JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Experimental Study on Cubic Strength of Concrete Cubes by using Fly Ash and E-waste

[1]Pushpendra Manjhi,[2]Sanjay Saraswat,

[1]Student,[2]Astt. Professor,
[1]Department of Civil Engineering,
[1]Samrat Ashok Technological Institute, Vidisha (M.P.), India

Abstract: Cement concrete is a most widely used construction material in the world over which generally consists of cement, fine aggregate, coarse aggregate and water. It is the material, which used more than any other man made material on the earth in construction industry. As we know now a days, most of developing country facing shortage of post consumers disposal waste site and it has become very serious problem. For this reason, regenerating and using waste product as resources prevents environmental pollutions. 5-8% of all human - generated atmospheric carbon-dioxide worldwide comes from the concrete industry.

In this study, Cement and Coarse aggregates were both replaced by Fly ash and E-waste simultaneously at 10%, 20% and 30% respectively. The specimens were made with these mixes and tested for determining strength properties of M-25 grade concrete.

IndexTerms **- Concrete, Fly Ash, E-waste, waste product**

I. INTRODUCTION

India produces nearly 62 million tonnes of solid waste out of which around 5-10 million tonnes is electronic waste and according to the report of "The Hindu" it will be tripled in 2025. So it is so important to recycled these waste products. All over the world, the quantity of electrical and electronic waste generated each year, especially computers, televisions and mobile phones, has assumed alarming proportions. In 2012, the International Association of Electronics Recyclers (IAER) projected that 3 billion electronic and electrical appliances would become WEEE (Waste Electrical and Electronic Equipment) or e-waste by 2020. E-waste accounts 5% of all municipal solid waste which is disposed off.

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is a pozzolana material, containing aluminous and siliceous material that posses similar property as of cement in the presence of water. There are two common types of fly ash: Class F and Class C. Class F fly ash contains particle covered in a kind of melted glass. Whereas Class C fly ash is typically composed of high calcium material. Fly ash can be a cost effective substitute for Portland cement in many markets. It is also recognized as an environmentally friendly material because it is a byproduct.

In this study, Cement is replaced by Fly Ash and Coarse aggregates were replaced by E-waste simultaneously at 10%, 20% and 30% respectively and the specimens were made with these mixes and tested at specified percentages and determining strength properties of M-25 grade concrete. The properties of admixtures (Fly Ash and E-waste) used in this research study are as follows;

Properties of Fly Ash and E-waste:

Table 1: Chemical properties of Fly Ash

Sr. No.	Compound	Content, % weight
1	SiO_2	59
2	Al_2O_3	21
3	Fe_2O_3	3.70
4	CaO	6.90
5	MgO	1.40
6	SO_3	1.00

7	K_2O	0.90
8	LOI	4.62

Table 2: Physical properties of Fly Ash

Sr. No.	Properties	Content
1	Color	Whitish grey
2	Bulk Density	0.994
3	Specific Gravity	2.288
4	Moisture (%)	3.14
5	Avg. Particle Size (μ m)	6.92
6	Appearance	Powder form

Table 3: Properties of E-waste

Sr. No.	Properties	Percentages
1	Water Absorption	0%
2	Specific Gravity	2.55
3	Size	< 20 mm
4	Shape	Flaky and Angular

II. LITERATURE REVIEW

1. Shayan Ahmad et al. 2002; concluded that 30% GLP could be incorporated as cement or aggregate replacement in concrete without any long-term detrimental effects. Upto 50% of both fine and coarse aggregates could also be replaced in concrete of 32 MPa strength grade with acceptable strength development properties.

2. Oliveira L.A. Pereira De et al. 2008; they replaced natural sand by glass powder and observed that the sand replacement by the waste glass sand reduced the concrete sorptivity coefficient . The reduction attaint a maximum of 39%for 28days with 100% of natural sand replacement and 29% of reduction at 63 days for the same waste glass rate . This reduction can influence by the favourable effect of waste glass sand grading that improve the particles packing almost certainly reducing the quantity of capillary pores.

3. Bajad M.N et al. 2011; in their study work, he observed the strength properties containing glass when subjected to sulphate attack and showed that the peak compressive strength is achieved at 20% replacement of cement by waste glass powder both when concrete is not subjected to sulphate attack and when concrete subjected to sulphate attack and the increment continues upto 25% replacement beyond which it decreases. Experimentally showed that 20% replacement by waste glass powder is optimal both in the case of concrete subjected to sulphate attack and when not subjected to sulphate attack.

4. Patel Dhirendra et al. 2012; he investigated the strength characteristics of pre cast blocks incorporating waste glass powder and studied that the moderate level decrease in the compressive strength at 28 days occurs. Studied the properties of cement sand mortar paste containing fine and coarse glass powder as partial replacement of cement and results showed that 15% dosage for replacement is optimal.

5. Vijaya Kumar G. et al. 2013; they proposed that cement replaced upto 40% by glass powder showed increment in compressive strength at both 28 days and 60 days age of curing as compared to conventional concrete**.** They showed that flexural strength increment is achieved upto 40% replacement of cement by waste glass powder. Their study shows that the glass powder concrete increases the tensile strength effectively when compared with conventional concrete.

6. Prema Kumar W P, Ananthayya M B and Vijay K. et al. 2014; they discussed about Storage and safe disposal of waste glass is a huge problem for municipalities everywhere. Reuse of waste glass reduces this problem. In this experimental work, the effect of partially replacing cement in concrete by glass powder is studied. The cement in concrete is replaced by waste glass powder in steps of 5% from 0% to 40% by volume and its effects on compressive strength, split tensile strength, workability and weight density are determined.

7. Muhammad Rafique Khattak et al. 2015; Various attempts were made by him through experimentation to check the feasibility of plastic waste to be use partially in concrete with respect to various properties of strength, workability, durability and ductility of concrete. This paper includes review of various studies conducted on utility of waste plastic material used in the concrete. Moreover this paper will draw our focus toward the impingement on the various properties of concrete when partially replacing with waste plastic.

III. RESEARCH METHODOLOGY

A. Experimental Investigation for design mix done in following steps:

1. Data for Mix Proportioning:

- Grade = M25
- Cement = OPC 43 grade conforming to [IS 8112]
- Nominal size of aggregate = 20mm
- Maximum cement content = 450kg/m3 [IS456:2000 cl. 8.2.4.2, page no.19]
- Minimum cement content = 300kg/m3 [IS456:2000 Table no.5, page no.20]
- Compaction factor = 0.9
- Workability = 75
- Exposure condition = Moderate

Mix Design: The specimens are to be cast with concrete of characteristics strength 25 N/mm^2 . The physical properties of constituent materials are investigated and presented as follows;

2. Test data [IS 10262:2009]:

- Specific gravity of cement =3.15
- Specific gravity of glass powder=1.785
- Specific gravity of coarse aggregate =2.68
- Specific gravity of fine aggregate= 2.6
- Water absorption of coarse aggregate=1.52%
- Water absorption of fine aggregate= 1.1%

3.Target Strength for Mix Proportioning:

$$f'_{ck}=f_{ck}+1.65s$$

$$=25+1.65*4 \quad \text{[IS 10262:2009 Table 1]}$$

$$=31.6 N/mm^2$$

where,

f'_{ck}=target mean compressive strength at 28 days in N/mm^2

f_{ck}= characteristic compressive strength at 28 days in N/mm ^{2}

s = standard deviation N/mm^2

4. Proportion of water-cement ratio:

The water-Cement ratio for design mix is calculated by following graph;

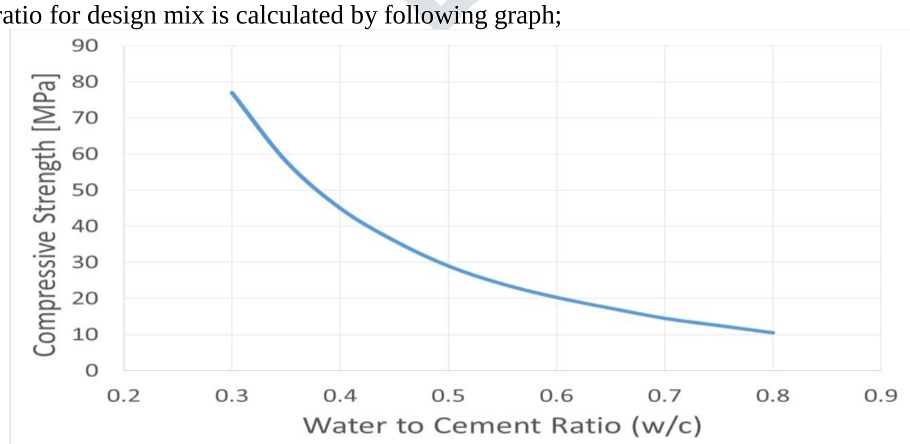

Fig. 1: Graph between Compressive strength and w/c ratio

5. Calculation of water content:

- Maximum water content % for 20mm aggregate = 186 liter (25mm to 50mm slump range) for 75mm slump

= 186+3%*186

= 191.58mm ≈192mm

6. Determination of cement content [IS 10262:2009 Table-2]:

C = water/(water-cement ratio)
= 192/0.43 [water- cement ratio assumed=0.43]
= 446.51kg

450>446.51>300 kg/m3 hence ok

7. Proportion of volume of coarse aggregate and fine aggregate content [for IS 10262:2009 Table-3]:

- For sand (zone -3)
- For water –cement ratio of 0.50= 0.64
- For present case , water cement ratio =0.43volume of coarse aggregate is to be increase to decrease the fine aggregate content .
- Corrected proportion of volume of coarse aggregate for water cement ratio of 0.43= 0.644
- For pumpable concrete volume should be reduced by 10%
- Volume of coarse aggregate = 0.644*0.9= 0.58
- Volume of fine aggregate= 1-0.58= 0.42

8. Mix calculation:

a. volume of concrete = 1m3
b. volume of cement = (446.51*1)/(3.15*1000)
= 0.1417
c. volume of water = (192*1)/(1*1000)
= 0.192m3
d. volume of all in aggregate =[a-(b+c)]
= [1-(0.1417+0.192)]
=0.666m3
e. mass of coarse aggregate = d*volume of coarse aggregate *specific gravity of coarse aggregate *100
= 0.666*0.58*2.68*1000=1035.23kg/m3
f. mass of fine aggregate= (d.)*volume of fine aggregate *specific gravity of fine aggregate *1000
= 0.666*0.42*2.6*1000
= 727.27kg/m3

Ratio: Cement : Fine Aggregate : Coarse Aggregate
446.51 : 727.27 : 1035.23
1 : 1.62 : 2.31

Table 4: showing the volume by weight of material for different proportioning of Glass powder mix concrete

Sr. No.	Percentage	Cement Kg/m3	Fly ash Kg/m3	Coarse Aggregate Kg/m3	E-waste Kg/m3	Fine Aggregate Kg/m3	Water Kg/m3
1	0	446.51	0	1035.23	0	727.27	0.43
2	10	401.86	44.65	931.71	103.52	727.27	0.43
3	20	357.21	89.30	828.18	207.05	727.27	0.43
4	30	312.56	133.95	724.65	310.58	727.27	0.43

B. Test performed on Fresh and Hardened Concrete:

- **Sampling of materials:**

Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.
The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.
The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients.
The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.

1. Workability Test by Slump Cone Method:

To determine the workability or consistency of concrete mix of given proportion by slump cone test.

Fig. 2: Slump Cone test

2. Compressive Strength Test:

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

Fig.3: Compressive Strength test

3. Flexural Strength Test:

To determine the Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking.

- Beam mould of size **15 x 15 x 70 cm** (when size of aggregate is less than 38 mm) or of size **10 x 10 x 50 cm** (when size of aggregate is less than 19 mm).
- Tamping bar (40 cm long, weighing 2 kg and tamping section having size of 25 mm x 25 mm)

Fig.4: Flexural strength test

- The Flexural Strength or modulus of rupture (f_b) is given by

(When a > 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen)

Or

(When a < 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cm specimen.)

Where,

a = the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen

b = width of specimen (cm)

d = failure point depth (cm)

l = supported length (cm)

p = max. Load (kg)

4. Split Tensile strength test:

This method covers the determination of the splitting tensile strength of cylindrical concrete specimens. The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

IV. RESULTS AND DISCUSSION

4.1 Workability: Slump test was carried out on each mix to ascertain workability of nominal mixed concrete as well as control mixtures (Fly ash and E-waste mixed concrete).

Table 5: Slump Cone test values for Fly ash and E-waste mix concrete

Sr. No.	% of Flyash and E-waste mix	Slump(mm)
1	0	78
2	3	71
3	6	69
4	9	63

4.2 Compressive Strength:

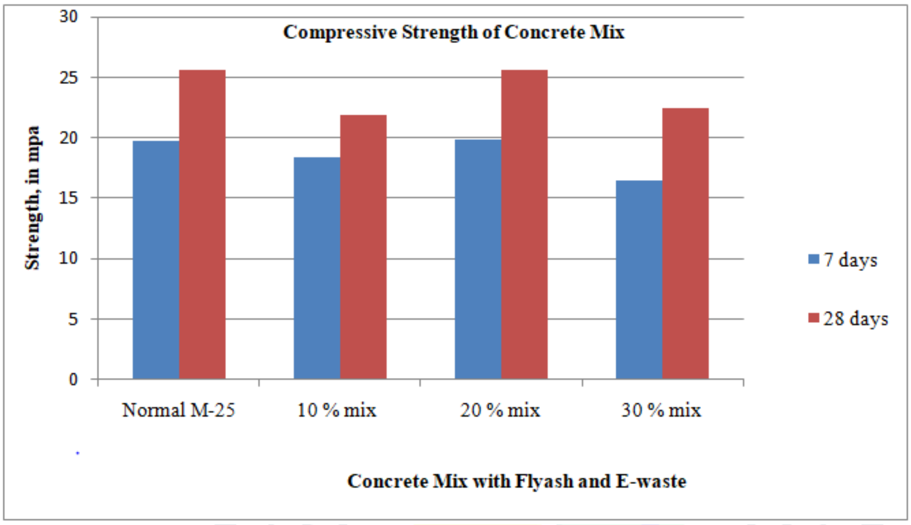

Fig.5: Graph showing test results of Compressive Strength Test

4.3 Flexural Strength:

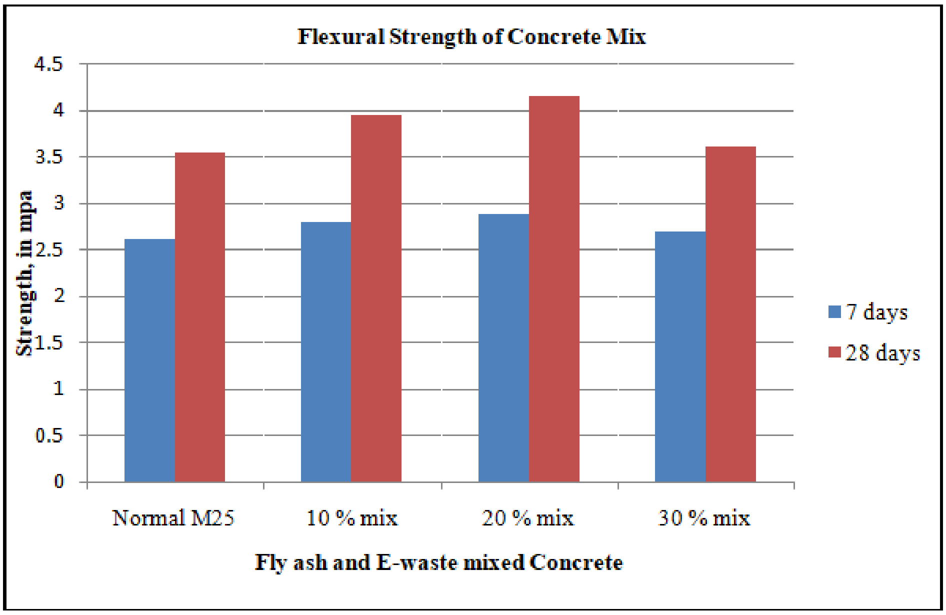

Fig.6: Graph showing Flexural Strength Test results

4.4 Split Tensile Strength:

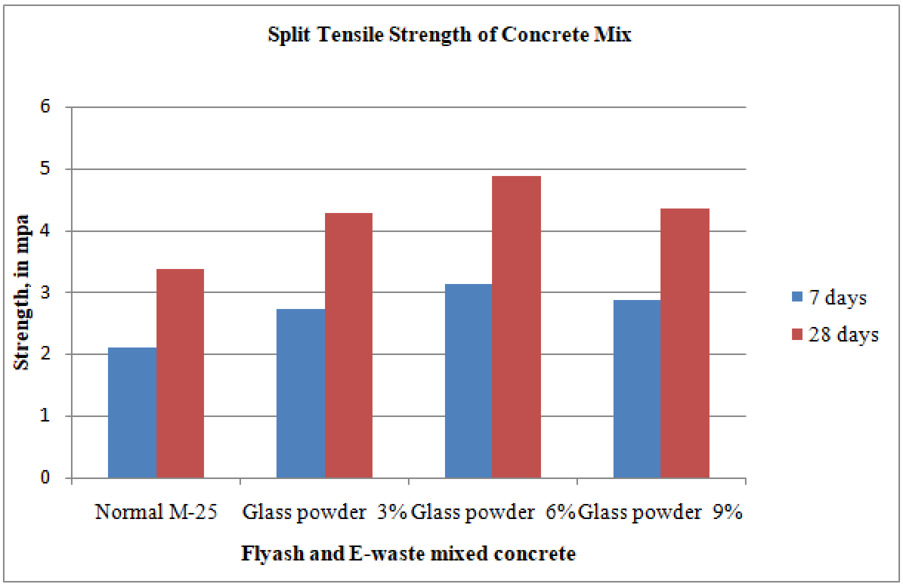

Fig.7: Graph showing Split Tensile Strength Test results

V. CONCLUSIONS:

- The results obtained from the present study shows that there is great potential for the utilization of best mix of fly ash and E-waste in concrete as replacement of cement and aggregate respectively.
- The compressive strength of concrete cube increases up to a replacement proportion of 20% of fly ash with cement and E-waste with Coarse aggregates respectively.
- The maximum compressive strength obtained for 28 days is 25.63 N/mm2 with the replacement of 20% of ingredients.
- The maximum values of Compressive Strength, Split Tensile Strength and Flexural Strength were found at 20% replacement of cement by fly ash and E-waste with coarse aggregates. With 20% replacement of ingredients by fly ash and E-waste, the increase in compressive strength was 25.63%, split tensile strength was 4.88% and flexural strength was 4.15%.
- There was marginal improvement in the Split tensile strength.

VI. FUTURE SCOPE OF THE WORK:

Further study can be carried out using different percentage of using fly ash and E-waste and determining the most optimum percentage of E-waste to achieve Compressive Strength and Flexural strength and Split Tensile Strength.

•Study on replacing coarse aggregate with other material can also be carried out.
•Replacement of cement with flyash and E-waste with coarse aggregate at different water cement ratio.
•Tests for chemical properties, tensile strength, slump loss, workability & many other can be done.

REFERENCES

[1] Vasudevan Gunalaan, Pillay. Ganis Kanapathy, Seri. 2013.Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement. American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-12, pp-175-181

[2] Kumarappan, N. 2013. Partial Replacement Cement in Concrete Using Waste Glass. International Journal of Engineering Research and Technology (IJERT) Vol. 2 Issue 10, ISSN: 2278-0181

[3] Patil, Dhanraj. Mohan and Dr. Sangle Keshav, K.. 2013. Experimental Investigation of Waste Glass Powder as Partial Replacement of Cement inConcrete. International Journal of Advanced Technology in Civil Engineering. ISSN: 2231 –5721, Volume-2, Issue-1

[4] Ahmad, Shayan. 2002. Value-added Utilization of Waste Glass in Concrete. IABSE Symposium Melbourne.

[5] Ahmad, Shayan. Aimin, Xu. 2005. Performance of glass powder as a pozzolanic material in concrete: A field trial on concrete slabs. ELSEVIER Cement and Concrete Research. pp 4657–4688.

[6] Ana, MafaldaMatos. Joana, Sousa-Coutinho. 2012. Durability of mortar using waste glass powder as cement replacement. ELSEVIER Construction and Building Materials. pp 205–215.

[7] Chikhalikarand, S.M. Tande, S.N. 2012. An Experimental Investigation on Characteristic Properties of Fibre Reinforced Concrete Containing Waste Glass Powder as Pozzolana. 37th Conference on Our World in Concrete & Structures. PP 29-31.

[8] Gautam, S.P., Srivastava, Vikas. and Agarwal, V.C. 2012. Use of glass wastes as fine aggregate in Concrete. Journal of Academia and Industrial Research. Vol.1(6). ISSN: 2278-5213.

[9] Ismail, Ansari. Sheetal, Sahare. 2015. Utilization of glass powder as a partial replacement of cement and its effect on concretestrength. Vishwakarma Institute of Information Technology, Pune, Maharashtra, India. IRF international conference, Pune, India.