EXPERIMENTAL INVESTIGATION ON BACTERIAL CONCRETE

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***Abstract*: The concrete is heavily used as construction material in modern society. With the growth in urbanization and industrialization and its demand is increased day by day.in order to minimize the negative impact of concrete, The use of sand as supplementary to the usual materials. Our deals with the partial replacement of fine aggregate by sand and also we reduce the crack in concrete by using bacteria (bacillus pasteurii) in concrete.100% cement concrete mix is of M_{20} and water cement ratio is 0.4. The strength will be tested during the period of 7 days, 14 days, 28 days respectively. We will compare replaced with the conventional about the strength and durability of the concrete and we use chemical protector as calcium lactate.**

Index Terms: calcium lactate, strength and durability.

1. INTRODUCTION

1.1. General

Construction technology has seen a rapid change over time. Many typical structure can be constructed within a month of duration using advanced construction techniques. Though it is proven that construction can be done economically without using concrete. Concrete is a construction material that consists of cement, aggregate, water and admixtures. Generally the high performance concrete usually contains ordinary Portland cement. The use of different type of sub products into the cement based materials has become a common practice in the concrete industry. However the partial introduction of waste from the industries is help to improve their strength properties.

1.2. Introduction of bacteria:

Chemical precursor to be used for bio-concrete.it is the special type of concrete which is invented by a group of microbiology under the head of HenkJkers. It is also termed as self-healing concrete. Bacterial concrete is a special type of concrete it has the ability to repair itself autonomously .one another advantage of bacterial concrete is that the introduction of bacteria in concrete also helps in enhancing the properties of concrete in both natural and laboratory conditions. Since 1980’s a lot of articles can be found related to bacterial concrete and many processes were proposed for preparing the bacterial concrete. The basic advantages of MICCP by the bacteria in concrete are the increase in strength, low maintenance cost of the concrete structure, resistance to freeze thaw, high carbonation which can help in decreasing the porosity and permeability, and increase in resistance towards chloride attack 17-25. This reaction is also expansive as ingress atmospheric carbon dioxide (CO_2) reacts with calcium hydroxide particles present in the concrete matrix to various calcium carbonate minerals. From the perspective of durability, rapid sealing of particularly freshly formed surface cracks is important as this hampers the ingress of water and other aggressive chemicals into the concrete matrix.

1.3. Objective of the research work

The objective or the present work is to study the effect of partial replacement of fine aggregate and coarse aggregate by sand and partial replacement of cement by bacteria and calcium lattes. The replacement is done at different levels of percentage that is aggregate are replaced by 50% of sand by 0%,10%,20%,50%. M_{20} concrete grade mix is initially designed without replacement and subsequently materials are replaced partially at different levels of percentages. The sample are to be tested for their strength characteristics. Certain objective of the work are follows:

- To determine the strength properties of concrete.
- To resist the easy damage.
- To use sand and bacteria and calcium lattes.

2. LITERATURE REVIEW

1. Sagura R, Jagadeesan R.2011..,studied on ‘‘Experimental Study on Mechanical Properties of Sand Concrete by Different Curing Methods’’ Concrete is widely used composite construction material consist of cement, fine aggregate and coarse aggregate. The shortage of the resources of natural sand(NS), have the possibility for the use of Sand performance and durability requirements. Curing plays a major role in developing the concrete microstructure and pore structure Using M25 grade of concrete cubes, cylinder and prism were casted for NS and MS. The specimens were allowed for air curing, standard moist curing, membrane curing and with Super-Absorbent Polymer (SAP) at different proportions of 0.2%, 0.3% and 0.4% by weight of cement and the various mechanical properties were studied Aggregates occupy 65 to 80% of the total volume of concrete and affect the fresh and hardened properties of concrete. Out of the total composition of aggregate, the fine aggregate consumes around 20 to 30% percent of the volume. The limiting resources of natural sand avail the possibility for the use of manufactured sands.

Inference

From this paper we take Sand with different proportions. The specimen were attain for curing of standard moisture and for air curing. Here we take 0.4% of water cement ratio. We use M25 grade concrete.

2.T. Shanmugapriya, R. Uma 2012.., studied on "Optimization of partial replacement of SAND by natural sand in high performance concrete with silica fume" and concluded that for M25 grade concrete. The ordinary Portland cement was partially replaced with silica fume by 1.5%, 2.5 %, and 5% and natural sand was replaced with manufactured sand by four proportions (I e 0%, 10%, 20%, 50%). However, further additions of manufactured sand caused reduction in the strength. The optimum percentage of replacement of natural sand by Sand is 50%.The results also revealed that increase in percentage of partial replacement of silica fume, increased the compressive and flexure strength of High Performance Concrete. From Literature Review it is observed that compressive and split tensile strength of M30 grade concrete increased by replacing 30% of natural sand with Sand.

