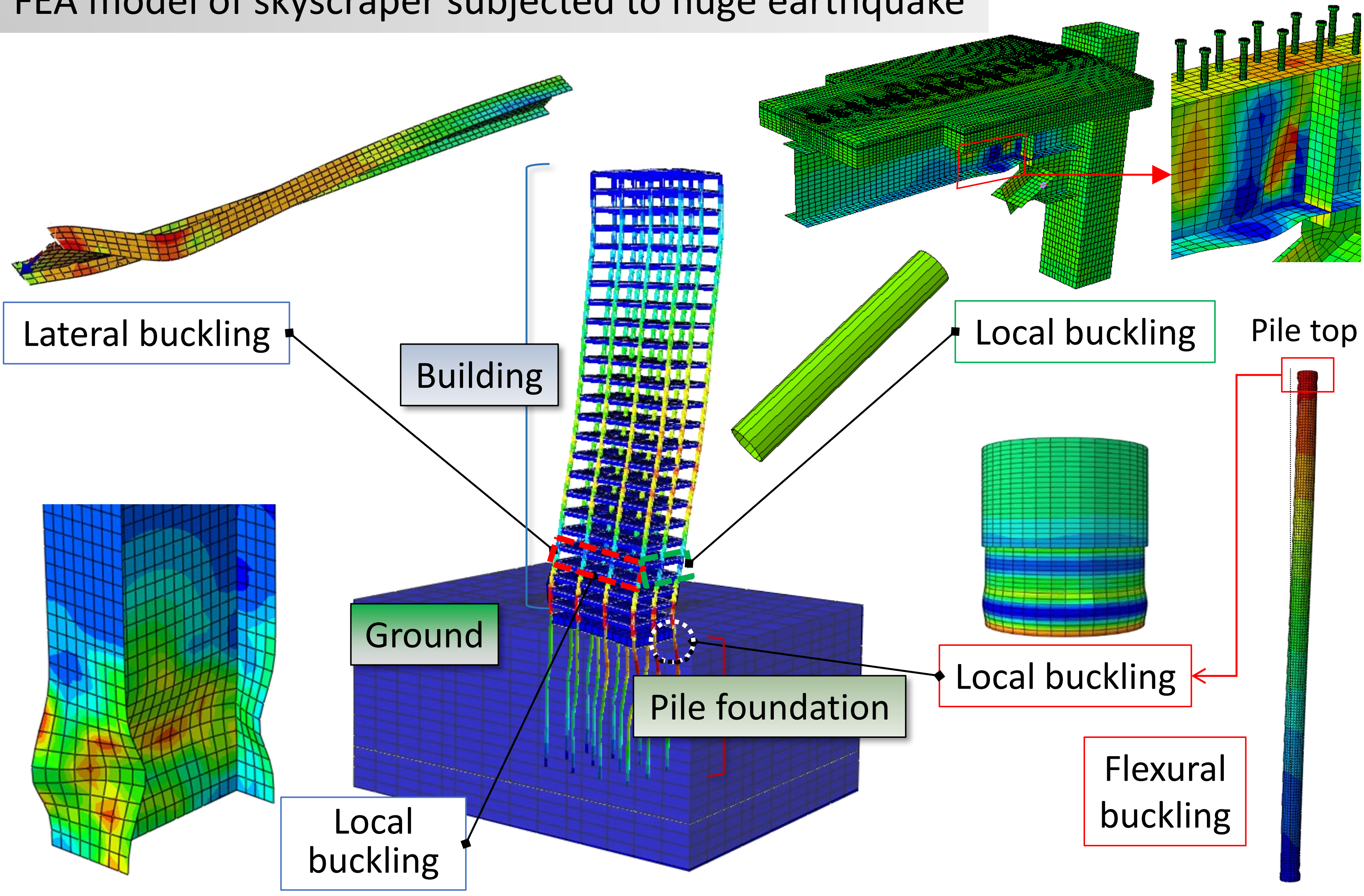
Introduction of Kimura Laboratory

Research topics

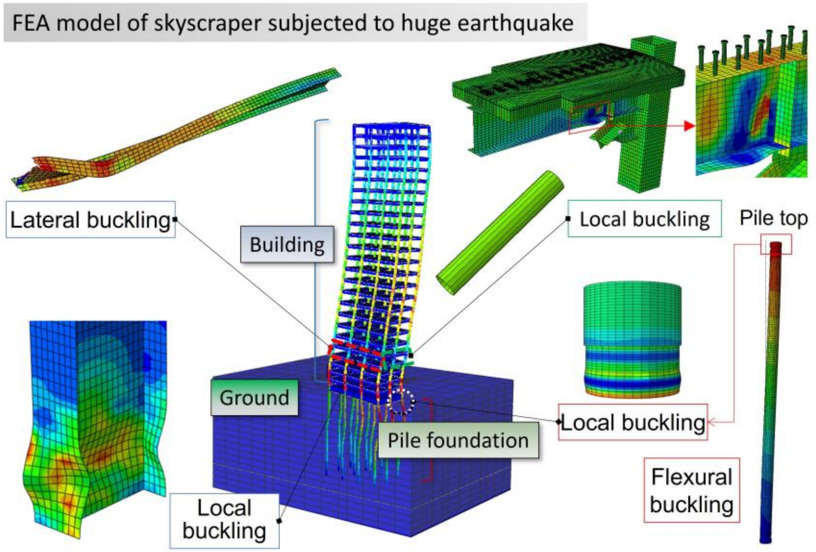
- Development of Mid-Story Pin Connection System Preventing Column Yield and Assessment of Ultimate Seismic Capacity of Steel Moment Resisting Frames
- Construction of Ultimate State Design Method of Steel Piles and Elucidation of Dynamic Buckling Behavior of Steel Piles in Liquefied Soil
- Invention of Evaluation Method of Lateral Buckling Strength of Large-Span Beams
- Creation of Seismic Design Method of Buckling Restrained Braced Frame with Concrete Slab

Research topics

FEA model of skyscraper subjected to huge earthquake

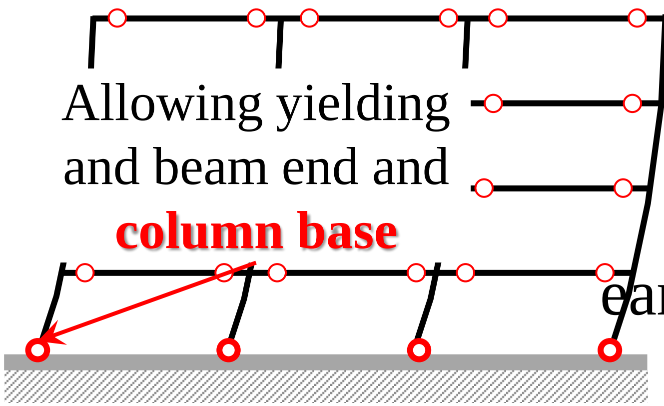


Development of Mid-Story Pin Connection System Preventing Column Yield and Assessment of Ultimate Seismic Capacity of Steel Moment Resisting Frames

