

ISU – FHWA – ACPA Surface Characteristics

Relating Pavement Texture to
Tire-Pavement Noise using RoboTex

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National Concrete Pavement
Technology Center



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

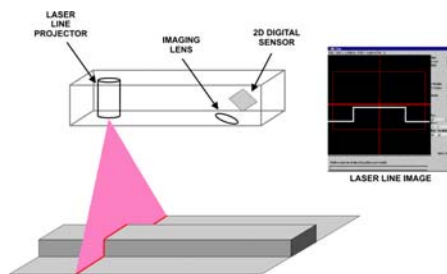
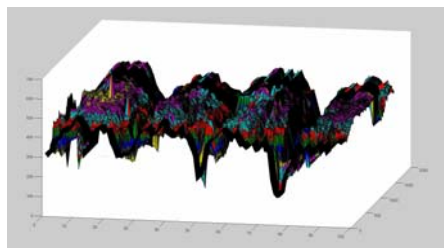


US Department
of Transportation
Federal Highway
Administration



RoboTex

- Robotic Texture (RoboTex) built around LMI-Selcom RoLine line laser
- 3-D texture profiling at 0.9 mm × 0.45 mm sample interval
- Height sensor resolution is 0.01 mm (accuracy ~ 0.05 mm)
- Same line laser unit currently being evaluated by profiler vendors to help solve “footprint” issues



