भारतीय मानक

मृदु इस्पात और अल्प मिश्र इस्पात की निमज्जन आर्क वेल्डिंग — सिफारिशें

(पहला पुनरीक्षण)

Indian Standard

SUBMERGED ARC WELDING OF MILD STEEL AND LOW ALLOY STEELS — RECOMMENDATIONS

(First Revision)

UDC 621·791·753·5 : 669·141·24

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1995

Price Group 7

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Arc Welding Applications and Thermal Cutting Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1967. While reviewing the standard in the light of experience gained during these years, the Committee decided to revise it, to bring in line with the present practices being followed by Indian industry in this field.

In this revision, the following changes have been made:

a) Joint preparation requirements have been modified;

b) Requirements for assembly for welding have been modified;

c) Typical welding current ranges for commonly used welding wires have been incorporated;

d) Typical welding parameters for various weld assemblies have been incorporated in Annex A; and

e) Form factor requirements has been incorporated in Annex B.

Submerged arc welding of mild steel and low alloy steels is becoming popular in the country. In order to provide sufficient guidance in the proper development of this type of welding, the technical committee felt that these recommendations will be helpful to the users of the submerged arc welding techniques. The details regarding edge preparation for joints and the type of equipment are given in this standard. For filler wire and flux to be used, reference may be made to IS 7280 : 1974 'Core wire electrodes for submerged arc welding of structural steel' and IS 3613 : 1974 'Acceptance tests for wire flux combinations for submerged arc welding'.

Typical welding parameters for various weld assemblies, as given in Annex A, are for reference purposes only.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SUBMERGED ARC WELDING OF MILD STEEL AND LOW ALLOY STEELS — RECOMMENDATIONS

(First Revision)

1 SCOPE

This standard covers recommendations on materials, equipment, plate-edge preparation and testing for automatic submerged arc welding of mild and low alloy steels having a tensile strength not exceeding 588 N/mm^2.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
812 : 1957	Glossary of terms relating to welding and cutting of metals
2002 : 1992	Steel plates for pressure vessels for intermediate and high temperature service including boilers (*second revision*)
2041 : 1982	Steel plates for pressure vessels used at moderate and low temperature (*first revision*)
2062 : 1992	Steel for general structural purposes (*fourth revision*)
2825 : 1969	Code for unfired pressure vessel
3039 : 1988	Specification for structural steels for construction of hulls of ships (*first revision*)
3503 : 1966	Specification for marine boilers, pressure vessels and welded machinery structure
3613 : 1974	Acceptance tests for wire flux combinations for submerged arc welding (*first revision*)
7280 : 1974	Core wire electrodes for submerged arc welding of structural steels
8500 : 1991	Structural steel-microalloyed (medium and high strength qualities) (*first revision*)
9595 : 1980	Recommendations for metal arc welding of carbon and carbon manganese steels

3 TERMINOLOGY

Terms used in this standard shall have the meaning assigned to them in IS 812 : 1957. Further, for the purpose of this standard, the following definitions shall apply.

3.1 Submerged Arc Welding

Arc welding in which a bare wire or a flux cored wire electrode is used. The arc is completely enveloped in a powdered flux, some of which fuses to form a removable covering of slag on the weld.

3.2 Single Wire Welding

Submerged arc welding using only one wire connected to one power source.

3.3 Two Wire Parallel Welding

Submerged arc welding using two wires fed through the same current carrying jaws or tips connected to one power source.

3.4 Multi-Wire Multi-Power Welding

Submerged arc welding using two or more wires, each with separately controlled power source.

3.5 Narrow Gap Submerged Arc Welding

A technique of submerged arc welding characterized by a constant number of beads per layer (usually two) that are deposited one on top of the other in deep narrow angle or square groove.

4 PARENT METAL

The parent metal shall conform to IS 2002 : 1992, IS 2041 : 1982, IS 2062 : 1992, IS 3039 : 1988, IS 3503 : 1966 and IS 8500 : 1991.

5 FILLER WIRE AND FLUX

The filler wire and flux combination shall conform to the requirements for the desired application as laid down in IS 3613 : 1974 and IS 7280 : 1974.

6 EQUIPMENT

The equipment used for submerged arc welding shall generally comprise:

a) A welding head or heads with a motor or motors for feeding the wire or wires, and a flux receptacle for feeding the flux;

b) A control panel with ammeter, volt meter, inch-up and inch-down switch, and suitable controls to control the arc length and hold it steady at a predetermined value;

c) Power sources, either d.c. with dropping or constant potential characteristics or a.c. or both as required for the arc length controls provided; and

d) Appropriate mechanical devices to traverse the welding head or the weldment at desired speeds. Seam tracking and guidance system may be provided.

7 JOINT PREPARATION

7.0 General

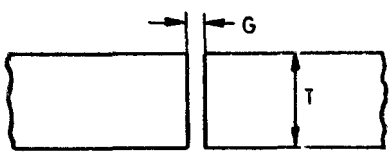
Joint preparation depends upon plate thickness, type of joint for example longitudinal or circumferential, joint approachability (whether accessible from both sides or from one side only) and standard of construction. The recommendations given in **7.1** to **7.7** are based on good practice and are expected to yield satisfactory results. A seal run by shielded metal arc process is recommended for joints **7.2** to **7.5** when the gap is excess and the occurrence of burn-through is likely.

7.1 Square Butt Preparation

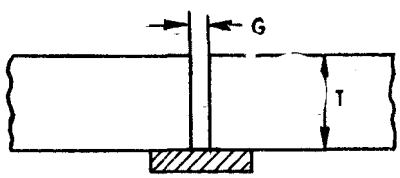
Figures 1A and 1B illustrate the butt preparation generally recommended, this is the most economical type both from the point of view of cost of edge preparation and volume of filler materials required. Generally, square edge close butt preparations without back chipping are not recommended for thicknesses above 16 mm because the weld reinforcement becomes unacceptably heavy.

7.2 Single V and Single V with Nose, or Y Preparation

Figures 2A to 2D illustrate the recommended single V and Y preparations. When both sides are accessible for submerged arc welding, the bevelled side is welded first. If only one side is accessible for submerged arc welding, a temporary copper backing bar or flux backing or an integral backing bar may be employed. When a temporary backing bar or flux backing is used, it is good practice to backchip the underside of the weld and lay a sealing run by manual welding. Figure 2D illustrates the preparation recommended for submerged arc welding of thicknesses 30 mm and over with manual weld backing. The U groove is welded first by manual arc welding which acts as backing for subsequent automatic arc welding.



