IS 814 : 1991
(Superseding IS 815 : 1974)
(Reaffirmed 1997)

भारतीय मानक

हस्त्य धातु आर्क वेल्डिंग के लिए आवृत्त कार्बन और कार्बन मैगनीज़ इस्पात इलैक्ट्रोड – विशिष्टि

(पाँचवां पुनरीक्षण)

Indian Standard

COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF CARBON AND CARBON MANGANESE STEEL – SPECIFICATION

(Fifth Revision)

Second Reprint OCTOBER 1997

UDC 621·791·753·042·4

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October 1991

Price Group 9

FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Welding General Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Requirements of covered electrodes for metal arc welding of structural steel were covered in Part I and Part II of IS 814 for welding products other than sheets and for welding sheets respectively. IS 814 was first published in 1957 and subsequently revised in 1963, 1967, 1970 and 1974. In the fourth revision, IS 814, was split in two parts.

The classification and coding of the covered electrodes was covered in IS 815. IS 815 was first issued in 1956 and subsequently revised in 1966 and 1974.

While revising these two standards the committee thought it appropriate to cover the classification and coding along with the specified requirements of electrodes by merging both the parts of IS 814 and IS 815. Important modifications affected in this revision are as under:

a) The classifiation system has been simplified to a code consisting of a alphabets to indicate the type of coating and four digits to indicate the basic properties of the electrode;

b) The tests for deep penetration electrodes have been eliminated as these were considered to be of little significance;

c) In the butt weld assembly the transverse tensile and charpy impact tests have been eliminated and only bend test has been specified. Provisions for 'hydrogen removal heat-treatment' for the bend specimen have also been included;

d) For the determination of the quantity of diffusible hydrogen a reference has been made to IS 11802 : 1986 'Methods for determination of diffusible hydrogen content of deposited weld metals from covered electrodes in welding mild and low alloy steels';

e) Use of non-rimming steel for core wire has been permitted by giving reference to the amended IS 2879 : 1975 'Mild steel for metal arc welding electrode core wires (*second revision*)';

f) Assessment of all weld impact test has been made on the lines of ANSI/AWSA 5.1-81, 'Specification for covered carbon steel arc welding electrodes'; and

g) Under the initial tests, radiographic test has been included.

This standard keeps in view the manufacturing and trade practices being followed in the country in this field. Assistance has also been derived from the following publications:

a) ISO 2560-1973, 'Covered electrodes for manual metal arc welding of mild steel and low alloy steel — Code of symbols for identification' issued by the International Organization for Standardization (ISO).

b) BS 639 : 1986 'Specification for covered carbon and carbon manganese steel electrodes for manual metal arc welding' issued by British Standards Institution (BSI).

c) ANSI/AWSA. 5.1-1981 'Specification for covered carbon steel arc welding electrodes' issued by American National Standards Institute (USA).

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 should be the same as that of the specified value in this standard.

Indian Standard

COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF CARBON AND CARBON MANGANESE STEEL – SPECIFICATION

(Fifth Revision)

1 SCOPE

This standard specifies the requirements for covered carbon and carbon manganese steel electrodes for carbon and carbon manganese steel, including hydrogen controlled electrodes for manual metal arc welding of mild and medium tensile steels including structural steels, depositing weld metal having a tensile strength not more than 610 N/mm².

NOTES

1 For weld metal with tensile strength higher than 610 N/mm², a reference may be made to IS 1395 : 1982, 'Low and medium alloy steel covered electrodes for manual metal arc welding (*third revision*)'

2 As this standard is primarily concerned with the mechanical properties of the weld metal, no limits have been specified on the chemical co nposition of the weld metal.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard definitions given in IS 812 : 1957 shall apply except for the following:

3.1 Weld Slope

It is the angle formed between the lines of the weld root and a horizontal reference plane. Slope may be measured either clockwise or anticlockwise and either above or below the horizontal between 0 degree and 90 degree.

3.2 Weld Rotation

The rotation of a weld is the angle formed between upper portion of a vertical reference plane passing through the weld root and a point on the face of weld equidistant from both the edges of the weld. Rotation may be measured either clockwise or anticlockwise between 0 degree and 180 degree.

3.3 Welding Position

The welding position is given by the combination of weld slope and weld rotation (*see* **5.4.1**).

4 SUPPLY OF MATERIALS

General requirements relating to supply of covered electrodes for metal arc welding shall be as laid down in IS 1387 : 1967.

5 CLASSIFICATION

5.0 General

Classification of electrodes shall be indicated by the following coding system of letters and numerals to indicate the specified properties or characteristics of the electrode.

5.0.1 *Main Coding*

It consists of the following letters and numerals and shall be followed in the order stated:

a) a prefix letter 'E' shall indicate a covered electrode for manual metal arc welding, manufactured by extrusion process;

b) a letter indicating the type of covering (*see* **5.1**);

c) first digit indicating ultimate tensile strength in combination with the yield stress of the weld metal deposit (*see* **5.2**);

d) second digit indicating the percentage elongation in combination with the impact values of the weld metal deposited (*see* **5.3**);

e) third digit indicating welding position(s) in which the electrode may be used (*see* **5.4**); and

f) fourth digit indicating the current condition in which the electrode is to be used (*see* **5.5**)

5.0.2 *Additional Coding*

The following letters indicating the additional properties of the electrodes may be used, if required:

a) letters H_1, H_2, H_3 indicating hydrogen controlled electrodes (*see* **5.6**).

b) letters J, K and L indicating increased metal recovery as 'Effective Electrode Efficiency' as per IS 13043 : 1991. Specification in the followings range (*see* **5.7**) :

J = 110 — 129 percent;

K = 130 — 149 percent; and

L = 150 percent and above.

c) letter 'X' indicating the radiographic quality (*see* **5.8**).

NOTE — Examples illustrating for establishing electrodes coding from the initial test results have been given in Annex B.

5.1 Type of Covering

Type of covering shall be indicated by the following letters:

A — Acid

B — Basic

C — Cellulosic

R — Rutile

RR — Rutile, heavy coated

S — Any other type not mentioned above.

NOTE — For guidance only the charactertisics of each of the covering and coating ratio are described in Annex C.

5.2 Strength Characteristics

The combination of ultimate tensile strength and yield strength of the weld metal deposited shall be indicated by the digits 4 and 5 (*see* Table 1).

Table 1 Designation of Strength Characteristics

(*Clauses* 5.2 *and* 5.3)

Designating Digit	Ultimate Tensile Strength N/mm²	Yield Strength, *Min* N/mm²
(1)	(2)	(3)
4	410-510	330
5	510-610	360

5.3 Elongation and Impact Properties

The combination of percentage elongation and impact properties of all weld metal deposited for the two tensile ranges (*see* Table 1) shall be as given in Table 2.

Table 2 Combination of Percentage Elongation and Impact Strength

(*Clause* 5.3)

Designation Digit	Percentage Elongation (*Min*) on 5·65/So	Impact Strength in Joules (*Min*)/at °C
(1)	(2)	(3)
For Tensile Range 410-510 *N/mm²*		
0	No elongation and impact requirements	
1	20	47J/+27° C
2	22	47J/+0° C
3	24	47J/−20° C
4	24	27J/−30° C
For Tensile Range 510-610 *N/mm²*		
0	No elongation and impact requirements	
1	18	47J/+27° C
2	18	47J/+0° C
3	20	47J/−20° C
4	20	27J/−30° C
5	20	27J/−40° C
6	20	27J/−46° C

5.4 Welding Position

The welding position or positions in which the electrode can be used as recommended by the manufacturer shall be indicated by the appropriate designating digits as follows:

1 — All positions

2 — All positions except vertical down

3 — Flat butt weld, flat fillet weld and horizontal/vertical fillet weld

4 — Flat butt weld and flat fillet weld

5 — Vertical down, flat butt, flat fillet and horizontal and vertical fillet weld

6 — Any other position or combination of positions not classified above.

