SECTION 1

INTRODUCTION TO POST-TENSIONED CONCRETE

DEVELOPED BY THE PTI EDC-130 EDUCATION COMMITTEE

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NOTE: MOMENT DIAGRAM CONVENTION

- In PT design, it is preferable to draw moment diagrams to the tensile face of the concrete section. The tensile face indicates what portion of the beam requires reinforcing for strength.
- When moment is drawn on the tension side, the diagram matches the general drape of the tendons. The tendons change their vertical location in the beam to follow the tensile moment diagram. Strands are at the top of the beam over the support and near the bottom at mid span.
- For convenience, the following slides contain moment diagrams drawn on both the tensile and compressive face, denoted by (T) and (C), in the lower left hand corner. Please delete the slides to suit the presenter's convention.

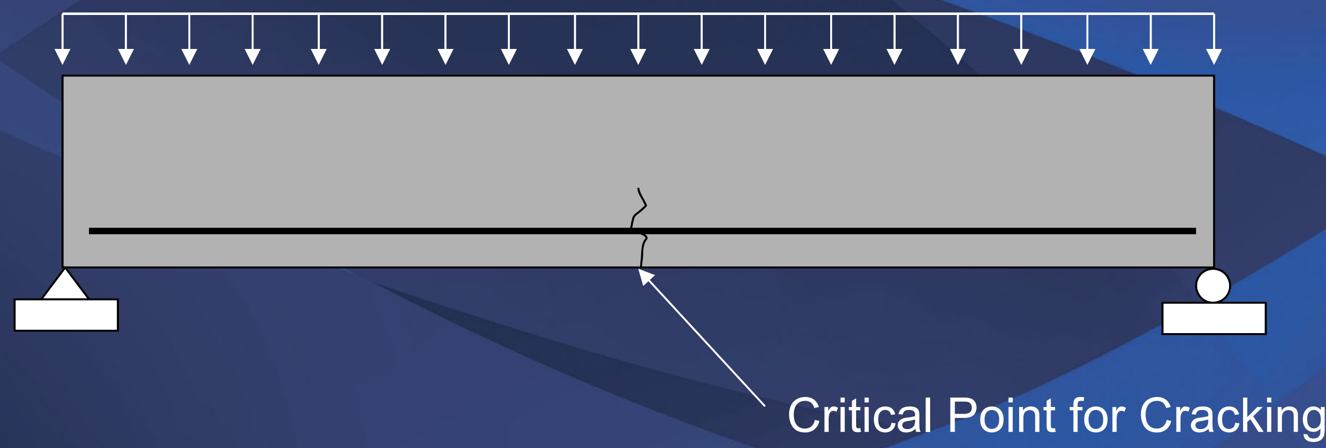
REVIEW:

FUNDAMENTALS OF PRESTRESSED CONCRETE

NEW:

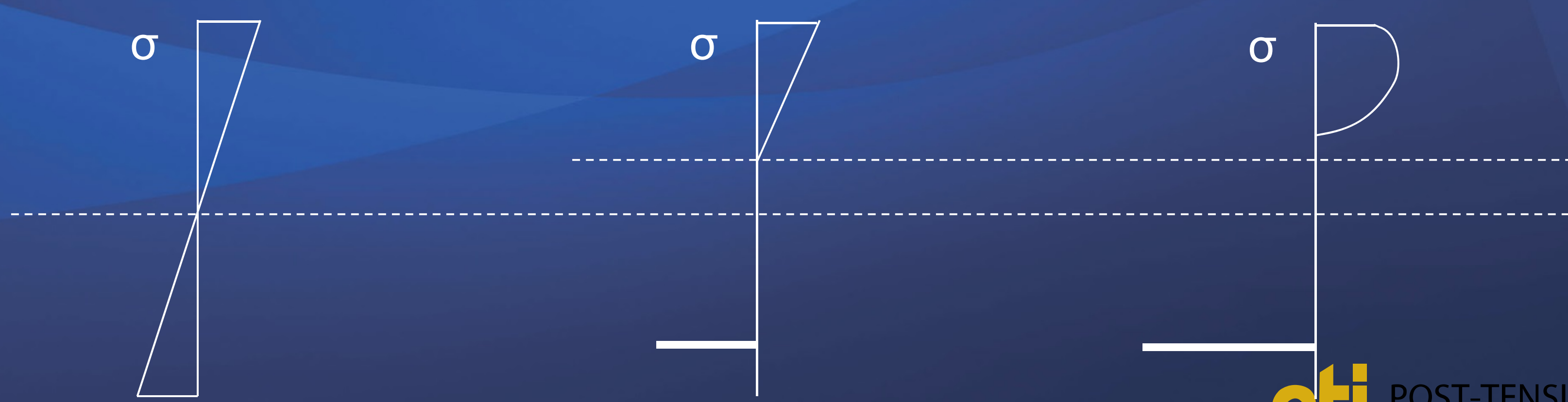
DIFFERENCES BETWEEN PRE-TENSIONING AND POST-TENSIONING

REVIEW OF REINFORCED CONCRETE

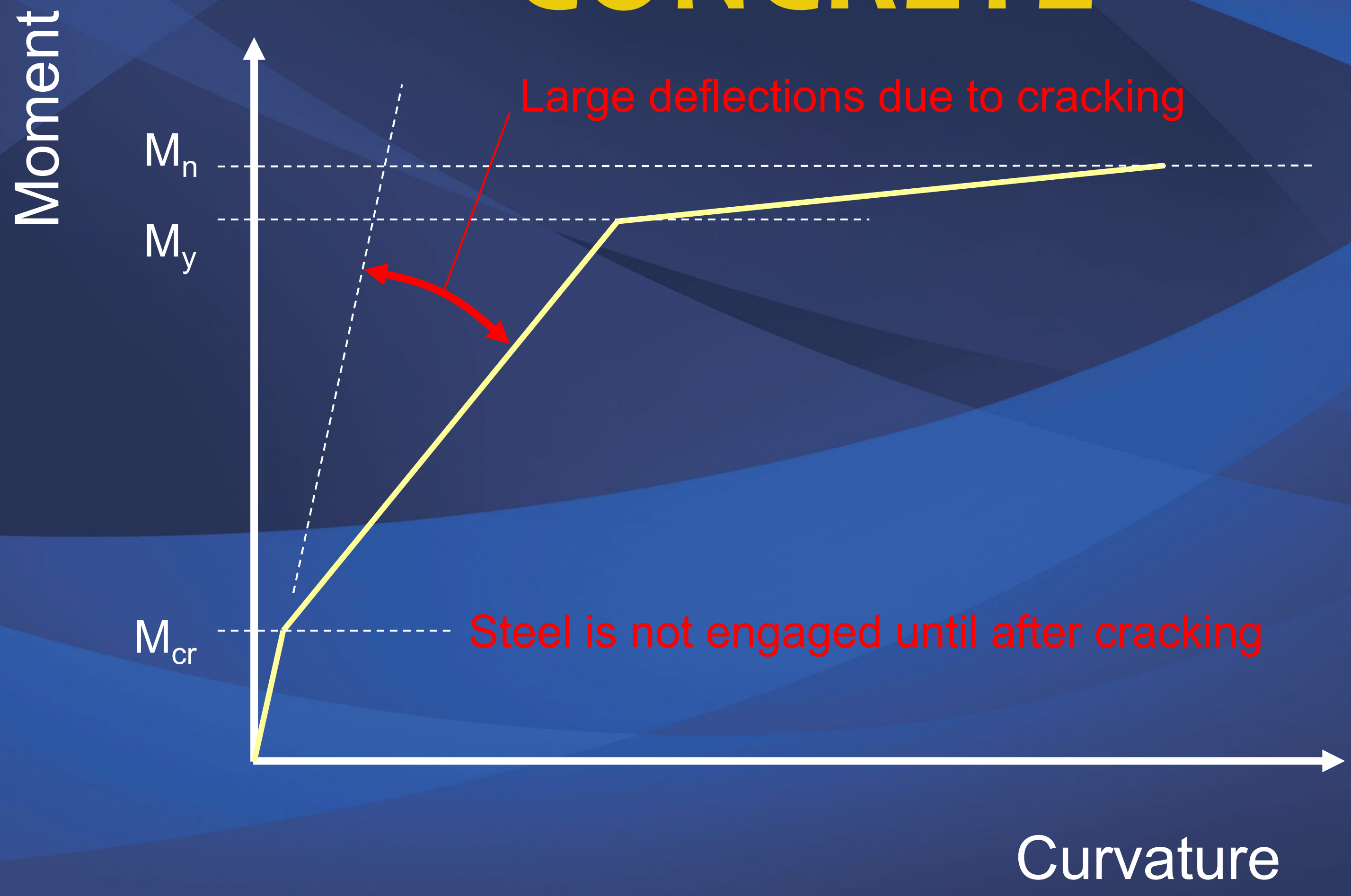


Stages of Behavior

Uncracked | Cracked (~Elastic) | Ultimate



REVIEW OF REINFORCED CONCRETE



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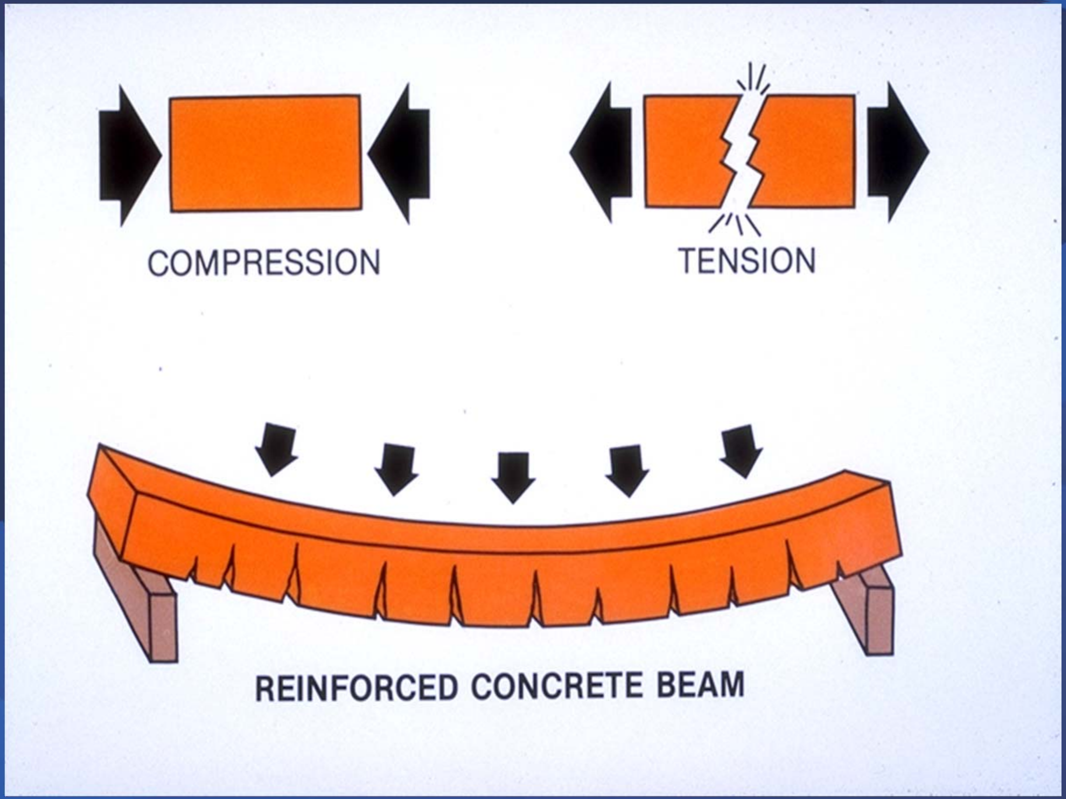
REVIEW OF REINFORCED CONCRETE



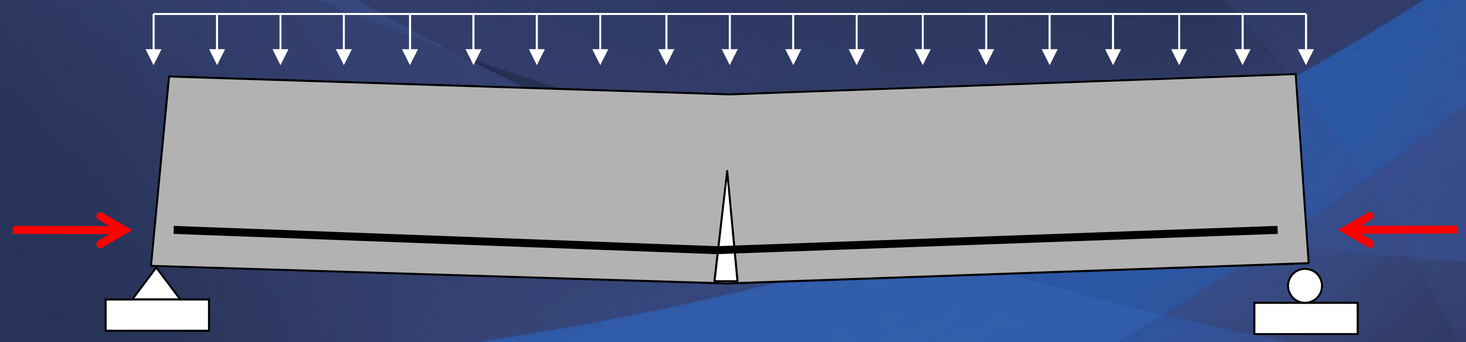
Reinforcement is PASSIVE

Steel crosses cracks, but does not prevent them


POST-TENSIONING MANUAL SIXTH EDITION

QUESTION TO PONDER

Suppose a R/C beam has too much cracking and too much deflection. How might you propose to fix it? (i.e. not replace it)



Tension (bending) + Compression (“squeezing”) =

Net Zero Stress

<u>“Sqeezed” Before Loading (Pre-compressed):</u>

Pre-Compression (“prestressing”) + Tension (bending) =

Net Zero Stress

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- Prestressing: Concrete pre-compressed before loading in bending (flexural tension)

HOW TO BUILD IT?

