GIVE FEEDBACK

CONTINUE >

This section demonstrates the application of engineering design concepts and techniques to bolted and welded joints.

Connections between components are essential in mechanical engineering applications. The way in which these connections are made impacts on the performance of the resultant mechanical system.

Bolted connections

The methods of joining two structural members, or two plates of metal, together can be divided into two groups:

- Bolted connections
- Welded connections

Bolted connections have the advantage of being semi-permanent, i.e. they are capable of being disassembled.

Bolts are the basic screw fasteners generally used with through holes and the appropriate nuts.

GIVE FEEDBACK

OK

Which of the following is an advantage of bolted joints compared to welded joints?

Click the correct answer.

- It is often the least expensive process
- It has the advantage of not requiring holes to be drilled in the parts being joined and therefore does not reduce their original strength
- It is a semi-permanent connection method
- It is preferred when a permanent structure or a tight boiler joint is required

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are advantages of bolted joints compared to welded joints?

Check all that apply.

- [ ] It is often the least expensive process
- [ ] It has the advantage of not requiring holes to be drilled in the parts being joined and therefore does not reduce their original strength
- [ ] It is a semi-permanent connection method
- [ ] It more readily allows for component maintenance and replacement
- [ ] It is preferred when a permanent structure or a tight boiler joint is required
- [ ] It can be used with through holes and the appropriate nuts

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Welded connections

The methods of joining two structural members, or two plates of metal, together can be divided into two groups:

- Bolted connections
- Welded connections

When a permanent structure or a tight boiler joint is required, construction methods presently used in industry tend to favour welding in preference to bolted connections.

Welding is often the least expensive process and has the advantage of not requiring holes to be drilled in the parts being joined, and therefore not reducing their original strength.

However, the choice of the most suitable construction method depends on many design variables, which the engineer must understand.

GIVE FEEDBACK

OK

Which of the following is an advantage of welded joints compared to bolted joints?

Click the correct answer.

- It is a semi-permanent connection method
- It more readily allows for component maintenance and replacement
- It is preferred when a permanent structure or a tight boiler joint is required
- It can be used with through holes and the appropriate nuts

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are advantages of welded joints compared to bolted joints?

Check all that apply.

- [ ] It is often the least expensive process
- [ ] It has the advantage of not requiring holes to be drilled in the parts being joined and therefore does not reduce their original strength
- [ ] It is a semi-permanent connection method
- [ ] It more readily allows for component maintenance and replacement
- [ ] It is preferred when a permanent structure or a tight boiler joint is required

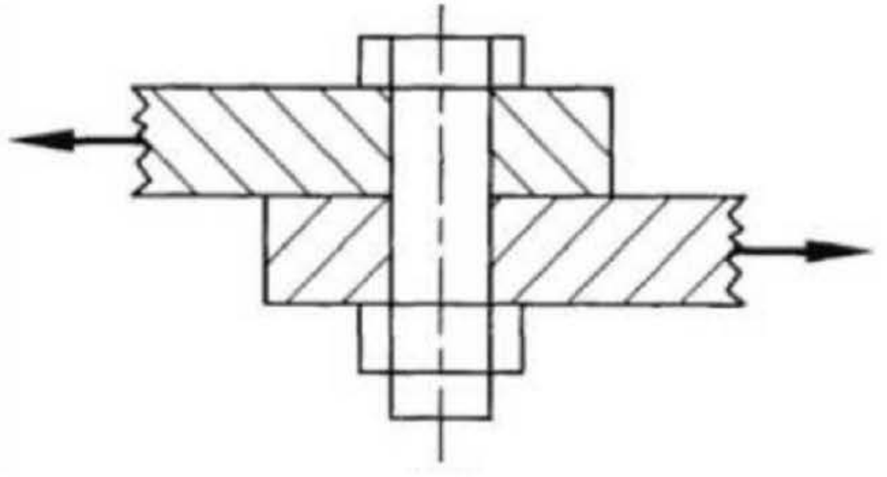
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

In this section we consider two types of bolted joints: lap joints and butt joints.

Lap joints

A **lap joint** is formed when two plates are lapped over one another and the bolt goes through both plates as in the figure below.



Lap joint

GIVE FEEDBACK

OK

Which type of joint is formed when two plates are lapped over one another and a bolt goes through both plates?

Click the correct answer.

- A lap joint
- A butt joint
- A welded joint
- A permanent joint

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A [ ] joint is formed when two plates are lapped over one another and the bolt goes through both plates.

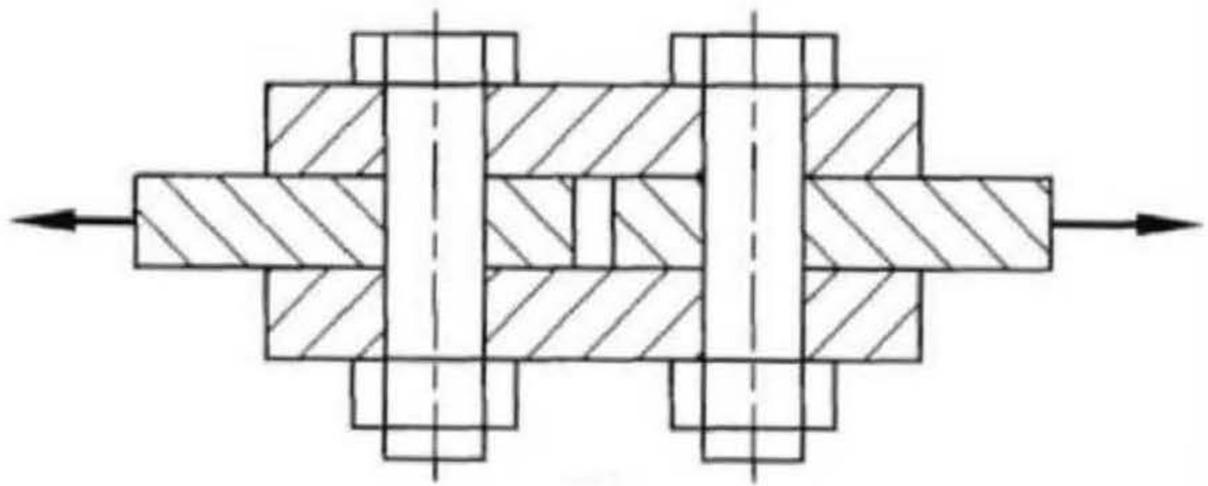
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

In this section we consider two types of bolted joints: lap joints and butt joints.

Butt joints

In a **butt joint**, the plates are placed edge to edge and the joint is made with the use of straps as shown in the figure below.



Butt joint

GIVE FEEDBACK

OK

Type your answer in the box.

In a [ ] joint, the plates are placed edge to edge and the bolted joint is made with the use of straps.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which type of joint is formed when plates are placed edge to edge and the joint is made with the use of straps?

Click the correct answer.

A lap joint

A butt joint

A welded joint

A permanent joint

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Common types of failure in bolted joints

There are single, double and multiple joints, according to whether there are one or more rows of bolts.

Our discussion will be limited to single-row joints only.

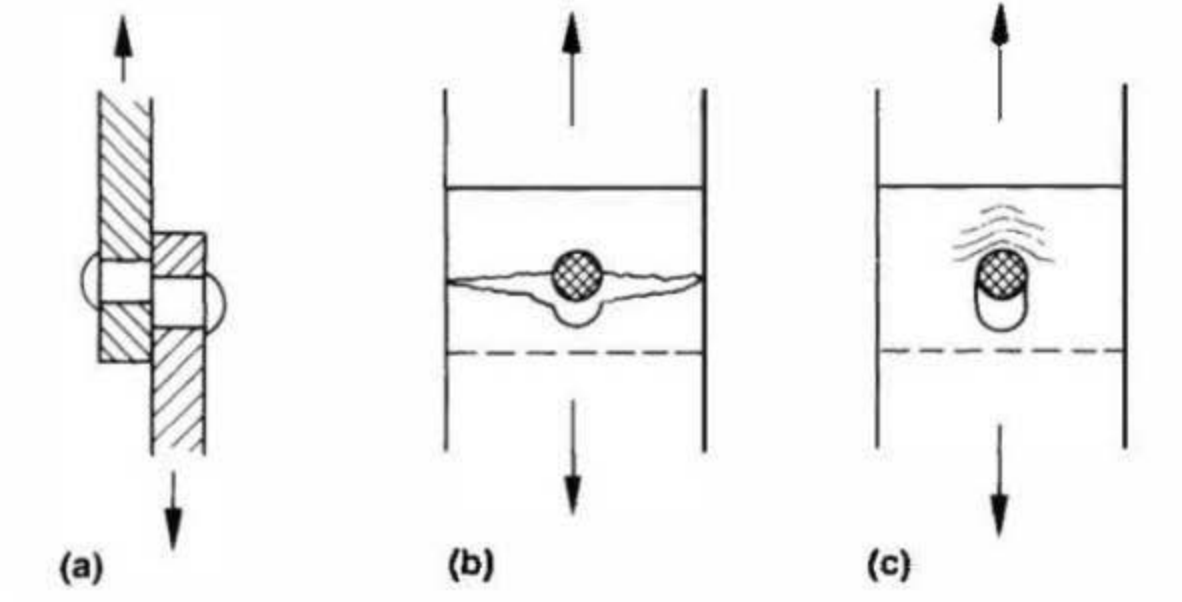
Scope	Bolted joint failure	Three failure modes

GIVE FEEDBACK

OK

Common types of failure in bolted joints

When a bolted joint is subjected to a force which is in excess of its strength, the joint will usually fail in one of three ways.



Scope	Bolted joint failure	Three failure modes

GIVE FEEDBACK

OK

Common types of failure in bolted joints

The shearing of the bolts in single or double shear (Figure a).

The tearing apart of the plate weakened by the presence of holes (Figure b).

The compression or crushing failure between the bolts and the plate (Figure c).

Other types of failure, e.g. bending of the bolts, are possible but less common and are not discussed in this resource.

Which of the following are typical modes of bolted joint failure?

Check all that apply.

- [ ] The shearing of the bolts in single or double shear
- [ ] The tearing apart of the plate weakened by the presence of holes
- [ ] The tearing apart of the bolts weakened by the presence of holes
- [ ] The compression or crushing failure between the bolts and the plate
- [ ] The compression or crushing failure of the bolts in shear

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

Three typical modes of bolted joint failure are:

The _____ of the bolts in single or double shear.

The _____ apart of the plate weakened by the presence of holes.

The _____ or crushing failure between the bolts and the plate.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculating the allowable stress of a bolted joint

The analysis of a bolted joint involves the calculation of each type of stress, i.e. in shear, tension (tearing) and compression (crushing), and then comparing these with allowable stresses for the materials used.

For the purposes of illustration in this chapter, we adopt the following typical values of allowable stress based on permissible stress recommended for structural joints in certain types of steel construction:

- Allowable stress in shear: 90 MPa
- Allowable stress in tension: 110 MPa
- Allowable stress in compression: 220 MPa

For materials other than typical steel, or for detailed design purposes, appropriate codes and handbooks should be consulted.

In calculations it is convenient to consider the allowable load per bolt calculated as the product of the area under stress and the corresponding value of the allowable stress.

Each joint must be checked separately with respect to shear, tearing and crushing, and the least allowable load resulting from these calculations can then be taken to be the allowable strength of the joint.

