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STUDY ON PERFORMANCE OF CONCRETE FOR PARTIAL REPLACEMENT OF COARSE AGGREGATE USING E-WASTE

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INTRODUCTION

- Concrete is the most important engineering material and the addition or replacement of some of the materials that may be more feasible to change the philosophy of the concrete.
- This paper reports the study of concrete using partial replacement of Coarse aggregate by E-waste.
- In this project work, M25 grade of concrete was taken for concrete mix design.
- The properties and characteristics of materials for cement, fine aggregate, coarse aggregate and other supplementary materials was studied for concrete mix design with reference to Indian standard codes as per specification.
- The compressive strength, split tensile strength and flexural test of concrete was studied for various replacements of Coarse aggregate that are **0%, 6%,12%,18%** and **24%.**partial replacement of Coarse aggregate with E-waste, the concrete gains higher compressive strength at 7 and 28 days..
- As the Integral part of this project, the maximum optimum content of the E-Waste substituted concrete is occurred at partial replacement of Coarse aggregate respectively.

SCOPE AND OBJECTIVE OF THE PROJECT

Scope of the project:

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.

Objectives of the project:

1. To determine the properties of basic concrete making materials such as cement, fine aggregate, coarse aggregate, E-waste and water.
2. To compare the properties with E-waste with coarse aggregate and to check the suitability of adopting in concrete.
3. To determine the mechanical properties of e-waste concrete and to compare with controlled concrete.

LITERATURE REVIEW

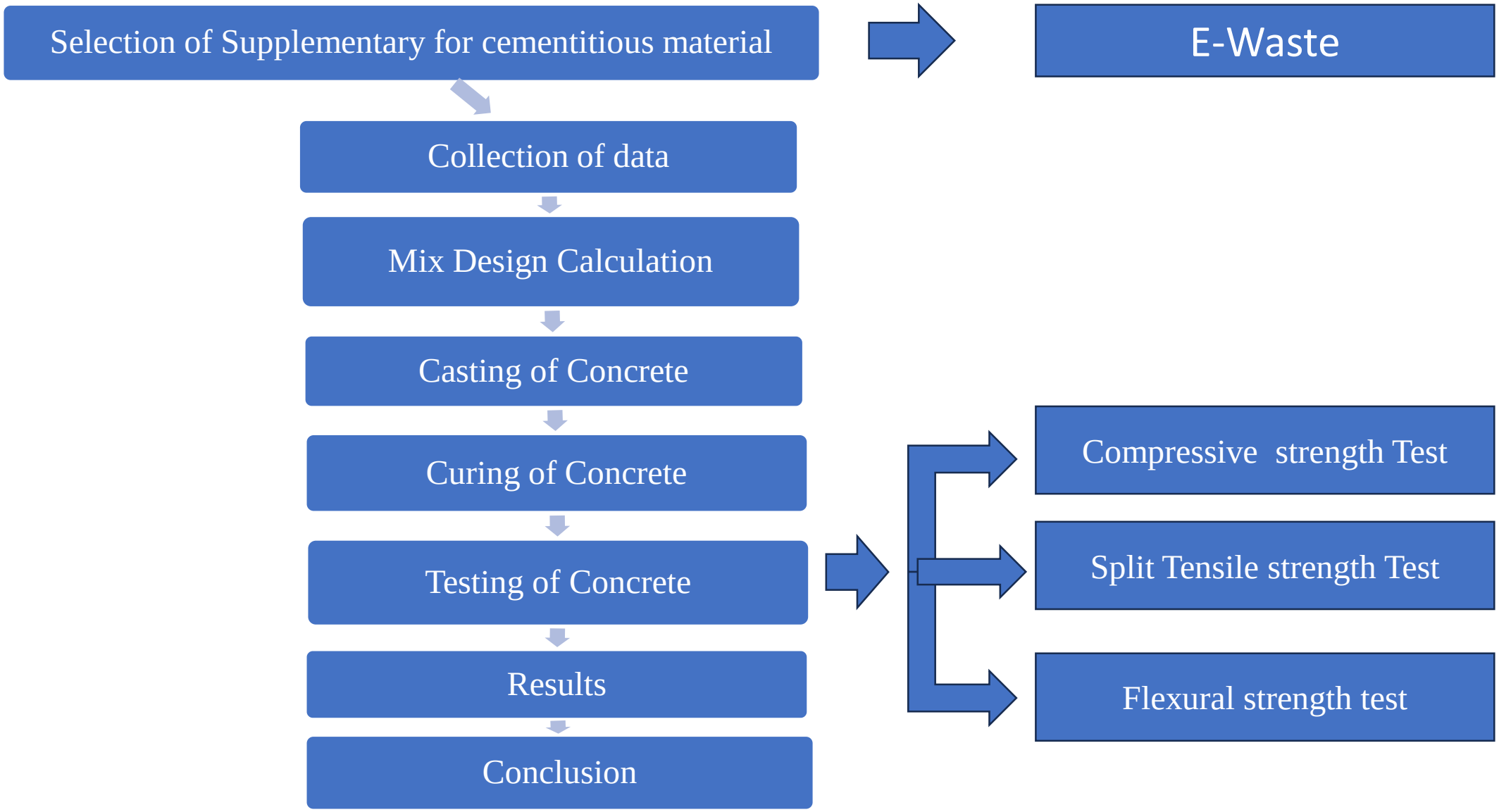
S.L NO	JOURNAL PAPER TITLE	AUTHOR NAME	REMARKS
1.	Study on Replacement of Coarse Aggregate by E-Waste in Concrete (2015)	Suchithra.S et.al.,	• The addition of E-waste shows increase in compressive strength up to 15% replacement. • Increase in split tensile strength is almost insignificant whereas gain in flexural tensile strength have occurred even up to 15 % replacements. • When compared to other mix the loss in weight and compressive strength percentage was found to be reduced by 2.23 and 7.69.

S.I NO	JOURNAL PAPER TITLE	AUTHOR NAME	REMARKS
2.	An Experimental Study on Concrete by using EWaste as Partial Replacement for Course Aggregate (2016)	Sunil Ahirwar M. Tech. Scholar 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

S.I NO	JOURNAL PAPER TITLE	AUTHOR NAME	REMARKS
3.	An Experimental Study on Partial Replacement for Coarse Aggregate by E-waste in Concrete (2017)	Saranya.K 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

S.I NO	JOURNAL PAPER TITLE	AUTHOR NAME	REMARKS
4.	Partial replacement of coarse aggregate using E-waste (2020)	A.Rajesh 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.

METHODOLOGY



MATERIALS PROPERTIES

Cement:

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

Fine aggregate:

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

Coarse aggregate:

Machine crushed aggregate confirming 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.

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.

MIX DESIGN

TEST DATA FOR MATERIALS

Cement	OPC 43 Grade
Specific gravity of cement	3.16
Specific gravity of fine aggregate	2.7
Specific gravity of coarse aggregate	2.60
Water absorption of fine aggregate	0.80%
Water absorption of coarse aggregate	1.5%

MIX CALCULATION:

STEP:1 TARGET MEAN STRENGTH

F ’ck = fck +1.65 S

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

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 = 383.16kg/m^3

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

Hence ok

STEP 6: MIX CALCULATION

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

b) Volume of cement = mass of cement/ specific gravity of cement x 1/100

= (383.16/3.15) x (1/1000)

= 0.122 m^3

c) Volume of water = mass of water / specific gravity of water x 1/100

= (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 = 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 FOR CONCRETE :

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

RESULT :

Ratio of M_{25} grade = 1 : 1.8 : 2.8

% OF PROPORTION	FOR CUBE	FOR CYLINDER	FOR PRISM
0%	0	0	0
6%	0.486	0.76	0.72
12%	0.972	1.52	1.44
18%	1.45	2.28	2.16
24%	1.95	3.05	2.88

MATERIAL : E-WASTE

TEST FOR FINE AGGREGATE

TEST FOR COARSE AGGREGATE

SLUMP CONE TEST

PREPARATION OF THE CONCRETE TEST SPECIMEN

MIXING

CASTING

DEMOULDING

CURING

EXPERIMENTAL INVESTIGATION

COMPRESSION STRENGTH :

The Compressive strength test is done on cube and the results are obtained.

