International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 4, April 2017, pp. 744-751, Article ID: IJCIET_08_04_086
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=4
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

EXPERIMENTAL STUDY ON BACTERIAL RICE HUSK ASH CONCRETE BY INCORPORATING QUARRY DUST AS PARTIAL REPLACEMENT OF FINE AGGREGATE

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ABSTRACT

Cracks in concrete leads to the seepage of salts and water causing damage to the structure. So there is a need to use microbial material which self heals the cracks present in the concrete. In the present study, bacillus subtilis was used as a microbial material for the preparation of bacterial concrete. Control concrete was prepared for comparison with bacterial concrete. Rice husk ash (RHA) and Quarry dust (QD) are used as a partial replacement of cement and fine aggregate in both control concrete and bacterial concrete. Cement was partially replaced with 5%, 10%, 15% RHA and fine aggregate was replaced with 45% QD. Bacillus subtilis was added in the amount of 10^5 *cells/ml during the mixing of bacterial concrete. Bacillus subtilis releases calcium precipitate which combines with carbonates present in the concrete and forms calcium carbonate which fills up the internal voids present in the concrete. Tests were performed to determine the compressive strength, split tensile strength and flexural strength for 3,7 and 28 days. It is observed that bacterial concrete shows higher strength compared to control concrete due to internal filling of voids by calcium carbonate. Concrete with RHA and QD shows little less strength than the control concrete due to its less workability.*

Key words: Bacterial concrete, Rice husk ash, Quarry dust, Bacillus subtilis, Compressive Strength.

Cite this Article: K. Nagajyothi, K. Shyam Chamberlin, SS. Asadi and M. Maheswara Reddy, Experimental Study on Bacterial Rice Husk Ash Concrete By Incorporating Quarry Dust as Partial Replacement of Fine Aggregate. *International Journal of Civil Engineering and Technology*, 8(4), 2017, pp. 744-751.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=4

1. INTRODUCTION

Concrete is a standout amongst the most generally utilized development material. The materials used as a part of cement are from earth's hull. As the need for infrastructure is increasing day by day, the production of concrete materials also increases leading to the depletion of natural resources. Hence, there is need to move to the substitute materials. Over the past, there have been a few papers on the usage of industrial and agriculture wastes. Most noticeably utilized waste materials are rice husk ash, copper slag, quarry dust, silica fume, fly ash and so forth. In present study cement is partially replaced with rice husk ash and fine aggregate is partially replaced with quarry dust.

RHA is mostly composed of silica (80-95%). The high micro porous cellular structure of RHA helps its pozzolanic reaction in mixtures containing Portland cement. The Pozzolanic activity of RHA fundamentally depends upon silica crystalline phase, silica content, surface area and size of ash particle. In addition to this, the ash must contain a small amount of carbon [1]. By utilizing RHA as an additional cementitious material it may lead to the reduction of emission of co_2 caused by the cement production [2]. With the reasonable fineness, the addition of RHA can minimize the porosity of cement paste [3]. Addition of RHA as a pozzolanic material in concrete provides several advantages such as enhanced strength and decrease in the disposal of waste materials [4 and 5].

A vast measure of crusher stone is accessible from the crushers as a waste material. If this crusher stone dust is used as a fractional substitution of stream sand, then it will not only save the cost of construction but also reduce disposal of crusher dust[6]. QD is known to increase the quality of concrete over control concrete made with equivalent amounts of stream sand, but it leads to the reduction in concrete workability [7].

There are a number of factors which adversely influence the durability and thus resulting in early damage of structures. One of the major cause is the formation of cracks which increases the permeability of concrete. All RCC members are porous in texture. This porosity prompts to seepage of water and chemicals into concrete causing cracks thereby corrosion of steel reinforcement. Cracking of concrete should be reduced and the potential healing mechanism used should result in the sealing of newly formed cracks in order to reduce the increase in matrix permeability [8]. Bacterial concrete is an innovative technique in which bacteria is added to concrete blend to upgrade the strength and furthermore, it acts as the best self-healing agent [9]

Bacillus subtilis exhibits a process known as bio calcification. Bio calcification is a process in which bacillus subtilis secrets calcium precipitate which consolidates with carbonates present in concrete and form calcium carbonate. This calcium carbonate fills the inner voids present in the concrete thus making it more compact. As the concrete become more compact the strength likewise significantly increases [10].

