UNIVERSITY *of* WASHINGTON

PBEE of California High Speed Rail System

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California High Speed Rail

Credit: NC3D

Original Project Vision: Great Candidate for PBEE

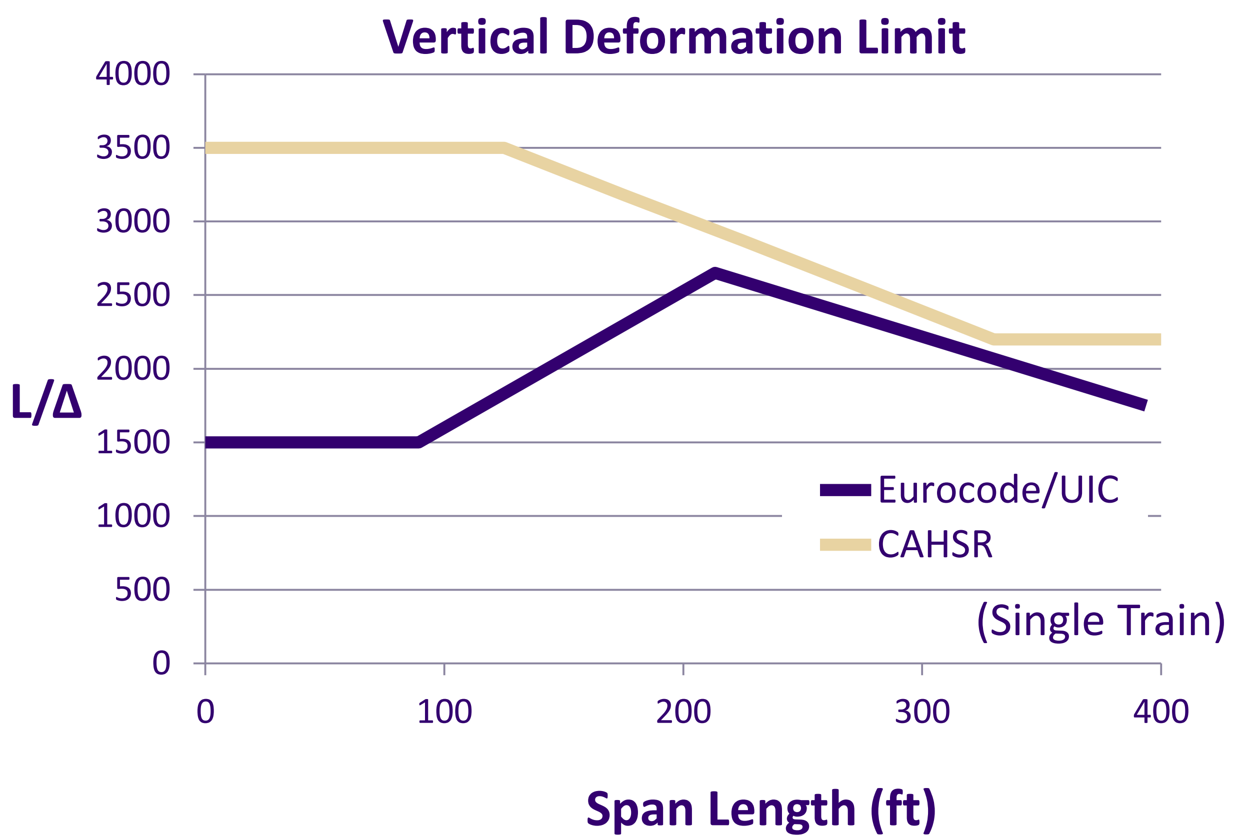
- Specific (and stringent) Performance Expectations
- Large Variation of Seismic Hazard
- Large Budget (>$77B cost)
- Numerous Bridges → Standardization
- Enthusiastic Partner (CA_HSR)

Collaboration with ABC UTC

- Accelerated Bridge Construction US DOT University Transportation Center (FIU)
  - Work closely with CA-HSR and Consultants
  - Extend ABC Concepts to CA-HSR
    - Prefabrication
    - Seismic Isolation (multiple-level resistance)
    - Contracting Methods
  - CA-HSR Workshop

