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Review Article

Step toward alternative bricks: Introducing interlocking blocks to building construction system in Bangladesh

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ABSTRACT

In the present day, environmental degradation and global warming are major concerns worldwide. Significant environmental damage has resulted from the massive greenhouse gas emissions connected to the current method of making masonry bricks. Haze, fog, acid rain, air pollution, and global warming are a few of them. Burnt clay bricks are being replaced with a new kind of block called interlocking blocks, which is more ecologically friendly. Sand and cement are combined to create the brick, which has strong strength without burning. One way to lessen pollution and global warming is to utilize interlocking bricks. The purpose of the study is to scrutinize the entire process of using interlocking blocks to create a single-story structure to comprehend the applications of the blocks as a substitute to burnt clay bricks.

Keywords: Burnt clay bricks, carbon emission, dredged soil, interlocking bricks

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INTRODUCTION

One of the key industries that have evolved and contributed to national growth is the masonry system. Nevertheless, despite the benefits, there are some drawbacks to the way masonry is currently built, including high time and energy costs as well as issues with sustainability and environmental friendliness. A substitute would be to produce these materials, which can have respectable strength, need less energy in the process, be environmentally benign, and, most significantly, be affordable. This necessitates the development of novel materials or their consideration to overcome the shortcomings of traditional construction materials.[1] However, to assure a simple, eco-friendly, quick, and energy-efficient process, it is necessary to apply sustainable technologies in its manufacture, such as using locally accessible natural materials to cut down on transportation.[2] Bangladesh, a country with a population of 160 million, is currently contributing 0.14% to the world's emission of carbon dioxide (CO_2). Bangladesh's share in CO_2 emissions is – despite the increasing use of alternative energy – expected to rise sharply.[3] Brick-making is a significant sector in Bangladesh, contributing about 1% to the country's gross domestic product.[4] The brick kiln industry is one of the fastest-growing sectors, supporting the booming infrastructure and construction industry, with a current manufacturing capacity of 12 billion bricks a year from 4500 brick kilns surrounding all major cities of Dhaka, Khulna, Rajshahi, and Chittagong, and expected to grow 50% by 2020. Brick manufacturing is the fastest-growing industrial sector in Bangladesh and among the top three sectors, along with vehicle exhaust and suspended road dust, contributing to the air pollution and health problems in Dhaka. The total emissions are estimated at 23,300 t of PM 2.5, 15,500 t of sulfur dioxide (SO2), 302,000 t of carbon monoxide (CO), 6000 t of black carbon, and 1.8 million tons of CO_2 emissions from these clusters, to produce 3.5 billion bricks per year, using energy in efficient fixed chimney bull trench kiln technology and predominantly using coal and agricultural waste as fuel.[5] The total surface area of cultivable land in the nation is 8.8 million ha (21.7 million acres), according to the Ministry of Agriculture. There are three types of crops among them: Single-cropped 2.1 million ha (5.2 million acres), double-cropped 4.1 million ha (10.1 million acres), and multi-cropped 2.2 million ha (5.4 million acres). The legislation states that no one may use soil from hills, agricultural land, or tila (tiny hills) to build bricks. The legislation forbids removing soil from various locations, such as fallow areas, canals, beels

