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Stress Distribution of Different Shapes of Opening in Shear Wall

Shubham Subhash Chaudhary[1] | Dr. S. R. Parekar[2]

[1]PG Student, Department of Civil Engineering, AISSMS College of Engineering, Pune, Maharashtra, India

[2] Associate Professor, Department of Civil Engineering, AISSMS College of Engineering, Pune, Maharashtra, India

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ABSTRACT

Shear wall with openings are provided in apartment buildings so as to serve the purpose of windows in external walls or for doors ways or corridors in internal walls. Hence, to provide opening in wall the effect of different shape of opening is governed. The main aim is to find the effective shape which shows relatively similar or lesser results as rectangular opening and make it advantageous in architectural point of view. In order to minimize the effect of load at opening in the wall, different shapes such as rectangular, semi-circular, triangular etc. are analyzed. In present work, static analysis is performed by using ANSYS 16.0 software, in which parameters such as stress strain and deformation is obtained in the form of load transfer path. Maximum and minimum values are compared between the rectangular, semicircular and triangular shapes of specimen. The dimension of specimens are same in all cases , only the shape is varying.

KEYWORDS: *shear wall, opening, shapes of opening, ansys16.0 , static analysis, stress, strain, deformation.*

I. INTRODUCTION

Lateral forces caused by wind, earthquake, etc. causes structures to shake and vibrate and moreover to displace from their original position. These forces need to be well resisted so as to provide comfort to the occupants residing in it. Shear wall is a structural member which is employed to resist the lateral force. Shear walls are placed parallel to the plane of the wall, thus providing adequate strength and stiffness to control lateral displacements.

The behaviour of structure during earthquake and wind excitations is governed by the shape of openings and planed position of the shear wall. Speaking theoretically, centre of each half of the building, is the best position for the shear walls. In day-to-day practice, walls are placed at the ends, since it utilizes the lot of space in structure frame work. With respect to these, walls around lift shafts and stairwells are used.

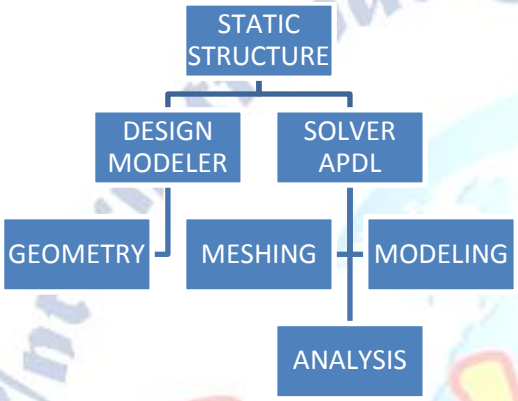
Fig. 1: Shear wall with Opening

Types of shear wall are as follows:
1. Reinforced concrete shear wall
2. Concrete block shear wall
3. Mid-ply shear wall
4. Plywood shear wall
5. Steel shear wall

II. METHODOLOGY

Methodology

Following step by step procedure is followed in ANSYS 16.0:



1. Geometry

In ANSYS 16.0 geometry can either be created or can be imported from other software in ACIS format which makes work easy. Following below geometry is imported from REVIT software.

The dimensions of the shear wall specimen taken are as follows:
1) Thickness of wall - 150mm
2) Width of wall - 6000mm
3)Height of wall - 3000mm
4) Size of opening - 1000mm X 2100mm

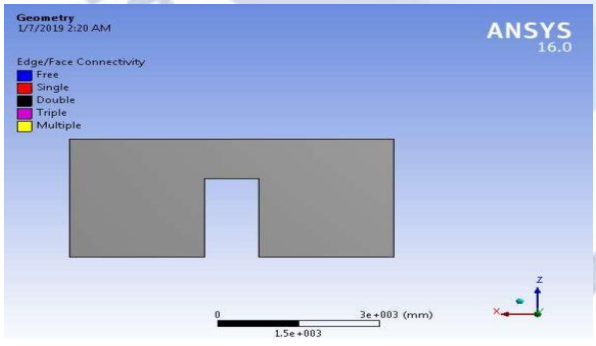


Fig. 2: Geometry

2. Modeling

Modeling is done after deciding the proper geometry and dimension of the model specimen. In modeling, supports and loading conditions are applied. All other specimen dimensions are similar, only the shape of opening is changed.

