# EFFECT OF OPENING SIZE ON AN R.C. MULTISTOREY BUILDING FRAME

Deepak Kumar Bandewar[1], Mr. Praveen Singh Tomar[2], Dr. Prakash Porey[3]
[1]*PG-Student, Department of Civil Engineering,*
[2,3]*Asso. Prof., Department of Civil Engineering,*
*Patel Institute of Engineering & Science, Bhopal, Madhya Pradesh, India*

***Abstract*- The recent earthquakes may damage the structures to a large extent. It is needed to provide the seismic resistant capacity to the structure and the way to provide the same to the structure can be due to different means. In this work, shear walls are used for the same purpose. Practically due to some reasons it may be possible to provide some openings on shear walls which can affect the structural stability of structure. The opening can be of different sizes. For the same purpose to determine the effect of opening sizes on some parameters such as maximum shear force and maximum bending moment are considered in this paper. In this work (G+5) storey R.C. building frame has been analyzed for seismic zone-II by using STAAD-pro. V8i (series4). Special moment resisting frames (SMRF) and medium soil type were used. The method used in this work is Equivalent Static Analysis method. There are various parameters were considered such as maximum shear force in Y–direction, maximum bending moment in Z-direction are taken to compare the result for different model. According to this analysis Model–IV is most effective one.**

***Index Terms*- Equivalent static analysis**, **shear wall, Staad-pro. v8i (series 4)package, SMRF, Medium soil,is 1893 (part-1)-2002**.

## I. INTRODUCTION

Occurrences of recent earthquakes in India and in different parts of the world and the resulting losses, especially human lives, have highlighted the structural inadequacy of buildings to carry seismic loads. There is an urgent need for assessment of the building for its present condition of its components and strength of materials. Further, seismic demand on critical individual components is determined using seismic analysis methods described in IS 1893 (Part1) for lateral forces prescribed for existing buildings in terms of seismic resistance. Reinforced concrete (RC) buildings often have *vertical plate-like* RC walls called *Shear Walls* in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along *both* length and width of buildings. Shear walls are like *vertically-oriented* wide *beams* that carry earthquake loads downwards to the foundation. The procedure is divided into several distinctive steps in order to create a solid feeling and confidence that R.C. building frame with openings on shear walls with varying sizes may also be designed as engineered construction. This work is done to analyze the effect of opening sizes on various parameters of building frames.

## II. LOADING CONSIDERATION

**Loads acting on the structure :**

- Dead Load (DL) and Live load (LL) : As per IS 875 (Part 1) (1987) and IS 875 (Part 2) (1987), respectively.
- Seismic load (SL): As per IS 1893 (Part 1) (2002) approach.
- DL: Self weight of the structure, Floor load and Wall loads.
- LL: Assumed Live load 3 kN/sq.m is considered for all floors (except top floor level) and 1.5 kN/sq.m for top floor level.
- SL: Zone: II (Z=0.1)
- Rock/soil type: Hard
- Rock and Soil site factor: 1
- Response reduction factor: 5
- Importance factor: 1
- Damping: 5%
- Depth of foundation: 2.5m

The preliminary data as is taken up for this study are given in table 1.

Table.1. Preliminary Data

| | |
|---|---|
| Number of storey | G+5 |
| Plan size | 9m x 9m<br>(Each grid size 3m x 3m) |
| Size of all columns | 400mm × 400 mm |
| Wall thickness<br>(including Plaster) | 230mm |

| | |
|---|---|
| Size of beams | 300mm × 230 mm |
| Total height | 18m |
| Floor to floor height | 3.0m |
| Ground storey height from Foundation | 3.0m |
| Depth of slab | 125 mm |

| | |
|---|---|
| Support condition | Fixed |
| Sizes of openings | 1. MODEL-I: NO OPENING<br>2. MODEL-II: 0.6m x 0.6m<br>3. MODEL- III: 1.2m x 1.2m<br>4. MODEL-IV: 1.8m x 1.8m |

## III. LITERATURE REVIEW

There are number of literatures available on multistorey buildings for seismic forces. Some of them are reviewed here. Anshuman. S, Dipendu Bhunia , Bhavin Ramjiyani [10] found the Solution of Shear Wall Location in Multistorey Building. Dr. Sudhir K Jain (IIT Kanpur) and Dr. R.K. Ingle (VNIT, Nagpur) [4] analyzed the seismic behaviour of an R.C. multistorey frame with R.C. rectangular shear walls at different location. Ashis Debashis Behera, K.C. Biswal [1] studies 3D Analysis of building frame using Staad Pro. However the study related to R.C Shear walls with openings of different sizes has not been yet done much.

