"Structural Repairs to Conventionally Reinforced Concrete and Post Tensioned Members"

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Presented by:
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Acqualina
17749 Collins Avenue
Sunny Isles Beach, FL 33160

One Miami Condominium
1778 Collins Ave.
Miami Beach, FL 33160

Ritz-Carlton Residences
Singer Island
2700 North Ocean Drive.
Singer Island, FL 33404

Luxuria
2500 S. Ocean Blvd.
Boca Raton, FL 33160

Reinforced Concrete Buildings

Design Requirements

- Gravity Loads
- Wind Loads
- Seismic Loads

Structural Framing Systems

- Reinforced Concrete Cast-in-place
- Post-Tensioned Concrete
- Pre-cast, Pre-stressed Concrete
- Composite Concrete

LONGEVITY OF REINFORCED CONCRETE BUILDINGS

Developer → Design & Construction → Current Owners

- Selection of structural framing systems
- Quality of construction during Original Construction
- Maintenance by the Current Owners

Federal Drug Enforcement Agency Building in Miami
August 5, 1974

Federal Drug Enforcement Agency Building in Miami
August 5, 1974

Do you know what you are doing?

LONGEVITY OF REINFORCED CONCRETE STRUCTURES

Minimize possibility of future failure of structural components of the older buildings and to be better prepared for hurricane and seismic events.

- Proper Maintenance
- **Regular Periodic Inspections by qualified individuals.**
- **Follow recommendations of the professionals.**
- **Implementation of structural repairs in a timely manner**

STRUCTURAL EVALUATION

The fundamental propose of the required inspections is to confirm in reasonable fashion that the building or structure under consideration is safe for continued use under the present occupancy

- Visual Examination – Required of all exposed structural members.
  - Movement of the structure.
  - Deterioration.
  - Signs of structural distress
  - Signs of Foundation Settlement
- Testing – Not required unless its need is established by the inspector.
  - Concrete strength.
  - Size of the structural member.
- Evaluation
  - Statement to the effect – Safe or not safe.

Typical High-rise older building

Typical High-rise older building

Typical High-rise older building

Repairs to Reinforced Concrete Building Components

Crack in reinforced concrete slab – Initial Symptom

Typical symptom of corroded rebar

Crack in reinforced concrete beam

Corroded reinforcing steel rebars with cracked and spalled concrete

Signs of structural distress in reinforced concrete beam

Corroded reinforcing steel rebars in reinforced concrete slab (TYP)

Corroded reinforcing steel rebars in main building column

Spalled concrete – Corroded Rebar

Water leaking through expansion joints

Main structural beam at expansion joint

Damage caused by water intrusion

Corroded reinforcing steel rebar in reinforced concrete beam

Cracks and spalled reinforced concrete beam

Crack in column, indicative of corroded reinforcing steel

Typical corroded reinforcing steel rebar ends

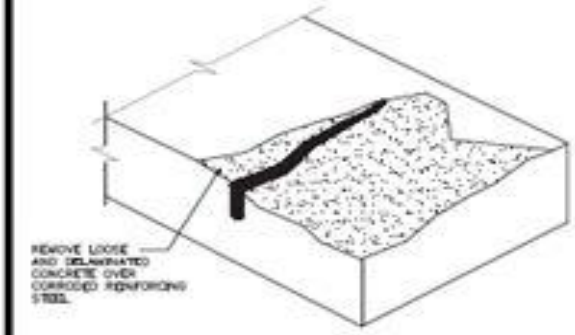
Corroded Rebars and Other Steel Inserts

Repairs to Reinforced Concrete Structural Members

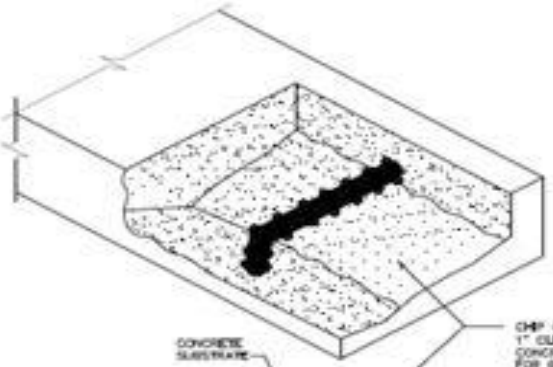
Repairs to Reinforced Concrete Slab

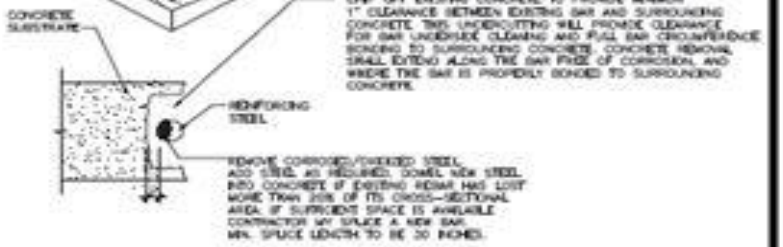
Repairs to Reinforced Concrete Slab

Repairs to Reinforced Concrete Slab

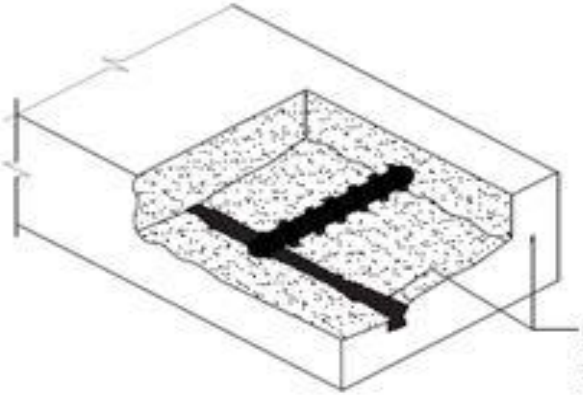


EXISITING CORRODED STEEL



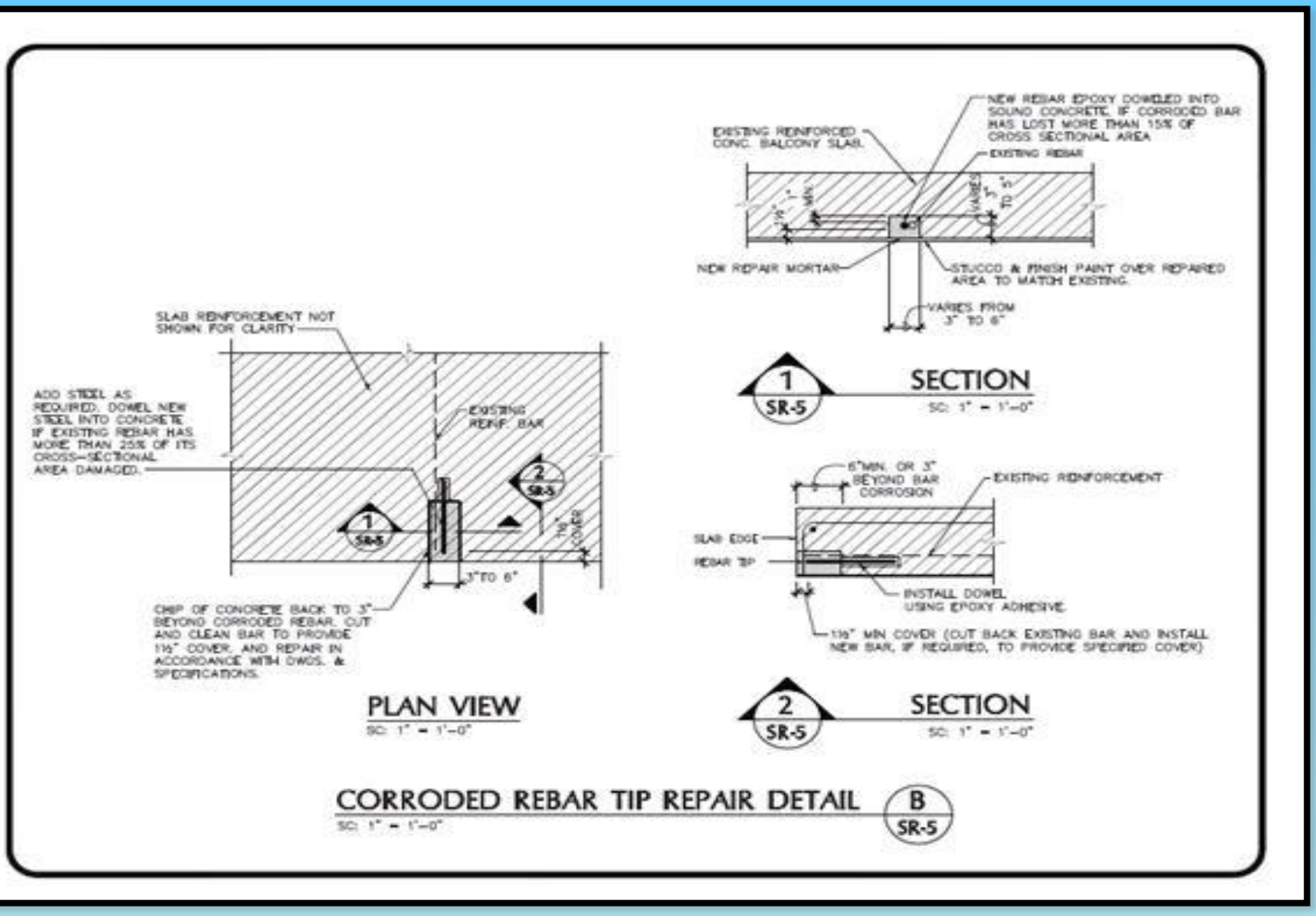


CLEANING THE BACKSIDE OF CORRODED BARS

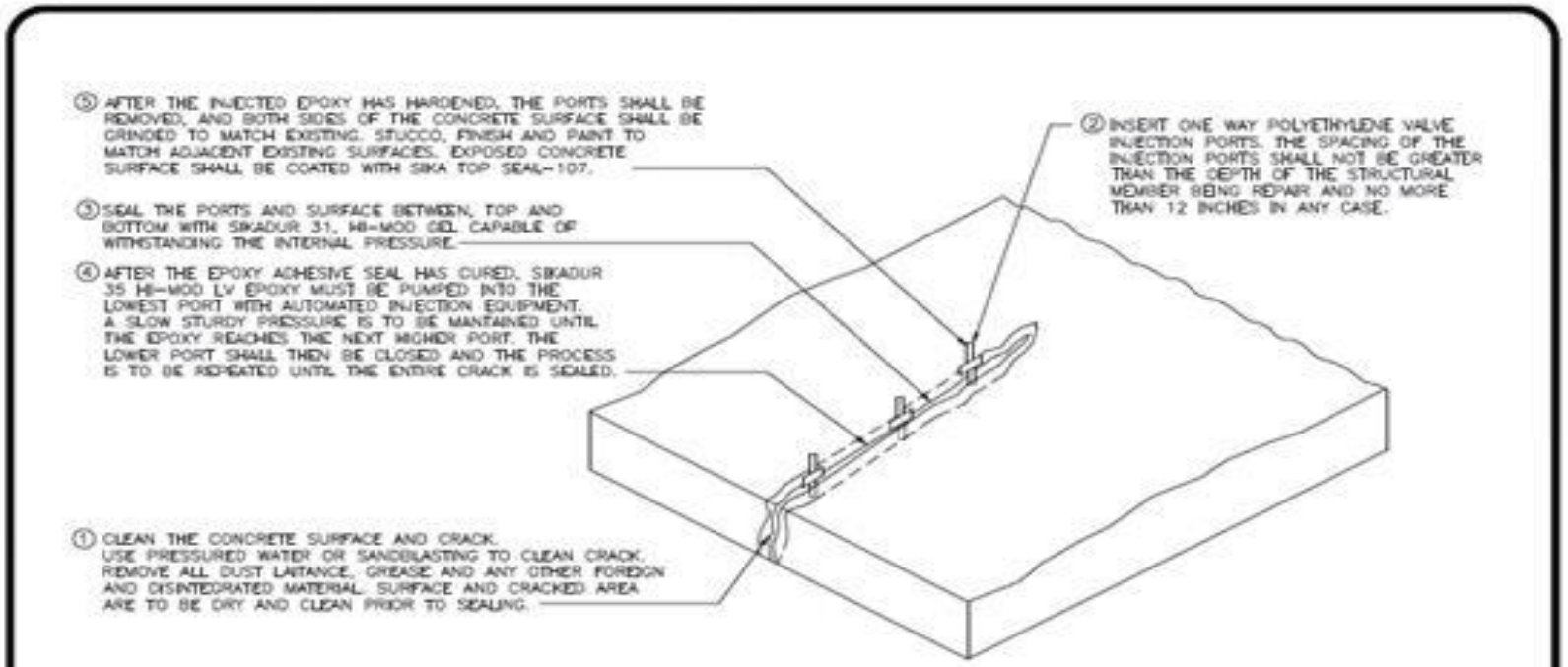


CORRODED REINFORCING BAR REPAIR DETAIL (A / SR-5)

It's in the details!



It's in the details!



NOTES:

1- SEE TYPICAL REPAIR DETAILS ON SR DRAWINGS AND CONTRACT SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.

