NCDOT Experience with Diamond Grinding

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Learning Objectives

- Introduction to Diamond Grinding
- Advantages, Benefits and Use
- Performance and Costs
- NCDOT Projects
- Summary
What is Diamond Grinding?

- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades;
- Results in smooth, level pavement surface;
- Longitudinal texture with desirable friction and low noise characteristics;
- Frequently performed in conjunction with other CPR techniques, such as full-depth repair, dowel bar retrofit, and joint resealing.
- Comprehensive part of any PCC Pavement Preservation program;
Diamond Grinding
Cutting Head
Diamond Grinding

Dimensions

Width of diamond blades (.10 to .125 inches)

Land area - .080 inches for hard aggregate
- .110 inches for soft aggregate
Diamond Grinding
Grinding Machine
Diamond Grinding
Grinding Process
Diamond Grinding
Finished Product
Diamond Grinding Was Invented in California

- Diamond grinding was first used in California in 1965 on a 19-year old section of I-10 to eliminate significant faulting (Neal and Woodstrom 1976).

- In 1983, CPR was conducted on this same pavement section, including the use of additional grinding to restore the rideability and skid resistance of the surface. In 1997, the process was repeated.

- Since its first use in 1965, the use of diamond grinding has grown to become a major element of PCC pavement preservation.
Effectiveness of Diamond Grinding - CALTRANS

- CALTRANS has determined that the average life of a diamond ground pavement surface is 17 years and that a pavement can be ground at least three times without affecting pavement structurally. See IGGA.net for full report.
Advantages of Diamond Grinding

- Costs substantially less than AC overlays;
- Enhances surface friction and safety;
- Can be accomplished during off-peak hours with short lane closures and without encroaching into adjacent lanes;
- Grinding of one lane does not require grinding of the adjacent lane;
- Does not affect overhead clearances underneath bridges;
- Blends patching and other surface irregularities into a consistent, identical surface;
- **Environmentally friendly**.
Pavement Problems Addressed

- Faulting at joints and cracks
- Built-in or construction roughness
- Polished concrete surface
- Wheelpath rutting
- Permanent upward slab warping
- Inadequate transverse slope
- Unacceptable noise level
Faulted Joints
Diamond grinding can provide a 60% to 70% improvement over the pre-grind profile on average!
Safety
Polished Surface
Safety, Surface Texture and Friction

- Increased macrotexture 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 (Drakopoulos et al. 1998).
Safety

- Increased macrotexture of diamond ground pavement surface provides for improved drainage of water at tire-pavement interface.
- Grooves provide “escape route” for water trapped between tire and pavement surface.
- Reduces the potential for hydroplaning.
Wheel Path Rutting
Curling
Unacceptable Noise Level
Traffic Control

What do you remember most about your summer vacation?

The traffic.
Traffic Management

- Minimal traffic control required
- Perform off-peak hours
- Short closures - re-open lanes as needed
- No equipment encroachment into other lanes
- Can do just one lane
- Does not affect overhead clearances
Performance
Diamond Grinding Study
By ERES

- Extends service life;
- Initial smoothness comparable to new pavement or overlay;
- Average life of 32 years;
- May be reground 3 to 4 times;
CALTRANS has determined that the average life of a diamond ground pavement surface is 17 years and that a pavement can be ground at least three times without affecting pavement structurally. See IGGA.net for full report.
Noise Performance

- So what is all this noise about diamond grinding in Arizona?!?
Typical ARFC Noise Research Results - ADOT

- “The results shown represent the average of twenty projects. The projects were located on I-8, and I-10, and ranged in age from three years to twelve years. The regression indicates approximately a 5 dBA increase in noise generation in a ten year period. The current data further indicates that AR-ACFCs typically range from 94 to 99 dBA throughout their life.”
California and Arizona PCCP SI Test Results
Diamond Grinding - The Long Life Solution to Tire/Pavement Noise
Costs

- Depends on —
  - Aggregate and PCC mix properties;
  - Average depth of removal;
  - Smoothness specifications;
  - Size of the project;
  - Work schedule;

Cost effective whether used alone or as part of a comprehensive CPR program. In most cases, the cost of diamond grinding is only about half the cost of bituminous overlay.
Costs

- Soft limestone — as low as $1.50 per sq. yd.
- Hard river gravel — as high as $10.00 per sq. yd.
- Typical price — $2.00 to $4.00 per sq. yd.

*for a job with min. 20,000 sq. yds. and reasonable traffic control requirements
Evaluate Rideability

- Rainhart profilograph (or similar)
- Take traces before and after grinding
- Should be able to provide 60% to 70% improvement over pre-grind profile
- Verify profile index against specification requirement
NCDOT Projects – Reasons for DG

A) I-85 in Salisbury (Ride quality)
B) I-95 North of Henderson (Rehab)
C) I-40 in Orange/Durham Counties (Rehab)
D) I-77 in Yadkin Co. (DB as benefit to NCDOT)
E) I-26 in Hendersonville (Rehab)
F) US1 in Cary (Included in Contract due to work)
G) NC 147 in Durham (Rehab)
H) WWF (NCTA Project) (Noise Reduction)
I-40 in Orange/Durham Counties

- DG as part of PCCP rehabilitation
- Completed in 2011
NC 147 in Durham ($2.60/SY)

- DG as part of PCCP rehabilitation
- Completion in early 2012
NCTA: WWF project in Wake County

- DG entire project for noise reduction
- Completion date December 2012
## NCDOT DG Projects – IRI Results

<table>
<thead>
<tr>
<th>Location</th>
<th>IRI (avg) – Before DG</th>
<th>IRI (avg) – After DG</th>
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<tbody>
<tr>
<td>I-85</td>
<td>102.4</td>
<td>55.0</td>
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<tr>
<td>I-95</td>
<td>116.2</td>
<td>46.5</td>
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<tr>
<td>I-40 (2010)</td>
<td>102.7</td>
<td>61.9</td>
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<tr>
<td>I-77 (DB – 2009)</td>
<td>112.6</td>
<td>61.0</td>
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<tr>
<td>I-26</td>
<td>99.3 (Faulting)</td>
<td>75.4</td>
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<tr>
<td>US 1 (2006)</td>
<td>94.9</td>
<td>60.8</td>
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<tr>
<td>NC 147 (2012)</td>
<td>121.4</td>
<td>57.0</td>
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<tr>
<td>WWF (2013)</td>
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<td>38.9</td>
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It’s a Fact!

- Diamond grinding can provide the safest, smoothest, most quiet PCC pavement texture available when properly designed and constructed with durable aggregates!
FHWA Technical Advisory

○ TA 5040.36 Surface Texture For Asphalt And Concrete Pavements
  - State Of Practice Surface Texture includes diamond ground surfaces for new pavements
  - Technique Recommended Application
  - Factors For Selecting Texture Techniques

○ See IGGA.Net for a copy of TA 5040.36
Summary

- **Diamond grinding** can extend pavement life significantly at a competitive cost.
- Diamond grinding is a key **Preventive Maintenance** tool.
- Diamond grinding will increase customer satisfaction, increase friction, reduce noise and reduce life cycle costs.
- Performance and cost vary with given conditions.
- Timing is everything.
- **ACPA** and **IGGA** are ready to assist!