Type your answer in the box.

In calculations it is convenient to consider the allowable load per bolt calculated as the product of the area under [ ] and the corresponding value of the [ ] stress.

Each joint must be checked separately with respect to shear, tearing and crushing, and the [ ] allowable load resulting from these calculations can then be taken to be the allowable strength of the joint.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the types of allowable stress with the correct typical value.

Drag statements on the right to match the left.

Allowable stress in shear	90 MPa
Allowable stress in tension	110 MPa
Allowable stress in compression	220 MPa

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate the allowable strength of the bolted joint

A simple lap joint is composed of two steel straps, 40 mm wide × 8 mm thick, held together by a single bolt 16 mm in diameter.

Calculate the allowable strength of the joint.

Example	Bolt strength in shear	Strength of straps in tension (tearing)	Bearing strength	Conclusion

GIVE FEEDBACK

OK

Calculate the allowable strength of the bolted joint

The area in single shear:

$$A_s = \frac{\pi D^2}{4}$$
$$= \frac{\pi (16)^2}{4}$$
$$= 201.1 \text{ mm}^2$$

Allowable shear stress:

$$\sigma_s = 90 \text{ MPa}$$

Allowable load in shear:

$$A_s \times \sigma_s = 201.1 \times 90$$
$$= 18{,}100 \text{ N}$$
$$= 18.1 \text{ kN}$$

Calculate the allowable strength of the bolted joint

Net area of the plate subjected to tearing:

$$\begin{aligned} A_1 &= \text{net width} \times \text{thickness} \\ &= (40 - 16)\ \text{mm} \times 8\ \text{mm} \\ &= 192\ \text{mm}^2 \end{aligned}$$

Allowable stress:

$$\sigma_t = 110\ \text{MPa}$$

Allowable load in tension:

$$\begin{aligned} A_t \times \sigma_t &= 192 \times 110 \\ &= 21{,}120\ \text{N} \\ &= 21.1\ \text{kN} \end{aligned}$$

Example	Bolt strength in shear	Strength of straps in tension (tearing)	Bearing strength	Conclusion

Calculate the allowable strength of the bolted joint

The projected area of the bolt subjected to crushing:

$$\begin{aligned} A_c &= \text{plate thickness} \times \text{bolt diameter} \\ &= 8\ \text{mm} \times 16\ \text{mm} \\ &= 128\ \text{mm}^2 \end{aligned}$$

Allowable compressive stress:

$$\sigma_c = 220\ \text{MPa}$$

Allowable bearing load:

$$\begin{aligned} A_c \times \sigma_c &= 128 \times 220 \\ &= 28{,}160\ \text{N} \\ &= 28.2\ \text{kN} \end{aligned}$$

Calculate the allowable strength of the bolted joint

The joint can only be as strong as its weakest element, in this case the bolt in shear.

Therefore the allowable load on the bolt represents the strength of the joint.

$$\therefore \text{Strength of joint} = 18.1\ \text{kN}$$

Example	Bolt strength in shear	Strength of straps in tension (tearing)	Bearing strength	Conclusion

GIVE FEEDBACK

OK

Type your answer in the box.

A simple lap joint is composed of two steel straps, 20 mm wide by 4 mm thick, held together by a single bolt 12 mm in diameter.

The allowable load in shear is _____ kN (correct to two decimal places).

The allowable load in tension is _____ kN (correct to two decimal places).

The allowable bearing load is _____ kN (correct to two decimal places).

The joint can only be as strong as its weakest element. Therefore the strength of the joint is _____ kN (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A simple lap joint is composed of two steel straps, 25 mm wide by 6 mm thick, held together by a single bolt 10 mm in diameter.

The allowable load in shear is _____ kN (correct to two decimal places).

The allowable load in tension is _____ kN (correct to two decimal places).

The allowable bearing load is _____ kN (correct to two decimal places).

The joint can only be as strong as its weakest element. Therefore the strength of the joint is _____ kN (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Joint efficiency of a bolted joint

The strength of a bolted joint is always somewhat less than that of the unpunched parent metal.

If the strength of the joint is compared with the original strength of the unpunched plate, the efficiency of the joint can be calculated.

$$\text{Joint efficiency} = \frac{\text{strength of joint}}{\text{strength of unpunched plate}}$$

GIVE FEEDBACK

OK

Type your answer in the box.

Joint efficiency = strength of [ ] / strength of [ ] plate.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct definition for joint efficiency?

Click the correct answer.

$$\text{Joint efficiency} = \frac{\text{strength of joint}}{\text{strength of unpunched plate}}$$

$$\text{Joint efficiency} = \frac{\text{strength of unpunched plate}}{\text{strength of joint}}$$

$$\text{Joint efficiency} = (\text{strength of joint}) \cdot (\text{strength of unpunched plate})$$

$$\text{Joint efficiency} = (\text{strength of joint}) + (\text{strength of unpunched plate})$$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate the efficiency of the bolted joint

A simple lap joint is composed of two steel straps, 40 mm wide × 8 mm thick, held together by a single bolt 16 mm in diameter.

The allowable strength of the joint is 18.1 kN.

Determine the efficiency of the joint.

Example	Strength of the unpunched plate	Efficiency of the joint	Discussion

GIVE FEEDBACK

OK

Calculate the efficiency of the bolted joint

The cross-sectional area of the unpunched plate in tension is:

$$40\ \text{mm} \times 8\ \text{mm} = 320\ \text{mm}^2$$

Therefore the strength of the unpunched plate, using 110 MPa for the allowable stress in tension, is:

$$\begin{aligned} \sigma \times A &= 110\ \text{MPa} \times 320\ \text{mm}^2 \\ &= 35{,}200\ \text{N} \\ &= 35.2\ \text{kN} \end{aligned}$$

Example	Strength of the unpunched plate	Efficiency of the joint	Discussion

Calculate the efficiency of the bolted joint

The strength of the joint is 18.1 kN.

