

Concrete Pavements Surface Characteristics Program

A Link to Two-Lift Concrete Paving

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National Concrete Pavement
Technology Center



Uniting agencies, industry, and researchers
to advance concrete pavement technology



U.S. Department
of Transportation
Federal Highway
Administration



Performance

- Structural
 - Faulting, fatigue cracking
- Material
 - ASR, D-cracking
- Functional (Surface Characteristics)
 - Friction
 - Noise
 - Smoothness
 - Splash & Spray
 - ...

Surface Characteristics

Understand and
Control Texture:
Geometry

Texture: Tining



Texture: Drag



Texture: Diamond Grinding



Texture: Exposed Aggregate



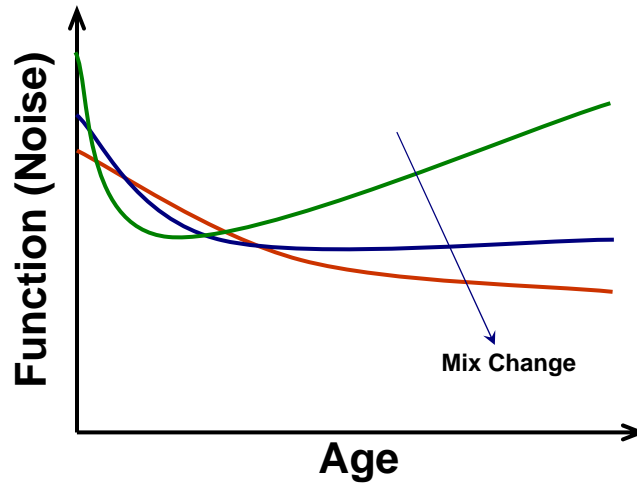
Surface Characteristics

Understand and
Control Texture:

Geometry and
Durability

Surface Characteristics

For the same “texture”, we might get...



Surface Characteristics

Understand and
Control Texture:

which means...

Mixture and
Construction

Concrete Pavements Surface Characteristics Program

Field Experiments

- Key Study Points
 - What can we learn from our current inventory?
 - What can we recommend for the future?

Test Sites

Type 1 New (1 site)	IA
Type 2 Existing (8 sites)	CO, ND, KS, IA, GA, WI, VA
Type 3 Existing (18 sites)	CO, ND, MN, IA, AL**, GA, NC, VA, OH, IN, MI, Quebec, NY, MO

** NCAT



Test Sections

- 395 Unique Textures Tested
 - 140 Transverse Tining (incl. 12 skewed and 2 cross-tined)
 - 104 Longitudinal Tining (incl. 2 sinusoidal)
 - 39 Diamond Ground
 - 16 Grooved (4 longitudinal, 12 transverse)
 - 59 Drag (Burlap, Turf, Broom, Belt, Carpet)
 - 10 Shot Peened
 - 5 Exposed Aggregate
 - 2 Milled
 - 20 HMA and Surface Treatments
- Over 1000 unique test sections
- Over 240,000 ft. of total length!

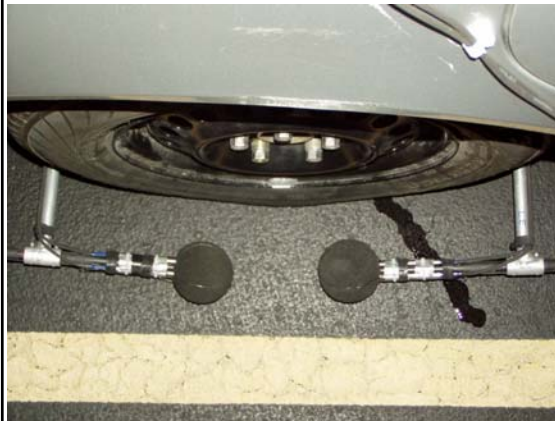
Test Methods

- Noise
 - On-Board Sound Intensity (OBSI)
 - Wayside (Roadside)
 - In-Vehicle
- Smoothness
 - Inertial Profiler
- Macrotexture
 - RoboTex (LMI RoLine)
 - Circular Texture Meter (CTM)
 - Sand patch
- Microtexture / Friction
 - Locked wheel skid trailer (smooth tire)
 - Dynamic Friction Tester (DFT)

