

SECTION 1

INTRODUCTION TO POST-TENSIONED CONCRETE

DEVELOPED BY THE PTI EDC-130 EDUCATION COMMITTEE

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.

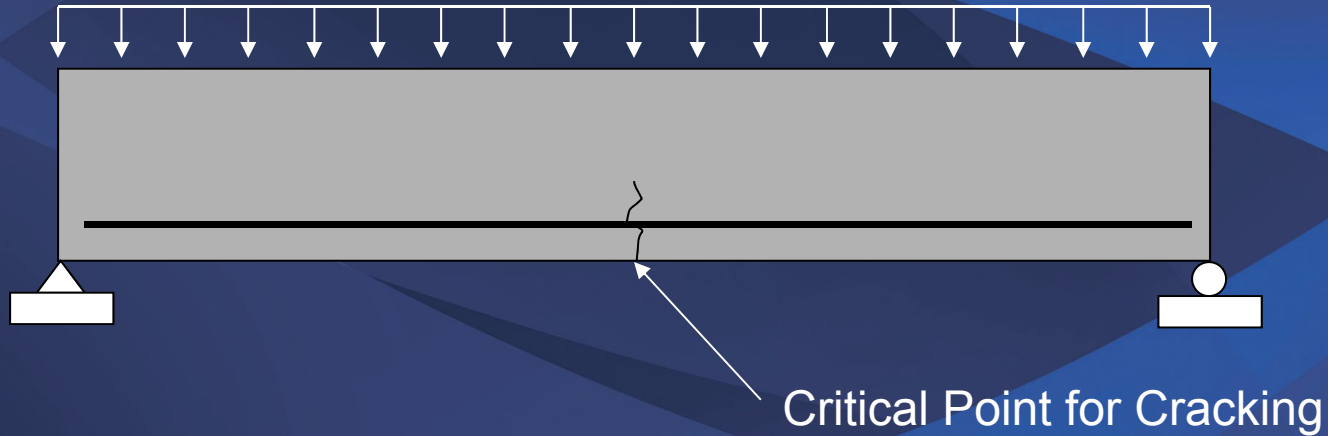
REVIEW:

**FUNDAMENTALS OF
PRESTRESSED CONCRETE**

NEW:

**DIFFERENCES BETWEEN
PRE-TENSIONING AND
POST-TENSIONING**

REVIEW OF REINFORCED CONCRETE



Stages of Behavior

Uncracked



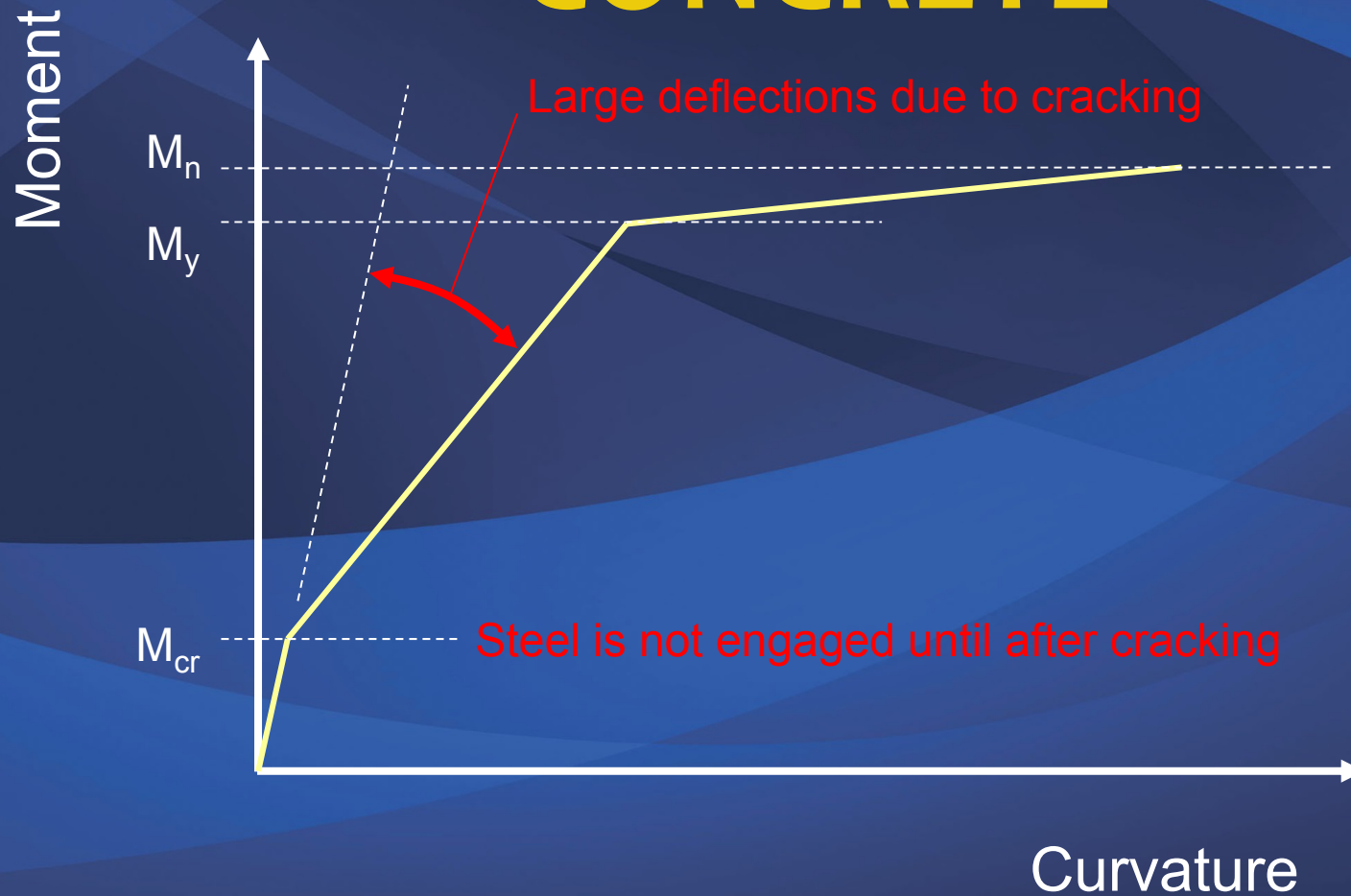
Cracked (~Elastic)



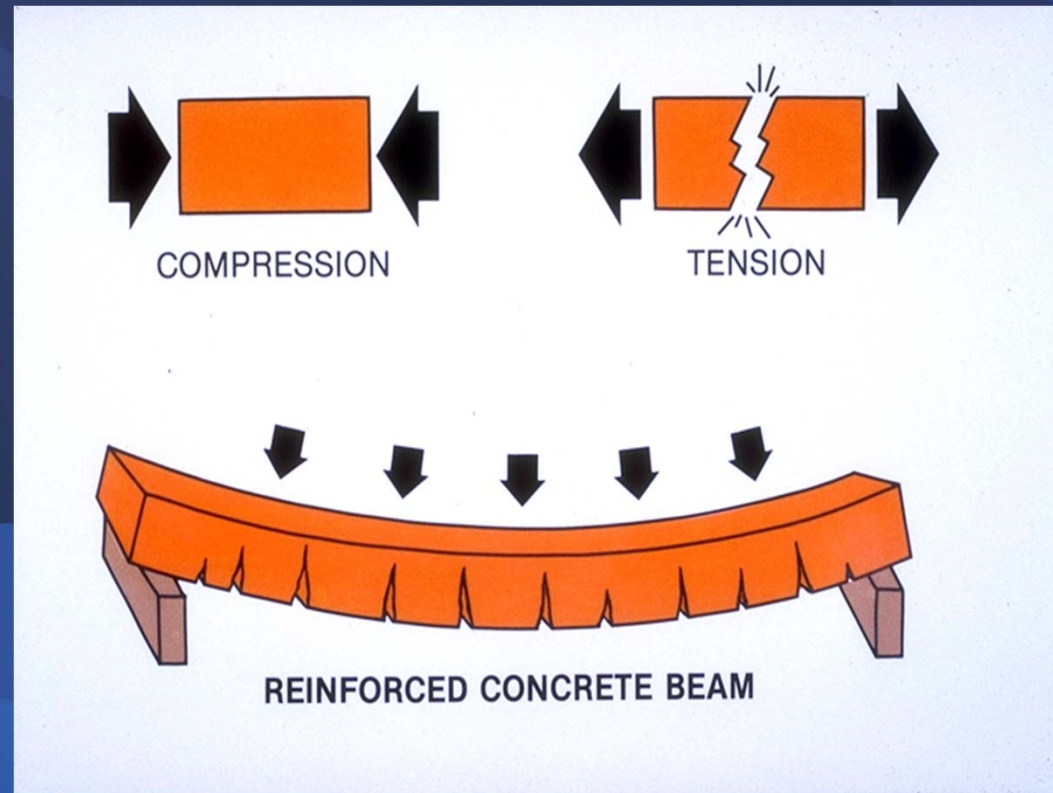
Ultimate



REVIEW OF REINFORCED CONCRETE



REVIEW OF REINFORCED CONCRETE



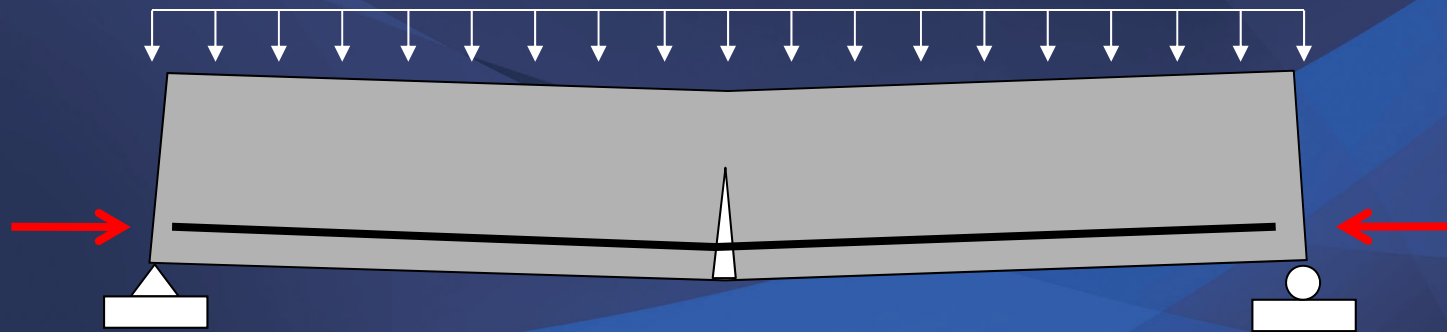
Reinforcement is **PASSIVE**

Steel crosses cracks, but does not prevent them



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

“Squeezed” Before Loading (Pre-compressed):

Pre-Compression (“**prestressing**”) + Tension (bending) =
Net Zero Stress

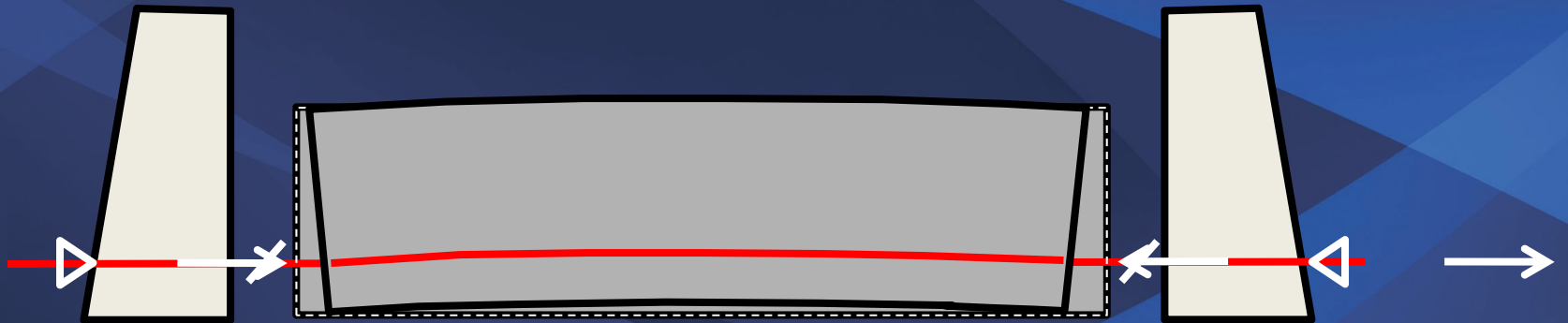
- **Prestressing**: Concrete pre-compressed before loading in bending (flexural tension)

HOW TO BUILD IT?

