MILD STEEL WELDING ELECTRODES

Electrode Sizes

The electrode size refers to the diameter of its core wire. Each electrode has a certain current range. The welding current increases with the electrode size (diameter).

Electrode size	Electrode size
1.6mm	5.0mm
2.0mm	6.0mm
2.5mm	6.3mm
3.15mm	8.0mm
4.0mm	10.0mm

STANDARD LENGTH OF ELECTRODES

The electrodes are manufactured in two different lengths,

350 or 450mm.

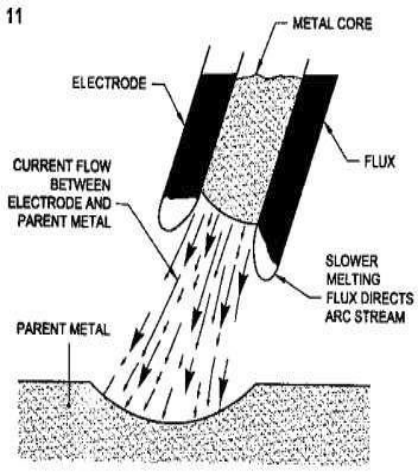
Functions of an Electrode in Shielded Metal Arc Welding (SMAW)

There are two main functions of an electrode in shielded metal arc welding:

The core wire conducts the electric current from the electrode holder to the base metal through the arc.

It deposits weld metal across the arc onto the base metal.

The flux covering melts at a slower rate than the metal core and a cup is formed at the tip of the electrode which helps to direct the molten metal to the required spot.



Identification of Electrodes

For easy identification and selection of a suitable arc welding electrode for welding mild steel plates, the electrodes are coded by Bureau of Indian Standards (B.I.S). According to the B.I.S., the electrodes to be used for welding mild steel for training a beginner is coded as ER4211.

The classification for the electrode ER4211 is given below for easy understanding:

E = Flux coated or covered electrode

R = Type of flux covering (Rutile)

4 = Strength of the joint (UTS = 410-510 N/nm^2 and YS = 330N/nm^2 min.

2 = Elongation and impact properties of the weld
(Elongation = 22% min. and impact = 47 J min. at 0°C)

1 = Welding position (all position) welding can be done in all positions

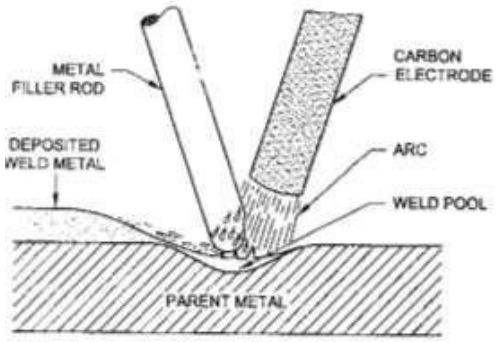
1 = Welding current and voltage conditions. This means that for DC welding, the electrode can be connected to the +ve or -ve terminal. For AC welding, the open circuit voltage should be 50 volts.

TYPES OF ELECTRODES

Electric arc welding electrodes are of generally following three types:

(i) Carbon electrodes
(ii) Bare electrodes
(iii) Flux coated electrodes

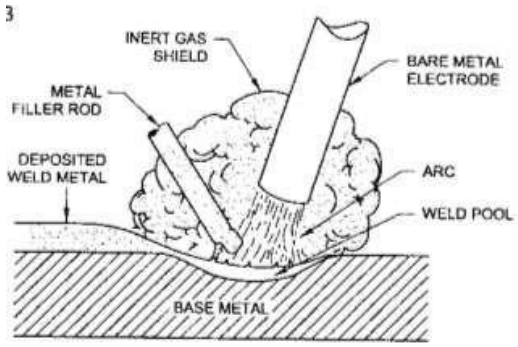
Carbon electrodes are used in the carbon arc welding process. The arc is created between the carbon electrode and the job. The arc melts a small pool in the job and filler metal is added by using a separate rod.
Normally the carbon arc has very little use of welding. Its main application is in cutting and gouging operations.



CARBON ARC PROCESS

Bare electrodes-

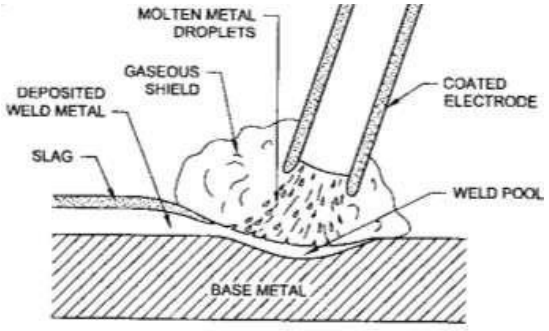
It is also used in some arc welding processes. An inert gas is used to shield the molten weld metal and prevent it from absorbing oxygen and nitrogen. Filler metal is separately added through a filler rod. Usually tungsten is used as one of the bare wire electrode. In CO2 welding and submerged arc welding processes the mild steel bare wire electrode is also used as a filler wire.



