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ON CARBONATION CORROSION OF MODIFIED CONCRETES USING MICROWAVES

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Abstract: Carbonation of concrete is one of the main factors affecting its durability and structural integrity. This research work provides some analysis on the effect of mineral microtschliers on the carbonation process of modified concrete.

Key words: concrete, cement, carbonation of corrosion, microtschliers, modification.

The concentration of carbon dioxide in the Earth's atmosphere is not considered to be very high and is 0.03—0.045% (300-450 ppm) in dry air.

In the XIX century, there was a progressive increase in anthropogenic emissions of carbonate anhydride into the atmosphere, which led to a violation of the carbon cycle and an increase in the concentration of CO₂ (Fig. 1) [1].



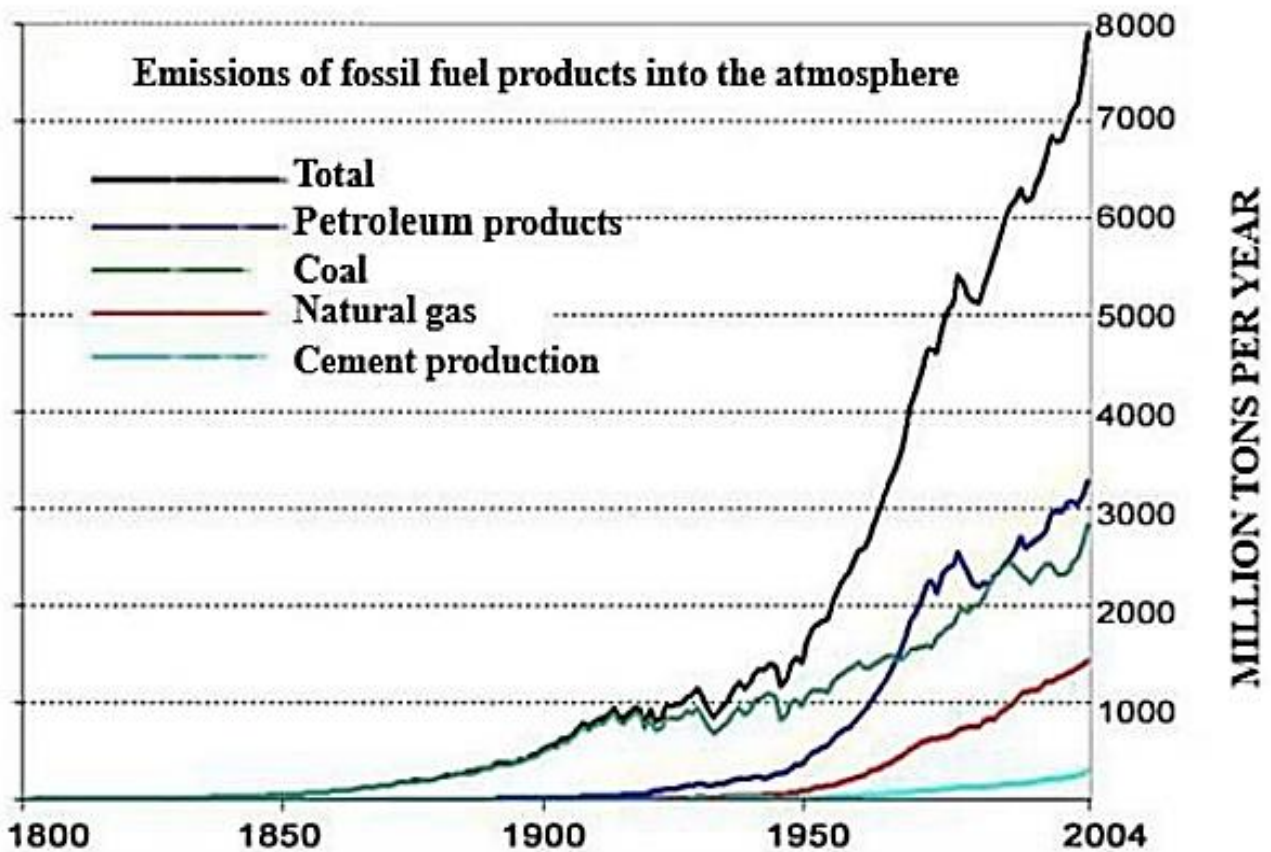


Figure 1. Emissions of carbon emissions into the atmosphere as a result of industrial activity in 1800-2004

In modern times, the concentration of carbon dioxide continues to grow steadily, in 2009, the average concentration of CO₂ in the Earth's atmosphere was 0.0387% or 387 ppm, and this cohort amounted to 400 ppm in September 2016 (Figure 2) [1].

