STUDENT DAY 2016
SEISMIC ENGINEERING OF BRIDGES

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OUTLINE

1. My background
2. Seismic engineering in general
3. The Kashmir bridges (India)
4. The George Massey Tunnel Replacement bridge (Canada)

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MY BACKGROUND

Simon M. Gren

- 2013: M.Sc. from DTU, Carbon fiber and aramid fiber reinforced glulam beams
- 2013: Employed at Ramboll in the International Bridges Department

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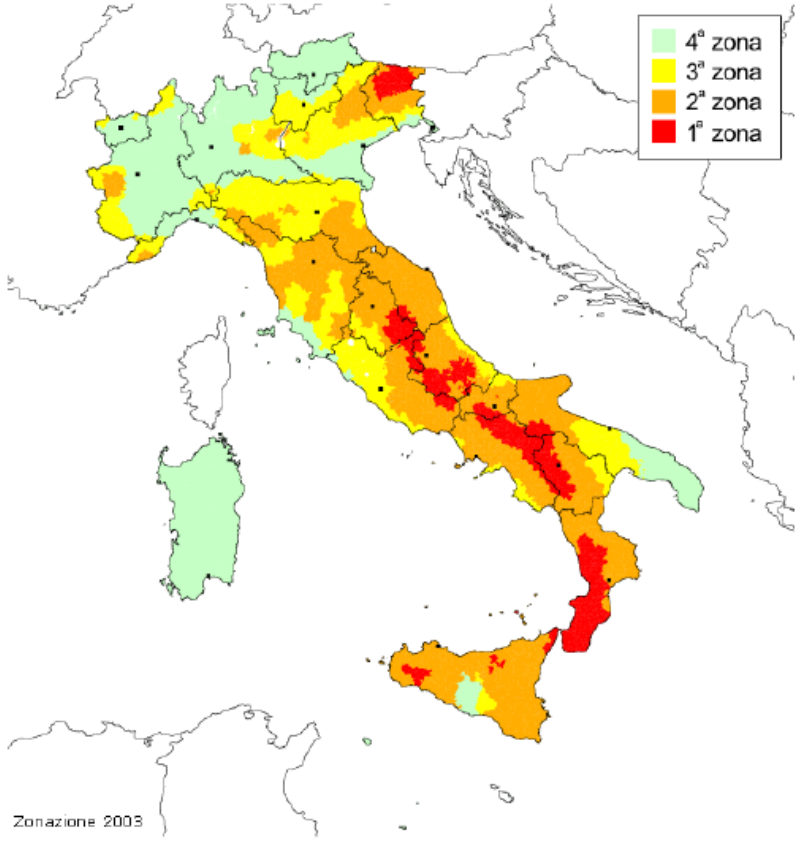
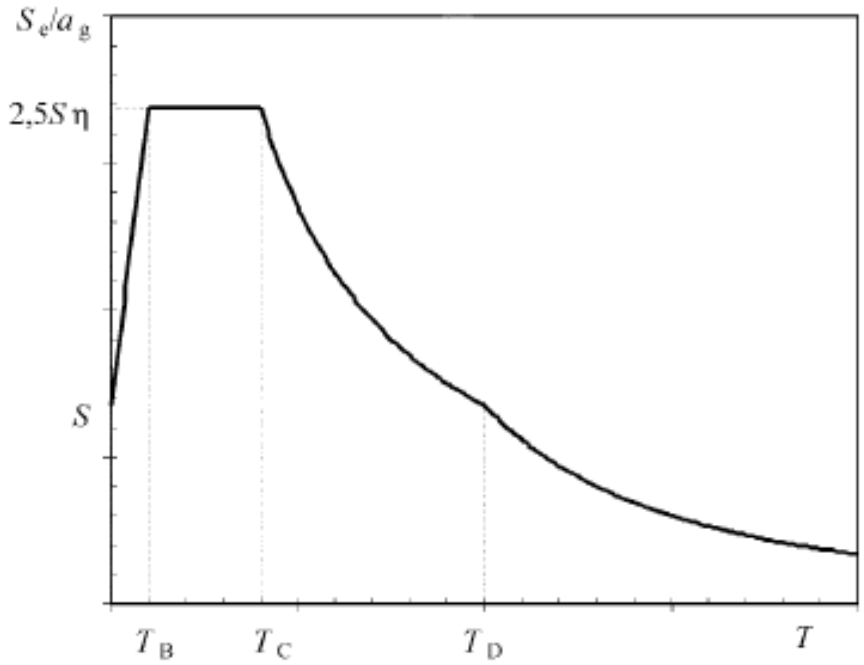
SEISMIC ENGINEERING IN GENERAL

- Design load
  - Peak ground acceleration – Seismic hazard map



SEISMIC ENGINEERING IN GENERAL

- Design load
  - Peak ground acceleration – Seismic hazard map
  - Acceleration response spectra – Frequency domain



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SEISMIC ENGINEERING IN GENERAL

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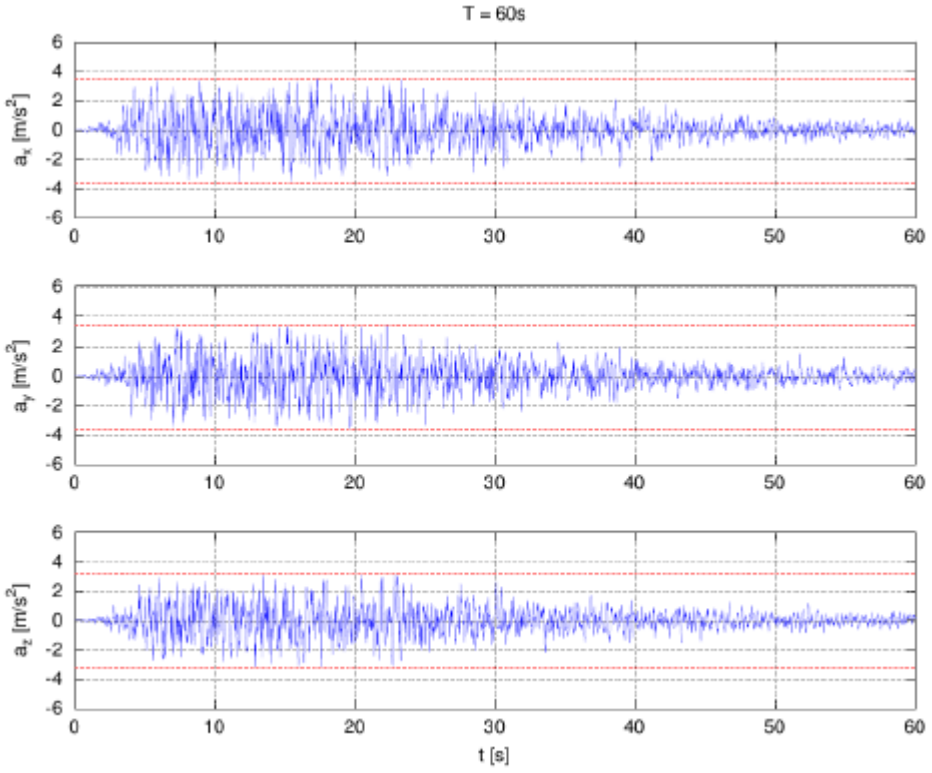
  - Accelerograms – Time domain



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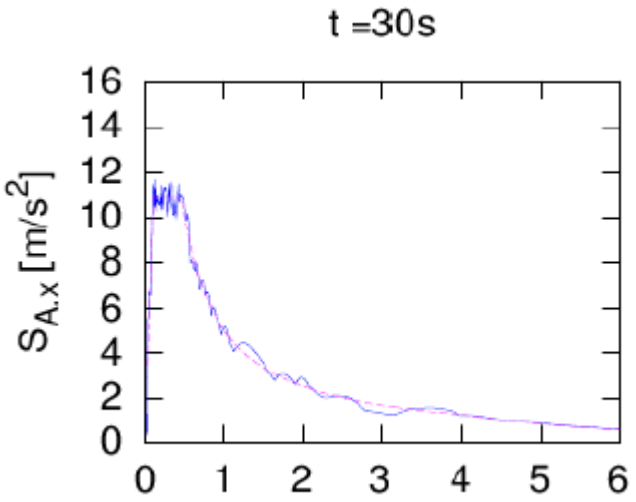
SEISMIC ENGINEERING IN GENERAL

