DIAMOND GRINDING
AN OVER VIEW OF PAVEMENT PERFORMANCE
IN TEXAS

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Outline

- Introduction
- Individual Case Studies
- Pavement Performance Statistical Analysis
  - Ride quality
  - Skid
- Summary
Diamond Grinding

- DG is concrete pavement restoration technique
- DG works by removing a very thin layer off the top of a pavement
- DG was used to improve pavement functionality such as smoothness and skid resistance, etc.
- DG has been used in pavement field for over half a century in the U.S.
- 750,000+ square yard areas were diamond ground on Texas highways in 2012
Case Study 1 @ IH35

- **Location**
  - Fort Worth district, IH35 W

- **Pavement type**
  - CRCP

- **Treatment**
  - DG in 2011 & 2012
  - Purpose: Improve skid resistance

- **Performance index**
  - Crash accident (source: crash report information system, CRIS)
  - Skid (source: project 5-9046)
  - Noise (source: project 5-9046)
  - Ride quality (source: project 5-9046)
Case Study 1 @ IH35: Results

Accident

<table>
<thead>
<tr>
<th>Percent Reduction</th>
<th>Fatality+Incap Injury</th>
<th>Incap Injury</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Noise Level (dB)

- Before: 21 dB
- After: 34 dB

62% increase

Skid Number

- Before: 21
- After: 34

62% increase

IRI (in/mi)

- Before: 124 in/mi
- After: 80 in/mi

35% reduction

Noise Level (dB)

- Before: 104.8 dB
- After: 101.6 dB

3% reduction
Case Study 2 @ US287

- **Location**
  - Childress district, US287

- **Pavement type**
  - JCP (13” JCP over 9” lime treated subgrade)

- **Treatment**
  - DG & Dowel Bar Retrofit (DBR) in 2004
  - Purpose: fix faulting at joint

- **Performance index**
  - Ride quality (source: pavement management information system, PMIS)
Case Study 2 @ US287: Results

Before DBR & DG

After DBR & DG
Case Study 3 @ US69

- **Location**
  - Beaumont district, US69

- **Pavement type**
  - JCP (12” JCP on 6” stablized base)

- **Treatment**
  - DG & Dowel Bar Retrofit (DBR) in 2001
  - Purpose: fix faulting at joint

- **Performance index**
  - Ride quality (source: PMIS)
Case Study 3 @ US69: Results

The graph shows the change in IRI (in/mi) over years from 2003 to 2013. The graph is divided into three phases:

- **Before DBR&DG**: The IRI value starts at a high level and remains relatively stable until 2008.
- **After DBR**: In 2008, there is a significant decrease in IRI, indicating an improvement after the DBR intervention.
- **After DBR&DG**: The IRI value remains lower than before DBR, indicating the additional benefits of DG (Drainage and Geotechnical) interventions.

The graph highlights the effectiveness of DBR and DBR&DG in reducing IRI over time.
Case Study 4 @ US96

- Location
  - Beaumont district, US96

- Pavement type
  - JCP (11” JCP on 1” AC bond breaker on 6” cement-treated base)

- Treatment
  - DG in 2008
  - Purpose: improve ride

- Performance index
  - Ride quality (source: PMIS)
Case Study 4 @ US96: Results

Graph showing the change in IRI (in/mi) over years before and after DG implementation.
# Performance Trend Analysis: Data Summary

<table>
<thead>
<tr>
<th></th>
<th>Highway</th>
<th>DBR</th>
<th>MESAL</th>
<th>ADT</th>
<th>Truck%</th>
<th>Year DG</th>
<th>Change in IRI (in./mi.)¹</th>
<th>Change in Skid</th>
<th>Change in ADT</th>
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<td>-52.0</td>
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<td>24,000</td>
<td>18.6</td>
<td>2010</td>
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<td>-</td>
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<td>22.6</td>
<td>2009</td>
<td>-19.6</td>
<td>8.5</td>
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</tbody>
</table>

Average

¹ 1 in./mi. = 1/63 m/km
Ride Analysis: Statistical Model

\[ IRI = a_0 + a_1 Age + a_2 BeforeIRI + a_3 DBR + a_4 ADT + a_5 Site1 + a_6 Site2 + a_7 Site3 + \epsilon \]

Where:
- \( IRI \): The ride quality after DG, in./mi.;
- \( Age \): Time after DG, years;
- \( BeforeIRI \): The ride quality before DG, in./mi.;
- \( DBR \): Dowel bar retrofit, dummy variable;
- \( ADT \): Average daily traffic, in 1,000 vehicles;
- \( Site1 \): Site specific factor representing site 1;
- \( Site2 \): Site specific factor representing site 2;
- \( Site3 \): Site specific factor representing site 3;
- \( a_0, a_1, \ldots \): Parameters to be estimated; and
- \( \epsilon \): Error term.
## Ride Analysis: Model Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Mean</th>
<th>t-stat</th>
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<tbody>
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<td>Age</td>
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<td>ADT</td>
<td>$a_7$</td>
<td>1.7</td>
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<tr>
<td>Site1</td>
<td>$a_4$</td>
<td>2.1</td>
<td>0.5</td>
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<tr>
<td>Site2</td>
<td>$a_5$</td>
<td>42.1</td>
<td>12.7</td>
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<td>$R^2$</td>
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</table>
Ride Analysis: Change and Trend

Before treatment

~59 in/mi reduction in IRI due to treatment

1.7 in/mi increase per year after treatment
Skid Analysis: Trend

- 2.0 SN reduction per year after treatment
- ~ 5.6 SN increase after treatment

Before treatment
Summary

- Based on field studies of a sample of concrete pavements across Texas, it is suggested that DG could be an effective measure to:
  - Improve ride quality
  - Improve skid resistance
  - Reduce noise
Acknowledge

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Thank you & Be safe

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