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AN EXPERIMENTAL INVESTIGATION ON COMPRESSION STRENGTH OF PARTIALLY REPLACED CONCRETE WITH SHREDDED PET BOTTLES AS COARSE AGGREGATE

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Abstract: Plastic bottles are becoming a growing segment of the municipal solid waste. While plastic bottles offer convenience, they also create unnecessary waste in landfills. As plastic bottles are non-biodegradable, they remain for ages in the environment. The waste **Polyethylene Terephthalate (PET) bottles** are considered as an urban junk with sustainability characteristic which can be used as a material instead of some conventional material such as brick in water tank construction. The plastic bottles are filled with waste filler materials, and casting of block is done with the appropriate mortar mix. These blocks work as bricks and form a framework for walls of water tank in which plaster made of clay or a cement mixture fills the space between all bottles. This paper investigate the compression strength of the partially replaced concrete with shredded PET bottles. The shredded plastic that get mixed with the different proportion (5%, 10%, 15%). The test result that get included in this paper.

Key words: PET (shredded) bottles, M25 grade concrete, maximum strength, different proportion of plastic.

1. INTRODUCTION

Concrete is the mostly used man made material used in construction industry and is the second after water as the most utilized thing on the Earth. In simple words it is defined as a mixture of four ingredients as coarse aggregates that form the largest proportion of the mix, fine aggregates such as sand that act as filler material in the voids, binding material such as lime or Portland cement that binds these material together and water that reacts with binding material. Typically a plastic is not recycled into the same type of plastic products made from recycled plastics are often not recyclable.

Among different waste fractions, plastic waste deserves special attention on account non biodegradable property which is creating a lot of Problems in the environment. In India approximately 40 million tons of solid waste is produced annually.

The production and consumption of plastic and the rate at which solid plastic waste (SPW) is created have increased considerably since the first industrial scale production of synthetic polymers (plastics) in the 1940s. According to the Central Pollution Control Board, the world produces nearly 150 million tonnes of plastics per year, which is nearly 4.8 tonnes per second and a per capita production of 25 kg/year (Al- Salem et al. 2009). In Bangladesh, due to the rapid increase in the use of PET bottles, solid wasteproblem is raised. It is known that a long time (more than a hundred years) is needed to degrade the waste PET bottles in the nature (Silva et al., 2005). In recent times, waste plastic recycling has become one of the major challenges in Bangladesh (Islam, 2011). At present there are many plastic industries in our country. They are using a huge number of plastics for recycling and many other purposes.

2. MATERIALS

2.1 CEMENT

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by calcining at high temperature. It is a mixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete and it is available in different forms. When cement is mixed with water, a chemical reaction takes place as a result of which the cement paste sets and hardens to a stone mass. Depending upon the chemical compositions, setting and hardening properties, cement can be broadly divided into following categories.

i. Portland cement

ii. Special cement

The cement used in this experimental investigation is Portland pozzolano cement. Storage of cement requires extra special care to preserve its quality and fitness for use. To prevent its deterioration it is necessary to protect it from rain, winds and moisture.

2.2 FINE AGGREGATE

Fine aggregate / sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only from size of grains or particles, but is distinct from clays which contains organic minerals. Sands that have been sorted out and separated from the organic material by the action of current of water or by wind across arid lands are generally quite uniform in size of grains. Good quality river sand was used as a fine aggregate. Ref. Code : IS 383-1963 & 2386.

2.3 COARSE AGGREGATE

The material whose particles are of size as are retained on I.S Sieve No.480 (20 mm) is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 20mm sizes, crushed angular in shape. The aggregates are free from dust before used in the concrete. Ref .Code : IS :2386 & 383-1970

2.4 PET (Polyethylene Terephthalate) BOTTLES

Polyethylene terephthalate polyester (PETP) is a hard, stiff, strong, dimensionally stable material that absorbs very little water. It has good gas barrier properties and good chemical resistance except to alkalis (which hydrolyse it). Polyethylene Terephthalate (PET) bottles are thermoplastic materials. This type of plastic are polymers with or without cross linking and branching, and they gets easily softened on the application of heat and pressure and require cooling to get a specified shape.

Fig 1 Shredded PET bottles

Following are properties of plastic bottle: odourless

ii. Flexible over a wide range of temperature.

iii. Heat resistant.

iv. Chemically stable

v. Do not absorb moisture

vi. Transparent

3. MIX DESIGN FOR M25 GRADE CONCRETE

Table 1 MATERIALS REQUIRED AS PER IS METHOD OF DESIGN

Materials	5%	10%	15%
Cement	7.74 kg	7.74 kg	7.74 kg
Water	4.1 kg	4.1 kg	4.1 kg
Fine aggregate	14.530 kg	14.530 kg	14.530 kg
Coarse aggregate	27.36 kg	25.92 kg	24.48 kg
Shredded plastic	0.647 kg	1.29 kg	1.95 kg

Mixing grade of concrete – M25.

The properties of materials used are

- Specific gravity of cement – 3.05
- Specific gravity of fine aggregate – 2.63
- Specific gravity of coarse aggregate – 2.88
- Specific gravity of shredded PET – 2.197 bottles.

3.1 EXPERIMENTAL PROGRAMME

The following tests were made after 28 days curing:

- ❖ Workability test
- ❖ Compressive strength test
- ❖ Compression strength test,

3.1.1 Workability test (SLUMP CONE TEST)

The concrete slump test is an empirical test that measures workability of fresh concrete. Metal mould, in the shape of the frustum of a cone, open at both ends, and provided with the handle, top internal diameter 100mm, and bottom internal diameter 200mm with a

height of 300mm.

The slump value of the concrete for = 75mm w/c ratio of 0.53 is

The nature of the slump cone - True slump.

i. Wax like in appearance translucent,

Fig 2 Slump cone test

3.1.2 COMPACTION FACTOR TEST

The sample of concrete to be tested is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. In the case of a dry-mix, it is likely that the concrete may not fall on opening the trap-door. In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades.

$$\text{The compaction factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}$$

$$= (15.420 / 17.48)$$

$$= 0.882.$$

Fig 3 Compaction factor test

3.1.3 COMPRESSION STRENGTH TEST

The compression test is one of the major test that have to be done to determine the strength of the harden concrete in day wise. Compression test machine (CTM) is the machine that use to check the compression test of the concrete. The concrete should attain the certain value to be used in the working area. There are two mold have been casted to check the compression test.

ii. Cylindrical compression test.

These are the two test that have been take with the different shapes and different proportion of the mix.

Fig 4 Compression test

4. RESULT AND DISCUSSION

Table 2 COMPRESSION STRENGTH AT 7 DAYS OF CURING

SI.NO	% OF SHREDDED PLASTIC	COMPRESSION STRENGTH
1.	0%	15.335
2.	5%	15.24
3.	10%	15.395
4.	15%	13.38

Table 3 COMPRESSION STRENGTH AT 14 DAYS OF CURING

SI.NO	% OF SHREDDED PLASTIC	COMPRESSION STRENGTH
1.	0%	22.3
2.	5%	22.125
3.	10%	22.385
4.	15%	19.915

iii. Cube compression test.

Table 4 COMPRESSION STRENGTH AT 28 DAYS OF CURING

SI.NO	% OF SHREDDED PLASTIC	COMPRESSION STRENGTH
1.	0%	28.665
2.	5%	28.545
3.	10%	29.18
4.	15%	26.855

5. CONCLUSIONS

The experimental results have shown the use of shredded PET bottles in making concrete/mortar can provide an alternative solution to minimize the environmental impact due to unscientific disposal of waste plastic.

The following conclusions were drawn:

- ✓ The properties of concrete containing various percentage of plastic (0%, 10%, 15%) were tested for its compressive strength.
- ✓ The compressive strength of test concrete is compared with conventional concrete and it is found that the compressive strength up to 90% is achieved for a mix of shredded PET bottles up to 10% (as a replacement for coarse aggregate) in concrete. Hence it is recommended for light weight concrete structures.
- ✓ Further replacement up to 15% compression strength of the test concrete did not achieved because of the improper binding between the specimen of concrete.
- ✓ This research also has potential application for the production of lightweight concrete, for minimizing the amount of polymer wastes in landfills, and the creation of decorative, attractive landscaping product.

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