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RESEARCH ARTICLE OPEN ACCESS

Seismic Analysis of Regular and Irregular Configuration of Building

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ABSTRACT
As India is the fastest growing country across the globe and in need of shelter with higher land cost in major cities where horizontal expansion is not much possible due to space shortage. Thus, we are left with the solution of vertical expansion.In India basic need of people is not only structurally robust and aesthetically pleasing building but also economical building. To design these building best technology and best material are required.The analysis and design procedure adopted for the evaluation of multi- storey building(G+6) is based on the STAAD Pro. Software. The properties of structural elements are then optimized for the worst load case after a comparative study of reinforcement and concrete requirement for different load cases.
Structural planning and design is an art and science of designing with economy andelegance, serviceable and durable structure. The entire process of structural planning and designing requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and byelaws backed up by example experience.The process of design commences with planning of structural primarily to meet thedefined as he is not aware of various implications involved in the process of planning and design. The functional requirements and aspects of aesthetics are locked into normally be the architect while the aspect of the safety, serviceability, durability and economy of the structure are attended by structural designer.

Keywords: Seismic Analysis, Regular Building, Irregular Building, STAADPro, Weak Storey, Seismic Load, Deflection, Stress, Bending Moment, Shear Force, Storey Drift, Joint Displacement.

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I. INTRODUCTION

Structure is subjected to earthquake seismic forces are developed during earthquake. Seismic forces develop the seismic waves these wavesproduce ground motions. Earthquake is the rapid movement of the earth surface. When the structure is subjected to ground motions during earthquake the vibrations are occurred the structure will be responds. When the ground motions occurred, it should affect the structure in three perpendicular directionsone is vertical direction (Z) and other two are off horizontal directions (X & Y). When the building structure is designed for considering only the vertical ground motions in general this design is not safe. This not satisfies the horizontal ground shaking. In generally the forces generated due to Horizontal ground motions of earth is taken as important for the design of the structures. Therefore, it is important that the structure is designed to resist the forces acting horizontally due to earthquake. The ground surface is displaced or move due to earthquake the structure base is also moves with it but roof has tendency to stay with its original position. Since the roofs and foundations are connected with the columns and walls. During the designing of the building according to the codes the lateral force is considered in two orthogonal horizontal directions of the structure. Buildings consisting of asymmetrical distribution of strength, stiffness and mass suffer severe damage during earthquakes. The varying geology at different locations in the country implies that the likelihood of damaging earthquakes taking place at different locations is different. A seismic zone map is required to identify these regions. Based on the levels of intensities sustained during damaging past earthquakes. The 1970 version of the zone map subdivided India into five zones – I, II, III, IV and V. The map has been revised again in 2002, and it now has only four seismic zones – II, III, IV and V.IS code Followed for Seismic calculation is IS:1893(Part 1):2016.

To investigate various seismic responses of regular and irregular structure. The comparison of various seismic parameters would allow us to propose the best suitable building configuration.

The salient objective of this research is comparison between regular and irregular frame on the basis of shear force, bending moment. Storey drift and node displacement.

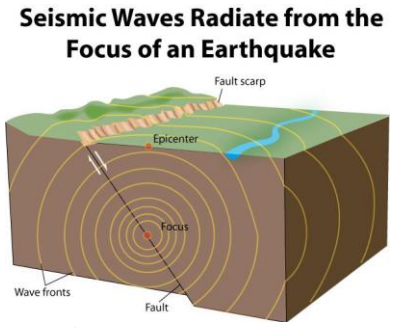

Figure: Seismic Waves

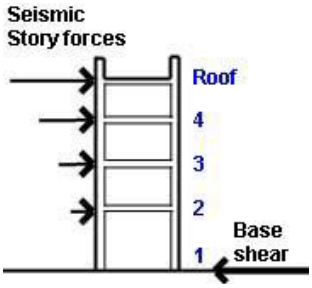

Figure: Seismic Story Forces

Regular And Irregular Configuration of Building

Regular satisfactory building configurations refers to simple and spatially balanced solution that can be easily encircled in seismic analysis.


Figure: Regular Building

Irregular configurations are difficult to predict, uneconomic and requires tough calculations.

