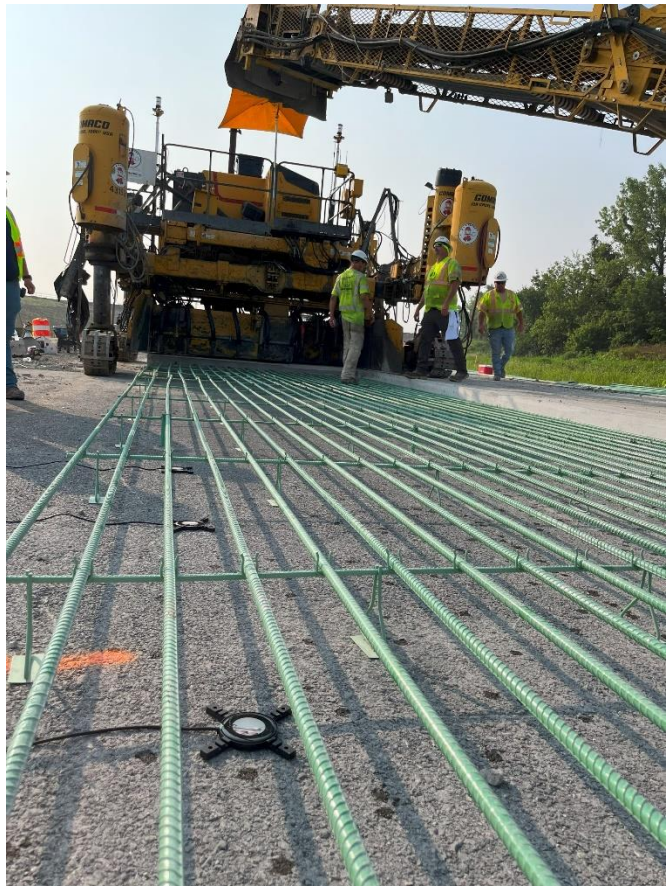
REBEL® Concrete Sensor Test Results Overview for INDOT Paving & Bridge

