Preserving and Protecting Rural Roads:

Proactive Steps Wisconsin Towns, Counties and the Ag Industry are Taking

Kevin Erb
UW Extension
Environmental Resources Center
Why Industry is Involved

• Road/Bridge issues in 3 top priorities identified in initial organizational meetings

• Continues to be a growing concern statewide and regionally.
The Issues

• Many rural roads are not designed for heavy loads.

• Farm equipment (all types) is getting larger and larger.
The Issues

- Farm equipment regulations (WisDOT) had not changed as equipment has evolved.
The Issues

• Unknown impact of innovations in axle spacing, tire design (and type) on rural roads.

• Conflicting previous research studies (SD, IA)
The Issues

• Many smaller loads vs. fewer large loads—which is best?

• PSI (Pounds per square inch) on pavement or axle weight?
Background

• Study initiated by Professional Nutrient Applicators Association of Wisconsin (PNAAW) in consultation with industry.

– Several others with similar interest, including Wisconsin Towns Association, Minnesota county highway engineers, DOT in IA, IL, MN, WI.
Background

- $640,000 invested by industry and agencies
MnROAD Research Facility

- A comprehensive pavement research facility
- Constructed in 1994 and located about 40 miles NW of the Twin Cities
- Mainline and Low Volume Road (LVR) sections
- Originally more than 4,500 sensors embedded within 40 sections
- Strain gauges, LVDTs, thermocouples, pressure cells, etc.
MnROAD Farm Loop

- PCC Test Sections
  - Cell 32
  - Cell 54

- HMA Test Sections
  - Cell 83
  - Cell 84
Background

- **Industry Partnership**
  - Manure Applicator Associations/groups
    - WI, MN, IA, OH-IN, PA, MI
  - Farm equipment manufacturers
    - Husky, Houle, Deere, CNH, AgCo
  - Tire manufacturers
    - Titan, Michelin, Firestone/Bridgestone
Major Objectives

• Determine pavement responses to selected agricultural equipment using instrumented pavements.

• Compare pavement response to typical 5-axle semi (80,000 lbs).
Testing Schedule

- As frost comes out (worst case) 08, 09, 10
  - Target frost law week

- Driest part of year (August) 08, 09, 10
  - Captured both a wet and dry August

- Mid-point temperature (November) 10
Cell 84 (Thick)
- 5.5” HMA with PG58-34
- 9” gravel aggregate base
- A-6 subgrade soil (existing subgrade soil).

Cell 83 (Thin)
- 3.5” HMA with PG58-34
- 8” gravel aggregate base
- A-6 subgrade soil (existing subgrade soil).
• Cell 32
  – 5” PCC
  – 6” Aggregate base

• Cell 54
  – 7.5” PCC
  – 12” Aggregate base
Equipment Tested

- Provided by haulers and industry

- Could not have done it without our partners
MN: 80,000 LB

S1/S5: 4400 gal

MN: 102,000 LB

S2/S4: 4400 gal
T1: 6000 gal (Houle)

T2: 4000 gal

T3: 6000 gal (Husky)