COMPRESSIVE STRENGTH OF THE CUBE FOR 7 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	260	260	272
6%	280	285	288
12%	310	320	328
18%	390	380	386
24%	288	290	312

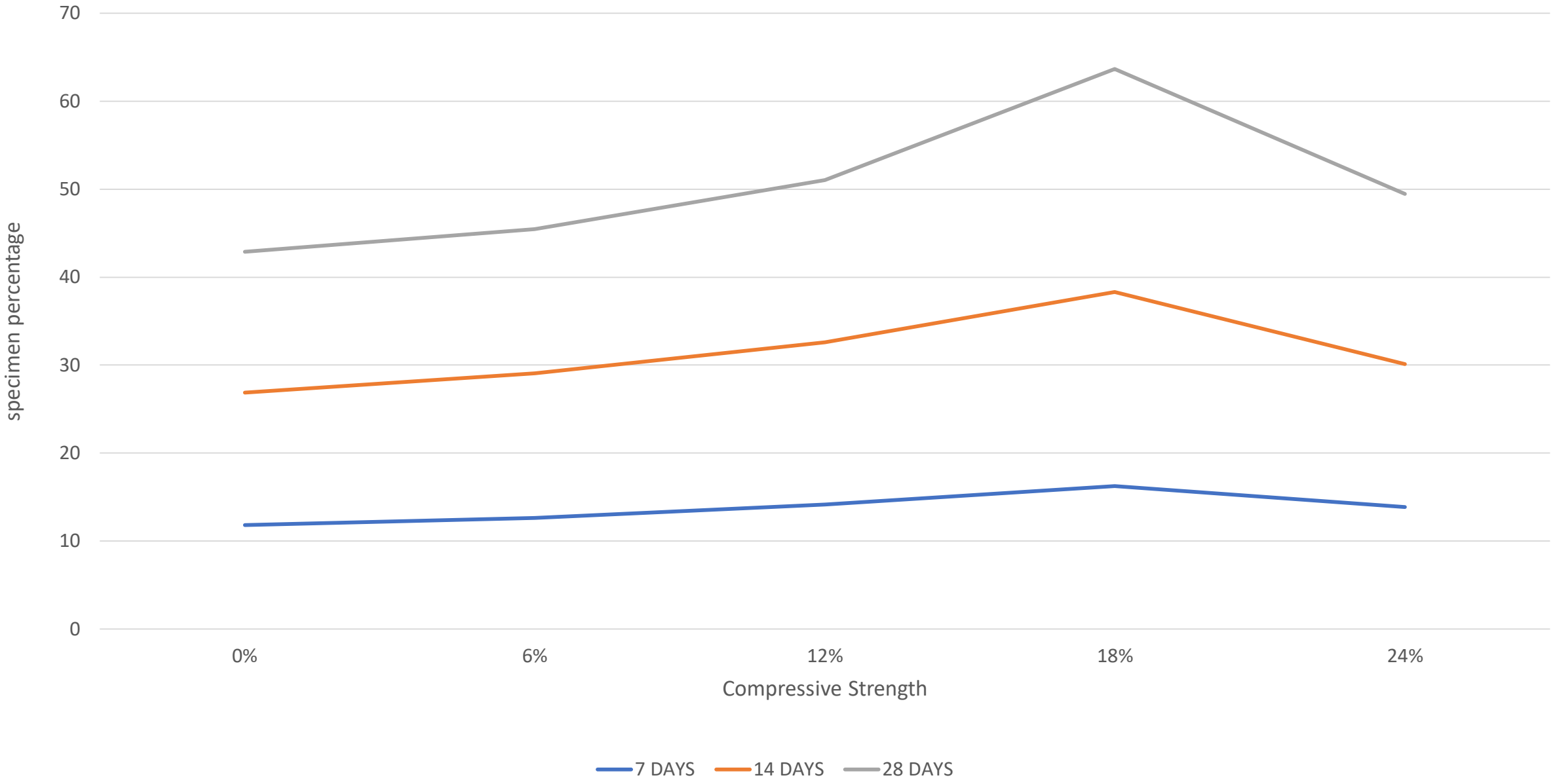
COMPRESSIVE STRENGTH OF THE CUBE FOR 14 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	330	340	348
6%	368	360	372
12%	410	415	418
18%	492	490	502
24%	348	350	384

