When The Rubber Is The Road :: By Linley Erin Hall
Nearly 4 million miles of road crisscross the United States. Wide freeways cut through huge cities. Small streets wind through residential and agricultural areas. Each and every day more than 235 million cars, trucks, buses, and motorcycles travel over these roads to transport children to school, adults to work, and goods from producer to consumer. When a road develops potholes, cracks, or other problems that require construction, the resulting detours and delays often make drivers and their passengers cranky. The hazards can also cause accidents.

Conventional pavements are made of either asphalt or concrete. These materials require major maintenance every 10 to 20 years. But researchers have found that adding a common, simple material to asphalt can increase the pavement’s lifetime. It also can reduce freeway noise, increase visibility in wet weather, reduce air pollution, decrease waste going to landfills, and even affect the temperature of a city. The material is rubber.

“ Longer pavement service life translates to fewer detours and highway closures for maintenance. It can also decrease time delays and vehicle operating costs for the user,” says Kamil Kaloush, an assistant professor of civil and environmental engineering at Arizona State University. “Asphalt rubber pavements have performed well in Arizona since 1988.”

Road builders have used asphalt rubber pavements in Arizona for many years. But researchers still have much to learn about their properties and long term benefits. Kaloush and his ASU colleagues work closely with the Arizona Department of Transportation (ADOT) and other agencies to study the material.
To produce asphalt rubber pavements, old tires are shredded to make crumbs of rubber about the size of coarse sand. This rubber is then mixed with asphalt and cement. The resulting mix is then blended with aggregates such as sand or crushed gravel using conventional methods to produce the mixture for paving. Kaloush says that about 2,000 tires go into each lane-mile of asphalt rubber pavement. In Arizona, more than 20 million tires have been recycled in this way since 1988.

No one wants to live near a freeway. The noise that cars make as they zoom by is intense. Sound walls that separate the freeway from the surrounding area can help, as can recessing the freeway into the ground. But these solutions have other problems. Sound walls are expensive and generally unattractive. Recessed freeways surrounded by sound walls trap heat. This is particularly bad on summer days in metropolitan Phoenix when the temperature can soar above 115 degrees.

One huge benefit of asphalt rubber pavements is noise reduction. Freeways made of concrete are noisier than those made of asphalt—and asphalt rubber is by far the quietest pavement.

Concrete is hard and brittle. Running a tire over it makes more noise than the same tire would on a surface that is more elastic and flexible. Asphalt rubber has those desired characteristics.

To date, researchers have found that asphalt rubber reduces road noise by up to six decibels. The difference between normal conversation and a whisper is about 10 decibels. When asphalt rubber pavements are warmer, they are also more elastic. As a result, noise improvements may be more noticeable in the summer.

Kaloush says that asphalt rubber pavements may also contribute less to air pollution than do conventional pavements. To study the possibility, Kaloush teamed up with ASU colleague Jonathan Allen, an assistant professor of civil and environmental engineering. “Tire wear may be a significant contributor to the amount of particulate matter in the air,” Allen says. Both he and Kaloush believe that tires running over asphalt rubber pavement wear down slower than those rolling over concrete pavement.

The recent repaving of the Interstate 10 Deck Park Tunnel in downtown Phoenix provided an opportunity to test the hypothesis. Researchers collected air samples from the tunnel before and after the rubber asphalt was laid down. They also measured surface friction, ride, noise levels, and temperatures. The study is ongoing.

Asphalt rubber pavements also have the potential to make central Arizona cooler at night. The Phoenix metropolitan area is an urban heat island. Buildings, parking lots, and roads absorb heat during the day, then slowly release it during the night. As a result, average nighttime temperatures have increased yearly.

Other cities around the world struggle with the same problem. With urban areas gaining an estimated 67 million people per year, it’s likely to become worse.

“According to the United Nations, by 2030, approximately 5 billion people are expected to live in urban areas. That is about 60 percent of the projected global population of 8.3 billion people,” says Jay Golden. He directs the Sustainable Materials and Renewable Technologies (SMART) Program at ASU’s brand new International Institute for Sustainability. “The rapid urbanization of our planet places various stresses on a region. We want to support the sustainable development of urban regions on a global scale.”

