17096 - Large Friction Connection Performance and Reparability

Project Title

Large Friction Connection Performance and Reparability

Research Team

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Project Description

Friction connections have been advocated as economical low damage systems because of their cheap construction cost, low damage performance, and perceived reparability. Friction connections have been developed and investigated in a range of systems including as beam-end connections, braces, column base connections, in links, and other systems (Pall & Marsh; 1982), (Filiatrault & Cherry; 1987), (FitzGerald et al.; 1989), (Tremblay; 1993), (Grigorian & Popov; 1994), (Clifton; 2005), (MacRae et al.; 2009), (MacRae et al.; 2010), (Latour et al.; 2011), (Chanchí et al.; 2014), (Khoo et al.; 2014), (Latour et al.; 2015), (Ramhormzian et al. 2015) and (Borzouie et al.; 2015). They have also been implemented in buildings such as Wellington Bellagio Apartment Building and Fairlie Terrace Student Accommodation Building (Gledhill et al.;2008), in Christchurch Peterborough Street Hospital (2013), in The Terrace Project (2015). Two different strands of work are being progressed on this topic. These connections may be Asymmetric Friction Connections (AFC) or Symmetric Friction Connections (SFC).

Research has been led by NZ with research undertaken collaboratively between the universities in Auckland and Canterbury. The focus has been on beam end moments, active links, braces with large sliding displacements, and column base connections with and without Belleville washers. While significant work has been conducted, there remain a number of issues/gaps to develop robust sliding criteria for connections. These include the lack of: i. Testing of connections with multiple large/strong bolts sliding over large distances (> 30mm). Many, but not all of these tests, have been conducted with small bolts (some M16) with moderate strength (Grade 8.8). Tests by Borzouie (2015b) have shown that the greater bolt forces may result in a change in the way friction occurs between the sliding surfaces. If the forces are very high, the likelihood of scouring increases. These greater bolt forces may be due to greater size bolts, or higher strength (E.g. Grade 10.9) bolts. Also, indications are that the sliding strength/bolt of connections with multiple bolts in the direction of force may be lower than that when there is just one bolt in the direction of force.

1. Quantified guidance on bolt tightening and bolt relaxation effects on the variation in the sliding strengths.
2. Quantified guidance on how bolt manufacture and thread friction effect the component of torque resulting in bolt twisting, rather than in bolt axial extension and clamping.
3. Quantified guidance on how a connection can be reinstated after a major event.
4. Understanding why friction coefficients for AFC and SFC are currently not consistent according to current theories.
5. Robust design guidelines for such connections.

Key Objectives

Experimental testing is conducted in order to address the gaps specified above for large (M24 and M30 bolts) in order to develop robust design recommendations. This involves:

1. Determining the effects of big bolt size and number of bolt rows in the performance of friction connections considering the sliding and post sliding influence of heat (which related to the size of bolts) and the prying effects.
2. Defining a range of required turn angle for tightening the bolts in friction connections considering a potential plate thicknesses, different bolt length, bolt size, lubrication material, lubrication degree and structural washer configurations.
3. Defining acceptable lubrication for the large bolts.
4. Determining how a connection may be reinstated after an event.
5. Seeking a unified theory for friction coefficients for AFC and SFC bolts.