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COMPARATIVE STUDY OF RC BUILDING WITH & WITHOUT OPENING IN THE INFILL WALL USING RESPONE SPECTRUM METHOD

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Abstract **- In Reinforced concrete frames the masonry infill walls are a common practice in countries like India, where the region is prone to seismic activity. In general, the masonry infill walls are treated as nonstructural element in structural analysis and only the contribution of its mass for is considered and it's structural parameters like strength and stiffness is generally ignored in practice, such an approach may lead to an unsafe design. Infill walls resist lateral loads but because of the openings in the infill wall the resistance may slightly reduce. The IS code provisions do not provide guidelines for the analysis and design of RC frames with infill wall and for different percentage of openings. In this study is proposed to compare models of buildings considering the openings (10% of surface area) in the infill walls for the seismic behaviour. A G+13 residential building is considered in Zone III with soil type II and analysis is carried out by Response Spectrum Method. Various parameters are considered such as Natural Time period, Base shear, Storey displacement, and Storey stiffness were studied.**

Key words: Openings Infill Wall, Natural Time Period, Base Shear, Storey Shear, Storey Displacement, Storey Stiffness.

(1) INTRODUCTION

Earthquake is responsible for the ground motion in all directions, inducing the inertial forces on the structures. Thus the structure has to withstand lateral loads due to earthquake, wind loads along with the gravity loads. Nowadays RC frames are the common construction practice. The gap created between the columns, beams are filled by infill materials like bricks. Due to functional requirements the openings are provided in wall for windows, doors etc. The presence of infill walls increases the lateral stiffness, strength and reduces the fundamental period. The presence of openings in the infill walls can reduce some amount in the increase of lateral stiffness due to infill wall.

(2) OBJECTIVE OF STUDIES

To study the behavior of RC multi-storey residential building under gravity and earthquake loads.

i) To study the function of residential building considering with and without openings in the infill wall during seismic disturbances.

ii) To study the different factors such as natural time period, Storey displacement, stiffness, base shear of the models.

iii) To find optimized model under given loads.

(3) METHOD OF ANALYSIS: Response Spectrum Method: Response spectra are curves plotted between maximum response of SDOF system subjected to specified earthquake ground motion and its time period (or frequency). The maximum response is plotted against the undamped natural period and for various damping values and can be notified in terms of maximum relative velocity or else maximum relative displacement.

(a) **Natural Period**: Natural Period 'Tn' of a building is the time taken by it to undergo one complete cycle of oscillation. It is an essential property of a building controlled by its mass 'm' and stiffness 'k'. These three quantities are related by:

$$Tn = 2\Pi\sqrt{(m/k)}$$

Its units is seconds (s).

(b) **Base shear**: The design base shear of a structure shall be designed by:

$$V_b = A_h \times W$$

$$A_h = \frac{\left(\frac{Z}{2}\right)\left(\frac{Sa}{g}\right)}{\left(\frac{R}{I}\right)}$$

Where,

A_h = Design horizontal acceleration spectrum
W= Seismic weight of the building

(c) **Storey Shear** : The allocations of base shear at each storey of building is called storey shear, storey shear increases as the number of storey are increases.

(d) **Storey Displacement:** The storey displacement can be considered as the displacement of any storey of building with regarding to ground level due to lateral loads is referred as storey displacement.

According to EURO CODE 2004, permissible displacement is considered as H/250, Where H is total height of building above the ground level in millimeters (mm).

(e) **Storey Stiffness**: According to IS 1893-2016, soft story is define as story whose lateral stiffness value is less than that of story above.

Factors and Coefficients

Seismic Zone Factor, Z [IS 1893-2016 Table 2]
Response Reduction Factor, R [IS 1893-2016Table 7]
Importance Factor, I [IS 1893-2016 Table 6]
Soil Type [IS 1893-2016 Table 1]

(4) STRUCTURAL BUILDING DETAIL

The length and width of the building are 24m and 16m. The height of base floor is 3.2m and floor to floor height is 3m. The columns are assumed to be fixed at ground level. In this study, A G+13 storey RC building considering with and without openings in the infill walls. In this study, assume opening 10% of surface area. Below table shows details of the building that is used for the analysis of the building. The building has been analyzed using commercially available ETAB software.

