Rowan University
CENTER FOR RESEARCH & EDUCATION IN
ADVANCED TRANSPORTATION ENGINEERING SYSTEMS

ERDC

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CWCC-ERDC
Technical Brief

Cold Weather Conductive Concrete

Background

Electrically conductive concrete is an emerging technology used to melt snow and prevent ice formation on pavements. When connected to a power source, conductive materials within the concrete allow electrical current to pass and generate heat through Joule heating. This can improve safety on roadways, airfields, bridges, and parking facilities while reducing the need for heavy snow removal equipment. Conductive additives such as steel fibers, carbon fibers, graphite, and carbon particles lower the electrical resistivity of conventional concrete. Recent studies suggest that carbon-based materials can achieve similar conductivity with smaller amounts than steel fiber. However, conductive concrete has not been fully developed for placement and curing in below-freezing conditions. Additive-based freeze protection can lower the freezing point of concrete and accelerate hydration at low temperatures. Combining these technologies creates Cold Weather Conductive Concrete (CWCC), which can be placed and cured at -5°C (23°F) while providing long term snow-melting and de-icing capabilities.

Research Objectives and Approach

This project focuses on the laboratory development of CWCC. The study determines the best means of conductivity for cold weather concrete by evaluating different electrically conductive additives. It measures how these additives affect workability, strength gain, electrical resistivity, and heating capacity. The mechanical properties of each mixture are also tested to determine whether CWCC can meet performance requirements. Durability testing is conducted to evaluate its resistance to cold-weather exposure. The results are used to identify the conductive mixture with the best overall performance for de-icing and snow melting applications.

Direct Benefit to Military Engineering

Cold weather conductive concrete provides a practical method for keeping military airfields, runways, and pavements clear during winter conditions. Unlike conventional snow removal, this approach can reduce the need for snowplows, de-icing chemicals, and extensive manpower. Heated pavement can improve safety and help maintain access to critical infrastructure, supporting military readiness. Reducing chemical use can also limit concrete deterioration and corrosion of steel reinforcement. This may extend the service life of airfield pavements, bridge decks, roadways, and drainage systems.

Conclusions and Recommendations

Experimental results show that CWCC can achieve adequate strength, durability, and heating performance when cast and cured at -5°C (23°F). The mixture containing 1% carbon

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fiber produced the best overall results, reaching a 28-day compressive strength of 6,470 psi and flexural strength of 1,060 psi. It also achieved a slant shear strength of 3,320 psi. All mixtures showed no visible deterioration after 300 freeze-thaw cycles. When subjected to 40 VAC the carbon-fiber slab increased in temperature from −5°C to above 16°C within 30 minutes. Although carbon fiber improved strength and heating capacity, it reduced concrete workability. Future research should focus on improving workability and verifying laboratory results through field trials. Additional simulations should determine the energy demand, electrode spacing power level, and operating time required for full-scale pavement systems.

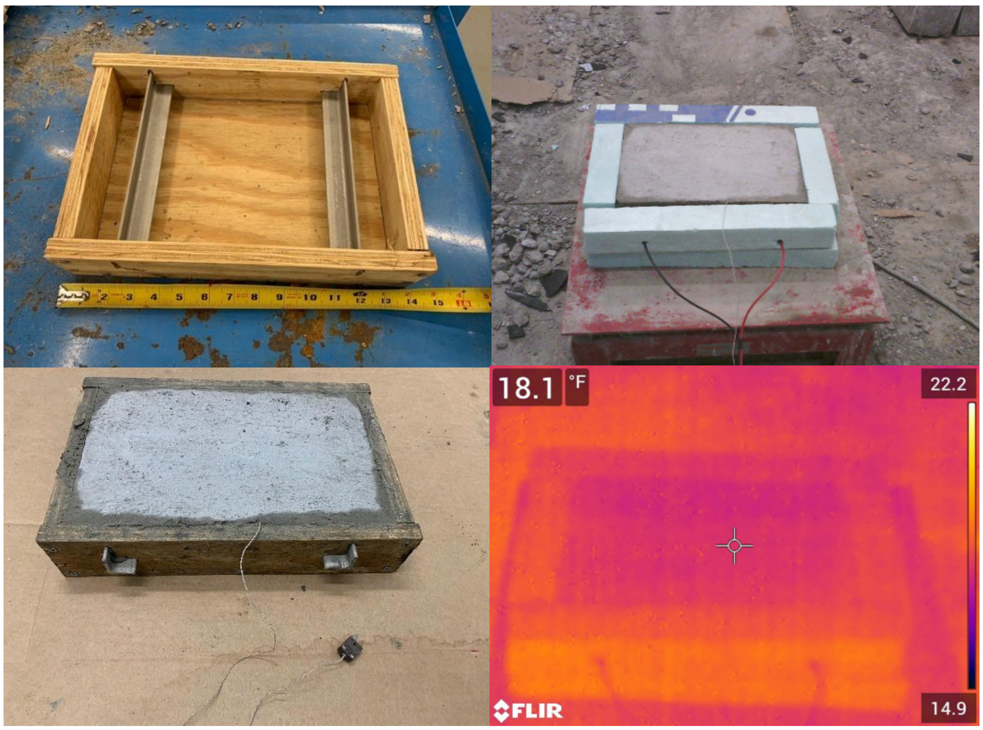

Figure 1. Cold Weather Conductive Concrete performance: (left) preparation and casting of CWCC test slabs; (right) thermal images showing slab surface temperatures during 30 minutes of heating under 40 VAC

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