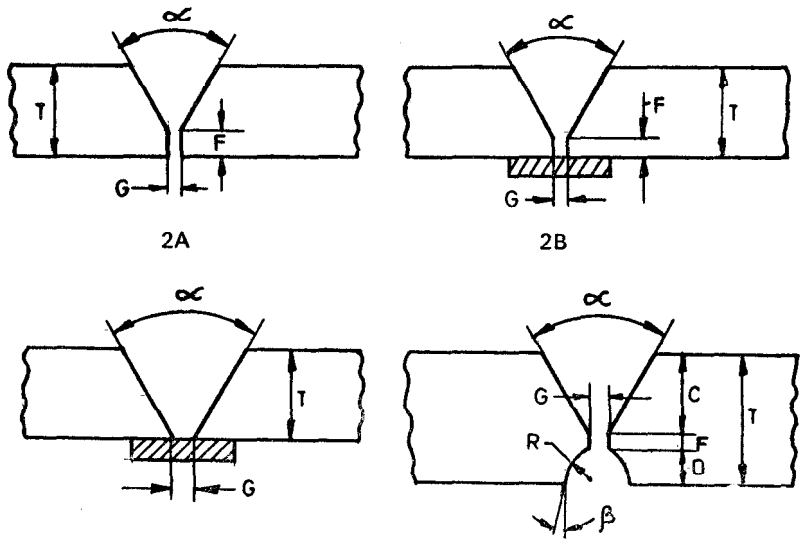
1A



1B

	Thickness *T* mm	Gap *G, Max* mm
One run from each side (Fig. 1A)	5 — 16	1
One run from one side only (Fig. 1A)	Up to 8 mm	1
One run with temporary backing bar or flux backing or ceramic backing (Fig. 1B)	1·5 — 8	3
One run with integral steel backing strip (Fig. 1B)	5 — 10	5

FIG. 1 SQUARE BUTT PREPARATION



2A 2B

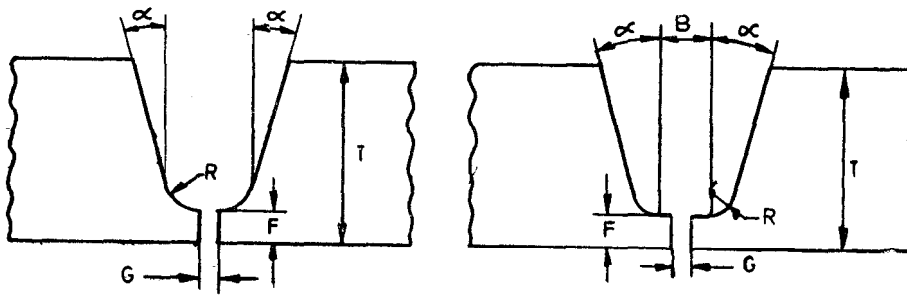
2C 2D

	Thickness T mm	Included Angle α	Root Face F mm	Root Gap, G, *Max* mm	Depth of V C mm	Depth of U D mm	Root Radius R mm	Bevel Angle β
One run from each side (Fig. 2A)	12-36	45°-75°	6	1	—	—	—	—
One run with copper backing (Fig. 2B)	5-36	30°-60°	3-5	1·5	—	—	—	—
One run with flux backing	6-36	30°	—	1	—	—	—	—
One run with integral backing (Fig. 2C)	12-20	30°-45°	—	5	—	—	—	—
One run with manual backing run (Fig. 2D)	32-63	70°-80°	3	3	18-25	9-32	6	7

FIG. 2 SINGLE V OR Y PREPARATION

7.3 Single U Preparation

Figure 3A illustrates the single U preparation. The cost of this type of edge preparation is high but as the volume of weld metal required is less than that for single V or Y preparations, the cost of welding is low. Consequently above a certain thickness, say 40 mm, reduction in cost of welding offsets the increased cost of plate edge preparation. For such applications, this preparation is recommended. A slightly modified form is illustrated in Fig. 3B. Recommendations about the use of backing bars and back sealing welds in **7.2** are applicable to this preparation as well.



3A 3B

	Thickness T mm	Angle α	Root Face F mm	Root Gap G, *Max* mm	Radius R mm	Width B mm
With subsequent hand sealing run (Fig. 3A)	Over 40	5°-15°	5-12	1·5	5-8	—
With integral backing strip	Over 40	5°-15°	5-8	3	5-8	—
Modified U (bucket shaped) with subsequent hand sealing run (Fig. 3B)	Over 40	5°-15°	5-12	1.5	—	0-15

FIG. 3 SINGLE U PREPARATION

7.4 Double V or Double V with a Nose

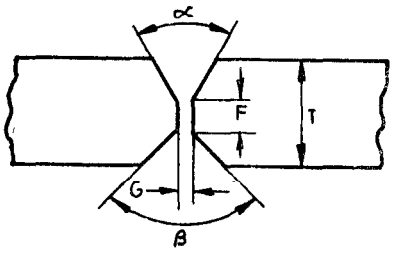
Above a certain thickness, say 20 mm, a double V preparation as illustrated in Fig. 4A and 4B may prove more economical than a single V preparation (provided both sides of the weldment are accessible) and is, therefore, to be preferred. This preparation helps to minimize angular distortion usually met within joints welded with single V and single U preparations. If applications warrant, this preparation may be made asymmetrical for example with one third or two thirds of the thicknesses. The V on one side generally has wider included angle and is welded last.

7.5 Double U Preparation

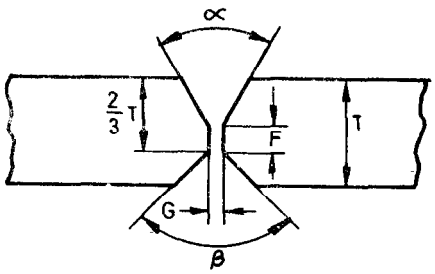
On very thick sections, say over 50 mm, a double U preparation will be found to be even more economical than a double V and is illustrated in Fig. 5. If required, asymmetrical double U preparations may be adopted.

7.6 T, Fillet and Corner Preparation

Besides the joints described in **7.1** to **7.5**, fillet joints, T joints and corner joints may also be welded by submerged arc welding process. Some of the recommended preparations are illustrated in Fig. 6A and 6B and 7A to 7E. Fillet and T welds should preferably be tilted as shown in Fig. 6A and 6B.