Noise Testing: OBSI

On-Board Sound Intensity (OBSI)

- Developed by Dr. Paul Donovan
- Two test tires – Aquatred III and SRTT



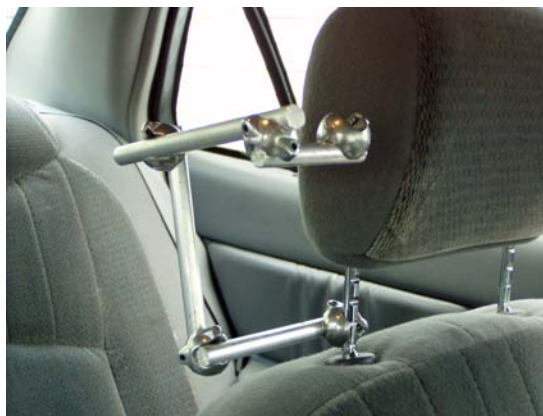
Noise Testing: Wayside

- ❑ Controlled pass-by (CPB) measures noise “roadside” using test vehicle under controlled conditions
- ❑ Same vehicle used for OBSI and CPB noise testing



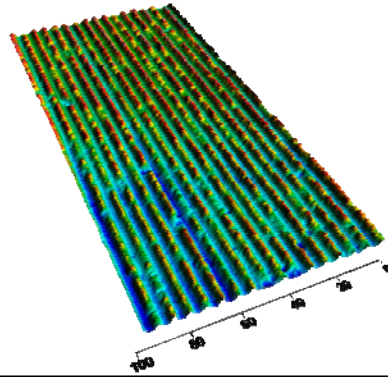
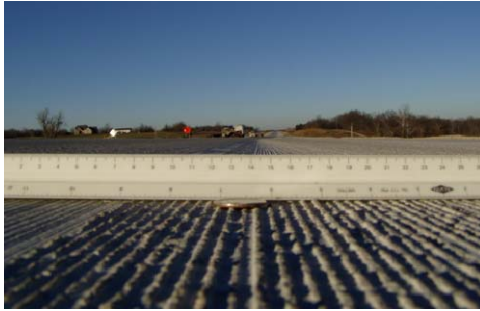
Noise Testing: In Vehicle

- ❑ Standardized by SAE J1477 and ISO 5128
- ❑ Same vehicle used for OBSI and In-Vehicle noise testing



