INDOT STRUCTURES CONFERENCE 2010
PRESTRESSED CONCRETE

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PRESTRESSED CONCRETE

- IDM Chapter 63
- Beam Fabrication
- Beam Detailing
- Design Resources

PRESTRESSED CONCRETE

Approach to Manual Rewrite

Existing Chapter 63 Contains:

- "Text Book" Information
- INDOT Specific Information
- Repeats Topics Stated in AASHTO
- Beam Standard Details

PRESTRESSED CONCRETE

Approach to Manual Rewrite (continued)

What is Really Needed:

- ~~"Text Book" Information~~
- INDOT Specific Information
- ~~Repeats Topics Stated in AASHTO~~
- ~~Beam Standard Details~~ *

* Move Beam Details to Standard Drawings

PRESTRESSED CONCRETE

- Proposed Manual Changes
  - Model after AASHTO Code
    - Use AASHTO code as basis
    - Specify criteria / modifications to criteria that are specific to INDOT
  - Unification of Concrete Chapter?
    - AASHTO LRFD has combined Reinforced & Prestressed Concrete, will INDOT??

PRESTRESSED CONCRETE

- Proposed Manual Changes (continued)
  - Concrete Strength
    - Add Criteria for U-Beams
    - Clarification on Release Strength
  - Estimated Losses of Shrinkage & Creep
    - Allow use of CEB-FIP 1978 Code (Proven code)

PRESTRESSED CONCRETE

- Proposed Manual Changes (continued)
  - Adoption of PTI for Grouting Procedures
    - Follow up expected in PT Roundtable Discussions
  - Beam Lengths & Weights
    - Beam Lengths over 100 ft., verify with fabricators
    - Beam Weights over 90 tons, verify with fabricators

PRESTRESSED CONCRETE

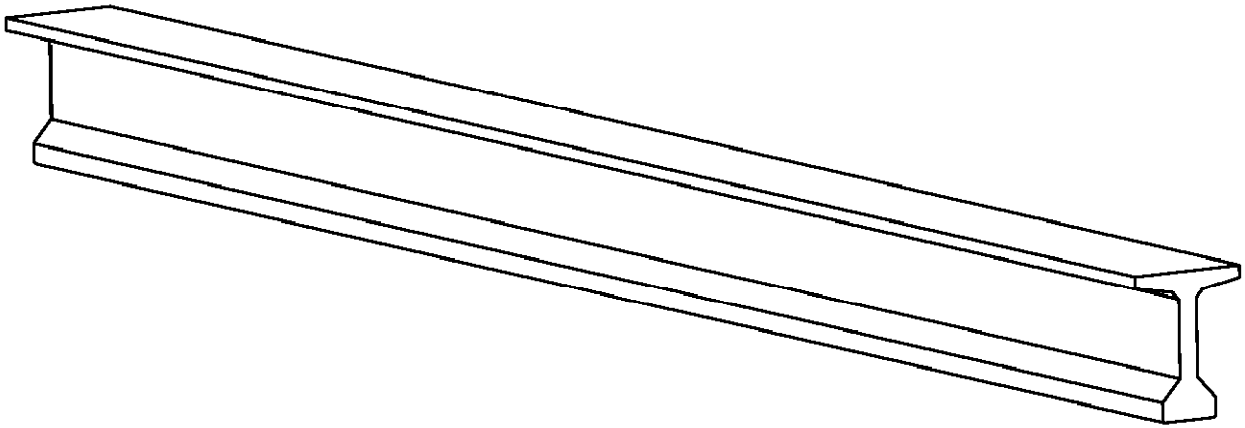
- Proposed Manual Changes (continued)
  - Transformed Section Properties
    - No longer allowed under any circumstance
  - Prestressed Beam Details
    - Remove standard sections and details and move to INDOT standard Drawings
    - Add additional sections for U-beams

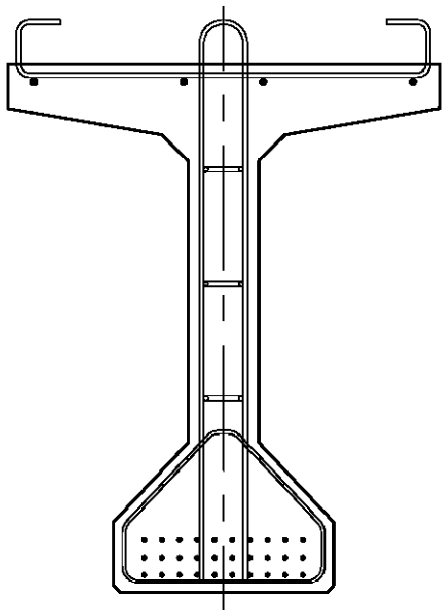
BEAM FABRICATION

Step-by-Step Procedure for Prestressed Beams

- Understanding of how beams are fabricated leads to better plan detailing
- Following procedure is from one major fabricator supplying beams in Indiana. Other fabricator's procedures may vary slightly

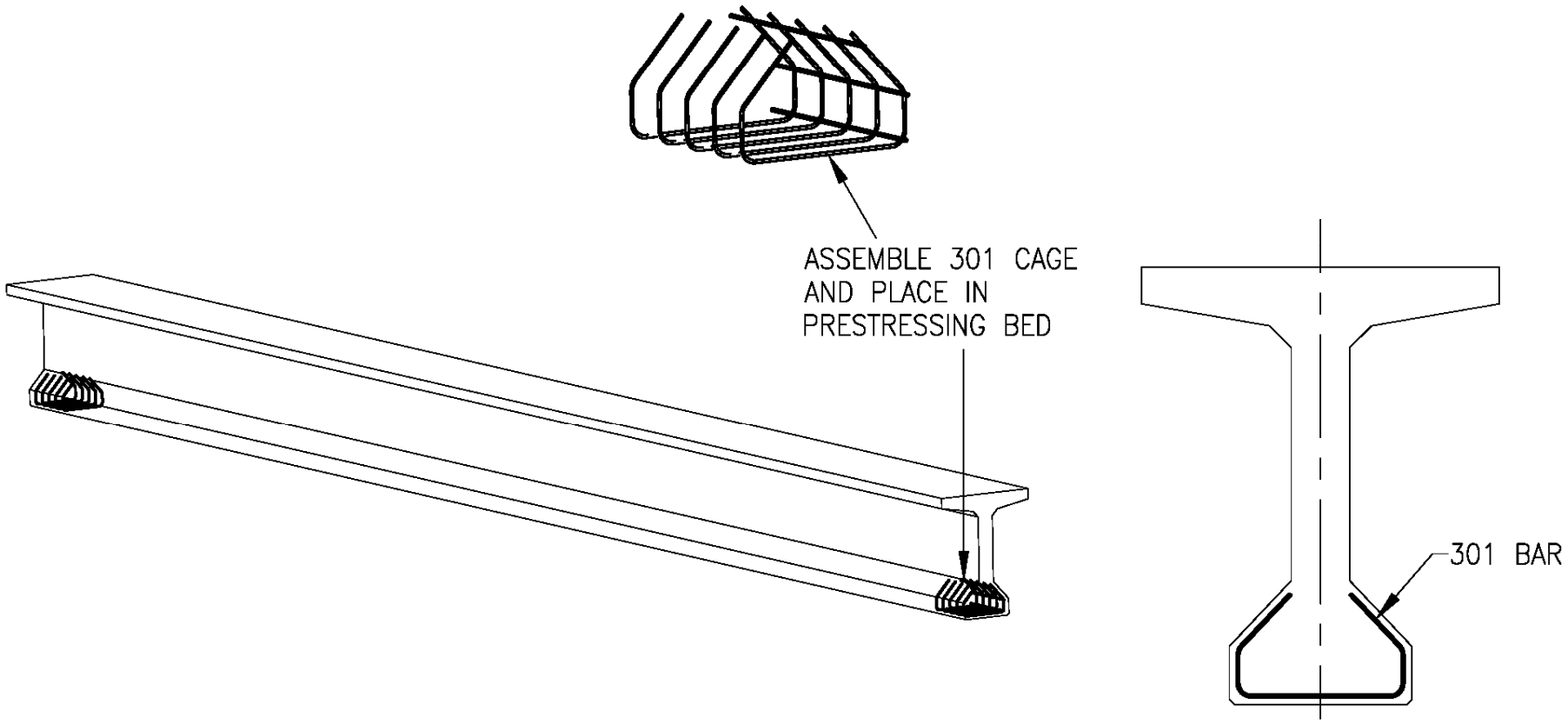
BEAM FABRICATION





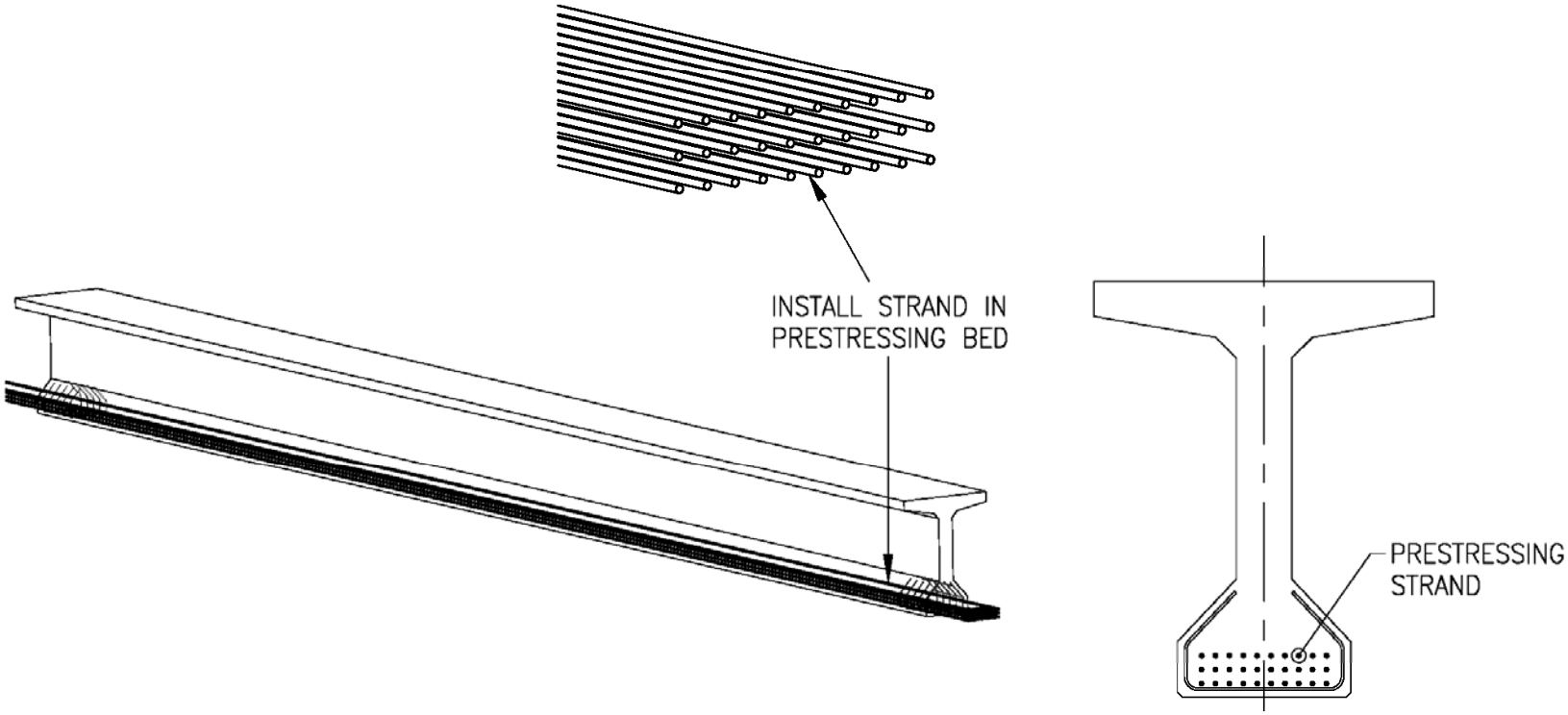
Example - Bulb Tee Type BT 72 x 48

BEAM FABRICATION



Step 1 – Assembly of 301 Bar Cages