Therefore the efficiency of the joint is:

$$\text{Efficiency} = \frac{18.1\ \text{kN}}{35.2\ \text{kN}}$$
$$= 0.514$$
$$= 51.4\%$$

Calculate the efficiency of the bolted joint

In a continuous joint bolts are usually equally spaced or form a pattern which repeats itself along the length of the joint.

In such a case a section equal in length to a repeating section is used as a unit for calculations.

Example	Strength of the unpunched plate	Efficiency of the joint	Discussion

GIVE FEEDBACK

OK

Type your answer in the box.

A simple lap joint is composed of two steel straps, 40 mm wide by 8 mm thick, held together by a single bolt.

The strength of the unpunched plate is _____ kN (correct to two decimal places).

If the strength of the joint is 19.36 kN, the joint efficiency is _____ %.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A simple lap joint is composed of two steel straps, 25 mm wide by 6 mm thick, held together by a single bolt 10 mm in diameter.

The strength of the unpunched plate is _____ kN (correct to two decimal places).

If the strength of the joint is 7.07 kN, the joint efficiency is _____ % (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The process of welding

Welding is a manufacturing process for the permanent joining of metal parts by fusion.

The most common method of joining is achieved by striking an electric arc between a rod of similar metal and the pieces to be joined, metal being melted from the electrode into the joint.

As a method of construction, welding is widely used in structural work and for repair and fabrication of boilers, pressure vessels and heavy machinery.

GIVE FEEDBACK

OK

Type your answer in the box.

Welding is a manufacturing process for the permanent joining of metal parts by _____.

The most common method of joining is achieved by striking an electric arc between a rod of similar metal and the pieces to be joined, metal being melted from the _____ into the joint.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are correct statements about welding?

Check all that apply.

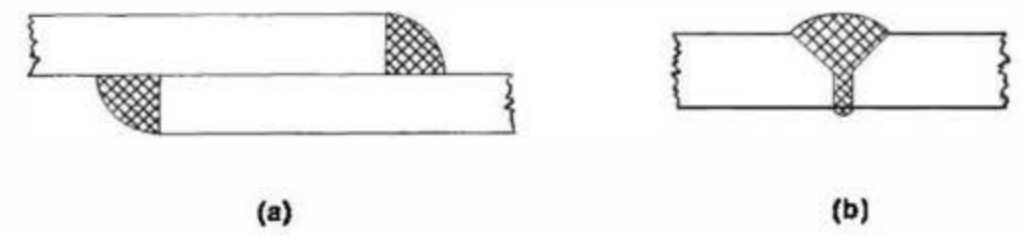
- [ ] It is a manufacturing process for the permanent joining of metal parts by fusion
- [ ] It is achieved by striking an electric arc between a rod of similar metal and the pieces to be joined, metal being melted from the electrode into the joint
- [ ] It is a manufacturing process for the semi-permanent joining of metal parts
- [ ] It is widely used as a method of construction in structural work and for repair and fabrication of boilers, pressure vessels and heavy machinery
- [ ] It is achieved by striking an electric arc between two rods of similar metal, the metal being melted from the electrode into the joint

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Common types of welds

The two types of welds most frequently used are **fillet welds** and **butt welds**, illustrated in the figures below.



(a) Double-fillet lap joint (b) Butt weld joint

GIVE FEEDBACK

OK

Type your answer in the box.

The two types of welds most frequently used are _____ welds and _____ welds.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are frequently used types of welds?

Check all that apply.

- [ ] Fillet
- [ ] Butt
- [ ] Radius
- [ ] Lap
- [ ] Compound

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

For our purposes we regard the strength of a butt weld as equal to that of the plates joined.

Butt welds

The plates for butt welds may be unbevelled for thin plates or bevelled on one or both sides. They are most frequently used for manufacturing boiler shells, air receivers, etc., and are usually subjected to tension and compression, not to shear.

The thickness of the weld is at least equal to the thickness of the plates joined and its strength is thought of in relation to the strength of the plate.

Tests show that good butt welds have about the same strength as the plates being joined.

In practice it is safe to assume an efficiency of the joint of approximately 90 per cent.

A butt weld

GIVE FEEDBACK

OK

Type your answer in the box.

Good _____ welds have about the same _____ as the plates being joined.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct statement about butt welds?

Click the correct answer.

- Good butt welds have about the same strength as the plates being joined
- Butt welds have about half of the strength of the plates being joined
- Butt welds typically have a joint efficiency below 60%
- The plates for butt welds must be bevelled on both sides

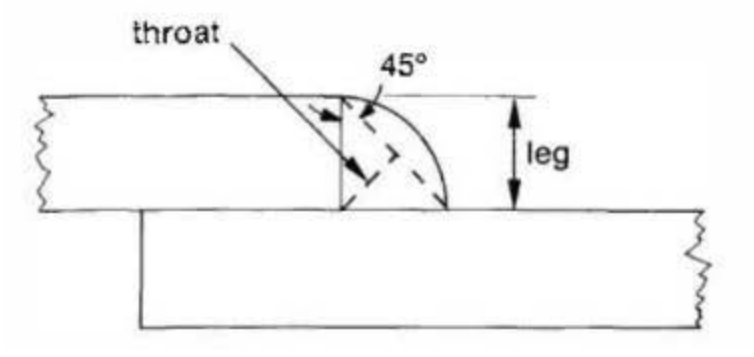
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Fillet welds

A standard full fillet weld has a section of an isosceles right triangle, as shown in the figure below, with the legs of the triangle equal to the thickness of the plate.

