The behavior of reinforced concrete constructions and their interaction with the environment

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Summary

Concrete and reinforced concrete are the most commonly used and most reliable construction materials today. Concrete producers states that, under optimal conditions, their products have an infinite lifespan. However, various weather phenomena (eg rain, frost or chemicals from the air), in combination with poor quality of concrete and structural damage over time can cause severe damage to the concrete structure. The current conditions on the performance demands on the durability of construction, their quality, minimizing risk during the operation, including in extreme conditions requires the development and use of new materials. Priority action is moving particularly on ensuring construction to withstand an earthquake.

Keywords: durability, reinforced concrete, concrete structure, corrosion.

1. INTRODUCTION

1.1. Degradation of reinforced concrete constructions operated in weather conditions from Moldova

Causes that produce degradations of reinforced concrete constructions are often favored by quality defects of concrete and are usually determined by the environmental conditions affecting the construction.

The causes of degradation can be divided into the following groups:

Degradation as a result of freezing and thawing of water in concrete. Moldova is located in an area where climatic cycles are often repeated freeze-thaw over a year. Rainfall in many cases depending on the operating conditions of the construction of reinforced concrete, helping to increase their moisture.

Water seeps through the pores of the concrete inside and in the presence of frost, the water volume change, cause great pressure which causes cracks in the concrete. By freezing water changes its volume by 9%. Cycles of freezing - thawing accelerate the degradation, which is all the more serious when the concrete is porous, coating of concrete over the reinforcement is lower, and the quality of the concrete is weaker.

R.H.% variation relative humidity of the environment determines dimensional changes of concrete structures. These changes translate into practice the emergence of tensions that manifests itself by the appearance of cracks. Cracks are of two types:

- Plastic shrinkage cracks of fresh concrete;

- Concrete creep and shrinkage cracks of strengthened concrete. In both cases, cracks occur due to evaporation of water from the concrete into the room.

Chemical aggression of carbonation of concrete. The seriousness of this phenomenon is related to the quality of concrete, the thickness of concrete covering the reinforcement and the degree of compaction of the concrete. At incorrectly dosed concrete, with a high ratio of water / cement, resistance to carbonation is even lower when the concrete is permeable. CO_2 present in the air / water reacts with the alkaline components of the concrete to form calcium carbonate. By carbonation or by the action of chloride ions, microscopic film formed on the steel surface can be destroyed locally or over larger areas.

Carbonation is a chemical reaction which takes place between the hydroxides of calcium and carbon dioxide, which penetrates through the pores in the concrete. CO_2 is penetrating from the surface inwards. Carbonation phenomenon causes a reduction in the pH of concrete from 13 to 8.5-9, values that are below the threshold necessary to ensure conditions for passivity of the reinforcements. As a logical consequence, armature begins to oxidize, forming rust which expands and creates tensions higher breaking strength of concrete. Thus protect the reinforcement layer of concrete fall off, exposing it directly to rust corrosion.

Carbonation phenomenon not automatically lead to corrosion of reinforcement. If you meet certain conditions of moisture, even if the concrete is carbonated reinforcement can not corrode. This was evidenced by the research of old buildings. Thus, reinforcements were detected in advanced stages of corrosion in environments with high humidity (bathrooms, kitchens, toilets) and fittings unaffected environments "dry", for the same values of pH concrete.

Carbonation is quicker when the relative humidity is 50-60%.

Chloride penetration into concrete. Chloride ions (preventing, for example from groundwater) penetrate the pores in concrete. Chlorides diffusion is a process that takes place wholly or partly water-filled pores, always ensuring a balance between bound chlorine and free chlorine ions.

After carbonation, chlorine is opened once again, increasing the risk of corrosion. This phenomenon is encountered when using substances to dry concrete surface, chloride ions penetrate the concrete through the pores of capillary and drying, water migrates outwards, producing an enriched chlorides the area affected by wetting and drying. The thickness of this area has a great importance, especially on the coverage that the bars. Both CO_2 and chlorine can enter through cracks in reinforcement steel, non-cracked concrete faster than time to overcome, depending on crack width.

