Imagine a pavement that offers a quieter ride, lasts longer than conventional asphalt pavement, and makes use of a consumer waste product. Not only would this pavement be easier and less expensive to maintain, it would benefit the environment and incorporate used tires—a resource that currently has very few uses. Crumb rubber asphalt made with recycled tires may be that pavement, and a research project in Michigan may determine whether crumb rubber roads will be sustainable in northern Michigan.

The use of crumb rubber in asphalt can be traced back to the 1840s, but its debut as a successful surface treatment came in the 1960s. To make crumb rubber asphalt, tires are processed to remove the steel and fiber from the treads, and the rubber is either ground or fractured to make it small enough to blend into the asphalt binder. Cryogenic fracturing the tire pieces results in smooth particles with a relatively small surface area, while grinding at ambient temperatures results in particles which are rough in texture and have a larger surface area. The resulting particles will vary in size, with 4 to 5 mm being the largest.

Once the rubber has been processed, there are three general options for creating binders and mixtures, which will result in pavements with very different properties. The dry process replaces between 1 and 3% of the aggregate with crumb rubber. Because the crumb rubber acts more as an aggregate than an asphalt cement, it is the least used method of the three. The wet on-site process blends the crumb rubber in a mixing tank on site and allows it to react with the asphalt binder for a set period of time, which results in the rubber particles being “digested” by the binder. Wet on-site process asphalt is typically used in gap- or open-graded mixes and chip-seal applications. Terminal blend is also a wet process that produces a binder of crumb rubber blended with hot asphalt. The mixing process occurs at the asphalt terminal or refinery and does not require special facilities. Terminal blends are notable for long storage life with proper agitation. They can be used in all pavement applications, but are best for dense-graded mixes. Terminal blends can also be used in chip seal, slurry seal, and tack coat applications.

Benefits of Crumb Rubber Asphalt

Crumb rubber has been successfully used in surface treatments in Texas, Florida, Arizona, and California for more than 30 years. According to the California Department of Transportation, crumb rubber asphalt boasts lower maintenance costs because of its improved durability and performance. The higher binder content and elasticity are the source of that durability, along with greater resistance to cracking and less susceptibility to temperature fluctuations. In addition to a longer life span, reduced traffic noise (from 40 – 88% reduction) has also been documented in California, Arizona, and several European countries.

Because crumb rubber is made from recycled tires that would otherwise be discarded or burned, there are also environmental benefits. Up to 11 million tires are discarded each year in Michigan alone; tires that pile up at scrap tire sites are...
eventually processed and burned, which still leaves the incinerator ash to dispose of. Without careful monitoring of tire waste, there is potential for massive fires like the one that burned for 23 days in the Traverse City area in 1995. Using those scrap tires instead as a performance-improving material in asphalt eliminates waste, reduces the risk of fire fires, and is ultimately a beneficial process.

**Research Addressing Concerns**

Two of the main concerns with using crumb rubber asphalt are air quality and worker health. Although the process is environmentally friendly from the perspective of recycling tire waste, the effect on air quality must also be within the standards of the State of Michigan. There have also been documented paving issues related to cold temperature paving or late season paving, raising the question of whether this technology would be viable in states with a colder climate.

This year, the Michigan Department of Environmental Quality (DEQ) awarded a series of grants to research whether crumb rubber asphalt could be viably used in Michigan. Two of those grants were awarded to Michigan Technological University and totaled $1.2 million. One study, led by David Hand, PhD, chair of the Civil and Environmental Engineering (CEE) Department, focused specifically on monitoring emissions from the plants producing the asphalt. The second study, led by Zhanping You, PhD, also of the CEE Department, was centered on producing a low emission crumb rubber asphalt mix.