PROCESS USING BARE ELECTRODE & GASEOUS SHIELD

Flux coated electrodes-

It is used in the manual metal arc welding process for welding ferrous and non-ferrous metals. The composition of coating provides the flux, the protective shield around the arc and a protective slag which forms over the deposited weld metal during cooling.



PROCESS USING FLUX COATED ELECTRODE

Merits of Flux Coated Electrodes

- A good quality weld is made.
- The arc remains stable.
- The weld penetrates into the job.
- The slag produced during welding reduces the cooling rate of the weld metal.
- Low oxidation.
- Protect the weld metal to become brittle.
- Overhead and vertical welding is easy.
- The spatter loss is low and the bead remains controlled.

Two Basic Types of AW Electrodes-

1. Consumable Electrodes

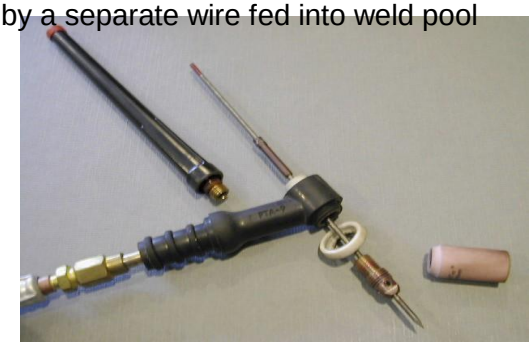
- Consumed during welding process. Source of filler metal in arc welding
- Forms of consumable electrodes-
  -Welding rods are 9 to 18 inches and 3/8 inch or less in diameter and must be changed frequently
  -Weld wire can be continuously fed from spools with long lengths of wire, avoiding frequent interruptions
- In both rod and wire forms, electrode is consumed by the arc and added to weld joint as filler metal

Consumable Electrode (AW Processes)-

- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Flux-Cored Arc Welding (FCAW)
- Electro gas Welding (EGW)
- Submerged Arc Welding (SAW)

2. Non Consumable Electrodes

- Non consumable - not consumed during welding process-Filler metal must be added separately if it is added
- Made of tungsten which resists melting
- Gradually depleted during welding (vaporization is principal mechanism)
- Any filler metal must be supplied by a separate wire fed into weld pool



Non Consumable Electrode (AW Processes)-

- Gas Tungsten Arc Welding
- Plasma Arc Welding
- Carbon Arc Welding
- Stud Welding

CODIFICATION OF MMAW ELECTRODES AS PER IS: 814-1991

A1 **Prefix Letter**: Letter 'E' shall indicate a covered electrode for manual Metal arc welding manufactured by extrusion process.

A2 **Types of Covering**: Letter(s) indicating to type of covering as described below: -

(A) **Acidic:** The covering contains besides oxide of Iron or Manganese a fairly high percentage of Ferro-manganese and or other de-oxidizers. The slag is easily detachable.

(B) **Basic:** This type of covering contains appreciable quantities of calcium or other basic carbonates and fluorspar. The slag produced is dense and brown in color. This slag is also easily removable.

(C) **Cellulosic:** The covering of cellulosic type contains a large quantity of combustible organic substances producing easily detachable slag.

(R) **Rutile:** This type of covering contains large quantity of rutile or component derived from titanium oxide. The slag produced is easily removable.

(RR) Same as rutile type electrode but having higher coating factor.

(S) Covering of any other type not classified above.

A3 **First Digit**: Indicates ultimate tensile strength in combination with the yield strength of the weld metal deposits given below: -

Designating Digit	**UTS (N/sq.mm)**	**YS min. (N/sq.mm)**
4	410-510	330
5	510-610	360

A4 **Second Digit** Indicates the percentage elongation in combination with the impact values of weld metal deposited as given below. These values are as per two tensile ranges as given by first digit.

For tensile range 410-510 N/sq.mm

Designating digit	%Elongation on $5.65\sqrt{a}$	Impact (in joules) (min)
0	No elongation & Impact requirements.	
1	20	47J (+ 20°C)
2	22	47J (-0°C)
3	24	47J (-20°C)
4	24	27J (-30°C)

For Tensile Range 510-610 N/sq.mm

0	No elongation & impact requirements.	
1	18	47J (+ 27°C)
2	18	47J (0°C)
3	20	47J (-20°C)
4	20	27J (-30°C)

5	20	27J (-40°C)
6	20	27J (-46°C)

A5 Third Digit Indicates welding positions in which electrode may be used.

Indicating digit	Welding Position
1	F,H,V,D,O (All position)
2	F,H,V,O
3	F,H
4	F only
5	F and HF
6	Any other position or combination of Positions not classified above.

