

## FOG SEAL TO PROTECT NEW PAVEMENTS, REJUVENATE OLD ONES

— *Richard Kronick, Minnesota LTAP, University of Minnesota*

In his presentation on fog seals at the Feb. 15, 2007, Minnesota Pavement Conference, chemist and pavement consultant Gayle King said “I’ve been working with civil engineers all my life, and never do I remember 95 percent of them agreeing on anything. So when I tell you that 20 of 21 civil engineers surveyed thought fog seals were cost-effective, that’s amazing!” Nonetheless, King also pointed out that fog seals are banned in many states because of deadly accidents apparently caused by fog seals that reduced tire-to-pavement friction.

King showed that the root cause for much of the raveling and cracking of pavements is asphalt oxidation. He used results of shear rheometry on an Arizona highway to explain the problem. A core, illustrated in Figure 1, was taken from a four-year-old pavement.

The bottom section of the core—about 1/2-inch thick—was found to have about the same performance grade (PG) as the original asphalt; in other words, virtually no aging had occurred. But the top 1/2 inch of the core had aged 3.5 PG grades. “We found that the asphalt binder at the top wasn’t just getting harder,” King said. “It was also getting more

brittle—so brittle that it couldn’t flow at lower pavement temperatures to relieve stresses.” In other words, its m-value—its ability to flow in response to stress—had been reduced.

“That changes the way we need to think about protecting asphalt,” King said. He recommended that we target oxidation as the enemy. Preventing oxidation in a new pavement will prolong its life. Reversing oxidation in an old pavement—i.e., increasing its m-value—will rejuvenate it.

King said fog seals can perform these important tasks, but he cautioned that we need to develop a more sophisticated approach to using fog seals. “A fog seal is not a fog seal is not a fog seal!” King has been researching a variety of fog sealing applications and products in a five-year study that was scheduled for conclusion in August of 2007.

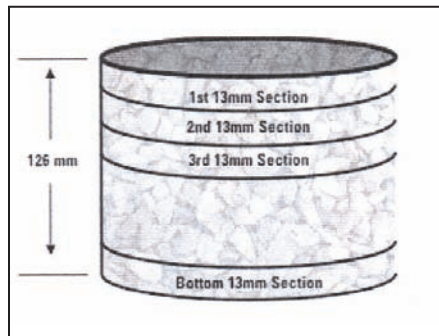



Figure 1: A core taken from a 4-year-old pavement

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### Fog seal to prevent oxidation right after chip seal

King strongly recommended fog seals on several types of new pavement surface—especially chip seals. He showed a chip-sealed pavement that had been fog-sealed only on one lane. The lane with the fog seal had no measurable chip loss, but the lane without fog seal showed a great deal of raveling and plow damage. “If you’re not losing chips to raveling or plows and your customers aren’t complaining about wind shield damage,” King said, “you don’t necessarily need to fog seal. But you can take a little bit of the emulsion out of the chip seal application and put it down on top as a fog seal instead, so it doesn’t cost much more, and it may save you a lot in terms of the length of time your chip seal lasts before you have to come back and fix it.” The blacker color of the fogged



(Fog Seal continued)

surface also looks more like hot-mix and can offer safety advantages as well, particularly when applied to shoulders.

King enthusiastically recommended one particular product for fog seal over chip seals: “the Minnesota special: CRS-2P,” as he nicknamed it. CRS-2P is a polymer-modified emulsion developed by Mn/DOT’s Tom Wood. King explained that diluting CRS with water doesn’t work: “That will break it, and it won’t come out of the distributor, and you’ve got a mess.” But if CRS is diluted with the soap from which it was made, King said “it dilutes very well, it applies very well, and it only costs 13 cents per square yard so you can afford to fog seal all your chip seals.” He compared that with some of the “high-priced spreads”—specialty emulsions that cost as much as \$1.60 per square yard. He concluded that “fog seals can be very cost-effective if you know what you’re doing.”

King especially recommended fog seal over chip seal on shoulders, pointing out that, because shoulders receive little traffic, they don’t become as highly densified as travel lanes. This means shoulders absorb more oxygen, which eventually leads to raveling. He recommended applying the fog seal heavily on a shoulder so that it is very black. That helps drivers at night to easily see the edge of the travel lane. But he expressed caution at the idea of fog sealing the travel lanes themselves because of potential friction loss. King recommended experimentation on a small section before proceeding with a large project.