Superstructure LL Deformation Limits

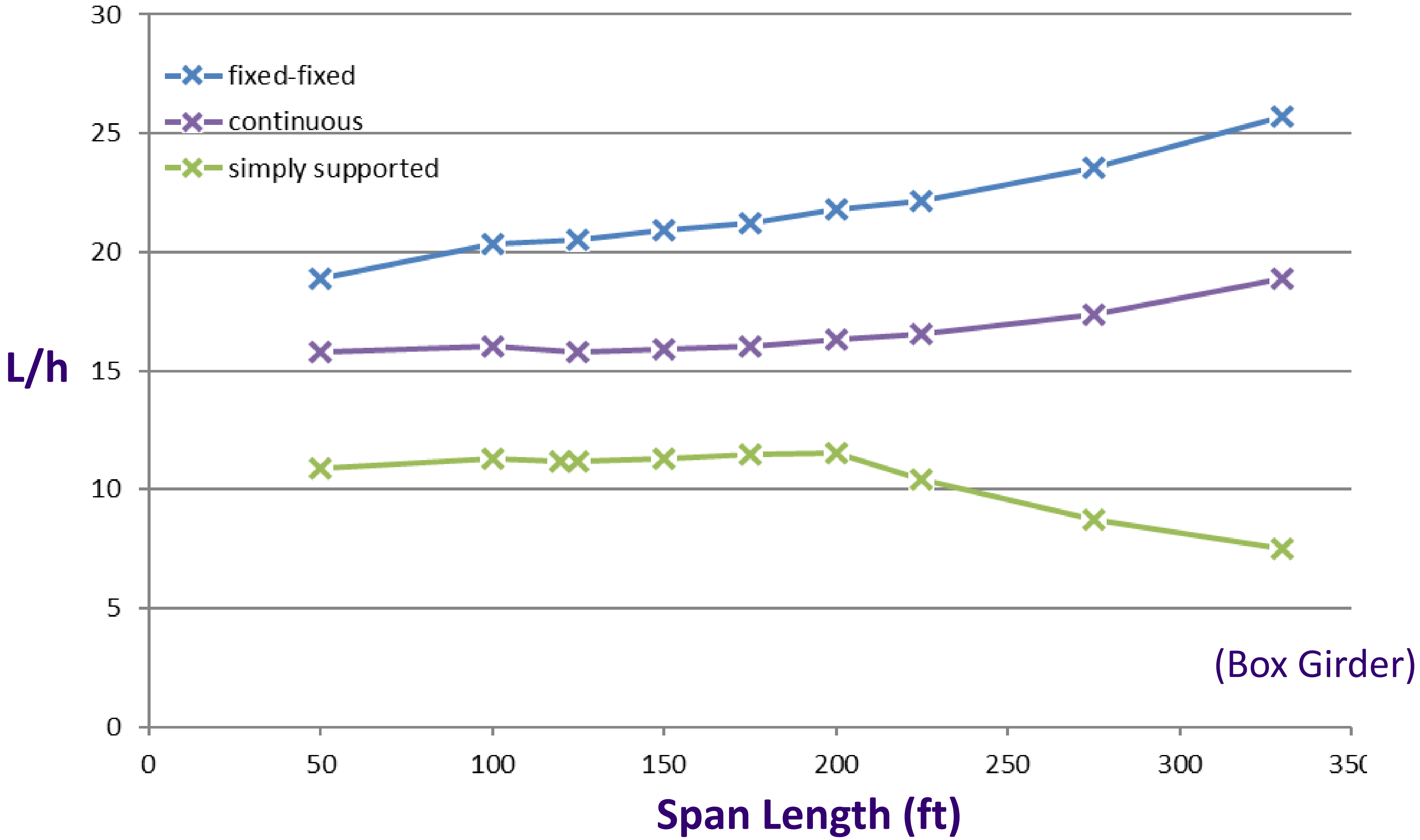
- Vertical Deformations
- Relative Deformations
- End Rotations
- Frequency Ranges



Note:
Higher L/Δ implies a more stringent requirement

Example: 150 ft * 12 in./ft /3200 = 0.56 in.

