



CORROSION OF REINFORCED CONCRETE (CAUSES AND TREATMENT)

SALEM FALEH ALAJMI

*Specialist Trainer - Construction Training Institute -
The Public Authority for Applied Education and Training - Kuwait*

KeyWords

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ABSTRACT

The study aimed to identify the causes of erosion of reinforced concrete in projects, and to develop some solutions and proposals for these problems, by identifying the types of modern additives and chemicals that are used by giant companies to improve the quality of reinforced concrete, and ensure the safety of facilities.

The results of the study concluded that it is necessary to study the construction sites from a geological point of view to identify the type of soil on which the building will be built, and to determine the purpose of the building, whether it is a residential building or an administrative building or a factory ... etc., to determine the live mechanical loads on the building, the materials used, and the additions Suitable for this purpose with concrete, in order to ensure the quality and safety of buildings, and to extend their life. Without eroding the concrete, or being affected by the surrounding environmental factors, and what guarantees the reduction of losses in facilities and the general safety of the building and individuals, and to ensure the success of the project for which the building was built.

Introduction :

Before identifying the causes of erosion of reinforced concrete, it is necessary to identify the components of reinforced concrete and its various components to find out the causes that lead to these problems, such as corrosion in concrete structures, and affects the safety of engineering facilities.

The Romans are considered the first to use concrete in history, about 2000 years ago, and it was used in most of their buildings because of its ease of formation, and the possibility of implementing it with a simple trained labor (Maragh, 2019). The process of cohesion between them.

Reinforced concrete structure is a structural structure formed after concrete is poured into the formwork after placing the reinforcing steel in these formwork. Rebar combined with concrete increases the tensile strength, that is, the bending strength of the concrete frame. (Allahyari, et al., 2021)

Study Problem :

The problem of the study is summed up in what concrete structures are exposed to in different environments from erosion factors, and damage negatively on their durability and durability.

Concrete corrosion can be divided into two basic types: (concrete damage, steel strength corrosion), and the causes that lead to these two types include one or more mechanisms of mechanical, physical, structural, chemical, biological, or steel corrosion. The most common cause of this type of wear and tear is the wear of conventional carbon steels (black steels), pressed steels, and post-tensioned rebar. (Wang, et al., 2019)



Figure. (1-A) : Concrete slab corrosion from not using trapped air additives

It is clear from Figure (A) the erosion of the concrete slab from not using trapped air additives.



Figure. (2-B) : Concrete sample to which the trapped air release material has been added

Figure (B) shows a concrete sample to which these additives were added. The two samples were exposed to the same low temperatures and the same environmental conditions.

The study is an attempt by the researcher to identify the most important and widespread causes of erosion of reinforced concrete, and to try to develop some solutions to these problems to reduce them, as follows:

First Axis: Reinforced Concrete :

[1] Characteristics of reinforced concrete:

Reinforced concrete has many characteristics that distinguish it from other materials, as it gradually takes the form of a solid solid with time, and begins with initial doubt, then final doubt, as well as it is very resistant to pressure, and at the same time very weak in its resistance to pressure, so ordinary concrete is not used in places that occur has pressure. (Ata El-kareim, et al., 2021)

As for iron, it is generally resistant to tensile and pressure forces, while long iron bars can withstand all tensile forces, and at the same time, concrete cannot bear to the same degree all compressive forces as a result of its denting that may occur if its sectors are thin, and accordingly we find that a composite of concrete materials Iron gives an ideal material to resist the various stresses affecting it, and this compound is what gives an ideal material to resist the different stresses affecting it, and this compound is what is known as reinforced concrete, and concretes vary a lot nowadays as a result of their components such as: (Dongyun, et al., 2021)

- Concrete mortar: It consists of mixing asphalt or with sand and cement mortar.
- Ordinary concrete: It may be called asphalt concrete, and it works by mixing ordinary gravel with sand and cement mortar.
- White concrete: It consists of mixing white broken stone with sand and cement mortar.
- Brick-breaking concrete: It consists of mixing broken bricks with sand and cement mortar.
- Reinforced concrete: It consists of using iron skewers with the regular concrete mix.

