Experimental Investigation of Concrete Masonry Units with Plastic Bottle Cores and PET Fibers

Rakesh Fataniya[1] Rihan Maaze[2] Kalpesh Kapadiya[3]
Prof. Vijay F. Pipalia[5]
[1,3]PG Student [2]Assistant Professor
[1,2,3]Department of Civil Engineering
[1,2,3]RK University, Rajkot

Abstract— In construction industries, concrete masonry units are used commonly. Since the masonry units can be constructed with ease. Fifty billion plastic water/beverages bottles are consumed every year. The use of plastic bottles in construction materials has been around for the past twenty years, but with little focus on using full plastic bottles and PET fibers in the materials. This thesis presents the results of a study conducted to determine the compressive strength of concrete masonry units with plastic bottle cores and PET fibers. The plastic bottles were used to create the centre voids in the masonry units. Solid waste can be filled in plastic bottle for increase the compression strength of block. PET fibers used as partially replacement of fine aggregate. Concrete with 1%, 2%, 4% and 6% PET bottle fibers for fine aggregate were produced and compared against control mix with no replacement. Concrete was placed around the bottle to encase them in the masonry units. The study utilized 1000-mL plastic bottle from two different companies placed inside masonry units of 16-inch long by 8-inch wide by 8-inch high in size and analyzed the resultant compressive strength. The testing for compressive strength was determined according to the IS standard. Determination of the compressive strength of the concrete masonry units allows for further study to continue in concrete masonry units with plastic bottle cores to determine if they are viable in third world countries.

Key words: Plastic bottle, sustainable material, construction material, PET flakes, plastic fibers, compressive strength, % replacement

I. INTRODUCTION

Concrete masonry units are one type of building construction material that can be used for residential and commercial buildings. These units are available in various nominal unit shapes and sizes; one of the most common sizes is a nominal 16-inch long by 8-inch wide by 8-inch high (406.4-mm long by 203.2-mm wide by 203.2-mm high). Concrete masonry units have one core of 3.25-inch wide by 10.75-inch long (82.5-mm wide by 273.0-mm long) in the middle of the block to help reduce the weight of the block and also allow for reinforcement and grout to be placed in the masonry wall and using the waste PET fibers as the partial replacement of aggregate. The face shell thicknesses of the concrete masonry units varies between 2.25-inch to 2.75-inch (57.2-mm to 69.8-mm).

Research conducted for this thesis utilizes plastic water bottles of two brands that are coca cola and Bislery and place them as the cores for concrete masonry units. Concrete is placed around the plastic bottle in the plywood forms to create the concrete masonry unit.

Hence an attempt on the utilization of waste water bottles and Poly-ethylene Terephthalate (PET) bottle granules as fine aggregate is done and its mechanical behaviour is investigated.Testing of new concrete masonry units is necessary to determine if the new design meets the IS standards.

II. LITERATURE SURVEY

Mojtaba Valinejad Shoubi et Al (1) Application of Plastic Bottle as a Sustainable Material in the Building Construction, It has been demonstrated that the plastic/PET bottles can be used in some parts of building construction. Reusing the plastic/PET bottles as the building materials can have substantial effects on saving the building embodied energy by using them instead of bricks in walls and reducing the CO2 emission in manufacturing the cement by reducing the percentage of cement used. Generally the bottle houses are bioclimatic in design, which means that when it is warm outside is cold inside and vice versa. Ms. K.Ramadevi, Ms. R. Manju (2) Determine the mechanical behaviour of Concrete with Plastic PET (Bottle) Fibers as Fine Aggregates. The concrete with PET fibers reduced the weight of concrete and thus if mortar with plastic fibers can be made into light weight concrete based on unit weight. It was observed that the compressive strength increased up to 2% replacement of the fine aggregate with PET bottle fibers and it gradually decreased for 4% and 6% replacements. Raghatate Atul M (3) The properties of concrete containing varying percentages of plastic were tested for compressive strength and shows that an appreciable improvement in tensile strength of concrete can be achieved by introducing cut pieces of plastic bags. Compressive strength of concrete is affected by addition of plastic pieces and it goes on decreasing as the percentage of plastic increases addition of 1 % of plastic in concrete causes about 20% reduction in strength after 28 days curing. Thus it is conclude that the use plastic can be possible to increase the tensile strength of concrete. Khilesh sarwe (4) study to the compressive strength of concrete using waste plastics and also add steel fiber with waste plastics. The use of plastics in concrete lowered the strength of resultant concrete.

