Performance of Thin Jointed Concrete Pavements Subjected to Accelerated Traffic Loading

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Why Thin PCC?

- Economics
  - Less money in budgets
  - Thicker PCC pavements far exceeded design lives
  - Quicker to construct

- Sustainability
  - Optimize material usage
  - Less energy use during construction

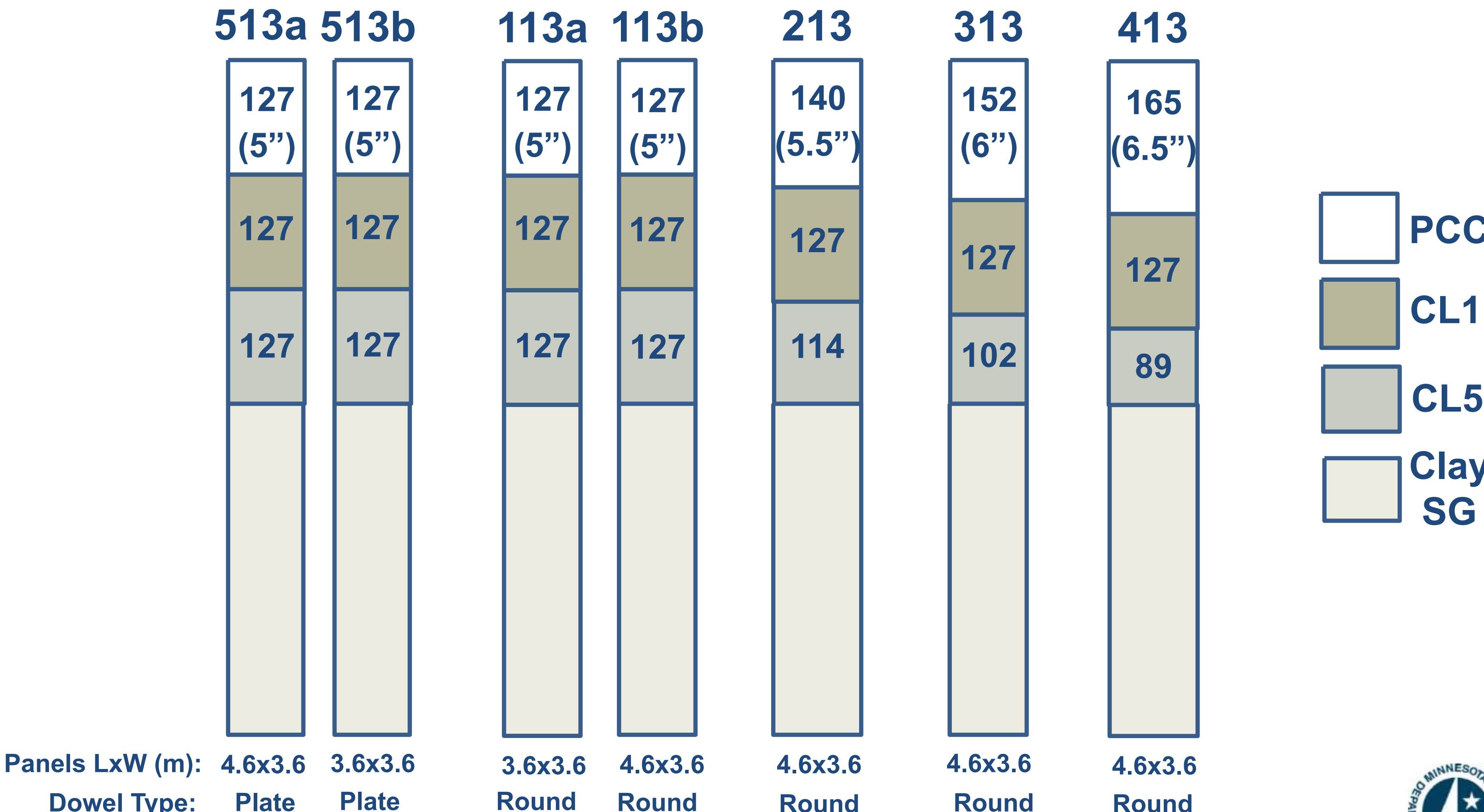
"How Thin Can You Go?"

- Structural Capacity
  - Flexural strength
  - Joint load transfer
  - Fatigue loading
  - Ultimate loading

- Environmental response
  - Warp and curl
  - Uniform slab support

MnROAD

Cells 113-513



MnROAD

Cells 113-513

Cell	Average slab thickness in driving lane outer wheelpath, mm	Average slab thickness at centerline, mm	Average slab thickness in passing lane outer wheelpath, mm	Overall average slab thickness, mm	Design slab thickness, mm	Difference between as-built and design thickness, mm
513	156	144	150	149	127	+22
113	145	132	151	143	127	+16
213	156	143	158	151	140	+11
313	158	157	159	158	152	+6
413	164	159	165	163	165	-2