Span-To-Depth Ratios (L/h)



Example: Simply Supported: 150 ft / 12 = 12.5 ft

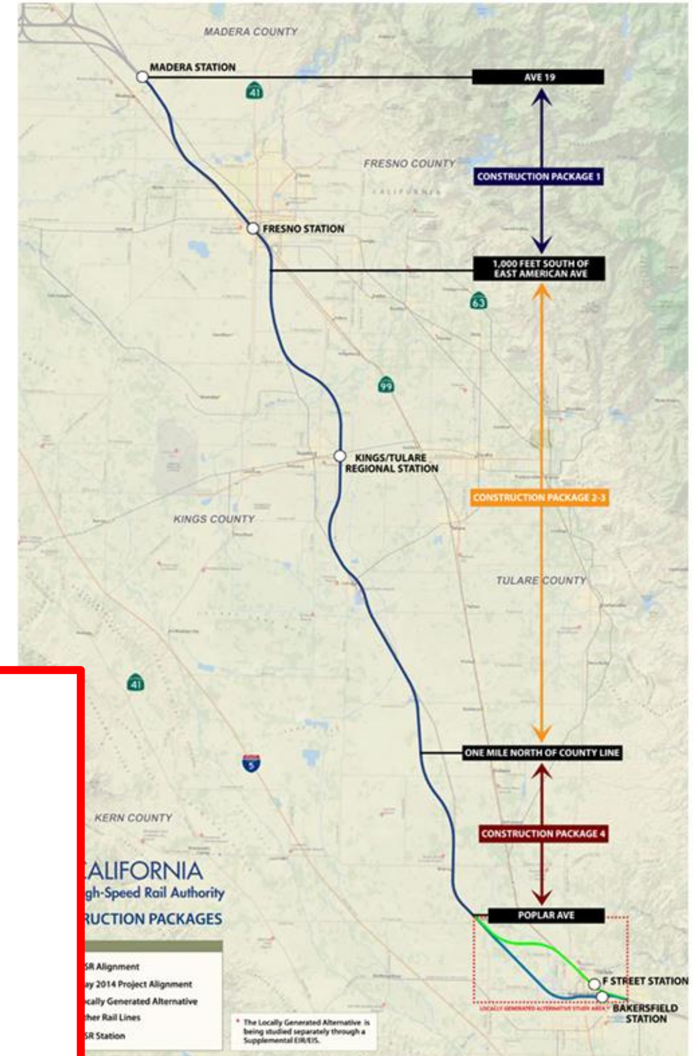
Superstructure: Controlling Design Criteria.

- Superstructure dimensions are controlled by service load criteria (L/h ratio).
- Deep members are too deep and heavy for prefabrication and road transportation.
- *Cast-in-place* or *Full-Span Precasting* are the only real options.
- *Full-Span Precasting* requires large capital investment, large contracts, lots of repetition.

ABC Project Challenges

> Huge Superstructures → Heavy → Focus on Substructures

> Separate Design-Build Contracts → Each uses a different system → Little Repetition



BUSINESS NEWS FEBRUARY 12, 2019 / 12:22 PM / 6 MONTHS AGO

California to scale back $77 billion high-speed rail project: governor

David Shepardson 4 MIN READ

(Reuters) - California Governor Gavin Newsom said on Tuesday the state will dramatically scale back a planned $77.3 billion high-speed rail project that has faced cost hikes, delays and management concerns, but will finish a smaller section of the line.