NOTE:
F - Flat position
H - Horizontal Vertical
V - Vertical up
D - Vertical down
O - Overhead
HF - Horizontal Fillet

A6 Fourth Digit Indicates the current condition in which electrode is to be used as given below :

Digit	DC Recommended Polarity	AC Open Circuit Voltage (min.)
0	(+)	Not recommended
1	(+)OR (-)	50
2	(-)	50
3	(+)	50
4	(+) OR(-)	70
5	(-)	70
6	(+)	70
7	(+) OR(-)	90
8	(-)	90
9	(+)	90

Suffix letters: The following letters indicating the additional properties of electrodes may be used:-

(a) H1, H2 & H3 indicating hydrogen controlled electrodes as explained below :
H1 = Diffusible hydrogen up to 15 ml/100 gm.

H2 = " " " 10 ml/100 gm.

H3 = " " " 5 ml/100 gm.

(b) Letters J, K & L indicating increased metal recovery as given below :

J - 110 to 129%

K - 130 to 149%

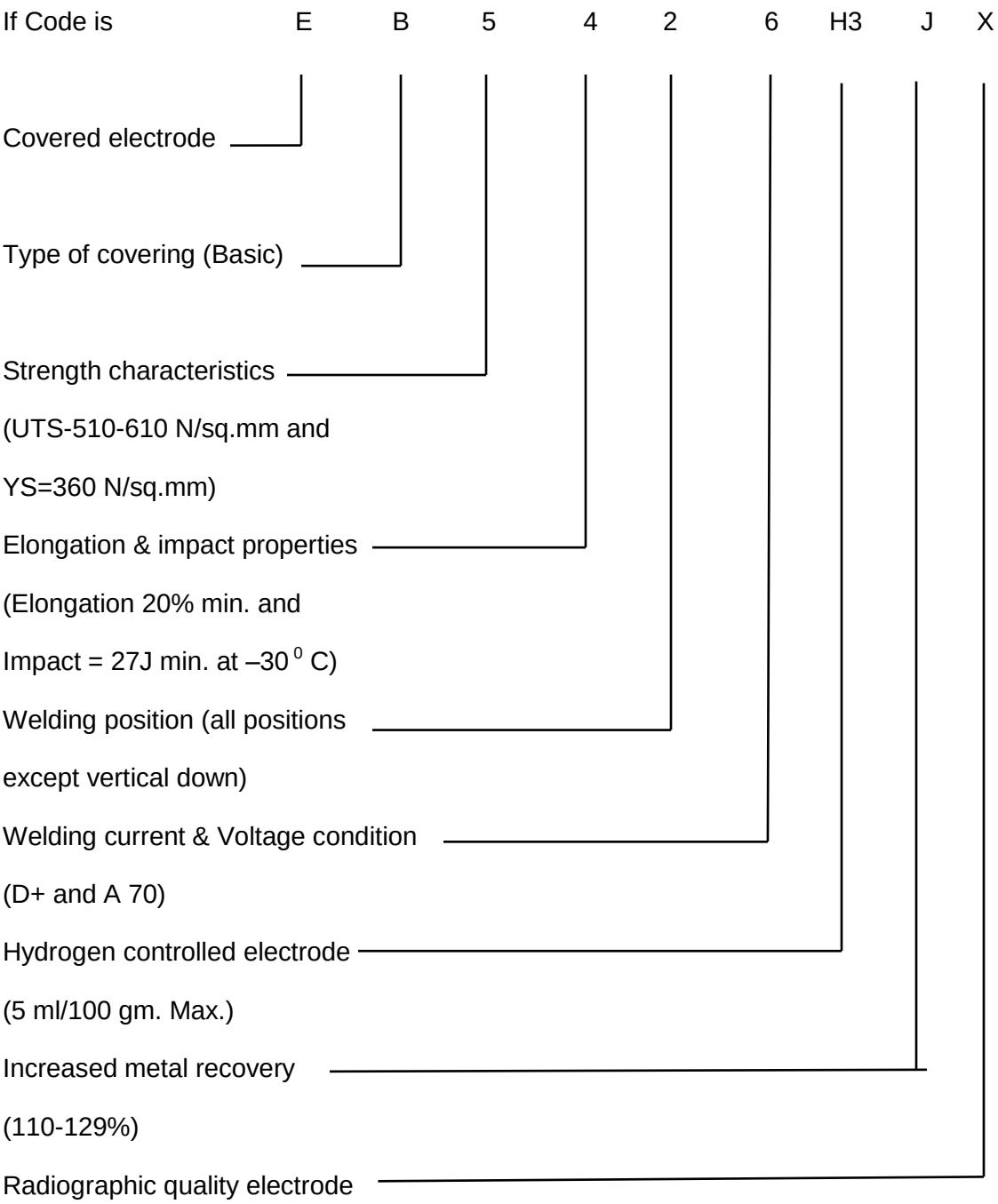
L - 150% and above.

(c) X - Indicating radiographic quality.

