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RESEARCH ARTICLE

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AN EXPERIMENTAL INVESTIGATION ON USE OF POST CONSUMED E- PLASTIC WASTE IN CONCRETE

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ABSTRACT

Electronic waste or **w**aste electronic and electrical equipment is an emerging issue posing serious pollution problems to the human and the environment. New effective waste management options need to be considered especially on recycling concepts.This research paper seeks to optimize the benefits of using E Plastic Waste in the fiber form in concrete. The E Plastic waste (insulation wires) is shredded into fibers of specific size and shape. Several design concrete mixes with different percentages of waste plastic fibers for three aspect ratios, are casted into desire shape and size as per requirement of the tests. Each specimen was cured for 7, 14 and 28 days. The workability, compression, and split tension were carried out. The test results showed that a significant improvement in compressive and tensile .Strength was achieved in the E-plastic concrete compared to conventional concrete.

Keywords: Solid Waste, E Plastic waste Fibers, Fiber Reinforced Concrete, Strengths

INTRODUCTION

Global environmental activities are developed with expansion of living and nonliving resources and related social activities. The relationship of environmental issues with the electronic and electrical industries begins with the generation of E-waste and the contamination possibilities. Waste Electronic and Electrical Equipment (WEEE) is diverse and complex in terms of materials and components as well as the manufacturing process. The characterization of this waste stream is of paramount importance for developing a cost effective and environmental friendly recycling system.

E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Rapid technology change, low initial cost has resulted in a fast growing surplus of electronic waste around the globe .Several tones of E waste need to be disposed per year. Traditional landfill or stockpile method is not an environmental friendly solution and the disposal process is also very difficult to meet EPA regulations. How to reuse the non disposable E waste becomes an important topic to be discussed.

The generation of E-waste is the fastest growing area and the disposal poses a major problem in the related neighbourhood. The use of recycled plastic in the manufacturing of new plastic consumes considerable energy, raw material use and wear and tear on machinery. The use of recycled materials in construction applications is among the most attractive option because of the larger quality demand, low quality requirements and widespread extent of construction. The use of E-waste plastic cement concrete aggregate has been focused on this investigation as a viable solution to the problem of recycling costs and high disposal costs.

2. Plastics with Concrete

The plastic is one of the recent engineering materials which have appeared in the market all over the world. Plastics were used in bath and sink units, corrugated and plain sheets, floor tiles, joint less flooring, paints and varnishes and wall tiles. Other than these, domestically plastics were used in various forms as carry bags, bottles, cans and also in various medical utilities. 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. It is estimated that on an average 25% of the total plastic production in the world is used by the building industry. The per capita consumption of plastics in the developed countries ranges from 500 to 1000 N while in India, it is only about 2 N. There is however now increase in awareness regarding the utilization of plastic as a useful building material in India.

Plastics are normally stable and not biodegradable. So, their disposal poses problems. Research works are going on in making use of plastics wastes effectively as additives in bitumen mixes for the road pavements. Reengineered plastics are used for solving the solid waste management problems to a great extent. 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.

3. Plastic Waste- Copper Wire Insulation

Polyvinyl Chloride (PVC) wire insulations as seen in fig 1 are used as an admixture in the concrete. The insulations are acquired from various scrap vendors. PVC is a major plastic material which finds widespread use in building, transport, packaging, electrical/electronic and healthcare applications. PVC is a very durable and long lasting construction material which can be used in a variety of applications, rigid or flexible, white or black and a wide range of colours in between.

