INVESTIGATION ON PARTIAL REPLACEMENT OF E-WASTE AS COARSE AGGREGATE IN CONCRETE

Dr.K Ramadevi[1]
[1] *Associate Professor,*
Department of Civil Engineering,
Kumaraguru College of Technology,
Coimbatore-641049.

Menaka D [2]
[2] *PG Student,*
Department of Civil Engineering,
Kumaraguru College of Technology,
Coimbatore-641049.

Abstract

Electronic waste is an emerging issue which causes serious pollution problems to the human and the Environment. E-waste is used as an alternative for coarse aggregate. In year 2014 produce near about 650000 MT of E-waste in India that includes all waste electronics and electrical equipment.

The main aim of this investigation is to study the change in properties of concrete with the replacement of E-wastes as coarse aggregate in concrete. Moreover, due to fast growing construction Industry, the demand for river sand has increased, which tends to use Manufactured sand instead of river sand. The project work is to be conducted on M30 concrete. The partial replacement of Coarse aggregate with ***Electronic waste*** *is in the range of 10%, 20%, 30%. Moreover, 25% of cement is to be replaced by* ***Fly ash*** *and 25% of Fine aggregate is to be replaced by* ***M sand****. The strength test results were compared with those of the Conventional concrete at 7 and 28 days. It is thereby suggested that utilization of this E-waste in concrete will reduce the usage of conventional coarse aggregates which results in conservation of Natural resources.*

Keywords: Electronic Waste (E-Waste), Pollution Problems, M30 Concrete.

I. INTRODUCTION

Concrete is the most widely used building material in construction industry. Concrete is very popular its high strength and durability. Today, the world is too fast and our environment is changing progressively. The generation of E-waste is the fastest growing area and the disposal poses a major problem in the related neighborhood**.** In developed countries, previously it was about 1% of total solid waste generation and now it grows to 2% by 2010. In developing countries, percentage of E-waste is about 0.01% to 1% of the total municipal solid waste generation. **Printed Circuit Boards (PCB)** forms most of its weight by 3% of WEEE (Waste of Electrical and Electronics Equipment) are the fundamental of all Electric and Electronic waste materials.

A. *Electronic Waste*

- Electronic waste or E-Waste, is a defined as an Electronic products that is unwanted, non-working or obsolete, and have essentially reached the end of their useful life.
- Electronic scrap components, such as CPUs, contain harmful components such **as Lead, Cadmium, Beryllium or Brominated flame retardants.**

B. *Objective*

- The main objective is to study the effect of addition of Electronic waste as Coarse aggregate in concrete.

- To determine the hardened properties of E-waste concrete with conventional concrete.
- To determine the Durability Properties of Concrete Specimens.

II TESTS ON HARDENED CONCRETE

A. *Rebound Hammer Test*

Rebound hammer test (Schmidt Hammer) is used to rapid indication of the compressive strength of concrete.

The rebound hammer test method is used for the following purposes:
(a) To find out the compressive strength of concrete.
(b) To assess the quality of concrete in relation to standard requirements.

Table 1 Rebound Hammer test

Mix ID	Rebound number	28th day compressive strength (N/mm^2)
CM	29	22.1
M10	28	20.6
M20	24	14.9
M30	21	12.4

B. *Ultrasonic Pulse Velocity Test*

This test is used to determine the quality of concrete. Ultrasonic pulse velocity method is done as per IS: 13311 (Part 1) – 1992. The method is done by passing an ultrasonic pulse through the concrete specimen and time of travel is measured.

Figure 1 Ultrasonic Pulse Velocity Test

Table 2 Ultrasonic Pulse Velocity Test

Mix ID	Path Length(km)	Travel Time (Mic. Sec)	Velocity (km/s)
CM	0.3	74.4	26.90
M10	0.3	70.6	69.90
M20	0.3	231	8.70
M30	0.3	263	7.60

C. *Modulus of Elasticity of Concrete*

Young ‘s modulus is defined as a measure of the stiffness of an elastic isotrophic material and is a quantity used to characterize materials. A stiffer material will have a higher Elastic modulus. The Cylinder specimen was fitted with compression testing machine and subjected to compression up to 50 % of ultimate cylinder compressive strength.

Table3 Modulus of Elasticity of concrete

Mix ID	Modulus Of Elasticity E_c (Mpa)	
	Experimental value (N/mm²)	Theoretical value $5000\sqrt{fck}$ (N/mm²)
CM	21250	23960
M10	22320	24380
M20	17320	19610
M30	16230	18160

D. *Stiffness of the Prism*

Stiffness is defined as

$$\text{Stiffness} = \frac{P}{\delta}$$

where,

P is the load applied on the body in N
δ is the displacement or deflection (mm)

Table 4 Stiffness of the Prism

Mix ID	Ultimate load(N)	Deflection at ultimate load (mm)	δ (N/mm)	% reduction in stiffness
CM	980	73	13.42	-
M10	980	78	12.56	6.41
M20	550	52	10.57	21.2
M30	500	74	6.75	49.7

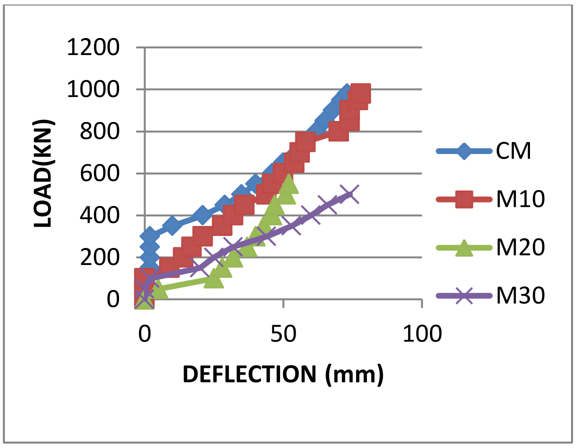

Figure 2 Load -Deflection Behaviour of the prism

E. *Density of the Concrete Specimens*

Concrete would always fail from tensile stresses even when loaded in compression. The density of the concrete is the measure of its unit weight.

Table 5 Density of the Specimens

Mix ID	Density of the specimens (Kg/m³)		
	Cube	Cylinder	Prism
CM	2593.48	2522.16	2690
M10	2406.8	2361.81	2385.2
M20	2303.40	2225.61	2364.6
M30	2106.9	2180.15	2121.2

III DURABILITY PROPERTIES

A. *Water Absorption Test*

This test is used to determine the rate of absorption of water by the cement concrete and measuring the increase in mass of concrete specimen.

Table 6 Water Absorption Test

WEIGHT OF THE SPECIMENS	CM	M10	M20	M30
Oven dry weight (Kg)	8.85	8.7	8.69	8.151
Wet weight (Kg)	8.95	8.739	8.71	8.167
% Water Absorption	1.13	0.44	0.23	0.19

B. *Rapid Chloride Penetration Test*

The test measures the electrical current passing through the concrete specimen for a period of standard 6 hours at a standard voltage of **60VDC**.

Table 7 RCPT Results

Mix ID	Voltage used	Charge passed(coulombs)	Permeability class
CM	60	925	Very low
M10	60	668	Very low
M20	60	275	Very low
M30	60	4	Negligible

Figure 3 RCPT Setup

C. *Permeability Test*

This test determines the depth of penetration of water under pressure in the concrete specimens.

Table 8 Permeability Test Results

Mix ID	Permeability Depth(cm)
CM	3.92
M10	4.1
M20	4.23
M30	4.3

D. *Acid Resistance Test*

Chloride attack is important because it causes corrosion of reinforcement.

Table 9 Acid Resistance Test- 5% of H_2SO_4

Mix ID	Initial weight (Kg)	Reduced weight(Kg)	% Loss of weight
CM	2.607	2.593	0.53
M10	2.599	2.595	0.154
M20	2.567	2.564	0.116
M30	2.4	2.398	0.083

Table 10 Acid Resistance Test – 5% of HCl

Mix ID	Initial weight (Kg)	Reduced weight(Kg)	% Loss of weight
CM	2.610	2.597	0.498
M10	2.603	2.591	0.461
M20	2.567	2.561	0.234
M30	2.41	2.405	0.207

IV CONCLUSIONS

- In the Rebound Hammer test, the compressive strength of E-Waste concrete get reduced when compared with Conventional Concrete.
- In the UPV test, velocity of M10 is more than Conventional Concrete.
- Stiffness and Density of E-Waste concrete get reduced when compared with Conventional Concrete.
- In the **Water Absorption Test**, the % of absorption get reduced compared with control mix.
- In the **RCPT**, the charge passed on the Conventional concrete is more than the E-Waste concrete. In the 30% replacement of E-Waste, the charge passed is negligible.
- Permeability of E-Waste concrete is more than the Conventional concrete.
- The optimum percentage of replacement of E-waste as Coarse aggregate is **10%**.

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