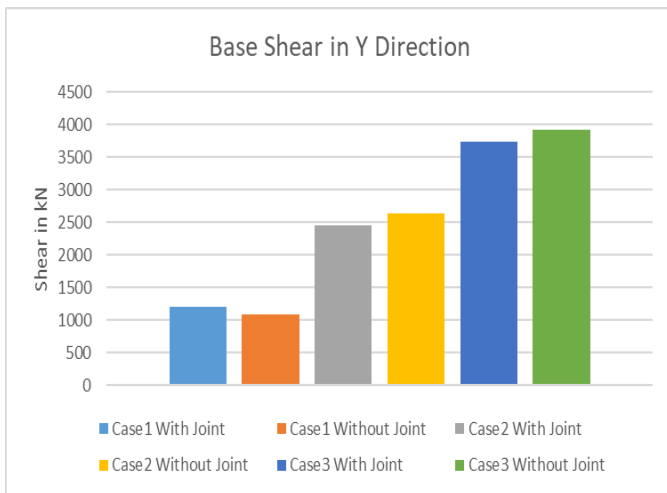
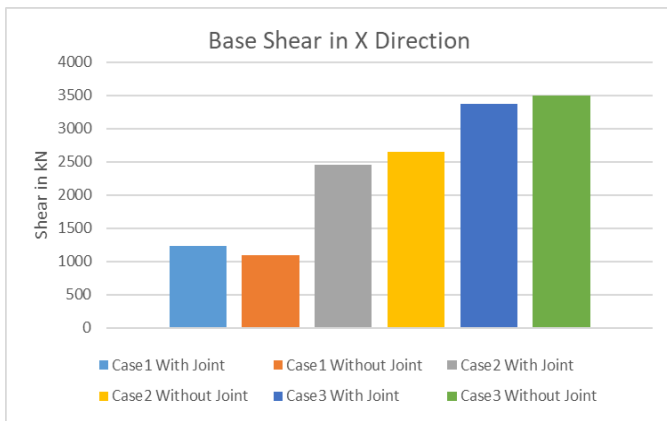
Graph 4.3: Storey Forces in kN of all three cases with and without Expansion Joint in X and Y Direction



Graph 4.2: Storey Drift of all three cases with and without Expansion Joint in X and Y Direction



Graph 4.4: Storey Stiffness in kN/m of all three cases with and without Expansion Joint in X and Y Direction



Graph 4.5: Base Shear in kN of all three cases with and without Expansion Joint in X and Y Direction

### 5. CONCLUSIONS

From the results of a structural model with bare frame, bare frame with shear wall and bare frame with shear wall and bracing is been compared with their respective models with expansion joint provided at the intersection and the buildings are made regular. Here, these models are subjected to seismic zone V, their corresponding behaviors and results are extracted and interpreted. Various parameters such as displacements, storey drifts, storey force, storey Stiffness, and base shear have been gathered. Hence from the obtained results the following conclusions are made,

- The storey displacement values of the bare frame 8% and 4%, bare frame with shear wall 30% and 19%, Frame section with shear wall plus bracings 59% and 34%, Reduced with the provision of expansion joint in comparison to models without expansion joint, along X and Y directions respectively.
- The storey drift values of models without expansion joint of bare frame, bare frame with shear wall and bare frame with shear wall plus bracing were found

to be having lesser values than that of the models with expansion joint.

- The storey force values of models with expansion joint were found to be having lesser values than that of the models without expansion joint.
- The storey stiffness values in the bare frame, bare frame with shear wall and bare frame with shear wall plus bracing with expansion joint was found to be slight lesser in comparison to that of their respective models without expansion joint.
- The base shear values in the bare frame with shear wall and bare frame with shear wall plus bracing with expansion joint was found to be less in comparison to that of their respective models without expansion joint.
- From the above study it is finally concluded that, the regular frame structure performs better than the irregular frame structure in plan.

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