

PERFORMANCE-BASED SEISMIC DESIGN

JOE FERZLI, PE, SE



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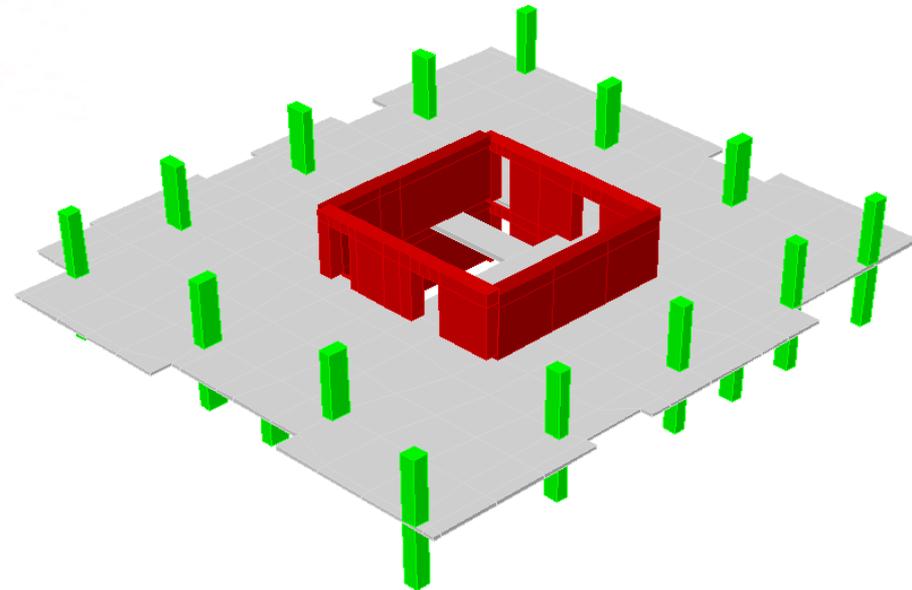
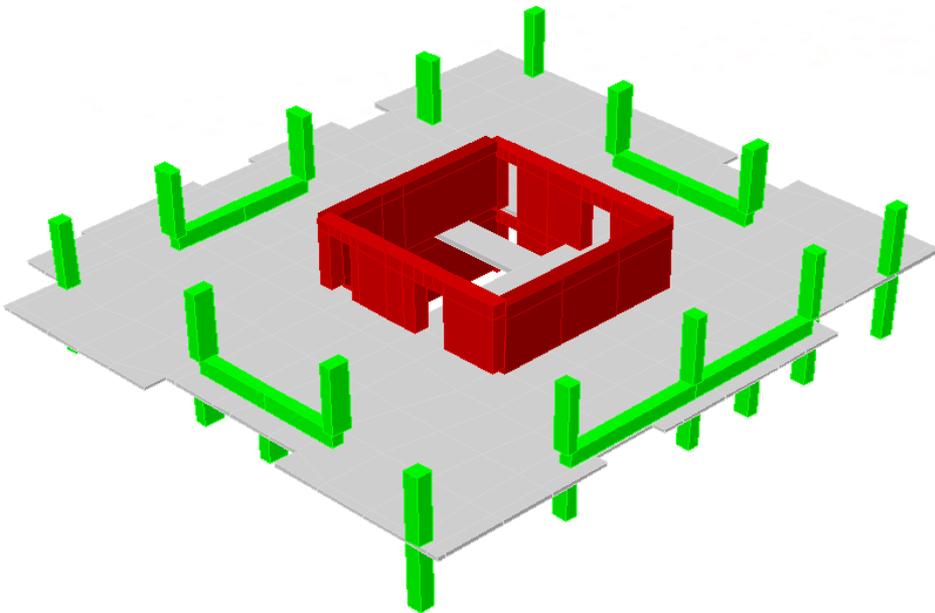
CODE VS PBS D

CODE

PBSD

LAYOUT

LAYOUT



GOVERNING STANDARDS

ASCE STANDARD

ASCE/SEI

7-16

Minimum Design Loads and
Associated Criteria for
Buildings and Other Structures

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS



TBI



Tall Buildings Initiative

Guidelines for
Performance-
Based Seismic
Design of
Tall Buildings

Version 2.01
May 2017

Developed by
Pacific Earthquake Engineering Center
Report No. 2017/06

Sponsored by
Charles Pankow Foundation
ACI Foundation (Concrete Research Council)
American Institute of Steel Construction
Federal Emergency Management Agency
Structural Engineering Institute of ASCE (SEI)
Structural Engineers Association of California

Los Angeles Tall Buildings Structural Design Council



AN ALTERNATIVE PROCEDURE FOR
SEISMIC ANALYSIS AND DESIGN OF
TALL BUILDINGS LOCATED IN THE
LOS ANGELES REGION

A CONSENSUS DOCUMENT

2017 Edition

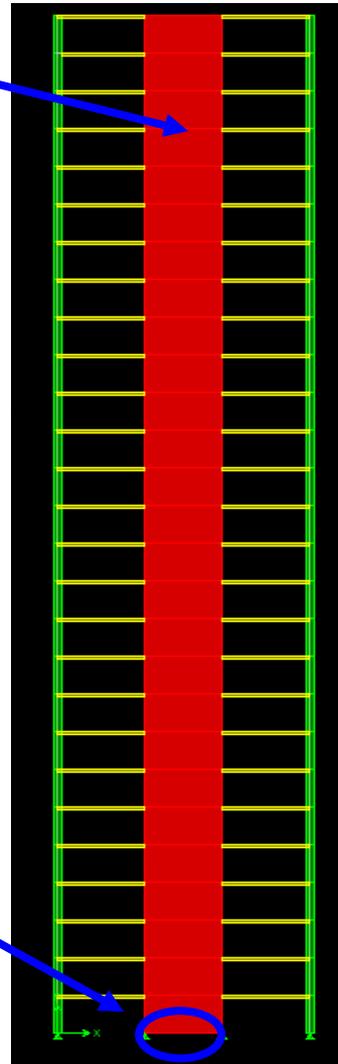


June 8, 2017

SHEAR WALL BEHAVIOR

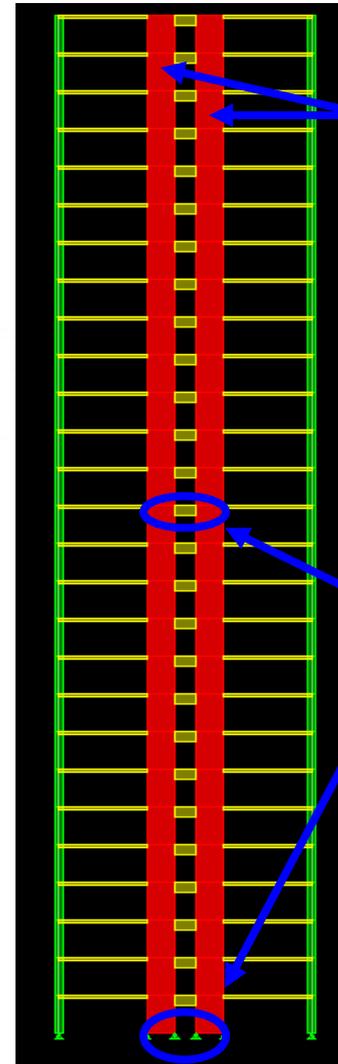
Concrete core wall
without openings
(Cantilever wall)

