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Analysis of Concrete Strength on Partial Replacement of Coarse Aggregate with Electronic Scrap -A Research

Akash Pushpad[1], Rahul Sharma[2]

[1]M. Tech scholar, Department of Civil Engineering, Prashanti Institute of technology & Science, Ujjain
[2]Assistant Professor, Department of Civil Engineering, Prashanti Institute of technology & Science, Ujjain

ABSTRACT

Now, A days it is widely seen that the electronic scrap is becoming a major task to decompose. There are very limited no. of ways to do so that are also conventional which consumes a lot of machineries, manpower and high costs. This study is done by us to minimize the electronic scrap in the world so to eliminate the ill effects of the electronic scrap on the ecosystem. It has also seen that it also polluting the natural resources in many ways. So here we are partially replacing the coarse aggregate with different-different percentage of electronic scrap material or we can also say it a E-Waste material. The percentage of coarse aggregate we are replacing are 6%, 12%, 18%, 24% with the electronic scrap. The age of the concrete structures is generally between Fifty to Hundred years. After this time the structure starts to develop little crack and get deteriorate. Solution for this problem is the bacteria which plays a significant role in self healing. Here we analyse the strength of bacillus bacteria and the source of calcium. The capacity of the self healing concrete is studied from many sources. Source of calcium is supplied at 4% and 8% and the bacteria of bacillus is added at 4% & 6% resp. so this study plays a significant role in the construction economy and the maintenance purpose as well.

Keywords: E-scrap, Bacteria of bacillus, durable, Source of calcium

INTRODUCTION

Concrete is type of combined susbstance which is get ready by cement, sand, aggregate and water. Nearly we can see that all the civil engineering work is composed of concrete material. Various infrastructure such as road, building, dam and various construction activities is mainly consisting of concrete material. One time clay material is used by the people for the binding property in building and various construction activities. After a long time there so many changes have been take place in the construction field such as lime and gypsum also play a crucial role. Joseph Aspdin once a time created a cement called portland cement by burning and the crushing of limestone and the clay material. Because this material is very suitable for the concrete material which is durable and long lasting. In aggregate materials 4.75 mm size is referred as fine material while the size more than it is referred as coarse materials of aggregate. When this all the materials we can combine in a single lump type shape we can give any type of shape to the concrete material, this contact material is a thick material in a weight state and in the dry state it takes a hard shape. After the making of this concrete up to many days during is done on it to get the desired strength as per the design mix. Hydration process start when the water get mixed into cement in the concrete & as a result water start evaporating and the concrete starts to take its strength in the initial phase. Now in additional more water is needed to enhance its hydrating property of the concrete. So here our curing process place a crucial factor in achieving proper concrete strength . Technical words for calcium silicate jel is prepared also known as CHS gel. Generally we are curing a concrete in 3 Phase. While considering the first phase it is seen that very less strength this achieve in the concrete we can say it a minimum strength. Ine d second face it take about 8-9 hours in the completion and to achieve strength in a faster rate. In the third stage we can see that the hydration is taking place

at a higher rate and required strength is taking its original position in the concrete specimen. Here low amount of heat is produced and also the rate of strength we are gaining is at a very slow rate. Now we have to test is its compressing strength in the compressive testing machine grade of concrete we have to determine after a 28 days of curing. Generally we are using concrete strength we are getting after the 28 days of fasting with full curing. Basically we are getting the ultimate strength after the 99 days by keeping in mind that there are very low number of vehicles which is related to commercial will drive on a period of 99 days. But normally we are identifying the 28 days strength as per the IRC providing the multiplying factor so that to determine the 90 days strength from the strength of 28 days

OBJECTIVES OF THE STUDY-

The aim of the research we are performing is to reduce the environmental pollution to a high rate which is generated by the electronic scrap plastic material which is harmful in many ways to the environment and life and to the ecosystem where many species are getting affected by it. On the other hand we are performing it to reduce the cost of the concrete structure and to reuse the electronic scrap plastic material in a better way. Here we are also using self heeling concrete as a modern technique to give much advance result and performance for the future.

Some of the objectives are as follows of the study-

1. Finding the concrete strength by adding the calcium Source.

2. Calculating the strength variation of concrete by partial replacing aggregate with the electronic scrap.

3. Analysing the ill effect of bacteria and the calcium source on the strength of concrete

4. To find out the optimum quantity of calcium source and bachelors bacteria in the concrete mix

5. Finding the improvement in concrete strength by the addition of electronic plastic scrap and the bacteria of bacillus with the lactate of calcium

6. To calculate cost efficient and economy in construction

METHODOLOGY

The approach used for the job is covered in this chapter. The chapter's different sections cover the material and its characteristics, the amount of materials utilised, the tests conducted on the concrete, and the methodology employed. Following tasks were completed in order.

1. Gathered & carefully examined all relevant data and research papers on e-waste in concrete and self-healing concrete.

2. Gather and smash the e-waste from the collage, then filter the sample through the appropriate sieves. Samples ranging in size from 10 to 20 mm are selected for analysis.

3. Coarse & fine aggregate are graded.

4. Partially substituting coarse aggregate, M-30 grade concrete was made by different % of Electronic Waste in the range (0%-24%).

5. All mixes undergo tests for comp. strength & tensile strength & test results were documented.

6. Conclusion based on test results and future research scope.

The entire project is completed primarily in three phases.

1. To ascertain the qualities of the various materials utilised in the study, a number of tests were conducted on them.

2. Specimen casting.

3. Examining specimens and observing the bacteria's capacity for self-healing.

TEST RESULTS & DISCUSSIONS

General Various test findings were presented in this section.

Materials including aggregate, sand, cement, e-waste, etc. are used in the testing. These experiments are also published here, along with testing conducted on both fresh and hardened concrete.

Cement test results

OPC 43 grade is utilised in the study to create the concrete mix. The cement test results are displayed in Table 4.1. Every cement test result was acquired in accordance with IS 8112-20 specifications.

Table 4.1 Results of test of OPC cement of 43grade

Test	**Result**
Specific gravity	3.15
Time of Initial setting	40min
Time of Final setting	365min
Comp. strength in 7 days	32.8
Comp. strength in 28 days	46.33
Consistency	28%
fineness	8%

Aggregate Test Outcome

Both fine and coarse aggregate tests are conducted using the following forms.

4.3.1 F**ine Aggregates Test results (Sand)** - Tables 4.2 and 4.3 display the properties of sand. The results of fine and coarse aggregate are completed in sections 4.3.1 and 4.3.2. Figure 4.1 illustrates how fine aggregate is graded.

Tables 4.2 Fine agg. Test results-

Test	**Results**
Specific gravity	2.62
F.M	2.64
Density in loose state	1580(kg/m3)
Density in Compact state	1595(kg/m3)
Zone (grading)	2

Tables 4.3 Fine agg. Grading as per sieve analysis

S.no	**IS sieve**	**Wt. retain**	**Cumu. Wt retained**	**Cumu. % Retained**	**Cumu. % passing**
1	10mm	0	0	0	100
2	4.75mm	27	27	5	95
3	2.36mm	52	79	16	84
4	1.18mm	80	159	32	68
5	600micron	52	211	43	57
6	300micron	159	370	74	26
7	150micron	104	474	95	5
8	PAN	26	500		
	Total	500		265	

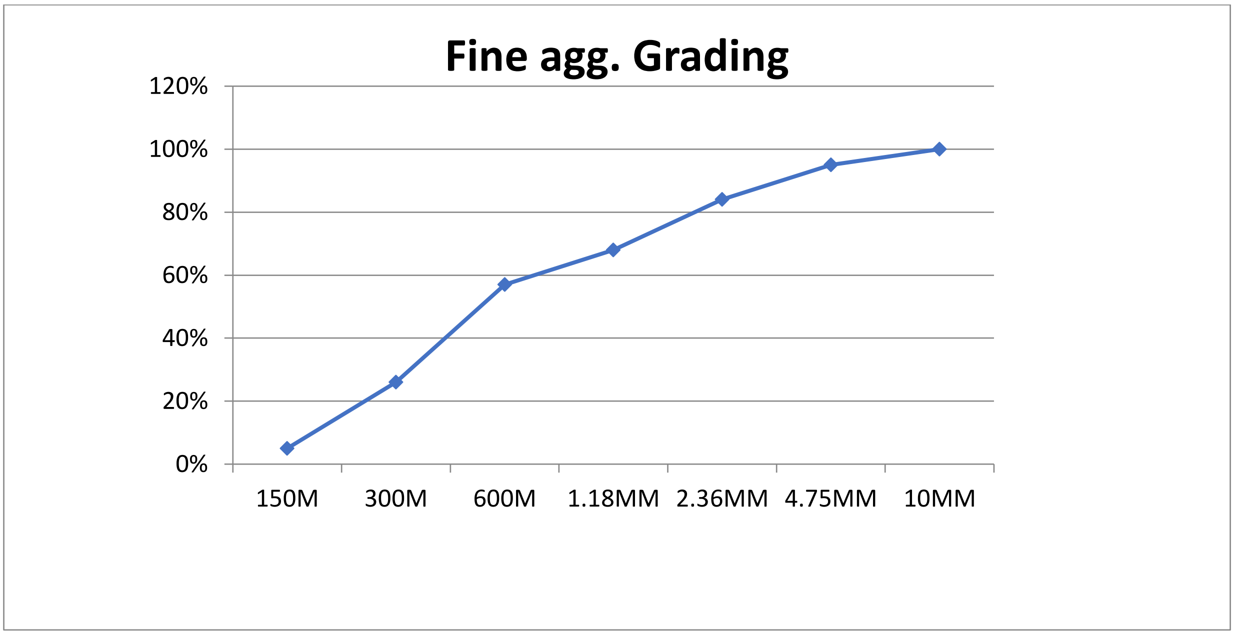

Fig.4.1Grading of Fine aggregate

Graph B/w % Passing on y axis & Sieve size on x-axis

4.3.2 Coarse aggregate test findings are provided in Tables 4.4 to 4.8. Table 4.4 lists the characteristics of the aggregate that was employed, while Tables 4.5 to 4.8 list the different grades of coarse aggregates. The coarse aggregate grading is shown in Figures 4.2 to 4.5

Table4.4 Coarse aggregate test results

TEST	RESULTS
Specific gravity	2.92
Water absorption %	0.62%
Crushing value	22.91%
Impact value	10.04%
Abrasion value	21.22%
Density	1743.3kg/m3

Table4.5 20mm aggregate Grading

Sieve	Wt Retained in gm	Retained %	Cumu. Retained %	Passing %
40	0	0%	0%	100%
20	2510	25%	25%	75%
10	7060	70%	95%	5%
4.75	430	5%	100%	0%
Total	10000			

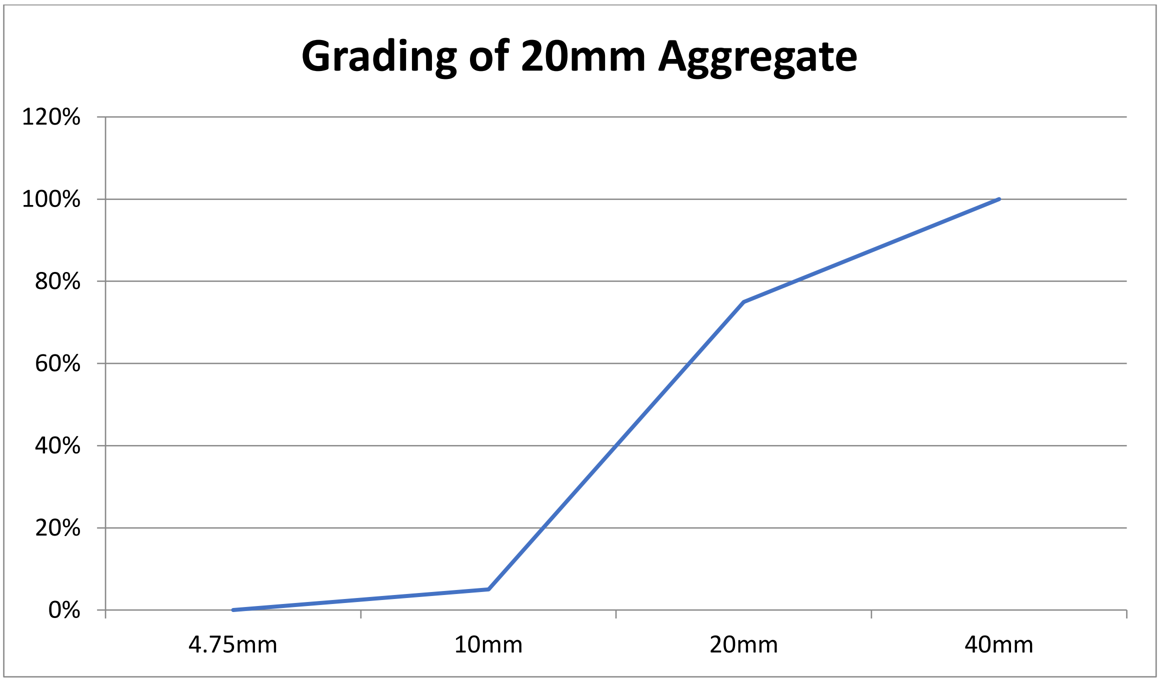

Fig.4.2 Grading of 20mm aggregate

Graph B/w % Passing on y axis & Sieve size on x-axis

Table 4.6 10mm aggregate Grading

Sieve	**Wt Retained in gm**	**Retained %**	**Cumu. Retained %**	**Passing %**
20mm	0	0%	0%	100%
10mm	600	12%	12%	88%
4.75mm	4100	82%	94%	6%
2.36mm	160	3%	97%	3%
pan	140	3%	100%	0%
Total	5000			

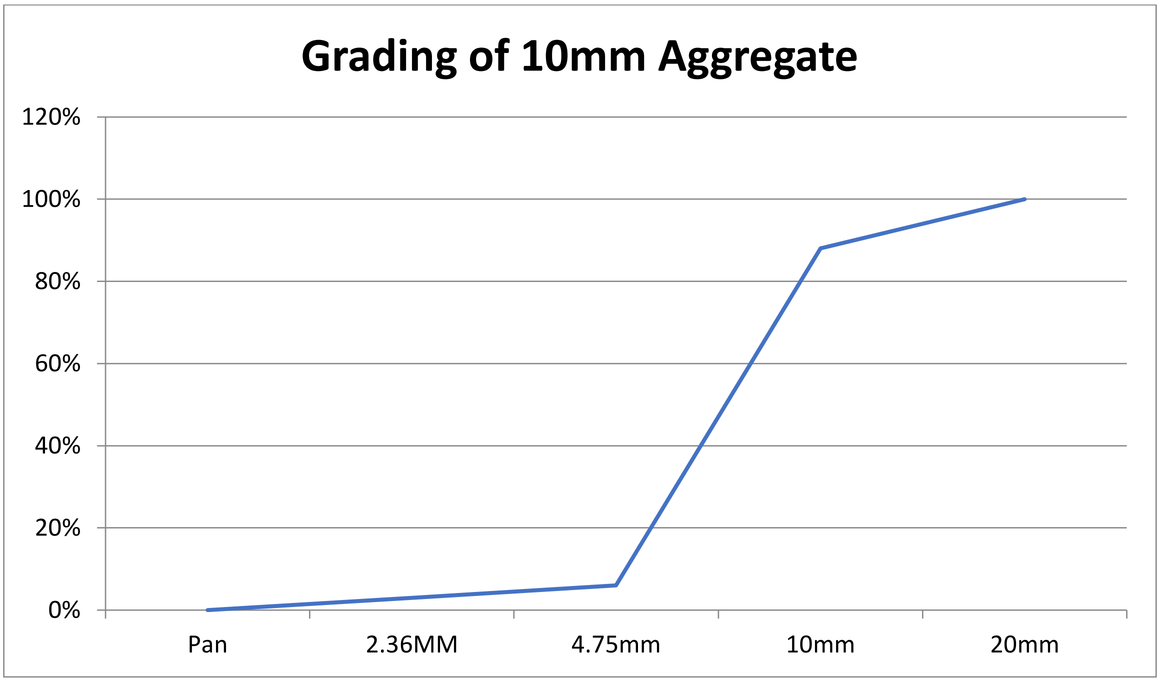

Fig.4.3 Grading of 10mm aggregate

Graph B/w % Passing on y axis & Sieve size on x-axis

Table 4.7 Mixed aggregate Grading

Sieve size	**Aggregate size**		**Blended aggregate**	**Required proportion**
	20mm(50%)	**10mm(50%)**		
40mm	100%	100%	100%	100
20mm	%74	100%	87%	90 to 100
10mm	4%	89%	47%	25 to 55
4.75mm	0%	7%	4%	0 to 10

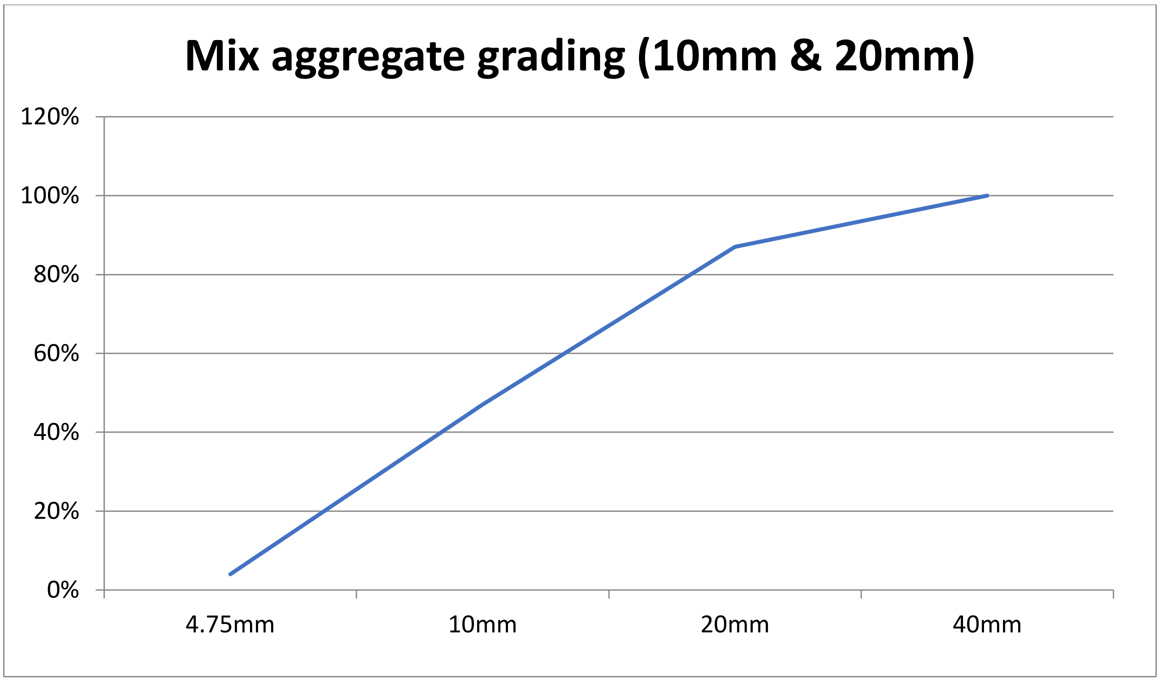

Fig.4.4 Mixed Grading of 10mm & 20mm aggregate

Graph B/w % Passing on y axis & Sieve size on x-axis

Concrete Tests-

Concrete is used for primarily two tests. Fresh concrete must first pass a workability test, and hard concrete must pass a strength test.

1. Slump cone test for workability
2. Compressive strength test
3. Test of split tensile strength

Test of Workability

The ease of mixing, placing, and finishing fresh concrete is known as workability. According to IS Code 1199, we are using slump cone apparatus to know the concrete's workability. Slump cone test requires the fresh concrete to test workability. The Cone mould's top & bottom diameters are 100 and 200 mm, respectively. According to IS Code 1199, the mold's height is 300 mm. Concrete is mixed, then poured into a cone in three stages, with a tamping rod compacting each layer 25 times. The temping rod is 600 mm in length & has Dia of 16mm. A workability with range of 75-88 is used here.

Concrete Test Results By partially replacing coarse aggregate by E-scrap

Electronic scrap is used to partially replace coarse aggregate. The results of split tensile strength test & the compressive strength test using E-Waste in lieu of C.A is displayed in (Table 4.10 & Figure 4.6).

