

2016 PTI Convention Long Beach, California

Technical Session 7
Strengthening and Repair

Considerations in Designing Post-Tensioning Repairs

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Presentation Goals

- Recognize factors that influence repair design
- Maintain load path for post-tensioning force during repairs
- Identify and avoid common issues during design and construction
- Understand de-tensioning and stressing operations



POST-TENSIONING
INSTITUTE™

Outline

- Define the problem
 - Damage, deterioration, design
- Design the repair
- Construction
 - De-tensioning
 - Potential pitfalls
 - Stressing



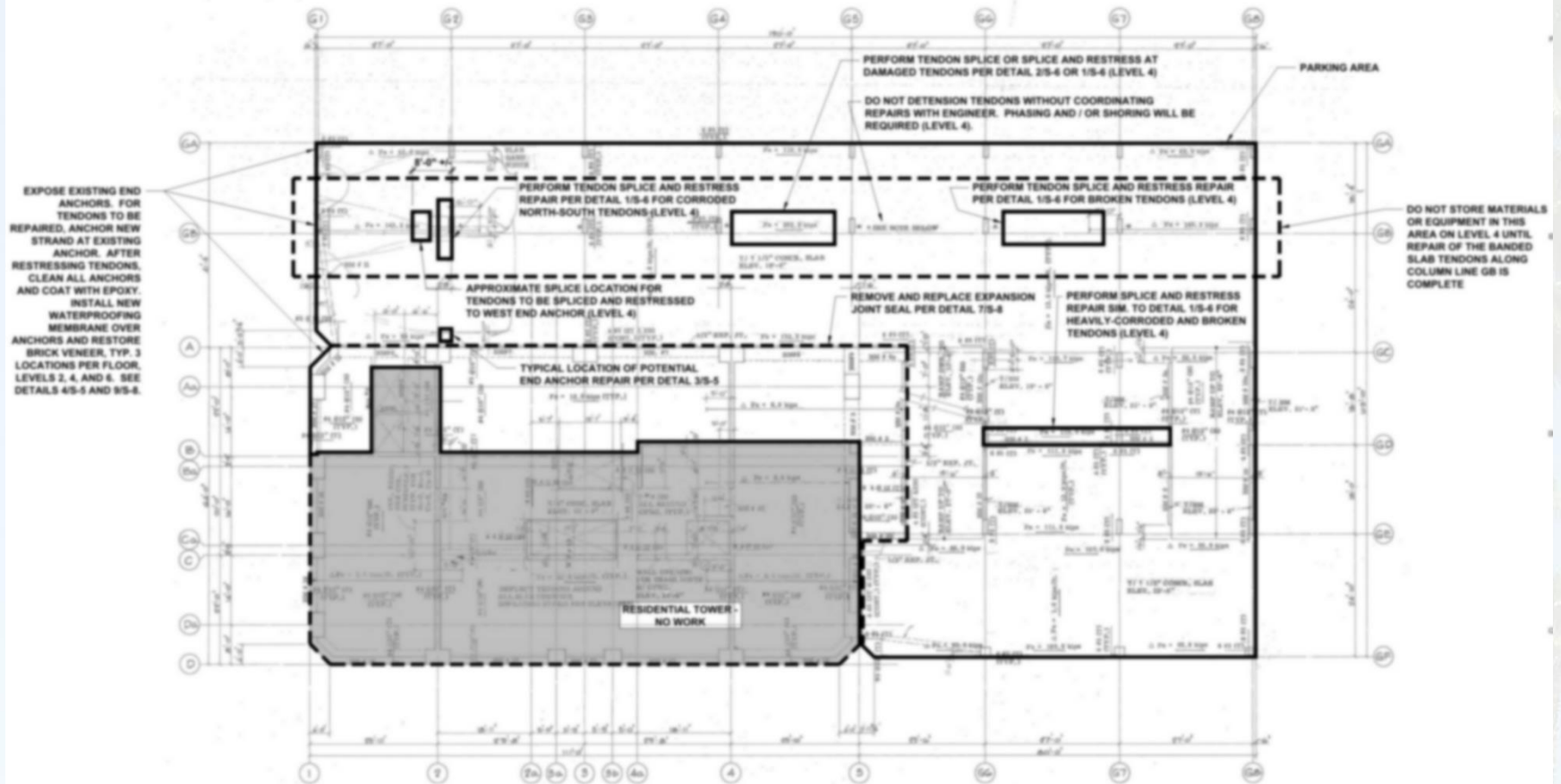
WHAT WENT WRONG?











