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HIGH STRENGTH CONCRETE WITH SELF-HEALING PROPERTIES

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ABSTRACT
High-strength concrete is indeed a new progression in concrete technology. It groups compressive strength of 40 MPa or above. Since HSC is another kind of solid, it has not been broadly utilized by the designers. Because of absence of research, it has just been utilized as a part of some reinforced concrete members and few large and precise structures.

In our study, we will try to discover the ideal extent of mineral admixture with cement to accomplish most extreme packing density and make a mix design based on the obtained results. We will be utilized five mineral admixtures as a pozzolanic material in cement. The mineral admixtures utilized were Quartz powder, Fly ash, Metakaolin, Ultra-fine slag and Rice-husk ash. A third-generation superplasticizer will also be additionally used to set up the mix design with a specific end goal to minimize the water necessity for cement hydration.

In this study we will also like to address two challenges that are commonly faced with concrete. One is the negative impact produced on environment due to huge Carbon Dioxide emission during cement manufacturing. We will try to in cooperate some greener materials partially replacing the cement in order to reduce harsh effect on environment.

Crack development is also another bigger challenge that is faced by concrete. Crack development in high strength concrete is not a common phenomenon due to higher pore refinement and interface refinement. But with later ages if cracks developed it will deteriorate the structure. We can also do its reaping by filling those cracks, but it is not a sustainable technique. In this study we will try to make a concrete that will be able to heal its crack with the help of calcite precipitating bacteria. So that it can provide us a more sustainable structure.

The scope of this study is huge as in recent times due to limited space we need to design a structure that may occupy space as less as possible meanwhile provide a great strength. So, HSC is key player for this situation. The Self-Healing concrete will help us to make a durable and sustainable structure. It will also help inn structure where crack development is common phenomenon and the repairing is that is also tough e.g.: Dams Bridges etc.

The trial work will be done in four stages. The main stage incorporates finding of different properties of materials like specific gravity and water retention. The second stage incorporates optimization of binary blend by accomplishing greatest packing density utilizing strategy given by Puntke. After the analyses utilizing diverse materials, graphical portrayal was done to acquire the advanced extent the third stage which can go simultaneously with other stages is the development of calcite precipitating bacteria

colonies. In the last stage we will make an optimum mix design which we will find from the above three stages. We will conduct experimental work for it and find the suitability of this concrete.

Keywords: Bacteria, Self-healing concrete, High strength concrete, Crack, Mineral precipitation, Biomineralization

INTRODUCTION

1.1 GENERAL

Nowadays, Self-healing concrete has come out as the material of choice as a repair construction material which makes concrete more durable. In this report, self-healing is done through biological processes as a repair material is completely reviewed. This report represents a new research in the field for repair of unexpected cracking of concrete. In this study we attempted to make a High Strength Concrete which will also have self-healing properties, which will give this concrete some extra durability.

Biomineralization in High Strength Concrete

In recent times concrete has become the second most consumes material on the planet after water. In past concrete mixes of low grades or strength were enough to meet our requirements. But due to recent innovations and big structures it was found that past methodologies were not enough. So, researchers decided to find new methods and materials that can meet our requirements. In this series researches came up with a new term known as High Strength Concrete. High Strength cement is a rising innovation that gives another measurement to the expression "High performance concrete".[1–4] It has a lot of potential in construction development industry. It has great mechanical properties and durability properties when contrasted with the traditional cement. It can likewise substitute basic steel in a few applications by joining fiber support. It can also substitute structural steel in some applications by combining fiber reinforcement.

Standards like packing density, micro structural improvement can be used to accomplish HSC. The advantage like water resistance and strength are likewise given by HSC. Different examination of the HSC has been performed for assurance of mechanical and durability properties. The outcomes demonstrate that HSC have more prominent compressive and flexural strength and a decreased water penetrability. The most extreme compressive strength is between 120-150 MPa. [5-7]

Occasionally strength may likewise reach up to 200MPa.[8] At such a high compressive strength the coarse aggregates are the weakest part in concrete. The concrete is liable to fail from coarse aggregates. Classifications of Bacteria

Classification based on shapes: According to their basic shapes, bacteria can be classified into 5 groups.

i) Spherical (Cocci)

ii) Comma (vibrios)

iii) Spiral (spirilla)

iv) Rod (Bacilli) &

v) Corkscrew (spirochaetes).

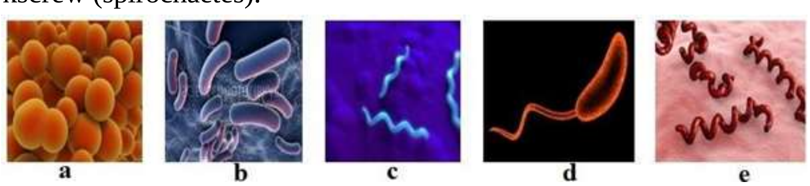

Figure 1.1 Classification of bacteria based on shapes. (a. Spherical (Cocci); b Rod (Bacilli); c. Spiral (Spirilla); d Comma (Vibrios); e Corkscrew (Spirochaetes). “Source:

LITERATURE REVIEW

Lee et.al (2009) pointed discover the suitability of HSC with (RPC) to be utilized as another repair material and they additionally assessed its bond soundness and durability with existing cement. They attempted to test the solid utilizing quickened maturing condition test in which constant freezing–thawing cycles were made. It is one of the Important tests toinvestigate the durability of repair materials of concrete. Compressive strength of concrete sections was tried prior and then afterward the solidifying defrosting activity and the distinction between the quality decided the appropriateness of RPC as repairing material. [29]

In this trial concentrate Reactive Powder Concrete showed great outcomes which makes it suitable to utilize it as a repairing and retrofitting material as it upgraded the compressive and flexural quality of old tried examples. The impacts of flexural and compressive strength with holding RPC having thickness of 10-mm was about 150% and 200% increase than that of ordinary quality cement. Compressive strength tests after 1000 freeze–defrost cycles demonstrate that RPC is profoundly solid.

Figure 3.2 Nutrient Broth

Step 3

Autoclave: An autoclave is used for the sterilization of media, glass wares and plastic wares (tools and materials). Autoclaving effectively destroys potential viral or bacterial contamination through exposure to extreme heat. It works under the principle of steam under pressure.

Step 4

Pouring We will pour the autoclaved media in the Petri plates inside the Laminar Airflow and incubated at 37°C.

RESULTS

GENERAL

In this Chapter results of all the experimental work conducted till date are given in respective tables. In this discussion of the results obtained after conducting various tests is donechapter all the results obtained from various tests are discussed

Results obtained during identification and isolating bacteria with calcite precipitating properties of calcite precipitating bacteria

The data of the size of colonies obtained, and time for obtaining those colonies are given in Table 4.1

Table 4.1 Time taken for colonies appearance along with their size

Sample No.	Colonies Size	Time taken to obtain colonies
1	Small	3 days
2	Medium	4 days
3	Small	4 days
4	Very Small	4 days
5	Medium – Large	4 days
6	Very Small	5 days
7	Small	3 days
8	Small	5 days
9	No colony	-
10	Medium	5 days

CONCLUSION

Results from this investigation revealed that, in concrete microbial cells can be utilized for purpose of crack healing of both Macro and Micro sizes. From the isolation stage, 11 bacterial cultures having potential are isolated, and when the further screening proceeded, the number reduced to just 2. It is because of the concrete's high alkaline harsh environment. The survival of major group of bacterial genus becomes difficult in such a high pH environment. In this way it can be said that only those isolates which can survive in high pH environment needs to be isolate, separated for use in concrete. Test conducted on concrete revealed that the performance of concrete with microorganisms in it showed higher strength and better characteristics when compared to control concrete (without bacteria). This happened due to the presence of calcite precipitating bacteria in concrete which filled the pores inside matrix and the cracks appeared on the surface with thin calcium carbonate crystals. Bacteria is only able to precipitate Calcium carbonate when it gets nutrition i.e rich calcium course and moisture. However the moisture requirement and food requirement of the colony of bacteria is so less that it can be fulfilled with the moisture present in air and minute food particles travelling in air .Whitish-yellow colored crystals were observed near the crack surfaces when visual inspection of the crack was done at 7 days of concrete casted. As the investigation further continued for 28 days it was observed that the highest crack healed in comparison to both isolate and control concrete was found in Standard concrete system. According from this investigation following conclusion were drawn.

I. It is better to use soil which is rich in lime and magnesia in order to obtain calcite precipitating bacteria. As the chances of getting one in such soil is quite higher
II. For developing bacterial cells, it was observed that rather than using direct plate technique we should use enrichment culture technique. With the help of this technique we can limit the growth of other bacteria which are not required
III. The concrete with Standard culture of bacteria showed highest compressive strength 60.92 (MPa) when compared to compressive strength of Isolate concrete 54.74 (MPa) and control concrete specimen 38.80 (MPa).
IV. Only those bacterial isolates can be used in crack healing of concrete which show positive urease activity and endospore formation. It is a fact that the microscopic organisms which are unable to

frame endospore can't survive in an exceptionally highly alkaline environment of new concrete.

V. The scope of this examination was to make a concrete which has high strength and if cracks occurred it will be able to heal its crack autonomously. In further research the long ter durability, its cost effectiveness and its behavior in normal world needs to be explored. It is also needed to be checked that how this type of concrete will behave in marine conditions.

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