Pervious Concrete Pavements at MnROAD

LRRB Project 879

Ally Akkari, MnDOT

Project Details/Acknoledgements

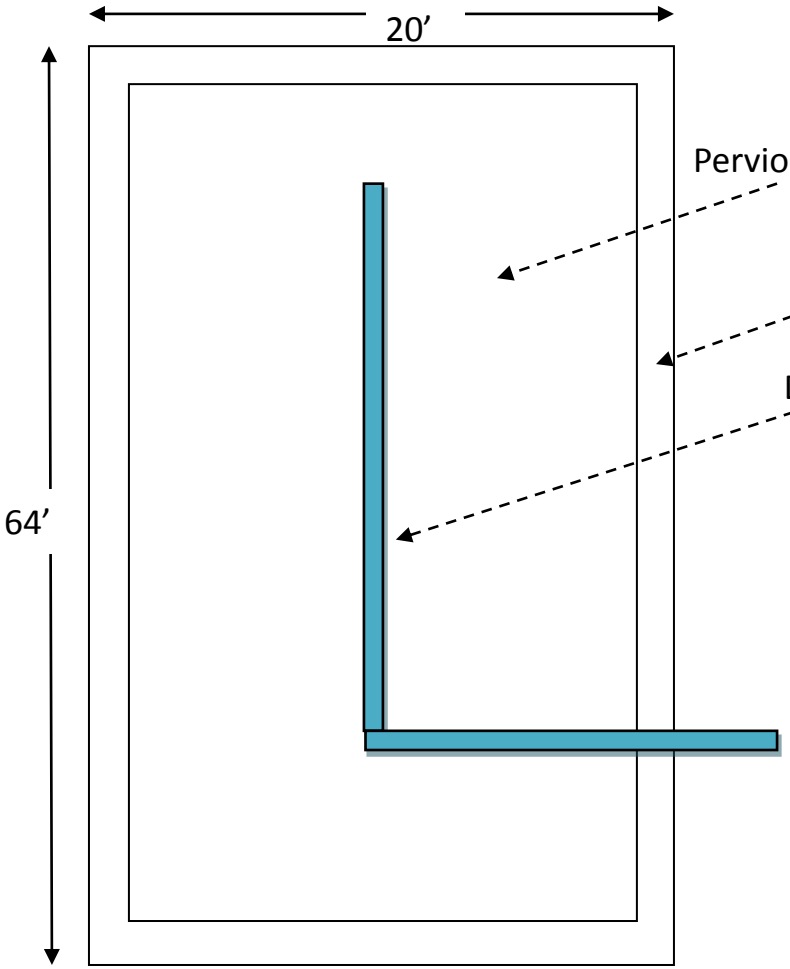
- **LRRB:** Funding
- **MnDOT:** Construction of Cells 85 and 89
- **MnDOT and CP Tech Center:** Porous Overlay

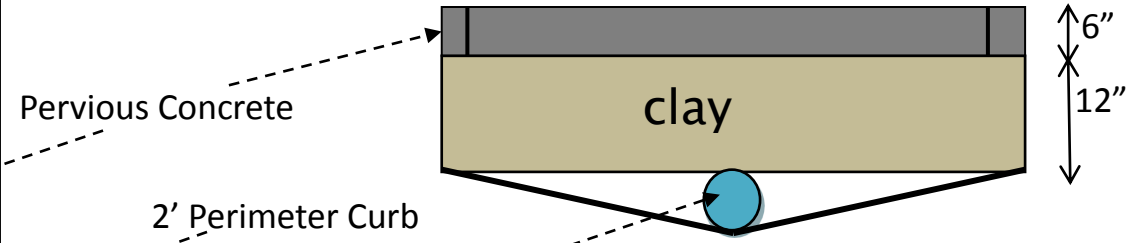
- PI: Bernard Izevbekhai
- TL: Mark Maloney (City of Shoreview)
- AL: Bruce Holdhusen

Introduction

- Objectives
  - Storm water management
  - Freeze thaw durability
  - Traffic noise reduction
  - And more…