- Design load
  - Peak ground acceleration – Seismic hazard map
  - Acceleration response spectra – Frequency domain
  - Accelerograms – Time domain
  - Correlation



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SEISMIC ENGINEERING IN GENERAL

- Design load
  - Peak ground acceleration – Seismic hazard map
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  - Accelerograms – Time domain
  - Correlation
- Limit states
  - No-collapese (ultimate limit state)
  - Minimisation of damage (serviceability limit state)

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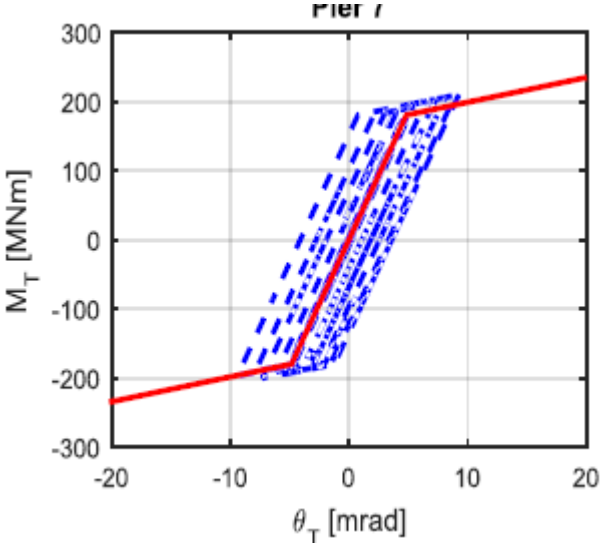
  - Correlation
- Limit states
  - No-collapese (ultimate limit state)
  - Minimisation of damage (serviceability limit state)
- Ductility
  - Plastic hinges



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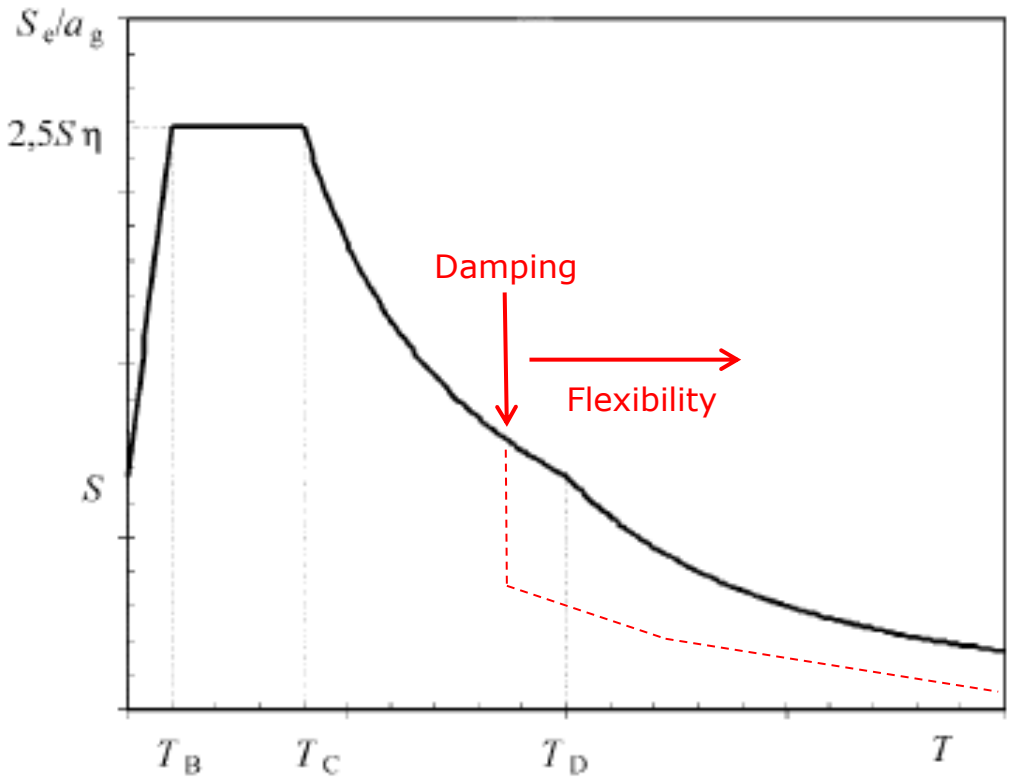
SEISMIC ENGINEERING IN GENERAL

- Seismic isolation



SEISMIC ENGINEERING IN GENERAL

- Design philosophy
  - Force based design vs. displacement based design

SEISMIC ENGINEERING IN GENERAL

- Design philosophy
  - Force based design vs. displacement based design
  - Performance requirements

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CASE STUDIES

- The Kashmir bridges

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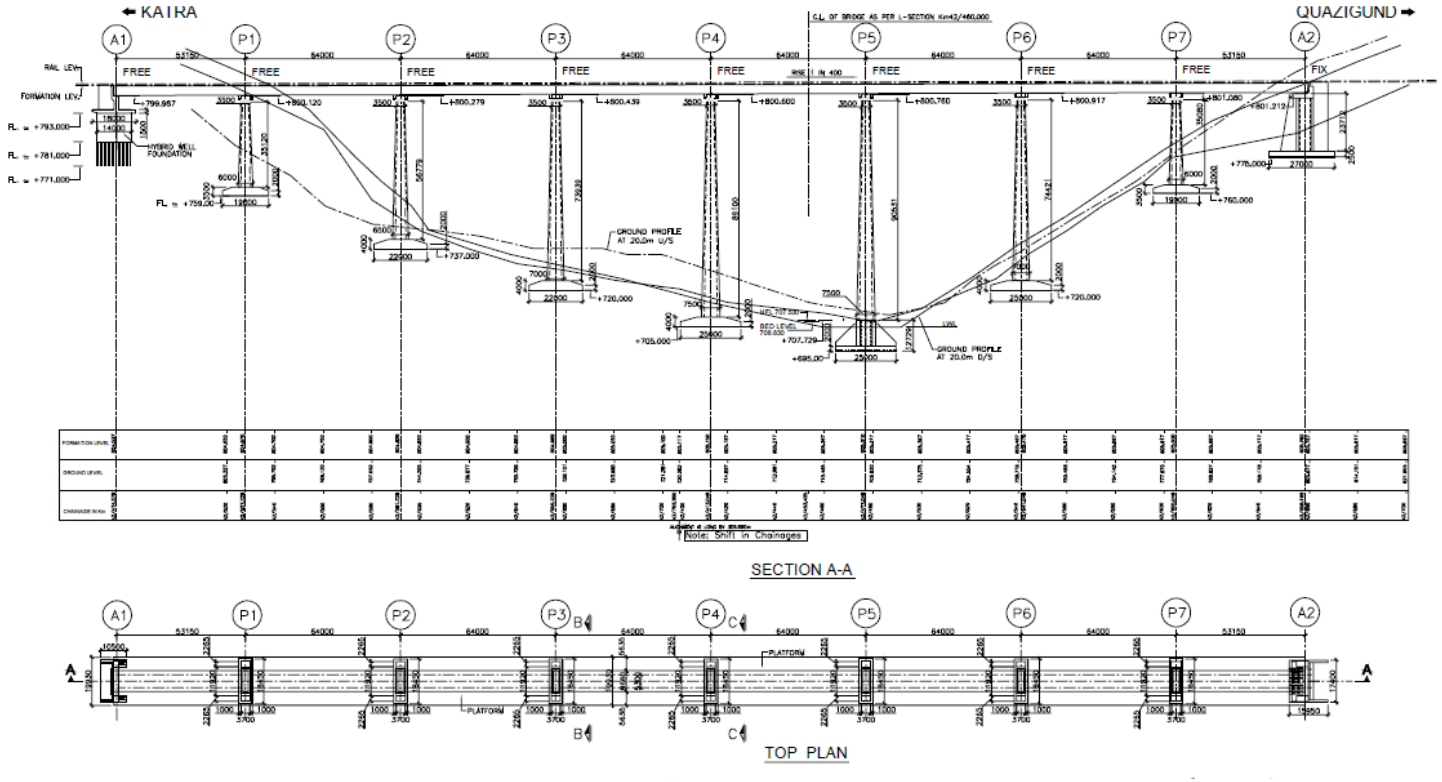
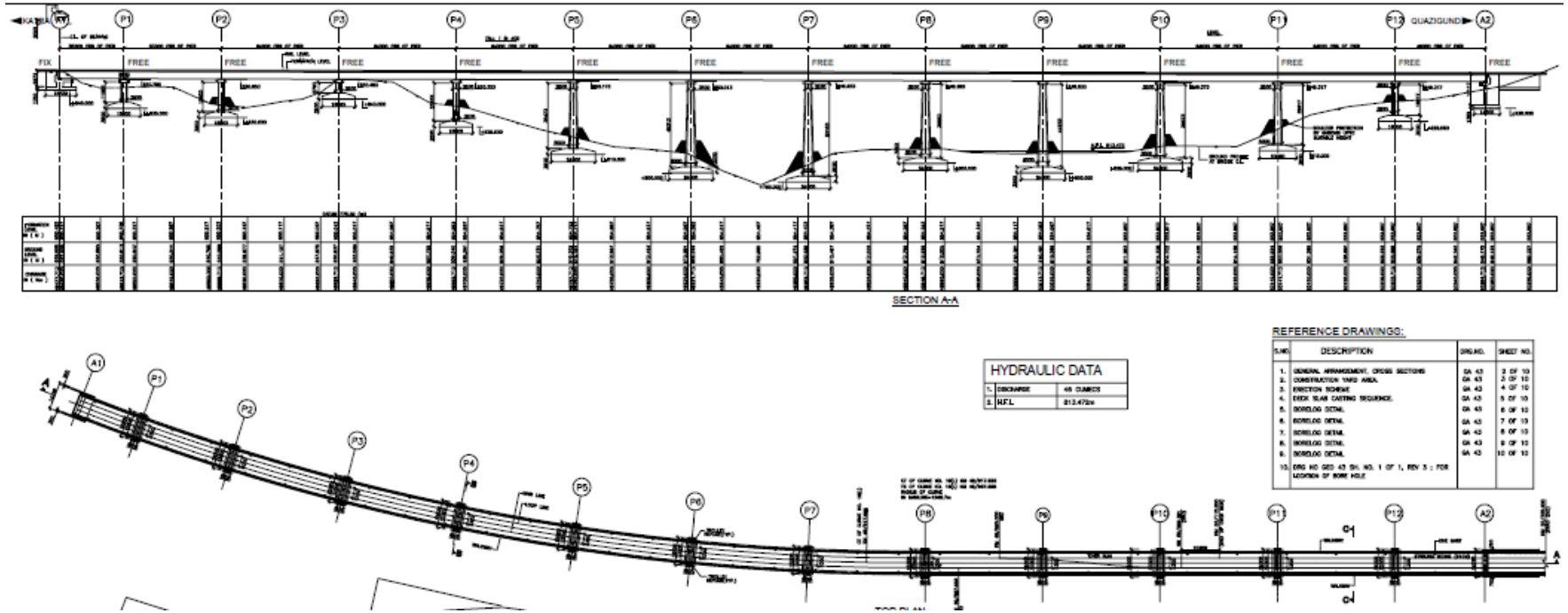
CASE STUDIES

