UTILIZATION OF PLASTIC GRANULES IN CONCRETE PAVER BLOCKS (ECO-FRIENDLY CONCRETE)

[1]SUMEGA N, [2]OVIYA I, [3]RAMADEVI

[1,2]PG Student, [3]Associate Professor
E-mail: [1]Sumega.18mse@kct.ac.in, [2]oviya.18mse@kct.ac.in, [3]ramadevi.k.ce@kct.ac.in

Abstract - Concrete is one of the most proficient construction materials. Seeking aggregates for concrete and sustainability of the construction industry is very essential. One of the environmental issues in most regions is the large number of bottles made from Poly-Ethylene Terephthalate (PET) deposited in domestic wastes and landfills, which are not bio-degradable. The purpose of this experimental study was to investigate the possibility of usingplastic granulesas replacement to fine aggregates in concrete of M25, M30 grade to make eco-friendly concrete. Concrete with a replacement of sand by plastic granules ofPET plastic bottles waste at 15%, 25% and35%to fine aggregates (sand) were casted in form of paver blocks were casted and cured for 28 days for Compressive Strength. Test results are in form of tables and graphs. It is observed that replacement of sand by plastic granules of PET plastic bottles waste improved the compressive strength.

Keywords - Poly-Ethylene Terephthalate (PET) granules,eco-friendly concrete,paver blocks.

I. INTRODUCTION

Due to an increase of day to day disposal goods, waste disposal management has become a major environmental issue in the World. The use of plastic is consistently growingbecause of its versatility. The total plastic produced worldwide in 2014 was estimated at 313 million tones in 2015 it increased to 322 Mt, which is about 3% rise in 2 years. India consumption of Plastics will grow 15 million tons by 2015 and is set to be the third largest consumer of plastics in the world. One of the new waste materials used in concrete industry isthe recycled E-Plastic. For solving the disposal of large amount Recycled Plastic Material, the reuse of plastic in the Concrete industry is considered as the most feasible application. Recycled plastic can be used as coarse aggregate in concrete. Choi et al. studied the use of plastic waste PET bottles as aggregates on some properties of concrete. This research aims to investigate the use of recycled plastic components of E-waste in construction applications. This is an alternative solution to administer the growing quantity ofthe E-waste. The properties of concretes containing various waste E-plastic particle contents were investigated in this study. Waste E plastic particles were derived from obsoleteelectrical and electronic equipment's, The strength properties of specimens were observed with the use of waste E-plastic in various percentages (15%, 25% and 35%).

A. Plastic Granules

The word "plastic" means substances which have plasticity, and accordingly, anything that is formed in a soft state and used in a solid state can be called a plastic. Therefore the origin of plastic forming can be traced back to the processing methods of natural high polymers such as lacquer, shellac, amber, horns, tusks, tortoiseshell. As well as inorganic substances such as clay, glass, and metals. Because the natural high polymer materials are not uniform in quality and lack mass productivity in many cases, from early times it has been demanded in particular to process them easily and into better quality and to substitute artificial materials for naturalhigh polymers. Celluloid, synthetic rubber, ebonite, and rayon are these artificial materials. Presently, it is defined that the plastic is synthesized in high polymers which have plasticity, and consequently, substances made of these natural materials are precluded

The Features of the plastic granules are High melting point, Machinable, Flexible and robust in structure, Maintenance free, Excellent electrical properties, Very efficient performance.

II. OBJECTIVE

Here an attempt on the utilization of plastic granules of Poly-ethylene Terephthalate (PET) bottle pieces as replacement to fine aggregate is done and its mechanical behaviour is investigated.

- The main objective is to study the replacement of sand by plastic granules of PET plastic bottles waste in concrete by 15%, 25% and 35% .
- To investigate the Mechanical properties like Compressive Strength and flexural Strength of such replacement of sand by plastic granules of PET plastic bottles waste concrete with conventional concrete.
- To determine the optimum percentage of plastic granules of pet bottles at which it gives more strength when compared to conventional concrete.
- To study the workability of conventional concrete and replacement of sand by plastic granules of PET plastic bottles waste concrete.

 To Study the Cost benefit of conventional concrete and replacement of sand by plastic granules of PET plastic bottles waste Concrete.