5.4.1 Welding position in detail have been described in Annex D.

5.4.2 Where an electrode is coded as suitable for vertical and overhead positions it may be considered that sizes larger than 4 mm are not normally used for welding in these positions.

5.4.3 An electrode shall not be coded as suitable for a particular welding position unless it is possible to use it satisfactorily in the position to comply with test requirements of this code.

5.5 Welding Current and Voltage Conditions

The welding current and open circuit voltage conditions on which the electrodes can be operated as recommended by the manufacturer

shall be indicated by the appropriate designating digits as given in Table 3.

5.5.1 For the purpose of coding an electrode for any of the current conditions under **5.5**, shall be of size 4 mm or 5 mm and shall be capable of being operated at that condition satisfactorily within the current range recommended by the manufacturer.

5.6 Hydrogen Controlled Electrodes

The letters H_1, H_2 and H_3 shall be included in the classification as a suffix for those electrodes which will give diffusible hydrogen per 100 gm when determined in accordance with reference method given in IS 11802 : 1986 as given below:

H_1 = Up to 15 ml diffusible hydrogen
H_2 = Up to 10 ml diffusible hydrogen
H_3 = Up to 5 ml diffusible hydrogen

Table 3 Welding Current and Voltage Conditions

(*Clause* 5.5)

Digit	Direct Current Recommended Electrode Polarity[2]	Alternating Current Open Circuit Voltage, V, *Min*
(1)	(2)	(3)
0[1]	+	Not recommended
1	+ or −	50
2	−	50
3	+	50
4	+ or −	70
5	−	70
6	+	70
7	+ or −	90
8	−	90
9	+	90

1) Symbol 0 reserved for electrodes used exclusively on direct current,

2) Positive polarity +. Negative polarity −.

NOTES

1 The frequency of the alternating current is assumed to be 50 or 60 Hz. The open circuit voltage necessary when electrode are used on direct current is closely related to the dynamic characteristics of the welding power source. Consequently no indication of the minimum open circuit voltage for direct current is given.

2 Welding current and voltage conditions have been described in detail in Annex E.

5.7 Increased Metal Recovery

The letters J, K and L shall be included in the classification as a suffix for those electrodes which have appreciable quantities of metal powder in their coating and give increased metal recovery with respect to that of core wire melted, in accordance to the range given in **5.0.2** (b).

5.7.1 The Metal Recovery shall be determined as 'Effective Electrode Efficiency (E_E) as per the method given in IS 13043 : 1991.

5.8 Radiographic Quality Electrodes

The letter 'X' shall be included in the classification as a suffix for those electrodes which deposit radiographic quality welds (*see* **9.6**).

6 CORE WIRE FOR ELECTRODES

The core wire used for the manufacture of electrodes shall conform to IS 2879 : 1975

7 DIMENSIONS AND TOLERANCES

7.1 Size and Length

The size of an electrode shall be designated by the nominal diameter of the core wire expressed in mm. Sizes of electrodes and corresponding lengths of electrodes shall be as given in Table 4.

The tolerance on the specified diameter of the core wire shall be ± 0·05 mm.

The tolerance on the specified length shall be ± 3 mm.

7.1.1 Sizes and lengths of electrodes other than those mentioned in Table 4 may be supplied subject to agreement between the manufacturer and the purchaser. The tolerance in such cases shall be agreed to between the manufacturer and the purchaser.

Table 4 Sizes and Lengths of Electrodes

(*Clause* 7.1)

Size, mm	Length, mm
(1)	(2)
1·6	150 or 200 or 250
2·0	200 or 250 or 300 or 350
2·5	250 or 300 or 350
3·15	350 or 450
4·0	350 or 450
5·0	350 or 450
6·3	350 or 450
8·0	350 or 450

7.2 Bare Length (Contact End)

The contact end of the electrode shall be clean and free from covering for enabling it to be gripped by the electrodes holder as specified below:

Electrode Size, mm	*Bare Length*, mm	
	Minimum	*Maximum*
1·6 to 3·15	15	30
4·0 to 8·0	20	40

7.3 Bare Length (Arc Striking End)

The arc striking end of the electrode shall be bare and permit easy striking of arc. The distance from the arc end to the first point where the full cross section of the covering prevails shall not exceed the following limits:

(i) Classification EBXXXXH1: EBXXXXH2, EBXXXXH3 and any other hydrogen controlled type	1/2 core wire diameter or 2·0 mm whichever is less
(ii) Other types	2/3 core wire diameter of 2·5 mm whichever is less

7.4 Concentricity of Flux Covering with Core Wire — Tolerance

The flux covering on the electrode shall be uniform and concentric with the core wire. The tolerance for concentricity of the covering (*see* Fig. 1) shall be such that the maximum core plus one covering dimension shall not exceed the minimum core plus one covering dimension by more than:

a) 5 percent of the mean of two dimensions for EBXXXX and ESXXXX class electrodes,

b) 4 percent of the mean of two dimensions for ERXXXX, ERRXXXX and EAXXXX class electrode, and

c) 3 percent of the mean of two dimensions for ECXXXX class electrode.

$A - B \leq \frac{5}{100} \frac{(A + B)}{2}$ for EBXXXX and ESXXXX class electrodes.

$A - B \leq \frac{4}{100} \frac{(A + B)}{2}$ for ERXXXX, ERRXXXX and EAXXXX class electrodes.

$A - B \leq \frac{3}{100} \frac{(A + B)}{2}$ for ECXXXX class electrodes.

where

A = maximum core plus one covering dimension, and

B = minimum core plus one covering dimension.

7.5 Core wire and coverings shall be free of defects which would interfere with the uniform welding performance of the electrode.

8 TESTS FOR ELECTRODE PROPERTIES

8.0 General

Electrode shall be subjected to the following tests for assessing the mechanical properties of the deposited weld metal and the usability of an electrode for a particular welding position:

a) Initial tests,

b) Periodic check tests, and

c) Quality control tests.

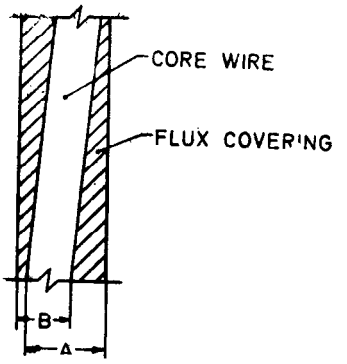


FIG. 1 PERMISSIBLE TOLERANCES FOR FLUX COVERING

8.0.1 An electrode suitable for operation on a.c. or d.c. shall be tested on a.c.

8.0.2 When an electrode of a particular nominal size is manufactured in more than one lengths, the electrodes used for the tests shall be longest manufactured.

8.0.3 The parent metal used for test plates shall conform to the requirements specified in Annex F.

8.1 Initial Tests

These are qualifying or proving tests for each type or modified type of electrodes and shall comprise the following:

a) All weld metal mechanical tests for tensile and impact (*see* **9.1**);

b) Butt weld bend tests (*see* **9.2**);

c) Running performance test (*see* **9.3**);

d) Increased metal recovery tests for electrodes claiming recovery 110 percent and above (*see* **9.4**);

e) Diffusible hydrogen estimation test for hydrogen controlled electrode (*see* **9.5**); and

f) Radiographic quality test (*see* **9.6**).