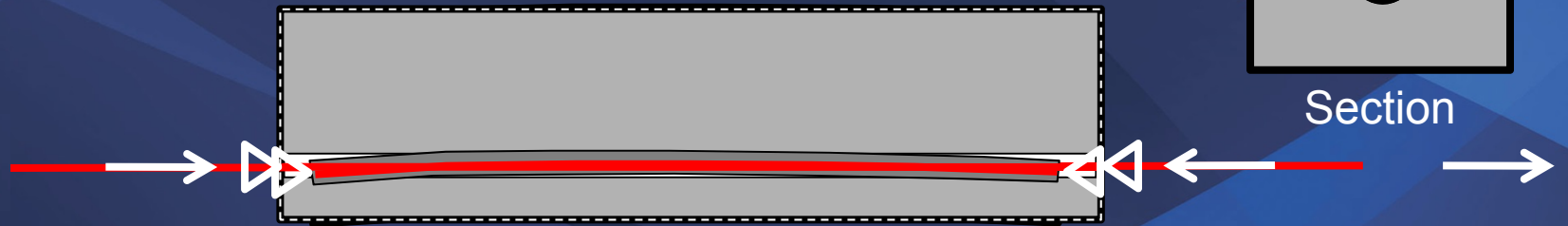
1. **Pre-Tensioning**: Steel tensioned **before** concrete is placed
2. **Post-Tensioning**: Steel tensioned **after** concrete is hardened

Prestressing is **ACTIVE** – can prevent cracks from forming

PRE-TENSIONING

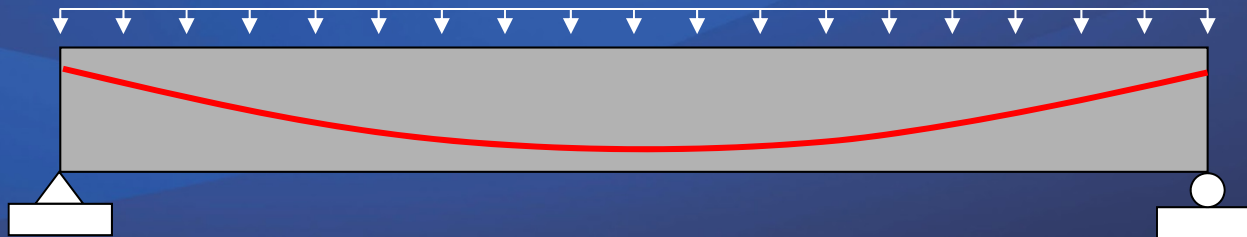


POST-TENSIONING



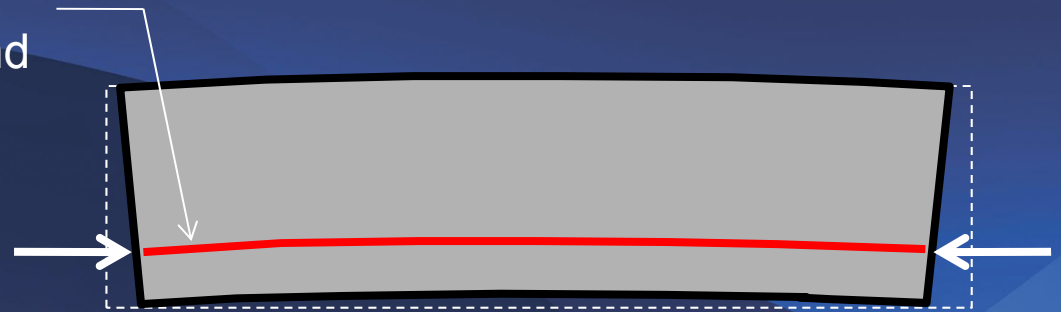
POST-TENSIONING

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



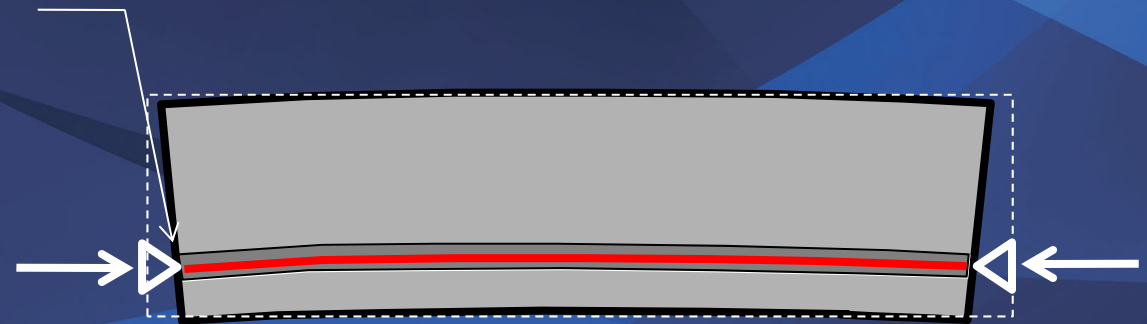
PRE-TENSIONING

Force Transfer by
Steel-Concrete bond



Post-Tensioning

Force Transfer at
end anchor



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.

PRE-TENSIONING

INSTALL PRESTRESSING STRANDS

DESIGNATION-GRADE 270K CSA G279
ASTM A416

SIZE **0.6 INCH/15.24 mm** LENGTH: **8,600 FT./2621 m**

APPROX. WEIGHT: **6460 lbs./2936 Kg** E. VALUE **28.8 X 10⁶ psi/** **196.2 GPa**

HEAT NO: **61198** COIL NO: **D 20689**

LOW RELAXATION STRAND
FOR PRESTRESSED CONCRETE
MADE IN CANADA

*3/11/16
JFAT*

SUMIDEN WIRE PRODUCTS CORPORATION
1413 Elwood Dr.
Stockton, CA 95210
Phone (209) 498-9024
Fax (209) 941-2990

*** MILL CERTIFICATE OF INSPECTION *** PAGE 1 OF

ORDER NUMBER : 019709 ISSUE DATE : 02/23/10

CONCRETE : STEEL STRAND, UNCOATED SEVEN-WIRE
FOR PRESTRESSED CONCRETE

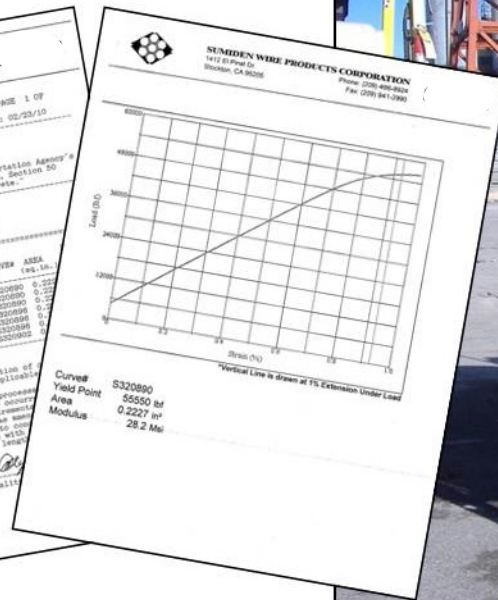
SPECIFICATION : ASTM A416-LATED Low Relaxation
The California Transportation Agency's
Spec 7.5 Standard Specification, Section 50
for Prestressing Concrete.

OVERSIC : CONCRETE TECHNOLOGY CORPORATION
P.O. NUMBER : 0-01840
MANUFACTURED : Sumiden Wire Product Corporation
DESTINATION : TACOMA WA

NO.	PACKS	HEAT#	GRADE	R.S.	EL.	I.S.	CURVE#	AREA
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	5320880	270	58,007	5.5	56,250	5320880	0.2227	28.2
2	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2
3	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2
4	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2
5	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2
6	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2
7	5320884	270	58,007	5.5	56,250	5320880	0.2227	28.2

We hereby certify that:
 * We have accurately carried out the inspection of
 the material described above in accordance with all applicable
 specifications and all manufacturing processes
 of the contract, and all manufacturing processes
 of the material described above occur
 in compliance with the American requirements
 of the American Institute of Steel Construction, Inc.
 in compliance with the California Transportation Agency's
 Specification for Prestressing Concrete.
 * The material described above will conform with
 the material specifications and requirements listed
 herein for transfer and development tests.
 * The material described above will conform with
 all applicable specifications.
 * The material described above will conform with
 all applicable specifications.

