HSS CONNECTION DESIGN

Effective Width in Rectangular HSS Connections

Finding B_e and B_{ep} for use in branch and weld checks with rectangular HSS · AISC 360-22 Section K1.2a

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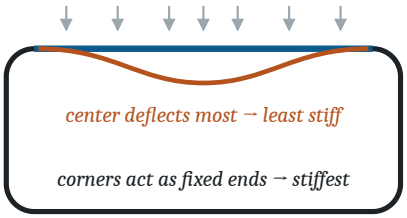
When a force is applied normal to the flat face of a rectangular HSS, it **does not spread evenly** across the connected element. The HSS face is stiffer near the rounded corners, where the sidewalls clamp it, and more flexible at the center. Load follows stiffness, so it concentrates toward the edges of the branch or plate.

Because the edges carry more load, forces do not distribute evenly across the full width of the connected element. Design equations capture this by using an **effective width**: the reduced width treated as fully active. There are two, **B_e** for local yielding and **B_{ep}** for shear yielding (punching, where the branch tends to punch through the chord face). This guide shows how to find them for the connection types where they apply.

WHAT THIS GUIDE COVERS

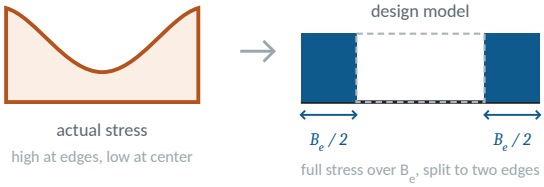
Finding B_e and B_{ep} for use in checks for **branch local yielding** and **shear yielding (punching)** (the member), and **effective weld length** (the weld). The capacity calculations themselves can be found in the examples and tables referenced on the back.

WHY THE LOAD IS UNEVEN



The connecting face behaves like a fixed-end beam, stiff at the corners and flexible at the center, so it draws load toward the edges.

THE STRESS PEAKS AT THE EDGES



Because the edges carry the most stress, the design equations concentrate the load over the effective width B_e, split between the two edges, and ignore the lightly-loaded center.

AISC 360-22

LOCAL YIELDING · EQ. K1-1

$$B_e = \left(\frac{10}{B/t}\right)\left(\frac{F_y t}{F_{yb} t_b}\right) B_b \le B_b$$

SHEAR YIELDING (PUNCHING) · EQ. K1-2

$$B_{ep} = \left(\frac{10}{B/t}\right) B_b \le B_b$$

Both B_e and B_{ep} are capped at the actual width B_b: if the formula gives a value ≥ B_b, the full width is effective and there is no reduction. A thinner chord (small t), wider chord (large B), or stronger/thicker branch all **shrink the effective width**. Other connection types use related forms, shown per type on the back. In the HSS-to-HSS truss equations, B_{ep} appears as the dimensionless ratio $\beta_{eop} = B_{ep}/B$.

CHECKING THE BRANCH MEMBER

Local yielding & punching shear

B_e sets the effective width for **local yielding** of the branch or plate; B_{ep} sets it for **punching shear**, where the branch tends to punch through the chord face. Both check the strength of the connection.

CHECKING THE WELD

Effective weld length

B_e also sets the effective length of the transverse weld (e.g. $l_e = 2B_e$ for a plate, per Table K5.1). B_{ep} is a member check only and is not used here.

VARIABLES USED CONSISTENTLY THROUGHOUT THIS GUIDE

CHORD (MAIN MEMBER)

B	connecting face width
H	chord depth
t	chord wall design thickness
F_y	chord yield strength

BRANCH OR PLATE

B_b	branch/plate width
H_b	branch height (HSS branch)
t_b	branch wall thickness (= t_p for a plate)
F_{yb}	branch/plate yield strength

RESULT & GEOMETRY

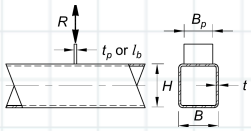
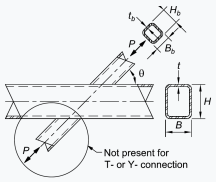
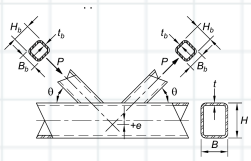
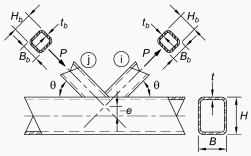
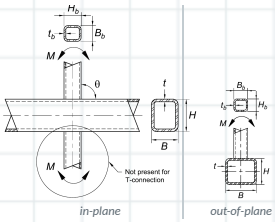
B_e	effective width, local yielding
B_{ep}	effective width, shear yielding
β_{eop}	= B_{ep}/B, ratio form used in truss equations
l_e	effective weld length
θ	angle between branch and chord

BY CONNECTION TYPE

Finding B_e and B_{ep}

For the connection types where these checks apply, the table below shows how each behaves and the equations that define B_e (local yielding) and B_{ep} (punching shear).

