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MODELING OF INTERLOCKING SOIL STABILIZED BRICKS FOR IMPROVED WALL CONSTRUCTION FLEXIBILITY AND ALIGNMENT ACCURACY

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Abstract– Housing is one amongst the fundamental human wants and is sometimes stratified third after food and wear. In most developing countries housing is insufficient and therefore the housing backlog has been increasing apace. One fundamental speculation considering shelter insufficiency is that of the multiplication in dwellers. it's been calculated that the World's population is rising weekly by over 1,000,000 folks, a rate that new construction doesn't match because of the high pace of urbanization and socio-economic factors that embrace the increase in costs of land and building materials, those classified as poor measure the bulk and that they cannot afford correct housing. The end result of this will be noticed proportionately by the inferior status of the homes in this regard, mainstream in each urban and rural environment. All over the world housing scarcity has instigated a need for research that will prove to be applicable, easy, quick and cost-efficient in wall construction. Among many technologies found to possess promise is mortar-less technology exploitation dry-stack interlocking bricks/blocks.

Key Words: Cost-efficient, Wall construction, Mortar-less technology, Dry-stack, Interlocking bricks.

1. INTRODUCTION

The inter locking bricks are totally different from traditional bricks because it needs no mortar or cement for masonry work. These bricks are interlocked with one another by means of positive and negative frogs on the top and bottom of the bricks that command the horizontal movement of bricks. There are numerous applications of this bricks namely; load-bearing walls, lintels, sills, wall corners, partition walls etc. The specifications and also the characteristics of this brick depend upon the machine wont to manufacture it or the mold used for its production. The foremost common size of brick is 300x150x120mm. The essential material used for the manufacture of interlocking brick is same as that of ancient brick. Little or no water is employed. This is doable solely with mechanized compaction and vibration and provides the block prime quality in spite of the lean mix that uses little or no cement. The weight of the concerned brick is 2-3 kg.

In the countries like Malaysia, the Philippines, homes within the rural areas were historically designed of timber that was extensively there within the forest areas. However, the dread rate of deforestation in Thailand - from 70% forest cover in 1936 to concerning 55% in 1961 (now it's but 30%) ushered the govt. to initiate analysis into different materials for building construction within the rural areas. Initially, the analysis undertaken by the Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, focused on soil-cement blocks created with the CINVA-Ram manual block press (which was developed in Colombia in 1956).

The incontestable homes designed with these blocks were cheaper than timber homes, a lot of sturdy, water resistant, fire resistant, resistant to termites, and visually pleasing. The limitations, on the other hand, were that the blocks were analogously weighty, and building construction needed an assured supply of brickwork skills. Moreover, the grout linkages utilized a substantial measure of cement and construction time was comparatively long and this further led to the event of the interlocking block technique by Human Settlements Division of the Asian Institute of Technology (HSD-AIT), Bangkok, among the first early 1980s . the primary demonstration house using interlocking soil-cement style of interlocking bricks for increased wall construction and load bearing Between 1986 and 1990, the Post Graduate Centre Human Settlements (PGCHS), of the Catholic University of Leuven, Belgium, assisted these establishments in optimizing interlocking blocks technique, that has currently reached a high degree of maturity internationally.(R. K. Watile, S. K. Deshmukh and H.C.Muley *et al*., May 2014)conclude that it has been always challenging for researchers to make interlocking brick lightweight, low cost and improve the performance of aggressive environment. The experimental results compared with that ordinary brunt clay brick and interlocking brick was found durable in aggressive environments and have sufficient strength for their use in sustainable building construction.

2. METHODOLOGY

The current study focuses on the production of interlocking bricks without using any mortar for the construction of walls, what accuracy for the evenness and parallelism of the uppermost and bottom brick surfaces is necessitated to make sure wall alignment is slender and not beyond the limits as prescribed by [1]BS code 8000-3:2001 which states that the erectness diversion in each 5m lengthiness wall should not exceed ±5mm, and verticality lean up to 3m wall height is within ±10mm[2].Here in this study, we have designed a mold in order to make customized interlocking bricks(figure 1).From the figure we can see two up heaved holes that can be called positive or negative frogs as per convention.

