A Precast Bridge Bent System for Seismic Regions

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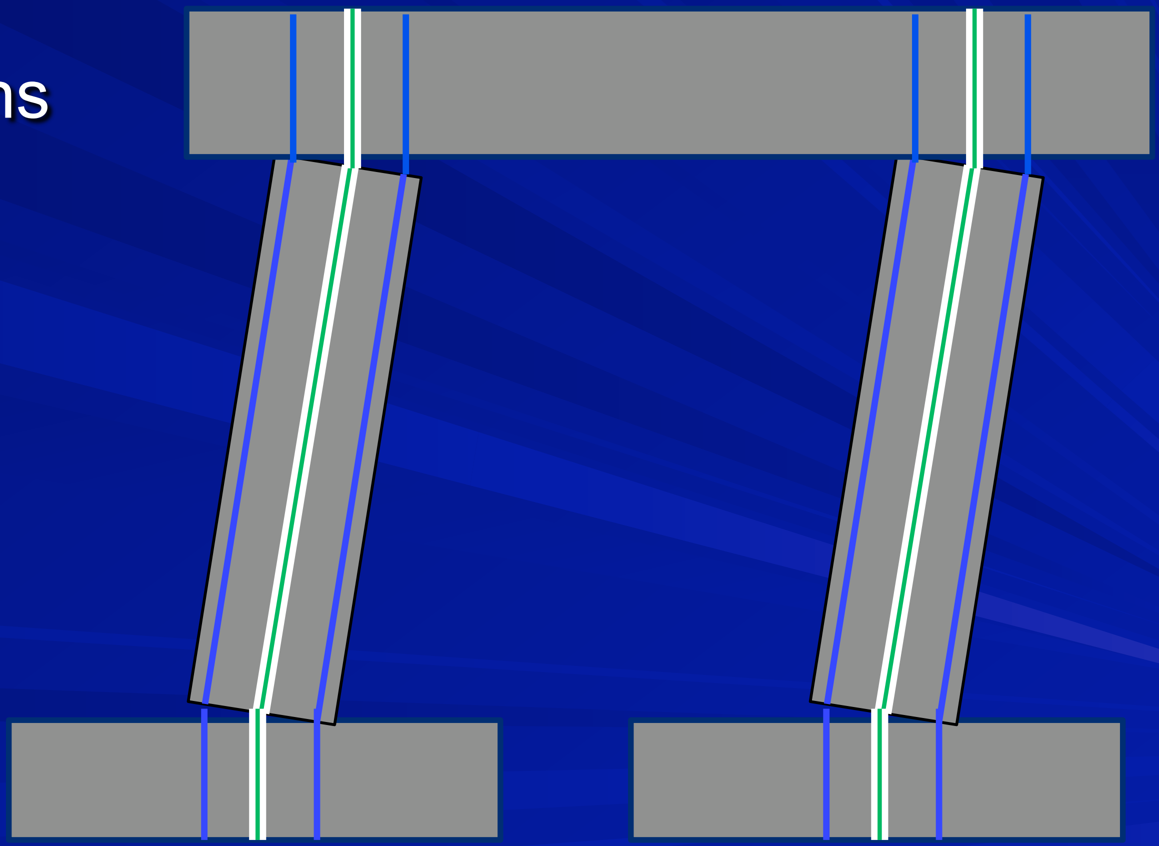
Background

- Traffic congestion.
- Need to accelerate on-site bridge construction.
- Use precast concrete components.
- Connection details need to be:-
  - seismic-resistant
  - readily constructible.

Background

Self-centering structural systems

- Unbonded prestressing tendons for elastic restoring force.
- Yielding steel for energy dissipation.



Project Tasks

1. Analysis of Residual Displacements.

- Improve previous OpenSEES models.
- Simulate responses for a range of bridge properties and ground motions.
- Correlate degree of re-centering with structural details.

Work is ongoing (Haraldsson).

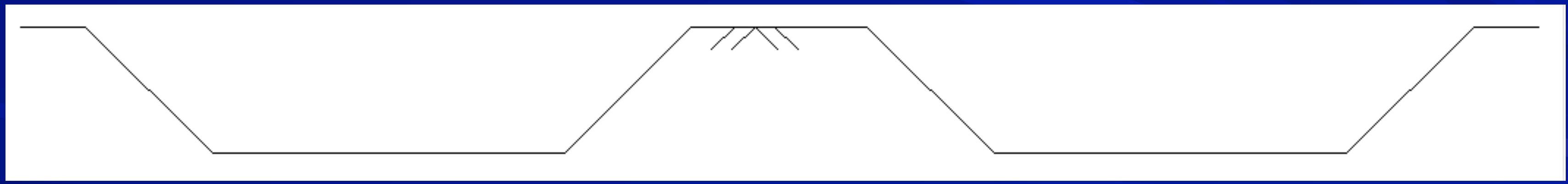
Project Tasks

2. Self-centering performance.

- Laboratory tests to investigate ways of incorporating self-centering into ABC systems.

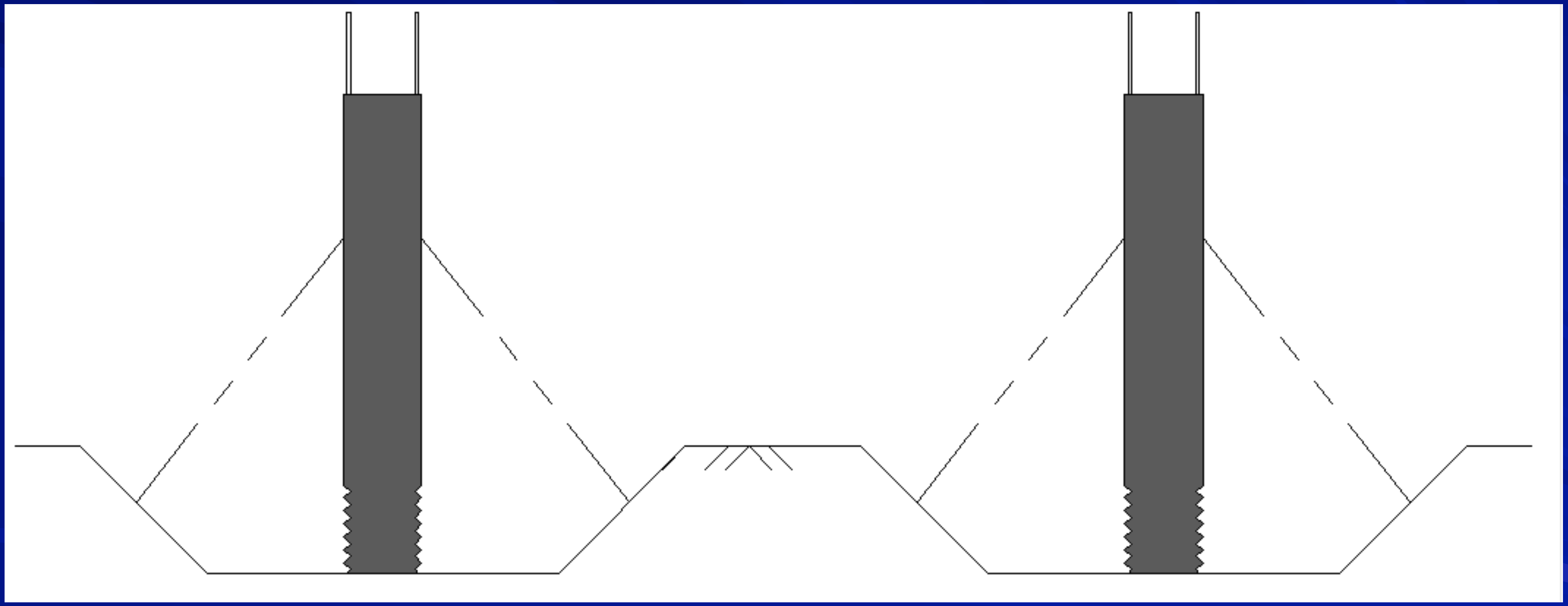
Work is ongoing (Janes, Hung).

Proposed Construction Procedure



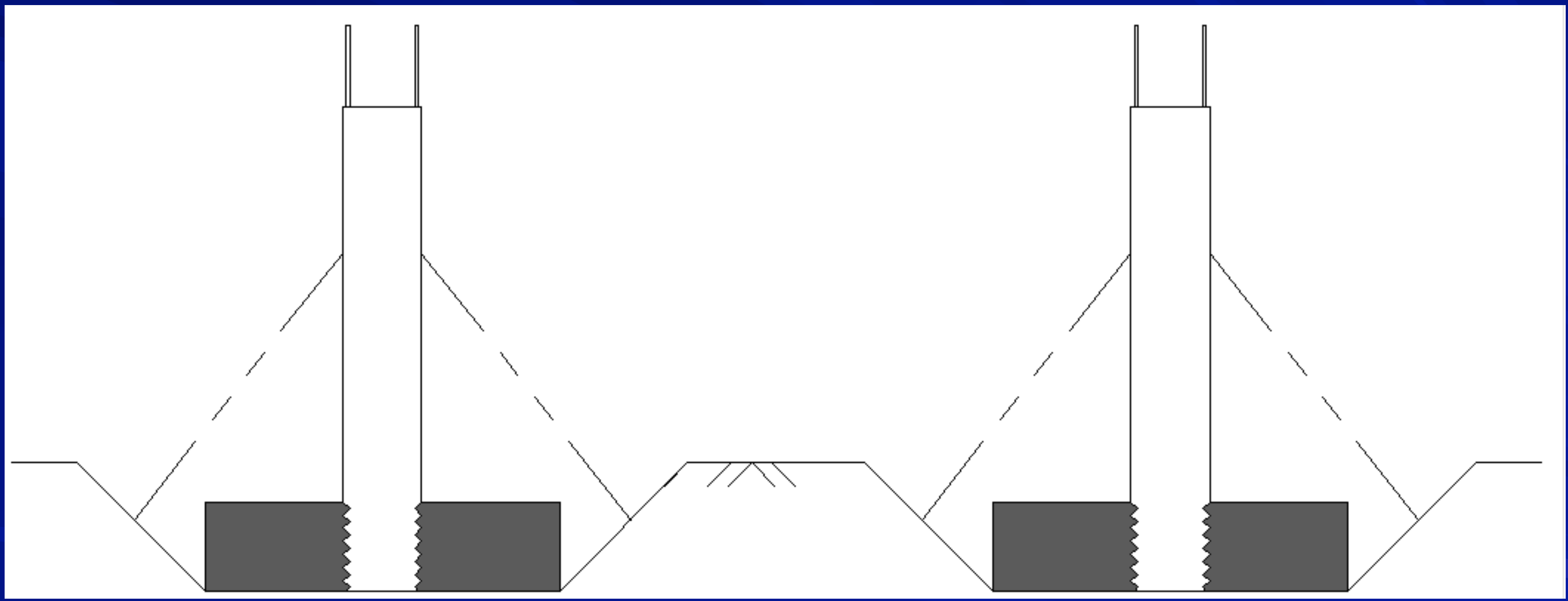
1) Excavate footing.

