

# ACHASM

2016 Construction H&S Summit



## Essential Factors to ensure Successful (Safe) Temporary Works



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WESTVILLE COUNTRY CLUB,  
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Essential Factors to ensure Successful (Safe) Temporary Works



- A** The importance of temporary works
- B** Understanding Loads Imposed on Formwork & Falsework
- C** Main Causes of Formwork Failure
- D** Critical Success Factor in the Construction Industry
- E** Questions & Answers



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## Essential Factors to ensure Successful (Safe) Temporary Works



*“Temporary works are a vital and safety critical part of every construction, building and civil engineering project. Even so, they are only well understood by a handful of engineers. This is surprising.”*

***Smart design wins projects: poor design costs time and money and failure, should it occur, often results in fatality.”***

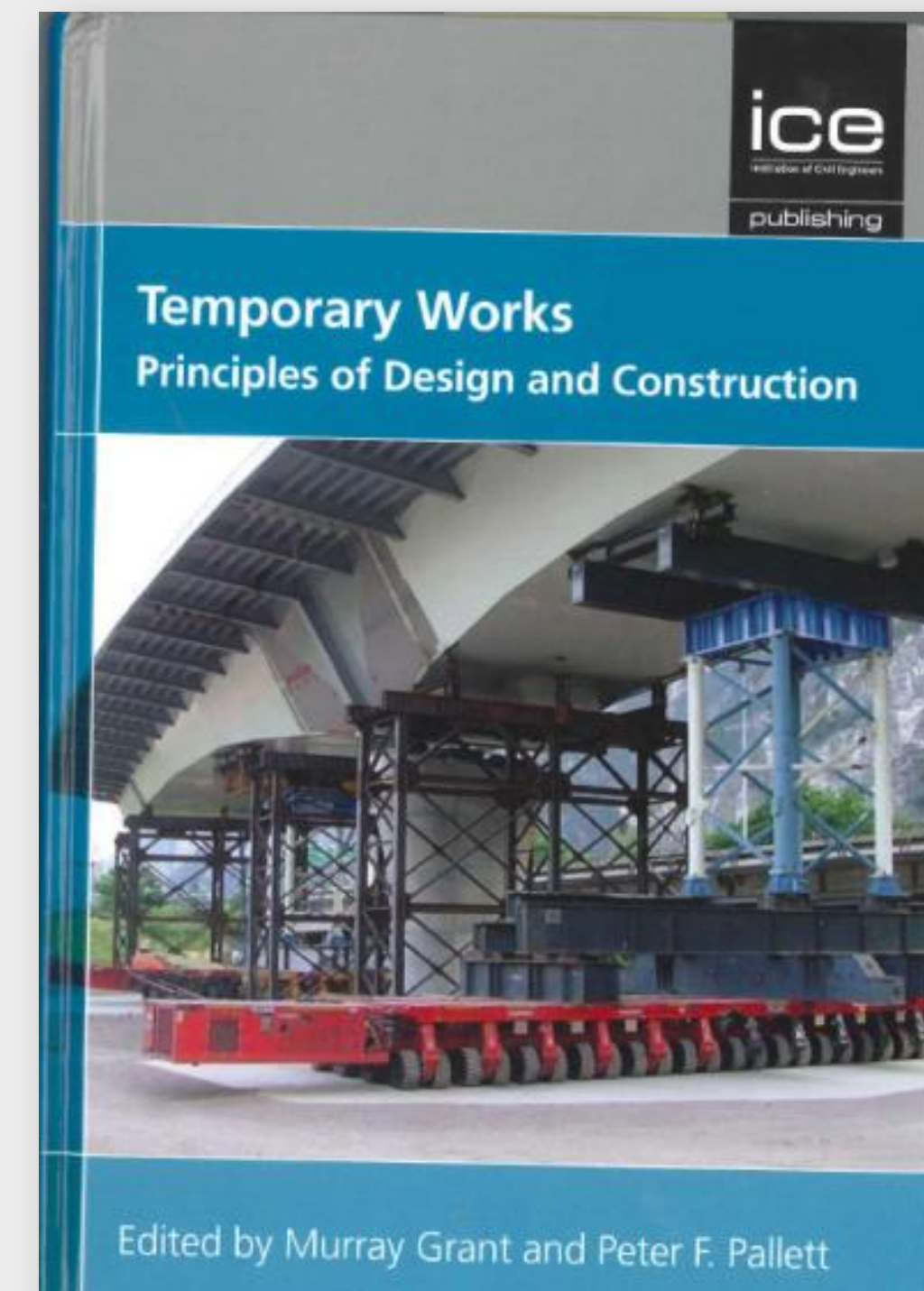
Bill Hewlett MA, FICE,  
C.Eng.





■ **The element of work needed to enable the structure to be built and supported until it has sufficient strength to support itself and can be:**

- Ground support, sheet piling, shoring;
- Formwork;
- False work;
- Scaffolding;
- Facade retention;
- Temporary bridges and roads;
- Underpinning;
- Earth-retaining structures.



■ **The term "Temporary Structures" may not fully imply temporary, since some forms, tie hardware and accessories are used hundreds of times, which necessitates high durability and maintainability characteristics and design that maximizes productivity.**



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**B Understanding Loads Imposed on Formwork and False**