## IV. OBJECTIVE OF STUDY

1) To understand the purpose of using shear wall using STAAD-pro. through this work.
2) To investigate an R.C. multistorey building frame using STAAD-pro.
3) To judge the effect of openings size on an R.C. shear wall in an R.C. Building frame.
4) To study the results of maximum node displacement and maximum reactions for different opening sizes on a shear wall.

## V. PROBLEM STATEMENT

The 3D views of the R.C. building frame with openings in shear walls at ground floor as shown in Fig.1. has been considered to carry out the present study. The size of the openings is varying for different models.

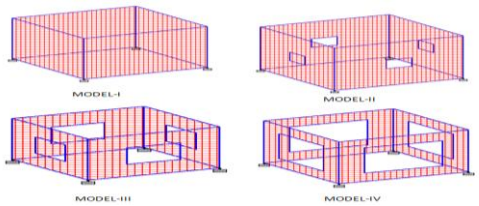



**Fig-1: Various models considered**

## VI. METHODOLOGY

Steps to model and analyze the R.C. building frame.

Firstly go to run structure wizard and select bay frame. Then follow the following steps given in Fig.2.

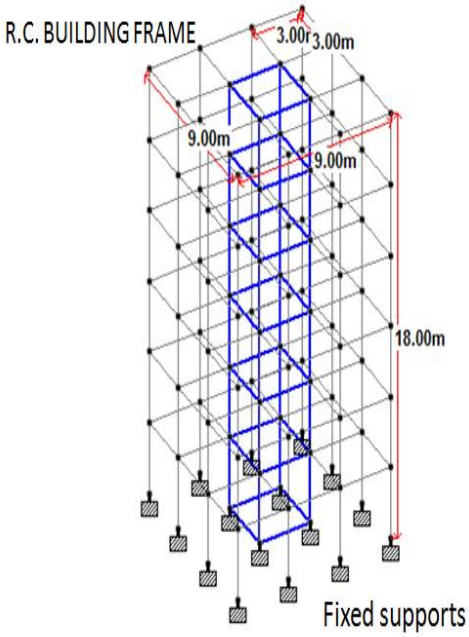



**Fig-2: 3-D view of model-I with dimensions**

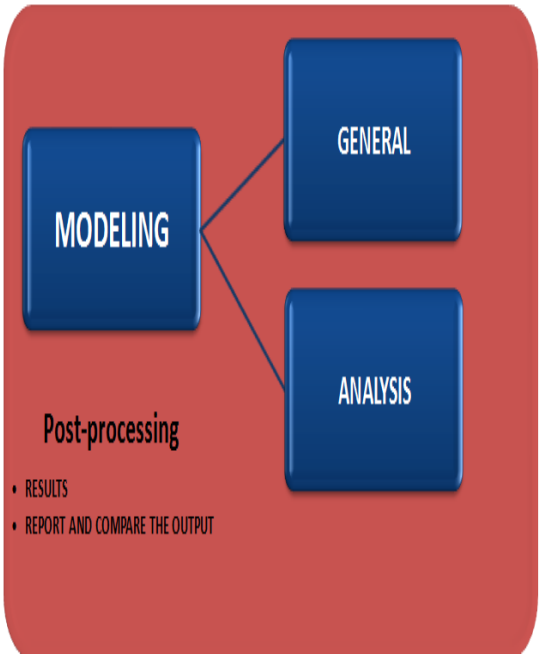



**Fig-3: Analysis steps**

## VII. RESULT AND GRAPHS

### 1. MAXIMUM SHEAR FORCE & MAXIMUM BENDING MOMENT

The maximum shear force is given in Table 3

**TABLE 3: MAXIMUM SHEAR FORCE (Y-DIRECTION)**

| MAX. SHEAR FORCE (KN) (Y-DIRECTION) | | | | |
|---|---|---|---|---|
| FLOOR LEVEL | Model-I | Model-II | Model-III | Model-IV |
| 1 | 66.326 | 66.351 | 66.308 | 66.221 |
| 2 | 67.483 | 67.491 | 67.436 | 67.302 |
| 3 | 69.046 | 69.060 | 69.021 | 68.843 |
| 4 | 70.208 | 70.220 | 70.200 | 70.027 |
| 5 | 71.006 | 71.017 | 70.997 | 70.821 |
| 6 | 37.796 | 37.797 | 37.795 | 37.794 |