PLANNING AND DESIGN (UNBONDED MONOSTRAND SYSTEMS)

Structure Information

- Type of structural system
 - One-way slab over beams
 - Two-way slab
 - Distributed
 - Distributed/banded
 - Other post-tensioned elements
 - Beams
 - Balconies
 - Openings/discontinuities
- Repair History

PT Information

- Type of post-tensioning system
 - Bars, buttonhead wires, monostrand
 - Bonded vs. unbonded
- Sheathing
 - Paper wrapped
 - Heat-sealed
 - Push-through
 - Extruded



Force Continuity

24 tendons = ~650 kips



POST-TENSIONING
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Load-Carrying Capacity

- Evaluation
 - Service loads vs. code-prescribed factored design loads
- During construction
 - Restricted live load
 - Phased repairs

Durability

- Interior conditions
 - Adequate protection at end anchors
- Aggressive environment
 - Encapsulated systems
 - Sheathing repair
 - Surface-level protection
- Protection during construction





IMPLEMENTING REPAIRS

De-tensioning

- Grinder or sawcut
- Flame cut
 - Along length
 - End anchor
- Controlled release
 - Along length
 - End anchor
- Confirm that tension is released for full length of tendon.



Collateral Damage



Displaced wedge and
projecting king wire



Retracted strand,
missing wedges

Temporary Lock-Off Anchor

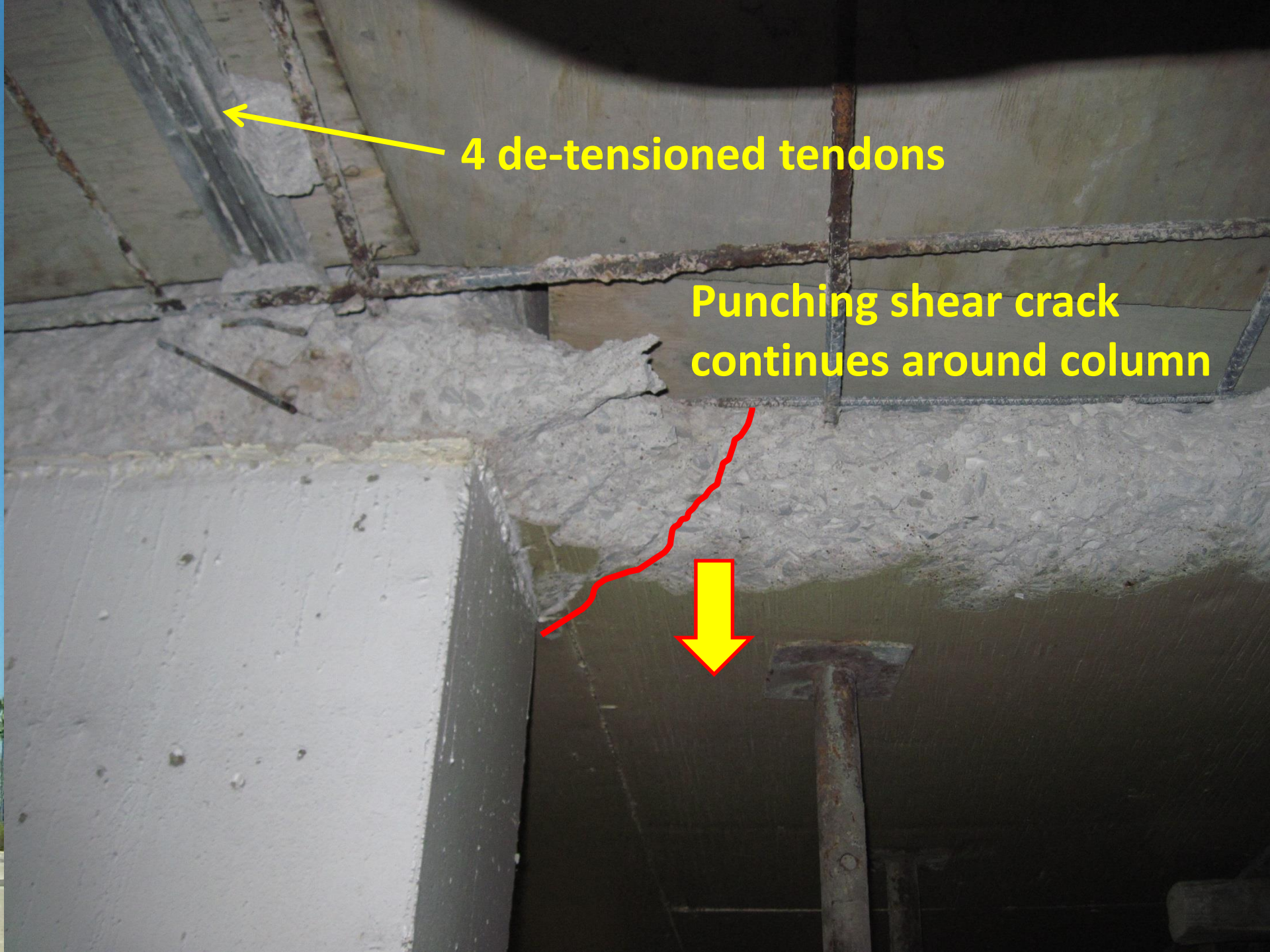
- Prevent de-tensioning of full length of tendon
- Sensitive to flatness of bearing surface
- Required sufficient clearance between tendons
- **Not designed for permanent installation**



