Behavior of RCC In-filled Buildings with Different Configurations of Plan Under Seismic Force

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Abstract- The behavior of building during earthquake depends critically on its overall shape, size and geometry. Building with simple geometry in plan have performed well during strong past earthquake but building with u, v, H & + shaped in plan have sustained significant damage. So the proposed project attempts to evaluate the effect of plan configurations on the response of structure by RSM (Response Spectrum Method). The Indian Standard Code (IS-Code) of practice IS-1893 (Part I: 2002) guidelines and methodology are used to analyze the problem. In this proposed work the study is carried on the effect of difference geometrical configurations on the behavior of structure of the already constructed building located in the same area during earthquake by RSM in this paper, more emphasis is made on the plan configurations and is analyzed by RSM since the RSM analysis provides a key information for real – world application.

Keywords – Geometry, configurations, RSM, irregular profiles, susceptible

I. INTRODUCTION

Buildings are the complex system and multiple items have to be considered at the moment of designing them. Hence at the planning stage itself, architects and structural engineers must work together to ensure that the unfavorable features are avoided and good building configuration is chosen. If we have a poor configuration to start with, all the engineers can do is to provide a bad aid → improve a basically poor solution as best as he can.

Conversely, if we start off with a good configuration and reasonable framing system, even a poor engineer cannot harm its ultimate performance too much. But constructions can suffer diverse damages when they put under seismic excitations, although for same structural configuration, region, EQ damages in the systems are neither nor homogenous. A desire to create an aesthetic and functionally efficient structure drives architects to conceive wonderful and imaginative structures. Sometimes the shape of building catches the eye of visitor, sometimes the structural system appeals, and in other occasions both shape and structural system work together to make the structure a Marvel. However, each of these choices of shapes and structure has significant bearing on the performance of building during strong earthquake. So the symmetry and regularity are usually recommended for a sound design of earthquake resistant structure.

Figure1. Irregular plan of residential buildings

II. STRUCTURAL IRREGULARITY

Is defined by location at the resistant elements, walls, columns, joints with nonstructural elements, floor systems, wall openings and geometric arrangement. When irregular features are included in buildings, a considerably higher level of engineering effort is required may not be as good as one with simple architectural features. Observations of structural damage due to strong earthquake show the class of building.

So the structure can be classified on the basis of irregularity:

1. Regular
2. Moderately irregular
3. Strongly irregular

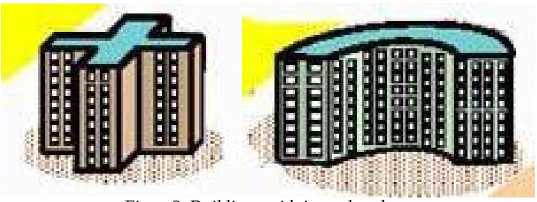

Figure2. Buildings with irregular plans

Decisions made at the planning stage on building configuration are more important since the wide range of structural damages observed during past earthquake across the world is very educative in identifying structural configurations that are desirable versus those which must be avoided. So the irregular structure needs a more careful structural analysis to reach a suitable earthquake system. Where the parameter α is called embedding intensity and their effect of validity of the algorithm directly is apply after this process, after that apply the inverse wavelet transform to the image for find out watermark image.

III. STRUCTURAL CONFIGURATIONS

Configuration plays an important role in the seismic performance of structures subjected to earthquake actions. Past earthquake reconnaissance has pointed towards the observation that buildings with irregular configurations are more vulnerable than their regular counterparts. To prevent unfavorable failure modes adequate 'Conceptual design' is required at an early stage. In addition, through assessment of the structural configuration is vital to achieve adequate seismic performance

IV. RESPONSE SPECTRUM METHOD

A response spectrum is simply a plot of the peak or steady – state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency, that are forced into motion by the same base vibration or shock. The RSM plays an important role in practical analysis of multistory buildings for earthquake motions. The maximum response of the building is estimated directly from the elastic or inelastic design spectrum characterizing the design earthquake for the site and considering the performance criteria for the building. RSM is very useful tool for earthquake engineering for analyzing the performance of structures and equipments in earthquake. Since many behave principally as simple oscillators (also known as single degree of freedom systems). Thus if natural frequency is find out then the peak response of the building can be estimated by regarding the value from the ground response spectrum for the appropriate frequency. Earthquake engineers prefer to report interaction between ground acceleration and structural systems through.