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(wetlands), rivers, wetlands, char (river islands), and moja ponds (ponds that dry up in the summer).[6] On the other hand, the increases in material cost in the construction work have increased the need to find more cost-saving alternatives so as to maintain the cost of construction houses, multistory, etc., which can be affordable to all people. Due to the lightweight of these blocks, there will be less dead load that will act on the structure, therefore the structure became lighter. If the structure will be lighter than there will be a reduction in the reinforcement, a reduction in the size of the member, reduction in the concrete, and also using these blocks, there will be no use of coarse sand for the plastering purpose. Moreover, the building should be constructed in the most economical way.[7] Again Bangladesh contains over 300 rivers, many of which are heavily silted and have not been dredged in nearly 30 years. The government plans to dredge the rivers in an effort to reduce potential flooding that inevitably follows regularly occurring natural disasters and to make the rivers more navigable. Dredging helps the nation to retrieve its old heritage of river transportation and saves the economy as a whole by making all major rivers of the land navigable round the year. Dredge soil introducing in blocks is a new one in our country that will help our economy definitely because of from the beginning of civilization, people, equipment, materials, and commodities have been transported by water. To do this, the channel depths of many waterways needed to be increased to provide access to ports and harbors. Most major ports in the world require dredging at some time to enlarge and deepen access channels, waterways, and turning basins and to provide appropriate water depths along waterside facilities. These channels often require frequent and regular maintenance dredging. In the case of fluvial navigation, dredging is also required to construct and maintain vital links to inland ports and facilities.[8] Recently, there has been an increase in interest in mortar-less interlocking masonry buildings. This is due to the fact that interlocking bricks self-align during building and do not require mortar, unlike conventional masonry structures. As a result, building interlocking brickwork requires a lot less labor expertise, and construction efficiency is also significantly increased. The interlocking mechanism of the bricks allows for differing

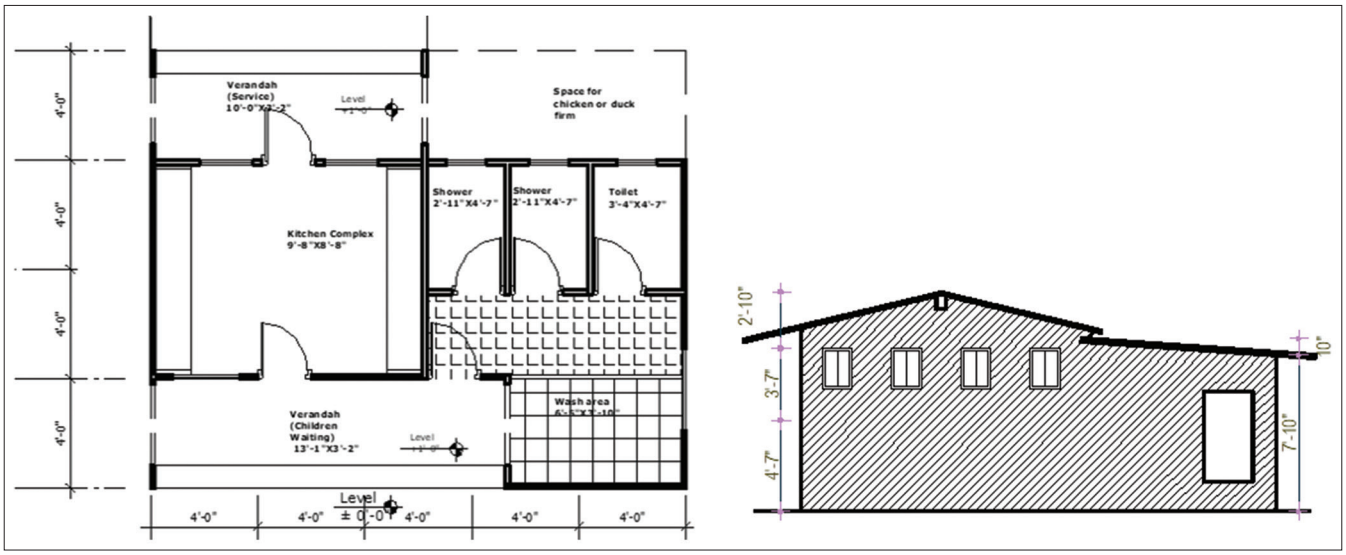

Figure 1: Plan and elevation of toilet and kitchen (female zone)