Note:

It is mandatory to indicate the first six alphabets/numeric's on the packet to get BIS approval. The remaining codes are optional for the manufacturer if he wants to emphasize on those characters also. Apart from that, recommended current range is also indicated on the packet.

Example:



Packing:

To guard against ingress of moisture and damage during transportation storage till its consumption, the following packing system shall be incorporated in IRS M-28, which has to be followed by the electrode manufacturers:

1. The counted/weighed electrodes shall be kept in moisture proof polythene bag and sealed.
2. This sealed bag shall further be kept in card board carton printed with name of the manufacturer, electrode brand name, batch number, date of manufacture, size, current condition and welding parameters, quantity, cautionary note on safety during welding, BIS Code and any other special recommendation. The total weight should not exceed 7 Kg.
3. This carton shall be sealed and put in polythene bag and sealed/shrink sealed.
4. A counted number of sealed cartons shall be kept in suitable wooden/card board boxes and stripped tightly.

The shelf life of the electrodes should be a minimum of 12 months from the date of receipt in Stores or 18 months from the date of manufacture, whichever is more.

GUIDELINE FOR PROCUREMENT OF ELECTRODES AND PLACING INDENT:

(a) **Choosing of class of Electrodes & IS Code:** The class of electrodes shall be chosen as per classification and their purpose of use as per IRS M-28 (as described in Chapter-I).

(b) **Diameter of electrode**: The diameter of electrode shall be as per thickness of job. For thin sheets the diameter of electrodes should not be more than thickness of sheet. The root runs in the grooves shall be given by using small diameter of electrodes preferably 3.15/4.0 mm to avoid lack of penetration & slag inclusions.

(c) **Type of coating:** Medium, heavy or super heavy-coated electrodes shall be used according to the job & welding positions. A medium coated electrode shall be used for positional welding. Higher coating will increase production & also produce superior quality of weld but may create problem in overhead & vertical down welding positions.

Type of coating	Coating factor (i.e. Ratio to overall dia Including coating to core wire dia
Light coated	1.25 to 1.35
Medium coated	1.36 to 1.50
Heavy coated	1.51 to 2.20
Super heavy coated	more than 2.20

(d) **Type of covering**: Normally mild steel manual metal arc electrodes have following type of covering. The salient features of each type are given below:

Acidic (A)

(i) The slag is easily detachable.
(ii) High fusion rate.
(iii) Good penetration.
(iv) Most suitable for welding in flat position.
(v) Can be operated both on AC & D.C.

Basic (B)

(i) Slag is easily removable.
(ii) Penetration is average.
(iii) Suitable for welding in all positions but difficult in vertical down position.
(iv) Can be operated both on AC & D.C. but D.C. (+) is generally preferred for critical applications.
(v) Good quality of weld is obtained with low hydrogen content.
(vi) Electrodes should be dried to about 250°C for at least two hours before use.

Cellulosic (C)

(i) Highly penetrating arc.
(ii) Uneven spaced ripples.
(iii) Usually suitable in all positions.
(iv) Suitable for use on D.C. with electrode positive. Some electrodes are also suitable with AC

Rutile (R)

(i) Smooth arc.
(ii) Little spatter.
(iii) Can be used in all positions.
(iv) Can be operated on both AC & D.C.
(v) Slag is easily removable.

Other types (S): No general guidance on special covering electrode characteristics is possible, so potential users should seek the manufacturer's advice.

(C) **Deposition efficiency**:The deposition efficiency of electrode shall be calculated by using formula:

$$\text{Deposition efficiency \%} = \frac{\text{Wt. of weld metal deposit}}{\text{Wt. of core wire used}} \times 100$$

Advantages of high deposition efficiency

(i) Improve arc stability.
(ii) Increase productivity.
(iii) Spatter will be reduced.
(iv) Slag removal is easy.
(v) Appearance of bead will be good
(vi) Economy in power consumption.
(vii) Reduce the welding/repair cost.

Limitations

It may create problem in positional welding.

Cost benefit:

Let weight of 20 meter of core wire of 4mm diameter = 1kg

Let an electrode A of diameter 4.0 mm has deposition efficiency = 120%, and

B electrode of same size has deposition efficiency = 130%

Net cost of electrode A (20 meter length 4.0 mm diameter) = Rs.40/-

Net cost of electrode B (-do-) = Rs.42/-

Weld deposit of electrode A = 1.2 kg

Cost of weld deposit per Kg = $\frac{1x40}{1.2} = 33.3$

Weld deposit of electrode B = 1.3 kg

Cost of weld deposit per kg = $\frac{1x42}{1.3} = 32.3$

Hence cost of per kg of weld deposit in case of electrode B is less although its cost per meter length of core wire is higher.

