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PERFORMANCE OF USED PURE WATER SACHETS AS PARTIAL REPLACEMENT FOR COARSE AGGREGATES IN CONCRETE PRODUCTION

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ABSTRACT

Use of waste materials in construction works is becoming an interesting concept. This study is an investigation into the use of thermoplastic waste materials as partial replacement for coarse aggregates in concrete production. A total number of sixty-four cubes were cast in which sixteen cubes each were cast for varying thermoplastic material proportions of 0%, 2.5%, 5% and 7.5% as partial replacement for coarse aggregates. The concrete materials were batched by volume with 1:2:4 mix and the cubes were cured for 7, 14, 21 and 28days. Slump test revealed that the workability is low. The strength decreases as the proportion of Softened Thermoplastic Aggregate (STA) increases and the strength showed that it is lightweight concrete. The compressive strength values of the Thermoplastic concrete at 28days of curing were found to be 15.35 N/mm^2, 14.10 N/mm^2 and 12.78 N/mm^2 for 2.5%, 5.0% and 7.5% thermoplastics content respectively as against that of conventional concrete which was 18.44N/mm^2. The thermoplastic concrete of 2.5% content is recommended for use because of its slight reduction in compressive strength.

1. INTRODUCTION

Use of waste materials in construction works is becoming an interesting concept. Moreover, it has also been observed by United Nations Environment Program (2009) that the rapid urbanization and industrialization all over the world has resulted in large deposition of waste polymer materials. The world's annual consumption of plastic materials has increased from around 5 million tons in the 1950s to nearly 100 million tons in 2001. Hence the need to valorize these plastic wastes. Tapkire *et al.* (2014) describes plastic as a material which contains one or more number of polymers having large molecular weight. Solid in its finished state or same state will manufacturing or processing into finished articles is known as Plastic. Looking to the global issue of environmental pollution by post-consumer plastic waste, research efforts have been focused on consuming this waste on massive scale in efficient and environmental friendly manner. Polymers have a number of vital properties, which when exploited alone or together, make a significant and expanding contribution to constructional needs. The properties include: being durable and corrosion resistant, having good insulation for cold, heat and sound saving energy, being economical and having a longer life, having free maintenance (such as painting is minimized), being hygienic and clean, having ease of processing/installation and having light weight.

Rahman *et al.* (2012) posited that the incorporation of Polyurethane Formaldehyde (PUF) into the masonry poly blocks makes the material very light compared to High Density Polyethylene (HDPE) modified concrete. PUF-based poly blocks can respond to the many needs of current and future construction works where lightweight materials are recommended while *Wong et al.* (2012) submitted that the use of recycled plastics in the permeable interlocking pavement system, as well as pavement reinstatement by reusable modular paving blocks, will reduce waste materials. Some other researches conducted on plastic wastes were highlighted as follows: Tapkire *et al.* (2014) in their study concluded that it is possible to use the plastic in concrete mix up to 20% weight of coarse aggregate and that the use of recycled plastic aggregate in concrete is the best option for the disposal of plastic & ultimately reduces the plastic pollution in the environment. Similarly, Patil *et al.* (2014) concluded that the modified concrete mix, with addition of plastic aggregate replacing conventional aggregate up to certain 20% gives strength within permissible limit. Modified concrete cast using plastic aggregate as a partial replacement to coarse aggregate shows 10% it could be satisfied as per IS codes. Density of concrete is reducing after 20% replacement of coarse aggregates in a concrete; while Chowdhury *et al.* (2013) concluded from their study that Polyethene terephthalate (PET) aggregates concrete have less compression strength, flexural rigidity and tensile strength which can be attributed to the decreased bonding tendency of PET with cement matrix. But as the density of PET fibre is lower than the conventional aggregate, it is very useful in producing light weight construction entities. The thrust of this study is to investigate the use of softened thermoplastic waste in concrete production.

2. MATERIALS AND METHODS

Materials used for the Study

These include Pure Water Sachet, Ordinary Portland Cement, Fine and Coarse aggregates.

Experimental Procedure

Used pure water sachets collected were melted and manually formed into coarse-like particles. After batching, 1:2:4 mix of concrete was produced in varying recycled plastics proportions of 0%, 2.5%, 5% and 7.5% by weight of total aggregate content with 0.55 water-cement ratio. Slump test was conducted on fresh concrete mix to determine their workability. Concrete cube specimens of size 150mm X 150mm X 150mm were produced to determine the compressive strength of the concrete at 7^{th}, 14^{th}, 21^{st} and 28^{th} days of curing.

3. RESULTS AND DISCUSSION

The thermoplastic material (used pure water sachet) was found to have the following engineering/physical properties as shown in Table 1. The reduction in slump was recorded as the thermoplastics content increases (as shown in Table 2), that is, thermoplastic concrete was not as workable as conventional concrete.

Table 1: Engineering Properties of the Thermoplastics

Property	Value/Remarks
Specific Gravity	1.07
Density	1070kg/m^3

Table 2: Slump Test Result

Thermoplastic Content (%)	**Slump Value (mm)**	**Form of Slump**	**Remark**
0	27.5	True Slump	Low Workability
2.5	26.5	True Slump	Low Workability
5	26.5	True Slump	Low Workability
7.5	26.0	True Slump	Low Workability

The thermoplastics were found to have some features related to coarse aggregate, a relatively large fraction of the particles (up to 85 percent) were found to be retained on 9.5mm sieve size (as shown in Table 3). The compressive strength values of the thermoplastic concrete were as represented in Table 4 below.

Table 3: Sieve Analysis of the Thermoplastics

Sieve Diameter (mm)	% Retained	% Passing
19	-	100.0
9.5	84.7	15.3

Table 4: Compressive Strength Test Result for Conventional and Thermoplastic Concrete

Thermoplastic Content (%)	**Compressive Strength (N/mm^2) For Various Curing Ages**			
	7 Days	**14 Days**	**21Days**	**28 Days**
0	11.73	15.22	16.25	18.44
2.5	8.88	10.84	12.76	15.35
5	7.65	9.14	10.78	14.10
7.5	6.12	7.95	9.74	12.78

4. CONCLUSION AND RECOMMENDATIONS

The compressive strength of the Thermoplastic concrete at 28days of curing decreases linearly from 18.44N/mm^2 (for conventional concrete) to 12.78 N/mm^2 (for 7.5% thermoplastics content). Concrete of 2.5% thermoplastic content can be used in lightweight concrete, and it is even recommended as the 2.5% thermoplastic concrete has a slight reduction in compressive strength. The thermoplastic concrete tends to fail the more at higher values of 5% and 7.5% thermoplastic content. Likewise, the thermoplastic concrete is not as workable as the conventional concrete, though they all have low workability at the chosen water-cement ratio.

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