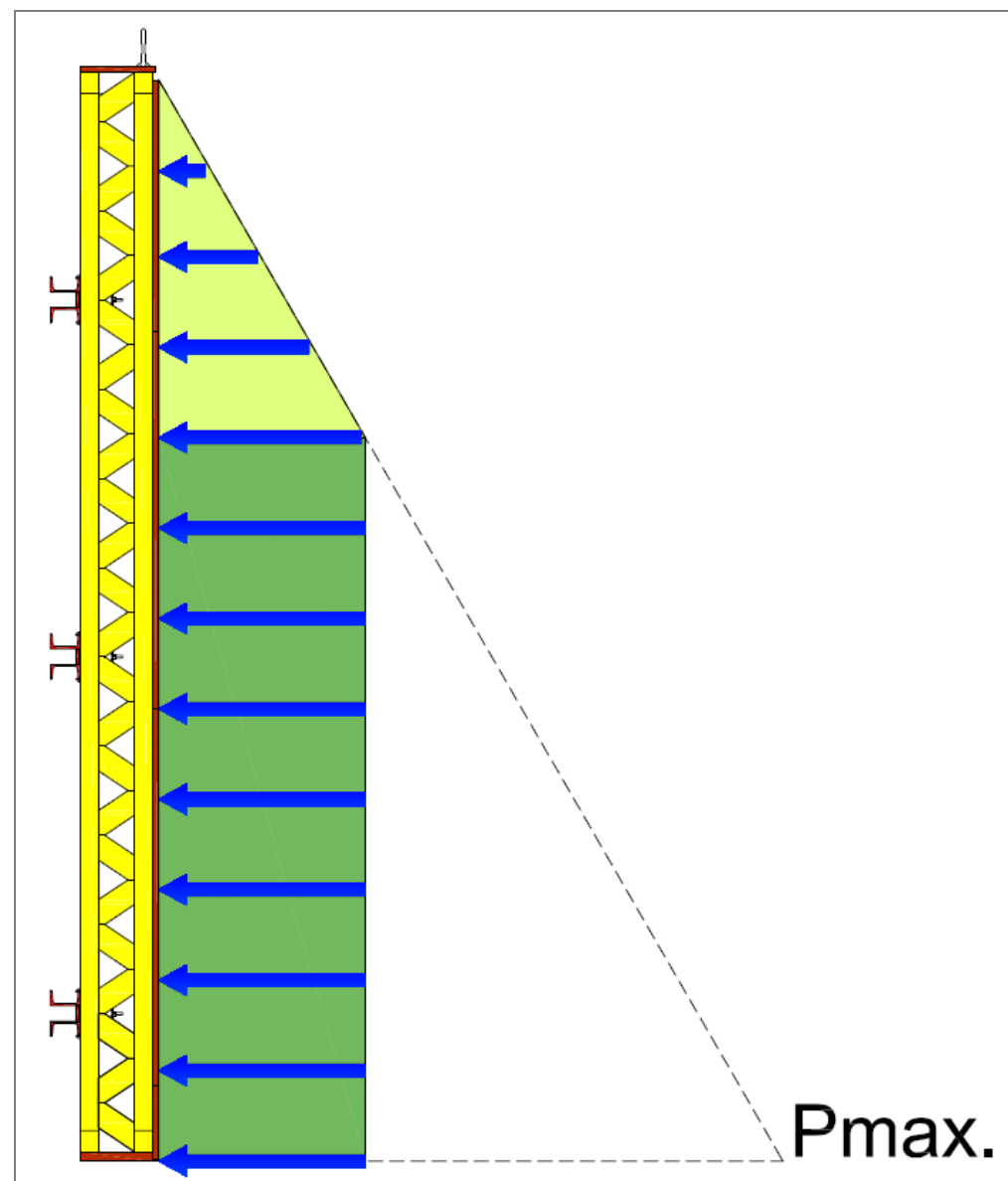


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## Essential Factors to ensure Successful (Safe) Temporary Works



- **Loads that must be considered in formwork and false are similar to the load case scenarios used during the design of concrete and steel structures as per SANS 10160**
- **The most important loads to take cognizance off are:**
  - Hydrostatic pressure on walls and column formwork,

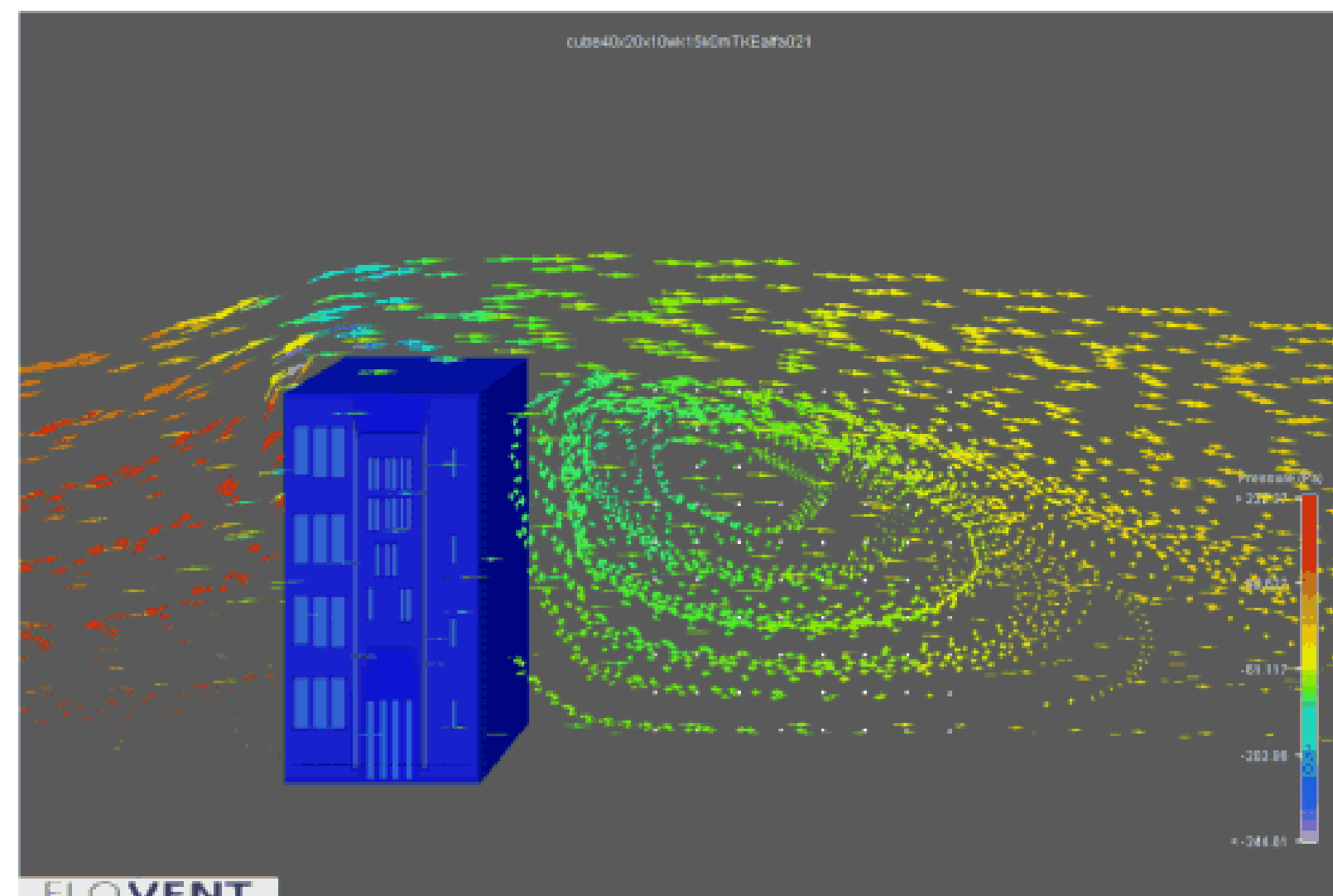


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  - Load from continuous work .







