Experimental Study of Concrete using Combination of E-Waste and Plastic Waste as Coarse Aggregate

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Abstract:
Population growth by leaps and bounds followed by industrialization and a dynamic change in amount of waste generated. These hazardous and other wastes pose a great threat to the human health and environment. The issue of proper management of wastes, therefore, is critical to the protection of livelihood, health and environment. The feasibility studies related to the use of recycled e-waste & plastics as coarse aggregate in concrete are discussed here. Tests were conducted to determine the properties of plastic and e-waste as a coarse aggregate (2.5, 5, 7.5 & 10%) such as density, specific gravity ,water absorption, compressive strength and tensile of the different concretes, were investigated and analyzed in comparison to the control concrete.

Keywords: *E-waste, Plastic Waste, Combination of E+ plastic Waste, Compressive Strength, Replacement of Coarse Aggregate*

I. INTRODUCTION

The rapid growth of technology, up gradation of technical innovations and a high rate of obsolescence in the industrial sector have led to one of the fastest growing waste streams in the world which consist of end of life electrical and electronic equipment products & plastic. Many of the trends in consumption and production processes are unsustainable and pose serious challenge to environment and human health. Optimal and efficient use of natural resources, minimization of waste, development of cleaner products and environmentally sustainable recycling and disposal of waste are some of the issues which need to be addressed by all concerned while ensuring the economic growth and enhancing the quality of life .According to the Comptroller and Auditor-General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tones of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually. Therefore, with increasing consumerism and an anticipated rise in the sales of electronic & plastic products in the countries experiencing rapid economic and industrial growth, the higher percentage of e-waste & plastic waste in municipal solid waste is going to be an issue of serious concern. There is no large scale organized waste recycling facility in India and the entire recycling exists in unorganized sector. The integrated waste management approach is to be considered involving efficient use of plastic& electronic materials, recycling and disposal mechanisms. So best thing to do out of this waste is to utilize it as a replacement for coarse aggregate in concrete mix since the coarse aggregate is also is a resource of economic value that cannot be readily replaced by natural means on a level equal to its consumption, resulting in economical and sustainable concrete.

II. EXPERIMENTAL WORK

A. Overview

For the characterization of the E-Waste and Plastic Waste in concrete mix mechanical & chemical properties of E-Waste and Plastic Waste are determined (like, Density, Specific Gravity, Fineness modulus, Melting point etc...) as representative parameter for the modified concrete. Now by using substitution mixing method in coarse aggregate replacement by weight ratio of 2.5% , 5%, 7.5% & 10% of E-waste + Plastic Waste followed by further tests of strength of mix.

B. Material

The potential applications of industry byproducts in concrete are to be partial replacement of aggregate or partial cementicious materials depending on their chemical composition and grain size. Reuse of E- waste and Plastic Waste as coarse aggregate in concrete has economical and technical advantages for solving the disposal of large amount of e+p - waste. E- Waste and Plastic Waste particles can be used as coarse aggregate , fine aggregate, fine filler in concrete depending on its chemical composition and particle size. E- waste and Plastic Waste available in the form of loosely discarded, surplus, obsolete, Broken, electrical or electronic devices and plastic bottles , cans , from commercial informal recyclers have been collected which were crushed to the particle size. Table I represents physical properties of E- waste and plastic waste particle and coarse aggregate.

Table I - Physical Properties of E- Waste And Plastic Waste Partical And Coarse Aggregate.

Properties	E-waste	Plastic Waste	Coarse Aggregate
Specific Gravity	1.1	0.9	2.8

Absorption	<0.2	<0.1	0.55.
Colour	Green and Brown	White and brown	Dark
Shape	Angular	Angular	Angular
Crushing Value	<2%	2%	21%
Impact Value	<2%	<2%	17%

C. Concrete Mix

The e-waste + plastic waste contents are calculated on weight basis as coarse aggregate in the conventional mix: The fineness modulus of coarse aggregate with various E- waste and Plastic Waste contents is observed as 6.947 .The divided particle size is assumed to be between 10mm and 20mm. Then e-waste + plastic waste particles can be considered as partial coarse aggregates substitute and remaining mix ratio as the same with conventional mix are listed below in Table II. The strength criteria of M25 grade concrete mix were analyzed.

