An Experimental Study on Concrete by using Powder form of E-Waste as Partial Replacement for Cement Material

Sarvesh Honaji Kolhatkar[1] Prof. Aniket Nemade[2] Dr. Sanjay Kulkarni[3]
[1]ME Student [2]Associate Professor [3]Assistant Professor
[1,2,3]Dr.D.Y.Patil School of Engineering and Technology Charholi (BK) Via Lohgaon Pune 412105, India

Abstract— The management and recycling of E waste is rapidly growing as it is a valuable resource of IT industries and it is very hazardous substances and with low recycling rate. The Utilization of e waste materials is a partial solution to environmental and ecological problems. As the use of E waste will reduces the cement cost and provides a good strength for the structures and roads. It will reduces the landfill cost and it is energy saving. The e E- waste consists of discarded plastic waste from the old computers, TVs, refrigerators, radios; these plastics are non-biodegradable components of E plastic waste as a partial replacement of the cement. An experimental study is made on the utilization of E-waste crush fine powder as cement in concrete with a percentage replacement ranging from 0 %, 10% to 50% .on the strength criteria of M30 Concrete. test were conducted at Dr D.Y. Patil School of Engineering and Technology, concrete lab by proper curing period 7, 14, 28 days .Compressive strength and Flexural strength Concrete with and without E- waste plastic as partial replacement cement was observed which exhibits a good strength. The feasibility of utilizing E-waste powder as partial replacement of cement has been presented. In the present study, compressive strength was investigated for Optimum Cement Content and 10% E-waste content in mix yielded stability and very good in compressive strength of 53 grade cement.

Keywords: E Waste, Concrete, Compressive Strength; Flexural Strength

I. Introduction

Now-a-days, the world facing a real challenge is disposal of solid waste in particular E- waste without inducing any environmental issues. Electronic waste accounts that obsolete, broken, surplus, and loosely discarded electrical or electronic devices (Krishna and Kanta, 2014; Suchithra, et al., 2015). In India, the primary source of E–waste is public and private sector, institutions which leads 70% of the total waste (Balasubramanian, et al., 2016). The estimated annual generation of electronic waste is 4, 00,000 tons that is (10-15%) approximately. The wastes are generated from the top cities such as Mumbai, New Delhi, Bangalore and Chennai were calculated to be 10,000 tons, 9,000 tons, 8,000 tons and 6,000 tons respectively. But from these sources only 4% recycling of it (Vivek, et al., 2015). The need for disposal of E–waste several tons per year due to its increasing manner.

The efforts have been made to use the components of E–waste as a partial replacement of cement in the field of construction. Utilization of crushed E–waste materials as a conventional concreting material and other materials in the building construction helps in reducing the cost of concrete manufacturing. It is the most important method to reduce the quantity of E–waste as well as to achieve an eco–friendly concrete and protecting environment from the effect of pollution.