4A SYMMETRICAL



4B ASYMMETRICAL

Submerged Arc Welding from Both Sides	Thickness *T*, mm	Included Angle α	Included Angle β	Root Face *F* mm	Root Gap *G, Max* mm
Symmetrical (Fig. 4A)	Over 15	50°-70°	70°-90°	5-8	1
Asymmetrical (Fig. 4B)	Over 15	40°-60°	60°-80°	5-8	1

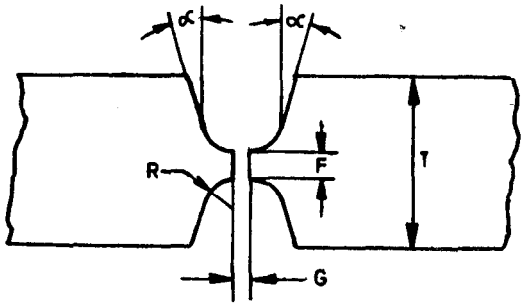
NOTES

1 Ratio of joint thickness to cylinder diameter when the above preparation is used for welding circumferential welds should be less than 1 : 25.

(Cylinder Diameter/Joint Thickness) > 25

2 Asymmetrical double V preparation may also be used for welding one side by submerged arc welding and the other by manual arc to act as the backing.

FIG. 4 DOUBLE V PREPARATION



Symmetrical Joint
(Both sides welded by submerged arc welding)

Thickness *T*	Angle α	Root Face *F*	Root Gap *G, Max*	Radius *R*
mm		mm	mm	mm
Over 50	5°-15°	5-8	1-5	5-6

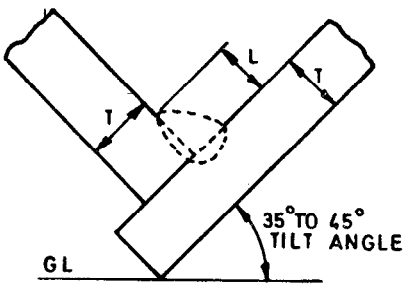
FIG. 5 DOUBLE U JOINT

7.7 Unusual Preparations

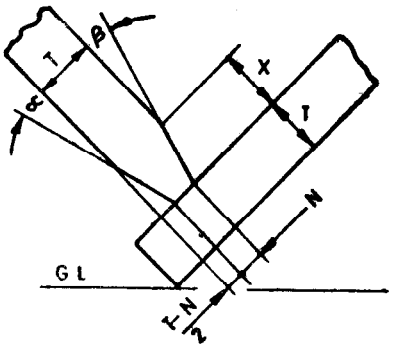
Some unusual joint preparations are illustrated in Fig. 8A to 8C. These joints may be used with submerged arc welding. These are purely optional and may be used after suitable trials.

8 ASSEMBLY FOR WELDING

8.1 If a jig is not used, the edges should be kept in alignment during welding by tack welds spaced at regular intervals all along the joints. The tack welds should be melted out during welding or made part of and of the same quality as the main welds. Defective tack welds should be removed before welding commences. Edges may be prepared by flame cutting, flame gouging or machining.



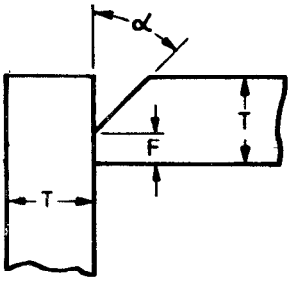
6A



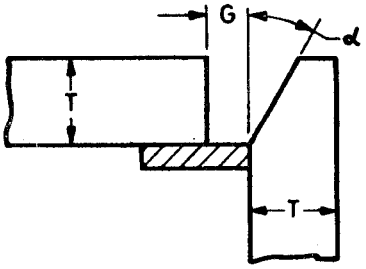
6B

	Thickness T mm	Nose N mm	Bevel X mm	Angle α	Angle β
Fillet weld titled without edge preparation (Fig. 6A)	16-36	Nil	Nil	Nil	Nil
T butt weld titled with edge preparation (Fig. 6B)	16-36	6-10·5	10-22	20°-25°	20°-30°

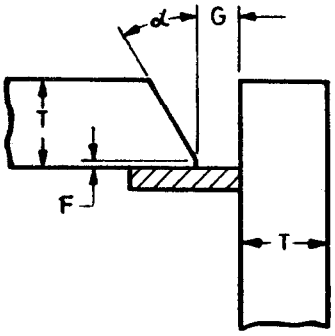
FIG. 6 TILTING OF FILLET WELD AND T JOINTS



7A



7B



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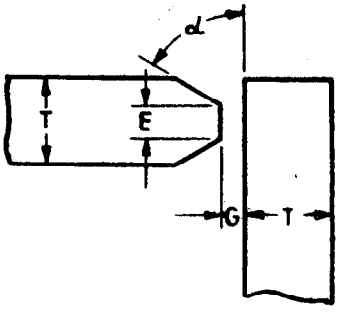
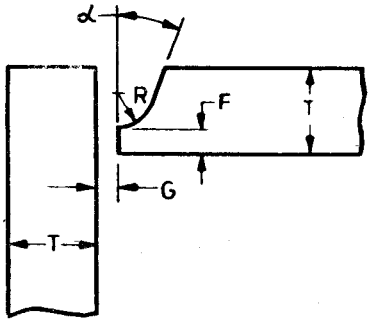
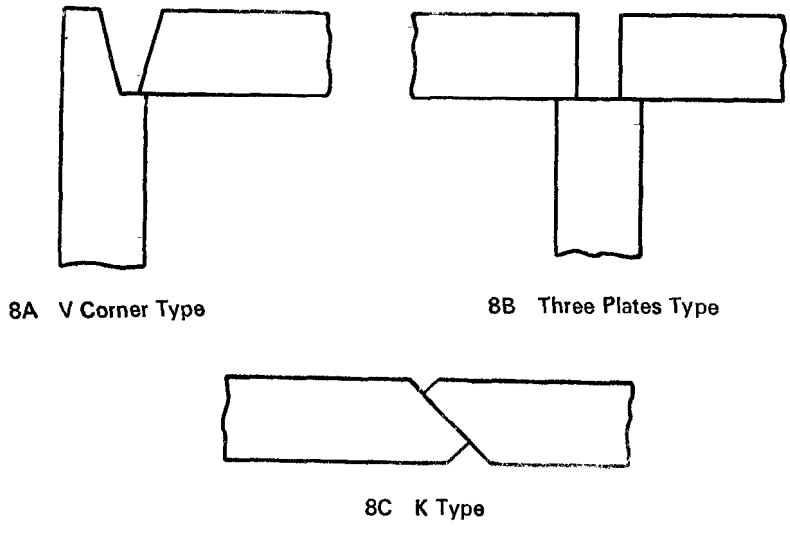




