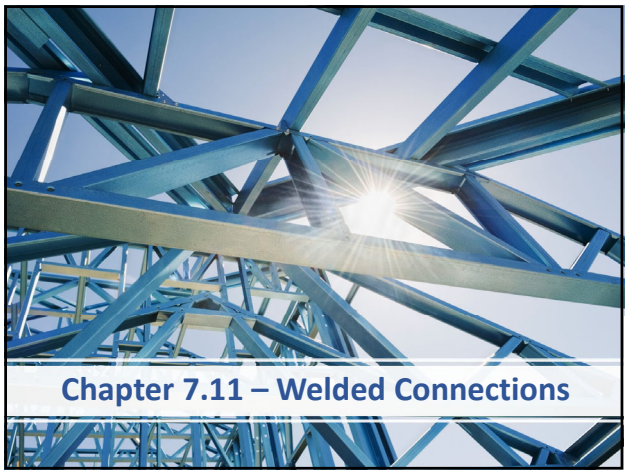
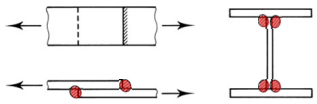


1

Chapter 7.10 – Welded Connections

- ***Structural welding*** is a process whereby the parts to be connected are heated and fused, with supplementary molten metal added to the joint.
- The tension member lap joint shown below can be constructed by welding across the ends of both connected parts.

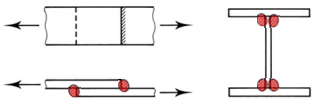


- A relatively small depth of material will become molten, and upon cooling, the structural steel and the weld metal will act as one continuous part where they are joined.

2

Chapter 7.10 – Welded Connections

- The two most common types of welds are the ***fillet weld*** and the ***groove weld***.
- The lap joint below is made with fillet welds, which are defined as those placed in a corner formed by two parts in contact.

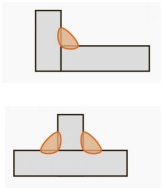


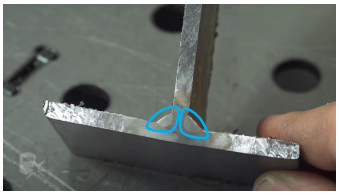
- Fillet welds can also be used in a tee joint.

3

Chapter 7.10 – Welded Connections

- The two most common types of welds are the ***fillet weld*** and the ***groove weld***.
- The lap joint below is made with fillet welds, which are defined as those placed in a corner formed by two parts in contact.

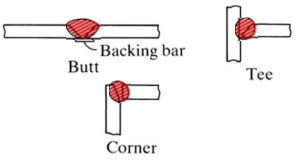


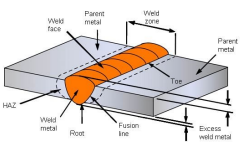


4

Chapter 7.10 – Welded Connections

- ***Groove welds*** are those deposited in a gap, or groove, between two parts to be connected.
- They are most frequently used for butt, tee, and corner joints.
- In most cases, one or both connected parts will have beveled edges, called ***prepared edges***.

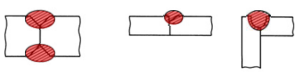




5

Chapter 7.10 – Welded Connections

- ***Partial penetration*** groove welds can be made from one or both sides, with or without edge preparation.





6

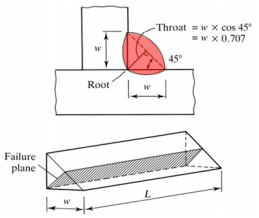
Chapter 7.10 – Welded Connections

- Of the two major types of welds, ***fillet welds are the most common*** and are considered here in some detail.
- The design of ***complete penetration groove welds*** is a trivial exercise in that the weld will have the ***same strength as the base metal***, and the connected parts can be treated as completely ***continuous at the joint***.
- The strength of a ***partial penetration groove weld*** will depend on the ***amount of penetration***; once that has been determined, the design procedure will be essentially the same as that for a ***fillet weld***.

7

Chapter 7.11 – Fillet Welds

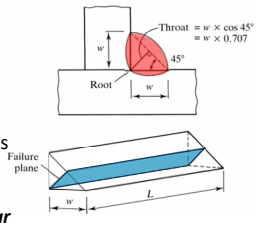
- The design and analysis of ***fillet welds*** assumes that the cross-section of the weld is a 45° right triangle.
- Any reinforcement or penetration is neglected.
- The size of a fillet weld is denoted ***w*** and is the length of one of the two equal sides of this ***idealized cross-section***.
- Standard weld sizes are specified in increments of $^1/_{16}$ *in* with a minimum size of $^1/_8$ *in*.



8

Chapter 7.11 – Fillet Welds

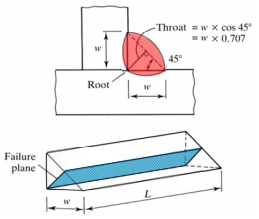
- The design and analysis of ***fillet welds*** assumes that the cross-section of the weld is a 45° right triangle.
- The length of the weld can be loaded in any direction in shear, compression, or tension.
- A ***fillet weld is weakest in shear*** and is always assumed to fail in this mode.
- Failure is assumed to occur in ***shear on a plane*** through the throat of the weld.



