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SEISMIC ANALYSIS OF INTERLOCKING BLOCKS IN WALLS

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Abstract- A rise in demand for infrastructure has led the way towards requirement of fast construction practices while maintaining the quality of construction and at a low cost. Construction of practice walls with conventional and aerated cement blocks is common practice in India. Hence, change in the system of partitioning wall by making alterations in the blocks was made to develop a new system of partition wall. A system of self-interlocking blocks was developed which enabled easy construction and provided the required bond in absence of mortar which in turn helps in reducing the cost of construction of walls. Self-interlocking blocks were developed by digital modelling and dimensions were fixed for the blocks. Further, physical model was casted with help of customized moulds

Index Terms- Interlocking blocks, conventional brick, Ansys

I. Introduction

With the growth in population, housing facilities are typically insufficient in developing nations. Land and building supplies are becoming more expensive quickly as aresult of the high rate of urbanisation. As a result, the lower classes in society cannot afford decent homes. It was desired to use the newly designed structural element in the construction of masonry structures with new interlocking mortar concrete masonry blocks. According to earlier research, interlocking bricks help to cut down on both the cost and time needed for building. The construction of a mortar less load bearing wall employing interlocking blocks differs from conventional mortar brick work systems in that there are no mortar layer and instead of that blocks were joined by grooves and protrusions. Compressed stabilised soil will produce interlocking blocks with good fire resistance and insulation qualities.

A wall built with stabilised soil provided good compressive strength in a dry region. One of the best technologies for producing inexpensive building materials is the expansion of interlocking earthen blocks. The load bearing system of the building partition wall will also play a significant role in preventing lateral loads from acting on the structure. Therefore, fencing materials are crucial for building. It was discovered that it represents around 22% of the building's overall cost. Finding a material that is economical is therefore crucial. By minimising the mortar connections, interlocking stabilised earth bricks have successfully decreased building costs. If the interconnecting blocks are properly stabilised, they will also act as a decorative element. All across the world, several interlocking block kinds are being produced.

Bricks consisting of stabilised and compacted soil which join fit tightly provide the structure strength. Depending on the supplier, interlocking bricks are available in a variety of sizes and locking mechanisms. The blocks with designs that fit together. Each brick is depressed on one side and projects on the other. Individual block turns perfectly into the depression of the following because of its interlocking design. Without employing cement mortar for bonding, walls will be constructed. Figure 1 shows the interlocking block model.

Interlocking bricks made of stabilised and compacted soil provide the structure's strength. Depending on the supplier, interlocking bricks are available in a variety of sizes and locking mechanisms. Interlocking bricks are typically not baked and are created by mechanically combining and compressing sand, soil, and cement. They can also be created using stone dust and cement. Building walls with interlocking bricks is faster and requiresless skilled labour than with traditional bricks because they don't require mortar during the bricklaying process. These bricks are

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fastened against each other without cement mortar to build walls that are structurally sound and take less time and money to build. Making interlocking bricks: These bricks are made by mixing cement, sand, and stone dust in the right proportions.

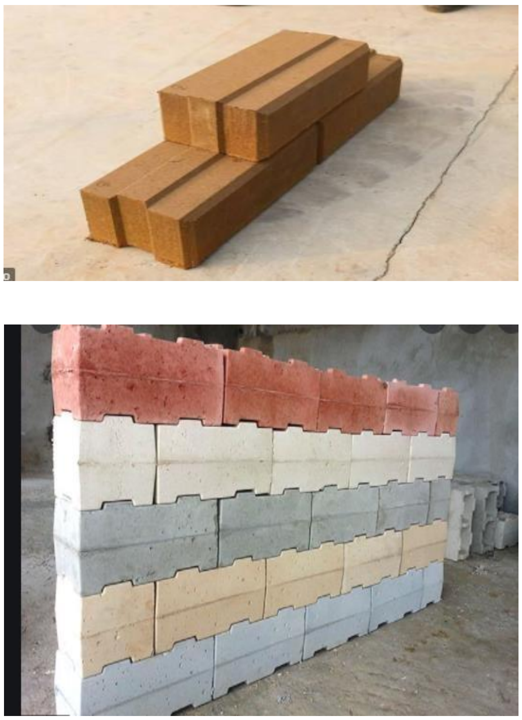

Fig 1.1: Interlocking blocks

II. OBJECTIVES

These are the main objectives of this research:

1. To design the interlocking blocks with varying depths.
2. To study the behaviour of interlocking blocks.
3. To evaluate strength of interlocking blocks in earthquake zone.
4. To evaluate displacements of interlocking blocks in earthquake zone
5. To evaluate comparison between interlocking blocks
6. FEM analysis will be used to analyse the model (Ansys 16.2).