### **Fog seal over open-grade friction courses (OGFC)**

King also recommended fog seals over Superpave coarse mixes and open-grade friction courses (OGFCs). In both of these pavement types, because there is more exposed surface and greater permeability, the pavement is more susceptible to oxidation and ages faster than other types. “Aggregate raveling caused by oxidation probably starts in three years if it’s a straight OGFC and in six years if it’s polymer-modified,” he said. “But a regularly scheduled fog seal program can eliminate the problem.”

However, King said the fog seal on these more permeable surfaces must be different from the type used on a chip seal: “On an OGFC or a coarse-mix Superpave asphalt, you’re not doing it to avoid oxidation; you’re doing it either to rejuvenate the asphalt or re-stick the aggregate with a less brittle binder to avoid raveling. Because we’re doing the fog seal for a different reason, the emulsion needs to be different.” The same factor that makes Superpave coarse mixes and OGFCs susceptible to oxidation—their permeability—also makes them good candidates for fog sealing because the fog seal emulsion can more easily and more deeply penetrate into the pavement. This means the friction problems associated with chip seals are avoidable and that it is possible to restore m-values at greater depths in the pavement. For these pavement types, he recommended polymer-modified emulsions because the high polymer content helps to lock down the aggregate.

### **Developing fog seal testing methods**

King’s research includes assessments of several test devices and methods,


including:

- A pavement permeameter developed by the National Center for Asphalt Technology
- A “ring test” for emulsion infiltration
- A portable seismic pavement analyzer—essentially a mini-FWD
- A bending beam rheometer test for thin mixture specimens, as developed by Professor Mihai Marasteanu of the University of Minnesota
- A dynamic shear rheometer torsion bar test for mixtures
- Several friction testing methods, from portable lab procedures to full-scale skid trailers

He said friction values change as a fog seal ages. “When applying a fog seal to a dense HMA surface, friction may be 30 percent lower on the first day; by the second day you may have a 20 percent loss; a month later it may be only 10 percent; and nine months later, you’re typically back to the original value.” Sanding immediately after the emulsion application will significantly improve early friction.

Detailed evaluations of testing devices and all other aspects of King’s research are on a Web site hosted by the National Center for Pavement Preservation at [www.pavementpreservation.org/fogseals](http://www.pavementpreservation.org/fogseals).

### **Can research overcome well-founded fears?**

It remains to be seen whether King’s research will be enough to convince justifiably skittish officials to repeal their fog seal bans. But King’s research shows that, with a greater understanding of how fog seals work and more care in matching products to conditions, fog seals offer great promise in the fight against pavement oxidation. 



## Maintaining Gravel Road Surfaces

— *Dave Levi, NDLTAP*

The dramatic change in vehicles and equipment using county and township roads in recent years has caused major concern in maintaining gravel roads. Farming has changed over the years and trucks and agricultural equipment are increasing in size and horsepower. The energy boom in North Dakota has also resulted in the increase in the size and volume of traffic on our gravel roads.

**Maintaining** existing gravel roads depends on two basic principles; first, the use of good gravel and second, the proper placement of the gravel. The use of a motor grader to properly place and shape the road is well understood, but the quality of gravel needed is not as obvious. **Often**, the quality of a gravel road is blamed on the grader operator when the real problem is the gravel itself. This is particularly true when dealing with washboarding or excess loose gravel that doesn't seem to stay where it's placed.

To help understand the need for good gravel it is necessary to know what good gravel is. Good gravel contains a mixture of irregular shaped stones along with sand and clay. When selecting gravel it's important to have a proper blend of different size stones. The different size stones allow the gravel to pack together with the small sized-stones filling the voids between the larger-sized stones. **The** shape of the stones is also very important. It is easier to pack stones shaped like a block than those shaped like


a marble. The correct amount of clay is also a very important part of good gravel because, when moist, clay acts as the glue or binder and will lock the sizes together to make a strong, tight surface. Be careful because too much clay will cause the roadway to rut and possibly be slippery when it rains.

Moisture in gravel roads is important. **During** long dry spells the binding action of the clay will diminish and traffic will start to loosen and even drive the fines and clay out of the roadway. **This** is very evident by the dusting that occurs behind your vehicle. **When** the fines and clay are no longer bound in the road top, the clay and fines start to float on the surface and washboarding starts to occur. **Driving** habits also have an impact on washboarding. **The** braking action at intersections or the acceleration on hills will cause shoving of the clay and fines and lead to washboarding.

When washboarding is present on a roadway, the only way to remove it is to rip the surface of the roadway to about one inch below the washboard and relay and recompact the gravel. **Remember** that moisture is necessary to cause the clay to bind so the best time to repair washboarding is in the spring or after a rain. **If** you attempt to repair a gravel road during dry weather you will need a water truck. Filling the washboard areas with loose gravel will not fix the problem. The loose gravel will push out **and** the wash board will return as soon as traffic starts using the roadway.

