IRS:M-39-2020

भारत सरकार

GOVERNMENT OF INDIA

रेल मंत्रालय

MINISTRY OF RAILWAYS

रेलवे बोर्ड

(RAILWAY BOARD)

सत्यमेव जयते

INDIAN RAILWAY STANDARD SPECIFICATION FOR CLASSIFICATION, TESTING AND ACCEPTANCE CRITERIA OF WIRE AND FLUX FOR SUBMERGED ARC WELDING OF STRUCTURAL STEEL FOR USE ON INDIAN RAILWAYS

Issued by

धातु व रसायन निदेशालय

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Indian Railway Standard Specification for classification, Testing and Acceptance Criteria of Wire and flux for Submerged Arc Welding of Structural Steel for use on Indian Railways

FOREWORD

0.1 This specification is issued under the fixed Serial No. M-39, the final number indicates the year of original adoption as standard, or in the case of revision, the year of last revision.

This specification has now been revised and issued in 2020 to cover the amendments issued to this specification till date and to update the latest revision of IS/IRS and other codes.

ADOPTED 1968: REVISED 2001, 2020

0.2 This specification is issued to facilitate assessment and procurement of wire and flux by Indian Railways for welding of structural steels in place of existing IRS **M: 39-2001.**

0.3 In earlier IRS:M-39, wire-flux combinations were taken into consideration. In this version, wire and flux are delinked to the extent that approval and procurement of both can be done separately.

0.4 In Table-1 of this specification reference has been made to MMAW electrodes of IRS M-28:2020 in Column 4. This has been provided for direct co-relation and interchangeability.

0.5 Packing conditions for both wire and flux have been incorporated in Clause 4.4 and 5.6. The same has been kept as requirement of acceptance also.

0.6 In framing this specification, guidance from the following specification has been taken:

IS 15977:2013 (R2019)	Classification and acceptance tests for bare solid wire electrodes and wire flux combination for submerged arc welding of structural steel-specification
AWS-A5.17 /A5.17M-2019	Specification for Carbon steel electrodes and fluxes for Submerged Arc Welding
AWS-A5.23 /A5.23M-2017	Specification for Low alloy steel electrodes and fluxes for Submerged Arc Welding

0.7 Wherever a reference to any other standard appears in this specification, it shall be taken as a reference to the latest version of that standard.

0.8 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 (R2016) '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.

0.9 All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D-8.1-11 dated 08.10.2020 (Title "Vendor-Changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

0.10 **PREFERENCES TO MAKE IN INDIA:**Firm should comply Make in India policy and Public Procurement (Preference to Make in India) order-2017 under this specification" and subsequent amendment done time to time.

0.11 The purchaser or inspecting official(s) or his representative shall have free access to the manufacturer's works at all reasonable times. He shall be at liberty to inspect the process of manufacturing at any stage and to reject any material that fails to conform to the provisions of the specifications.

1.0 Scope:

This standard lays down the classification, acceptance requirements and procedure for selection and testing of different grades of wire and flux manufactured for the use on Indian Railways.

2.0 Definition:

2.1 **Manufacturer** means as defined in RDSO's ISO Apex documents No. QO-D-8.1-5 Ver 2.1 and QO-D-8.1-6 Ver 3.2 and subsequent versions/amendment thereof shall be applicable.

2.2 **Sister Concern** means as defined in RDSO's ISO Apex documents No. QO-D-8.1-6 Ver 3.2 and subsequent versions/amendments thereof shall be applicable.

2.3 **Approving authority** means Director General (M&C), R.D.S.O., Lucknow or his representative.

3. Classification:

3.1 The wire-flux combinations are classified into five classes i.e. I, II, III, IV & V depending upon the type of structural steel to be welded. The purpose for which each class of wire-flux combination is to be used is given in **Table.1**

3.2 The wire has been classified in five grades, namely **W-1** to **W-5.**

3.3 The flux has been classified in five grades, namely **F-1** to **F-5**.

3.4 When wire and flux combination of same grade i.e. W-1 & F-1 or W-5 & F-5 is used in combination, the weldment shall have the properties of the respective IRS class i.e. class-I or class V. Interchanging the grades of wire or flux is not permitted. However, a flux may be approved in more than one grade.

TABLE-1

CLASSIFICATION OF DIFFERENT WIRE-FLUX COMBINATIONS AND THEIR PURPOSE OF USE

Sr. No.	Class of wire & Flux Combination	Purpose of use	Equivalent Class of IRS M-28- 2020	Grade of wire	Flux	
					Type	Grade
1	I	For two run and multirun submerged arc welding of steels to IS2062-2011 (R2016), IS1875-1992 (R2014) Class I & IA and other equivalent steels. The weld shall be of radiographic quality.	A3	W-1	Agglomerated	F-1
2	II	For two run and multirun submerged arc welding of steels to IS 2062-2011 (R2016) E-300 and E-350, IS2002-2009 (R2018) grade I& II, IS1875-1992 (R2014) class II & IIA or other equivalent steels. The weld shall be of radiographic quality.	B2	W-2	-do-	F-2
3	III	For two run and multirun submerged arc welding of steels to ASTM 516 Gr.70 or equivalent where low temperature (at -46°C) impact properties are required. The weld shall be of radiographic quality.	B3	W-3	-do-	F-3

4	IV	For two run and multirun submerged arc welding of steels to IS 2062-2011 (R2016) E410 and E-450, IS 2002:2009 (R2018) Grade III, IS 1875:1992 (R2014) Class IIIA or other equivalent steels. The weld shall be of radiographic quality.	C3	W-4	-do-	F-4
5	V	For two run and multirun submerged arc welding of weather resistant steels to IRS M41 and IRS M42 with same steel and with other grades of steel with same or lower strength to IS 2062-2011 (R2016), IS2002-2009 (R2018) and IS 1875-1992 (R2014). The weld shall be of radiographic quality.	D	W-5	-do-	F-5

4.0 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 copper coating, well bonded and smooth.