Inference

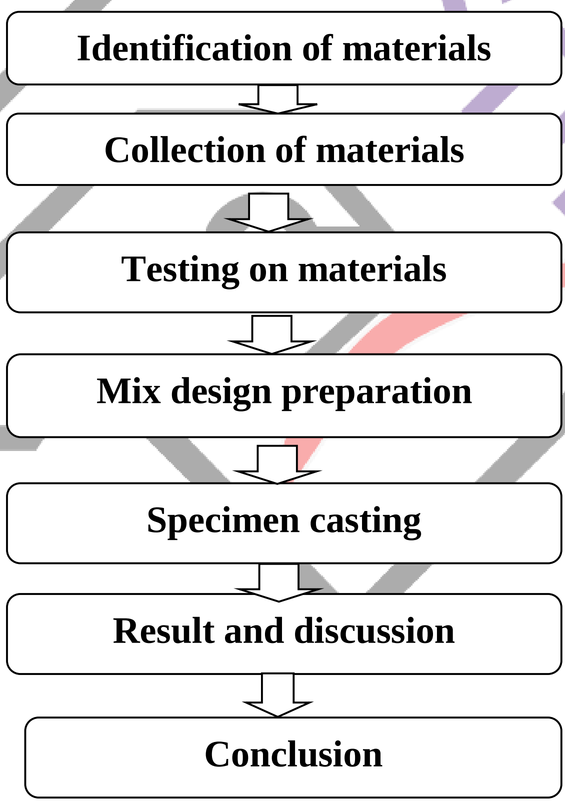
From this paper we take Sand is partially replaced with natural sand. We make test comparison b/w ordinary concrete and Sand (partially) concrete. The proportion of mixing of Sand is (15%, 30% & 50%).We make certain test to identified its strength.

3.Nimithavijayaraghavan.., 2013studied on "Study of compressive strength of concrete by partial replacement of Sand with Natural sand" and concluded that sand has a potential to provide an alternative to fine aggregate and helps in maintaining the surrounding every bit well as economical balance. The compressive strength properties of concrete containing sand at 0%,5%,10%,15%,20%,25% of fine aggregate.The result obtained for 28 days of compressive strength confirms that the optimal percentage for replacement of sand with natural sand is about 10%.

Inference

Here we take sand for concrete to identify the compressive strength for (7, 21, 28) days respectively. We use fine aggregate as natural sand & Sand of various proportions

3. METHODOLOGY



4. MATERIAL AND DESIGN METHODOLOGY

4.1. General

The present chapter deals with the presentation of results obtained from various tests conducted on material used for the concrete .In order to achieve the objectives of present study, an experimental program was planned to investigate on compression strength and spilt tensile strength of concrete. The various steps involved in our thesis are as follows,

- Identification of materials.
- Collection of materials.
- Testing of materials.
- Mix design preparation.
- Specimen casting.
- Results and Discussion Conclusion.

4.2. Materials

The properties of materials used for making concrete mix are determined in laboratory as per relevant codes of practice .Different materials used in present study were cement, coarse aggregate and fine aggregate, in addition of sand. The aim of studying of various properties of materials is used to check the appearance with codal requirements and to enable an engineer to design a concrete mix for a particular strength.

4.2.1 Ordinary Portland cement

Although all materials that go into concrete mix are essential, cement is very often the most important because it is usually the delicate link in the chain. The function of cement is first of all to bind the sand and stone together and second to fill up voids between sand and stone particle to from a compact mass. It constitutes only about 20% of the total volume of concrete mix; it is active portion of building medium and is the only scientifically controlled ingredient of concrete.

4.2.2 Aggregates

Aggregates constitute the bulk of concrete mixture and give dimensional stability to concrete. To increase the density of resulting mix, the aggregate frequently used in two or more size. The fine aggregate is to assist the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate, particularly when is necessary to transport the concrete some distance from the mixing plants to placement. The aggregate provide about 75% of the body of concrete and hence its influence is extremely important. They strong, durable and economical.

a)Coarse aggregate:

The aggregate which is retained over IS sieve 4.75mm is termed as coarse aggregate. The coarse aggregate may be of following types:

- Crushed graves or stone obtained by crushing of gravel or hard stone.
- Uncrushed graves or stone resulting from the natural disintegration of rocks.
- Partially crushed gravel obtained of product of blending of above two types.

The normal maximum size is gradually 10-20mm; however particle size up to 40mm or more have been used in self compacting concrete.

4.2.3 Specific gravity of coarse aggregate:

Specific gravity is used in design calculation of concrete mixes. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required to be considered when we deal with light weight and heavy weight concrete.

Table 4.1 specific gravity of coarse aggregates

S. No	Description	Trial-I	Trial-II
1.	Weight of empty pycnometer(W_1)	0.680	0.680
2.	Weight of pycnometer+coarse aggregate(W_2)	1.308	1.310
3.	Weight of pycnometer +coarse aggregate+ water(W_3)	1.915	1.922
4.	Weight of pycnometer+water(W_4)	1.527	1.527
5.	Specific gravity (G)	2.62	2.68

Specific gravity (g) $= (w_2-w_1)/(w_4-w_1)-(w_3-w_2)$ $= (2.62+2.68)/2$ $= 2.65$

Table 4.2 Properties of coarse aggregates

Characteristics	Value
Colour	Grey
Shape	Angular
Maximum size	20 mm
Specific gravity	2.65
Water absorption,%	0.5%

Fineness modulus(sieve analysis)

The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which we call gradation. The consists of the simple operation of dividing aggregate into fractions, each consisting of particle of the same size. The sieve used for the test has square opening, sieve are described by the size of their opening as ,80mm ,63mm ,50mm, 40mm, 25mm,16mm, 12.5mm,10mm, 6.3mm, 4.75mm, 3.35mm, 2.36mm,1.70mm, 1.18mm, 850μm, 600 μm, 300 μm, 212 μm, 150 μm, 75 μm. All sieve are mounted in frames one above the other in ascending order. The sieve used for coarse aggregate are of size 80mm, 40mm, 20mm,10mm, 4.75mm, 3.35mm, 2.36mm,1.70mm, 1.18mm,850μm, 600 μm.

