Performance of concrete by using Non recyclable plastic wastes as concrete constituent

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Abstract

The safe disposal of non-recyclable thin plastics bags is the most challenging issue for the solid waste management across the globe. Even today, at least 15% of total plastic waste remains untreated [1]. Concrete is the first choice for construction in many countries today. This has increased the fast vanishing of natural resources. It could be worth experimenting to use non recyclable plastic bags in concrete to overcome the dual issue of shortage of raw material and safe disposal of leftover plastic to environment. This paper presents a comparative study of compressive strength of concrete made by mixing of plastic bags as concrete constituent. This study focuses on the use of polyethylene plastic bags of 20 micron thick in M25 concrete. Plastic was added 0% to 1.2% by volume. The compressive - strength was compared for manually cut and shredded plastic form.

Keywords: polyethylene plastic bags, Land filling, workability, compressive strength, Green concrete, Aspect ratio of fibres.

1. Introduction

The present Indian concrete industry is consuming about 370 million m^3 of concrete every year and it is expected, that it shall reach about 580 million m^3 by 2022[1][6].The re-formation of natural sources is beyond the proportion of mankind. Hence the increased demand of concrete has raised a serious question on the quickly vanishing valuable natural sources. It is therefore has become a necessity to find an alternate material could be used along with the conventional materials and try to reduce the quick and huge usage of valuable sources. A new term evolved called Green concrete – it is a concrete prepared by using the waste products of different industries with the conventional materials. Wide variety of such wastes are already being added and tested for various observations and their effects on different aspects of concrete properties.

One of the fastest growing industries is a plastic industry. Around the world almost one trillion bags per year are being used and it is just one example of a product of plastic. The plastic is one of the recent engineering materials which have appeared in the market all over the world. There has been a steep rise in the production of plastics from a mere 30 million KN in 1955; it has touched 1000 million KN at present.

Plastics are normally stable and not biodegradable. So, their disposal is a problem. Research works are going on in making use of plastics wastes effectively as additives in plain and reinforced concrete mixes for variety of purposes[2][3]. Different forms and types of wastes are utilised to check the feasibility of them in concrete [4][7][8]. This study attempts to give a contribution to the effective use of waste plastics in concrete in order to prevent the ecological and environmental strains caused by them, also to limit the high amount of environmental degradation.

2. Materials for tests

2.1 Cement: Ordinary Portland cement of 53 grades available in local market is used in the investigation. The cement used has been tested for various proportions as per IS 4031-1988 and found to be conforming to various specifications of IS 12269-1987. The specific gravity was 2.96 and fineness was 3200cm^2/gm.

2.2 Coarse aggregate: Crushed angular granite metal of 20 mm and 10 mm size from a local source was used as coarse aggregate. The specific gravity of 2.71 and fineness modulus 7.13 was used.

2.3 Fine aggregate: River sand was used as fine aggregate. The specific gravity of 2.60 and fineness modulus 3.25 was used in the investigation

2.4 Plastic fibres: The ordinary plastic bags having thickness of less than 20 microns were collected and investigated for the plastic waste classification, category and density were checked before the use. The bags were shredded in form of fibres by two methods manually and by shredders.

3. Mix Proportions for the test

The concrete mix is designed as per the guidelines given in the various Indian standards namely IS 10262 – 1982, IS 456-2000 and SP 23. Table no. 1 gives the materials required for the M25 grade concrete. The water cement ratio was maintained at 0.50 and mix proportions are 1: 1.69: 3.04.

Vol. of Concrete	Cement (OPC -53 G)	Water	Fine aggregate	Coarse aggregate	Grit
$1m^3$	383.16 kg	185.152 kg	649.256 kg	698.869 kg	465.913 kg

Table: 1 Requirement of material quantity as per the Mix design of M25 grade of concrete

4. Mixing and Casting

Mixing being an important aspect of any successful experiment and to avail the desired results, utmost care was taken in the mixing and casting process. All materials were mixed with the standard practice of mixing them in a mixer and the plastic fibres were added to the mix. Specimens were prepared by following the standard methods of mould preparation. Total 48 cubes of the size of 150X150X150 mm were prepared for the compressive strength tests.

5. Study of fibre form on strength of concrete

Plastic bags were cut manually in the proportion of 60mm x 3mm macro fibres. As a second form the bags were shredded in to very fine random palettes. The intentions were to study the effect of the aspect ratio of the form and size of the fibres to the strength and workability of the mix.

