Friction-based Force-limiting Connections: Materials, designs, subtractive and additive manufacturing, numerical simulations, and experimental characterizations

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This presentation summarizes the development of different types of friction-based force-limiting composite bolted connections used to enhance the post-earthquake functional recovery, rapid repair, and adaptive reuse of buildings. We will focus on the materials, designs, subtractive and additive manufacturing, numerical simulations, and experimental characterizations of friction-based connections. We will introduce friction-based connections with conventional designs and their force-displacement responses. We will discuss the advantages and limitations of conventional connections using results from integrated numerical and experimental research. We will present connections we developed with novel designs and force-displacement characteristics. More specifically, we will present a friction-based connection that decouples the materials used to generate a stable friction force in the sliding interfaces from the materials used in the structural connections (e.g., steel, aluminum, wood, or fiber-reinforced composites). We will present a friction-based connection that develops predetermined discrete variable friction force at target displacement demands through a practical design with components that are easy to manufacture. Last, we will present a friction-based connection whose design aims to reduce its potential repair time and results in a force-displacement response that is less sensitive to the manufacturing tolerances compared to conventional connections. We will present how we translate research activities to educational design, manufacturing, and testing activities for undergraduate and graduate students at the University of California San Diego.