Received by
David P. Collins
 3/11/16



PRE-TENSIONING

TENSION STRANDS



PRE-TENSIONING

STRANDS AFTER TENSIONING



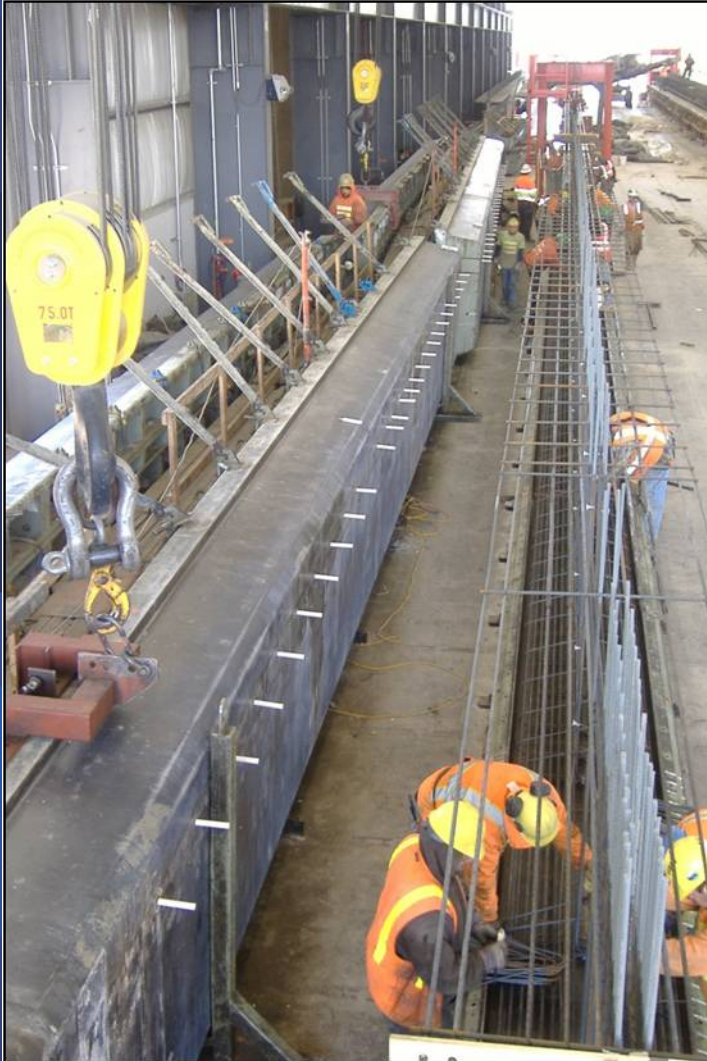
PRE-TENSIONING

INSTALL MILD REINFORCEMENT



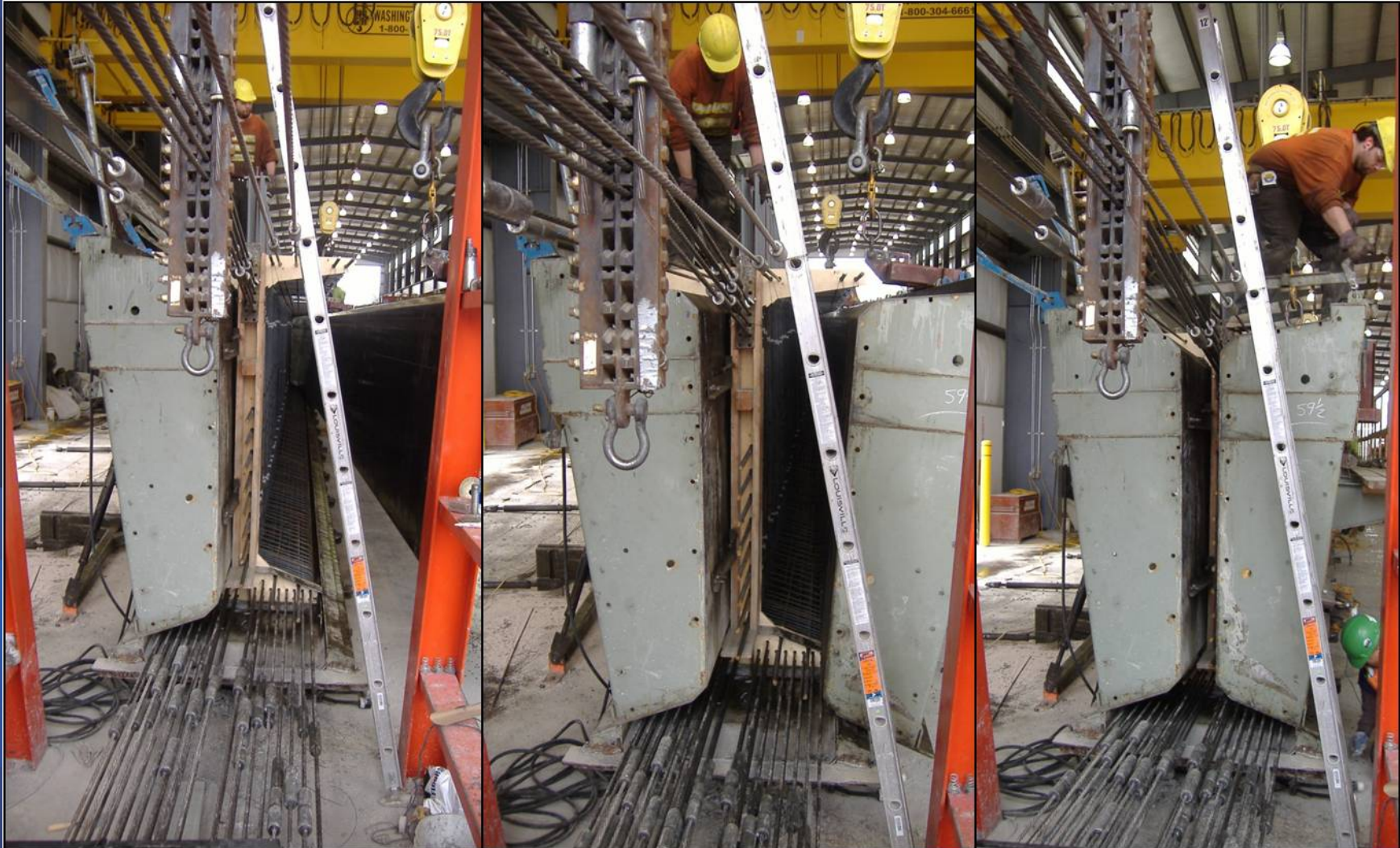
PRE-TENSIONING

INSTALL INSERTS AND ASSEMBLIES



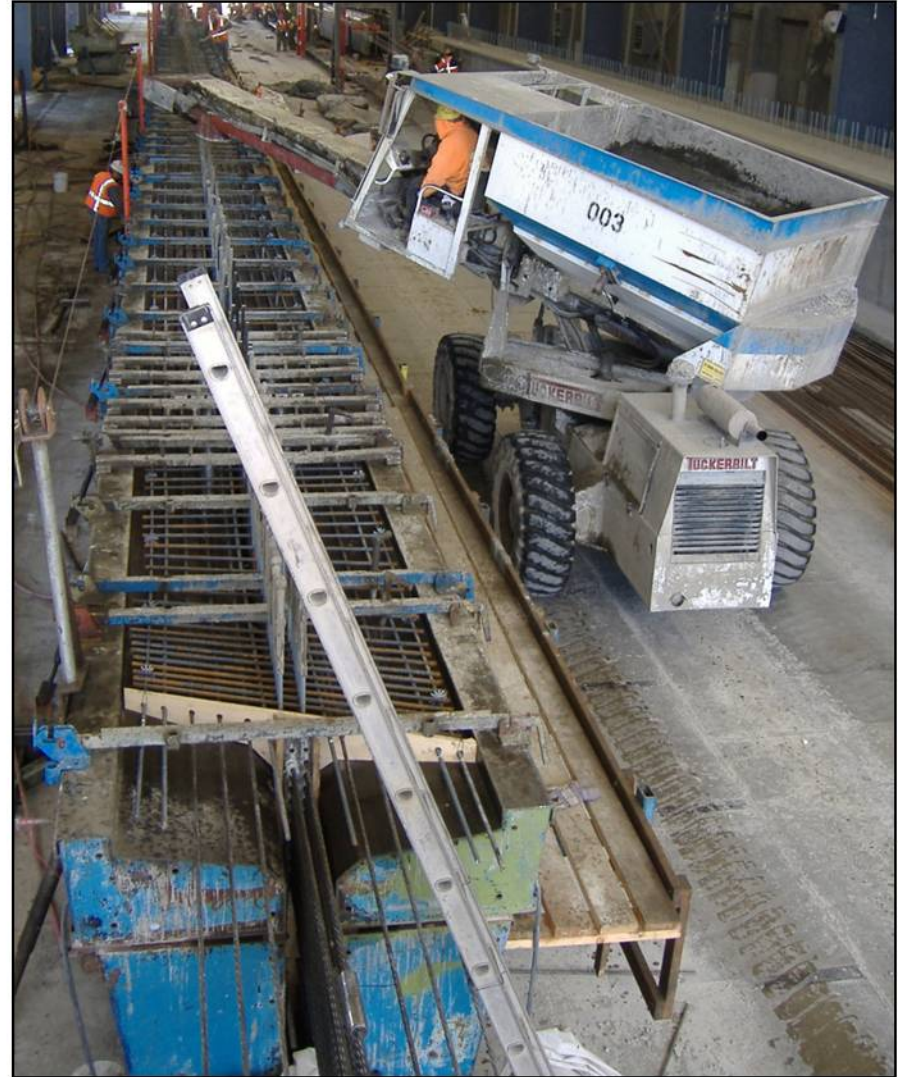
PRE-TENSIONING

SET FORM SIDES



PRE-TENSIONING

PLACE CONCRETE



PRE-TENSIONING

CURE CONCRETE WITH ACCELERATED METHODS



PRE-TENSIONING

REMOVE GIRDER FROM CASTING BED



PRE-TENSIONING

MOVE GIRDER TO STORAGE



PRE-TENSIONING

TRANSPORT TO JOBSITE



PRE-TENSIONING



POST-TENSIONING

Ducts for Post-Tensioning



POST-TENSIONING



POST-TENSIONING



POST-TENSIONING



POST-TENSIONING



POST-TENSIONING



POST-TENSIONING

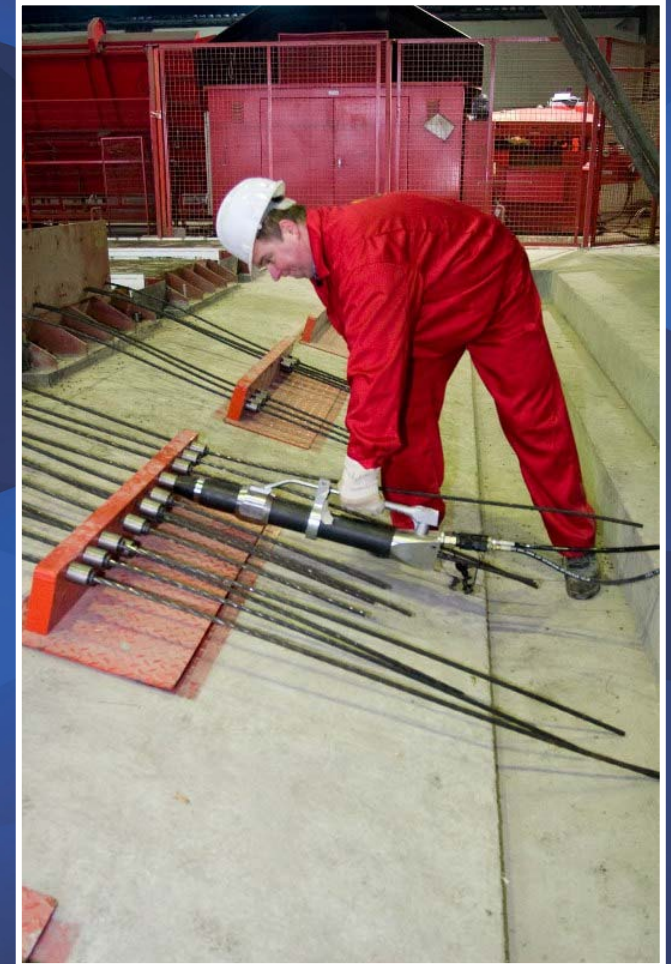


POST-TENSIONING

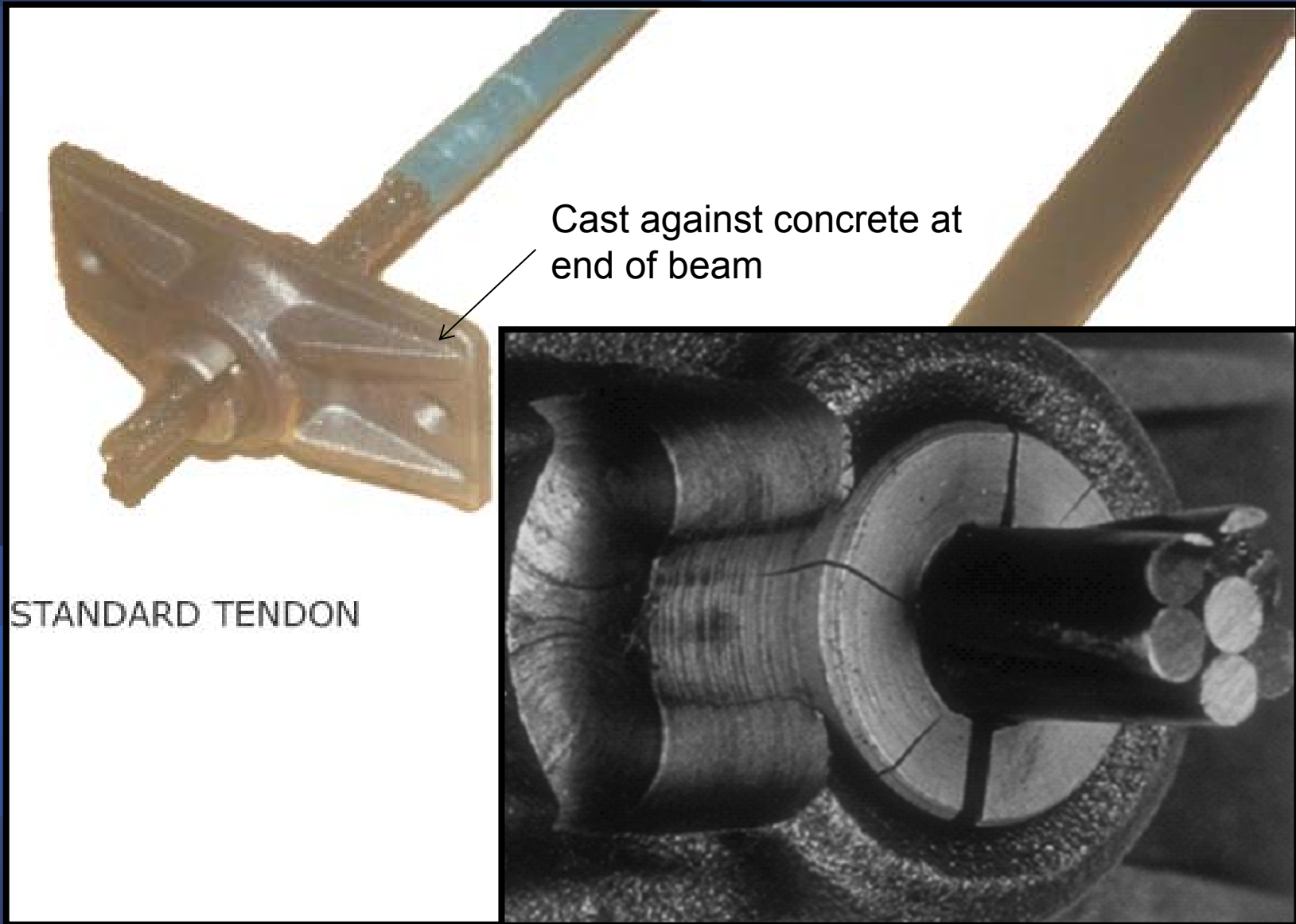
Stressing Strands:

Single Strand: Monostrand

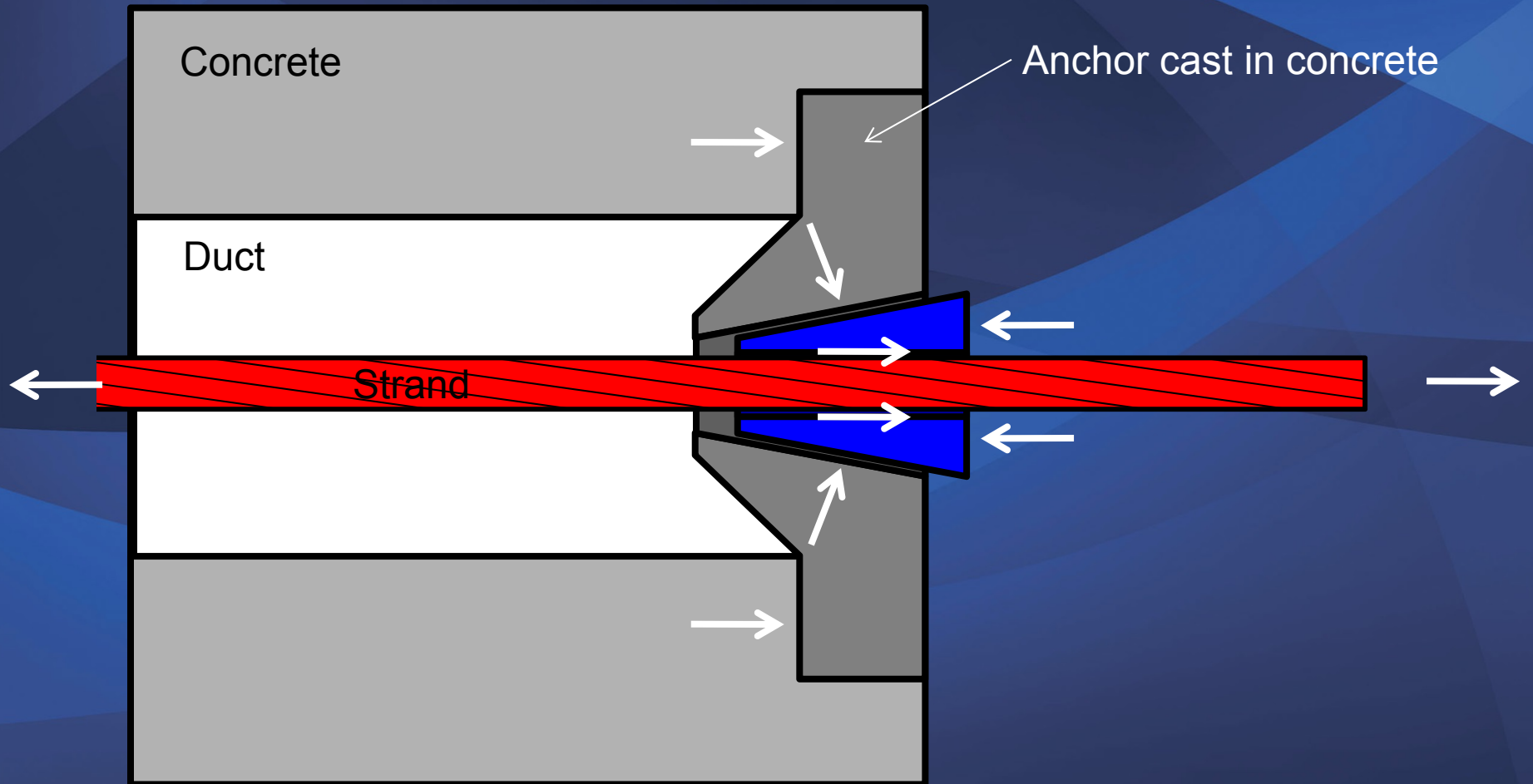
Multiple Strands: Multistrand



HOW ARE STRANDS ANCHORED?

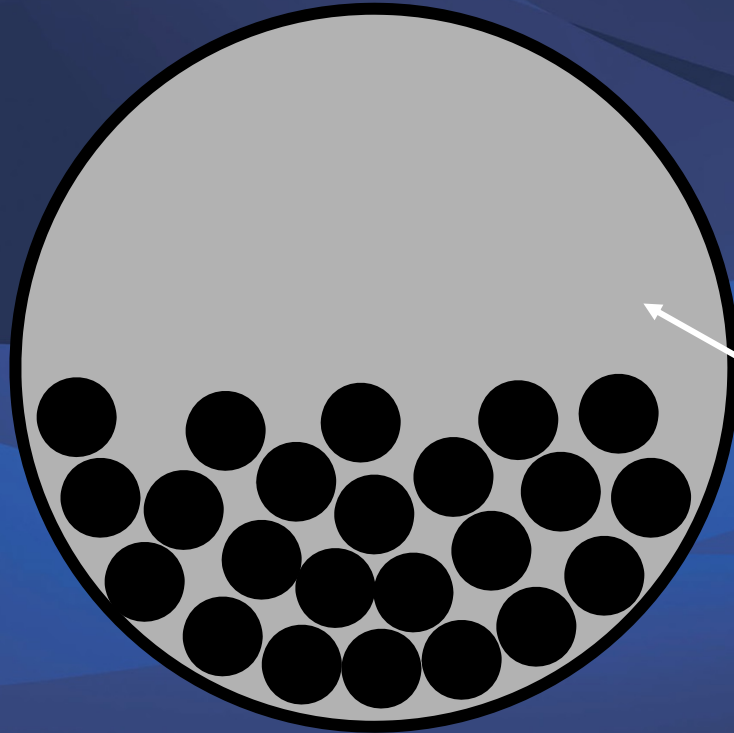


HOW ARE STRANDS ANCHORED?



POST-TENSIONING:

Bonded System
(at high point)



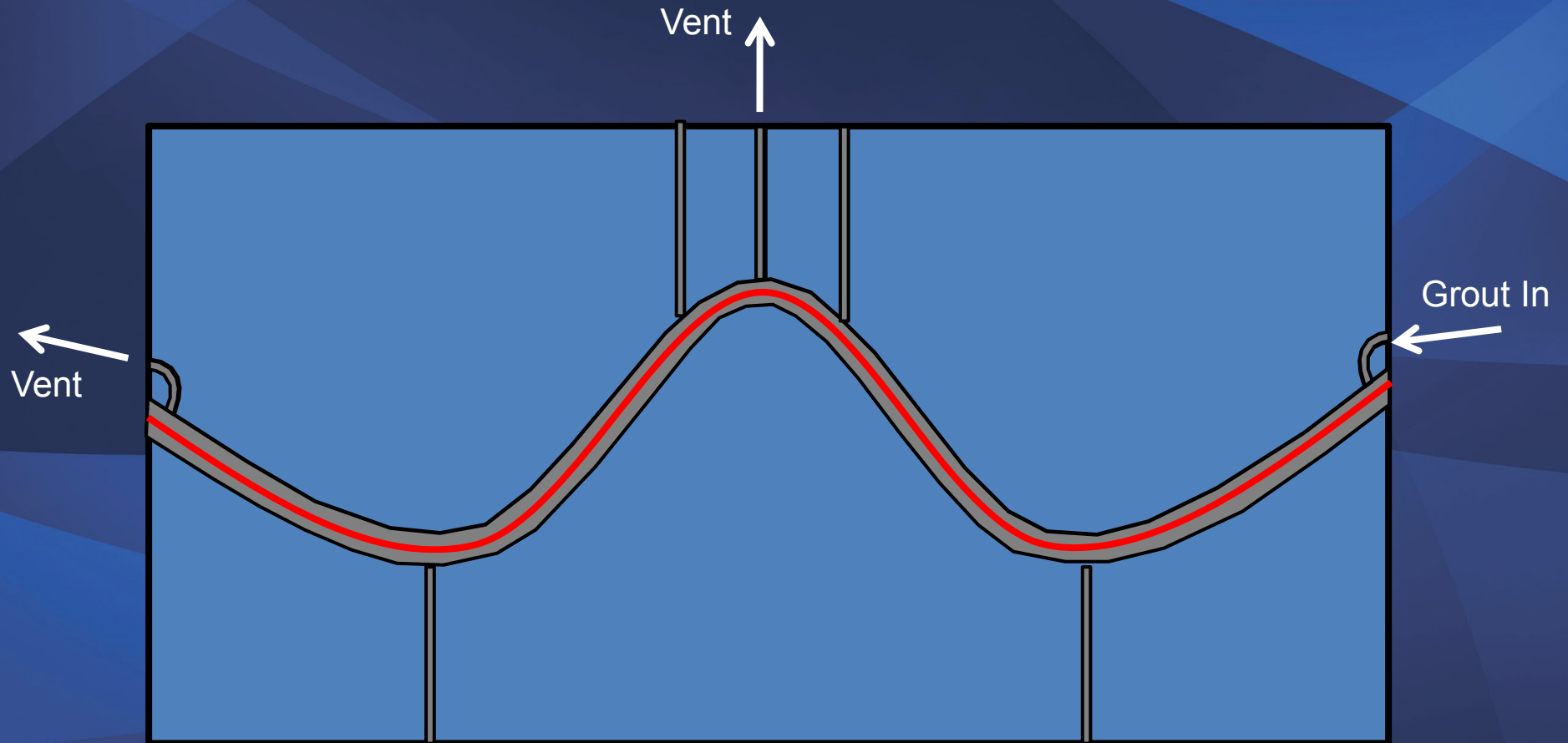
Unbonded System



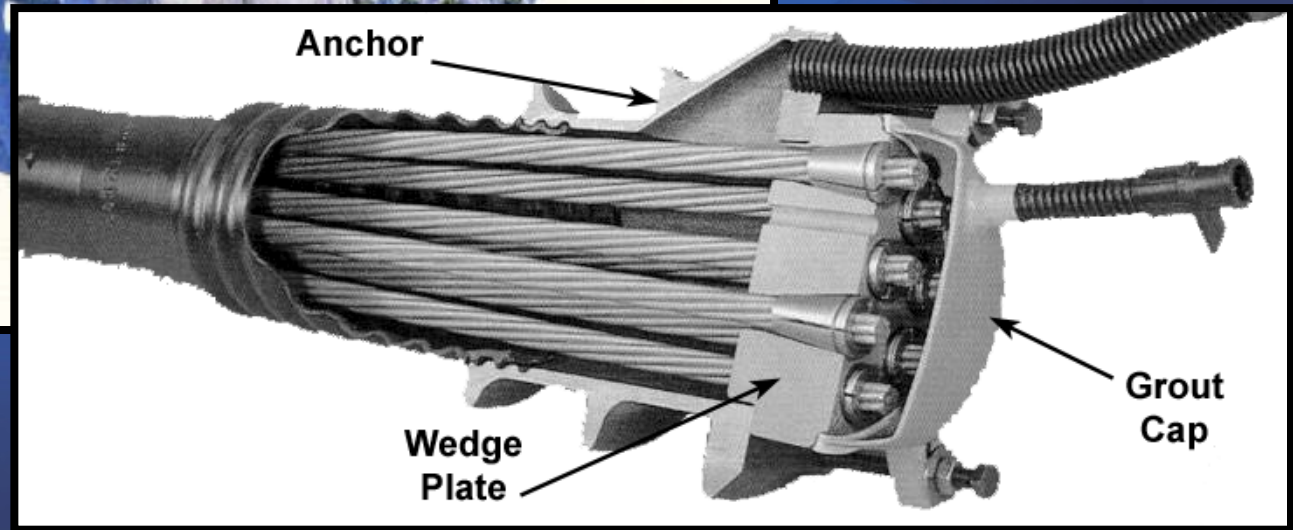
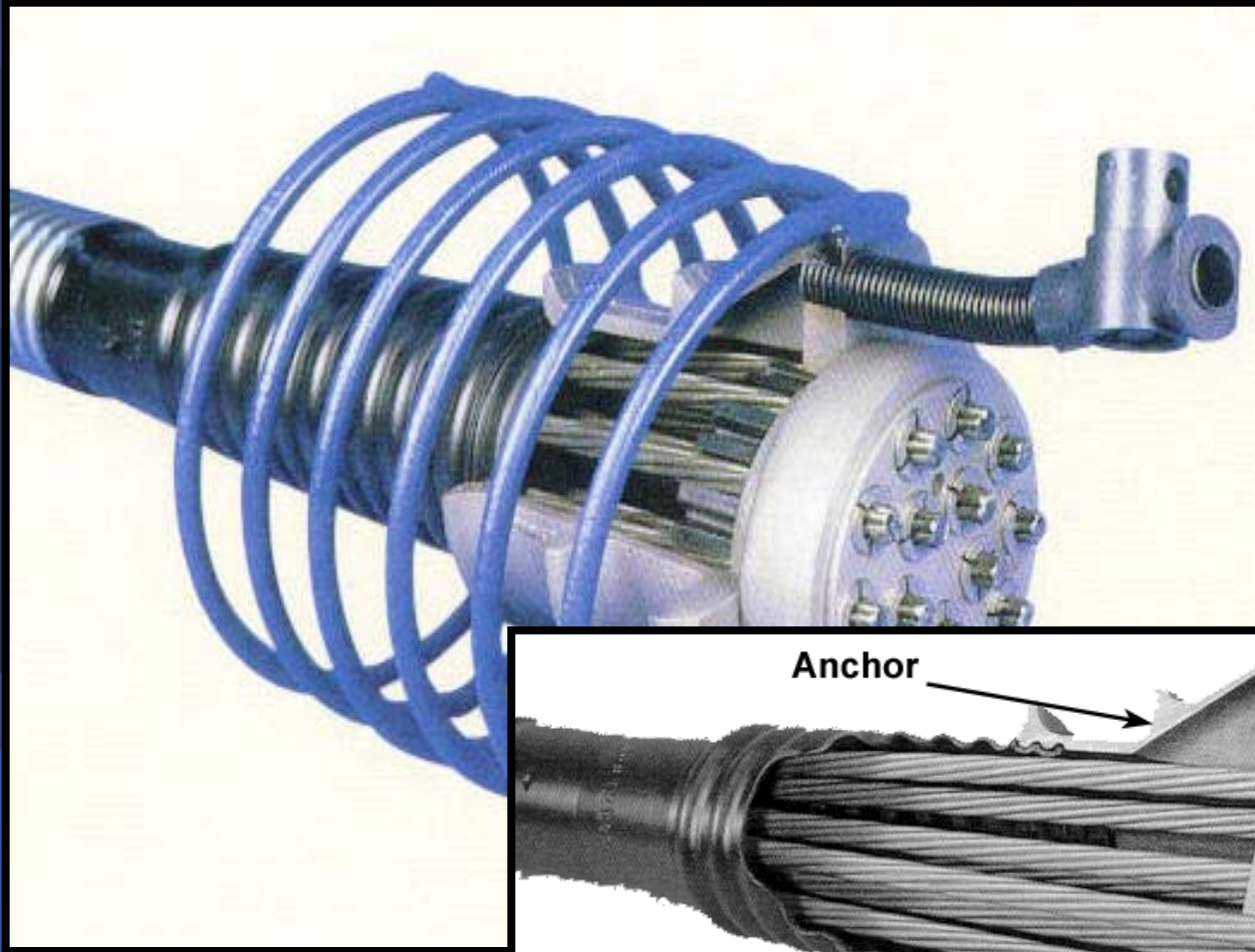
Grout

