

Resistance of Concrete and Cement to Chemical and Aggressive Environments

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Annotation: The resistance of the cement mortar to aggressive influences, when exposed to air, lime becomes denser due to gas formation in the air, the durability of the garage erected in the building. It has also been found that exposure to harmful exhaust gases increases, usually in wet conditions.

Keywords: Cement mortar, aggressive action, acid, carbonic acid, carbonization, tubular pores, crystalline hydrate, calcium hydroxide.

The rate of degradation as a result of sulfate corrosion of cement depends on the amount of sulfates in the water and the mineralogical composition of the clinker. There is no clear data in the literature on the effect of S_3S and S_2S content of clinker on cement resistance in sulfated waters. Some studies have shown that with an increase in S_2S , the resistance of cement to sulfated water increases due to a decrease in $Ca(ON)_2$. As a result, calcium hydroaluminate dissolves and combines with calcium sulfate in solution, while the cement stone does not break down. In such a solution, calcium hydroaluminate is insoluble and remains solid. This causes the cement to break down.

The opinion of some researchers

Alkaline solutions with very high concentrations break down the cement. Some researchers believe that with an increase in S_3S , the resistance of cement stone to sulfate corrosion increases.

However, this phenomenon is not due to the deterioration of the conditions necessary for the formation of calcium hydrosulfoaluminate, but due to

the fact that the cement stone, which has a high content of S_3S in the clinker, hardens and condenses much faster. As a result, the infiltration of sulphate water into the cement stone slows down and the mechanical resistance to its degradation increases as the volume of calcium hydrosulfoaluminate expands.

There is a general idea about the effect of the amount of tri-calcium aluminate on the sulfate corrosion resistance of cement stone: As the amount of S_3A increases, the sulfate resistance of the cement decreases. Cement is less resistant to sulfate when the water contains a lot of sulfates.

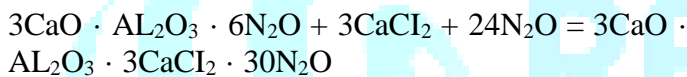
Thus, ettringite is formed when the concentration of calcium hydrate oxide is at least 1.08 g / l (0.4 ... 0.46 g / l in relation to CaO) and in the presence of four and three calcium hydroaluminates. Formed in ettringite liquid at lower concentrations of $Ca(ON)_2$, the cement does not cause the concrete to break down. The corrosion protection effect of hydraulic joints is based on this method.

If the cement contains hydraulic additives, it will slow down the corrosion of the alkali. $Ca(ON)_2$ can form poorly soluble calcium hydrosilicate with compound sand-soil, as well as the hydraulic compound can interact with three calcium hydroaluminates to convert it to low-base aluminate. At the same time, the formation of dangerous "cement bacilli" is not allowed.

The active sand (silicon oxide) in the hydraulic compound reacts with calcium oxide to reduce the

concentration of the aquatic environment from 1.2 ... 1.3 to 0.06 ... 0.08 g / l in terms of SaO. Therefore, solutions of CaSO₄, Na₂SO₄ and MgSO₃ with a concentration of up to 0.5% are not dangerous for concretes made of puttsolan portland cement. The presence of NaCl, SaCl₂, and other salts in the composition of these sulfates reduces the aggressive effect of the former.

Thus, solutions of salts containing Cl⁻ and SO₄⁻ ions have an aggressive effect on portland cement, and therefore they must be present in a certain amount in water (environment). The amount of one ion allowed varies depending on the amount of the second ion. For example, with the increase of Cl⁻ ions, the allowable SO₄⁻ ions also increase; the chloride ion absorbs a portion of the calcium oxide and converts it into an insoluble compound such as 3 calcium aluminate (by the following reaction):



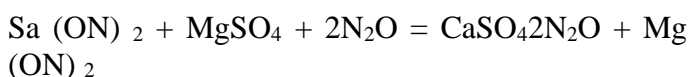
A 0.5% concentrated solution of MgSO₄ starts concrete made of puttsolan portland cement only at the expense of magnesium corrosion.

Magnesium corrosion. Such corrosion is caused by the action of magnesium salts other than

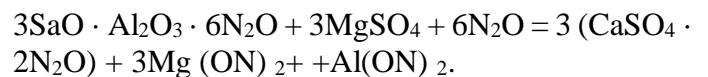


The result is amorphous magnesium hydrate oxide and calcium chloride, which is easily washed off with filter water and is very soluble. Mg(ON)₂ is sparingly soluble in water. It converts solid Ca(ON)₂ crystals into a soft mass that does not coalesce. It also has no binding properties. Hydrosilicates and hydroaluminates can also decompose under the influence of MgCl₂. Corrosion under the influence of MgSI₂ increases as the concentration of this salt in water exceeds 1.5 ... 2%. Such water is not considered aggressive when the amount of Mg₂ + ions in water reaches 0.5g / l.

Sulfate-magnesium corrosion. This type of corrosion occurs under the influence of MgSO₄ solution:



As a result, the molten lime is reduced, thereby calcium hydrosilicate and hydroaluminates begin to decompose. The amorphous substance Mg(ON)₂, which does not have binding properties, either remains where it is formed, or is washed away from the cement stone. Further, MgSO₄ interacts with three calcium hydroaluminates to break it down to aluminum hydrate oxide;



Previously, the formation of 2 molecules of aqueous gypsum with a mass of porous Mg(ON)₂ had a very bad effect on maintaining the integrity of cement and concrete. The addition of reaction 2 makes the process worse. When SO₄⁻ is present in MgCl₂ salts and the amount of SO₄⁻ ions is high, the effect of magnesium ions is strong. Therefore, the allowable amount of ions is reduced accordingly with the increase of Mg₂ + ions.