The size of the weld is its leg length and the throat is 0.707 times that length. In a fillet weld the throat is the critical dimension.



Standard full fillet weld

GIVE FEEDBACK

OK

Type your answer in the box.

In a fillet weld the _____ is the critical dimension.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What is the throat in a fillet weld equal to?

Click the correct answer.

- 0.707 times the weld leg length
- The weld leg length
- The nominal size of the weld
- 0.707 times the nominal thickness of the weld

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculating the strength of a fillet weld

It is common practice to take one-third of the nominal tensile strength of the electrode used as the permissible working stress, i.e. allowable stress, in fillet welds, and to refer it to the area based on the length of weld and thickness of the throat.

The strength of the fillet weld is therefore given by the following equation.

$$F = \sigma l t = 0.707 \sigma l s$$

where:
F is the maximum allowable load on the weld
σ is the allowable stress
l is the length of the weld
s is the nominal size of the weld
t is the throat thickness

Stress distribution within the weld may be a complex combination of shear, tension and sometimes bending.

However, for many practical purposes, it can be assumed that stress in the weld is uniformly distributed shearing stress.

GIVE FEEDBACK

OK

Match each of the symbols from the equation $F = \sigma l t = 0.707 \sigma l s$ with the correct description.

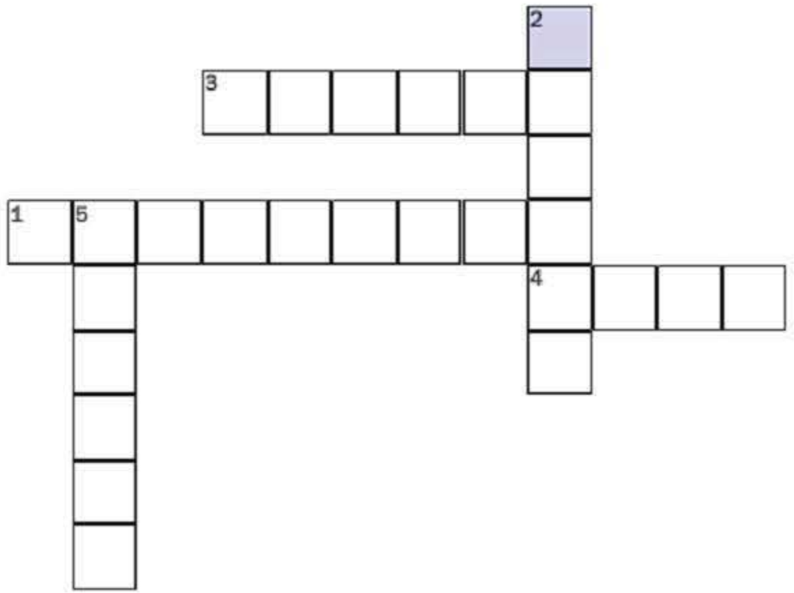
Drag statements on the right to match the left.

F	The maximum allowable load on the weld
σ	The allowable stress
l	The length of the weld
t	The throat thickness
s	The nominal size of the weld

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Loads on fillet welds



Complete the crossword for the equation $F = \sigma l\, t = 0.707\, \sigma l\, s$.

1) F refers to the maximum _____ load.

2) σ refers to the allowable _____.

3) t refers to the _____ thickness.

4) s refers to the nominal _____ of the weld.

5) l refers to the _____ of the weld.

Done | Hint | Challenge

Calculate the throat thickness of a given welded joint

Example

For a fillet weld of 8 mm in nominal size and electrode strength of 410 MPa, determine the throat thickness.

GIVE FEEDBACK

CONTINUE >

Calculate the throat thickness of a given welded joint

Example

For a fillet weld of 8 mm in nominal size and electrode strength of 410 MPa, determine the throat thickness.

Solution

$$\begin{aligned}\text{Throat thickness} &= 0.707\,s \\ &= 0.707 \times 8\ \text{mm} \\ &= 5.66\ \text{mm}\end{aligned}$$

< BACK GIVE FEEDBACK OK

Type your answer in the box.

For a fillet weld of 9 mm in nominal size, the throat thickness is _____ mm (answer correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

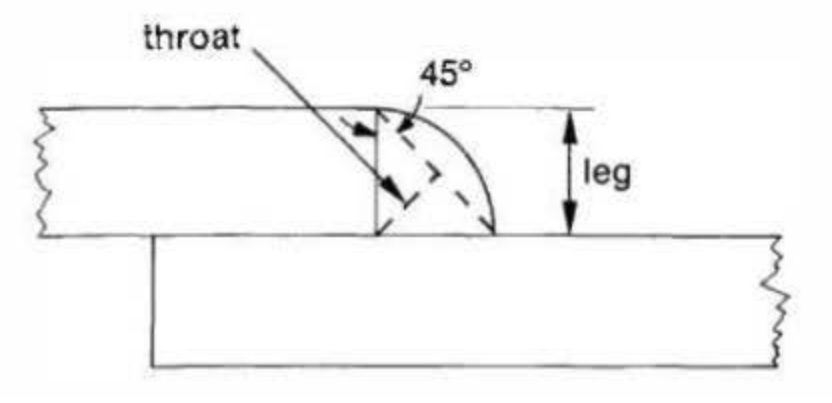
For a fillet weld of 7 mm in nominal size, the throat thickness is _____ mm (answer correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate the allowable stress for a given welded joint

For a fillet weld of 8 mm in nominal size and electrode strength of 410 MPa, determine the allowable stress.



Example	Allowable stress

GIVE FEEDBACK

OK

Calculate the allowable stress for a given welded joint

The allowable stress is based on one-third of the nominal tensile strength of the electrode:

$$\sigma = \frac{410}{3}$$
$$= 136.7 \text{ MPa}$$

Example | Allowable stress

GIVE FEEDBACK

OK

Type your answer in the box.

