Sustainable Development of Housing in Rural Area by the Concept of Interlocking Lightweight Block

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Abstract— Since the last one or two decades there has been many new research done in construction industry. Construction is the industry which is time consuming for completion of project while many of the solutions has been provided to reduce the time consumption of construction. In all this scenario, brick masonry was the area which was under-rated, less research and up gradation has not been done in this area. Interlocking mortar less brick masonry is one of the solution toward this tedious and time consuming area. This report provides somewhat research and solution for this area. Many of the factors have been consider for ease in construction, use of this Block reduces self-weight of structure, reduces cost per product and cost of construction. This method also help in reducing the time of construction with well quality and stability. Material used for production of this Block is cement, fly ash, foam. Block has been casted in specially designed in specially fabricated mould. The concept design and application of this method proves to be effectives and has more sustainable approach towards sustainable construction. Fly ash is considered to be harmful component for environment if kept open to air hence use of it in construction reduces the environmental stress without compromising with the construction quality.

Keywords: Fly Ash, Foaming Agent, Interlocking Block, Light Weight and Cement

I. INTRODUCTION

Shelter is considered to be the third important factor of human need after food and clothing. Permanent housing has become the need of developing country as it is inadequately available. Affordable housing should be considered as the significant infrastructure of the country.

As per our perception and our guessing towards field of construction we are at the point of conclusion that the fast construction is what the society needs. At least in the country like India which is mostly speedily developing in infrastructure needs the solution on fast construction.

A very high amount of waste is being generated all around the world that need to be disposed well. Construction industry is trying to use waste generated construction to provide green infrastructure. Huge amount of waste that is being generated from thermal power plant known as fly-ash is hazardous for environment. This fly-ash is used in the production of Interlocking Lightweight Block. It is a solution to tackle this problem of environment as well as slow construction needed to be found.

A. What are Interlocking Block?

The conventional method of brick masonry is tedious and time consuming and expensive sometimes. To cope up with hardship and issues faced during construction various methods are being implemented. Simultaneously, various materials and equipment is used in practice to reduce the hard diligence and time consumption during construction. Interlocking mechanism is one such advancement in the construction industry.

Interlocking Block are the boon over the conventional clay brick. Each Block is constructively designed to lock itself to the other Blocks around without the use of mortar. The self-locking is achieved by using male-female locking mechanism. Based on the design, shape of female side will vary and a complimentary lock is provided on the opposite side of Block. Load transfer is achieved by shear transfer and gravity.

B. Preparation of Interlocking Block

Interlocking Block are made by the combination of cement, fly-ash and Foam together in appropriate proportions. The required materials are batched and mixed proportionately. Once the required mix is prepared, it is then poured in specially fabricated mould for interlocking patterns. It takes about 48 hours to set with required hardness. The Block are then subjected to curing for about 7, 14 & 21 days.

Once the curing is done, the Block is ready to use at site without using mortar in masonry. The interlocking Blocks come in different designs, finishes and patterns.

C. Advantages of Interlocking Light Weight Block

1) Help in reducing waste generated in thermal power station
2) It is 3/4 times lighter than traditional clay brick therefore easier in transportation.
3) Interlocking light weight Block reduces overall construction cost as compared to clay brick.
4) It reduces construction time. It locking mechanism help to easier and faster construction.

Specially designed interlocking Block:

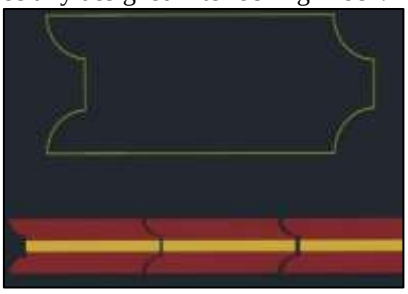


Fig. 1: shape of interlocking Block.

Fig. 2: (a) bond of interlocking Block

Fig. 2: (b) bond of interlocking Block.

II. OBJECTIVES

As brick masonry is found to be the brittle in nature it tends to fail in shearing by diagonally sometimes before maturity. For overcoming this above mentioned factors various methods are being implemented such as use of porous Block and use of interlocking Block for better lateral stability.

From this investigation the following characteristics are studied.

There has been the huge requirement of housing in the country of India. And most of the population cannot bear the expense for construction of concrete structure.

To provide a solution to the rising in the cost of construction day by day.

In case of any heavy project, to reduce the weight of construction and the cost of construction as well.

To provide speedy construction without compromising quality.

III. EXPERIMENTAL PROGRAMME

Material used

A. CEMENT

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other material to bind them together.

Ordinary Portland cement were used satisfying all the IS requirements was used in making the Blocks.

The physical properties of cement listed in Table 1

Material	Physical Properties	Value
Cement	Specific gravity	3.17
	Specific surface	2240 cm2/gm
	Soundness	1 mm
	Initial setting time	35min
	Final setting time	380 min
	Compressive Strength (1:3 cement sand mortar)	19.2 Mpa (3 day) 28.5 MPA (7 day)

B. FLY ASH

Fly ash is a fine powder that is a by-product of burring pulverized coal in electric generation power plant.

The fly ash was collected in dry state from the Thermal power station, koradi Nagpur

The Chemical properties of fly ash listed in Table 2

Chemical composition	Min	Max	mean
Silica (as SiO2)	21.95	71.50	53.30
Alumina (as Al2O3)	7.52	27.68	20.70
Iron (as Fe2O3)	2.18	10.13	7.22
Sodium (as Na2O)	2.12	16.15	8.74
Sulphur Trioxide (as SO3)	0.64	4.39	2.64
Magnesium Oxide (as MgO)	0.66	3.27	1.76
Loss of ignition (as I.OI)	0.26	1.31	0.70

C. Foaming agent

A foaming agent is a material that facilitates the formation of foam such as a surfactant or a blowing agent.

The foaming agent was collected in liquid state from the chemical industry near Nagpur. And the test was performed in the laboratory of the same industry.

Figure No.3 foaming agent

Test report of the foaming agent are given in table 3

Test performed	Test results	Requirement reference
Physical state	Clear liquid	Clear / hazy liquid
pH value	7.15	> 6
Relative density gm/cc	1.03	1.020 + 0.02
Storage condition & shelf life	Maximum storage life is	365 days

D. Water

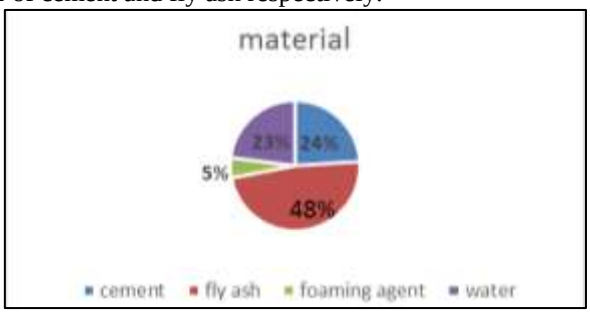
Ordinary tap water was used for both mixing the constituents of the Blocks as well as for the curing of Blocks.

IV. PROCESS OF OPERATION

A. Casting of interlocking Blocks:

Batching:

In the preparation, weight batching is used with the ratio of 1:2 of cement and fly ash respectively.



B. Mixing

Interlocking light weight Block is carried out by mixing of a pre-formed foam with cement, fly-ash, and water slurry. Manual method of mixing is used to mix cement, fly ash and foam. Foam is generated with the help of fast rotating drill machine connected with hoe shaped component at downward end.

C. Casting

In this method, the dry mixture of cement and fly-ash is mixed first. After the mixing of dry component it is added in 25% of water required and then adding remaining required. At the same time the foam agent is generated with the help of machine. The foaming agent is diluted into the 40 part of portable water and after the dilute it in water the foam is generates with the help of high rpm of machine.

D. Curing

Hardening of any concrete products requires the continued presence of water in the Block to enable cement to complete hydration process. The strength of the concrete components made from Ordinary Portland Cement (OPC) increase gradually with time. The purpose of curing is to maintain moisture in the concrete component for the whole period required of hydration process. To achieve proper curing, it is necessary to control curing duration and site conditions.
For the Interlocking light weight Block immersed curing are to be adopted. Curing period of 7, 14 and 21 days are to be carried out in curing tank or steamed curing to be adopted for approximately 56 hours.

E. Testing

The casted Blocks were taken out from water one day prior to the testing and were tested for compressive strength after 7, 14 and 21 days and water absorption test as per IS 1077-1957 Code.

