

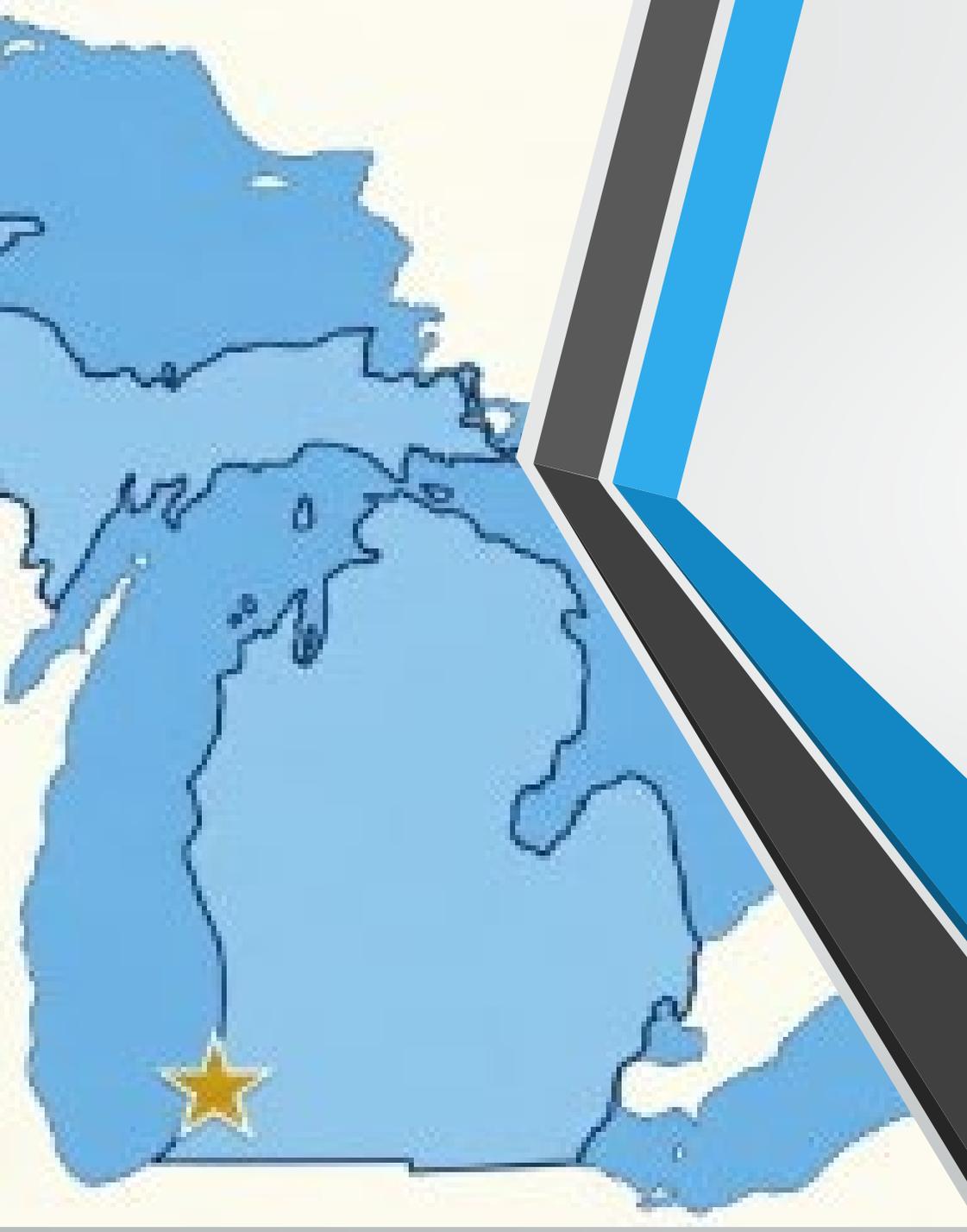
Prestressed Beam Fabrication and the Importance of QC and QA inspection

Structural Precast Concrete Specialist

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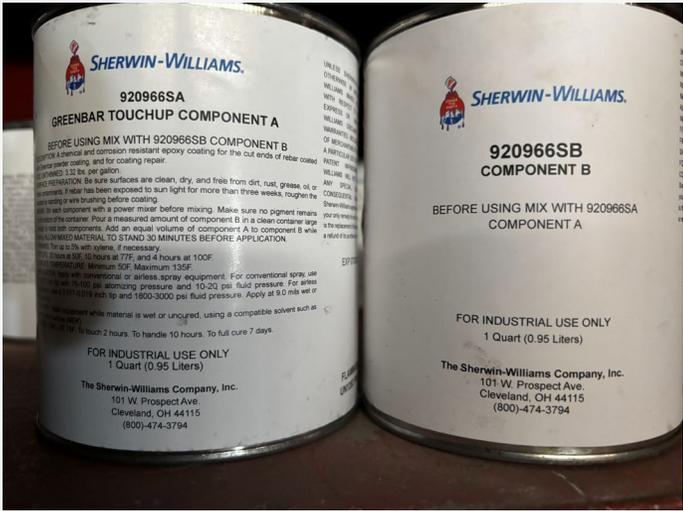