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Chapter 7.11 – Fillet Welds

- The design and analysis of ***fillet welds*** assumes that the cross-section of the weld is a 45° right triangle.
- The throat is the perpendicular distance from the corner, or root, of the weld to the hypotenuse and is equal to ***0.707 times*** the size of the weld.



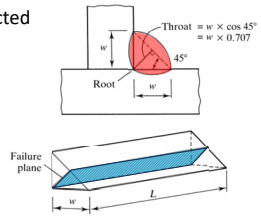
10

Chapter 7.11 – Fillet Welds

- The design and analysis of ***fillet welds*** assumes that the cross-section of the weld is a 45° right triangle.
- For a given length of weld ***L*** subjected to a load of ***P***, the critical shearing stress is:

$$f_v = \frac{P}{0.707wL}$$

where ***w*** is the weld size.

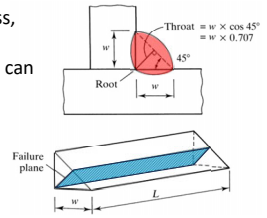


11

Chapter 7.11 – Fillet Welds

- The design and analysis of ***fillet welds*** assumes that the cross-section of the weld is a 45° right triangle.
- If the weld ultimate shearing stress, F_{nw}, is used in this equation, the nominal load capacity of the weld can be written as:

$$R_n = (0.707wL)F_{nw}$$



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Chapter 7.11 – Fillet Welds

- The strength of a ***fillet weld*** depends on the weld metal used—that is, it is a function of the type of electrode.
- The strength of the electrode is defined as its ***ultimate tensile strength***, with strengths of 60, 70, 80, 90, 100, 110, and 120 *ksi*.
- The standard notation for specifying an electrode is the letter ***E*** followed by ***two or three digits*** indicating the tensile strength in *ksi* and ***two digits*** specifying the type of coating.
- As strength is the property of primary concern to the design engineer, the last two digits are usually represented by ***XX***.

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Chapter 7.11 – Fillet Welds

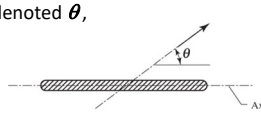
- Most of the AISC Specification provisions for welds have been taken from the ***Structural Welding Code of the American Welding Society*** (AWS, 2020).
- The design strengths of welds are given in ***AISC Table J2.5***.
- The ultimate shearing stress F_{nw} in a fillet weld is ***0.6 times*** the tensile strength of the weld metal, denoted F_{EXX}
- The nominal stress is: $R_n = 0.6F_{EXX}$



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Chapter 7.11 – Fillet Welds

- ***AISC Section J2.4(a)*** presents an alternative fillet weld strength that accounts for the direction of the load.
- If the angle between the direction of the load and the axis of the weld is denoted θ,



AISC Equation J2-4

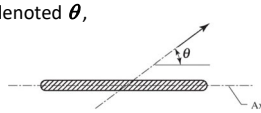
- The nominal fillet weld strength is: $R_n = F_{nw} A_{we} k_{ds}$

where: F_{nw} is the nominal stress of the weld metal, *ksi*
A_{we} is the effective area of the weld, in^2

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Chapter 7.11 – Fillet Welds

- ***AISC Section J2.4(a)*** presents an alternative fillet weld strength that accounts for the direction of the load.
- If the angle between the direction of the load and the axis of the weld is denoted θ,



AISC Equation J2-4

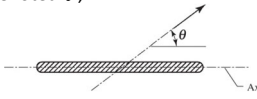
- The nominal fillet weld strength is: $R_n = F_{nw} A_{we} k_{ds}$

where: k_{ds} is the directional strength increase factor,
For fillet welds where the strain compatibility of the various weld elements is considered:
$k_{ds} = (1.0 + 0.50\sin^{1.5}\theta)$ ***AISC Equation J2-5***

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Chapter 7.11 – Fillet Welds

- ***AISC Section J2.4(a)*** presents an alternative fillet weld strength that accounts for the direction of the load.
- If the angle between the direction of the load and the axis of the weld is denoted θ,



AISC Equation J2-4

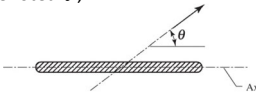
- The nominal fillet weld strength is: $R_n = F_{nw} A_{we} k_{ds}$

where: k_{ds} is the directional strength increase factor,
For fillet welds to the ends of rectangular HSS loaded in tension:
$k_{ds} = 1.0$

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Chapter 7.11 – Fillet Welds

- ***AISC Section J2.4(a)*** presents an alternative fillet weld strength that accounts for the direction of the load.
- If the angle between the direction of the load and the axis of the weld is denoted θ,



AISC Equation J2-4

- The nominal fillet weld strength is: $R_n = F_{nw} A_{we} k_{ds}$

where: k_{ds} is the directional strength increase factor,
For all other conditions:
$k_{ds} = 1.0$

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Chapter 7.11 – Fillet Welds

- This table shows the strength for several values of θ

Direction of load (θ)	$R_n = 0.60F_{EXX}(1.0 + 0.50\sin^{1.5}\theta)A_{we}$
0°	$0.60F_{EXX}(1.0)A_{we}$
15°	$0.60F_{EXX}(1.066)A_{we}$
30°	$0.60F_{EXX}(1.177)A_{we}$
45°	$0.60F_{EXX}(1.297)A_{we}$
60°	$0.60F_{EXX}(1.403)A_{we}$
75°	$0.60F_{EXX}(1.475)A_{we}$
90°	$0.60F_{EXX}(1.5)A_{we}$

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Chapter 7.11 – Fillet Welds

- For simple welded connections with both longitudinal and transverse welds, ***AISC J2.4(b)*** specifies that the nominal strength, R_n, of the fillet weld group is permitted to be calculated as:

$$R_n = 0.85F_{nw}A_{wel} + 1.5F_{nw}A_{wet} \qquad \textit{AISC Equation J2-6}$$

where: A_{wel} is the effective area of ***longitudinally*** loaded fillet welds, in^2, and
A_{wet} is the effective area of ***transversely*** loaded fillet welds, in^2.

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Chapter 7.11 – Fillet Welds

- In this case, the nominal strength of fillet weld groups can also be calculated by:

$$R_n = F_{nw}\left(A_{wel} + A_{wet}\right)$$

- To maximize economic benefit, a designer can calculate the nominal strength using ***Equation J2-6*** and the above expression, and then ***select the larger value***.
- For ***LRFD***, the design strength is ϕR_n, where $\phi = 0.75$

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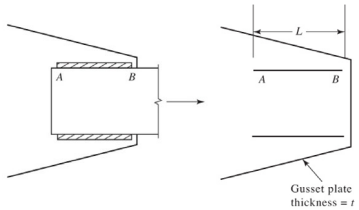
Chapter 7.11 – Fillet Welds

- An additional requirement is that the shear on the base metal cannot exceed the ***shear strength of the base metal***.
- This means that we cannot use a ***weld shear strength*** larger than the ***base-metal shear strength***.
- The base-metal shear strength is an ***upper limit*** on the weld shear strength.

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Chapter 7.11 – Fillet Welds

- Consider the welded connection shown:

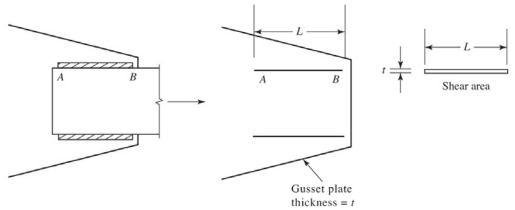


- Although both the gusset plate and the tension member plate are subject to ***shear***, we will examine the shear on the gusset plate adjacent to the weld ***AB***.

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Chapter 7.11 – Fillet Welds

- Consider the welded connection shown:

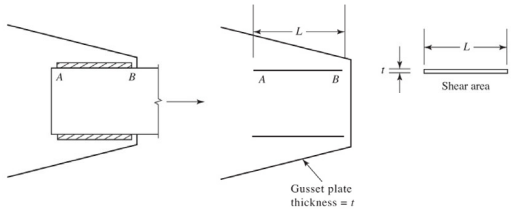


- The shear would occur along line ***AB*** and subject an area of ***tL*** to shear.

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Chapter 7.11 – Fillet Welds

- Consider the welded connection shown



- The shear strength of the weld ***AB*** cannot exceed the shear strength of the base metal corresponding to an area ***tL***.

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Chapter 7.11 – Fillet Welds

- The strength of components at connections, including connecting elements such as gusset plates and elements of the members, is covered in ***AISC J4***, "Affected Elements of Members and Connecting Elements."
- Shear strength is covered in ***Section J4.2***, where the limit states of shear ***yielding*** and shear ***rupture*** are given.

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Chapter 7.11 – Fillet Welds

- For ***yielding***, the nominal strength is

$$R_n = 0.6F_yA_{gv} \qquad \textbf{AISC Equation J4-3}$$

where: $0.6F_y$ is the shear yield stress, *ksi*, and
A_{gv} is the gross area of the shear surface = ***tL***, in^2

For ***LRFD***, $\phi = 1.0$

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Chapter 7.11 – Fillet Welds

- The ***rupture*** strength is

$$R_n = 0.6F_uA_{nv} \qquad \textbf{AISC Equation J4-4}$$

where: $0.6F_u$ is the shear ultimate stress, *ksi*, and
A_{nv} is the net area of the shear surface = ***tL***, in^2
(for material adjacent to a weld)

For ***LRFD***, $\phi = 0.75$

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Chapter 7.11 – Fillet Welds

- The ***LRFD*** strength of a fillet weld can now be summarized.