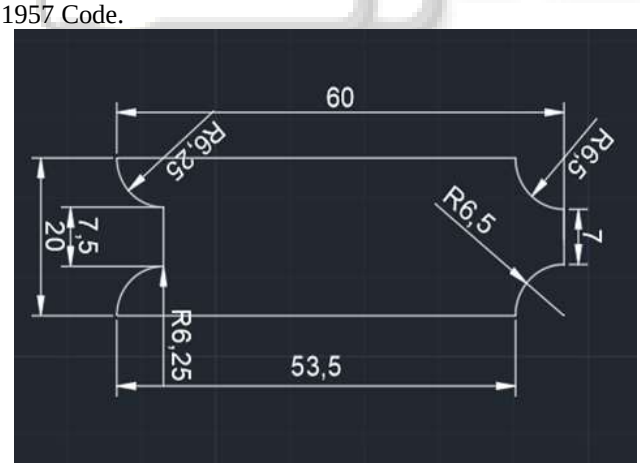


Fig. 4: dimension od interlocking Block.
Block size 60x30x20 cm (all values are in Cm)

V. RESULT

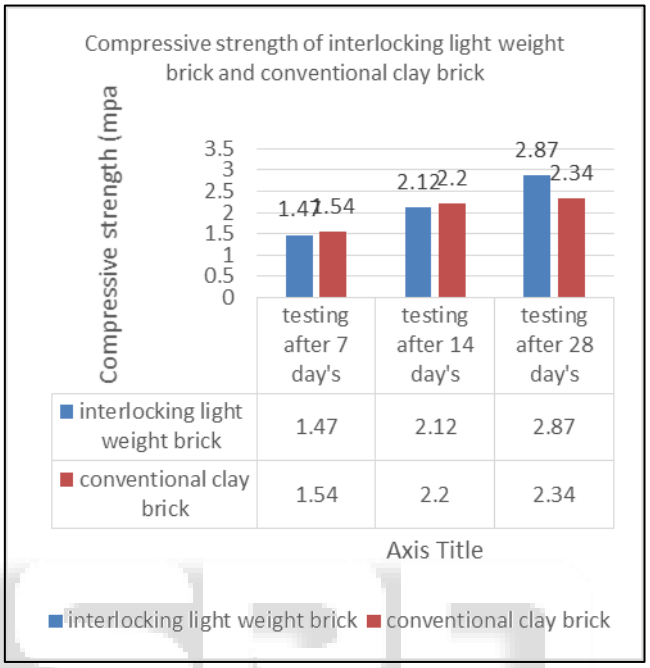
A. Compressive Strength

Compression testing machine should be used to carry out compressive strength test. Block should be placed between the jaws and load should be applied gradually. Precaution should be taken such that load should be applied to the top portion of the Block.

For this cement mortar of proportion 1:2 are placed on top flange as well as at bed and gradual load is applied over the complete area till the failure occurs and not the maximum load at failure.

The load at failure shall be the maximum load at which the specimen fails to produces any further increase is the indicator reading on compression testing machine.

$$\text{Compressive strength} = \frac{\text{Maximum load at failure}}{\text{Avg. area at bed face}}$$



Graph 1: Compressive strength of interlocking light weight Block and conventional clay brick. (All values are in N/mm2)

VI. COSTING

Cost per product Comparison.

1) Costing of one Block = 103 rs (consist 21 conventional brick)
2) Costing of 21 conventional brick = 126 rs
   Comparison in brick masonry:
3) Cost per cu.m of ILB (interlocking light weight Block) = 3932 rs/cu.m
4) Cost per cu.m of conventional brick = 4553 rs/cu.m
   Hence, proved that usage of ILB reduces cost of construction

VII. CONCLUSIONS

The concept, design and application of interlocking Block design proves to effective example for sustainable approach towards construction

Interlocking Blocks with economically available fly ash in large proportion have sufficient strength for their use in low cost housing, non-load bearing construction and in regions where good quality burnt clay brick are not available.

This study shows that the reduction in self-weight of Block is 32%-34% less compared to conventional clay brick.

Use of the suggested interlocking lightweight Block may help in reduction of cost of the project for about 15%-20% in area of brick masonry.

By usage of 40%-50% of fly-ash in the Block helps in reducing the environmental stress up to certain level.

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