Flexural plastic
hinge location,
detailed for
ductility

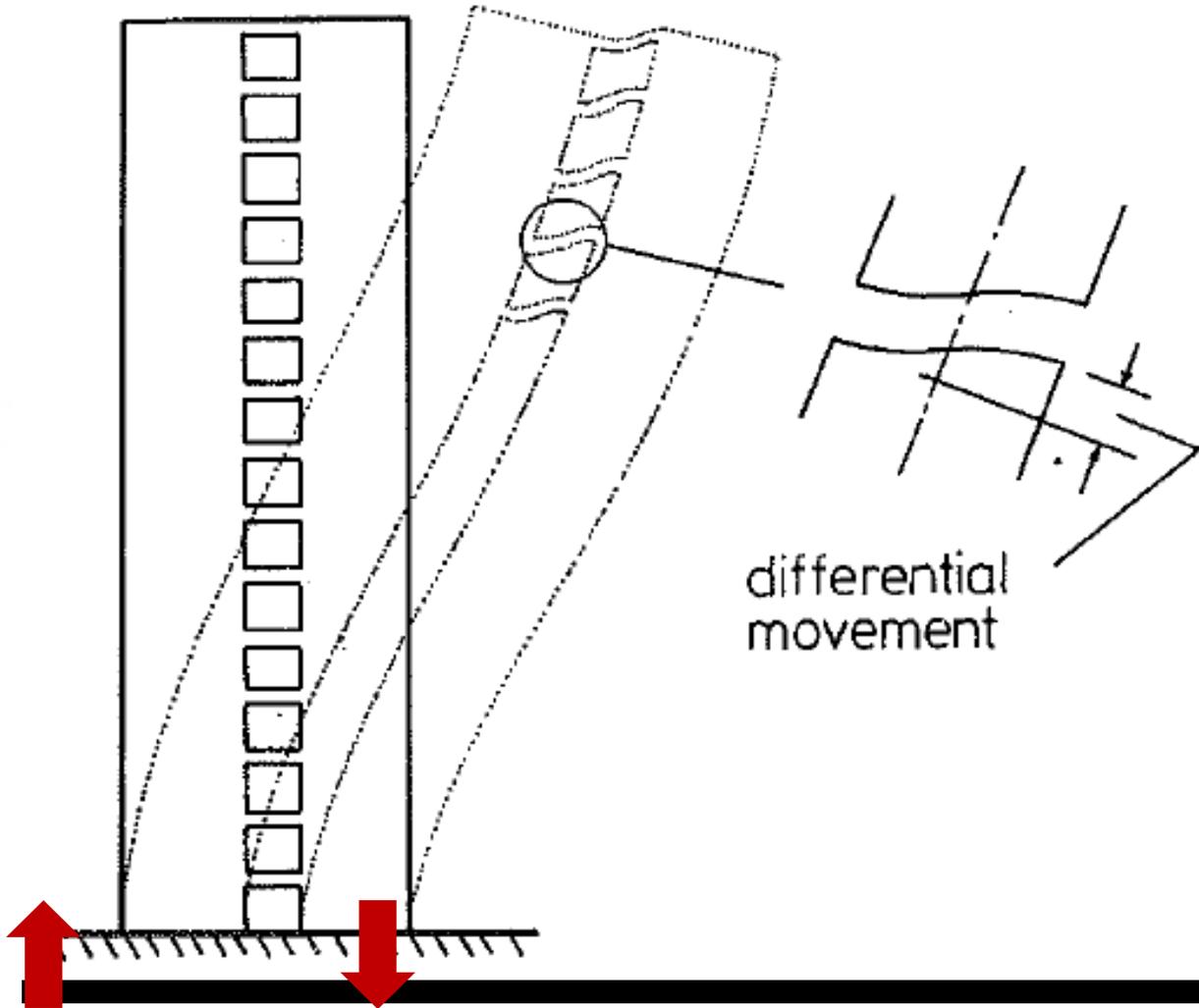


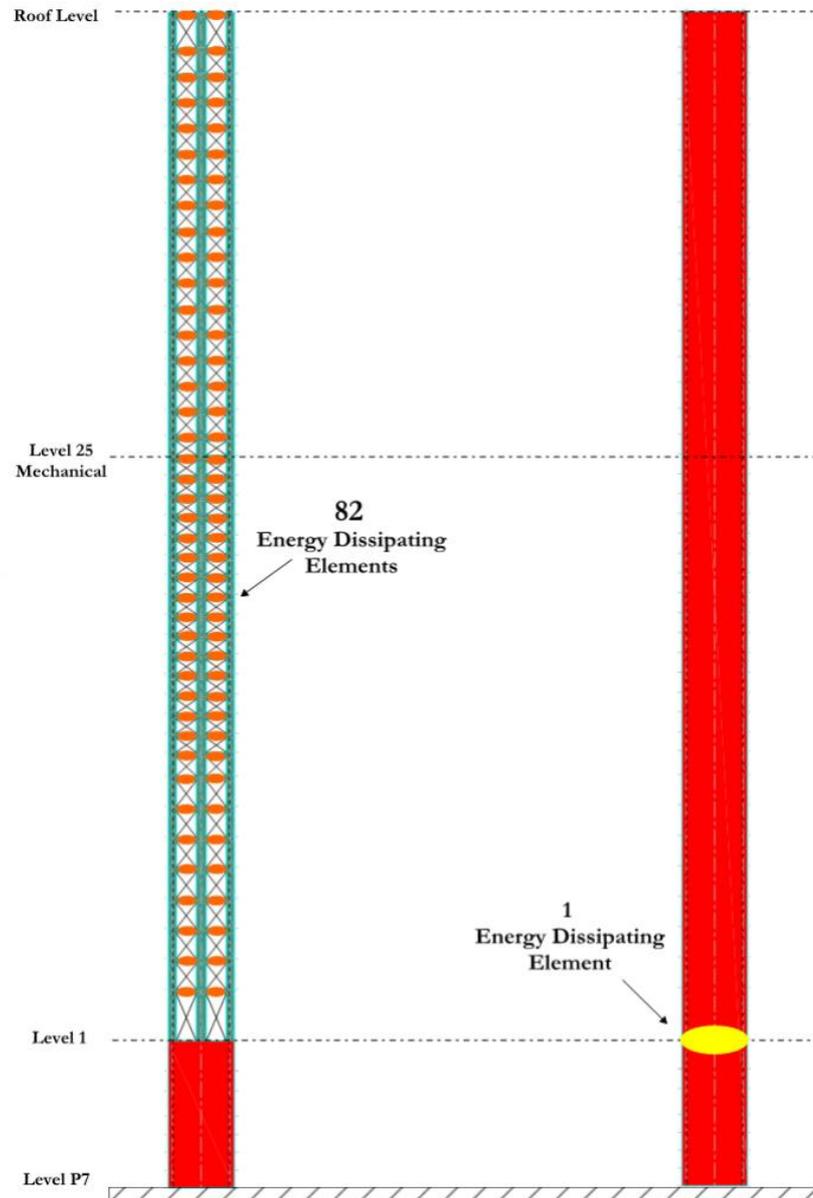
Concrete
shear wall with
openings
(Coupled Wall)

Plastic hinge
locations at
coupling beams
and base of wall

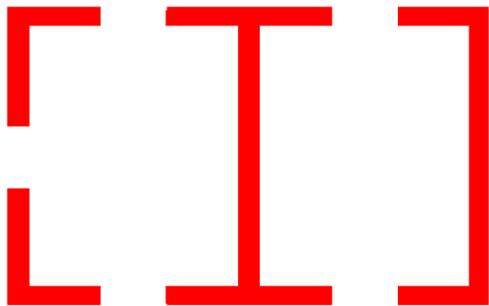
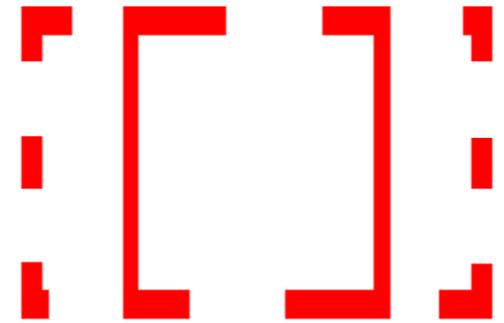
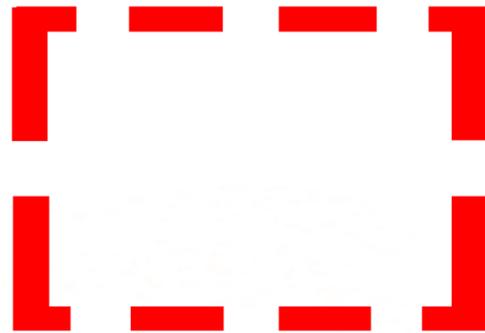