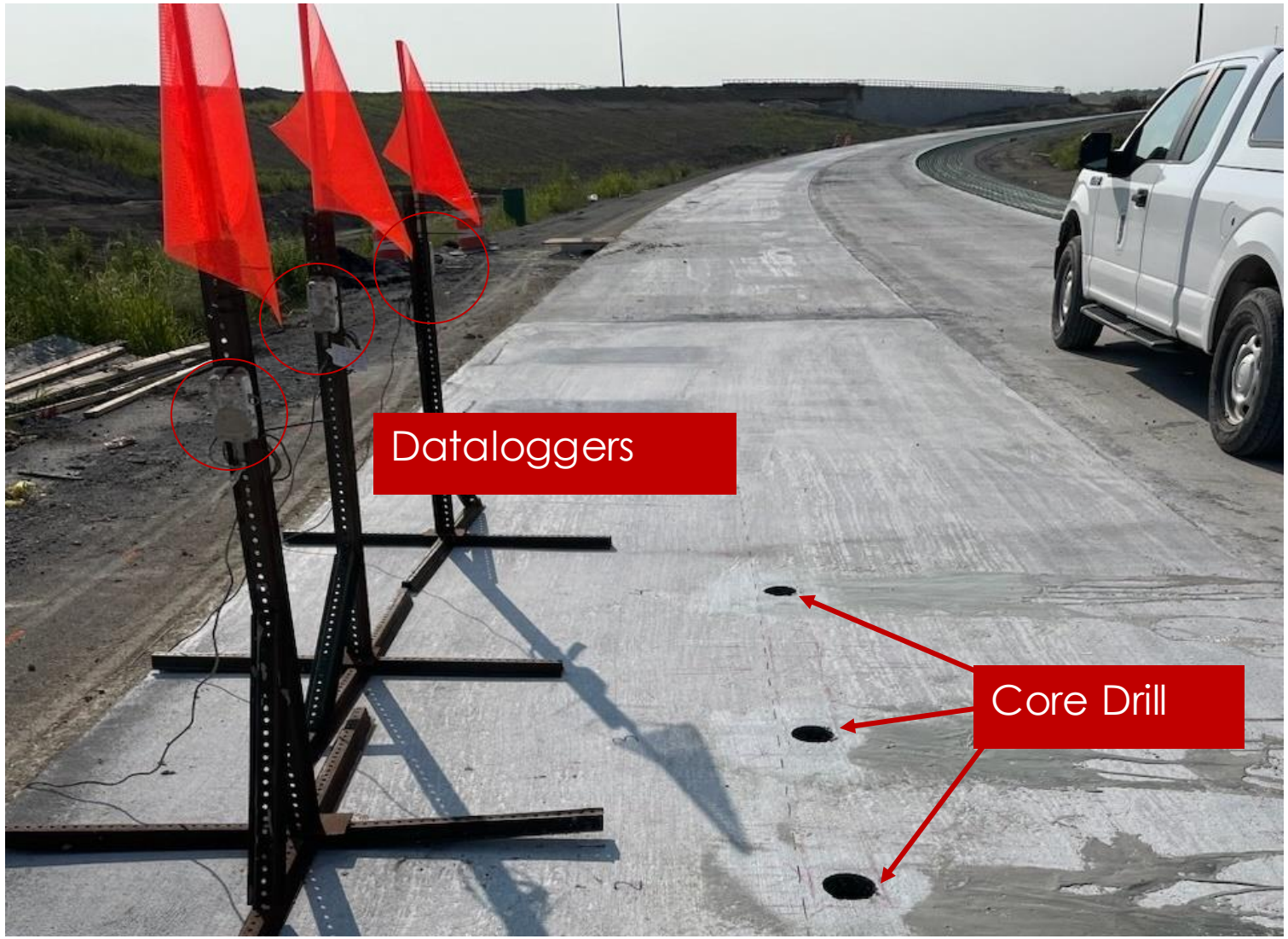
Summer 2023 – Fall 2024

Date	7-25-2023
Location	Indianapolis, IN
Pavement Thickness	11’’
Rebar	#6 (0.75’’)

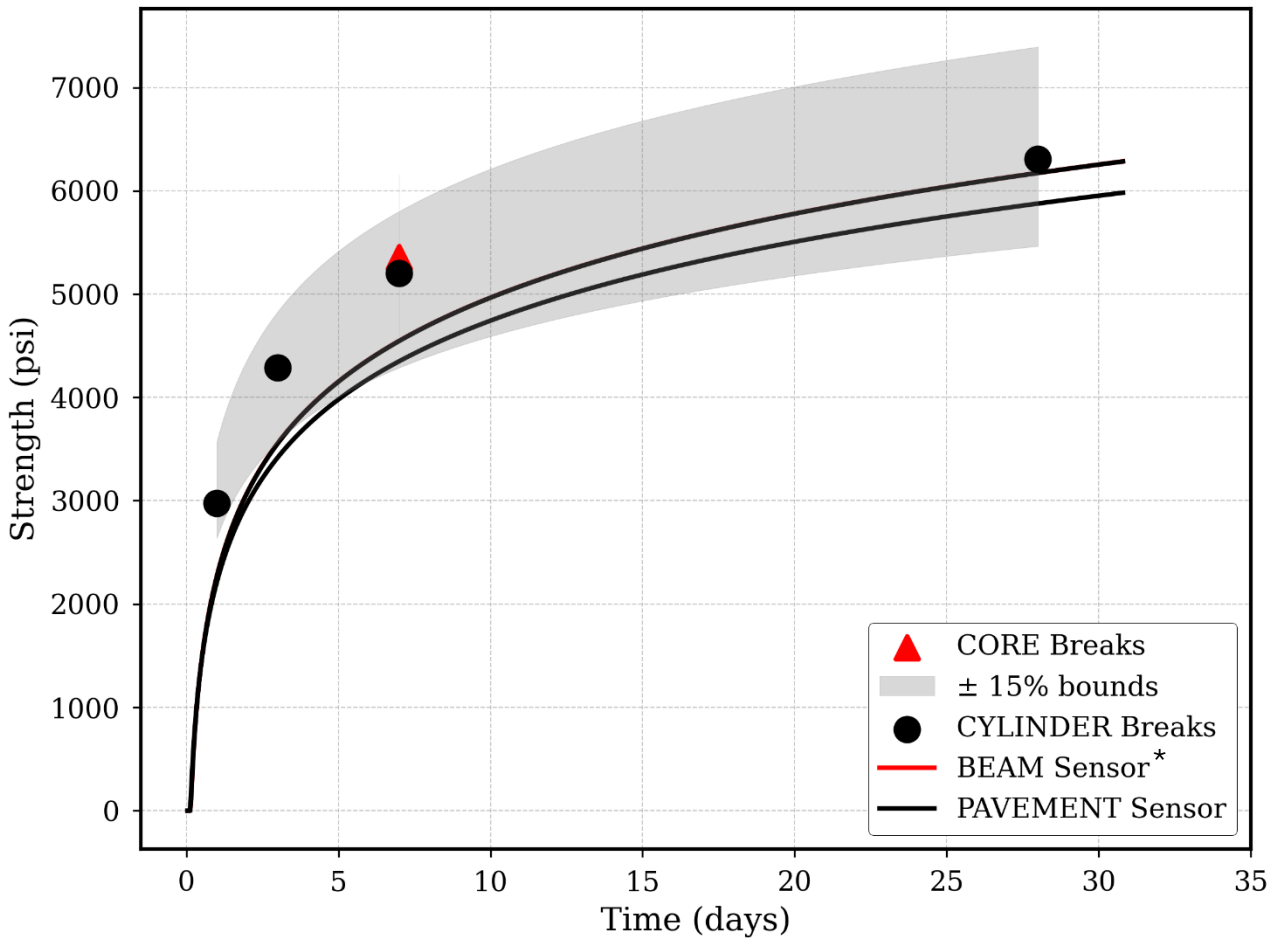
Ingredients	**Amount (/yd^3)**
Fine Agg.	1268 lbs.
Coarse Agg.	1830 lbs.
Cement	425 lbs.
Slag	145 lbs.
Water	233.7 lbs.
W/C Ratio	0.410


