AN EXPERIMENTAL STUDY ON BACTERIAL CONCRETE WITH EFFECT OF DIFFERENT BACTERIA ON THE STRENGTH OF CONCRETE

ABSTRACT:

The worldwide utilization of cement is second just to water. As the interest for concrete as a development material increments, so likewise the interest for Portland concrete. Concrete is a tough development material delivered by blending Portland concrete, water, totals and added substances with extraordinary extent. Changing the fixings and creation technique for ordinary cement is significant concerning maximum usage of concrete as a development material.. This pattren presents the aftereffects of a trial examination did to assess the impact of Bacillus Subtilis and Bacillus Licheniformis on the compressive strength, water retention and its self-recuperating properties. An endeavor is made to recuperate these breaks by the expansion of the microbes in the substantial and furthermore to increment of the strength of the substantial. Every microscopic organisms of fixation are added. Tests were performed at the ages of 7, 28 and 56 days. It is found that the breaks in the substantial have been recuperated and the development of calcite precipitation is noticed utilizing Scanning Electron Microscopy (SEM). In the current venture here is an endeavor made to fill the breaks with the assistance of microscopic organisms which has a self-mending property. Calcite development of separated microbes which can deliver calcite hastens on reasonable media enhanced with a calcium source.

Watchwords: Bacillus Subtilis, Bacillus Licheniformis, SEM.

I. Presentation

Bacterial concrete or self mending substantial tops off the breaks created in structures by the assistance of bacterial response in the substantial subsequent to solidifying. Kinds of microorganisms, its component and arrangement of bacterial cement is talked about. In present day days, the utilization of innovation has taken the norms of development to another significant level. Concrete as a champion among the most regularly used improvement materials, expects a critical part in many fields. It has been extensively used as a piece of the improvement of designs, dams, storing

tanks, sea ports, roads, ranges, tunnels, cable cars and various structures. Concrete is generally a mix of water, all out (coarse and fine), and bond. Bond is the most basic piece of the strong material. It ties the aggregates and makes up for the shortcomings among coarse and fine particles. High compressive quality, openness, sturdiness, and moreover appropriate conduct with stronghold bars, low worth, direct preparation and credibility of tossing in needed shapes and sizes make concrete the material of choice for certain applications. Despite strong's positive conditions, it has a high penchant to approach divides empowering powerful synthetics to go into the design.

Crack Repair Methodologies:

- Stitching
- Muting and sealing
- Resin injection
- One of the technique is self-healing i.e. bio-concrete

BENEFITS OF BACTERIAL CONCRETE

- Self-fixing of breaks with no outside assistant.
- Huge expansion in compressive strength and flexural strength when contrasted with typical cement.

- Obstruction towards freeze-defrost assaults.
- Decrease in penetrability of cement.

HISTORY OF MICROBIOLOGY

- Microorganisms are little living creatures, single-celled prokaryotic creatures. Minute creatures come in different shapes and the sizes.

- Microorganisms are a ubiquitous in every area on Earth, creating in soil, acidic underground aquifers, radioactive waste, water, and some place down in the Earth's outside layer, and also in regular issue and the live gatherings of plants and animals. There are normally 40 million bacterial cells in a gram of soil and 1,000,000 bacterial cells in a milliliter of fresh water; overall, there are approximately five nonillion (5×1030) microorganisms on Earth (Whitman et al. 1998, Vol.95) molding a huge region of the planet biomass.

SCOPE and OBJECTIVE OF THE PROJECT

- Foster a bacterial cement by presenting the microscopic organisms' of bacillus family (Bacillus Subtilis).
- To find the ideal measurement of microorganisms expected for bacterial cement
- To decide the practical bacterial cells by sequential weakening technique.
- To know the presence of voids by ultrasonic heartbeat speed test.

