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Mechanical Properties of Concrete with Septic Tank Sludge

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ABSTRACT
Quantities of sludge from septic tank have been on the rise in recent years due to the rapid improvement in the standard of living. Unfortunately, the majority of sludge from septic tank is not being recycled and hence it causes serious problems on natural resources and environment. For these reasons, this study has been conducted through basic experimental research in order to analyze the possibilities of recycling the sludge from septic tank as a supplementary material in cement concrete. In this research various proportions of septic tank sludge is used as supplement to sand in cement concrete. The works under taken here dealt with the use of septic tank sludge as a supplementary material in cement concrete. In this investigation,% of water absorption and compressive strength criteria were analyzed by introducing septic tank sludge into the cement concrete.

Key words: *Septic tank sludge*

I. INTRODUCTION

Concrete is the most commonly used building material but the cracks in concrete create problem. Cracks in concrete occur due to various mechanisms such as shrinkage, freeze-thaw reactions and mechanical compressive and tensile forces. Cracking of the concrete surface may enhance the deterioration of embedded steel bars. Therefore a novel technique has been developed by using a selective microbial plugging process in which microbial metabolic activities promote calcium carbonate (calcite) precipitation. In this technique septic tank sludge which contains ureolytic bacteria is used. Bacteria is able to influence the precipitation of calcium carbonate by the production of urease enzyme. This enzyme catalyzes the hydrolysis of urea to co_2 and ammonia,resulting an increase of P^H and carbonate concentration in the bacterial environment. Bacteria (Singular-Bacterium) are relatively simple, single celled (Unicellular) organisms. Bacteria have a wide range of shapesranging from spheres to rods and spirals. There are typically 40 million bacterial cells in gram of soil. In this research an environment friendly and autonomous crack technique is explored.

II. BIOMINERALIZATION PROCESS:

Bio mineralization is defined as a biologically induced precipitation in which an organism creates a local micro environment conditions that allow optimal extracellular chemical precipitation of mineral phases. Almost all bacteria are capable of calcium carbonate precipitation. Bio mineralization of calcium carbonate is one of the strategies of remediate cracks in building materials.

Calcium ions in the solution are attracted to the bacterial cell wall due to the negative charge of the later. Upon addition of urea to the bacteria, dissolved inorganic carbon and ammonium are released in the micro environment of the bacteria. In the presence of calcium ions, this can result in a local super saturation and hence heterogeneous precipitation of calcium carbonate on the bacterial cell wall. $Ca^{+2} + CO_3^{2-} \rightarrow CaCO_3$

III. MATERIALS AND THEIR PROPERTIES

The following materials are used in this study
1. Sand
2. Cement
3. Sludge from Septic Tank

3.1. SAND

Medium size sand from a local quarry near Nagercoil with a modulus of fineness = 2.80, Specific gravity 2.677, normal grading with the silt content 0.8%

3.2 CEMENT

Ordinary Portland Pozzolana Cement (Fly ash based) conforming to BIS(Part1):1991having specific gravity of 3.15 was used. The consistency value becomes 30% and the initial and final setting time were 90 and 195 minutes respectively.

3.3 SLUDGE FROM SEPTIC TANK

Settledmaterial from either bacterial activity or yeast activity is called as sludge. Inorganic or inert solid materials and the by products of bacterial digestion, sink to the bottom of tank and form a layer commonly known as sludge. It is not bio-degradable and will not decompose.

Fig 3.2 Sludge

IV. METHODOLOGY

Replacement of sand by various supplementary materials like septic tank sludge as supplementary material is used in this study with different proportions based on the literature review. In this mix, cement and water are taken as constant then by varying sludge as 5, 10, 15%. The basic mix proportions used for the trial mixtures are as per IS: 10262-2009 mix design procedure. The material for each mix proportion is mixed separately. M_{20} grade concrete is used for this research.

4.1 TESTS ON CONCRETE

- Compressive strength test
- Water absorption test

4.1.1 COMPRESSIVE STRENGTH TEST

Compressive test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, the partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The cube specimen is of the size 150 X150 X 150 mm. The fresh concrete were cast and allowed to set for 24hours before being removed from the moulds and kept at room temperature (20º C). Compressive strength for each mortar mixture was obtained from an average of 3 specimens.The tests are done on Compression-testing machine and compressive load is applied on opposite faces axially, slowly at the rate of 140 Mpa/minute. The compressive load is noted for the ultimate failure. Record the total maximum load indicated by the testing machine, and calculates the compressive strength as follows:F_{ck} = P/A

4.1.2 WATER ABSORPTION TEST

Three cubes of size 150mm were casted for each mix. All specimens were removed after 24 hours of casting and subsequently water cured for 24 hours. Samples were removed from water and wiped out any traces of water with damp cloth and differenceinweight was measured.