**“It should do well in a colder climate.”**

The studies took place in Keweenaw and Muskegon counties. In each county, a stretch of road was paved in three sample sections: one with regular HMA, one with hot mix crumb rubber asphalt, and one with low emission crumb rubber asphalt (called warm mix asphalt). In both crumb rubber asphalt road sections in the study, the crumb rubber content was 12% of the volume of the asphalt binder. The low emission asphalt was produced at temperatures approximately 50 degrees Fahrenheit below standard HMA temperatures; lower temperatures mean fewer volatiles are released into the air and a safer environment for workers during construction. This also means less fuel is consumed in the production process, which lowers emissions significantly.

Dr. Hand monitored the emissions of the full-scale plant for each mix. Testing full-scale plants ensures the production process will meet air quality standards in the State of Michigan. At this point in the study, he believes the results are promising for meeting the standards.

Dr. You employed a comprehensive set of tests to evaluate the performance at high, intermediate, and low temperatures. The tests include the Hamberg Wheel Tracking test to analyze rutting and stripping; the Asphalt Pavement Analyzer test to analyze rutting; anti-rutting and anti-cracking testing on the asphalt binder; the crack energy of the materials (how much energy is needed to crack the samples); and moisture susceptibility. “It should do well in a colder climate,” he says. He is continuing to monitor and test samples of the asphalt pavement from both Keweenaw and Muskegon counties.

Lincoln Noel is the Michigan area manager of Payne & Dolan, Inc., the contracting company responsible for implementing the project in Keweenaw County. The crumb rubber asphalt used in the project was a terminal blend, which he says required that it be circulated continuously. “Otherwise, the rubber will separate from the liquid asphalt. Once that happens the product cannot be re-blended for use again.” Regarding the low emission crumb rubber asphalt, he says, “The paving process was very similar to paving with regular HMA.” The biggest problem they encountered was being able to pump the crumb rubber asphalt binder out of their asphalt tank to produce a consistent quality product. He also notes that the crumb rubber asphalt cooled at a faster rate than traditional HMA, and the final product is a much coarser mix. “Fortunately,” he says, “we didn’t experience any issues with compaction. With the coarser mix, though, the mixture will tend to cool at an uneven rate, which could cause compaction difficulties.”

**Cost versus Life Cycle**

The cost of crumb rubber asphalt is notably greater than standard HMA, which Dr. Hand explains was significantly impacted by shipping distance. The closest crumb rubber asphalt binder supplier was in Illinois, which meant a nine-hour shipping time to Keweenaw County. However, if crumb rubber asphalt increases the long-term performance of a pavement over standard HMA, the market demand should grow and would likely result in the product being much more readily available.

Although rubber processing, handling, and blending are additional costs in crumb rubber asphalt manufacturing, the use of a waste product may counteract those costs. It's yet unclear how the costs of crumb rubber and HMA will compare in the future.

**Conclusion**

Use of crumb rubber in HMA projects is generally not eligible for financial reimbursement in projects funded through the Federal transportation program. An underlying reason for this is the lack of a standard for crumb rubber asphalt binder testing in the field. Nonetheless, continued research intends to determine whether additional costs will be worthwhile, especially if a longer lifespan means less time and funds spent on maintenance. Both studies will help the Michigan regulatory agencies to decide whether crumb rubber asphalt is safe for workers and the environment, and Keweenaw and Muskegon Counties will continue to monitor the sample roads through Michigan winters and under regular traffic.

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The road was paved with three sample sections and sample cores were taken from each section for testing.

Final reports of the Michigan Tech studies should be released in 2016. The Bridge will provide updates or links to the reports.
Imagine walking through your daily route in your city. Now imagine navigating that same path in a wheelchair or with a walker. Can you think of a few sidewalks, curbs, or sets of stairs that would prove to be a real challenge, or even an impossibility?

Nearly one in five Americans have a disability; more than 10 percent of Americans have reported “difficulty walking or climbing stairs, or used a wheelchair, cane, crutches, or walker”.1 With disabilities being a reality for so many Americans, it’s necessary to update and improve sidewalks, curbs, and crosswalks to ensure that everyone can access our public places. Fortunately, there are plenty of resources available for local and state agencies looking to improve their ADA compliance plans.

What is ADA compliance?

Beginning in 1968 with the Architectural Barriers Act and culminating with the significant Title II of the Americans with Disabilities Act (ADA) in 1990, legal proceedings require local and state road agencies and municipalities to ensure equal access to transportation. According to Title II of ADA, transportation authorities must make sure all pedestrians, regardless of ability or disability, have access to public right-of-way. Ensuring this equal access is known as ADA compliance.

When is ADA compliance necessary?

ADA compliance is necessary for transportation facilities when beginning new construction, when altering existing construction, and when the design of existing facilities denies access. But, when considering a new project, such as a road construction project, it is important to ask yourself — are you maintaining the road or altering it? This difference is key to understanding when ADA compliance is necessary.

Maintaining, according to the US DOT Federal Highway Administration (FHWA), is sealing chips, filling cracks, and patching pavement; it does not require you to bring existing structures into ADA compliance. However, alteration is reconstruction, rehabilitation, or widening of a road. This does require you to bring existing structures into compliance. What may be surprising is that alteration, according to the US Court of Appeals, includes resurfacing. Road construction projects that require modifications for ADA compliance most commonly involve installation of curb ramps.

Forming an ADA Transition Plan

If you are a public entity with more than 50 employees, then you must develop a plan for compliance. A transition plan includes an ADA coordinator, a complaint process, design standards, public involvement opportunities, identified Barriers to Access, and a timeline and budget for removing barriers.2 The FHWA publishes the NCHRP report ADA Transition Plans: A Guide to Best Management Practices (www.fhwa.dot.gov/indiv/docs/ada_transition_plans_report.pdf), which provides information on developing a transition plan.

Developing a good process to facilitate dialogue with the public ensures that barriers to access can be addressed quickly. While not all types of projects may require ADA compliance, ADA compliance can also be enforced if someone makes a complaint. Once a citizen has filed a grievance or a complaint on an area, it should be prioritized. If the area remains unaddressed, the issue could escalate into lawsuits, heavy fines, and legal fees.

ADA Compliance Workshop

The Michigan Concrete Association in conjunction with Michigan’s LTAP, MDOT, and the FHWA offers a half-day workshop in Okemos, Michigan that presents ADA standards for transportation infrastructure, such as roads, sidewalks, and driveways. By learning how to integrate ADA-compliant designs in construction projects, contractors and inspectors will guarantee mobility opportunities for all pedestrians. Sessions include:

• Tuesday, February 2, 2016
• Tuesday, March 1, 2016
• Tuesday, April 5, 2016

For more information, visit ctt.mtu.edu or call (906) 487-2102.

Additional Resources

US Access Board: http://tinyurl.com/mjhmk3j

ADA Updates: http://www.ada.gov/

FHWA: http://www.fhwa.dot.gov/

MDOT: http://mi.michigan.gov/mdot

(Search "ADA")

1 According to a study by the United States Census Bureau in 2012, http://tinyurl.com/6auna4

PPE: Investing in a Safety Lifestyle

Victoria Sage - Technical Writer
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Center for Technology & Training

Workplace-related eye injuries affect about 2000 workers every day; a third of these injuries need emergency medical care. Each year, eye injuries cost employers “over $300 million in lost production time, medical and legal expenses, and workers compensation.”

With proper protective eyewear, an estimated 90% of workplace-related eye injuries are preventable. Employees don’t wear their personal protective equipment (PPE) primarily due to a lack of employer enforcement but also because the PPE “lack[s]... style/comfort” and “hampers job performance.” PPE styling and its impact on job performance proved important in a subsequent military study that discovered that soldiers were more likely to wear modern-looking, easy-to-use, versatile protective eyewear without extra prompting.

PPE is a necessary and important budget item for protecting your employees. While cheap PPE may be a tempting way to economize, buying poorly designed, low-quality PPE might not equate to long-term safety or savings. Purchasing PPE is an investment in protective technology that is engineered to fit well and comfortably in the face of occupational hazards; making wise choices for your PPE investments can lead to long-term savings.

Proper Fit is Part of Safety

Improperly designed PPE doesn’t fit well, isn’t comfortable, and can even be a safety hazard. For example, standard-issue, buy-in-bulk safety glasses may feature slip resistance, wraparound design, and anti-scratch lenses. But, these glasses are often all one piece and come in general sizes so they fail to account for facial structure variances in an increasingly diversified workforce. If safety glasses can’t accommodate narrower faces or nose bridges, they’ll create unprotected gaps diminishing the ability to shield against hazards like debris and dust, glare, and chemical splashes. Likewise, if they can’t adjust to wider faces or nose bridges, they’ll fit too tightly and create soreness. Constantly needing to reposition or remove safety glasses impedes productive and increases chances of lens scratches. Proper fit or styling ensures employee comfort and protection without hampering their work.

Quality safety glasses come equipped with improved fit/styling features like adjustable silicone nose pads, pivoting temple arms, and distortion-free wraparound designs. Such safety glasses, which range from $10-30 a pair to $200+, are a value-laden technology that safeguard workers through their additional options like prescription lenses, polarized lenses (blocks UV and blue light, which gives additional clarity), tinted lenses (optimizes protection against various light exposures), anti-scratch and anti-fog lenses, and oil-repellent coatings.

Spending a little extra upfront for safety eyewear that has changeable lenses or for higher quality eyewear may save money in the long run. Purchasing more expensive safety eyewear and replacement lenses may yield cost savings over buying lower quality safety eyewear and completely replacing the eyewear. Similarly, purchasing and occasionally replacing higher-quality safety eyewear can result in greater savings than frequently buying and replacing low-quality safety eyewear.

The advantages of good design and quality don’t just apply to safety glasses, but to all PPE. Hard hats, for example, range from nothing but a vinyl headband to terrycloth linings that wick away sweat. Or, high-visibility safety vests can be made from non-breathable polyester mesh or from longer lasting, more comfortable materials like high-performance polyester blends.

Quality PPE in a Safety Lifestyle

Because quality PPE is a technology that’s engineered to protect with improved comfort and style for the user, it’s an investment in something your employees feel good about wearing. And, if they can select brand name eyewear like Harley Davidsons or Oakleys or Gargoyles, they may even want to wear their PPE. Making quality PPE possible and fostering pride of ownership in employees for their PPE can be done through a co-purchase: determine how much you can allot for each employee’s PPE, give employees the option to cover costs in excess of your allowance when they select their own PPE (e.g., using unspent flexible spending account money, out of pocket), and give full ownership of the co-purchased PPE to the employee. PPE that fits well and is versatile for the employee is more likely to be worn and cared for. Ensuring adequate protection and engaging your employees in a safety lifestyle can guarantee the safety of your greatest asset: your workers.

References

1. CDC, "Eye Safety", 2013: http://www.cdc.gov/niosh/topics/eye
7. See Steven Hott’s story in Road Commission for Oakland County Coins a PPE Reward Program on page 5
The Road Commission for Oakland County (RCOC) has its own way of making PPE and safety a priority. Steven Hott, RCOC Safety Supervisor, first instituted a coin incentive program in May 2015. When talking about how the idea came about, Hott says, “I wanted to give back to the employees and give them a token from the road commission itself. It’s basically a big brass coin — I got the idea from the military which uses coins like this to commemorate things.”

Once the coins were made, everyone was given one. If Hott sees someone wearing all of their PPE and safely completing their job while they have the coin with them, they are given a ten dollar gift card to businesses like Target, Kroger, or Bass Pro Shops. If they don’t have the coin on them, there’s no punishment — the only downfall is missing out on a gift card.

If an employee loses their coin, they’ll be given a replacement. Hott says, “It’s given our employees a little bit more of a push to make sure they’re always wearing their PPE and complying with the safety regulations we have in place.”

When asked if he has any advice for other road commissions looking to make safety and PPE a priority, Hott said, “Safety is a lifestyle. That’s one of the things printed on this coin and you have to keep putting safety in front of them. You can’t just have safety training once a year; you need to keep introducing safety on a constant basis.”

Hott’s coin does just that by giving employees a physical reminder to carry even when they aren’t on the job. His program is proof that it’s possible to make safety a lifestyle for everyone.

Win a Brand New Safety Vest!

Do you have worn out PPE?
Is your safety vest more asphalt gray than safety orange?
Send us your pictures of worn, dirty, torn up PPE and you could win a new safety vest worth up to $200!

To Enter
Send us a photo of you wearing your worn-out safety vest along with a short story about how your safety vest was damaged.

All submissions should be sent to ctt@mtu.edu by February 29, 2016. Use “Safety Vest Contest” in the subject line. Include your name, phone number, and safety vest story in your email and attach your photo before sending.

Winners will be announced in the Spring issue of The Bridge.
12 Tips for Maintaining Unpaved Roads Using Motor Graders

Article re-printed from Iowa LTAP’s adaptation of Caterpillar’s Governmental Solutions, Spring 2012.

Like fingerprints, each unpaved road is unique. The wear surface may be gravel, crushed rock, or sand, but all have one thing in common: maintenance is required to keep the roadway in good driving condition. Traffic displaces road surface material onto shoulders and into ditches, forming ruts in the roadway. Washboarding forms at stop signs, hills, and turns, and in areas of acceleration or braking. Storms, runoff, and snowplowing also take their toll on unpaved roadways.

Following are 12 tips that can help motorgrader operators to lengthen road maintenance intervals and avoid rework:

1 To remove washboarding, cut the corrugations to their full depth, then regrade the area with moist material that will compact. (Corrugations filled with loose, dry materials will reform quickly in areas of high vehicle traffic.) Corrugations are best removed using a scarifier or a serrated cutting edge.

2 Articulating the rear frame toward the toe of the moldboard by 2 to 5 degrees helps reduce motor graders’ tendency to bounce, and is extremely effective when cutting out washboards. This places one front tire slightly ahead of the other, allowing one tire to be on top of a corrugation while the other is in the bottom. As the tires roll up and down through the washboard, the front axle will pivot up and down, keeping the front mainframe stable. Don’t use the crab mode when scarifying washboarded areas, as this can bend the scarifier shanks and/or linkage.

3 Cut to the depth of major potholes to eliminate them. (Again, filling holes with loose, dry material is ineffective, as traffic quickly displaces the loose material and the holes reform.)

4 Typically, begin road maintenance with the moldboard top approximately 2 inches ahead of the cutting edge, and then adjust to the material and conditions. Tip the moldboard forward or back to obtain and maintain the desired cutting-rolling action. Tipping the moldboard forward will increase moldboard throat clearance. Generally, a wider throat opening allows better material flow along the moldboard in a wide variety of soil types. Maintaining a rolling action on the material while working reduces the horsepower required and provides maximum productivity.

5 Material buildup in the circle area may increase circle wear. It can also stop material rolling action and cause it to be bulldozed. Bulldozing material requires more horsepower and more traction and reduces motor grader productivity.

6 Apply only enough downward pressure to accomplish the task. Excessive downward pressure on a hard, dry surface causes rapid cutting edge wear, requires more horsepower and fuel, and reduces productivity.

7 The blade’s tip angle should be positioned with the cutting edge at 90 degrees to the road surface. In this position, downward pressure on the moldboard places less stress on the cutting edge and retaining bolts. The edges also tend to ride over objects, which helps prevent machine damage.

8 For maximum machine stability when maintaining roadways, the motor grader’s main frame should be straight with the drawbar and circle-centered under the frame.

9 For the widest possible pass on the travel surface, keep the moldboard angle as square to the frame as possible. If material starts to flow around the leading end of the moldboard, or the rolling action dies, increase the blade angle.