B.LITRETURE REVIEW

MASTANVALI N (2017)[1] Worked on experimental investigation on providing PET bottle waste as supplement to concrete as fine aggregate. The goal of this paper is to decide ideal quality and impact of utilization of reused pet bottle. The amount of PET bottle waste provided is up to 20% Theflexural quality is expanded up to 10% supplanting of fine total with PET containerwaste and slowly diminished up to 15% and further upto 20%.

SAHILVERMA ET AL (2015)[2] In this study experimentally investigated on replacement of river sand by pulverized plastic waste flakes and they observed the effect of plastic bottle over the compressive strength of concrete. He concluded that proper encapsulation of these plastic bottle can substantially reduce the environmental effect.

TANZEENM SHAIKH (2018)[3] In this study the behaviour of concrete which is made of recycled plastic bottle along with the study of the some of the physical properties that are related in concrete mix they replaced the PET to fine aggregate up to 50% and concluded that the weight of concrete is reduced due to use of recycled plastic bottles.

BK KOLHAPURE(2018)[4] worked on replacement of fine aggregate by shattered pieces of PET bottles in concrete from 1% to 6% . In this paper they concluded that the flexural strength of the concrete has been increased, and at 4% replacement the compressive strength of concrete tends to be 42.48 for 28 days.Hence they concluded that the strength of concrete is higher than that of nominal concrete. The flexural strength is increased up to 7.92% than that of nominal concrete,and split tensile strength is increased upto 5.25% than that of nominal concrete.

ZAINABZ ISMAIL[2008] [5]worked on replacement of waste plastic on aggregate in concrete and they reduced the weight of concrete with increasing the weight of waste plastic at all curing ages, and this decreased the adhesive strength between the surface of the waste plastic and cement paste.

K.RAMADEVI(2012)[6] Experimentally investigated on property of concrete with plastic PET bottle pieces as a fine aggregate. It was observed that flexural strength of concrete is increased upto 2% replacement.

MOJTABAVALINEJADSHOUBI (2013)[7] Investigated on application of plastic bottles as a sustainable material in building construction they observed that bottle panel technology mitigates the carbon emission while comparing with the brick panel.

FRANCISCO CASNOVA DEL ANGEL 2013[8] worked on pet bottle as a fine aggregate. The crushed the pet bottle using jaw crusher and the shattered plastic is used as fine aggregate, and they found that the flexural strength of concrete is tends to be increased, and weight of concrete is 68% lesser than nominal concrete.

KASIBR.MALAK (2015)[9] studied use of waste plastic in concrete mixture as aggregate replacement modified concrete, casted by using plastic aggregate as a partial replacement to coarse aggregate shows 10% it could be satisfy as per IScode.

SAWSAND.A.SHUBBAR (2016)[10]Worked on utilization of waste plastic bottles as fine aggregate in concrete in this research, effect of using waste PET that was converted to granules in concrete has been studied experimentally.

III. METHODOLOGY

The main purpose of this project is to utilize recycled materials for the production of concrete. As disposal of plastic waste is not possible easily, they create an adverse impact on the environment. Reuse of plastic waste in concrete industry is considered as the most feasible application. It decreases the pollution of the environment and reduces the cost of materials

- Collect the PET bottles needed for research
- Procure the equipments needed
- Granulating the pieces to smaller size
- Casting and curing of the basic test specimens (cubes, cylinders) for determination of strength
- Test the structural models with various percentage of plastic waste for the results

MATERIALS USED

Plastic: PET bottle waste granules.
Fine aggregate: M-sand.
Cement: OPC53 grade.
Coarse aggregate: 20 mm – 60% & 12 mm-40%.

W/C RATIO	0.45
CEMENT	394
FINE AGGREGATE	647
COARSE AGGREGATE	1238

PROCEDURE

In this project, The plastic bottles broken to granules or into small (PET) particles and used as sand-substitution aggregates in cementitious concrete composites which appear to offer an economical material with consistent properties. Msand found in percentages 15%, 20%& 35%is substituted for 25 and30 molar grade concrete. The amount of replacement percentage with respect to volume wise incomparison to the total volume is relative and it is blend proportioned.150 mm x 150 mm × 150 mm cubical and axle specimens of admeasurements 100 mm × 100mm × 500 mm and the butt specimens admeasurements are 150mmx600mm dia of 36 numbers arechosen for the purpose of casting for altered accommodation with PET bottles (grounded) andascendancy mixture. Slump analysis was performed initially accurate to actuate the feasibility. Theextensive performance evaluation tests performed on accustomed accurate afterwards 7 and 28dayscanicule of abating were compression bend analysis and spilt compactness tests.The calm decay PET canteen granules are apparent in Figure 1