4.2 **Size of Wire**- Wire shall be manufactured in five different sizes, namely 2.5, 3.15, 4.0, 5.0 & 6.3 mm diameter. Approval will be considered only if the firm manufacturers at least 3.15, 4.0 or 5.0 mm diameter of wire and offer the same during inspection and sampling. The tolerance in diameter shall be ±0.05mm.

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. Gross weight of the spool including wire shall not exceed 25.0 kgs. Net weight of wire shall be mentioned on each spool.

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

4.4.1 Wire shall be smoothly wound over a wooden, metallic or plastic spool.

4.4.2 The spool cover shall contain name of manufacturer, wire, dia., batch no., date of manufacture, expiry date, current condition & welding parameter, Net weight of wire, Gross weight of spool, IS code, IRS Grade, guidelines on safety during welding, storage & handling and other special recommendations, if any.

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

4.4.4 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.4.4.2.

4.4.5 The details of packing may vary from one manufacturer to other, but in essence, it must have 3 moisture proof polythene layers or 2 moisture proof polythene layers with 1 layer of gunny along with cardboard box. At least one inner packing must be evacuated & shrink packed type.

4.5 Requirement of acceptance for different grades of wire:

4.5.1 All the wires shall fulfill the condition as laid down in clause 4.1 to 4.4

4.5.2 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 have been given.

TABLE-2

ACCEPTANCE CRITERIA OF WIRE FOR SUBMERGED ARC WELDING

Sr. No.	Gr. of Wire	Copper Content in Coating	Storage Stability Test	Chemical Composition	Cast & Helix
1.	W-1	0.2-0.4%	No appreciable corrosion	As per Table-3	As per Cl.4.5.6
2.	W-2	-do-	-do-	-do-	-do-
3	W-3	-do-	-do-	-do-	-do-
4	W-4	-do-	-do-	-do-	-do-
5	W-5	-do-	-do-	-do-	-do-

4.5.3 **Copper Coating:** Details of testing of copper coating of the wire shall be as per Appendix 'A'. The percentage of copper by weight should be between 0.2 to 0.4% in copper coating.

4.5.4 **Storage Stability:** The test shall be carried out as per Appendix "A". No appreciable corrosion shall be present on the surface of wire.

4.5.5 **Chemical Composition:** Chemical Composition of solid wires (bare wire) shall be as per Table-3. The details of testing have been given in Appendix "B".

4.5.6 **Cast and Helix:** The cast & helix of the wire in coil shall be such that the wire will run in an uninterrupted manner on automatic and semi-automatic equipment.

TABLE-3

Ref. Appendix 'B'

CHEMICAL COMPOSITION OF BARE WIRE

IRS Class	Grade of wire	Chemical composition%							
		C	Mn	Si	S	P	Mo	Ni	Cu*
I	W-1	0.10	0.4-0.6	0.03	0.030	0.030	-	-	0.40
II	W-2	0.08-0.15	0.80-1.20	0.15-0.40	0.030	0.030	-	-	0.40
III	W-3	0.12	0.75-1.25	0.05-0.30	0.020	0.020	-	2.10-2.90	0.40
IV	W-4	0.07-0.17	1.20-1.70	0.20	0.030	0.025	0.45-0.65	-	0.40
V	W-5	0.10	0.30-0.55	0.10-0.20	0.035	0.030	-	-	0.40

Note: Single values in the above table are max. value.
*The Wt% of copper includes copper coating also.

5.0 **FLUX:**

5.1 **Quality of Flux:** The flux shall be of agglomerated type and be granular in nature. The consignment of flux shall be homogenous and free from any foreign matter. It shall be flow freely through the flux feeding system.

5.2 **Grain size:** Grain size distribution of flux shall be as follows:

a) Particles to remain within 10-30-44 BS mesh Size equivalent to 1.7 mm, 500 micron and350 micron as per IS:460 Pt.I - 90% min

b) Particles above 5 BS mesh equivalent to 3.5 mm as per IS: 460 Pt.I - Nil

c) Particles below 100 BS mesh equivalent to 150 micron as per IS: 460 Pt.I - 2% max.

The procedure for determination of Grain size is given in Appendix "C".

5.3 Basicity:

5.3.1 Basicity index of flux for all the grades shall be minimum 1.6.

5.3.2 Basicity shall be determined by the formula given below:

$$Basicity\ Index = \frac{MgO + K_2O + Na_2O + CaO + CaF_2 + Li_2O + \frac{1}{2}(FeO + MnO)}{SiO_2 + \frac{1}{2}(Al_2O_3 + TiO_2 + ZrO_2)}$$

The procedure for determination of Basicity index is given in Appendix "C".