II. Design of Concrete Mix M30

Grade designation = M30
Characteristic strength (fck) = 30 N/mm2
Type of cement = OPC 53 Grade confirming to IS: 12269-1987
Maximum size of coarse aggregate = 20 mm (angular)
Degree of workability = 0.90 compaction factor
Type of exposure = Moderate
Specific gravity of cement = 3.15
Specific gravity of water = 1.00
Specific gravity of coarse aggregate = 2.8
Specific gravity of fine aggregate = 2.7
Water absorption of coarse aggregate = 0.4%
Water absorption of fine aggregate = 0.10%
Target slump = 100 mm
As per codal provisions,
Sand content = 36% of total aggregates
Water cement ratio for M30 concrete = 0.5 (IS: 456, 2000 Table 5)
From Figure.2 of IS: 10262-1982,
Select water content = 186 kg [up to 25 to 50 mm slump] increase 3% for
Every 25mm slump
For 20 mm size of aggregates,
Estimated water contain for 100 mm slump = 186 + [6/100] x 186 =196 liter
Standard deviation (SD) for M30Concrete = 5.00 MPa
Target mean strength = 30 +1.64 SD
= 30+1.64 x 5
= 30+8.25 = 38.25 N/mm2 From IS: 456-2000,
Aggregate type = Crushed broken granites
From IS: 10262 for 20mm size of coarse aggregates
Max. Water content = 197 kg/m3
Hence, Cement content = 197/0.5
= 394 kg
394 kg/m3 greater than 300 kg/m3 hence OK….
Minimum cement content required = 394 kg
Formula for mix proportion of fine and coarse aggregate,
1000 (1-a0) = [(Cement content / Spa .gr. of cement) + water content+ (Fa / sp.gr.* Pf)]
1000(1-a0) = [(Cement content / Sp.gr. of cement) +water content+ (Ca/sp.gr. *Pc)]
Where,
Ca = Coarse aggregate content,
Fa = Fine aggregate content,
Pf = Sand content as percentage of total aggregates = 0.40
Pc = Coarse aggregate content as percentage of total aggregates
= 0.64
a0 = Percentage of air content,
As per IS: 10262, for 20mm normal size aggregate,
Entrapped air content is 2% = 0.02

Hence,
1000 (1-0.02) = [186+ (394/3.15) + (Fa/2.7*0.40)]
Fa = 732 kg/m3 (say 710 kg/m3)
1000 (1-0.02) = [186+ (394/3.15) + (Ca/2.8*0.61)]
Ca = 1139 kg/m3 (say 1280 kg/m3)

A. *Mix Ratio*

Cement: Sand: Coarse Aggregate: w/c = (394: 732: 1139: 0.5) The design mix proportions for the required target strength is as Follows, Cement: Sand: Coarse Aggregate: w/c = {1: 1.84: 2.87:0.5}

III. METHODOLOGY

The step by step procedure for testing the concrete cube given below

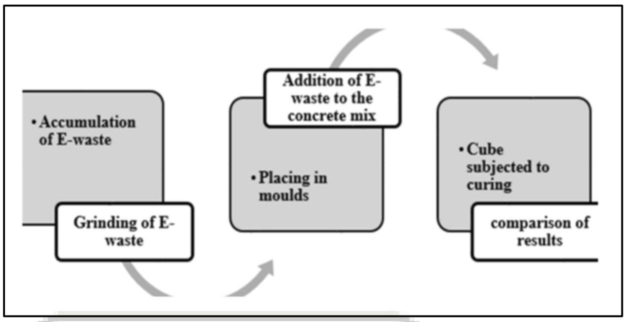

Fig. 1: flow chart of Experiment

A. *Preparations of Test Specimens*

The concrete of various specimens were prepared for different mixes with added cement and E–waste. After that water was added and the mixing was continued until the consistent mix was obtained and the concrete was placed in the moulds. For compressive strength and durability test, cubes of size 150 × 150 × 150 mm were cast. For flexural strength test beams of size 100 × 100 × 500 mm were cast and curing for 7,14,28 days.

Fig. 2: Casting Cube and Beam

B. *Compressive Strength*

It is one of the most vital properties of concrete and influences many other desirable hardened concrete. The compression type is a laboratory test to determine the characteristics strength of concrete. The compressive strength is determined as

Compressive Strength = P/A.
Where,
P = Load at failure in N/mm2.
A = Area of the specimen in mm2.

The compressive strength of the control mix, A1, A2, A3, A4, A5 concretes are given in Figure 2. A1, A2, A3, A4, A5 represents the mixing of E-waste in different Percentage for the replacement of cement in a concrete. The compressive strength result presented in the Figure 2 is for 7, 14 and 28 days. The testing of cubes in UTM is presented that the 28th day strength of control mix concrete is 27.35 N/mm2. It reduces gradually.

Fig. 3: compressive strength test

When E-waste crush powder. As the percentage of replacement of cement by E-waste increases, the compressive strength decreases progressively after 10% mix of E-waste.

