Kansas LTAP Newsletter
Spring 2009

Introduction to Crack Sealing

Water is the most destructive element to our pavement. Water entering the roadway through cracks accelerates deterioration. In time, the water will undermine and weaken the roadway base material, creating cracks and potholes. Sealing pavement cracks to prevent water from entering the base and subbase will extend the pavement life from three to five years.

Pavements expand and contract with seasonal temperature changes. Consequently, cracks and joints expand and contract when the pavements move. Sealing the cracks with flexible rubberized asphalt that bonds to the crack walls and moves with the pavement will prevent water intrusion. As part of a pavement management system, crack sealing can reduce pavement deterioration by restricting water penetration into the underlying base and subbase layers. This restriction helps to maintain pavement structural capacity and

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KUTC (and LTAP) Get New Look

This issue of the Kansas LTAP Newsletter (formerly the KUTC Newsletter) debuts a new look for Kansas LTAP and the KU Transportation Center. The KUTC, which hosts two technology transfer programs (LTAP and the public transit-related RTAP) is in the process of updating its look. This includes a change in logo and fresh newsletter designs for both of these programs.

The new logo, at right, features a design that is reminiscent of the letters K or T and also of a roadway intersection. It replaces the sunflower logo that we have been using for many years.

In the newsletter redesign, we wanted to keep the color

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Crack sealing

limits future degradation. Simply stated, sealing cracks and joints in pavement extends the service life of the surface treatment and the pavement. It should be noted that crack sealing will not improve the initial pavement ride-ability. The benefits are realized in three to five years when it becomes obvious that the pavement has not deteriorated as quickly. Roads and bridges that are crack sealed last longer than those that are not. Sealing prior to surface treatments and bituminous paving overlays enhances the treatment and further extends the pavement life. The overall successes of pavement maintenance systems that include crack sealing make crack sealing a desired maintenance program.

Sealants

Asphalt rubber was the first generation of flexible sealant to move with the pavement at warm and cold temperatures. Unlike fillers, asphalt rubber is flexible below 35°F and does not migrate or run when temperatures reach 85°F.

Regional climate conditions prompted manufacturers to develop sealants that would outperform standard flexible sealants. Extreme high temperatures in the Southwest and severe cold temperatures in the northern Midwest prompted the development of sealants that have greater flexibility and better bonding to crack walls. A generation of sealants utilizing polymer technology was introduced. Polymers, when added to a liquid asphalt base, formulate a sealant that has a greater expansion capability than asphalt rubber sealants. Sealants are now manufactured with a performance range from 200°F to -30°F.

Rubberized sealants perform best in wet climates. Because modified and proprietary products are typically more expensive, an agency should perform a cost effectiveness analysis before choosing a product. Manufacturers are a good source of information and know the performance of their products. Manufacturer’s claims should be carefully reviewed for applicability to the specific situation.

Preparation and application

Preparation is key to successful use of crack sealants. In the same way that a dentist prepares a tooth before filling a cavity, crews must prepare cracks to receive sealants.

The better the preparation, the better the chance that the sealant will last and perform. Surface preparation can be accomplished with compressed air (100 psi minimum) and a simple blowpipe. This technique works well when the dirt is dry and not packed hard. If the cracks are filled with wet dirt, the dirt needs to be removed and the crack must be completely dried. An air compressor or a hot-air lance generating temperatures in excess of 2,000°F is the best tool.

In simple terms, a heat lance uses hot compressed air that blows cracks clean while drying them out. Field studies and research are finding that heat lances are valuable tools for proper preparation.

Studies show that there is almost a 40 percent greater chance of sealant success if cracks are routed prior to sealing. Cutting a reservoir also ensures that the proper amount of sealant penetrates the crack. An operator passes the pavement cutter or router over the crack, through a series of star-shaped steel teeth, and cuts a reservoir into the crack.

Modern routers can follow even the most random pavement cracks. Once the rout is complete, compressed air (hot or cold) can be used to remove the dust created by the router. Engine-powered steel wire brushes can also be used to clean routed and nonrouted cracks. (Note: Older-aged asphalt pavements and thin asphalt pavements may not be suitable for routing.)

Application equipment

The most visible piece of equipment is the melter. In years past (and still in use), the “tar pot” was simply a steel pot with a direct flame burner used to heat the material. Also in use today are indirect fire melters, which require a high temperature heat transfer medium such as oil. These kinds of melters are known as “oil jacketed” melters or “double boilers.” Special care must be taken to assure that the sealant temperature does not exceed the manufacturer’s recommendations; otherwise, the polymers may be

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Sealant temperature important for effective operation

Hot-pour sealants are effectively applied through a delivery hose and wand. These materials are commonly applied at 375°F; however, the manufacturer’s recommended application temperature should be followed. To prevent sealant cooling, setup, and clogging, the hose is placed under constant pressure and the sealant circulates constantly back into the main tank.
blue long-associated with our newsletter, and use it with white paper to help with readability and for better quality photographs. All programs of the KU Transportation Center will have this color scheme and the new logo for better consistency.