5.4 Tap Density:

5.5 Tap Density of flux shall be between 1.0 to 1.7 gm/c.c. The procedure for determination of Tap Density is given in Appendix –"C"

5.5 Moisture Content:

5.5.1 The Moisture Content of flux when heated at 150°C for 2 hrs. will not exceed 0.3%. The procedure for determination of Moisture Content shall be as given in Appendix "C".

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

5.6.1 Flux shall be packed in plastic container, with replaceable lid which when placed tightly shall prevent any ingress of moisture.

5.6.2 Net weight of the flux shall be max. 50 kg. The container shall contain the brand name, name of manufacturer, batch No., date of manufacture, current condition & welding parameter, grain size distribution, weight, IS Code, IRS Grade, guidelines on safety during welding, storage & handling and other special recommendations, if any. A tag containing all the information as above shall also be kept inside the container.

5.6.3 Alternatively, flux shall be packed in a polythene inner bag sealed and kept it inside the polythene lined paper bag or polythene lined plastic bag. After filling the flux, these bags shall be sealed so that flux is protected through two polythene coverings. The thickness & strength of inner polythene & outer polythene lined bag shall be adequate resistance against transportation damage. The net weight of flux in this type of packaging shall be kept as 20±1 Kg or 25±1 Kg. The outer bag shall contain the information as given in clause 5.6.2 for plastic container.

5.7 Requirement of acceptance for different grades of fluxes:

5.7.1 All the flux shall fulfill the conditions as laid down in clause 5.1 to 5.6.

5.7.2 The flux when used in conjunction with the wire of corresponding IRS grade/grades as recommended by the manufacturer shall produce satisfactory crack free weld deposit meeting the acceptance criteria of that particular class of wire-flux combination (weldment). When welded with normal parameter, slag shall be self-peeling or easily detachable by light tapping. The weld bead shall be sound and free from porosities and any other welding defect. Bead shape shall be flat to convex and blend evenly with the parent metal.

5.7.3 The acceptance criteria for each class of wire-flux combination (weldment) have been indicated in **Table.4**. The minimum value requirement of each criteria is either given in the table or reference to appropriate appendix and table has been made wherein details have been given.

TABLE-4

ACCEPTANCE CRITERIA OF WIRE-FLUX COMBINATION FOR SUBMERGED ARC WELDING

S. No.	IRS Class of wire-flux combination	Corresponding Grade of wire Flux	Multirun All Weld		Two Run Weld		Chemical composition	Corrosion Resistance
			Mechanical	Radiography/ Ultrasonic (NDT)	Mechanical	Radiography/ Ultrasonic (NDT)		
1.	I	W-1, F-1	Tab-5	Clause 5.7.3.3	Tab-6	Clause 5.7.3.3	-	-
2.	II	W-2, F-2	-do-	-do-	-do-	-do-	-do-	-
3	III	W-3, F-3	-do-	-do-	-do-	-do-	Tab-7	-
4	IV	W-4, F-4	-do-	-do-	-do-	-do-	Tab-7	-
5	V	W-5, F-5	-do-	-do-	-do-	-do-	Tab-7	Cl.F-4 of APP-F

5.7.3.1 **Mechanical properties of Multirun All Weld:** Method of preparation of Multirun All Weld assembly and test pieces for mechanical testing shall be as given in **Appendix "D"**. Minimum acceptance values of different mechanical properties shall be as given in **Table-5.**

5.7.3.2 **Mechanical properties of Two Run Weld:** Method of preparation of Two Run Weld assembly and test pieces for mechanical testing shall be as given in **Appendix "E"**. Minimum acceptance values of different mechanical properties shall be as given in **Table-6**.

5.7.3.3 **Non Destructive Testing (NDT):** Both Multirun All Weld and Two Run Weld assembly shall be subjected to radiographic/Ultrasonic examination. Minimum acceptance criteria shall be as per IIW Blue Standard for radiographic examination or as per RDSO Procedure No. MC-4 for ultrasonic testing of plate or as per ASTM E390 – Gr. I (For cluster porosity, linear porosity or globular indication and slag inclusion), ASTM E390 –Gr. II (For scattered porosity & coarse scattered porosity). The incomplete penetration, lack of fusion and any type of crack of any grade not allowed.

5.7.3.4 **Chemical composition:** Method of preparation of pad weld and testing shall be as given in **Appendix "B"**. The acceptable range of each element shall be as given in **Table-7.**

5.7.3.5 **Corrosion Resistance:** Method of preparation of corrosion test assembly and testing shall be as per **Appendix "F"**. There shall not be any significant difference in the appearance of the parent plate, heat affected zone and weld zone with respect to corrosion.

TABLE-5

Ref. Appendix 'D'

MECHANICAL PROPERTIES OF MULTIRUN ALL WELD

IRS Class	UTS (N/mm^2)	YS (N/mm^2)	%Elongation on 5 x d G.L.	% Reduction in Area	Impact (Joules)
I	410	330	26	50	27 at –20ºC
II	490	360	24	45	30 at –20ºC
III	540	390	24	45	25 at –46ºC
IV	590	450	20	40	25 at –20ºC
V	490	350	22	40	50 at –20ºC

TABLE-6

Ref. Appendix 'E'

MECHANICAL PROPERTIES OF TWO RUN WELD

IRS Class	Transverse tensile strength (N/mm^2)	Bend Test at 90°bend both with face up &root up using 3T mandrel	Impact value (Jules)
I	410	Satisfactory without any crack	27 at –20°C
II	490	-do-	30 at –20°C
III	540	-do-	25 at –20°C
IV	590	-do-	25 at –20°C
V	490	-do-	50 at –20°C

TABLE-7

Ref. Appendix 'B'

CHEMICAL COMPOSITION OF WELDMENT

S. No.	Class	Chemical composition%								
		C	Mn	Si	S	P	Mo	Ni	Cu	Cr
1	I	-	-	-	-	-	-	-	-	-
2	II	-	-	-	-	-	-	-	-	-
3	III	0.12	1.60	0.80	0.030	0.030	-	2.0-2.90	0.40	-
4	IV	0.15	1.60	0.80	0.040	0.030	0.40-0.65	-	0.40	-
5	V	0.10	0.25-0.90	0.28-0.90	0.045	0.045	-	0.28-0.75	0.25-0.75	0.35-1.20

Note: **1)** Single values in the above table are max. values.
2)Wt% of Cr + Wt% of Mn shall not exceed 2% for S.No.5

6.0 It shall be the responsibility of the flux manufacturer to submit free of cost one spool of wire of 3.15 mm dia. of corresponding grade for which approval is sought. However, RDSO reserves the right to test the flux against any approved brand of wire in the corresponding grade to arrive at a conclusion about the suitability of the flux against that particular grade of wire.

7.0 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 filler wire and/or flux from the same batch wherever possible and subjected to the test in which failure occurred. The filler wire or the flux shall not be accepted as having passed that test unless all the test results on the additional specimens are satisfactory.

8.0 Storage

The spools of wire/container of flux shall be stored in some dry area to minimize ingress of moisture. The roof, floor and walls shall be made of damp proof concrete/brick. The storeroom shall not be used as storage place for grease, oil or other chemicals, which may affect the performance of wire or flux adversely. Preferably a separate room shall be allotted. The storing system shall be First In First Out (FIFO) to prevent undue storage.

9.0 Shelf Life

a) Wire: The shelf life of wire shall be minimum 9 months from the date of receipt in Stores or 12 months from the date of manufacture, whichever is more.

b) Flux: The shelf life of flux shall be minimum 12 months from the date of receipt in Stores or 18 months from the date of manufacture, whichever is more.

10.0 Approval of wire and flux

Approval of a firm will be given as per laid down procedures given in RDSO's Vendor Registration Guidelines (ISO Guidelines in regard to vendor approval process). These documents are available on RDSO website www.rdso.indianrailways.gov.in. These documents are regularly updated and updated documents shall be applicable as on date of application.

LIST OF APPENDICES

1.	**Appendix 'A'**	Procedure for determination of Copper Content in coating of wires and Storage Stability test.
2.	**Appendix 'B'**	Procedure for determination of Chemical Composition of wire and wire & flux combination.
3.	**Appendix 'C'**	Procedure for determination of Basicity Index, Tap Density, Moisture Content and Grain Size Distribution of flux.
4.	**Appendix 'D'**	Procedure for preparation of Multirun All Weld assembly and test pieces.
5.	**Appendix 'E'**	Procedure for preparation of Two Run Weld assembly and test pieces.
6.	**Appendix 'F'**	Procedure for preparation of Corrosion Resistance Test assembly and testing.
7.	**Appendix 'G'**	Sampling plan for wire and flux.

APPENDIX 'A'

PROCEDURE FOR DETERMINATION OF COPPER CONTENT IN COATING OF WIRES AND STORAGE STABILITY TEST

A-1 Copper Content in Coating

A-1.1 About 50 cms of wire of 3.15 mm dia. shall be taken from coil and weighed on chemical balance (W_1 grams).

A-1.2 After weighing, the wire shall be kept in 25% ammonia solution for about 10-12 hrs. Reaction may be accelerated and completed within 1 hour by addition of 1-3 cc of Hydrogen Peroxide.

A-1.3 After all the copper is dissolved; the wire shall be removed from ammonia solution, washed with distilled water and alcohol, dried and weighed (W_2grams).

A-1.4 Difference in weight of wire (Cl.A-1.1 and A-1.3) shall be calculated.

A-1.5 $The\ Percentage\ of\ copper\ by\ weight = \frac{(W_1 - W_2)\ gms}{W_1\ gms} \times 100$

A-1.6 The percentage of copper by weight in copper coating shall be within 0.2-0.4%.

A-2 Accelerated Storage Stability Test

A-2.1 A coil of wire shall be kept in a humidity chamber at 95%-100% RH at 48°C temperature for 24 hours.

A-2.2 After removal of coil from humidity chamber the wire shall be free from any rust or peeling off of copper coating from the surface.

APPENDIX 'B'

PROCEDURE FOR DETERMINATION OF CHEMICAL COMPOSITION OF WIRE AND WIRE-FLUX COMBINATION

B-1 Solid (bare) wire

B-1.1 Sample for analysis shall be taken from 3.15 mm dia. Wire.

B-1.2 Chemical analysis of solid wire shall be conducted after removing the copper coating by emery paper.

B-1.3 Clean wire shall be forged into flat condition and small chips cut out so that weighing and dissolve become easy.

B-1.4 The wet analysis for different elements shall be carried out in accordance with IS: 228. The composition of the wire shall conform to the values given in **Table-3**.

B-2 Wire-flux combination

B-2.1 About 15 mm thick weld metal shall be deposited on mild steel plate conforming to IS2002-2009 (R2018) or IS 2062-2011 (R2016) or its equivalent in flat position using 3.15 mm/4.0 mm wire to prepare a pad.

B-2.2 Sufficient sample shall be taken from that weld metal by an appropriate means (by drilling or shaping). 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 samples.

B-2.3 The wet analysis for different elements shall be carried out in accordance with IS: 228.

B-2.4 Spectrometric analysis may also be carried out on solid and smooth surface of the pad on at least 3 spots. The average of 3 readings shall be taken as the value for a particular element.

B-2.5 In case of any controversy in the spectrometric analysis, wet analysis shall be considered as reference method.

B-2.6 The chemical composition of wire-flux combination i.e. all weld metal shall conform to the range of values for respective IRS class given in **Table-7.**

APPENDIX 'C'

PROCEDURE FOR DETERMINATION OF BASICITY INDEX, TAP DENSITY, MOISTURE CONTENT AND GRAIN SIZE DISTRIBUTION OF FLUX

C-1 Basicity Index:

C-1.1 Flux is to be dried in a drying oven at around 150°C for 1 hour.

C-1.2 Measured amount of flux shall be taken to analyze for determination of MgO, K_2O, Na_2O, CaO, SiO_2, Al_2O_3, CaF2, Li_2O, MnO, FeO, TiO_2 and ZrO_2.

C-1.3 Basicity of flux shall be determined as per the formula given below:

$$Basicity\ Index = \frac{MgO + K_2O + Na_2O + CaO + CaF_2 + Li_2O + \frac{1}{2}(FeO + MnO)}{SiO_2 + \frac{1}{2}(Al_2O_3 + TiO_2 + ZrO_2)}$$

C-1.4 The minimum acceptable value of basicity Index shall be 1.6.

C-1.5 Basicity index of flux may be obtained by XRF method or by Chemical Analysis method.

C-2 Tap Density

C-2.1 Flux is to be dried in drying oven at around 150°C for 1 hour.

C-2.2 An empty 100 c.c. Graduated cylinder is to be carefully weighed (W_1 grams).

C-2.3 About 50 grams of dried flux is to be taken in the cylinder and weighed (W_2 grams).

C-2.4 The cylinder is to be kept on a vibratory platform or tapped lightly till the level of the flux in the cylinder reaches a constant.

C 2.5 The volume of the flux is to be recorded (Vc.c.).

C 2.6 The density of flux shall be determined as per the formula given below-

$$Tap\ Density = \frac{(W_2 - W_1)}{V}\ gms/c.c.$$

C-2.7 The value of Tap density shall be between 1.0 – 1.7 grams/c.c.

C-3 Moisture Content

C-3.1 Some quantities of flux say 50 grams is to be taken in a previously dried glass dish and carefully weighed (W_1 grams).

C-3.2 The dish is to be placed in a drying oven at 150°C for 2 hours.

C-3.3 The dish is to be weighed.

C-3.4 Clause 3.2 and 3.3 is to be repeated till weight becomes constant (W_2 grams).

C-3.5 Moisture content of the flux shall be determined as per the formula given below –

$$Moisture\ Content\ = \frac{(W_1 - W_2)}{W_1} \times 100\%$$

C-3.6 The moisture content of flux shall be maximum 0.3%.

C-4 Grain size distribution

C-4.1 A sieve set is to be prepared consisting of BS: 5, 10, 30, 44 and 100 mesh or corresponding IS sieve No. along with base pan.

C-4.2 Flux is to be dried in drying oven at around 150°C for 1 hour.

C-4.3 100 grams of dried flux is to be kept at the top most pan and lid placed. The whole sieve set is to be put on a sieve shaker and shaken for 5 minutes.

C-4.4 The lid shall be opened after 2 minutes and contents of each sieve and bottom pan shall be weighed separately and reported.

C-4.5 If the sum total of all the weights becomes less than 99.5 grams, the results are to be discarded and repeat experiment shall be carried out.

C-4.6 The acceptance criteria shall be as per clause 5.2.

APPENDIX 'D'

PROCEDURE FOR PREPARATION OF MULTIRUN ALL WELD ASSEMBLY AND TEST PIECES

D-1 Preparation of all weld test assembly

D-1.1 Material

D-1.1.1 **Parent Plates and Backing Strips:** The parent plates used for preparing test assembly and backing strip shall conform to IS 2002, IS 2062 or any other equivalent specification.

D-1.1.2 **Wire:** The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4.

D-1.1.3 **Flux:** The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.

D-1.2 **Dimensions:** The dimension of plates and backing strips shall be as given below.

