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Experimental Investigation on Glass Fibre Reinforced Concrete Containing E Plastic Waste

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Abstract : Electronic waste or waste electronic and electrical equipment is an emerging issue posing serious pollution problems to the human and the environment[1,4]. New effective waste management options need to be considered especially on recycling concepts. Glass fibre reinforced concrete (GFRC) is a recent introduction in the field of civil engineering. In the view of global sustainable scenario, it is imperative that fibres like glass, carbon, aramid and poly-propylene provide very wide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. This paper presents the results of an investigation to study the performance of glass fibre reinforced concrete prepared with E plastic waste as part of coarse aggregate. An experimental study is made on the utilization of 0.1% glass fibre (by the weight of concrete) and E waste particles as coarse aggregates in concrete with a percentage replacement ranging from 0 % to 30% on the strength criteria of M30 Concrete. The results indicated that the E-plastic aggregate up to 20% weight of the coarse aggregate and 0.1% glass fibre (by the weight of concrete) can be used effectively in fibre reinforced concrete and thus results in waste reduction and resources conservation.
Keywords : Glass Fiber, E-Plastic waste, Compressive strength, Split tensile strength

1.0 Introduction

Concrete is a widely used construction material in growing construction industry. Utilization of waste materials and by products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects[4,6]. Electronic waste, abbreviated as e-waste, consists of discarded old computers, TVs, refrigerators, radios basically any electrical or electronic appliance that has reached its end of life. Efforts have been made in the concrete industry to use non biodegradable components of E waste as a partial replacement of the coarse aggregates.

Plain concrete possess very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle failure of the concrete.

The most widely accepted remedy to the flexural weakness of concrete is the conventional reinforcement with high strengths steel[2,8] .Although these methods provide tensile strength of concrete itself.

Also the reinforcement placing and efficient compaction of RCC is very difficult if the concrete is of low workable especially in case of heavy concrete (M35 etc....). In plain concrete and similar brittle materials, structural cracks (micro – cracks) develop even before loading, particularly due to drying shrinkage or other causes of volume change.

When loaded, the micro cracks propagate and open up and owing to the effects of stress concentration, additional cracks form in places of minor defects. The structural stress concentration, additional cracks form in places of minor defects[5-7]. The structural cracks proceed slowly because they are retarded by various obstacles. The main cause of inelastic deformation in concrete is the development of such micro cracks. It has been recognized that the additional of small, closely spaced and uniformly dispersed fibres to concrete would act as crack arresters and would substantially improve its static and dynamic properties. This type of concrete is known as fibre reinforced concrete. Glass fibres do the same effect and perform better than any other fibres.

2.0 Design Mix Materials

2.1 Cement

The cement used is OPC 43 grade cement. The ordinary Portland cement of 43 grades conforming to IS: 8112-1989 is to be used. Tests were conducted on the cement like specific gravity test, consistency test, setting tests.

Table 1 Properties of Cement

S.NO	Properties	Values
1.	Specific gravity	3.15
2.	Standard consistency	29%
3.	Initial setting time	30 mins
4.	Final setting time	600mins

2.2 E-Plastic Waste

Table 2 Properties of E-Plastic Waste

S.No	Description	Value
1.	Specific gravity	1.01
2.	Absorption (%)	0.2%
3.	Colour	Dark
4.	Shape	Angular
5.	Crushing Value	2%
6.	Impact value	1.8%

2.3 Fine aggregate

The sand used for experimental program was locally procured and conforming to zone II. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm. The fine aggregate were tested as per Indian standard specification IS: 383-1970.

Table 3 Properties of fine aggregate

S.No	Characteristics	Value
1.	Type	River
2.	Specific gravity	2.62
3.	Fineness modulus	2.84
4.	Grading zone	II

2.4 Coarse aggregate

Locally available coarse aggregates were used in this work. Aggregates passing through 20mm sieve and retained on 16mm sieve were sieved and tested as per Indian Standard Specifications IS: 383-1970.

Table 4 Properties of coarse aggregate

S.No	Characteristics	Value
1.	Type	Crushed
2.	Maximum size	20mm
3.	Minimum size	16mm
4.	Specific gravity	2.74
5.	Impact value	16.26%

2.5 Glass fibre

The glass fibre used for experimental program was brought from M.J.Supplier, Madurai.