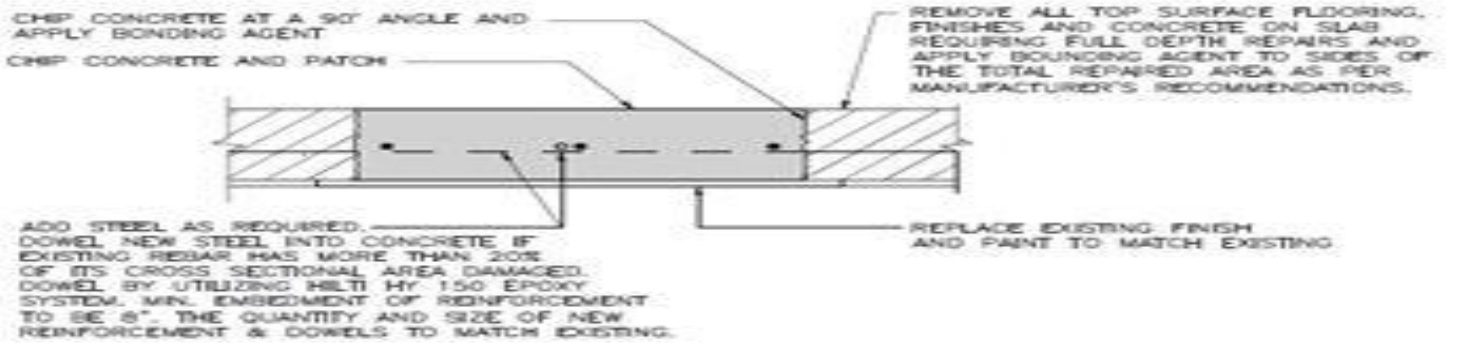
2- EPOXY INJECTION TO BE DONE BY QUALIFIED APPLICATOR WITH MINIMUM OF 5 YEARS EXPERIENCE AND CERTIFIED AS QUALIFIED BY THE MANUFACTURER.

REINFORCED CONCRETE SLAB, BEAM OR COLUMN SEAL CRACKS BY PRESSURE EPOXY INJECTION

N.T.S.

E
SR-5

It’s in the details!



FULL DEPTH SLAB REPAIR DETAIL

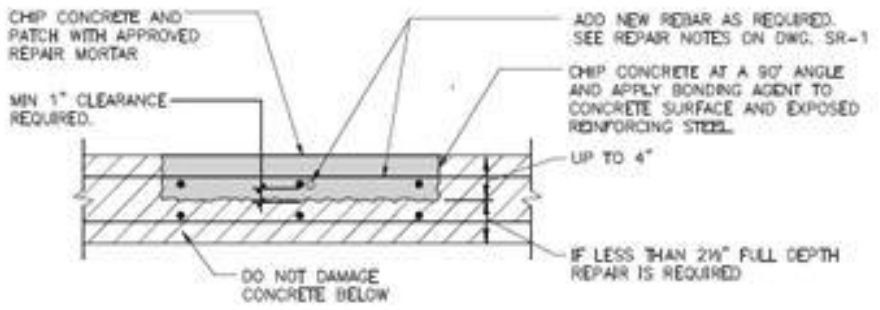
N.T.S.

TWO LAYERS OF REINFORCING MAY BE PRESENT

A

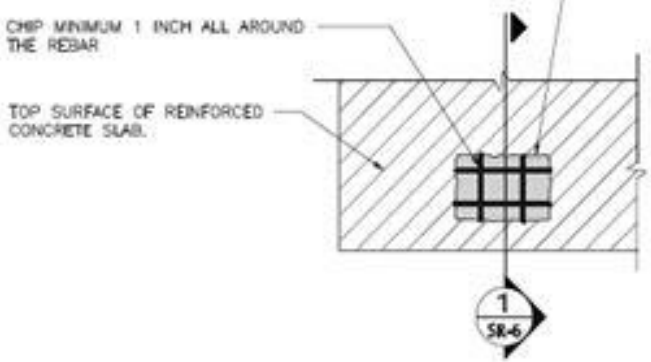
SR-6

It's in the details!



SECTION 1 / SR-6
N.T.S.

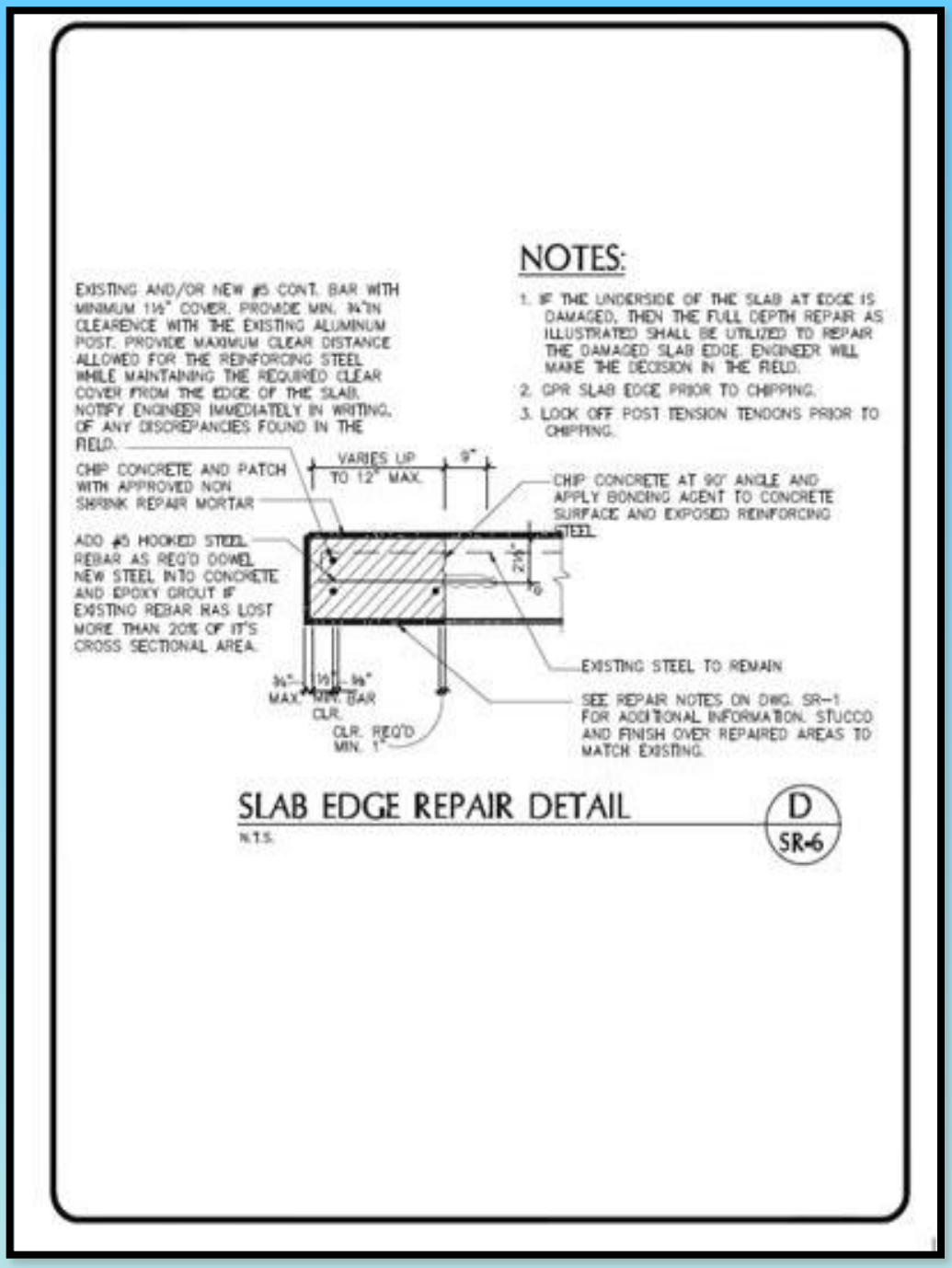
CHIP OFF SPALLED OR HOLLOW SOUNDING CONCRETE TO VERTICAL AND HORIZONTAL SURFACES. IF EXISTING REBAR HAS LOST 20% OR MORE OF ITS CROSS-SECTIONAL AREA, REPLACE WITH NEW BAR OF SAME SIZE. IF NEW BAR IS TO BE PROVIDED, MINIMUM SPLICE LENGTH SHALL BE IN ACCORDANCE WITH ACI 318-05. REPOSITION EXISTING AND NEW STEEL TO ACHIEVE 1½ INCH CONCRETE COVER. CLEAN EXISTING BAR WITH POWERED WIRE BRUSH TO SILVER STEEL SURFACE. COAT REBARS AND EXISTING CONCRETE WITH BONDING AGENT. REPLACE CHIPPED OFF CONCRETE WITH REPAIR MORTAR AND FINISH TO MATCH ADJACENT AREAS.



PARTIAL DEPTH REPAIR PLAN

PARTIAL DEPTH SLAB REPAIR DETAIL B / SR-6
N.T.S.

It's in the details!



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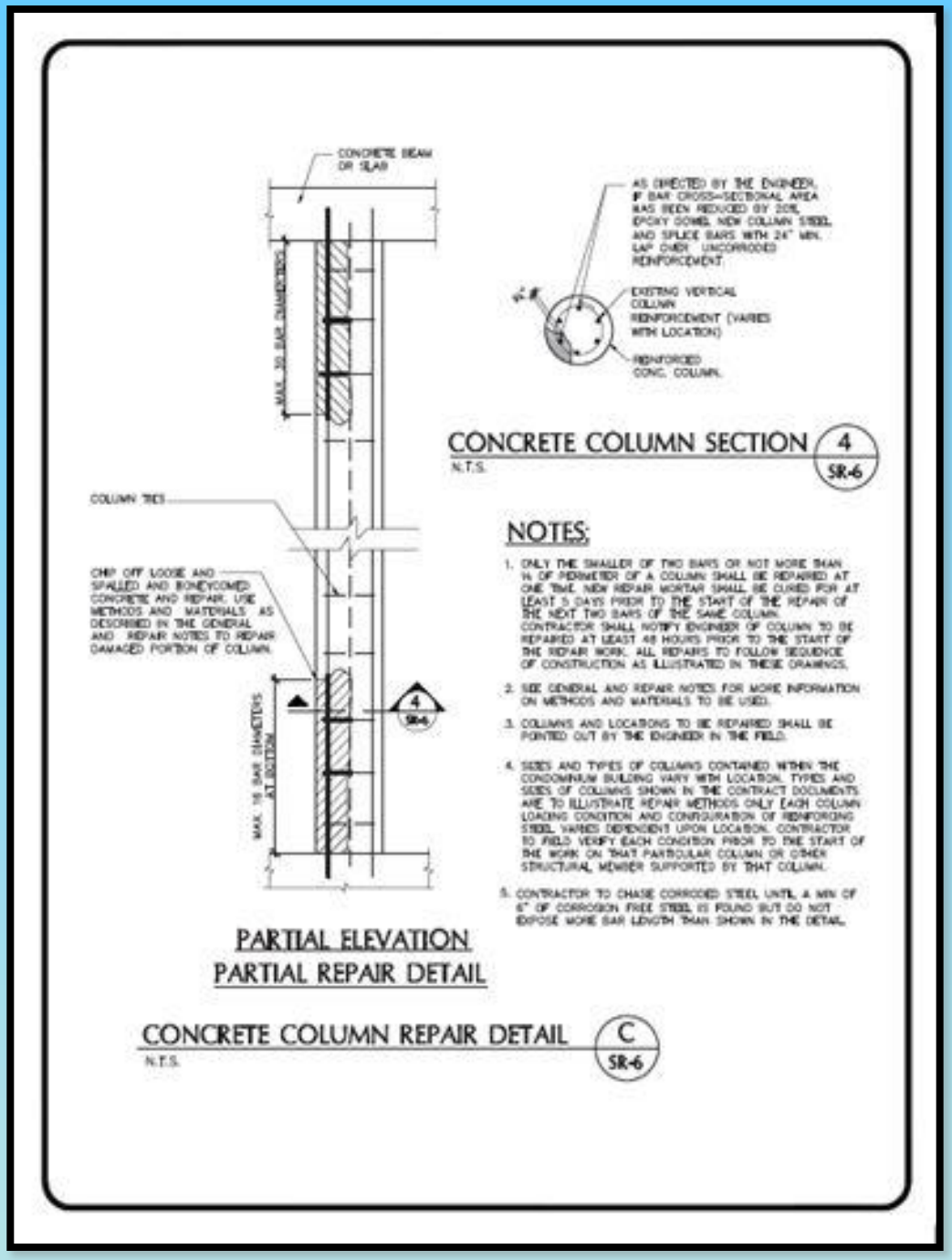

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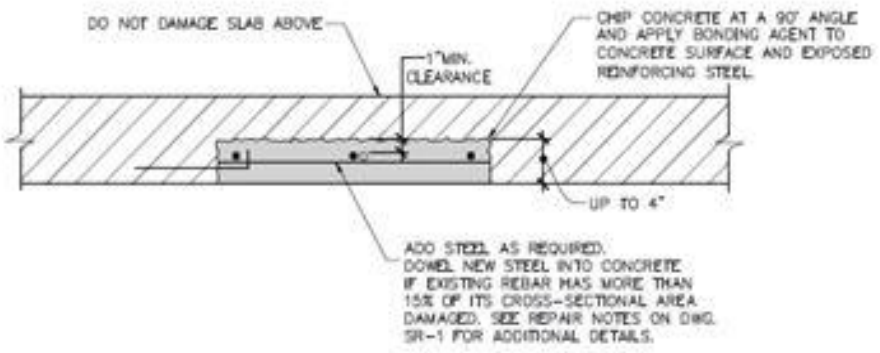
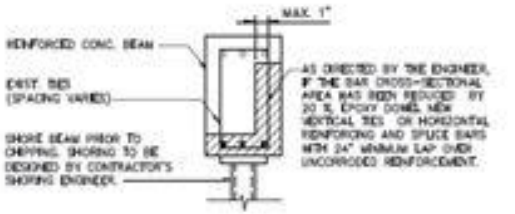


PARTAIL DEPTH CEILING REPAIR DETAIL (H / SR-6)

N.T.S.

It's in the details!

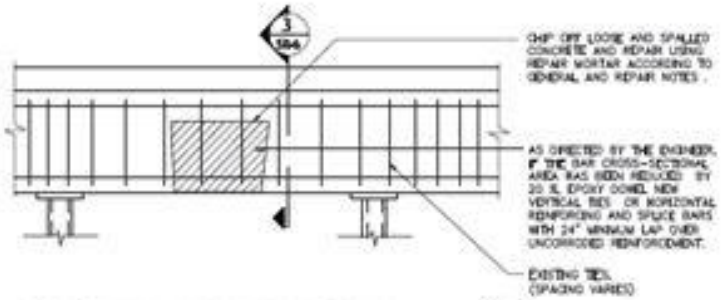


CONCRETE BEAM CROSS - SECTION 3 SR-6

N.T.S.

NOTES:

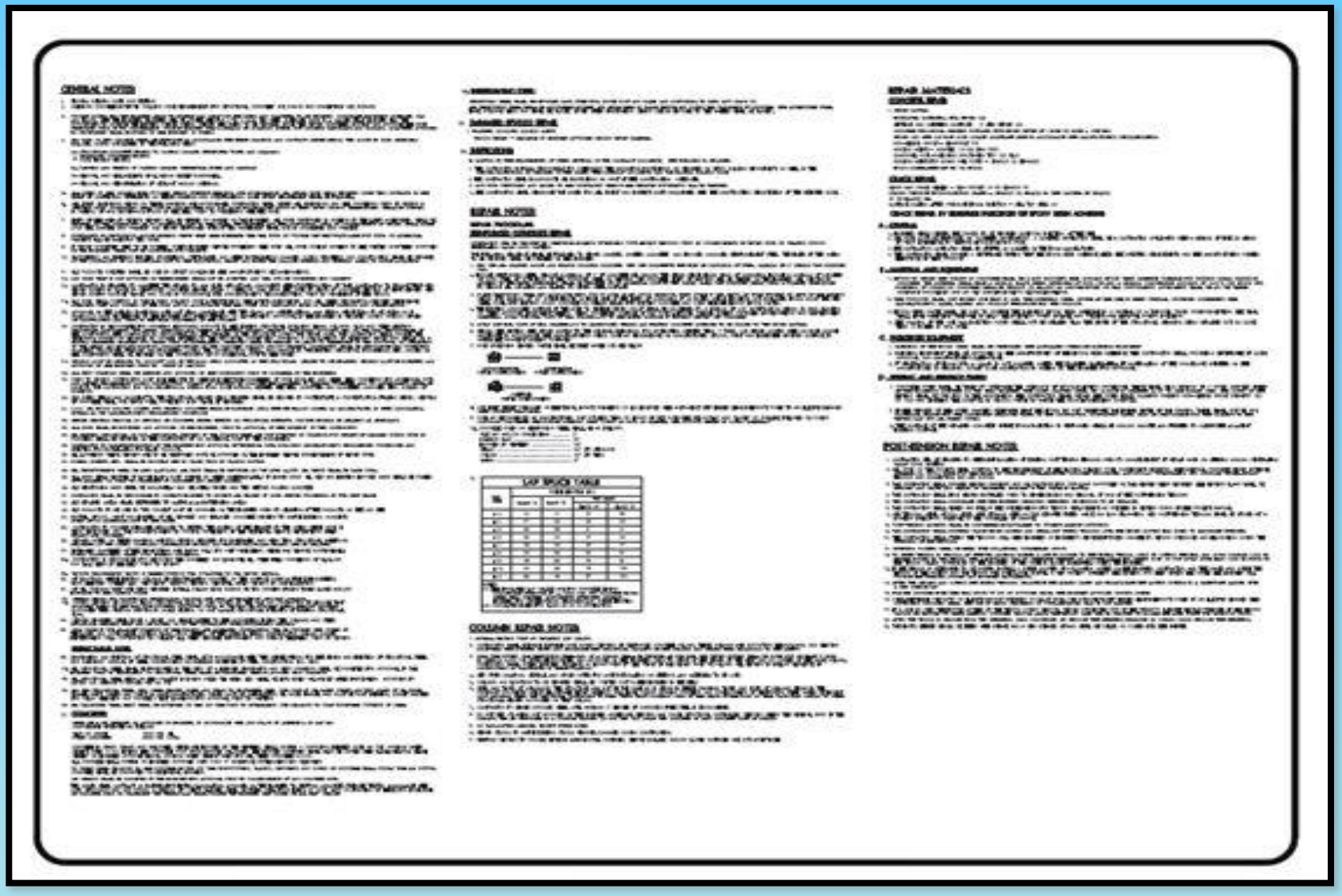
1. ONLY A LIMITED PORTION OF THE BEAM SHALL BE REPAIRED AT ONE TIME, AS ALLOWED BY THE ENGINEER. REPLACED CONCRETE SHALL BE CURED FOR AT LEAST 3 DAYS PRIOR TO THE START OF REPAIR OF THE NEXT CORNER OR SECTION OF THE SAME BEAM. CONTRACTOR SHALL NOTIFY ENGINEER OF AREAS TO BE REPAIRED AT LEAST 48 HOURS PRIOR TO START OF THE REPAIR.
2. HEAVY DUTY SHORING IS REQUIRED TO SUPPORT THE STRUCTURE BEING SUPPORTED BY THE REINFORCED CONCRETE BEAMS. SHORING SHALL BE DESIGNED TO SUPPORT THE LOADS OF ALL FLOORS ABOVE IF MORE THAN 15% OF THE BEAM'S CROSS-SECTIONAL AREA IS TO BE CHIPPED OFF. CONTRACTOR TO SUBMIT SHORING DRAWINGS AND CALCULATIONS FOR REVIEW AND APPROVAL. SHORING CALCULATIONS AND DRAWINGS ARE TO BE SIGNED AND SEALED BY AN ENGINEER REGISTERED IN THE STATE OF FLORIDA.
3. SEE REPAIR NOTES FOR ADDITIONAL INFORMATION ON METHODS AND MATERIALS TO BE USED.



CONCRETE BEAM REPAIR DETAIL G SR-6

N.T.S.

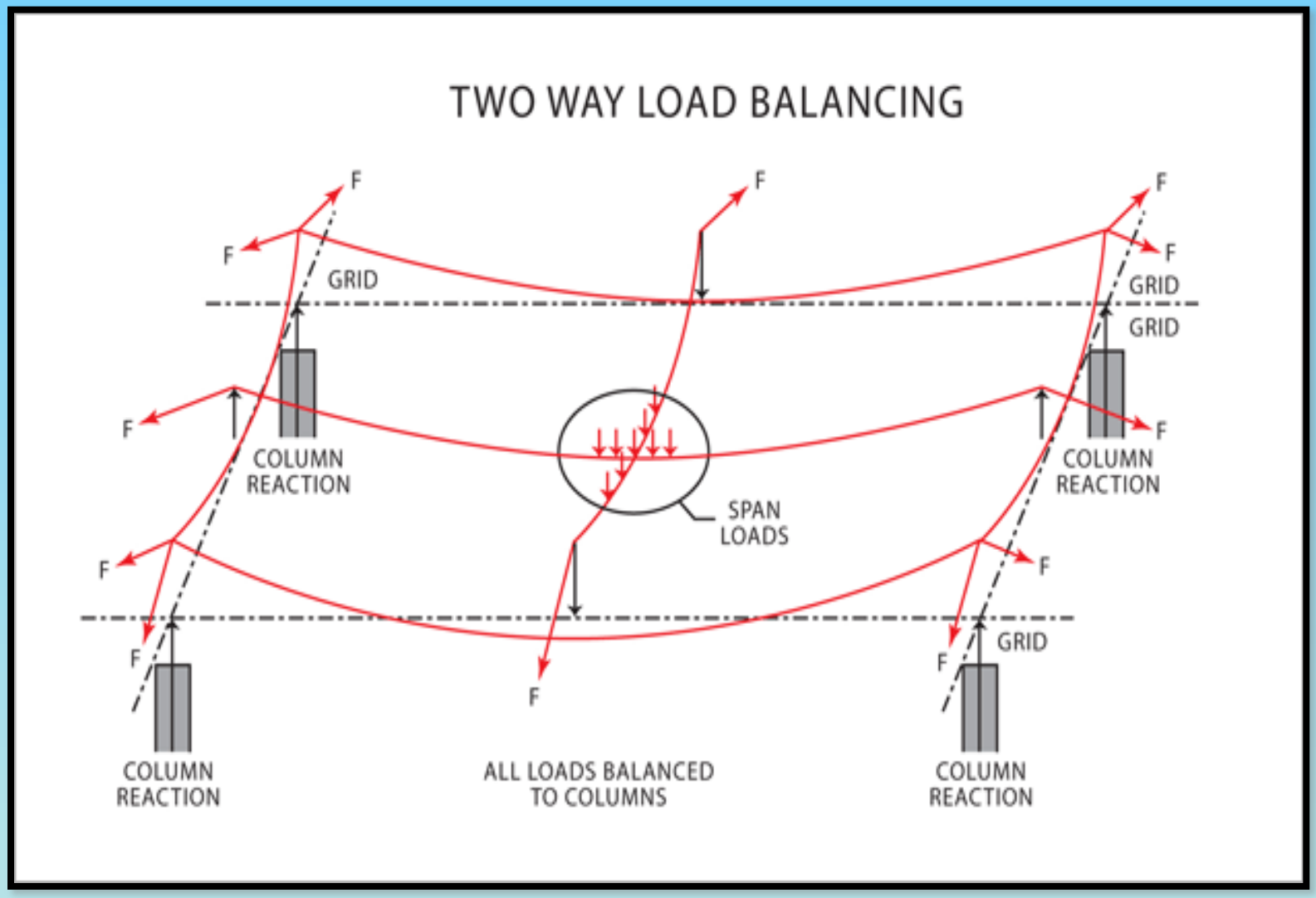
It's in the details!



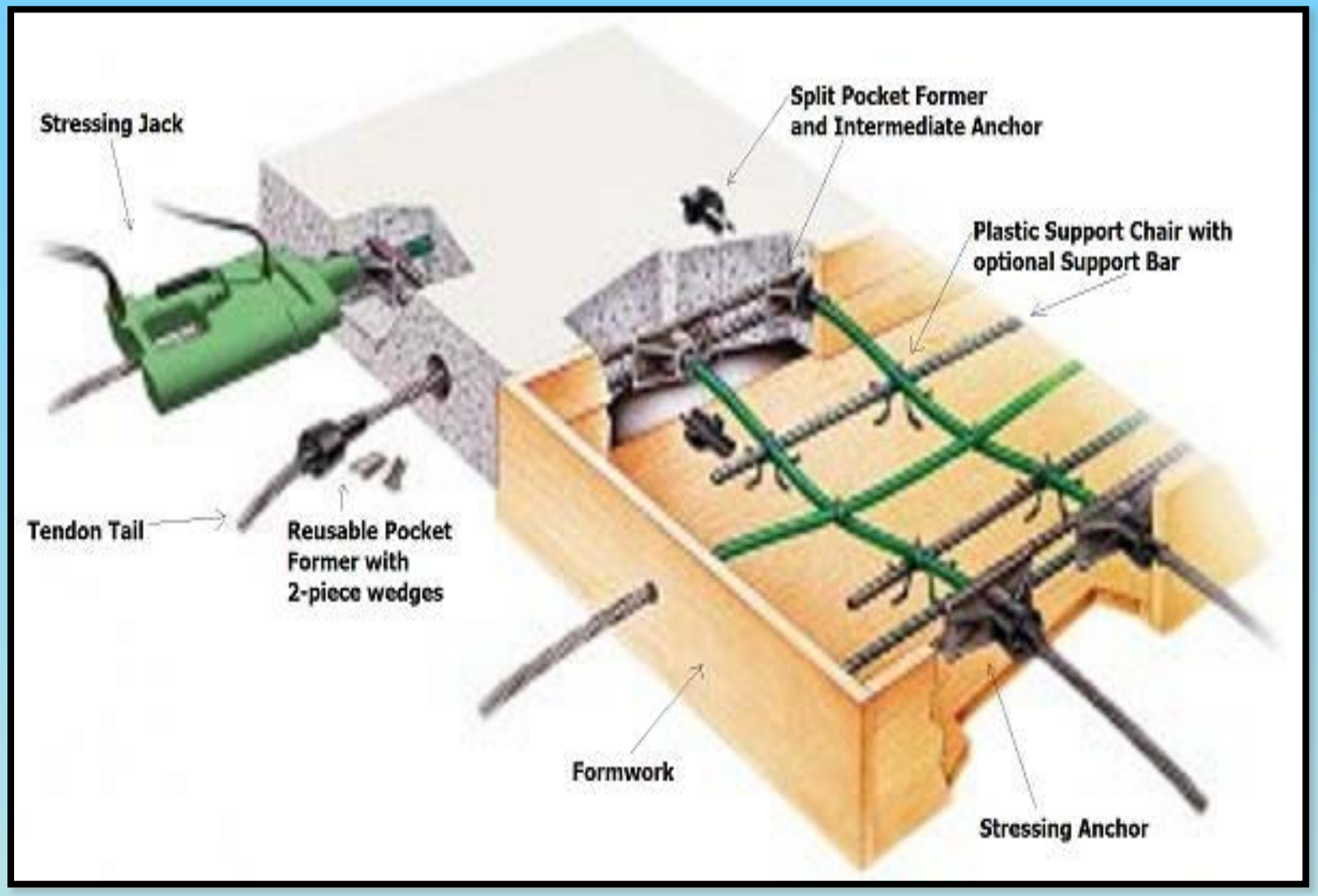
It’s in the details!