1. Pre-Tensioning: Steel tensioned before concrete is placed
2. Post-Tensioning: Steel tensioned after concrete is hardened

Prestressing is ACTIVE – can prevent cracks from forming

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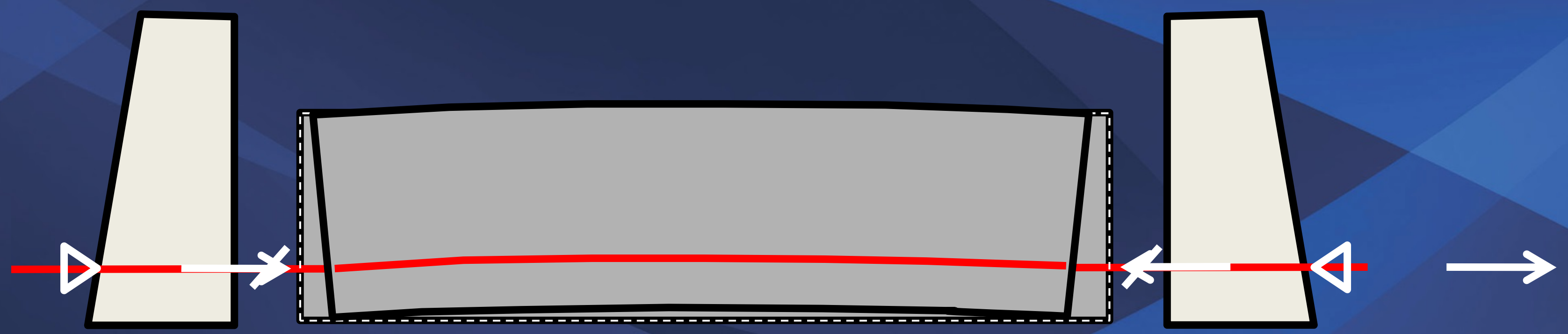
PRE-TENSIONING



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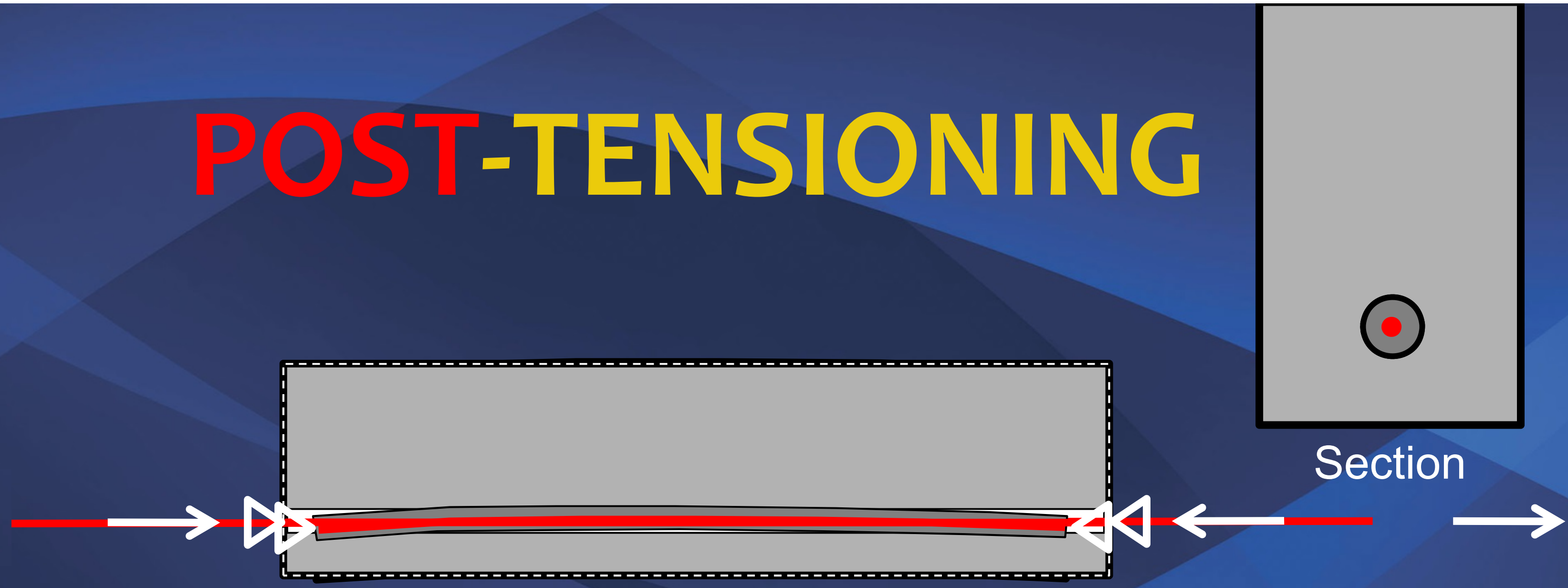
POST-TENSIONING



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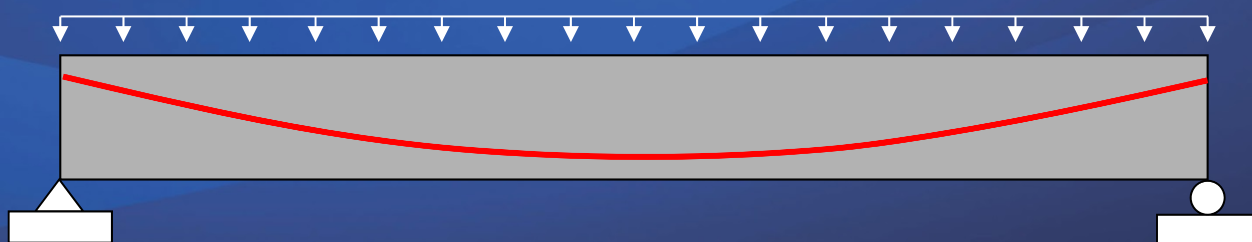
POST-TENSIONING

- Post-tensioning can take on any profile
- Draped configurations are much more common than straight tendons
  - Why?

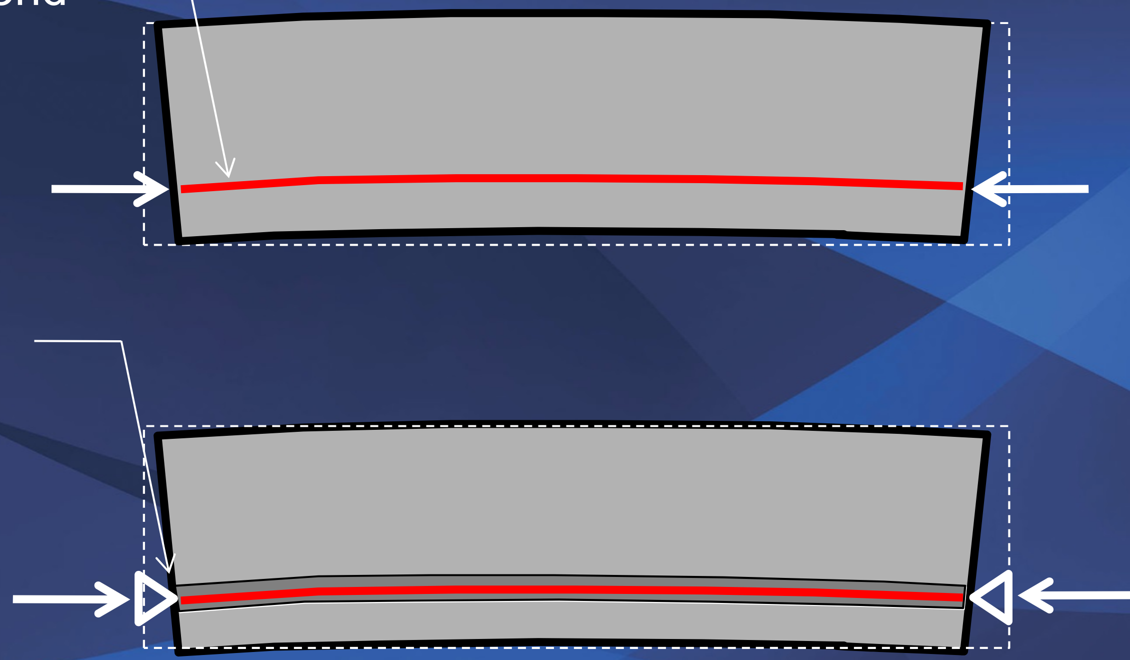


Force Transfer by
Steel-Concrete bond

PRE-TENSIONING

Force Transfer at
end anchor

Post-Tensioning



Strain Compatibility and Force Equilibrium:

Steel held at length longer than it “wants” to be: Tension

Concrete compressed shorter than it “wants” to be: Compression

- Pre-Tensioned elements are often precast in a factory and shipped to the site
- Post-Tensioned elements can be cast and tensioned in the final location (cast-in-place). They can also be precast.

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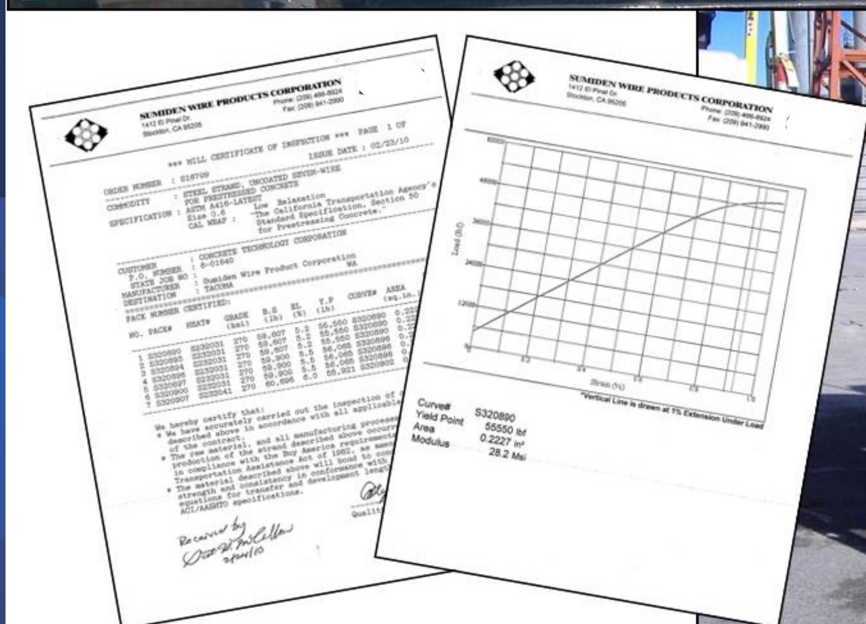
PRE-TENSIONING

INSTALL PRESTRESSING STRANDS



PRE-TENSIONING

TENSION STRANDS

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PRE-TENSIONING

STRANDS AFTER TENSIONING

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PRE-TENSIONING

INSTALL MILD REINFORCEMENT

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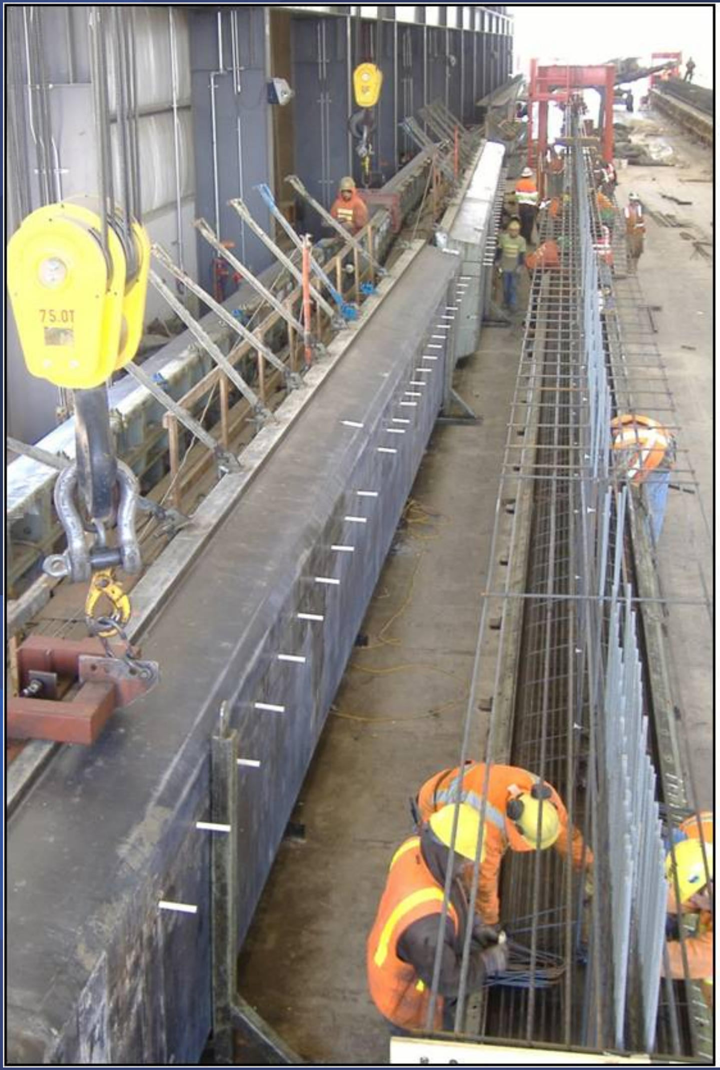
PRE-TENSIONING