In the present study, an experiment is conducted to determine how the *bacillus subtilis* affect the strength parameters of concrete in which cement is partially replaced with RHA and sand is partially replaced with QD. The following objectives are proposed for the present study based on the review of literature.

- To study how *bacillus subtilis* varies the strength of concrete.
- Studying the strength variations due to the addition of RHA as a partial replacement of cement and QD as a partial replacement of sand.

2. MATERIALS AND METHODS

2.1. Materials

OPC43 grade meeting the requirements of Indian standard IS: 8112(2013) was used in this study having a specific gravity of 3.15 [11].Natural sand (<4.75mm)was used a fine aggregate and Crushed stone (12.5mm and 20mm) as a coarse aggregate having specific gravity 2.60 and 2.80 respectively. RHA which is used as the partial replacement of cement was obtained from rice mill located in Vijayawada having a specific gravity of 2.10.QD which was used as the partial replacement of sand was collected from a quarry in Vijayawada, Andhra Pradesh having a specific gravity of 2.54.*Bacillus subtilis* was the bacteria used in this study. A pure culture of *bacillus subtilis* which was obtained from food testing laboratory at Vishakhapatnam is as shown in the Fig. 1.

Figure 1 Pure culture of *Bacillus subtilis*

2.2. Preparation of Bacterial Solution

50ml of distilled water was taken along with 1.25gm of nutrient broth in a conical flask. The conical flask along with medium was closed with cotton balls and wrapped with the silver foil as shown in the Fig. 2(a) and 2(b)to avoid contamination. The medium was kept in an autoclave at 121°C and 15 lbs pressure for 20 minutes. After sterilization process, the pure culture of *Bacillus subtilis* was inoculated into the 50 ml of nutrient broth solution under aseptic conditions (within UV sterile laminar air flow chamber). After inoculation, the sample was placed in an orbital shaker and incubated at 37°C and 125 rpm for 16-18 hrs..

Figure 2 (a) Solution without bacillus subtilis

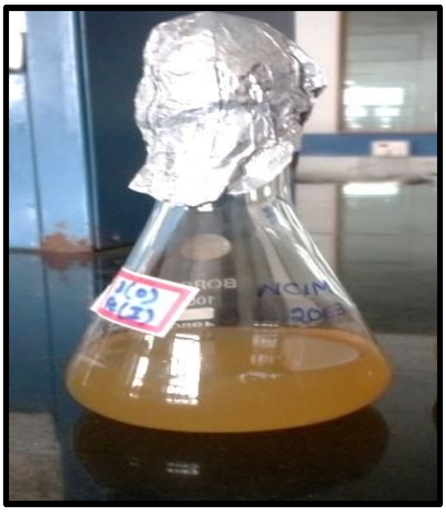


Figure 2 (b) Solution with bacillus subtilis

2.3. Tests Conducted

Concrete mix was prepared by replacing cement with 5%, 10%, 15% of RHA and fine aggregate was replaced with 45% of QD. The same proportions of RHA and QD are used in bacterial concrete. Table 1 and Table 2 represent the mix specimen details of control concrete and bacterial concrete. *Bacillus subtilis* was added to concrete at a proportion of 10^5cells/ml. The following tests are conducted on these specimens to determine the strength of concrete

Table 1 Mix specimen details of control concrete

S.no	RHA%	Quarry dust%	Mix name
1.	0	0	C1
2.	5	45	C2
3.	10	45	C3
4.	15	45	C4

Table 2 Mix specimen details of bacterial concrete

S.no	RHA%	Quarry dust%	Bacillus subtilis	Mix name
1.	0	0	10^5cells/ml	B1
2.	5	45	10^5cellsml	B2
3.	10	45	10^5cells/ml	B3
4.	15	45	10^5cells/ml	B4

2.3.1. Compressive Strength

Concrete specimens of size 150X150X150 mm were cast to determine the compressive strength of concrete. Different mixes of concrete were prepared by adding rice husk ash and quarry dust. Tests were conducted for3, 7 and 28 days in compression testing machine as shown in the Fig. 3.

Figure 3 Cube tested in compression testing machine

2.3.2. Split Tensile Strength

Cylindrical specimens of size 150X300 mm were cast. Specimens are cured for 3, 7 and 28 days and tested in compression testing machine to determine the split tensile strength as shown in Fig. 4.

Figure 4 Cylinder tested in compression testing machine

2.3.3. Flexural Strength

Prisms of size 100X100X500 mm were cast to determine the flexural strength. Prisms are cast for both control concrete and bacterial concrete mix. Fig. 5 shows the testing of prisms in flexure testing machine.

