SPECIFICATION FOR STRUCTURAL JOINTS USING HIGH-STRENGTH BOLTS

SECTION 1. GENERAL REQUIREMENTS

1.1. Scope

This Specification covers the design of bolted *joints* and the installation and inspection of *bolting components* and *bolting assemblies* listed in Section 1.5. The Specification also considers the use of alternative-design *bolting components, assemblies*, or installation methods as permitted in Section 2.12. This Specification relates only to those aspects of the connected materials that bear upon the performance of the bolted *joints*.

The Symbols, Glossary, and Appendix are a part of this Specification. The Commentary to this Specification that is interspersed throughout is not part of this Specification.

This Specification shall not be interpreted in a way that prevents the use of *bolting components* or *assemblies* and the use of installation methods not specifically referred to herein, provided that the requirements of Section 2.12 are satisfied.

Commentary:

This Specification covers the design of bolted *joints* with collateral materials in the *grip* that are made of steel. These provisions do not apply when materials other than steel are included in the *grip.* These provisions are not applicable to anchor rods.

Recently, other types of *joints* that contain low-modulus materials in the *grip*, and most notably thermal break joints, have made an entrance in the market and questions on their use, chiefly for components, such as cladding, awnings, and roof posts, that are not part of a primary load-resisting system, have come forward. Thermal break joints are not intended for primary load resisting systems. Several research projects have been conducted (Peterman et al., 2017; Peterman et al., 2020; Hamel and White, 2016) investigating the structural properties of thermal break joints showing that the presence within the *grip* of compressible gaskets, insulation, or other materials or coatings will preclude the development and/or retention of the installation *pretension* in the bolts.

Peterman et al. show that low-modulus materials are permissible in snug-tightened *joints* with bolts subject to shear when long-term loads are limited to 30% of the low-modulus materials' ultimate load. Low-modulus materials that showed acceptable behavior in that study had through-thickness modulus of elasticity between 400 ksi and 800 ksi and through-thickness compressive strength between 25 ksi and 65 ksi.

Additionally, with the presence of compressible materials in the *grip*, the snug-tightening operation will not generate a sufficient force in the bolt to deform the shank so that the head and/or the nut adapt to the slope of the surfaces under them. Therefore, only surfaces that are near-perpendicular to the bolt axis should be used in thermal break joints.

Based on the results in the literature, the *Engineer of Record* should consider, as a minimum, the following aspects of a thermal break joint:

- The stiffness and strength of the inserted layers and their influence on the intended performance of the joint;
- The maximum bolt tension that the layers in the *grip* can withstand without losing integrity or performance;
- The installation instructions to prevent overtightening of bolts;
- The effects of the thickness of the added plies on the stiffness and strength of the *bolting assembly* and of the *connection* as a whole;
- The resistance to exposure of the added plies, when applicable;
- The type of forces that the joint is intended to transfer (e.g., shear, shear and tension, compression, tension without fatigue);
- The long-term behavior of the inserted layers; and
- The electro-chemical interactions of the inserted layers with coatings on steel, if applicable.

1.2. Loads, Load Factors, and Load Combinations

The design and construction of the structure shall conform to either an applicable load and resistance factor design specification for steel structures or to an applicable allowable strength design specification for steel structures. Because factored load combinations account for the reduced probabilities of maximum loads acting concurrently, the *design strengths* given in this Specification shall not be increased.

1.3. Design for Strength Using Load and Resistance Factor Design (LRFD)

Design according to the provisions for load and resistance factor design (LRFD) satisfies the requirements of this Specification when the *design strength* of each structural component or *connection* element equals or exceeds the *required strength* determined on the basis of the *LRFD load* combinations.

Design shall be performed in accordance with Equation 1.1:

$$R_u \leq \phi R_n \qquad \text{(Equation 1.1)}$$

where

R_u = *required strength* using *LRFD load* combinations
R_n = *nominal strength*
ϕ = *resistance factor*
ϕR_n = *design strength*

1.4. Design for Strength Using Allowable Strength Design (ASD)

Design according to the provisions for allowable strength design (ASD) satisfies the requirements of this Specification when the *design strength* of each structural component or *connection* element equals or exceeds the *required strength* determined on the basis of the *ASD load* combinations.