II LITERATURE REVIEW

SakinaNajmuddinSaifee et .al1 published a paper on Critical appraisal on Bacterial Concrete. In this paper they discussed about the different types of bacteria and their applications. The bacterial concrete is very much useful in increasing the durability of cemetous materials, repair of limestone monuments , sealing of concrete cracks to highly durable cracks etc. It also useful for construction of low cost durable roads , high strength buildings with more bearing capacity,

erosion prevention of loose sands and low cost durable houses. They have also briefed about the working principle of bacterial concrete as a repair material. It was also observed in the study that the metabolic activities in the microorganisms taking place inside the concrete results into increasing the overall performance of concrete including its compressive strength. This study also explains the chemical process to remediate cracks.

III: MATERIALS AND METHODOLOGY

The materials used in the present study are
Cement (OPC – 53 grade), Fine aggregate (sand), Coarse aggregate, Barite powder, Calcium Carbide, RTPP Fly ash, Water

Cement

53 grade OPC manufactured by Zuari Cement Company Conforming to IS. 12269 is used.

Table:1 Cement Properties

S.No.	Characteristics	Value
1	Specific gravity	3.05
2	Normal Consistency	31%
3	Initial and Final setting times	30min. to 480min.

Fine Aggregate
Natural Sand obtained from local river bed Cheyyeru is used in the present investigation

Table: 2 Properties of fine aggregate

S. No	Property	Results
1	Specific gravity	2.68
2	Fineness Modulus	2.57
3	Bulk Density	1530Kg/m3(Compat)

Coarse Aggregates
20mm crushed granite aggregate obtained from local stone crusher is used in the present investigation.

Table: 3 Coarse Aggregate Physical Properties

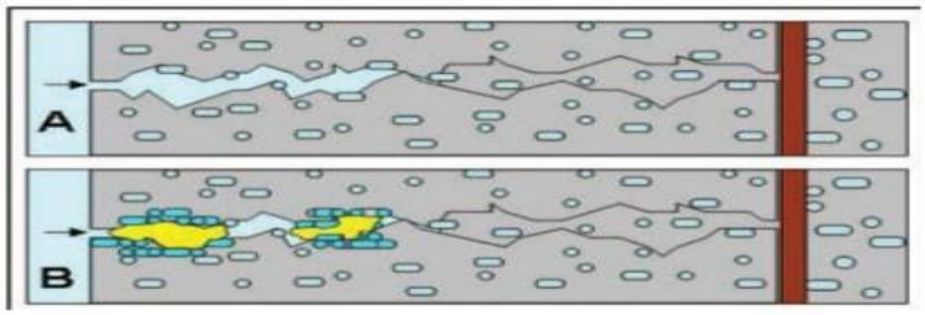
S. No	Property	Results
1	Specific gravity	2.7
2	Fineness Modulus	4.42
3	Bulk Density	1636Kg/m3(Compat)

Microscopic organisms
In this assessment the bacillus pasteurii microorganisms is used .Sporosarcina pasteurii in the past known as Bacillus pasteurii from additional laid out logical groupings is a bacterium with the ability to speed up calcite and solidify sand given a calcium source and urea, through the methodology of microbiologically impelled calcite precipitation or regular cementation. Bacillus pasteurii has been proposed to be used as a normally steady natural improvement material.

WATER
The most affordable however the main element of cement is water. The water which is utilized for blending cement ought to be perfect and liberated from destructive pollutions, for example, oil, soluble base, corrosive and so on convenient water was utilized for blending and relieving work.

BACTERIAL CONCRETE OR SELF-HEALING CONCRETE
This typical issue of parting in building has many fixes earlier and afterward subsequently the break. One of the helpful method is Bacterial Concrete or Self-Healing Concrete. The methodology of self-repairing of makes or self-filling chuckle wildly of breaks by the help of bacterial reaction in the strong following hardening is known as Self-Healing Concrete. It tends to be watched that little parts that occur in a design of width in the extent of 0.05 to 0.1mm gets completely fixed in bleak dry and wet cycles.

