Evaluation of Pavement Impacts of Senate Bill 506

The Pavement Engineering Unit at WisDOT was asked to provide an assessment of the impact of allowing vehicles involved in highway construction and maintenance activities to exceed normal weight limits. In general, this proposal has negative impact on the life of a pavement structure. Considering the huge volume of this traffic, this impact could be very serious.

Background

Roads are built to carry cars and trucks. Each time a vehicle drives over a pavement, its weight causes a slight deflection in the structure. Over the years, and thousands of loads, a road, just like a piece of metal being bent back and forth repeatedly, will fatigue and break.

These loads are measured in terms of their effect on the roadway. The unit of measure is the "Equivalent Single Axle Load" or ESAL. One ESAL is the amount of damage done by an 18,000-pound load being carried by a single axle. All other load and axle configurations are calculated based on this factor. It should be noted that the relationship between load and ESAL are not linear. As weight increases, the load factors increase even faster.

Pavement Structure Analysis

There are several tools available to engineers to evaluate pavement structures to determine load-carrying capabilities. The Pavement Engineering Unit used the AASHTO 1986 Design Guide to provide basic data for the analysis.

This analysis indicated, that depending on the basic pavement structure, the load conveyed, and the configuration of on the vehicle, an increase of 15-45% in loading on the road would occur. This comes from a change in load carrying capacity of 0-12%.

For example, a fully loaded common dump truck carrying a 15-ton load currently has a limit of 13,000 pounds on the steering axle and 34,000 pounds on the tandem rear axle group. This generates 1.79 ESALs for a typical pavement group (asphalt SN of 3 and Pt=2.5). If the proposed legislation were enacted, the rear tandem axle could carry 37,000 pounds (a load of 16.5 tons). The new ESAL factor would be 2.33, or an increase of 30% for an increase of load of 10%.

Another way of looking at this is to assume that we have 165 tons of material to move. In the current regulation, this would require 11 trucks. The subsequent load factor for those eleven trucks is 19.69 ESALs (11 * 1.79). In the proposed legislation, that same move would require 10 trucks causing 23.30 ESALs of damage. The same load is conveyed, but 18% more damage occurs on the pavement.

Cost Analysis

Evaluation of cost impacts in this type of analysis is difficult. In order to do this type of analysis with precision, we would need to know the number and loading of vehicles before and after these changes, the general type of road they would be operating on, and the number of miles of road impacted. This level of data is rarely if ever available.

When this type of exemption is typically requested, it is for a very limited population of vehicles operating over a very limited type of roadway. In those cases, estimates are easily made and the evaluation is relatively straightforward.

In this case, however, the number of vehicles and roadways impacted are enormous. Thousands of these vehicles operate on just about every mile of road in the state. However, with some basic assumptions, realistic impacts can be assessed.

To illustrate the effect of this proposal, assume that we have a highway construction job that requires the movement of 100,000 tons of material (soil, rock, paving material, etc.) to the job site 5 miles distant (on average) from suppliers, traveling on a typical rural state trunk highway.

Under the current legislation, this job would require about 6665 truckloads and the effective damage would be 11,930 ESALs. Using the higher payload in the proposed legislation, the job would require 6060 truckloads, but the ESAL loading would be 14,120 ESALs. The difference in impact would be 2,190 ESALs.

A typical rural highway is costs about $500,000 per mile and is expected to convey 350,000 ESALs over a life of 15 years. The impact of the 2190 ESALs is small (less than 1% of the pavement life), but when multiplied by the cost of the road and the miles impacted, the cost of the legislative change would amount to over $15,000.

The example above is a simple illustration of the problem. It shows that overall global impacts are going to be quite illusive to determine due to the highly variable nature of the jobs impacted. But if we assume that the relatively modest project in the example is representative of all jobs in the state, we would conclude that every 100,000 tons of road building material transported on and off a job, it will have an negative impact of $15,000 on pavement structures. There are literally millions of tons of material conveyed for road building annually. Even the modest costs indicated here become quite large when the volume of material transported is considered. Because of this, the negative impacts will be quite large.

Work Zone Impacts

All of the discussion above relates to "typical" pavements and load configurations. The impact of these higher loads would be substantially greater as the quality of the roadway pavement decreases.

One aspect of road construction as it is currently practiced is that the work is done "under traffic". Temporary roads, driving on shoulders and other temporary expediencies are the rule. These temporary roads are built or improved to last only during the course of the construction. They are to convey the construction traffic as well as normal traffic through their life.

If we are to consider higher weight limits for construction vehicles, we will also need to accommodate additional costs for temporary roads and shoulder improvements. Once again, realistic cost impacts are difficult to develop, but they could potentially be very serious.

Safety Considerations

As a final note, some trucks may not be rated by their manufacturer to handle loads outlined in the proposed legislation. Some consideration should be included to insure that construction vehicles have the proper weight limitations as defined in the manufacturer's specifications.