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The Recycled Polyethylene Terephthalate (PET) Bottles Waste as a Fine Aggregate Replacement in Concrete

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Abstract:

This research aims to study the potential of shreddedPET bottles waste as a fine aggregate replacement in concrete. PET bottles waste was preferred because it is readily available, and it causes an environmental problem. The PET bottles waste was shredded into a fine particle. The size of fine particle is of similar size of the sand particle. It is partially replaced by sand with 0.5%, 1% and 1.5% in the concrete mix. This mix design method is referred from the Department of Environment (DOE), and the test is carried out for M30 grade concrete for 7-days,28-days, and 90-days. The performance of recycled PET bottles concrete was investigated based on experimental tests such as slump test, flexural strength test, and compressive strength test. The slump value of PET bottle concrete is similar to conventional concrete. Flexural strength and compressive strength increased for 90 days of curing for 0.5%,1%, and 1.5% substitution of shredded PET bottles aggregates by sand. For 7 days and 28 days strength is slightly more or less equal to conventional concrete. The application of this newly developed concrete material can be sustainable for the construction industries. It has the potential to improve the properties of concrete.

Keywords: *Recycled PET bottles waste, Slump, Flexural Strength, Compressive Strength.*

I. INTRODUCTION

Theconcrete is manufactured using river sand from riverbeds as fine aggregate. Diminishing natural resources leads to the environmental issue and consequently the restriction of government's on sand extracting has resulted in insufficiency and drastically cost increases [1].

The environment was primarily categorized into five types, i.e.forests, deserts, aquatic,tundra and grasslands.Polyethylene Terephthalate (PET) Bottles waste has deleterious impacts on all major biomes. PET bottles burningis not a solution for overriding such waste because it will discharge hazardous gasses into the atmosphere[2][3].

PET bottles waste in concrete manufacturing can be a helpful way to eliminate harm to the environment. The PET bottles are light in weight, utilization of PET bottles waste in concrete, will reduce the unit weight of concrete. It will lead to

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reduction in building weight and reduce the seismic danger due to the earth quake[4].

The impact of PET bottles waste on concrete properties: whenshreddedPET bottles aggregate is added in several quantities and various water/cement ratios. It can be noticed that, for a constant water/cementratio, the slump decreases, as the shredded PET bottles aggregate amount increases [5][6]. As the shredded PET bottles aggregate increases cause diminution in the density of fresh concrete, becauseshredded PET bottles aggregatesdensity is very low compared to natural sand[6].

In most of research papers it was initiate that the inclusion ofshredded PET bottles aggregates reduced the strength of the concrete[5][6][7].The 5% incorporationPET bottles aggregate with fine aggregates enhancegood results in compression[5].Compressive strength increased for 2% incorporation PET bottle waste with fine aggregates and it decrease for 4% and 6% incorporation of PET bottles waste.

As the amount of shredded PET bottles aggregates increases The split tensile strength decreases[6][8].The split tensile strength of the cylinder is observed to be increasing till the 2% substitution of PET bottle fibers and decreases with increase in the PET bottle fibers[9][10].

The flexural strength expanded up to 10% replacing of the fine total with shredded PET bottles aggregate and it slowly diminished by 15% and continues as before for 20% substitutions[4].Flexural strength increased for 2% incorporation PET bottle waste with fine aggregates and it decrease for 4% and 6% incorporation of PET bottles waste with sand[9].The flexural strength decreases,ifanyform of PET bottles aggregates in concrete increases. Nevertheless, the heat-treated PET bottles aggregate gives good results compared to PET bottles flaky coarse aggregateand PET bottles flaky fine aggregate [6].

II. OBJECTIVES

- To inspect the extent of PET bottles waste as new concrete material for construction.
- To determine the impact of shredded PET bottles waste as fine aggregate on hard and fresh concrete properties.

III. MATERIAL SELECTION

The materials selected are cement, aggregates and water. These are the important element of the concrete mix. The shredded PET bottles also included as partial replacement of sand.

A. Cement

Cement is the binder for the aggregates to attach constitutes. In this project the Ordinary Portland Cement (OPC) with class of 42.5 was selected.

B. Coarse Aggregate

In this project, coarse aggregate used is maximum 20mm size. To avoid the aggregates absorbing water from the PET bottles concrete mixture. Saturated Surface Dry (SSD) coarse aggregate are prepared by washing the aggregates prior to mixing process.

C. Fine Aggregate

For fine aggregates, Sand passing through 5mm sieve size was used to produce PET bottles concrete. Natural sand was partially replaced with PET bottles fine aggregates. Both coarse and fine aggregates conforming to BS EN 933-1:2012.

D. Polyethylene Terephthalate (PET) Bottles

PET bottles will be collected from the trash and recycled bin from International Islamic University Malaysia (IIUM) campus. Bottles were washed and dried. Finally, they were shredded into small pieces by using a shredding machine. Sieve analysis for shredded PET fine aggregates was conducted in order to get the similar size as natural river sand. The reason to use recycled PET bottle in this research was, it is easily available and it cause environmental problem.

IV. METHODOLOGY

Shredded PET bottle concrete mixture is mixed in mixed in 3 various batches with various amount of fine aggregates. In this research,shredded PET bottles aggregates are used as fine aggregate to replace natural fine aggregate at 0.5%,1% and 1.5% by weight respectively, in mix proportion. The normal concrete specimen without addition of PET bottles as fine aggregates is used as control sample.

The concrete mixture for this project produced by using DOE method. The grade used in this study is M30. The reason of using this grade is to suit with domestic construction because it is commonly used

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by standard house developer. After the mixing process, the fresh concreted will be casted in molds for flexural test and compression test respectively.

