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An Experimental Study on Concrete by Using E-Waste as Partial Replacement of Coarse Aggregate

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Abstract: ***The world population been growing rapidly and the urbanization spreading widely throughout the world. These been cause remarkable increase in the development of the construction industry which causing a huge demand for concrete and it is resulting in exceeding generation of natural resources. Therefore an alternative source is essential to replace the materials used in concrete. In other hand, Electronics industries also been growing rapidly and the electronic products have became integral part of daily life of people throughout the world. This is causing the rapid production of electronic products and this resulting the production of a huge quantity of E-waste every year throughout the world. These E-wastes have serious human health concerns and required extreme care in it's disposal to avoid any adverse impact. Disposal or dumping of these also cause major issues because it is highly complex to handle and they contain highly toxic chemicals. But many studies say that the E-wastes can be incorporated in concrete and it helps to make a sustainable environment. Therefore This project explores the feasibility and Impact of incorporating electronic waste (E- waste) as partial replacement of coarse aggregate in traditional cement concrete. In this experimental research we are replacing the coarse aggregate by E-Waste by 0%, 5%, 10%, 15% and 20% of the volume of course aggregate in M20 Concrete and Hence test it for Compressive strength and uniformity. The tests are conducted on the 7th, 14th and 28th day of Curing.***

Keywords: Concrete, E-waste, Compressive strength, UPV, M20, Replacement, Coarse aggregate.

I. INTRODUCTION

In the present world two of the most common problems are the handeling of E-waste and shortage of natural resources that provide material for building construction.

Almost every country produces the e waste and China, US and India are the three countries that produce major part of e waste. Reports say that there is 347 Million metric tons of unrecycled e waste present in the world till the year 2024. Germany, UK and france are the three countries that recycle the 50% to 60% of the e waste produced per year and China recycles the highest amount of e waste by weight i.e., >1600 Kilo tons per year.

The disposal of E-waste have been a major problem in the field of waste management. If it is processed then it will cause seriouse health and environmental problems, especially in the populated areas due to the presence of hazardous chemicals such as lead, cadmium, etc. The potential application of e-waste in concrete is to be partial replacement of aggregates depending on their chemical preperties and grain size. And it is very feasible to reuse the e-waste in concrete. E-waste particles can be used as coarse aggregate, fine aggregate or fine fillers based on their chemical composition and particle size. E-waste can be collected from the commercial informal recyclers in the form of loosely discarded, obsolete, surplus, brocken, electrical or electronic devices which were crushed and ground.

II. LITERATURE REVIEW

1) Lakshmi R, Nagan S : (Nov 3. 2010) Volume 1 , ISSN 0976-4402

" studies on concrete containing E-plastic waste."

This Experimental study is made on the Utilization of E-waste particle as Coarse aggregate in a concrete with a percentage of replacement ranging 0% 4% 8%.....30% on strength criteria of M20 concrete, Compressive strength of concrete with a fly ash compressive strength is executed. Maximum Compression strength achieve without fly ash is : 4% of replacement at 28 days of curing (Strength obtained is 19.89N /mm2)

Maximum strength achieved with fly ash is : 4% of E-waste replacement at 28 days of Curing (obtain strength is 27.83 N/mm2)

2) S. R Shamili , C Natarajan, J Karthikeyan: (Nov :10 2017) Vol 11

"An overview of Electronic waste as Aggregate in Concrete."

This paper provides a detailed Explanation on the behavior of concrete with incorporation of E-waste . E-waste replace as a fine aggregate , replacement range is 0% 5% 10% 15% and 20% . Replacement effect on Compressive strength, workability , when Increases the e-waste that time compressive strength will be decreases

3) P Muthupriya and B Vignesh kumar (2021):
"Experimental investigation on concrete with E-waste – A way to minimize solid waste deposition"
This work conducted on M25 Concrete. The Replacement of CA with e-waste in the range of 0% 5% 10% & 20%. Finally the mechanical properties of concrete mix obtain strength such as Compressive, Split tensile and Flexural strength without adding fly ash, It is well understood e-waste Can be used as an alternative for concrete making material.

4) P. Krishna Prasanna, M.Karda Rao (Jan - June 2014) vol-4, Issue _2 ,ISSN: 2348-0033 / ISSN: 2249-4944
" Strength variations in concrete by using E-waste as CA."
An Experimental Study is made by preparing specimen by utilizing E-waste particles as course aggregate with replacement from 0% to 20% and Conventional specimens are also prepared for M20 grade. It is observed that Strength of concrete & reduced by 33.7% when CA is replaced by 20% of E-waste.

