Electrodes should be selected to match the base metal.

Use E70XX electrodes with steels that have a yield stress less than 60 ksi.

Use E80XX electrodes with steels that have a yield stress of 60 ksi or 65 ksi.

Nominal load capacity of weld, \( R_n = F_w A_w = [0.707 w L] F_w \)

Design Strength, \( \varphi R_n = \varphi F_w A_w = \varphi [0.707 w L] F_w \)

Where \( \varphi = 0.75 \)

Where

\( F_w = \text{nominal strength of the weld metal per unit area} = 0.6 F_{EXX} \)

\( F_w \) based on the angle of the load to the longitudinal axis of the weld (\( \theta \)):

\[
F_w = 0.60 F_{EXX} [1.0 + 0.5 \sin^{1.5} \theta]
\]
Fillet weld symbols

- **Near side (arrow side)**
- **Other side**
- **Both sides**
- **Weld all around**
- **Field weld**
EXAMPLE 1: Determine the strength of the following welds.

(a) 3/4" weld, 8" long, loaded along the weld

(b) 3/4" weld, 8" long, loaded perpendicular to the weld

(c) 3/4" weld, 8" long, loaded at a 45° to the weld

(a) Nominal Design Strength, \( \varphi R_n = \varphi F_w A_w = \varphi [0.707 w L] F_w \)

Where \( \varphi = 0.75 \)

\[ \varphi R_n = 0.75 [0.707(3/4") (8")](0.6 \times 70) = 133.62 \text{kips} \]

(b) \( F_w = 0.60 F_{EXX} [1.0 + 0.5 \sin^{1.5} \theta] = 0.60 F_{EXX} (1.5) \) \{ \sin \theta = \sin (90^\circ) = 1 \}

\[ \varphi R_n = 133.62 \times 1.5 = 200.4 \text{kips} \]

(c) \( F_w = 0.60 F_{EXX} [1.0 + 0.5 \sin^{1.5} \theta] = 0.60 F_{EXX} (1.292456) \) \{ \theta = 45^\circ \}

\[ \varphi R_n = 133.62 \times 1.292456 = 172.7 \text{kips} \]
**Example 2:** Determine the design strength for C-shaped welds. Use E70XX electrodes and a 3/16” Fillet weld.

For 3/16” weld, 2-10” long, loaded along the weld

\[ R_{w(L)} = 0.707 (3/16") (2 \times 10") (0.6 \times 70) = 111.35 \text{ kips} \]

For 3/16” weld, 8” long, loaded perpendicular to the weld

\[ R_{w(T)} = 0.707 (3/16") (8") (0.6 \times 70) = 44.54 \text{ Kips} \]

Without considering the weld and load orientation, Weld Design Strength

AISC Specification, Equation (J2-10a) (AISC Steel Manual 14th Ed.)

\[ R_n = 111.35 + 44.54 = 155.89 \text{ Kips} \]

Weld Design Strength considering the added contribution of the transverse welds while reducing the contribution of the longitudinal welds,

AISC Specification, Equation (J2-10b) (AISC Steel Manual 14th Ed.)

\[ R_n = (0.85)111.35 + (1.5)44.54 = 161.46 \text{ Kips} \]

Select the largest one, \( \phi R_n = (0.75)(161.46) = 121.10 \text{ Kips} \)
**Example 3:** Determine the LRFD design strength of the connection as shown in Figure. Follow the following steps:

(a) Strength based on yielding in the gross section  
(b) Strength based on tensile fracture  
(c) Strength based on block shear failure  
(d) Weld strength.  
(e) What is the design strength of this connection?

![Diagram of connection with dimensions and labels](image)

**SOLUTION:**

(a) **Strength based on yielding in the gross section**  
\[ \phi_t P_n = \phi_t F_y A_g \]
\[ = 0.9 \times 36 \text{ ksi} \times (8\text{"} \times 0.5\text{")} = 129.6 \text{ Kips} \]

(b) **Strength based on tensile fracture**  
\[ A_e = U \times A_n \]
\[ \phi_t P_n = \phi_t F_u A_e \]

AISC Specification TABLE D3.1, Case 1, U= 1  
\[ A_e = (1) (8\text{"} \times 0.5\text{")} = 4 \text{ Sq in.} \]
\[ \phi_t P_n = \phi_t F_u A_e \]
\[ = (0.75) (58 \text{ ksi}) (4 \text{ sqin}) = 174 \text{ Kips}. \]

(c) Strength based on block shear failure

Design Block Shear Strength = \( \phi R_n \) where \( \phi=0.75 \)

\[ R_n = 0.6 F_u A_{nv} + U_{bs} F_u A_{nt} \leq 0.6 F_y A_{gv} + U_{bs} F_u A_{nt} \]

\[ A_{gv} = (2 \times 10") (0.5") = 10 \text{ sq in} \]
\[ A_{nv} = 10 \text{ sq in} \]
\[ A_{nt} = 8" \times 0.5" = 4 \text{ sq in} \]
\[ U_{bs} = 1.0 \text{ for uniform tension stress} \]

\[ Rn = 0.6(58 \text{ ksi})(10 \text{ sq in}) + (1)(58 \text{ ksi})(4) = 580 \text{ kips} \]
\[ Rn = 0.6(36 \text{ ksi})(10 \text{ sq in}) + (1)(58 \text{ ksi})(4) = 448 \text{ Kips} \]

\[ \phi R_n = 0.75 \times 448 = \textbf{336 kips} \]

(d) Weld strength.

For 5/16” weld, 2-10” long, loaded along the weld

\[ R_{w(L)} = 0.707(5/16") (2 \times 10") (0.6 \times 70) = 185.59 \text{ kips} \]

For 5/16” weld, 8” long, loaded perpendicular to the weld

\[ R_{w(T)} = 0.707(5/16") (8") (0.6 \times 70) = 74.24 \text{ Kips} \]

AISC Specification (AISC Steel Manual 14th Ed.)

Equation (J2-10a): \( R_n = 185.59 + 74.24 = 259.82 \text{ Kips} \)

Equation (J2-10b): \( R_n = (0.85)185.59 + (1.5)74.24 = 269.10 \text{ Kips} \)

Design Wed strength, \( \phi R_n = (0.75)(269.10) = \textbf{201.8 Kips} \)

(e) What is the design strength of this connection?

Based on (a), (b), (c), and (d), Yielding controls (a):

The design Strength = \( \textbf{129.6 Kips} \).
Fig 1: Complete penetration groove welds

Fig 2: Partial penetration groove welds