S03-3 of 11016, Job
Number 131843
EB I-94 over Pipestone
Road

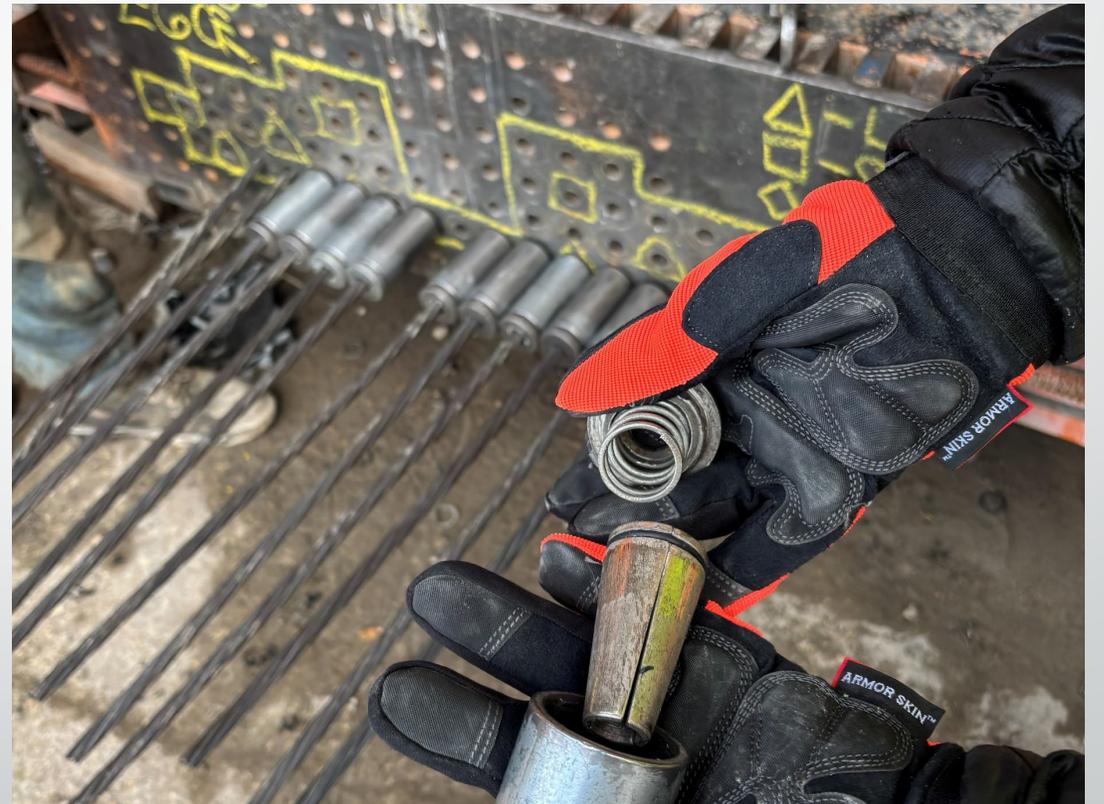
QC and QA Comparison.

- QC ensures that the finished product meets or exceeds contract requirements.
- QC presents materials and documentation to the QA inspector in a manner that will allow a thorough inspection.
- QC keeps the QAI informed of project schedule and notifications when inspection activities are ready for inspection.
- QA verifies the effectiveness of the QCI's evaluation of the work.
- QA performs verification inspection after the QCI has completed their inspection and testing in accordance with the fabricator's QCP.

Materials incorporated in the prestressed beam are first inspected by QCI then QAI.