The variation of shear forces along Y-direction are found in such a way that the values are increasing in Model-II as compared to Model-I. It is noticed that the least values of shear forces are for Model-IV for all floor level. The graphs for the maximum shear force is shown in figure 5.

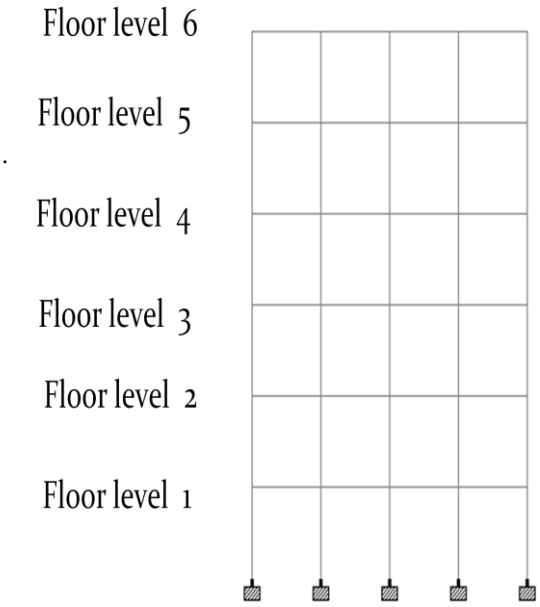
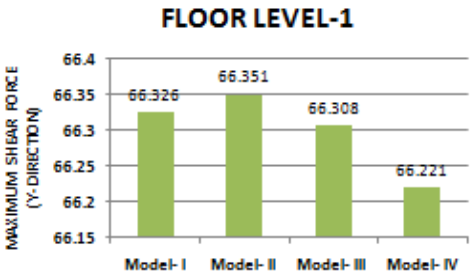
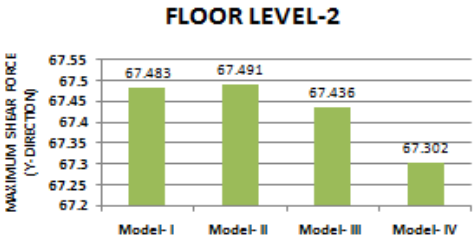
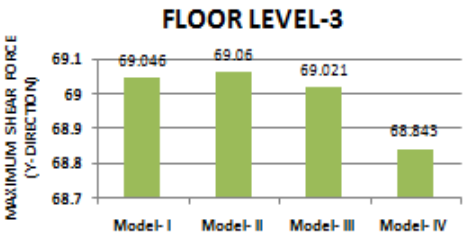
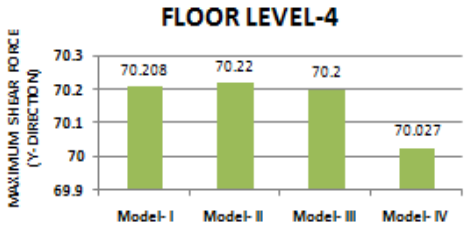


