Experimental Investigation on Lightweight Ferrocement Beam Under Flexural Behavior and Self-Healing Capability

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Abstract— The aim of this study is to analyse the self-healing capability of high-strength fibre-reinforced concrete (M20) with fly ash and crystalline admixture (CA) in two types of environmental exposures i.e. Water Immersion (WI), Wet-Dry Cycles (WD). Specimens for four mixes are cast, one mix containing 1.5% of CA and three mixes with 10%, 20% and 30% partial replacement of cement with fly ash and additions of 1.5% CA. The specimens were pre-cracked at 28 days, in the range of 0.10-0.40 mm and the time set for healing was 42 days. The result shows that all the mixes have considerable amount of closing ability and strength-regaining capability for all exposure conditions. The concrete with 20% fly ash and 1.5% CA has complete crack closing ability and 100% strength-regaining capability for WI and WD cycle conditions. From SEM analysis, it is confirmed that self-healing products are CaCO3 and C-S-H gel.

Index Terms— Crystalline Admixture, fly ash, glass reinforced concrete, self-healing, SEM analysis.

1 INTRODUCTION

In recent years, with the development of economy and growth of urban population, more and more buildings have been constructed and this has led to the vast concentration of people and goods. Currently, construction material such as concrete is highly used because it has high compressive strength, notable fire resistance, better casting and lower expense than other construction materials. However, a major problem with the concrete is that it is vulnerable to cracking due to its relatively low tensile strength. The cracks will reduce the capabilities of anti-permeability, anti-chloride corrosion and anti-carbonisation greatly, which can make the corrosion of interior reinforcements much easier and can lower the carrying capacity and durability of the structure. If the repair of concrete cracks is not completed in time, it will affect the normal use of concrete structure, resulting in total destruction and even collapse. High-strength concrete with self-healing system based on the combined action of fly ash and CA has been developed in order to seal developing cracks, which improves durability of concrete. Self-healing admixtures are those which have the capability of repairing small damages or cracks. The main reason for investigating the properties of self-healing admixtures is that constructions built with them will have increased service-life; likewise, structures with difficult or expensive repairs will benefit from self-healing their own damages. Thus, self-healing concrete will lead to an increase in the sustainability of the structures. In concrete, microcracks cannot be avoided completely and responsible for their failure in strength. This is even more important when it comes to infrastructure, as this type of construction requires high level of user performance, high durability and minimum ecological impact possible.

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2 MATERIAL AND METHODS

The material used in this study are cement, fine aggregate, coarse aggregate and glass fibre.

Cement (OPC)

The ordinary Portland cement used for the project was 43 grades. The following test were done to understand the properties of cement

Specific gravity of cement – 3.05

Fine aggregate (M sand)

The M sand that passes through the sieve size of 4.75mm used.

Specific gravity of fine aggregate – 2.6

Coarse aggregate (crushed stone)

The 20mm size of graded crushed stones is used.

Specific gravity of coarse aggregate – 2.68

Glass fibre properties (table. 1)

Fibre	AR Glass
Specific gravity	2.68
Elastic modulus (Gpa)	72
Tensile strength (Mpa)	1700
Diameter (micron)	14
Length(mm)	12

Mix design is carried out according to IS 10262: 2009 for M20

Weight of Cement Content: Weight of Fine

aggregate: Weight of Coarse aggregate

328.6: 723.112: 1084.668

1: 2.2: 3.3

Crystalline admixture 1.5%

Glass fibre 5%

Fly ash 10% 20% 30% replacement with cement.

Normal reinforced beam

The size of beam =1x0.15x0.15m

Grade of concrete = M20

Volume of cement = 8kg

Fine aggregate = 17kg

Coarse aggregate = 25kg

8mm diameter bars of 250mm centre to centre

3 Results

Self-healing efficiency is to evaluate whether the material was able to recover some of its strength after acquiring some minor damages. Concrete with CA increasing the self-healing efficiency at all ages i.e. 7, 14, 21, 28 and 42 days. It can be clearly observed that catalytic reaction between calcium ions and by products of cement hydration and un hydrated cement particles forming the C– S–H and CaCO3 content. CAs acted as a bridge between cracks thus actuating considerable mechanical strength recovery. Self-healing was evident, as the healing materials proliferation in the sample exposed to the WI has high Crack healing efficiency.

Fig. 1. Casted beam

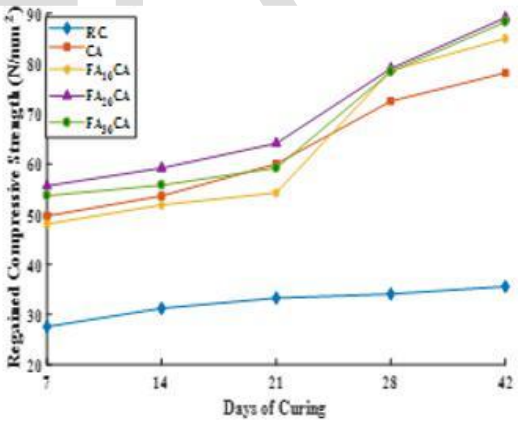

Fig 2. Crack healing graph

4 Conclusion

In this paper, a study on the self-healing ability of high-strength fibre reinforced concrete with fly ash andcrystalline admixture are to be shown. High-strength concrete with self-healing system based on the combined action of Fly ash and CA has been developed in order to seal developing cracks, which improves durability of concrete. Self-healing admix-

tures are those which have the capability of repairing small damages or cracks. The main reason for investigating the properties of self- healing admixtures in buildings constructed healing on their own damages. From thestudy of the ferrocement beam using crystalline admixture and fly ash the test results show that the crystalline admixture of 1.5% mixed with 20% of fly ash gives the healing of concrete cracks in 48 days after the initial crack occurs.

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