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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

The rapid growth of electronic industries has led to a significant increase in electronic waste (E-waste), posing serious environmental challenges due to improper disposal. In response to this issue, this study explores the potential use of E-waste as a partial replacement for natural coarse aggregate in concrete. The main objective is to evaluate the mechanical and physical performance of concrete when coarse aggregates are partially replaced with E-waste materials such as crushed printed circuit boards and plastic components. Concrete mixes were prepared with varying percentages of E-waste (0%, 6%, 12%, 18%, and 24%) by weight of coarse aggregate. Standard tests including compressive strength, split tensile strength, and flexural strength were conducted after 7, 14, and 28 days of curing to assess the impact of E-waste on concrete performance. The workability of fresh concrete was also evaluated using the slump test. The study concludes that E-waste can be effectively utilized in concrete as a sustainable construction material, contributing to waste reduction and resource conservation.

Key words :

E-Waste, Compressive strength test, Split tensile strength test, Flexural strength test

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CHAPTER 1

INTRODUCTION

Background :

Concrete is the most widely used construction material in the world due to its durability, strength, and versatility. It is composed of cement, fine aggregates, coarse aggregates, and water. Among these, coarse aggregates occupy a significant volume and play a crucial role in defining the strength and stability of concrete. However, the continuous extraction of natural aggregates from riverbeds and quarries has raised environmental concerns, including depletion of natural resources and ecological imbalance.

At the same time, the global increase in electronic devices has led to a surge in electronic waste (E-waste), which includes discarded computers, mobile phones, televisions, and other electronic appliances. E-waste contains non-biodegradable materials such as plastics, metals, and glass, which pose serious environmental and health hazards when improperly disposed of in landfills or through open burning.

Need for the Study :

With increasing environmental regulations and the need for sustainable construction practices, there is a growing interest in utilizing waste materials in concrete. The partial replacement of natural aggregates with E-waste offers a promising solution to two major challenges: reducing the burden on natural aggregate sources and managing the disposal of E-waste. If proven effective, this approach could significantly contribute to eco-friendly and economical construction.

Objective of the Study :

The primary objective of this study is to evaluate the performance of concrete when a portion of the coarse aggregate is replaced with E-waste. The specific goals include:

- To analyze the workability of fresh concrete with E-waste.
- To determine the compressive strength, split tensile strength, and flexural strength of concrete at different replacement levels (e.g., 0%, 6%, 12%, 18%, 24%).
- To compare the mechanical properties of E-waste concrete with conventional concrete.
- To assess the feasibility of using E-waste as a construction material in practical applications.

Scope of the Study :

This study focuses on the use of non-metallic, shredded E-waste materials such as plastic housings and crushed circuit boards as partial replacements for coarse aggregates. The investigation includes laboratory testing of mechanical properties over a curing period of 7, 14, and 28 days. The findings are expected to provide insights into the potential use of E-waste in structural and non-structural concrete applications.

CHAPTER 2

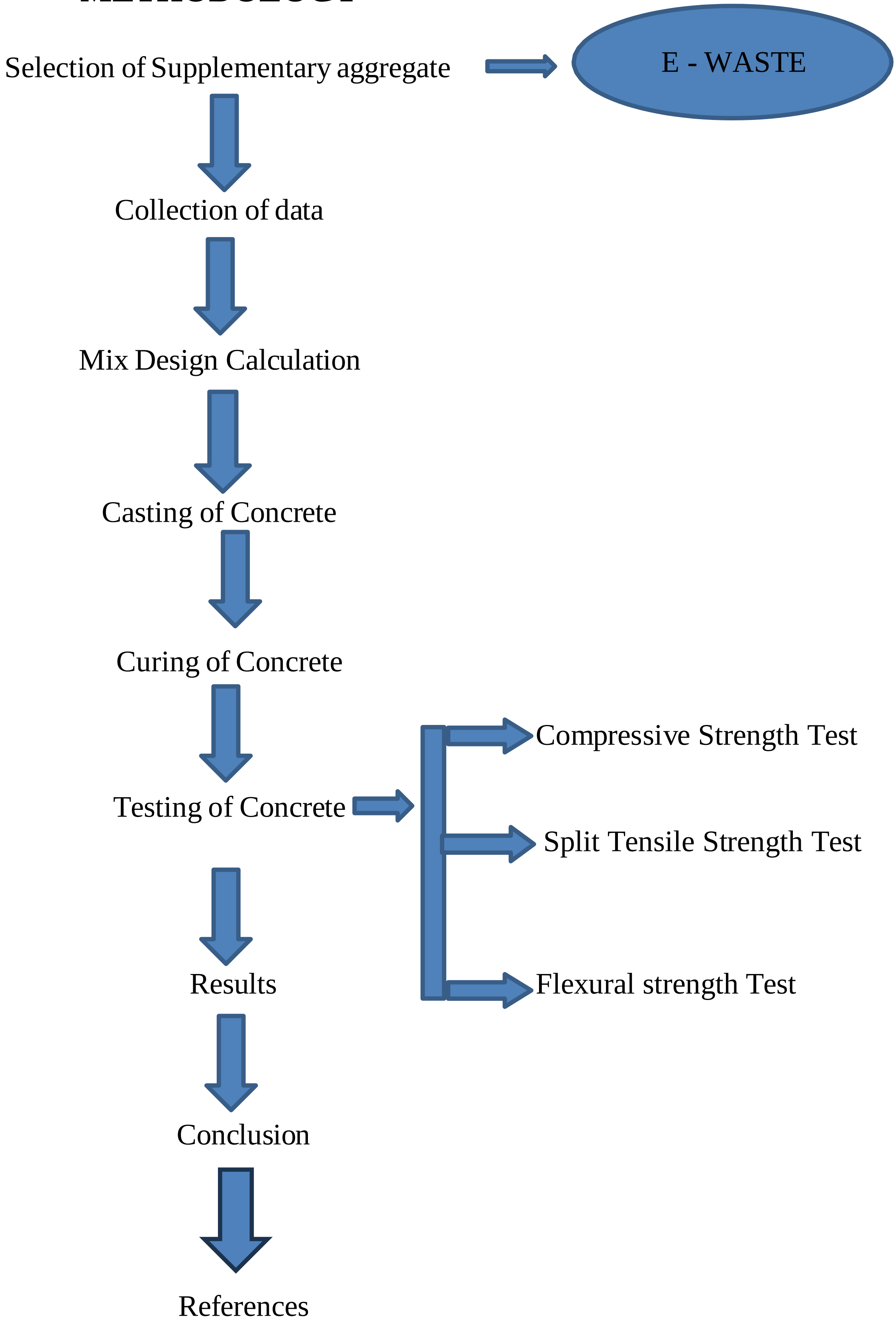
LITERATURE REVIEW

S.I NO	JOURNAL PAPER TITLE	AUTHOR'S NAME	REMARKS
1.	Study on Replacement of Coarse Aggregate by E-Waste in Concrete (2015)	Suchithra.S Indu .VS, et.al.,	• The addition of E-waste shows increase in compressive strength up to 15% replacement. • Increase in split tensile strength is almost insignificant whereas gain in flexural tensile strength have occurred even up to 15 % replacements.
2.	An Experimental Study on Concrete by using E-Waste as Partial Replacement for Coarse Aggregate (2016)	Sunil Ahirwar, Pratiksha Malviya, et.al.,	• Workability of the concrete increases when percentage of the electronic waste increases • Cement replacement of 30% by fly ash along with electronic waste gives best result. • Current study concluded that Electronic waste can replace coarse aggregate upto 10% or 20%. • Current study also concluded that electronic waste can replace coarse aggregate upto 30% in concrete when 30% fly ash is replaced by cement

