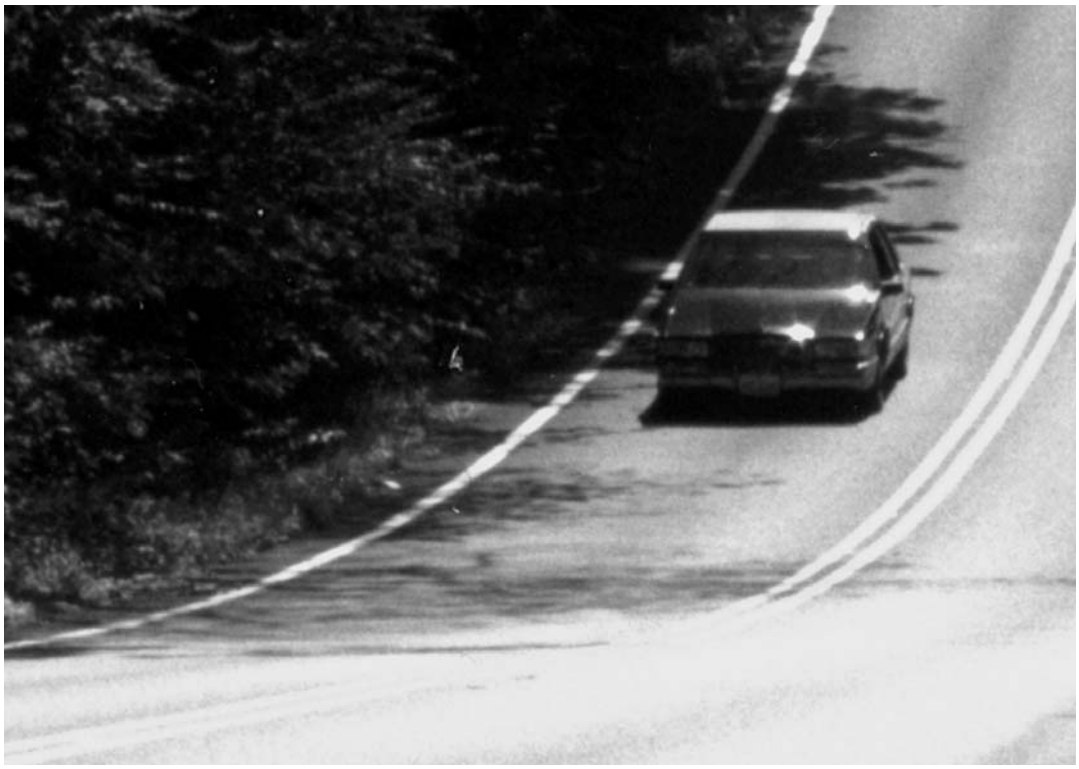
# Open-Graded Friction Course



# A Treatment for Wet Accident Areas

While hot mix asphalt (HMA) surfaces generally provide good skid resistance, some agencies are confronted with adverse geometric conditions that can benefit from high-friction properties. These locations may be steep grades or curves, often at intersection approaches that experience abnormally high rates of wet pavement accidents. A number of Ohio agencies have found relief by using a specialty mix, Rubberized Open-Graded Friction Course (OGFC), to provide high skid resistance and superior surface drainage.

**Properties of OGFC**

The most common HMA mixtures are dense-graded mixtures designed to be impermeable to water. By contrast, open-graded friction courses are formulated to result in an internal structure of interconnected voids that allow water to drain through the mix. This is accomplished by using an open gradation of aggregate that lacks the mid-sized aggregates that would fill the voids between the coarse

aggregate particles. This gradation is bound by a heavy coating of tough, polymer-modified asphalt that makes the mix durable, despite its internal exposure to air and water.

The internal drainage properties of OGFC prevent water from standing on the surface and are used to reduce hydroplaning and splash and spray from tires. This surface also has the benefit of less glare from headlights and more visible pavement markings on rainy nights.

OGFC surfaces are also the quietest pavement surfaces known. The open voids in the mix attenuate noise like no other surface. OGFC is sometimes used solely to reduce traffic noise in particularly sensitive areas.

It is generally believed OGFC requires more treatment to prevent icing. Since water drains through the OGFC, brine does not spread across or stay on the surface. OGFC also performs differently thermally speaking than dense-graded mixes. As a consequence, OGFC may require more frequent applications of salt. OGFC's durability can be compromised, if the material is not formulated to prevent damage from the exposure to air and moisture. However, experience in Ohio with the highly polymer-modified binder that is required by the ODOT specification, has generally been very satisfactory.

ODOT's specification for RUBBERIZED OPEN-GRADED ASPHALT FRICTION COURSE, is Supplemental Specification 803. SS 803 requires a crushed, air-cooled slag coarse aggregate and an overall gradation with 100 percent passing the 1/2-inch sieve and less than 17 percent passing the #8 sieve. You could think of this gradation as a Type 1 mix with most of the sand omitted. The binder is specified as a PG 58-28, modified by the addition of 5 percent rubber solids. Under SS 803, the ODOT laboratory determines the mix design or Job Mix Formula for the specific combination of aggregates and binder. ODOT's mix designs have typically resulted in total binder contents of around 7.5 to 8 percent.

ODOT provides the following note to guide its designers in the use of OGFC: A) Use where surface water drainage is a concern, a high-skid condition exists or it is desired to control sound in abnormally high-sound problem areas. B) This product uses only air-cooled slag, so check on availability and cost for your area. C) Use 0.75-inch lift on an existing or new 446 or 448 Type 1 or 442 9.5 or 12.5 mm asphalt course. D) Do not apply over milled surfaces. Apply over surfaces that have sound aggregate and no visual evidence of stripping. E) When selecting for use, be careful if applying low-tonnage applications. The best production product is achieved in quantities of at least 300 tons. F) No special maintenance or traffic considerations.

OGFC mixes are designed using an aggregate blend of the specified gradation and asphalt drain-down and abrasion-loss tests to determine optimum asphalt content. Mixes are usually tested for moisture susceptibility. Final air voids in the mix are required to be a minimum of 18 percent.

**Centerville Experience**

The City of Centerville placed a rubberized open-graded friction course on Clyo Road on the approach to Alex-Bell Road about 10 years ago. The project was an ODOT-funded reconstruction of the existing roadway. The new pavement was a 10-inch, full-depth, asphalt design with an OGFC surface. The area treated with OGFC is an excessive grade, more than 7 percent. Because of the grade, the project required a design exception. The OGFC was placed as a mitigating treatment for the excessive grade. Mary Lou Pence of the Centerville engineering office reports that the pavement has performed satisfactorily and is still in service.

(above) Open-Graded Friction Course, such as this used on Columbia Parkway in Cincinnati, features course aggregate that is bound by a heavy coating of polymer-modified asphalt.

(opposite page) Ebenezer Road in Hamilton County is less prone to accidents because of the use of OGFC material, which features high-skid resistance and superior surface drainage.

**Kettering Experience**

The City of Kettering also placed an OGFC on Stoop Road, from Far Hills to Tate, nearly 10 years ago. According to Al Fullenkamp, public service director/engineer for the city, it has performed well, providing good, skid resistance, but is now showing the wear and tear of time and traffic. Therefore, the city is planning its resurfacing. Fullenkamp noted that the OGFC has taken a lot of salting to keep it de-iced.

**Hamilton County Engineer's Experience**

Hamilton County is on its second generation of using OGFC on the hills of Ebenezer Road, from Muddy Creek to Oakhaven, in western Hamilton County.

**Cincinnati's Columbia Parkway provides motorists a quiet ride, better visibility during the night because of less headlight glare, and less chance of hydroplaning during wet conditions because of the use of OGFC.**

The road was first surfaced with OGFC nine years ago. Pat Ashcraft of the Hamilton County engineer's office says that the material has served well enough that the county resurfaced it with OGFC again in 2002. The cost of the mix in 2002 was $159.50 per cubic yard. The county is planning another project for a steep grade on Anderson Ferry Road in 2003.

**Cincinnati Experience**

In 2003, the City of Cincinnati placed OGFC on a curve on Columbia Parkway, west of Delta Avenue. The contractor was Barrett Paving and the bid price was $200-per-cubic yard for a bid quantity of 60 cubic yards. Joe Flading of Cincinnati Engineering said he drove it in a hard rain and that it seemed almost as if it wasn't raining on the OGFC.

**Special Considerations**

There are several cautions that must be observed in the use of OGFC. First, there is the expense of producing any special mix in a small quantity. Switching the plant to use special aggregates and binders entails a lot of cost that must be spread over the quantity to be produced. The air-cooled, blast furnace (ACBF) slag aggregate required by ODOT specifications is generally only available in northern and eastern Ohio, West Virginia, Detroit and Chicago areas where steel making has occurred. Costs of producing and transporting the aggregate are higher than for locally available aggregates. Also, the PG 58-28 binder specified for SS 803 is a non-standard grade for most Ohio HMA producers. A contractor will have to order a special tanker load of this binder from the asphalt producer and dedicate a separate tank. Lastly, there is the synthetic latex, SBR, rubber additive. The additive is expensive and requires some special equipment to add to the HMA mixing process. All of this adds expense to the production of the mix, and makes small quantities costly. However, large quantities attract low prices. A review of ODOT bid prices indicates that quantities of 300 cubic yards or more generally cost $100 per cubic yard or less.

Drainage must be provided for the OGFC layer. This means day-lighting the course to the shoulders or providing a shallow gutter or slotted drain to provide positive drainage for the water flowing through the OGFC. The OGFC must be kept clean to prevent clogging. High-speed applications tend to be somewhat self cleaning. But, low speed applications may need swept with a vacuum sweeper regularly.

Then there is an issue of durability that depends on the surface on which the OGFC is placed. Water that drains through the OGFC will tend to lay on the top of the intermediate course just below the OGFC. If that course is a new layer of dense graded HMA that was properly designed and compacted, there should be no problem. The dense-graded HMA will be sufficiently impermeable to resist attack by the moisture coming through the OGFC. If, however, the surface is existing weathered asphalt or a milled surface, then the moisture will rapidly attack the porous layer and lead to early failure by raveling or delaminating. To prevent this deterioration, some agencies have placed a chip seal under the OGFC to seal off the underlying surface. Also, there is that issue of OGFC possibly requiring more frequent salting to prevent icing.

**Alternatives**

Using an OGFC eliminates water laying on the surface of the pavement, and that is an important characteristic of its use in reducing wet accidents. But, it may not always be feasible to provide the necessary drainage for an OGFC, such as between curbs or on an inlay. In these cases, perhaps it would be better to use a dense-graded mix with special aggregates that will provide high-friction numbers. The same slag aggregate that provides high-friction numbers in OGFC could be specified in a Type 1 gradation to give high-skid resistance. And there are other special aggregate requirements that could be used to improve the skid resistance of dense graded mixes. SS 854, Smoothseal™, gets its good skid resistance from a requirement that calls for "… natural sand with at least 50 percent silicon dioxide by weight." Similarly, skid resistance of mixes could be improved by using very hard, crushed, aggregates like granite or basalt. While these aggregates are not found in Ohio, their importation can be feasible for special applications. Some agencies have found that texturing an existing surface by cold milling serves as a temporary remedy for skidding accident problems. ODOT and Montgomery County have successfully used this technique as a temporary measure on accident-prone curves.

**Summary**

Certain adverse geometric conditions can benefit from using highly skid-resistant surfaces. HMA mixtures can be formulated to meet this requirement. OGFC and dense-graded mixes using special aggregates selected for their high-friction properties can meet the traffic needs in these applications. For more information on OGFC, consult the National Asphalt Pavement Association's publication, *"Design, Construction and Maintenance of Open-Graded Asphalt Friction Courses,"* IS 115.