Proposed Construction Procedure



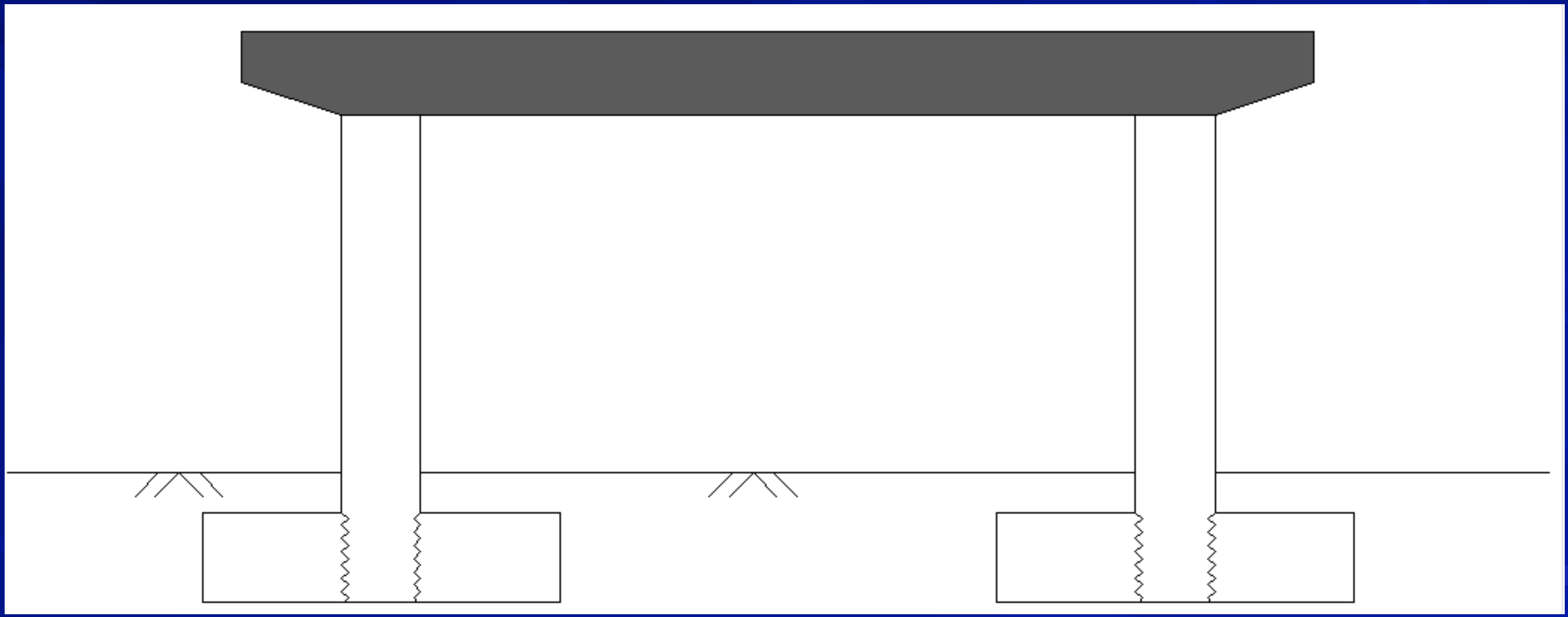
2) Position and brace precast column.

Proposed Construction Procedure



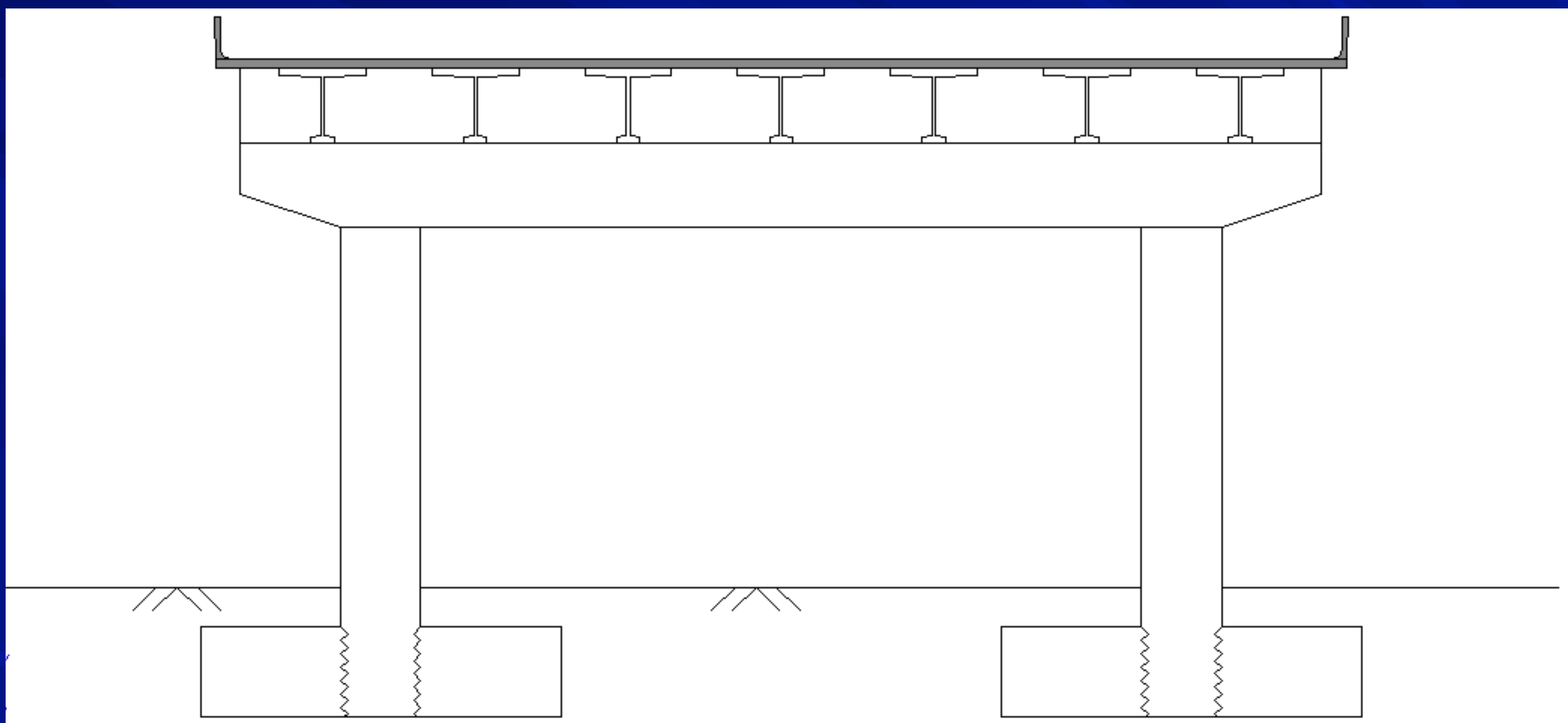
3) Place footing reinforcement and cast.

Proposed Construction Procedure



4) Set cap-beam, grout bars into ducts.