ASU researchers are exploring many different strategies to help mitigate heat. Canopies in parking lots can keep both pavement and cars cooler. Use of light colored building materials can also help. Dark colors absorb more heat. Despite its black color, asphalt rubber pavement may also have a role to play.

Paved areas, including highways, roads, sidewalks, and parking lots, make up 40 percent of the surface area in metropolitan Phoenix. ASU researchers have used satellite imaging, in-pavement temperature sensors, and other techniques to examine the amount of heat absorbed by different materials over different periods of time. They found that paved areas are warmer than the rest of the region, in part because they are often dark-colored. However, asphalt rubber pavements are more porous. Because of this and the insulating effects of the rubber crumbs, the pavement doesn’t retain heat. It is cooler at night.

Golden and Kaloush have teamed with international researchers and governmental agencies. They are performing environmental and economic evaluations of a variety of infrastructure projects that use crumb rubber. For example, crumb rubber can also be added to concrete to provide porosity and insulation. “The work has environmental, economic, and social importance not only for our region but on a global basis,” Golden says. “We want to use materials that are cost-effective, easily maintained, and socially appealing. We also want to identify materials that reduce energy, can be recycled, improve air quality, and are efficient with storm water.”

Despite its many advantages, asphalt rubber pavement is not widely used in the United States. One obstacle is money. The initial cost of paving can be twice that of conventional pavements. However, research and use shows that asphalt rubber lasts longer and requires less maintenance than other pavements. Its life cycle cost—the cost over the entire lifetime of the pavement—is less than that of conventional pavements.

The research also provides a good educational opportunity in the classroom. The paving process is taught as part of a Highway Materials and Construction class for senior undergraduate civil engineering students. “We’re not just focused on asphalt rubber,” Kaloush adds. “But it has been a very successful material in Arizona.”

With the help of ASU researchers, driving in Phoenix is becoming a more pleasant experience. Next time your car glides from a bumpy, cracked, noisy road onto a smooth, quiet one, enjoy the asphalt rubber pavement.

Research on asphalt rubber pavement at ASU is supported by the Arizona Department of Transportation and the Ford Motor Company. For more information, contact Kamil Kaloush, Ph.D., P.E., Department of Civil and Environmental Engineering, 480.965.5569. Send e-mail to kaloush@asu.edu.
Material Worlds  Engineers at ASU’s Advanced Pavements Laboratory want to understand how different materials behave under different conditions. Matt Witczak, a professor of civil and environmental engineering, leads the effort. To get answers, ASU researchers test the performance characteristics of different pavement mixes. They use tests to study a variety of properties of the pavement material, including deformation at high temperatures and cracking at low temperatures. **Two major types** of pavement exist, asphalt and concrete. **Asphalt** is a black byproduct of petroleum distillation. It can also occur naturally. What people normally think of as asphalt is the mixture of asphalt with crushed gravel and sand, which is used for paving. Rubber is added to the mixture to produce asphalt rubber pavement. The amount of rubber varies, but in Arizona it usually makes up 20 percent of the asphalt weight, or approximately 2 percent of the total pavement mixture. **Cement** is a powder of limestone and clay. It can be mixed with water and set or used as an ingredient in concrete. **Concrete** is a mixture of cement and sand, gravel, pebbles, broken stone or slag. **The amount** of various components used can vary depending on the climate and traffic where the paving mixture will be used. A busy highway in snowy Flagstaff will have very different needs than a quiet, residential street in sunny Tempe.

“Laboratory testing of mixtures that are used in construction will identify inferior mixtures as well as predict the pavement performance,” says Kamil Kaloush, assistant professor of civil and environmental engineering. “If something were to go wrong in the first few years, we want to be able to trace it to a construction or a material problem. Understanding the material behavior in the laboratory will help us design and construct better performing pavements in the future.” The lab’s results are stored in a database that can be used by other researchers and transportation agencies. Those results can help them to decide if asphalt rubber is the best material for a particular paving project. Despite only four years of work in this area, the ASU Advanced Pavements Laboratory received the 2002 Research Award from the Rubber Pavements Association.

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