10 Keep machine travel speed as high as possible for maximum productivity but low enough to prevent machine bounce (generally, 3 to 5 mph).

11 Moldboard angles of 10 to 30 degrees are normally used in light, free-flowing material. Higher moldboard angles of 30 to 50 degrees are required when processing wet-sticky material, mixing large windrows, and ditching.

12 To cut hard material or for finishing work, tip the moldboard further forward than the start position. When finishing, tip the moldboard top 4 to 5 inches ahead of the cutting edge so the cutting edge is approximately 90 degrees to the cut surface. This moldboard tip position will generally position the drawbar parallel to the finished grade.

As always, road conditions and your fleet are factors in your agency’s road maintenance practices.
The summer after my sophomore year of college, I took my first internship. When the project I was hired to work on was cancelled (on my first day, no less!), I ended up in a position where there just wasn’t enough work to keep me busy. Just the same, I spent time with mentors who gave me valuable advice about the work place and about life. I went to meetings where I learned more from the firmware engineers about solid state drives than I ever thought I would. I hung around my coworkers whenever I could, laughing at their jokes and stories. That summer wasn’t so bad, as I learned an important message: it’s the people that matter.

This issue of The Bridge has two articles that center on issues related to people. Certainly everyone knows about PPE and why it’s important, but how often have you considered how safety glasses or a reflective vest might save a friend’s life? And ADA compliance isn’t exactly a new legal obligation, but have you ever imagined your own aging parent being unable to cross a street without proper cross ramps? Whether it’s designing things that will be accessible and useful to everyone, or maintaining the roads and facilities that the ramps? Whether it’s designing things that will be accessible and useful to everyone, or maintaining the roads and facilities that the ramps?

The Motor Grader Operator’s Training Manual developed by Michigan LTAP is used in motor grader trainings throughout Michigan each year. In addition to gravel road maintenance, the manual covers parts of the road, dust and erosion control, and safety procedures.

The 2015 FHWA Gravel Roads Construction & Maintenance Guide is now available! The Center for Technology & Training will be sending a copy to every county road commission, and there will be 20 additional copies available for cities, townships, and villages on a first come, first served basis. The electronic version is available here: http://www.fhwa.dot.gov/construction/pubs/ots15002.pdf

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About LTAP

The Local Technical Assistance Program (LTAP) is a nationwide effort funded by the Federal Highway Administration and individual state departments of transportation. The goal of the LTAP effort is to foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers.

Steering Committee

The LTAP Steering Committee makes recommendations on, and evaluations of, the activities of Michigan’s LTAP.

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Michigan Tech
Upcoming Events
Register at ctt.mtu.edu/training

2016 Materials Acceptance Process Seminar
Feb 17 – Prudenville
Mar 17 – Grand Rapids

2016 County Engineers’ Workshop
Feb 2-4 – Manistee

2016 Michigan Bridge Conference
Mar 22-23 – Lansing

PASER Training 2016

Webinars
• Feb 16 – 9:00AM-11:30AM
• Feb 18 – 1:00PM-3:30PM
• Mar 9 – 9:00AM-11:30AM
• Mar 21 – 1:00PM-3:30PM

On-site Training 8:00AM-12:00PM
(Certification Testing 1:00PM-3:00PM)
• Feb 23 – Forward Conference Center, West Branch
• Feb 24 – Dow Event Center, Saginaw
• Feb 25 – Okemos Conference Center, Okemos
• Mar 29 – Crowne Plaza, Grand Rapids
• Mar 30 – Kalamazoo CRC, Kalamazoo
• Mar 31 – Henry Ford Community College, M-TEC, Dearborn
• Apr 5 – University Center at Gaylord, Gaylord
• Apr 6 – Delta CRC, Escanaba
• Apr 7 – Red Rock Banquet Center, Ishpeming

Registration and additional information on the sessions can be found at ctt.mtu.edu/training