Table 1: Description of the Building

S.No.	Structural component	Dimensions
1	Building Height	(G+13)
3	Beam Size	320mm X 320mm
4	Slab Thickness	140 mm
5	Wall Thickness	250mm
6	Plan Dimensions	24m x 16m (384 sq.m)
7	Length in X-direction	4m
8	Length in Y-direction	4m
9	Floor to Floor Height	3m
10	Base Floor Height	3.2m
11	Location	Sitapur (UP)
• **Opening Size = 1.2 sq.m (10% of 4x3 sq.m)**		

Table 2: Material Properties

S.No	Material	Grade
1	Reinforcement	HYSD FE500/Mild Steel Fe250
2	Concrete	M35
3	Young's modulus 'E'	$2.1x10^5 N/mm^2$
4	Shear modulus	$80000 N/mm^2$
5	Poisson's ratio	0.3

Table 3: SEISMIC DATA As per 1893:2016

1	Earthquake Zone	III
2	Zone Factor	Z = 0.16 (clause 6.4.2)
3	Damping Ratio	0.5
4	Importance Factor (I)	1.2 (clause 7.2.3)
5	Type of soil (Sa/g)	Medium soil(clause 6.4.2.1)
6	Response Reduction Factor (R)	5 (OMRF) (clause 7.2.6)

LOADINGS:

a) Imposed load 2 KN/m2 as per code IS 875 Part II
b) Dead Load of Building as per code IS: 875- Part (I)
c) Earthquake/Lateral load as per code IS 1893:2016 Part (I)

(5) PROBLEM FORMULATION

A residential reinforcement concrete building with and without opening in the infill walls at different location subjected to under earthquake loading as per IS code 1893:2016. Seismic analysis of RC building with and without opening (10% of surface area) at different location in the infill walls model is carry out Response Spectrum method by using ETAB software.

- Model 1 -RC Building (G+13) without Opening.
- Model 2 -RC Building (G+13) with Opening