Weld shear strength: $\phi R_n = 0.75\left(0.707wLF_{nw}\right)$

Base-metal shear strength: $\phi R_n = \min\left[1.0\left(0.6F_ytL\right);\ 0.75\left(0.6F_utL\right)\right]$

It is more convenient to work with the strength per unit length, in which case, ***L*** = 1 *in*.

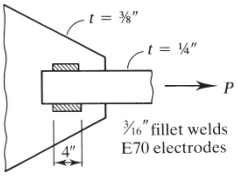
Weld shear strength: $\phi R_n = 0.75\left(0.707wF_{nw}\right)$

Base-metal shear strength: $\phi R_n = \min\left[1.0\left(0.6F_yt\right);\ 0.75\left(0.6F_ut\right)\right]$

29

Chapter 7.11 – Fillet Welds

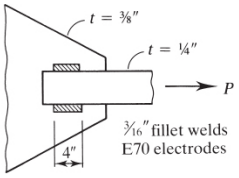
- **Example 7.12**: A plate used as a tension member is connected to a gusset plate. The welds are $^3/_{16}$-*in* fillet welds made with ***E70XX*** electrodes.
- The connected parts are of **A36** steel (F_y = 36 *ksi*; F_u = 58 *ksi*).
- Assume that the tensile strength of the member is adequate and determine the available strength of the welded connection.



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Chapter 7.11 – Fillet Welds

- **Example 7.12**: Because the welds are symmetrically placed about the member's axis, this connection qualifies as a simple connection, and there is no additional load due to eccentricity. Since both weld segments are parallel to the applied load, $\theta = 0°$, therefore $k_{ds} = 1.0$:



31

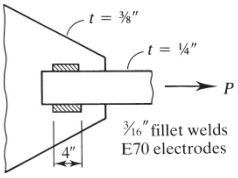
Chapter 7.11 – Fillet Welds

- **Example 7.12**:

$$F_{nw} = 0.60F_{EXX} = 0.6(70ksi) = 42ksi$$

$$A_{we} = 0.707(t)in^2/in = 0.707(3/16)in^2/in = 0.1326in^2/in$$

$$R_n = F_{nw}A_{we}k_{ds} = 42ksi(0.1326in^2/in)(1.0) = 5.568k/in$$



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Chapter 7.11 – Fillet Welds

- **Example 7.12**: The design strength of the weld is:

$$\phi R_n = 0.75(5.568k/in) = \boxed{4.176k/in}$$ ***Controls**

Check the base-metal shear.
Since both components are of the same steel type, the ***thinner component will control***.

$$\phi R_n = \phi(0.6F_y t) = 1.0(0.6)(36ksi)(1/4in) = \boxed{5.4k/in}$$

The shear rupture strength is:

$$\phi R_n = \phi(0.6F_u t) = 0.75(0.6)(58ksi)(1/4in) = \boxed{6.53k/in}$$

$$\phi R_n = 4.176k/in \times (4in + 4in) = \boxed{33.4k}$$ Design strength

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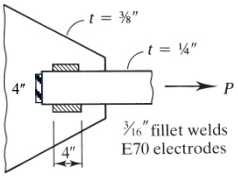
Chapter 7.11 – Fillet Welds

- **Example 7.13**: Same as **Example 7.12**, except an additional 4-in. long transverse weld is added at the end of the member.

- From **Example 7.12**:

Weld shear strength: $\phi R_n = 4.176k/in$

Base-metal shear strength: $\phi R_n = 5.4k/in$



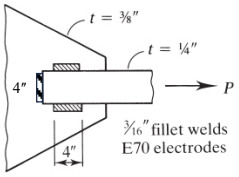
34

Chapter 7.11 – Fillet Welds

- **Example 7.13**: To determine the strength of the connection, we will investigate the two options given

1. Use the basic weld strength for both the longitudinal and transverse welds.

$$\phi R_n = 4.176k/in(4 + 4 + 4)in = \boxed{50.1k}$$



35

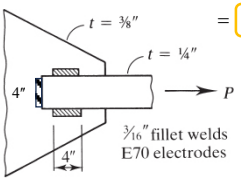
Chapter 7.11 – Fillet Welds

- **Example 7.13**: To determine the strength of the connection, we will investigate the two options given

2. Use 0.85 times the basic weld strength for the longitudinal welds and 1.5 times the basic weld strength for the transverse weld.

$$\phi R_n = 0.85(4.176k/in)(4 + 4)in + 1.5(4.176k/in)(4)in$$

$$= \boxed{53.5k}$$ ***Controls**



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Chapter 7.11 – Fillet Welds

- When ***E70*** electrodes are used, and this will usually be the case, computation of the weld shear strength can be simplified.
- The ***strength per unit length*** can be computed for a $^1/_{16}$ *in* increment of weld size (and fillet welds are specified to the nearest $^1/_{16}$ *in*)
- For ***LRFD***: The weld design shear strength is:

$$\phi R_n = 0.75(0.707 w F_{nw})$$
$$= 0.75(0.707)\left(\tfrac{1}{16}in\right)(0.6\times 70ksi) = 1.392 k/in$$