BIOCONCRETE MECHANISM
Exactly when the strong is mixed with microorganisms (bacillus subtilus), the infinitesimal organic entities go into a torpid express, an incredible arrangement like seeds. All of the microorganisms require is prologue to the air to impel their abilities. Any parts that should happen give the significant show. Right when the breaks outline, microorganisms closeness to the split, starts speeding up calcite valuable stones. Exactly when a strong construction is hurt and water starts to spill through the splits that appear in the strong, the spores of the microorganisms foster on contact with the water and enhancements.



CULTIVATION OF BACTERIA

The unadulterated culture of microscopic organisms i.e. Bacillus Subtilis is safeguarded on supplement agar inclines.

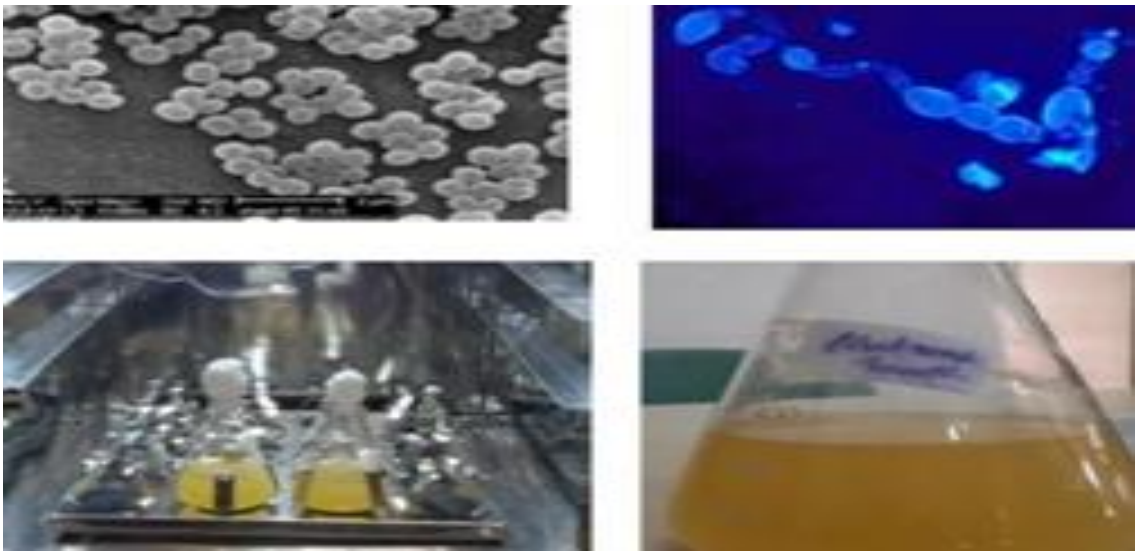


Fig. Bacteria in incubatorMIX PROPORTIONING

MIX DESIGN

Standard grade concrete (M40) Mix proportion 1: 1.76: 2.71: 0.45

Cement : 400 Kgs

Fine aggregate : 704 Kgs

Coarse aggregate: 1084 Kgs

Water : 180 Lt

MIXING OF CONCRETE

Blend configuration can be characterized as the way toward choosing reasonable elements of cement, for example, bond, totals, water anddeciding their relative extents with the question of creating cement of required least quality, workability and toughness as financially as could be expected under the circumstances.

PHASE - I

The phase-I of investigation is carried out to culture the bacteria

PHASE – II

The phase-II of investigation is carried out to study the strength behavior of bacterial concrete.

IV EXPERIMENTAL INVESTIGATION

Blend configuration can be characterized as the most common way of choosing appropriate elements of cement and deciding their relative extents with the object of creating cement of specific least strength and toughness as financially as could be expected. In our examination we have made M40 grade of cement. The blend proportion acquired after the blend plan

according to IS 456: was given in pervious part
.Further, we have poured the substantial in the 3D shape Molds and six distinct examples were made which are as per the following

a. Conventional Concrete of grade M 40.
b. Concrete with 15 ml bacterial arrangement.
c. Concrete with 30 ml bacterial arrangement.
d. Concrete with 45 ml bacterial arrangement.
e. Concrete with 60 ml bacterial arrangement.
f. Concrete with 75 ml bacterial arrangement.

