International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

Studies on the Effect of Fiber Size on Strength of Fibrous Concrete Mixture Made From Recycled Electronic Waste Fibers

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Abstract - *Electronic waste (e-waste) consists of waste electrical and electronic equipments that have reached its life. With the advancement of technology a huge quantity of e-waste is generated day by day. Several tons of e-waste needs to be disposed per year. Thus e-waste in concrete is a concept of sustainable concrete because it reduces the environmental pollution and solid waste problem. In this work the fibers obtained from recycled wires of internet and telecommunication cables were used as fiber reinforcement in concrete. Addition of fibers to concrete acts as a crack arrester and would substantially improve concrete properties. These fibers were added to the concrete at 0.6%, 0.8%, and 1% with respect to the weight of cement. Also the sizes of fibers were varied for each percentage of fiber as 2cm, 3cm, and 4cm. The compressive strength of fiber-reinforced concrete with varying size for each percentage of fiber was determined and compared with normal concrete at the respective age of curing. The experimental results reveal that the optimum percentage of e-waste fibers to be added in concrete was found to be 0.8% of weight of cement. Also maximum compressive strength was obtained for concrete reinforced with 3cm fibers than 2cm and 4cm length fibers. Thus, fiber reinforced concrete using e-waste fibers is an alternative to normal concrete because it gives increased trend in properties and also reduces the amount of dumping e-waste into nature.*

Key Words: **Fiber reinforcement, fibers, Electronic waste, Compressive strength, Optimum percentage.**

1.INTRODUCTION

Rapid technology change, low initial costs have resulted in a fast growing surplus of electronic waste around the globe. In India there are a huge number of e-waste recycling units that are working but most of them are in the informal sector; they should be formal to meet the environmental problems. In India most of the cities like Mumbai, Bangalore and Chennai face e-waste management problems that are not solved to that extent. Electronic waste is considered more toxic than municipal waste because it contains more toxic materials and is threat to developing countries. This type of waste consists of more than 1000 different components that are toxic and nontoxic materials. Traditional landfill is not an environmental friendly solution and the disposal process is also very difficult.

E-waste powders were added to the cement mortar and also to the asphalt binders for modifying the conventional type of construction materials, to introduce green concrete methodology. The results reveals that the addition of e-waste powders in asphalt increase the binding capacity and stiffness, and addition to the cement mortar will result in a slight increase in the compressive and flexural behaviour but reduces the tensile bond capacity (Wang et al., Palos et al, 2012). E-waste concrete can be used as sustainable concrete with the usage of e-waste plastics and other kinds of e-wastes like printed circuit boards, recycled acrylo nitrile butadiene styrene (ABS), high impact polystyrene (HIPS) wastes(Colbert and You, Palos et al, Wang et al., Senthil Kumar and Baskar, and Gull and Balasubramanian). Electronic waste (e-waste) from PVC cable outer casing was used as fiber in concrete(Arjun Ramakrishna Kurup and K. Senthil Kumar, 2016). E-waste concrete using e-waste fibers will create a trend in the evolution of special concrete and will increase the strength values of its properties. E-waste plastic type fibers of different length and mix were added to the concrete, and studies show that a small size of e-plastic waste will show good results in properties of concrete as compared with the larger size (Gull and Balasubramanian, 2014). Thus, the use of e-waste fiber in concrete will be one of the optimal solutions for the e-waste management problem and thereby reduce environmental pollution.

In this work, fibers obtained from electronic waste are used as fiber reinforcement. Small diameter wires found inside the cables used for internet or telecommunication are made into fibers to be added into concrete. These fibers consist of copper wire insulated with plastic coating.

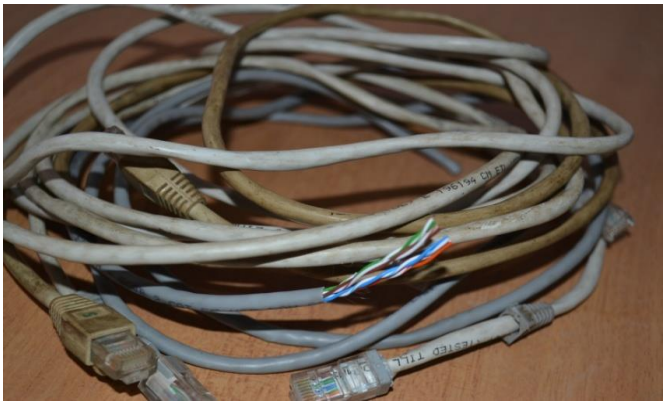

Fig -1: Cables from which fibers are obtained

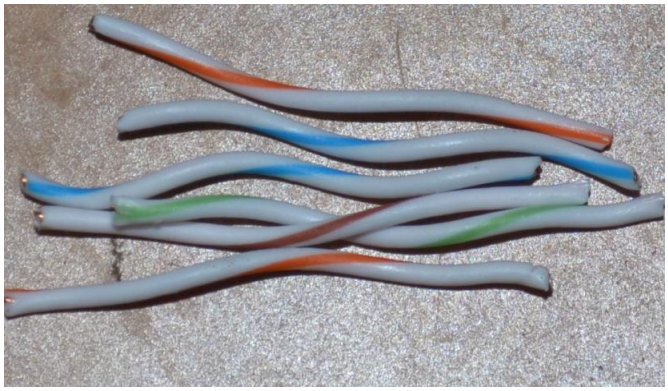

Fig -2: E waste made into fibers

2. EXPERIMENTAL PROGRAM

2.1 Materials Used

Portland slag cement was used throughout, M sand and crushed stone aggregate are used as fine and coarse aggregate respectively. The specific gravity of both coarse and fine aggregate was 3.03 and 2.89 respectively. E-waste fibers obtained from wires found inside the internet and telecommunication cables are used. There wires are cut to obtain fibers of different lengths say 2cm, 3cm and 4cm. The diameter of fiber is 1mm, consisting of copper wire with plastic coating. Superplasticizer was used as the water reducing agent

Fig -3: Fibers made to different lengths

2.2 Test Programme

To evaluate the compressive strength a total of 10 mixes were tried with different percentages of e-waste fibers (0%, 0.6%, 0.8% and 1% of cement) and different lengths of fiber (2cm, 3cm and 4cm). In all mixes the same type of aggregate i.e. crushed granite aggregate; M sand and the same proportion of fine aggregate to total aggregate are used. The relative proportions of cement, coarse aggregate, sand and water are obtained by IS - Code method. M30 is considered as the reference mix. Table 1 shows M30 mix proportion that was used to cast the e-waste fiber reinforced concrete.