Parent Plate

Length	-	600 mm ± 10 mm
Breadth	-	150 mm ± 10 mm
Thickness	-	20 mm ± 2 mm
Edge Angle	-	10° ± 1°

Backing Strip

Length	-	700 mm ± 10 mm
Breadth	-	40 mm - 50 mm
Thickness	-	10-12 mm

D-1.3 Pre-setting and Welding

D-1.3.1 The back strip shall be tacked with parent plates at root gap of about 24 ± 1 mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.

D-1.3.2 Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.

D-1.3.3 Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.

D-1.3.4 The gap shall then be filled up by using 3.15 mm or 4.0 mm or 5.0 mm diameter of wire in combination with flux in flat position.

D-1.3.5 Each run shall be properly de-slagged before putting another run on or adjacent to previous run.

D-1.3.6 The temperature of weld assembly shall be kept between 110°C-180°C. For this, inter pass time gap, if necessary shall be maintained.

D-2 Preparation of test pieces

D-2.1 Radiographic/Ultrasonic Examination

D-2.1.1 About 20 mm from both sides of the assembly shall be cut and discarded.

D-2.1.2 After removal of back strip, assembly shall be subjected to Radiographic/Ultrasonic examination.

D-2.1.3 The assembly shall meet the criteria as given in Clause 5.7.3.3.

D-2.1.4 After satisfactory completion of radiographic/Ultrasonic tests, the assembly shall be used for making tensile and impact test pieces.

D-2.2 All Weld Tensile Test

D-2.2.1 Two tensile test pieces shall be made from weld metal consuming a length of about 300mm.

D-2.2.2 The dimension of test piece shall be as per IS: 15977.

D-2.2.3 The test piece shall be tested as per IS: 1608.

D-2.2.4 The value of both test results shall meet the minimum requirement of offered class as given in **Table-5**.

D-2.3 Charpy Impact Test

D-2.3.1 Six test pieces shall be made from the remaining plate.

D-2.3.2 The dimension of test pieces shall be as per IS: 15977

D-2.3.3 From these test pieces, 5 nos. shall be tested as per IS: 1757 at required temperature as indicated in **Table-5** against different classes of wire-flux combinations.

D-2.3.4 From these five test results, the highest and lowest results shall be discarded. The average of remaining three shall be taken as average impact value.

D-2.3.5 One test piece shall be kept as spare, which shall be tested in case one more test results is to be discarded because of testing fault.

D-2.3.6 The individual value of the three tests shall not fall below 20% of the minimum average value given in **Table-5** for respective class. The average value shall meet the minimum requirement of offered class as given in **Table-5.**

APPENDIX 'E'

PROCEDURE FOR PREPARATION OF TWO RUN WELD ASSEMBLY AND TEST PIECES

E-1 Preparation of two run weld assembly:

E-1.1 Material:

E-1.1.1 Parent Plate: The parent plates used for preparing test assembly shall conform to IS 2002-2009 (R2018), IS 2062-2011 (R2016) or any other equivalent specification.

E-1.1.2 Wire: The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4.

E-1.1.3 Flux: The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.

E-1.2 Dimensions: The dimensions and edge preparation of the plates shall be as given below:

Length	-	600 mm ± 10 mm
Breadth	-	150 mm ± 10 mm
Thickness	-	20 ± 2 mm
Edge Preparation	-	As per IS:15977

E-1.3 Presetting & Welding:

E-1.3.1 The plates shall be tack welded at the ends keeping a gap of about 1 mm-2mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.

E-1.3.2 Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.

E-1.3.3 Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.

E-1.3.4 One welding run each shall be given from both the sides of the plates.

E-1.3.5 The temperature of weld assembly shall be kept between 110°C-180°C. For this, inter pass time gap, if necessary shall be maintained.

E-2 Preparation of test pieces:

E-2.1 Radiographic Examination/Ultrasonic Examination:

E-2.1.1 About 20 mm from both sides of the assembly shall be cut and discarded.

E-2.1.2 The assembly shall be subjected to Radiographic examination/Ultrasonic Examination.

E-2.1.3 The assembly shall meet the criteria as given in Clauses 5.7.3.3.

E-2.1.4 After satisfactory completion of Radiography examination/Ultrasonic Examination, the assembly shall be used for making test pieces.

E-2.2 Transverse Tensile Test:

E-2.2.1 Two test pieces shall be made as shown in **figure-1.**

E-2.2.2 The test pieces shall be tested as per IS:1608.

E-2.2.3 The value of both test results shall meet the minimum requirement of offered class as given in **Table-6**.

E-2.3 Bend Test:

E-2.3.1 Two test pieces shall be made as shown in **figure-1**.

E-2.3.2 The test pieces shall be tested as per IS: 1599. One piece shall be tested keeping one face in tension and other piece with opposite face in tension.

E-2.3.3 No crack shall appear on the tension face. However, minor cracks at the end may be ignored.

E-2.4 Charpy Impact Test:

E-2.4.1 Six test pieces shall be made as shown in **figure-1.**

E-2.4.2 The test pieces shall be tested as per IS: 1757.

E-2.4.3 From these test pieces, 5 nos. shall be tested as per IS: 1757 at temperature as indicated in **Table-6** against different classes of wire-flux combinations

E-2.4.4 From these five test results, the highest and lowest results shall be discarded. The average of remaining three shall be taken as average impact value.