METHODS OF MIXING BACTERIAL SOLUTION INTO CONCRETE

There are different methods of mixing the bacterial solution in the concrete which are viz.
Direct Mixing
Indirect Mixing
Injection method

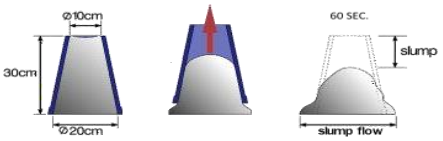
CASTING OF CUBES AND CURING

Once the concrete is completely mixed the concrete is poured in the cube, compaction is been done by the vibration machine. Concrete cubes were removed from the Moulds after 24 hrs. And they were put into the curing tank. Curing was done for 7, 14 and 28 days for all samples viz. Conventional, 15 ml, 30 ml, 45 ml, 60 ml and 75 ml.

EXPERIMENTAL TEST ON BACTERIAL CONCRETE

Various test are performed on bacterial concrete in order to get the results in various forms these experimental methods are summarized below- Slump cone test

The concrete slump test is an empirical test that measures workability of fresh concrete. The slump cone test indicates the behavior of a compacted concrete cone under the action of gravitational forces. The test is carried out with a Moulds called as slump cone. The slump cone is placed on a horizontal and a non-absorbent surface and filled in three layers of fresh concrete, each layer being tamped 25 times with a standard tamping rod.



Showing the Slump Height.

Fig: Slump Cone Tests

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Compressive strength test

Water absorption
UPV test
Plate count test

Experimental procedure to obtain plate counttest of bacterial solution

To begin with blending of 24hr. Hatched 1 g solid material from each piece was finished by rolling the test tube between the palms to guarantee even scattering of cell in the way of life. By using sterile pipette, aseptically exchange of 0.1ml bacterial suspension to the test tube containing 10 ml waterfall infusion was finished. Quantities of reasonable microbes are corresponding to the quantity of bacterial provinces. Quantities of bacterial provinces are checke by utilizing state counter.

Fig: Scanning Electron Microscope Machine

V RESULTS

Tests performed:
Compressive strength test
Water absorption
UPV test
Plate count test

COMPRESSIVE STRENGTH TEST
Concrete cubes of sizes150mm×150mm×150mm were tested for crushing strength. Compressive strength depends on loads offactor such as w/c ratio, cement strength, excellence of concrete material and excellence control during manufacture of concrete. These cubes are tested by compression testing machine after 7 days, 14 days or 28 days curing. The sampleis placed centrally on the base plate of machine andthe load have to be apply gradually at the rate of 140 kg/cm^2 per minute till the specimen fails.

Table: COMPRESSION TEST RESULT @7 DAYS

Mix id	Type of concrete	Compressive strength of concrete after 7 days		
		Sample 1	Sample 2	Sample 3
A0	Conventional	23.12	23.32	24.1
A1	15 ml	25.32	32.02	32.65
A2	30 ml	29.93	34.01	33.53
A3	45 ml	33.28	34.02	34.39
A4	60 ml	35.29	37.89	36.02
A5	75 ml	37.28	39.21	36.9