Table 4.10 Comp. Srength of Ee-waste for partial replacement of coarse aggregate with E-waste with various %

Mix	E-Scrap(%)	Comp. strength	
		7days	28days
C	0%	27.42	42.17
R-i	6%	29.84	42.89
R-ii	12%	30.43	42.99
R-iii	18%	29.32	40.47
R-iv	24%	28.47	39.78

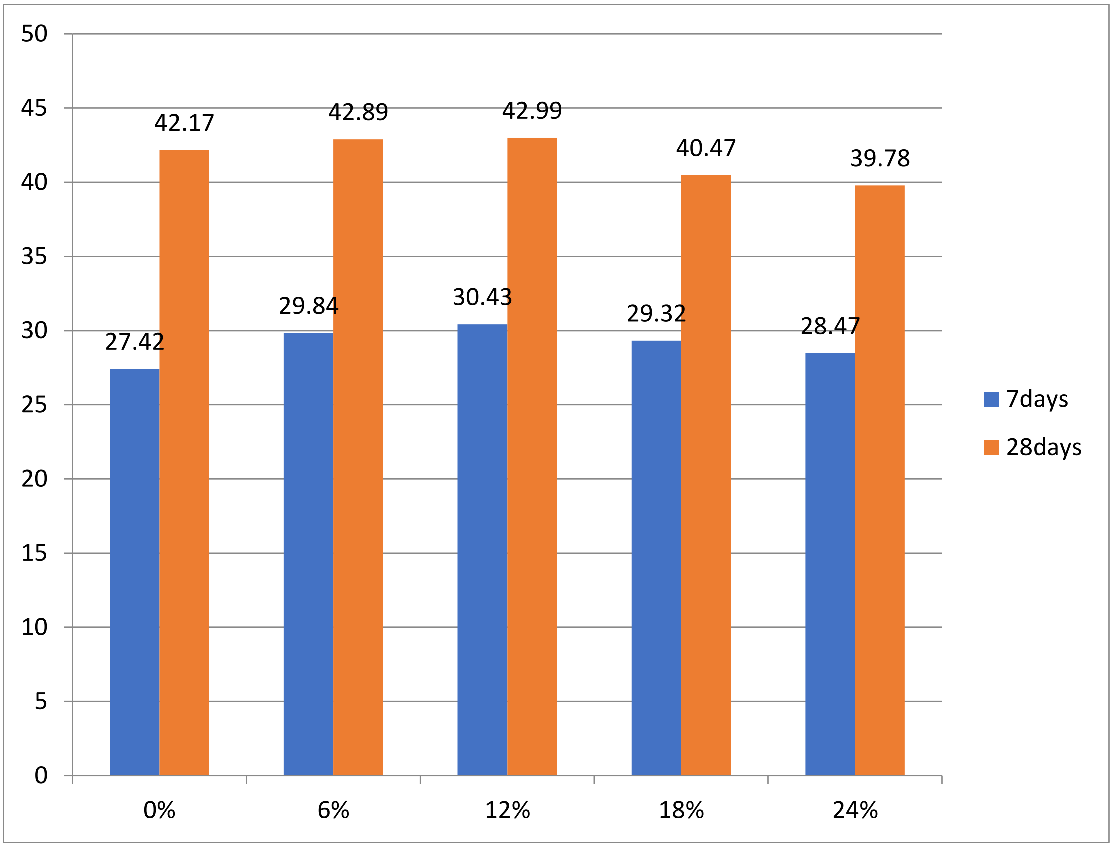

Fig4.6 Comp. strength at 7days & 28days with varying E-scrap %

Graph B/w Strength on y axis & E-scrap% on x-axis

Table 4.11 Split tensile Srength of concrete for partial replacement of coarse aggregate with E-waste with various %

Mix	**E-Scrap(%)**	**Split tensile. strength**	
		7days	**28days**
C	0%	3.78	4.67
R-i	6%	3.85	4.78
R-ii	12%	3.99	4.98
R-iii	18%	3.95	4.67
R-iv	24%	3.78	4.51

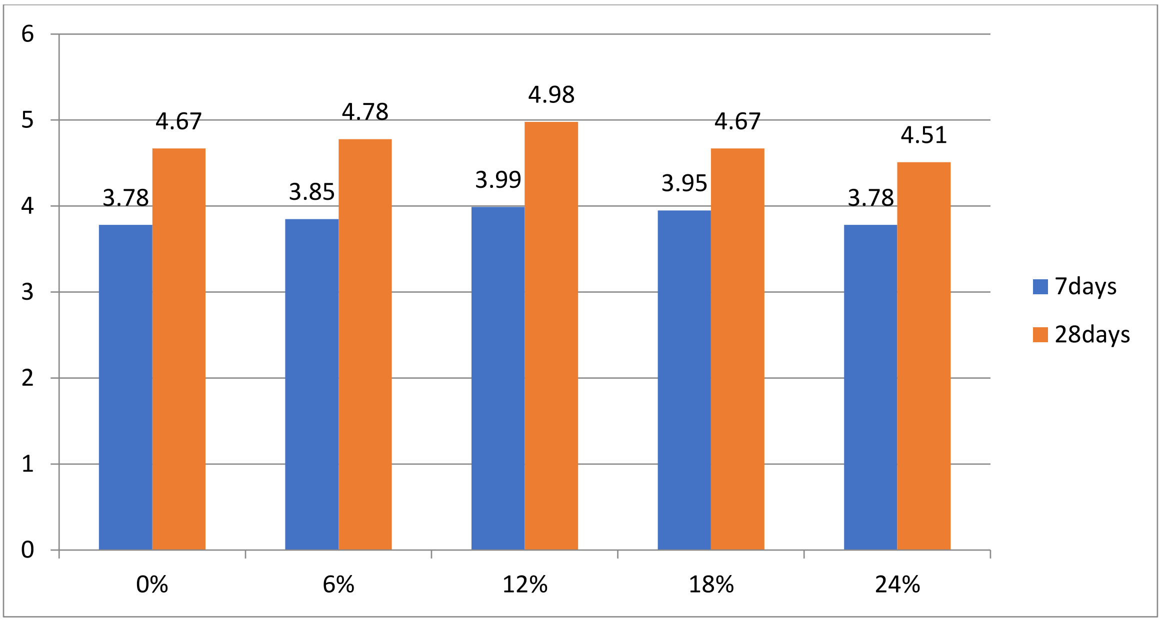

Fig4.7 Split tensile strength at 7days & 28days with varying E-scrap %

(Graph B/w Strength on y axis & E-scrap% on x-axis)

Concrete Test Results with Calcium Lactate Added

Tab.4.12 & Fig.4.8 display findings of comp. strength results with calcium lactate added, and this page displays the split tensile strength test results.

