Performance of Concrete Pavements

May 22, 2019

Delaware, OH

Kevin Senn, P.E.—NCE

OHIO DEPARTMENT OF TRANSPORTATION

Overview

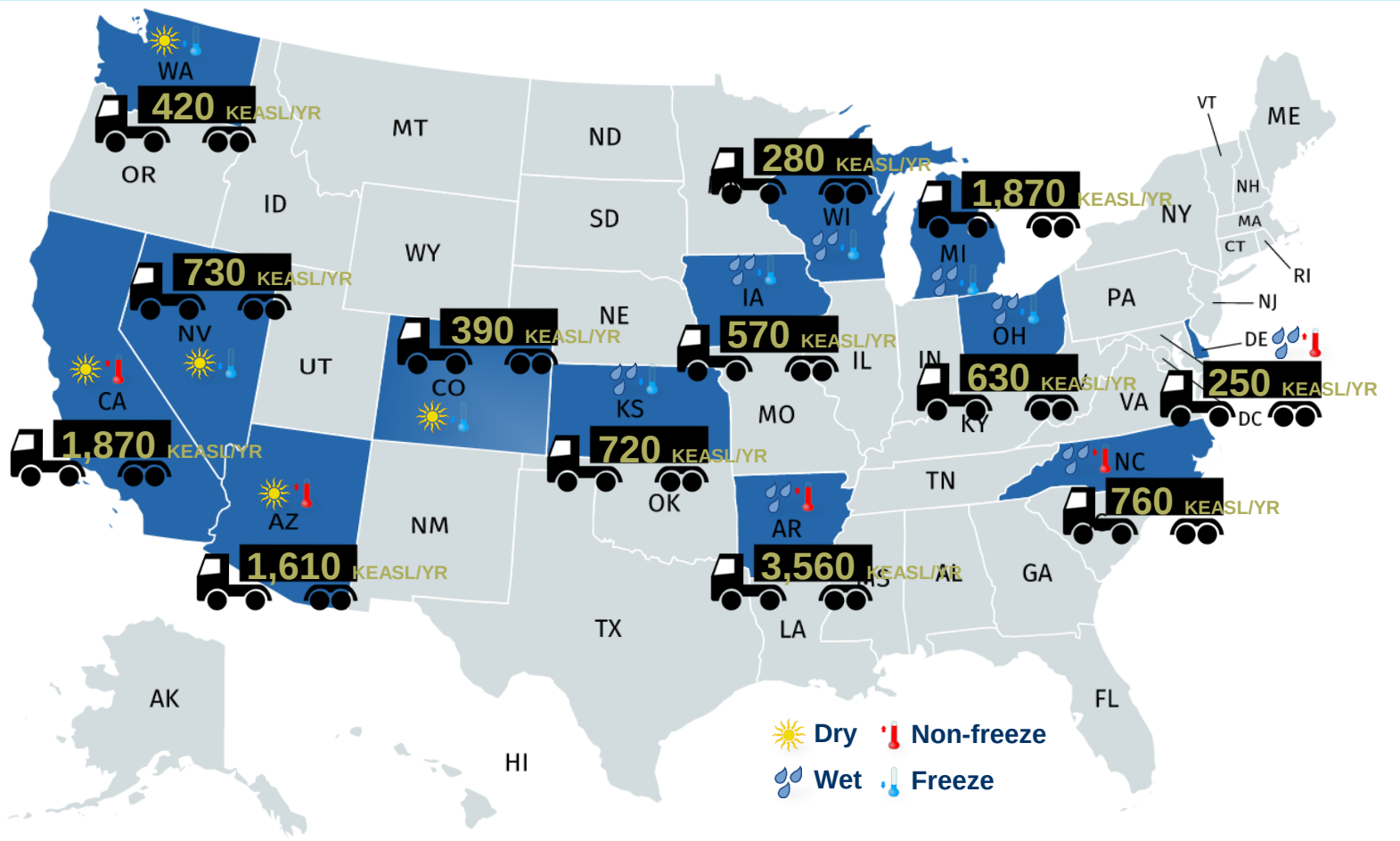
- Construction Effects on PCC Performance
- National SPS-2 Performance
- National SPS-2 PavementME Predictions
- Ohio SPS-2 PavementME Predictions

Construction Effects on PCC Performance

Construction Practice	Classification	Effect on Distress Type			Average Ranking
		JPCP Faulting	JPCP Cracking	Roughness	
Dowel Placement	Others	3	X	X	**3**
	Mechanical Install	2	X	X	**2**
	Preplaced In Baskets	1	X	X	**1**
Joint Forming	Sawed	2	X	X	**2**
	Plastic Insert	1	X	X	**1**
Coarse Agg. Content	<1800 Kg/M^3	X	2	X	**2**
	>1800 Kg/M^3	X	1	X	**1**
Fine Agg. Content	<1300 Kg/M^3	X	1	X	**1**
	>1300 Kg/M^3	X	2	X	**2**
Concrete Curing	Membrane	X	X	3	**3**
	Polythene	X	X	1.5	**1.5**
	Burlap	X	X	1.5	**1.5**
Concrete Texture	Astroturf	X	X	6	**6**
	Others	X	X	5	**5**
	Broom	X	X	4	**4**
	Tine	X	X	3	**3**
	Burlap Drag	X	X	2	**2**
	Grooved Float	**X**	**X**	**1**	**1**

