

Interpreting Metal Fab Drawings

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Cameren Duke Moran

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OPEN OREGON EDUCATIONAL RESOURCES



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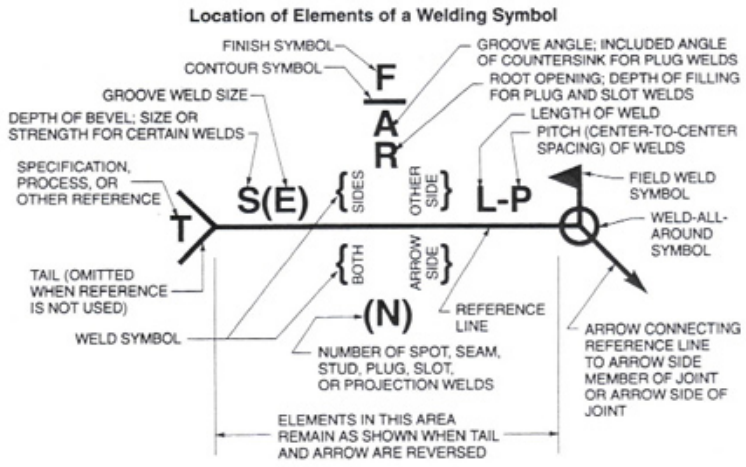
1. Interpreting metal fab drawings

Interpreting metal fab drawings is a course that introduces the principles of interpretation and application of industrial fabrication drawings. Basic principles and techniques of metal fabrication are introduced by planning and construction of fixtures used in fabrication from drawings. Basic tools and equipment for layout fitting of welded fabrications are utilized. Covers the use and application of the AWS welding symbols. This course will utilize blueprints and welding symbols and will apply them in classroom and in shop as practical assignments.

The largest reason for understanding this information is to communicate between all parties involved. This could include the welder, engineer, quality control, as well as many more. This is a universal language that provides clear instructions for a quality part.

American Welding Society has created a detailed publication (Standard Symbols for Welding, Brazing, and Nondestructive Examination AWS A2.4) that gives an extended amount of knowledge in this language.

Below is an overview of what the elements of a welding symbol may or may not include. The welding symbol provides a visualization for the welder or those involved to be able to apply the applicable weld to the work piece.



http://www.weldersuniverse.com/welding_symbols.html

2. Blue Print Review

Blue Print Reading Review

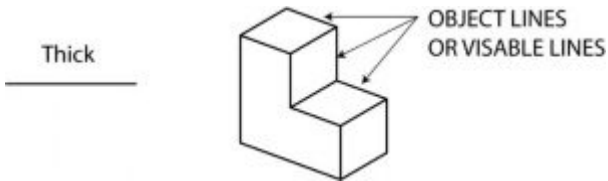
Understanding blue prints is a vital skill in the metals industry. Whether it be as a structural welder, pipe fitter, or quality control, this is the language that is universal for all individuals involved in a project.

This chapter is here to recap some line types as well as visualizing blue prints and plans.

Line Types

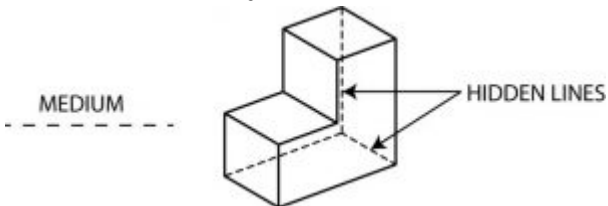
1. Object Line

A visible line is a thick line, without breaks, that indicates all edges and visible surfaces of an object. An object line may also be called a visible line.



2. Hidden Line

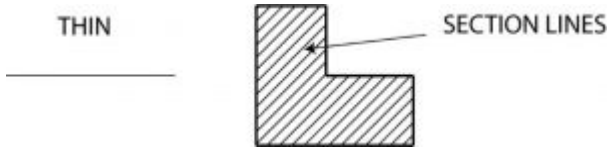
A hidden line is a medium weight line, made of short dashes, to show edges, surfaces and corners which cannot be seen. Sometimes they are used to make a drawing easier to understand. Often they are omitted.



3. Section Line

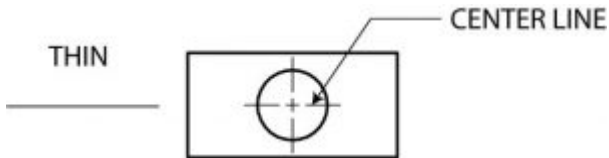
Section lines are used on a drawing to show how an object would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very

thin (size), and are usually drawn at an angle of 45 degrees. They show the cut surface of an object in a sectional view. Sections and section lines will be explained in BPR 7.



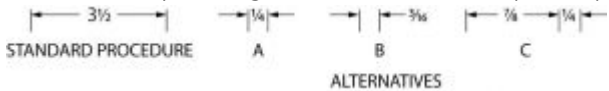
4. Center Line

Center lines are used to indicate the centers of holes, arcs, and symmetrical objects. They are very thin (size), long-short-long kinds of lines. (More detail needed?)



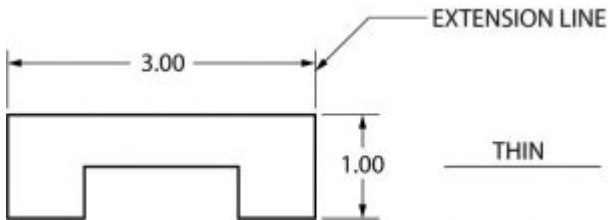
5. Dimension Line

Dimension lines are thin lines with a break for entering a measurement of some sort. The ends of the lines will also have an arrow head pointing to an extension line (below.)



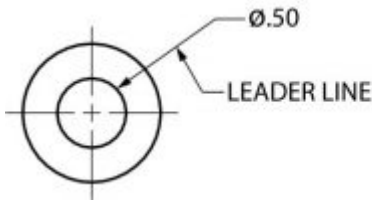
6. Extension Line

Extension lines are also thin lines, showing the limits of dimensions. Dimension line arrowheads touch extension lines.



7. Leader Line

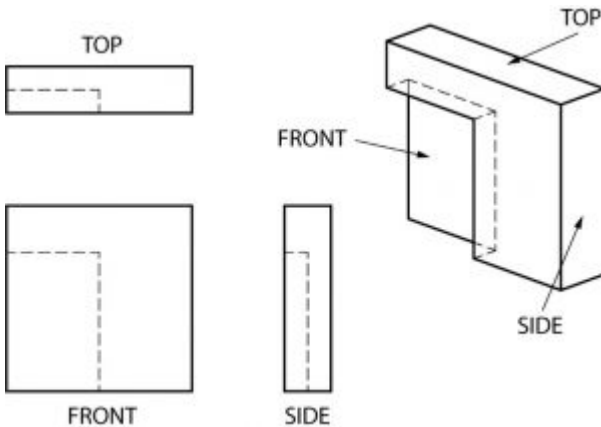
Leaders are more thin lines used to point to an area of a drawing requiring a note for explanation.



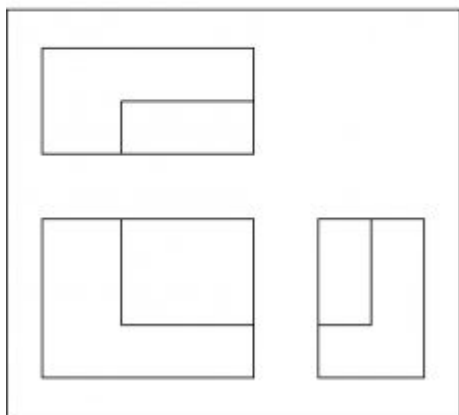
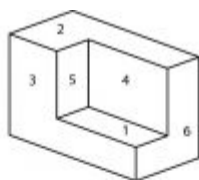
THIN

Visualizing parts

As a welder it is imperative that you can visualize the part you are building from the print. This is not always an easy task. Prints may have a variety of parts or are not detailed as well as they should be but being able to distinguish sides and faces can help decipher these harder prints.



Surface identification quiz



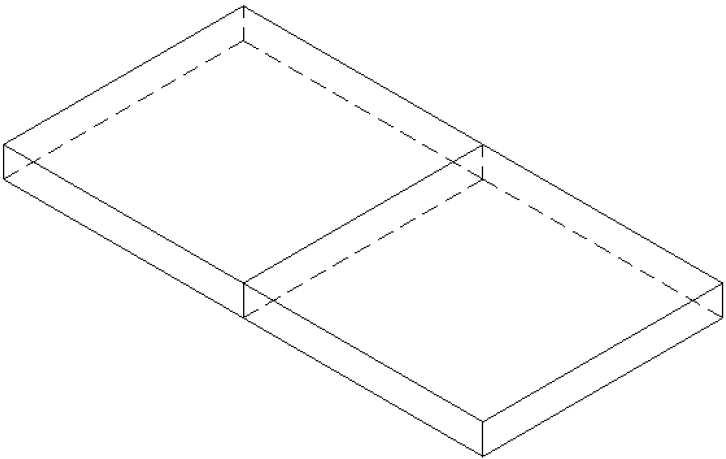
3. Joint types and Terminology

Terminology of joints may play a large role in communication with supervisors and others working on the same weldment. Understanding the concepts associated with joint design as well as identification of parts is critical for any metal worker.

Joint Types

There are 5 basic joint types used in the metal fabrication field:

Butt Joint: A joint type in which the butting ends of one or more work pieces are aligned in approximately the same plane. A butt joint has a possibility of many prepared faces. We will talk about these in subsequent chapters. Represented is a square groove butt joint.



