ANALYSIS OF PVC AND PET WASTE REPLACEMENT AS A COARSE AGGREGATE IN CONCRETE

Safeer Ullah, Amjad Islam, Syed Hamza Mustafa, Fawad Ahmad, Shah Rukh Khan

Abstract— Concrete is a universal mixture commonly used in recent era for construction of different structures. Due to rapid increase of concrete the aggregates decreasing rapidly. So there must be an alternative aggregate to replace convectional aggregate. Plastic use is increasing day by day, although steps were taken to reduce plastic consumption. Concrete cylindrical samples partial replacement of coarse aggregate with 0%, 5%, 15% and 25% of shredded PVC & PET waste were casted and then cured for 28 days. After completion of the curing period, concrete cylindrical specimens were tested for compressive and split tensile strength. The results showed that, Based on specific gravity of PVC & PET, lightweight concrete is produced. Results of Tensile strength increases with increase in PVC & PET replacement upto 25%, however at 25% PET replacement tensile strength was maximum. The data trends revealed that compressive strength test results of 5%, 15% and 25% PVC replacement were in comparison with control sample. Results of compressive strength of PET replacement decreases with increase in PET amount upto 25%.

Index Terms— Concrete, Light weight concrete, PVC & PET waste, Plastic concrete, concrete cylindrical samples, compression strength, split tensile strength.

1 INTRODUCTION

The utilization of plastics have turned into a critical piece of our life. Plastic is typically more strong and durable than different materials like paper and that is the reason it has been favored by the general population everywhere throughout the world.

For the most part, the utilization of plastic expanded in our day by day life because of its light-weight, minimal effort, long life and extensive quality. Plastic has a huge number of utilization in everyday life. Plastic are normally utilized as a part of bundling, mechanical applications, private and business utilize, sustenance safeguarding, supply of nourishment, medical purposes, sanitary fittings and for transfer of waste.

As plastic comprise of various kinds, for example, Polythene, Polyethylene terephthalate (PET), Polyvinyl chloride (PVC), Low density plastic (LDP), High density plastic (HDP), etc. With such an immense number of uses, the yearly utilization of plastic has been expanding quickly. The high utilization and un-disposability of plastic are the elements which cause contamination in the common habitat and have adverse effects on plants, wildlife and human population.

Countless ocean turtles, whales and other marine warm blooded creatures die every year from swallowing of discarded plastic (plastic packs, plastic containers and so on) for mistaken food. Also, when such plastics are singed, hurtful amounts of dioxins, a group of highly toxic chemicals are emitted. Dioxins are most harmful to the human life forms.

As plastic waste is non-biodegradable, so it's reusing is relatively feasible option to reduce the harm initiated by its disposal.

Concrete is for the most part thought to be a weak material in light of its low elasticity. This weak nature of cement can cause unexpected and appalling disappointment, particularly in the structures which are presented to seismic tremors, blasts and suddenly connected burdens.

The aim of this experimental study is that, Instead of increasing burden on landfills the PVC & PET waste is partially replaced as a coarse aggregate in concrete.

Pakistan generates around 30 million tonnes of solid waste per year, an increase of over 2% per year. Like other developing countries, Pakistan does not have a waste management base that causes significant environmental problems. Most urban waste is burned, thrown away and buried in empty areas that threaten the health and happiness of the general population. The major portion of this solid waste contains waste plastic which is non-biodegradable. Pakistan annual consumption of plastic resins is over one million tons. The country consumes around 300,000 tons/year of polypropylene (PP) and 280,000 tons/year of polyethylene (PE), its almost entire demand is met by imports, as Pakistan has very small PP or PE production. The total PVC demand in Pakistan is estimated at 70,000 tonnes which is met through imports at a cost of $345 million per annum. The total PET demand in Pakistan is estimated at 120,000 tonnes. When such plastics are burned, harmful quantities of dioxins, a group of highly toxic chemicals are emitted. Some chlorinated plastic produce injurious chemicals which can then infiltrate into underground aquifer resulting in the contamination of drinking water.

2 RELATED WORK

Research work was done about use of waste plastic in concrete and a review was presented in this paper. The following con-

clusions were obtained from the study. It was observed that compressive strength and splitting tensile strength of concrete decreased with increase in aggregates content. The failure of the concrete specimens having plastic aggregate under compression and splitting tensile load, did not show the typical brittle type of failure usually obtained for conventional concrete (Siddique, Khatib, & Kaur, 2008).

An experimental analysis was done in which there is use of recycled plastic waste sourced from scraped PVC pipes to replace river sand as fine aggregate in proportion of 0%, 5%, 15%, 30% and 45% by volume. Two major findings are identified; the positive side shows that the concrete prepared with a partial replacement by PVC was lighter (lower density), was more ductile, and had lower drying shrinkage and higher resistance to chloride ion penetration. The negative side reveals that the workability, compressive strength and tensile splitting strength of the concrete were reduced. In compression test cracks were initiated quickly around the PVC particles due to the modulus mis-match because the PVC granules have a lower elastic modulus than the surrounding cement paste (Poon et al., 2009).

Another research study was done. To make an attempt to substitute in concrete the 5% by weight of fine aggregate (natural sand) with an equal weight of PET aggregates manufactured from the waste un-washed PET bottles (WPET). Specimens with different cement content and water/cement ratio were manufactured. Rheological characterization on fresh concrete and mechanical tests at the ages of 28 and 365 days were performed on the WPET/concretes as well as on reference concretes containing only natural fine aggregate in order to investigate the influence of the substitution of WPET to the fine aggregate in concrete. It was found; it was found that the WPET concretes display similar workability characteristics, compressive strength and splitting tensile strength slightly lower that the reference concrete and a moderately higher ductility (Frigione. M, 2010).

Another experimental study was conducted in which waste plastic was added as sand replacement in proportion of 10%, 15% and 20%. Toughness indices tests were performed on simple beams and beams having Polythene and the following conclusion was obtained. Under centre point loading on beams having waste plastic, the arrest of propagation of micro cracks was observed. While at same loading a sudden failure of beams having plain concrete was observed due to its brittle nature. It was also observed that unlike the control sample, the concrete beam having polythene has reached the plastic behavior at all curing stages (Ismail & AL-Hashmi, 2008).

Research analysis was done. To study a method of strengthen concrete by the addition of percentages recycled waste plastic (polyethylene) in proportion of 1%, 3%, and 5% from fine aggregate recycled waste plastic (polyethylene). It's found; When waste plastic bottles increased from 0% to 5% of the sand in the mix, the compressive, tensile and flexural strength of concrete decreased by the ratio of 12.81%, 10.71% and increased by 4.1% respectively at 7 days age and also these concrete strength decreased by the ratios 7.93%, 28.6%, and 23.6% at 28 days age. The compressive strength of concrete decreased with increasing the percentages of plastic bottles and also with waste plastic bags. The effect of waste plastic bottles on the decreasing strengths is less than the waste of plastic bags (Jibrael. A. M & Peter. F, 2016).

3 MATERIALS

The materials used in this research are listed below. Experimental study conducted at Iqra National University Peshawar.

3.1 Cement

Ordinary Portland cement most commonly available in local market was used. Specific gravity of cement is 3.15.

3.2 Aggregate

Fine aggregate is collected from Ghazi subdivision of Haripur and coarse aggregate from Badha Agency.

3.3 PVC & PET aggregates

PVC aggregate are collected from Royal PVC industry and PET aggregate are collected from Al-Hafiz cristoplast in shredded form i.e (1in down). Both industries are located at industrial state Peshawar.

Fig. 1. PVC aggregate

Fig. 2. PET aggregate

4 METHODOLOGY

4.1 Casting of concrete cylindrical specimen

Concrete ratio was selected as 1:2.11:2.63 with 0.49 water cement ratio. Then three more batches were prepared with 5%, 15% and 25% replacement of coarse aggregate with shredded PVC & PET respectively. Total 42 concrete cylindrical speciemen were casted 6 specimens for 0%, 18 for PVC and 18 for PET for 5%, 15% and 25% replacement for 28 days curing period and tested for compression (ASTM C39, 2016) and split

tensile strength(ASTM C496 / C496M- 11) by universal testing machine (UTM).

5 Result and Discussion

5.1 Compressive strength result for PVC

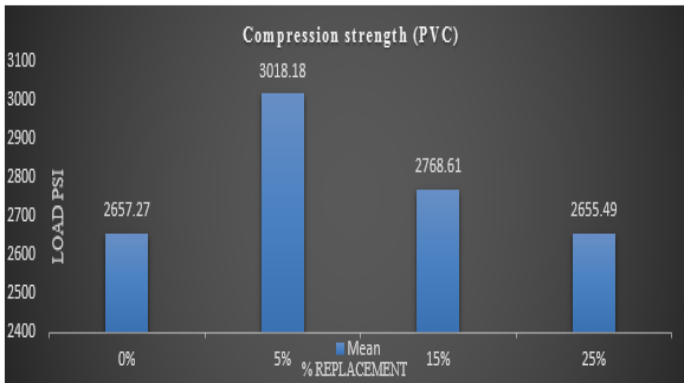

Fig. 3. Comparison of Compressive strength

Discussion

As it can be seen from the results a gain in the compressive strengths of concrete as plastic is added. It gain from 2657.270 psi to 3018.180 psi with 5% addition of waste PVC aggregate, an average strength of 2768.610 psi with 15% addition of waste PVC aggregate and finally 2655.490 psi strength with 25% addition of waste PVC aggregate.

5.2 Compressive Strength result for PET

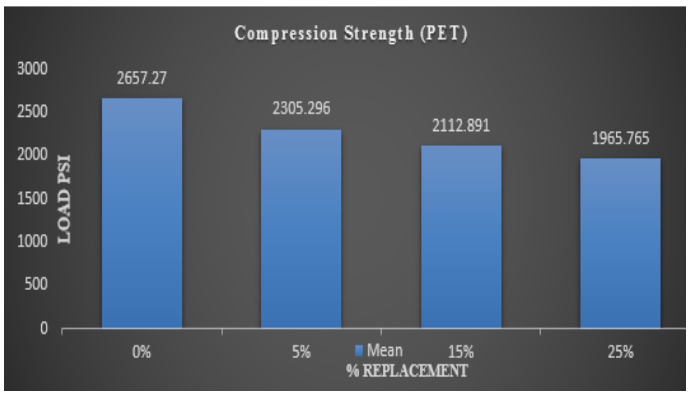

Fig. 4. Comparison of Compressive strength

Discussion

As it can be seen from the results that decrease in the compressive strengths of concrete as plastic is added. It decrease from 2657.270 psi to 1965.765 psi upto 25% addition of waste PET aggregate.

5.3 Split Tesile strength result for PVC

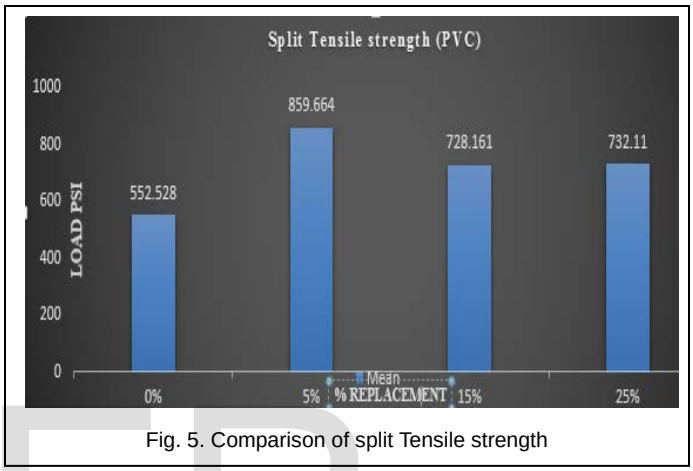

Fig. 5. Comparison of split Tensile strength

Discussion

Tensile strength tests of concrete cylinders showed a gain in strength from the strength of 552.528 psi of control sample to 859.664 psi, 728.161psi and 732.110 for addition of waste PVC aggregate in the amount 5%, 10% and 25% respectively. The strength gain was observed due to the strong bonding of cement with the coarse and fine aggregate.

4.2 Split Tensile Strengt result of PET

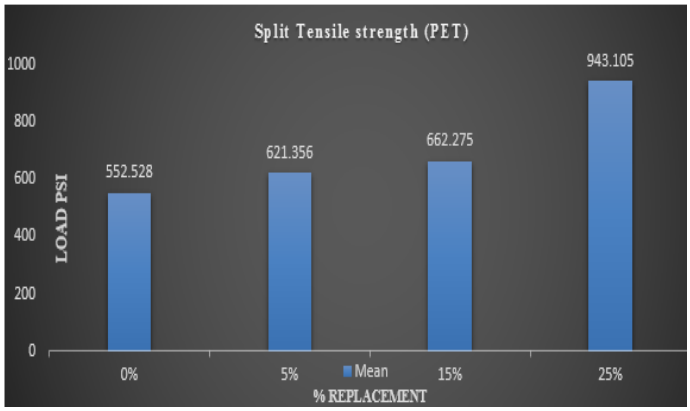

Fig 3. 1 Comparison of split Tensile strength

Discussion

Tensile strength tests of concrete cylinders showed a gain in strength from the strength of 552.528 psi of control sample to 621.356 psi, 662.275psi and 943.105 psi for addition of waste PET aggregate in the amount 5 %, 10% and 25% respectively.

The strength gain was observed due to the strong bonding of cement with the coarse and fine aggregate.

6 Conclusion

Based on specific gravity of PVC & PET, lightweight concrete is produced.

Tensile strength increases with increase in PVC & PET replacement upto 25%, however at 25% PET replacement tensile strength was maximum.

The data trends revealed that compressive strength test results of 5%, 15% and 25% PVC replacement were in comparison with control sample.

Compressive strength decreases with increase in PET replacement upto 25%.

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