



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 1, January 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

# Effect of E-Waste as Coarse Aggregate in Concrete

Sauhardra Ojha, Kanhaiya Lal Pandey, Amit Singh, Prince Poddar\*

Department of Civil Engineering, IET, Dr. Rammanohar Lohia Avadh University Ayodhya, U.P, India

**ABSTRACT:** The innovative technologies lead to upgrade of E- Equipment's like Smart phones, laptop, Gadgets, etc. The increase in E-waste (Electrical / Electronic) is also inevitable and hence increase in pollution and health hazard cannot be denied. Due to inappropriate management of E-waste, India will generate approximately 4.8 million tons of Electrical waste by 2020. The Utilization of Waste materials in construction industry as by-products is a sustainable solution to E waste management. Use of such waste materials as coarse and fine aggregate makes their reutilization in cement-concrete, RCC and other construction materials, which is more economical as conventional concrete. In this article the effect of E-waste as coarse aggregate on the mechanical properties of M 20 mix concrete has been studied. It has been found that the addition of E-waste causes the concrete to form light weight concrete and also enhance various properties. In this research article 10%, 15% and 20% of E- waste is partially replaced by Coarse aggregate.

**KEYWORDS:** E-waste utilization, Green Concrete, Ecological Pollutant, Electronic Waste (E-Waste),

## I. INTRODUCTION

In recent years, whole world is facing enormous problem due to scarcity of natural resources and waste management. Construction industry is facing the issues of scarcity as natural resources are getting depleted day by day. Concrete is considered as one of the prime important construction material that has to withstand various environmental conditions. Several researchers in recent days have utilised waste materials like electronic waste or e-waste to improve the quality and properties of concrete. E-waste are generally categorised as the electrical and electronics devices that have been discarded. The discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste). There is, however, no standard or generally accepted definition of e-waste in the world. E-waste is not hazardous if it is stocked in safe storage or recycled. The e-waste can, however, be considered hazardous if recycled by primitive methods. E-waste contains several substances such as heavy metals, plastics, glass etc., which can be potentially toxic and hazardous to the environment and human health ,if not handled in an environmentally sound manner (Kale et al 2013). E-waste recycling in the non-formal sector by primitive methods can damage the environment. The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; in water due to contamination of rivers, wells and other water sources; in air due to emission of gases and burning of e-waste. The recycling process, if not carried out properly, can cause damage to human being through inhalation of gases during recycling (Arora, A et al.2013), contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process. The hazardous and toxic substances found in e-waste include lead (Pb) and cadmium (Cd) in printed circuitboards (PCBs). Lead is primarily found in all electronic products/ assembly, cathode ray tubes (CRT) etc. Cadmium is found in monitor/ CRTs while there may be mercury in switches and flat screen monitors. Mercury is also found in CFL, relays and some other specific products. Besides the cadmium in computer batteries, cadmium is also used for plating metal enclosures/ metal parts in sub-assemblies (Ghosh .B et al.2015). Polychlorinated biphenyls are found in capacitors and transformers and as brominated flame retardant on printed circuit boards, plastic casings, cable and polyvinyl chloride (PVC) cable sheathing for insulation and PBD/PBDE in plastic parts of electronics. No exclusive study has so far been made to know the effect of the e-waste in the environment. (Zhitong Yao et al. 2018).

## II. MATERIAL USED

Details of various material used for this work has been given here in a well-defined manner in order to understand the properties and need of these materials.

**2.1-FineAggregate**

Fine aggregates are small size filler materials in construction, they are the particles that pass through 4.75 mm IS sieve and retain on 0.075 mm sieve. Sand, surkhi, stone screenings, burnt clays,cinders, flyash and also stone dust etc. are used as fine aggregate in concrete. The surface area of fine aggregates is higher and the voids between the coarse aggregate are filled up by fine aggregate.[7]

Stone dust as fine aggregate is used during mix design the properties of the material is given below.

**Table 1 Physical properties of stone dust of zone II**

Properties	Value
Specific Gravity	2.7
Water absorption (%)	8
Density in loosest state (g/cc)	1.7
Density in densest state (g/cc)	1.9

**2.2-CoarseAggregate**

Coarse aggregates are larger size filler materials in construction works and coarse aggregates are the particles that retain on 4.75 mm sieve [8], some of the good example for coarse aggregate can be given as brickchips(brokenbricks),stonechips(brokenstones),gravels,pebbles,clinkers,cindersetc.Dolomite aggregates, crushed gravel or stone, natural disintegration of rock are the major sources ofcoarse aggregate. The surface area of coarse aggregate is less than fine aggregates and also coarseaggregate acts as inert filler material for concrete while they are mainly used in concrete, railway trackballast, etc.

Coarse aggregate for concrete, except as noted above and for other than lightweight concrete shallconform to IS 383. This shall consist of natural or crushed stone and gravel and shall be clean and freefrom elongated, flaky or laminated pieces adhering coatings, clay lumps, coal residue, clinkers slag,alkali, mica, organic matter or other deleterious matter.

**2.3-Electrical/Electronic Waste (E waste )**

We have selected the range of electrical waste of size in between 4.75mm to 20mm for this project as it can be seen in figure 1.



**Fig.1. electronic waste as coarse aggregate**

## 2.4 Cement

Cement is a binder substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used alone but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource. OPC33 grade is used in this project as it is used for moderate strength works and perfect for M20 grade concrete. The properties of OPC 33 grade as per IS code is given below in table 2

**Table 2 : Physical Properties of OPC 33 Cement**

Characteristics	Test value (OPC33 Grade)
Normal consistency %	32.5
Specificgravity	3.15
Fineness(cm <sup>2</sup> /gm)	2340
3dayscompressive Strength, MPa	18
7dayscompressive Strength, MPa	24
28 days compressive Strength ,MPa	36

### III. CTM (Compression Testing Machine)

Compression testing is one of the most fundamental types of mechanical testing of concrete. Compression tests are used to determine a material's behavior under applied crushing loads, and is typically conducted by applying compressive pressure to a test specimen (usually of either a cube or Cylinder) using platens or specialized fixtures on a universal testing machine. During the test, various properties of the material are calculated such as compressive strength.

CTM can be seen in figure 2 given below, this compression testing is manual testing machine as it is operated by hand through a lever provided which is moved up and down which results in compression of the plates of compression testing machine which compresses the cube in between and a dialgauge is provided to record the strength of that cube.



**Fig. 2 Compression testing Machine**

**IV. METHODOLOGY**

The cubes were prepared by replacing Coarse Aggregate by 0%, 10%, 15% and 20% by e-waste in concrete. The size of e-waste taken in the range of 4.75-20mm. Cement used was OPC 33 and grade used was M20. Standard size of cube casted should be of the size 15x15x15 in cm. Compression testing machine was used for calculating the difference in compressive strength of the cube casted with having e-waste as coarse aggregate and with standard coarse aggregate. Total Number of cubes casted for testing was 36. Compressive test will be conducted on the 7<sup>th</sup> day, 14<sup>th</sup> day and 28<sup>th</sup> day with the replacement containing 0%, 10%, 15% and 20% having 3 cubes of similar Percentage. Average compressive strength was calculated by the compressive strength calculated on the 3 cube samples of same e-waste concentration.

**V. RESULTS AND DISCUSSION**

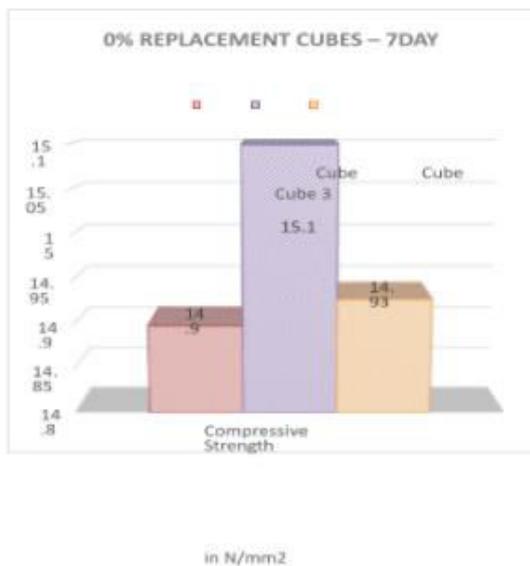


Fig.3. Conventional cubes strength at 7 days

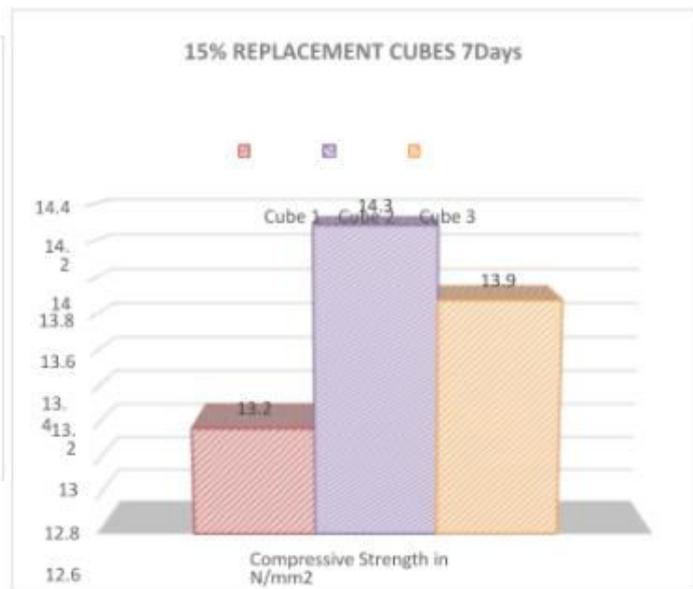


Fig.4. Cubes strength (15% E waste ) at 7days

**Table 3 Strength Comparisons of Various Cubes (Average Strength)**

	0% e-waste	10% e-waste	15% e-waste	20% e-waste
<b>Day 7</b>	14.97 N/mm <sup>2</sup>	15.63 N/mm <sup>2</sup>	13.96 N/mm <sup>2</sup>	13.73 N/mm <sup>2</sup>
<b>Day 14</b>	20 N/mm <sup>2</sup>	20.27 N/mm <sup>2</sup>	18.4 N/mm <sup>2</sup>	18.3 N/mm <sup>2</sup>
<b>Day 28</b>	24.6 N/mm <sup>2</sup>	25.36 N/mm <sup>2</sup>	23.43 N/mm <sup>2</sup>	22.36 N/mm <sup>2</sup>

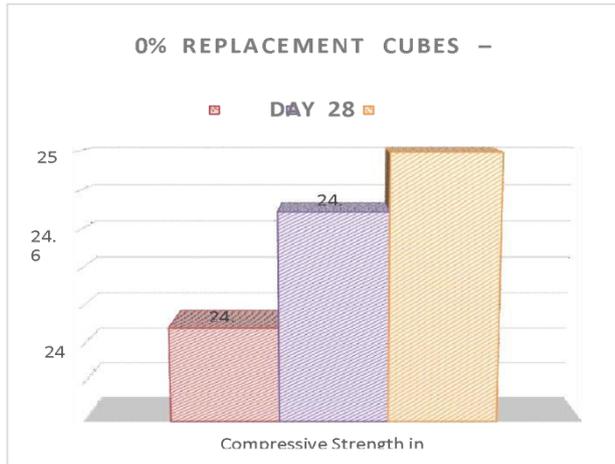


Fig.5. Cubes strength (10% E waste) at 7days

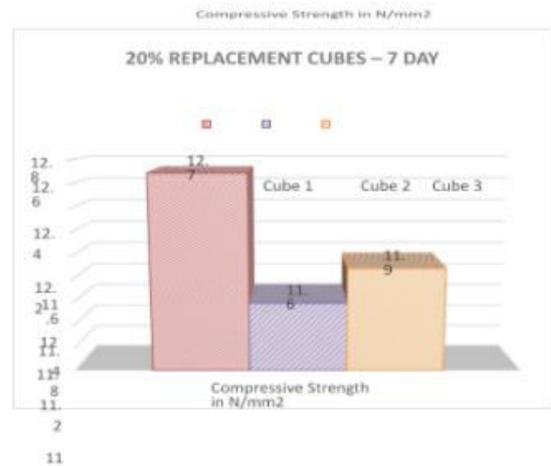


Fig.6. Cubes strength (20% E waste) at 7days

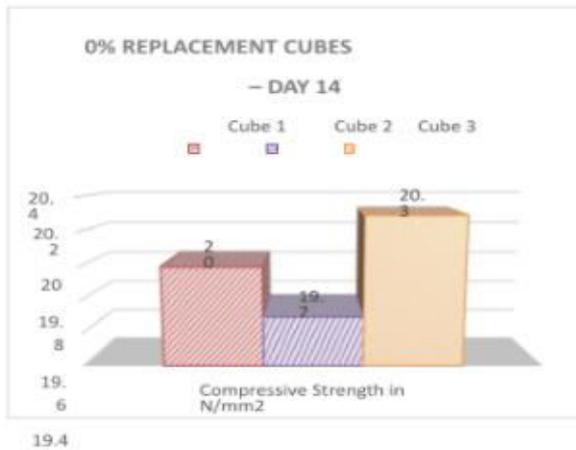


Fig. 7. Conventional cubes strength at 14 days

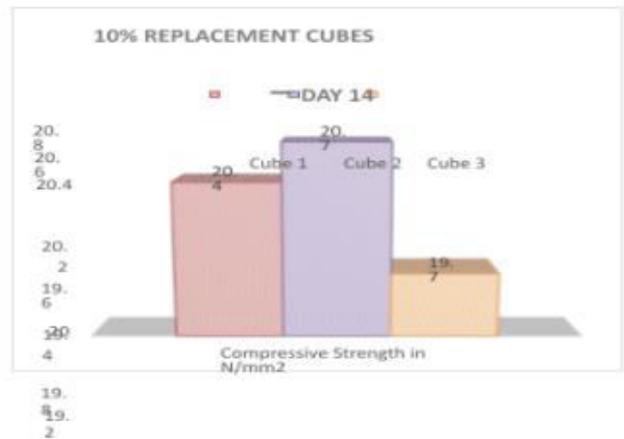


Fig. 8. Cubes strength (10% E waste) at 14 days



Fig. 9. Cubes strength (15% E waste) at 14 days

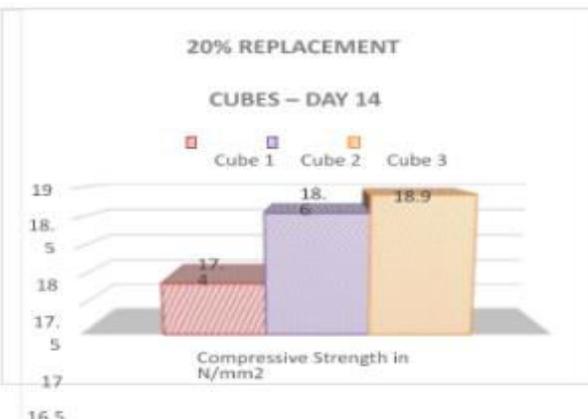


Fig.10. Cubes strength (20% E waste) at 14 days

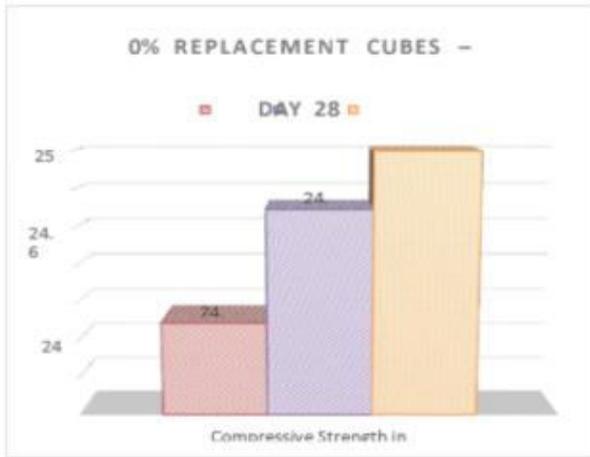


Fig .11. Conventional cubes strength at 28 days

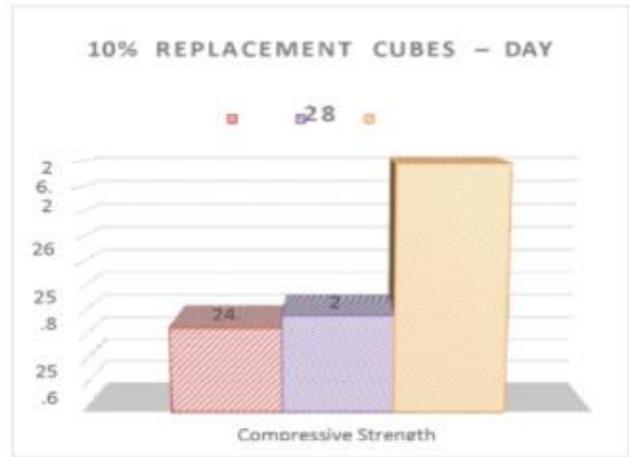


Fig.12. Cubes strength (10% E waste ) at 28 days

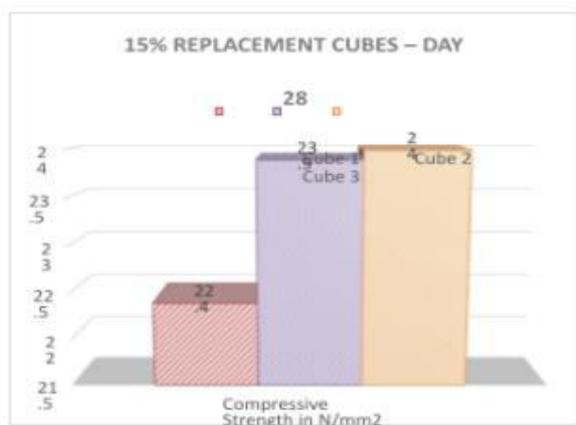


Fig.13. Cubes Strength (15 % E waste) at 28 days

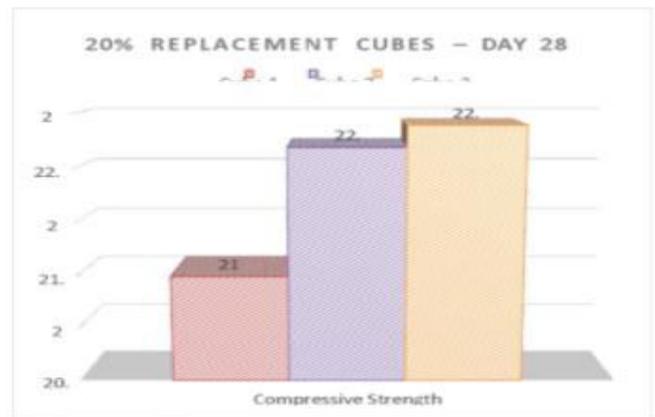


Fig .14. Cubes Strength (20% E waste) at 28 days



Fig.15. Combined data of all cube strength with % replacement and No of days



## VI. SUMMARY AND CONCLUSIONS

Following points can be deduced from the experiment performed above, which can be summarized as following -

1. As the amount of electrical waste increases, strength increases from 0% to 10% but when the amount is further increased the decrease in strength can be noted from 15% to 20%.
2. Hence this experiment was successful in utilization of electrical waste in concrete for M20 grade
3. The highest strength can be noted at 10% electrical waste when mixed in coarse aggregate than the other percentages
4. At day 7, 10% electrical waste has shown 4.408% increase in strength than the conventional cubes.
5. At day 14, 10% electrical waste has shown 3.35% increase in strength than the conventional cubes.
6. At day 28, 10% electrical waste has shown 3.089% increase in strength than the conventional cubes.
7. So, from the above we can finally conclude that we can use electrical waste in concrete to solve various environmental problems like pollution and also save human or living life from poisonous chemicals and this will also be accompanied by greater strength than the conventional concrete.

## REFERENCES

1. Zhitong Yao., Tung-Chai Ling., P.K.Sarker., Weiping Su., Jie Liu Weihong., Wu Junhong Tang., "Recycling difficult to-treat E-waste cathode-ray-tube glass as construction and building materials", 2018.
2. Alagusankareswari, K., Kumar, S. S., Vignesh, K. B., & Niyas, K. A. H. (2016). An experimental study on E-waste concrete. *Indian Journal of Science and Technology*, 9(2).
3. Kale, S. P., & Pathan, H. I. (2013). Recycling of Demolished Concrete and E-waste. *International Journal of*, 260-268.
4. Ghosh .B, Ghosh.MK, Parhi. P, Mukherjee. PS , Mishra B.K (2015)"Waste Printed Circuit Boards recycling: an extensive assessment of current status", *Journal of Cleaner Production* 94, pp. 5-19
5. Arora, A., & Dave, U. V. (2013). Utilization of e-waste and plastic bottle waste in concrete. *International Journal of Students Research in Technology & Management*, 1(4), 398-406.
6. Raut, Sagar R., Roshani S. Dhapudkar, and Monali G. Mandaokar. "Experimental study on utilization of E-waste in cement concrete." *The International Journal of Engineering and Science (IJES)* 5.5 (2018): 82-86.
7. IS 456:2000 - Bureau of Indian Standards, Indian Standard Code of Practice for Plain and Reinforced Concrete.
8. IS 383:1970 Bureau of Indian Standards, Indian Standard specification for coarse and fine aggregate .
9. IS 269:2013 Bureau of Indian Standards, Indian Standard Code of Ordinary Portland cement 33 Grade



**Impact Factor:  
7.569**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details