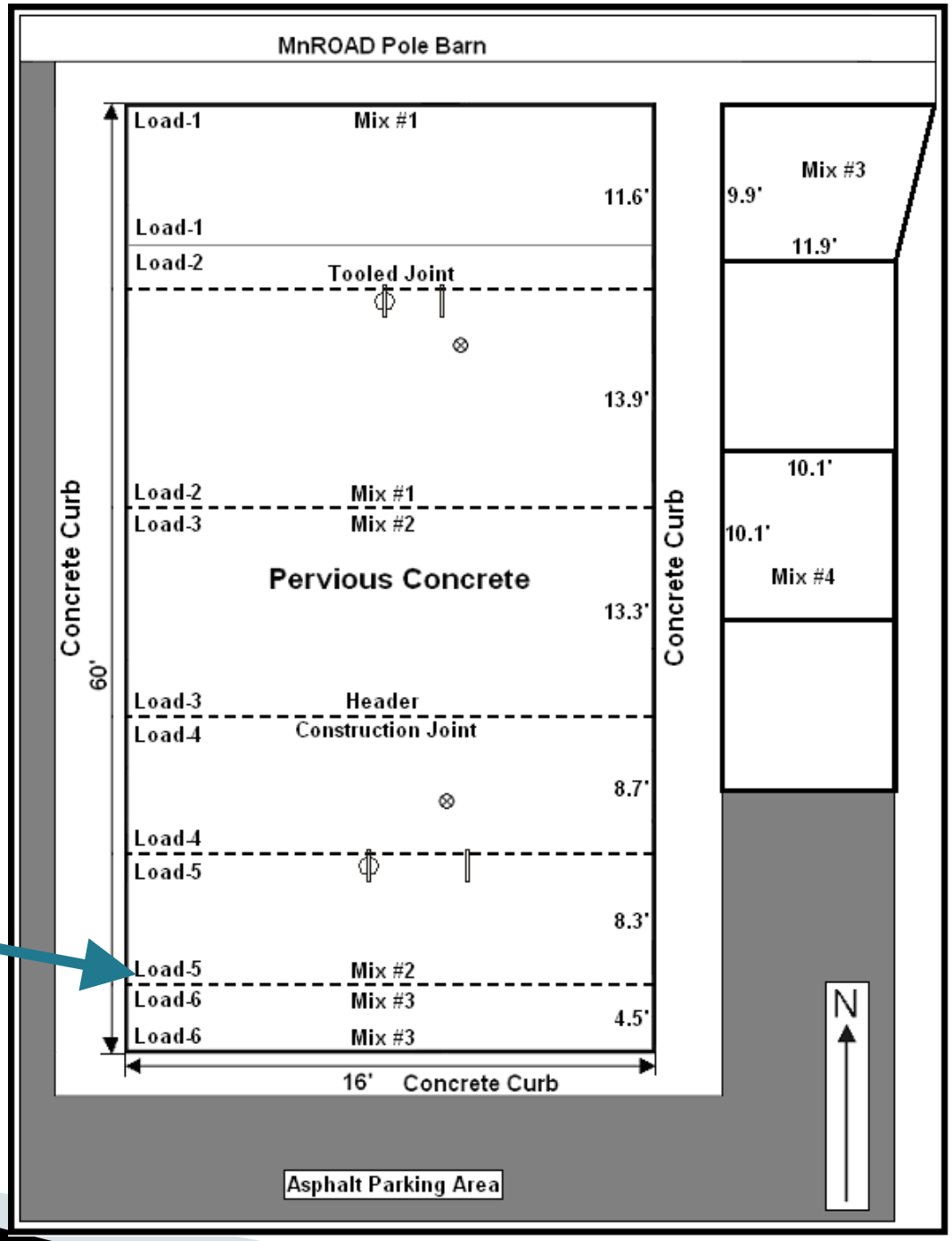
Cell 64 – Pervious Driveway



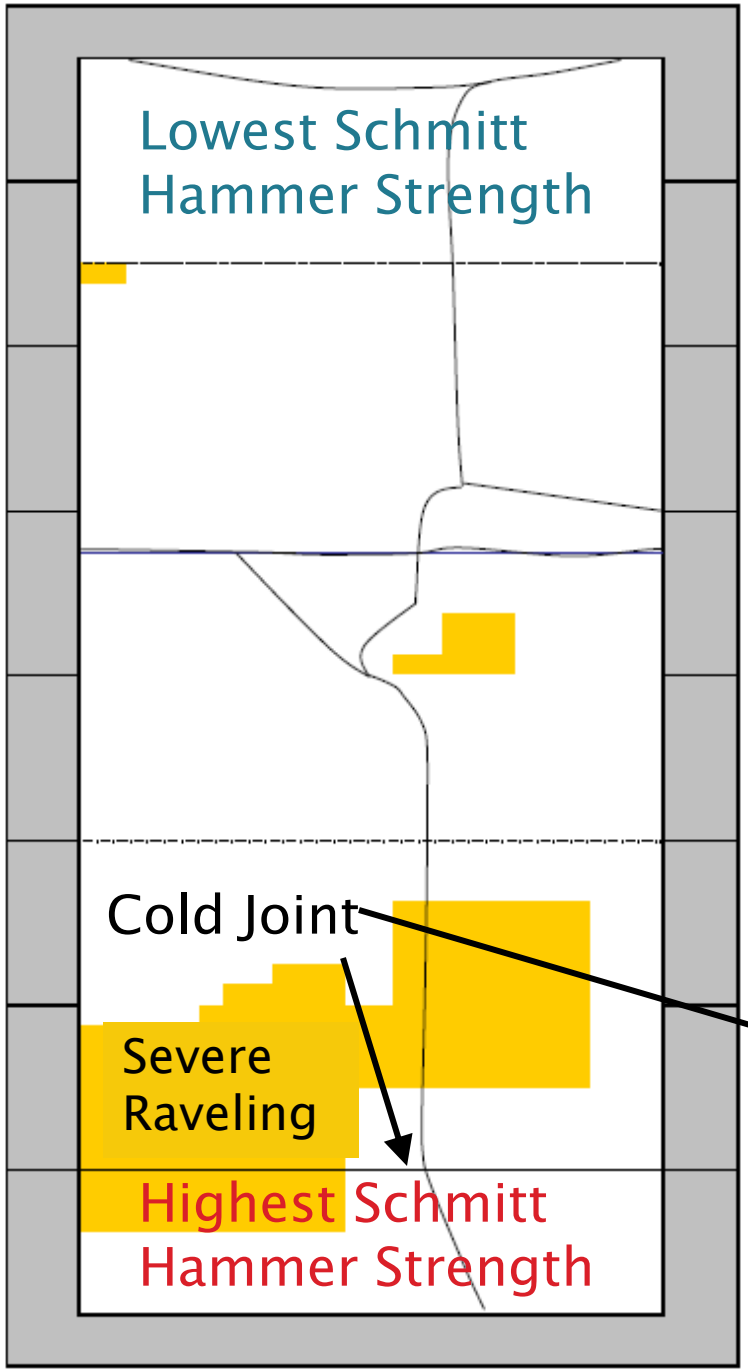


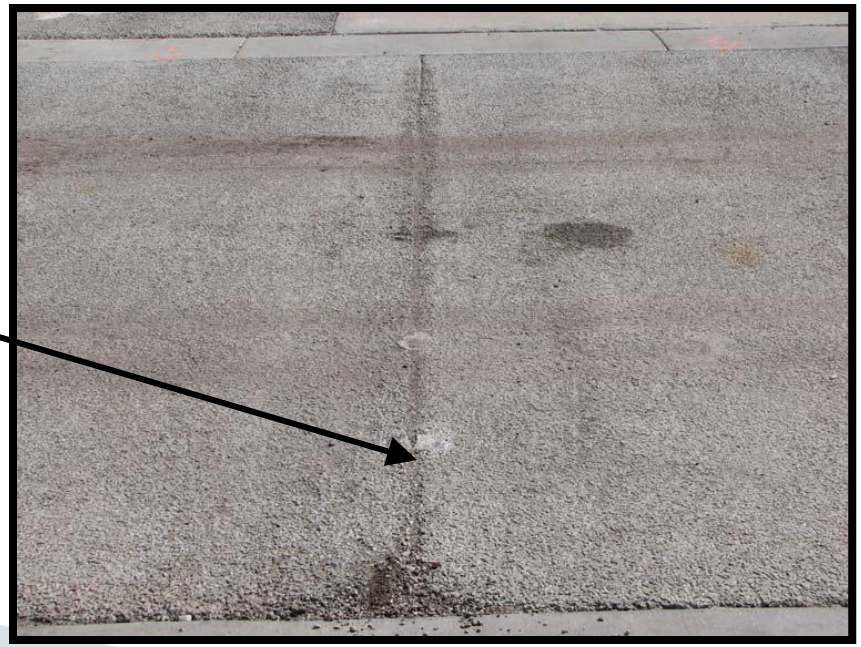
Cell 64 – General Layout

Cold Joint



Pole Barn

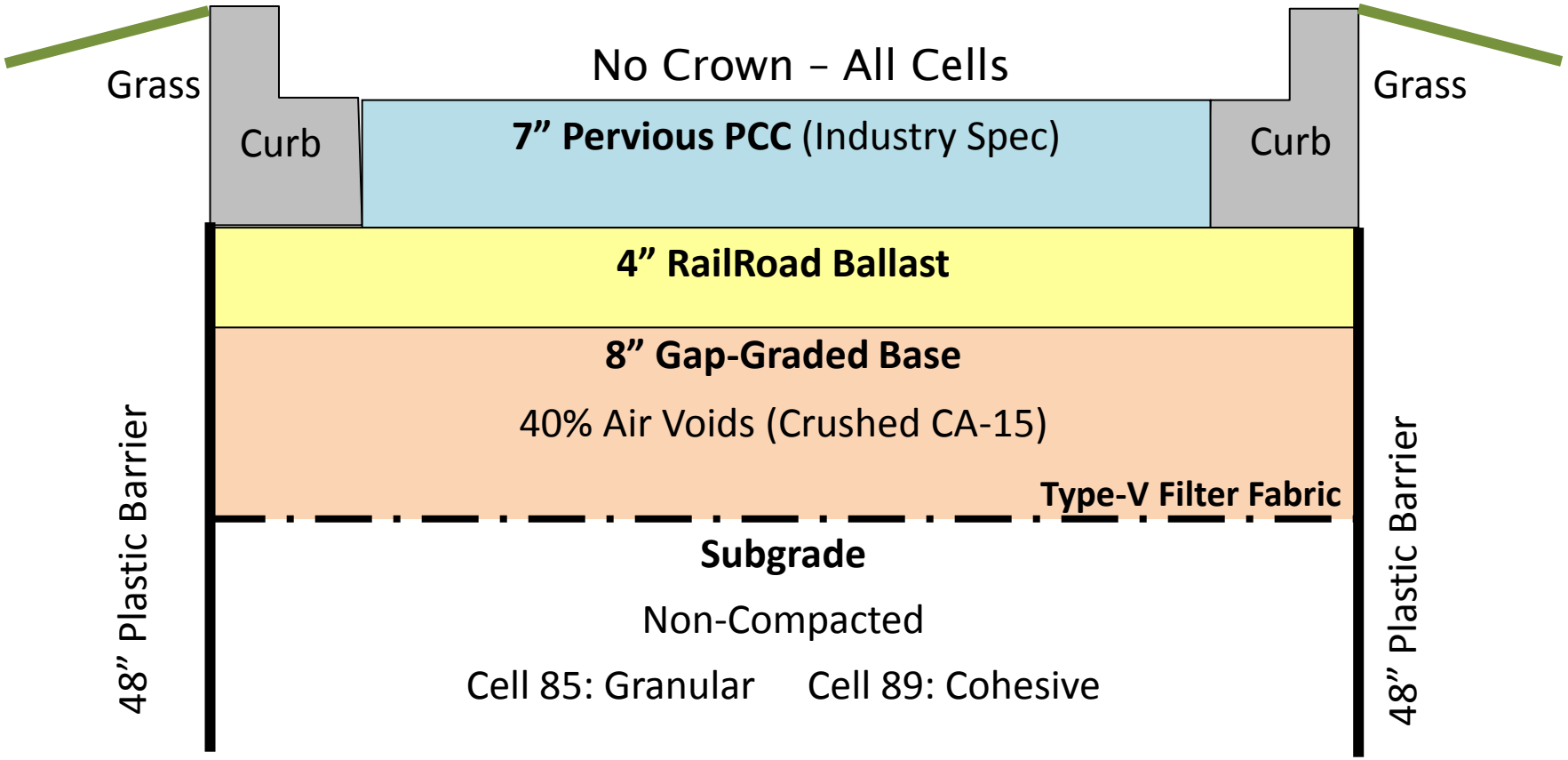

Lowest Schmitt Hammer Strength
Cold Joint
Severe Raveling
Highest Schmitt Hammer Strength



Cell 64 – Lessons Learned

- Raveling not due to low strength
- Pervious concrete in cell 64 experienced less freeze-thaw cycles than impervious pavements of similar thickness
- Increased subgrade temps in winter,
  Decreased suggrade temps in summer
- Damage due to lack of regular maintenance beginning immediately after construction is irreversible, Vacuuming cannot remediate this degree of clogging.

Cells 85 and 89 – Design



Location – Cells 85, 87 and 89

Cell 85:
Pervious PCC on Sand

Cell 86:
Pervious HMA on Sand

Cell 87:
Control

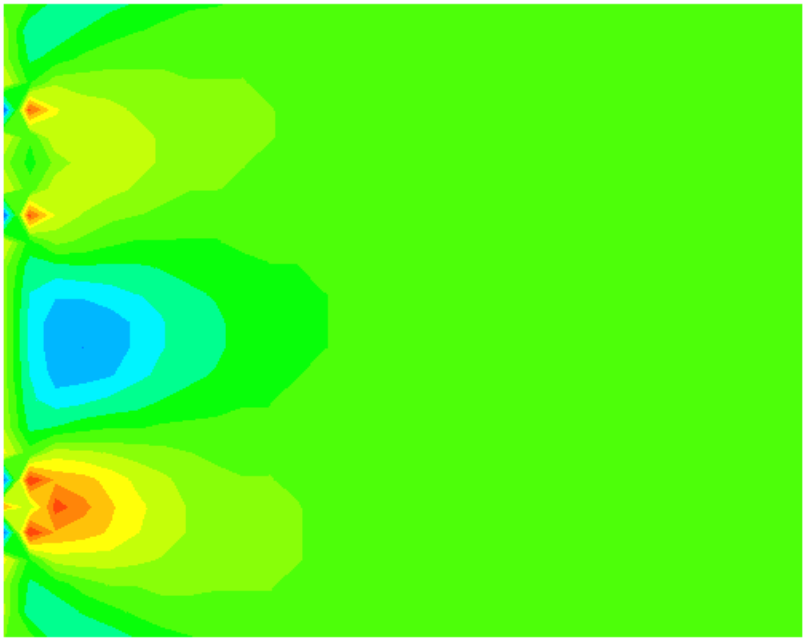
Cell 88:
Pervious HMA on Clay

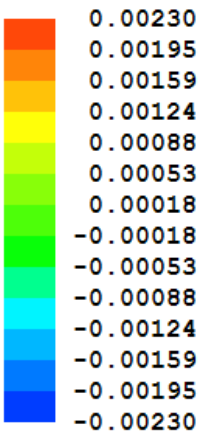
Cell 89:
Pervious PCC on Clay

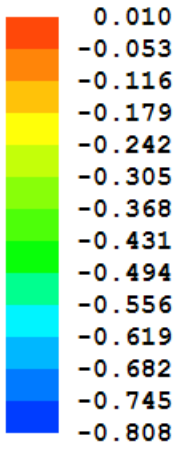
Structural Design –MEPDG

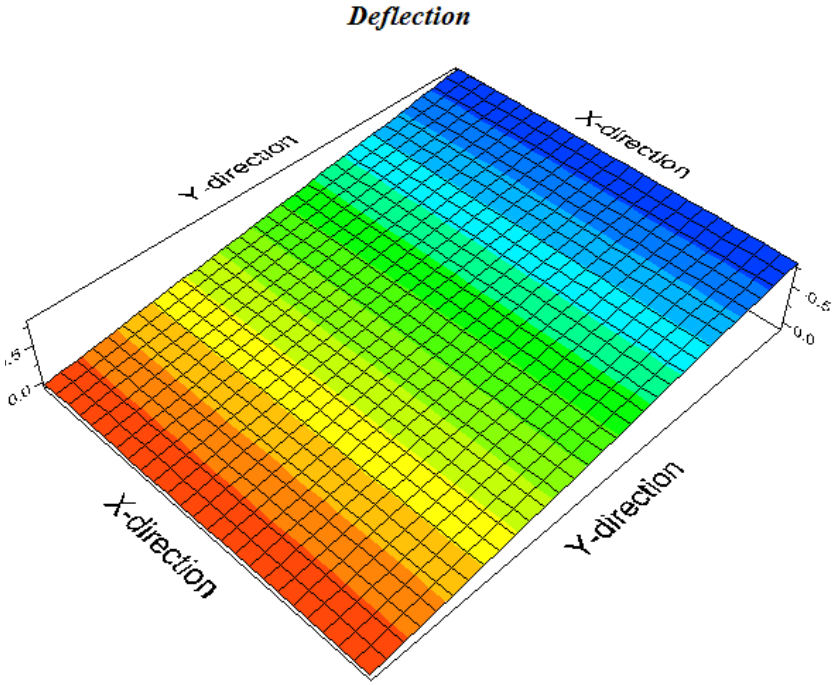
Project: MnROAD Pervious Reliability Summary					
Performance Criteria	Distress Target	Reliability Target	Distress Predicted	Reliability Predicted	Acceptable
Terminal IRI (in/mi)	130	90	70.9	99.34	Pass
Transverse Cracking (% slabs cracked)	15	90	0	99.999	Pass
Mean Joint Faulting (in)	0.12	90	0.008	99.999	Pass

Structural Design – ISlab









Component	Specified Range per yd3 Concrete	Note
Cement ASTM C150 Type I	500 – 600 lb	From a source recently tested for Blaine fineness, SO_3, etc.
Fly Ash ASTM C618 Type F	90 –120 lb	Coal Creek / Similar Type F source
Coarse Aggregate	2300-2500 lb	Mn/DOT 3137
Fine Aggregate	0**	Initially 0% allowed, but 6% was used in final mix
Water Cement ratio	0.4	
Water content	250 –305 lb	Adjust with absorption to SSD
Mid range Water Reducing Admixture	4 oz	
Viscosity Modifier	Manufacturer's spec	Mn/DOT Approved List
Air Entraining Agent	4 oz	Mn/DOT Approved List
Air Content	18% - 21% Volume	

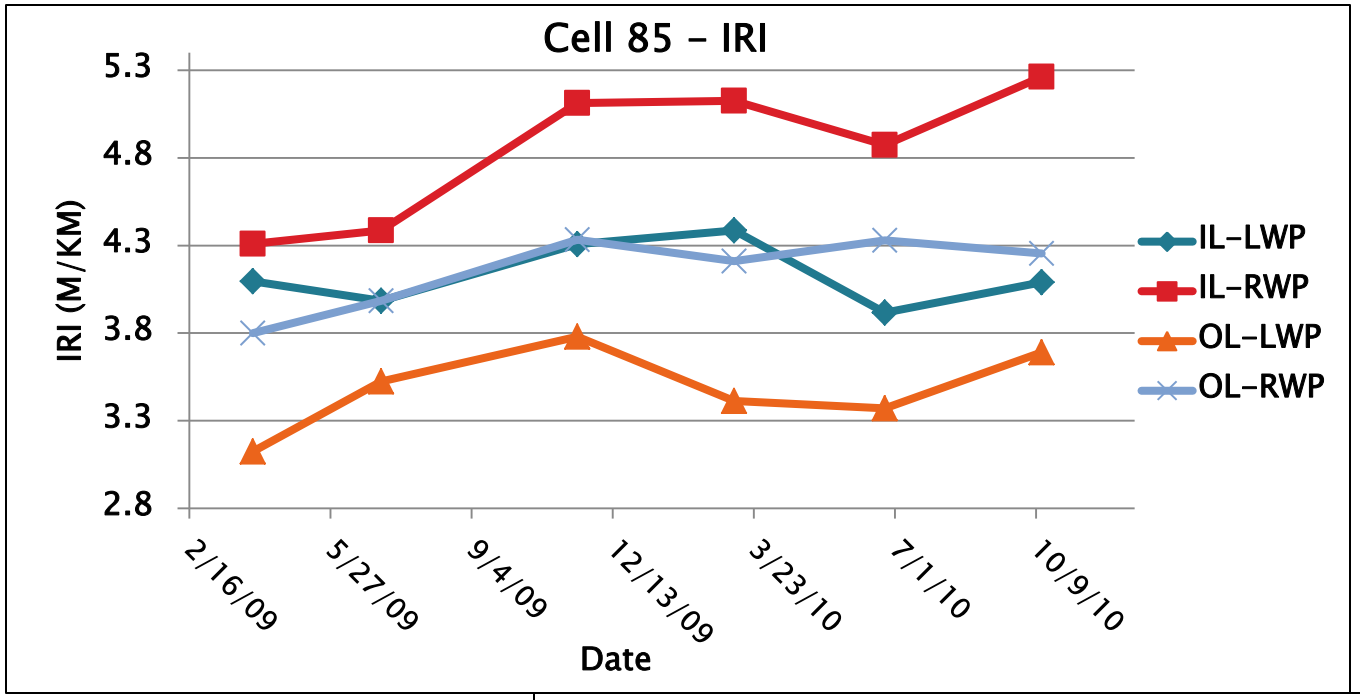
Construction

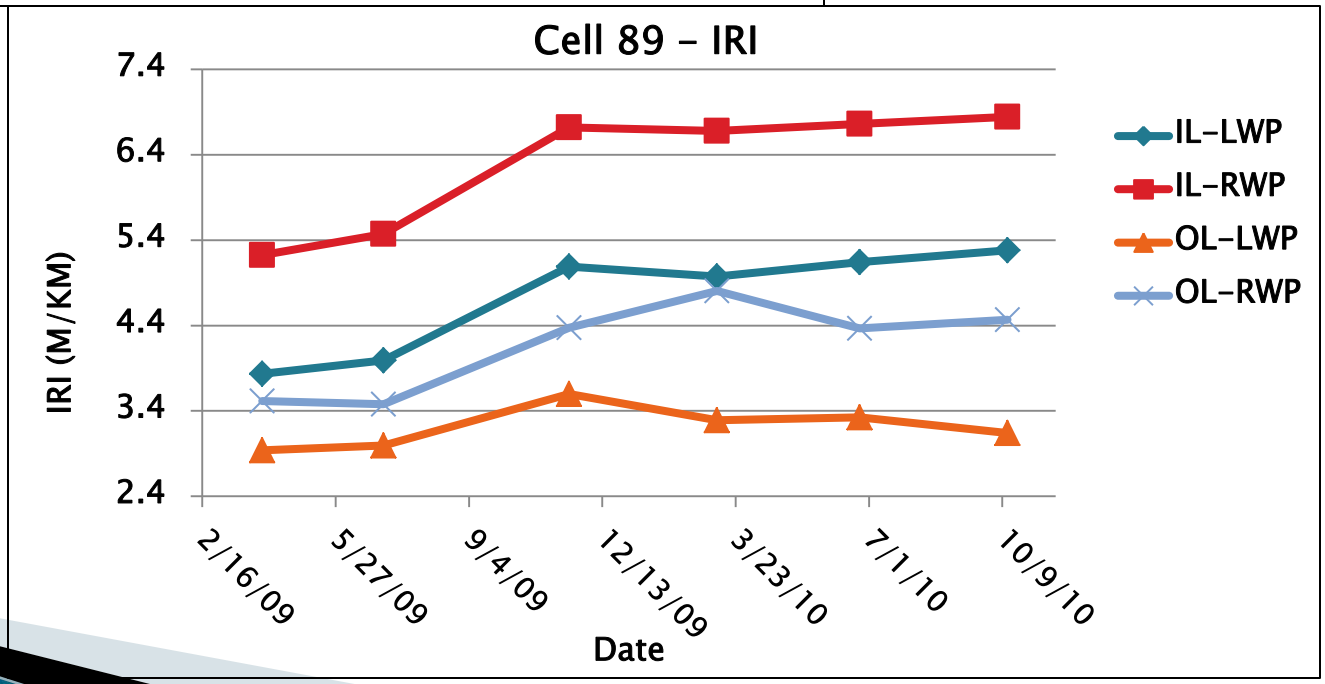
Test Program Overview

- **Ride Characteristics**
  - International Roughness Index (IRI)
  - Surface Rating (SR)
- **Surface Properties**
  - Surface Texture
  - Friction Number (FN)
- **Noise Characteristics**
  - On Board Sound Intensity (OBSI)
  - Sound Absorption (SA)
- **Physical Properties**
  - Nuclear Density
  - Dissipated Volumetric Rate
  - Clogging Characteristics
  - Pavement Surface Deflection from FWD
  - Temperature and Moisture