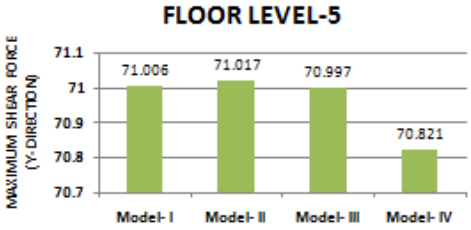

**Fig 4: Screenshot of different floor levels**

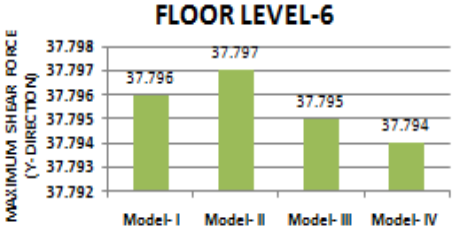


The maximum bending moment is given in Table 4

**TABLE 4: MAXIMUM BENDING MOMENT**

| MAX. BENDING MOMENT (KN-m) (Z-DIRECTION) | | | | |
|---|---|---|---|---|
| FLOOR LEVEL | Model- I | Model- II | Model- III | Model- IV |
| 1 | 36.927 | 36.905 | 36.922 | 36.923 |
| 2 | 36.836 | 36.801 | 36.830 | 36.831 |
| 3 | 38.378 | 38.330 | 38.240 | 37.944 |
| 4 | 40.276 | 40.199 | 40.109 | 39.822 |
| 5 | 41.429 | 41.351 | 41.261 | 40.969 |
| 6 | 23.088 | 23.026 | 22.951 | 22.713 |

The most reduced values of maximum bending moment in Z-direction is found at floor level 6 for all considered models. The graphs for the maximum bending moment is shown in figure 6

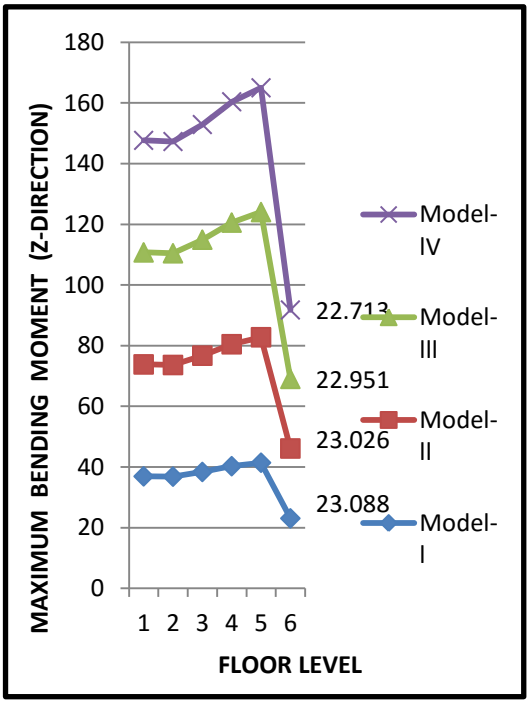



**Fig 6 : Maximum Bending Moment graph (Z- direction)**

## 2. TOTAL WEIGHT OF REINFORCEMENT

The values of total weight of reinforcement for beams and columns are given in Table 5 and variation of reinforcement for different models are given in figure 7.

The Total weight of reinforcement for beams & columns is given in Table 5

**TABLE 5: TOTAL WEIGHT OF REINFORCEMENT**

| Weight (N) | Model- I | Model- II | Model- III | Model- IV |
|---|---|---|---|---|
| | 70795 | 70792 | 70795 | 70769 |

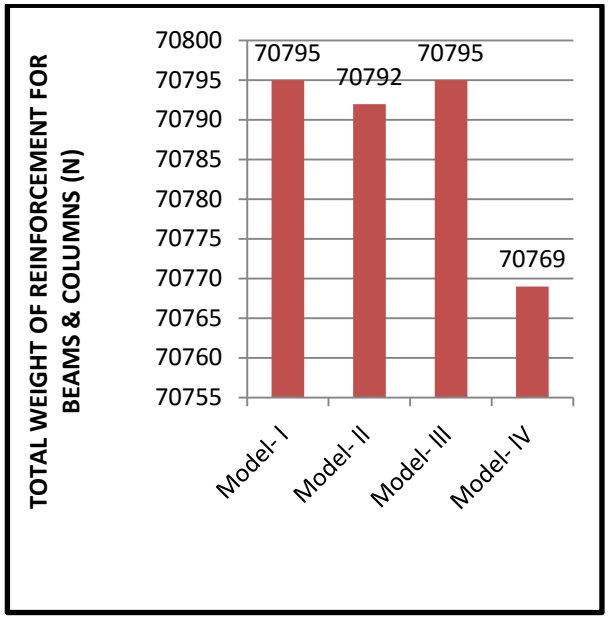



**Fig 7 : Total weight of reinforcement for beams & columns graph**

## VIII. DISCUSSIONS & RESULTS

### A. Maximum Shear Force

The values of maximum shear forces are increasing as the floor levels are increasing for each model. The values of maximum shear forces are most reduced for Model-IV w.r.t. Model- I i.e., 6.221, 67.302, 68.843, 70.027, 70.821, 37.794 for floor level 1,2,3,4,5 & 6 respectively. The maximum shear force was found

in each model for all floor levels and the least value is found for model-IV among all four models.