Texture Testing: RoboTex

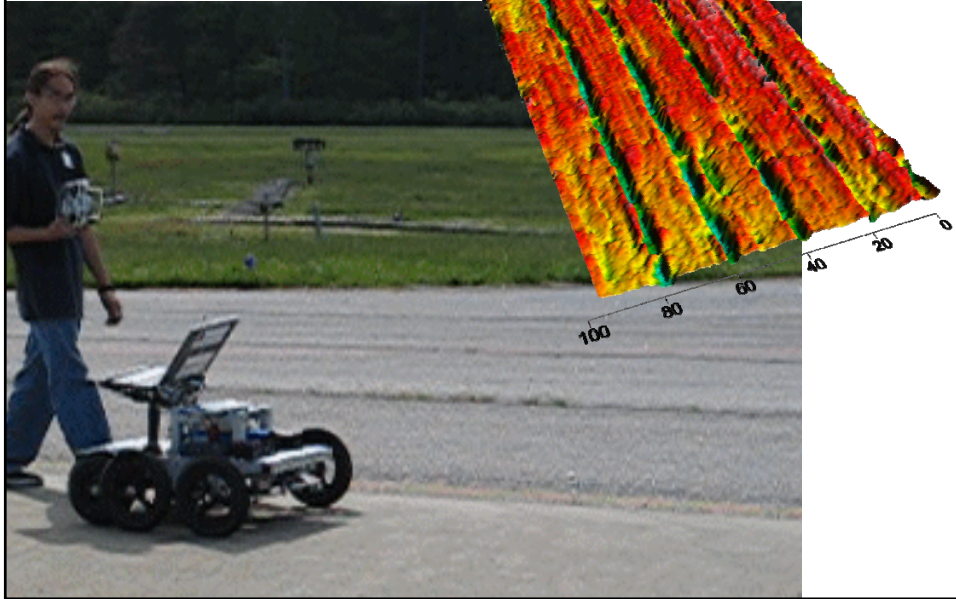
- ▣ Robotic Texture (RoboTex) Measurement System
- ▣ Built on LMI-Selcom RoLine sensor
- ▣ 3-D texture profiling at 0.9 mm x 0.45 mm sample interval
- ▣ Height sensor resolution is 0.01 mm (accuracy ~ 0.05 mm)
- ▣ Same line laser sensor currently being used by some profiler vendors to help solve “footprint” issues



RoboTex



RoboTex



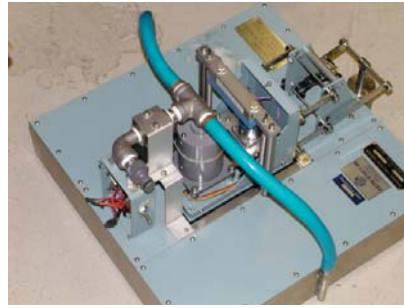
Friction Testing: Skid Trailer

- ▣ Measures wet friction at one speed
- ▣ Smooth tire allows for differentiation of macrotexture effects on friction
- ▣ Allows for comparison to some current DOT practices
- ▣ Standardized in ASTM E 274 (ASTM E 524 tire)



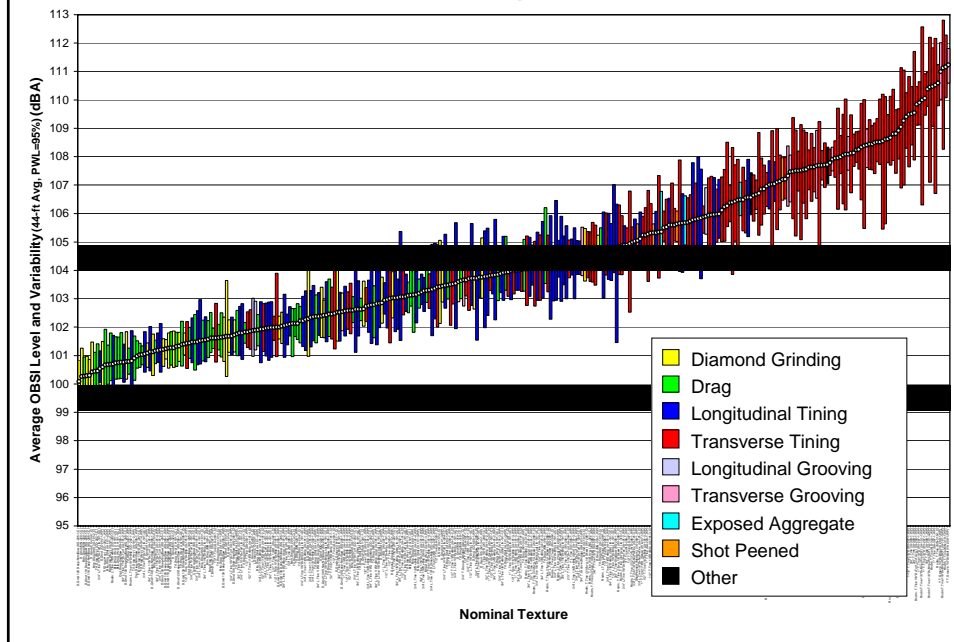
Friction Testing: DFT

- ❑ Dynamic Friction Tester (DFT) loan from FHWA
- ❑ Measures friction as a function of speed – ASTM E 1911
- ❑ Measures wet friction on small rubber pads which slow from 50 mph
- ❑ Coupled with macrotexture, allows prediction of International Friction Index (IFI) and correlated relationships to E 274 trailer

