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International Grooving & Grinding Association
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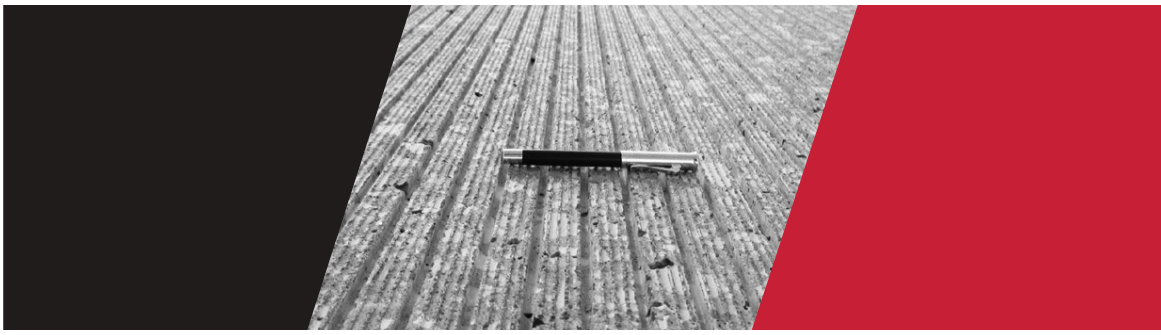
longitudinal vs. transverse grooving

Grooving is Great No Matter What Your Angle

Safe and Sure Handling of a Vehicle Depends on How Well the Tires Grip the Road



» SLIPPERY WHEN WET

Wet weather poses a challenge and a threat to motorists regardless of their driving skills or the condition of their vehicles, increasing the risk of accidents every time it rains or snows. Without question, safe and sure handling of a vehicle depends greatly on how well the tires grip the road – or in engineering terms, the coefficient of friction between the tire and the pavement. In a very real sense, the presence of water upsets the balance of friction that is so necessary to safety.

» HISTORICAL BACKGROUND

The ancient Greek and Roman societies have been credited with many innovations considered to be well before their time including concrete, aqueducts and paved roads. Interestingly, the concept of pavement grooving—the process of cutting precise channels into runways and highways to help prevent hydroplaning and wet weather accidents—can be added to that list. The modern-day use of transverse and longitudinal tining/grooving evolved during the 1960s and 70s, when it was observed that these textures provided better performance and longevity than the traditional burlap drag surface used at that time. At the same point in time and as a result of a 1979 FHWA technical directive, transverse tining became the predominant form of tining on highway pavements. Although Virginia was the first state to specify longitudinal tining, the FHWA required supporting research to justify the continued use of longitudinal tining. Therefore, most states simply followed the FHWA requirements in lieu of conducting additional research. However, California undertook the effort and developed research initiatives to study the issue. As a result, California is the only state that never used transverse tining on highways (except for test sections) and instead utilized longitudinal grooving and tining. California today experiences approximately 13% of vehicle miles traveled in the US.

The belief at the time was that transverse tining produced higher friction levels, although little data was provided to support this. Few long term studies have been carried out evaluating the friction levels of the different texture types over an extended period of time. Most studies claiming an advantage from transverse tining are either laboratory based studies or test results from recent construction projects where texture depth is a more important factor than the direction of tining. Adding more ambiguity to the discussion, agencies that use transverse tining or grooving on highways and bridges oftentimes terminate the tines/grooves prior to a free flow condition out of the tine/groove. This can occur from the stripe placement, which provides a barrier to the flow, or perhaps the groove installation not extending to an open flow condition. In these situations, which are not uncommon, the grooves merely provide additional water storage capacity and drain no better than a longitudinal texture.

» FRICTION VERSUS HYDROPLANING

Although the terms are often used interchangeably, “friction” and “hydroplaning” are different events. In the U.S., friction is generally measured by the use of the ASTM locked wheel skid trailer which administers 0.5mm (1/2 the thickness of a dime) of water in front of a locked/skidding tire. Since most tined/grooved surfaces provide sufficient texture to allow the water to escape, this technique measures wet friction. Hydroplaning, on the other hand, occurs when the water cannot be removed from within the tire contact patch area fast enough and the tire loses contact with the surface of the pavement. In highway applications, this most often occurs at high speeds and in locations with poor surface drainage.

NASA did extensive research in the 1960s and 70s on aircraft hydroplaning and concluded that transverse grooving was superior to longitudinal grooving on runways for water removal and hence hydroplaning prevention. Simply put, the transverse direction has a shorter path for the water to travel to get out from beneath the tire contact patch. Full scale testing with actual aircraft was conducted in that effort.

Recent research in the early 2000s (Ong, et al) used computational modeling methods to evaluate the hydroplaning resistance of both longitudinal and transverse grooving. As with the NASA effort, transverse grooving had an advantage for the conditions established in the modeling. Both runways and the modeling employ flatter cross slopes than are found on interstate type highways, hence the apparent superior drainage capability of the transverse textures on runways. The modeling efforts evaluated, among other things, the effect of groove size, depth, and spacing. This work is perhaps the most current research on impacts of grooving of pavements in prevention of hydroplaning.

The National Cooperative Highway Research Program (NCHRP) has sponsored a large research effort investigating hydroplaning and developing newer and improved models for evaluation of hydroplaning potential. Historical models, such as Pave Drain (a previous NCHRP research effort), employ some empirically derived components and use only a one-dimensional analysis approach.

» LATERAL STABILITY

During the 1960s and early 1970s, the California Highway Department began using longitudinal grooving to prevent wet weather accidents. The program was very successful and had significant reductions in wet weather accidents. It began with a study that compared 322 lane-miles of longitudinally grooved concrete pavement to 750 miles of ungrooved concrete pavement used as a control section. The average daily traffic varied from 60,000 to 200,000 vehicles on these freeway research sections. Wet pavement accident rates decreased an average of 70% on all the grooved pavements studied as compared to the control sections, where there was only a 2% reduction in accident rates. The study concluded that longitudinal grooving produced an overall average 69% decrease in accident rates for the highways studied, in both wet and dry conditions.

Longitudinal grooving provides a superior benefit when compared to transverse grooving for curve situations and run-off-the-road accidents. This is attributable to embedment of the tread in the longitudinal grooves which then resists lateral motion of the vehicle, providing additional stability in both wet and dry conditions. This does not occur with transverse grooving.

» NOISE BECOMES A CONCERN

During the 1990s and early 2000s, highway noise became an issue for consumers. At that time research was done at Marquette University which recommended a randomly spaced transverse tined surface as a noise solution. Although theoretically correct in their concept, the resulting noise signature of the new tining design did not meet the needs of the driving public. Since most states were using transverse tined highways, they were reluctant to switch to longitudinal based textures for noise purposes. However, the annoying tonal aspects of transversely textured pavements were sufficient to continue pressuring the agencies to switch away from transverse textures.

» SUMMARY

Experience has shown that grooving a pavement's surface is a very effective method to increase traction, reduce hydroplaning and minimize splash and spray as well as provide a more effective braking surface. This easily constructed and economical surface treatment provides the superior traction needed for vehicles to maintain control while driving in wet, dangerous conditions on both concrete and asphalt pavements.

Please visit us at **IGGA.net** for more information and for detailed specifications.

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ABOUT IGGA

The International Grooving & Grinding Association (IGGA) is a non-profit trade association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to form what is now referred to as the Concrete Pavement Preservation Partnership (IGGA/ACPA CP3). The IGGA/ACPA CP3 now serves as the lead industry representative and technical resource in the development and marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world.