**B. Maximum Bending Moment**

The values of maximum bending moment are increasing as the floor levels are increasing for each model . The value of maximum bending moment is found least for Model-IV w.r.t. Model- I i.e., 22.713 for floor level 6. The values of maximum bending moment for model-IV are 36.923, 36.831, 37.944, 39.822, 40.969, 22.713 for floor levels 1, 2, 3, 4, 5 & 6 respectively.

**C. Total Weight of Reinforcement**

The total weight of reinforcement for beam and columns is found least for Model-lV i.e., 70769 N than Model-I.

## IX. CONCLUSION.

The behavior of an R.C. building was analyzed with shear walls having openings of varying sizes. There are the following parameters considered and concluded as follows:

**A. Maximum Shear Force :**

The maximum shear force was found in each model for all floor levels and the least value was found for Model II w.r.t. Model-I.

**B. Maximum Bending Moment :**

The maximum bending moment was found in each model for all floor levels and the least value was found for Model-lV among all four models and the maximum bending moment for Model-II is found at floor level 1.

**C. Total Weight of Reinforcement**

The total weight of reinforcement for beam and columns is found least for Model-lV i.e., 70769 N. Therefore the overall conclusion is that Model-IV is the most effective among all other Models.

## REFERENCES

[1] Ashis Debashis Behera, K.C. Biswal "3D ANALYSIS OF BUILDING FRAME USING STAAD PRO." NIT ROURKELA

[2] Sachdeva Gourav, Jain Rajesh, Chandak Rajeev, "SEISMIC BEHAVIOUR OF AN R.C. MULTISTOREY FRAME WITH R.C. RECTANGULAR SHEAR WALLS AT DIFFERENT LOCATION", IJIRST, Volume 2, Issue 05, October 2015,ISSN (online): 2349- 6010

[3] IS: 1893-2002 (part-1) "CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES" fifth revision, Bureau of Indian Standards, New Delhi.

[4] Dr. Sudhir K Jain (IIT Kanpur) and Dr. R.K. Ingle (VNIT, Nagpur) "EXPLANATORY EXAMPLES FOR DUCTILE DETAILING OF RC BUILDING" IITK-GSDMA-EQ22- V3.0

[5] IS: 875-1987 (part-2) for Live Loads or Imposed Loads, code practice of Design loads (other than earthquake) for buildings and structures.

[6] Bureau of Indian Standards: IS:875-1987, (part 1), Dead Loads on Buildings and Structures, New Delhi, India.

[7] Bureau of Indian Standards: IS:875-1987, (part 1), Dead Loads on Buildings and Structures, New Delhi, India.

[8] P.C.Varghese, "Advanced Reinforced Concrete Design", Second Edition.

[9] Pankaj Agrawal and Manish Shrikhande "Earthquake resistant design of structure" Third Printing

[10] Anshuman. S, Dipendu Bhunia , Bhavin Ramjiyani, "SOLUTION OF SHEAR WALL LOCATION IN MULTISTOREY BUILDING", International Journal of Civil and Structural Engineering, Volume 2, No 2, 2011,493-506.

[11] Dr. Sudhir K Jain (IIT Kanpur) and Dr. H.J.Shah (M.S.University of Baroda, Vadodara) "Design Example of a Six Storey Building" IITK-GSDMA-EQ26-V3.0

[12] Arvind Vinayakrao Achole, Dr. G.N. Ronghe " Behaviour of building frames with steel plate shear walls " VNIT NAGPUR (2006)

[13] Anand, N, Mightraj, C.Prince Arulraj, G. "Seismic Behaviour of RCC Shear Wall Under Different Soil Conditions" IGS Mumbai & IIT Bombay, (2010)