INNOVATIONS IN SCMS & SUSTAINABLE CONSTRUCTION

First Year Field Performance (2024-2025)

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CP Tech Center

DULUTH

CELL INFORMATION

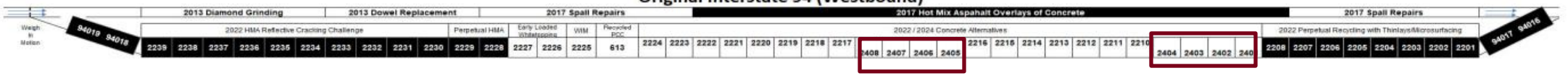
Continued..

Test Section Number	Cementitious Material Type	Total Cementitious Content (pcy)	Mixture Components	Paving Date
2401	Limestone Calcined Clay Cement Concrete (LC3)	570	50% Type IL cement, 30% calcined clay, 15% limestone, 5% gypsum	9/9/2024
2403	Quaternary Concrete Mixture (Q)	540	48% Type IL cement, 24% slag cement, 8% natural pozzolan blend, 20% Class F fly ash	9/10/2024
2405	Binary Concrete Mixture Control Section (SC)	570	70% Type IL (10) cement, 30% Class F fly ash	9/11/2024
2406	Activated Slag Cement Concrete Mixture (AS)	700	100% slag cement + activator	9/11/2024
2407	Ternary Concrete Mixture (T)	570	50% Type IL cement, 30% Class F fly ash, 20% slag cement	9/12/2024
2408	Binary Concrete Mixture (SB)	540	76% slag cement, 24% Type IL cement, and activator	9/12/2024

CELL INFORMATION

MnROAD

Original Interstate 94 (Westbound)



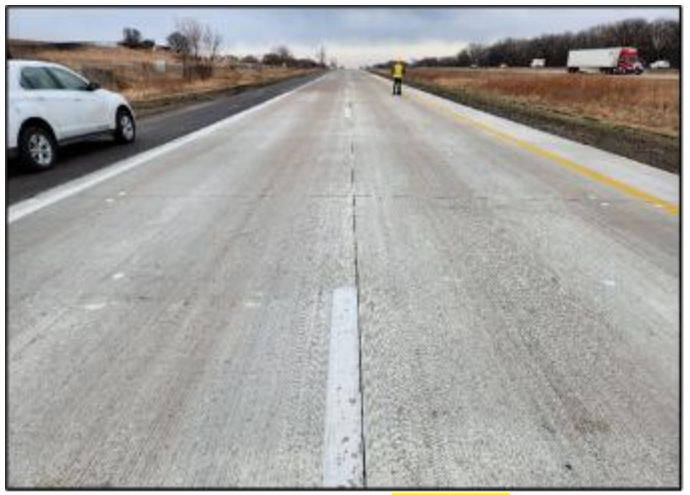
Cells 2405-2408

Cells 2401-2404

INTRODUCTION

At 4 days

PHOTOGRAPH OF CELLS IN MARCH 2025

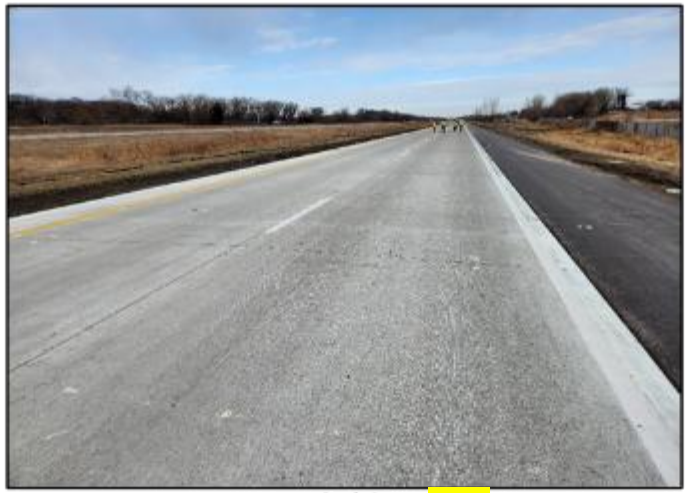


2401 (LC3)

2403 (Q)

2405 (SC)

2406 (AS)



2407 (T)

2408 (SB)

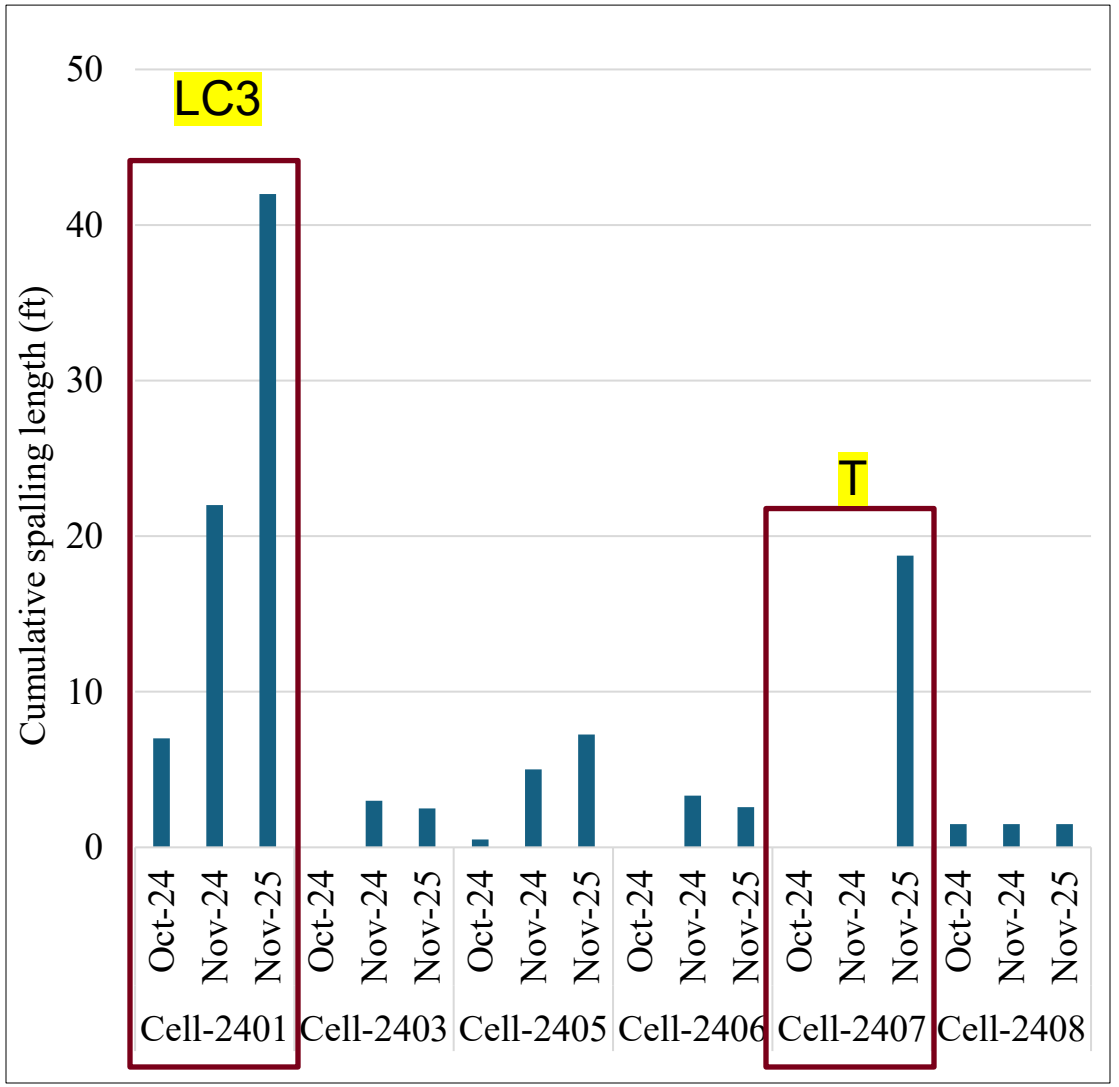
All cells are performing well ☺

Courtesy: Dan King (Co-PI)