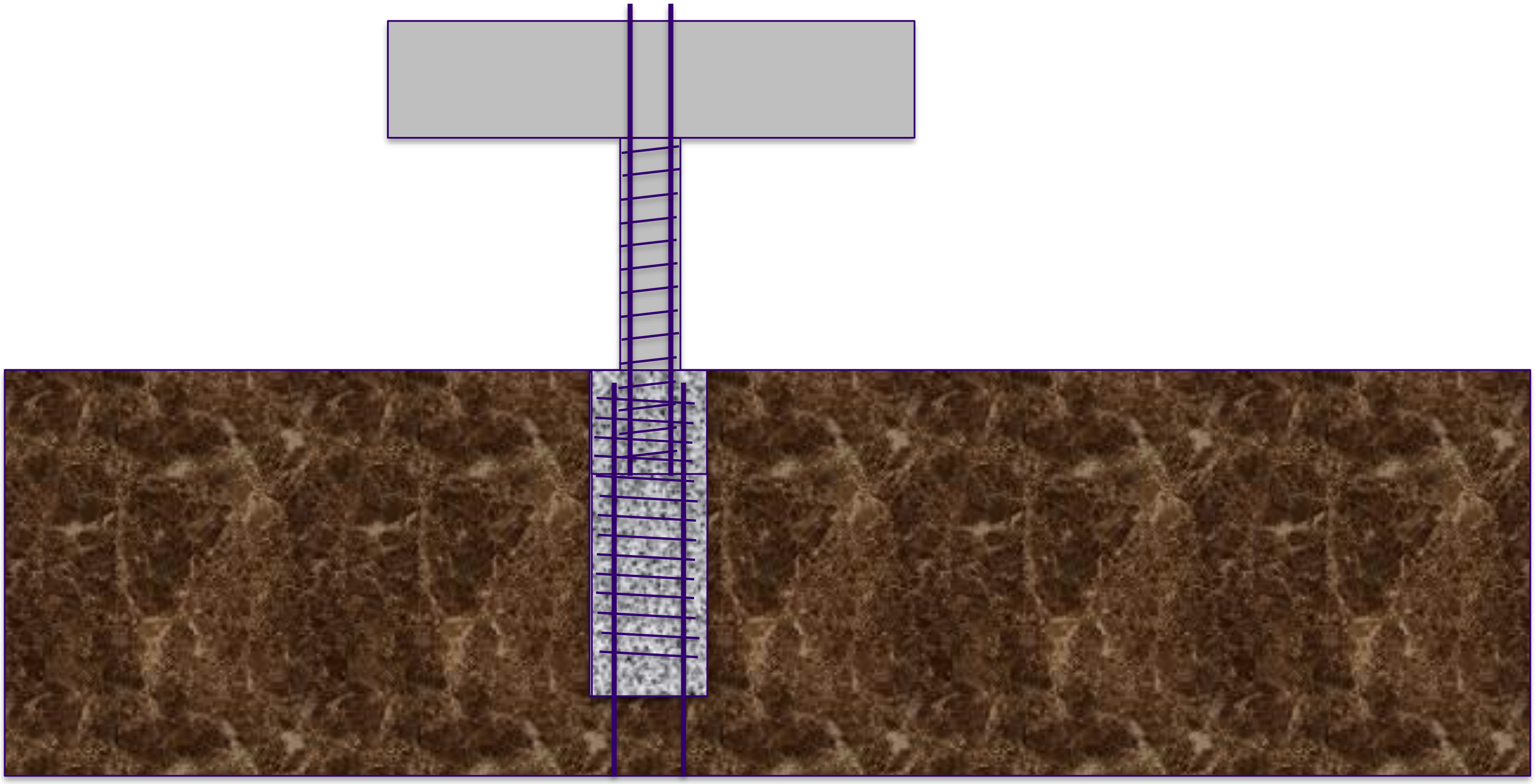
Revised Vision for PEER Project

- Focus on PBEE of Connection between Column and Enlarged (Type 2) Drilled Shafts
  - System important for HSR and Caltrans (Type 2 shafts).
  - How should PBEE design requirements change with differences in performance expectations?
  - Builds on work at UCSD and UW.
  - Has potential for collaboration with other PEER TSRP projects
    - Joel Conte (Uncertainty in PBSD)
    - Sashi Kunnath (Bridge Column Capacity Limit States)
    - Dawn Lehman (Concrete-filled Steel Tubes for HSR)
    - Michael Scott (Bridge Functionality as PBEE Metric)