For Portland cement-based concretes, the amount of Mg₂ + ions in the aqueous medium should not exceed 5 g per liter, regardless of the amount of SO₄⁻ ions present.

Cement stone does not always break down under the influence of saline solutions containing SO₄⁻ and Cl⁻ ions. In the initial period of exchange reactions or when the amount of ions indicated is low, these reactions may result in the cement stone becoming denser and its filtering ability loosening. This involves low-solubility products of metabolic reactions, such as calcium sulfate and magnesium hydrate oxide, which completely seal the pores and prevent aggressive water from penetrating the cementite. However, this phenomenon is not due to the deterioration of the conditions necessary for the formation of calcium hydrosulfoaluminate, but due to the fact that the cement stone, which has a high content of S₃S in the clinker, hardens and condenses much faster. As a result, the infiltration of sulphate water into the cement stone slows down and the mechanical resistance to its degradation increases as the volume of calcium hydrosulfoaluminate expands.

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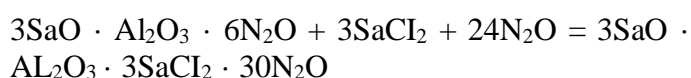
resistance of cement stone: As the amount of S_3A increases, the sulfate resistance of the cement decreases. Cement is less resistant to sulfate when the water contains a lot of sulfates.

Thus, ettringite is formed when the concentration of calcium hydrate oxide is at least 1.08 g / l (0.4 ... 0.46 g / l in relation to SaO) and in the presence of four and three calcium hydroaluminates. Formed in ettringite liquid at lower concentrations of $Sa(ON)_2$, the cement does not cause the concrete to break down. The corrosion protection effect of hydraulic joints is based on this method.

If the cement contains hydraulic additives, it will slow down the corrosion of the alkali. $Sa(ON)_2$ can form poorly soluble calcium hydrosilicate with compound sand-soil, as well as the hydraulic compound can interact with three calcium hydroaluminates to convert it to low-base aluminate. At the same time, the formation of dangerous "cement bacilli" is not allowed.

The active sand (silicon oxide) in the hydraulic compound reacts with calcium oxide to reduce the concentration of the aquatic environment from 1.2 ... 1.3 to 0.06 ... 0.08 g / l in terms of SaO . Therefore, solutions of $CaSO_4$, Na_2SO_4 and $MgSO_3$ with a concentration of up to 0.5% are not dangerous for concretes made of puttsolan portland cement. The presence of $NaCl$, $SaCl_2$, and other salts in the composition of these sulfates reduces the aggressive effect of the former.

Thus, solutions of salts containing Cl^- and SO_4^- ions have an aggressive effect on portland cement, and therefore they must be present in a certain amount in water (environment). The amount of one ion allowed varies depending on the amount of the second ion. For example, with the increase of Cl^- ions, the allowable SO_4^- ions also increase; the chloride ion absorbs a portion of the calcium oxide and converts it into an insoluble compound such as 3 calcium aluminate (by the following reaction):



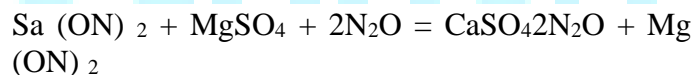
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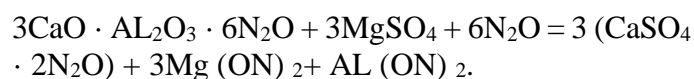
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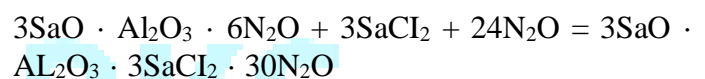
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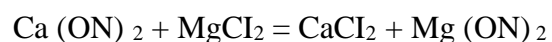
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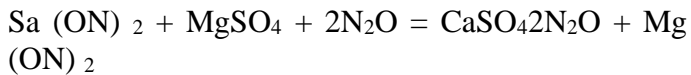
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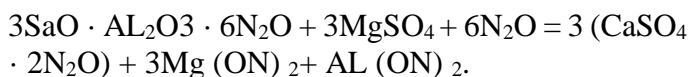


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All types of corrosion seen so far are chemically formed. Physical corrosion processes can also occur in cement stone. This can occur due to the occasional wetting, drying and swelling (deformation) of cement and concrete, and the accumulation of soluble salts due to evaporation of water in the cement pits, as well

as freezing and thawing of water-saturated concrete. Especially in cement and concrete pits, as well as in tubular capillaries, as a result of the transition of salts to crystal hydrates, the walls of the pits and capillaries are subjected to a large compressive force.

Concrete has the following soluble salts at a concentration of 5% for 3 months; The crystallization pressure of Na_2SO_4 , $MgSO_4$, $NaCl$, $CaSO_4$ as a result of decomposition and bonding is 0.44; 0.36; 0.20; 9 MPa, respectively.

Cementstone and concrete may also contain salt that has accumulated due to chemical corrosion in microclimates and capillaries - it is two molecules of aqueous gypsum and hydrosulfoaluminate. The degradation of concrete under its influence was discussed above. Such corrosion is common in Central Asia and the Republic of Kazakhstan. Salts such as Na_2SO_4 , $MgSO_4 \cdot N_2O$ are transferred from anhydrous, low-water, hydrated salts to multi-hydrated salts

($Na_2SO_4 \cdot 10N_2O$; $MgSO_4 \cdot 7N_2O$, etc.) in cement and concrete pits at such unfavorable times of temperature and humidity.

This rotation process increases the volume of solid phases by 1.5 ... 3 times, which creates tensile MPa pressure on the concrete surface and creates strong deformations.

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