COUPLED WALLS



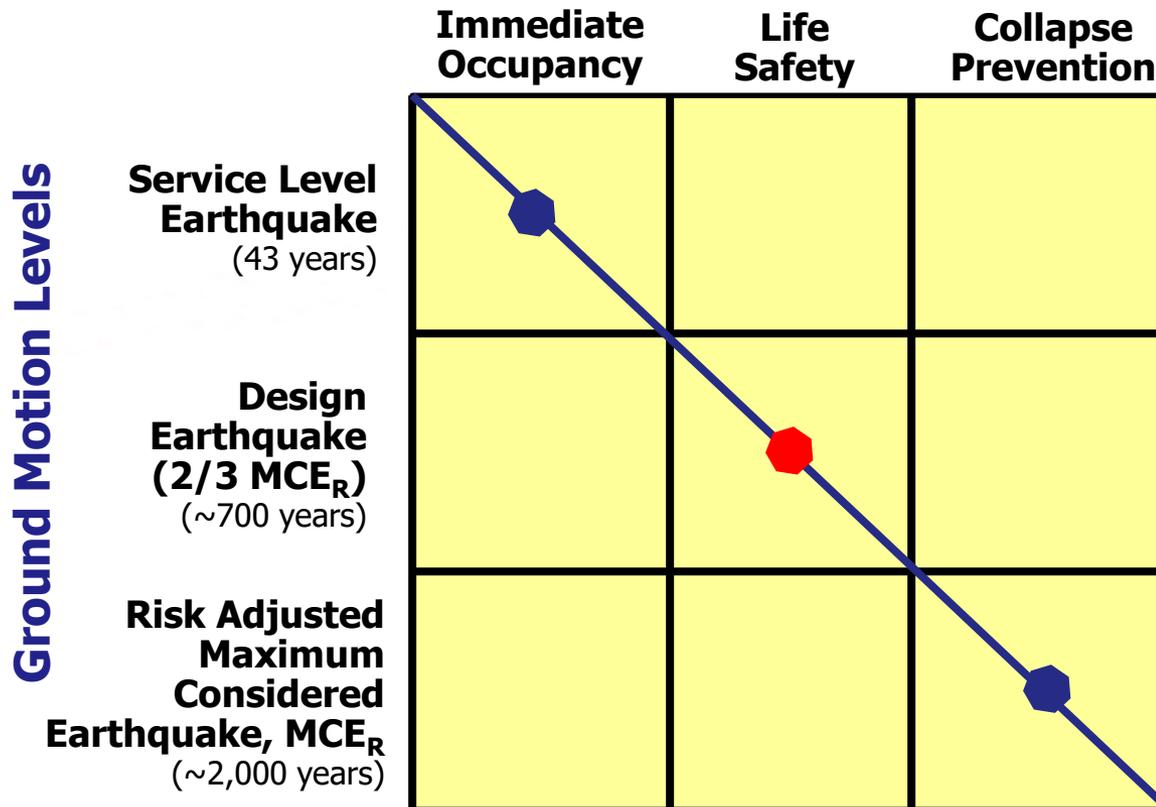


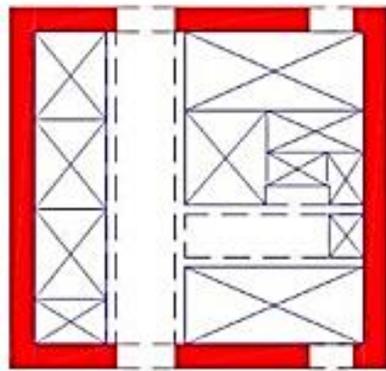
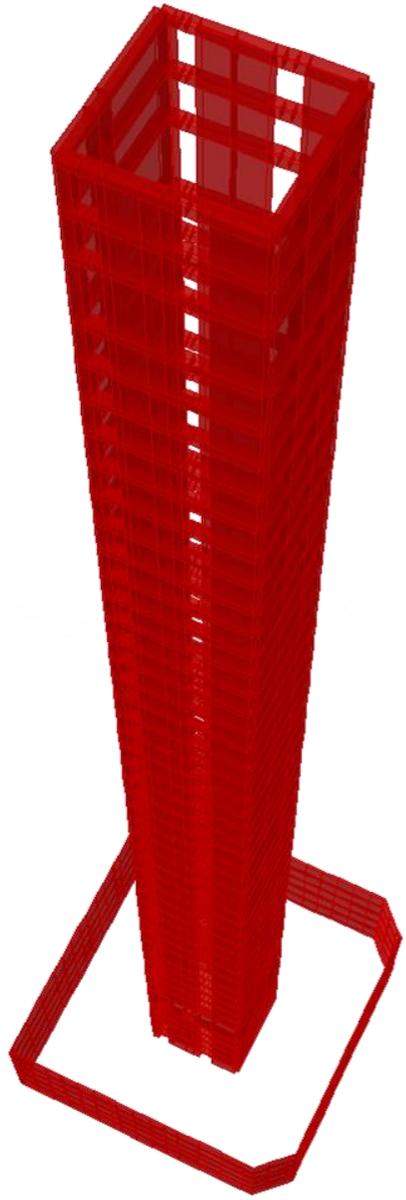
CORE WALL CONFIGURATIONS