Table 4.3 Sieve analysis of coarse aggregate:

S.No	Aperture size(mm)	Weight soil retained(kg)	Percentage of weight retained	Cumulative % retained	% of coarse aggregate
1.	80	0.00	0.00	100	0.00
2.	40	0.00	0.00	100	0.00
3.	25	0.90	1.8	98.2	1.8
4.	20	1.307	26.4	73.6	28.2
5.	12.5	3.397	67.94	32.06	96.14
6.	10	0.132	2.64	97.36	98.78
7.	4.75	0.061	1.22	98.78	100
8.	Pan	0.00	0.00	0.00	
	Total	**5.00**		**SUM**	323.92
				FM	3.24

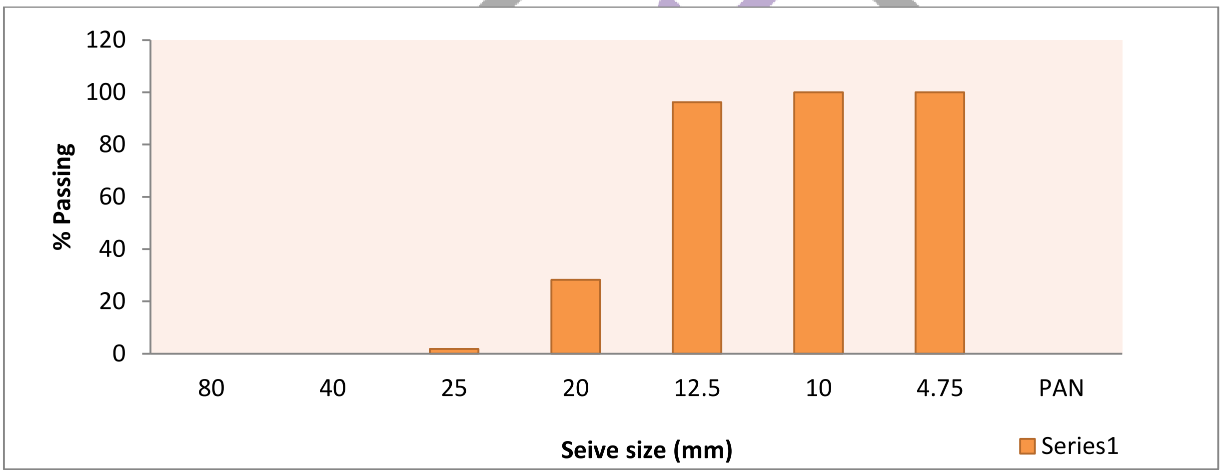


fig 4.3.1 Fineness Modulus Graph for Coarse Aggregate

Crushing strength on aggregate:

Dimension of mould = 15.10cm

Height of mould = $(\pi x(15.1)^2)/(4x13)$

= $2328.02cm^3$

Table 4.4: Crushing strength on aggregate

S. No	Total weight of aggregate (W_1)g	IS sieve 2.36mm passing materials (W_2)g	Aggregate crushing value (W_2/W_1)x100g
1.	2500	400	16.00
2.	2500	350	14.00

Calculation:

= (W_2/W_1)x100 g
= (400/2500)x100 =16%

= (350/2500)x100 = 14%

Total percentage:

= (16+14)/2 = 15%

Table No.4.5: water absorption test

S.No	Weight of oven dry specimen(g)	Weight of standard specimen(g)	Weight of water observed $W_3=W_2-W_1g$	% of water absorption $=W_3/W_1x100g$
1.	200	210	10	5%
2.	200	210	10	5%

Calculation:

To find W_3 ;

$W_3 = W_2-W_1g$ = 210-200= 10g

% of water absorption;$=W_3/W_1x100g$= 5%

Table.4.6 Abrasion test

Description	% of loss angle test(or) abrasion test
Let the original weight of aggregates (W_1) g	5000g
Weight of aggregate retained on 1.7mm IS sieve after test (W_2) g	4785g
Loss in weight due to wear (W_1-W_2) g	215 g
% of wear	((W_1-W_2)/w)x100=(5000-4785)/5000)x100=4.3%

Table 4.7 Impact test on coarse aggregate

S.No	Details of sample	Trial-I	Trial-II	Trial-III
1.	Total weight of aggregate sample filling the cylinder measure (W_1)g	440	370	390
2.	Weight of aggregate passing 2.36mm sieve test(W_2)g	80	84	82
3.	Weight of aggregate retained 2.36mm sieve (W_3)g	360	286	295
4.	(W_1-W_2+W_3)	0	0	13
5.	Aggregate impact value (W_2/W_1)x100	18.18	22.70	21.02

Calculation:

= (18.18+22.70+21.02)/3

= 20.63 (or) 21 say.

d) Fine aggregate:

The aggregate most of which pass through 4.75mm IS sieve are termed as fine aggregates. The fine aggregate may be of following types:

- Natural sand , i.e fine aggregate produced by crushing hard stone.
- Crushed stone sand, i.e fine aggregate produced by crushing natural gravel.
- Crushed gravel sand, i.e fine aggregate produced by crushed natural gravel.

Table.4.8 Sieve analysis test for M- sand

S.No	Aperture size(mm)	Weight soil retained (kg)	Percentage of weight retained	Cumulative % retained	% of natural sand
1.	4.75	0.005	0.5	99.5	0.5
2.	2.36	0.122	12.2	87.8	12.7
3.	1.18	0.314	31.4	68.6	34.1
4.	0.600	0.357	35.7	64.3	69.8
5.	0.300	0.100	10	90	79.8
6.	0.150	0.094	9.4	90.6	89.2
7.	Pan	0.018	1.8	98.2	91
8.	Total			**SUM**	377.1
9.				**FM**	3.77

Calculation:

= Total cumulative/100 = 377/100== 3.77

Fines modulus = 3.77

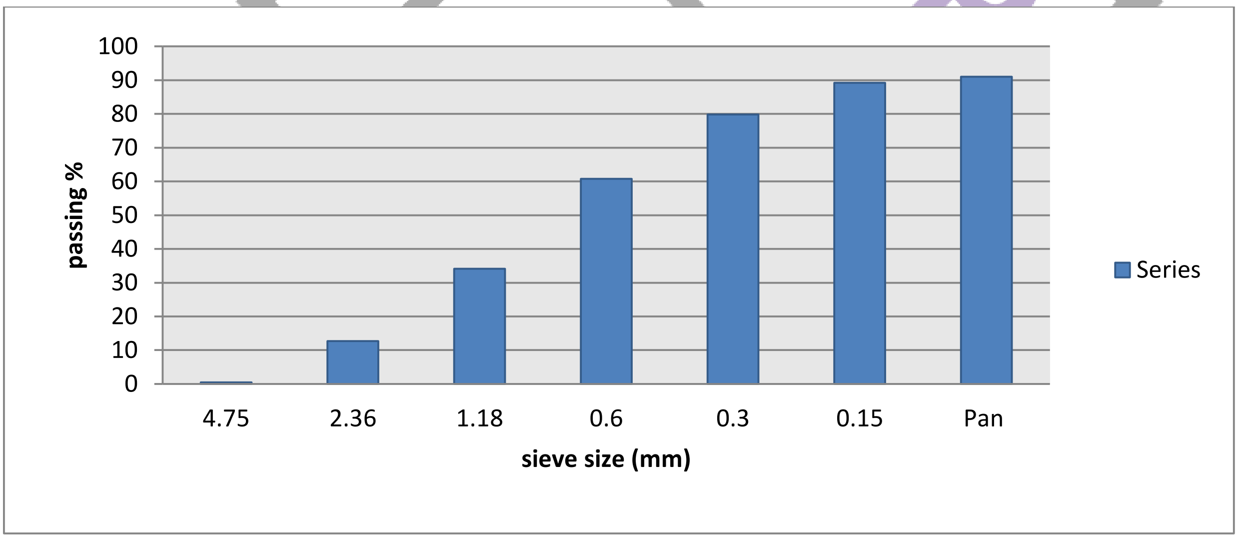


Table 4.9. Specific gravity of natural sand

S. No	Description	Trial-I	Trial-II	Trial-III
1.	Weight of empty pycnometer(W_1)	0.657	0.657	0.657
2.	Weight of pycnometer+coarse aggregate(W_2)	1.472	1.489	1.501
3.	Weight of pycnometer +coarse aggregate+ water(W_3)	1.985	1.990	1.998
4.	Weight of pycnometer+water(W_4)	1.527	1.527	1.527

5.	Specific gravity (G)	2.28	2.36	2.46

Specific gravity (g) $= (w_2-w_1)/(w_4-w_1)-(w_3-w_2)$

Specific gravity (g) $= (2.28+2.36+2.46)/3$

(G) = 2.36

Table 4.10 Specific gravity of Sand

S. No	Description	Trial-I	Trial-II	Trial-III
1.	Weight of empty pycnometer(W_1)	0.658	0.658	0.655
2.	Weight of pycnometer+coarse aggregate(W_2)	1.361	1.372	1.365
3.	Weight of pycnometer +coarse aggregate+ water(W_3)	1.921	1.934	1.934
4.	Weight of pycnometer+water(W_4)	1.527	1.527	1.527
5.	Specific gravity (G)	2.27	2.32	2.34

Specific gravity (g) $= (w_2-w_1)/(w_4-w_1)-(w_3-w_2)$
Specific gravity (g) = 2.27+2.32+2.34)/3
(G) = 2.31

Table :4.11Sieve analysis test for natural sand

S.No	Aperture size(mm)	Weight soil retained (kg)	Percentage of weight retained	Cumulative % retained	% of natural sand
1.	4.75	0	0	100	0
2.	2.36	0	0	100	0
3.	1.18	0.092	9.2	90.8	9.2
4.	0.600	0.307	30.7	69.3	39.9
5.	0.300	0.044	4.4	95.6	44.3
6.	0.150	0.040	4.0	96	48.3
7.	Pan	0.026	2.6	97.4	50.9
8.	Total	500.00		**SUM**	192.6
9.				**FM**	1.926