8.2 Periodic Check Tests

These comprise of the following tests selected from among the initial tests and are meant to be repeated at intervals to provide evidence that the electrodes currently produced possess the properties proved in the initial tests. Such

tests shall be conducted at least once in a year. These check tests shall not apply to the electrodes not manufactured during that period. When production of a type of electrode after stoppage of production for more than six months is restored, the following periodic check test shall be conducted:

a) All weld metal mechanical tests for tensile and impact (*see* **9.1**);

b) Running performance test (*see* **9.3**).

8.3 Quality Control Tests

By means of a suitable system of control, the manufacturer shall satisfy himself that the composition and quality of all the electrodes currently produced are similar to those of electrodes subjected to initial tests. He shall ensure that the result of quality control tests and date of manufacture of electrodes is traced from the batch number of the relevant details, or both.

NOTES

1 For the purpose of this standard, a batch is defined as a lot of covered electrodes not exceeding 1 000 kg in weight, of any one size and classification produced from coating identified by a dry mix or more than one dry mix of controlled chemical composition and core wire identified by a heat number of controlled chemical composition.

2 Identification of electrode core wire:

i) Solid core wire for manufacture of electrodes identified by heat no shall consist of material from a single heat of metal.

ii) Solid electrode core wire identified by controlled chemical composition, rather than by heat, shall consist of mill coils of one or more heat from which samples have been taken for chemical analysis. The results of the analysis of each sample must be within the composition limits as specified in IS 2879 : 1975.

3 Identification of covering mix:

i) A dry mix is the quantity of dry coating ingredients mixed at one time in one mixing vessel. A dry mix may be divided into smaller quantity for production of wet mixes in using a liquid binder.

ii) Covering identified by a dry mix shall consist of electrode produced from a single dry mix of coating ingredients.

iii) Covering identified by controlled composition (rather than by dry mix) shall consist of one or more dry mixes and shall be subjected to sufficient tests to assure that all dry mixes within the lot are equivalent. These tests shall include chemical analysis, the results of which must fall within the manufacturers acceptance limits. The identification of the test procedure and the results of the tests shall be recorded.

8.3.1 The manufacturer on request shall make available to the approving and certifying authorities the records maintained for quality control, for ensuring that the composition and quality of all the electrodes currently produced are similar to those electrodes subjected to initial and periodic check tests.

8.4 Additional Tests

Subject to agreement with the manufacturer, the purchaser may request for additional tests to be made or certificates to be provided for each batch of electrodes supplied. If so, the tests and batch definition shall be agreed between the manufacturer and the purchaser.

9 DETAIL OF TESTS

9.1 All Weld Metal Mechanical Tests for Tensile and Impact

9.1.1 *Weld Assembly*

Two all weld test assemblies shall be prepared one using 4·0 mm and the highest size manufactured the other using in accordance with the method described in Annex G. If the highest size produced by any manufacturer is 4·0 mm, then two all weld test assemblies using 4·0 mm and 3·15 mm respectively shall be prepared.

9.1.2 *All Weld Tensile Tests*

Two all weld tensile test specimens one from each of the assemblies as given in **9.1.1** shall be prepared and tested in accordance with the method described in Annex G. The ultimate tensile strength and the minimum yield stress shall comply with the values given in Table 5. When particular ductile properties are claimed or specified, the minimum percentage elongation shall comply with the appropriate value given in Table 5.

NOTE — The all weld tensile test is for quality control purpose only. It is not intended to imply that values obtained in all weld tests should be used for design purposes.

9.1.3 *All Weld Impact Tests*

Five charpy V-notch impact test specimens shall be machined from the same test assembly and tested in accordance with the method described in Annex G at the temperature specified in Table 5 and shall comply with the values given in Table 5 at specified temperature. The results of the impact test from five test specimens shall be assessed as specified in **9.1.3.1, 9.1.3.2** and **9.1.3.3.**

9.1.3.1 When computing the average values of the impact properties from the set of five specimens, the lowest value and the highest value obtained shall be disregarded.

9.1.3.2 For classification EXX1XX EXX2XX and EXX3XX, two of the three remaining values shall be greater than the specified 47 joules;

Table 5 Mechanical Properties of Weld Metal

(*Clauses* 9.1.2 *and* 9.1.3)

Classification	Ultimate Tensile Strength N/mm²	Yield Strength, *Min* N/mm²	Percentage Elongation on 5·65/So	Temperature for Impact °C	Impact *Min* in joules
(1)	(2)	(3)	(4)	(5)	(6)
EX40XX	410-510	330	—	—	—
EX41XX	410-510	330	20	+27	47
EX42XX	410-510	330	22	0	47
EX43XX	410-510	330	24	—20	47
EX44XX	410-510	330	24	—30	27
EX50XX	510-610	360	—	—	—
EX51XX	510-610	360	18	+27	47
EX52XX	510-610	360	18	0	47
EX53XX	510-610	360	20	—20	47
EX54XX	510-610	360	20	—30	27
EX55XX	510-610	360	20	—40	27
EX56XX	510-610	360	20	—46	27

NOTE — In view of the possible scatter in welding and testing the upper limit of ultimate tensile strengths that is 510 N/mm² and 610 N/mm² in the two ranges may be exceeded by 40 N/mm².

one of the three may be lower but shall not be less than 41 joules. The computed average value of the three values shall be equal to or greater than 47 joules.

9.1.3.3 For classification EXX4XX, EXX5XX and EXX6XX, two of the three remaining values shall be greater than the specified 27 joules; one of the three may be lower but shall not be less than 23 joules. The computed average value of the three values shall be equal to or greater than 27 joules.

9.2 Butt Weld Bend Test

Butt weld assemblies shall be prepared in different welding positions for the various electrode classification as per the recommendations given in Table 6 and the procedure given in Annex H.

9.2.1 From each butt weld assembly two bend tests, one with face and one with root in tension shall be carried out. The test specimens shall be bent through an angle of 180 degree over a mandrel having a diameter equal to three times the thickness of the specimen in accordance with IS 1599 : 1985. The electrodes shall be deemed to be satisfactory, if on completion of the test no crack or defect at the outer surface of the test specimen is greater than 3 mm measured across the test specimen or 1·5 mm measured along the length of the test specimen. Premature failure at corners of the test specimen shall not be considered as a case for rejection.

9.3 Running Performance Test

This test is to be carried out for electrodes of 2·5 mm size and below to assess the welding performance. The tests shall be conducted using three electrodes as per details given in Annex H. The bead should be visually inspected and should be free from porosities, slag inclusions, cracks etc in the main portion of the bead as given in Annex J. The bead shall be reasonably straight and evenly rippled. The slag should be removed with little effort.

9.4 Increased Metal Recovery Test

The metal recovery shall be determined for the electrodes classified under EXXXXXJ, EXXXXXK and EXXXXXL or EXXXXXHJ, EXXXXXHK and EXXXXXHL on the largest size eleroctrode manufactured but not lower than 4 mm in accordance with the method given in IS 13043 : 1991. The value obtained by the method shall be rounded off to the nearest multiple of 5.

The rounded recovery figure shall conform to the requirements of **5.0.2** (b) for the respective classification.