3.	An Experimental Study on Partial Replacement for Coarse Aggregate by E-waste in Concrete (2017)	K.Saranya, Muthuswamy, R.Sathiyaraj, A.Sudharsan, et.al.,	• In this project, the Compressive strength and split tensile strength have been studied for various replacements of coarse aggregate (32%, 34%, 36 %, 38%) by E-waste. • We have the optimum percentage of replacement is 34%. Its strength more than the conventional concrete. • E-waste concrete provide high Non permeability and safe compared to normal concrete construction. • Based on the results, E-waste is recommended in concrete for an economical construction
4.	Partial replacement of coarse aggregate using E-waste (2020)	A.Rajesh, J. Louis Maria Leveil, R.Sasikumar, V.Karthikeyan, et.al.,	• Greater compressive strength is achieved when E-waste is replaced by 15% • Addition of E-waste in Concrete reduces the self-weight of conventional Concrete and can be utilized for constructing lightweight structures. • May be at higher risk of conducting electricity since E-waste particles contain permits electricity to pass through • E-waste is found to be a better replacement for coarse aggregate, thereby by saving earth’s natural resource.

CHAPTER 3

METHODOLOGY



CHAPTER 4

MATERIALS AND TESTS

4.1 MATERIALS REQUIRED

The quality of concrete can be achieved by selection of suitable materials, admixtures and choice of mix proportions, W/C ratio and use of proper methods of placements and curing. All these aspects depend upon material and admixtures.

4.1.1 CEMENT :

In the present investigation, Ordinary Portland Cement 43 grade, confirming to IS specifications was used. The specific gravity of the cement is 3.16.

Fig 4.1 CEMENT

4.1.2 FINE AGGREGATE :

Locally available M - sand, confirming to IS specifications with a specific gravity of 2.7, was used as the fine aggregate in the concrete

Fig 4.2 FINE AGGREGATE

4.1.3 COARSE AGGREGATE :

Machine crushed aggregate confirming to IS 383-1970 obtained from the local quarry was used in this study. The nominal sizes of aggregate adopted in the present investigation were 20mm. Specific gravity of coarse aggregate study were 2.60.

Fig 4.3 COARSE AGGREGATE

4.1.4 WATER :

Water is an important component of the concrete curing process and it is used in several ways to ensure that the concrete sets and hardens properly. During the initial stage of curing, water is used to keep the concrete moist, which prevents it from drying out too quickly and cracking.

4.1.5 E-WASTE :

E-waste, or electronic waste, is discarded electrical and electronic equipment. It encompasses a wide range of items, including computers, phones, appliances, and TVs. The term "e-waste" is a broad category encompassing all types of discarded electrical and electronic equipment.

Fig 4.4 E - WASTE

4.2 TEST ON MATERIALS:

4.2.1 TEST ON CEMENT:

4.2.1.1 FINENESS MODULUS OF CEMENT:

Fineness of cement is carried out to check proper grinding of cement. It should be checked with the sieve 90 micron's it is the measure of surface area of cement particles for Ordinary Portland Cement, the fineness by weight should not be more than 10%.

1. 100 gm of cement sample was weighted accurately in plate and transferred it to a clearly dry I.S Sieve of 90 micron's air set lumps was broken down.
2. Cement was sieved by gentle wrist motion until most of the fine materials pass through and the residue looked fairly clean.
3. Sieve was done for 15 min.
4. The residue was weighted.
5. Fineness of cement was calculated by the formula.
6. Fineness = (Weight of residue / Weight of sample) x100
7. Procedure is repeated for two more samples.
8. This weight shall not exceed 10 percentage for ordinary cement.

Table: 4.1 Fineness Modulus of Cement

Weight of sample taken = 100 gms

Cement sample	Weight of sample (W1) (gm)	Weight of sample (W2) (gm)	Percentage weight of residue (w1 / w2) (%)
1	100	3	3%
2	100	3	3%
3	100	3	3%

Percentage of cement retained = (3/100) x 100

= 3%

RESULT:

Fineness of cement = 3%

4.2.1.2 SPECIFIC GRAVITY OF CEMENT

Specific gravity of cement is the ratio of its weight in air for the weight on equal volume of kerosene.

1. Weight the empty Specific Gravity Bottle capacity of 250 ml with stopper and note it as W1.
2. About 50 gms of cement is poured into the Specific Gravity Bottle and the content is weighed W2. (%) (gm) 10
3. Kerosene is added and the Bottle is filled completely. All the air present is removed and the content is weighed and noted as W3.
4. Then the Bottle is cleaned and completely filled with kerosene, it is weighed and noted as W4.
5. Specific Gravity of cement can be calculated by using the following formula,

$$= (W2-W1)/(W2-W1) - (W3-W4)$$

Table 4.2 Specific Gravity of Cement

Trial	W1(gm)	W2(gm)	W3(gm)	W4(gm)	Specific Gravity
1.	72	139	205	159	3.19
2.	72	135	202	159	3.14
3.	72	138	204	159	3.15

RESULT:

Specific gravity of cement = 3.16.

4.2.2 TEST ON FINE AGGREGATE:

As per IS: 383-1970 code provisions the following test were carried outstand test results are tabulated. The discussions also mentioned here with.

4.2.2.1 FINENESS MODULUS OF FINE AGGREGATE:

Fineness modulus is defined as the empirical value obtained by adding the Cumulative percentage of the material retained by weight in each of a series of sieves and dividing the total thus obtained by 100. For good concrete, the value of fineness modulus for the fine aggregate should be up to 2–3.50.

- 1kg of dry sand is taken. The sieves are arranged in the order as given in the observation table.
- Pan is placed at the bottom. Now, the aggregate is transferred to the top sieves and Lid check is kept.
- The whole arrangement is kept in the mechanical sieve shaker and sieved for 15 min.
- The aggregate retained in each sieve is weighted and noted down.
- The fineness modulus is calculated.
- Fineness Modulus = Total sum of the cumulative% retained / 100

4.2.2.2 SPECIFIC GRAVITY OF FINE AGGREGATE:

Specific gravity of fine aggregate in the ratio of its weight in air to the weight of an equal volume of water. Specific gravity of fine aggregate is an important factor which is used in computing other properties of fine aggregate like degree of saturation, void ratio and its unit weight.

Table 4.3 Specific Gravity of Fine Aggregate

Specification	Trial 1 (gm)
Weight of empty pycnometer (W1)	658
Weight of pycnometer + fine aggregate (W2)	858
Weight of pycnometer + fine aggregate + Water (W3)	1624
Weight of pycnometer + water (w4)	1498

Specific gravity = (W2-W1)/(W2-W1) - (W3-W4)

= (858– 658) / ((858 – 658) – (1624 –1498))

= 2.7.

Fig. 4.5 SPECIFIC GRAVITY OF FINE AGGREGATE

RESULT:

Specific Gravity of Fine aggregate = 2.7.

4.2.3 TEST ON COARSE AGGREGATE:

4.2.3.1 FINENESS MODULUS OF COARSE AGGREGATE:

Fineness modulus is defined as the empirical volume obtained by adding the cumulative percentage of the material retained (by weight) in each of the sieves and dividing the total thus obtained by 100.

1. 200gms of coarse aggregate that passes through the 40mm sieves is taken.
2. Sieves are set in order 40mm, 20mm, 16mm, 12.5mm, 10mm,4.75mm, 2.36 mm, 1.18mm, 0.6mm and pan.
3. Sieving is carried out manually not less than 2 min.
4. The shaking is done with a varied motion. So that the material is kept moving over the sieve surface in frequently changing direction.
5. The coarse aggregate, retained on each sieve is weighed.

4.2.3.2 SPECIFIC GRAVITY OF COARSE AGGREGATE:

Table: 4.4 SPECIFIC GRAVITY OF COARSE AGGREGATE:

Specification	Trial 1 (gm)
Empty weight of pycnometer (W1)	658
Weight of pycnometer + fine aggregate (W2)	1288
Weight of pycnometer + fine aggregate + Water (W3)	2046
Weight of pycnometer + water (w4)	1658

Specific gravity = (W2-W1)/(W2-W1) - (W3-W4)

= (1288 – 658) / ((1288 – 658) – (2046 – 1658))

= 2.60.

RESULT:

Specific gravity of coarse aggregate is 2.60.

Fig. 4.6 SPECIFIC GRAVITY OF COARSE AGGREGATE

4.2.3.3 WATER ABSORPTION OF COARSE AGGREGATE:

The following procedure is adopted,

Weight of saturated aggregate: W1 g

Weight of oven dry aggregates in air: W2 g

The water absorption is calculated using formula,

Water absorption = (W2–W1 / W1) ×100

= (1000 – 985 / 985) ×100

= 1.5 %

Table 4.5 WATER ABSORPTION OF COARSE AGGREGATE

S. No	Observation	Weight
1	Weight of saturated aggregate (W1)	1000gm
2	Weight of oven dry aggregates in air (W2)	985gm
3	Water absorption	1.5%

4.2.4 TEST FOR FRESH CONCRETE :

SLUMP TEST:

1. The internal surface of the mould is completely cleaned by using water and oil is applied over the internal surface of the cone.
2. The mould is placed on a smooth, horizontal and non-absorbent surface.
3. The mould is then filled with 4 equal layers of concrete. Each layer is tamped with 25 strokes of tamping rod.
4. After the completion of 4 layers, the top surface is levelled with a trowel and tamping rod.
5. The mould is then lifted slowly in vertical direction.

   The permits the concrete to sub side, and this subsidence is called slump of the concrete. The slump value of the concrete is the difference in level between the height of the mould and that of the highest point of the sub sided concrete.

Fig. 4.7 Slump Cone Test

CHAPTER 5

5.1 MIX DESIGN :

The purpose of experimental investigation is to obtain the compressive strength, tensile strength, Flexural Strength of M_{25} grade of concrete by partial replacement of E-waste. Concrete specimen were prepared with E-waste of 0%, 6%, 12%, 18% and 24%.

Grade designation = M_{25}

Type of cement = OPC 43 grade

Maximum nominal size of aggregate = 20 mm

water cement ratio = 0.50

Exposure condition = moderate

Workability = 75 mm

Minimum cement content = 280 kg/m^3

5.1.1 MIX CALCULATION

TEST DATA :

Cement = OPC 43 grade

Specific gravity of cement = 3.16

Specific gravity of coarse aggregate = 2.60

Specific gravity of fine aggregate = 2.7

Water absorption of coarse aggregate = 0.80%

Water absorption of fine aggregate = 1,5%

STEP:1 TARGET MEAN STRENGTH

F 'ck = fck +1.65 S

where,

F 'ck- target average compressive strength

fck – characteristics composition strength @ 28 days

S – standard deviation

(IS 10262:2009) From table 1,

S = 4 N/mm2

Target mean strength = 25 + (1.65 x 4)

= 31.6 N/mm^2

STEP 2: SELECTION OF WATER – CEMENT RATIO

From table 5 of IS 456: 2000

Maximum water cement ratio is 0.50

STEP 3: SELECTION OF WATER CONTENT

From table 2 of IS 10262:2009, maximum water content for 20mm aggregate = 186 litre (for 25 to 75 mm range)

Maximum water content for 20mm aggregate = 186 lit.

Estimation of water content = 186 +(3/100)186

= 191.58 litres

STEP 4: CALCULATION OF CEMENT CONTENT

Water cement ratio = 0.50

Cement content = 191.58/0.50

$= 383.16 kg/m^3$

From table 5 of IS 456:2000, minimum cement content for moderate exposure condition = $300 kg/m^3$

$383.16 kg/m^3 > 300 kg/m^3$

Hence ok

STEP 5: PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE

From table 3 of IS 10262: 2009

Volume of coarse aggregate corresponding to 20mm size and fine aggregate

(zone 1) for water cement ratio of 0.50 = 0.64

Therefore corrected proportion of volume of coarse aggregate for the

water cement ratio of 0.45 = 0.65

Volume of coarse aggregate = 0.65 x 0.95 = 0.62

Volume of fine aggregate = 1- 0.62

= 0.38

STEP 6: MIX CALCULATIONS

The mix calculation per Unit volume of concrete should be,

a) Volume of concrete = $1m^3$

b) Volume of cement = mass of cement/ specific gravity of cement x 1/1000

= (383.16/3.16) x (1/1000)

= $0.122\ m^3$

c) Volume of water = mass of water / specific gravity of water x 1/1000

= (191.58/1) x (1/1000)

= $0.192\ m^3$

d) Volume of all in aggregate = a – (b+c)

= (1-(0.122+0.192))

= 0.686 m^3

e) Mass of coarse aggregate = d x volume of coarse aggregate x specific gravity of coarse aggregate x 1000

= 0.686 x 0.62 x 2.60 x 1000

= 1105.83 kg

f) Mass of fine aggregate = d x volume of fine aggregate x specific gravity of fine aggregate x 1000

= 0.686 x 0.38 x 2.7 x 1000

= 703.83 kg

Mix proportion of conventional concrete:

CEMENT CONTENT	**FINE AGGREGATE**	**COARSE AGGREGATE**	**WATER**
383.16kg/m^3	703.83 kg/m^3	1105.83 kg/m^3	191.58kg/m^3
1	1.8	2.8	0.5

RESULT:

Ratio of M_{25} grade = 1 : 1.3 : 2.08 = 1:1:2:

5.1.2 MIX PROPORTION OF CUBE:

Cement = 4.96 Kg
Fine aggregate = 9.07 Kg
Coarse aggregate = 14.29Kg
Water = 2.48 Litre

6 % of E-waste

= 0.15 x 0.15 x 0.15 x 2400 x [6/100]

= 0.486

12 % of E-waste

= 0.15 x 0.15 x 0.15 x 2400 x [12/100]

= 0.972

18 % of E-Waste

= 0.15 x 0.15 x 0.15 x 2400 x [18/100]

= 1.45

24 % of E-Waste

= 0.15 x 0.15 x 0.15 x 2400 x [24/100]

= 1.94

Table 5.1 Mix proportion of cube

% of Proportion	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Water (lit)	E-Waste
0	4.96	9.07	14.29	2.48	0
6	4.96	9.07	14.29	2.48	0.486
12	4.96	9.07	14.29	2.48	0.972
18	4.96	9.07	14.29	2.48	1.45
24	4.96	9.07	14.29	2.48	1.94

5.1.3 MIX PROPORTION OF CYLINDER:

Cement = 7.79 Kg
Fine aggregate = 14.26 Kg
Coarse aggregate = 23.03 Kg
Water = 3.89 Litre

6 % of E-Waste
$= [\pi/4] \times d^2 \times h \times 2400 \times [0.5/100]$
$= [\pi/4] \times 0.15^2 \times 0.3 \times 2400 \times [6/100]$
$= 0.76$
12% of E-Waste
$= [\pi/4] \times d^2 \times h \times 2400 \times [1/100]$
$= [\pi/4] \times 0.15^2 \times 0.3 \times 2400 \times [1/100]$
$= 1.52$
18% of E-Waste
$= [\pi/4] \times d^2 \times h \times 2400 \times [1.5/100]$
$= [\pi/4] \times 0.15^2 \times 0.3 \times 2400 \times [1.5/100]$
$= 2.28$
24% of E-Waste
$= [\pi/4] \times d^2 \times h \times 2400 \times [1.5/100]$
$= [\pi/4] \times 0.15^2 \times 0.3 \times 2400 \times [1.5/100]$
$= 3.05$

Table 5.2 Mix proportion of cylinder :

% of Proportion	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Water (lit)	E-Waste
0	7.79	14.26	23.03	3.89	0
6	7.79	14.26	23.03	3.89	0.76
12	7.79	14.26	23.03	3.89	1.52
18	7.79	14.26	23.03	3.89	2.28
24	7.79	14.26	23.03	3.89	3.05

5.1.4 MIX PROPORTION OF PRISM :

Cement = 7.35 Kg
Fine aggregate = 13.45 Kg
Coarse aggregate = 21.17 Kg
Water = 3.67 Litre

6 % of E-Waste
= 0.1 x 0.1 x 0.5 x 2400 x [6/100]
= 0.72

12 % of E-Waste
= 0.1 x 0.1 x 0.5 x 2400 x [12/100]
= 1.44

18 % of E-Waste
= 0.1 x 0.1 x 0.5 x 2400 x [18/100]
= 2.16

24 % of E-Waste
= 0.1 x 0.1 x 0.5 x 2400 x [24/100]
= 2.88

Table 5.3 Mix proportion of Prism :

% of Proportion	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Water (lit)	E-Waste
0	7.35	13.45	21.17	3.67	0
6	7.35	13.45	21.17	3.67	0.72
12	7.35	13.45	21.17	3.67	1.44
18	7.35	13.45	21.17	3.67	2.16
24	7.35	13.45	21.17	3.67	2.88

PROCEDURE FOR CASTING A CONCRETE CUBE AND CYLINDER:

- First of all, the interior of mixing drum was wetted with water in order to minimize the absorption of water added as a part of the Concrete mixture.
- Firstly, the coarse aggregate, fine aggregate and cement paste content was added and silica powder was added after it and mixed properly. Plasticizers was mixed with water and then added to the cement paste in three steps. All mixed for about 5 minutes.
- Clean the standard moulds 3 no's thoroughly and tight all nuts – bolts properly.
- Apply oil to all contract surface of mould.
- Take the sample from the mixing spot while concreting.
- Fill the concrete in moulds in 3 layers.
- Compact each layer with 25 No's of stroke by tampering rod.
- Finish the top surface by trowel after completion of last layer.
- Place mould on vibrator table for 10 sec vibrations for properly compaction of concrete.
- The specimens were left in the laboratory at room temperature for 24 hours.
- After the 24 hours remove the specimen out of mould.
- While removing take care to avoid breaking of edges.
- Submerge the specimen in fresh water till the time of testing.
- Test 3 specimens for 7 days and test 3 specimens for 14 days and 3 specimens for 28 days
- Average strength of 3 specimens represents the strength of concrete.

DIFFERENT STAGES OF MAKING A CONCRETE CUBE, CYLINDER AND PRISM

Fig 5.1 MIXING

Fig 5.2 CASTING

Fig 5.3 DEMOULDING

Fig 5.4 CURING

CHAPTER 6

6.1 TEST ON CONCRETE

6.1.1 COMPRESSIVE STRENGTH TEST:

Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. The specimens are determined after 7 and 28 days of curing with surface dried condition as per IS: 516-1959. When the limit of compressive strength is reached, brittle materials are crushed and hardness of cubical, cylindrical specimens is determined. The cube specimen is of the size 150 x 150 x 150 mm. If the largest nominal size of the aggregate does not exceed 20 mm, 100 mm size cubes may also be used as an alternative. Compressive strength was determined by using compression testing machine (CTM) of 2000 kN capacity.

$$F = P/A$$

Where,

F = Compressive strength

P = Maximum load applied to the specimen

A = Area of the cube

Fig 6.1 TESTING OF CUBE

6.1.2 SPLIT TENSILE TEST :

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The cylinders are placed in the compression testing machine and load is applied as similar to the cube. The cylinder is placed horizontally and the test is performed. The load is increased until the specimen fails and the maximum load applied to test specimen during the test is recorded. In these 2 concrete cylinders moulds are filled with concrete at every casting or with different percentage. Cylindrical test specimens have a length equal to twice the diameter. They are 150 mm in diameter and 300 mm long.

$$T = 2P / \pi LD$$

Where,

T = split tensile strength

P = maximum Applied Load

L = Length of cylinder

D = Diameter of cylinder

Fig 6.2 TESTING OF CYLINDER

6.1.3 FLEXURAL STRENGTH TEST :

Flexural strength of concrete prisms was determined based on recommendations IS Code 516: 1959 . A beam mould of size 500 mm × 100 mm × 100 mm was used in the test. With and without E-Waste concrete was filled in the beam moulds and then compacted using the tamping rod. After 24 h the specimens were unmoulded and subjected to water curing. The cube specimens were loaded to UTM and ultimate load at failure at the period of 7, 14 and 28 days. Two- point loading method were adopted to fail the specimen at the constant rate. Flexural strength of the concrete beam specimens was determined using the formula recommended by IS 516:1959.

Flexural strength (N/mm^2) = $P\,L/B\,D^2$

Where,

b= measured width in mm of the specimen,

h= measure depth in mm of the specimen at the point of failure,

l= length in mm of the span on which the specimen was supported, and

P= maximum load in N applied to the specimen.

Fig 6.3 TESTING OF PRISM

CHAPTER 7

RESULTS

GENERAL

The study is conducted to analyse the compressive strength, split tensile strength and flexural strength of concrete when the coarse aggregate is partially replaced by E-Waste 0%, 6%, 12%, 18%, 24% of cement content is replaced with E-Waste. There were a total of 30 specimens of cube (150 mm X 150 mm X 150 mm), 30 specimens of cylinder (150 mm X 300 mm),30 specimens of prism (100 mm X 100 mm X 200 mm). All the specimens were tested for compressive, split tensile strength and Flexural strength test after a curing period of 7 days,14 days and 28 days. The result of the test specimen is given below.

COMPRESSIVE TEST RESULTS:

Compressive strength of the cube on control specimen:

Table: 7.1 Compressive strength of the cube for 7 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On $7^{th\ day}$ (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	260	260	272	266	11.82	
6	280	285	288	284	12.62	
12	310	320	328	319	14.17	13.74
18	390	380	386	388	16.24	
24	288	290	312	300	13.86	

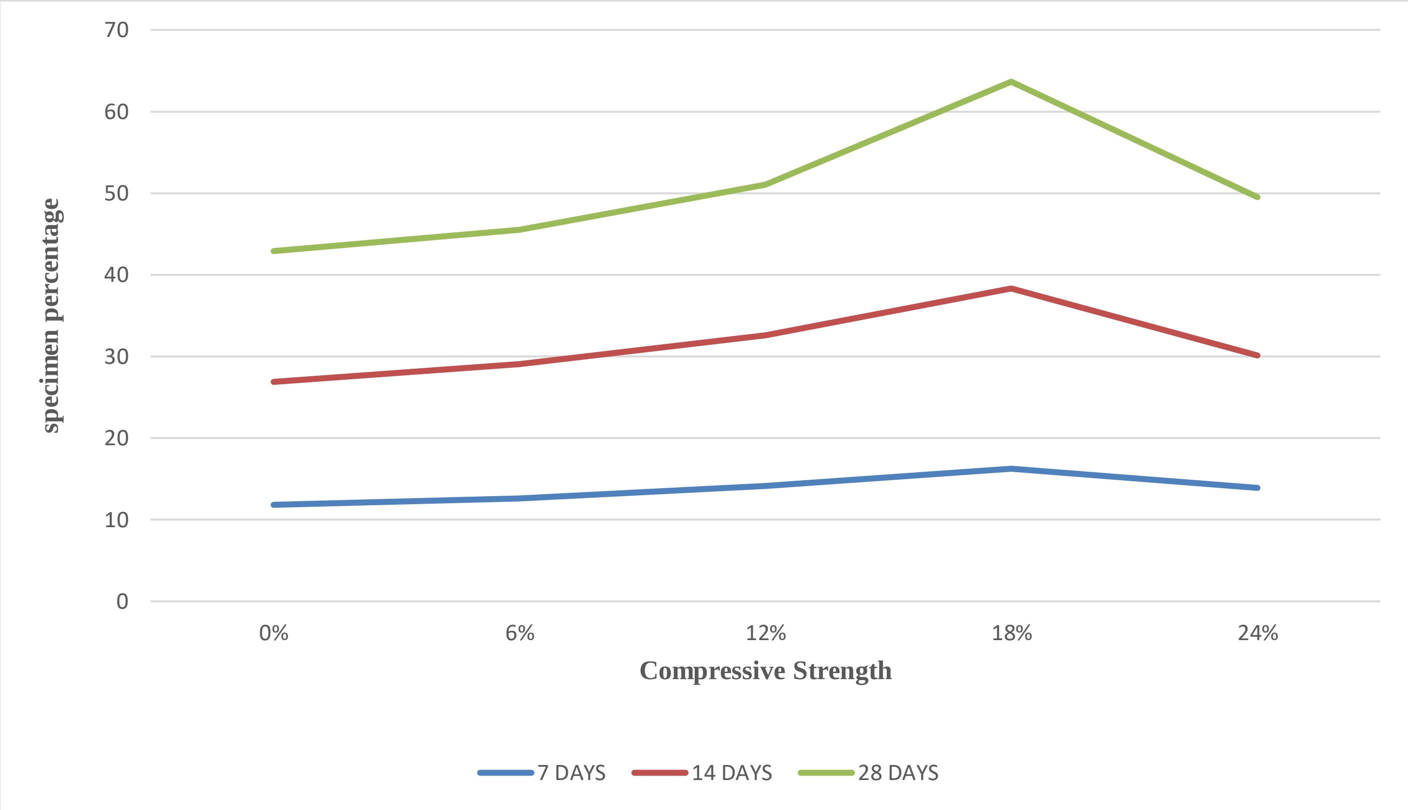
Table: 7.2 Compressive strength of the cube for 14 days

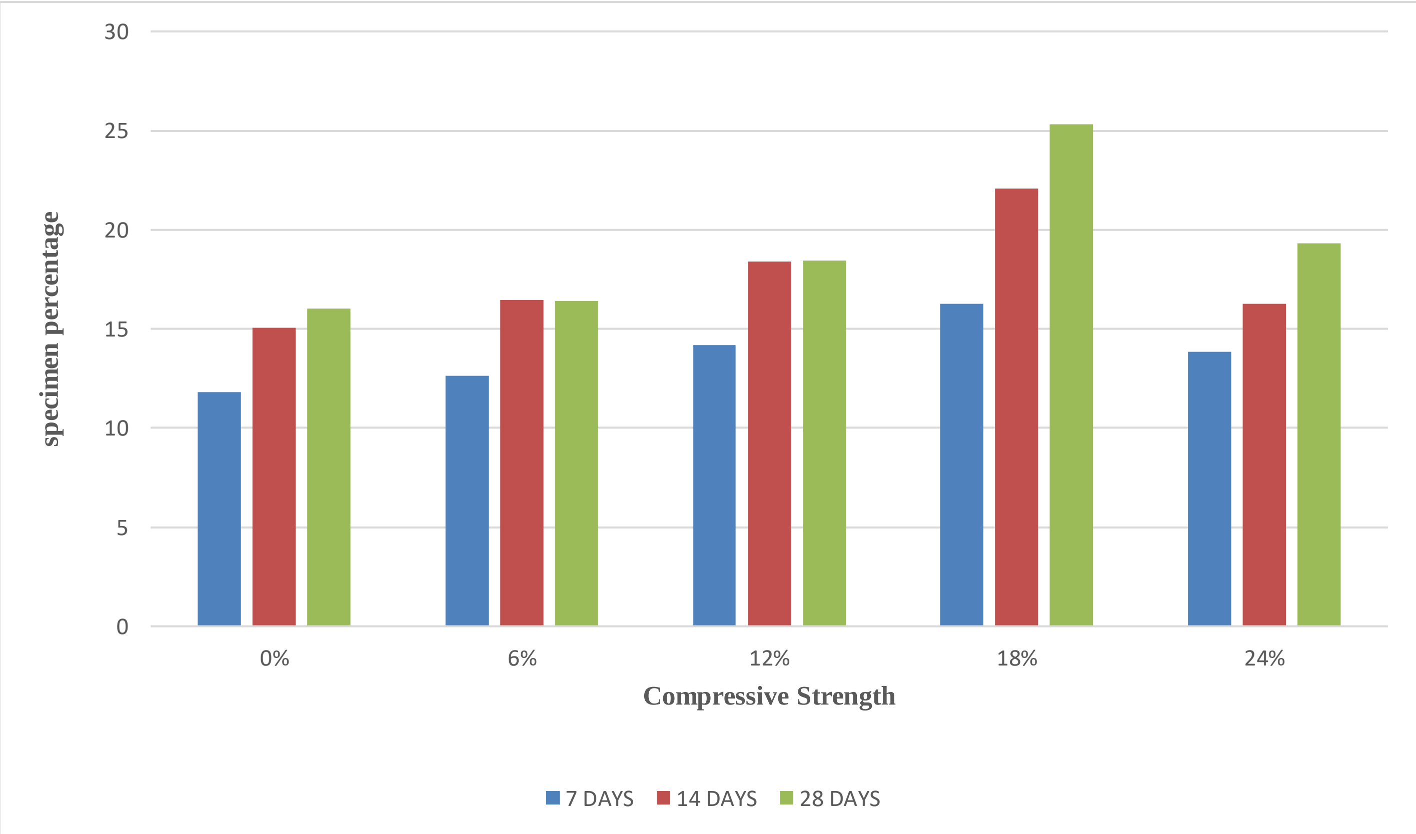
SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 14^{th} day (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	330	340	348	339	15.06	17.65
6	368	360	372	370	16.44	
12	410	415	418	414	18.41	
18	492	490	502	497	22.08	
24	348	350	384	366	16.26	

Table: 7.3 Compressive strength of the cube for 28 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 28^{th} day (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	340	350	380	360	16.02	19.64
6	368	360	370	369	16.42	
12	410	415	420	415	18.44	
18	490	500	510	570	25.33	
24	430	420	440	435	19.33	

Fig 7.1 Graph Analysis for cube





SPLIT TENSILE STRENGTH:

Split tensile strength of the cylinder on control specimen:

Table: 7.4 Split tensile strength of the cylinder for 7 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 7th day (kN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0	230	240	245	237.5	3.35	3.88
6	265	260	268	266.5	3.77	
12	260	265	280	270	3.81	
18	290	285	294	292	4.13	
24	300	310	320	310	4.38	

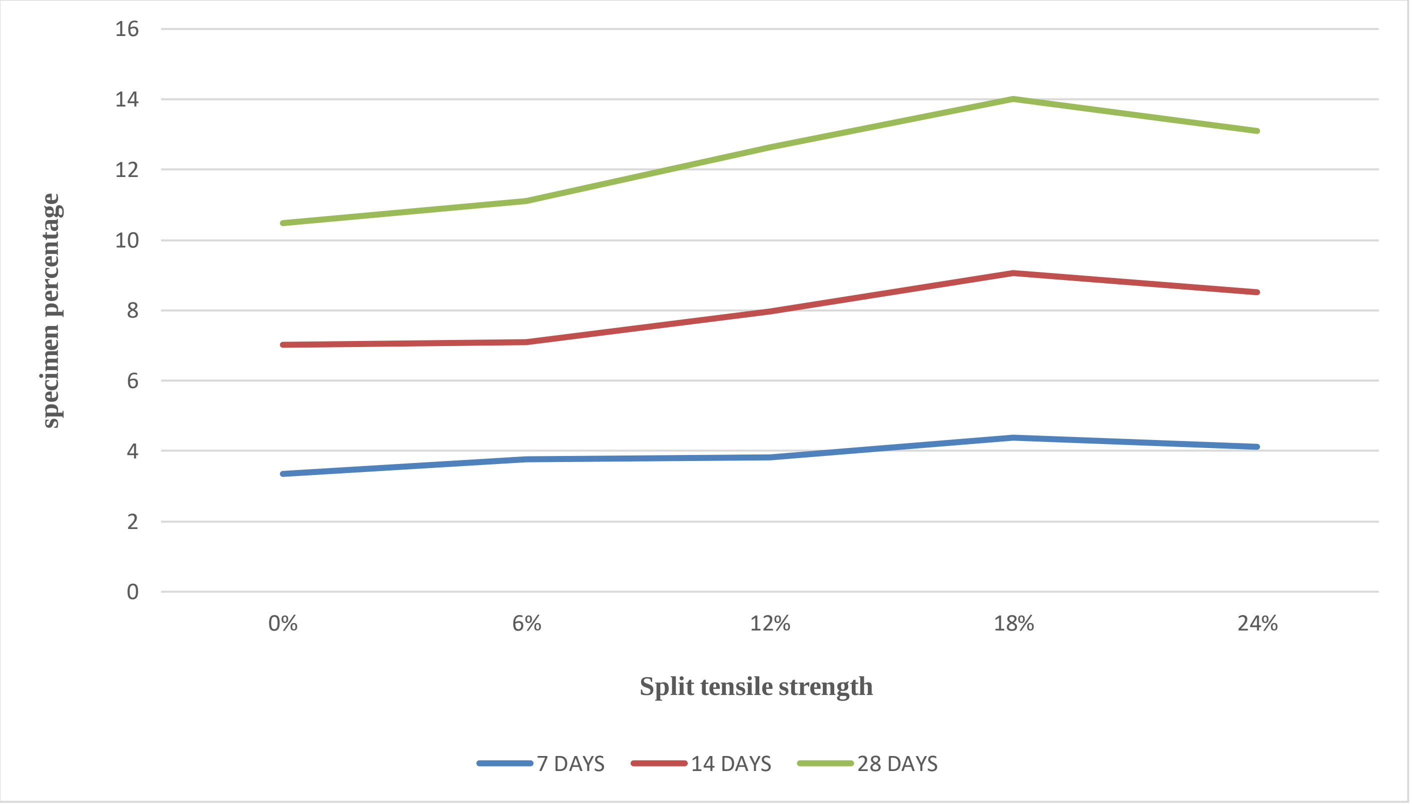
Table: 7.5 Split tensile strength of the cylinder for 14 days

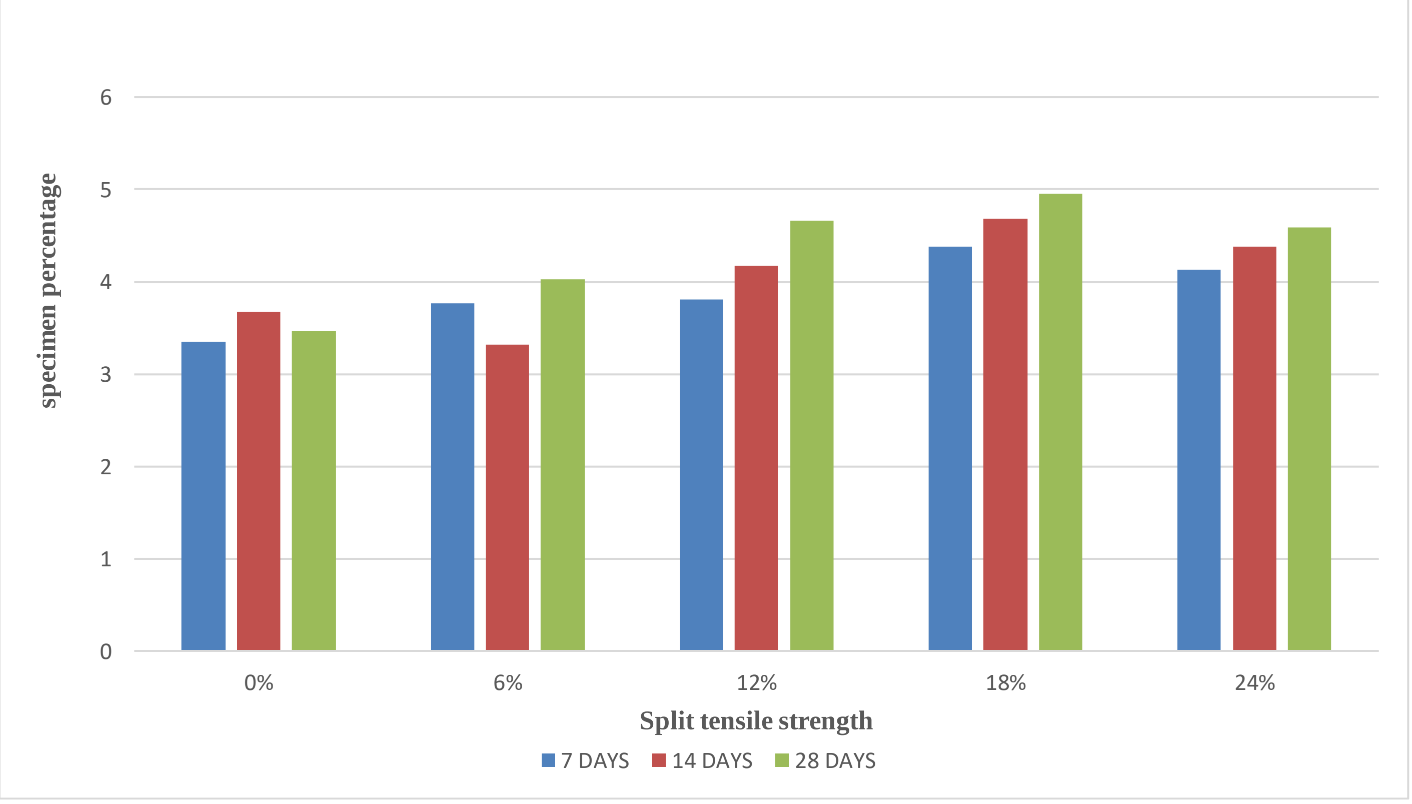
SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 14th day (kN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0	240	250	280	260	3.67	4.04
6	210	240	260	235	3.32	
12	280	300	310	295	4.17	
18	320	330	343	331.5	4.68	
24	290	310	330	310	4.38	

Table: 7.6 Split tensile strength of the cylinder for 28 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 28^{th} day (kN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0	230	240	260	245	3.46	5.37
6	270	280	290	285	4.03	
12	310	320	350	330	4.66	
18	340	345	360	350	4.95	
24	310	320	330	325	4.59	

Fig 7.2 Graph Analysis for cylinder





FLEXURAL STRENGTH TEST:

Flexural Strength Test of the cylinder on control specimen:

Table: 7.7 Flexural Strength Test of the Prism for 7 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 7th day (kN)	Flexural Strength (N/mm^2)	Average Flexural Strength (N/mm^2)
0	4.3	4.4	4.45	4.38	2.2	2.76
6	4	5	6	5	2.5	
12	5.4	5.6	5.7	5.5	2.8	
18	6.2	6.4	6.7	6.43	3.2	
24	6	6.2	6.3	6.16	3.1	

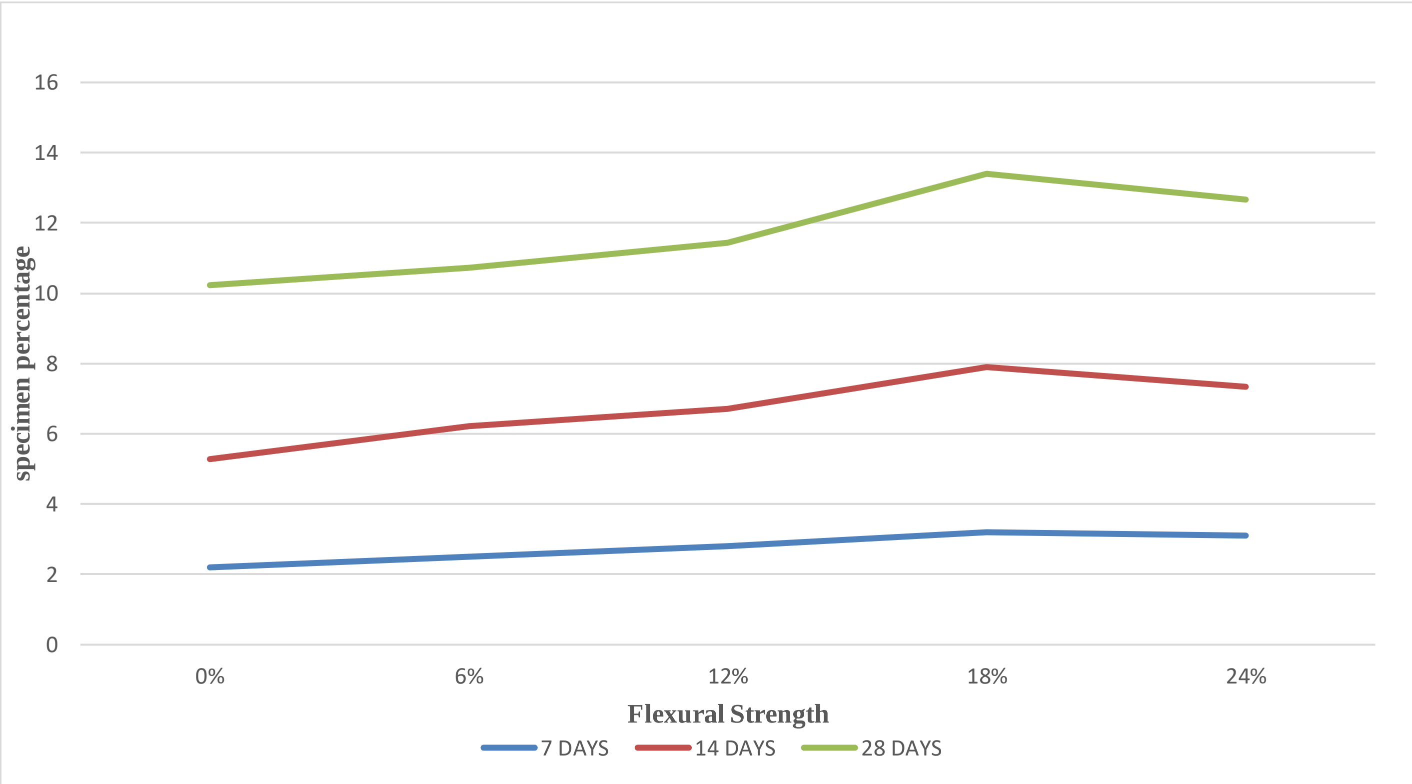
Table: 7.8 Flexural Strength Test of the Prism for 14 days

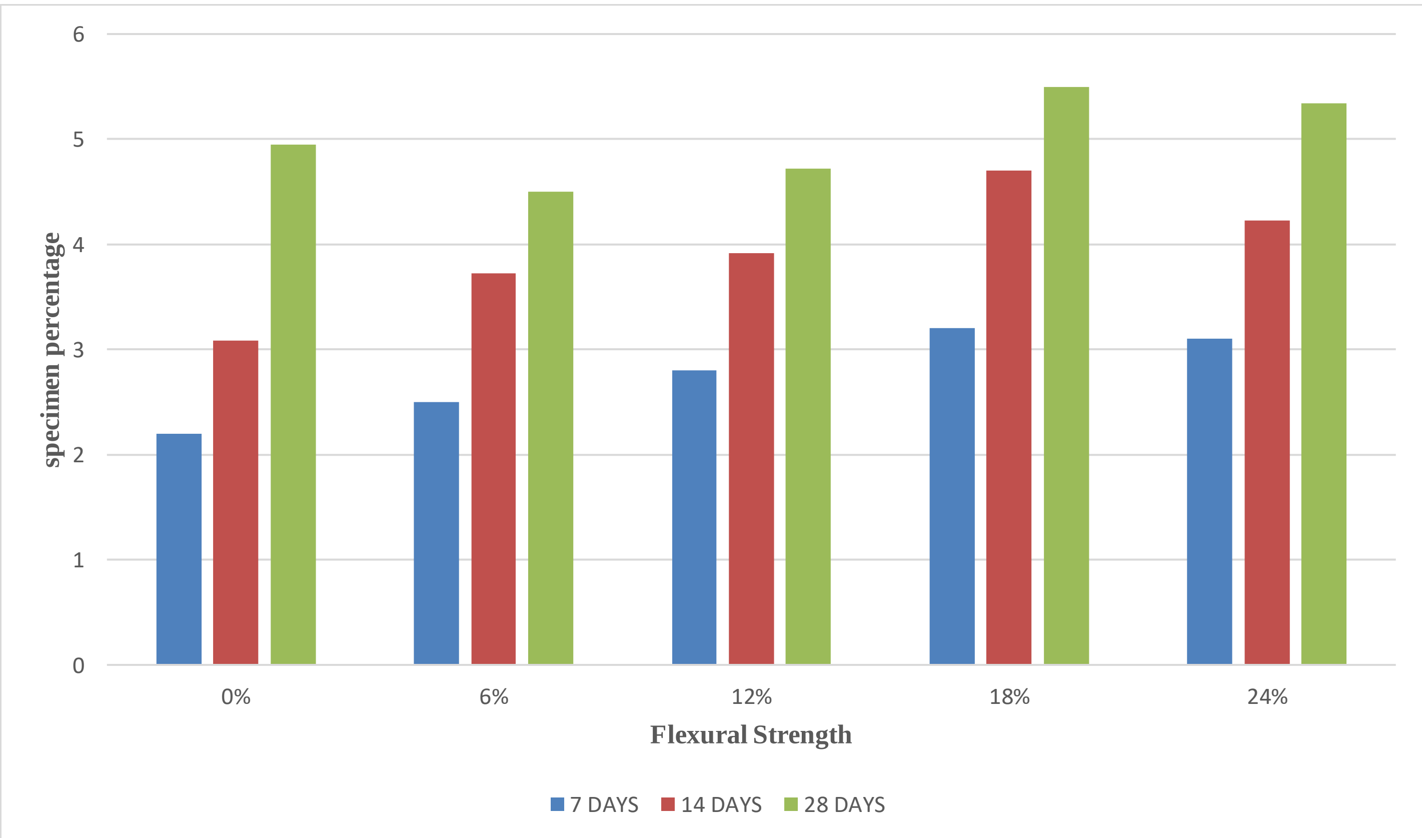
SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 14th day (kN)	Flexural Strength (N/mm^2)	Average Flexural Strength (N/mm^2)
0	5.2	5.57	5.8	5.52	3.08	3.93
6	6	6.2	6.4	6.2	3.72	
12	6.8	7.2	7.4	7.13	3.92	
18	7.8	8.2	8.4	8.13	4.7	
24	6.2	6.4	6.8	6.46	4.23	

Table: 7.9 Flexural Strength Test of the Prism for 28 days

SPECIMEN PERCENTAGE	Specimen 1 (kN)	Specimen 2 (kN)	Specimen 3 kN)	Load On 28^{th} day (kN)	Flexural Strength (N/mm^2)	Average Flexural Strength (N/mm^2)
0	9.34	9.44	9.5	9.42	4.95	5.02
6	7	9	10	8.66	4.50	
12	9.2	9.4	9.7	9.43	4.72	
18	10	11	13	11.33	5.5	
24	10.4	10.6	10.7	10.56	5.34	

Fig 7.3 Graph Analysis for Prism





CHAPTER 8

CONCLUSION

The experimental investigation on the partial replacement of coarse aggregate with e-waste in concrete reveals promising results in terms of mechanical performance and sustainability. The study indicates that e-waste, when used in controlled proportions, can effectively replace natural coarse aggregates without significantly compromising the strength of concrete. Among all the tested mixes, the concrete with 18% e-waste replacement showed the best performance, achieving strength values comparable to conventional concrete. However, beyond this percentage, a decline in strength was observed, likely due to the irregular shape and poor bonding characteristics of the e-waste particles. Workability also decreased slightly with increasing e-waste content, necessitating the use of plasticizers if higher replacement levels are considered. Overall, the use of e-waste as a partial replacement contributes to environmental sustainability by reducing the burden on natural resources and minimizing electronic waste disposal. It can be recommended for use in non-structural applications and in areas where strength requirements are moderate, with further research encouraged to explore long-term durability and environmental safety.

CHAPTER 9

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