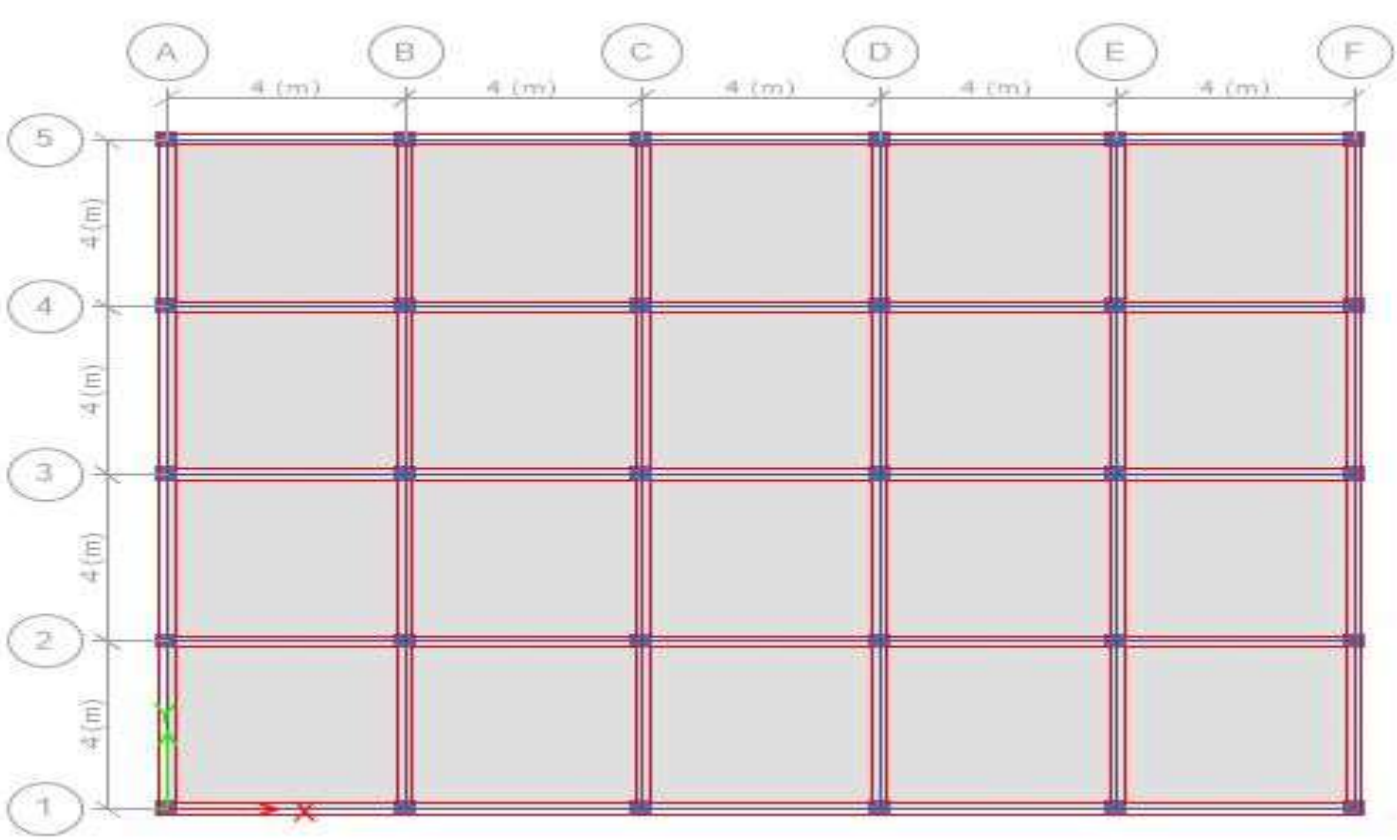


Fig:1 2D Plan of Model

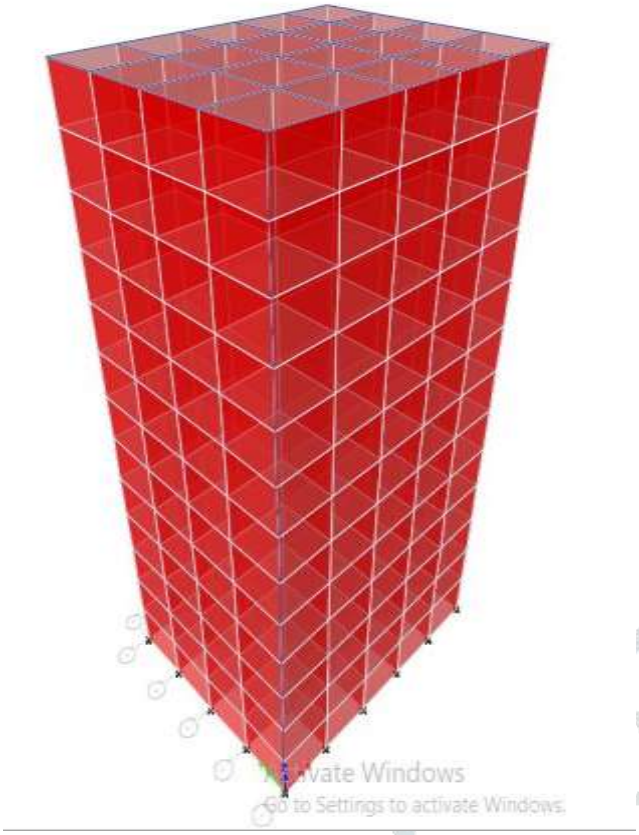


Fig:2 3D View of Model Without Opening

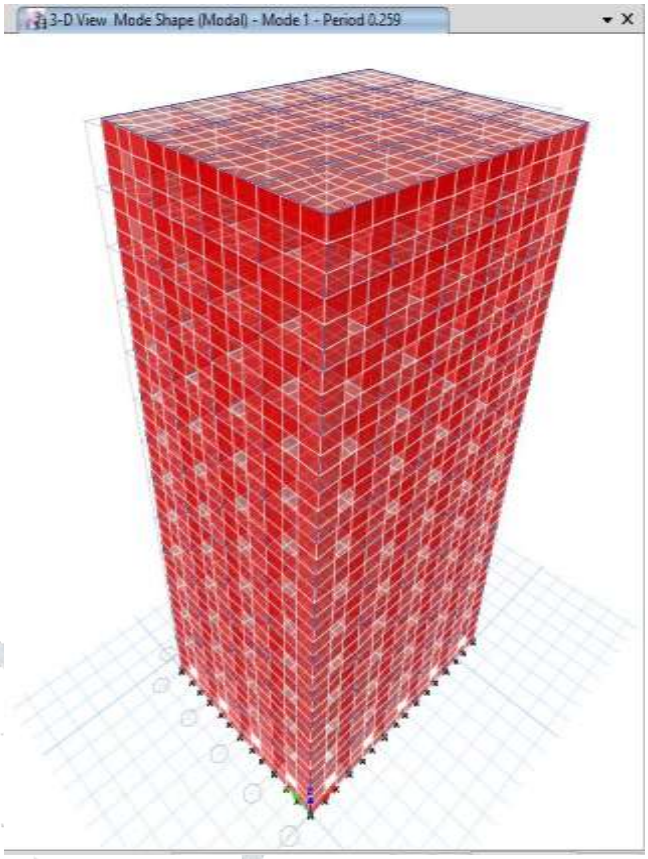


Fig:3 3D View of Model With Opening

(6) RESULT AND DISCUSSION

The parametric study of building in different stories by response spectrum analysis for (G+13) storeys is performed here. The results obtained from the analysis are compared by graphical representation:

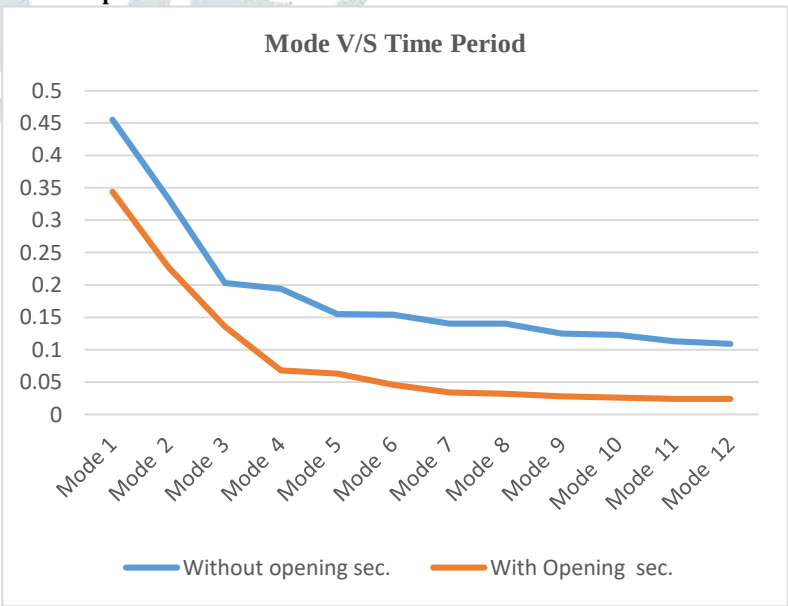
a) Natural Time period
b) Base Shear
c) Storey Displacement
d)Storey Stiffness

(a) NATURAL TIME PERIOD

Table 4: Natural Time Period

MODE	Without opening	With Opening
	sec.	sec.
Mode 1	0.456	0.343
Mode 2	0.334	0.226
Mode 3	0.204	0.135
Mode 4	0.195	0.067
Mode 5	0.156	0.062
Mode 6	0.155	0.045
Mode 7	0.145	0.033
Mode 8	0.141	0.031
Mode 9	0.126	0.027
Mode10	0.124	0.025
Mode 11	0.114	0.023
Mode 12	0.112	0.022