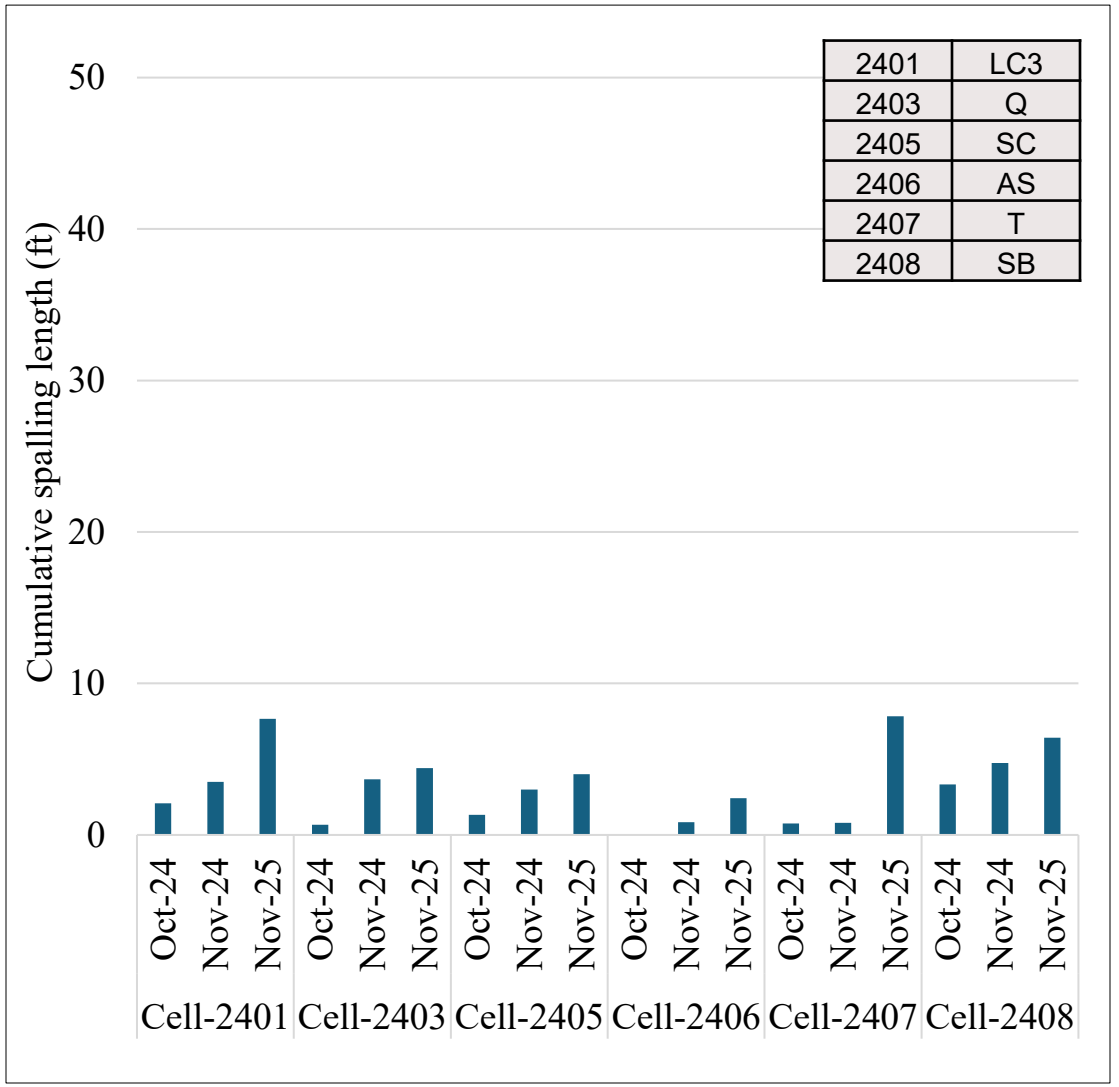
PAVEMENT DISTRESSES & RIDE QUALITY

Spalling	October 2024, November 2024, and November 2025
Cracking	
Pop Out	
Faulting	November 2024, March 2025, and November 2025
IRI	October 2024, March 2025

PAVEMENT DISTRESSES: Spalling



Longitudinal Joints

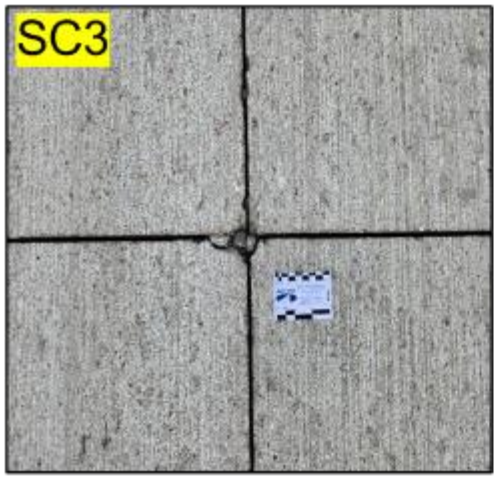


Transverse Joints

PAVEMENT DISTRESSES: Photographs

2401

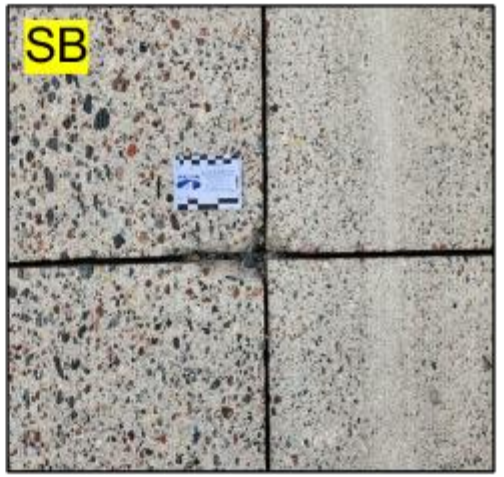
2403



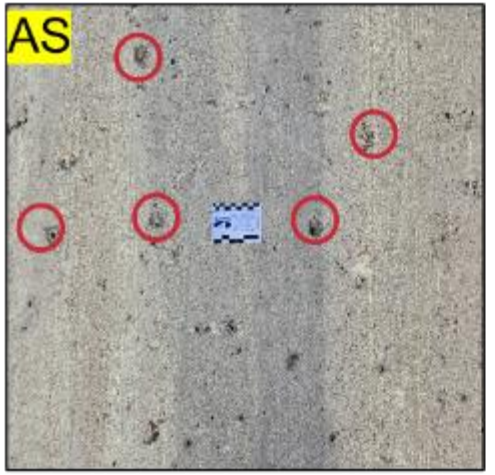
2405

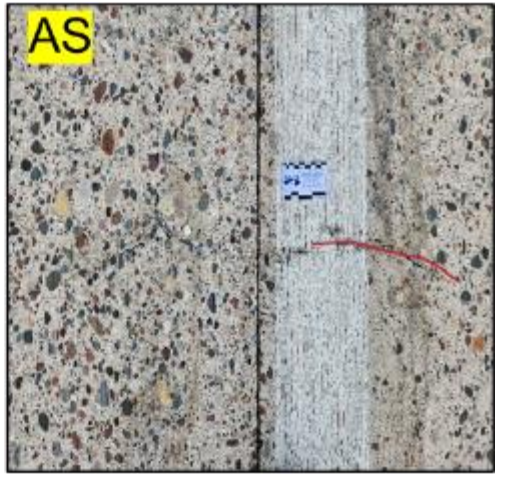
2406

2407



2408

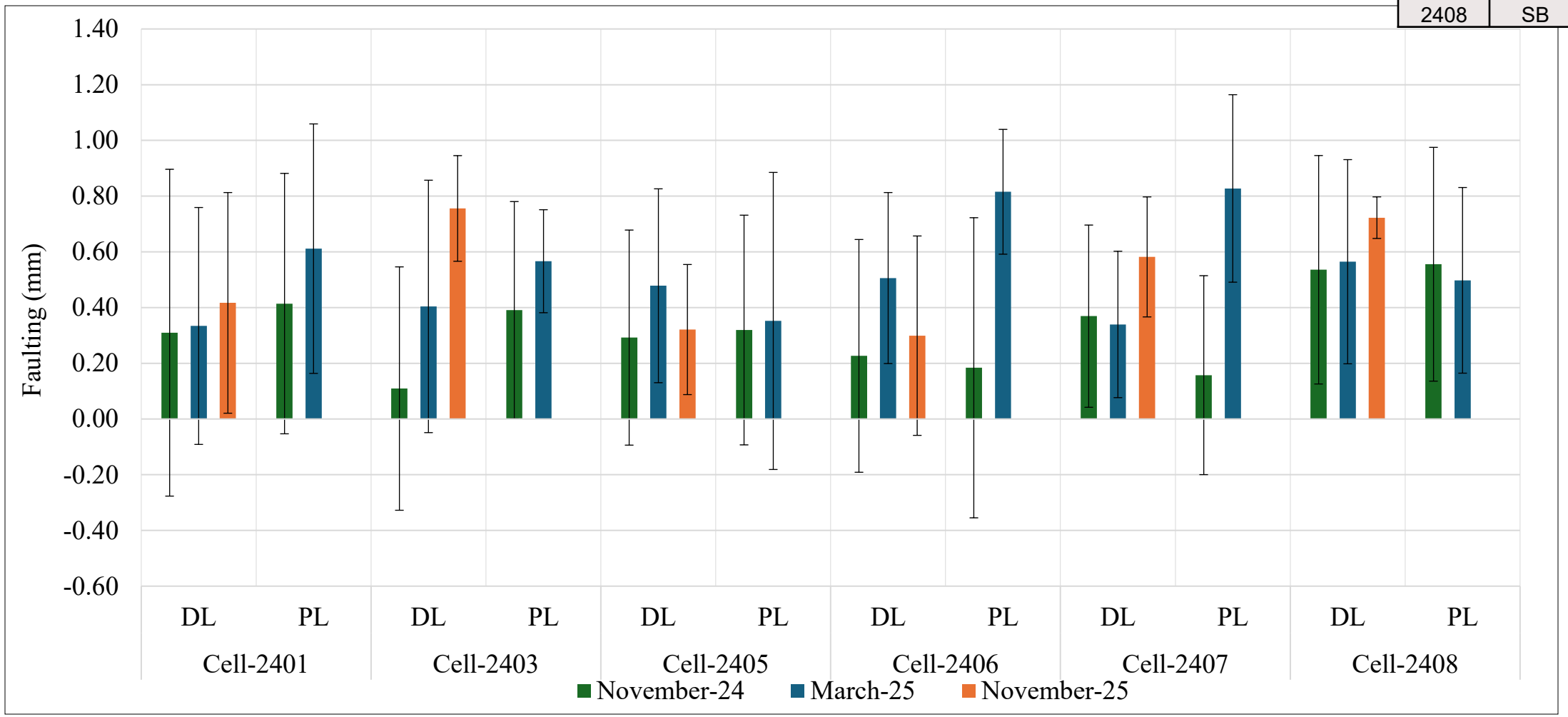




Aggregate pop out (left) and transverse crack (right) observed in Cell 2406

PAVEMENT DISTRESSES: Transverse Joint Faulting

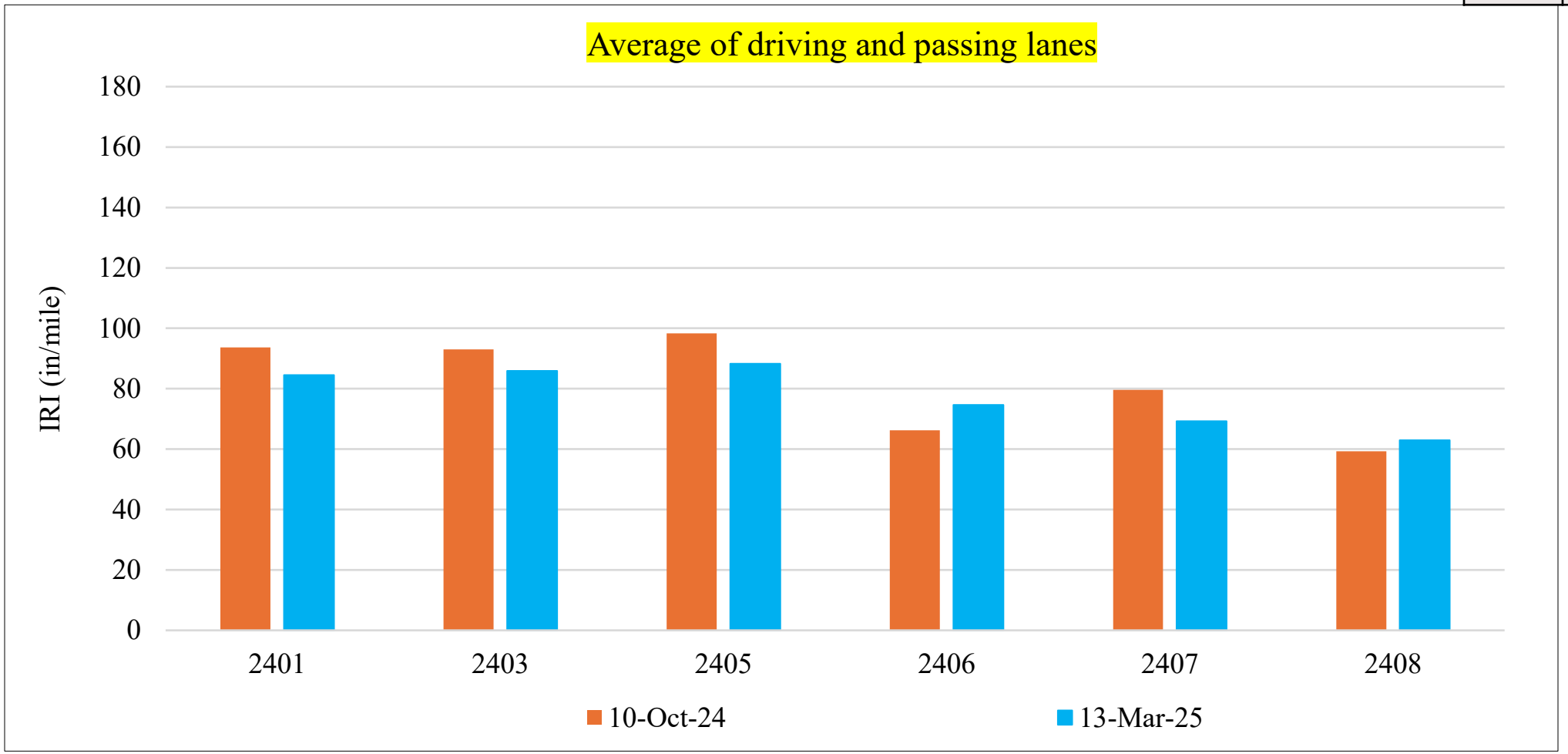
2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



Minimal faulting in all cells; Average <1 mm

RIDE QUALITY: International Roughness Index (IRI)

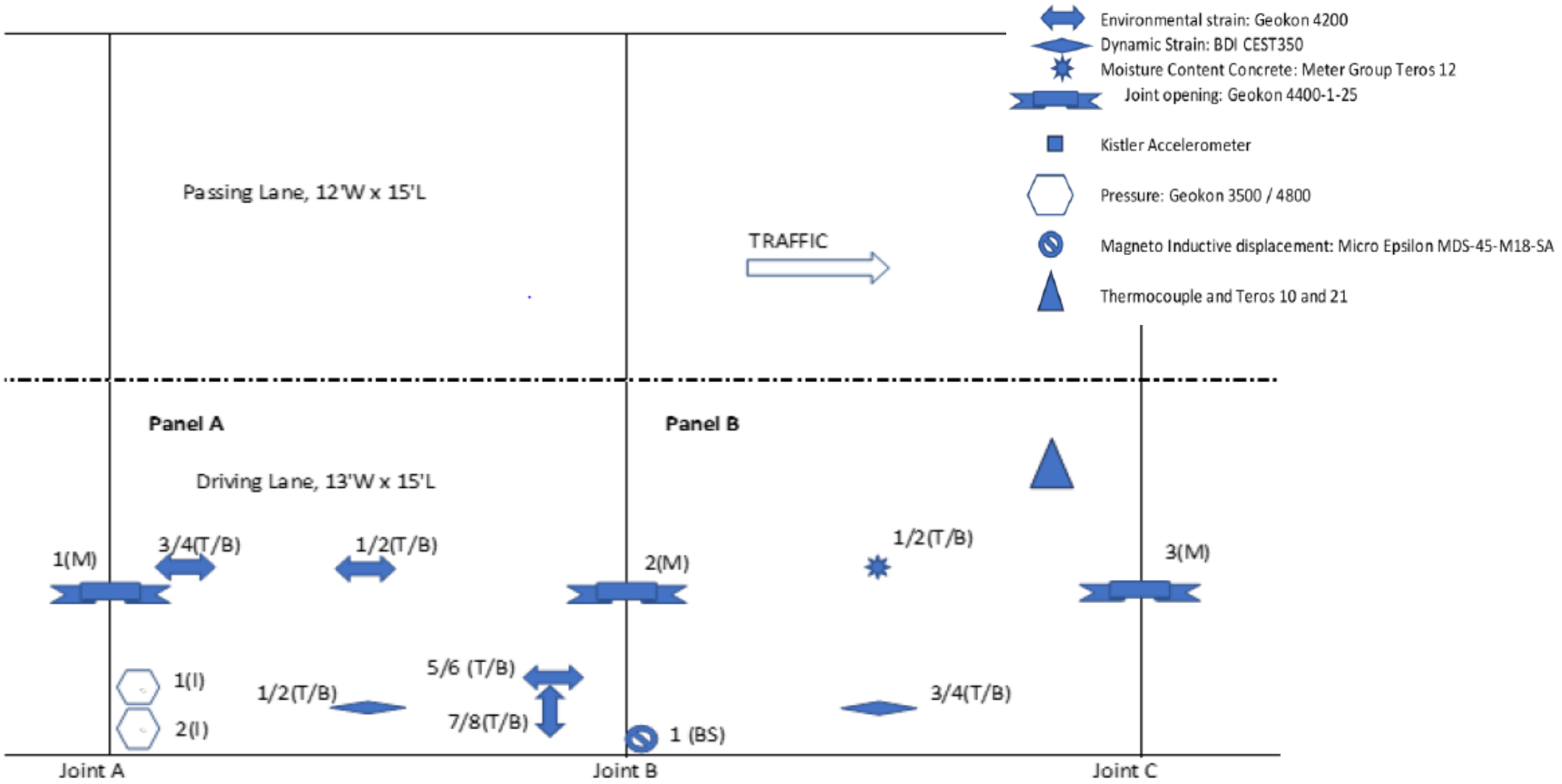
2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



IRI: 60 to 98 in/mile. March 2025 IRI < Oct 2024 IRI; may be just a seasonal variation affected by curling and warping.

SENSOR DATA ANALYSIS

SENSOR LAYOUT



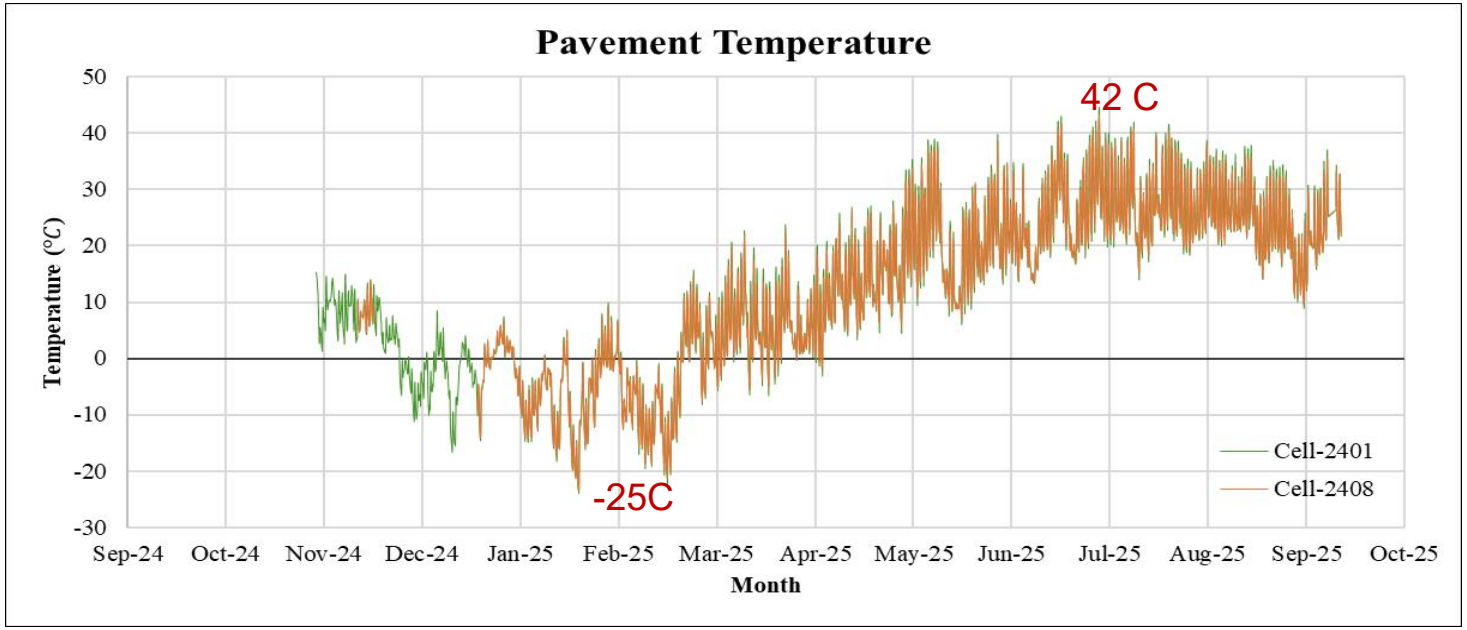
SENSOR DATA COLLECTION TIME PERIOD

	Cells	Data available date range
Temperature (Thermocouple)	2408	November 12 2024 12:45 PM - September 19 2025 12:15 AM
Environmental strain (Vibrating Wire)	2401	October 30 2024 11:00 AM - September 19 2025 12:45 AM
	2403	October 03 2024 08:30 AM - September 19 2025 12:15 AM
	2405	September 12 2024 03:00 PM - September 19 2025 12:00 AM
	2406	October 03 2024 09:30 AM - September 19 2025 12:00 AM
	2407	September 12 2024 03:00 PM - September 18 2025 11:45 PM
	2408	November 12 2024 12:45 PM - September 19 2025 12:15 AM
Joint opening (Transverse joint opening Sensor)	2401	December 18 2024 01:00 PM - September 19 2025 12:45 AM
	2403	December 18 2024 01:00 PM - September 19 2025 12:15 AM
	2405	December 18 2024 02:00 PM - September 19 2025 12:00 AM
	2406	December 20 2024 09:15 AM - September 19 2025 12:00 AM
	2407	December 18 2024 02:00 PM - September 18 2025 11:45 PM
	2408	December 20 2024 09:00 AM - September 19 2025 12:15 AM

