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WELDING AND WELDED JOINTS

INTRODUCTION OF WELDING

➢*Welding is a method of joining pieces of metal together either by heating the metal to suitable temperature with or without the application of pressure and with or without the use of filler metal*

➢Production of leak proof joints for high pressures and temp. are made possible with advanced welding technology

➢When compared to riveting, welding is cheaper, stronger and simpler to execute at site with considerable freedom in design

➢Used in ship building, boilers, bridges, steel structural fabrication etc…

CLASSIFICATION OF WELDING PROCESS

The welding process can be classified in to following two groups

- *Pressure or non fusion welding:* ***In this method, two metal parts are heated at the joint up to plastic condition and then joined together by applying external mechanical pressure/force***
- *Non-pressure or Fusion welding:* ***In this method, the parts of metals are heated to a molten state and the space between two parts is filled with molten filler***

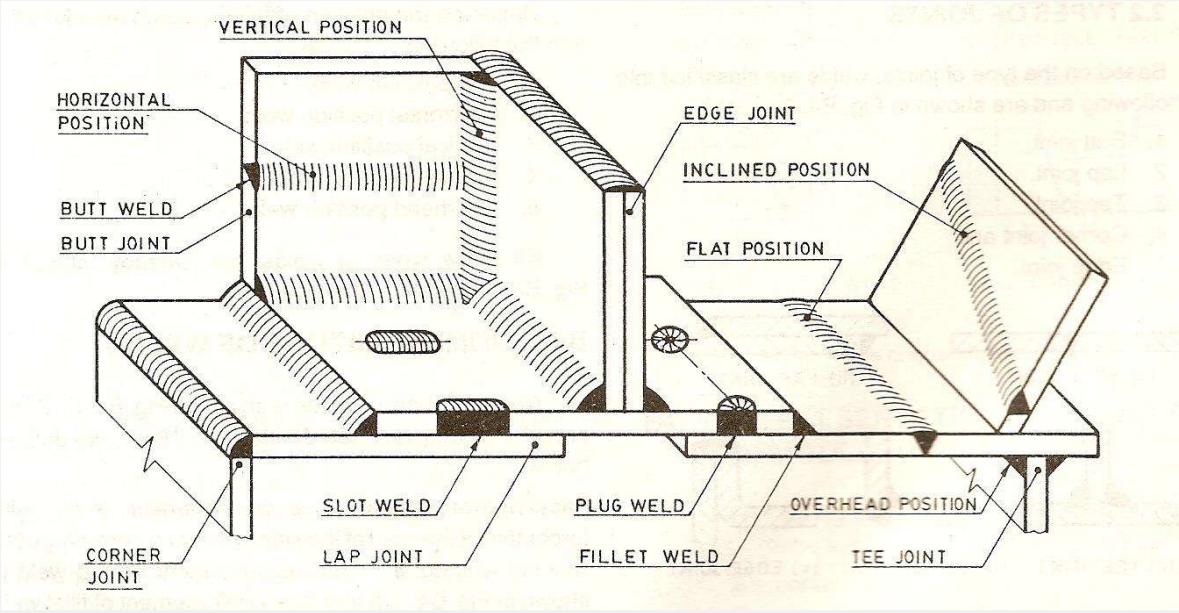
Other methods of joining metal parts include;

- *Solid state welding:* ***Joining takes place without fusion e.g. ultrasonic & friction welding etc…***
- *Brazing and soldering:* ***Use filler metals and involve lower temperatures then welding***

CLASSIFICATION OF WELDING PROCESS

Welded Joints: ***The joints which are prepared by welding processes are known as welded joints***

Classification of welded joints may be based on; (A) Types of welds (B) Position of work pieces (C) Length of welds

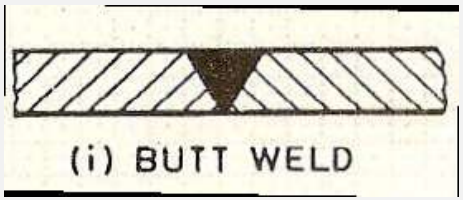


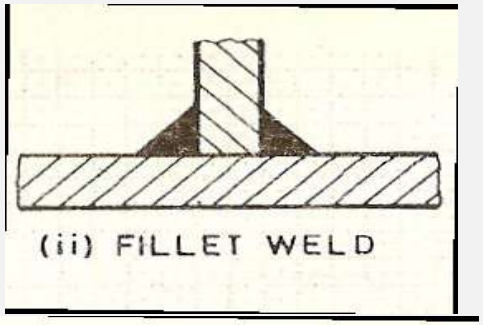
TYPES OF WELDS

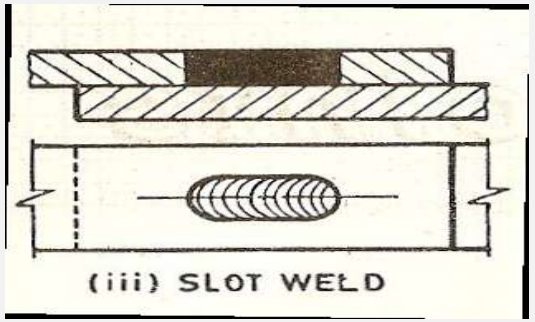
Based on the *types of welds, welded joints are classified in to following*

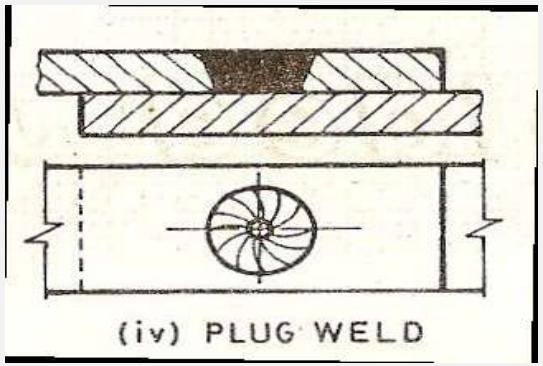
(1) Butt weld *(2) Fillet weld* *(3) Slot weld*

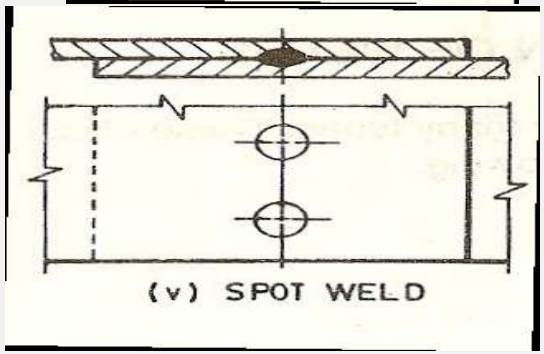
(4) Plug weld *(5) Spot weld and* *(6) Seam weld*

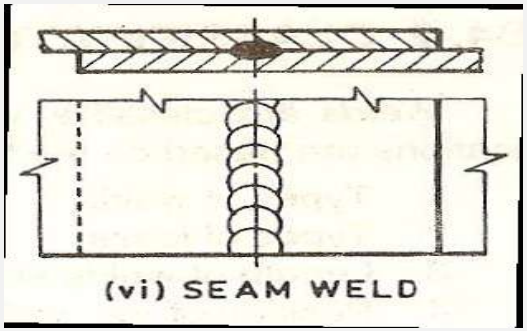










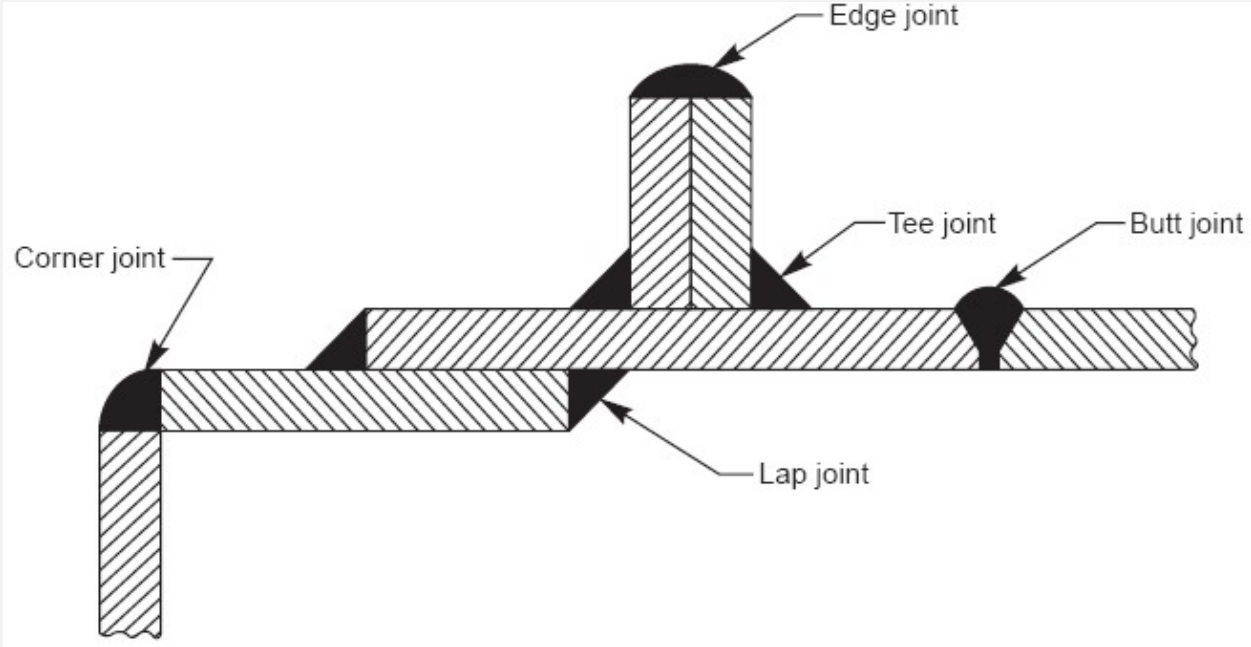


POSITION OF WORK PIECES

Based on the *position of work pieces, welded joints are classified in to following*

(1) Butt joint *(2) Lap joint* *(3) Corner joint*

(4) Edge joint *(5) T-joint*

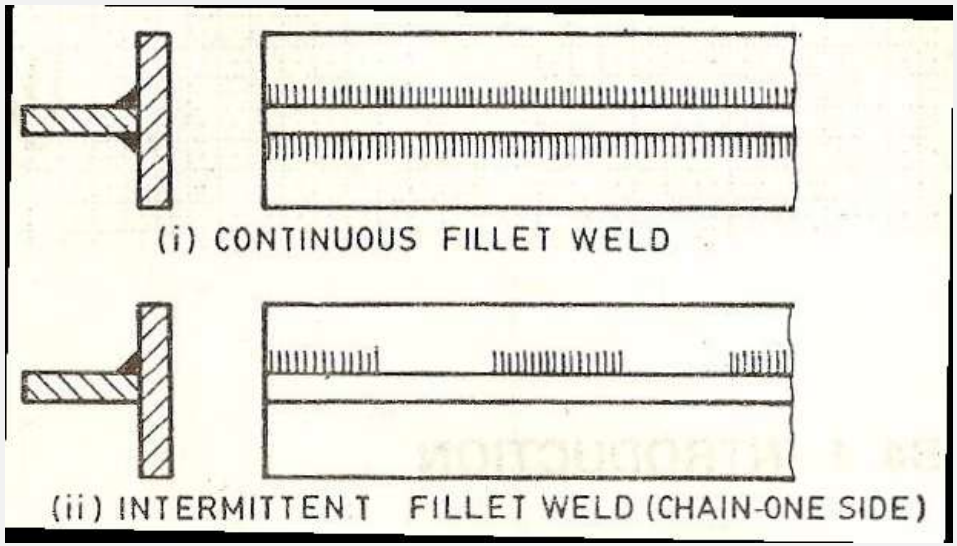


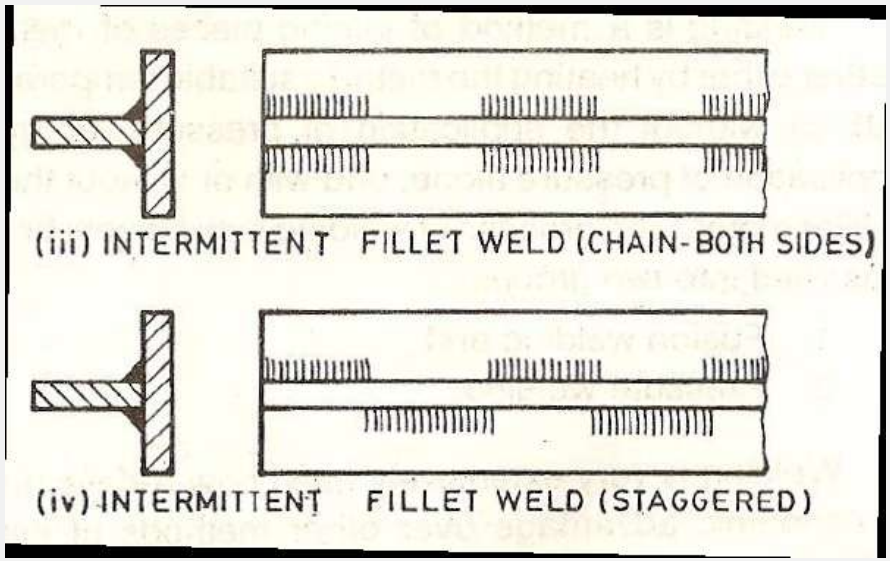
LENGTH OF WELDS

Based on the *length of the weld, welded joints are classified in to following*

(1) Continuous fillet weld

(2) Intermittent fillet weld

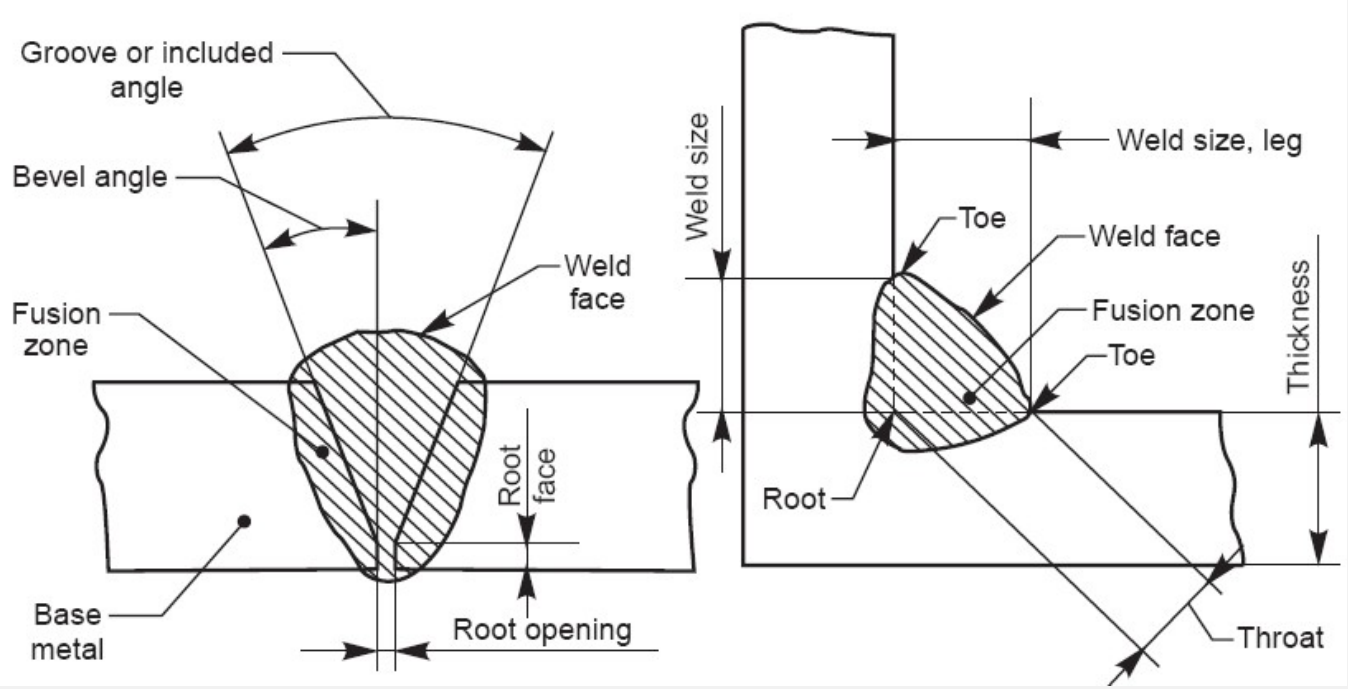




NOMENCLATURE OF WELDS

Nomenclature of welds is shown in figure

- ***Throat of fillet weld is the distance from root to the hypotenuse***
- ***Leg or size of fillet weld is the distance from root to toe***



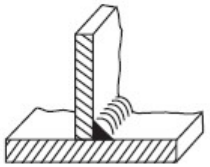
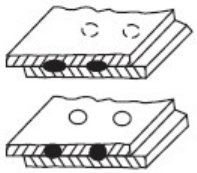
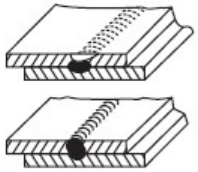
WELD SYMBOLS

ELEMENTARY SYMBOLS

No.	*Designation*	*Illustration*	*Symbol*
1.	Butt weld between plates with raised edges (the raised edges being melted down completely)		
2.	Square butt weld		
3.	Single-V butt weld		
4.	Single-bevel butt weld		
5.	Single-V butt weld with broad root face		
6.	Single-bevel butt weld with broad root face		
7.	Single-U butt weld (parallel or sloping sides)		
8.	Single-U butt weld		

WELD SYMBOLS

ELEMENTARY SYMBOLS

No.	*Designation*	*Illustration*	*Symbol*
9.	Backing run; back or backing weld		
10.	Fillet weld		
11.	Plug weld; plug or slot weld		
12.	Spot weld		
13.	Seam weld		

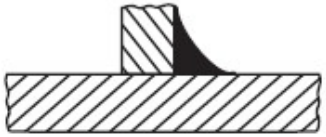
WELD SYMBOLS

SUPPLEMENTARY SYMBOLS

Shape of weld surface	*Symbol*
(*a*) Flat (usually finished flush)	
(*b*) Convex	
(*c*) Concave	

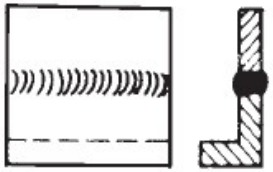
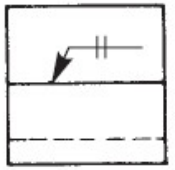
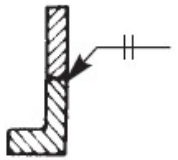
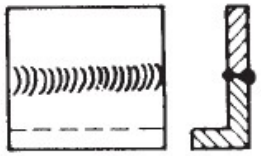
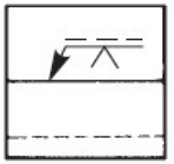
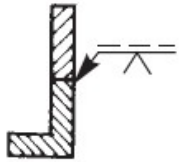
WELD SYMBOLS

COMBINED SYMBOLS

Designation	*Illustration*	*Symbol*
Flat (flush) single-V butt weld		
Convex double-V butt weld		
Concave fillet weld		
Flat (flush) single-V butt weld with flat (flush) backing run		

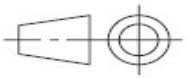
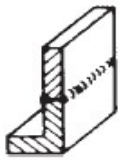
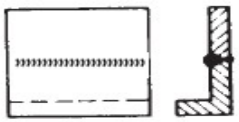
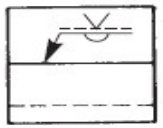
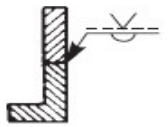
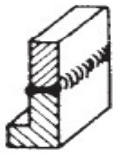
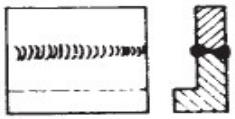
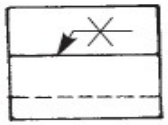
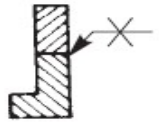
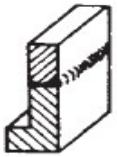
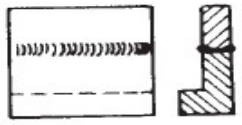
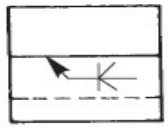
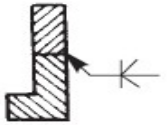
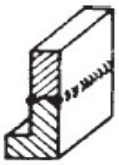
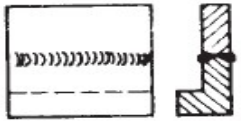
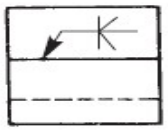
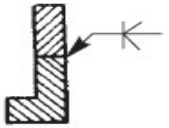
WELD SYMBOLS

COMBINED SYMBOLS

No.	*Designation symbol (For number refer to Table 11.1)*	*Illustration*	*Representation*	*Symbolization*	
				either	*or*
1.	Square butt weld ‖ 2 welded from both sides 2–2				
2.	Single-V butt weld ∨ 3				

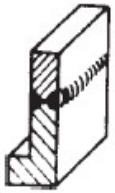
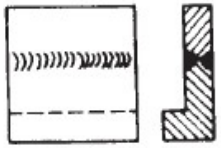
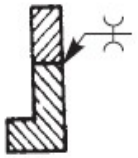
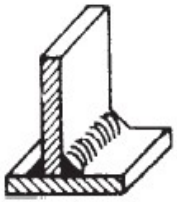
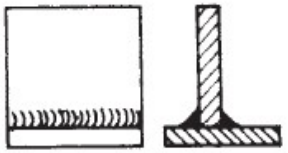
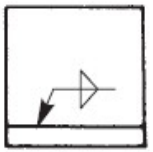
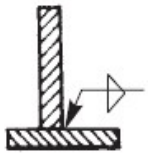
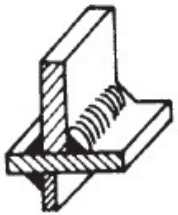
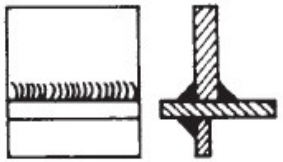
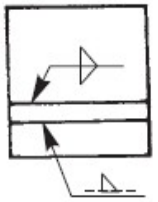
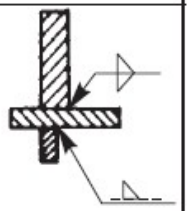
WELD SYMBOLS

COMBINED SYMBOLS

No.	Designation symbol (For number refer to Table 11.1)	Illustration	Representation 	Symbolization	
				either	or
3.	and backing run  9 3–9				
4.	Double-V butt weld  3 (X weld) 3–3				
5.	Double bevel butt weld  4 (K weld) 4–4				
6.					

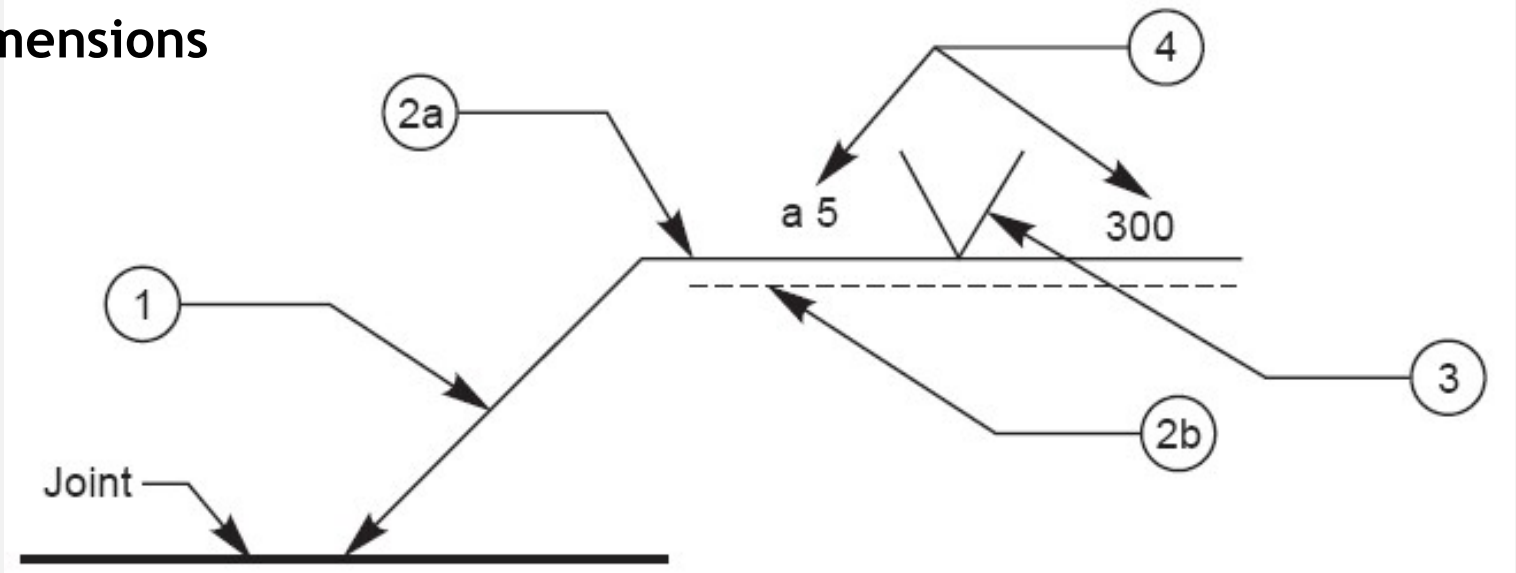
WELD SYMBOLS

COMBINED SYMBOLS

No.	Designation symbol (For number refer to Table 11.1)	Illustration	Representation	Symbolization	
				either	or
7.	Double-U butt weld 7 7–7				
8.	Fillet weld 10 and fillet weld				
9	10 10–10				

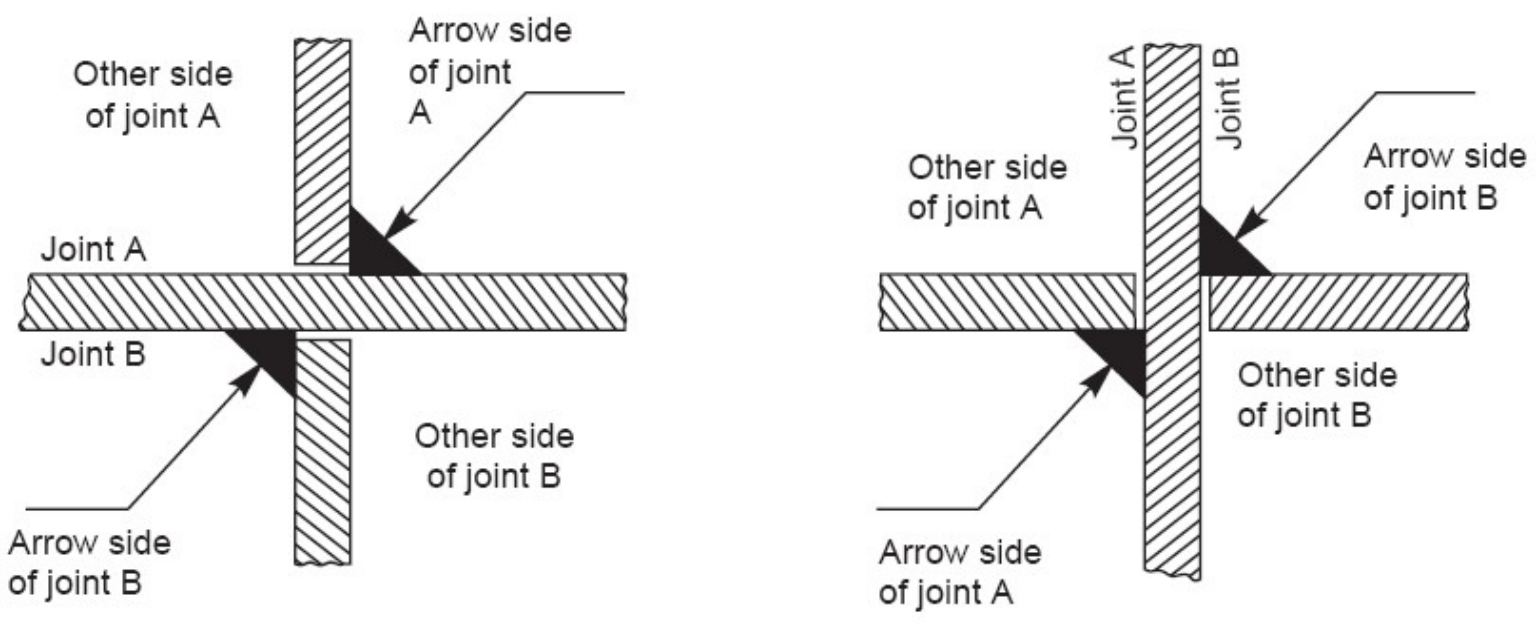
POSITIONING OF WELDING SYMBOLS AS PER B.I.S.

The positioning of weld symbols on drawing consists of
(1) An arrow line
(2) Dual reference lines
(a) continuous and (b) dashed
(3) Symbols and
(4) dimensions



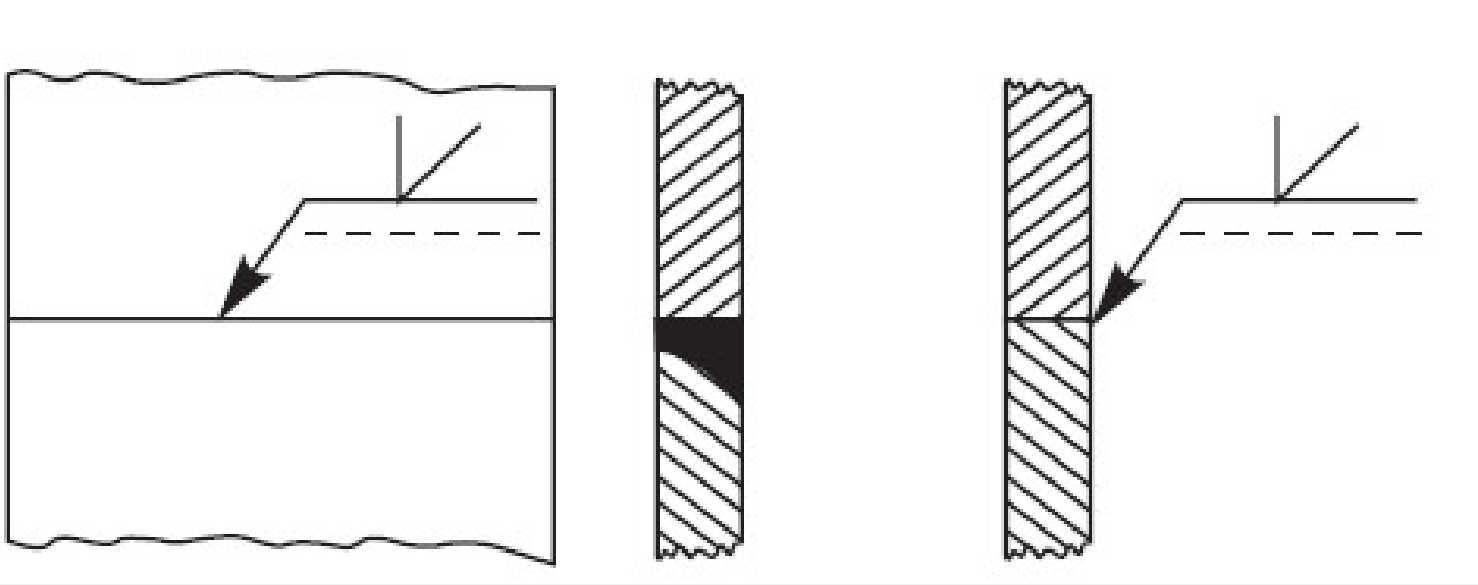
POSITION OF ARROW LINE

- The arrow line is used to identify a joint
- One end has arrow head while its other end is connected to reference line
- Its position generally has no special significance



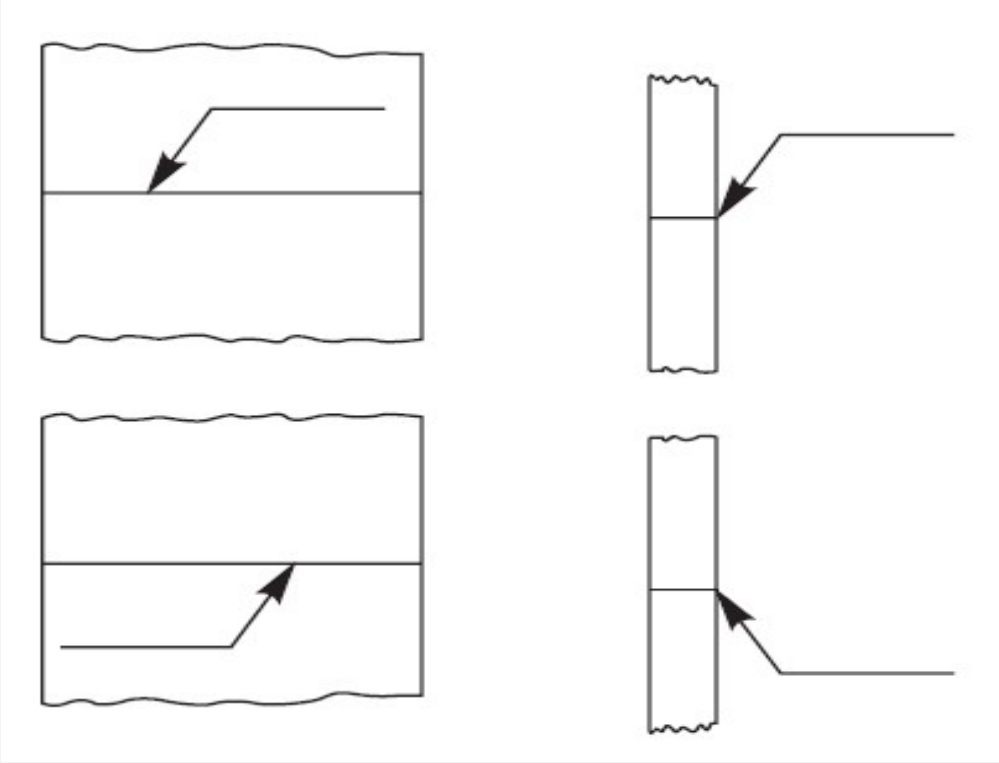
POSITION OF ARROW LINE

- But for bevel butt and J-butt welds, the arrow line should point towards the plate which is prepared as shown in the figure
- The thickness of arrow line should be in accordance with the thickness of the dimensioning lines



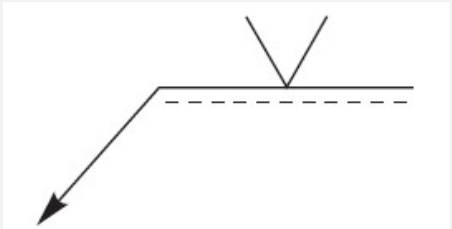
POSITION OF REFERENCE LINE

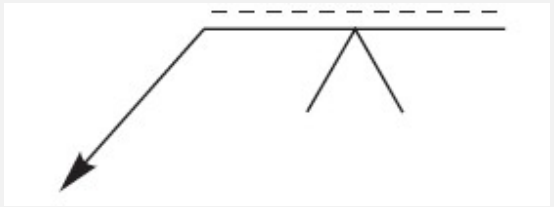
➢The reference line shall preferably be drawn parallel to the bottom edge of the drawing or perpendicular to the bottom edge of the drawing



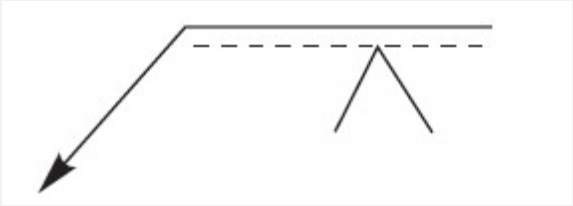
POSITION OF SYMBOLS

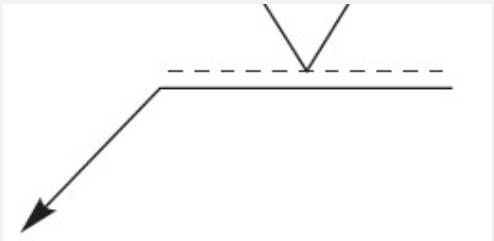
- If the weld is on the arrow side of the joint, the weld symbol should be placed on the continuous line



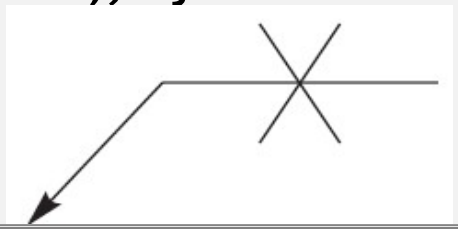


- If the weld is on the other side of the joint, the weld symbol should be placed on the dashed line



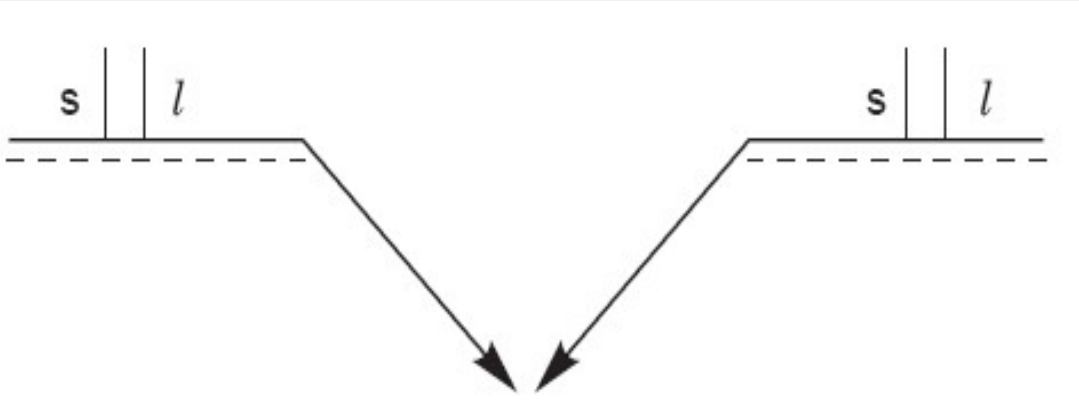


- If weld is on both sides (symmetric), symbols should be placed on both side of continuous line



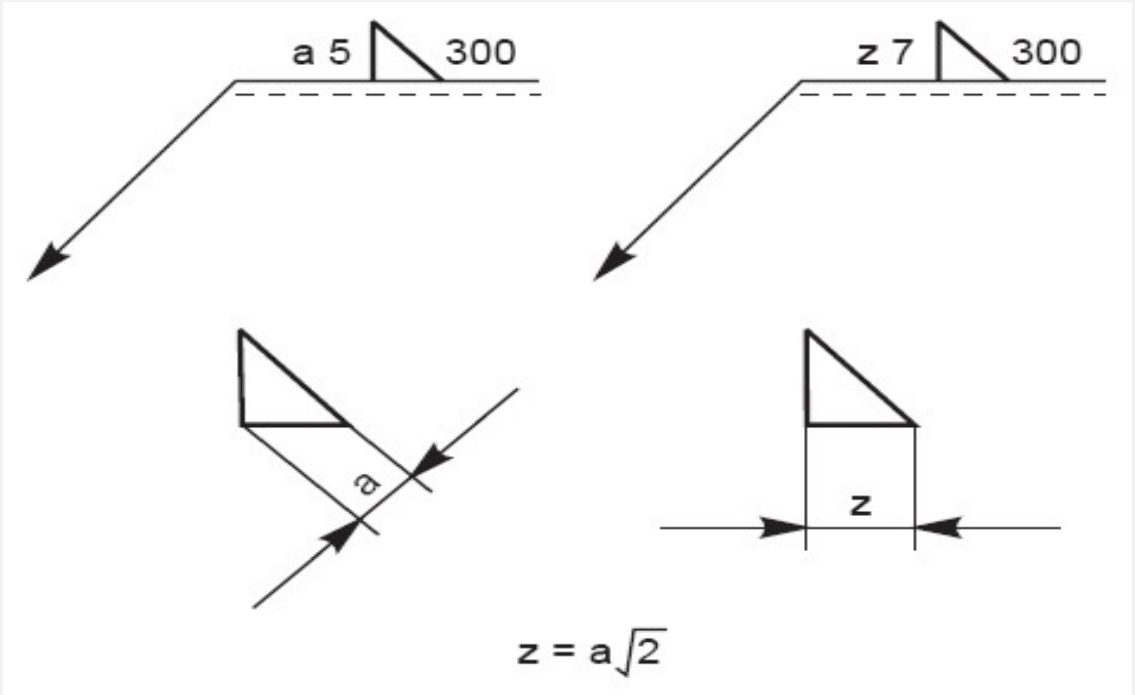
DIMENSIONING OF WELDS

- Each weld symbol may be accompanied by a certain number of dimensions.
- The main dimensions relative to the cross-section is written on the left-hand side of (before) the symbol and longitudinal dimension is written on the right-hand side of (after) the symbol.
- The absence of any indication following the symbol, signifies that the weld is to be continuous over the whole length of the work



DIMENSIONING OF WELDS

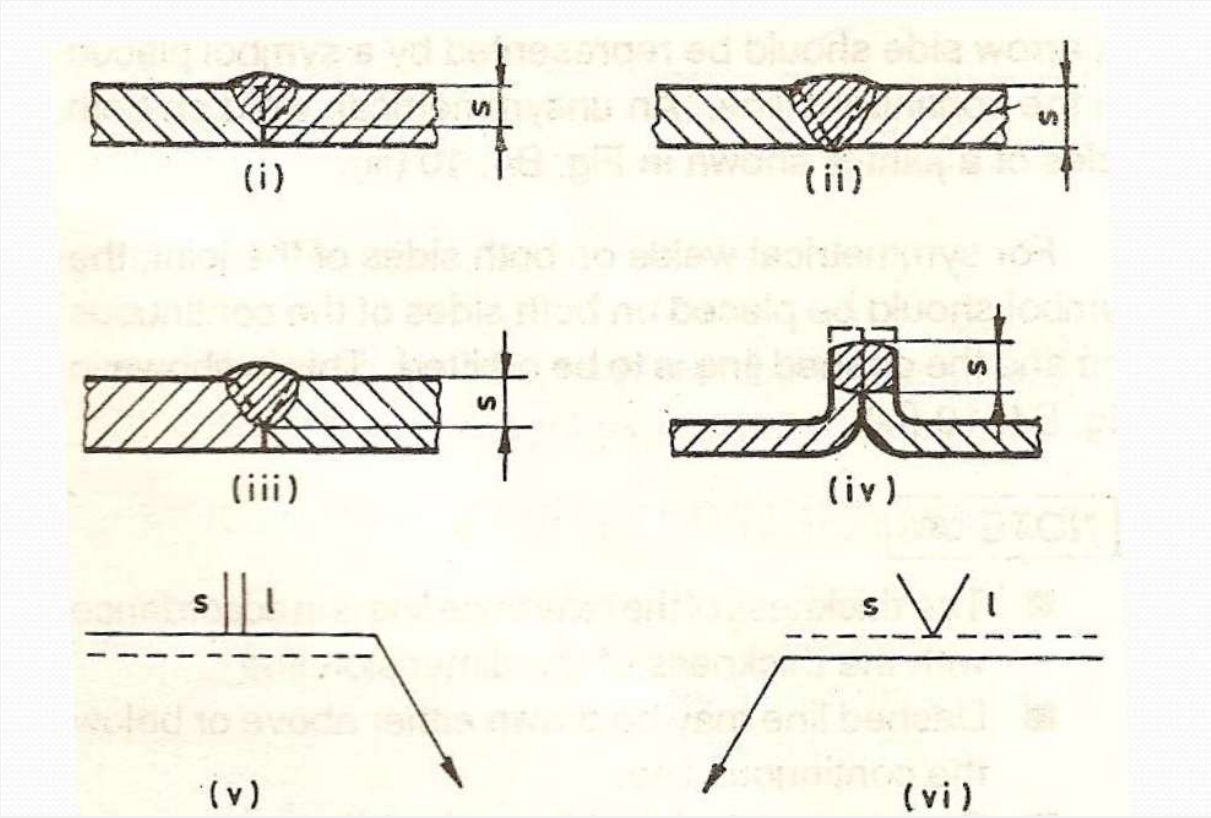
- There are two methods to indicate the dimensions of fillet welds
- The letter ‘a’ (throat thickness) or ‘z’ (leg length) is always placed in front of the value of the corresponding dimension



DIMENSIONING OF WELDS

Dimensioning of *Butt welds* *is shown in figure*

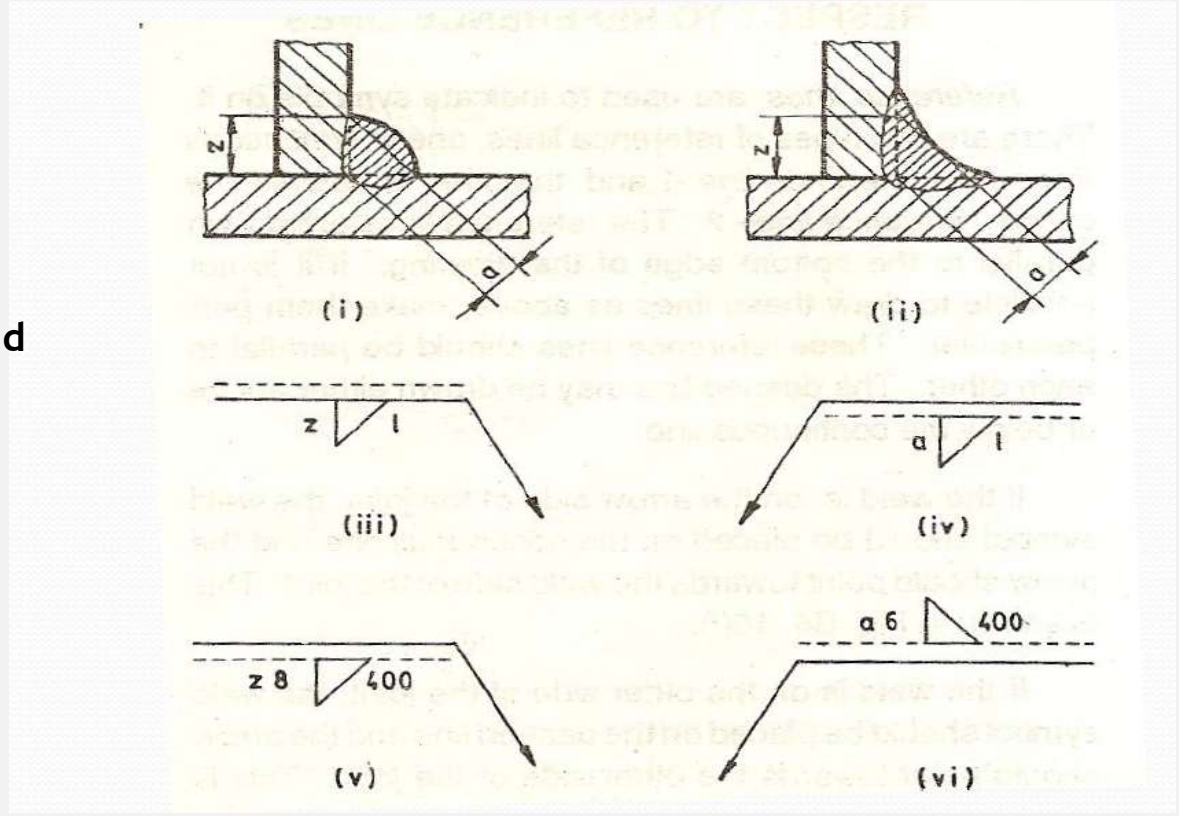
Where…
S = Penetration (mm) and
l= Length of weld (mm)



DIMENSIONING OF WELDS

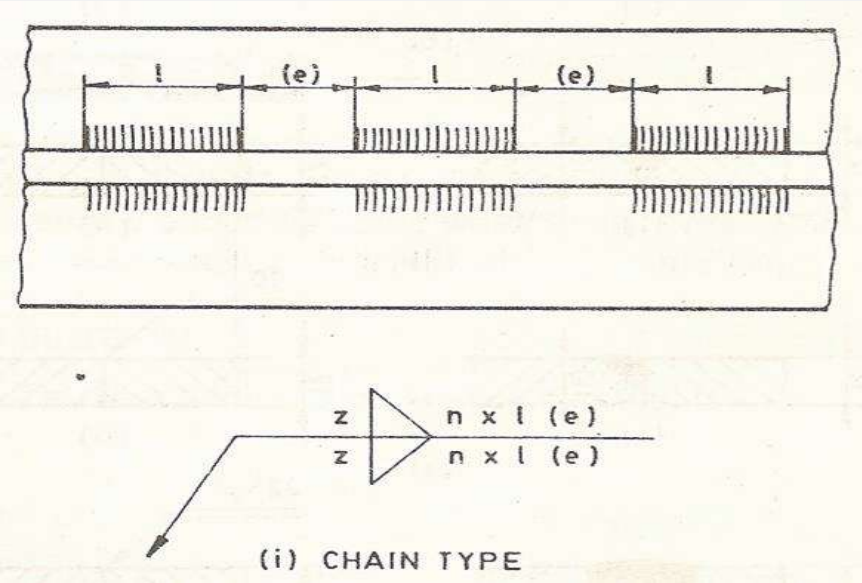
Dimensioning of *Fillet welds* *is shown in figure*

Where…
a = throat thickness (mm) and
z= Size or leg (mm)

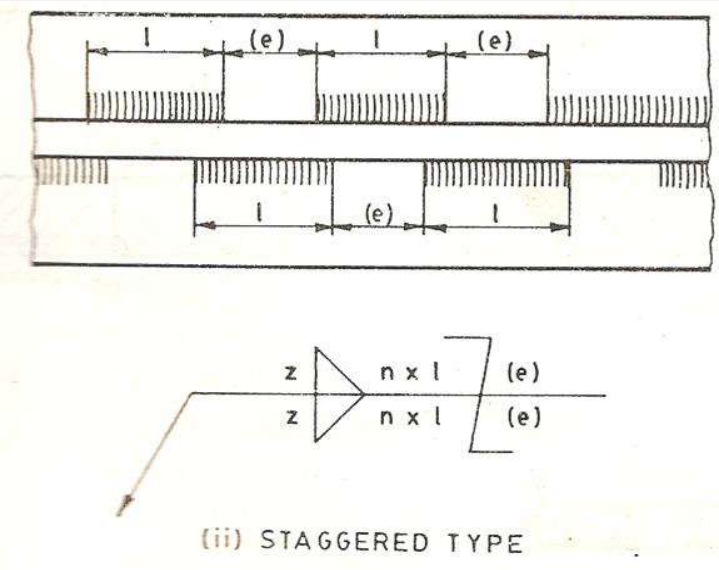


DIMENSIONING OF WELDS

Dimensioning of *Intermittent fillet* *is shown in figure*



(i) CHAIN TYPE



(ii) STAGGERED TYPE

Where…

l = weld length (mm)

z = Size or leg(mm)

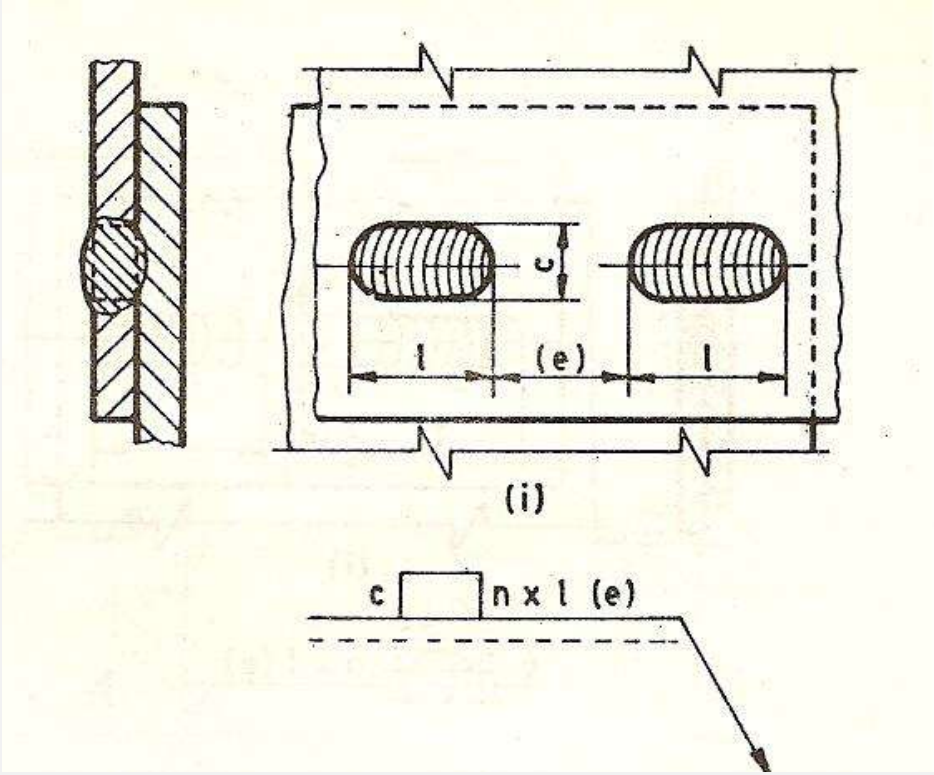
n= no. of weld elements

e= distance between adjacent weld elements(mm)

DIMENSIONING OF WELDS

Dimensioning of *Slot welds* *is shown in figure*

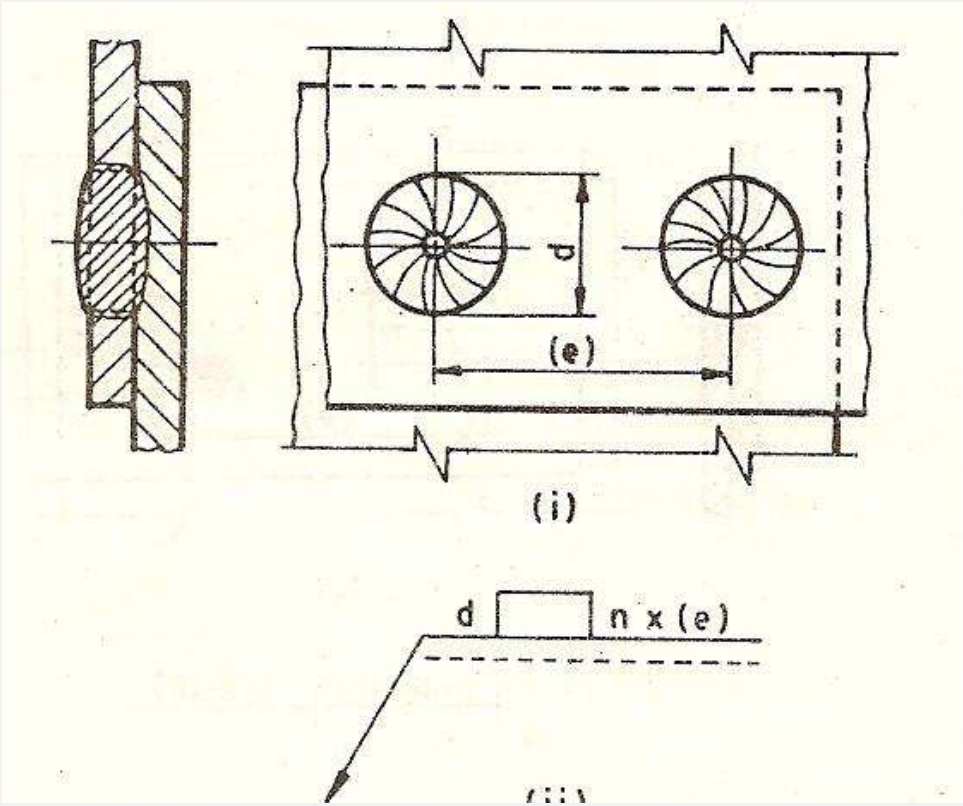
Where…
c= Width of the slot/weld(mm)
n= no. of weld elements
e= distance between adjacent weld elements(mm)
l = length of weld(mm)



DIMENSIONING OF WELDS

Dimensioning of *Plug welds* *is shown in figure*

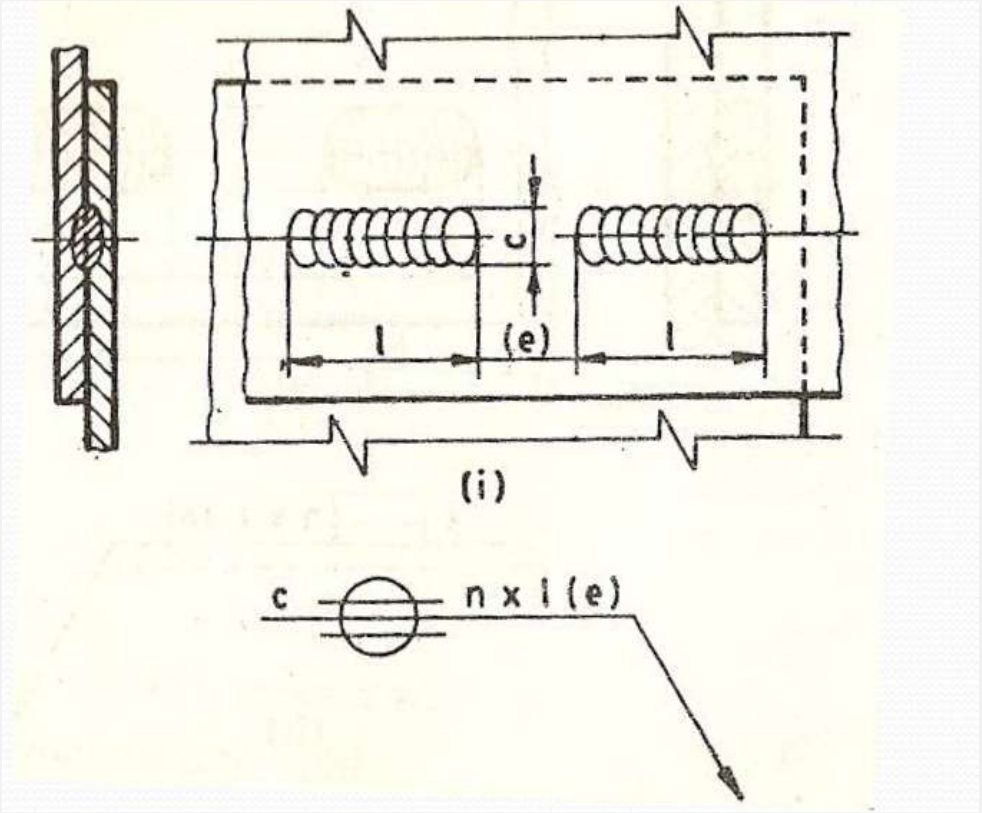
Where…
d= Diameter of the hole (mm)
n= no. of weld elements
e= distance between adjacent weld elements(mm)



DIMENSIONING OF WELDS

Dimensioning of *Seam welds* *is shown in figure*

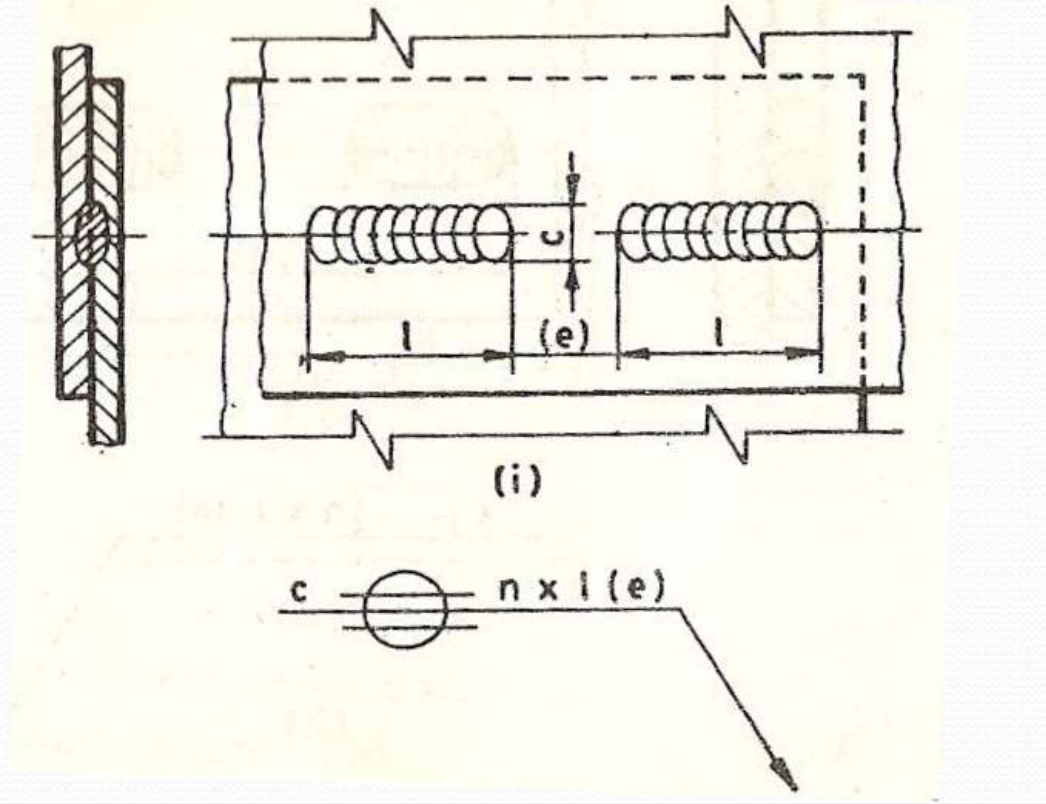
Where…
c= Width of the slot/weld(mm)
n= no. of weld elements
e= distance between adjacent weld elements(mm)
l = length of weld(mm)



DIMENSIONING OF WELDS

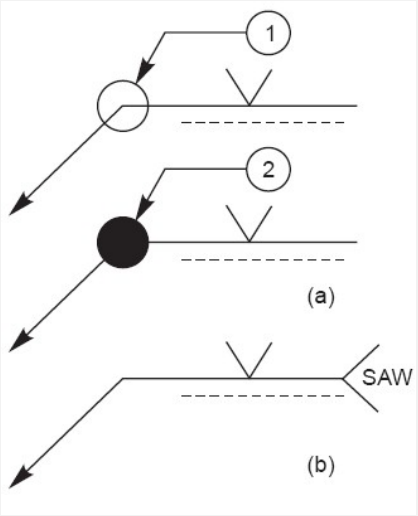
Dimensioning of *Spot welds* *is shown in figure*

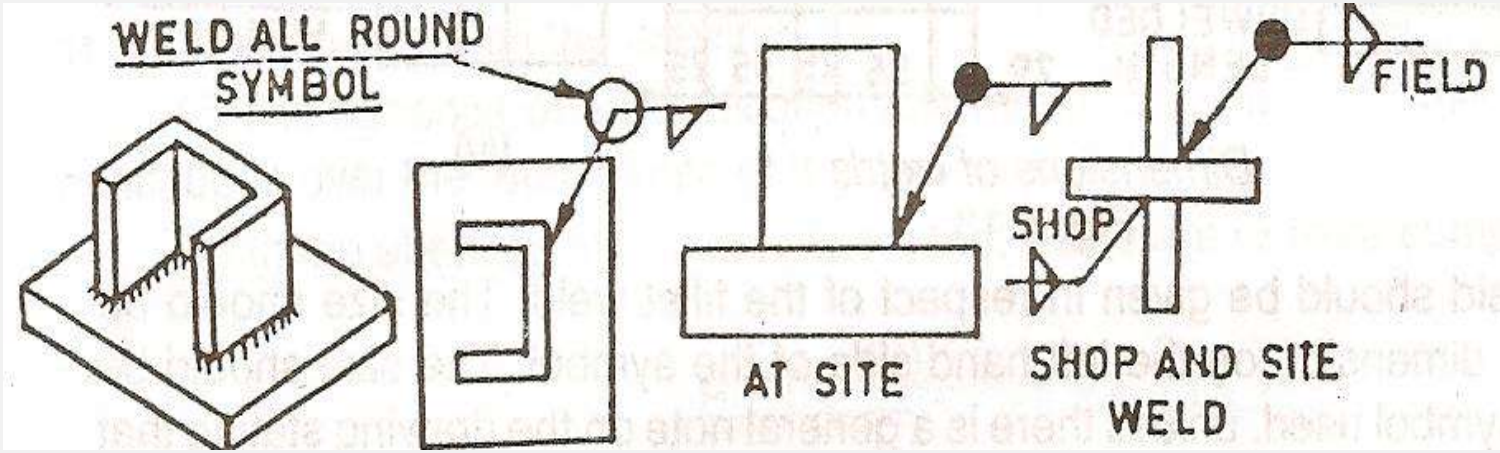
Where…
d= Diameter of the spot (mm)
n= no. of weld elements
e= distance between adjacent weld elements(mm)



SURFACE CONTOUR AND FINISH OF WELDS

- Circle at the elbow (1), connecting the arrow and the reference line to indicate welding all around
- Filled-in circle (2) at the elbow indicate welding on site
- To indicate the process of welding, the abbreviation of the welding process is written as a note at the tail end of the arrow, forming a 90°V (Here, SAW stands for Submerged Arc Welding)

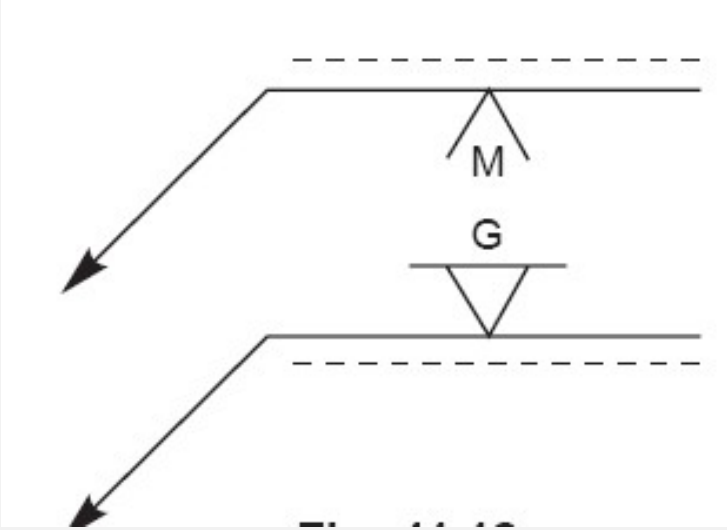




SURFACE CONTOUR AND FINISH OF WELDS

➢Finishing of welds other than cleaning, shall be indicated by suitable contour and finish symbols, viz., chipping C, machining M and grinding G

➢Where a weld is required to have approximately flush surface without any other method of finishing, a straight line should be added below the symbol to indicate it

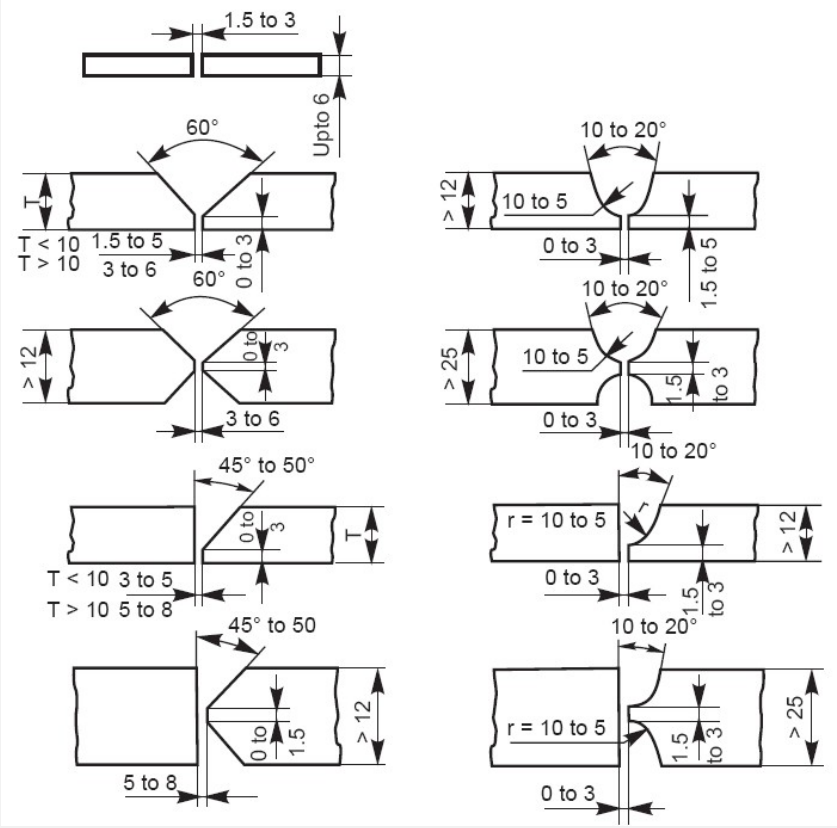


EDGE PREPARATION

- Distortion of parts during welding can be reduced by properly preparing the edges to be joined
- Edge preparation ensures proper fusion at the root of the weld with minimum weld metal
- No edge preparation is required for fillet welds
- For butt welds it is essential

EDGE PREPARATION

Edge preparation for various butt joints are shown in figure



RULES FOR SYMBOLS

- Symbols for fillet and similar welds should be shown, such that the vertical portion of the symbols are indicated on the left hand side of the symbol, irrespective of the orientation of the weld metal.
- If the welds are to be made on the arrow side of a joint, the corresponding symbol should be placed either above or below the continuous reference line.
- If the welds are to the made on both sides of a joint, the corresponding symbols should be placed on both sides of the reference line and the dashed line is not shown
- The arrow of the symbol must point towards the joint which requires welding.
- When only one member is to be edge prepared to make the joint, the arrow should point at that plate.

RULES FOR SYMBOLS

- Dimensions of size are indicated in mm without writing the unit mm. The letter ‘a’ or ‘z’ is placed in front of the value of the fillet size, depending upon whether the throat or leg and length of the weld is shown on the right hand side. If no length is given, it implies that full length is to be welded
- If unequal legs of fillet are to be used, they should also be given on the left hand side
- If a weld is to be made all around a joint, a circle should be placed at the elbow, connecting the arrow to the reference line
- If a weld is required to be made on the site or during erection or assembly, it is represented by a filled-in circle at the elbow, connecting the arrow and the reference line
- If a weld is to have a flush or flat finish, a straight line should be added above the symbol
- The welding process is indicated, if required, at the end of the arrow

WELDING PROCESS DESIGNATION

Designation	*Welding process*
CAW	Carbon arc welding
CW	Cold welding
DB	Dip brazing
DFW	Diffusion welding
EBW	Electron beam welding
ESW	Electro slag welding
EXW	Explosion welding
FB	Furnace brazing
FOW	Forge welding
FRW	Friction welding
FW	Flash welding
GMAW	Gas metal arc welding
GTAW	Gas tungsten arc welding

WELDING PROCESS DESIGNATION

Designation	*Welding process*
IB	Induction brazing
IRB	Infra red brazing
OAW	Oxy-acetylene welding
OHW	Oxy-hydrogen welding
PGW	Pressure gas welding
RB	Resistance brazing
RPW	Projection welding
RSEW	Resistance seam welding
RSW	Resistance spot welding
RW	Resistance welding
SAW	Submerged arc welding
TB	Torch brazing
UW	Upset welding

Thank you for your attention

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