Figure 2: Layout of foundation

loading resistances than those of conventional construction.[9] The brick can be classified in several ways which are ASTM standard categorized brick as building brick (ASTM C 62), facing brick (ASTM C 216), hollow brick (ASTM C 652), and thin veneer brick (ASTM C 1088). The building brick can be used in load-bearing and non-load-bearing walls and also for insulation purpose.[10] Triple benefits of interlocking bricks can be considered as cost-effectiveness, energy efficiency, and creation of new job opportunities. Interlocking concrete block is a way to build a strong wall without mortar. The flanges slope the wall back into the slope for additional strength. Interlocking block walls do not require a footing, but some styles require setting the first course in a trench to hold the bottom of the wall in place. All these positive qualities advocate using interlocking bricks as the replacement of burnt clay bricks.[11]

Figure 3: Completion of first-floor area

Although this technology has been employed in other countries, Bangladesh has not yet seen a surge in the use of mortar-less load-bearing interlocking brick building. To establish the interlocking bricks in wall construction, Housing and Building Research Institute (HBRI) of Bangladesh had taken initiatives to complete a one storied building within an area of about 320 sft. The successful implication of interlocking bricks can be proved to be an exceptional substitute to burnt clay bricks. To introduce the dredging soil in the development of interlocking bricks, dredged soil has been collected from the river Kapotakkho. Some soil from the HBRI premises had been

Figure 4: Placement of the first course of bricks

Figure 5: Installation of wooden frames

Table 1: Result of compressive strength test

Sample	Breaking load (Ton)	Breaking load (Ib)	Compressive Strength (psi)	Interlocking block
Interlocking bricks with Kapotakkho dredged soil	11.27	25,237.33	525.78	
Interlocking bricks with Dhaka soil	15.80	35,392.00	737.33	

also collected which has been entitled as "Dhaka Clay." These two types of soil have been used to produce interlocking bricks.

EXPERIMENTAL INVESTIGATION

The experimental investigation has been conducted by mixing the Kapotakkho dredged soil and Dhaka soil has been mixed with 10% cement, respectively, to form two types of bricks. Compressive strength tests, determination of modulus of rupture, and water absorption tests have been carried out in the establishment of the brick [Table 1].

APPLICATION OF INTERLOCKING BRICKS

Details of the Pilot Project: Community Toilet and Kitchen

Proper approaches have been taken to apply interlocking bricks, for providing community-based service facilities such as toilets and kitchens for the female residents from approximately 16 families living in the HBRI property. Some considerations were taken based on the social and environmental context and service flow. The female zone consisted of separate toilets, two numbers of bathrooms, and a wash area. Each female toilet zone could be used by four families. Kitchen complex with four burners could be used by at least four families [Figure 1].

Construction Process from Foundation to Finish with Interlocking Bricks

Foundation

The foundation was approximately 376.83 sft (the trench was about 1′3″ width) which had been prepared for the construction of a female zone with interlocking bricks. 3″ thickness and 18″ width of C.C work had been provided first. The plinth area was completed by laying bricks up to 1′6″ [Figure 2].

Completion of the floor area

The floor area was filled with sand cement stabilized earth and the floor finish was completed with mortar (cement-sand ratio was maintained 1:4). The thickness of the finished floor was about 2″ [Figure 3].

Application of interlocking bricks

The blocks were laid dry on the foundation around the entire building, to ensure that they fit exactly next to each other (leaving no gaps). When laying the first course, proper care had been taken that the blocks are perfectly horizontal and in a straight line or at right angles at corners and joints (T-junction). Once the base course is properly hardened, the blocks are stacked dry, with the help of a mallet to knock the blocks gently into place. Up to 10 layers can be placed at a time. Every corners and joints were provided with 10mmϕ rods with 1:4 ratio of mortar in the hollow section of the wall. The rods were drilled into the floor (approximately 4″ inside the floor depth). They were also placed in the middle of the long span of the walls [Figure 4].

Installation of frames for windows and doors

Wooden frames were placed for doors and windows. Frames were connected to the walls by placing mortar between the walls and the frame [Figure 5].

