Longitudinal Grooving for Safe, Quiet, Bridge-deck Surfaces

IGGA
International Grooving & Grinding Association
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DRIVING IN INCLEMENT WEATHER can be perilous. In particular, bridge decks can often be more dangerous than the roadways they connect. Standing water on relatively flat surfaces can cause hydroplaning and wet weather accidents. Additionally, bridge decks often freeze faster than roadways, creating particularly hazardous conditions.

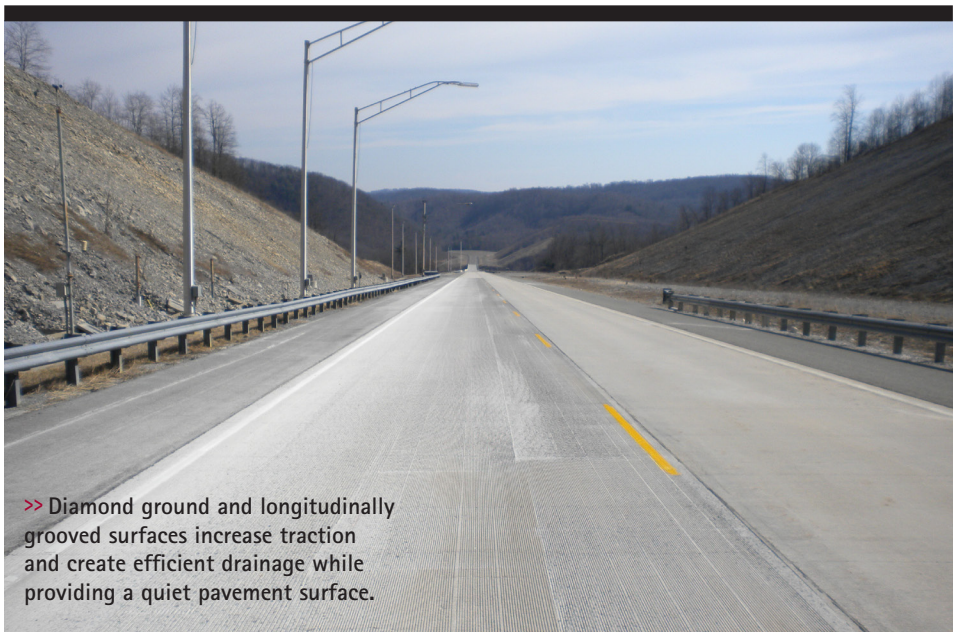
Motorist safety is paramount and reliable drainage at the tire/pavement interface will reduce the risk of hydroplaning and wet weather accidents. Considering the huge investment required to design and construct highway bridges, it is imperative to invest in time-tested methods that provide the safest possible driving surfaces for the motorist while preserving operator comfort.

For decades, Department of Transportation (DOT) officials have recognized the importance of grooving on bridge deck surfaces to reduce hydroplaning risks, increase drainage at the tire/pavement interface and aid in a vehicle's control. DOTs have found the low cost required to groove a bridge deck offers the best return on investment for the entire project. Statistics show a clear relationship between grooved surfaces and a reduction in accident rates.

In recent years tire/pavement noise has become a hot-button issue for many bridge owners, causing some to shift from transversely oriented textures to longitudinal grooving due to its low noise signature and pronounced safety benefits.

>>> THE BEST SOLUTION

Bridge deck grooving is the best solution for bridge deck weather hazards. Longitudinal grooves increase traction and create efficient drainage while providing a quiet pavement surface.. This is accomplished because the grooves allow for the displacement of water between vehicle tire tread and deck surface. Grooving also improves roadway visibility, because the water contained within grooves is less likely to create splash and spray visibility hazards. Under normal wet pavement conditions, the potential adverse effect of splash and spray is reduced because runoff water in the groove channels often lies below the pavement surface and is not dispersed due to tire/pavement interaction. Additionally, grooving allows the contractor to begin immediate curing methods after concrete placement which improves deck longevity. The main alternative, tining, can't provide any of these attributes as well as grooving.



>> Diamond ground and longitudinally grooved surfaces increase traction and create efficient drainage while providing a quiet pavement surface.

>>> WHAT THE NUMBERS SHOW

It is now possible to perform sophisticated highway and bridge research at dedicated testing facilities. The Virginia Smart Road is a 2.2 mile long, two lane closed roadway which is used for this type of research, as well as vehicle and Intelligent Transportation Systems (ITS) research. The facility, completed in 2002, is located near Blacksburg, Virginia, the home of Virginia Tech Transportation Institute (VTTI). The research facility is a joint project between the Virginia DOT, Virginia Tech Transportation Institute, and the Federal Highway Administration.

The research facility has many unique features, including weather making capability (rain, snow, and fog), a variable lighting test bed, pavement markings, road weather information systems, and road access surveillance systems. The facility also includes a signalized intersection and an advanced communication system using both wireless LAN and fiber-optic based systems. The communications network is used to transfer data between pavements, vehicles, and the research facility.

Tests previously performed on ungrooved pavements during simulated rainstorms show that water depths on pavement are dependent upon:

- Rainfall (or water flow) rate
- Surface winds
- Pavement cross slope
- Pavement macro texture
- Drainage path length

While no one can control the rainfall rate or surface winds, their effects can be minimized. The other three factors can indeed be "controlled." Cross slope is normally determined when the bridge is built. Once constructed, diamond grinding may be used to modify the existing cross slope. Pavement macro texture and drainage path length can be altered any time after the bridge is built. It is at this point that pavement grooving enters the picture.

Measurements collected at the Virginia Smart Road research facility confirm that safety grooving can increase macro texture by two to five times that of the original pavement. Their tests show that an original, tined stretch of PCC had an average Mean Profile Depth (MPD) of 0.38 mm, while a test section of diamond ground and grooved PCC had an average MPD of 2.14 mm. The higher MPD of the diamond ground and grooved surface demonstrates a significantly increased macrotexture for the roadway, which in turn improves the skid resistance of the sur-

face and reduces the potential for hydroplaning.

Friction on the Virginia Smart Road test surfaces was measured using both smooth and ribbed tires on a locked wheel skid testing device. Smooth tire results showed a significant increase in the skid numbers of the concrete section subjected to diamond grinding and grooving. This agrees with the higher measured macrotexture achieved on concrete after grinding and grooving. Another interesting observation for smooth tires is the slope of the correlation line between skid number and speed for the sections. This slope is lower for ground and grooved PCC than it is for tined PCC which suggests that friction is less sensitive to the changes of speed for this section. At lower speeds (25 mph) smooth tire measurements for both sections seem to be relatively close, however, at high speeds the difference is much more evident (40 & 55 mph). In general, the effect of hydroplaning is more pronounced at higher speeds; since the grooved section has a higher macrotexture, it is less sensitive to hydroplaning and consequently provides higher friction at high speeds.

>>> IRI

Several single spot laser profilers and a SURPRO reference profiler were used at the Virginia Smart Road research facility to measure surface smoothness before and after grinding and grooving. As expected, the SURPRO IRI measurements on ground and grooved PCC section were found to be lower than the transversely tined PCC section. There was a more substantial improvement in smoothness on the right wheel path as compared to the left wheel path. The left wheel path had an IRI measurement of 58 inches/mile before grinding and grooving and 45 inches/mile after grinding and grooving. The right wheel path had an IRI measurement of 60 inches/mile before grinding and grooving and 32 inches/mile after grinding and grooving.

On the other hand, a significant increase in the average IRI values was observed for profiles collected by the single spot laser profilers on PCC section after it was subjected to diamond grinding and longitudinal grooving; this was mainly caused by the wander of the inertial profiler as it traveled along the road. Longitudinal grooving made the single spot laser profilers incapable of measuring the correct road profile.

>>> HOW IS A SURFACE GROOVED?

To groove a concrete surface, bridge-grooving machines equipped with circular diamond-tipped saw blades saw discrete groove channels into the surface. The grooving machine's blades are mounted and spaced on a horizontal shaft, and are cooled constantly by water pumped from a tanker. State DOTs typically specify grooves ranging from 1/8 inch to 3/16 inch deep and 1/8 inch wide. Some states have adopted their own spacing configurations although the standard spacing is typically 3/4 inch center-to-center. The low-noise longitudinal grooved surface is constructed parallel to the centerline, covering the full lane width.

In many states, owners now require all new bridge decks be subject to smoothness tests using a profilograph or light-weight profiler prior to the grooving operation. Decks and approach slabs that do not meet smoothness requirements must be corrected by diamond grinding before they are grooved. This trend is based on several factors; bridge decks built to a tight ride requirement will produce a safer, more comfortable driving experience for the motorist while adding years of life to the structure due to reduced dynamic loading.

Advantages of longitudinal bridge deck grooving:

- Helps prevent hydroplaning
- Enhances braking action
- Provides a quiet riding surface
- Lasts the life of the bridge deck
- Helps facilitate ice breakup
- Can be sawed in any concrete including high performance and latex mix designs
- Outlasts conventional tining

What else happens during construction of the grooved surface?

- The diamond blades are cooled by water, which then mixes with the concrete fines to form a concrete slurry.
- This slurry is collected by a vacuum pickup system located near the cutting head.
- The deck is kept relatively clean and dry as the grooving operation progresses.
- The slurry is collected and disposed of as required by specification.

>>> THE BEST INVESTMENT

Motorist safety is paramount, and longitudinal grooving has been shown to reduce the risk of hydroplaning and wet weather accidents while improving visibility during a rainstorm. Other benefits include a quiet ride, better curing and low construction costs. Diamond grinding the deck in addition to the grooving operation will provide a smoother ride and will add longevity to the structure due to decreased dynamic loading.

Surface-grooved bridge decks are a win-win solution for the owner, contractor and motorist. Longitudinal grooving is a low cost investment, easy to implement and provides safer driving conditions in inclement weather. Dating back to the Roman era, history shows that bridge deck grooving is an investment for LIFE.

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.