Type 2 shafts – background

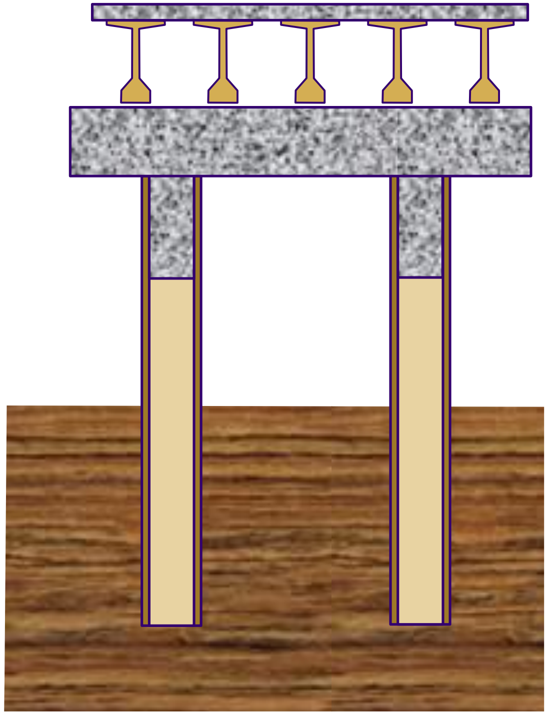
- Shafts have a smaller footprint than spread footings. May be used even in competent soil.
- Type 2 shafts: shaft diameter > column diameter.
- Beneficial because:
  - Shaft is stronger than the column, so
  - Critical plastic hinge forms at base of column, where it is accessible for inspection and/or repair after an earthquake. *(Performance benefit.)*
  - Provides the opportunity to place column accurately after the main part of the shaft has been poured. (*Construction benefit*)

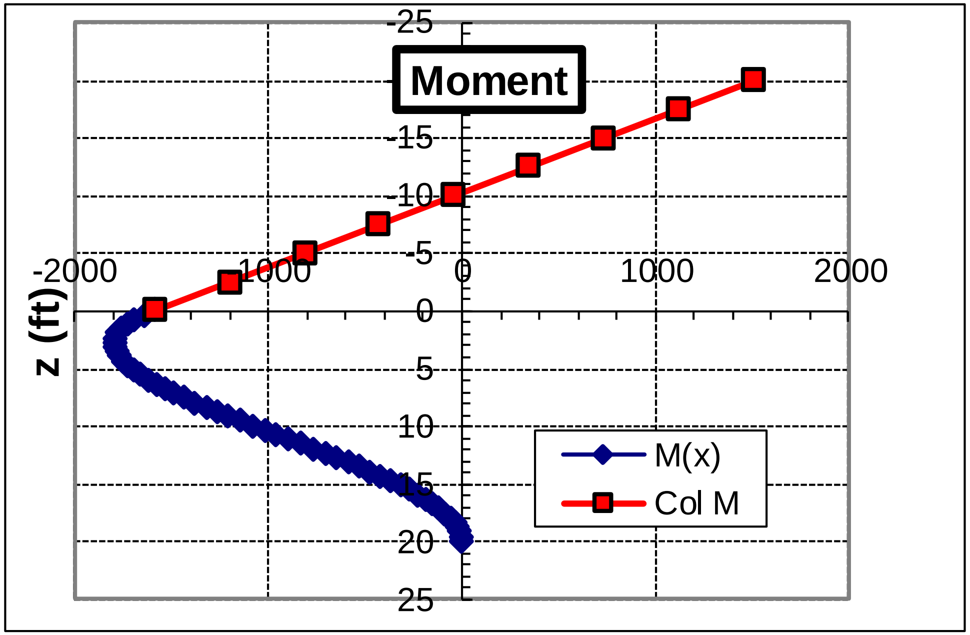
Type 2 shafts – construction



Type 2 shafts – features

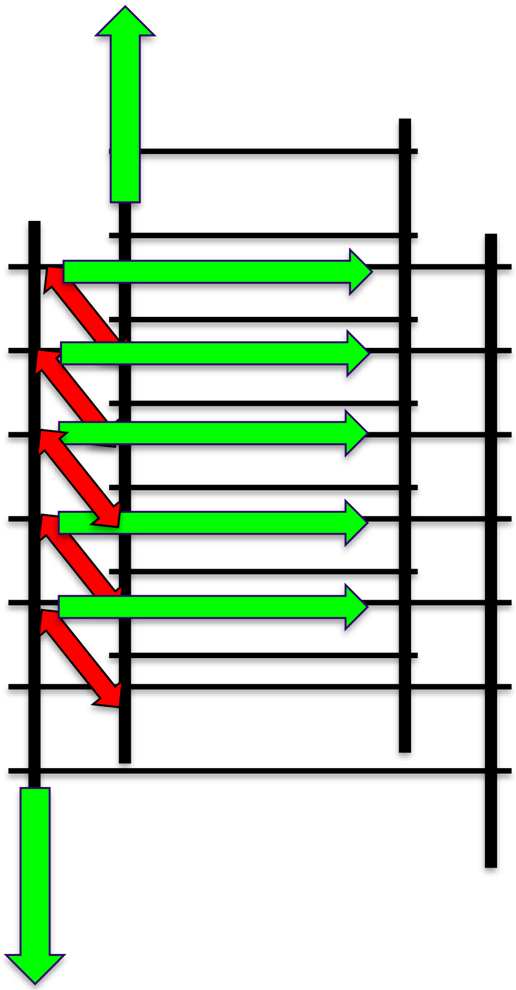
- Shaft reinforcement controlled by moments about 2 column diameters below grade.
- Thus, shaft reinforcement in transition region is stronger than needed there.
- Bond of column bars more critical than shaft bars.