Note: X denotes no effect; ranking of 1-5 indicates best-worst performance

SPS-2
Traffic and Climate

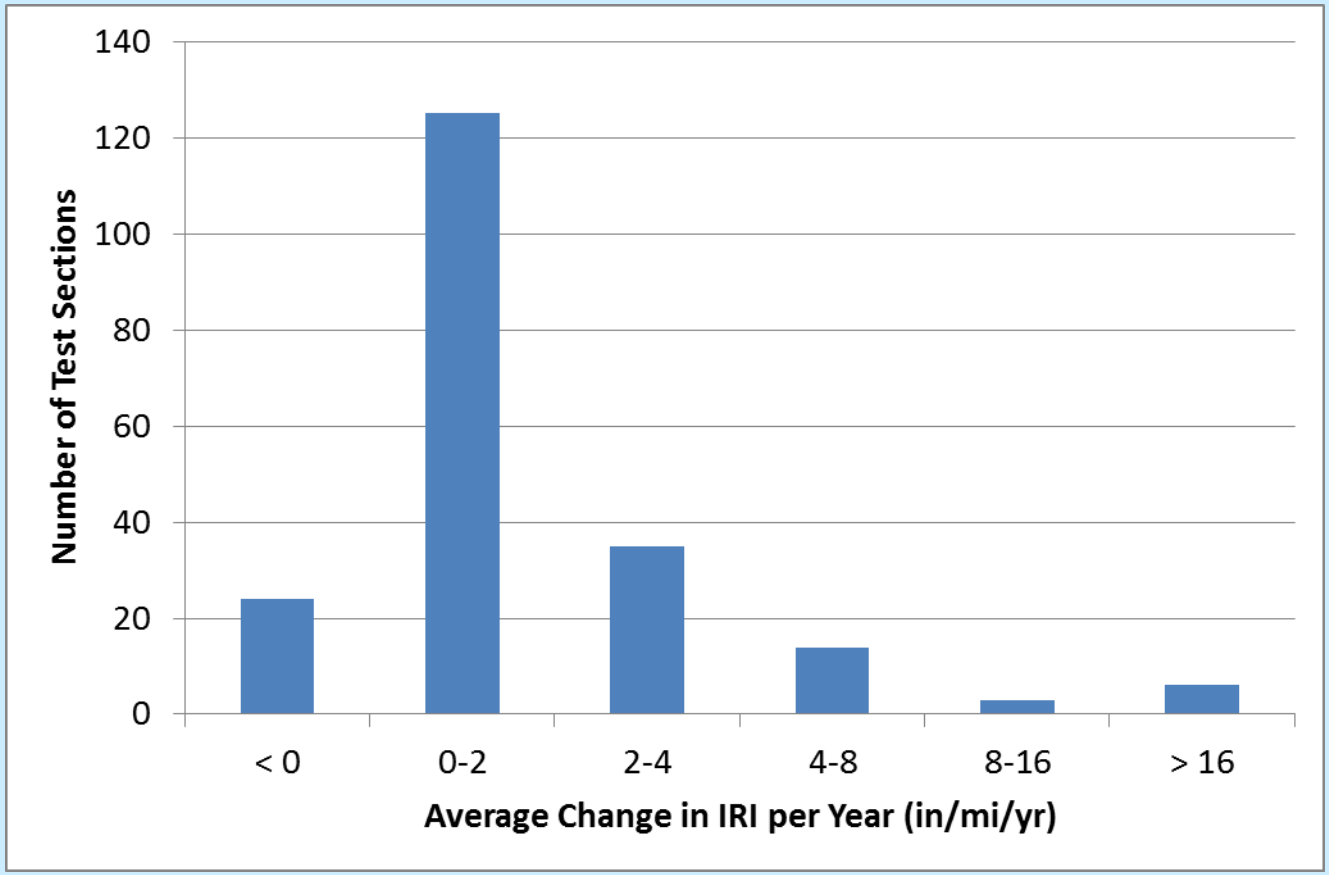


National SPS-2 Performance Roughness

- The initial IRI of SPS-2 sections after placement ranged from 48 to 139 in/mi with a mean of 82 in/mi.

- JPCP constructed on PATB were smoother than sections constructed on LCB or untreated aggregate base.

National SPS-2 Performance Roughness



National SPS-2 Performance Faulting

- Widened slab sections show less faulting than conventional width slabs.

- Sections with aggregate base show the highest joint faulting level. Sections with LCB and PATB have the lowest joint faulting.

National SPS-2 Performance Transverse Cracking

- Thinner (203 mm) slabs show more transverse cracks than thicker slabs. Sections with a thinner slab and a widened slab show the highest level of transverse cracking.

- Sections with PATB show the lowest percentage of slabs cracked transversely, while the sections with an LCB show the highest transverse cracking.

National SPS-2 Performance Longitudinal Cracking

- Sections with PATB show the lowest total longitudinal cracking levels, while the sections with LCB show the highest longitudinal cracking.

National SPS-2 Performance Lessons Learned (so far)

- In general, LCB provided the worst performance and PATB over DGAB provided the best performance.
- Longitudinal cracking was influenced by base type and slab thickness.
- Widened lanes contributed to lower transverse joint faulting.

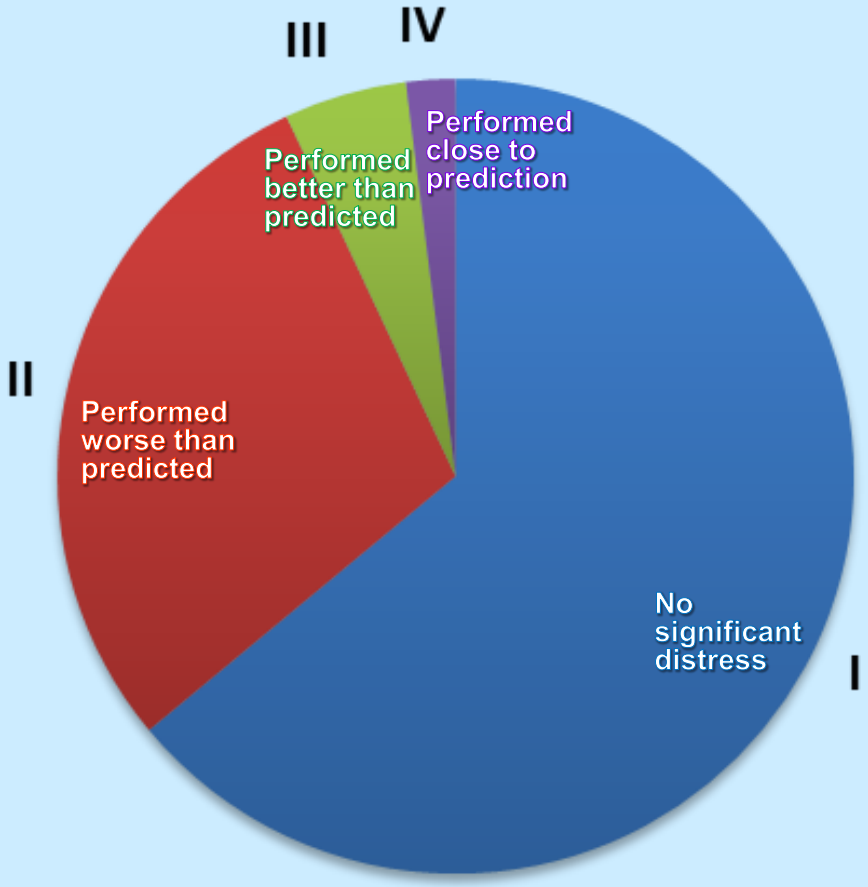
National SPS-2 PavementME Predictions

Slabs Cracked Transversely

Predicted Slabs Cracked	Measured Slabs Cracked	
	LOW	HIGH
LOW	I	II
HIGH	III	IV

LOW: < 5% of slabs were cracked
HIGH: > 5% of slabs were cracked

MEPDG analysis assumed the default value for PCC-base Contact Friction (full friction with friction loss at 240 months)



National SPS-2 PavementME Predictions

- Type I sections
  - Lower traffic loads
  - Thicker PCC
  - 34% with PATB and 24% with LCB
- Type III sections
  - Heavier traffic loads
  - PCC with lower strength and/or more elastic
  - No LCB sections
- Type II sections
  - 28% with PATB and 47% with LCB
  - PCC with higher strength and/or less elastic
- Type IV sections
  - Most design factors are near the average

National SPS-2 PavementME Predictions

State	Number of Test Sections			
	Type I	Type II	Type III	Type IV
Arizona	10	5	4	-
Arkansas	5	2	3	2
California	3	5	1	3
Colorado	9	4	-	-
Delaware	13	1	-	-
Iowa	12	1	-	-
Kansas	9	2	1	1
Michigan	7	6	-	-
Nevada	2	10	-	-
North Carolina	12	2	-	-
North Dakota	16	2	-	-
Ohio	5	13	-	1
Washington	9	4	-	-
Wisconsin	20	-	-	-

National SPS-2 – Slabs Cracked Transverse vs. Total

Slabs Cracked Transverse	Slabs Cracked - Total					
	0	0-20	20-40	40-60	60-80	80-100
0	112	15	1	0	0	0
0-20	0	35	3	2	1	0
20-40	0	0	4	1	0	3
40-60	0	0	0	8	0	0
60-80	0	0	0	0	6	1
80-100	0	0	0	0	0	13