9.5 Diffusible Hydrogen Evaluation Test

This test shall be carried out for all electrodes classified under EXXXXXH and EXXXXXHL preferably using 3·15 mm or 4·0 mm size. The tests shall be conducted as per procedure given in IS 11802 : 1986.

Table 6 Welding Procedure for Preparation of Bend Test Pieces

(*Clause* 9.2)

Positional Classification	No. of Butt-Weld Assemblies	Position	Welding Procedure
(1)	(2)	(3)	(4)
EXXX1X	2	Flat (Weld-slope 0° weld-rotation 0°)	a) First run with 3·15 or 4·0 mm b) Subsequent runs (except last two layers) with 4 or 5 mm according to normal practice of the electrode c) Runs of last two layers with largest size submitted for approval
	1	Vertical-up (Weld-slope 0°)	a) First run with 2·5 or 3·15 mm b) Subsequent runs with one of the following: b.1) with 4·0 mm or if recommended by the manufacturer with 5·0 mm b.2) when the increased metal recovery exceeds 110 percent, with 3·15 mm
	1	Vertical-down (Weld-slope 0°)	a) First run with 2·5 or 3·15 mm b) Subsequent runs with one of the following: b.1) with 4·0 mm or if recommended by the manufacturer with 5·0 mm b.2) when the increased metal recovery exceeds 110 percent, with 3·15 mm
	1	Overhead (Weld-slope 0° weld-rotation 180°)	a) First run with 2·5 or 3·15 mm b) Subsequent runs with one of the following: b.1) with 4·0 mm or if recommended by the manufacturer with 5·0 mm b.2) when the increased metal recovery exceeds 110 percent, with 3·15 mm
EXXX2X	2	Flat	Same as EXXX1X
	1	Vertical-up	Same as EXXX1X
	1	Overhead	Same as EXXX1X
EXXX3X	2	Flat	Same as EXXX1X
	1	Horizontal-Vertical (Weld-slope 0° Weld-rotation 90°)	a) First run with 3·15 mm or 4·0 mm b) Subsequent runs with 5·0 mm
EXXX4X	2	Flat	Same as EXXX1X
EXXX5X	2	Flat	Same as EXXX1X
	1	Vertical-down	Same as EXXX1X
EXXX9X	As required	In all the positions specified by the manufacturers	a) If the position comes nearer to 'Flat' position — a.1) First run with 3·15 or 4·0 mm a.2) Subsequent runs (except last two layers) with 4·0 mm or 5·0 mm a·3) Last two layers with largest size submitted for approval b) For other position(s) — b.1) First run with 2·5 or 3·15 mm b.2) Subsequent runs with 4·0 mm or if recommended by the manufacturer with 5·0 mm

9.6 Both the all weld metal assemblies after the removal of backing strips and before heat-treatment shall be subjected to X-ray radiographic tests. The radiographs should conform to the standards as agreed to between the manufacturer and the purchaser.

10 RETESTS

Where any test specimen fails to fulfill the test requirements, twice the number of the test specimens made for that test for the initial or periodic test shall be prepared by using electrode from the same batch wherever possible and submitted only for the tests in which failure occured. The electrodes shall not be accepted as having passed that test unless the tests on the additional specimen are satisfactory.

11 PACKING AND STORAGE

11.1 The net mass of an individual bundle or carton of electrodes for manual operation shall not exceed 7 kg.

11.2 Electrodes shall be suitably packed to guard against damage during transportation. The packing shall be suitable to ensure that under normal store room conditions, the electrodes shall, for a period of 6 months after the despatch from the manufacturer's stores, be capable of giving results in accordance with the provisions of this standard and that if the flux covering is of a type requiring special protection during storage, the details of such special protection shall be furnished by the manufacturer and reference to this should be included in the marking of the bundle or carton of electrodes. The electrodes shall be stored in a dry store room.

11.3 The batch of electrodes represented by the electrodes tested shall not be certified as complying with the specification unless the test results obtained satisfy the requirements specified in the *Qualily Control Tests* and the manufacturer has performed tests at intervals in accordance with the requirements of this specification.

12 TEST RESULTS

12.1 On request, as evidence that the electrodes supplied comply with the requirements of this specification, the manufacturer shall produce the results of the most recent periodic check test on electrodes representative of the electrodes supplied.

12.2 If required by the purchaser, the manufacturer shall furnish a test certificate by mutual agreement for each batch of electrode supplied.

13 MARKING

13.1 As agreed between the manufacturer and the purchaser brand name/classification shall be printed on all the electrode.

13.2 Each bundle or carton of electrode shall be clearly marked with the following information :

i) Classification (*see* **5**) ;

ii) Indicating the source of the manufacture;

iii) Trade name and brief description of electrode;

iv) Size and quantity of electrode;

v) Batch number;

vi) Recommended current range, polarity and open circuit voltage;

vii) Date of manufacture;

viii) Recommendation for special storage conditions and redrying temperature; and

ix) A cautionary note on safety during welding should be printed.

13.2.1 The bundle or carton of electrodes may also be markeed with the Standard Mark.

ANNEX A

(*Clause* 2)

IS No.	*Title*	*IS No.*	*Title*
226 : 1975	Structural steel (standard quality)	1387 : 1967	General requirements for the supply of metallurgical materials
812 : 1957	Glossary or terms relating to welding and cutting of metals	1395 : 1982	Low and medium alloy steel covered electrodes for manual metal arc welding (*third revision*)
961 : 1975	Structural steels (high tensile)		

IS No.	*Title*
1599 : 1985	Method for bend test
1608 : 1972	Method for tensile testing of steel products
1757 : 1973	Method for beam impact test (V-notch) on steel
1977 : 1975	Structural steel (ordinary quality)
2002 : 1982	Steel plates for pressure vessels for intermediate and high temperature service including boilers
2062 : 1984	Weldable structural steel
2879 : 1975	Specification for mild steel for metal arc welding electrodes
3039 : 1980	Structural steels for construction hulls of ships
8500 : 1977	Weldable structural steel (medium and high strength quality)
11802 : 1986	Methods for determination of diffusible hydrogen content of deposited weld metal from covered electrodes in welding mild and low alloy steels.
13043 : 1991	Determination of efficiency metal recovery and deposition coefficient of covered manual metal arc welding electrodes.

core wire (Amendment 1, 2 and 3)

ANNEX B

(*Clause* 5.1)

EXAMPLES OF ELECTRODE CLASSIFICATION

B-1 The example given in **B-2** and **B-3** illustrate the way in which the coding is expressed and the use of complete classification.

B-2 EXAMPLE 1

The electrode is a covered electrode having a light rutile type coating.

The electrode may be used for welding in all positions and it welds satisfactorily on a.c. with a minimum open circuit voltage of 50 V and on d.c. with both positive and negative polarity. The electrodes are not designed to give hydrogen controlled weld metal. The electrode is not meant for radiograph application.

The electrode desposits weld metal with the properties given in Table 7. When tested in accordance with this standard and when the manufacturer submits 8 mm electrode as the maximum size to be classified. The table of result shows that the manufacturer carried out sets of impact tests at + 27°C, 0°C and —20°C in order to determine the appropriate classification.

