RESEARCH ARTICLE OPEN ACCESS

Seismic Behavior of Regular and Irregular Structure With and Without Infill

Sukumar N. Batkulwar *, R.R. Alurwad **
*(M.Tech Student, MGM's C.O.E, Nanded, Maharastra, India.)
** (Assistant Professor, M.G.M.S C.O.E., Nanded,Maharastra, India.)

ABSTRACT
Behavior of multi storey building during earthquake motion depends on structural configuration. Irregular configuration either in plan or in elevation is recognized as one of the major causes of failure during earthquake. Thus irregular structures, especially the ones located in seismic zones are a matter of concern of failure of infill wall effect. Structures generally posses combination of irregularities and consideration of a single irregularity may not result in accurate prediction of seismic response. Hence, the present study addresses the seismic response of reinforced concrete structures possessing various combinations of irregularities with and without infill walls. Eight storied three types of building frames (Regular frame, inverted T frame and stepped frame) is taken for project work. The Performance of different configuration of building frame i.e. Bare frame, Full infill Frame, 50% Bottom Infill Frame, 50% Top Infill Frame in SAP2000 software is used for design. For all configurations Non Linear static Push Over analysis is done.

Keywords - Irregular structure, Combinations of irregularity, infill, SAP2000, Non linear static.

Date of Submission: 02-12-2022 Date of Acceptance: 13-12-2022

I. INTRODUCTION

Irregularities in building structures refer to the non-uniform response of a structure due to non-uniform distribution of structural irregularities. There are two types of irregularities commonly in building one is vertical irregularity second is plan irregularities. The effect of seismic action on building frame with and without infill is different. Reinforced concrete frame buildings with masonry infill walls have been widely constructed for commercial, industrial and multi-family residential uses in seismic-prone regions worldwide. The building with infill in seismic condition behaves vulnerable. The improper infill leads to damage the building. Masonry infill typically consists of brick, or concrete block walls constructed between columns and beams of a RC frame. These panels are generally not considered in the design process and treated as architectural (Non-Structural) components. Nevertheless, the presence of masonry walls has a significant impact on the seismic response of an RC frame building, increasing structural strength and stiffness (relative to a bare frame).

The regular buildings in plan and elevation perform well in earthquakes due to the proper distribution of forces along buildings. In different types of irregularities the performance vertical irregularity is critical because of its variation in stiffness, mass and strength. The irregularities in buildings are 1) Horizontal irregularity 2) Vertical irregularity.

The present research work studies about the regular frames and irregular frames having full infill, bare frame, 50% top infill, 50% bottom infill in SAP-2000 software. We considered the infill action and assume the infill acts inclined to the seismic force. So we considered the inclined strut which is axially in nature.

Types of Irregularities:

The Irregularity in the building structures may be due to irregular distributions in their mass, Strength and stiffness along the height of building. When such buildings are constructed in high Seismic zones, the analysis and design becomes more complicated. There are two types of Irregularities:

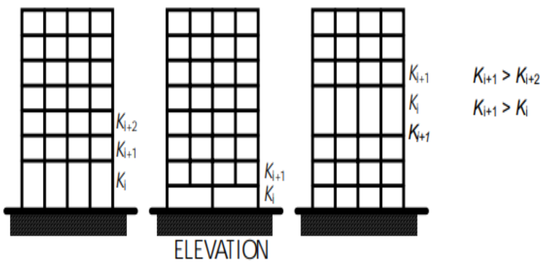
A] Plan Irregularities:

The irregularity presents in the plan of the building and affects the seismic behavior of the building and makes building weak

B] Vertical Irregularities:

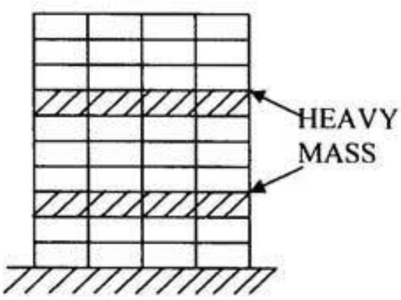
Vertical irregularities are one of the major reasons of failures of structures during earthquakes. Vertical Irregularities are mainly following types –

1] Stiffness Irregularity: Under stiffness irregularity the stiffness of the members in a frame are not equal and they vary according to the floor height, modulus of elasticity of concrete and moment of inertia of that member

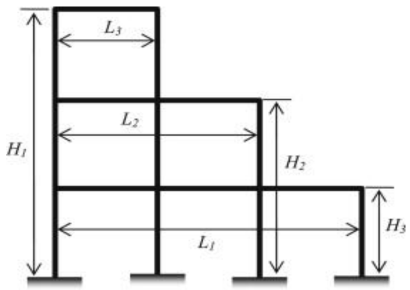


4A STIFFNESS IRREGULARITY (SOFT STOREY)

2] Mass Irregularity: Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storeys. In case of roof irregularity need not be considered.