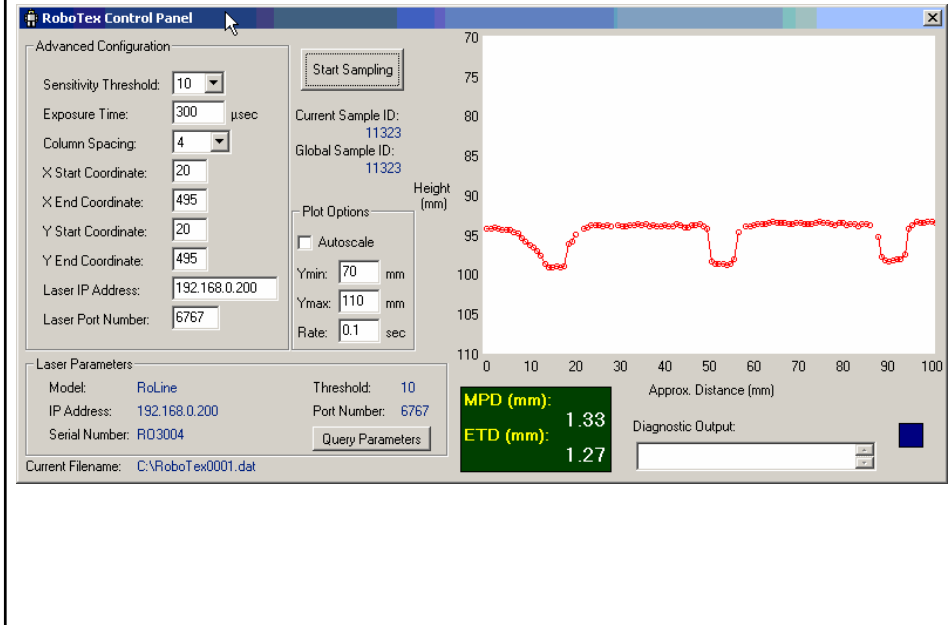
RoboTex Texture Device



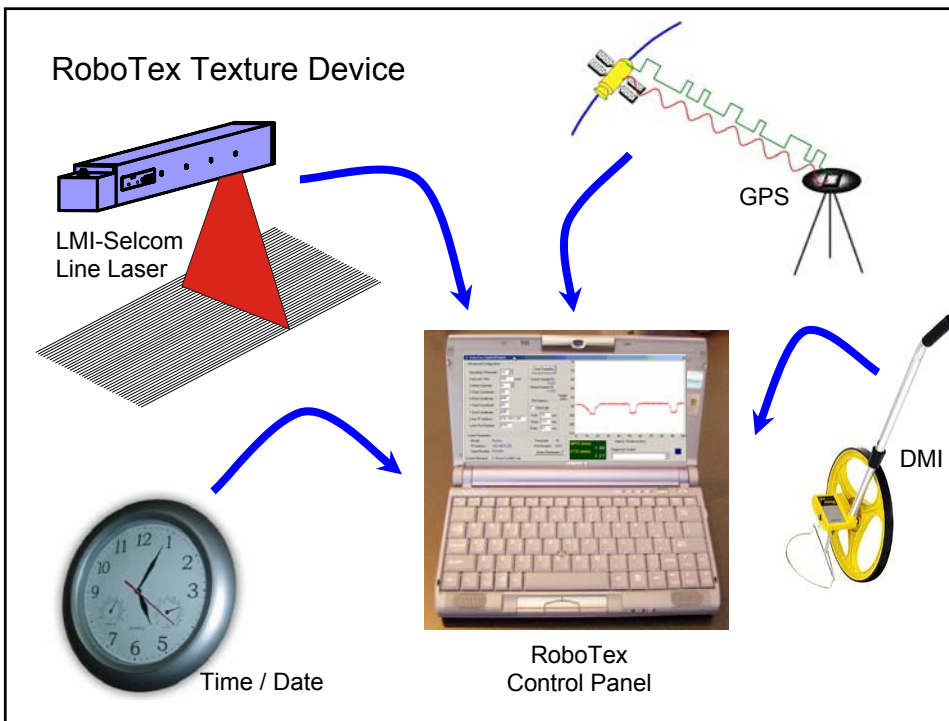
RoboTex Texture Device



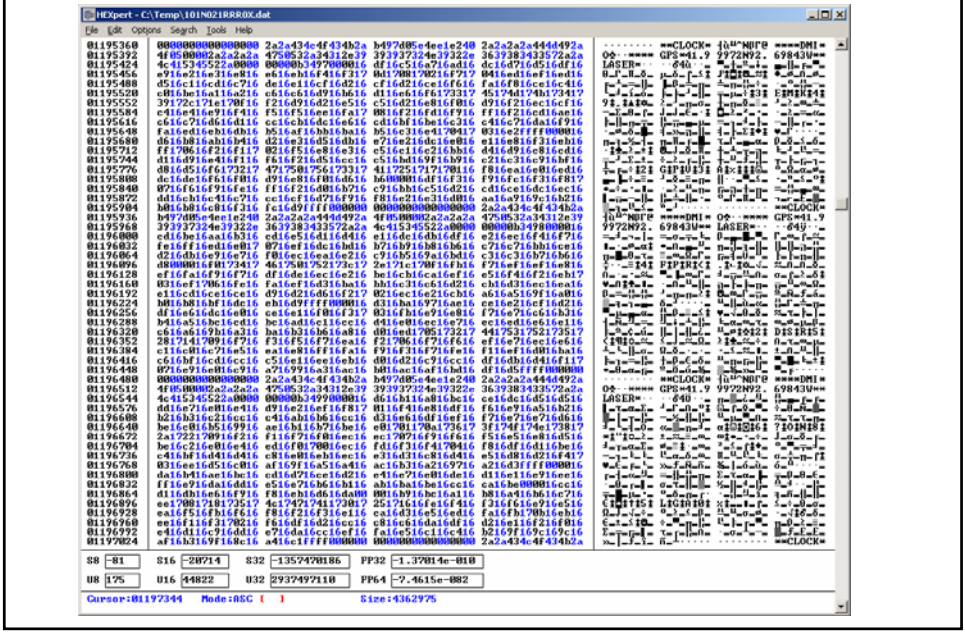
RoboTex Texture Device



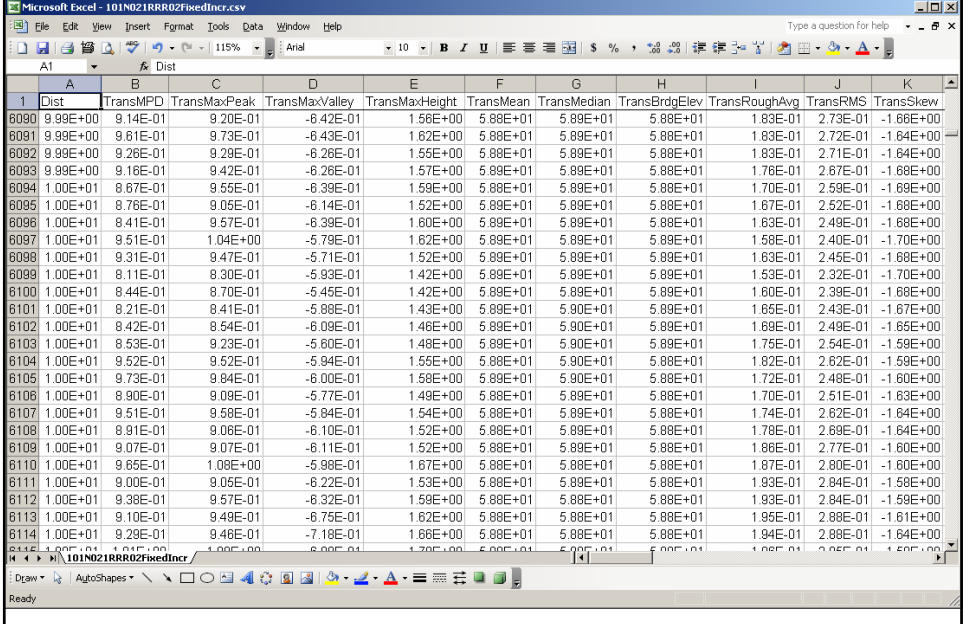
RoboTex Texture Device



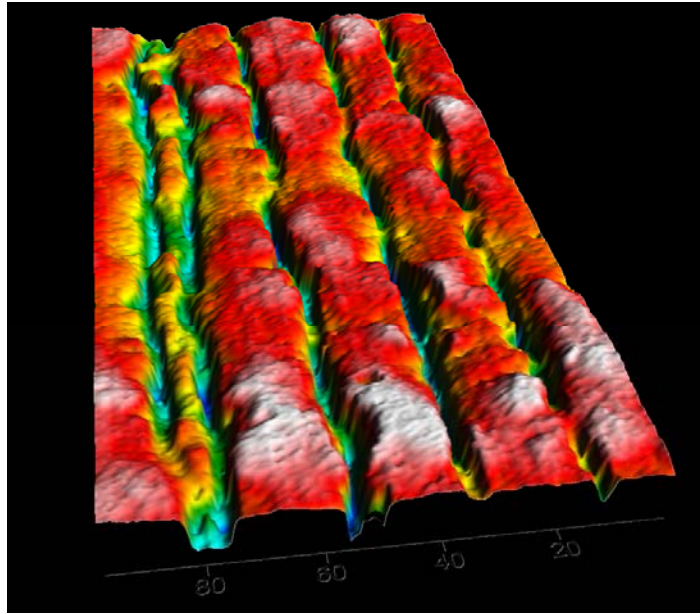
RoboTex Data Processing



RoboTex Data Processing

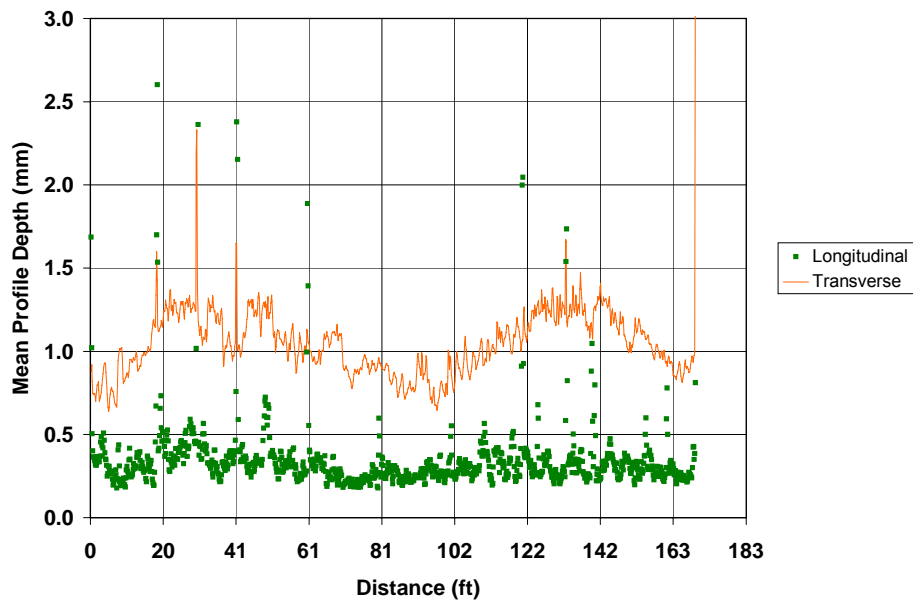


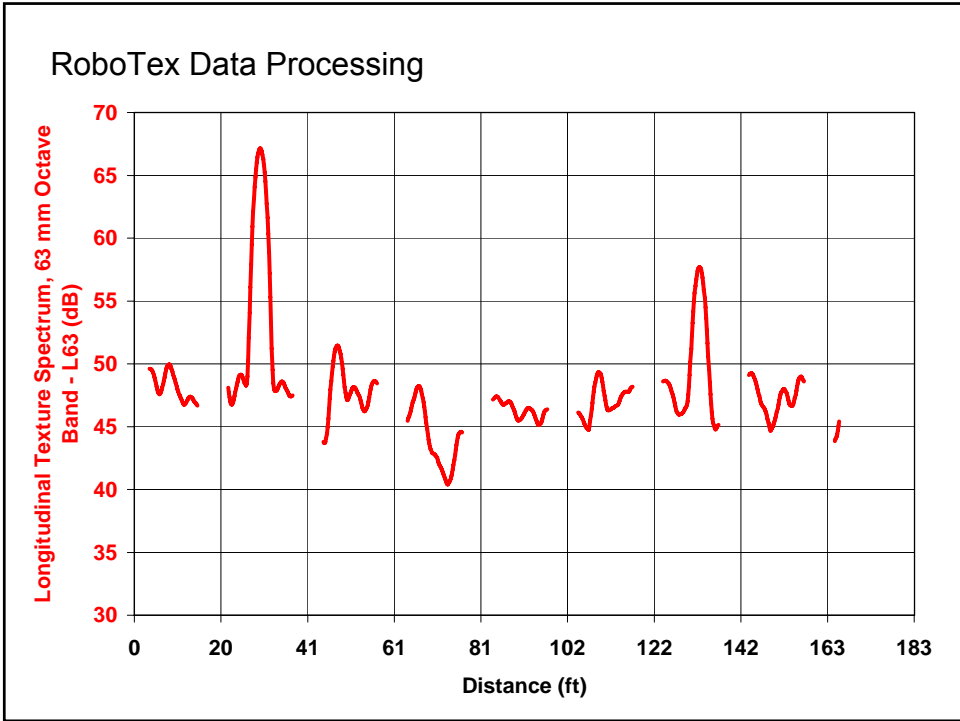
RoboTex Data Processing



| A | B | C |
|----|-------|--------|
| 1 | 0.82 | 6605.5 |
| 2 | 1.64 | 6605.5 |
| 3 | 2.47 | 6605.5 |
| 4 | 3.29 | 6605.5 |
| 5 | 4.11 | 6605.5 |
| 6 | 4.93 | 6605.5 |
| 7 | 5.75 | 6605.5 |
| 8 | 6.58 | 6605.5 |
| 9 | 7.4 | 6605.5 |
| 10 | 8.22 | 6605.5 |
| 11 | 9.04 | 6605.5 |
| 12 | 9.86 | 6605.5 |
| 13 | 10.69 | 6605.5 |
| 14 | 11.51 | 6605.5 |
| 15 | 12.33 | 6605.5 |
| 16 | 13.15 | 6605.5 |
| 17 | 13.97 | 6605.5 |
| 18 | 14.8 | 6605.5 |
| 19 | 15.62 | 6605.5 |
| 20 | 16.44 | 6605.5 |
| 21 | 17.26 | 6605.5 |
| 22 | 18.08 | 6605.5 |
| 23 | 18.91 | 6605.5 |
| 24 | 19.73 | 6605.5 |
| 25 | 20.55 | 6605.5 |
| 26 | 21.37 | 6605.5 |
| 27 | 22.19 | 6605.5 |
| 28 | 23.02 | 6605.5 |
| 29 | 23.84 | 6605.5 |
| 30 | 24.66 | 6605.5 |
| 31 | 25.48 | 6605.5 |
| 32 | 26.31 | 6605.5 |
| 33 | 27.13 | 6605.5 |

RoboTex Data Processing





Iowa DOT
Type 1 Testing

US Highway 30
Near Marshalltown, IA

Type 1 Iowa DOT

Data Collection

- Noise
 - ✓ Tire-Pavement (OBSI)
 - ✓ In-Vehicle
 - ✓ Wayside (Roadside)
- Texture
- Smoothness
- Friction

Collection Periods

- Pre-Broom / Pre-Traffic
(September 2005)
- Post-Broom / Pre-Traffic
(October 2005)
- Post-Broom / Opening
(December 2005)
- 3-5 months After Traffic
(April 2006)
- 1 year After Traffic
(Fall 2006)

Type 1 Iowa DOT

| <i>Texture</i> | <i>Spacing (in.)</i> | <i>Depth (in.)</i> | <i>Pre-texturing</i> |
|-----------------------|-----------------------------|---------------------------|-----------------------------|
| Longitudinal Tining | 1 | 1/8 | Burlap Drag |
| Longitudinal Tining | 3/4 | 1/4 | Burlap Drag |
| Longitudinal Tining | 3/4 | 1/8 | Burlap Drag |
| Longitudinal Tining | 3/4 | 1/8 | none |
| Longitudinal Tining | 3/4 | 1/8 | Burlap Drag |
| Longitudinal Tining | 3/4 | 1/8 | Artificial Turf |
| Longitudinal Tining | 3/4 | 1/16 | Artificial Turf |
| Longitudinal Tining | 3/4 | 1/16 | Burlap Drag |
| Longitudinal Tining | 1/2 | 1/8 | Burlap Drag |
| Burlap Drag | n/a | (Heavy Weight) | none |
| Burlap Drag | n/a | (Standard Weight) | none |
| Artificial Turf Drag | n/a | (Standard Weight) | none |
| Artificial Turf Drag | n/a | (Heavy Weight) | none |
| Transverse Tining | 1/2 | 1/8 | Burlap Drag |
| Transverse Tining | 1/2 | 1/16 | Burlap Drag |
| Transverse Tining | 1 | 1/8 | Burlap Drag |
| Transverse Tining | Random** | 1/8 | Burlap Drag |
| Diamond Grinding | | | |

Type 1 Iowa DOT



Type 1 Iowa DOT



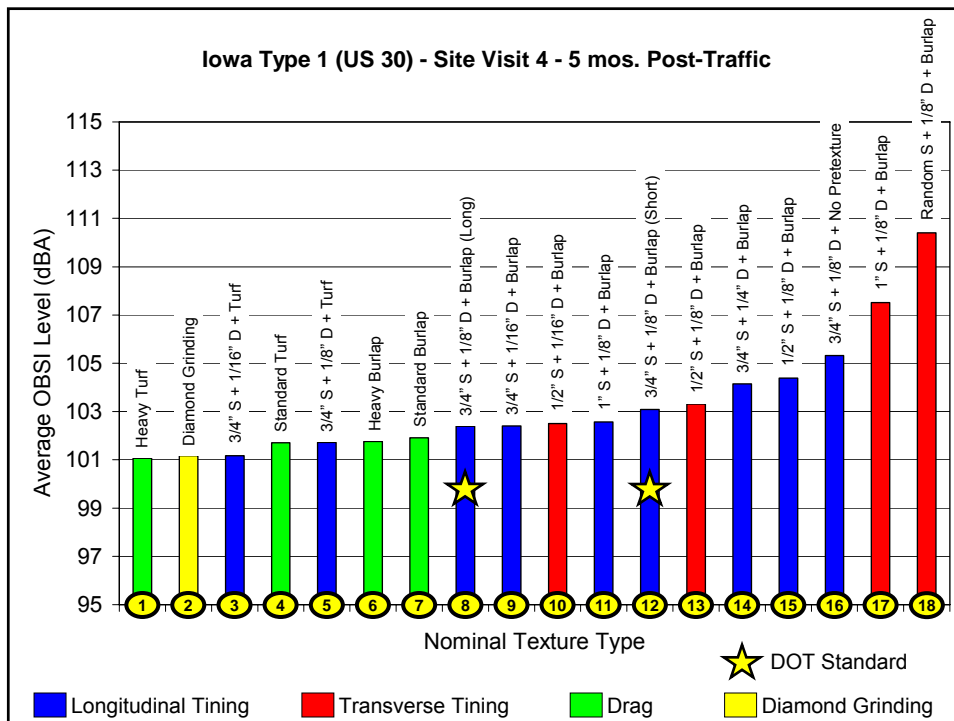
Type 1 Iowa DOT

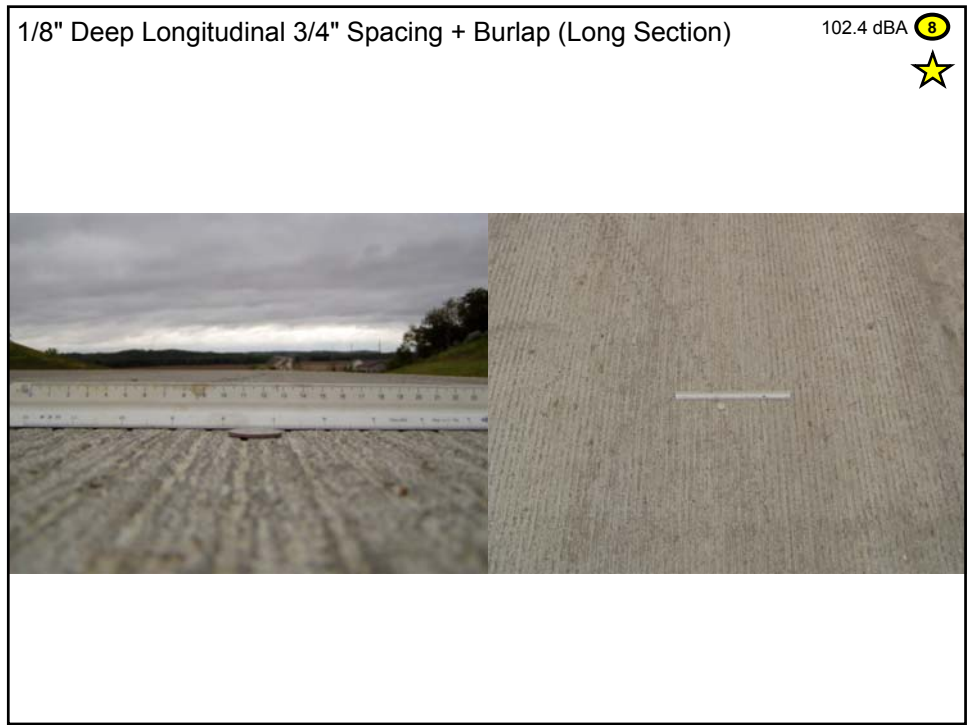
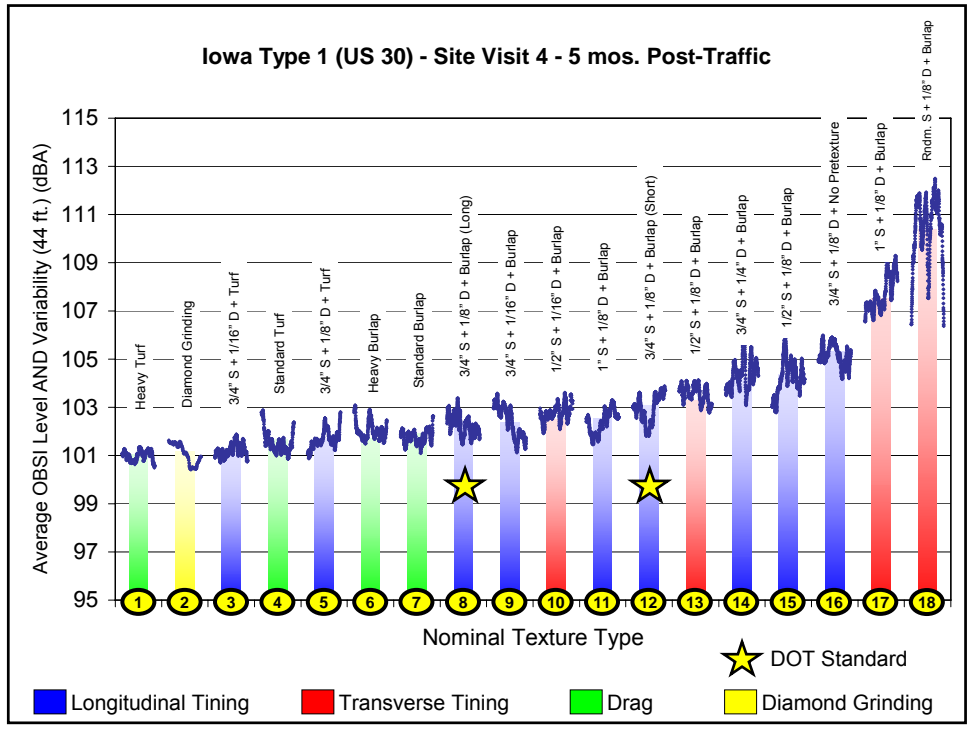


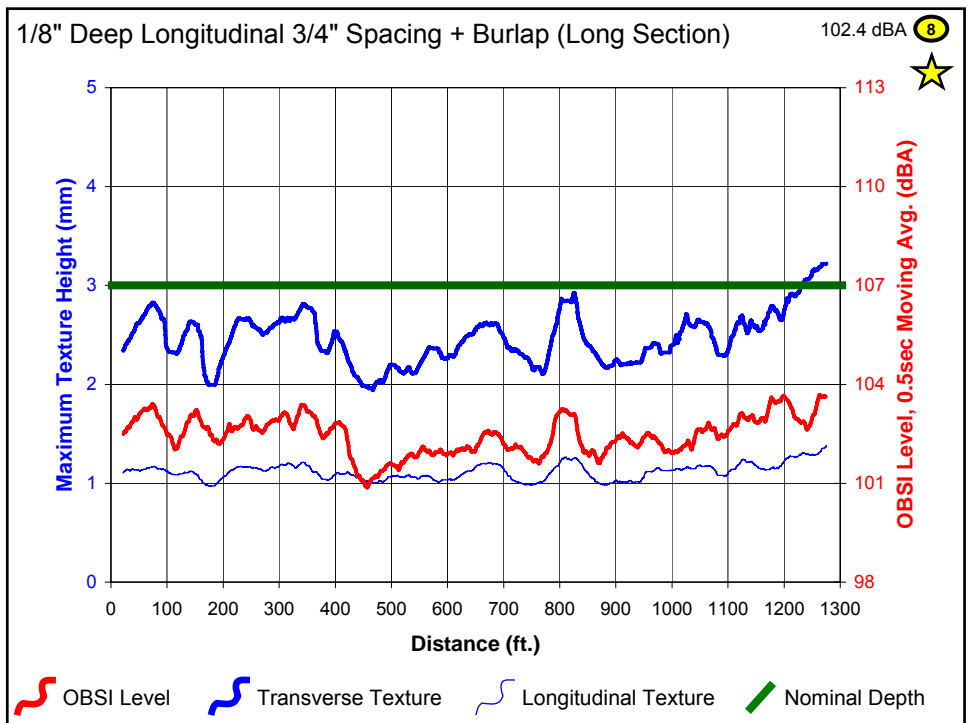
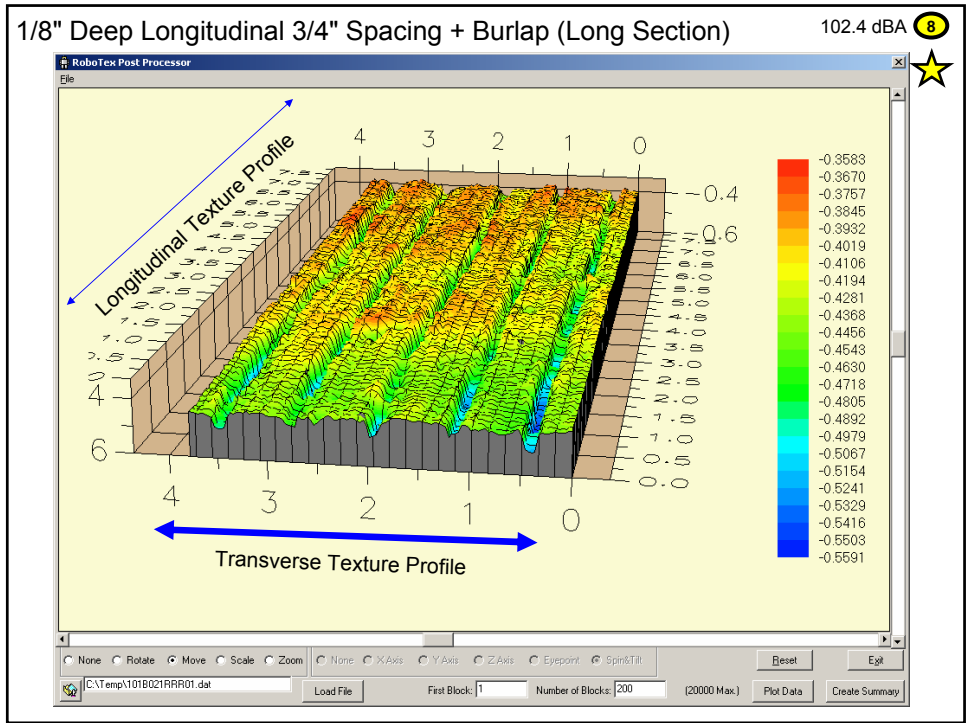
Type 1 Iowa DOT