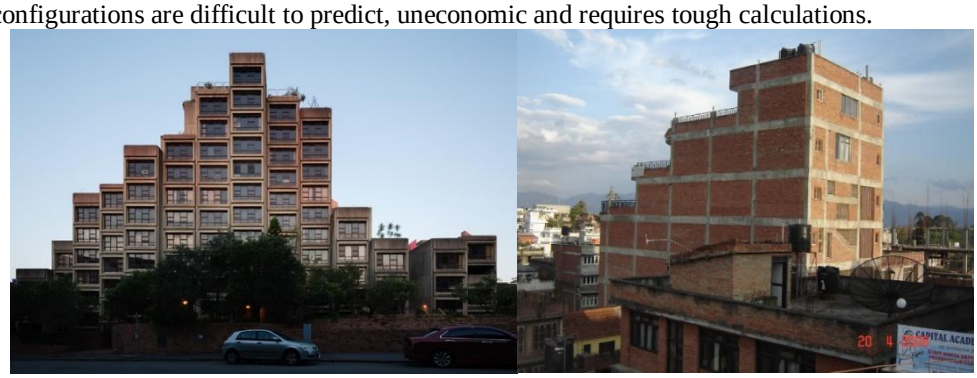
Figure: Irregular Building

Types ofirregularities:

The irregularities in the building structure may be due to irregular distributions in their mass, strength and stiffness along the height of building. There are two types of irregularities:

1. Plan Irregularities
2. Vertical Irregularities

Vertical irregularity of Structures

- Stiffness Irregularity (Soft Storey):

A soft storey is one in which the lateral stiffness is less than 70% of that in the storey above or less than 80% of the average of the stiffness of the three storeys above.

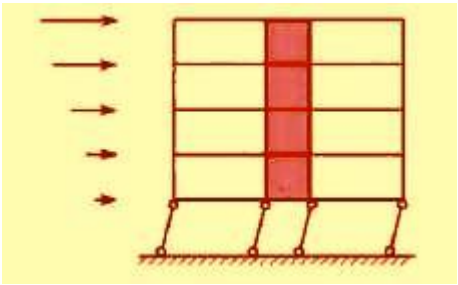

Figure:Soft Storey

- Mass Irregularity:

Mass irregularity shall be considered to exist where the effective mass of any storey is more than 150% of the effective mass of an adjacent storey. A roof which is lighter than the floor below needs to considered.

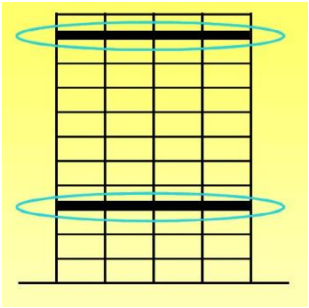

Figure: Mass Irregularity

- Vertical Geometric Irregularity:

Vertical geometric irregularity shall be considered to exist where horizontal dimension of the lateral force resisting system in any storey is more than 130% of that in an adjacent storey, one-storey penthouses need to be considered.

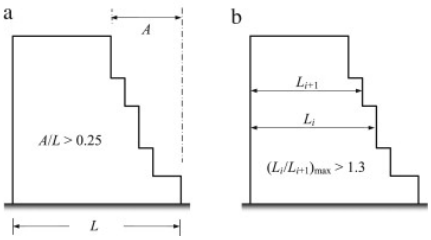

Figure:Vertical Geometric Irregularity

- In-Plan Discontinuity in Vertical Lateral Force-Resisting Element:

An in-plane offset of the lateral load resisting elements greater than the length those elements.

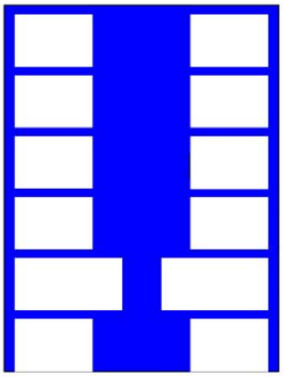

Figure: In-Plan Discontinuity

- Discontinuity in Capacity (Weak Storey):

A weak storey is one in which the storey strength is less than 80% of that in the storey above. the total strength is the total strength of all seismic resisting elements sharing the storey shear for the direction under consideration.

II. PROBLEM STATEMENT FOR RESEARCH

For Regular and Irregular Building:

- Plot Area = 24X24 m(Regular frame)
  = 40X24 m (Irregular frame)
- Story Height = 5 m
- Number of Story = 6
- Depth of Foundation = 2.5 m
- Column Size = 600X600 mm
- Beam Size = 600X400 mm
- Floor finishing load = 1 KN/m²
- Live load on floor = 4 KN/m²
- Live load on terrace = 1.5 KN/m²
- Seismic zone = IV
- Soil type = Medium

