

PREVENTIVE AND PROTECTIVE SOLUTION FOR CORROSION IN CONCRETE THROUGH CHEMISTRY

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ABSTRACT

Damage caused by corrosion of concrete structure has been recognized as one of the major problem affecting service life of structure. But corrosion cannot be stopped completely. It can be reduced if certain practices to combat corrosion are applied. Permeability is the gateway of corrosion. Hence corrosion - permeability interaction has been presented in this paper. Water proofing has been suggested as preventive solution for concrete structure exposed to corrosive environment. Structures are damaged due to corrosion in concrete. Suitable and effective repair system is unavoidable protective solution for corrosion affected concrete structure. In the present paper the authors have made an attempt to present preventive and protective solution of corrosion in concrete through chemistry. Repair material, its criteria, various techniques and methodology has also been discussed. The approach is also illustrated by presenting two case studies.

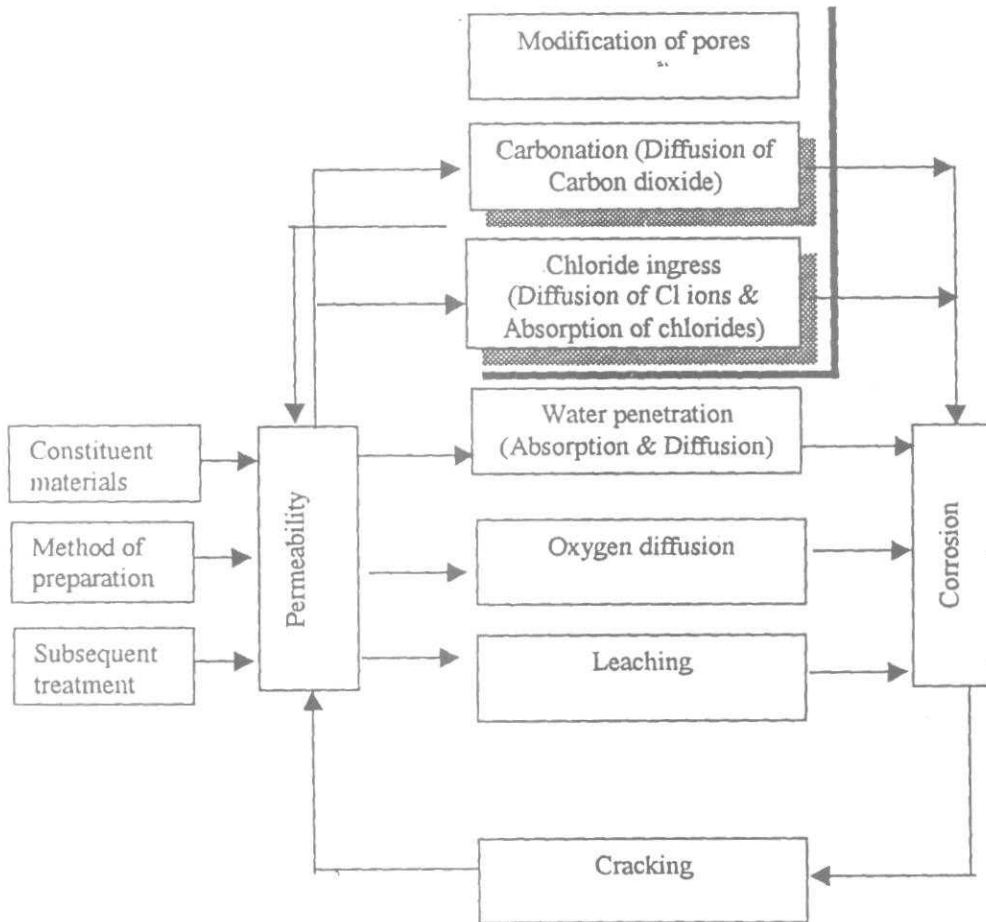
INTRODUCTION

Though concrete is quite strong mechanically, it is highly susceptible to chemical attack and thus structure gets damaged and even fail unless some preventive measures are adopted to counteract this and thereby increasing the durability of structure. In the case of Reinforced concrete structure the ingress of moisture or air may lead to corrosion of steel, cracking and spalling of concrete cover thereby reducing durability of concrete structure. Repair has been suggested as the protective solution for damaged structure due to corrosion. The successful repair of concrete in the long term depends on a number of factors including correct diagnosis, careful selection of appropriate repair material and accurate methodology of material application. The main focus of this paper is to highlight the methodology of repair of damage due to corrosion, criteria of repair material used and the mechanism of preventive and protective solution of corrosion affected concrete structure illustrating two case studies.

PREVENTIVE SOLUTION

It is an accepted fact that permeability is the gateway of corrosion. It is clearly seen that permeability of concrete contributes to corrosion and corrosion induces cracking and cracking further promotes permeability and this cycles continues till concrete is completely destroyed. Figure -1 shows the permeability- corrosion interaction model.

Fig 1. Corrosion - Premability Interaction Model



To prevent the corrosion activity in concrete structure, water proofing is the accepted preventive solution. Water proofing treatment of typical roof slab with parapet junction for an office building is shown in figures -2 .

PROTECTIVE SOLUTION AND ITS MECHANISM:

The damage to concrete due to corrosion of reinforcement has been recognized as one of the most serious causes for durability problem over the last several years. Research has given rise to a variety of concrete corrosion protection measures in both new concrete and in repair of damaged concrete. Epoxy based thin coating has been found to be extremely effective except few drawbacks. The innovative method of corrosion protection is the development of a two component anti-corrosive coating of rebars which has all the positive features of epoxy coating excluding all the short comings of the same.

For corrosion not to occur it is necessary that the alkalinity around the rebar is high. The various component have been so designed in this cementitious product that the alkalinity around the rebar is increased to the tune of 13. Specific reactive fillers reduces the permeability of protective coating over rebar. Selective polymer in the formulation increases the bond between coating and rebar and also makes the coating more impenetrable to polluting gas. Thus the increased corrosion inhibiting property of the coating helps in achieving a durable and successful repair of corrosion affected concrete structures.

PROTECTIVE MATERIAL

Concrete protection is a complex system. Repair is the only way to protect the corrosion affected concrete structure. In carrying out repair we attempt to create a bond between old structure and new repair materials which will restrict the shrinkage in repair material. A good repair mortar should have following properties.

1. Lowest shrinkage
2. High tensile creep
3. Low modulus of elasticity
4. Low coefficient of thermal expansion
5. Impermeability.
6. High tensile and flexural strength
7. High chemical resistance
8. Low water absorption
9. High bond strength
10. High flexibility

By adding accurate granulometry of aggregate, keeping water - cement ratio to the lowest possible, suitable quality of cement for the job and appropriate polymers in right proportion we may incorporate the above properties to repair mortar to achieve a durable repair system. For smaller repair job and where cement based products are either technically unsuitable or will take too long to cure, epoxy mortars are often the most cost effective solution.

CASE STUDIES 1 : REPAIR TO RESIDENTIAL BUILDING

The building which is 20 year old has sign of spalling, roof leakage, wet patches and efflorescence. The reinforcement were also exposed.

Repair methodology:

Damage which was attributed to corrosion of reinforcement the repair was divided into several activities which are briefly discussed below:-

- a. Surface preparation:** The area where corrosion of reinforcement has external sign, the area was prepared by removing the loose concrete till sound concrete was reached. All the exposed reinforcement were suitably cleaned in order to free from rust. The exposed concrete surface was repeatedly washed with water spray.
- b. Anticorrosive treatment to reinforcement:** Anti corrosive treatment was given to derusted reinforcement for an ideal protection against removed corrosion. For this purpose 2 coats of Sikatop armatec 108 was applied followed by curing for 24 hours.
- c. Bonding coat:** The cleaned concrete surface was made totally saturated with clear water. Cement slurry modified with polymer emulsion sikalatec was brushed in to concrete surface as bond coat.
- d. Polymer mortar for inner layer:** While the bond coat is still tacky, the filling of inner portion was done with polymer modified sikatop 122 and was well finished. Repaired mortar was cured for 2 days and the repair was allowed to dry.
- e. Carbonation resistant coating:** In order to prevent ingress of moisture and carbon dioxide a coat of carbonation protective coating with pure acrylic based sealoflex was applied.

CASE STUDIES 2: RCC OVERHEAD HEAD WATER TANK

In water tank the visible damage consisted of cracking and spalling of concrete mainly in circumferential bracings, junction of bracing and columns and radial bracing connecting inner and outer column.

Repair methodology: The repair of corrosion affected water tank was done as per following steps :

1. The area was prepared by removing all dirt, dust and other foreign materials. Loose concrete were removed till the sound concrete was reached. All the exposed reinforcement were suitably cleaned in order to free from rust.
2. Holes were drilled in order to fix nozzles.
3. Nozzles were placed with Sikadur 31, epoxy based adhesive along the crack line with deep penetration at a standard centre to centre distance.
4. The crack mouth were then chipped open and sealed along its entire length with Sikadur 31 adhesive. It was then cured for at least 6 hours before the actual injection was carried out.
5. Flexible tubes were attached to the nozzle for injecting into the cracks. The other end of the flexible tube would be fixed to injection gun.
6. To avoid any counter pressure and to ensure an open injection system, the pipes were blown through in continuous sequence with compressed air starting from the bottom to the top and it was made sure that prepared injection system was interconnected and open.
7. The gun with sikadur 52, water thin epoxy-based resin was then connected to the lowest injection pipe. Slow and even pressure was applied until such time as the injection mass oozed out of the pipe immediately above the one being used. The gun was withdrawn and flexible pipe was immediately bent and tied with binding wire. The same process was repeated starting from the next injection pipe till all the nozzles were used. Next day, the nozzles were cut off.

CONCLUSION

1. Water proofing is the most effective solution to prevent corrosion in concrete.
2. New repair materials meeting the specification requirements along with use of right type of aggregate mix proportion, optimum use of water, proper surface preparation and proper bonding play a crucial role in ensuring effective protective solution for corrosion affected concrete structures.
3. In the present scenario repair is not just replacement of damaged concrete with new concrete but a protective solution to the corrosion affected concrete structure through chemistry.

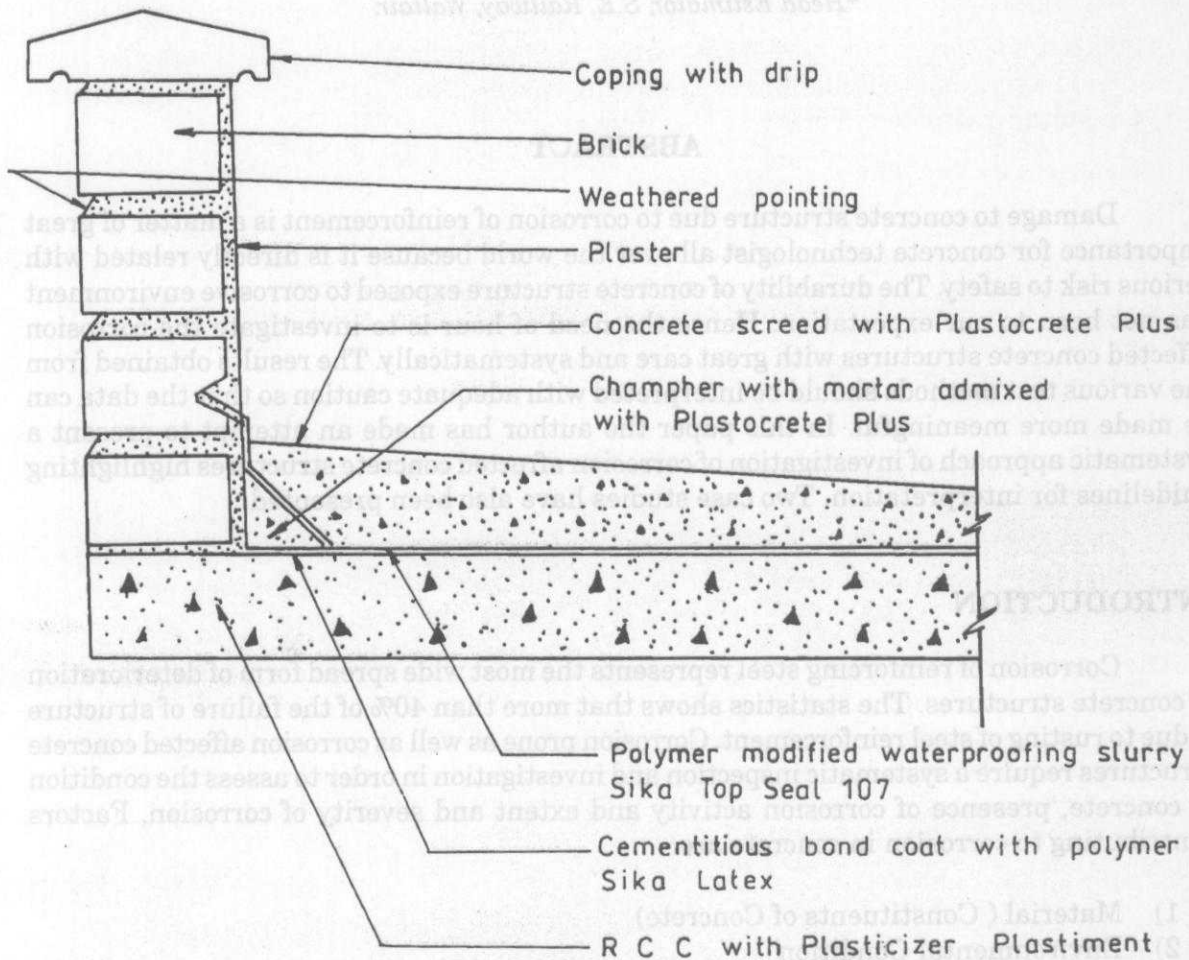
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INVESTIGATION OF CORROSION AFFECTED CONCRETE STRUCTURES - A SYSTEMATIC APPROACH

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**Fig 2 WATERPROOFING TREATMENT OF TYPICAL ROOF SLAB
WITH PARAPET JUNCTION**

MECHANISM OF CORROSION

For corrosion to occur, it is necessary that both the passivating film on steel is destroyed and there exists a differential electrochemical potential within the steel concrete system. The pH value of concrete which is more than 11.5 is lowered by ingress of carbon dioxide, thus providing a corrosive environment while the passive layer can be broken when chloride ions migrate through concrete and reach a critical level at which the passivity is destroyed. Depending on oxidation state, the iron increases 6 times in volume due to rusting as a result of which expansive force acting on concrete surrounding the