BEAM FABRICATION



Step 2 – Prestressing Strand Installation
(2 stages)

BEAM FABRICATION

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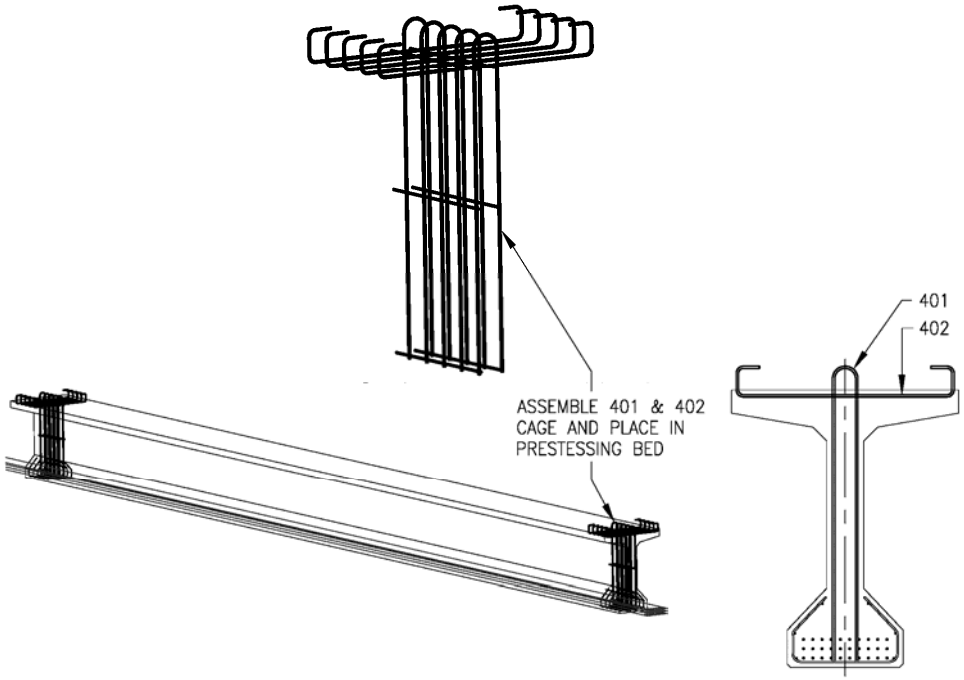

