Significance of Abutment Models in Seismic Analysis of Bridges

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Topic of Interest

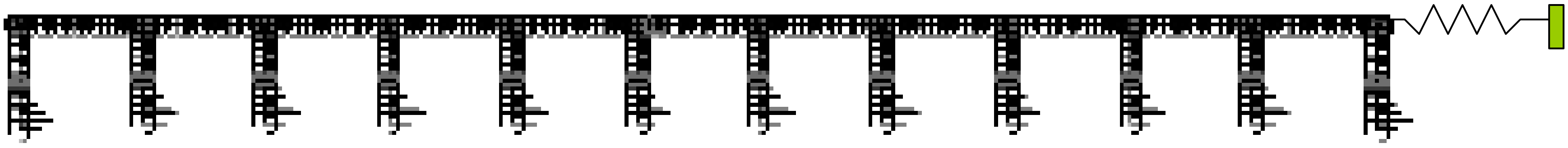
- Significance of Abutments in Seismic Modeling of Bridges.
- Abutment Influence versus Bridge Length.
- Function of Abutment Back Wall.
- Function of Abutment Shear Key.

Significance of Abutments in Seismic Modeling of Bridges.

- Purpose of modeling abutments:
  - Reasonable estimate on displacement demand values (at bents and abutments).
  - Design of plastic hinges in columns with adequate rotation capacities.
  - Design of abutment seats.

Typical Bridge Model in the Longitudinal Direction.

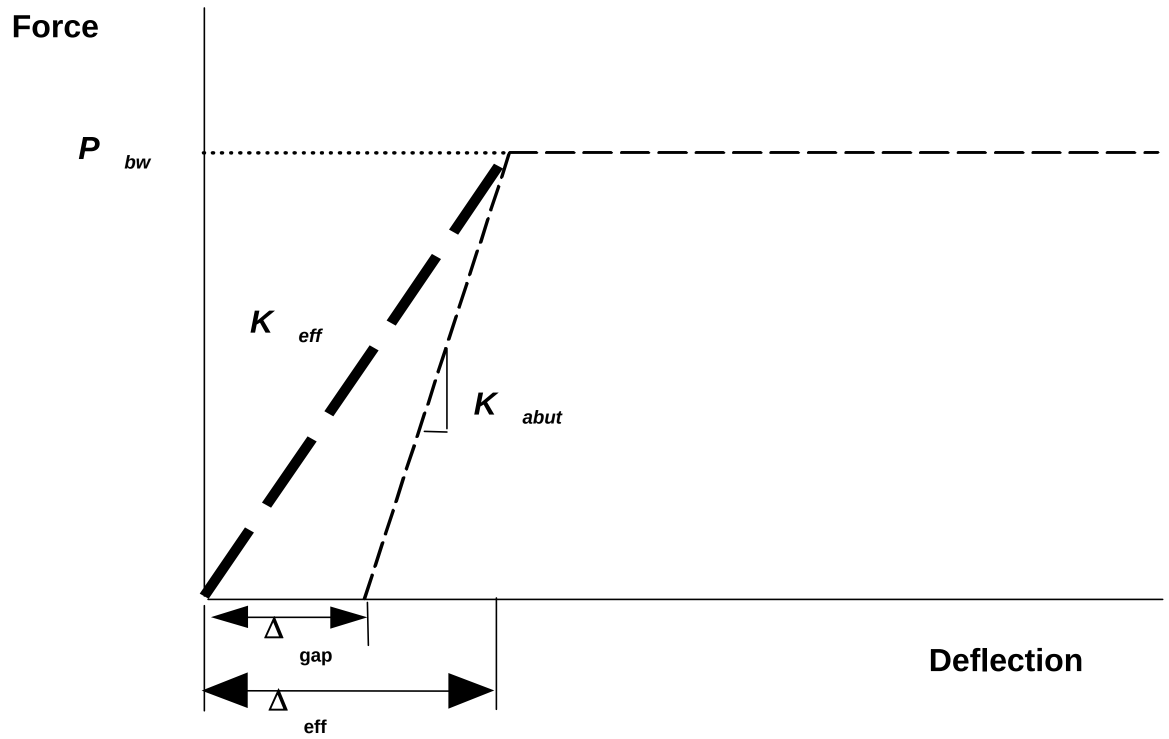
- Abutment backfill modeled as a bi-linear spring.



Elevation View

Typical Bridge Model in the Longitudinal Direction.

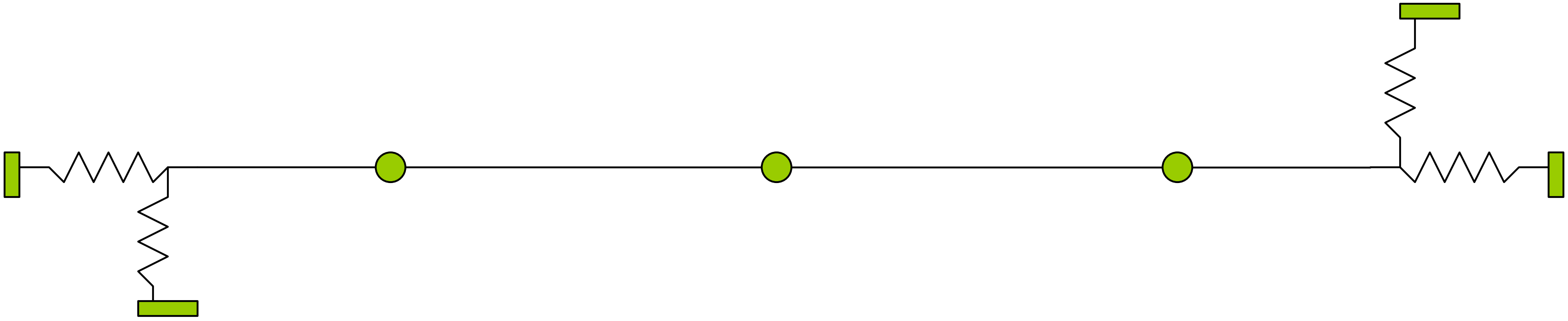
- Abutment backfill modeled as a bi-linear spring.
  - SDC 7.8
  - Min 30”
  - $R_A = \Delta_D / \Delta_{eff}$
  - If $R_A > 4$
  - $K_{res} = 0.1 * K_{eff}$



Seat Abutments

Typical Bridge Model in the Transverse Direction.

- Stand-alone bent model for Δ_D of column.
- Abutment shear key in 3-D demand model.
  - Elastic Spring = 0.5 * K_{bent}
  - Non-Linear Spring (UCSD)



Plan View

Consequences of Ignoring Abutments in Seismic Modeling of Bridges.

- Large Δ_D at the bents.
  - More confinement needed for the columns.
  - Larger columns needed if P-Δ is large.
- Larger columns lead into:
  - Stiffer structure; Shorter period; Move towards the peak of ARS curve.
  - Larger Mp; Larger Foundations; Higher cost.

Abutment Influence versus Bridge Length.

- $R_A = \Delta_D / \Delta_{eff}$ (measure of abutment participation)
- $R_A < 2$; $R_A > 4$; $2 < R_A < 4$ (ONLY one interpolation of K and one iteration for Δ_D)
- Single-frame bridges.
- 2-frame bridges (two frames engage one abutment).
- 3-frame bridges (middle frame, no abutment participation).
- Bridges longer than 900 feet?

Function of Abutment Back Wall.

- To contain the back fill soil.
- To engage the back fill soil in the longitudinal movement of the bridge.
- Reduce longitudinal Δ_D of the bridge (bents, specifically).
- Back wall is sacrificial.

Function of Abutment Shear Key.

- To constrain the transverse movement of the bridge in small and moderate earthquakes.
- Reduce transverse Δ_D of the bridge (bents, specifically).
- Design of shear key: (0.3g)? (0.5g)? or (%75 of pile group capacity + one wing wall)? No damage to stem wall.
- Shear keys are sacrificial.

Conclusions.

- Cannot afford to ignore abutment contribution for short bridges.
- Seismic damage at abutments is un-avoidable.
- Dissipation of seismic energy at the abutments reduces the seismic demand at the bents.