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Chapter 7.11 – Fillet Welds

- When ***E70*** electrodes are used, and this will usually be the case, computation of the weld shear strength can be simplified.
- The ***strength per unit length*** can be computed for a $^1/_{16}$ *in* increment of weld size (and fillet welds are specified to the nearest $^1/_{16}$ *in*)
- For ***LRFD***: The design shear strength of the $^3/_{16}$ in fillet weld is:

$$\phi R_n = 1.392 k/in(3 \text{ sixteenths}) = 4.176 k/in$$

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Chapter 7.11 – Fillet Welds

- The ***base-metal shear strength*** expression can also be somewhat simplified.
- The shear yield design strength per unit length is:

$$\phi R_n = 1.0(0.6F_y t) = 0.6F_y t \quad \text{for a 1-}in\text{ length}$$

- The base-metal shear rupture design strength per unit length is:

$$\phi R_n = 0.75(0.6F_u t) = 0.45F_u t \quad \text{for a 1-}in\text{ length}$$

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Chapter 7.11 – Fillet Welds

- To summarize, for ***E70*** electrodes, the design strength of a fillet weld can be taken as:

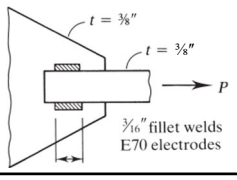
$$\phi R_n = \min\begin{Bmatrix} 1.392D \\ 0.6F_y t \\ 0.45F_u t \end{Bmatrix} k/in$$

where: ***D*** is the number of $^1/_{16}$ *in* of weld size, and
t is the thickness of the base metal, *in*.

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Chapter 7.11 – Fillet Welds

- **Example 7.14**: A connection of the type used in **Example 7.12** must resist a service dead load of 9 *k* and a service live load of 18 *k*. What total length of ¼-*in* fillet weld, ***E70XX*** electrode, is required?
- The connected parts are of **A36** steel (F_y = 36 *ksi*; F_u = 58 *ksi*).
- Assume that both connected parts are ⅜-*in* thick.



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Chapter 7.11 – Fillet Welds

- **Example 7.14**:

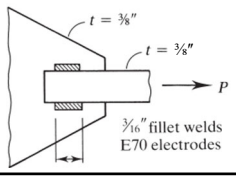
$$P_u = 1.2D + 1.6L = 1.2(9k) + 1.6(18k) = 39.6k$$

The shear strength of the ¼-*in* fillet ***weld*** per inch of length is:

$$\phi R_n = 1.3692D = 1.392(4)k/in = \boxed{5.568 k/in}$$

The shear yield strength of the ***base metal*** is:

$$\phi R_n = 0.6F_y t = 0.6(36ksi)\left(\tfrac{3}{8}in\right) = \boxed{8.1 k/in}$$



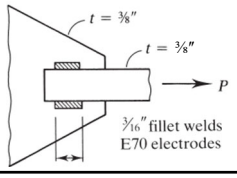
42

Chapter 7.11 – Fillet Welds

- **Example 7.14**: The shear rupture strength of the ***base metal*** is:

$$\phi R_n = 0.45 F_u t = 0.45(58 ksi)\left(\tfrac{3}{8} in\right) = \boxed{9.788 k/in}$$

$$\phi R_n = \min\begin{Bmatrix} 1.392D \\ 0.6F_y t \\ 0.45F_u t \end{Bmatrix} k/in = \min\begin{Bmatrix} 5.568 \\ 8.100 \\ 9.788 \end{Bmatrix} k/in = \boxed{5.568 k/in}$$



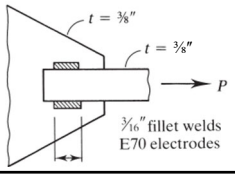
43

Chapter 7.11 – Fillet Welds

- **Example 7.14**: The weld strength of **5.568 *k/in*** controls.

The total length required is: $\frac{P_u}{\phi R_n} = \frac{39.6k}{5.568 k/in} = 7.11 in$

or $\boxed{8 in}$



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Chapter 7.11 – Fillet Welds

- Practical design of welded connections requires a consideration of such details as ***maximum*** and ***minimum*** weld sizes and lengths.
- The requirements for fillet welds are found in ***AISC J2.2b.***

2b. Limitations

Fillet welds shall meet the following limitations:

(a) The minimum size of fillet welds shall be not less than the size required to transmit calculated forces nor the size as shown in Table J2.4. These limitations do not apply to fillet weld reinforcements of groove welds.

(b) The maximum specified size of fillet welds of connected parts shall be

(1) Along edges of material less than ¼ in. (6 mm) thick; not greater than the thickness of the material.