Other General information:

1. The electrode must be purchased on the basis of length of core wire only.
2. (a) Amongst five classes A, B1, B2, C1 and C2 class A is meant for the lowest quality followed by B1, B2 etc. While class C2 is for highest quality of work. Class C2 electrodes can be used in lieu of C1, B2, B1 and A electrodes. Similarly, Class C1 can be used where classes B1, B2 is required and so on. The reverse, however, is not permissible.
   (b) Electrodes approved under IRS class H3A can be used in lieu of Class H3 electrodes. Reverse, however, is not permissible.
   (c) On the basis of hydrogen content on weld metal covering having H3 in its code is superior and can be used in lieu of covering having H2 & H1 in code but reverse, however, is not permissible.
   (d) The consignee is advised that besides the IRS class, they should also stipulate diameter of electrode, type of covering, deposition efficiency percentage in case of coating in all varieties of electrodes depending upon the specific applications for which the electrodes are being procured as explained earlier.

CORRECT ELECTRODE SIZE-

The following factors should be kept in mind in the correct choice of electrode size :-

- Type and preparation of joint.
- Position of welding.
- The specific requirement welding quality.
- The ability of electrode to carry high current values.
- The mass of the work metal and its ability to maintain its original properties after welding.
- The characteristics of assembly with reference to stress set up by the heat application.
- The practicability of heat treatment before and after welding.

Electrode Cost

The cost of the electrode per foot of weld is determined by several factors. The first is the weight of electrodes deposited per foot of weld. This is dependent on the size of the weld to be made. The second is the cost per pound of the electrode. The third is the deposition efficiency of the electrode. The deposition efficiency is the percentage of the total weight of the electrode that is actually deposited in the weld. This varies from electrode to electrode and for the calculations we will be using, a 2 in. (51 mm) stub loss is assumed. Some of the weight is lost to spatter, slag, and some of the electrode becoming gas. *Table 5-1* shows the electrode consumption for different sizes and types of welds. The equation for the cost of the electrode per foot of weld is:

$$\frac{Electrode Cost}{Foot\ of\ Weld} = \frac{\frac{Pounds\ of\ Weld\ Deposit}{Foot\ of\ Weld} \; X \; \frac{Cost\ of\ Electrode}{Pound}}{Deposition\ Efficiency}$$

Table 5-1 — Calculation of Electrode Consumption

CLASIFICATION OF ELECTRODES AS PER THEIR APPLICATION-

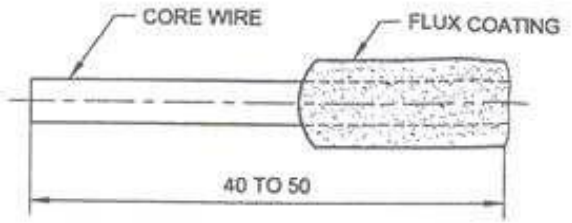
IRS CLASS	Purpose of use	IS/AWS SPEC.	IS/AWS CODE
A-1	Steel sheet joining & GR. FE 330, repairing welding of cast steel GR.200-400W & IS: 2062-99, GR A.IS: 1875-92 class 1 & 1A or Similar. For welding of side walls, Body side stanchions, floor welding, under frame such as crossbar, diagonals, side panels etc.	IS: 814-91	ER 4112 medium coated
A-2	Fabrication of steel bridges the weld deposit shall be of radiographic quality IS:2062-99 GR.B.IS: 1875-92 class 1 & 1A or similar	IS: 814-91	ER 4112X medium coated
A-3	Highly dynamic application made of steel IS:2062-99 GR.C. & low temperature impact property. The weld deposit shall be of radiographic quality	IS: 814-91	EB 5326H2X medium coated
A-4	Highly dynamic application made of steel IS:2062-99 GR. C & low temperature impact property. The weld with high efficiency deposit shall be of radiographic quality	IS: 814-91	EB 5326H2X heavy coated
A-5	Pipe welding or where high penetration of arc is needed	IS: 814-91	ER 4316X medium coated
B-1	Welding of steel component as steel to IS: 8500-91 GR.4408 & 4908, IS: 2002-92 GR. 1&2, IS: 1875-92 class 2, 2A & 3 or similar suitable for repair welding of cast steel to IS: 1030 GR. 230-450W. The weld deposit shall be of radiographic quality. Joining of stainless steel type 3CR 12, IRS M-44 or its equivalent with milo steel / low alloyed steel / corten steel. (For welding of spring buckles)	IS: 814-91	EB5426H3X medium coated
B-2	Application same AS B-1 above with high deposition efficiency	IS: 814-91	EB5426H3JX heavy coated
B-3	Fabrication of components made of steel to ASTM 516 GR. 70 or equivalent where low temperature (AT-46^{O}C) impact properties are required. The weld deposit shall be of radiographic quality.	IS: 1395-B2	E55BC126 heavy coated
B-4	Application same as B-3 above with high deposition efficiency.	IS: 1395-B2	E55BC126J heavy coated
C-1	Fabrication of components made of steel to IS: 8500-91 GR.5408, 5708, 590, IS: 2002-92 GR.3, IS: 1875-92 class 3A or similar. The weld deposit shall be of radiographic quality.	IS: 1395-B2	E63BD126 heavy coated

IRS CLASS	Purpose of use	IS/AWS SPEC.	IS/AWS CODE
C-2	Application same as C1 above with high deposition efficiency.	IS: 1395-B2	E63BD126J Heavy coated
D	Fabrication of component made of weathering. (For welding of centre pivot)	AWSA55	E8018W2 (Heavy coated)
E-1	For fabrication & repairing of buckles, gear	IS: 814-91	ES4213X (Medium coated)
E-2	Repair welding of bogies, both cast & fabricated.	IS: 1395-82	E55BG1Ni26 Heavy coated
F	For reclamation of cast iron with non-machine able deposit.	IS: 5511-91	EfcB26 Medium coated
G	For welding of cast iron with machine able	IS: 5511-91	ENIFeG16 Medium coated
H3s	For resurfacing of fabricated medium-Mn steel or	IS: 5511-91	ENIFeG16 Medium coated
H3A s	Application same as H3 above to withstand a	IS: 5511-91	ENIFeG16 Medium coated
H3B s	Application same as H3 above to withstand a	IS: 5511-91	ENIFeG16 Medium coated
H3C s	Application same as H3 above to withstand a	IS: 5511-91	ENIFeG16 Medium coated
H4A	For non-machineable hard facing of ferrous items	IS: 7303-74	Efe-IC314 (Heavy coated)
H4B	For non-machineable hard facing of ferrous items	IS: 7303-74	Efe-IC314 (Heavy coated)
K	For welding of copper, bronze and other copper	IS: B666-77	ECUSN-A Medium coated
L	For welding of aluminum and aluminium alloys	AWS A5, 3	AL-43 Medium coated
M1	For fabrication of stainless steels type 18% Cr 8% Ni types its equivalent. Welding of stainless Steel, Side walls, End walls, floor, Ladder, Door way stifferner.	IS: 5206-83	E19.9R26 heavy coated
M2	For fabrication of ferritic stainless steels type 3Cr12IRS M-44 or its equivalent, also suitable for fabrication of 18% Cr 8% Ni stainless steels with low carbon.	IS: 5206-83	E19.9R26 heavy coated
M3	For fabrication of stainless steels to ASTM grade 316 or its equivalent.	IS: 5206-83	E19.12.2R26 heavy coated
M4	For joining of dissimilar stainless steels as mentioned in M1, M2 and M3 or their equivalent & also suitable for joining M1, M2 and M3 stainless steels as mentioned above or their equivalent with mild steel or low alloyed steel.	IS: 5206-83	E23.12R26 heavy coated

IRS CLASS	Purpose of use	IS/AWS SPEC.	IS/AWS CODE
M5	For joining of manganese steel liners and other austenitic manganese steel components with steel casting to IS: 1030 Gr.230-450W/280-520W or to IS: 2062 Welding of casnub trolley liners, Axel box liners, Coupler, Reclamation of crane pulleys.	IS: 5206-83	E18.8MnB26 heavy coated
M6	For repair welding of cracked gas inlet casting of diesel locomotives. Used for other repair welding of stainless steels casting having higher percentage of carbon and for welding of high heat resisting stainless steels 25% Cr 20% Ni type or its equivalent.	IS: 5206-83	E25.20R26 heavy coated
N-1	For cutting mild steel low alloy steel, stainless steels, austentic manganese steels, cast iron caststeel & non-ferrous alloys such as nickel alloys, ALU, C, bronzes etc.	IS: 5206-83	E25.20R26 heavy coated
N-2	For gouging & piercing of steels and non-ferrous alloy as described in N1.	IS: 5206-83	E25.20R26 heavy coated
N-3	For gouging of mild & low alloy steel, stainless steels, austenitic manganese steel and cast iron & cast steel, copper coated graphitic type electrode.	IS: 5206-83	E25.20R26 heavy coated

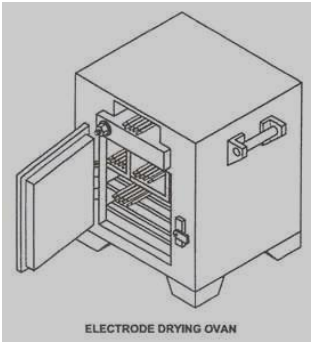
USAGE AND STORAGE OF ELECTRODES

- Electrodes are costly, therefore, use and consume every bit of them.
- Do not discard STUB ENDS more than 40-50 mm length.
- Electrode coating can pick up moisture if exposed to atmosphere.



STUB END

- Store and keep the electrodes (air tight) in a dry place.
- Heat the moisture affected/ prone electrodes in an electrode drying oven at 110-150°C for one hour before using.


