Technical Advice Note 9

Chloride Attack

Chloride attacks are one of the most common causes of the failure of concrete structures totalling approximately 40%. Chloride attack reduces the protection to the reinforcement within the concrete allowing to corrode and reduce the strength of the structure.

Causes:

Internal causes:

1) Use of calcium Chloride as an additive to increase the setting time

2) Use of aggregates that contained chlorides which were not washed for mixing.

3) Aggregates with chloride content more than the limit stated in the specification.

External Causes:

4) Exposure to seawater

5) Diffusion from the atmosphere (particularly marine environments)

6) De-Icing Salts

Determining Chloride Ingress

The chloride profile of the concrete is determined by taking dust samples from increments of depth,

- 5 to 25 mm (The first 5 mm is discarded as being non-representative)
- 25 to 50 mm
- 50 to 75 mm etc

The dust samples are then sent to a UKAS accredited laboratory where the chloride is extracted with hot dilute nitric acid and then silver nitrate solution is added to precipitate any chloride present.

Repair

Unfortunately there is no way to remove the chloride ions from the concrete. The only method of repair is to remove the concrete section which has been impregnated with chloride ions and replace with a cementitious repair mortar

Process of Chloride Attack

A significant proportion of any chloride introduced into the concrete when being cast will tend to be bound by the hydrating cement minerals, leading to the formation of chloride-containing phases meaning that the chlorides are partly immobilised. The remainder will be present as free chloride ions in the pore solution that can cause corrosion

The introduction of chlorides during construction is a much reduced problem since the restrictions in the UK, in 1977, of the use of calcium chloride as an admixture for reinforced concrete.

The chloride content in the vicinity of the reinforcement primarily controls the risk of its corrosion. In a situation where chlorides are penetrating concrete from an external source, the chloride level at the depth of the reinforcement, and, consequently, the risk of corrosion, will usually increase with time.

Even if further ingress is prevented, the process of transporting chloride ions from zones of high to low concentration may continue for months, possibly years, modifying the risk and potential severity of corrosion.

Much like the carbonation of concrete, when the chloride ions reach the passive layer protecting the steel, the chloride ions change the PH to breakdown the passive layer thereby corroding the steel

Holes drilled into substrate to extract dust at three different depths

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