3] Vertical Geometric Irregular: As per IS 1893 (Part 1):2002 Clause No: 7.1 Table no. 6 a structure is considered to be vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey. In case of roofs irregularity need not be considered.



II. OBJECTIVES OF WORK:

i. To study the Non Linear behavior of irregular structure with various infill configuration.

ii. To Study the displacement of irregular structure with various infill configuration

iii. To study the failure pattern of irregular structure with various infill configuration

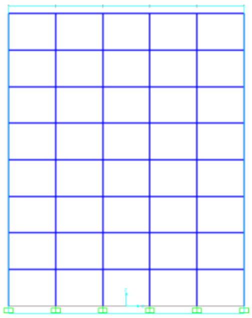
iv. To identify suitable pattern of vertical irregular structure with and without infill.

III. PROBLEM STATEMENT

To examine the Non Linear behavior of vertical irregular frame with various configuration of infill walls. The Regular, Stepped structure and Inverted T Frame of 8 Story with 5 bays is considered. The Push over Analysis is done and Non-Linear behavior is studied.

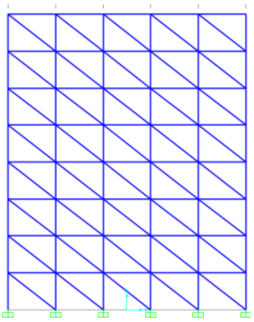
In Regular, Stepped and inverted T the various configuration of infill pattern is considered. Following are the Configuration:

3.1: Regular Frames



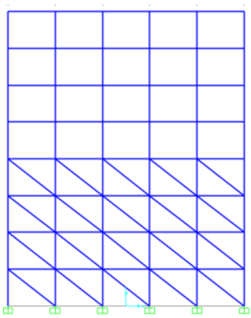
Bare Frame

Fig. no 3.1.1



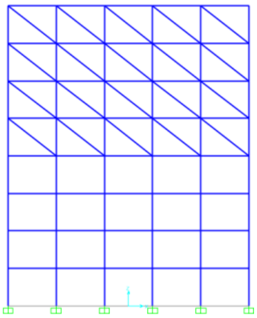
Full Infill

Fig. no 3.1.2



50% Bottom Infill

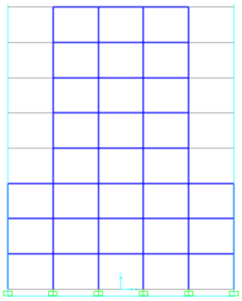
Fig. no 3.1.3



50% Top Infill

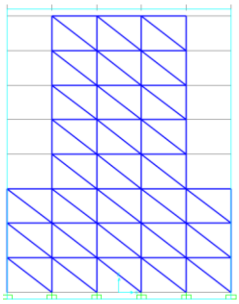
Fig. no 3.1.4

3.2: Inverted T Frames:



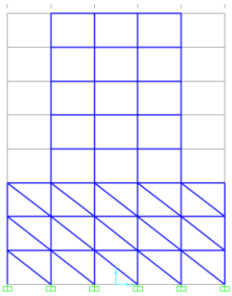
Bare Frame

Fig. no 3.2.1



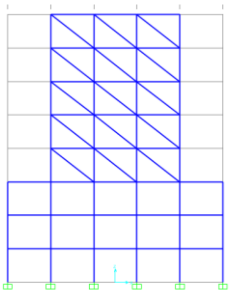
Full Infill

Fig. no 3.2.2



50% Bottom Infill

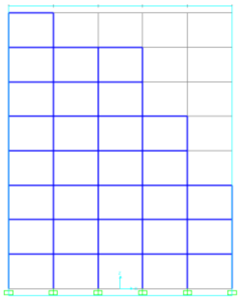
Fig. no 3.2.3



50% Top Infill

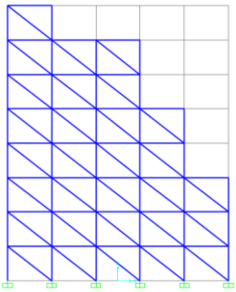
Fig. no 3.2.4

3.3: Stepped Frames



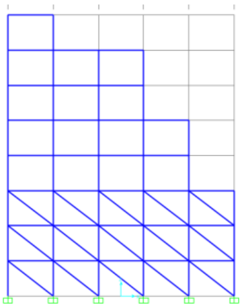
Bare Frame

Fig. no 3.3.1



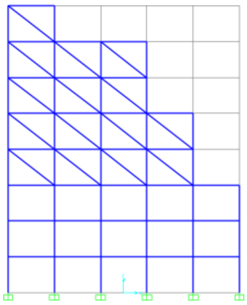
Full Infill

Fig. no 3.3.2



50% Bottom Infill

Fig. no 3.3.3



50% Top Infill

Fig. no 3.3.4

3.4 The preliminary data assumed for analysis of building model is mentioned below:

3.4.1 Geometric Configuration of Building Model

Bay Width: 4m

No. of storey: 8

Each storey height: 3.1m

3.4.2 Material Properties

Grade of concrete: M20

Grade of steel: HYSD 415

Density of Concrete: 25kN/m^2

Density of Brickwork: 20kN/m^2

3.4.3 Structural Element sizes.

Size of column: 450mm*450mm

Size of beam: 230mm*450mm

Size of Strut: 230mm*710mm

Slab thickness: 150mm

Wall thickness: 230mm

3.4.4 Loading

3.4.4 a) Gravity Loading

i. Live Load: 3 kN/m^2
ii. Floor Finish: 1kN/m^2

3.4.4 b) Seismic Loading

As per IS 1893 (Part-1):2002 Equivalent Static Lateral Force Method

Type of soil: Medium (II)

Seismic zone: Zone (III)

Importance factor, I: 1

Response reduction factor, R: 3 (OMRF)

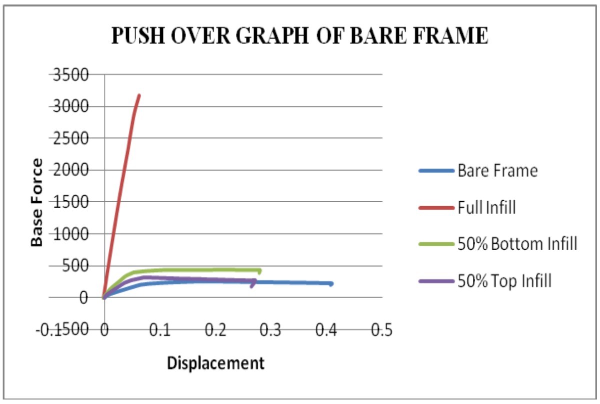
3.4.5 Load Combinations

As per IS 1893 (Part-1): 2002 Clause No.6.3.1.2, the following load combinations mentioned in table is considered in Analysis.

Load case no	Load combination
1	1.5(DL+LL)
2	1.5 (DL+EQX)
3	1.5 (DL-EQX)
4	0.9DL+1.5EQX
5	0.9DL-1.5EQX
6	1.2 (DL+LL+EQX)
7	1.2 (DL+LL-EQX)

IV. RESULT AND DISCUSSION:

Case I: Regular Frames.

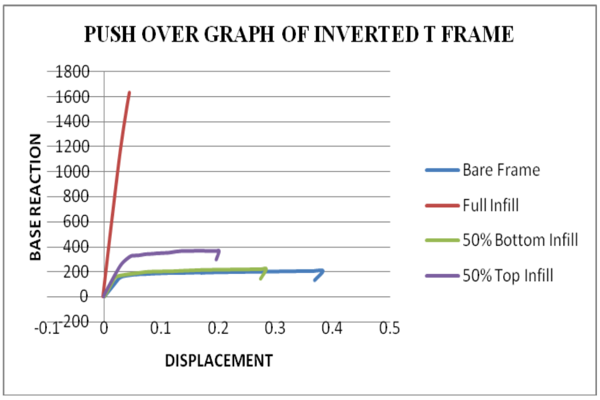


Regular Frame	Performance Point	
	V	D
Regular Bare Frame	235.57	325
Regular Full Infill Frame	485.781	6.214
Regular 50% Bottom infill Frame	431	121
Regular 50% Top Infill Frame`	307	71

Table No 4.1 Comparison of Performance point of Regular Frames

The performance of the regular frame with full infill is better than the regular bare frame.

