

HSS

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ROUND BRANCH-TO- RECTANGULAR CHORD HSS CONNECTIONS

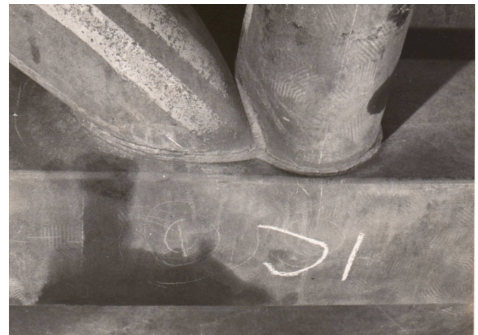
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AISC 360 gives design procedures for round branch-to-round chord HSS welded connections, and for rectangular branch-to-rectangular chord HSS welded connections (where rectangular includes square). These limit state checks are contained in Chapter K of the current Specification (AISC, 2010), in Chapters J and K in the forthcoming edition of the Specification (AISC, 2016), and in AISC Design Guide No. 24 (Packer et al., 2010). However hybrid trusses, which are not covered by AISC design guidance, involving a mix of round and rectangular HSS members, do occasionally occur. Pipe sections may potentially be readily sourced, and used for branch members, yet square or rectangular HSS might be preferred for the chords to make fabrication easier. As shown in Figure 1(a), only straight cuts to the round branches are required for gapped K-connections. For overlapped K-connections, however, some tube profiling will be required for the overlapping round HSS branch member (Figure 1(b)); the overlapped round branch would be straight cut and welded directly to the flat chord face. Hybrid trusses using square or rectangular branches welded to round HSS (or pipe) chord members would be very impractical, because of the profiling required for all branch member ends.

Experimental research has been performed on a considerable number of round-to-rectangular HSS N-connections (a special case of the general K-connection) and it has been observed that the connection limit states resemble those of similar rectangular HSS connections. An inspection of contemporary design recommendations reveals that most failure modes for hollow section connections are dependent on the circumference or “footprint” of the branch member at the joint with the chord, or dependent on the cross-sectional area of the branch members. The perimeter of a round HSS of diameter D_b is πD_b , and that of a square HSS of width D_b is $4D_b$ (excluding the rounded corners), thus approximately in the ratio of $\pi : 4$. Similarly, the cross-sectional area of a thin round HSS of diameter D_b and thickness t_b is approximately $\pi D_b t_b$, whereas the cross-sectional area of a thin square HSS of width D_b and thickness t_b is approximately $4D_b t_b$, again in the ratio of $\pi : 4$. (Note that well-designed HSS truss-type connections will have branches that are thin relative to the chord thickness). It was hence surmised that round-to-rectangular HSS welded connections could potentially be treated as square-to-rectangular HSS connections, by converting the round branch members to square sections.



(a) gapped K-connection



(b) overlapped K-connection

Figure 1: Round branch-to-rectangular/square chord welded

BRANCH CONVERSION METHOD

This method has been examined by analyzing the results of 40 gapped and overlapped round-to square HSS N-connections (as shown in Figure 1), tested as both isolated connections and as connections within complete trusses, of which 27 tests resulted in connection failure (Packer et al., 2007). Implementation of this method involves replacing round branches (of diameter D_b) by square branches of width $\pi D_b/4$, keeping the amount of gap or overlap the same and the thickness the same, and then using rectangular HSS connection design formulas. Alternatively, since the conversion is approximate anyway, one might perhaps just assume the round branch to be a square of width D_b , calculate the connection resistance using rectangular HSS design formulas, and then multiply this connection capacity by $\pi/4$. Either implementation produces the same result for gapped K- and N-connections, but a different result for overlapped K- and N-connections. Correlation with experimental results showed that the branch conversion process was valid, for both gapped and overlapped connections, with very little difference evident between the two interpretation methods for overlapped connections (Packer et al., 2007). Recent international design recommendations for HSS connections (Packer et al., 2009; ISO, 2013) have followed the simpler route of assuming each round branch to be a square of width D_b , calculating the connection resistance using rectangular HSS design formulas, and then multiplying this connection capacity by $\pi/4$. Moreover, the principle has been extended to axially loaded round-to-rectangular HSS T-, Y- and X- (cross) connections.

APPLICATION TO AISC 360-10

In Table K2.2: Available Strengths of Rectangular HSS-to-HSS Truss Connections, round HSS branches with $0.25 \leq D_b/B \leq 0.80$ can be accommodated by the following:

- For T-, Y- and Cross Connections, replace both B_b and H_b by D_b in the following equations and in participating variables: (K2-7), (K2-8), (K2-12) and (K2-13); then multiply the resulting connection available strength by $\pi/4$. No reduction by $\pi/4$ is required for the chord shear criterion (in the rare instances where this limit state applies). The Limits of Applicability are generally those in Table K2.2A but round branches are also subject to the D_b/t_b limits in Table K2.1A.

- For *Gapped K-Connections*, replace both B_b and H_b by D_b in the following equations and in participating variables: (K2-14), (K2-15), (K2-16) and (K2-13); then multiply the resulting connection available strength by $\pi/4$. No reduction by $\pi/4$ is required for the chord shear criterion. The Limits of Applicability are generally those in Table K2.2A, but round branches are also subject to the D_b/t_b limits in Table K2.1A and $D_b/B \geq 0.1 + \gamma/50$.
- For *Overlapped K-Connections*, replace both B_{bi} and H_{bi} by D_{bi} , plus B_{bj} by D_{bj} , in the following equations: (K2-17), (K2-18), (K2-19), (K2-20) and (K2-21); then multiply the resulting connection available strength by $\pi/4$. Equation (K2-22) requires no modification. The Limits of Applicability are generally those in Table K2.2A but round branches are also subject to the D_b/t_b limits in Table K2.1A.

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