7D 7E

	Thickness, T mm	Included Angle α	Root Face F mm	Root Gap G, *Max* mm	Radius R mm
Fig. 7A	10-30	40°-50°	6-12	0	—
Fig. 7B and 7C with integral backing strip	16-40	10°-30°	0-1	10	—
Fig. 7D and Fig. 7E temporary or integral backing bar as deemed fit	12-20	45°-60°	6-10	5	—
	20-40	20°-40°	6-10	15	6-15

FIG. 7 CORNER JOINTS



8A V Corner Type

8B Three Plates Type

8C K Type

FIG. 8 SOME UNUSUAL PREPARATION WHICH MAY BE USED WITH SUBMERGED ARC AUTOMATIC WELDING

8.1.1 All welding faces and adjoining surfaces for a distance of at least 15 to 20 mm from the edge of the welding groove or from the toe of the fillet should be thoroughly cleaned of rust, paint, oil, grease, etc, to avoid pick up of impurities. Flame cut edges should be ground or wire brushed to avoid the defects arising out of bad cuts.

8.1.2 *Square Groove Butt Joint*

The reinforcement of square groove welds tends to increase with the plate thickness. However, with suitable backing and adjustment of root gap, this can be somewhat controlled and single pass good quality welds can be achieved.

8.1.3 *Double Sided Welding*

In double sided welding, welding is made on each side of the assembly. The first pass penetrates the joint partially and receives weld metal support from the butted plates themselves. For this reason, fit up is important and the plates must be butted tightly together. Any misalignment can cause excessive rework. Also in the improper double V groove joint, the gap causes porosity in the first pass.

8.1.4 *Manually Welded Backing*

Often manual backing welds are used due to fabrication reason. It is important that sufficient root opening or gap is provided so that proper penetration can be obtained.

8.2 Welding Current

The generally accepted current ranges for the commonly used welding wire diameters are:

Welding Wire Diameter in mm	*Current Range* Amperes
2·4	250-700
3·2	350-900
4·0	400-1 000
5·0	500-1 200
6·0	600-1 400

NOTE — The current range shall be selected depending upon the capability of welding flux, as recommended by manufacturer of flux.

8.2.1 Typical welding parameters for various weld assemblies are given in Annex A. The parameters given are for reference only. Actual parameters are to be established by the fabricator/supplier depending upon his experience.

8.2.2 *Incorrect Form Factor*

Form factor is the ratio of weld pool width (w) to its maximum depth (b_T). For sound welds, form factor should be around 3/2. Too high a form factor gives tendency for surface cracks and too low a form factor gives tendency for center line cracking. Form factor is greatly influenced by current and weld groove shape, *see* Annex B.

9 PRE-HEATING AND POST-WELD HEAT TREATMENT

9.1 Pre-heating is normally not required for mild steel joints up to 40 mm. For welding restrained joints or when welding low alloy steels, joints may be pre-heated to a temperature of 150°C. However, pre-heating shall be done for all steels having carbon equivalent greater than 0·45.

9.2 Pre-heating shall be done so as to ensure a uniformly heated band of 50 to 75 mm on either side of the weld and to maintain the pre-heating temperature until the entire welding operation is completed.

9.3 Post-weld heat treatment is normally not required for mild steel joint up to 40 mm. For all other steels, post-weld heat treatment shall be done as per steel manufacturer's recommendation.

10 ACCEPTANCE FOR WELDING PROCEDURE

10.1 For establishing welding procedure, joints shall be welded by submerged arc welding process and tested in accordance with **10.2**, **10.3** and **10.4**. Depending upon the application, tests shall be grouped under three categories namely:

Group A — Structural welding,

Group B — Hull construction, and

Group C — Pressure vessels.

10.2 Group A — Structural Welding

The parent plate, the thickness, the preparation and the technique of welding employed for the test piece shall be same as those to be used for the fabrication except that for multi-pass welding. For multi-pass welds, if the thickness employed for the fabrication is less than or equal to 20 mm, the test shall be carried out on similar material thickness. If the thickness employed for the fabrication is more than 20 mm, the test shall be carried out on 20 mm thick base material minimum and not less than half the thickness of the fabrication material. If the two-run technique is employed, thickness of the specimen shall be 12 mm minimum and not less than the thickness of fabrication material. Two pieces each 600 mm long and 150 mm wide shall be butt welded along the length.

10.2.1 The tensile test, bend test and the impact test specimens shall be prepared and the tests conducted in accordance with appropriate clauses in IS 3613 : 1974, the tensile strength, yield point, elongation, and the Charpy V notch impact value shall not be less than the minimum prescribed for the parent plate used in the fabrication. The bend test specimen, after bending to the angle specified for the parent metal, should show no cracks on the tension side.

10.3 Group B — Hull Construction

Besides the tests conducted under Group A above, a further test piece shall be prepared as prescribed in IS 3613 : 1974 for approval for hull construction. Regardless of the thickness employed for the fabrication, this test piece shall be prepared from similar material of 20 mm thickness. Test results shall conform to the requirements laid down for wire-flux combination for hull construction for the grade of steel employed.

10.4 Group C — Pressure Vessels

The procedure qualification test for pressure vessels shall conform to the provisions of IS 2825 : 1969.

11 TESTING AND INSPECTION

11.1 Having established the most suitable welding procedure, actual jobs shall be welded strictly in accordance with it.

11.1.1 Whenever possible a run-on and run-off plate shall be tacked on the joints to be welded. These plates shall preferably be of the same material and thickness as the parent plate and prepared in an identical manner. Welds shall be so deposited that the run-off plate will form a part of the main weld and tested to determine its quality.

ANNEX A

(*Foreword* and *Clause* 8.2.1)

WELDING PARAMETERS FOR WELD ASSEMBLIES

A-1 SQUARE GROOVE WELDS WITH COPPER BACKING (1·6 to 8 mm)

Welding parameters for square groove welds with copper backing (1·6 to 8 mm) are given in Table 1 (*see* Fig. 9).

