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EFFECT OF OPENINGS IN THE INTERLOCKING BLOCK MASONRY WALLS SUBJECTED TO LATERAL LOADING

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Abstract – *A new structural component desired to be developed in masonry building construction is the new interlocking mortarless masonry blocks. Mortarless load bearing walls built using interlocking blocks are dissimilar from usual mortared brickwork systems, as the bonding between the blocks are provided by making use of grooves and protrusions. The behavior such walls under the seismic loadings are still not well understood. In this study, the effect of openings in the wall under the lateral loadings are studied and discussed.*

Key Words: Interlocking, Blocks, Grooves, Protrusions, Seismic

1. INTRODUCTION

The shear capacity of the wall is a predominant factor for its earthquake resistant properties. There are several factors that govern the shear capacity of a masonry wall. In this case of interlocking masonries, those factors are there, density or self-weight, bonding, percentage of openings etc. All other factors other than the percentage of openings will be constant for every particular masonry type. For practical case, the openings are mainly for doors, windows, ventilations, counters etc. The needs of these openings are inevitable for every buildings those are used for dwelling purpose. Hence, the trend of change in the shear capacity with respect to the percentage of openings is needed to be investigated. The study is conducted on a Finite Element model of 1m x 1m Hydraform brick wall, in order to find the trend of decreasing rate of shear capacity, with the increase in the percentage of openings in the wall. The percentages of openings range from 0% to 30%.

1.1 Hydraform Blocks

The Hydraform blocks are used mainly in underdeveloped an developing countries for construction purposes. It is made of soil cement mixture and is hydraulically compressed to form interlocking soil blocks. This blocks are similar to sandcrete and landcrete, but they are not compressed. These blocks are very popular due to their cost saving properties during the construction. As the bonding is by interlocking system, unskilled labours can be employed for construction, therefore it empowers the rural communities and there by creates job opportunities. The grooves and protrusions are provided at the top, bottom and the two side faces of the block. Dimensions of the blocks are 220 mm wide, 115mm high, and 230 mm long. It weighs about 12 kg. The blocks are wet cured for a period of 14 to 21 days.

2. FINITE ELEMENT ANALYSIS

The study is conducted on a finite element model of Hydraform brick wall, having a dimension of 1 m length and 1m height. The model is made up of an element, which is a user defined one by inputting the predetermined values of the material properties. Each brick unit is modeled using the design modeler, an inbuilt software with the ANSYS Workbench software. The individual units modeled are assembled in the software for obtaining the whole wall unit. After creating the geometry of the wall, the rotation and translation of the bottom face of the wall is restrained in all directions. After that , an in-plane lateral loading is given until the failure of the wall, along with an axial load of 9100 N/m2, on the top surface of the top most layer of blocks shown in fig-2. This load is calculated as the load from the roof slab, which is supported on the masonry wall. The wall consists of 9 rows of blocks inorder to make 1m high. Fig-1 shows a typical model of wall having 0% of openings.

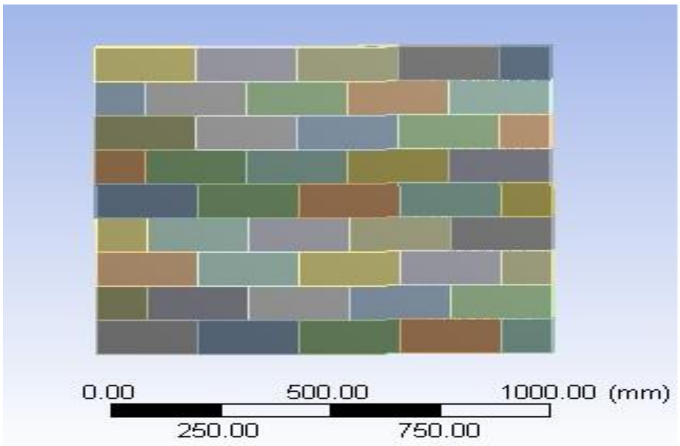

Fig -1: Typical model of Hydraform wall

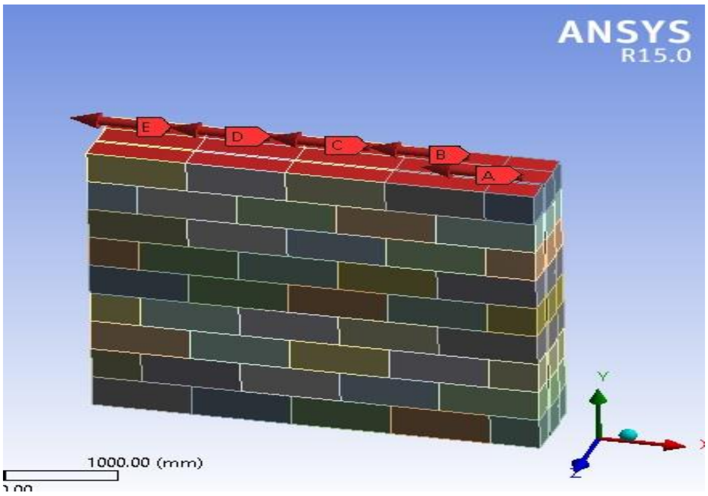

Fig -2: In- Plane lateral loading

Various models of Hydraform interlocking block masonry walls are created by changing the percentage of openings ranging from 0 to a maximum of 30%. In every practical case, for every opening, it is relevant to provide lintels at the top of the openings in order to support the blocks above it, preventing them from falling off. But here in this analytical model, lintels are not provided, but the blocks just above the openings are restrained of downward movement, i.e., the movement in –y direction. Walls having 10% 20% and 30% of openings are shown in fig-3, fig-4 and fig-5.

