

Structural Strengthening Using Carbon Fiber Wrapping and Protection by Sinicon PP Heat and Fire Resistant Protective Plaster



Dr. V. Rajendran,
Managing Director, Hitech Group

Abstract:

Repair & Rehabilitation using the Carbon Fiber and Glass Fiber wrapping are becoming more common to strengthen reinforced concrete structures either to address the durability issues or to address the additional load carrying capacity. The causes for such requirements are many and the most common distress to old structures are related to corrosion of rebars, while for the new structures, issues related to construction quality resulting in reduction of strength of the member and changes/increase in load. During these systems of repair & rehabilitation, which are comparatively simple and cost effective, the protection of this system from UV rays, fire and heat are becoming complex, as these systems are being installed with epoxy resin.

This case study deals with the strengthening and rehabilitation of reinforced concreted crane columns of the EOT crane at Melting shop of Foundry Industry. The heat inside the plant and the chances of fire is also high, where a specialized heat & fire resistant, patented glass granules usage to protect the fiber wrapping system implemented. This article addresses in detail on the heat & fire resistant protective plaster.

Introduction

A deficient structure is defined as one which fails to fulfill its intended function. As

per the European Committee for Concrete (CEB) and International Federation for Prestressing (FEB), the deficiency is classified under four categories viz., Retrofitting, Strengthening, Rehabilitation and Repair.

Retrofitting

Action to modify the functionality or form of a structure or its components and to improve future performance.

Strengthening

Action to increase the strength of the structure or its components to improve structural stability.

Rehabilitation

Bringing the structure to its original or higher level of function including durability and strength.

Repair

Action taken to reinstate to an acceptable level the current functionality of a structure or its components which are either defective or deteriorated, degraded or damaged in some way and without restriction upon the materials or method employed.

Case Study

The referred case study deal with an industry situated on the outskirts of Chennai where the jobbing foundries

commenced production from the year 1961, with the capacity to produce cylinder block and head ranging from 25 kgs. to 500 kgs. of automobile casting.

The columns are of 0.47m x 0.92m and 12.45 meters height with intermediate beam and at top Gantry beam. The client wanted to check for the beams & columns for 20 MT capacity and in case, if it is not safe, it was decided to carry out the Strengthening & Rehabilitation as corrosion has also initiated in these members. During the check it was found that the columns are inadequate and also recommended to confine the columns with carbon fiber and glass fiber wrapping.

The existing concrete cover was removed followed by cleaning the reinforcement and self-sacrificial anode Galvashield XP were installed to take care of the durability. Depends up on the thickness the cover was reinstated with polymer modified mortar and micro concrete jacketing with required waterproof form works. On completion of the curing time, Glass fiber of 900 GSM wrapping for few columns and also Carbon Fiber of 450 GSM wrapping was done using epoxy resin followed by protecting these wrapping with heat/fire resistant screed Sinicon PP, without which the strengthening system will be at question incase fire as the strengthening & rehabilitation carried out in melting shop.

Numerous studies have been

conducted to trace the response of CFRP strengthened RC elements at ambient and elevated temperature. These studies address the structural response of CFRP strengthened members under elevated temperatures: Behavior of CFRP composite at high temperature, Gamge et al., 2005, Epoxy adhesive bonds and bond strength variation at elevated temperature., Firmo et al., 2002, Insulated CFRP Strengthened RC beam exposed to fire Kodur., et al., 2009. The referred research papers commented on the susceptibility of CFRP materials to elevated temperature.

Gypsum plaster, also known as plaster of Paris, is the one that is most commonly used in modern construction because it is a very easy method of fireproofing the structure of a building. Gypsum plaster is created through a process in which the gypsum is heated to a temperature of 150 degrees Celsius. Once plaster is added to water an exothermic reaction occurs in which the heat is released from the solution, the plaster and water eventually hardens into a solid block although it does remain quite soft. However, it has been experienced on the field that the Gypsum plaster gets delaminated over a period of

time and being very soft, susceptible to damages.

Alternatively heat resistant plaster is used in fire proofing due to the nature of the material itself, as when the plaster is exposed to flame or heat water vapour is released from it and it can slow a fire down by up to two hours although the time is dependent on the thickness of the plaster itself. Heat resistant plaster has to be used with extreme caution as the exothermic reaction is extremely hot, if you were to place your hands into a bucket full of water and plaster then your hands may suffer from severe burns unless they are very well protected. It is advised that when using plaster, you use only thin strips and allow time for the strips to cool between each application. The reaction gives the plaster its strength during a fire but it also makes heat resistant plaster extremely dangerous to use without proper precautions being taken.

