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Development of an Innovative Interlock Blocks

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Abstract: **Cost effective earth quake resistant housing is desirable in seismically active rural areas of developing countries. These regions often suffer a significant loss of life during strong ground motion because of lack of seismic-resistant housing. Recently, in the most developed countries, it has been verified that the traditional and conventional technologies used for construction and maintenance of buildings are inefficient and resource wasteful due to enormous amount of resources consumed. This situation leads to an increasing demand for further development of their technologies (Ghosh, 2002). To enable an efficient and cost-effective solution, a new concept of construction was investigated with these innovative interlocking blocks. Each blocks have two interlocks (i) a projection 'tongue' part and a depression 'groove 'part , this helps to resist the lateral movements and horizontal compressive stresses caused due to earthquakes. (ii) a 'T' projection in the end of block's side face and a depression in other end .The projection of one block fits in to the depression of the next so that they always align perfectly. And a partial replacement of flyash to cement is done . Fly ash decreases mechanical properties while increasing durability of blocks. One of the main aims of our approach, is to build mortar-free structures with the help of this type of interlocks. It is anticipated that the mortar-free construction can reduce the impact of earthquake to a greater extent due to the relative movement of the interlocking blocks.In this study a general study about the exisiting interlock patterns, sizes , types and characteristics of our innovative interlocking blocks**

index terms :

Seismic resistant ; projections ; lateral movements; tilt table test ; durability,mortar-free structures.

1. INTRODUCTION

Brick masonry is a well proven building material possessing excellent properties in various terms, for example, appearance, durability ,cost .However the quality of masonry in building depending on the material used and hence all the brickworks must certain minimum amount of standard .The basic component of brickworks are brick and mortar . The latter being in itself a composite of cement, lime and sand and sometimes of other constituents .

All these bricks are either produced by machines or manually using skilled or unskilled require mortar joints and some degree of skill replacement when building walls .It's also consume labour's time .Furthermore, since bricks are mostly solid, the wall become rather massive and oversized for single storey load bearing construction while being insufficient stable for multi-storey construction .In addition, conventional mortar joint allow only light reinforcement to be used making the wall an unstable structural component in earth quake zones. (SCI) brick is inexpensive and can be used without cement or mortar, easy to handle, mould and manufacture, the hollow portions allow insertion of certain fixtures or conduits without having to do extra work on the building structure, no need fire treatment and therefore ease the fast depletion of the forest cover, need less water for their production and treatment compared with the production of other bricks and use very small amount of cement per brick. Moreover,(SCI)brick Can be produced at or near the site – reduced transportation cost, Green technology–Zero carbon emission, Energy Efficient, Uses local available materials, Reduces the.Given unskilled or semiskilled labour can easily and quickly construct the wall . The interlocking brick is deferent from the other normal brick .They are rectangular, but they don't require mortar for the masonry work because they interlocked with each other by positive and negative frogs on the top and the bottom of the bricks which do not allow horizontal movement between them They can be used for all kinds of structures like load bearing walls, lintels, sills and wall corners . There is significant heterogeneity between the normal bricks used for construction and the interlocking bricks which will be addressed accordingly Firstly, Interlocking bricks are not baked, it is just mud in high density pressed using a pressing machine and allowed to solidify by drying naturally. Some chemicals are added for increasing the

bond strength .Whilst, normal bricks are baked ones. Secondly, size of interlocking brick is more. It is approximately 2.5 times more in volume than the baked bricks .Thirdly weight of Interlocking bricks is more than equivalent volume of baked bricks. .However, there are certain drawbacks which might be caused by (SCI) bricks represented by the technology being relatively new, people may be reluctant to apply it. Hence, a well co-ordinate dissemination strategy to introduce it to potential builders is vital. Although skilled masons are not needed for constructing walls, a certain amount of training is required to ensure that the walls are properly aligned and no gaps are left. Also in the production of the blocks training is needed not only in determining the correct type of soil, correct mix proportion and moisture content, but also in producing uniform sized blocks (that is, avoiding under or over-filling the block moulds before compaction).Even with the greatest care in assembling the walls, the joints are not entirely resistant to wind and rain penetration, therefore, plastering the interior wall surfaces is usually necessary.

2. INTERLOCKING BLOCKS AND ENERGY EFFICIENCY

Introduction of interlocking or "dry stack" mortarless masonry systems in masonry construction requires the development of efficient, easy to handle, and yet versatile blocks. Varied interlocking blocks developed for use include Sparlock system, Meccano system, Sparfil system, Haener system, and the Solid Interlocking blocks (SIB) or Hydraform blocks, which are an improvement over the traditional adobe bricks or unfired laterite blocks that were prevalent in the 20th century in some African countries (Anand & Ramamurthy (2003). Interlocking blocks can also be of cement and sand content only.

CATEGORY A	CATEGORY B
Both horizontal and transversal brick movements restricted	Free horizontal and restricted transversal movements
Auram Bamba Haener Interlocking System Osteomorphic Sparlock System	Alan block Hydraform Solbric

3. SOME EXISTING INTERLOCKING PATTERNS

4. CONCEPT OF OUR INTERLOCKING PATTERN

- The blocks are shaped with projecting parts, which fit exactly into depressions in the blocks placed above, such that they are automatically aligned horizontally and vertically thus brick laying is possible without special masonry skills.
- Each block has a 'T' projection in one end of block's side face and a depression in other end
- Since the bricks can be laid dry, no mortar is required and a considerable amount of cement is saved.

Fig.1 shows the vertical tongue and grove part

Fig.2 shows the 'T' projection in the model of interlock block that we did at (iitmadras)

5. TYPES OF INTERLOCK BLOCKS

A variety of interlocking blocks have been developed during the past years, differing in material composition, shape and size, depending on the required strengths and uses:

A. Different materials

- Soil-cement blocks

  Depending on the soil and cement qualities, the cement-to-soil ratio usually lies between 1: 6 and 1: 10, by volume. (Laboratory tests are essential).

- Rice husk ash (RHA) cement blocksThe cement-to-RHA ratio is generally 1: 4, by volume. Two types of blocks can be produced:white blocks, with a compressive strength of 4 N/mm, using ash (amorphous silica) from field kilns, burnt below 900C;black blocks, with a compressive strength of 1.4 N/mm, using boiler ash (crystalline silica), burnt up to 1200C; concrete blocks. A typical mix proportion of cement-to-sand-to-gravel is 1: 5: 3.

B. Different shapes and sizes

- Full blocks (300x 150x 100 mm) for all standard walls (single or double brick thick)
- Half blocks (150 x 150 x 100 mm), which can be moulded to size, or made by cutting freshly moulded full blocks in half.

6. PRODUCTION OF INTERLOCK BLOCKS

Interlocking blocks are produced in special moulds, in which compaction can be done by hand or mechanically, depending on the type of block, material used, required quality and available resources. The blocks can be made directly at the building site, or on a larger scale in a production yard.Soil-cement blocks are commonly manufactured in manually operated blockpresses. Two workers prepare the soil mix, shovel it into the mould box and close the lid. Compaction is done by a third worker, who pulls down a long steel handle (lever arm), which pushes up the base plate. After opening the lid and ejecting the block, it is removed by a fourth worker and stacked in a shaded place for curing and hardening.Rice husk ash and concrete blocks need tamping, or better still vibration, for proper compaction. Therefore, the manual block press is not suitable. Manual tamping is done by jabbing the mix with a piece of wood or dropping the filled mould several times on a hard surface. Higher compaction and greater strengths are achieved by placing the mould on a vibrating table, or holding a portable vibrator against the sides. After demoulding, the blocks are carried away on pallets for curing.

7. ONSTRUCTION OF WALL USING INTERLOCK BLOCKS

Before placing the first course in a mortar bed, the blocks must be laid dry on the foundation around the entire building, in order to ensure that they fit exactly next to each other (leaving no gaps), and that an exact number of full blocks are used, otherwise the system will not function When laying the first course in the mortar bed, care must be taken that the blocks are perfectly horizontal, and in a straight line, or at right angles at corners.Once the base course is properly hardened, the blocks are stacked dry, with the help of a wooden or rubber hammer to knock the blocks gently into place. Up to 10 layers can be placed at a time, before the grout holes are filled with a liquid mortar - 1 part cement to 3 parts sand (or soil or rice husk ash) to 1 part water.It is advisable to place channel blocks around the building, at window sill height, to install a ring beam. They should also be placed directly above doors and windows to install lintels, and directly below the roof to finish the walls with a ring beam.Care must be taken to achieve a good bond between the walls and frame-work.

General design of building with interlock blocks

Almost any type of building can be constructed with interlocking blocks, the main design constraints being that the plan should be rectangular and all wall dimensions and openings mustbe multiples of the width of the block type used. All other principles of design and 38 construction, such as dimensioning of foundations, protection against rain and ground moisture, construction of ceilings and roofs, and the like, are the same as for other standard building types.