Paving Depth = 11”
#6 Rebar




Dataloggers
Core Drill

- 2 sensors placed in the pavement and 1 in a companion beam taken to the lab
- Cylinders were measured at 1, 3, 7, and 28 days
- Core was taken at 7-days
- Pavement sensors were within ACI allowable variability of 15% across all ages beyond 7 days



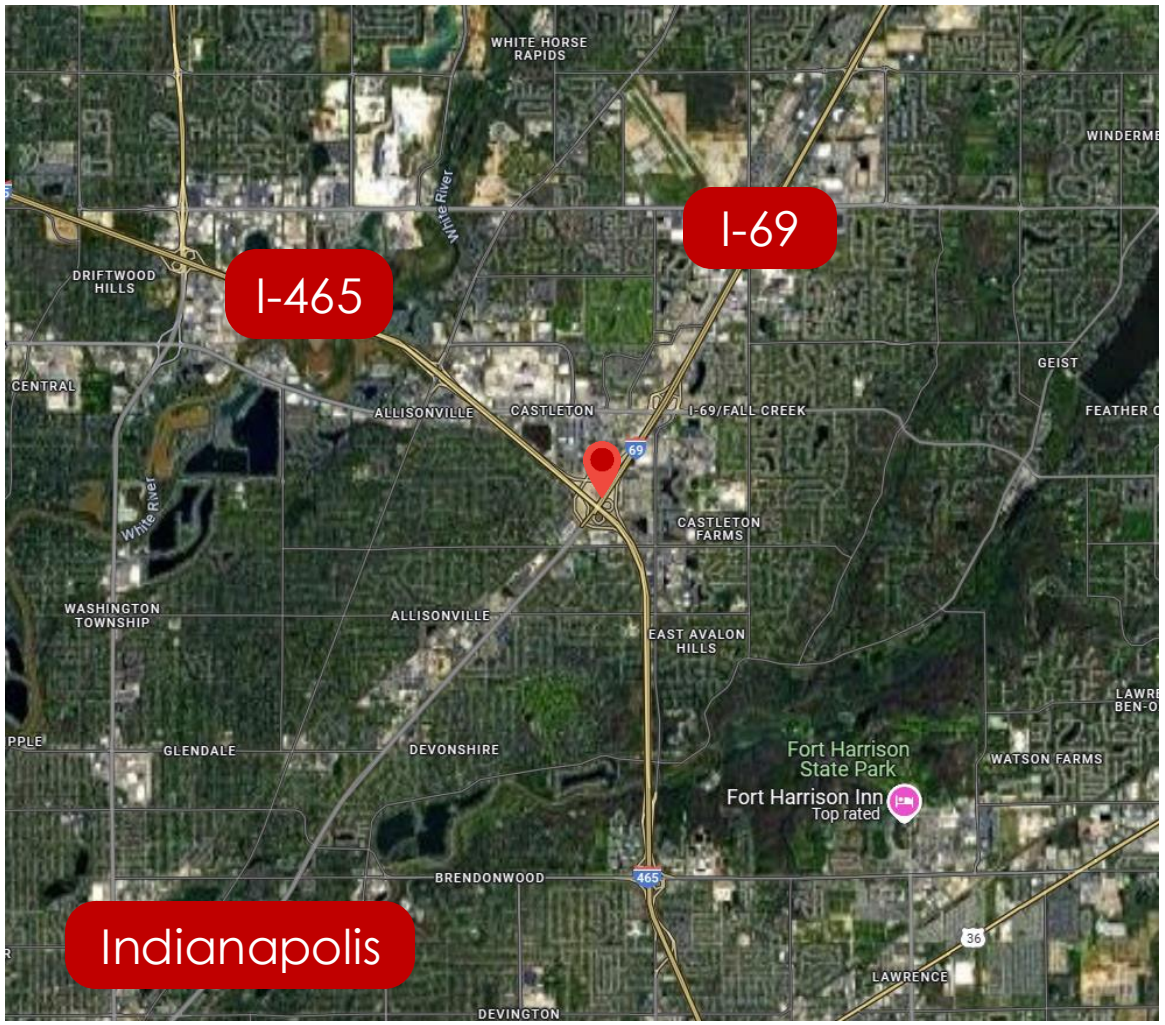
* Red BEAM Sensor Line Overlapped with Top PAVEMENT Sensor Line