Repairs to Post-Tensioned Concrete Building Components

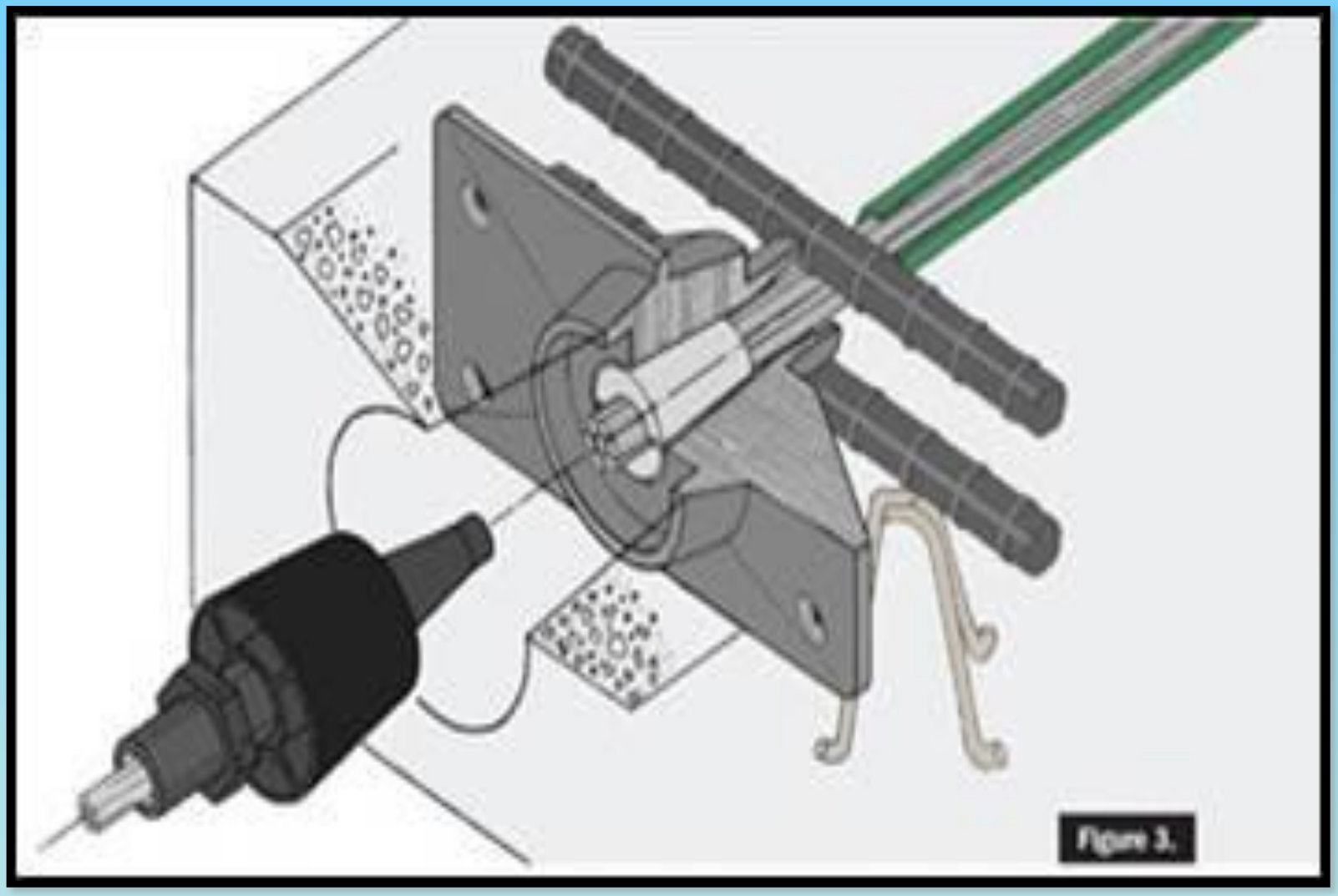
Two Way Load Balancing



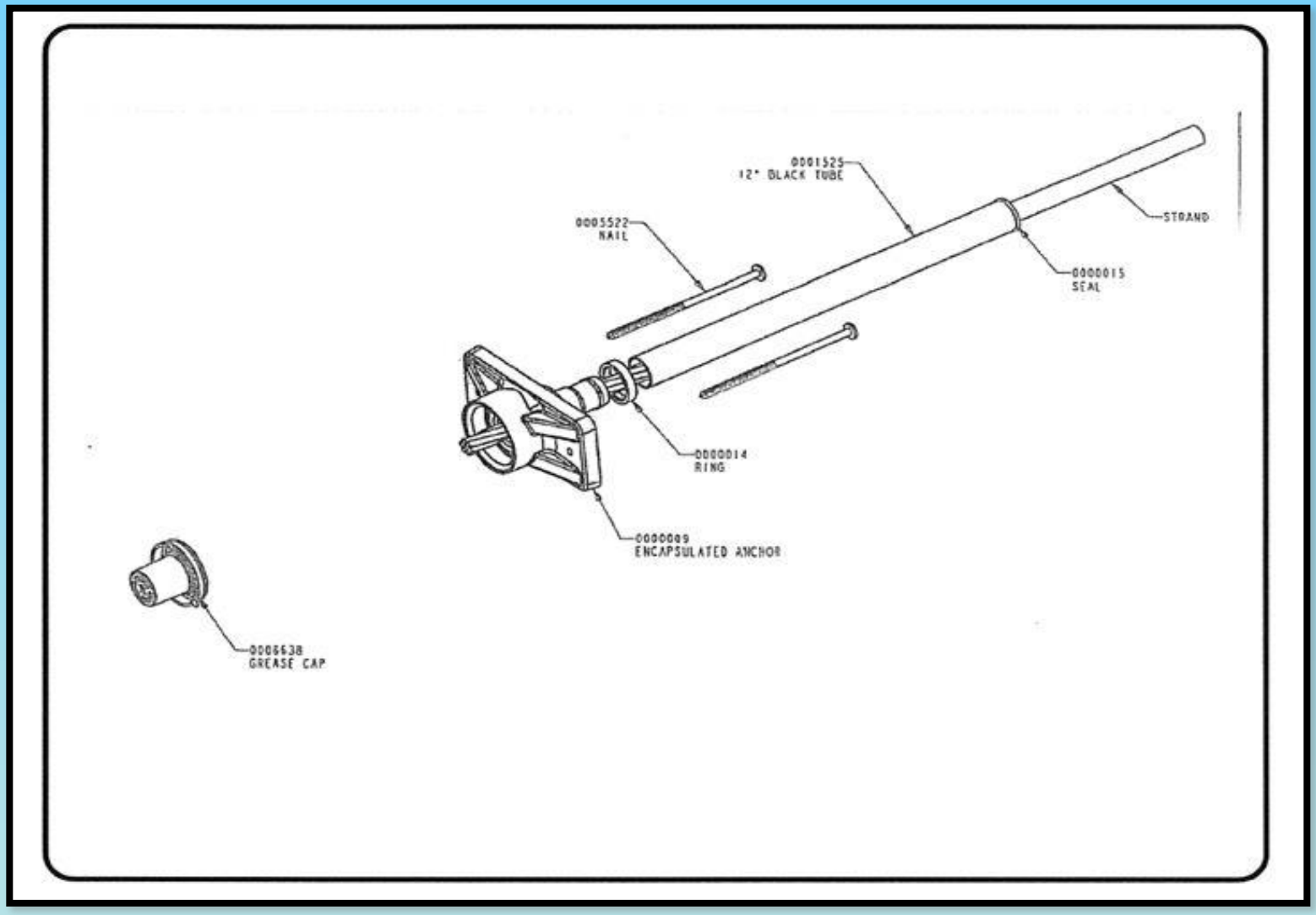
Post-Tension Slab



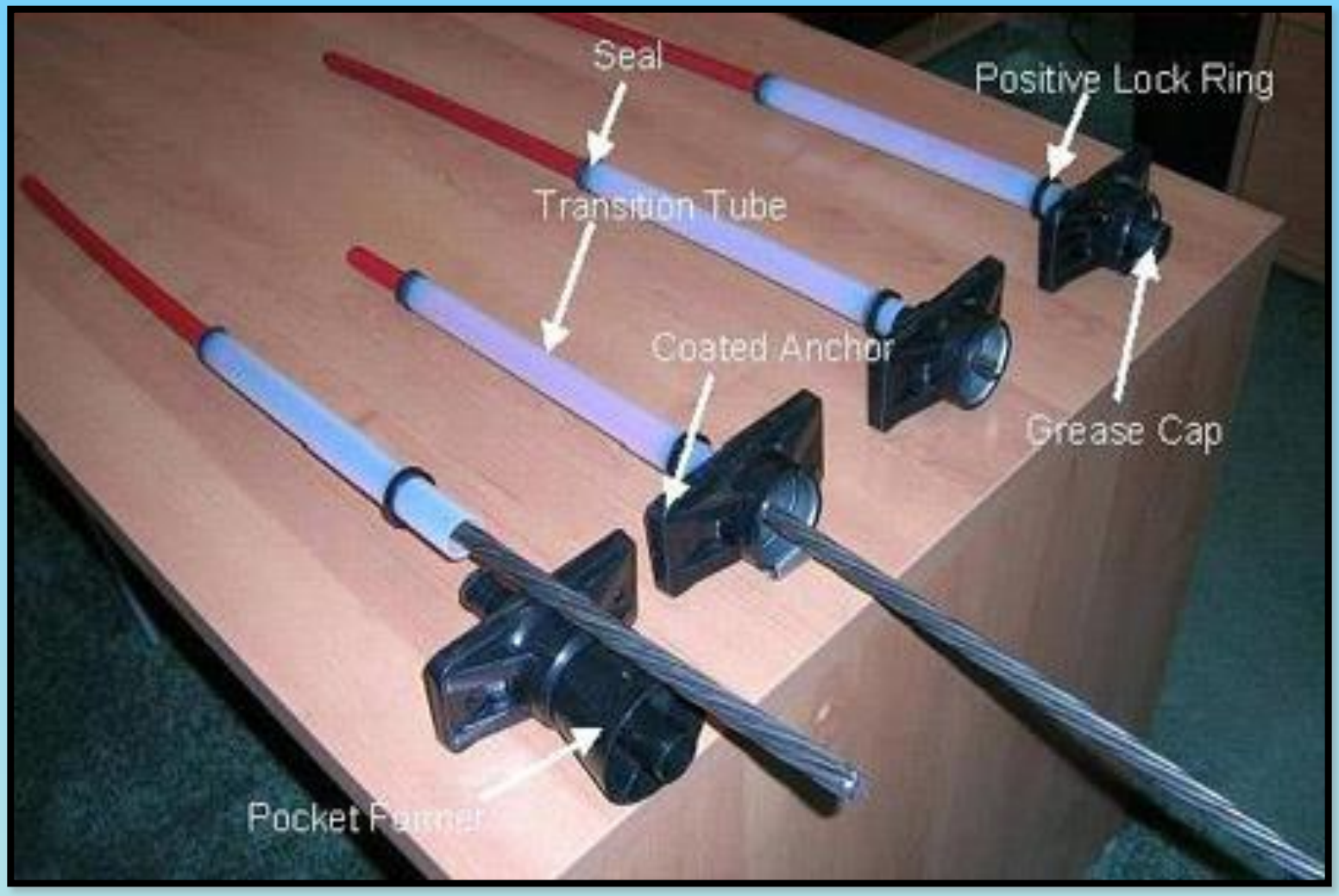
Post Tension Anchorage Assembly



Standard PosiLock Stressing End

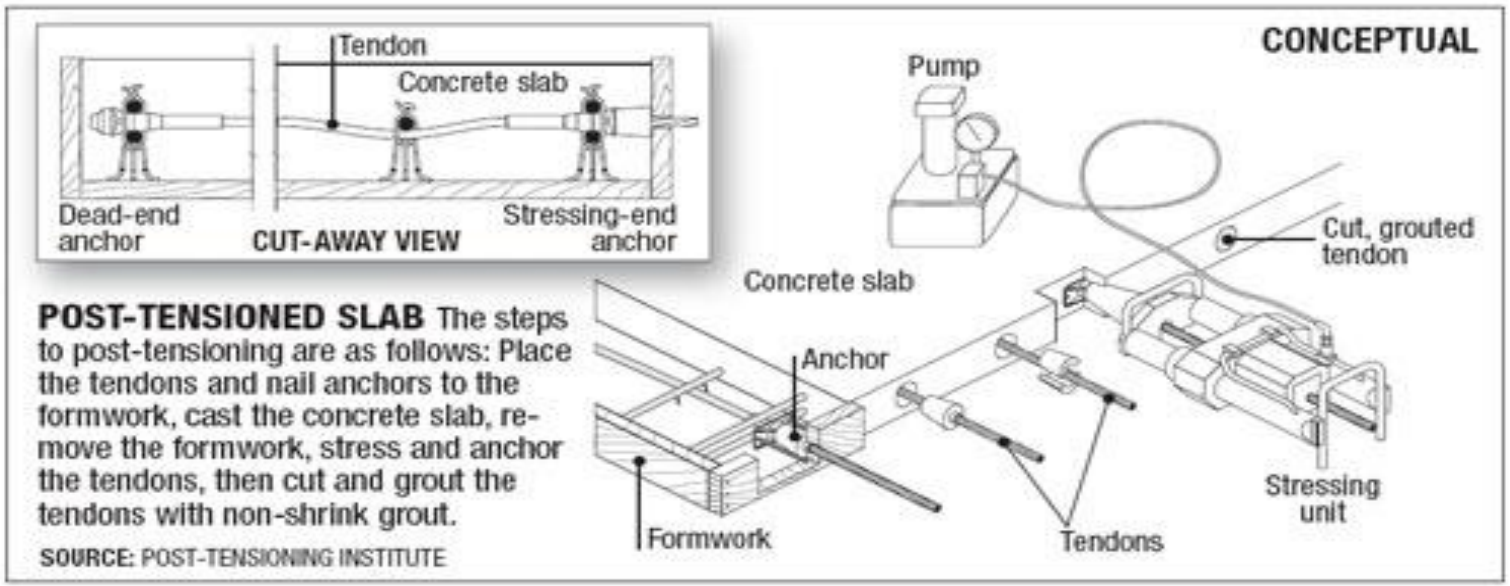


Typical Encapsulated Anchor Assembly



Typical Steel Wedges

Stressing Tendons with Hydraulic Jack

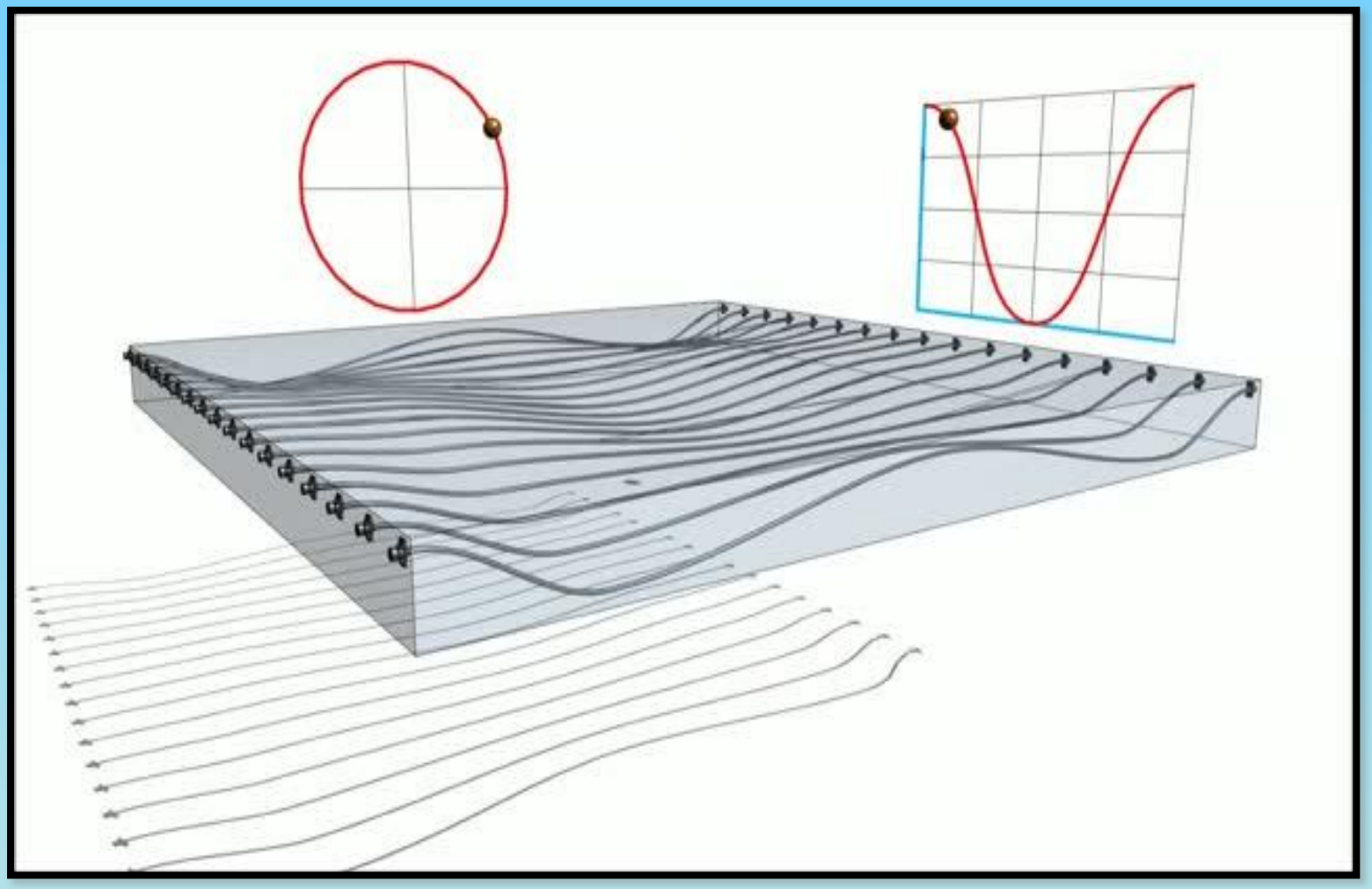


POST-TENSIONED SLAB The steps to post-tensioning are as follows: Place the tendons and nail anchors to the formwork, cast the concrete slab, remove the formwork, stress and anchor the tendons, then cut and grout the tendons with non-shrink grout.