(2) Along edges of material ¼ in. (6 mm) or more in thickness; not greater than the thickness of the material minus 1/16 in. (2 mm), unless the weld is especially designated on the design and fabrication documents to be built out to obtain full-throat thickness. In the as-welded condition, the distance between the edge of the base metal and the toe of the weld is permitted to be less than 1/16 in. (2 mm), provided the weld size is clearly verifiable.

(c) The minimum length of fillet welds designed on the basis of strength shall be not less than four times the nominal weld size, or else the effective size of the weld shall not be taken to exceed one-quarter of its length.

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Chapter 7.11 – Fillet Welds

- ***The minimum size*** permitted is a function of the thickness of the thinner connected part and is given in ***AISC Table J2.4***.
- This requirement is taken directly from the ***American Welding Society Structural Welding Code*** (AWS, 2020).

TABLE J2.4
Minimum Size of Fillet Welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld,[a] in. (mm)
To ¼ (6) inclusive	⅛ (3)
Over ¼ (6) to ½ (13)	3/16 (5)
Over ½ (13) to ¾ (19)	¼ (6)
Over ¾ (19)	5/16 (8)

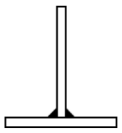
[a]Leg dimension of fillet welds. When non-low hydrogen electrodes are used, single pass welds must be used.
Note: See Section J2.2b for maximum size of fillet welds.

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Chapter 7.11 – Fillet Welds

- Along the edge of a part ***less than ¼-in thick***, the maximum fillet weld size is equal to the thickness of the part.
- For parts ***¼-in or more in thickness***, the maximum size is:

  t*-$\left(\frac{1}{16}\right)$*in, where ***t*** is the thickness of the part.
- For fillet welds other than those along edges, as shown below, there is ***no maximum size specified***.
- In these cases, the ***maximum size*** to be used in strength computation would be that limited by the ***base metal shear strength.***



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Chapter 7.11 – Fillet Welds

- The ***minimum permissible length*** of a fillet weld is ***four times its size***.
- ***AISC*** does not impose a limit on the length of welds, but for end-loaded welds, there are some restrictions.
- End-loaded welds are longitudinal welds at the end of an axially loaded member.
- If the ***length exceeds 100 times the weld size***, a reduced effective length is used in the computation of strength.

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Chapter 7.11 – Fillet Welds

- The effective length is obtained by multiplying the actual length by a factor β

$$\beta = 1.2 - 0.002(\ell/w) \le 1.0$$

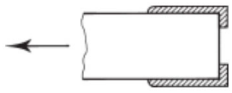
where: ℓ is the actual length of the weld, *in*, and
w is the weld size, *in*.

- If the length is larger than 300 times the weld size, use an effective length of 180***w***.

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Chapter 7.11 – Fillet Welds

- When a weld extends to the end of a member, it is sometimes continued around the corner, as shown below.
- The primary reason for this continuation, called an ***end return***, is to ensure that the weld size is maintained over the full length of the weld.
- The ***AISC Specification*** does not require end returns.



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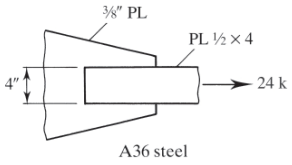
Chapter 7.11 – Fillet Welds

- ***Small welds*** are generally cheaper than large welds.
- The ***maximum size*** that can be made with a single pass of the electrode is approximately $^5/_{16}$ *in*, and multiple passes will add to the cost.
- In addition, for a given load capacity:
  - small welds will be longer
  - larger welds will be shorter and require more volume of weld metal
- ***Reducing the volume of weld metal*** will also minimize heat buildup and residual stresses.

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Chapter 7.11 – Fillet Welds

- **Example 7.15**: A plate ½ x 4 of **A36** steel (F_y = 36 *ksi*; F_u = 58 *ksi*) is used as a tension member to carry a service dead load of 6 *k* and a service live load of 18 *k*.
  It is to be attached to a ⅜-*in* gusset plate.
  Design a welded connection.

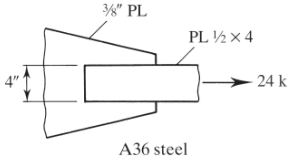


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Chapter 7.11 – Fillet Welds

- **Example 7.15**: The base metal in this connection is **A36** steel, so ***E70XX*** electrodes will be used.

  No restrictions on connection length have been stipulated, so weld length will not be limited, and the smallest permissible size will be used.



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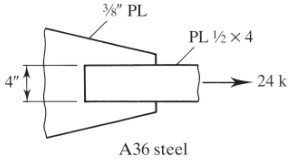
Chapter 7.11 – Fillet Welds

- **Example 7.15**: From ***AISC Table J2.4***:

TABLE J2.4
Minimum Size of Fillet Welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld,[a] in. (mm)
To ¼ (6) inclusive	⅛ (3)
Over ¼ (6) to ½ (13)	³⁄₁₆ (5)
Over ½ (13) to ¾ (19)	¼ (6)
Over ¾ (19)	⁵⁄₁₆ (8)

[a]Leg dimension of fillet welds. When non-low hydrogen electrodes are used, single pass welds must be used.
Note: See Section J2.2b for maximum size of fillet welds.



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Chapter 7.11 – Fillet Welds

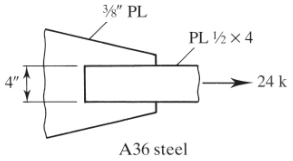
➢ **Example 7.15**: Try a $^3/_{16}$-*in* fillet weld, using ***E70XX*** electrodes.

The design strength per inch is:

$$\phi R_n = 1.3692D = 1.392(3)k/in = \boxed{4.176k/in}$$

The shear ***yield*** strength of the ***base metal*** is:

$$\phi R_n = 0.6F_y t = 0.6(36ksi)\left(\tfrac{3}{8}in\right) = \boxed{8.1k/in}$$



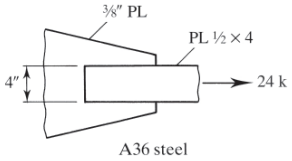
55

Chapter 7.11 – Fillet Welds

➢ **Example 7.15**: The shear ***rupture*** strength of the ***base metal*** is:

$$\phi R_n = 0.45F_u t = 0.45(58ksi)\left(\tfrac{3}{8}in\right) = \boxed{9.788k/in}$$

$$\phi R_n = \min\begin{Bmatrix}1.392D\\0.6F_y t\\0.45F_u t\end{Bmatrix}k/in = \min\begin{Bmatrix}4.176\\8.100\\9.788\end{Bmatrix}k/in = \boxed{4.176k/in}$$



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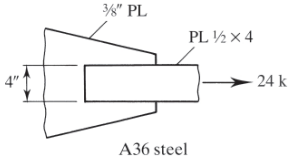
Chapter 7.11 – Fillet Welds

➢ **Example 7.15**: The weld strength of **4.176 *k/in*** controls.

$$P_u = 1.2D + 1.6L = 1.2(6k) + 1.6(18k) = 36k$$

Required length: $\dfrac{36k}{4.176k/in} = 8.62in$

Minimum length: $4w = 4\left(\tfrac{3}{16}in\right) = 0.75in < 8.62in$

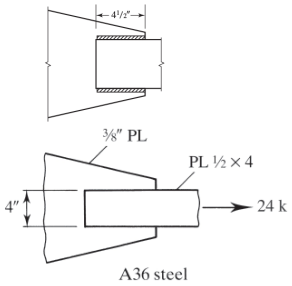


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Chapter 7.11 – Fillet Welds

➢ **Example 7.15**:

Use ***two 4.5-in*** long-side welds for a total length of ***9 in.***

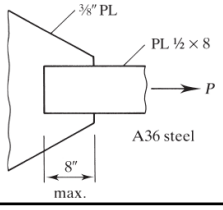


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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: A plate ½ x 8 of **A36** steel (F_y = 36 *ksi*; F_u = 58 *ksi*) is used as a tension member and is to be connected to a ⅜-*in* gusset plate.

The length of the connection cannot exceed 8 *in*, and all welding must be done on the near side. Design a weld to develop the full tensile capacity of the member.



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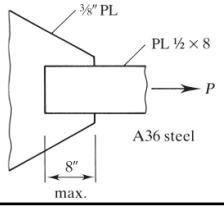
Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: The design strength of the member based on its gross area is:

$$\phi P_n = 0.9F_y A_g = 0.9(36ksi)(1/2in)8in = 129.6k$$

Compute the design strength of the member based on its effective area.

$$A_e = UA_g$$



From ***AISC Table D3.1***

If there is also a transverse weld at the end, then

$$A_e = A_g$$

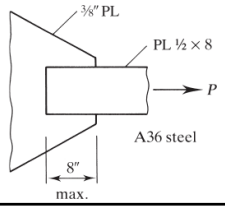
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: The design strength of the member based on its effective area is:

$$\phi P_n = 0.75 F_u A_e = 0.75(58ksi)(1/2in)8in = 174.0k$$

A design for a factored load of ***129.6 k*** is used.



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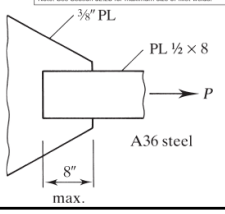
Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: From ***AISC Table J2.4***:

TABLE J2.4
Minimum Size of Fillet Welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld[a] in. (mm)
To ¼ (6) inclusive	⅛ (3)
Over ¼ (6) to ½ (13)	3/16 (5)
Over ½ (13) to ¾ (19)	¼ (6)
Over ¾ (19)	5/16 (8)

[a]Leg dimension of fillet welds. When non-low hydrogen electrodes are used, single pass welds must be used.
Note: See Section J2.2b for maximum size of fillet welds.



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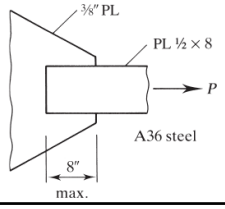
Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: Because of the length constraint, however, try a slightly larger weld. ***Try ¼-in E70 fillet weld***

$$\phi R_n = 1.3692D = 1.392(4)k/in = \boxed{5.568k/in}$$

The shear yield strength of the ***base metal*** is:

$$\phi R_n = 0.6 F_y t = 0.6(36ksi)\left(\tfrac{3}{8}in\right) = \boxed{8.1k/in}$$



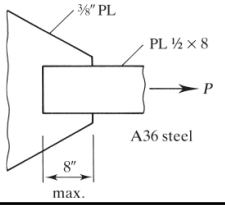
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: The shear rupture strength of the ***base metal*** is:

$$\phi R_n = 0.45 F_u t = 0.45(58ksi)\left(\tfrac{3}{8}in\right) = \boxed{9.788k/in}$$

$$\phi R_n = \min\begin{Bmatrix}1.392D\\0.6F_y t\\0.45F_u t\end{Bmatrix} k/in = \min\begin{Bmatrix}5.568\\8.100\\9.788\end{Bmatrix} k/in = \boxed{5.568k/in}$$



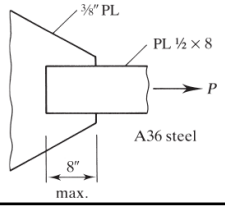
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: The weld strength of **5.568 *k/in*** controls.

Both longitudinal and transverse welds will be used.

To determine the required length of the longitudinal check, ***AISC Equation J2-6***



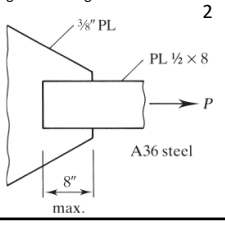
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: First, assuming the same strength for both the longitudinal and transverse welds

Total required length: $= \dfrac{129.6k}{5.568k/in} = 23.28in$

Longitudinal length: $= \dfrac{23.28in - 8in}{2} = 7.64in$



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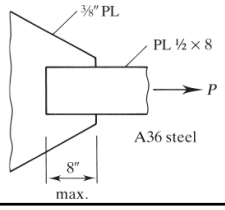
Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: Second, using ***AISC Equation J2-6,*** the strength of the longitudinal welds is:

$R_n = 0.85F_{nw}A_{wel} + 1.5F_{nw}A_{wet}$ ***AISC Equation J2-6***

Longitudinal strength: $= 0.85(5.568k/in) = 4.733k/in$

Transverse strength: $= 1.5(5.568k/in) = 8.352k/in$



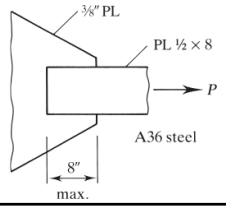
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: The load carried by the longitudinal welds is:

$\Rightarrow 129.6k - (8in)8.352k/in = 62.78k$

Required longitudinal weld: $= \dfrac{62.78k}{2(4.733k/in)} = 6.63in$



The second option requires shorter longitudinal welds.

Try an ***8-in transverse*** weld and ***two 7-in longitudinal*** welds.

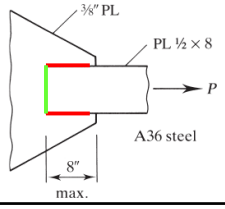
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: Check the block shear strength of the gusset plate.

$A_{gv} = A_{nv} = 2\times(3/8in)(7in) = 5.25in^2$

$A_{nt} = (3/8in)(8in) = 3in^2$



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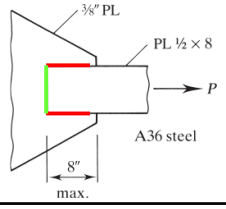
Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: Using ***AISC Equation J4-5***

$R_n = \min\left[0.6F_uA_{nv}, 0.6F_yA_{gv}\right] + U_{bs}F_uA_{nt}$

$= \min\left[0.6(58ksi)5.25in^2, 0.6(36ksi)5.25in^2\right]$

$+1.0(58ksi)(3.0in^2)$



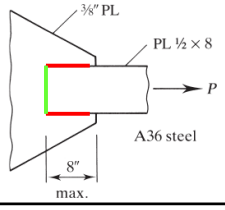
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Chapter 7.11 – Fillet Welds

➢ **Example 7.16**: Using ***AISC Equation J4-5***

$R_n = \min\left[0.6F_uA_{nv}, 0.6F_yA_{gv}\right] + U_{bs}F_uA_{nt}$

$= \min\left[182.7k, 113.4k\right] + 174k = 287.4k$



$\phi R_n = 0.75(287.4k)$

$= 216k > 129.6k$

O.K.

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Chapter 7.11 – Fillet Welds

Any questions?



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