Table II- Mix Specification

Mix Specification	Conventional Mix X	2.5 % E.W.+ P.W.	5 % E.W. + P.W.	7.5 % E. W + P. W	10 % E. W + P. W
Proportion of E-waste	0%	2.5 %	5 %	7.5 %	10 %

Water Absorption Test and Specific Gravity Test were done with the help of wire basket method. Compressive strength test was conducted to evaluate the strength development of concrete containing various E- waste + Plastic Waste contents at the age of 7, 14, 28 days respectively. Cylindrical and Beam specimens were also casted for finding the tensile strength and flexural strength respectively of specimens on 7, 14, 28 days for each mix specification following the standard test procedures.

III. RESULT& DISCUSSION

A. Specific Gravity

Table III
Specific Gravity of Coarse Aggregate and E Waste + Plastic Waste

% Replaced	Specific Gravity
0% E.W.+P.W.	2.65
2.5% E.W. +P.W.	2.64
5% E.W.+ P.W.	2.69
7.5% E.W.+ P.W.	2.53
10% E.W.+ P.W.	2.50

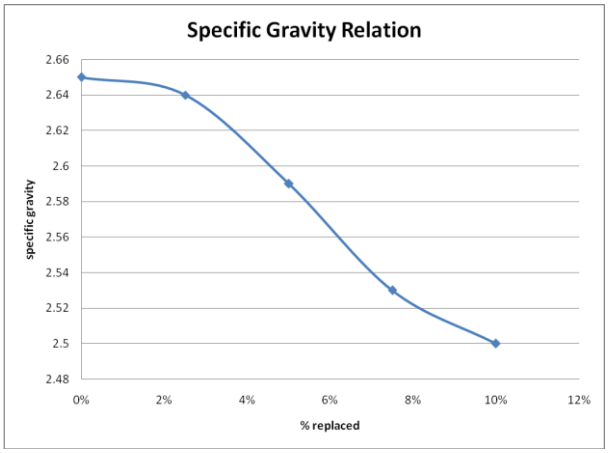

Figure I - Relation Between Specific Gravity and % E-Waste+ Plastic Waste Replaced

B.Water Absorption

Table IV
Water Absorption of Coarse Aggregate and E Waste

% Replaced	Water Absorption
0% E.W.+ P.W.	1.85
2.5% E.W. + P.W.	0.6
5% E.W. + P.W.	0.8
7.5% E.W. + P.W.	1.1
10% E.W. + P.W.	1.4

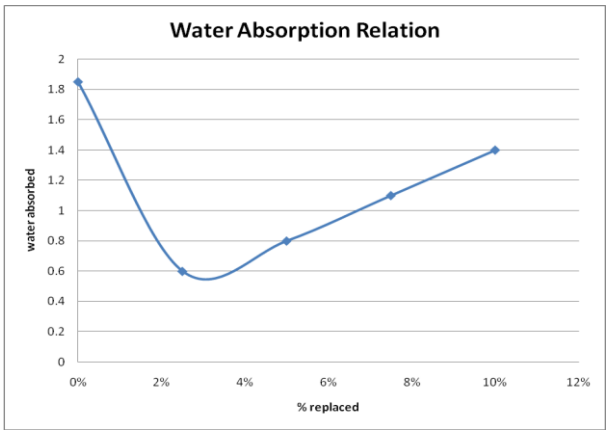

Figure II -Relation Between Water Absorption And % E-Waste+Plastic Waste Replaced

C. Compressive Strength

Table V - Compressive Strengh of Mix

% Replaced	7 days Compressive Strength. (MPA)	28 days Compressive strength. (MPA)
0% E. W.+P.W.	19.03	28.30
2.5% E.W. +P.W.	20.70	29.46
5% E.W+P.W.	21.05	30.08
7.5% E.W+P.W.	18.93	27.05
10% E.W. +P.W.	17.60	25.15

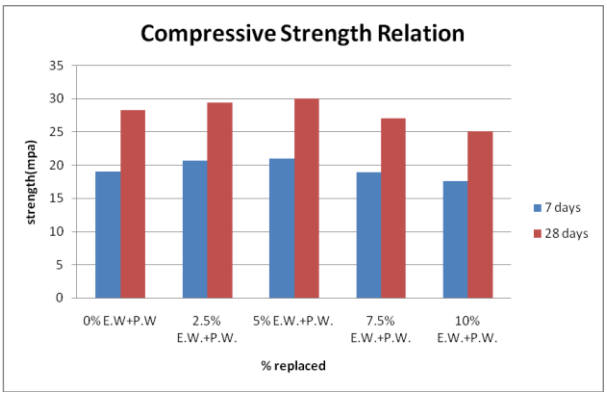

Figure II - Relation Between Compressive Strength and % E-Waste+Plastic Waste Replaced

D. Tensile Strength

Table VI- Tensile Strengh Of Mix

% Replaced	7 days Tensile Strength (MPA)	28 days Tensile Strength (MPA)
0% E. W. +P.W.	1.84	2.73
2.5% E.W.+P.W.	2.03	2.86
5% E.W+P.W.	2.04	2.96
7.5% E.W+P.W.	1.65	2.55
10% E.W.+P.W.	1.44	2.34

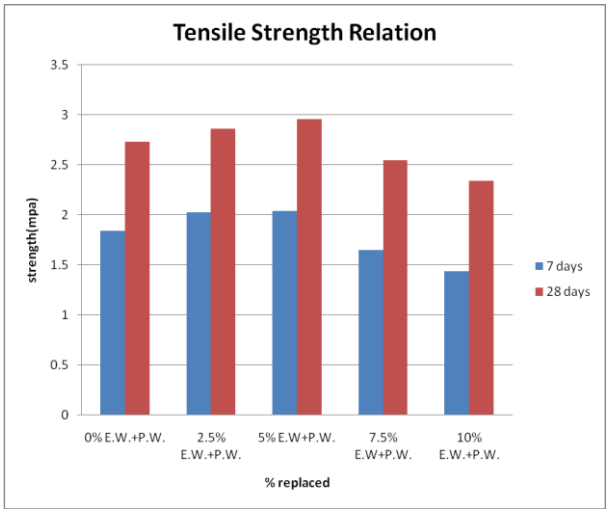

Figure III - Relation Between Tensile Strength and % E-Waste+Plastic Waste Replaced

E. Flexural Strength

Table VII - Flexural Strength Of Mix

% Replaced	7 days Flexural Strength (MPA)	28 days Flexural Strength (MPA)
0% E. W. +P.W.	5.20	7.72
2.5% E.W.+P.W.	5.65	8.07
5% E.W+P.W.	5.80	8.29
7.5% E.W+P.W.	5.13	7.34
10% E.W.+P.W.	4.59	6.56

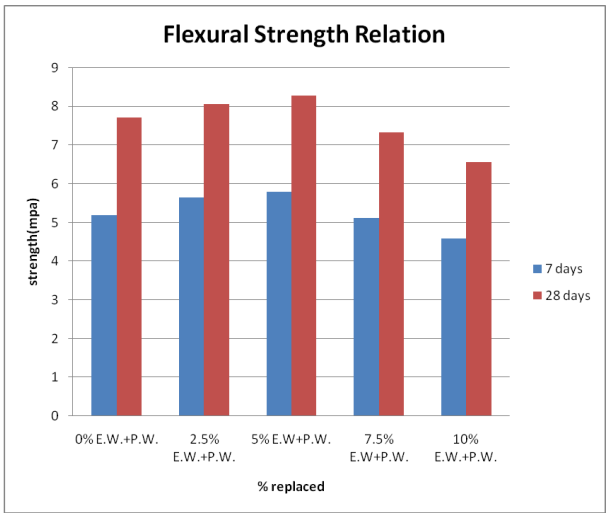

Figure IV - Relation Between Flexural Strength and % E-Waste+Plastic Waste Replaced

IV. CONCLUSION

This study intended to find effective ways to reutilize the hard e-waste and plastic waste particles as

coarse aggregate. It is observed that the specific gravity of the mix having e-waste + plastic waste and coarse aggregate together is decreasing with increasing percentage of replacement. By comparing the result with conventional concrete at 28 days strength we found out that the compressive strength is first increasing by 4.1% and 6.3% for 2.5% and 5% of e-waste replacement respectively. And it is decreasing by 4.4 % for 7.5% of e-waste replacement which is within the permissible limit of target mean strength value .Same is happening with the result of flexural strength and tensile strength. Hence we get that optimum percentage up to which we can introduce a mix of e-waste and plastic waste in concrete as coarse aggregate is 0%-5% (increase in strength) to 5%-7.5% (permissible mean strength)

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