Regular Building:
Plan and elevation of building

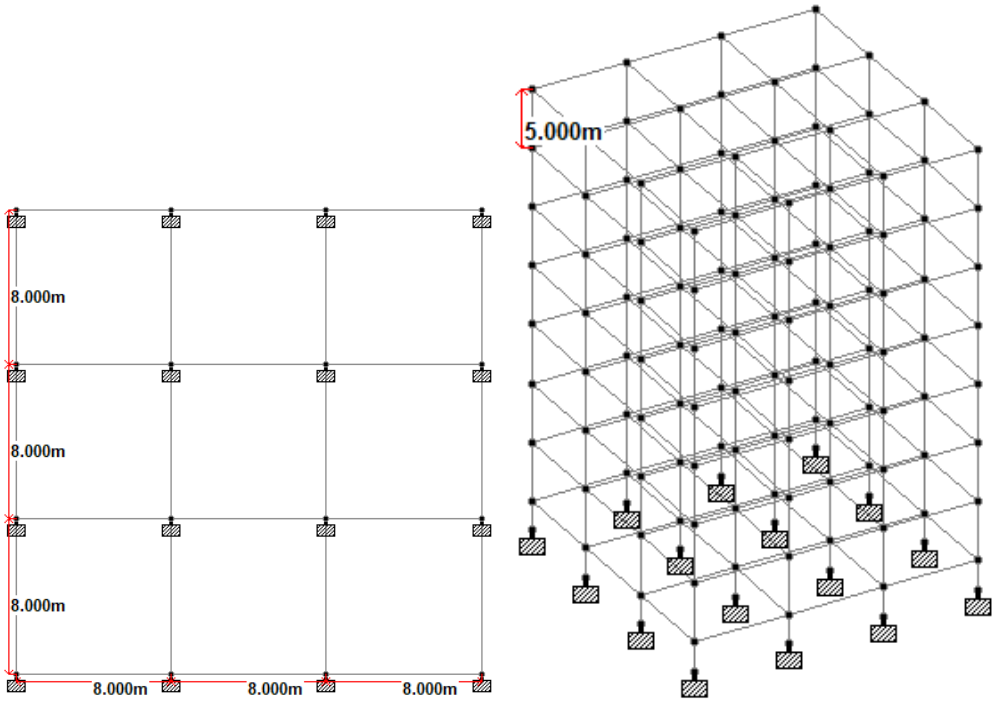

Figure: PlanFigure: Elevation

Irregular Building:
Plan and elevation of building

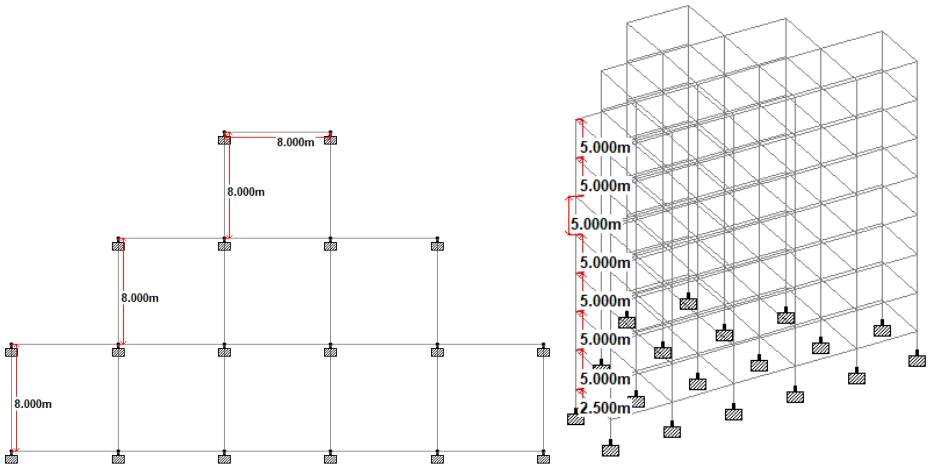

Figure: Plan Figure: Elevation

LOAD CONSIDERED

Dead load:

Dead loads are also known as permanent or static loads. Building materials are not dead loads until constructed in permanent position. The unit weight of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 KN/m² and 25 KN/m² respectively. The detail ofdesign dead loadsare given in IS:875(PART-1)

Imposed load:

Live loads, sometimes also referred to as probabilistic loads, include all the forces that are variable within the object's normal operation cycle not including construction or environmental loads. Roof and floor live loads are produced during maintenance by workers, equipment and materials, and during the life of the structure by movable objects, such as planters and people. The imposed load has been assumed in the building as per IS:875(PART-2)

Earthquake load:

Earthquake load are horizontal loads caused by earthquake and shall be computed in accordance with IS: 1893-2016**.** For monolithic reinforcement concrete structures located in seismic zone II and III without more than 5 storey high and importance factor less than 1, the seismic force are not critical.

Applied loads and load combinations

Dead load:

- Self-weight (whole structure)
- Floor finishing load = 1 kN

Live load:

- On floors = 4 kN
- On terrace = 1.5 kN

Earthquake load:

Building is constructed in zone IV hence; zone factor is 0.24. Importance factor 1. Damping ratio is 0.05. Load is applied in two directions.

