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ABSTRACT

Traditionally, removing ice from pavement can be accomplished by a combination of several methods, such as plowing, natural melting, traffic movement, and chemical treatment. Because the bond between ice and pavement is strong, removal by plowing alone is not effective. Chemical treatment helps break the bond by melting into the ice and spreading under the ice layer. Most highway winter maintenance depends on using chemicals and fine granular particles as a primary means for deicing. However, using deicing chemicals and salt has caused damage to concrete and corrosion of reinforcing bars in concrete bridge decks which is partially responsible for the rapid deterioration of the transportation infrastructure in the U.S. The search for improved deicing methods has been a research focus for quite some time. The use of electric heating cables and heated fluid in pipes have been attempted, however, those techniques were too expensive to operate and difficult to maintain.

Conductive concrete is produced by adding electrically conductive components to a regular concrete mix to attain stable electrical conductivity. Due to its electrical resistance, a thin layer of conductive concrete can generate enough heat to prevent ice formation on concrete pavement when connected to a power source. A concrete mix containing 1.5 percent of steel fibers and 25 percent of steel shavings by volume was developed specifically for concrete bridge deck deicing. The mix has adequate strength and provides a thermal power density of 600 W/m^2, producing a heating rate of 0.25^{o}C/min under subfreezing temperature. The average energy cost was about \$0.8/m^2 per snow storm. A comparison of conductive concrete technology against other deicing technologies in the literature has revealed that it has the potential to become the most cost-effective deicing technology in the future.

This research project has national and international implications. Statistics indicate that 10 to 15 percent of all roadway accidents are directly related to weather conditions. This percentage alone represents thousands of human injuries and deaths and millions of dollars in property damage annually. Ice accumulation on paved surfaces is not merely a concern for motorists; ice accumulation on pedestrian walkways accounts for numerous personal injuries, due to slipping and falling. The conductive concrete deicing technology is readily available for implementation at accident-prone areas such as bridge overpasses, exit ramps, airport runways, street intersections, sidewalks, and driveways.

During development of the conductive concrete, several drawbacks about using steel shavings in the mix were noticed. Carbon and graphite products were subsequently used to replace steel shavings in the conductive concrete design. The electrical conductivity and the associated heating rate were improved with the carbon products. A conductive concrete deck has been implemented for deicing on a highway bridge at Roca, located about 24 km (15 miles) south of Lincoln, Nebraska. The Roca Spur Bridge has a 46 m long and 11 m wide conductive concrete deck overlay. The Roca Bridge project was let in December 2001 and construction completed in November 2002. The overlay has been instrumented with temperature and current sensors to provide data for heating performance monitoring during winter storms. Experimental data and operating costs are presented in this report.

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