Table 5 Properties of glass fibre

S.No	Description	Value
1.	Length	6 mm
2.	Diameter	0.0135 µm
3.	Aspect ratio	962
4.	Density	2380 kg/m3
5.	Tensile strength	3.5 Gpa
6.	Elongation rate	4.8 %

3.0 Design Mix Methodology

3.1 Mix design

A cement concrete mix 1:1.87:3.28 was designed as per IS: 10262:2009 methods and the same were used to prepare the test samples.

Table 6 M30 Mix proportions in kg/m^3

Mix	Water	Cement	FA	CA
M30	160	380	712	1250

4.0 Experimental Investigation

4.1 Compressive strength test

The specimens of standard cube of size 150 x 150 x 150 mm were used to determine the compressive strength of concrete. Three specimens were tested for 28 days with varying proportions of E plastic waste as 0%, 10%, 20% and 30% while keeping the proportion of glass fibre as constant as 0.1% of the weight of concrete. These were compared with the conventional concrete mix. The constituent were weighed and the materials were mixed by hand mixing. The mixes were vibrated using table vibrator. The weight of super plasticizer was 0.5% by the weight of binder. After 24 hours, the specimens were removed from the mould and subjected to water curing for 28 days. After curing, the specimens were tested for compressive strength using a compression testing machine. The tests were carried out on 15 specimens and average compressive strength values were obtained.

Table 7 Compressive strength test results in N/mm^2

S.NO	M30	0%	10%	20%	30%
1.	34.95	37.95	35.64	35.74	32.11
2.	32.13	37.02	33.68	36.17	33.42
3.	32.96	36.03	34.32	38.12	31.82

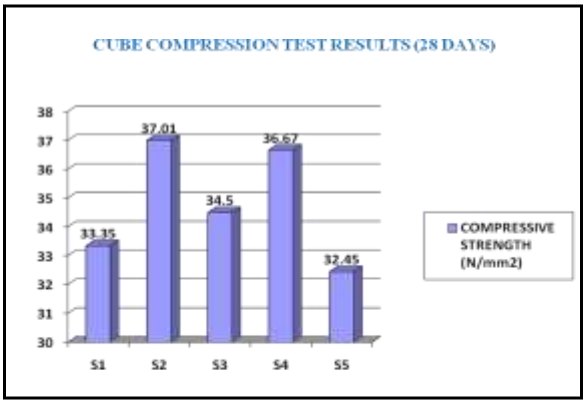

Fig 1 Compressive Strength

4.2 Split tensile strength test

Cylinder specimens were tested for split tensile strength. Standard cylinder moulds (150mm x 300mm) were cast for split tensile strength. In this test compressive line loads were applied along a vertical symmetrical plane, which causes splitting of specimen. The tests were carried out on 15 specimens and average split tensile strength values were obtained.

Table 8 Split tensile strength test results in N/mm2

S.NO	M30	0%	10%	20%	30%
1.	2.95	3.21	3.01	3.25	2.68
2.	2.98	3.49	2.87	3.32	2.88
3.	3.20	3.40	3.07	3.10	2.72

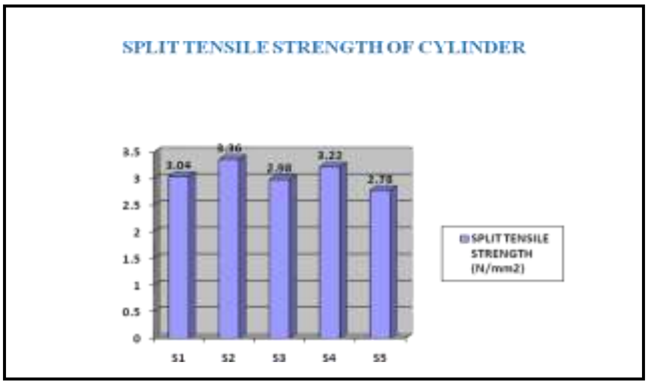

Fig 2 Split tensile strength

4.3 Flexural strength test

The specimens were tested under two point loading.100mm x 100mm x 500mm were used to determine the flexural strength of beams. The tests were performed on universal testing machine (UTM) having capacity of 40T. The beams were cast with glass fibre and various proportions of E plastic waste.

5.0 Conclusion

This study intended to find the effective ways to reutilize the hard plastic waste particles as concrete aggregate. Analysis of the strength characteristics of concrete containing recycled waste plastic and glass fibre gave the following results.

- It is identified that E waste can be disposed by using them as construction materials.
- Environmental effects from the wastes and disposal problems of waste can be reduced through this research.
- Has been concluded 20% of E waste aggregate can be incorporated as coarse aggregate replacement in fibre reinforced concrete without any long term detrimental effects and with acceptable strength development properties.

6.0 Reference

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