- The Kashmir bridges
  - Bridge 39



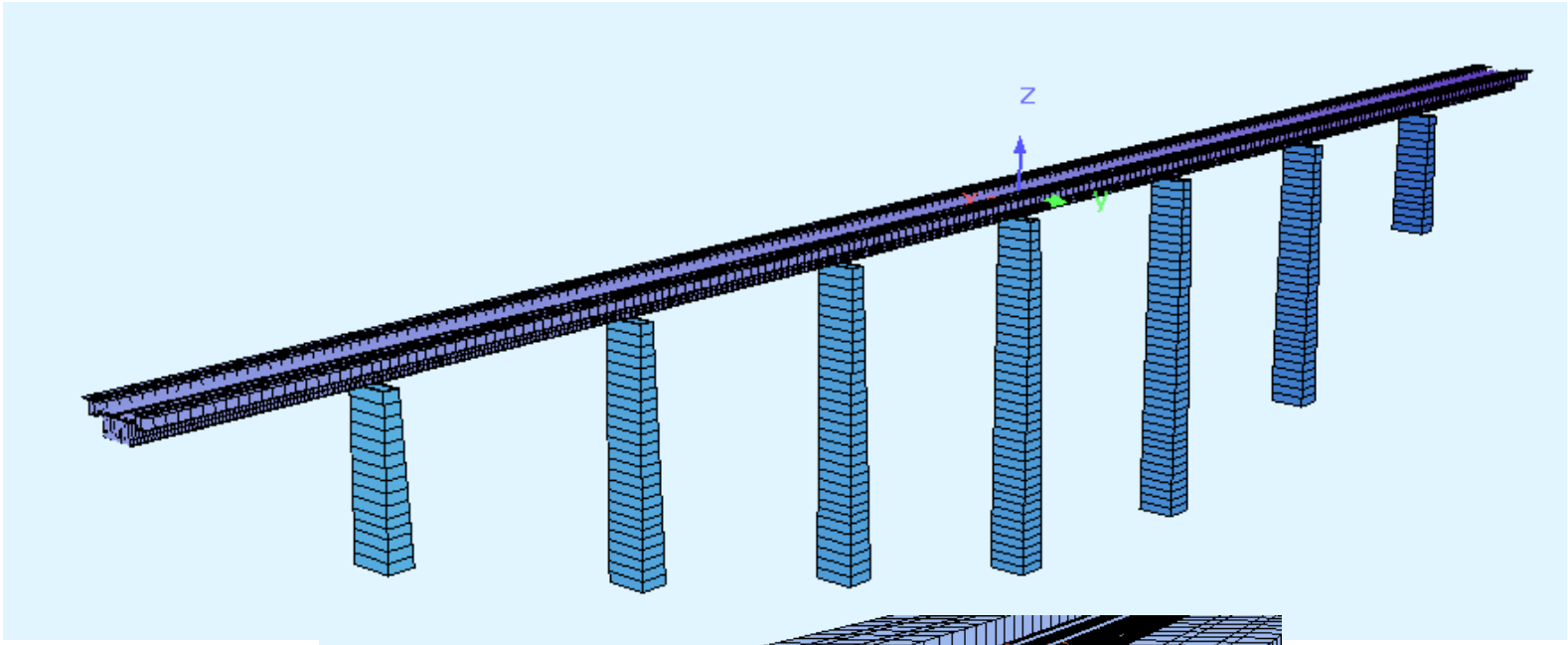
CASE STUDIES

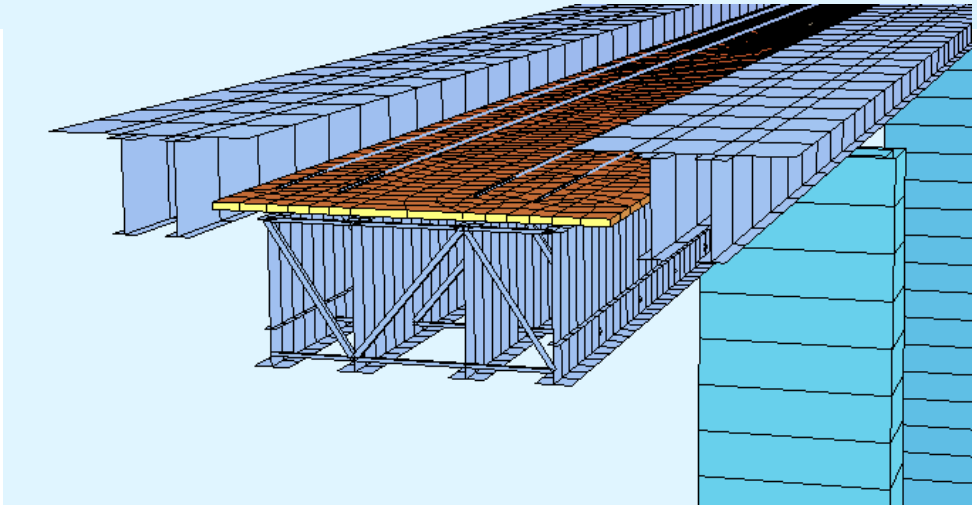
- The Kashmir bridges
  - Bridge 39
  - Bridge 43



BRIDGE 39

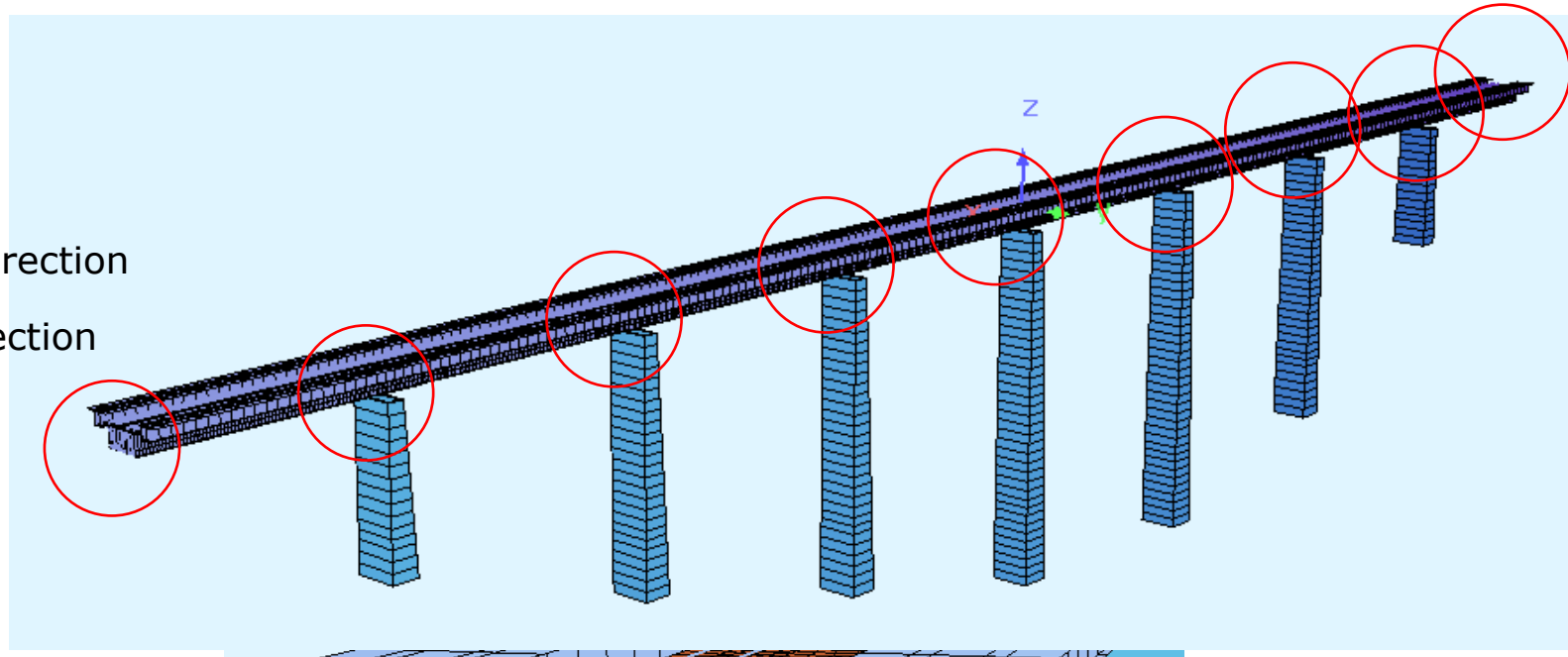
- Structural system

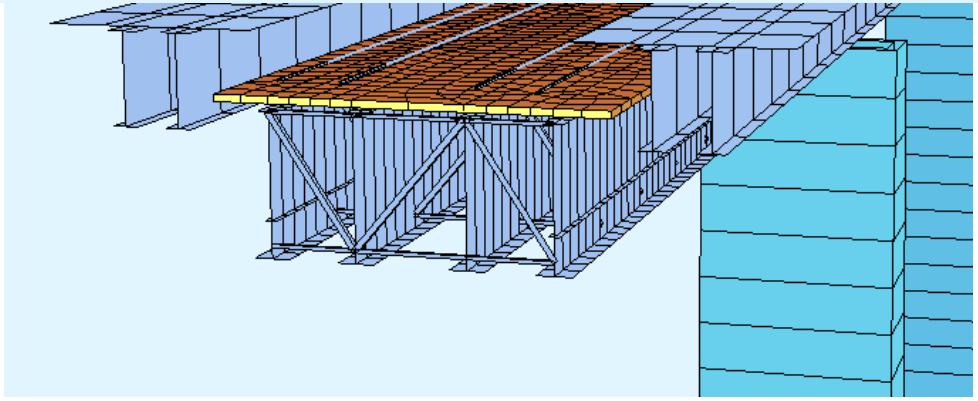




BRIDGE 39

- Structural system
  - Bearings
    - Free to move in the long direction
    - Fixed in the transverse direction
    - Lift-lock at platforms





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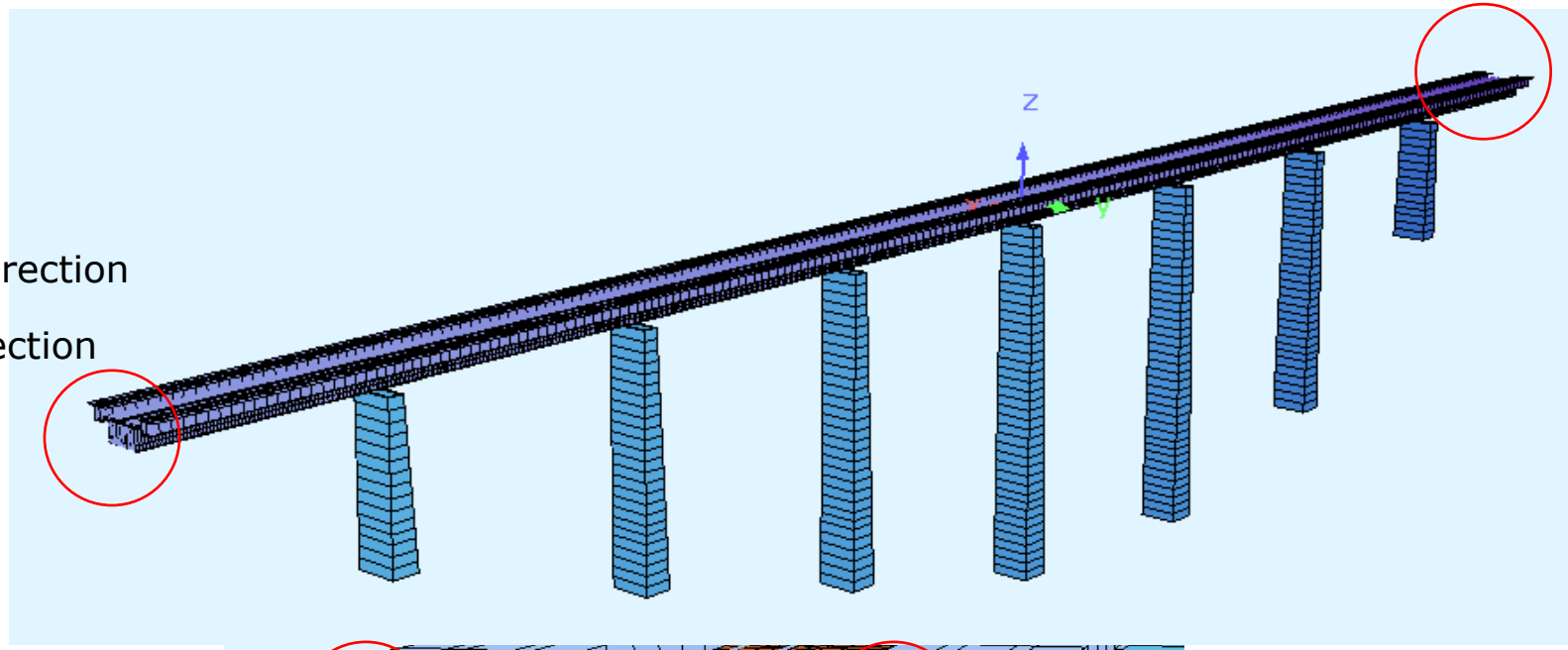
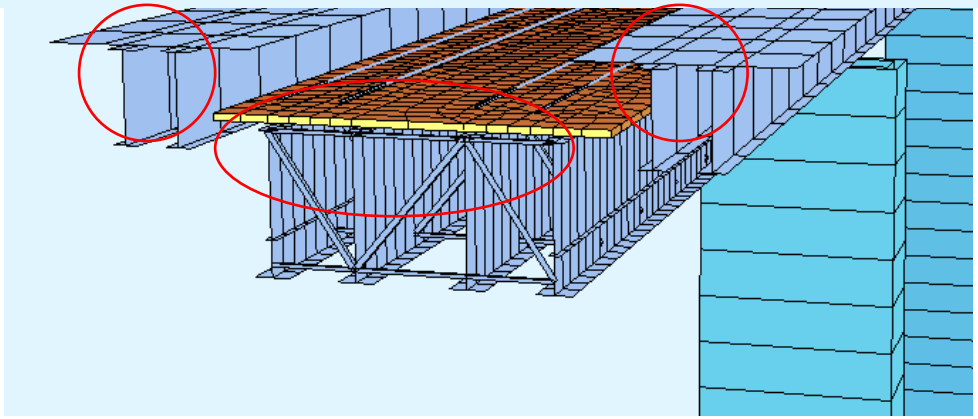
BRIDGE 39

