A COMPARATIVE STUDY OF I96 INTERLOCKING FLY ASH BRICKS AND TRADITIONAL BRICKS

[1]Nilesh Vishwas Avhad
Lecturer in Civil Engineering Department,
SRES's Sanjivani K. B. P. Polytechnic,
Kopargaon, Maharashtra, India- 423603.

[2]Pratap Madhavrao Aher
Sr. Lecturer in Civil Engineering Department,
SRES's Sanjivani K. B. P. Polytechnic,
Kopargaon, Maharashtra, India- 423603.

[3]Snehal Shankar Dupargude,
Lecturer in Civil Engineering Department,
SRES's Sanjivani K. B. P. Polytechnic,
Kopargaon, Maharashtra, India- 423603.

[4]Varun Ravindra Chaudhari,
[4]Last Year Student of Three Years Diploma,
Department of Civil Engineering,
SRES's Sanjivani K. B. P. Polytechnic,
Kopargaon, Maharashtra, India- 423603.

[5]Harshal Kishor Parjane
[5]Last Year Student of Three Years Diploma,
Department of Civil Engineering,
SRES's Sanjivani K. B. P. Polytechnic,
Kopargaon, Maharashtra, India- 423603.

Abstract:

The paper focuses on wide use of interlocking bricks over the replacement of traditional clay bricks in masonry systems. It also focuses in terms of various structural applications. I96 the name itself states that 'I' for interlocking, '9' for 9 inch and '6' for 6-inch brick-wall construction. This innovative brick facilitates the locking arrangements in such a way that both 9 inch and 6-inch brick-wall can be built using a single brick as other interlocking bricks are manufactured to construct a wall of single width. Interlocking bricks have superior structural stability. The interlocking mechanism creates a robust bond between bricks, enhancing earthquake resistance and load-bearing capacity. Additionally, interlocking brick constructions exhibit excellent thermal insulation properties, leading to energy-efficient buildings with reduced heating and cooling costs. In this paper, we have proved the various aspects of interlocking bricks making it a better replacement to traditional brick masonry system. As in today's market AAC blocks have gained a tremendous market this brick also proves better in comparison with AAC blocks with respect to various aspects. These interlocking bricks can replace the faulty workmanship on the construction site which is explained in this paper. Interlocking bricks also eliminates the use of cement mortar which in terms reduces the cost of construction.This system can be very useful for faster, efficient and low cost construction which will help in future development of the country.

Keywords- I96 Fly-ash brick, sustainable construction, green building material, Thermal compatibility, Earthquake resistance, Recyclable brick, Mortar less, Environmental friendly, Cost effective.

1. Introduction:

1.1 General:

Masonry in general is the construction of structure by using individual units which are laid and mortar is used for binding those units. One of the high durable types of construction is masonry. The common masonry materials are burnt clay bricks, stones such as marble, granite, concrete bricks, stabilized earth blocks, etc. The most commonly used masonry units are burnt clay brick (conventional brick) and concrete blocks. Generally, masonry units possess high compressive strength, but masonry units will possess low tensile strength. Tensile strength can be increased by increasing the thickness of wall and providing columns (piers) at regular intervals.

1.2 Interlocking Brick Masonry:

I-96 Interlocking bricks are the new improved innovative structural components used for construction of buildings which initiates mortar-less construction. These bricks can be produced mechanically. These bricks bring about economical production, reduction in cost of labour and utilization of abundantly available materials for construction of structures for both urban and rural development. These bricks have grooves which leads to proper fixing of bricks (bricks will be locked on either side since grooves are provided). The assembling of these bricks does not require skill and can be assembled faster with high efficiency. In temporary structures, the dismantling is very simple, and no part of the wall is destroyed.

2. Materials Used for study:

2.1 Cement:

For good quality of mortar, the selection of Portland cement is very much important. Different brands of cement give different strength results due the variation in composition and fineness of particles. Strength development will be dependent on both cement characteristics and cement content. Birla Super Ordinary Portland cement of 53 grade confirming to IS: 12269-1987 is used in our investigation.

2. 2 Fly Ash:

In this particular case, fly ash was used to replace the cement for about 50%. Fly ash is a byproduct of thermal power plant. Fly ash collected from thermal power plant is used for this study.

2. 3 Sand:

Crushed stone sand which is popularly known as manufactured sand (M Sand) passing IS: 480 sieves are used in this study. Sieve analysis is conducted as per specifications of IS: 383-1970and IS: 2386 Part-I 1963.

2. 4 Bricks:

Bricks which are available will be having large variation in shapes and sizes. According to IS:1077-1992, according to the dimensions, bricks can be classified as modular and non- modular bricks. Standard sizes of modular and non-modular bricks are tabulated in table

Modular Bricks		
Length (mm)	Width (mm)	Height (mm)
190	90	90
190	90	40
Non-Modular Bricks		
Length (mm)	Width (mm)	Height (mm)
230	110	70
230	110	30

Table 1: Standard sizes of modular and non-modular bricks

3. Casting of 96 Interlocking Fly Ash Bricks:

i. Fine aggregates that are stone dust and sand are mixed thoroughly with cement and fly ash and bought into semi-consistency by adding water in the pan mixer.
ii. This mix is transferred into the dual mould mechanical machine and pressure of 45 tons is applied to obtain the blocks of high compaction effort and density.
iii. The dimension of the block is 9” x 6” x 3”.
iv. Here the mix proportion is 1: 4: 8 i.e. 1 cement: 4 stone dust: 8 aggregates(6mm) 70% Fly ash and Hardener is used.

4. Experimental Investigations:

i. Compression test of Interlocking Blocks:

The compression test of interlocking blocks was done after 28 days of curing for three samples. Steel plates were placed on the grooves of the interlocking block. According to the specifications given in IS: 2185 (Part 1)-2005, the value of compressive strength should not be less than 4 N/mm2. I-96 Brick has compressive strength of 6 N/mm2 which is more than sufficient according to IS code.

ii. Compression test of Bricks:

Compressive strength for bricks is done for three specimens. The factors affecting the compressive strength of bricks are the ingredients, method of manufacture of the brick and rate of loading. Voids on the surface of the brick were filled with cement mortar. The test is performed by proper packing and by providing steel plate of 15mm thick on both sides while testing. According to the specifications of IS: 1077 – 1992, the minimum compressive strength should not be less than 3.5 N/mm2.

iii. Water Absorption test of Interlocking Blocks:

Water absorption test of interlocking blocks were conducted as per the specifications of IS: 2185(part1)-1979, which specifies that the interlocking concrete blocks should not absorb more than 10% of water. The results obtained are satisfied according to this code.

iv. Water absorption of Conventional Bricks

Water absorption of conventional bricks was calculated as per the specifications of IS: 3495 (Part II) – 1992, which specifies that the bricks should not absorb more than 20% of water. The results obtained are satisfied according to this code.

v. Dimensional test of Conventional Bricks:

Conventional bricks which are available will be having large variation in sizes and shape. IS-1077 (1992) classifies conventional bricks as modular and non-modular bricks. The results obtained shows that the bricks neither belong to modular bricks nor non-modular bricks. The width and height of the bricks considered are very much closer to non-modular bricks.

5. Experiment Results and Analysis:

i. Compressive Strength of Interlocking and Conventional Brick:

Sr. No.	Specimen size l x b x h (mm)	Load (kN)	Compressive Stress (N/mm^2)	Mode of failure
1	230 x 150 x 80	578.5	16.77	Crushing
2	230 x 150 x 80	544.9	15.79	Crushing
3	230 x 150 x 80	549.7	15.93	Crushing

Table 2: Compressive Strength of Interlocking Brick

Sr. No.	Specimen size l x b x h (mm)	Load (kN)	Compressive Stress (N/mm^2)	Mode of failure
1	228 x 104 x 75	235.1	9.91	Splitting
2	225 x 100 x 74	246.4	10.95	Splitting
3	230 x 99 x 77	231.9	10.18	Splitting

Table 3: Compressive Strength of Conventional Brick

ii. Water Absorption test of Interlocking Blocks and Conventional Bricks:

Sr. No.	Dry weight of interlocking block	Wet weight of interlocking block	Waterabsorption % (by mass)
	Ml (gms)	M2 (gms)	[(M2 -Ml)/M1]x100
1	4190	4617	10.19
2	4185	4606	10.06
3	4195	4607	9.81
Average Water Absorption			10.02%