ELECTRODE DRYING OVAN

Remember a Moisture Affected Electrode:

- has rusty stub end.
- has white powder appearance in coating.
- produces porous weld.

Storage of Electrodes:

- The efficiency of an electrode is affected if the covering becomes damp.
- Keep electrodes in unopened packets in a dry store.
- Place packages on a duckboard or pallet, not directly on the floor.
- Store so that air can circulate around and through the stack.
- Do not allow packages to be in contact with walls or other wet surfaces.
- The temperature of the store should be about 5°C higher than the outside shade temperature to prevent condensation of moisture.
- Free air circulation in the store is as important as heating. Avoid wide fluctuations in the store temperature.
- Where electrodes cannot be stored in ideal conditions place a moisture absorbent material (e.g. silica gel) inside each storage container.

Drying Electrodes:

Water in electrode covering is a potential source of hydrogen in the deposited metal and thus may cause.

- Porosity in the weld
- Cracking in the weld

Indications of electrodes affected by moisture are:

- White layer on covering
- Swelling of covering during welding
- Dis-integration of covering during welding
- Excessive spatter
- Excessive rusting of the core wire.

Electrode affected by moisture may be dried before use by putting them in a controlled drying oven for approximately one hour at a temperature around 110-150°C. This should not be done without reference to the conditions laid down by the manufacturer. It is important that hydrogen controlled electrodes are stored in dry, heated conditions at all times.

Welded joints and their advantages:

Welding is a very commonly used permanent joining process. Thanks to great advancement in welding technology, it has secured a prominent place in manufacturing machine components. A welded joint has following advantages:

(i) Compared to other type of joints, the welded joint has higher efficiency. An efficiency > 95 % is easily possible.
(ii) Since the added material is minimum, the joint has lighter weight.
(iii) Welded joints have smooth appearances.
(iv) Due to flexibility in the welding procedure, alteration and addition are possible.
(v) It is less expensive.
(vi) Forming a joint in difficult locations is possible through welding.

The advantages have made welding suitable for joining components in various machines and structures. Some typically welded machine components are listed below.

- Pressure vessels, steel structures.
- Flanges welded to shafts and axles.
- Crank shafts
- Heavy hydraulic turbine shafts
- Large gears, pulleys, flywheels
- Gear housing
- Machine frames and bases
- Housing and mill-stands.

Basic types of welded processes:

Welding can be broadly classified in two groups

1) Liquid state (fusion) –
Welding where heat is added to the base metals until they melt. Added metal (filler material) may also be supplied. Upon cooling strong joint is formed. Depending upon the method of heat addition this process can be further subdivided, namely-
(i)Electrical heating: Arc welding
Resistance welding
Induction welding
(ii) Chemical welding: Gas welding
Thermit welding
(iii) Laser welding
(iv) Electron beam welding

2) Solid state welding: Here mechanical force is applied until materials deform to plastic state. Bonds are then formed through molecular interaction. Solid state welding may be of various kinds, namely,
(i) Cold welding
(ii) Diffusion welding
(iii) Hot forging

Descriptions of the individual welding processes are to be found in any standard textbook on welding.

Strength of welded joints:

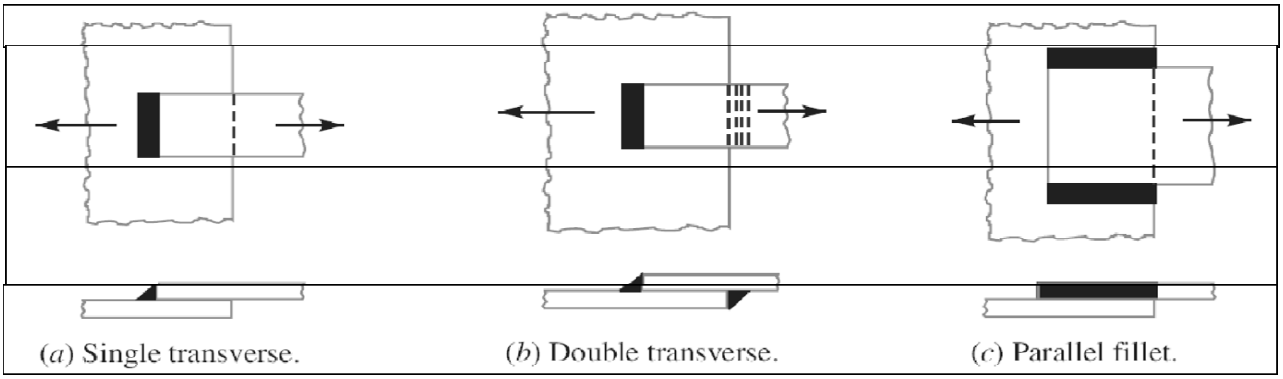
Adequate care must be taken to enhance strength of the welded joint. It is seen that strength of a welded joint gets affected mainly by the following factors.