The new look is starting to appear on other printed pieces. Our conference booth panels were revamped last Spring, to launch Kansas LTAP’s 25th anniversary. The 2009 LTAP Resource Catalog cover (for the lending library) has the new look, along with the recent LTAP fact sheet on training and technology transfer available to road and bridge departments in the Kansas. Next will be our Web site. Look for enhancements over the coming months, both in design and functionality.

Why the newsletter name change? It’s because the KUTC has added programs over the years in addition to LTAP, and it has become confusing to have the LTAP newsletter carry the entire Center’s name. Also, “LTAP” was not visually prominent with the old design. Changing the name to Kansas LTAP Newsletter now clearly ties this newsletter to the LTAP program.

We hope you like the redesigned and renamed newsletter and find it to be more readable. If you have any questions or comments, contact Lisa Harris, KUTC’s communications and outreach manager, at (785) 864-2590 or LHarris@ku.edu.

New look

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If the road has alligator cracking, high density multiple cracking, poor subbase drainage, or structural damage, crack sealing will not solve the problem. In these cases the damage is too far advanced. If attempting to save a pavement that has too much cracking, the result will be disappointing.

The best candidates for crack sealing are newer pavements that are beginning to form cracks. Always begin a crack sealing program by sealing the best or newest roads first. A good rule of thumb is to monitor roadways that have been resurfaced, and consider crack sealing within three to five years following the resurfacing.

Keep in mind that more sealant is not always better. Over applying sealant material can lead to problems when paving over with HMA or bleeding up through the seal or paving application. These new sealants are not designed to be “road glue.” Yes, they are very sticky and have tremendous bonding power. However, they were not made to “hold the road together.” Crack sealing has one objective: to prevent water from further damaging our roads. Sealing “buys time” and saves money by delaying the expense of major reconstructive pavement work.

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Good Gravel Roads

A good gravel road starts with good gravel. More than half of the problems that occur on gravel roads stem from using the wrong kind of gravel. Learn what makes “good” gravel and other tips about effective gravel road maintenance.

While interstate and other highway systems may see more traffic day to day, in reality the system of gravel roads throughout the United States provides a transportation resource for millions of Americans. In fact, more than half of the roadways in the U.S. are gravel surfaces. We depend on them to transport goods, access services, and for traveling to and from locations off of the highway system. This dependence makes the proper construction and maintenance of gravel roads critical to the nation’s overall road system.

Gravel road maintenance requires continuous attention, often starting in the spring but occurring throughout the year. Read below for further information on gravel maintenance, including safety aspects and a general explanation of maintenance techniques.

Use the right kind of gravel

The importance of having good surface gravel cannot be understated. It is estimated that more than half of the problems that occur on gravel roadways stem from using ineffective gravel. Gravel roadways should avoid “base gravel,” which is less fine and more drainable, but erodes much faster. Instead, crushed surface gravel should be used. Crushed gravel has different sizes of particles and sand, plus eight to 15 percent “fines,” or gravel dust, that acts as the glue holding the bigger pieces together. This type of gravel allows the road to bond well, but also allows for proper drainage.

Maintain good drainage

Gravel road maintenance is aimed at making sure that the driving surface, as well as the shoulder, are both designed and maintained in a manner that allows for proper drainage.

If a roadway is allowed to have poor drainage, erosion of both the driving surface and the underlying structure of the road can occur. So, in addition to potholes and other damage to the driving surface, the integrity of the roadway can be compromised. In extreme cases, this can lead to no other option except completely rebuilding the road. This is an expensive option, and most agencies do not have the time or money to take on such a task. Instead, they should concentrate on proper maintenance.

To ensure good drainage, the gravel roadway should maintain a four percent slope on either side of the crown of the roadway. This equates to about a half inch drop per foot on a 24 ft-wide roadway. If the slope is flatter than four percent, rainwater will accumulate on the driving surface and cause potholes and erosion. If the slope is over four percent, water will drain from the roadway but will also wash away the fines that hold a gravel road together.

An easy way to spot whether or not a roadway’s crown and slope are appropriately maintained is to check the wheel tracks from vehicles on the road. If wheel tracks are concentrated to the middle of the road, the crown may be too high and the slope more than 4 percent. Under these conditions, vehicles traveling in both directions may tend to drive in the center of the road, creating a safety hazard.

There are several instances when the roadway should not have a crown —specifically, when a roadway intersects another roadway or train track. When a gravel road meets a railroad crossing, bridge crossing, or intersection with another gravel road or paved road, the crown should be removed as to not cause drainage on to the intersecting element.

Curves on gravel roads also require a different tactic: Instead of a crown and four percent slope, the curve should be graded so that the collected sediment is distributed from the outside of the curve to the inside, meaning the curve will not be too steep for vehicle traffic.

Aside from maintenance of the driving surface and shoulders, other maintenance may be necessary to keep the roads in good condition. For instance, debris and sediment will need to be cleaned from ditches or culverts on a periodic basis to keep water flowing and prevent it from backing up onto the road.
Fix high shoulders

A “high shoulder” refers to the tendency for sediment and loose gravel to collect near the edges of gravel roads. Loose gravel can cause vehicles to lose traction. Loose, flying gravel, kicked up by passing vehicles, can also break windshields.

A high shoulder also interferes with the proper drainage of the road.

High shoulders are caused by water draining off the road (even on roads that have the appropriate four percent slope), by passing vehicle traffic, by snowplows during winter maintenance, and inadvertently by road graders while maintaining the roadway.

To address high shoulders, road grader operators should set the grader blade correctly to eliminate the high shoulder, or can use a “shouldering disc”—similar to the disc attachment used in farming to break up the soil.

Set the blade properly

The mowboard should be set to an appropriate angle and appropriate tilt for whichever maintenance task you are undertaking. This will be different, for instance, if you are working to maintain a four percent slope or are breaking up a high shoulder. When working on a four percent slope, keep an eye on the slope gauge to make sure you really are at or around four percent. For more information on setting a blade, see the resources at the bottom of this page.

Go slow!

Most importantly, GO SLOW. The maximum speed for correct grading is 3-5 miles per hour; anything faster than this will risk “washboarding,” where the mowboard only contacts the road intermittently. This creates a situation where the road is extremely bumpy, and can compromise the drainage of the roadway as well.

Consider safety aspects

At the work site, think about both your safety and that of vehicles using the roadway. Use your flashing warning lights, have a “slow moving” or “keep back” sign on the back of the grader, attach red flags to the front of the grader, and wear a safety vest for when you will be outside the grader on or near the roadway.

Take care of your grader

Before leaving for the work site, give the grader a thorough inspection, including tire pressure and an inspection of the mowboard underneath the grader. The mowboard will naturally wear down, so be sure that it is in good condition, otherwise proper road maintenance will be much more difficult.

More information

For more information and resources about gravel road maintenance, check out the 2009 Kansas LTAP Resource Catalog. The publications and training video sections of the catalog each has an “unpaved roads” section with numerous resources listed. See page 15, above the request form, to order a copy of this catalog.

Or you can search the catalog online at http://www.ksltap.org. Click on “Lending Library.”

Source

• Minnesota LTAP, Gravel Roads Maintenance: Meeting the Challenge. 2006.

Two Great Resources on Gravel Roads Maintenance

The above article touches on some of the basics of making good gravel roads. For more detailed information, be sure to consult the following resources:

- **Gravel Road Maintenance: Meeting the Challenge DVD.** This DVD can either be used as a stand-alone tutorial or as a trainer’s tool to introduce the topics of gravel road maintenance. Each chapter of the DVD discusses a specific maintenance topic. After playing a chapter, the trainer can pause the DVD and use other teaching materials, if desired.

- **Gravel Roads Maintenance and Design Manual.** This manual, produced by FHWA and South Dakota LTAP, is a very comprehensive guide on the design and maintenance of gravel roads. It contains a wealth of illustrations and photographs to help readers understand proper blading techniques.

These resources are free and can be ordered on page 15.
Roller-Compacted Concrete: It’s Concrete Pavement, Just Different!

By Thomas Winkelman, P.E.

Roller-compacted concrete, or RCC, gets its name from the construction methods used to place the material. RCC is placed with conventional, or high density, asphalt paving equipment and then compacted with conventional steel drum rollers. RCC has the same basic ingredients as conventional concrete, but unlike conventional concrete, it’s a drier, zero-slump mixture—stiff enough to be compacted with vibratory rollers. The construction process does not require formwork or any hand finishing of the surface. Also, it does not contain any type of steel reinforcement. RCC can offer three basic benefits for certain types of pavement construction: low cost, high strength, and rapid construction.

Where RCC has been used
RCC for pavement applications got its start in the 1970s with the Canadian logging industry. This industry was in need of an economical and strong pavement that could survive the massive loads and specialized equipment for sorting logs, while at the same time survive the harsh Canadian environment. The success and performance of these early projects led to additional applications such as intermodal yards, military facilities, and very large pavement areas such as manufactures' storage, staging, and parking areas.

The U.S. Army Corp of Engineers has used roller-compacted concrete for many years with embankments and small- to medium-size reservoir dams. Only recently has RCC been introduced to certain highway pavement applications.

How RCC is designed and placed
The roller-compacted concrete mixture design contains the same basic ingredients as conventional concrete: rock, sand, cement and water. However, the combined gradation of the aggregates should be optimized for maximum compaction and density during construction. This optimization may require the addition of a second (coarse or fine) aggregate to the mixture. The design also minimizes the amount of water used. Depending upon aggregate moisture, absorptions, and ambient conditions, the water to cementitious materials ratio is generally between 0.30 and 0.40. Cementitious contents are similar to conventional concrete mixtures; however, it is recommended to use at least 500 pounds per cubic yard. Supplementary cementitious materials may also be used.

The roller-compacted concrete construction process is very similar to the construction of hot mix asphalt. The mixture is generally combined in on-site continuous-mixing pugmills, or central batch concrete plants, and transported to the placement location in dump trucks. The RCC mixture is then placed with asphalt paving equipment in layers up to eight inches thick.

Compaction of the pavement begins immediately with passes of the roller in both vibratory and non-vibratory mode. Compaction of the pavement is critical to the final performance, as this will ensure the density, strength, and smoothness of the finished product.