- REBEL Sensor measurements were within 15% of cylinders at 7-day and 28-day
- Sensor measurements were within ~16% of cores at 7-days
- Sensor variability was excellent, with <2.5% variation in measurements across sensors at all ages

7-Day Strength	Avg. Strength	Difference from Core (%)
Core	5355	--
Cylinders	5044	5.8
REBEL Sensor	4481	16.3

Age	Avg. Difference Cylinders vs Sensors (psi)	Avg. Difference Cylinders vs Sensors (%)
1-Day	730	24.3
3-Day	778	18.5
7-Day	721	13.8
28-Day	233	3.6

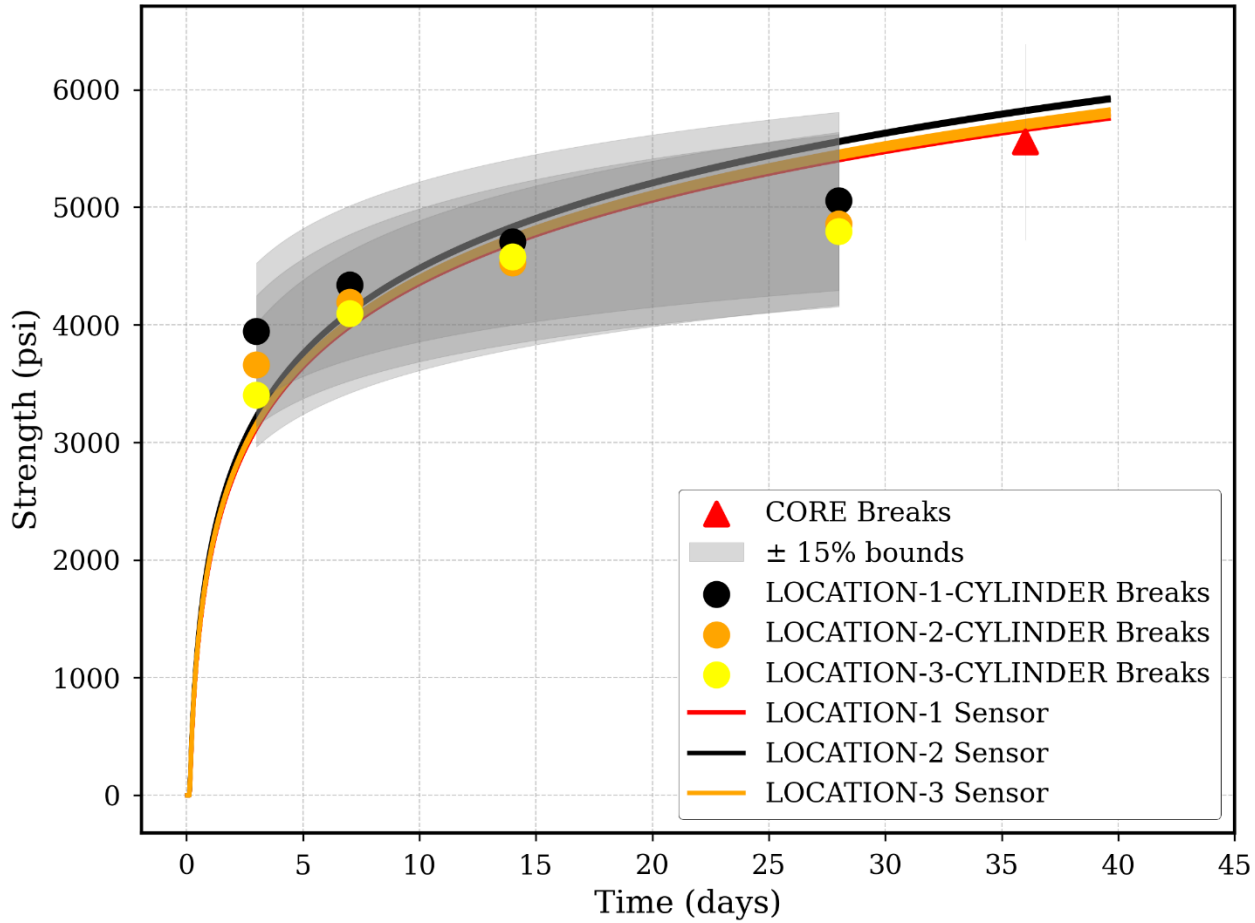
Age	Sensor Variability (%)
1-Day	1.2
3-Day	1.8
7-Day	2.1
28-Day	2.3



Date	9-16-2024
Location	Indianapolis, IN
Project Type	Pavement

Ingredients	**Amount (/yd^3)**
Fine Agg.	1301 lbs.
Coarse Agg.	1780 lbs.
Cement	520 lbs.
Water	230 lbs.
W/C Ratio	0.442

- 3 REBEL sensors were placed at different locations in the pavement
- 3 cylinders were measured for each critical age (3, 7, 14, and 28-days)
- Core was measured at day 36
- Sensors were within the 15% of cylinders across all ages, and were within 15% of the core at 36-days