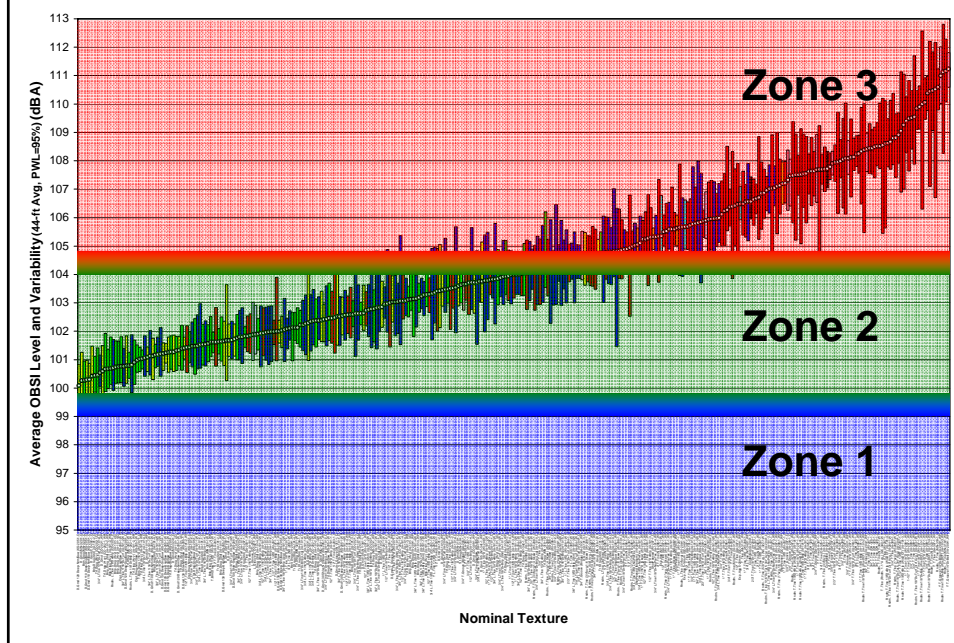


What did we
learn?

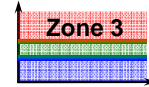
OBSI Noise Catalog



Noise Zones



Noise Zones



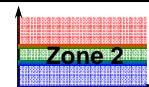
Zone 3 – “No Zone”

~ Above 104/105 dBA (OBSI, Aquated)

- Mixed Population
 - Transverse
 - Some Longitudinal
- Harsh Texture AND Worn Texture
- Rougher Pavement
- Deteriorated Joints

Learn and eliminate !!

Noise Zones

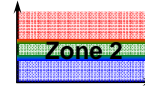


Zone 2 – “Quality Zone”

~ 99/100 to 104/105 dBA (OBSI, Aquatred)

- Mixed Solutions
 - Longitudinal, Drag, Grinding
 - Some Transverse
- Lower Variability
- Better Joints

Noise Zones

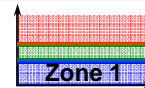


Zone 2 – “Quality Zone”

~ 99/100 to 104/105 dBA (OBSI, Aquatred)

- Quieter Solutions <102 dBA OBSI
 - Improve mixtures
 - Understand construction operations
 - Experiment with two-lift construction
 - Thin top course with high quality mix
 - Should improve and hold friction and noise
 - May prove economical

Noise Zones

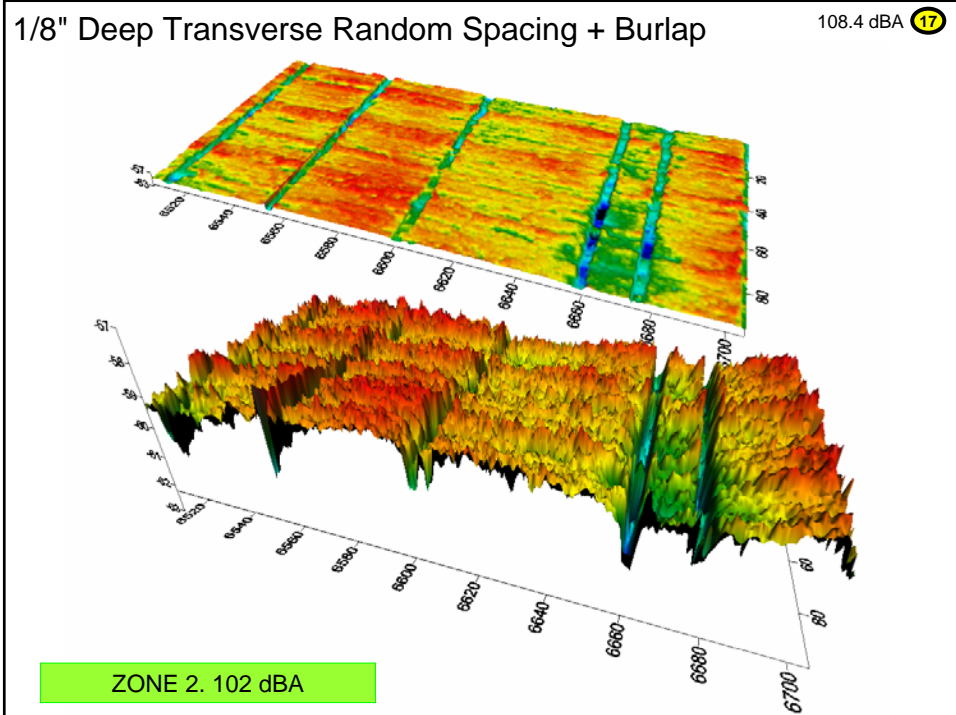
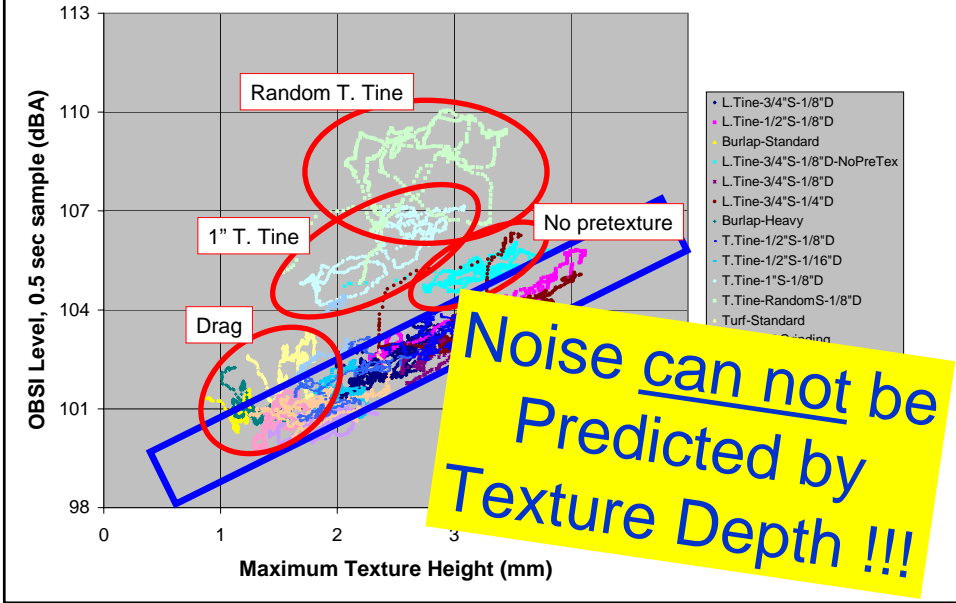