Case II: Inverted T Frame

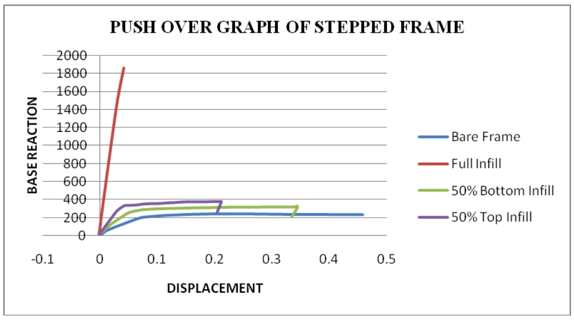


Graph 4.2 Push over Graph of Inverted T Frames

Inverted T Frame	Performance Point	
	V	D
Inverted T Bare Frame	193	218
Inverted T Full Infill Frame	309.12	5.629
Inverted T 50% Bottom infill Frame	201	152
Inverted T 50% Top Infill Frame`	368	163

Table No 4.2 Comparison of Performance point of Inverted T Frames

The performance of the Inverted T frame with Full infill is better than inverted T bare frame.



Graph 4.2 Push over Graph of Stepped Frames

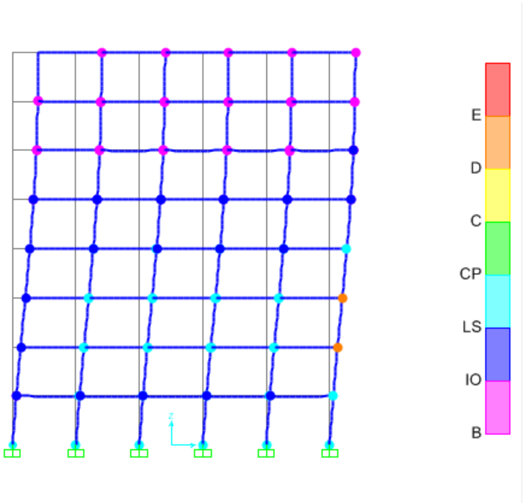
Stepped Frame	Performance Point	
	V	D
Stepped Bare Frame	241	260
Stepped Full Infill Frame	339.63	4.97
Stepped 50% Bottom infill Frame	305	137
Stepped 50% Top Infill Frame`	376	161

Table No 4.3 Comparison of Performance point of Inverted T Frames

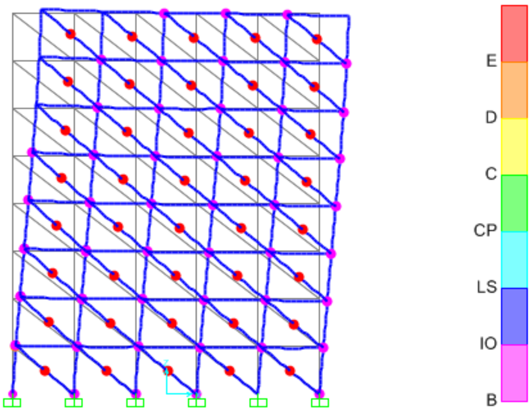
The performance of the stepped frame with full infill is better than the stepped bare frame.

