ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

Seismic Analysis of Horizontal Irregular Building Using Conditional Mean Spectra

[1] Vaishnavi Vilas Khot, [2] Mr. Atul Patane

[1] Student of PG- M-TECH (Civil-Structure), Department of Applied Mechanics, Walchand College of Engineering, Sangli, India
[2] Assistant Professor, Department of Applied Mechanics, Walchand College of Engineering, Sangli, India
[1] vaishnavi.khot@walchandsangli.ac.in, [2] atul.patane@walchandsangli.ac.in

Abstract— ***Conditional Mean Spectrum is new term discovery in recent years. When a target spectral acceleration value occurs within the time of interest, the CMS gives the anticipated (i.e., mean) response spectrum. This target response spectrum is said to be the most suited one to choose ground motions as input for dynamic analysis. To learn more about how a building responds to linear dynamic loads, a comparative study is first provided between three-story buildings with regular and asymmetrical plans. For each model, two identical models with the same height and plan area have been created. A ten-story structure with a plan irregularity was also modelled and examined in Sap 2000, in addition to these two buildings. Results of the investigation were compared using Base Shear and Maximum Story Drift as structural terms. The conditional mean spectrum's impact on a structure's seizure response is clearly displayed in a bar chart***

Index Terms— ***Multistoried building, Plan irregularity, Response spectrum analysis, Base shear, Maximum Story Drift, Conditional Mean Spectrum, SAP2000..***

I. INTRODUCTION

The Modern engineering techniques and cutting-edge technology have been created recently to enhance the seismic performance of buildings. These include dampers, which absorb and release seismic energy, and base isolation systems, which uncouple the structure from ground motion. In earthquake-prone areas, these ground-breaking methods can improve the stability and safety of horizontally connected high-rise structures.

Response spectrum analysis is a technique for determining structural responses to transient, chaotic dynamic events. These phenomena include earthquakes and shocks. Because the precise time history of the load is unknown, performing a time-dependent analysis is difficult. The foundation of the response spectrum approach is a particular kind of mode superposition.

One of the primary goals of dynamic structural analysis is to predict how a structure will respond to ground motions with a certain spectral acceleration (Sa) over a given time period. This spectrum acceleration is frequently large because it is coupled with a tiny risk of surpassing, such as 10% or 2% in 50 years. Conditioning on Sa at a single period is helpful because probabilistic assessments gain greatly from a direct relationship to a ground-motion hazard curve for spectral acceleration at a single period derived by probabilistic seismic hazard analysis (PSHA). This is because PSHA predicts that large-amplitude spectral values will occur at all periods inside a single ground motion. Another method provided here is a conditional mean spectrum (CMS). soil, pile and the soil, raft and the pile and pile to pile. Further in the case of piled raft the pile group alone is not intended to ensure the safety of the system but it is the combined system of raft, pile and the soil ensures the safety of the structure. If a target spectral acceleration value happens within the time of interest, the CMS returns the expected (i.e., mean) response spectrum. It is claimed that this target response spectrum is appropriate for achieving the stated goal and can be used to choose the ground motions to be used as inputs in dynamic analysis. The CMS is introduced, its advantages over the UHS are noted, and useful advice for selecting a ground motion are provided.

.

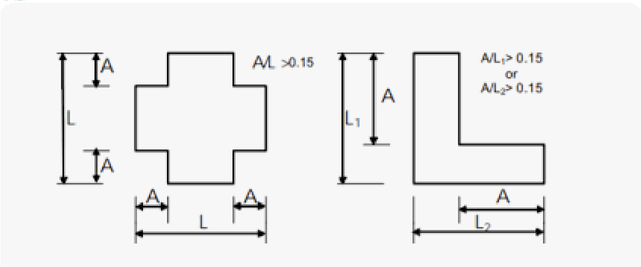

Figure 1. Plan Irregularities

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

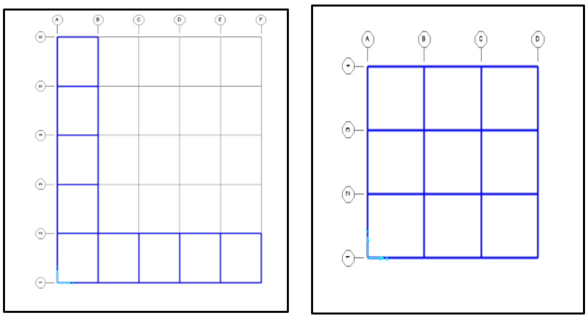

Figure 2. Plan Of G+3 Building

II. PROPOSED STUDY

The current study focuses on the seismic behaviour of the G+10 Plan Irregular Building. First G+3 structure Regular configuration and Irregular Configuration with same Plan area consider for analysis. The models are tested for Linear Dynamic Analysis (RSA) and Analysis done using Conditional Mean Spectrum as a Input Function and results are obtained for both the structure.

III. OBJECTIVES OF PROPOSED WORK

- To understand the Practical Application of Conditional Mean Spectrum.
- To differentiate seismic behaviour of the structure Analysed by Response Spectrum and Conditional Mean Spectrum in terms of Base Shear and Maximum Story Drift.

IV. METHODOLOGY

- G+10 and G+3 Buildings model creation in Sap2000 Software.
- Define materials, section properties.
- Assign sections and loads on section.
- Define Lump Mass for Structure as per IS code.
- Define Input Function for Analysis of structure.
- Perform Response Spectrum Analysis and Conditional Mean Spectrum Analysis on each of the structures.
- Compare results of structure with G+3 regular, G+3 Irregular and G+10 Irregular structure.

V. EXAMPLE BUILDING AND DESIGN OF FOUNDATION

In the current study the 10-storey with Plan Irregularities and 3-story building with Regular and Plan Irregularities is considered for the seismic analysis. The G+3 and G+10 is designed as per the IS 456-2000. The buildings located in a Seismic zone V. Plan and 3D view of the building is shown in figure 3. Height of storey is 3 m. Average size of the column is 450mm x 450mm and size of beam is 300mm x 450mm. The thickness of the slab is 180mm. The grade of concrete is M35 and Fe500 steel is used.

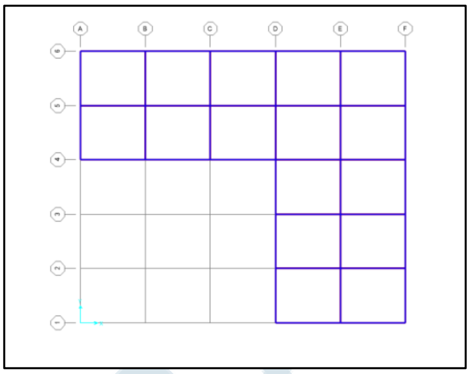

Figure 3- Plan of G+10 Building

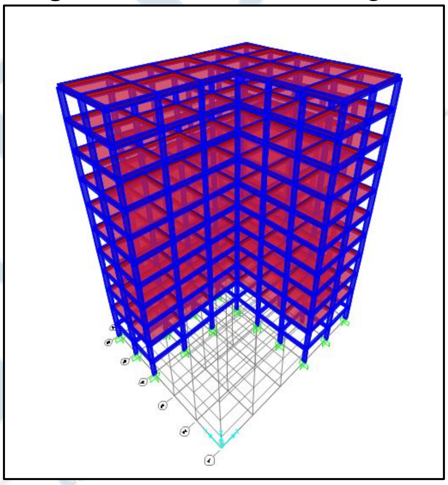

Figure 4- 3D view of G+10 Building

The following equations estimate various design parameters for this model.

- For calculating Base shear, the required parameter is calculated as mentioned below,

$$Vb = \left[\frac{Z}{2}\ \frac{I}{R}\ \frac{Sa}{g}\right] W \qquad (1)$$

Where,

Z= Seismic zone factor from Table 3 IS 1893 2016

I= Importance factor

R= Response factor

Sa/g= Design acceleration coefficient for different soil types

W= Seismic weight of the building as per (Cl. 7.4 IS 1893 2016)

- The seismic weight of the floor is made up of the full dead weight plus the necessary amount of living load, as well as the proportionate weight of the column and the walls above and below the floor.

DL+25%LL+wt. of walls and columns (Cl.7.3.2. IS 1893 2016) (1)

DL+50%LL+wt. of walls and columns (Cl.7.3.2. IS 1893 2016) (2)

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

Time period in direction of acceleration:

$$Ta = \frac{0.075h^{0.75}}{\sqrt{Aw}} \geq \frac{0.09h}{\sqrt{d}} \quad (3)$$

Where A_w is total effective area (m^2) of walls in the first storey of the building given by,

$$Aw = \sum_{i=1}^{Nw}\left[Awi\left\{0.2 + \left(\frac{lwi}{h}\right)^2\right\}\right] \quad (4)$$

Where,

h=height of building in m. (Cl.7.6.2.(a) IS 1893 2016)

Awi=effective cross-sectional area of a wall i in the first story of building in m2,

Lwi=length of a structural wall i in the first story of building in considered direction of lateral force in m,

d=base dimension of the building at the plinth level along the considered direction of earthquake shaking in m,

Nw=number of walls in the considered direction of earthquake shaking,

Drift = 0.004*h where, h = height of story considered

Top story displacement = 0.004*H

where,

H = height of building as defined by (Cl.4.10. IS 1893 2016)

Table 1 The properties of the buildings

Sr. No.	Item	Dimension (mm)	Description
2	Floor height	3600	floor
5	Floor slabs	150	M30, Fe500
6	column	300x600	M30, Fe500
8	Beam	230x600	M30, Fe500

Table 2 Seismic Load properties of the buildings,

Sr. No.	Seismic Load
1	Seismic zone= V
2	IF= 1
3	Soil type = 2
4	Response reduction factor= 5

VI. RESULTS

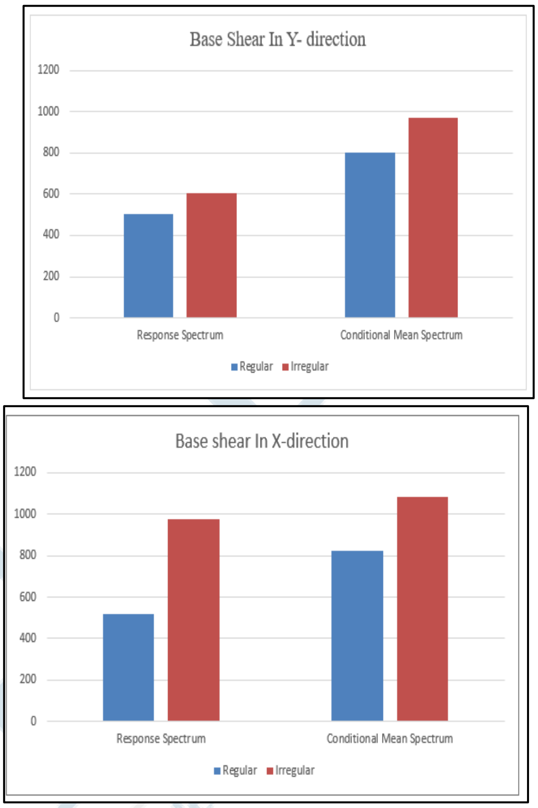

Figure 5- Base Shear G+3 Building

Fig 5 shows that Base shear in X-direction get increases upto 60% for regular structure using Conditional Mean spectrum same in case of for Y-direction for G+3 Building.

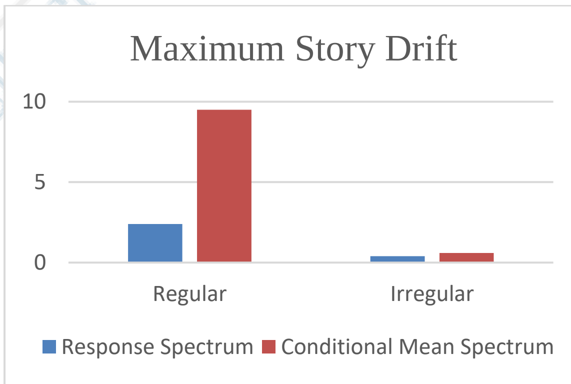

Figure 6- Maximum Story Drift

As shown in Figure 6, Maximum Story Drift is Increased for Conditional Mean Spectrum.

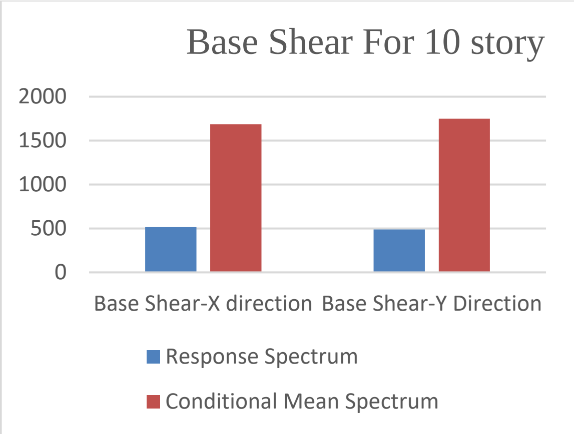

Figure 7- Base Shear G+10 Building

As shown in Figure 7, Base Shear is increased Conditional Mean Spectrum than Response Spectrum Analysis.