III. MODELLING AND ANALYSIS

Any type of analysis highly depends on modelling. Any analytical software can be used for modelling, or CAD software for either. All modelling for this article was completed using Ansys 2015(16.2) version. Before being assembled at the assembly session, the numerous parts of the brick wall are built one at a stage in Ansys 2015.These components are all modelled in millimetres, which are the conventional units (mm). The interlocking blocks used in brick walls have different depths, such as 130mm, 140mm, and 150mm, and they are made with measurements of [(0.4X0.15X0.13m) (length X breadth X height)]. There is a pattern for each stabilised interlocking block that is separated into three volumes, with projections and depressions in the central volume of the brick. Out of three volumes, the end volumes' width differs greatly from the centre volume. While the main volume has a 270mm width, the ends of the volume have a 150mm width. This design is intended to interlock with other designs. The distance between the projection and depression is 1 cm. With these dimensions, several wall components were modelled, and has already indicated, all of these components are put together during a meeting to make a 1m x1m wall. Some half bricks with the dimensions 0.2mX0.15mX0.13m must be modelled in order to construct this wall (length X breadth X height). With these measurements, the bottom layer consists of 4 bricks stacked lengthwise, while the top layerconsists of 8 complete bricks.

The evaluation of interconnecting blocks is carried out using the finite element method, a flexible technique that can accommodate the structure of complicated shapes and limiting conditions. To simulate any particular physical phenomena, the numerical methodof FEA is applied (FEM). Depending on how you look at it, FEA can be traced all the wayback to Euler's work in the 16th century. However, papers by Shellback (1851) and Courantprovide the earliest mathematical article on FEA (1852). To address structural mechanics issues in civil and aeronautical engineering, engineers from many industries independently developed FEA. Distinguish and Conquer: Simulations need the construction of a mesh made up of up to millions of minuscule elements that collectively create the geometry of the building. Each individual component is given a calculation, and the final outcome of the structure is produced by adding the individual outcomes. The aforementioned approximations are actually interpolations over the element and are often

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polynomial in nature. Instead of referring to values everywhere, this is referring to values at particular points inside the components. The accuracy with which the variable varies as indicated by an approximation, such as linear, quadratic, cubic, etc., is specified as the nodal points, which are typically found at the edge of the elements. FEM applications have just recently begun to realise their full potential in other sectors, such as fluid-structure interaction in the thermomechanical, thermochemical, piezoelectric/ferroelectric, electromagnetic, and otherrelated fields.

A FE model of an interlocking block was made using the software ANSYS Workbench 16.2. A commercial finite element modelling (FEM) tool called ANSYS has capabilities that range from straightforward linear static analysis and complex nonlinear transient dynamic analysis.

1. Establish and distribute material properties.
2. Using the ANSYS 16.2 software, model infill walls made of interlocking blocks of various depths and ordinary brick.
3. Combining
4. Apply loads and boundary conditions.
5. Result Evaluation

Analytical Method

Ansys 16.2's "Space claim" is used to generate a model of the interconnecting blocks and regular bricks. Data entry is needed for both conventional and interlocking bricks. Select "Static Structural (Ansys)" as the analysis system in Ansys Workbench open. a drop-down menu with "statics" Click edit after selecting Engineering data.

Traditional brick and interlocking blocks are used in the construction.

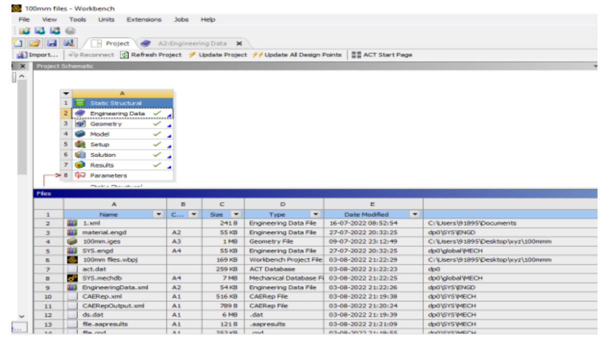

Fig 3.1: Input data required for conventional & interlocking blocks

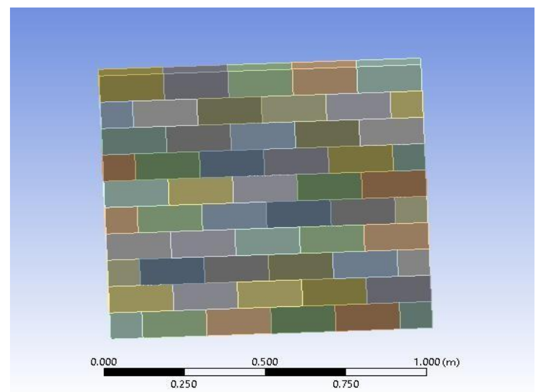

Fig 3.2: Model of conventional brick wall

IV. ANALYSIS RESULTS

The following tables show the ANSYS-FEA results that were obtained. The conventional brick is here been used as a comparison product with the best efficient interlocking model within the different depths i.e.120mm,130mm,140mm,150mm with varying loading of 0.5,1, 1.5,2, 2.5,3, 3.5, 4N to all varying depths & Reported the result of the equivalent strain and stress, as well as the total deformation.