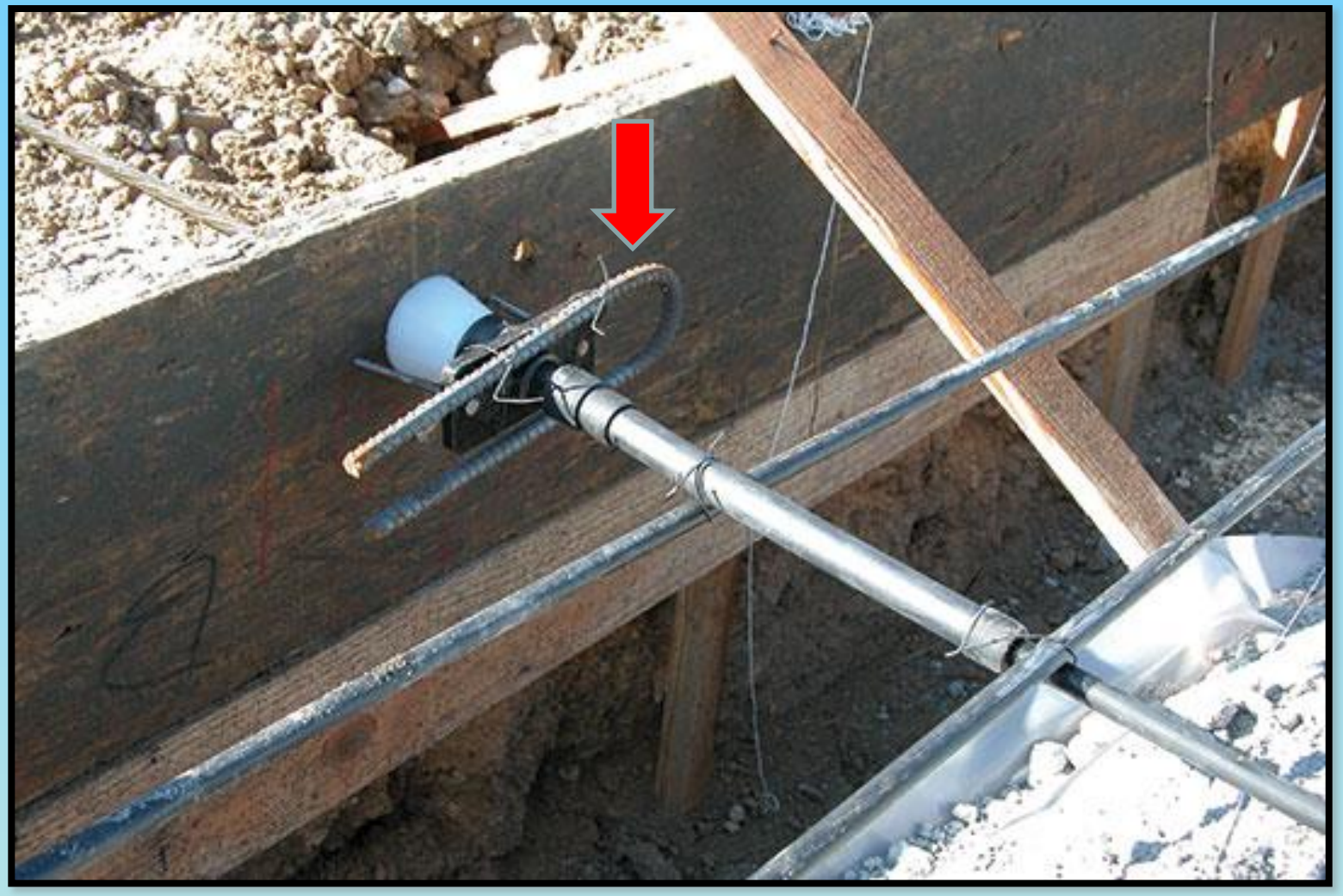
SOURCE: POST-TENSIONING INSTITUTE

Typical Tendons Layout

Typical PT Slab Layout



Back-up Bars

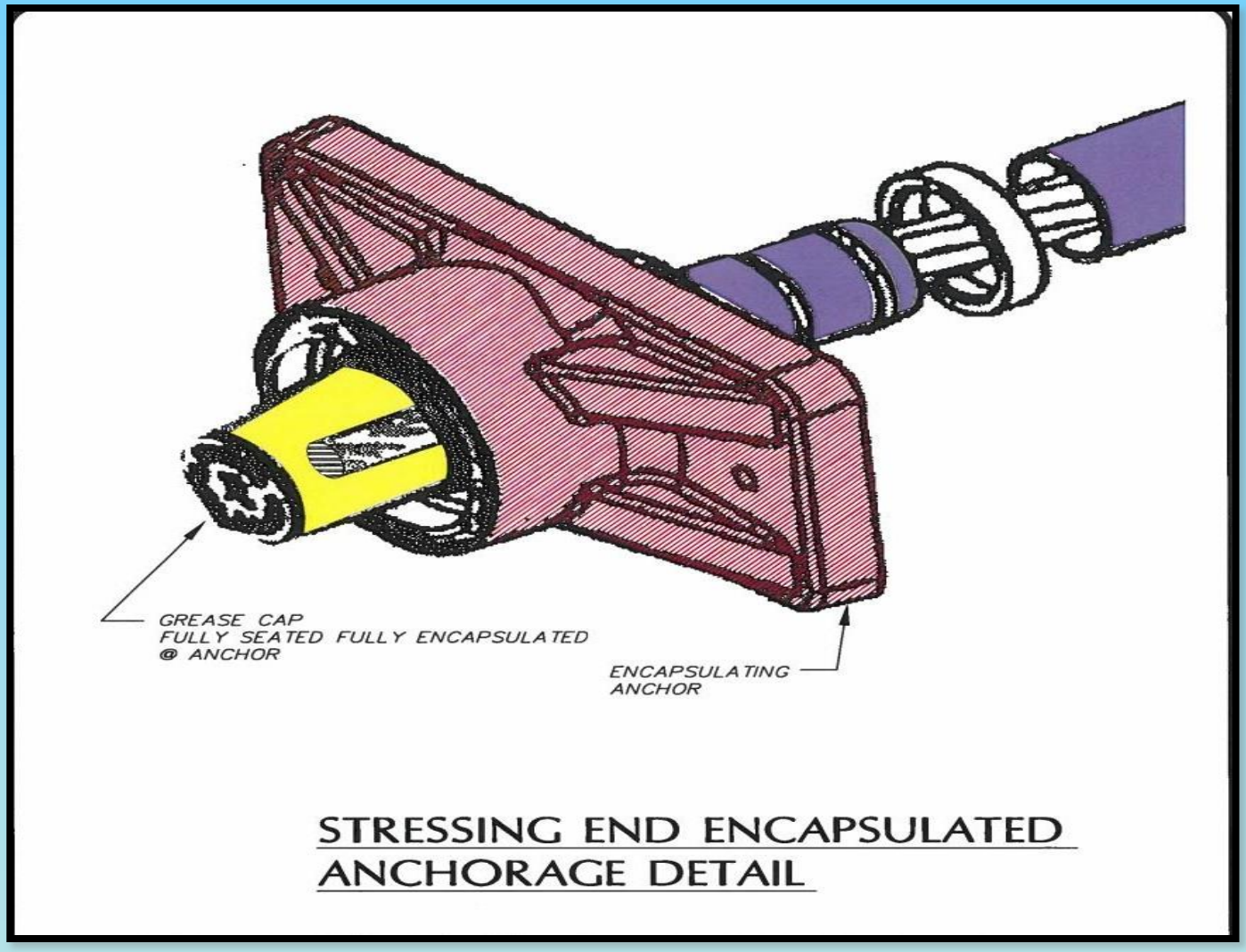


Post-Tensioned Transfer Slab

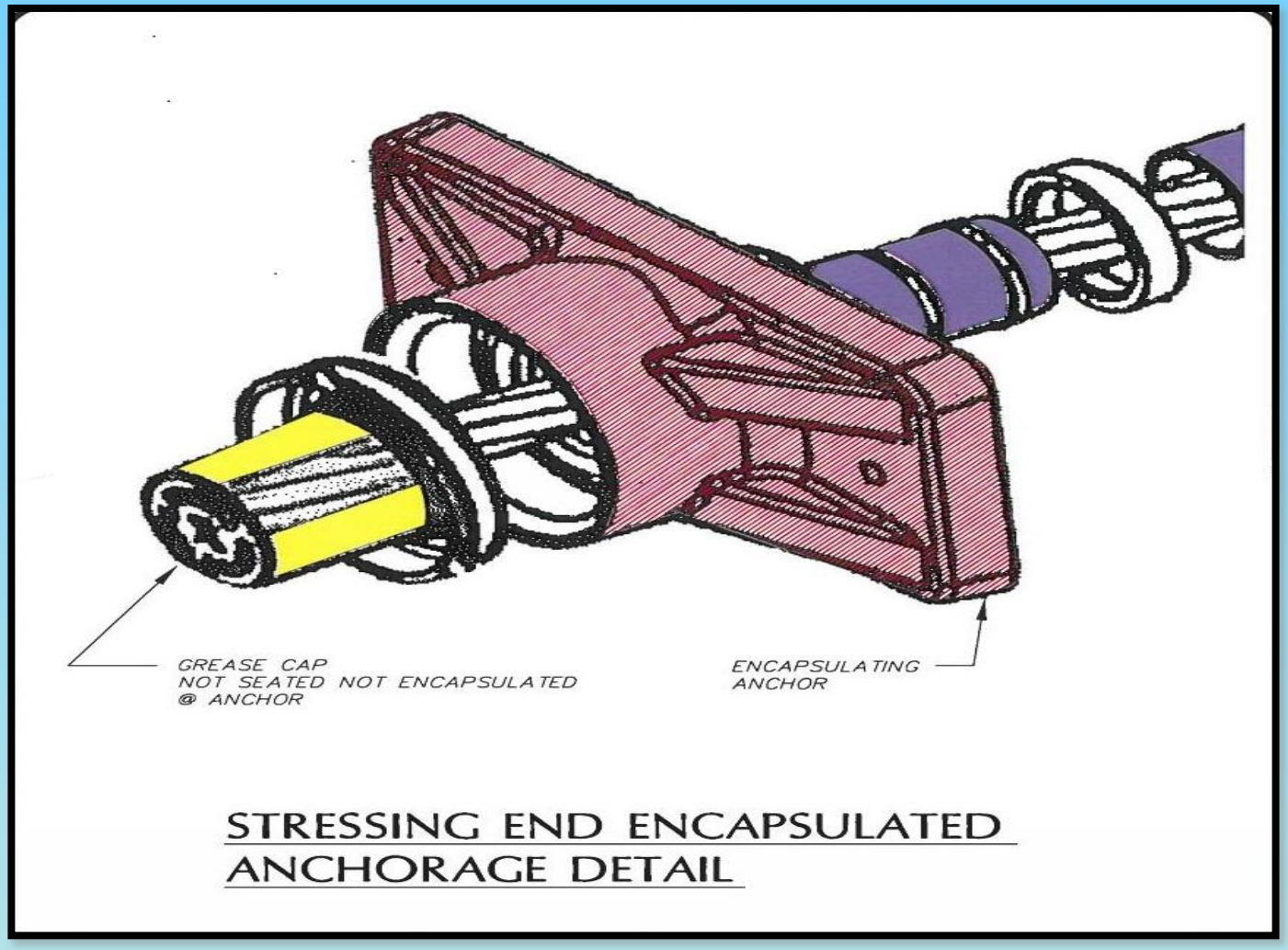
Tendons prior to stressing

Stressing Hydraulic Jack

Properly Seated Plastic Cap

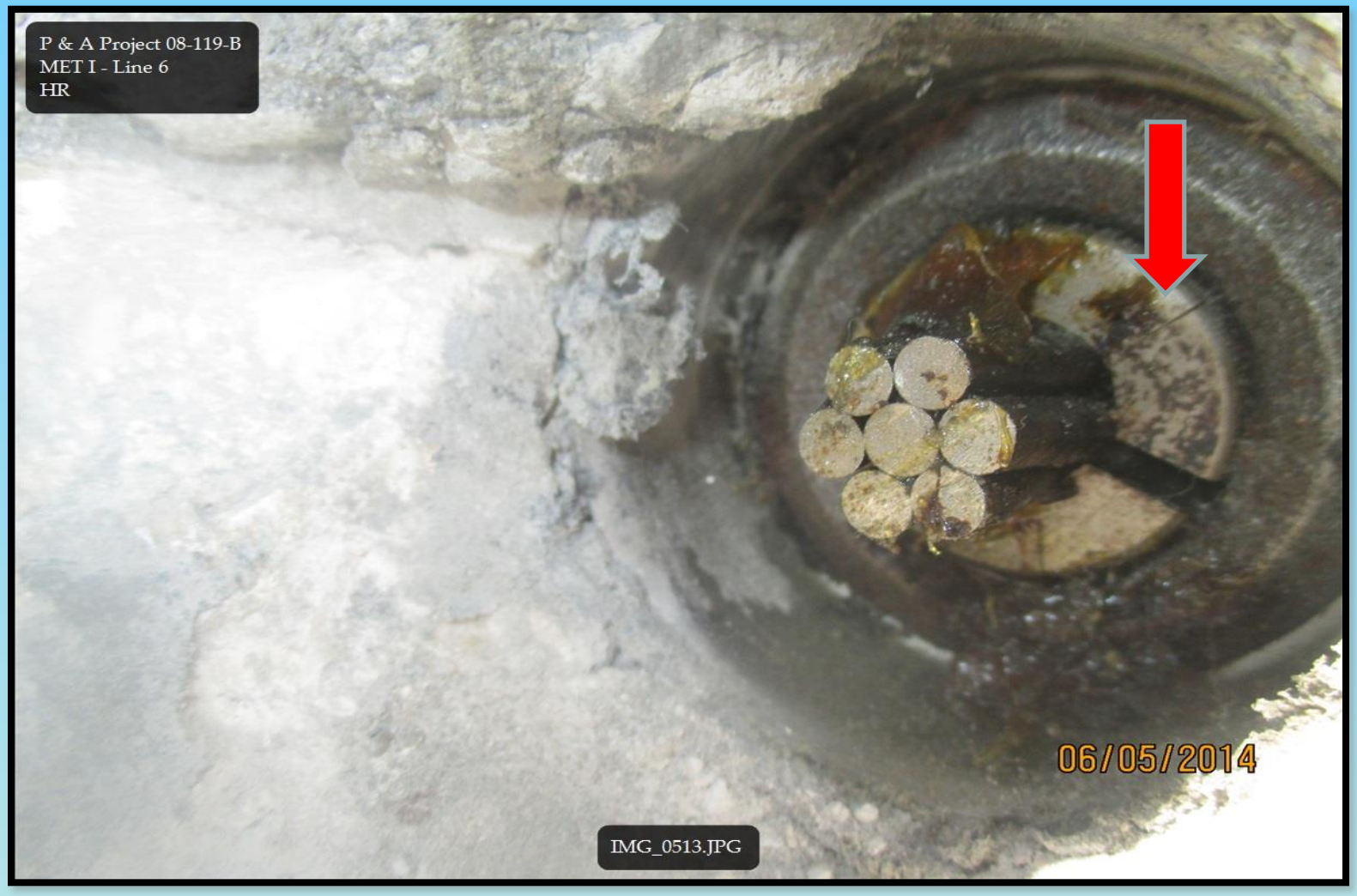


Improperly Seated Plastic Cap



Improperly installed plastic cap – Tail length too long

Cracked Wedges



Use Qualified Individuals

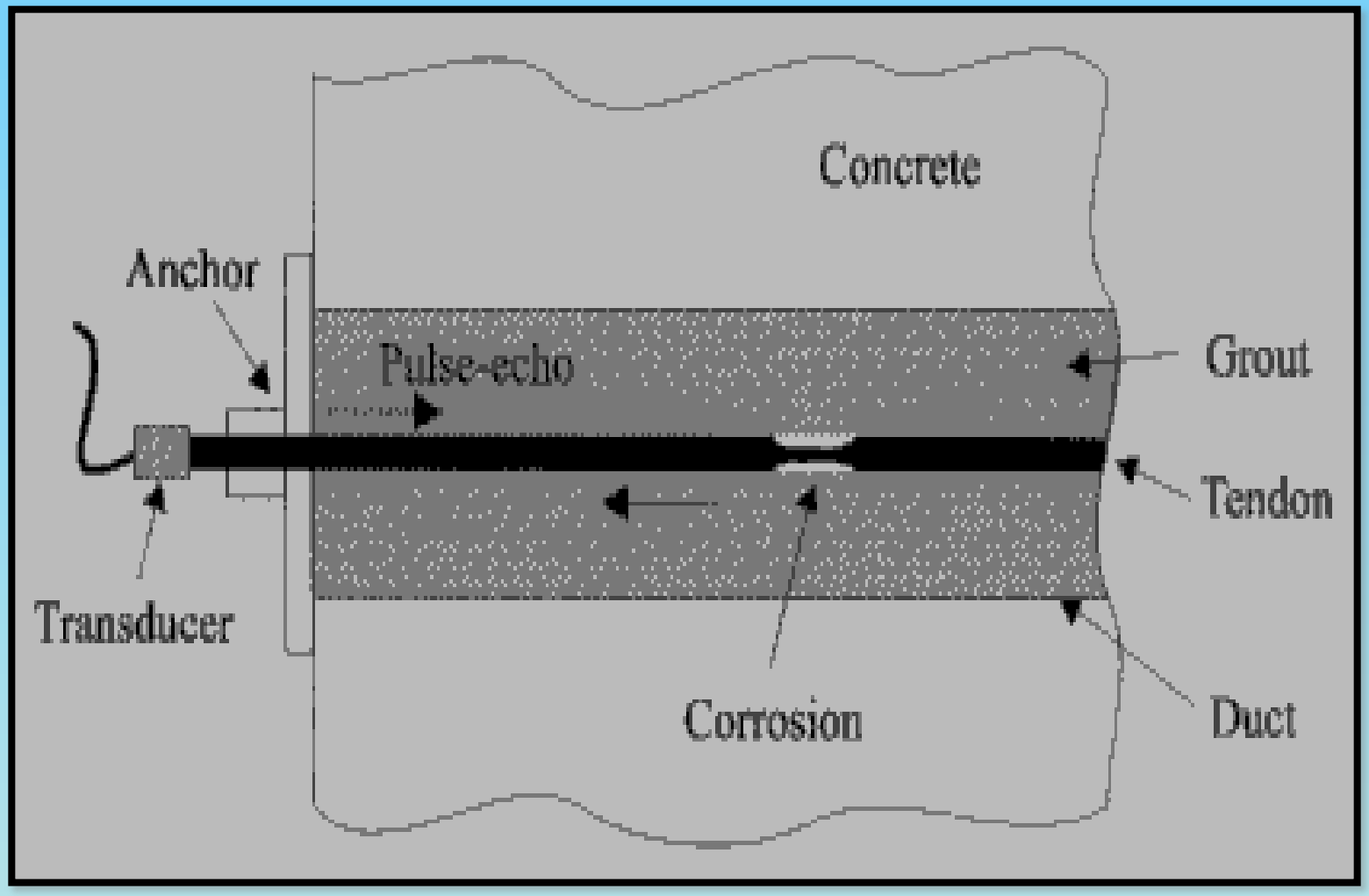
TRAINING AND CERTIFICATION OF FIELD PERSONNEL FOR UNBONDED POST-TENSIONING

LEVEL 1 - FIELD FUNDAMENTALS




pti POST-TENSIONING INSTITUTE ®

Corrosion of PT Tendons



Corroded reinforcing steel and post-tensioned anchor

Corroded Post-tensioned tendon anchor and reinforcing steel rebars

Corroded reinforcing steel rebar and Post-Tensioned tendon

Corroded Post-Tensioned Tendon

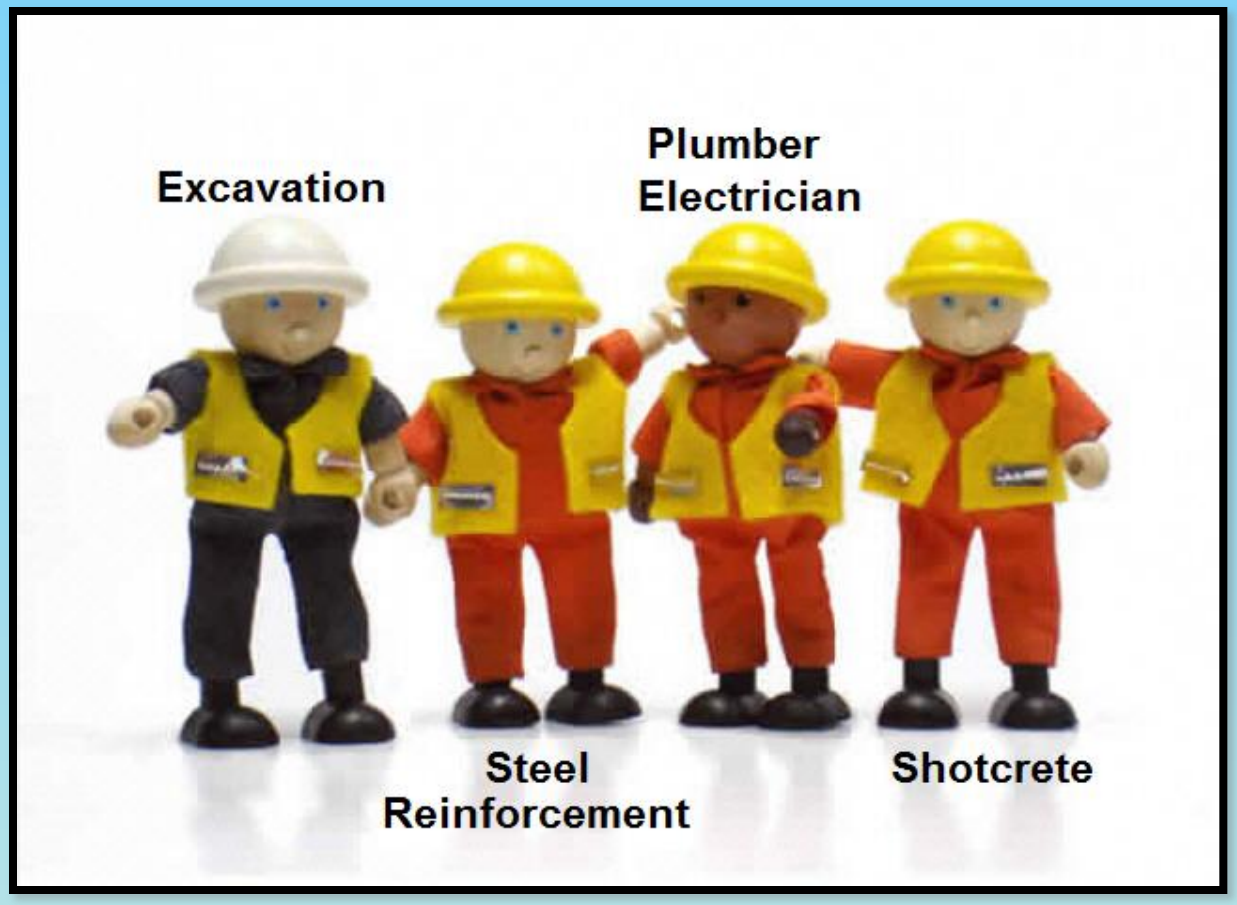
Damaged Post-Tensioned Tendons

Corroded Post-Tensioned Tendon's Anchorage Assembly

Corroded Post-Tensioned Tendon Anchorage Assembly

Corroded and Broken Post-Tensioned Tendons

Repairs to Post-Tensioned Structural Members



Concrete Chipping

Chipping of Concrete

Splicing of Tendons

Splicing of Tendons

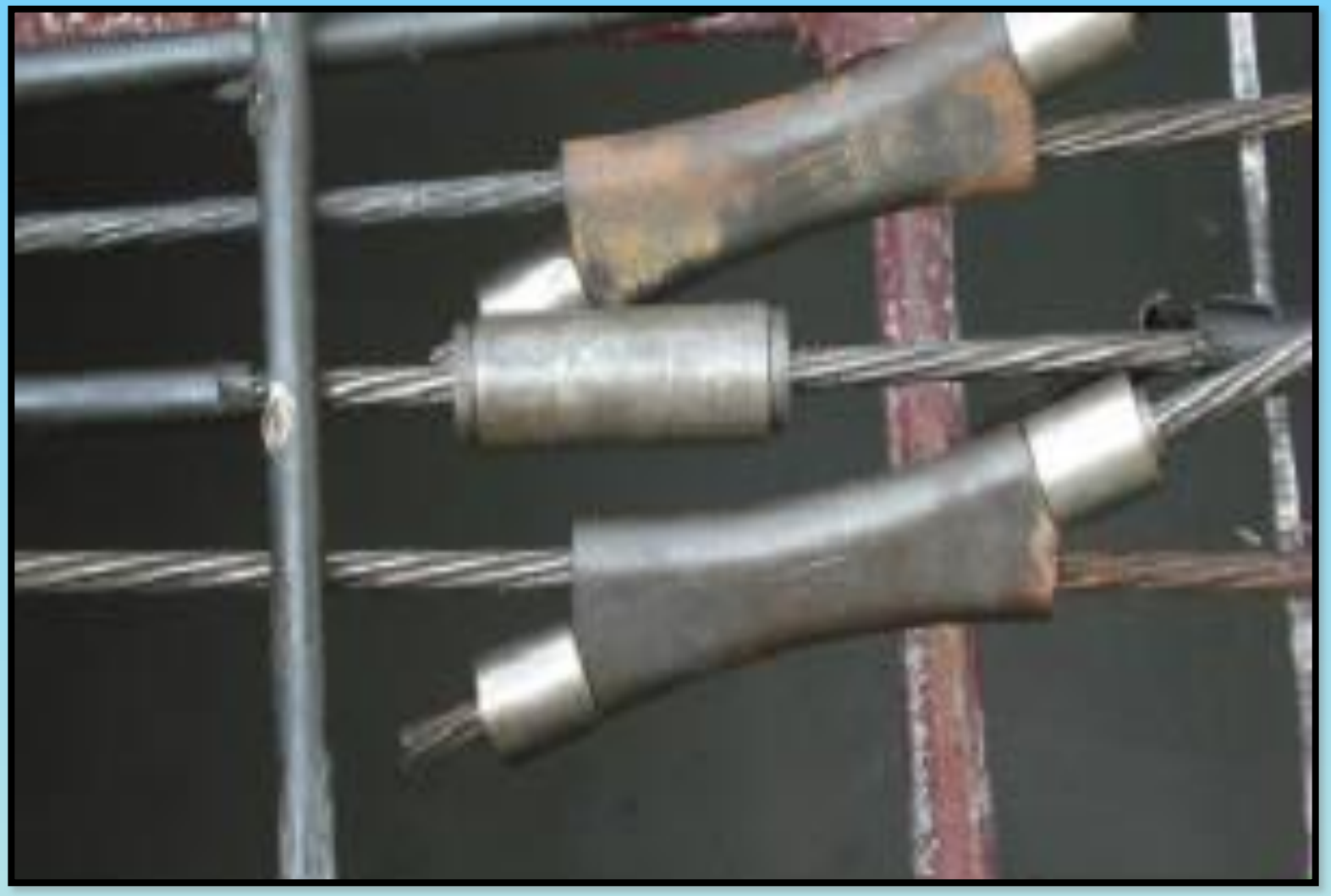
Splicing of Tendons

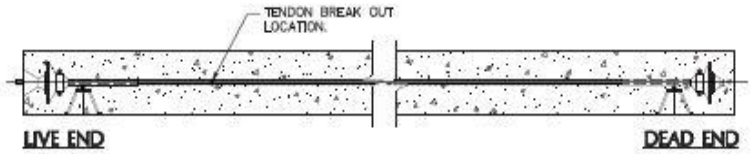
Splicing of Tendons

Splicing of Tendons

Splicing of Tendons

Splicing of Tendons



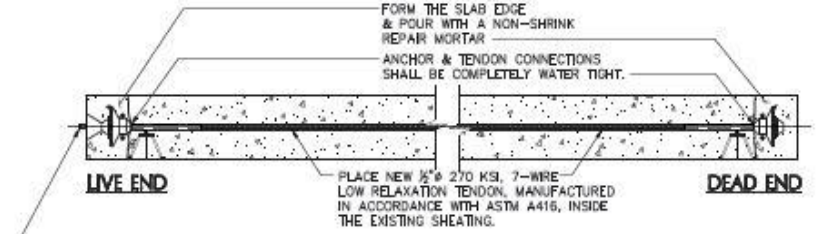


EXISTING POST TENSION TENDON CONDITION (A / SR-8)

N.T.S.

TENDON & ANCHOR REMOVAL DETAIL (B / SR-8)

N.T.S.



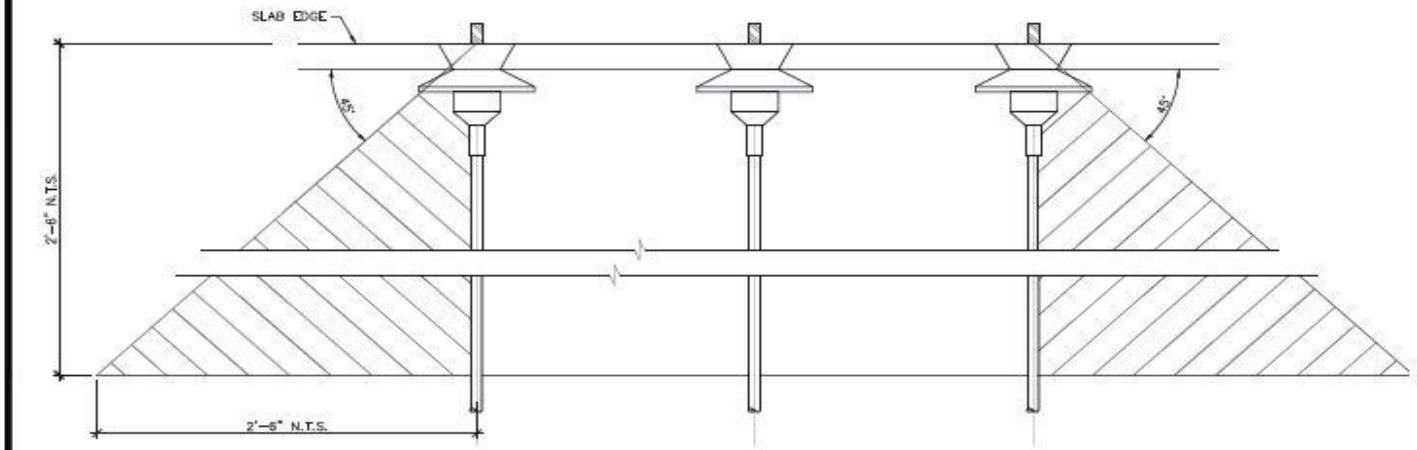
- PROVIDE NEW ANCHOR AT THE STRESSING END AS MANUFACTURED/SUPLIED BY SUNCOAST POST-TENSIONING OR APPROVED EQUAL TO MATCH EXISTING