INSTALL INSERTS AND ASSEMBLIES



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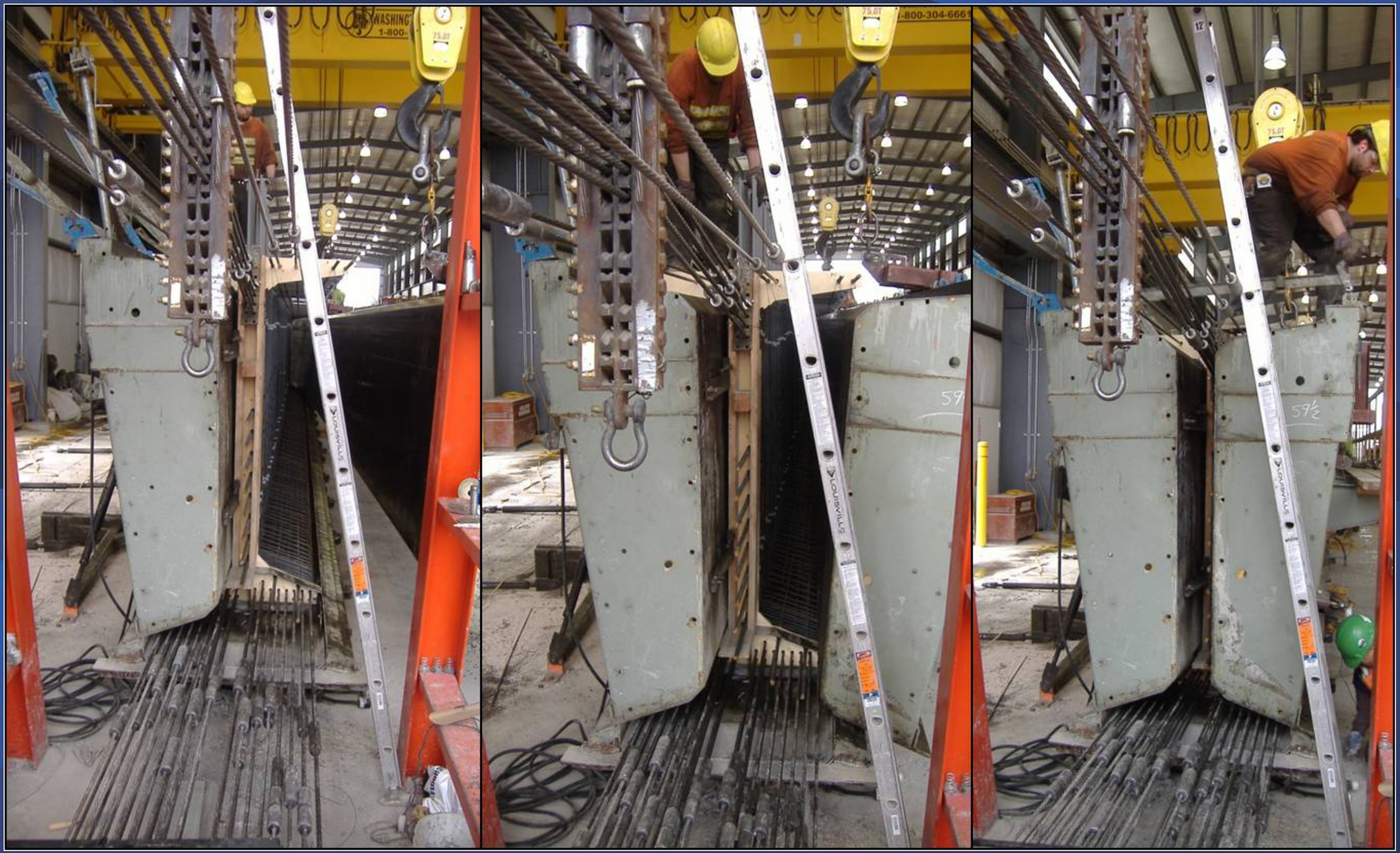
PRE-TENSIONING

SET FORM SIDES



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PRE-TENSIONING

PLACE CONCRETE

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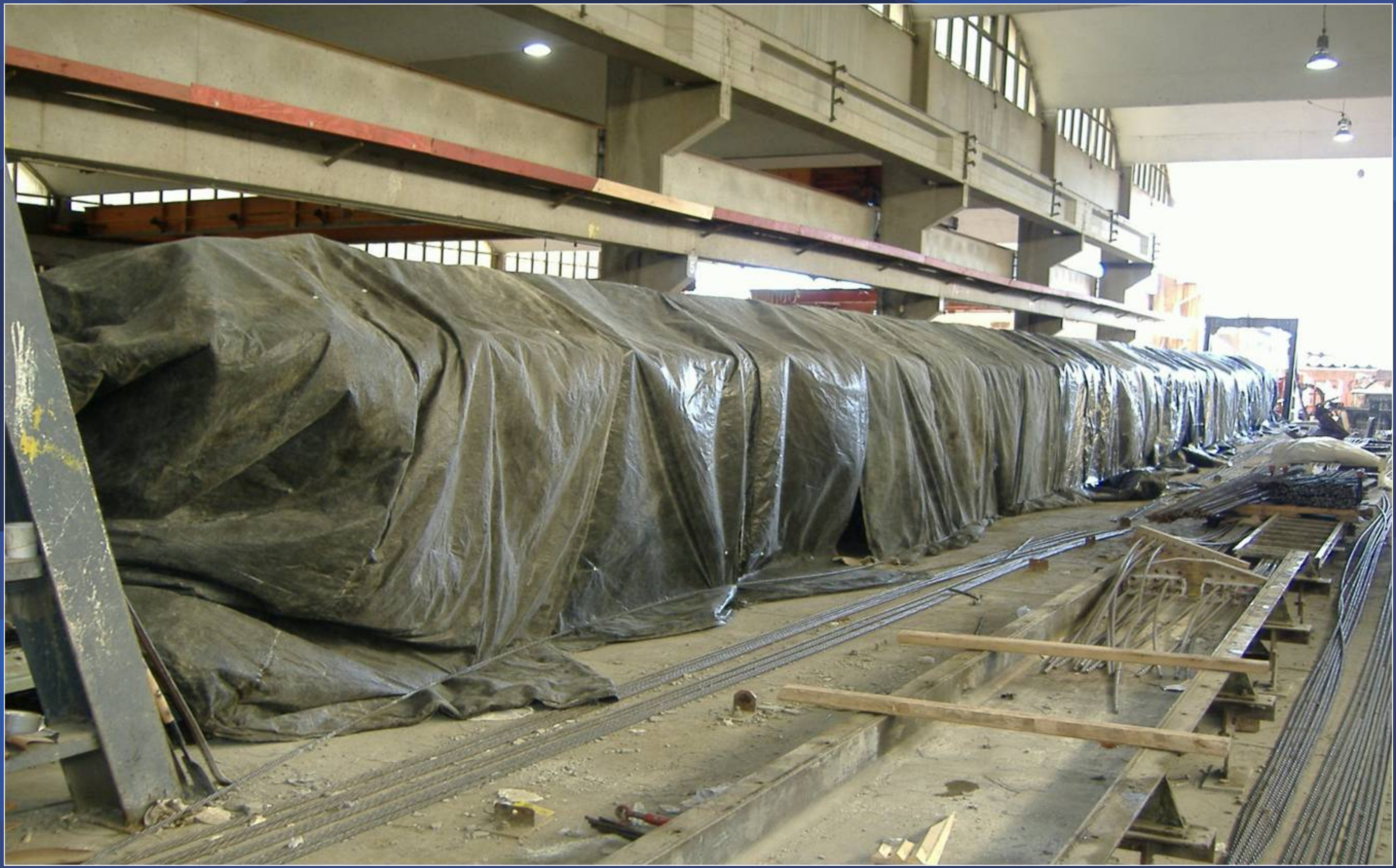
PRE-TENSIONING

CURE CONCRETE WITH ACCELERATED METHODS



PRE-TENSIONING

REMOVE GIRDER FROM CASTING BED

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PRE-TENSIONING

MOVE GIRDER TO STORAGE

PRE-TENSIONING

TRANSPORT TO JOBSITE

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PRE-TENSIONING

POST-TENSIONING

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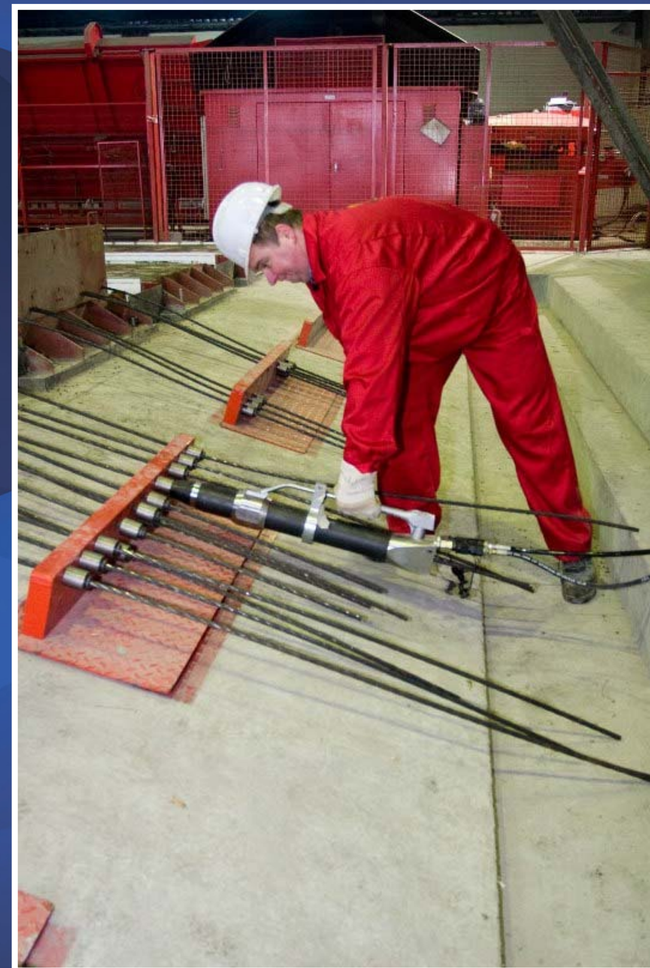
POST-TENSIONING

Stressing Strands:

Single Strand: Monostrand



Multiple Strands: Multistrand

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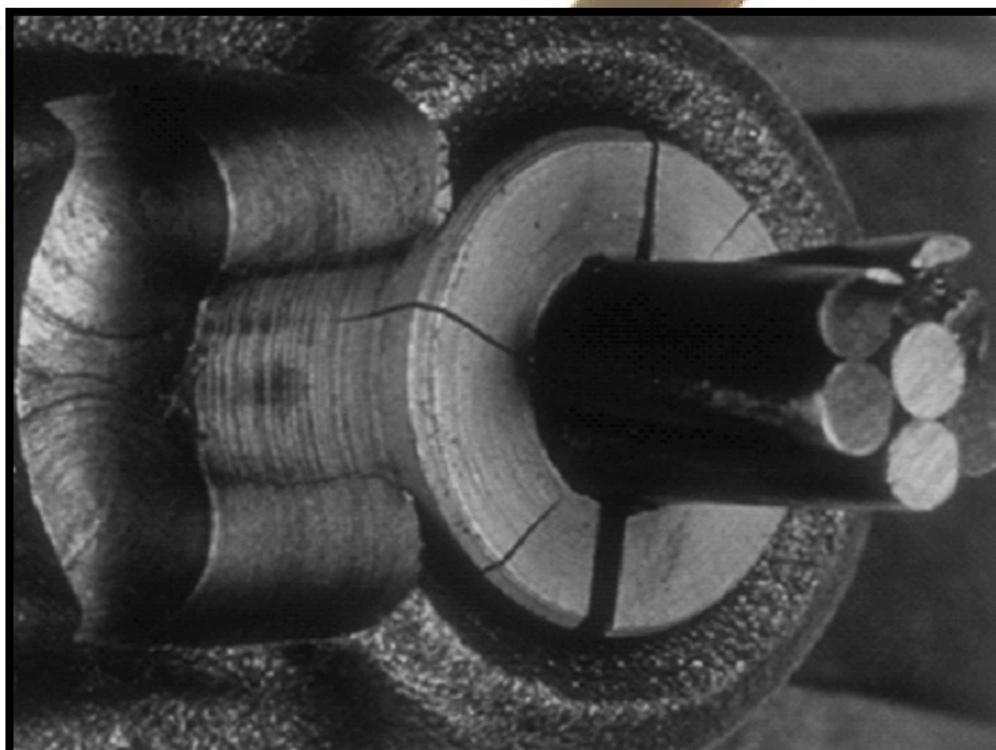
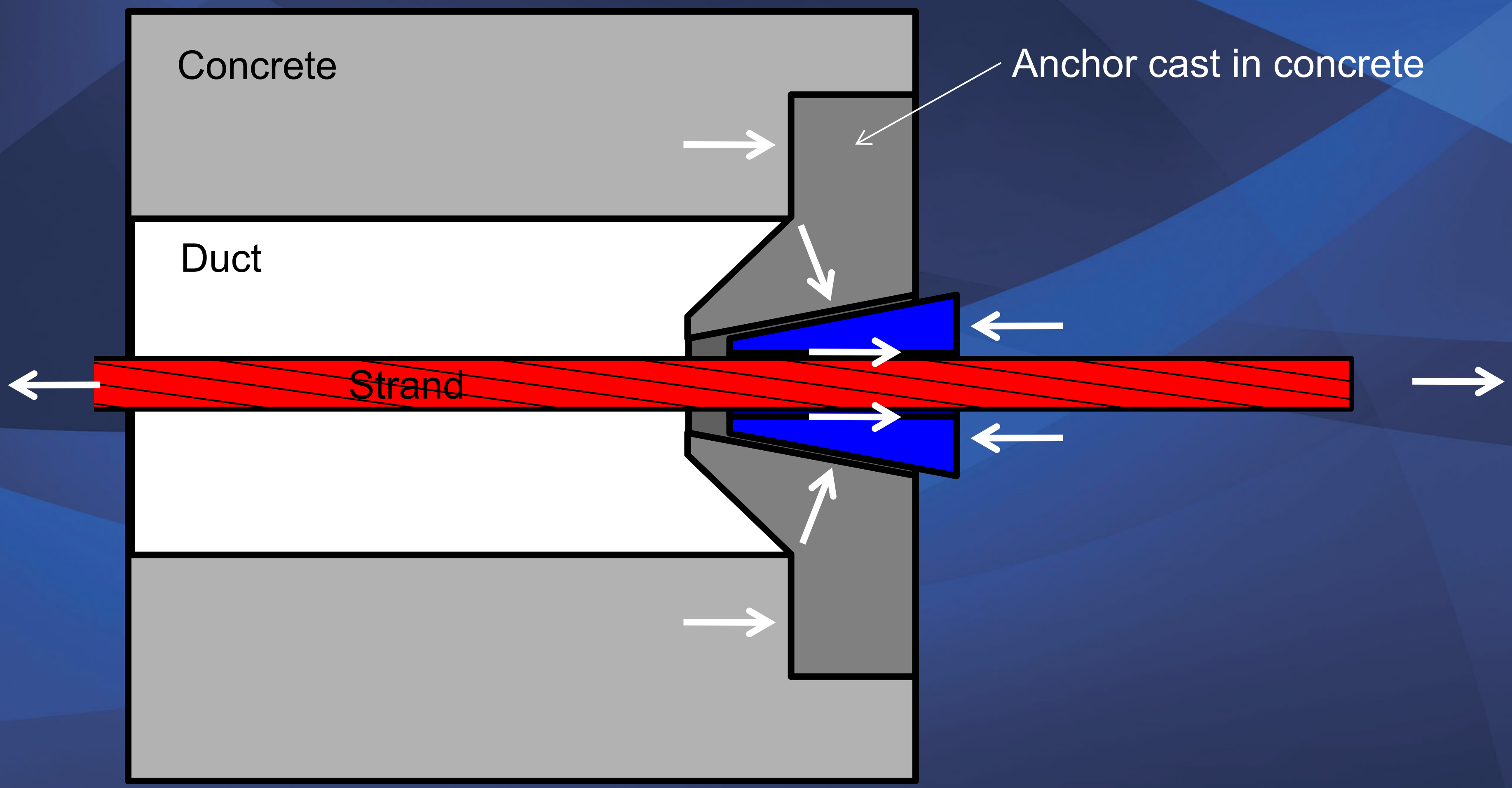
HOW ARE STRANDS ANCHORED?

Cast against concrete at end of beam



HOW ARE STRANDS ANCHORED?



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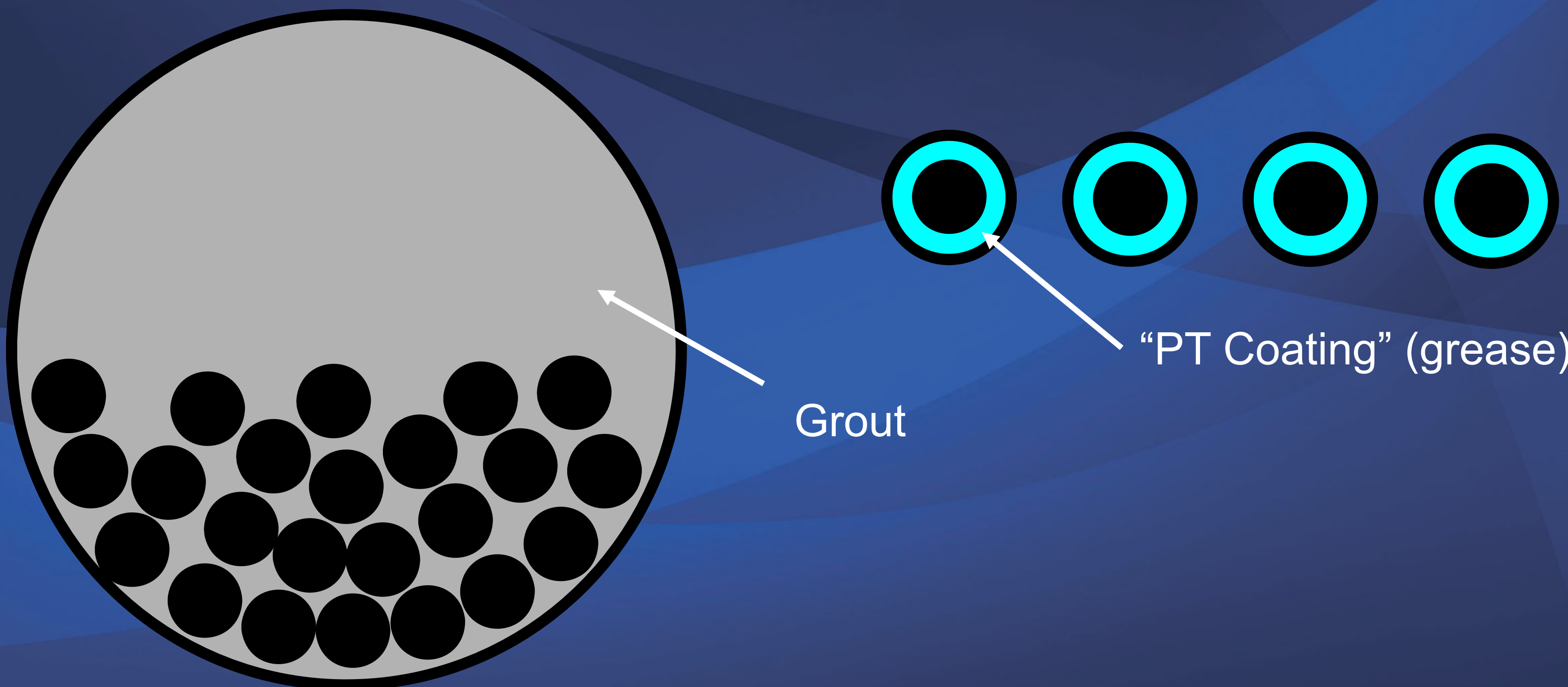
POST-TENSIONING:

Bonded System
(at high point)

Unbonded System



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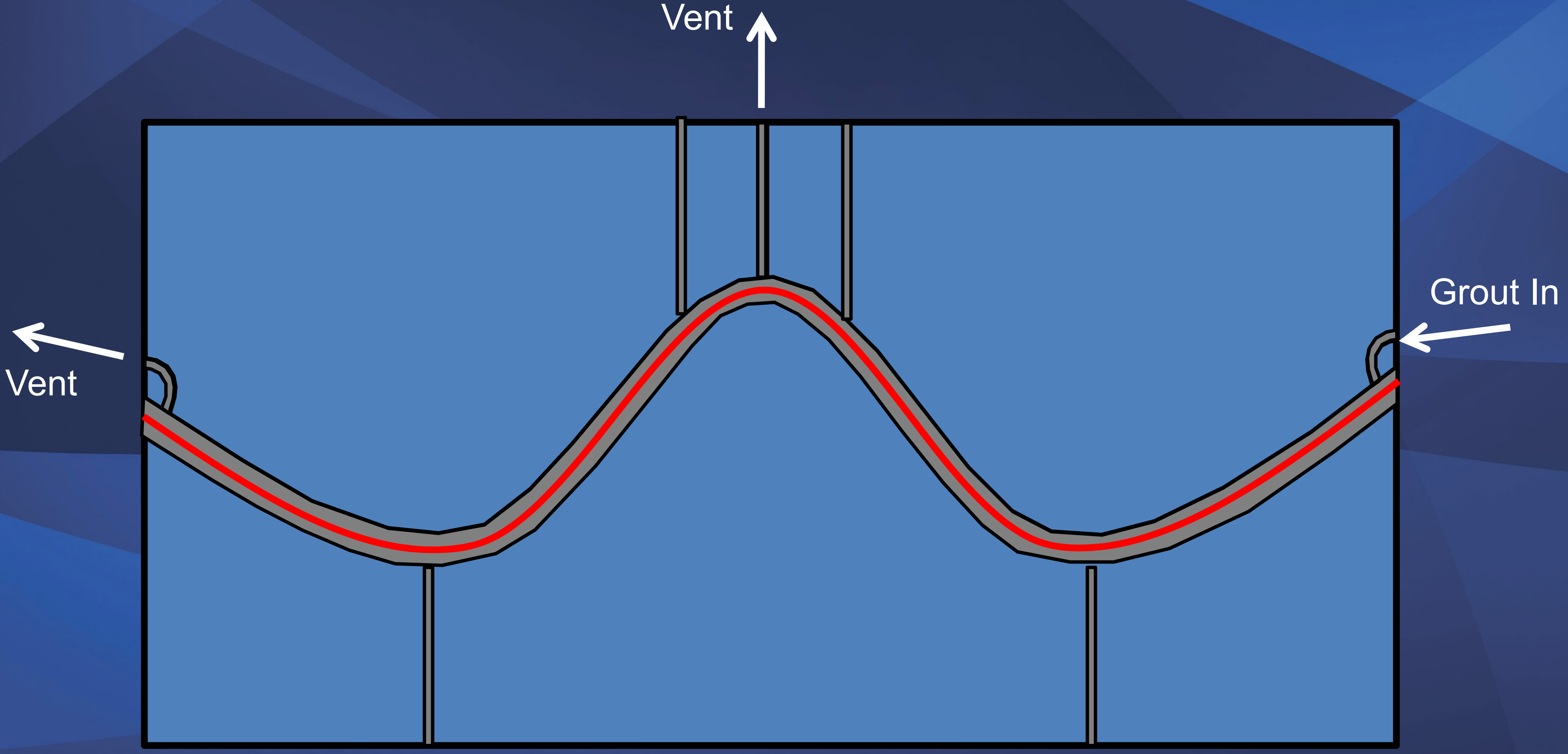
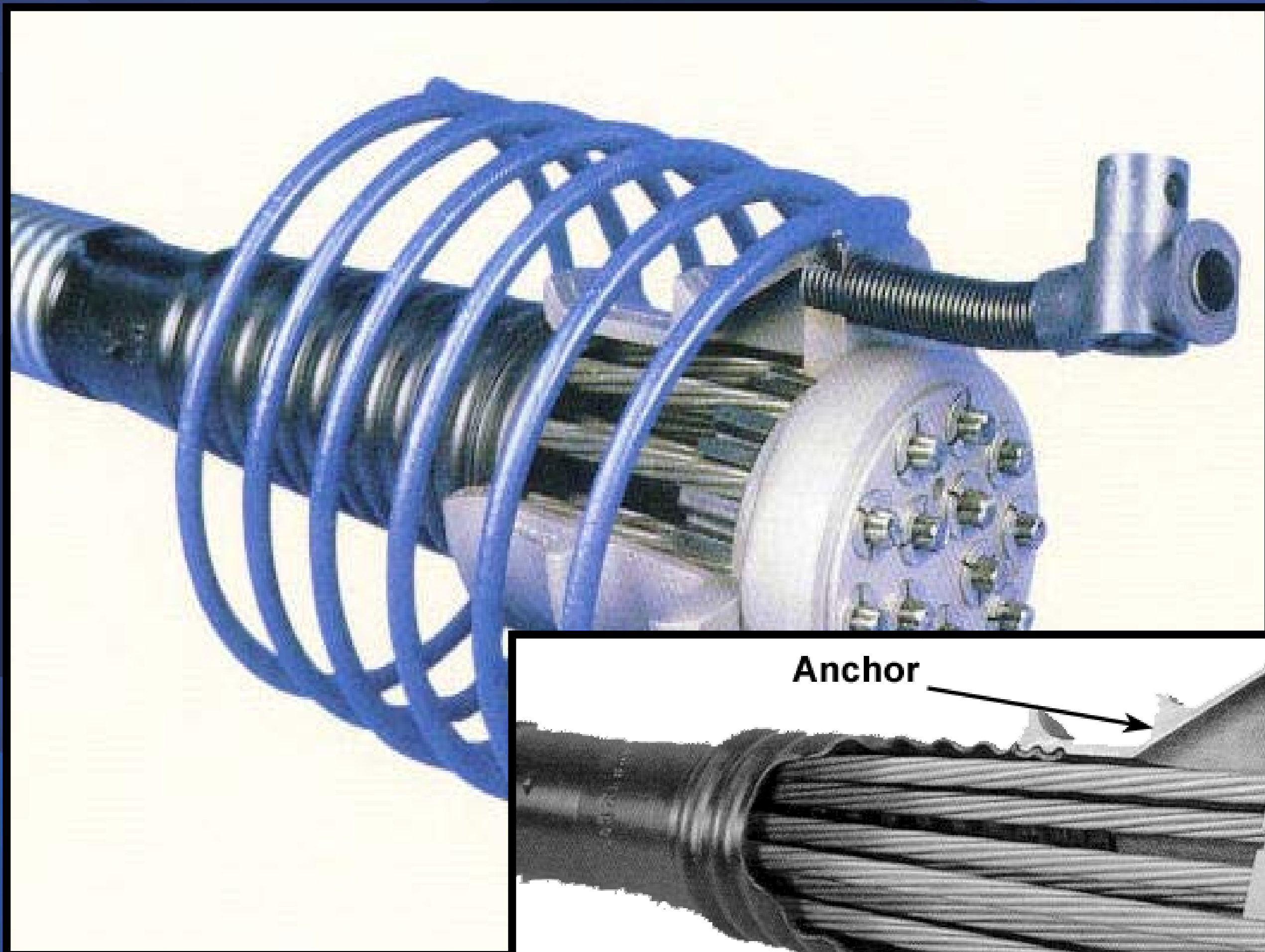
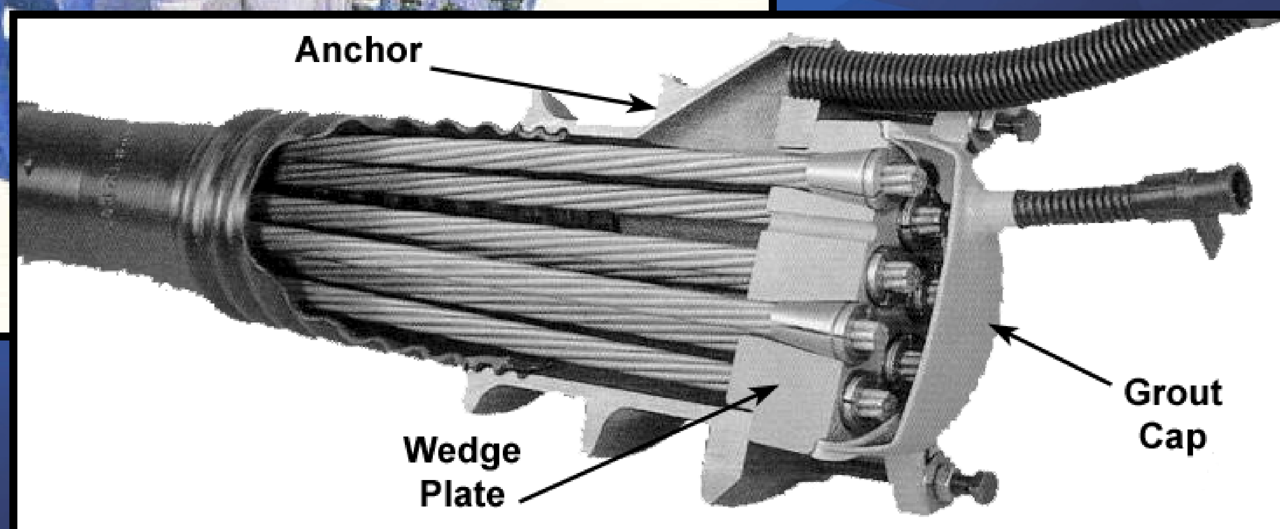
GROUTING POST-TENSIONED SYSTEMS