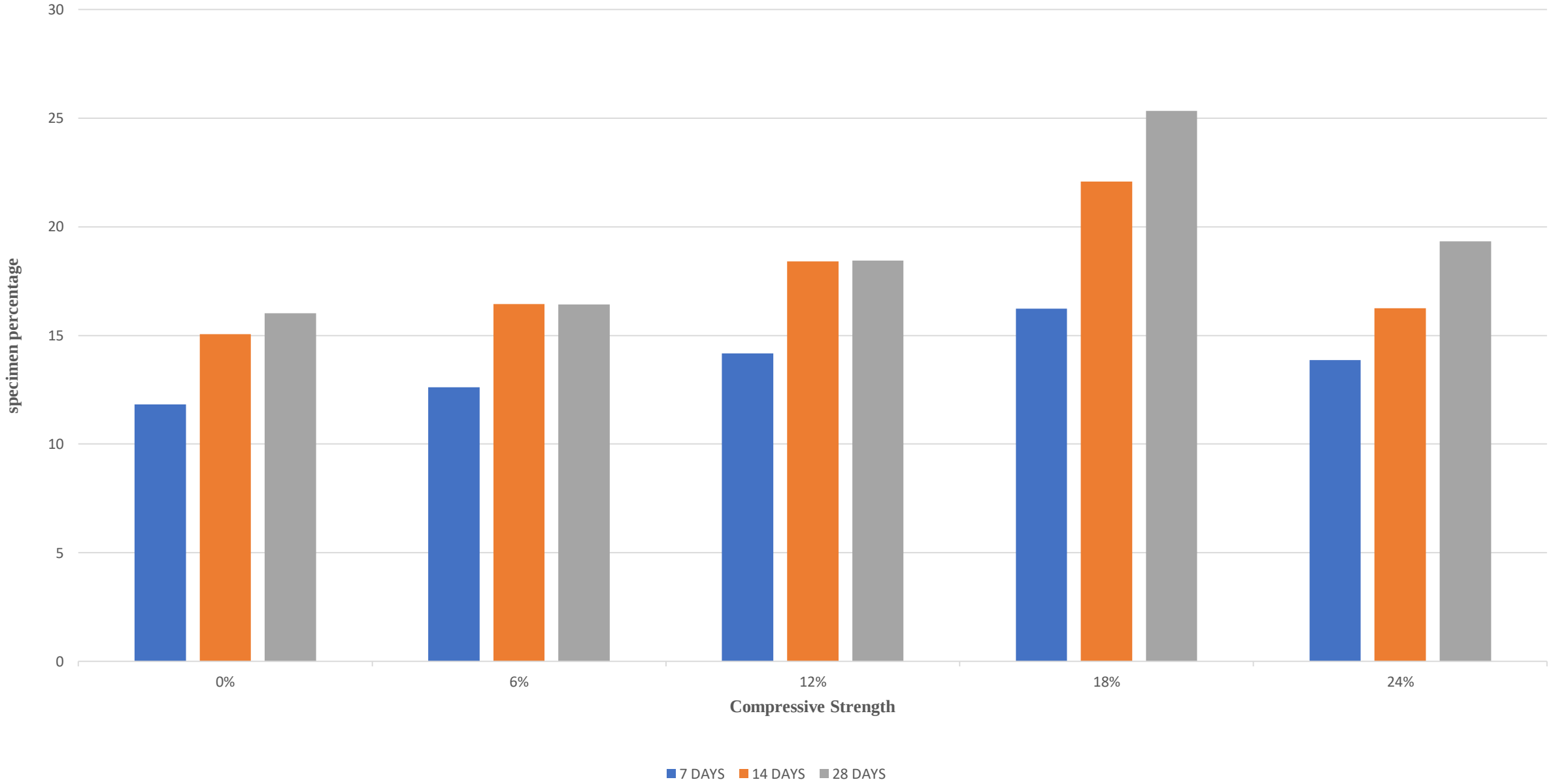
COMPRESSIVE STRENGTH OF THE CUBE FOR 28 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	340	350	380
6%	368	360	370
12%	410	415	420
18%	490	500	510
24%	430	420	440

GRAPH ANALYSIS FOR CUBE



GRAPH ANALYSIS FOR CUBE



SPLIT TENSILE STRENGTH

The Split tensile strength test is done on cylinder and the results are obtained for 7, 14 and 28 days.

Split Tensile Strength, $(N/mm^2) = 2P / (\pi \times d \times l)$

SPLIT TENSILE STRENGTH OF THE CYLINDER FOR 7 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	230	240	245
6%	265	260	268
12%	260	265	280
18%	290	285	294
24%	300	310	320

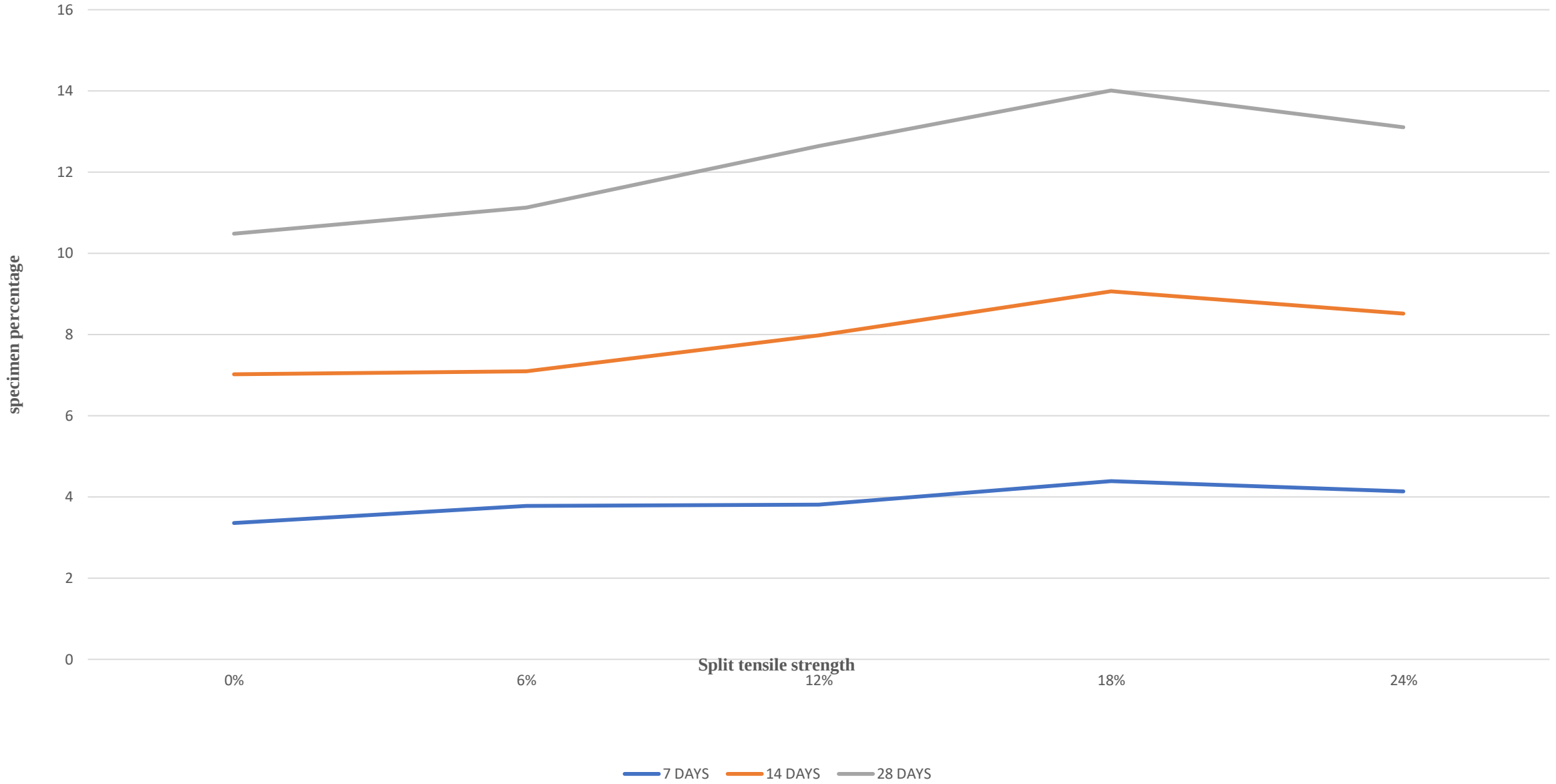
SPLIT TENSILE STRENGTH OF THE CYLINDER FOR 14 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	240	250	280
6%	210	240	260
12%	280	300	310
18%	320	330	343
24%	290	310	330