FUTURE ACCEPTANCE

In general, this paper reviews the process of creating a single-story structure out of interlocking blocks. According to this specific study, the cost of building an interlocking brick structure is around 25% cheaper than that of building a reinforced concrete structure. Additional advantages of using the blocks include using green building materials, lowering total construction costs, having a structure with fair finishes, finishing projects quickly, and being easy to install. Since the interlocking blocks match the minimal requirements and specifications mentioned in the standards, they can be utilized in load-bearing or non-load-bearing systems. There are currently few studies on interlocking blocks, despite the fact that there are several potential applications and research gaps that must be filled to explore the interlocking blocks in detail.

CONCLUSION

Alternative building material is an alternative to traditional engineering construction materials such as hollow concrete block, autoclaved aerated concrete block, compressed stabilized earth block, thermal block, interlocking block, and cellular lightweight concrete block. Alternative materials offer both economic and environmental incentives.[12] The majority of structures are made feasible by interlocking blocks, which have a significant impact on the strength development of any building by effectively assisting with seismic and compression ability. These blocks are made up of several interlocking embargo configurations that work together to resist movement and provide resistance against earthquakes and unexpected shocks.[13] As one of the major busiest cities in the world, Dhaka is being distressed from air pollution due to the regular blazing fossil energy. The situation is getting worst due to the emission of fossil fuel from the surrounding brickfields. In this case, the use of interlocking blocks could be a suitable alternative to the burnt clay bricks. To facilitate the use of interlocking brick in buildings in the construction industry, this article aimed to detail the process.

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REFERENCES

1. Nadeem M, Gul A, Bahrami A, Azab M, Khan SW, Shahzada K. Evaluation of mechanical properties of cored interlocking blocks - A step toward affordable masonry material. Results Eng 2023;18:101128.
2. Ahmed H. A study on interlocking brick innovation using recycled plastic waste to support the acoustic and thermal performance of a building. ARTEKS 2021;6:335-48.
3. Gunter BG. The Impact of Development on CO_2 Emissions: A Case Study for Bangladesh Until 2050. Washington, DC: Bangladesh Development Research Center; 2010.
4. Introducing Energy-Efficient Clean Technologies in the Brick Sector of Bangladesh. Washington, DC: Manufactured in the United States of America; 2011.
5. Guttikunda SK, Begum BA, Wadud Z. Particulate pollution from brick kiln clusters in the Greater Dhaka region, Bangladesh. Air Qual Atmos Health 2014;6:357-65.
6. Siddique A. To Save Topsoil and Reduce Pollution, Bangladesh Moves Toward Alternative Bricks. Menlo Park: Mongabay; 2024.
7. Kumawat G, Maru S. Analysis and comparison of R.C.C. structure using CLC block with burnt clay bricks. Int J Eng Res Gen Sci 2016;4:125-31.
8. Habib A, Begum R, Salam A. Effect of stone dust on the mechanical properties of adobe brick. Int J Innov Sci Eng Technol 2015;2:631-7.
9. Xie G, Zhang X, Hao H, Thomas J. Parametric study of reinforced interlocking brick wall under cyclic loading. J Build Eng 2024;83:108415.
10. Asman NS, Bolong N, Mirasa AK, Saad I, Asrah H, Han LC. Life Cycle Assessment of Interlocking Bricks System Construction- A Review. In: Joint Seminar on Science, Engineering and Technology, Malaysia; 2018.
11. Alaloul WS, John VO, Musarat MA. Mechanical and thermal properties of interlocking bricks utilizing wasted polyethylene terephthalate. Int J Concrete Struct Mater 2020;14:24.
12. Sadeque MA. Advantages of Alternative Materials Over Conventional Clay Burn Bricks. Kazi Nazrul Islam Avenue: The Daily Star; 2019.p. 1-3.
13. Kumar R. Investigation on interlocking concrete block of different configurations to enhance strength and seismic effect. J Emerg Technol Innov Res 2021;8:494-502.