# SPRING LOAD RESTRICTIONS

## *Improving Minnesota's Policy*

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Spring is a critical period for highways in freeze–thaw environments; the freeze–thaw cycle allows water to be trapped between pavement layers and leads to weakened roads. Spring load restrictions (SLRs) must be implemented as a pavement preservation strategy and means for protecting the public investment. It is important to post SLRs when they will be most effective—at the beginning of the thaw when the base layer is less stiff. Proper measurement and prediction of thaws are crucial to establishing a successful load restriction strategy. The Minnesota Department of Transportation (Mn/DOT) recently implemented a more effective SLR strategy.

### Problem

In Minnesota, SLRs affect significantly more miles of the local highway system (97 percent of the 30,300 miles) than the state trunk highway system (13 percent of 11,900 miles). Counties, townships, and municipalities are required to follow state recommendations on load restriction start and end dates—dates that previously have been subjective and sometimes ineffective.

Mn/DOT last revised its SLR procedure in 1986. The procedure involved monitoring conditions that indicate the potential for spring load-related damage, such as movement and seeping water near cracks, thaw depth measurements with frost tubes or probe rods in shoulders, and weather conditions and forecasts. The guidelines for lifting the load restrictions were based in part on deflection measurements. However, basing the end of SLRs on deflection measurements was not practical, since many roads required weekly testing.

Minnesota places SLRs by zones (Figure 1). Once it was determined that SLRs should be placed in a certain zone, a 7-day notice was given to the public. However, some SLRs were posted 7 to 10 days too late, resulting in damage that required early maintenance and reconstruction; this added direct costs to the state and local governments. Also, users bore the costs associated with vehicle damage, increased travel times on deteriorated pavement, and lost time from construction detours. The duration of the SLRs varied each year—SLRs generally started between March 9 and March 18 and lasted from 7 to 9 weeks, depending on the conditions of the roadways.

### Solution

Mn/DOT began conducting a study in 1996 that focused on evaluating previous SLR policy and recommending ways to improve it. Improvements were based on enhanced predictive methods for determining when to apply SLRs. The final report was completed in 2000 (authors can provide information on obtaining copies).

A research review revealed that the Washington State Department of Transportation had developed a method for determining the timing for SLRs. The method was based on the cumulative thawing index (TI), a parameter that depends on the air temperature and that can be determined from the following equation:

TI = Summation (Average Daily Temperature – Reference Temperature)

According to this procedure, SLRs would apply when the TI reaches 15°C- to 30°C-days (25°F- to 50°F-days).

Adjusting the reference temperature makes the spring-thaw predictions more accurate. The revised Mn/DOT equation uses a reference temperature that decreases 0.56°C (1°F) per week during February and March to account for increased solar radiation as the sun moves higher in the sky. The TI was calibrated using frost and temperature sensor data from the Minnesota Road Research Project (Mn/ROAD).


FIGURE 1 Minnesota's SLR zones.

The predicted and actual SLR placement dates were compared with data obtained from falling weight deflectometer (FWD) and in situ instrumentation at Mn/ROAD. FWD results from the low-volume road at Mn/ROAD showed that the deflections increased dramatically as the thawing index reached 15°C- to 30°C-days (25°F- to 50°F-days). The deflections also showed that for roads with plastic subgrade soils, recovery takes place slowly and continues throughout the entire summer. When posting dates predicted with the revised equation were compared with historical postings from 1986 through 1998, the data confirmed that there was typically a week or more delay from the time SLRs should have been placed.

As a result of the study, the duration of SLRs is currently fixed at 8 weeks to allow the roadbed to recover most of its strength and for transporters to plan for the end of SLR.

## Benefits

Improved load restrictions should result in substantial savings—approximately 39,000 miles of paved roads in Minnesota are subject to SLRs; the majority of these are paved with hot-mix asphalt (HMA). The time before the first HMA overlay, between multiple overlays, and in the total life of the pavements is reduced if excessive damage occurs in the spring. Research has demonstrated that a delay in the start of SLRs may lead to the need for a first overlay one-year earlier and to complete reconstruction after 32 years instead of the projected 35 years. These shortened periods would raise the annual road cost from $12,000 to about $12,500 per mile per year—therefore, the improved timing of SLRs will result in a savings of $500 per mile per year. Considering the number of miles of restricted roads that are most likely to sustain spring damage (approximately 29,000 miles of the 39,000 total miles of paved roads in Minnesota), an annual cost savings of about $15 million would be expected. However, quantifying the financial and economic affects of SLRs requires a comprehensive cost–benefit study; this was one of the primary recommendations of the Minnesota Legislature's SLR Task Force.

The research has enabled more accurate predictions of when the spring-thaw weakening will occur based on the air temperatures recorded and forecasted for most areas of Minnesota. In addition to benefiting the local road network, the research results are also useful for Minnesota's trunk highway system. For example, Mn/DOT allows a 10 percent load increase during winter, when the ground is frozen; this load increase should be removed before weakening is expected. Also, Mn/DOT grants special overload permits for some unique loads; the strength of the roadway during the winter and spring must be considered to avoid excessive damage. The benefits and costs associated with SLRs will be quantified further through cooperative research efforts by Mn/DOT, other state DOTs, and several Canadian provinces.

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EDITOR'S NOTE: *Appreciation is expressed to Amir N. Hanna and Inam Jawed, Transportation Research Board, for their efforts in developing this article.*

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 2101 Constitution Avenue, NW, Washington, DC 20418 (telephone 202-334-2952, e-mail gjayapra@nas.edu).