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Study and Analysis of Corrosion and Protection Methods for Reinforced Concrete

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Abstract: Corrosion is the wear of building materials under the influence of physical, chemical and biological factors in contact with the environment. Concrete contains in its composition the least durable component - it is a cementitious stone. From this part of the material the corrosion process begins. Corrosion occurs as a result of exposure to different types of water. A good way to protect reinforcement concrete from corrosion is the primary passivation of the reinforcing surface, as well as the formation of protective films of oxide under the influence of the aqueous-alkaline environment of the concrete stone. The protective properties are improved by introducing passivating agents into the concrete mixture. The introduction of special additives into the composition of concrete during its manufacture and formation, while changing its mineral composition. This method is considered the most effective. Many additives can be used for water retention, plasticizing, stabilization, chemical modifiers, and amorphous silica.

Keywords: Corrosion, composition, influence, protect, rebar.

INTRODUCTION

Rebar corrosion is the main cause of concrete deterioration and a global problem and The failure of concrete structures due to corrosion imposes significant safety implications for critical infrastructure such as highways, tunnels, bridges and other projects exposed to harsh environments [Toutanji, H.A. *et al*., 2013].

Steel is not a natural material (to some extent molten and refined iron ore) and is therefore susceptible to corrosion. As a thermodynamically unstable metal under normal atmospheric conditions, steel will release energy and return to its natural state: iron oxide or rust [Zur, E. *et al*., 2010].

The build up of rust increases the volume of the embedded steel element and this increase in volume exerts extensive pressure on the surrounding cement causing the concrete to crack, loosen and chip. The resulting damage affects the durability and service life of concrete [McGettigan, E. *et al*., 1995].

Steel is naturally protected against corrosion in the alkaline environment of concrete (pH 12 to 13) by a thin layer of oxide that quenches the metal. This layer prevents the metal atoms from melting and reduces the rate of corrosion to negligible levels [Ibrahim, M. *et al*., 1999; Moon, H.Y. *et al*., 2007].

The corrosion of steel in concrete begins when the oxide layer is destroyed and The destruction of the passivation layer is due to an increase in the chloride concentration or a decrease in the pH level (low alkalinity) in the concrete[De Muynck, W. *et al*., 2008; De Muynck, W. *et al*., 2006].

The penetration of chloride ions into concrete is the main and best-documented cause of corrosion of rebar.

Water-soluble chloride ions present in sea water and dissolving salts enter the concrete through capillaries and micro-cracks. Upon reaching the reinforcement, steel chlorides begin to penetrate the passivation oxide layer as soon as a certain chloride concentration (limit value) is exceeded on the reinforcement steel surface, it begins Corrosion as long as oxygen and water is present [Amidi, S. *et al*., 2015].

In general, in Iraq, the permissible chloride content is limited to about 0.4% by weight of cement [Garbacz, A. *et al*., 2005].

Carbonation gradually lowers the pH level of concrete. Carbon dioxide (CO 2) in air or water penetrates concrete and reacts with hydroxides to form carbonate, which will turn into calcium carbonate (CaCO 3) when it reacts with calcium hydroxide (Ca (OH) 2).

This reaction lowers the pH of the pore solution. Altogether, carbonation can reduce the pH to about 7 and when the pH of concrete drops below a value of about 9, corrosion of the rebar begins because it is no longer inert.

The carbonation process requires the water inside the concrete to dissolve the carbon dioxide and form carbonic acid (H 2 CO 3). If the concrete is too dry (RH < 40%), the carbon dioxide cannot dissolve and carbonization cannot occur.

Concrete carbonization is a slow process that occurs over time and is generally not a concern for

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concrete with a design life of less than 50 years. However, it is still a major concern as carbonation is accelerated in more permeable concrete (higher w/c ratio, lower cement content, lower strength).

Effects on the Reinforced Concrete System

One characteristic that allows steel and concrete to work together is the adhesion with the installation between the two. And during the corrosion process, products subject to contact with concrete appear, therefore, the nature of the boundary between both steel and concrete is variable, and the adhesion to steel is lost.

With increasing radial stresses exerted by wear products, cracks occur in concrete to a greater extent. At lower levels of wear, the adhesion between steel and concrete increases, but with the levels of wear that produce the first cracks, the adhesion between both materials decreases sharply [Soebbing, J.B. *et al*., 1996].

Solutions to the Problem of Corrosion

Due to the damage caused to reinforced concrete structures by corrosion and the economic loss from this chemical phenomenon, several years of research have resulted in some solutions to prevent corrosion from being a bad problem. In the field of construction, thus ensuring that reinforced concrete structures are reliable, durable and achieve greater durability and resistance that is not diminished by this phenomenon.

Extensive use of new high-quality materials and an increase in the durability of structures due to the anti-corrosion protection of concrete and reinforced concrete is one of the important national economic tasks. The most severe corrosion is observed in the buildings and structures of the chemical industry, which is explained by the effect of gases, liquids and various fine particles directly on building structures, equipment and structures, as well as the penetration of these factors into the soil and their impact on the foundations.

The main task facing anti-corrosion equipment is to increase the reliability of protected equipment, building structures and structures. This should be done through the widespread use of high-quality paints and varnishes, in particular epoxy resins, fiberglass, polymeric substrate materials and new sealants.

According to the nature of the corrosive environment, the following main types of corrosion are distinguished: gas, atmospheric, liquid and soil. Gas corrosion occurs in the absence of moisture condensation on the surface. In practice, this type of corrosion occurs during the operation of metal and concrete at elevated temperatures. Atmospheric corrosion refers to the most common type of electrochemical corrosion, since most metal and reinforced concrete (concrete) structures operate under atmospheric conditions. The corrosion that occurs in any wet gas can also be referred to as atmospheric corrosion. Depending on the conditions of liquid exposure of the surface of concrete and reinforced concrete, these types of corrosion acquire additional properties: with full and variable immersion, drip, and jetting [Garbacz, A. *et al*., 2005].

An increase in the service life of construction structures and equipment is achieved by selecting the appropriate materials, taking into account their resistance to aggressive environments operating in production conditions. In addition, preventive measures must be taken. Such measures include tight sealing of production equipment and pipelines, good ventilation of premises, trapping of gaseous and dusty products during the production process; proper operation of various drainage devices, with the exception of the possibility of penetration of aggressive substances into the soil; Use of waterproofing devices, etc.

The most common way to protect reinforced concrete (concrete), various building structures and equipment from corrosion is the use of chemically resistant non-metallic materials: acid-resistant ceramics, liquid rubber compounds, polymeric materials

Types of corrosion destruction of concrete are different and varied. Many builders are interested in the issue of protecting concrete structures from the influence of negative external environmental factors.

The upper layers of concrete are often destroyed, then the protection consists in the use of concrete with a small number of capillaries in its structure and with the use of the drug from the occurrence of cracks at the initial stage of construction, this will help protect the structures from leaching and washing out.

Protection against destruction in the form of rust is divided into:

Methods that change the composition of concrete and make it more durable and resistant to negative environmental influences;

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Measures for coating the surface of the material with hydraulic preparations

The use of crystal cement in the concrete composition will reduce the amount of calcium hydroxide released, which contributes to the evaporation of the liquid. This component will allow the material to be compacted, thereby stopping the penetration of liquid through the concrete solution.

Another type of destruction of the concrete structure from rust is sulphate corrosion of concrete. It appears as a result of the relationship of sulphate to stone in cement mortar. Destruction is observed in the form of structural deformations and explosion of structural elements.

Concrete protection against corrosion is divided into: primary and secondary. It is also susceptible to corrosive corrosion in reinforced concrete structures. For their preservation, metal corrosion inhibitors are used at the time of preparing the concrete solution. Thus, a film is formed on the reinforced concrete components, which stops the metal from contacting the concrete.

CONCLUSION

Corrosive effects are hazardous to concrete buildings and reinforced concrete structures. It is important to monitor the buildings and in every possible way to prevent the appearance of corrosive rust. Otherwise, the building, which took a lot of effort and financing, may collapse completely. There are many different additives on the building materials market that can save the building from destruction.

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