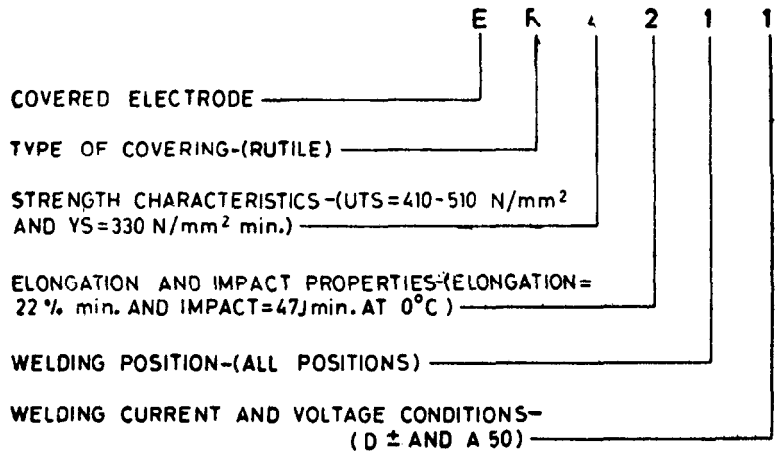
Table 7 Test Result for Example 1

(*Clause* B-2)

Property	With 4 mm Size	With 8 mm Size	Requirement for Class		Remarks
			EX4XXX	EX5XXX	
(1)	(2)	(3)	(4)	(5)	(6)
Ultimate tensile strength, N/mm²	480	465	410-510	510-610	Satisfactory for EX4XXX but unsatisfactory for EX5XXX class
Yield strength, N/mm²	365	350	330 *Min*	360 *Min*	Satisfactory for both EX4XXX and EX5XXX classes
Impact in joules at +27°C	80, 78 Av 70 69 55, 62	72, 65 Av 69 64·6 55, 60	47 *Min*	47 *Min*	Satisfactory for both EX4XXX and EX5XXX classes
Impact in joules at 0°C	65, 58 Av 50 50 49, 53	62, 58 Av 43 50 40, 49	47 *Min*	47 *Min*	Satisfactory for both EX4XXX and EX5XXX classes
Impact in joules at —20°C	46, 40 Av 45 40 30, 35	40, 37 Av 32 33 25, 30	47 *Min*	47 *Min*	Unsatisfactory for both EX4XXX and EX5XXX classes
Elongation percent	26	25	22 *Min**	18 *Min**	Satisfactory for both EX4XXX and EX5XXX classes

*Elongation incorporated here from Table 2 after establishment of impact property at specified temperature.

The classification for the electrode is therefore



Complete classification is therefore **ER 4211.**

B-3 EXAMPLE 2

A covered electrode having a basic covering with an increased metal recovery of 120 percent and depositing weld metal containing 7 millilitres of diffusible hydrogen per 100 g of desposited weld metal. The electrode can be used for welding in all positions except vertical-down and operates on a.c. with a minimum OCV of 70 volts and on d.c. with positive polarity. The deposit gives radiographic quality welds.

The electrode deposits weld metal with the properties given in Table 8 in accordance with this standard and when the manufacturer submits 6·3 mm as the maximum size to be classified. The results show that the manufacturer carried out sets of impact tests at −30°C and −40°C.

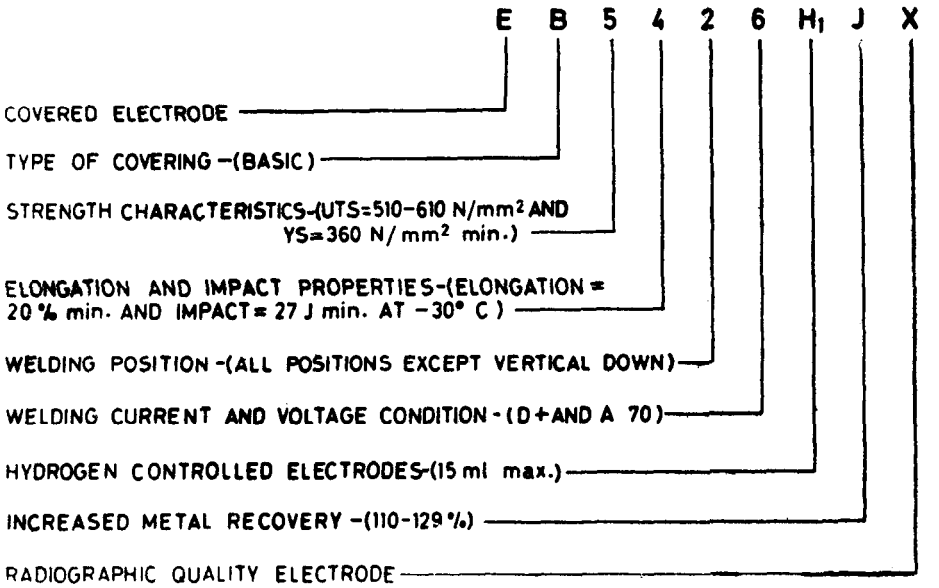
Table 8 Test Result of Example 2

(*Clause* B-3)

Property	With 4 mm Size Electrode	With 6·3 mm Size Electrode	Requirement for Class EX4XXX	Requirement for Class EX5XXX	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
Ultimate tensile strength, N/mm²	570	550	410-510	510-610	Unsatisfactory for EX4XXX clas but satisfactory for EX5XXX class
Yield stress, N/mm²	420	400	330 *Min*	360 *Min*	Satisfactory both for EX4XXX and EX5XXX classes
Impact in joules at −30°C	65, 62 Av 50 56·6 45, 58	55, 46 Av 52 46 37, 40	27 *Min*	27 *Min*	Satisfactory for both EX4XXX and EX5XXX classes
Impact in joules at −40°C	30, 24 20 Av 16, 19 21	22, 16 20 Av 14, 17 17·6	No requirement	27 *Min*	Unsatisfactory for EX5XXX class
Elongation, percent	26	25	24 *Min**	20 *Min**	Satisfactory for both EX4XXX and EX5XXX classes

*Elongation incorporated here from Table 2 after establishment of impact property at specified temperature.

The classification of the electrode is therefore



Hence complete classification is **EB 5426H2JX.**

ANNEX C

(*Clause* 5.1)

CHARACTERISTICS OF COVERING AND COATING RATIO

C-1 ACID (A)

Electrode of acid type have a medium or thick covering and produce an iron oxide, manganese oxide, silica rich slag (with some titania in some cases), the metallurgical characteristics of which is acidic. The covering contains, besides oxides, of iron/or manganese (with some titania in some cases), a fairly high percentage of ferro-manganese and/or other deoxidisers. The slag generally solidifies in a charcteristics honeycomb structure and is easily detached.

This type of electrode usually has a high fusion rate and may be used with high current intensities. Penetration can be good, particularly if the covering is thick. These electrodes are most suitable for welding in flat position but can be used in other positions and can be operated both on a.c. and d.c.

C-2 BASIC (B)

Electrode of basic type usually have a covering containing appreciable quantities of calcium or other basic carbonates and fluorspar so that metallurgically they are basic in character. There is a medium quantity of dense slag, which often has a brown to dark-brown colour and a glossy appearance. It is easily detached, and as it rises to the surface of the weld very quickly, slag inclusions are not likely to occur. This type of electrode given an arc of average penetration, and is suitable for welding in all positions. This type of electrode is used both on a.c. and d.c. where d.c. positive polarity is generally preferred for critical applications.

As the weld metal is highly resistant to hot and cold cracking, these electrodes are particularly suitable for welding heavy sections and very rigid mild steel structures. They are also recommended for welding low alloy steels and steels, carbon and sulphur content of which are higher than those of mild steel of good weldable quality.