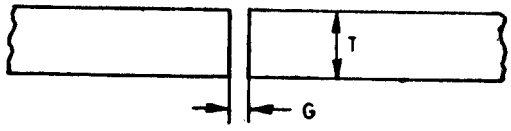


FIG. 9 SQUARE GROOVE WELD

Table 1 Welding Parameters for Square Groove Welds

Thickness, *T* mm (1)	Root Gap *G* mm (2)	Welding Wire Diameter mm (3)	Welding Current Amp (4)	Welding Current Volts (5)	Welding Speed mm/min (6)
1·6	0	2·4	250-350	22-24	2 550-3 800
2·0	0	2·4	325-400	24-26	2 550-3 800
3·0	0	2·4	350-425	24-26	1 900-2 550
3·5	1·6	2·4	400-475	24-27	1 275-2 025
4·4	1·6	3·2	500-600	24-27	1 000-1 775
4·7	1·6	3·2	575-650	25-27	900-1 150
6·35	2·4	4·0	750-850	27-29	750-900
8·0	2·4	5·0	800-900	26-30	650-750

A-2 DOUBLE V GROOVE WELDS WITH MANUAL WELD BACKING (10 to 30 mm)

Welding parameters for double V groove welds with manual weld backing (10 to 30 mm) are given in Table 2 (*see* Fig. 10).

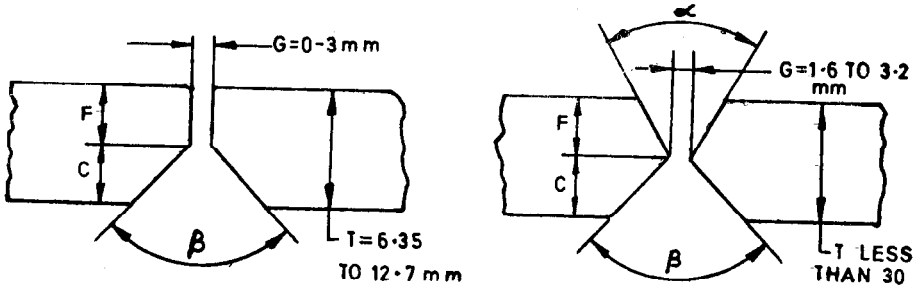


FIG. 10 DOUBLE V GROOVE WELDS

Table 2 Welding Parameters for Double V Groove Welds

(*Clause* A-2)

Thickness *T*	Single Machine Pass I.D. *Min*	Root Face *F*	Angle α	Welding Current		Welding Speed	Welding Wire Diameter	Manual Backing	
				Amp *Min*	Volts *Max*			*C*	β
mm	mm	mm				mm/min	mm	mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
10	350	5	60°	700	33	450	4	5	90°
12	350	6	60°	850	33	400	4	6	90°
14	375	7	60°	900	35	400	5	7	90°
16	375	8	90°	1 000	35	350	5	8	90°
17	400	10	90°	1 000	35	325	5	7	90°
19	450	10	90°	1 050	35	300	5	9	90°
20	500	10	70°	1 100	35	325	5	10	90°
22	500	12	70°	1 150	35	300	6	10	90°
25	550	16	70°	1 250	35	275	6	9	90°
30	750	20	70°	1 350	36	250	6	10	90°

A-3 TWO PASS DOUBLE V GROOVE WELDS (10 to 25 mm)

Welding parameters for two pass double V groove welds (10 to 25 mm) are given in Table 3 (*see* Fig. 11).

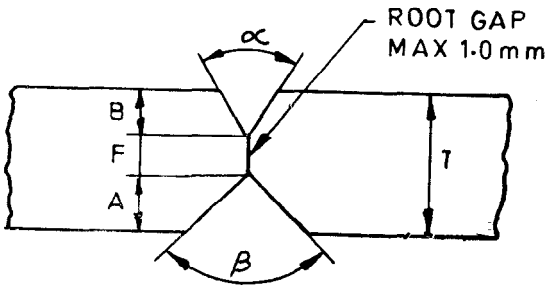


FIG. 11 TWO PASS DOUBLE V GROOVE WELDS

Table 3 Welding Parameters for Two Pass Double V Groove Welds

Thickness *T*	Finishig Weld							Backing Weld						
	Min ID	Depth of *V* *B*	Angle α	Welding Current		Welding Speed	Wire Diameter	Root Face *F*	Depth of *V* *A*	Angle β	Welding Current		Welding Speed	Wire Diameter
				Amp *Min*	Volts *Max*	mm/min					Amp *Min*	Volts *Max*	mm/min	
mm	mm	mm					mm	mm	mm					mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
10	350	*	*	600	33	500	4	10	0	0	550	33	550	4
12	450	*	*	900	35	400	4	10	3	90°	650	35	450	4
14	400	*	*	1 000	35	400	5	10	5	90°	700	35	450	5
16	450	5	90°	1 050	35	350	5	6	5	90°	750	33	450	5
17	500	6	90°	1 100	35	325	5	6	5	90°	800	33	400	5
19	525	6	90°	1 150	35	325	6	8	5	90°	850	33	400	6
20	530	8	90°	1 200	35	325	6	8	5	90°	900	33	400	6
22	600	8	90°	1 250	35	300	6	8	6	90°	950	34	375	6
25	600	8	10°	1 300	35	275	6	8	7	90°	1 000	34	375	6

*Chipback grinding up to sound weldmetal. Groove profile should be smooth and wide enough to carry out SAW.

A-4 SINGLE V GROOVE WELDS WITH COPPER BACKING (5 to 20 mm)

Welding parameters for single V groove welds with copper backing (5 to 20 mm) are given in Table 4 (*see* Fig. 12).

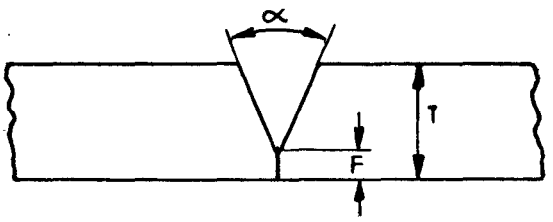


FIG. 12 SINGLE V GROOVE WELD

Table 4 Welding Parameters for Single V Groove Welds

(*Clause* A-4)

Thickness, *T* mm (1)	Angle α (2)	Root Face *F* mm (3)	Welding Current Amperes (4)	Welding Current Volts (5)	Welding Speed mm/min (6)	Wire Diameter mm (7)
5	60°	3·2	500-575	28-31	725-1 250	4
6	60°	3·2	725-825	29-32	700-1 125	4
8	60°	3·2	775-900	30-33	650-1 000	5
10	60°	3·2	900-1 000	32-36	600-675	5
11	60°	3·2	1 000-1 100	32-36	550-625	5
12	60°	5	1 075-1 175	34-37	550-575	6
16	45°	5	1 150-1 250	35-38	400-475	6
20	45°	5	1 200-1 300	36-39	325-350	6

A-5 SQUARE GROOVES AND SINGLE V GROOVE WELDS WITH STEEL BACKING

Welding parameters for square groove and single V groove welds with steel backing (5 to 20 mm) are given in Table 5 (*see* Fig. 13).