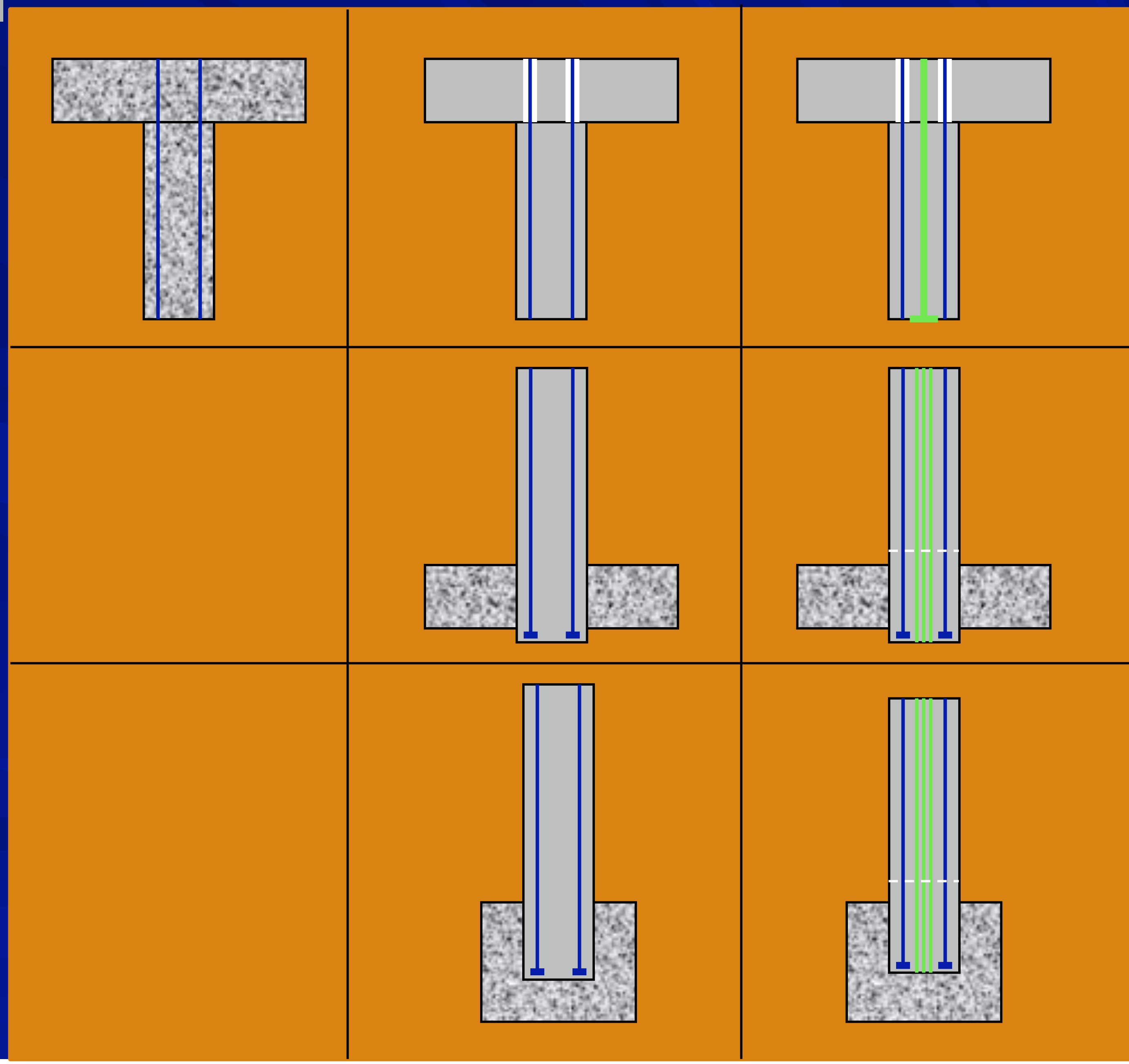
Proposed Construction Procedure



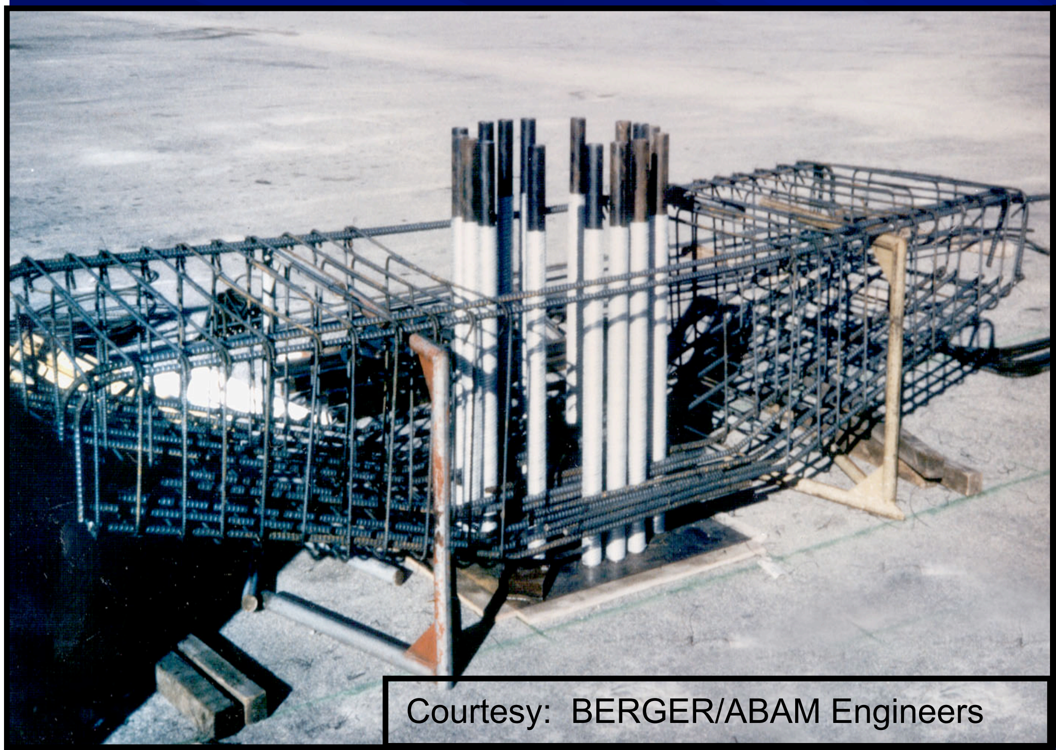
5) Place girders, diaphragms and deck.

Connection Details

	c.i.p. RC (ref)	Precast RC	Precast prestressed
Cap-beam to column			
Column to spread footing			
Column to drilled shaft			



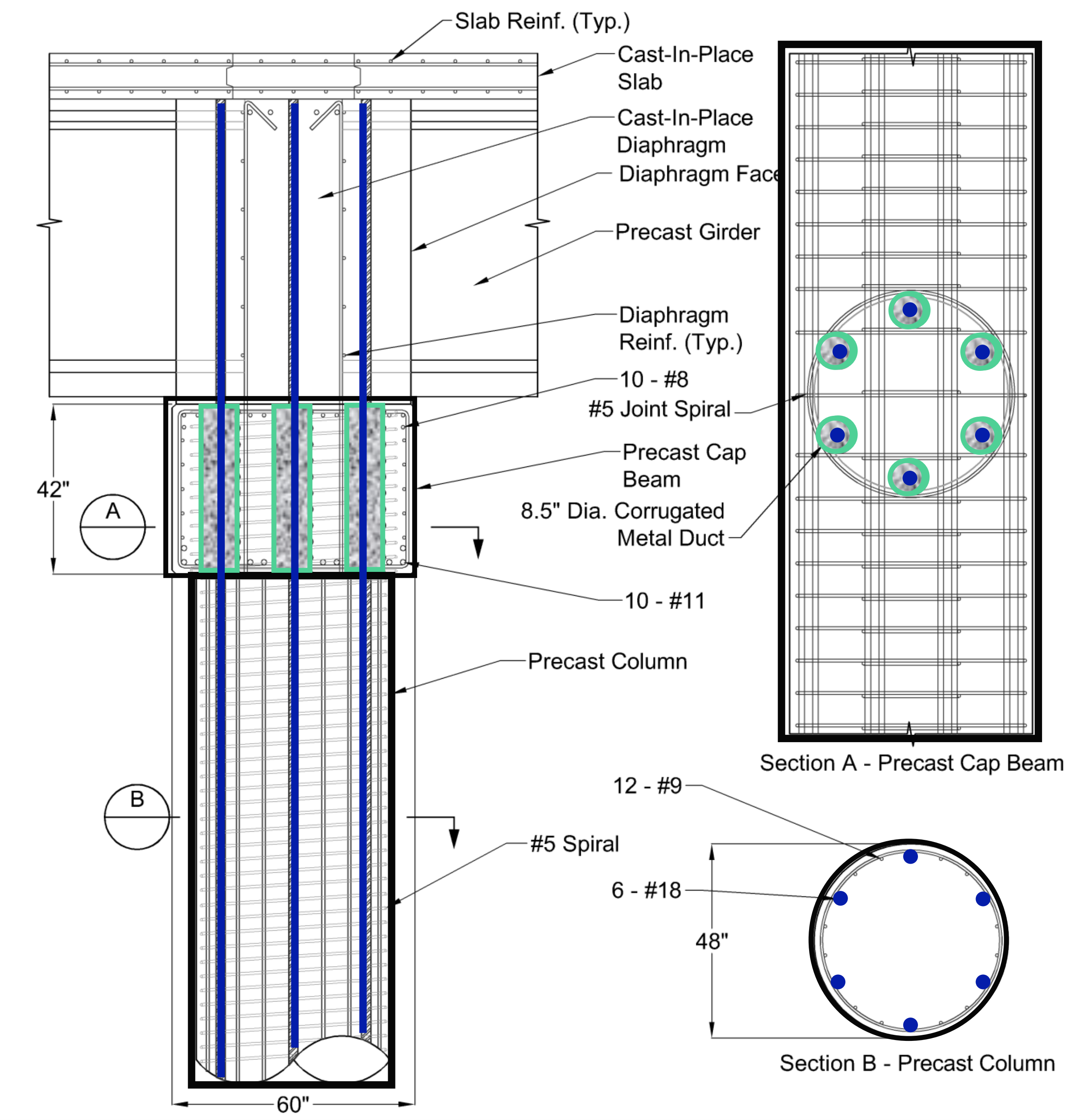
Cap Beam Connection - Many small ducts


Courtesy: BERGER/ABAM Engineers

Conventional c.i.p. detail → precast.

Many ducts, tight tolerances.

Cap Beam Connection – Large bars



- 4ft diameter column
- 5ft x 3.5ft cap beam
- 6 # 18 rebar
- 8.5" corrugated steel ducts
- High strength grout

Cap Beam Connection – Seismic test

Failure occurs in the column.