These electrodes must be stored in a reasonably dry place and should be dried before use, according to the recommendation of the manufacturer. This ensures that the weld metal will have a low hydrogen content and there is a less risk of underbead cracking when welding steel likely to show a marked hardening in the heat affected zone.

C-3 CELLULOSIC (C)

The coverings of the cellulosic type contains a large quantity of combustible organic substances, so that the decomposition of the latter in arc produces a voluminous gas shield. The amount of slag produced is small and the slag is easily detached.

This type of electrode is characterised by a highly penetrating arc and fairly high fusion rate. Spatter losses are fairly high and the weld bead is some what coarse, with unevenly spaced ripples. These electrodes are usually suitable for welding in all positions. Generally this type of electrodes are suitable for use on d.c. with electrode positive, but some electrodes are also available which are suitable for use on a.c.

C-4 RUTILE (R)

These electrodes have a covering containing a large quantity of rutile or components derived from titanium oxide. The electrodes have smooth arc characteristics and normally produces very little spatter and are comparatively easy to use. This type of electrode can be generally used in all positions and can be operated both on a.c. and d.c. The slag detachability is generally good.

C-5 RUTILE, HEAVY COATED (RR)

Generally similar in characteristics to Rutile type but having a higher coating ratio (above 1·5). Application wise it is usually preferred for flat and horizontal vertical position though welding in other positions can also be possible.

C-6 OTHER TYPES (S)

Electrodes with other type of coverings may range from rarely used types such as oxide or acid fluxes, to newly developed flux systems. No general guidance on special covering electrode characteristics is possible, so potenial users should seek the manufacturers advise.

C-7 COATING RATIO

The coating ratio of an electrode is the ratio of the standard outer diameter of the covering and the nominal diameter of the core wire both expressed in millimetres.

For guidance, coating ratio for various types of coating is given below:

Type of Coating	*Coating Ratio*
Light coating	Up to 1·3
Medium coating	Above 1·3 up to and including 1·5
Heavy coating	Above 1·5

ANNEX D

(*Clause* 5.4.1)

WELDING POSITION

D-1 WELDING POSITION

The welding position of a weld is defined by its slope and rotation as indicated in Table 9.

Table 9 Welding Positions

(*Clause* D-1)

Position	Slope (Degree)	Rotation (Degree)	Illustration (Reference to:)
(1)	(2)	(3)	(4)
Flat	0 – 5	0 – 10	Fig. 2
Horizontal/ Vertical	0 – 5	30 – 90	Fig. 3
Vertical-up	80 – 90	0 – 180	Fig. 4
Vertical-down	80 – 90	0 – 180	Fig. 5
Overhead	0 – 15	115 – 180	Fig. 6

NOTE — Any intermediate position not specified above is undefined, but the general term ' inclined' is sometimes used.

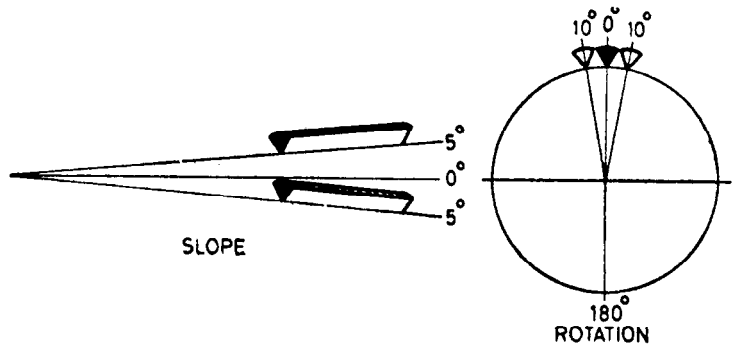


FIG. 2 FLAT POSITION

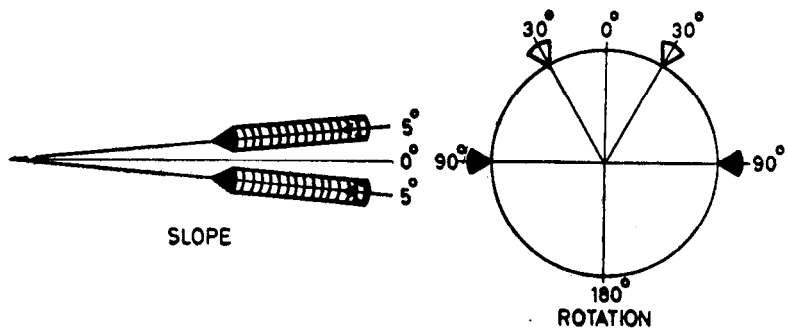


FIG. 3 HORIZONTAL/VERTICAL POSITION

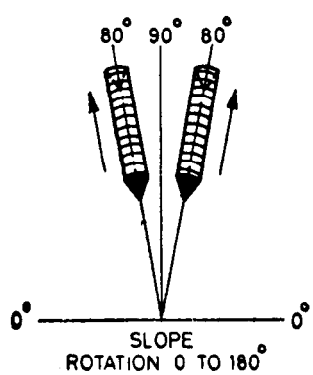


FIG. 4 VERTICAL-UP POSITION

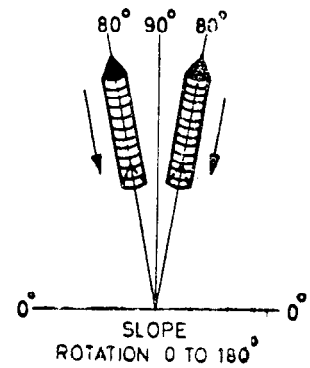


FIG. 5 VERTICAL-DOWN POSITION

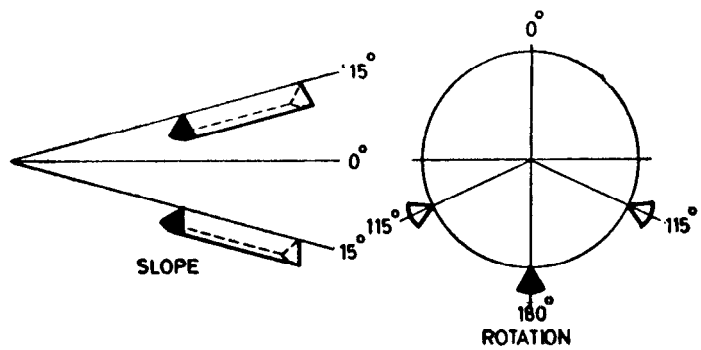


FIG. 6 OVERHEAD POSITION

ANNEX E

(*Clause* 5.6)

STANDARD WELDING CURRENT AND VOLTAGE CONDITION

E-1 STANDARD WELDING AND VOLTAGE CONDITION

Specific welding current and open circuit voltage conditions are denoted by symbols given in Table 10. When an electrode is meant for use with either direct or alternating current, combination of the symbols given in Table 10 shall be used.

Table 10 Welding Current and Open Circuit Voltage

(*Clause* E-1)

Description	Symbol
d.c. with electrode positive	D +
d.c. with electrode negative	D —
d.c. with electrode positive and negative	D ±
a.c. with an open circuit voltage not less than 90 volts	A 90
a.c. with an open circuit voltage not less than 70 volts	A 70
a.c. with an open circuit voltage not less than 50 volts	A 50

NOTES

1 The electrode may not function satisfactorily at a lower voltage than that for which it is classified but a higher voltage may be used in service with advantage.

