Session 9: Diamond Grinding and Grooving
Learning Outcomes

1. Differentiate between diamond grinding and diamond grooving and list the benefits of each
2. Identify appropriate blade spacing dimensions for grinding and grooving
3. Describe recommended construction procedures
4. Identify typical construction problems and remedies
Grinding vs. Grooving

- **Diamond grinding**
  - Removal of thin layer of concrete surface to restore smoothness and friction
- **Diamond grooving**
  - Creation of channels in concrete pavements to reduce hydroplaning potential
Surface Comparison

Diamond Grinding

Diamond Grooving
Diamond Grinding
Diamond Grinding

Benefits

- Restores smoothness
- Improves friction
- Improves cross slope
- Reduces noise
## Diamond Grinding

### Effect on Roughness

Percent decrease in IRI

<table>
<thead>
<tr>
<th>Test Area</th>
<th>Lane 1</th>
<th>Lane 2</th>
<th>Lane 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>59%</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>53%</td>
</tr>
<tr>
<td>3</td>
<td>64%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>55%</td>
</tr>
</tbody>
</table>

Source: 2003 ADOT Study
## Diamond Grinding

### Effect on Friction

Percent increase in friction

<table>
<thead>
<tr>
<th>Test Area</th>
<th>Lane 1</th>
<th>Lane 2</th>
<th>Lane 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>18%</td>
</tr>
<tr>
<td>3</td>
<td>41%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>26%</td>
</tr>
</tbody>
</table>

Source: 2003 ADOT Study
Diamond Grinding

Project Selection

- Structurally sound pavement
- Pavement not excessively rough (< 160–190 in/mi)
- Consider hardness of aggregate
- Consider need for associated treatments (e.g., load transfer restoration)

Recommended evaluation procedures
- Distress surveys
- Roughness/friction testing
Diamond Grinding

Project Selection (Trigger Values)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>JPCP</th>
<th>JRCP</th>
<th>CRCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faulting</td>
<td>0.08 in</td>
<td>0.16 in</td>
<td>N/A</td>
</tr>
<tr>
<td>Friction</td>
<td>Minimum Local Acceptable Levels</td>
<td>Minimum Local Acceptable Levels</td>
<td>Minimum Local Acceptable Levels</td>
</tr>
<tr>
<td>PSR</td>
<td>3.4 to 3.8</td>
<td>3.4 to 3.8</td>
<td>3.4 to 3.8</td>
</tr>
<tr>
<td>IRI</td>
<td></td>
<td>63 – 90 in/mi</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.1 on p. 9.3
Diamond Grinding

Limitations

- Does not address structural or durability issues
- Hardness of aggregate affects costs, productivity, and performance life
- Roughness and deterioration will develop if causes are not addressed
  - Full- and partial-depth repairs
  - Load transfer restoration
  - Slab stabilization
  - Joint resealing
## Diamond Grinding

### Design Considerations

- **Degree of faulting**
- **Project layout**
- **Blade spacing**

![Diagram of Diamond Grinding](image)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Range</th>
<th>Hard Aggregate</th>
<th>Soft Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groove</strong></td>
<td>2.3 - 3.8 mm</td>
<td>2.5 - 2.8 mm</td>
<td>2.3 - 3.6 mm</td>
</tr>
<tr>
<td></td>
<td>(0.09 - 0.15 in)</td>
<td>(0.10 - 0.15 in)</td>
<td>(0.09 - 0.14 in)</td>
</tr>
<tr>
<td><strong>Land area</strong></td>
<td>1.5 to 3.3 mm</td>
<td>2.0 mm</td>
<td>2.5 mm</td>
</tr>
<tr>
<td></td>
<td>(0.06 - 0.13 in)</td>
<td>(0.08 in)</td>
<td>(0.10 in)</td>
</tr>
<tr>
<td><strong>Depth</strong></td>
<td>1.5 mm</td>
<td>1.5 mm</td>
<td>1.5 mm</td>
</tr>
<tr>
<td></td>
<td>(0.06 in)</td>
<td>(0.06 in)</td>
<td>(0.06 in)</td>
</tr>
</tbody>
</table>

Fig. 9.5 on p. 9.7
Diamond Grinding

Construction Considerations

- Mobile single lane closure
- Conduct grinding parallel to centerline
- Multiple passes per lane
  - Maximum overlap of 50 mm (2 in)
  - Maintain cross slope of adjoining passes
  - Minimize drop-off
- Slurry removal

9.13
Diamond Grinding

Cutting Head Specifications

- Diamond blades mounted in series on cutting head
- Cutting head width from 1,220 to 1,270 mm (48 to 50 in)
- Spacing of 164 to 197 blades per meter (50 to 60 blades per ft)
Diamond Grinding
Cutting Head
Diamond Grinding
Grinding Machine
Diamond Grinding

Grinding Machine
Diamond Grinding
Trucks Collecting Slurry
Diamond Grinding
Grinding Process
Diamond Grinding
Front of Grinding Head
Diamond Grinding
Behind the Grinding Head
Diamond Grinding
After First Pass of Grinding Machine
Diamond Grinding
Slurry Disposal
Diamond Grinding
Finished Product
Key Factors For Success

Diamond Grinding

- Selection of proper candidate projects
- Proper design (blade spacing, transverse slope, and project layout)
- Conduct grinding parallel to the centerline
- Check that overlaps are within tolerances
- Monitor grinding depth
- Verify end product meets specification
  - Smoothness testing
  - Friction and/or texture measurements
Troubleshooting—Grinding
Possible Construction Problems

Lack of Horizontal Overlap ("Dogtails")
Problem:
*Uneven material removal at wide expansion joints in pavement*

Potential causes? Solutions?
Troubleshooting—Grinding

Possible Construction Problems

- Problem:
  
  Remaining fins do not break easily

- Potential causes? Solutions?
Troubleshooting—Grinding

What is wrong here?

Unground Areas (“Holidays”)
Troubleshooting—Grinding

What is wrong here?

Poor Vertical Match Between Passes
Troubleshooting—Grinding

What is wrong here?

Vacuum Failure
Diamond Grooving
Diamond Grooving

- Cutting parallel grooves into the pavement using diamond saw blades
- Longitudinal (more common) or transverse

Benefits
- Improved wet weather friction
- Reduction in splash and spray
Diamond Grooving
Project Selection

- Historical crash rate, friction number, or macrotexture depth data
- Generally performed at localized areas
- Pavements should be structurally and functionally sound

<table>
<thead>
<tr>
<th>SURFACE</th>
<th>Scale of Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rough</td>
</tr>
<tr>
<td></td>
<td>Harsh</td>
</tr>
<tr>
<td>B</td>
<td>Rough</td>
</tr>
<tr>
<td></td>
<td>Polished</td>
</tr>
<tr>
<td>C</td>
<td>Smooth</td>
</tr>
<tr>
<td></td>
<td>Harsh</td>
</tr>
<tr>
<td>D</td>
<td>Smooth</td>
</tr>
<tr>
<td></td>
<td>Polished</td>
</tr>
</tbody>
</table>
Diamond Grooving

Longitudinal vs. Transverse Grooving

- Longitudinal
  - Decreased hydroplaning potential
  - Improved curve tracking
  - Easier to conduct under traffic
  - Lateral “wiggle” of vehicles

- Transverse
  - Most direct channel for water drainage
  - Significant braking traction
  - Difficult to conduct under traffic
  - Noise may be an issue
Diamond Grooving
Effect on Friction

Fig. 9.4 on p. 9.6
Diamond Grooving

Design Considerations

- Groove entire lane area (but allow for small areas with surface irregularities)
- Use recommended blade spacing

Saw blade thickness

3.2 mm (0.125 in) min.

19 mm (0.75 in) max.

3.2 mm (0.125 in) min.

6.4 mm (0.25 in) max.

Fig. 9.6 on p. 9.8
Diamond Grooving
Construction Considerations

- Groove dimensions
- Direction of grooving
- Disposal of slurry
- Procedures similar to diamond grinding
Diamond Grooving

Equipment

- Head width: 0.3 to 3.7 m (1 to 12 ft)
- Longitudinal blade spacing of 19 mm (3/4 in)
- Vacuum system employed to collect slurry
Diamond Grooving
Longitudinal Grooving
Diamond Grooving
Transverse Grooving

Bridge Deck

Airport
Key Factors For Success

Diamond Grooving

- Selection of proper candidate projects
- Proper selection of groove dimensions
- Selection of grooving direction
Review: Learning Outcomes

1. Differentiate between diamond grinding and diamond grooving and list the benefits of each
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