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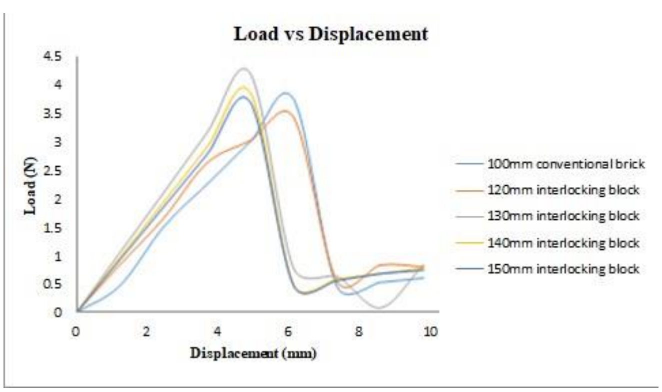
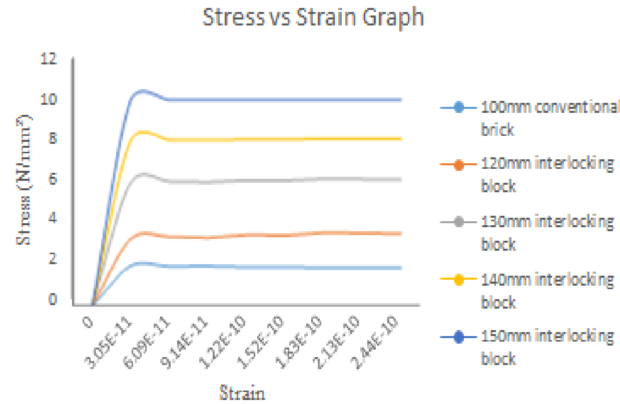
TABLE 1: Total Deformation for different loading cases for varying thickness

Infill wall blocks name		Load(N)							
		0.5	1	1.5	2	2.5	3	3.5	4
100mm(conventional brick)	Deformation (mm)	1.6727e-11	3.3454e-11	5.0182e-11	6.6909e-11	8.3636e-11	1.0036e-10	1.1709e-10	1.3382e-10
150mm(inter-locking block)		2.0619e-11	4.1237e-11	6.1855e-11	8.2474e-11	1.0309e-10	1.2371e-10	1.5086e-10	1.6495e-10
140mm(inter-locking block)		2.1553e-11	4.3105e-11	6.4658e-11	8.6211e-11	1.0309e-10	1.2932e-10	0.15086	1.7242e-10
130mm(inter-locking block)		2.3441e-11	4.6881e-11	7.0322e-11	9.3763e-11	1.72e-10	1.4064e-10	0.16409	1.8753e-10
120mm(inter-locking block)		3.8712e-11	3.6841e-11	6.851e-11	8.7336e-11	1.65e-10	1.2106e-10	0.1854	1.78e-10

TABLE 2: Stress for different loading cases for varying thickness

Infill wall blocks name		Load(N)							
		0.5	1	1.5	2	2.5	3	3.5	4
100mm(conventional brick)	Stress (N/mm^2)	0.91366	1.8273	2.741	3.6546	4.5683	5.4819	6.3956	7.3093
150mm(inter-locking block)		0.90718	1.8144	2.7216	3.6288	4.536	5.4431	6.3503	7.2575
140mm(inter-locking block)		0.94482	1.8896	2.8344	3.7793	4.7241	5.6689	6.6137	7.5585
130mm(inter-locking block)		1.2648	2.5295	3.7943	5.059	6.3238	7.5885	8.8533	10.118
120mm(inter-locking block)		0.60123	1.3564	1.9122	2.985	3.6354	4.965	5.6534	6.3256





Stress versus Strain graph for conventional brick and interlocking blocksof varying thickness

V. CONCLUSION

A To understand the behaviour of traditional brick and interlocking blocks under loading conditions, a well-planned analytical study was conducted. For the examination oftraditional brick and interlocking blocks, the efficacy of a finite element analysis utilising the Ansys programme has been looked into. Here is a summary of the key takeaways fromthe discussions.

1. Percentage variation of deformation of 150mm, 140mm, 130mm, 120mm thick interlocking block when compared with conventional brick is 3.839%, 9.96%, 0%, 2.37% respectively.
2. Percentage variation of stress of 150mm, 140mm, 130mm, 120mm thick interlocking block when compared with conventional brick is 0.71%, 3.27%, 27.75%, 16.58% respectively.
3. Percentage variation of strain of 150mm, 140mm, 130mm, 120mm thick interlocking block when compared with conventional brick is 0.703%, 3.82%, 3.09%, 14.07% respectively.
4. Interlocking block size should be 140mm thick as mentioned in IRC: SP: 63-2004.
5. Due to mortar less joints, interlocking blocks are only appropriate for three-story buildings.

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