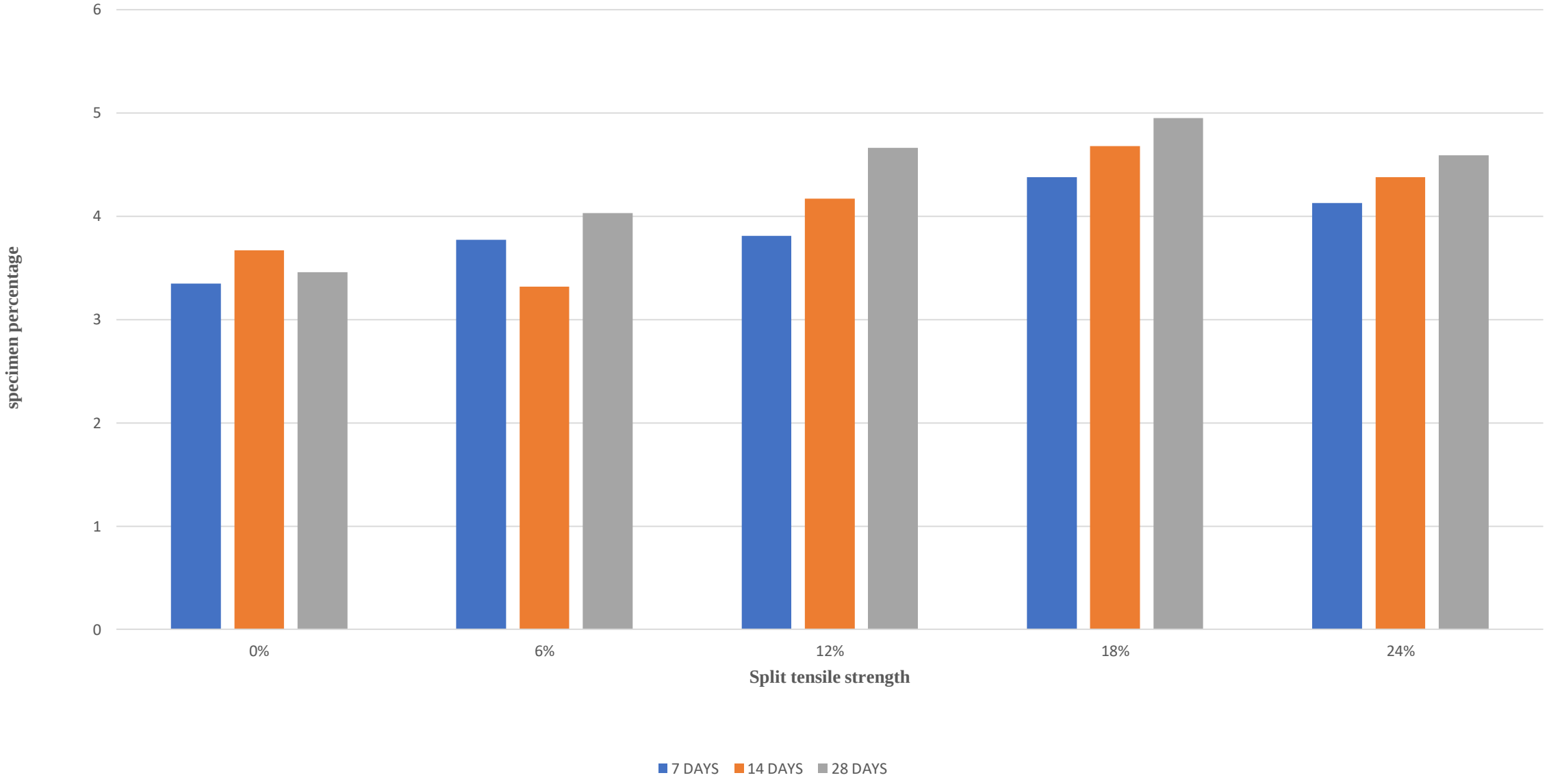
SPLIT TENSILE STRENGTH OF THE CYLINDER FOR 28 DAYS:

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	230	240	260
6%	270	280	290
12%	310	320	350
18%	340	345	360
24%	310	320	330

GRAPH ANALYSIS FOR CYLINDER



GRAPH ANALYSIS FOR CYLINDER



FLEXURAL STRENGTH TEST

The Flexural Strength Test is done on Prism and the results are obtained for 7, 14 and 28 days.

Flexural strength (N/mm2) = P L/B D2

FLEXURAL STRENGTH TEST FOR 7 DAYS :

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	4.3	4.4	4.45
6%	4	5	6
12%	5.4	5.6	5.7
18%	6.2	6.4	6.7
24%	6	6.2	6.3

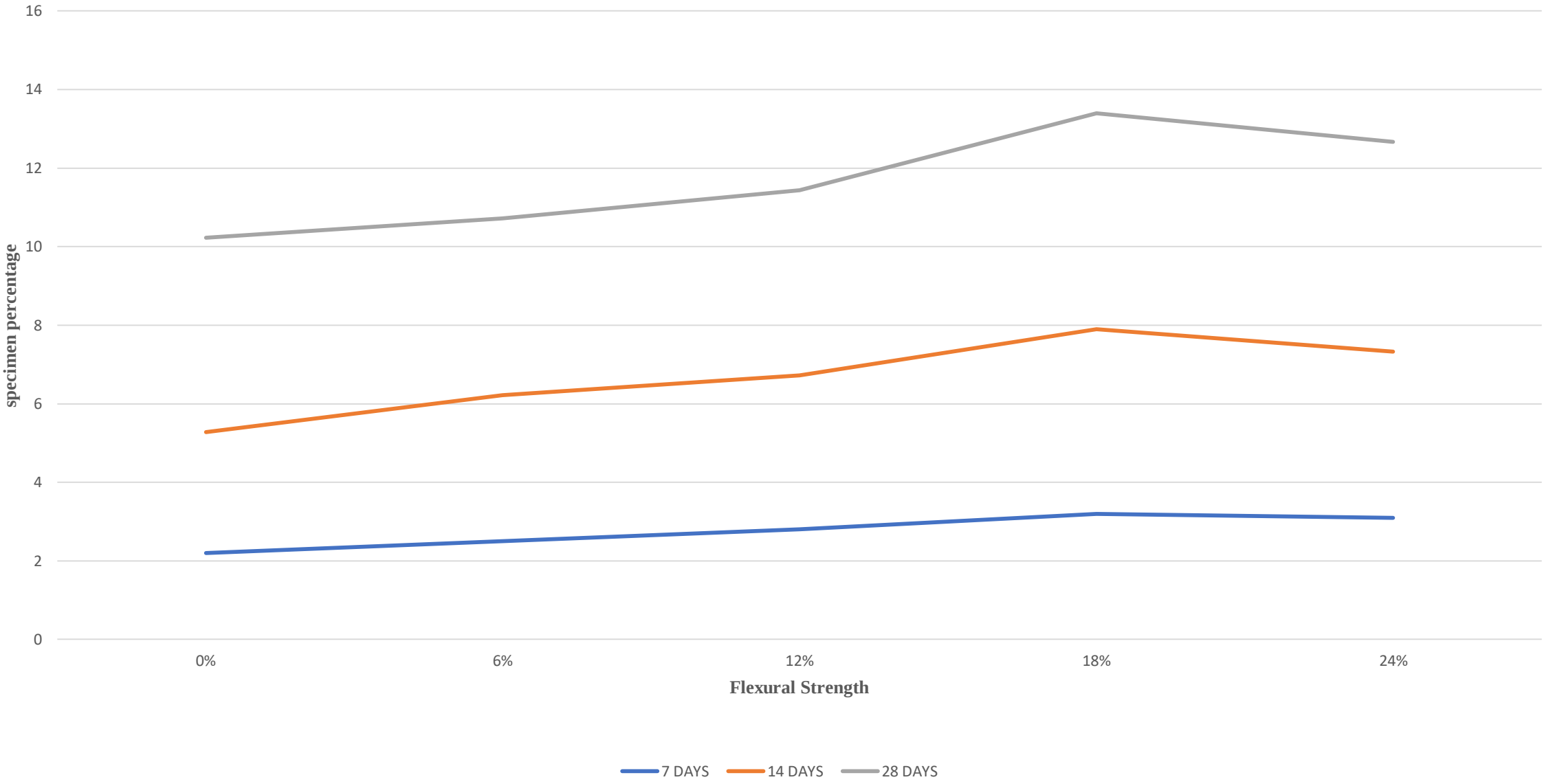
FLEXURAL STRENGTH TEST FOR 14 DAYS :

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	5.2	5.57	5.8
6%	6	6.2	6.4
12%	6.8	7.2	7.4
18%	7.8	8.2	8.4
24%	6.2	6.4	6.8