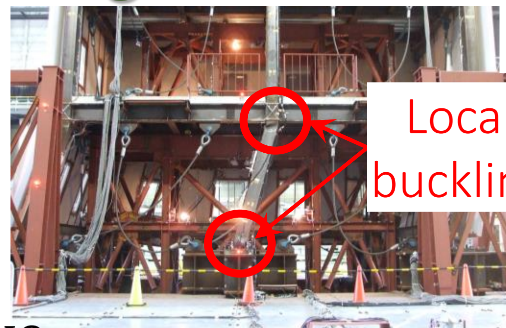


Development of new column base system

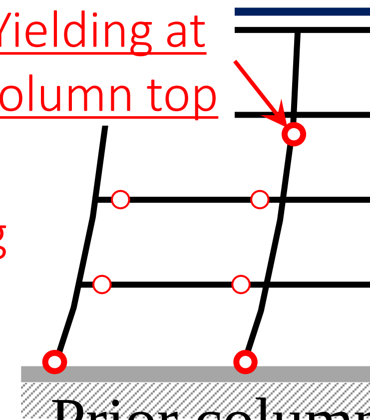
Conventional moment resisting frame



Huge
earthquake



Story collapse at
1st story

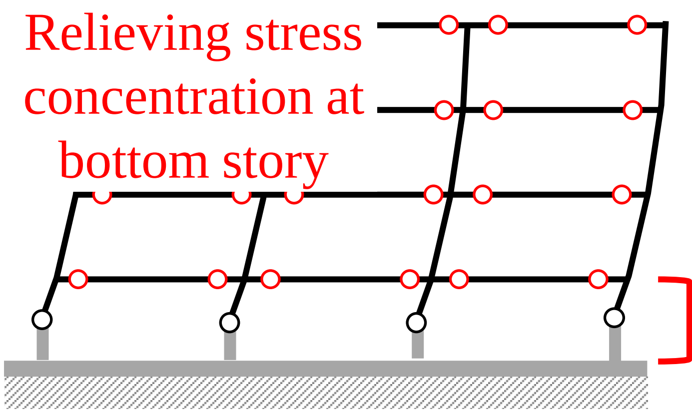


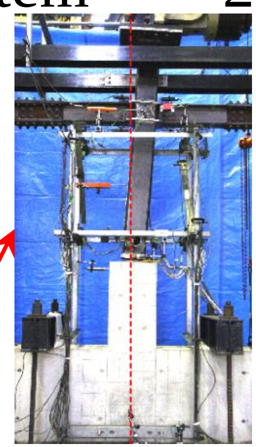
Prior column
yielding

Relieving stress at hot-spot of structure

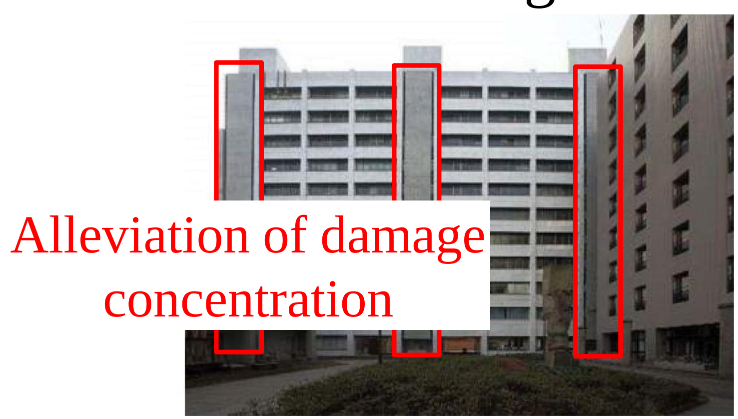
New steel moment resisting frame

1) Mid-story pin-support system



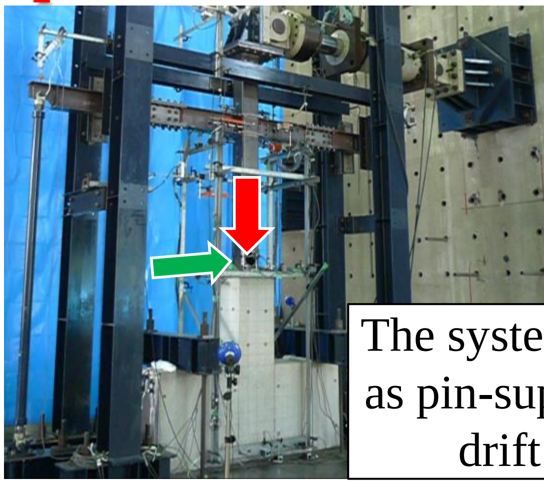
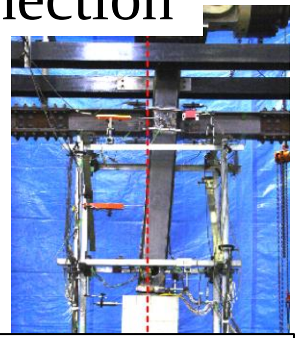


2) Installation of leaning column



Development of new column base system

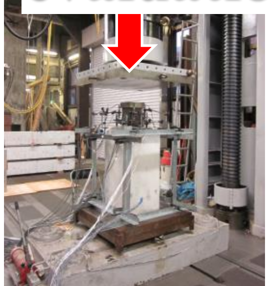
Understanding mechanical performance of connection

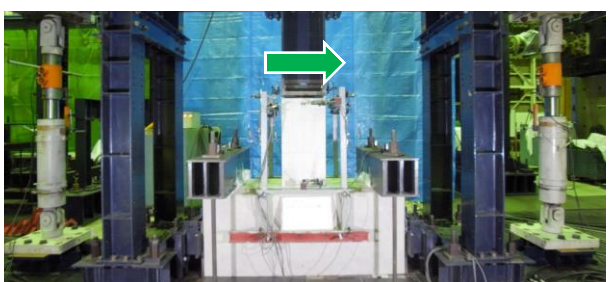
The system can be treated as pin-support up to story drift of 0.03 rad