Type 2 shafts – questions

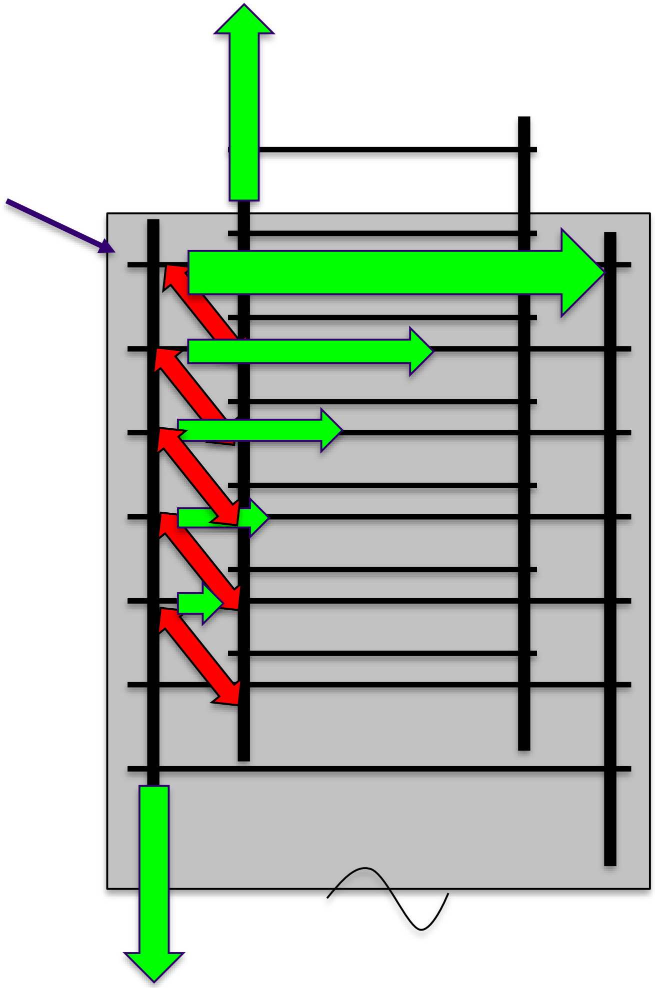
- Connection between shaft and column is a non-contact splice.
- That causes the need for transverse reinforcement.



Type 2 shafts – questions

- Traditional approach is to assume uniform bond stress along (non-contact) spliced bars. *Strength approach.*
- Test evidence (Tran, UW; Murcia-Delso, UCSD) suggests that the bond stress is distributed very non-linearly.
- Peak bond stress, and lateral force, at “live” end of the column bar.
- High lateral forces at top of shaft, not uniform along splice.
- Mechanics of load transfer in connection region unclear.

Type 2 shafts – questions



Potential damage when spiral yields

- Potential for damage at top of shaft.
- Consider design for damage, not just life safety. (PBEE).