4.1 Study of Hinge Pattern:

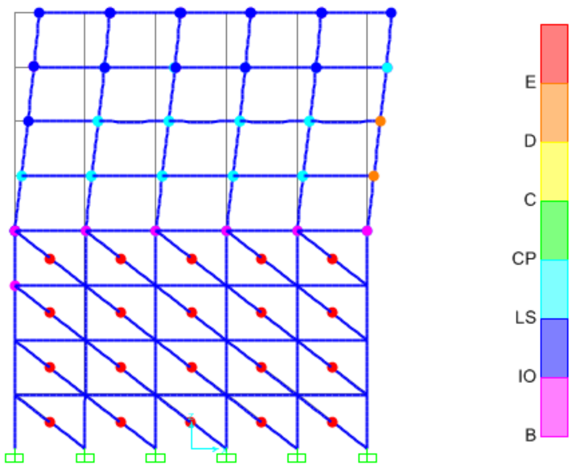
4.1.1 Regular Frame



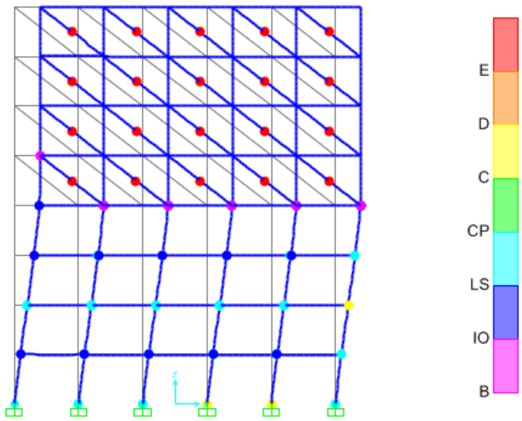
Bare Frame



Full Infill Frame

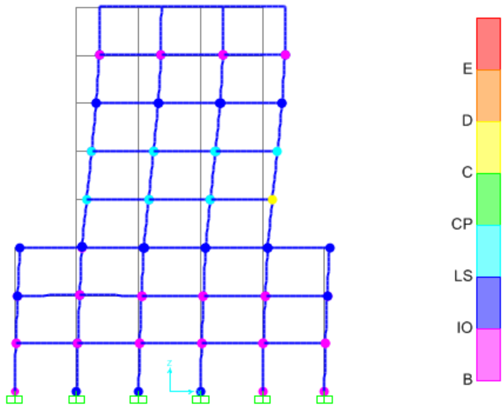


50% Bottom Infill Frame

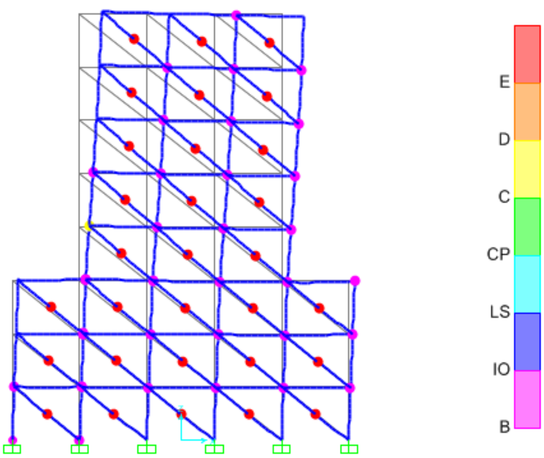


50% Top Infill Frame

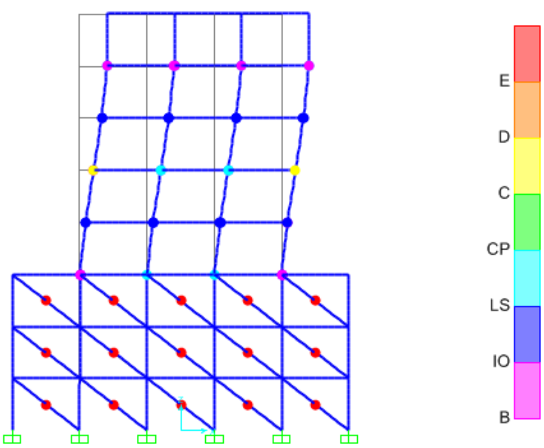
4.1.2 Inverted T Frame



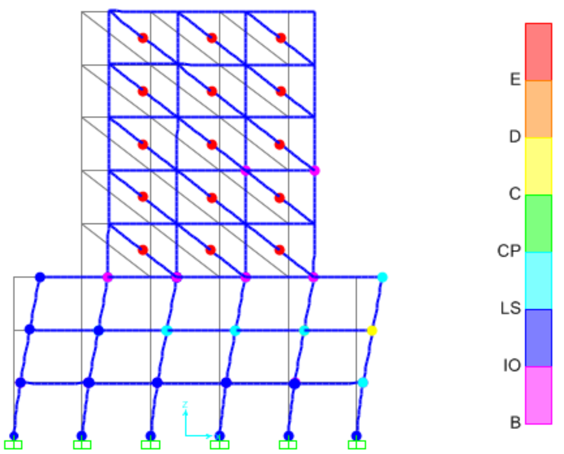
Bare Frame



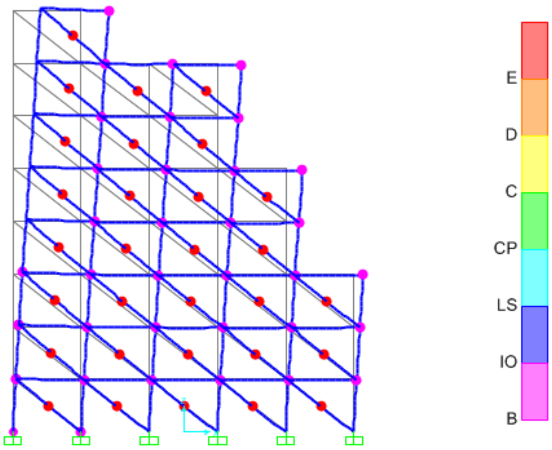
Full Infill Frame



50% Bottom Infill Frame

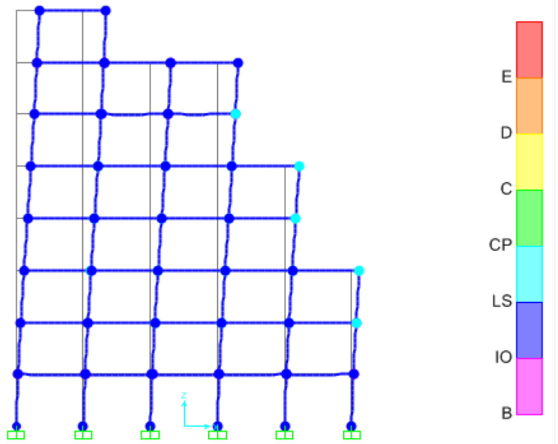


50% Top Infill Frame

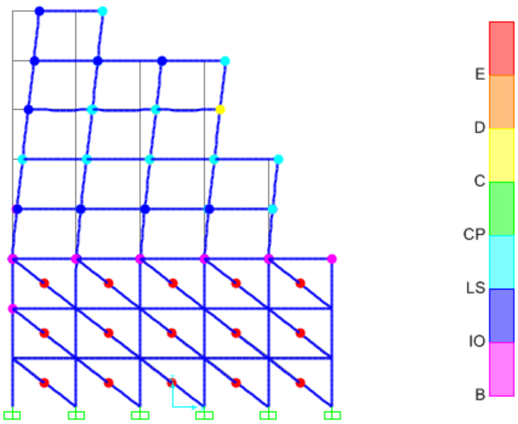


Full Infill Frame

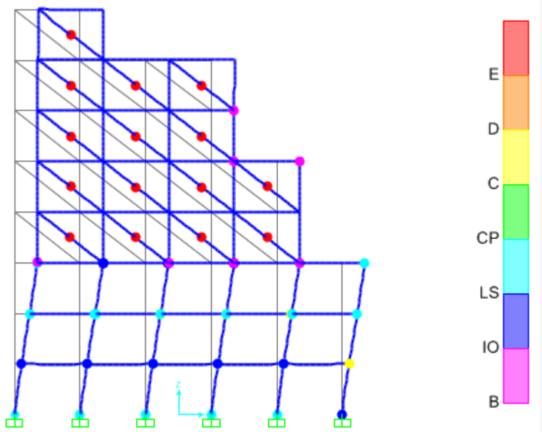
4.1.3 Stepped Frame



Bare Frame



50% Bottom Infill Frame



50% Top Infill Frame

V. CONCLUSION

- For Regular Frames, The frame with Full Infill has good performance and the frame with 50% top infill has poor performance.
- For Inverted T Frames, The frame with Full Infill has good performance and the frame 50% bottom infill has poor performance.
- For Stepped Frames, The frame with Full Infill has good performance and the frame with 50% bottom infill has poor performance.