Table -1: Concrete Mix Proportion

Material	Quantity(kg/m^3)	Mix proportion
Cement	469	1
Fine aggregate	640.239	1.35
Coarse aggregate	1267.392	2.7
Water	197	0.42

Fig -4: Test setup for cube compressive strength

3. RESULTS AND DISCUSSION

Compressive strength test was conducted at 7 days and 28 days. The results obtained from the experimental procedures were tabulated and presented below

Table -2: Compressive strength data at the age of 7 days in N/mm^2

Length of fiber(cm)	0.6% E-waste fiber	0.8% E-waste fiber	1% E-waste fiber
2	20.44	25.77	24.24
3	26.66	31.11	26.22
4	21.7	29.33	24.8

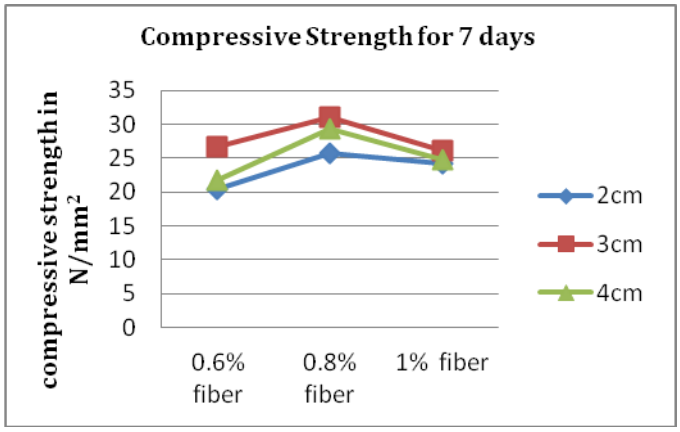

Chart -1: Compressive strength for 7 days

The 7 day compressive strength for normal concrete is obtained as 27.11N/mm^2. From the above graph it is understood that for all percentages of e-waste fibres, at 3cm length of fiber there is an increase in compressive strength for 7 days. At 0.8% replacement of e-waste fibres there is optimum increase in compressive strength at 7 days. The compressive strength obtained for 0.8% e-waste fibres and 3cm length fiber for 7 days is 31.11N/mm^2.

Table -3: Compressive strength data at the age of 28 days in N/mm^2

Length of fiber(cm)	0.6% E-waste fiber	0.8% E-waste fiber	1% E-waste fiber
2	30.66	36.44	36
3	35.11	42.66	39.55
4	31.55	38.22	37.77

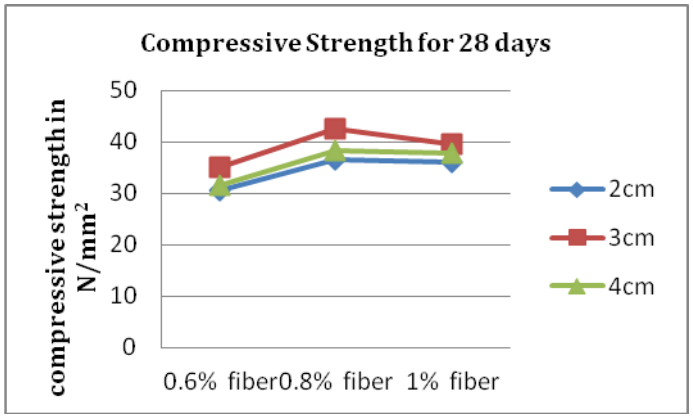

Chart -1: Compressive strength for 28 days

The 28 day compressive strength for normal concrete is obtained as 36.88N/mm^2. From the above graph it is understood that for all percentages of e-waste fibres, at 3cm length of fiber there is an increase in compressive strength for 28 days. At 0.8% replacement of e-waste fibres there is optimum increase in compressive strength at 28 days. The compressive strength obtained for 0.8% e-waste fibres and 3cm length fiber for 28 days is 42.66N/mm^2.

4. CONCLUSIONS

This study represents the effect of waste fibers obtained from electronic waste used in concrete on compressive strength. From the results obtained during investigation following conclusions can be drawn:

- 7 day compressive strength for normal mix was 27.11N/mm^2. The maximum value of 7 day compressive strength is obtained as 31.11N/mm^2 that is for 0.8% fiber and 3 cm length fiber.
- 28 day compressive strength for normal mix was 36.88N/mm^{2}The maximum value of 28 day compressive strength is obtained as 42.66 N/mm^2 that is for 0.8% fiber and 3 cm length fiber.
- The compressive strength shows an increasing trend from 0.6% to 0.8% and further shows a decreasing strength. So the optimum percentage of fiber is obtained as 0.8% fiber.
- The maximum value for compressive strength is obtained for 3 cm length and so 3 cm can be considered as the optimum length of fiber to be used as reinforcement in concrete.
- Addition of waste fibers in concrete is an effective method to reduce the environmental problems as well as to increase the strength of concrete.

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