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## C Main Causes of Formwork Failure



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1. Improper stripping and prop/shore removal
2. Inadequate bracing - Yoking, Patching of Columns, Diagonal & Transverse bracing
3. Vibration
4. Unstable soil under \*sole-plates props/shores not plumb
5. Inadequate control of concrete placement, heaping
6. Lack of attention to formwork details or design

\* Sole boards etc. Element used for load distribution



# 1. Improper Stripping, Shore Removal & Re-shoring



Premature stripping of forms, premature removal of shores, and careless practices in re-shoring can produce catastrophic results.

## Case study:

Too early shore removal at Bailey's Crossroads in Virginia (1972):

26-stories + apartment building

At Bailey's Crossroads, concrete was placed on the 24th floor while shoring was prematurely removed from the 22nd, causing a progressive collapse down to the ground level.



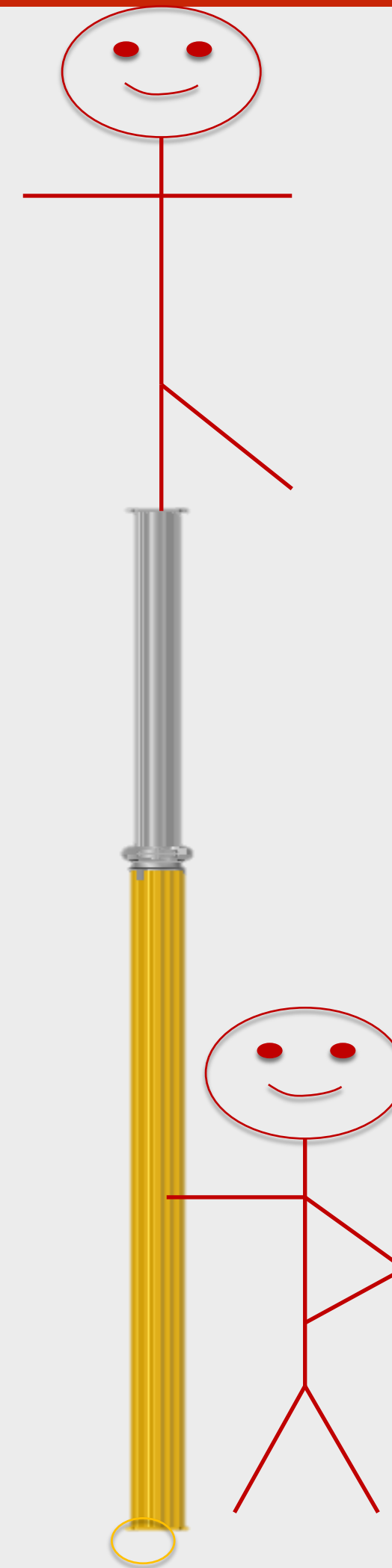
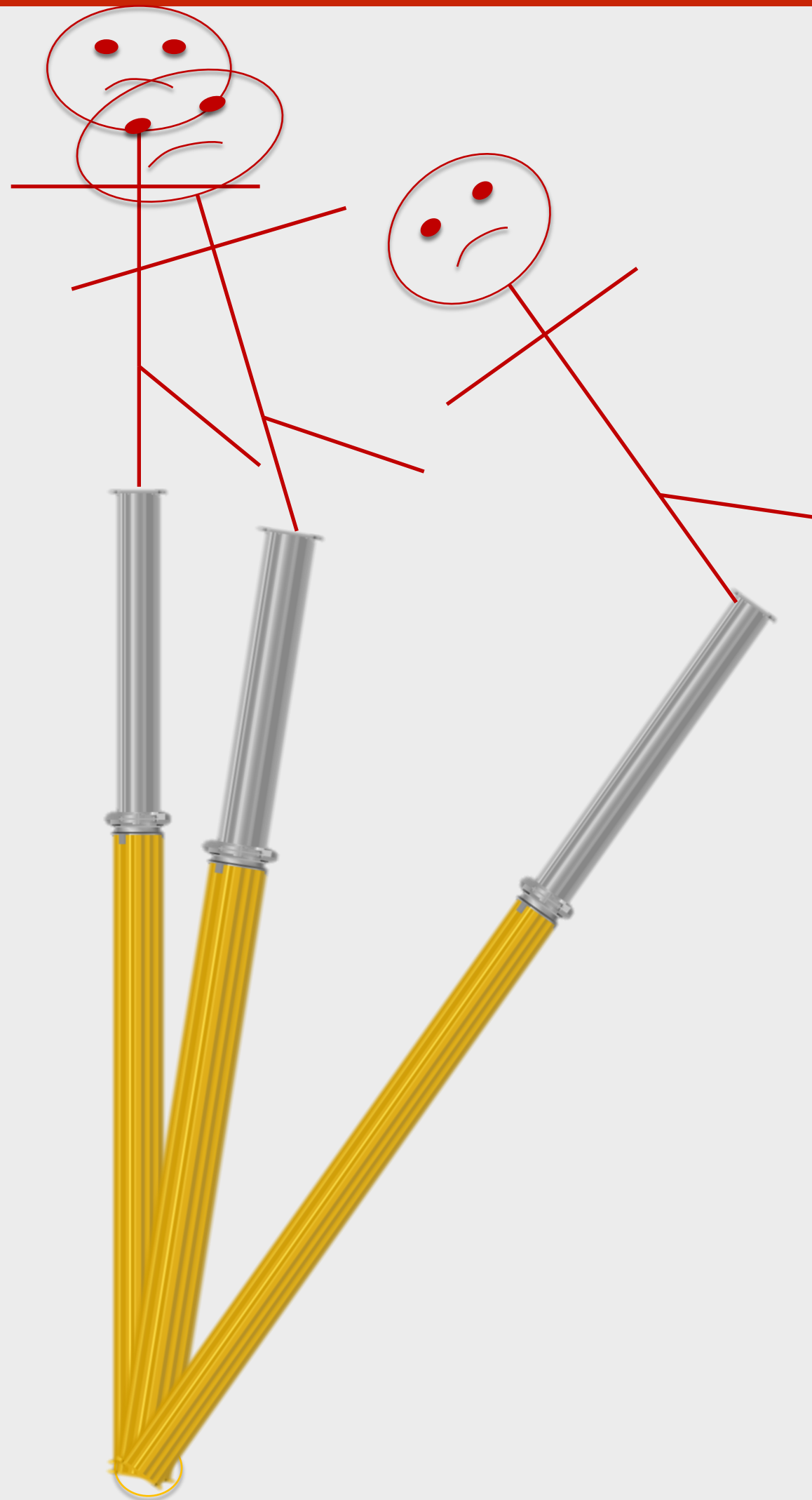


