Research Project Highlight

Fracture of Deficient Steel Details in Pre-Northridge Transportation Infrastructure

TSRP Topics – Systems, PBE,Tools - S1, T2, T5

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Start-End Dates:
2/1/2020 – 6/30/2021

Abstract
The transportation infrastructure consists of numerous pre-Northridge welded Steel Moment Frames in airports (a large majority of airports in California utilize these to achieve unobstructed bays), as well as other facilities, including transportation control centers. Numerous recent studies in the professional practice, insurance industry as well academia suggest an alarming level of risk of catastrophic fracture in these buildings that are constructed with brittle materials and poor detailing. This has serious safety and downtime consequences for transportation and other infrastructure. Although a post-Northridge building, the recent fracture in the TransBay Terminal in San Francisco is a timely reminder of such consequences. While some pre-Northridge transportation structures have undergone expensive retrofit to address these deficiencies, a vast majority of connections in these buildings remain unretrofitted. Specifically, pre-Northridge column splices are extraordinarily susceptible to fracture, due to the presence of large flaws (containing Partial Joint Penetration – PJP welds with ~50% penetration) and low-toughness materials, such that the return period of splice fracture in many structures is on the order of 80-100 years, which is unacceptable, given that column failure (especially loss of shear capacity) has the potential to trigger structural collapse. Motivated by these issues, the project will conduct simulations to support large scale tests on prototypical pre-Northridge column splices, resulting in: (1) performance-based decision support frameworks for whether splice retrofit is required, and (2) validated design guidelines and details for effective retrofit in cases where it is necessary.

Deliverables
A PEER report and conference and journal papers describing the pre-test analysis, testing plans, as well as test results, and guidelines/strategies for retrofit of pre-Northridge column splices.

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Research Impact

Cumulatively, the work (including the PEER and other related projects involving academics and industry experts) will result in decision support frameworks and guidelines for retrofit of vulnerable pre-Northridge column splices, with the following broad impacts: (1) Averting a significant debacle (similar to or worse than the TransBay fracture) due to failure of pre-Northridge splices in the transportation infrastructure, (2) Achieving the above while minimizing unnecessary conservatisms through probabilistic performance assessment of retrofit strategies, and (3) Increased awareness regarding this issue, leading to cities/transportation districts examining and repairing their infrastructure.

Project Images

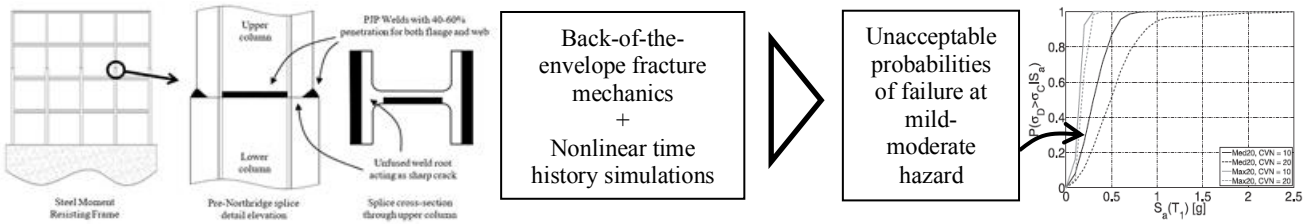

Figure 1: Risk of pre-Northridge connection fracture

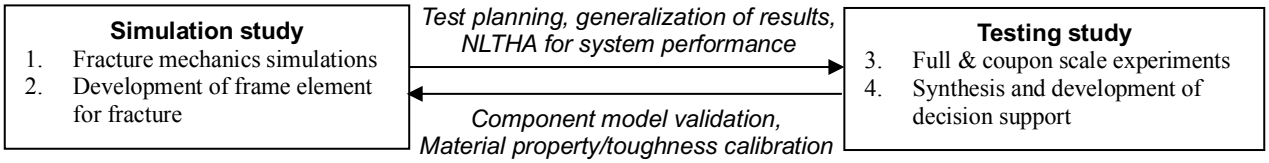

Figure 2: Overview of research plan

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