5) B. M. Dilip Kumar , J. Sai Krishna Reddy vol-10 Issue -07 , july-2023 ISSN-2395-0056
" Study on strength of concrete with partial replacement of E-waste"
This research work focuses on cetilisation of E-waste & Construction demolition waste as partial replacement of CA in concert. Also the changes in properties of concrete & replace the aggregate with 5%. 7.5% & 10% of E-waste.

6) S.S.Singh ,Arun Patel • vol-3, Issue 09 ,2015 , ISSN- 2321-0613
" Utilization of E-waste in high strength cement concrete"
The main aim of the study is to investigate the change in mechanical properties of concrete with the addition of e-waste in concrete .It is found that use of E-waste aggregate results in formation of lightweight concrete. The CA is partially replaced up to 25% with regular Interval of 5% in concrete of grade M50.

7) V.Rathore and A.Rawat,
"Effective utilization of electronic waste in concrete mixture as a partial replacement of Coarse Aggregates", AIP Conference Proceedings 2158,020037(2019). ISSN-2395-0072.
V.Rathore at (2019) carried out investigation with replacement of Coarse Aggregate with E-waste in the range of 5%,10%,15%,20%,25% and 30%.They found that compressive strength of concrete is 20.35% higher when coarse aggregate is replaced by 15% of two sizes of e-waste materials.

8) Suchitra.S,Manoj Kumar.Indu V.S
"Study in replacement of Coarse Aggregate by E-waste in concrete". International Journal of Technical Research and Applications,Volume 3, Issue 4,(July-August 2015),266-270. ISSN-2395-0072.
Suchitra have conducted an experimental investigation on partial replacement of E-waste in the range of 0%, 5%, 10%, 15% & 20% with coarse aggregate on the M20 grade mix. The addition of E-waste shows increase in compressive strength upto 15% replacement. Flexural to tensile strength have occurred even upto 15%replacements.Thus the author concluded that it is possible to use E-waste in concrete as environment friendly manner.

9) Pravin A. Manatkar,Ganesh P Deshmukh,
"Use of non-metallic E-waste as Coarse Aggregate in a concrete" International Journal of Research in Engineering and Technology, Volume 04, Journal 03,March 2015.ISSN-2395-0072
Pravin A Manatkar (2015) have analyzed compressive strength of M20 &M25 grade of concrete by replacing coarse aggregate by adding non-metallic E-waste in 0%-20%(0%,5%,10%,15%,20%).They have observed that compressive strength decreases with increasing E-waste percentage for both grades.Upto 5%,it is nearly same to normal concrete but after 15%,it reduces maximally. Upto 56% replacement of E-waste is suitable to use upto (G+2) building construction and road construction.
E-waste concrete block having flexibility will not fail during test.Firstly it compresses upto 1cm then breaks.

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III. PHYSICAL PROPERTIES OF E-WASTE PARTICLE AND CONCRETE MATERIALS

Table 3.1 represents the physical properties of e-waste particle and coase aggregate.

Table 3.1

Properties	E-waste	Coarse aggregate
Specific gravity	1.12	2.65
Absorption	<0.2	0.42%
Colour	green	Dark grey
Shape	Angular	Angular

IV. CONCRETE MIXES

The details of concrete mix with various e-waste content are presented in the Table 4.1. The mix proportion and strength criteria of M20 grade was adopted for concrete mix.

Table 4.1

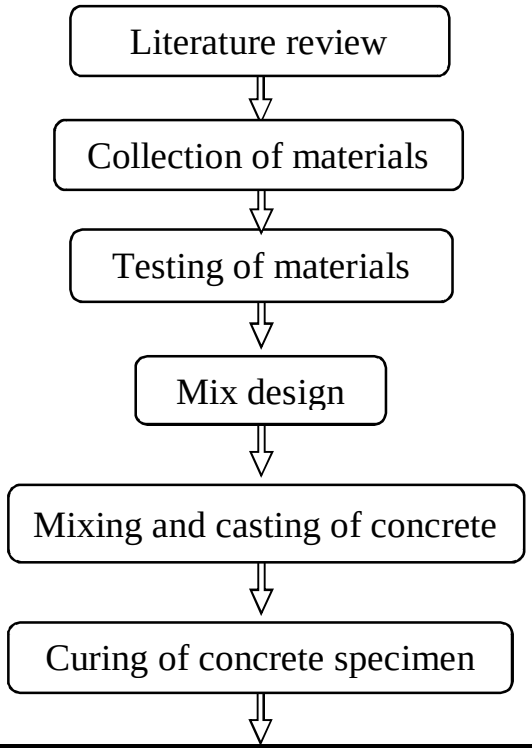
Mix specification	A1	A2	A3	A4	A5
Propotion of E-waste	0%	5%	10%	15%	20%

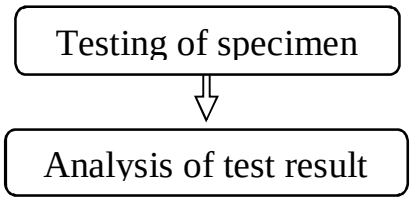
Table 4.2 represents the materials content to be used as per the mix design calculations for M20 concrete with suitable stipulations and material data.

Table 4.2

Material	Content
Cement	358.18 Kg/m^3
Water	197 ltr
Coarse Aggregate	662.117 Kg/m^3
Fine Aggregate	1122.66 Kg/m^3
Water Cement Ratio	0.55

V. RESEARCH METHODOLOGY

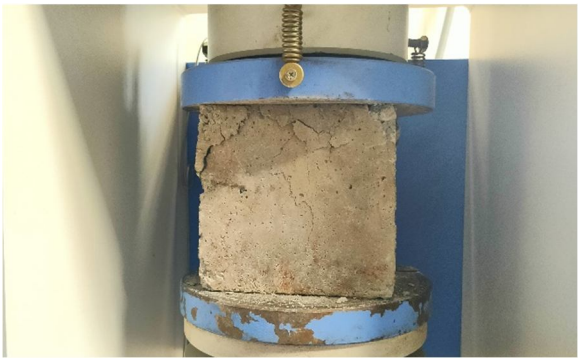




VI. TESTS CONDUCTED

A. *Compression Test*

The compressive strength test was conducted on the concrete cubes of 150mm side. The compresion testing machine was used for testing. Three cubes of each mix specification are tested and average compressive strength was noted.



B. *Ultrasonic Pulse Velocity (UPV) test*

The UPV strength test was conducted on the concrete cubes of 150mm side. The UPV testing machine was used for testing. Three cubes of each mix specification are tested and average time taken and UPV were noted.

Table 6.2 : Quality criteria

Velocity (Km/s)	Classification	Overall strength (mg/cm^2)
Above 4.5	Excellent	300 to 500
3.5 to 4.5	Good	250 to 300
3.0 to 3.5	Medium	200 to 250
Below 3.0	Poor	150 to 200