[2] Types of reinforced concrete :

There are many different ways to prepare reinforced concrete, which gives it common characteristics and names, among which we mention the most common types, namely :

[A] Concrete poured on the site :

This concrete is prepared by placing rebar on the concrete model on the site according to the construction drawings of the building, and then pouring concrete on it after mixing it well. This type of concrete is the most widely used type. (Malekipoura, et al., 2021)

[B] Precast Concrete :

Precast concrete units may be produced in typical shapes and sizes in the factory equipped for that, then special transport vehicles are transported to the site and installed in the building using mechanical hoists, or concrete pieces are poured at the edge of the building site and then installed in their location in the building with a crane, and there are many factories and companies that work This type of concrete is in another way, where complete units are manufactured by preparing them in a private factory, such as manufacturing a complete bathroom or kitchen. (Mojtaba, 2021)

[C] Prestressed Concrete :

The idea of pre-stressed concrete is that it is a composite of high-resistance concrete and iron, as the pre-stress has an anti-stress effect on the stresses resulting from the loads affecting the structural element, which ultimately increases its ability to withstand live and dead loads affecting it, as well as the process of prestressing in reducing From bending and cracks that can occur in the concrete part. (Hesam, et al., 2021)

There are other types of concrete that have special properties such as :

- reinforced concrete poured under water.
- Fire-resistant reinforced concrete.
- Reinforced concrete resistant to atomic radiation.

- Reinforced concrete dams.
- Colored reinforced concrete.
- Reinforced concrete against bombs.
- Reinforced concrete for earthquake resistance.

[D] Armament :

Reinforcing steel bars for concrete consist of ordinary mild steel, called steel 37, or high-strength steel, called 52, and the percentage of carbon in it is 0.25% - 0.50%. There is also steel, iron, tensile strength of 60 kg / mm, which gives greater safety in concrete structures and provides in the use of iron. (Yong, et al., 2021)

And rolled iron is used a lot, and it shows a strong cohesion with concrete when it is intended, and extracting iron from concrete depends on the degree of compression strength of the concrete itself. (Mojtaba, 2021)

The second axis: problems of corrosion of reinforced concrete :

All facilities need to isolate their buildings completely from moisture, rain, ground and surface water and their filtration. One of the disadvantages of the effect of moisture and leaching water on buildings is that it helps to damage the elements of its structural and building materials, which leads to a shortening of the life of the building other than rotting of these materials and the emission of unpleasant odors from them to the owners of the building with Insects, mice, etc. (Philipp, et al., 2021)

Among the most important problems of concrete erosion affecting the building and resulting from many sources :

[A] Orientation of the building: The walls that receive a permanent splash of rain and a little sunlight make them damp, and accordingly we find the orientation of the building plays a major role in the way of isolating the building from moisture. (Abdulgader, 2021)

[B] Rain water : The amount of its fall varies from one place to another. Usually, rain water represents a danger to buildings that are not equipped with moisture barriers due to the ability of water to directly penetrate the roof of the building and its various elements. Therefore, the ceiling and the lining must be isolated from moisture. Moisture can also penetrate the external walls exposed to rain. Severe if a suitable insulator does not work for her. (Neumann, 2021)

[C] Flat water: It consists of rivers, seas, or swamps formed as a result of rain or torrents. Sometimes this water mixes with the ground soil, and areas of water-saturated mud are formed near the foundations of the building, and some of this water may seep into the soil and collect groundwater, thus increasing its level. Water reaches the foundations of the building close to it, which threatens the building if an insulator does not work for it from the effect of this water. (Ivan, 2021)

[D] Groundwater: It is the water formed under the surface of the earth and passes through the pores of its soil until it settles at a level that is almost constant for each region. Therefore, the soil near the groundwater is usually saturated with water and it is not preferable to penetrate into the basements of buildings in this area without work. There are barriers to water, otherwise wetness or flooding will occur inside these basements. (Chao, et al., 2021)

[E] Rise of ground moisture: Moisture rises from the soil under the origin to the floor of the ground floor or basements in buildings by capillary property through the pores of the soil and the building materials used in the building. (Ahmed, et al., 2021)

[F] Condensation: Cold air contains less vapor than hot air, and therefore moisture is deposited in walls, ceilings and floors when the hot, moisture-laden air cools. (Dongzhi, et al., 2021)

[G] Poor water drainage in the site: a collection of wastewater occurs under the building if it is difficult to drain it from the low lands of the site, especially if the soil of the site is impermeable to water, and accordingly moisture and erosion occur for these buildings built on those lands. (Zhiqiang, 2021)

The third axis: Solutions and suggestions to avoid the erosion of reinforced concrete :

In light of the foregoing, and the many causes of reinforced concrete erosion observed, there are some solutions and proposals that may contribute to reducing concrete erosion, and they are as follows :

[1] Choose the type of insulator :

The following main elements must be taken into account when determining the type of moisture and water insulating layers in the building, as well as the economic and rich aspect of them.

[A] The purpose of insulation in buildings : (Hamed, et al., 2021)

- Insulate the ground moisture.
- Moisture insulation for basements and below.
- Isolate moisture from bathrooms and the like.
- Isolate moisture from ceilings and upper surfaces

[B] The nature of the land on which the buildings are erected : (Dongyun, et al., 2021)

- Dry sandy or rocky land.
- Dry clay soil.
- A muddy land saturated with water.
- Muddy or sandy soil prone to water intrusion from surrounding sources.

[C] The nature of the atmosphere in the areas on which the buildings are erected : (Malekipoura, et al., 2021)

- Moderate humidity, light rain.
- Moderate humidity, moderate rain.
- High humidity and a lot of rain.
- An atmosphere prone to snowfall.

After determining the type of moisture and water insulating layers in the building, in addition to the economic and rich aspect of them, the moisture insulating materials can be divided as follows :

[2] Flexible insulation material :

Flexible insulating materials are suitable to be placed in the walls of buildings due to their ability to withstand the slight slump of buildings without breaking or crushing if compared to non-flexible or rigid insulating materials, and their quality can be divided into materials that have the possibility of insulation only and materials that are weak and insulating, and the most important of these materials are :

- **Metal panels:** They are panels that are used to insulate strongly against moisture and water in roofs, walls, floors, flower boxes, etc. Besides, they can be made materials. Metal panels have many shapes: (lead panels, copper panels, aluminum panels, galvanized iron panels, stainless steel panels). (Mohammad, et al., 2021)
- **Bitumen:** bitumen is made from what is left of the distillation of crude petroleum oils, as its texture ranges between hard and semi-hard, and its color ranges between black and brown, and it is soluble in carbon sulfur.) is less than 2%, and this material is considered of the quality with the possibility of insulation only, and among the most famous types used in moisture insulation: (blown [oxidized] bitumen, hardened bitumen, bitumen suspensions). (Rajput, et al., 2021)

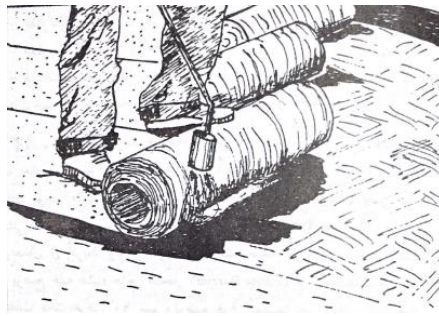


Figure. (3-C) : Coil and spray film for moisture insulation of concrete surfaces

- **Water-insulating liquid:** This liquid is made from mixing paraffin with volatile oil, where the liquid mixture is painted with the mattress or sprayed with special spray machines on the areas of buildings permeable to water above the level of the ground surface, and this method can be relied on to prevent moisture from 3-5 years depending on the type of material And how it is exposed to moisture, and this material can also be considered of the quality with the possibility of insulation only. (Reza, et al., 2021)
- **Polyethylene tarpaulin:** It is black in color and is used as an insulating material for buildings. Its thickness must be at least 0.46 mm and its weight is about 0.48 kg / m². Polyethylene is a flexible material that resists the dent resulting from the landing of light buildings without damage, and due to the thin density of this linoleum. As for bitumen, it is preferable to put it in building mortar welds, as well as in isolating bathrooms and showers, and there are transparent types of low water permeability called vapor barriers, and they are always used to trap moisture in buildings as well, and this material can be considered of the quality with the possibility of insulation only. (Hao, et al., 2021)



Figure. (4-D) : A layer of insulating material for concrete surfaces spread by a spray device

[3] Semi-rigid insulating materials :

They are moisture insulating materials that are always used in buildings due to their ease of processing and formation in the place to be isolated, and their quality can be divided into materials with the possibility of insulation only and materials that are insulating and insulating, and the most important of these materials are :

- **Asphalt:** It is a good insulator for moisture, and one of its disadvantages is that it does not bear high tensile strength and dents, especially when descending a light building. Asphalt cracks and damages and is prone to water penetration. Therefore, it is not preferred to place it in these places except after a special study. There are three types of asphalt that are frequently used in buildings as follows. : (natural asphalt, synthetic asphalt, mastic asphalt). (Bin, et al., 2021)
- **Moisture-blocking rolls:** This material can be considered of the quality with the ability to isolate and wet together, and it is the most widely used type for insulating water and moisture in roofs. The insulating layer for roofs usually consists of placing 2-3 rolls of asphalt felt on top of each other, where they are attached to hot paint or bitumen, and the number of Felt layers according to the strength of the hydrostatic pressure of the water to be prevented from penetrating through it to the buildings, and the floors and walls on which the insulating layer is to be placed must be prepared to be smooth, dry and free from any impurity that prevents these materials from sticking to them. (Zhang, 2021)

- **Asphalt pieces with a thin layer of metal on it:** This material can be considered of the quality with the possibility of insulating and insulating together. It is made of asphalt material and a very thin material of metal such as aluminum or otherwise is affixed to it. This material is usually placed to isolate moisture and heat as well inside the walls. and ceilings or on end surfaces as a finishing material for them. (Zhen, et al., 2021)

[4] Solid insulation material :

They are moisture insulating materials that are used in buildings due to their ease of processing, in addition to that some of them are materials that have the possibility of insulation only, and others have the possibility of insulation, and they can be listed in the following :

- **Cement plaster:** It can work as an insulation material, but in order to be used as an insulation material, it stipulates the need to increase the amount of cement than what it is in the case of ordinary plaster of mortar, but one of the disadvantages of this material is that it needs repair, maintenance and restoration. (Roz-Ud-Din, et al., 2021)
- **Water-insulating additives:** a Liquid substance that is mixed as an additive for mortar and helps stop water permeability by filling the spaces between concrete or mortar grains, in addition to accelerating the chemical process of cement formation activity, and these materials include: (hydro-lime, acidic fat, iron powder, and other materials Sikka or other modern chemicals such as adicrete and so on), and these materials are made either in the form of a powder or a liquid paste. Ratio 5:1 Material: water or according to the proportions indicated in the specifications for the manufacture and operation of different materials, each according to its type. (Qing, et al., 2021)
- **Plastic layer:** It is a material with the possibility of insulation, and it is manufactured layers that are used as insulation materials or decorative panels, and after treatment it is characterized as insulating from moisture and heat, and many people prefer to use this material in covering walls and foundations. (Xing, et al., 2021)
- **Pottery tiles:** They are materials with the possibility of insulation made of good pottery material and used to cover inclined surfaces. They are good insulation for moisture and water. They are considered durable materials as they protect ceilings for long periods from rain water and give a variety of aesthetic forms in attractive colors and can be re-coated with enamel in the required colors. The following conditions must be met in the tiles used: (completely burnt, free from holes or cracks, smooth surface). (Xing, et al., 2021)

[5] Add concrete chemicals :

Concrete additives have many uses, whether they are used in the on-site mixing process or in central mixing stations or in ready-made concrete factories or prestressed concrete. Fulfill quick orders as additives are used to get early stresses for these items, including :

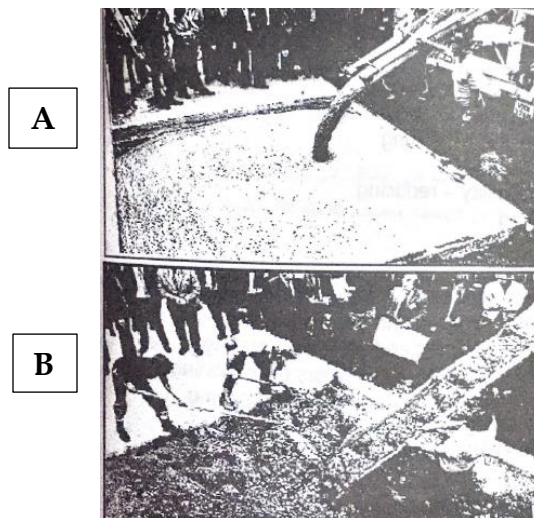


Figure. (5-E) : A layer of insulating material for concrete surfaces spread by a spray device

It is clear from the previous figure that the vast difference between concrete in Figure (A), Concrete in Figure (B) and in Figure (A) is concrete with the addition of concrete fluidity materials, And in Figure (B) concrete without any additives, which occurs in nesting, weakness and erosion in concrete.

[A] Addition to increase operating resistance (Workability) :

The purpose of these additives is to facilitate the transfer of concrete and ease of pouring it into the chopping without separating its granules, and this thus helps to prevent the occurrence of nesting in the concrete, and the resulting weakness of the concrete, its erosion and the occurrence of rust as a result of the leakage of chlorides through the pores of the nesting, and the additives come in the form of a liquid added to the mixing water At rates ranging from 0.1% to 0.5% of cement, according to the design mixture. (Pradeep, et al., 2021)

[B] Air Entraining :

Trapped air additives are one of the latest additions, as concrete designed by producing trapped air inside gives it the following properties: (Sundar, et al., 2021)

- High resistance to weather conditions and ice.
- Increased operability.
- Increased endurance over time.
- Reduce granulomatous separation.
- Light concrete production.
- Reduce the mixing water.