Roller-compacted concrete should be cured in a similar fashion to conventional concrete. A water cure, or spray-on curing membrane, should be applied as soon as practical to seal in moisture and ensure proper strength gain of the concrete. It is recommended that the curing membrane be applied at a rate of 1.5 to 2 times that of conventional concrete. Joints may be saw cut into the RCC to control crack locations, or the concrete may be allowed to crack naturally for increased cost savings on the project. Due to the dry nature of the mixture, crack spacing tends to be larger and crack width tends to be less than conventional concrete.
Advantages of RCC

The high-volume, high-speed construction methods for RCC lend themselves to improved economics over conventional concrete. Large RCC projects with continuous pugmill operations can produce up to 250 cubic yards per hour, while central batch concrete plants may be able to produce up to 150 cubic yards per hour. Placement rates for RCC will vary with equipment and contractor experience, but generally will be 100 to 150 cubic yards per hour for each paving machine. The compaction and density of RCC allow for faster opening to light duty traffic on time sensitive projects, providing substantial savings in traffic control and signage costs to the contractor.

Roller-compacted concrete has the potential for numerous low-volume road applications as well as parking and off-highway pavement applications. The economical construction process makes this a viable solution for select projects. This is especially true considering the current state of the economy and continued limited funding for highway and pavement construction.

Thomas Winkelman is a technical services engineer with Continental Cement Company, LLC.

Grade Separation: Working With the Railroad Yielded a Better Solution in Olathe, Kansas

By Matthew Barnett

Have you ever considered grade separation for a rail crossing in your community? Olathe City Engineer, Phil Estes, has too, and with some help, he was able to put a “gateway through the wall.”

The wall he’s referring to is a railroad track that runs north and south through Olathe, a suburb of Kansas City. The track has 44 trains that run through Olathe each day. Originally, the city was going to build a bridge on Sante Fe road to take cars over the track, but a consultant advised that it would be just as economically feasible to raise a section of the track itself, and that way they could go over four roads instead of one.

Estes said they considered grade separation for four reasons: traffic inconvenience, noise, safety, and pollution.

“We have 44 trains a day averaging 5 to 10 minutes of delay each competing with 50,000 cars per day for the same space. This is equivalent to almost 30 cars sitting with their engines running 24 hours a day, seven days a week. This is a huge economic cost, environmental cost, and human cost to the city.”

The City of Olathe has 23 at-grade crossings, and this project decreased that number by six percent. As Estes put it, “The public is avoiding east-west travel, and this was a huge relief for… the delay that people experience.”

The City of Olathe, Burlington Northern Santa Fe Railroad (BNSF), and State of Kansas all participated in this project. The city received funds for the 43 million dollar project from city general obligation bonds and some money from BNSF and the State for closing three of the crossings. Estes also worked with Lyn Hartley, BNSF’s Director of Public Projects to accomplish this project.

“[The project] was built without taking one single home or business,” said Estes. “The tricky part for this was finding the funding.”

Once the rail fly-over is completed, the responsibility of maintenance is the railroad’s.

When asked if grade separation is the always the best solution, Estes replied, “It has to be economically justified… [but] sometimes the best thing to do is close the crossing.” In this case, Estes thinks Olathe made the right decision, and believes downtown Olathe will benefit from it.
**A Leg Up**

### Potholes: Enlisting Help to Find and Fix Them

By Lisa Harris

Holes in the road are especially hazardous to bicyclists and pedestrians. Your citizens can help you find them, and you can build some positive public relations at the same time.

There is no national standard for frequency of checking for, and fixing, holes in the road. This is a risk management issue for communities, and it is in your best interest to develop an internal protocol for finding and fixing potholes in a reasonable amount of time (reasonable to a jury). Some local agencies make a point to instruct their crew members to keep their eyes open for potholes when they are out on the roads. Others enlist the public to help. Below are some examples of the latter, in Kansas and elsewhere.

#### Ways to find them

**Pothole hotlines.** Several communities in Kansas have pothole hotlines. Even the worst potholes are just a phone call away from being filled, and some cities also provide an opportunity to report potholes online.

Some cities in Kansas that offer pothole hotlines, some with online reporting, include: Salina, Hutchinson, Wichita, Overland Park, Topeka, Lawrence, Great Bend, and the Unified Government of Wyandotte County and Kansas City, KS.

Using an online reporting feature is an easy enough process. Most cities provide a form that a citizen fills out with requested information, such as the location of the pothole, side of the street it's on, and the resident's name and address.

**Special campaigns.** In March 2009, the Washington, D.C. Department of Transportation began a month-long crusade to fill the city's potholes, and they decided to make it fun. Called “Potholepalooza,” the initiative aimed to have all reported potholes filled within 48 hours (typical turnaround is 72 hours). Citizens were encouraged to report potholes in any number of ways—by phone, fax, to a pothole-dedicated email address, at the Web site, even with Twitter. Within just the first week, over 1,200 potholes were filled—518 on the first day alone. The city also provided online monitoring of the daily pothole-filling progress.

Brooklyn, NY, has an annual pothole filling campaign that kicks off with the mayor and the city's DOT commissioner filling potholes in a photo op. Two-thirds of the city's potholes are typically filled during the month-long promotion. The city sees the effort as helping to fulfill its sustainability goals, as the city uses recycled asphalt in the patch mix. And it helps with overall safety and maintenance, because the campaign takes place as the first potholes appear in winter. The campaign kicks off in early January.

The City of Chicago is also working with an advertising firm to develop a pothole repair program.

**Maps.** Boston, MA, has a Google based mapping system that shows the location of known potholes and enables submission by the public of those not yet identified. The map also shows how many other people who viewed the site would like a particular pothole fixed. See the map at http://www.boston.com/news/local/massachusetts/specials/013009_pothole/.

#### Ways to pay for potholes

**Public works budget.** Pothole repair is usually part of a local agency's maintenance budget. But if funds are short, it may pay to think creatively.

**Partnership.** Here’s a unique idea: KFC, known for its fried chicken, is getting into the business of fixing potholes. They stamp and paint the patched holes with a KFC logo in return. [I am not making this up.] The fast-food chain has sent off a letter to the nation’s mayors, offering to patch their potholes for free. The company will leave behind a stenciled brand on the patch informing people the road has been “Re-Freshed by KFC.”

“In honor of our ‘Fresh Tastes Best’ campaign, we want to come and Re-Fresh your roads!” KFC president Roger Eaton says in the letter. “Every patched pothole comes with the Colonel’s very own stamp of approval.” Some of
the filled potholes will also be stenciled with a logo that says they were “re-freshed by KFC.” The spokesman said the stenciling will be done with nonpermanent spray chalk, so they will eventually go away.

Louisville, KY, (KFC’s headquarters) is taking advantage of the offer, as are a few other cities. But Chicago, for one, has declined. They do not allow any type of printing or advertising placed on a city street or sidewalk. If your city does not have such a prohibition, maybe a local business would be interested in partnering with you in exchange for some creative marketing—and a boon to your street maintenance bottom line.

Sources

Using Rock Reclamation Blades

The challenges faced by road and bridge crews in Northeast Kansas in 2008, as well as throughout the state, were significant to say the least. During the first week of January, an unseasonably warm week resulted in an early thaw that turned our gravel roads into mud. The crews were reporting a softening of roads not seen for over 20 years. This was all happening as diesel fuel prices were rapidly marching toward record highs above $4.00 per gallon.

The solution was to start hauling rock immediately to take care of the most serious problems. This operation was successful, but at a high cost to the budget. Nearly 20 percent of the annual rock budget was spent during the first two weeks of the year, with 70 percent of the budget exhausted by the end of March. This combined with soaring fuel costs, meant we were not going to be able to haul much rock in the fall to prepare the roads for the winter. We estimate that the cost of rock need for the fall could have been around $75,000.

A few years prior, we purchased two sets of “tiger–teeth” blades for use on the gravel surface roads. Our initial tests were mixed, due in part to inexperience with the system and unrefined techniques. However, we did find that these blades were very effective in scarifying a smooth ice surface on a gravel road during the winter, and we eventually acquired sets for each grader in the fleet. It was at this time that Leavenworth County Road & Bridge Superintendent Doug Smith modified operations and re-visited the use of rock reclamation blades for their designed purpose.

The majority of the graders were equipped with the “tiger-teeth” in the fall, but this time with excellent results. The blades brought the larger diameter rock to the surface; in effect rejuvenating the aggregate surface of the gravel roads.

Here are some of the results we came up with:
- Leavenworth County has had a significant amount of fines in the road rock used over the last few years. The teeth pulled the larger rock to the surface, leaving the fines in place and not damaging the crust.
- The “tiger-teeth” should be the only part of the blade that comes into contact with the road. Too much depth will result in damage to the road crust, worsening the condition of the road.
- A combination of ESCO® Bucyrus Blades and CAT® GraderBit System blades were used on the roads. Both were effective, yet the ESCO Blades have a lower purchase price and lower repair cost for broken teeth, albeit a higher tooth failure rate.
- This will most likely not be part of our annual gravel road maintenance plan, but will be implemented on a periodic basis. Overuse may reduce the road base depth and damage the crust.

Michael Spickelmier is county engineer for Leavenworth County, Kansas, and Doug Smith is the county’s road and bridge superintendent.
Test Your Knowledge: How Cool are You?  
By Matthew Barnett

With road work season upon us, it’s going to get HOT out there. Do you know how to stay healthy while working in the heat? Take this quiz to find out.

1. The best drink to have when working outside in the heat is:
   a. Pop or a sports beverage
   b. Iced coffee
   c. Sun tea
   d. Cool water

2. A worker can lose up to how many gallons of sweat a day?
   a. 1 gallon
   b. 7-10 gallons
   c. 2-3 gallons
   d. 5 cups

3. When is the best time to do strenuous work outside?
   a. There isn’t one
   b. High noon
   c. Early morning/late afternoon
   d. 10:00am – 4:00pm

4. Which of these types of clothing help reduce heat stress when working outside?
   a. Breathable clothing
   b. Loose-fitting
   c. Light-colored clothing
   d. A, B, and C

5. How often should you take breaks to drink water?
   a. Every couple hours
   b. Every 15-20 minutes
   c. A couple times a day
   d. When you are thirsty

6. What are sweating, dizziness, nausea and clammy skin symptoms of?
   a. Heat rash
   b. A hangover
   c. Heat exhaustion
   d. Heat stroke

7. The best foods to eat when working in the heat are?
   a. Fruits & veggies
   b. BBQ & fries
   c. Taquitos & refried beans
   d. Pizza

8. Road workers should eat...
   a. Three “squares” a day
   b. One main meal: a large breakfast
   c. Small meals frequently
   d. Whenever hungry

9. A worker with heat cramps should:
   a. Stop all activity and sit in a cool place
   b. Drink clear juice or a sports beverage
   c. Seek medical attention if on a low-sodium diet
   d. All of the above

10. Which of the following is NOT a heat stroke symptom?
    a. Dilated (large) pupils
    b. Skin that is dry to the touch
    c. Flushed complexion
    d. Confusion

11. How long does it approximately take the human body to adapt to working in the heat?
    a. 1 day
    b. 1 month
    c. 4-14 Days
    d. About 2 hours

12. Where is the best place to take a shade break?
    a. In your boss’s truck
    b. The nearest restaurant
    c. A shaded area with flowing air
    d. A hammock

13. Where can a worker go to find more information on working in the heat?
    c. http://www.cdc.gov/niosh/topics/heatstress
    d. All of the above

See page 13 for answers.
With the new regulations requiring accommodation for passage of fish and other aquatic organisms in culvert design, KDOT will be placing more open culverts with bends in them. That’s because, in some instances, bent culverts better approximate the geometry of the stream over which the road is crossing. Trouble is, adding a bend to a culvert can lower its efficiency in carrying water, and increase the likelihood of flooding upstream during a significant rain event.

A recent study sponsored by the Kansas DOT through its K-TRAN research program investigated head loss due to abrupt and gradual bends in open rectangular culverts, with the goal of helping practitioners build culverts with bends that will efficiently carry water. Surprisingly, researchers found little information in the literature about this.

The research methodology

Laboratory experiments were performed for subcritical flow in rectangular channels with abrupt bends. Bend angles of approximately 30, 45, 60, 75 and 90 degrees were tested.

A procedure was developed to estimate head loss for gradual bends, as well. The bend loss coefficients for gradual bends in closed conduits flowing full were used together with the abrupt bend experimental results to develop an adjustment factor. This factor was used to estimate a gradual bend loss coefficient for free surface flow in rectangular channels.

Example problems were presented illustrating the computation of bend loss for both an abrupt bend and a gradual bend in a rectangular open channel. The experimental data were plotted and analyzed by statistical methods. Several iterations were performed to obtain reasonable fits.

The results

The flume experiments demonstrated that head loss at abrupt bends in rectangular channels is influenced by both flow conditions and geometry. This study produced results in the form of tables, charts or equations that can be used by practicing engineers to compute head losses for abrupt and gradual culvert bends. The bend-loss coefficients can then be input into HEC-RAS via the Steady Flow Data editor option.

The researchers say that culvert bends will likely become more commonplace in the face of continued restrictions on construction at stream crossings to allow for passage of aquatic organisms.

The researchers recommend that the results of this study be used with a good degree of engineering judgement. They also recommend that experiments be undertaken to test the validity of the factors developed in the study that determined losses for gradual bends in rectangular channels.

For more information on this study, contact Dr. Dave Parr, University of Kansas Department of Civil, Environmental and Architectural Engineering, (785) 864-3808 or parr@ku.edu.

For a copy of the full report, contact the KDOT Library at (785) 291-3854 or library@ksdot.org. Or you can download it at http://www.ksdot.org/burmatrres/kdotlib2.asp.

Search for the word “culverts.”

Sources

Just Add Water

Pre-wetting your salt can save money by making the salt go further.

When winter weather strikes, a powerful weapon in a road crew's arsenal is salt—or rather, salt brine. Salt by itself does not melt ice. Salt needs moisture so that it can form salt brine, which then begins the chemical reaction that melts ice.

Chemicals like calcium chloride can be used to pre-wet salt, but just plain water works well, too. You can mix salt brine at your shop and use it to pre-wet road salt before it hits the roads.

As a pre-wetting agent, salt brine costs almost one-tenth the price of the popular calcium chloride, and because you can make it at the shop, there are no delivery charges.

Not too much salt, not too little
Although salt brine is simply salt and water, you must be precise in your measurements because salt's ability to melt ice relies on moisture content. To melt ice properly, salt brine should be 23.3 percent salt. If there is too much water, the salt will be diluted too much, and the water in the brine, not to mention the falling precipitation, will freeze on the road. If there is too much salt in the brine mixture, the road salt will lack the moisture needed to melt ice.

Pre-wetting your road salt
After you have finished making the salt brine, it can be added to your road salt using three basic methods. Some of these methods are better than others.

1) Soak the stockpile. At the first onset of winter, stockpiles of road salt can be pre-treated with salt brine. The method is not very effective because it is difficult to make sure that all of the salt in the stockpile is uniformly wet. It is also a challenge to keep the brine from leaching into the ground. Not recommended.

2) Prewet the salt one truckload at a time, using a sprayer at the shop. This method is more effective, because prewetting small amounts of salt increases the likelihood that all of the salt is uniformly prewetted.

3) Pre-wet before the salt hits the ground. This is the best method. It requires a conveyor belt and a flat brine sprayer mounted directly on the back of a truck that pre-wets salt as it enters the spreader.

Special equipment is needed
Salt brine pre-wetting reduces the amount of road salt (and its associated costs) needed to de-ice roads. However, special equipment is required to mix the brine and treat the salt. You need storage tanks, a brine-maker, and salt-brine sprayers. If you plan to use on-board sprayers to pre-wet salt, non-contact pumps that are resistant to corrosion are needed to move the brine to the truck sprayer tanks.

Cost
Brine mixing tanks cost about $5,000. On-board salt sprayers costs about $1,000. To avoid large initial investments, many road and bridge agencies have created their own systems for far less money. If you are building your own system, or just want to make sure the equipment you are about to buy is of good quality, it is important that all of the materials be non-corrosive.

Do's and don'ts
You don't need to pre-wet roads that are already wet. You can probably use dry salt alone for wet snow or freezing rain, while low temperatures with ice and powdery snow will require pre-wetted salt. The Federal Highway Administration considers salt brine to be effective in pre-wetting down to 15 degrees Fahrenheit. Below this temperature, they recommend mixing it with other pre-wetting chemicals that have lower freezing points, like calcium chloride.

Conclusion
Pre-wetting road salt with salt brine is an effective method to jump-start the melting process and make roads safer, faster. With the correct equipment and application procedures, pre-wetting can be a time-saving and cost-effective practice.

Sources
• The Salt Institute, www.saltinstitute.org
Salt may melt ice and snow, but it also causes wear to vehicles, equipment and the infrastructure it helps make safer. Over time, corrosion of steel in infrastructure can become extensive and cause major rehabilitation projects for bridges and roadways, projects that are costly and time-consuming. However, despite all of the research on alternatives to salt, and even with the wet salt technologies described on the previous page, salt remains the best deicing option for many. So what can agencies do to limit the corrosive potential of this important and powerful winter weapon?

**New protection technologies**

New technologies have been researched by the Federal Highway Administration (FHWA), and these include epoxy-coated rebar, cathodic protection, mixing concrete with an admixture, chloride sensors, improved sealers, and even replacing steel with plastic composite rebar. With these advancements in corrosion protection, FHWA has predicted that some bridges and parking garages will last 75-100 years.

The Salt Institute (www.saltinstitute.org) reports that each of these options has provided positive results. The New York Department of Transportation (DOT) has had success with the use of an admixture, or substance that is added to the mixture of cement and water during infrastructure construction. Cathodic protection, often used to prevent corrosion in water or fuel pipelines and storage tanks, has also proved valuable and has recently fallen in cost. With this drop in price, FHWA predicts that cathodic protection will be used more and more extensively in the future.

The Indiana DOT has studied the use of concrete sealers, which are applied to newly constructed or existing infrastructure. Improved sealants have shown possible protection for up to 3-5 years. Sealants are sprayed onto the painted steel and concrete of the infrastructure, curtailing permeability of the paint and therefore limiting corrosion.

**New inspection techniques**

Even the best sealants, however, will need to be reapplied after some period of time. However, until recently the knowledge of when new sealant was needed and how to determine the state of corrosion within a given infrastructure was based primarily on visual techniques. That is, the wear and tear of a specific bridge or roadway was evaluated through visual criteria that left the potential for misinformation. In 2004 the FHWA began testing new assessments of chloride corrosion through quantitative means, which would allow agencies to gain knowledge about the strength of the infrastructure and when sealant reapplication was necessary. Each of these tests, including the swab test, patch test, and sleeve test, had strengths and weaknesses, though the swab test proved most effective when done carefully and correctly. To read more about the FHWA tests, consult the source by Chong at the end of this article.

**Conclusion**

It is important to remember that while preventing corrosion of the steel in infrastructure is a key element in minimizing damage to infrastructure due to salt, preventing corrosion of the concrete itself is also critical. However, by taking appropriate measures during a construction or rehabilitation project—including controlling water content, proper placing, consolidating, finishing and curing—high levels of concrete durability can be achieved even in conditions of severe exposure.


**Sources**


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**How Cool Are You?**

*Continued from page 10*

**Quiz answers:**


Note: The heat stress Web sites in Questions 13 were the sources for this article.
WHAT’S NEW

By Lisa Harris

A QUICK CHECK OF YOUR HIGHWAY NETWORK HEALTH

Here’s a brief document that spells out the benefits of having a preventive maintenance strategy for pavement, rather than a “worst first,” project-driven approach. By using the quick checkup tool, road agencies can assess their maintenance needs and determine the adequacy of their resource allocation effort. The quick checkup can done with minimum calculations. A network maintenance strategy is illustrated in the document that includes preservation techniques such as concrete resealing, asphalt crack sealing and chip sealing. 6 pages. FHWA and the National Pavement Preservation Association, 2007.

TRANSPORTATION ASSET MANAGEMENT CASE STUDIES: CULVERT MANAGEMENT SYSTEMS

This report includes detailed case studies of culvert management systems from DOTs in Alabama, Maryland, Minnesota and also from Shelby County, Alabama. The 6-page case study from Shelby County will be of particular interest to local agencies. The full report is 40 pages. FHWA Office of Asset Management, 2007.

STOCKPILE RECOVERY TO MINIMIZE SEGREGATION

Proper stockpile management and loading procedures are a critical part of the overall highway construction process. This video describes how to prevent material segregation in a stockpile. Per the video, improper loading and sampling are the most common causes of segregated materials and are also the most easily corrected. This production is 10 years old, but the information is still valid. 8 minutes, FHWA and the Ohio Aggregates & Industrial Minerals Association, 1999.

CALENDAR

See our Web site for even more training calendar listings.
Go to www.ksltap.org and click on “View the LTAP Calendar.”

MINK 2009 LOCAL ROADS MEETING
October 13-14 in St. Joseph, MO
Call Lisa Harris at KS LTAP, 785/864-2590

CONCRETE ROAD AND STREET MAINTENANCE ▲ T
October 21 in Great Bend
October 23 in Topeka

BRIDGE MAINTENANCE
November 3 in Hays
November 4 in Wichita
November 5 in Chanute
November 6 in Lawrence

ROAD SAFETY ASSESSMENT ▲ M
(This is an elective course for the Master Road Scholar)
October 27 in Salina
December 1 in Wichita

SAFETY EFFECTS OF GEOMETRIC DESIGN FEATURES OF TWO-LANE RURAL HIGHWAYS ▲ M
(This is an elective course for the Master Road Scholar)
December 9 in Salina

SAVE THE DATE!
October 13-14, 2009 MINK9 Local Roads Meeting in St. Joseph, MO

For information on calendar items or to suggest a topic for an LTAP workshop, contact:
Kristin Kelly, LTAP Training Coordinator, 785/864-2594, kbkelly@ku.edu. For information on the Kansas Road Scholar Program, go to www.ksltap.org and click on “Road Scholar Program.”

▲ T = KS Road Scholar Program Level 1 — Technical skills required course.
▲ S = KS Road Scholar Program Level 2 — Supervisory skills courses are provided by the Kansas Association of Counties. Go to http://www.kansascounties.org and click on “Education Program.”
▲ M = KS Road Scholar Program Level 3 — Master Road Scholar course.

NEED SOME TRAINING ON RISK AND LIABILITY?

Kansas LTAP is offering a course on risk and liability, in two locations, in late fall. See the last listing above. This course is offered every other year, so don’t miss out! It is a required Level 1 Road Scholar course.
FREE ROAD & BRIDGE RESOURCES

Check off your selections, fill in the bottom portion, and return this form to:
LTAP Materials Request, 1530 W. 15th St., Room 2160, Lawrence, Kansas 66045 or fax to 785/864-3199

REPORTS & TRAINING VIDEOS
You are free to keep these unless otherwise noted.
Or you can download at the links provided.

A Quick Check of Your Network Health
6 pages. See description on page 14.
Download at: www.ksltap.org or ❑ request hard copy

Transportation Asset Management Case Studies: Culvert Management Systems
40 pages. See description on page 14.
Download at: www.ksltap.org or ❑ request hard copy

Stockpile Recovery to Minimize Segregation (video)
8 minutes. See description on page 14.
❑ DVD to keep; or ❑ VHS, with two week loan period

Gravel Roads Maintenance and Design Manual
102 pages. See description on page 5.
Download at: www.ksltap.org or ❑ request hard copy

Gravel Road Maintenance: Meeting the Challenge (video)
22 minutes. See description on page 5.
❑ DVD to keep; or ❑ VHS, with two week loan period

EQUIPMENT
We offer turning movement counter boards for loan to local highway agencies. Call us at (785) 864-5658 to arrange a loan. There could be a waiting list for these items.

❑ Turning Movement Counter Board DB-400, Jamar Technologies, Inc.
A basic model for recording turning movements at intersections. The board is lightweight and comes with its own case.

❑ Turning Movement Counter Board TDC-8, Jamar Technologies, Inc.
Can be used to do turning movement counts, classification counts, gap studies, stop-delay studies, speed studies, and travel time studies. The board is lightweight and comes with its own case.

REQUEST FORM
❑ send materials indicated ❑ address correction ❑ add to newsletter mail list ❑ send 2009 Resource Catalog

Name________________________________________________ Phone number ____________________________

Position__________________________________ E-mail address ___________________________________

Agency ______________________________________________________________________________________

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*For requests outside the United States: After receiving your request, we will notify you of the postage cost and will send materials after receiving payment for postage.

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Let us at the Kansas LTAP help you find the answers to your transportation-related questions.

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The Kansas LTAP Newsletter is one of the KUTC's educational and technology transfer activities. Published quarterly, the newsletter is free to counties, cities, townships, tribal governments, road districts and others with transportation responsibilities. Editorial decisions are made by the Kansas LTAP. Engineering practices and procedures set forth in this newsletter shall be implemented by or under the supervision of a licensed professional engineer in accordance with Kansas state statutes dealing with the technical professions.

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