October 17, 2023
ICRI 2023 Fall Convention

Maintaining *Structural Safety* and Avoiding Defects a Part of the the Pre-Planning Process

Jay Thomas
Vice President
Structural Group

What is Structural Safety?

Avoiding a structural collapse
- Overloading
- Shoring errors
- Major defects- design, workmanship, materials
- Demolition, coring, etc.

Damaging the structure
- From same items above

Ensuring that the structure is repaired to the designed capacity

Structural Safety issues that create personnel safety for people onsite during construction

Maintaining Structural Safety as Part of the Pre-Planning Process

GOAL:

1. Recognize structural problems before they occur by knowing the typical errors that cause them

2. If problems occur, recognize typical signs of structural distress (understanding structural cracks vs non-structural)

3. How to incorporate Structural Safety in your Pre-planning Process

AGENDA

Most common contributors to Structural Safety situations

How is reinforced/PT concrete designed- *Eng. 101 for Contractors*

Safe loading of structures during construction- OVERLOAD

Understanding the purpose of typical steel placement

What if that steel is set in the wrong place?

- *Too high, low or close*

Avoiding concrete placement errors- Honeycombs & Voids

Structural Safety issues to avoid when:

- *Cutting, coring, chipping, drilling concrete*

Avoiding Shoring/Re-shoring & early loading of slab errors

Repair strategies if Structural Safety or defects occur

How do we incorporate Structural Safety in your Pre-planning Process

Proper Shoring & Re-shoring

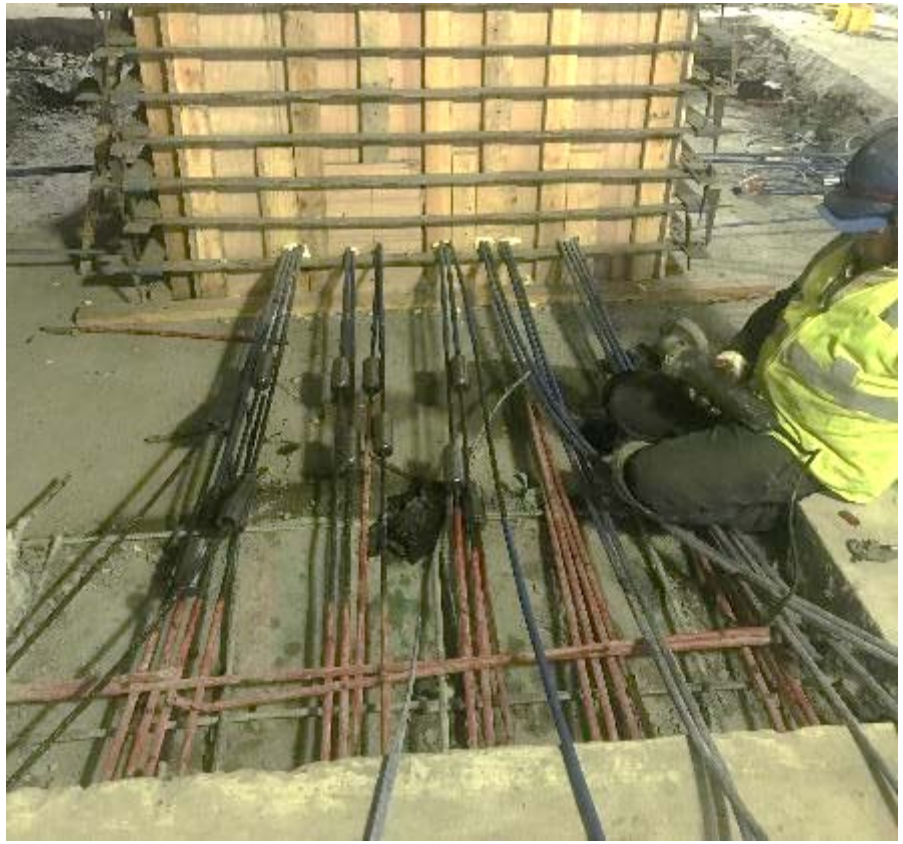
Overloading Structures With Construction Materials, Equipment and Debris *With No Preplanning*

DAMAGED

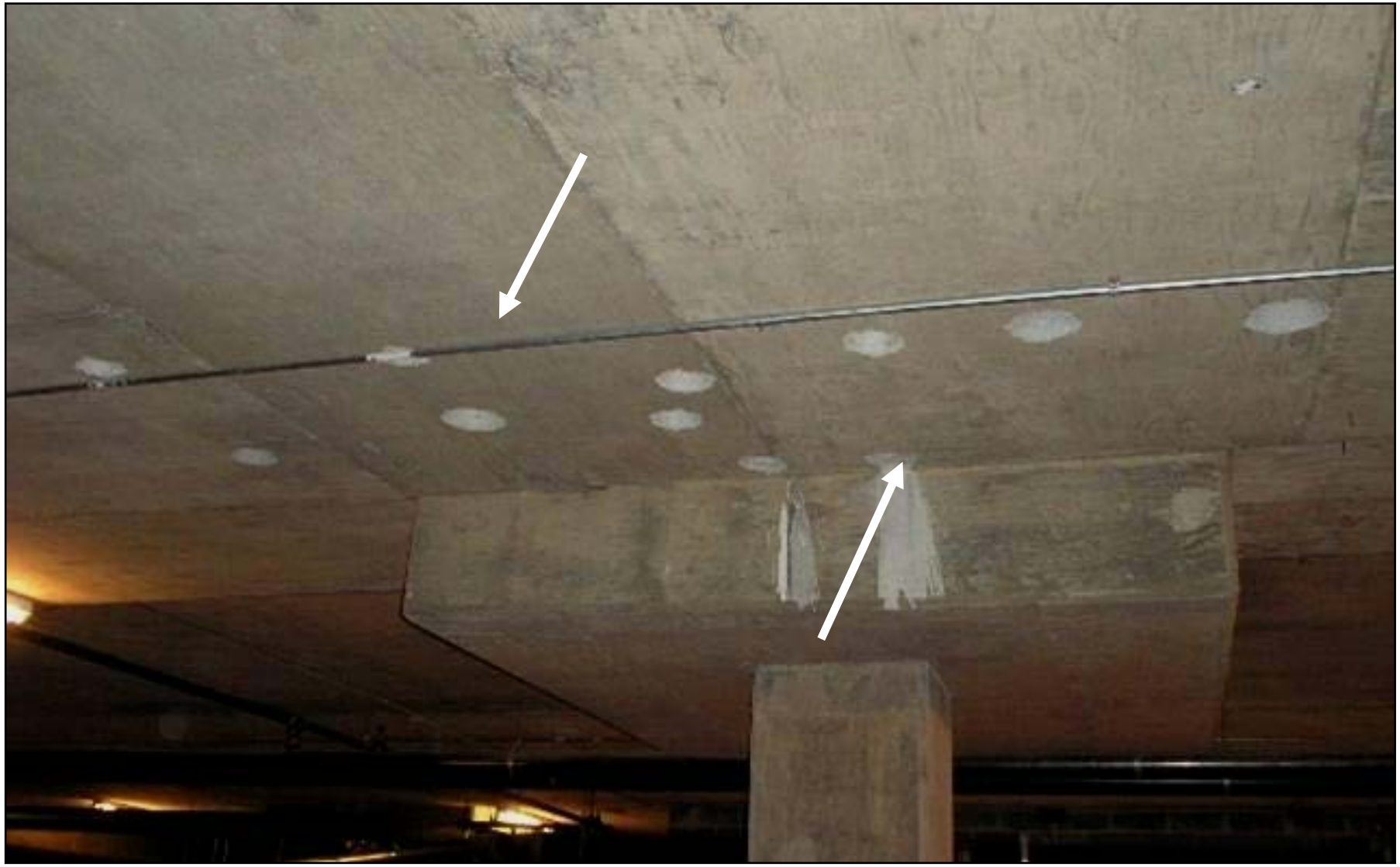
FAILED

Pre-Pour Checklist

With No Sign Off



Cut, Core, Chip, and Drill Concrete
With NO Preplanning to Avoid Structural Safety Problems



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Maintaining Structural Safety Starts With These CONCEPTS:

-For structural problems there is no such thing as a *"Little Mistake"*

-On almost every project w/major structural defect someone said:

"I have built this before & something looks different this time…"

"I knew something was wrong BUT I am not a structural engineer…"

or "I was told it was OK"

NOT ASKING OUR PEOPLE TO MAKE LDP DECISIONS

WE ALL HAVE PERSONAL TRAINING SAFETY PROGRAMS

BASED ON A *SEE SOMETHING-SAY SOMETHING* CONCEPT

DO THE SAME FROM A STRUCTURAL PERSPECTIVE

AGENDA

What are the most common defects?

How is reinforced/PT concrete designed- *Eng. 101 for Contractors*

Safe loading of structures during construction- OVERLOADING

Understanding the purpose of typical steel placement

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Incorporating Structural Safety in your Pre-planning Process

How is Reinforced Concrete Designed?

"How do you design a slab that SPAN 30 feet and can carry 60psf LOAD"

Equilibrium

Section Properties

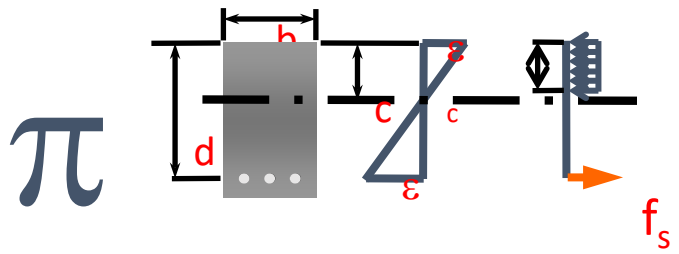
"Yield"

$\sum f + 3\sigma$

$WL^2/24$

Moment

Strain Compatibility



Basic engineering concepts are ***not complex***

Basic mechanics can explain most engineering concepts

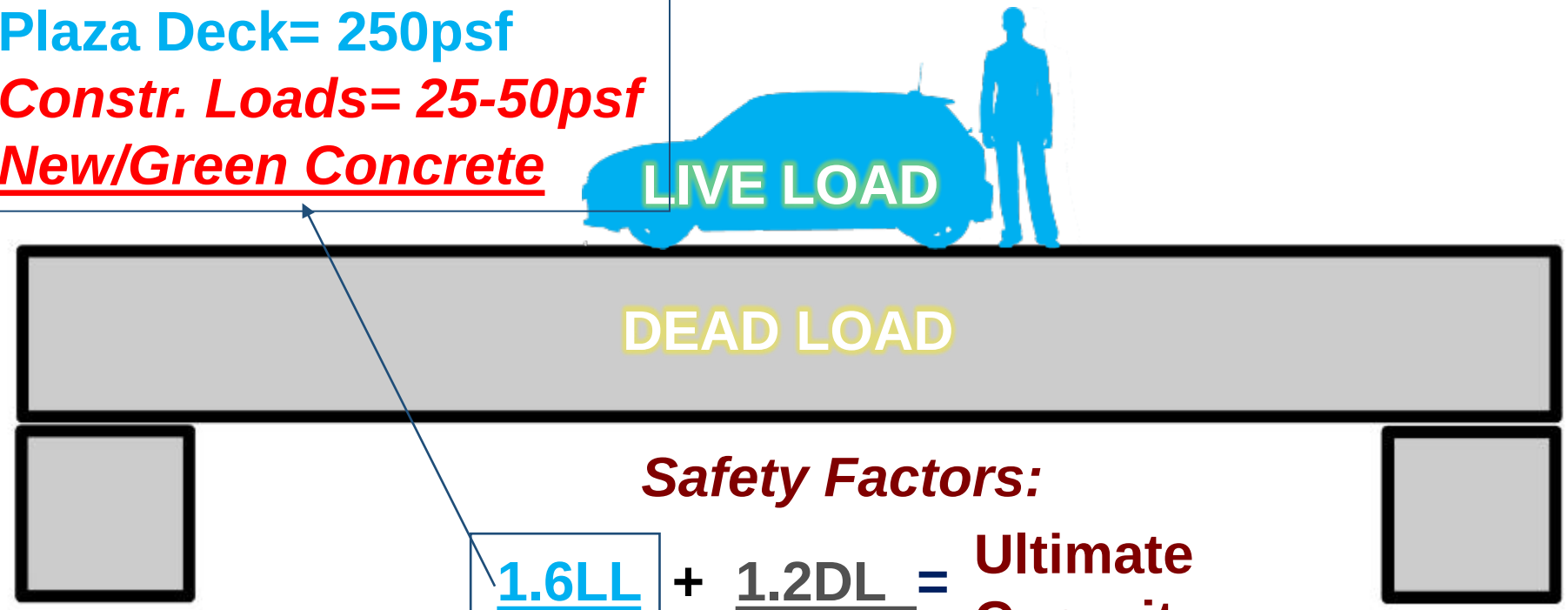
Explain them today using a Foam Beam instead of Formulas

WHO IS RESPONSIBLE AND IS THERE A PROCEEDURE?
Someone with the your company GC, Sub, EOR, Inspector?

Safety Rule

Typical Loads and Safety Factors in Concrete Design

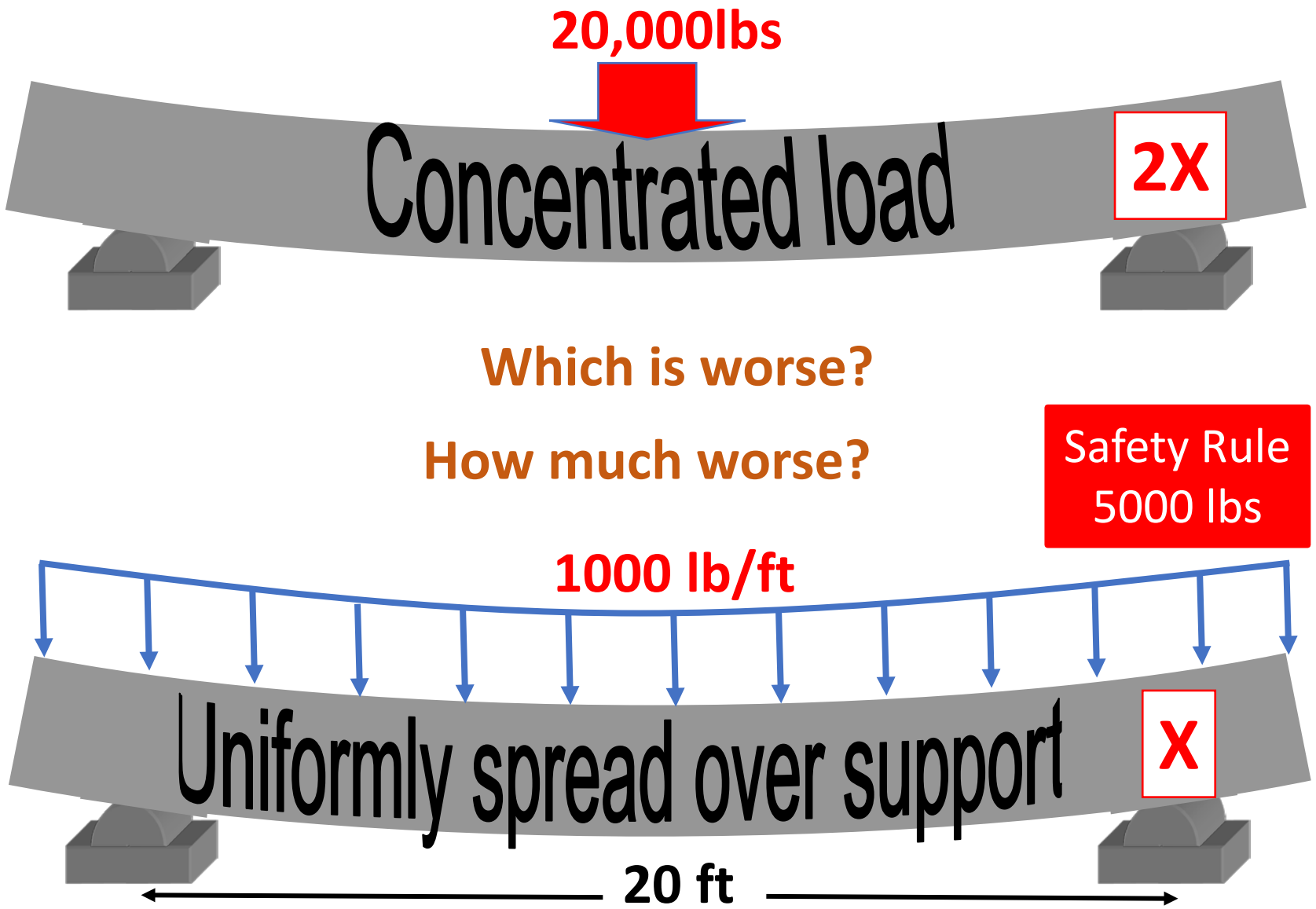
Standard Live Loads:
Parking= 50psf
Condo = 60psf
Office = 60-100psf
Lobby = 100psf
Mech/Elect= 150-200psf
Plaza Deck= 250psf
Constr. Loads= 25-50psf
New/Green Concrete



Safety Factors:

1.6LL + 1.2DL = Ultimate Capacity

Uniform Loads Are Different Than Concentrated Loads



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Need a Structural Safety Planning for Staging Materials

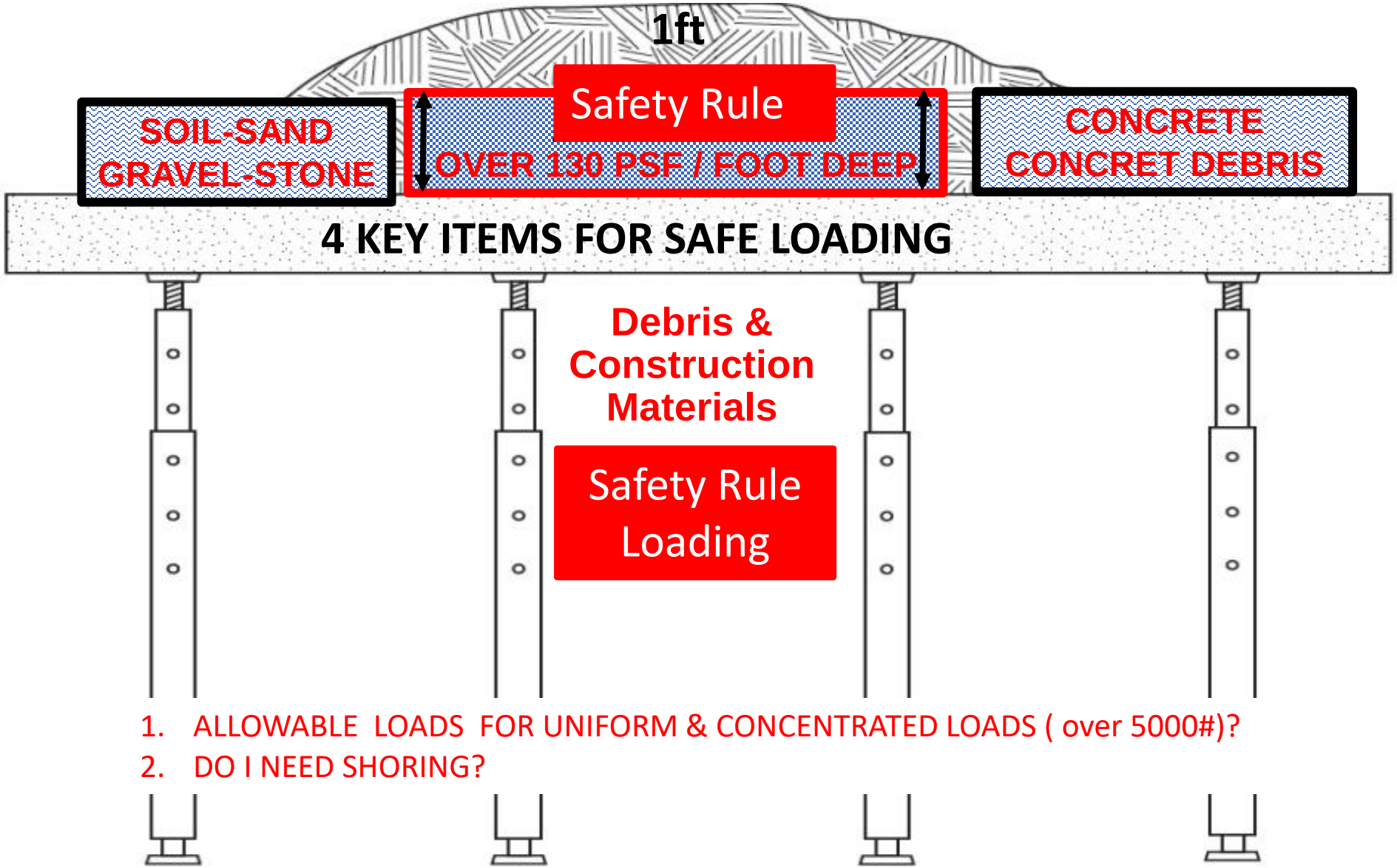
Uniform-1X

Concentrated- 2X

Ever have this happen?