SENSOR PHOTOGRAPHS

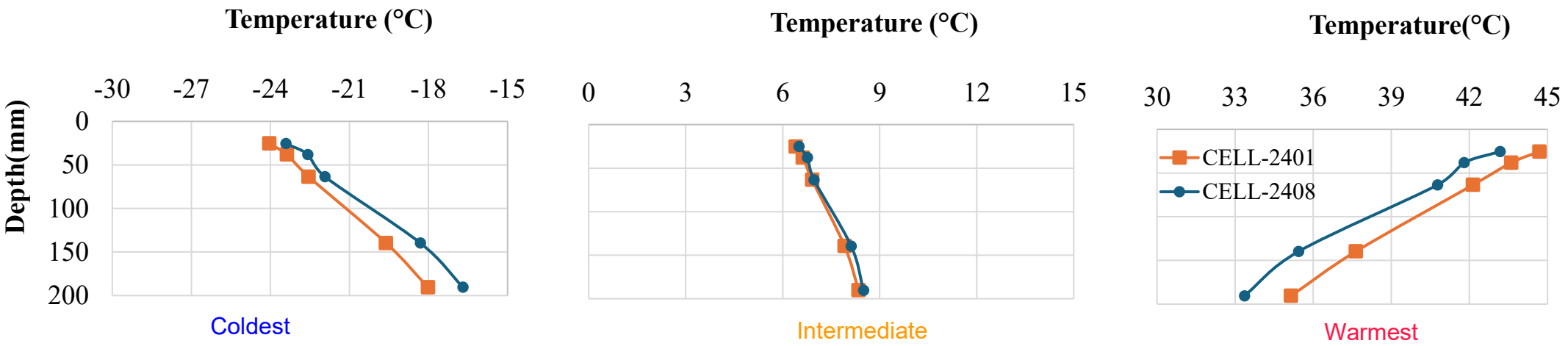
SENSOR PHOTOGRAPHS

PAVEMENT TEMPERATURE



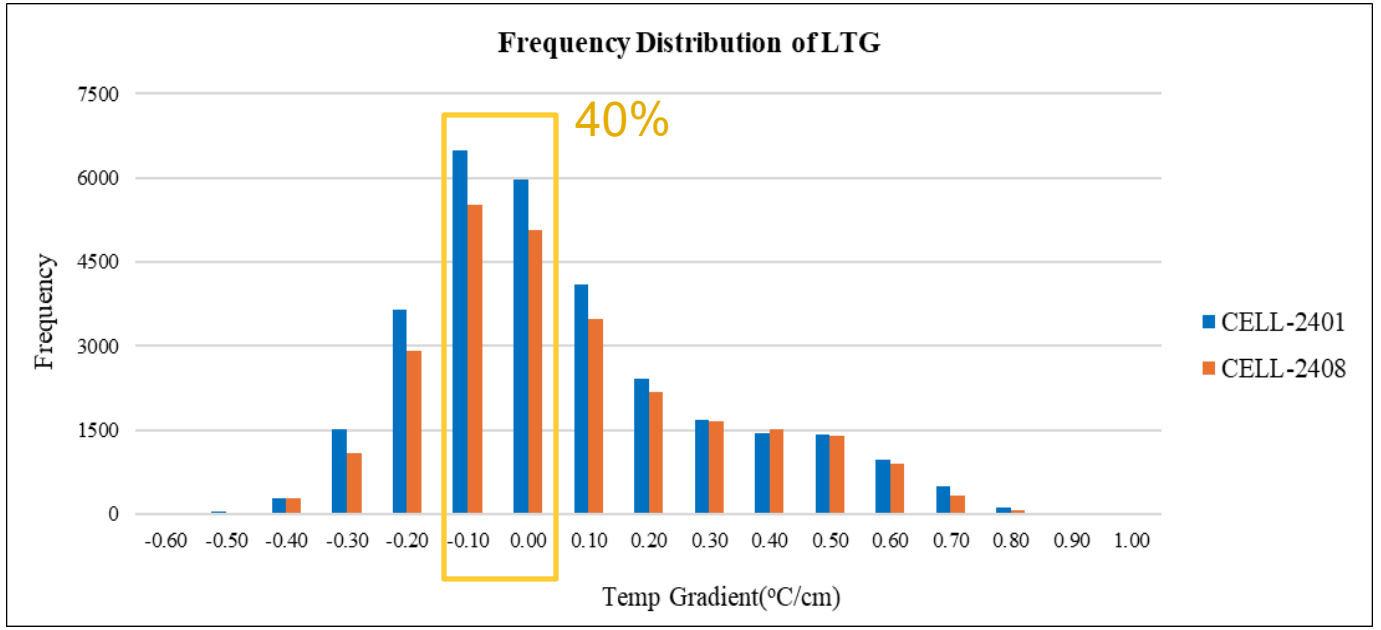
67C

120F



Temp. was measured only in two cells: 2401 and 2408. Temp vs depth relationship is mostly linear.

LINEAR TEMPERATURE GRADIENT



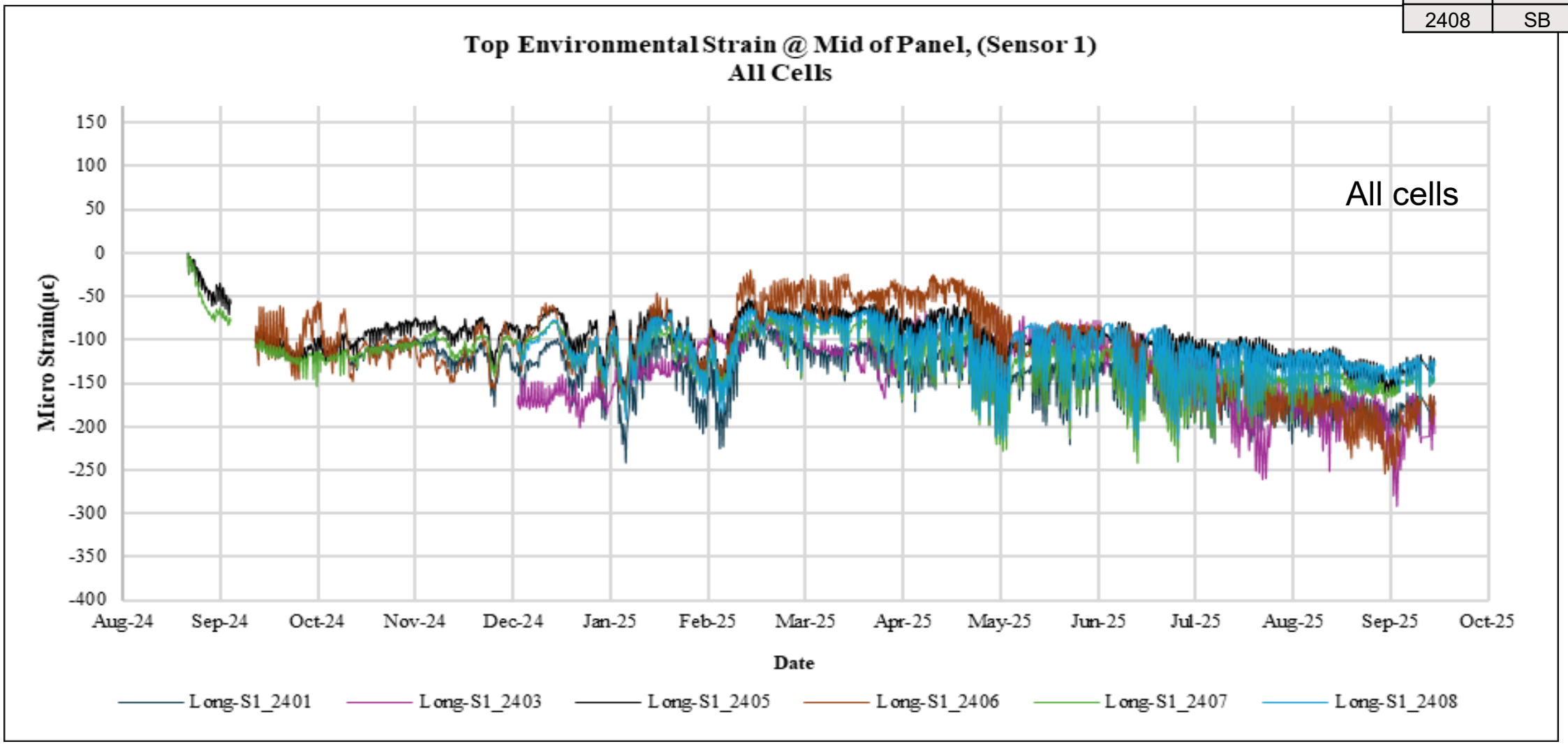
CELL 2401	LTG (°C/cm)		CELL 2408	LTG (°C/cm)	
	Max	Min		Max	Min
Oct-24	0.00	-0.46	Oct-24	-	-
Nov-24	0.33	-0.42	Nov-24	0.25	-0.21
Dec-24	0.47	**-0.53**	Dec-24	0.28	-0.42
Jan-25	0.50	-0.46	Jan-25	0.48	**-0.47**
Feb-25	0.64	-0.45	Feb-25	0.62	-0.44
Mar-25	0.77	-0.40	Mar-25	**0.89**	-0.42
Apr-25	0.74	-0.32	Apr-25	0.71	-0.32
May-25	**0.86**	-0.35	May-25	0.80	-0.34
Jun-25	0.79	-0.31	Jun-25	0.75	-0.30
Jul-25	0.69	-0.37	Jul-25	0.67	-0.35
Aug-25	0.59	-0.34	Aug-25	0.57	-0.32
Sep-25	0.63	-0.37	Sep-25	0.60	-0.36

Linear temp. gradient was either 0 or -0.1°C/cm for 40% of the time.

Negative temp. gradient = top of the pavement is colder than bottom

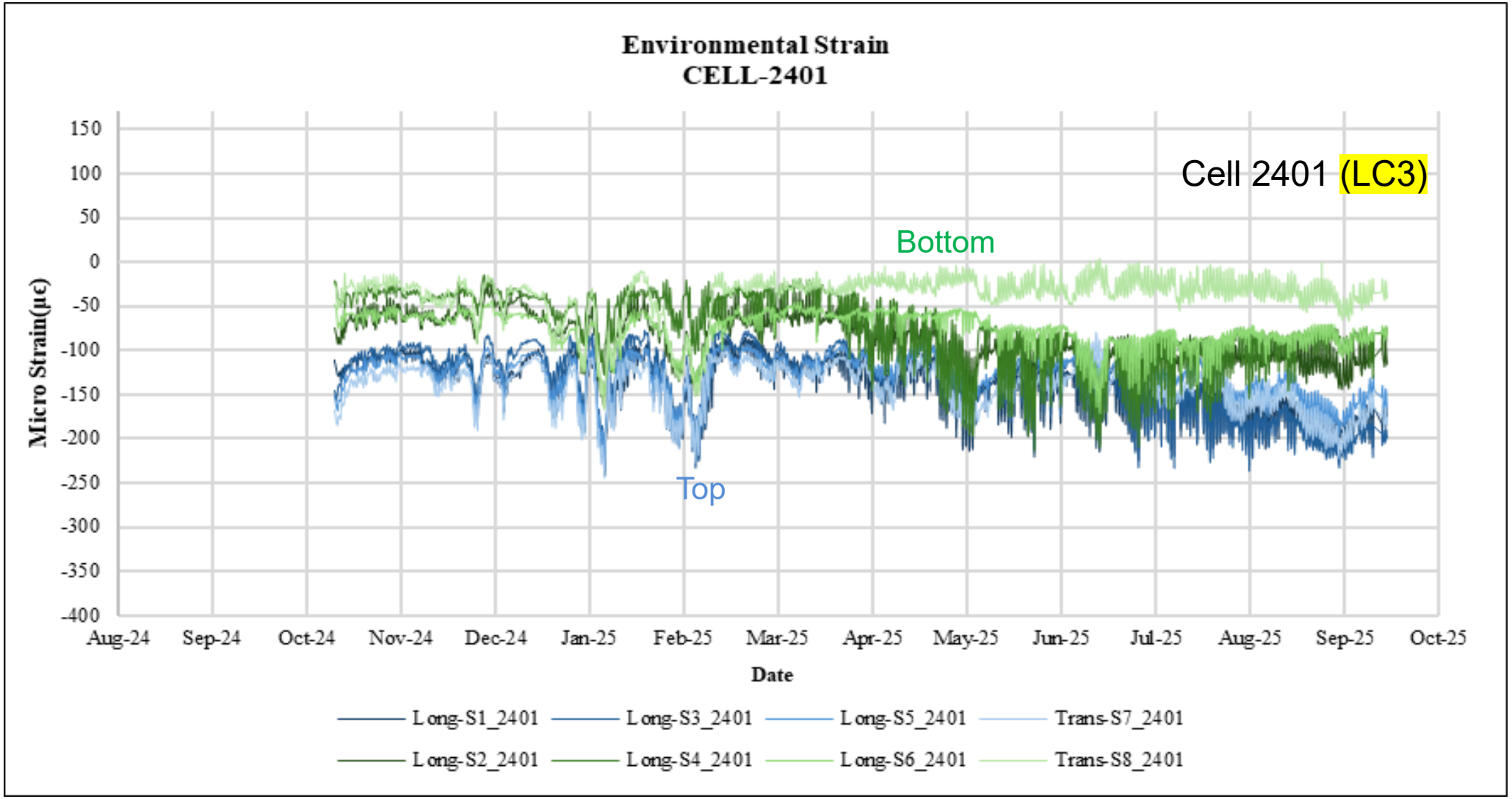
STRAIN IN CONCRETE- COMPARISON BET. CELLS

2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



Only Cells 2405 and 2407 have data from beginning; other cells missed of first 3 to 4 weeks.

STRAIN IN CONCRETE: SLAB DEPTH WISE COMPARISON



STRAIN ANALYSIS

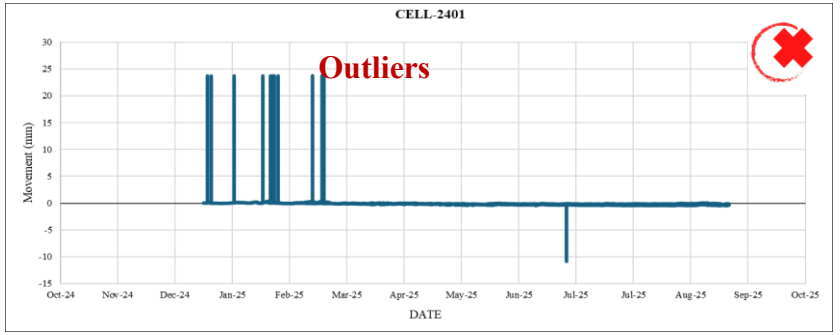
Cell		Microstrain Max
2401	Long-S1_2401	-241.68
	Long-S2_2401	-171.92
	Long-S3_2401	-236.74
	Long-S4_2401	-213.70
	Long-S5_2401	-230.48
	Long-S6_2401	-171.37
	Trans-S7_2401	**-244.41**
	Trans-S8_2401	-167.56
2403	Long-S1_2403	-291.65
	Long-S2_2403	-189.28
	Long-S3_2403	-231.48
	Long-S4_2403	-274.77
	Long-S5_2403	-247.24
	Long-S6_2403	-237.75
	Trans-S7_2403	-213.19
	Trans-S8_2403	-117.61
2405	Long-S1_2405	-198.62
	Long-S2_2405	-169.25
	Long-S3_2405	-233.68
	Long-S4_2405	-214.05
	Long-S5_2405	-209.30
	Long-S6_2405	-123.13
	Trans-S7_2405	-234.75
	Trans-S8_2405	-

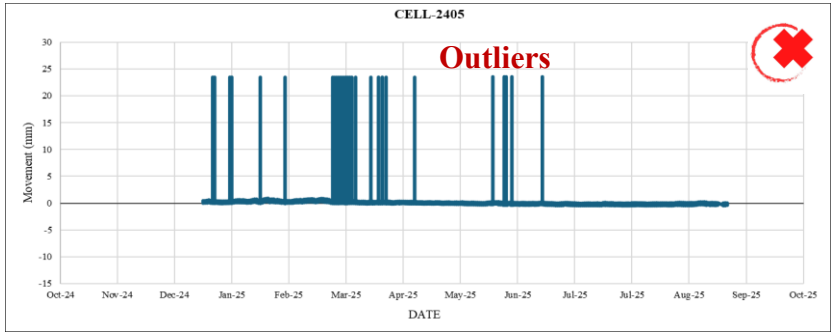
Cell		Microstrain Max
2406	Long-S1_2406	-254.71
	Long-S2_2406	-
	Long-S3_2406	-328.84
	Long-S4_2406	-145.89
	Long-S5_2406	-302.83
	Long-S6_2406	-101.02
	Trans-S7_2406	-370.24
	Trans-S8_2406	-71.59
2407	Long-S1_2407	-242.39
	Long-S2_2407	-224.39
	Long-S3_2407	-280.20
	Long-S4_2407	-281.29
	Long-S5_2407	-204.55
	Long-S6_2407	-182.96
	Trans-S7_2407	-205.28
	Trans-S8_2407	-110.38
2408	Long-S1_2408	-216.45
	Long-S2_2408	-202.23
	Long-S3_2408	-280.23
	Long-S4_2408	-246.71
	Long-S5_2408	-211.08
	Long-S6_2408	-180.48
	Trans-S7_2408	-221.52
	Trans-S8_2408	-116.30

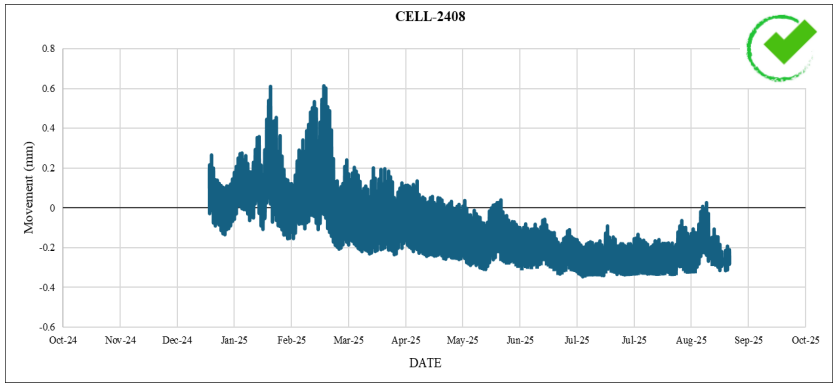
Cell	Highest Max Strain (microstrain)	% increase of strain compared to control cell
2401 (LC3)	-244.41	4
2403 (Q)	-291.65	24
2405 (SC)	-234.75	1
2406 (AS)	-370.24	58
2407 (T)	-281.29	20
2408 (SB)	-280.23	19

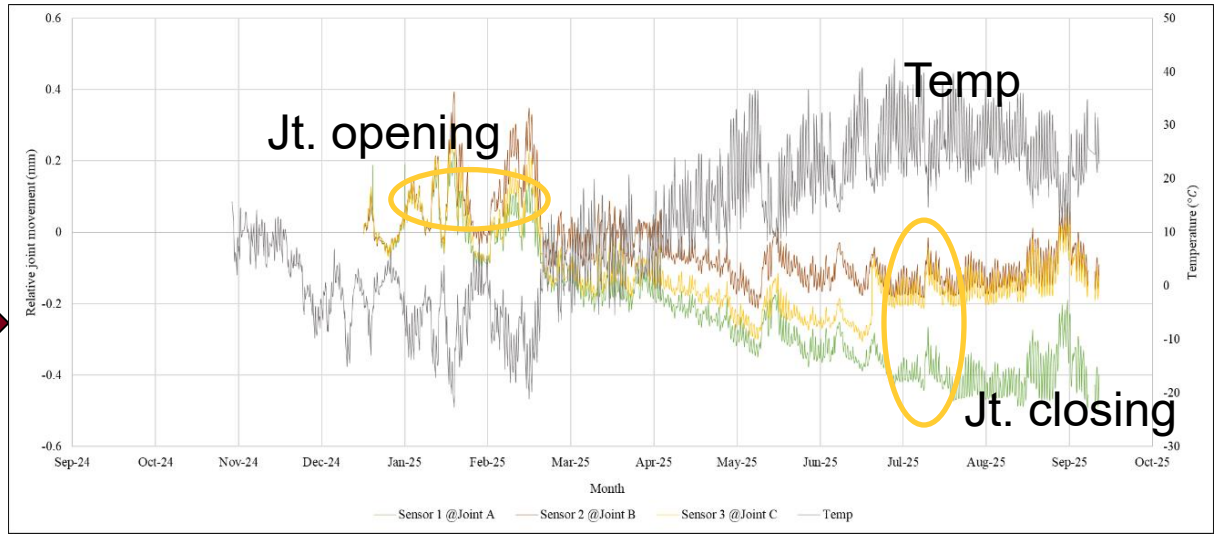
Cell 2406 experienced the highest amount of strain followed by Cell 2403. Control Cell 2405 experienced the least.

