Electrically Conductive Concrete

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Electrically Conductive Concrete

- Definition
  - Chopped Carbon Fiber (CCF)
  - Resistive heating
Problem

- Ice and snow build-up
  - driving hazards
  - traffic and time delays
History and Past Projects

- Sodium chloride
  - Pros
    - Inexpensive
    - Simple application
  - Cons
    - Ruins groundwater and vegetation
    - Corrosion of reinforcing bars
    - Concrete surface damage
History and Past Projects (cont’d)

• Heating cables
  ➢ Pros
    ➢ Effective deicing
  ➢ Cons
    ➢ Traffic disturbances
    ➢ High energy costs

• Heating Pipes
  ➢ Pros
    ➢ Effective deicing
  ➢ Cons
    ➢Leaks lead to almost impossible maintenance
    ➢ Complex and costly
Purpose

- Solving the de-icing problem
- Achieving and maintaining cost efficiency
- Reduce damage and maintenance to concrete and environment
Scope

- Investigation into conductive concrete’s:
  - Resistive properties
  - Heating properties
Design of System

Sample Design

Thermocouple

Electrode slots

Regular mortar upper layer

Conductive mortar middle layer

Regular mortar bottom layer

10,000
5,000
3,000
3,000

10,000
15,000
0.125
Design of System (cont’d)

- Two types of electrodes
  - Zinc Perforated Metal Sheets (a)
  - Aluminum Mesh (b)
Procedures

- Resistivity Testing
  - Two point probe method
  - Input: voltage
  - Output: current readings
  - \( V = I \times R \)
  - Slope: resistance

- Heating Testing
  - Heating and Cooling
  - Temperature and current readings
Resistivity Results

Average Resistance (Ohms) vs. % CCF by Mass of Cement

- Resistance (Ω)
- % CCF by Mass of Cement

Graph showing the relationship between resistance and % CCF by mass of cement.
Resistivity Results (cont’d)

Resistance (Ohms) vs. % CCF by Mass of Cement

% CCF by Mass Cement

Resistance (Ω)

0 50 100 150 200 250 300 350 400 450 500

0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80

Civil & Environmental Engineering
Problem

- Due to the unexpected high amount of resistance encountered when the sample was frozen, which did not occur when the sample was at room temperature, a heating and cooling test were done to investigate the relationship between temperature and resistance.
Cooling Results

![Graph showing cooling results with two markers for different CCF levels.](image)
Example of mortar blocks in a freezer
Discussion

• Resistive Testing

  ➢ Correlation

  ➢ Inversely proportional relationship between resistance and percentage of CCF

  ➢ Increase in CCF triggers a decrease in resistance and increase in current
Discussion (cont’d)

• Heating Testing

➤ Problem

➤ Resistance too high (quadrupled)

➤ Only .05 A and 1 W power output with 20 V input

➤ Correlation: Inversely proportional relationship between temperature and resistance
Future Work

• Design better concrete system to solve resistance problem in the heating test
• Various course aggregates and admixtures
• Sonication and compaction
  – eliminate entrapped air bubbles in non-solidified concrete mixtures

Fly Ash
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