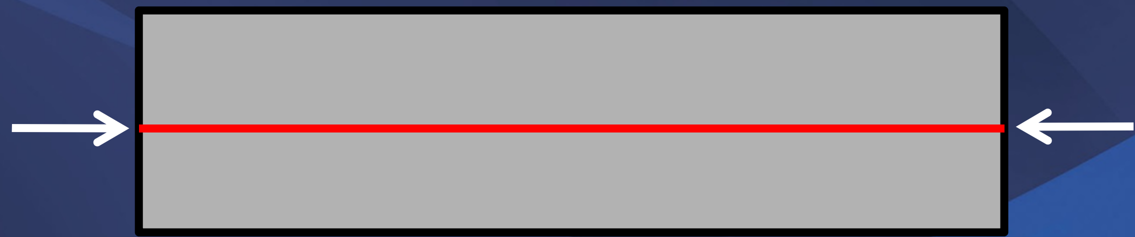
POST-TENSIONING

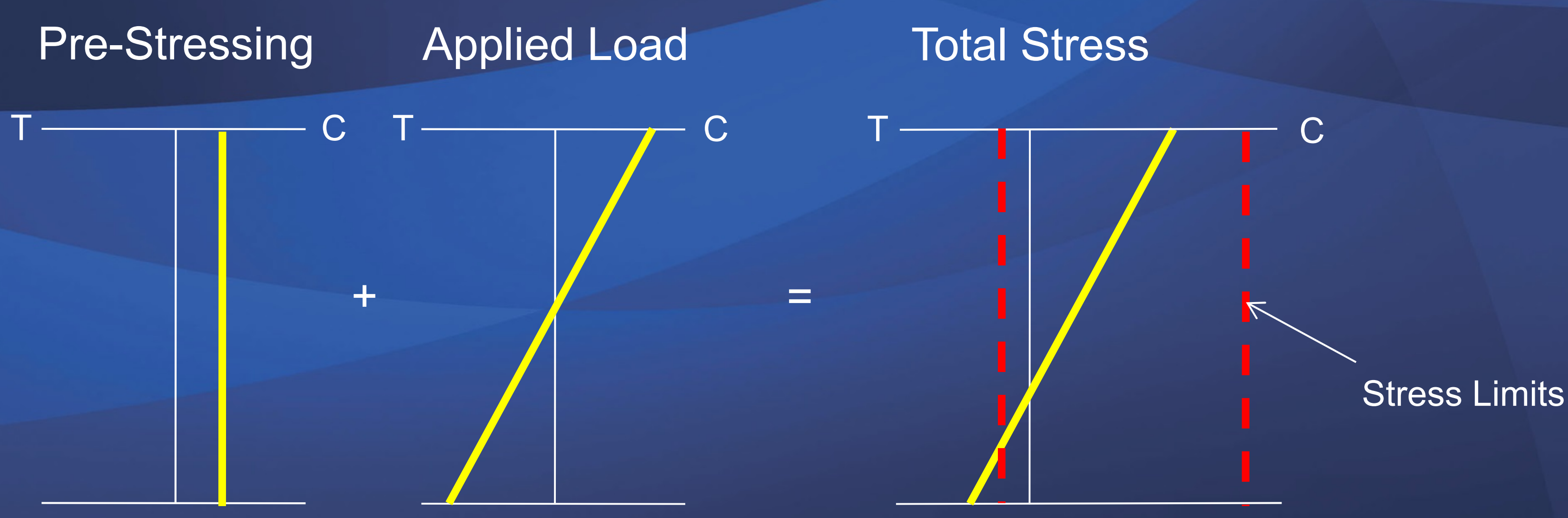




STRUCTURAL EFFECT OF PRESTRESSING

True for Pre- and Post-Tensioning





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STRUCTURAL EFFECT OF PRESTRESSING

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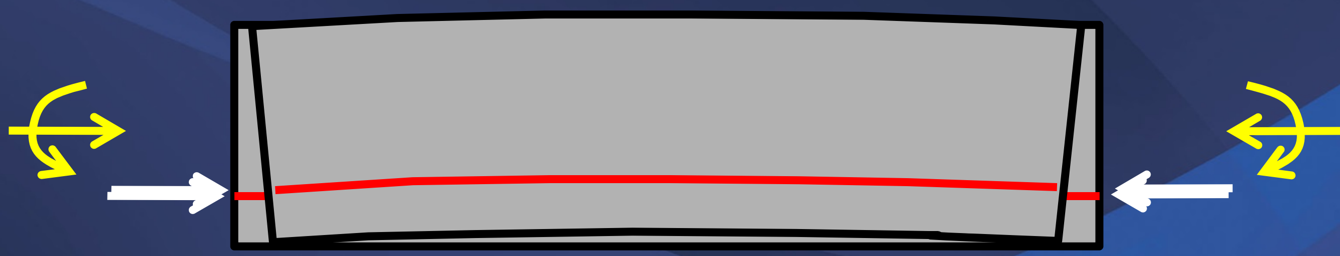

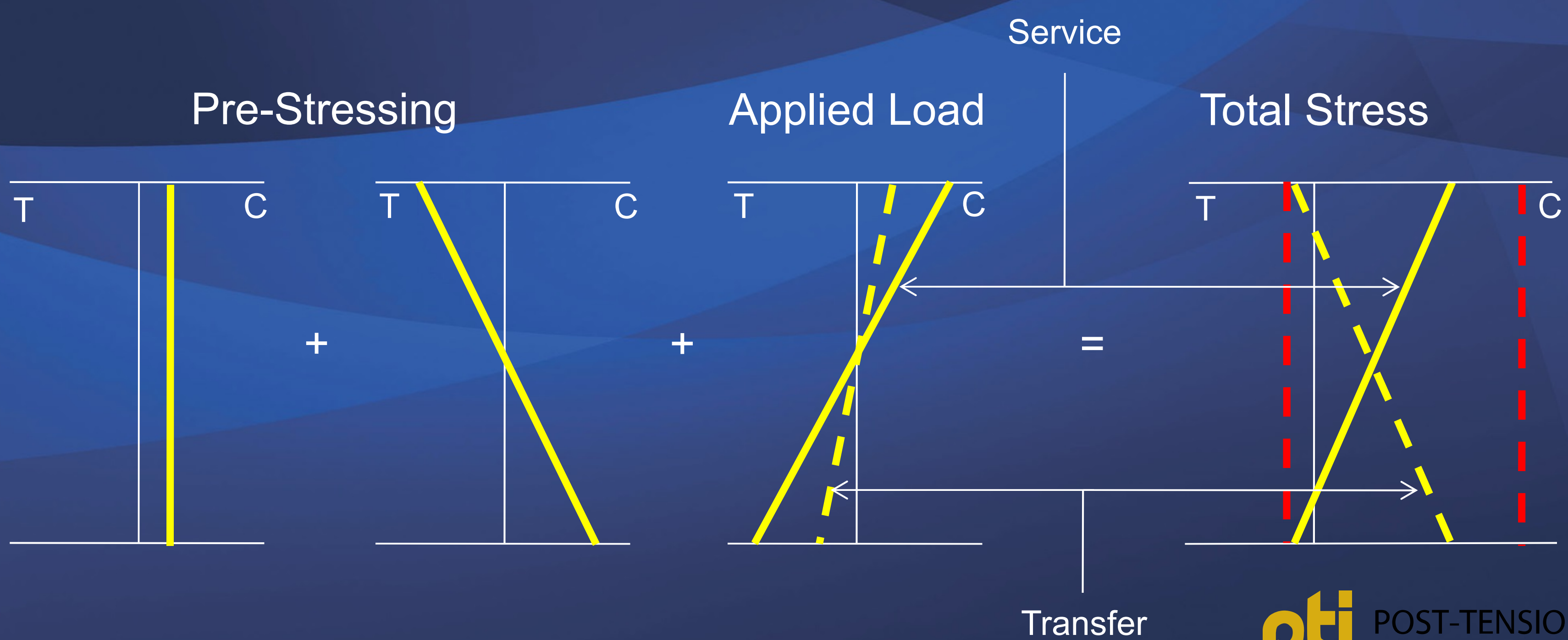

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ECCENTRIC PRESTRESSING

Eccentricity in prestressing:

- Desirable at midspan
- Not productive, even detrimental, at end of span

Strategies for pre-tensioned systems:

- Draped / harped profiles

  Temporarily held in place before concrete is hardened

- Debonding

  Not all strands are active at end of span

Strategies for post-tensioned systems:

- Install ducts in desired profile

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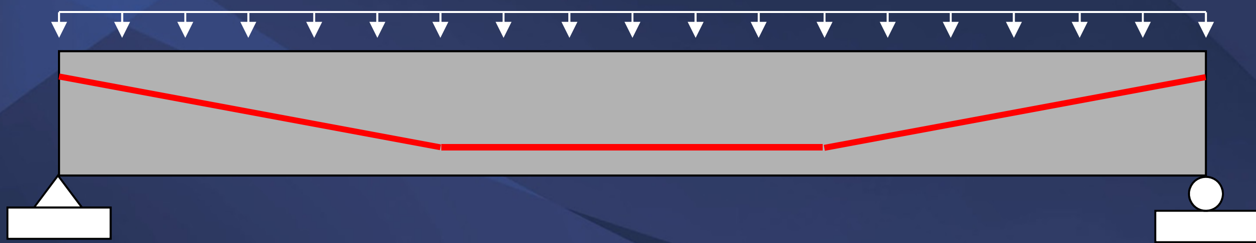
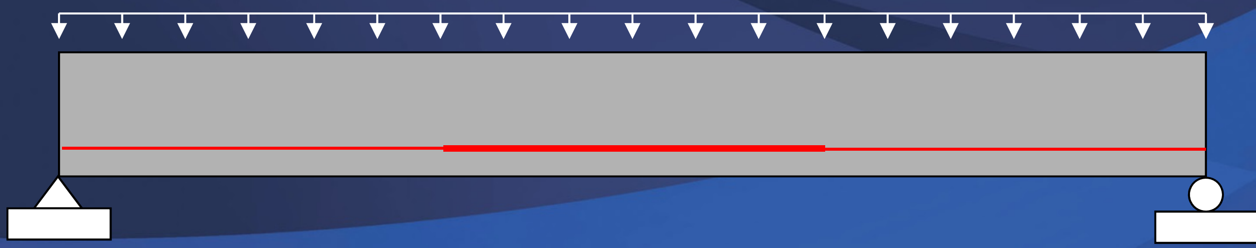
COMMON CONFIGURATIONS

Pre-tensioning:

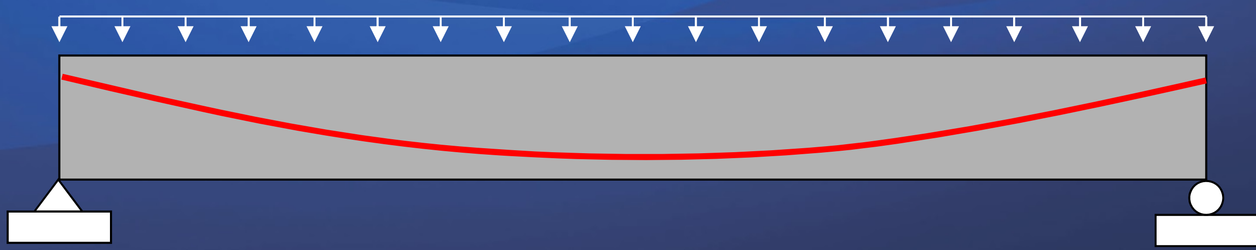


Draped



Debonded

Post-tensioning:



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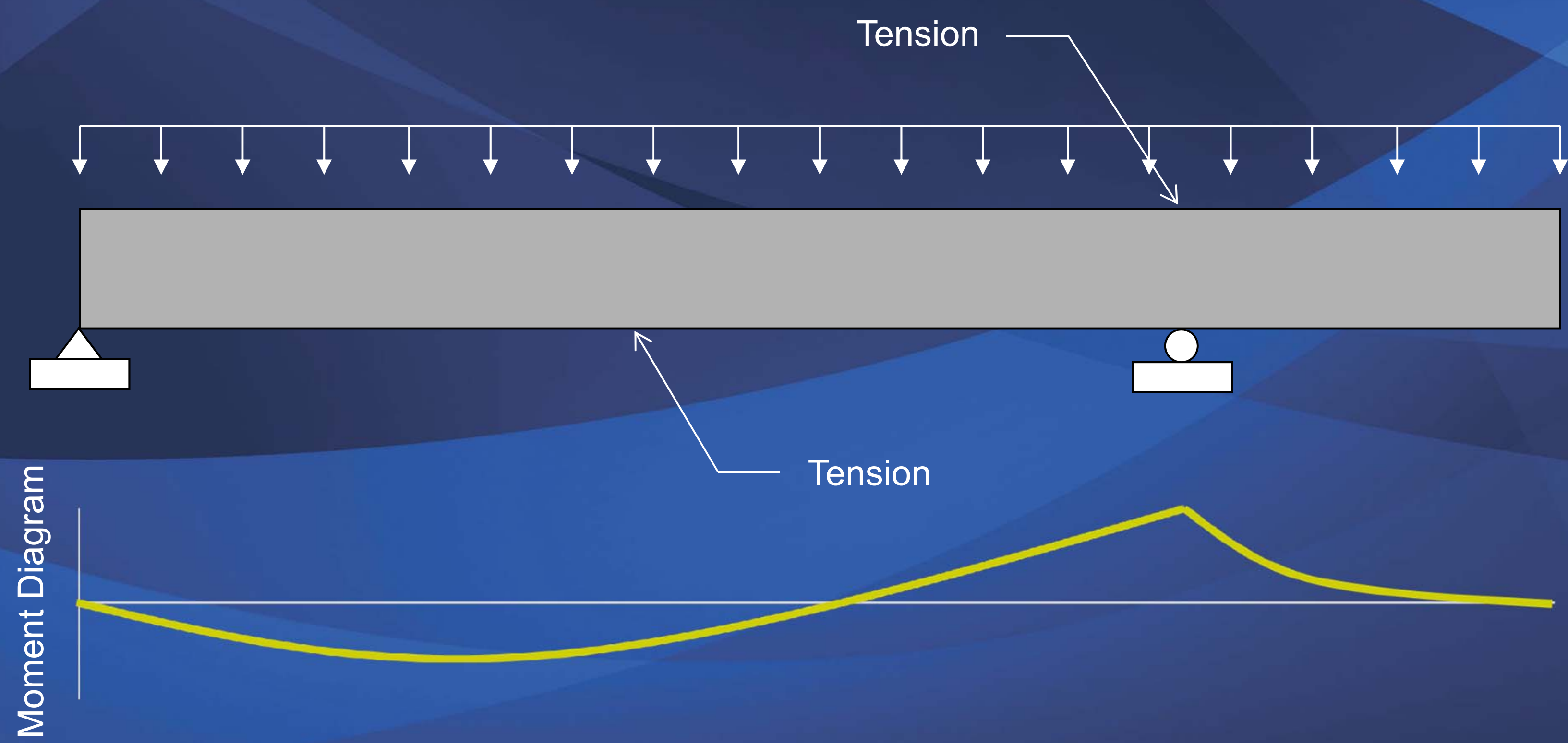
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?



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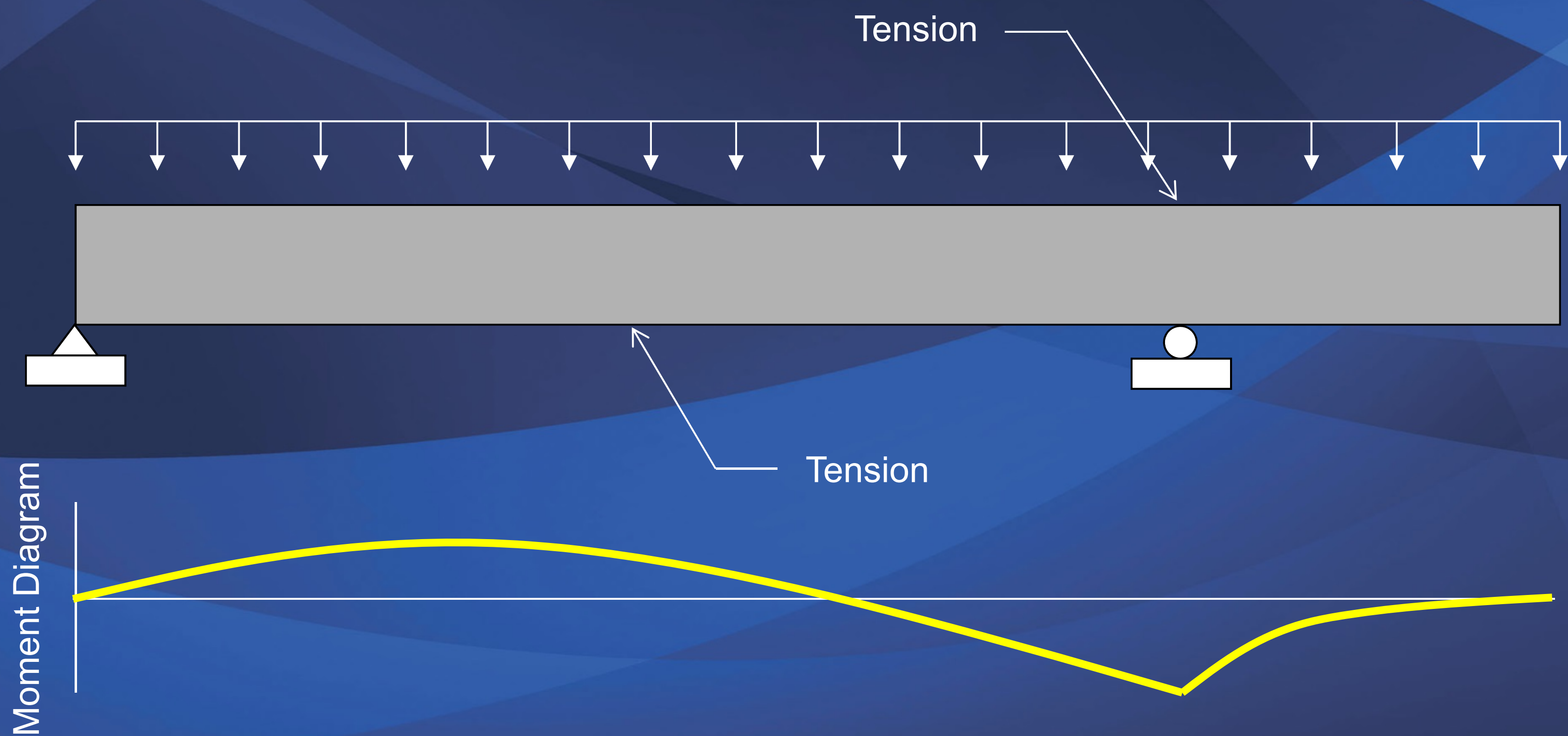

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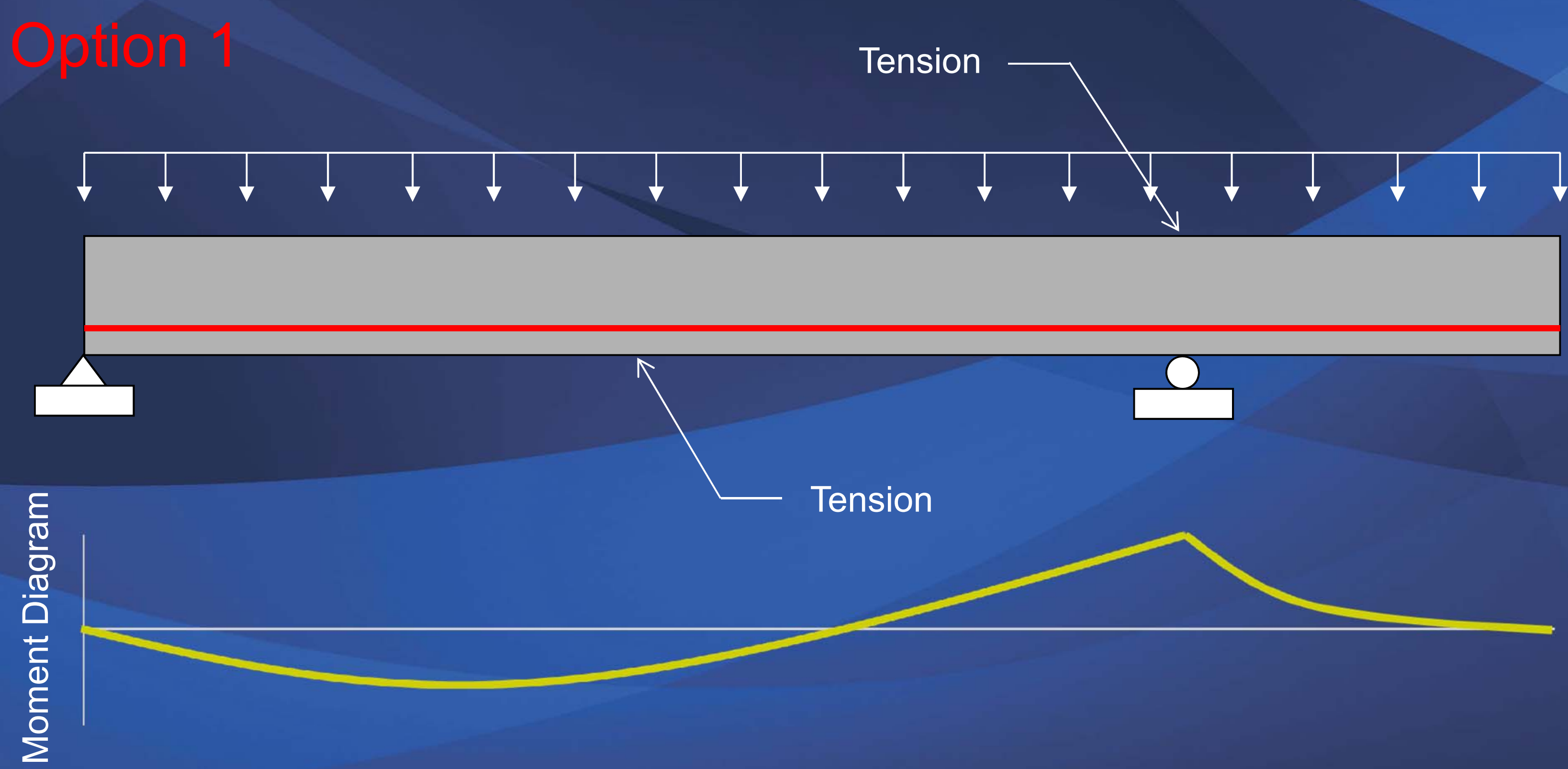
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?