III. PROBLEM AND RESULT

A. Following are G+3 storied RC Special Moment Resisting Brick Infilled Frame residential buildings have plan as shown in fig. situated in seismic zone III

Beam size – 0.23 m x 0.45 m
Column size – 0.23 m x 0.53 m
Thickness of slab – 150 mm
Thickness of wall – 250 mm
Height of storey – 3 m
Plinth height above GL – 2 m
Unit weight of concrete – 24 kN/m^3
Live load on floor – 3 kN/m^2
Live load on roof – 2 kN/m^2
Grade of steel - Fe415
Soil type –Medium soil
Grade of concrete - M 20

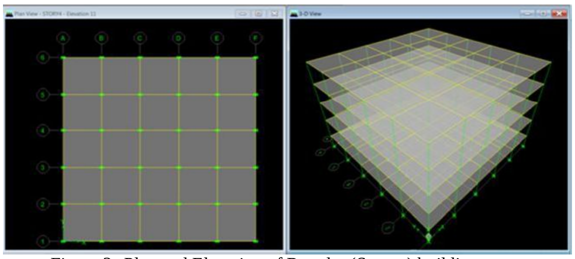

Figure 3. Plan and Elevation of Regular (Square) building

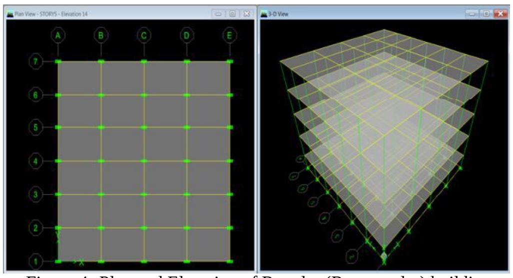

Figure 4. Plan and Elevation of Regular (Rectangular) building

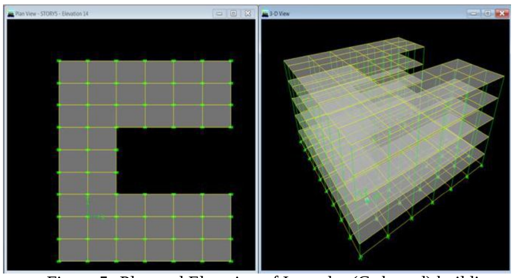

Figure 5. Plan and Elevation of Irregular (C shaped) building

Table 1. Modal Results for Regular (Square) building

Mode	Period	UX	UY	UZ	Modal Stiffness
1	0.4546	0	0	0	191.0135
2	0.3815	-34.926	0	0	271.3046
3	0.2762	0	-11.918	0	517.5331
4	0.1771	0	7.1875	0	1258.343
5	0.156	0	0	0	1621.981
6	0.1412	0	4.6178	0	1979.647
7	0.1296	12.296	0	0	2350.695
8	0.1191	0	11.177	0	2781.667
9	0.0997	0	0	0	3968.565

Table 2. Modal Results for Regular (Rectangular) building

Mode	Period	UX	UY	UZ	Modal Stiffness
1	0.85671	-39.96	0	0	141.1642
2	0.60141	0	-13.605	0	346.3786
3	0.52883	0	-8.2489	0	841.9235
4	0.3376	0	0	0	923.5082

5	**0.21654**	**13.852**	**0**	**0**	**1207.679**
6	**0.20676**	**0**	**-5.3375**	**0**	**1326.965**
7	**0.1808**	**0**	**-12.751**	**0**	**1859.16**
8	**0.17249**	**0**	**0**	**0**	**2250.429**
9	**0.14579**	**-8.4275**	**0**	**0**	**2993.994**

