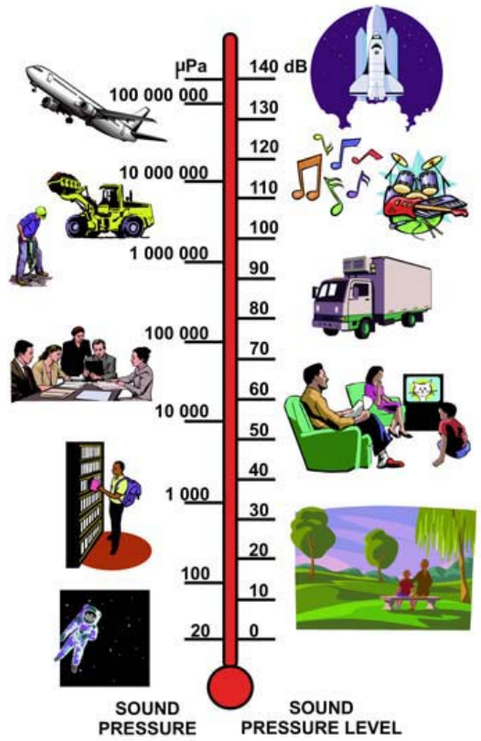
Pavement Types
There are several standard types of pavement that the Colorado Department of Transportation (CDOT) can choose from when constructing or resurfacing a roadway including Superpave Hot Mix Asphalt (HMA), Stone Matrix Asphalt (SMA), and Portland Cement Concrete. There are several others that are under experimentation such as an Open-Graded Friction Course (OGFC).

Pavement Type Selection Process
CDOT conducts a 40-year life cycle cost analysis when selecting a particular type of pavement to be used on a project. The analysis includes the initial construction cost, maintenance costs, rehabilitation costs and even user costs like traffic delays for motorists. If the life cycle cost analysis of certain pavement types is a tie, then secondary factors relating to unique project goals, such as noise can be considered to break the tie.

Noise
Before embarking on a major transportation improvement, an environmental study is conducted to assess the potential impacts an improvement may have on the social, economic and natural environmental conditions as well as on the lives of residents and commuters. This study is required as part of the National Environmental Policy Act (NEPA). Noise is a major consideration as part of this process. For these projects, a noise study is required to assess existing noise levels and predict future noise levels. Noise studies and mitigation efforts are not required on minor projects or on existing highways in the absence of proposed major projects.

If a noise impact is identified during a noise analysis, CDOT then examines and considers noise mitigation measures. Typical noise mitigation includes traffic management techniques such as reducing the speed limit and requiring truck jake brakes; providing sufficient distance between roadway and impacted areas when possible; or constructing the noise barriers or earth berms.



FHWA does not recognize pavement type, in and of itself, as a noise abatement measure, and noise, therefore, is not a primary factor when selecting a pavement. This is due to the fact that there are several components to the noise generated from a roadway facility including tire-surface contact, engine, brakes (including truck jake brakes) and wind drag around vehicles. The application of quieter surface materials would only address one component of this spectrum.

Will Adding Rubber to Asphalt Make Pavements Quieter?

What is Rubberized Asphalt?
Wasted tires are turned into crumb rubber, which is then processed and blended with asphalt. Aggregate is heated and the asphalt/rubber blend is added to it. This mix is often used with OGFC and is believed to reduce noise. However, it is still unclear if it is the rubber in the mix or the gradation of the mix that actually has an impact. Many studies are being conducted to gather more information in this area as the product is still being tested.

In addition to the questions regarding the effectiveness of asphalt rubber, CDOT has other concerns including cost, placement temperature, safety, and long-term noise mitigation. These additional questions make it difficult for CDOT to move its pavement program towards this one product.

Cost
There is a significant cost variance for different pavement types. Cost of materials and placement is more than $4.00 a square yard per inch of thickness, making asphalt rubber one of the most costly asphalt products. It is twice the cost of a regular HMA.

