

TPF Studies>>>Detailed View

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Title: Investigation of Jointed Plain Concrete Pavement Deterioration at Joints and the Potential Contribution of Deicing Chemicals
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Background: Problem Description:
A recently completed study SD2002-01 Investigation of the Long Term Effects of Magnesium Chloride and other Concentrated Salt Solutions on Pavement and Structural Portland Cement Concrete conducted by Michigan Technological University identified several chemical and physical mechanisms which can lead to concrete deterioration over an extended period of time due to repeated exposure to concentrated deicing solutions. One of the tasks in the study was to determine the life cycle cost implications of exposure to various deicing chemicals for pavements and structures. Unfortunately, this task was not accomplished as field evidence of deterioration was lacking, as was documentation of deicer usage. The field investigations consisted of coring various pavements and structures and were mostly completed in 2002. Follow-up work was done on several promising sites in 2005 which yielded compelling evidence of deicer-induced damage but the deicing history for the sites was ambiguous. Overall, the evidence suggested that potential impacts to concrete from winter maintenance practices utilizing concentrated deicers are slow to develop and insufficient time may have passed to yield a clear picture of deterioration.

Interestingly, during the last several years, a problem has arisen of national significance involving severe deterioration of concrete joints on many pavements in states where deicing chemicals are routinely used. Although no cause and effect has been determined, the relatively recent switch to concentrated deicing chemicals such as sodium and magnesium chloride brines coincides with the development of these joint problems and may be a primary contributor to the distress. The characteristics of the distress are often anomalous compared to known distress mechanisms and manifest in a way consistent with the deterioration mechanisms identified in the above research project.

The goal of this research project is to investigate the causes of this joint deterioration, estimate impacts based on an understanding of the problem and to develop repair, material and construction strategies to minimize the sources.

Objectives:

Research Objectives:

1. To determine the causes of anomalous concrete joint deterioration nationwide.
2. To quantify any contributions to joint deterioration due to deicing chemicals and develop estimates of service reduction and life cycle costs.
3. To develop recommendations based on research results for minimizing future joint deterioration on both existing pavements and new construction including possible repair methodologies and specification modifications.

Scope of Work:

Research Tasks:

1. Perform a literature search on the incidence of PCC joint deterioration nationwide and any proximate causes.
2. Conduct a survey of states and Canadian provinces to determine the incidence of joint deterioration, collect available information on possible causes, including construction practices, maintenance and repair activities, current deicing/anti-icing practices and other concrete performance issues. Distribute the survey, after a panel review of the draft, to obtain suitable information for use in conducting the research.
3. Select appropriate locations for coring and extensive concrete analysis based on survey results and panel input. Each participating state will provide a list of at least two potential sites, including a control, for consideration at the

meeting outlined in Task 4. Documentation provided for each site will include age and service history, concrete mix design, aggregate characterization (coarse and fine), method of curing, deicer types and application history, sealant, climatic conditions and the presence and type of any concrete surface treatments.

4. Meet with the technical panel four months after initiation of the project to discuss the project scope and finalize the list of coring locations and develop a sampling plan for each.

5. Examine concrete field samples that will be obtained by the state DOT's, with the cooperation of the researchers, using appropriate test methods to determine concrete quality, hardened air content, permeability, possible mechanisms of deterioration and any effects due to various deicers including a chemical analyses of the cement paste for chloride, sodium and magnesium ions in the top and bottom portion of each specimen (estimated xx cores).

6. Develop a laboratory testing plan, based on any evidence obtained from field cores, designed to duplicate, in an accelerated fashion, the joint deterioration process, or processes, emphasizing any chemical or mechanical agencies which may be involved.

7. Provide an interim report summarizing the results obtained from completing the above tasks and outlining necessary further laboratory testing of both field and laboratory specimens, both to demonstrate any mechanisms thought to cause joint deterioration and to validate proposed methods to repair damage in existing concrete and mitigate any future damage in new concrete.

8. Meet with the technical panel at the researcher's facility to review the interim report and scope of work prior to approval for further testing.

9. Conduct the second phase of laboratory testing to demonstrate joint deterioration by under controlled conditions.

10. Develop joint repair guidelines based on the field and laboratory results and any input from state DOT's as to successful repair strategies.

11. Develop general guidelines for current practices, which will insure minimal damage to concrete pavements and structures while allowing the ongoing application of appropriate liquid deicers if they are implicated in the deterioration.

12. Estimate effects on concrete life and performance characteristics based on the utilization of different deicers and proposed

mechanisms of deterioration with various concrete types using available deicer application strategies and develop life cycle cost analyses derived from the research results.

13. Prepare a final report and executive summary of the literature review, research methodology, findings, conclusions, guidelines and recommendations.

14. Make an executive presentation to the research panel and provide each panel member with an MS PowerPoint version of the presentation after submission of the final report.

15. Make an executive presentation to the SDDOT Research Review Board summarizing the findings and conclusions.

Comments:

The scope of work indicated here is preliminary only. The actual scope of work will be developed by a technical panel of states' technical representatives to the project.

A commitment of \$15,000 per year for 4 years from at least 10 states is requested.