Shoring During Construction

- Location of concrete openings
- Loss of tension for tendons through columns

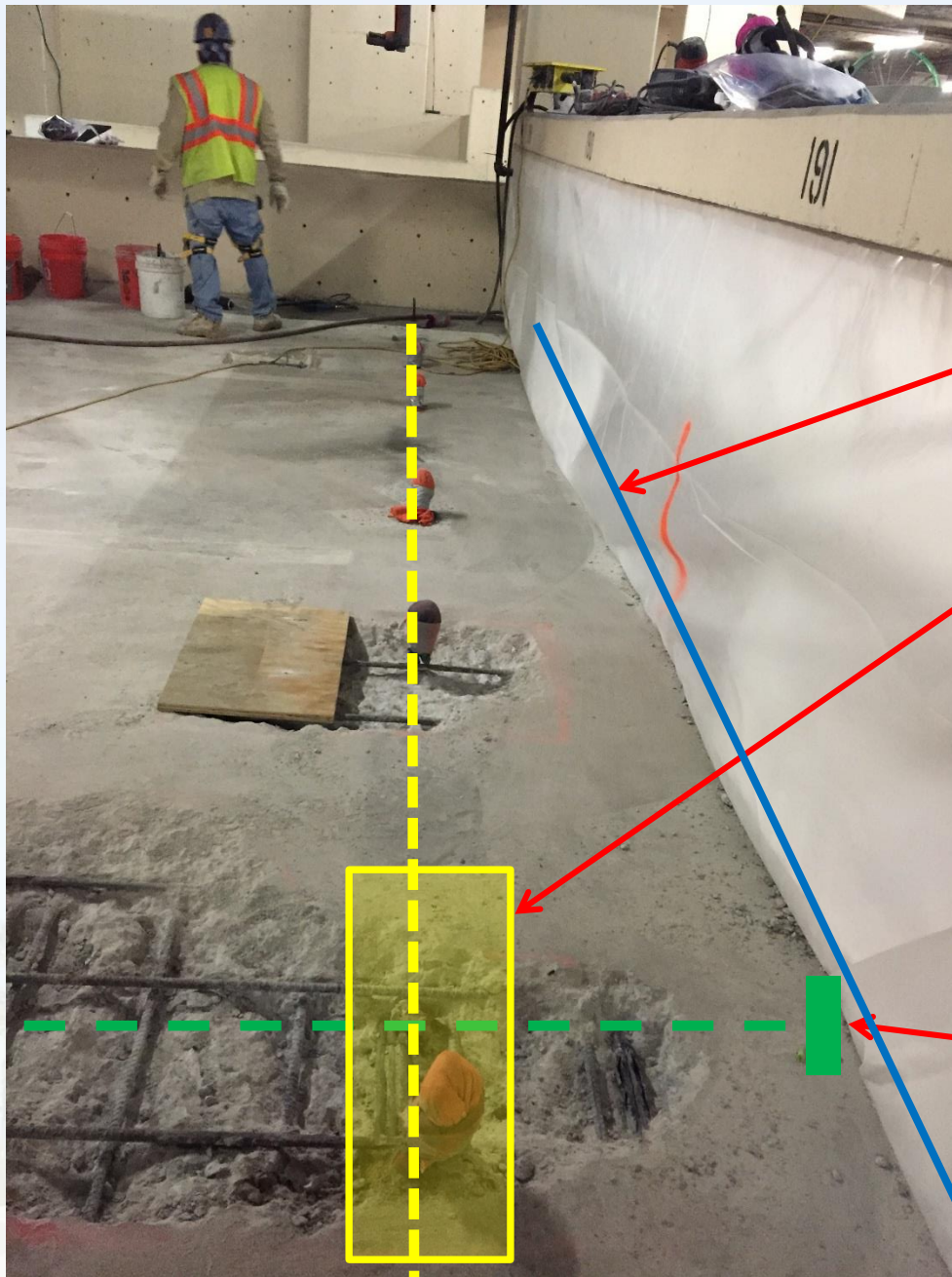




4 de-tensioned tendons

Punching shear crack
continues around column

Work near end anchors

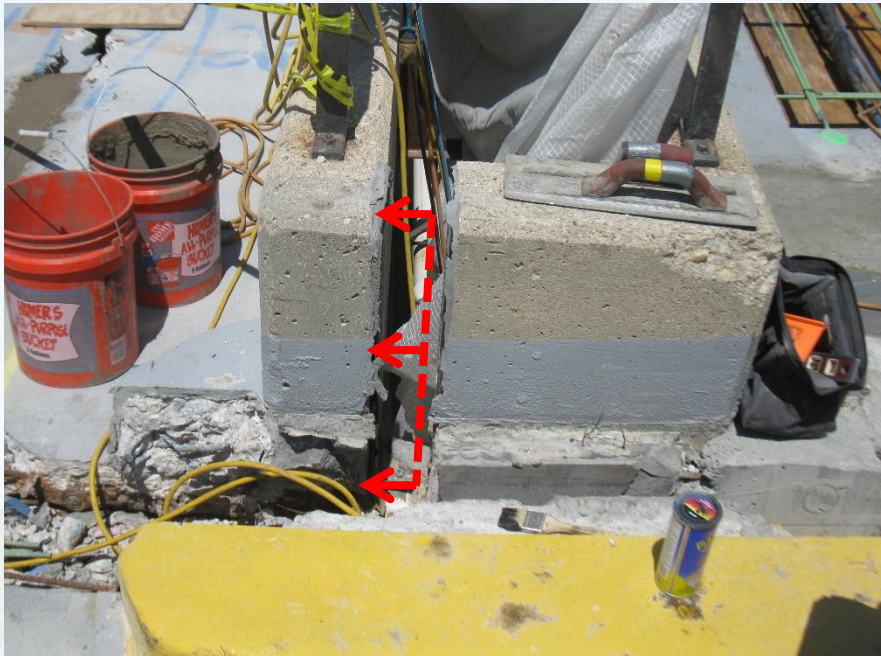


Slab edge

Future repair opening
for tendon parallel to
slab edge

Embedded tendon
and anchor

Whoops.



Where is the force going to go?



Phased concrete placement



- New concrete receives post-tensioning force
- Restore force load path
- Accommodate hardware travel during stressing