Curing is the crucial part in concrete hardening process. In this project, the curing method used is immersion curing method. The curing tank will be filled with water. After demolding, the hardened specimen will be directly immersed into the water in curing tank for 7 days, 28 days and 90 days

V. PROPERTIES OF CONCRETE

A. Slump Test

In most of the studies,the substitution of several forms of PET bottles aggregatereduces the slump value of fresh concrete as the PET bottles increases as compared to conventional concrete mix was noticed[6][11]. The lower slump value is because of the PET bottles aggregate particles are sharp in edges and angular in size [6][11].

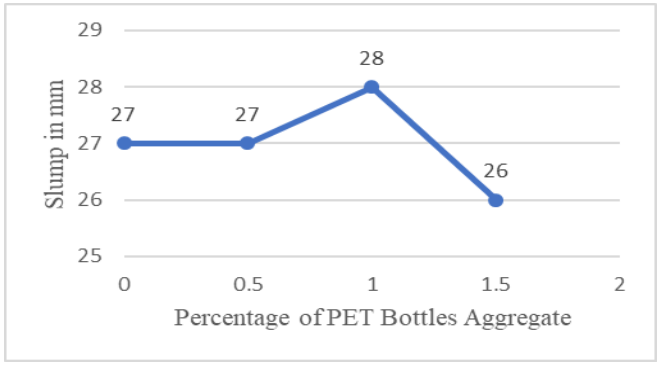

Fig. 1. Slump test

From Figure.1it is noticed that the the slump value is similar to conventional concrete forsubstitution of shredded PET bottles aggregate by fine aggregate for 0.5%, it is 1mm increase for 1% substitution of shredded PET bottles aggregate and 1mm decrease for 1.5% substitution of shredded PET bottles aggregate as compared to conventional concrete, the difference is very negligible, so as per [12]the small amount of PET bottles aggregates substitution in place of fine aggregate do not affect the workability of concrete.

B. Compressive Strength Test

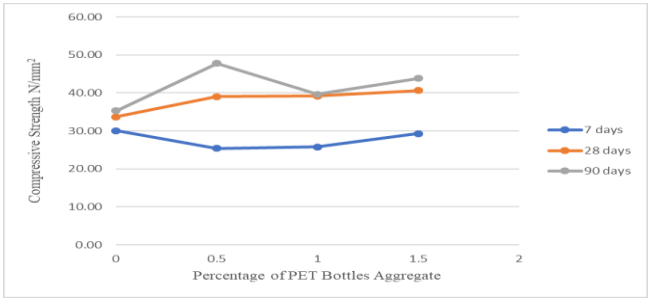

Fig. 2. Compressive Strength Test

From figure 2, it is noticed that the compressive strength decreases for 0.5% and 1% substitution of shredded PET bottles aggregate with fine aggregate, for 7 days of curing.For 1.5% replacement of shredded PET bottles aggregate by fine aggregate it enhances strength equal to conventional concrete.

The compressive strength increased for 28 days and 90 days of curing as increase in shredded PET bottles aggregate as a fine aggregate.

It is noticed that, for 1% PET bottles aggregate substitution there is decrease in strength as compared to 0.5% and 1.5% substitution, but it is increase as compared to conventional concrete, as per [7] fluctuation in compressive strength values is due to the PET bottle aggregate increase in concrete, the test results indicates no majordifference between PET bottle concrete and conventional concrete.

C. Flexural Strength Test

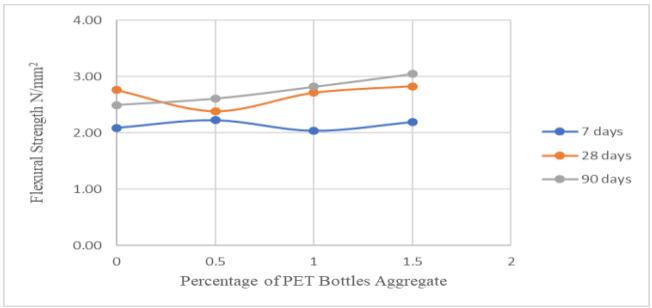

Fig. 3. Flexural Strength Test

From figure 3,it is noticed that the flexural strength increases for 0.5% and 1.5% replacement of shredded PET bottles aggregate by fine aggregate for 7 days of curingand for 1% substitution of shredded PET bottles aggregates by fine aggregates strength is similar to conventional concrete.

For 28 days flexural strength decreases for 0.5% substitution of shreddedPET bottles aggregates by fine aggregates and it is increase for 1% and 1.5% of substitution.

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For 90 days as the shredded PET bottles aggregates increases flexural strength also increases up to 1.5% substitution of shredded PET bottles aggregates by fine aggregates, as per [7] fluctuation in values is due to the PET bottle aggregate increase in concrete.

As per [9] The substitution of PET bottle aggregates up to 2% in place of fine aggregate it will enhance the compressive strength andflexural strength of concrete as compare to conventional concrete.

VI. CONCLUSION

From the above results and discussion, it can be presumed that flexural strength and compressive strength increases for 90 days of curing for 0.5%,1% and 1.5% substitution of shredded PET bottles aggregates by sand and for 7 days and 28 days strength is slightly more or less equal to conventional concrete.

The slump value is almost equal to conventional concrete for substitution of PET bottles aggregate by fine aggregate for 0.5%, 1% and 1.5%, the small amount of PET bottles aggregates substitution in place of fine aggregate do not affect the workability of concrete.

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