Figure.1

A.OPTIMAL MIX

The optimal values of the material composition as the standard guidelines are tabulated in Table1.
The blended mix for M25 brand accurate considered according to IS 456:2000, IS 10262:2009 inthis paper.
Pet Bottle Waste As A Supplement To Concrete Fine Aggregate

Table I Materials Used

SPECIFIC GRAVITY	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
01.	3.15	2.64	2.84

B.PLASTICGRANULE MIX

The plastic granule mix was performed for predefined percentages i.e., 15%, 25% and 35% backup for aggregates.
The process of deformation of composites takes place for one day and are well treated in accelerated curingtank usually for 18 hours under boiling. Then, the samples are prepared for the process of testing. Theillustrations were attempted in the suitable designated testing machine.The results were differentiated andseparated and that of control mix.The Compression, Flexural quality and split tensile tests are performed as shown in figure 2(a)and figure2(b)

Table IIPlastic Granule Mix

MATERIALS	PET BOTTLE WASTE AS %			
	15	25	35	45
WATER	197	197	197	197
CEMENT(kg/m^3)	394	394	394	394
FINE AGGREGATE(kg/m^3)	550	485	421	356
COARSE AGGREGATE(kg/m^3)	1238	1238	1238	1238

C.TESTS CONDUCTED

Various tests like fineness modulus of cement (by sieving), standard consistency test and initial and final setting time tests were conducted on cement. Sieve analysis, clay content in sand and bulking of sand were the tests conducted on fine aggregates. Tests like sieveanalysis, flakiness index test and water absorption tests were conducted on coarse aggregates and slump test wasconducted on fresh concrete. IS:383-1970 for testsoncoarseand fine aggregates were used. Since, plastic waste was being tried as partial replacement for sand, the same IS:383-1970 was used for tests on plastic waste.

IV. TESTS ON SPECIMENS

All the cast specimens were de-moulded after 24 hours and were placed in curing tank for a period of 7 to 28 days. The specimens were taken for testing such as compression test, split tensile strength test and flexure test, waterabsorption test, abration test.The specimens were tested in the universal testing machine. Three numbers of specimens in each were tested and the average value is calculated. The results were compared and analysed with that of control mix. The test set up of specimens for Compression test and flexural strength test are shown in Figure 2(a), Figure 2(b) respectively.



Figure.2(a)



Figure.2(b)

A.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 3(a)&3(b) illustrates the variation of the compressive strength of specimens with different replacement percentage of fine aggregates by plastic PET fibres. Figure 3(a)&(b) Compressive strength Vs Plastic fibres (%) An appreciable increase in the compressive strength is observed till 15% replacement of the fine aggregate with PET bottles fibres and then the compressive strength is gradually reduced. The replacement of fine aggregate with 15% replacement is found to be reasonable.

Compressive strength (MPA)

TABLE IVcompressive strength of concrete

Compressive strength (MPA)	0%	15%	25%	35%
For M25 Grade Concrete (MPA)	26	35	32	30
For M25 Grade Concrete (MPA)	32	43	40	35

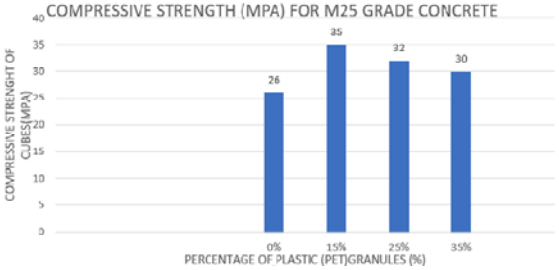


Figure.3(a)

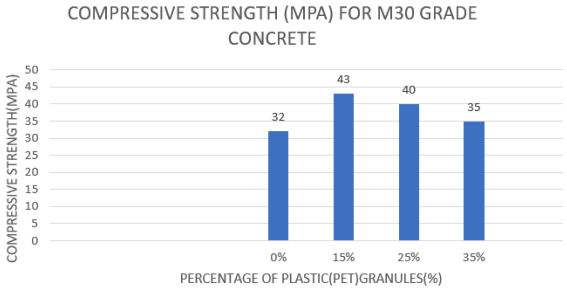


Figure 3(b)