Graph 1: Mode v/s Time Period

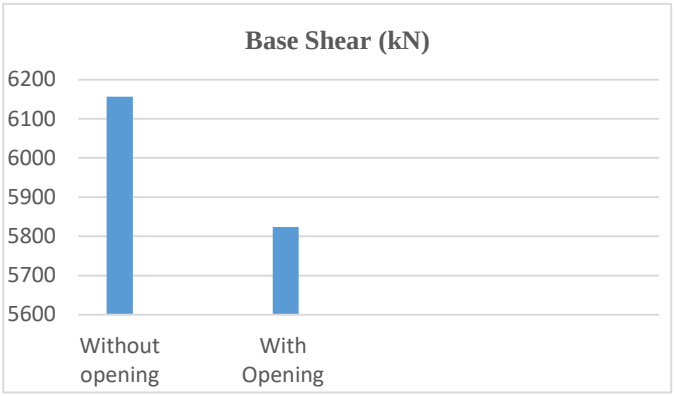


b) BASE SHEAR

Table 5: Base Shear

Model	Base Shear (kN)
Without opening	6158.5388
With Opening	5844.1967

Graph 2: Base Shear

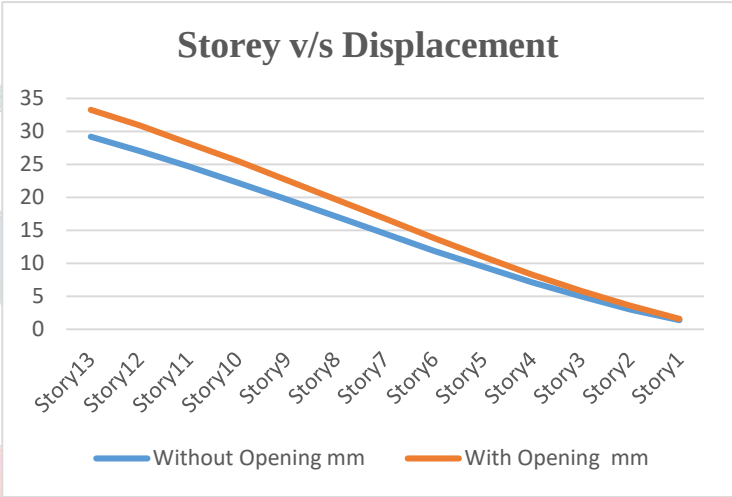


c) STOREY DISPLACEMENT

Table 6: Storey Displacement

Story	Without Opening	With Opening
	mm	mm
Story13	28.3	34.6
Story12	28	31.6
Story11	25.5	29.2
Story10	23.1	26.7
Story9	18.9	23.6
Story8	18.5	18.5
Story7	15.3	17.3
Story6	12.3	14.4
Story5	10.44	12.32
Story4	9.3	9.29
Story3	6	6.14
Story2	5	4.81
Story1	2.13	2.26

Graph 3: Storey Displacement

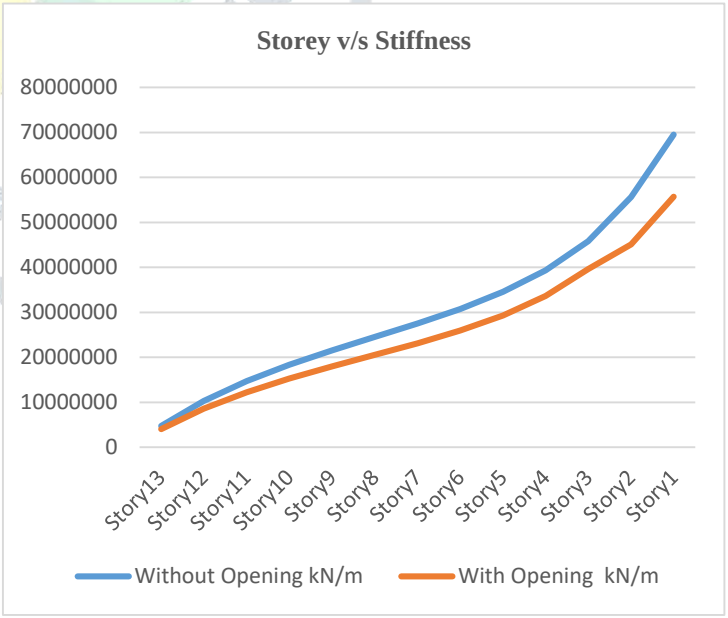


d) STOREY STIFFNESS

Table 7: Storey Stiffness

Story	Without Opening	With Opening
	kN/m	kN/m
Story13	5754716.1	440048.2
Story12	20327096	8691660.3
Story11	24749914	12355587
Story10	28385240	1628014
Story9	31548841	1872350
Story8	34516444	21567843
Story7	37504737	24149825
Story6	40756273	26987487
Story5	44563421	28334854
Story4	59345974	34618351
Story3	55830281	38631214
Story2	65612863	46073611
Story1	68530757	56684346

Graph 4: Storey Stiffness



(7) CONCLUSIONS

From the above work the following conclusion are given below:

i) From table 4 and graph 1 of Natural Time period v/s Mode, the result is that With Opening is having less value of Natural Time Period (sec) as compared with model having Without Opening in the Infill Wall and it is evaluated 32.26 % efficient as compared model.

ii) From table 5 & graph 2 of Base shear , the result is that Without Opening model is taking more value of Base shear (kN) as related with Openings and it is evaluated Without Opening model is 5.706 % efficient as compared to with Openings models.

iii) From table 6 and graph 3 of Storey Displacement v/s Storey, the analysis gives a result that Without Opening model is taking least value of Storey Displacement (mm) as related with Opening & it is evaluated 14.04 % efficient as compared model.

iv) From table 7 and graph 4 of Stiffness v/s Storey , the analysis gives a result that Without Opening model is taking more value of Stiffness (kN/m) as related with Opening & it is evaluated 24.87 % efficient as compared model.

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