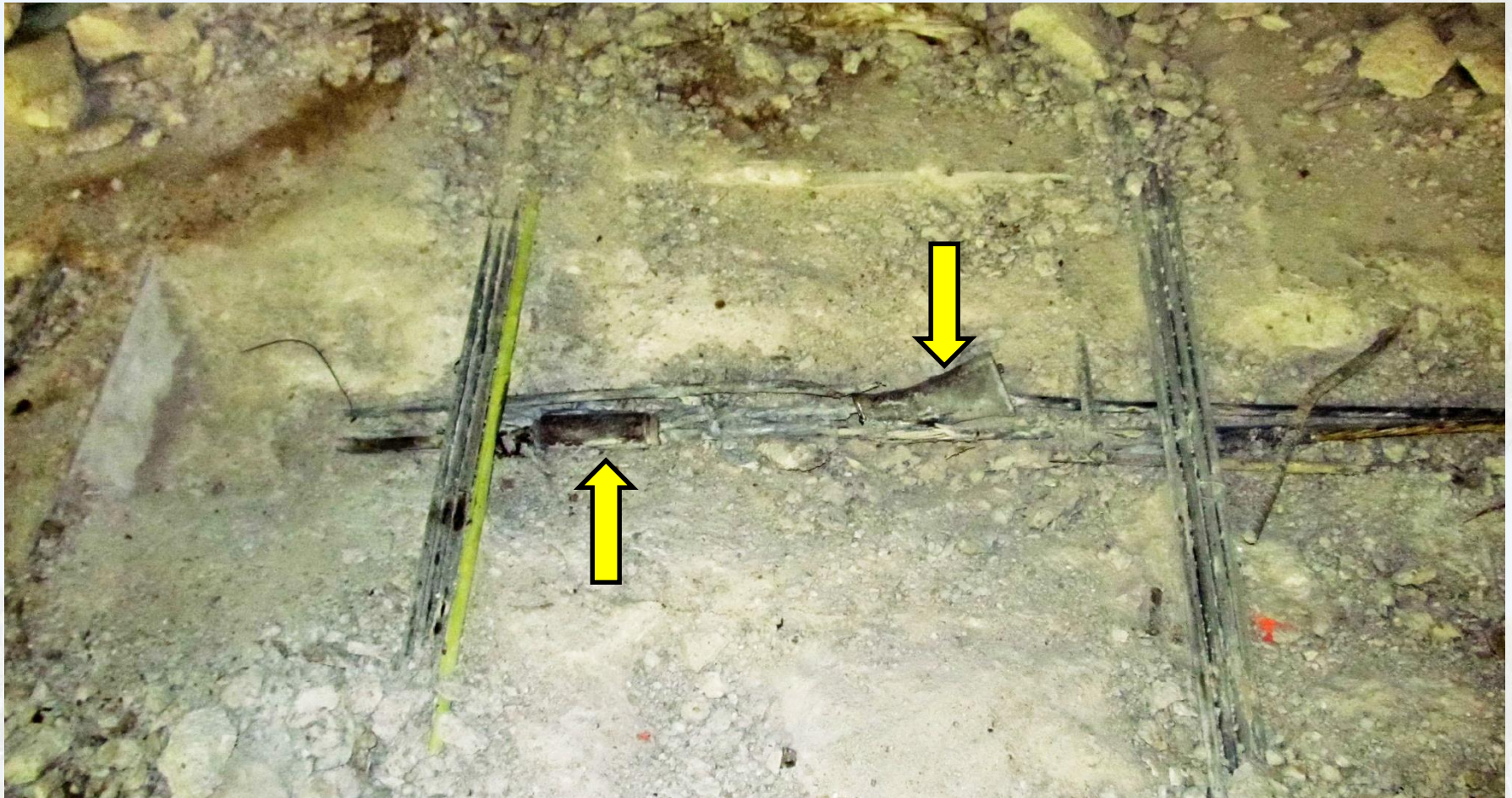
Impact of Previous Repairs



Impact of Previous Repairs

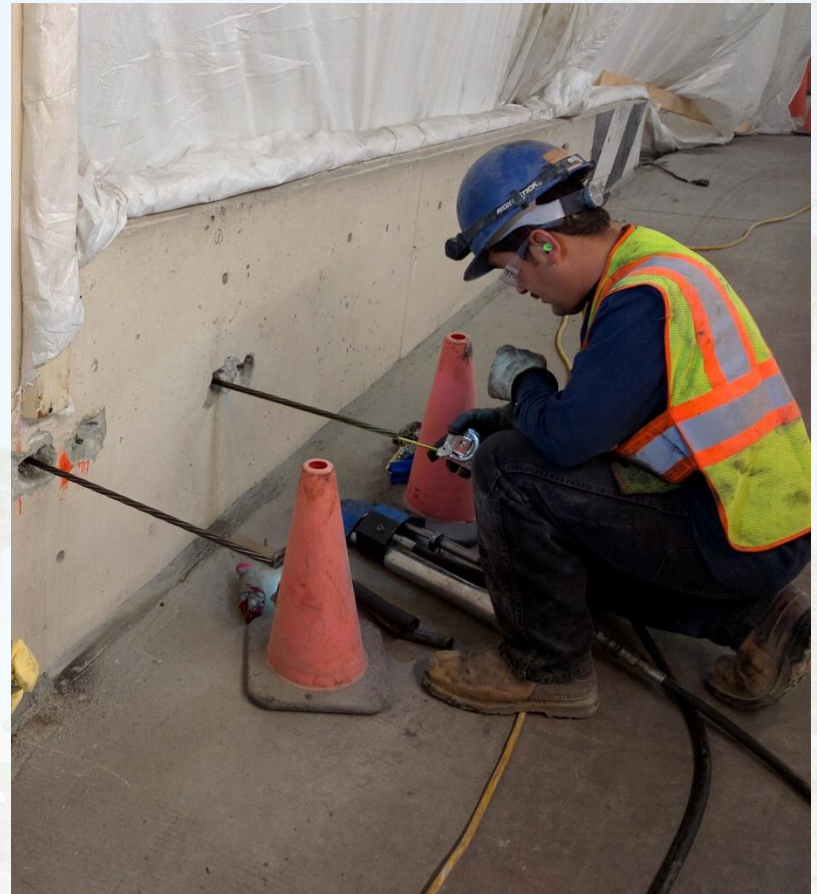


Impact of Previous Repairs



Stressing

- Target force and elongation
 - $0.6 \cdot P_u$ or $0.65 \cdot P_u$
 - Reduced creep, shrinkage, and shortening
- Multiple stressing points
 - Center stressing
 - End stressing



- “Short” elongation
 - Interferences
 - Construction joints
 - Binding from corrosion
 - Old PT repairs



Summary

- Address the problem
- Potential shoring requirements
- Maintaining load path for post-tensioning force
- De-tensioning challenges
- Construction pitfalls
- Stressing

Questions?

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