Table 4.12 Comp. Srength of concrete after adding calcium lactate

Mix	Calcium lactate%	Comp. Strength	
		7days	28days
C	0%	29.42	42.20
M-1	6%	29.30	39.25
M-2	12%	25.20	32.24

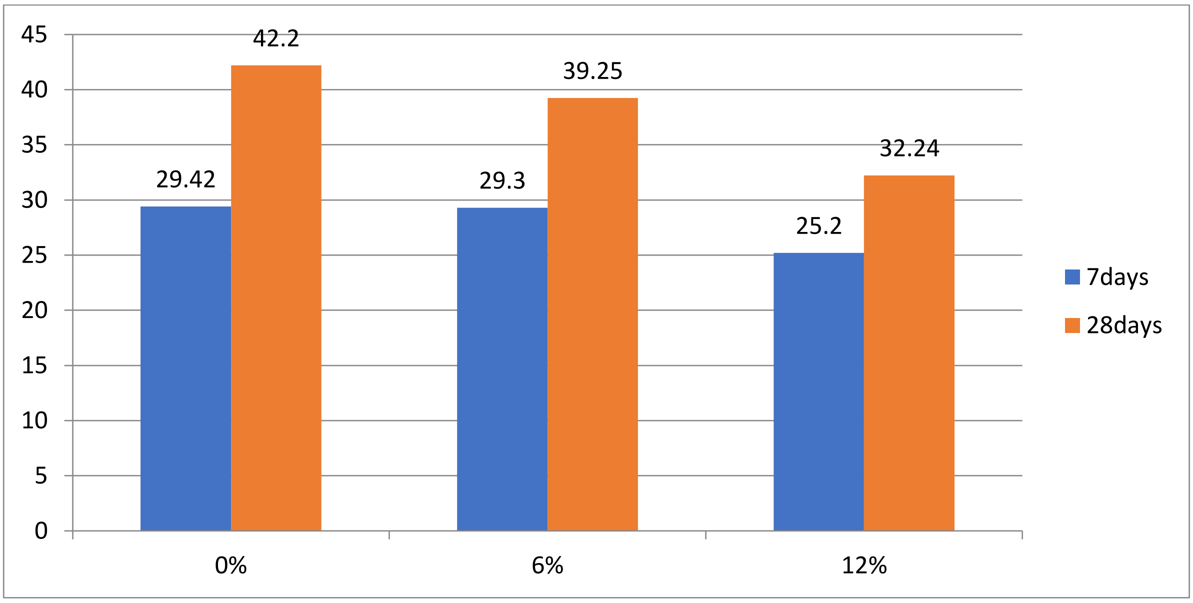

Fig4.8 Comp. strength at 7days & 28days with varying calcium lactate %(Graph B/w Strength on y axis & calcium lactate% on x-axis)

Table 4.13 split tensile Srength of concrete after adding calcium lactate

Mix	Calcium lactate%	Split tensile strength	
		7days	28days
C	0%	3.89	4.33
M-1	6%	3.98	4.57
M-2	12%	3.37	4.01

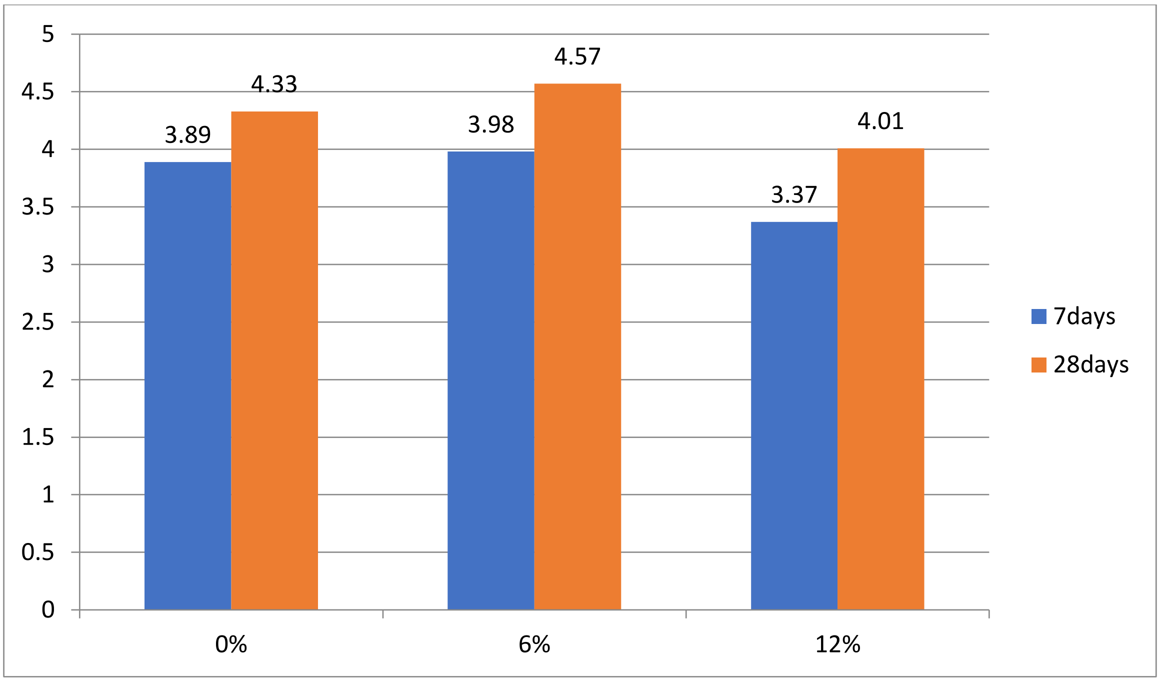

Fig4.9 Split tensile strength at 7days & 28days with varying calcium lactate %(Graph B/w Strength on y axis & calcium lactate% on x-axis

Test for Concrete findings By Bacteria (Bacillus Subtilis)

The findings of the concrete's compressive strength test by adding bacteria (Bacillus Subtilis) are displayed here, together with outcomes of split tensile test.

Table 4.14 Comp. Srength of concrete after adding Bacteria

Mix	Bacteria%	Comp. strength(mpa)	
		7days	28days
C	0%	29.74	42.55
B-1	4%	32.47	45.66
B-2	6%	27.44	39.87

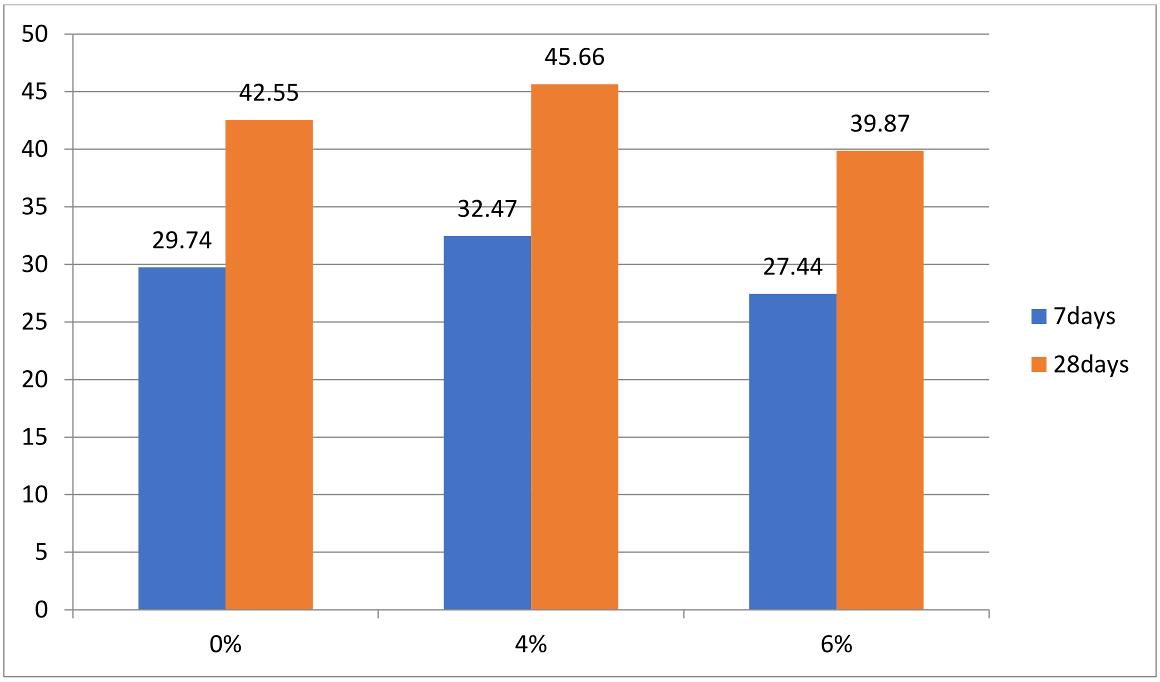

Fig4.10 Comp. strength at 7days & 28days with varying Bacteria % (Graph B/w Strength on y axis & Bacteria% on x-axis)

Table 4.15 Split tensile Srength of concrete after adding Bacteria

Mix	**Bacteria%**	**Comp. strength(mpa)**	
		7days	**28days**
C	0%	3.89	4.66
B-1	4%	4.23	4.95
B-2	6%	3.78	4.33

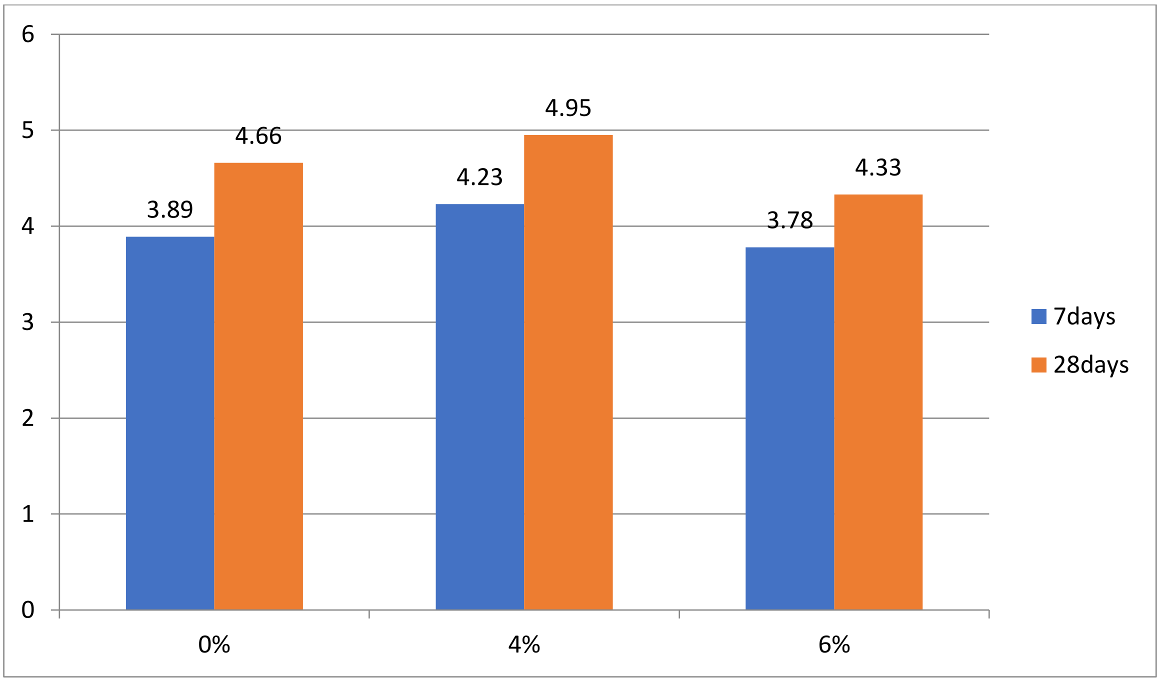

Fig4.11 Split tensile strength at 7days & 28days with varying Bacteria% (Graph B/w Strength on y axis & Bacteria% on x-axis)

Concrete test results using a combination of calcium lactate and bacteria (Bacillus subtilis).

The ideal proportions of Calcium Lactate and Bacillus Subtilis were taken from the previously made mixes in order to produce the concrete by combining the two substances. Through these, we learnt that the most strength is provided by 4% bacteria and, similarly, by 6% calcium lactate. Thus, a mixture of 4% bacteria and 6% calcium lactate is made here. These are the outcomes. Following tables display compressive strength test outcomes, and the split tensile strength test is provided.

Table 4.16 Comp. Srength of concrete after adding calcium lactate & Bacteria

Mix	**Calcium lactate%**	**Bacteria %**	**Comp. Strength**	
			7days	**28days**
C	0%	0%	28.42	41.20
M-1	6%	0%	28.30	40.25
B-1	0%	4%	30.20	42.24
M+B	6%	4%	30.04	42.12

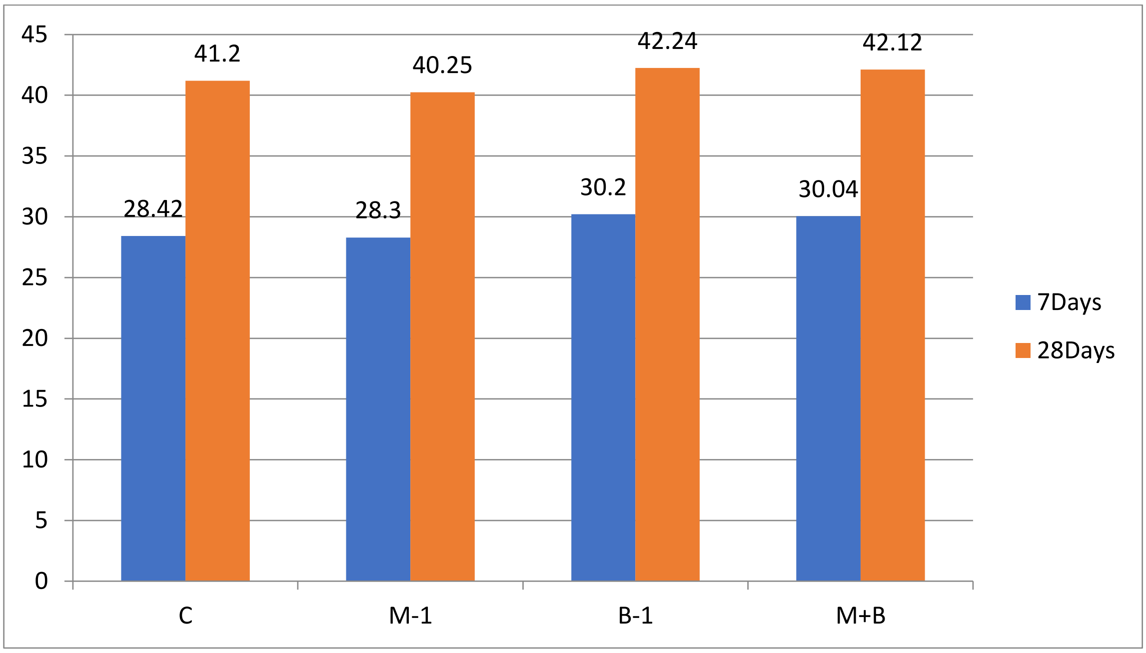

Fig4.12 Comp. strength at 7days & 28days with varying Bacteria & calcium lactate % (Graph B/w Strength on y axis & Mix type on x-axis)

Table 4.17 Split tensile Strength of concrete after adding calcium lactate & Bacteria

Mix	**Calcium lactate%**	**Bacteria %**	**Comp. Strength**	
			7days	**28days**
C	0%	0%	3.78	4.30
M-1	6%	0%	3.95	4.51
B-1	0%	4%	3.99	4.62
M+B	6%	4%	4.37	5.10

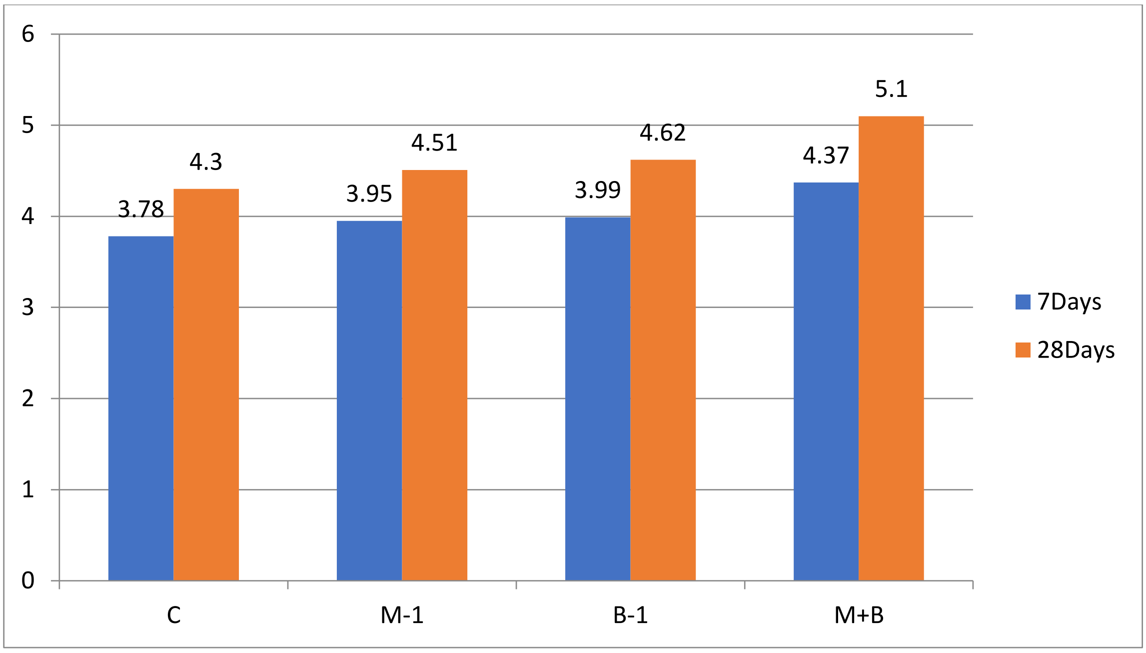

Fig4.13 Split tensile strength at 7days & 28days with varying Bacteria & calcium lactate % (Graph B/w Strength on y axis & Mix type on x-axis)

4.10 Concrete Test Results by Combining E-Waste, Calcium Lactate, and Bacteria (Bacillus Subtilis)

We employ the best possible combination of Bacillus subtilis, calcium lactate, and e-waste to produce the concrete. This is 10% of e-waste, 5% calcium lactate, and 3% bacteria (Bacillus subtilis). These are the outcomes. Results of tests for comp. strength & split tensile strength are displayed in following table & fig., respectively.

Table 4.18 Comp. Srength of concrete after adding calcium lactate, Bacteria & E-scrap

Mix	Calcium lactate%	Bacteria %	E-Scrap %	Comp. Strength	
				7days	28days
C	0%	0%	0%	28.42	41.20
M-1	6%	0%	0%	28.30	40.25
B-1	0%	4%	0%	30.20	42.24
M+B	6%	4%	0%	30.04	42.12
M+B+R	6%	4%	10%	32.78	43.28

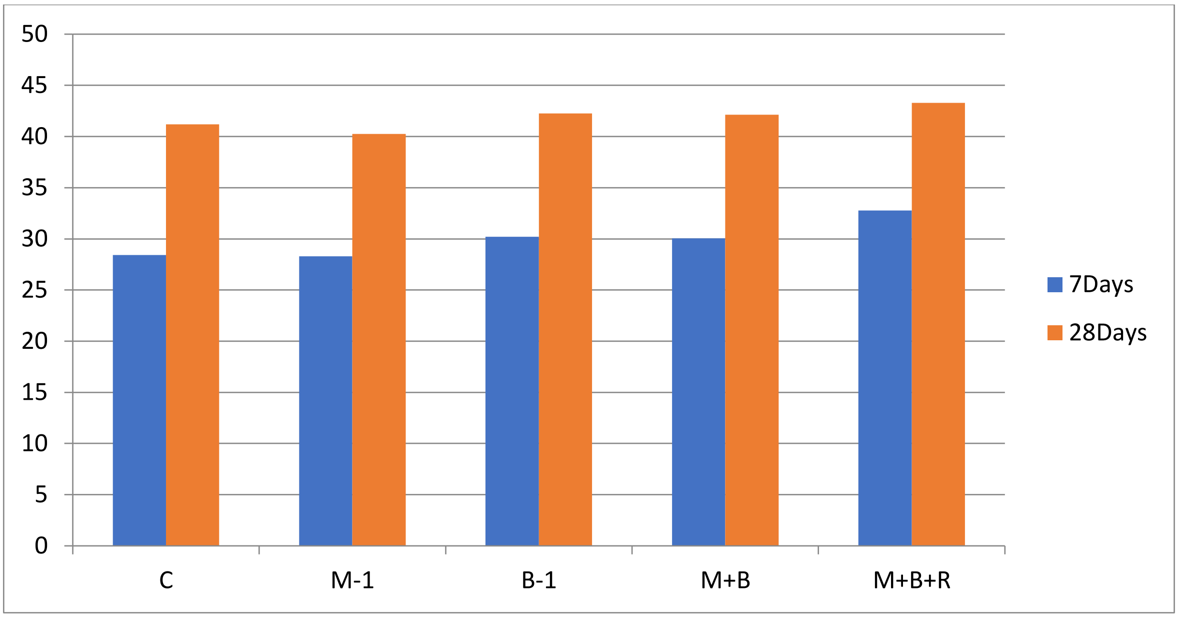

Fig4.14 Comp. strength at 7days & 28days with varying Bacteria, calcium lactate & E-scrap % (Graph B/w Strength on y axis & Mix type on x-axis)