Possible Welds for a Butt Joint:

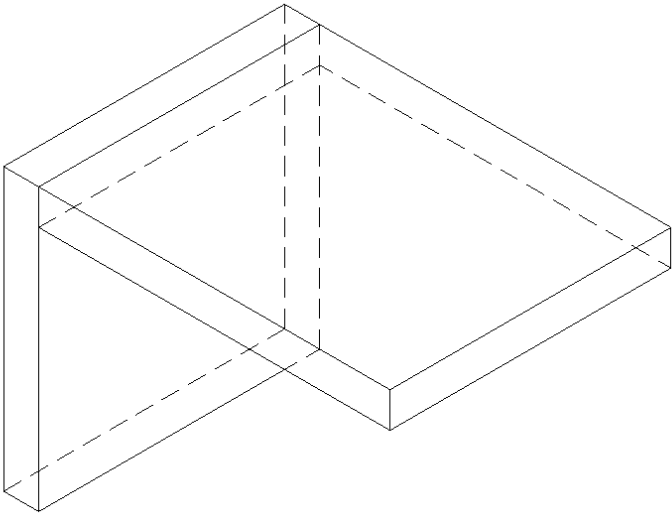
Square Groove

Bevel Groove

V Groove

- J Groove
- U Groove
- Flare Bevel Groove
- Flare Vee Groove
- Flanged Edge
- Scarf (Brazed Joint)

Corner Joint: being one of the most popular welds in the sheet metal industry the corner joint is used on the outer edge of the piece. This weld is a type of joint that comes together at right angles between two metal parts to form an L. These are common in the construction of boxes, box frames and similar fabrications. There are variations of a corner joint, shown is a closed corner joint.

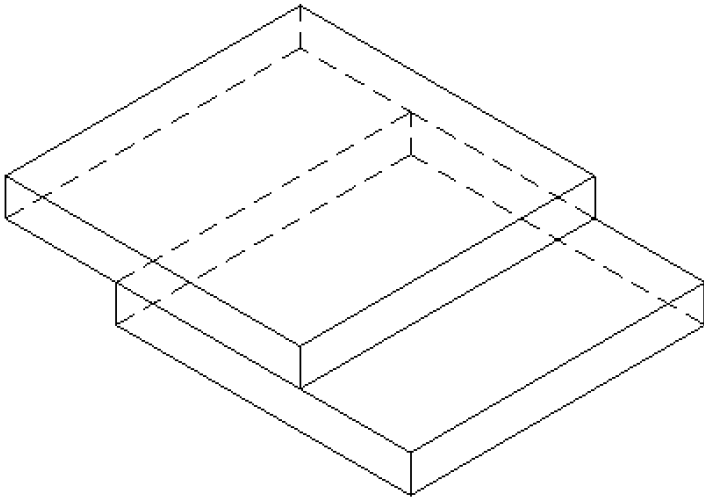


Possible welds for a corner joint:

- Fillet
- Edge Flange
- Corner Flange
- Bevel Groove
- V Groove Flare Bevel
- Flare V Groove

- J Groove
- U Groove
- Square Groove
- Seam
- Spot
- Projection
- Slot
- Plug

Lap Joint: A joint between two overlapping members in parallel planes.

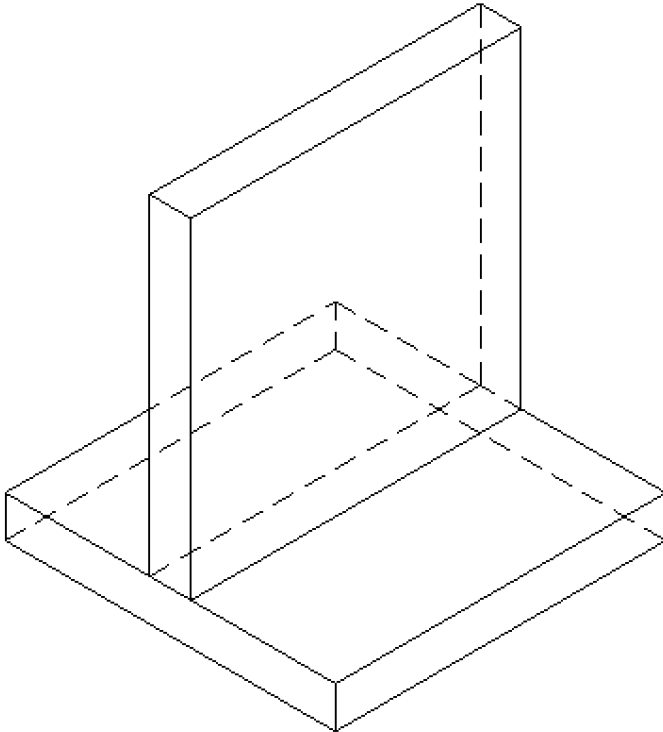


Possible welds for lap joint:

- Fillet
- Bevel Groove
- Square Groove
- Flare V groove
- J Groove
- Plug
- Slot
- Spot
- Projection
- Seam

*Brazed

Tee Joint: A joint which are two pieces of metal are perpendicular to each other. This is one of the most common joint that will be encountered in the metal fabrication industry.



Possible welds for a Tee joint:

Fillet

Bevel Groove

Square Groove

Flare V groove

J Groove

Plug

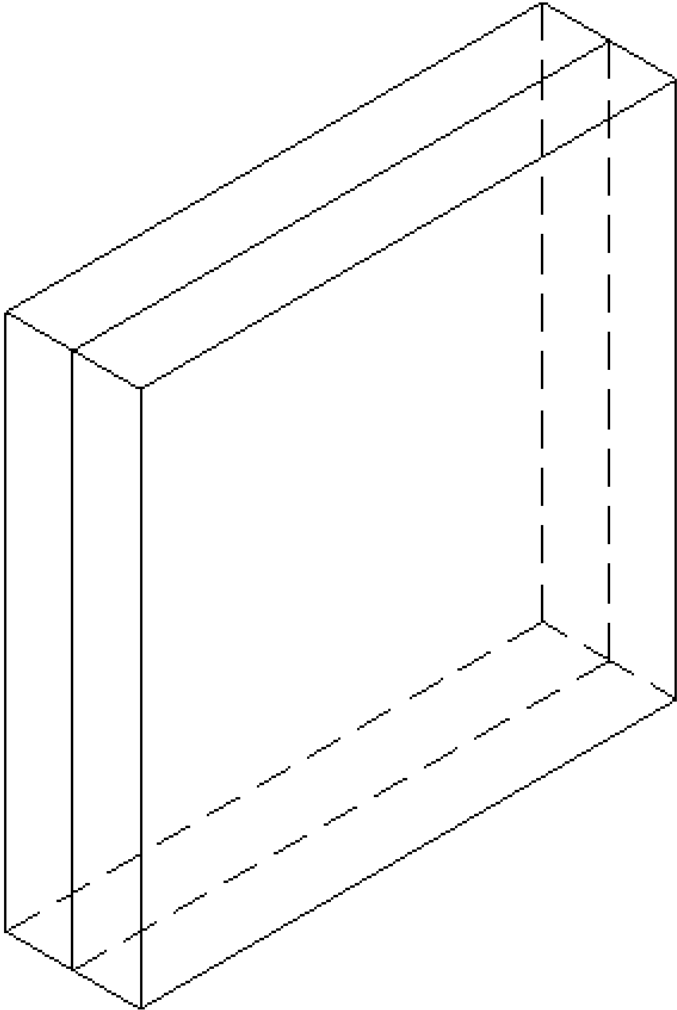
Slot

Spot

Projection

Seam

Edge Joint: A joint formed by uniting two edges or two surfaces (as by welding) especially making a corner.



Possible welds for edge joints:

Square Groove

Bevel Groove

V Groove

Edge
J Groove
U Groove
Flare Bevel Groove
Flare V Groove
Corner Flange
Edge Flange
Seam

Joints may be left as cut but some may have a prepared surface that is determined by the engineer, designer or welder. This is commonly seen with a Butt weld when the members to be joined are larger in thickness. This will be visited in subsequent chapters.

Joint terminology

Outside of specific joint types there are some terms that will play a role in deciding the correct procedure for welding or prepping the member(s) of a weldment.

Joint Root- This is the area which is in closest proximity to another member making the joint. This could be viewed as a line, area, or a point depending on the view in front of you.

Groove Face- The surface within the groove the weld may be applied to. This can be measured at an angle from the surface of the part to the root edge.

Root Edge- This is a root face that has no width (land) to it. In GTAW it is commonly referred to as a knife edge preparation.

Root Face- This part of the prepped member is the portion of the groove face that is also within the joint root. This is commonly called a flat or land in the industry. This is usually a predetermined size even though the size is not always called out. If you take the overall thickness of the member and subtract the groove depth you will be left with the root face depth.

Bevel Angle- an angle between the bevel of a member and a perpendicular plane in relation to the surface. This may be only equal to half of a groove angle if the opposite joining member

is also prepped. If only a single member is prepped this is also considered the groove angle.

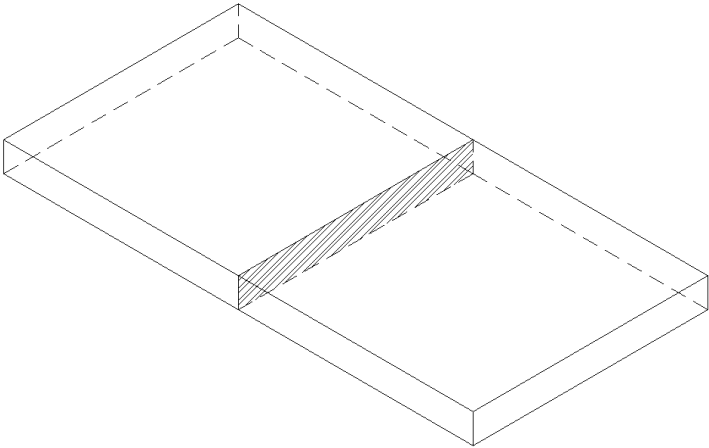
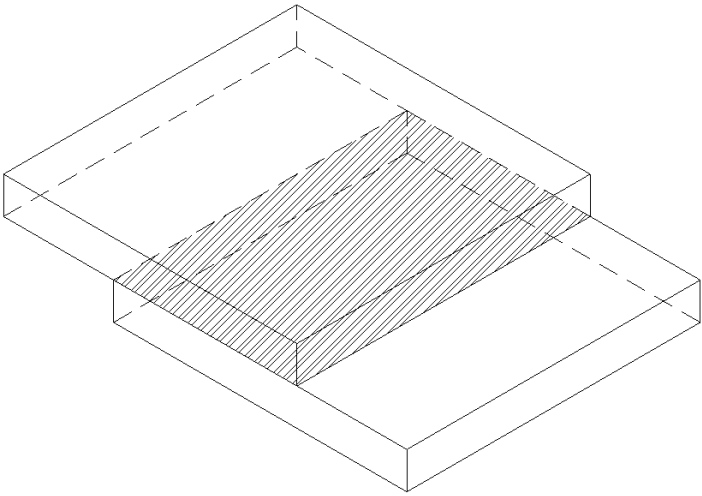
Depth of Bevel- the distance from the surface of the base metal to the root edge or beginning of the root face.

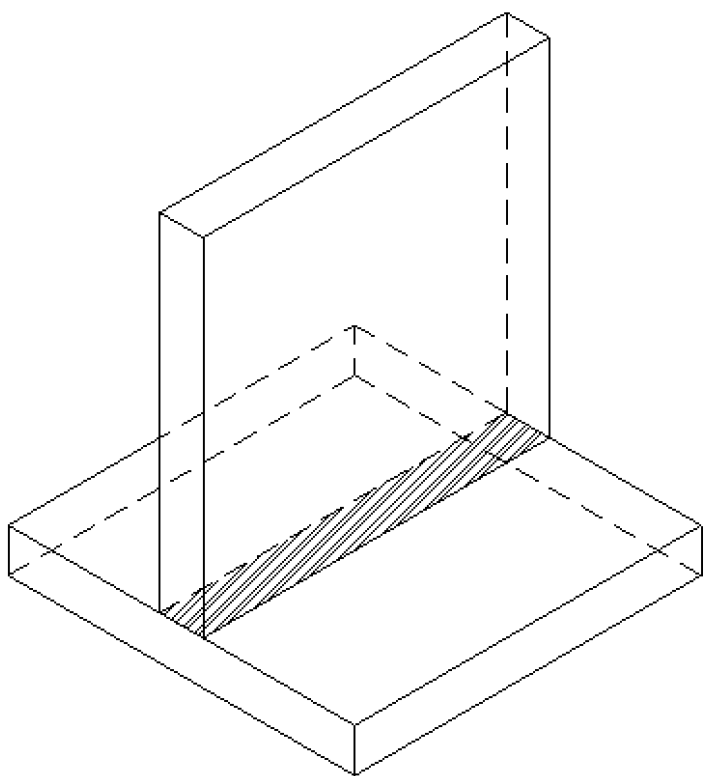
Groove Angle- an included angle of the groove between work pieces. If both members are prepared this angle is from groove face to groove face. This dimension is shown in degrees above or below the welding symbol depending on if it is arrow side or other side designation.

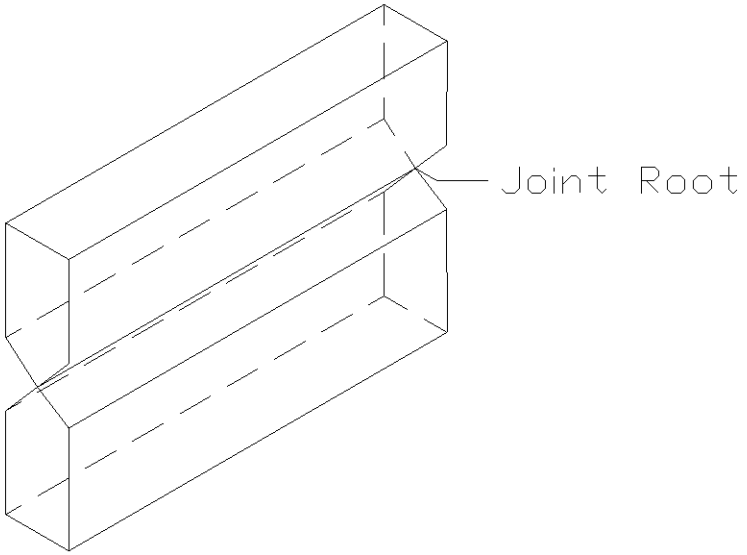
Groove Radius-This pertains specifically to J or U groove welds as these have a radius most commonly specific by machining.

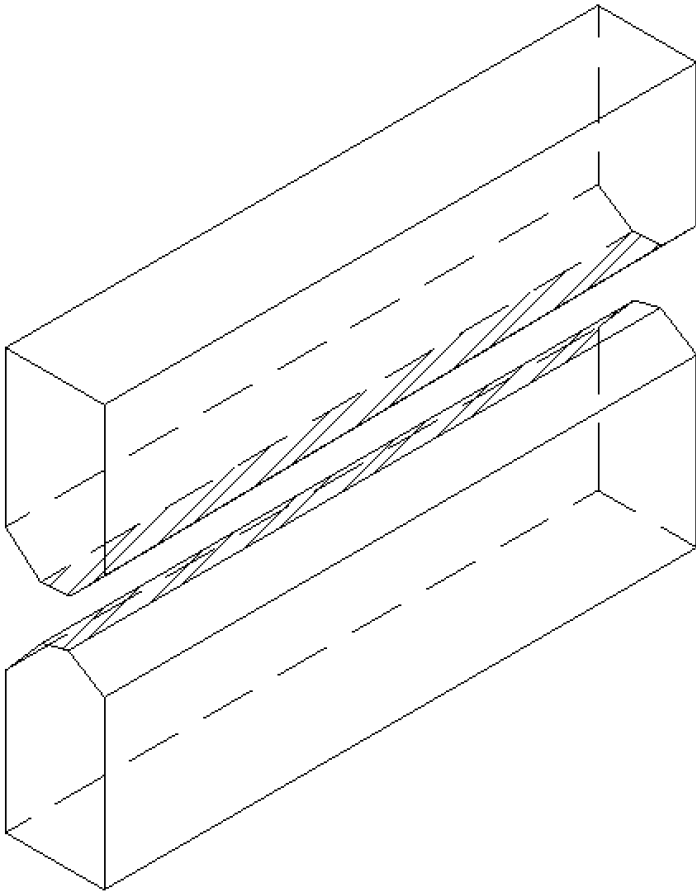
Root Opening- a gap between two joining members.

Joint Root Examples. Some may be shown with hatching.

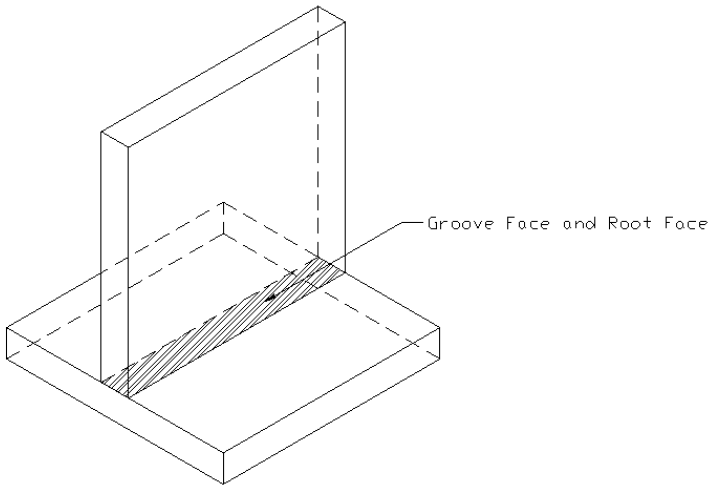
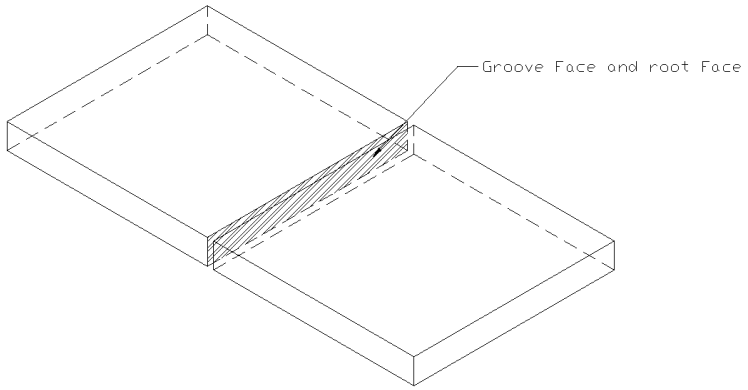


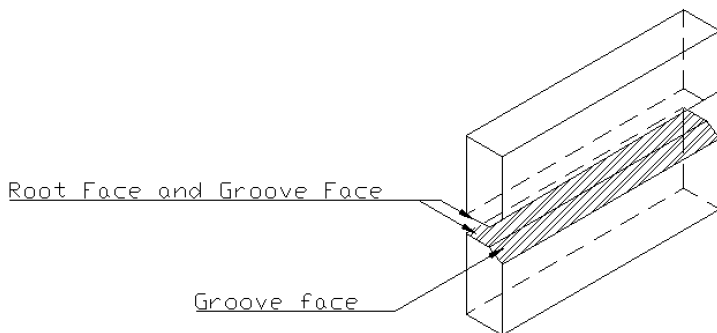
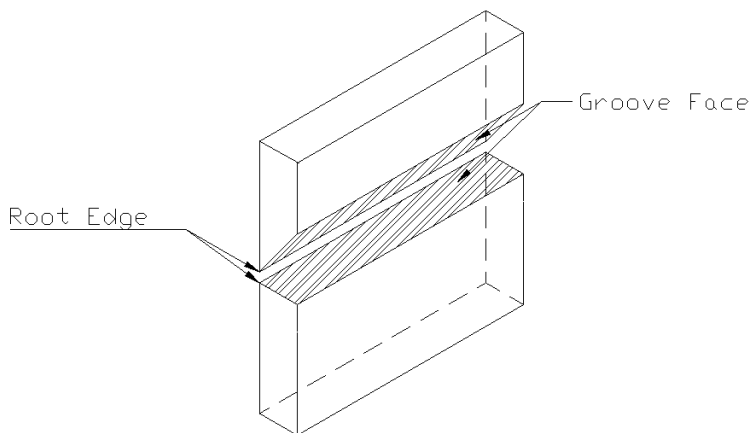




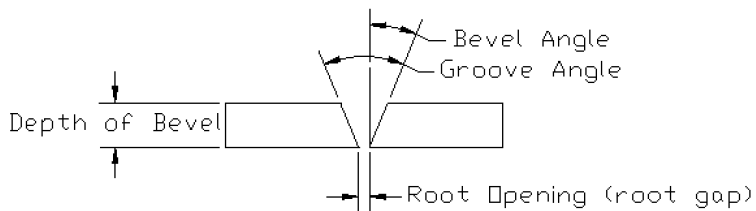


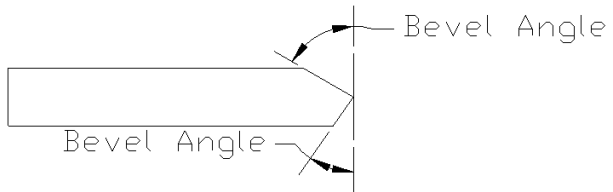
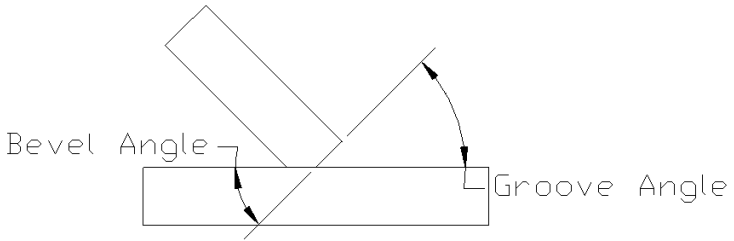
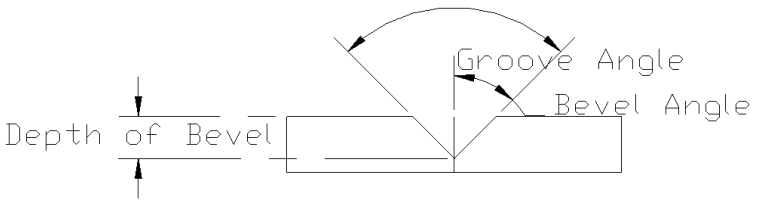
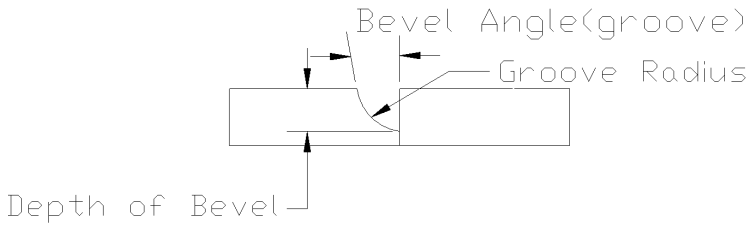
Groove Face, Root Edge, Root Face examples. Some are shown with or without hatching to better depict a visual.





Shown below are examples of bevel angle, groove angle, depth of bevel, groove radius, and root opening.





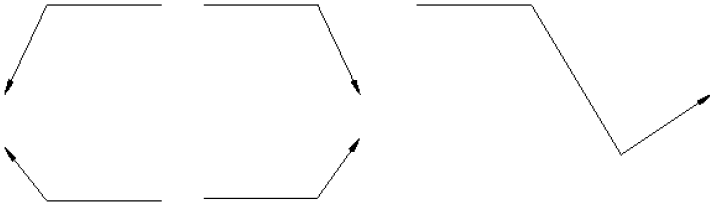
4. Basics of Welding Symbols

Understanding Weld vs. Welding symbol

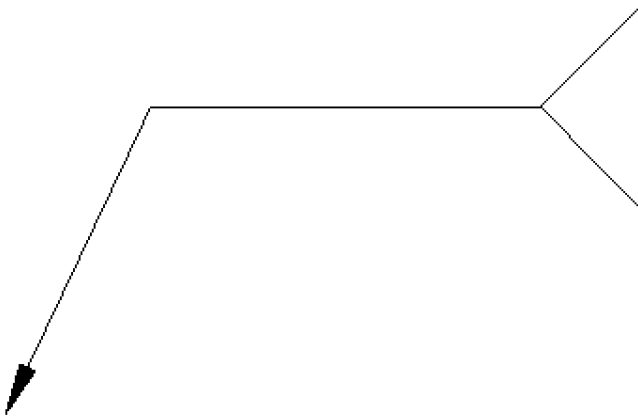
A weld symbol is not the same as a welding symbol. The weld symbol specifies the type of weld to be applied to a part. The welding symbol is made of several parts including the reference line, arrow, and weld symbol when required. The symbols in this book are a representation of what weld and welding symbols look like. There are specific design requirements when used in accordance to a blueprint.

Reference Line and Arrow

There are two parts that make up the main body of a welding symbol. These include the reference line and the arrow. The horizontal line that makes up the main body is called the reference line. This is the anchor to which all the other welding symbols are tied. The information that is pertinent for making the weld are placed on the reference line in specific places. The arrow connects the reference line to the joint in which the weld(s) is (are) to be made. There are several combinations of the reference line and arrow, but the reference line will always be placed in a horizontal position. This symbol is also always read from the left to the right. If you have been around blueprints the arrow may look a lot like a leader line. They are not the same thing so be mindful when reviewing welding symbols.

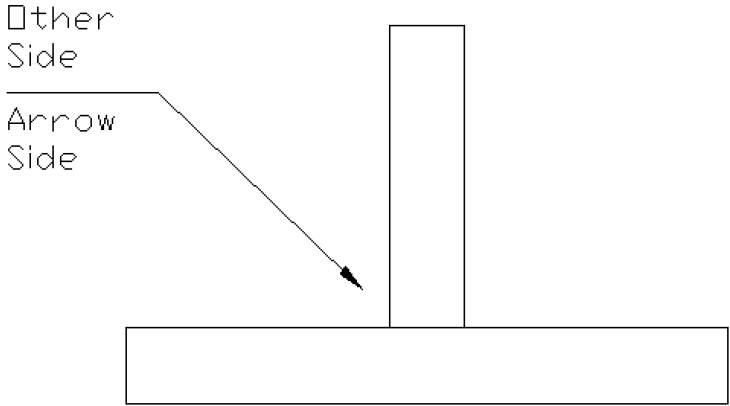


The reference line may include what is called the tail. This looks like the letter V turned sideways. Such as this >. This tail gives an area to write specifics about what weld process, welding procedure, and even material specifications are required for that specific welding symbol.

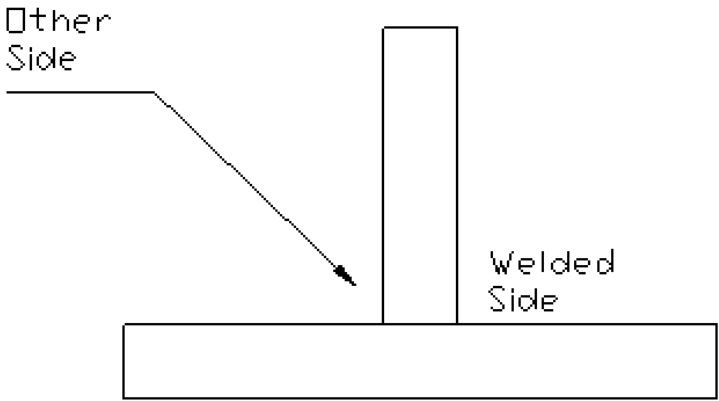


Arrow vs Other Side

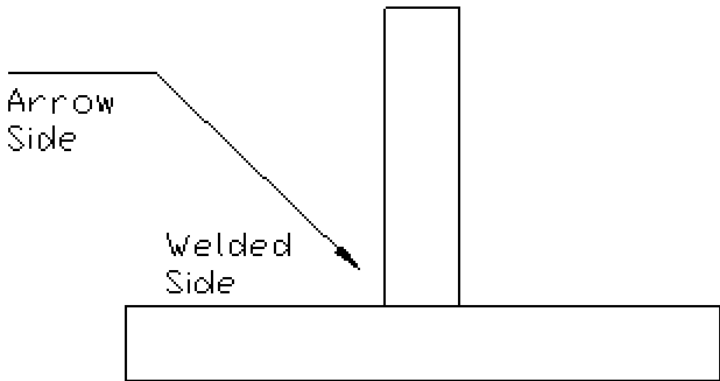
Placement of the weld will depend on placement of the symbol above or below the reference line. If the symbol has been placed above the reference line this is calling for the other side. If it is placed below the reference line this is calling for the arrow side. Other and arrow side define exactly what it is calling for. If the arrow is pointing to the right side of the joint the weld will be placed on the right side if an arrow side weld is called out. If the arrow is pointing at the right side of the joint and another side weld is called then the weld will be applied to the left side of the part.



If a weld is to be placed on the other side of a joint a symbol will be placed above the reference line.



If a weld is to be placed on the arrow side of a joint the symbol will be placed below the reference line.



It is very important to understand the difference of these two sides as it could finish a product or if done incorrectly send it back to be reworked in order to get the correct outcome. The concept behind this may seem very simple at the moment but as we work through this book and start adding more elements to the welding symbol it may become more taxing on the thought process. The most important thing to do is break it down piece by piece and truly understand what the symbol is asking/ requiring for the weld.

At times there may be multiple reference lines. If this is the case it is important to remember the order of which the welding is to occur. The reference line nearest the arrow will be the first operation, followed by the second, and so on until all operations are complete.

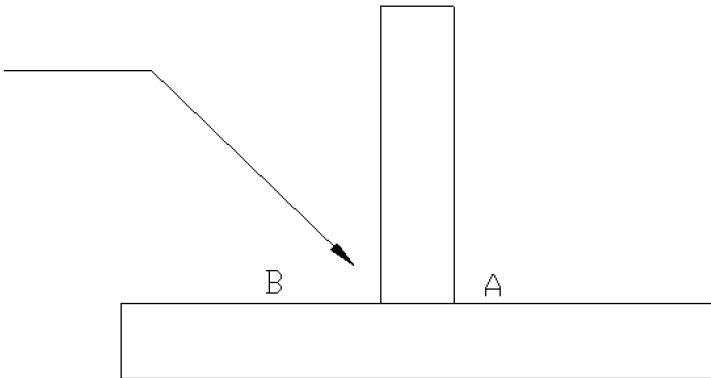
2nd operation

1st operation



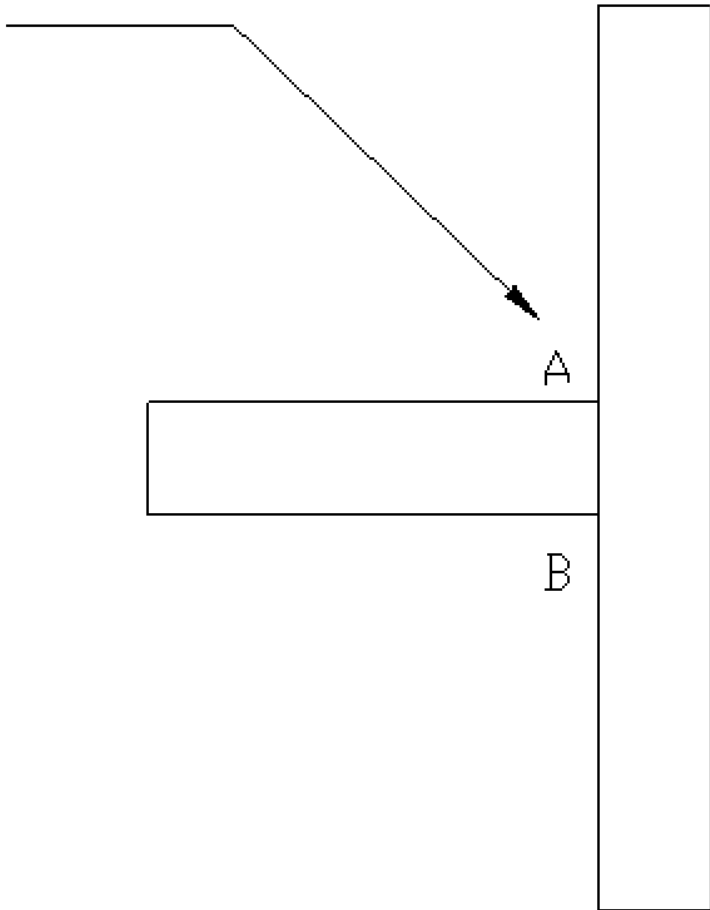
Symbol Fundamental Quiz

Label the image below with the appropriate letter (arrow/other) designation.



Letter _____ designates the Arrow side of the joint.

Letter _____ designates the Other side of the joint.

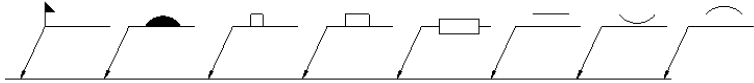


Letter _____ designates the Arrow side of the joint.

Letter _____ designates the Other side of the joint.

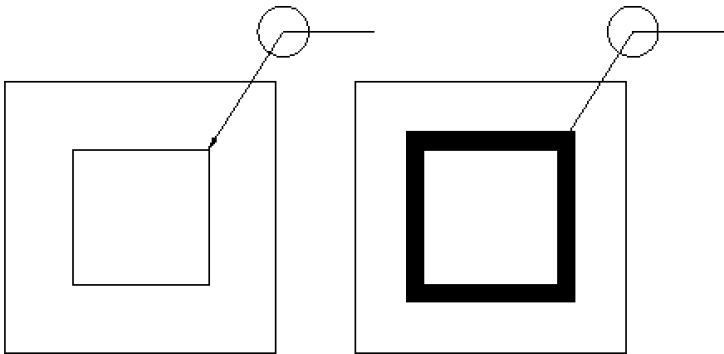
5. Supplementary Welding Symbols

These are symbols that are added onto a weld symbol to give further instruction or knowledge of the final product.



Weld all around

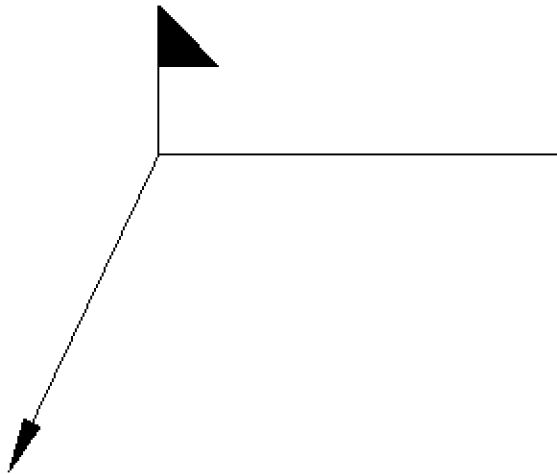
This symbol is simply a circle at the junction of the arrow and the reference line. This indicates that on a part that a weld could be completed around an entire joint. A common place you could see this is the junction of a square or round tube and a plate.



Field Weld

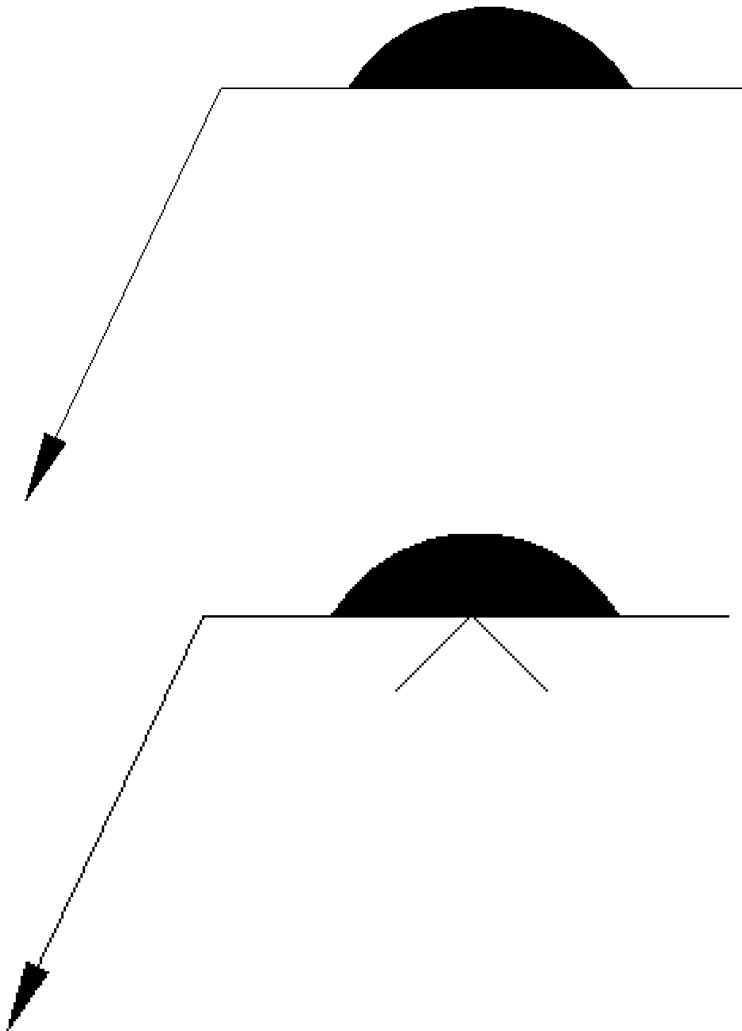
The symbol is a flag that will be at the junction of the arrow and reference line. This indicates that the part while may be assembled in a shop setting, its final welding procedures will be completed in the field during installation. The flag itself should point in the direction of the tail (end of reference line.)

It can also be placed above or below the reference line for an other or arrow side specification.



Melt Through

Melt through is most commonly associated with a groove weld. This is indicating you are achieving 100% penetration with a root reinforcement. This symbol can also be seen when sheet metal is being welded and there is an implied melt through in seams and joints.

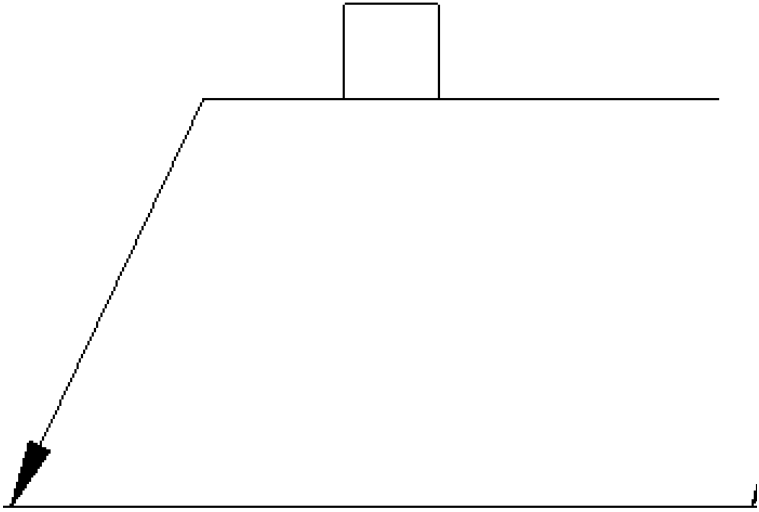


Melt through may include a finishing contour as well as finishing method as parts are often cleaned up before they are sent to be painted, powder coated, or put into service.

Consumable Insert

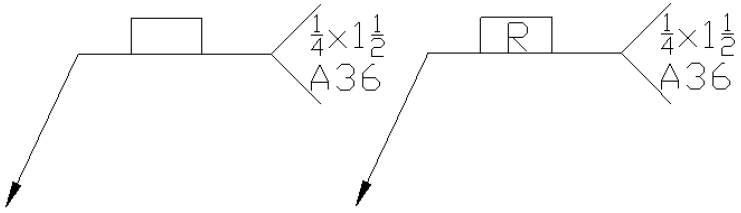
A consumable insert symbol is used when an insert is used within a welded joint that becomes part of the weld. These are

commonly specified in shape, size, and material. The symbol is placed on the opposite side of the groove weld symbol. The consumable insert class must be placed in the tail of the welding symbol. This class is defined by the American Welding Society.



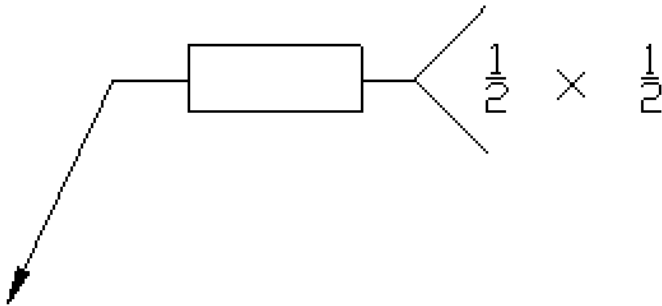
Backing

A backing strip is specified by placing a rectangle on the opposite side of the reference line from the groove weld symbol. If the backing must be removed after the welding operation has been finished, the letter R must be placed inside of the backing symbol. Material to be used as well as the dimensions must be placed in the tail of the symbol or somewhere on the drawing.



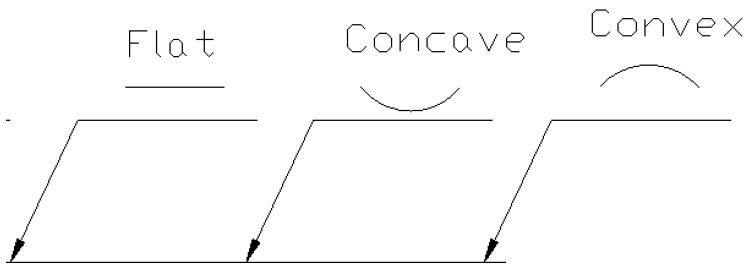
Spacer

A spacer may be used on a double groove weld. In this case both the top and bottom are prepped and a spacer is added to the middle of the groove. The symbol is a rectangle that breaks the reference line. A note on the print or in the tail can specify material and dimensions.



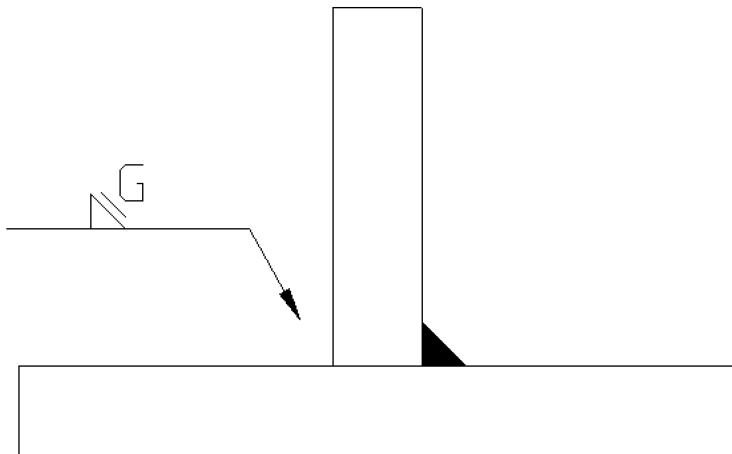
Weld contour

There are 3 symbols used for specifying the contour finish of a weld. This is the final appearance of a weld as it goes into service. These are commonly associated with fillet welds but sometimes will present themselves with groove welds. If a "flat" symbol is used with a groove weld it will then be called a flush contour rather than flat.



Contour symbols may also include yet another element which will show to the right of the fillet weld symbol above the contour. These are letter designations which will be for finishing methods.

- C- Chipping
- G- Grinding
- H- Hammering
- M- Machining
- P- Planishing
- R- Rolling
- U- Unspecified

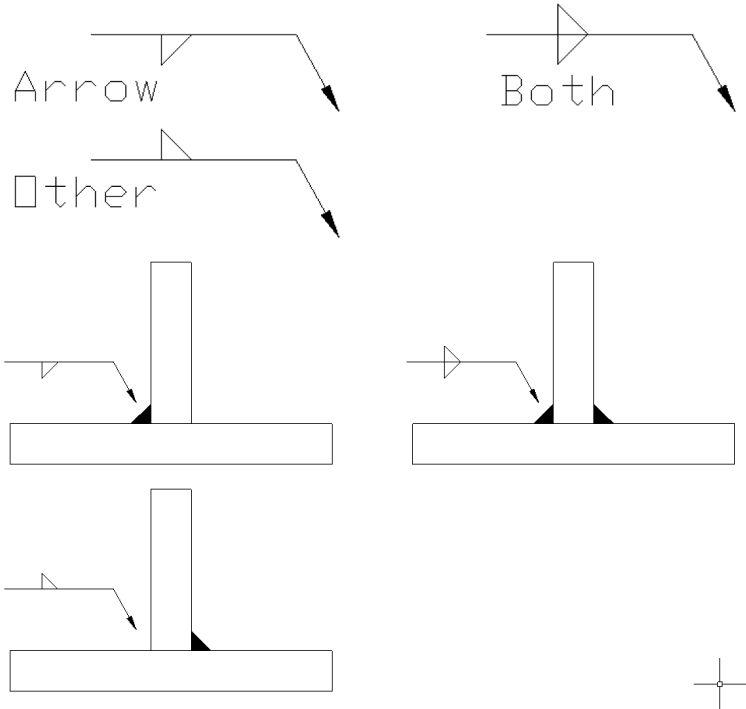


Shown is a fillet weld to be applied to the other side with a flat contour by grinding.

6. Fillet Weld Symbols

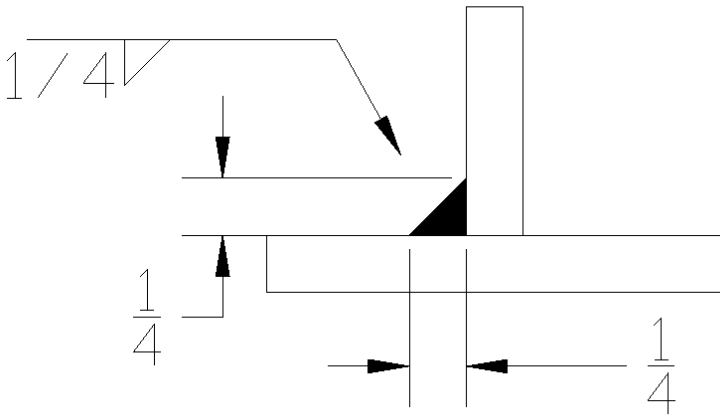
Fillet welds are one of the most common weld types in the industry. This weld is used when the joint has two members coming together to form an intersection of commonly 90 degrees. These welds can be applied on varying angles but this would be the most prominent.

A fillet weld symbol can be used with an arrow side (below reference line) other side (above reference line) significance or on both sides (both sides of the reference line.) When a fillet weld is required on both sides of the reference line it is called a double fillet weld. The vertical leg of the symbol will always be placed to the left regardless of which way the arrow is pointing.

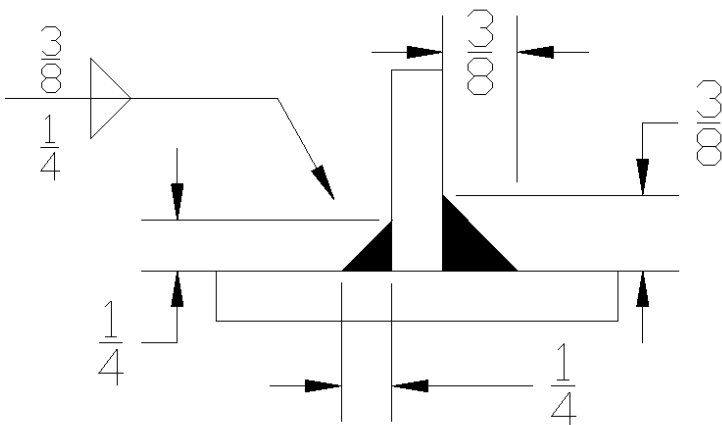


Fillet welds may have a size associated with them. This size

is called out on the left side of the symbol before the vertical side. The size is indicating the leg length of the weld. If a single size is called out this is specifying that weld should have equal leg sizes. If it is an equal leg fillet weld it is not common to dimension it on the print as shown below for demonstration purpose.

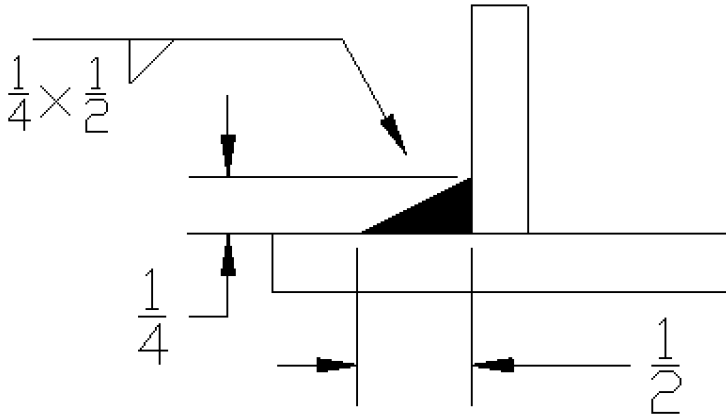


If a double fillet weld is called out the size will be shown for both sides of the joint, depending on the part these welds could vary in size so it is necessary to provide this information.

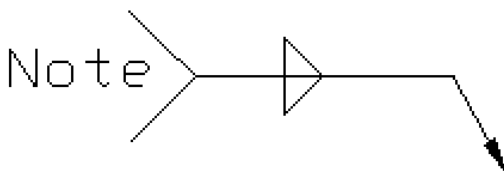


There are times when an unequal leg fillet weld is called

out. In this situation the part must be dimensioned in order to apply the correct leg size to the right member being welded. This may include only one of the two leg lengths. If there were no indication of which leg is which the part could be welded incorrectly.



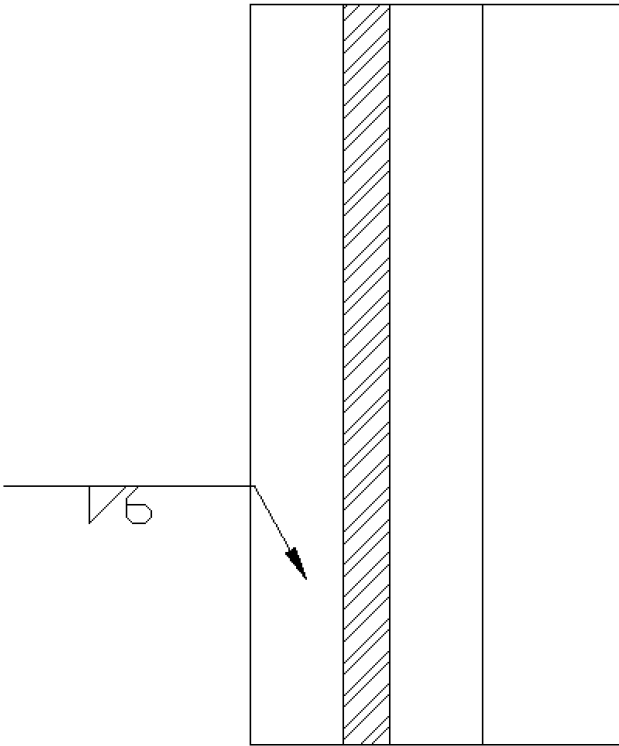
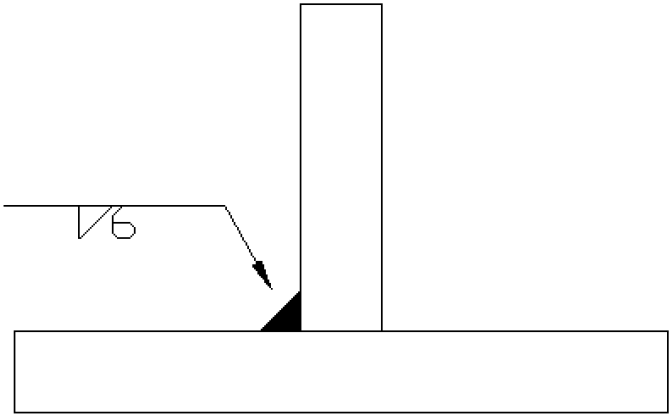
Sometimes fillet welds will not be shown with a size but will rather have a note in the tail of the symbol that gives required information for size. This is common when fillet welds will all be the same size.



Note: all fillet welds to be $\frac{1}{2}$ " in size.

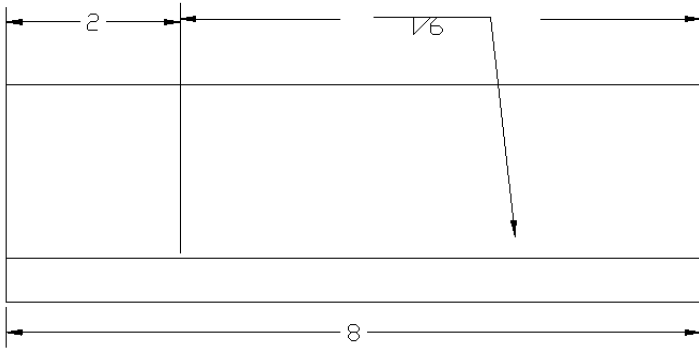
In the case of the length of a weld, this may or may not have a dimension associated with it. If the weld does not have a

dimension the weld will be the continuous length of the joint. Whether the part is 2" or 60" long if it has no dimension the weld will run the length of the joint. A weld may be applied only to a specific length of a joint. This must be shown in the weld symbol to communicate the information between individuals. The weld length will be provided on the right side of the fillet weld symbol.

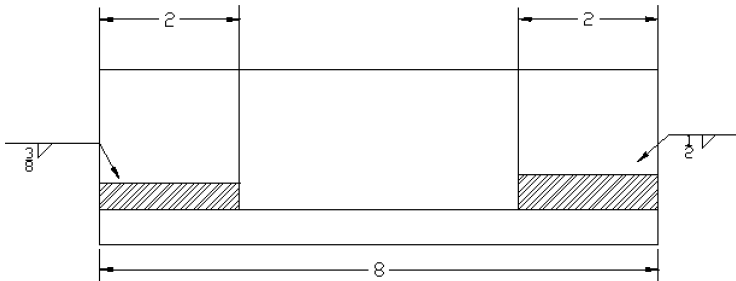


This shows a 6" fillet weld to be applied to the arrow side.

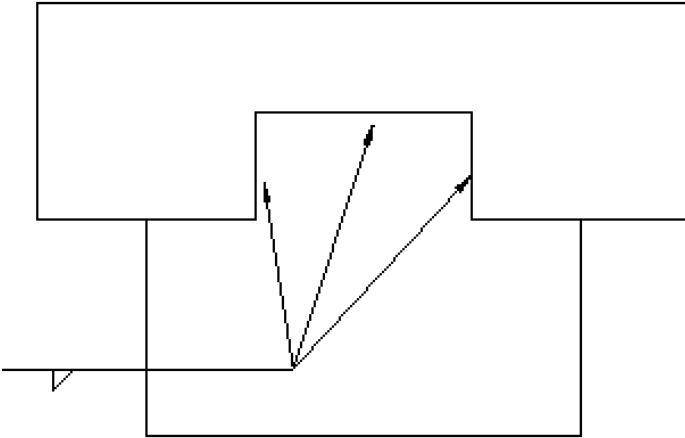
There may be times where a length is given on a part and the location of the weld will be given with a dimension in order to achieve the correct location.



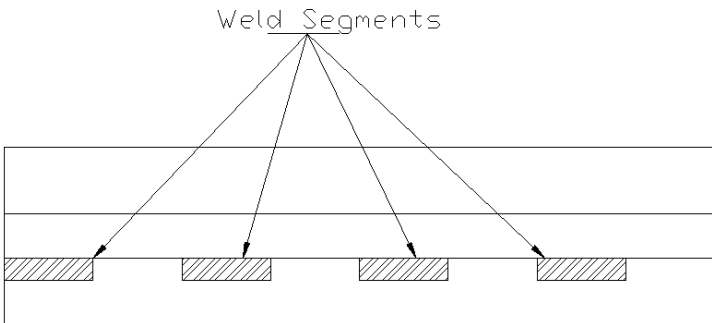
Hatching lines may be used to indicate the length of a weld instead of using a dimension on the weld symbol itself.



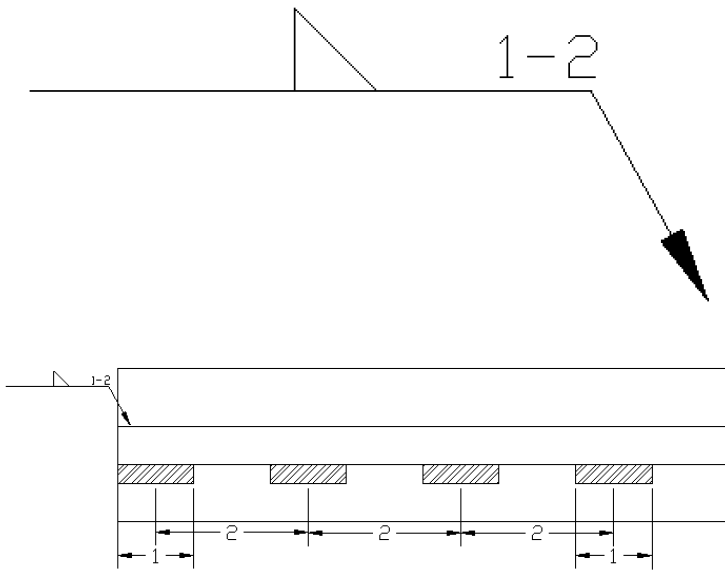
There are instances when a weld may change direction because of part geometry. If this happens it will be called out using multiple arrows off of one reference line.



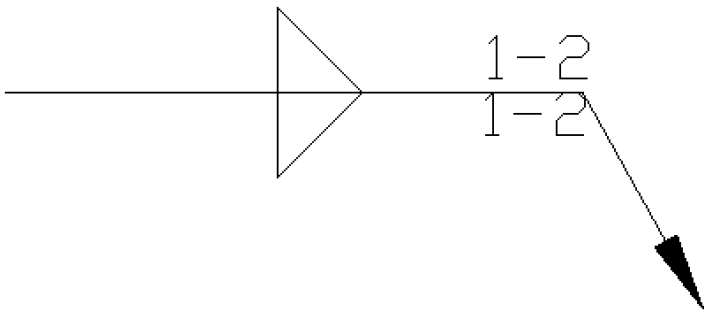
When a weld is not required to be continuous it is common to apply an intermittent weld. This means that there are gaps between the termination of one weld and the start of the next. These are called weld segments. They are commonly referred to as skip welds in the industry.

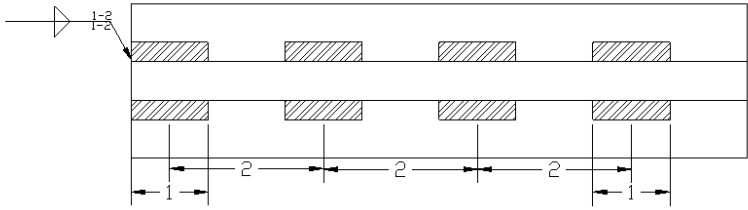


When using an intermittent weld there is a call out specified for the length of the weld and also the pitch that is to be applied. When this is shown on the right side of the symbol and it is called as the length of segment a hyphen and then the pitch of the welds. The pitch of the weld is measured as center to center of the next segment. (Ex. 1-2)

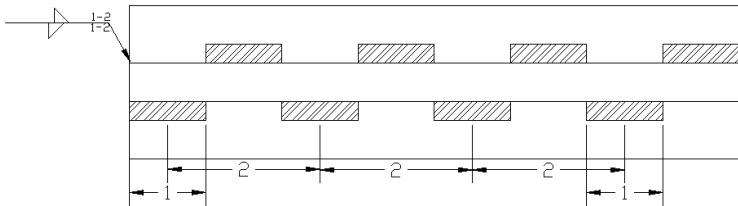
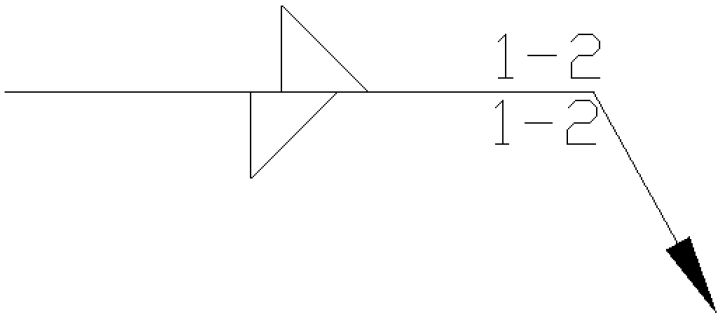


At times that there are welds on both sides of the joint and they are intermittent, this now becomes chain intermittent welding. This can be seen on long sections of a tee joint that isn't under a large amount of stress.

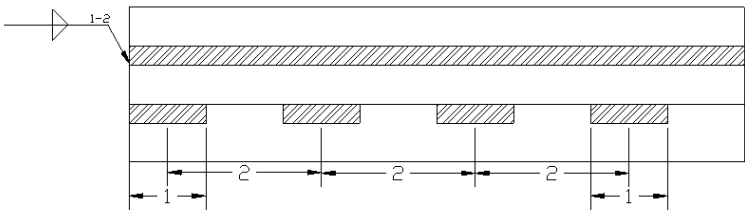
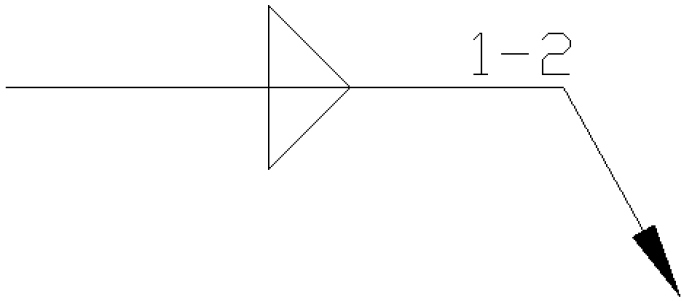




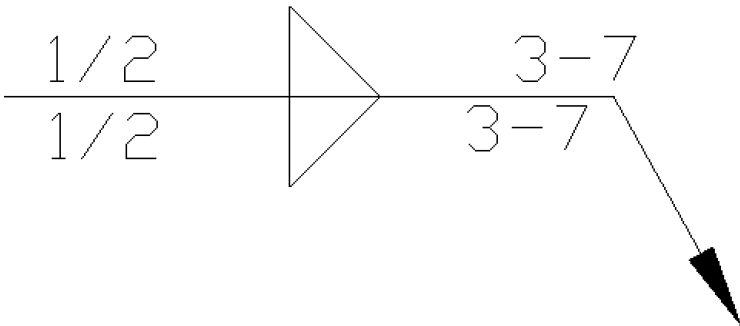
When an intermittent fillet is not a chain weld it will then be called out as a staggered intermittent fillet weld. The welds will be placed on both sides of the joint but it will be offset with one another. This offset shows on the reference line as well. It could be staggered in either direction on the reference line. Dimensions of these welds must be specified on both sides of the reference line.



If the weld is only to be intermittent on one side and a continuous weld on the other the symbol must be dimensioned individually.



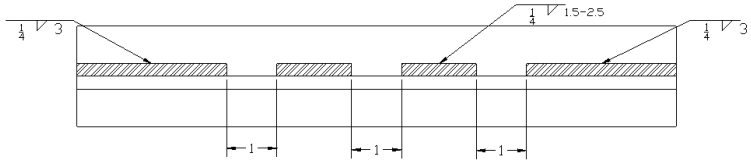
Not all pitch will be the same, or necessarily common space. You must be able to calculate the spacing between weld stops and weld starts in order to apply the correct welds to the specification. An easy way to find this distance is simply subtract the pitch from the weld length (segment.)



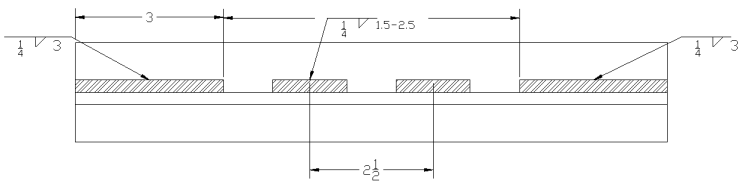
7 inches (pitch) - 3 inches (length of segment) = 4 inches (spacing in between welds)

At times there will be a mixture of continuous welding as

well as intermittent welding. If this occurs the spacing between these segments will all be the same.



If this combination occurs welding symbols should specify continuous and intermittent on the same side of the joint. These are also often dimensioned.



Fillet Weld Quiz

Write down the corresponding information with each letter and specify what it is.