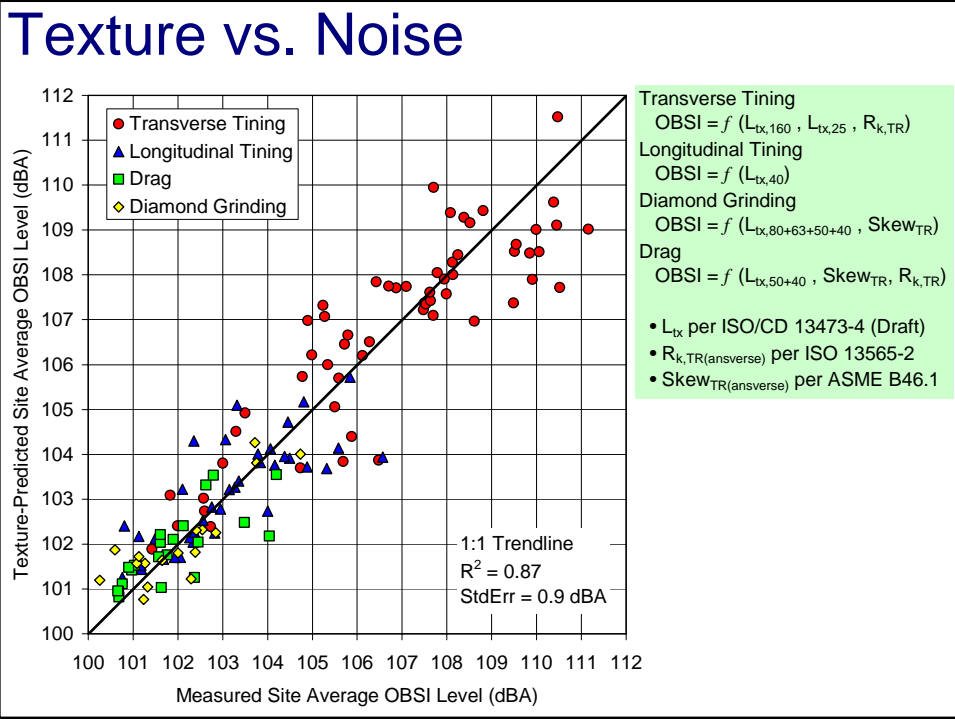
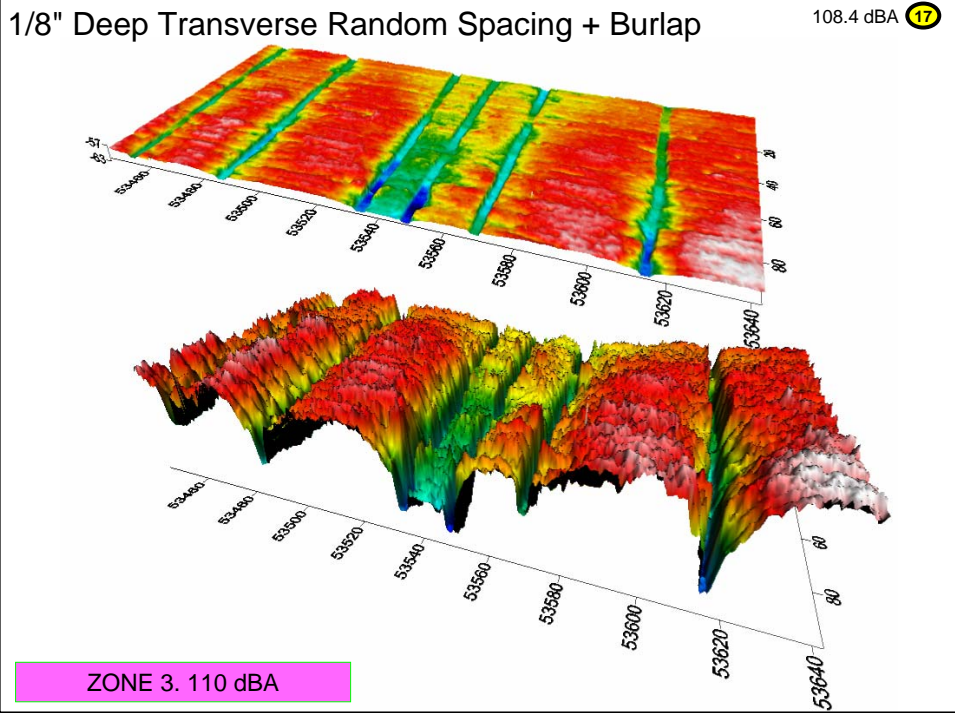
Zone 1 – “Innovation Zone”

~ Below 99/100 dBA (OBSI, Aquatred)

- Beyond capability of dense concrete
- No current solutions
- Innovative Possibilities
 - Need small negative texture
 - Mechanical damping ??
 - Porous, inclusions, polymers ??
 - Low Volume – pervious pavements ??
 - High Volume – thin overlay w/polymers and fibers ??
 - Two-lift a key since the innovation must also accommodate structure and economics

Texture vs. Noise ???



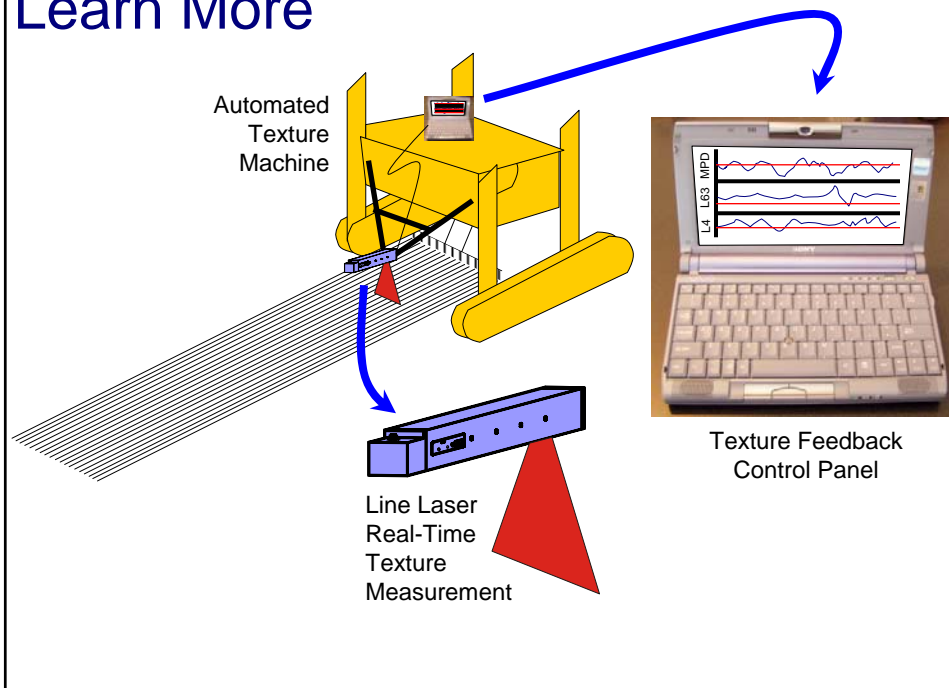


What can we recommend?

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Learn More



Interim Recommendations

- Better Practices
 - Minimize Construction Variability
 - Durable Concrete
 - Improved Curing
 - Nominal Texture
- Narrower Joints
- Two-Lift Applications
 - Exposed Aggregate Trials
 - More Durable Conventional Texture