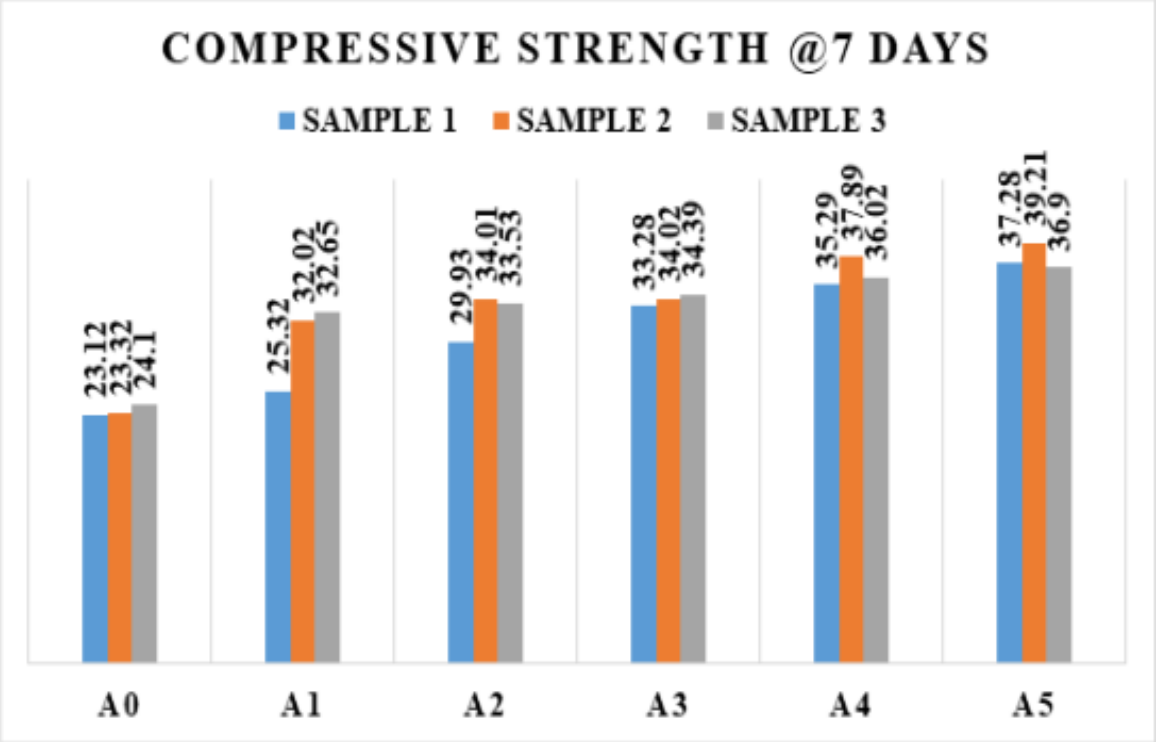

Fig.: Compressive Strength test results Table: COMPRESSION TEST RESULT @28 DAYS

Mix id	Type of concrete	Compressive strength of concrete after 28 days		
		Sample 1	Sample 2	Sample 3
A0	Conventional	32.42	34.29	37.45
A1	15 ml	45.25	47.89	49.2
A2	30 ml	55.24	52.35	53.2
A3	45 ml	52.8	54.89	55.96
A4	60 ml	53.92	55.02	55.32
A5	75 ml	52.2	53.24	54.09