2 The open-circuit voltage necessary for striking the arc varies according to size of the electrode. Table 10 applies to the sizes 2·5 mm and above. The reference size for coding of 'welding current and voltage condition' should be 4 mm or 5 mm. If electrodes of size less than 2·5 mm are 'used' a higher voltage may be necessary. Within the range of sizes 2·5 mm to 8 mm, the open circuit voltage necessary may be expected to vary approximately as follows:

Code Voltage (volts)	*Variation in Voltage (volts)*
90	100 to 80
70	80 to 60
50	60 to 40

Here, the higher voltages are associated with 2·5 mm electrodes and the lower voltages are with 8 mm electrodes.

ANNEX F

(*Clause* 8.0.3)

PARENT METAL FOR TEST PIECES

F-1 The parent metal and its mechanical properties, to be used for preparing different test pieces from all weld assembly and butt weld assembly for different class of electrodes is given in Table 11. The mechanical properties shall be verified from tests on the plate before the test pieces are prepared. The chemical composition shall also be verified from plates before the test.

F-2 The plate may be in 'as rolled' or 'normalized' condition.

Table 11 Parent Metal for 'All Weld' Assembly

(*Clause* F-1)

Class of Electrode	Tests for Electrode	Parent Metal		
		Indian Standard	Range of Tensile Strength, N/mm²	Percent Elongation (*Min*)
(1)	(2)	(3)	(4)	(5)
EX4XXX	All weld and Butt weld	IS 226, IS 1977, IS 2002, IS 2062, IS 3039 or any other steel considered equivalent to any of these standards	410 — 530	22 on gauge lengths of 5·65/So (determined as per IS 1608 : 1972)
EX5XXX	All weld			
EX5XXX	Butt weld	IS 961 Grade HTW-52 IS 8500 Grade Fe 540HT or any other steel considered equivalent to any of these standard.	510 — 660	19 on gauge lengths of 5·65/So (determined as per IS 1608 : 1972)

ANNEX G

(*Clause* 9.1.2)

ALL WELD TESTS FOR TENSILE AND IMPACT

G-1 PREPARATION OF TEST PIECES

G-1.1 The parent metal for plates used in preparing test pieces shall be in accordance with Annex F. The test specimens shall not be subjected to any mechanical or thermal treatment other than that required under this Annex.

G-1.2 All weld metal test pieces shall be prepared as shown in Fig. 7 by depositing weld metal between the chamfered edges of the two plates placed on a backing strip. The backing strip shall be tack welded to the test assembly.

The backing strip material shall also be made from a steel used for all weld metal assemblies described in Annex F.

G-1.3 The dimensions of test assembly are shown in Fig. 7 and given in Table 12. The length of the plate shall be enough to accommodate a tensile test specimen and at least six charpy V-notch test specimen as shown in Fig. 7.

G-1.4 The plate edges shall be beveled by machining or machine gas cutting. In the latter case, any remaining scale should be removed from beveled edges. The surface of the backing strip should be free from rust or scale.

G-1.5 In order to counteract shrinkage deformation the test assembly should be preset as shown in Fig. 8 in such a way that after completion of welding a level joint is obtained.

G-2 WELDING PROCEDURE

G-2.1 The assembly shall be welded in flat position unless the electrode is not recommended in the flat position in which case welding position shall be one that is recommended by the manufacturer.

G-2.2 The test assembly shall be preheated to (110° C ± 15° C)° C. Welding shall be continued with an interpass temperature of not less than 110° C and not more than 180° C as measured by temperature indicating crayons or surface thermometers at the area specified in Fig. 7.

G-2.3 The Pass Sequence

The weld metal shall be deposited in layers made up of two passes as shown in Fig. 9. The welding speed shall be adopted to obtain the number of layer given in Table 13. The direction of welding to complete a pass and a layer shall be same. The direction of deposition of each layer shall alternate from each end of the plate.

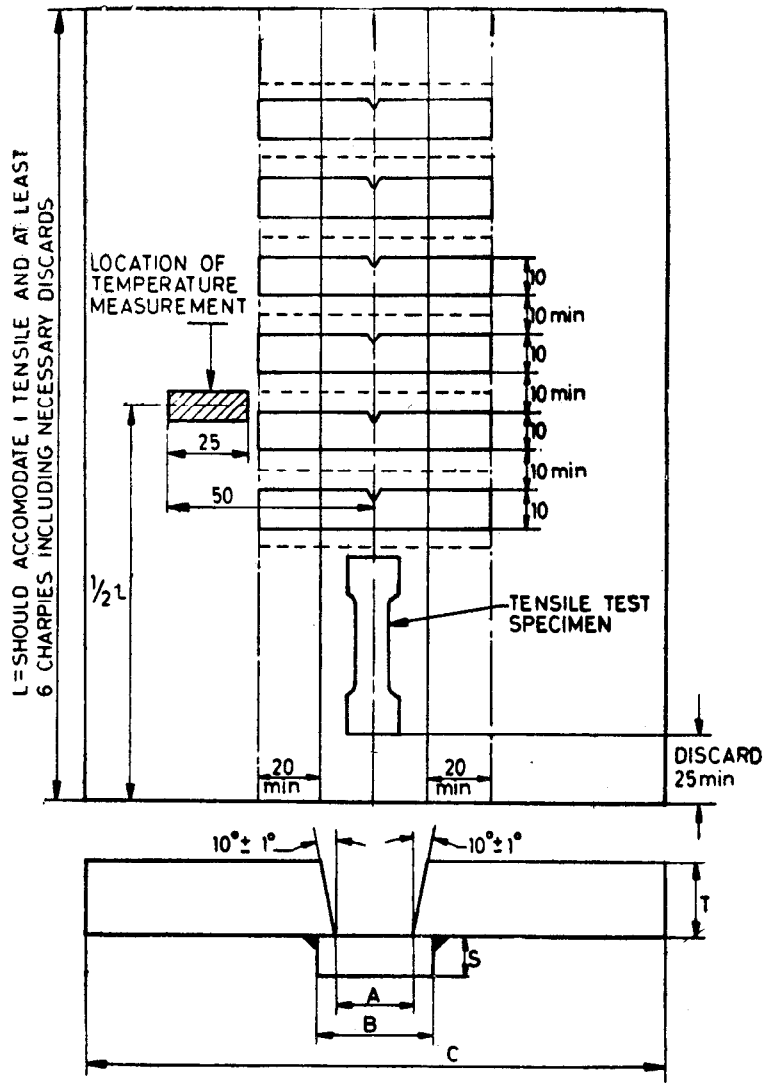
NOTE — The test specimens to be located on the center line A-A.

Table 12 Dimensions of Test Assembly

(*Clause* G-1.3)

All dimensions in millimetres.

Electrode Size,	Plate Width, *C*	Plate Thickness, *T*	Width of Welding Gap, *A*	Backing Strip	
				Width, *B*, *Min*	Thickness, S, *Min*
(1)	(2)	(3)	(4)	(5)	(6)
3·15	90 ± 10	14 ± 2	12 ± 1	A + 10	6·5
4·0	90 ± 10	20 ± 1	16 ± 1	A + 10	10
5·0	120 ± 10	20 ± 1	18 ± 1	A + 10	10
6·3	120 ± 10	20 ± 1	20 ± 1	A + 10	10
8·0	150 ± 10	25 ± 1	20 ± 1	A + 10	12·5



All dimensions in millimetres.