- In X-direction factor 1
- In Z-direction factor 1

Table 18 Values of Partial Safety Factor γ_f for Loads
(*Clauses* 18.2.3.1, 36.4.1 *and* B-4.3)

Load Combination	Limit State of Collapse			Limit States of Serviceability		
	DL	*IL*	*WL*	*DL*	*IL*	*WL*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
DL + IL	1.5		1.0	1.0	1.0	–
DL + WL	1.5 or 0.9[1)]	–	1.5	1.0	–	1.0
DL + IL + WL	1.2			1.0	0.8	0.8

NOTES

1 While considering earthquake effects, substitute *EL* for *WL*.

2 For the limit states of serviceability, the values of γ_f given in this table are applicable for short term effects. While assessing the long term effects due to creep the dead load and that part of the live load likely to be permanent may only be considered.

[1)] This value is to be considered when stability against overturning or stress reversal is critical.

Figure: Load Combination from IS Code

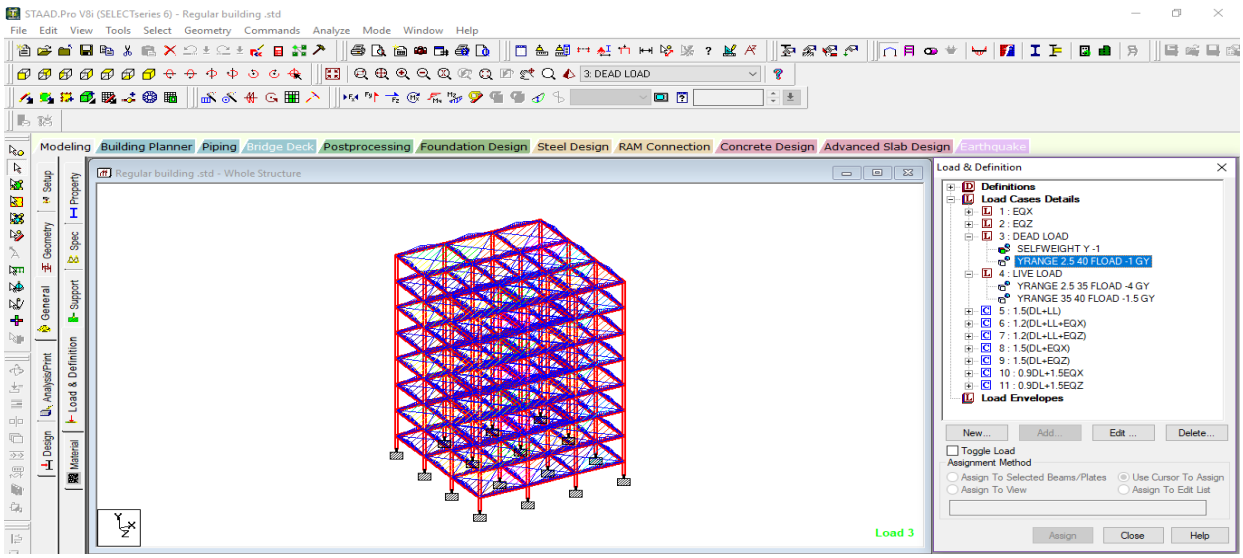

Figure: Loads onRegular Building

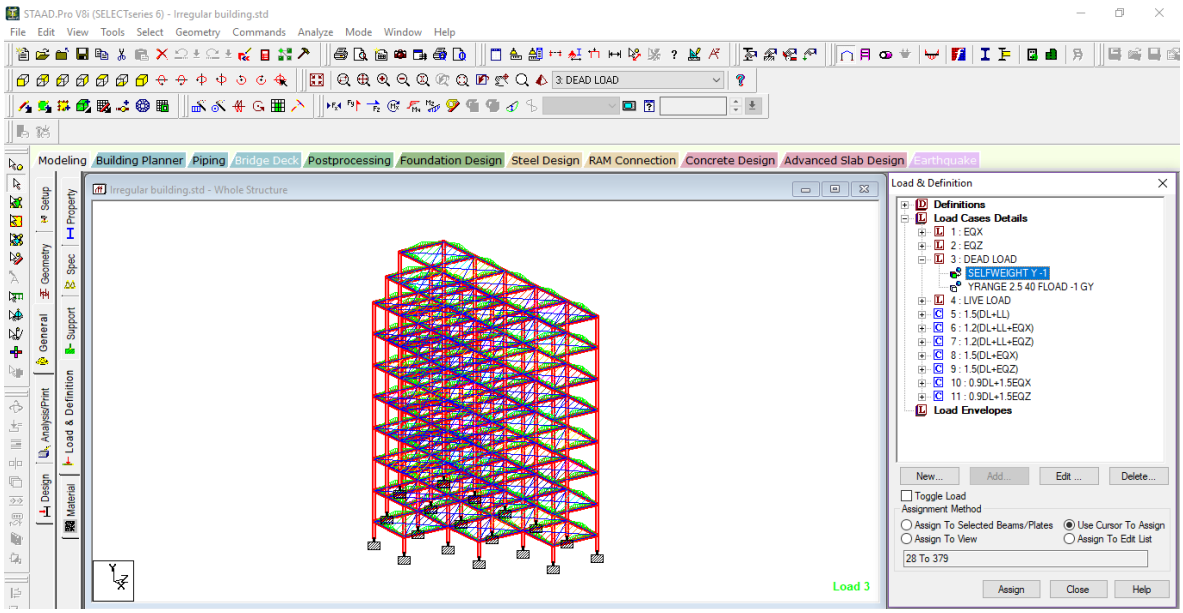

Figure: Loads on Irregular Building

III. RESULT

BENDING MOMENT DIAGRAM :

The diagram shows a beam which is simply supported at both ends. Simply supported means that each end of the beam can rotate; therefore, each end support has no bending moment. The ends can only react to the shear loads. Other beams can have both ends fixed; therefore, each end support has both bending moment and shear reaction loads. Beams can also have one end fixed and one end simply supported. The simplest type of beam is the cantilever, which is fixed at one end and is free at the other end (neither simple nor fixed). In reality, beam supports are usually neither absolutely fixed nor absolutely rotating freely.

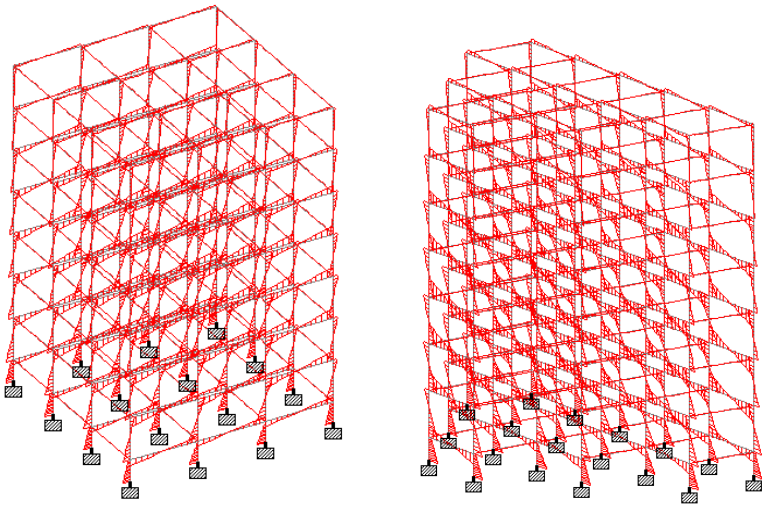
Figure: BM In Z-direction

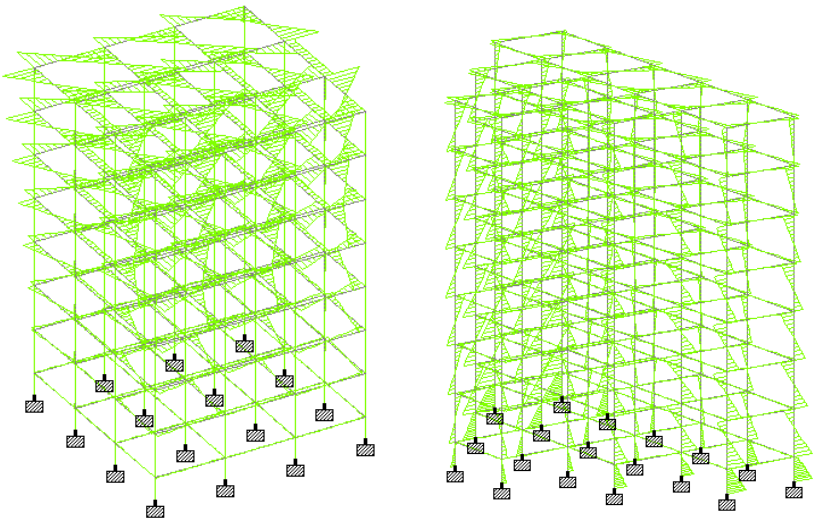

Figure: BM In Y-direction

Comparison between regular and irregular building

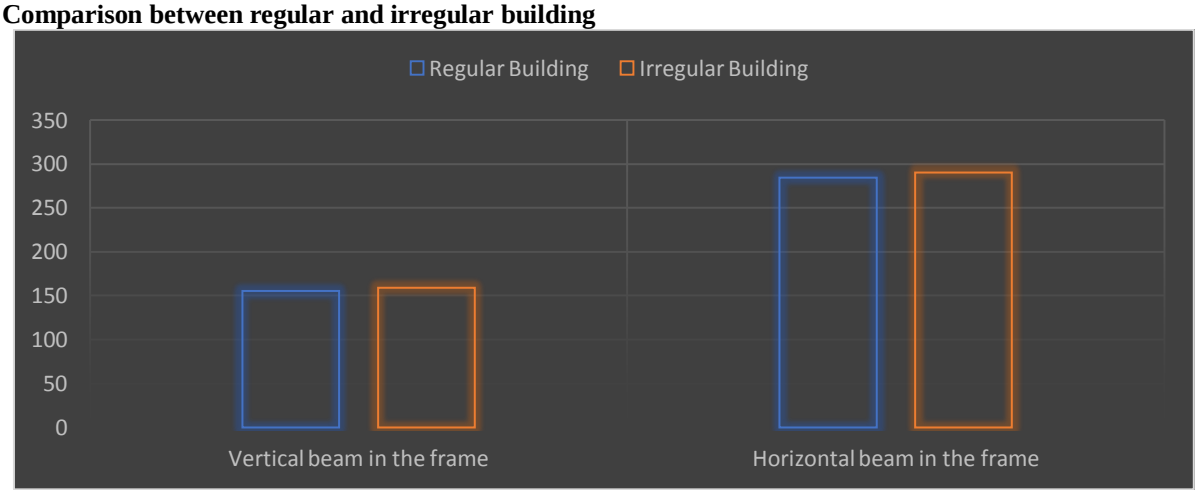

Chart: BM Comparsion

SHEAR FORCE DIAGRAM

Shearing forces are unaligned forces pushing one part of a body in one specific direction, and another part of the body in the opposite direction. When the forces are aligned into each other, they are called forces. When wind blows at the side of a peaked roof of a house - the side walls experience a force at their top pushing in the direction of the wind, and their bottom in the opposite direction, from the ground or foundation. If a plane is passed through a body, a force acting along this plane is called a shear force or shearing force.

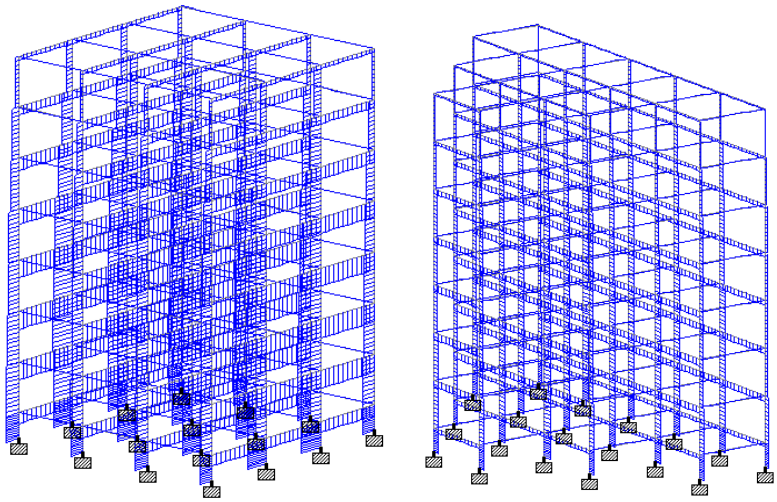

Figure: Shear Force In Y-direction

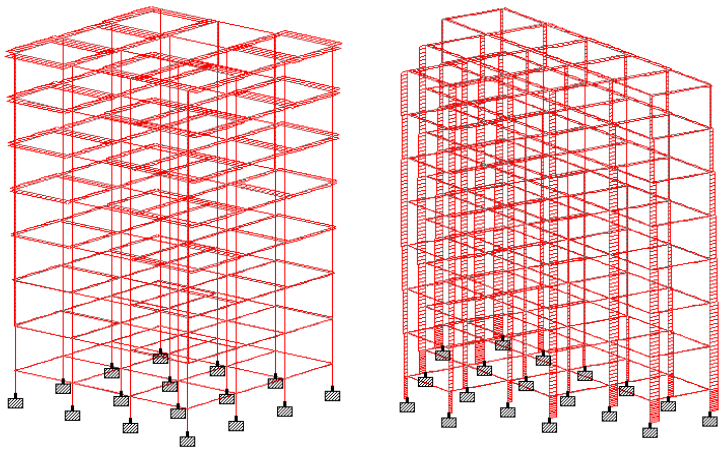

Figure: Shear Force In Z-direction

Comparison between regular and irregular building

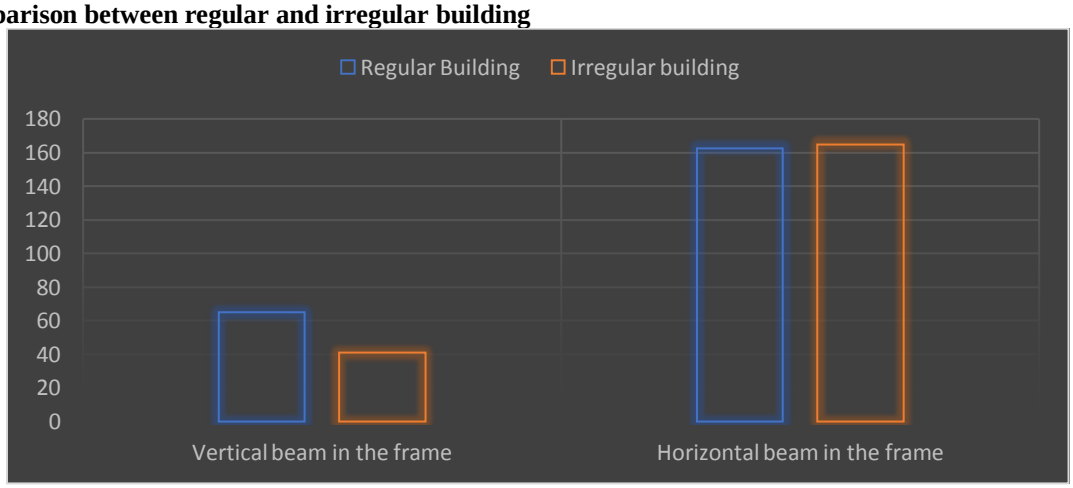

Chart: SF Comparison

DEFLECTION

Deflection is the degree to which a structural element is displaced under a load. It may refer to an angle or a distance.Deflection can be calculated by standard formulaby methods such as virtual work, direct integration, Castigliano's method, Macaulay's method or the direct stiffness method, amongst others. The deflection of beam elements