Research Project Highlight

Advanced Guidelines for Stability Design of Slender Reinforced Concrete Bridge Columns

PEER-Bridge TO4

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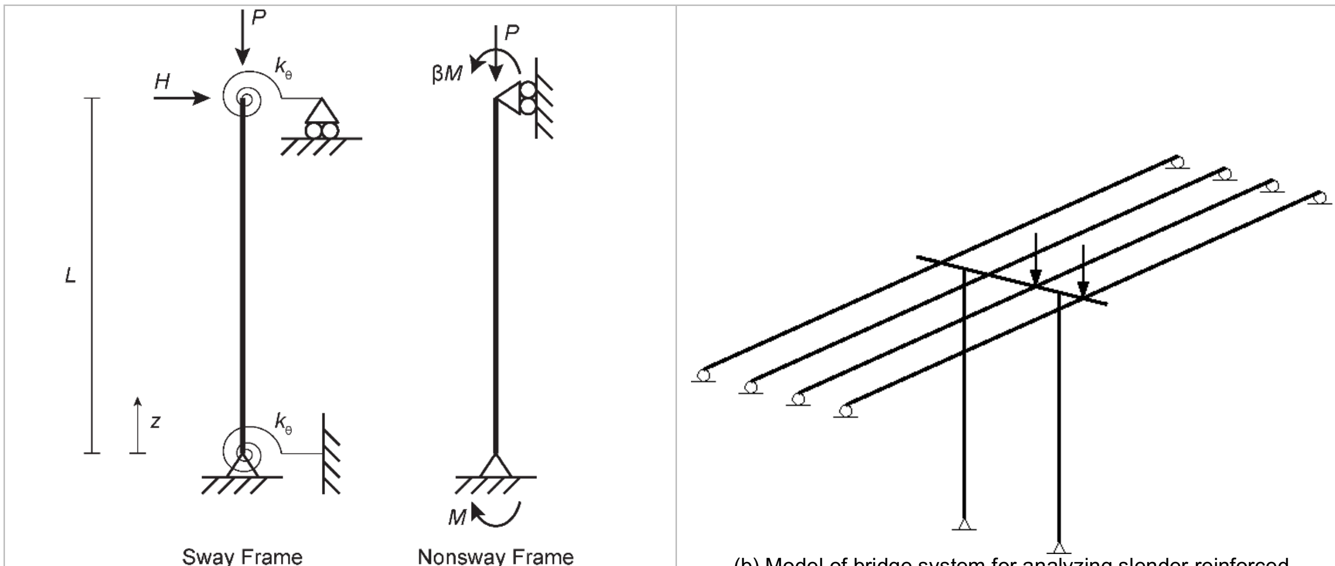
Abstract
The AASHTO approximate method for the design of slender reinforced concrete (RC) bridge columns was adopted from building design codes. Accordingly, the AASHTO method applies to a certain range of parameters and configurations based on floor framing stiffness, building story heights, material properties, and reinforcing ratios. While some analogies carry over to bridge columns, the superstructure stiffness and unbraced column lengths can be quite different for bridge systems compared to buildings. As a result, bridge engineers typically make very conservative assumptions on the strength of slender RC bridge columns. Although engineers can obtain more efficient designs using refined analysis, this is rarely used in practice due to computational effort and model uncertainty. This project will evaluate the AASHTO approximate moment magnification method using advanced second order inelastic analyses. Parametric studies will be conducted on single column models and common Caltrans bridge types. The impact of major parameters, e.g., slenderness, out of plumb, and superstructure stiffness, on structural behavior according to both the approximate method and advanced analysis will be quantified and refinements to the approximate method will be developed where these methods differ substantially.

Deliverables
This project will lead to a PEER report and journal publications describing the analyses and design recommendations for slender RC bridge columns. Project presentations at PEER annual meetings and researcher workshops will be made.

Research Impact
Through the development of design recommendations, this project will help engineers design more efficient slender RC columns in bridge structures when compared to approximate methods in AASHTO. Design recommendations will be based on inelastic second order finite element analyses performed

using the OpenSees software framework. A new approach for modeling the time-dependent effects of creep and shrinkage in slender RC columns will be developed and validated against published experimental data. Effective stiffness and effective length factors will be assessed along with design limitations and guidance for second order analysis of RC bridge columns. To increase confidence in and applicability of analysis results, modeling recommendations based on OpenSees analyses will be further validated using CSiBridge. Integration of slender RC column experimental data with current PEER databases for cyclic loading of RC columns will be explored and will facilitate the sharing of information and further refinements of second order analysis and design methodologies for bridge structures.

Project Images



(a) Schematic of individual columns in sway and non-sway conditions for investigation of slender reinforced concrete columns – the simplicity of these structures allows wide ranging investigations of different cross sections, member lengths, and boundary conditions.

(b) Model of bridge system for analyzing slender reinforced concrete columns in bridge structures.

Figure 1: Example structural models that will be used to achieve the project research objectives.

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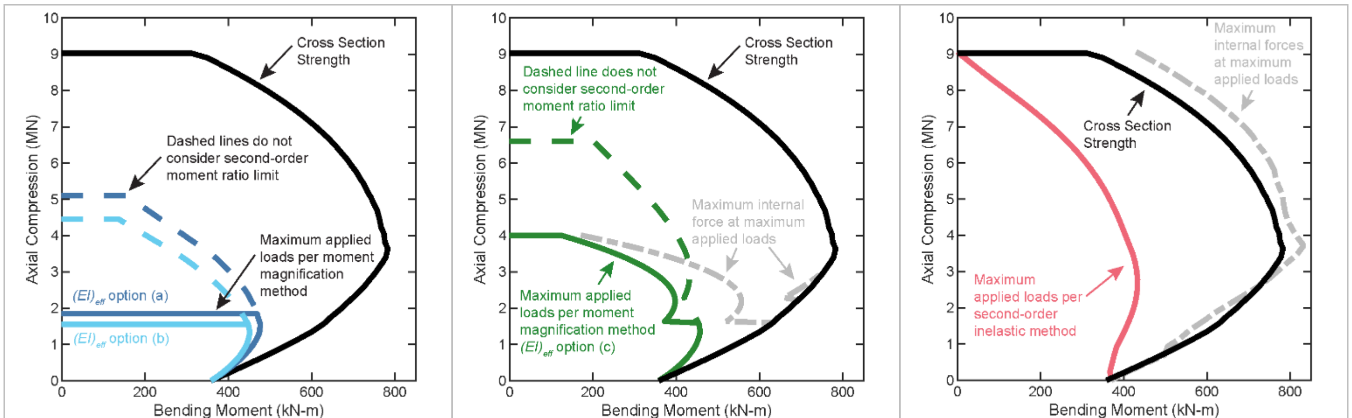

(a) Maximum permitted applied loads per ACI Code provisions using constant flexural stiffness

(b) Maximum permitted applied loads per ACI Code provisions using variable flexural stiffness

(c) Maximum permitted applied loads per second-order inelastic analysis

Figure 2: Example interaction diagrams for slender RC columns that will form the basis for achieving the project research objectives.

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