- Structural system
  - Bearings
    - Free to move in the long direction
    - Fixed in the transverse direction
    - Lift-lock at platforms
  - Preloaded spring dampers





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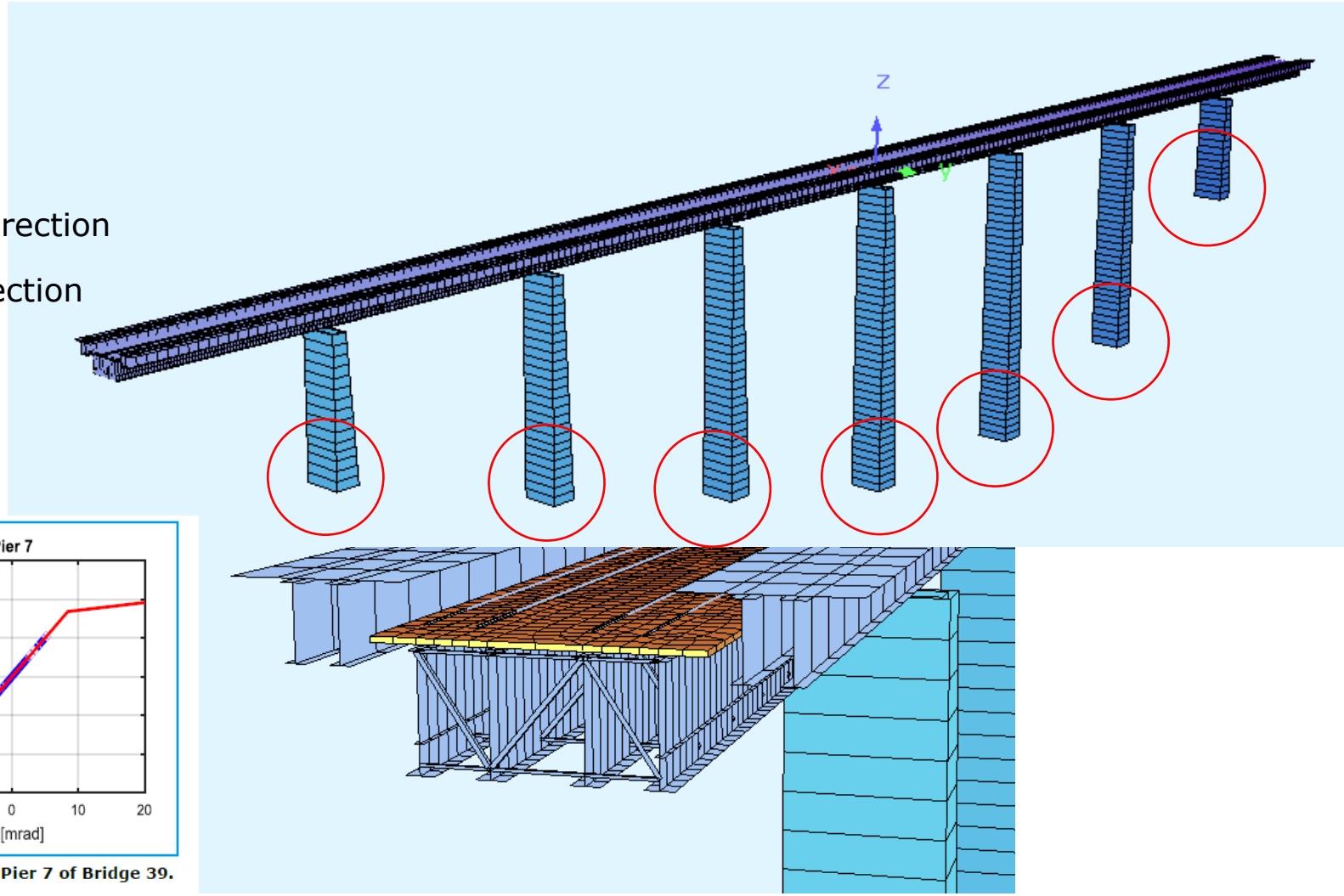
BRIDGE 39

- Structural system
  - Bearings
    - Free to move in the long direction
    - Fixed in the transverse direction
    - Lift-lock at platforms
  - Preloaded spring dampers
  - Plastic hinges at pier bases



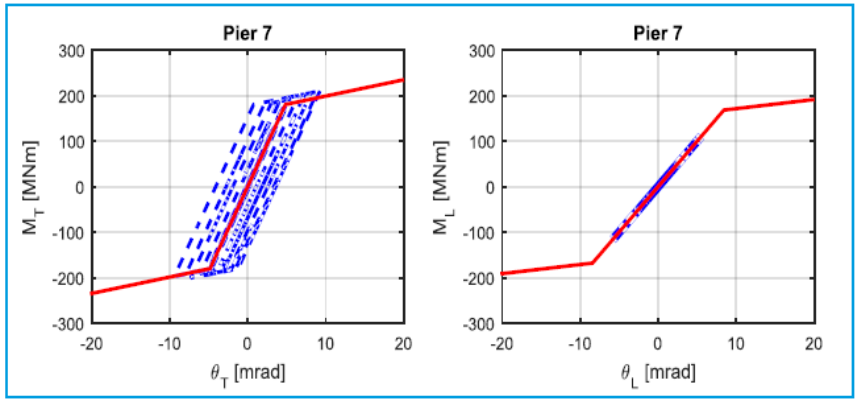
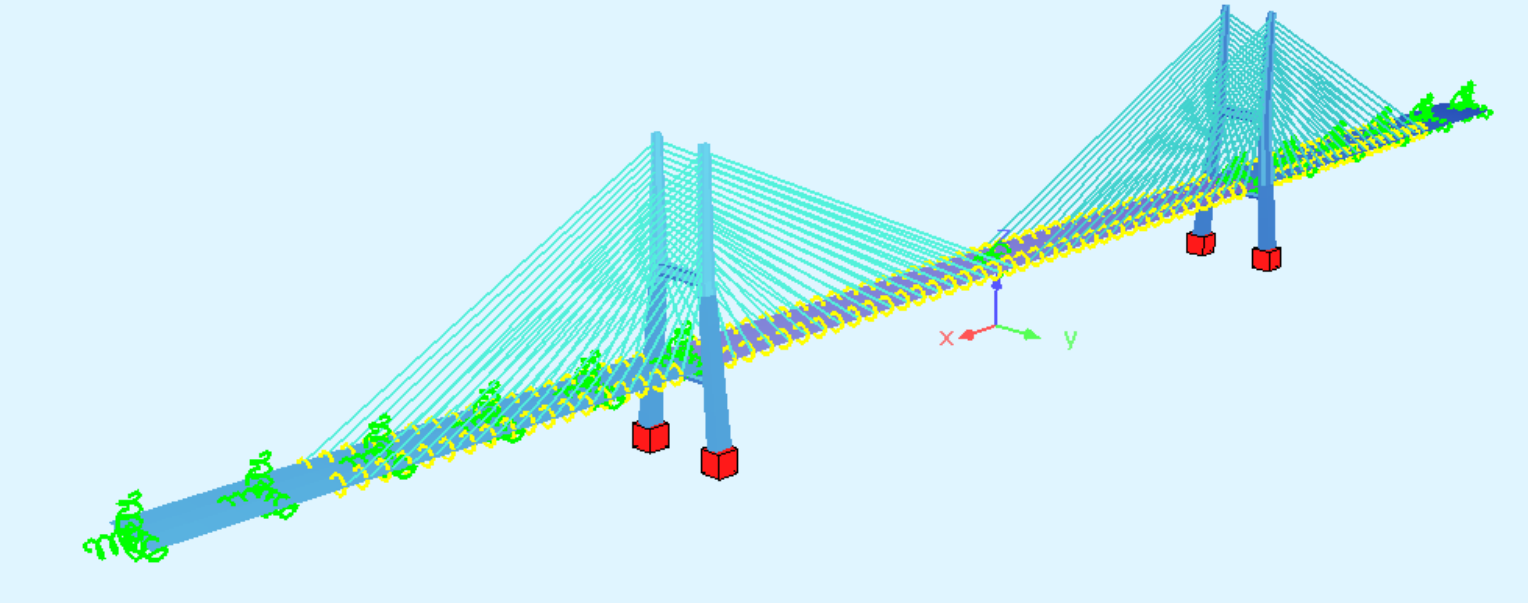


Figure 50. Plastic hinges about global y- and x-direction for Pier 7 of Bridge 39.

CASE STUDIES

- The Kashmir bridges

- The George Massey Tunnel Replacement (GMTR) bridge



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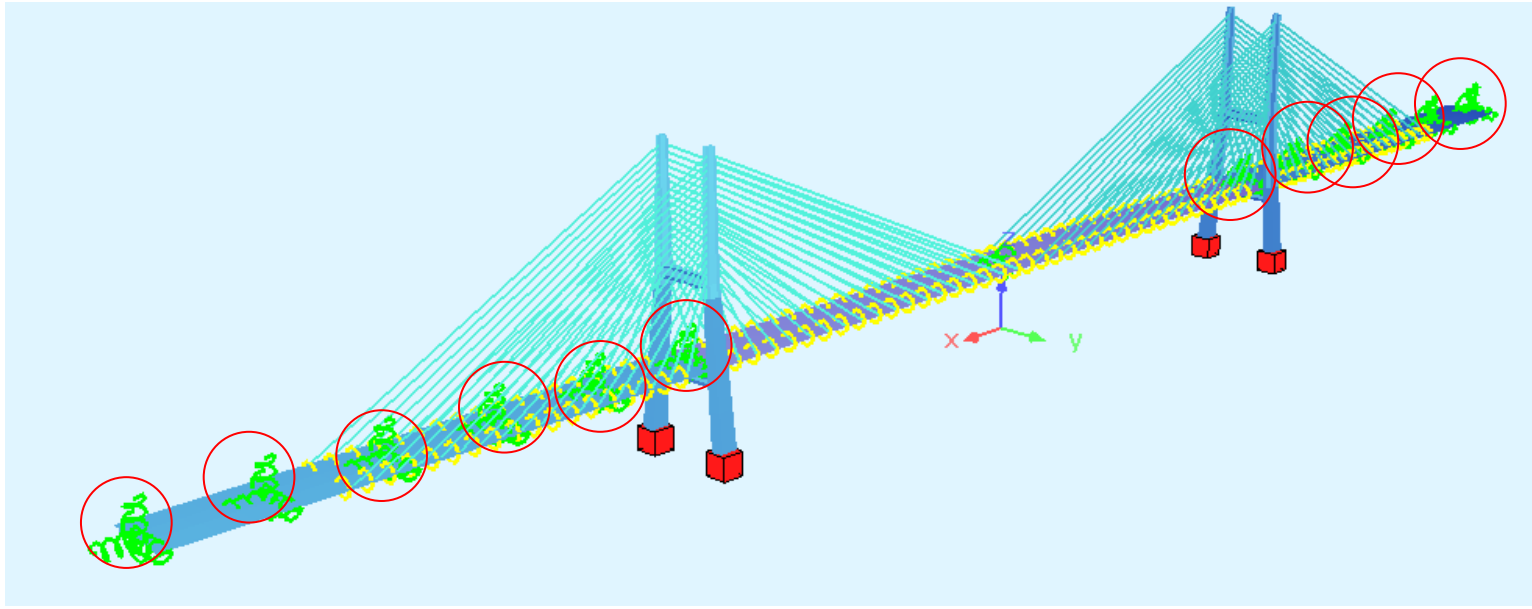
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- History
  - Shock transmission units (STU)



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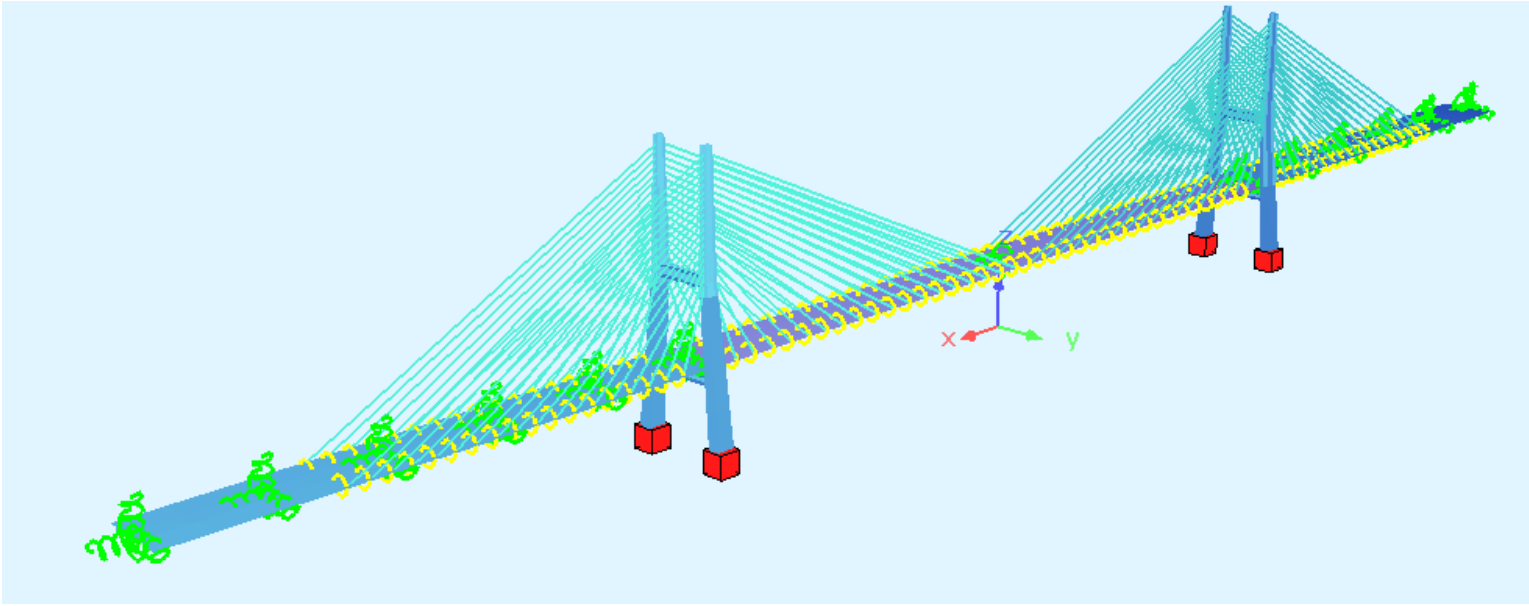
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- History
  - Shock transmission units (STU)
  - Forced base design



