Strength Properties Of Concrete Containing Post Consumer Metalized Plastic Wastes

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Abstract – Eating habits in modern life has increased the demand of packaged food. Metalized polythene plastic is used in most of the food packaging industries. Such plastic becomes the waste and shares almost 15% of the total municipal wastes. The plastic waste has become a hazardous material for environment and ecology due to its disposal management issues. Concrete is the first choice of construction material in most of the countries. Many research works are done on addition of plastic wastes generally PET type in concrete towards the waste utilization and mitigation of the plastic disposal issues. In this study plastic waste known as metalized polythene in macro pellet form added to the conventional concrete to study the changes in the basic strength properties. A conventional concrete with 0.45 water/cement ratio was prepared and plastic pellets were added by 0.5%, 1% and 1.5% by concrete volume. Compressive strength, split tensile strength and surface tensile test were performed on the samples. The test results reviled the reduction of strength properties up to 60%. It could be observed that the plastic beyond 1.5% proportion could make the concrete not suitable for construction work except where the lean concrete could be used.

Keywords: metallised polyethylene, plastic waste management, compressive strength, split tensile strength, pull off test, water/cement ratio, municipal plastic wastes.

I. INTRODUCTION

With the rapid growth in the in the urbanization people have changed their routine life style from conventional to a modern approach. This includes the food habits also. As a result, today a large variety of prepared, pre-processed and ready to eat food stuff is available. Consequently, to provide the better hygienic food to the consumers, it was required to use the material having high degree of flexibility, toughness and chemical and moisture resistance. Plastic made with low density polythene is utilized for this purpose. Especially the laminated plastic like metalized polythene has been the first choice for food packaging industries. This has created a giant rise in the production and thereby in the post consumer plastic waste or municipal waste.

Keeping the eye opening and alarming facts in the centre many countries have taken steps towards safe disposal of plastic waste. 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.

The concept of carbon blue print is also applied to the plastic waste generation and to the construction industry as well. The concrete made by the ordinary cement is a source of the carbon emission to the environment and to the reduction of the non recoverable natural material sources like lime stone and other rock types. Researchers have focused on utilization of plastic wastes in concrete to set some feasibility marks towards the mitigation of this dual and problematic situation. PET bottles are successfully utilized in the concrete as a constituent. Even other HDPE plastics wastes are utilized in form of powder and fibres in the concrete by partial replacement of cement or aggregates. This paper presents the results of experimental study on strength properties of concrete added with the metalized polythene plastic waste which is LDPE type of the plastic and it is practically difficult to even recycle or reuse. There for the experimental program is designed to check the effects of addition of such metalized polythene plastics on the strength properties of the conventional concrete. 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.

II. RESEARCH WORK EXTRACTS

Immense efforts are made towards checking the feasibility of use of plastic waste in different form along with the fibre form. A. Bhogayata et. all [1, 2] tested the concrete prepared with the non recyclable plastic of less than 20 micron thickness. The strength was reduced up to certain percentage. However it was still a safe way of plastic waste disposal. Physical and mechanical behaviour was checked for waste PET bottle fibres used in controlled concrete by Luiz A. Pereira de Oliveira and João P. Castro-Gomes [6]. They noticed that the PET fibre incorporation (1:1:6) increases the bending strength about 100% at 7 days, 30% at 28 days and the order of 50% at 63 days. The volume of PET fibre of 1.5% is the optimum volume for the best performance of the mortar. F. Mahdi and et all [4], noticed the energy saving aspect of use of PET bottle resins in mortar and concrete. They also noticed the improvement of tensile strength of the mortar and concrete when PET resins were added. F. Pacheco-Torgal et and all [5], tested the durability aspects of concrete added with rubber waste and PET bottles fibre in different aspect ratio and form of rubber wastes. They observed that such materials can be used for non load bearing structures. They have suggested further investigations to maximise such energy effective utilisation of wastes in concrete mix. C. Meyer [3] has presented an overview of different variety of wastes from different industries like fly ash, silica flume, recycled aggregates, granulated blast furnace slag, tire wastes, post consumer glass products, and recycled plastic wastes, experimented towards the sustainable building material as an alternative towards the conventional and energy consuming conventional material. This paper discusses the similar efforts towards utilisation of post consumer plastic waste used in packaged food and snacks in India. It is observed that even after a well organised waste management in various cities such plastic bags remains unhandled and becomes problem for the environmental cleanliness.

III. MATERIALS

The experiment was done with the basic and conventional concrete making materials like OPC 53 grade, fine and coarse aggregate of maximum size as 20mm and tap water. The metalized polythene waste bags were shredded to the macro pellet form. The bags were not given any treatment except the normal water wash cleaning and day light drying. The average size of the pellet was 1mmx2mm approximately. The properties of polythene bags were as given in table no.1

Properties	**Values**
Thickness	60µ
Density	1.4 gm/cc
Type	Polythene film (single metallised)
Category	Metallised food packing grade

Table 1: Properties of polythene film used

Fig.1: Shredded fibres of polythene bags

Cement: Ordinary Portland cement of 53 grades available in local market is used in the investigation. The specific gravity was 2.96 and fineness was 3200cm^2/gm.

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.

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

Fly ash: class F fly ash was used. The chemical details are as given below in table no. 2

Content	value
Silica	52.8%
Alumina	22.3
Lime	Trace
Iron	9.2
Sulphur	0.7
Magnesium	0.2
Available alkalis	0.5
Specific gravity	2.25

Table: 2 Contents of F class fly ash used

IV. TESTING METHODS

All materials except the fibres were tested for their basic properties and towards quality control of the experiment. Standards were followed including general and specific notes in ASTM and the IS codes. For mix preparation and curing purposes, the general laboratory methods were used with utmost care. According to the IS 456 requirements, four specimens were prepared, cured and casted and the average value of four samples was considered for mean strength values.

V. 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 64 cubes and 32 cylinder specimens of standard size were prepared and cured and tested for compressive, split tensile and pull off tests.

VI. TESTS

Total 93 specimens were prepared including controlled concrete and concrete mixed with polyethylene fibres in different proportions from 0%, 0.5%, and 1% to 1.5% of the volume of concrete. Fly ash was also added in different proportion like from 0% to 30%. The samples were tested at full curing periods and the average values were taken in to the consideration. Standard compression test, standard split tensile strength test and pull off tests were performed according to the guidelines of the IS codes.

VII. RESULTS AND DISCUSSIONS

All the cube samples were tested for compressive strength. Following are the results obtained,

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- The targeted mean compressive strength was noticed as 42 N/mm^2 for the controlled concrete. Along with the addition of plastic fibres, up to 1.5% by volume the strength was reduced to 18.3 N/mm^2.
- The compressive strength of the concrete prepared was reduced by 56.43%.
- The maximum split tensile strength of the specimen prepared with the controlled concrete was noticed as 3.96 which get reduced to 2.26 after addition of plastic fibres up to 1.5% by volume of the mix.
- Addition of fibres up to 1.5% reduced the split tensile strength by 43%.
- The surface tensile strength of the controlled concrete was noticed as 1.36 N/mm^2. After the addition of plastic fibres up to 1.5% by volume the surface tensile strength was reduced to 0.65 N/mm^2.
- Addition of plastic fibres reduced the surface tensile strength of the controlled concrete by 56%.
- It could be noticed that the reduction of strength value of compressive strength was negligible between additions of fibres from 0.5% to 1% in the concrete.
- Variation of strength reduction in the split tensile strength of the specimen was found negligible after the addition of plastic fibres from 0.5% to 1.5%.
- The reduction of surface tensile strength was negligible for the addition of plastic fibres from 0.5% to 1%.
- Addition of fly ash contributed to reduce the strength reduction within the limit of addition of plastic fibres up to 0.5% compared to the controlled concrete.

VIII. CONCLUSIONS

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

- Untreated metalized plastic bags could be used in the concrete as a constituent in pellet form of 1mmx2mm approximate size.
- Addition of plastic reduced the values of compressive strength for the controlled concrete but addition of fibres from 0.5% to 1% in concrete showed negligible reduction in compressive strength.
- The most suitable water to cement ratio was found as 0.45. It could be noticed that increase in water to cement ratio reduces the cement content and ultimately more reduction of basic strength properties could be expected.
- The probable reason of reduction in strength in compression and tension could be the presence of the macro fibres in the concrete, may have interrupted the bonding and complete hydration of the cement paste and aggregates.
- It could be worth experimenting to further reduce the size of the plastic fibres to avoid the bonding issues of cement and aggregates in a mix.
- 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.
- Addition of plastic fibres to the concrete could be a safe option for the disposal problem of unhandled and littering metalized plastic wastes.
- Fly ash of F class could not be utilized for compensating the strength loss. It could be interesting to use class C fly ash with high calcium content which may result in resistance to the strength loss.

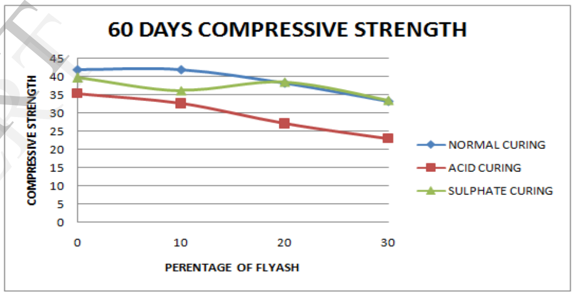

Fig.2: compressive strength test results

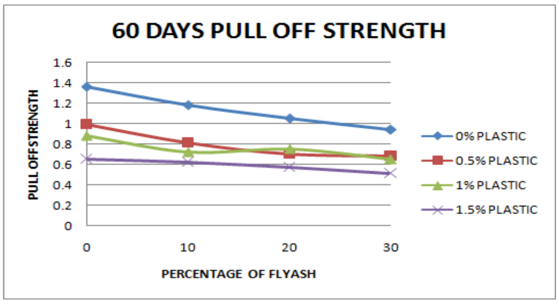

Fig.3: Surface tensile strength of concrete

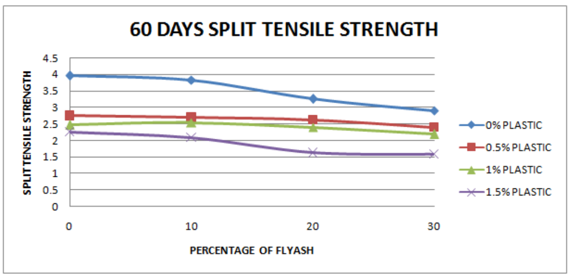

Fig 4: Split tensile strength of concrete

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