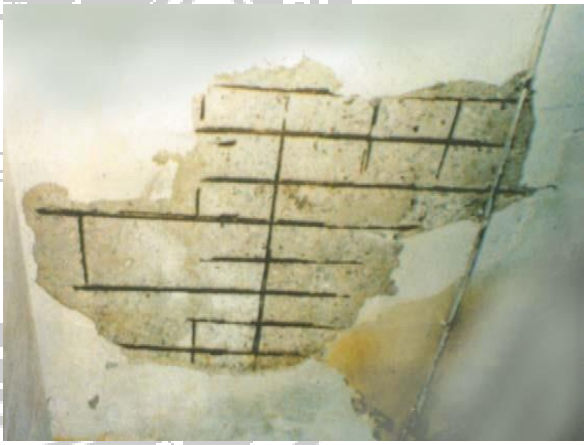
CORROSION PROTECTION TECHNIQUES

Corrosion Control

From the literature survey and case studies it has been reported that 40% of failure of structures is on account of corrosion of embedded steel reinforcement in concrete. Proper mix design, use of right quality and quantity of cement for different exposure conditions is to be adopted. Recently it has been realised that lower W/C ratio which has been always associated with lower permeability is not enough to make impermeable concrete contributing to high durability. Use of supplementary cementitious materials such as fly ash, ground granulated blast furnace slag (GGBS), silica fume etc. are required to be used as admixtures or in the form of blended cement in addition to lowest possible W/C ratio to make concrete dense. These materials improve more than one properties of concrete which will eventually reduce corrosion of reinforcement.

Rusting of reinforcements



Example of delamination of concrete cover

Other measures to control the corrosion of steel reinforcement. They are listed and briefly explained.

Metallurgical methods

Corrosion inhibitors

Coatings to reinforcement

Cathodic protection

Coatings to concrete

Design and detailing

***Metallurgical Methods*:**

Steel can be made more corrosion resistant by altering its structure through metallurgical processes. Different methods such as rapid quenching of the hot bars by series of water jets, or by keeping the hot steel bars for a short time in a water bath, and by such other process the mechanical properties and

corrosion resistance property of steel can be improved. There are many situations where stainless steel reinforcements are used for long term durability of concrete structures.

Corrosion inhibitors:

Corrosion can be prevented or delayed by chemical method by using certain corrosion inhibiting chemicals such as nitrites, phosphates, benzoates etc. Of the available materials, the most widely used admixture is based on calcium nitrite. It is added to the concrete during mixing of concrete. The typical dosage is of the order of 10-30 litres per m^3 of concrete depending on chloride levels in concrete.

As mentioned earlier, in the high pH of concrete, the steel is protected by a passivating layer of ferric oxide on the surface of steel. However, the passivating layer also contain some ferrous oxide which can initiate corrosion when the chloride ions reach the steel. The nitrite ions present in the corrosion inhibiting admixture will oxidise the ferrous oxide to ferric oxide, thus stabalising the passivating layer even in the presence of chlorides. The concentration of nitrite must by sufficient to cope up with the continuing ingress of chloride ions.

Calcium nitrite corrosion inhibitor comes in a liquid from containing about 30 per cent calcium nitrite solids by weight. The more corrosion inhibitor is added, the longer the onset of corrosion will be delayed. Since most structures in a chloride environment reach a level of about 7 kg of chloride iron per m^3 during their service life, use of less than 18 litres/m^3 of calcium nitrite solution is not recommended.

Coatings to reinforcement:

The object of coating to steel bar is to provide a durable barrier to aggressive materials, such as chlorides. The coatings should be robust to withstand fabrication of reinforcement cage, and pouring of concrete and compaction by vibrating needle. Simple cement slurry coating is a cheap method for temporary protection against rusting of reinforcement in storage.

Central Electro Chemical Research Institute, (CECRI) Karaikudi have suggested a method for prevention of corrosion in steel reinforcement in concrete.

The steps involved in this process are

Derusting:

The reinforcements are cleaned with a derusting solution. This is followed without delay by cleaning the rods with wet waste cloth and cleaning powder. The rods are then rinsed in running water and air dried.

Phosphating:

Phosphate jelly is applied to the bars with fine brush. The jelly is left for 45-60 minutes and then removed by wet cloth. An inhibitor solution is then brushed over the phosphated surface.

Cement coating:

A slurry is made by mixing the inhibitor solution with portland cement and applied on the bar. A sealing solution is brushed after the rods are air cured. The sealing solution has an insite curing effect. The second coat of slurry is then applied and the bars are air dried.

Sealing:

Two coats of sealing solution are applied to the bars in order to seal the micro-pores of the cement coat and to make it impermeable to corrosive salts.

The above is a patent method evolved by CECRI and license is given to certain agencies. Somehow or other this method has not become very popular. Some experienced consultants and engineers are doubting the efficacy of this method.

Fusion Bonded Epoxy Coating:

The fusion bonded epoxy coating is a specialised job carried out in a factory and not at site of work. Initially the bar is shot blasted to remove all mill scale and to give the kind of surface finish required. This ensures an adequate bond between epoxy and steel. The bar is then heated to a carefully controlled temperature. Electrostatically charged epoxy powder particles are deposited evenly on the surface of the bar. It looks, greenish in colour. The coating thickness may vary from 130 to 300 microns. Although epoxy coated bar have an excellent protection to corrosion in aggressive environment, there are a few limitations.

Galvanised reinforcement:

Galvanising of reinforcement consists of dipping the steel bars in molten zinc. This results in a coating of zinc bonded to the surface of steel. The zinc surface reacts with calcium hydroxide in the concrete to form a passive layer and prevents corrosion.

Cathodic Protection:

Cathodic protection is one of the effective, well known, and extensively used methods for prevention of corrosion in concrete structures. Due to high cost and long term monitoring required for this method. The cathodic protection comprises of application of impressed current to an electrode laid on the concrete above steel reinforcement. This electrode serves as anode and the steel reinforcement which is connected to the negative terminal of a DC source acts as a cathode. In this process the external anode is subjected to corrode and the cathodic reinforcement is protected against corrosion and hence the name "**Cathodic protection".**