If you are working with a gravel road that has **been** in service for a

long time without additional gravel being added you might have a roadway without adequate gravel or one with too much large stone that will not compact. **If** you have the first situation, a **regraveling** project is necessary. If you have the latter situation, where over time the clay and fine stones have been lost, the best **way** to correct it is to sweeten the existing stone with material that is needed to make it good gravel. **Occasionally** pulling material up from the shoulders and reshaping will correct the problem. **At other times**, hauling in fine stone and clay to rejuvenate the existing gravel is required. **Whichever concern** you have, moisture and proper compaction are necessary in the restoration.

The NDLTAP center provides training for the **maintenance of gravel roads**. This year we have workshops scheduled for Feb. 5 & 6 in Bismarck and Oakes respectively. **The instructor** is Ken Skorseth from the South Dakota LTAP center. **Ken** is known **nationally for his expertise on gravel road maintenance**. County supervisors, commissioners and township supervisors are **encouraged** to attend these workshops to get a better understanding of what occurs on the roadway and how to best correct problem areas. Visit the LTAP website at [www.ndltap.org](http://www.ndltap.org) for updated information on the workshops or feel free to contact our office at (800) 726-4143, Vern at (701) 328-9858 or Dave at (701) 328-9857 for additional information. 

## Sign Retroreflectivity Final Rule Published

— *Dave Levi, NDLTAP*

The final rule for maintained sign retroreflectivity was published in the Federal Register Dec. 21, 2007, and became effective Jan. 22, 2008. The text of the final rule can be found at [www.fhwa.dot.gov/retro](http://www.fhwa.dot.gov/retro).

The final rule will be incorporated into the Manual of Uniform Traffic Control Devices (MUTCD) as Revision No. 2 of the 2003 Edition. The revision includes standards for minimum levels of retroreflectivity that must be maintained for traffic signs and pavement markings. The new standards will apply to all roads open to public travel. The rule also provides additional requirements, guidance, clarification, and flexibility in maintaining traffic sign retroreflectivity that is already required by the MUTCD.

The minimum retroreflectivity levels and maintenance methods consider changes in the composition of the vehicle population, vehicle headlamp design, and the demographics of drivers. The FHWA expects that the levels and maintenance methods will help to promote safety and mobility on the nation's streets and highways.

Russ McDaniel is in the process of updating the NDLTAP signing program to accommodate the changes required by the final rule. For those of you who are using the program, updates will be made available in the near future. If you are not using a signing program and would like to get started, contact Russ at (701) 328-9858.

You should also be aware that the FHWA is conducting research to develop a standard for minimum levels of pavement marking retroreflectivity. The FHWA expects to initiate the pavement marking retroreflectivity rule making process once the research is concluded and the results are analyzed and considered. //

## Mandan Engineer Tom Little Retires

Tom Little, Mandan City Engineer, retired Jan. 2, after 30 years in the position. Little graduated from North Dakota State University in 1968 with a B.S. degree in civil engineering. He came to Mandan from Grand Forks after several years of engineering experience. He is a registered professional engineer and also a registered land surveyor.



During his tenure as city engineer, Little was involved in all the planning and engineering and helped assure the orderly development of the city. Tom has been involved in reconstruction of all major streets within the city, including Collins Avenue, Old Red Trail, Main Avenue, ND Highway 1806 and ND Highway 6. Also major water and sewer projects have been completed under his direction. Mayor Ken Lamont notes that the city engineer position involves making critical and sometimes unpopular decisions and Tom has handled them very well.

According to Little, he and his wife, Gloria, will continue to reside in Mandan. They will do some

traveling, visiting their daughter in Tucson. Following an adjustment period, Little will determine how to fill his spare time. //

## Build a Crashworthy Work Zone Sign Stand

— *Lloyd H. Rue, Design-Safety-Traffic Engineer, FHWA Helena, Montana*

Where there are cars, there will be collisions.

When there are collisions, people will get hurt.

How do we lessen the chances of injuries when there are collisions with sign stands in our work zones?

We make sign stands 'crashworthy.' Once upon a time, work zone devices were not held to a crashworthy standard. Crashworthy work zone devices now, and for the last decade, follow an industry standard.

Making a crashworthy device can be complicated. The ultimate proof for a crashworthy device is testing at highway speeds with test vehicles. One test criteria examines whether there is an intrusion into the occupant compartment. A gaping hole in the windshield, for example, would cause the test to fail.

Numerous types of crashworthy sign stands can be purchased from suppliers. Often these sign stand designs are patented. Patented or proprietary devices usually are more costly than those fabricated in a local shop.