Loading test on bottom story subassemblies

Proposition of capacity evaluation formula of connection

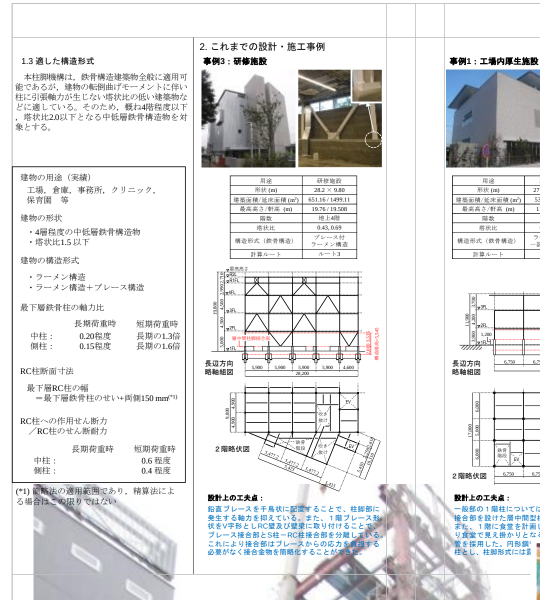


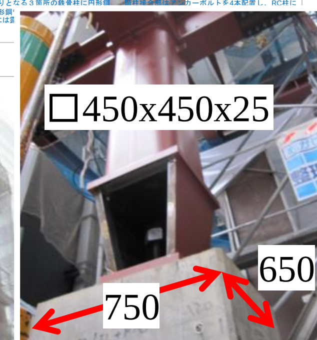
Compression test



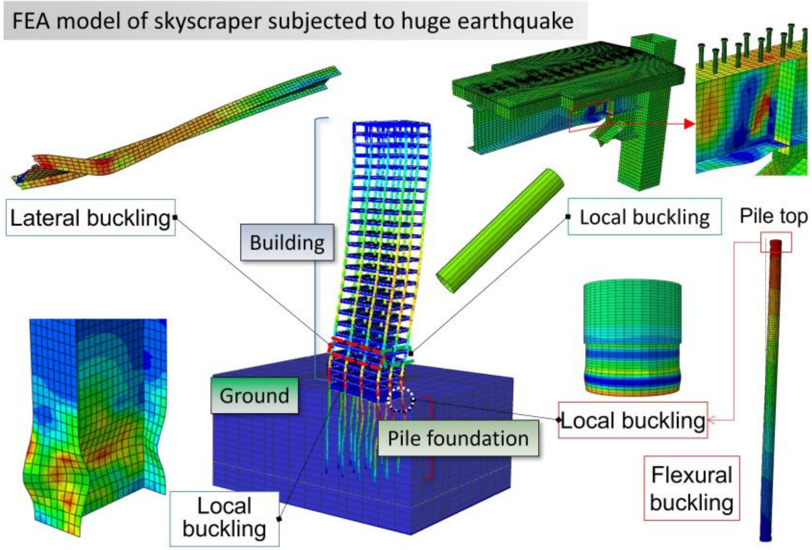
Shear test

Manualization

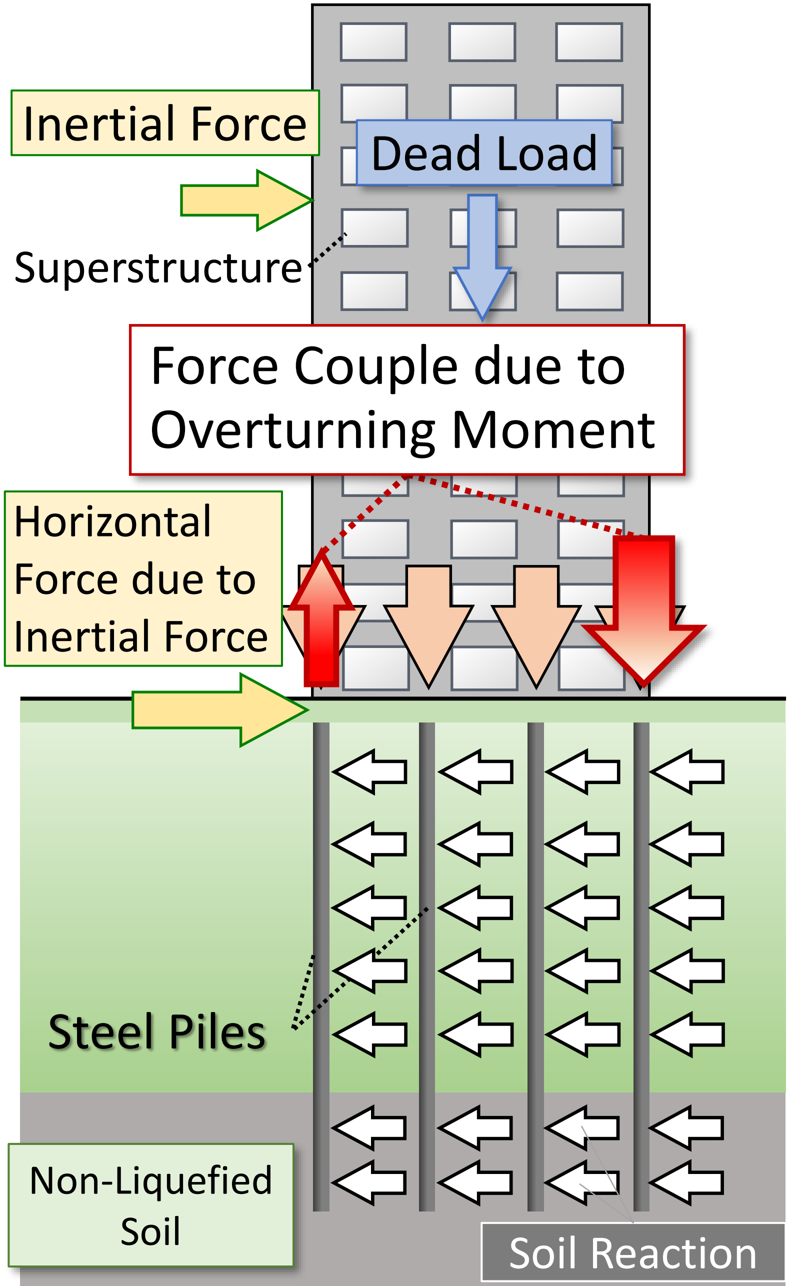




Construction of Ultimate State Design Method of Steel Piles and Elucidation of Dynamic Buckling Behavior of Steel Piles in Liquefied Soil



