Building Materials Corrosion Control by Fiber Reinforced Polymers

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e destructive attack by corrosive substances which come into external contact with the concrete is the main cause for its corrosion. e major cause of corrosive reaction in concrete is water, cement and ballast.

Natural water is suitable for mixing with concrete. Chemical

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 de ned as the nely 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;

$$2(3CaO.SiO_2) + 6H_2O \rightarrow 3CaO.2SiO_2.3H_2O + 3Ca(OH)_2$$

e 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.

So water has less calcium and magnesium salts. For this reason water can dissolve relatively large quantities of these salts from concrete. Very so 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 so water.

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Organic compounds (plant and animal) fats and oils produce corrosive e ect with concrete. All contain smaller or larger quantities of free fatty acids, which like other weak acids attack concrete. e fatty acids can react with calcium compounds contained in the set concrete with formation of calcium salts (soaps) of the fatty acids and glycerol. is decomposition of the fat (saponi cation) causes a so ening 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. ere is generally swelling action is possible. Sulphate solutions penetrate into concrete, chemical reactions take place between di erent parts of the set cement and the hydrates of calcium aluminate. ese form voluminous new structures inside the concrete. e following equation gives:

$$3CaO.Al_2O_3 + 3(CaSO_4.2H_2O) + 26H_2O \rightarrow 3CaO.Al_2O_3.3CaSO_4.32H_2O$$

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.

is sulphate expansion can be avoided by using cements which contain little trisulphate. With very high sulphate concentration (1200 mg $SO4^{2-}$/litter) it is possible for gypsum to separate from calcium hydroxide solution in the hardened concrete. is also causes swelling. Mostly Sulphate occurs in ground and e uent waters.

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Fiber reinforced polymers are not a ected as severely as other building materials by various environmental conditions over the periods of time. e ageing process is not quickly in uenced by the weather variations of ambient temperature, moisture in the air in the form of fog, rain, snow, hail and water vapour, air impurities, ultra-violet radiation, wind etc. Physical factors (e.g. mechanical stresses, static electricity) and chemical agents (e.g. salt solution, oxygen) have no in uence. 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. e ber reinforced polymers [4] provide chemical resistance, stability of surface structure, colour and embrittlement. e ageing process can be slowed down by addition of special additives. e additives should stabilize the molecular structure, lter out ultraviolet light and longer wave radiation and reduce oxidation tendencies, such materials are called stabilizers, light lters and antioxidants, respectively. e weather resistances of ber 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 ber reinforced polymers like polytetra uorethylene (Te on etc.) and phenolic and amino plastics, polyamides, polystyrene, polyethylene and polyvinylchloride [5]. e ageing reactants do not provide bad a ect these reinforced polymers and concretes. Some important polymeric materials are mentioned in Table 3, they can protect reinforced concrete in acidic and alkaline medium.