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Study on Flexural Behaviour of Concrete by Partially Replacing Fine Aggregate with E-Plastic Waste

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Abstract - **In this experimental work, the behavior of E-plastic waste (Bakelite) in concrete as partial replacement of fine aggregate was investigated regarding Mechanical and Flexural strength. Totally 6numbers of beam specimens and 54numbers of cube specimens were casted with partial replacement of fine aggregate. The size of plastic used in the concrete mixtures was less than 4.75 mm. The E-plastic waste was used to replace fine aggregate and the percentage of replacement carried out in this work is 2%, 4%, 6%, 8%, 10% by weight of total aggregate. The flexural behavior, deflection characteristics, and crack patterns of reinforced E-plastic waste concrete beams were calculated.**

Keywords-E-Plastic waste, Fine aggregate, Recron fiber.

I.INTRODUCTION

E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Rapid technology change ,low initial cost have 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 research topic. However, technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment).According to the OECD any appliance using an electronic power supply that has reached its End –of life would come under WEEE. E plastic waste is one of the fastest growing waste streams in the world. In developed countries, previously, it was about 1% of total solid waste generation and currently it grows to 2% by 2010. In developing countries, it ranges 0.01% to 1% of the total municipal solid waste generation.

The E waste inventory based on this obsolescence rate and installed base in India for the year 2005 has been estimated to be 146180.00 tones. This is expected to exceed 8, 00,000 tones by 2012. In India, e waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e waste handling infrastructure has developed mainly based on a long tradition of waste recycling. Sixty five cities in India generate more than 60% of the total e waste generated in India. Ten states generate 70% of the total e waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e waste generating states in India. Among top ten cities generating e waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. There are two small WEEE/E waste dismantling facilities are functioning in Chennai and Bangalore. There is no large scale organized e waste recycling facility in India and the entire recycling exists in unorganized sector.

BAKELITE:

Bakelite is an early plastic. It is a thermosetting phenol formaldehyde resin, formed from an elimination reaction of phenol with formaldehyde, usually with wood flour filler. It was developed in 1907 by Belgian chemist Leo Baekeland.

Bakelite was used for its electrically nonconductive and heat-resistant properties in radio and television casings and electrical insulators, and also in such diverse products as kitchenware, pipe stems, and children's toys. In 1993 Bakelite was designated a National Historic Chemical Landmark by the American Chemical Society in recognition of its significance as the world's first synthetic plastic.

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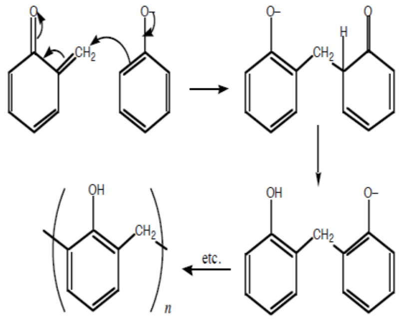

Fig 1: Bakelite

TOXIC EFFECTS OF BAKELITE

Generally toxic effects of Bakelite are due to the presence of phenol and also methyl and ethyl alcohols. The influence of Bakelite on water quality can be seen in an increase in ox disability and in the appearance of phenol in the water. In rabbits that had received water from a container coated with Bakelite, there was some retardation of increase in body weight by the end of a 1-month experiment. Abnormalities were also noted in the condition of mice and rats. On dissection, an increase in the relative mass of the liver was discovered. Hence disposal of Bakelite should be avoided to prevent water pollution.

II.MATERIALS USED

Following are the materials used for the experimental investigation of flexural strength of steel mill concrete with silica fume.

Cement

The cement used for this study is ordinary Portland cement (OPC) of 53-grade.

Fine Aggregate

The sand is of river sand screened and washed to remove all te organic and inorganic compounds that are likely to present in it. Sand has been sieved2.37mm (passed) and retained

Coarse Aggregate

The material which is retained on BIS test sieve 4.75mm is termed as a coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 20mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per Indian Standard Specifications IS: 2386-1963.

E plastic waste

Bakelite is an early plastic. It is a thermosetting phenol formaldehyde resin, formed from an elimination reaction of phenol with formaldehyde, usually with wood flour filler. It was developed in 1907 by Belgian chemist Leo Baekeland.

Fig 2: E plastic waste

Recron Fibre

Shape - Triangular

provide higher surface bonding and results in three dimensional crack controls.

It improves bonding by 40% over circular fiber.

Circular fiber tends to slip out from cement matrix when load is applied.

Aspect ratio - 175

Ratio of length to diameter.

TABLE1: Properties of Recron fiber

Diameter	35 µm
Specific Gravity	1.36
Tensile Strength	1000 MPa
Modulus of Elasticity	17250 (N/mm2)
Dispersion	Excellent
Acid resistance	Good
Thermal conductivity	Low
Length	6 mm

III.MIX RATIO

TABLE 2: Mix Ratio

Water	Cement	Fine Aggregate	Coarse Aggregate
188.79 Kg/m^3.	496.82 Kg/m^3.	511.71 Kg/m^3.	1186.37 Kg/m^3.
0.38	1	1.03	2.49

IV. EXPERIMENTAL PROGRAM

TABLE 3: Experimental program

Sl No.	Identification of beam specimen	% of waste plastic replaced	No of cubes	
			7 day	28 day
1	control	0	3	3
2	Sp1	2	3	3
3	Sp2	4	3	3
4	Sp3	6	3	3
5	Sp4	8	3	3
6	Sp5	10	3	3

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Casting of specimens

Cube:

150*150*150mm

Beam:

1200*150*100mm

Casting of specimen:

The specimens were casted in the laboratory. Steel moulds were used for casting. Reinforcement cage was made and placed inside the moulds during casting. Required quantities of cement, fine aggregate, coarse aggregate, bakelite is weighed and mix is prepared according to the mix proportions. The mix is poured into the mould and compacted by using vibrator. The specimen is kept for 24 hours and curing is done for 28 days.

Reinforcement details:

At bottom 3 nos of 10 mm diameter bars are used . At top 2 nos of 10mm dia bars are used. To arrest shear shear reinforcement are provided. 8 mm stirrups are used at 100mm spacing.

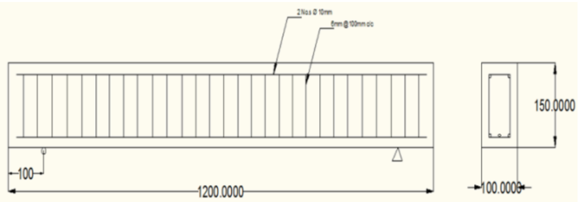

Fig 3: Reinforcement details

V. TESTING OF SPECIMENS

- Compression Strength Test
- Flexural Strength Test

Compression Strength Test:

The compression test is used to determine the hardness of cubical and cylindrical specimens of concrete. The strength of a concrete specimen depends upon cement, aggregate, bond, w/c ratio, curing temperature, and age and size of specimen. Mix design is the major factor controlling the strength of concrete

Fig 4: Compression testing of cube

Flexural Strength Test:

It is the resistance of concrete to tension under flexural loading. The tensile strength of concrete is primarily made to estimate the load under which cracking develops.

Fig 5: Testing of Beam Specimen

VI. RESULTS

Compressive Strength

TABLE 4: Compressive Strength of Concrete cube

S. No.	Description of specimen	% of plastic waste replaced	7th day Compressive Strength (N/mm^2)	28th day Compressive Strength (N/mm^2)
1.	Control	0	28.33	38.62
2.	Sp1	2	35.59	41.23
3.	Sp2	4	24.66	33.90
4.	Sp3	6	29.97	38.23
5.	Sp4	8	35.11	45.43
6.	Sp5	10	16.07	25.63

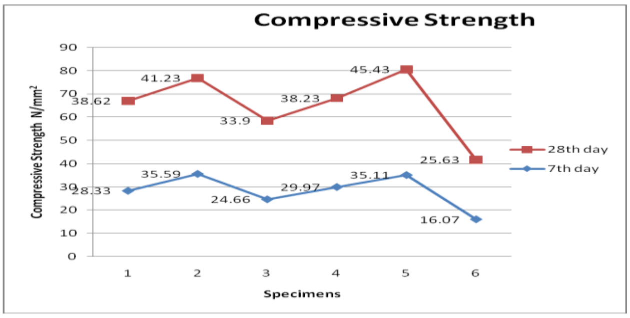

Fig 6: Compression Strength results

Flexural strength

TABLE 5: Flexural strength of Beams

S. No.	Identification of beam specimen	% of plastic waste replaced	Ultimate Load (kN)	Flexural Strength N/mm^2
1.	Control	0	87	45.653
2.	Sp1	2	63	32.106
3.	Sp2	4	72	38.270
4.	Sp3	6	77	40.160
5.	Sp4	8	86	45.333
6.	Sp5	10	58	29.44

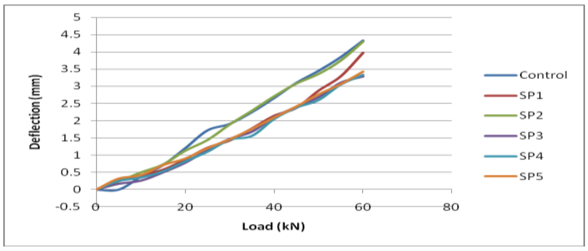

Fig 7: Load vs Deflection for all specimens

VII. CONCLUSION

From the above findings, it is concluded that E-Plastic waste up to 8% may be used for replacement of fine aggregate in concrete without any reduction in compressive strength and flexural strength.

It is also concluded that the use of industrial wastes such as E-Plastic waste in concrete provides some advantages, like reduction in the use of natural resources, disposal of wastes, prevention of environmental pollution and energy saving.

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