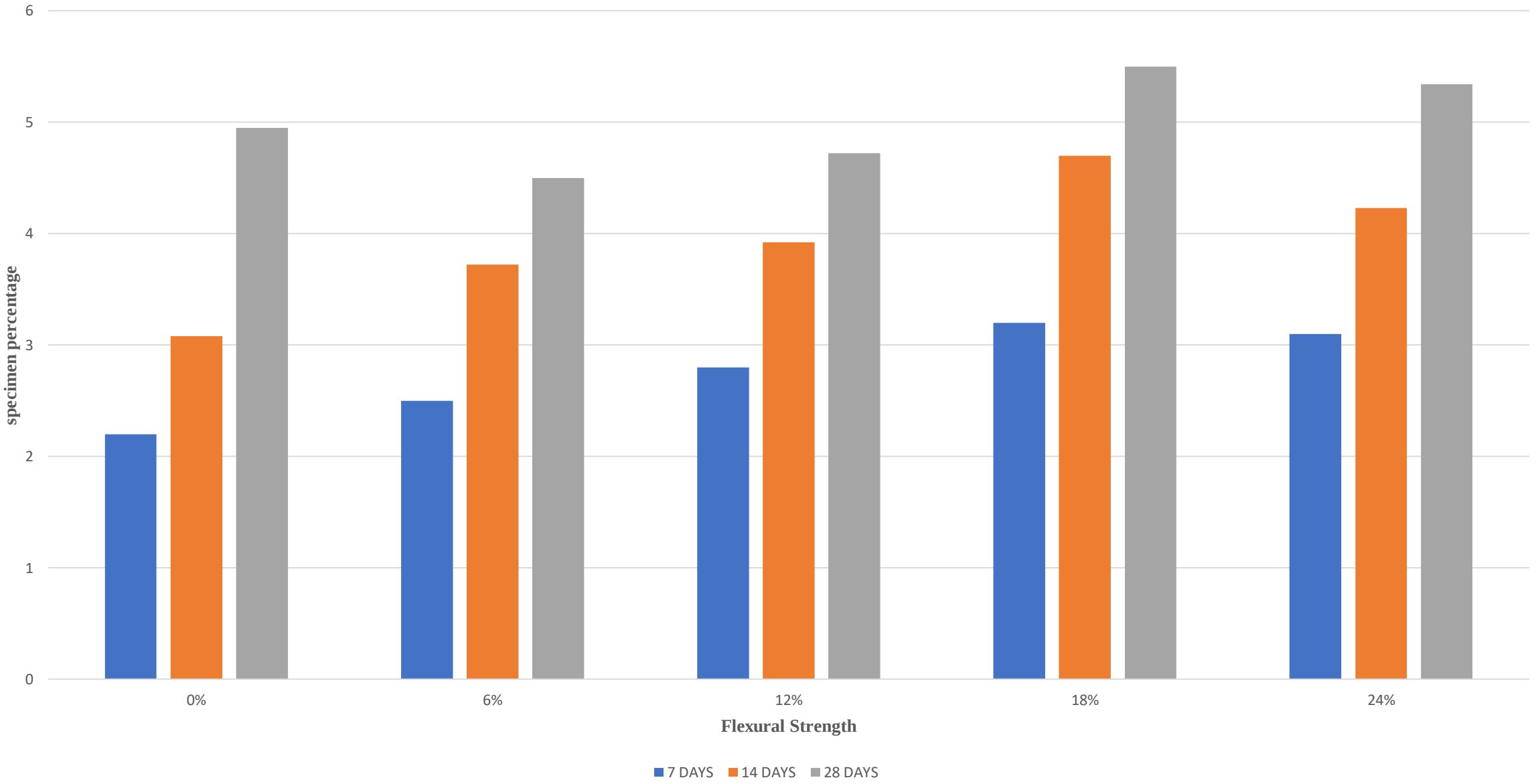
FLEXURAL STRENGTH TEST FOR 28 DAYS :

SPECIMEN PERCENTAGE	SPECIMEN 1 (KN)	SPECIMEN 2 (KN)	SPECIMEN 3 (KN)
0%	9.34	9.44	9.5
6%	7	9	10
12%	9.2	9.4	9.7
18%	10	11	13
24%	10.4	10.6	10.7

GRAPH ANALYSIS FOR PRISM



GRAPH ANALYSIS FOR PRISM



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.
- 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.

REFERENCE

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- IS 10262:2019 – Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards, New Delhi.
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- Deepika, K., & Gowda, H.S. (2020). Experimental study on concrete using e-waste as coarse aggregate replacement. Materials Today: Proceedings, 33, 1560–1565.

THANK YOU