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EXPERIMENTAL INVESTIGATION OF INTERLOCKING CONCRETE BLOCK BY PARTIAL REPLACEMENT OF BRICK WASTE AND PLASTIC WASTE

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Abstract - *The innovative usage of recycle products has increased in this present scenario. Manufacturing of new product with the utilization of waste product is a challenging job. The necessity of the waste products increases with the decrease in the availability of Natural Resource over a short period. The main objective of this project is to encourage the use of Plastic waste (PW) and Brick Waste (BW) products as constitution of Interlocking Blocks. In this project Interlocking block was made with OPC 53 Grade and by replacing Coarse aggregate and Fine aggregate with Plastic waste of about 5%, 10%, 15% while the Brick Waste (BW) of about 2%, 4%, 6%, 8% respectively. Initially the Plastic waste (PW) was only replaced for the coarse aggregate and the optimum percentage was calculated which is 10% Plastic waste. Next the Plastic waste (PW) was standardized and the Brick Waste (BW) was replaced for fine aggregate. From the experiment conducted 10% Plastic waste (PW) and 4% of Brick Waste (BW) was obtained as the optimum percentage replacement. With this percentage replacement the Interlocking Blocks are casted and compressive tests were conducted.*

Key Words: *Interlocking Block, Plastic Waste, Brick Waste, Replacement, Compressive Strength*

1. INTRODUCTION

The conventional brick masonry is a most renowned building material in the construction industry which has extreme properties like durability, cost etc. [7]. The traditional bricks are made with clay and they are treated with high temperature kiln firing [6]. These bricks are produced either by machine or by manually. The conventional bricks can be used for the construction of single story building and not for multi-story building as they are large in size and have less resistance to earthquake [7]. To overcome few of the above and to compete in this rapidly growing construction industry engineers are in search of the new technique and that should be an alternate for conventional burnt clay bricks [6].

The Interlocking concrete block are different from the normal bricks. These blocks interlock with each other by means of positive and negative frog on top and bottom of the block [4]. This frog connection does not allow the structure for horizontal compressive stress and lateral movement of block [4]. The interlocking blocks are of different shapes and the most common shape is regular or full block (300mm X 150mm X 100mm), half sized (150mm X 150mm X 100mm) and U-Shaped [7,4].

The construction with the interlocking blocks are does not required a large amount of cement mortar as of conventional bricks masonry. The cement mortars are used only for plastering the wall to resist the structure from the penetration of wind and rain [7].
There is little heterogeneity between normal brick and interlocking blocks and they are: [7].

- Interlocking Bricks are not backed; it's just mud in high density pressure using a pressing machine and allowed to dry naturally. Whereas normal bricks are burned clay materials.
- The sizes of the interlocking blocks are approximately 2.5 times the size of the normal bricks.
- The weight of the interlocking block is greater than the equivalent volume of the baked bricks.

1.1 Advantages: [7, 4]

- The dry assembly of interlocking blocks saves large amount of time and reduces the building cost.
- They can be shipped easily from one location to another.
- The manufacturing of these blocks is simple and does not required skilled labors and the production can be done at any geographical locations.
- Grout hole and channel block are provided to insert steel reinforcement in any point of the building to resist the structure from wind and earthquake.

1.2 Disadvantages: [7]

- As it is the new technique so there lack of proper awareness toward the peoples.
- As the joints are not entirely resistance to wind and rain, so plastering is required.

2. MATERIALS USED

2.1 Cement

The OPC 53 grade Cement is used as the Binder material. The properties of the cement are tested and the results are Specific Gravity of the cement is 3.23 and Normal Consistently is 32%. The Initial Setting Time of cement is 47 min and the Final Setting Time of cement is 610 min.

2.2 Coarse aggregate

The granite materials are crushed and the materials retaining 20 mm sieve and 12.5 mm sieve was used. The Specific Gravity of coarse aggregate is 2.54 and the Fineness modulus is 7.03 and the Water absorption is 0.62%.

2.3 Fine Aggregate

There is a huge demand for the river sand the M-Sand is used as the alternative over the construction industry and so do we. The Specific Gravity of the M-Sand is 2.33 and the Fineness modulus is 2.68 and the Water absorption is 1.01%

2.4 Water

Portable fresh water, which is free from organic substance and concentrations of acid, was used for mixing of concrete.

2.5 Plastic Waste

The Plastic are non-biodegradable waste material which has few intelligent features also they are extremely versatile, light weight, high lesser, production cost and ability to combine with other materials [2, 5]. So the locally available plastics wastes were collected and they are hand crushed. The plastic which are retained in 20mm sieve and 12.5 mm sieve are used. The properties of the Plastic are determined and they are Specific gravity of Plastic is 2.06 and the Water absorption is 1.07%.

2.6 Brick Waste

There is need in the further improvement of recycling the brick waste produced during the construction of buildings. Construction practices still create too much waste during both the design and build phases. This waste can be recused in an effective as they are a lower cost option and is more resource efficient [1, 3]. The Brick Waste produced from the construction sites were collected and they are tested to determine their properties and are the Specific gravity of Brick waste is 2.44 and the Water absorption is 2.71%.

2.7 Compression test

As per the Indian Standard Method of Tests for Strength of Concrete (IS 516:1959), the Cube compression test and the compression test for interlocking Blocks are evaluated.

3. METHODOLOGY

The Design mix for M20 grade of concrete is done with IS 10262: 2019. The Mix ratio was 1:1.61:2.86 with the water cement ratio of 0.5 (9). Then the cube samples are casted only with the partial replacement of Coarse aggregate with the Plastic waste was done and the optimum percentage was derived. Then with the optimum percentage replacement of Plastic waste, the Brick waste is replaced for Fine aggregate and the compressive strength was calculated and the optimum percentage replacement is determined. Finally the Interlocking Blocks are casted with the optimum percentage replacement obtained with the replacement of both the plastic waste and the brick waste, and the compressive strength was determined for the Interlocking Block.

4. RESULT AND DISCUSSIONS

The Concrete Cube Mold of size 150×150×150 mm was used for casting the specimens. Totally 54 cube samples and 12 Interlocking Block samples were casted and tested. The Sample details are as follows:

TABLE -1: Details of Specimens.

Types	% Aggregate Replacement	
	Plastic Waste (PW)	Brick Waste (BW)
CON 1	0	0
PW 1	5	0
PW 2	10	0
PW 3	15	0
CON 2	10	0
PBW 1	10	2
PBW 2	10	4
PBW 3	10	6
PBW 4	10	8
CON 3	0	0
ILB	10	4

4.1 Compressive Strength Test for Plastic Waste

The Concrete cube with the Partial replacement of plastic waste (PW) for coarse aggregate was done at 5%, 10% and 15%. Then they are placed for curing for 7 and 28 days.

TABLE - 2: Compressive Strength test of Plastic Waste.

Specimen Details	7 Days (N/mm2)	28 Days (N/mm2)
CON 1	20.73	27.64
PW 1	14.79	19.72
PW 2	22.37	29.83
PW 3	19.21	25.61

From the table 2 the compressive strength of concrete cube with varying proportions of plastic waste was tested and the test results are compared with the conventional concrete. According to which there was a rise in compressive strength in PW 2 (10% of plastic waste replacement) in both 7 days and 28 days compressive strength. Thus the PW 2 sample was considered as the optimum percentage for plastic waste replacement.

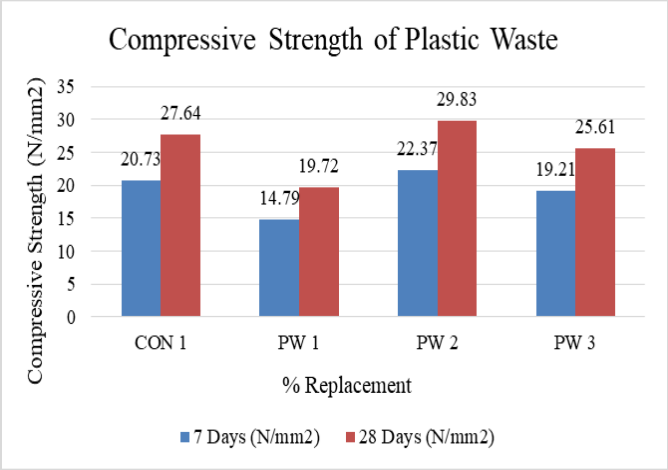

Chart -1: 7 Days and 28 Days Compressive strength of Plastic Waste

From the Chart-1 we can also conclude that there was a rise in the compressive strength which was 7.81% in 7 days and 7.92% in 28 days.

4.2 Compressive Strength Test for Plastic Waste and Brick Waste

The Concrete cube with the Partial replacement of plastic waste for coarse aggregate was done at 5%, 10% and 15% and the optimum percentage was determined i.e., 10% replacement. With that optimum percentage additional partial replacement of Brick waste was done at 2%, 4%, 6%, and 8%. Then they are placed for curing for 7 and 28 days. Then they are tested and from the test results optimum percentage for the casting of Interlocking Concrete Blocks was determined.

TABLE - 3: Compressive Strength test of Plastic Waste and Brick Waste.

Specimen Details	7 Days (N/mm2)	28 Days (N/mm2)
CON 2	21.45	30.93
PCW 1	21.23	30.07
PCW 2	22.67	31.63
PCW 3	20.32	29.56
PCW 4	19.68	29.07

From the table 2 the compressive strength of concrete cube with varying replacement of Brick Waste with optimum percentage of plastic waste which was determined from table 1 was casted and they were tested. In that result the plastic waste and Brick Waste replaced cubes test results are compared with the conventional concrete. According to which there was a rise in compressive strength in PCW 2 (10% of plastic waste replacement and 4% replacement of Brick Waste) in both 7days and 28 days compressive strength as compared to CON 2. Thus the PCW 2 sample was considered as the optimum percentage for plastic waste and Brick Waste replaced cubes.

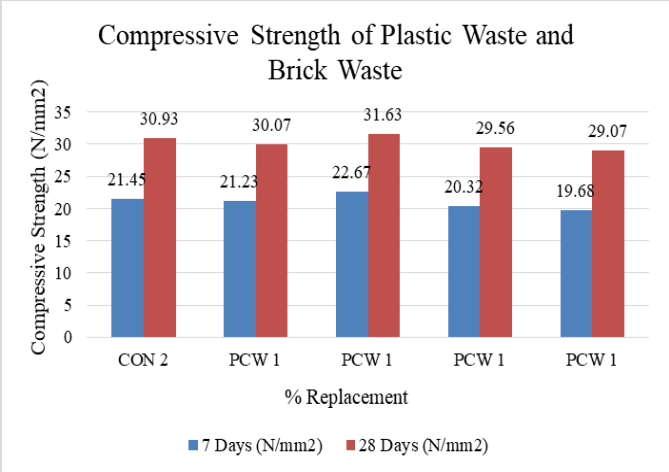

Chart -2: 7 Days and 28 Days Compressive strength of Plastic Waste and Brick waste

From the Chart-2 we can also conclude that there was an upsurge in the compressive strength which was 5.69% in 7 days and 2.26% in 28 days.

4.3 Compressive Strength Test for Interlocking Concrete Block

In this project the Interlocking concrete blocks of dimension of 400mm X 200mm X 200mm was casted and the compressive strength was calculated. The interlocking blocks are made with the final optimum percentage obtained from the compressive strength of Plastic Waste and Brick Waste i.e. 10% Plastic Waste and 4% Brick Waste.

TABLE - 4: Compressive Strength test of Interlocking Concrete Block

Specimen Details	7 Days (N/mm2)	28 Days (N/mm2)
CON	7.5	11.3
ILB	9	16.4

From the table 4 the compressive strength of Interlocking concrete block with optimum percentage of Brick Waste and optimum percentage of plastic waste which was determined from table 3 was casted and they were tested. In that the results of plastic waste and Brick Waste replaced interlocking concrete blocks are compared alongside with the test result of conventional concrete. According to which there is a clear upsurge in the compressive strength in ILB (10% of plastic waste replacement and 4% replacement of Brick Waste) in both 7 days and 28 days compressive strength as compared with Conventional Concrete (CON).

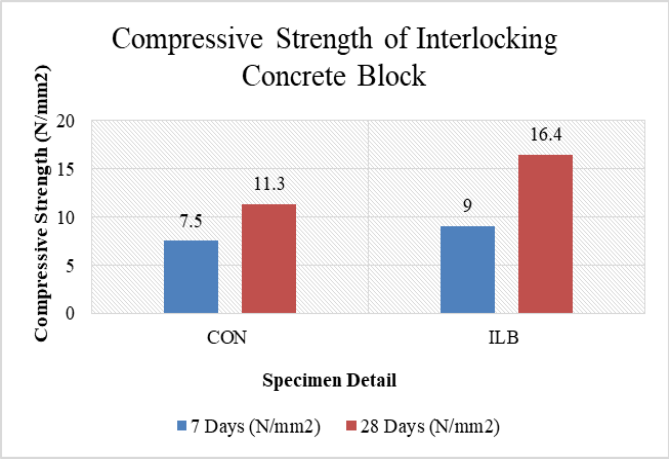

Chart -3: 7 Days and 28 Days Compressive strength of Interlocking Concrete Block

From the Chart-3 we can also conclude that there was an increase in the compressive strength which was 50.67% in 7 days and 82.22% in 28 days.

5. Conclusion

This experimental investigation was done according to the material properties based on IS specifications and its physical which are obtained through various tests conducted. The design mix for M20 grade of concrete was done and verified with the reference of IS code. The compressive strength of Plastic Waste replaced concrete with 10% replacement; it gives acceptable strength of 29.83 N/mm2. Also the compressive strength of Plastic Waste replaced concrete with 10% replacement and Brick Waste replaced concrete with 4% gives an optimum result for casting interlocking Block; it gives acceptable strength of 31.63 N/mm2.

From the test results the interlocking blocks are casted and the Compressive Strength was evaluated and thus we are concluding that the Interlocking concrete block with 10% replacement of Plastic waste with 4% replacement of Brick Waste shows an evident result.

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