(Work Zone continued on page 7)

## Walsh County Road Superintendent Dennis Markusen Retires

— *Vernon Monger*

Dennis Markusen, Walsh County Road Superintendent, recently retired after 35 years as a county employee. Markusen began his career with the road department in 1972, after receiving his associate degree from the North Dakota State College of Science at Wahpeton. He accepted the position of highway superintendent in 1974. Dennis is a registered land surveyor.



Planning for and maintaining the road systems within the county has been a major challenge, with more than 500 miles of county roads, 1,600 miles of township roads, and 14 full-time workers, Markusen says. The county also maintains 500 county and township bridges.

According to Markusen, the best part of his years with the county was his association with the people. Managing a county road system takes cooperation, he states, from all the road department personnel, the county commissioners and the general public.

Markusen states he is not really retiring, but changing careers. He will be working for Kadmas, Lee and Jackson (KLJ), continuing in the transportation field.

Markusen has been active in NDACE, serving as a past president. He has also been involved in the LTAP program, both as a participation and in sending his employees to the workshops.

Dennis and his wife, Linda, have 6 children. They will continue residing in the Walsh County area.

Sharon Lipsh, administrative assistant, has been appointed to the road supervisor position. ▀

### Looking for your ideas and news articles

Contact Dave Levi at  
(701) 328-9857 or  
dave.levi@ndsu.edu  
to share your ideas and  
articles for the upcoming  
editions of The Center Line.

## COMING EVENTS

### ND LTAP Events

#### Asphalt Conference

March 25-26, 2008

Bismarck, ND

(info at [www.ndltap.org](http://www.ndltap.org))

#### Asphalt Pavement Repair

April 1, 2008

Two Way Inn Café

Stanley, ND

April 3, 2008

Cass County Shop

Fargo, ND

#### Advanced Work Zone Management (TLN)

April 1, 8, & 15, 2008

9:00 am – 5:00 pm

3-Day Course

#### Transition to Supervision (TLN)

April 9, 2008

9:00 am – 5:00 pm

#### Traffic Safety Workshop: Basic Concepts (TLN)

April 22 & 29, 2008

9:00 am – 5:00 pm

2-Day Course

#### Traffic Control Supervisors Training Course (TLN)

April 23-24, 2008

8:30 am – 5:30 pm

2-Day Course

#### Traffic Safety Workshop: Identifying Projects (TLN)

April 29, 2008

9:00 am – 5:00 pm

#### Decision Making & Problem Solving (TLN)

June 11, 2008

9:00 am – 5:00 pm



## WORK SITE SAFETY

### Maintain a clean work environment

- Designate storage space for everything.
- Provide sufficient housekeeping tools, including brooms, clean rags, and spill absorbers.
- Define areas for scrap storage and schedule regular collection, removal, and disposal.
- Assign clean-up responsibilities and make sure work sites are cleaned and cleared before quitting time.

### Keep the worksite safe

- Install non-slip treads on ramps and steps.
- Remove excess vegetation around combustible storage areas.
- Clearly mark aisles and passageways.
- Be sure shop lighting is adequate in all areas.
- Allow at least 18 inches of clearance between storage and sprinklers.
- Secure all storage racks to the floor, wall, and each other.
- Check functioning of ventilation equipment for effective removal of exhaust, paint spray, and other fumes.
- Store full propane cylinders outside or in a non-heated, well-ventilated structure. Keep them secure from tampering. Make sure they're marked according to National Fire Protection Association standards.
- Store oxygen tanks and acetylene tanks for welding and cutting separately. See OSHA regulation 1910.253 for details.
- Check the condition of power tool cords and hoses.
- Monitor noise in the shop.
- Review guidelines for safe equipment operation.

- Review the contents and hazards of the materials your crew may handle and coach them on proper protective procedures. Use Hazardous Material Identification System placards (check with your local fire department).

### Maintain safety equipment

- Check fire extinguishers monthly and maintain a record of inspection.
- Have a qualified company check fire extinguishers yearly.
- Good housekeeping habits and organization can help prevent injuries from tripping and slips as well as from hazardous materials. Make sure you know how to operate all equipment safely.

### Prevent tripping

- Keep access ways and aisles free from debris.
- Return tools, especially small hand tools, to their storage areas after use.
- Minimize the use of extension cords.

### Prevent slips

- Clean up spills promptly with the appropriate (nonvolatile) solvents.
- Remove grease, oil, ice, snow, and mud from walkways, steps, and ladders.