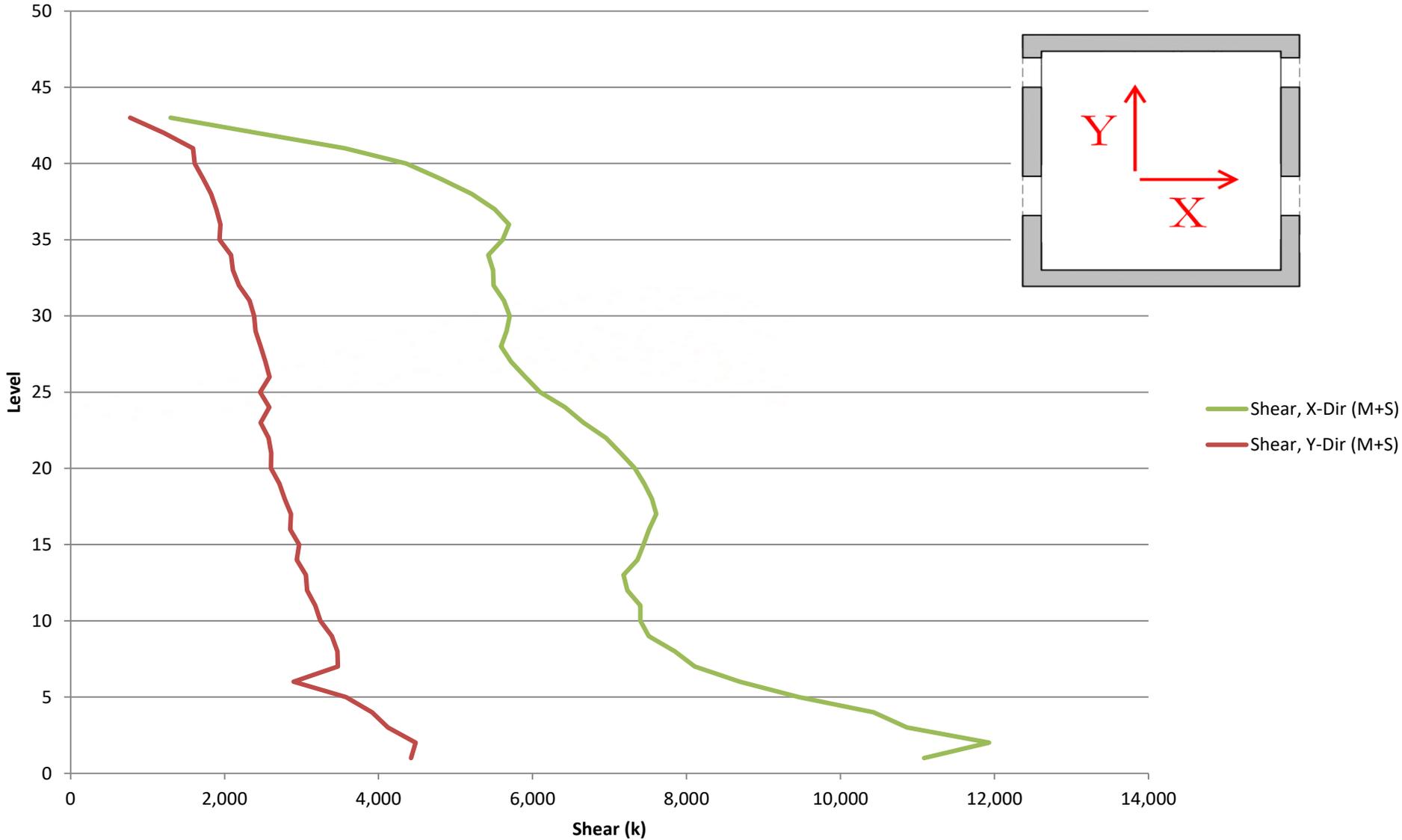
BUILDING SEISMIC PERFORMANCE

Building Performance Levels

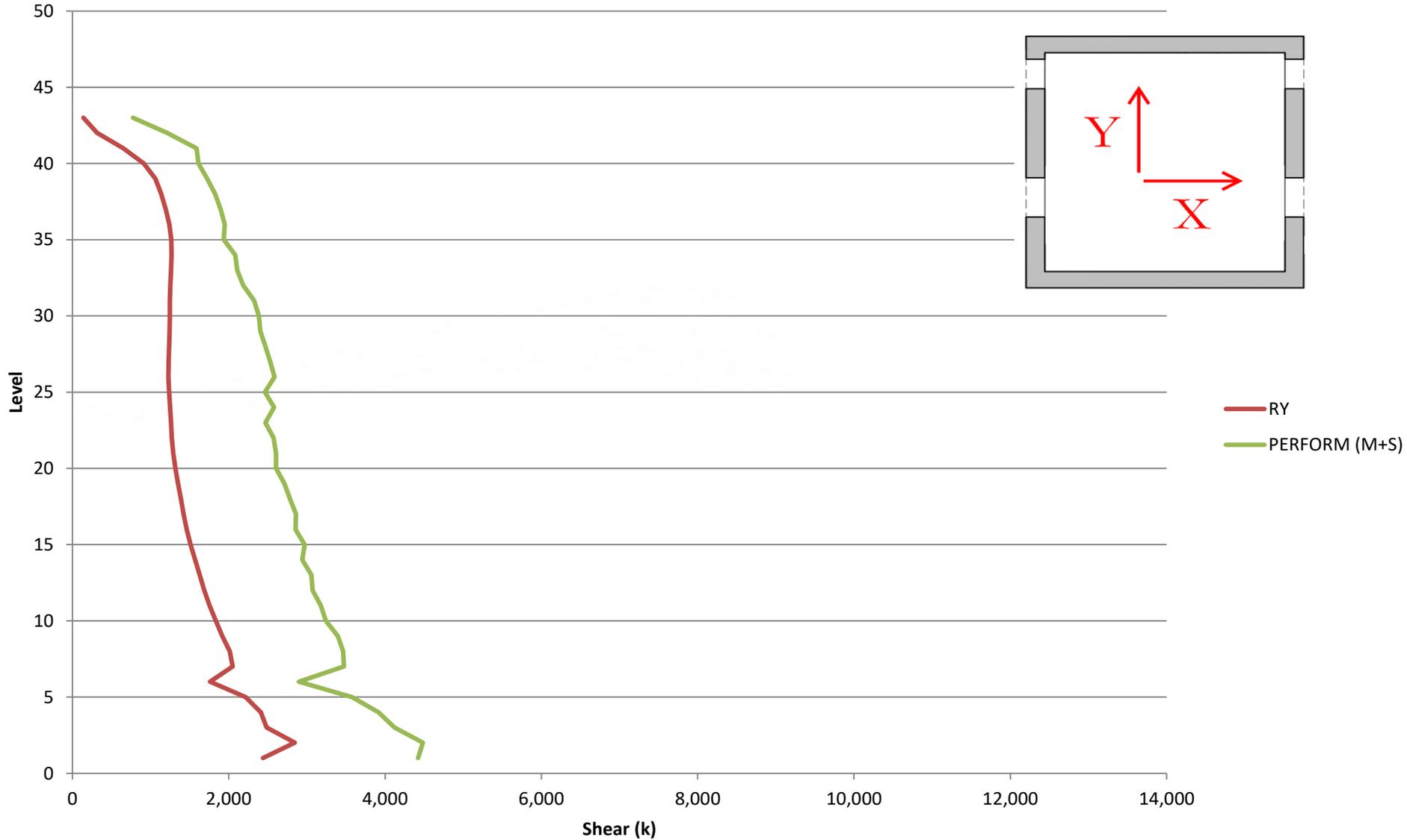




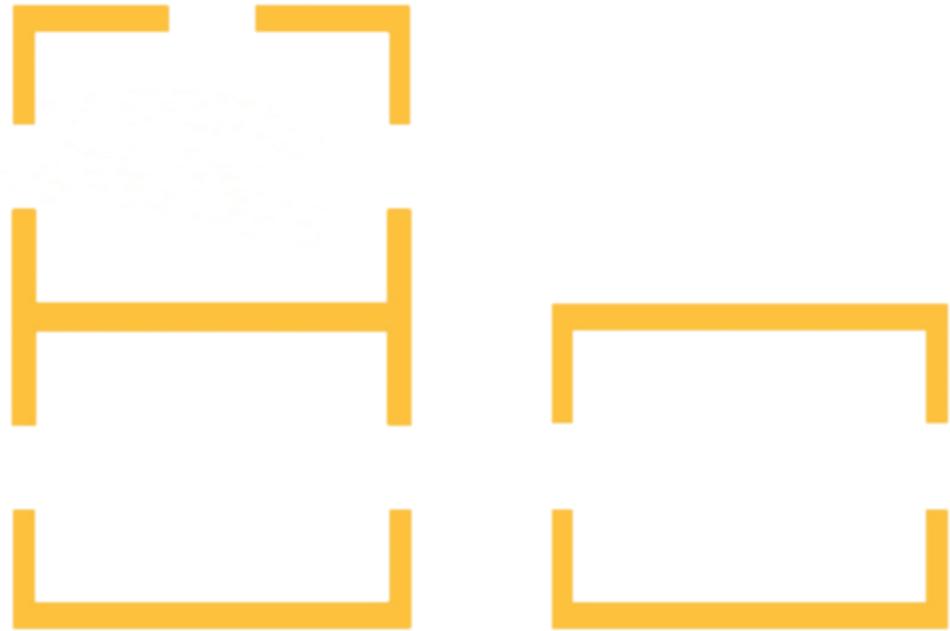
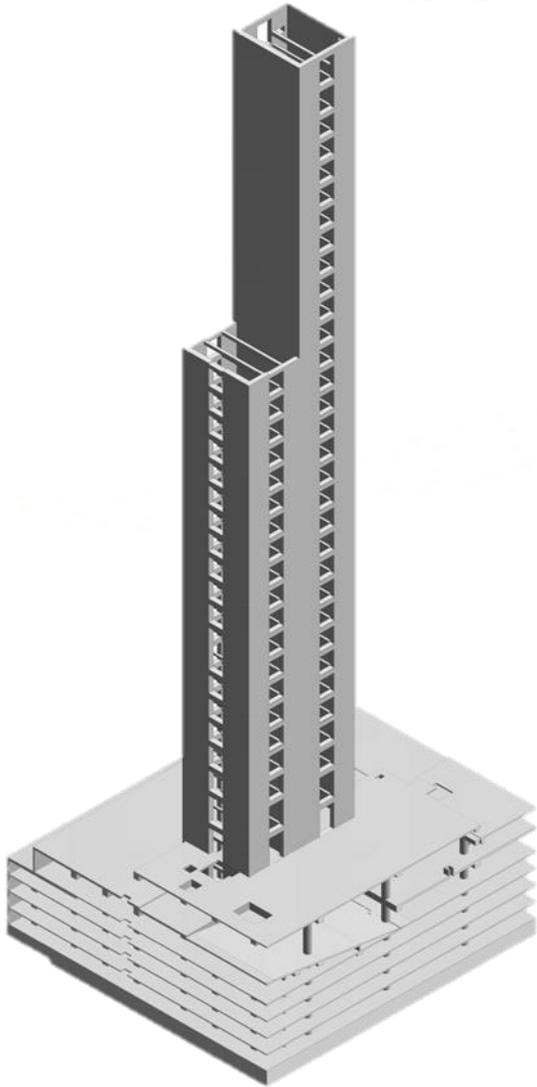
Core Shear Comparison