Climate
Construction temperatures are a critical factor in the placement of asphalt rubber. To ensure the highest quality, the placement temperatures must be 65 degrees and rising. This makes night paving in Colorado virtually impossible. Since traffic congestion requires most construction in Colorado, especially in urban areas such as Denver and Colorado Springs, to be conducted at night, there is a very small window of opportunity to pave.

Additionally, asphalt rubber has not been proven to ensure a safe riding surface for Colorado's extreme winters and variable temperatures resulting in numerous freeze-thaw cycles.

Open-Grade Friction Course
As mentioned earlier, OGFC is often used in combination with asphalt rubber. Some experiments, such as the one in Arizona, suggest that the combination of asphalt rubber and OGFC helps reduce noise. Once again, this product has some disadvantages that are preventing many states and European countries from changing to this product.

Long-term durability
While short-term studies show that OGFC can be quieter than other pavement types such as Superpave, SMA or concrete, the noise mitigating qualities deteriorate over time. CDOT has gathered an inventory of all their pavement types ranging in different ages and have found that the noise level of an ultra-thin bonded wearing surface (a type of OGFC) pavement built in 2003 was only 95 decibels. On the other hand, the noise level of one built in 2002 was approximately 99 decibels. That is an increase of four decibels in one year. Although these are different designs,

there is an increase of four decibels in one year. More research is clearly needed.

Cost
Just like asphalt rubber, OGFC runs about $4 per square yard for materials and placement. Since this product lacks a performance history to support it, the cost makes experimenting difficult.

Safety
OGFC also has some safety issues having to do with preferential icing. This pavement type is designed to collect water and drain out to the sides. Due to the nature of the design, the pavement often gets clogged with road sand or other grit, preventing drainage from occurring. When the pavement cannot drain, the remaining water freezes, creating patches of black ice. This preferential icing creates safety hazards for motorists and emergency crews that have to work on these roadways.

Stone Matrix Asphalt
One standard pavement type that CDOT currently uses frequently is SMA, which provides a rut resistant pavement with a skid resistant surface. Other reported benefits include better drainage, reductions in glare and lower tire noise than normal Superpave mixes.

Cost

SMA is significantly cheaper while still providing the same benefits as asphalt rubber and OGFC.

Durability
In CDOT's pavement noise inventory, it was determined that SMA has a slightly higher initial noise level than OGFC, but as the pavement aged, the noise levels did not increase as quickly. A SMA constructed in 2002 had a noise decibel level of 96.15 and in 2003 the decibel level was 96.28. This change one of 0.1 decibels is likely within the repeatability of the testing. To be noticeable by the human ear, it takes a change of three decibels or more.

Concrete
When CDOT chooses concrete as the pavement type for a project, two types of methods will often be used that have noise-reducing benefits.

Tining and Grooving
Tining is the creation of shallow channels in a concrete roadway to enhance weather traction of an otherwise smooth surface. While tining is necessary for safe driving conditions in wet weather, it does affect roadway noise. CDOT has conducted several studies that look at different ways of applying tining. The results show that some tining patterns, including longitudinal tining, can help produce lower levels of pavement noise. Through various studies, it has been demonstrated that longitudinal tining is quieter than transverse tining and is, thus, the standard tining pattern of choice. In CDOT's inventory of pavement type, it was discovered that noise levels in a concrete roadway with longitudinal tining only increased by one decibel over several years, which is below the level that the human ear can distinguish. Grooving the surface produces an even quieter pavement at a nominal cost increase.

Research
With new technology emerging constantly, CDOT will continue to monitor experiments around the world and continue to conduct experiments when funding allows. CDOT's goal is to maintain the safety and durability of the existing highway system and the methods to reach this goal must fall within funding abilities. Experimentation will continue when possible to enhance secondary goals, such as noise.

Highway Traffic Noise: Effect of Pavement Types

Taking Care To Get You There
DOT