- In all above configuration, the Regular frame with full infill has good performance.
- In all above configuration, the Regular frame with 50% Top Infill has poor performance.

REFERENCES

[1]. T. Mahdi and V. Bahreini, Seismic Response of Asymmetrical Infilled Concrete Frames, The 2nd International Conference on Rehabilitation and Maintenance in Civil Engineering.

[2]. E. Siva Naveen, Nimmy Mariam Abraham & S.D. AnithaKumari, Effect of Structural Irregularities on the Seismic Behavior of Reinforced Concrete Frames, February 2019 Journalof Structural Engineering (Madras).45(6):546-554.

[3]. Siva Naveen E., Nimmy Mariam Abraham, AnithaKumari S.D, Analysis of Irregular Structures under Earthquake Loads, 2nd International Conference on Structural Integrity and Exhibition2018.

[4]. Shivkumar Hallale, H Sharada Bai, Seismic Behavior of Buildings with Plan Irregularity with and without Structural Infill Action.

[5]. Pradip Sarkar, A. Meher Prasad, Devdas Menon, Vertical Geometry irregularity in stepped building frames, Engineering Structures 32 (2010) 2175-2182.

[6]. IS 1893 (Part-1): 2002 Indian Standard "Criteria for Earthquake Resistant Design of Structures.