Fig -1: The Mould For Brick Making With A Brick Adjacent To It

2.1 STUDY AREA

Interlocking bricks is the most straightforward approach of implementing in IBS (industrialized building system) and can easily penetrate in the construction merchandise. Interlocking bricks engages load bearing wall by integrating the columns and beams as an elemental part of the wall for each and every type of houses (up to 5-storey in high). The budget that can be safeguarded on a wall construction can vary between 10% to 30% as compared to traditional brick with additional unsubstantial foundation cost as per IBS Roadmap 2011-2015. Interlocking bricks give 3 times faster in regard to that of the wall construction, columns & beams in comparison to conventional ways and means. More rapid construction gives a key benefit to commercial clients and in addition keeping up government's policy to construct 10,000 affordable housings in 2012.[3]

2.2 BRICK PRODUCTION STEPS

Step 1: Excavation

Excavation involves un-soiling and digging. Unsoiling is the process of stripping off top surface about 200mm in depth as top surface is full of impurities and must be rejected. Digging involves excavating clay and then spreading in heaps of about 600-1200 mm.

Step 2: Cleaning And Sieving:-

Obtained clay is cleaned of stones, pebbles, vegetable matter and other impurities by passing it through a conventional sieve. If impurities are in excess clay needs to be washed and screened.

Step 3: Pulverizing

Pulverizing is a process of grinding of clay to convert lumps of clay into powdered form. Pulverized clay is subjected to weathering process. Weathering involves exposure to atmospheric conditions for softening purpose as shown in figure 2.

Step 4: Mixing And Pugging

Clay is made loose and any ingredient to be added are spread out at the top followed by turning up and down vertically. Pugging is the process of tempering the clay to make it plastic of uniform consistency for bricks. Clay was added with sufficient amount of water and was thoroughly mixed with the shovel.

Step 5: Moulding Of Bricks

Moulding involved was hand molding. Here we leveled the ground surface and sprinkled fine sand over the ground. Mould was dunked inside water, next placed on the ground to occupy the prepared clay. Over and above clay is detached by wooden or metal strike, soon after the skeleton of the mold is held up and raw brick is departed on the ground

Step 6: Drying Of Bricks

Bricks are laid longitudinally, allowed to dry till they become hard(moisture content of 2%).Sufficient gap is provided for air circulation as shown in figure 2

Fig -2: Drying Of Brick

Step 7: Burning Of Bricks

Bricks should be burnt properly if over burnt they will be brittle and if under burnt bricks will be soft and will not carry loads. A dull red heat temperature of about 650^{0}C,here water is evaporated or exhausted and carbon matter is burnt known as dehydration. During oxidation, remainder carbon is oxidized and ferrous iron is converted into ferrous form and sulfur is also removed. During vitrification, mass is converted into glass type substance in the temperature range of 900-1100^0 C for low melting clay and 1250ºC for high melting clay. Alumina and sand start to bind together resulting in the increase of strength and density. If the temperature is further raised brick starts to lose its shape.

3. MOULD DESIGN AND FABRICATIONS

Design of mould should be done in such a way that clay inserted in that should permit production of the interlocking bricks. Our study required the manufacture of 25-30 bricks, which is a fairly big number as the bricks were produced manually by the group. In order to save production duration, material and the constrained space in the laboratory, help from construction plant was taken.

3.1 BRICK MANOEUVRING

In conventional concrete block manufacture, the block is discharged as a pallet from the machine and is positioned at the curing area while waiting for the next day. But then again at the time of a manufacture of stabilized-soil or we can say interlocking bricks, it is usual process for each brick to be removed manually. The brick is from then on placed on the curing surface whichever of its end-face or else on its front or back-face. The finishes are likely to be distressed through warping or shrinkage. Similar distortion is presumably to recur if the two frontages are left free during curing. In this extent one of these frontages should be putted on a strong, rectilinear and level ground for the first two to three calendar days. The logic why interlocking bricks are not old-fashionably placed on eir bottom or top frontages is to keep away these frontages from the grimy and bumpy surfaces of poorly provided curing floors. The operating factors for figuring how and where the bricks are are laid on the curing surface are enlisted below as follows: -

• As the process of handling is a not worthy part and parcel of labor key in, it ought to be contrived as fast and as more than adequate as possible, paragon by towering the bricks on high waist table onto which bricks will be quartered while waiting for their hardening.

• The excellence of the curing floor:- if the floor isn't coming up to snuff which in other words means that floor is not leveled or it has friction or may contain indistinct sand or aggregates that may perhaps plunk over the expanse and may instigate the bricks to acquire a curved face. Legion professionals speak highly of using a plastic sheet in order to cover the floor. The aforementioned one does not transfigure the floor surface level but it does avert unclasped material from adhering against the brick surface. Any distortion of the floor will howbeit be imprinted on the brick surface, giving it a distorted shape from that anticipated.