Table 4: Water Absorption test of Interlocking Bricks

Sr. No.	Dry weight of interlocking block	Wet weight of interlocking block	Waterabsorption % (by mass)
	Ml (gms)	M2 (gms)	[(M2 -Ml)/M1]x100
1	2103	2435	15.78
2	2089	2422	15.96
3	2970	3448	16.09
Average Water Absorption			15.94%

Table 5: Water Absorption test of Conventional Bricks

iii. Dimensional test of Interlocking Blocks and Conventional Bricks:

Sr. No.	Length (mm)	Width (mm)	Height (mm)
1	2755	150	80
2	2760	150	78
3	2761	150	76

Table 6: Dimensional test of Interlocking Bricks

	Traditional Bricks		
Sr. No.	Length (mm)	Width (mm)	Height (mm)
1	230	110	70
2	230	100	76

Table 7: Dimensional test of Conventional Bricks

iv. Efflorescence test of Interlocking Blocks and Conventional Bricks:

Type of Brick	Size of brick (L x B x t)mm	Observed Degree of Efflorescence in					Average Degree of Efflorescence
		Brick Sample 1	Brick Sample 2	Brick Sample 3	Brick Sample 4	Brick Sample5	
Conventional Bricks – Red clay brick	228 x 104 x 75	Low	Medium	Medium	Medium	Medium	Medium

Table 8: Efflorescence test of Interlocking Bricks

Type of Brick	Size of brick (L x B x t) mm	Observed Degree of Efflorescence in					Average Degree of Efflorescence
		Brick Sample 1	Brick Sample 2	Brick Sample 3	Brick Sample 4	Brick Sample 5	
Interlocking Blocks	230 x 150 x 80	Low	Low	Low	Low	Medium	Low

Table 9: Efflorescence test of Conventional Bricks

v. Shape and Size test of Interlocking Blocks and Conventional Bricks:

a. Shape and Size test of Interlocking Blocks

The average size of the I-96 interlocking brick was found out to be 230 x 150 x 80 mm which is satisfied as per standards.

b. Shape and Size test of Conventional Bricks

The average size of the conventional bricks was varying in lengths. Although, the average size found out to be 230 x 110 x 76 mm. Through these observations, we can say that the bricks closely comes under the category of non-modular bricks as per the code IS-1077 (1992).

vi. Soundness test of Interlocking Blocks and Conventional Bricks:

a. The interlocking block produce a clear ringing sound when struck with each other and also it doesn't break while striking.

b. The conventional brick produce a clear ringing sound when struck with each other and one out of five bricks may break while striking.

vii. Impact test of Interlocking Blocks and Conventional Bricks:

a. The interlocking block does not break or crack when felt from a height of 1 m. Hence, the interlocking brick is passed in impact test.

b. The conventional brick may likely break if it is not burnt properly when felt from height of 1 m. Hence, it has comparatively less impact value than interlocking block.

viii. Cost Analysis:

S.No	Description	Conventional Red Brick				Interlocking Brick			
		Quantity	Unit	Rate	Cost	Quantity	Unit	Rate	Cost
		Brickwork with first class bricksin super-structure in cement mortar 1:4 (9” x 6” x 4”)				Brickwork with Interlockingbrick in super-structure (9” x 6” x 3”)			
A	Material								
1	Brick	2312	Nos.	15	34680	3767	Nos.	13	48971
	Wastage	5%			1734	2%			979
2	Cement	18	Bag	400	7200	2	Bag		800
3	Sand	2.4	m^3	1600	3840				
	Total (A)				47454				50750
B	Labour				14350				12900
C	Int. Plaster	66.67	Sq.m	400	26668	66.67	Sq.m	271	18068
D	Ext. Plaster	66.67	Sq.m	325	21668	66.67	Sq.m	271	18068
	Total (A+B+C+D)				110140				99786
C	Scaffolding 1% extra	1%			1101	1%			998
E	Other charges 2% extra	2%			2202	2%			1996
F	Add for water charges @1%	1%			1101	1%			998
		Cost of 10 cu.m.			114544	Cost of 10 cu.m.			103778
		Cost of 1 cu.m.			11454	Cost of 1 cu.m.			10378
		Round off cu.m.			11500	Round off cu.m.			10400