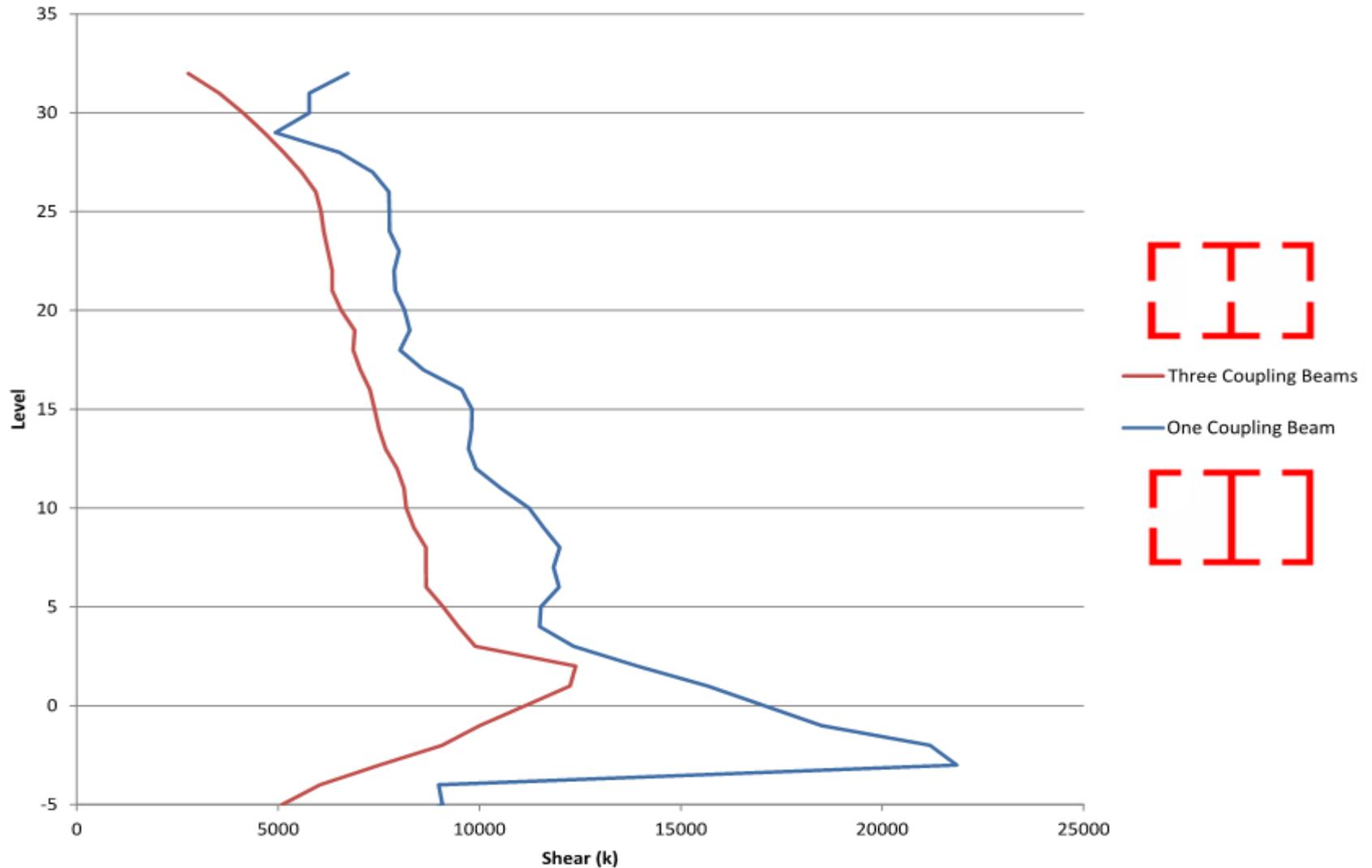
Shear Comparison - Y dir



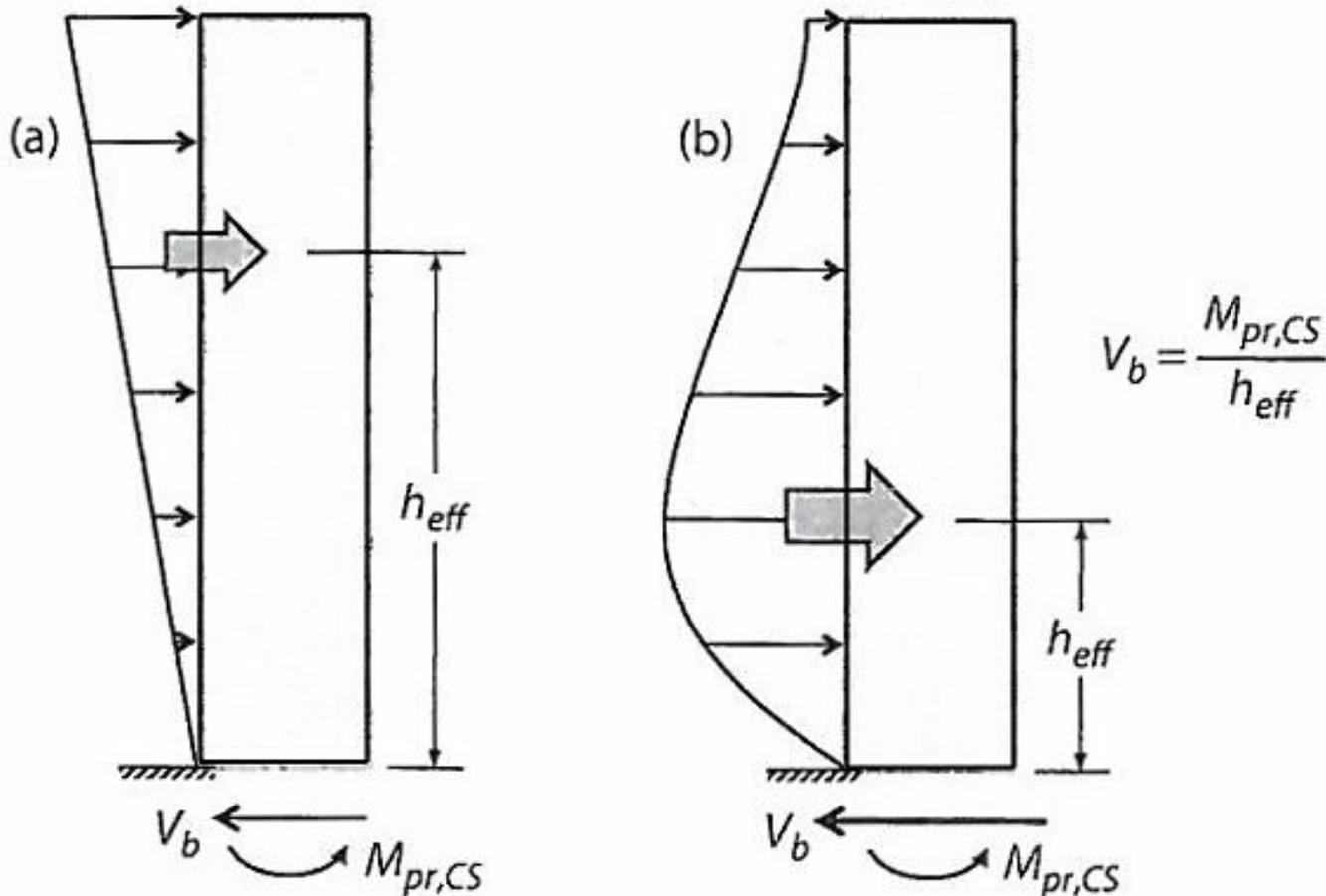
CORE GEOMETRY STUDY



CORE SHEAR COMPARISON



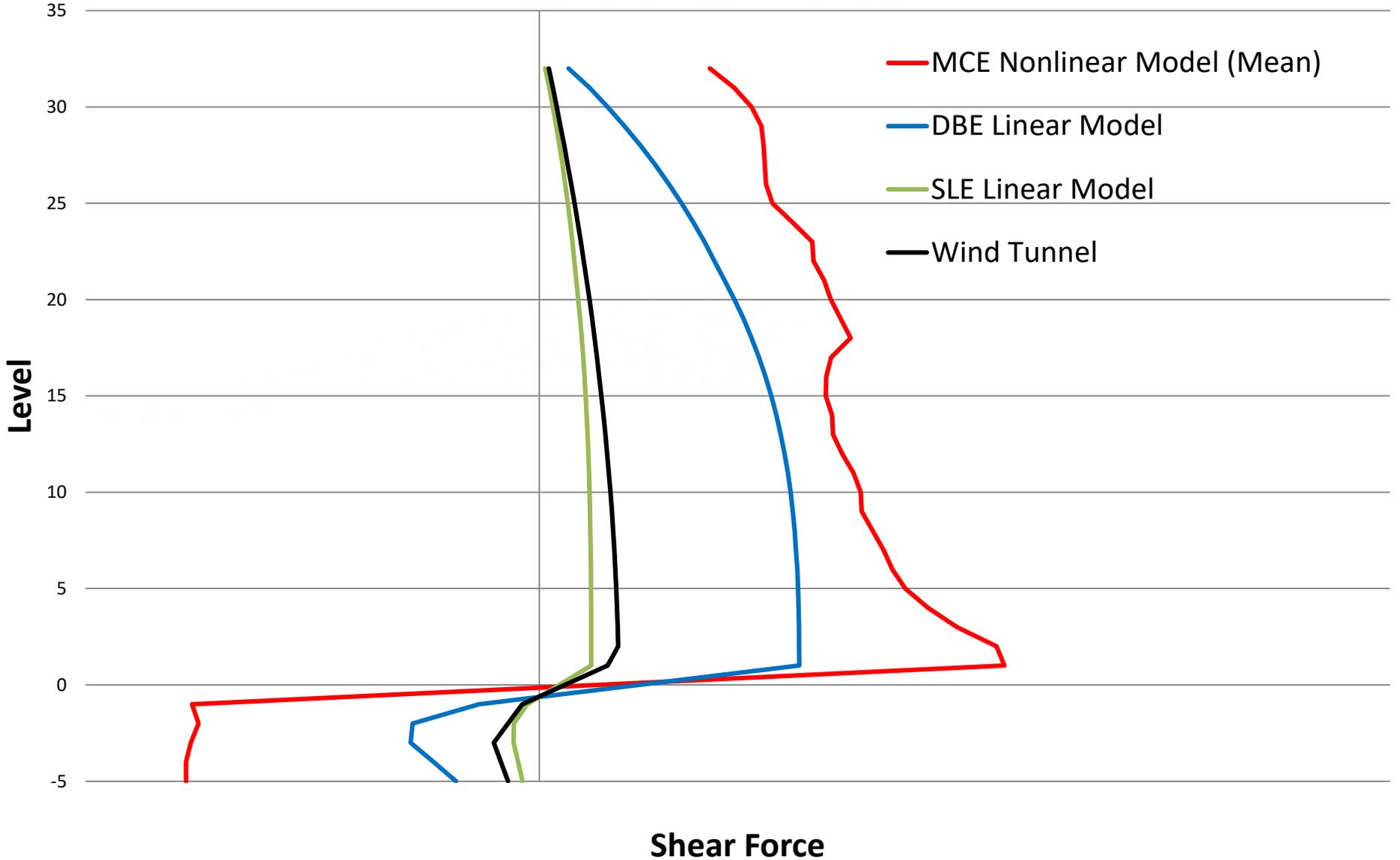
DYNAMIC AMPLIFICATIONS



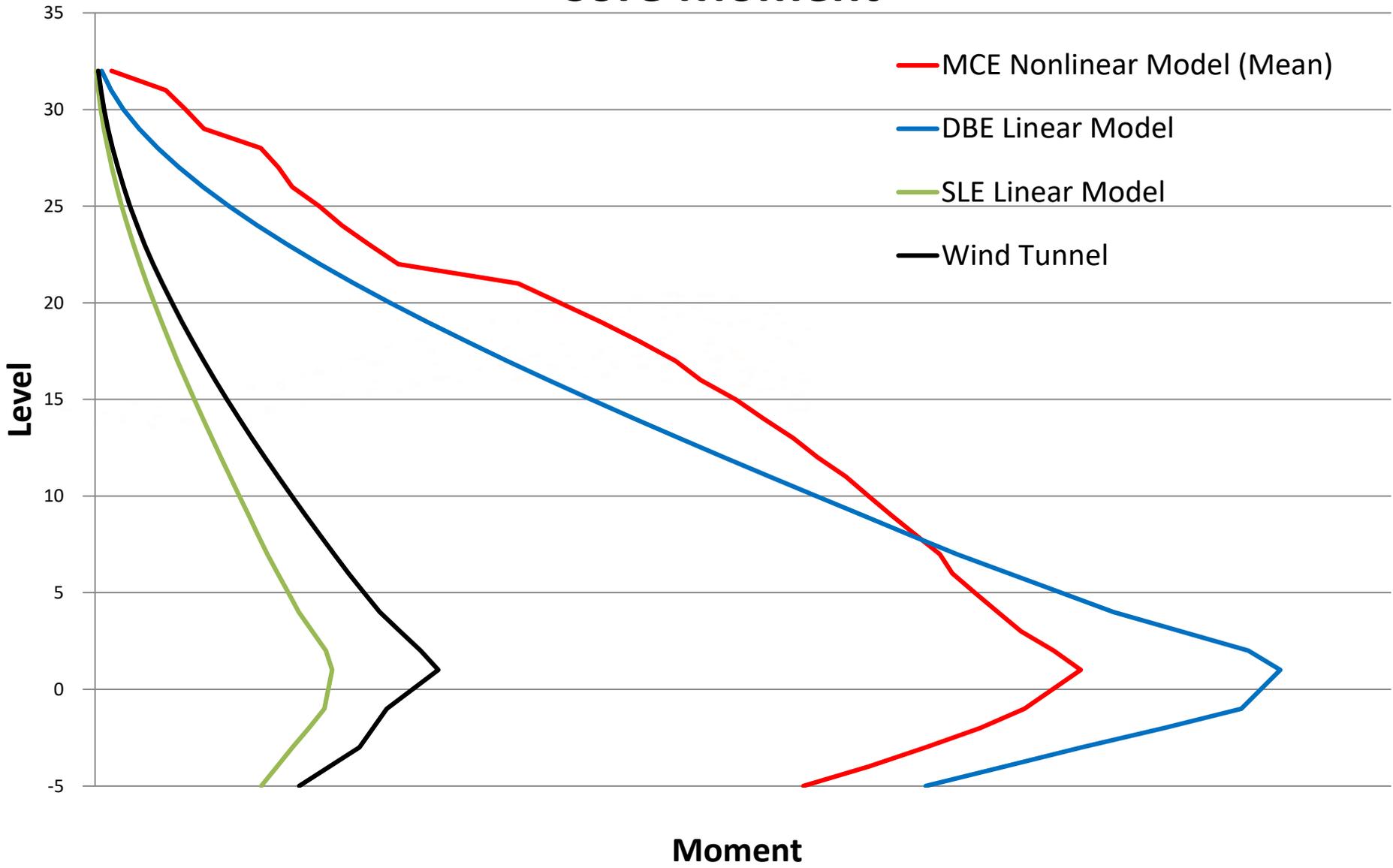
DYNAMIC AMPLIFICATIONS



Core Shear Force



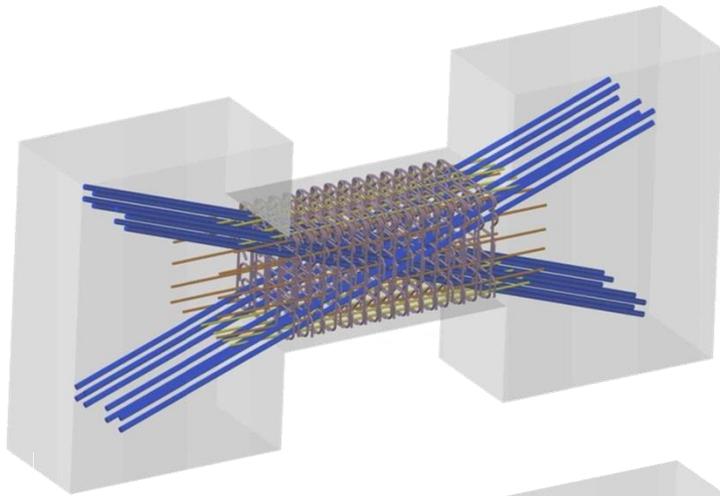
Core Moment



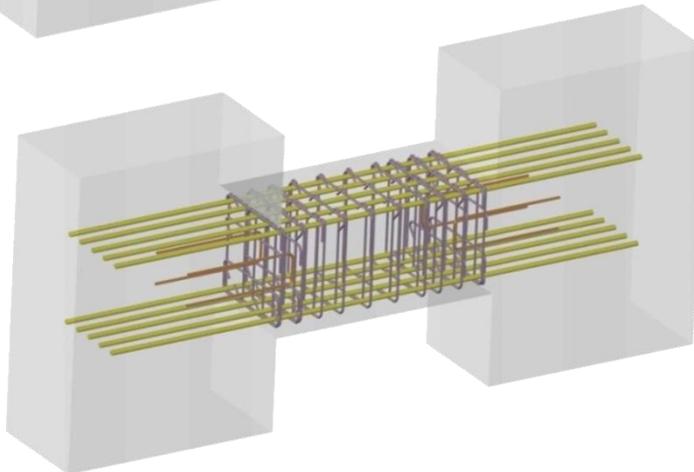
DIAGONALLY REINFORCED COUPLING BEAMS



DIAGONALLY REINFORCED VS. SFRC COUPLING BEAMS

