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Experimental investigation on concrete by replacing cement on rice husk ash

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Abstract— The field of construction is always touting for more powerful and longer lasting concrete structures ,but which concrete really do last longer and retain its properties effectively? This project looks at which Bacterial concrete could be used to produce **self healing capacity** to concrete, by using common bacterium like bacillus subtillis, and Rice husk ash (RHA) in cement at different percentages with the behavioural characteristics of addition of Nylon fibre, to attain its properties effectively. The inherent weakness of concrete is its cracks and the major downside of concrete is its low tensile strength due to which micro cracks occurs when the load applied is more than its limit and this paves way for the seepage of water and other salts. To remediate this type of failure due to cracks and fissures, an approach of using bio mineralisation in concrete has evolved known as bacterial concrete. Here, the effective utilisation of agricultural and industrial wastes, to generate high profile concrete also takes place by the partial replacement of cement with Rice husk ash (RHA) and addition of Nylon fibre to the concrete, where Rice husk when burnt into ash possess, pozzolanic activity and Nylon fibres, a thermoplastic material which includes its strength, durability, high pressure –bearing capacity and corrosion resistance. According to the literatures, the effective utilization of RHA has not yet been into account in construction industry due to lack of understanding. Nylon, as a polymer is always known for its utilisation as only a raw material for manufacturing units, but it can be used for wide range applications in construction industry for its water proofing and fast-drying ability. Thus, this paper is an attempt to define bacterial concrete with the characteristics of RHA and the addition of nylon fibre to generate self healing concrete with effective utilisation of agricultural and industrial wastes for their strength and durability.

Index Terms— Bacillus Subtillis, Calcium Lactate, Nylon fibre, Rice husk ash, Self healing bacteria.

1 INTRODUCTION

Globally concrete is the back bone for the development of infrastructure , buildings, industrial structures, bridges and highways etc .In today's context concrete needs special combinations of performance and uniformity requirements that cannot be always achieved by using conventional constituents and normal mixing. Since the availability of raw materials for construction is limited in nature, the effective utilisation of agricultural and industrial wastes came into account. Thus, the era of modern construction materials evolved. Several techniques have been evaluated for the purpose and many were accomplished and found successful. The thought of need for reduction in rehabilitation of structures, generated the different types of concrete that are commercially used nowadays. One such property that was developed innovatively was the self healing capacity of concrete by the effective utilisation of abundantly available bacteria, which were conventionally considered as harmful

The process of self-healing of cracks or self filling up of cracks by the help of bacterial reaction in the concrete after hardening is known as self healing concrete. Micro cracks are one of the main reasons to failure of the structure. Cracking of concrete is a common phenomenon. Cracks in concrete structures tend to expand further and eventually require costly repairs, due to improper treatment. This leads to the major problem of maintenance cost of concrete. Natural processes like weathering, faults, land sliding, earthquake, changes in climate and temperature, have the tendency to create cracks in concrete. Therefore to control their effects, it has become mandatory to come up with certain processes which will not only help in resisting to formation of cracks but in improving the quality of concrete in most advanced way.

Application of bacteria can be a convenient solution for crack formation in concrete. Other conventional methods like chemical application are effective but are harmful to human body and environment as well. In this study, we have introduced a novel technique in fixing cracks with environmentally friendly biological processes that is a continuous self remediating process by using the bacteria bacillus stipullus along with partial replacement of cement by Rice husk ash and addition of Nylon fibre. Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. Burning the husk under controlled temperature below 800 °C can produce ash with silica mainly in amorphous form. Today inspired from the ancient application of techniques artificial fibres are commonly used now a days in order to improve the mechanical properties of concrete. Nylon fibre is a polymer which has a molecular structure built up from a large number of similar units bonded together based on aliphatic or semi-aromatic polyamides, which contributes to higher bond strength. Mineral admixture suc-h as rice husk ash, are finely divided siliceous materials and are added to concrete as a partial replacement for cement. The addition of this admixture results in significant savings in energy and cost. The detailed experimental investigation is doing to study the effect of partial replacement of cement by rice husk ash with using Nylon fiber in bacterial concrete.