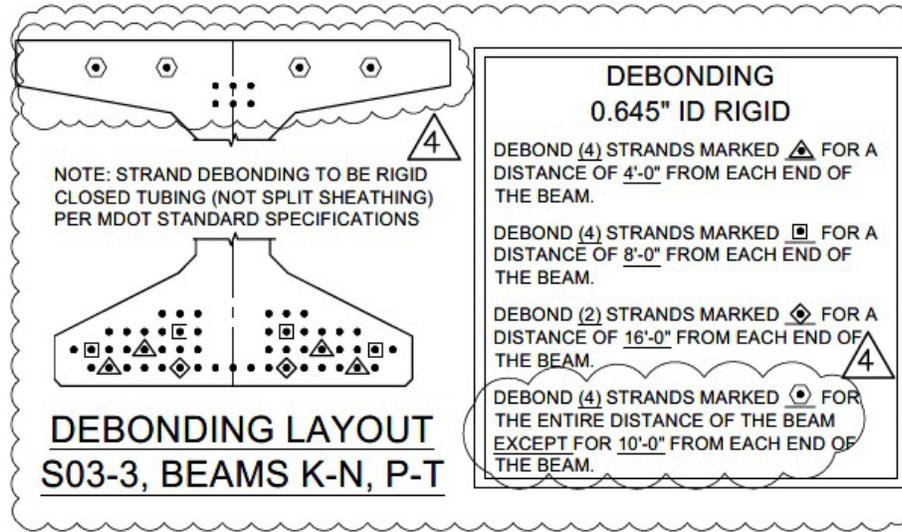
Strand Chuck Assembly



Steel Cylinder, Spring, Conical Steel Wedges

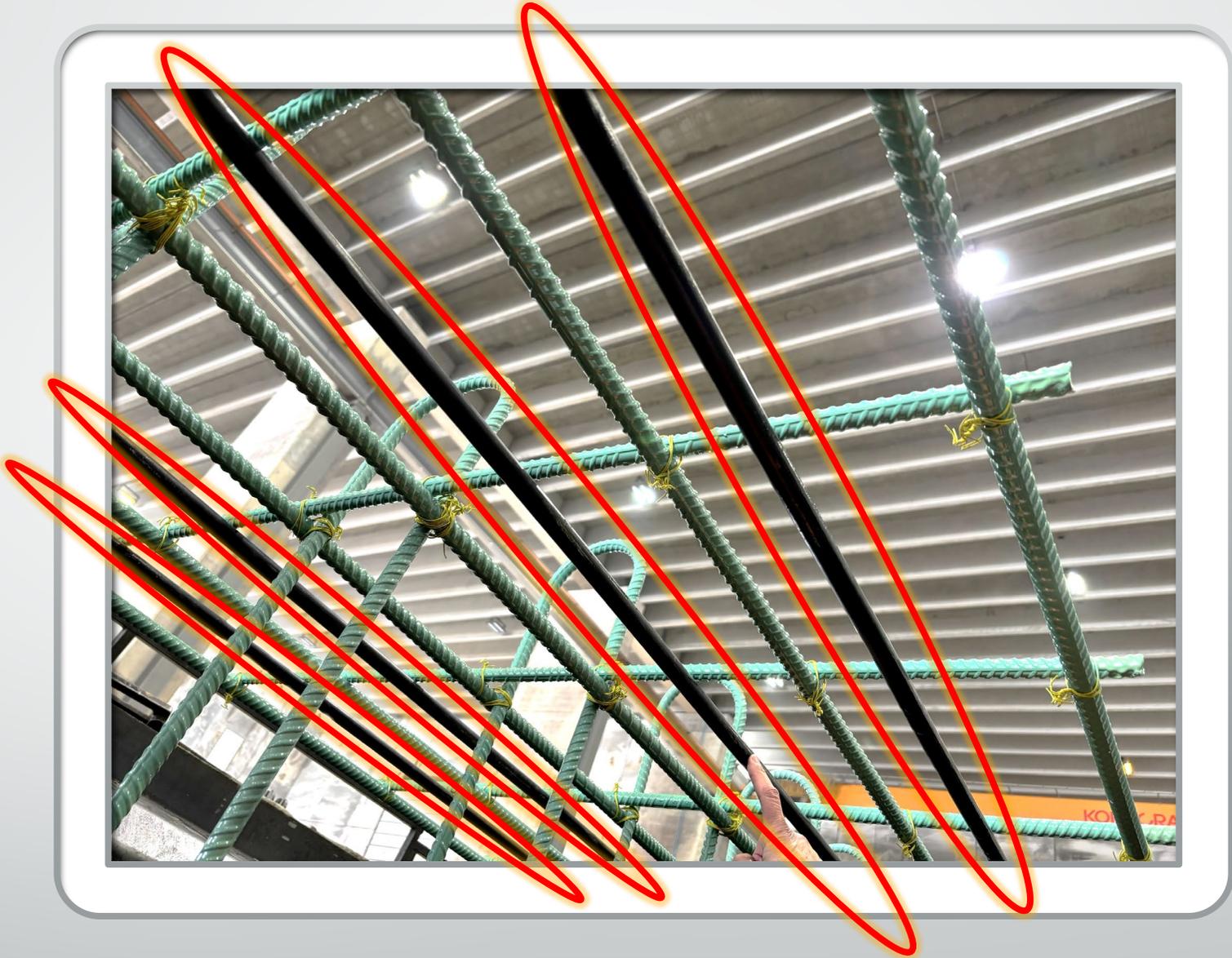
Strand Hold Up and Strand Hold Down





Strand Debonding

Top flange
reinforcement
showing debonding
covering
shipping strands.



The Ingredients of a Tensioning Calculation

The Material Properties

- Grade and Area of Strand
- Modulus of Elasticity (E) (how "stretchy" the steel is)

The Setup and Equipment

- Bed Type (self-stressing or abutment) and Bed Length
- Chuck Seating
- Abutment Rotation (the leaning or tilting of the abutment bed ends from the massive force of the pulled strands)

Environmental Factors

- Strand and Concrete Temperature

The Target

- Initial Pull and Final Force

Results of Tensioning Calculations

- Required Prestressing Force (P) (+ cold temps for abutment beds, -hot temps for abutment beds, + chuck seating, + abutment rotation)
- Theoretic Elongation $\Delta = PL/AE$
 - This is the amount of stretch that should be seen in the strand.



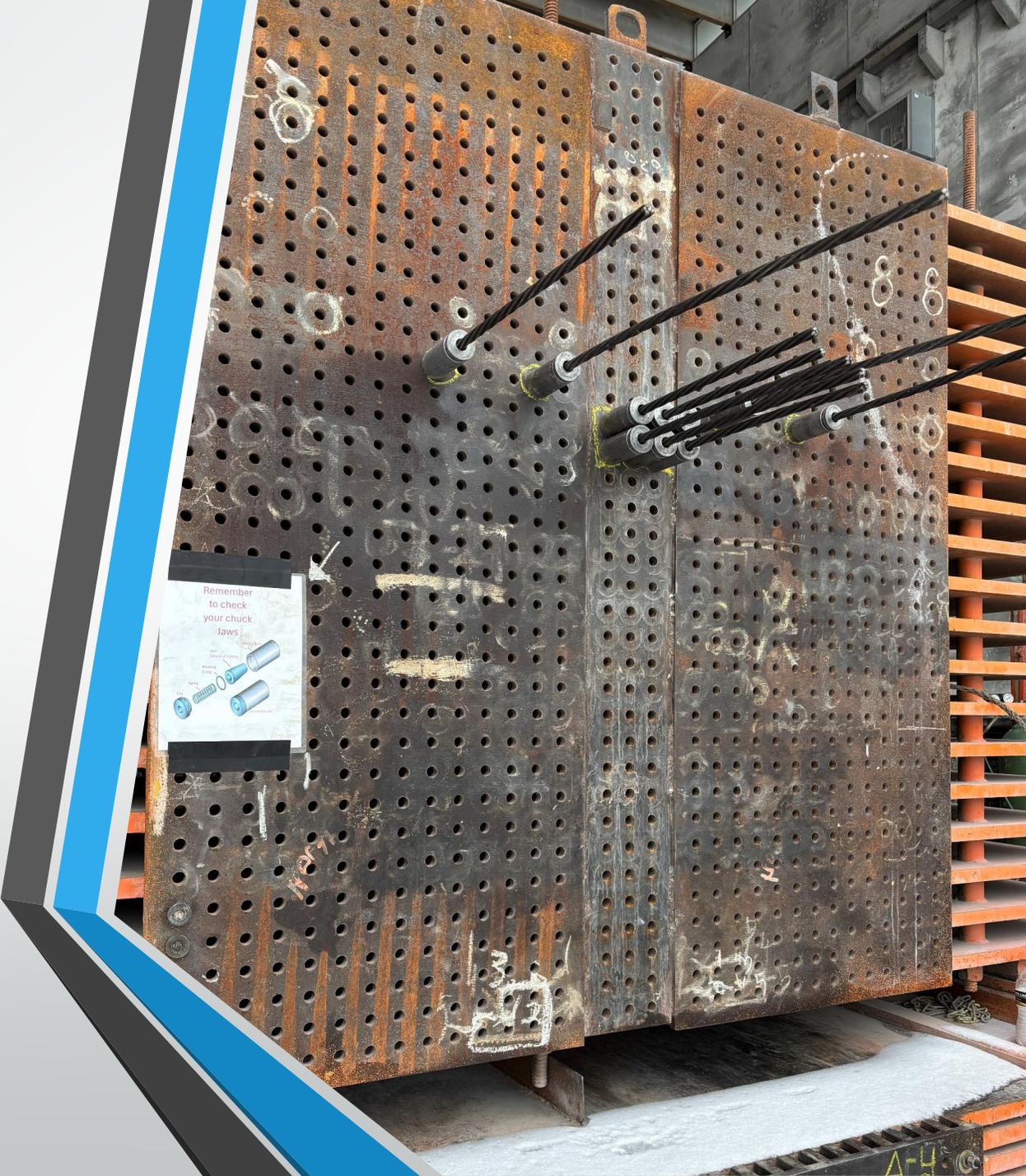
Tensioning Process

Elongation Measurement

Marks are placed at end of check after initial force is put on the strand. As force is applied to the strand the strand elongates. This elongation measurement is checked against what was calculated by QCI. QAI performs an independent check to verify the elongation measured is within determined range.