C. Flexural Strength

The flexural behavior of the beams shows that structural properties similar to the load–deflection curve pattern. Before cracking, The linear slope of the load–deflection curve was steep occurred in all testing beams due to the stiffness reduction, The flexural cracks were observed from the change in slope of the load–deflection. Flexural strength can be described as the capacity of a beam Fb= (pl)/(bd2)

Where,
p = Maximum load applied (N),
I = Supported length of the specimen (mm)
b = Measured width of the specimen (mm)d= Measured depth of the specimen at the point of failure (mm)
after the testing of beam we get 6.8 N/mm2 flexural strength of control mix . for the M30 mix which is 18%of compressive strength for the same concrete mix matrix .

Fig. 4: flexural strength test

IV. TEST RESULT

Mix Specification	Control mix	A1	A2	A3	A4	A5
Proportion of E-waste	0%	10%	20%	30%	40%	50%
7 Days	24.73	25.43	23.72	22.47	21.34	20.10
14 Days	31.10	32.36	30.12	28.43	27.13	25.15
28 Days	37.35	39.85	37.15	35.26	33.72	32.14

Table 1: Compressive strength test results in N/mm 2

Mix Specification	Control mix	B1	B2	B3	B4	B5
Proportion of E-waste	0%	10%	20%	30%	40%	50%
7 Days	5.2	4.12	3.85	3.14	2.91	2.85
14 Days	6.4	5.54	4.2	3.44	3.24	3.1
28 Days	6.8	6.2	5.8	5.4	4.8	4.2

Table 2: Tensile strength test results in N/mm 2

A. Discussions

1) By observation of cube and beam moulding after 24 hours. drying spaciman change its collour from gray to pink due to chemical reaction between cement and E-waste (Due to mineral contain)
2) After placing spaciman into water tank for curing after some days white floc is produce on water surface. Which is float on water
3) After test result notice the compressive strength values of all waste plastics concrete mix tend to decrease below the values for the reference concrete mixtures with increasing the waste plastic ratio at all curing stages. This may attribute to the decrease in the adhesive strength between the materials. In addition waste plastic is hydrophobic materials which may restrict the hydration of cement.

V. CONCLUSION

According to the experimental results, we can concluded that:

1) Utilization of partial replacement of E–waste as a cement is the best alternative for the conventional concrete.
2) The disposal of E–waste can be used as a cement provides the reduction in burden on landfill disposing and environmental pollution.
3) The E–waste concrete density is less as compared with the conventional concrete which reduces the cost of the concrete and produces the light weight concrete structure.
4) The results shows that the good strength, greater durability and addition of E–waste exhibits increase
5) in compressive strength upto 10% replacement.
6) This is useful in applications requiring non-bearing lightweight concrete, such as concrete panels used in facades, P.C.C concrete Road. Also making building Material i.e E-waste concrete paving block , Bricks etc
7) For a given w/c, the use of E-waste powder in the mix lowers the density, flexural strength of concrete.
8) The flexural strength 18% of compressive strength of control mix and 16% of A1 specimen which is

continuously decreasing with increasing percentage of E-waste of forward specimen .

9) The effect of water –cement ratio of strength development is not prominent in the case of E-waste concrete. It is because of the fact that the E-waste powder reduce the bond strength of concrete. Therefore, the failure of concrete occurs due to failure of bond between the cement paste and E-waste powder.
10) Introduction of E- waste plastic powder in concrete tends to make concrete ductile, hence increasing the ability of concrete to significantly deform before failure. This characteristic makes the concrete useful in situations where it will be subjected to harsh weather such as expansion and contraction, or freeze and thaw.

References

Research Papers

[1] R. Lakshmi and S. Nagan, Utilization of waste E plastic particles in cementitious mixtures, Journal of Structural Engineering, 38(1), 2011, 26-35.
[2] R. Lakshmia and S. Nagan, Investigations on durability characteristics of e-plastic waste incorporated concrete, Asian Journal of Civil Engineering (Building and Housing), 12(6), 2011, 773-787.
[3] P. Nagajothi, and T. Felixkala, Compressive Strength of Concrete Incorporated with E-fiber Waste, International Journal of Emerging Technology and Advanced Engineering, 4(4), 2014, 23-28.
[4] Arora and U. Dave, Utilization of e- waste and plastic bottle waste in concrete, International Journal of Students Research in Technology & Management, 1(4), 2013, 398-406.
[5] P. Prasanna and M. Rao, Strength variations in concrete by using e-waste as coarse aggregate, International Journal of Education and applied research, 4(2), 2014, 82-84.
[6] C. Chen, R. Hwang, J. Wu and C. Yang, Waste E-glass particles used in cementious mixtures, Cement and Concrete Research, 36, 2006, 449-56.
[7] S Joshi, Growing e-waste is causing concern, The Hindu, 28 February 2009.
[8] M Basu, New e-waste management plan lucrative for states, The Pioneer, New Delhi, 18 May 2010.
[9] K. Alagusankareswari, S. Sandeep Kumar, K. B. Vignesh and K. Abdul Hameed Niyas (2016) "An Experimental Study on E-Waste Concrete", Indian Journal of Science and Technology, Vol 9(2), DOI: 10.1748
[10] Sunil Ahirwar, Pratiksha Malviya, Vikash Patidar, Vikash Kumar Singh (2016) "An Experimental Study on Concrete by using E- Waste as Partial Replacement for Course Aggregate" IJSTE – International Journal of Science Technology & Engineering Vol 3 Issue 04.
[11] Vivek S, Damal, Saurabh S. Londhe, Ajinkya B. Mane (2015) Utilization of Electronic Waste Plastic in Concrete" Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 5, Issue 4, (Part-2) April 2015, pp. 35-38.
[12] Suchithra, Manoj Kumar, Indu V. S. (2015) "Study on Replacement of Coarse Aggregate by E-Waste in concrete". International Journal of Technical Research and Applications Vol 3 Issue 04
[13] S. P. Gautam, Vikas Srivastava and V. C. Agarwal (2012) "Use of glass wastes as fine aggregate in Concrete" Journal of Academia and Industrial Research Vol. 1(6).
[14] Yanhong Zheng Zhigang Shen, Chujiang Cai, Shulin Ma, Yushan Xing (2008) Influence of non-metals recycled from waste printed circuit boards on flexural properties and fracture behavior of polypropylene composites. Materials and Design.
[15] Pramila S., Fulekar M.H., Bhawana P., E-Waste- A Challenge for Tomorrow Research Journal of Recent Sciences ,1(3), 86-93, 2012.
[16] Widmer R., Global perspectives on e-waste, Environmental Impact Assessment Review, 25, 436–458, 2005.
[17] Borthakur A., Singh P., Electronic waste in India: Problems and policies, International Journal of Environmental Sciences , 3(1), 353-362, 2012.
[18] Gaidajis G., Angelakoglou K., Aktsoglou D., E-waste: Environmental Problems and Current Management, Journal of Engineering Science and Technology Review , 3 (1) , 193-199, 2010.
[19] Ladou J. , Lovegrove S., Export of electronics equipment waste, Int J Occup Environ Health. ,14, 1-10, 2008.
[20] Aizawa H., Yoshida H. and Sakai S. I., Current results and future perspectives for Japanese recycling of home electrical appliances, Res Conserv Recycl., 52, 1399-1410, 2008.

IS Code

[21] IS 456:2000 Code of practice for plain and reinforced concrete
[22] IS 383:1970 – Specification for coarse and fine aggregates from natural sources for concrete
[23] IS 516:1959 Method of test for strength of concrete
[24] IS 10262-2009 concrete mix design guideline

