Conductive Concrete Overlay for Bridge Deck Deicing

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Acknowledgment

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Outline

• Background
• What is Conductive Concrete
• Conductive Concrete Mix Design
  – Mixing Procedure
  – Implementation Projects
    • Construction
    • Operation
• Modified Mix at Western Michigan University
• Concluding Remarks
• Questions
Background

Existing Deicing Methods

- Deicing Chemicals
- Insulation against Freezing

Background

Heating Systems

Approximate Cost

$5/ft²

Electric Cables in the Bridge Approach
Roadway, Newark, New Jersey 1961

Background

Heating Systems

Approximate Cost

$16/ft²

Deck Heating System on Approaches of a Pedestrian Overpass in Lincoln, NE, 1993
Background

Heating Systems

Deck Heating System in the Buffalo River Bridge, Amherst, Virginia, 1996

Approximate Cost

$35/ft²

Conductive Concrete

- What is Conductive Concrete?
- Conductive Concrete Applications

Conductive Concrete Mix Design

The Conductive Concrete Mix Contains:
- Carbon & Graphite Products
- Steel Fiber

In addition to cement, fly ash, silica fume, sand, coarse aggregate, water, and superplasticizer
Mixing Procedure
(Mass production)
Mixing procedure (Mass Production)

Implementation Projects

• Test section on I-480 Missouri River Bridge, 1999
• Implementation Project at Shelby City, OH, 2001
• Roca Spur Bridge, Roca Nebraska, 2002
Implementation Project

Material evaluation - Durability test (I-480 Patch) under traffic load and freeze-and-thaw action. Poured on December 3, 1999

Test section on I-480 Missouri River Bridge using conductive concrete mix.
Implementation Project

at

Shelby City, OH

September 2001

Temperature Sensors

Site Before Casting Concrete
Implementation Project - Roca Spur Bridge

- Roca, located about 15 miles south of Lincoln, Nebraska
- The Roca Spur Bridge is a three-span slab type bridge has a 45.70m (150 ft) long and 11m (36 ft) wide concrete deck
- The Bridge has a 36 m (117 ft) long and 8.5 m (28 ft) wide conductive concrete inlay
- The inlay consists of 52 individual 1.2m × 4.1m (4 ft × 14 ft) conductive concrete slabs
Working with Ready Mix Concrete – Lincoln, NE
Mixing Procedure

- The conductive concrete mix with steel fibers and carbon and graphite products was used to cast the inlay
- Several, two cubic yards, trial batches were prepared to examine the mixing procedure and travel time from the mixing plant to the job site
- The contractor and the pouring and finishing crews practiced at a test site
**Temperature Time History - Dec. 17, 2003**

**Stability of Electrical Conductivity**

**Modified Conductive Concrete Mix Developed at WMU**

- The main objective of this research project is to make the conductive concrete an economical viable deicing method. This can be achieved by the following:
  - Reduction of the operating voltage and current requirements.
  - Development of a simplified mix procedure
Conductive Concrete Mix
Developed at WMU

- Optimization and mix proportioning
- Evaluation of the mechanical properties of the optimized mix
- Investigation of an electric model for the optimized mix

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**Comparison of all Slabs Temperature readings**

Temp vs Time

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**Temperature vs. Time Using Different Voltage Values**
Concluding Remarks

- The conductive concrete deicing technology can be readily implemented at accident-prone areas such as bridge overpasses, exit ramps, airport runways, street intersections, sidewalks, and driveways.
- The heated bridge deck of Roca Spur Bridge is the first implementation in the world of using conductive concrete for highway bridge deicing.

Concluding Remarks

- The initial results showed that the modified conductive concrete mix which was developed at Western Michigan University has the potential to be used for bridge deck deicing application as well as the proposed new applications including Electromagnetic Shielding and Cathodic protection of reinforcement.

Questions