Collapse mechanism of pile



Current Japanese design codes

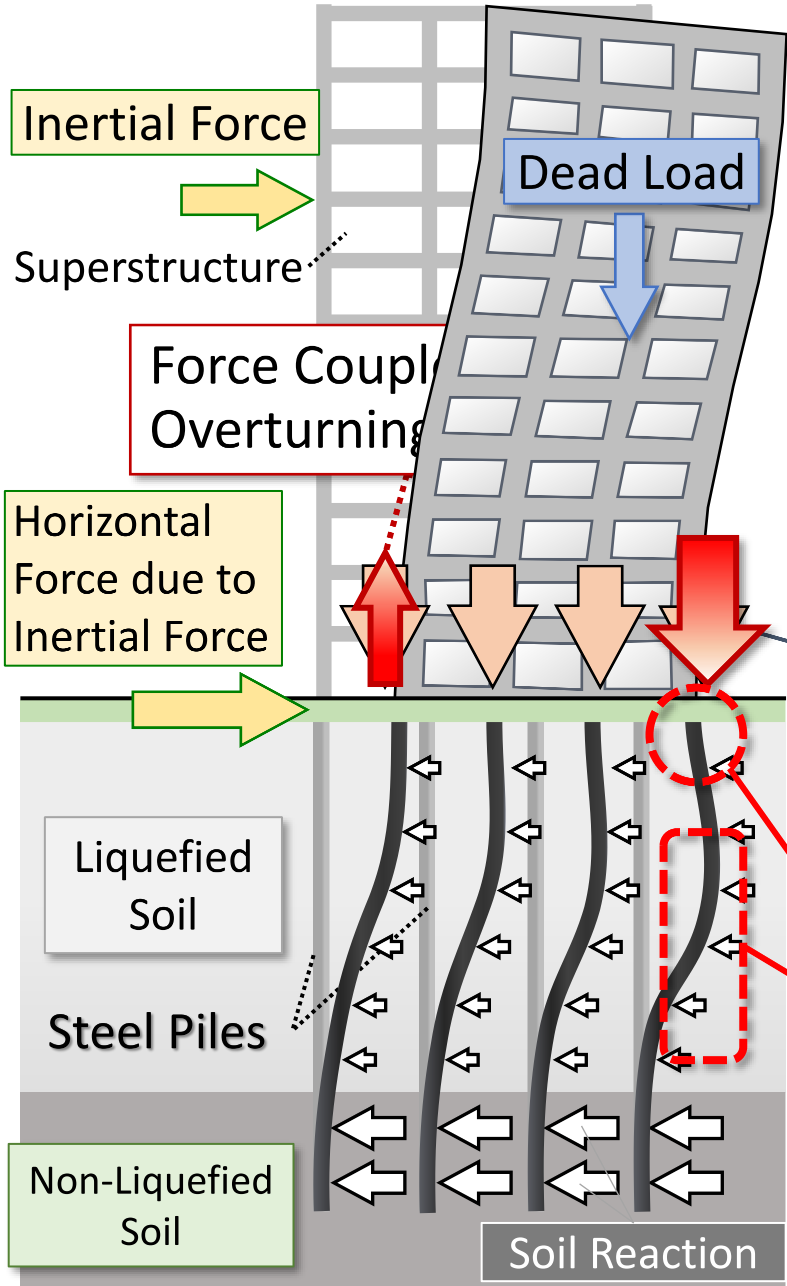
It is assumed that **steel pile's flexural buckling does not occur** because of soil restriction against piles lateral deformation.

↓

The design codes have **no prescription about the limitation of slenderness** for steel piles.

Reference: Architectural Institute of Japan, Recommendation for Design of Building Foundations, 2001. (in Japanese)

Collapse mechanism of pile



However, when **liquefaction** occurs during an earthquake,

horizontal stiffness of the ground is reduced drastically.

+

Slender steel piles beneath **high-rise buildings** experience **large axial compression force.**

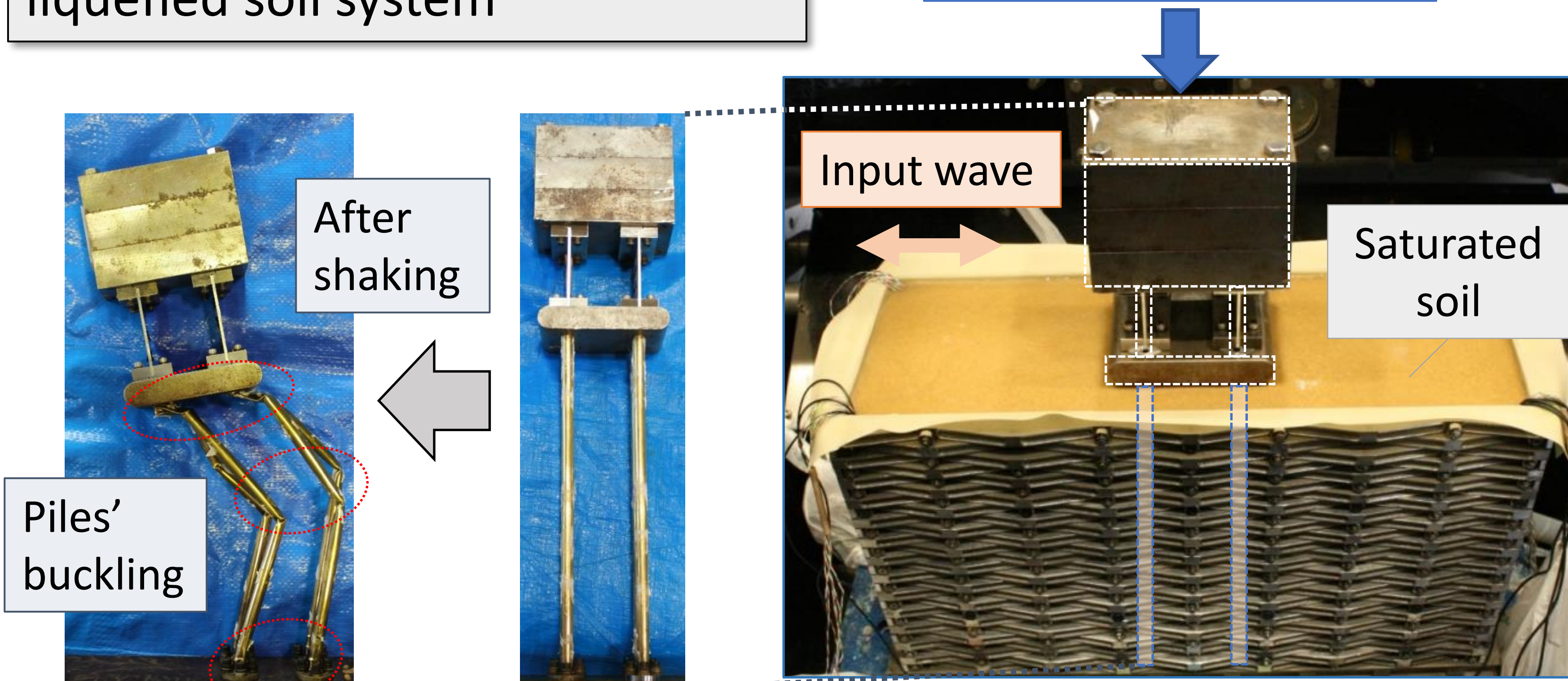
Steel pile's flexural buckling may occur.