3. Meshing

Meshing is done to divide the model specimen in finite parts in order to find the stresses are specified point. Sizing of mesh can be done in meshing in order to get more suitable results.

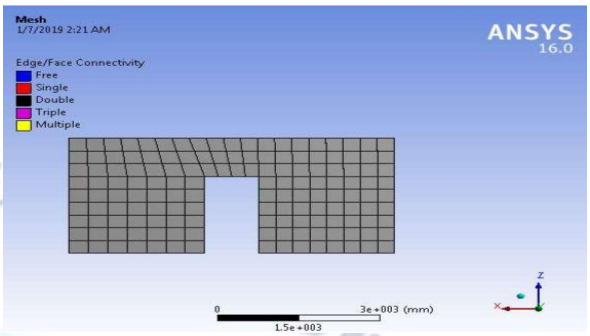


Fig. 3: Meshing

4. Analysis

In Analysis, stress strain and deformation pattern of the shear wall with opening are obtained . The load applied on all three specimens is similar that is 6000KN.

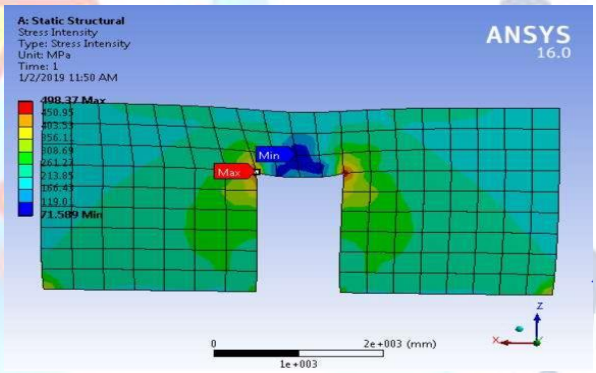


Fig. 4: Stress Pattern Analysis

5. Solution

After analysis results are obtained in the form of solution. The parameters such as stress strain deformation and strain energy are selected, which are to be worked out. Results below show the stress distribution pattern and load transfer path.

III. RESULTS

Preparing geometry, model and performing static analysis in ANSYS 16.0 following results are obtained:

1) Stresses obtained are as follows:

Table 1: Stresses in Mpa

Sr. No.	Type of opening	Maximum	Minimum
1	Rectangular	25.29	1.36
2	Semicircular	18.90	0.29
3	Triangular	27.33	0.12