V. RESULTS AND DISCUSSIONS

5.1WATER ABSORPTION TEST

Table 5.2 water absorption test

S:NO	MIX	% OF WATER ABSORPTION
1	CC	1.02
2	S-5%	0.968
3	S-10%	0.912
4	S-15%	0.86

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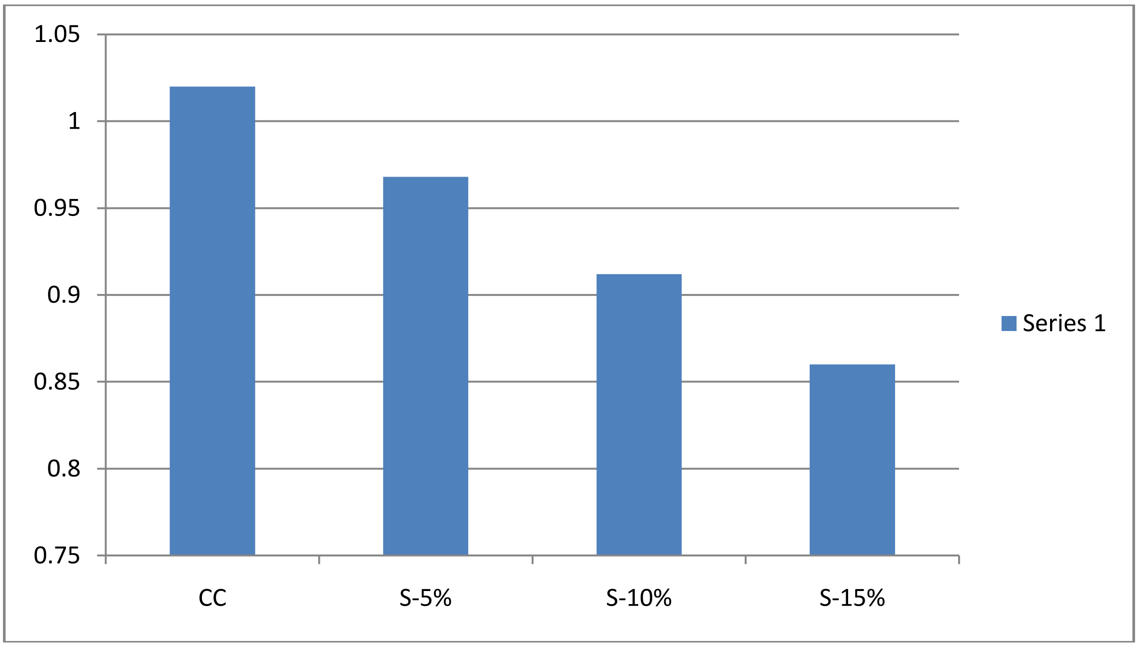

Fig 5.1 Water absorption test

Fig 5.1 shows the percentage of water absorption for various types of mixtures at the age of twenty four hours curing. The absorption characteristics indirectly represent the porosity. The result clearly shows that the mix containing sludge can improve considerably the resistance of water penetration of concrete(ie.reduce the percentage of voids) Bacteria present in septic tank sludge precipitates the calcite crystals which is of cubical in shape plug the pores as well as cracks inside the concrete.The percentage water absorption in mixture containingsludge decreased by 10.5% compared to control concrete. The concrete with septic tank sludge shows better result when compared to control concrete. Bacteria precipitates the calcite crystals which are of cubical in shape plug the pores as well as cracks inside the the concrete.

5.2 28 DAYS COMPRESSIVE STRENGTH

Table 5.3 Compressive strength for various types of mixes

MIX	28 DAYS COMPRESSIVE STRENGTH IN N/mm ^{2}
CC	34
S-5%	35.33
S-10%	40.89
S-15%	35.55

Fig. 5.2. 28 Days Compressive Strength

Figure 5.2 shows the 28 days compressive strength for replacement of sand by sludge in cement concrete after 28 days of curing. The sand is replaced by sludge in cement concrete at three different percentages such as 5%, 10% and 15%. The result shows that the higher compressive strength is achieved in 10% of replacement of sand by sludge .It is observed that 5%,10% and 15% replacement of sand by sludge induced 3.9%,20% & 4.6% in compressive strength with respect to the control concrete. This increase in strength is due to the presence of bacteria in septic tank sludge. Bacteria precipitates the calcite crystals which is of cubical in shape plug the pores as well as cracks inside the concrete.

