Closure to "Component-Based Model for Single-Plate Shear Connections with Pretension and Pinched Hysteresis"

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The author would like to thank the discussers, Professor Shiming Chen and Doctoral Candidate Junming Jiang, for their interest in this paper and for their substantive discussion of the presented component-based modeling approach. Indeed, addressing the discussion points identified by the discussers will provide an increased degree of clarity to the paper. This closure is organized to address each of the sections of discussion, as designated by the discussers, individually.

Component-Based Connection Model

As correctly described by the discussers, when the shear-plate and beam-web are in tension (Fig. 3(b)), the contributions of the shear-plate and beam-web segments to the stiffness of the component-based model result from bearing of the bolt shaft on the faces of the shear-plate bolt hole (occurring on the right side of the lower plate in Fig. 3(b)) and the beam-web bolt hole (occurring on the left side of the upper plate in Fig. 3(b)), respectively. In the paper, the author chose to keep the labels in Fig. 3 for the shear-plate consistently on the left and the labels for the beam-web consistently on the right; however, the labels for the springs in series can be rearranged at will, having no influence on the mathematical formulation or behavior of the single-plate shear connection spring.

Friction-Slip Behavior

The discussers emphasize the importance of both the shear-plate and beam-web hole geometries on the behavior of single-plate shear connections stating: "Based on the discussers' research including some experiments involved with single-plate connections, the diameter

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and shape of the bolt holes on the beam-web have an obvious influence on the slip behavior of the connection." The author agrees, based on observations made during his own testing of single-plate shear connections (Weigand and Berman 2014), and that is why slip between the bolt and the beam-web is explicitly included in the formulation for the beam-web component spring. The discussers further suggest existence of a "hidden hypothesis that under loading, no relative movement occurs between the bolt and the beam-web hole." No, there is no hidden hypothesis. As stated in the paper: "The shear-plate and beam-web component springs (i.e., plate springs) are modeled using the same formulation, with responses that differ only as a result of differences in their input material properties and geometry." Thus, slip of the bolts relative to the shear-plate holes is modeled in the shear-plate component spring, and slip of the bolts relative to the beam-web holes is modeled in the beam-web component spring.

Additionally, the discussers argue that use of the notation A_b for the bolt cross-sectional area in Eq. (8) is too general, since that area could correspond to either the gross area of the bolt or the net tensile area of the bolt, depending on whether or not threads are excluded from the shear plane, respectively. The discussers' point is well-taken, since use of the appropriate bolt cross-sectional area is implied by Eq. (8) and users of the component-based modeling approach should take care to use the appropriate cross-sectional area of the bolt as dictated by the presence or absence of threads in the shear plane. The notation used in the paper in Eq. (8) is intended to mirror that found in the *ANSI/AISC 360-10 Specification for Structural Steel Buildings* (AISC 2010), in which there is precedence for use of A_b in designating the bolt cross-sectional area, whether it be the gross area or net tensile area.

Bolt Behavior

The bearing equation in Tate and Rosenfeld (1946) corresponds specifically to the behavior of "symmetrical butt joints" – bolted double-lapped connections with outer plates of equal thickness. In Nelson et al. (1983), "the double shear formula (Tate and Rosenfeld 1946) was modified to account for the bolt rotation that occurs in single-shear joints." Although the differences between the unmodified and modified equations are subtle, it is the modified bearing equation, found only in Nelson et al. (1983), that was used in writing Eq. (21). However, the discussers are correct in their appraisal that a clear typographical error was made by the author when transcribing the equation given in Nelson et al. (1983) to the form shown in Eq. (21), which should read:

$$K_{\mathrm{br,bolt}} = \frac{1}{1+3\beta_{\mathrm{b}}}\left(\frac{t_{\mathrm{p}} t_{\mathrm{w}} E_{\mathrm{bolt}}}{2\left(t_{\mathrm{p}}+t_{\mathrm{w}}\right)}\right) \quad , \tag{1}$$

The author gratefully acknowledges the discussers' careful inspection of the paper in identifying this error. The correct equation was used in the analyses, so the results presented in the paper are unaffected.

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