Step 3 – Assembly of 401, 402 & Longitudinal Rebar

BEAM FABRICATION

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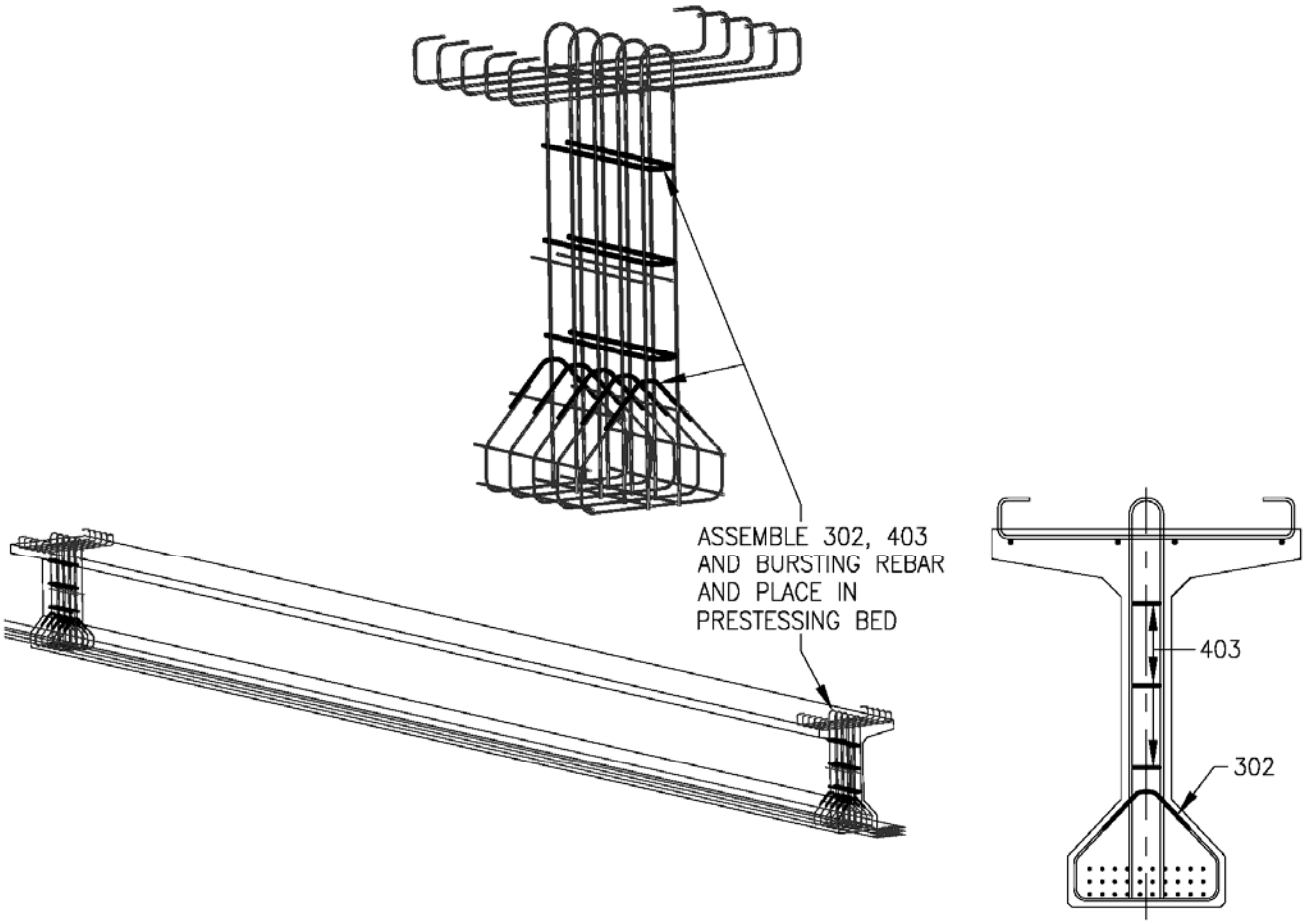
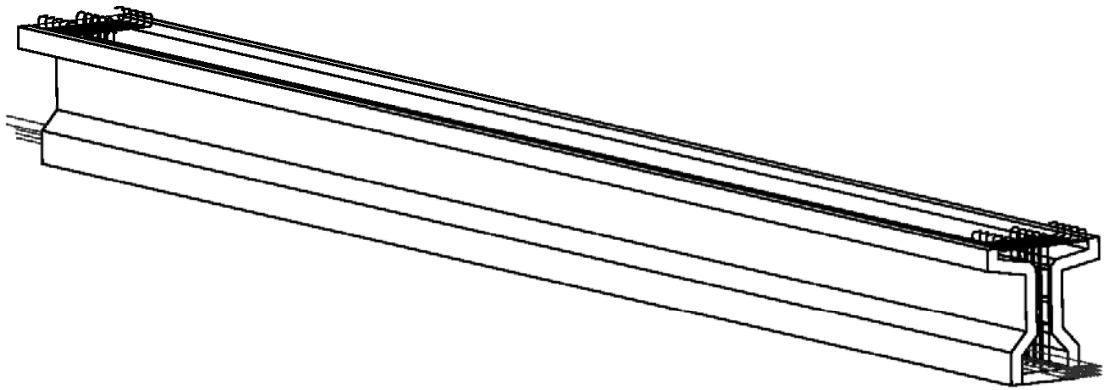
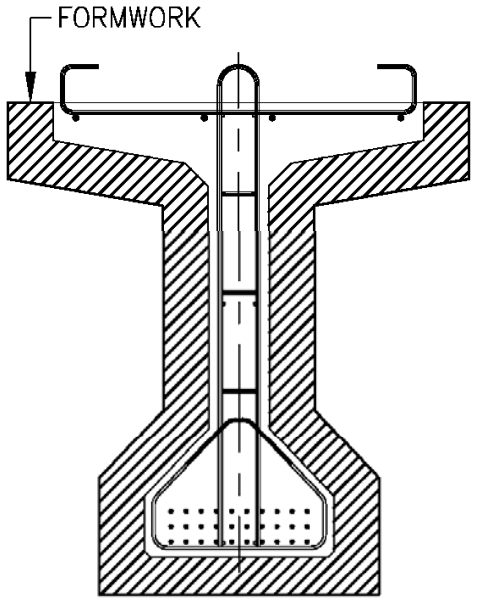


Step 4 – Tie in 302, 403, & Bursting Rebar

BEAM FABRICATION

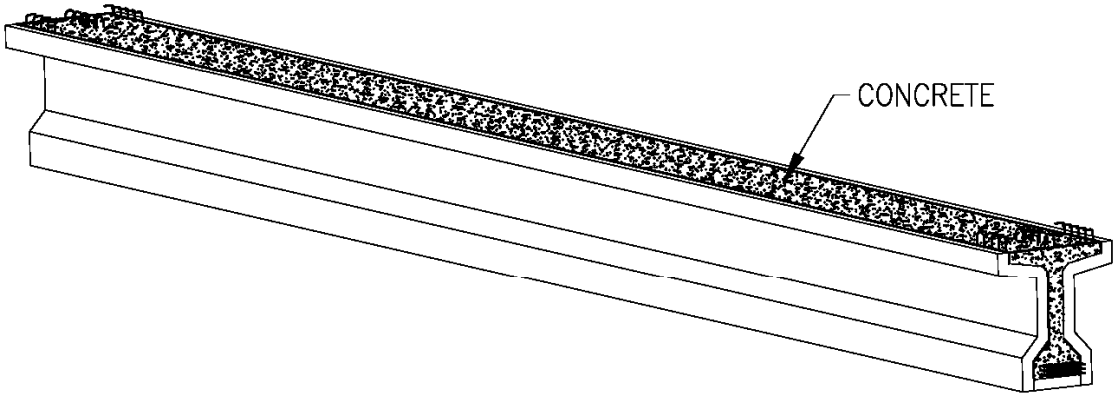
BEAM FABRICATION

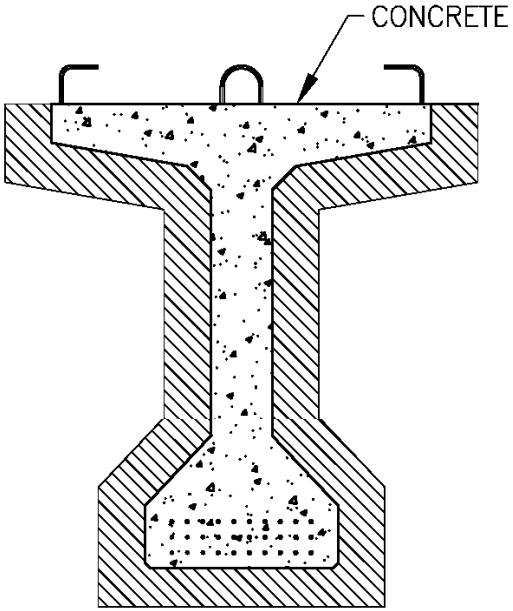




Step 5 – Place Formwork

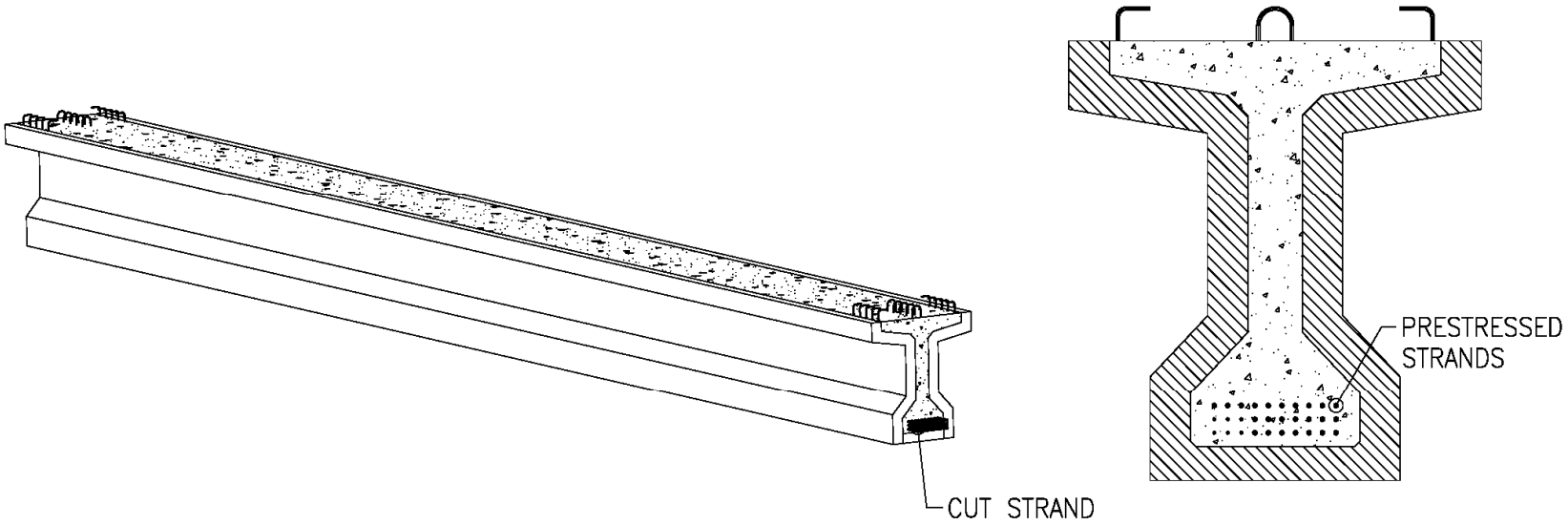
BEAM FABRICATION





Step 6 – Pour Concrete and Cure

BEAM FABRICATION



Step 7 – Release Strength Achieved, Cut Strands

BEAM DETAILING

Details of Prestressed Beams

BEAM DETAILING

301 & 302 Bars

Confinement Reinforcement

- AASHTO LRFD 5.10.10.2

"For the distance of 1.5d from the end of the beams other than box beams, reinforcement shall be placed to confine prestressing steel in the bottom flange. The reinforcement shall be…"

- IDM

"The reinforcement should be #3 bars spaced at 6" for a minimum distance of 1.5 times the depth of the member from the end of the beam or to the end of the strand debonding, whichever is greater"

BEAM DETAILING

301 & 302 Bars

- No need for epoxy coating
- No requirement specified for continuing these bars for the entire length of the beam
- Many engineers are detailing these bars for the full beam length
- Adds rebar (and cost) to beams

BEAM DETAILING

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401 Bars

Shear Reinforcement

- Typically # 4 bars
- Contained along entire length of beam and meet maximum spacing requirements
- Epoxy Coated
- Includes a 90 degree hook on bottom

BEAM DETAILING

401 Bars

90 degree hook on bottom…

- AASHTO LRFD 5.8.2.8

" Transverse reinforcement shall be anchored at both ends in accordance with the provisions of Article 5.11.2.6"

- AASHTO LRFD 5.11.2.6.2

"Ends of single-leg, simple U-, or multiple U-stirrups shall be anchored as follows: For #5 bar ... and smaller...: A standard hook around longitudinal reinforcement..."

BEAM DETAILING

401 Bars

90 degree hook on bottom…

- Neighboring states not doing this
- INDOT standard is not in 100% agreement with AASHTO requirement
- Hooks are adding difficulties to fabrication
- Interfering with adjacent vertical steel in end regions

BEAM DETAILING

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402 Bars

Interface Shear Transfer Reinforcement

- Typically # 4 bars
- Contained along entire length of beam and meet maximum spacing requirements
- Does not need to be spaced with 401 bars
- Epoxy Coated

BEAM DETAILING

BEAM DETAILING

BEAM DETAILING

403 Bars

Crack Control Reinforcing

- Contained horizontally to limit cracking
- Does not protrude out of the beam (do not epoxy coat)
- Have also been used as the vertical bursting reinforcement

BEAM DETAILING

BEAM DETAILING

Bursting / Splitting Reinforcement

Bursting Reinforcement

- Typically # 5 or #6 bars, though design may require larger
- Contained vertically in between 401 bars to satisfy Article 5.10.10.1, Splitting Resistance
- Does not protrude out of the beam (do not epoxy coat)

BEAM DETAILING

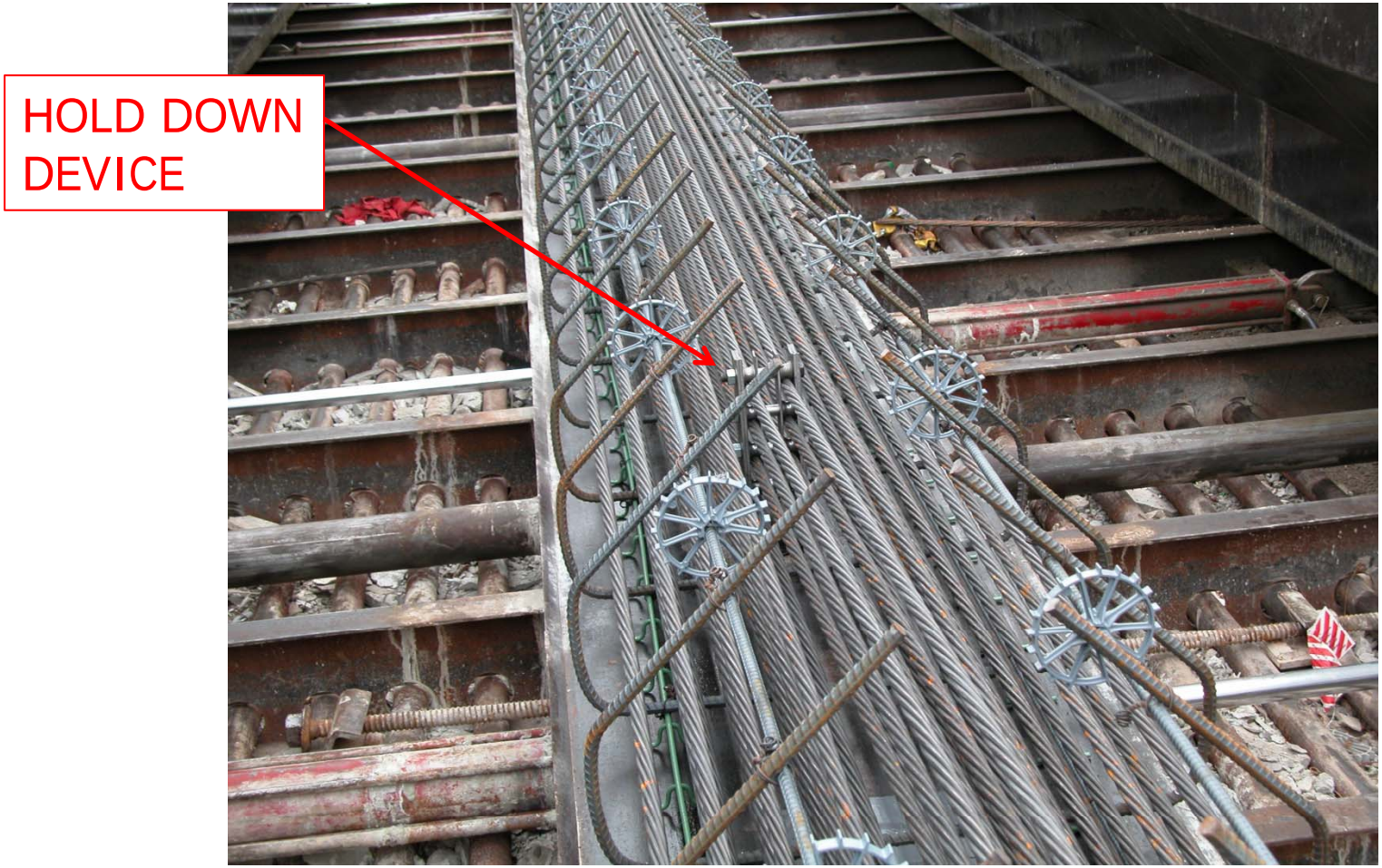
BEAM DETAILING

Hold Down Points

Check Uplift at Hold Down Points

- Limited to 3.8 kips per strand, 38 kips total per point
  (Check with fabricator for exceptions)
- Stagger hold down points to stay under 38 kips
- Hold down points typically on 6” intervals on stressing beds (not necessarily 0.4L)