Large-bar precast connection

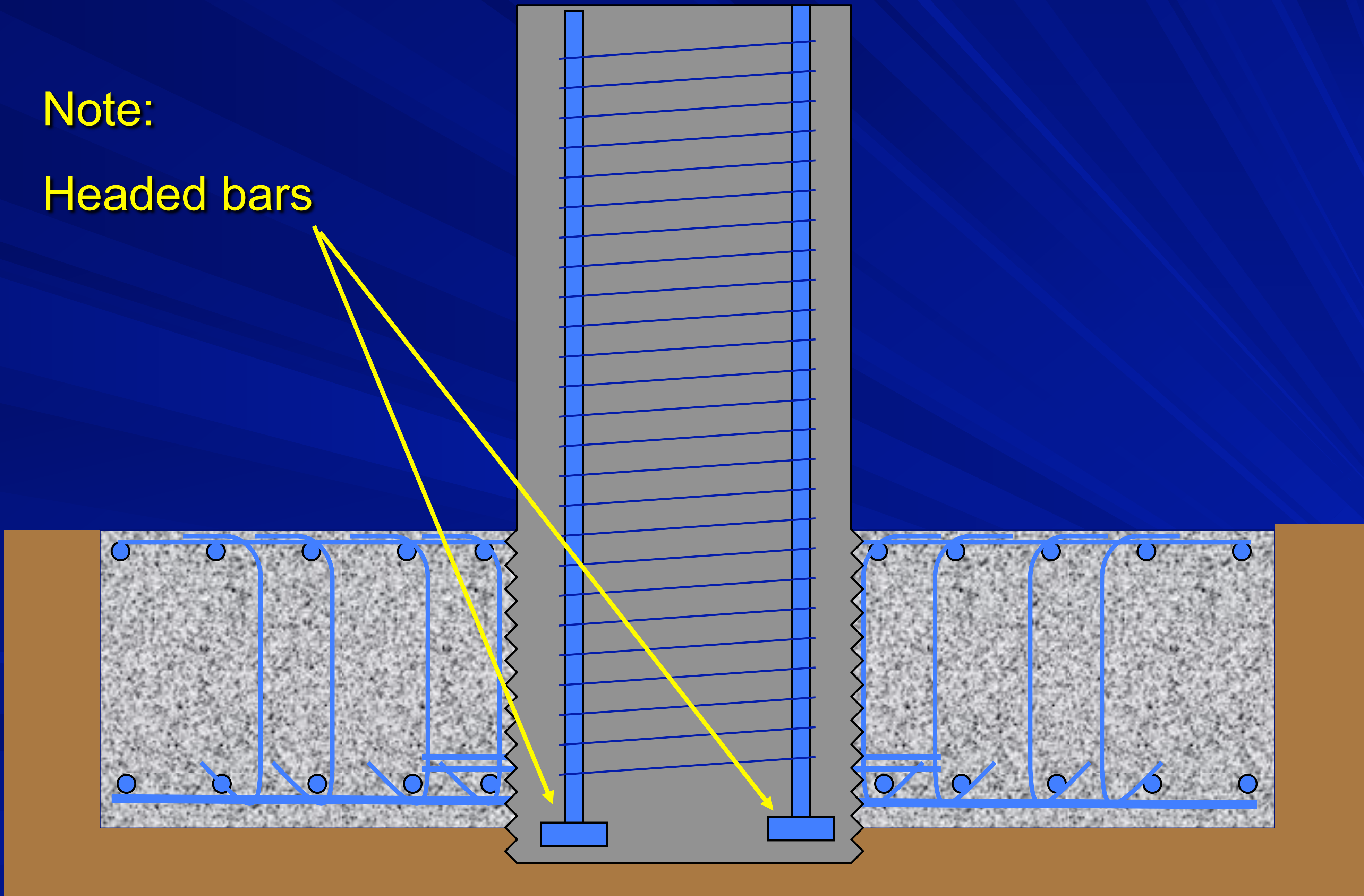
behaves the same as a

cast-in-place connection.

Footing Connection - Construction

Note:

Headed bars

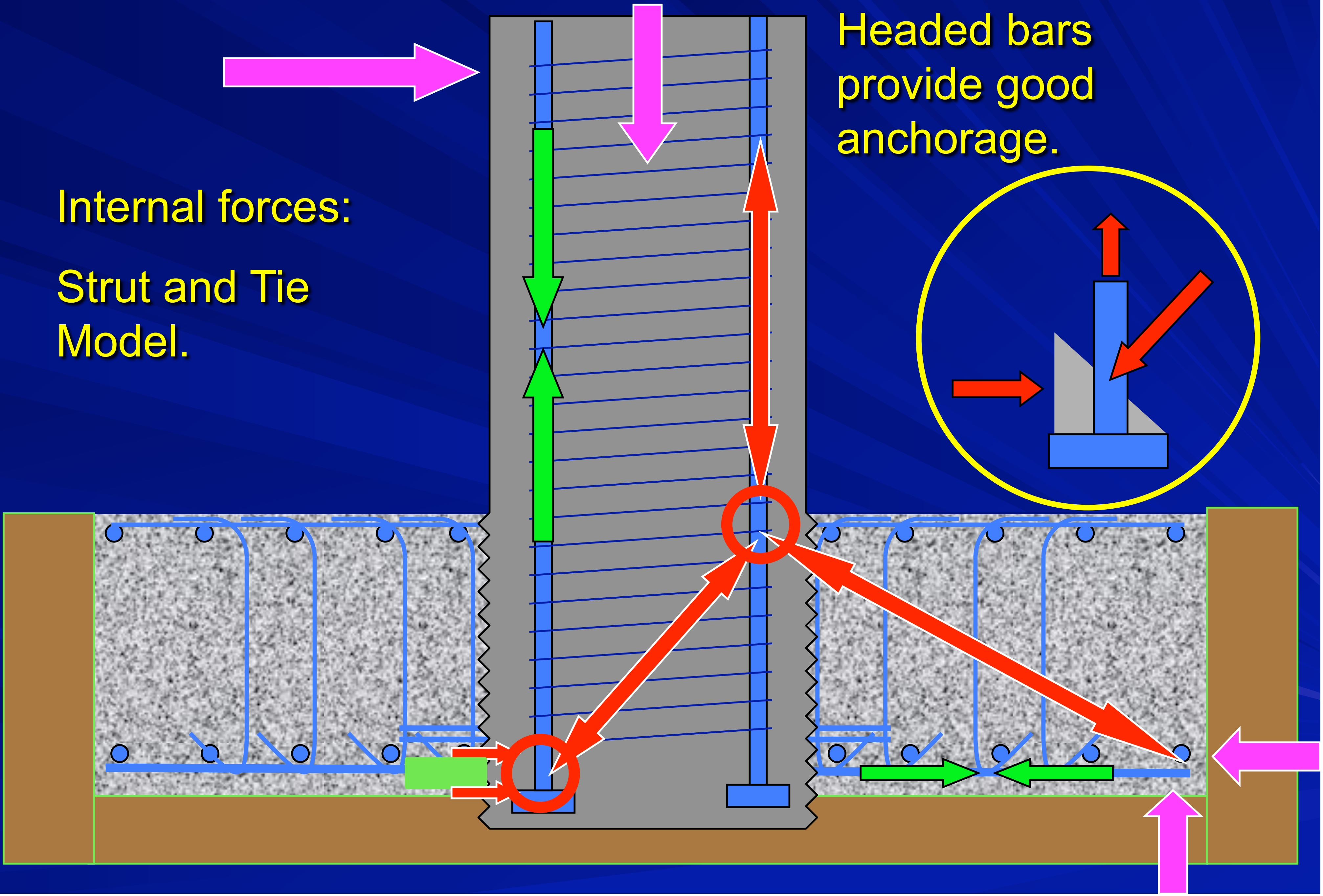


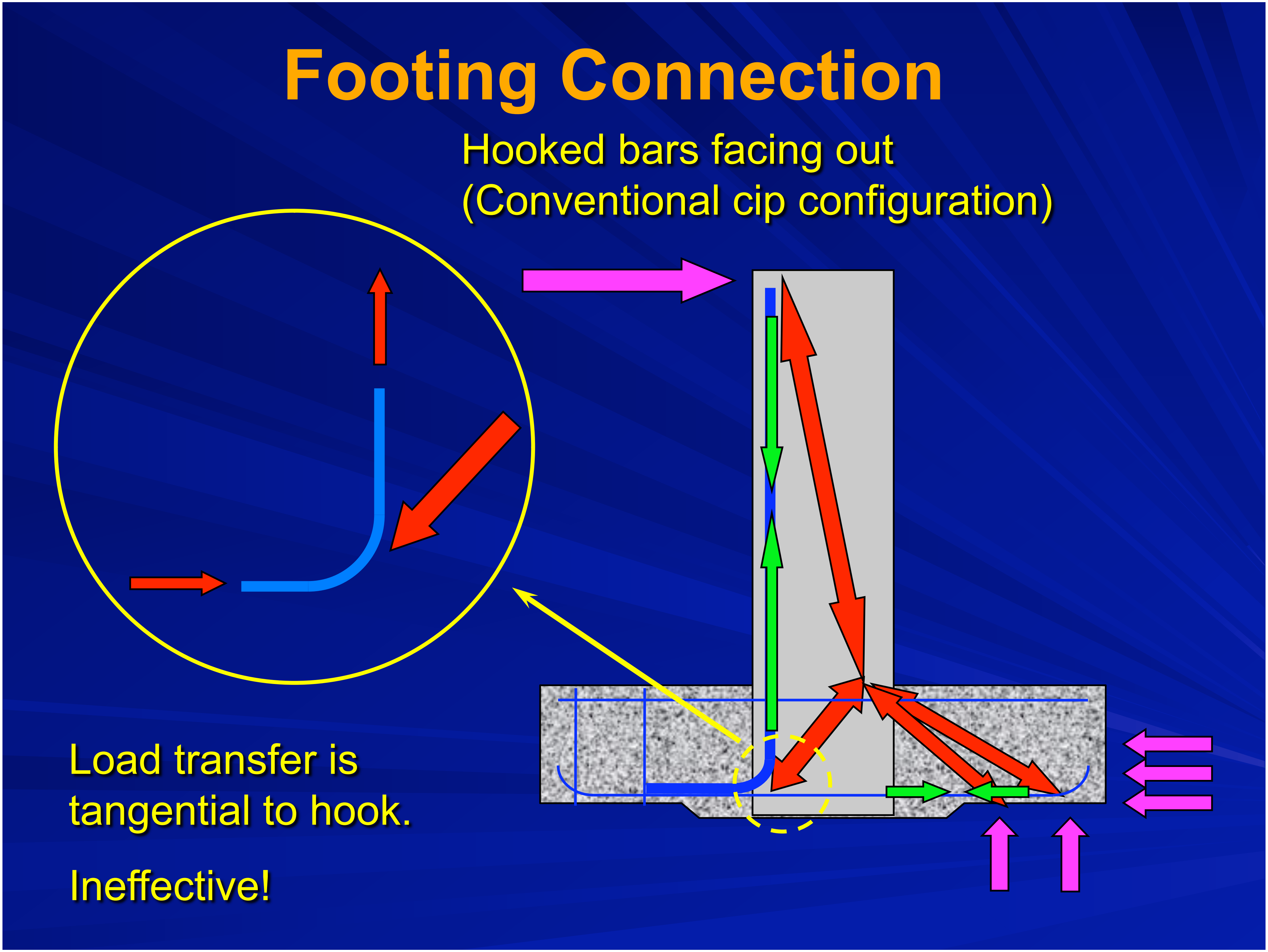
Footing Connection - Headed Bars

Internal forces:

Strut and Tie Model.

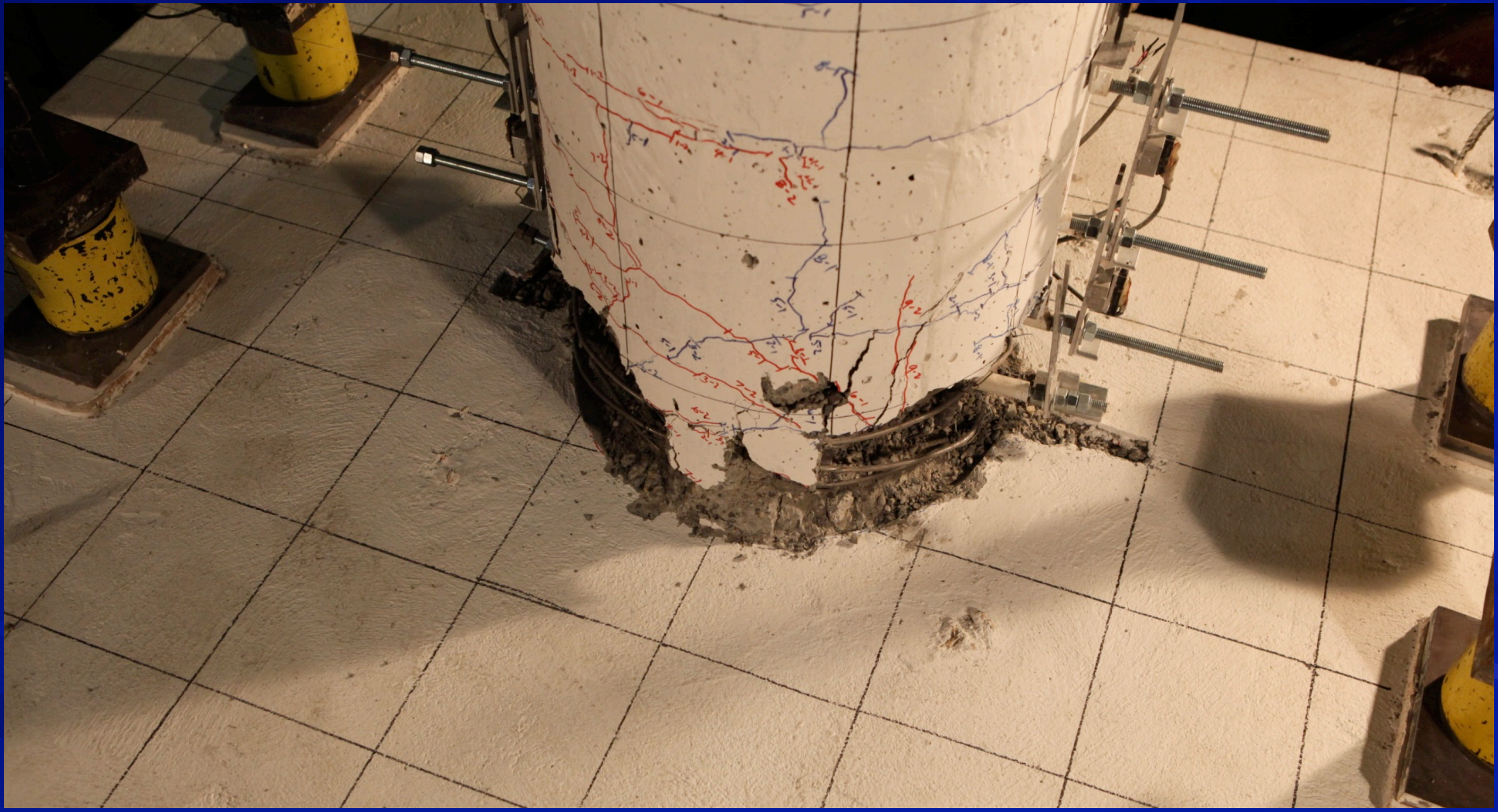
Headed bars provide good anchorage.