Global Distribution of Atmospheric Carbon Dioxide
NOAA ESRL Carbon Cycle

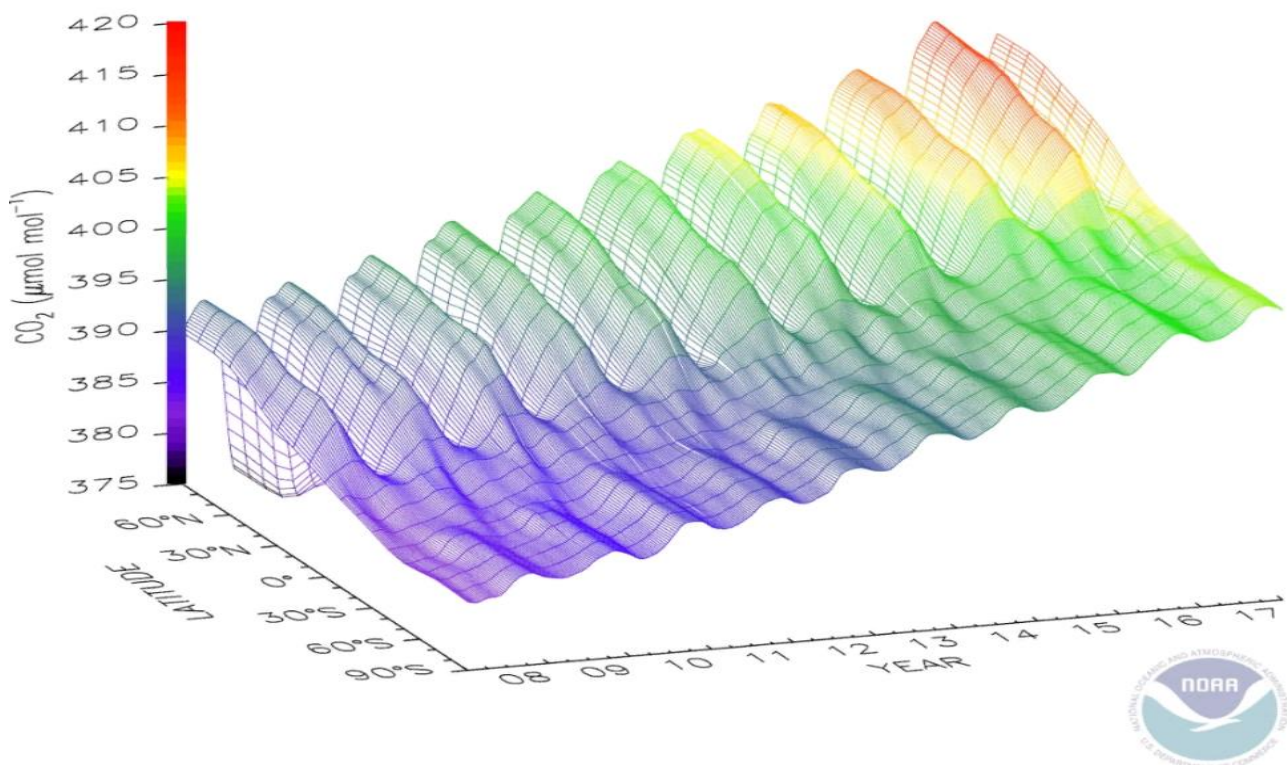


Figure 2. Seasonal fluctuations in the time interval from 2005 to 2014 and variations in this latitude of carbon dioxide concentration

Because the concentration of carbon dioxide in the air is 10 to 104 times higher than the concentration of other gases, reinforced concrete structures applied in the air environment are subject to the action of this acidic gas. The main process of neutralization of concrete is carbonization. In rural areas, the amount of carbon dioxide can reach 600 mg/m³, while in urban conditions this value is 0.3% or 6000 mg/m³. In some industrial areas, the value of carbon dioxide can reach -1%.

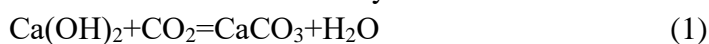
The concrete has a porous structure that adsorbs well the carbon dioxide, oxygen and moisture present in the atmosphere. The absorption capacity of concrete has a detrimental effect on the reinforcement, it enters the acidic environment when the concrete is damaged and causes the corrosion process to occur. The rust formed during the oxidation of the reinforcement increases its volume and the internal tension increases, and leads to the destruction of the concrete, as well as the opening of the corroded reinforcement. The open fittings are impregnated even faster, which causes the reinforced concrete structure to lose its very fast operating properties.

Carbon dioxide CO₂ present in the atmosphere is exposed to moisture, interacting with the hydrolysis products of clinker minerals and cement Stone Minerals.

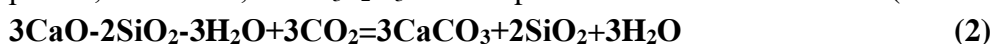
This interaction also occurs at a low concentration of CO₂ in the atmosphere, where the partial pressure can be about 3x10⁻⁵ MPA, and in a non-ventilated room up to 12x10⁻⁵MPA.