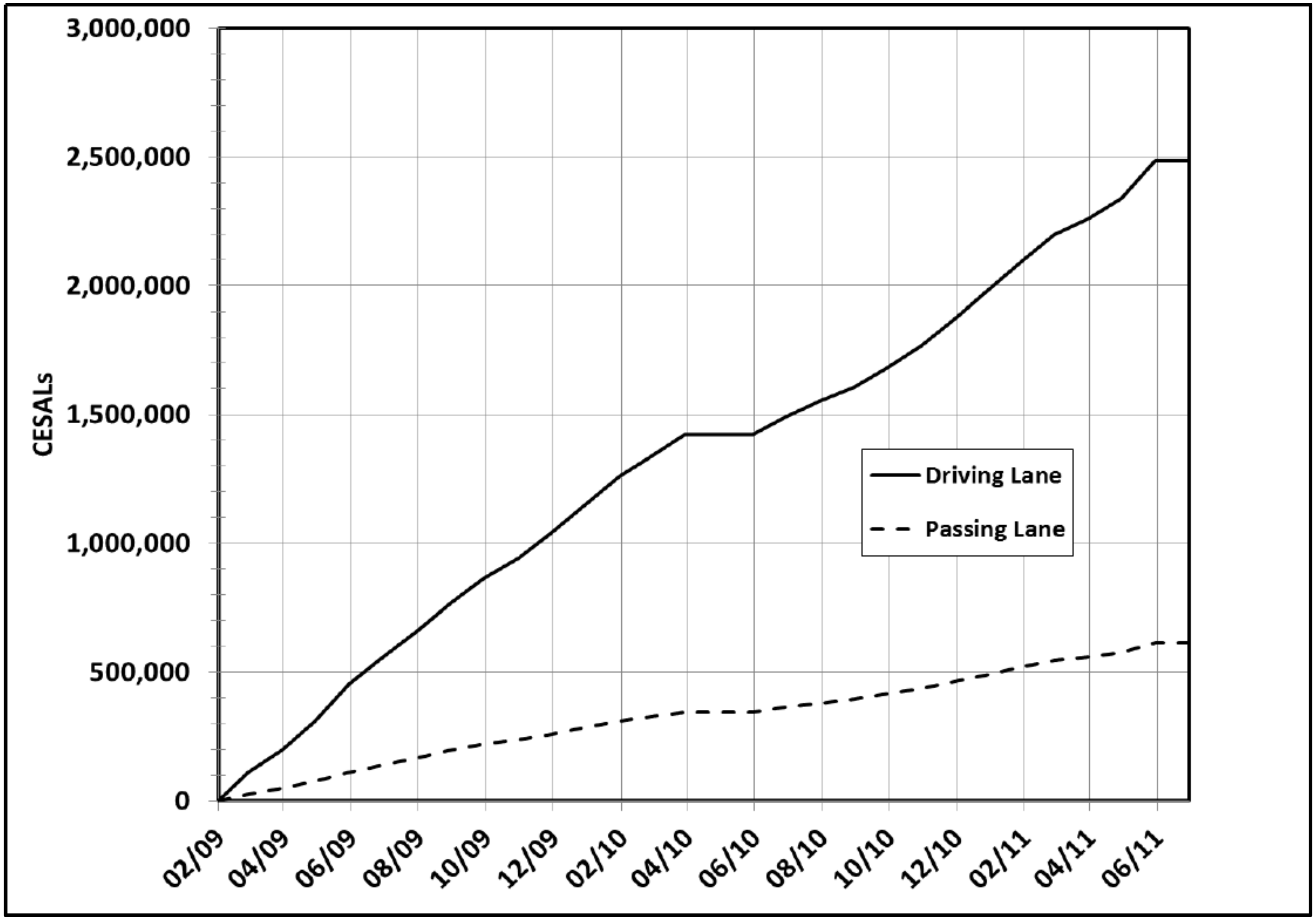
Joint Load Transfer Devices

- Standard 25 mm (1”) dia. x 381 mm (15”) long epoxy coated steel dowels for Cells 113-413
  - ACI 302.1R-04 recommends against 25mm dowels in slabs < 178 mm (7”) thick
  - This experiment > recommendations in all test cells

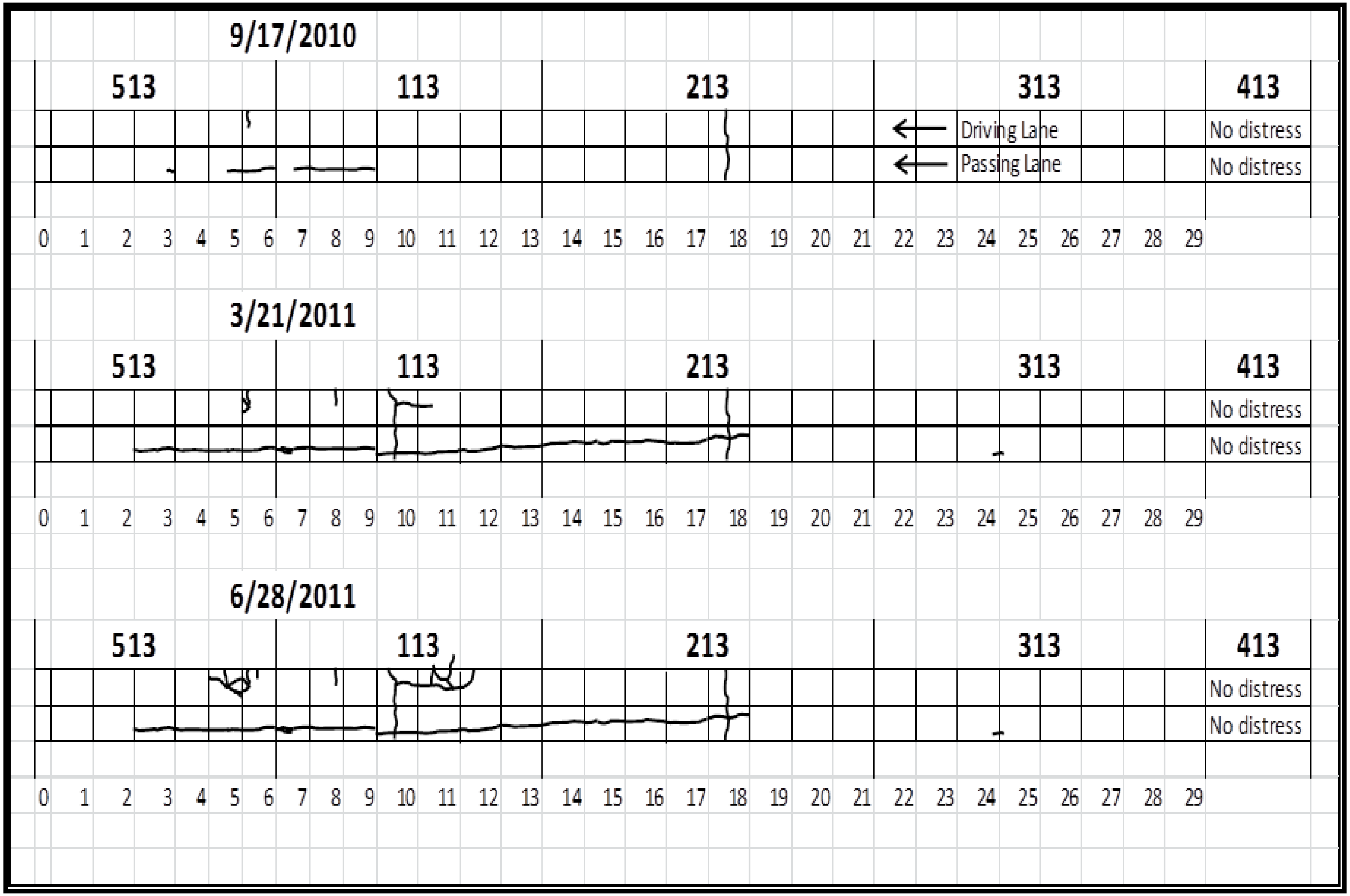
- Plate dowels for Cell 513
  - 9.5 mm (3/8”) x 305 mm (12”) long tapered width

MnROAD Traffic Load History

Live interstate traffic = "Accelerated" for thin PCC designs



Test Cell Performance

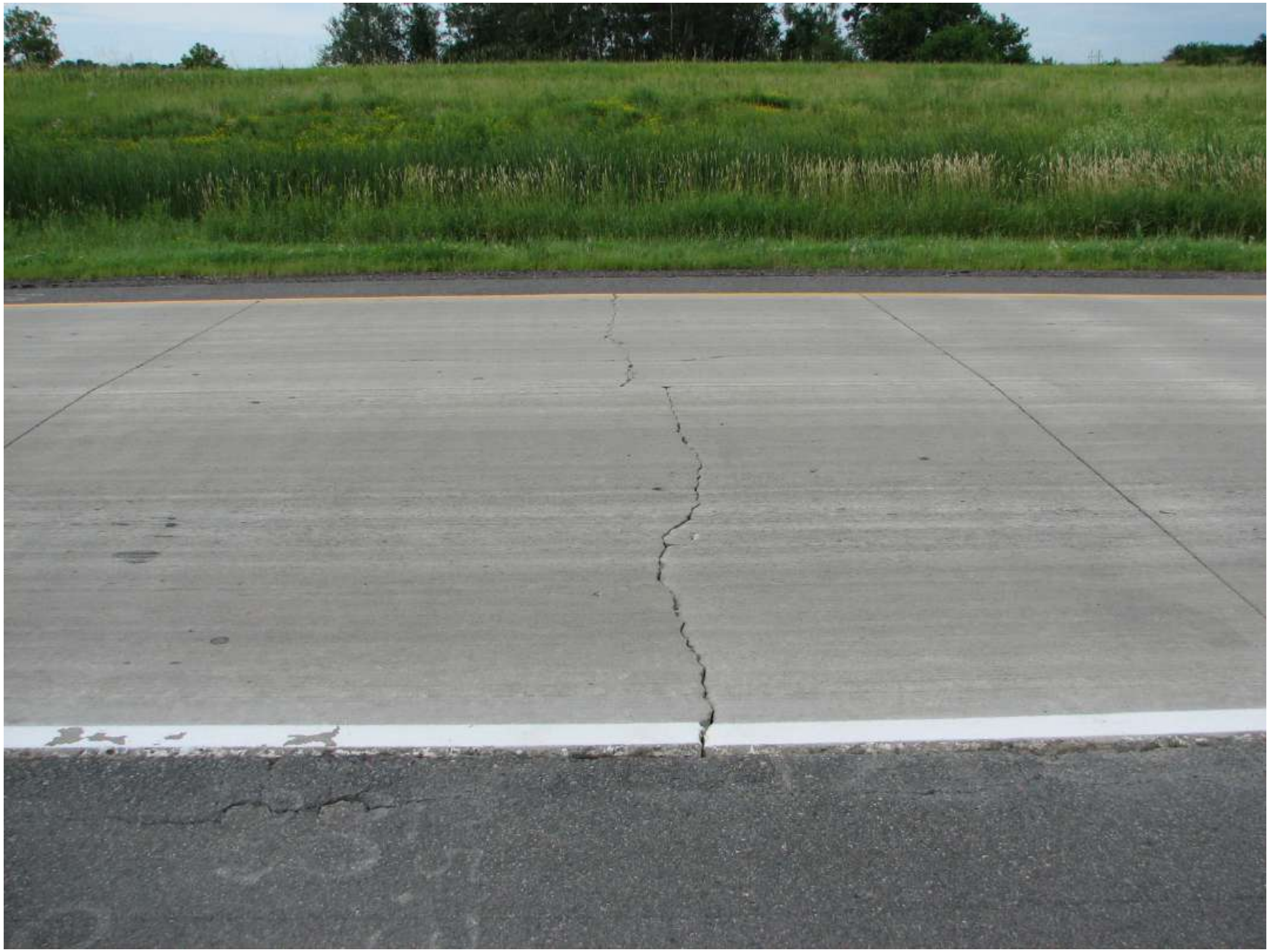


> 1 million CESALS to first visible cracks

Test Cell Performance

Cell 213 transverse crack, Oct 2010

Test Cell Performance



Cell 213 transverse crack, Oct 2011

Test Cell Performance

Cell 213 passing lane cracks, July 2011

Test Cell Performance

Cell 113 cracks in sensor area, July 2011

Routing Sensor Leads

Test Cell Performance

Distress from sensor leads?

