

Dowel Bar Retrofit and Diamond Grinding Best Practices

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Pavement Preservation Philosophy



Keeping good roads in Good Condition!

PCCP Preservation Techniques

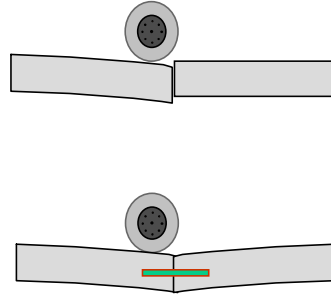
- Subsurface rehabilitation
- Partial-depth repair
- Cross-stitching longitudinal cracks/joints
- **Dowel bar retrofit (AKA Load Transfer Restoration)**
- Full-depth repair
- **Diamond grinding**
- Joint & crack resealing

Dowel Bar Retrofit (DBR)



Purpose of Dowel Bar Retrofit

- Reestablish load-transfer across joints or cracks
 - Load-transfer is a slab's ability to transfer part of its load to its neighboring slab
- Used in JRC and JPC pavements to limit future faulting

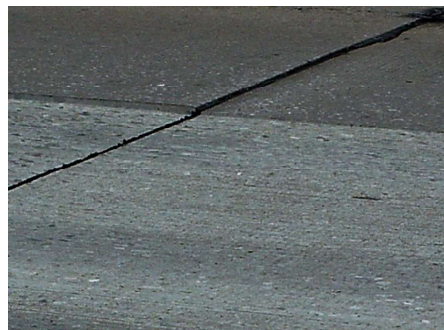


Where is DBR Utilized

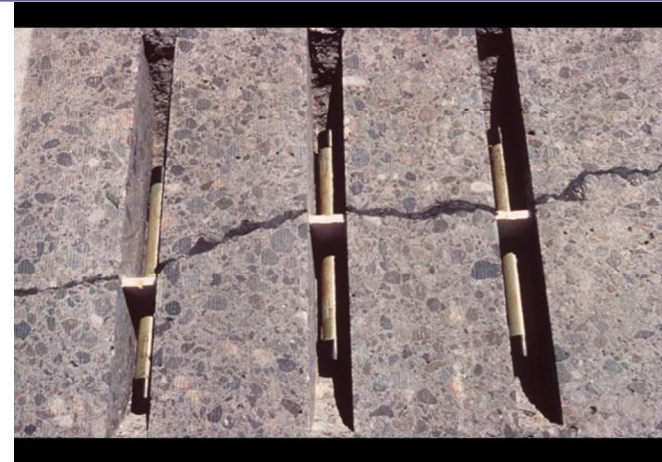
- Interstate Highways
- Secondary Roads
- County Roads
- City Streets
- Industrial Facilities



Joint Faulting



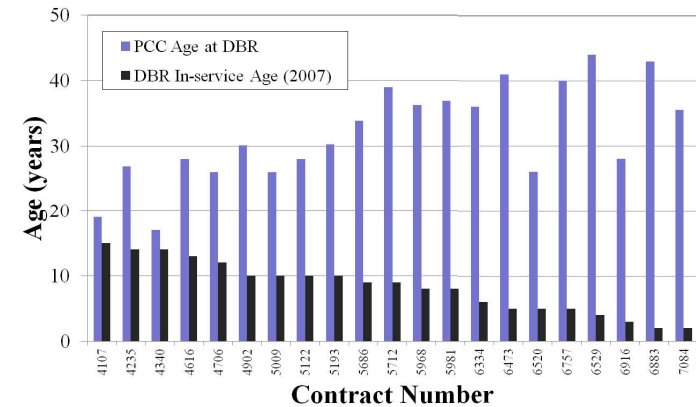
DBR Used to Fix Transverse Crack



WSDOT DBR Research

- Since 1992, WSDOT has retrofitted well over 300 Lane-mi in excess of 700,000 bars
- Average age of pavement prior to DBR was 32 yrs.
- DBR provides superior performance providing in excess of 20 years additional life
- Many 30 and 40 year PCCPs successfully retrofitted for additional pavement life at a fraction of the cost of reconstruction