National SPS-2 PavementME Findings

- Predictions using agency calibration coefficients did not significantly improve upon predictions using default calibration values
- However, the Root Mean Square Error (RMSE) of Type III predictions reduced by 13.6 (% of slab cracked) on average.

$$RMSE = \left[\sum_{i=1}^{N}\left(x_m - x_p\right)^2 \Big/ N\right]^{\frac{1}{2}}$$

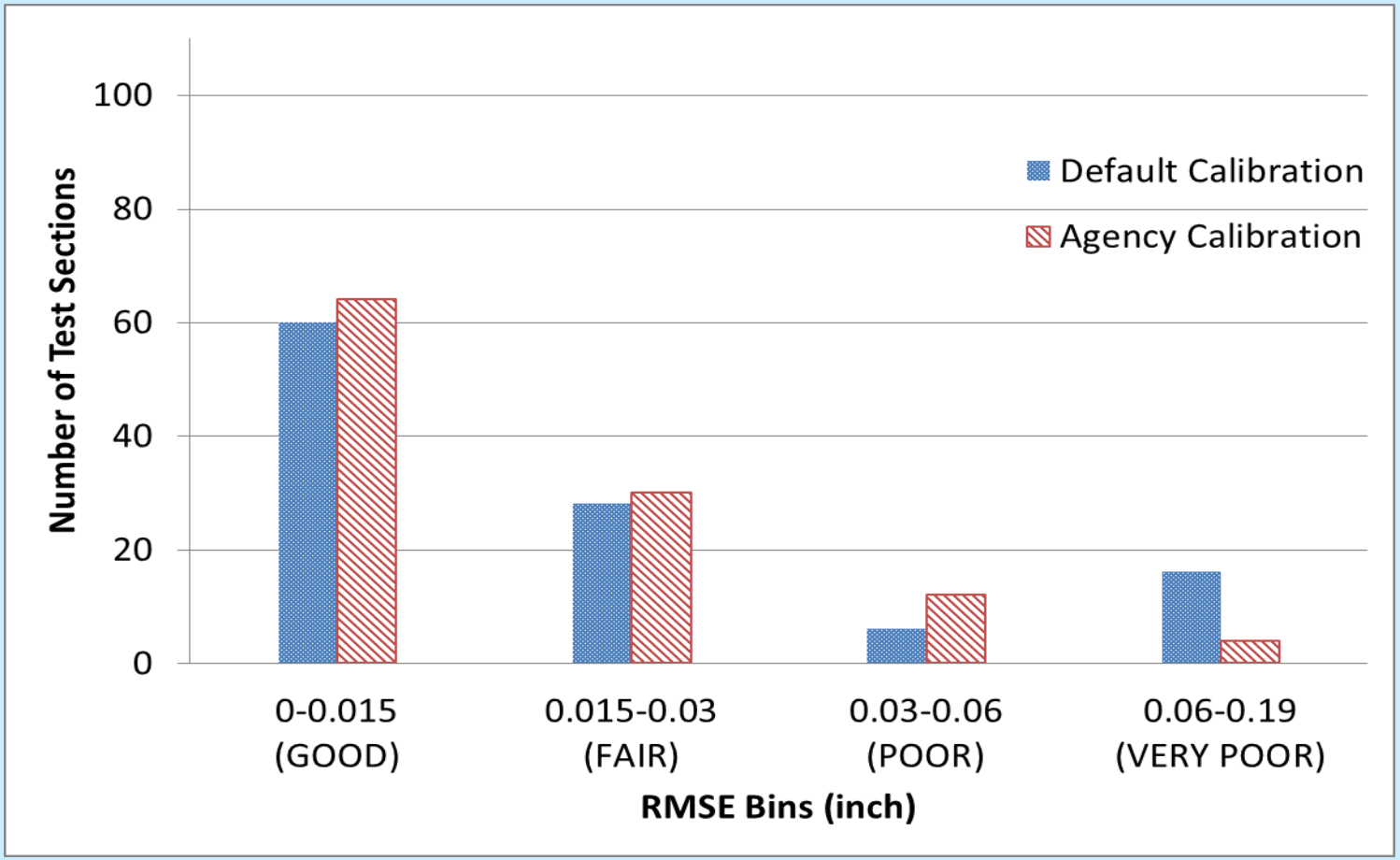
Where:

$x_m = measured\ performance$

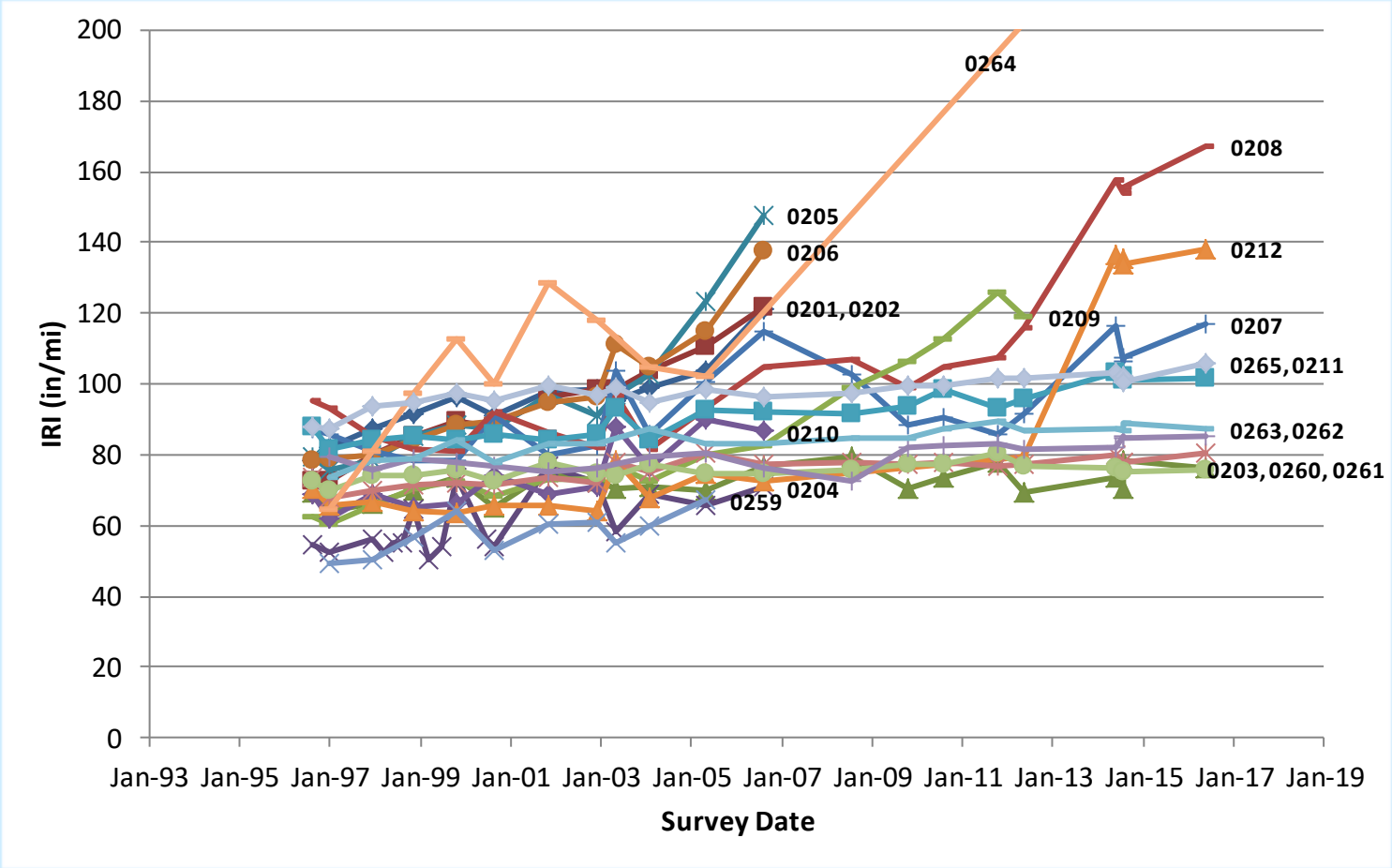
$x_p = predicted\ performance$

$N = sample\ size$

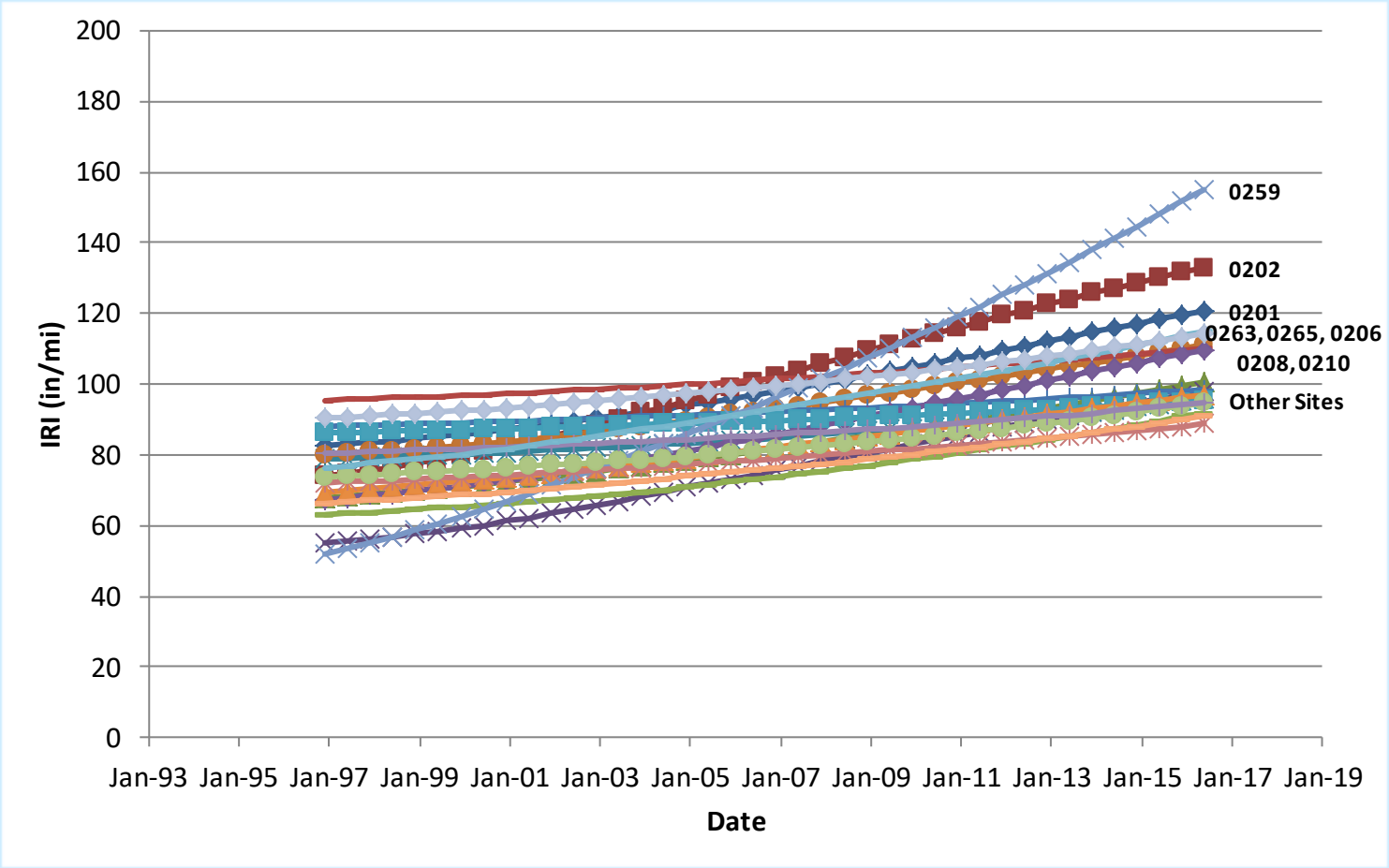
National SPS-2
RMSE Distribution – Faulting



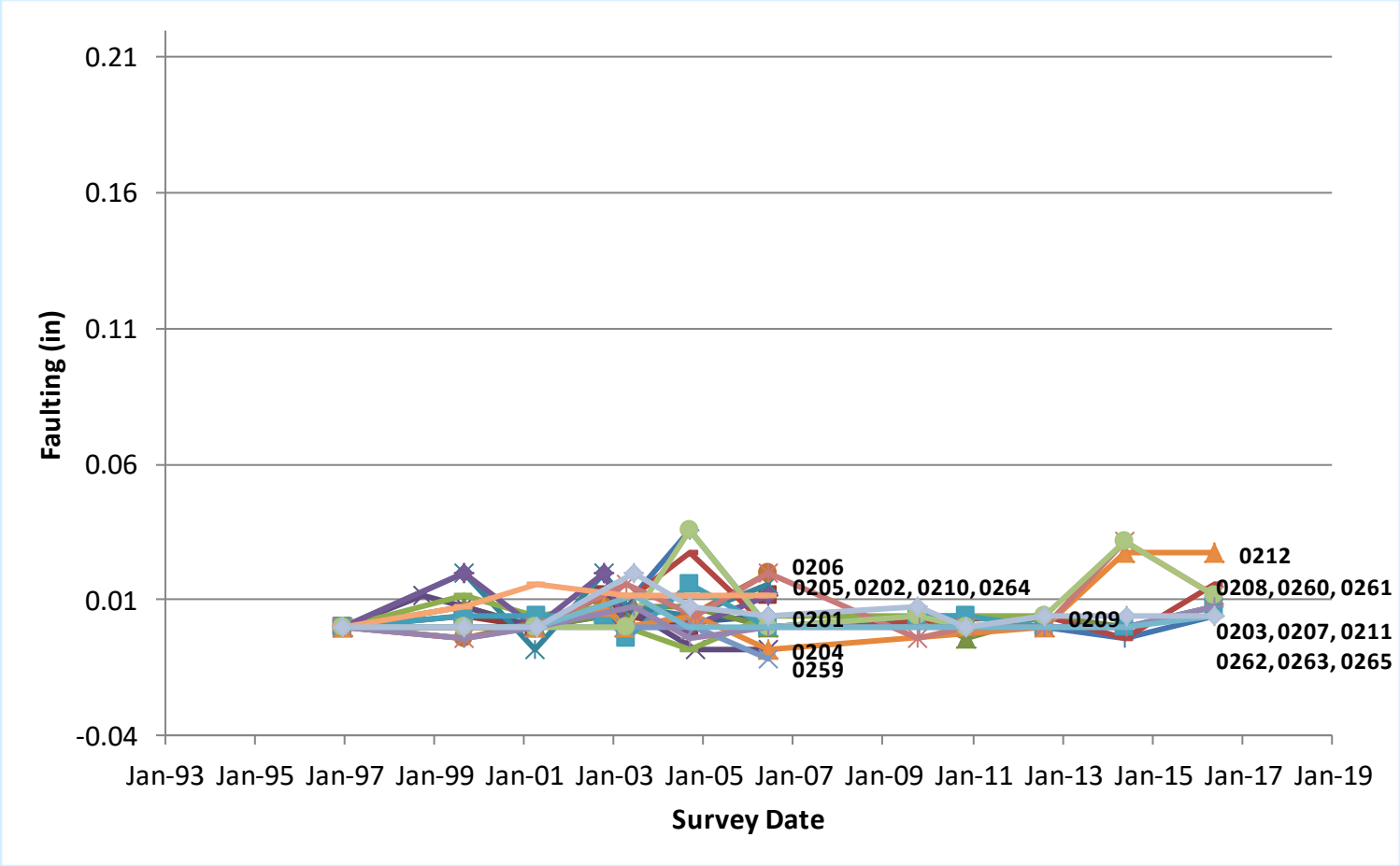
Ohio SPS-2 Measured Roughness



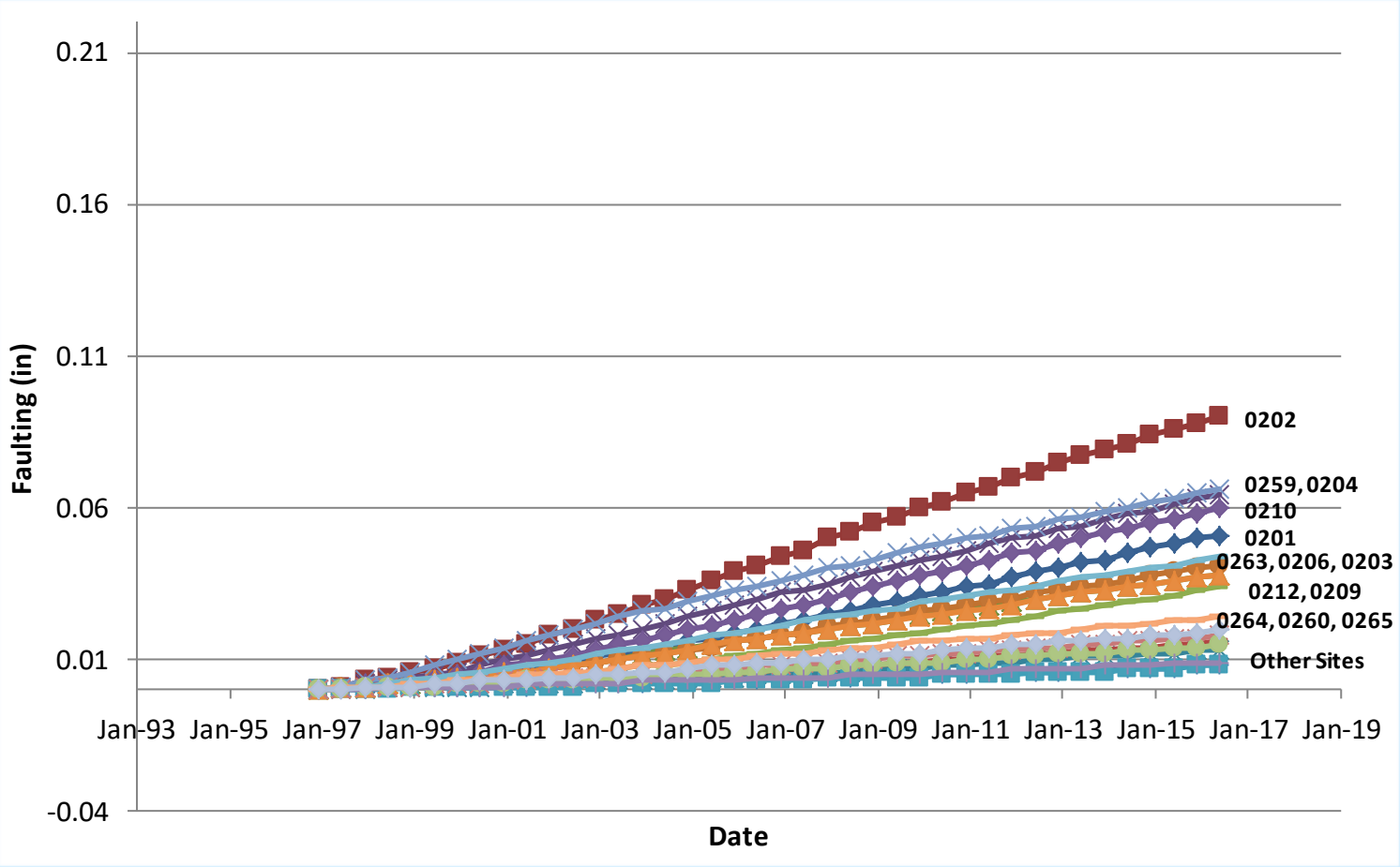
Ohio SPS-2
Predicted Roughness



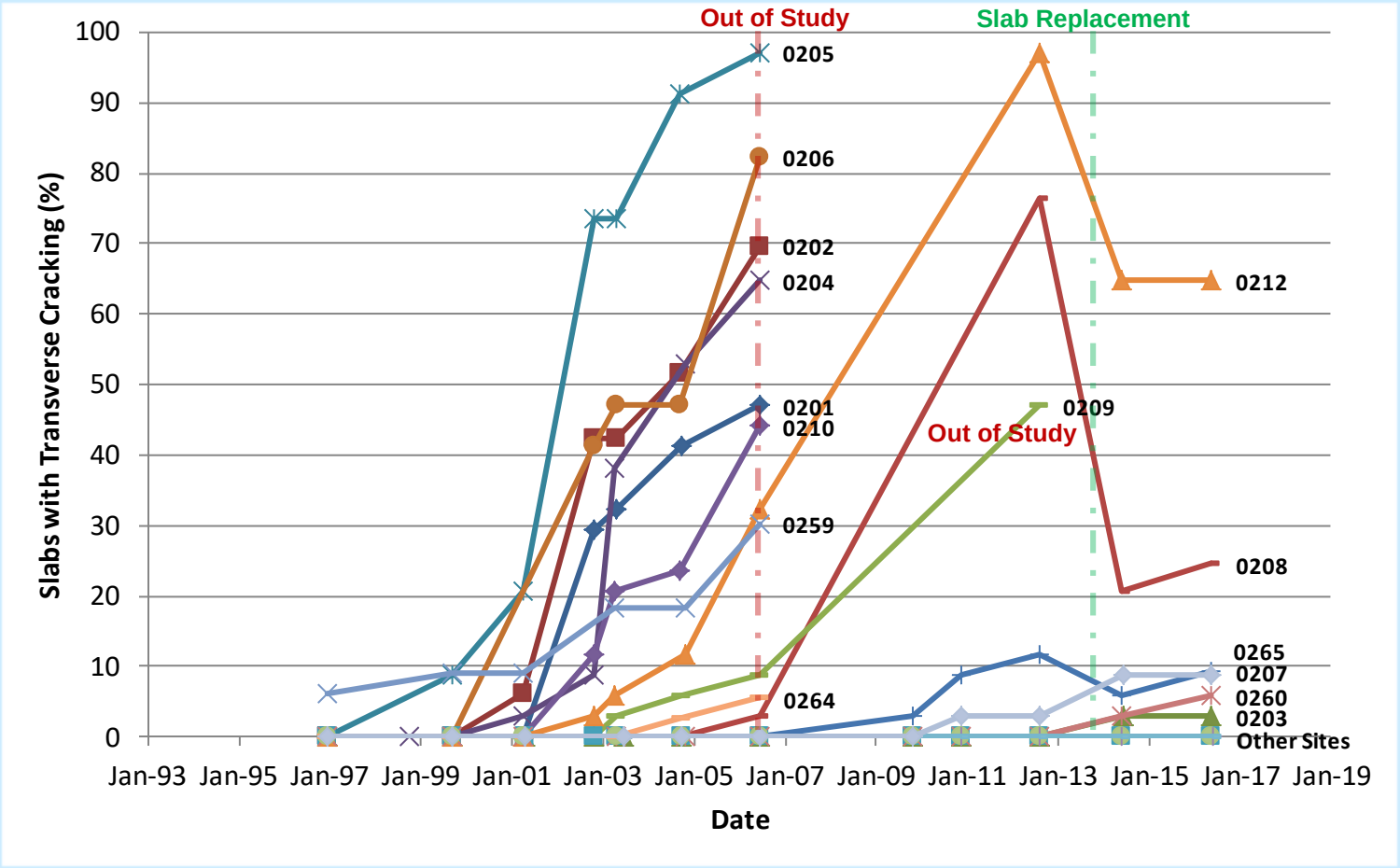
Ohio SPS-2
Measured Faulting



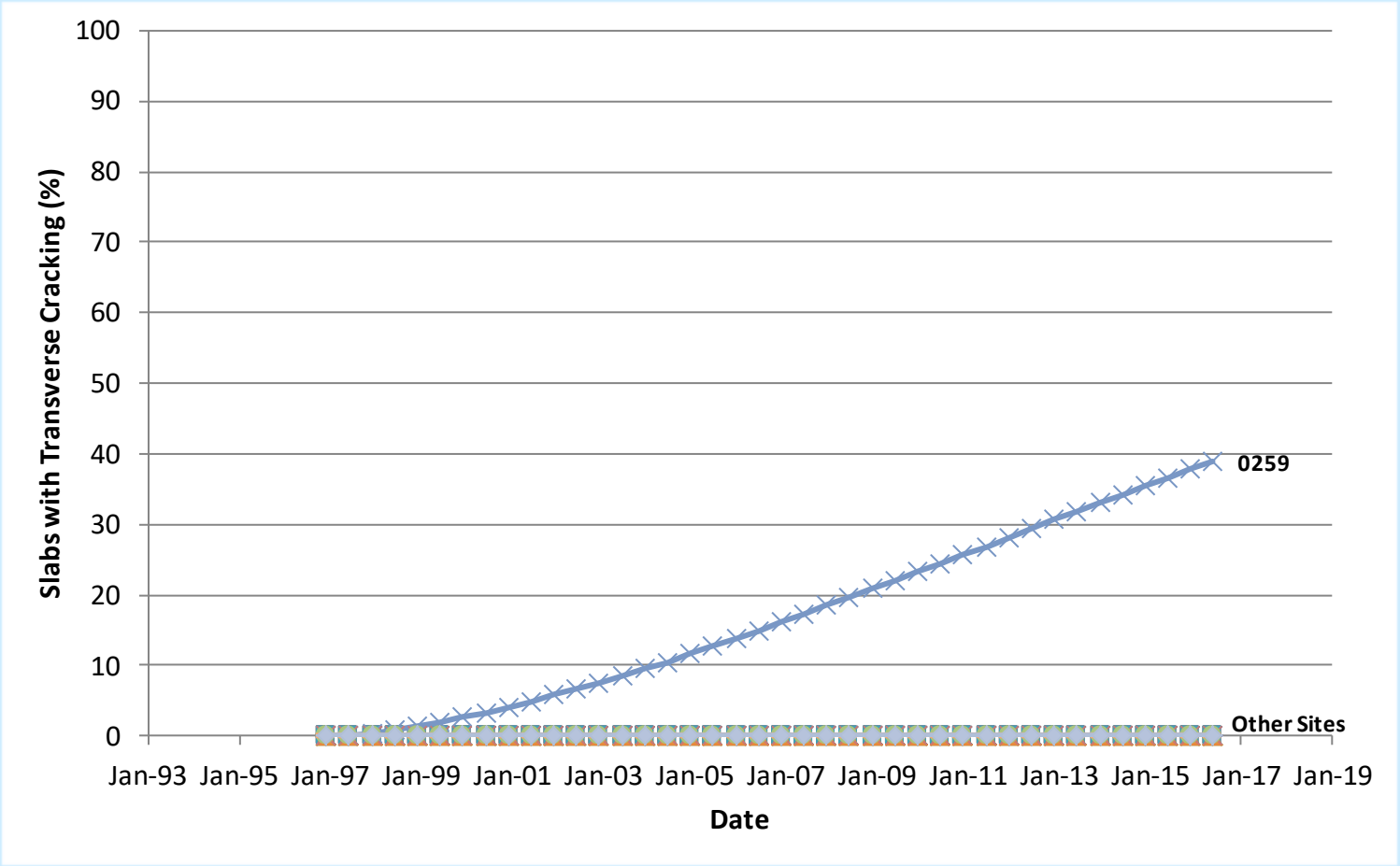
Ohio SPS-2
Predicted Faulting



Ohio SPS-2
Measured Cracked Slabs



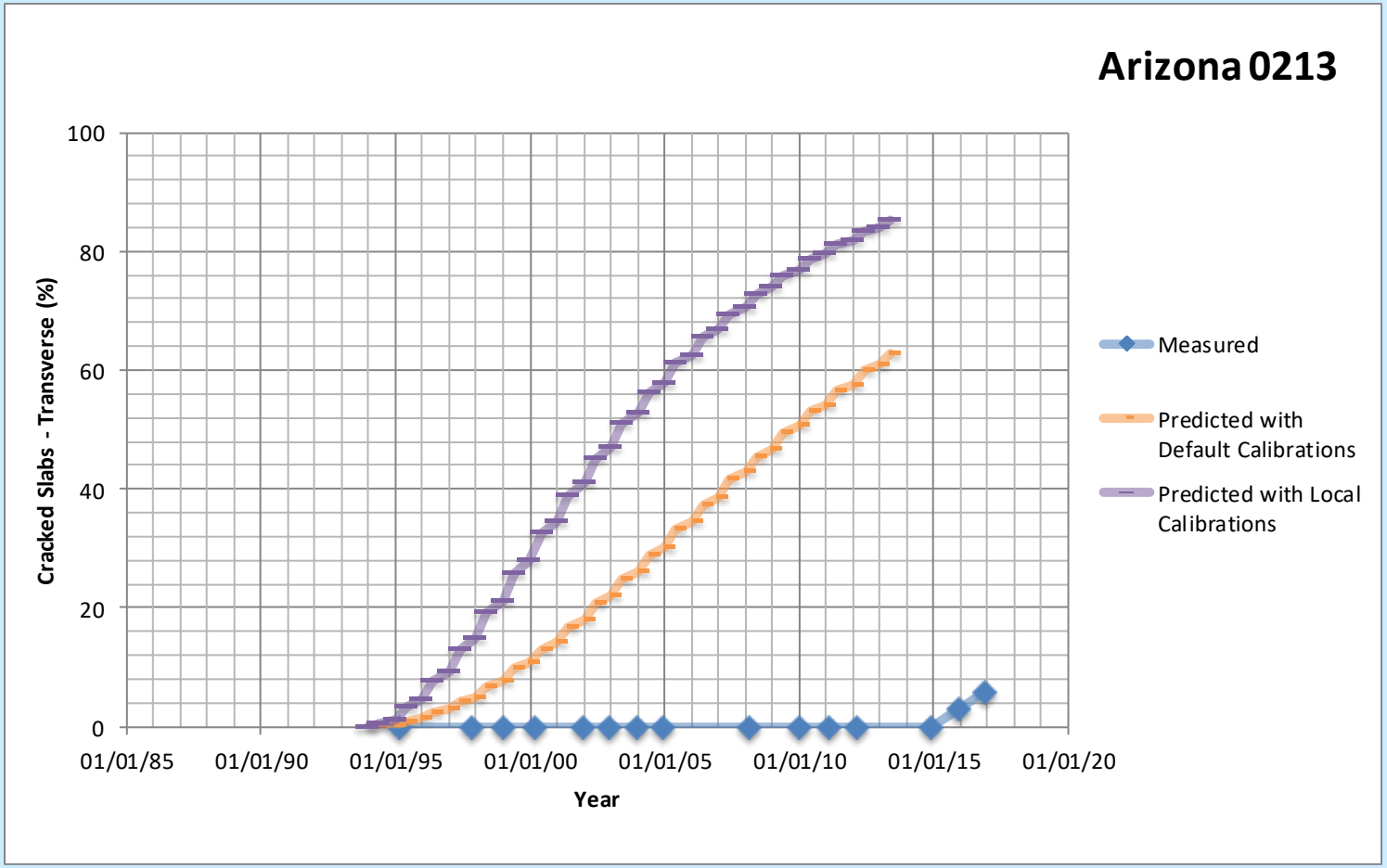
Ohio SPS-2
Predicted Cracked Slabs



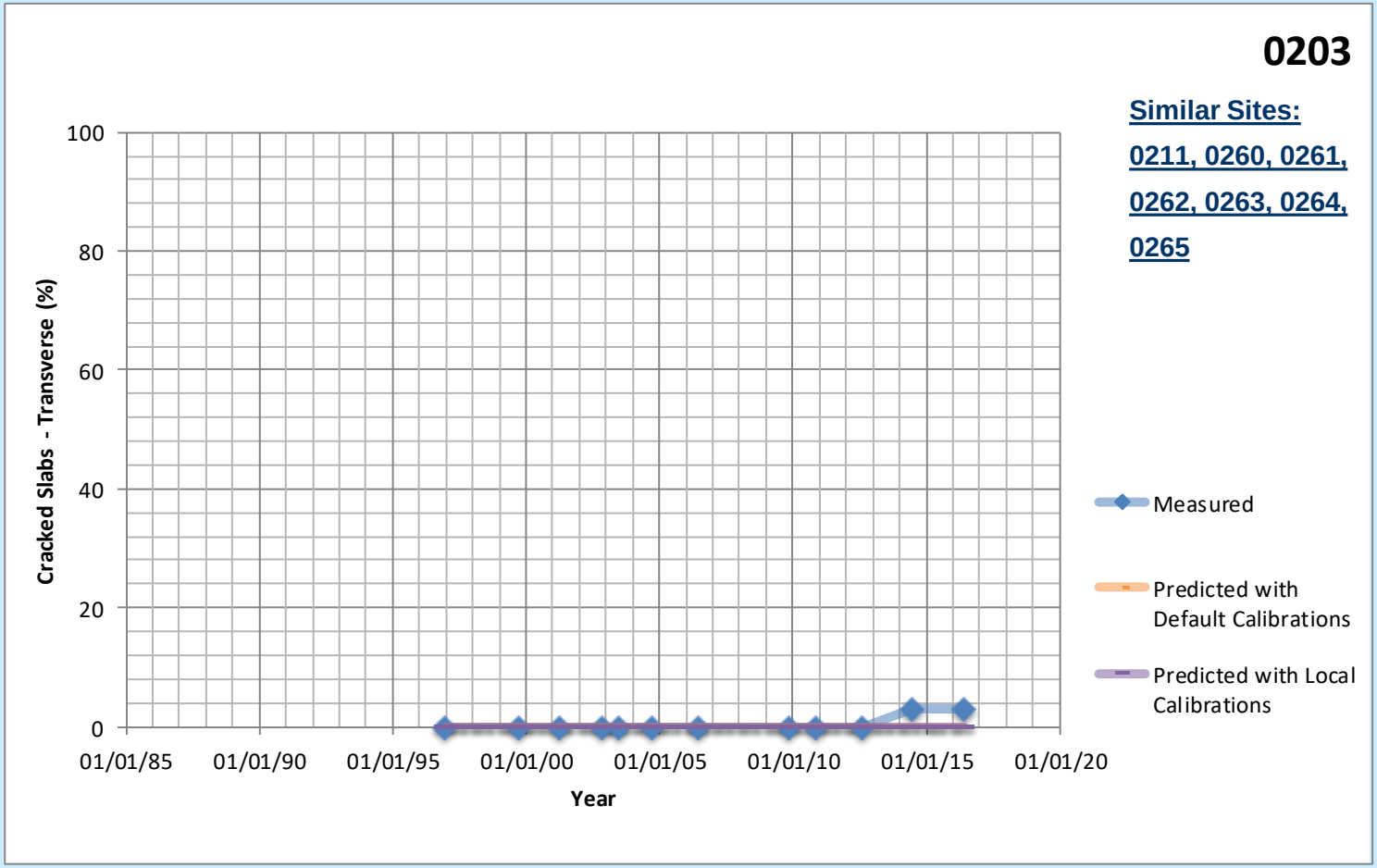
Ohio SPS-2 Over-Prediction

- Except for section 0259, PavementME predicted all other sections would show no distress.
- Therefore, none of the other Ohio SPS-2 test sections performed significantly better than the PavementME prediction.