E-2.4.5 One test piece shall be kept as spare, which shall be tested in case one more test result is to be discarded because of testing fault.

E-2.4.6 The individual value of all three tests shall not fall below 20% of the minimum average value given in **Table-6** for respective class. The average value shall meet the **minimum** requirement of offered class as given in**Table-6**.

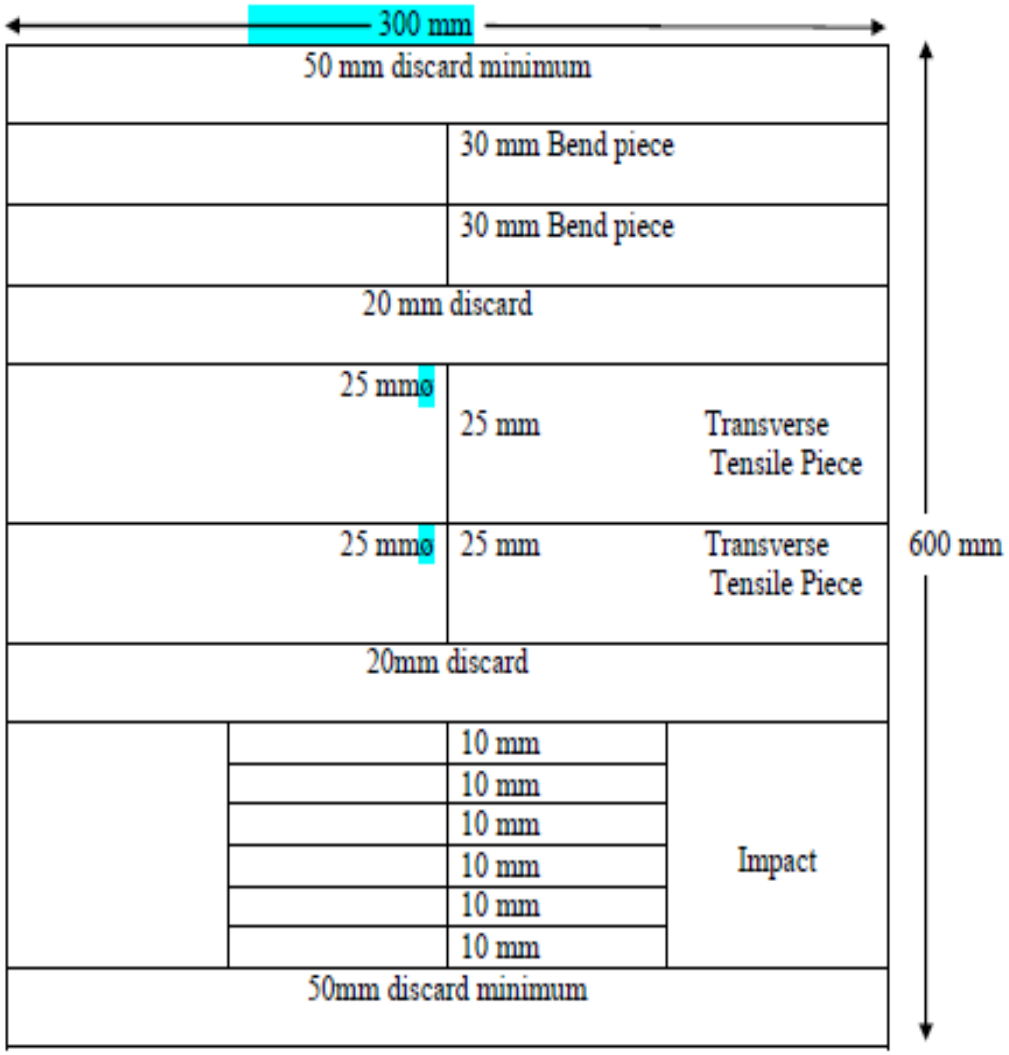

Fig.1 – Preparation of different test pieces from Two Run Weld Assembly.

APPENDIX 'F'

PROCEDURE FOR PREPARATION OF CORROSION RESISTANCE TEST ASSEMBLY AND TESTING

F-1 Preparation of Corrosion Resistance Test Assembly:

F-1.1 Material:

F-1.1.1 Parent Plate: The parent plates shall conform to Indian Railways Standard Specifications IRS: M-41, IRS: M-42 or their equivalent.

F-1.1.2 Backing Strip: The backing strip shall conform to **IS 2002-2009 (R2018), IS 2062-2011 (R2016)**, IRS: M-41, IRS: M-42 or their equivalent.

F-1.1.3 Wire: The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4.

F-1.1.4 Flux: The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.

F-1.2 Dimension: The dimensions of plates and backing strips shall be as given below:

(a) Parent Plate:

Length	-	300mm ± 10mm
Breadth	-	150mm ± 10mm
Thickness	-	10mm ± 2mm
Edge Angle	-	10º ± 1º

(b) Backing Strip:

Length	-	400mm ± 10mm
Breadth	-	50mm ± 10mm
Thickness	-	10mm ± 2mm

F-1.3 Pre-setting and Welding:

F-1.3.1 The back strip shall be tacked with parent plates at root gap of about 24 ± 1 mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.

F-1.3.2 Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.

F-1.3.3 Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.