Collapse mechanism of pile

◆ Collapse Mechanism of Steel Piles below High-Rise Building in Liquefied Soil

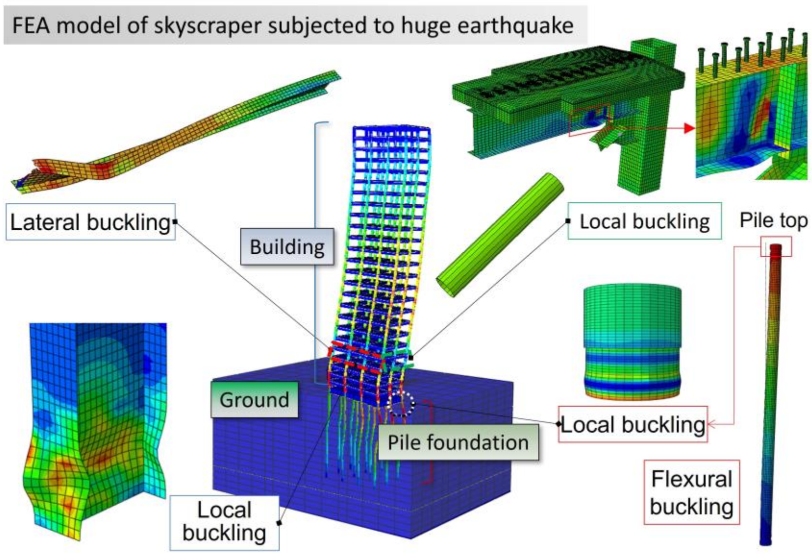
Centrifugal tests of high-rise superstructure, steel piles, and liquefied soil system

under the centrifugal acceleration of 40G

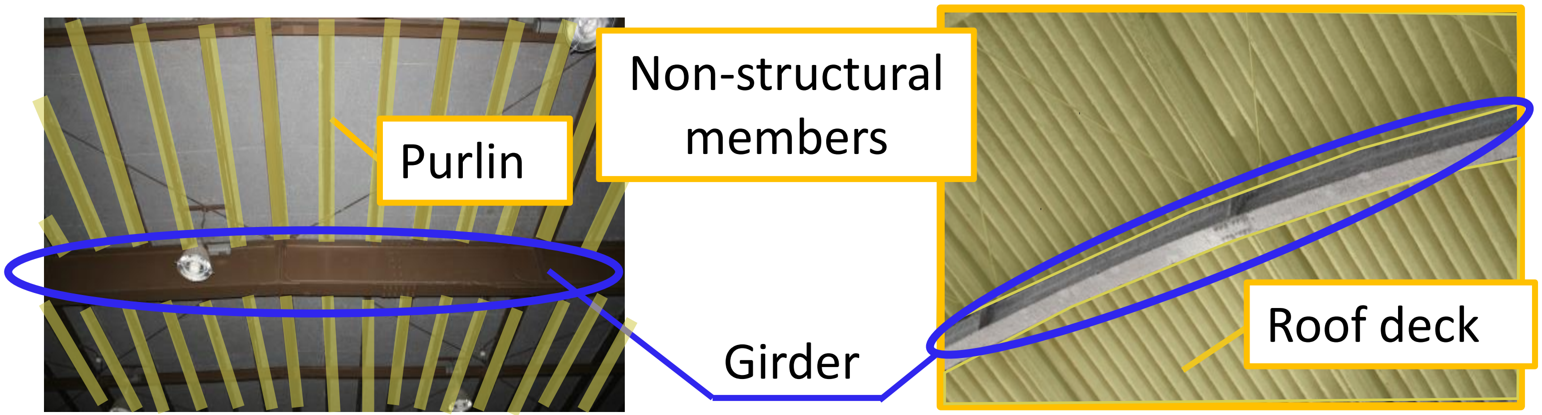


Ultimate state　　Initial state　　Specimen for centrifugal test

Invention of Evaluation Method of Lateral Buckling Strength of Large-Span Beams



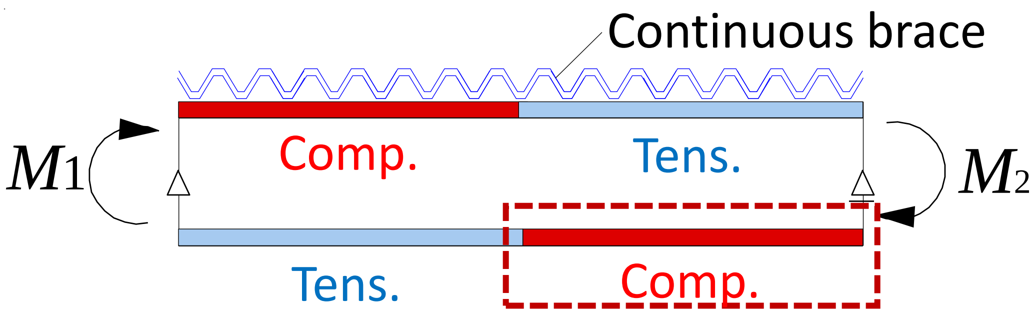
Lateral buckling of I-beam

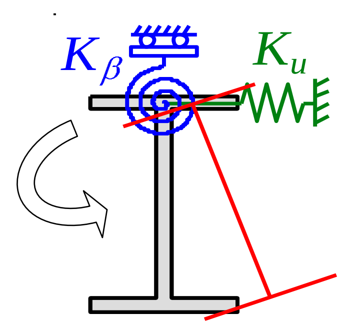


Non-structural members settle on a top flange (continuous brace)