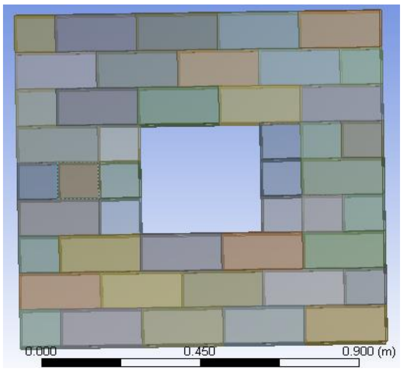

Fig -3: 10% Opening

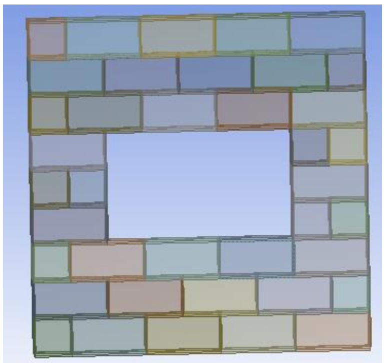

Fig -4: 20% Opening

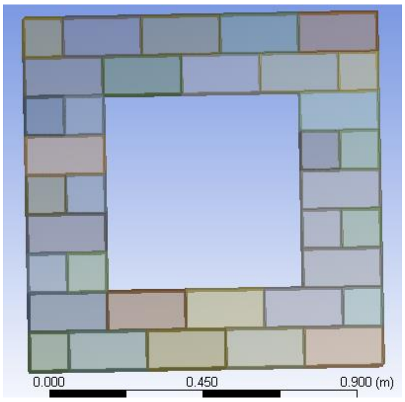

Fig -5: 30% Opening

3. RESULTS AND DISCUSSIONS

The stress vs. deformation characteristics of the typical wall having 0% opening shown in Chart-1, clearly shows the brittle nature of the material and the failure is obtained when the stress reaches the maximum of 5 N/mm2.The corresponding applied in-plane lateral loading at failure is determined as, 18.117kN, along with a total deformation of 1.37mm.The values obtained on different trials of varying percentage of openings are shown in Table-1.

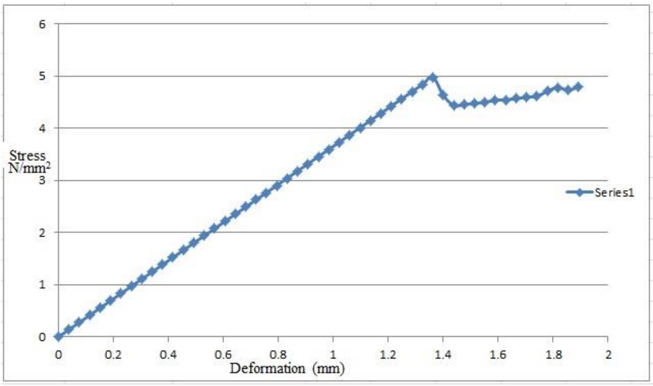

Chart -1: Stress Vs. Deformation

Table -1: Sample Table format

Percentage of Openings	Ultimate Load (N)	Deformation (mm)
0	18117.2	18117.2
5	17122	17122
10	14654	14654
15	11956	11956
20	9026	9026
25	6520	6520
30	3178	3178

The percentage of openings vs. ultimate load graph is shown in Chart-2. It shows that the change in ultimate load capacity of the wall, with the percentage of openings is not linear. It is observed that the load capacity of the hydraform wall decreased by 82% with an increase in 30% of opening size.

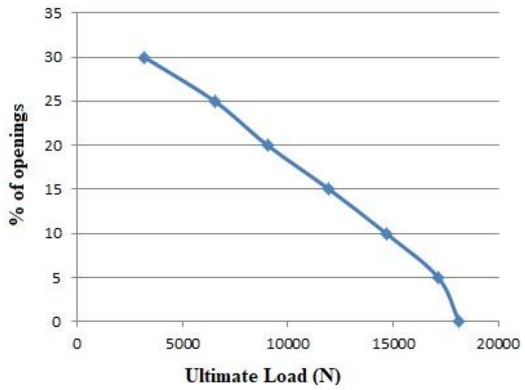

Chart -2: Percentage of Openings Vs. Ultimate Load

3. CONCLUSIONS

The relationship between the percentage of openings and ultimate load are not linear, but non-linear continuous, The load capacity of the hydraform wall decreased by 82% with an increase in 30% of opening size. Therefore it is recommended to minimize the percentage of openings as much as possible in the earthquake prone regions.

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