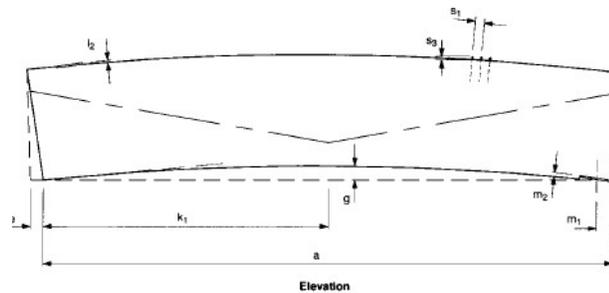
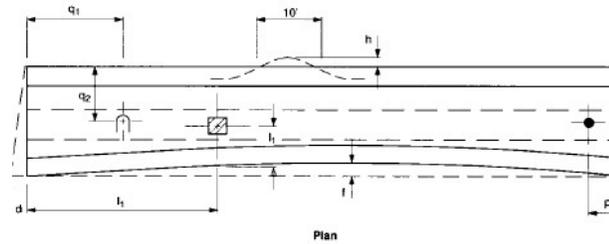
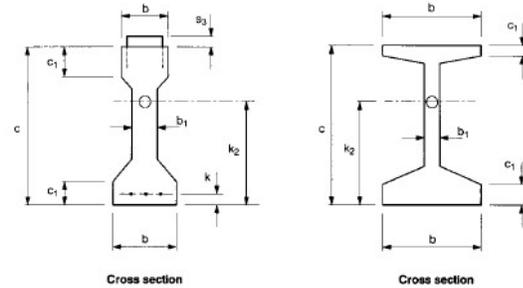


Back side of abutment showing four shipping strands and six draped strands



PCI MNL 135 - Tolerance Manual for Precast and Prestressed Concrete Construction

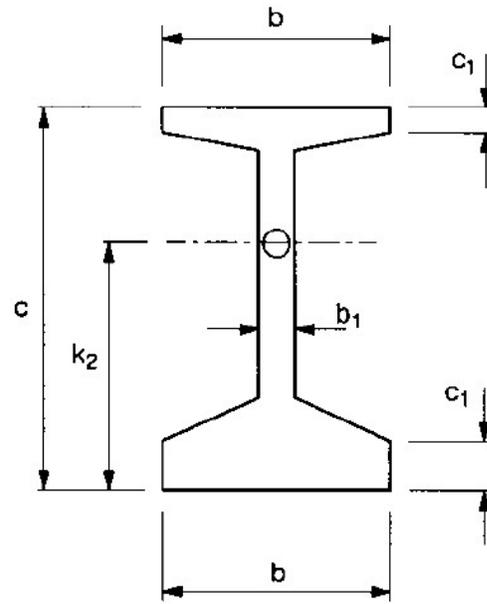
10.1 I Beams (Girders) or Bulb Tee Girders



10.10 I Beams (Girders) or Bulb Tee Girders

a = Length	.....	$\pm \frac{1}{4}$ in. per 25 ft. length, ± 1 in. maximum [± 6 mm per 7.5 m length, ± 25 mm maximum]
b = Width (overall)	.....	$+\frac{3}{8}$ in., $-\frac{1}{4}$ in. [10 mm, -6 mm]
b ₁ = Web width	.....	$+\frac{3}{8}$ in., $-\frac{1}{4}$ in. [$+10$ mm, -6 mm]
c = Depth (overall)	.....	$+\frac{1}{2}$ in., $-\frac{1}{4}$ in. [$+13$ mm, -6 mm]
c ₁ = Flange depth	.....	$\pm \frac{1}{4}$ in. [± 6 mm]
d = Variation from specified plan end squareness or skew	.....	$\pm \frac{1}{8}$ in. per 12 in. width, $\pm \frac{1}{2}$ in. maximum [± 3 mm per 300 mm width, ± 13 mm maximum]
e = Variation from specified elevation end squareness or skew	.....	$\pm \frac{3}{16}$ in. per 12 in. depth, ± 1 in. maximum [± 5 mm per 300 mm, ± 25 mm maximum]
f = Sweep	.....	$\frac{1}{8}$ in. per 10 ft. length [3 mm per 3 m length]
g = Camber variation from design camber	.....	$\pm \frac{1}{8}$ in. per 10 ft. [± 3 mm per 3 m] $\frac{1}{2}$ in. [13 mm] maximum up to 80 ft. [24 m] length 1 in. [25 mm] maximum for length greater than 80 ft. [24 m]
h = Local smoothness of any surface	.....	$\frac{1}{4}$ in. in 10 ft. [6 mm in 3 m]
k = Location of strand*	.....	Individual $\pm \frac{1}{4}$ in. [± 6 mm] Bundled $\pm \frac{1}{2}$ in. [± 13 mm]
k ₁ = Location of harp points for harped strands from design location	± 20 in. [± 510 mm]
k ₂ = Location of post-tensioning duct	.....	$\pm \frac{1}{4}$ in. [± 6 mm]
l ₁ = Location of embedment	± 1 in. [± 25 mm]
l ₂ = Tipping and flushness of embedment	.....	$\pm \frac{1}{4}$ in. [± 6 mm]
m ₁ = Location of bearing assembly	.....	$\pm \frac{3}{8}$ in. [± 16 mm]
m ₂ = Tipping and flushness of bearing assembly	.....	$\pm \frac{1}{8}$ in. [± 3 mm]
p = Location of inserts for structural connections	.....	$\pm \frac{1}{2}$ in. [± 13 mm]
q ₁ = Location of handling device parallel to length of member	± 6 in. [± 150 mm]
q ₂ = Location of handling device transverse to length of member	± 1 in. [± 25 mm]
s ₁ = Longitudinal spacing of stirrups	± 2 in. [± 50 mm]
s ₂ = Longitudinal spacing of stirrups within dist. "c" from member ends	± 1 in. [± 25 mm]
s ₃ = Stirrup projection from beam surface	.....	$\pm \frac{1}{4}$ in., $-\frac{1}{2}$ in. [± 6 mm, -13 mm]

* The location of harped strand at the end of the beam may be controlled to $\pm \frac{1}{2}$ in. [± 13 mm] providing that calculations show that such a variation will not result in unacceptable stresses at any design load condition.