Calculation:

Fine modulus = total cumulative % / 100
= 192.6/100
= 1.926 %

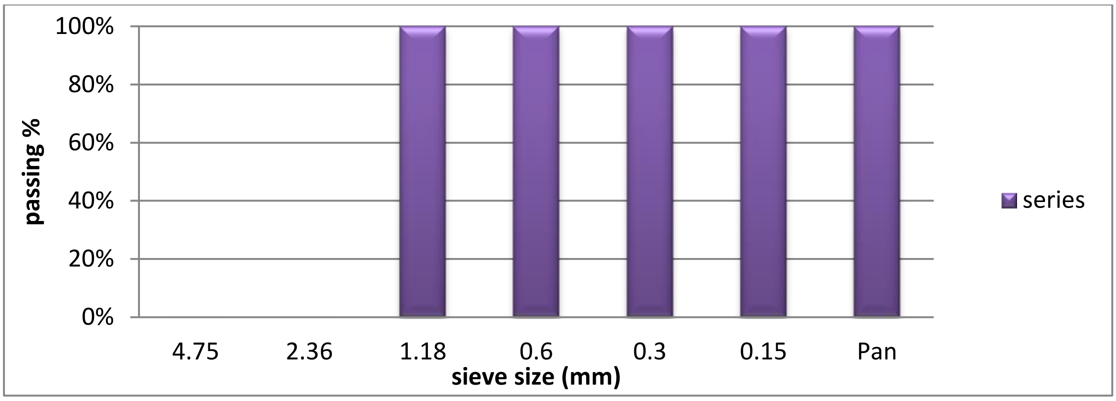


fig 4.11.1 Graph for natural sand

4.2.4.Water

Generally, water that is suitable for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is waste from industries plants, it should not be used in concrete unless test indicate that it is satisfactory. Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent tab water is used for casting. The portable water is generally considered satisfactory for mixing and curing of concrete in material testing laboratory. This was free from any detrimental contamination and was good potable quality.

4.2.5. Slump cone test

Slum is a measurement of concrete's workability, or fluidity. It's an indirect measurement of concrete consistency or stiffness. A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicate how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirement for the finished quality.

Table 4.12 Test on slump value

CONCRETE MIX	SLUMP VALUE (MM)
Normal	94
15%	85
30%	80
50%	72

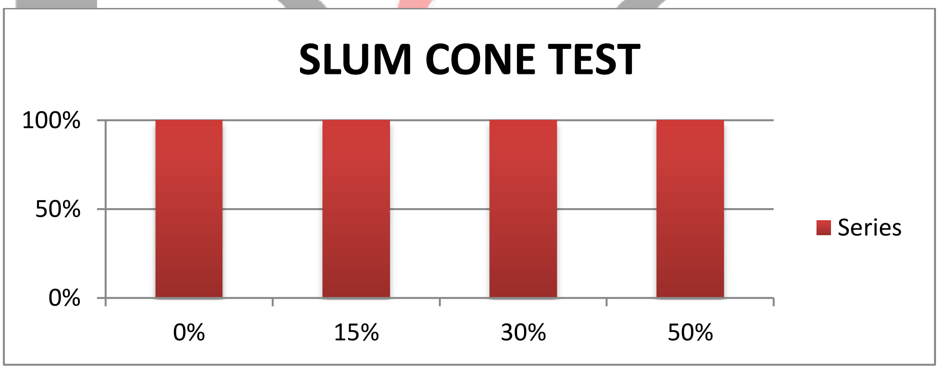


fig 4.12.1 Graph for slump cone test

Compaction test on concrete

It is a test that is used to determine the compacting factor of the prepared concrete mix.

Table 4.11: compaction test on concrete

S. NO	Description	Compaction factor
1	Normal	93
2	15 %	86

3	30 %	79
4	50 %	68

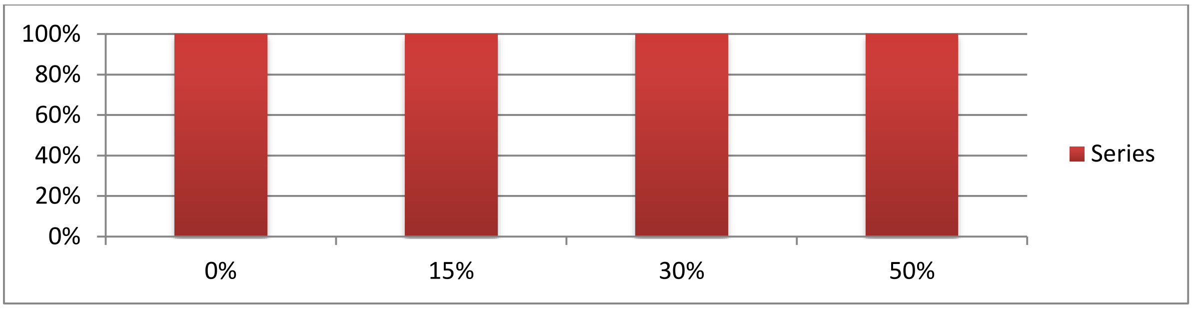


Fig 4.13.1 Graph for compaction test on concrete

5.MIXED DESIGN (M_{25}):