・Constraint against lateral buckling deformation

⇒ This effect is ignored in the current design guideline

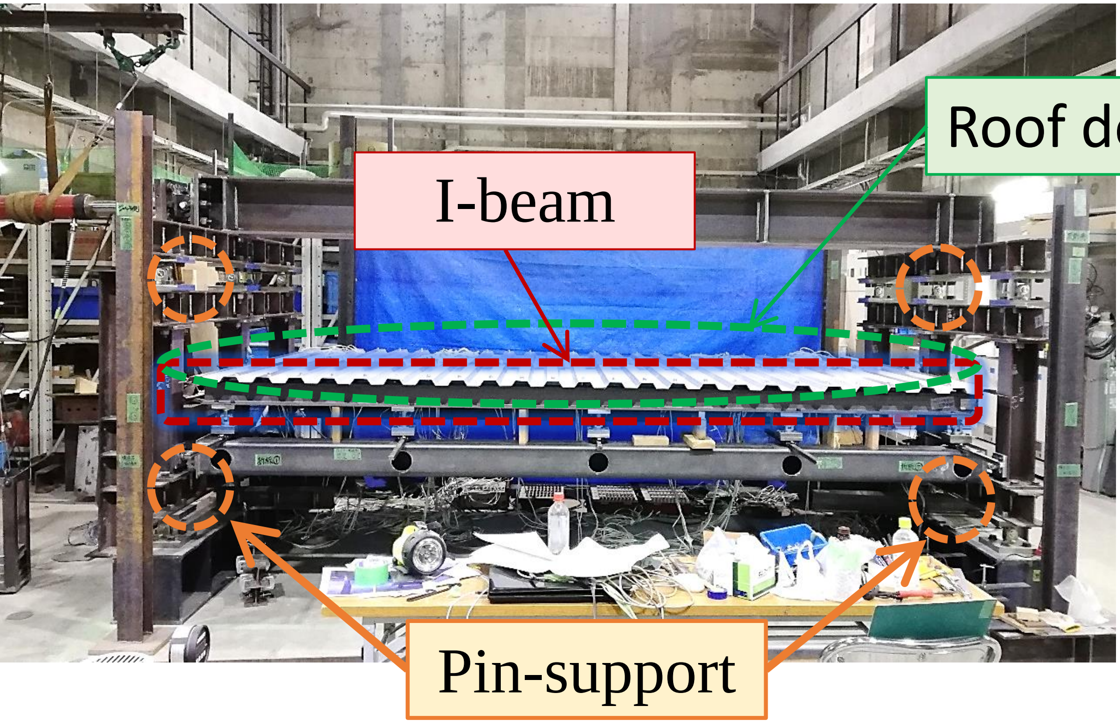


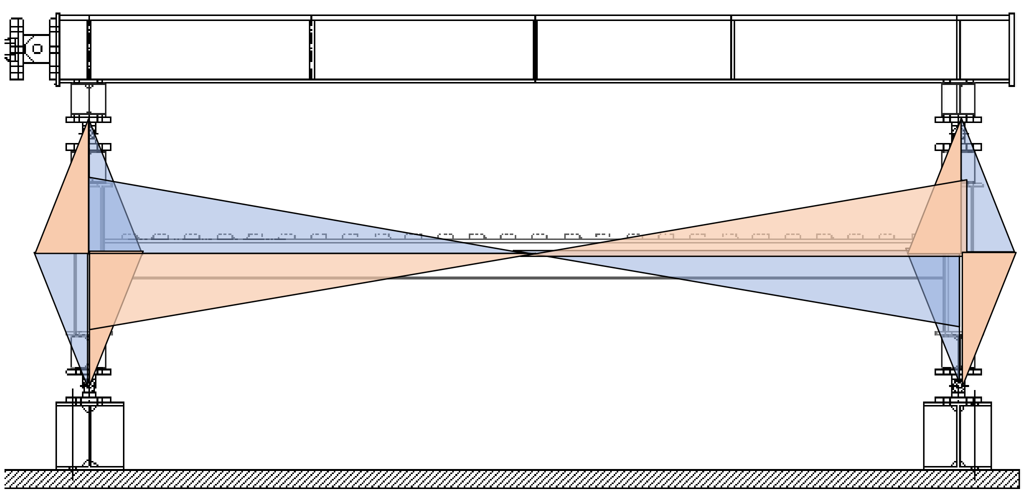


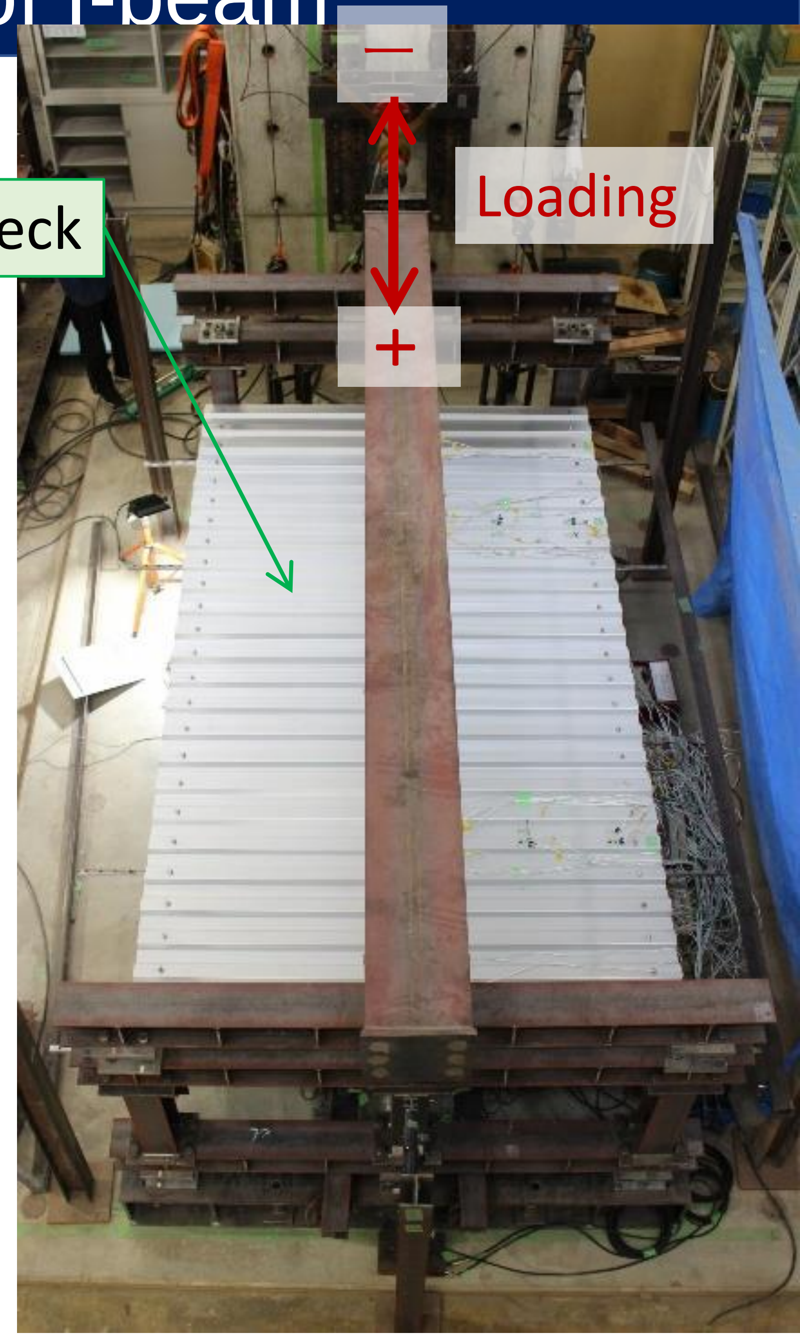
Lateral buckling on bottom flange

