Using Road Weather Information Systems to Control Load Restrictions

project summary

Aurora

working to advance road weather information systems technology

RESEARCH PROJECT TITLE
Using Road Weather Information Systems (RWIS) to Control Load Restrictions on Gravel and Surface-Treated Highways–Aurora Project 2005-05

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ABOUT AURORA
Aurora is an international partnership of public agencies performing joint research, evaluation, and deployment initiatives related to road weather information systems (RWIS).

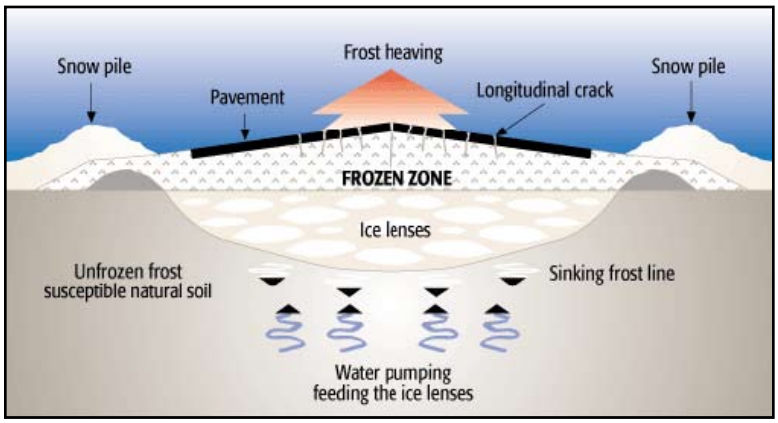
www.aurora-program.org

Objective

The main intent of this research was to examine how the use of a predictor for frost formation and thawing could improve the scheduling of load restrictions by tracking the frost-strengthening and thaw-weakening of the pavement structure.

Problem Statement

Northern Ontario's secondary highways are challenged by a combination of heavy, low frequency traffic loading and a high number of freeze-thaw cycles for which most of these highways have not been structurally designed. Therefore they experience environmental damage and premature traffic-induced deterioration.



Frost heave in the pavement structure

To cope with this issue, the Ontario Ministry of Transportation places Spring Load Restrictions (SLR) every year during spring thaw. For economic reasons, the duration of SLRs is usually fixed in advance and is not applied proactively or according to conditions in a particular year. This rigidity in the schedule needs to be addressed, as it can translate into economic losses either when the payload is unnecessarily restricted or when pavement deterioration occurs.

The transportation and resources industries are penalized when the payload is unnecessarily restricted and maintenance expenses increase

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when fully loaded trucks are allowed on a weakened pavement. This problem can be further compounded by enforcement related issues such as the five-day notice traditionally given to the trucking industry to disseminate the information and abide by the weight restrictions. There is therefore a need to assist policy makers on when to enforce and lift SLR and Winter Weight Premiums (WWP).

Technology Description

Minnesota, Manitoba and Quebec have developed jurisdiction-specific models able to relate air temperatures to freezing and thawing indices and to the depth of frost in the pavement. Inspired by this approach, the first phase of this project adapted the empirical model to Ontario conditions and related the amount of frost in the pavement structure to RWIS environmental data. As a follow-up to this preliminary analysis, the model was further developed during the second phase of the project.

Two sites located in Northwestern and Northeastern Ontario respectively (and both low-volume roads subject to SLR) were selected in fall 2005.

The research carried out thus focused on proposing a model coherent with the data collected as well as on developing a calibration that could be used to calibrate the model to any site once field data is gathered. Also, along with troubleshooting work, further plans were made in close collaboration with the Ministry of Transportation (MTO) to replace the failing devices and equip additional sites with similar installations.

Northwestern experimental site

Key Findings

Analysis of relative pavement performance indicated that in general, longer periods of load restrictions could protect the pavement infrastructure and that better scheduling could result in up to six years additional service life for the pavement. The greatest gain (based on IRI, longitudinal cracking or total rutting) was obtained with either a four or five-month SLR period. As longer SLR periods might not have an overall economic benefit, shorter periods costs should be balanced against road user benefits. Moreover, the historical analysis showed that load restrictions should imperatively be in place during April, as it appears to be the major contributor to pavement preservation.

Implementation Benefits

In the long term, the information gathered in this study can be derived into automatic algorithms and coupled with life cycle cost analysis to find a good balance between the economic needs of the transportation industries and the level of serviceability of each roadway. Also, provided the frequency of magnitude changes does not exceed a workable rate for the truckers and that continuous movement is allowed on common freight routes, restrictions could be removed on certain roads of the network each time conditions would warrant. This strategy would provide Northern Ontario with means of estimating optimal schedules for the enforcement and removal of load restrictions or overloads on the low-volume road network.

Implementation Recommendations

Rational determination of seasonal load limits should use thaw and frost depth criteria to set the timing of SLR and WWP application, while the limit magnitude required to keep the damage to that normally experienced by the pavement should be derived from a structural analysis carried out on representative test sections. Moreover, such limits could be adjusted periodically on each road if pavement strength is measured on-site and over time, by means of portable falling weight deflectometer (FWD) equipment, for example.