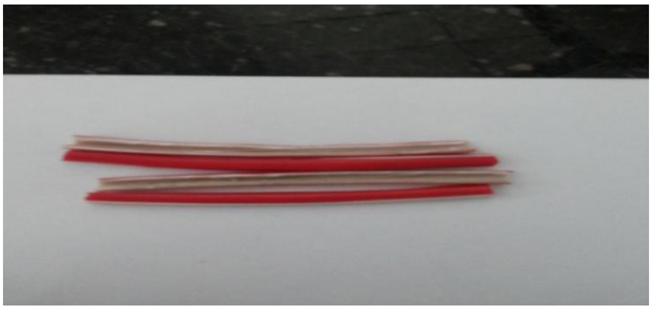

Fig 1: Pvc Copper Wire Insulation with 4mm Diameter

4. Properties of E Plastic Waste

Properties of E Plastic waste is tabulated in table 1

Table 1: Properties of Material used

Physical Properties	
Diameter of wire	4mm
Thickness of insulation	0.8 mm
Tensile Strength	2.60 N/mm²
Notched Impact Strength	2.0 - 45 kj/m²

Max Cont Use Temp	60^{o} C
Density	1.38 g/cm^3

5. Objective of the Study

- To present a comparative study on the Mechanical and Physical properties of E-Plastic waste incorporated concrete.
- To reuse & improve the efficiency of utilizing the E-Plastic waste particles as a concrete constituent, thereby objective lies in E-Plastic waste Management.

6. Methodology

Preliminary tests are carried as per IS standard on the material used for concrete like specific gravity, fineness, consistency, and initial setting time for cement. For fine and coarse aggregates tests such as sieve analysis, specific gravity, impact value, crushing value are conducted as per standard and results are tabulated.

Based on the results of the materials the mix design is prepared and the casting is done for conventional concrete and the tests are to be done on hardened concrete. Based on the same mix design, concrete with E-Plastic waste incorporated in it is casted and the test results are to be found from the hardened concrete.

The addition of plastics will be based on the results of the trial mixes that will ensure the confirmation of the perfect aspect ratio and the volume to be used. After the confirmation of aspect ratio, the casting of the specimen will be done accordingly followed by the strength tests. The design mixes will be prepared and different specimens will be casted and later on tested after that the results will be drawn and concluded.

Table 2: Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate
188.79	377.58	495	1171
0.5	1	1.31	3.10

From above table the mix ratio is 1:1.31:3.10

7. Experimental Investigations

The main aim of this paper is to study the mechanical related properties of concrete with different proportions of materials and to compare them.

8. Materials used in the Present Work

The materials used in the present investigation are;

- Cement – OPC 53 grade conforming to IS 12269 – 1987
- Fine aggregate – natural sand – IS383 – 1970
- Coarse aggregate – crushed 20mm maximum size – IS383 – 1970
- E Plastic waste material (wire insulations)
- Portable water

9. Tests on Materials

The various types of tests were conducted on the cement, fine aggregate and coarse aggregate and the results are tabulated in table 3, table 4 and table 5 respectively.

The table 3 below shows the different types of tests carried out on cement.

Table 3: Test on Cement

Test	Results
Specific Gravity	2.54
Fineness	97.33%
Consistency	31%
Initial Setting Time	34 min

The table 4 below shows the different types of tests carried out on fine aggregate.

Table 4: Test on Fine aggregates

Test	Results
Specific Gravity	2.73
Free Surface Moisture	2%
Gradation	Zone II

The table 5 below shows the different types of tests carried out on coarse aggregate.

Table 5: Test on Coarse Aggregates

Test	Results
Specific Gravity	2.78
Aggregate Impact Value	32.73%
Aggregate Crushing Values	18.90%

A total of 13 mixes of concrete with different proportion of E Plastic waste (0%, 0.4%, 0.6%, 0.8 % and 1%) were prepared as shown in table 6 on which the experimental investigation was carried out.

