The Asphalt Rubber

When asphalt rubber silenced road noise on an Arizona freeway, the public demanded more.

By Michael Fickes

The equipment for adding crumb rubber to Hot Mix Asphalt can be set up at a typical HMA plant.

Dan Galvin winced as he scrolled down a long list of e-mails. As community-relations liaison for Granite Construction Co., Watsonville, California, Galvin had been brought in to take the heat in case construction along Superstition Freeway (US 60) between Tempe and Mesa, Arizona made drivers mad. The project included widening 12 miles of road in both directions and then resurfacing with an open-graded asphalt rubber overlay.

Galvin clicked on the first e-mail. "I just had to write and say that the new rubberized asphalt on US 60 totally rocks. …What is the chance of re-surfacing ALL of our highways with that stuff?"

Surprised, Galvin clicked on the second message: "Congratulations to all of you on this super job, completed early! And the quiet pavement is fabulous — it should be used everywhere."

And the next: "Love that rubberized surface…will you be doing the off-ramps like that too?"

What was so tough about community-relations, smiled Galvin.

Overall, the public reaction to the US 60 job was massive and positive. Within months, e-mail to Galvin had given way to letters-to-the-editor and calls to radio talk shows. Drivers liked the quiet asphalt rubber ride. People living near the roadway liked not hearing the quiet-driving cars. Everyone wanted more asphalt rubber roads.

While Granite Construction Co. has constructed a number of asphalt rubber pavements across the southern tier of the country, US 60 was the first to set off a public movement. Arizona's state and local governments soon responded with a $34-million asphalt rubber resurfacing plan that will encompass 115 miles of existing concrete freeways in Maricopa County, which surrounds Phoenix, the state capital.

The Departments of Transportation in Arizona, California, Florida, and Texas routinely specify asphalt rubber for road overlays. A number of other states have experimented with the material.

Since 1988, Arizona has paved 2,400 miles of its 7,400-mile state road network with asphalt rubber. About 14 million old tires have been ground up and added to Arizona's growing inventory of asphalt rubber roads.

The state began using asphalt rubber overlays to maintain roads, according to George Way, chief

Phenomenon

The asphalt rubber overlay on Superstition Freeway (US 60) prompted numerous compliments from neighbors.

pavement design engineer for Arizona DOT. The overlays performed so well that recently the state has begun to experiment with asphalt rubber as a material for new roads.

During the past decade, continues Way, fears about constrained supplies of aggregate have crept into public discussions of roads. Public land in Arizona contains mountains of aggregate, but acquiring permits to mine the stone has grown difficult. Looking ahead to a time when aggregate may be in short supply, the state has begun to research alternatives, Way says.

One idea involves using native materials to construct the road base. According to Way, native soil mixed with lime or cement makes a good base but tends to crack. Conventional asphalt overlays don't help such a road base. Reflective cracks come through with relative ease. On the other hand, the more flexible asphalt rubber mix reduces the amount of reflective cracking to acceptable levels.

Why doesn't the asphalt rubber crack? "Think of it like putting peanut butter on a cracker," says Way. "The cracker might crack, but the peanut butter won't."

Eventually, of course, asphalt rubber will crack. The question is, how long will it take? The Arizona DOT has been monitoring its oldest asphalt rubber roads to find out. The state's first full-scale non-experimental asphalt rubber overlay, a two-mile stretch of Interstate 19 south of Tucson that was overlaid in 1988, has yet to require serious maintenance.

Built in 1965, the plain jointed concrete pavement on Interstate 19 south of Tucson began showing its age in the 1980s. By 1988, it needed maintenance badly. With annual traffic of 400,000 Equivalent Single Axle Loads (ESAL), the road's International Roughness Index (IRI) had risen to 172. A Mu Meter reading of 38 showed that the surface had grown slick. Approximately 6 percent of the surface had cracked. Annual maintenance costs per lane mile had risen to $857.

The Arizona DOT applied a one-inch-thick open-graded asphalt rubber overlay in 1988. By 2001, after 13 years, the IRI was holding at 70; skid readings stood at 64; 1 percent of the surface had cracked; and annual maintenance was running $50 per lane mile. "That's impressive," says Way.

While the Arizona DOT and other proponents have always known that open-graded asphalt rubber reduces road noise, engineers have by and large focused on mix characteristics. Few attached importance to the material's noise resistance — until the public started making noise about how quiet Superstition Freeway had become.

Numerous studies conducted since the early 1980s support the public view of asphalt rubber's ➤

noise-reducing characteristics. As early as 1981, a Belgian study found that an open-graded asphalt rubber Hot Mix Asphalt reduced noise by 8 to 10 decibels or 75 percent when applied to the Brussels Loop.

The Arizona DOT conducted a noise study of Interstate 19 after that resurfacing project and found that noise had been reduced by 6.7 decibels or 78 percent.

Asphalt rubber has been proven over the years to be one of several asphalt options for noise reduction. They include Open Graded Friction Courses (OGFCs) with polymer additives, Stone Matrix Asphalt (SMA), and the proprietary product known as Novachip.

A recent asphalt rubber Porous Friction Course (similar to an OGFC) overlay of a continuously reinforced concrete pavement in San Antonio reduced noise levels by 14 decibels, improved its ride quality by 61 percent, and increased the skid resistance by 200 percent.

"With the new emphasis on sound, the potential is to lower the height of sound walls or eliminate them, thus reducing cost," said Jay McQuillen, Granite Branch Manager – Southern California. "The Federal Highway Administration is in the middle of considering and operationalizing this possibility in their design guidelines. This is another major cost-saving opportunity for the public." (See sidebar, page 23.)

