WSDOT Receives Award for Excellence in Quieter Pavement Research

The Quieter Pavement test sites on I-5, SR 520 and I-405 are three of the most tested and documented quieter pavements in the world. WSDOT received an award for excellence in Quieter Pavements Research from the Rubber Pavements Association (RPA) in recognition of WSDOT's contribution to understanding the acoustics and performance of quieter pavements. RPA is a non-profit industry association of manufacturers, contractors, consultants, testing laboratories, suppliers, government organizations and individuals that encourage the use of asphalt pavements containing recycled tire rubber.

Award received by WSDOT from the Rubber Pavements Association for our research on Quieter Pavements.

What steps are being taken in the search for quieter concrete pavements?

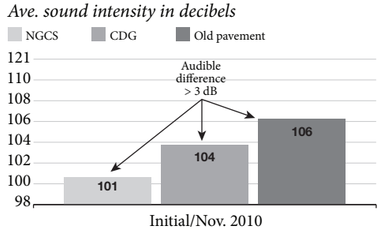
In October 2010 a new diamond grinding technique called the Next Generation Concrete Surface (NGCS) was installed on I-82 near Sunnyside, Washington. NGCS test sections in other states are being reported to be quieter than conventional diamond ground sections. The NGCS grinding was done in two stages, the first stage ground the pavement to a very smooth profile. The second stage put ½-inch deep grooves into the surface parallel to the centerline and spaced ½-inch apart.

I-82 NGCS noise measurements

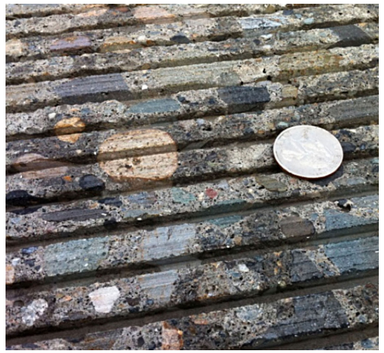
Initial noise measurements from November 2010 showed that the NGCS is a little more than three decibels quieter than the adjacent lane of conventional diamond grinding (CDG) and five decibels quieter than the transversely tined surface that existed on I-82 prior to any grinding, both audible differences.

I-82 Sunnyside initial noise levels

Ave. sound intensity in decibels



NGCS test section on I-82 near Sunnyside, WA.



NGCS close-up showing ½ inch deep groves spaced ½ inch apart. Coin is a US quarter.

For more information visit the Quieter Pavement website:

www.wsdot.wa.gov/Business/materialslab/quieterpavement

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Washington State Department of Transportation

Quieter Pavement Performance in Washington

June 2011

Typical noise barrier wall that can reduce noise by 5 to 10 decibels.

Traffic noise is a concern for many residents living along state highways. The Washington State Department of Transportation (WSDOT) is studying ways to reduce the noise generated from our highway facilities and its effects on nearby residents.

Historically, noise barriers have been the most effective method for reducing traffic noise. Noise barriers include noise walls and earthen berms that separate traffic noise from adjacent properties. Typical noise reduction is five to 10 decibels, with 10 decibels cutting the perceived noise level by 50 percent. While noise barriers can be effective, they can also be expensive to install and are not constructible or effective in all locations.

What new things are being tried to combat noise?

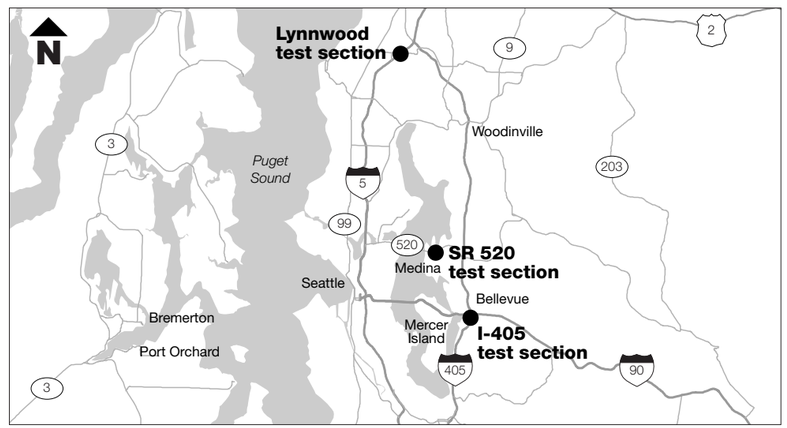
WSDOT has been evaluating new types of pavements that might reduce the portion of freeway noise generated from tires as they roll across the pavement. Open Graded Friction Courses (OGFC) are asphalt pavements that have been used in other states with success in reducing tire/pavement noise. For concrete pavements, various types of surface textures either built into a new pavement or added to existing pavement with diamond grinding have the potential to reduce noise.