B.FLEXURAL STRENGTH TEST

Flexural strength test for a rectangular sample under a load in a three-point bending setup

$$\sigma = \frac{3FL}{2bd^2}$$

{\displaystyle \sigma ={\frac {3FL}{2bd^{2}}}}

- F is the load (force) at the fracture point (N)
- L is the length of the support span
- b is width
- d is thickness

Flexural strength of concrete	0%	15%	25%	35%
For M25 Grade Concrete (MPA)	3.1	4.6	4.2	3.7
For M30 Grade Concrete (MPA)	3.2	3.8	3.4	3.3

In case of 10 cm prism specimen, flexural strength is given as

fb= pa/bd2 in case of a >13.3 cm

fb = 3pa/bd2 in case of a < 13.3cm where the symbols have usual meaning

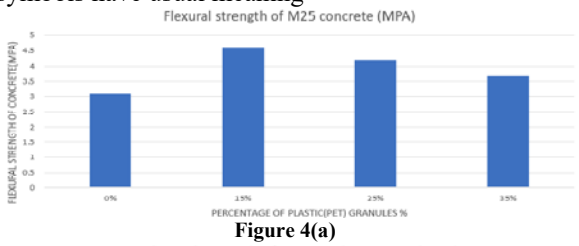


Figure 4(a)

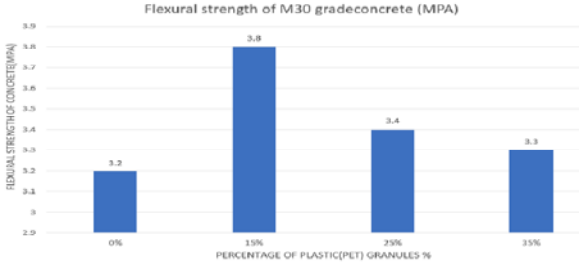


Figure 4(b)

C.WATERABSORPTION TEST

Paver blocks are not impervious to water, and in order to bond well with mortar, they must be able to absorb some water. The initial rate of water absorption is measured in grams and is used to determine whether or not pavers should be soaked in water prior to laying.

Water absorption of paver is calculated by using formula

Calculation of Water Absorption of pavers

Water absorption, % by mass, after 24 hours immersion in cold water in given by the formula,

$$W = \frac{M_2 - M_1}{M_1} X\ 100$$

The average of result shall be reported. The test set up of specimens for water absorption is show in figure5 respectively.



Figure.5

Percentages of plastic (PET)granules in concrete	0%	15%	25%	35%
water absorption	4.1	3.8	3.6	3.3

CONCLUSION

1. It was observed that the compressive strength increased up to 15% replacement of the fine aggregate with PET bottle granules and it gradually decreased for 25% and 35% replacements. Hence replacement of fine aggregate with 15% replacement will be reasonable.
2. It was observed that the flexural strength increased up to 15% replacement of the fine aggregate with PET bottle granules and it gradually decreased for 25% and 35% replacements. Hence, the replacement of the fine aggregate with 15% replacement will be reasonable with flexural strength compared to the other specimens casted and tested.

REFERENCES

[1] Mastan Vali N , SS. Asadi“PET bottle waste as supplement to concrete as fine aggregate”, Volume 8, Issue 1, January 2017, pp. 558–568

[2] .SAHILVERMA, replacement of river sand by pulverized plastic waste flakes

[3] TANZEENM SHAIKH (2018) Replacement of fine aggregate with plastic in concrete,volume-4,issue 3,2018

[4] BKKOLHAPURE (2018),Ecofriendly concrete by partial rplacement of sand by shhered pieces of PET plastic bottles volume 5,issue 05,may 2018

[5] ZAINABZ ISMAIL[2008], Use of waste plastic in concrete mixture as aggregate replacement,November 2007

[6] K.RAMADEVI(2012) Experimental Investigation on the Properties of Concrete With Plastic PET (Bottle) Fibres as Fine Aggregates, July 2012

[7] MOJTABAVALINEJAD SHOUBI (2013),Investigating the Application of Plastic Bottle as a Sustainable Material in the Building Construction,Volume 2, Issue 1, January 2013

[8] FRANCISCO CASNOVA DEL ANGEL (2013), Eco-Friendly concrete by Partial Replacement of Sand by Shredded Pieces of Pet Plastic Bottles

[9] KASIBR.MALAK (2015),Eco-friendly concrete by partial replacement of sand by shredded pieces of pet bottles,volume:05 issue:05,may-2018

[10] SAWSAND.A.SHUBBAR(2016),utilization of waste plastic bottles as fine aggregate in concrete

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