Seismic Performance Limit-States of Steel Bridge Piers with Socket-type Connections

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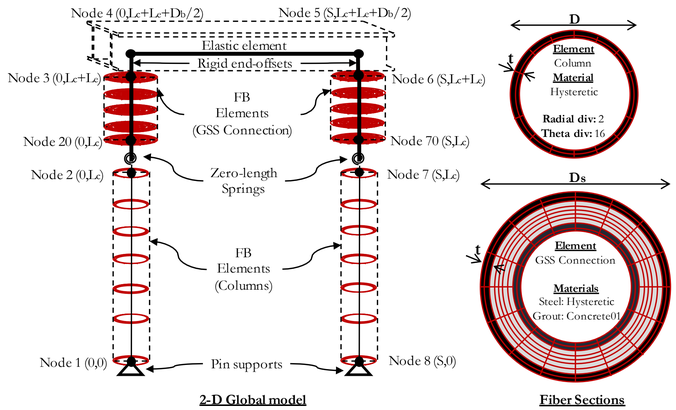
Introduction

- An **underground pile** that **doubles up as a column** above ground is a **workhorse in port and bridge** structures.
- **Steel pile-to-cap element welded connection** was found to exhibit premature **brittle failure** under cyclic loading (Fulmer et al., 2011).
- **The GSS connection**, short for **G**routed **S**hear **S**tud connection was developed to relocate damage to columns (Fulmer et al., 2015).
- Need for **displacement-based design recommendations** for socket-type connections was realized.
- This study (Jayaprakash, 2020) was undertaken to address this need.

Methods

Experimental:
We performed large-scale structural tests on two-column steel bridge pier specimens with GSS connections (see photograph to your right).

Numerical Modeling:
We developed fiber-based OpenSees models (see below) to capture full cyclic behavior of these piers.



Parametric Studies:
We performed parametric studies using calibrated numerical models to develop semi-empirical equations.

Result and Broader Impact

A set of equations that can **predict** the **force and displacement** of these types of systems at various **key performance limit-states**.

This model is a **crucial component** in **displacement-based seismic design and assessment** of **steel bridge piers** with **socket connections**.

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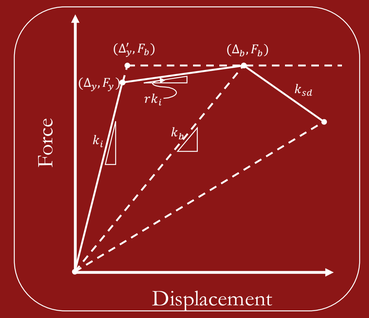
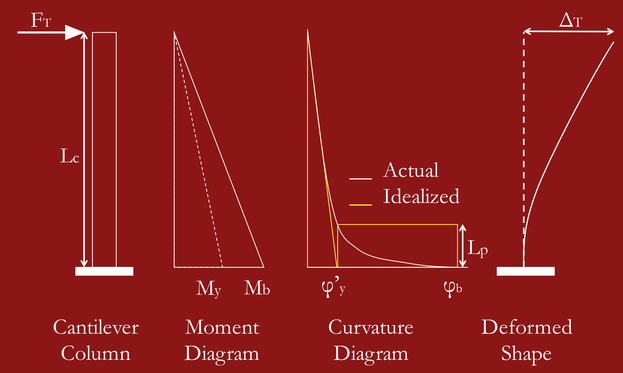
We propose a **simple hand-calculation** model that can estimate the **complete non-linear response** of two-column **steel bridge piers** under cyclic lateral loading.

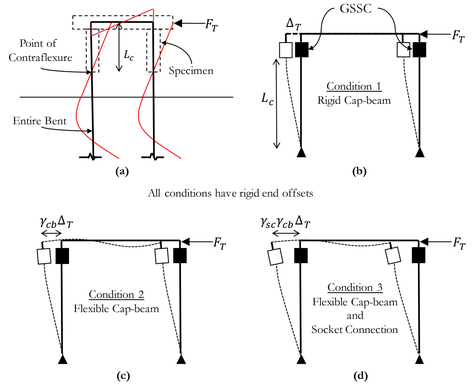




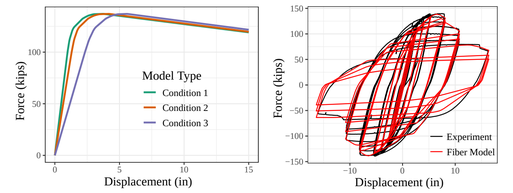
Scan the QR-code to get the model equations & more

Supplemental Information

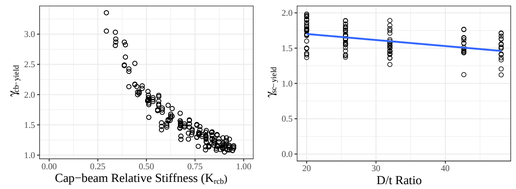
Flexibility Correction Coefficients, γ_{cb} and γ_{sc}:



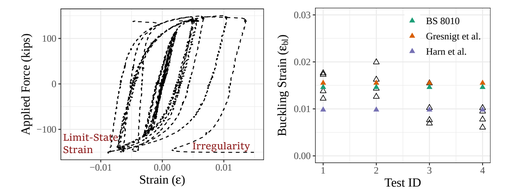
Model Calibration:



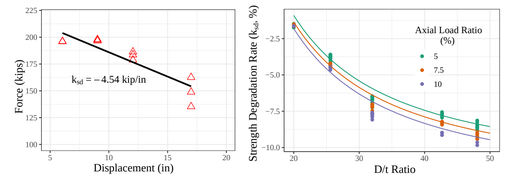
Yield Limit State, ϵ_y:



Buckling Limit State, ϵ_b:



Strength Degradation Rate, k_{sd}:



What the model looks like: