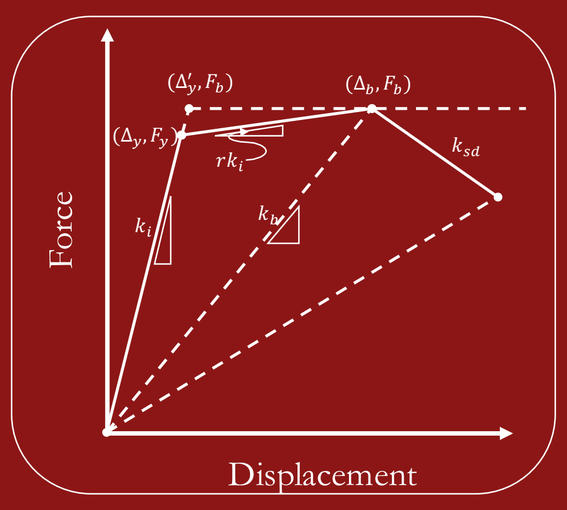
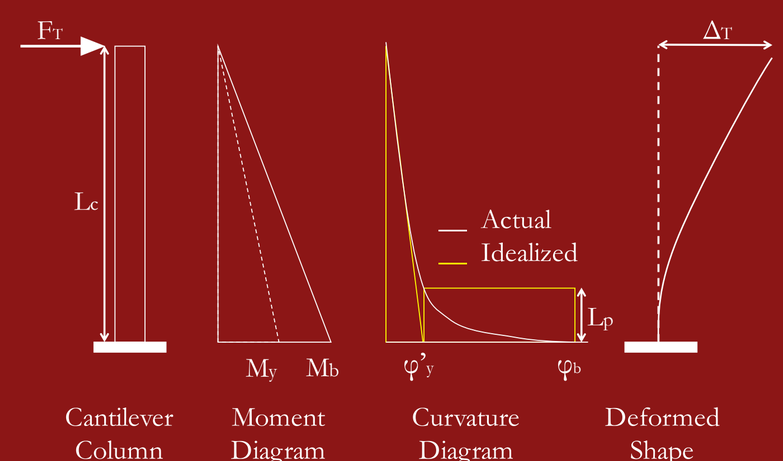
We propose a **simple hand calculation** model that can estimate the **complete non-linear response** of two-column **steel bridge piers** subjected to **cyclic lateral loading**.





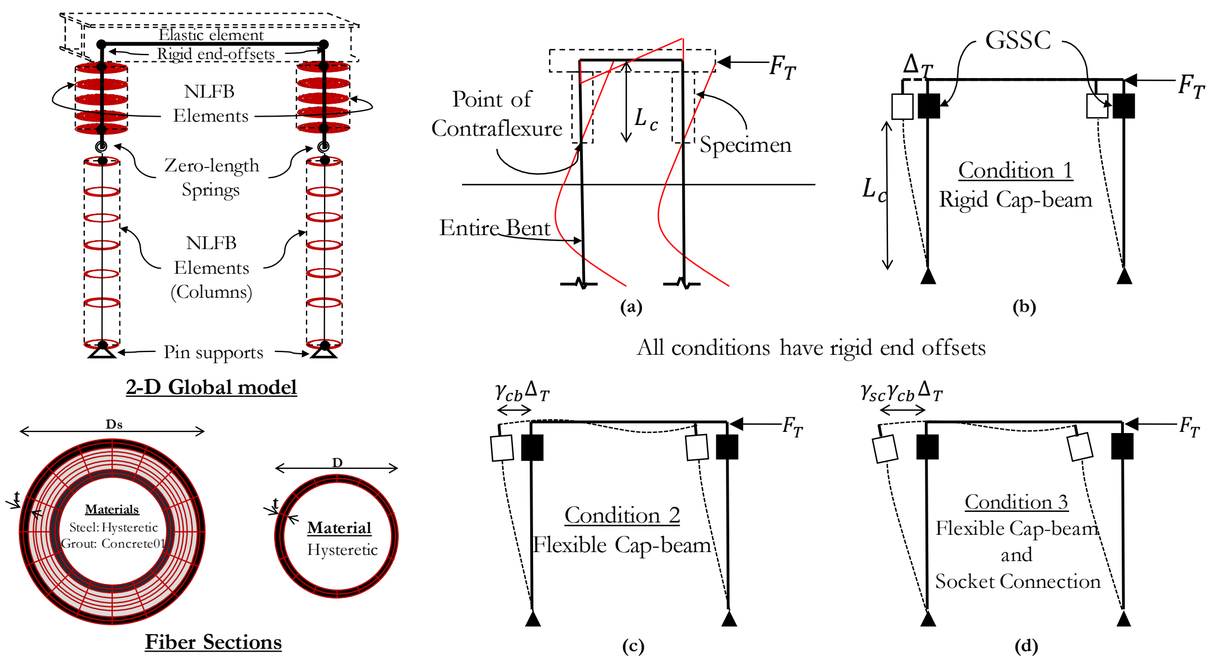
Seismic Performance Limit-States of Steel Bridge Piers with Socket-type Connections

Arjun Jayaprakash, James Nau, Mervyn Kowalsky, and Mohammad Pour-Ghaz

Introduction

- Driven steel piles which double up as columns above ground are prevalent in port and bridge structures.
- Steel pile-to-cap element welded connections were found to exhibit premature brittle failure under cyclic loading (Fulmer et al., 2011).
- The **G**routed **S**hear **S**tud connection was developed to protect the weld and relocate damage to columns (Fulmer et al., 2015).
- Seismic design procedure or recommendations for these types of connections, do not exist.
- 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 at the top).

Numerical Modeling:

We developed fiber-based OpenSees models (see above) to capture full cyclic behavior of these piers.

Parametric Studies:

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

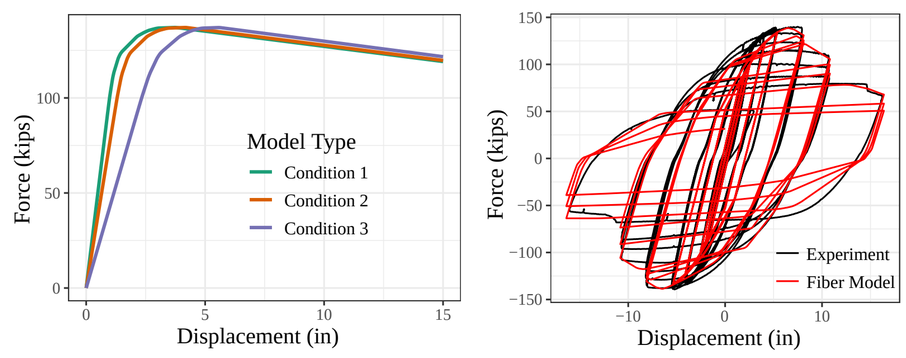
Result and Broader Impact

A set of equations that can **predict** the **force and displacement** of two-column steel bridge piers at various **key performance limit-states**.

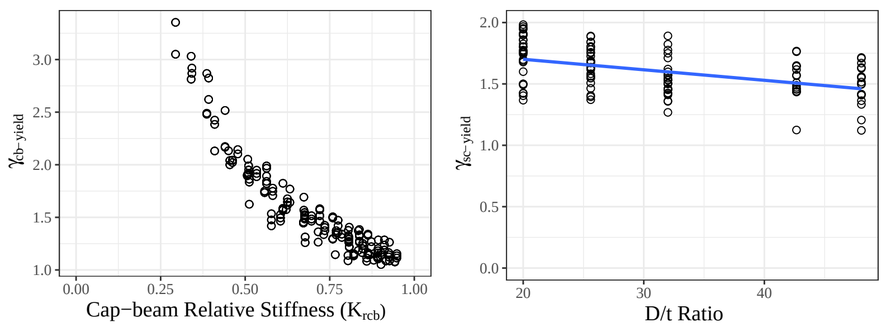
This model is a **crucial component** in **displacement-based seismic design and assessment** of **steel bridge piers** with **socket connections**.

Supplemental Information

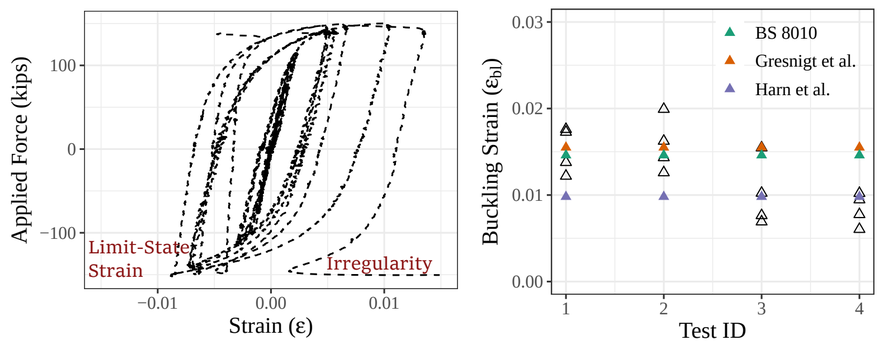
Model Calibration:



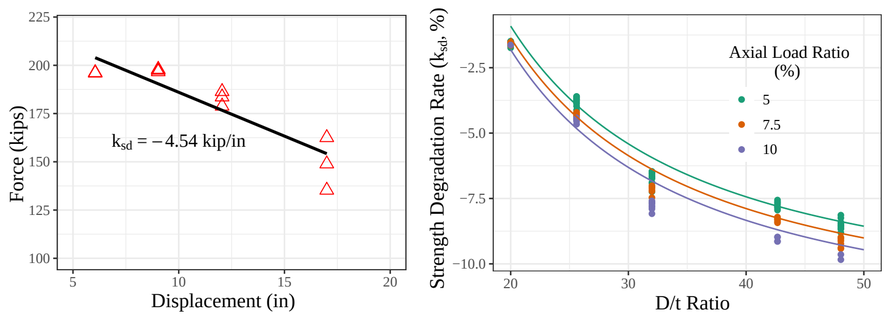
Correcting Yield Limit State, ϵ_y:



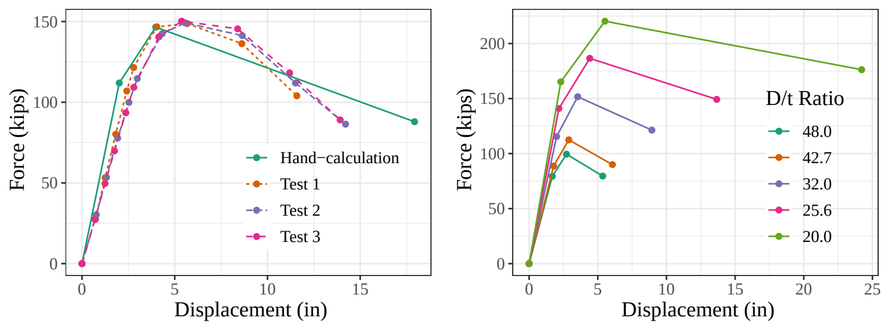
Correcting Buckling Limit State, ϵ_b:



Accounting for Strength Degradation Rate, k_{sd}:



What the model looks like:



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

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