Design stipulations;

Characteristic compressive strength
Requirements the filed at 28 days = 25N/mm^2
Maximum size of aggregate = 20mm
Degree of workability = 0.86 (compaction factor)
Degree of quality control = good
Type of exposures = mild
Fine aggregate = zone-II

Table 5.1.The mix proportion then becomes

Water	Cement	Fine aggregate	Coarse aggregate
186kg	456kg	913.86 kg/m^3	1187.13 kg/m^3
0.40	1	1.150	3.09

Actual quantities required for the mix per bag of cement

The mix is 0.40:1:1.50:3.09(by mass).for 50kg of cement ,
The quantities of materials are worked out as below:

a) cement =50kg
b) sand =57.5kg
c) coarse aggregate =154.5kg
(fraction I=92.7kg)
(fraction II=61.8kg)

d)water
1.For water cement ratio of 0.40 quantity of water=20.0 liters
2.Extra quantity of water to be added for absorption in case of coarse aggregateat 0.5% by mass =(+0.77)
3. Quantity of water to be deducted for free moisture present in sand at 2% by mass=(-1.42)
4.Actual quantity of water to be added =20+0.77-1.42
=19.35 liters.
5.Actual quantity of sand required, after allowing for mass of free moisture
= 57.5 +1.42
=58.92kg
6.Actual quantity of coarse aggregate required:
(fraction I=92.7kg)
(fraction II=61.8kg)

Therefore, actual quantity of different constituents required for the mix are:
Water : 19.35
Cement : 50.00kg
Sand : 58.92kg
Coarse aggregate : (fraction I=92.7kg)
(fraction II=61.8kg)

Table 5.2.Mix proportion with sand:

Mix	Water	Cement	Fine aggregate	Coarse aggregate	Sand
0%	0.4	1	1	3	0
10%	0.4	0.90	0.5	1.5	0.5
20%	0.4	0.80	0.5	1.5	0.5
50%	0.4	1	0.5	1.5	0.5

6. RESULTS AND DISCUSSION

6.1General

This chapter deals with the presentation of results obtained from various tests conducted on concrete specimens cast with or without sand and bacterial concrete. The main obtained of the research is to understand the strength and durability aspects of concrete obtained using bacteria as partial replacement of sand. Inorder to obtained the present study, an experimental program was planned to investigation the effect of sand on compressive strength and split tension test. The experimental programs consist of casting, curing and testing test. The experimental program consist of casting, curing and testing of sand on bacterial concrete specimen at different percentage.

6.2. Compressive strength

Test specimen of size 150mmx150mmx150mm was prepared and tested using the compressive testing machine. The concrete mixes with varying percentages (0%, 15%, 30%, and 50%) after 24 hours the specimen was removed from the molds and placed in fresh water. The specimen so cast was after 7, 21, and 28 days of curing were tested to determine the compressive strength of concrete.

Table 6.2: Compressive strength of concrete measurement

S.NO	Mix	Compressive strength of N/mm^2		
		7 days	21 days	28 days
1	Normal	17.33	24.66	25.33
2	15%	21.33	30.66	36.88
3	30%	24.00	35.11	37.55
4	50%	30.44	36.88	38.22