2. RESEARCHING METHODS

2.1. Types and causes of concrete damages

In case of damaged concrete structures, it is necessary to know the material, properties and types of damage to choose the best methods of rehabilitation and the

best materials. Below are the most common damage to the concrete:
- The segregation. If transporting concrete, the concrete fluid prepared on site (rare use of prefabricated structures) damage occurring during transport or casting in formwork when aggregates with different specific weight are separated in the fresh concrete; layer can be formed more or less distinct.
- Shrinkage and cracking. Cracks may form due to drying too fast, because of differences in temperature, load (static, dynamic), the movement supports shuttering, frost or from the effects of chemicals.
- Carbonation and corrosion of steel-reinforced concrete. Carbonation is a process by which carbon dioxide from the air reacts with calcium hydroxide in the concrete. The process begins at the concrete surface and continues inwards. Carbonation is harmful reinforced concrete structures due to pH decreasing, leading to corrosion of concrete steel, tensile strength and thus weakening the structure.
- Eflorescence. Washing and leaving the surface of materials soluble stains appeared after water evaporation is called efflorescence. Most often, the color is white.
- The effects of frost and de-icing salts. The salts used to melt snow and ice derive their heat needed to melt the concrete effects are similar to those of frost. Thrust thus created detach concrete surface.
- Effect of chemical materials. If chemical effects, deteriorating concrete is either quick or physical characteristics are not significantly affected. Damage is of two types: chemical and chemical decomposition swelling.
- The effect of sulfates. The aqueous solution sulphates degrading effect on the content of alumina cement stone. Sulphate aqueous solution is found primarily in the case of concrete structures used in wastewater treatment plants.
- The effects of fire and mechanical load. Concrete is not combustible and stops the spread of fire, but when exposed to high temperatures (> 500 ° C) lose water content, this leads to sharp decrease resistance.

2.2. Evaluating the causes of concrete degradation

Analyzing the causes and effects of corrosion, different authors have sought to systematize corrosion problems, seeking proposing criteria and classifications. Without being too differentiated, there are several classifications, of which we will mention some.
Corrosion classification into three types, namely:
- Corrosion leaching (type I);
- Corrosion of the parts, to form sparingly soluble compounds (type II);
- Natural corrosion (sulfoaluminate by forming crystals of calcium or gypsum, accumulation of other crystals, freeze-thaw etc ,. ie Expansion) (type III).
Briefly, definition and characterization of these types of corrosion may be made as follows:
- Type I corrosion is caused primarily by the action of water with a small or temporary hardness with a low content of carbonic acid. In principle, corrosion is the result of the percolation of water through the concrete, but can also be attributed to soft water that comes in contact with the concrete surface. As a result of these actions, $Ca\ (OH)_2$ is

leached from the concrete
- Type II corrosion is caused by a reaction between compounds readily soluble double instead of stone, cement and corrosive substances aggressive solution. The new products are either leachate formed either remain in place, but in an unbound form.
Some authors completes the description of the phenomenon. Thus, Al. Steopoe considers that at the same time leaching a portion of the components of the cement (in particular of Ca $(OH)_2$) is reduced and the pH value, which results in the final formation of the gel, the gel of aluminum hydroxide and gel ferric hydroxide. The formation of such gels reduce the mechanical strength of the cement.
- Corrosion of type III is caused by certain salts attack, with a tendency to form crystals. This makes a first phase to observe an increase concrete strength, an increase in its density due to the clogging of pores and voids. Since the pores formed crystals tend to increase the volume to expand, significant internal stresses are formed, which finally lead to the destruction of the concrete. Thus, the destructive action is explained sulfates, salts of sulfate crystals that form calcium-aluminate and hydrated calcium sulphate.