New Sensor Installation Technique

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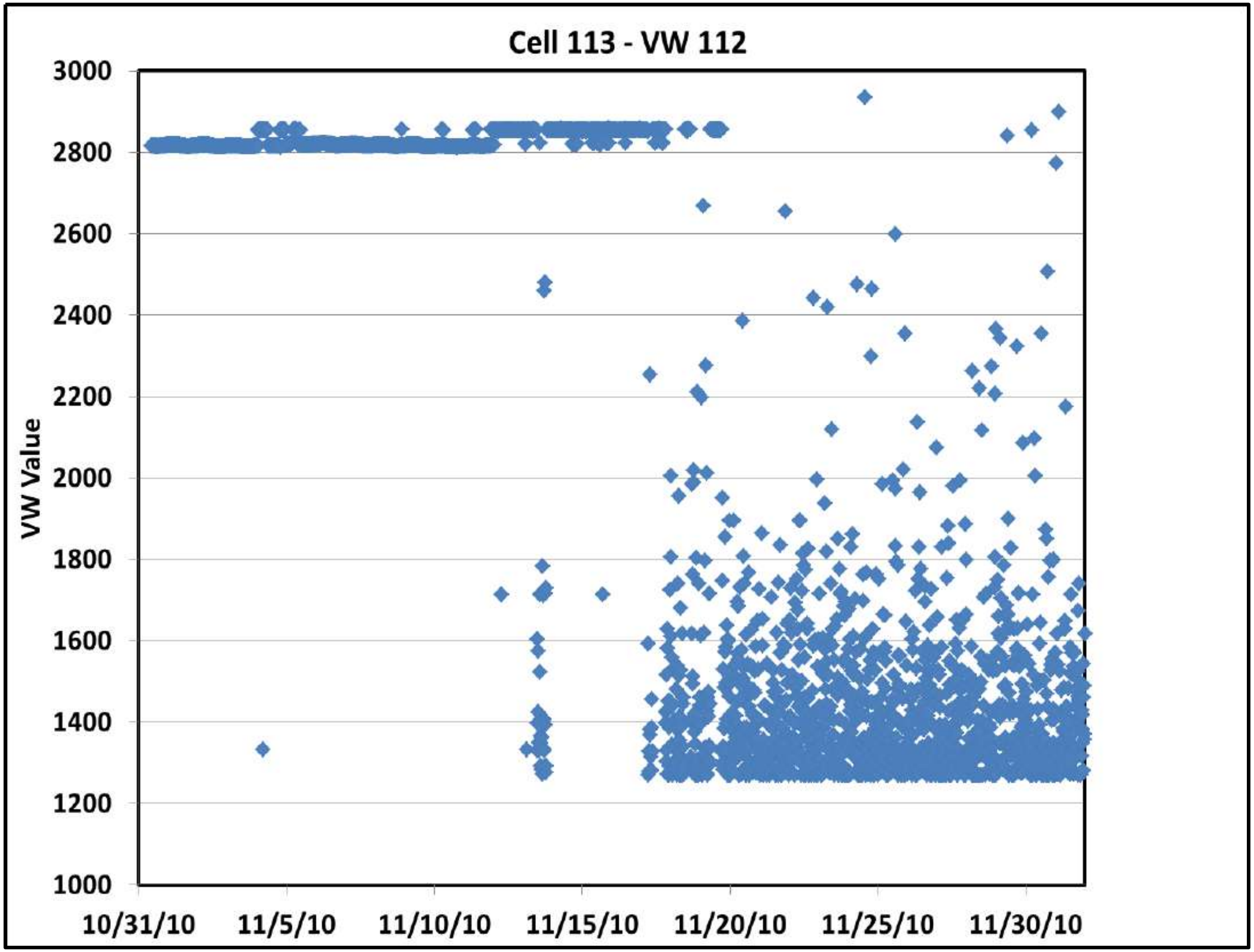


Sensor indicates when cracking occurred

Test Cell Performance

Pumping from shoulder joint, July 2011

Test Cell Performance

Slow draining base

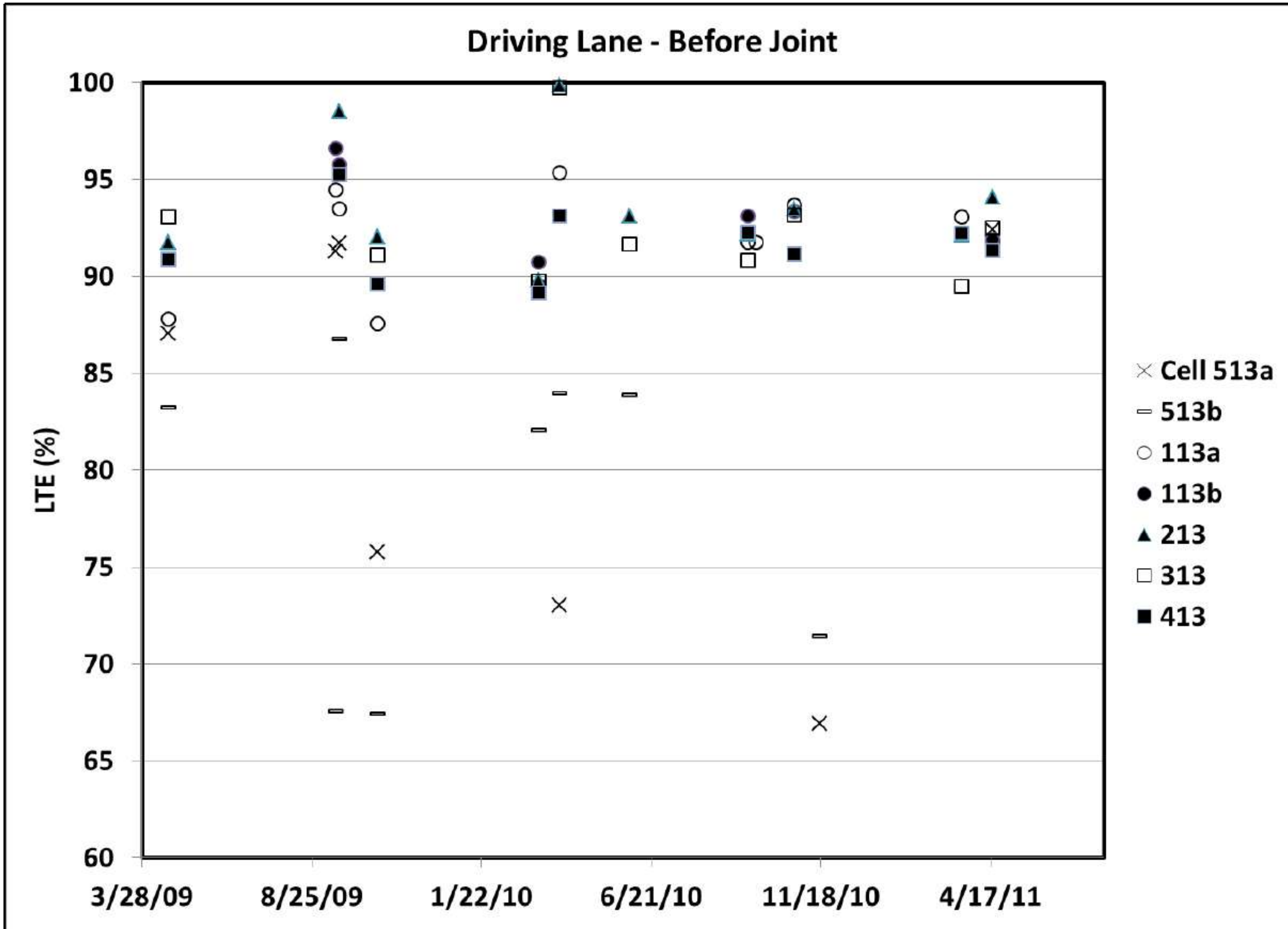
Repairs

Difficult to repair such thin slabs!

