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# Building Materials Corrosion Control by Fiber Reinforced Polymers

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**K** : Building materials; Elements; Pollutants; Flues gases; Wastes; Acid rain; Weather; Heat; Light; RC structures and Fiber reinforced polymers

**I**

The destructive attack by corrosive substances which come into external contact with the concrete is the main cause for its corrosion.

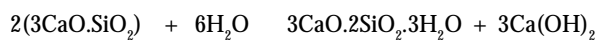
The major cause of corrosive reaction in concrete is water, cement and ballast.

Natural water is suitable for mixing with concrete. Chemical

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Portland cement is one of the most important building materials at the present time. It is formed when mixture of limestone and clay are strongly heated. It is mixed with small amount of water, set in few hours to a hard stone like substance. Portland cement [3] is chemically defined as the finely ground mixture of calcium aluminates and silicates of varying compositions, which hydrate when mixed with water to form a rigid solid structure with good compressive strength. Portland cement is a mixture of the following compounds mention in Table 1.

It is produced from the Portland cement clinker phase by reactions with water. A typical reaction is that of tricalcium aluminate, which forms more than 50% by weight of Portland cement. It illustrates the complicated nature of the hydration of cement;



The set cement consists of hydrated calcium silicate, calcium hydroxide and reaction products originating from calcium aluminate (e.g. hydrated tetracalcium aluminate) and calcium aluminate ferrate.


**F**

Soft water has less calcium and magnesium salts. For this reason water can dissolve relatively large quantities of these salts from concrete. Very soft water (less than 1.1 milliequivalent total hardness) can attack the surface, but dense concrete which has been made correctly is resistant even to very soft water.

**F**

Organic compounds (plant and animal) fats and oils produce corrosive effect with concrete. All contain smaller or larger quantities of free fatty acids, which like other weak acids attack concrete. Fatty acids can react with calcium compounds contained in the set concrete with formation of calcium salts (soaps) of the fatty acids and glycerol. The decomposition of the fat (saponification) causes softening of concrete. Mineral oils and fats provided they contain no acids or resins, do not attack concrete. If concrete is completely impregnated with fats and oils its hardness and strength of adhesion to the steel reinforcement are impaired. There is generally swelling action if possible. Sulphate solutions penetrate into concrete, chemical reactions take place between different parts of the set cement and the hydrates of calcium aluminate. These form voluminous new structures inside the concrete. The following equation gives:



Crystalline trisulphate is produced which is a very much larger volume than the solid starting materials because of the introduction of an appreciable quantity of water of crystallization. As the space it has to occupy is limited, it subjects its surrounding to pressure and therefore induces cracking.

Sulphate expansion can be avoided by using cements which contain little trisulphate. With very high sulphate concentration (1200 mg SO4<sup>2-</sup>/litter) it is possible for gypsum to separate from calcium

hydroxide solution in the hardened concrete. This also causes swelling. Mostly Sulphate occurs in ground and effluent waters.

**R D**

**F**

**RC**

Fiber reinforced polymers are not affected as severely as other building materials by various environmental conditions over the periods of time. The ageing process is not quickly influenced by the weather variations of ambient temperature, moisture in the air in the form of fog, rain, snow, hail and water vapour, air impurities, ultraviolet radiation, wind etc. Physical factors (e.g. mechanical stresses, static electricity) and chemical agents (e.g. salt solution, oxygen) have no influence. Other variable processes like chemical reactions as oxidation, displacement and double displacement reactions also can be minimized by the application of FRP. Fiber reinforced polymers check absorption of water, evaporation, swelling, dissolution, precipitation and all other factors that take part in these processes and stop breaking of reinforced concrete structures. Fiber reinforced polymers [4] provide chemical resistance, stability of surface structure, colour and embrittlement. The ageing process can be slowed down by addition of special additives. These additives should stabilize the molecular structure, filter out ultraviolet light and longer wave radiation and reduce oxidation tendencies, such materials are called stabilizers, light filters and antioxidants, respectively. The weather resistances of fiber reinforced plastics are very satisfactory and they can enhance the life of building materials. Good weather resistance and corrosion protection of reinforced concrete are shown by fiber reinforced polymers like polytetrafluoroethylene (Teflon etc.) and phenolic and amino plastics, polyamides, polystyrene, polyethylene and polyvinylchloride [5]. These ageing reactants do not provide bad affect these reinforced polymers and concretes. Some important polymeric materials are mentioned in Table 3, they can protect reinforced concrete in acidic and alkaline medium.