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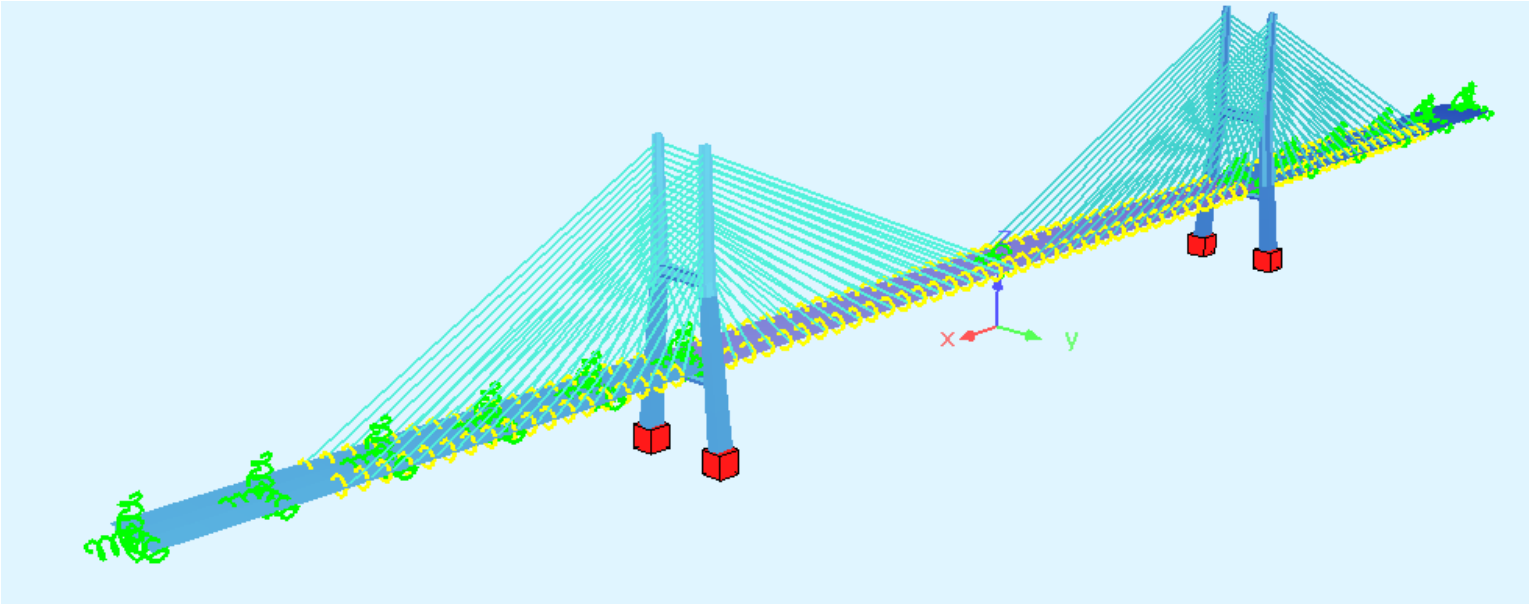
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- History
  - Shock transmission units (STU)
  - Forced base design
  - Change in Canadian design code – Performance based design



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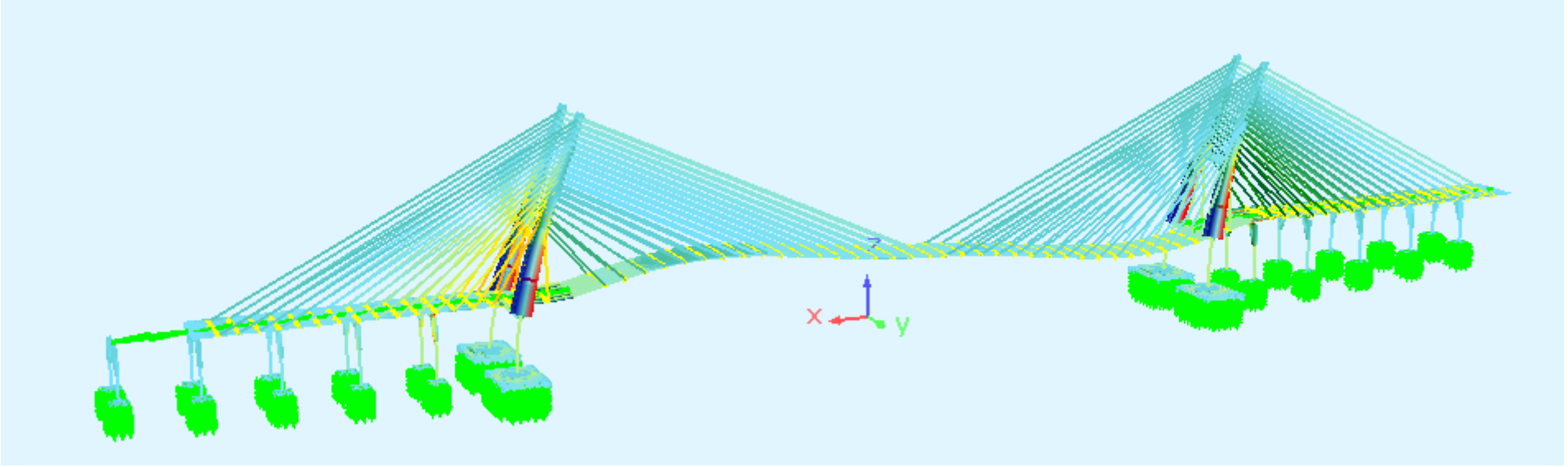
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Structural system
  - Removing STU’s



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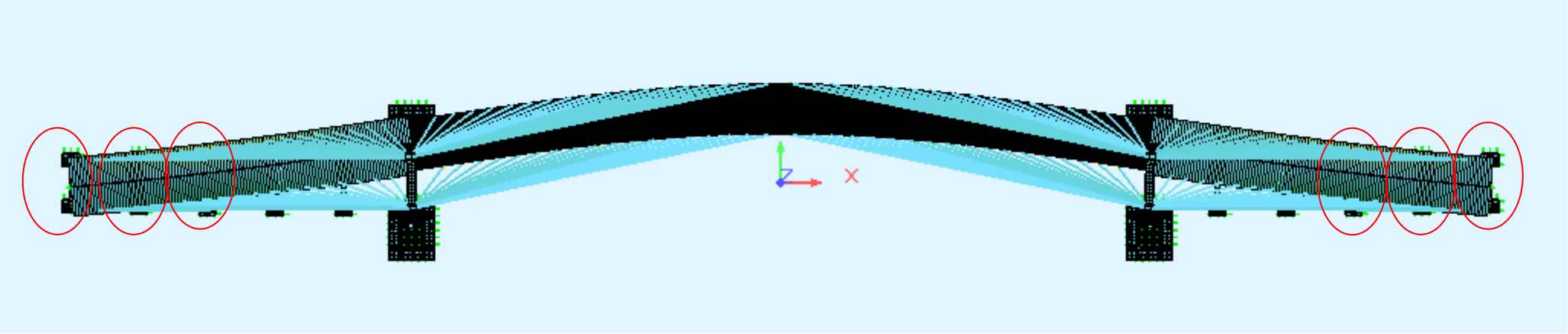
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Structural system
  - Removing longitudinal STU’s
  - Transverse shear keys at specific locations



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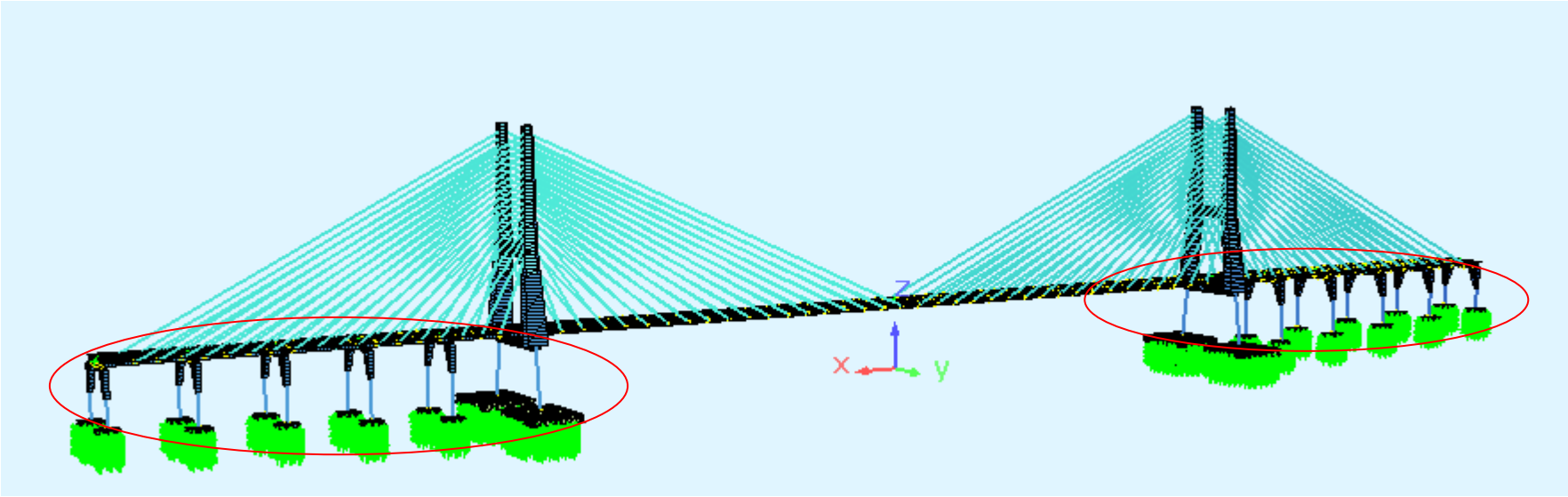
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Structural system
  - Removing STU’s
  - Transverse shear keys at specific locations
  - Include cracked stiffness



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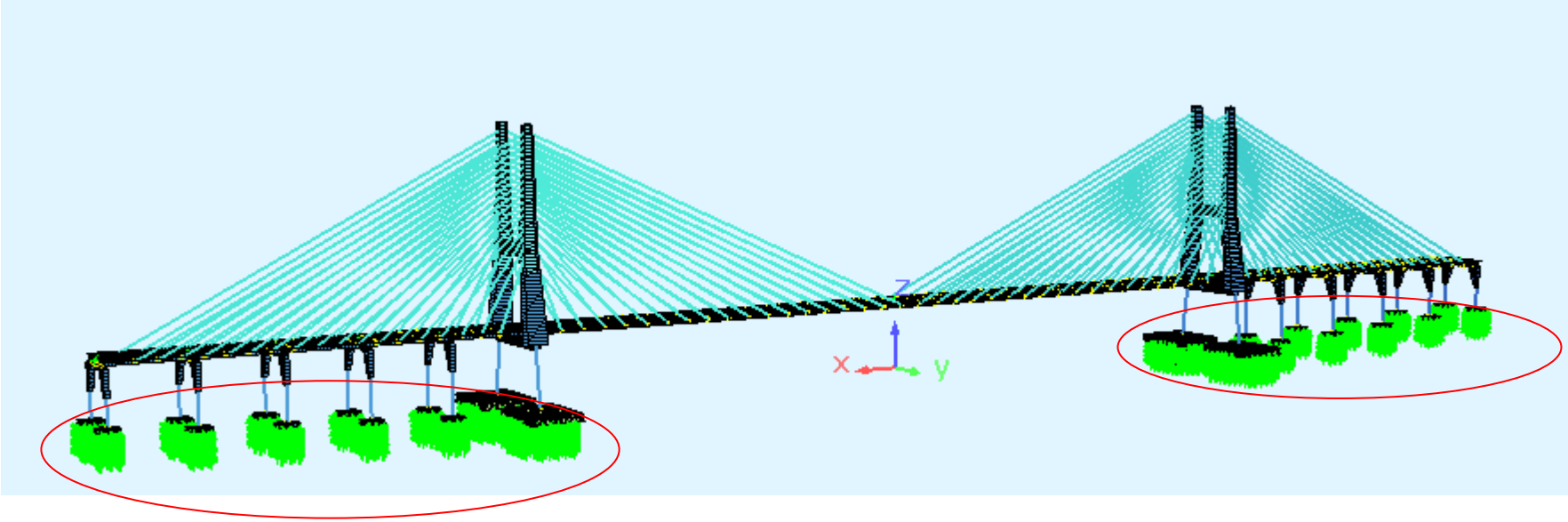
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Structural system
  - Removing STU’s
  - Transverse shear keys at specific locations
  - Include cracked stiffness
  - Include piles and soil stiffness



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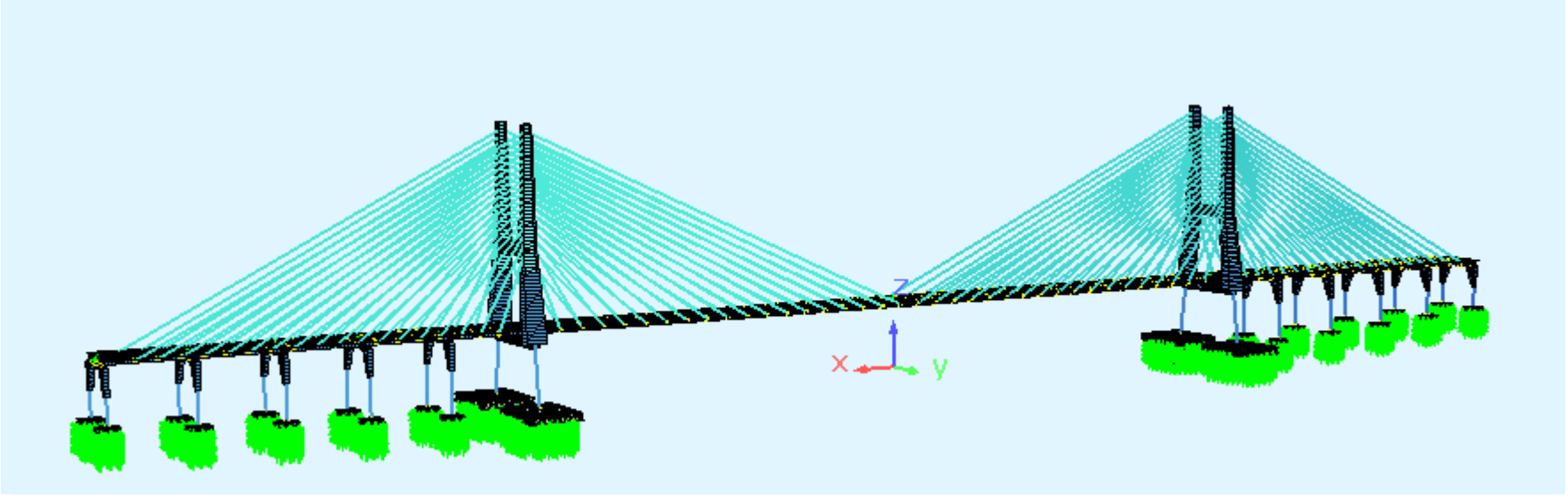
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Cross-section analysis
  - 2475yr event – Plastic reinforcement steel strain



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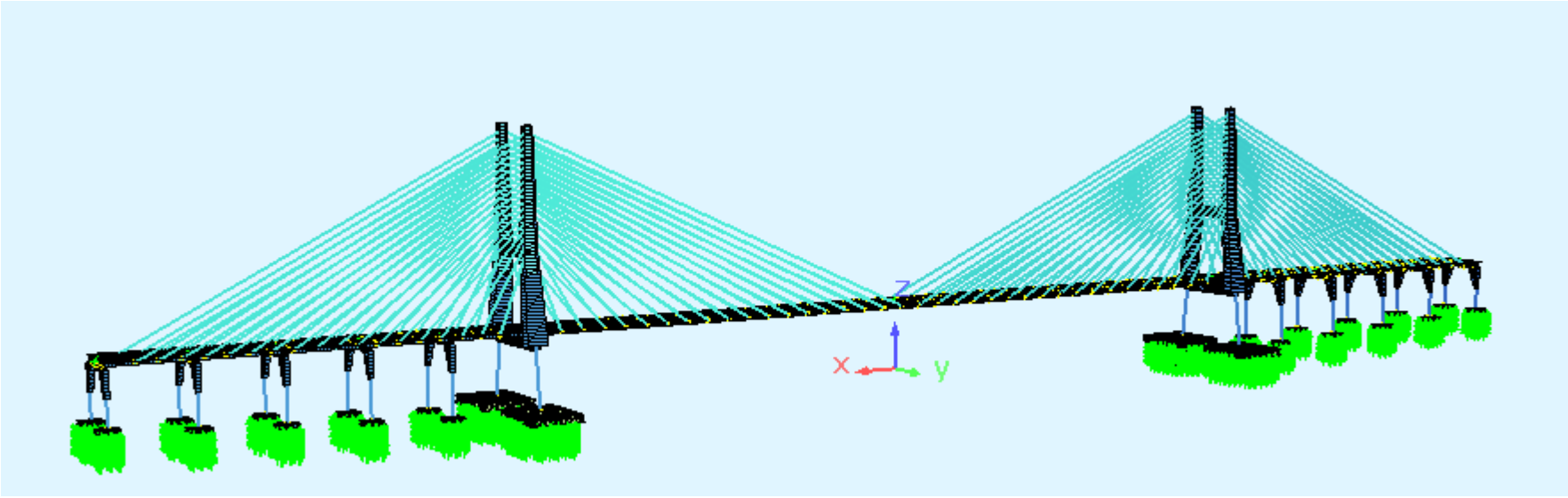
GEORGE MASSEY TUNNEL REPLACEMENT BRIDGE

- Cross-section analysis
  - 2475yr event – Plastic reinforcement steel strain
  - 975yr event – Elastic reinforcement steel strain



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QUESTIONS