Fig.1: Hand cut fibres

Fig.2: Shredded fibres

6. Tests

Total 48 cubes were prepared including controlled concrete and concrete mixed with polyethylene fibres in different proportions from 0.3%, 0.6%, and 0.9% to 1.2% of the volume of concrete. The samples were prepared by addition of shredded and manually cut fibres separately. Some tests were performed only with manually cut fibre samples, to notice the effect of macro size of fibres on strength and workability of concrete. The samples were tested with standard apparatus at two different curing intervals of 7 days and 28 days. The results were collected and presented with a graphical mode

7. Results and Discussions

All the cube samples were tested for compressive strength and compaction test. The compaction factor test represents the indirect indication of the degree of workability of the mix. Similarly compressive strength tests were conducted on cubes. Following are the results obtained,

- The graph in Fig. 3 shows that the shredded fibre has comparatively good workability due to their higher aspect ratio or the form. The shredded fibres get well mixed and evenly sprayed in the mix.
- While the hand cut fibre which are having lower aspect ratio or bigger size found difficult to get well mixed in concrete and resulted in lower values of compaction factors. Especially in terms of percentage of fibre added to the mix.
- Increased percentage of fibres- beyond 0.6% - in both form shows reduction in the compaction factor values that means the workability and density is getting affected adversely. In other terms it could be taken as the maximum dosage of the plastic fibres in the mix.
- Addition of fibres also affected the compressive strength. Fig. 6 explains the reduction of the values of compressive strength as the percentage of fibre increases. This is a general observation made after testing the specimens after the curing period of 7 and 28 days. In both the cases, the reduction in the values of compressive strength was noticed.
- The hand cut macro fibres showed greater strength loss, compared to shredded fibres.
- The test results show that the macro fibres where responsible for low compacting factor value as noticed as 0.7.

8. Conclusions

Based on the experimental data received after a wide range of samples with different proportions of polyethylene fibres, following conclusions are made,

- The plastic bags could be used preferably in shredded form to avoid difficulty in workability.
- Macro fibres made from bags by hand cut, are not suitable due to their low aspect ratio.
- Beyond 0.6% of concrete volume of the fibres made from the plastic bags having thickness less than 20 microns reduced the strength and compacting factor nearly up to

30% and at 1.2% the strength reduced up to 50% compared to the controlled concrete.

- The concrete prepared by addition of polyethylene fibres less than 20 micron thickness, could be suitably used for non structural works, where the strength of concrete is not a prime concern.
- Various durability aspects must be checked with wider range of sampling and testing.
- The authors are experimenting different types of post consumer plastic wastes in different form and proportions to check the feasibility of usage of such wastes in concrete to have an alternate solution towards the solid wastes.
- The concept of mixing of plastic wastes in concrete could be a very environment friendly method of disposal of solid waste in the country, this study has shown a potential towards this concept.

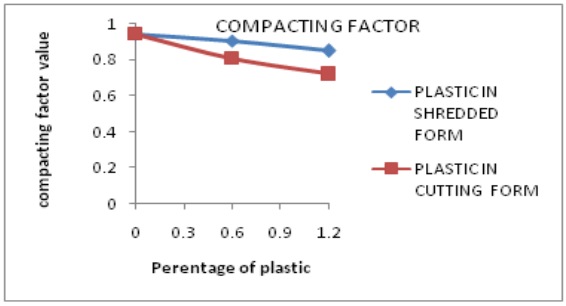

Fig.3: Compacting factor test results

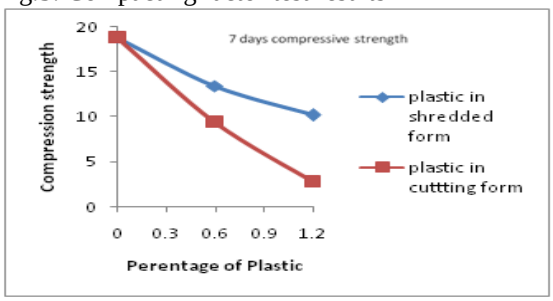

Fig.5: 7 days compressive strength results

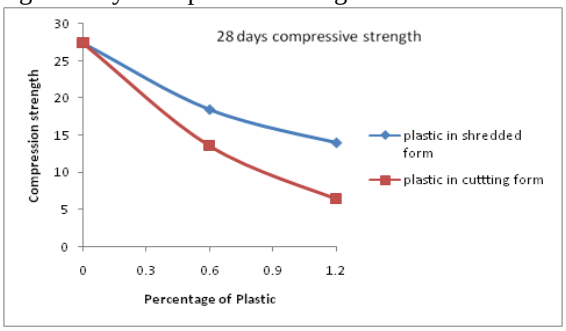

Fig.6: 28 days compressive test results

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