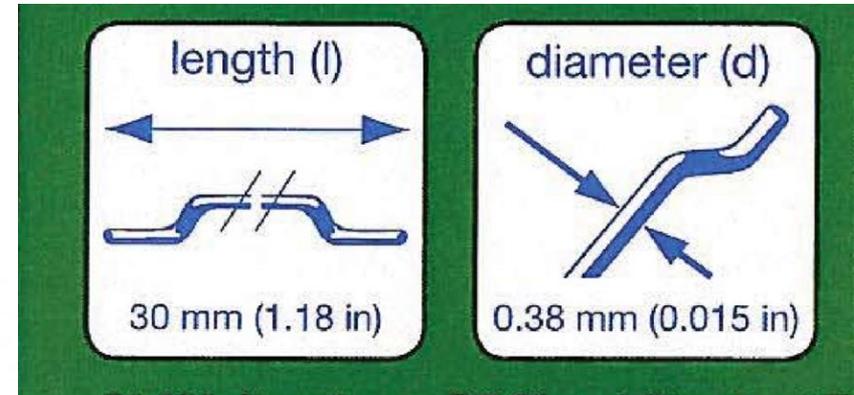


**Diagonally Reinforced
Concrete Coupling
Beam**



**Steel Fiber
Reinforced
Concrete (SFRC)
Coupling Beam**

BEKAERT DRAMIX® STEEL FIBERS



DIAMETER: 0.015"

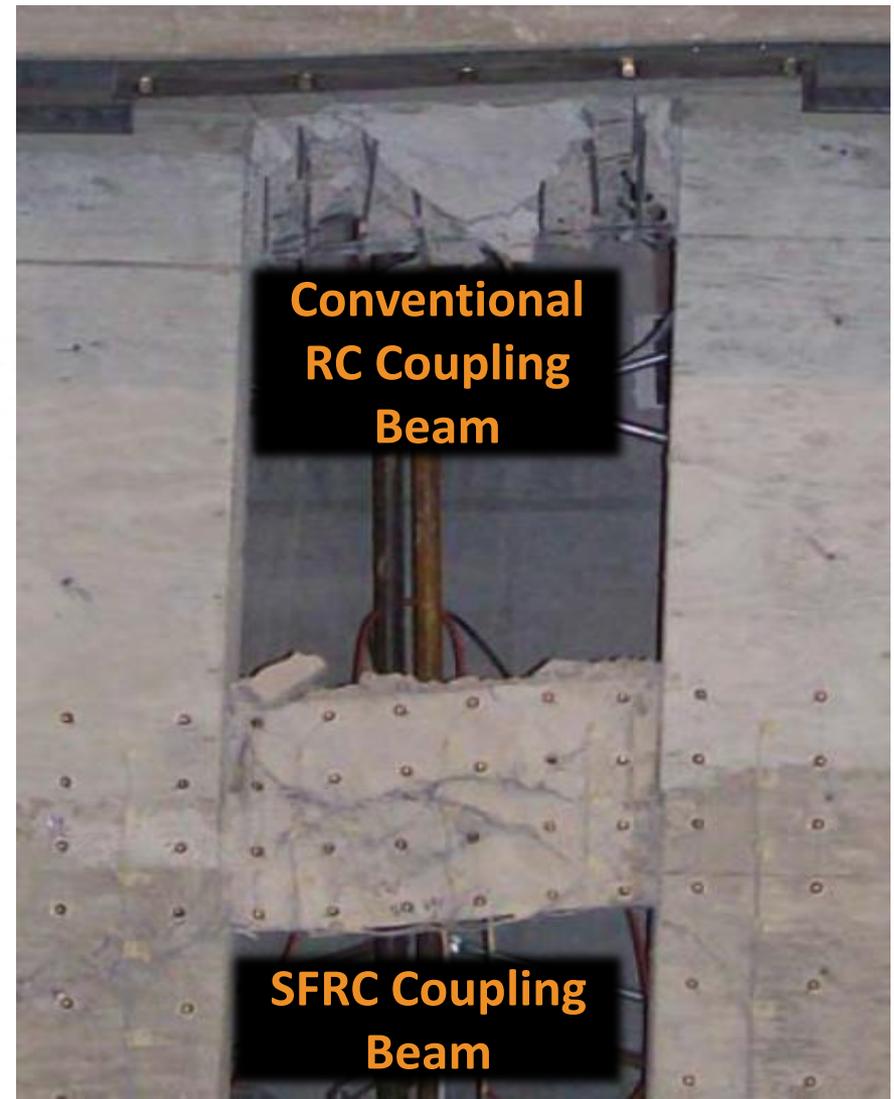
LENGTH: 1.18"

STRENGTH: 445 KSI

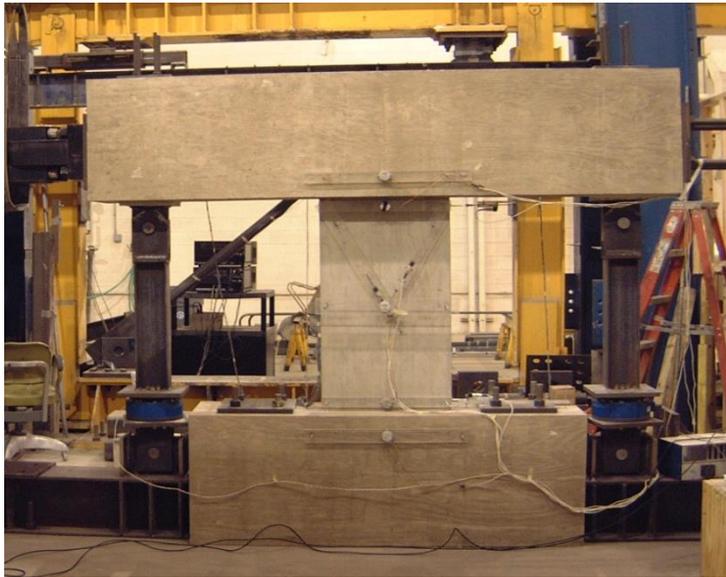
MATERIAL: ASTM A820

DOSAGE: 1.5% BY VOLUME
= 200 #/YD³

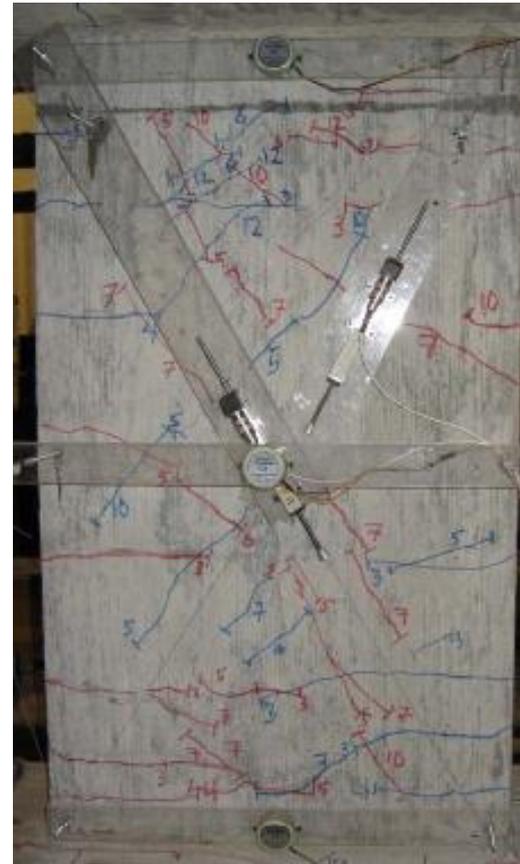
COUPLED WALL TEST



SFRC COUPLING BEAM TESTING



TESTED WITH
ASPECT RATIOS
[1.75 2.75 3.3]



3% Drift



5% Drift

SFRC COUPLING BEAMS

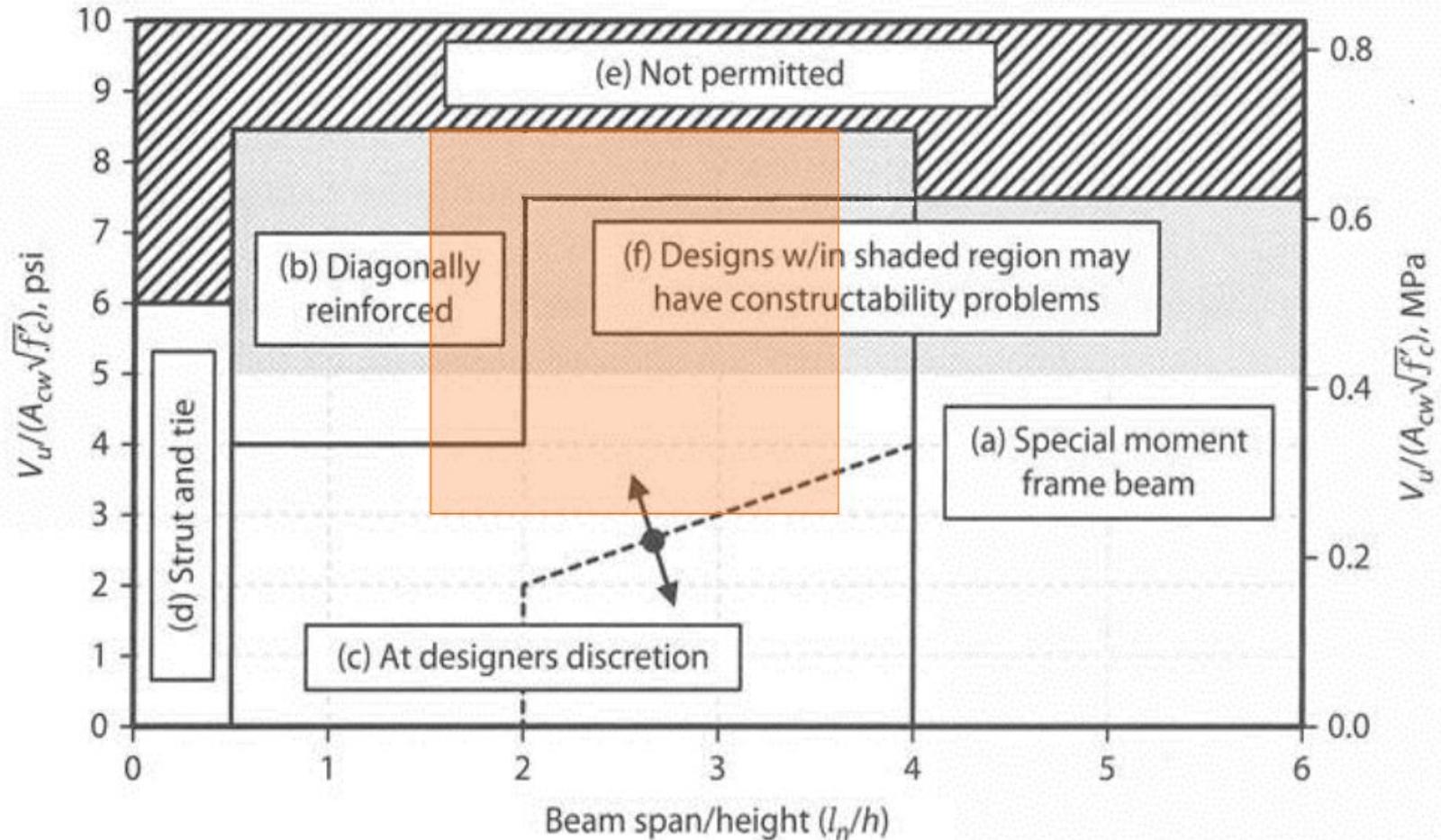


FIGURE 13.45 Coupling beam design space.

