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EXPERIMENTAL INVESTIGATION ON CONCRETE USING PVC WASTE AS A PARTIAL REPLACEMENT OF FINE AGGREGATE

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Abstract ---

This paper ambitions to investigate the clean and hardened fine aggregate concretes that are prepared with using recycled plastic waste sourced from scraped PVC waste to interchange river sand as fine aggregates. A number of laboratories prepared concrete mixes were established, where river sand was once partially replaced by PVC plastic waste granules in percentages of 0%, 5%, 10%, 15%, 20% and 25% through volume. Two most important findings are recognized. The confident side indicates that the concrete prepared with a partial alternative through PVC was once lighter. Moreover, this study reveals that the compressive strength and Split tensile strength of the concretes were increased in mixing of PVC. The outcome gathered would kind a part of valuable know-how for recycling PVC Plastic waste in pleasant concrete mixes.

Keywords – PVC Waste, Concrete, Compressive Strength, Split Tensile Strength, Fine Aggregate

I. INTRODUCTION

The world is facing a waste disaster from the foremost problematic plastic made today: vinyl resin or PVC, usually known as vinyl. For years, abandoned product of PVC are a number one explanation for hydrocarbon in incinerators once they area unit burned. As a lot of PVC product area unit being disposed of, the community currently suffers Associate in Nursing imminent PVC waste drawback. World production of PVC nowadays is quite twenty million tonnes p.a. - up from 3 million tonnes in 1965 – that corresponds to regarding common fraction of the full plastic production. Since the Nineteen Sixties, PVC has been used quite common altogether styles of product. Considering that the time period of the PVC product is regarding 30– 40 years, a big increase in PVC waste generation is predicted within the close to future[1,2].

Although there are some analysis studies according on victimisation steam chemical process or transmutation to convert the PVC to alternative product[3–5], there's still no sensible thanks to recycle PVC waste effectively. Recycling PVC wastes to replace river sand for concrete manufacturing may be one of the environmentally pleasant techniques due to the fact there's an outstanding call for concrete global, particularly in developing economies along with china, and river sand has these days end up a scarce natural aid. The possible use of recycled plastic waste as aggregates in concrete and different construction materials has been studied with the aid of a number of researchers[6–9]. These studies particularly investigated the impact of incorporating polyethylene terephthalate (PET) waste on the residences of concrete and cementitious mortar.

Generally, the effects confirmed that granules or flakes of crushed bottles can be used to replace river sand to provide excellent high-quality concrete products. It turned into determined that the density and compressive strength of the concrete have been among 1000– 2000 kg/m3 and 5– 60 MPa, respectively, depending on the replacement percentages. But it turned into mentioned that the compressive strength of concrete decreased with a boom in the amount of plastic within the concrete, specifically while the plastic content material turned into above 0.5% of the entire weight of the concrete blend. However, the advent of the recycled pet flakes into concrete can reduce the drying shrinkage cracks of the cementitious material. Concrete, probably the most original development materials, requires a colossal quantity of typical assets and power. Average assets used in concrete combinations incorporate lime stone, clay, river sand, ordinary gravel, beaten stone, and water. With the rapid development in city areas worldwide in the contemporary years, our traditional assets are depleted in an ever-growing cost. Therefore, it is vital to increase a new fabric that consumes less traditional assets and vigour in order to make our development approaches extra sustainable. Many efforts had been made to gain knowledge of the use of waste by using product substances, similar to fly ash[10,11], slag, silica fume, and ordinary pozzolan, to interchange portland cement in a concrete mixture[12,13].

In recent years, a sizable work has already been achieved on the use of plastic waste together with polyethylene terephthalate bottle[14–16], glass reinforced plastic (GRP)[17], polycarbonate, high density polyethylene (HDPE)[18], expanded polystyrene foam (EPS)[19], thermosetting plastics[20], polyvinyl chloride (PVC) pipe[5], polyurethane foam[21,22], polypropylene fibre[23] as a mixture, shredded and recycled plastic waste[24], a filler or a fibre in the preparation of concrete. Limited research has been done on the use of waste PVC granules as aggregates in concrete. This paper reports on a scientific take a look at on investigating the effect of replacing river sand by using PVC granules on the sparkling and hardened properties of fine aggregate concrete.

II. EXPERIMENTAL SECTION

2.1 Materials

2.1.1 Cement

ASTM Type 1 Portland Pozzolana cement of 43 Grade was used as a binder in concrete.

2.1.2 Aggregates

In this study a crushed granite metal gained from a local source was used as the coarse aggregate. The nominal sizes of the aggregates used were 12.5 mm and 10 mm. Recyclable waste PVC plastics were crushed into small granules with about 97% passing the 4.75 mm sieve (Fig. 1). The physical and mechanical properties of the River sand and PVC granules are given in Table 1. These granules were used to replace a segment of river sand in the concrete. A summary of the particle grading of all types of aggregates used are shown in Fig. 2. Although, the particle size of the PVC granules is similar to river sand.

Fig. 1. Recycled PVC waste (a) before crushing, (b) after crushing

Table 1: Physical and Mechanical Properties of River sand and PVC granules

Properties	River Sand	PVC
Density g/cm³	2.60	1.40
Bulk Density kg/cm³	1560	570
Fineness Modulus	2.44	2.68
Shape	Sphere	Angular
Chemical Formula	Siliceous	$(C_2H_3Cl)_n$

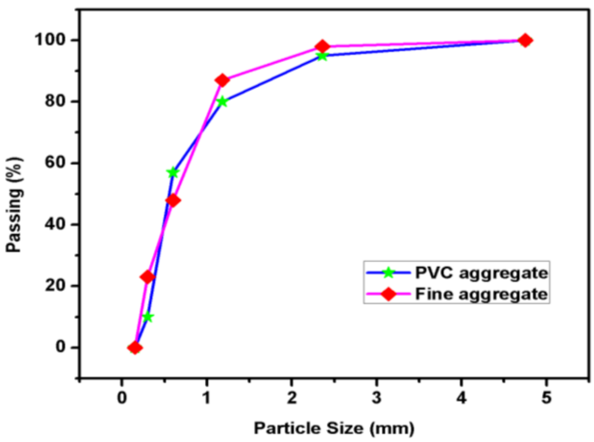

Fig. 2. Grading of all types of aggregates

2.2 Test Methods

The compression strength test and tensile test was conducted to identify the hardened properties of mixed concrete. The 150 x 150 x 150 mm cubic specimens had been used to decide the compressive strength of concrete at the concrete ages a while of 7 and 28 days. A Universal Testing Machines" with a loading capacity of 2000 kN became used for the experiment. The 100 x 200 mm cylinder specimens were used to decide the Split tensile strength of concrete on the concrete ages a while of 7 and 28 days. A Universal Testing Machines" with a loading potential of 2000 kN changed into used for the experiment.

2.3 Sample Preparation

Preparation of test specimen includes the following procedure: Batching and Mixture of concrete. The quantity of ingredients was arrived by conducting proper weigh batching and stored separately for mixing. Mixing of concrete was carried out manually. Six concrete mixes were prepared in the laboratory. The concrete mixtures were prepared with a cement content of 345 kg/m3 a. The proportion of river sand become designed at 967 kg/m3. The PVC granules were used to replace 0%, 5%, 10%, 15%, 20% and 25% by means of volume of sand within the 5 mixes. The mixture proportions of the concrete are shown in table 2.

Table 2: Mixture proportions of the concrete

Mix	Cement (opc 43) Kg/m^3	River sand (0-4.75) Kg/m^3	PVC (0-4.75) Kg/m^3	Coarse Aggregate Kg/m^3
0	345	967	0	981
5	345	918.6	19.7	981
10	345	870.2	39.5	981
15	345	822	59.3	981
20	345	773.6	79.1	981
25	345	725.2	99	981

III. RESULTS AND DISCUSSION

3.1 Slump cone Test

The slump cone test was carried out for the workability of plastic waste concrete with various percentage of PVC waste as a partial replacement of fine aggregate and the results are tabulated in Table 3.

Table 3. Slump cone test

S. No	Percentage of PVC Plastics	Slump Cone Test (mm)
1	0	50
2	5	60
3	10	75
4	15	80
5	20	90
6	25	100

3.2 Compressive Strength Test

The optical image of compression test clearly demonstrated in Fig. 3. The consequences of compressive strength of the concrete are tabulated in Table 4. It can be visible that at all check a long time, the compressive Strengths of the fine aggregate content have been reduced with the increase in PVC granule content material. The ratios of 28-day compressive strength values of the concrete mixes prepared with PVC waste additional to that of the manipulate (0%) are shown in Fig. 4. For 5%, 15%, 20% and 25%, the compressive strengths had been decreased, respectively, then that of the control (0%). Interestingly, by mixing of 10% of PVC granules increase the compression strength in the concrete.

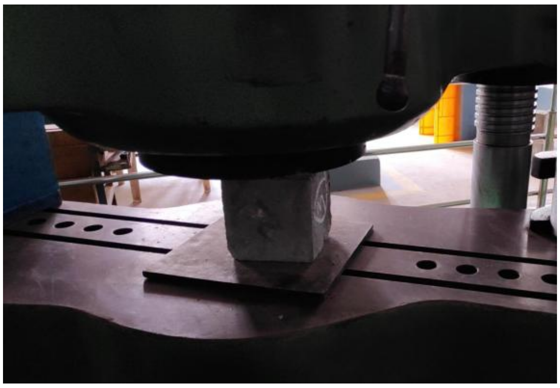

Fig. 4. Optical image of Compression Test

Table 4. Compressive strength of concrete mixtures

Mix	Sand kg/m³	PVC kg/m³	Compression Strength (MPa)	
			7 days	28 days
0	967	0	16.2	26.7
5	918.6	19.7	17.7	26.8
10	870.2	39.5	19	30
15	822	59.3	17.4	25.8
20	773.6	79.1	16.6	25
25	725.2	99	15.9	22.9

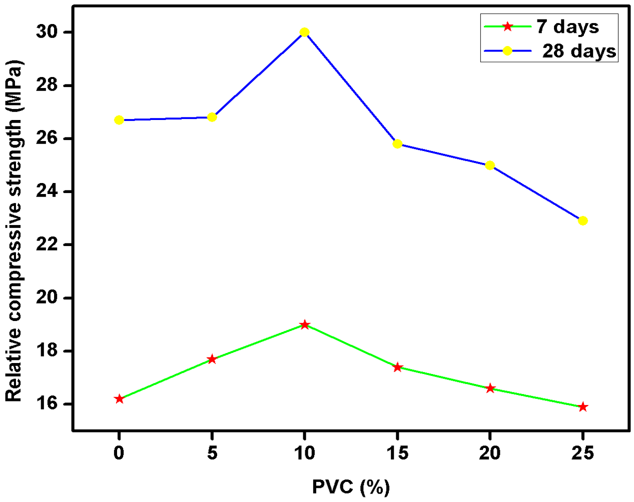

Fig. 4. Relative compressive strength of concrete mixtures

3.3 Split Tensile Strength Test

Fig. 5 clearly shows the optical image of Split tensile strength test. The Split tensile strength of the concrete mixer is provided in Table 4. Every provided value is an average of six measurements (0%,5%, 10%, 15%, 20%, 25%) and the strength ratios are proven in Fig. 6. The splitting tensile strength became reduced with an increase in PVC content in a way much like that observed for compressive strength. Although, the mixing of 15% PVC granules in the concrete increased the tensile strength. It is probably due to the similar mechanisms defined earlier than.

Fig. 5. Optical image of Split tensile strength test

Table 4. Split tensile strength of concrete mixtures

Mix	Sand kg/m³	PVC kg/m³	Split Tensile Strength (MPa)	
			7 days	28 days
0	967	0	2.21	3.56
5	918.6	19.7	2.3	3.6
10	870.2	39.5	2.43	3.9
15	822	59.3	2.55	3.92
20	773.6	79.1	2.48	3.67
25	725.2	99	2.2	3.5

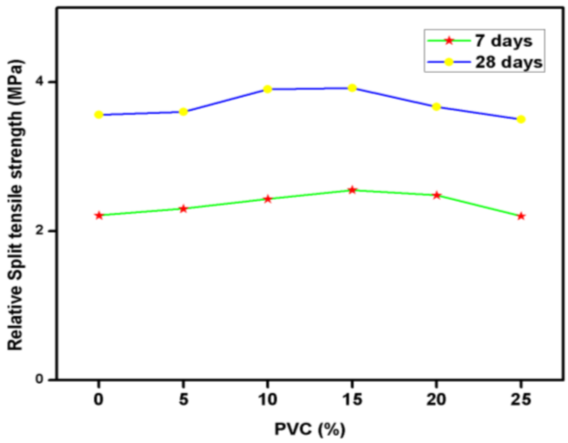

Fig. 6. Relative Split tensile strength of concrete mixtures

IV. CONCLUSION

This paper supplied the results of a scientific study on the effect of incorporating PVC granules at the properties of fine aggregate concretes. The effects of various volume replacements of sand by using PVC granules in percentages of 0%, 5%, 10%, 15%, 20% and 25% on the clean and hardened properties of the concrete. Based totally on the results, with a boom of substitute ratio of river sand via PVC granules: the compressive strength has been increased by mixing of 10% PVC granules and split tensile strength have been increased by mixing of 15% PVC granules in the concretes. The outcomes of the have a look at would form a part of beneficial information for recycling scrapped PVC plastic waste in fine concrete mixes. The results show that the PVC granules derived from scrapped PVC waste has capacity to be used as aggregates to replace sand for making non-structural fine aggregate concrete.

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