→Bracing on top flange＝Horizontal and rotational bracings are necessary

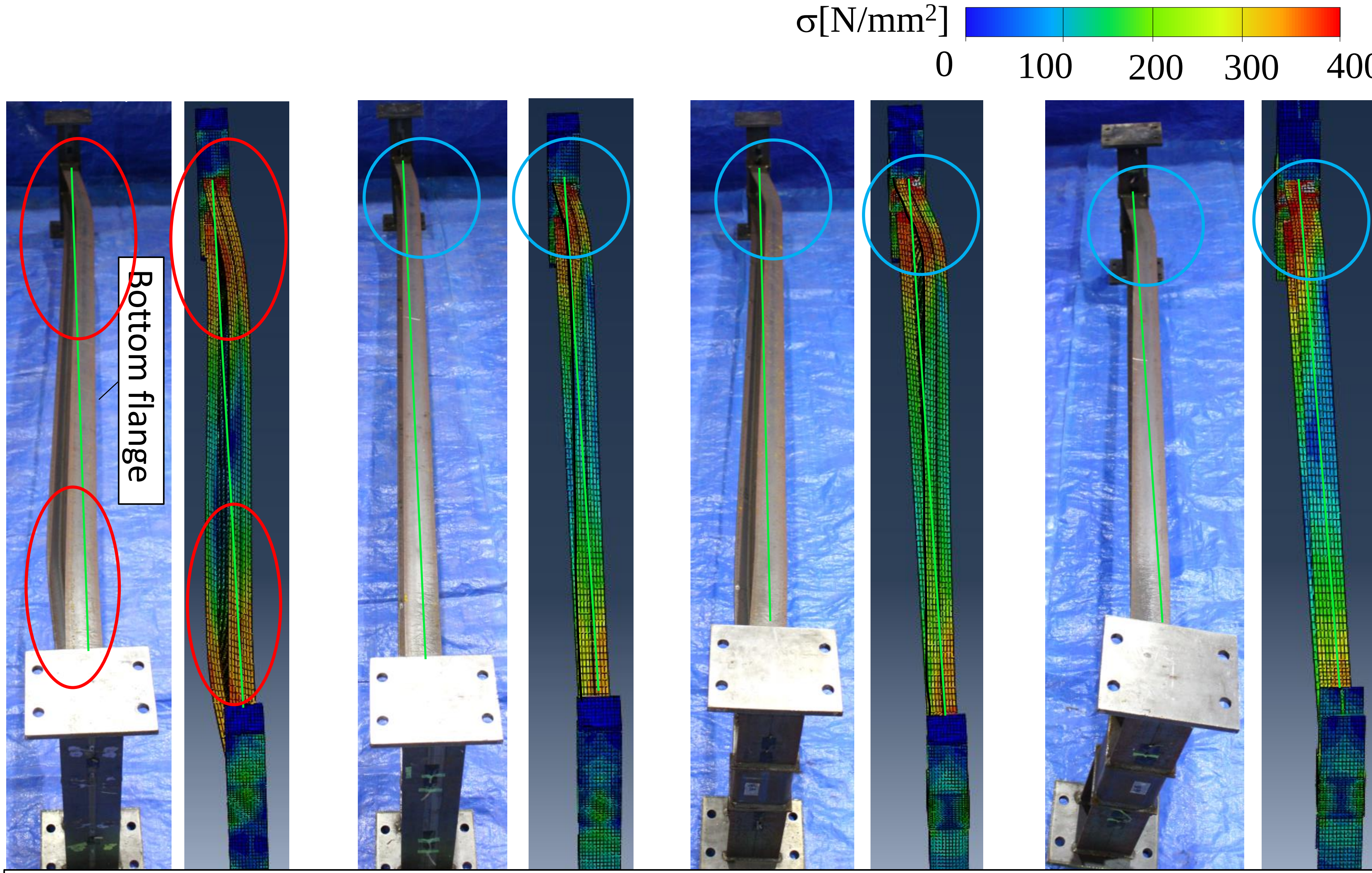
Lateral buckling of I-beam





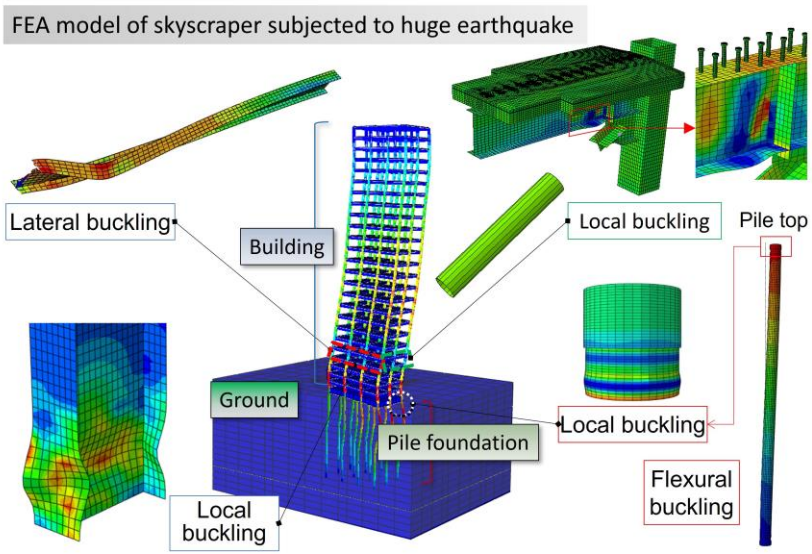


Lateral buckling of I-beam



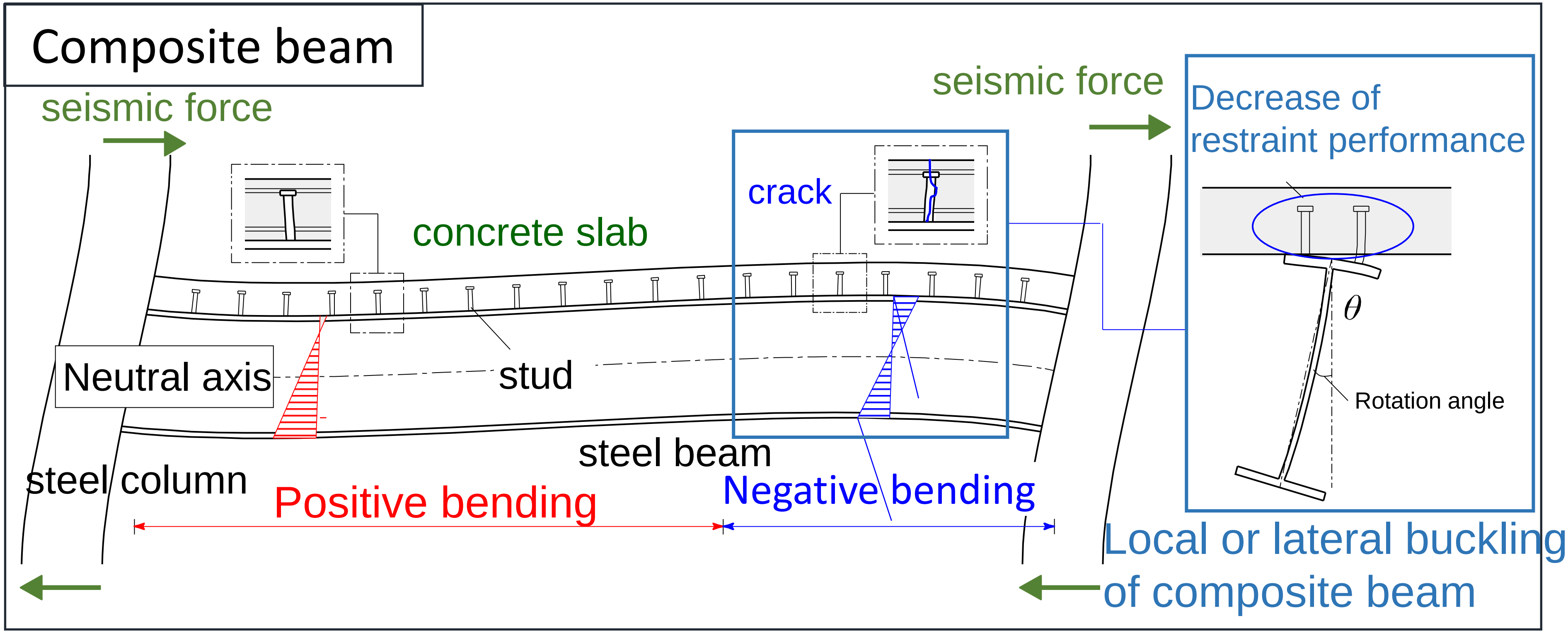
Buckling behavior is revealed based on experimentation and FEA

Creation of Seismic Design Method of Buckling Restrained Braced Frame with Concrete Slab

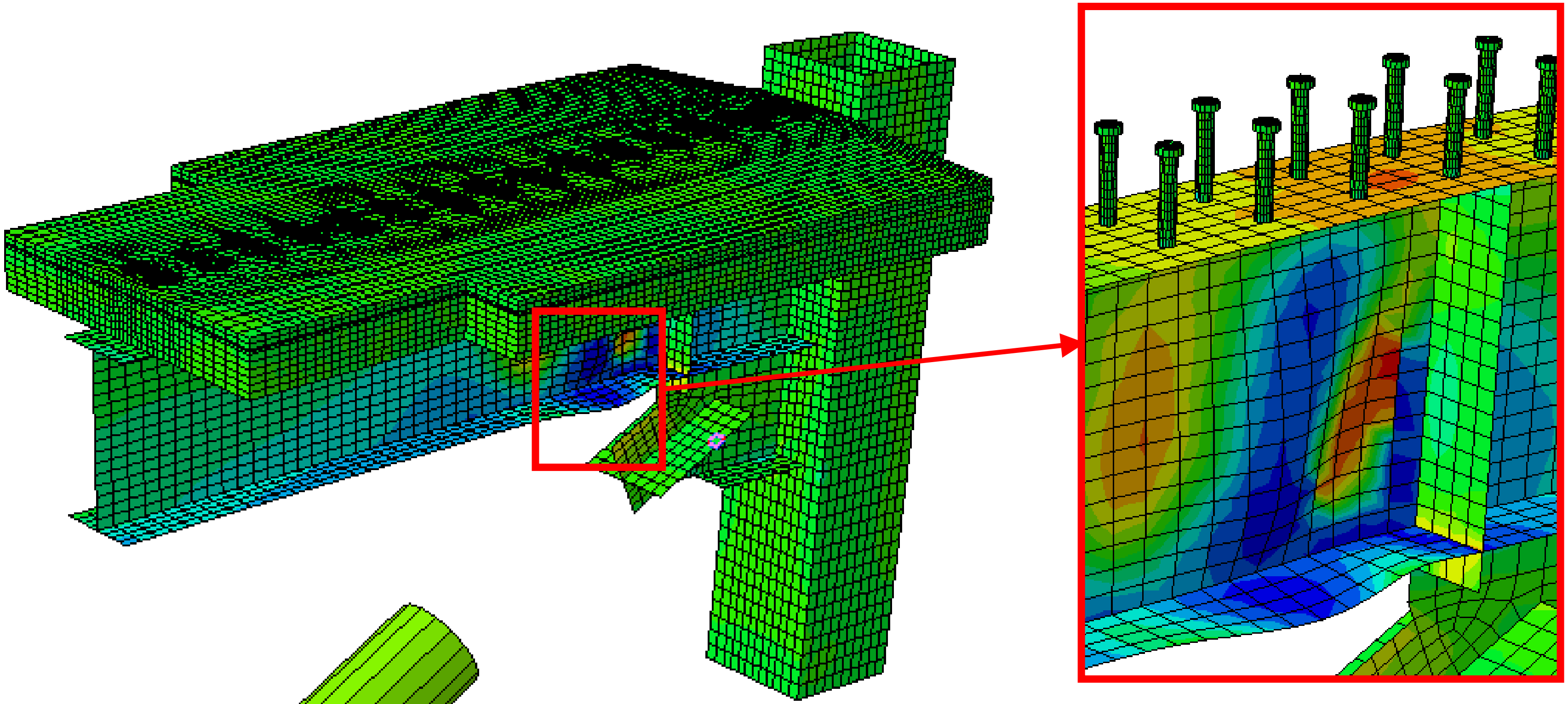


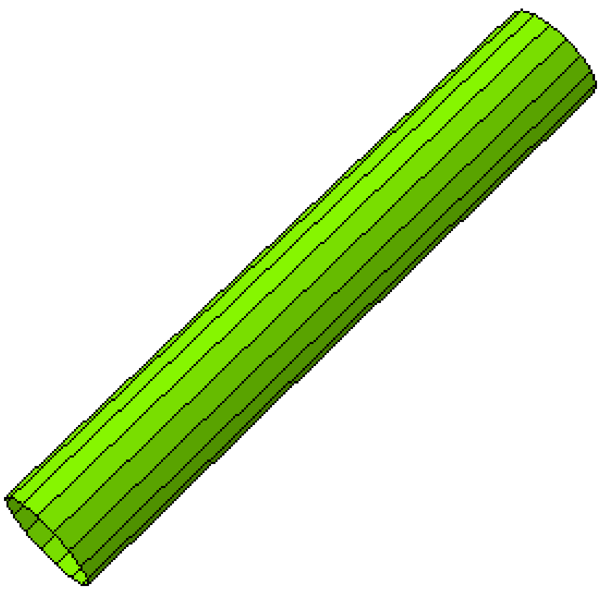
Stress transfer mechanism of composite beam

The neutral axis location varies due to the composite effect during positive bending and negative bending.



Stress transfer mechanism of composite beam





Buckling may occur at the bottom flange. The capacity is also influenced by the shear anchor.

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Prospective impact of composite dowel to the buckling instability is inevitable for the practical application to the building structures.