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Збірник містить тези доповідей науковців вищих навчальних закладів України та інших країн, підприємств транспортної та будівельної галузі за трьома напрямками: залізниці, автомобільні дороги, промисловий транспорт і геодезичне забезпечення; будівельні конструкції, будівлі та споруди; будівельні матеріали, захист і ремонт конструкцій та споруд.

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The proceedings include abstracts of presentations by researchers from higher education institutions in Ukraine and other countries, as well as representatives of enterprises in the transport and construction industries. The topics are organized into three main areas: railways, highways, industrial transport, and geodetic support; building structures, buildings, and facilities; and construction materials, including the protection and repair of structures and facilities.

СЕКЦІЯ
БУДІВЕЛЬНІ МАТЕРІАЛИ, ЗАХИСТ І РЕМОНТ КОНСТРУКЦІЙ ТА СПОРУД

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THE INFLUENCE OF CARBONATE ADDITIVES ON THE FORMATION OF THE STRUCTURE OF CEMENT STONE

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Concrete and reinforced concrete hydraulic structures located in marine areas and transport structures where road salt is regularly used are exposed to chlorides. As is known, chlorides are hazardous substances for concrete structures, as they accelerate the corrosion processes of steel reinforcement. Penetration of chlorides into concrete leads to a series of chemical reactions that cause corrosion of reinforcement and, ultimately, destruction of concrete. Understanding the mechanisms of chloride penetration into concrete, the mechanisms of chloride corrosion and the development of appropriate protection strategies are key tasks in the context of durability and operational safety of the mentioned structures.

The presence of chloride ions in reinforced concrete leads to the destruction of the passivation layer of reinforcing bars; to the decrease in the pH of the pore solution, since the solubility of calcium hydroxide decreases; to the increase in humidity due to the absorption properties of salts in concrete; and an increase in the electrical conductivity of concrete [1, 2].

There are conflicting data in various literature sources on the effect of carbonate admixtures on chloride penetration in concrete. Research [3] shows that the more limestone powder in concrete, the faster chloride ions penetrate into it. Limestone powder increases the content of capillary pores, which is the main factor affecting the rate of diffusion of chloride ions in concrete. In turn, other studies discussed in the literature have shown that the penetration of chloride ions is significantly reduced when using mineral additives in concrete production, including calcium carbonates [4].

It is reliably known that chloride ions bind to ordinary Portland cement paste and thus change its mineralogy. Chloride ions entering the cement system displace sulfates from the monosulfoaluminate, thereby forming Kusel's salt at lower chloride concentrations and Friedel's salt at higher concentrations. The released sulfate ions react with calcium and aluminum. This leads to the formation of ettringite, which usually causes volume expansion but also seals the pores. In the presence of carbonate additives, chloride ions displace carbonate from the monocarboaluminate

phase and thus form Friedel's salt [5-6]. Carbonate-containing systems and conventional systems have their advantages and disadvantages. Carbonate suppresses the potentially expansive chloride penetration reactions, but at the same time reduces the overall chloride binding capacity and increases the Cl-/OH- ratio in water [5].

Samples of cement-sand mortar were studied using Portland cement without additives and Portland cement with limestone as a binder. The samples were placed in solutions with different chloride concentrations. As a result of the studies, it was found that the depth of chloride penetration in all samples, as expected, varies depending on the concentration of the solution in which the samples were stored. Changing the composition of the cement did not lead to a significant change in the depth of chloride penetration. It can be concluded that the structure of the material still determines the penetration of chlorides. Although the addition of carbonates will affect the composition of the hydration products of the cement stone, it will not slow down the penetration process at high chloride concentrations. To learn more about this topic, studies are needed to detect additional hydration products and analyze their effect on chloride penetration. It is necessary to analyze individual hydration products and determine which of them affect the spread of chlorides. It is also necessary to conduct a detailed analysis of the structure of the cement stone and assess how the combined change in the mineral composition of hydration products and the capillary-porous structure will affect the permeability of the cement composite for chlorides.

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