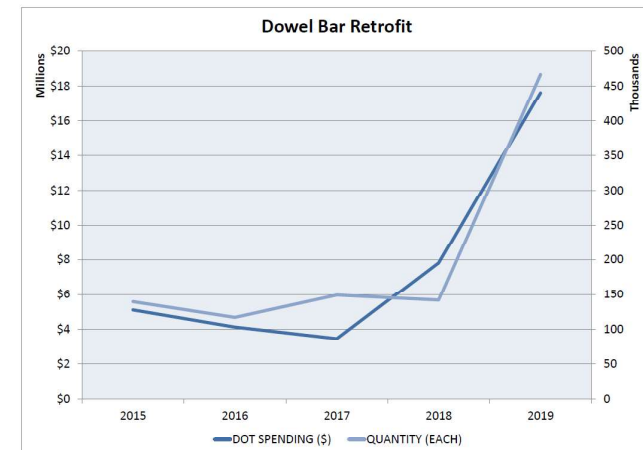
Pavement Age vs. DBR Placement



IGGA DBR Project Database

- Includes individual project data including:
 - Project Location
 - Project Date
 - Number of bars installed
- Over 7.5 million bars installed in the US since 1992

DBR Usage in the USA



Dowel Bar Retrofit Operations

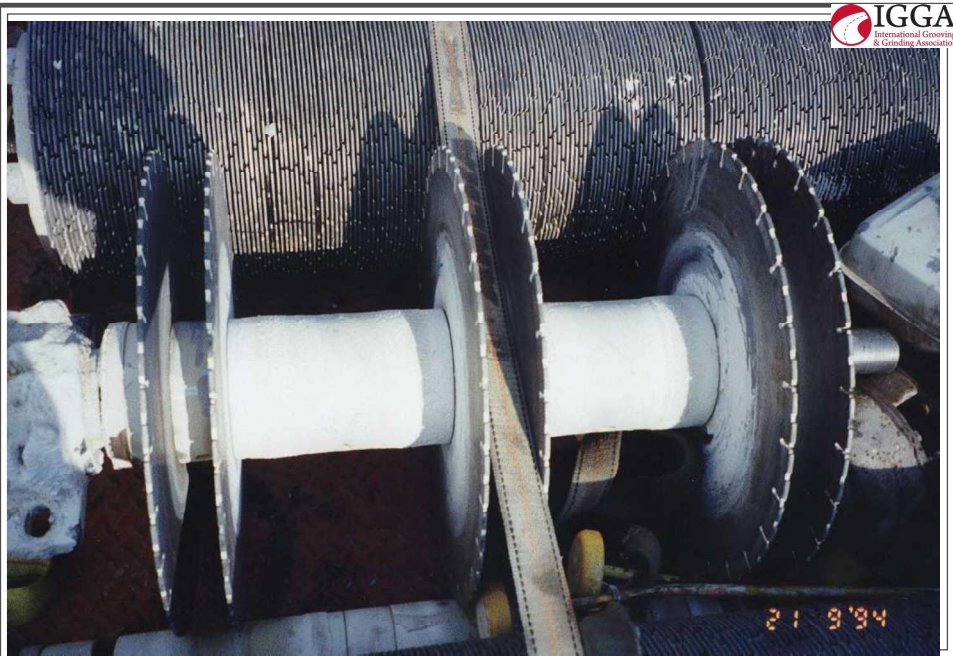
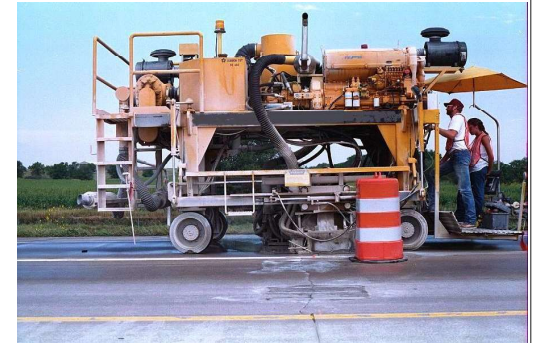
Consists of 4 main operations:

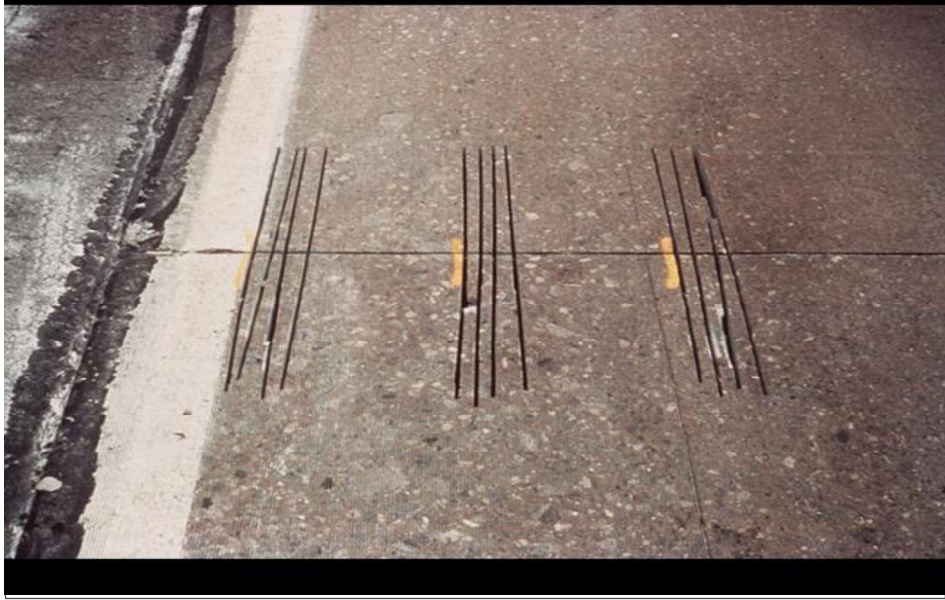
1. Cutting the slots
2. Preparing the slots
3. Preparing and placing the dowel bars
4. Backfilling the slots

Cutting the Slots

Diamond saw slot cutter

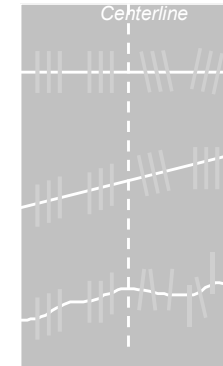
- Cuts multiple slots in a single pass.
- Cuts form the edges of the slots
- Fins are removed later
- Saws cut between 3 to 8 slots in a single pass





Dowel Slot Alignment

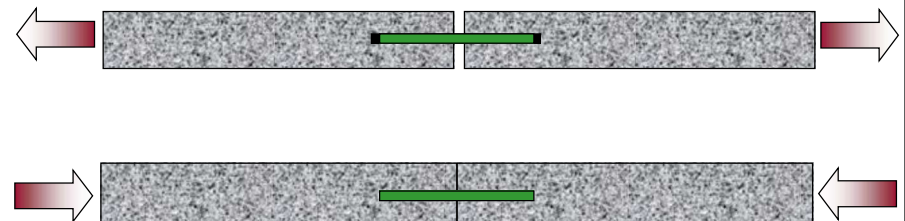
- Must always be parallel to centerline
- Must be cut so at least one-half of dowel can be on each side of the joint or crack



Misaligned Slots



Proper Alignment is Critical



Slot Creation

Slot Cutting with Milling Machine



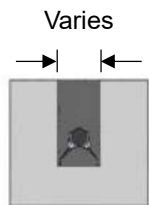
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Retrofitted Dowel Bar