3. QUANTITY, QUALITY AND INTERPRETATION RESULTS

3.1. Factors that influence the construction

The nature and concentration of the corrosive agent. The corrosive action in different environments is different. It is typical of the subject chemical (acid, alkaline, oxidizing, reducing sulfate, etc.) and the way it manifests (double exchange reaction, oxidation-reduction, electrochemical, etc.) and how they react with the material on which actions. It is appropriate to clarify: pH environment (acidic, alkaline or neutral) with dosing analytical mg value agent corrosive type, the basic feature and the specific corrosive environment (for example - inorganic acid, organic acid, basic acid strong, weak acid, alkali hydroxide etc. and oxidizing acid, reducing environment, etc.).
Concentration of the aggressive agent is the first indication of the nature and amount of corrosion, taking into account, of course, the material characteristics attacked, and therefore basic elements for choosing protection measures.
Ambient temperature: maximum (minimum) and accidental. It is known that, in general, warmer temperatures entail an increase in destructive corrosive effect that it has on the environment corrosive material. There are also cases when the temperature is lowered (below 0 ° C) has a similar effect, that can increase the corrosive effect-destructive.
Environmental pressure: maximum, minimum and accidental. And the pressure is generally similar to the temperature influence. Its influence is less pronounced and does not appear in all cases (depending on the nature of the material is used).
Sunlight. Apart from the overall effect through the influence they have on the value of temperature, sunlight - through direct action - can act destructively on some materials, the so-called effect of aging (structural changes may negatively impact the properties of the material).

Temperature changes (shocks) specific for technological process. Action corrosive-destructive is more marked in the case where, outside the specific parameters, there is a frequency variation of the temperature values, not by gradient of slowly temperature, but the impact, which changes stronger structure of the material (accelerates the destructive by cracking, swelling or peeling surface, structural changes, etc.).
The moisture content of the environment. In all studies of corrosion emphasizes the importance and influence of moisture. Gas aggressive compounds, perfectly dry, have no influence whatsoever on most materials, while much lower concentrations of corrosive, wet, corrosive effects are important. The moisture content not only makes possible corrosive effect, but directly influences, corrosion increasing with moisture.
The nature, structure and dimensions of the construction. Depending on the nature of the material of construction, concrete, steel, nonferrous metal, etc. and its structure is different effect of different environments. Also, the element sizes (eg thickness of the concrete pieces) intervene directly, corrosion is more dangerous with a smaller size.
The compactness of the material, its chemical composition, the structure in the case of a sandwich structure, etc. It must also be considered.
Time. Corrosion is generally a phenomenon which continues to develop in time.
Therefore, the effect of corrosion is related to the amount of time, even if events whose intensity decreases with time.
Thus, in Figure 3.1 shows the cycle to be covered by a construction project to ensure sustainable development and who pass through phases of the project, in case of principles and data resources.

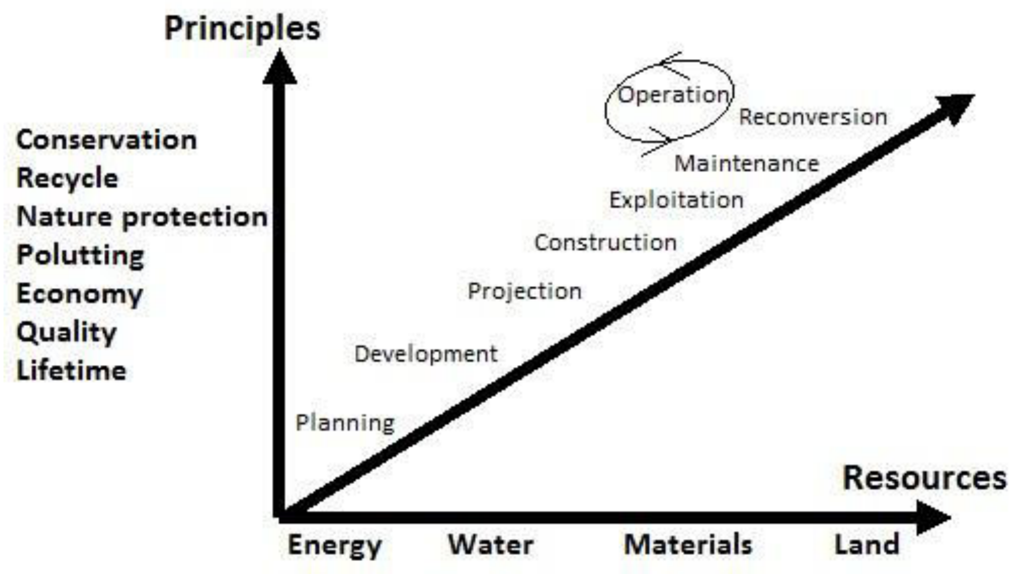

Figure 3.1 Project phases in terms of principles and data resources.