"PT Coating" (grease)

GROUTING POST-TENSIONED SYSTEMS

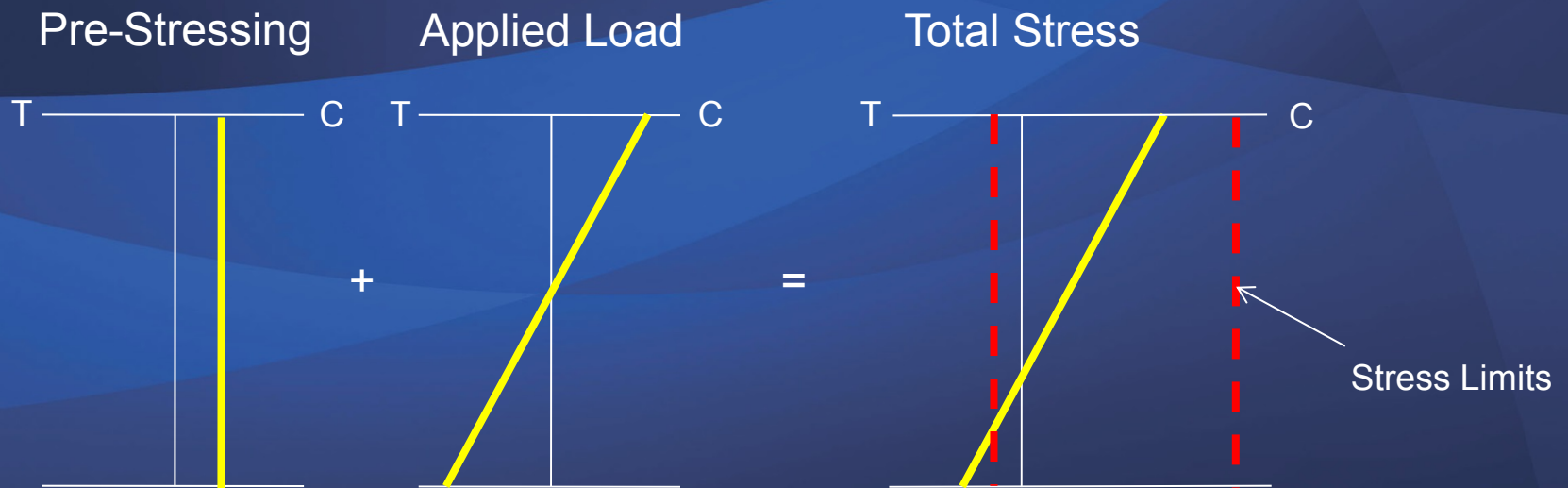
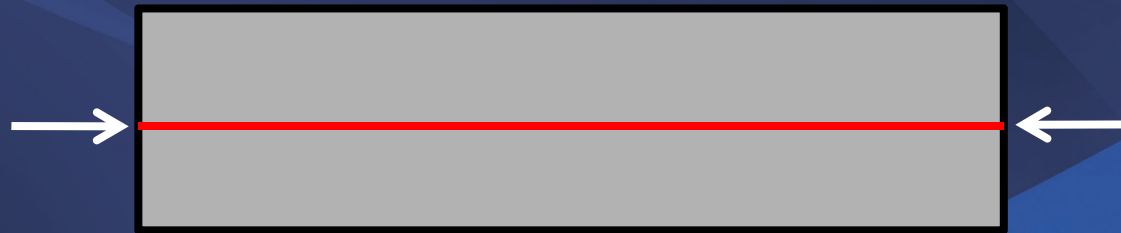


POST-TENSIONING



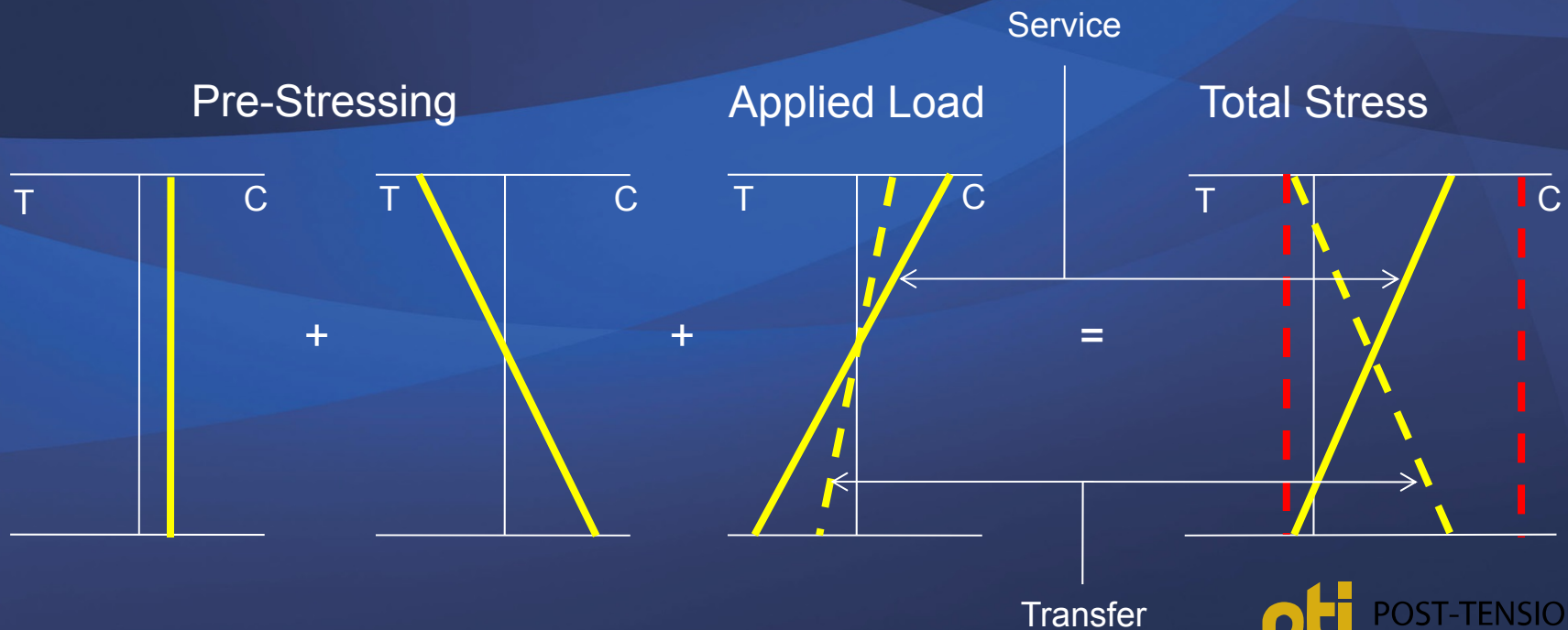
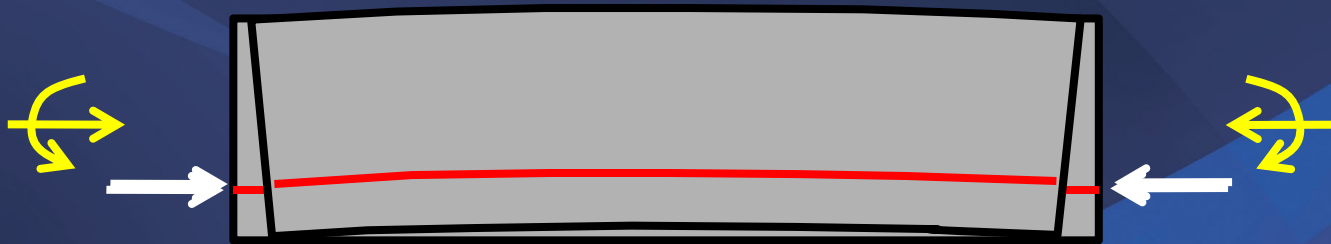
STRUCTURAL EFFECT OF PRESTRESSING

True for **Pre-** and **Post-**Tensioning



STRUCTURAL EFFECT OF PRESTRESSING

True for **Pre-** and **Post-**Tensioning



ECENTRIC PRESTRESSING

Eccentricity in prestressing:

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

Strategies for pre-tensioned systems:

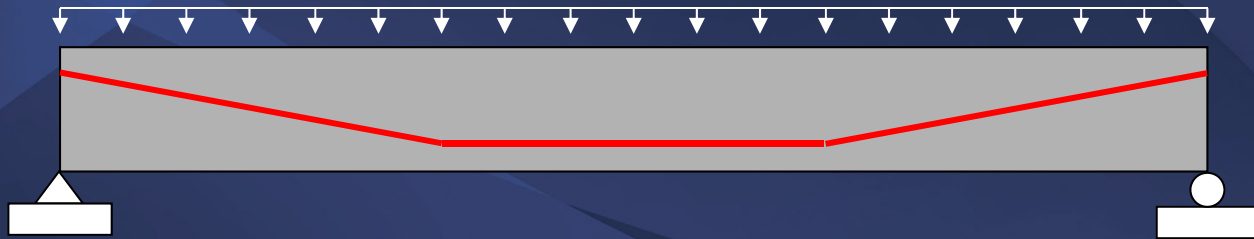
- Draped / harped profiles
 - Temporarily held in place before concrete is hardened
- Debonding
 - Not all strands are active at end of span

Strategies for post-tensioned systems:

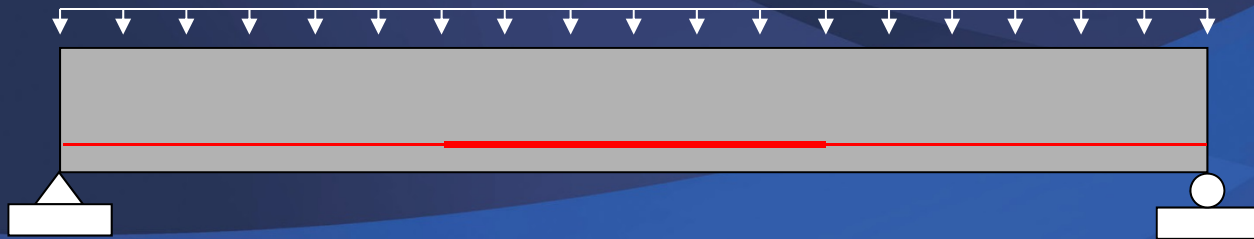
- Install ducts in desired profile

COMMON CONFIGURATIONS

Pre-tensioning:

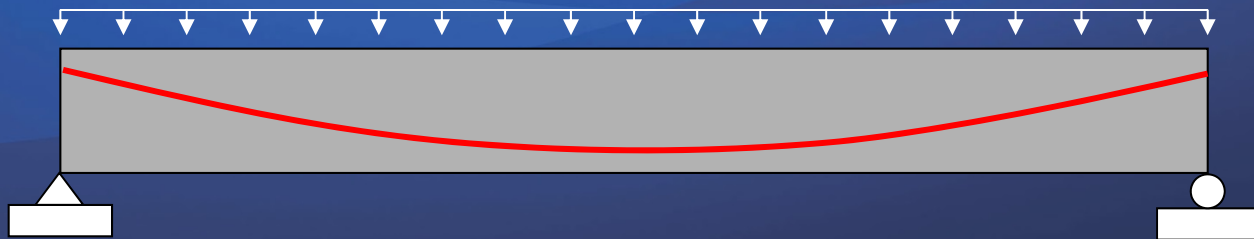


Draped



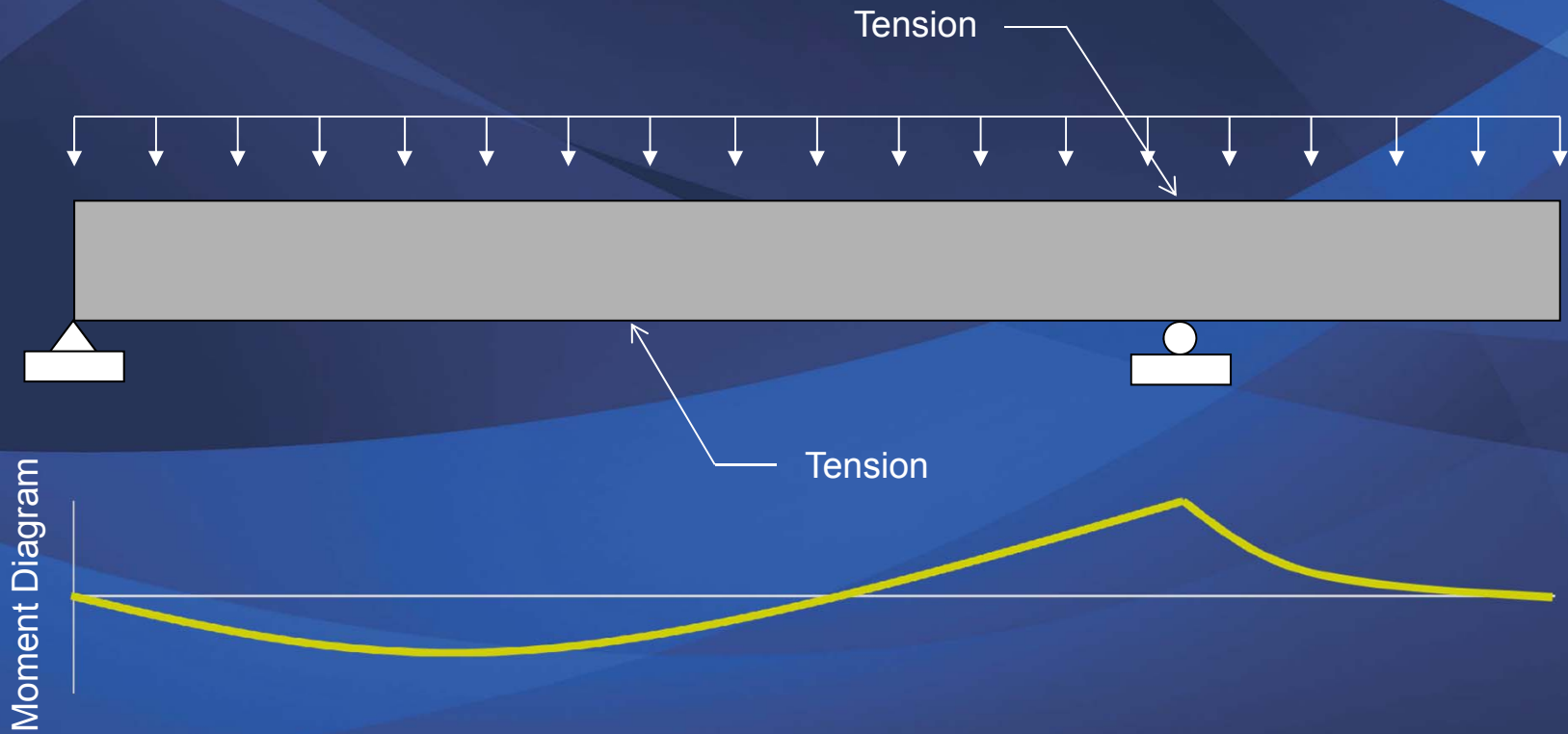
Debonded

Post-tensioning:



PROBLEM FOR THOUGHT...

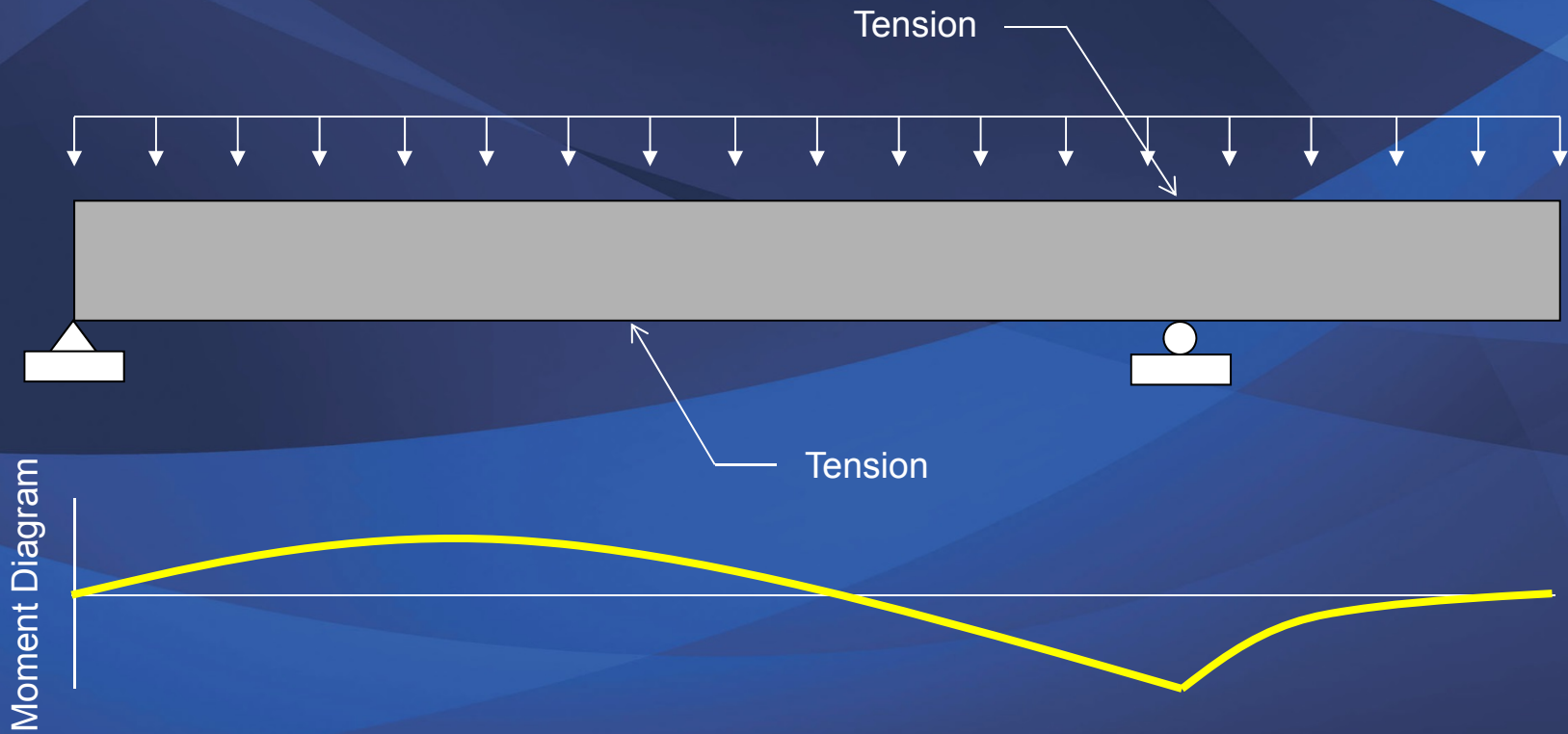
Where should the prestressing be placed?



(T)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

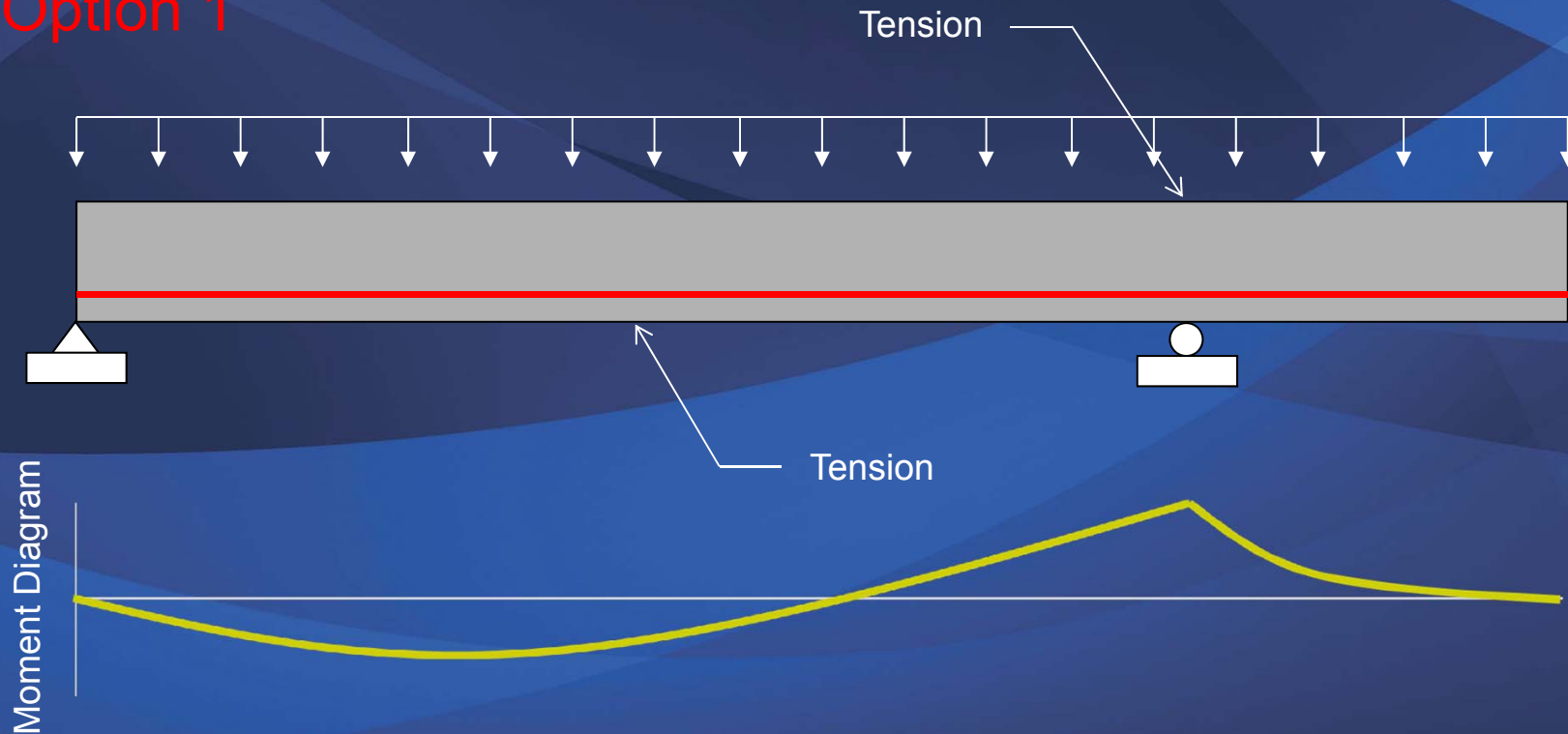


(C)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 1



Good:

- Efficient at midspan
- Easy to construct

Bad:

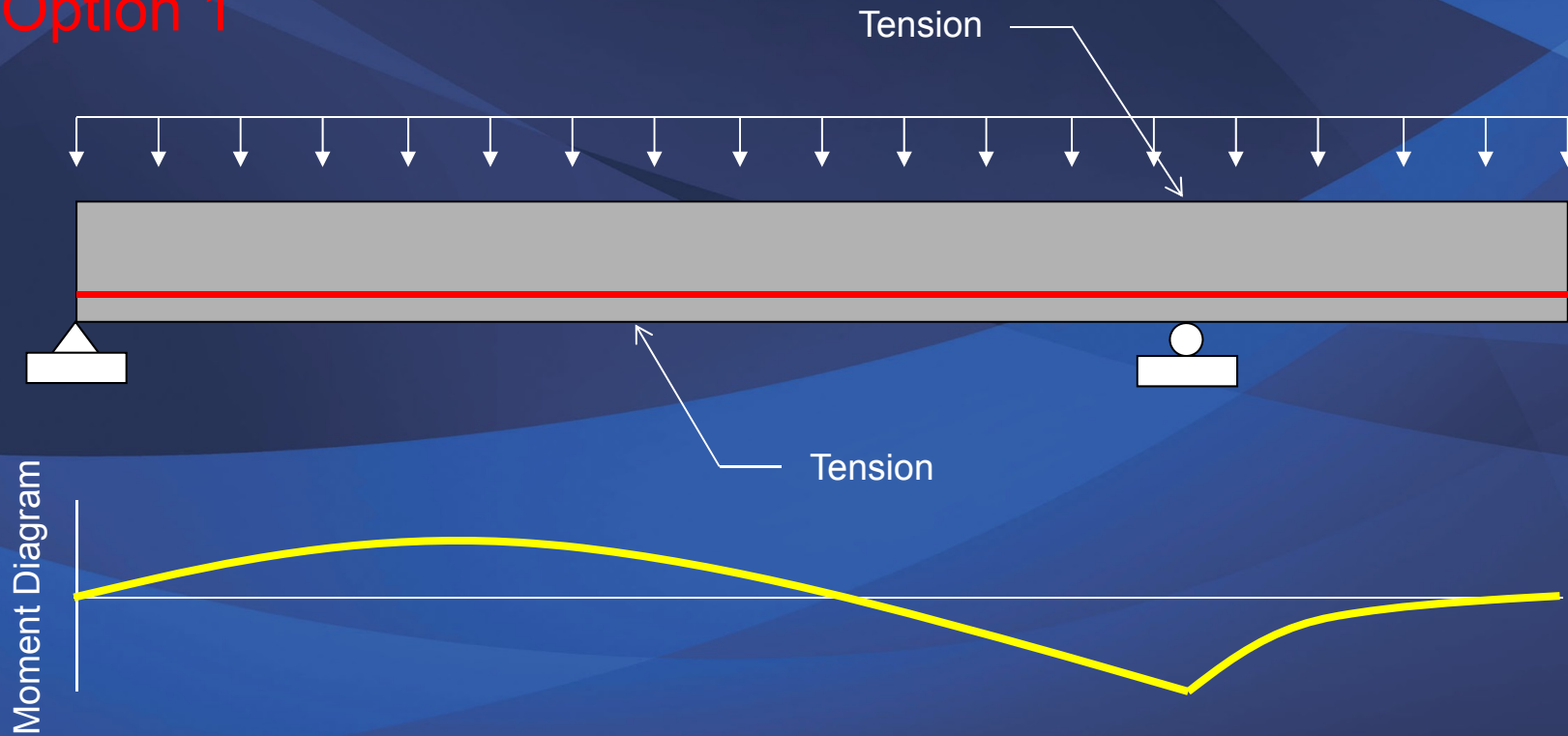
- Counter-productive over support

(T)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 1



Good:

- Efficient at midspan
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Bad:

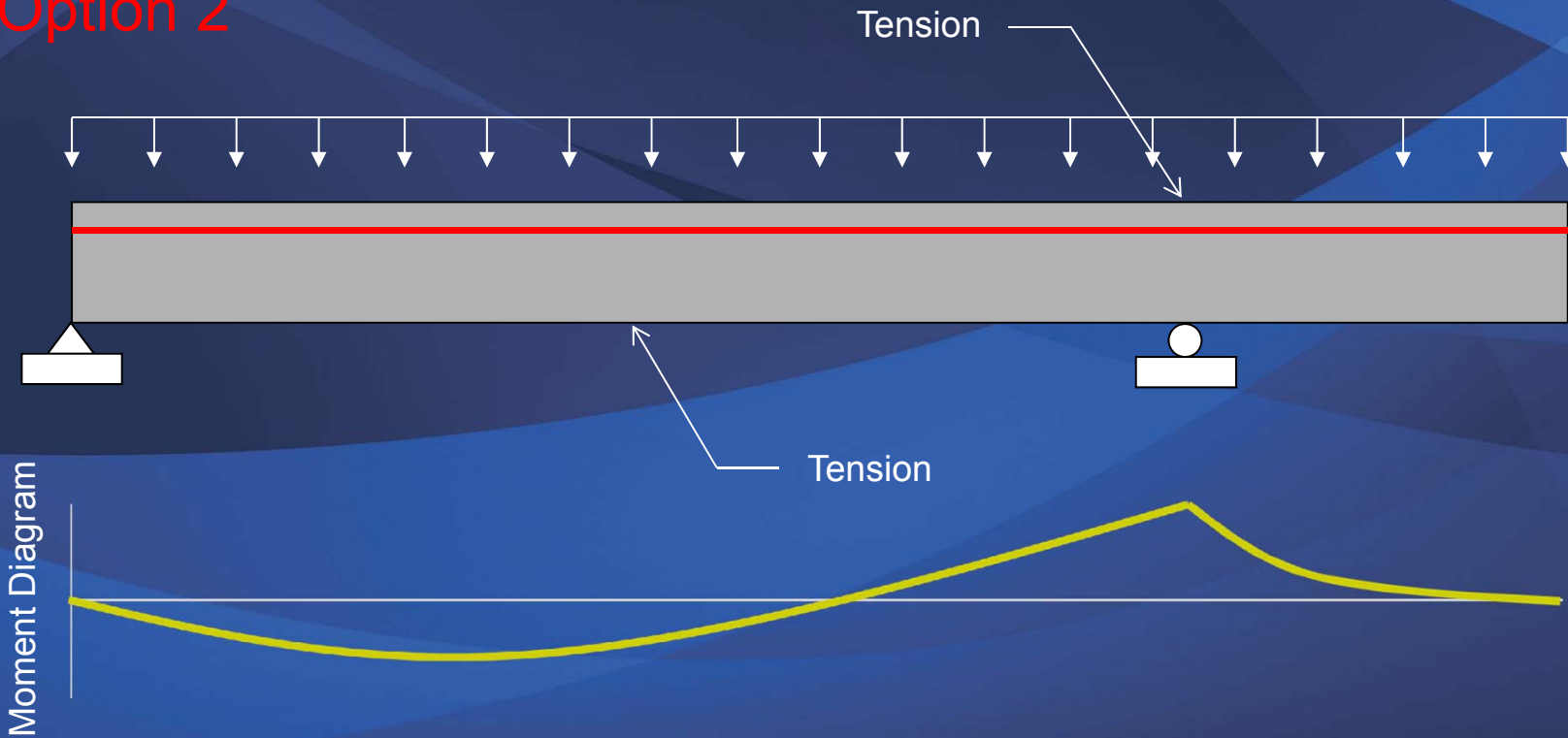
- Counter-productive over support

(C)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 2



Good:

- Efficient over support
- Easy to construct

Bad:

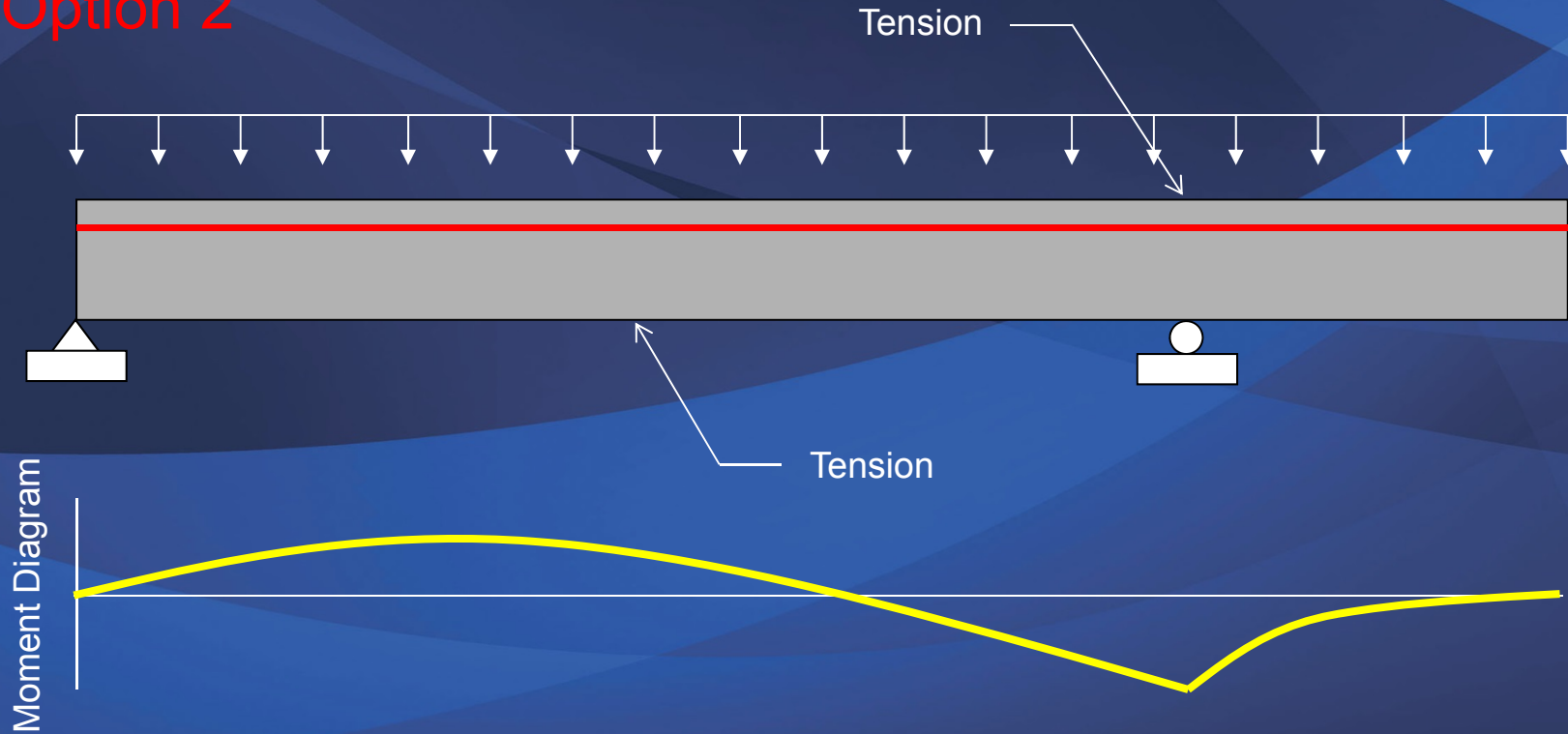
- Counter-productive at midspan

(T)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 2



Good:

- Efficient over support
- Easy to construct

Bad:

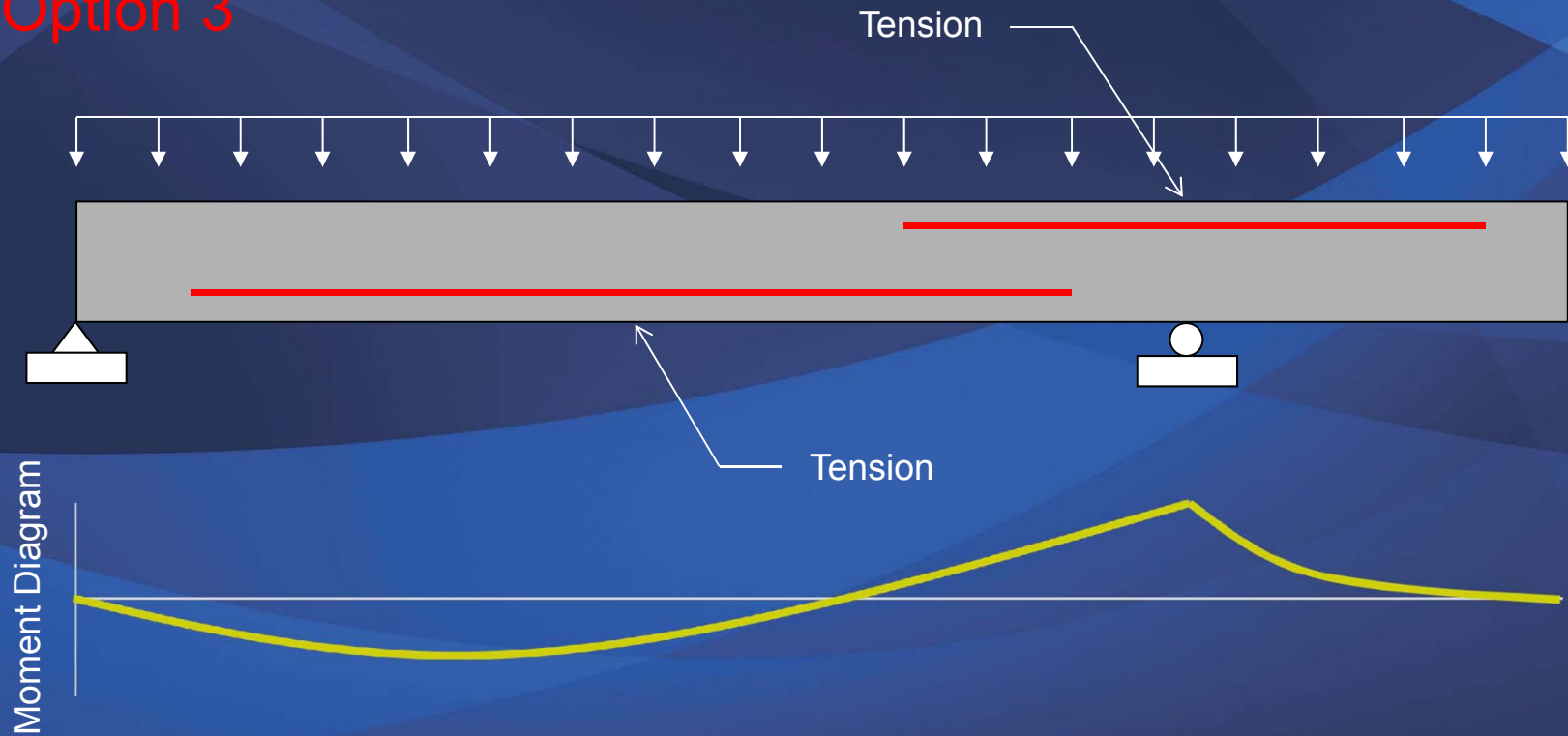
- Counter-productive at midspan

(C)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 3



Good:

- Efficient over support
- Efficient at midspan

Bad:

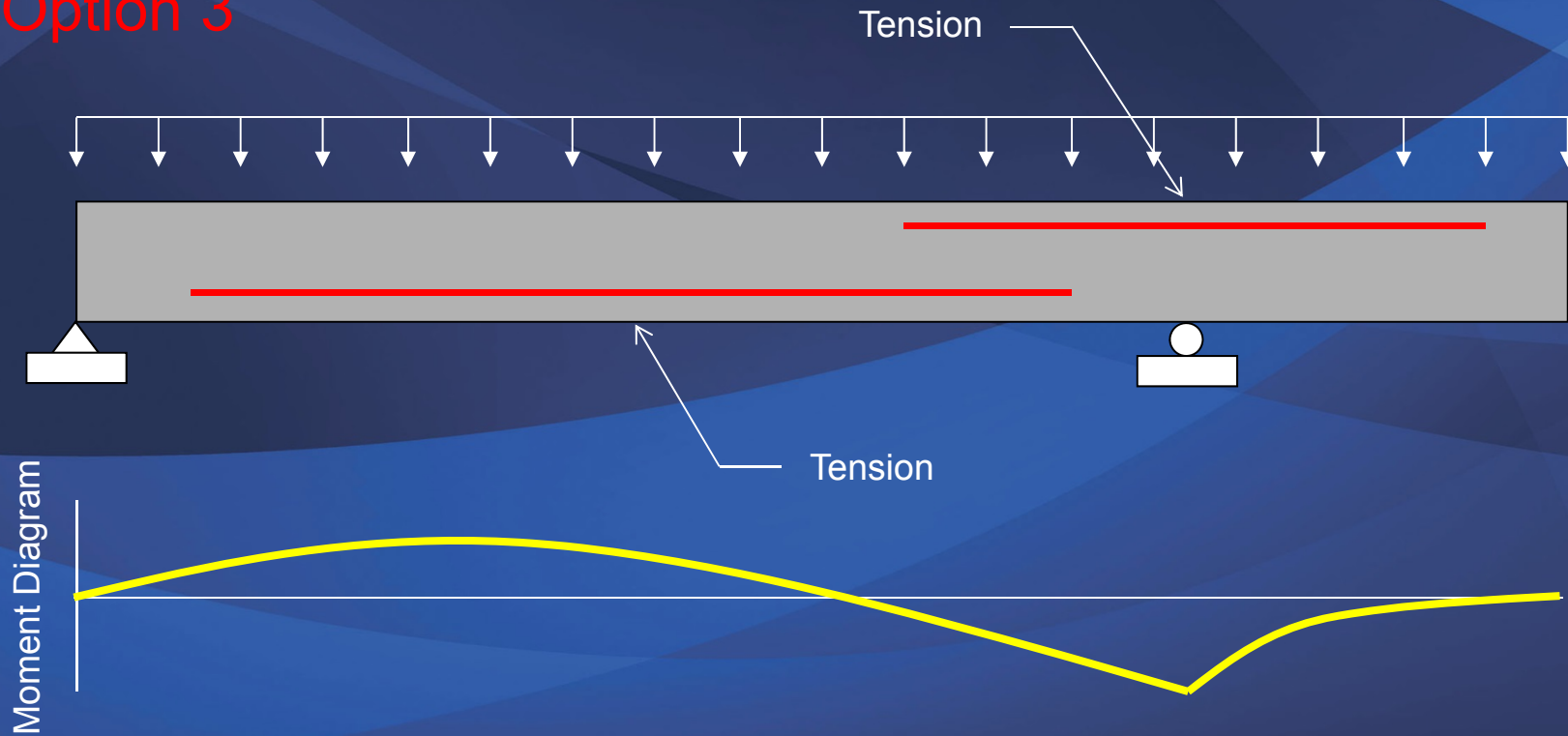
- Difficult to construct

(T)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 3



Good:

- Efficient over support
- Efficient at midspan

Bad:

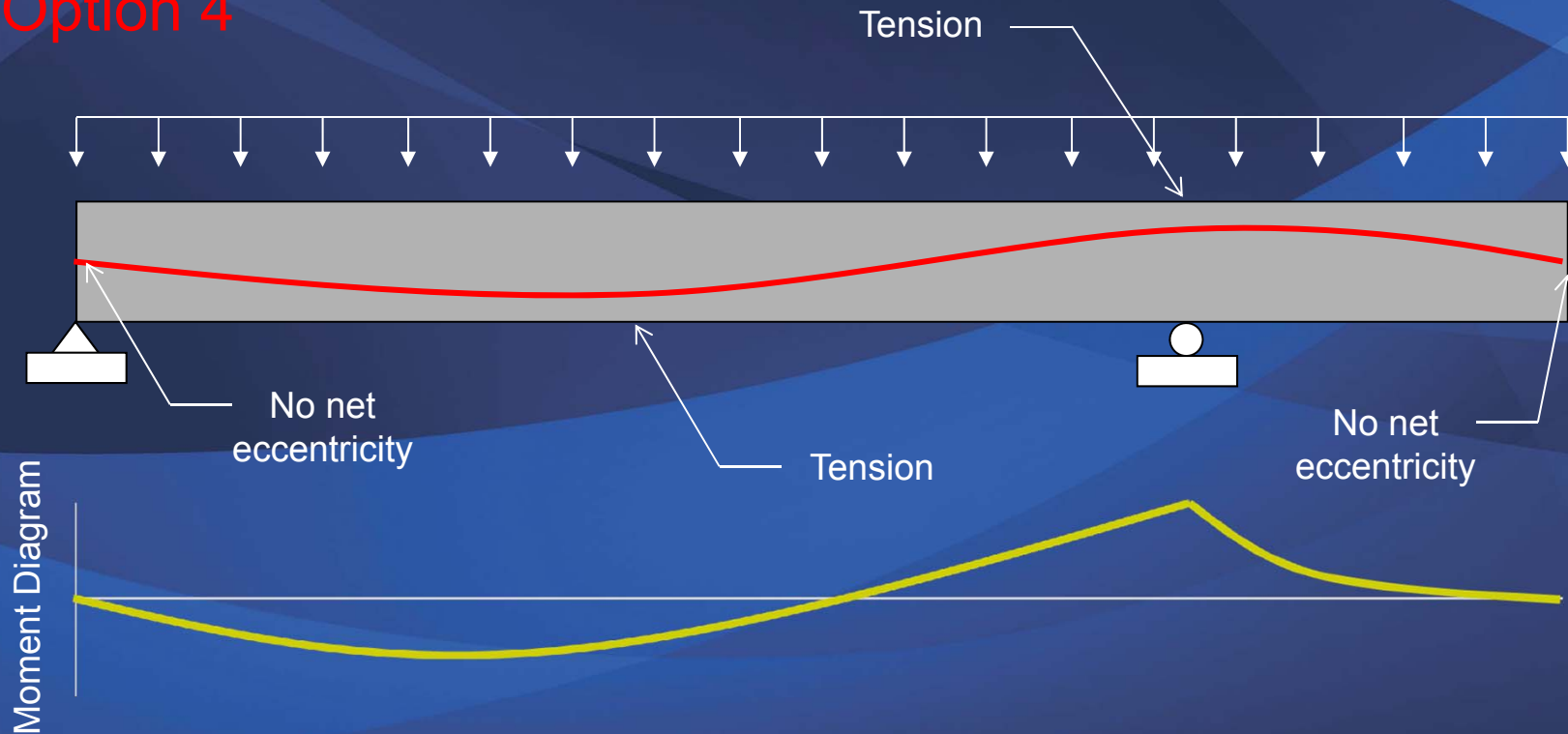
- Difficult to construct

(C)

PROBLEM FOR THOUGHT...

Where should the prestressing be placed?

Option 4



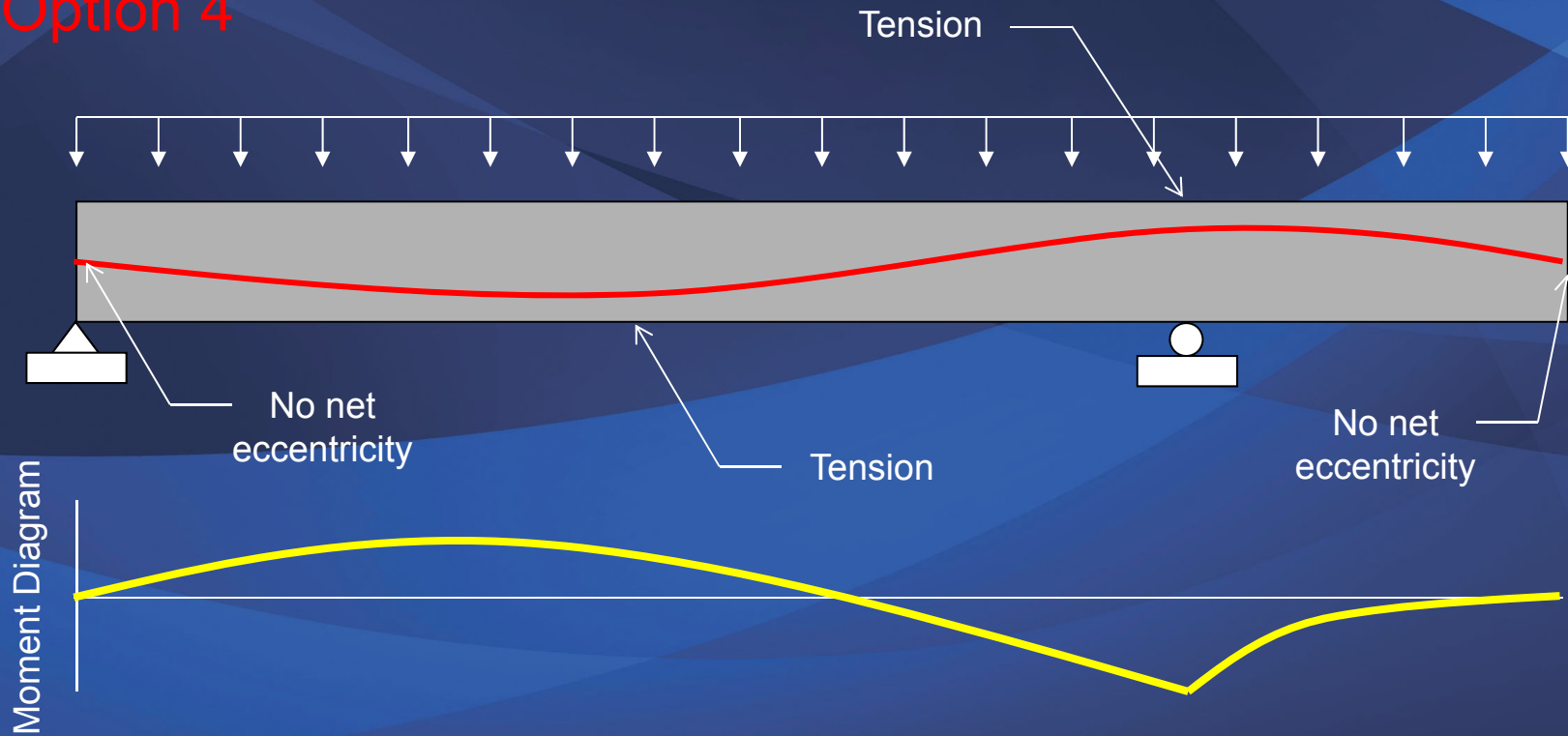
Requires post-tensioning; very difficult to achieve by pre-tensioning

(T)

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