Type 1 Iowa DOT







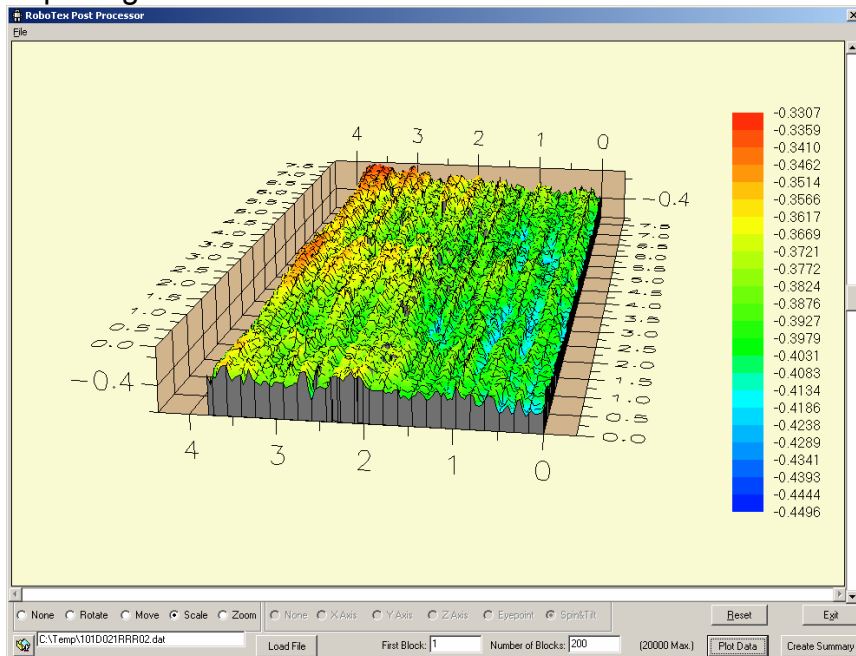
Burlap Drag

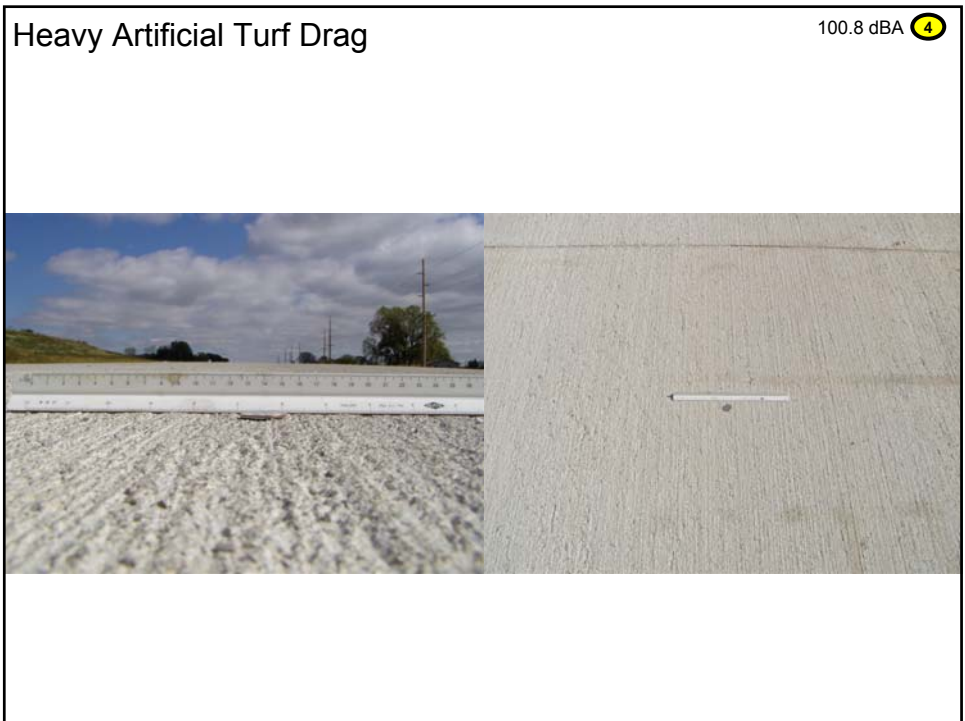
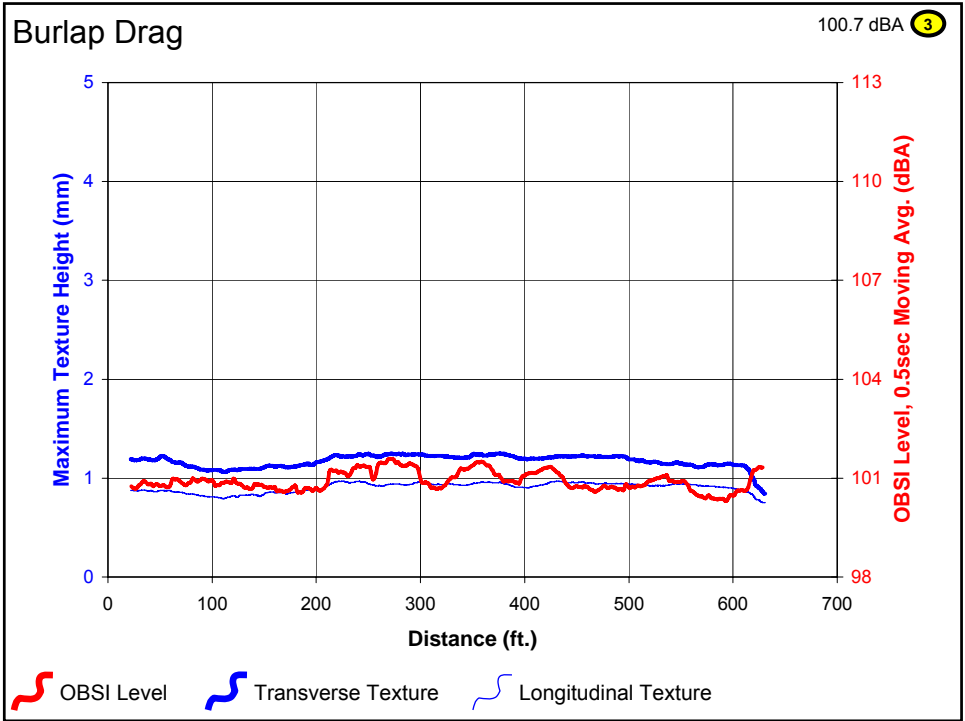
100.7 dBA 3

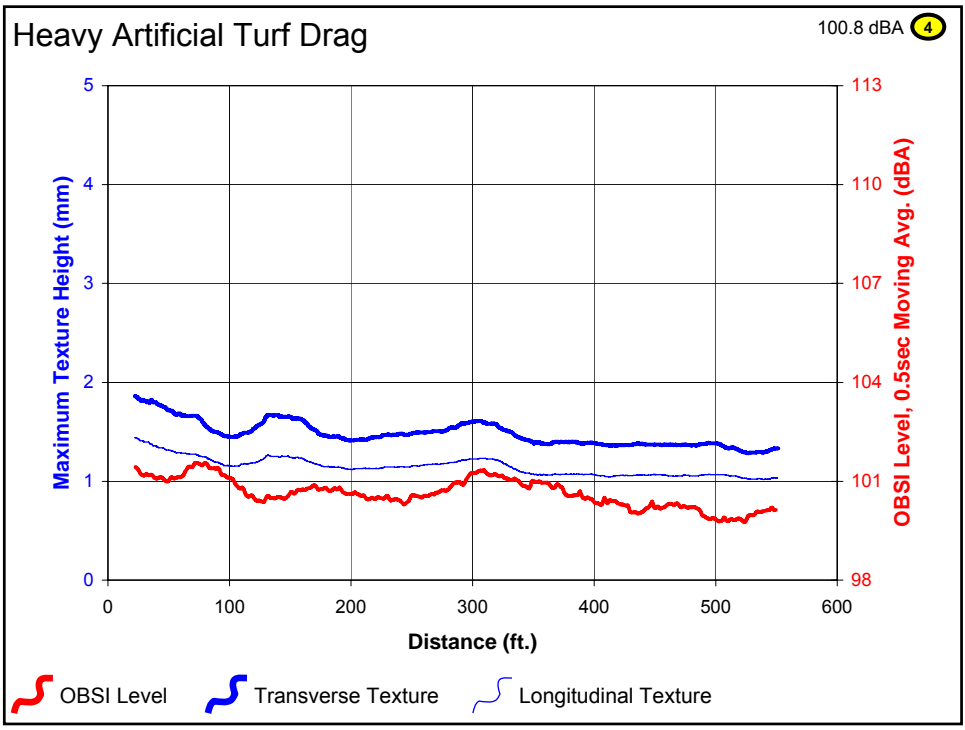
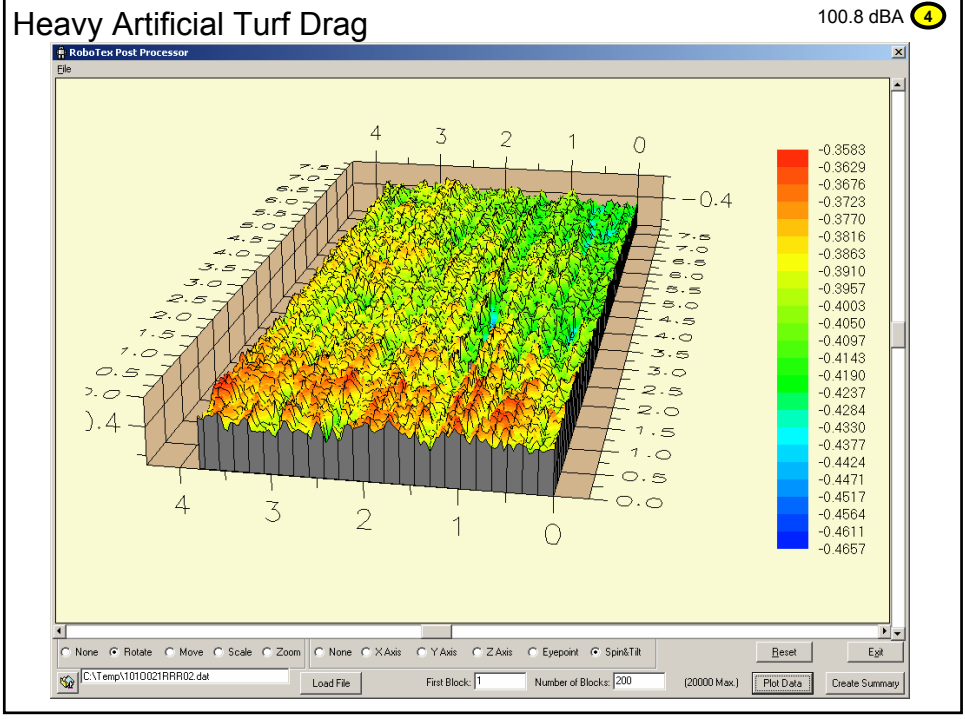


Burlap Drag


100.7 dBA 3







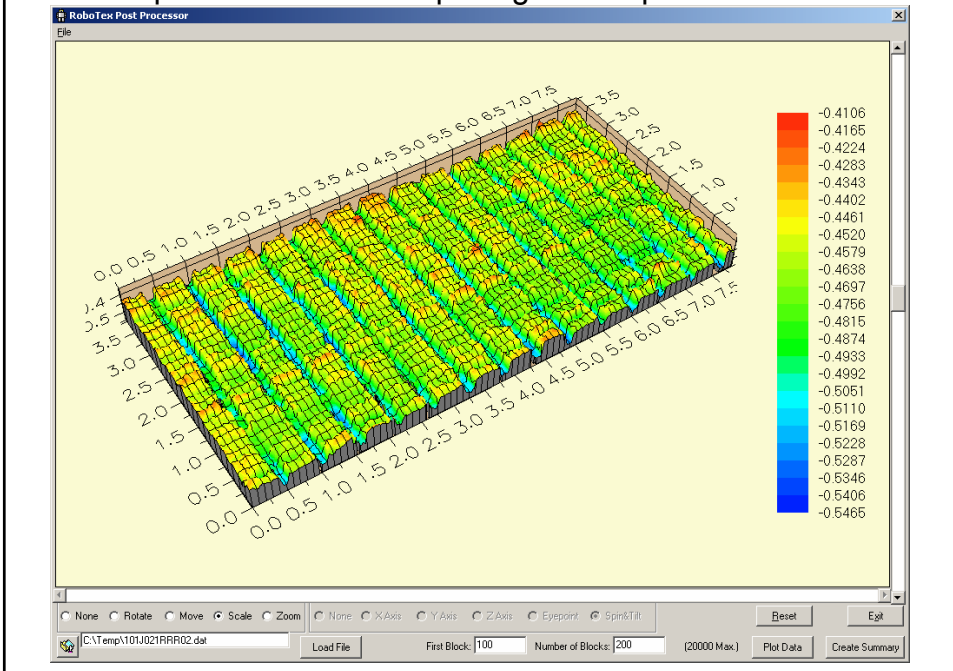
1/16" Deep Transverse 1/2" Spacing + Burlap