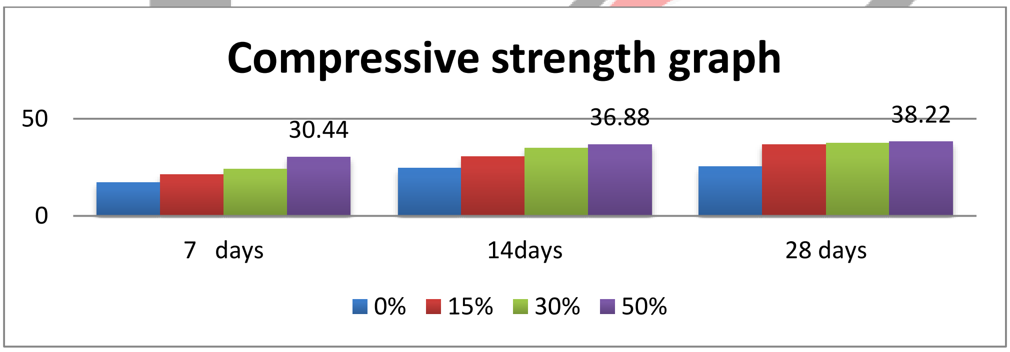


fig 6.2.1 Graph for compressive strength test

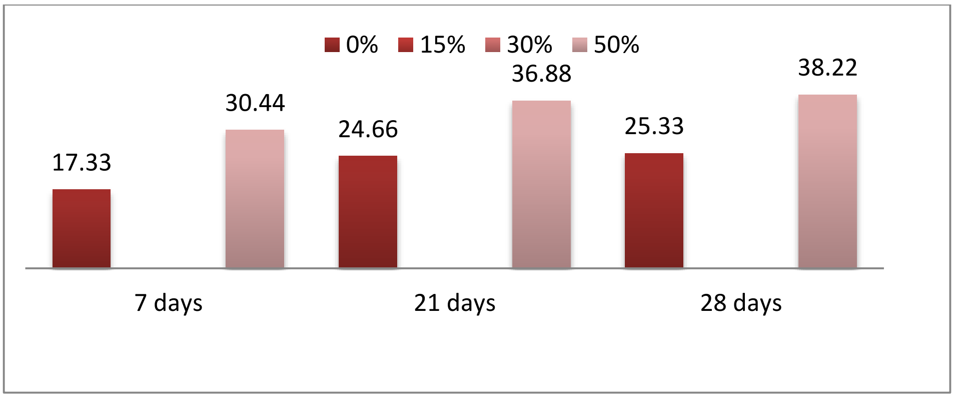


fig 6.2.2. Percentage (%) Increase in compressive strength of concrete

6.3.Split tensile strength test

The splitting tensile strength test result of using sand in concrete. The results show that in general, there is an increase in splitting tensile strength varying from 0%,15% ,30% & 50% with the addition of Sand to the concrete. The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete.

Table 6.3: Split tensile strength of concrete measurement

S.NO	Mix	Split tensile strength of N/mm^2		
		7 days	21 days	28 days
1	Normal	4.67	5.02	5.58
2	15%	5.23	5.37	6.29
3	30%	5.52	5.58	6.36
4	50%	5.80	6.08	7

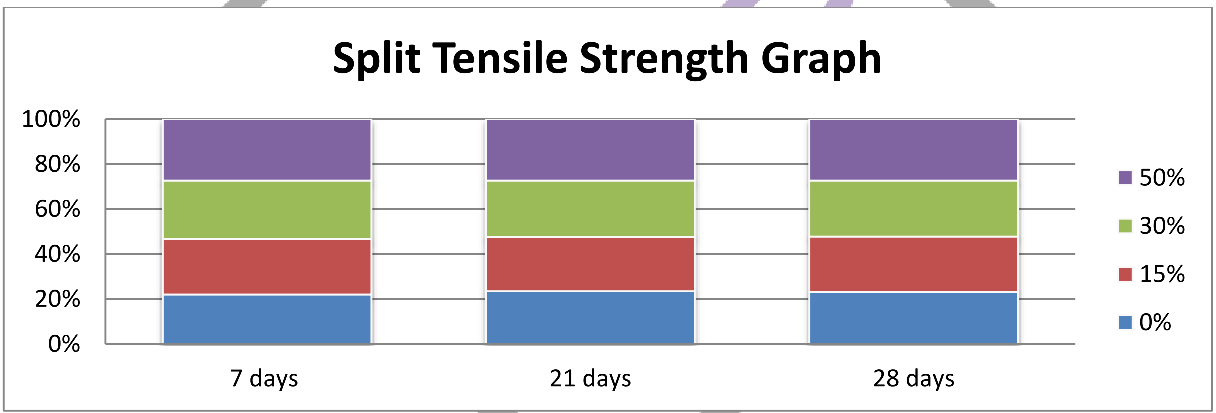


fig 6.3.2. Graph for spilt tensile strength

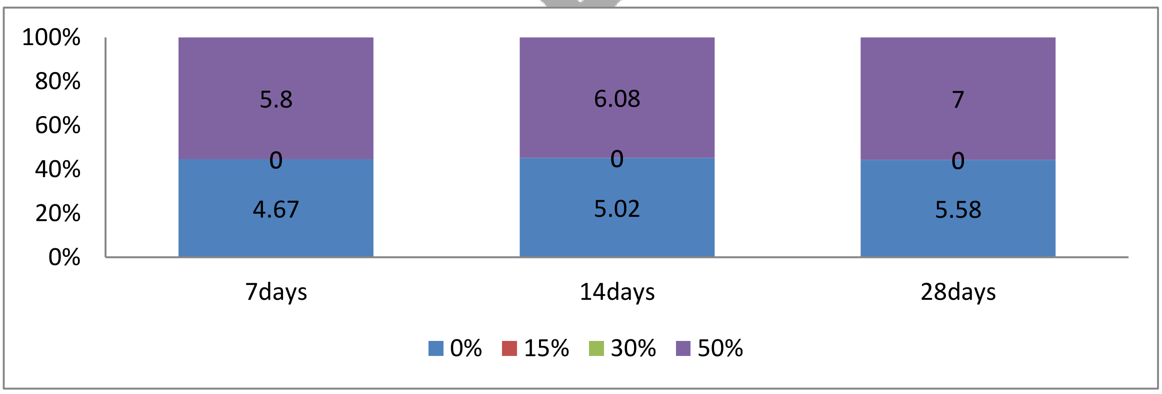


fig 6.3.3 Percentage (%) Increase in Split tensile strength of concrete

6.4.Flexural strength test

The result of flexural strength test conducted on concrete using sand. The use of Sand reinforcement concrete is Compare to convention concrete by added 0%, 15%, 30%,50% sand with per weight of cement. The specimens were the concrete beams of

size 45cm x 10cm x 10cm supported on rollers, so that their center to center distance is 40cm for 10cm specimens. However , it was the flexural tensile stress or strength that play an important role for the failure of beam.
Flexural strength,

$$Fb = PL/bd^2$$

Where,

P = Maximum Load, L = Span of Specimen,B = Width of specimen,

Table 6.4: Flexural strength of concrete measurement

S.NO	Mix	Flexural strength of N/mm²		
		7 days	21 days	28 days
1	Normal	3.60	3.93	4.50
2	15%	3.96	4.35	5.95
3	30%	4.95	5.10	6.45
4	50%	5.25	5.70	7.23