WHO IS RESPONSIBLE? DO YOU HAVE A PRE-PLANNING PROCESS?

HOW DO I DETERMINE ALLOWABLE LOADING?...ASK an ENGINEER!

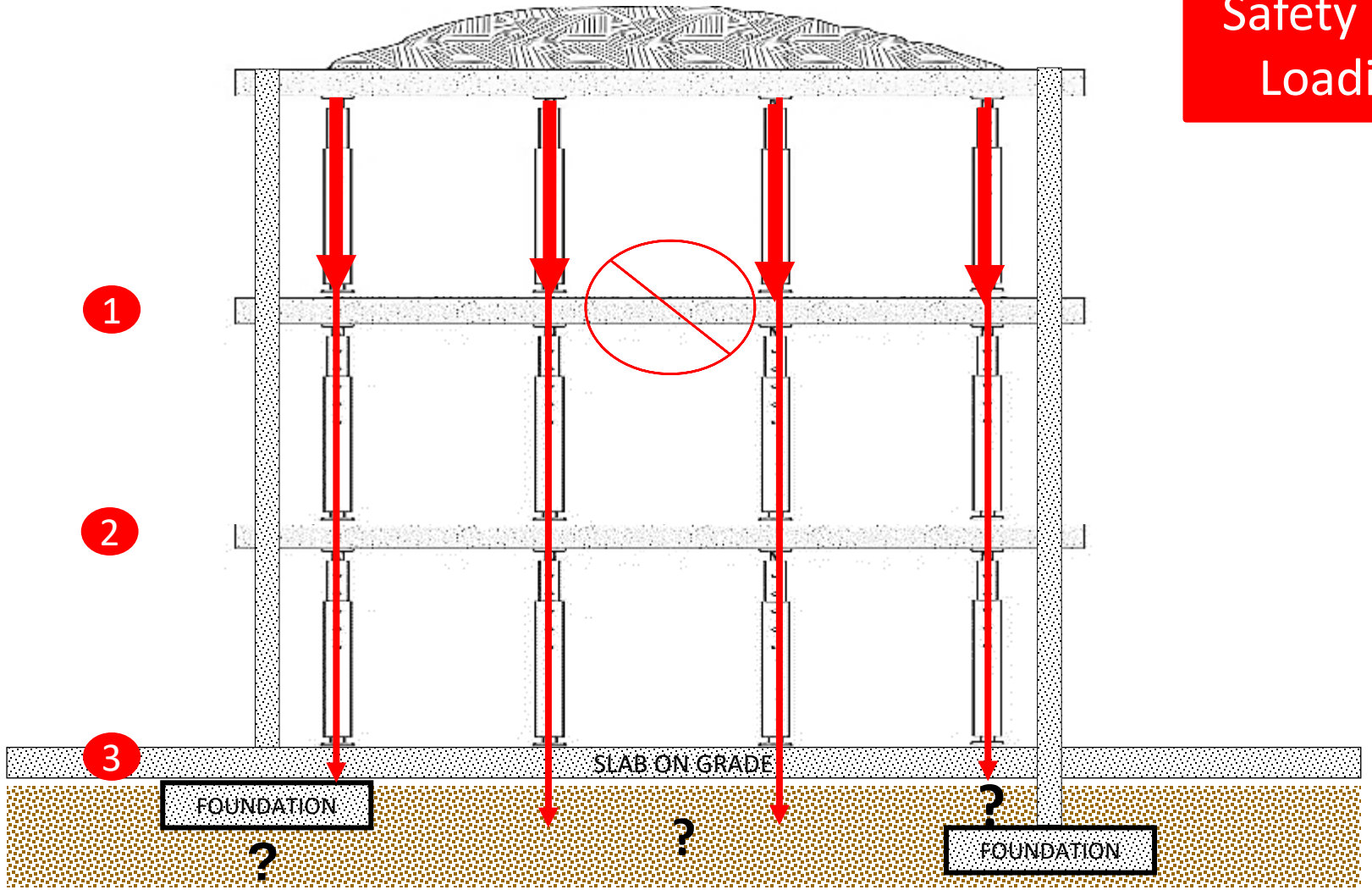


1. ALLOWABLE LOADS FOR UNIFORM & CONCENTRATED LOADS (over 5000#)?
2. DO I NEED SHORING?

HOW DO I DETERMINE ALLOWABLE LOADING?...ASK an ENGINEER!

3. DO I NEED MULTIPLE LEVELS OF SHORING?

Safety Rule
Loading



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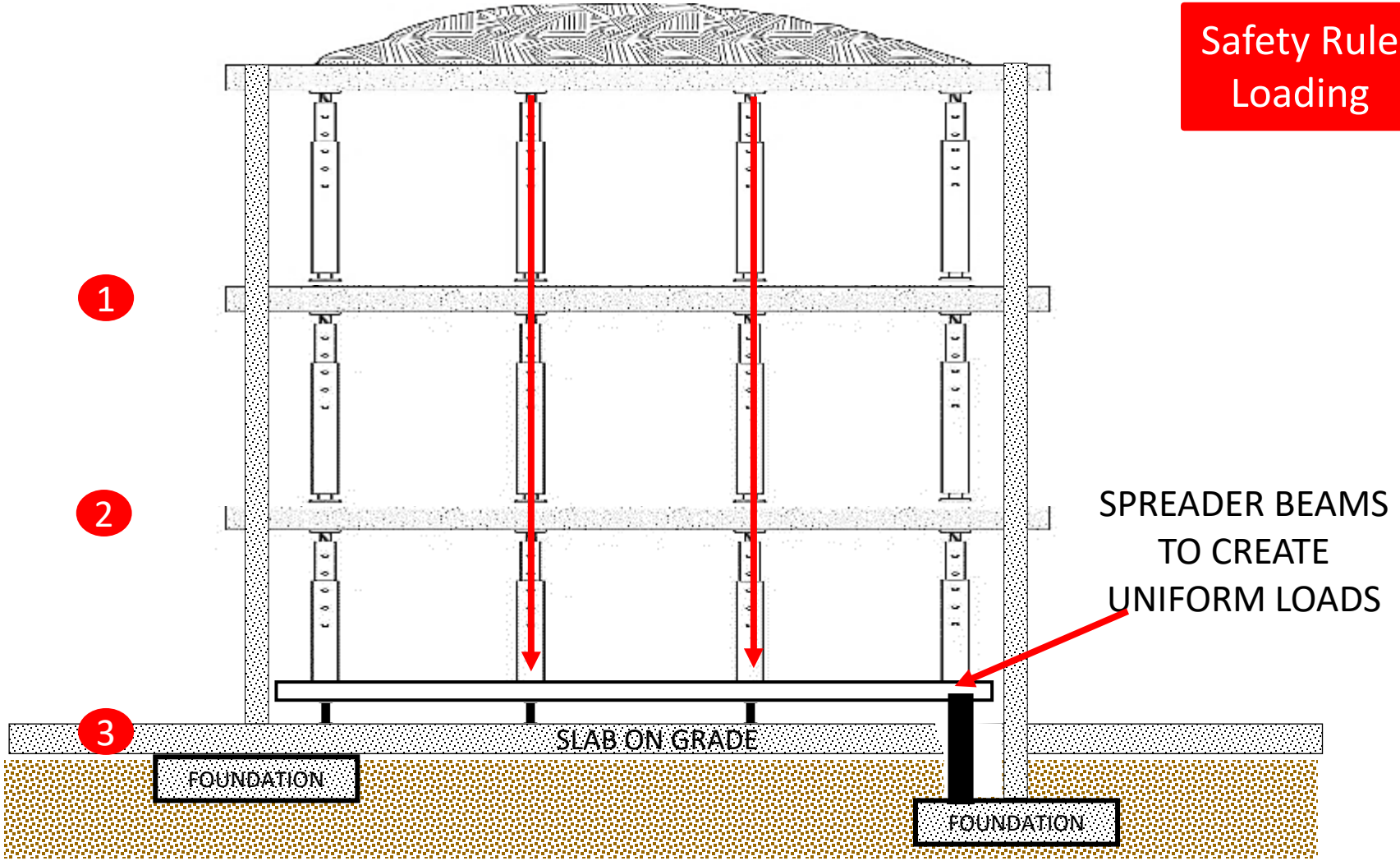
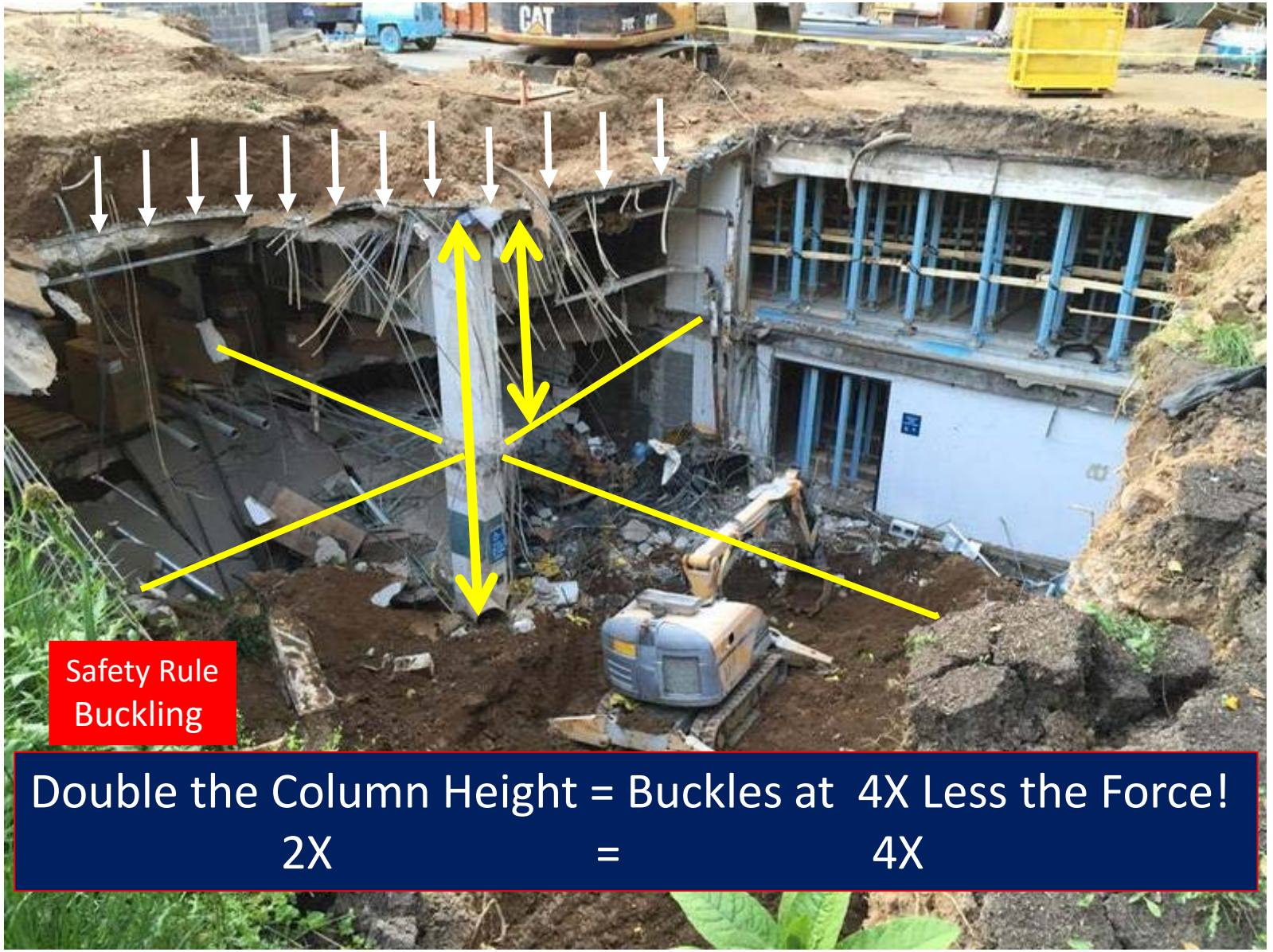
HOW DO I DETERMINE ALLOWABLE LOADING?...ASK an ENGINEER!

4. DO I NEED TO SPREAD THE LOAD OUT AT THE BOTTOM ?

Safety Rule
Loading



Slab Overload Failures & Column Buckling Can Happen!



Construction Overloading

“Progressive Collapse”

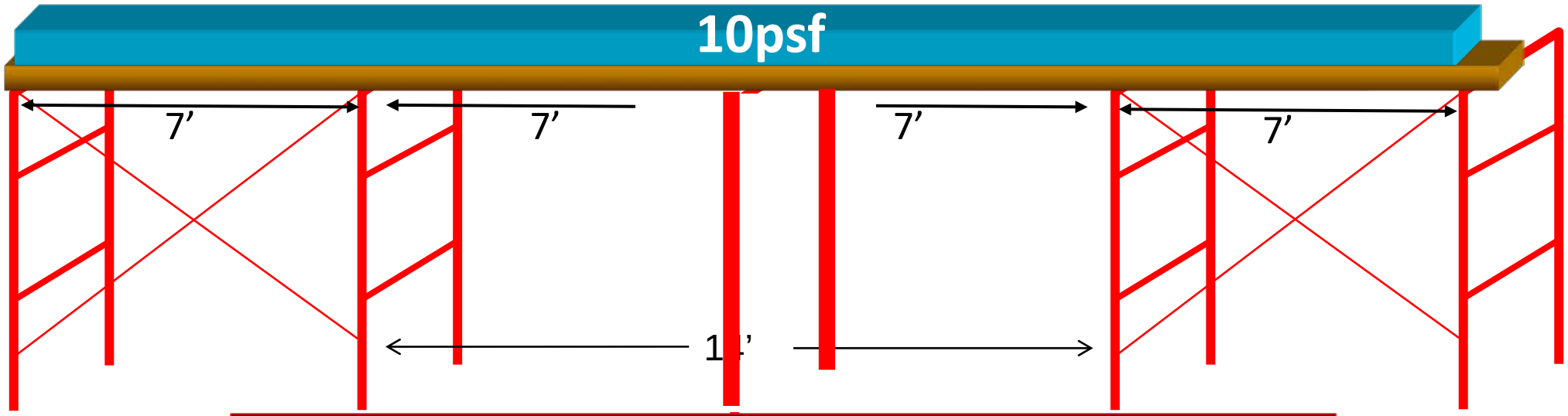
What is the Structural Effect of INCREASING Span Length

EXAMPLE: Continuous Scaffold PLATFORM on 7-foot span Frames with 10 PSF Load

Force on each 7 foot span= $WL^2/24$ (W= Load, L= Span)
= Load X *Span X Span* ÷ 24

10psf X 7’ X 7’ ÷ 24= **20**

10psf X 14’ X 14’ ÷ 24= **80**

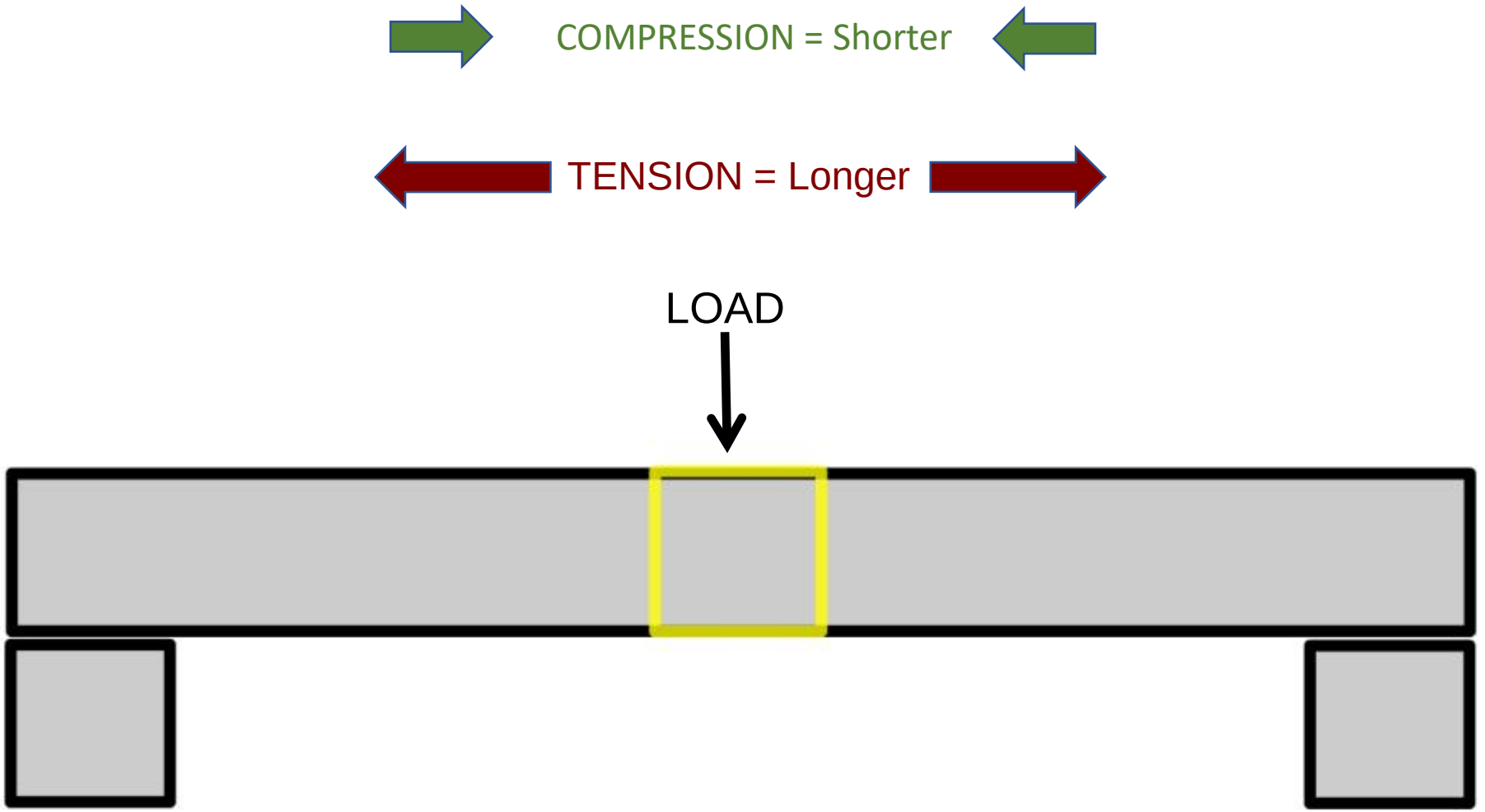


Safety Rule + Spans

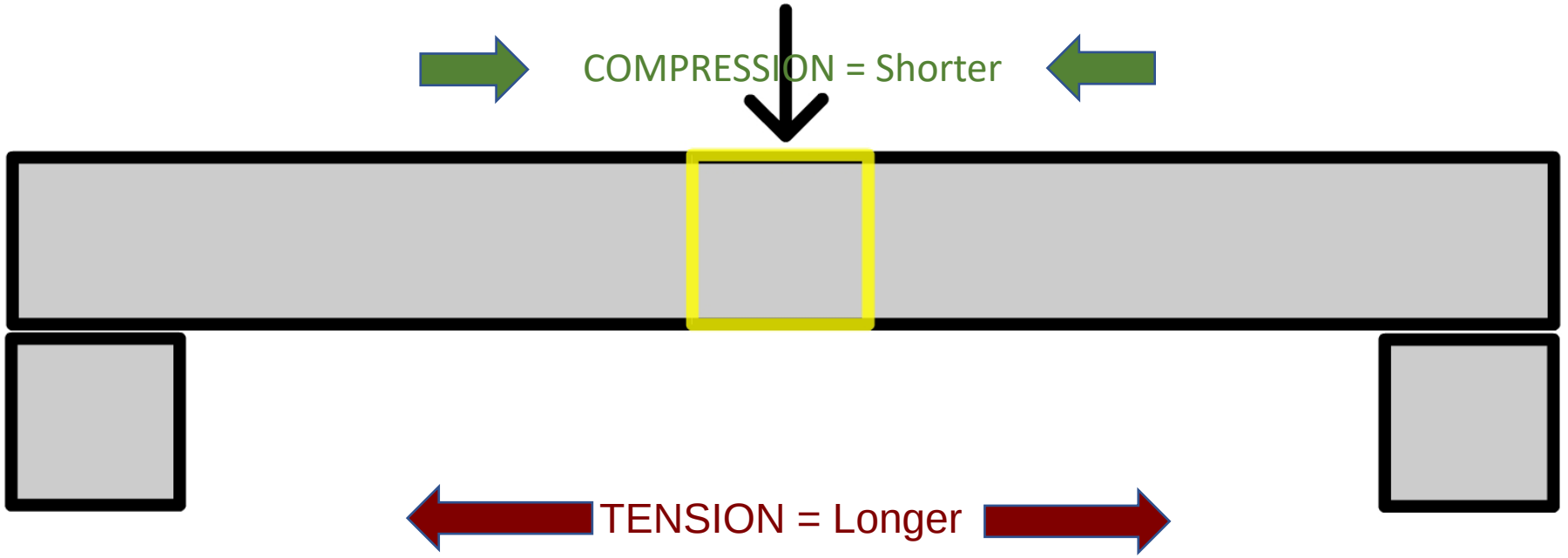
Double the Span = 4 Times the Force! 2X = 4X

