**TESTING THE INTEGRITY OF STEEL GRAVITY FRAMES SUBJECTED TO LARGE VERTICAL DEFLECTIONS: CONNECTION COMPONENT AND BOLT TESTS**

**INTRODUCTION**

When a column loses the capacity to support gravity load alternate load paths must be developed if the load is to be supported. This causes the connection subassemblage and the concrete slab and steel decking, among other frame elements, to become load supporting components. If these elements cannot support the loads and moments caused by the column collapse the entire structure could collapse.

**PROJECT OVERVIEW**

This ongoing joint research project explores the behavior of a steel gravity frame system during a column collapse scenario. It has been taking place at:

- University of Washington Connection Component Test
- Purdue University Concrete Slab and Steel Decking Test
- University of Illinois at Urbana-Champaign Large Scale Floor System Test

**PROJECT OBJECTIVES**

- Evaluate the structural integrity of current practice steel gravity framing systems, when subjected to an unforeseen loss of column load carrying capacity.
- Design next generation gravity frame systems, which will include new details to enhance performance and ensure structural integrity.

**CONNECTION COMPONENT TEST**

**TEST OVERVIEW**

A self-reacting load frame, which is capable of delivering combined shear, tension and flexural loading, was used to test the gravity frame connection subassemblies.

Three connection geometries were tested:

- a) Single plate shear
- b) Bolted angle
- c) Top-and-seat

**TEST OBJECTIVES**

- Determine the strength and ductility of typical connections used in steel gravity frames when subjected to combined axial, shear and flexural demands.
- Provide data for the calibration of design oriented models of typical gravity connections.
- Develop economical improvements to current practice to improve connection performance and enhance system robustness.

**PRELIMINARY RESULTS**

**Single Plate Shear Connections:**

- Addition of a bolt returns a lesser horizontal force contribution than the capacity of that bolt in tension.
- The return on strength decreases with the addition of each bolt.

**Bolted Angle Connections:**

- Web angle specimens achieve larger rotation before initial failure.

**BOLT TEST**

**TEST OVERVIEW**

A small frame was used to test the capacity of the bolts batches used during the connection tests, under shear loading.

**TEST OBJECTIVES**

- Evaluate the shear capacity of the bolt batches used in the connection tests.
- Determine if the bolts are responsible for the connections having a higher strength than predicted.

**PRELIMINARY RESULTS**

- Bolt have a significantly higher shear capacity than their specified nominal shear strength.

<table>
<thead>
<tr>
<th>ASTM Designation</th>
<th>A325</th>
<th>A490</th>
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<tbody>
<tr>
<td>Specified Shear Strength (ksi)</td>
<td>48</td>
<td>69.6</td>
</tr>
<tr>
<td>Average Experimental Shear Strength (ksi)</td>
<td>60</td>
<td>72.4</td>
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</tbody>
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**FURTHER INFORMATION**

For further information please contact the author at stephanie.lopez@prrpu.edu. For further information on the full joint research project please contact Jeffrey W. Berman at jeberman@uw.edu.

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**Photo by MR38.**

Photo of the 110 Liberty Plaza, New York, after losing a column due to damage from the collapse of the World Trade Center on September 11, 2001.

Photo of the 130 Liberty Plaza, New York, a[er losing a column due to damage from the collapse of the World Trade Center on September 11, 2001.

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**Graduate Mentor:**

Jonathan López

Large Scale Floor System Test

Concrete Slab and Steel Decking Test

University of Illinois at Urbana-Champaign

Purdue University

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