For a fillet weld with an electrode strength of 390 MPa, the allowable stress is _____ MPa.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

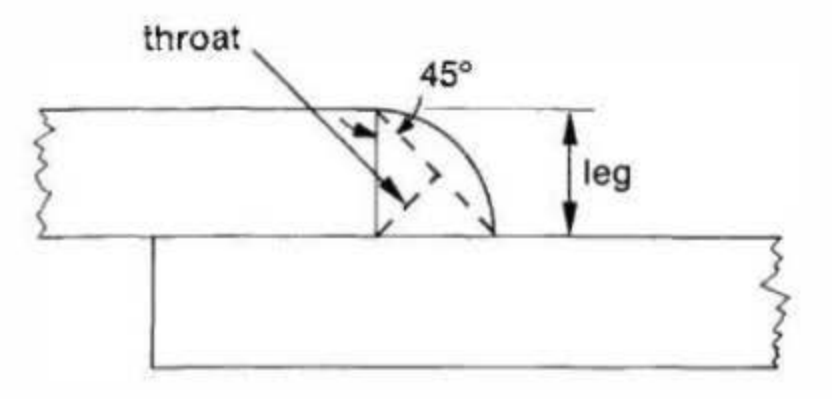
For a fillet weld with an electrode strength of 450 MPa, the allowable stress is _____ MPa.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate the allowable load per millimetre of length for a given welded joint

For a fillet weld of 8 mm in nominal size and electrode strength of 410 MPa, determine the allowable load per millimetre of length.



Example	Throat thickness	Allowable stress	Allowable load per millimetre of length

GIVE FEEDBACK

OK

Calculate the allowable load per millimetre of length for a given welded joint

$$\begin{aligned}\text{Throat thickness} &= 0.707\,s \\ &= 0.707 \times 8\ \text{mm} \\ &= 5.66\ \text{mm}\end{aligned}$$

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length

GIVE FEEDBACK

OK

Calculate the allowable load per millimetre of length for a given welded joint

The allowable stress is based on one-third of the nominal tensile strength of the electrode:

$$\sigma = \frac{410}{3}$$
$$= 136.7 \text{ MPa}$$

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length

GIVE FEEDBACK

OK

Calculate the allowable load per millimetre of length for a given welded joint

$$\text{Allowable load per millimetre} = \frac{F}{l}$$
$$= \sigma t$$
$$= (136.7\ \text{MPa})(5.66\ \text{mm})$$
$$= 773\ \text{N/mm}$$

Note that if stress is expressed in megapascals and linear dimensions are expressed in millimetres, force will be in newtons.

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length

GIVE FEEDBACK

OK

Type your answer in the box.

For a fillet weld with an allowable stress of 130 MPa and a throat thickness of 4.95 mm, the allowable load per millimetre of length is _____ N/mm (answer correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

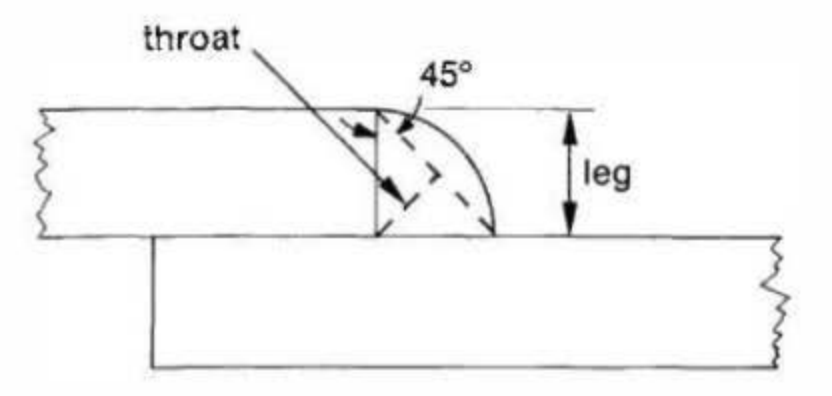
For a fillet weld with an allowable stress of 150 MPa and a throat thickness of 6.36 mm, the allowable load per millimetre of length is _____ N/mm.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Determine the required length of weld for a specified strength

For a fillet weld of 8 mm in nominal size and electrode strength of 410 MPa, determine the length of weld required to carry a load of 52.6 kN.



Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

Determine the required length of weld for a specified strength

$$\begin{aligned}\text{Throat thickness} &= 0.707\,s \\ &= 0.707 \times 8\ \text{mm} \\ &= 5.66\ \text{mm}\end{aligned}$$

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

Determine the required length of weld for a specified strength

The allowable stress is based on one-third of the nominal tensile strength of the electrode:

$$\sigma = \frac{410}{3}$$
$$= 136.7 \text{ MPa}$$

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

Determine the required length of weld for a specified strength

$$\text{Allowable load per millimetre} = \frac{F}{l}$$
$$= \sigma t$$
$$= (136.7\ \text{MPa})(5.66\ \text{mm})$$
$$= 773\ \text{N/mm}$$

Note that if stress is expressed in megapascals and linear dimensions are expressed in millimetres, force will be in newtons.

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

Determine the required length of weld for a specified strength

Length of weld:

$$l = \frac{F}{\sigma t}$$
$$= \frac{52{,}600}{136.7 \times 5.66}$$
$$= 68 \text{ mm}$$

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

Determine the required length of weld for a specified strength

It is customary to add an allowance for end-craters, i.e. for starting and stopping, equal to about twice the nominal weld size.

Therefore the required length of weld specified in the previous example would be:

$$68\ \text{mm} + 2 \times 8\ \text{mm} = 84\ \text{mm}$$

We will omit this allowance and simply regard the computed answers, e.g. 68 mm in the above example, as representing the effective length of weld required in each particular case.

Example	Throat thickness	Allowable stress	Allowable load per millimetre of length	Required length of weld	Discussion

GIVE FEEDBACK

OK

A fillet weld of 6 mm in nominal size has an electrode strength of 360 MPa.

SMALL | MEDIUM | LARGE

Type your answer in the box.

1. For this fillet weld the throat thickness is _____ mm (answer correct to two decimal places).

2. For this fillet weld the allowable stress is _____ MPa.

3. For this fillet weld the allowable load per millimetre of length is _____ N/mm (use the answer to 1. above to perform the calculation and answer correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A fillet weld of 6 mm in nominal size has an electrode strength of 360 MPa.

SMALL MEDIUM LARGE

Type your answer in the box.

The length of weld required to carry a load of 50 kN is _____ mm (answer correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

1. For this fillet weld the throat thickness is _____ mm (answer correct to two decimal places.

2. For this fillet weld the allowable stress is _____ MPa (answer correct to two decimal places).

3. For this fillet weld the allowable load per millimetre of length is _____ N/mm (answer correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A fillet weld of 9.5 mm in nominal size has an electrode strength of 385 MPa.

SMALL MEDIUM LARGE

Type your answer in the box.

1. For this fillet weld the throat thickness is _____ mm (answer correct to two decimal places.

2. For this fillet weld the allowable stress is _____ MPa (answer correct to two decimal places).

3. For this fillet weld the allowable load per millimetre of length is _____ N/mm (answer correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A fillet weld of 9.5 mm in nominal size has an electrode strength of 385 MPa.

SMALL MEDIUM LARGE

Type your answer in the box.

The length of weld required to carry a load of 36 kN is _____ mm (answer correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A clearer understanding of this concept can be obtained by considering an example.

The effect of load eccentricity on weld design

Eccentricity of welded joints is a common problem in structural design (e.g. when non-symmetrical members, such as structural angles, are welded to gusset plates).

The lack of symmetry introduces a complication to the analysis of the welded joints because the load is not shared equally between the welds.

The total load is presumed to act along the centroidal axis, while the required resistances offered by the welds are inversely proportional to their individual distances from the axis, determined by the summation of moments.

GIVE FEEDBACK

OK

Which of the following statements regarding eccentricity of welded joints are true?

Check all that apply.

- [ ] It is a common problem in structural design
- [ ] It occurs when non-symmetrical members are welded to gusset plates
- [ ] It occurs when symmetrical members are welded to gusset plates
- [ ] It rarely occurs in structural design
- [ ] Its effect is usually negligible

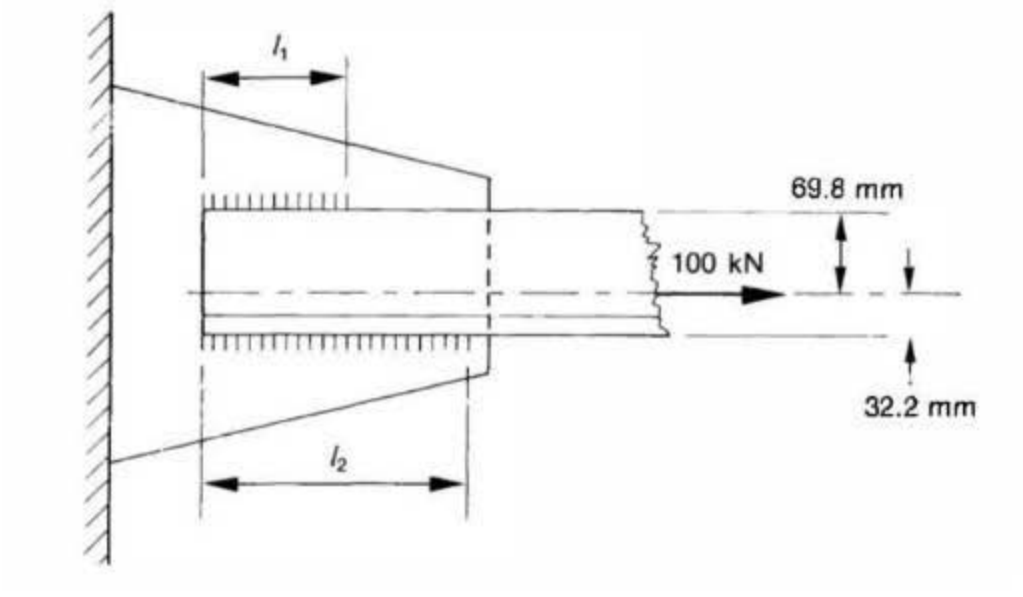
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate the required strength of a given welded joint

A structural steel angle is to be welded to a gusset plate as shown in the figure.

Calculate the required strength of the welds to withstand a load of 100 kN.



Example	Required weld resistance

GIVE FEEDBACK

OK

The required resistance at the toe of the angle is found by taking moments about the heel of the angle:

$$F_1 = \frac{100{,}000\ \text{N} \times 32.2\ \text{mm}}{102\ \text{mm}}$$
$$= 31{,}570\ \text{N}$$

The resistance of the weld at the heel is:

$$F_2 = 100{,}000\ \text{N} - 31{,}570\ \text{N}$$
$$= 68{,}430\ \text{N}$$

Example	Required weld resistance

Type your answer in the box.

A structural steel angle is to be welded to a gusset plate to withstand a load of 50 kN.

The weld at the toe of the angle is 75 mm from the centroidal axis.

The weld at the heel of the angle is 25 mm from the centroidal axis.

The required strength of the weld at the toe of the angle is _____ N.

The required strength of the weld at the heel of the angle is _____ N.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A structural steel angle is to be welded to a gusset plate to withstand a load of 27 kN.

The weld at the toe of the angle is 40 mm from the centroidal axis.

The weld at the heel of the angle is 20 mm from the centroidal axis.

The required strength of the weld at the toe of the angle is _____ N.

The required strength of the weld at the heel of the angle is _____ N.

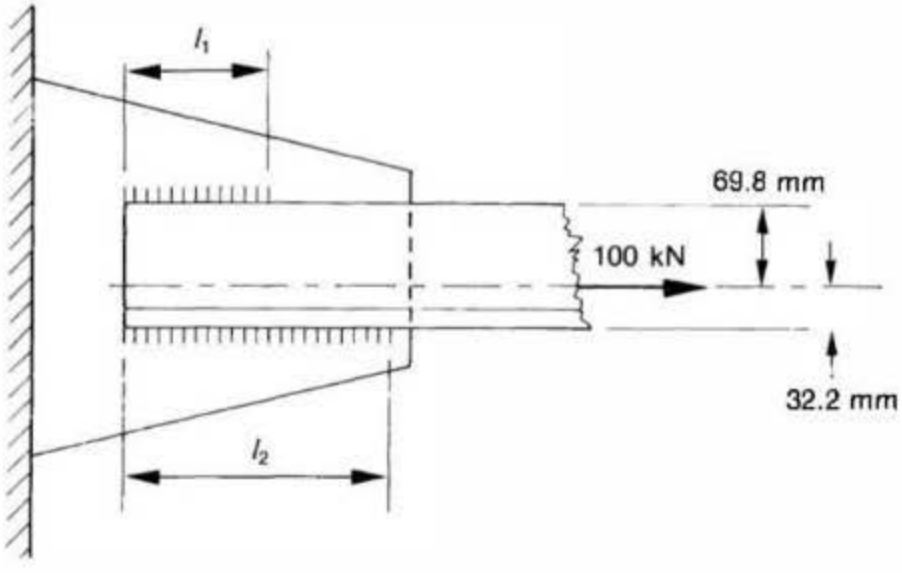
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Determine multiple lengths of weld for a specified strength

A structural steel angle is to be welded to a gusset plate as shown in the figure.

Determine the length of 8 mm weld required to withstand a load of 100 kN if the allowable stress is 136.7 MPa.



Example	Strength of weld per millimetre	Required weld resistance	Required weld length

GIVE FEEDBACK

OK

Determine multiple lengths of weld for a specified strength

Strength of weld per millimetre is:

$$\frac{F}{l} = 0.707\,\sigma s$$
$$= 0.707 \times 136.7 \times 8$$
$$= 773.2\ \text{N/mm}$$

Example	Strength of weld per millimetre	Required weld resistance	Required weld length

GIVE FEEDBACK

OK

Determine multiple lengths of weld for a specified strength

The required resistance at the toe of the angle is found by taking moments about the heel of the angle:

$$F_1 = \frac{100{,}000\ \text{N} \times 32.2\ \text{mm}}{102\ \text{mm}}$$
$$= 31{,}570\ \text{N}$$

The resistance of the weld at the heel is:

$$F_2 = 100{,}000\ \text{N} - 31{,}570\ \text{N}$$
$$= 68{,}430\ \text{N}$$

Example	Strength of weld per millimetre	Required weld resistance	Required weld length

GIVE FEEDBACK

OK

The corresponding lengths of weld required are:

$$l_1 = \frac{31{,}570\ \text{N}}{773.2\ \text{N/mm}}$$
$$= 40.8\ \text{mm}$$

$$l_2 = \frac{68{,}430\ \text{N}}{773.2\ \text{N/mm}}$$
$$= 88.5\ \text{mm}$$

Example	Strength of weld per millimetre	Required weld resistance	Required weld length

A structural steel angle is to be welded to a gusset plate to withstand a load of 36 kN. The allowable stress in the welds is 135 MPa.

The 9 mm weld at the toe of the angle is 40 mm from the centroidal axis.

The 9 mm weld at the heel of the angle is 20 mm from the centroidal axis.

SMALL MEDIUM LARGE

Type your answer in the box.

The required strength of the weld at the toe of the angle is _____ N.

The required strength of the weld at the heel of the angle is _____ N.

The strength of the weld per millimetre is _____ N/mm (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A structural steel angle is to be welded to a gusset plate to withstand a load of 36 kN. The allowable stress in the welds is 135 MPa.

The 9 mm weld at the toe of the angle is 40 mm from the centroidal axis.

The 9 mm weld at the heel of the angle is 20 mm from the centroidal axis.

SMALL MEDIUM LARGE

Type your answer in the box.

The required length of weld at the toe of the angle is _____ mm (correct to two decimal places).

The required length of weld at the heel of the angle is _____ mm (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A structural steel angle is to be welded to a gusset plate to withstand a load of 40 kN. The allowable stress in the welds is 120 MPa.

The 7 mm weld at the toe of the angle is 75 mm from the centroidal axis.

The 7 mm weld at the heel of the angle is 25 mm from the centroidal axis.

SMALL MEDIUM LARGE

Type your answer in the box.

The required strength of the weld at the toe of the angle is _____ N.

The required strength of the weld at the heel of the angle is _____ N.

The strength of the weld per millimetre is _____ N/mm (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A structural steel angle is to be welded to a gusset plate to withstand a load of 40 kN. The allowable stress in the welds is 120 MPa.

The 7 mm weld at the toe of the angle is 75 mm from the centroidal axis.

The 7 mm weld at the heel of the angle is 25 mm from the centroidal axis.

SMALL MEDIUM LARGE

Type your answer in the box.

The required length of weld at the toe of the angle is _____ mm (correct to two decimal places).

The required length of weld at the heel of the angle is _____ mm (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA