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Investigation of the Impact of Different Earthquake Zones on Irregular Plan Buildings Managed by Belt Wall

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Abstract: The least sturdy areas of a structure sustain damage first during an earthquake. Failures in the structure's mass, rigidity, and shape are the root cause of this weakness. Structures are composing of structures with discontinuities, like this one. The majority of urban infrastructures are unstructured systems. An unequal distribution of mass, strength, and stiffness within a building could result from structural irregularities. One of the primary causes of structural failures and earthquakes are abnormalities in mass, stiffness, plane, torsion, etc. As a result, it is essential to consider how all four of these irregularities affect a structure's performance. These buildings differ from typical buildings in their dynamic qualities because of variations in mass and stiffness with height. The study design are more difficult when the building is construct in a seismically active area. In this research work investigate about the impact of different earthquake zones on irregular plan buildings managed by belt wall. For modeling and analysis work use ETABS 2016. In this work select G+11 building for study that plan irregularity. Perform response spectrum analysis in all four zones of earthquake. Study their displacement, bending moment, story drift, shear force and base reactions. After complete the analysis work all parameters are controlled by belt wall and compare controlled and uncontrolled parameters.
Keywords: Belt Wall, earthquake zone, Irregularities of Building, Storey displacement, bending moment etc.

I. INTRODUCTION

The distribution of mass, planes, relationships, vertical and stable stiffness, and several other abnormalities and structures determine the behavior of structures during an earthquake. An earthquake's structural failure was largely caused by abnormalities based on past building disasters. A structure suffers a shock wave upon its impact by an earthquake, which causes the inertial members to operate through the force of gravity within the structure. Columns and vertical walls counterbalance all of these forces. The center of rigidity was the point through which the consequence of these forces conducts itself. The performance of the structures as a result of severe ground shaking primarily determines how much of the irregularities and vertical structures. The present structures may become weaker as a result of seismic excitation. Because the seismic risk of buildings could result in socio-economic losses, planning might take this into consideration. In referring to plane irregularities, previous seismic events show that this type of uneven behavior caused mass, stiffness, and strength to be dispersed across the structure, greatly minimizing rotation. Ground displacement as well as ground displacement (a torsional response is force).

A. Coding Standards

They irregularities are divided into two categories of as per IS 1893(part 1): 2016

1) Plan irregularity
- Torsion irregularity
- Re – entrant corners

2) Vertical irregularity
- Stiffness Irregularity
- Mass Irregularity

B. Earthquake Zone of India

Seismic Zoning can be defined as a process by which areas are subdivided into seismic zones based on expected of ground motion, which is expressed in terms of peak horizontal ground acceleration (PGA) or peak ground velocity (PGV). On the other way, seismic Zonation demarcates equal hazard with respect to a characteristic of strong ground shaking and of site or structural response. A seismic zoning map differs from seismicity map by the fact that it specifies the levels of force or ground motions for earthquake resistance design, whereas seismicity map provides location and characteristics of earthquakes.

C. Seismic Zonation in India by BIS: (IS: 1893-1962 To IS: 1893-1984)

During the January 15, 1934, Bihar-Nepal earthquake, which reportedly recorded a magnitude of 8 or 4, the Geological Survey of India (GSI) created the country's first seismic zone map in 1935 (Auden, 1959). The map of India's seismic zones was initially proposed by Tandon in 1956. It involves three zones: high danger, low risk, and lower risk. It is predicated on the idea of comprehensive spatial seismic data and a broad understanding of geotectonic. The Seismic Zoning Map of India (IS: 1893–1962) was released in 1962 by the Bureau of Indian Standards (BIS) known as the Institute of Indian Standards. Based on isozoic and epicenter maps published in 1962 by the Japan Geographic Information Authority, India was divided in 1935 into seven zones, with 0 indicating no damage and VI indicating significant destruction. With a risk rating of 0, the Deccan plateau is essentially regarded as safe, whereas northeastern India is categorized as VI.

D. Belt Wall

Massive horizontal constructions known as outriggers, such as frames and beams, join a building's exterior columns and central walls to reinforce them and resist collapse. Although extensions have been a feature of tall structures for over 50 years, new design ideas have enhanced their functionality. The structural system known as the foundation system is made up of horizontal cantilever portions that are fastened to the structure's external columns and interior core. The central moment arm is impacted by this connection, which makes the system more rigid laterally. The stabilizer's function is to join the building's core to its columns, minimizing the bridge's return time and shifting the moment from the column to the exterior columns. Steel, concrete, and composite materials are just a few of the elements that can be used to create stabilization systems.

II. PROBLEM STATEMENT

1) G+11 models are ready to be studied in this research project. In the IS code, there are actually four different earthquake zone, all zones of earthquake should be chosen for analysis because they both have different intensity of loading conditions, meaning that to study a structure having maximum damage due to earthquake and controlled by belt wall.
2) Some parameters are selected to study like shear force, storey drift, joint displacement, bending moment, base shear etc.
3) Approach for professional practice in the field of structural engineering. Compare both results generated from controlled and un-controlled cases.
4) To reduce the effect of lateral load with belt wall and compare their result data to analyse them to understanding of seismic load design concept for structure.

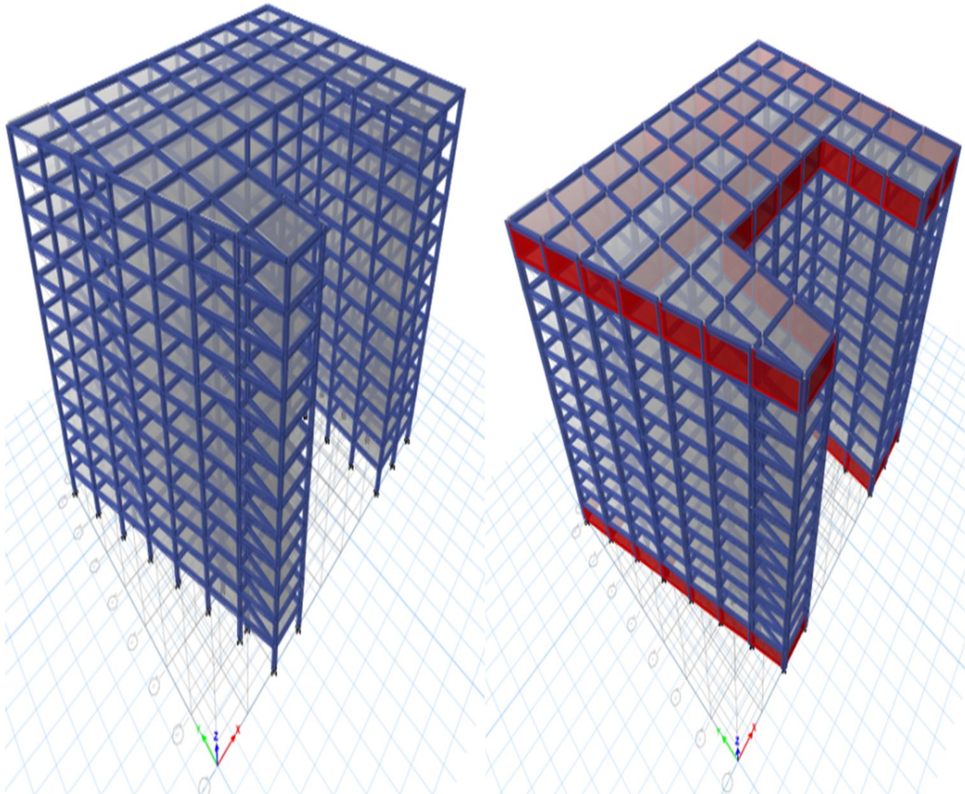
III. OBJECTIVES

1) To study the impact of different earthquake zones on irregular plan buildings managed by belt wall.
2) To analysis storey displacement, base reaction, bending moment, shear force for a G+11 storey model with different earthquake zone.
3) To analysis of building with belt wall in different earthquake zone.
4) To study earthquake loading in different zone of the India using IS code.
5) To investigate the structure response with and without belt walls.

IV. RESEARCH METHODOLOGY

In this research work investigate about the impact of different earthquake zones on irregular plan buildings managed by belt wall. For modeling and analysis work use ETABS 2016. In this work select G+11 building for study that plan irregularity. Perform response spectrum analysis in all four zones of earthquake. Study their displacement, bending moment, story drift, shear force and base reactions. After complete the analysis work all parameters are controlled by belt wall and compare controlled and uncontrolled parameters.