F-1.3.4 The gap shall then be filled up by using 3.15 mm or 4.0 mm or 5.0 mm diameter of wire in combination with flux in flat position.

F-1.3.5 Each run shall be properly de-slagged before putting another run on or adjacent to previous run.

F-1.3.6 The temperature of weld assembly shall be kept between 110°C-180°C. For this, inter pass time gap, if necessary, shall be maintained.

F-1.3.7 Two such test assemblies shall be prepared as shown in **figure-2**.

F-2 Preparation of Test Pieces:

F-2.1 After removing the back plate a square panel of 100mm x 100mm x 10mm shall be removed from center as shown in **figure-3.**

F-2.2 A test panel of 100mm x 100 mm x 6mm shall be prepared as shown in **figure-4** by shaping.

F-2.3 The whole test panel shall be thoroughly polished.

F-2.4 Two such panels shall be prepared from two test assemblies.

F-2.5 One blank panel of same dimensions shall be prepared using same material of parent plates.

F-3 Testing:

Two test panels with weld bead at middle along with one blank panel shall be subjected to corrosion test at a temperature of 42°C- 48°C with humidity between 95%-100% as per section 1 of IS: 101-88, Pt-6 (R2015). Condition of the weld and parent metal surfaces shall be examined after a period of seven day exposure as follows.

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

F-4 Acceptance Criteria:

There shall not be any significant difference in the appearance of the parent plate, heat affected zone and weld zone with respect to corrosion.

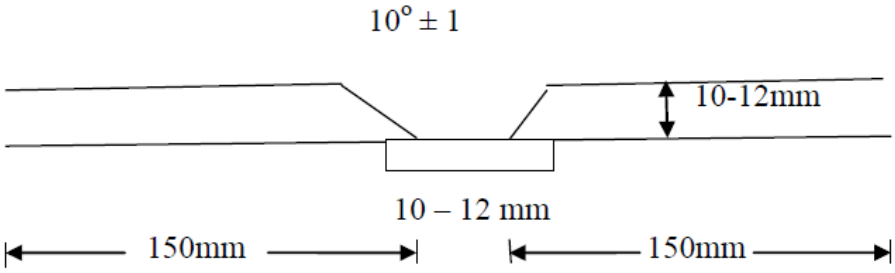

Fig.2 – Presetting of plates & back strip before welding.

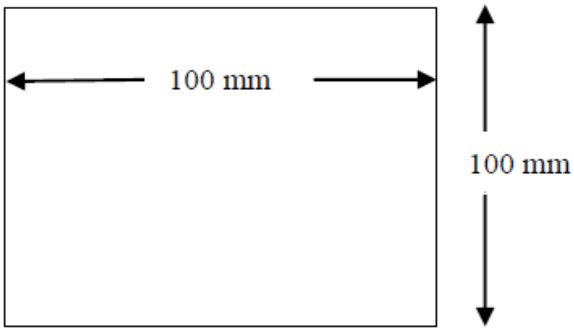

Fig.3 – Middle part of the assembly for making the test panel.

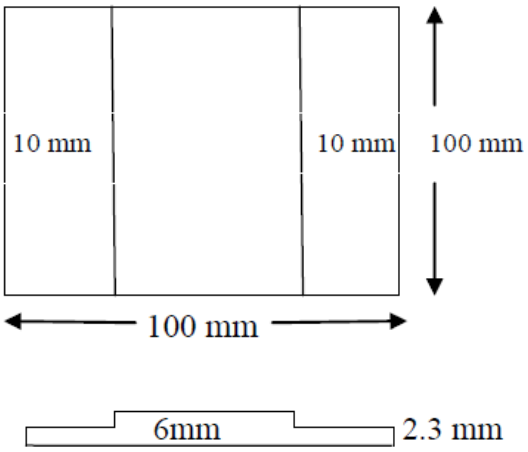

Fig.4 – Plan & Elevation of the test panel.

APPENDIX-G

SAMPLING PLAN FOR WIRE AND FLUX

The basic purpose of sampling is to obtain real representative quantity of a particular welding consumable out of the entire bulk stock of the manufacturer. During inspection for periodic and initial assessment statistical methods as indicated in IS: 4905-2015 will be resorted to. A few salient features of sampling are given below:

1. No. of samples to be drawn will be decided as per testing requirement.

2. The manufacturer has to submit a minimum lot size 'N' as indicated against each consumable so that representative sample can be drawn.

3. All the individual spools of the lot size 'N' must be of same batch.

4. Sampling of flux shall be done by coning & quartering process.

5. During sampling, double the quantity required in each size will be drawn and sealed. Half of the quantity sampled shall be treated as counter sample, which are to be preserved by the firm in safe custody till the approval is granted or otherwise. In case of any discrepancy while testing, reference may be drawn from the counter samples to finalize the issue. If approval is granted, these counter samples are to be preserved till the shelf life of the product is over. Other half shall be sent to RDSO for testing.

The minimum lot size requirement is given below: -

Type of Consumable	Size	No. of Samples To be drawn	Minimum lot size to be offered
Wire	3.15mm, 4.0mm and/or 5.0mm	2 spools of each size	15 spools of each size
Flux	20 Kg Container	4 Containers	25 Containers
	25 Kg Container	4 Containers	25 Containers
	50 Kg Container	2 Containers	15 Containers