Cross section

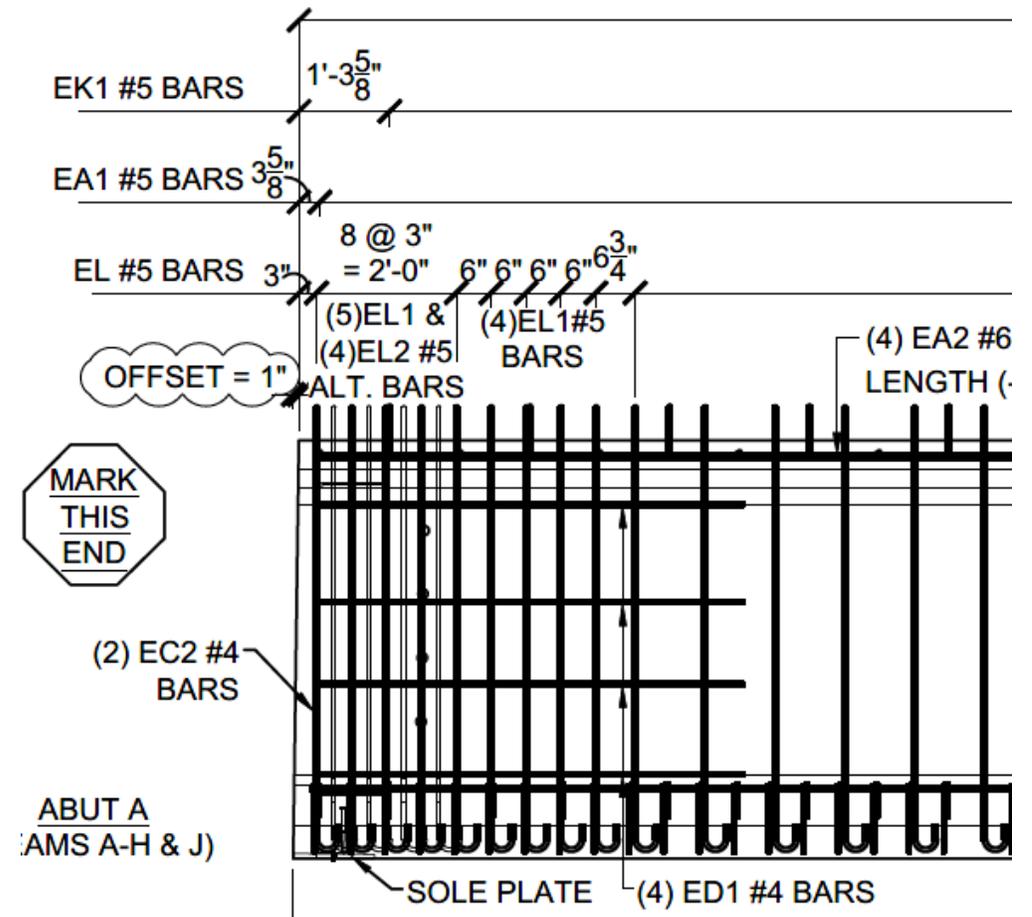
Longitudinal spacing of stirrups +/- 2 inches

Longitudinal spacing of stirrups within distance "C" from member ends +/- 1 inch

Production places the bar reinforcement,
QC inspector checks production,
QA inspector verifies QC's effectiveness.

Spacing for Stirrups

- EL1 bars are alternated with EL2 bars starting 3 inches from the beam end. EL1 bars are placed 6 inches apart for 4 spaces, the 5th space is 6 ¾ inches, then spacing for the EL1 bars are 1'0"
- The beam height is 72 inches which allows a tolerance of +/-1 inch for a distance of 72 inches from beam end. The tolerance becomes +/-2 inches beyond that.



QA inspector checking location of stirrups



QA inspector verifies that the stirrups are placed ± 1 inch from planned location. EL1 and EL2 bars are alternated and placed 3 inches apart and the first EL1 bar is set 3 inches from beam end.

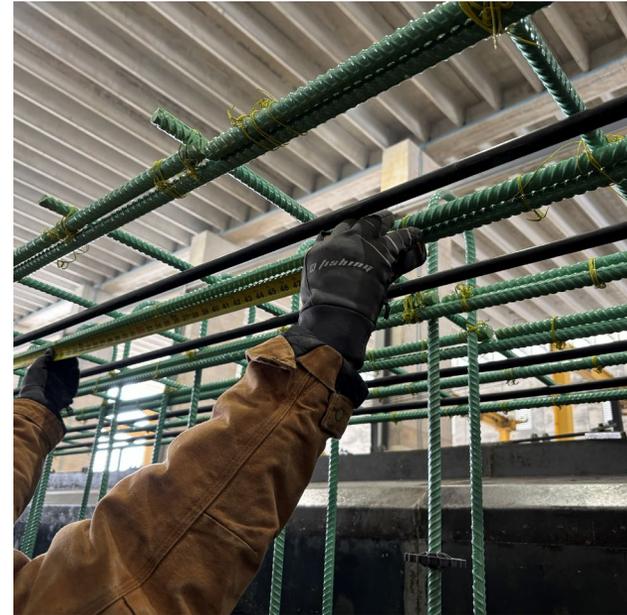
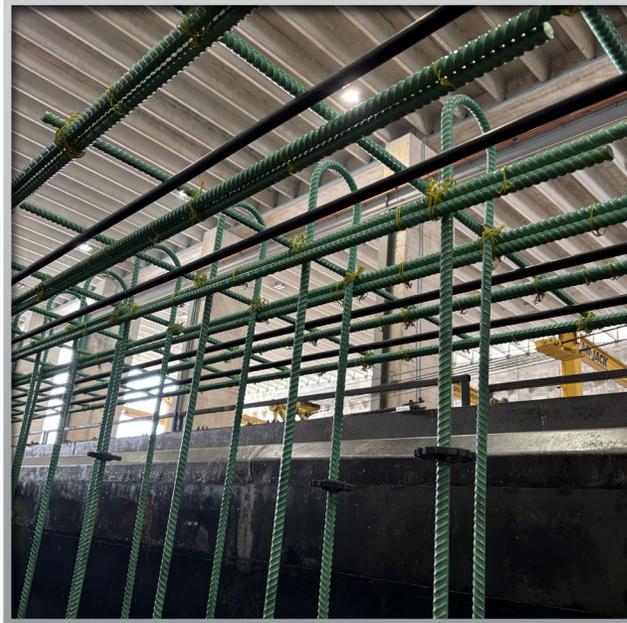


QA inspector is verifying that the first EL1 bar required to be at 6-inch spacing is set correctly with ± 1 -inch tolerance.

Bar Reinforcement Layout in Bulb T-Beam

These beams are 155 feet, 5.25 inches long
Fabricated to a tolerance of +/- 1 inch.





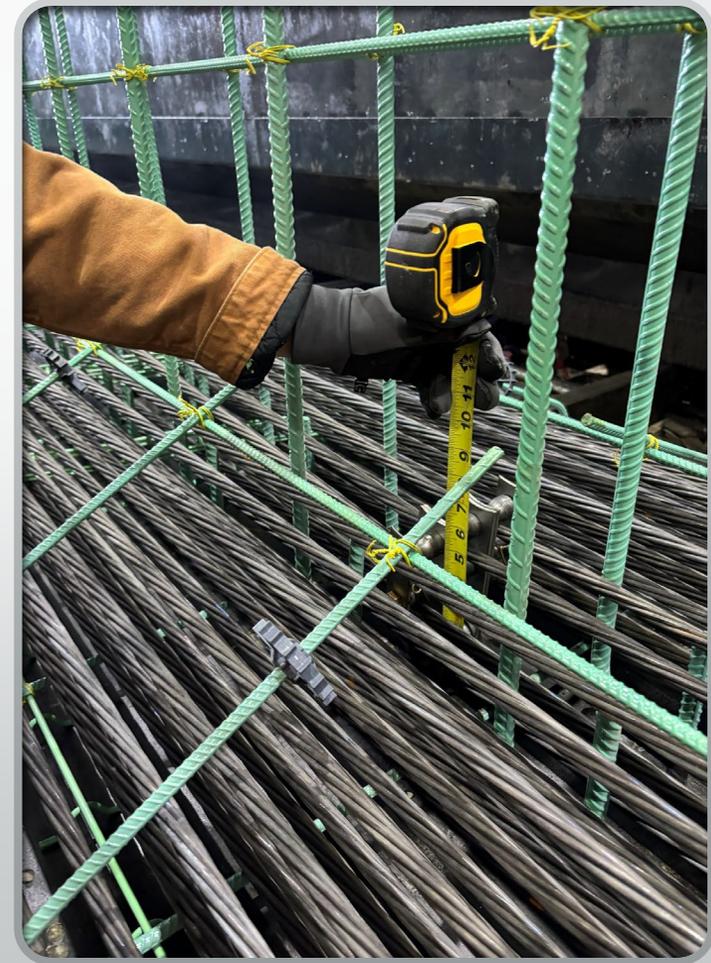
Overlapping of reinforcement is checked in the top flange reinforcement.

Pockets around shipping strands that will be cut by the contractor.



Bottom Flange and Web of Prestressed Beam

QAI is verifying height of the top strand location in the hold down assembly.





Strand and reinforcement in
the web and top flange.

Prestressing Strand Process



Stressing Machine

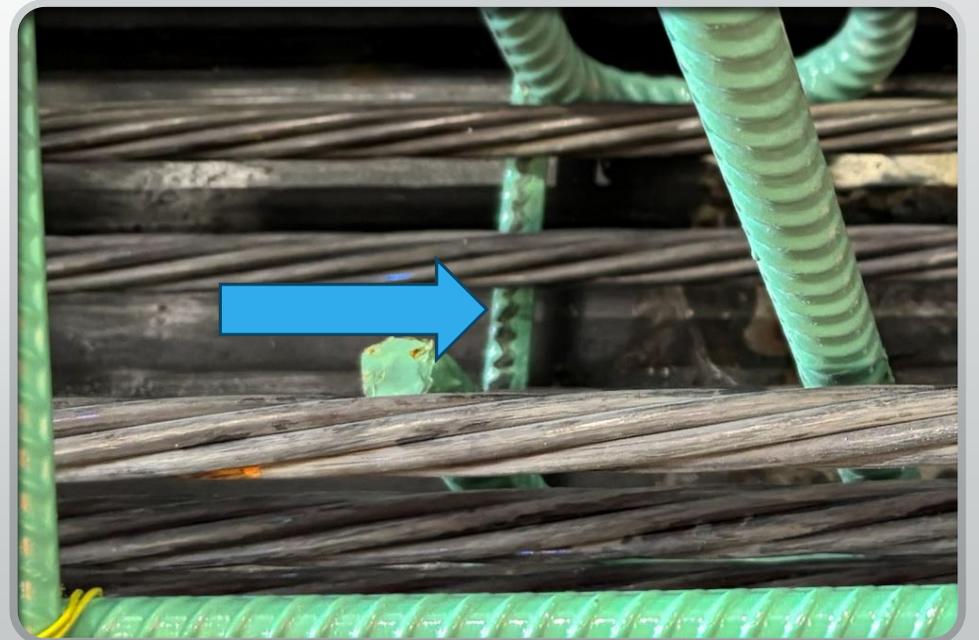


Stressing Jack

Bottom Flange Beam End Showing Reinforcement Congestion



Bar Reinforcement and
Prestressed Strand is
Required to be Clean.



End Header



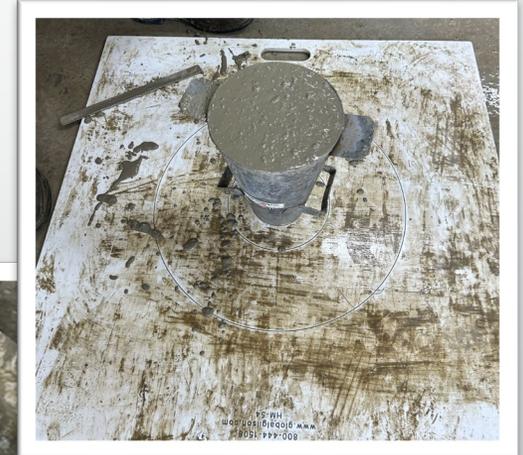
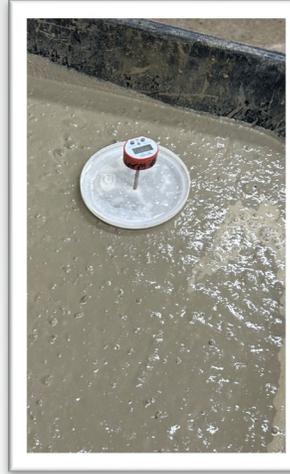
Cold Weather Precautions

Temperature of steel forms and reinforcement is required to be between 40 and 75 degrees Fahrenheit.

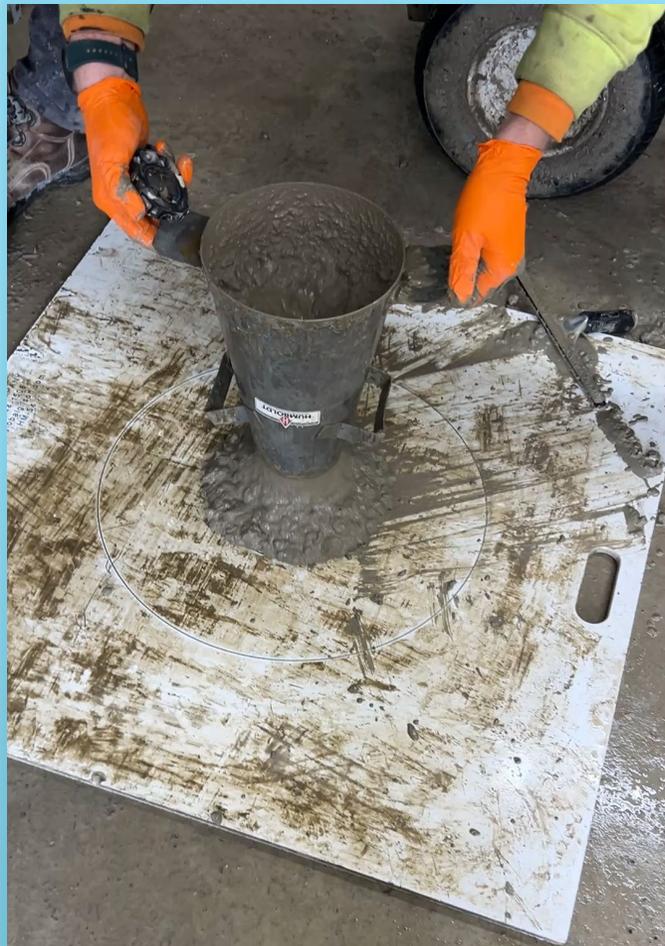


Self-Consolidated Concrete Tests Performed by QC

Temperature
Penetration Test
Air
Slump Flow and Flow Rate
Visual Stability Index
J-Ring Flow



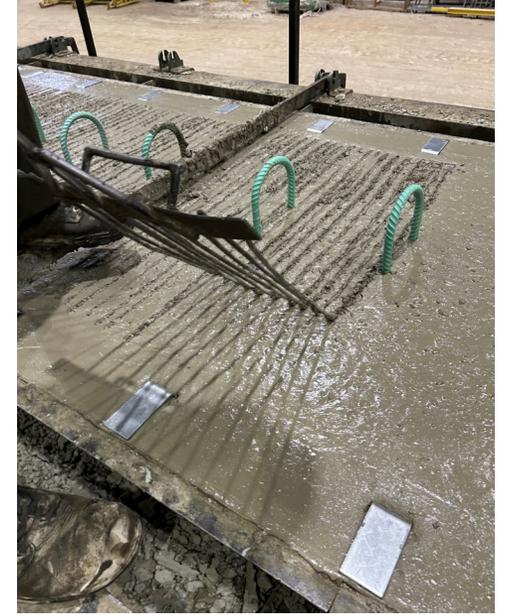
Slump Flow and J-Ring Flow





B-consolidated concrete being poured into bulb T-beam forms.

No internal or external vibration is used and pours out in a fraction of the time that it takes conventional concrete to be poured.



Sequence of Beam Finishing



Finished beam surface.



Heavy weight tarps used for moisture retention.

Required strength for release: 6,200 PSI

Two of three must meet the required strength and the third must meet or exceed the required strength.

- 6,724 PSI
- 6,307 PSI
- 6,400 PSI
- Average 6,480 PSI

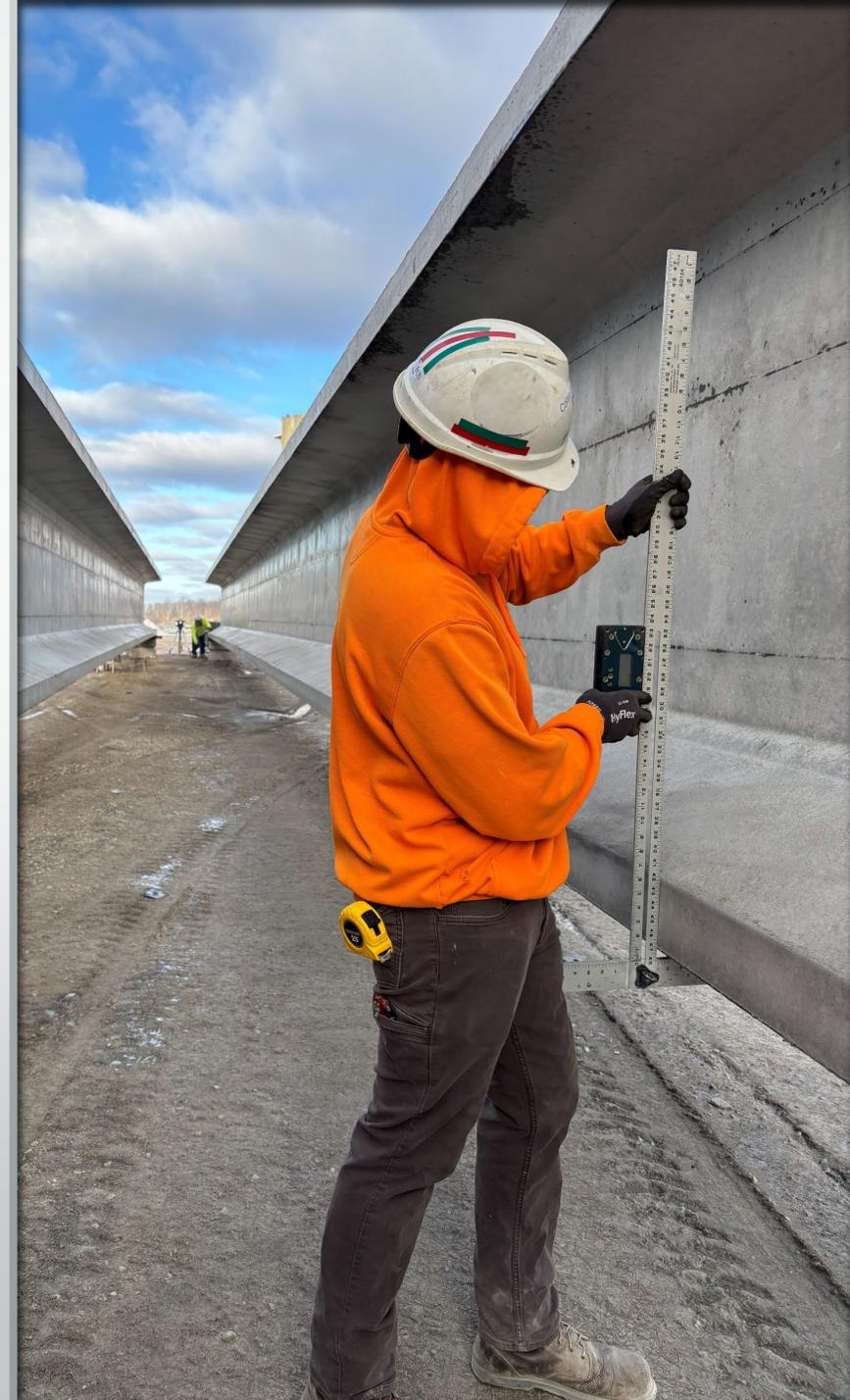
Prestressed beam can be detensioned.





QC checking soundness of concrete after detensioning.

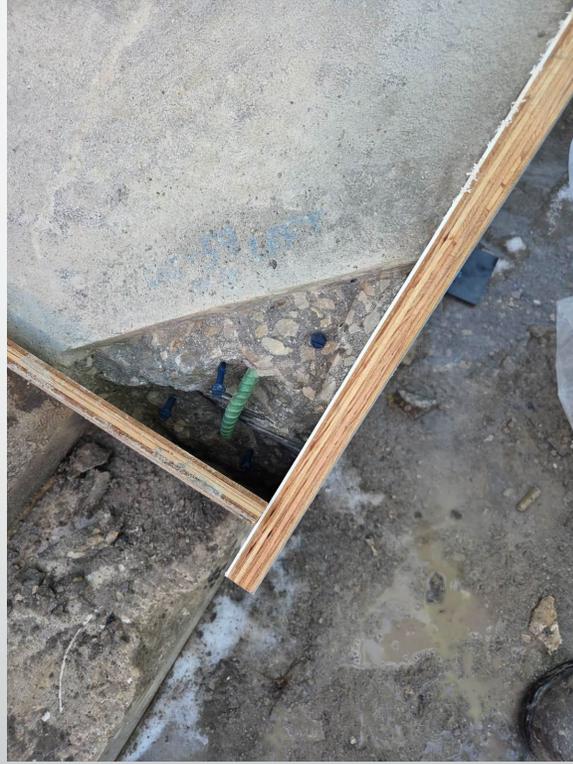
QC performing camber measurement.



QA checking insert locations after QC.

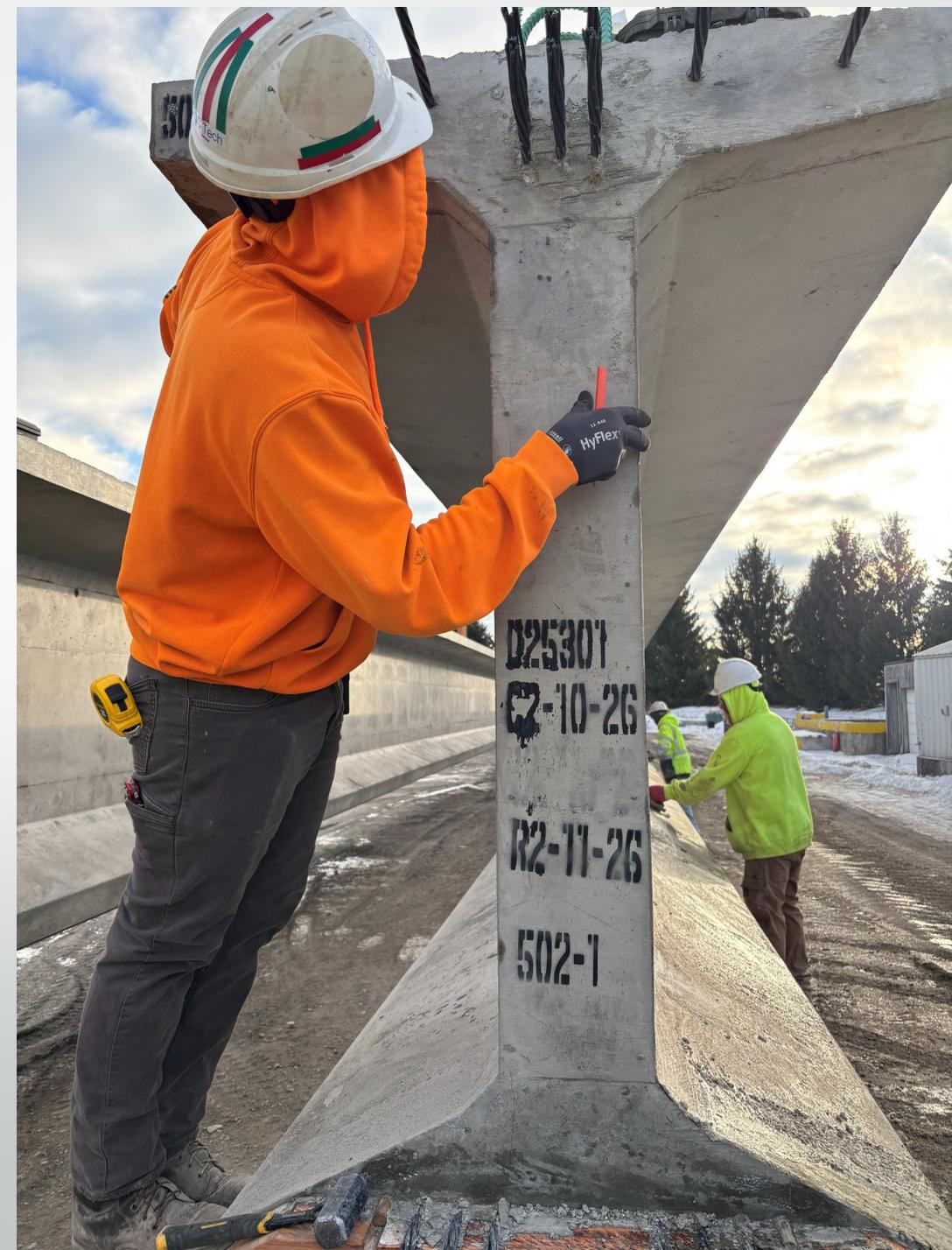


Unsound concrete removed and repaired.





QC checking for and documenting cracks at beam ends.



A special thanks to the team at Prestress Services Industries (Decatur, Indiana) for their hospitality and for providing access to document the beam fabrication process.