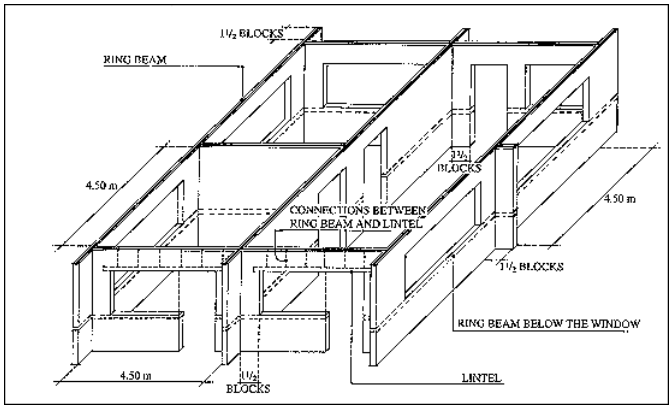

Fig.3 Principle of interlock block construction

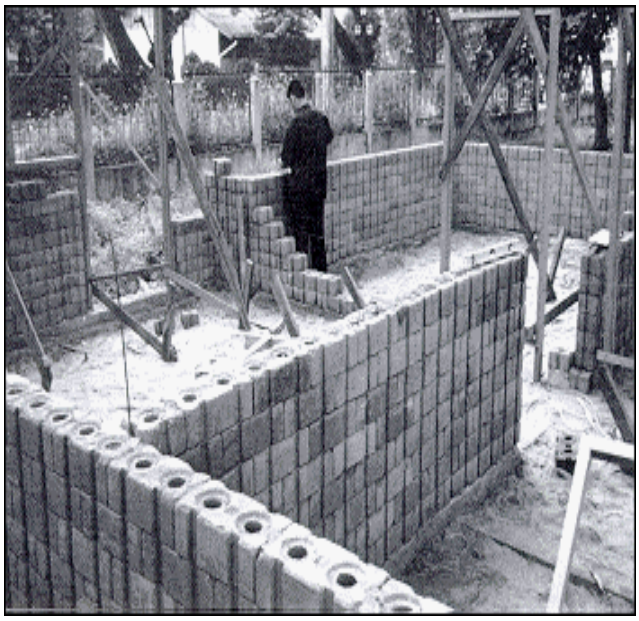

Fig .4 Typical construction site of an interlocking soil-cement block house

8. ADVANTAGES

The materials required for block production and building construction are usually locally available in most regions; therefore, in areas in which timber is scarce and expensive, construction with interlocking blocks has environmental advantages (no deforestation, low energy requirement for block production and transportation). Unlike the case of timber constructions, termites cannot cause damage to the blocks.Compared with conventional masonry, the dry assembly of interlocking blocks saves construction time and a large amount of mortar, which would otherwise be required for the horizontal and vertical joints.Without the need for high-waged skilled masons (except for the base course), by saving cement (less mortar) and with the speed of construction, the building costs are lower than for standard masonry construction. Additional costs are saved by building loadbearing walls, instead of infill walls between a structural framework.The structural stability and durability of interlocking block constructions can be far greater than for comparable timber constructions. Grout holes and channel blocks provide means to insert steel reinforcements in vulnerable parts of buildings for increased wind and earthquake resistance.Interlocking blocks can be produced on a small scale on the building site (for self-help construction), or on a large scale in centralized production units.

9. DISADVANTAGES

The technology being relatively new, people may be reluctant to apply it. Hence, a well co-ordinated dissemination strategy to introduce it to potential builders is vital. Although skilled masons are not needed for constructing walls, a certain amount of training is required to ensure that the walls are properly aligned and no gaps are left. Also in the production of the blocks training is needed not only in determining the correct type of soil, correct mix proportion and moisture content, but also in producing uniform sized blocks (that is, avoiding under or over-filling the block moulds before compaction). Even with the greatest care in assembling the walls, the joints are not entirely resistant to wind and rain penetration, therefore, plastering the interior wall surfaces is usually necessary. It was observed that professionals in the building industry showing high preference for the use of interlocking masonry as compared with the conventional types in Asian countries This is based on shorter period of setting, higher strength, reduced number of labour involved in its operation and overall reduction in cost of masonry works. The level of suitability of interlocking block as an innovative and alternative material to the conventional blocks used for construction is very high i.e. 71.7% Although the material is not common in the market due to its relative newness. But its acceptability is gaining. The high acceptability level of interlocking blocks will aid good patronage by both professionals and clients as a better replacement for the sandcrete blocks. Its popularity will continue grow as it becomes available in the market and more houses are built with it. The acceptability indices of interlocking-block masonry is also based on the fact that interlocking masonry has much higher output per productive hour, aesthetically pleasing, cost-efficient and environment friendly as compared with conventional-brick/hollow-block masonry.

10. CONCLUSION AND SUGGESIONS

Although the study revealed unparalleled advantages of interlocking-block masonry in terms of shorter period of operation, lesser gang of labour and reduced cost of construction, its usage in construction of houses is very low. This is partly due to low level of awareness on the part of professionals and the public and its non-availability in the market. In view of this, Government agencies and stakeholders in the building industry should accept the use of the material as proposed in this research to give a wide publicity to them and make the proposed building materials available in the market for users. Interlocking-block masonry should be used in public housing projects to demonstrate government's sincerity and to create awareness within the populace. In conclusion, accelerated dry masonry system through interlocking masonry is recommended for housing projects as an alternative method

that is cheaper than the conventional wet type. Since this innovative interlock system is earthquake resisting .It is also faster in operation with a potential of saving over 65% of time and cost of the masonry work. It reduces wastage of materials, and gangs of labour required for operation. Interlocking blocks can be produced with the same materials as used in the production of conventional blocks.

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