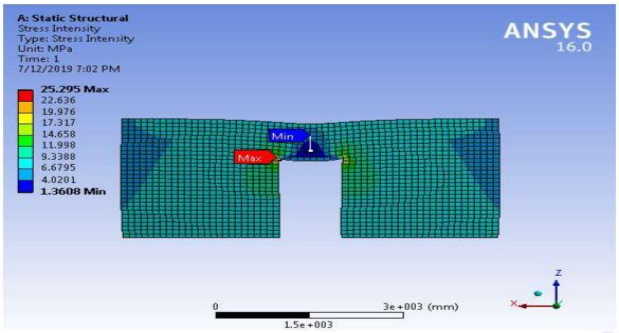


Fig. 5: Stress In Rectangular Opening

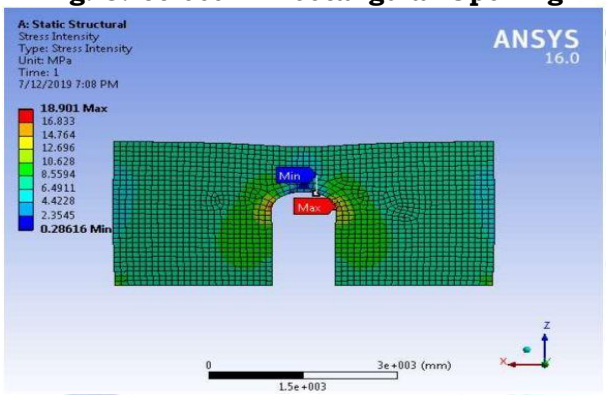


Fig. 6: Stress in Semicircular Opening

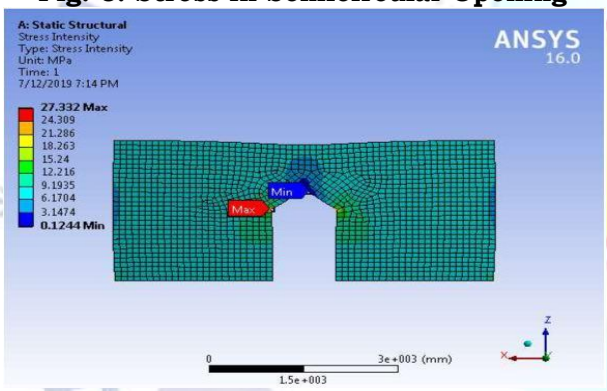


Fig. 7: Stress in Triangular Opening

2) Strains obtained are as follows:

Table 2: Strain in mm/mm

Sr. No.	Type of opening	Maximum	Minimum
1	Rectangular	$9.90*10^{-4}$	$5.35*10^{-5}$
2	Semicircular	$7.40*10^{-4}$	$1.15*10^{-5}$
3	Triangular	$1.00*10^{-3}$	$4.98*10^{-6}$

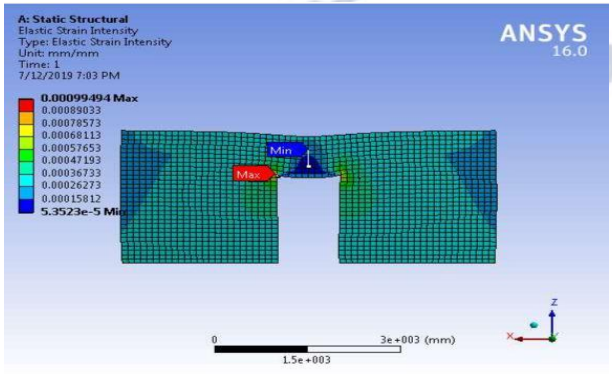


Fig. 8: Strain In Rectangular Opening

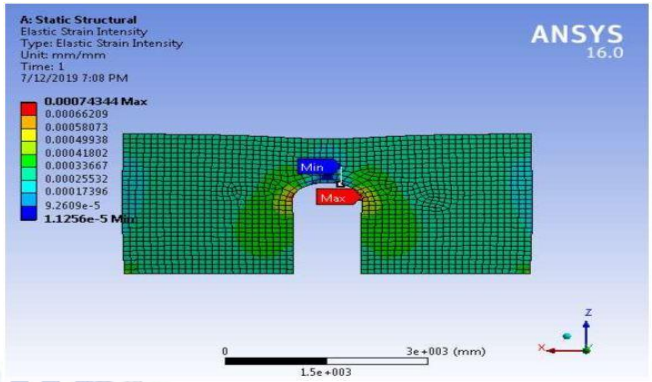


Fig. 9: Strain in Semicircular Opening

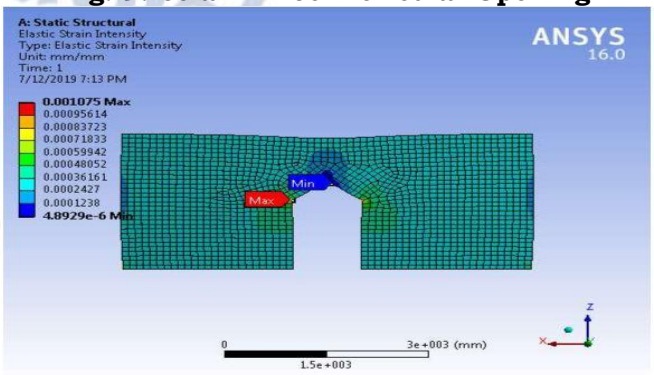


Fig. 10: Strain in Triangular Opening

Table 3: Deformation in mm

Sr. No.	Type of opening	Maximum	Minimum
1	Rectangular	1.07	0.00
2	Semicircular	0.97	0.00
3	Triangular	0.93	0.00