Half the Span = ¼ the Force! 1/2X = 1/4X

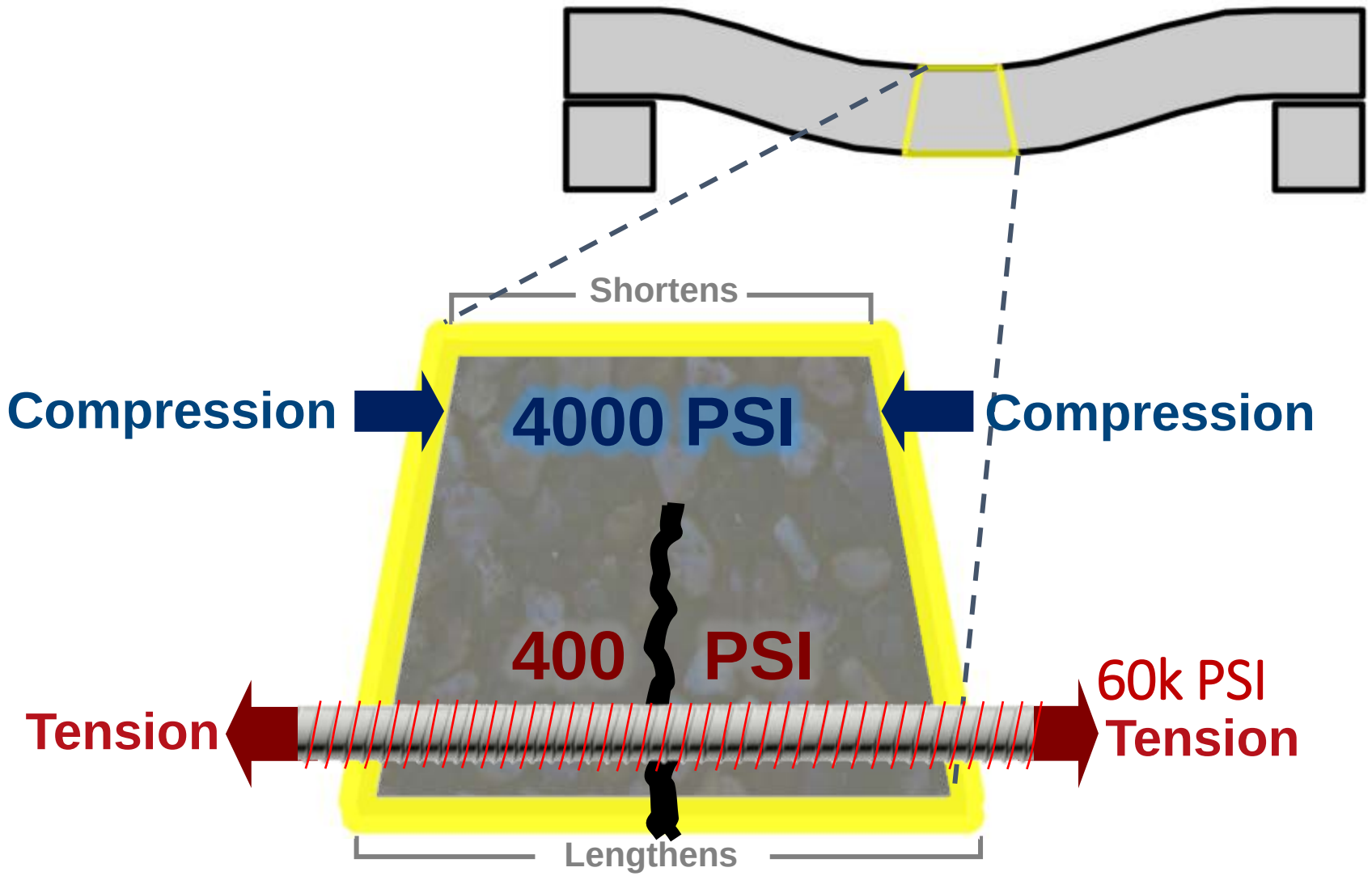
Understanding compression & tension



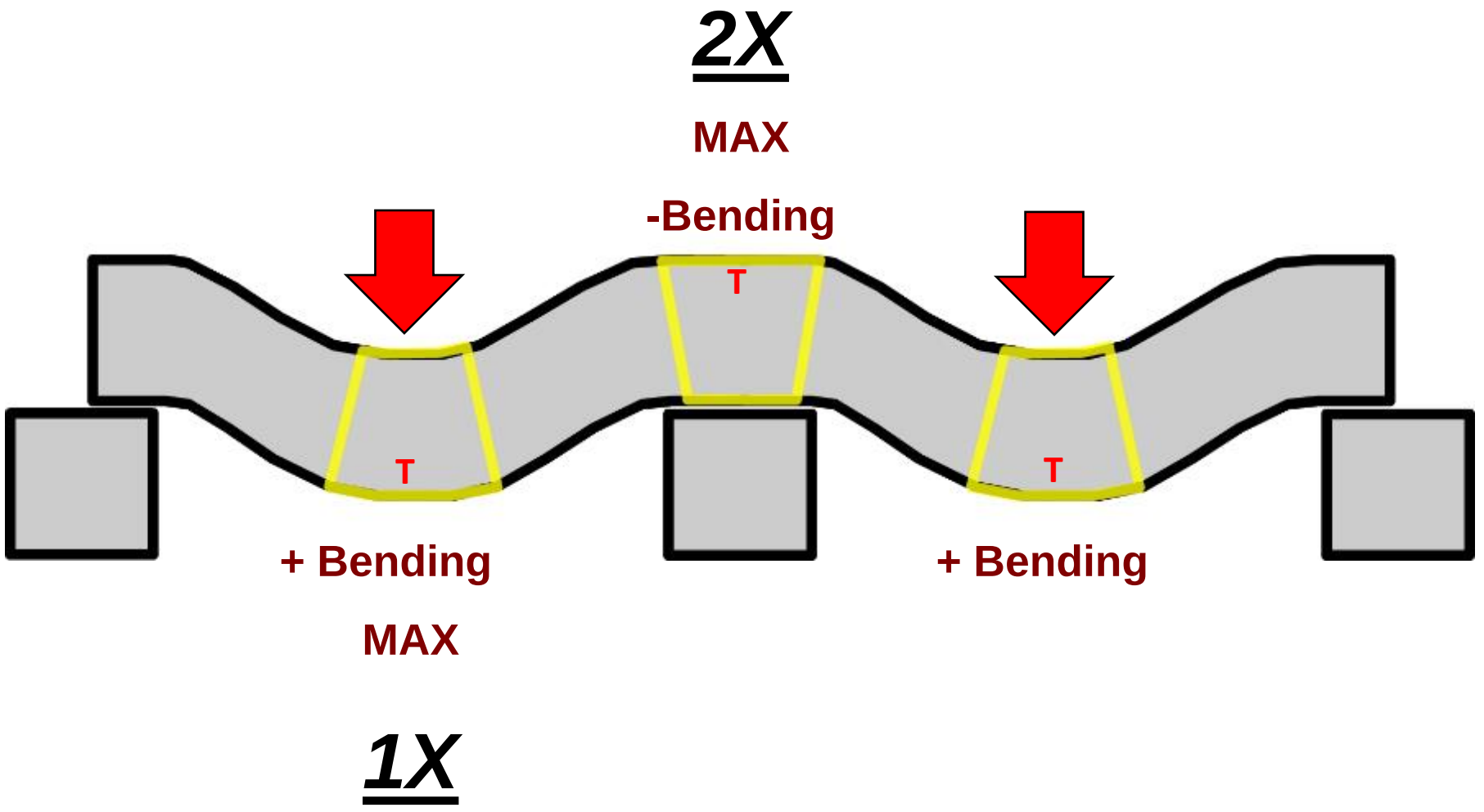
Understanding compression & tension



Understanding compression & tension



Understanding compression & tension forces on multiple spans



What are the most common defects?

How is reinforced/PT concrete designed- *Eng. 101 for Contractors*

Safe loading of structures during construction- OVERLOAD

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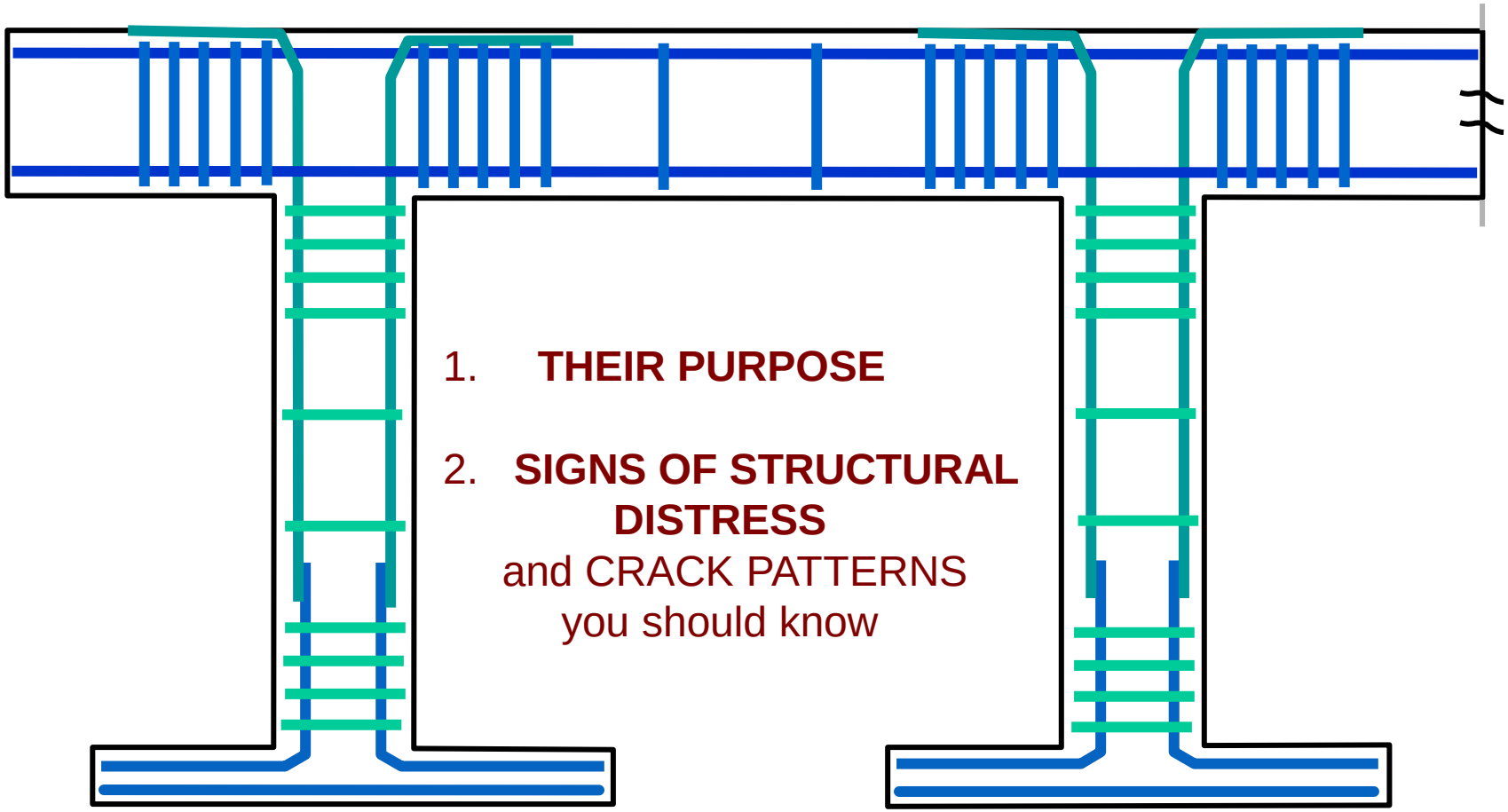
Repair strategies if Structural Safety or defects occur

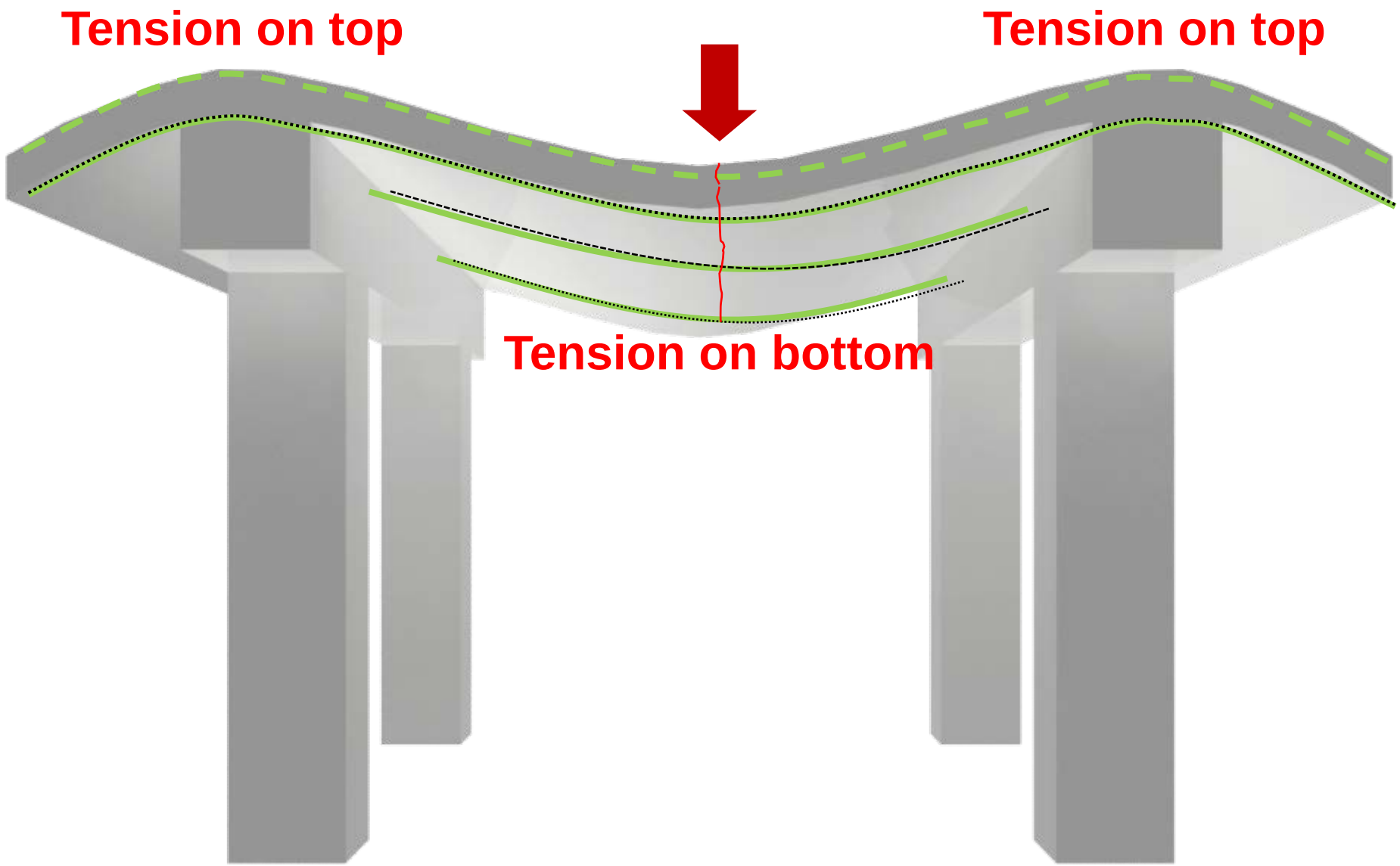
Incorporating Structural Safety in your Pre-planning Process

Understanding Typical Steel Placement

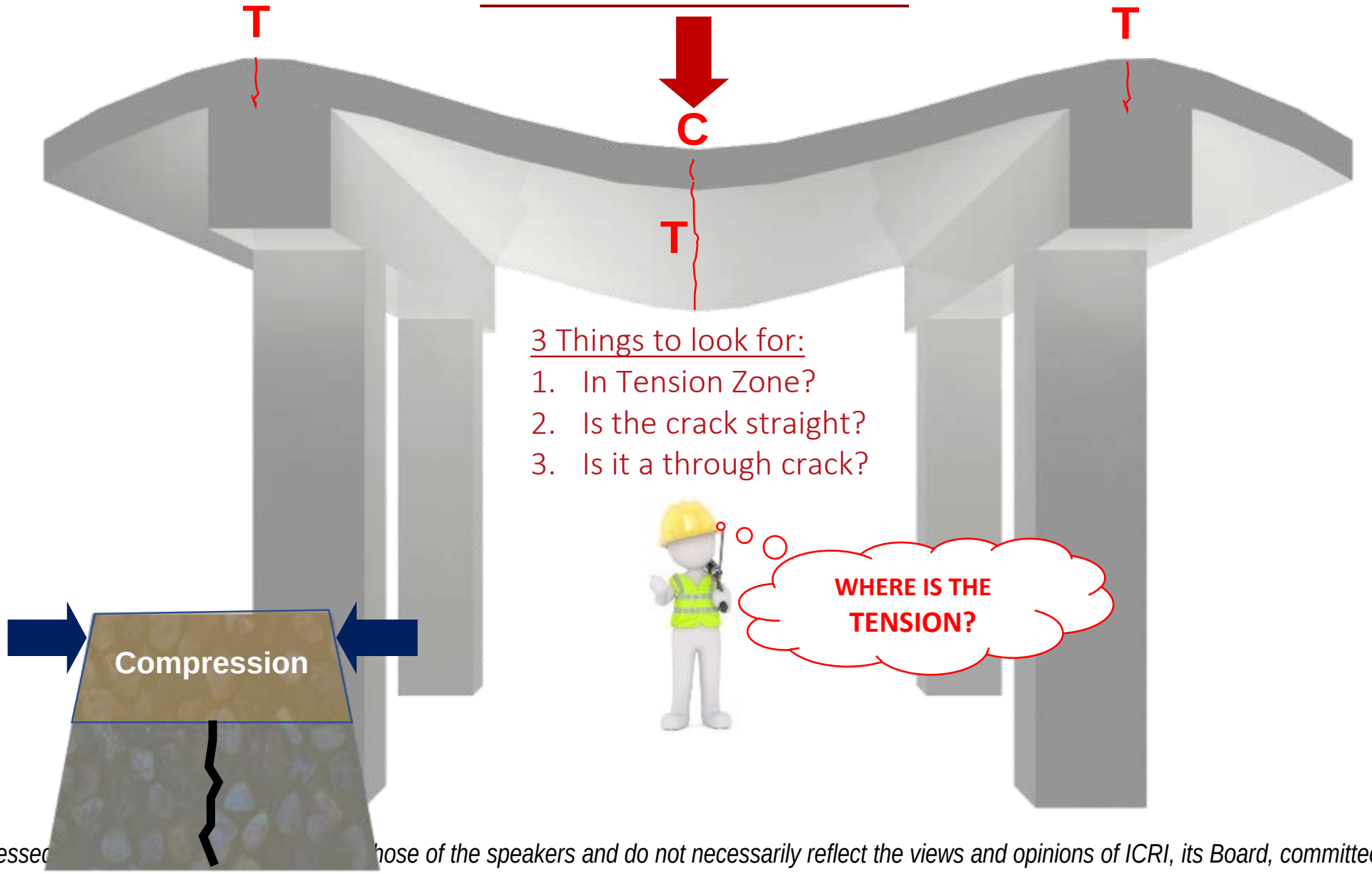
Reinforcement in Beams, Slabs, Columns, and Shear Walls



Steel placement in “1 Way” Slab to resist + & - bending forces



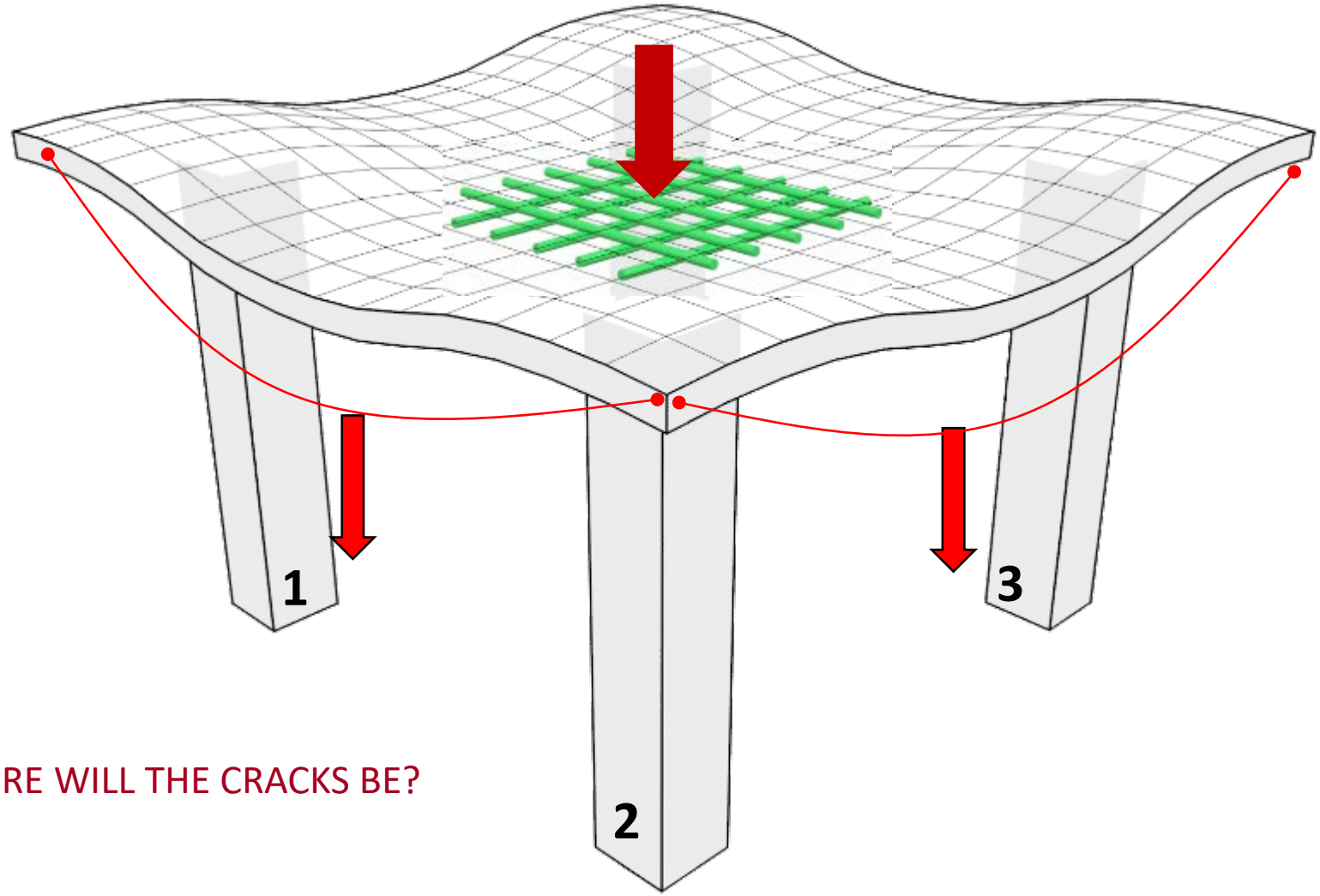
Identifying Signs of Structural Distress:
What do *STUCTURAL CRACKS* look like?



3 Things to look for:

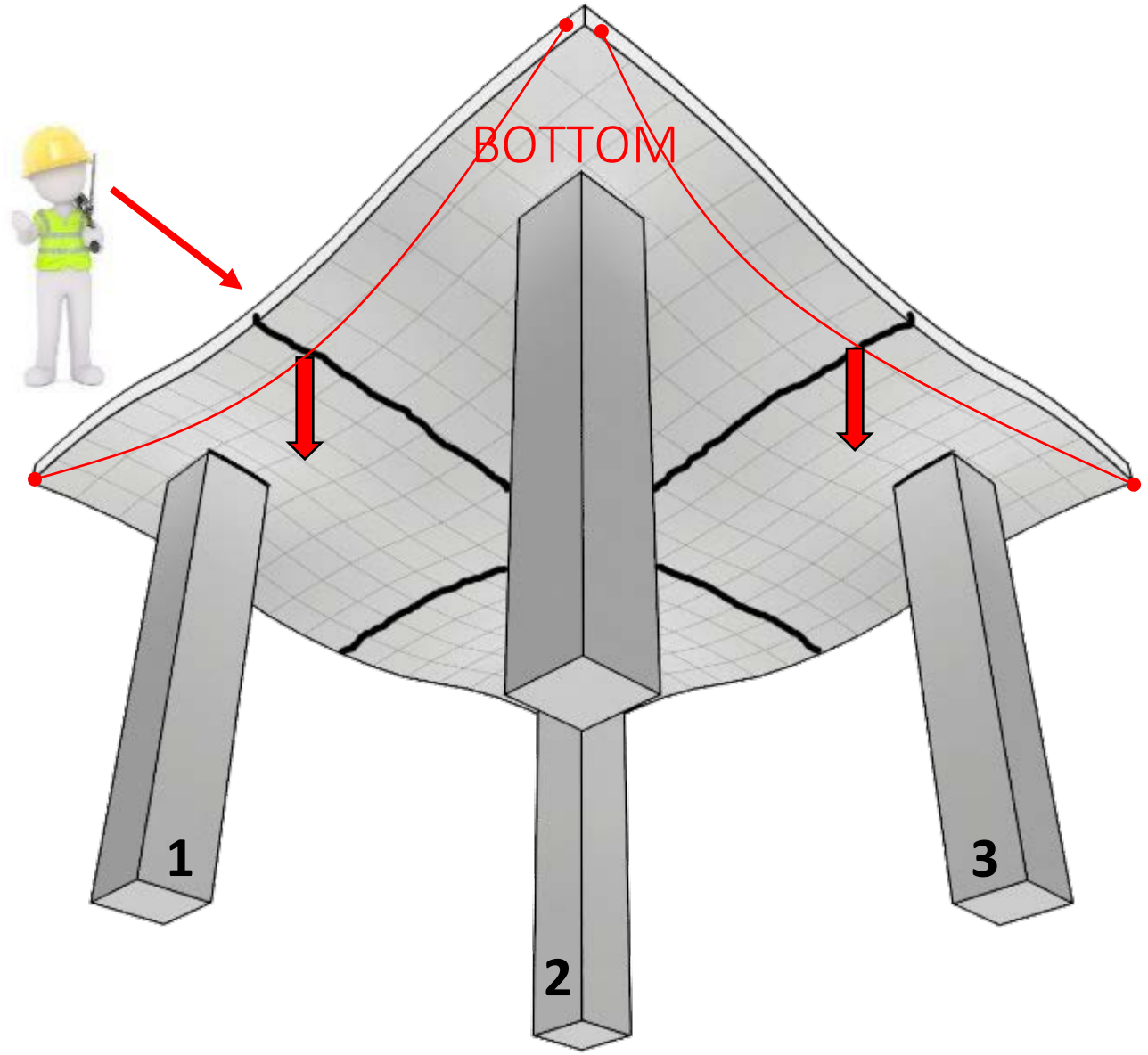
1. In Tension Zone?
2. Is the crack straight?
3. Is it a through crack?

Steel placement in “2 Way” Slab to resist + bending forces

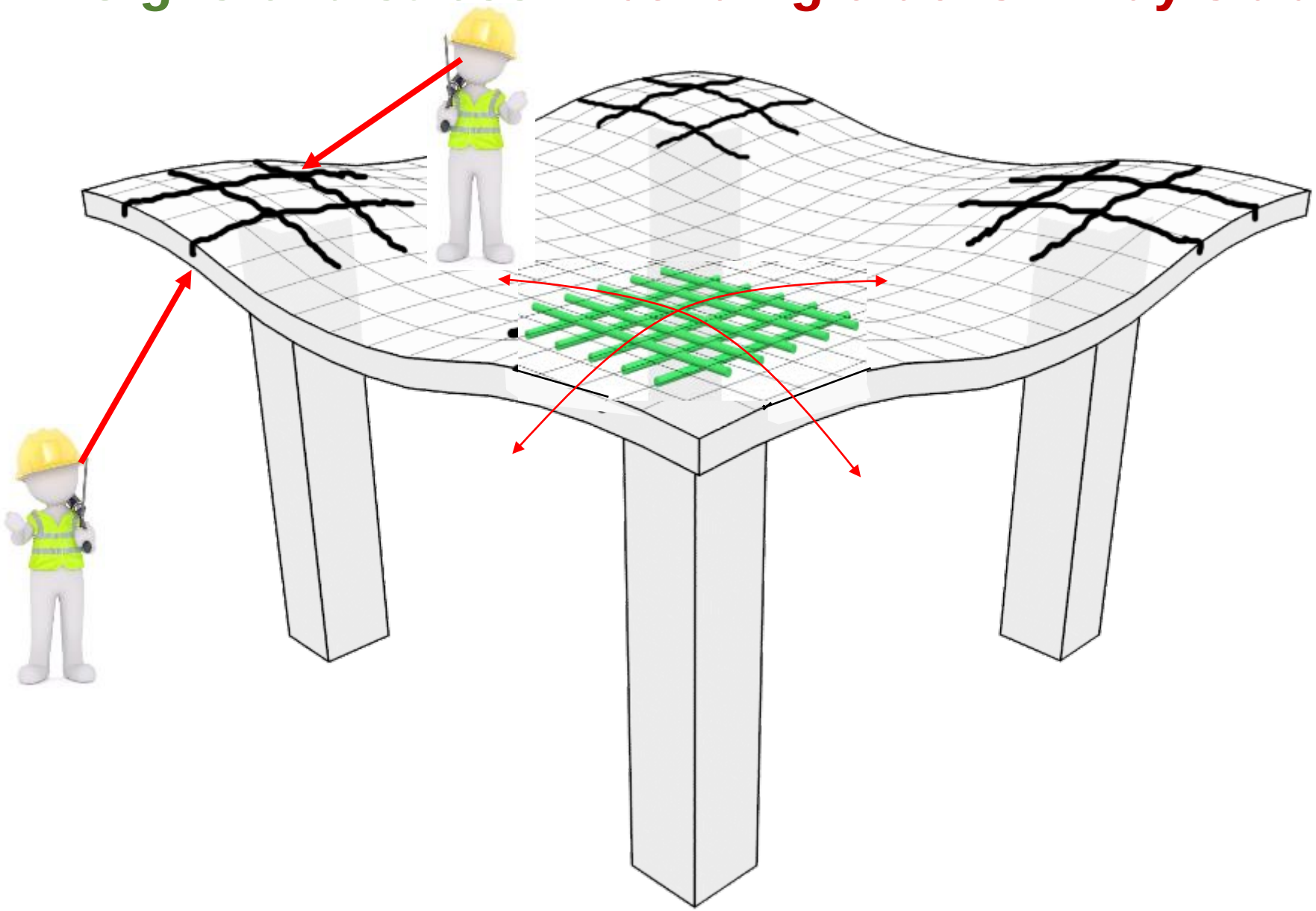


WHERE WILL THE CRACKS BE?

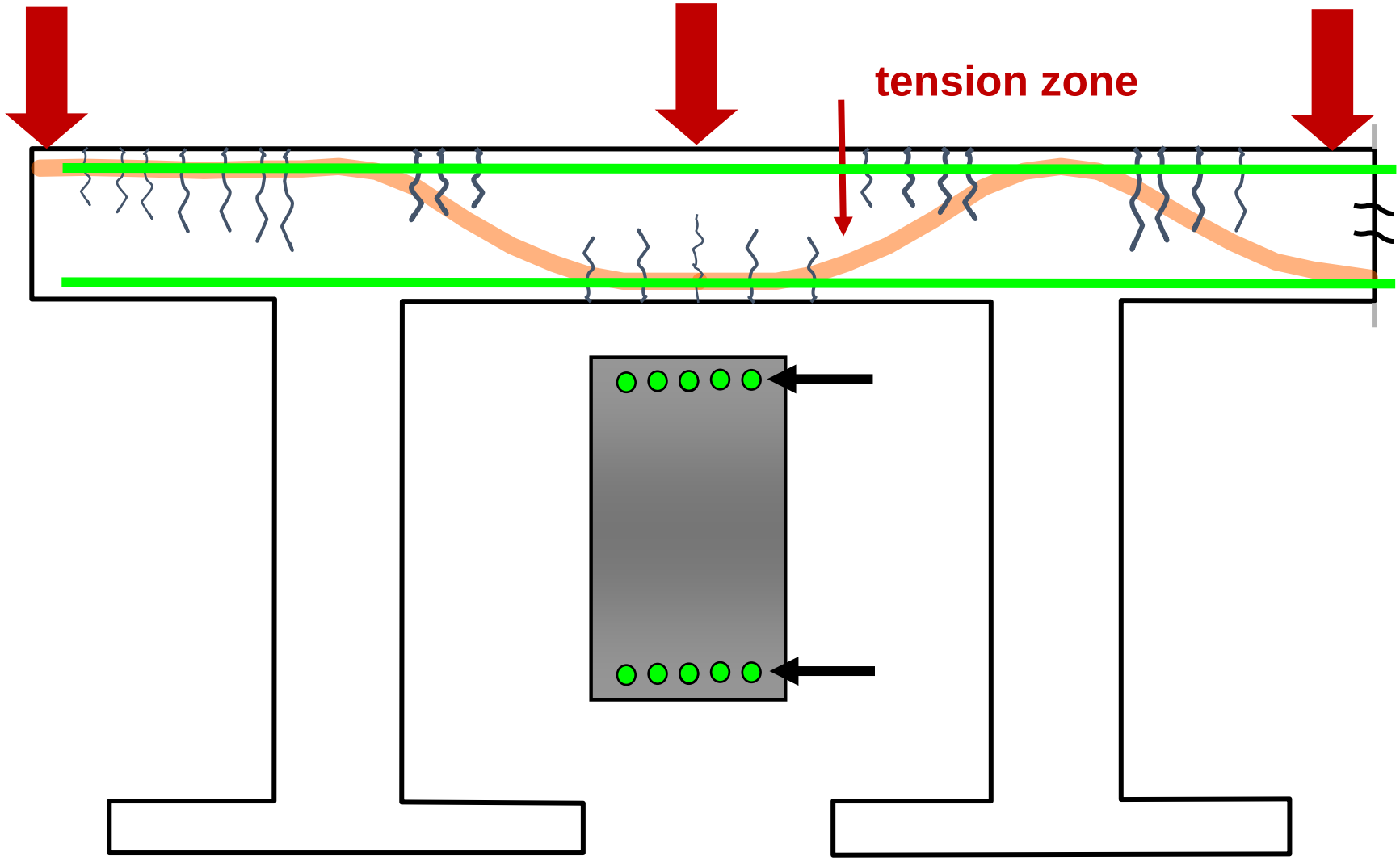
Signs of distress: + bending cracks 2 way slab BOTTOM



Signs of distress: - bending cracks 2 way slab-TOP



Steel placement in Beam to resist bending forces

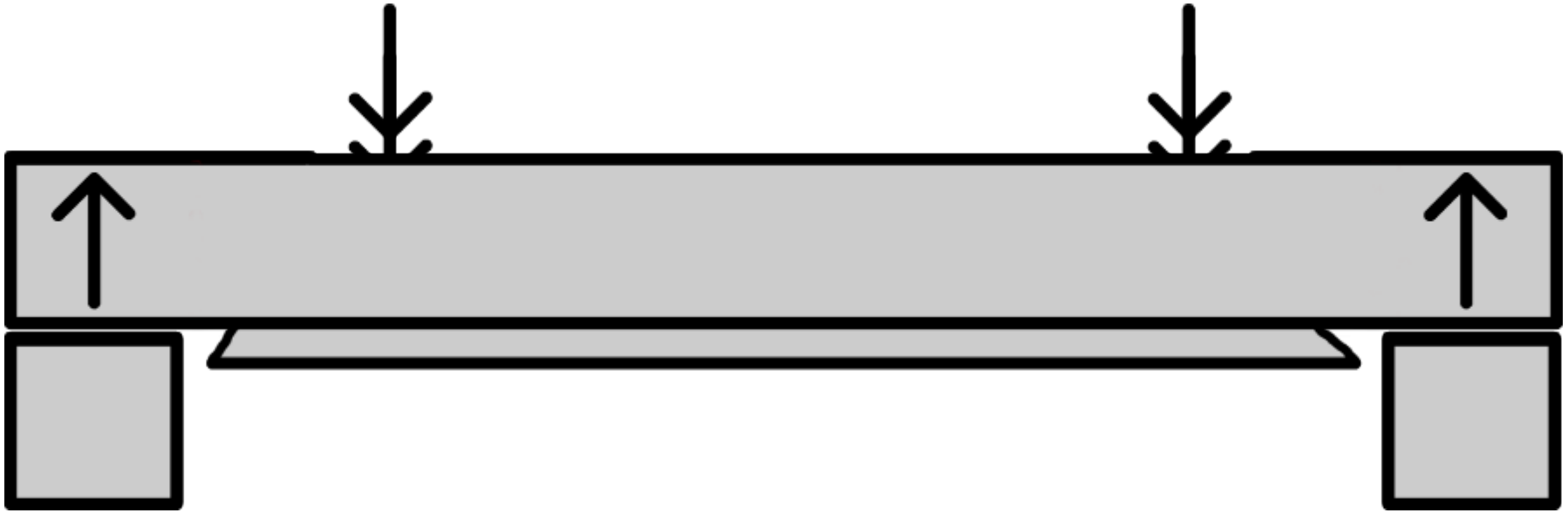


WHERE WILL THIS CRACK?

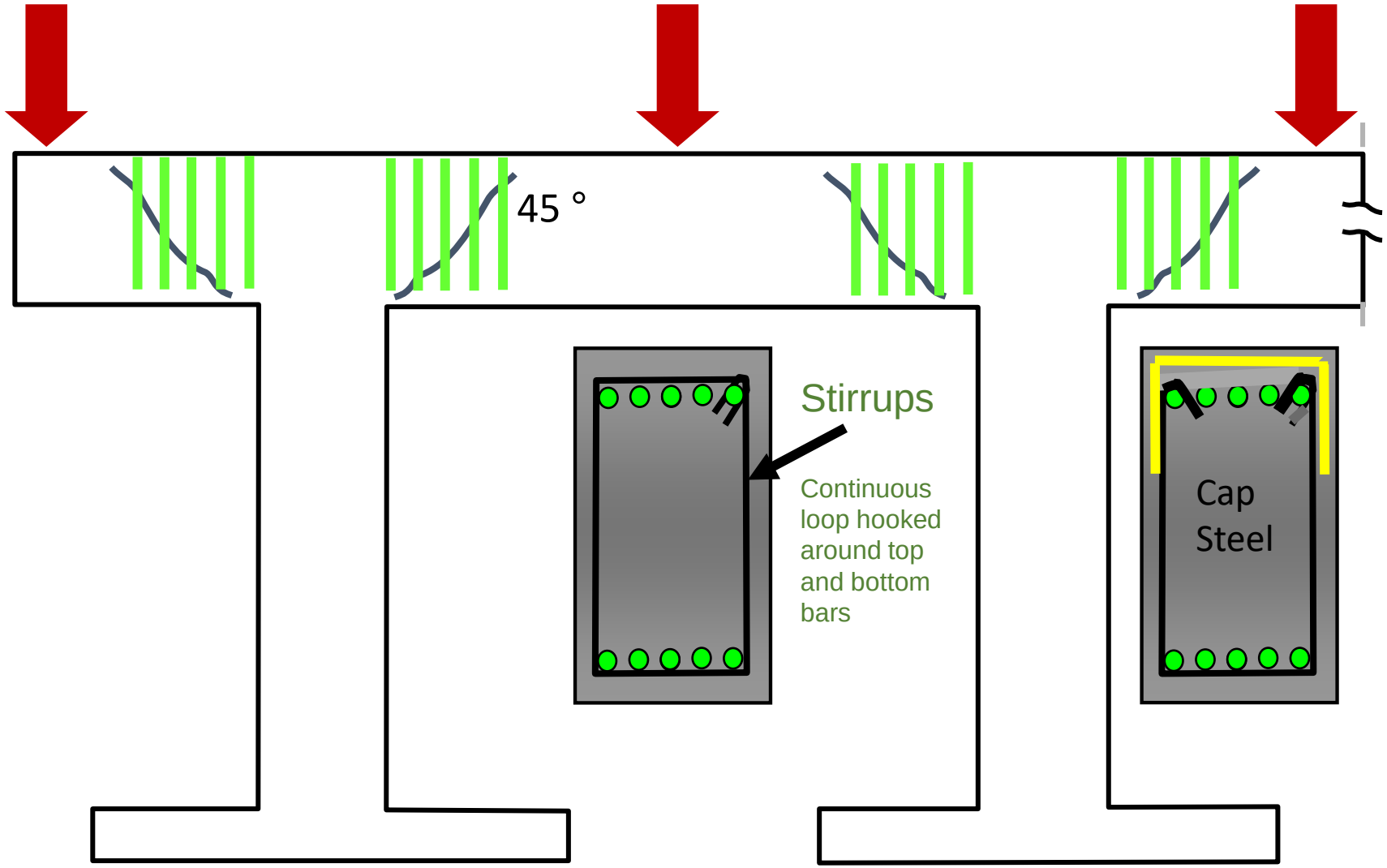
Signs of distress: beam + bending cracks

Understanding 2 types of shear forces

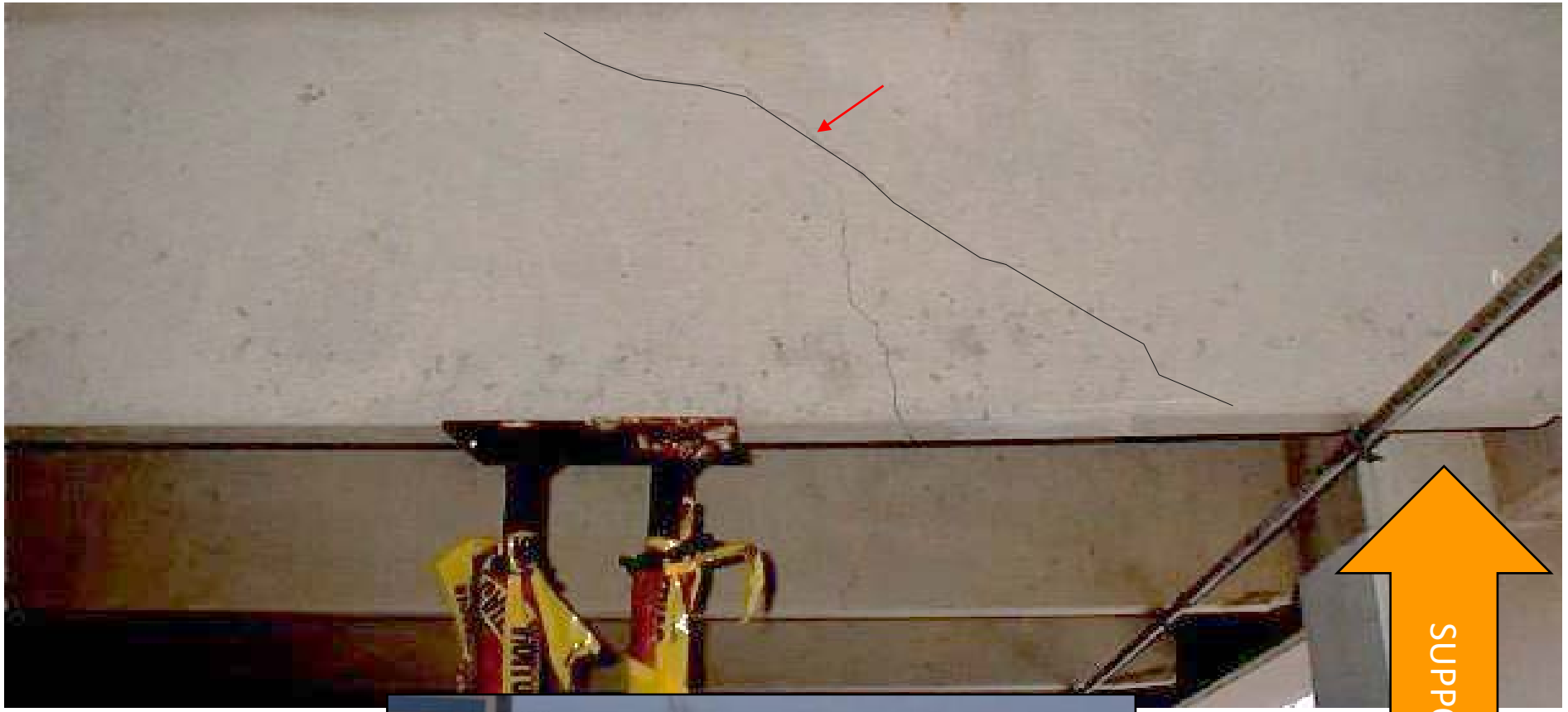
1. Beam shear



Steel placement in Beam to resist shear forces

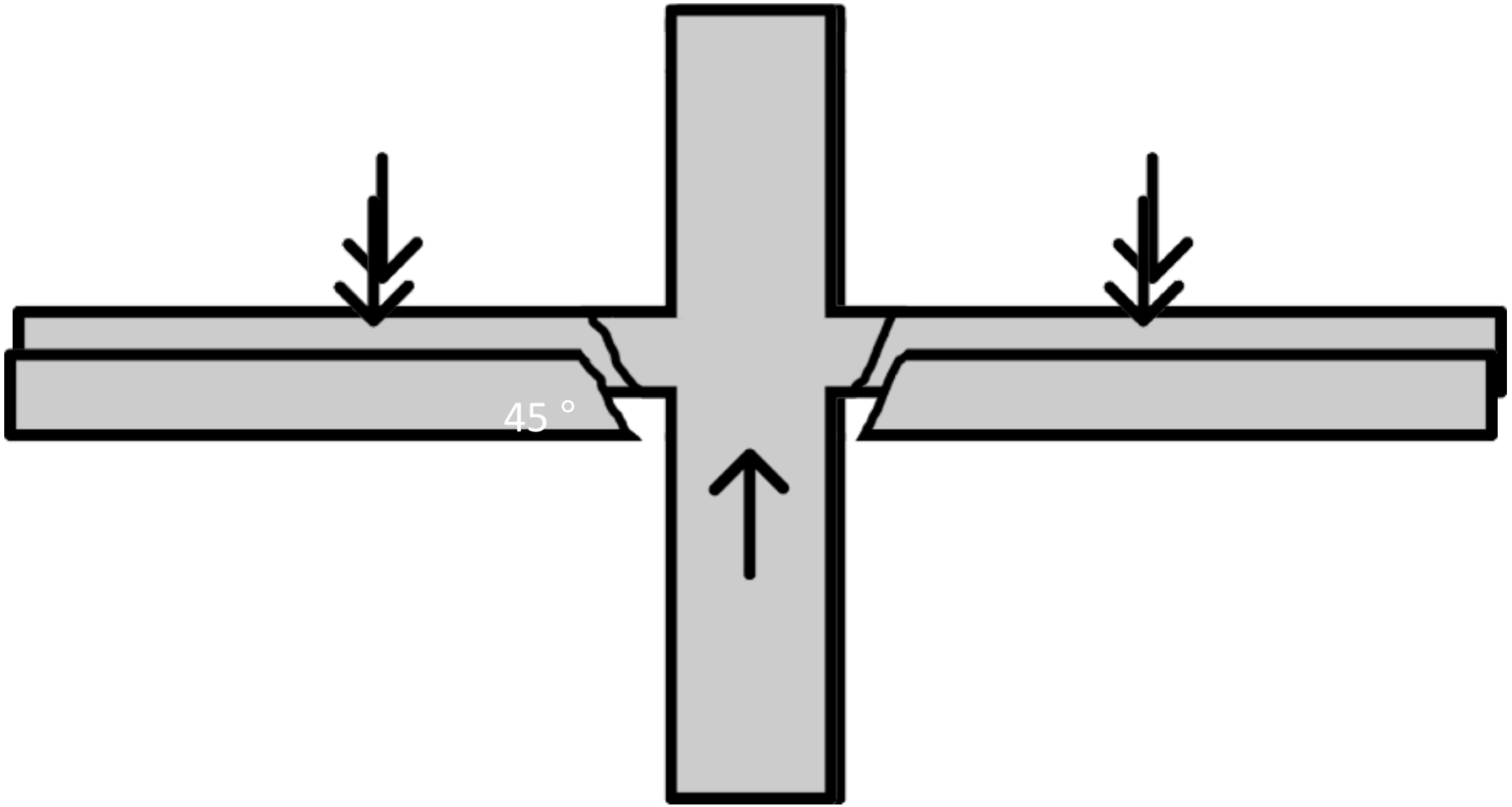


Signs of distress: beam shear cracking

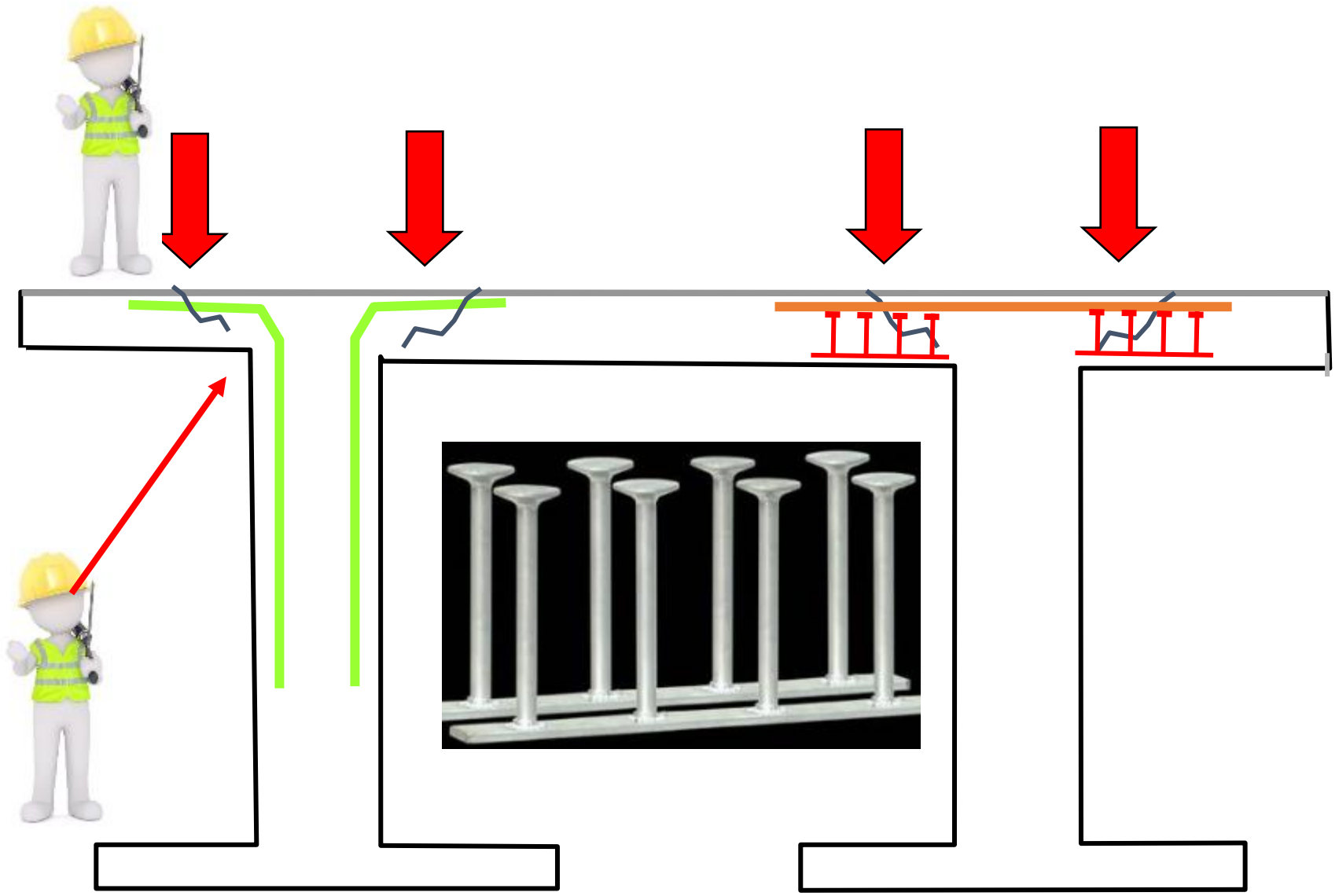


Understanding shear forces

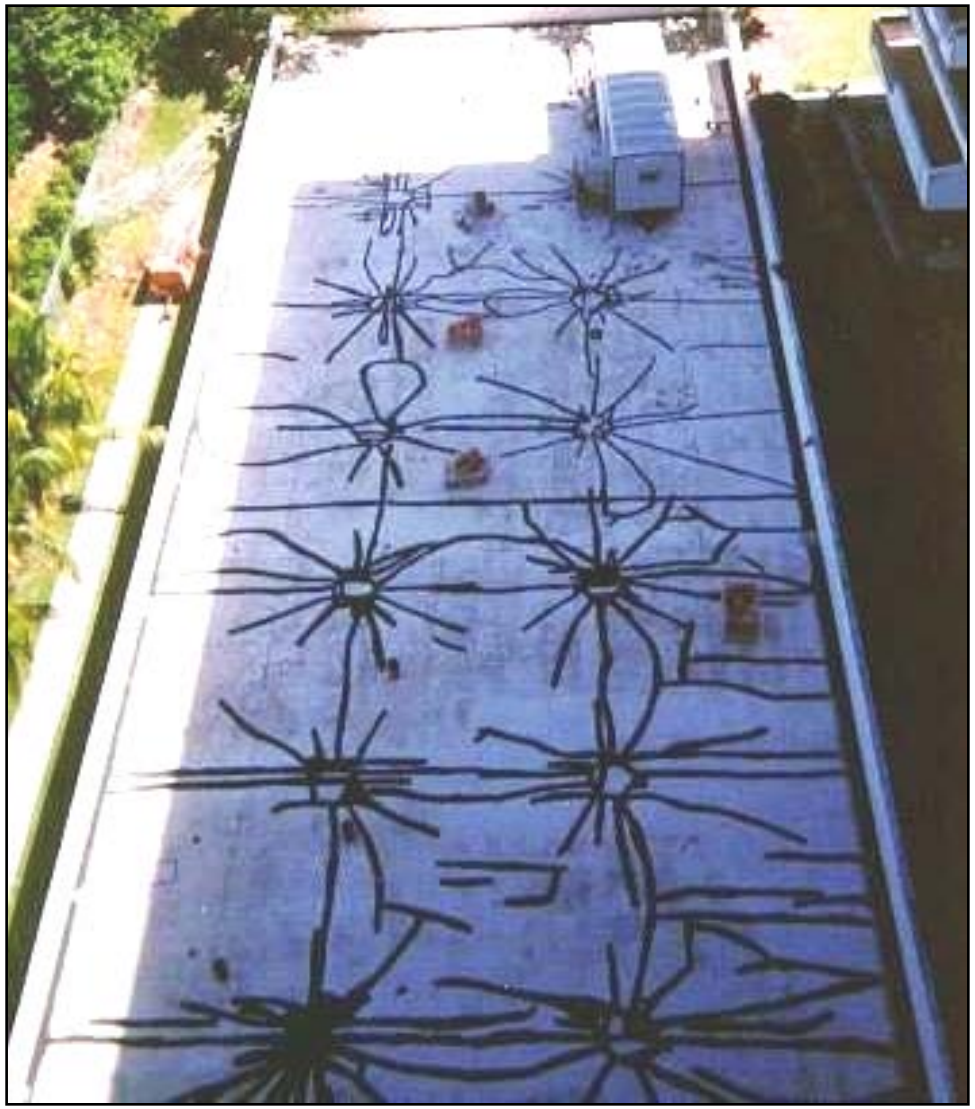
2. Slab Punching shear

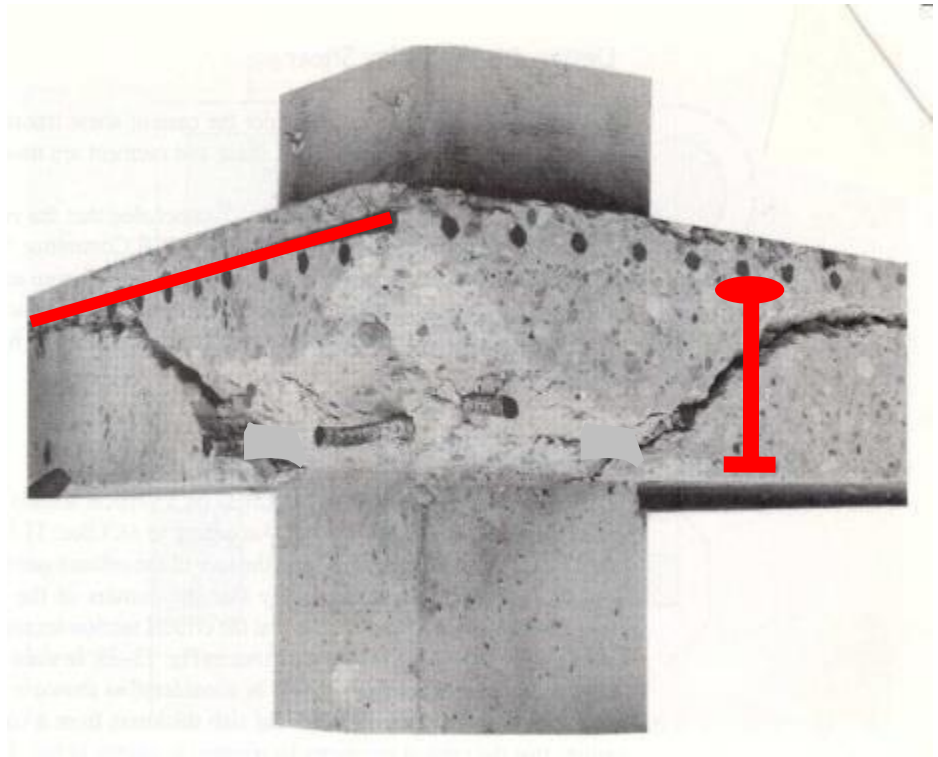


Slab steel placement to resist punching shear



Signs of distress: slab punching shear cracking



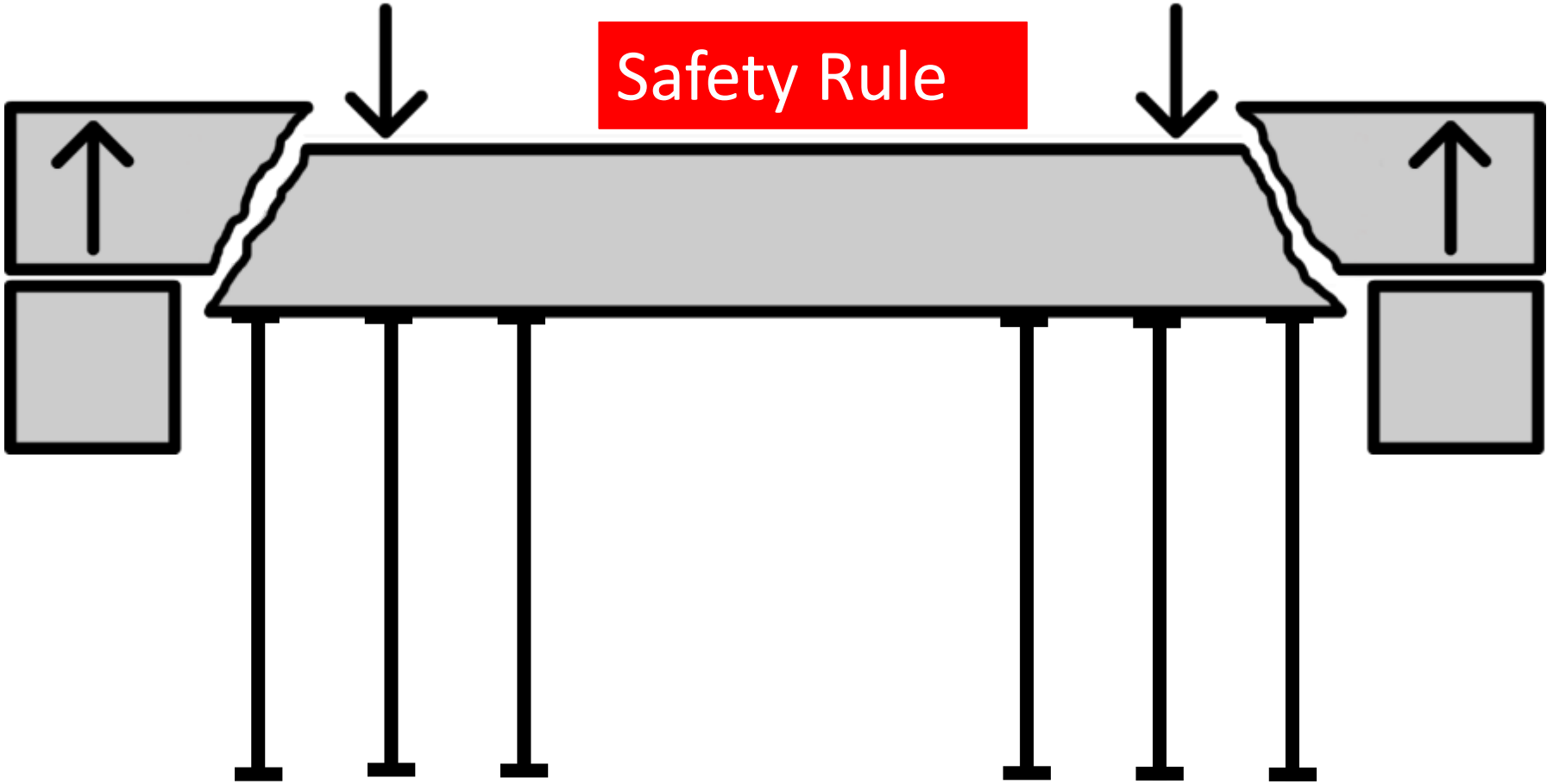


HIGH LEVEL OF CAUTION FOR SHEAR CRACKS!

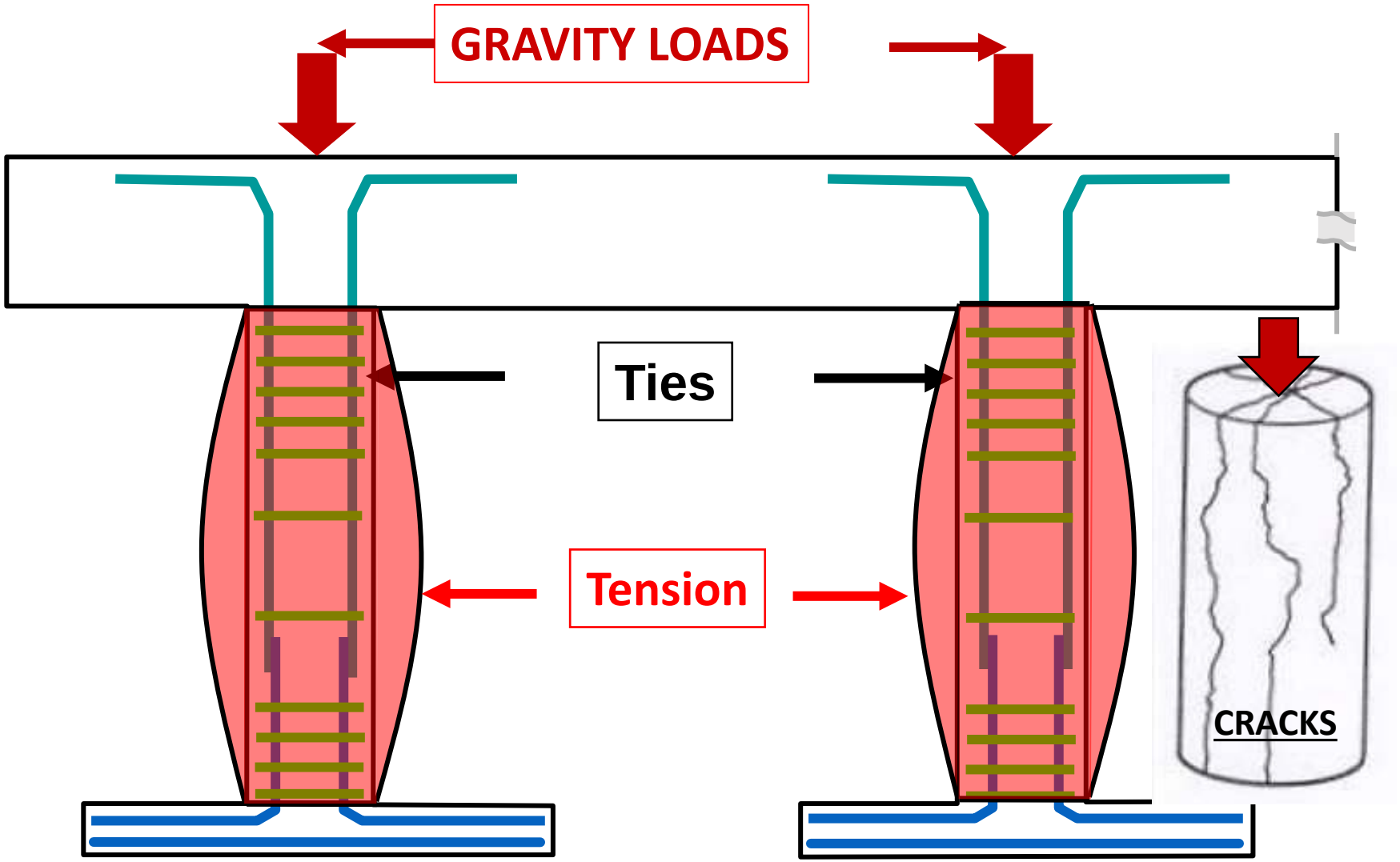
BEAM AND SLAB SHEAR FAILURE IS ABRUBT

NO WARNING

ALERT ENGINEER SHORE?

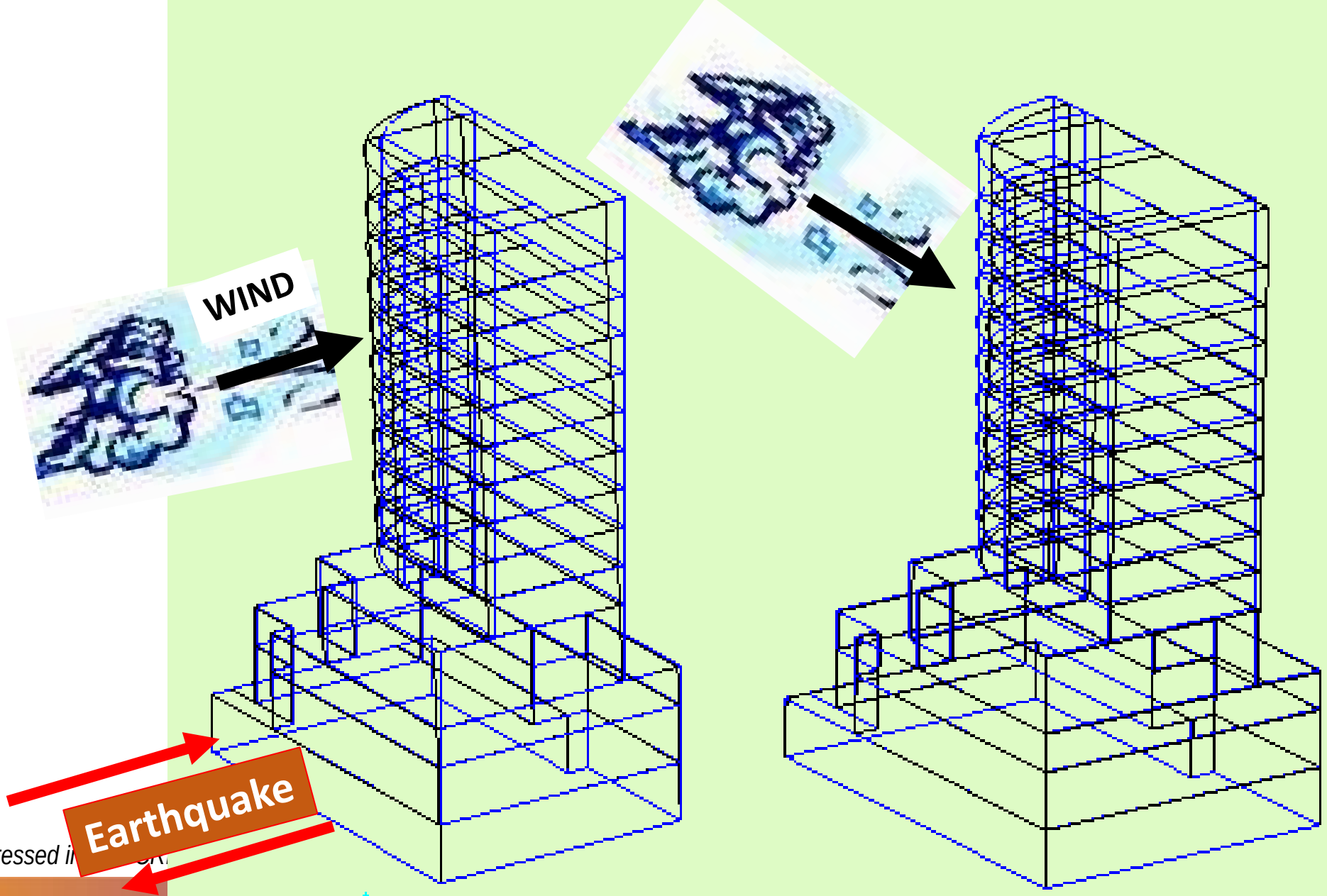


Column steel placement to resist vertical forces



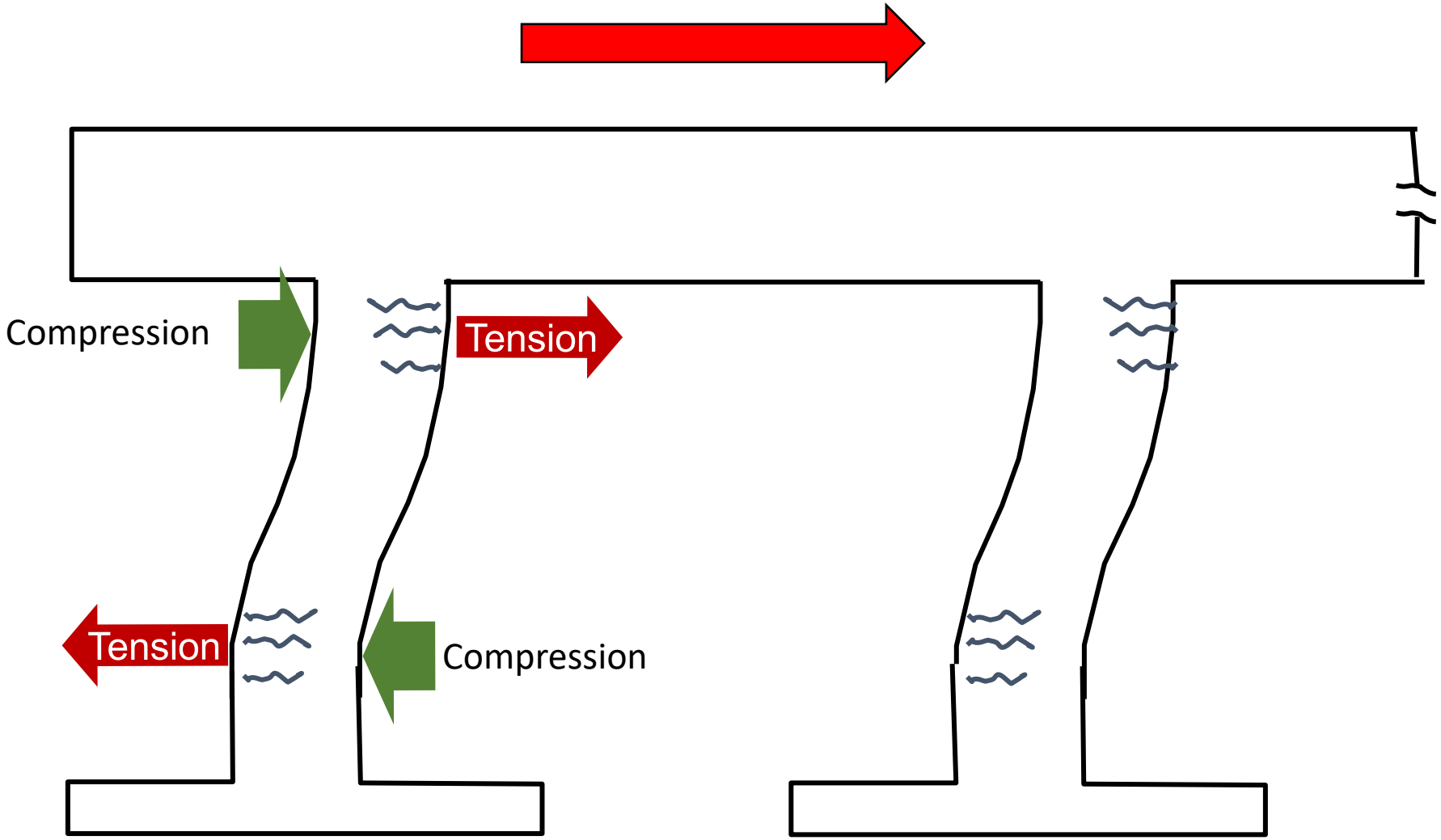
Column steel placement to resist lateral forces

Wind or Seismic



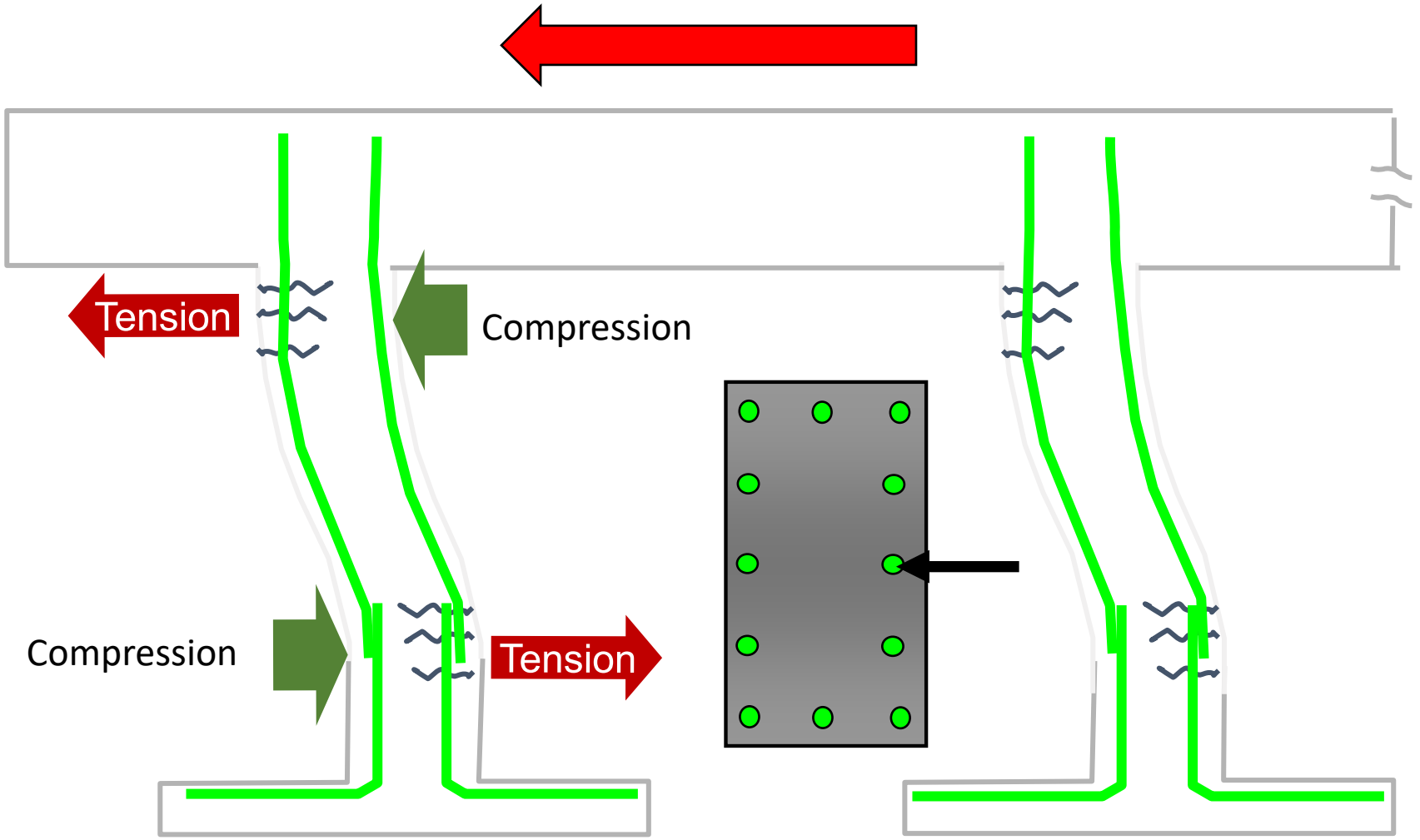
Column steel placement to resist lateral forces

Wind or Earthquake



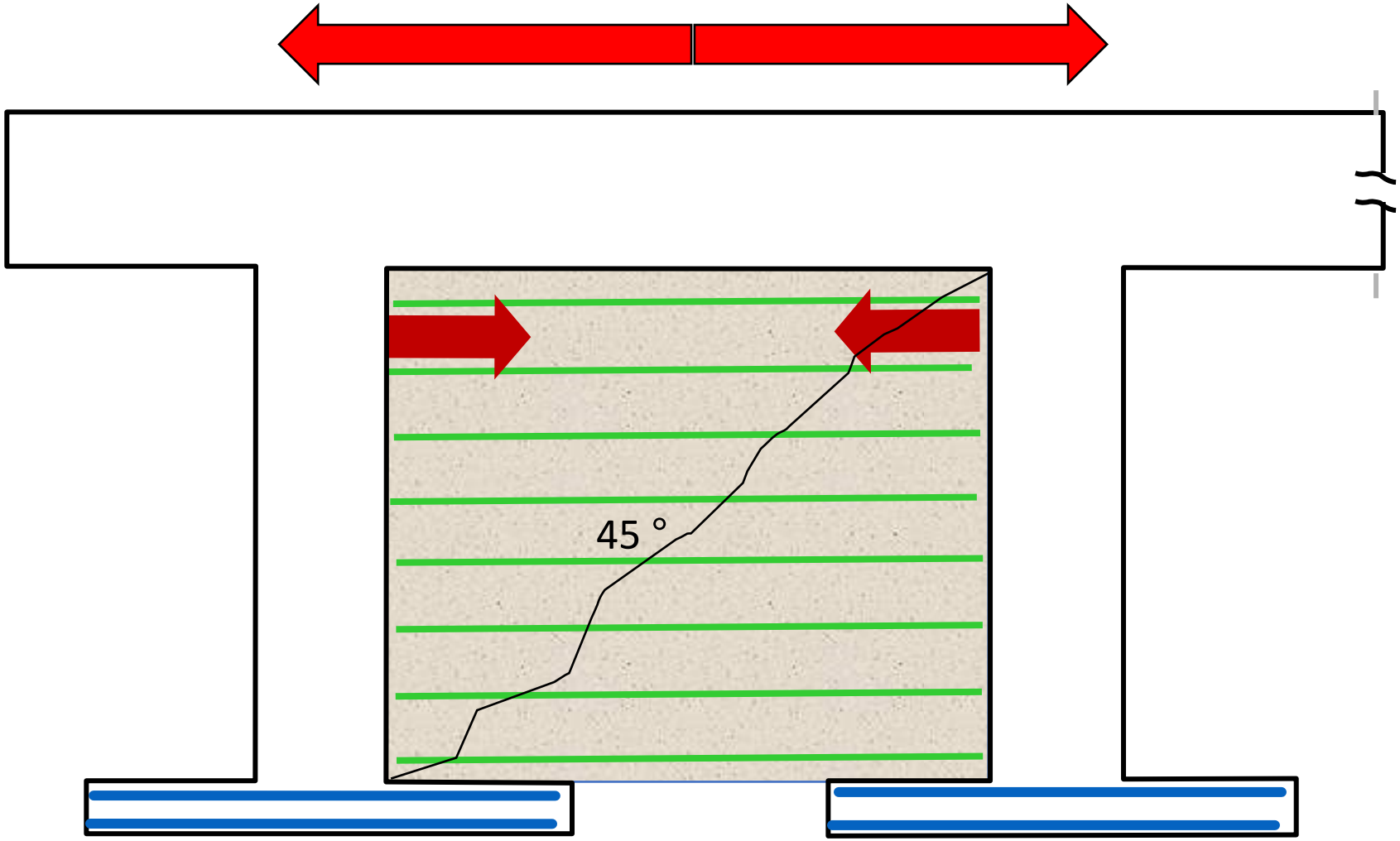
Column steel placement to resist lateral forces

Wind or Earthquake



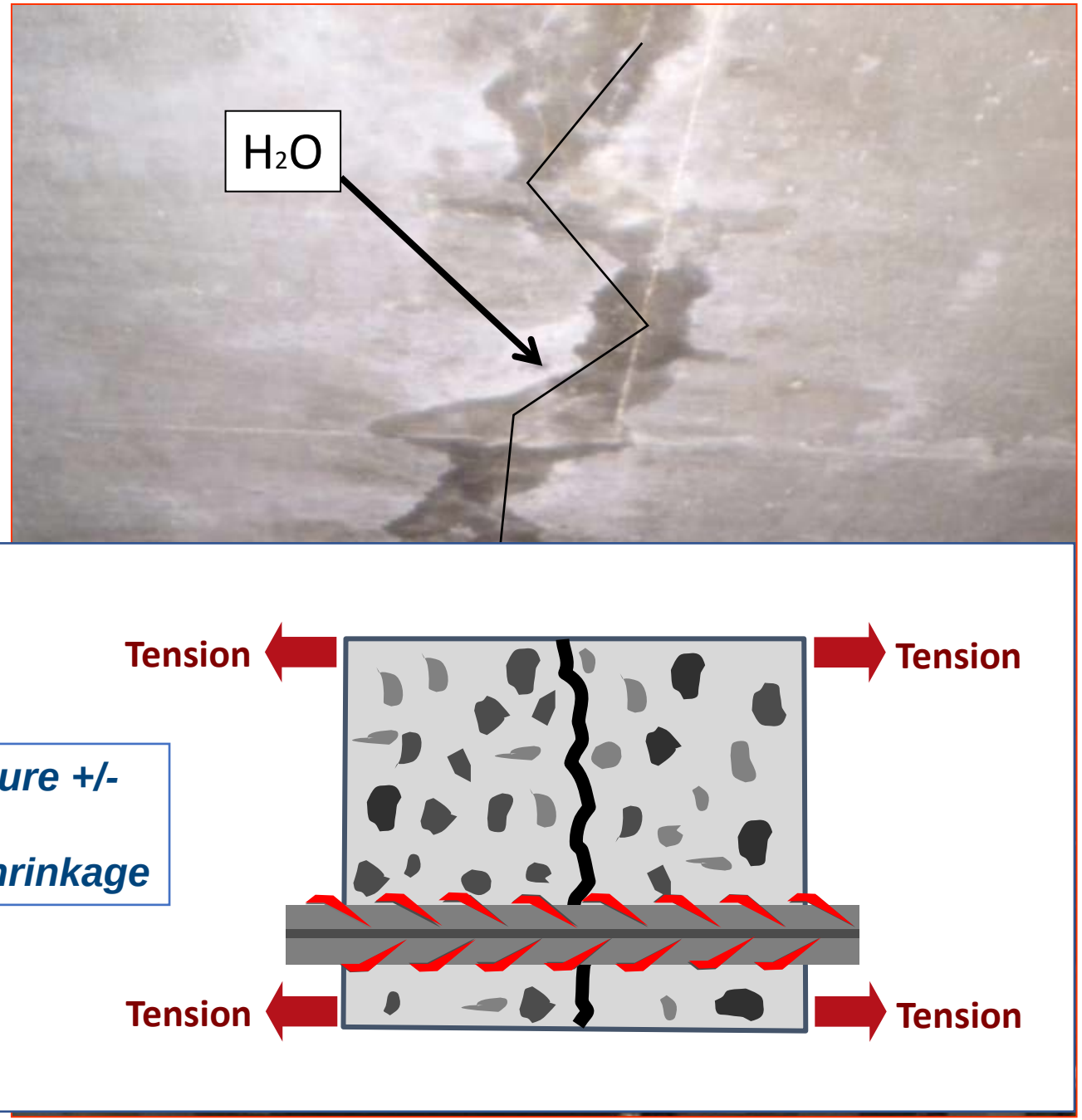
Shear walls to resist lateral forces

Shear Walls



Is this a Structural crack?

(TOP LEVEL OF PARKING GARAGE)



3 Things to think about

1. In Tension Zone?
2. Is the crack straight?
3. Is it a through crack?

What are the most common defects?

How is reinforced/PT concrete designed- *Eng. 101 for Contractors*

Safe loading of structures during construction- OVERLOAD

Understanding typical steel placement

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Repair strategies if Structural Safety or defects occur

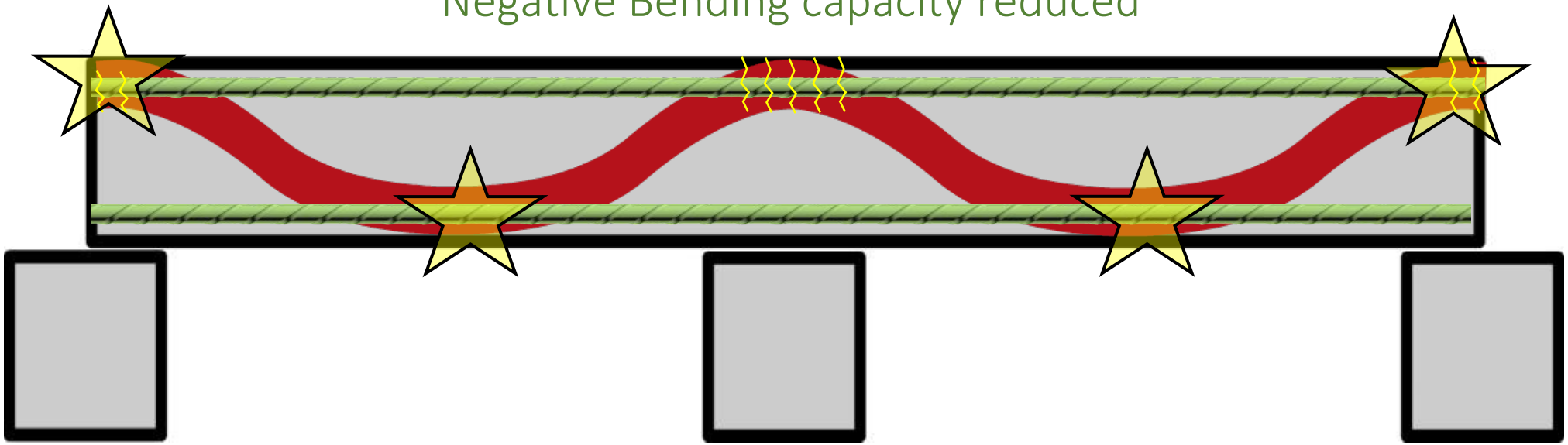
Incorporating Structural Safety in your Pre-planning Process

What if the steel is set in the too LOW?

Safety Rule

Effect #1

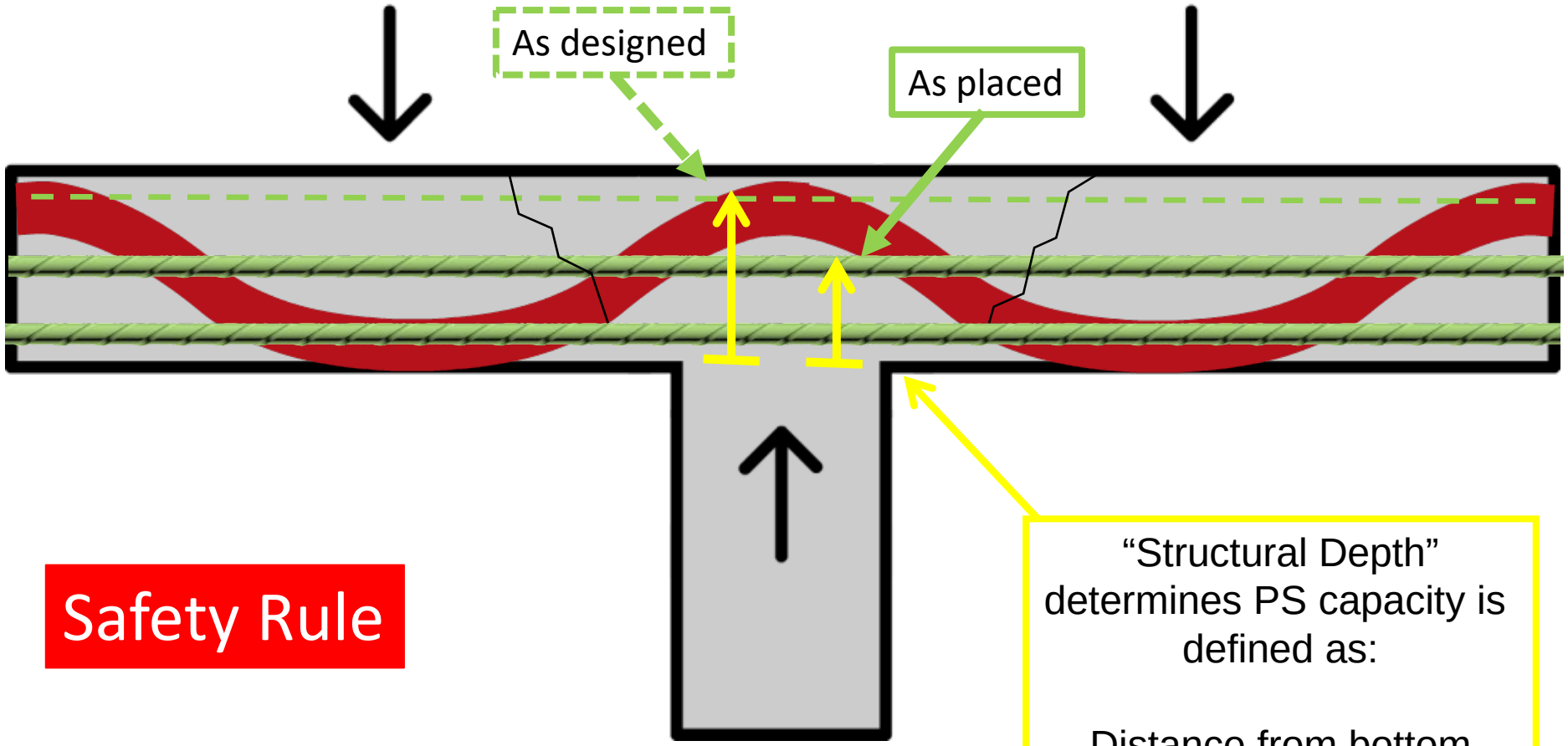
Negative Bending capacity reduced



What if the steel is set in the too LOW?

Effect #2

Slab Punching Shear Reduced



Safety Rule

"Structural Depth" determines PS capacity is defined as:

Distance from bottom
Of slab to highest rebar

What if the steel is set

Too Close to Surface- Less Cover

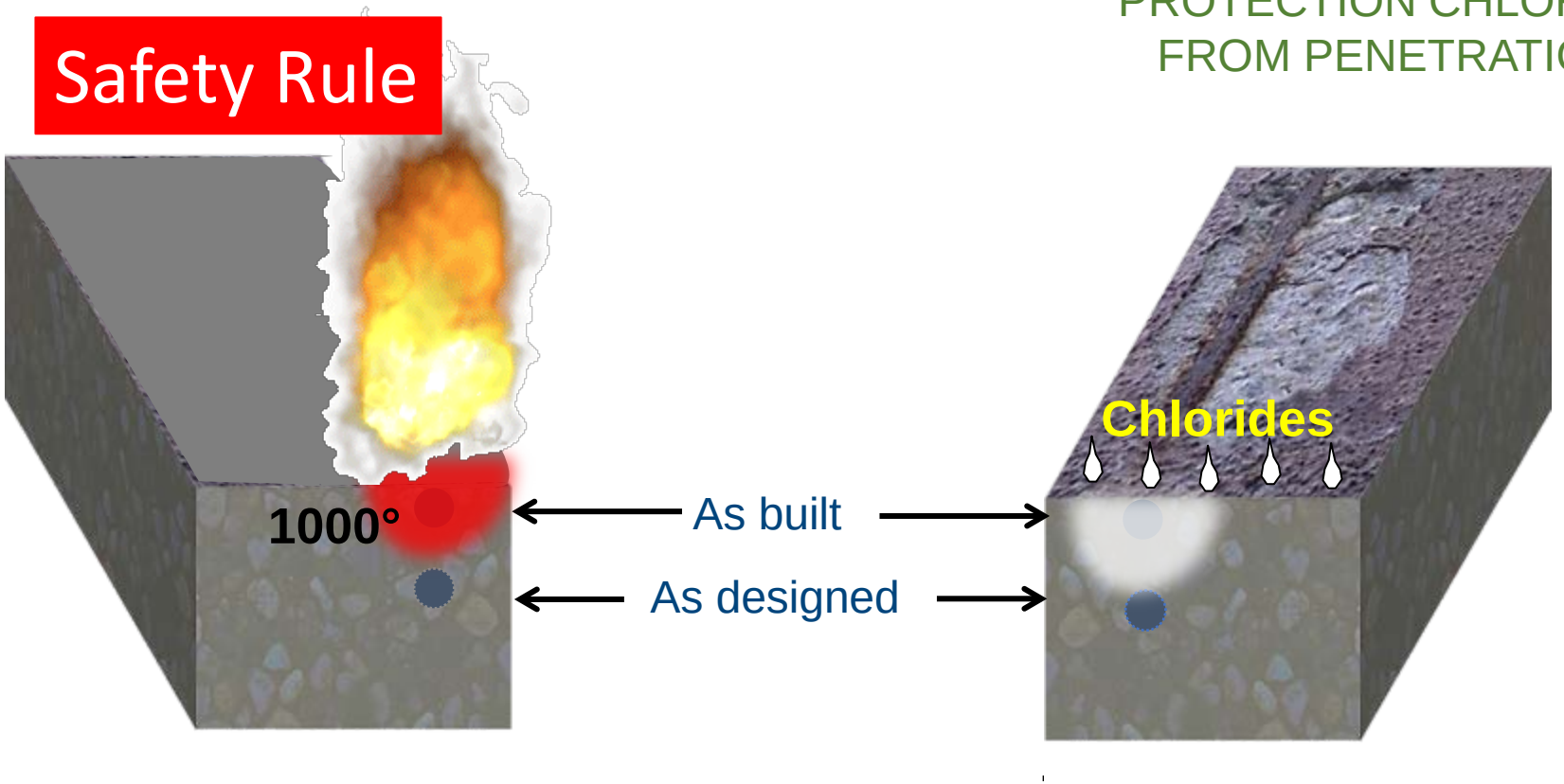
Effect #1

REDUCED FIRE RATING AS COVER INSULATES REBAR FROM HEAT

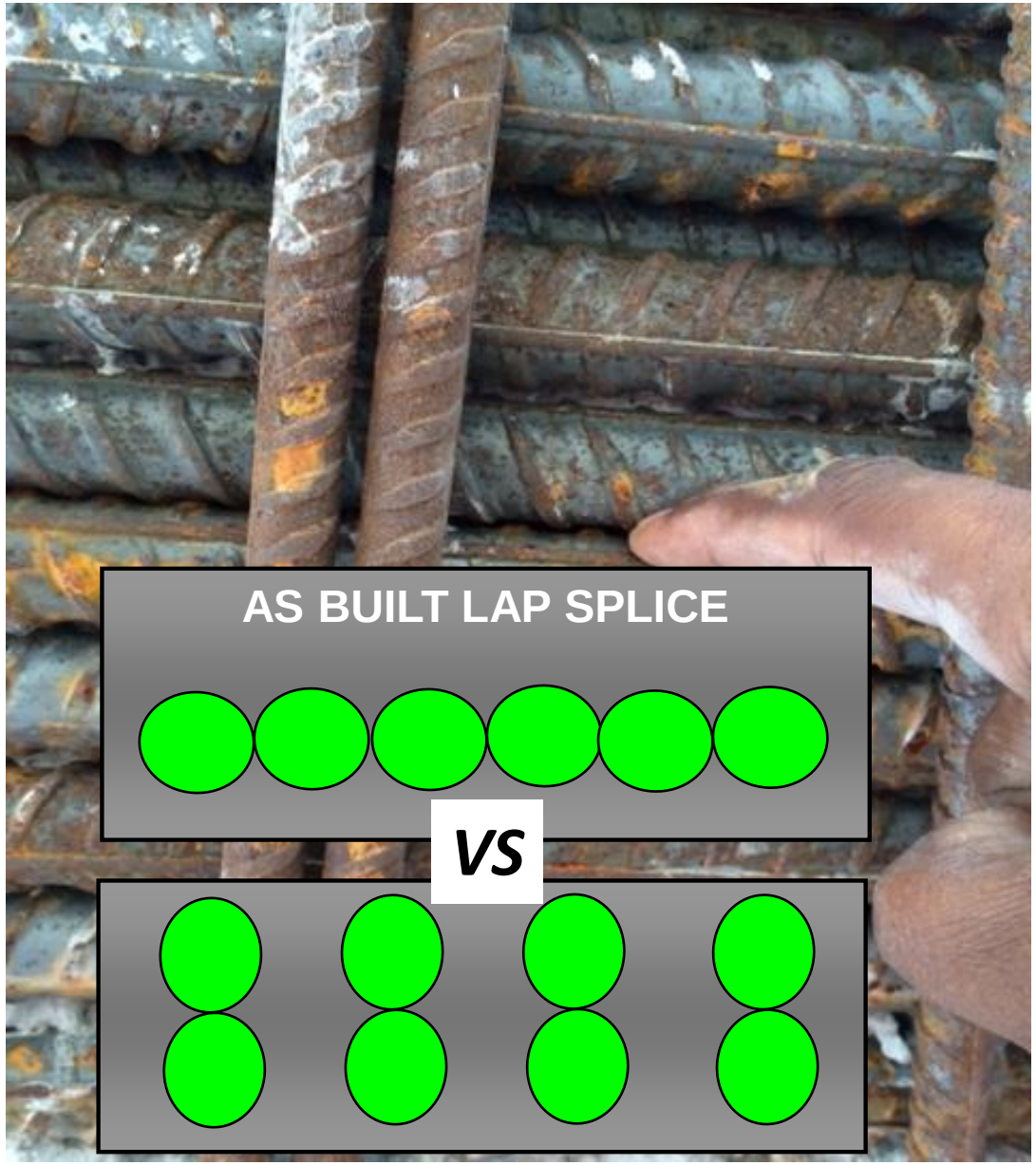
Safety Rule

Effect #2

REDUCED CORROSION RESISTANCE AS COVER IS PROTECTION CHLORIDE FROM PENETRATION



What if the rebar is set too close?



Min. spacing between bars?

What can't get through?

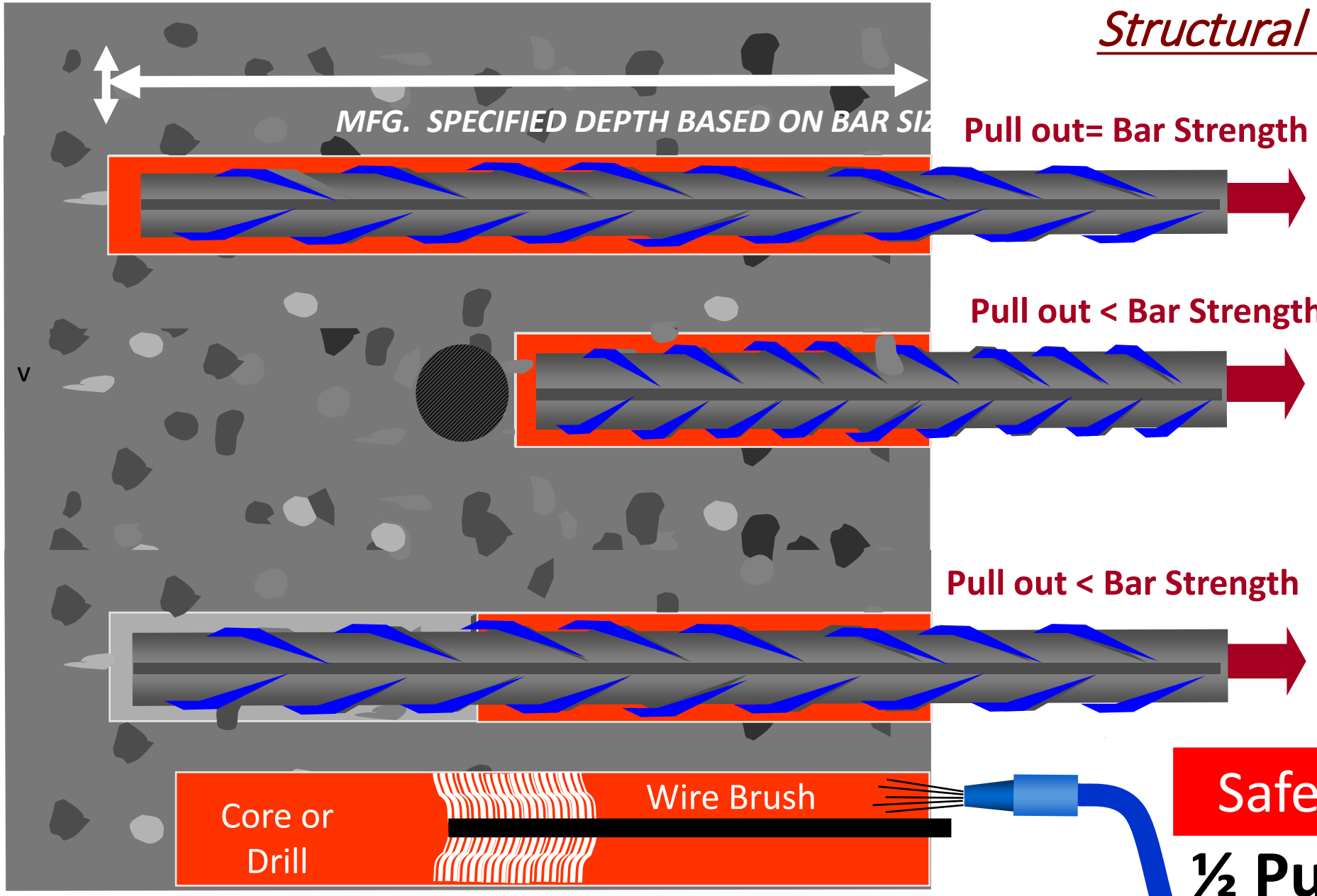
AGGREGATE!
Min. Rebar Spacing Rule:
1.5 X aggregate size!

¾" Aggregate = 1 1/8" gap

Do you have a pre-pour check off process?
WHO IS RESONSIBLE?

Safety Rule? Lap splice needs concrete!

Proper Doweling Procedures-
Structural Connections



Safety Rule

½ Pull Out

What are the most common defects?

How is reinforced/PT concrete designed- *Eng. 101 for Contractors*

Safe loading of structures during construction- OVERLOAD

Understanding the purpose of typical steel placement in:

- Beams, slabs, columns, shear walls

What if that steel is set in the wrong place?

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Avoiding concrete placement errors- Honeycombs & Voids

Structural Safety issues to avoid when:

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Incorporating Structural Safety in your Pre-planning Process

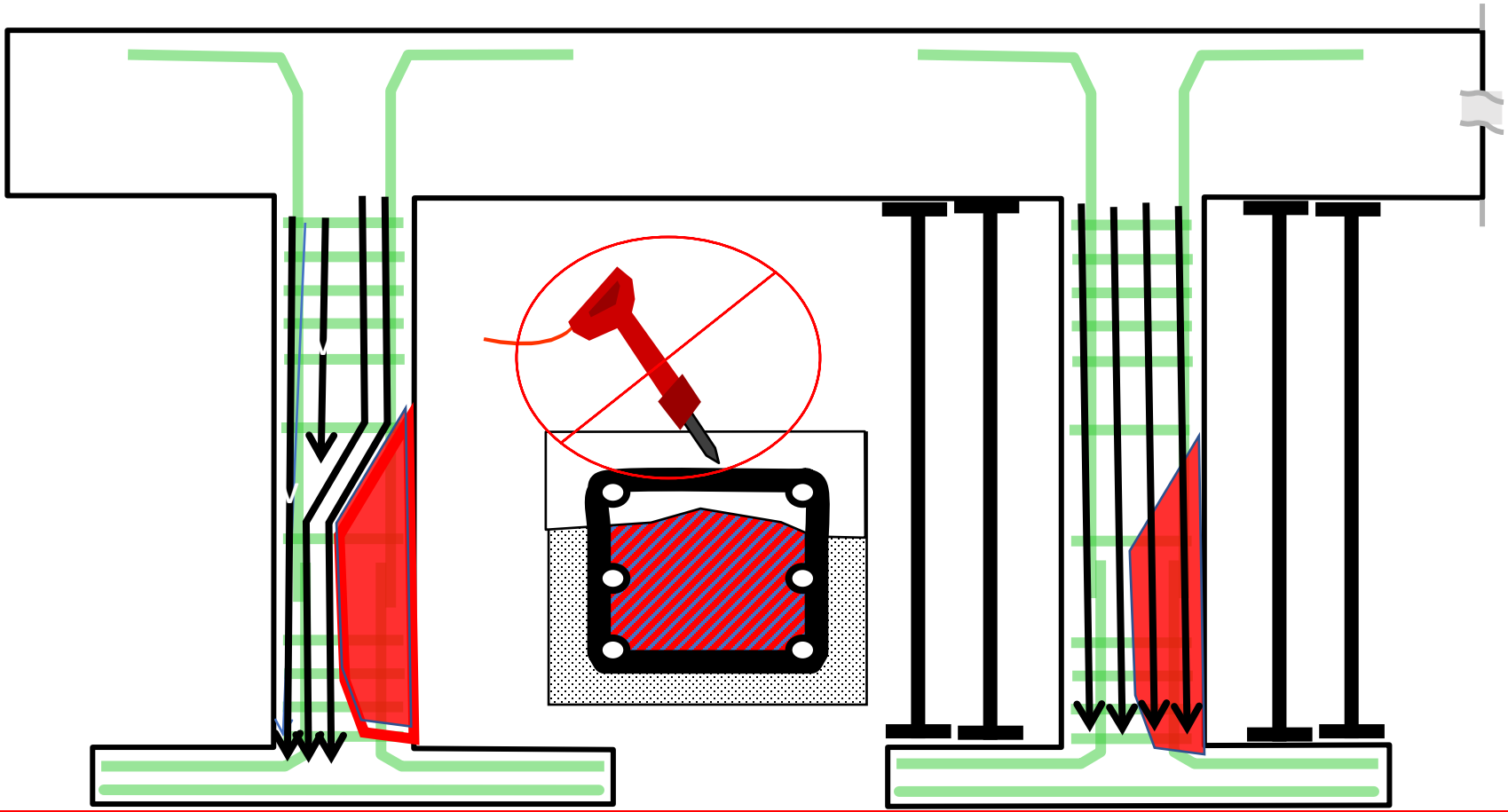
WHO IS RESPONSIBLE? DO YOU HAVE A PRE-PLANNING PROCESS?

*CONSIDERATIONS **BEFORE** CHIPPING, CORING, CUTTING **SLABS***

Safety Rule

*CONSIDERATIONS **BEFORE** CHIPPING **COLUMNS & SHEAR WALLS***

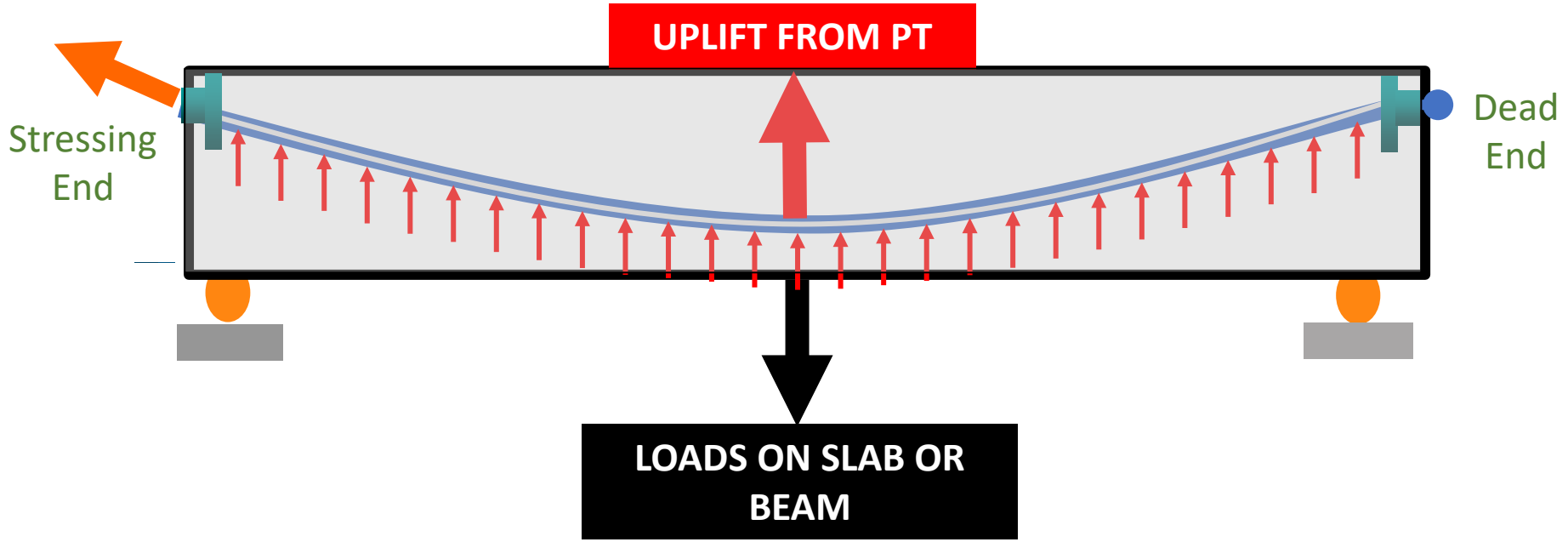
1. WHERE IS THE STEEL 2. DO I NEED TO SHORE?



Safety Rule- NEVER CHIP INSIDE STR. CORE!

Post Tensioned Concrete- How does it work in a slab or beam?

LOAD BALANCING



WHY POST TENSION?

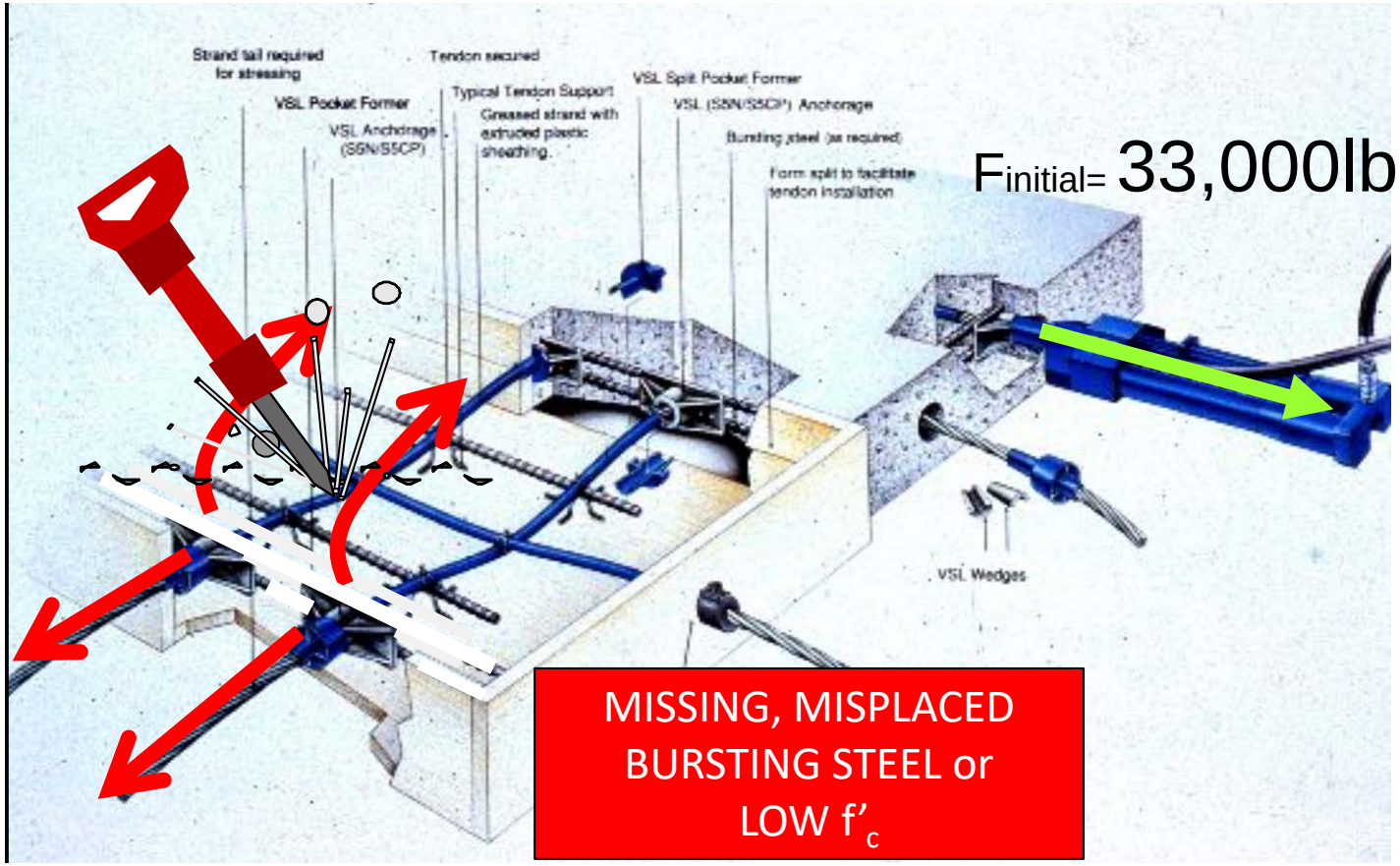
- Less columns & longer spans
- Less cracking (in compression)
- Faster construction (after stressing forms pulled)

PT *SAFETY CONSIDERATIONS*

During stressing, de-tensioning field investigation and repairs

Post Tension Safety Considerations
CONCRETE REMOVAL SAFETY GUIDELINES

Stay out of 'Line of Fire"

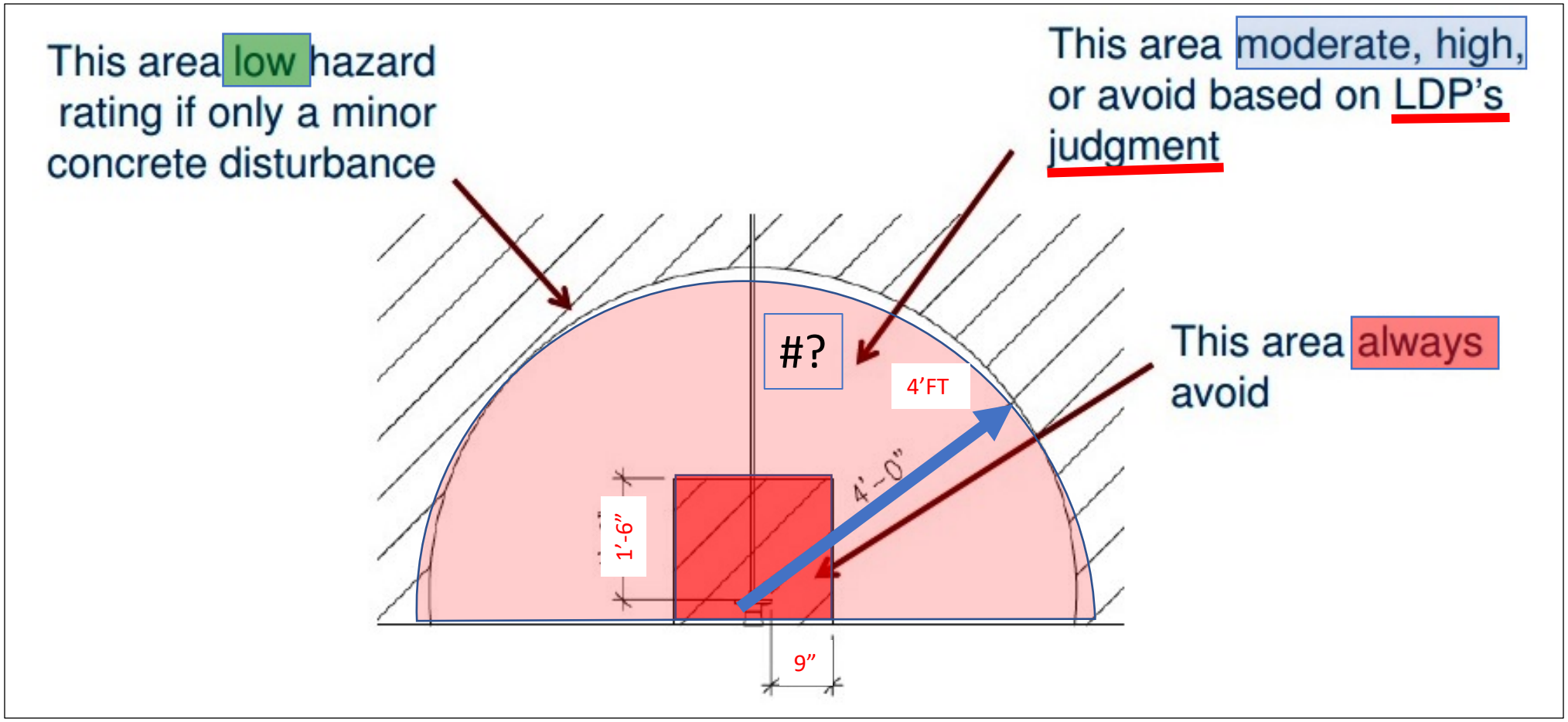


$F_{initial}$ = 33,000lbs = Empty Tractor Trailer

The ideas expressed in this ICRI hosted webinar are those of the speakers and do not necessarily reflect the views and opinions of ICRI, its Board, committees, or sponsors.

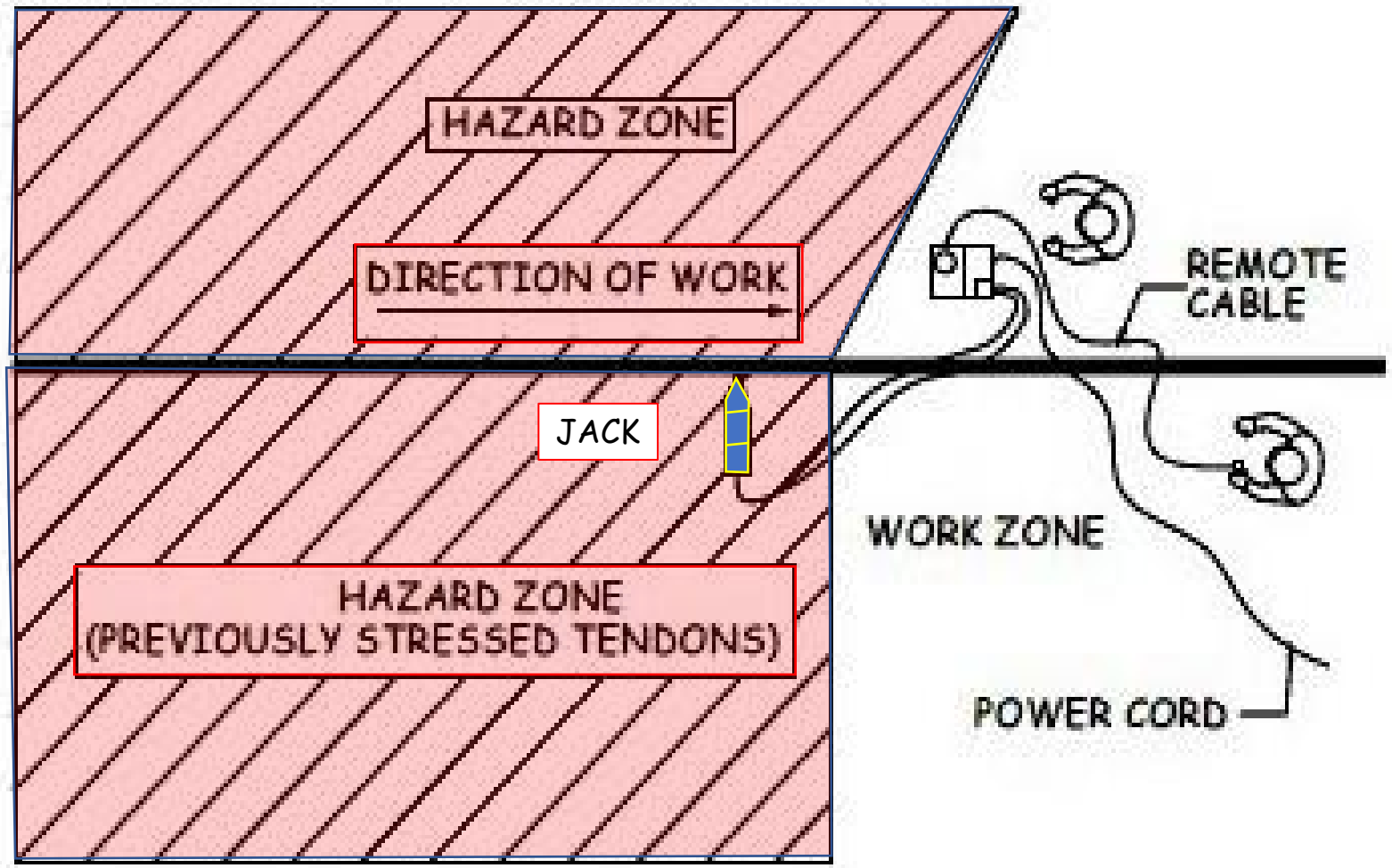
Post Tension Safety Considerations
CONCRETE REMOVAL SAFETY GUIDELINES

Stay out of 'Line of Fire"



Post Tension Safety Considerations

STRESSING SAFETY GUIDELINES (PTI)- *Line of Fire Rule*



1/S1 STRESSING SAFETY DETAIL
(NTS)

SUMMARY

How to Incorporate Structural Safety in your Pre-planning Process?

Much Like Your Safety Program it requires, Training, Knowledge, Procedures, Preplanning & *Commitment*

I will not walk by an UNSAFE ACT

SAFETY will not be waived for PROFIT

If I SEE something, I will SAY something

I have the ability to STAND DOWN a job

1. Proper shoring/re-shoring
2. Pre pour review checklist
3. Managing loads for construction materials or debris
4. Before you cut, core, chip concrete

Questions?

Jay Thomas
Structural Group
443-271-7100
jthomas@structuralgroup.com