The Next Generation
Concrete Surface

Innovations in Diamond Saw-cut Pavement Textures
2016
Introduction

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Looking Back In Time

- In the not so distant past noise, ride quality, noise and customer comfort (functional considerations) took a back seat to structural considerations.
Transportation Authorities React

- Specifiers place greater emphasis on tire/pavement noise, smoothness and construction delays.
  - Development of tighter smoothness and new noise specifications.
  - Development of low noise surface treatments.
  - Increased use of sound walls.
  - Night work becomes the norm.
  - Safety concerns still paramount!
The first Portland Cement Concrete Pavement (PCCP) constructed in US was located in Bellefontaine, Ohio, 1891

- Used two lift construction
  - Hard aggregate on surface so horseshoes wouldn’t wear pavement.
  - Surface Texture was grooved in 4” squares so horses would not slip.
Performance Matters!

- Bristol Motor Speedway 2012
Diamond Saw Cut Surface Textures

- Increasingly Specifiers are utilizing diamond saw cut surfaces to reduce roughness, reduce noise and increase the friction of their pavements, bridges and runways.
  - Economical
  - Long-lasting
  - Effective
  - Environmentally Friendly
IRI of KY Interstate Pavements

Consider performance monitoring associated with the FAST ACT!
What is Diamond Grinding?

- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades
- Results in smooth, level pavement surface
- Provides a longitudinal texture with desirable friction and low noise characteristics
- Frequently performed in conjunction with other CPR/CPP techniques, such as full/partial depth repair, undersealing/slabjacking, dowel bar retrofit, and joint resealing
Blades and Spacers
Typical Conventional Diamond Grinding (CDG) Blade Configuration

- Land Area 0.090 (2.3 mm)
- Core 0.105 (2.7 mm)
- Spacer 0.110 (2.8 mm)
- Saw Blade Segment

A diagram illustrates the configuration with dimensions labeled.
Diamond Grinding Equipment
Diamond Grinding Process
Conventional Diamond Ground Surface

Diamond Grinding

- Width of diamond blades: 0.125 inches (3.2 mm)
- Land area: 0.080 inches (2.3 mm) for hard aggregate; 0.110 inches (2.8 mm) for soft aggregate
Safety, Surface Texture and Friction

- 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.
- CALTRANS has reported a 70% reduction in wet weather accidents following a 3 year research effort investigating longitudinal textures (grooving/tining).
Advantages of Saw-Cut Textures

- Costs substantially less than AC overlays;
- Enhances surface friction and safety
- Saw-cut surfacing can be accomplished during off-peak hours with short lane closures
- Diamond saw-cut 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
- Environmentally friendly
Diamond Grinding Asphalt Pavement

- Asphalt pavement can be ground and grooved just like concrete pavement.

Indianapolis Motor Speedway
Diamond Ground Asphalt Surface
Noise Performance

- So what is all this noise about tire/pavement noise?!?
Transverse Tining

- For many years the use of transverse tining created the perception that all concrete pavement is noisy.
NCPTC OBSI Testing

- In 5 years the National Concrete Pavement Technology Center tested over 1500 unique textures
  - Transverse Tining
  - Longitudinal Tining
  - Diamond Ground
  - Diamond Grooved (Longitudinal, Transverse)
  - Shot Peened
  - Exposed Aggregate
  - Pervious Concrete
  - HMA and Surface treatments
- Hundreds of Miles in 20 States and 6 Countries
NCPTC OBSI Testing
NCPTC Noise Catalogue

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

![Graph showing sound intensity levels for different conditions: Ground, Longitudinal, Uniform Transverse, Random Transverse, measured in dBA. The graph displays a comparison of sound intensity across these conditions.]
Purdue-Tire Pavement Testing Apparatus
MNROAD Field Validation of TPTA
Duluth Minnesota NGCS
NGCS is Built Using DG Technologies
Comparison to Other Pavement Surfaces

Sound Intensity Level, dBA

Pavement Section

- NGCS Lane 2
- NGCS Lane 1
- Typical 4-5 Yr Old ARFC
- 2002 ARFC Test Section
- CDG
- Longitudinal Tinning