Table 4.1 Details of mix proportion

Mix	Mix Id	Cement %	Sand %	Sludge %	Water %
Control mix	CC	100	100	-	100
Mix (Trial1)	S -5 %	100	95	5	100
Mix (Trial 2)	S-10 %	100	90	10	100
Mix (Trial 3)	S -15 %	100	85	15	100

Table 5.3 Compressive strength for various types of mixes

MIX	COMPRESSIVE STRENGTH IN N/mm ^{2}		
	3 DAYS	7 DAYS	28 DAYS
CC	17.33	30.00	34.00
S-5%	22.67	30.00	35.33
S-10%	22.67	32.89	40.89
S-15%	22.22	29.78	35.55

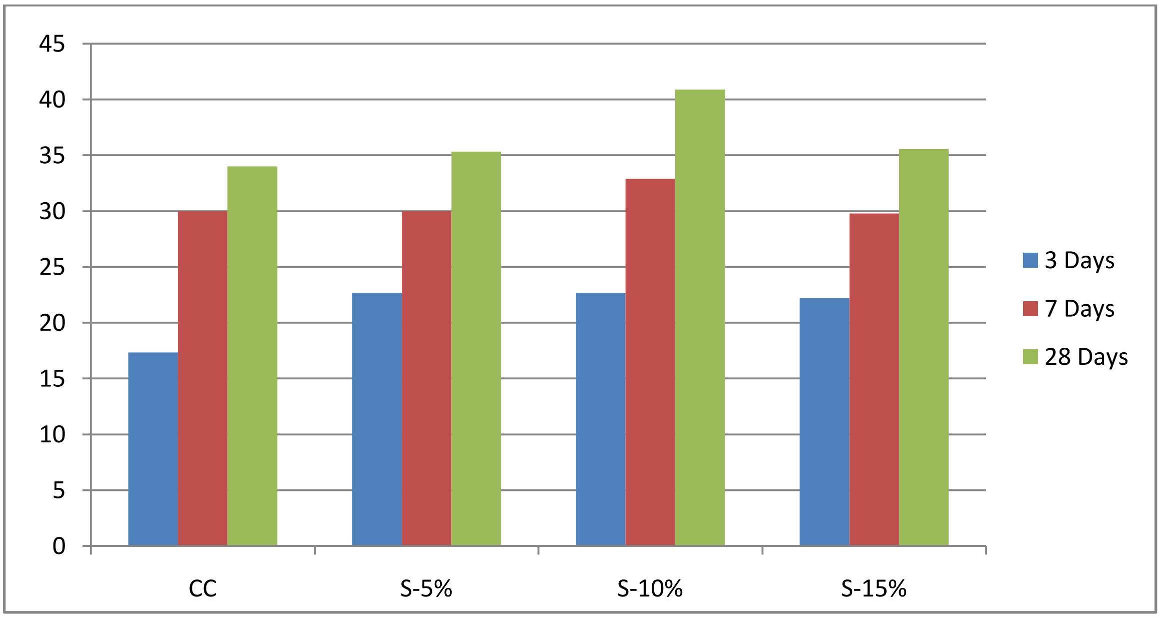

Fig 5.3 Compressive strength for various types of mixes

Fig 5.3 shows the 3days,7days and 28days compressive strength of various types of mixes.The compressive strength of cement concrete made with PPC (i.e. the control) is compared to concrete made with septic tank sludge. The compressive strength of specimens containing sludge is higher than the control concrete. Mix S – 10% which contained 10% of sludge achieved a 20% increase in compressive strength with respect to the control concrete. This indicates that the sludge greatly improves the mechanical performance of concrete.

FURTHER STUDIES

Future studies need to focus by increasing the percentage ofseptic tank sludge content above 15% of partial replacement of sand.

VI. CONCLUSION

The various combinations of cement, sand, coarse aggregate, septic tank sludge were mixed and casted into 150mm cubes and tested for their water absorption and compressive strength at 3 days, 7 days and 28 days curing.

- All the experimental data shows that addition of septic tank sludge improves the strength.From the above study, it is concluded that the sludge may be used as a replacement material for fine aggregate.
- The water absorption test result clearly demonstrate that percentage of water absorption in mixture containing sludge decreased by 10.5% compared to control concrete.
- The use of septic tank sludge exhibited excellent performance due to the efficient micro filling ability. Therefore, the results of this study provide a strong recommendation for the use of septic tank sludge as fine aggregate in concrete manufacturing.

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