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VEMENT MACROTEXTURE REVIEW

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Final Report

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Implementation Division
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Performance problems, such as raveling and flushing, can occur with open-graded overlays as well as with open-graded asphalt surfaces. In addition, reflective cracking of the overlay is a potential problem that often occurs more quickly on open-graded overlays than on dense-graded overlays, particularly for surfaces placed over portland cement concrete. Reflective cracks of an overlay result from cracks left in the old wearing surface. Proper preparation of the existing surface is vital to assure the success of an open-graded overlay. If the existing surface is rough, uneven or extremely cracked a binder or leveling course should be used under the open-graded surface course. Such leveling courses will provide a smoother ride and help extend the life of the surface course by preventing early failures.

There has been no comprehensive evaluation of the accident reduction effectiveness of open-graded asphalt overlays. Studies from California and Virginia provide some indication of the effectiveness. A before-after study of 10 sections in California overlayed with open-graded asphalt concrete found that the wet-pavement accident rate was reduced by 70% in the after period.[23/] An evaluation of one section in Virginia resurfaced with an open-graded asphalt overlay found that 39% of all accidents before the overlay occurred on wet pavement, whereas only 17% of all accidents after the overlay occurred on wet pavement.[28/] However, neither study provides any quantitative measure of the improvement in macrotexture or skid number or any comparison with the accident reduction effectiveness of dense-graded overlays.

B. Pavement Grooving

Pavement grooving is the process of making a pattern of parallel, shallow cuts of uniform depth, width, and shape in the surface of an existing pavement. The grooves are usually cut with a diamond saw. Portland cement concrete pavements are most frequently grooved, but grooving has been accomplished successfully on older bituminous pavements where the asphalt is well-cured. Grooving should not be confused with texturing of new portland cement concrete pavements, which is a finishing process that is accomplished while the concrete is in the plastic state. The International Grooving and Grinding Association defines grooving as patterns spaced more than 12.7 mm (1/2 in.) center-to-center; they consider texturing to be patterns spaced less than 12.7 mm (1/2 in.) center-to-center.[33/]

Both longitudinal and transverse grooves have been used in the United States, but longitudinal grooves are more common. The objective of this treatment is to place grooves in the tire-pavement interface that provide a path for water to escape from under the tire. Thus, grooving acts like other forms of pavement macrotexture in reducing the potential for hydroplaning. However, despite its proven wet-pavement accident reduction effectiveness, longitudinal grooving does not normally increase the skid number of a pavement surface. Thus, this form of texturing does not influence skid number in the same manner as the random macrotexture of open-graded asphalt surfaces or the pattern macrotexture of finished portland cement concrete surfaces. There is some indication that transverse grooving may increase skid number.

There are variations in the depth, width and spacing of grooves that have been used in the United States. Typical ranges are 2.4 to 6.4 mm (0.095 to 0.25 in.) for groove width, 3.2 to 6.4 mm (0.125 to 0.25 in.) for groove depth and 12.7 to 38.1 mm (0.5 to 1.5 in.) for center-to-center spacing. The most common specification for pavement grooves is 2.4 mm (0.095 in.) wide, 6.4 mm (0.25 in. deep), and 19.1 mm (0.75 in.) center-to-center spacing. The grooves cut by a diamond saw have a rectangular cross-section. The usual practice in most states is to groove the center 3 m (10 ft) portion of a 3.7 m (12 ft) land and leave a 0.3 m (1 ft) strip ungrooved at the edge of each lane.

The depth of pavement grooves is extremely important to their proper functioning as a wet-pavement accident countermeasure. The use of a tire tread depth guage is a relatively simple, but effective, method adopted by many highway agencies to measure the depth of grooves on construction projects.

The cost for pavement grooving is quite variable and depends on the construction contractor's familiarity with grooving equipment and the hardness of the aggregate in the pavement surface course. The best available cost estimate in 1977 for longitudinal pavement grooving was $1.20 per sq m ($1.00 per sq yd). However, lower unit costs for grooving are reported in areas where grooving is used extensively.

Several contractors report typical productivity rates for longitudinal grooving of 0.6 lane-kilometers per hour (0.4 lane-miles per hour). However, extremely hard aggregates produce a noticeable decrease in productivity rates for grooving. Transverse grooving of in-service pavements is more time consuming and more expensive than longitudinal grooving. While longitudinal grooving can be accomplished by closing one lane of traffic at a time, transverse grooving requires at least two lanes to be closed for equipment moving. One equipment manufacturer reports that longitudinal grooving can be accomplished 50 times as fast as transverse grooving.

The service life of pavement grooves depends on the type of traffic to which they are exposed. High traffic volumes shorten the service life of pavement grooves, but this effect has not been adequately quantified. The presence of tire chains or studs on vehicles in the traffic stream also has an important effect on grooving service life. California reports that grooves 3.2 mm (1/8 in.) deep on highways where tire chains and studs are not used have a service life of 8 to 10 years;[13/] but Pennsylvania reports service life of 3 years or less where tire chains and studs are used.[7/]

Dramatic reductions in wet-pavement accidents have resulted from pavement grooving. Two California studies completed in 1972 and 1975 have found reductions in wet-pavement accident rate of 73% and 70%, respectively.[23,43/] The largest decreases reported were in sideswipe, fixed object and rear-end accidents. However, the accident reduction effectiveness of grooving does not appear to be consistent. In the 1972 California study, 27 projects decreased in total accident rate, while 11 projects increased. The change in total accident rate with grooving for these 38 projects ranged from a 100% reduction to a 45% increase. A review of 77 grooving projects in 13 states reported by Rasmussen showed an overall decrease of 75% in the number of wet-pavement accidents.[33/] The before and after periods in this evaluation range from 2 months to 5 years in length and the decreases in the number of wet-pavement accidents for individual projects range from 16% to 100%.

Some users have also observed that longitudinal grooving is effective in increasing the directional control of automobiles. Apparently, the automobile tires penetrate slightly into the grooves and form a mechanical interlock that helps to hold the vehicle in alignment with the roadway.[45/] However, a persistent concern exists about handling difficulties of motorcycles and small cars on grooved pavements. Pavement grooves do produce a sensation of instability while riding a motorcycle, but a recent study sponsored by the California Department of Transportation, in which seven motorcycles of different sizes were driven by two riders on grooved pavements, found no significant control problem.[43/] Furthermore, this study found decreases in the number of motorcycle accidents after grooving on both wet and dry pavements, even though total motorcycle registrations and, presumably, motorcycle traffic on the study sections increased by 14.5% between the before and after study periods. However, because the sensation of instability is unsettling to motorcyclists, even though it does not lead to loss of control, the use of warning signs at the beginning of grooved pavement sections is recommended.

The major advantages of pavement grooving are that wet-pavement accident experience may be substantially reduced and that traffic can use the pavement surface soon after grooving. In addition, longitudinal grooving can be accomplished quickly and only one lane of traffic at a time has to be closed. The disadvantages of pavement grooving are that bituminous pavements cannot be grooved unless the asphalt is well cured; that the use of studded tires or tire chains reduces the service life of grooves; and that motorcyclists and drivers of small cars may have a sensation of instability.