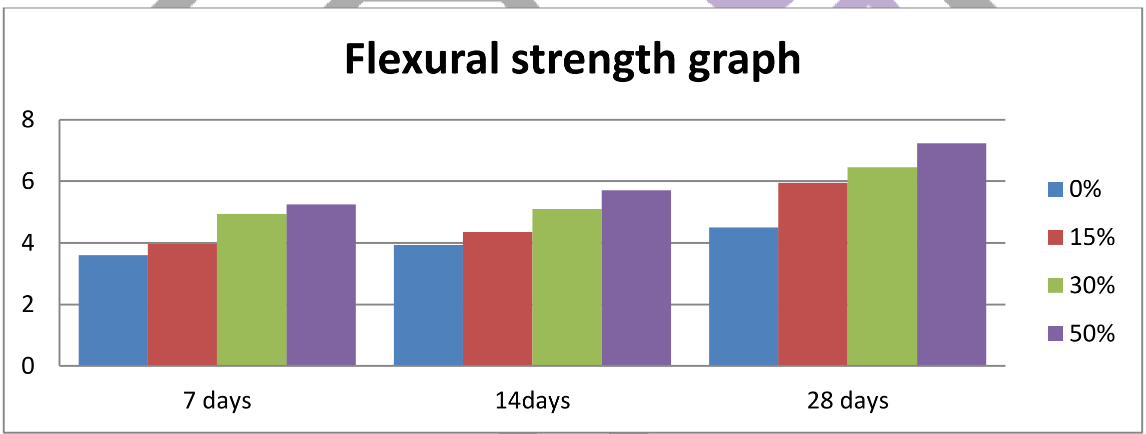


fig 6.4.2 Graph for flexural strength test

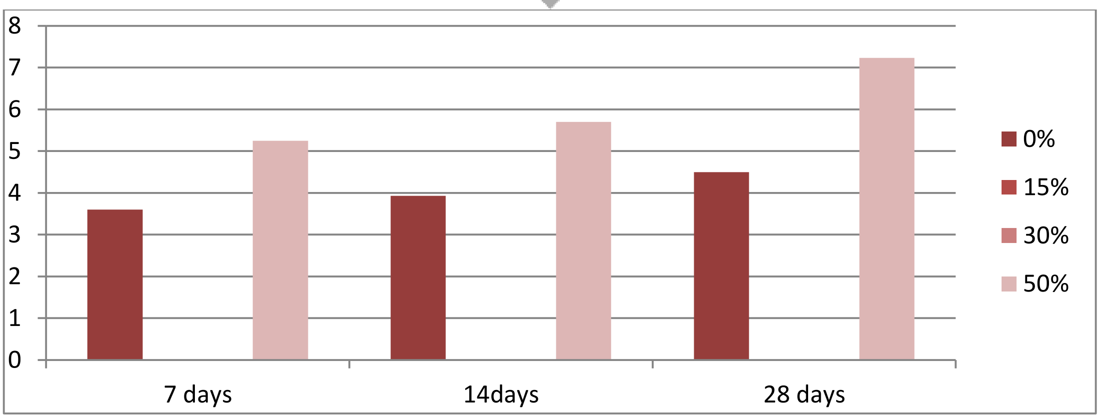


fig 6.4.3 Percentage (%) Increase in Flexural strength of concrete

7.CONCLUSION

7.1.General:

The strength and durability characteristics of concrete mixtures have been computed in the present work by replacing 15%, 30% and 50% of Sand for increasing strength on concrete and using bacteria in concrete to reduce the crack in concrete .On the present study, following conclusions are drawn.

7.2.Compressive strength:

The compressive strength for the concrete samples is done during the durations of 7, 14 and 28 days respectively. After the replacement of materials (Sand) it is found that the compressive strength of concrete is increasing gradually.The compressive strength tends to increase with the increase in different percentages of replacement of sand such as 15, 30 and 50 percentages.

7.3.Split tensile strength:

The split tensile strength also tends to increase with the increase in the partial replacement of Sand to the concrete and addition bacteria to the concrete.By replacing partially of 15%, 30 and 50% of sand to fine aggregate. Curing duration of 7, 21, 28 days there is increase in split tensile strength at considerable rate. By replacing quarry waste is beneficial for improving the strength characteristics.

7.4. Flexural strength:

The flexural strength in which also tends to increase of strength by replacing sand partially to the concrete and also mixing of bacteria to the concrete during the process of curing.The partial replacement of sand to fine aggregate is increasing the strength gradually with the curing duration of 7, 21 and 28 days respectively. The general measure is to show the variation b/w the ordinary concrete and sand concrete.

In the present study it is used for all types of building to reduce the timing of the building and the cost wise it should be low compare to using natural sand. In the present study only up to 15%, 30% and 50% replacement of fine aggregate by sand has been considered.

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