Model geometry
Model 1: G+11 building with bare frame without bellwall
Model 2: G+11 building with bare frame with bellwall



A. Model 1 B. Model 1

Figure 1 3D view of G+11 different G+11 floor building models

Table 1 Parameters of Models

Data	Value	
Grade of steel	Fe345	HYSD 550
Grade of concrete	M30	
No. of stories	G+11	
No. of bay along X-direction	5	
No. of bay along Y-direction	5	
Span along X-direction	5m	
Span along Y-direction	5m	
Floor height	3m	
Column size (mm)	600*600	500*500
Beam size (mm)	600*400	
Depth of Slab	200mm	
Dead load	13.8 kn/m^3	
Live load	2.5kN/m^2	
Software	ETABS 2016	
Seismic Load	IS 1893-2002	

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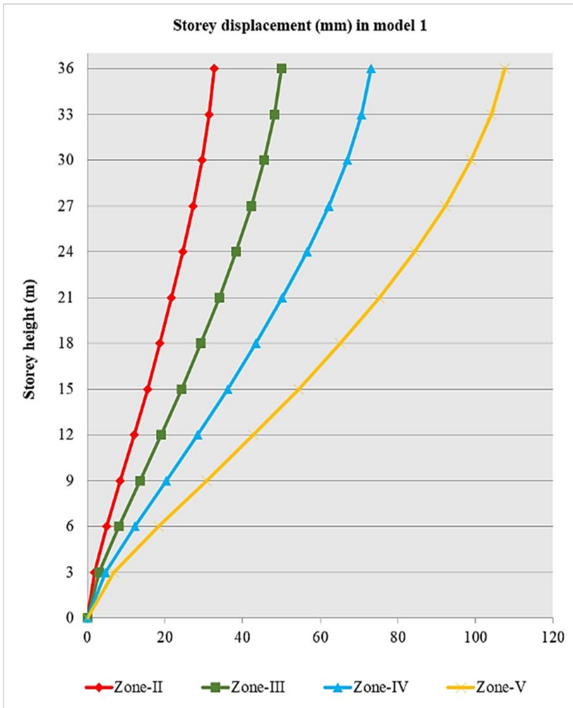
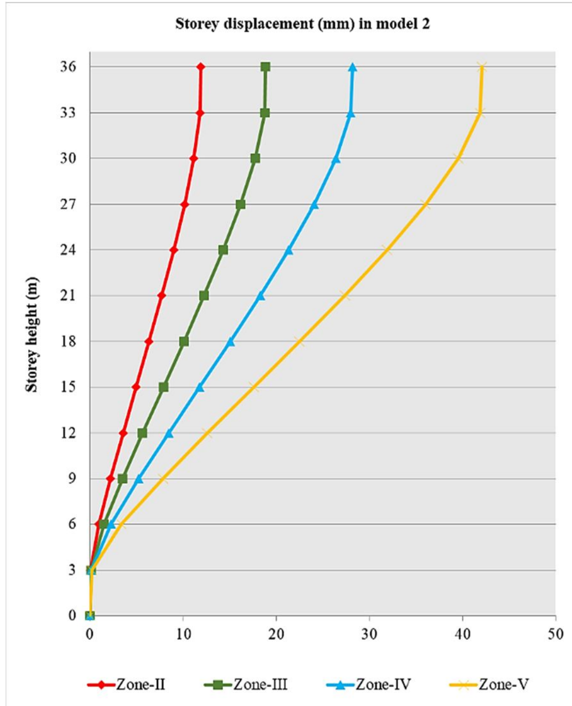
V. RESULTS AND DISCUSSION

1) Results of storey displacement (mm)