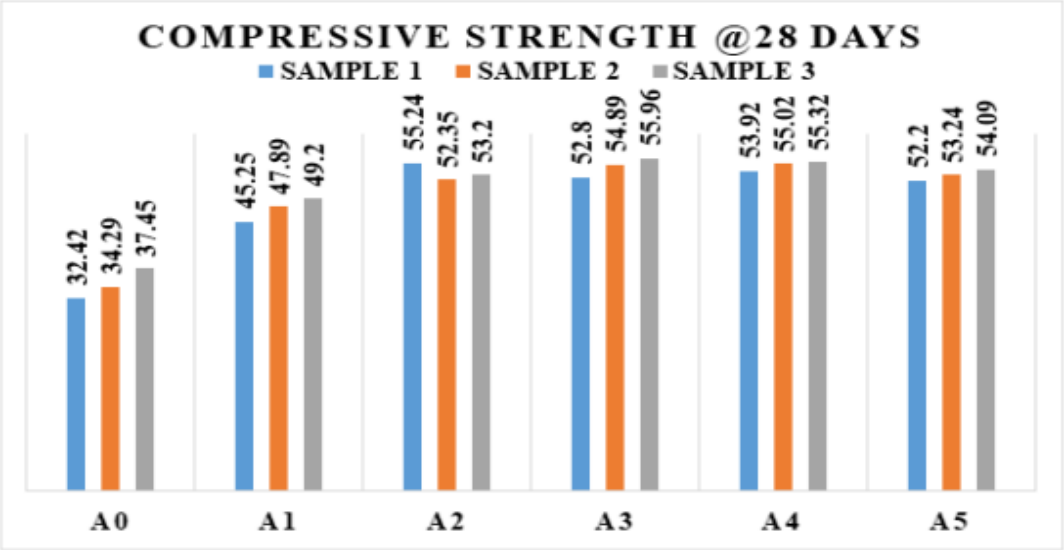

Fig.: Compressive Strength test results

Mix id	Type of concrete	Compressive strength of concrete after 56 days		
		Sample 1	Sample 2	Sample 3
A0	Conventional	33.45	37.02	38.25
A1	15 ml	43.23	49.89	50.01
A2	30 ml	56.265	54.34	54.45
A3	45 ml	53.8	57.42	58.56
A4	60 ml	55.9	58.01	58.8
A5	75 ml	53.2	58.25	58.9

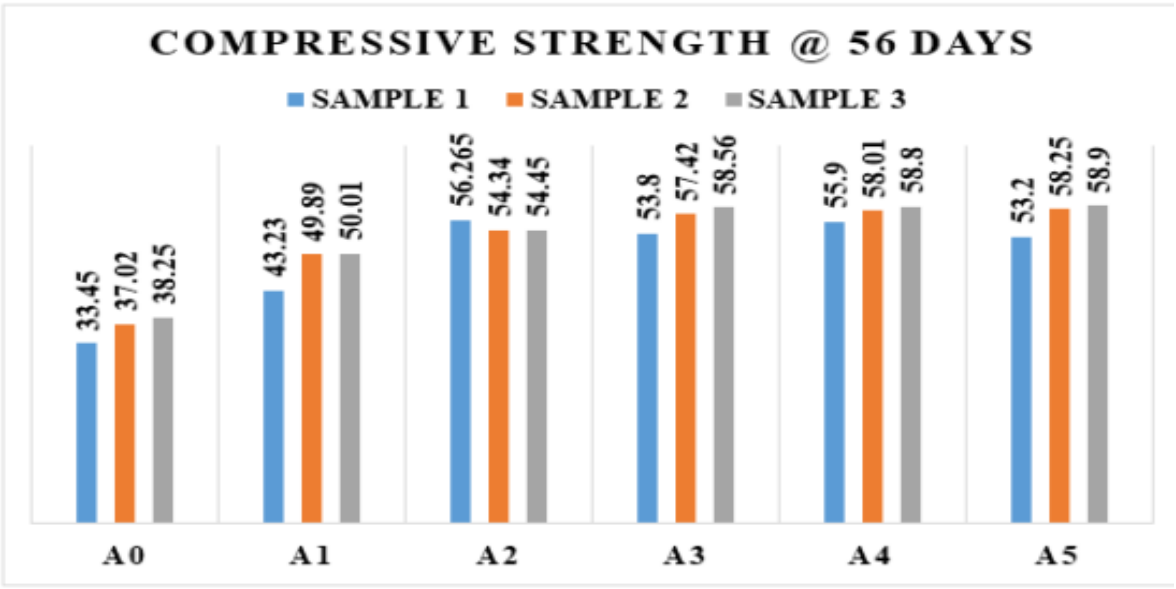

Fig.: Compressive Strength test result

From the above the graphs we can clearly notice that the compressive strength of the cubes increment, as we see from A0 to A1 the strength of cubes moves ahead by this we make an inference that increases in the volume of bacterial solution increase in the compressive strength of the cubes. According the mix we did addition of bacterial solution in the increment order i.e. 15ml 30ml 45ml60ml 70 ml. Actually we have taken 3 cubes in each sample so by the way we got three results in each sample. On average of the three results we can conclude that increment in the bacterial solution gives more strength and cares concrete not to crack by their mechanism.

