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भारत सरकार

GOVERNMENT OF INDIA

रेल मंत्रालय

MINISTRY OF RAILWAYS

(रेलवे बोर्ड)(RAILWAY BOARD)

INDIAN RAILWAYS STANDARD SPECIFICATION FOR CLASSIFICATION, TESTING AND ACCEPTANCE CRITERIA OF FILLER WIRES FOR MIG/MAG WELDING

(WITH AND WITHOUT GAS SHIELDING)

OCT-2012

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(R.D.S.O.)

Indian Railways Standard Specification For Classification, Testing And Acceptance Criteria Of Filler Wires For MIG/MAG Welding (With And Without Gas Shielding)

1. FORWORD

0.1 This specification is issued under the fixed serial No. M-46, the final number indicates the year of original adoption as standard, or in the case of revision, the year of last revision.

ADOPTED 2003

0.2 This specification is issued to facilitate selection and procurement of MIG/MAG filler wires by Indian Railways for welding of structural steels & stainless steels. It also covers filler wires for reclamation work used by Indian Railways.

0.3 The selection of correct type of filler wire to be used for MIG/MAG welding is a very important consideration. In this regard, the BIS and AWS have issued the following specifications:

IS: 6419 -2004	Welding rods and bare electrodes for gas shielded arc welding of structural steels.
AWS A5.9 –10	Corrosion Resisting Chromium and Chromium-Nickel Steel Bare Arc Welding Electrodes and Welding Rods.
AWS A5.18 -10	Carbon Steel Electrodes and Rods for gas shielded arc welding.
AWS A5.20 –10	Carbon Steel Electrodes for flux-cored arc welding.
AWS A5.22 –10	Stainless Steel Electrodes for flux-cored arc welding.
AWS A5.28 –10	Low Alloy Steel Electrodes and rods for gas shielded arc welding.
AWS A5.29 –10	Low Alloy Steel Electrodes for flux-cored arc welding.

0.4 Considering that the above specifications do not cover the requirements of Indian Railways for various types of filler wires, it is felt necessary to lay down suitable classification of such MIG/MAG welding consumables, their testing and acceptance criteria for specific requirements of Indian Railways.

0.5 Over the passage of time, more technologically advanced processes have come into market to augment traditional CO_2 welding with solid filler wires. Two such processes namely flux cored gas shielded wire and flux cored self shielded wire are to be used on Indian Railways to increase productivity and cover new areas of welding.

0.6 In framing the specification, effort has been made to maintain parity with IRS M 28-12, so that interchangeability and cross reference are easier. For every class in this specification, equivalent class of electrode as per IRS M-28-12 has been indicated.

0.7 Packing conditions for both solid and flux-cored wires have been incorporated in Clause 5. The same has been kept as requirement of acceptance also.

0.8 Wherever a reference to any other standard appears in this specification, the latest version of the same shall be referred to.

0.9 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 values shall be the same as that of the specified value in this standard.

1. **Scope**:

This standard lays down the classification, acceptance requirements and procedure for selection, testing and grading of different filler wire for MIG/MAG welding for use on Indian Railways.

2. Definition:

2.1 **Manufacturer:** ***Manufacturer*** means the indigenous unit manufacturing the Solid/Flux-cored MIG/MAG and self shielded flux-cored wires for welding applications. A manufacturer must have complete infrastructure required for production along with testing & quality control facilities. All the facilities must be located in single premises under its ownership dedicated for production of subject items.

2.2 **Sister Concern**: ***Sister Concern*** means a separate production unit of the same concern or separate production unit under the same administrative control. Each such unit located in different premises will be treated as different firm.

3. Classification:

3.1 The MIG/MAG and self shielded welding filler wires have been broadly classified in three categories:

(i) Solid wire with shielding gas.

(ii) Flux cored wire with shielding gas.

(iii) Flux cored wire without shielding gas.

Table-1 shows the purpose of use, equivalent class of IRS M-28-12 (MMAW electrodes) and different classes of fillers wire available in each section along with IS/AWS code.

TABLE-1

CLASSIFICATION OF MIG/MAG FILLER WIRE AS PER THEIR PURPOSE OF USE ALONG WITH IS/AWS SPECIFICATION AND CODING THEREOF.

Sr. No.	IRS Class of wire	Purpose of use	Equivalent Class of IRSM 28-2012	Type of Wire							
				Solid with Shield gas			Flux cored with Shield gas			Flux cored without Shield gas	
				Grade	IS/AWS Spec.**	Gas	Grade	IS/AWS Spec.**	Gas	Grade	IS/AWS Spec.**
1.	I	For MIG/MAG welding of steels to IS: 2062-11 Gr E250, E300 & E350 of all quality, IS: 1875-04 Class I, IA, II & IIA, IS: 2002-01grade I & II and other equivalent steels. The weld shall be of radiographic quality.	All classes of 'A' series and B1&B2	S3X503 *	IS: 6419-04	CO_2 or 75-80% Argon, rest CO_2	E71T-12	AWS A5.20-10	CO_2	E71T-8	AWS A5.20-10
2.	II	For MIG/MAG welding of steels to ASTM 516 Gr.70 or equivalent where low temperature (at -46^0C) impact properties are required. The weld shall be of radiographic quality.	B3 & B4	ER80S-Ni1	AWS A5.28-10	Ar. + 1 – 5% O_2	E81T1-Ni2C	AWS A5.29-10	-do-	E81T8Ni2	AWS A5.29-10
3.	III	For MIG/MAG welding of steels to IS: 2062-11 grade E410, E450 of all quality , IS: 2002-01 Grade-III, IS: 1875-04 class IIIA or other equivalent steels. The weld shall be of radiographic quality.	C1 & C2	ER90S-D2	AWS A5.28-10	-do-	E91T1-D1C	AWS A5.29-10	-do-	-	-

* X- Stands for C or M only as per IS: 6419-04.

