Feature Articles

Successful Electroshock Therapy for Deteriorated Bridges

Dwight E. Robinson

A team of research and development employees of the State Highway Commission of Kansas are exploring a new method of removing chlorides from bridge decks in an effort to eliminate concrete deterioration caused by deicing chemicals.

Developing the electro-osmosis technique as a research project has been a cooperative effort by Garrett L. Morrison, research geologist, Yash Paul Virmani, research chemist, Wayne Stratton, maintenance and materials development engineer, Carl Crumpton, assistant engineer of research planning and development, and John Bukovatz, concrete research engineer.

Also included in the objective of the project is the possibility of moving a polymer (form of plastic) into the concrete to fill the voids created by removal of the chlorides.

The theory that direct electrical current will pass through concrete was first attempted in the laboratory. A reinforced concrete block made with saltwater was cast in the lab to use in the experiment. A number of people have used the electro-osmosis principle to move water through different types of soils, but many believe that concrete will not conduct electricity. The Kansas concrete electro-osmosis research team felt that concrete and soils would react similarly and that the unwanted chloride solution in bridge decks would act as a conductor of electricity in the bridge deck.

Ions (charged atoms), which are part of the molecular makeup of all matter, have either positive or negative charges, and these ions will move when they are subjected to a charge of electricity. Positive ions will move toward a negative electrical pole, and negative ions will move toward the positive pole. Chlorides are negative ions.

The top surface of the concrete slab was covered with a copper screen to form a positive electrode. The reinforcing bars in the concrete were used as the negative pole. A direct electrical current was then applied to the electrodes. The negatively charged chloride ion in the water in the concrete block was then attracted to the positive pole formed by the copper screen at the top of the block. The tests showed the chloride water in the concrete slab was drawn to the surface.

A number of materials were used in the lab to fill the pores (voids through which the chlorides are withdrawn), but none proved completely successful. The placement of a material in the pores is an important part of the project to prevent the concrete from taking on more chlorides after further deicing applications.

A work program was set up to conduct the experiment on a bridge that had been subjected to deicing chemicals. The bridge recently replaced by a relocation of US-24 at Tonganoxie was selected.

A 3 x 4-ft (0.9 x 1.2-m) copper screen was placed on the bridge, and a gasoline-powered generator was used for the electrical power source. Direct current was attached to the bridge in the same manner as in the lab experiment, and the chloride was removed successfully.

The experiment to fill the pores (voids) was started.

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The method used for the filling of voids was basically the same as the withdrawal method except in this procedure a liquid with positive ions (polymer) was used on the copper screen to move it toward the negative poles, which were the reinforcing bars near the bottom of the bridge deck.

Furfuryl alcohol, which is made from oat hulls and corn cobs, was used as the polymer. A catalyst was added to the furfuryl alcohol. The electrical charge was transmitted through the liquid, forcing it to move into the pores of the concrete toward the negative poles. Heat created in the concrete from the electricity conducted through the concrete caused the polymer to become a solid plastic-like material. Tests show the electrical charge raised the heat of the bridge deck to approximately 175 F (80 C). Core tests showed that the polymer was moved to a depth of 15 in. (38.1 cm) into the bridge deck, which was the level of the bottom reinforcing steel.

Kansas is believed to be the only state at the present time to be researching the electro-osmosis technique for the removal of chloride from concrete and the emplacement of sealants. Concrete deterioration caused by deicing chemicals is a national problem, which has not been solved. An inexpensive method that would successfully eliminate this would result in the savings of millions of dollars a year on bridge repairs throughout the nation.

Will Gilliland operates the transformer used to regulate electrical current in bridge deck for removing chloride.