* Cylinder strength extrapolated from curve fit

- REBEL Sensors were within 15% of cylinders at all ages
- REBEL Sensors were also within 3% of the 36-day core
- Sensor variability was excellent, with <6% variation in measurements across sensors at all ages

36-Day Strength	Avg. Strength	Difference from Core (%)
Core	5557	--
Cylinders*	5087	8.5
REBEL Sensor	5720	2.9

Age	Avg. Difference Cylinders vs Sensors (psi)	Avg. Difference Cylinders vs Sensors (%)
3-Day	513	13.6
7-Day	180	4.2
14-Day	98	2.1
28-Day	552	11.3

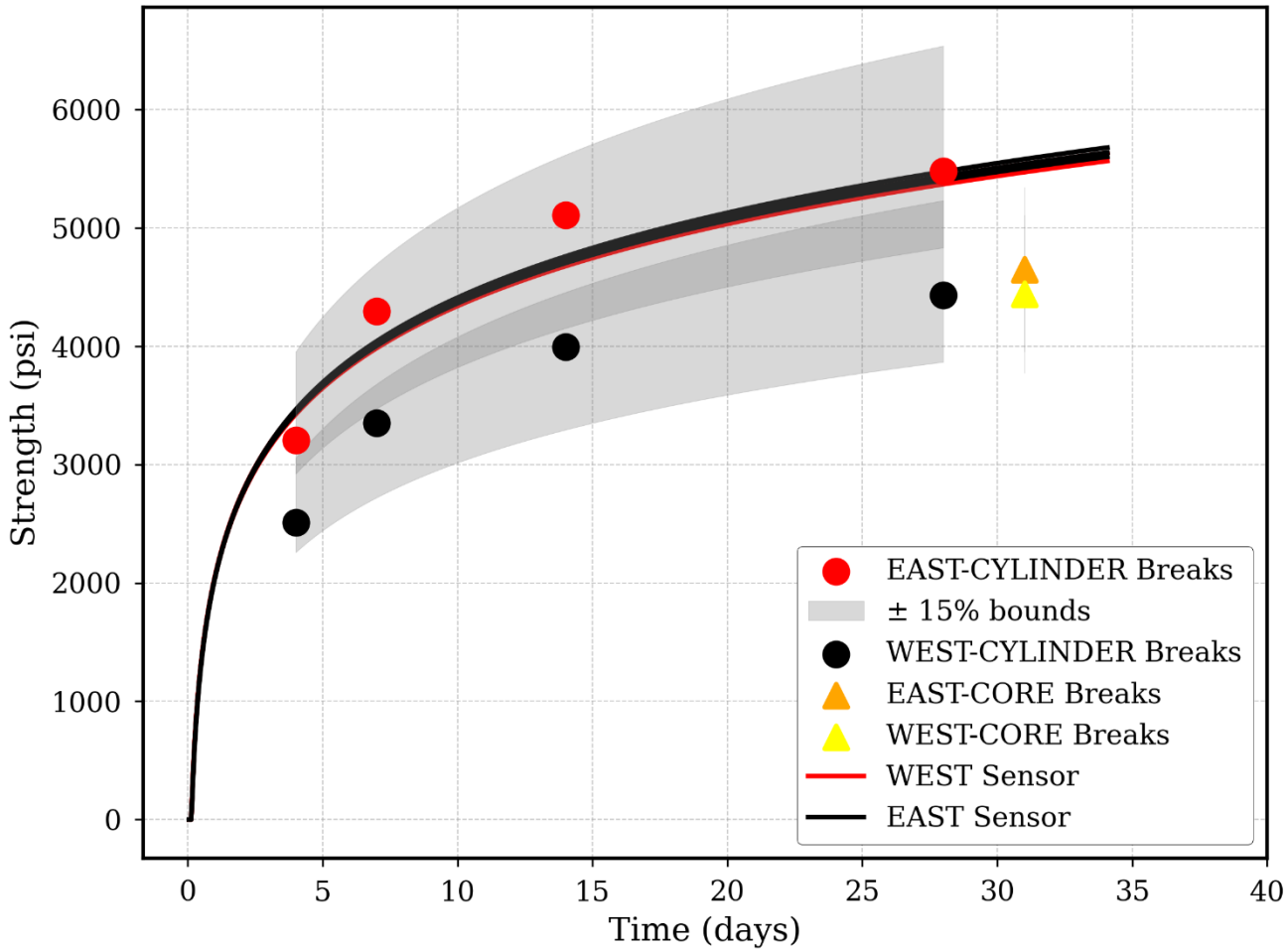
Age	Sensor Variability (%)	Cylinder Variability (%)
3-Day	1.2	6.0
7-Day	1.1	2.4
14-Day	1.1	1.6
28-Day	1.1	2.2