- PROVIDE NEW DEAD-END ANCHOR BY SUNCOAST POST-TENSIONING OR APPROVED EQUAL TO MATCH EXISTING
- STRESS THE TENDON TO REQUIRED FORCE, AS PROVIDED BY ENGINEER.
- INFORMATION REGARDING EXPECTED ELONGATION WILL BE PROVIDED BY SPECIALTY ENGINEER. MEASURED ELONGATION SHALL BE WITHIN 5% OF THE EXPECTED ELONGATION.
- AFTER STRESSING CUT THE EXCESS TENDON TO ½ TO ¾ INCH FROM THE WEDGES.
- ENCAPSULATE THE ANCHOR WITH A GREASE CAP IN A WATER TIGHT MANNER.
- FILL THE GROMMET HOLE WITH NON-SHRINK, NON-METALLIC GROUT.
- APPLY STUCCO OVER THE REPAIRED AREAS & PAINT TO MATCH ADJACENT AREAS.
- ALL WORK MUST BE IN COMPLIANCE WITH THE CONTRACT DOCUMENTS & FLORIDA BUILDING CODE 2007.
- SEE POST TENSION REPAIR NOTES FOR ADDITIONAL DETAILS.

TENDON ANCHOR INSTALLATION DETAIL (C / SR-8)

N.T.S.

It's in the details!

It’s in the details!