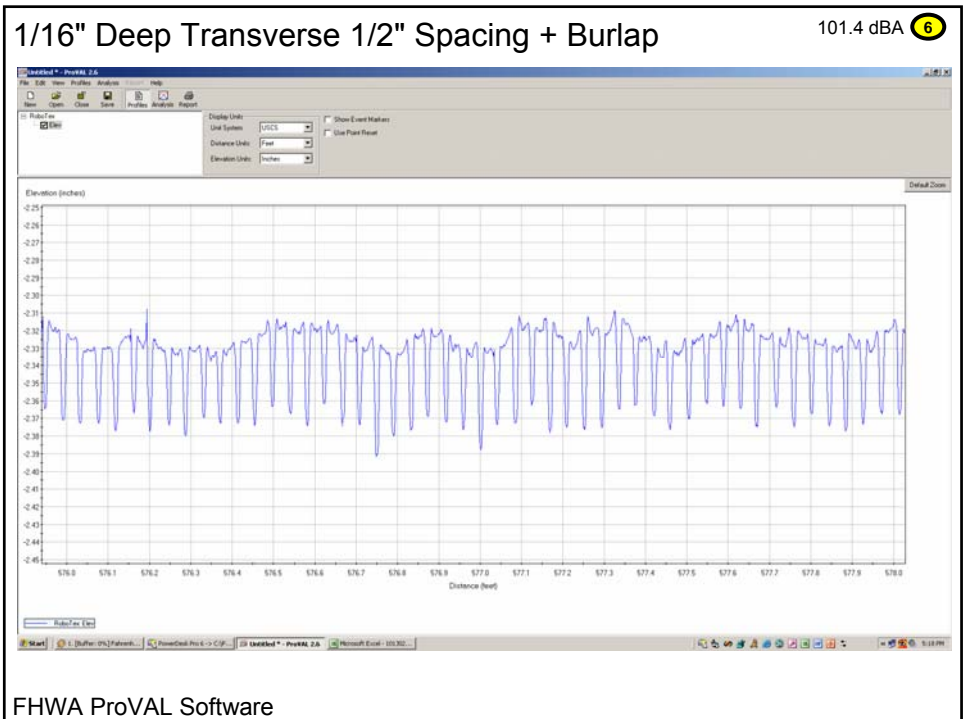
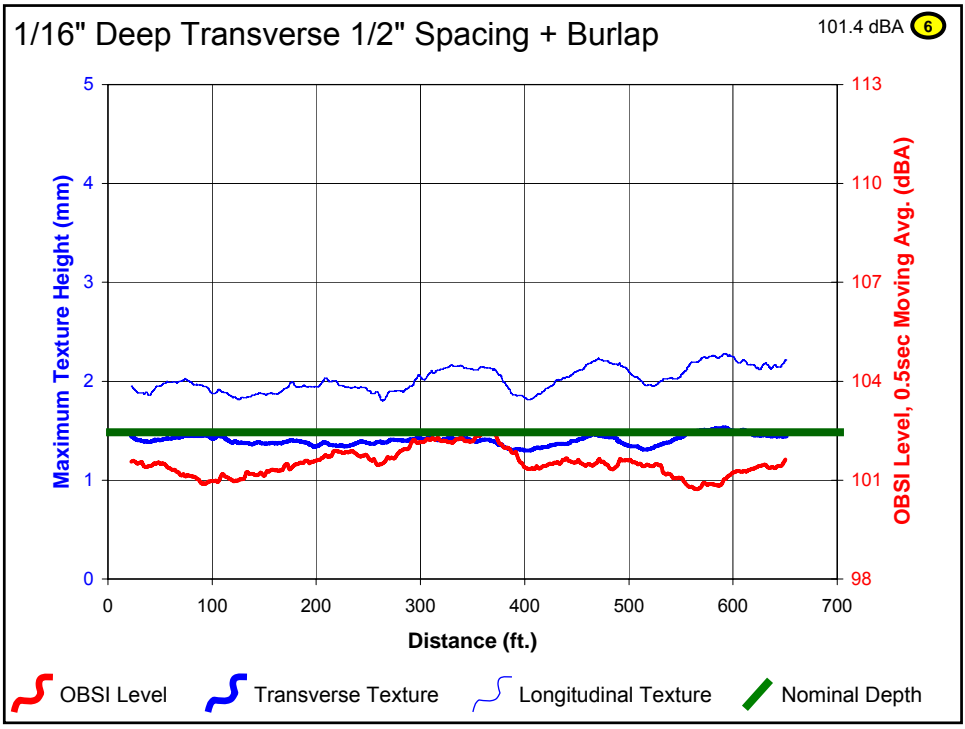
101.4 dBA 



1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA 





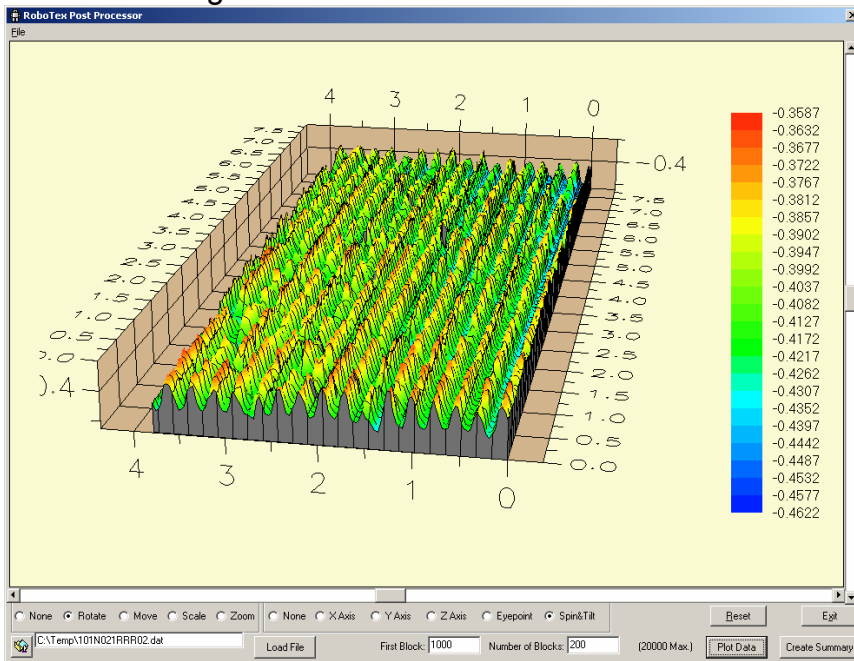
Diamond Grinding

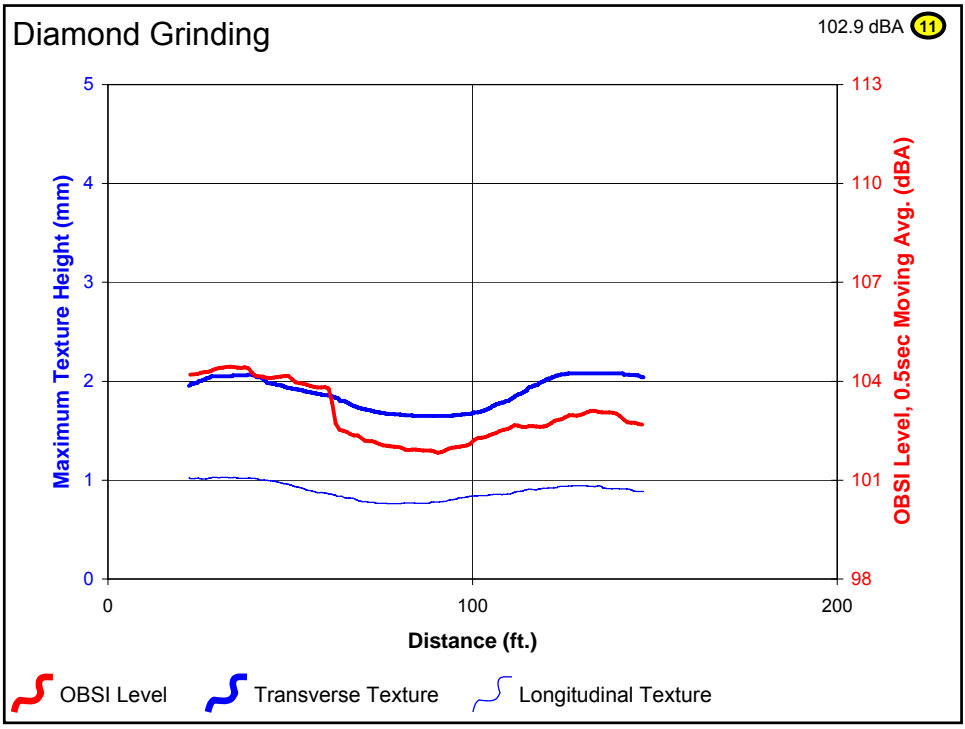
102.9 dBA **11**

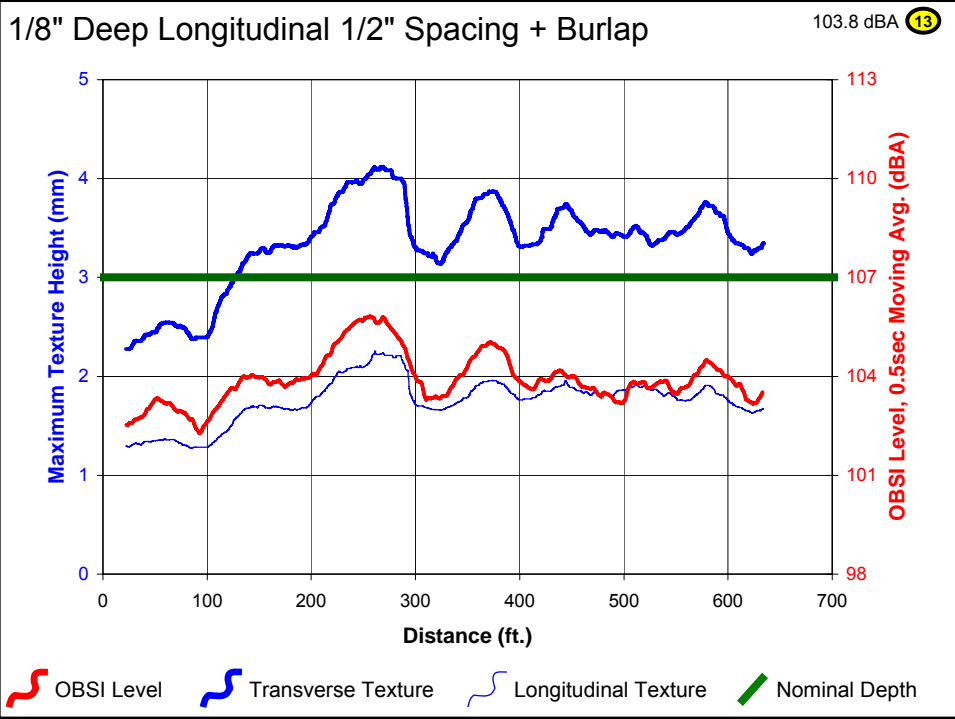
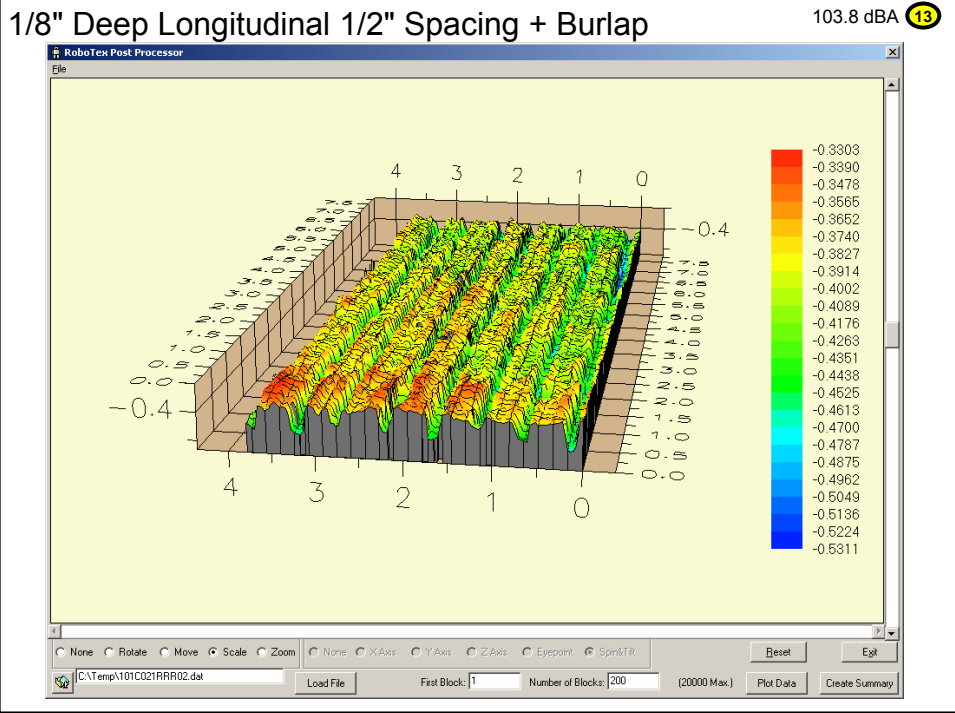


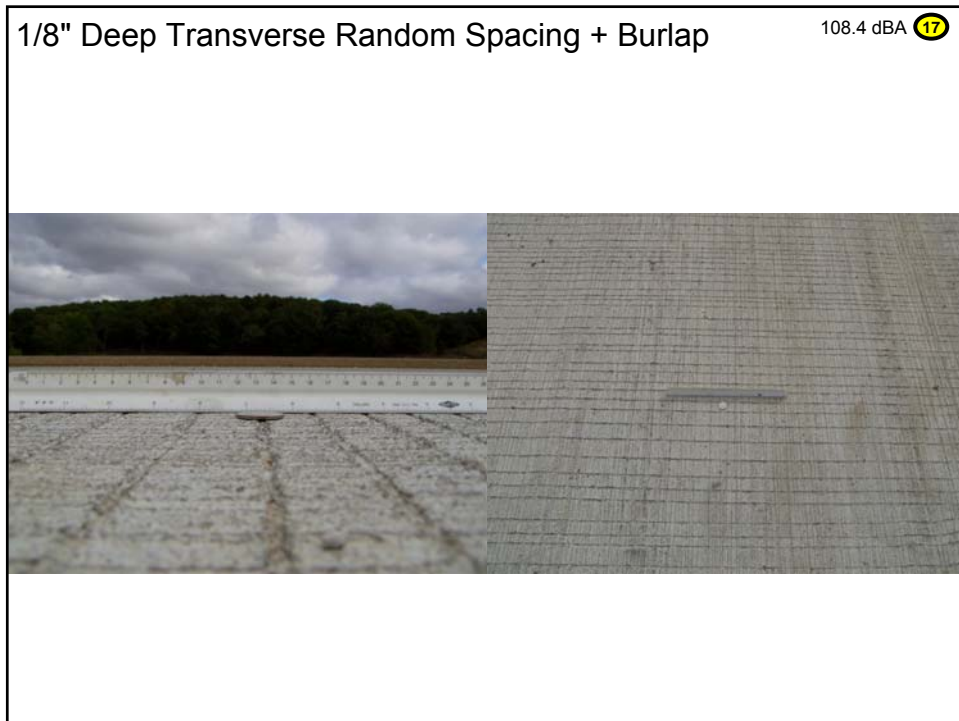
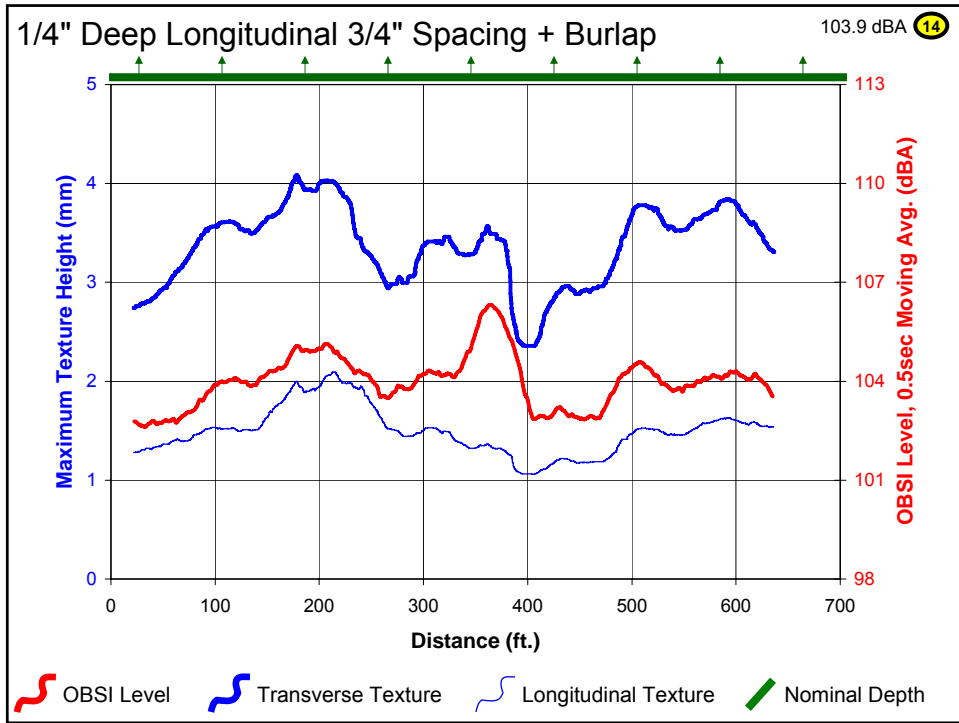
Diamond Grinding

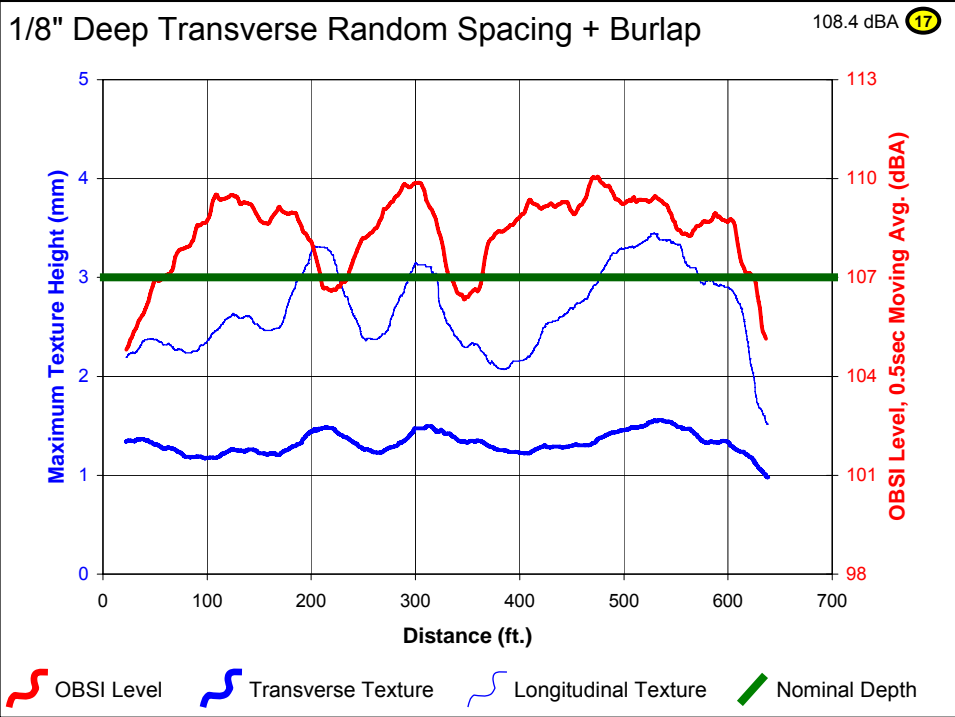
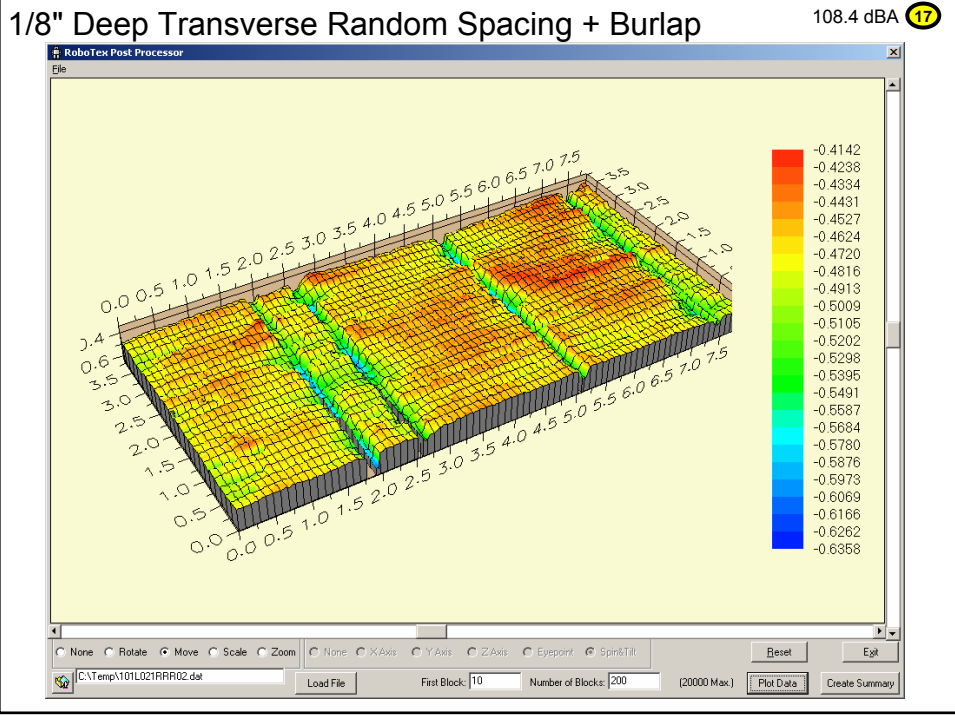
102.9 dBA **11**