Table 4.19 Split tensile Strength of concrete after adding calcium lactate, Bacteria & E-scrap

Mix	**Calcium lactate%**	**Bacteria %**	**E-Scrap %**	**Comp. Strength**	
				7days	**28days**
C	0%	0%	0%	3.78	4.30
M-1	6%	0%	0%	3.95	4.51
B-1	0%	4%	0%	3.99	4.62
M+B	6%	4%	0%	4.37	5.10
M+B+R	6%	4%	10%	4.87	5.42

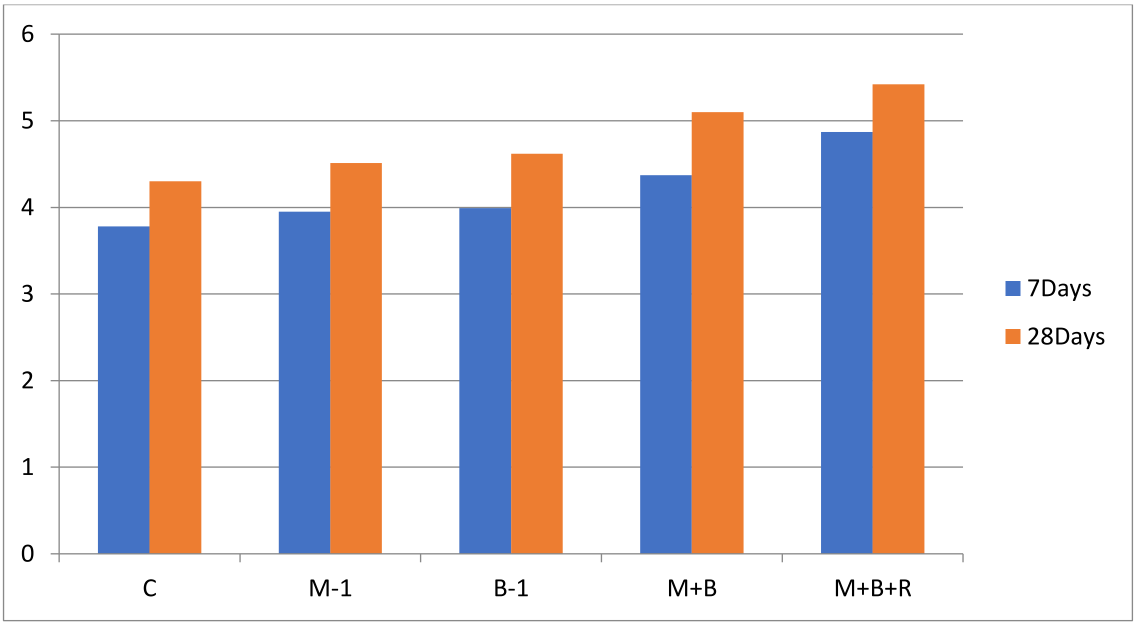

Fig4.15 Split tensile strength at 7days & 28days with varying Bacteria, calcium lactate & E-scrap % (Graph B/w Strength on y axis & Mix type on x-axis)

According to the results, when the E-Scrap % is increased upto 10%, comp. strength & tensile strength both rise. Tensile ability or strength rises when the E-Waste content is increased to 15%, but its compressive strength falls. The compressive strength increases by 3.52% for 7 days and 4.30% for 28 days when 10% e-waste is substituted. Similarly, the split tensile strength increases by 5.04% for Seven days & 3.50% for twenty eight days. Comp. strength of Concrete decreases when more e-waste is substituted. The reason for this is that concrete contains plastic, which provides it a higher tensile strength than regular concrete. In actuality, the plastic's good tensile strength will allow for a good reaction up to 10% replacement. For both comp. & tensile strength, Bacillus subtilis will produce better results at 3%. When 3% bacteria are added, the compressive strength increases by 9.71% after 7 days and 6.60% after Twenty eight days. Similarly, tensile strength increases 5.31% & 6.76% after 7 and 28 days, respectively. Conversely, adding the same at 5% reduces the concrete's tensile and compressive strengths by 1.86% and 9.01%, respectively. The addition of calcium lactate and microorganisms will also produce encouraging outcomes. The purpose of adding calcium lactate to bacteria is simply to determine the ideal calcium source for them, which is 5% of calcium lactate for just 3% of bacteria. Both comp. & strength for tensile have rises, according the data. The compressive strength rises by 4.71% after 28 days and 6.58% after 7 days. However, during 7 and 28 days, the split tensile strength increases by 16.98% & 18.41%, respectively. All three—E-Waste, Bacteria, and Calcium Lactate—are finally added to the ideal amounts that were previously established. When all three are added in the right proportions, the results indicate that, in comparison to conventional concrete, the compressive strength improves by 12.39% and 8.93% for Seven & Twenty eight days, & tensile strength increases by 19.89% and 20.28% for 7 and 28 days, respectively.

CONCLUSIONS

Below are the conclusions of the research performed :

1. Maximum strength is seen when 12% C.A are substituted by E-scrap. By replacing 12% of the coarse material, Com. strength & split tensile strength rises by 4.30% & 3.50%, resp. when relate to normal concrete.

2. The strength increases by 10% when e-waste is substituted for coarse aggregate; however, Strength reduces when replacement percentage rises.

3. The Tensile strength & concrete’s compressive strength rises by 6.76% and 6.6%, respectively, when bacteria up to 4% were introduced. When the bacterial percentage hits 6%, the potency begins to decrease.

4. Adding 6% additional calcium lactate to regular concrete produces a 2.02% reduction in comp. strength while a 3.03% rise in split tensile strength. However, when calcium lactate is raised to 12%, both comp. and split tensile strength reduces.

5. If calcium lactate and bacteria are combined, then comp. strength & split tensile strength rises by 6% & 4%, resp..

6. By adding 12%, 4%, and 6% of E-Plastic, Bacteria, and Calcium Lactate, respectively, the compressive and split tensile strengths are raised by 8.93% and 20.28% in comparison to regular concrete.

7. Application of Partial E-Scrap materials instead of C.A lowered construction costs by up to 4.14%

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