Under the influence of CO₂, carbonation of Ca(OH)₂ (calcium hydroxide) concrete to CaCO₃ (calcium carbonate) occurs. These reactions can occur at low concentrations of CO₂ in the atmosphere, but the depth of carbonation is of little value and gradually increases over time. The degree of carbonation increases with an increase in the concentration of CO₂ in the air. The carbonation of concrete and cement stone depends on many external and internal factors: relative humidity of atmospheric air, permeability and porosity of the material, temperature, pressure, hydration conditions and moisture content of cement stone.

The interaction of calcium hydroxide with carbon dioxide is characterized by the following reaction:



Hydrate new minerals of cement stone can also undergo carbonization, and the final products of the reaction are a whole complex of various substances: calcium carbonate, hydrated silicate and aluminate phases, iron oxide, etc. C₃S₂H₃ the complete carbonation reaction of (tobermorite) may look like this:



It should be noted that carbonation of concrete has a positive effect on its strength, since the water solubility of CaCO₃ is 100 times lower than the solubility of Ca(OH)₂. The washing process of alkali in such concrete is much slower. Calcium carbonate is difficult to dissolve in water and tends to hermetically close pores on the concrete surface when formed. Carbonation plays a positive role until it reaches the deeper layers of concrete that come into contact with the steel reinforcement surface. The negative consequences of carbonation in deep areas are associated with a decrease in its alkalinity and the loss of the chemical properties of concrete, which prevents corrosion of steel reinforcement [3].

The lime formed during the hydrolysis of cement creates an alkaline environment in concrete with a high pH=12-14 (hydrogen index of porous moisture of cement stone). Typically, the pH value of porous water in concrete lies in the range from 10.5 to 11.5. Lime is neutralized by the formation of calcium carbonate, which reduces the pH from 12.6 to 10 (for calcium carbonate) and drops below 10 for the combined calcium bicarbonate Ca(HCO₃) mixture of calcium carbonate. Many researchers claim that as soon as the pH of the concrete drops below 10 conditionally, it loses its ability to reliably protect the reinforcement from corrosion. According to several scientists, the critical limit of the minimum pH value for concrete is indicated as 11.8.



The rate of carbonization of concrete to a greater extent depends on the structure and composition of the concrete, especially the dimensions of the capillary pores, the structure of the hydrate phases, and the ability to react with CO_2 . Basically it is characterized by the content of calcium hydroxide $\text{Ca}(\text{OH})_2$ in concrete.

Schissel's research [4] shows that the type and composition of cement in concrete (whether or not there is an active additive) affects both the ability to bind carbon dioxide and the diffusion resistance to its penetration. The more alkaline hydration products in concrete, the more CO_2 can be bonded, and the carbonation facade penetrates deeper into concrete. According to Meyer [5] and Maekawa [6, 7], the carbonation rate of concrete increases from an average of 1.2 times (15% when using a microwave) to 2 times (75% when filling with a microwave-slackportlandtsement) during the transition from Portland to active additive Portland. Meanwhile, S.N.Alekseev [2] and M.Hamad [3] studies cite that Portland cement-based concrete has the lowest carbonation depth, an active microwave and sulfate-resistant cement-based concrete average, a binder containing 50-80%.

It is also worth noting that the effect of active mineral microwaves on carbonization kinetics, which are used in the composition of cement Composites, has not been sufficiently studied. An important issue is the study of the effect of the use of additives of different natures in cement content on the level of carbonization, taking into account the above.

References

1. https://ru.wikipedia.org/wiki/Углекислый_газ_в_атмосфере_Земли.
2. Alekseev, S.N. Corrosion and protection of reinforcement in concrete / S.N. Alekseev. - M.: Publishing House of literature on construction, 1968. - 230 p.
3. Hamada, M. Carbonation of concrete and corrosion of reinforcing steel (main report) / M. Hamada // The Fifth International Congress on Cement Chemistry / Sokr. Trans. from English. Edited by O.P. Mchedlov-Petrosyan et al. - M.: Stroyizdat -1973.-pp.306-307.
4. Ishida, T. Theoretically Identified Strong Coupling of Carbonation Rate and Thermodynamic Moisture States in Micropores of Concrete / T. Ishida, K. Maekawa and M. Soltani // Journal of Advanced Concrete Technology Vol. 2, No. 2, p.p.213-222, June 2004 / Copyright © 2004 Japan Concrete Institute.
5. Maekawa, K. Multi-scale Modeling of Concrete Performance. Integrated Material and Structural Mechanics / K. Maekawa, T. Ishida, T. Kishi // Journal of Advanced Concrete Technology Vol. 1, No. 2, p.p. 91-126, June 2003 / Copyright © 2003 Japan Concrete Institut.
6. Tuutti K/ Corrosion of steel in concrete.-Swedish Cement and Concrete Research Institute.-1982.
7. Wiering H.J. Longtime Studies on the Carbonation of Concrete under Normal Outdoor Exposure/RILEM - Seminar Durability of Concrete Structures Under Normal Outdoor Conditions, Hannover, 1984, p.p.104-108.