2 MATERIALS REQUIRED

2.1 Cement

OPC of grade 53 of specific gravity 3.125

2.2 Coarse aggregate

Coarse aggregate conforming to the specification of IS10262:2009-Zone II and specific gravity of 2.77

2.3 Fine aggregate

M-sand of specific gravity 2.6 and conforming to the specifications of IS10262:2009-zone II

2.4 Water

Natural potable water was used. It satisfies the provisions of IS456:2000

2.5 Microorganisms

Bascillus Subtilis JC3 cultured in nutrient agar broth

2.6 Rice Husk Ash

RHA which is used as the partial replacement of cement was obtained from rice mill having a specific gravity of 2.10

TABLE 1
DIFFERENT COMBINATIONS FOR CASTING

MIX DESIGNATION	Cement kg/ m3	Water kg/ m3	Coarse aggregate kg/ m3	Fine aggregate kg/ m3	Rice husk ash 20 %	Nylon fibre 20%
NORMAL CONCRETE	438	197	1017.4	799.3	0	0
30% RICE HUSKASH + 70% CEMENT	336.14	186	1120	673.53	131.4	0
20% NYLON FIBRE	336.14	186	1120	673.53	131.4	75

3 TESTS CONDUCTED

Slump flow test was performed as perIS:1199-1959(CLAUSE 5.1).Compressive strength tes, Flexural strength test were carried out at an interval of 3,7,14,28 and 56 days I accordance with the guidelinesmentioned in IS:516-1959.Moreover,Split tensile strength test was also carried out according to IS:5816-1976.

4 METHODOLOGY

4.1 Procuring of bacteria

The bacteria of concentration of 10^8 per cells/ml was procured from agricultural center, Farmer's Bio-fertilizers and organics Subramaniam Palayam Road Coimbatore.

4.2 Serial Dilusion of bacteria

The bacteria obtained were serially diluted with water to the required concenrtration of 10^3, 10^5, 10^7 cells/ ml under the guidance of chemistry department of JCTCET Pichanur Coimbatore.

4.3 Casting

Four sets of M25 grade concrete cubes, cylinders and prisms with and without bacteria, 3cubes, 3 cylinders and 3 prisms.

4.4 Curing

Potable water was used for 7, 14 and 28 days of curing.

4.5 Testing

The testing was conducted for the compressivestrength test andsplitting tensile test and the results are as follws.

5 RESULTS

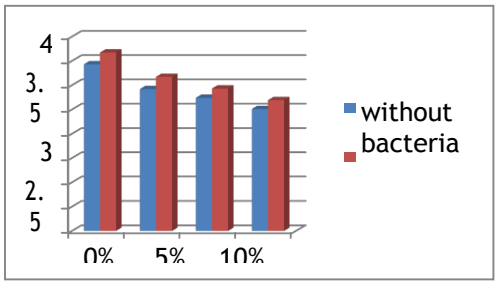
5.1Compressive strength test

Copmressive test on concrete cubes (15×15×15cm^3) and cylinders (heights=30cm , diameter=15cm) was done on 7,14 and 28 days

TABLE 2
COMPRESSIVE STRENGTH OF CONCRETE

Concrete	3 days	7 days	14 days	28days
Conventional concrete	14.4	21.8	28.5	35.9
Bacteria10^3 cells/ ml	16.4	25.8	30.3	39.8
Bacteria 10^5 cells/ ml	17.4	27.8	37.5	45.9
Bacteria 10^7 cells/ ml	14.6	24.5		35.8
RHA 10% of cement weightand nylon fibre 0.25% addition	14.1	21.3	27.5	40.7
RHA 30% of cement and nylon fibre 0.5% addition	12.5	27.4	36.8	42.8

Compressive strength of concrete

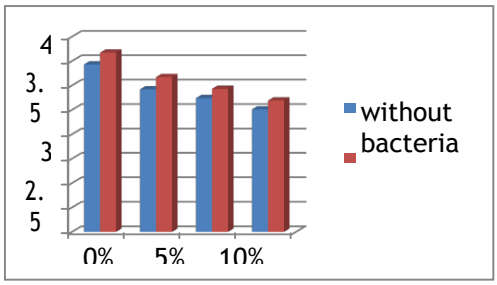


5.2Split tensile test

Splitting tensile strength test on concrete cylinders was conducted on 28th day. Also the Ultrasonic Pulse Velocity test was conducted on concrete cubes on 3, 7, 14 and 28 days.

