

# ***Concrete Pavement Preservation***



***Integrating Engineering,  
Economics and the Environment***

# ***Some Things Last Forever***



*And others need a little TLC*





# ***PCCP Withstands the Test Of Time & Traffic***





# ***Priorities Have Shifted***



- ✧ **Maintain the present system**
- ✧ **Minimize traffic disruptions**
- ✧ **Increase safety**
- ✧ **Address operator comfort**
  - ✧ **Reduce Roughness**
  - ✧ **Reduce Noise**
  - ✧ **Protect the Environment**
- ✧ **Save money**

# ***The Marketplace Has Changed***



© WreckedExotics and their Respective Owners

# ***Preservation and Restoration***

- ✧ First level of response for deteriorating concrete pavements should always be Preservation/Restoration
  - ✧ Least cost – Cheaper than reconstruction
  - ✧ Least service disruption
  - ✧ Increases safety
  - ✧ Environmentally sound
  - ✧ Addresses operator comfort





# ***PCCP Preservation Techniques***

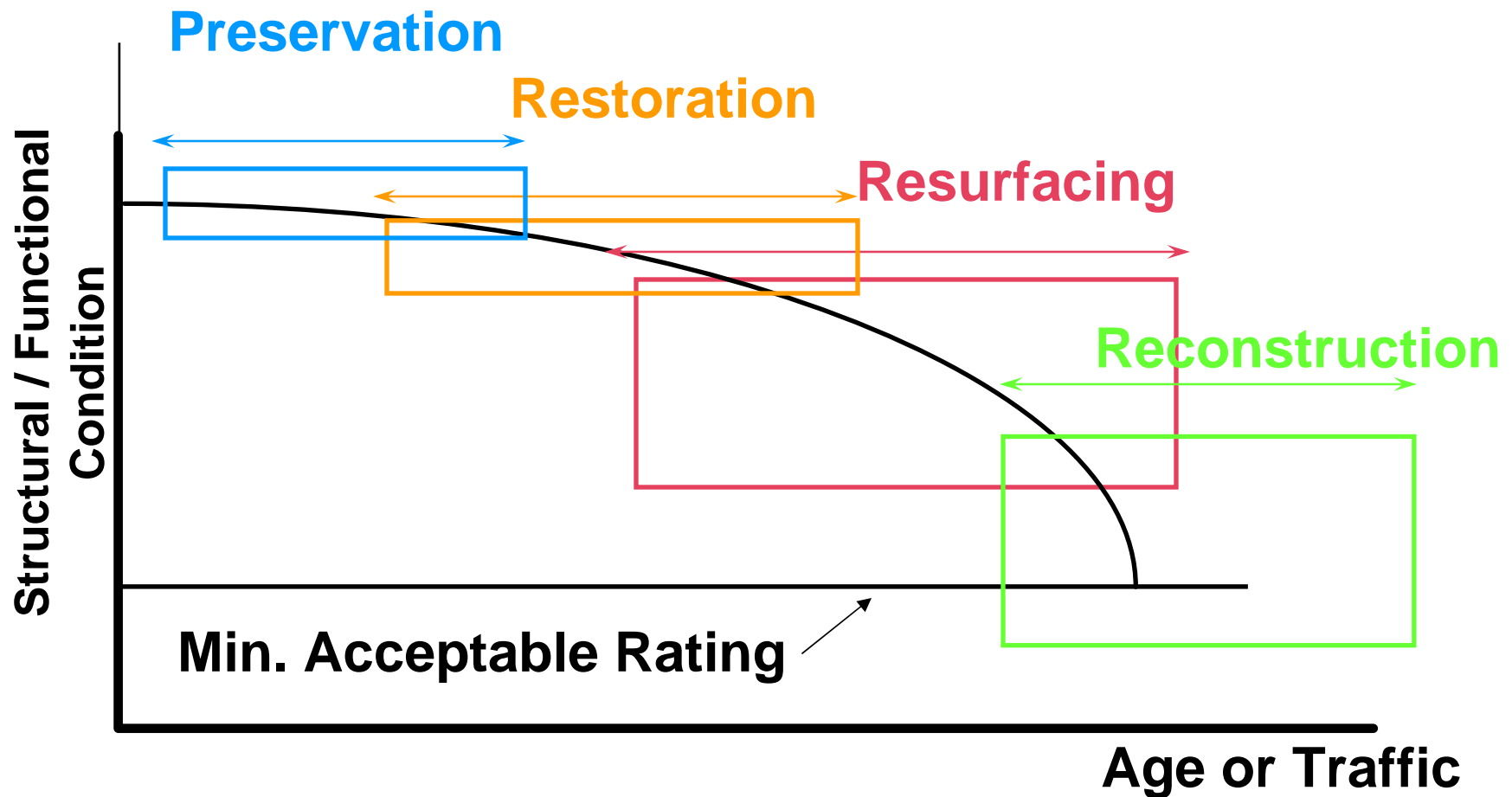
- ✧ Partial-depth repair
- ✧ Slab stabilization
- ✧ Retrofitting dowels
- ✧ Cross-stitching longitudinal cracks/joints
- ✧ Diamond grinding
- ✧ Joint & crack resealing
- ✧ Full-depth repair

*How do preventive treatments  
differ from routine/reactive  
treatments?*



*Same treatments  
...different TIMING!*

# ***Rehabilitation Timing***



# *Purpose of CPP*

- ✧ Used early when pavement has little deterioration.
- ✧ Repairs isolated areas of distress.
- ✧ Repairs some construction defects.
- ✧ Manages the rate of deterioration



# *Expected Benefits*

- ✧ Preservation of investment
  - ✧ Improved pavement performance
  - ✧ Long term cost savings/leveling
- ✧ Maintain a high level of service
  - ✧ Increased safety
  - ✧ Greater customer satisfaction

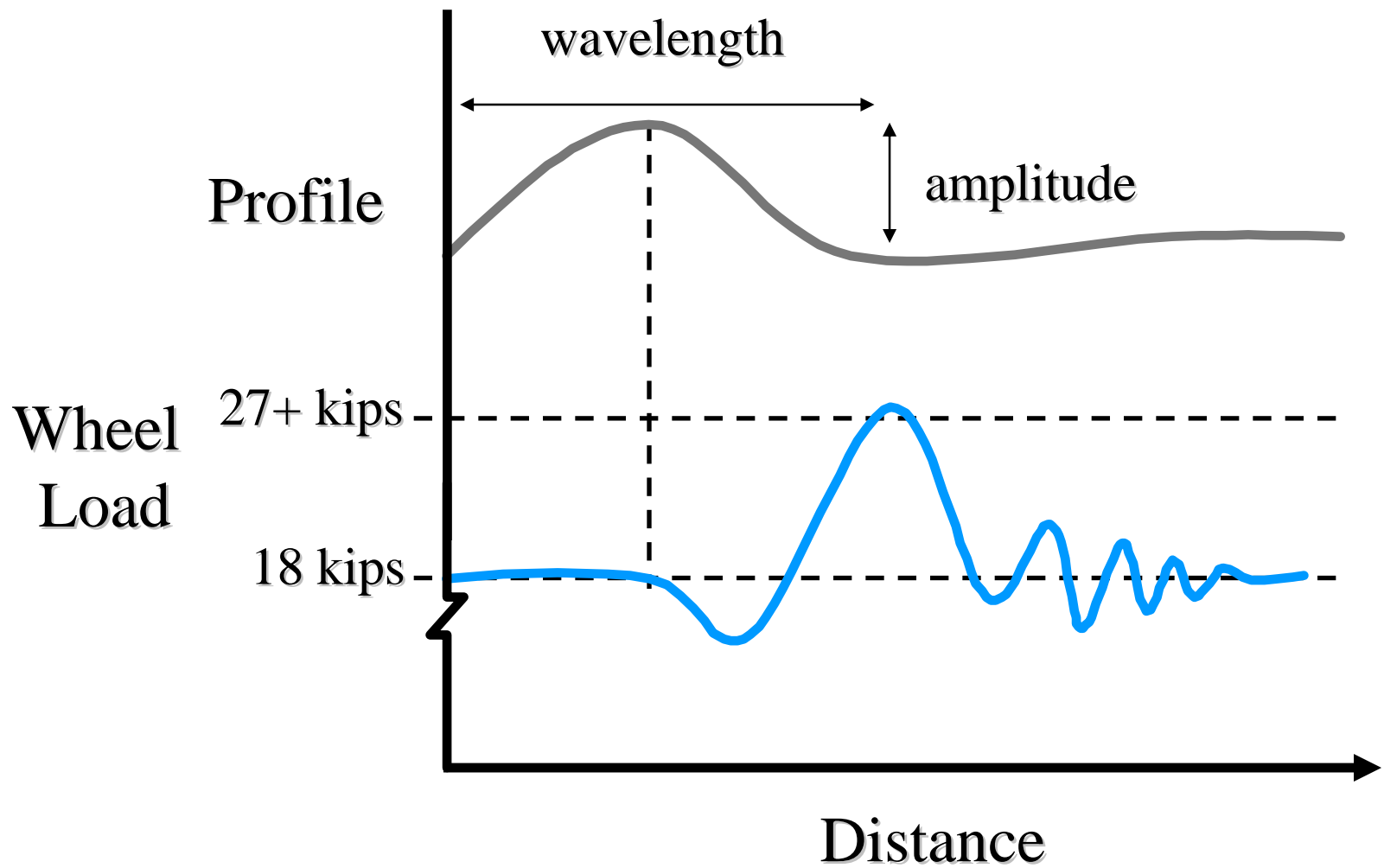


# ***Preserving the Investment***

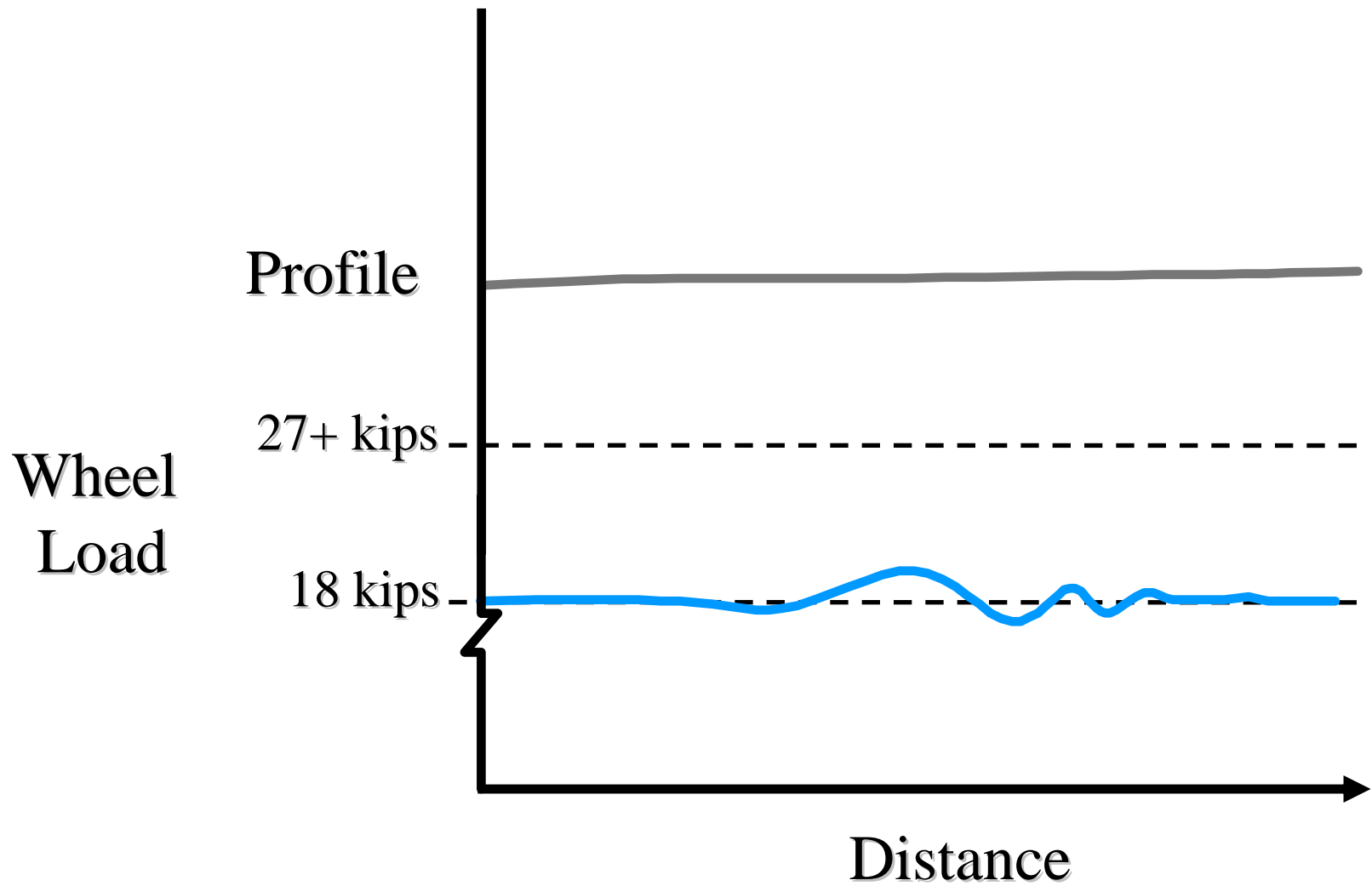
- ✧ Keep water out!
- ✧ Reduce debris infiltration into joints or cracks
- ✧ Minimize dynamic loads

***SMOOTH PAVEMENTS LAST LONGER!***

# *Rough Pavement*



# *Smooth Profile*

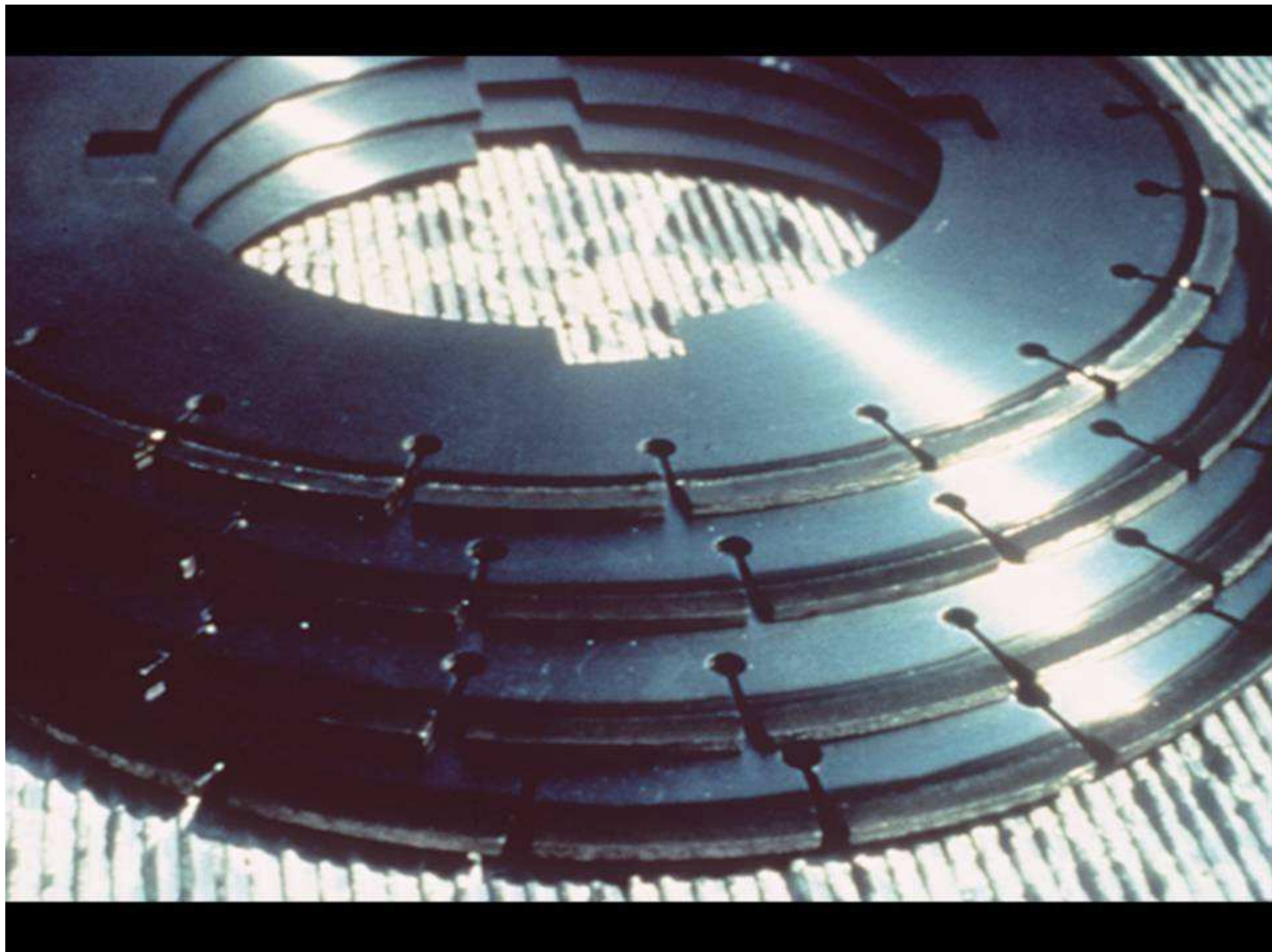


# ***Diamond Grinding***



# ***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***

## ***Grinding Machine***



# ***Diamond Grinding***

## *Grinding Process*





# ***Diamond Grinding***

## ***Finished Product***



# *Advantages of Diamond Grinding*

- ✧ Cost competitive;
- ✧ 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;
- ✧ Provides a low noise surface texture!

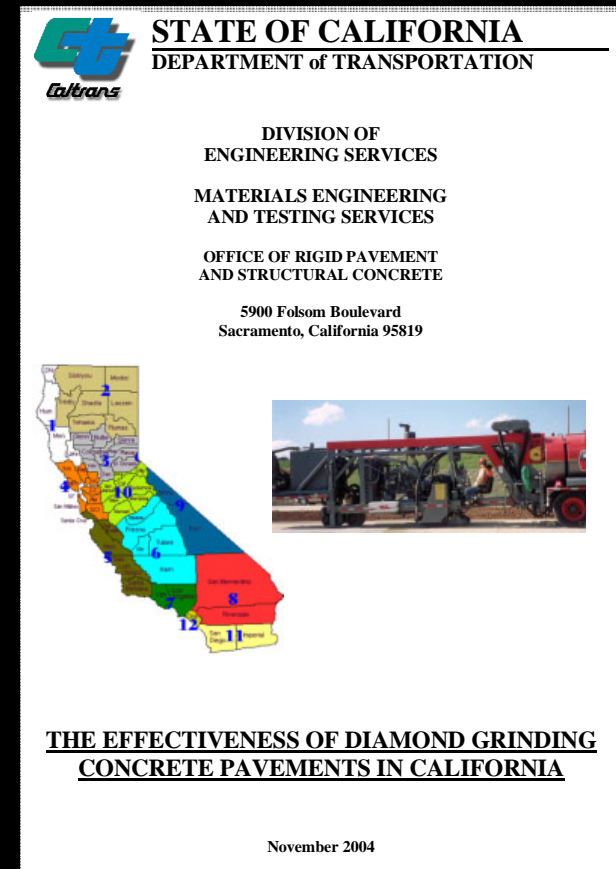
# *Surface Characteristic Research*

- ✧ CALTRANS Diamond Grinding Research
- ✧ WSDOT Safety Research
- ✧ National Concrete Pvmt Technology Center
- ✧ Purdue Tire Pavement Testing Apparatus
- ✧ ACPA Sound Intensity Testing
- ✧ California and Arizona PCCP SI Testing
- ✧ NITE Sound Intensity Testing (CALTRANS)



# *Effectiveness of Diamond Grinding - CALTRANS*

- ✧ Diamond grinding was first used in California in 1965 on a 19-year old section of I-10 to eliminate significant faulting
- ✧ 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



# *MODOT- Safer, Smoother, Sooner*

- ✧ MODOT initiates Safer, Smoother, Sooner program in 2005 – 2007
- ✧ The initiative invests \$400 million on 2,200 miles
- ✧ Improve customer satisfaction through
  - ✧ Safer pavements
  - ✧ Smoother ride quality
  - ✧ Quiet ride quality
- ✧ Approx 18,000,000 sq yds let since 1<sup>st</sup> Qtr 2005
- ✧ See IGGA.Net for MODOT's BMP on diamond grinding new PCCP

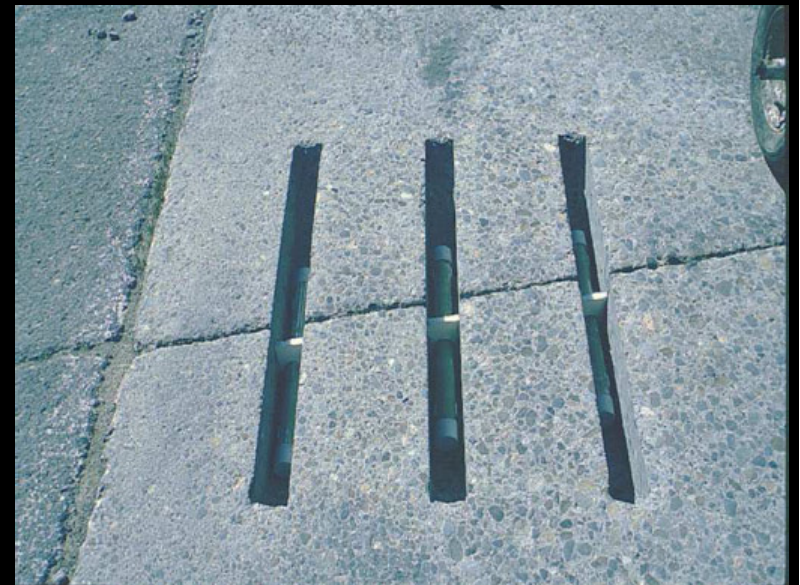
# *LOAD TRANSFER RESTORATION*

*Dowel Bar  
Retrofit*



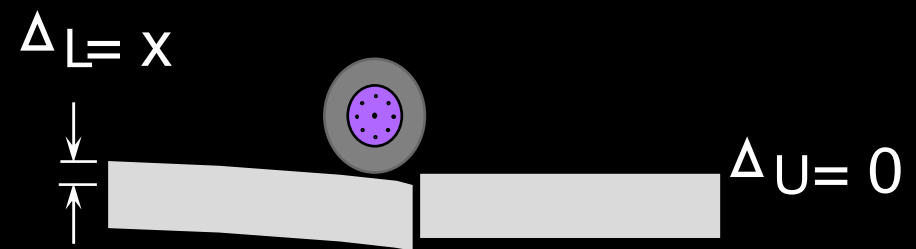
# ***Load Transfer Restoration***

- ✧ Placement of load transfer devices across joints or cracks of existing pavements
- ✧ Candidate projects
  - ✧ Poor load transfer ( $< 70\%$ )
  - ✧ Pumping
  - ✧ Faulting
  - ✧ Corner breaks

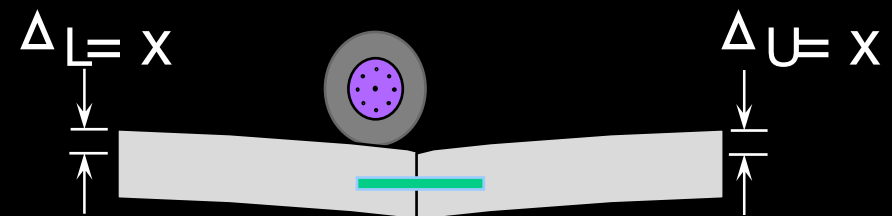


# ***Purpose of Load Transfer Restoration***

- ✧ Reestablish load-transfer across joints or cracks
  - ✧ Load-transfer is a slab's ability to transfer part of its load to its neighboring slab
- ✧ Used in JRC and JPC pavements to limit future faulting



Load Transfer = 0% (Poor)



Load Transfer = 100% (Good)

# Performance of DBR Concrete Pavement Under HVS Loading *by CALTRANS, UC Davis and UC Berkeley*

- ✧ Tested two retrofitted PCCPs under a Heavy Vehicle Simulator (HVS) aka accelerated loading frame
- ✧ HVS results demonstrated large improvement in LTE and decrease in vertical deflections
- ✧ DBR sections not damaged by HVS loading, unlike control section
- ✧ DBR less sensitive to temp changes than control section
- ✧ Total of 11,000,000 ESALS applied to DBR sections without failure occurring



# Ten-Year Performance of DBR Application ... *by WASHDOT*

- ✧ First production DBR project completed in Washington in 1992
- ✧ WASHDOT has retrofitted 225 miles since 1992
- ✧ Subject DBR sections still maintain average LTE of 70% to 90%
- ✧ Determined that carbide roto-milling is NOT a viable alternative for diamond grinding
- ✧ Based on 10 yr results, DBR is considered a successful alternative for rehabilitation of aging PCCPs in WS

# *Full-Depth Patching Operations*



# ***Full-Depth Repair***

- Purpose
  - Restore structure
  - Restore ride
- Used for:
  - Joint deterioration
  - Transverse cracking
  - Longitudinal cracking
  - Broken slabs & corner breaks

# ***Pre-cast Pavement Panels***



# ***Insitu Full Depth Repair***

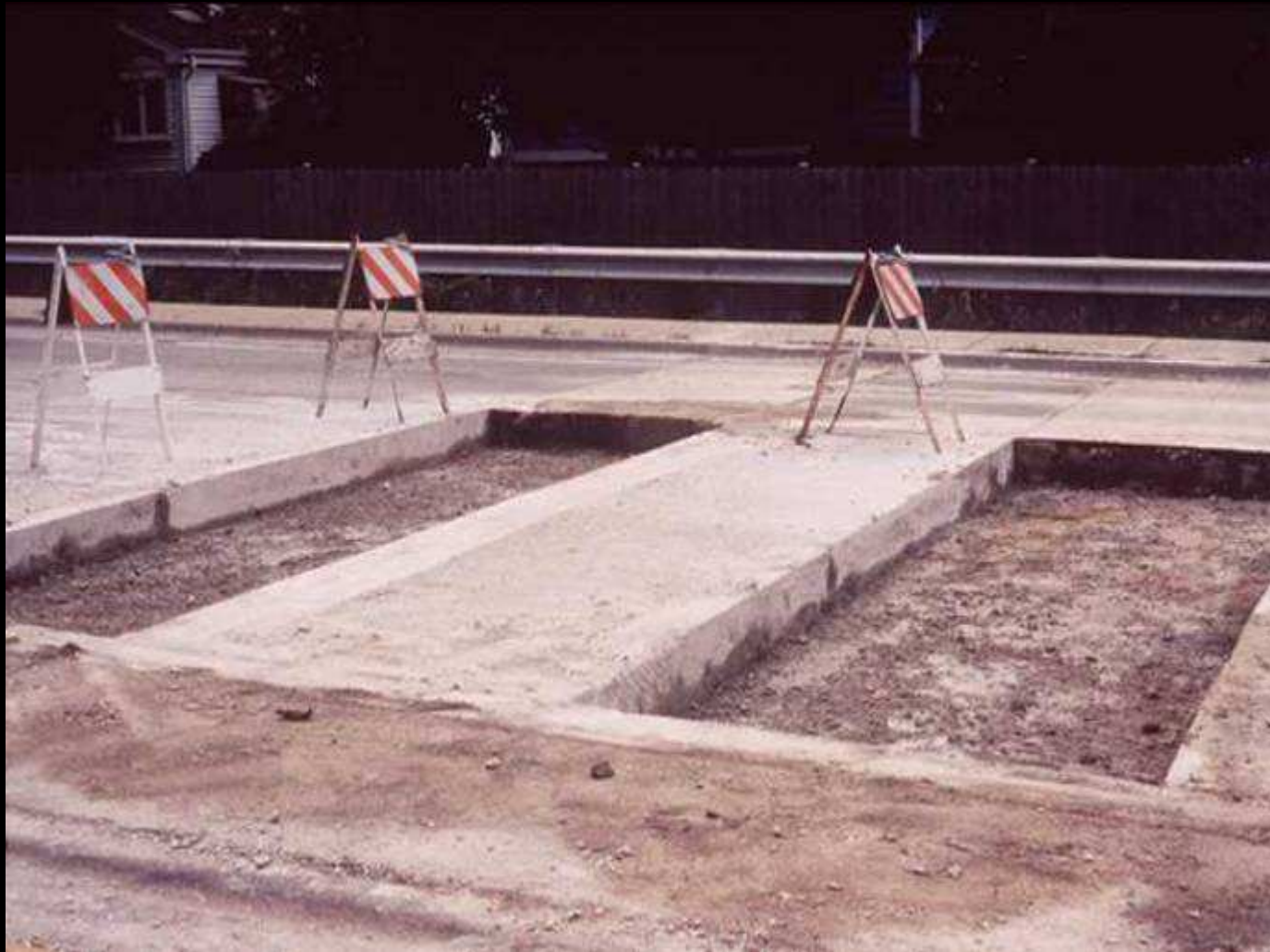


## ***Sizing a Patch***

- ✧ Go beyond deterioration
- ✧ Remember to check for below-surface spalling
- ✧ Minimum length 6 feet
- ✧ Adjust as necessary
- ✧ Combine closely spaced patches



# ***Combine Patches!!***







# ***Load Transfer***

## Jointed Pavements:

- ✧ 1.5 inch dowels
- ✧ At least 6 inches of embedment on either side
- ✧ Minimum of 3 dowels in each wheelpath
- ✧ Corrosion resistance necessary if deicing chemicals will be used

# *Performance of Full-Depth Repair*

- ✧ Can provide 20 or more years of service when properly designed and constructed
- ✧ High-early strength materials allow early opening to traffic and limited lane closures



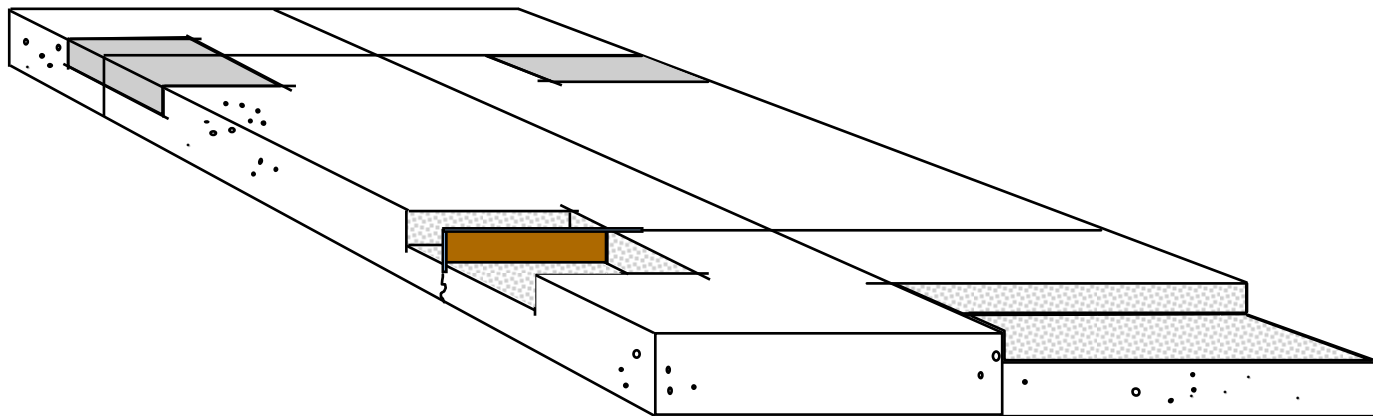
# *Partial-Depth (Joint Spall) Patching Operations*





# ***Partial Depth Repairs***

- ✧ Repairs deterioration in the top 1/3 of the slab.
- ✧ Generally located at joints, but can be placed anywhere surface defects occur.



























# ***Trunk Highway 53 Ramp Duluth, MN - 1994***



# ***Joint/Crack Resealing***

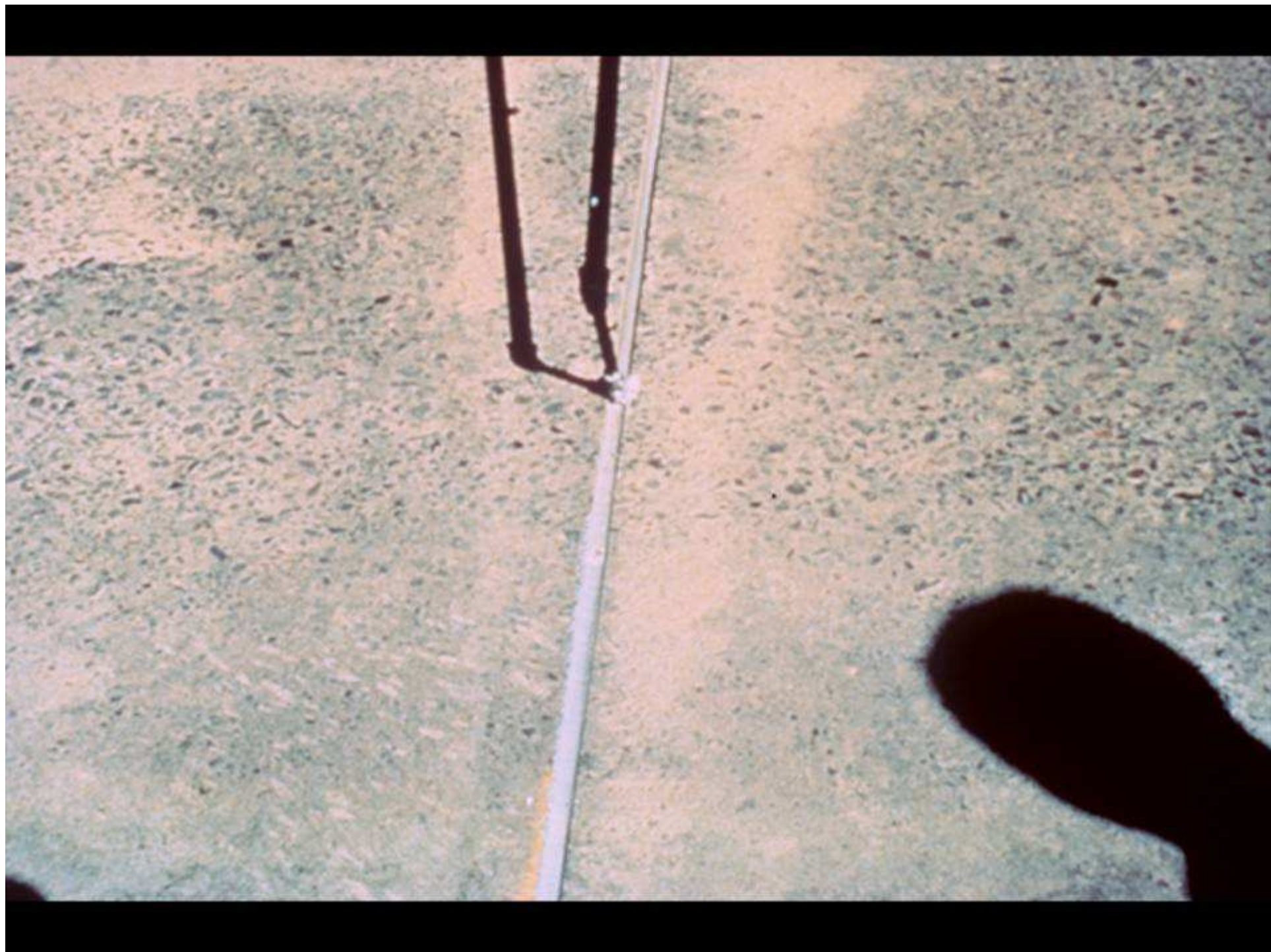
- ✧ Application of a sealant material in concrete pavement joints and cracks
- ✧ Purpose
  - ✧ Minimize moisture infiltration
  - ✧ Prevent intrusion of incompressibles
- ✧ Sealant Materials
  - ✧ Rubberized asphalt
  - ✧ Silicone



# ***Performance of Joint Resealing***

- ✧ Original sealant typically requires resealing after 5 to 12 years
- ✧ Resealing required every 5 to 8 years thereafter
- ✧ Regular resealing may extend pavement life 5 to 6 years
- ✧ Most beneficial on pavements that are not badly deteriorated





# *Good Candidate Pavements for Preventive Maintenance*

- ✧ Minimal distress (extent and severity)
- ✧ Relatively young in age
- ✧ *Minor* functional problems
- ✧ Few historical problems with similar projects

# *Next Generation Concrete Surface (NGCS)*

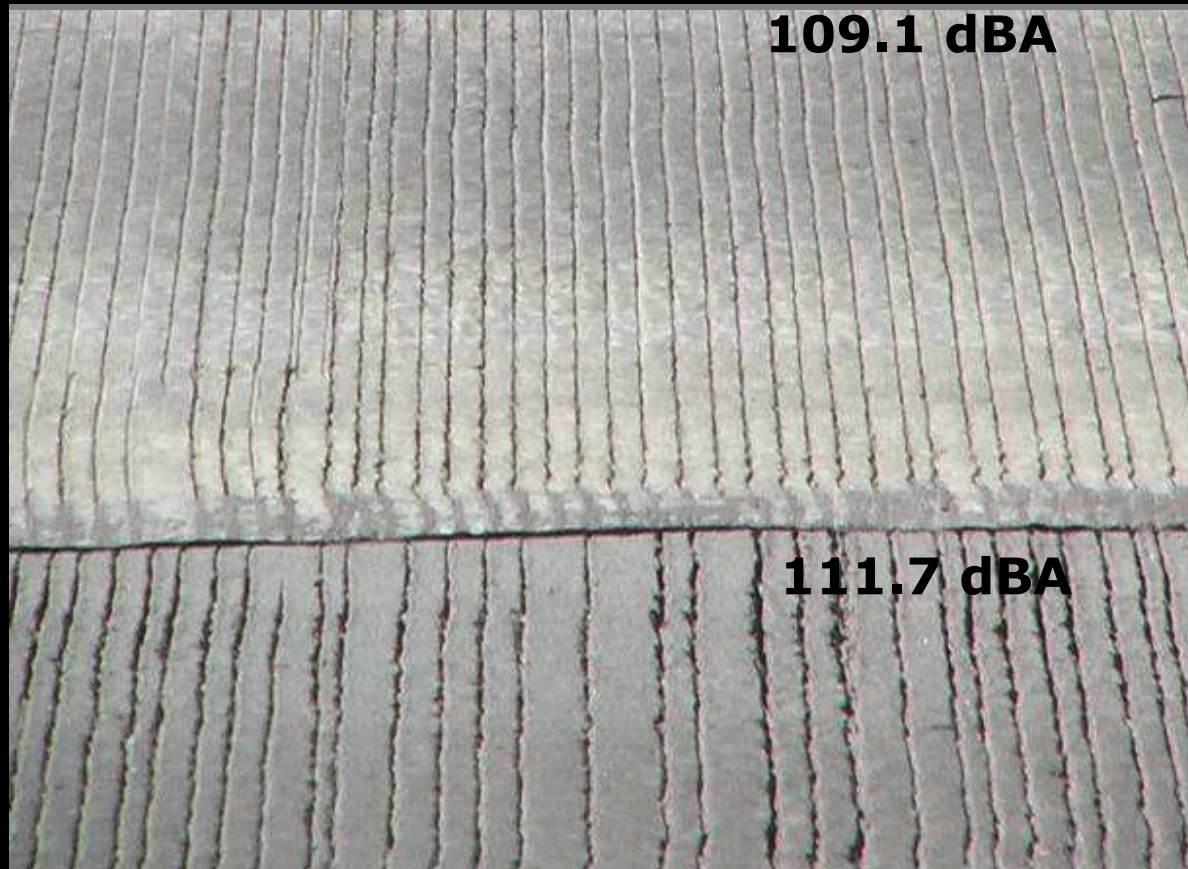
- ✧ Term used to describe a category of texture (s) that have evolved through current research. The term may apply to several textures that evolve for both new construction and rehabilitation



## *What Were The Issues?*

- ✧ Existing Transverse Tined Projects were Creating Noise Issues and were Adversely Affecting Public Perception of Concrete Pavement
- ✧ Development of Quieter New Pavement Textures
- ✧ Development of the Quietest Rehabilitation Texture

# *Problems With Conventional Textures*



# ***Diamond Grinding***



# ***Purdue's Tire Pavement Testing Apparatus***



# *Why Use the Purdue Tire Pavement Test Apparatus (TPTA)*

## ✧ Since its Laboratory Based:

- ✧ Innovation Made Easier - Can Produce Any Kind of Texture or Surface
- ✧ No Issues of Safety, Cost, or Measurement Associated with Field Constructed Test Sections
- ✧ Can Establish the Limits of What Can be Accomplished With Textures in Concrete
- ✧ Can Evaluate Multiple Surfaces at the Same Time
- ✧ Good Environmental and Instrumentation Control

# ***Pursuit of the TPTA Research***

- ✧ IGGA Developed a Diamond Grinding Attachment
- ✧ Optimize the Relationship Between Blade Width and Spacer Width on Noise Generation
- ✧ Develop Innovative New Textures
- ✧ Quantify the Joint Slap Effects
  - ✧ Effect of Opening Width
  - ✧ Effect of Faulting
  - ✧ Effect of Sealant Recess



# ***Purdue Research-- Tire Pavement Test Apparatus***



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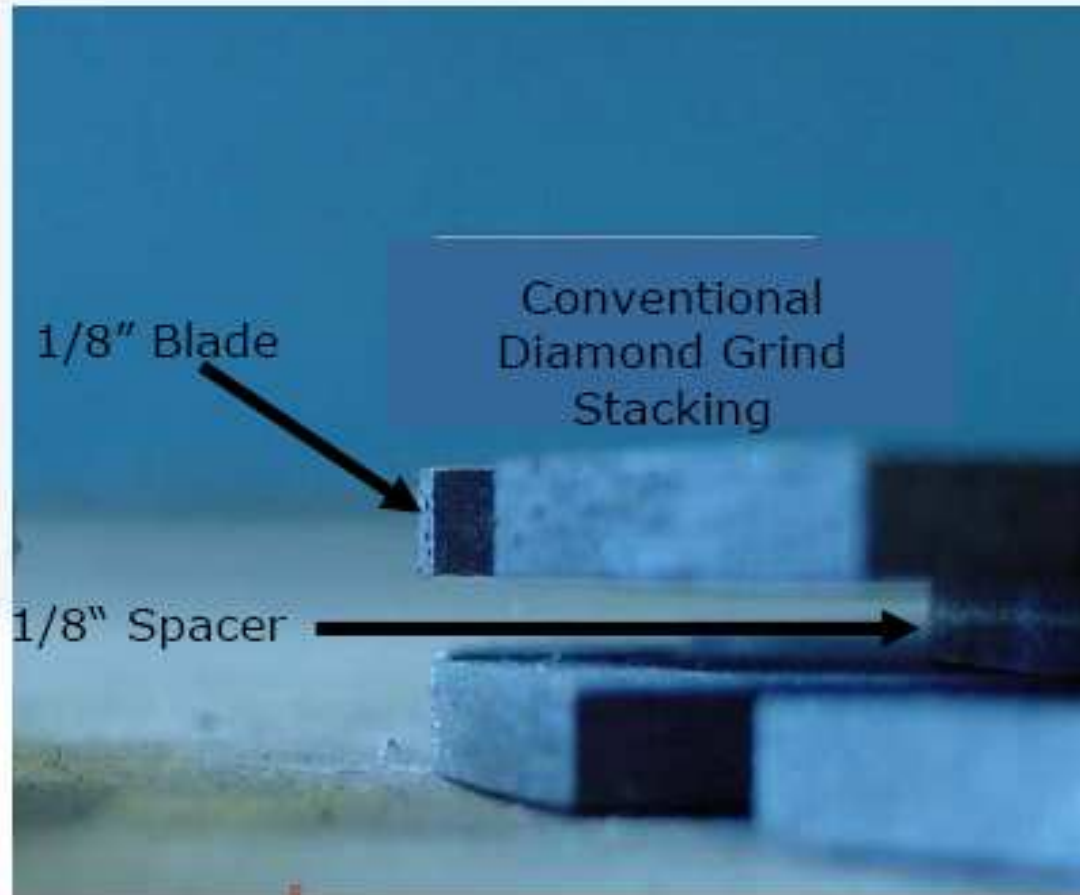


**CDG**



**NGCS**

# ***What's Different about NGCS***



Space Provides  
Cooling and Debris  
Removal

# ***NGCS Head Stack with Small Spacers***

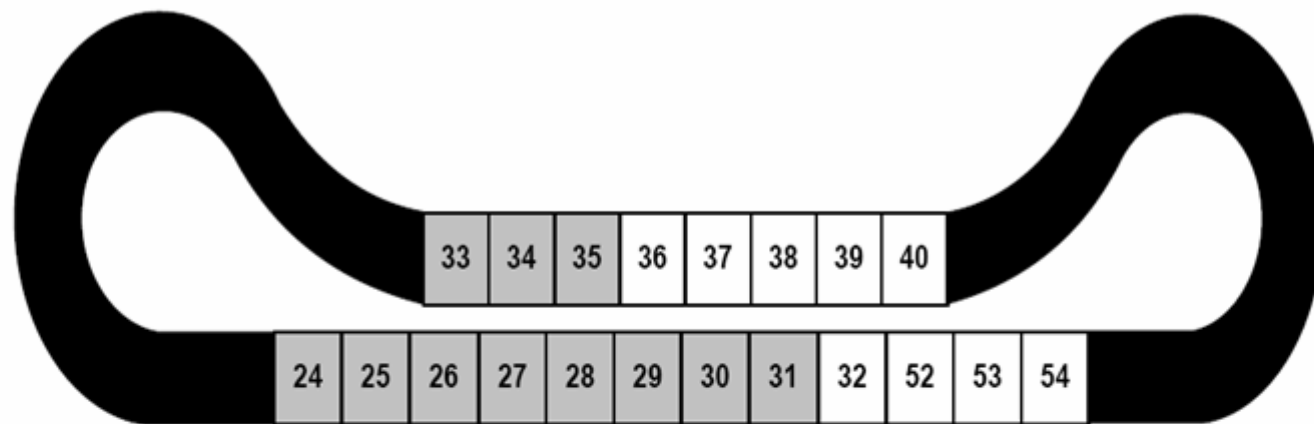




# ***Results of the Purdue Research***

- ✧ Blade Width and Spacing not the Most Important Parameter
- ✧ Fin Profile Governs Noise
- ✧ Developed and Laboratory Tested the NGCS
- ✧ Continue to Establish Joint Slap Relationship to Overall Existing Texture
- ✧ Innovative Texture Development Still On-going

# MN Roads Validation of TPTA DG



	36	37	38	39	40	32	32	52	53	54	54
Layer Depth (Inches)	6.4" 5" Sand	6.4" 12" Sand	6.4" 5" Clay	6.4" 5" Clay	6.3" 7.6" 5" Clay	6" 6" Clay	5" 1" 6" Clay	7.5" 5" Clay	7.5" 5" Clay	4" 60" Culverts Clay	7.5" 12" Clay
Panel Width	12'	12'	12'	12'	12'	Gravel	12'	13'/14'	13'/14'		12'
Panel Length	15'	12'	15'	20'	15'	Section	10'	15'	15'		15'
Dowel Bar Diameter	1"	none	1"	1"	none	--	none	Varies	none		1"
Subgrade "R" Value	70	70	12	12	12	12	12	12	12	12	12
Construction Date	Jul-93	Jul-93	Jul-93	Jul-93	Jul-93	Sep-98	Jun-00	Jun-00	Jun-00	Oct-00	Oct-04



# ***TPTA Field Validation Four Test Wheel Tracks***



# *Construction of NGCS— First Pass*



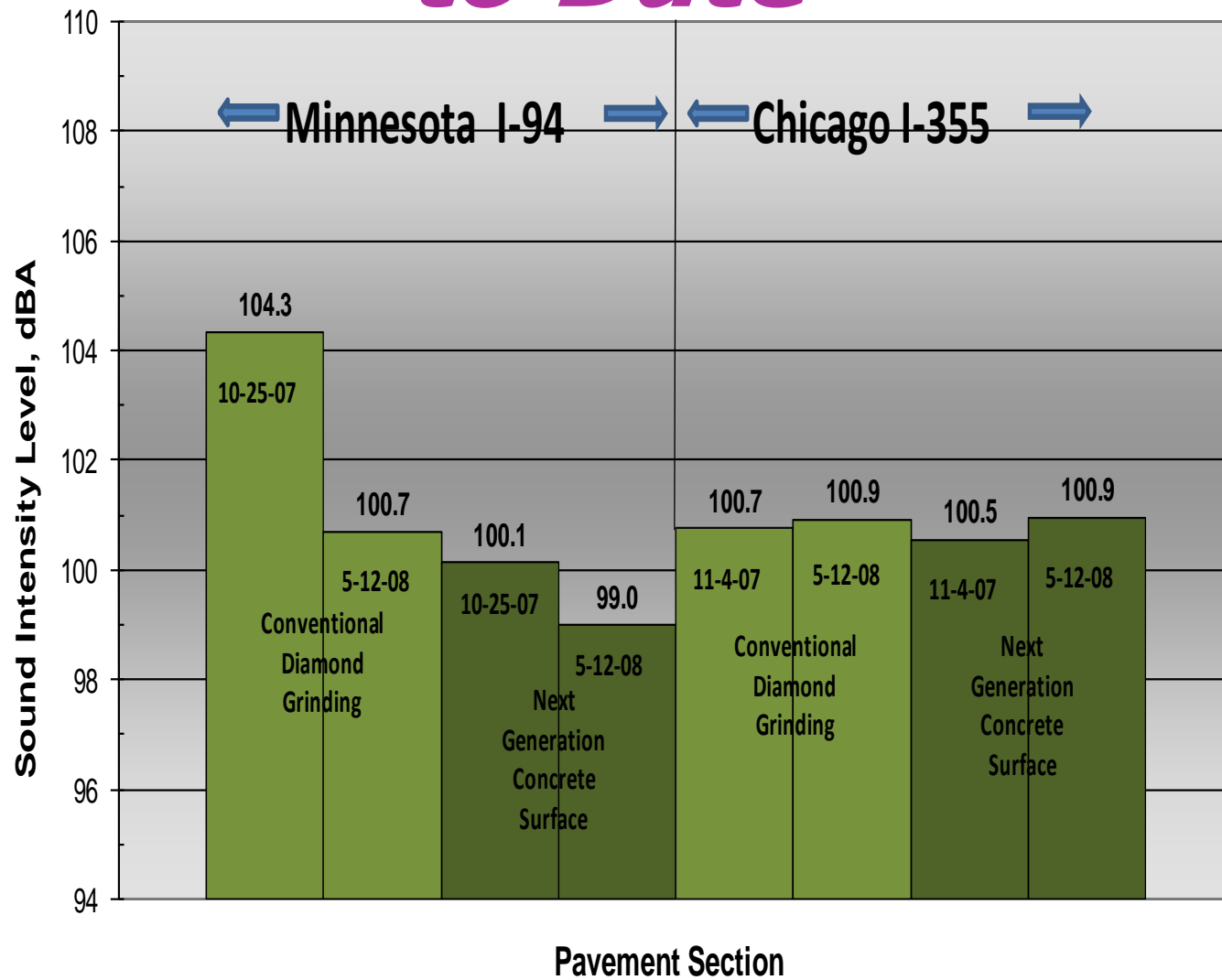
# ***NGCS Construction – Second Pass***



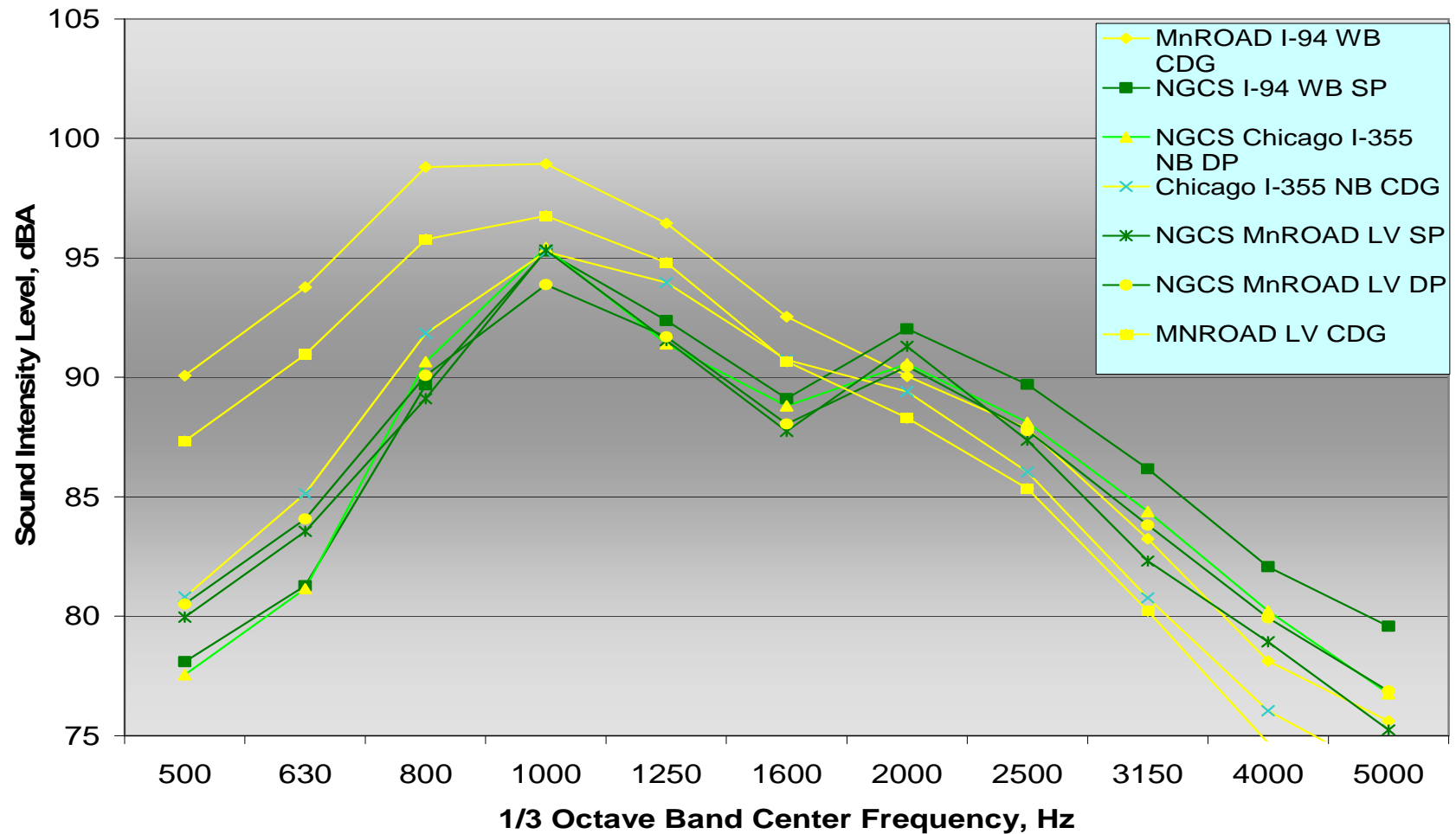
# ***Results of MnROAD's LVR Sections***

- ✧ Validated the Purdue TPTA Research Findings
- ✧ NGCS Produced the Quietest (non-porous) Surface
- ✧ Validated that Surface Could be Produced in both a Single Pass and Double Pass Configuration
- ✧ 18 Inch Wide Pass by 500 ft long, no traffic

# ***NGCS Results Noise Results to Date***

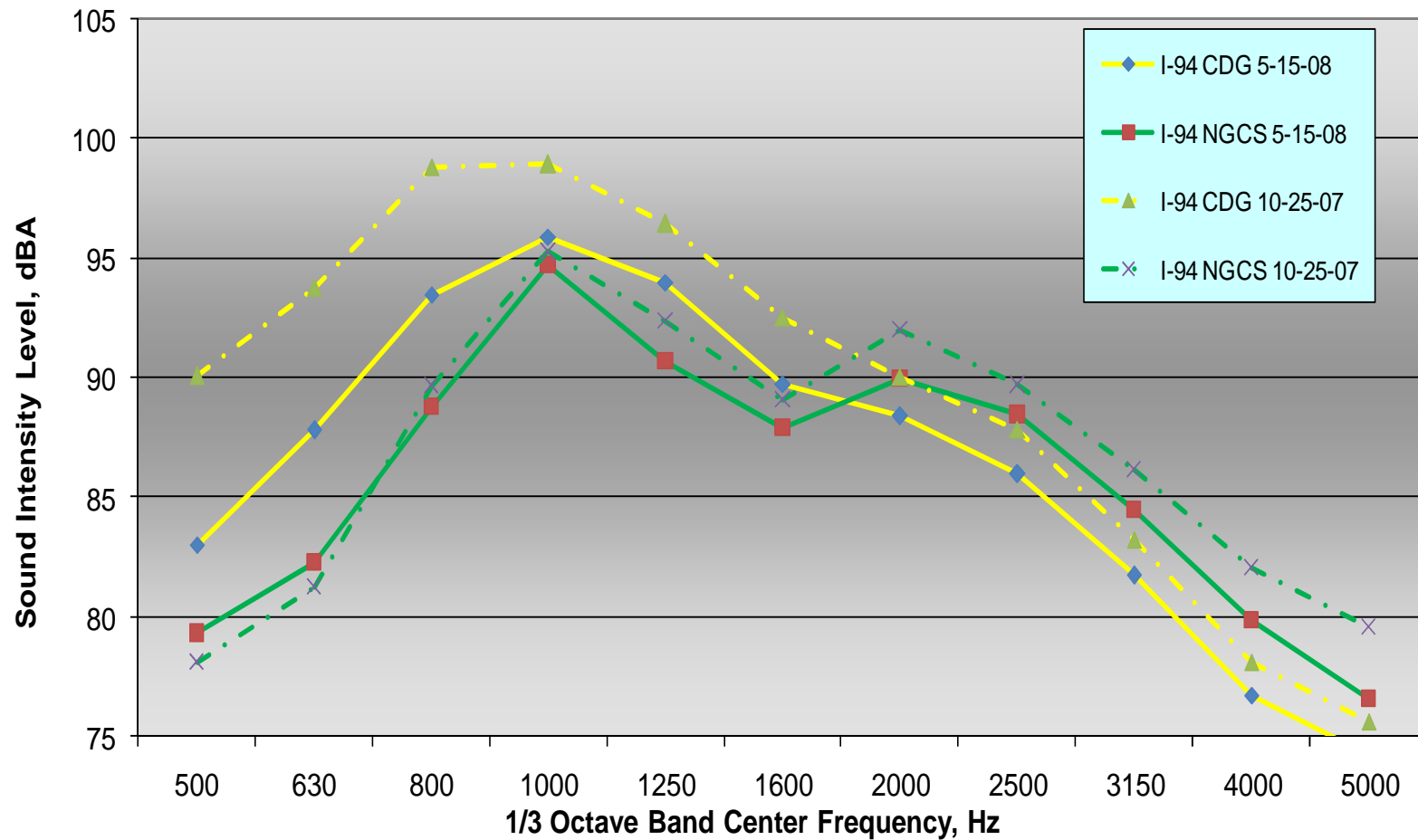


# ***OBSI Frequency Spectrums***

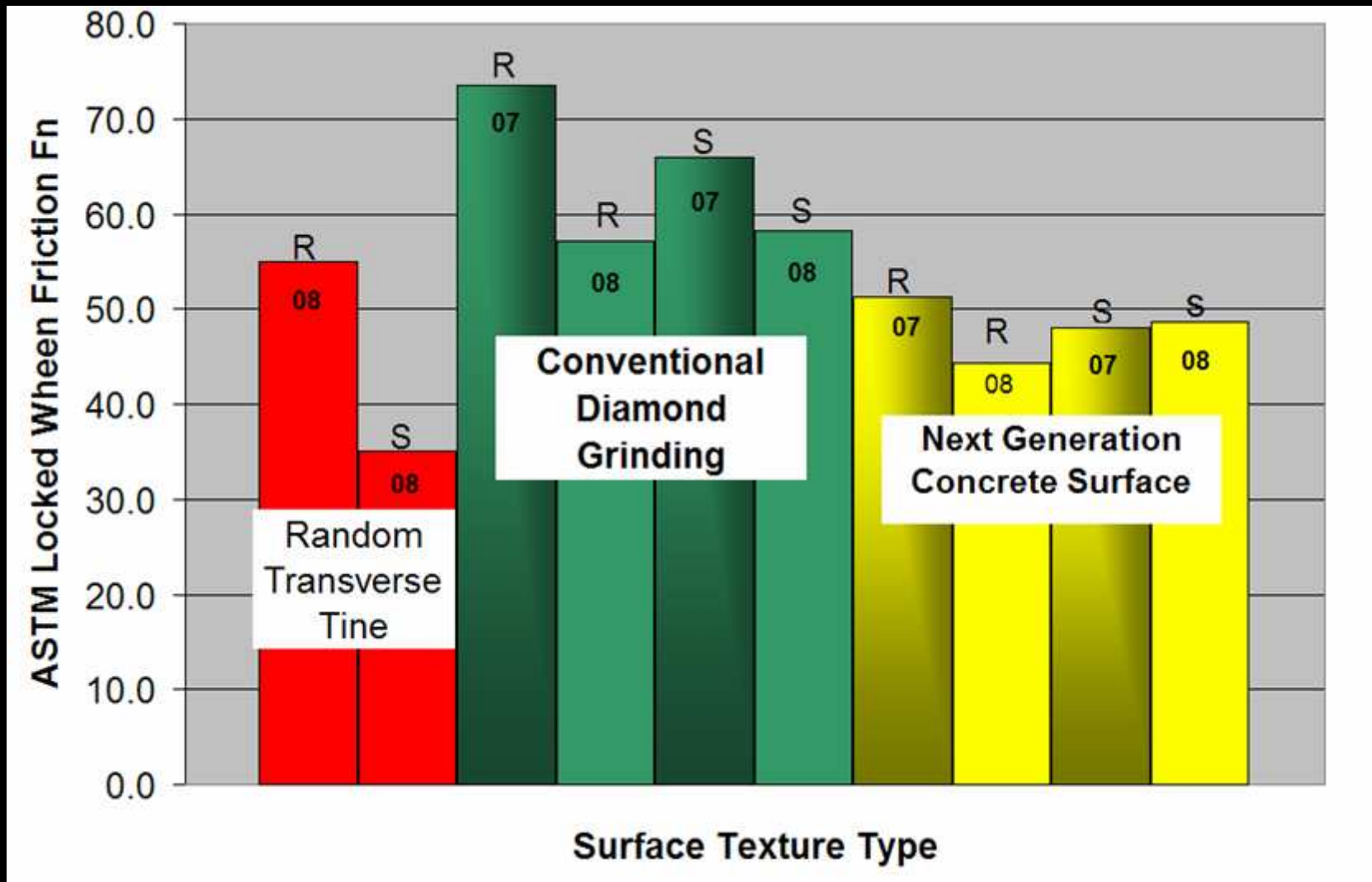




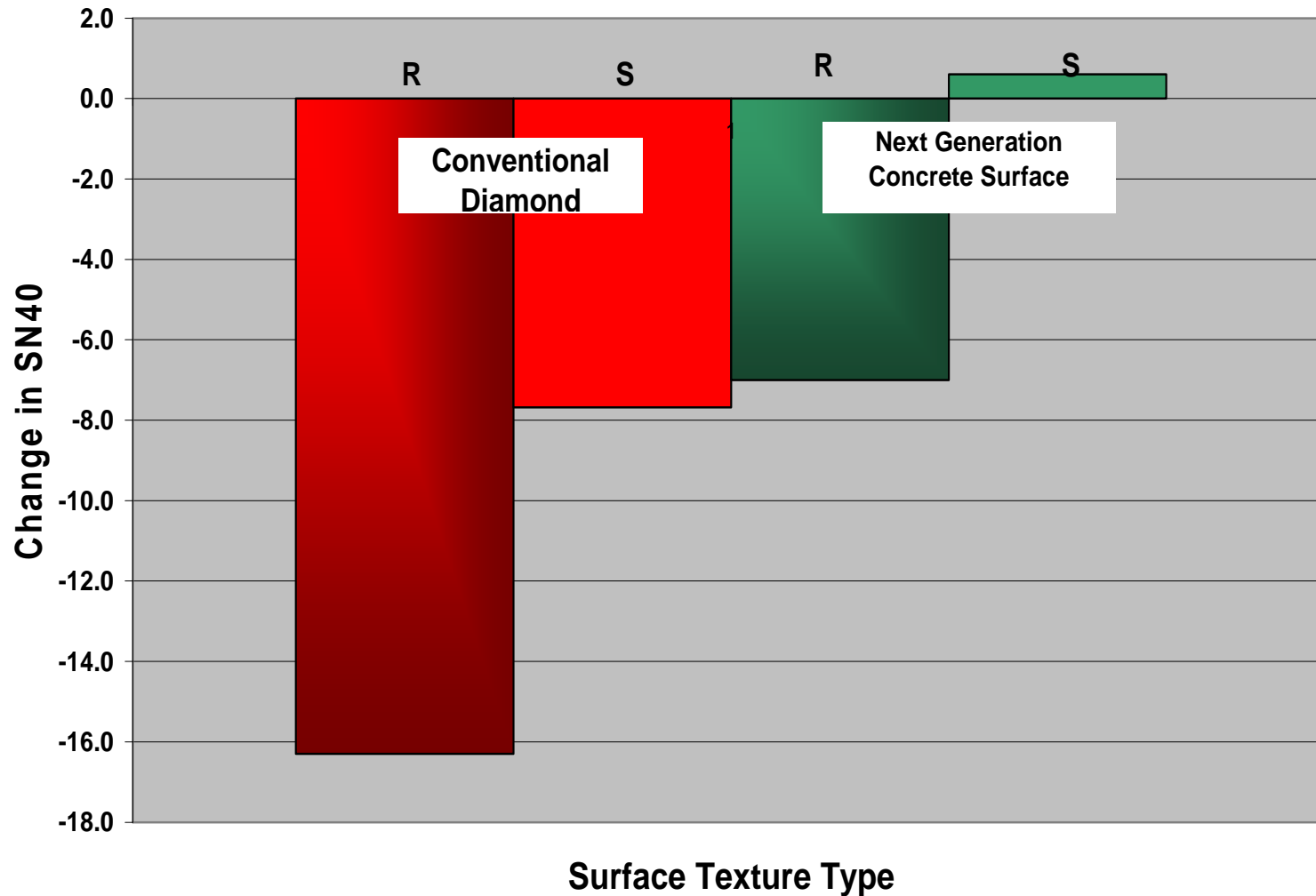
# ***Shifts from As Constructed to As Trafficked***



# ***I-94 Friction Results***

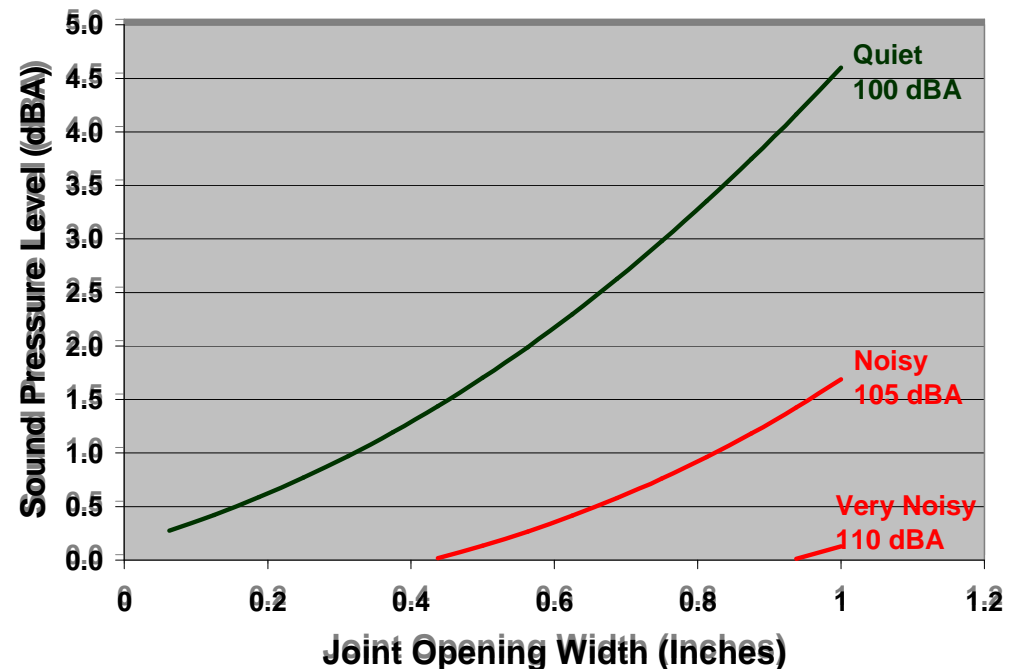


# ***Change from As Constructed to As Trafficked***



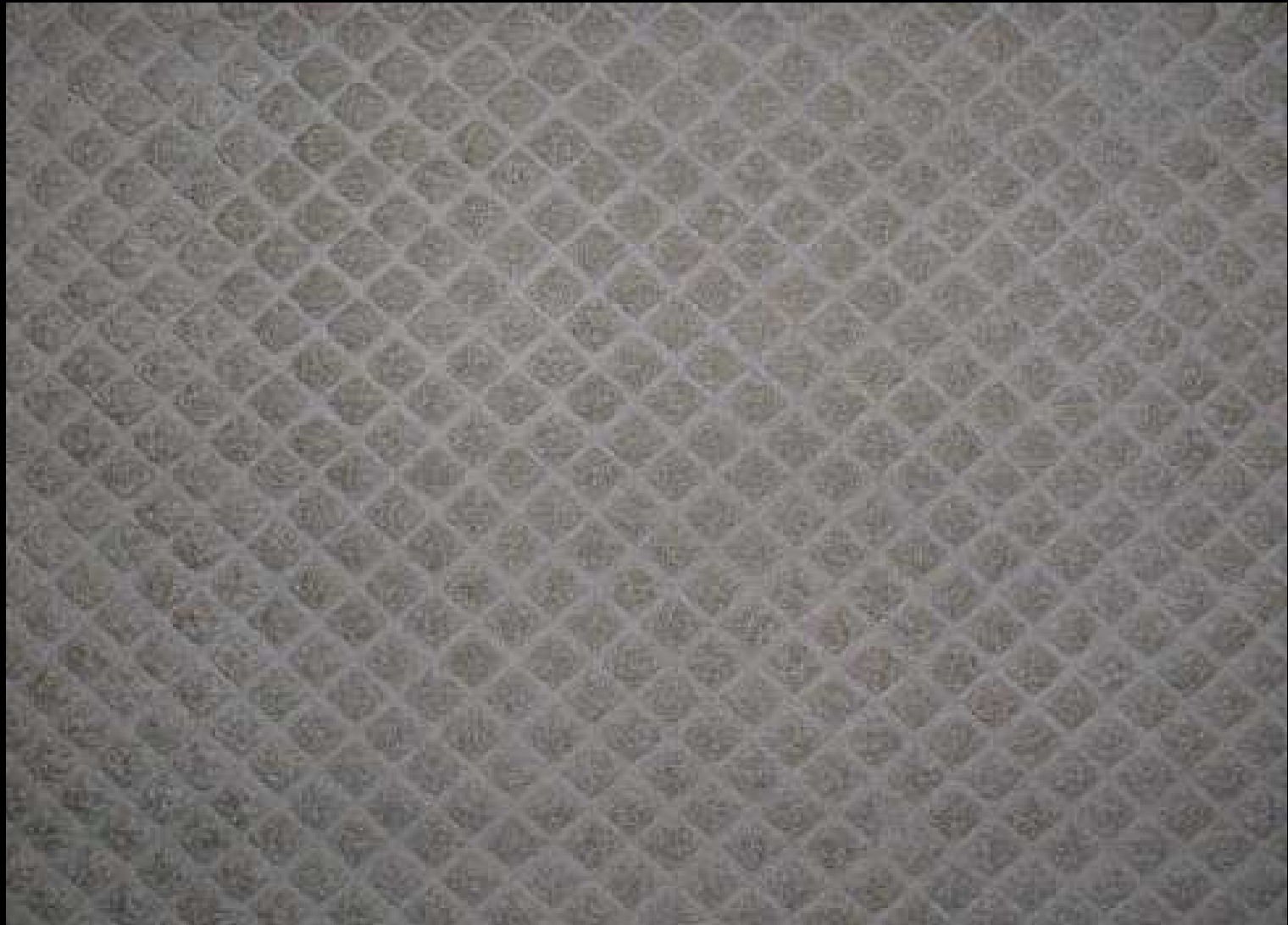
# *Establishing Joint Effects*

- ✧ Effect of Joint Opening Width
- ✧ Effect of Faulting
- ✧ Effect of Sealant Recess

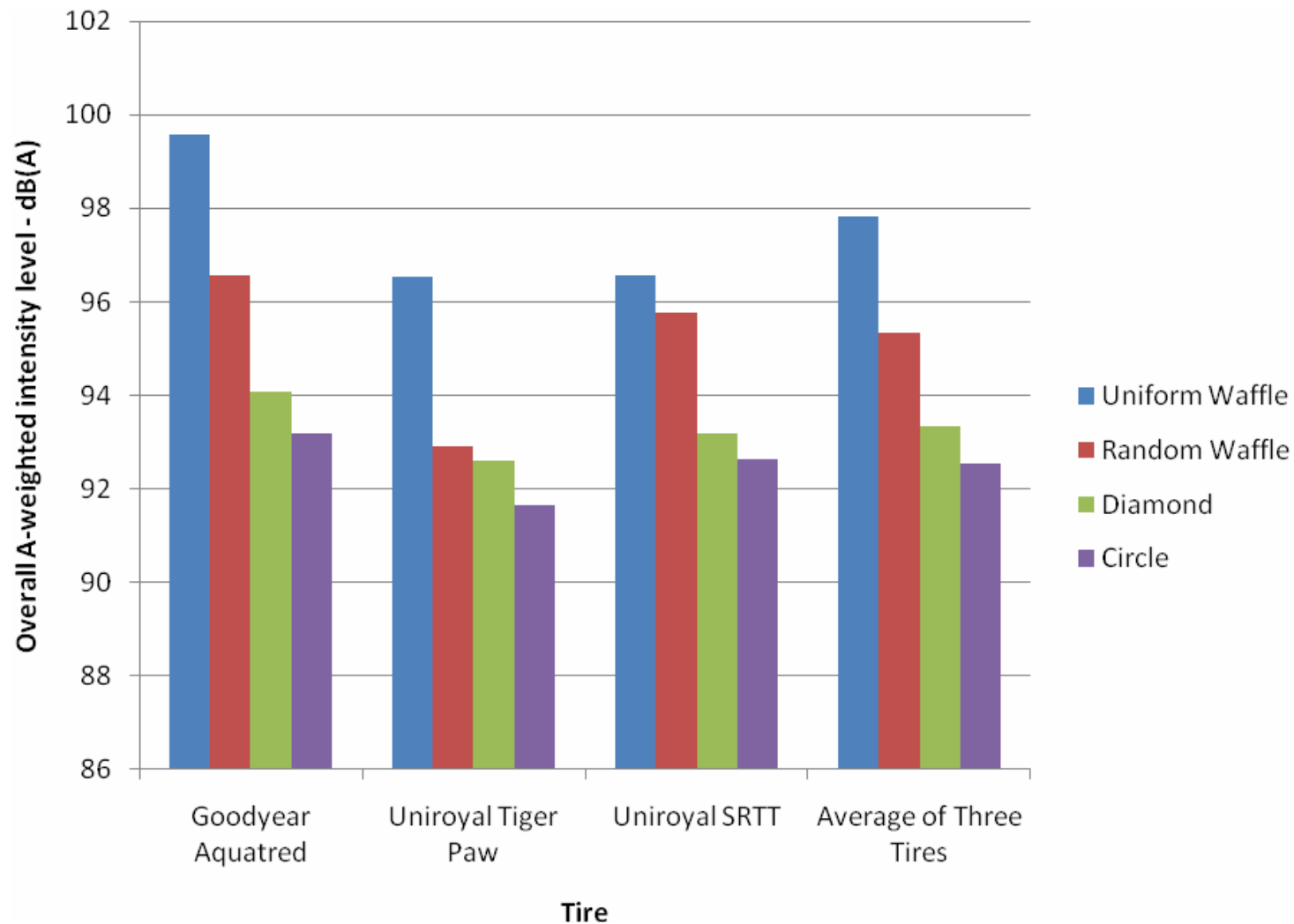




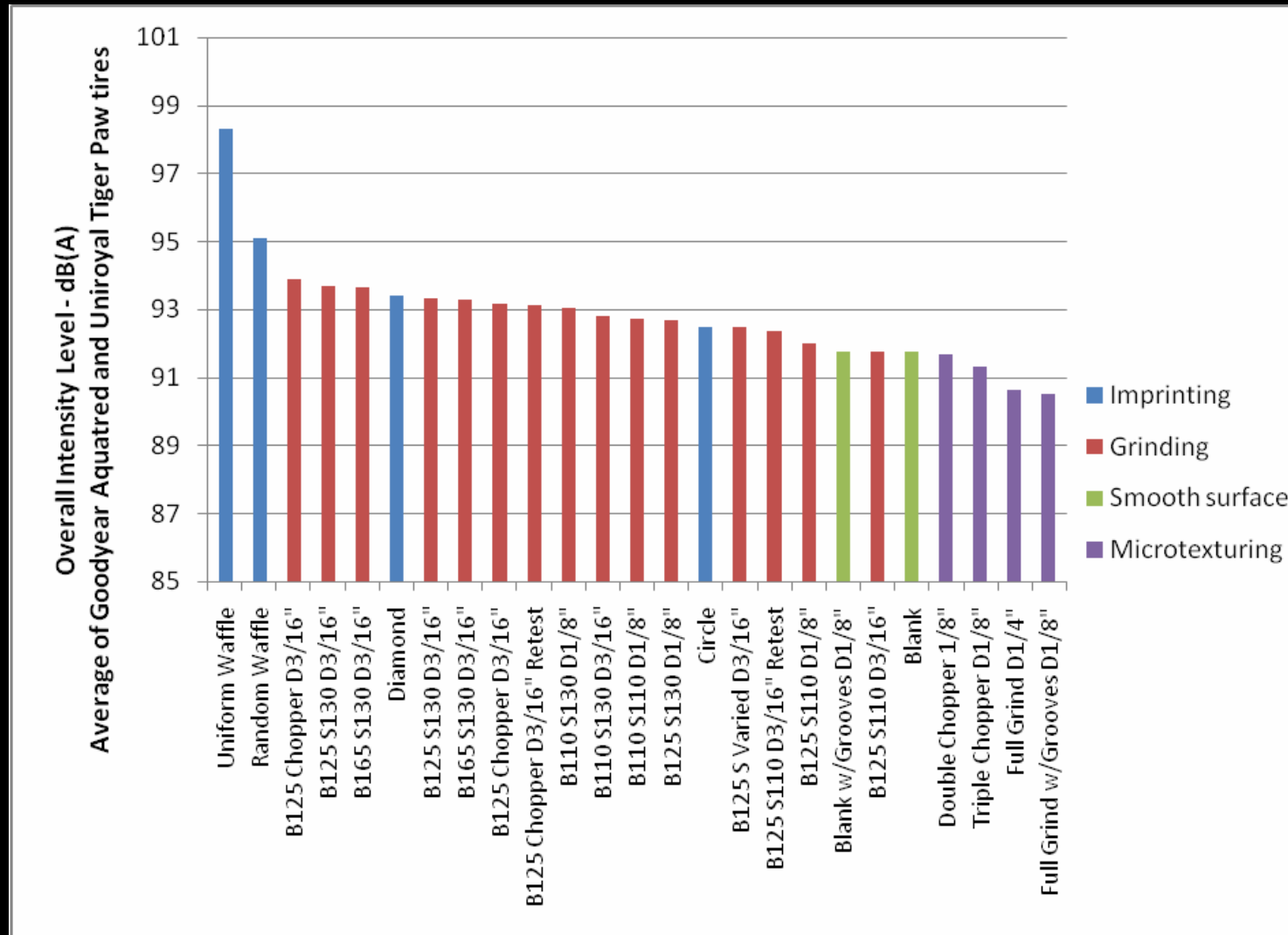




# ***Early Results of Innovative Textures***



# *Comparison of Grinding to Innovative Textures*



# *Summary*

- ✧ Many available treatments for PCC pavements
- ✧ Each has advantages and limitations
- ✧ Performance and cost vary with given conditions
- ✧ Applying the right treatment to the right pavement *at the right time*
- ✧ No universal method available
- ✧ Take advantage of local contractor experience
- ✧ IGGA is ready to assist

# ***Visit Us on the Web***

International Grooving and Grinding  
Association

✧ [igga.net](http://igga.net)