# 1. Improper Stripping, Shore Removal & Re-shoring





## 2. Inadequate Bracing

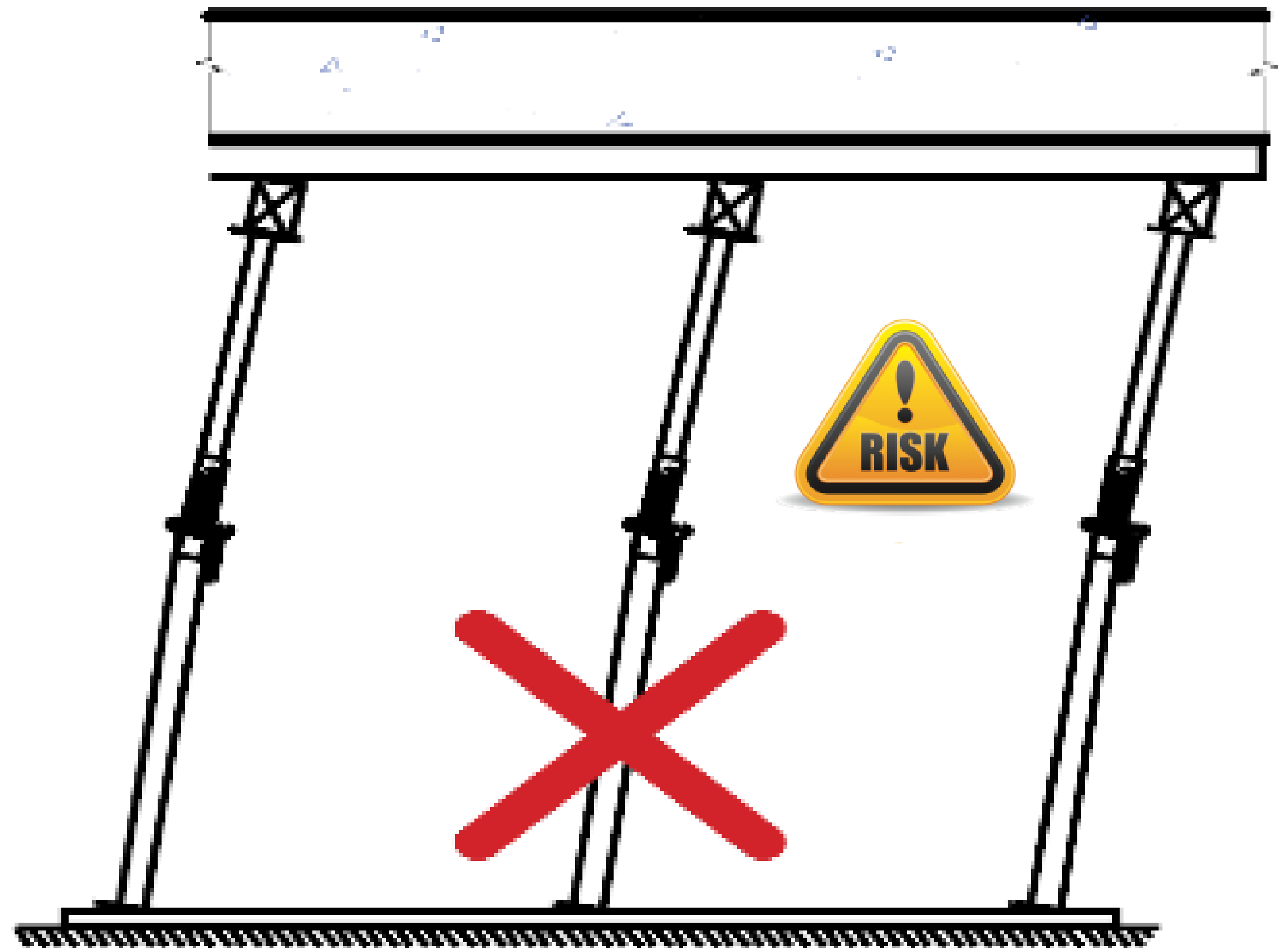


- Effect of lateral support – be it bracing and yoking to columns



## 2. Inadequate Bracing

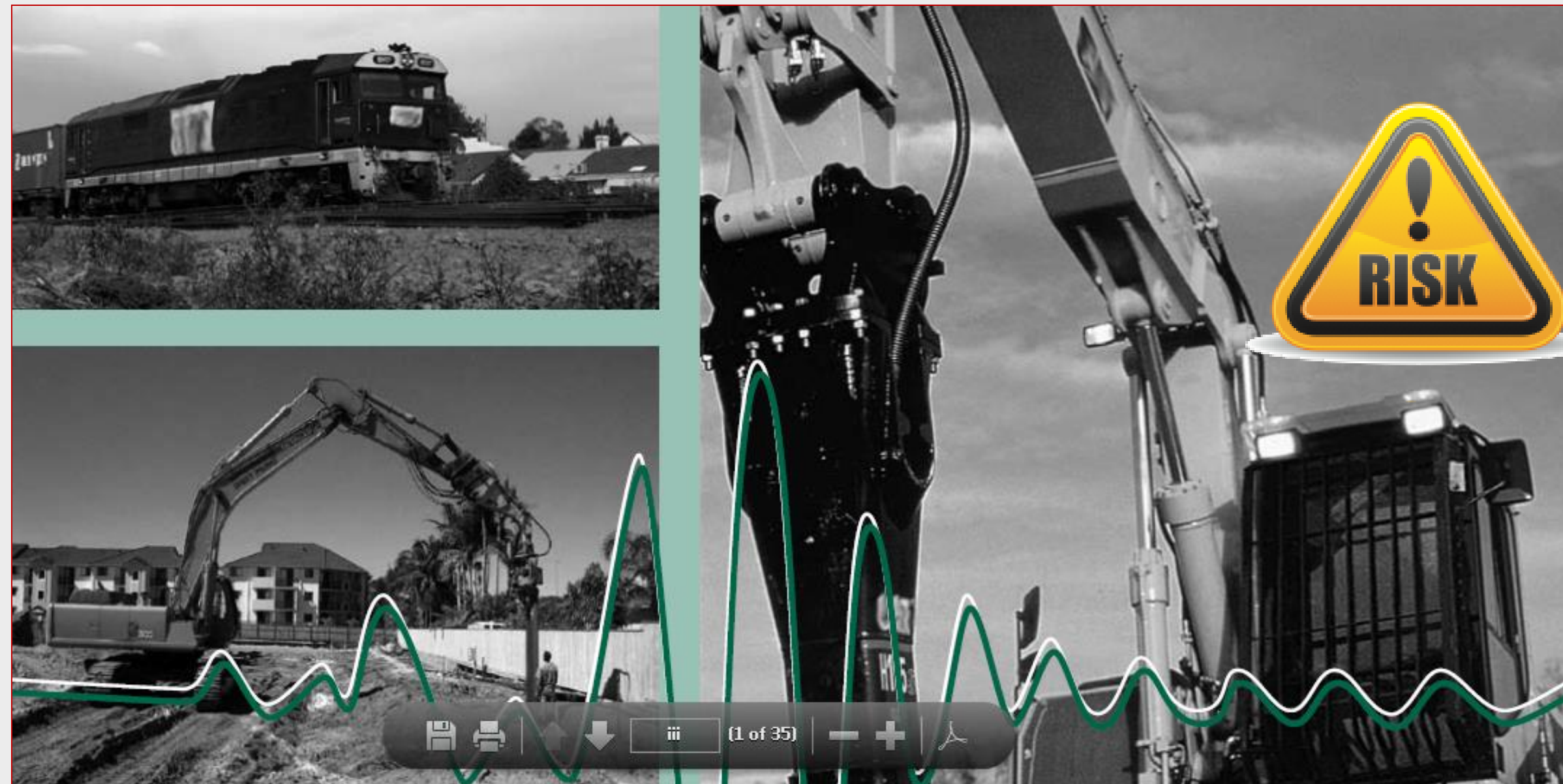
- The more frequent causes of formwork failure, however, are other effects that induce lateral force components or induce displacement of supporting members
- Inadequate cross bracing and horizontal bracing of shores is one of the factors most frequently involved in formwork accidents
- Investigations prove that many accidents could have been prevented if a minimal amount had been spent on diagonal bracing for the formwork support





### 3. Vibration

- Forms sometimes collapse when their supporting shores or jacks are displaced by:
  - passing traffic
  - movement of workers and equipment on the formwork
  - the effect of vibrating concrete to consolidate it
- Diagonal bracing can help prevent failure due to vibration