Good:
- Efficient at midspan
- Easy to construct

Bad:
- Counter-productive over support

(T)

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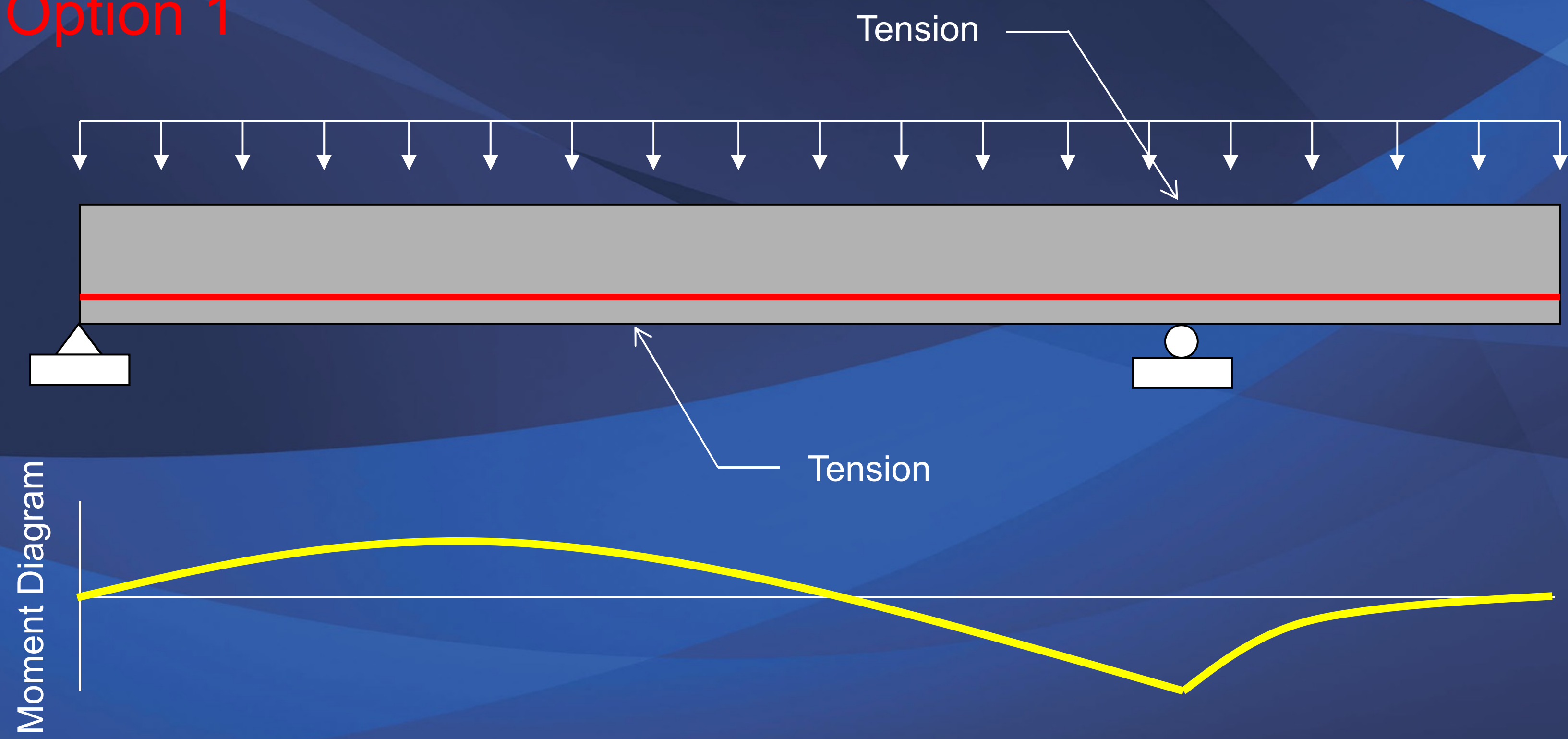
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 1



Good:
- Efficient at midspan
- Easy to construct

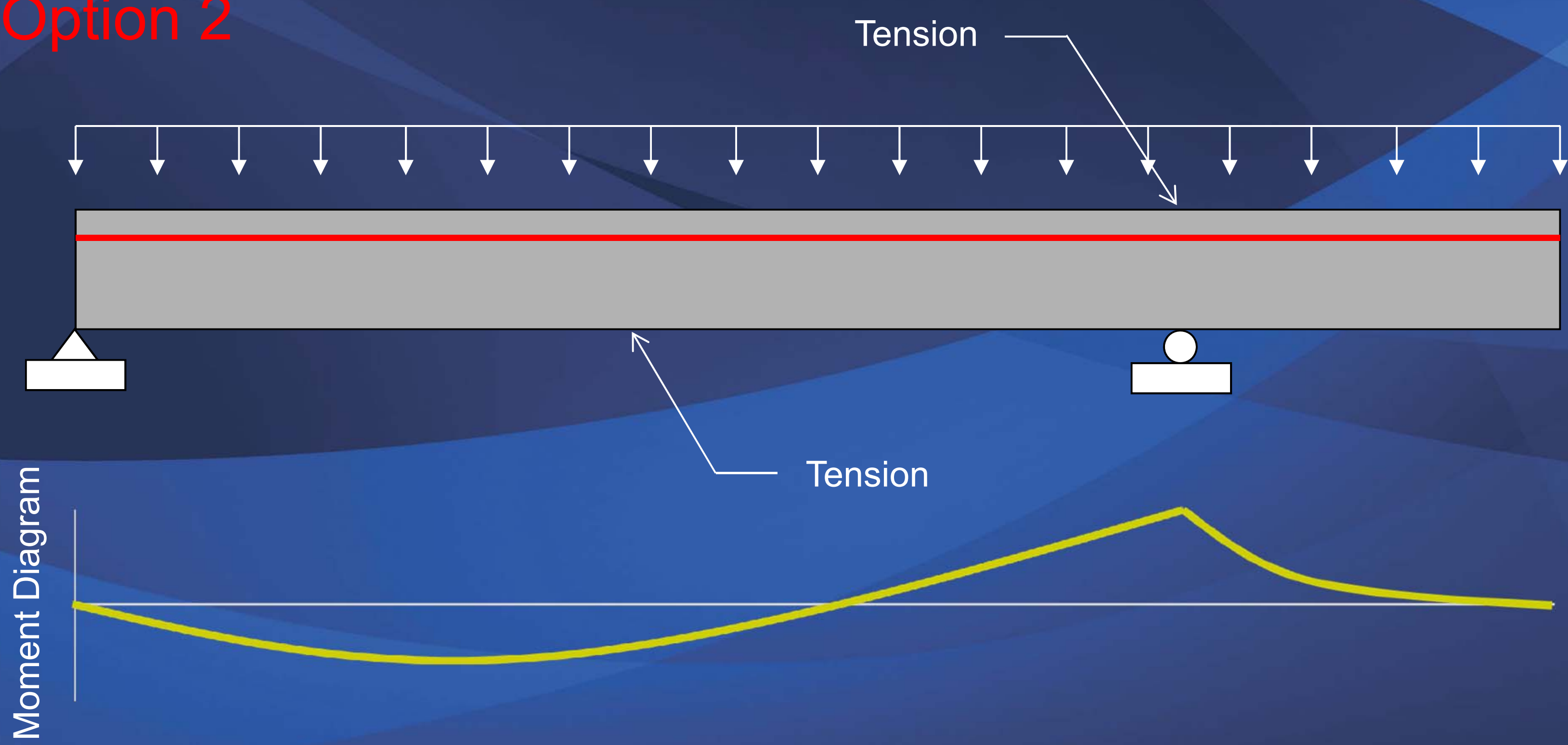
Bad:
- Counter-productive over support

(C)

PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 2



Good:
- •Efficient over support
- •Easy to construct

Bad:
- •Counter-productive at midspan

(T)

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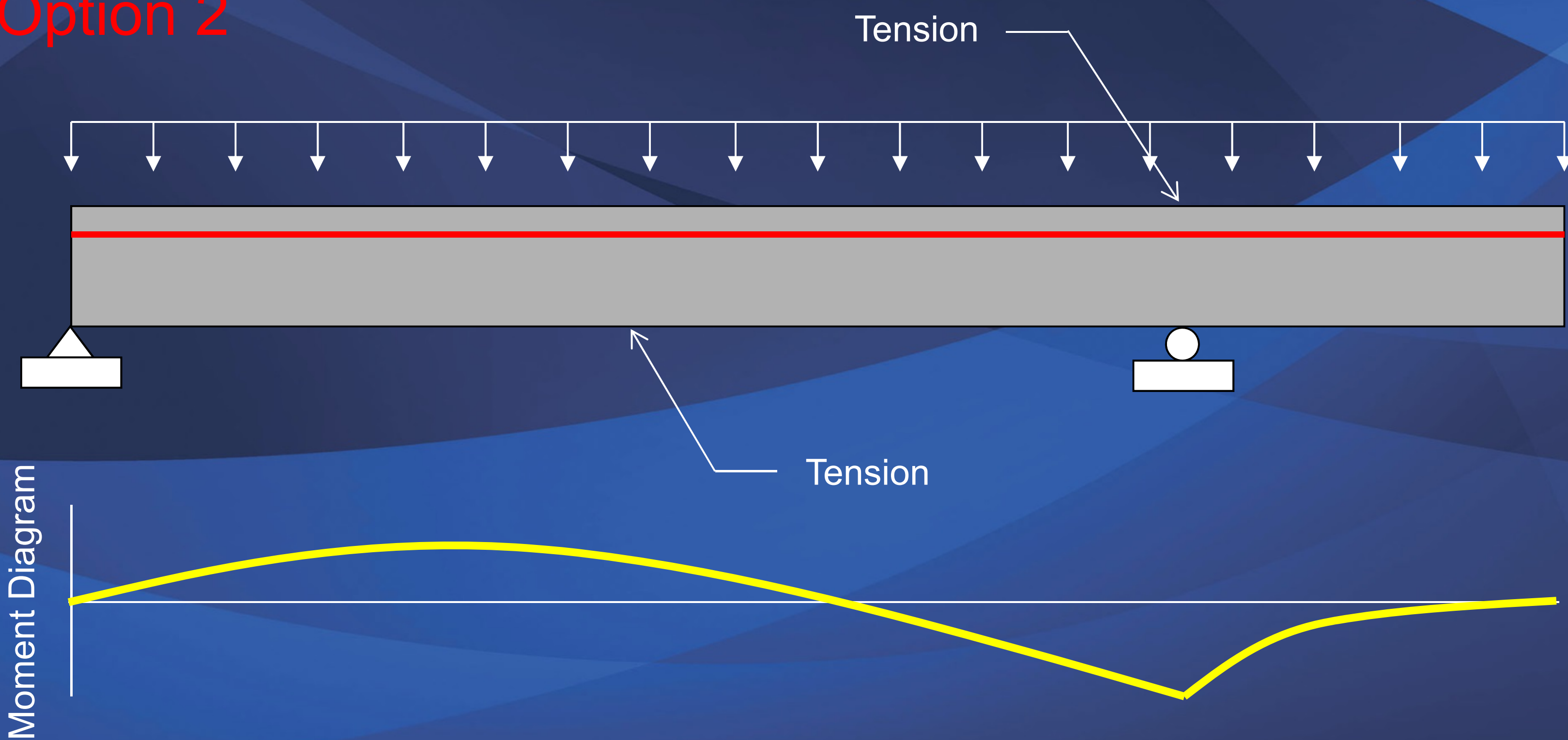
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 2



Good:

- Efficient over support
- Easy to construct

Bad:

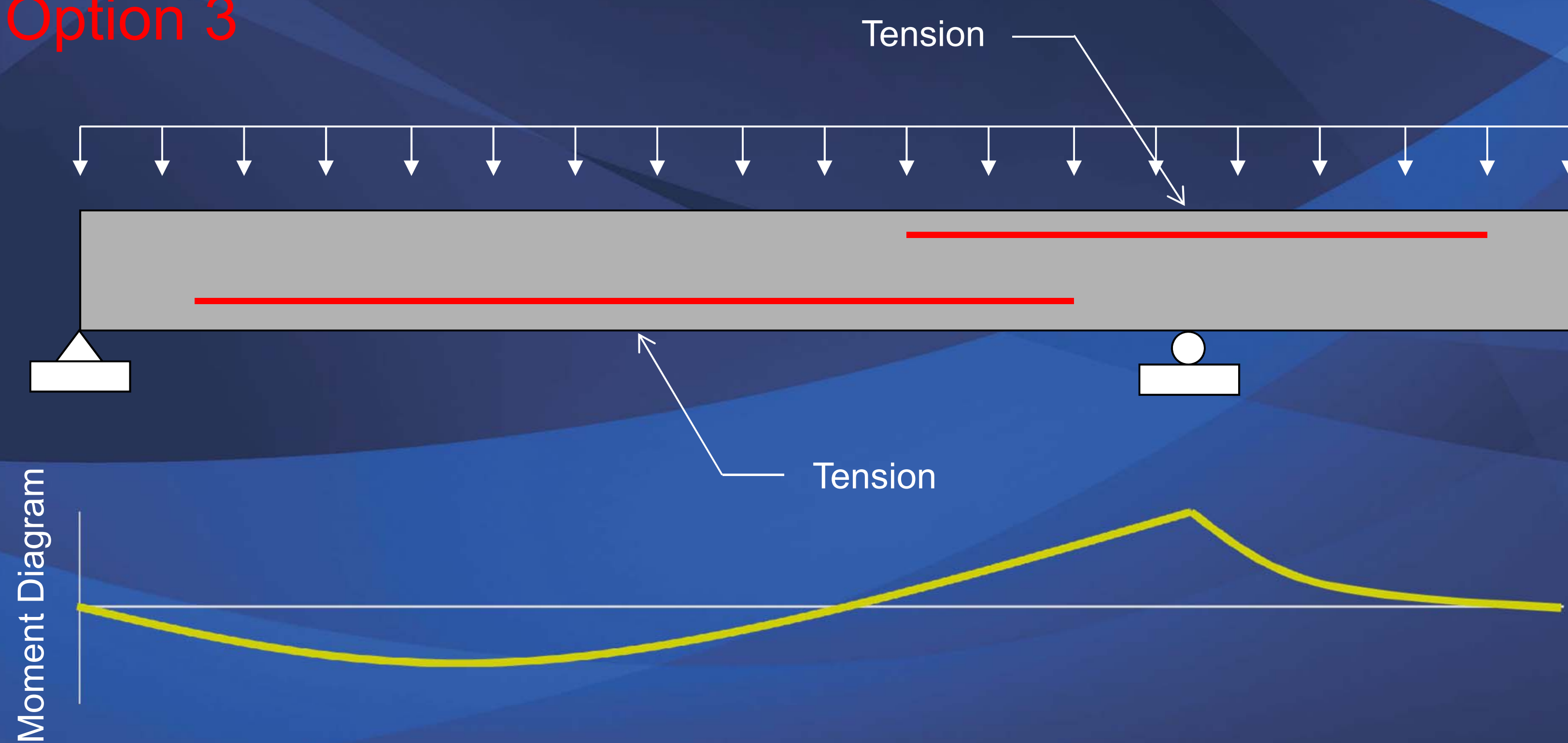
- Counter-productive at midspan

(C)

PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 3



Good:
- Efficient over support
- Efficient at midspan

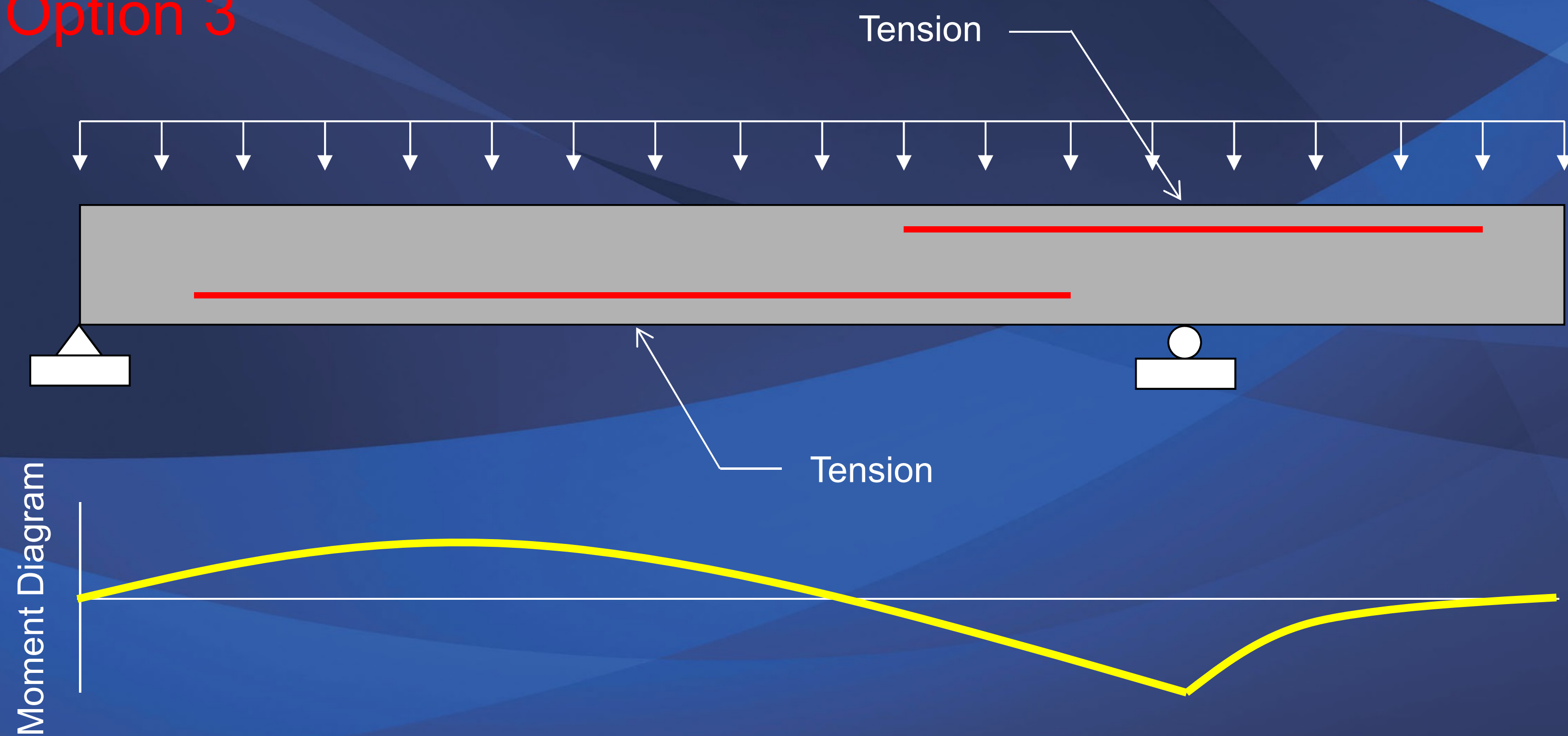
Bad:
- Difficult to construct

(T)

PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 3



Good:

- Efficient over support
- Efficient at midspan

Bad:

- Difficult to construct

(C)

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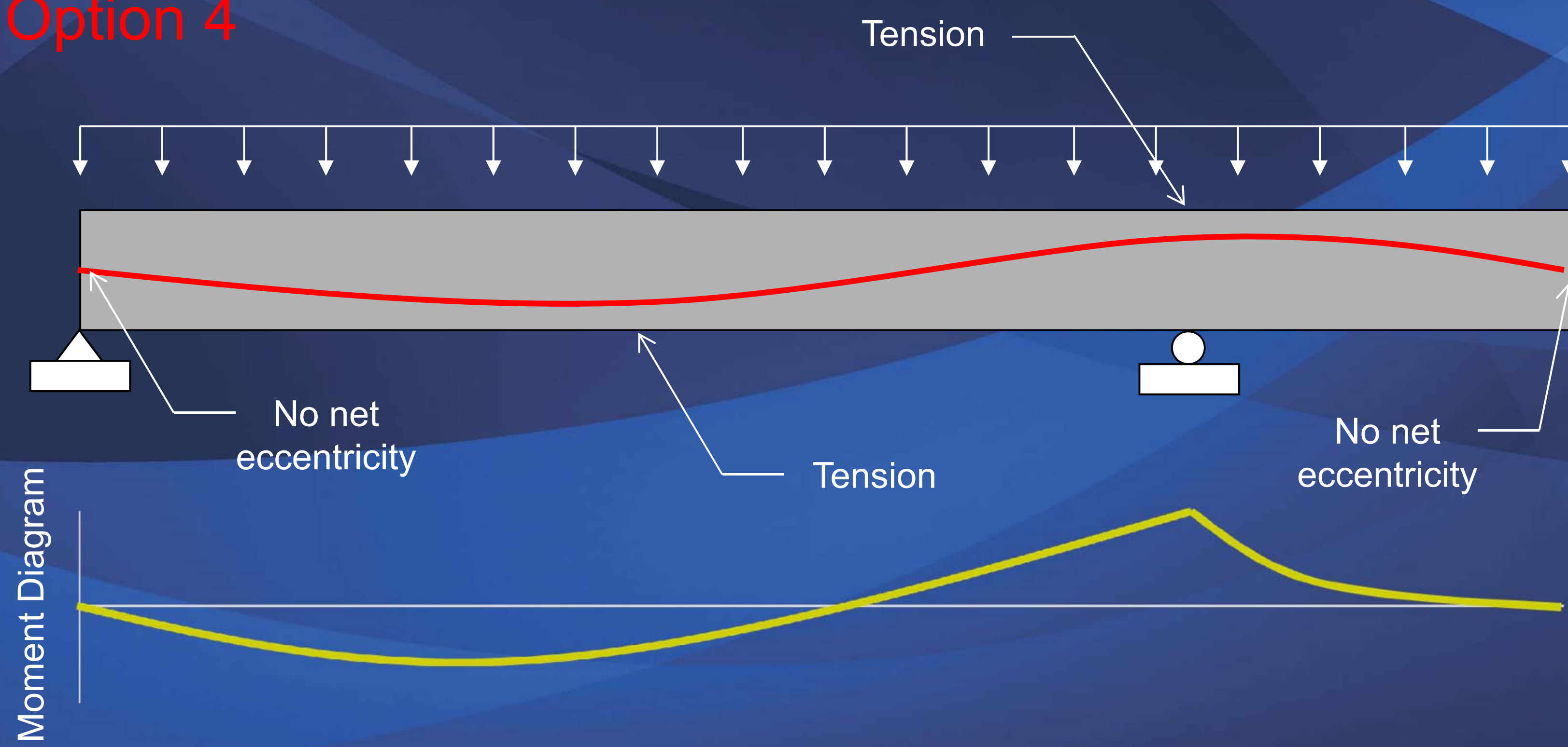
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 4



Requires post-tensioning; very difficult to achieve by pre-tensioning

(T)

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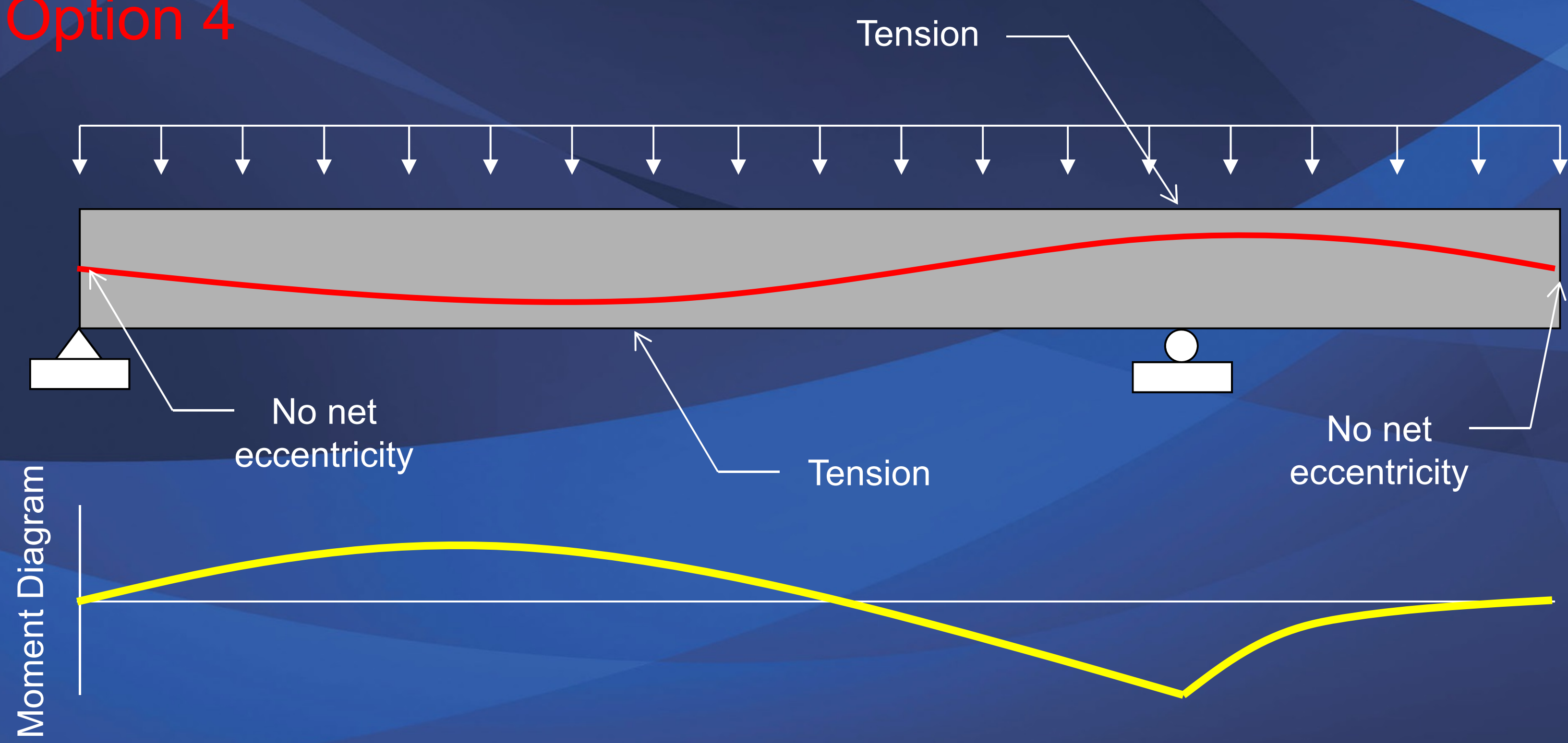
PROBLEM FOR THOUGHT…

Where should the prestressing be placed?

Option 4



Requires post-tensioning; very difficult to achieve by pre-tensioning

(C)

SUMMARY: PRESTRESSED CONCRETE

- Efficient use of materials – concrete maintained in compression, crack control
- Smaller deflections/thinner members
- Longer spans
- Corrosion resistance
- Less material; reduced environmental impact