TRANSVERSE JOINT OPENING: Data Cleaning









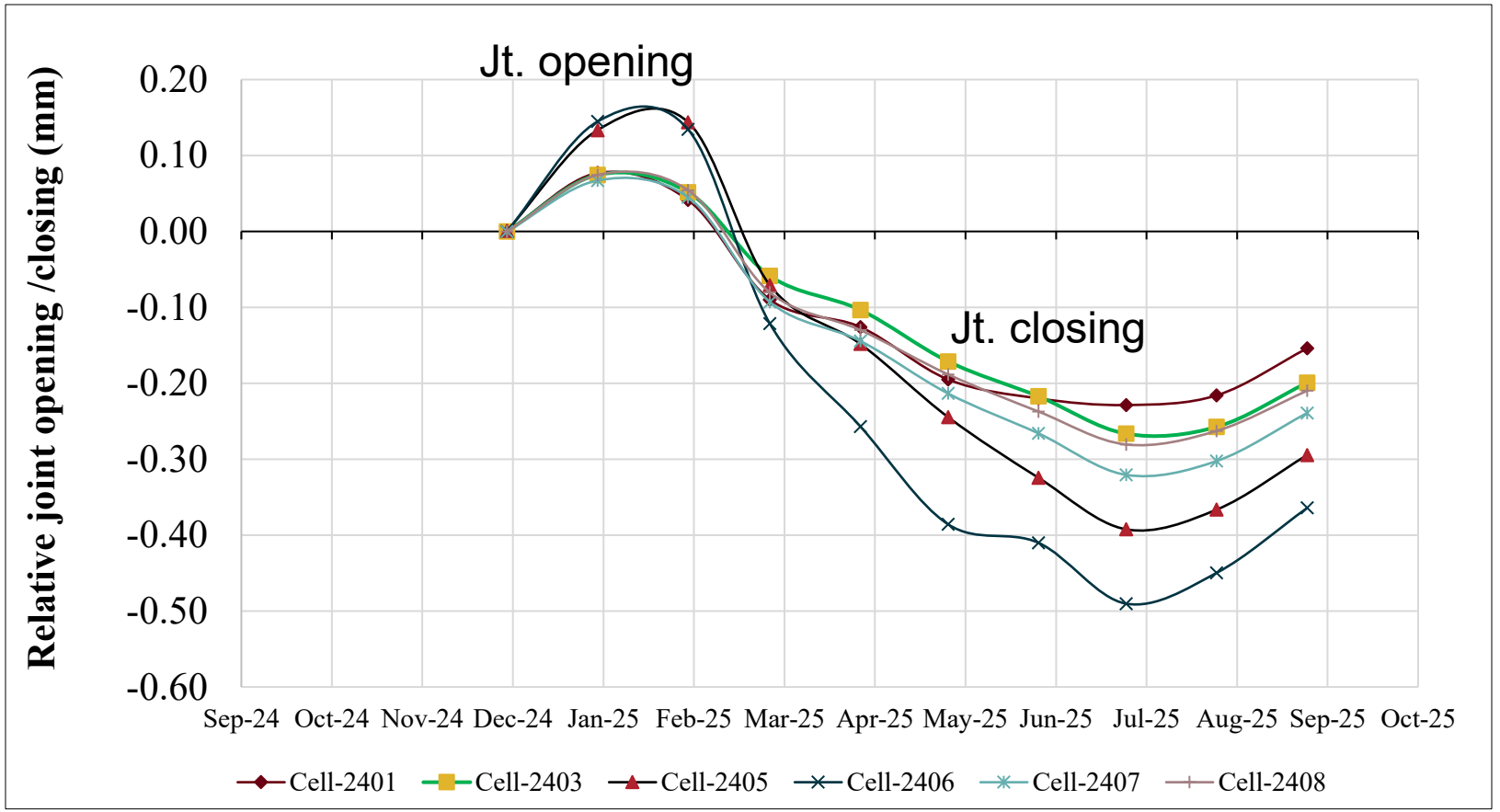
Outlier data was filtered out.

Joint opening data was available only from December

Relative joint opening with respect to December is shown in the graph above

TRANSVERSE JOINT OPENING

2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB

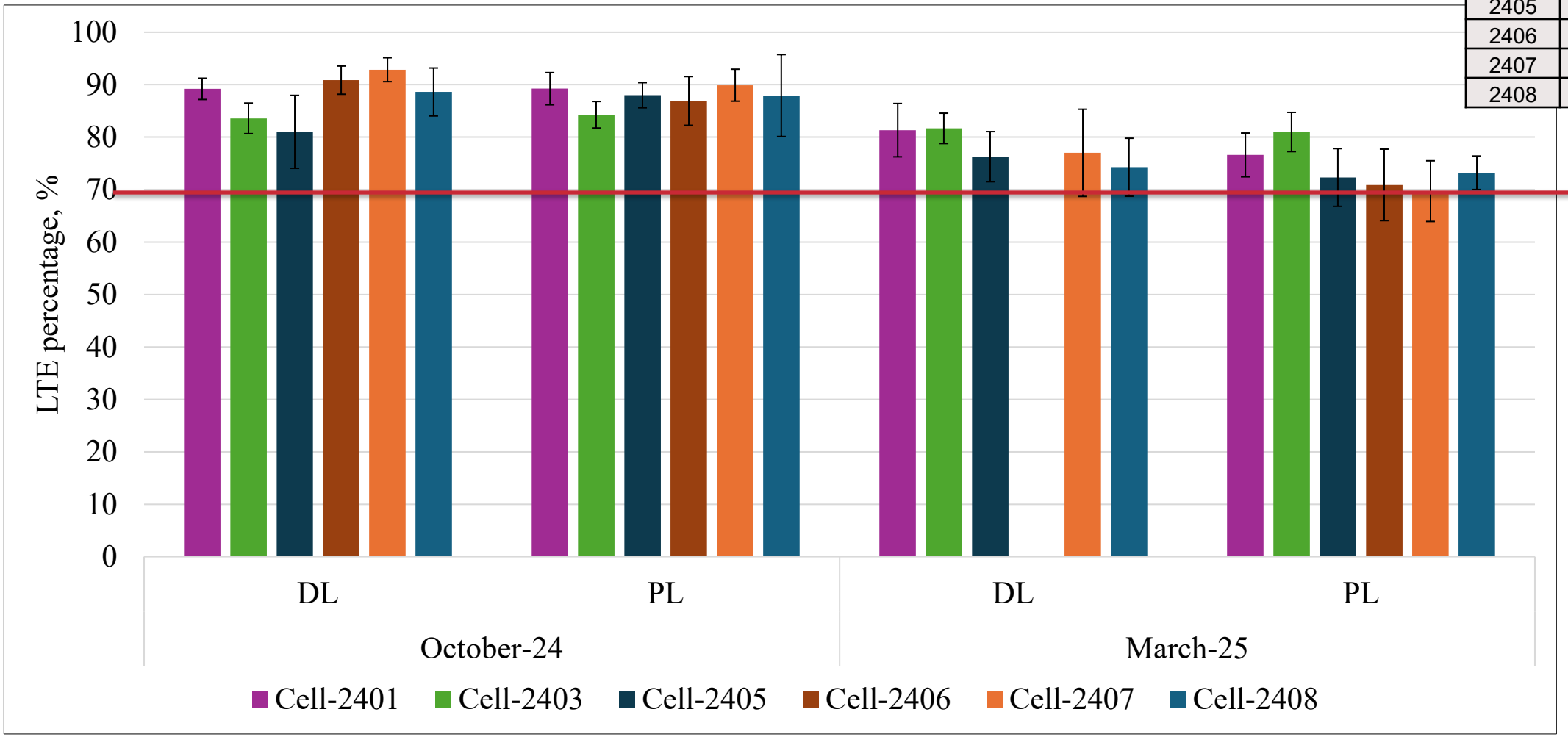


Cell	Opening (mm)	Closing (mm)
2401	0.077	-0.229
2403	0.074	-0.266
2405	0.143	-0.393
2406	0.145	-0.490
2407	0.067	-0.321
2408	0.074	-0.281

Relative joint opening/closing (mm) = Joint sensor reading at any month - Joint sensor reading in December 2024
Cell 2406 exhibited the largest joint movement.