## 4. Unstable Soil



- Falsework should be safe if it is adequately braced and constructed so all loads are carried to solid ground through vertical members
- Shores must be set plumb and the ground must be able to carry the load without settling
- Site drainage must be adequate to prevent a washout of soil supporting the soleplate

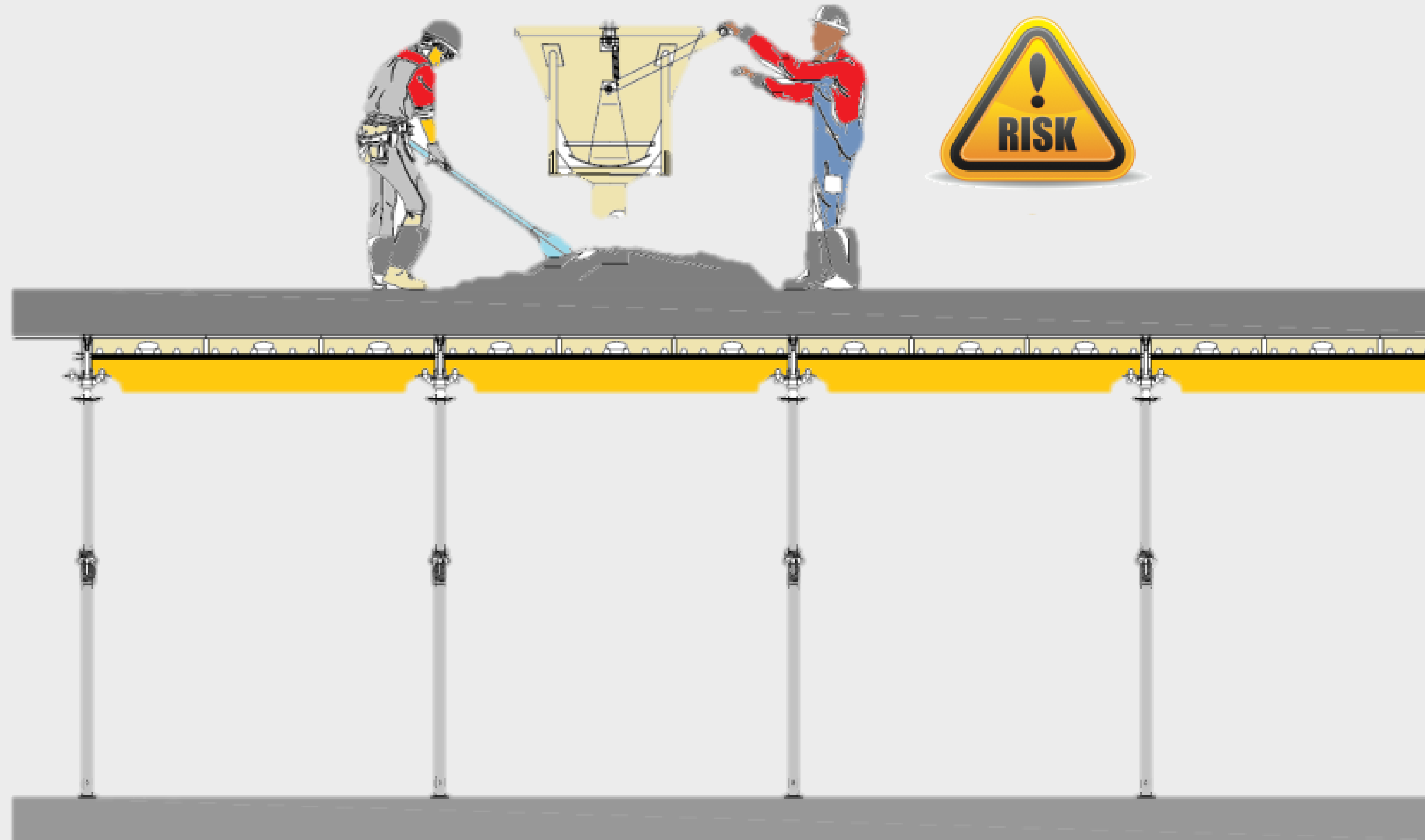




## 5. Inadequate Control of Concrete Placement



**TOP 2  
Cause of  
Failure**





## 6. Lack of Attention to Formwork Details



- Even when the basic formwork design is soundly conceived, **small differences** in assembly details may cause local weakness or overstress loading to form failure
  - This may be as simple as insufficient nailing, or failure to tighten the locking devices on metal shoring
- **Other details that may cause failure are:**
  - Inadequate provisions to prevent rotation of beam forms where slabs frame into them on the side
  - Inadequate anchorage against uplift for sloping form faces
  - Lack of bracing or tying of corners, bulkheads, or other places where unequal pressure is found
  - Over loading of the system