* Cylinder strength extrapolated from curve fit

Date	7-2-2024
Location	Indianapolis, IN
Project Type	Bridge Deck

Ingredients	**Amount (/yd^3)**
Fine Agg.	1115 lbs.
Coarse Agg.	1700 lbs.
Cement	460 lbs.
Slag	198 lbs.
Water	288 lbs.
W/C Ratio	0.438

- REBEL Sensors were placed at the East and West sides of the structure
- Cylinders were measured at 4, 7, 14, and 28-Days for both the East and West sides
- Cores were taken for the East and West sides at 32 days



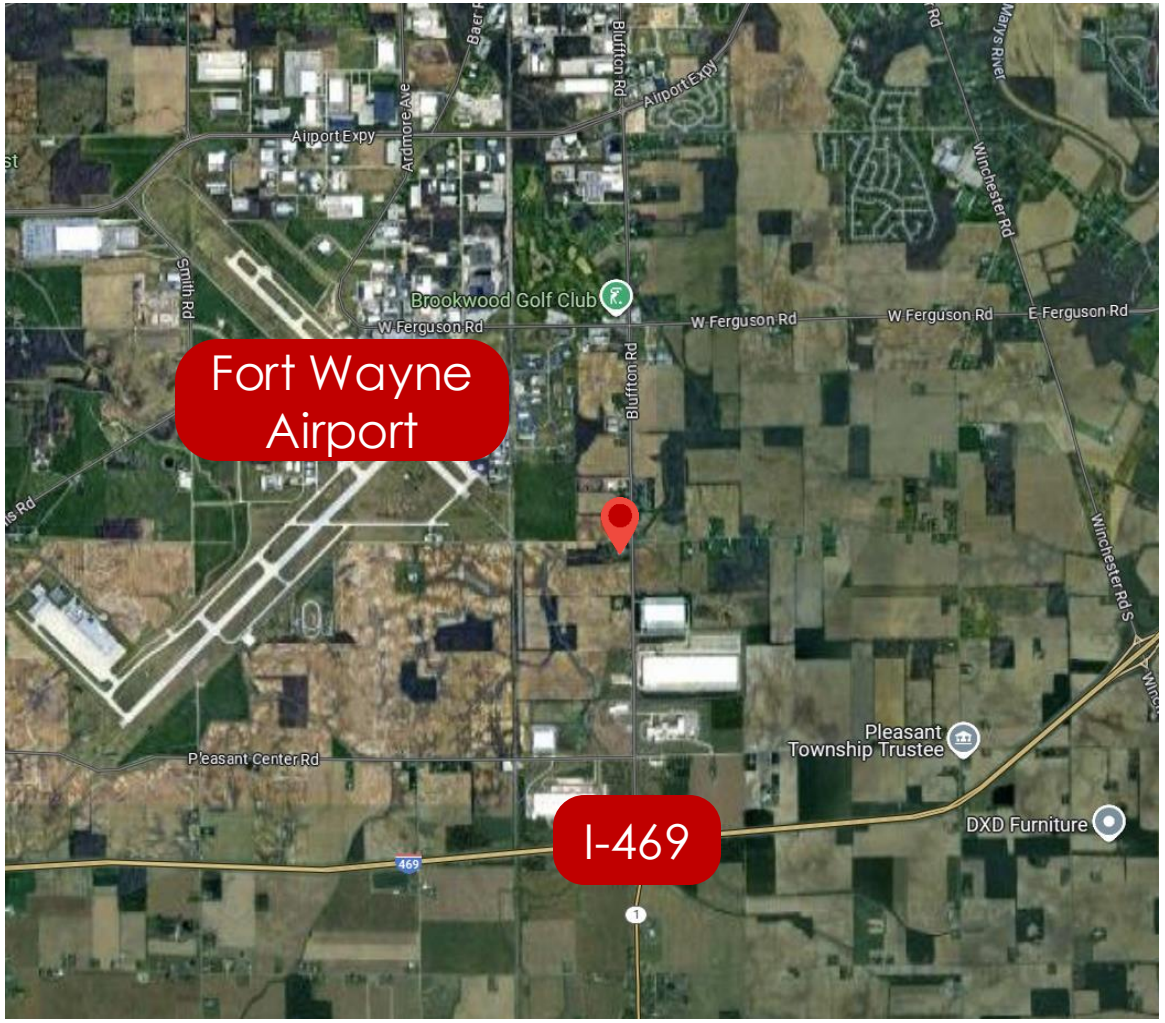
- Cores were significantly lower than both sensor and cylinder measurements
- Average sensor measurements were very consistent with cylinder measurements (within 5% across ages greater than 7 days)
- Sensor measurements were significantly more consistent than cylinders, with less than 1% variability across measurements

32-Day Strength	Avg. Strength	Difference from Core (%)
Core	4543	--
Cylinders*	5225	15.0
REBEL Sensor	5529	21.7

Age	Avg. Difference Cylinders vs Sensors (psi)	Avg. Difference Cylinders vs Sensors (%)
4-Day	370	12.2
7-Day	151	3.5
14-Day	257	5.1
28-Day	115	2.2

Age	Sensor Variability (%)	Cylinder Variability (%)
4-Day	0.4	12.2
7-Day	0.5	12.4
14-Day	0.6	12.2
28-Day	0.6	10.6

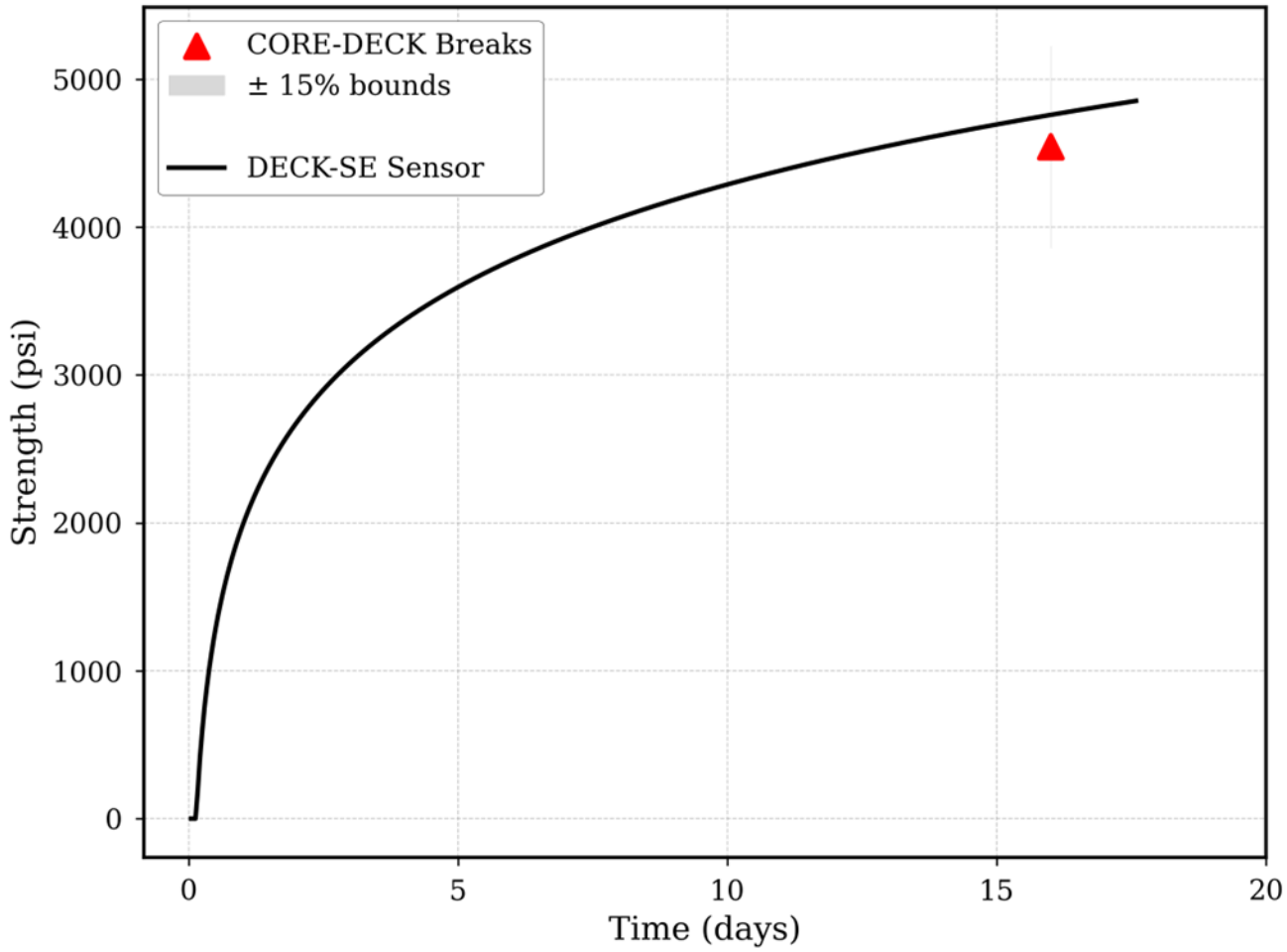
* Cylinder strength extrapolated from curve fit



Date	9-10-2024
Location	Fort Wayne, IN
Project Type	Bridge Deck

Ingredients	**Amount (/yd^3)**
Fine Agg.	1283 lbs.
Coarse Agg.	1720 lbs.
Cement	580 lbs.
Water	261 lbs.
W/C Ratio	0.450

- Sensor was placed in the bridge deck, with one core taken at 16-days
- Sensor was very accurate (within 4.7% of core measurement)



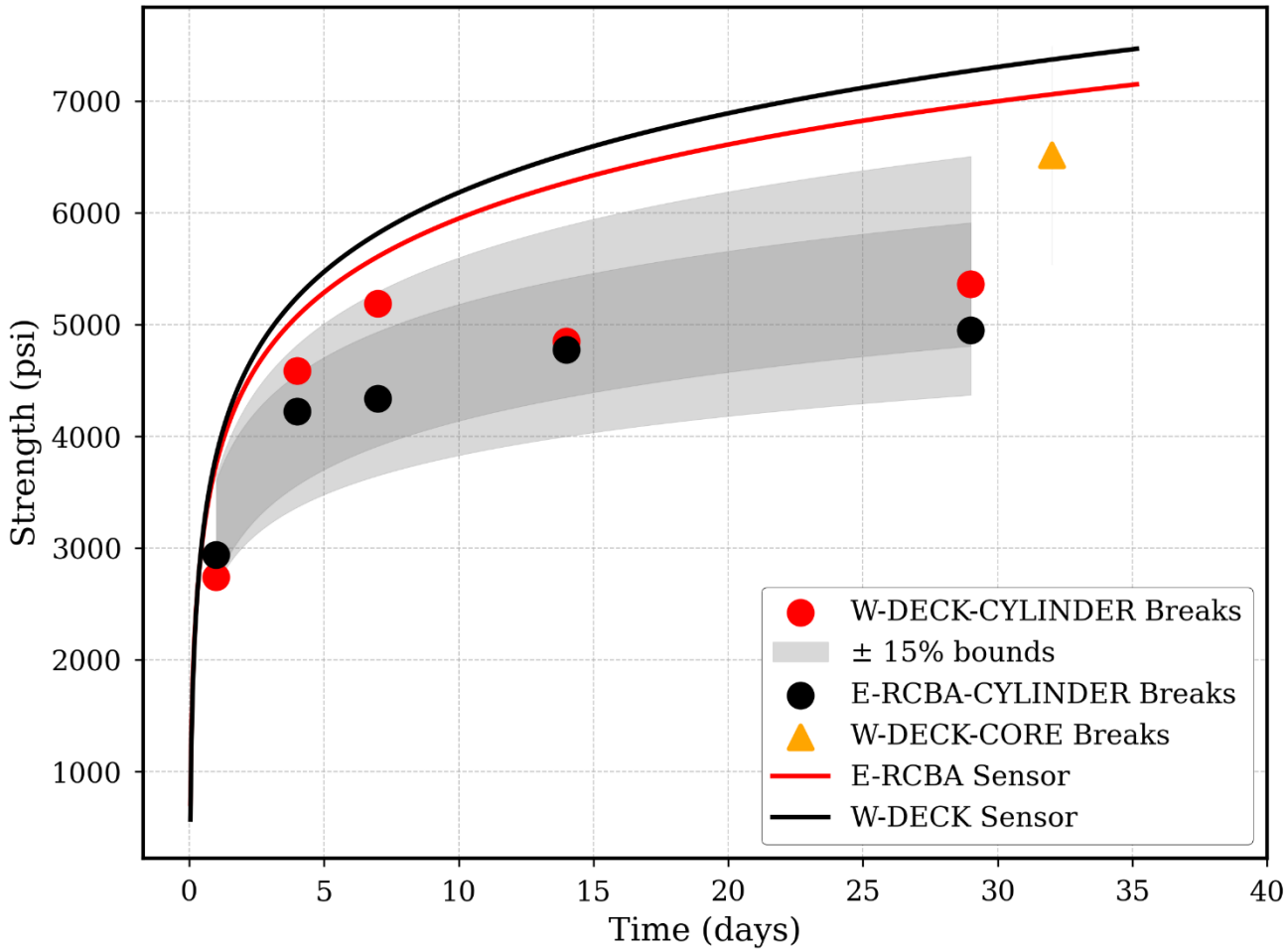
	Avg. Strength	Difference from Core (%)
Core	4545	--
REBEL Sensor	4760	4.7

Age	Avg. Difference (psi)	Avg. Difference (%)
16-Day	214	4.7

Date	6-6-2024
Location	Anderson, IN
Project Type	Bridge Deck

Ingredients	**Amount (/yd^3)**
Fine Agg.	1188 lbs.
Coarse Agg.	1634 lbs.
Cement	650 lbs.
Water	287 lbs.
W/C Ratio	0.441

- 1 sensor was placed in the bridge deck with another in the approach
- Cylinders made for 1, 4, 7, 14, and 28-days
- Both sets of cylinders broke below expectations at 14 and 28 days
- Core break at 32 days confirms that the sensor results fall in line with the in-place strength



- Both sets of cylinders broke below expectations at 14 and 28 days
- The core break at 32 days confirms that the sensor results fall in line with the in-place strength

32-day	Avg. Strength	Difference from Core (%)
Core	6517	--
Cylinders*	5464	16.1
REBEL Sensor	7216	10.7

* Cylinder strength extrapolated from curve fit