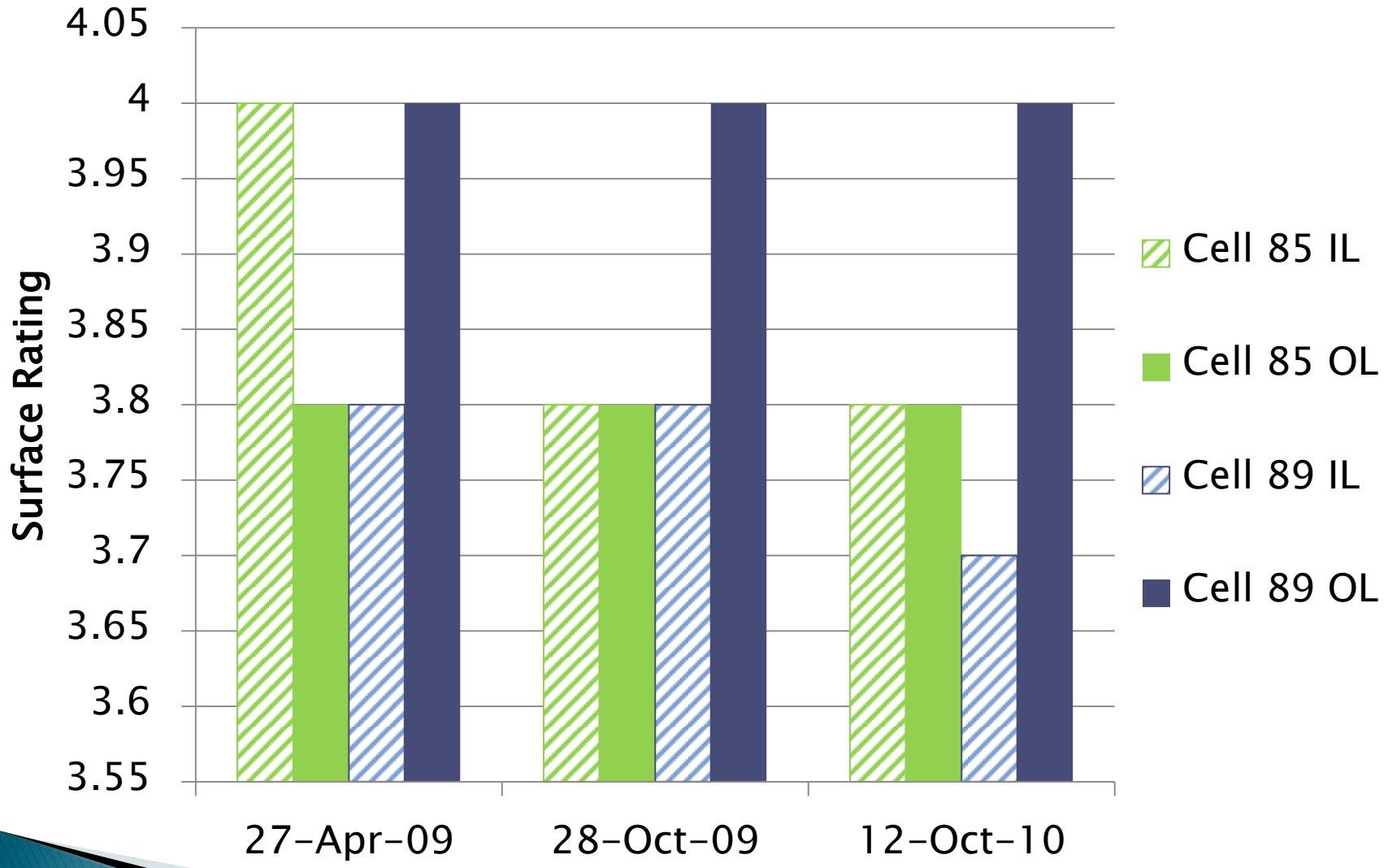
Test Equipment

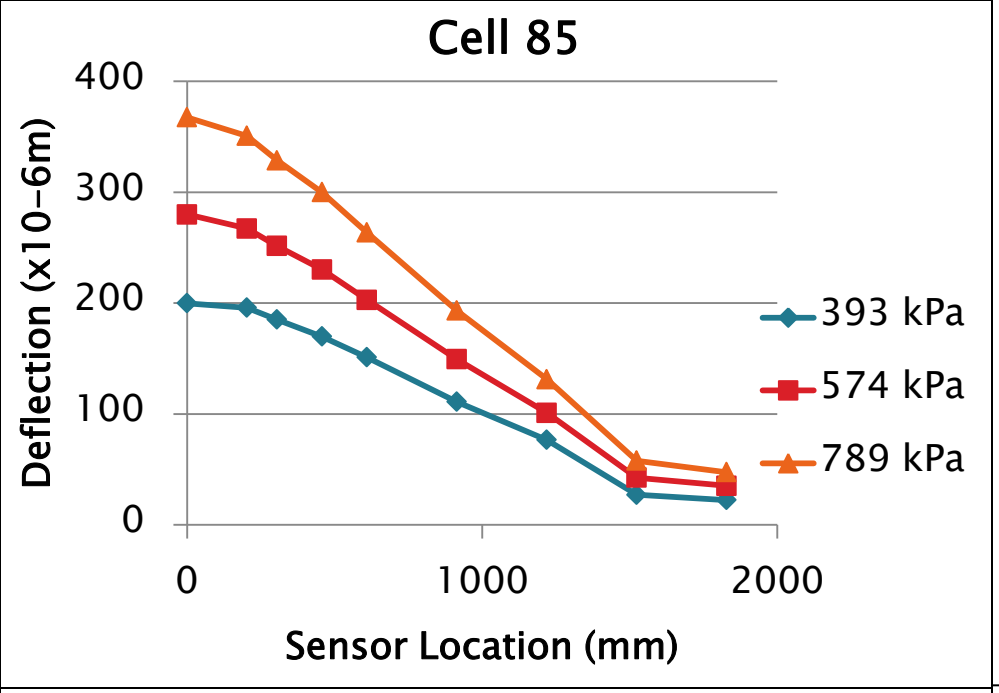
International Roughness Index





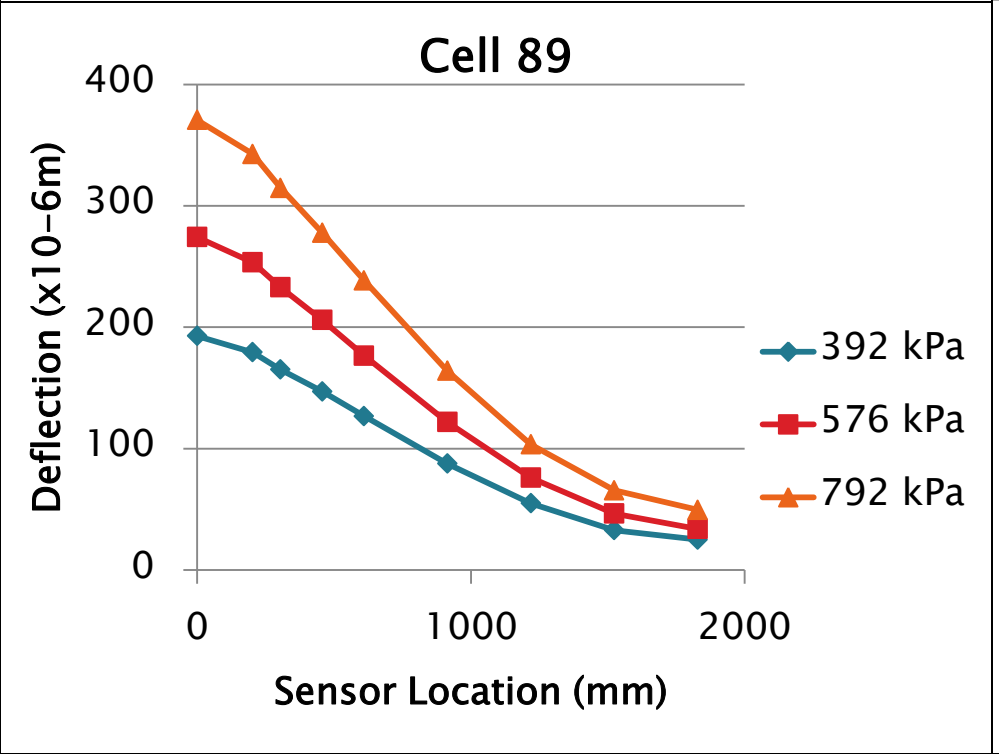
Surface Rating

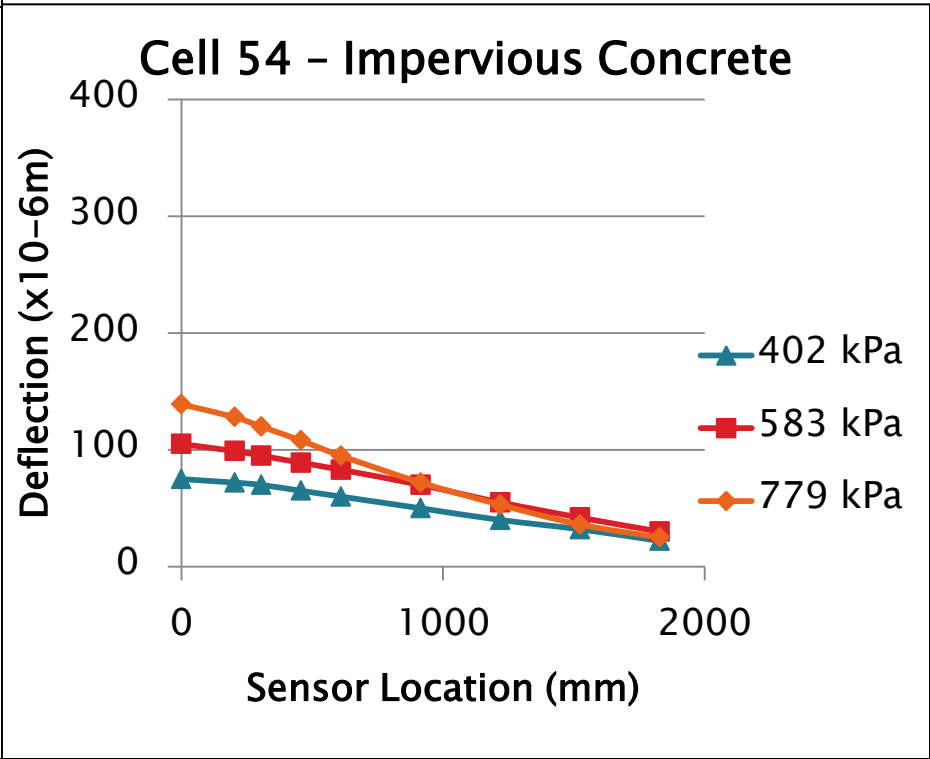




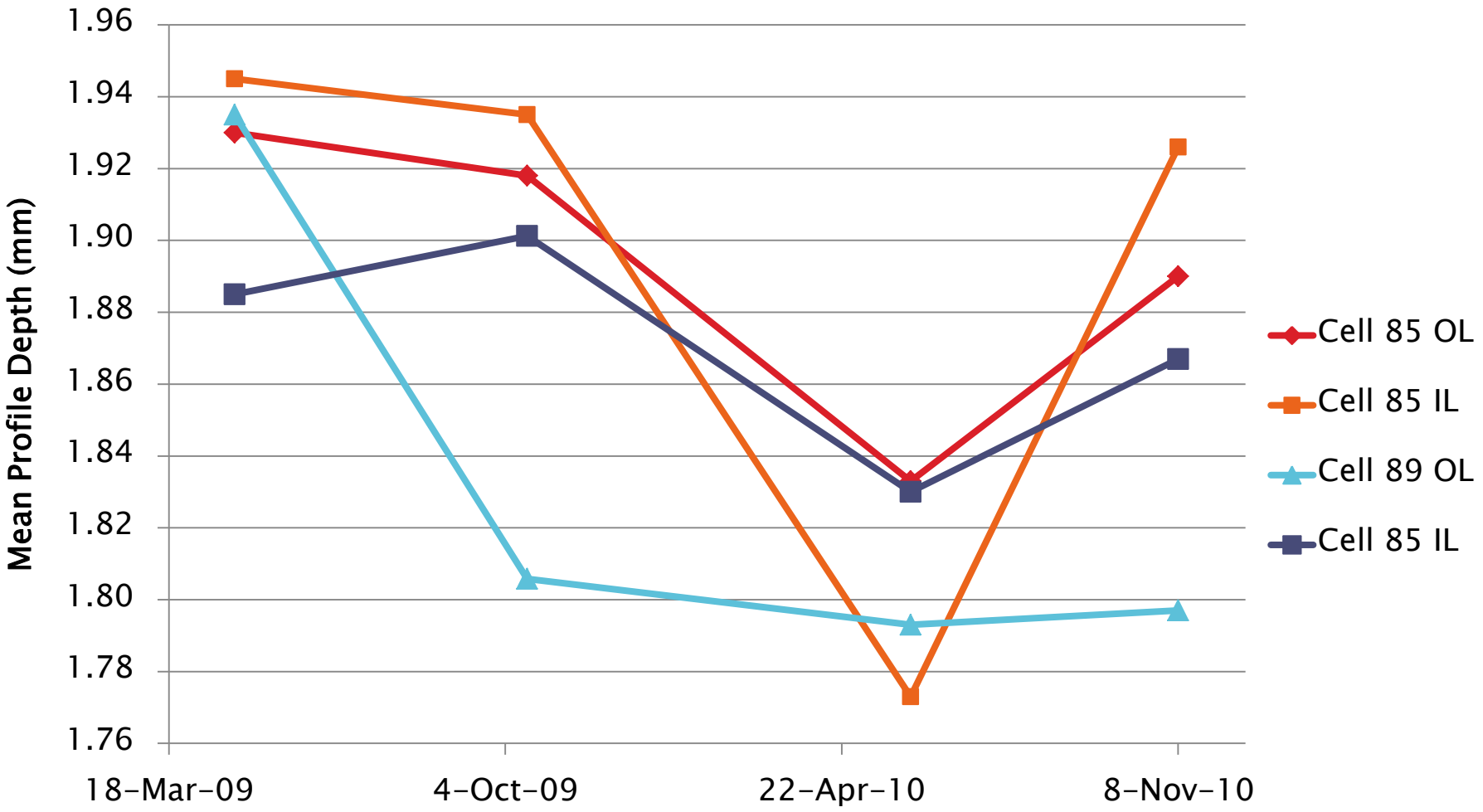
FWD

** center of slab
** outside lane
** September 20, 2010

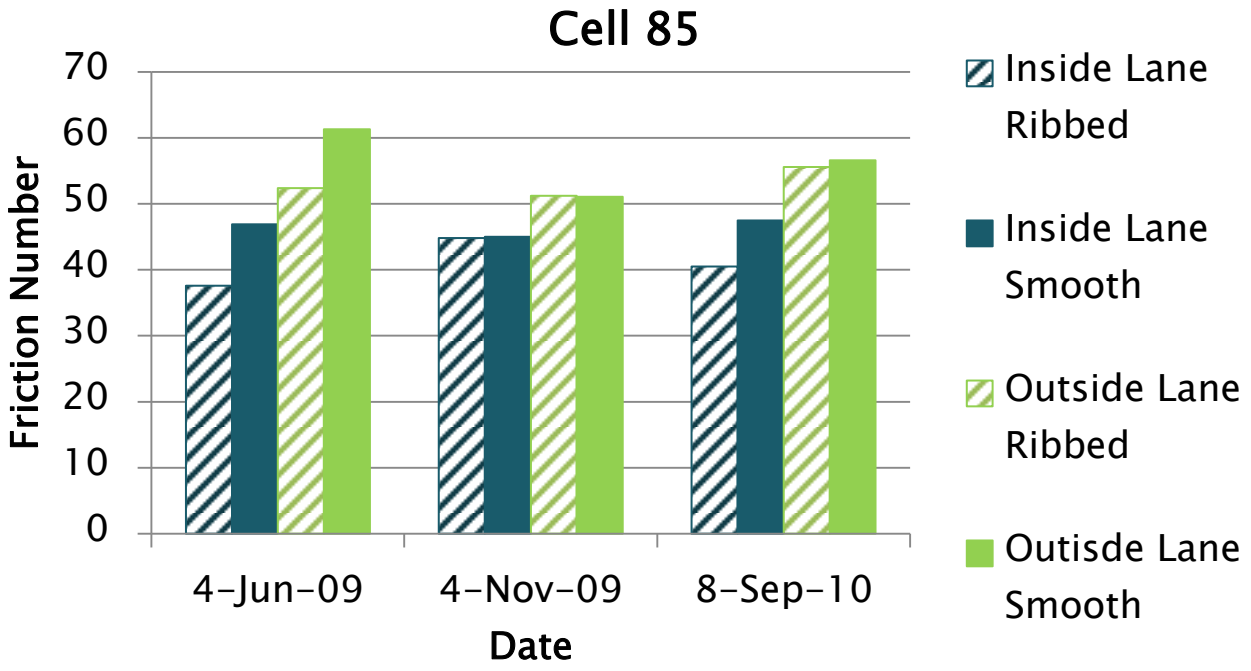


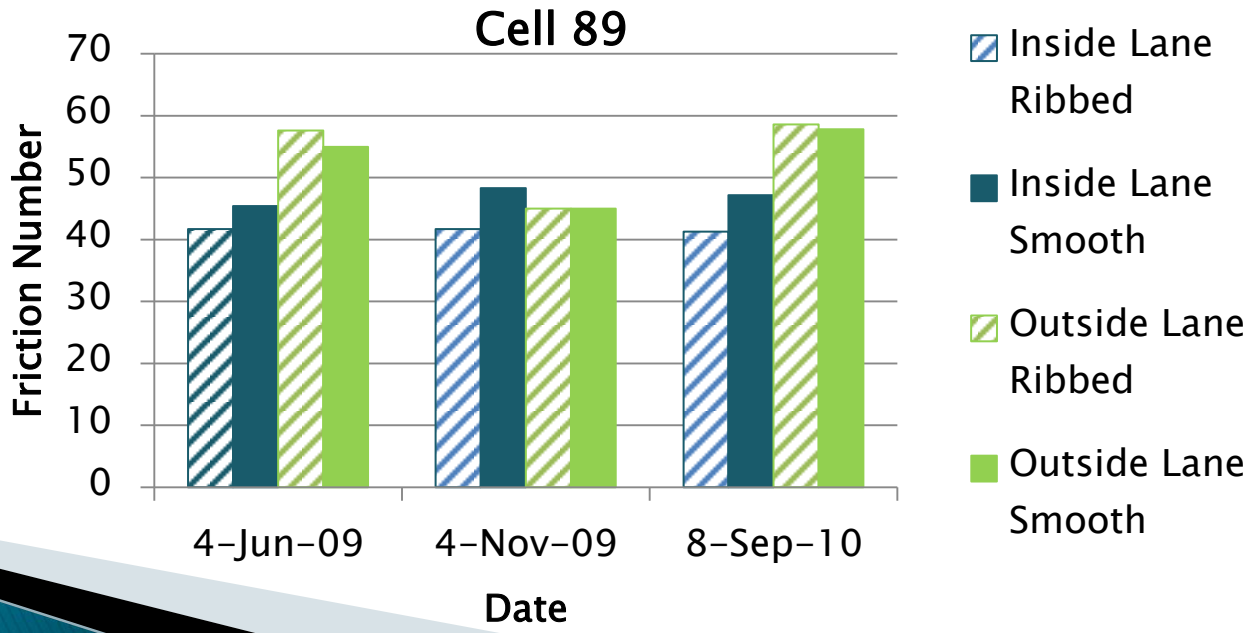


Mean Profile Depth with CTM

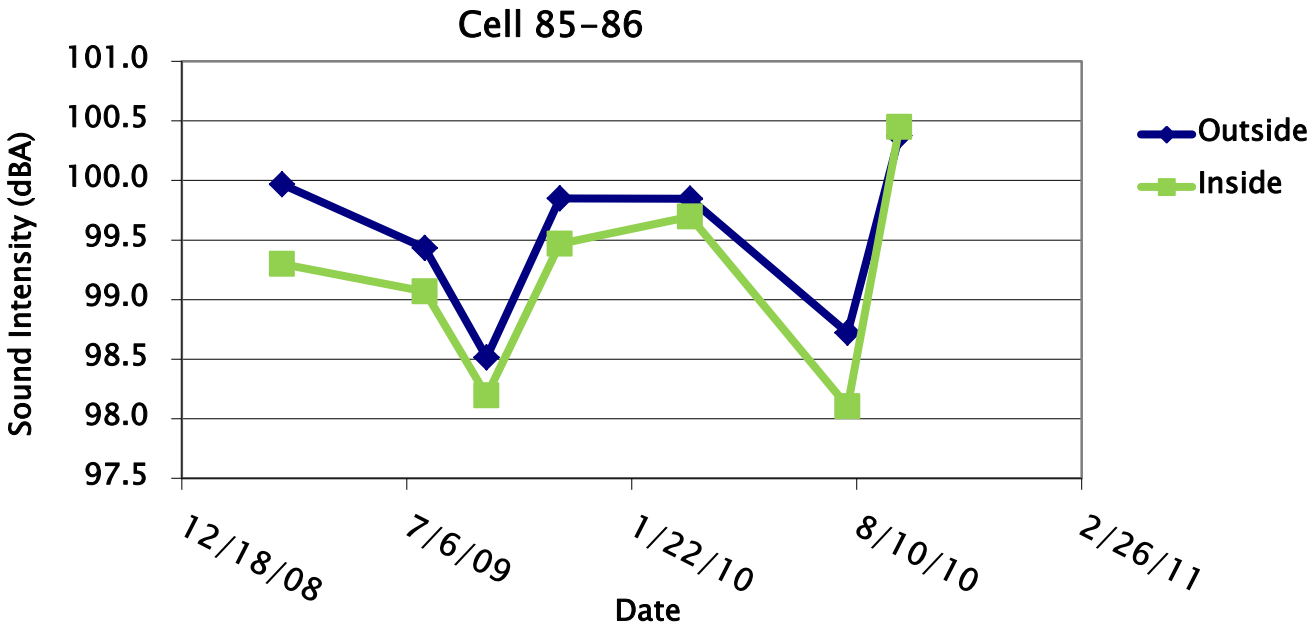


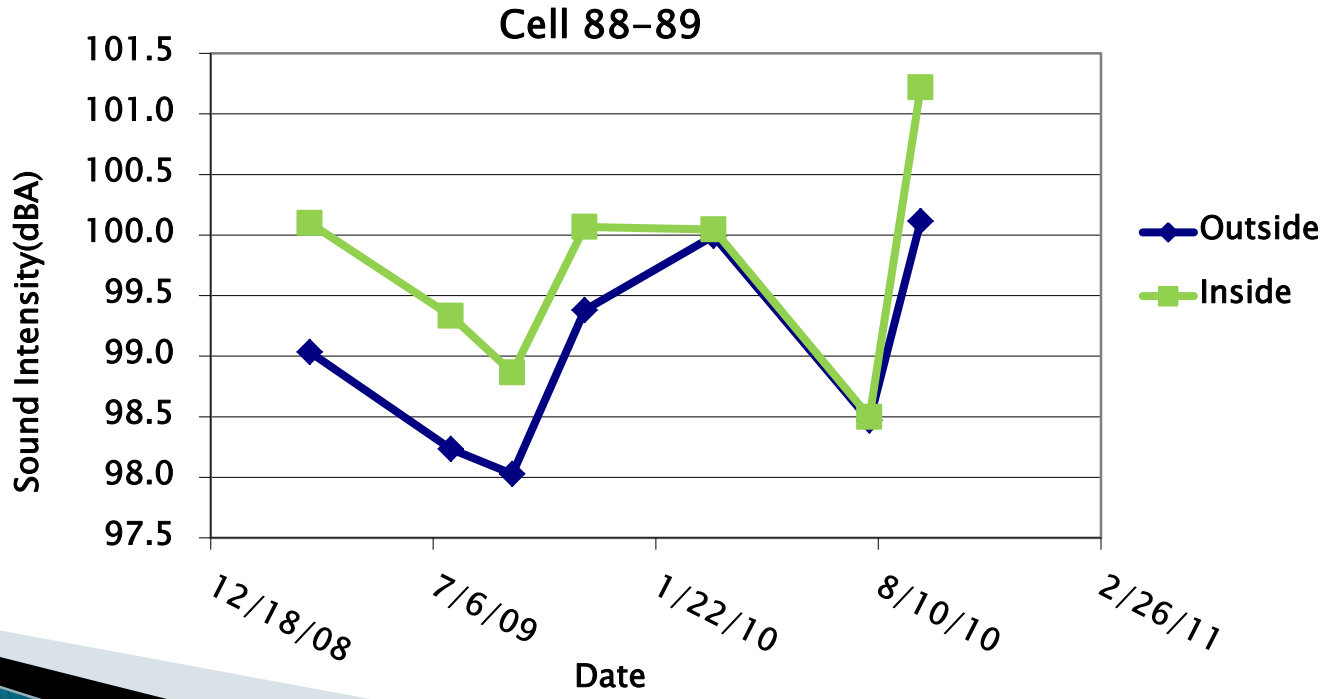
Friction Number (FN)



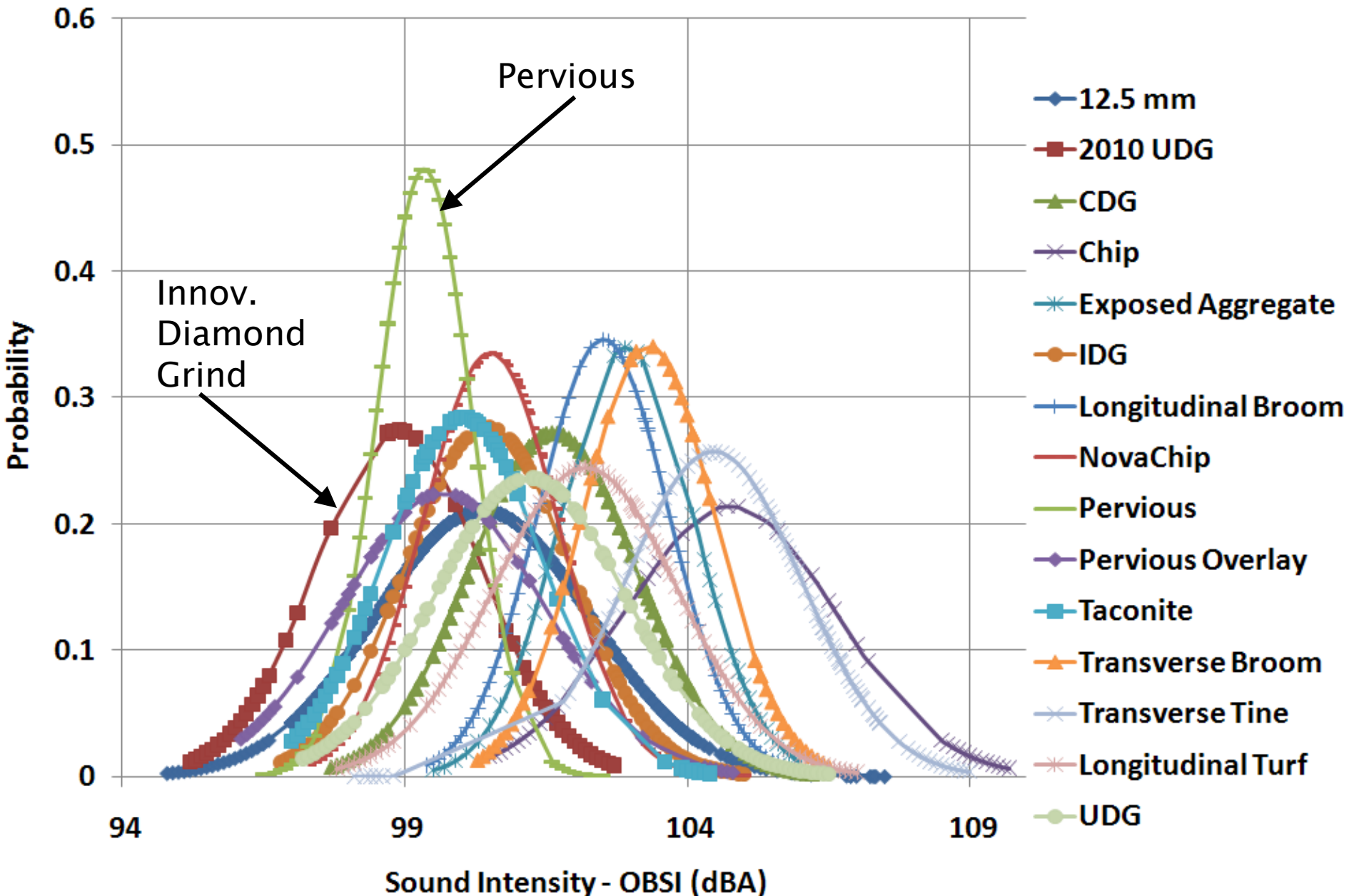


On Board Sound Intensity (OBSI)

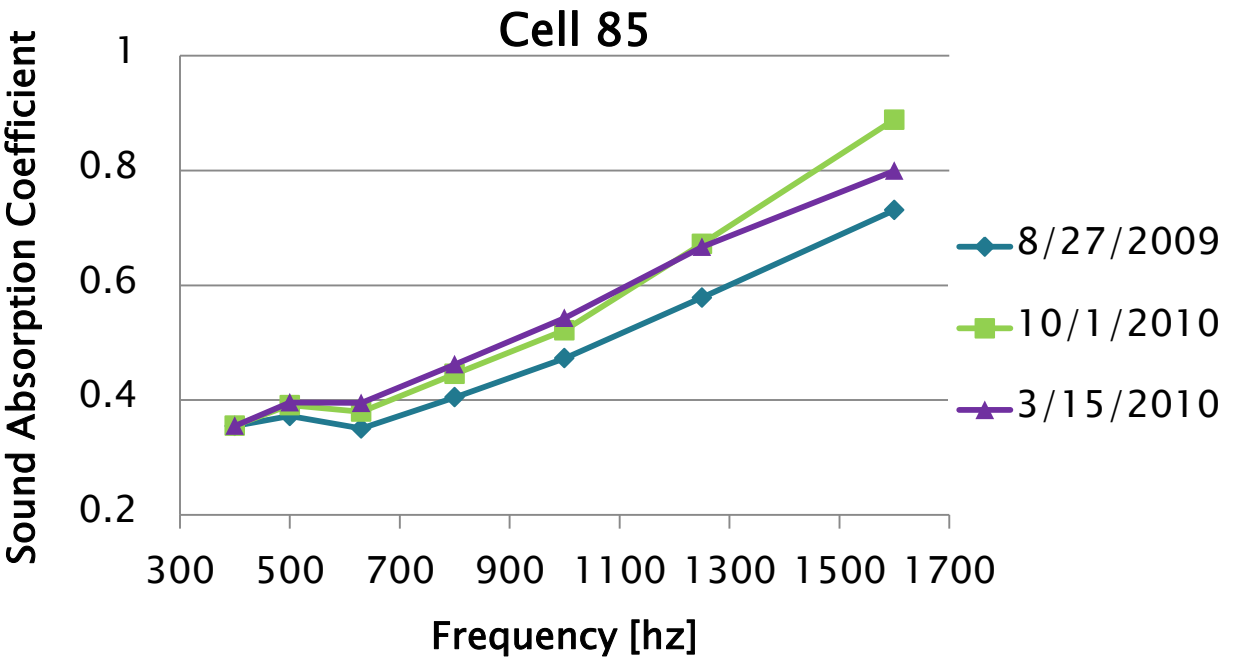


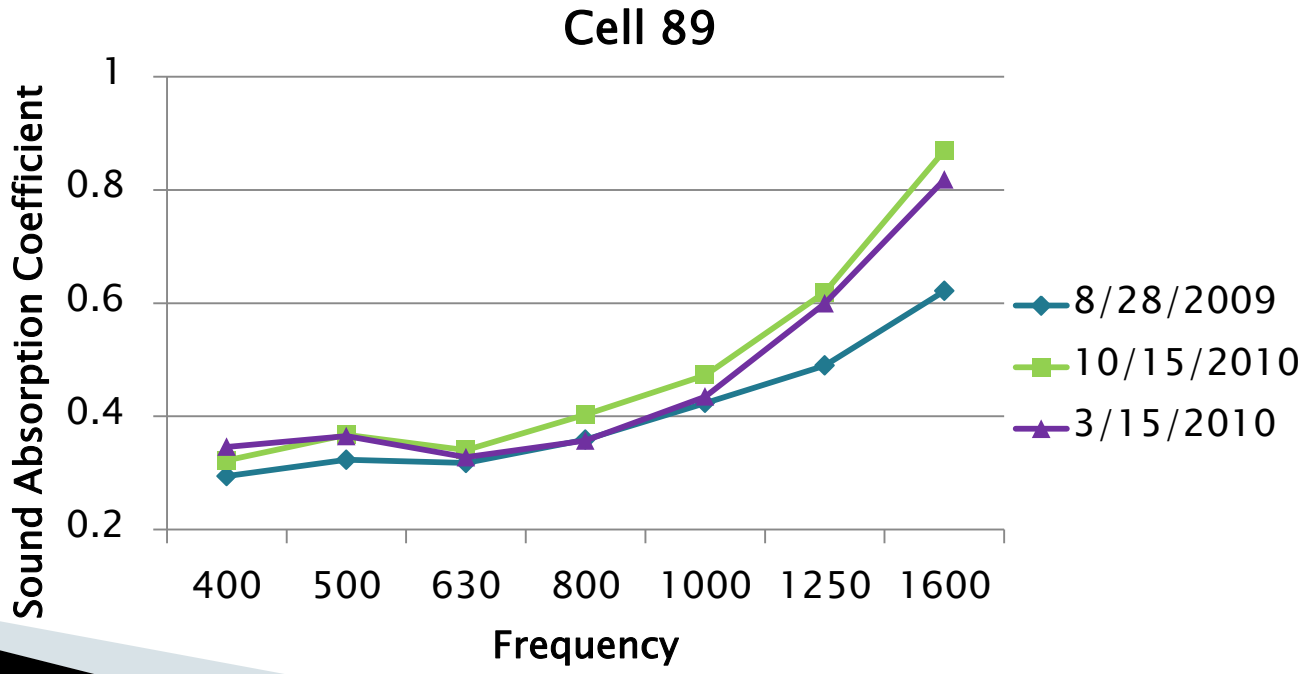


OBSI Probability Density Function

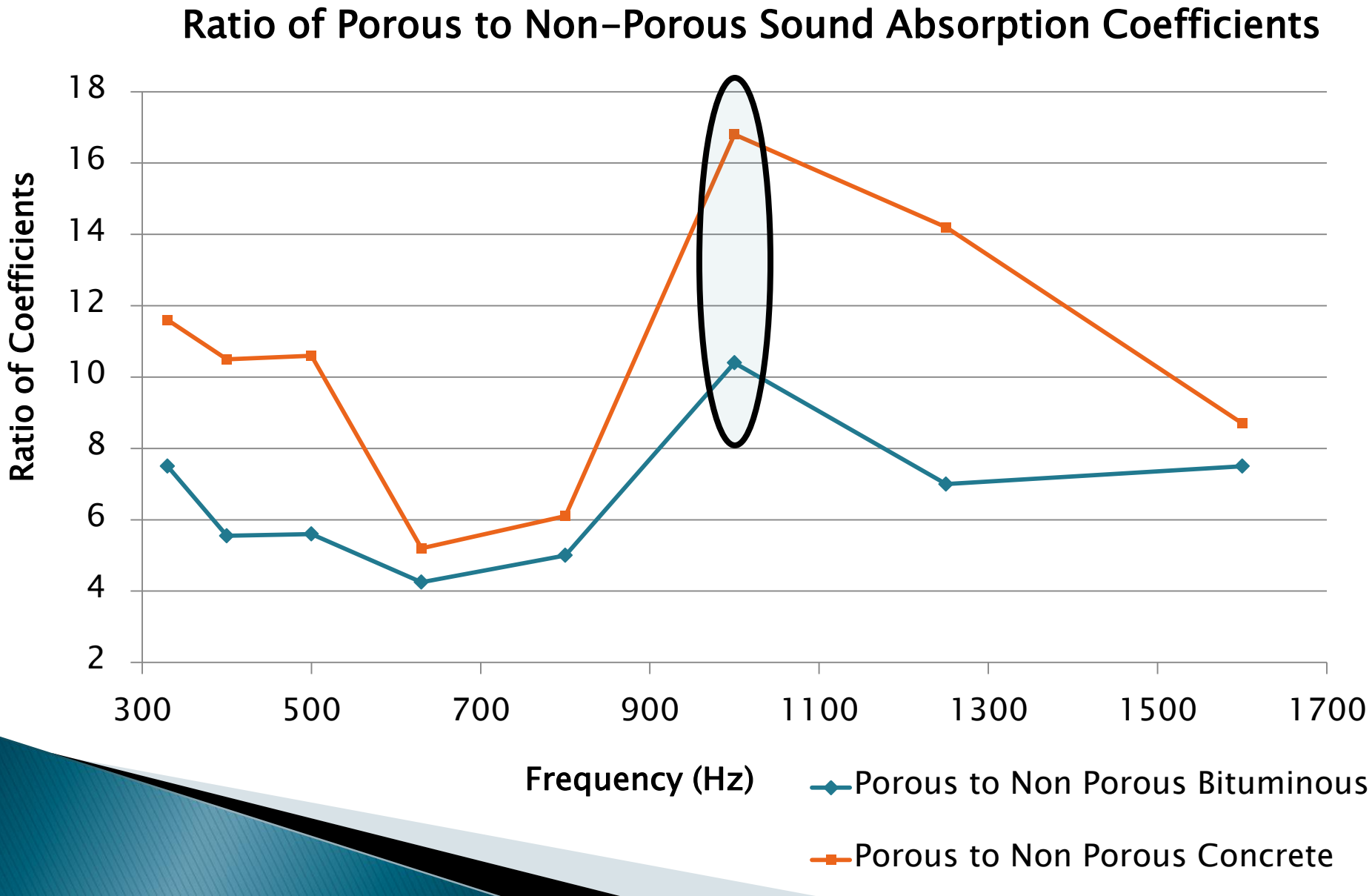


Sound Absorption

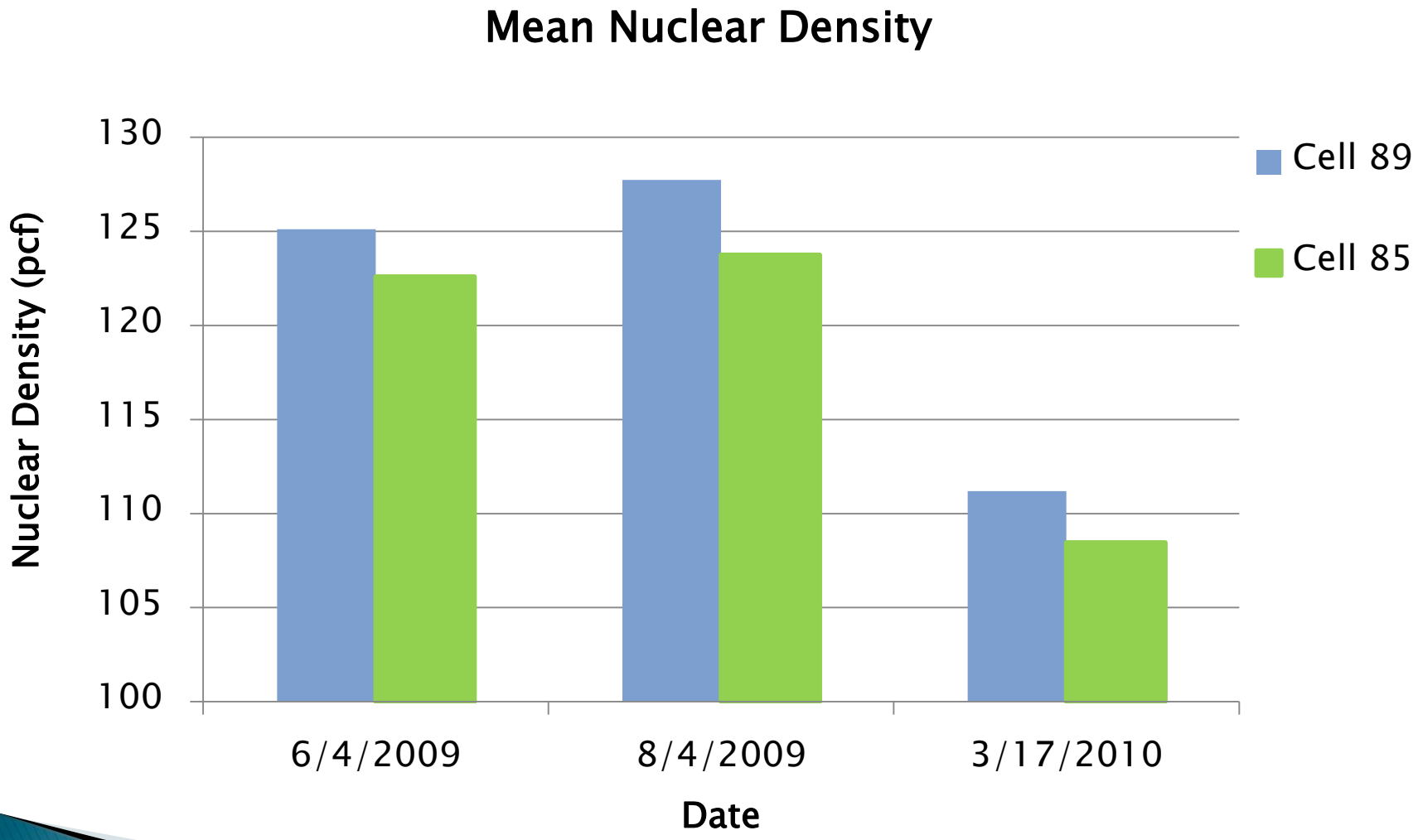




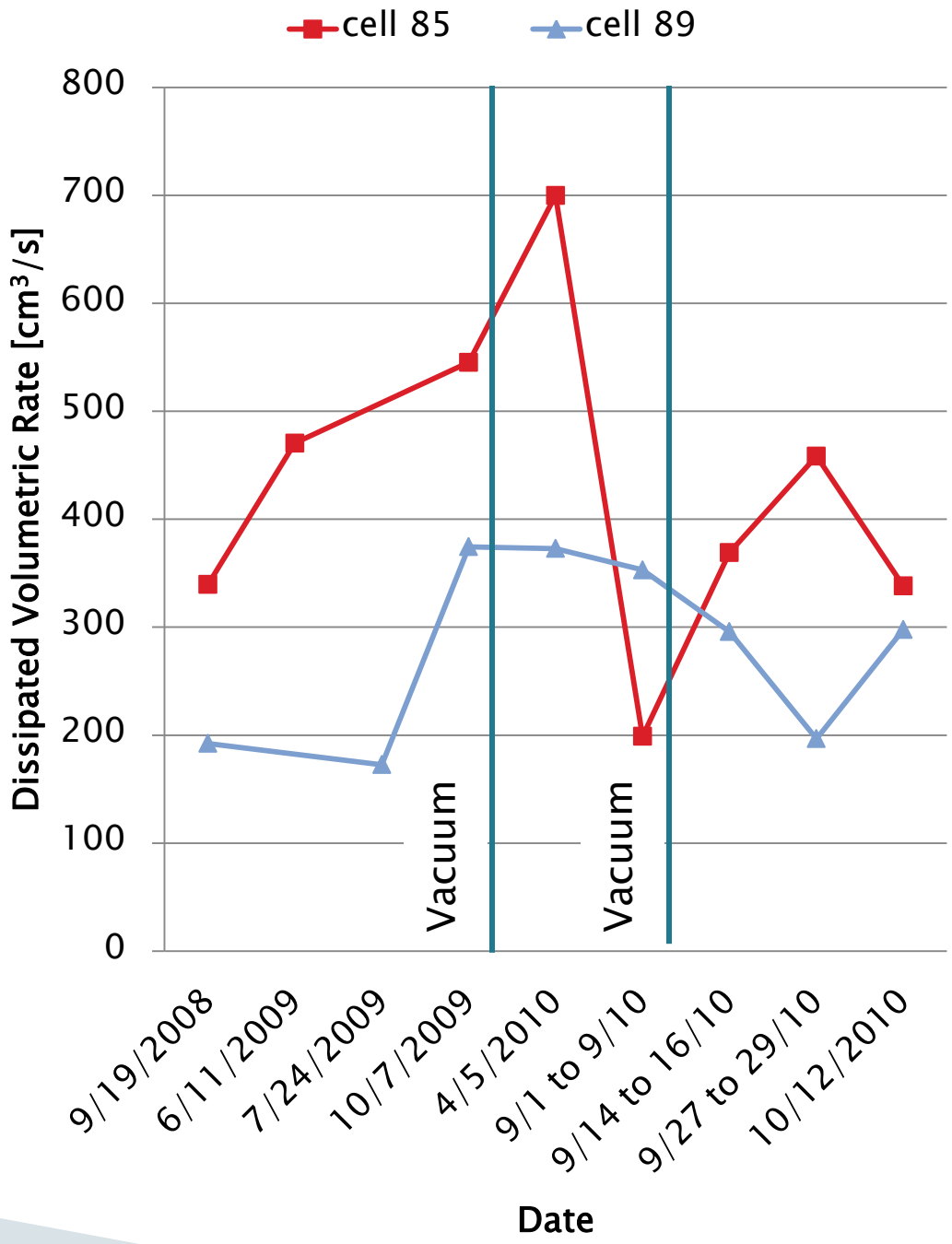
Sound Absorption Improvement



Nuclear Density

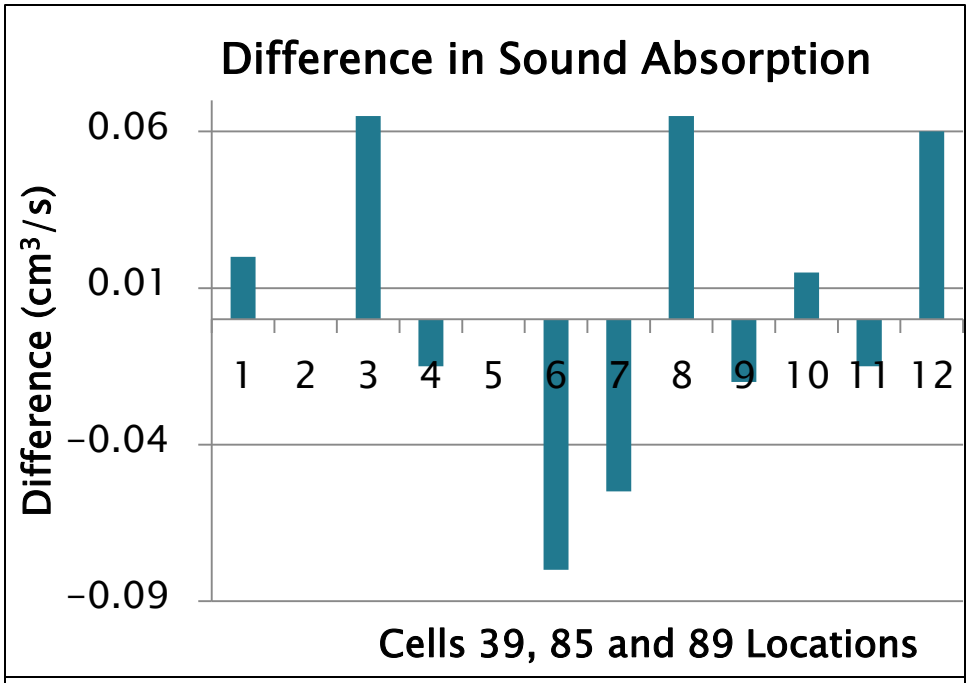


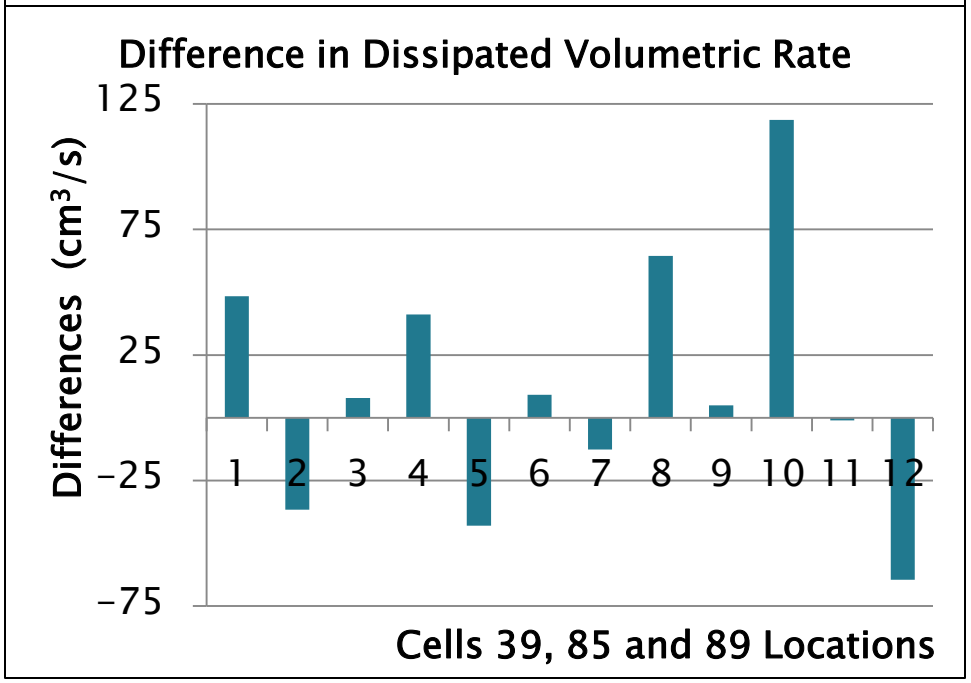
Permeability
(Dissipated Volumetric Rate)



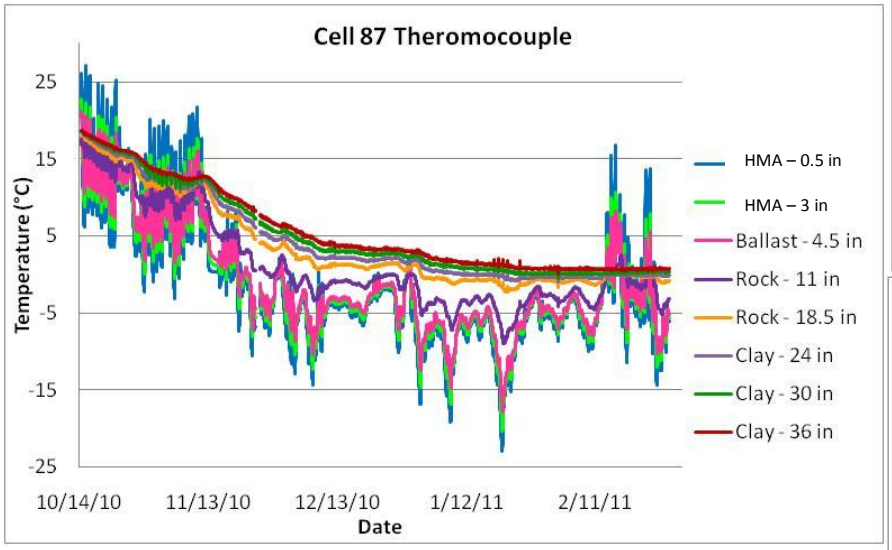
Clogging

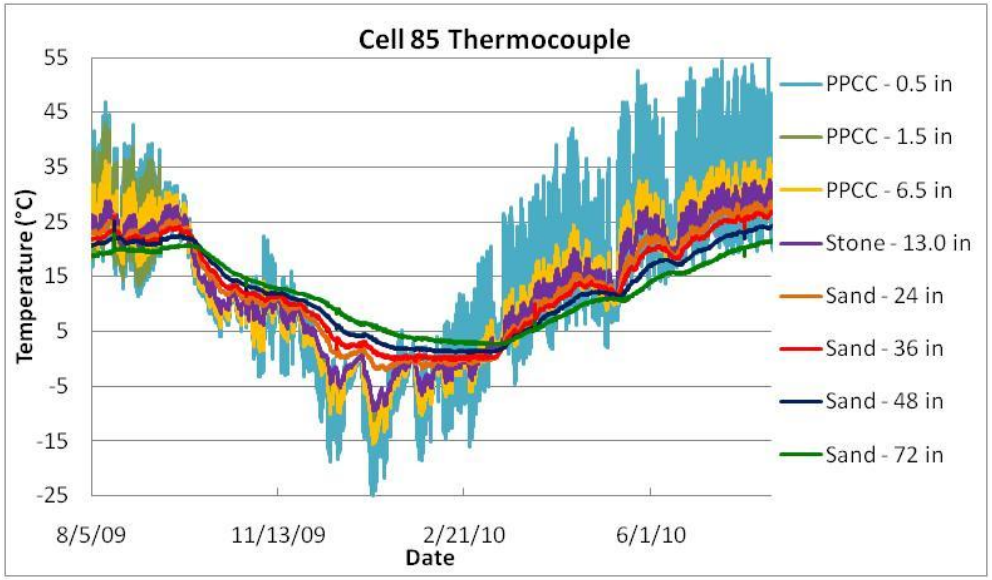

Reliakor
USDOT 1038469
200

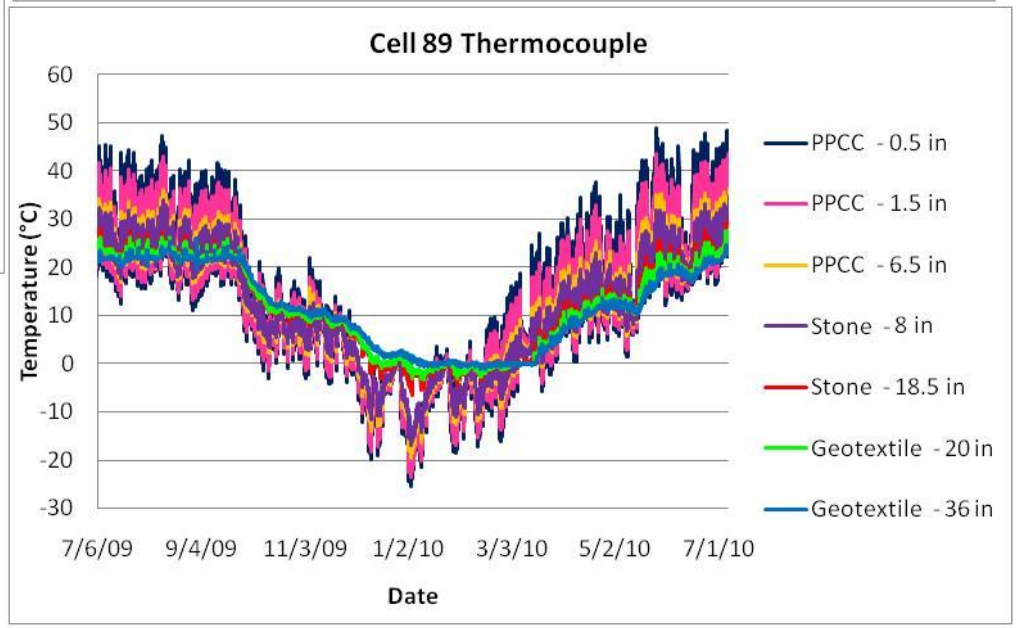

Difference in Sound Absorption
Difference (cm³/s)
0.06
0.01
-0.04
-0.09
1 2 3 4 5 6 7 8 9 10 11 12
Cells 39, 85 and 89 Locations


Difference in Dissipated Volumetric Rate
Differences (cm³/s)
125
75
25
-25
-75
1 2 3 4 5 6 7 8 9 10 11 12
Cells 39, 85 and 89 Locations

Temperature Gradient







Surface Distress

- Cell 89
  - 5 year design life for clay base
- After 3 years
  - Inside lane
  - Longitudinal crack
  - Both wheel paths

Conclusions

- Higher deflection in FWD over 2 years than typical PCC.
- **Reduced amount of freeze thaw cycles.**
- Vacuuming more than two times a year recommended
- Begin **regular maintenance** immediately after construction to avoid irreversible clogging.
- Unclogging **maintenance lessens chances for freeze-thaw** damage, reducing raveling
- Flow rate was higher with **granular base** than clay base

Conclusions

- **Slip form paving may improve ride**
- Can't predict OBSI from SA: Pervious concrete reduces noise by air compression relief (not by absorption)
- Sound absorption is related to the porosity
- **Improved sound absorption** compared to typical PCC pavement
- Improvement of SA dependant on the sound frequency

  (**1000 Hz best**)
- Second **quietest** pavement at MnROAD.