

CROSSROADS



WISCONSIN TRANSPORTATION INFORMATION CENTER – LTAP at the University of Wisconsin–Madison

Road weight study provides answers



The road weight study measured the seasonal effect of vehicle loads among other factors. Rutting failure on the 3.5-inch thick asphalt section above occurred during a spring test period when temperatures were hot and the pavement base and subgrade close to fully saturated.

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OFFICIALS WHO MANAGE local roads in rural areas recognize the impact large farm equipment can have on asphalt pavements and aggregate shoulders. As farms and the vehicles that carry their loads get bigger, the risk of damage to town roads is greater.

Now road officials know for a fact that heavy agricultural loads can do more harm to pavements than an 80,000-pound semi-truck. That finding comes from a report released last year on a pavement performance study conducted at MnROAD, the Minnesota research facility.

The study provides local and state transportation agencies with information about how heavy farm vehicles put stresses and strains on the roads they travel. It also recommends actions local governments and the agricultural industry can take to minimize damage.

Unique collaboration

Proponents say this newest study on road weight, titled *Effects of Implements of Husbandry (Farm Equipment) on Pavement Performance*, provides more useful data than previous research.

Kevin Erb, Conservation Professional Development Specialist in the Green Bay office of the University of Wisconsin-Extension (UWEX), works with agricultural businesses that haul manure and other farm materials. He calls the three-year study unique because it looked at the problem of heavy loads from many perspectives. “It’s the only study of its kind that invited public agencies, industry and the companies that run the equipment to ask the same questions: *What can we do to minimize damage now and what innovations are on the horizon?*”

Study sponsors include state transportation departments in Minnesota, Wisconsin, Illinois and Iowa, equipment manufacturers, and industry partners representing agricultural trade associations from the Midwest.

Erb now includes study findings in his training programs and presentations. He highlights actions local governments, custom manure and forage haulers, and farmers can take to protect local roads. Along with other UWEX outreach professionals across the state, Erb also helps haulers and local road officials on joint efforts to implement road-saving alternatives like temporary one-way road patterns that allow heavy vehicles to travel in the middle of the road away from the weakest part of the pavement.

Farm loop

The study involved running selected farm equipment on different test sections at MnROAD, including two flexible pavement sections built at the Minnesota Department of Transportation (MnDOT) test track specifically for the study. One section had an asphalt pavement thickness of 3.5 inches on an 8-inch gravel base. The other had 5.5 inches on a 9-inch gravel base. The test sections replicate asphalt pavements found on some of the region’s newer low-volume rural county roads. Local road officials will recognize that these test sections are thicker than many of their town roads.



This tandem-axle semi truck with dual tires is one of two control vehicles the study researchers used to compare the impact on pavement performance of a fully loaded semi to that of the farm vehicles tested. Results showed the agricultural equipment consistently did more damage than the 18-wheelers.

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Severe run-off-the-road crashes account for a significant number of fatalities on Wisconsin's rural roads each year. Shoulder rumble strips, shown above, alert drivers to pull safely back into their travel lane.

Finally, because rumble strips can spook horses pulling buggies, Zogg says they will not install them on roadways in Amish communities.

Model for safety

With the pilot underway, WisDOT will review how rumble strips might affect state design standards and issue installation guidelines for public agencies and contractors. Zogg says the department is committed to adding rumbles where appropriate on all future state improvement projects and will continue working with the TOPS Lab to monitor the impact of the safety feature on crash types and frequency. WisDOT transportation planners will use the information from this pilot to determine how to balance application of this safety measure with other initiatives.

Zogg says when they embarked on the process of deciding which two-lane state roads would benefit most from rumble strip installation, WisDOT wanted to create a model for introducing safety counter-measures on state and local roads. "Relying on good data and good collaborations, we found a mix of projects I feel will tell us much more about how this application can make these and other roads safer." ■

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The study also measured results on two existing concrete sections.

Shongtao Dai, a MnDOT Research Operations Engineer involved in the study, says the dedicated asphalt road sections, known as the "farm loop," gave the researchers control over the tests, from construction and time-of-day traffic patterns to making detailed calculations of each vehicle tested. They installed electronic sensors in the test sections to monitor pavement responses under the test vehicles. Equipment companies participating in the study supplied farm vehicles and drivers. The tests took place in the spring and fall, times of the year when pavements often are at their weakest and the movement of farm equipment is heaviest.

Key study results

Besides confirming that a typical 5-axle, 80,000-pound semi when fully loaded produced lower sub-grade stresses than all the farm equipment tested, the study

posed questions that helped prove or disprove existing assumptions held by various road users and road managers.

Dr. Dai says results showed clearly that individual axle weight is more important than gross vehicle weight when it comes to pavement damage. Increasing the number of axles along with distributing the load evenly can reduce the impact.

Asphalt thickness made a huge difference. The test section with 3.5-inch design thickness had extensive structural failure and severe rutting early in the test while the 5.5-inch section did not experience any significant break down.

The research team found that paved shoulders reduce the potential for damage and provide more support when a large vehicle rides near the edge of the driving lane. Given this and the fact that roads are strongest at their center, the study recommends operators drive heavy equipment at least 16 inches away from the

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The road researchers used portable scales to measure the weight of all study vehicles at the start of each test period, as with this double-axle applicator. It was one of two applicators tested that produced some of the highest stresses and strains recorded.

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pavement edge and, where the shoulder is unpaved, get permission to travel down the middle of the road. On asphalt, the 16-inch offset reduced both asphalt strain and subgrade stress by more than 75 percent.

Some counties and towns in Wisconsin began to apply that idea last year with temporary one-way routes during manure hauling operations. See *related story on page 2*. Working with local governments to implement these measures, Erb learned several of them consider the approach a success and anticipate getting four or five more years of service out of their pavements as a result.

One assumption discounted by the study was that wider (flotation) tires decrease pavement damage. Installed on manure tankers and other equipment to reduce soil compaction in the field, the oversized tires tested actually produced contact pressure on road pavements similar to regular truck tires.

Towns’ perspective

Rick Stadelman of the Wisconsin Towns Association says the farm equipment study is validating discussions the Association has

had with its members for some time about the tendency of newer, heavier agricultural vehicles to accelerate the deterioration of asphalt pavements. Study data on tire type and weight per axle correspond with what local road officials are seeing in their jurisdictions.

“For many reasons, seasonal hauling of agricultural materials is more intense than in the past,” Stadelman says. “It’s critical that local governments have strategies for managing large equipment weight issues. There are practical ideas in this study many towns should be willing to try.” Towns are already initiating discussions with local farmers and haulers, he adds, implementing seasonal or special weight limits, developing an approval process for temporary traffic patterns and taking other actions.

More attention to local weight limits raises the issue of consistency. Stadelman says the Association encourages towns to prevent confusion by coordinating their rules with other local governments and avoid acrimony by treating all large loads—farm and forest—the same.

Other measures

Other measures are in use or under discussion by parties concerned with the issue of heavy ag equipment harming local roads. Some haulers are modifying the equipment they use to transfer large quantities of material from farm to field, especially as they learn more about the impact of the heavier equipment on the roads.

Farmers and towns are working together to install wider driveways with longer culverts that give large hauling vehicles more room to turn, minimizing their impact on pavement edge and shoulder. Erb says significant damage can occur as vehicles speed up and slow down so this modification helps. Another method the industry is adopting to avoid turns and keep from tracking mud onto the roads is to transfer loads in the field from semi-tankers to spreaders rather than transport a loaded spreader.

A method that circumvents town roads completely involves pumping the manure through pipes or flexible hoses threaded along ditches or running underneath roads. Some towns and counties in Wisconsin are starting to install dedicated under-pavement pipes or culverts to facilitate this type of transport.



Testers compared farm vehicles like this single-axle grain cart, loaded and empty, to measure pavement deflection and other results. The study found that individual axle weight mattered more than gross vehicle weight in causing pavement failure, suggesting the more axles, the better.

Building roads that can carry the heaviest loads without early failure is a long-term solution local governments need to consider, according to Stadelman. Recognizing the pressure on many towns to rebuild stronger to meet heavier agricultural and logging loads, he says the legislature allocated an additional \$10 million for the Town Road Improvement-Discretionary Funds in the last state budget specifically for improvements on roads damaged by or inadequate for heavy or high-volume traffic. The state awarded the funds in early April for this biennium.

Drivable and safe

The role of local governments is to make sure roads are available for all users. That means building road to meet local needs and keeping them in good shape, drivable and safe. It also means acting on opportunities to protect pavement life without unduly hampering local commerce.

Erb, Stadelman and others are in agreement that the farm equipment study provides local road officials, farmers and haulers with

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The study measured different load levels over five days of testing on the flexible pavement sections in each of the spring and fall test periods. Experienced drivers drove tankers like this one, empty and with loads at 25, 50, 80 and 100 percent capacity.

reasonable, fact-based recommendations for protecting those roads. Dr. Dai describes the project as a good example of how successful cooperation between the public and private sectors can accomplish something that benefits both.

"These groups came together to support this research because they knew it mattered," agrees Erb, who is doing his part through UWEX to educate town officials and farm businesses. "As many of them start to put the study findings into practice, that cooperation tied to a shared interest is evident."

Readers can download a copy of the complete roadway research report, titled *Effects of Implements of Husbandry (Farm Equipment) on Pavement Performance*, from the UW Cooperative Extension website, <http://fyi.uwex.edu/wimanuremgt/resources/road-study/>. ■

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Resources

MnROAD test-track website: An overview of farm equipment study and links to study details and related material.

<http://www.dot.state.mn.us/mnroad/projects/Implements%20of%20Husbandry/Index.html>

Cooperative Extension manure management site: Links to various December 2011 presentations about the road-weight study and an electronic version of the study.
<http://fyi.uwex.edu/wimanuremgt/resources/road-study/>

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