International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 05, May-2019

Comparative Study of various Infill Walls

Syed Raheel Ahmed[1], Prof. Aditi H. Deshmukh [2],

[1]*P.G Student, Civil Engineering Department, College of engineering& Technology, Akola, Akola, 444001India*
[2]*Assistant Professor, Civil Engineering Department, College of engineering& Technology, Akola, Akola, 444001India*

Abstract - It was intended to study the Comparative analysis and design of framed structure with different type of infill walls. Due to the lack of well accepted seismic design basis past engineers incline to treat the infill as a non-structural element that is the strength and stiffness characteristics are not considered in the design. Many researchers developed a number a macro-model to include the strength and stiffness parameters but by far, the equivalent diagonal strut model is more popular. Therefore, it is crucial to understand the contribution of infill walls to earthquake response of the Structures. In this study, an attempt is made to do comparative analysis and design of the structure when the structure is modelled using different types of infill walls. In this study, A R/C frame structure with different type of infill walls like AAC Block, Clay Brick, Fly Ash, Concrete block are considered to investigate the effect of different types of infill walls on earthquake response of the structures. The RCC frame analyzed & designed by using STAAD-Pro software. The diagonal strut approach is adopted for modelling of infill walls. The analytical results of the building frame will be compared and analyzed to obtain are, base shear, Lateral displacement, and Seismic weight, quantity of steel, shear force and bending moment when subjected to static earthquake loadings.

***Key Words*: stiffness, infill, AAC Block, Clay Brick, Fly Ash, Concrete block, diagonal strut, STAAD-Pro.**

1. INTRODUCTION

In reinforced concrete frame building, wall are generally used in as infill's and specified by architects as partitions in such a way that they do not contribute to the vertical gravity load bearing capacity of the structure. Infill walls protect the inside of the buildings from the environment hazards and create separation insides. In addition to this infill's have a considerable strength and stiffness and they have significant effect on the seismic response of the structural systems. Recently, it becomes important to determine the earthquake behavior of structures with infill Walls in earthquake engineering.

2. Literature review

On the basis of the topic selected various literatures were gone through on the reasons and findings related to infill. The literatures were studies on

- The behaviour of reinforced concrete frames with infill.
- Study on earthquake analysis of multi-storeyed buildings.
- Modelling methodology of infills
- Study of various infills.

The secondary data from various research journals as well as reports are studied and some important learning are mentioned below.

Polyakov (1956) et al [1] the study of the complicated behavior of masonry infill by suggested that the infill and frame disparate excluding at two compression corners. He established the idea of equivalent diagonal strut and proposed that transformation of stresses from the frame to infill occurs only in the compression zone of the infill.

Fardis (1996) et al [2] investigated the seismic response of an infilled frame which had weak frames with strong infill material. It was found that the strong infill which was considered as non-structural is responsible for earthquake resistance of weak reinforced concrete frames. However, since the behavior of infill is unpredictable, with the likelihood of failing in brittle manner, it was recommended to treat infill as non-structural component by isolating it from frames. On the contrary, since infill is extensively used, it would be cost effective if positive effects of infill is utilized.

Nasratullah Zahir, Dr. Vivek Garg et al [3] paper present static and dynamic analysis of R.C building frame with infill The results obtain from the analysis indicates that story shear increase for infill frame models compare to bare frame model by equivalent static method and response spectrum method. This increase in ratio is found to be more at roof compared to base of structure. The story shear values obtained by Smith and Holmes models are found to be more compared to Paulay and infill panel models.

Rahul P. Rathi , Dr. P.S. Pajgade et al [3] In this paper actual building such as college building (G+3) is considered by modeling of frame and Infills. Modelling of infills is done as per actual size of openings with the help of equivalent diagonal strut method for the various model such as bare frame, infill frame and infill frame with center and corner opening. Results indicate that infill panels have a large effect on the behavior of frames under earthquake excitation. In general, infill panels increase stiffness of the structure. The increase in the opening percentage leads to a decrease on the lateral stiffness of infilled frame.

3. METHODOLOGY

This research work on comparison of seismic analysis and design of G+15 building using different types of infill walls. Which include

1. Bare frame Model
2. Clay Brick Model
3. AAC block Model
4. Fly Ash brick Model
5. Concrete Block Model

4. DETAILS OF STRUCTURAL ELEMENTS AND MATERIAL USED

Type of Structure	G+15 RC Frame Building
Plan dimensions	13.62 m × 16.30 m
Total height of building	51.20 m
Height of each storey	3.2 m
Foundation Level to ground Level	3 m
Size of beams	300mm×450mm
Size of columns	600mm×750mm
Thickness of slab	125mm
Grade of Concrete	M25
Grade of Steel	Fe415
Seismic Analysis	Equivalent Static Method (IS1893-2002) clause 7.8.1 (a).
Design Philosophy	Limit State Method Conforming (IS456-2000)
Ductility Design	IS 13920-1993
Seismic zone	II
Response reduction factor (R)	5
Soil type	medium
Importance Factor (I)	1
Damping	5%
Time Period in X direction	1.39 sec (IS1893-2002) clause 7.6.2
Time Period in Z direction	1.27 sec (IS1893-2002) clause 7.6.2

Concrete:

Density of Concrete	25 kN/m^3
Modulus of Elasticity	$5000\sqrt{fck}$ = 25000 N/mm^2
Poisson’s ratio for concrete	0.17
Compressive strength	25 N/mm^2

Masonry Clay Brick infill:

Size	210 mm x 100 mm x 75 mm
Density	19 kN/m^3
Poisson’s ratio	0.16
Compressive strength	3.745 N/mm^2
Modulus of Elasticity	8675 N/mm^2

AAC Block infill:

Size	200 mm x 200 mm x 624 mm
Density	5.5 kN/m^3
Poisson’s ratio	0.25
Compressive strength	2.2 N/mm^2
Modulus of Elasticity	1600 N/mm^2

Fly Ash Brick infill:

Size	215 mm x 110 mm x 75 mm
Density	18 kN/m^3
Poisson's ratio	0.15
Compressive strength	5.203 N/mm^2
Modulus of Elasticity	10470 N/mm^2

Concrete Block infill:

Size	150 mm x 200 mm x 400 mm
Density	20 kN/m^3
Poisson's ratio	0.17
Compressive strength	4.50 N/mm^2
Modulus of Elasticity	6000 N/mm^2

5. CALCULATION OF THE WIDTH OF EQUIVALENT DIAGONAL STRUT

In this method the analysis is carried out by simulating the action of infills similar to that of diagonal struts bracing the frame. The infills are replaced by an equivalent strut of length D, and width W, and the analysis of the frame-strut system is carried out using usual frame analysis methods. Second stage analysis and design has been carried out by software STAAD- Pro then different parameters has been computed. The relationships proposed by Mainstone Walls have to resist the shear forces that try to push the walls over for computing the width of the equivalent diagonal strut, is widely used in the literature and is given by.

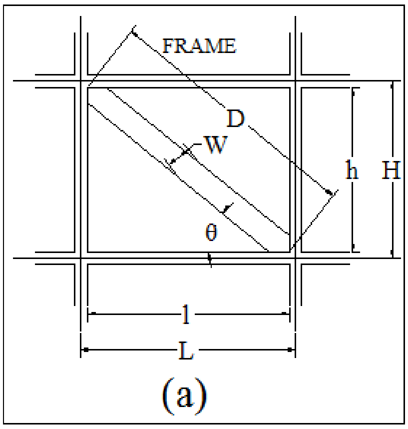

Figure no 1: shows equivalent diagonal strut model

$$\lambda = \sqrt[4]{\frac{E_i t \sin(2\theta)}{4E_f I_c h'}}$$

Where
λ =Stiffness reduction factor
Ei = the modules of elasticity of the infill material, N/mm2
Ef= the modules of elasticity of the frame material, N/mm2
Ic= the moment of inertia of column, mm4
t = the thickness of infill, mm
H =the center line height of frames
h = the height of infill
L =the center line width of frames
l = the width of infill
D = the diagonal length of infill panel
θ = the slope of infill diagonal to the horizontal.

Width of strut (W)
W= 0.175 $(\lambda H)^{-0.4}$ D

6. Results & Discussion

6.1 Nodal Displacements

The graph shows the comparative nodal displacement values for all the five models with respect to floor level. It is cleared that the nodal displacement is maximum for the upper storey and gradually reduces up to ground level. Further its it is found that the nodal displacement value is minimum for fly ash infill walls model where as its maximum for the bare frame i.e. for floor no 17, 0.874 cm minimum in X direction and 5.2625 cm maximum in Z direction as in table 5.1.Compartively the displacement is more for the model no 3 i.e. of AAC block Infill as compared to all other model.

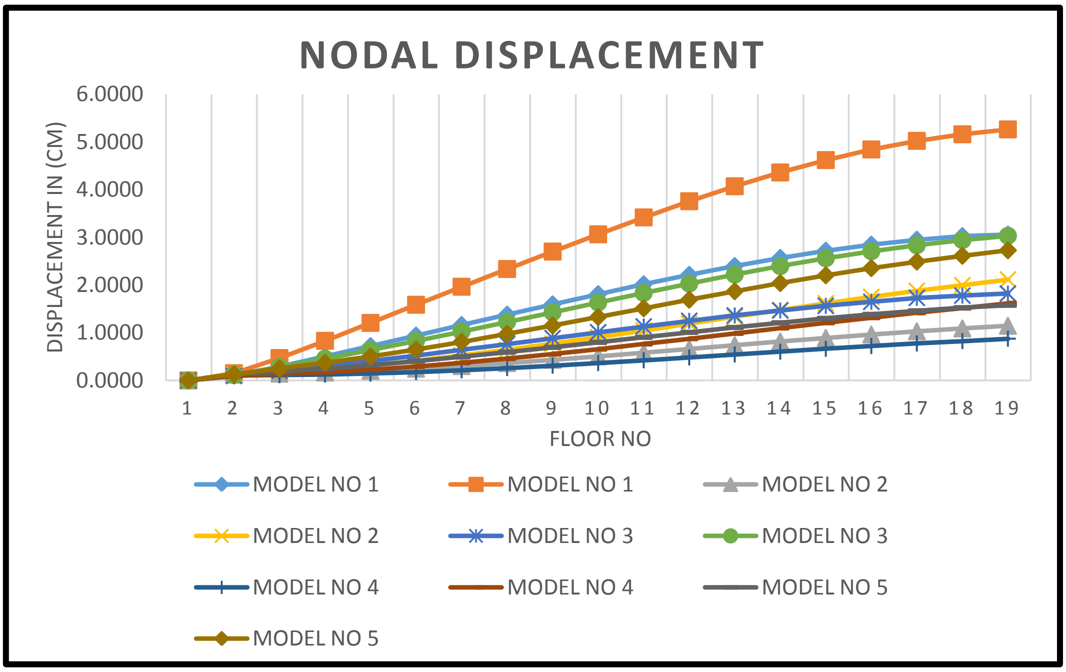

Figure no -3: shows graph of nodal displacement

6.2 Total Lateral Displacement of Building at Top Storey

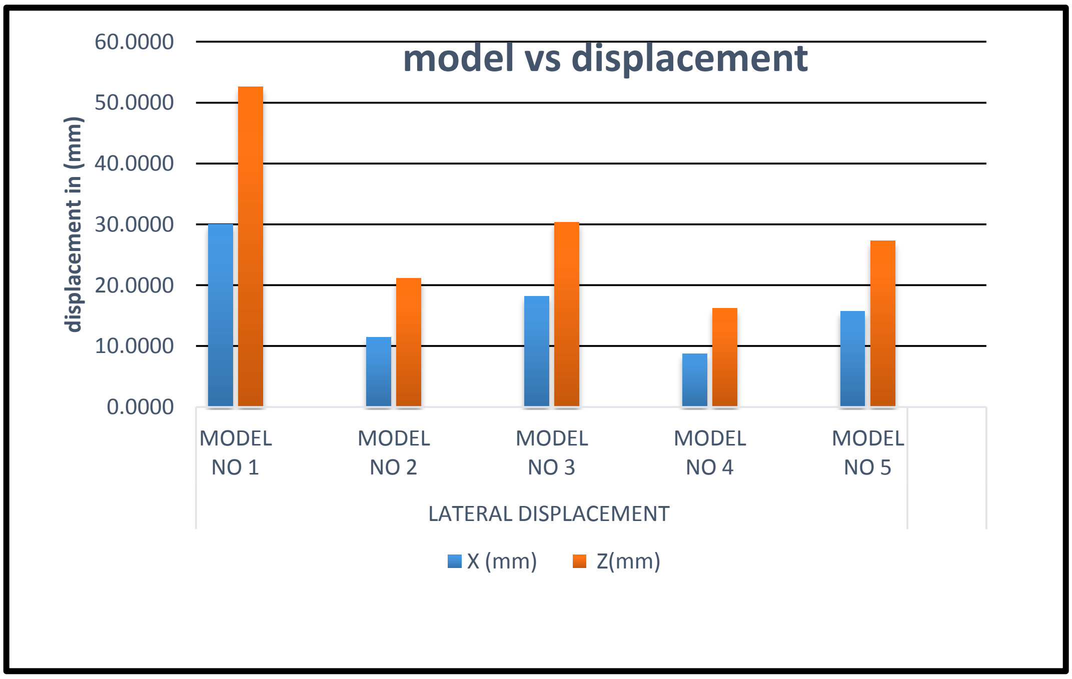

Figure no -4: shows graph of model displacement

From graph shown in fig 4 it's observed that the lateral displacement at top storey for model 1 bare frame is maximum as compared to other model as the displacement is inversely proportional to the stiffness. Hence Model 1 has smaller stiffness so it has largest displacement and model 4 fly ash brick infill model have minimum displacement then all other models.

6.3 Base Shear

From graph shown in figure 5 it is observed that out of X & Z direction base shear is more in the Z direction for all the five model. Out of all the five model the base shear value is maximum for the model no 2 Clay brick infill frame i.e.

1337.31 KN in Z direction. Whereas the minimum base shear value is for model no 1 bare frame i.e. 796.73 KN. Comparatively AAC block infill model have minimum base shear values than all other infill models.

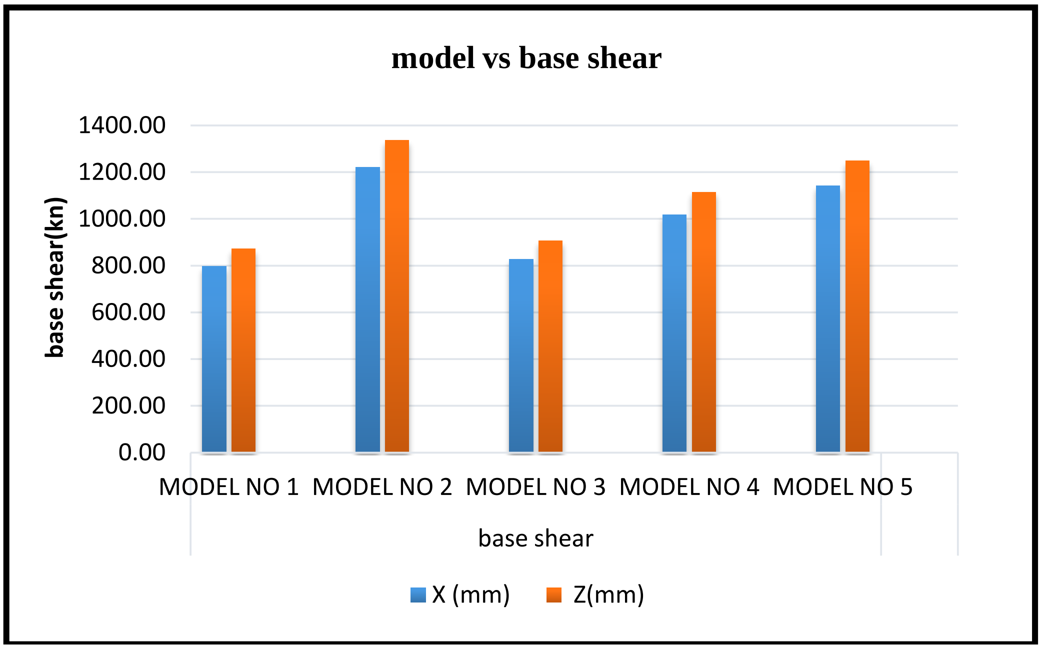

Fig-5: shows graph of base shear of all models

6.4 Shear Force and Bending Moment

The data for shear force and Bending moment collected from staad pro results for members no 88,125,249,373,497,621,745,869,993,1117,1241,1365,1489,1613,1737,1861,1985 for all five models it is observed that **t**he column shear force value more for model 1,2,3,5 and is less for model 4 fly ash brick infill model similarly the bending moment value for the model 1,2,3,5 is more. Whereas it is less for model no 4 as the bending moment is maximum for ground floor members and gradually decreases towards top floor members.

6.5 STEEL AND CONCRETE TAKE OFF

The amount of brick work from above excel sheets and quantity of steel and concrete is obtain from staad pro output results and tabulated in table 1 below.

Table.1 Brick Work, Concrete and steel take off

Take off			
Model no	**Brick Work Amount (Rs)**	**Concrete (cum)**	**Steel (tonne)**
1.Bare Frame	0.00	1165.3	87.02
2.Clay Brick	8086148.5	1165.3	91.88
3.AAC Block	9189942.96	1165.3	86.89
4.Fly Ash Brick	8046242.73	1165.3	87.51
5.Concrete Block	5613657.72	1165.3	90.17

From table 1 its observed that the AAC block infill have maximum construction cost compare to all other model as the rates of AAC block is 6333 Rs per cum given in SSR 18-19 that is more than all other model. On the other hand Concrete block brick work costing is minimum as rates and width of bricks is less compared to all other model. The concrete quantity is same for all models obtain from staad pro output result. On the other hand model 1 have minimum steel quantity of 87.02 tonne as it is bare frame model. Model 2 have maximum steel take off of 91.88 tonne, as its brick infill model. Model 3 AAC block model have minimum steel take off compare to another infill models. Fly Ash brick have less construction cost then clay brick and AAC block infill and steel take off is also less than clay brick infill but slightly more than AAC block infill model.

8. CONCLUSIONS

It was intended to study the Comparative analysis and design of framed structure with different type of infill walls. On the basis of modeling and analysis results of all the five model considered, the observation table and remark are drawn. From that observations following conclusion can be made out.

From the observation of the results in it is states that nodal displacement value for all other models is reduced as compare to model 1 as model 1 is bare frame model. Model 4 fly ash infill have minimum nodal displacement at all floor levels.

Further it is seen that strut model buildings has less displacement and then bare-frame buildings. It's because of increases in stiffness of the building model due to provision of strut in the frame. Fly ash brick model have minimum displacement as the properties of fly ash have beetr effect on lateral resistivity of strut in frame.

From the results it is concluded that due to infill walls in building the base shear is increased because of increased in seismic weight of the structure. Model 2 Clay brick infill model have maximum base shear as its seismic weight is more compare to all other model and base shear is minimum for bare frame.

From the observation the shear force and the bending moment value is less for the model made up of fly ash infill whereas it is more for bare frame model. The properties of infill wall material influence the shear force and bending moment.

Since computationally take of concrete and steel can be obtain the further quantity estimate for the infill wall material is done and it is shows that from the observation of the results in table 1 the use of AAC block, steel requirement will be less as seen from observation. But cost of brick work is more than all other model. One the other hand for fly ash brick infill there is 12.44% reduction in cost as compared to AAC block infill. For clay brick and concrete block infill steel take off is more then fly ash brick infill model.

From over all study it can be concluded that Fly Ash infill is more better than Clay Brick ,AAC Block, Concrete Block infills as it strength the lateral stability and resistivity and more economical as compared to all other infill models.

8.2 Limitation

The following limitation of the presented work.

- The analysis is done by static method and the output my change with the application of dynamic method.
- The change in the seismic severity may change the behaviour of structure.
- The equivalent formulation as suggested by various researcher will change the dimension and the total weight of strut, resulting into change in dependent output.

8.3 Future Scope

- The comparative analysis for various equivalent strut formulation can be done.so as to check the efficiency of formulation.
- The actual comparison by creating the infill plates of different material can be done.
- The same study can be carried out on asymmetric buildings and dynamic analysis can be performed with change in seismic severity.
- To investigate modelling of infill with consideration of opening.
- The same study can be carried out using different software like Etabs, Ensys.

REFERENCES

[1] IS 456-2000 Plain and Reinforced Concrete

[2] IS 1893 (Part 1): 2002 Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings (Fifth Revision)

[3] IS 13920: 1993.Ductile Detailing Of Reinforced. Concrete Structures Subjected To Seismic Forces -Code Of Practice. (Third Reprint November 1996).

[4] IS 2185 Concrete masonry units (Part 1): 1979 Hollow and solid concrete blocks (second revision)

[5] IS 2185 Concrete masonry units (Part 3): 1984 Autoclaved cellular aerated concrete blocks (first revision)

[6] IS 1077 : 1992 Common burnt clay building bricks (fifth revision)

[7] Earthquake Resistant Design of Structures Sk Duggal, Oxford, 2007

[8] Illustrated Design of Reinforced Concrete Building (Seventh edition), Dr.V.L.Shah & S.R Karve

[9] Nasratullah Zahir, Dr. Vivek Garg et al "Static and dynamic analysis of R.C building frame with infill" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 07 July -2017

[10] Rahul P. Rathi , Dr. P.S. Pajgade et al "Study of Masonry Infilled R.C. Frame With & Without Opening" International Journal of Scientific & Engineering Research Volume 3, Issue 6, June-2012 1 ISSN 2229-5518