Table 3. Modal Results for Irregular (C shaped) building

Mode	Period	UX	UY	UZ	Modal Stiffness
1	**0.8069**	**0.0089**	**0.0011**	**0.0002**	**22.7564**
2	**0.4634**	**0.0087**	**0.001**	**0.0002**	**47.2605**
3	**0.3798**	**0.0083**	**0.0009**	**0.0002**	**75.2934**
4	**0.2774**	**0.0077**	**0.0008**	**0.0002**	**103.616**
5	**0.2541**	**0.0069**	**0.0006**	**0.0002**	**112.995**
6	**0.1777**	**0.0061**	**0.0005**	**0.0002**	**159.125**
7	**0.1776**	**0.0051**	**0.0004**	**0.0002**	**242.696**
8	**0.1671**	**0.0039**	**0.0003**	**0.0002**	**315.579**
9	**0.1417**	**0.0025**	**0.0002**	**0.0001**	**417.565**

- UX- Displacement in X direction
- UY- Displacement in Y direction
- UZ- Displacement in Z direction

IV.CONCLUSION

1. For software validation; Time period and base shear results for G+3 building by using equivalent static method is approximately equal with response spectrum method in ETABs.
2. Considering the storey displacement with respect to base shear, the Asymmetrical building is the weakest since it suffers the maximum displacement that is 1.34 times more than Symmetrical building.
3. The analysis proves that irregularities are harmful for the structures and it is important to have simpler and regular shapes of frames as well as uniform load distribution around the building and use strong column and weak beam type design philosophy.
4. Large displacements were observed in the building no. 3 and least displacements were observed in building no. 1 & 2. It indicates that building with severe irregularity shows maximum displacement.

REFERENCES

[1] Dr. O. R. Jaiswal, “Seismic Response of Building Frame with Irregular Profile.

[2] Sharon L. Wood, (1992), “Seismic Response of R/C Frames with Irregular Profile”, JOSE (ASCE), Vol.118, No.2

[3] A. K. Chopra and Cruz, (1986), “Elastic Earthquake Response of Building Frames”, JOSE (ASCE), Vol.112, No.3.

[4] Jack P. Moehle, “Seismic Analysis of R/c Frame Wall Structures”.

[5] Cengiz Ozmen, Ali Ishan Ubay, “Commonly Encountered Seismic Design Faults Due to Architectural Design of Residential Building in Turkey.”

[6] X.L. Lu, H. J. Jian, (2011), “Research and Practice of Response Control for Tall Buildings in Mainland China”.

[7] Nevzat Kirac, Mizam Dogan, Hakan Ozbasaran Eskisehir, (2010) “Failure of Weak – Storey During Earthquakes”.

[8] Semih S. Tezcan, Cenk Alhan, (2000) “Parametric Analysis of Irregular Structures Under Seismic Loading According to the New Turkish Earthquake code”.

[9] Pradip Sarkar, A. Meher Prasad, Devdas Menon, (2010), “Vertical Geometric Irregularity in Stepped Building Frames”.

[10] Yong Chul Kim, Jun Kanda, Yukio Tamura, (2011) “Wind – Induced Coupled Motion of Tall Buildings with Varying Square Plan With Height”, Journal of wind Engineering and Industrial Aerodynamics.

[11] Liang Su, Shi Lin Dong, Shiro Kato, (2006) “A New Average Response Spectrum Method for Linear Response Analysis of Structures to Spatial Earthquake Ground Motion”.

[12] Sean Wilkinson, David Thambiratnam, (2001), “Seismic Procedure for Seismic Analysis of Asymmetric Buildings”.

[13] Hon-Seon Lee, Dong – Wooko, (2007), “Seismic Response Characteristics of High Rise RC Wall Buildings Having Different Irregularities in Lower Stories”.

[14] Raul Gonzalez Herrera & Consuelo Gomez Sobero, (2008), “Influence of Plan Irregularity of Buildings”, 14th World Conference on Earthquake Engine.

[15] J. H. Cassis and E. Cornejo, “Influence of Vertical Irregularities in the Response of Earthquake Resistant Structures”, 11th World Conference on Earthquake Engineering, paper no.1102.