TECHNICAL BRIEF

Estimate of Annual Studded Tire Damage to Concrete Pavements

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Washington State
Department of Transportation

Construction Division
State Materials Laboratory

Summary: A new estimate of the damage from studded tires to WSDOT's concrete pavement reveals an estimated damage rate of $12,000,000 to $18,000,000 per year.

Estimate of Annual Studded Tire Damage to Concrete Pavements

That studded tires damage pavements is without question. How much damage, and at what rate the damage occurs, is more difficult to quantify. WSDOT has approximately 2,400 lane-miles of concrete pavement, comprising 13% of the state road network. Studded tire damage, most obvious in the form of ruts in the wheel paths, is a chronic problem. In order to estimate how much damage occurs annually, rut depth data from the Washington State Pavement Management System (WSPMS) was reviewed. Using the current age since pavement construction, and the current rut depth in a uniform section of road, the average rate of rut depth wear can be estimated (expressed in terms of mm/year). (This data is plotted in Figure 1.)

Figure 1 shows that wear rates are initially high (as the paste, a mixture of Portland cement and fine aggregate, wears first). Wear rates gradually slow over time as the harder aggregates are exposed by the studded tires. This plot is for average statewide conditions, and represents data from the survey lane (typically lane 1, or lane 2 if more than 3 lanes in each direction). The use of data from lane 1 (the slow lane) may be conservative, because often more severe ruts occur in lane 2 where more automobile traffic is concentrated.

The average rate of rut wear per year for concrete pavements is estimated as 0.2 to 0.3 mm/year from the data in the attached figure. This average is weighted by lane-miles, considers all concrete pavements and does not consider local conditions. For example, Eastern Washington has experienced faster rates of wear because of softer aggregates, but traffic volumes in Eastern Washington are lower (which would reduce the wear rate). The average is a blend of all statewide conditions.

At the 0.3 mm/year wear rate, an average concrete pavement would experience a 12.5 mm rut (½") in about 40 years. The ½" (12.5mm) rut depth is the current action level to begin programming a project to remove the rutting through concrete pavement grinding. Given a concrete network of 2,400 lane-miles, and 40 years to develop ruts that would require grinding, generates an estimated average of 60 lane-miles per year of grinding.

Grinding of severe ruts in one lane usually requires transition grinding in both adjacent (transverse) lanes, as well as longitudinally. For this reason, a factor of 1.5 (a 50% increase) in the grinding area is assumed as a construction requirement. This would result in 60 x 1.5, or 90 lane-miles of grinding estimated per year. At an estimated unit cost of $200,000 per lane-mile (all-inclusive cost including traffic control, sales tax, etc.), this results in approximately $18 M per year or repair work due to studded tire wear on concrete pavements. A similar calculation for the 0.2 mm/year wear rate provides approximately $12 M per year of repair work due to studded tire wear on concrete pavements.

In order to verify the reasonableness of this estimate, a comparison was made with a completely different analysis that was performed in 2010 as part of the State Materials Lab Proviso report to the Washington State Legislature. This analysis was a comprehensive 10-year evaluation of concrete pavement rehabilitation and reconstruction needs for the WSDOT network. The table below is a copy of Table 5-1 from page 40 of the Proviso report. It shows the estimated construction requirements over the next 10 years, including 942 lane-miles of grinding. On average, this results in 94 lane-miles of grinding per year, which is very close to the 90 lane-miles per year in the estimate above.

The grinding required from Table 5-1 is not for rutting alone, but can also be triggered due to faulting if the pavement does not have severe cracking that would require panel replacement or reconstruction. So, the grinding due to rutting alone would be less than the total shown of 942 lane miles. However, some of the lane-miles due for reconstruction and panel replacement would also have severe ruts. These two factors tend to balance each other out: a) grinding due to faulting would reduce the cost of grinding associated with rutting, and b) rutting repaired by reconstruction would be construction costs associated with rutting that are not considered by grinding alone.

Table 5-1. WSDOT 10-year rehabilitation length summary for concrete pavements.

Length	**Grind**	**DBR**	**Reconstruction**	**Panel Replacement**
	(Lane-mile)	*(Lane-mile)*	*(Lane-mile)*	*(# of slabs)*
2011-2013	497.3	31.2	92.5	4009
2014-2020	445.2	38.4	152.1	2257
10-Year total	942.4	69.7	244.6	6266

The costs of rut wear on concrete pavements are estimated to be $12 M to $18 M per year. This is calculated from the cost of grinding alone, estimating 90 lane-miles per year. In comparison, a separate 10-year estimate of concrete needs determined a grinding need of 94 lane-miles per year. Even though these were different evaluations, the fact that the construction cost is relatively similar helps to validate the simple estimate. Note that the impacts to traffic due to studded tire damage to pavements have not been evaluated in this analysis.

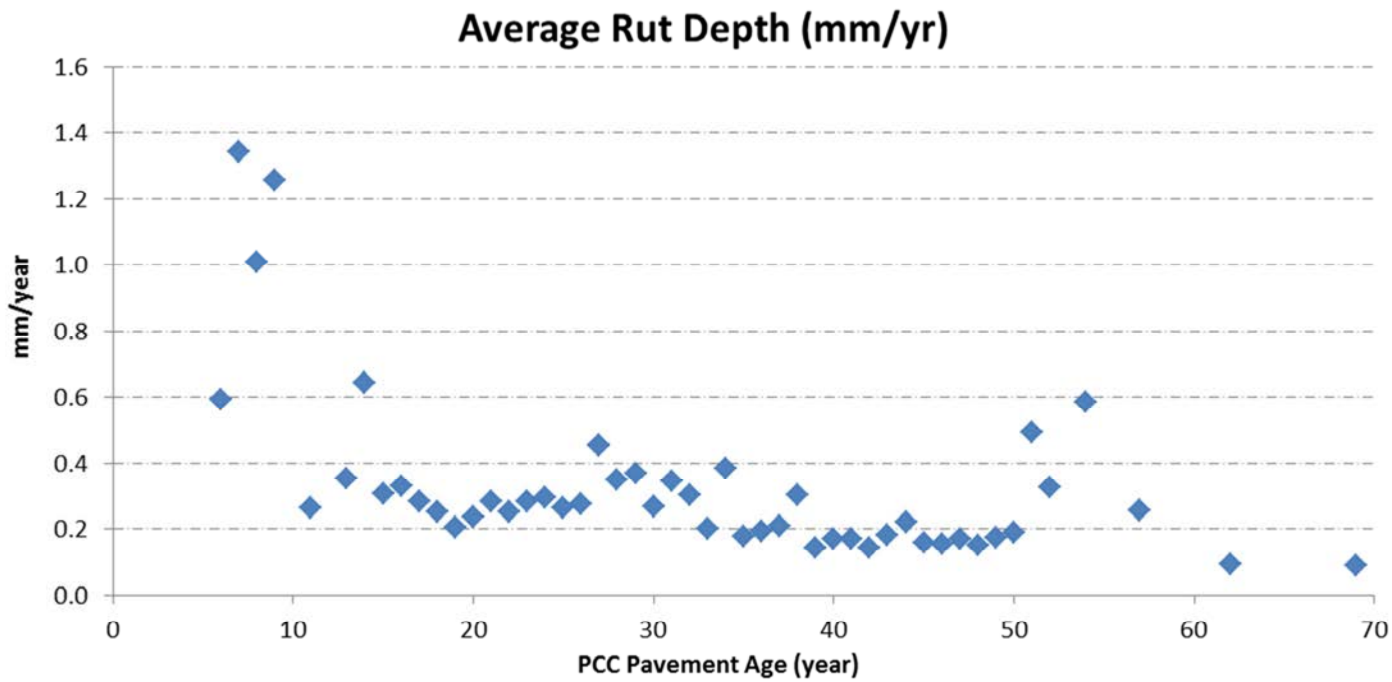

Figure 1: Plot of average rut depth increase per year (vertical scale, in mm/year) to time (horizontal scale, in years) for concrete pavements.

In the early years of a concrete pavement, studded tires grind away the paste (Portland cement and fine aggregate) at an aggressive rate (0 to 20 years) The paste eventually wears down to the coarse aggregate (between 20 and 30 years) and the per year stud wear slows down.