is usually calculated on the basis of the Euler–Bernoulli beam equation while that of a plate or shell element is calculated using plate or shell theory.

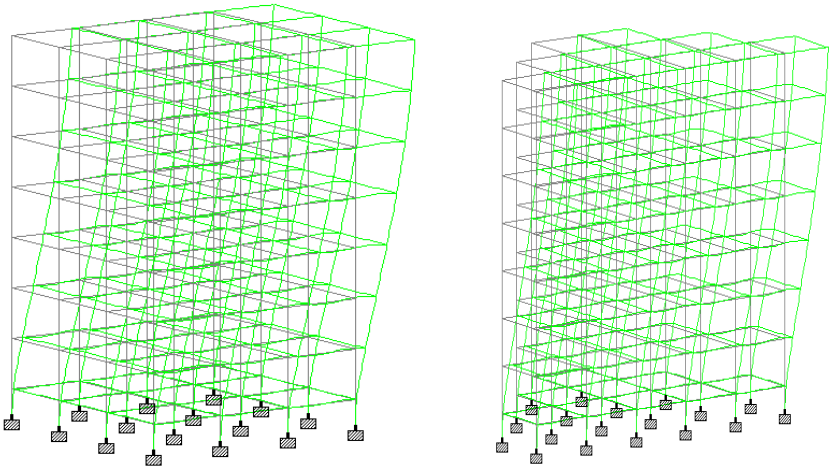

Figure: Deflection

STOREY DRIFT

Story displacement is the absolute value of displacement of the storey under action of the lateral forces.The importance of story drift is in design of partitions/ curtain walls. They must be so designed as to accommodate the storey drift; else they will crack. The total displacements must be controlled to mitigate the effects of secondary-PDELTA effects and overall stability of the building.

