Improvement on the concrete cracks by using Bacillus pastuerii

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Abstract - Cracks in concrete are irreversible and are one of the naturally weaknesses of concrete. Bacillus Pasteruii, a common soil bacterium induce the precipitation of calcite exhibited its positive potential in selectively consolidating simulated fractures in the consolidation of sand. A compression, flexural and durability tested on mortar cubes and concrete beams treated with bacteria were studied. The effect of different depth of crack on the compression, flexural and durability of concrete was studied. It was found that all the increase in depth of crack reduce the strength of cubes and beams.

I. INTRODUCTION

In concrete, cracking is a common phenomenon due to the relatively low tensile strength. High tensile stresses can result from external loads. Without proper treatment, cracks tend to expand further and eventually require costly repair of structure. Durability of concrete is also depend upon these cracks, since they provide an easy path way for liquids and gases that potentially contain harmful substances. If micro-cracks reached to the reinforcement, reinforcement will be corroded when it is exposed to water and oxygen, and possibly carbon dioxide and chlorides. Micro-cracks are therefore responsible for structural failure. There are lots of techniques for crack repairing but they are environmental and health hazards. Bacterially induced calcium carbonate precipitation has been proposed as an alternative and environmental friendly crack repair technique. B. pasteurii produces urease, which catalyzes urea to produce CO_2 and ammonia, resulting in an increase of pH in the surroundings where ions Ca_2^+ and CO_3^{2-} precipitate as $CaCO_3$. Possible biochemical reactions in medium to precipitate $CaCO_3$ at the cell surface that provides a nucleation site can be summarized as follows.

$$Ca^{2+} + Cell \rightarrow Cell\text{-}Ca^{2+} \quad (1.1)$$

$$Cl^- + HCO_3^- + NH3 \rightarrow NH_4Cl + CO_3^{2-} \quad (1.2)$$

$$Cell\text{-}Ca^{2+} + CO_3^{2-} \rightarrow Cell\text{-}CaCO_3\downarrow \quad (1.3)$$

II. EXPERIMENTAL PROGRAM

A. Compressive strength study: Mortar samples were made by using ordinary Portland cement. The composition of the mortar mix is shown in Table 1. Cement and sand ratio is used as 1:3 (by weight). Moulds with dimensions of 70.6 mm× 70.6 mm× 70.6 mm. After casting, all moulds were placed in a normal temperature of room with a relative humidity of more than 90% for a period of 24h. After de-moulding, the specimens were placed for the curing for 28 days.

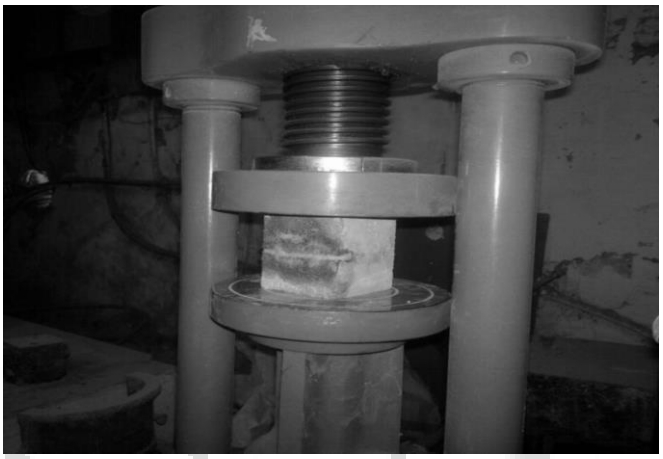

Fig.1. compression test

B. Flexural strength study:

Fig 2. Flexural test

The investigation is carried to study the flexural behavior of concrete. 36 simply supported beams consisting of balanced section are cast and tested. Concrete samples were made by using ordinary Portland cement. Moulds used had dimensions of 500 mm×100 mm ×100 mm. After casting, all moulds were placed in a normal temperature of room with a relative humidity of more than 90% for a period of 24h. After de-moulding, the specimens were placed for the curing for 28 days.

C. Durability study: After 28 days of casting, each cube is tested for weight an accelerated experimental test program is conducted on ordinary Portland cement concrete.

The specimens are arranged in such a way that the clearance around and above the specimen is not less than 30 mm. The solution has been changed for an interval of every 15 days .Before testing; each specimen is removed from the tubs, and brushed with a soft nylon brush and rinsed in tap water. This process removes loose surface material from the specimens. The percentage weight loss, percentage compressive strength loss is taken for a set of cubes at 56 days.

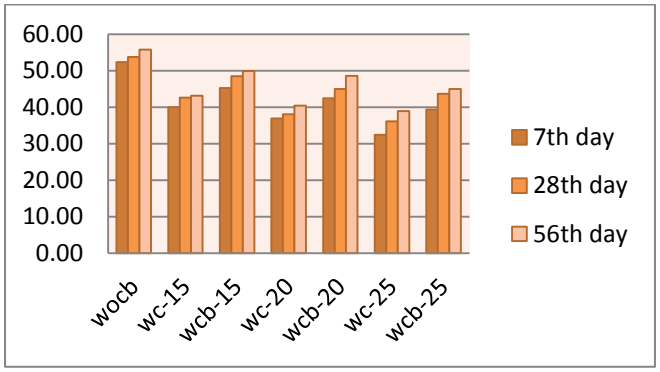

Fig 3. Compression test result

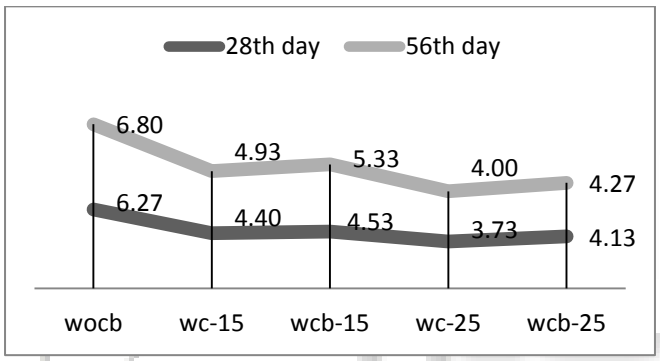

Fig 4. Flexural test result

III. DISCUSSION

The effects of the following parameters on the compression, flexural and durability of concrete were investigated:

i) Depth of crack
ii) Number of days from healing of crack

All the test results were compared with that of the uncracked and cracked concrete and mortar. It was found that all the specimens effectively healed which had less depth of crack.

IV. CONCLUSION

i) The addition of Bacillus Pasteruii in cracks bacteria improves the compressive strength. Improvement in strength is around 16.4% at 7th day, 17.3% at 28th day and 17.6% at 56th day.

ii) The experimental study on concrete beams shows that not much considerable improvement in flexural strength because of following reason :

a. At time of developing cracks due to continuous vibration of machine micro cracks has been developed in beams and just because of that reason at time of testing it may not have shown much improvement in flexural strength results.

b. The other reason is bond between calcite and concrete is not developed well in 56 days. It might take more than 6 month to create good bond between them.

iii) The percentage weight loss respectively in WOCB, WC-15, WCB-15, WC-25 and WCB-25 are 1.31%, 1.95%, 0.65%, 1.67% and 0.59%. It shows that weight loss percentage in WCB is less compared to WOCB and WC.

iv) The percentage strength loss respectively in WOCB, WC-15, WCB-15, WC-25 and WCB-25 are 3.07%, 4.31%, 3.22%, 5.29% and 3.79%. It shows that strength loss percentage in WCB is less compared to WC but larger than WOCB.

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