VII. RESULTS AND DISCUSSION

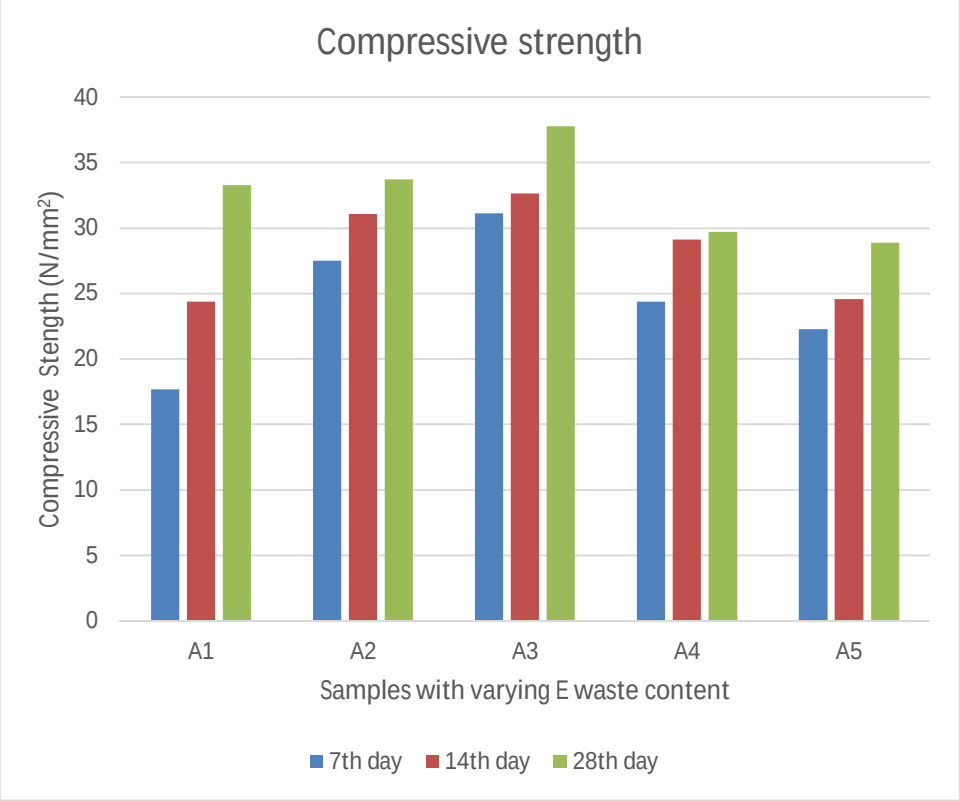
A. *Results of Compression test*

Table 7.1 represents the development of compressive strength in the concrete specimen with various e-waste content at 7th, 14th and 28th day of curing.

Table 7.1: Compression test results

Specimen	Compressive strength (N/mm^2)		
	7th day	14th day	28th day
A1	17.7	24.4	33.3
A2	27.5	31.1	33.7
A3	31.11	32.66	37.8
A4	24.4	29.11	29.7
A5	22.3	24.6	28.88

Chart 7.1: Variation of compressive strength



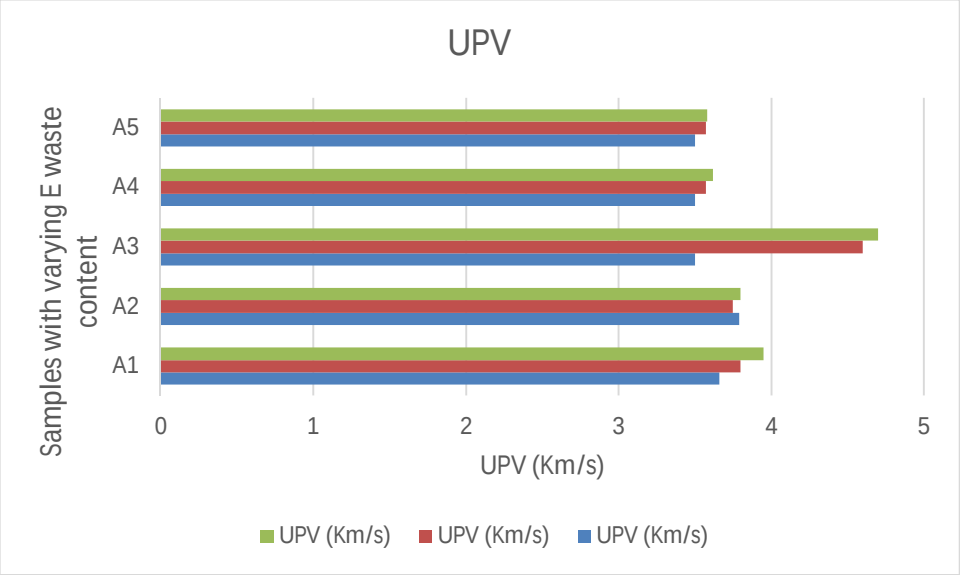
B. Results of UPV test

Table 7.3 represents the development of UPV in the concrete specimen with various e-waste content at 7th, 14th and 28th day of curing.

Table 7.2: UPV results

Specimen	UPV (Km/s)					
	7th day		14th day		28th day	
	Time (10^{-6})s	UPV (Km/s)	Time (10^{-6})s	UPV (Km/s)	Time (10^{-6})s	UPV (Km/s)
A1	40.98	3.66	39.47	3.8	37.97	3.95
A2	39.6	3.79	40	3.75	39.47	3.8
A3	42.85	3.5	32.6	4.6	31.91	4.7
A4	42.85	3.5	42.01	3.57	41.43	3.62
A5	42.85	3.5	42.01	3.57	41.89	3.58

Chart 7.2: Variation of UPV



By Conducting UPV test, the concrete fond to be GOOD in quality as per quality criteria.

VIII. CONCLUSION

By conducting this experimental project, we came to a conclusion that using the e waste as partial replacement of coarse aggregate in concrete mix is possible and it is one of the best way to dispose or use the e waste.