4. INTERLOCKING BRICKS AN INNOVATION FOR EARTHQUAKE RESISTANT DESIGN

For humanity, earthquakes are a big problem. As we all must know it is not the earthquake which kills but improper structures and masonry which kills causing the loss of precious lives. We can recall from 2001 Gujarat earthquake major damage occurred due to the failure of masonry structures. Conventional bricks have good strength and hence can transfer vertical compressive stress. During an earthquake, horizontal or lateral stresses are encountered and mortar is the only medium for transfer of stresses. This view leads to the development of the interlocking bricks. However, in case of interlocking bricks, the energy formed due to earthquake inside the wall is released by the space where mortar is not present and therefore there is no crack formation on the wall constructed by interlocking brick and moreover the lateral or horizontal force by the earthquake is resisted by the interlocking of the bricks conventionally called as posive and negative frogs.

4.1 TYPES OF REINFORCEMENT THAT CAN BE PROVIDED FOR LAYING BRICKS

We generally have two provisions of providing reinforcements:-
1.) Horizontal reinforcement can be used at a distance of every 4 feet. Next row of bricks is to be mortared to make a tight bond.
2.) Vertical reinforcement if provided increases strength manifold.

5. COMPRESSIVE STRENGTH TEST AS PER IS: 3495-(PART -I)-1992[4] RESULTS

In this test, the load is enforced axially at a equivalent rate of 14 N/mm^2 per minute unless failure results from UTM (universal testing machine). The maximal load at breakdown is jotted down. machine.

CALCULATION:-

Compressive strength (N/mm^2) = Maximum load at the breakdown (in N)/ Avg. related to bed faces (in mm^2).

Compressive strength table readings is shown as

S.NO	ACTUAL SIZE OF BRICK (mm^2)	COMPRESSIVE LOAD (N)	COMPRESSIVE STRENGTH(N/mm^2)
1.	22.05 x 10.5	27000	11.1
2.	22.06 x 10.6	26500	11.3
3.	22.05 x 10.5	27000	11.6
4.	22.06 x 10.5	25000	10.79
5.	22.05 x 10.6	26000	11.21

Average compressive strength =

$$= \frac{11.1+11.3+11.6+10.79+11.21}{5} \text{ N/mm}^2$$
$$= 11.33 \text{ N/mm}^2$$

6. ADVANTAGES OF INTERLOCKING BRICKS

- Cement consumption in interlocking bricks will be less than the brickwork with cement mortar for conventional bricks.
- Work can be completed faster than that of traditional estimated time.
- The houses constructed with mud made interlocking bricks the electricity consumption will be less, because of the cool atmosphere inside in summers and hot during winters.
- Using interlocking bricks means we are using the Eco-friendly construction as there is less cement and hence no emission of carbon dioxide gas.
- No cracks even after the earthquakes.
- Economical or in other words cost saving in terms of cement, sand, and water.

6.1 DISADVANTAGES OF INTERLOCKING BRICKS

- The space between the interlocks of these bricks is enough for insects and ants to set up their homes.
- If rainwater flows through these bricks, the colour of the brick changes very fast.
- Forecasting the prospects for ISSB (Interlocking soil stabilized bricks) in progressing countries is challenging because of current building standards, code of practice and rules and consequently create negative temperament towards new technologies.

7. CONCLUSIONS

Based on above study, following inferences are drawn:

- Interlocking bricks is also not about sizing and dimension.
- The interlocking bricks are the new and improvised version of bricks as the new innovations keep on evolving every now and then.
- It is an opportunity for the industry to acknowledge the new innovative product which has enhanced advantages over conventional bricks.
- The Interlocking bricks ideology is one of the simplified, discretionary and most flexible systems that can be used in the construction industry.
- The above study advocates that established on its characterization, benefits and innovative capability of interlocking bricks, it should be given concentration by CIDB (Construction Industry Development Board) to be counted in as one of IBS (industrialized building system) merchandise under the innovative or hybridise cluster.

8. FUTURE SCOPE

The future scope for interlocking bricks is enlisted below:

- The interlocking can be used in partition walls.
- They can be used at places where we need less self-weight of structures as no mortar is used.
- They can be used for earthquake resistant buildings as we know strain energy due to the earthquake is generally released from mortar resulting in the development of cracks in it, but interlocking bricks have no mortar so stain energy is released without causing cracks in the structure.
- Vertical reinforcement can also be provided which is not possible in conventional bricks in order to increase the strength of the structure.

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