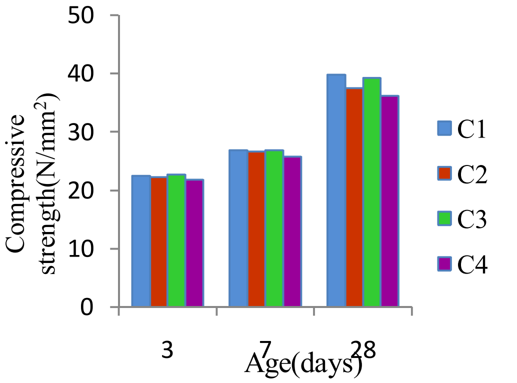
Figure 5 Prism tested in flexure testing machine

3. RESULTS AND DISCUSSION

Experimental results of control concrete and bacterial concrete specimens made by replacing cement with RHA and sand by QD for compressive, split tensile and flexural strength are mentioned below

3.1. Compressive Strength Test Results

In the present study, Concrete with RHA and QD was compared with the control concrete. From Fig.6 (a), it has been observed that concrete with 10% RHA and 45% QD showed more compressive strength when compared to other two proportions of RHA. But when the control concrete was compared to concrete with RHA and QD, the strength of concrete with RHA and QD was little less because of less workability of concrete. On the other hand, Fig. 6(b) shows the strength of concrete was increased for all proportions of RHA with the addition of bacillus subtilis when compared to the control concrete.



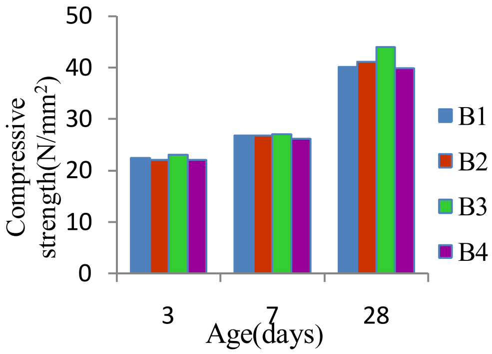


Figure 6 (a) Compressive strength of control concrete with RHA and QD

Figure 6 (b) Compressive strength of bacterial concrete with RHA and QD

3.2. Split Tensile Strength Test Results

The Split tensile strength of control concrete was compared with that of bacterial concrete. From Fig. 7(a), it has been observed that bacterial concrete shows higher strength compared to that of control concrete. Fig 7(b) shows bacterial concrete with 10% RHA and 45% QD shows higher strength when compared to that of other concrete mixes. It has also been observed that there is no increase in bacterial concrete strength for first 3 dayswhen compared with control concrete.

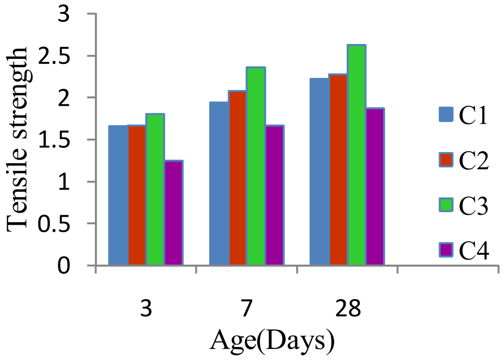


Figure 7 (a) Tensile strength of control concrete with RHA and QD

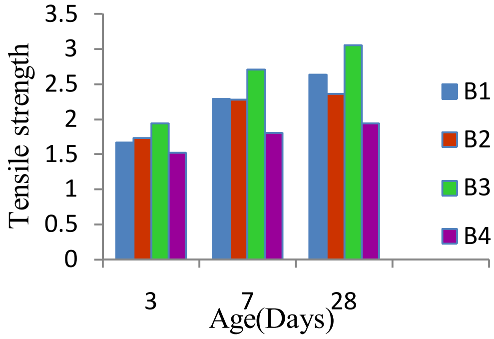


Figure 7 (b) Tensile strength of bacterial concrete with RHA and QD

3.3. Flexural Strength Test Results

In the present study, concrete strength was evaluated through the flexural strength analysis. From Fig. 8(b), it can be seen that flexural strength of bacterial concrete was more when compared to that of control concrete. It has also been observed that flexural strength of bacterial concrete for first 3 days was not increased.

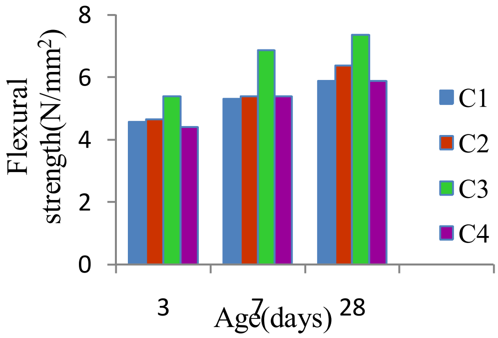


Figure 8 (a) Flexural strength of control concrete with RHA and QD

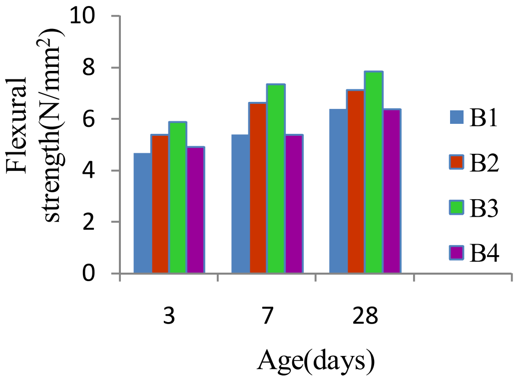


Figure 8 (b) Flexural strength of bacterial concrete with RHA and QD

4. CONCLUSIONS

- Bacterial concrete is found to be more advantageous compared to that of control concrete because of its self-healing nature and strength increase.
- Concrete mixes C_2,C_3,C_4 shows less compressive strength of 5.82%, 1.44%, 9.107% than control concrete(C_1) due to its less workability. Addition of super plasticizer may increase the compressive strength.
- Concrete mix B_1, B_2,B_3,B_4 showed an increase in compressive strength of 0.748%, 3.48%, 10.589% and 0.216% compared to control concrete(C_1).
- Increase in percentages of RHA in Bacterial concrete decreases the strength. Up to 10% of RHA shows an increase in strength.

- Addition of bacterial cell increased the compressive, tensile and flexural strength of concrete, thus it was conclude that produced calcium carbonate has filled up some internal voids present in the concrete.

REFERENCES

[1] Kulkarni, M. S., Govindmirgal, P., Bodhale, P. P. and Tande, S. N. *Effect of rice husk ash on properties of cement*, Journal of civil engineering and environmental engineering, 1(1), 2014, pp. 26-29.

[2] Cordeiro, G. C., Filho, R. D. T. and Fairbairn, E. D. M. R. *Use of ultrafine rice husk ash with high carbon content as pozzolan in high performance concrete*, Materials and structures, 2009, pp. 983-992.

[3] Bui, L. A., Chen, C., Hwang, C. and Wei-sheng, W. *Effect of silica forms in rice husk ash on the properties of concrete*, International journal of minerals, metallurgy and materials, 19(3),2012, pp. 252-258.

[4] Ramasamy, V. *Compressive strength and durability properties of rice husk ash concrete*, Korean society of civil engineers, 16(1), 2012, pp. 93-102.

[5] Gupta, A. I. and Dr. Wayal, A. S. *Use of rice husk ash in concrete: A Review*, IOSR journal of mechanical and civil engineering, 12(4), 2015, pp. 29-31.

[6] Kapgate, S. S. and Satone, S. R. *Effect of quarry dust as partial replacement of sand in concrete*, Indian stream research journal, 3(5), 2013, pp. 1-8.

[7] Vekariya, M. S. and Prof. Pitroda, J. *Bacterial concrete: New era for construction industry*, International journal of engineering trends and technology, 4(9), 2013, pp. 4128-4137.

[8] Jonkers, H.M. *Self-healing concrete: A Biological Approach*, Springer, 2007, pp.195-204.

[9] Amudhavalli,N.K., Keerthana,K. and Ranjani,A. *Experimental study on bacterial concrete*, International journal of scientific engineering and applied science, 1(8), 2015, pp.456-458.

[10] Sukesh, C., Krishna, K. B., Teja, P,S.L.S. and Rao, S. K. *Partial replacement of sand with quarry dust in concrete*, International journal of innovative technology and exploring engineering, 2(6), 2013, pp. 254-258.

[11] IS 8112 (2013), *Specifications for 43 grade ordinary Portland cement*, Bureau of Indian standards.

[12] IS 10262 (2009), *Concrete mix proportioning- Guidelines*, Bureau of Indian standards.