Study of Concrete using E-waste as Partial Replacement of Coarse Aggregate

Mr. Mohit Singh[1] Anup Yadav[2] Anirudh Sharama[3]
[1]Assistant Professor [2,3]ME Student
[1,2,3]WCTM, Gurugram, India

Abstract— Solid waste management is one in all the key environmental issues in our country currently a day. the current study covers the employment or recycled e-wastes as replacement of coarse aggregates in concrete. The most aim of the study is to analyze the amendment in mechanical properties of concrete with the addition of e-wastes in concrete. In conjunction with the mechanical properties, thermal characteristics of the resultant concrete is additionally studied. It is found that the employment of e-waste aggregates leads to the formation of light-weight concrete. The compressive, similarly as strength of concrete reduces with the introduction of e-wastes. The foremost necessary amendment led to by the employment of e-wastes is that the thermal conduction of concrete is reduced by victimization e-wastes in concrete. Therefore, it is often aforesaid that recycled e-wastes are often used for thermal insulation of buildings.

Keywords: Solid Waste Management, GGBS, E-Wastes

I. INTRODUCTION

Research regarding the employment of by-products to enhance the properties of concrete has been happening for several years. within the recent decades, the efforts are created to use business by-products like ash, silicon dioxide fume, ground granulated blast furnace slag (GGBS), glass cullet, etc., in civil constructions. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, counting on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these merchandise.

Big attention is being targeted on the setting and safeguarding of natural resources and recycling of wastes materials. Really several industries are manufacturing a major range of merchandise that incorporate scrap (residues). Within the last twenty years, plenty of works regarding the employment of many types of urban wastes in building materials industrials method are revealed. Several researches are extended to check new types of wastes to analyze deeply specific aspects. The addition of wastes, excluding the environmental advantages, conjointly produces sensible effects on the properties of final merchandise.

One of the new waste materials utilized in the concrete business is recycled e-waste. For finding the disposal of enormous quantity of recycled e-waste material, utilize of e-waste in concrete business is taken into account because the most possible application. Recycled e-waste are often used as coarse mixture in concrete. However, it's necessary to underline that re-using of wastes isn't nevertheless economically advantageous, thanks to the high prices of transport and its impact on the entire prices of production. Moreover, it's necessary to not neglect different prices, directly imputable to the type of wastes, due, especially, to the necessity of activity gas emission, throughout firing, and therefore the presence of poisonous and polluting parts.

II. EXPERIMENTAL PROGRAM

A. Mix Design

The concrete mix design is a process of selecting the suitable ingredients of concrete and determining their most optimum proportions which would produce, as economically as possible, concrete that satisfies the job requirements, i.e. the concrete having a certain minimum compressive strength, the desired workability and durability. In addition to these requirements, the cement content in the mix should be as low as possible to achieve maximum economy. The proportioning of the ingredients of concrete is an important part of concrete technology as it ensures the quality and economy.

1) The concrete mix design is based on the principles of

- Workability of fresh concrete.
- Desired strength and durability of hardened concrete which in turn is governed by water-cement ratio law
- Conditions at the site, which helps in deciding workability, strength and durability requirements.

2) Factors to be considered for mix design

- The grade designation giving the characteristic strength requirement of concrete.
- The type of cement influences the rate of development of compressive strength of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS 456:2000.
- The cement content is to be limited from shrinkage, cracking and creep.

3) Assumed standard deviation for mix design

Grade of Concrete	Assumed Standard Deviation N/mm2
M 10	3.5
M 15	
M 20	4
M 25	
M 30	5

4) Water-cement ratio:

Different cement, supplementary cementitious material and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concrete of different compressive strength for the same free water cement ratio. Therefore, the relationship between strength and free water cement ratio should preferably be established for the materials, actually to be used. In the absence of such data, the preliminary free water-cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the established relationship, if available. Otherwise the water-cement ratio table of IS 456 for

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respective environment exposure condition may be used as starting.

The free water-cement ratio selected according to 4.1 should be checked against the limiting water-cement ratio for the requirement of durability and the lower of the two value adopted

5) Selection of Water Content

The water content of concrete is influenced by a number of factors such as aggregate size aggregate shape, aggregate texture, workability, water-cement ratio, cement and other supplementary cementitious material type and content, chemical admixture and environment condition. An increase in aggregate size, a reduction in water-cement ratio and slump and used or rounded aggregate and water reducing admixture will reduce the water demand. On the other hand increased temperature, cement content, slump, water-cement ratio, aggregate angularity and a decrease in the proportion of the coarse aggregate to fine aggregate will increase water demand.

6) Test Performed on Material for Mix Design

Weigh a clean and dry specific gravity bottle eith its stopper (W1). Place a sample of material upto half og the flask (about 50 gm) and weight with its stopper (W2). Add water to material in flask till it is about half full. Mix thoroughly with glass rod to remove entrapped air continue stirring and add more water till it is flush with the graduated mark. Dry the outside and weigh (W3). Entrapped air may be removed by vacuum pump, If available. Empty the flask clean it and refills ir with water with the graduated mark, wipe dry outside and weigh (W4) and specific gravity is calculated by the formula given below

$$\text{Specific gravity} = \frac{(W2-W1)}{(W2-W1)-(W3-W4)\times 1}$$

W1 = Weight of empty flask

W2 = Weight of Flask + Material

W3 = Weight of flask + Material + Water

W4 = Weight of flask + Water

7) Mix design proposition of concrete of M 40 grade with E waste material.

Ingredient	Mix Design (Kg/m3)	
Cement	410	
Fine aggregate	648	
Water	184	
Coarse aggregate	890	
E-waste	5%	44.5
	10%	89
	15%	133.5
	20%	178
	25%	222.5

8) Mix proportion of M40 concrete with E- waste and Fly Ash

Ingredient	Mix Design (Kg/m3)	
Cement	410	
Fly Ash	10%	41
Fine aggregate	648	
Water	184	
Coarse aggregate	890	
E-waste	5%	44.5
	10%	89
	15%	133.5
	20%	178
	25%	222.5

III. OBSERVATIONS AND RESULTS

The results for different tests are as follows:

A. Crushing Value Test

Aggregate	Crushing Value
Natural Coarse Aggregate	15.22%
E-waste	3.26%

Form the result of crushing value we come to know that the E-waste is having more resistance to the wear and tear than the natural aggregate.

B. Impact Value Test:

Natural Coarse Aggregate	7.65%
E-waste	2.89%

Impact test is the good indicator of strength and durability from the test result we can say that natural and E-waste are having wide difference of impact and crushing value, which again shows that aggregate of e-waste is stronger than that of natural aggregate.

C. Abrasion Value Test

Aggregate	Impact Value
Natural Coarse Aggregate	11.23%
E-waste	4.67%

Los angles abrasion test result shows that abrasion value of natural coarse aggregate is much higher than e-waste.

D. Specific Gravity Test

Natural Coarse Aggregate	2.70
Natural Fine Aggregate	2.62
E-waste	1.24
Cement	3.14

Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance.

E. Fineness Modulus

Aggregate	Fineness Modulus
Natural Coarse Aggregate	2.65
Natural Fine Aggregate	1.92
E-waste	2.80
Cement	4.1

Sieve analysis test is performed on the aggregate i.e Natural coarse aggregate, Natural fine aggregate and E-waste.

F. Water absorption

Aggregate	Water Absorption %
Natural Coarse Aggregate	1.83
Natural Fine Aggregate	0.206
E-waste	0.05

Water absorption of is performed on the aggregate and it has find that all aggregate has water absorption below 5%.

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IV. CONCLUSIONS

This study intended to find the effective ways to reutilize the e-waste particles as concrete aggregate. Analysis of the Strength characteristics of concrete containing recycled waste plastic and fly ash gave the following results.

- It is identified that e-waste can be disposed by using them as construction materials.
- Since the e-waste is not suitable to replace fine aggregate it is used to replace the coarse aggregate.
- The compressive strength of concrete containing e-plastic aggregate is retained more or less in comparison with controlled concrete specimen. However, strength noticeably decreased when the e plastic content was more than 20%.
- Addition of fly ash in the mix considerably improves strength index of control mix as well as e-waste concrete. The strength development of fly ash based e plastic concrete in early days found to be less but 28 days compressive has proven results in comparison with controlled concrete up to 25% e plastic replacement.
- Has been concluded 20% of E waste aggregate can be incorporated as coarse aggregate replacement in concrete without any long term detrimental effects and with acceptable strength development properties.

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