Three projects have been built with OGFC test sections: on I-5 in Lynnwood, on SR 520 in Medina, and on I-405 in Bellevue.

Each test section has one section of OGFC modified with recycled tire rubber and one section modified with a synthetic polymer similar to natural rubber. Sections of conventional asphalt pavement were built alongside the OGFC pavements so the noise characteristics and pavement performance could be accurately compared.

What has been discovered to date?

Noise experts agree that sound levels must differ by at least three decibels to be noticeable to the human ear (audibly quieter). Immediately after construction, the OGFC pavements were audibly quieter than the conventional pavements. Today, the OGFC test sections are not audibly quieter than the conventional asphalt pavement. Additionally, these OGFC test sections are failing due to raveling: the small rocks are coming out of the pavement. The Lynnwood section was removed at the end of 2010 and will be replaced in early 2011 with a conventional asphalt pavement. The SR 520 and I-405 test sections are still in service and continue to be measured for noise level and pavement wear.



OGFC test section locations.

Why are OGFCs potentially quieter than conventional asphalt pavement?

OGFCs are designed to have tiny air holes or voids throughout their entire depth. The air voids absorb and dissipate the sound generated by the tires on the pavement surface. Conventional asphalt pavements have fewer voids, which gives them better durability than OGFC pavements, but doesn't allow much absorption of noise.

How did WSDOT design the OGFC pavements?

The Arizona Department of Transportation (ADOT) has been a pioneer in using OGFC pavement to reduce traffic noise. ADOT provided WSDOT with the mix design for the OGFCs built on I-5, including the design for the aggregate gradation and rubber content of the OGFC-Rubber and the aggregate gradation for the OGFC-Polymer. The National Center for Asphalt Technology (NCAT) recommended using styrene butadiene styrene (SBS), a synthetic polymer, for the OGFC-Polymer design. The SR 520 and I-405 used similar mix designs and material with some minor changes made to improve performance.

What are the challenges to using OGFC pavements?

Climate and studded tires are the biggest challenges to using OGFC pavements in Washington. Most of the states successfully using OGFC pavements (Arizona, California, Texas, and Florida) are in the southern US and have warmer climates than Washington. Warmer climates are more conducive to the construction of OGFCs with rubber, which requires higher surface temperatures during paving. These states also have low studded tire usage. OGFC pavements have less resistance to wear from studded tires due to the air holes or voids which decrease their strength.

The test sections are designed to answer questions regarding the noise reduction benefits and the long-term durability of OGFC pavements.

How is the noise being measured?

Noise attributable to the tire/pavement interaction is measured using the On Board Sound Intensity (OBSI) method. This method uses a pair of microphones mounted on the right rear tire of a sedan, three inches off the pavement, to ensure that only the tire/pavement noise is being measured. OBSI has become the standard for measuring tire/pavement noise, both in the US and internationally.

I-5 Lynnwood noise measurements

Four southbound lanes of I-5 through Lynnwood were paved with OGFC pavements between Milepost (MP) 180.0 and 182.5.

- MP 180.8 – MP 181.8 – OGFC modified with rubber
- MP 181.8 – MP 182.5 – OGFC modified with polymer
- MP 182.5 – MP 183.0 – conventional asphalt (control section)

OBSI measurements began immediately after construction in August 2006 and were taken monthly, weather permitting, through August 2010. Bar charts show the initial and current average sound intensity level measurements for all lanes of each pavement type.

Initially, there was a four-decibel difference between the conventional asphalt control section and the OGFC-Rubber section, which was an audible decrease. The OGFC-Polymer section was three decibels less than the conventional asphalt, which was not audible. The last readings in August 2010 show the OGFC-Rubber being one decibel quieter and the OGFC-Polymer two decibels quieter than the control section; neither of these differences is audible to the human ear.

Photo of open graded friction course placed on I-405 in 2010. Note the large amount of void space between the aggregate particles.

Photo of dense graded asphalt pavement. Note absence of void space between aggregate particles.

On Board Sound Intensity (OBSI) test apparatus. Microphones record the sound produced by the tires rolling over the pavement.