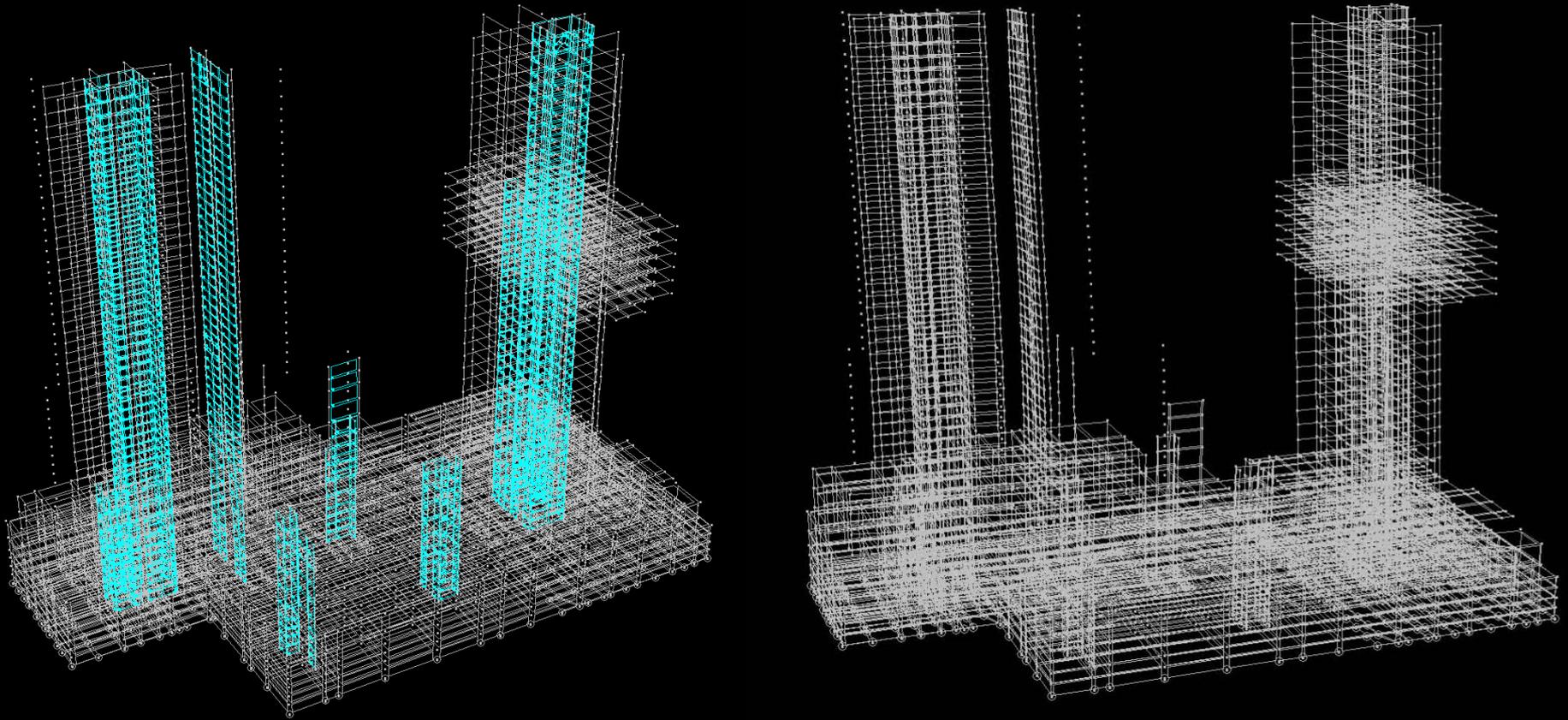
The Concrete Convention
and Exposition



*LINCOLN
SQUARE EXP*

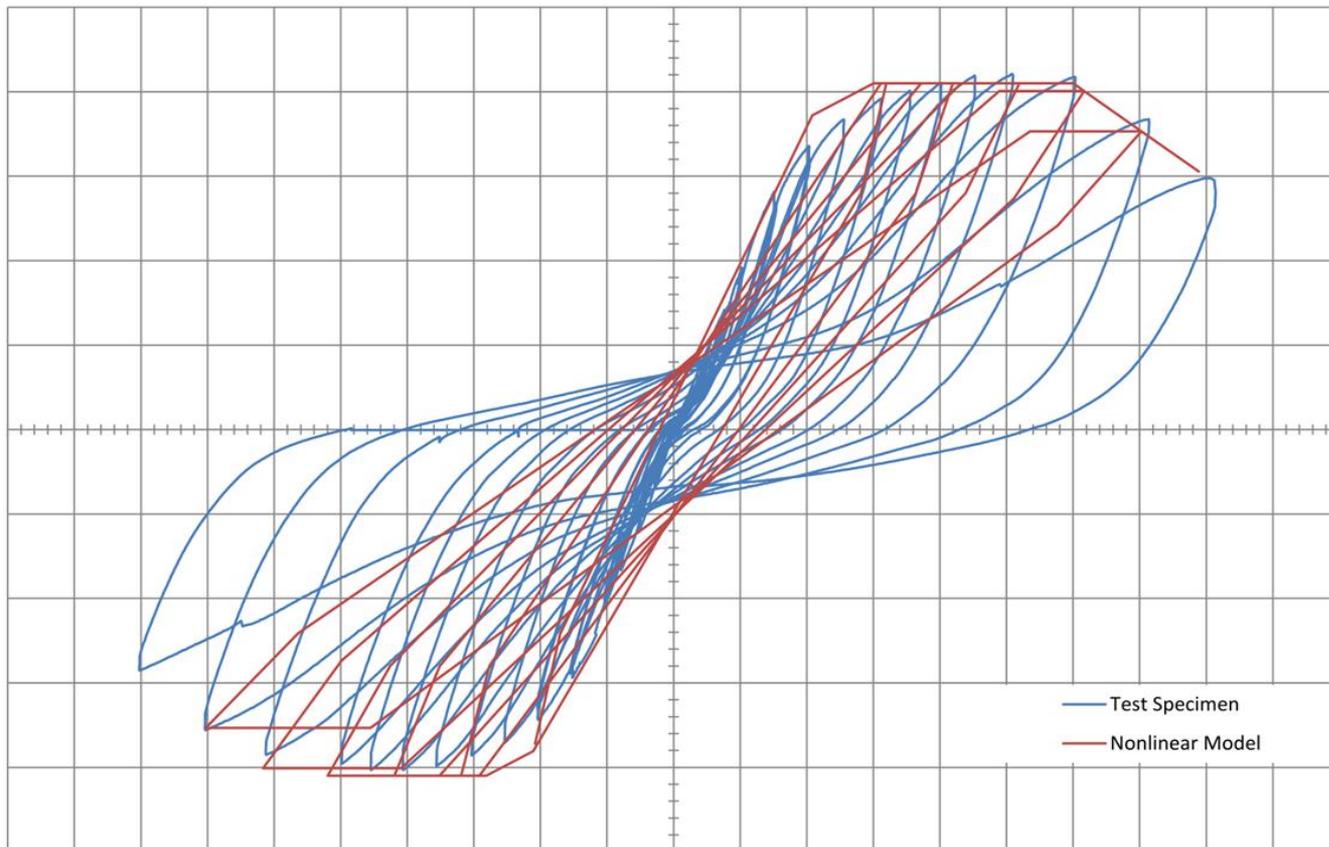
BELLEVUE

3D PERFORM MODEL

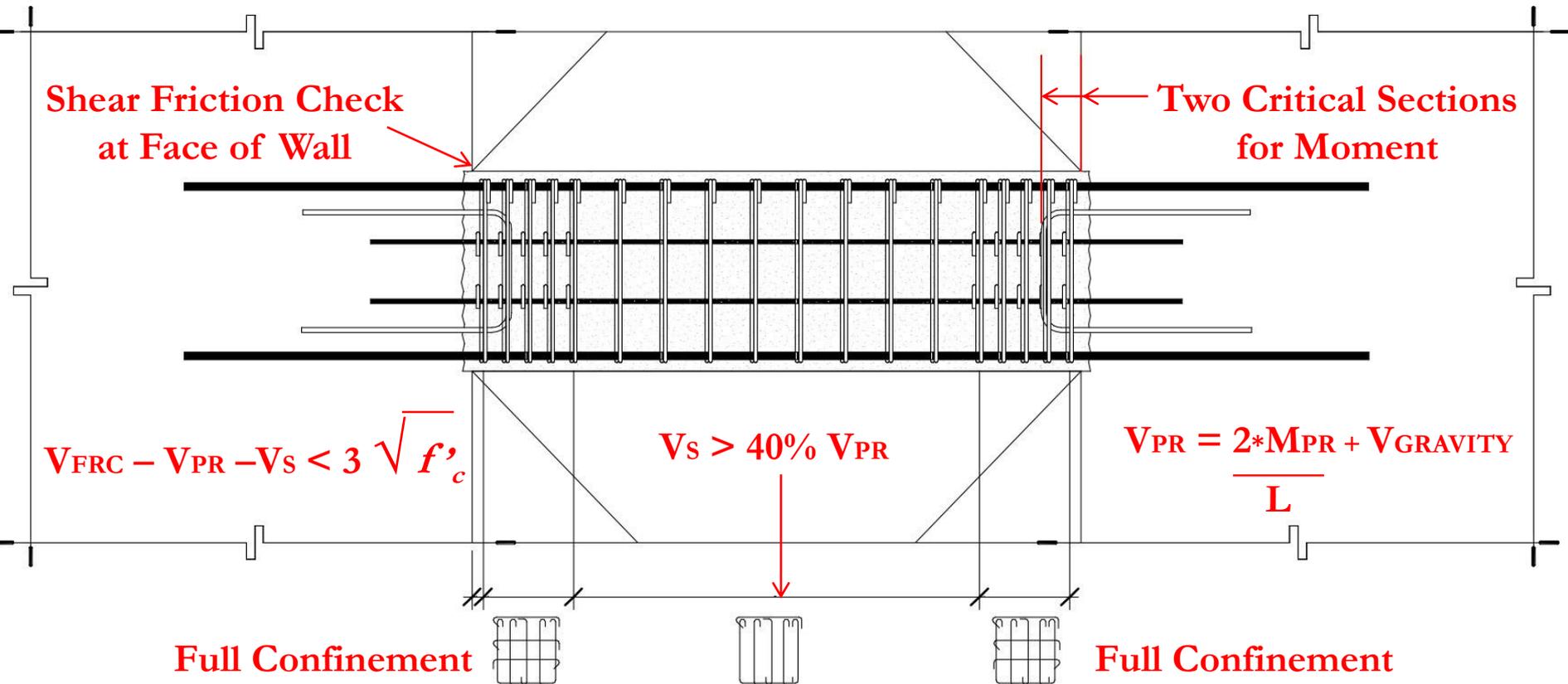


ANALYTICAL MODEL CALIBRATION

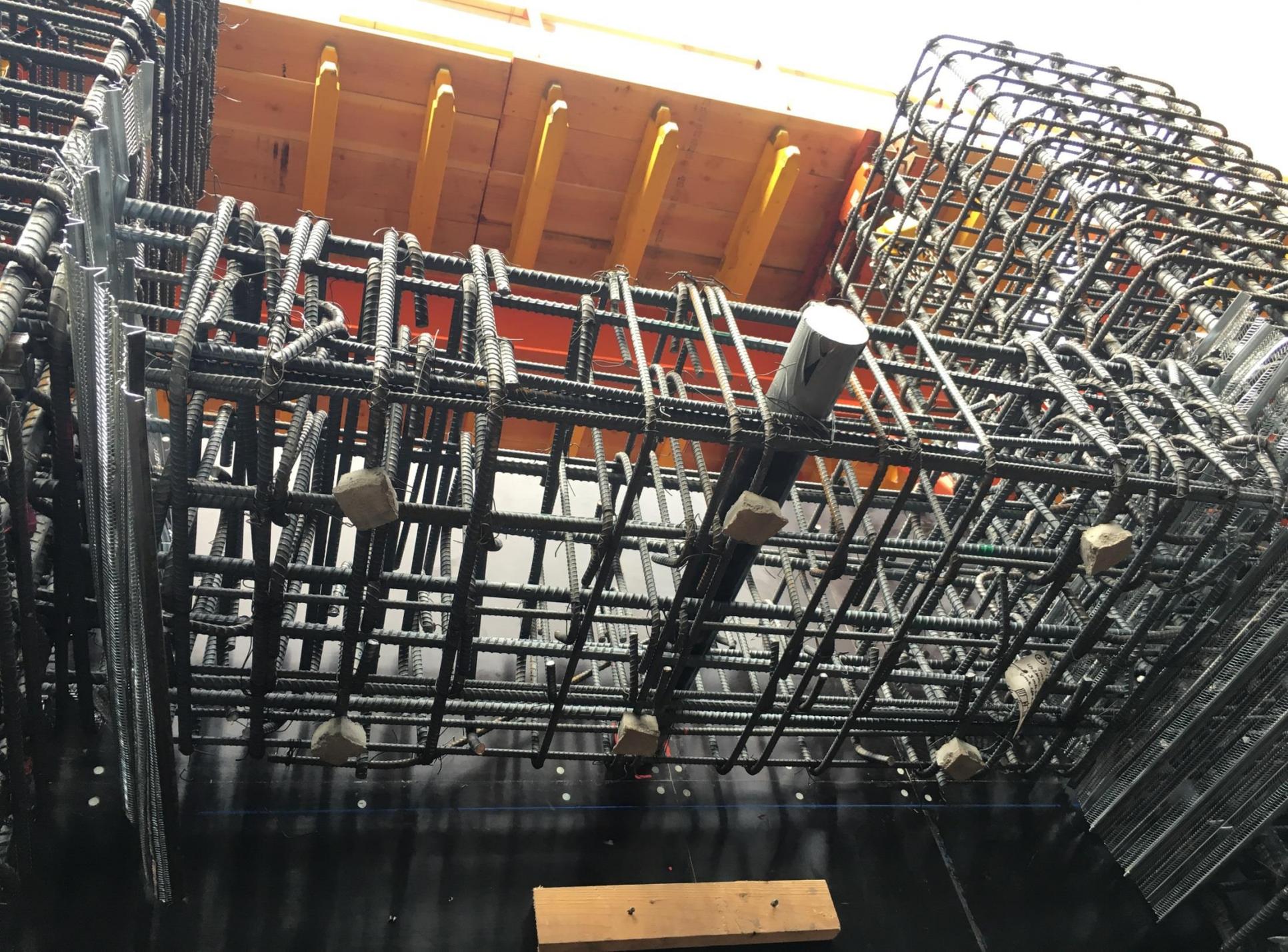
Moment vs Rotation
SFRC Test Specimen, L/h = 2.75



DESIGN PROCEDURE OF SFRC BEAM



- Full coupling beam section is active for resisting shear (reinforcement steel and concrete)
- Shear steel reinforcement shall be greater than 40% of design V_{PR}
- The remainder of shear attributed to SFRC $\leq 3\sqrt{f'_c}$



SFRC COUPLING BEAMS APPLICATION



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