6. Advantages of Interlocking Bricks:

i. Fly ash bricks absorb less heat and considering the Indian climate, it makes it better when compared to clay bricks.
ii. From the cost front, it requires less mortar during construction. Further, the machine that we provide requires less labor too.
iii. The compressive strength is very high and they are less porous.They absorb less water and saves cost there, as well.
iv. It is environmentally friendly and hence allows your business to take a step towards sustainable development.
v. Production of clay bricks damages the top-soil and this is prevented in the manufacturing process of fly ash bricks. There is no pollution or environmental damage, as a result of which it has been put into the white category of products.
vi. Fly ash bricks are stronger, more uniform and denser as compared to clay bricks. While their mortar consumption is low,their wastage is only about 1% as against that of clay bricks which are about 10%.
vii. Net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement.
viii. Reduction in amount of coal combustion products that must be disposed in landfills, and conservation of other natural resourcesand materials.
ix. AAC Blocks do not provide a good Shear strength hence it cannot be used for retaining structures but I96 brick has a good locking arrangement which provides a high Shear strength.
x. AAC blocks are used only for framed structures but I96 brick can be used for both framed and load-bearing structures
xi. AAC blocks have comparatively less compressive strength than I96 bricks hence it is not suitable in industrial buildings butI96 bricks can be used there.

6. Disadvantages of Interlocking Bricks:

One of the major disadvantage of I96 brick is its self-weight, it ways around 4.2 kg which increases the dead load of the structure. Research work is required for solving this issue.

7. Conclusion:

After comparing interlocking bricks and traditional bricks, it's clear that both have their pros and cons.Traditional bricks have a long history and proven durability, but they can be more expensive and time-consuming to install due to the need for mortar. On the other hand, interlocking bricks offer cost- effectiveness, faster installation, and enhanced structural stability. They also contribute to sustainable building practices. In conclusion, the choice between interlocking bricks and traditional bricks depends on factors like cost, durability, installation time, and sustainability goals. It's important to consider the specific requirements of the project and weigh the advantages and disadvantages of each option. This research needs to be developed further by using other typesof material in the mix design so that an effective and efficient mixture is obtained.

8. References:

[1] Z Erwanto, The Innovation of Interlock Bricks with A Mixture of Bagasse Ash Without Combustion, IOP Conference Series Materials Science and Engineering 854(1):012002, June 2020.Safwan A. Khedr, Utilization of Marble and Granite Waste in Concrete Brick, International Conference on Environment and BioScience , IPCBEE At: Singapore, Jan 2011.

[2] Fatheali A Shilar, Performance Evaluation Of Interlocking Bricks Using Granite Waste Powder, International Journal of Engineering Applied Sciences and Technology, 2019 Vol. 4, Issue 2, ISSN No. 2455-2143, Pages 82-87.

[3] G.Ghadvir, Manufacturing Of Interlocking Bricks Using Fly Ash, International Research Journal of Engineering and Technology, Volume: 08 Issue: 06, June 2021.

[4] Tabin Rushad S, Experimental Studies on Lime-Soil-Fly Ash Bricks, International Journal Of Civil And Structural Engineering, Volume 1, No 4, 2011.

[5] S Naganathan, Evaluation of The Engineering Properties of Fly Ash-Based Geopolymer Bricks, International Journal of Civil Engineering And Technology,Volume 11, Issue 2, February 2020.

[6] Abdul Samad, A review on past and present development on the interlocking loadbearing hollow block (ILHB) system, IOP Conference Series: Earth and Environmental, 2018.

[7] Amin Al-Fakih, Development of Interlocking Masonry Bricks and its' Structural Behaviour: A Review Paper, IOP Conference Series: Earth and Environmental, 2018.

[8] Vipin Kumar Kushwaha, A Review Paper on : Interlocking Wall Block For Temporary Structure © 2019 JETIR May 2019, Volume 6, Issue 5

[9] Sunil Kumar, A perspective study on fly ash–lime–gypsum bricks and hollow blocks for low cost housing development,Construction and Building Materials, Volume 16, Issue 8, December 2002, Pages 519-525