CORROSION PROTECTION PROPERTIES OF LOW-DENSITY CONCRETE CELLULAR GROUT FOR STEEL SURFACES

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Low density cellular concrete grout (LDCCG) has been used as a filler material in the annulus space between the steel final liner and the initial tunnel support. LDCCG is a mix of cement, fly ash grout, and a foaming agent and was investigated to characterize corrosion behavior of embedded steel by determining the permeability of four different cellular grout mixes, and compared to a standard grout, to chloride penetration.

Four mixes of cellular grout (Mix 3, Mix 10, Mix 10+Inhibitor and Mix 11)and one standard grout were tested using two experiments: pressurized with representation chlorides to service conditions (Pressurized Test) and ambient pressure with elevated chlorides (Ambient Test). The Pressurized Test was conducted at a pressure of 50 psig with 3,000 mg/kg (ppm) chloride solution. The Ambient Test was conducted at ambient pressure with 50,000 ppm chloride solution. The Pressurized Test results indicate that higher water-cement ratio LDCCG Mix-10, Mix-10+Inhibitor, and Mix-11 are more prone to chloride penetration due largely to permeation while lower water-cement ratio grouts such as Mix-3 and Standard Grout are more resistant to chloride penetration due to permeation.

The Ambient Test indicated chloride transport, largely due to diffusion, was greatest in LDCCG Mix-10, Mix-10+Inhibitor, and Mix-11 followed by Mix-3 and Standard Grout. The electrochemical corrosion potential (ECP) measurements for the embedded steel electrical resistance (ER) probes exposed in the Ambient Test indicated that Mix-10, Mix-10+Inhibitor, and Mix-3 were below the ASTM C876 potential of –350 mV v. CSE, indicating active corrosion. Mix-11 and Standard Grout initially follows the same trend, but recovers (repassivates) after approximately 45 days of exposure. The electrical resistance (ER) readings did not provide statistically significant and measurable corrosion since general corrosion rates were low. The linear polarization resistance (LPR) measurements indicate low corrosion damage accumulations. Based on the electrochemical measurements, Standard grout provided the most corrosion protection followed by LDCCG Mix-11, Mix-10+Inhibitor, Mix-10, and Mix-3.