From the above literature one can conclude that in most case people are less concentrated on using plastic bottle as replacement of concrete so in this paper we will try to use plastic bottle and pet fibers to increase strength and decrease carbon emission.

III. ABOUT THE PROJECT

A. Objectives of the Proposed Project

The main objectives of this research proposal are to evaluate the possibility of using full water bottle and granulated plastic waste materials. The following were also proposed.

- Check the compression strength of concrete masonry block when plastic bottle can be used as core part of concrete block.
- As partial substitute for the fine aggregate in concrete composites.
- To investigate the mechanical behaviour of the components by using fibers.
- To determine the percentage of plastic fiber which gives more strength when compared to control concrete.
- It is counted as one of the foundation for green project through reduce land and air pollution

B. Methodology

- Studying past research on innovative masonry
- Material Collection
- Finding Material Characteristic
- Calculating different proportion, aspect ratio of fiber
- Casting and curing concrete masonry units with plastic bottle core or use PET fibers
- Testing compression strength of block
- Analyzing the result

C. Material Used

Cement: Ordinary Portland cement 53 grade.

Fly ash

Fine aggregate: Crushed stone aggregate

Coarse aggregate: Grit (4.75mm-6 mm)

Plastic water bottles

Plastic fibers: PET bottles

D. Experimental Plan

In this project following specimens were casted.
Proportion: - 1(Cement):0.75(Fly Ash):6(Grit):12(Crushed stone aggregate), Size: - 400mm long by 200mm wide by 200mm height
By above specification make following no. of blocks
(1) 6Nos. - Blocks without Plastic bottle (hollow blocks)
(2) 6Nos. - Blocks with Empty bottle
(3) 6Nos. - Blocks with bottles having solid waste (plastic waste like wrappers and polythene bag)
(4) 6Nos. - Blocks with bottle having solid waste and wrapping of net around bottle
In between No. 3 & 4 strength of whichever block is more in that blocks use PET (Polyethelyne Teraphthilate) fiber in replacement of crushed stone aggregate in proportion of 0.5 %, 1%, 2%, 4%, 6%. 6 numbers each were casted for different proportions with PET fibers and compared against a control mixture. The compression test performed on hardened concrete after 28 days of curing.

Fig. 1:PE bottle flakes

Quantity of material in Kg/m^3			
Cement	Fly ash	F.A.(Crushed stone aggregate)	C.A.(Grit)
70.88	53.16	425.31	850.63

Table 1:Materials Required In Concrete Masonry Units, Kg/M^3

The properties of materials used are:
Specific gravity of cement = 3.15
Fineness of cement = 8 %
Initial Setting Time = 90 min.
Final Setting Time = 300 min
Standard Consistency = 34 %
Specific Gravity of Fly ash = 2.2
Specific gravity of fine aggregate = 2.66
Specific gravity of coarse aggregate = 2.81
Specific gravity of PET fibres = 1.39

E. Mix Proportions of plastic fibres

The mix proportion was done for various percentages of plastic fibres, 0.5%, 1%, 2%, 4% and 6% replacement for fine aggregates. The mix proportions for the various batches are given in table II.
The collected waste PET bottle flakes are shown in Figure 1.

PET Fibres	0.5 %	1 %	2 %	4 %	6 %
Cement	70.88	70.88	70.88	70.88	70.88
Fly ash	53.16	53.16	53.16	53.16	53.16
Fine Aggregate	423.2	421.1	416.8	408.3	399.8
Course Aggregate	850.6	850.6	850.6	850.6	850.6

Table 2: Materials Required In Kg/M^3

IV. EXPERIMENTAL PROCEDURE

A. Tests on specimens

All the cast specimens were de-moulded after 6 hours and were placed in Dry Place. After 24 Hours were placed in curing tank for a period of 28 days. The specimens were taken for testing such as compression test. The specimens were tested in the universal testing machine.

Six numbers of specimens in each were tested and the average value is calculated. The results were compared and analysed with that of control mix.

B. Compressive strength test

The compressive strength of the cube specimen is calculated using the following formula:
Compressive Strength, fc = P/A N/mm2
Where P = Load at failure in N
A = Area subjected to compression in mm2

The graph shown in figure 2 illustrates the variation of the compressive strength of specimens with different type of methods were casted concrete masonry units with water bottle core.

