Experimental Investigation on Concrete With Waste Plastic as Fine Aggregate Replacement

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Abstract- *Due to rapid infrastructure developments in the country there are enormous demand for concrete in construction industry. Considering the effect of over-exploitation of natural sand from river beds for ever increasing concrete production, alternatives to natural sand are being explored. Apart from this the generation of plastic waste is one of the fastest growing issue. So, effective ways to recycle and reuse of plastic waste has to be formulated. In this study fine aggregate is partially replaced with plastic waste in various proportions of 10%, 20%, 30%, 40%, 50%, 60% and 70% by volume. In order to enhance the strength of concrete the cement is partially replaced with silica fume. And the strength properties of concrete are studied with different plastic percentage proportions. The study shows that the strength of concrete was found to be decreased with the increase in percentage of plastic, but it is within limits. The concrete perform well for the replacement of sand by plastic in the range 10% - 20%. Also the replacement of sand by plastic improves split tensile strength of concrete. So that the plastic can be used as an alternative to sand there by to reduce the environmental pollution and over exploitation of sand.*

Keywords- Plastic, Compressive strength, Split tensile strength.

I. INTRODUCTION

Due to rapid industrialization & urbanization in the Country, lots of infrastructure developments are taking place. This process has in turn led questions to mankind to solve the problems generated by this growth. The problems faced are shortage of constructional materials and increased dumping of waste products. Among the constructional material sand is the major one facing serious shortage. This leads to the over exploitation of the sand from river bed, which leads to the problems like ecological imbalance, topographical disorder, disturbance of water table, etc.. Plastic bags which are commonly used for packing, carrying vegetables, meat etc creates a serious environmental problem. Plastic bag are durable and non-biodegradable so that they last for long time. Disposal of large quantity of plastic bag may cause pollution of land, water bodies and air. Hence in order to overcome the above problems waste products should be employed as construction material.

In this study an effort has been made to replace the sand with plastic waste. Waste plastic is collected, ground into small pieces, melted and pulverized in order to get small granules of plastic. And the plastic is added in various percentages to the concrete as a replacement to the sand in volume. The addition of plastic to the concrete reduces the compressive strength of the concrete [1]. To overcome this problem silica fume is added to the concrete as replacement to the cement.

In this investigation, the properties of concrete such as compressive strength and Split tensile strength are tested for varying percentages of plastic, at 7 and 28 days respectively. M25 grade concrete is chosen for the investigation. To improve the workability of the concrete super plasticizer are added.

II. METHODOLGY

In the present research various test have been conducted on materials such as cement, sand, coarse aggregates and plastic wastes as per IS codes wherever necessary. The following are the materials used and their properties:

A. Cement

The cements used in this experimental works was ordinary Portland cement. All properties of cement are tested by referring IS 8112-1989 specification for Ordinary Portland cement. Test results are presented in Table 1

Table 1: Cement properties

Physical properties	Test Results	Requirements as per IS:8112-1989
Standard consistency	31%	
Initial setting time	30 min	Minimum 30 min
Final setting time	486 min	Maximum 600 min
Specific gravity	3.15	
Fineness of cement	9%	

B. Silica fume

The chemical composition of silica fume is similar to that of cement clinker. Chemical composition and properties of silica fume is presented in Table 2.

Table 2: Silica fume chemical composition

Properties of Silica fume	
SiO2	85% Min
Loss of ignition	6% Max
Moisture	3% Max
Bulk density	550 to 700 Kg/m3
Pumping Aid	2-4%
High strength	5-10%
Chloride & sulphate resistance	6-10%
Impermeability/water tightness	8-10%

C. Super plasticizer Sulphonated Naphthalene Formaldehyde Liquid (S.N.F)

SNF is high range water reducer high concentrate naphthalene based super plasticizer. The quantity used was based on the required workability.

D. Plastic

Waste plastic such as plastic bags, bottles and HDPE, which are collected from Mangalore region processed and pulverized. This plastic was well graded and then partially used in concrete. The properties of the plastic is presented in Table 3

Table 3: Plastic properties

Physical properties	Test results
Specific gravity	0.9
Fineness modulus	5.066

E. Water

Potable water which was available in laboratory was used for mixing and curing of concrete as per IS 456-2000.

F. Physical Properties of Fine Aggregate (sand)

Natural sand from river confirming to IS 383-1970 is used. Various tests such as specific gravity, water absorption and fineness modulus have been conducted on CA and FA to know their quality and grading. The conducted test results are shown in Table 4.