Footing Connection
Hooked bars facing out
(Conventional cip configuration)
Load transfer is
tangential to hook.
Ineffective!

Spread Footing Connection - Test

Spread Footing Connection - Test



After seismic testing.   Foundation undamaged.

Spread Footing Connection – Seismic Test

Failure in column.

Footing undamaged.

Behavior identical to conventional c.i.p. system.

Seismic performance exactly as wanted.

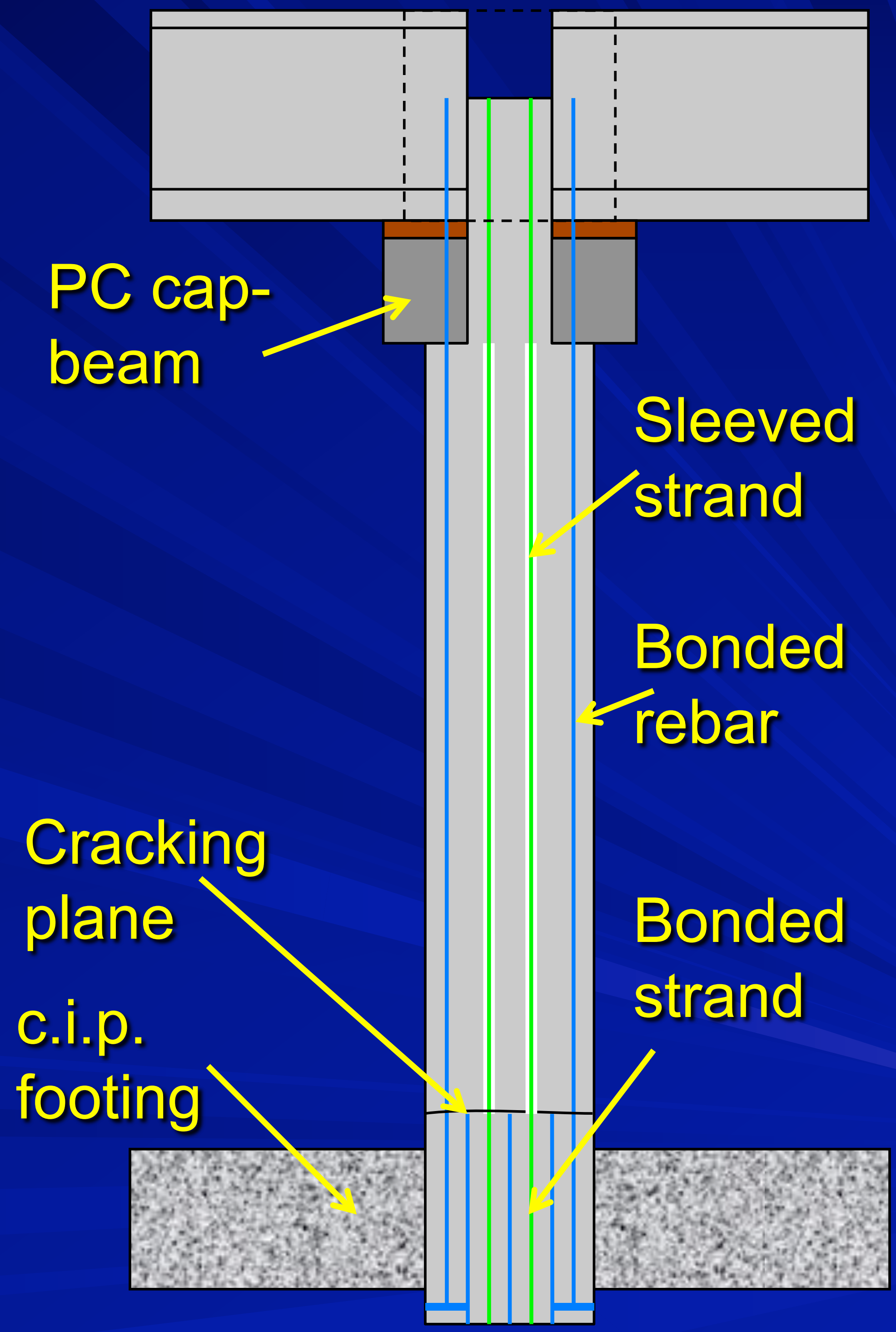
Spread Footing Connection
Conclusions

1. Shorter on-site construction time.
2. Simple to fabricate, transport and erect.
3. Footing undamaged in lateral load and vertical load tests.
4. Seismic performance as good as, or better than, conventional c.i.p. construction.

Spread Footing
Pre-tensioned system

1. Pre-tensioning solves corrosion problems perceived to exist in post-tensioning.
2. Pre-tension in a plant.
   - Good QC.
   - Special equipment and extra site time for post-tensioning are not needed.
   - Can add rebars for energy dissipation.
3. Configuration of connection to cap beam?

Pre-tensioned System Connections



Spread Footing
Pre-tensioned system

1. Strand needs to be:
   - Debonded over much of column height.
   - Anchored at top and bottom.
   - Use epoxy strand for good bond?

Spread Footing
Pre-tensioned system

Specimens now being designed.

- One footing connection
- One cap-beam connection

Testing planned to start October 2010.

Field load testing