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State-of-the-art review on effect of using E- waste for construction

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Abstract: This paper presents a detailed review on the effect of replacement of aggregate with E-waste and test its various physical and chemical properties and compare it with the conventional concrete. The main objective of this paper is to study the literature reviews available on E-waste and suggest the required research work which can be done in this field. The usage of E-waste solves the problem of its disposal. This paper deals with the various tests conducted on concrete containing E- waste. Various properties of concrete were determined. The strength of concrete containing E-waste was found at various days.

Keywords: Coarse aggregate; E-waste; recycle; silica fume; fine aggregate

In today's world with increase in number of population there is an increase in the number of building construction which needs demolition of existing old buildings , huge amount of waste is generated from various sectors i.e construction industry, IT industry etc. Disposal of these wastes is a problem. Some waste is harmful to the environment as well as the people. This paper focuses on the E-waste and its effect of replacement of E-waste in concrete. E-waste is nothing but electronic waste which is produced by discarding the electronic items. The E-waste poses disposal problem. Even when disposed it pollutes the ground water. The reuse of E-waste is not considered economical because of its transportation and production cost.

This paper discusses about the reuse of E-waste in different proportions and perform necessary tests to compare its strength a from conventional concrete.

Experimental Investigations

Balasubramanian, gopalakrishna and saraswathy 1 investigated on partial replacement of coarse aggregate using E-waste in concrete. The main objective of this research work was to get the characteristics of concrete which are replaces by E-waste as a coarse aggregate. Printed Circuit Boards were crushed in various sizes andsieved through 4.75mm, 10mm, and 20mm. It was then replaced with coarse aggregate (by weight) in concrete at various percentages .Concrete Grade of M20 was taken for the investigation. The concrete cubes of size 150x150x150 mm, cylinders of 100x200 mm size and beams of 500x100x100 mm size were casted. The cast specimens were removed after 24 hours and was immersed in a water tank for a curing period of 28 days and then tested for Compression, Split tensile and Flexural strength test. These results were then compared with conventional concrete. Different mix proportions were worked out along with a control mix to examine the properties of E-waste in concrete.

Concrete cube specimens with various mix proportions i.e 5%, 10%,15%,20%, and 25% were casted and tested for compressive strength. It was found that concrete with 15% replacement with E-waste has higher compressive strength than other mixes.

Cylindrical specimens were casted and tested for spilt tensile strength at 28 days. It was observed that OPC with 15% E-waste has higher tensile strength in comparison with the other systems. But beyond 15% if replaced the strengths are considerably reducing.

Therefore from this study it is found that replacement of concrete material with E-waste is possible and it also take scare of the disposal problem of E-waste.

Ashwini Manjunath B T (2016) has investigated the partial replacement if E-plastic waste as coarse aggregate in concrete.in this study, E-waste was utilized as both fine aggregate and coarse aggregate with 0%,

10%, 20% and 30% replacement on M20 concrete. Various strength tests, i.e compressive strength, Tensile strength strength and flexural strength tests were conducted and results were compared with the conventional concrete.

Uncrushed natural fine aggregate and crushed coarse aggregates were used and individual properties were determined as shown below in Table 1 and Table 2 respectively.

TABLE 1. PROPERTIES OF FINE AGGREGATE

Sl no	**Characteristics**	**Value**
1	Type	Uncrushed(natural)
2	Specific gravity	2.68
3	Total Water absorption	1.02%
4	Fineness modulus	2.507
5	Grading zone	III

TABLE 2. PROPERTIES OF COARSE AGGREGATE

Sl no	**Characteristics**	**Value**
1	Type	Crushed
2	Maximum size	20mm
3	Specific gravity	2.825
4	Total Water absorption	3.645%
5	Fineness modulus	7.68

Similarly, the properties of E-waste were also determined as listed in Table 3.

TABLE 3. PROPERTIES OF E WASTE

Sl no	**Characteristics**	**Value**
1	Type	Crushed
2	Maximum size	20mm
3	Specific gravity	1.1
4	Total Water absorption	0%
5	Fineness modulus(abv 20mm)	7.59
6	Fineness modulus(medium size)	8.2
7	Fineness modulus(below 20mm	9.18

Mix design was worked out for M20 Concrete as per IS-10262-1982 and specimens were casted and tested for its strength. Concrete was mixed by both hand mixing and machine mixing with w/c ratio of 0.5. E-plastic waste was added in various percentage and specimens were casted. Workability test was performed for each mix with various percentage replacement i.e 0%, 10%, 20% and 30%.it was found that for 0% and 10% mix, the workability was “high”, whereas for 20% and 30% replacement the workability was “medium”.

The specimens were tested for compressive strength and was found that with 10% replacement the compressive strength was found to be 44.07N/mm2 as compared to conventional mix of 47.18 N/mm2 at 28 days. Beyond 10% replacement the compressive strength of the concrete reduced. Similarly split tensile strength test result showed that with 10% replacement the tensile strength was found to be around 4.8 which is almost similar to the conventional concrete which has tensile strength of 4.9 at 28 days. Similarly flexural strength test result showed that with 10% replacement the tensile strength was found to be around 4.4 which is slightly more than that of conventional concrete which has tensile strength of 4.3 at 28 days.

Therefore , from this investigation it is concluded that with 10% replacement of E-waste the concrete shows almost same strength as compared to the conventional concrete. Use of E-waste as a replacement to fine and coarse aggregate will solve the disposal problem of E-waste to some extent.

S.S.Singh 1 Arun Patel2 (2015) investigated the utilization of E-waste in high strength concerete. In this study the E-waste was collected from local areas and it contained E-waste from Tv, Radio, Cd and plastic chairs. The E-waste was dismantled and sieved from 20mm sieved. Crushed natural stone was used as coarse aggregate and river sand as fine aggregate . Mix design was worked out as per IS 10262:2009. The various tests were performed on aggregate. The crushing value of the natural coarse aggregate was found to be 15.22% and that of E-waste is 3.26%. The impact value of natural coarse aggregate and E-waste was found to be 7.65% and

2.89% respectively. The abrasion value of natural coarse aggregate and E-waste was found to be 11.23% and 4.67%. the other physical properties are shown in table 4.

Table 4. Properties of aggregates

Aggregate	**Specific gravity**
Natural coarse aggregate	Crushed
Natural fine aggregate	20mm
E-waste	2.825
cement	3.645%
Fineness modulus	7.68
Aggregate	**Fineness modulus**
Natural coarse aggregate	2.65
Natural fine aggregate	1.92
E-waste	2.80
cement	4.1
Aggregate	**Water absorption**
Natural coarse aggregate	1.83
Natural fine aggregate	0.21
E-waste	0.05

Slump cone test was performed to check the workability of the E-waste at various percentage and E-waste with 10% flyash. The E-waste was added in proportion 0%, 5%, 10%, 15%, 20% and 25% and its slump value was found t be 26mm, 30mm, 37mm, 46mm, 60mm, 69mm respectively. The slump values of E-waste in different proportion with 10 % flyash was more than that of Slump of E-waste without flyash.

The specimens were casted and tested for compressive strength. The compressive strength was found to be 42.23 N/mm2, 39.89 N/mm2, 38.8 N/mm2, 36.23 N/mm2, 38.25 N/mm2, 36.15 N/mm2 for 0%, 5%, 10%, 15%, 20% and 25% of E-waste without flyash at 28 days. Similarly the compressive strength with 10% of flyash was found to be 49.79 N/mm2, 47.83 N/mm2, 47.27 N/mm2, 46.98 N/mm2, 45.45 N/mm2, 42.42 N/mm2 for 0%, 5%, 10%, 15%, 20% and 25% of E-waste respectively.

From the above results its was found that with increase in the percentage of E-waste the slump value increases. Till 20% replacement the considerable strength is more of less around the compressive strength of conventional concrete at 28 days but beyond 20% the compressive strength reduces.

Prof. Mithun Sawant, Chetan Pawar, Digvijay Shinde, Nikhil Shid, Suresh Vyavhare, Sandeep Naykinde, studied the combined effect of silica fume and E-waste in concrete. In this study various physical properties like specific gravity, fineness modulus, water absorption etc was conducted on fine aggregate , cement and coarse aggregate

The properties of E-waste and silica fume is shown in Table 6 and Table 7

TABLE 6 . PROPERTIES OF E-WASTE

Sl no	**Property**	**E-waste**
1	Specific gravity	1.03
2	Shape	Angular & triangular
3	size	4.75-20mm

TABLE 7. PROPERTIES OF SILICA FUME

Sl no	**Property**	**Silica fume**
1	Size	0.1 miocron
2	Specific Garvity	2.2
3	Surface Area	30000m2/Kg
4	SiO2	>90%

Mix proportion was worked out for various proportions of E-waste i.e 0%, 5% 10% and 15% with constant silica fume content of 10%. Standard cube specimens, 12 in number were casted for each proportion and tested for its compressive strength. It was found that with 5% of the E-waste replacement the compresseive

strength was found to be 23.36 N/mm2 at 28 days which is slightly less than the compressive strength of conventional concrete i.e 26.32 N/mm2. With increase in the percentage of E-waste compressive strength reduces.

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