Making and applying asphalt rubber

Making asphalt rubber is different from making conventional asphalt. Instead of mixing asphalt cement directly with aggregates, the process first mixes crumb rubber with the asphalt cement. ASTM specifications for asphalt rubber require a crumb rubber content of at least 15 percent. Today, rubber content is frequently boosted to 20 percent.

The production process can include a portable asphalt-rubber plant, consisting of a mixing unit and two tanks. The plant heats the asphalt cement and the crumb rubber is mixed in. After curing, the mixture is mixed with the aggregates, just like normal. In some cases, the crumb rubber is added at the asphalt terminal.

Heat control is important to asphalt rubber production. Too much heat generates smoke. "This is an issue with conventional asphalt, too, but it is more of a problem with asphalt rubber," says Mark Chalfa, project manager and estimator with Granite Construction Co., which owns four rubber plants.

Asphalt rubber is usually designed as a gap-graded or open-graded mix, either of which allows more room for the asphalt rubber to penetrate and fill gaps in the aggregate. The resulting mixture has thick binder films which are flexible, like the peanut butter in Way's analogy.

Placing asphalt rubber mixes differs slightly from the norm. Pneumatic rollers cannot be used, because rubber rollers pick up rubber in the asphalt. Steel-wheeled machines handle all compaction. "You also try to work the material at slightly higher temperatures than conventional asphalt," says Mark Belshe, a vice president with FNF Construction Inc. of Tempe. "You should use the breakdown roller before the temperature drops below 275 degrees Fahrenheit. That's similar to conventional asphalt, but it is important to realize that asphalt rubber is less forgiving than conventional asphalt. So you have to be a little more organized. The technique is essentially the same, there is just less margin for error."

Wider uses for asphalt rubber?

Industry observers say many contractors and material suppliers view asphalt rubber with a degree of suspicion. State DOTs have not been persuaded that the material will work as advertised. Many contractors and material suppliers may be more comfortable with conventional asphalt.

While asphalt rubber overlays appear to be long-lasting, the new material does carry a cost premium. DOTs trying to stretch thin budgets often hesitate to risk raising their up-front material investment in hopes of getting a longer-lasting road.

Recently, FNF persuaded New Mexico State Highway and Transportation Department to undertake a test of asphalt rubber. Last year, the state awarded FNF a contract to overlay 112 lane miles of US 54 between Alamogordo and El Paso. The contract called for conventional asphalt.

FNF, however, wanted to demonstrate asphalt rubber's performance to New Mexico's DOT officials. "We thought if we could make the economics work, they might try it," says Belshe.

Ford Motor Co. had been looking for ways to dispose of 6.5 million Bridgestone/Firestone tires recalled from Ford Explorers in 2001. When FNF approached Ford, the auto maker offered to donate the tires to support an asphalt rubber overlay demonstration. Under the ensuing agreement, Ford donated the tires and paid the cost of processing the asphalt rubber. As a result, New Mexico got its first asphalt rubber road surface for the cost of a conventional job. New Mexico is now monitoring the performance of the finished road.

Whether or not the New Mexico job bears fruit, cost will likely remain a barrier to the wholesale use of asphalt rubber by DOTs.

"We look at asphalt rubber as another tool in the toolkit for pavement design," says Belshe. "ASTM-type asphalt rubber binder brings something to the table that other products don't. At the same time, you can't justify using it all the time. You have to fit applications to needs."

Belshe does note that some jobs will call for asphalt rubber despite the material's higher costs. "Suppose you have a road in fatigue failure with alligator cracking," he says. "A 1.5-inch asphalt rubber overlay might hold that road together for another five to seven years, while the alternative is a total rehab. The cost difference is substantial. The rehab might cost $200,000 or more per lane mile. An asphalt rubber overlay could cost $60,000 per lane mile." Any major rehabilitation project would require an engineering evaluation to determine the appropriate treatment.

The higher first cost of asphalt rubber mixes will likely limit wider use of the material for the time being — unless, of course, the driving public starts making noise about wanting quieter roads. *HMAT*

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FHWA Evaluates Asphalt Rubber as Noise Mitigation Strategy

The following is an excerpt from the weekly newsletter of the Arizona Division of the Federal Highway Administration dated April 23, 2003.

Arizona's Quiet Pavement Pilot Program: The Arizona Division has approved an Arizona Department of Transportation (ADOT) request for a pilot program to evaluate the use of Asphalt Rubber Friction Courses (ARFCs) – as a noise mitigation measure. Under Arizona's Quiet Pavement Pilot Program (QPPP), ADOT will use a 4 dBA (decibel) reduction in their noise evaluations when ARFCs are used. This should reduce the height and length of noise barriers (primarily walls and berms) needed to meet the noise criteria; and in some cases, will eliminate the need for noise barriers entirely. There are obvious cost savings associated with reduced noise barrier height or the elimination of noise barriers entirely; however, there are other benefits as well. Increasingly, citizens are concerned about the negative effects of higher noise walls and berms – due to the loss of views and shading effects among others.

The primary purpose of the Arizona QPPP is to evaluate the durability of the noise reduction associated with ARFCs – to better determine the magnitude of the noise reduction, and more importantly, how long the noise reduction lasts. Preliminary data suggests that the initial reduction is substantial – 6 or more dBA and that it is fairly durable – lasting for 10 or more years. However, much more data is needed to confirm these assumptions and preliminary results. ADOT has agreed to monitor the performance of the ARFCs as noise mitigation, and provide considerable data to FHWA. The long-term hope is that the data will confirm both the viability and the durability of the ARFCs as noise mitigation; and possibly facilitate application nationwide. The over arching concept is that it is better to reduce the noise generated (at the source) rather than to attempt to contain the noise once it has been generated.