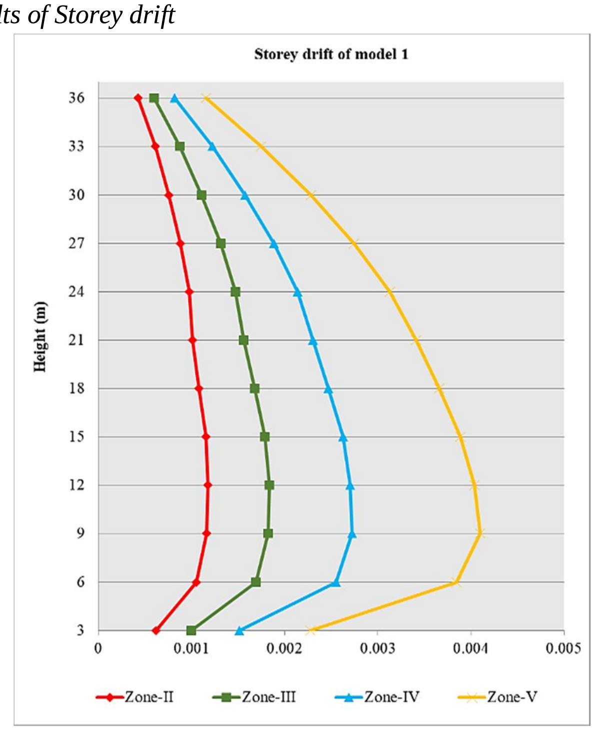
a) Model-1



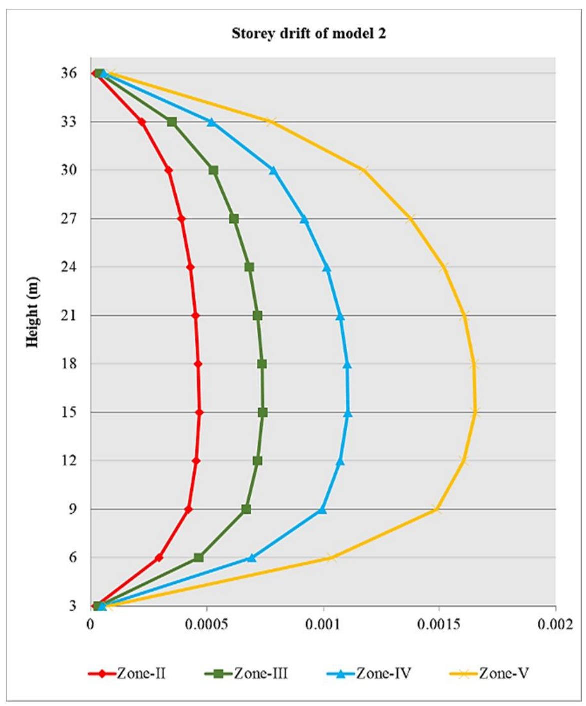
b) Model-2

Figure 2 Storey displacement of models in different zones

2) Results of Storey drift



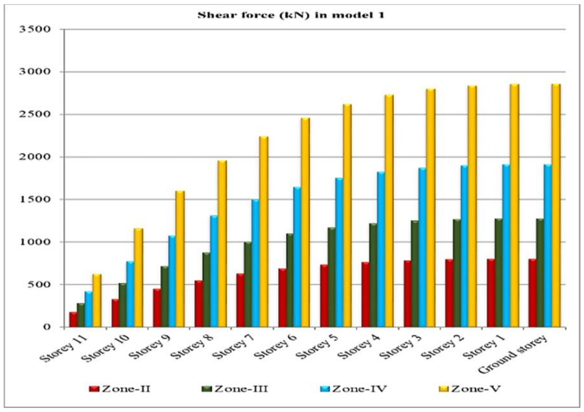
a) Model-1



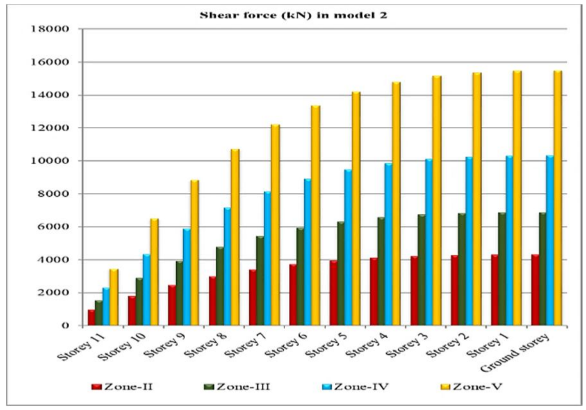
b) Model-2

Figure 3 Storey drift of models in different zones

3) Results of Shear force (kN)



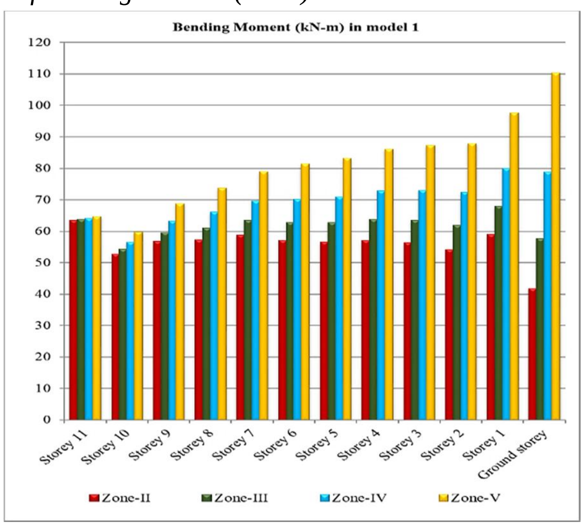
a) Model-1



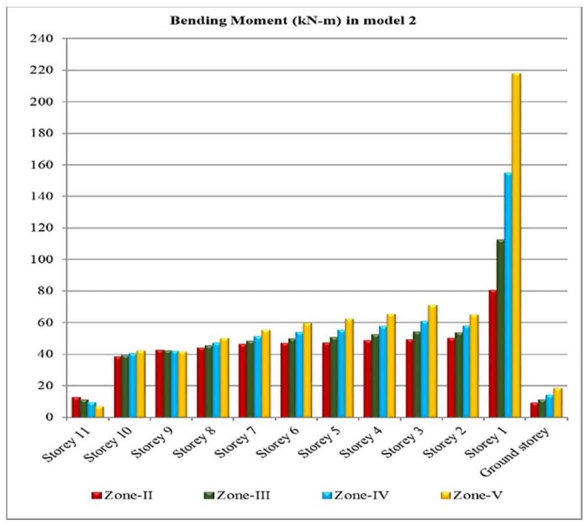
b) Model-2

Figure 4 Shear force of models in different zones

4) Results of Bending Moment (kN-m)



a) Model-1



b) Model-2

Figure 5 Bending moment of models in different zones

5) Results of Base reaction (kN)

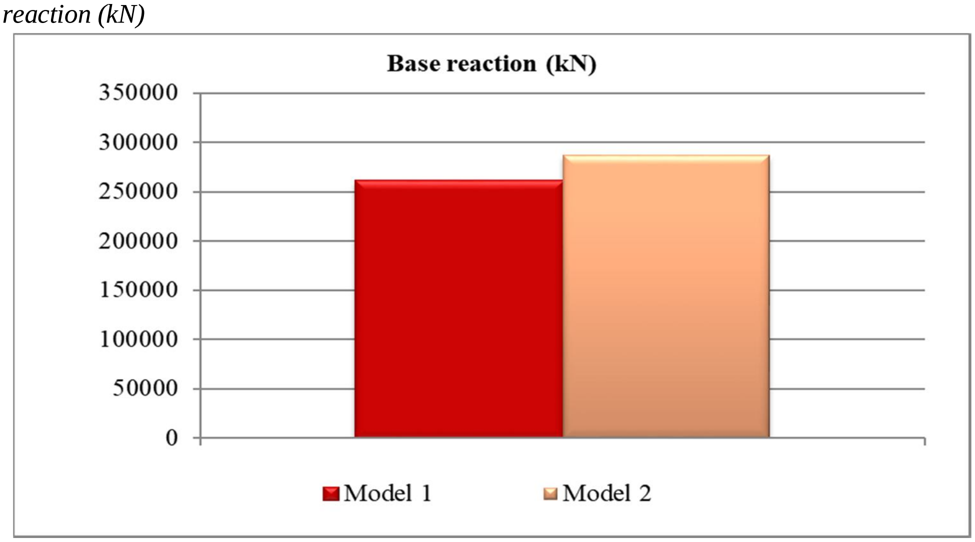


Figure 6 Comparison between model -1 and 2 Base reaction

VI. CONCLUSION

1) Maximum value of joint displacement of building exists in Zone-V and minimum value in zone-II for both models.
2) Due to application of belt wall in building displacement value reduced from displacement present in building not consider belt wall.
3) Total reduction of joint displacement in zone-II was 63.53%. Total reduction of joint displacement in zone-III was 62.27%. Total reduction of joint displacement in zone-IV was 61.47%. Total reduction of joint displacement in Zone-V was 60.87%. Maximum effect of belt wall occurs in Zone-V.
4) Maximum value of storey drift of building exists in Zone-V and minimum value in zone-II for both models.
5) Due to application of belt wall in building drift value reduced from storey drift present in building not consider belt wall.
6) Total reduction of storey drift in zone-II was 61.54%. Total reduction of drift in zone-III was 60.80%. Total reduction of storey drift in zone-IV was 60.36%. Total reduction of storey drift in Zone-V was 60.29%. Maximum effect of belt wall occurs in Zone-V.
7) Maximum value of shearforce of building exists in Zone-V and minimum value in zone-II for both models.
8) Due to application of belt wall in building shear force value reduced from shear force present in building not consider belt wall.
9) Total increment of shear force in zone-II was 4.404 times. Total reduction of shear force in zone-III was 4.405 times. Total reduction of shear force in zone-IV was 4.407 times. Total reduction of shear force in Zone-V was 4.410 times. Maximum effect of belt wall occurs in Zone-V.
10) Maximum value of bending moment of building exists in zone-II and minimum value in Zone-V for both models.
11) Due to application of belt wall in building bending moment value reduced from bending moment present in building not consider belt wall.
12) Total reduction of bending moment in zone-II was 80.3%. Total reduction of bending moment in zone-III was 82.64%. Total reduction of bending moment in zone-IV was 85.59%. Total reduction of bending moment in Zone-V was 89.97. Maximum effect of belt wall occurs in Zone-V.
13) Due to application of belt wall in building maximum increment in base reaction value was 10.27%.

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