END VIEW



SIDE VIEW

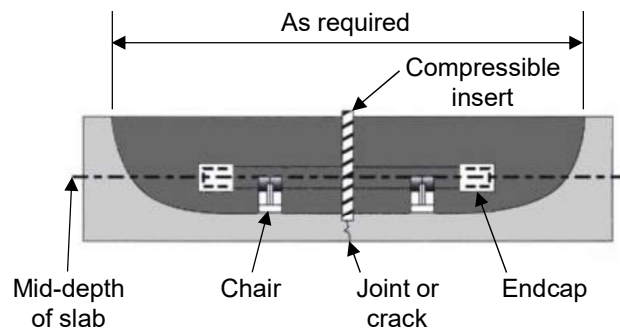


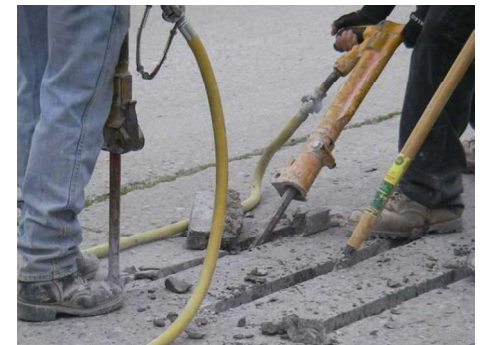
Fig. 8.3 on p. 8.7

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Removing the Concrete Fins

- Use 15 to 30 lb pneumatic hammers
- Chip out in large pieces
 - Pop with hammer at end of fin
 - Pop with hammer along saw cut



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Flattening the Slot Bottom

- Remove burrs and bumps from base with small bush hammer
- Allows the dowel to sit level and properly aligned.



Cleaning and Caulking the Slots

- Slot cleanliness is essential
 - Sandblast (Waterblast) first
 - Remove debris with compressed air
 - Check for dust with hand
- Caulk the joint / crack within the slot
 - Caulk bottom and sides
 - Prevents patch material from entering joint or crack

Sand/Water Blasting



Caulking the Slots

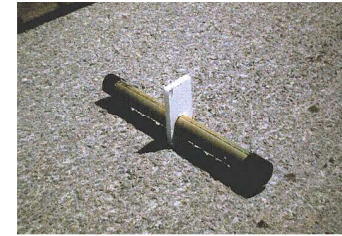


Dowel Bar Requirements

- Typical bar diameter: 1.5 inches
- Minimum length: 15 inches
 - Need at least 6 inches on each side of the joint or crack
- Epoxy Coated
- Lubricated with some type of bond breaker

Preparing the Dowels

- Add joint former
 - Styrofoam
 - Fiber board
- Attach non-metallic expansion caps
- Attach non-metallic chairs (sized for slot)

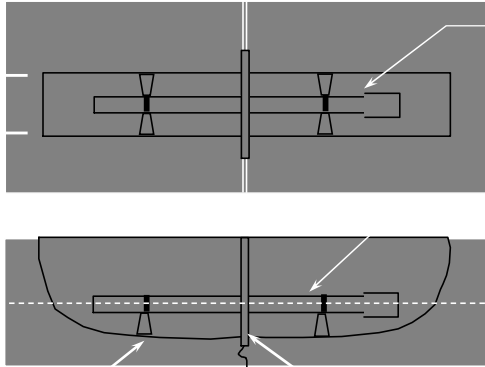


Placing the Dowels

- Ensure that legs of chairs fit tightly against slot walls
- Push assembly to base of slot
- Center reformer on the joint or crack



Plan and side view of inserted dowel

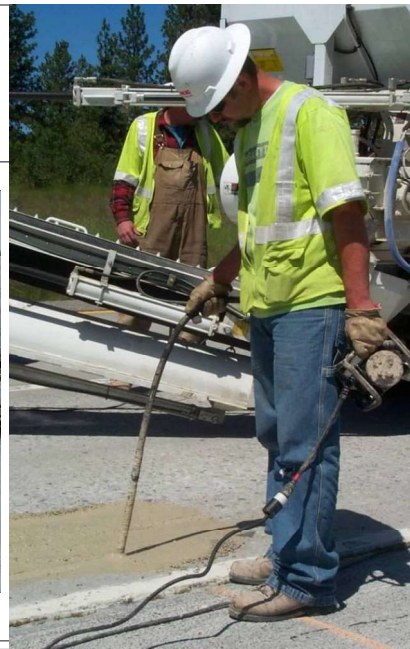


Backfill Materials

■ Basic requirement

- Thermal properties be similar to concrete.
- Must bond to the existing concrete
- Should be fast setting
- Should have little or no shrinkage
- Must consistently develop enough strength to allow traffic on it in a short time.
- Only use materials designed for the rigors of DBR
- Check www.IGGA.net for recommended materials

Backfill Placement



Repair Material Finishing



Seal The Joints!

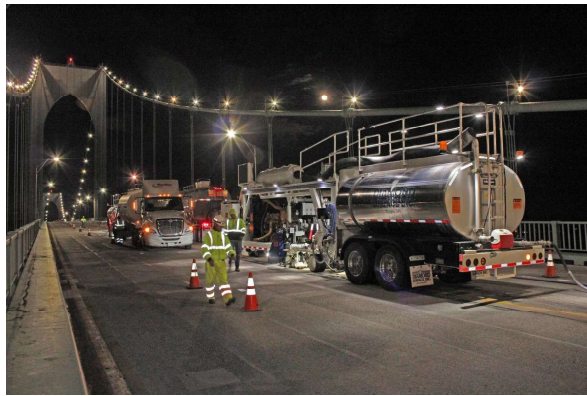


DBR Followed by Diamond Grinding



Diamond Grinding

Increasingly Specifiers are utilizing diamond saw cut surface textures to reduce roughness, reduce noise and increase friction on pavements, bridges and runways.



Advantages of Saw-Cut Textures

- Costs are competitive and stable over time;
- Enhances smoothness, surface friction and safety
- Can be accomplished during off-peak hours with short lane closures
- Texturing of one lane does not require grinding of the adjacent lane
- Does not affect overhead clearances underneath bridges, signs or tunnels
- Blends patching and other surface irregularities into a consistent, identical surface

Pavement Problems Addressed

- Faulting at joints and cracks
- Built-in or construction roughness
- Polished concrete surface
- Wheel-path rutting
- Permanent upward slab warping
- Inadequate transverse slope
- Unacceptable noise level

What is Diamond Grinding?

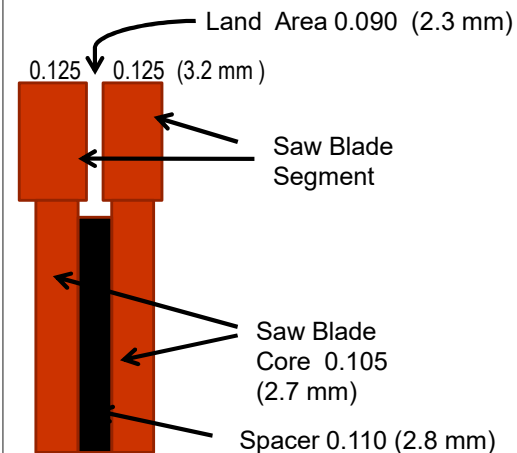
- Removal of thin surface layer of pavement using closely spaced diamond saw blades
- Results in smooth, level pavement surface
- Provides a longitudinal texture with desirable friction and low noise characteristics



