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In-Plane and Out-of-Plane Behavior of Confined Masonry Wall with Opening

N. S. Masne
PG Student, Department of Civil Engineering
College of Engineering and Technology, Akola, India
R. K. Watile
Assistant Professor, Department of Civil Engineering
College of Engineering and Technology, Akola, India

Abstract:
In this study, a model is proposed to determine the behavior of confined masonry (CM) walls with opening under In-plane and Out-of-plane loading, for this purpose a three dimensional finite element model is developed. The specimens of confined masonry wall are analyzed with the help of professional software (ANSYS Version 12.1) in this study, which is powerful tool for numerical modeling of such structures, has been used. Numerical results shown that variations of the stresses and deformation due to In-plane and Out of Plane loading The simulation is performed to determine the stresses, deformation, and diagonal failure of walls, the effect of openings for this type of construction.

Key words: *Confined masonry, Finite element analysis. Nonlinear behavior*

1. Theme

Research agenda developed by confined masonry network and NICEE, IIT Kanpur publish "A research need for confined masonry" in January 2008. [1]

2. Introduction

Confined Masonry is a construction system where the walls are built first, and the columns and beams are poured in afterwards to enclose the wall.

Confined masonry construction has emerged as a building technology that offers an alternative to both unreinforced masonry and RC frame construction. Confined masonry construction consists of masonry walls made either of clay brick and horizontal and vertical RC confining members built on all four sides of a masonry wall panel. Vertical members, called tie-columns horizontal elements, called tie-beams.

Over the past 25 years, thousands of people all around the globe have been needlessly killed by the collapse of their own homes during earthquakes. [1]The tie-columns and tie-beams provide confinement in the plane of the walls and also reduce out-of-plane bending effects in the walls. [2] If properly constructed, confined masonry construction is expected to show satisfactory performance in earthquakes. [3] Typically, concrete frame buildings with masonry infill perform very poorly when subjected to strong ground shaking, as do buildings of unreinforced brick masonry. An alternative construction technology, using the same construction materials, is confined masonry construction. In many developing countries, masonry is used for housing because of its low material cost and simplicity of construction. This type of construction is used for low rise buildings in earthquake prone countries in the world, as reported in the World Housing Encyclopedia. [4] Masonry is a sturdy and durable material for wind and vertical loads. Confined masonry houses can perform well in earthquakes, or they can cause deaths and injuries if designed and constructed poorly. The great interest in its use around the world is due to its metamorphosis from a brittle and fragile material to one that can successfully withstand earthquake and wind forces while maintaining those features that in the past made masonry the preferred construction material. [5]It is important to improve the design and construction quality of confined masonry where it is currently in use; and to introduce confined masonry in areas where it can reduce seismic risk. The interaction of the unreinforced masonry infill with the frames causes brittle behavior that is only, at best, marginally better than unreinforced masonry construction. The rise in cost of structures encourages engineers to seek more economical alternative designs often resorting to innovative construction methods without lowering the safety of the structure. Confined masonry has becoming one of the most important building materials and is widely used in many types of engineering structures. The economy, efficiency, strength and stiffness of confined masonry make it an attractive material for a wide range of structural applications. [6] Confined masonry housing construction is practiced in several countries that are located in regions of high seismic risk.

3. Objective

The objective of this study is to investigation of the behavior of the confined masonry wall under In-plane and Out-of-plane loading conditions.

4. Description of Models for Confined Masonry Walls

Confined masonry walls considered for in – plane and out-plain analysis consist of one clay brick wall panel confined by 150mmx150mm RC members (bond-beams and tie–columns) as shown in Figure 1. Here, a confined masonry wall is considered, panel with opening. The walls are assumed to be of solid fired clay bricks with dimensions 230 mm x150 mm x100mm and 10mm thick mortar joints, prepared with mortar having a volumetric ratio of 1:3 (cement: sand). The RC members are assumed to be of the concrete with a compressive strength equal to 28 MPa and 4 longitudinal reinforcement bars with 10mm diameter yielded at equal to 340 MPa. Also the RC members have closed stirrups with diameter 6 mm and equal to 220 MPa. [7]
The grid pattern with mesh sizes of 25mm x25mm for RC members, and masonry wall are generated.

E (MPa)	µ
2500.00	0.15

Table 1: Elastic Properties of Unreinforced Masonry Wall

E (MPa)	µ
26458.00	0.20

Table 2: Elastic Properties of Concrete

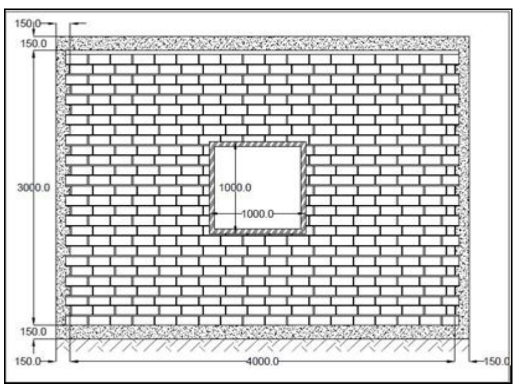


Figure 1.Confined masonry wall with opening

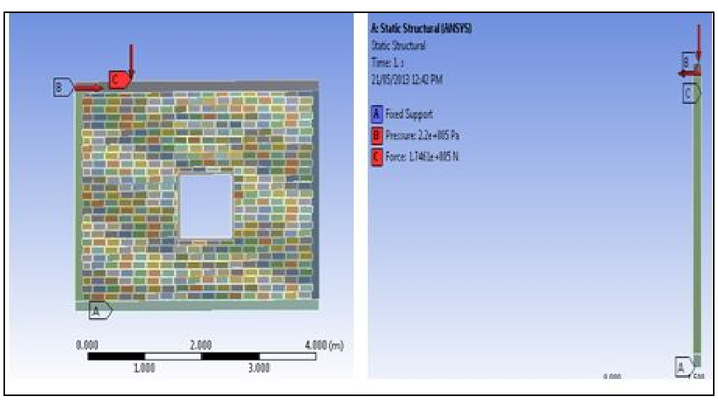
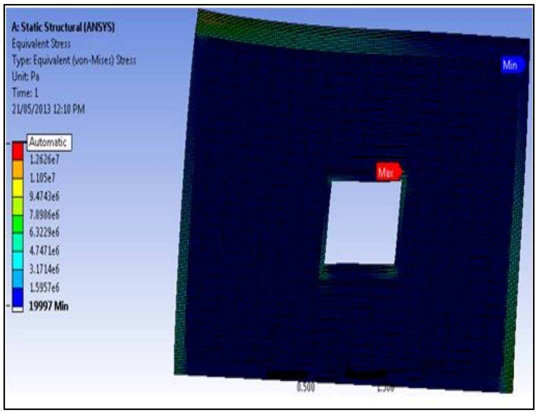


Figure 2: In-plane loads on CM Wall with opening
Figure 3: Out-of -plane loads on CM Wall with opening



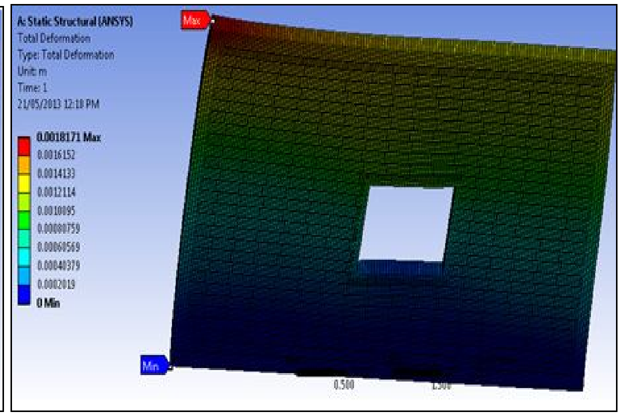
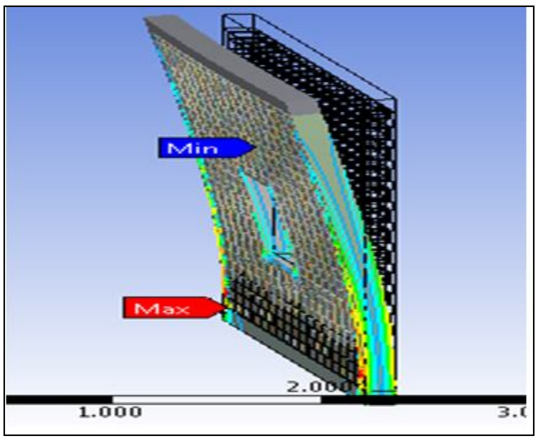


Figure 4: Maximum & Minimum Stresses due to Inplane Loading
Figure 5: Maximum & Minimum Deformation due to Inplane Loading



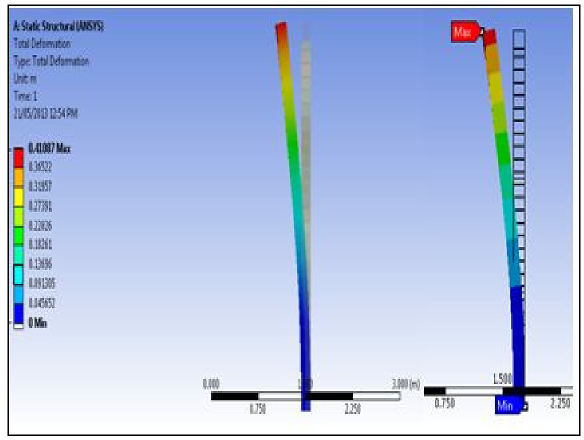


Figure 6: Maximum & Minimum Stress due to Out of Plane Loading
Figure 7: Maximum & Minimum Deformation due to Out of Plane Loading

5. Results and Discussion

5.1. In-plane loading wall with opening

- In first wall In-plane loading with opening maximum stresses is observed at right side top corner of the opening and minimum stresses are found at right side top corner column-beam junction.
- Maximum deformation at left side top beam i.e. near point load and minimum deformation are found at the bottom beam in right side
- Directional deformation start from left side top corner of model and flow towards right side bottom corner of model.

5.2. Out-of-plane loading wall with opening

- In this wall maximum stresses are found left side column and bottom beam junction and minimum stresses are found above the opening at the center of wall.
- Maximum deformation at the top beam and minimum deformation are found at the bottom beam.
- Directional deformation starts from top beam and flow towards bottom of wall.

6. Conclusion

- Maximum and Minimum Stresses due to In-plane loading are very small as comparative to Out-of Plane loading.
- Maximum stresses are developed at opening of right top corner due to In-Plane loading.
- Deformation due to In-Plane loading is very small but deformation due to Out-of-plane loading is very high.
- Also Stresses are found at intersection of masonry wall and column junction.
- A 3-D model are suitable for analyze the entire building.
- It has been confirmed that this analytical method is suitable for different shapes of wall and loading condition.

7. References

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