Water Absorption:

The 150mm x150 mm x 150 mm cube after casting were immersed in water for 28 days and 60 days curing. These specimens were then oven dried for 24 hours at the temperature110°C until the mass became constant and again weighed. The weight's was noted as the dry weight (W1) of the cylinder. After that the specimen was kept in hot water at 85°c for 3.5 hours. Then this weight was noted as the wet weight (W2) of the cylinder.

%water absorption= [(W2-W1)/W1] x100

Where, W1 = Oven dry weight of cylinder in grams W2 = after 3.5 hours wet weight of cylinder in grams.

Table: % WATER ABSORPTION TEST RESULT.

CONVENTIONAL CONCRETE	BACTERIAL CONCRETE				
	15 ml	30 ml	45 ml	60 ml	75 ml
2.362	1.232	0.992	1.264	1.436	1.23
2.536	0.956	0.926	1.326	1.235	1.28
2.532	1.628	1.302	1.074	1.236	1.36

ULTRA SONIC PLUSE VELOCITY TEST

Ultra-sonic pulse velocity test was carried out to know the presence of voids in the internal structure of the concrete cubes. The results so obtained after conducting the test are tabulated below table. This results shows that of all samples tested the trouble time of 30ml and 45ml bacterial concrete found to be much lesser, again velocity is also higher.

Table: 5.4.Ultrasonic pulse velocity test

S.No.	Property of concrete	RCC Member	Prob. Distance mm	Time Micro sec	Velocity Km/sec	Probing Method
1	Conventional concrete	Cube	150	29.3	5.12	Direct
2	Bacterial concrete					
	15ml	Cube	150	29.8	5.03	Direct
	30ml	Cube	150	28.3	5.30	Direct
	45ml	Cube	150	29	5.17	Direct
	60ml	Cube	150	30.2	4.97	Direct
	75ml	Cube	150	29.2	5.14	Direct

PLATE COUNT METHOD TEST

Table: 5.5. Plate count method test

S.No.	Ml of bacterial suspension	Number of viable bacteria
1.	15	$68 X 10^3$
2.	30	$77 X 10^3$
3.	45	$89 X 10^3$
4.	60	$48 X 10^3$
5.	75	$32 X 10^3$

CONCLUSION

The microorganisms which are known to be soluble base safe,
for example they fill in regular habitats described by a somewhat high pH. Also, these strains can deliver spores which are resting cells with tough cell walls that safeguard them against outrageous ecological mechanical-and substance stresses. In this manner these particular microorganisms might can possibly oppose the high inward substantial pH values (12-13 for Portland concrete based concrete), and stay reasonable for quite a while too, as spore suitability for as long as 200 years is reported.

- Compressive strength of the substantial is begin expanding when we bring microbes into the substantial contrast with show concrete
- In this venture we worked with UPV test and plate load count strategy by the manner in which the speed and number of bacterial cell present in the substantial was determined tentatively
- Water retention test is likewise done where from the analysis we can presume that we obtained improved brings about the microorganisms substantial contrast with traditional cement.
- By the way expansion in microorganisms in the substantial prompts expansion in the strength and furthermore we can plainly see that no breaks in light of component of microbes.

FUTURE SCOPE

More review expected to lessen the expense of self-mending concrete.
Further review expected to beat on the limits of bacillus subtilis microbes.
More work ought to be finished on the drawn out impact of microorganisms on human existence.
Can be utilized in the development of airplane runways, scaffolds and dams lessening the support cost.

Holding wall development.

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