I-5 Lynnwood rutting measurements

Rutting measurements made in May 2010 show that the OGFC-Rubber section was losing aggregate from the surface of the pavement and rutting in the wheel tracks. The outside lane was showing the most aggregate loss with 9.5 mm (3/8 inch) of rutting on a pavement that is only 19 mm (3/4 inches) thick. There were areas in wheel paths of the OGFC-Rubber section what were worn through to the underlying pavement.

SR 520 Medina noise measurements

The SR 520 project begins just east of the Evergreen Point Floating Bridge at MP 4.2 and ends at MP 5.8. There are two general purpose lanes in each direction and an outside HOV lane in the westbound direction.

- MP 4.2 – MP 4.6 – OGFC modified with rubber
- MP 4.6 – MP 5.2 – conventional asphalt pavement
- MP 5.2 – MP 5.8 – OGFC modified with polymer

OBSI measurements began immediately after construction in July 2007 and have been taken monthly, weather permitting, through February 2011. Bar charts show the initial and current average sound-intensity-level measurements for all lanes of the project.

Initially, the noise level of the OGFC-Rubber section was four decibels quieter than the control section, which would have been an audible difference. The initial noise level for the OGFC-Polymer, at two decibels quieter than the control section, was not audible. Currently, the OGFC-Rubber is one decibel louder and the OGFC-Polymer is at the same noise level as the control section.

Similar to the I-5 test section at Lynnwood, the OGFCs on SR 520 had lower initial noise levels, but these reductions were lost in less than six months.

SR 520 rutting measurements

Rutting measurements made on the SR 520 sections in April 2011 were 12.5 mm (½ inch) in the OGFC-Rubber section, 6.6 mm (¼ inch) in the OGFC-Polymer section and 8.4 mm (11/32 inch) in the control section. There are areas in the wheel paths of the OGFC-Rubber that are worn through to the underlying pavement.

I-405 noise measurements

The I-405 project is all in the northbound lanes and is split into two sections, one south and one north of I-90. The south section begins at MP 10.22 and ends at MP 10.83. The north section begins at MP 11.76 and ends at MP 12.40.

- MP 10.22 – MP 10.60 and MP 11.76 – MP 12.06 – OGFC-Rubber
- MP 10.60 – MP 10.93 and MP 12.06 – MP 12.40 – OGFC-Polymer
- MP 9.80 – MP 10.15 – conventional asphalt (HMA) control section.

OBSI measurements began immediately after construction in September 2009, and have been taken monthly, weather permitting, through February 2011. Bar charts show the initial and current average sound-intensity-level measurements for all lanes of the project.

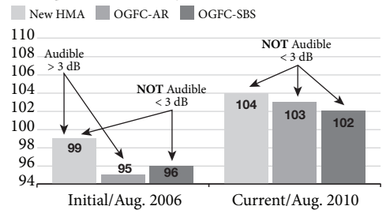
Initially both the OGFC-Rubber and OGFC-Polymer were four decibels quieter than the control section, which would have been an audible difference. However, within four months both OGFC's were not audibly quieter than the control section. Currently the OGFC-Rubber section is one decibel quieter and the OGFC-Polymer section is at the same noise level as the control section.

I-405 rutting measurements

Rutting measurements made in April 2011, 20 months after construction, are 5.0 mm (3/16 inch) for the OGFC-Rubber, 4.6 mm (3/16 inch) for the OGFC-SBS, and 3.8 mm (5/32 inch) for the conventional asphalt control section. The OGFC-Rubber is showing the most rutting as was the case with the I-5 and SR 520 test sections.

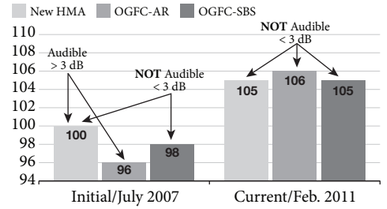
I-5 Lynnwood initial and current noise levels

Average sound intensity in decibels



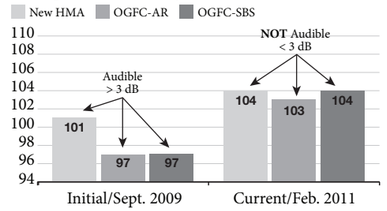
SR 520 initial and current noise levels

Average sound intensity in decibels



I-405 Bellevue initial and current noise levels

Average sound intensity in decibels



The simplified term "Decibel" is used in the document to represent an A-weighted decibel scale.

What are the next steps in the search for quieter pavements?

Testing of the SR 520 and I-405 OGFC test sections will continue until the pavements reach the end of their useful life, which, judging from the performance of the I-5 sections, could be as little as four years.