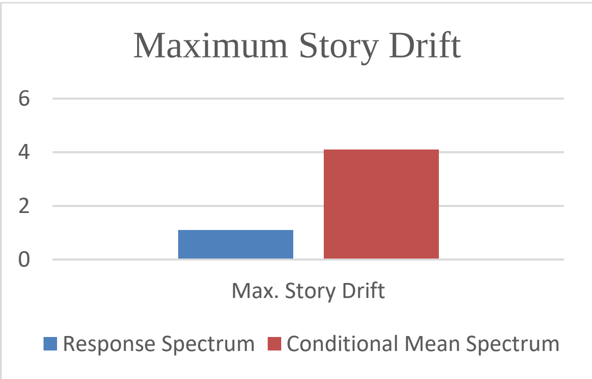

Figure 7- Maximum Story Drift of G+10 Building

VII. CONCLUSION

1)Bar chart comparison of the buildings G+3 Building showed that:

- As for Base shear in X-direction get increases up to 60% for regular structure using Conditional Mean spectrum same in case of for Y-direction
- As for the maximum story drift it was seen that it was additional 7.1 in case of Conditional Mean Spectrum than Response spectrum analysis in regular structure.
- As for the plan irregular structure base shear in X-direction was 11% more has seen in Conditional Mean Spectrum, as for Y-direction base shear it was 60% more.
- As for Maximum story drift it was more than 0.2 for response spectrum analysis.

2) Bar chart comparison of the two buildings G+10 Plan Irregularities showed that:

- the Base Shear in X-direction was 2.255 times gretarer than Response spectrum analysis, as for Y-direction it was 2.57 times greater than response spectrum analysis.
- Maximum Story Drift was in case of Conditional Mean Spectrum was greater than 3 than Response Spectrum analysis.

By considering the above values it states that Conditional Mean Spectrum is better option for Input function for Analysis of the structure. It gives more closely results of seismic behavior of the structure.

REFERENCES

[1] ATamika J. Bassman, Kuanshi Zhong, Jack W. Baker(2020), "Evaluation of Conditional Mean Spectra Code Criteria For Ground Motion Selection" Journal of Structure Engineering,Volumn 148(11), Page 04022177-1 to 04022177-9.

[2] Panagiotis E. Mergos, Anastasios G. Sextos(2019), "Selection of earthquake ground motions for multiple objectives using genetic algorithms" Engineering Structures Volume 187,2019,Pages 414-427,ISSN 0141-0296,https://doi.org/10.1016/j.engstruct.2019.02.067.

[3] Amit Shiuly "Performance of Buildings Using Site Specific Ground Motion of Kolkata, India," International Journal of Geotechnical Earthquake Engineering (IJGEE), IGI Global, vol. 10(1), pages 17-29, January 2019.

[4] K. Khy, C. Chintanapakdee, and A. C. Wijeyewickrema, "Application of Conditional Mean Spectrum in Nonlinear Response History Analysis of Tall Buildings on Soft Soil", Engineering Journal, vol. 23, no. 1, pp. 135-150, Jan2019.

[5] Inel, Mehmet & Cayci, Bayram & Meral, Emrah. (2018)." Nonlinear Static and Dynamic Analyses of RC Buildings". International Journal of Civil Engineering.16. 10.1007/s40999-018-0285-0.

[6] Homaei, F., Shakib, H. & Soltani, M (2017). "Probabilistic Seismic Performance Evaluation of Vertically Irregular Steel Building Considering Soil–Structure Interaction." International Journal of Civil Engineering 15, 611–625

[7] Işık, Ercan & Kutanis, Mustafa. (2015)." Determination of Local Site-Specific Spectra Using Probabilistic Seismic Hazard Analysis for Bitlis Province, Turkey."Earth Sciences Research Journal. 19. 129-13410.15446/esrj.v19n2.50101.

[8] Işık, E., Kutanis, M. and Bal, İhsan E. (2016) "Displacement of the Buildings According to Site-Specific Earthquake Spectra", Periodica Polytechnica Civil Engineering, 60(1), pp. 37–43. 10.3311/PPci.7661.

[9] Aslan S. Hokmabadi, Behzad Fatahi, Bijan Samali,(2013) "Assessment of soil–pile–structure interaction influencing seismic response of mid-rise buildings sitting on floating pile foundations", Computers and Geotechnics, Volume 55,2014, Pages 172-186, ISSN 0266-352X, https://doi.org/10.1016/j.compgeo.2013.08.011.

[10] Shukla, J., Choudhury, D. (2012). "Seismic hazard and site-specific ground motion for typical ports of Gujarat." Nat Hazards 60, 541–565 https://doi.org/10.1007/s11069-011-0042-z