Comparison between regular and irregular building

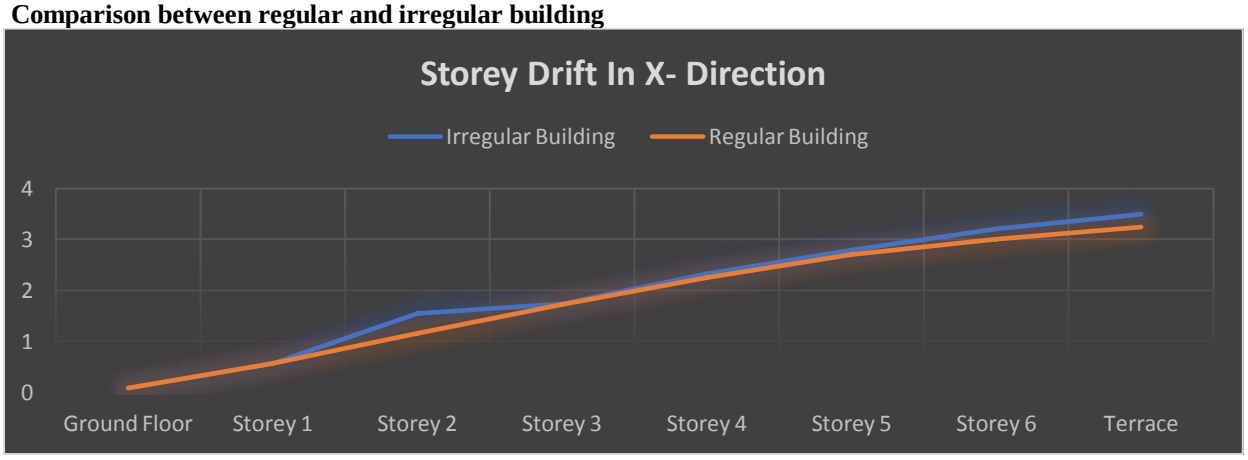

Chart: Storey Drift Comparison

JOINT DISPLACEMENT

Joints in concrete construction are construction, expansion, contraction and isolation joints. These joints are placed in concrete slabs and pavements at regular intervals to prevent development of cracks in concrete.

Construction joints are placed in a concrete slab to define the extent of the individual placements, generally in conformity with a predetermined joint layout. Construction joints must be designed in order to allow displacements between both sides of the slab but, at the same time, they have to transfer flexural stresses produced in the slab by external loads.

Construction joints must allow horizontal displacement right-angled to the joint surface that is normally caused by thermal and shrinkage movement. At the same time, they must not allow vertical or rotational displacements.

Comparison between regular and irregular building

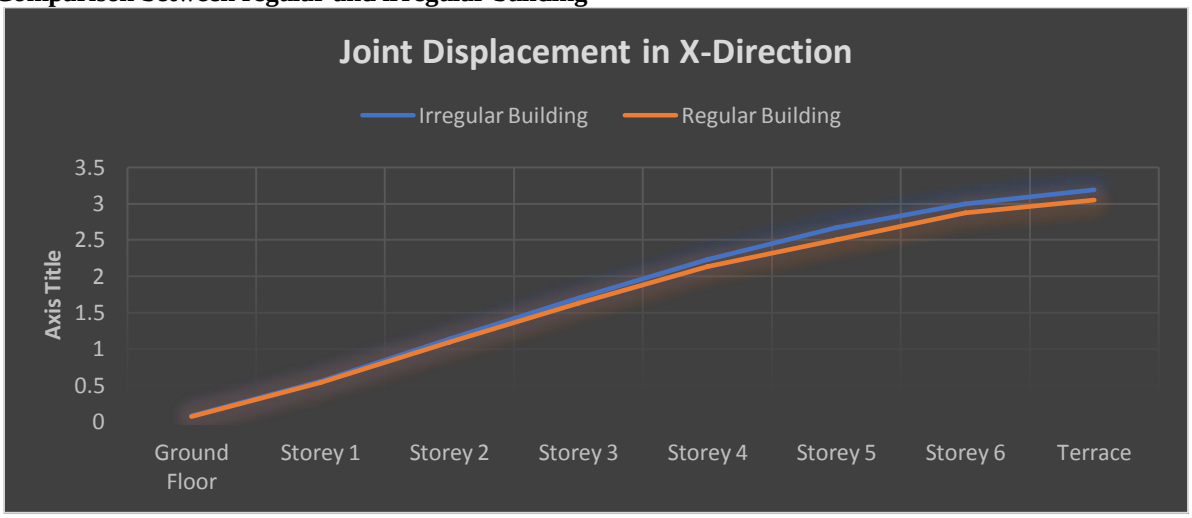

Chart: Joint Displacement Comparison

IV. CONCLUSION

- The bending moment and shear force in regular building is less then geometrical irregular building.
- Storey drift is more in irregular building than as compare to regular building.
- Storey Drift on terrace in maximum in both Regular and Irregular building.
- Joint displacement of regular and irregular building is almost same in x-direction.
- The seismic performance of regular building is found to be much better than corresponding irregular building of all cases. Therefore, it should be constructed in to minimize the seismic effects.
- Construction of Residential building should be providing safety and it should be economical.

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