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? Housekeeping

? Founding

? Soleplate





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## Essential Factors to ensure Successful (Safe) Temporary Works



- (I) the foundation conditions are suitable to withstand the loads caused by the temporary works structure and any imposed load in accordance with the temporary works design.

**Typical Design Load 28 kN - suitable founding?**



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? Supported

? Designed

? Founding





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Essential Factors to ensure Successful (Safe) Temporary Works



? Founding

? Level

? Compacted





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Essential Factors to ensure Successful (Safe) Temporary Works



- ? Supported
- ? Bracing
- ? Founding





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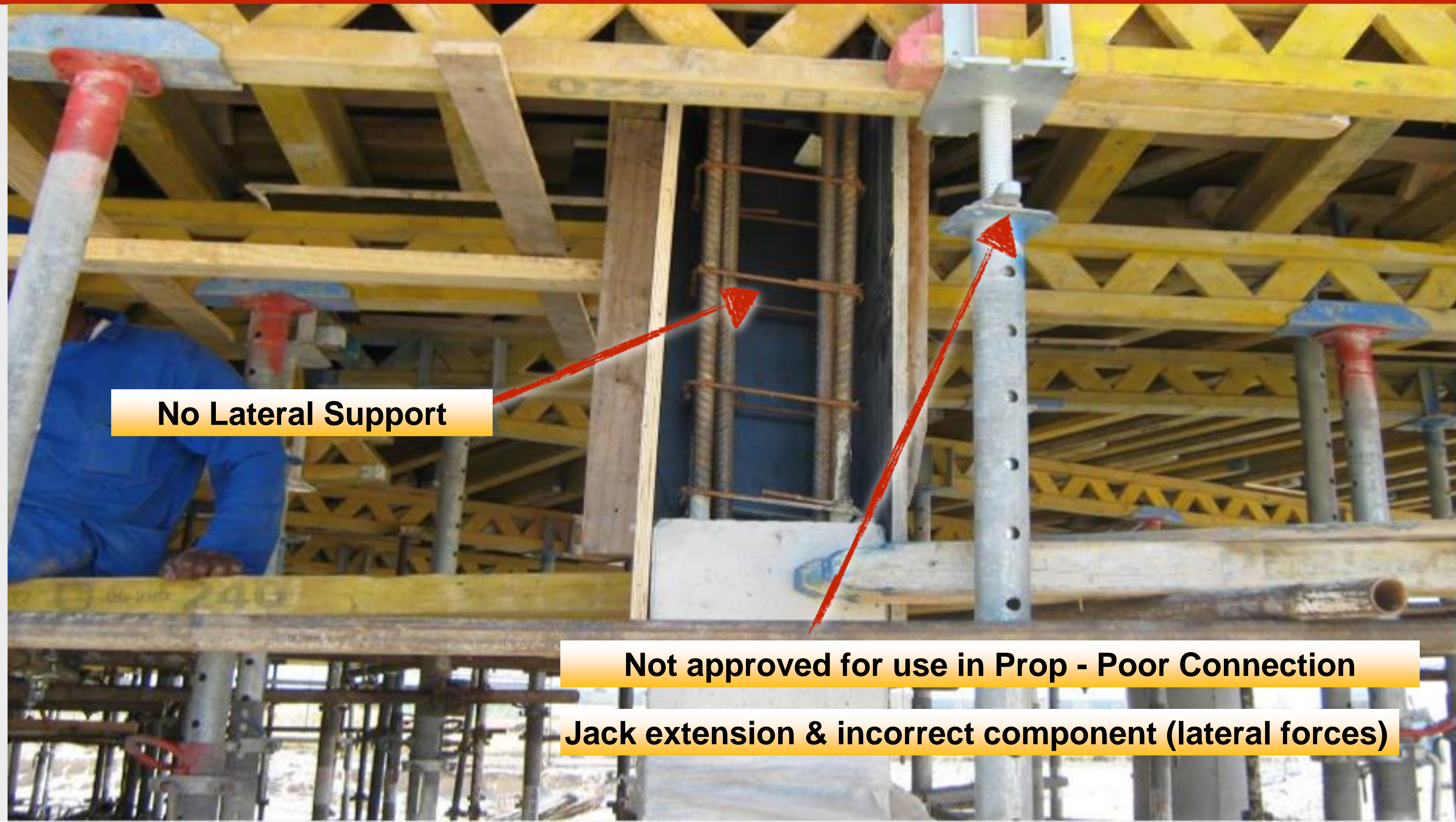
? Supported

? Braced

No Lateral Support

Not approved for use in Prop - Poor Connection

Jack extension & incorrect component (lateral forces)





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Essential Factors to ensure Successful (Safe) Temporary Works