** IS/AWS code is for the purposes as explained in Cl. 3.2.

Sr. No.	IRS Class of wire	Purpose of use	Equivalent Class of IRSM 28-2012	Type of Wire							
				Solid with Shield gas			Flux cored with Shield gas			Flux cored without Shield gas	
				Grade	IS/AWS Spec.**	Gas	Grade	IS/AWS Spec.**	Gas	Grade	IS/AWS Spec.**
4.	IV	For MIG/MAG welding of weather resistant steels to IRS: M41-97 and IRS: M42-79 with same steel and with other grades of steel with same or lower strength to IS: 2062-11 all grades & all quality, IS: 2002-01, & IS: 1875-04 class IIIA . The weld shall be of radiographic quality.	D	ER80S-G	AWS A5.28-10	CO_2	E81T1-W2C	AWS A5.29-10	CO_2	-	-
5.	V	For Hard facing of Ferrous components to achieve weld metal hardness between 30-40Rc.	H4B	ERXXS-G	AWS A5.28-10	-do-	EXXT1-GC	AWS A5.29-10	-do-	EXXT4-G	AWS A5.29-10
6.	VI	For MIG/MAG welding of stainless steels type 18% Cr 8% Ni, 3Cr12 & steel to IRS M-44-97 or its equivalent.	M1 & M2	ER308L	AWS A5.9-10	Ar. + (1 –5%) O_2	E308LT1-1	AWS A5.22-10	-do-	-	-
7.	VII	For dissimilar MIG/MAG welding amongst the steels mentioned above in class VI, joining austenitic stainless steels with plain carbon steel or low alloyed steel. This can also be used for welding of heat resisting stainless steels 22%Cr 12Ni type or its equivalent.	M4	ER309	AWS A5.9-10	-do-	E309T1-1	AWS A5.22-10	-do-	-	-
8.	VIII	For welding of cast steel of similar composition, Stainless steel to low alloy steel high in Nickel & welding of steel of unknown composition.	M7	ER 312	AWS A5.9-10	-do-	E312T1-1	AWS A5.22-10	-do-	-	-

** IS/AWS code is for the purposes as explained in Cl. 3.2.

3.2 **Standard code as per IS or AWS has been shown against each class of filler wire for welding position and shield gas only. For Mechanical properties and Chemical requirement, values stipulated in appropriate tables of this standard shall be followed. In areas not covered by this Standard, the views and conditions stipulated in the respective IS/AWS standard shall be followed.**

4. Wire & Wire Spool:

4.1 **Quality of Wire -** The wire shall have a smooth finish and shall be free from surface imperfections, corrosion, grease, oxides or any other foreign material. It shall have a uniform protective coating, well bonded and smooth.

4.2 **Size of Wire** - Wire shall be manufactured in diameter of 0.8, 1.2 and 1.6 mm for solid wires, 1.2 and 1.6 mm for flux cored wire with shield gas and 1.6 or 1.8, 2 and 2.4 mm for flux cored wire without shield gas.

4.3 **Wire Spool -** The wire shall be supplied in spools closely wound in layers of continuous length made from single heat or lot and shall be free from kinks, burrs and sharp bends. The wire shall be free to unwind without restrictions. Open end of the wire shall be properly secured and identified. The maximum weight of the wire excluding the spool should be 12.5 Kgs .

Packaging:

5.1 To guard against ingress of moisture and accidental damage during transportation and storage till its consumption, the packaging system shall be as follows:

5.1.1 Wire shall be smoothly wound over a wooden or plastic spool.

5.1.2 The spool cover shall have printed on it name & address of the manufacturer, brand name, IRS class with IS and/or AWS code, batch no., date of manufacture, date of expiry, size, weight of spool, current condition & welding parameters, cautionary note on safety during welding and any other special recommendation.

5.1.3 The spool shall be wrapped across the thickness of the spool along the periphery with a moisture proof polythene/gunny strip.

5.1.4 The spool shall be kept in plastic jacket, sealed and evacuated. Then it shall be kept in a cardboard box; be covered with polythene jacket and shrink sealed. The box shall have printed on it all the information given in **Cl. 5.1.2.**

5.1.5 The details of packing may vary from one manufacturer to other, but in essence, it must have **three** moisture proof polythene layers or **two** moisture proof polythene layers with **one** layer of gunny along with cardboard box. At least one inner packing must be of evacuated & shrink packed type.

6. **Requirements**:

6.1 **All the wires shall fulfill the condition as laid down in clause 4 & 5.**

6.2 The acceptance criteria for each Grade of wire have been indicated in **Table-2**. The minimum value requirement of each criteria is either given in the table or reference to appropriate appendix and table has been made wherein the details of testing and minimum value requirement has been described.

TABLE-2

TEST REQUIREMENTS FOR MIG/MAG FILLER WIRES

S. No.	IRS Class	Perfor-mance test*	Copper Coating $	Cast & Helix	Mechanical Properties	Chemical Composition	Radiogr-aphy #	Hydrogen content (Max) @	Hardness	Macro Examina-tion	Fillet weld test	Corrosion Resistance Test
1	I	App-A	App-B	App-B Table-3	App-C Table-4	App-C Table-5, 6 &7	IIW Blue Std.	4ml/100gm of weld metal	-	-	-	-
2	II	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-	-	-	-
3	III	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-	-	-	-
4	IV	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-	-	Cl.6.2.10	App-D
5	V	-do-	-do-	-do-	-	-do-	-	-do-	30-40Rc App-C	App-C	-	-
6	VI	-do-	-do-	-do-	-	-do-	-	-	-	-	Cl.6.2.10	-
7	VII	-do-	-do-	-do-	-	-do-	-	-	-	-	-do-	-
8	VIII	-do-	-do-	-do-	-	-do-	-	-	-	-	-do-	-

* Further tests shall be carried out only if the filler wire is found satisfactory in this test.

$ Applicable for copper coated wires only.

IIW Stands for International Institute of Welding.

@ Applicable for solid MIG/MAG wires only.

6.2.1 **Performance test:** Performance Test includes Running Performance and Accelerated Storage Stability Test. All classes of wires shall pass satisfactorily in the running performance test, where the running performance of the wire shall be checked along with general condition of wire and Cu coating. In Accelerated Storage Stability test, there shall not be any corrosion spot on the wire. The details of test procedure are given in **Appendix- A.**

6.2.2 **Copper coating:** The filler wires shall have uniform copper coating (wherever applicable) to prevent rusting. The copper content shall be within 0.2-0.4 % by wt.. The details of testing are given in **Appendix 'B'**.

6.2.3 **Cast and helix:** The cast and helix of solid MIG/MAG filler wire shall be as per **Table-3**. The details of testing have been given in **Appendix 'B'**.

TABLE-3

CAST & HELIX REQUIREMENT OF SOLID MIG/MAG FILLER WIRES

S.No.	IRS class	Spool Size (Diameter in mm)	Wire Size (Diameter in mm)	Cast in mm	Helix in mm (Max)
1	I,II.III.IV & V	(i) 100mm (ii) other diameters	All sizes (i) 0.8 mm or less (ii) 0.9 mm or large	100-230 i) 305min. ii) 380min.	13 (i) 25 (ii) 25
2	VI ,VII & VIII	300 mm.	All diameter	380-1300	25

6.2.3.1 Cast & Helix for flux cored wires with or without shielding gas shall be suitable for uniform uninterrupted feeding on automatic or semi-automatic welding equipment.

6.2.4 **Mechanical properties:** The mechanical properties of different classes of filler wires have been given in **Table-4**.

TABLE-4

MINIMUM REQUIREMENTS OF DIFFERENT MECHANICAL PROPERTIES FOR MIG/MAG FILLER WIRE

IRS Class	UTS (N/mm^2)	YS (N/mm^2)	%Elongation on 5 x d G.L.	% Reduction in Area	Impact (Joules)
I	510	350	26	50	47 at -20°C
II	540	390	24	45	25 at –46°C
III	590	450	20	40	27 at -20°C
IV	490	350	22	40	50 at -20°C

Note: Tolerances in limiting values as given in respective IS/AWS are not applicable.

Chemical Composition: The chemical composition requirement of solid MIG/MAG filler wire with shield gas, flux cored MIG/MAG filler wire with shield gas and self shielded flux cored wire have been given in **Table 5, 6 & 7** respectively. Procedure of weld pad preparation and sample collection for chemical analysis has been given in **Appendix C.**

6.2.5 **Radiography test:** Radiograph of all weld test piece shall be at least equal to or better than IIW Blue Standard radiograph.

6.2.7 **Hydrogen Content:** Diffusible Hydrogen content shall be determined by Mercury apparatus to IS:11802.

6.2.8 **Hardness Survey:** Hardness survey shall be carried out for IRS class V consumables. Procedure of weld pad preparation, testing and acceptance criteria have been given in **Appendix C**.

6.2.9 **Macro Examination:** Macro examination test shall be carried out for IRS class V consumables. Procedure of weld pad preparation, testing and acceptance criteria have been given in **Appendix C**.

6.2.10 **Fillet Weld Test:** Fillet weld test will be carried out for IRS class IV, VI ,VII ,VIII filler wire. The completed fillet weld test specimen shall be examined visually and the weld shall be free of cracks. The specimen shall be reasonably free of undercut, overlap, slag inclusion and surface porosity. Dimensional measurements and Macro examination shall be carried out on polished and etched transverse section. The transverse section shall have adequate penetration without any crack and shall reasonably be free from other welding defects .The dimensional requirement of fillet weld test is given in **Table –8**.

6.2.11 **Corrosion resistance test:** Corrosion resistance test shall be carried out for class IV filler wires. Procedure of testing and acceptance criteria has been given in **Appendix- D**.

TABLE-5

CHEMICAL COMPOSITION REQUIREMENTS FOR SOLID MIG/MAG FILLER WIRES

S.No.	IRS Class	Chemical Composition % wt.									
		C	**Mn**	**Si**	**S**	**P**	**Mo**	**Ni**	**Cu ***	**Cr**	V
1	I	0.07 – 0.15	1.00– 1.50	0.65 – 0.85	0.025	0.025	-	-	0.2 – 0.4	-	-
2	II	0.12	1.25	0.40 – 0.80	0.025	0.025	0.35	0.80 -1.10	0.2 – 0.4	0.15	0.05
3	III	0.07 – 0.12	1.60-2.10	0.50 – 0.80	0.025	0.025	0.40 – 0.60	0.15	0.2 – 0.4	-	-
4	IV**	0.12	0.60 – 1.20	0.25 – 0.70	0.03	0.03	-	0.30- 0.80	0.25 – .65	0.40 – 0.70	-
5	V**	0.20	3.0	1.50	0.03	0.03	1.50	-	0.2 – 0.4	5.0	-
6	VI	0.03	1.0 – 2.5	0.30 – 0.65	0.03	0.03	0.75	9.0 – 11.0	0.5	19.5 – 22.0	-
7	VII	0.12	1.0 – 2.5	0.30 – 0.65	0.03	0.03	0.75	12.0 – 14.0	0.5	23.0 – 25.0	-
8	VIII	0.15	1.0 – 2.5	0.30 – 0.65	0.03	0.03	0.75	8.0-10.5	0.5	28.0-32.0	-

* **The Wt% of copper includes copper coating of wire and copper content in weld metal .**

**** Chemical composition of Weld Metal.**

Note: 1) Single values are maximum except otherwise stated.

2) Tolerances in limiting values as given in respective IS/AWS are applicable.

TABLE-6

CHEMICAL COMPOSITION REQUIREMENTS FOR WELD METAL OF FLUX CORED MIG/MAG FILLER WIRES WITH SHIELD GAS

Sl.No.	IRS Class	Chemical Composition % wt									
		C	Mn	Si	S	P	Mo	Ni	Cu *	Cr	V
1.	I	0.15	1.60	0.90	0.03	0.04	0.30	0.50	0.2 - 0.4	0.20	0.08
2.	II	0.12	1.50	0.80	0.03	0.03	-	1.75 – 2.75	0.2 - 0.4	-	-
3.	III	0.12	1.25 - 2.0	0.80	0.03	0.03	0.25 - 0.55	-	0.2 - 0.4	-	-
4.	IV	0.12	0.5 0 – 1.30	0.35 – 0.80	0.03	0.03	-	0.40 – 0.80	0.30 – 0.75	0.45 – 0.70	-
5.	V	0.20	3.0	1.50	0.03	0.03	1.50	-	0.2 - 0.4	5.0	-
6.	VI	0.04	0.5 – 2.5	1.0	0.03	0.04	0.5	9.0 – 11.0	0.5	18.0 – 21.0	-
7.	VII	0.10	0.5 – 2.5	1.0	0.03	0.04	0.5	12.0 – 14.0	0.5	22.0 – 25.0	-
8.	VIII	0.15	0.5 – 2.5	1.0	0.03	0.04	0.5	8.0-10.5	0.5	28-32	-

* The ranges of copper is applicable for copper coated wires in case of Class I, II, III,IV & V. For non-copper coated wires, only upper limits will be considered as maximum.

Note: 1) Single values are maximum except otherwise stated.

2) Tolerances in limiting values as given in respective IS/AWS are applicable.

TABLE-7

CHEMICAL COMPOSITION REQUIREMENTS FOR WELDMENT OF FLUX CORED MIG/MAG FILLER WIRES WITHOUT SHIELD GAS

Sl.No.	IRS Class	Chemical Composition %wt.										
		C	Mn	Si	S	P	Mo	Ni	Cu *	Cr	Al	V
1.	I	-	1.75	0.90	0.03	0.04	0.30	0.50	0.20 - 0.40	0.20	1.80	0.08
2.	II	0.12	1.50	0.80	0.03	0.03	0.35	1.75 – 2.75	0.20 - 0.40	-	1.80	-
3.	V	0.20	3.0	1.50	0.03	0.03	1.50	-	0.20 - 0.40	5.0	1.80	-

- The ranges of copper is applicable for copper coated wires in case of Class I, II, & V.. For non copper coated wires, only upper limits will be considered as maximum.

Note: 1) Single values are maximum except otherwise stated.

2) Tolerances in limiting values as given in respective IS/AWS are applicable.

TABLE 8

DIMENSIONAL REQUIREMENTS FOR FILLET WELDS

Size of Fillet Weld (mm)	For IRS class IV		For IRS ClassesVI ,VII &VIII	
	Maximum convexity (mm)	Maximum diff. Between leg lengths (mm)	Maximum convexity (mm)	Maximum diff. Between leg lengths (mm)
3.15	1.1	1.0	1.2	1.5
4.0	1.2	1.2	1.3	1.5
5.0	1.5	1.5	1.4	1.5
5.6	1.6	2.0	1.5	1.5
6.3	1.8	2.5	1.6	1.5
7.0	1.8	2.8	1.7	1.5
8.0	2.0	3.15	1.8	1.5
9.0	2.0	3.6	1.9	1.5
10.0	2.0	4.0	2.0	1.5

7. Storage:

The filler wires shall be stored in a dry room to minimize ingress of moisture. The roof, floor and walls shall be made of damp proof concrete/brick. This storeroom shall not be used as storage place for grease, oil or other chemicals, which may affect the performance of filler wires adversely. Preferably a separate room should be allotted. The storing system shall be F**irst in First out (FIFO)** to prevent undue storage.

8. Shelf Life:

The shelf life of filler wire shall be 9 months from the date of receipt in Stores or 12 months from the date of manufacture whichever is more.

9. Sampling plan for inspection of lots

No. of spool (size wise) as lot size	No. of spool to be sampled
Up to 100	02
101-200	04
201-300	06
301 & above	08

Note: Minimum lot size shall not be less than 15 spools for sampling

10. **Test**:

Preparation of test pieces and testing shall be done as per relevant IS/AWS specification unless stated otherwise.

11. **Test for Bulk inspection**:

All the requirements as given in Cl. 6 shall be applicable, only the tests are to be conducted on the size/s given in the Purchase Order.

12. Retest:

Where any test specimen fails to satisfy the requirement of a particular test, twice the no. of test specimens for that test shall be prepared using consumable from the same batch and subjected to the test in which failure occurred. The consumable shall not be accepted as having passed that test unless all the test results on the additional specimens are satisfactory.

List of Appendices and Tables of IRS-M-46-12

Appendix - A (Clause 6.2.1)	-	Guideline for Running Performance Test and Storage Stability Test.
Appendix - B (clause 6.2.2 & 6.2.3)	-	Determination of cast & helix & copper content in coating for MIG/MAG filler wire
Appendix - C (clause 6.2.5, 6.2.8 & 6.2.9)	-	Method of preparation of test pad for macro test, hardness survey and chemical analysis
Appendix - D (clause 6.2.11)	-	Method of preparation of test piece for corrosion resistance test and acceptance criteria (For class IV filler wire).
APPENDIX - E		Safety considerations in welding

Table - 1 (Cl. 3.1)	Classification of MIG/MAG filler wire as per their purpose of use along with IS/AWS Specification and coding thereof.
Table - 2 (Cl. 6.2)	Test requirements for MIG/MAG filler wires.
Table - 3 (Cl. 6.2.3)	Cast & Helix requirement for solid MIG/MAG filler wires.
Table - 4 (Cl. 6.2.4)	Minimum requirements of different mechanical properties for MIG/MAG filler wires.
Table - 5 (Cl. 6.2.5)	Chemical composition requirements for solid MIG/MAG filler wires.
Table - 6 (Cl. 6.2.5)	Chemical composition requirements for weldment of flux cored MIG/MAG filler wires with shield gas.
Table - 7 (Cl. 6.2.5)	Chemical composition requirements for weldment of flux cored MIG/MAG filler wires without shield gas.
Table - 8 (Cl. 6.2.10)	Dimensional requirement for fillet welds

APPENDIX 'A' (Cl. 6.2.1)

REQUIREMENTS FOR RUNNING PERFORMANCE TEST AND ACCELERATED STORAGE STABILITY TEST.

A 1. **Running Performance**: Running performance test shall be done by deploying the welder approved as per IS: 7310 Part 1 and IS: 7318 Part 1 and performance test shall be applicable for all class of MIG/MAG filler wires.. Following criteria shall be checked

A 1.1 **General**:

a) Packing condition- should be as per clause 5.1

b) Physical condition of wire- Straight, smooth.

c) Corrosion of wire- free from corrosion ,pitting etc

A 1.2 **Performance test**: MIG/MAG filler wires shall be operated at ± 20 Amp of the middle of the current range given. Following parameters shall be checked:

a) Ease of arc striking- The electrode should produce arc easily

b) Arc stability- The arc must be stable & should not break during arcing.

c) Spatter quality & quantity- The spatter shall be less. & soft.

d) Ripple of weld bead- Smooth & evenly rippled.

e) Convexity/Concavity of weld bead- Flat to convex/concave

f) Tendency to undercut- No tendency to undercut

g) Crack, porosity etc.- Free from cracks & porosity & other defects

There shall not be any adverse remark in any of the items indicated above.

A 1.3 **Positional welding**: MIG/MAG filler wires shall be operated at all the welding positions as per IS/AWS code. The appearance and quality of weld shall be satisfactory.

A 1.4 **Any other adversity**: There shall not be any other adverse remark on the performance of the electrode.

A1.5 The precautions to be taken during welding are given in Appendix-E. These precautions must be followed during welding operation.

A 2 **Accelerated Storage Stability Test**: This test is applicable for all classes of MIG/MAG filler wires.

A 2.1 **Test**:Ten meters of MIG/MAG filler wire shall be kept in a humidity chamber maintained at 48^0C with Relative Humidity(RH) 90% min. for eight hours. After putting off the system, the wire shall be left in the humidity chamber for another 16 hours. After this period, the wire shall be taken out from the chamber and examined visually.

A 2.2 **Acceptance criteria**: The exposed MIG/MAG filler wire shall not exhibit more than ten corrosion spots over the full length of ten meters.

APPENDIX 'B' (clause 6.2.2 & 6.2.3)

DETERMINATION OF CAST & HELIX & COPPER CONTENT FOR MIG/MAG FILLER WIRE

B 1 **Cast & Helix**:

B 1.1 **Cast:** The cast of wire shall be such as to have imparted to the wire a curvature so that a specimen sufficient in length to form one loop or a maximum 300 cm in length, when cut from the spool and laid on a flat surface without restraint shall form a circle or a portion thereof of the maximum diameter shown for cast in **Table-3**.

B 1.2 **Helix:** The helix of the wire as exhibited by the ring of the wire used to determine the cast, when placed on a flat surface without restraint, such that the maximum distance from any point on the wire to the flat surface shall not exceed the dimension shown for helix in Table-3.

B 1.3 The Cast & Helix mentioned above are for solid wires only. For flux cored wires, the wire shall be suitable for uniform uninterrupted feeding on automatic or semi-automatic welding equipment.

B 2 **Copper Content:**

B 2.1 Copper Content in coating:

B 2.1.1 About 50 cm of wire shall be taken from coil & weighed in chemical balance.

B 2.1.2 After weighing, this will shall be kept in 25% ammonia solution for about 10-12 hours. Reaction may be accelerated and completed within 1 hour by adding of 1–3 ml Hydrogen Peroxide.

B 2.1.3 In ammonia solution, all copper coating dissolves.

B 2.1.4 The wire is removed from ammonia solution, washed with distilled water and alcohol, dried & weighed.

B 2.1.5 Difference in weight in wire in B 2.1.1 & B 2.1.4 will be calculated.

$$\text{The percentage of copper by Wt.} = \frac{\text{Difference in weight}}{\text{Wt. of wire with copper coating}} \times 100$$

B 2.2 **Copper Content in bare wire or weld metal:** Copper Content shall be determined by wet analysis method.

B 2.3 **Acceptance criteria**: The total percentage of copper by wt. (B 2.1 & B 2.2) shall be between 0.2-0.4 % by wt.

APPENDIX 'C' (clause 6.2.5, 6.2.8 & 6.2.9)

METHOD OF PREPARATION OF TEST PAD FOR MACRO TEST, HARDNESS SURVEY AND CHEMICAL ANALYSIS

C 1 **Preparation of Test weld Pad**:

C 1.1 **Material**: The parent metal for plates used in preparing test pieces shall be any grade of IS: 2062-11.

C 1.2 **Welding**: Test pad shall be prepared as shown in fig.1 using the welding parameters as specified by the manufacturers. The weld metal shall be deposited in flat position, using 0.8 mm dia or 1.2 mm dia or 1.6 mm dia. MIG/MAG filler wires, 1.8 mm dia or 2.0 mm dia or 2.4 mm dia. for self shielded flux cored wires at the discretion of the approving authority. The deposit shall be at least 15mm thick.

C 2 **Macro examination**:

The test shall be conducted only for class V type of filler wire. The surface of pad shall show no crack or other welding defects on macro examination with naked eye/magnifying glass. The pad shall be sectioned and etched suitably to examine the cross section and interface. The cross section shall be free of any welding defect with proper fusion and bonding at interface.

C 3 **Hardness survey**:

C 3.1 Rockwell hardness test shall be conducted at five places, one at the centre and four corners at a distance of D/4, D being the diagonal of the pad as shown in **Fig. 1**. Rockwell hardness number obtained shall be recorded.

C 3.2 The hardness requirement of class V type of filler wire shall be as given in **Table-2**.

C 4 **Sampling for Chemical analysis**:

C 4.1 Sufficient samples shall be taken from the test weld pad by an appropriate means (drilling or shaping). Post heat treatment may be carried out to soften the test pad for easy removal of metal. Metal for the analysis purpose shall not be taken closer than 5 mm from the base metal. No oil or other lubricant shall be used while removing the sample.

C 4.2 For solid wire analysis, known quantity of wire shall be taken as sample.

C 4.3 Wet analysis for different elements shall be carried out in accordance with IS: 228.

C 4.4 Spectrometric analysis may also be carried out on solid and smooth surface of the pad after removing about 5 mm from top on at least on 3 spots. The average of 3 readings shall be taken as the value for a particular element.

C 4.5 In case of any controversy in the spectrometric analysis, wet analysis shall be considered as referee method.

C 4.6 The chemical composition of the weldment shall confirm to the range given in **Table – 5, 6 & 7**.

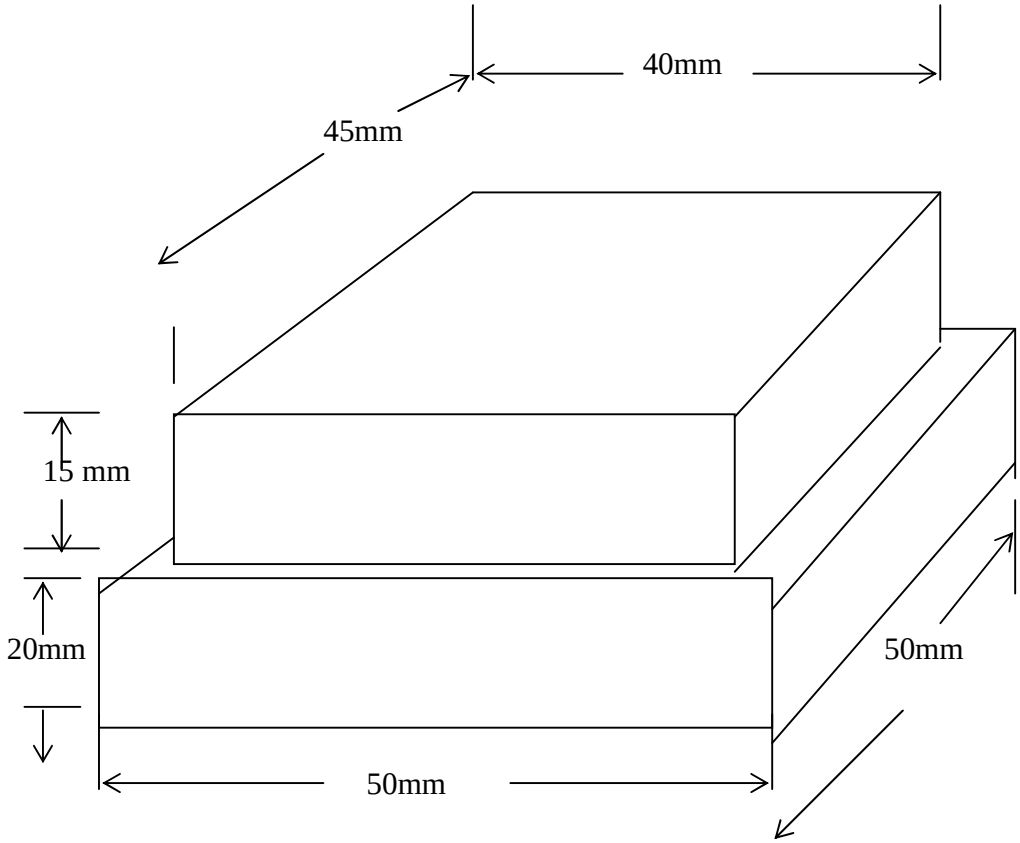

Fig: 1. Dimension of Weld Pad

APPENDIX 'D' (Clause 6.2.11)

METHOD OF PREPARATION OF CORROSION RESISTANCE TEST PIECE AND ACCEPTANCE CRITERIA

(For class IV type of filler wire)

D 1 **Preparation of Corrosion Resistance Test Assembly**:

D 1.1 **Material**:- Parent metal shall conform to IRS M-41, IRS M-42 or their equivalent.

D 1.2 **Dimensions**: The dimensions of plates shall be as given below:

Length	-	150mm ± 10mm
Breadth	-	75mm ± 10mm
Thickness	-	10mm ± 2mm
Edge Angle	-	45° ± 1°

D 2 **Pre-setting and Welding**:

D 2.1 The plates shall be tacked together with a root gap of about 2-3 mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.

D 2.2 The assembly shall be welded in flat position using class IV type of filler wire of 1.2mm diameter.

D 2.3 The temperature of weld assembly shall be kept between 110^{o}C-180^{o}C. For this, inter pass time gap, if necessary shall be maintained.

D 2.4 Each run shall be properly de-slagged before putting another run on or adjacent to previous run.

D 2.5 The welding parameters shall be kept within the range as recommended by the manufacturer.

D 2.6 Two such test assemblies shall be prepared as shown in **fig. 2**.

D 3 **Preparation of Test Pieces**:

D 3.1 A square panel of 100mm x 100mm x 10mm shall be removed from centre as shown in **fig. 3**.

D 3.2 A test panel of 100mm x 100mm x 6mm shall be prepared as shown in **fig. 4** by shaping.

D 3.3 The whole test panel shall be thoroughly polished.

D 3.4 Two such panels shall be prepared from two test assemblies.

D 3.5 One blank panel of same dimensions shall be prepared using same material of parent plates.

D 4 **Testing**:

D 4.1 Two test panels with weld bead at middle along with one blank panel shall be subjected to corrosion test at a temperature of $42^{o}C$-$48^{o}C$ at 100% RH as per Section 1 of IS: 101-88 Pt. 6. Condition of the weld and parent metal surfaces shall be examined after a period of seven days exposure as follows:

1st 24 hours	-	The weld assembly shall be exposed as indicated in Cl. D 4.1.
2nd 24 hours	-	Air-dried at ambient temperature.
3rd to 7th day	-	The weld assembly shall be exposed as indicated in Cl. D 4.1.

D 5 **Acceptance Criteria**:

D 5.1 The number of corrosion spots per 5 Sq. cm of the unwelded panel and the parent metal of the welded panel shall not vary by more than one. The severity of corrosion shall not be significantly different.

D 5.2 The number of corrosion spots in the HAZ or weld metal shall not be more than that of unwelded panel or parent metals whichever is more.

D 5.3 The severity of corrosion in parent metal and HAZ shall not be significantly more than that of parent metal of unwelded panel.

D 5.4 The electrode shall be considered satisfactory in case all the 3 clauses mentioned above are fulfilled.

D 5.5 The test shall be discarded and repeat test is to be carried out in case clause D-5.1 is not fulfilled.

D 5.6 The electrode shall be considered unsatisfactory only if clause D5.1 is fulfilled but either clause D 5.2 or clause D 5.3 is not fulfilled and retest shall be carried out.

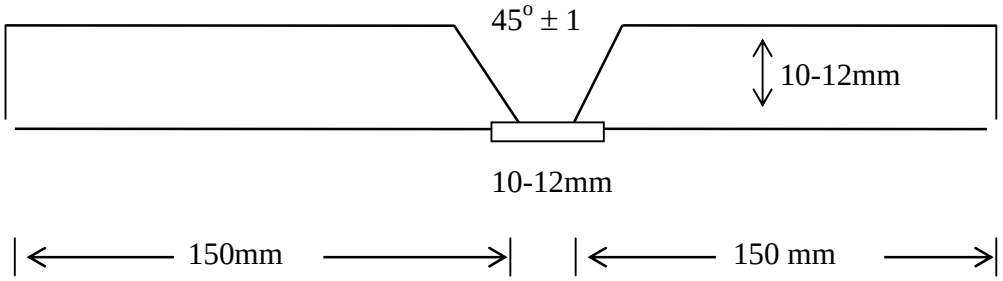

Fig. 2. Presetting of plates & back strip before welding.

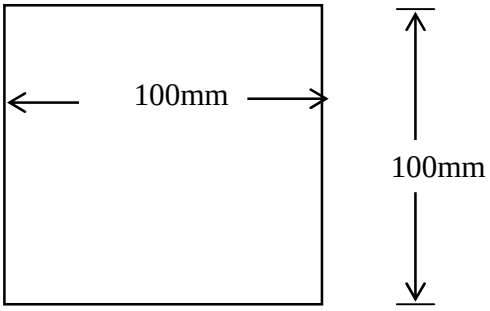

Fig. 3. Middle part of the assembly for making the test panel.

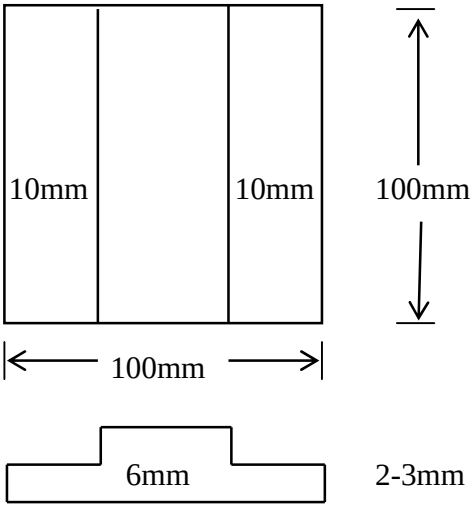

Fig. 4. Plan & Elevation of the test panel.

APPENDIX-E

SAFETY CONSIDERATIONS IN WELDING

E1 Burn Protection

E1.1 Molten metal, sparks, slag &hot work surfaces are produced by welding cutting & allied processes. These can causes burns.

E1.2 To avoid burns worker should wear protective cloths made of fire resistance material.

E1.3 Pant cuffs, open pockets or other places on clothing that can catch & retain molten metal should not be worn.

E1.4 High top shoes or lather leggings & fire resistant gloves should be worn.

E1.5 Helmet or hand shields that provide protection for face, neck & ear, & a head covering to protect the head should be used.

E1.6 The clothing should be kept free of grease & oil.

E1.7 Wear insulated gloves.

E2 Electrical Hazardous.

E2.1 All electrical instrument and work pieces should grounded.

E2.2 To prevent shock, the work area, equipment & clothing should be kept dry all the times.

E2.3 Welder should wear dry gloves & rubber sole shoes.

E2.4 Cables &connection should be kept in good condition.

E2.5 Correct cable size should be used to avoid over loading & subsequent failure of cable.

E2.6 All electrical connections should be tight, clean & dry.

E3 Fumes and gases.

E3.1 Fumes are solid particles which originates from welding filler metals and fluxes, the base metal and any coating presents in base metal.

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E3.2 Sufficient ventilation & exhausts should be used to keep fumes and gases away from breathing zone when welding is performed in the confined spaces.

E3.3 Use auto- darkening helmets.

E3.4 Follow the recommendations of manufacturers (if any) in this regard.

E4 Radiation.

E4.1 Welding, Cutting and allied operations may produce radiant energy.

E4.2 One should not look at welding arc except through welding filter plates.

E4.3 Exposed Skin should be protected with adequate gloves & clothing.