



## TECHNICAL SUMMARY

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### TOTAL PROJECT COST:

\$275,239

### TPF-5(148) CONTRIBUTIONS:

**LRRB:** \$105,000

**MnDOT:** \$105,000

### TOTAL TPF-5(148) COST:

\$1,000,258



Heavy farm equipment can put damaging loads on rural roads.



## RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,  
RESEARCH & INNOVATION

# Effects of Agricultural Equipment on Pavement Performance

## What Was the Need?

In Minnesota, as in many other states, rural roads bear the brunt of heavy agricultural equipment loads. These otherwise low-volume roads may rarely be built to withstand such occasional but significant stresses. Over the years these stresses have increased as the size of farms and farm equipment has grown. A particular challenge has been the increased application of liquid manure, which has led to larger and heavier equipment.

Studies of such loading conducted in Iowa in 1999 and South Dakota in 2001 led to more restricted use of rural roadways in those states. In Minnesota, a preliminary investigation of damage to rural roads, which was generally blamed on large agricultural equipment, found it difficult to distinguish between the impact of agricultural equipment and that of other large vehicles, such as those used for gravel hauling. Damage to these roads makes transportation difficult for area residents, and road repair and replacement are costly for local road agencies.

A rigorous examination of the impact of heavy agricultural equipment would require a controlled setting of test roads subject only to loads directed by a research team. Only then would it be possible to determine causes of such damage and examine possible solutions to an expensive problem.

## What Was Our Goal?

The Minnesota Local Road Research Board, in cooperation with MnDOT, other state departments of transportation and a number of industry organizations represented by the [Professional Nutrient Applicators Association of Wisconsin](#) initiated [pooled fund study TPF-5\(148\)](#) to examine the impact of heavy agricultural equipment on rural asphalt roads.

The current project, funded by that ongoing effort, aimed to measure the effects of different types of farm equipment on instrumented pavement test sections and compare these to the impact of a typical five-axle tractor-trailer. The results of this effort would be used to generate design or policy recommendations to mitigate the damage caused by heavy agricultural equipment.

## What Did We Do?

Test sections were constructed at [the MnROAD facility](#), including one section with 3.5 inches of asphalt over 8 inches of gravel, and one section with 5.5 inches of asphalt over 9 inches of gravel—both common rural configurations in recent years. Each was instrumented with strain gauges and soil pressure cells. Two instrumented concrete pavements were used as controls.

Loading included 20 vehicle configurations: three standard heavy vehicles, including a five-axle, 80,000-pound truck; and 17 farm vehicles, from 29,400-pound tractors to tanker trucks to tractors pulling 140,000-pound grain carts on a total of three axles. Investigators from MnROAD, the University of Minnesota and Iowa State University focused on axle loads, vehicle weights and speeds, wheel types and traffic wander. Testing was

*This study isolated the impact of heavy farm equipment on roadways by loading test sections. Results of this study will support policy decisions and construction practices to save money and enable longer-lasting rural roads.*

*“When county engineers asked us to study the impact of heavy agricultural equipment on rural roads, we found that axle loads matter far more than vehicle weight. Implementation of these findings will fall to county engineers.”*

—**Shongtao Dai**,  
Research Operations  
Engineer, MnDOT Office  
of Materials

*“Upgrading all roads to handle heavy agricultural equipment isn’t practical. We recommend keeping excessively heavy loads off the roads when they are the weakest, or temporarily making the road a one-way so heavy vehicles can drive in the middle of the road, away from the vulnerable edges.”*

—**Lev Khazanovich**,  
Associate Professor,  
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Failures on test sections like this one in March of 2009 show how heavy agricultural equipment driven near the edge of a rural pavement can cause structural failure.

conducted in March and August of 2008 and 2010 to match spring thaw conditions and high farm traffic periods, with additional testing in November 2010.

### What Did We Learn?

Investigators found that pavement structure, axle weights, seasonal effects, traffic wander, and vehicle type and configuration all significantly impact pavement responses:

- Pavement thickness was critical to resisting failure. The thinner asphalt sections suffered extensive cracking, severe rutting and failure in spring and fall of 2009. The thinner concrete pavement suffered several corner breaks.
- Pavement damage can be reduced if heavy loading avoids sensitive conditions like high asphalt temperature and fully saturated or thawed base and subgrade. November testing and morning testing both proved less damaging than August and afternoon testing, respectively.
- The most stress-inducing of the agricultural vehicle configurations are not recommended by manufacturers for use on paved surfaces when fully loaded. But even vehicles designed for use on paved surfaces caused greater stress than the standard five-axle, 80,000-pound vehicle.
- Axle weight was far more important than overall vehicle weight in stressing pavement. Increasing the number of axles while maintaining even load distribution is the primary recommendation for heavy vehicles on rural roads.
- Traffic wander and vehicle wheel path had significant impact on gauge responses.
- Use of paved shoulders reduced damage potential. In the absence of a paved shoulder, vehicles should be permitted to drive in the middle of the roads.
- Modeling led investigators to recommend that on concrete pavement, farm implements should be driven 18 to 24 inches from slab edges to minimize damage.

### What’s Next?

Recommendations from this study can be implemented immediately. Some townships in Wisconsin, a study partner-state, already have designated select roads as one-way for two- to three-day periods of high farm traffic or sensitive temperatures.

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*This Technical Summary pertains to the LRRB-produced Report 2012-08, “Effects of Implements of Husbandry (Farm Equipment) on Pavement Performance,” published April 2012. The full report can be accessed at <http://www.dot.state.mn.us/research/documents/201208.pdf>. Information about the ongoing pooled fund study TPF-5(148) can be found at <http://www.pooledfund.org/Details/Study/375>.*