Table 6: Mix Proportions

Mix	Proportion
Mix 1	OPC + FA + CA
Mix 2	OPC + FA + CA + 0.4% plastic material (size 5cm)
Mix 3	OPC + FA + CA + 0.6% Plastic Material (size 5cm)
Mix 4	OPC + FA + CA + 0.8% Plastic Material (size 5cm)
Mix 5	OPC + FA + CA + 1% Plastic Material (size 5cm)
Mix 6	OPC + FA + CA + 0.4% Plastic Material (size 4cm)
Mix 7	OPC + FA + CA + 0.6% Plastic Material (size 4cm)
Mix 8	OPC + FA + CA + 0.8% Plastic Material (size 4cm)
Mix 9	OPC + FA + CA + 1% Plastic Material (size 4cm)
Mix 10	OPC + FA + CA + 0.4% Plastic Material (size 3cm)
Mix 11	OPC + FA + CA + 0.6% Plastic Material (size 3cm)
Mix 12	OPC + FA + CA + 0.8% Plastic Material (size 3cm)
Mix 13	OPC + FA + CA + 1% Plastic Material (size 3cm)

Where

OPC: Ordinary Portland cement

FA: Fine aggregate

CA: Coarse aggregate

The plastic material is shredded into small pieces of 5cm, 4cm, and 3cm and is used accordingly.

10. Tests on Fresh Concrete

- The tests conducted on fresh concrete are shown below in table 7

Table 7: Test on fresh concrete

Test	Results
Slump	17 mm
Compacting Factor	0.9

11. Tests on Hardened Concrete

- Compressive Strength Test

The compression test on hardened concrete was conducted as shown in fig. 2 and the results are tabulated in table 8

Fig 2: Compression test on Concrete cube

The table 8 below gives the compressive strength of cubes for 7 days, 14 days and 28 days for all mixes.

Table 8: Compression test on Concrete cubes

mix	Compressive Strength, N/mm^2 (7 days)	Compressive Strength, N/mm^2 (14 days)	Compressive Strength, N/mm^2 (28 days)
1	21.3	27.3	30.1
2	22.5	28.2	31.2
3	20.7	27.2	30.3
mix	**Compressive Strength, N/mm^2 (7 days)**	**Compressive Strength, N/mm^2 (14 days)**	**Compressive Strength, N/mm^2 (28 days)**
4	20.5	26.5	30.01
5	19.3	25.9	29.3
6	22.9	27.8	31.2
7	23.6	28.3	31.8

8	23.3	28.9	31.9
9	20.8	26.9	30.8
10	27.7	27.7	30.5
11	22.5	27.9	31.9
12	21.5	28.7	32.2
13	20.9	28.9	33.3

The fig.3 below shows the compressive strength of concrete cubes with 5cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing. It clearly indicates that with increase of the material there is a gradual decrease in the compressive strength.

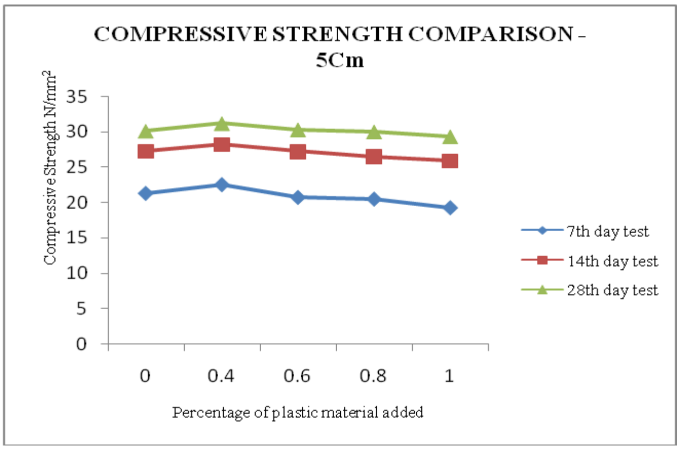

Fig.3: shows the compressive strength of concrete cubes with 5cm plastic size

The fig.4 below shows the compressive strength of concrete cubes with 4cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing.