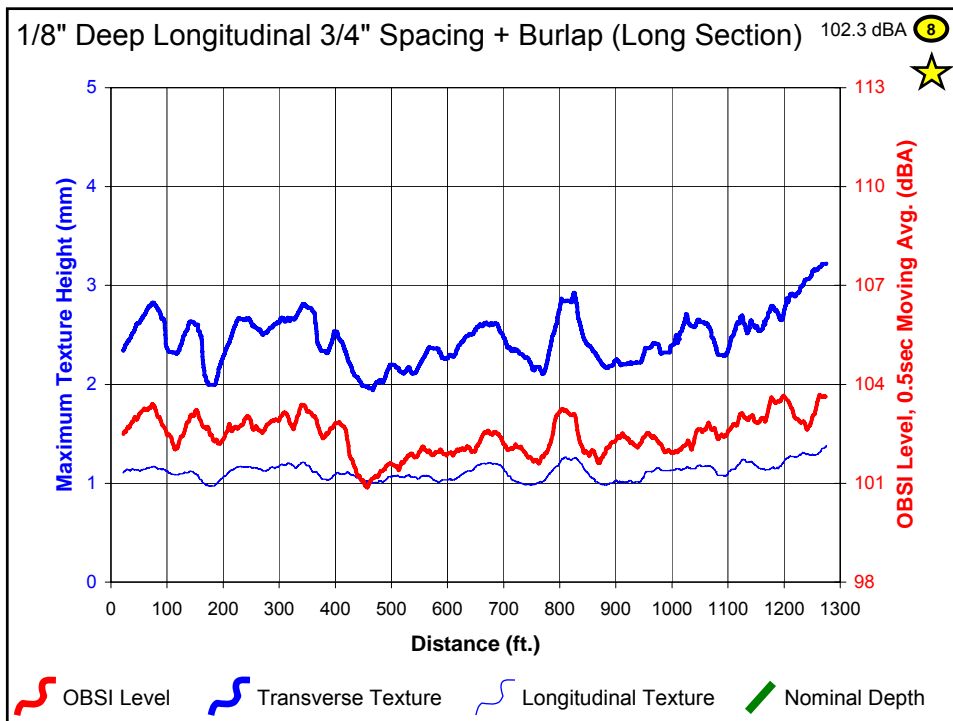
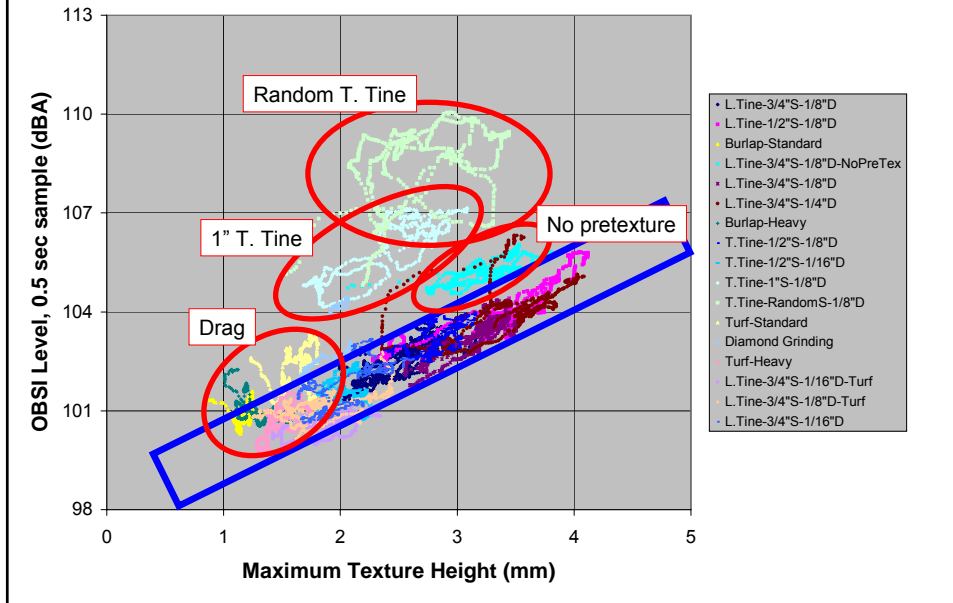


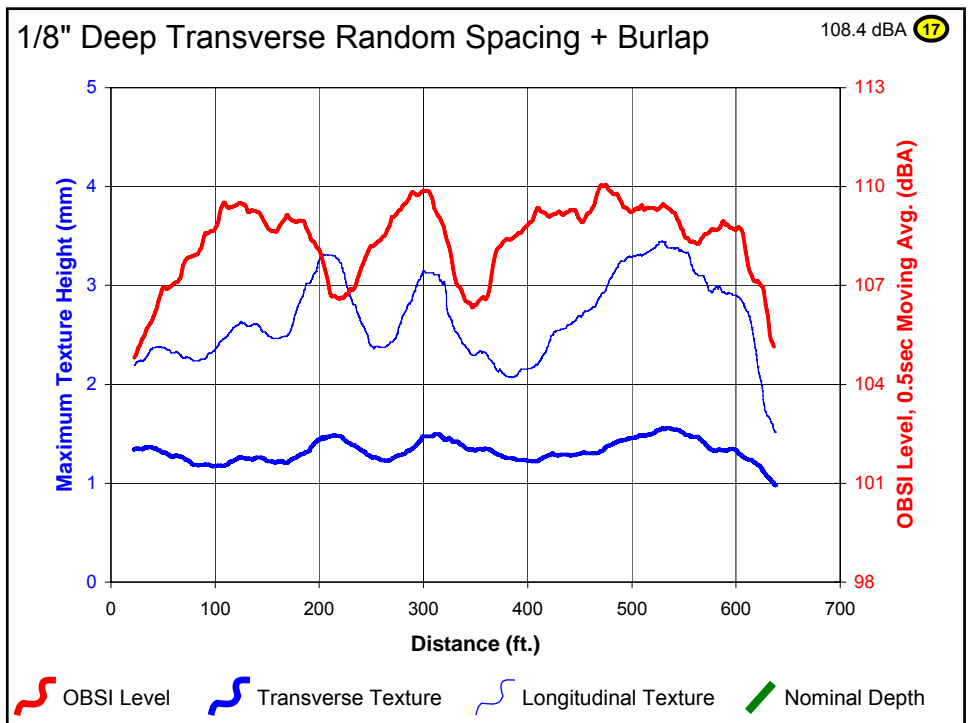
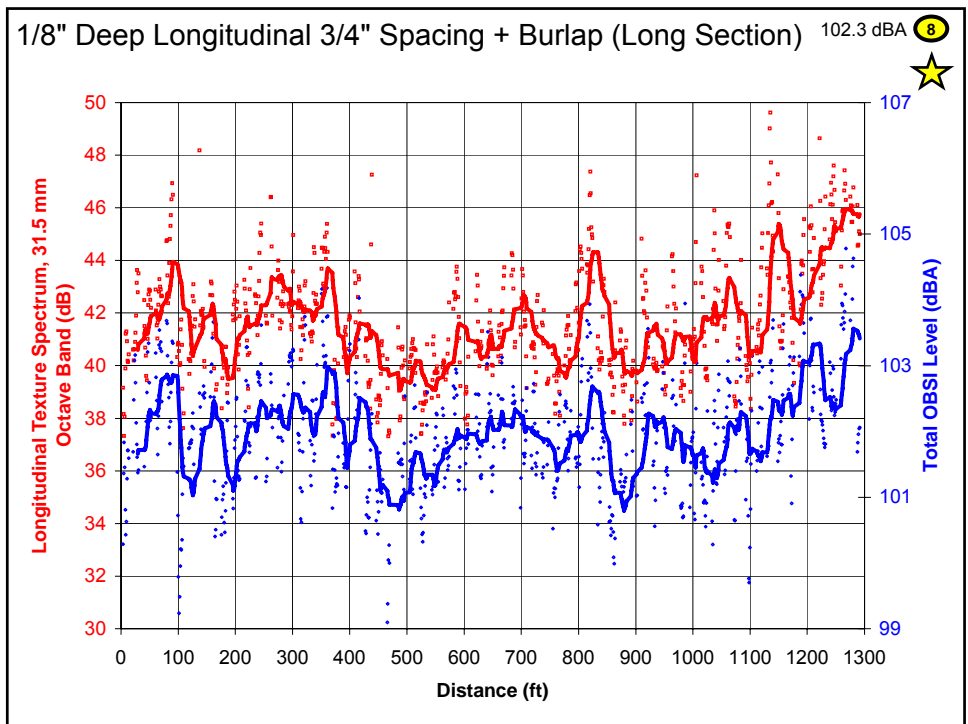


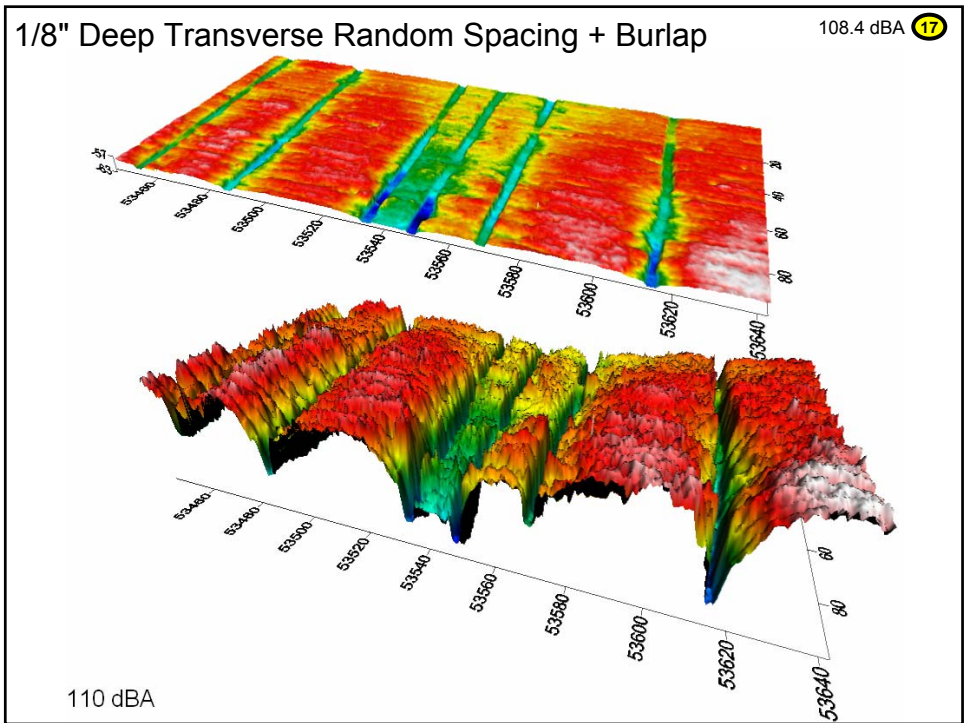
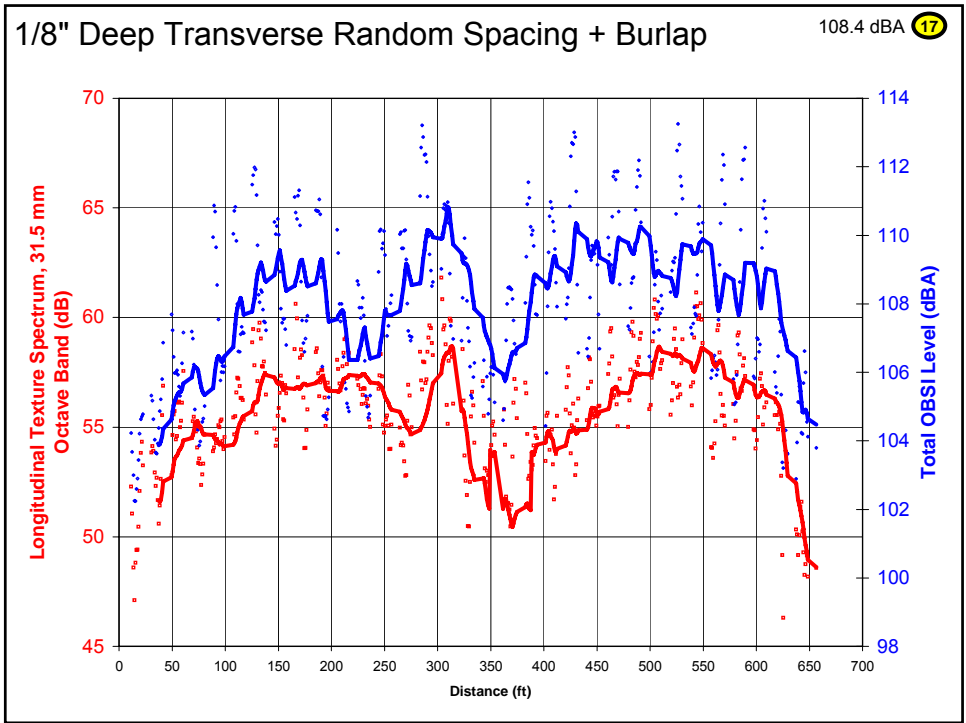




Texture vs. Noise

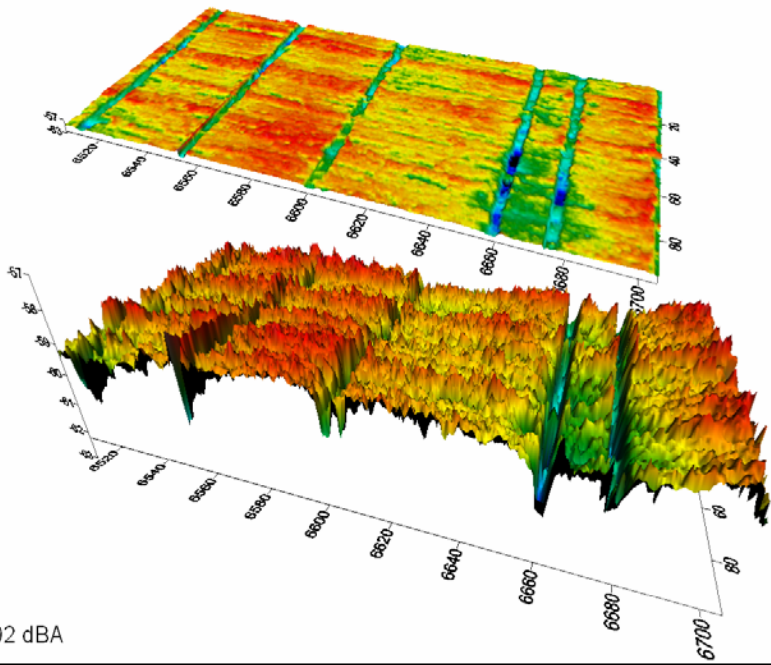






1/8" Deep Transverse Random Spacing + Burlap

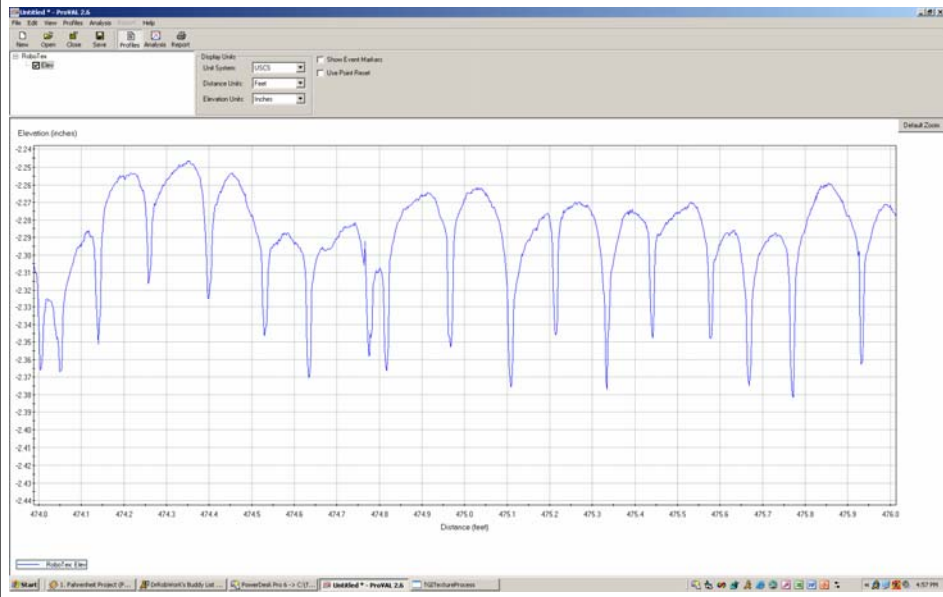
108.4 dBA **17**



102 dBA

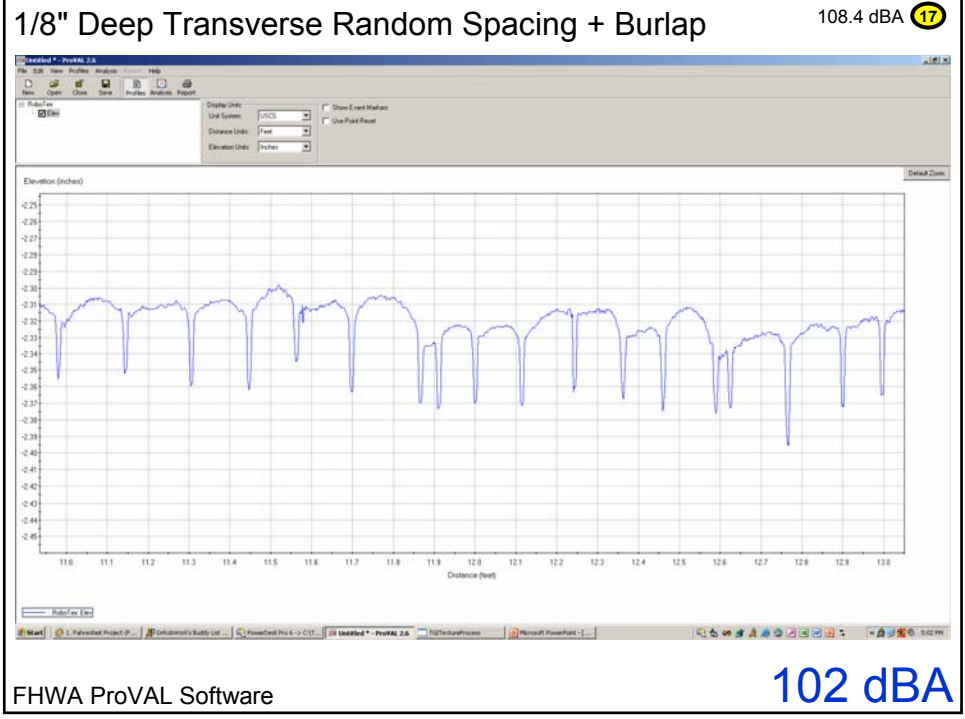
1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA **17**



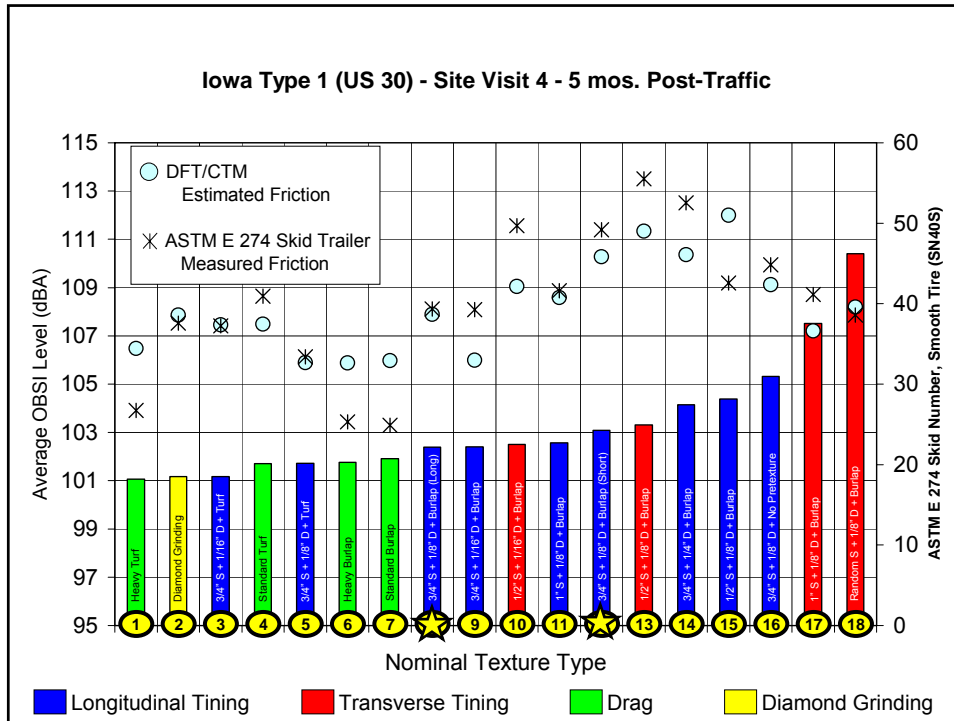
FHWA ProVAL Software

110 dBA



Again...

What about Friction?



Texture vs. Noise

- While a relationship can be observed between texture depth and noise as measured by OBSI, this is really caused more by the “bumps and dips” that occur every 1 to 2 inches

Texture vs. Noise

- Constructability
 - Depth does not match nominal
 - Nominal is not 'nominal'
 - Variability appears high

Work underway with equipment manufacturers to improve process.

Texture vs. Noise

- To predict noise, we need to understand much more about the texture than what we know now.
- To link to noise mitigation and wall construction, we have many miles to go
 - Average, variability, and time history

Critical Steps

- Categorize / rank over 200 unique nominal texture configurations (actual texture)
- Interrelate texture-noise-friction-smoothness
- Identify ways to reduce texture and noise variability
- Develop texture specification
- Build / evaluate trial sections to “new” specification
- Analyze in-vehicle and wayside noise
- Consider splash & spray experiment

Data Analysis Projects

1. 3D Tire Envelopment Filter Development
2. Spectral and Temporal Decomposition of Noise and Psychoacoustic Evaluation
3. Identification of Relevant Texture Metrics for Noise
4. Relating OBSI and Wayside Noise
5. Texture and Noise Artifacts due to Pavement Design and Construction

Data Analysis Projects

6. Pavement Joint Effects on Noise
7. Impact of Changing the OBSI Test Tire
8. Acoustical Durability
9. Relating OBSI and In-Vehicle Noise
10. Validating the Texture – Friction Relationship

Thank You