3.2. Interaction construction - environment

The key elements to be considered for achieving sustainable development in the construction industry are mainly: - reducing the use of energy sources and depletion of natural resources; - Conservation of natural areas and biodiversity; - Quality assurance and management of the built environment a healthy indoor environment. If ordinary buildings, existing undergo rehabilitation works or those we need to satisfy performance requirements set by the Law on Quality in Construction.

Some of the biggest problems of environmental damage are created by atmospheric warming and ozone depletion. Both processes are amplified by the construction lifecycle (from manufacturing to post-use).

The buildings consume large amounts of energy and raw materials, which represents a heavy burden for the environment. Large amounts of material extracted from the natural context (stone quarries, gravel, sand pits, wood from forests etc.) causes wounds hard to heal the natural environment. Each of these interventions influence the humidity, air currents, ground water, fertile soil layer etc., which endangers the ecosystems on which acts costly. During the operation of the buildings are new factors pollutants, represented mainly by consumption and disposal of the use of conditional constructions (household waste and waste from residential construction, industrial, agricultural, etc).

4. CONCLUSIONS AND FUTURE DEVELOPMENTS

Concrete and reinforced concrete are the most commonly used and most reliable construction materials today. So the first step to avoid degradation typical as:

4.1. Using high-performance concrete

The polymer cement concrete with the addition of a material different organic macromolecular combination in the form of aqueous polymer solutions (made of different emulsion polymerisation of polymers: vinyl acetate, vinyl chloride, latex, etc.) or water-soluble colloid (polyvinyl alcohol and furfuryl water-soluble epoxy resins, polyamide resins, and urea-formaldehyde). Additions are introduced to the concrete mix during its preparation.

The polymer cement concrete is characterized by the presence of two active components - the mineral binder and the organic. The binder in combination with water form cement stone, which sticks the particles of aggregate in a monolit concrete.

In order to increase mechanical strength of concrete and mortars in preparation is used as an additive various different fiber lengths and thicknesses. As a result, the polymer cement concrete acquires a greater resistance to stretching and bending strength as compared with ordinary concrete.

The additives used in the polymer cement concrete are rubber latexes and emulsions of polyvinyl acetate (in an amount of 5 ... 25% of the mass of cement calculated on a dry weight basis) and the water-soluble resin (0.5 ... 2% cement mass).

Fibers for concrete reinforcement are dispersed from different materials: polypropylene, polyethylene, nylon, acrylic, polyester, cotton, asbestos, glass, steel, carbon, polyamide, viscose, basalt etc. For example, concrete reinforced with steel fiber reduces the amount of compaction of 20-25% cracking, fiber polymer - 60-90%, in comparison with the conventional steel mesh, which decreases only by 6%.

4.2. Using non-corrosive fittings

The use of non-corrosive reinforcement is an effective way to prevent corrosion in aggressive chemical agents. They are already available:
- Fittings in stainless steel;
- Non-metallic reinforcements made of fiberglass, aramid or carbon fibers.

Stainless steel fittings have become commercially available and competitively priced. As reinforcement corrosion is the main problem of corrosion of reinforced concrete production at reasonable prices can revolutionize steel reinforcement corrosion problems in harsh environments.

Stainless steel can be used together with ordinary steel for the reinforcement of concrete elements without the risk of galvanic corrosion caused by bi-metal action. The explanation is that the two types of steel span nearly the same electrochemical potential when the concrete is poured. This finding has practical significance, since the possibility of arming local attest stainless steel parts exposed to agresivity.Armatures from nonmetallic fibers in turn can provide similar performance in terms of resistance to corrosion.

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