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Dynamic Friction Coefficient and Performance of Asymmetric Friction Connections

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Abstract:

Modern steel structures are increasingly using friction connections to enhance energy dissipation and minimize damage. The Asymmetric Friction Connection (AFC) was developed to create a repeatable, efficient means of dissipating seismic response energy and reducing structural damage without yielding of structural frame elements. Testing has demonstrated stable efficient hysteretic behavior. However, no full characterization of their dynamic friction behavior exists, nor any specific information relating their clamping bolt assembly torque/force to the dynamic friction coefficient during cyclic testing. A deeper understanding of these design and implementation aspects adds greater certainty and precision to design.

An experimental evaluation is performed, quantifying the effective dynamic friction coefficient as a function of connection clamping force from clamping bolt torque and input displacement, using torques from 20-500 Nm and a series of sinusoidal input motions. Bolt elongation and associated clamping force are evaluated with the measured resistive sliding force of the connection to derive a dynamic coefficient of friction for the AFC. Overall results show that friction is weakly dependent on input motion amplitude, but is direction dependent for all torques with larger friction coefficients in the positive, tension direction of input motion, where larger assembly torques over 200 Nm had larger direction dependence. Clamping bolt torques over 200 Nm result in bolt yielding during input motions, which would necessitate post-earthquake inspection and potential repair, and reduce resistive sliding forces during a subsequent seismic event. The overall results present a generalizable analysis to guide design, which is extendable to similar friction connections or devices. Equally, the results also provide a better understanding to enhance adoption/uptake of these friction connection in steel structures.

Keywords: asymmetric friction connection, AFC, structural connection, friction connection, coefficient of friction, energy dissipation, steel structures, low-damage steel structures

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