

Diamond Grinding

Increased Pavement Performance and Customer Satisfaction Using Diamond Grinding

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THE ULTIMATE QUESTION!

- *How do I make limited budget dollars stretch and provide a highway system that offers a high level of service?*



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1986-93 Rigid Pavement Design Equation

$$\text{Log}(ESALs) Z_R S_o + 7.35 \text{Log}(D+1) - 0.06 + \frac{\text{Log} \left[\frac{\Delta PSI}{4.5 - 1.5} \right]}{1 + \frac{1.624 \cdot 10^7}{(D+1)^{8.46}}} + (4.22 - 0.32p) \text{Log} \left[\frac{S'_c \cdot C_d \cdot D^{0.75} - 1.13}{215.63 \cdot J \cdot D^{0.75} - \frac{18.42}{(E_c/k)^{0.25}}} \right]$$

Labels in the diagram:
 - Overall Standard Deviation: S_o
 - Depth: D
 - Change in Serviceability: ΔPSI
 - Terminal Serviceability: S'_c
 - Modulus of Rupture: C_d
 - Drainage Coefficient: D
 - Load Transfer: J
 - Modulus of Elasticity: E_c
 - Modulus of Subgrade Reaction: k

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**SMOOTH PAVEMENTS
LAST LONGER!**

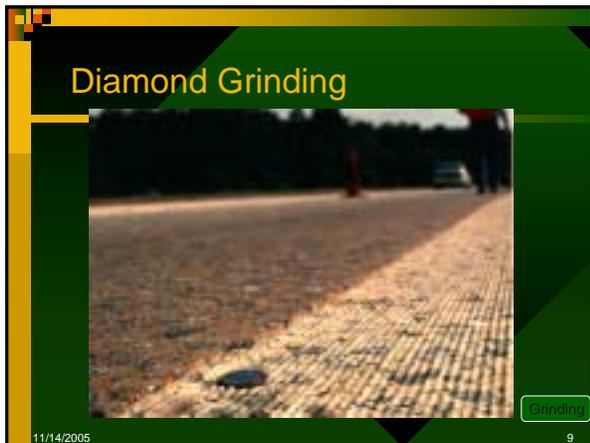
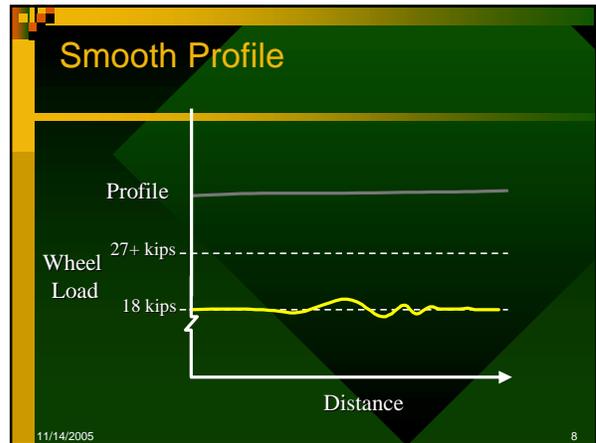
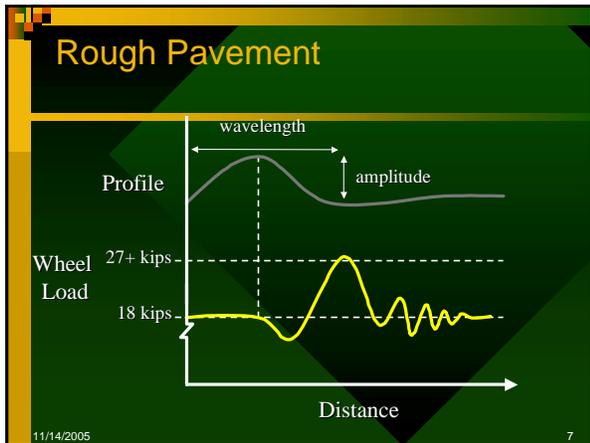
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- ### What is Diamond Grinding?
- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades;
 - Results in smooth, level pavement surface;
 - Longitudinal texture with desirable friction and low noise characteristics;
 - **Comprehensive part of any PCC Pavement Preservation program;**
 - Frequently performed in conjunction with other CPR techniques, such as full-depth repair, dowel bar retrofit, and joint resealing.
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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.
- 9,500,000 sq yds diamond ground in 1999

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MODOT- Safer, Smoother, Sooner

- MODOT initiates Safer, Smoother, Sooner program in 2005 – To be completed December 2007
- The initiative invests \$400 million in 2,200 miles of Missouri's roads that carry 60 percent of the traffic and are within 10 miles of where 86 percent of Missouri's residents live.
- Improve customer satisfaction through
 - Safer pavements
 - Smoother ride quality
 - Quiet ride quality
- Approx 8,000,000 sq yds let in 1st Qtr 2005 alone

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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;

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Pavement Problems Addressed

- Faulting at joints and cracks
- Built-in or construction roughness
- Polished concrete surface
- Wheelpath rutting
- Inadequate transverse slope
- Unacceptable noise level

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Faulted Joints



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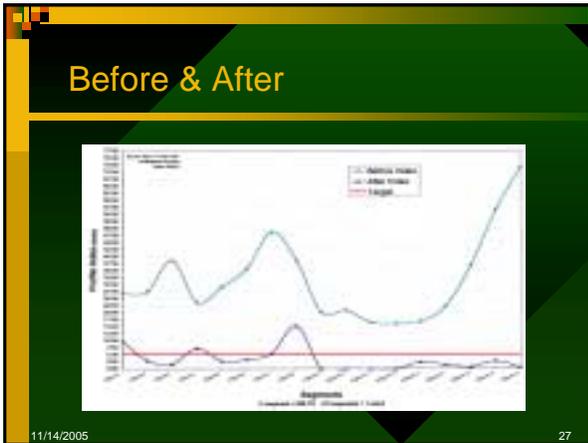
Diamond grinding will significantly increase smoothness over the pre-grind profile!



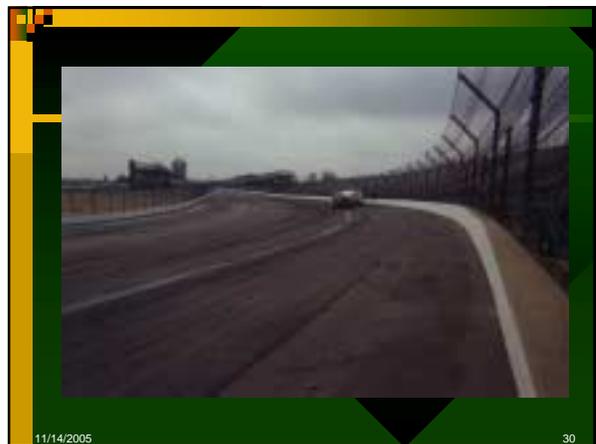
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- ### Safety, Surface Texture and Friction
- Improvement in friction number and skid resistance due to increase in pavement macrotexture
 - Longitudinal texture provides directional stability and reduces hydroplaning (side-force friction)
 - In Wisconsin, overall accident rates for ground surfaces were 40% less than for un-ground surfaces over a 6-year period, 57% in wet weather conditions (Drakopoulos et al. 1998)
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Traffic Control



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So what is all this noise about diamond grinding in Arizona?!?



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SR 202 West WB PC/CP Grinding

Prepared by Larry Scofield

Preliminary Draft 6/00



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Diamond Grinding Benefits Reported by Arizona DOT - 2003

- Restored smoothness
- Improved friction
- Improved cross slope
- Reduction in noise

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Diamond Grinding Effect on Roughness - ADOT

58 Percent decrease in IRI

Test Area	Lane 1	Lane 2	Lane 3
1	59%	56%	NA
2	NA	NA	53%
3	64%	60%	NA
4	NA	NA	55%

NA = Not applicable

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Diamond Grinding Effect on Friction - ADOT

27 Percent increase in friction

Test Area	Lane 1	Lane 2	Lane 3
1	25%	15%	NA
2	NA	NA	18%
3	41%	35%	NA
4	NA	NA	26%

NA = Not applicable

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Diamond Grinding Effect on Tire/Pavement Noise - ADOT

Arizona PCCP Noise Generation (Near Field)

Test Area	Lane 1	Lane 2	Lane 3
1	96.6	96.4	NA
2	NA	NA	98.1
3	98.5	95.6	NA
4	NA	NA	95.5

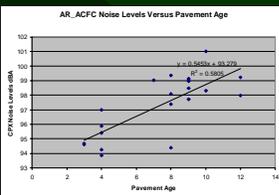
NA = Not applicable

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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."

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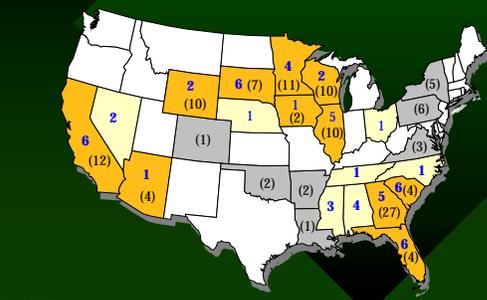
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THE ULTIMATE QUESTION!

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Diamond Grinding Study By ERES



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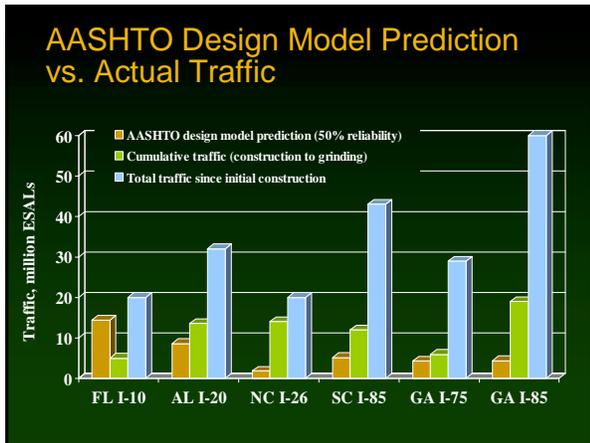
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Research Data Sources

- 1986 FHWA Database created for the study of CPR
 - 133 Diamond Ground sections at 76 sites
- LTPP SPS-6 CPR database
- In total 177 sections available for analysis

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Cost Comparisons

CPR in NC and dowel bar retrofit followed by diamond grinding

Location	Rehabilitation Technique	Project Size	Cost/Lane km
NC I-26	CPR	11.3 km	\$ 77,640
NC I-26	Crack/Seal and AC Overlay	4.2 km	\$232,920
WA I-90	DBR	53.1 km	\$ 73,800
WA I-90	110 mm AC Overlay	53.1 km	\$118,300

- ### 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

- ### 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. Roughness will return if causes are not addressed. Consider dowel bar retrofit if significant faulting is present.
 - Timing is everything.
 - NE ACPA and IGGA are ready to assist!

- ### Web site's
- International Grooving and Grinding Association
 - igga.net
 - American Concrete Pavement Association
 - pavement.com
 - North East Chapter – ACPA
 - ne.pavement.com