? Braced



Column Height to correct Level - Bracing to offer lateral support not possible



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? Supported

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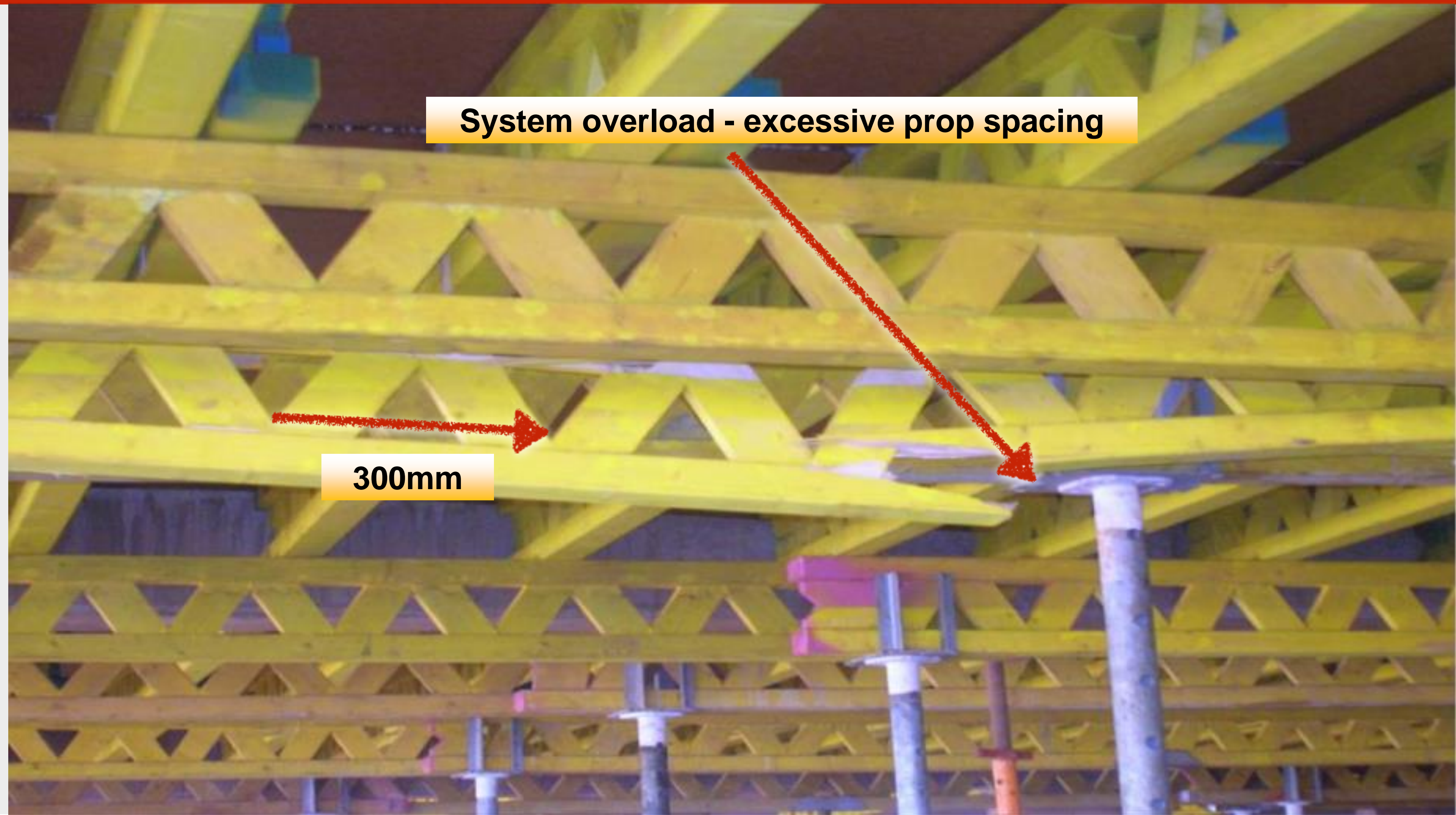
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? Design followed?

System overload - excessive prop spacing

300mm





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Plumb?

Sans approved?



Why?



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## Site Observations issued by PERI Technical & Sales Staff



**Is the newly cast slab designed to support this load?**

**Is this slab sufficiently back propped to support this load?**



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## Essential Factors to ensure Successful (Safe) Temporary Works



**Equipment and steel prematurely loaded on formwork**

**No progressive patching during erecting process**







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**D Critical Success Factor in the Construction Industry**



- **Risk categorization**
  - Consequence of failure (should it occur)
  - Design complexity
  - Execution criticality (scope for adaptation)
- **Good Temporary Works Design** (early involvement of temporary works designer)
- **Checking of Temporary works Designs** (clear to understand designs & documents)
- **(BIM) Good Temporary Works Site Inspection** (before the loading is applied)
- **(BIM) Good Temporary Works Co-ordination** (critical sequences or phases of work)



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## Essential Factors to ensure Successful (Safe) Temporary Works



Drafting board



CAD



BIM

time



Checklisten		Checkl. suchen	Element 1	Kopfzeile	
	19	HEX NUT ISO4032-M20-8-VZ		-	N/A
Mangel	<input type="text" value="Tippen, um Kommentare eingeben"/>				
	20	WASHER ISO7089-20-200HV-VZ.		-	N/A
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	21	HEX BOLT ISO4014-M20X160-8.8VZ		-	N/A
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	22	CROSS CONNECTOR VARIOKIT		-	N/A
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	23	GIRDER GT 24, 450	+		N/A
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	24	GIRDER GT 24, 420		-	N/A
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	25	GIRDER GT 24, 330		-	N/A
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	26	STEEL WALE U100 SRZ 182,5 CM		-	N/A
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	27	STEEL WALER SRU 147 U120		-	N/A
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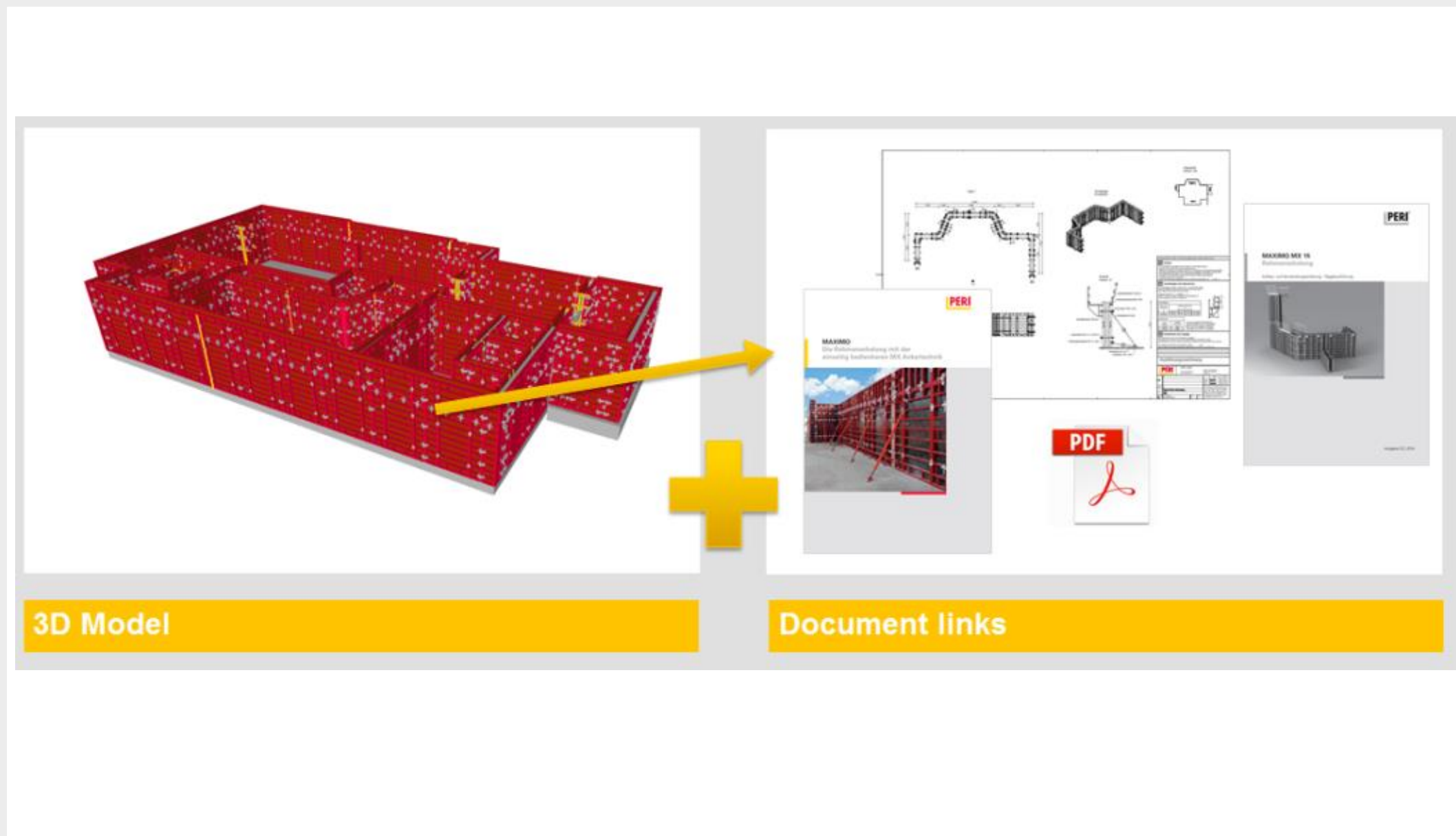