Table 4: Fine aggregate properties

Physical properties	Test results
Specific gravity	2.6
Fineness modulus	2.64
Water absorption	1.69%

G. Physical Properties of Course Aggregate

Crushed granite stones obtained from local quarries were used as a coarse aggregate. The maximum size of coarse aggregate used was 20 mm. The properties of aggregate were determined by conducting test as per IS: 2386 (Part – III). The results are tabulated in Table 5.

Table 5: Course aggregate properties

Physical properties	Test results
Specific gravity	2.7
Fineness modulus	7.2
Water absorption	0.37%

H. Mix Design for M25 grade concrete

Control mix concrete and modified concrete with varying percentages of waste plastic were prepared a typical mix has been presented Table 6. All the mixes were prepared for 0.4w/c ratio. Then the mix proportion is done as per IS 10262:1985. The mix proportion is given in table below,

Table 6: Mix design proportion

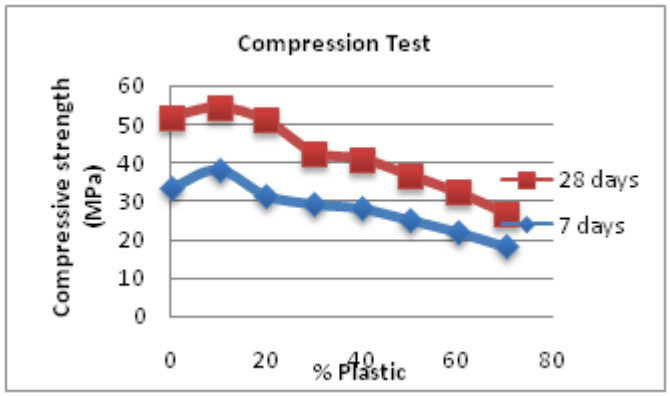
Grade of concrete	Cement	Fine Aggregate	Coarse aggregate	W/C
M25	1	1.22	2.27	0.4

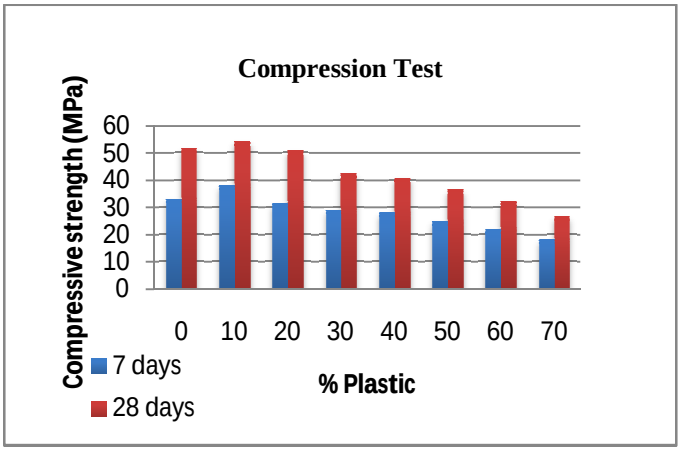
III. RESULTS

Compressive Strength

Standard cubes of size 15x15x15 were cast and cured and tested for 7 days and 28 days compressive strength. Results are presented below in graphical form. The graph shows that the compressive strength of concrete goes on reducing with increase in percentage of plastic but the rate of reducing compressive strength is very low. The reduction in strength is may be due reduction in bonding due introduction of plastic. It can be seen that the compressive strength is high

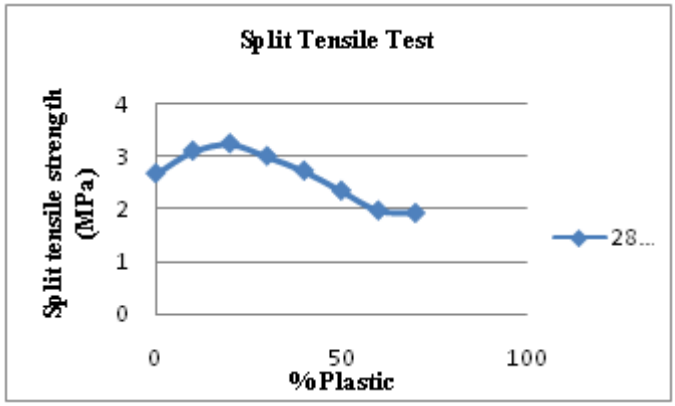
for the plastic replacement of 10%. So the plastic can be replaced to the range of 10-20% without compromising compressive strength.

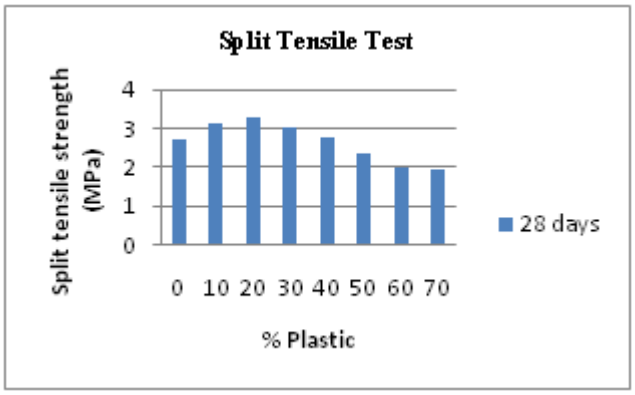




Tensile Strength

Result of Split tensile strength after 28 days were presented in chart. Improvement in splitting tensile strength after addition of plastic pieces in concrete was observed which is showed in graph.



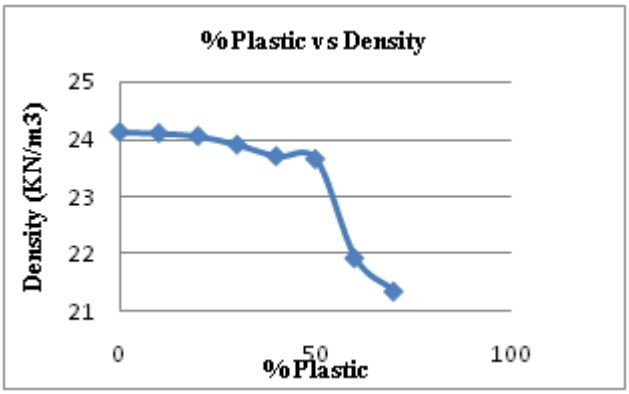


From the graph it can be maximum strength is obtained forthe replacement of 10-20% of the plastic replacement.

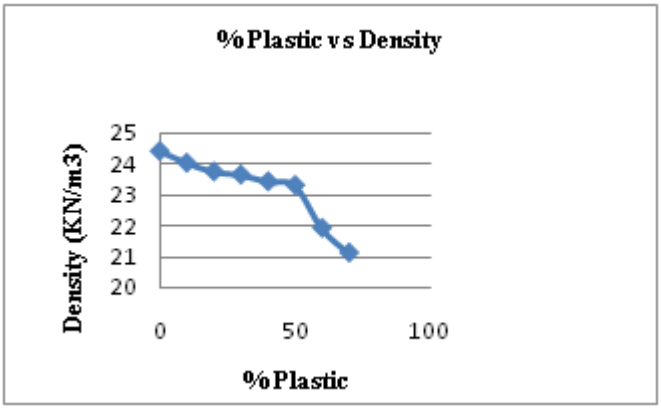
Density

It can be seen that the density keep on reducing as the percentage of the plastic is increasing. So the concrete can be used for the light weight construction.

Percentage Plastic vs Density (Cube)



Percentage Plastic vs Density(Cylinder)



IV.CONCLUSION

This study shows that post-consumer products and industrial waste products or by products can be successfully used in concrete to replace coarse or fine aggregates. The use of plastic waste as a natural aggregate substitute in concrete is a relatively recent concept. One of the first significant reviews on the use of waste plastic in concrete focused on advantages and financial benefits of such use, besides their physical and mechanical properties. And more over use of plastic as aggregate gives a solution to the problems encountered with the overexploitation of natural aggregate. The conclusions from the study are:

- Compressive strength of concrete is affected by addition of plastic pieces and it goes on decreasing as the percentage of plastic increases and it is within the limits.
- Concrete shows better properties for the replacement of the sand by plastic in the range of 10-20%.
- The weight of the concrete was also found to decrease with increase in plastic content as result reducing the dead load on the structure.
- The splitting tensile strength observation shows the improvement of tensile strength of concrete.

Thus it is conclude that the replacement of sand by plastic improve the strength of concrete. And it can be used as an alternative to pollution caused by plastic waste and also the sacristy and over exploitation of natural resources.

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