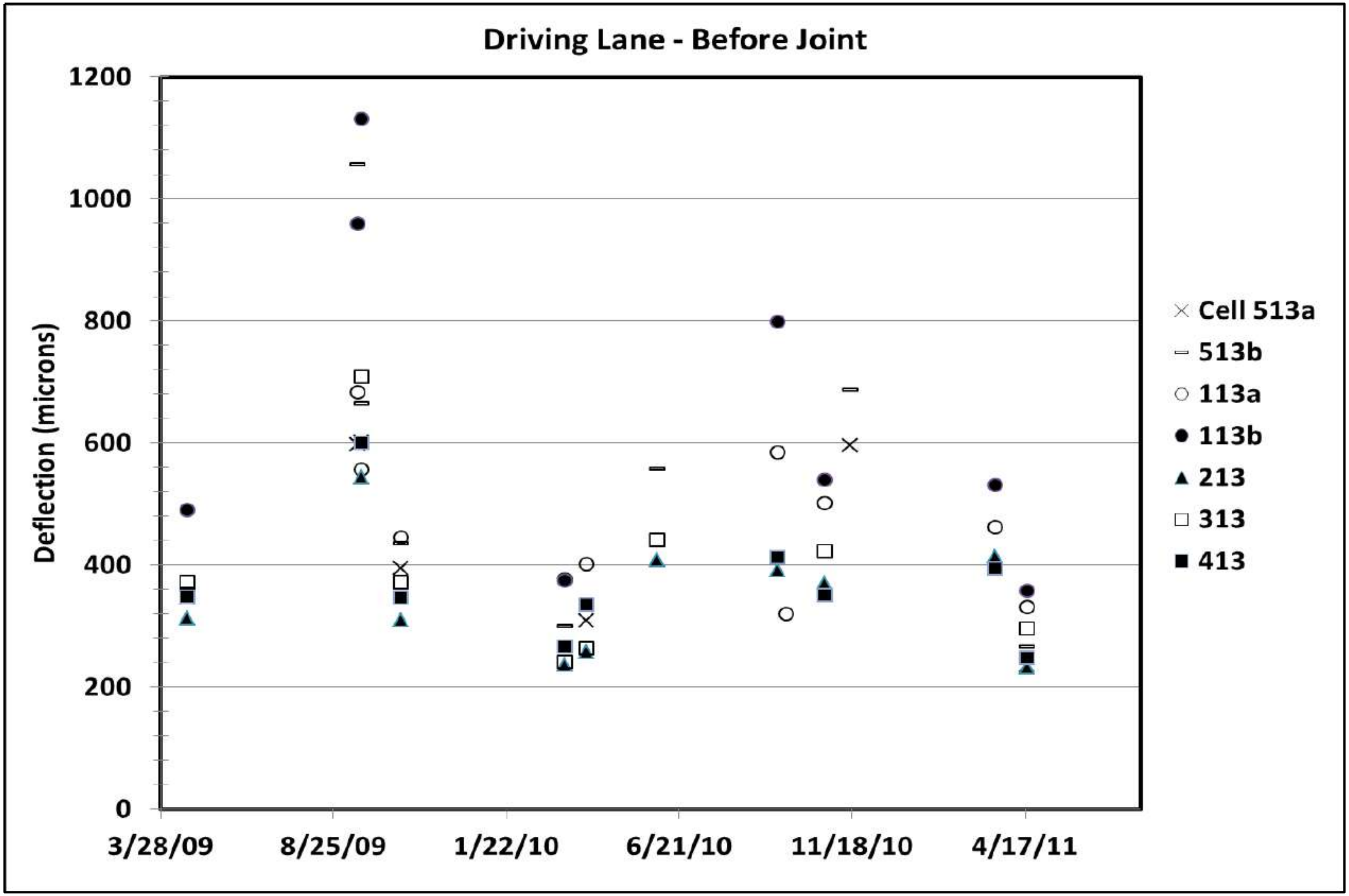
Repairs

Drainage and smaller slabs work better

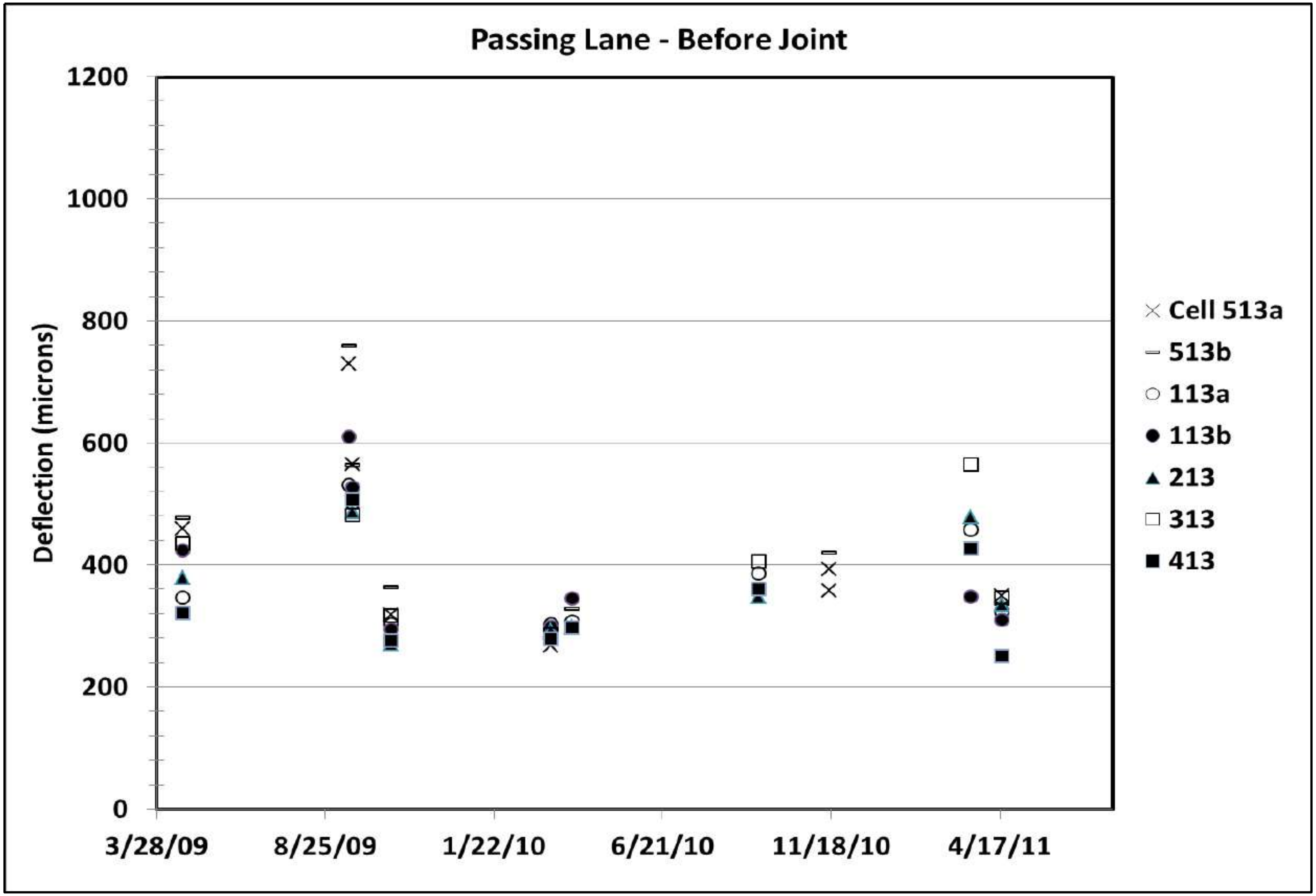
Joint Load Transfer Efficiency



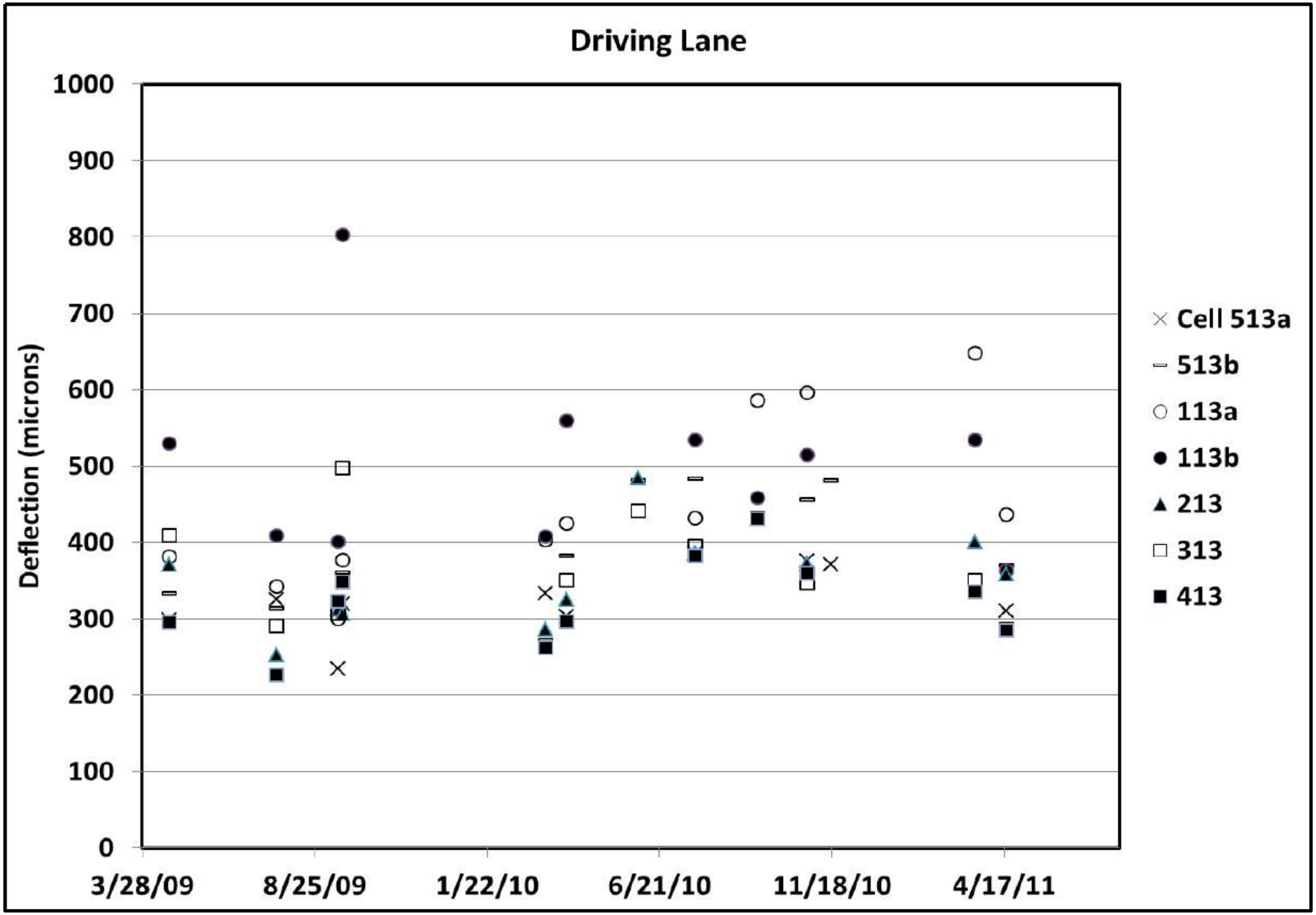