### Stack materials properly

- Do not allow materials to protrude past the edge of the shelf or bin.
- Use pallets when stacking uneven material.
- Store pipe, ladders, structural steel, etc., horizontally or secure with brackets so they don't fall due to machine vibration or accidental brushing.
- Build a pyramid when stacking pipe. Block the first layer to keep it from rolling away.
- Store tires vertically in racks.

- Remove nails from excess lumber, sort the lumber by size, and store it in a separate area.
- Securely strap gas cylinders to a support.

### Prevent fires and explosions

- Clean up gas and flammable liquid spills immediately.
- Do not wear clothing that has been in contact with flammable liquids.
- Remove all ignition sources from the fuel area.
- Never hang clothes or rags near operating machinery lines, heating vents, or ventilation ducts.
- Guard grinding wheels against explosion by using the properly rated wheel in the grinding device.
- When welding, eliminate fire hazards and adequately ventilate the area.

### Store combustible and hazardous material properly

- Store flammable materials in designated areas.
- Keep oily rags in covered cans.
- Place paint in a paint locker.
- Keep explosives in a protective hut.
- Store fuel oil and kerosene behind a concrete barrier.

### Store gas cans properly

- Use gasoline transport containers approved under the National Environmental Policy Act (NEPA).
- Ground gas cans to prevent sparking.
- Refill empty cans with gasoline to prevent fume buildup.
- Store full propane cylinders outside or in an unheated, well-ventilated structure. Secure them from unauthorized access and tampering.

### Keep sources of ignition away from combustibles, including the following:

- Lit cigarettes.
- Welders.

- Heaters.
- Running vehicles.

### Extinguish fires safely

Know how to operate each class of fire extinguisher and where fire extinguishers are located in the shop.

### Paint and painting

- Avoid prolonged exposure to paint fumes. Wear a properly designed ventilator to avoid inhaling paint and solvent fumes.
- When sanding or grinding paint, wear a ventilator or mask.
- Do not heat paint inside an enclosed structure unless the ventilation equipment meets the National Fire Protection Code.
- When spraying paint, be sure to do the following:
  - Use designated paint booths.
  - Keep out of the direct spray area. Paint sprayed at a pressure of only 30lbs/in<sup>2</sup> can become embedded in your skin. Do not use high-pressure air to blow dust from your clothing. Dust, like paint, can become embedded in your skin.
  - Always use factory-made and tested high pressure hose couplings, and do not exceed their pressure ratings.
  - Dispose of old paint and paint containers properly.

### Ventilate properly

- Adequately ventilate solvent, gasoline, and other chemical vapors and exhaust fumes.
- Know and employ proper maintenance methods to reduce contact with asbestos and asbestos dust.

### Use pneumatic tools safely

- Wear hearing protection while working with pneumatic tools that operate in a range above 85 decibels.

- Pay attention to where debris is thrown when using any pneumatic tool.
- Minimize the possibility of electrocution:
  - Don't stand in liquids.
  - Don't use a tool with a frayed cord, exposed conductors, or a broken grounding plug.

### Using an air hammer

- Before operating, be sure to do the following:
  - Put on safety shoes and eye protection.
  - Know the location of the "deadman" switch and check to see that it works.
  - Properly secure hose connections and use retainer clips.
  - Take frequent breaks to reduce the cumulative effects of vibration and noise.
  - Do not guide the air hammer with your feet.
  - When finished operating, vent the compressor air tank before removing the hoses or disconnecting the air hammer.

### Using cutting tools

- Check bolts for adequate tightness and check chuck bushing for excessive wear.
- Do not allow the heads of cutting tools to mushroom. Deformed heads should be ground to their original shape to prevent splinters from chipping off the tool.
- In cold weather, warm the cutting tool before use to prevent spalling.

*(Excerpt from Iowa LTAP Worker Safety Training Handout) ■*

Thanks to recent research, there is a crashworthy, non-patented sign-stand design that uses commonly available materials. The sign-stand design (among other devices tested) is outlined in a research report from the National Cooperative Highway Research Program, *Report 553: Crashworthy Work-Zone Traffic Control Devices*. And, the Federal Highway Administration issued an acceptance letter on the device (September 8, 2006, WZ-240).

If you need new sign stands for your county or city crews, there is a non-patented design you may use.

To view details of the strong dual-upright sign support system with sign panel mounted at a height of 1.5 m (5 ft) go to:  
<http://www.ltapt2.org/newsletter/2007/downloads/CrashSign5ft.pdf>

To view details of the strong dual-upright sign support system with sign panel mounted at a height of 2.1 m (7 ft) go to:  
<http://www.ltapt2.org/newsletter/2007/downloads/CrashSign7ft.pdf> ■



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