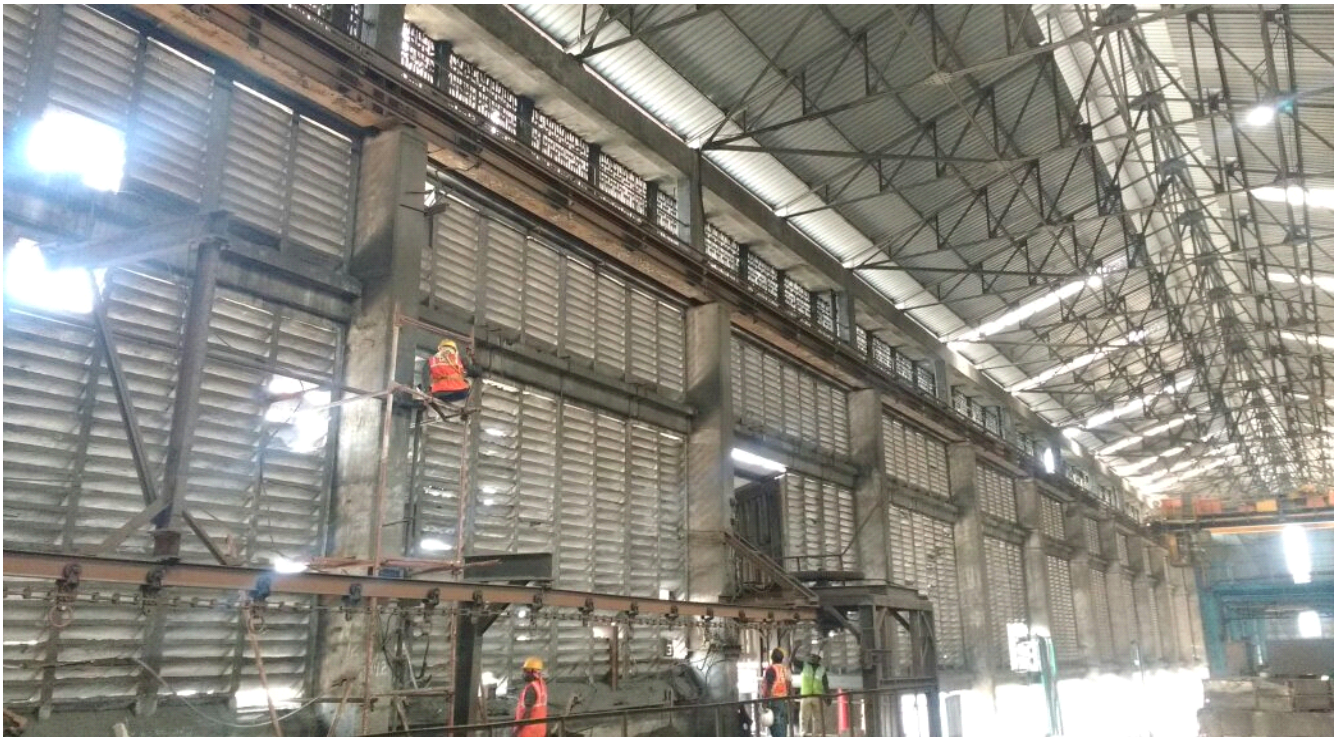
Sinicon PP Fire and Heatproofing Plaster, derived out from a unique volcanic glass, a large deposit of which is found at only one location on the earth which is South Africa, as claimed by the manufacturer, M/s. Sinicon Controls (P)

Limited. Sinicon PP is made out of feed from this unique mine using patented manufacturing process to convert this volcanic glass into well-sealed tough glass granules which is ideally suited for use with cementitious and other binders.

Under the microscope, each tough granules comprises a froth of glass-walled closed cells each enclosing a near vacuum. Sinicon PP is therefore best described as comprising millions of tiny sealed "thermos flasks", making it an absolutely unique and unrivalled insulating and fireproofing material. The properties of Sinicon PP are that it is a -

- A zero fire product,
- It cannot be burned. Can withstand 1250 DegC temperature.
- A zero fume product.
- It does not release fume when fire applied.
- A zero smoke product. Since it cannot be burned it does not emanate smoke.
- A light weight product.
- A sand like product.

In this present case study for the purpose of heat/fire resistance, Sinicon PP was used. With respect to the application there were



Over all View of the columns of the foundry section.



View of sacrificial anode Galvashield installed and connectivity checking



View of Polymer modified mortar application



View of CFRP Wrapping.



View of Sinicon PP mixing at site



Application of Sinicon PP over CFRP and the finished view

no issues like the handling issue which normally encountered with heat resistant plasters. Also, on curing the material gains surprising strength and it is not as soft as Gypsum. In addition to this it was noticed that there is no de-bonding of this plaster from the CFRP/GFRP wrapped surface and it behaved like a normal sand based plaster. The preparation of the Sinicon PP plaster at 1 : 3 ratio (Cement : Sinicon PP) by volume was also easy and no special skill was required.

Conclusion:

There are number of system available for providing the heat and fire protection system to the strengthened concrete structural members with CFRP/GFRP system. However, selection of a system for the effective protection of the rehabilitation system from heat/fire is very important and with the field experience in terms of application & performance, Sinicon PP heatproofing plaster can be placed as a good candidate. ■