JOINT PERFORMANCE (FWD): LTE

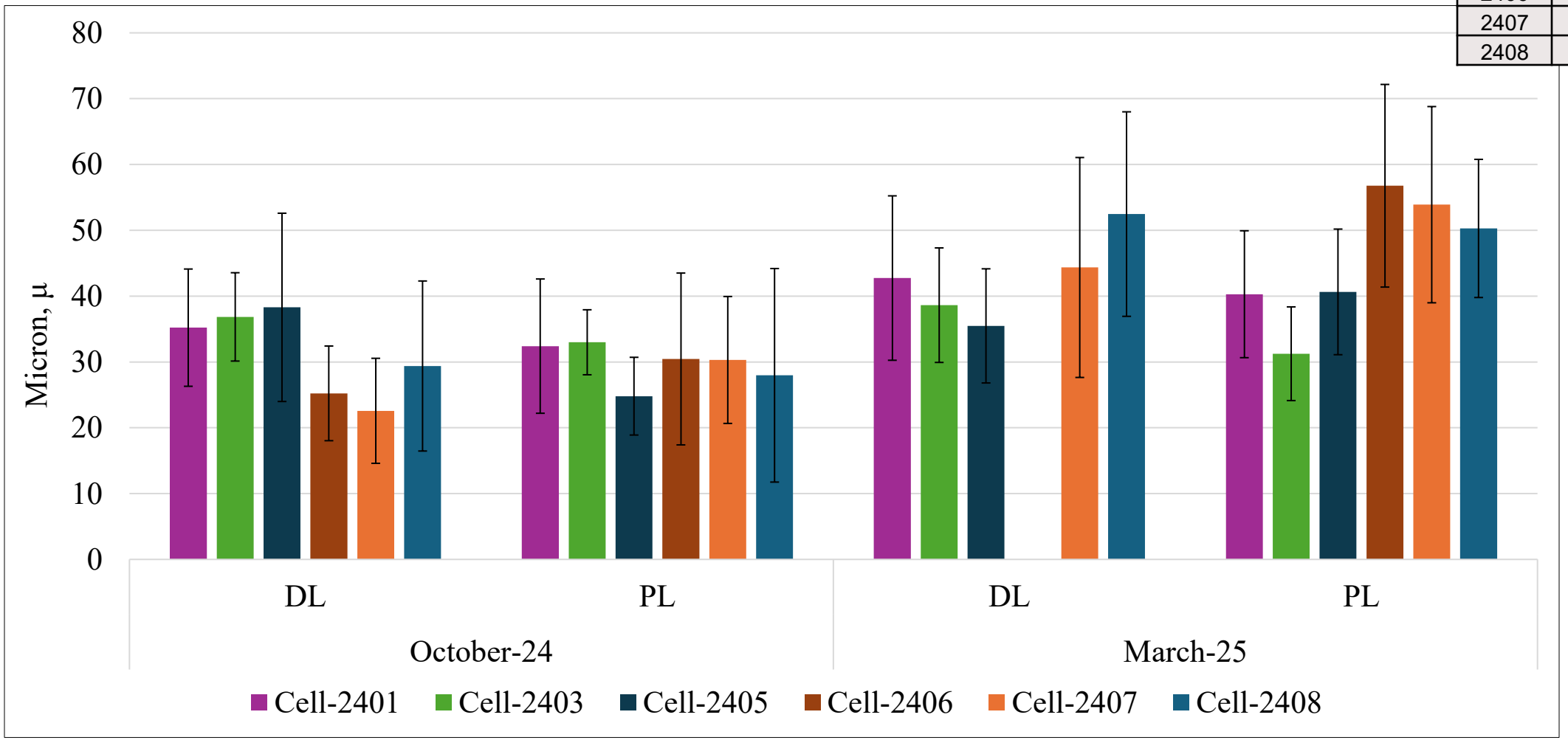
2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



LTE = Load Transfer Efficiency; All cells have greater than 70 LTE.

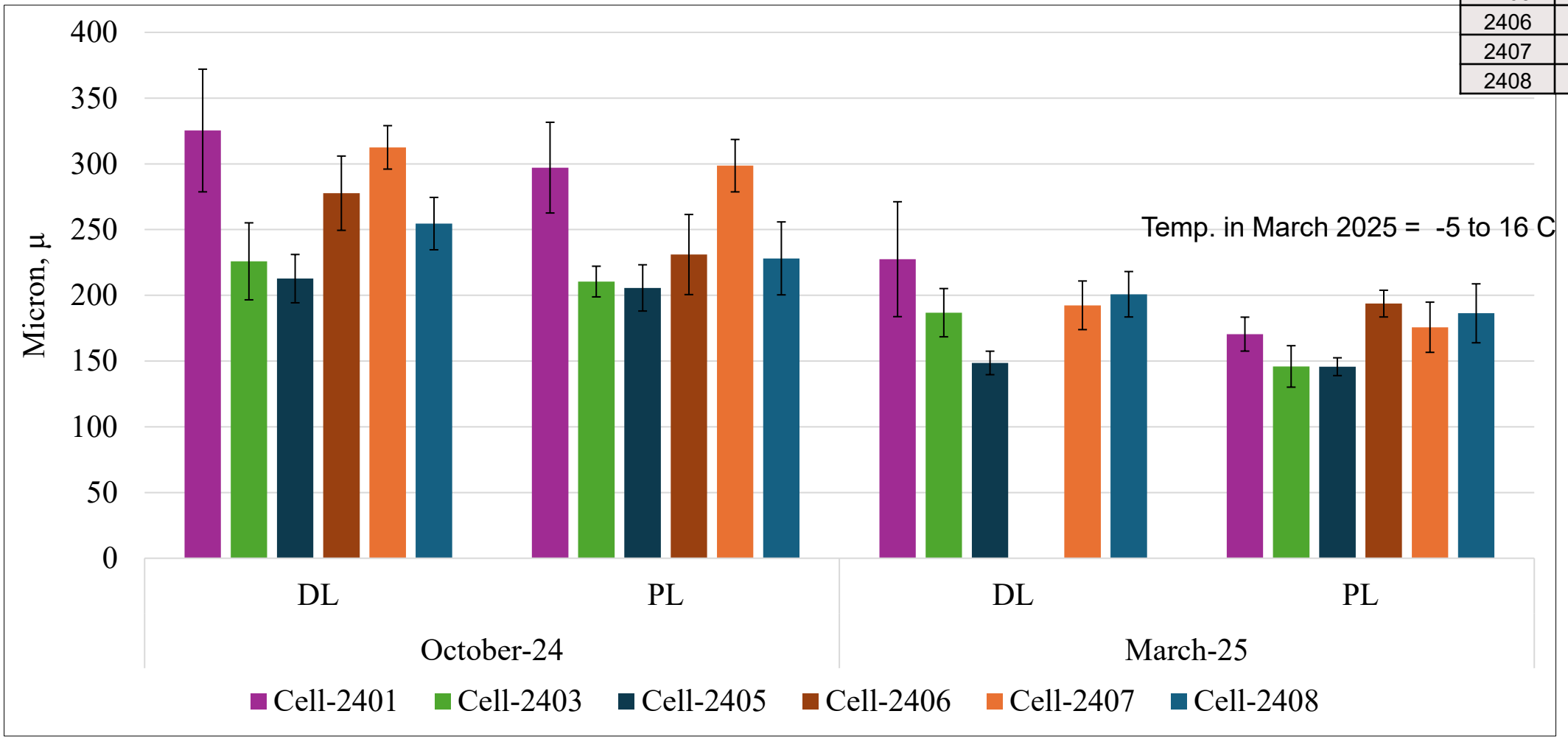
JOINT PERFORMANCE: Differential Displacement

2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



JOINT PERFORMANCE: Loaded side displacement

2401	LC3
2403	Q
2405	SC
2406	AS
2407	T
2408	SB



Slab displacement was lower in March 2025 than October 2024.

CONCLUSIONS

1. Overall, the distresses observed during the first year were minimal. Low-severity spalling along longitudinal and transverse joints was the most common distress.

2. All cells maintained IRI values well below the critical threshold of 170 in/mile.

3. Temperature profiles across slab depth were generally linear, and seasonal variations influenced strain development.

4. Cell 2406 (AS) was found to experience a slightly higher env. strain.

5. Joint opening followed seasonal temperature trends, widening during colder months and narrowing during warmer periods.

6. LTE and DD results were comparable between the cells. Deflection in all cells in March 2025 was less than that in October 2024.

thank you

Questions?

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