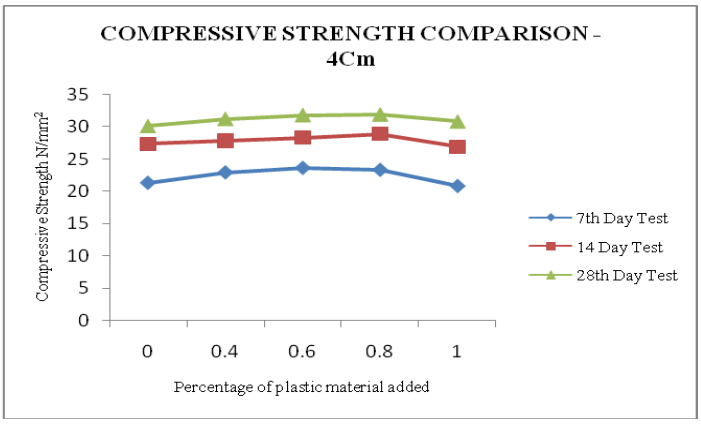

Fig.4: shows the compressive strength of concrete cubes with 4cm plastic size

The fig.5 below shows the compressive strength of concrete cubes with 3cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing. Increase in strength is seen at 28 days of curing and its even getting increased after addition of 1% of E plastic wastes.

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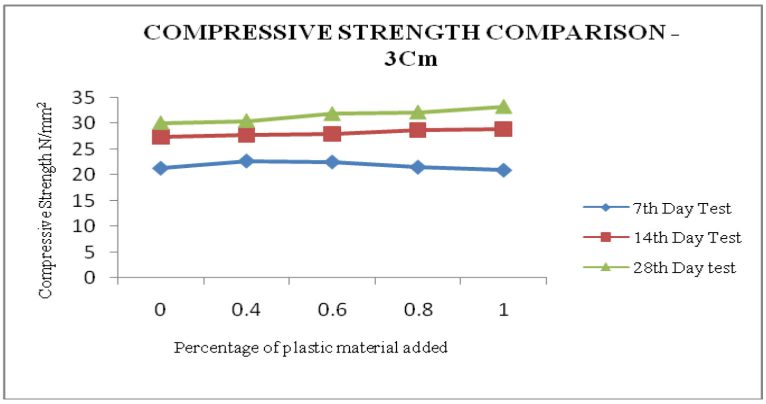

Fig.5: shows the compressive strength of concrete cubes with 3cm plastic size

- Tensile Strength Test

The Tensile test on hardened concrete was conducted as shown in fig. 6 and the results are tabulated in table 9

Fig 6: Tensile strength test on Concrete cylinders

The table 9 below gives the tensile strength of cubes for 7 days, 14 days and 28 days for all mixes.

Table 9: Tensile test on concrete cylinders

Mix	Tensile Strength, N/mm^2 (7 days)	Tensile Strength, N/mm^2 (14 days)	Tensile Strength, N/mm^2 (28 days)
1	2.4	2.88	3.44
2	2.42	2.92	3.46
3	2.46	2.9	3.48
4	2.56	2.98	3.5
5	2.3	2.86	3.52
6	2.5	2.96	3.5
7	2.54	2.98	3.52
8	2.48	3	3.58
9	2.46	3.02	3.6
10	2.58	2.92	3.6
11	2.56	2.94	3.58
12	2.52	2.96	3.48
13	2.36	2.82	3.38

The fig.7 below shows the tensile strength of concrete cylinders with 5cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing. The curve indicates an increase in the tensile strength .

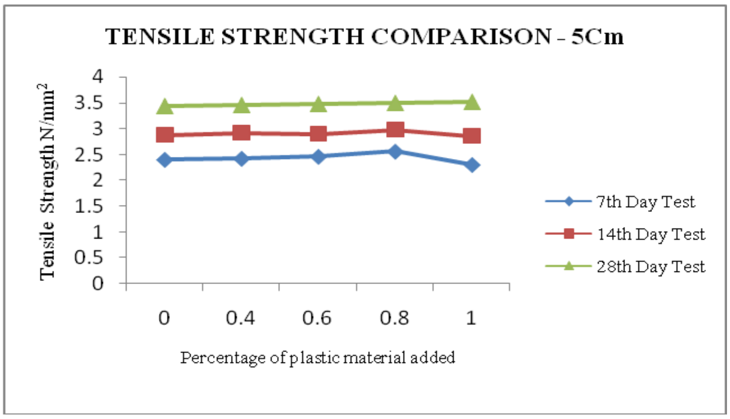

Fig.7: Tensile strength of concrete cylinders with 5cm plastic size

The fig.8 below shows the tensile strength of concrete cylinders with 4cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing.

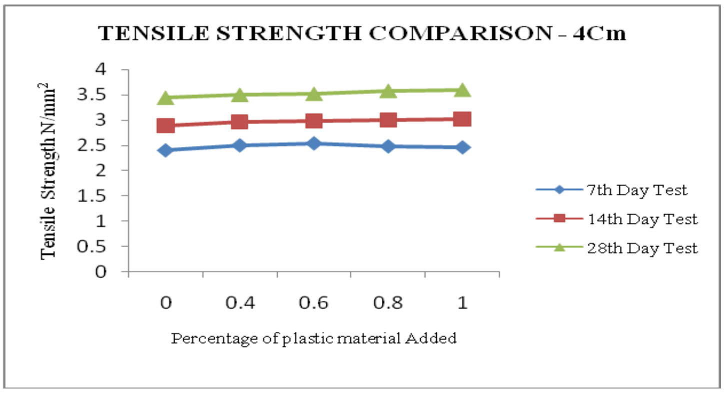

Fig.8: Tensile strength of concrete cylinders with 4cm plastic size

The fig.9 below shows the tensile strength of concrete cylinders with 3cm plastic materials incorporated in it with different proportions for 7 days, 14 days and 28 days of curing.

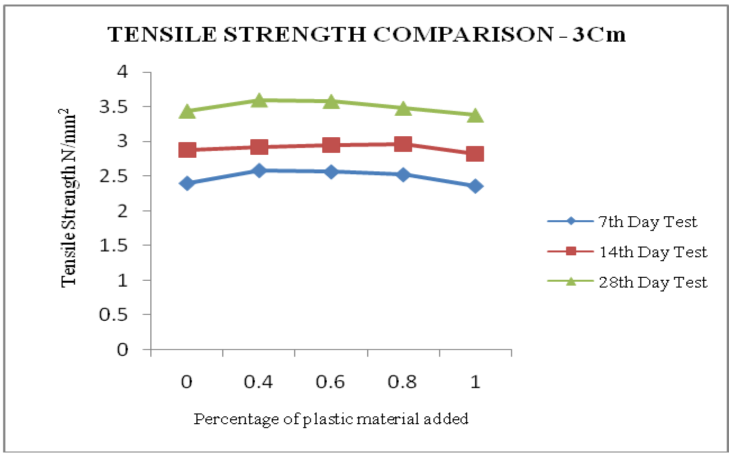

Fig.9: Tensile strength of concrete cylinders with 3cm plastic size

Conclusions

It has been confirmed that no major changes are found in the compressive strength of concrete with the presence of E-plastic. However when 1% of the E-plastic for 5cm is added, the compressive strength gets reduced by 2.59 % when compared to control mix. With addition of the E-plastic - 4cm and E-plastic - 3cm the compressive strength gets increased upto to a maximum of 5.9 % and 10.6% respectively when compared to control mix.

It has been confirmed that increase in strength is found in the tensile strength of concrete with the presence of E-plastic. when 1% of the E-plastic for 5cm is added, the tensile strength gets increased by 2.3% and for 1% of 4cm, the strength increase observed is 4.6% when compared to control mix at 28 days of curing. However when 1% of the E-plastic for 3cm is added, the tensile strength initially gets increased by 4.6% and then gets decreased with increase in percentage.

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