G1: 1000 Bushel
T4: 7300 gal

T5: 9500 gal
S3: 1800 gal

R4: 2400 gal

R5 (8144): 2300 gal

R6(3104): 4200 gal
## Testing

<table>
<thead>
<tr>
<th>Test Season</th>
<th>Test Dates</th>
<th>Vehicle Passes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2008</td>
<td>March 17&lt;sup&gt;th&lt;/sup&gt; – 19&lt;sup&gt;th&lt;/sup&gt; &amp; 24&lt;sup&gt;th&lt;/sup&gt; – 26&lt;sup&gt;th&lt;/sup&gt;</td>
<td>400</td>
</tr>
<tr>
<td>Fall 2008</td>
<td>August 26&lt;sup&gt;th&lt;/sup&gt; – 29&lt;sup&gt;th&lt;/sup&gt;</td>
<td>282</td>
</tr>
<tr>
<td>Spring 2009</td>
<td>March 16&lt;sup&gt;th&lt;/sup&gt; – 20&lt;sup&gt;th&lt;/sup&gt;</td>
<td>960</td>
</tr>
<tr>
<td>Fall 2009</td>
<td>August 24&lt;sup&gt;th&lt;/sup&gt; – 28&lt;sup&gt;th&lt;/sup&gt;</td>
<td>782</td>
</tr>
<tr>
<td>Spring 2010</td>
<td>March 15&lt;sup&gt;th&lt;/sup&gt; – 18&lt;sup&gt;th&lt;/sup&gt;</td>
<td>776</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>August 18&lt;sup&gt;th&lt;/sup&gt; – 19&lt;sup&gt;th&lt;/sup&gt;</td>
<td>426</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>3,626</strong></td>
</tr>
<tr>
<td>Vehicle ID</td>
<td>Type</td>
<td>Vehicle Make</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>S4</td>
<td>Straight Truck</td>
<td>Homemade</td>
</tr>
<tr>
<td>S5</td>
<td>Straight Truck</td>
<td>Homemade</td>
</tr>
<tr>
<td>S3</td>
<td>Terragator</td>
<td>AGCO Terragator 8204</td>
</tr>
<tr>
<td>R4</td>
<td>Terragator</td>
<td>AGCO Terragator 9203</td>
</tr>
<tr>
<td>R5</td>
<td>Terragator</td>
<td>AGCO Terragator 8144</td>
</tr>
<tr>
<td>R6</td>
<td>Terragator</td>
<td>AGCO Terragator 3104</td>
</tr>
<tr>
<td>T1</td>
<td>Tanker</td>
<td>John Deere 8430 w/ Houle tank</td>
</tr>
<tr>
<td>T2</td>
<td>Tanker</td>
<td>Massey Ferguson 8470 w/ Husky tank</td>
</tr>
<tr>
<td>T6</td>
<td>Tanker</td>
<td>John Deere 8230 w/ Husky tank</td>
</tr>
<tr>
<td>T7</td>
<td>Tanker</td>
<td>Case IH 335 with Houle tank</td>
</tr>
<tr>
<td>T8</td>
<td>Tanker</td>
<td>Case IH 335 with Houle tank</td>
</tr>
<tr>
<td>G1</td>
<td>Grain Cart</td>
<td>Case IH 9330 with Parker 938 cart</td>
</tr>
<tr>
<td>Mn80</td>
<td>Semi Truck</td>
<td>Navistar</td>
</tr>
<tr>
<td>Mn102</td>
<td>Semi Truck</td>
<td>Mack</td>
</tr>
</tbody>
</table>
Axle Weight and Contact Pressure Measured

0% full

80% full
Results

• Pavement damage did occur under certain conditions, but not under others

• Several key steps you can take to minimize damage potential
Key Damage Variables

- Axle weight
- Distance from edge of pavement
- Pavement Construction / Drainage
Axle Weight / Equipment

• Per-axle weight is a critical factor – much more so than total vehicle weight

• Equipment must be properly set up and adjusted
Vehicle Weight (# of Axles)

- **T6**, John Deere 8230, **6000 gal**
  - 100%: 60.0 kip (26.5 and **33.5** kip)

- **T7**, Case IH 335, **7300 gal**
  - 100%: 79.5 kip (26.3, 26.2, and 26.0 kip)

- **T8**, Case IH 335, **9500 gal**
  - 100%: 94.2 kip (23.3, 23.7, 23.5, and 23.7 kip)
Rutting potential: heaviest axle

- T1 and T6 are both 6,000 gal tankers.
  - T1 is balanced
  - T6 is not
  - T8 is 9,500 gal/4 axle
  - T7 is 7,300 gal/3 axle

ALL are more damaging than 80K semi
Distance from edge of pavement

- Asphalt strain / subgrade damage *drop* by >75% if center of tire is 16 or more inches away from asphalt edge

- Concrete: Key is slab edge distance
Distance from edge of pavement

• Paved shoulder (if not driven on) makes a huge difference
Seasonal Differences

• Avoid critical times of year
  – When frost is leaving the subgrade
  – When road subgrade is wet

• Consider critical time of day
  – Less damage in morning than afternoon
    • Move manure in morning in early spring
Time of Day

Mn80 AC Strain (84LE4) F09

- Strain [10^-6] vs. Rear axle relative offset [in]
- AM and PM data points shown

Mn80 Subgrade Stress (84PG4) F09

- Stress [psi] vs. Rear axle relative offset [in]
- AM and PM data points shown
Pavement Construction

• Quality of subgrade/asphalt is critical.
  
  – Where contractor skimped (2½ vs. 3½ inches of asphalt), damage appeared quickly.
  
  – No damage seen on 5 ½ in...
Bottom Line

- 3 ½ inch thick asphalt showed more damage for ALL ag equipment than 80K truck
- 5 ½ inch thick asphalt showed negligible damage (manure tankers)
Proactive Steps to Extend the life of rural roads
Proactive Solutions: Short and Long Term

- Move traffic away from shoulders
  - Sheboygan, Waupaca, Manitowoc Counties

- Improve Drainage
  - Brown, Waupaca

- Change road construction
  - Brown, Waupaca, Door Counties
Short Term: Move traffic to center of road

- One way traffic (limited or full) is the best way to accomplish it
- Safer operation
One Way traffic

- Applicators & farmers work with local towns and counties to make roads one-way for manure hauling

credit: www.ricesigns.com
Shoulder Driving

• Increase distance between asphalt edge and tire center.
• Do not drive on shoulder
  • 1’ asphalt on mud will not protect the road the same as a well built shoulder

Note where tire is in relation to shoulder edge!
Proactive Solutions
Two Creeks (Manitowoc County) approach Rockland (Brown County)

• Farmer, hauler, town meet prior to application
  – Farmer/hauler and town chair discuss routes for hauling, considering traffic, road condition, topography and safety.
  – All parties mutually agree on best route for loaded and empty traffic.
    • Given and take by all sides.
Proactive Solutions
Lima (Sheboygan County) approach

• Farmer, hauler, town meet prior to application
  – Designate certain roads as one way except for emergency traffic for limited time period (2-3 days).
  – All traffic (including farmer and hauler) must follow.
    • Empties go long way around.
    • Also done in Two Creeks in Manitowoc County
Proactive Solutions
Lima (Sheboygan County) approach

• Farmer, hauler, town meet prior to application
  - Farmer meets with neighbors, road users (school busses) to inform/explain in advance. Town notifies 911 and local responders.
  - Town and farmers should set procedure (who to contact – clerk, who notifies fire dept, etc and required advance notice)
Proactive Solutions
Lima (Sheboyganan County) approach

• Results and Suggestions
  
  – Lack of education led citizens to move barricades.
  
  – Enforcement needed at start to spread word that signs must be obeyed (warnings, not tickets)
  
  – “No Complaints” in Two Creeks in Manitowoc County
Proactive Solutions
One Way Roads - Costs

• May save or cost farmer money – depending on other roads, traffic patterns and bridges

  – Loaded right turns, simple return path – 20% more loads per hour possible
    • Not meeting empties (slow down/pull over)
    • Not meeting cars/passed by cars

  – Longer run with empties can wipe out savings.
Proactive Solutions
Town of Wrightstown (Brown Co) approach

• Farmer, hauler, town meet prior to application
  – Close short segment of certain roads to allow dragline to lay over road surface for limited time period (2-3 days).
  – Placement to minimize traffic disruption and hassle to residents on road

• Other applicators have used this approach and place drive-over ramps to allow emergency traffic to pass.
Proactive Solutions
200+ in Wisconsin

- Dedicated borings/culverts for pipelines / draglines
  - Extends to private property on both sides
  - Thread-through
  - Direct connect
Proactive Solutions
Underpavement/long distance pipes

• Construction Considerations
  – State/County/Town permitting process
    • Annual inspections required?
  – Road/Pavement impacts
  – Location compared to other utilities
    • Inside/outside public Right-of-Way?
Proactive Solutions
Underpavement/long distance pipes

• Long-Term Considerations
  – Ownership/maintenance
  – Farm membership in Diggers Hotline
    • Green Valley Dairy/Rosendale Dairy
  – Future costs
    • Relocation/road reconstruction
Proactive Solutions
Door County Pull-offs

 Allows semis to unload off the road – serve as a “focal point” for a one mile radius
Unintended Consequences

• Issue: weight on edge AND de-acceleration

• Solutions:
  – Closing road and parking in middle
  – Paved pad for transfer
    • Brown County
Longer Term Solutions

• What causes the damage and what can be done?
Intersections: De-acceleration
Intersections: De-acceleration
Edge Eaters

- Cut thru road ditch
- Turning in and out of driveway
  - Driveway entry
  - Far edge where equipment turning wide runs on shoulder
Edge Eaters

• **Solutions**
  - 50’ culverts
  - Enter field only at driveways
Moved and Shared Driveways
Moved and Shared Driveways

Field 1

Field 2

Field 3

Field 4

50 ft culvert

5 ft paved field driveway entry
Rebuilding roads near farms

- Investment (by farm and by local government) up front can prevent problems
Selective Investment
Selective Investment

- Invest in high quality subgrade / surface
  - Acceleration
  - Deceleration
  - Turning / driveways

- Pave shoulders at turning points
Selective Investment

- Longer culverts at field and farm driveways with paved shoulders

- Curb and Gutter / drainage improvements
  - Protect pavement edge
  - Proper drainage
Selective Investment

How to pay for necessary improvements?

• TIF (Tax Increment Financing) district

• Special Assessments for specific improvements that impact only the farm
  – Turn lanes, wider culverts
Proactive Solutions

• Investigate before repairing.
  – Drainage in subgrade
  – Asphalt/subgrade thickness
  – Poor repair = future failure
Bottom Line

• Long term solution needs to involve farmers, towns/counties and the industry
Bottom Line

- Innovation needed given time crunch in our narrowing application window

  - Knee-jerk reactions (no hauling in spring, etc) are not going to solve the long term problem, and will cause even more problems long term.
Solutions require Partnerships

Counties and Farms:

- Need good roads
- Have limited resources
- Must work together to solve this issue
Questions?

Kevin Erb
kaerb@wisc.edu