Joint Deflection



Joint Deflection



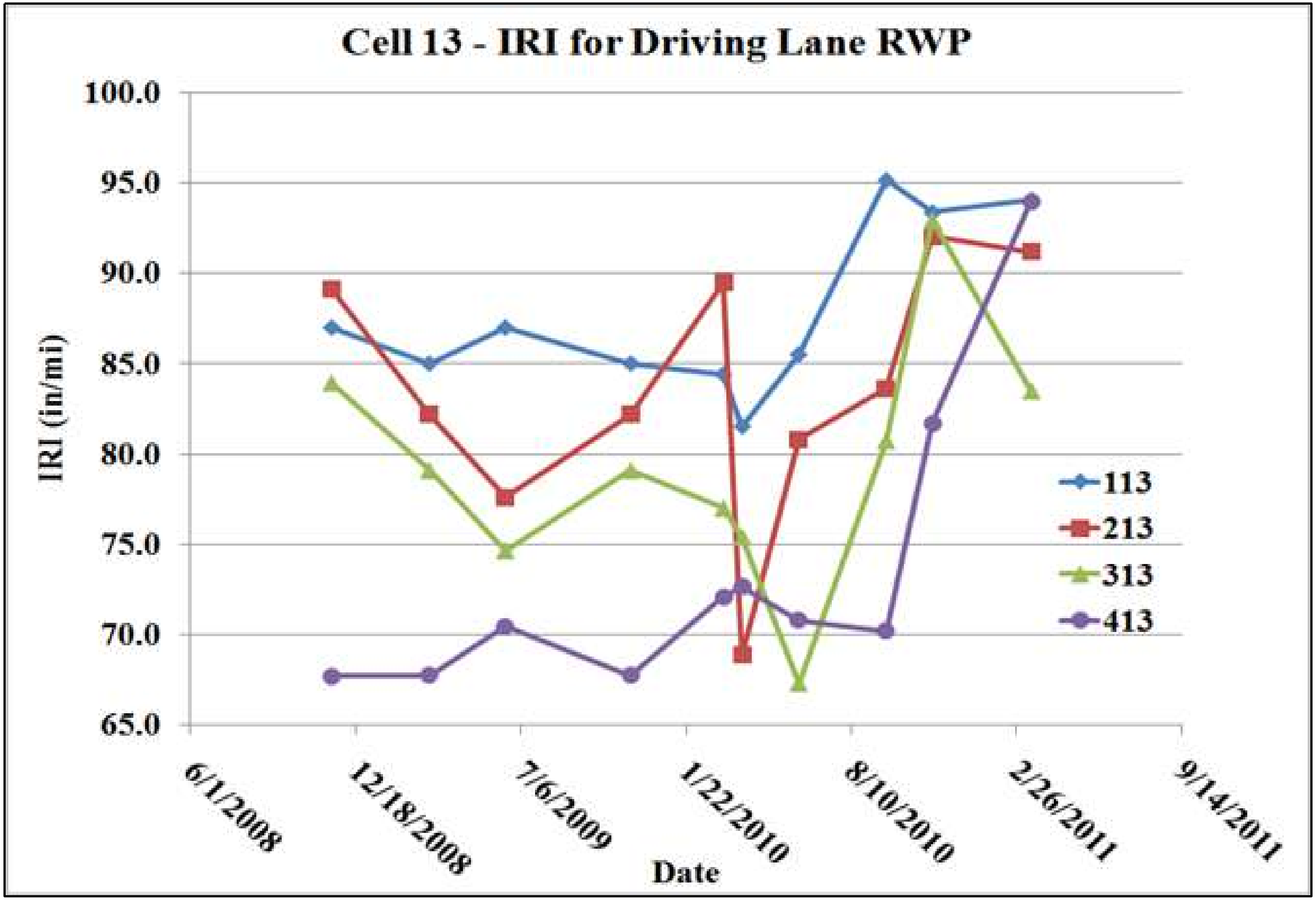
Mid-Panel Edge Deflection



Ride Quality History

IRI AND RN MEASURING DEVICE (LIGHTWEIGHT PROFILER)

