Flexural Strength of Micro-pile Threaded Connection

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Problem Statement

The use of steel tubular sections is widely extended in civil engineering structures, being micro-piles a common foundation system that provides constructability advantages in many applications, for instance, micro-piles can be drilled at shallow bedrock sites where typical piles cannot be driven to the desired embedment depth.

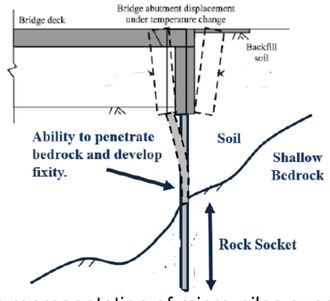

Figure 1. Schematic representation of micro-piles supported IAB (Modified from FHWA, 2011)

when used to support integral abutment bridges, thermal expansion/contraction of the bridge super-structure transmits considerably lateral load to the foundation (See Figure 1). **At the date, there is no validated methodology to predict threaded joints flexural strength.**

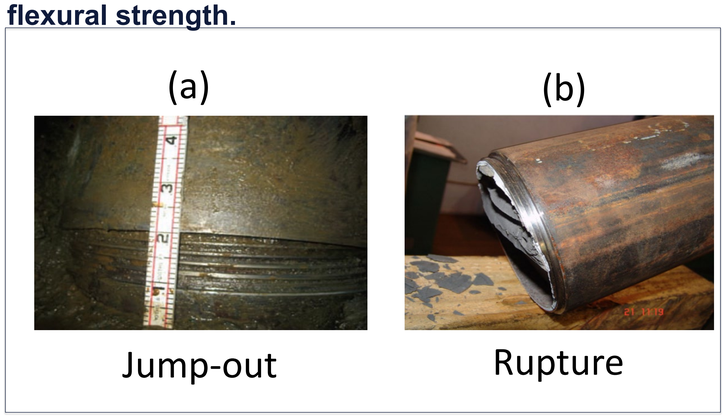

Figure 2. Threaded joint failure modes: (a) Jump-out; and (b) Rupture. Taken from Anderson and Babalola (2011) and Zanuy et al. (2012)

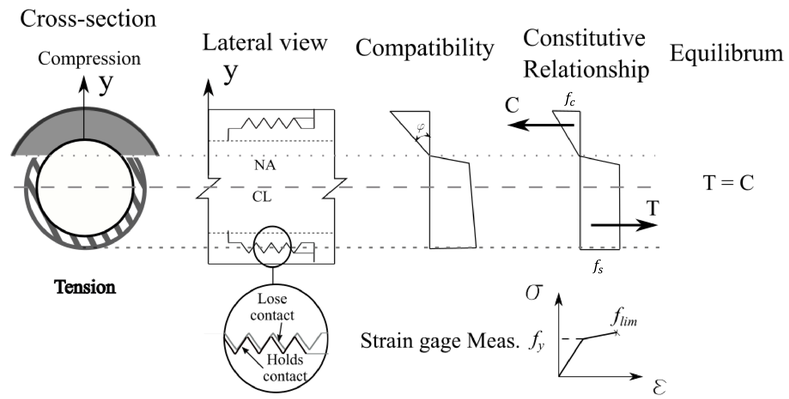

Figure 3. Reduced section analysis of threaded joint.

Failure Modes

Two failure modes have been identified in the technical literature for micro-piles subjected to bending: Jump-out failure; and Rupture failure (See Figure 2).

Structural model

Musselman et al. (2007) developed an structural model based on a reduced section analysis, jump-out and rupture loads predicted for threaded joints under pure tension in oil extraction applications (Clinedinst, 1965) and observed strain distribution through the cross-section (See Figure 3). However, their study was limited in extent of pile diameters, pipe-wall thickness, and threads shape.

The method required the computation of a limiting stress in the tensile region. The limiting stress will be equal to the minimum of the jump-out (f_j) stress and rupture stress (f_u).

Then, considering the reduced section and the limiting stress in tension, the compression stresses can be solved for equilibrium and obtained moment is stated as the flexural capacity of the connection.

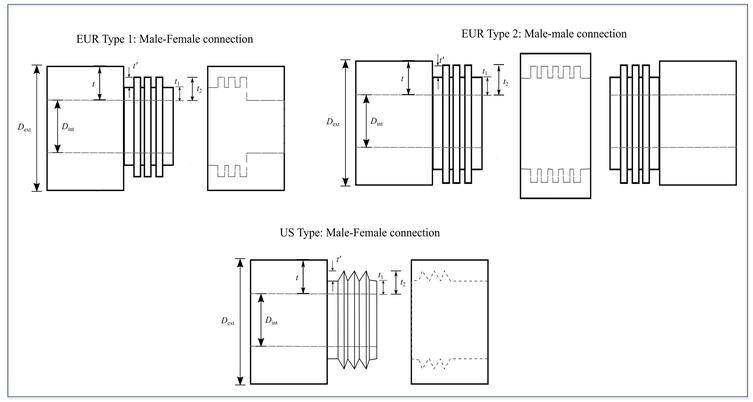

Figure 4. Connection types.

Validation

A set of 47 field and laboratory tests were used to validate the structural model. Three different types of connections are identified as US Type, and EUR Types 1 and 2 (See Figure 4), with diameters ranging from 88.7 to 273 mm. Predicted and measured moment capacity were in excellent agreement (See Figure 5).

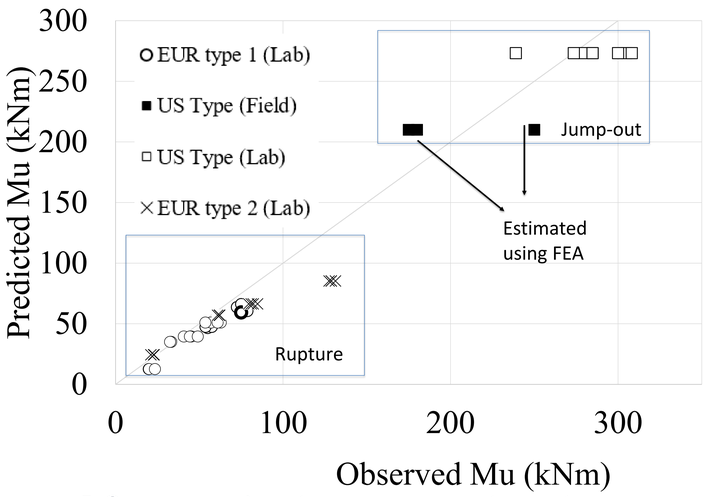

Figure 5. Observed vs. Predicted bending moment capacity