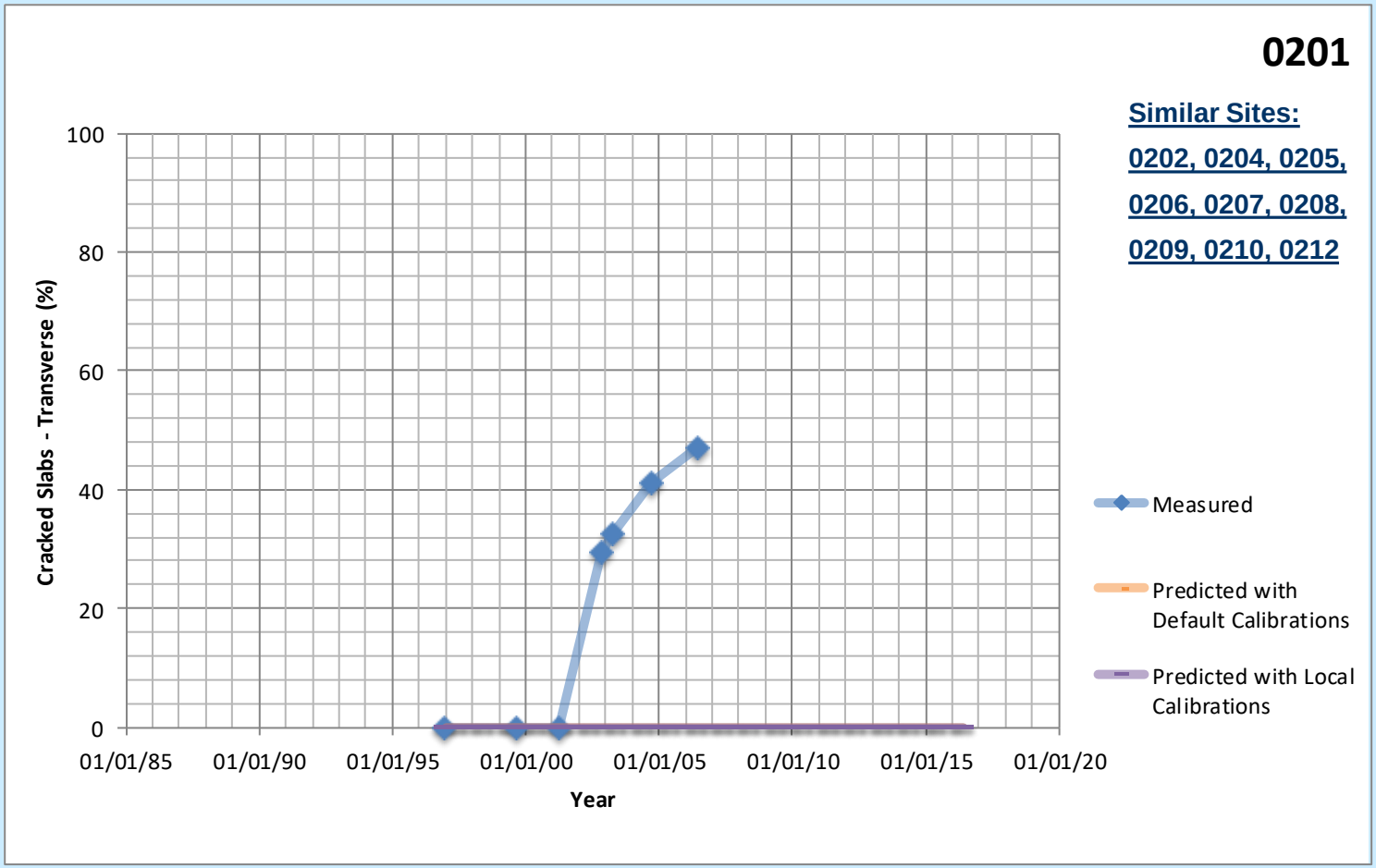
Example (Arizona) Over-Prediction



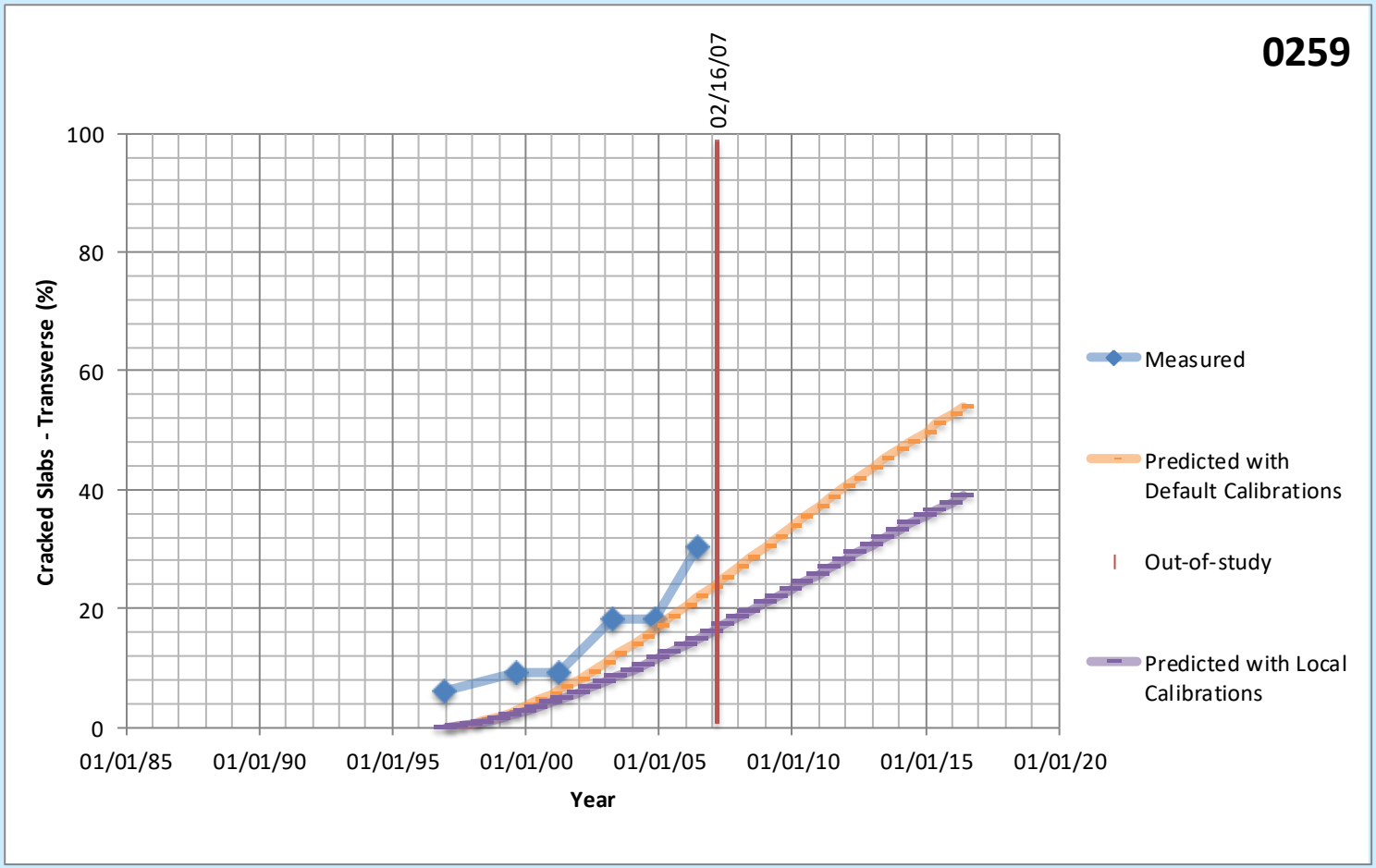
Ohio SPS-2
No Significant Distress



Ohio SPS-2 Under-Prediction



Ohio SPS-2
Good Prediction



Ohio SPS-2 PavementME Findings

- 0259 was the only section that performed as predicted.
- 0259 had an 11” thick high-strength PCC on a granular base.
- 0259 also had the lowest 28-day modulus of rupture (489 psi).

Ohio SPS-2 PavementME Findings

- All sections with no significant cracking had 11” thick PCC.
- Test sections with 8” thick PCC typically showed sudden increases in cracking and were consequently placed out-of-study.

Ohio SPS-2 PavementME Findings

- Test sections typically performed better when they had low cement content than when they had high cement content (with the exception 0201 and 0205).

SPS-2
Future

- LTPP monitoring
- SPS-2 Pavement Preservation Pooled Fund Study

For more information:

https://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp/getdata.cfm

ksenn@ncenet.com

***More products and information at*:**

https://infopave.com

Thank You