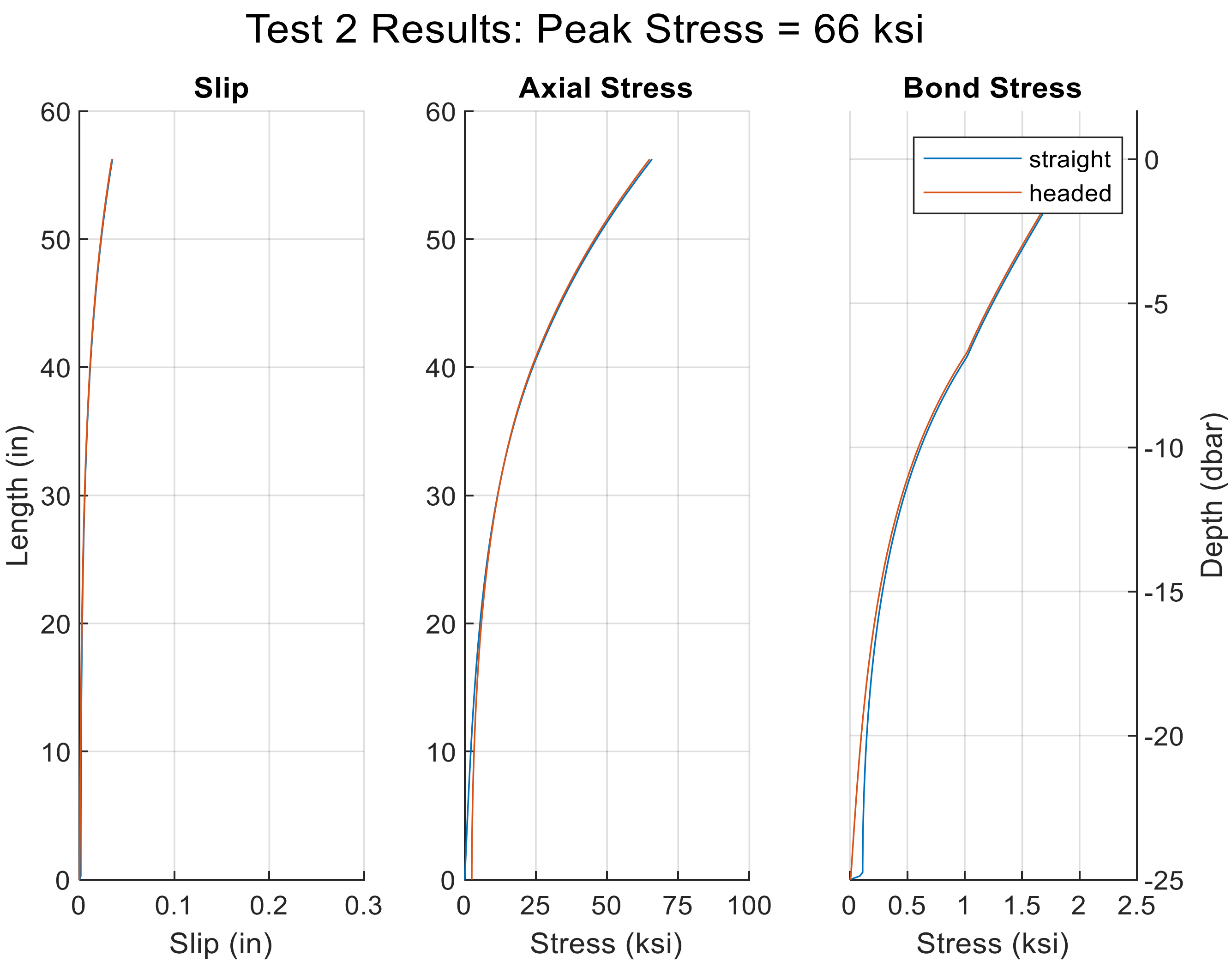
Research concept

- Investigate load transfer mechanism in non-contact splice region.
- Consider both cast-in-place (traditional) and precast column (ABC) configurations.
- Could concentration of load transfer at top be avoided by use of headed bars, combined with local debonding?

Planning activities

- Plan to conduct tests to investigate behavior.
- Preliminary analyses to design test configurations:
- Model the splice using bond models (*ongoing*).
  - Eligehausen model, with modifications by Murcia-Delso and Shing.
  - Reduction in bond strength caused by bar yielding appears to be important, but not well understood.
  - (Reduction in radius associated with plastic tensile strain causes lugs to partially disengage from surrounding concrete.

Bond stress modeling



Test Planning

Winter quarter (Jan-Mar) : test planning and design.

Spring quarter (Apr-Jun): Build first specimens

Summer: conduct tests

Thank You