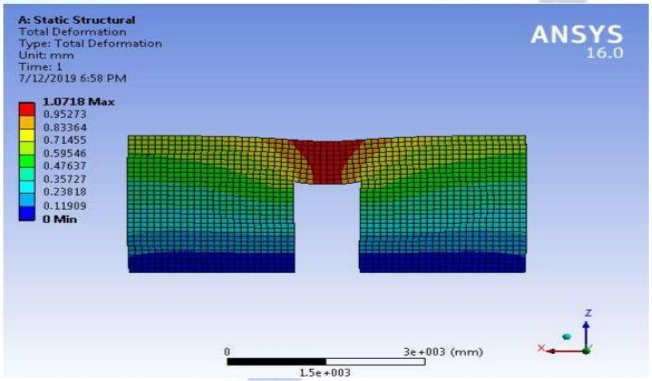


Fig. 11: Deformation In Rectangular Opening

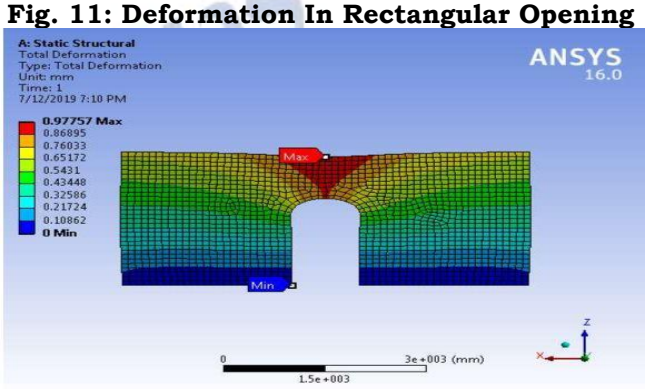


Fig. 12: Deformation in Semicircular Opening

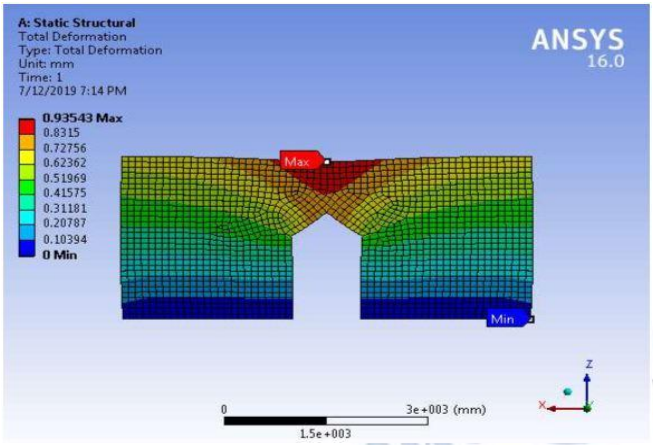


Fig. 13: Deformation in Triangular Opening

IV. DISCUSSION

Discussions from above results are as follows:

Table 1 shows the maximum and minimum stresses obtained by doing static analysis on shear wall specimen. **Fig. 5**, **Fig. 6** and **Fig. 7** represent the values that are tabulated in **Table 1**. It defines the stress pattern of applied load which shows the concentration of stress at sharp edges. Comparing the values of stress triangular opening shows high values than that of rectangular and semicircular. Since that edges are sharp in triangular opening it shows high concentration of stresses as show in **Fig. 7.**

Results of elastic strain obtained are tabulated in **Table 2**, for which **Figure 8, 9** and **10** represents strain flow pattern for rectangular, semicircular and triangular opening in shear wall with opening respectively. Since strain is defined as ratio of change in dimension to original dimension in terms of linear dimension, therefore it is unit less. Name itself specifies the property of the Elastic strain. If the elasticity of the structure or its members is more , then it is not preferred, therefore it is to be redesigned. In this study triangular shape shows high elastic strain than rectangular and semicircular shape from **Table 2** above.

Deformation is defined as the deflection of the structural member. Therefore **Table 3** above shows the deflection of different shapes of openings. Comparing the results from **Figure 11, 12 and 13**, it is seen that the deformation of all three openings come to be near about same. Since the dimensions and load applied on all three specimen is same only the shape of opening is varied therefore the results have very minor difference.

IV.CONCLUSION

Comparing the results of different shapes of opening, following conclusion listed below from discussion above are:

1. It is seen that semicircular and rectangular opening shows good result in terms of stress and strain than triangular opening.
2. In terms of deformation, it is noted that all the shapes of opening shows near about similar deformation. Only minor change is seen in the values. Since all dimensions are same only the shape of opening is changed.
3. Therefore, from overall study of effect of shape we come to know that shape also affects other than size and location of shear wall.

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