BEAM DETAILING



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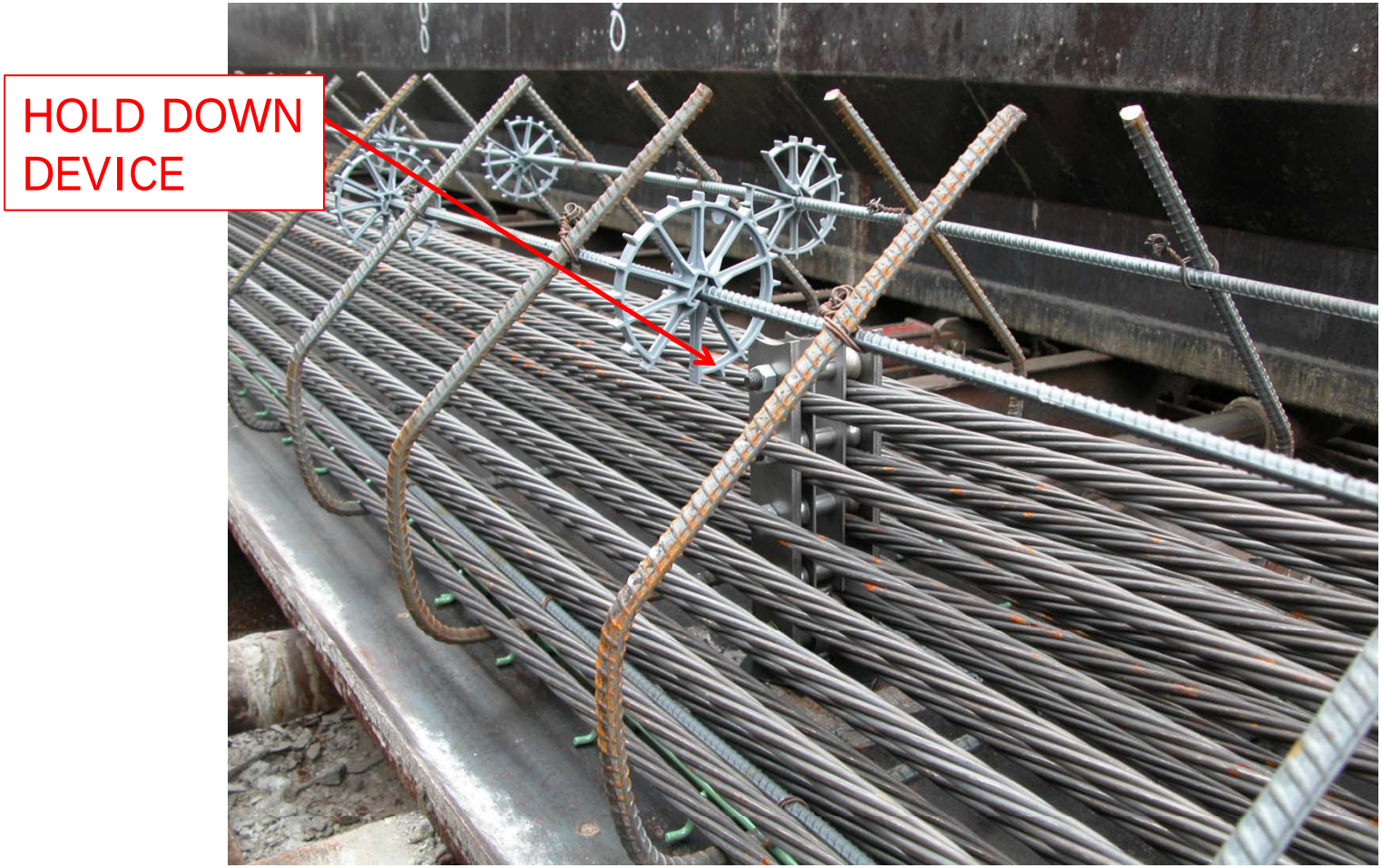

BEAM DETAILING

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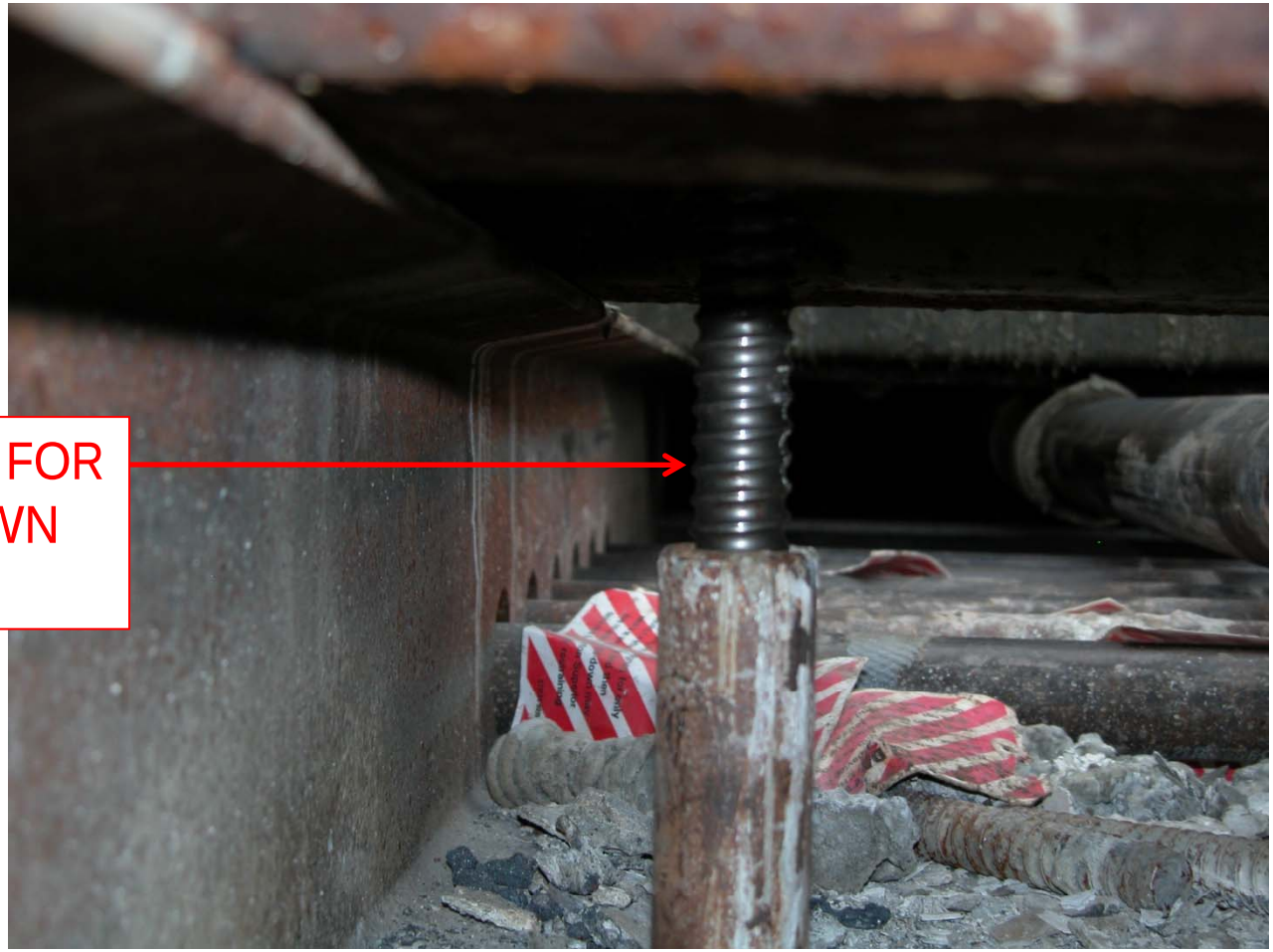


BEAM DETAILING

- Concrete Strengths
  - 8000 psi is easily obtained for 28 day strength
  - 6000 psi is max for release strength to make bed turnaround
  - When specifying release strength on plans round up to the nearest 100 psi of what is actually needed

BEAM DETAILING

- Prestressed Strands
  - Use ½" special is smaller beams (AASHTO I-beams)
  - Use 0.6" strands in Bulb Tees
  - Add courtesy cables even in top flange to assist fabricator (new spec requires ties and cages are now more flimsy)

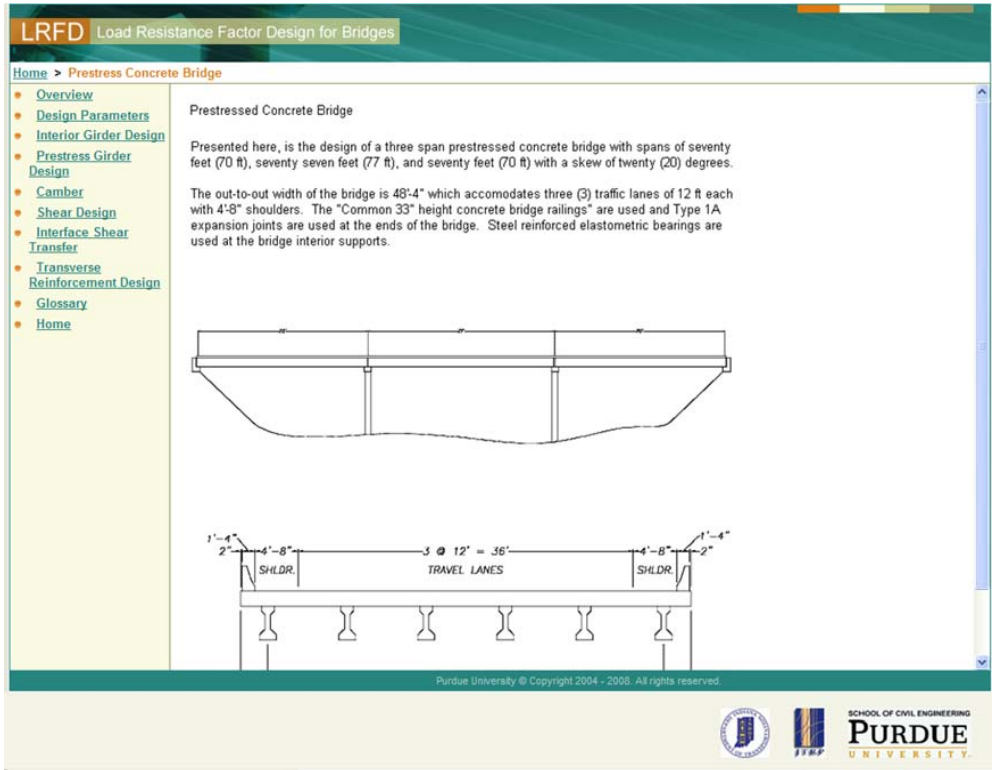
BEAM DETAILING

BEAM DETAILING

DESIGN RESOURCES

Purdue University

http://rebar.ecn.purdue.edu/lrfd2/Prestress/index.aspx



DESIGN RESOURCES

PCI – Bridge Design Manual

http://www.pci.org/publications/bridge/index.cfm

- Free Download
- Example Problems (LRFD & Standard)
- Discussion on Fabrication, Construction, & Economics
- Seismic Design & Example

DESIGN RESOURCES

Washington State DOT

http://www.wsdot.wa.gov/Publications/Manuals/M23-50.htm

- Example Problems (LRFD)
- Repair of Damaged Girders
- Fabrication, Handling & Shipping
- PG Super (Free Prestressed Beam Design Software)

  http://www.pgsuper.com/drupal/content/comparison-precast-bridge-girder-design-software

Washington State Department of Transportation

DESIGN RESOURCES

Arizona State DOT

http://www.azdot.gov/Highways/bridge/Guidelines/designguidelines/AppendixA.asp

- Example Problems (LRFD)
  - Post-Tensioned Concrete Box Girders
  - Prestressed Box Beams
  - Prestressed I-Beams

DESIGN RESOURCES

Commercially Available Software

Conspan

http://www.bentley.com/en-S/Solutions/Bridges/

PS Beam

http://www.lrfd.com/

DESIGN RESOURCES

Fabricators

Prestress Services Industries, LLC

*www.**prestressservices**.com*

Steve Fisher, Plant Manager

sfisher@prestressservices.com

(260) 724-7117

7885 NW Winchester Rd.

Decatur, IN 46733

QUESTIONS?