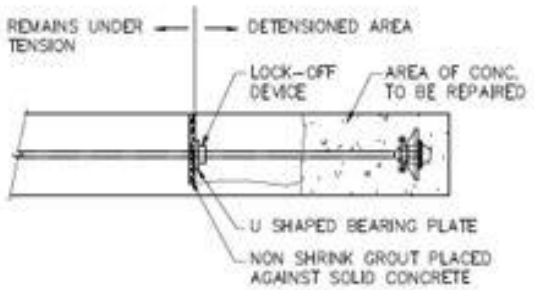


NOTES :

1. NO AREA OF CONCRETE SHALL BE REMOVED IN THE "V" SHAPED ZONE FOR 2'-6" IN BOTH DIRECTIONS.
2. DO NOT EXPOSE MORE THAN THREE TENDONS PAST THE "V" SHAPED ZONE.
3. IF REPAIRS ARE REQUIRED IN THE "V" SHAPED ZONE TENDONS SHALL BE LOCKED OFF PRIOR TO REPAIRS.
4. SEE POST TENSION REPAIR NOTES FOR ADDITIONAL DETAILS.

AREA OF RESTRICTED CONCRETE REMOVAL - DETAIL — D / SR-8

SC: 3" = 1'-0"



NOTE :

1. PROVIDE A LOCK OFF DEVICE AT LOCATION IDENTIFIED BY ENGINEER IN FIELD.
2. AFTER THE REPAIRS ARE COMPLETED, AND THE REPAIR MORTAR HAS GAINED ALLOWABLE STRENGTH, PROVIDE TENDON SPLICE COUPLER & STRESS TO ACHIEVE REQUIRED FORCE AND REMOVE LOCK-OFF DEVICE.
3. DURING THE REPAIRS LEAVE A PORTION OF SLAB SUFFICIENT TO RECEIVE TENSION SPLICE COUPLER.
4. SEE POST TENSION REPAIR NOTES FOR ADDITIONAL DETAILS.

POST TENSION LOCK-OFF DEVICE DETAIL

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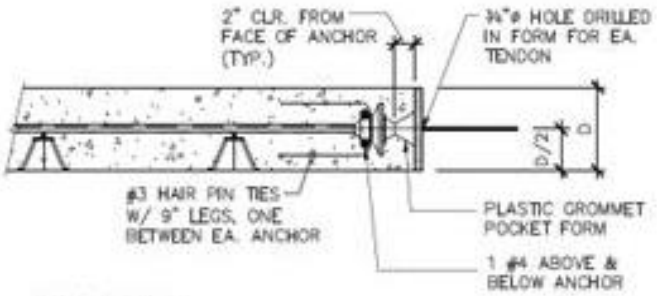
SR-8

It's in the details!



NOTES :

1. REMOVE PLASTIC CAP FROM GROMMET, POCKET.
2. LOCK OFF TENDON AT LOCATION IDENTIFIED BY ENGINEER IN FIELD.
3. REMOVE EXISTING ANCHOR AND INSTALL NEW ANCHOR.
4. PROVIDE TENDON WITH SPLICE COUPLER AND STRESS THE TENDON.
5. STRESS THE TENDON.
6. USE HYDRAULIC SHEARS OR GRINDERS TO TRIM EXCESS TENDON TO ½" TO ¾" FROM THE WEDGES.
7. PROVIDE PLASTIC CAP WITH GREASE ON TOP OF ANCHOR ASSEMBLY.
8. ENCAPSULATE THE ANCHOR WITH A GREASE CAP IN A WATER TIGHT MANNER.
9. FILL THE GROMMET HOLE WITH NON-SHRINK, NON-METALLIC GROUT.
10. APPLY STUCCO OVER THE REPAIRED AREAS & PAINT TO MATCH ADJACENT AREAS.
11. ALL WORK MUST BE IN COMPLIANCE WITH THE CONTRACT DOCUMENTS & FLORIDA BUILDING CODE 2007.
12. SEE POST TENSION REPAIR NOTES STRESSING END ENCAPSULATION SYSTEM FOR ADDITIONAL DETAILS.

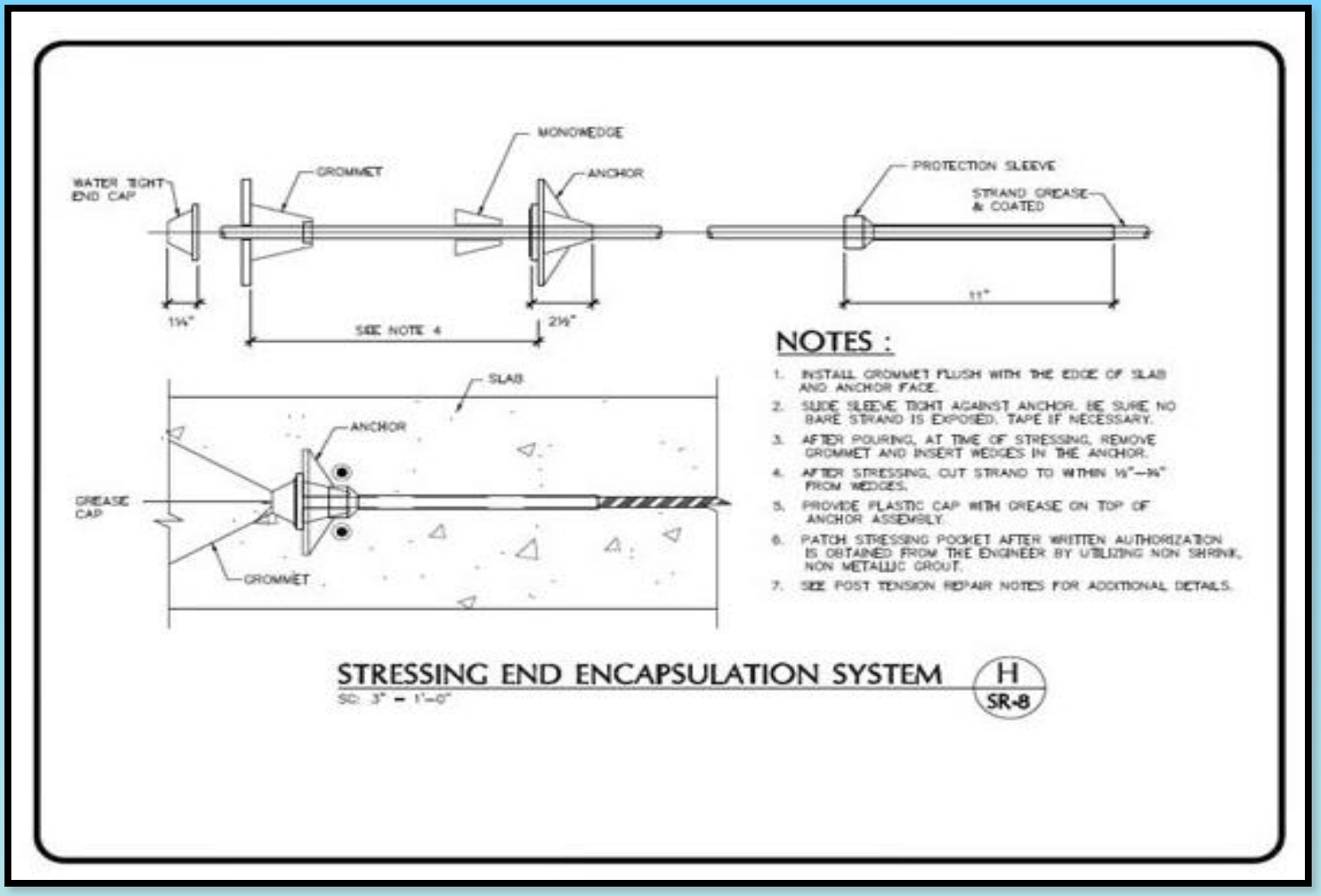
TYPICAL POST TENSION ANCHOR REPLACEMENT DETAIL

SC: 1" = 1'-0"

F
SR-8

It's in the details!

It’s in the details!

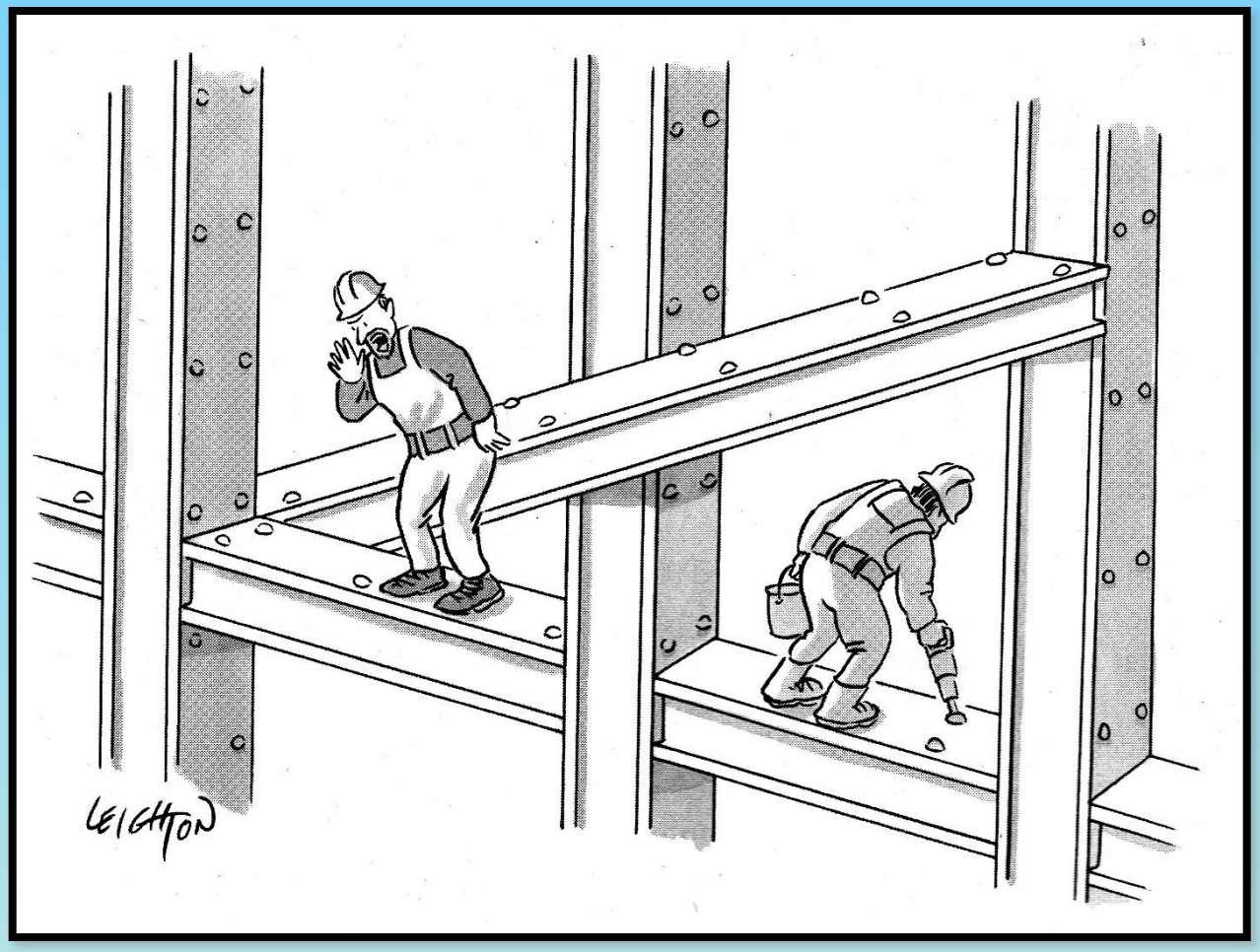


Reinforced Concrete High-Rise

Typical structural repairs to High-Rise Building using swing stage

Typical repair of High-Rise Building using swing stage

Do Not Make Mistakes



Concrete Repair Steps and Effects

- Removal of damaged Concrete by Chipping
  - Follow Engineer of Record's direction
  - Extent of concrete chipping – Limits of Corrosion
  - Follow ICRI Recommendations – Vertical and horizontal surface

- Reinforcing steel rebars cleaning
  - Sand blast
  - Powered wire brush

- Coating of concrete surface and steel rebars with rust inhibitor and bonding agent

Placement of the Repair Mortar

Selection of repair mortar

Repair Material adhesion (Bond) with substrate

Mechanical Bond

- **Roughen substrate – sandblasting, shot blasting, scarifying, water blasting & jetting and hammer chipped surfaces**
- **Open cavities of substrate – Interface texture**
- **Capillary absorption**
- **Substrate moisture condition – Optimal Moisture contents only**

Chemical Bond
Bonding Agent

Properties of Repair Material

Mechanical Bond

- **Early age strength and bond durability**
- **Shrinkage compensated – Non Shrink repair mortar**
- **Workability, compaction and consolidation**
- **Horizontal, vertical and overhead repairs**

Concrete Repairs - Steps and Effects

- Hardened repair material
  - Directly influence the bond strength
  - Development of stresses due to shrinkage
  - Elastic modulus, Thermal coefficient, Creep, Permeability
  - Concrete carbonation

- Substrate Temperature
  - At the time of repair mortar placement has significant effect on shear strength

- Curing of repaired areas.

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