We observed that 10% replacement of Coarse aggregate by e waste would provide more compressive strength to the concrete. So we can adopt this in construction field with suitable method. Using of e waste as a partial replacement of coarse aggregate gives many advantages such as,

1) Effectively reduce the demand upon the natural resources.
2) Reduce the cost and production of coarse aggregate.
3) Reduce the environmental pollution by landfills and deposits of e waste.
4) Waste utilization and recycling can prove to be beneficial to society by reducing the green house gases to atmosphere.

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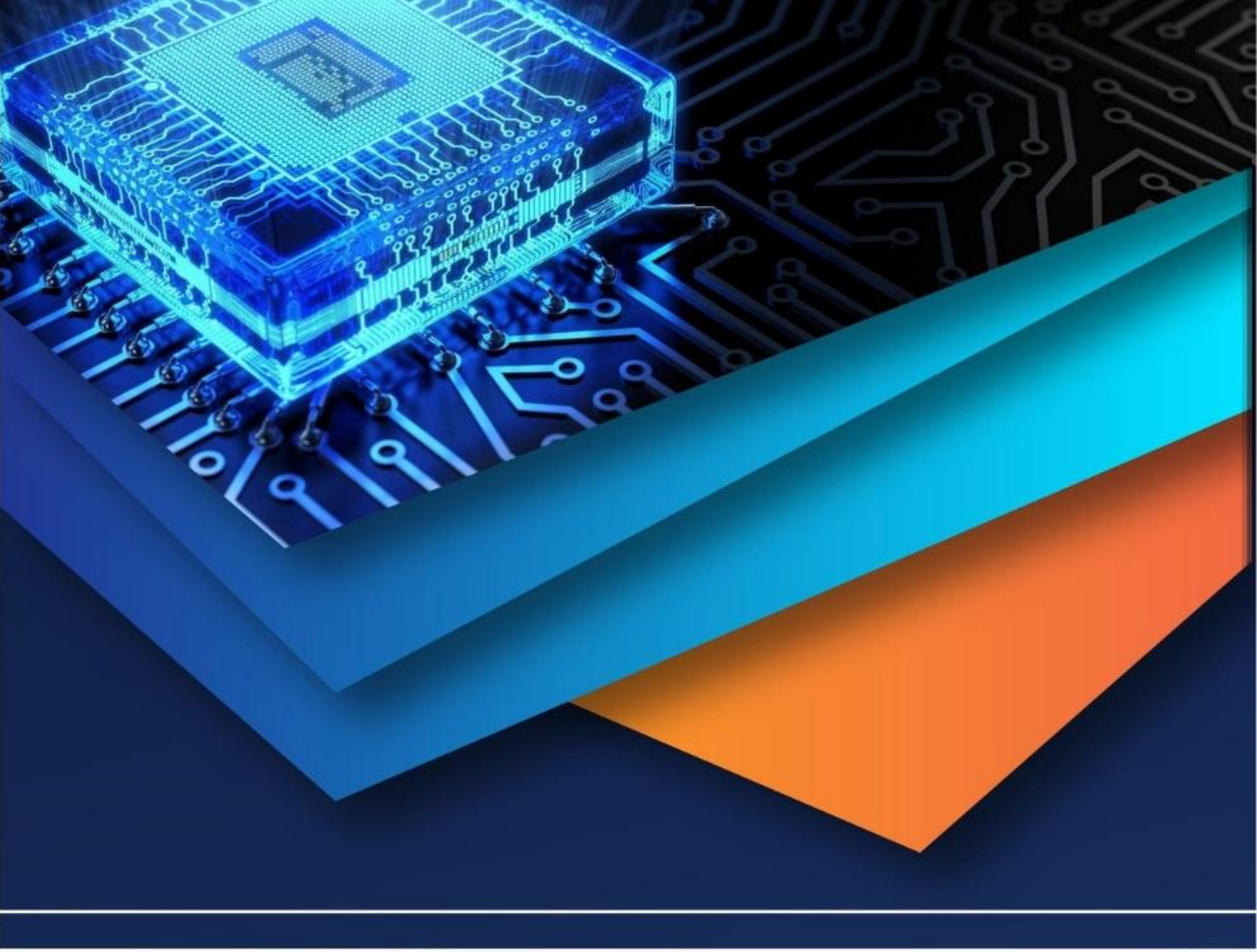

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