TABLE 3
SPLIT TENSILE STRENGTH OFCONCRETE

Type ofconcrete	14 days	28 days
Conventional concrete(N/mm2)	2.19	2.73
Bacteria 10^5 cells/ml (N/mm2)	2.48	3.36
RHA 10% of cement	2.16	2.53



Split tensile strength

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7 REFERANCES

[1] Neville, A.M. (1996) Properties of concrete (4th edition). Pearson Higher Education, Prentice Hall, New Jersey.

[2] Neville, A.M. (2002) Autogenous healing - A concrete miracle? Concrete Int24(11):76-82

[3] Edvardsen, C. (1999) Water permeability and autogenous healing of cracks in concrete.ACI Materials Journal 96(4): 448-454.

[4] Reinhardt, H.W., and Jooss, M. (2003) Permeabilitiy and self-healing of cracked concrete as a function of temperature and crack width. Cement and Concrete Res 33:981-985.

[5] Li, V.C., and Yang, E. (2007) Self-healing in concrete materials. In Self-healing materials An alternative approach to 20 centuries of materials science (ed. S. van der Zwaag), pp. 161–194. Springer, theNetherlands.

[6] Worrell, E., Price, L., Martin, N., Hendriks, C., and Ozawa Meida, L. (2001) Carbondioxide emissions from the global cement industry. Annual Review of Energy and theEnvironment26: 303-329.

[7] Bang, S.S., Galinat, J.K., and Ramakrishnan, V. (2001) Calcite precipitation induced bypolyurethane-immobilized Bacillus pasteurii. Enzyme Microb Tech 28: 404-409.

[8] Ramachandran, S.K., Ramakrishnan, V., and Bang, S.S. (2001) remediation of concrete using micro-organisms. ACI Materials Journal 98(1):3-9.

[9] Ghosh, P., Mandal, S., Chattopadhyay, B.D., and Pal, S. (2005) Use of micro- organisms to improve the strength of cement mortar. Cement Concrete Res 35:1980-1983.

[10] De Muynck, W., Debrouwer, D., De Belie, N, and Verstraete, W. (2008) Bacterial carbonate precipitation improve the durability of cementitious materials. Cement Concrete Res 38: 1005-1014.

[11] De Muynck, W., Cox, K., De Belie, N., and Verstraete, W. (2008) Bacterial carbonate precipitation as an alternative surface treatment for concrete. Constr Build Mater 22:875-885.

[12] De Muynck, W., De Belie, N., and Verstraete, W. (2010) Microbial carbonate precipitation in construction material: A review. EcolEng36:118-136

[13] Van Tittelboom, K., De Belie, N., De Muynck, W., and Verstraete, W (2010) Use of bacteria to repair cracks in concrete. Cement Concrete Res 40: 157-166.

8 Conclusion

The performanceof bacterial concrete by cement with Rice husk ash andadditionof Nylonfibre was investigated.The test rewulys show asignificant improvement in the strength.The slump achieved was 100mm.Thestrengths obtained from different concrete mixes state that it is very sustainableand durablematerial and can be used as a sustainable and durablematerial which shall be a suitablereplacement for ordinary Portland cement.There was asignificant improvement of compressive strength with more than 0.2 5% of Nylon fibre and 10 % of Rice husk ash.Finally, thereisa further scope of research as the experiment is concentrated on M25 grade concrete.Effect of bacteria on higher grade of concrete withand without use of different mineral admixturesshould be studied and itscompatibility, durability and performanceshould be designed.