3D Modelling is only a first step. It has to be confirmed

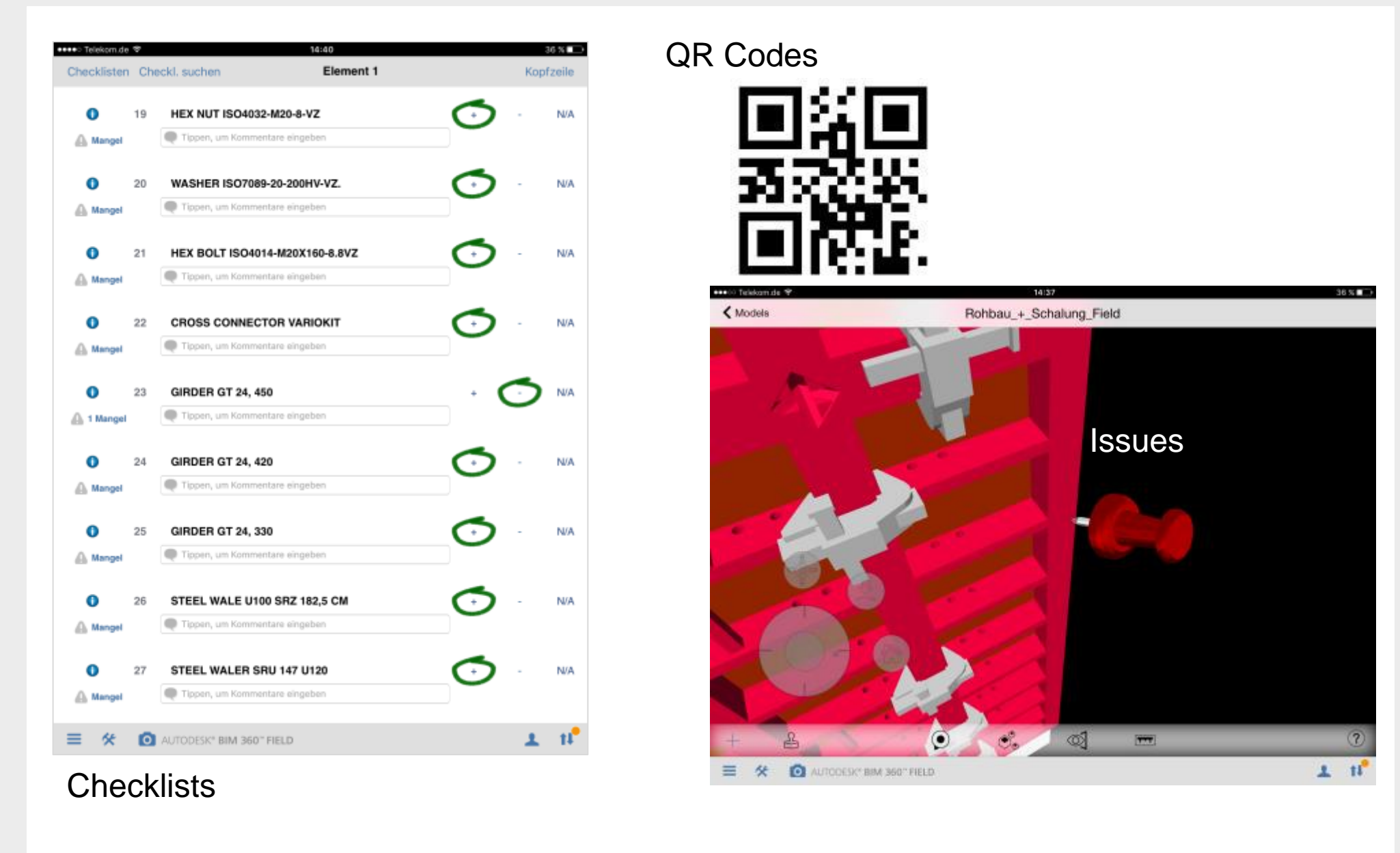


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## Essential Factors to ensure Successful (Safe) Temporary Works



3D Modeling and Assembly Instructions



Collaboration

AUTOCAD – 360 Field

3D Modeling – Active Collaborations on Site



## How can one contribute to minimizing RISK now and in FUTURE

- Effort to mitigate RISK & provide KNOWLEDGE to enable COMPETENCE
- Make use of Service providers tools offered – BIM etc.



# Questions