Connections shown in elevation, branch(es) welded to the chord face. Graphics: AISC Design Guide 24, 2nd Ed.

CONNECTION	ELEVATION	CONNECTION BEHAVIOR	EFFECTIVE WIDTH EQUATIONS
Transverse plate Plate across the chord face	 *AISC DG24, Table 8-2, p. 225*	The **full plate width** reduces to B_e for the check of local yielding of the branch plate, and to B_{ep} for the check of shear yielding (punching).	B_e: AISC 360-22 Eq. K1-1, with $t_b = t_p$ and B_b = plate width. B_{ep}: AISC 360-22 Eq. K1-2.
T-, Y- & cross HSS branch, axial load	 *AISC DG24, Table 9-2, p. 255*	The two branch walls **across the face** reduce to B_e for local yielding and to B_{ep} for punching shear. The two walls parallel to the chord sit over the stiff zone and stay fully effective.	B_e: AISC 360-22 Eq. K1-1, with t_b = branch wall thickness. B_{ep}: AISC 360-22 Eq. K1-2, utilized in the punching-shear check as the ratio $\beta_{eop} = B_{ep}/B$.
Gapped K Two branches, a gap between them	 *AISC DG24, Table 9-2, p. 256*	Opposing branch forces stiffen the inner region, so only each branch's **outer (heel) wall** reduces to B_e for local yielding (B_{ep} applies for punching shear). The other three walls stay fully effective.	B_e: AISC 360-22 Eq. K1-1, applied to the outer wall of each branch. B_{ep}: AISC 360-22 Eq. K1-2, utilized in the punching-shear check as the ratio $\beta_{eop} = B_{ep}/B$.
Overlapped K One branch laps over the other	 *AISC DG24, Table 9-2, p. 256*	The **outer wall of each branch** reduces, with effective widths that depend on the relative stiffness of all three members and the percent overlap. At high overlap, more of the overlapping branch becomes effective.	B_e: the overlap-case equations in AISC 360-22 Table K3.2 (Eq. K3-10 to K3-12), selected by percent overlap. B_{ep}: not applicable. Neither AISC 360-22 nor DG24 requires a punching-shear check for overlapped K-connections; the overlapping branches transfer load directly to each other rather than solely through the chord face.
Moment (T-connection) In-plane & out-of-plane bending	 *AISC DG24, Table 10-2, pp. 308–309*	Same as T/Y/cross: the branch walls **across the face** reduce to B_e (local yielding) and B_{ep} (punching shear); the walls parallel to the chord carry the force couple due to bending but stay fully effective.	B_e: AISC 360-22 Eq. K1-1, applied to the transverse walls. B_{ep}: AISC 360-22 Eq. K1-2.

Two limits to remember: The effective width equations are empirical, valid only inside the connection's **limits of applicability** (chord/branch yield ≤ 52 ksi, width ratios, slenderness, gap/overlap geometry); outside them, rational analysis is required. See STI's HSS Limits of Applicability article. Also, the member effective width reduction applies to **square & rectangular HSS only**; round HSS do not use B_e (though its welds have their own effective length rules).

MORE ON B_e AND B_{ep}

COMPANION TOOL · THE WELD SIDE

HSS Effective Weld Length Calculator

Turns B_e into effective weld length and weld group properties (Table K5.1) for plate-to-HSS and HSS-to-HSS connections.

steeltubeinstitute.org/resources/hss-effective-weld-length-calculator

EVERY LIMIT STATE EQUATION

STI HSS Limit State Tables

The free tables of every HSS connection limit state equation (360-22), for each connection type. Pairs with the Limits of Applicability article cited in the note above.

steeltubeinstitute.org/product/limit-state-tables

BACKGROUND ON THE MECHANISM

Local Yielding Due to Uneven Load Distribution

The STI article by Mike Manor covering the mechanism, the derivation, and the branch local yielding check this guide condenses.

steeltubeinstitute.org/resources/understanding-local-yielding-due-to-uneven-load-distribution

DESIGN EXAMPLES THAT USE THIS CHECK

Transverse flange plate (moment). WF-to-HSS moment connection, AISC 360-22, including the plate local yielding check.
steeltubeinstitute.org/resources/hss-moment-connections-design-examples-transverse-flange-plates

Overlapped K-connection. AISC 360-22 example covering branch local yielding due to uneven load distribution and the hidden-toe-weld question.
steeltubeinstitute.org/resources/design-example-hss-overlapped-k-connections-with-and-without-the-hidden-toe-weld