International Grooving and Grinding Association
## Kansas I-70 Results

<table>
<thead>
<tr>
<th>Pavement Section</th>
<th>Sound Intensity Level, dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGCS Long. Grooved</td>
<td>100.9</td>
</tr>
<tr>
<td>Drag Texture</td>
<td>101.9</td>
</tr>
<tr>
<td>CDG Long Tine Before</td>
<td>102.6</td>
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<tr>
<td>CDG Long Tine After</td>
<td>102.8</td>
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<tr>
<td>CDG Exposed Agg.</td>
<td>103.1</td>
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<tr>
<td>CDG Long Tine After</td>
<td>104.0</td>
</tr>
<tr>
<td>CDG Exposed Agg.</td>
<td>104.5</td>
</tr>
</tbody>
</table>
NCHRP Project 10-67
Acoustic Durability

Sound Intensity Level, dBA

Pavement Section

NGCS
10-25-07
5-12-08
6-18-10
7-7-09
6-18-10
10-25-07
NGCS LITE
100.7
5-12-08
6-18-10
CDG
102.1
7-7-09
6-18-10
101.8
“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.
Why Grooving?

- Reduce the number of wet pavement accidents
- The wet pavement accident occurs when the vehicle pavement friction demand exceeds the ability of the pavement-tire contact to produce the required amount of friction
Improved Internal Water Drainage

- Grooves provide “escape route” for water trapped between tire and pavement surface
- Increases macro-texture of pavement surface.
- **Reduces the potential for hydroplaning**
Reduced Splash and Spray
Grooved Pavement Study

- Study conducted over a four-year period
- All grooved and un-grooved control sections located on freeways in urban Los Angeles County
- Study includes 322 lane-miles of grooved pavement
- Study includes 750 lane-miles of un-grooved control sections
The Department of Public Works' accident experience reveals that grooving has yielded a:

1) 20 percent reduction in total accidents
2) 50 percent reduction in fatal accidents
3) 70 percent reduction in wet pavement accidents
Effects of Groove Geometry
California SR 58 - 10 Years Old

Friction (FN40)

- Long Tined
- Burlap Drag Textures
- Conventional Diamond Ground Textures

- Not Grooved
- Grooved

R S R S R S R S R S R S R S R S R S R S R S R S

Friction Values:
- Long Tined: 43.2, 35.9, 38.5, 18.2, 40.8, 41.6
- Burlap Drag Textures: 40.2, 48.3, 50.5, 55.0
- Conventional Diamond Ground Textures: 39.6, 36.8, 36.4, 41.4
- Grooved: 53.6, 54.4, 53.8, 54.2
- Not Grooved: 53.3, 53.9, 52.5

- Long Broom and Long Groove
Noise vs. Friction

![Graph showing the relationship between Fn Friction Number and Average OBSI Level (dBA). The graph includes data points for Diamond Grinding, Drag, Longitudinal Tining, Transverse Tining, and Other.](image-url)
Mean Texture Depths – KDOT1-70

- NGCS: 1.9
- Grooved Astro Turf: 1.5
- Exposed Aggregate: 1.2
- CDG: 1.0
- Astro Turf Drag: 0.9
- Long Tined: 0.7
- Burlap Drag: 0.3
NGCS Site Locations in The USA
In Summary

- Motorists are increasingly demanding safe, smooth, quiet and delay free roadways while funding necessary to meet these needs remains elusive.
- Diamond saw-cut textures are a time proven, cost effective means of providing consistently smooth, quiet and safe textures at a fraction of the cost of asphalt overlays.
- Diamond saw-cut textures are not as subject to inflationary pressures as asphalt based overlays.
In Summary

- The NGCS texture has performed as intended and typically is constructed at an OBSI level of 99 dBA.
- NGCS provides an ultra-smooth, high friction surface with acoustically durable properties, that will outperform asphalt based surfaces acoustically over time.
- NGCS has been constructed dozens of times in 14 states and 4 countries and is **THE** low-noise concrete surface texture appropriate for noise sensitive areas.
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