(i) Crack initiation: it is possible that cracks form while cooling a melted metal.
(ii) Residual stresses: due to inhomogeneous heating of the base metals, residual stresses may exist upon cooling
(iii) Metallurgical transformation: in heat affected zone (HAZ) metallurgical properties may change leading to weakening of the joint.
(iv) Defects: of various kinds like incomplete penetration, porosity, slag inclusion which affect the strength of a welded joint.
(v) Stress concentration: abrupt change in the geometry after welding may introduce stress concentration in the structure.

Types of welded joints:

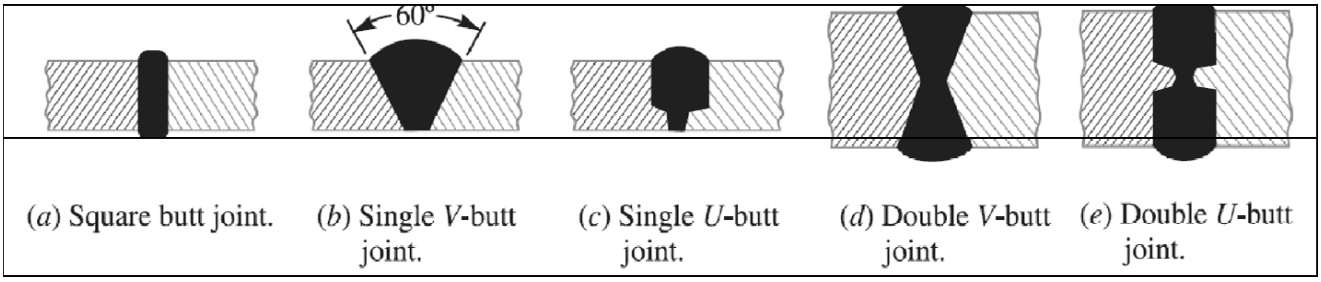
Welded joints are primarily of two kinds:

(i) **Lap or fillet joint**: obtained by overlapping the plates and welding their edges. The fillet joints may be single transverse fillet, double transverse fillet or parallel fillet joints.

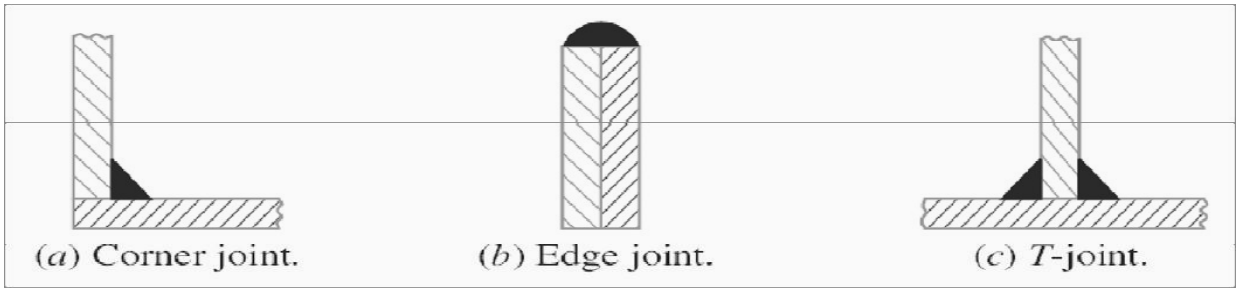


(ii) **Butt joints**: formed by placing the plates edge to edge and welding them. Grooves are sometimes cut (for thick plates) on the edges before welding. According to the shape of the grooves, the butt joints may be of different types, e.g.,

- Square butt joint
- Single V-butt joint, double V-butt joint
- Single U-butt joint, double U-butt joint
- Single J-butt joint, double J-butt joint
- Single bevel-butt joint, double bevel butt joint



(iii) **Other Joints:** The other type of welded joints are corner joint, edge joint and T-joint as shown in Fig. below.



Each type of joint has its own symbol. The basic weld symbols are shown below:

Basic weld types and their symbols

S. No.	Type of weld	Symbol
1.	Fillet joint	
2.	Square butt joint	
3	Single V- butt joint	
4	Double V- butt joint	
5	Single U - butt joint	
6	Single bevel butt joint	

After welding is done the surface is properly finished. The contour of the welded joint may be flush, concave or convex and the surface finish may be grinding finish, machining finish or chipping finish. The symbols of the contour and the surface finish are shown below:

Supplementary Weld Symbols

Sl No.	Particulars	Weld Symbol
1	Flush contour	
2	Convex contour	
3	Concave contour	
4	Grinding finish	G
5	Machining finish	M
6	Chipping finish	C

Welding symbol:

A welding symbol has following basic elements:

(i) Reference line
(ii) Arrow
(iii) Basic weld symbols (like fillet, butt joints etc.)
(iv) Dimensions
(v) Supplementary symbols
(vi) Finish symbols
(vii) Tail
(viii) Specification processes.

These welding symbols are placed in standard locations (see figure below)