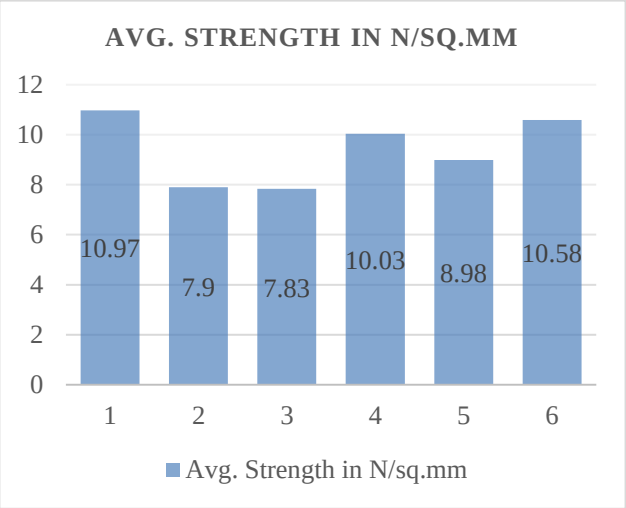

Fig. 2: Avg. Compressive Strength Vs. Different Types of Cores

(1) Solid Fly ash masonry units
(2) Use empty coca cola brand water bottle in masonry units
(3) Use empty Bislery or similar bottles in masonry units
(4) Use solid waste filled in coca cola brand water bottle in masonry units
(5) Filled solid waste in Bislery or similar other bottles in masonry units
(6) Use coca cola brand water bottle filled with solid waste with chicken mesh wrapping around bottle in masonry units

Comparatively, getting avg. compressive strength of solid fly ash block (1) and fly ash block with core as solid waste filled coca cola brand water bottle with net wrapping (6) is near about similar.

But its more expensive, so we can used coca cola brand water bottle filled with solid waste in masonry units. And its compressive strength getting more as per IS Standards.

The graph shown in figure 3 illustrates the variation of the compressive strength of specimens with plastic PET fibres replacement by percentage of fine aggregates.

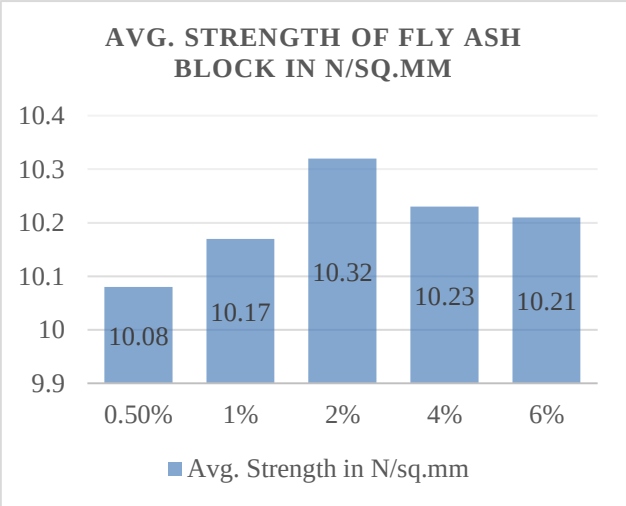

Fig. 3: Avg. Compressive Strength vs. PET Fibers

An appreciable increase in the compressive strength is observed till 2% replacement of the fine aggregate with PET bottles fibres and then the compressive strength is gradually reduced.

The replacement of fine aggregate with 2% replacement is found to be reasonable.

V. Conclusion

The use of fly ash concrete masonry units with plastic bottle cores could become possible in third world countries. Comfort of masonry unit construction on-site was of utmost importance in the creation of the laboratory units.

Reducing the CO2 emission in manufacturing the cement by reducing the use of cement. It is counted as one of the foundation's green project and has caught the attention of the architecture and construction industry.

Generally the plastic bottle core masonry block houses are bioclimatic in design, which means that when it is warm outside is cold inside and vice versa.

The concrete with PET fibres reduced the weight of concrete and thus if mortar with plastic fibres can be made into light weight concrete based on unit weight.

It was observed that the compressive strength increased up to 2% replacement of the fine aggregate (Grit) with PET bottle fibres and it gradually decreased for 4% and 6% replacements. Hence replacement of fine aggregate with 2% replacement will be reasonable.

VI. Scope for Future Studies

Further analysis of shear loading and cyclic loading on the masonry units is suggested to analyze the masonry unit for seismic loading. Admixtures can be used to improve bonding of fibres. Utilisation of fibres in plastic concrete in various proportions to improve the strength. A better way of grinding plastic bottles may be adopted to produce fibres in large scale.

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