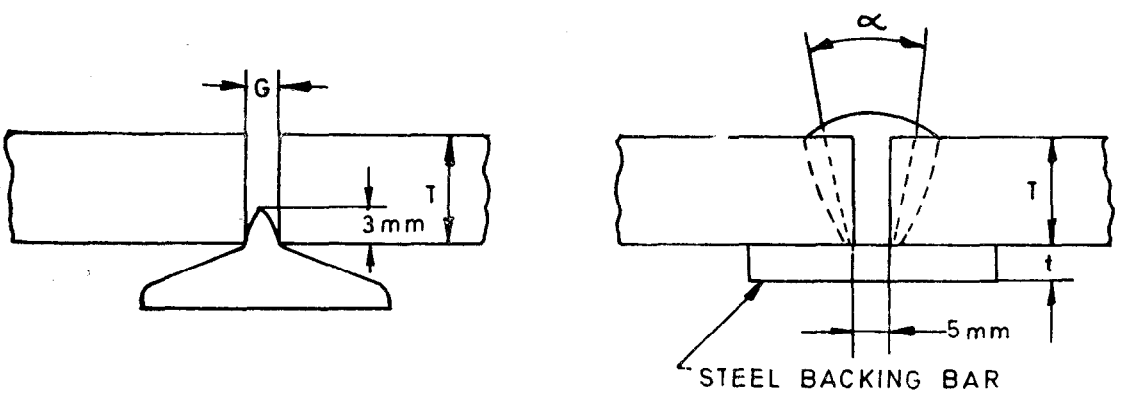


FIG. 13 SQUARE GROOVE AND SINGLE V GROOVE WELDS

Table 5 Welding Parameters for Square Groove and Single V Groove Welds

(*Clause* A-5)

Thickness of BM *T* mm (1)	Edge Preparation Angle α (2)	Root Gap *G, Min* mm (3)	Thickness of Backing Bar, *t* mm (4)	Welding Current Amperes *Min* (5)	Welding Current Volts *Max* (6)	Welding Speed mm/min (7)	Wire Diameter mm (8)
5	Square	1·6	5	750	27	700-1 000	4
6	Square	3·2	6	850	27	550-750	4
8	Square	3·2	6	850	28	500-750	5
10	Square	3·2	6	900	28	450-750	5
11	30° V	5	10	950	30	300-500	5
12	30° V	5	10	975	30	300-500	5
16	30° V	5	12	1 100	30	275	6
20	30° V	5	12	1 200	30	225	6

A-5.1 Modification to single V groove welds is given in Fig. 14 and parameters are given in Table 6.

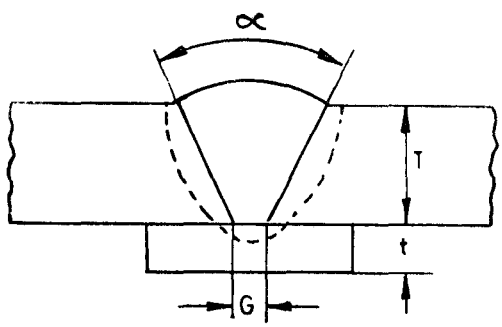


FIG. 14 MODIFIED SINGLE V GROOVE WELD

Table 6 Welding Parameters for Modified Single V Groove Welds

Thickness *T* mm (1)	Edge Preparation Angle α (2)	Root Gap *G, Min* mm (3)	Thickness of Backing Bar *t* mm (4)	Welding Current Amperes *Min* (5)	Welding Current Volts *Max* (6)	Welding Speed mm/min (7)	Wire Diameter mm (8)
6	45° V	3·2	6	800	30	450	4
8	45° V	3·2	6	800	30	400	5
10	45° V	3·2	6	800	30	300	5
12	45° V	5	10	960	30	240	5
16	45° V	5	10	800[1)]	35	300	5
				1 000	33	250	5
20	45° V	5	10	1 000[1)]	36	240	6
				1 000	33	250	6

[1)] First pass of two-pass weld

A-6 TWO-PASS SQUARE AND SINGLE V GROOVE WELDS (6 to 25 mm)

Welding parameters for two-pass square and single V groove welds (6 to 25 mm) are given in Tables 7 and 8 (*see* Fig. 15 and 16).

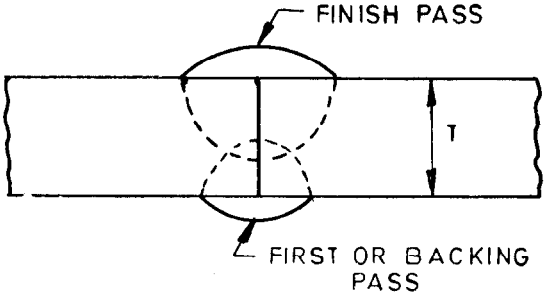


FIG. 15 TWO PASS SQUARE WELDS

Table 7 Welding Parameters for Two Pass Square Welds

Thickness, *T* mm	Welding Current		Welding Speed mm/min	Wire Diameter mm	Preparation Before Finishing Pass
	Amperes *Min*	Volts *Max*			
(1)	(2)	(3)	(4)	(5)	(6)
6 BP[1]	400	32	700-1 125	2·4 or 3·2	None
FP[2]	500	30	675-1 125	2·4 or 3·2	
8 BP[1]	420	32	700-1 000	2·4 or 3·2	None
FP[2]	550	30	650-1 000	3·2 or 4·0	
10 BP[1]	500	32	700-800	3·2 or 4·0	None
FP[2]	650	32	600-800	3·2 or 4·0	
11 BP[1]	600	33	600	3·2 or 4·0	None
FP[2]	700	33	550-675	3·2 or 4·0	
12 BP[1]	650	33	550	3·2 or 4·0	None
FP[2]	750	35	500-625	3·2 or 4·0	
14 BP[1]	700	33	500	3·2 or 4·0	None
FP[2]	800	35	450	3·2 or 4·0	
16 BP[1]	725	33	450	4·0 or 5·0	Gouge
FP[2]	850	35	400	4·0 or 5·0	
18 BP[1]	850	38	300	4·0 or 5·0	Gouge
FP[2]	1 100	42	300	5·0	
20 BP[1]	960	38	300	5·0	Gouge
FP[2]	1 100	42	300	5·0	

[1] BP = Backing Pass.
[2] FP = Finishing Pass.

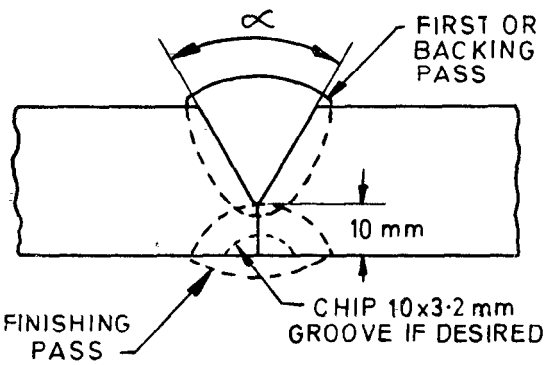


FIG. 16 TWO PASS SINGLE V GROOVE WELDS

Table 8 Welding Parameters for Two Pass Single V Groove Welds

(*Clause* A-6)

Thickness *T* mm	Welding Current		Welding Speed mm/min	Wire Diameter mm	Total V Angle α
	Amp, *Min*	Volts, *Max*			
(1)	(2)	(3)	(4)	(5)	(6)
14 BP[1]	850	33	500	4·0	75°
FP[2]	650	33	550	4·0	
16 BP[1]	900	33	450	4·0	75°
FP[2]	700	33	550	4·0	
20 BP[1]	950	33	400	5·0	60°
FP[2]	750	33	500	5·0	
22 BP[1]	1 100	35	350	5·0	45°
FP[2]	800	35	450	5·0	
25 BP[1]	1 200	35	300	6·0	75°
FP[2]	850	35	450	6·0	

[1] BP = Backing Pass.

[2] FP = Finishing Pass.

A-7 FILLET WELDS IN FLAT POSITION (3.2 to 38 mm)

Welding parameters for fillet welds in flat position (3·2 to 38 mm) for the two cases are given in Tables 9 and 10 (*see* Fig. 17 and Fig. 18).

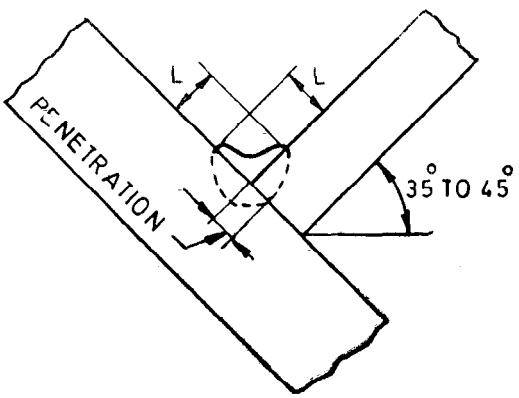


FIG. 17 FILLET WELD IN FLAT POSITION

Table 9 Welding Parameters for Fillet Welds in Flat Position

(*Clause* A-7)

Normal Fillet Size *L* mm (1)	Welding Current Amperes *Min* (2)	Welding Current Volts *Max* (3)	Welding Speed mm/min (4)	Wire Diameter mm (5)
3	400	25	900-1 625	2·4
5	500	25	800-1 000	3·2
6	650	27	700-875	4·0
8	650	27	550	4·0
10	750	29	450	5·0
12	900	32	400	5·0
16	1 050	32	325	6·0
20	1 150	32	275	6·0

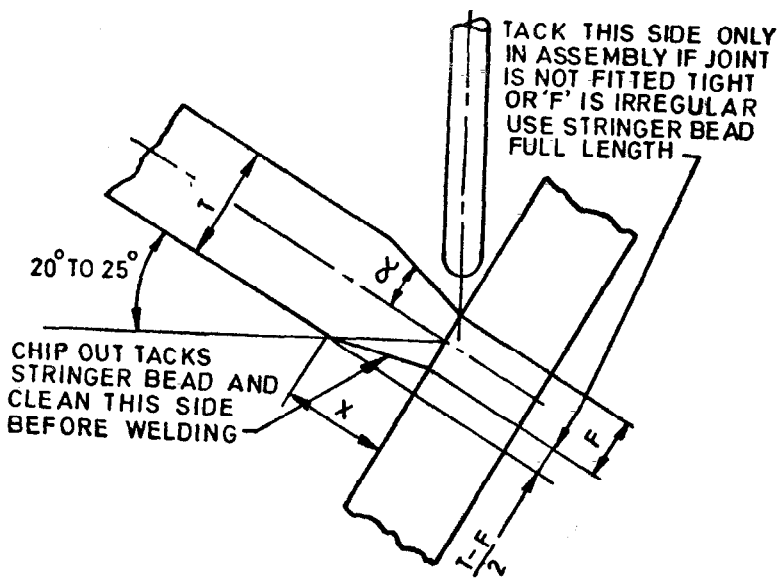


FIG . 18 FILLET WELDS IN FLAT POSITION (WELDING WIRE VERTICAL)

Table 10 Welding Parameters for Fillet Welds in Flat Position Welding Wire Vertical

(*Clause* A-7)

Thickness, *T* mm (1)	*F* mm (2)	*X* mm (3)	Bevel Angle α (4)	Welding Wire Diameter mm (5)	Welding Current Amperes *Min* (6)	Welding Current Volts *Max* (7)	Welding Speed mm/min (8)
16	6	10	26·5°	4	First weld 750	30	225
					Final weld 800	30	175
20	10	12	21·0°	5	First weld 950	30	210
					Final weld 1 050	30	210
25	11	16	24·0°	5	First weld 1 050	30	200
					Final weld 1 150	30	185
32	11	20	28·5°	6	First Weld 1 100	30	175
					Final weld 1 150	30	175
38	11	22	31·0°	6	First weld 1 150	30	160
					Final weld 1 200	30	150

A-8 FILLET WELDED LAP AND T JOINTS IN HORIZONTAL POSITION (3 to 20 mm VERTICAL LEGS)

Welding parameters for the fillet welded lap and T joints in horizontal position (3 to 20 mm vertical leg) are given in Table 11 (*see* Fig. 19).

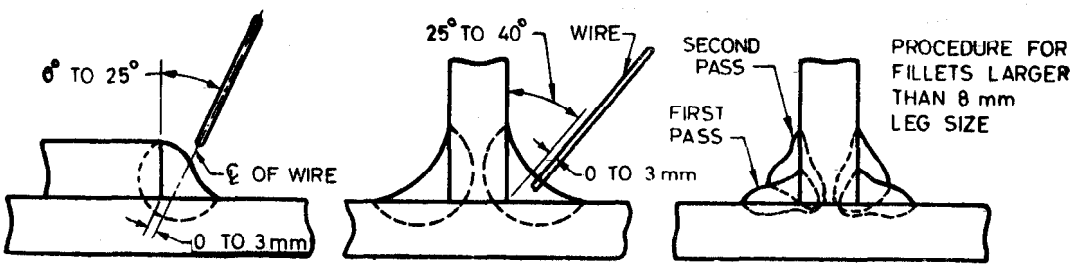


FIG. 19 FILLET WELDS LAP AND T JOINTS (HORIZONTAL POSITION)

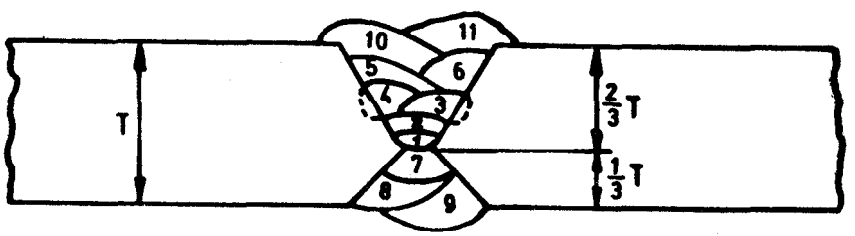
Table 11 Welding Parameters for Fillet Welds Lap and T Joints in Horizontal Position

(*Clause* A-8)

Dimension of Vertical Leg	Approx Manual Fillet Size for Equivalent Strength	Welding Current		Welding Speed	Wire Diameter
		Amperes	Volts		
mm	mm	*Min*	*Max*	mm/min	mm
(1)	(2)	(3)	(4)	(5)	(6)
3	3-5	400	25	750-1 625	2·4
4	5-6	450	27	650-1 375	3·2
5	6	500	27	550-755	3·2
6	8	550	28	500-750	3·2
8	10	650	28	450-625	4·0
10	1st pass	520	30	550	3·2
	2nd pass	520	30	550	3·2
12	1st pass	650	33	550	4·0
	2nd pass	750	35	500	4·0
16	1st pass	725	35	450	4·0
	2nd pass	850	35	400	4·0
20	1st pass	800	35	225	4·0
	2nd pass	820	33	225	4·0

A-9 WELDING TECHNIQUES FOR THICKER PLATES

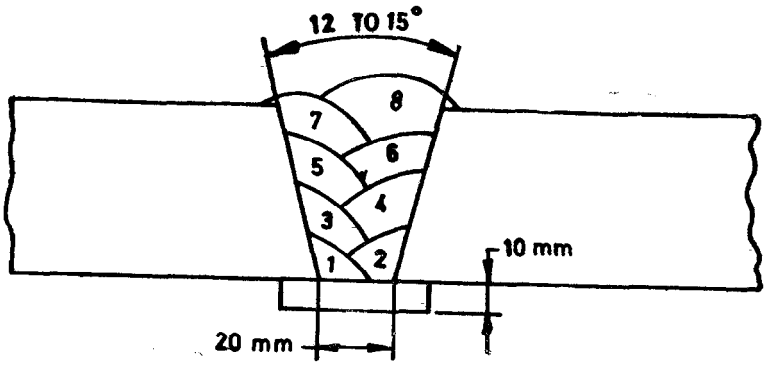
A-9.1 For plates of 25 to 50 mm thickness following techniques may be used:



Pass	Welding Current		Welding Speed	Wire Diameter
	Amps	Volts	mm/min	mm
Pass 1 & 2	By SHAW or GMAW PROCESS			
Pass 3 & 4	400-500	27-32	400-500	3·2/4·0
Remainder	500-600	27-32	350-450	3·2/4·0

FIG. 20 WELDING TECHNIQUE FOR THICKER PLATES (25 to 50 mm)

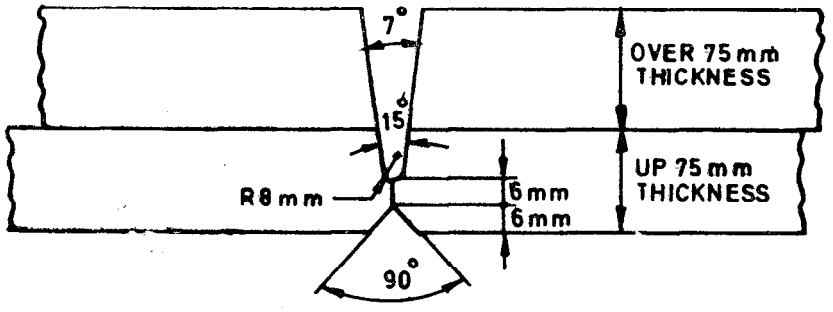
A-9.2 For plates of 50 mm and above, technique A or technique B may be followed (*see* Fig. 21 and 22).



Wire 4·0 or 5·0 mm
Volts 30-34

Amps 600-700
Travel 300 to 375 mm/min

FIG. 21 TECHNIQUE A



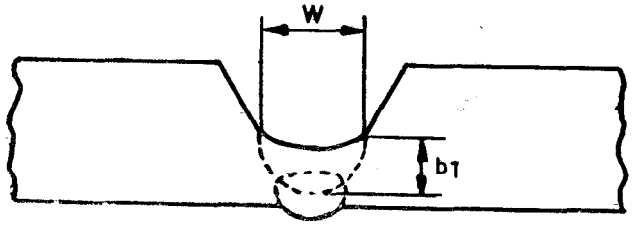
Welding Technique	Welding Current		Welding Speed	Wire Diameter
	Amperes	Volts	mm/min	mm
Single wire (a.c. or d.c.)	500-700	32-34	300-375	4 or 5

FIG. 22 TECHNIQUE B

ANNEX B

(*Foreword* and *Clause* 8.2.2)

FORM FACTOR



Form factor = Weld Bead Width (w)/Bead Thickness (b_T)

FIG. 23 FORM FACTOR

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Printed at Printwell Printers, Aligarh, India