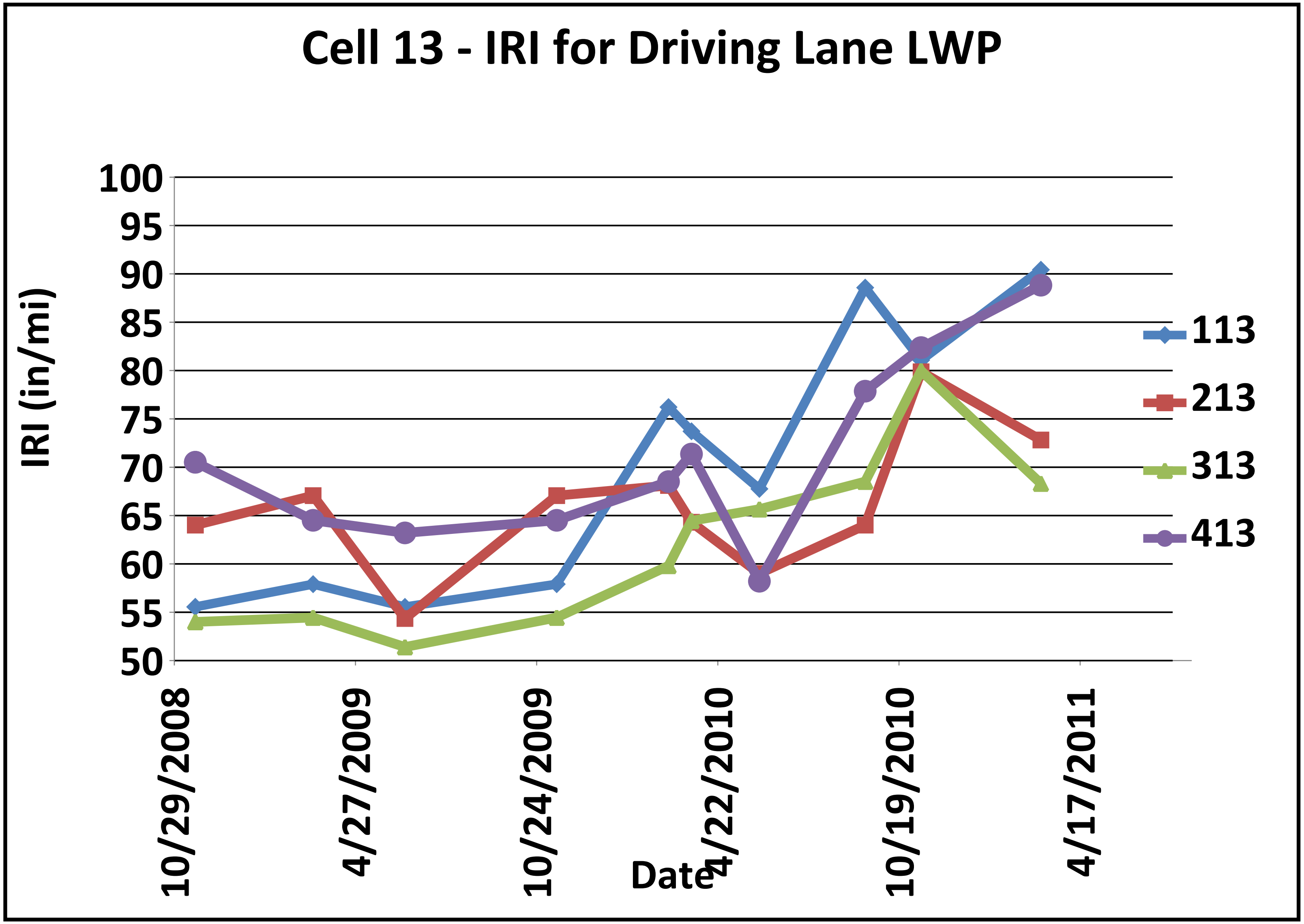
Ride Quality History - IRI



Ride measurements can be affected by repairs

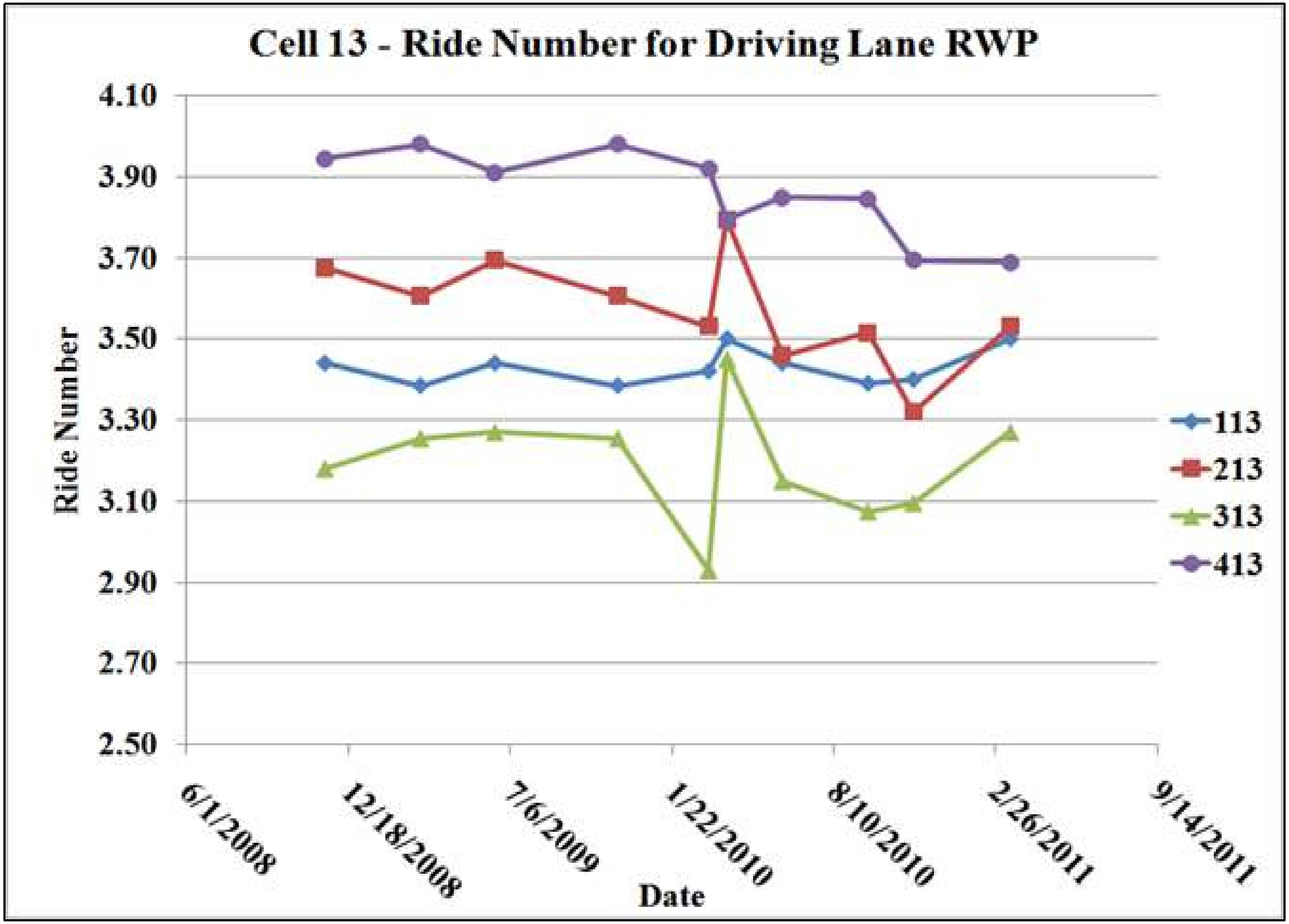
63.5 in/mi = 1 m/km

Ride Quality History - IRI



63.5 in/mi = 1 m/km

Ride Quality History - RN



Ride Quality History

- Overall, it cannot be deduced that IRI (or RN) and pavement thickness were correlated simply by observing the plots

- Statistical method used to ascertain the extent to which the IRI and RN may be attributed to pavement cell thickness
  - Ride Number appears to be significantly correlated to the thickness and traffic ESALs
  - IRI not significantly correlated to pavement thickness, but ESAL was a significant variable

Cells 306-406 Performance

- **6” PCC constructed in 2011**
- **Design based on “good” performance of Cell 313**
- **Cracking within 6 months (base related?)**

Summary

- MnROAD Cells 113-513 have provided valuable data toward determining "how thin can you go?"
- Thinnest cells able to carry interstate traffic in Minnesota climate for over 1 million ESALs before cracking.
- Cells failed by pumping of base materials in driving lane, settlement of base or slab curling in passing lane.
- Cracking occurred in all sections with a design thickness < 152 mm (6").
- Difficult to repair thin slabs.
- Now have data available for development and calibration of M-E pavement design procedures for thinner PCC pavements.
- Traffic loading was accelerated. Must be careful when translating to more typical design scenarios.

Recommendations/Questions

- Determine the effect of slab size on performance.
- Determine whether cracking related to pumping, or just a few overloaded axles.
- Determine cause of difference in cracking type between driving and passing lane.
- Understand how interstate traffic loads would translate to typical lower volume loadings.
- Are thinner slabs much more vulnerable to base settlement?

Questions?