This type of additive is used in road concrete in cold areas and in important installations. The materials that are added to concrete for this purpose are divided into two parts: (substances added to create foam, materials added to create gas and bubbles), which are materials that are added during mixing, causing foam, such as natural products and soap. Sulfonics, and must be added in limited proportions and according to the design mixture, and be in proportions ranging from 0.1% to 0.5%.

The materials that are added to create the trapped gas: They are materials that create gas, such as hydrogen gas, such as zinc and aluminum powder.

[C] Accelerating :

They are additives that reduce the time of doubt and increase the hardening of concrete, and thus speed up the doubt. These additives have the following advantages: (obtaining early resistance to concrete, early dismantling, reducing processing of concrete, frost resistance), and one of the most famous materials used in this is calcium hydrochloride, but it is recommended After using the additives containing that chloride because of the many damage it causes to the rebar, and there are other materials for this purpose of organic compounds or silicate, and the proportions must be well studied according to the time of doubt required with taking the necessary precautions during casting such as covering concrete in hot weather, These materials are added to the water in proportions ranging from 0.1% to 0.05% according to the design mixture, and the validity date must be checked and good storage care should be taken away from the heat of the sun and moisture, with the supplies matching the approved samples. (Haitham, 2021)

[D] Add-ons slow down (Retarded) :

It is one of the important modern additives that are used in concrete mixing vehicles and in pouring oil wells, where large works are taking place, and they must be additives that slow down the uncertainty calculated and in measured doses according to the design mixtures and according to the required stresses and the specified uncertainty time, and these additives are also used in hot climates for fear of rapid initial suspicion It is also used in concrete with prominent aggregates, where a quantity of these additives is placed on the surface required for the appearance of this gravel as a type of decoration. Among the most popular materials used in reducing doubt are gypsum, copper sulfate, cellulose products, shell molasses, and starch. It is not recommended to use sugar, honey, These materials are added in proportions ranging from 0.05% to 0.5% of the weight of the cement according to the appropriate

design mixture for use, with the need to review the validity of the additives and their conformity to the samples, ensuring the quality of storage, production date and validity. (Chia, et al., 2021)

[E] Water-blocking additives :

Among the most important and oldest additives that give concrete a high resistance to water permeability, the idea of these additives depends on filling the internal voids by interacting with cement: such as sodium silicate (glass water) or potassium silicate, and fillers may be used to perform this role such as kaolin, lime or slag, And the dose of these materials must be in a limited proportion according to the designed mixture, which ranges between 0.02% to 0.05% of the weight of the cement, with a review of validity, production, storage, and conformity of supplies to the approved and tested samples. (Maragh, 2019)

[F] Shrinkage and volume change additives :

These additives are used to treat concrete expansion as a result of heat. It is also important to reduce the occurrence of cracks in concrete. The engineers must take care of this. To prevent this, a good gradual aggregate must be used, the use of a quantity of cement and water according to the design mixture, and there are some chemicals that increase their size by oxidation, which fills the air spaces and equalizes This volume increase shrinks the concrete and increases its strength. (Wang, et al., 2019)

[G] Water reducing :

This type of additive gives concrete a good workability and a suitable texture in the case of a comparison between concrete with the normal ratios of water to cement, and the concrete used has high and low mixing water reducing additives. sulfonate, hydroxycarboxylic acid, as well as melamine formaldehyde. (Dongyun, et al., 2021)

Discussion and results :

Concrete is exposed to erosion due to several factors, the most important of which is its exposure to various chemicals, especially in chemical factories, sugars, dairy, meat, and food factories in general, (Malekipoura, et al., 2021) as well as fertilizer factories. Erosion of floors, increasing loads on foundations, especially in factories, exposing concrete to earthquakes and tremors, changing the use of the facility for a purpose that is not designed on its basis, (Mojtaba, 2021) such as converting an ordinary residential building into a school, hospital, building or storehouses without regard to the live mechanical loads, and exposing the installations to a high or low water level The groundwater contains salts, (Hesam, et al., 2021) acids and alkalis that are harmful to concrete and steel reinforcement.

Therefore, the construction sites must be studied from a geological point of view to identify the type of soil on which the construction will be built, and to determine the purpose of the construction, whether it is a residential building, an administrative building, or a factory ... etc., to determine the live mechanical loads on the building, and to determine the materials used, and the appropriate additives For this purpose with concrete, in order to ensure the quality and safety of buildings, and to extend their life without eroding the concrete, or being affected by the surrounding environmental factors, and what ensures the reduction of waste in facilities and the general safety of the building and individuals, and to ensure the success of the project for which the building is built.

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