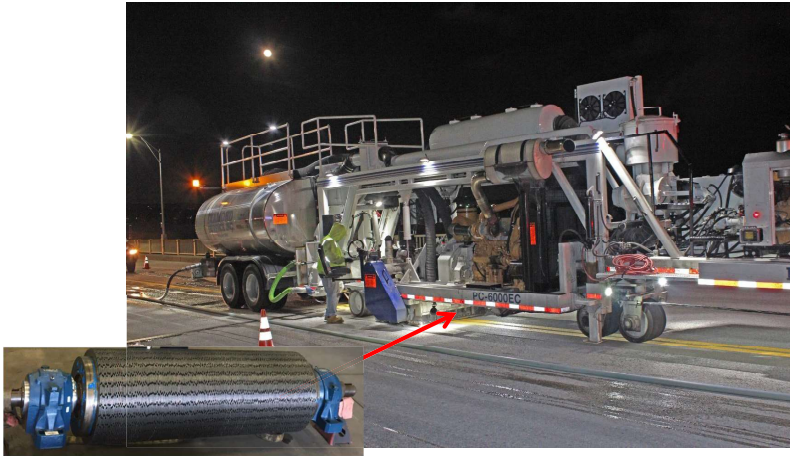
Blades and Spacers



Typical Conventional Diamond Grinding (CDG) Blade Configuration



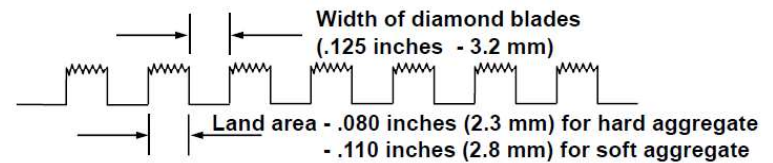
Diamond Grinding Equipment



Conventional Diamond Ground Surface



Diamond Grinding



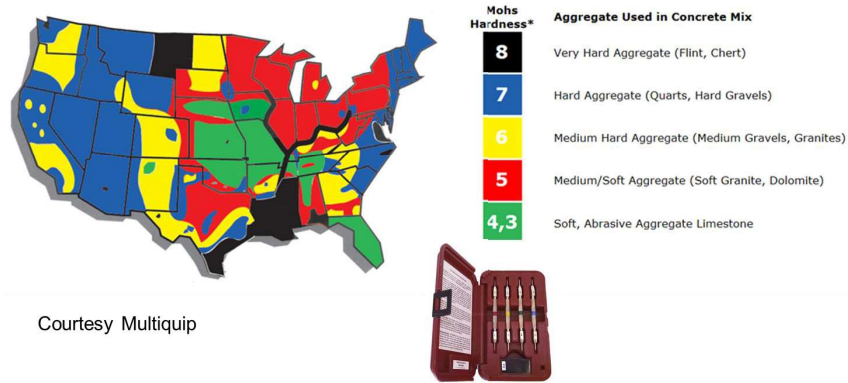
Purpose of Blade Spacers

- Spacers are Used to Separate the Cutting Blades to Allow for Cooling of the Blade and Removal of Cutting Debris
- They also stabilize the blades
- Spacer width determines the land area and controls unwanted fin development

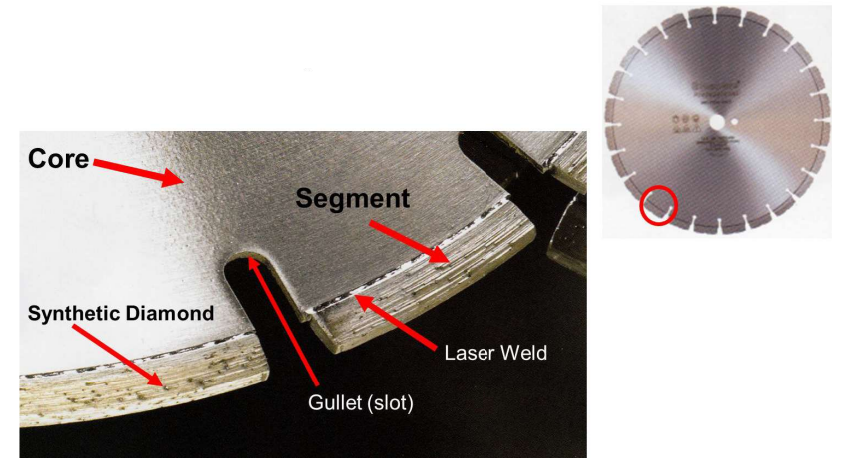
60 Blades vs 52 Blades per Foot



Aggregate Hardness Map



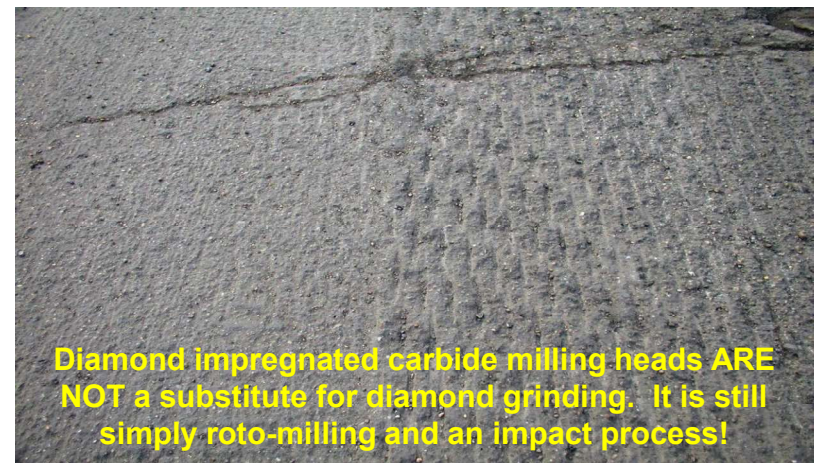
Impact vs Abrasion



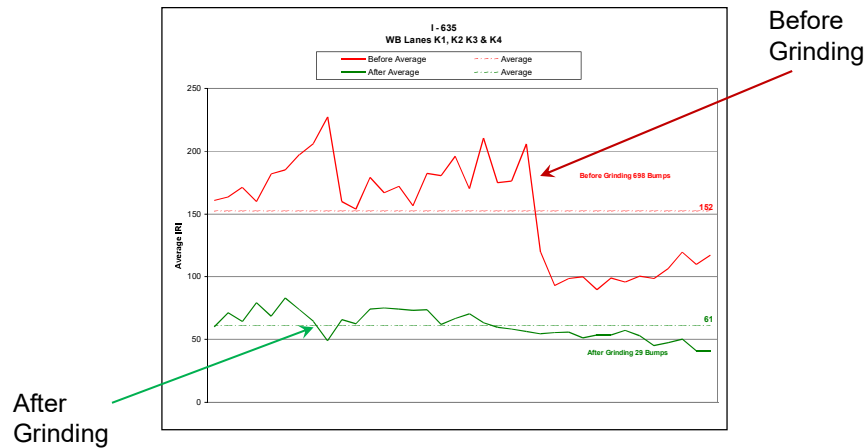
Uniform Repeatable Texture



Milled Surfaces



Diamond Grinding can provide a significant improvement over the pre-grind profile!



Safety, Surface Texture and Friction

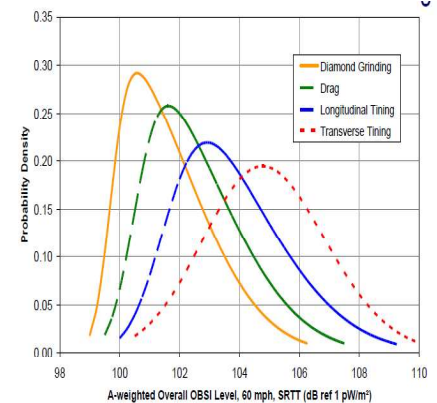
- Increased macro-texture of diamond ground pavement surface provides for improved drainage of water at tire-pavement interface
- Longitudinal texture provides directional stability and reduces hydroplaning (side-force friction). Grooves provide “escape route” for water trapped between tire and pavement surface
- In Wisconsin, overall accident rates for ground surfaces were 40% less than for un-ground surfaces over a 6-year period, 57% in wet weather conditions

Unacceptable Noise Level



NCPTC Noise Catalogue

- Research conducted by the National Concrete Pavement Technology Center shows diamond grinding as the most quiet PCCP surface texture commonly used.



DBR Followed by Diamond Grinding



Factors For Success Using DBR & DG

- Selection of proper candidate projects and contractors
- Proper dowel design and layout
- Cutting and preparation of dowel bar slots
- Proper placement of dowels
- Selection of appropriate backfill material
- Careful material placement and curing
- Clear and concise expectations and specifications for DG
- Proper grinding equipment and qualified operators
- Appropriate blade spacing
- Knowledgeable inspection and clear communication

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