FIG. 7 DIMENSIONS OF TEST ASSEMBLY AND POSITION OF CUTTING OF TEST PIECES

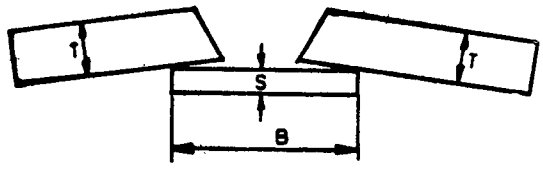


FIG. 8 PRESETTING OF TEST ASSEMBLY

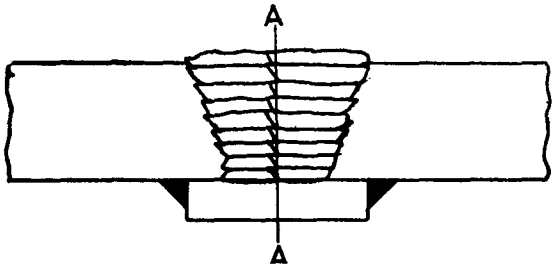


FIG. 9 WELD GEOMETRY

Table 13 Welding Details

(*Clause* G-2.3)

Electrode Size	Split Weave, Layer No.	Passes for Layer	Number of Layers
(1)	(2)	(3)	(4)
3·15 mm	1 to top	2	6 to 9
4·0 mm	1 to top	2	7 to 10
5·0 mm	1 to top	2	6 to 9
6·3 mm	1 to top	2	6 to 9
8·0 mm	1 to top	2	8 to 12

G-2.4 Each electrode shall be consumed completely (up to a stub end of not more than 50 mm).

G-3 The welding current used shall always be less than the maximum value and within the range recommended by the manufacturer. The open circuit voltage shall not be less than that specified by the manufacturer.

The welding current shall be a.c., if the electrode can be used with both a.c. or d.c. The welding current shall be d.c. electrode positive polarity, if the electrode can be used with d.c. negative or positive polarity.

G-4 If it is necessary to interrupt the welding procedure prescribed in **G-2**, the assembly shall be allowed to cool in still air to room temperature. When welding is resumed, the assembly shall be preheated to a temperature of 110° C ± 15° C.

G-5 When the assembly has been welded completely, it shall be allowed to cool in still air to room temperature. The portion including the weld shall then be removed by cutting away the excess plate at the places indicated in Fig. 7. Cutting along the chainlines (shown by- - - - - -) may be done mechanically or by machine gas cutting. Along the longitudinal boundaries (shown by broken lines as - - - - -) of the parts to be machined into impact test pieces cutting should be done by mechanical methods only.

G-6 HEAT TREATMENT OF ALL WELD TENSILE TEST PIECE

G-6.1 The all weld test pieces shall be heat-treated in a furnace at a temperature of 250°C for a period of not less than 6 hours and not more than 16 hours. After the soaking period, the specimen shall be withdrawn from the furnace and allowed to cool slowly, protected from drought and chilling.

G-6.2 The purpose of heat treatment is to remove hydrogen from weld metal.

G-6.3 The impact test pieces shall not be heat treated.

G-7 ALL WELD TENSILE TEST

G-7.1 The tensile test specimen shall be machined from the weld metal test pieces in accordance with IS 1608 : 1972, care being taken that the longitudinal axis of the test specimen coincides with the central line of the weld and the mid thickness of the plate (*see* Fig. 10). The dimensions of the specimen shall be as shown in Fig. 11 and Fig. 12. The specimen shall be tested in accordance with IS 1608 : 1972.

G-8 ALL WELD IMPACT TEST

G-8.1 The impact test specimen shall be machined from the weld metal test pieces to the dimensions given in Table 14 in accordance with IS 1757 : 1979. Care being taken that the logitudinal axis of the specimens are perpendicular to the weld axis and upper surface of the plate. The notch shall be positioned in the center of the weld and is to be cut on the face of the test piece perpendicular to the surface of the plate (*see* Fig. 13). The tests are to be conducted at the test temperature (*see* Table 5) on an approved impact machine.

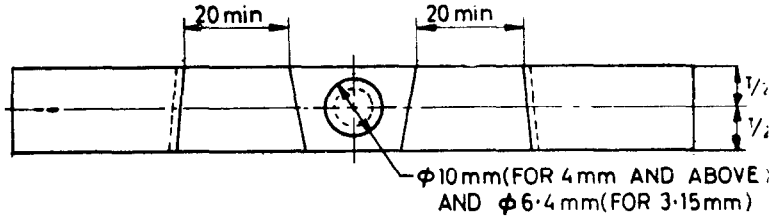


FIG. 10 CUTTING OF TENSILE TEST PIECE

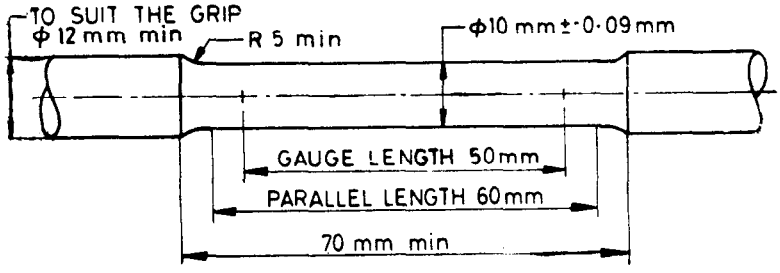


FIG. 11 TENSILE TEST PIECE FOR SIZE 4 mm AND ABOVE

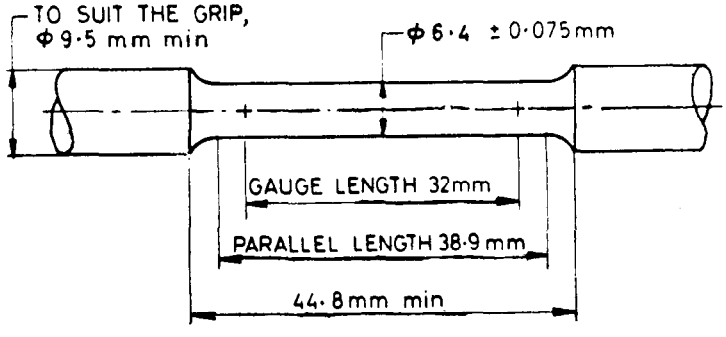


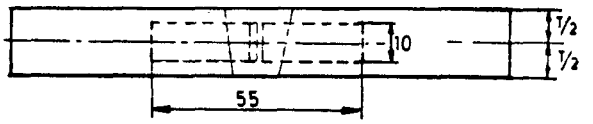
FIG. 12 TENSILE TEST PIECE FOR SIZE 3·15 mm

Table 14 Dimensions of Impact Test Specimen

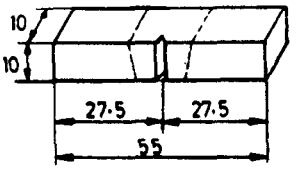
(*Clause* G-8.1)

All dimensions in millimetres.

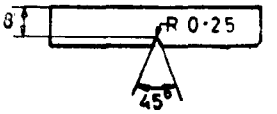
Length	Width	Thickness	Angle of Notch	Root Radius of Notch	Depth Between Notch (Measured at the Both End)	Distance of Notch from Either End of Test Piece
(1)	(2)	(3)	(4)	(5)	(6)	(7)
55 ± 0·6	10 ± 0·11	10 ± 0·11	45° ± 2°	0·25 ± 0·025	8 ± 0·11	27·5 ± 0·42



13A Position of Test Assembly



13B Dimensions of Test Piece



13C Dimensions of V-Notch

All dimensions in millimetres.

FIG. 13 IMPACT TEST PIECES/ASSEMBLY

ANNEX H

(*Clause* 9.2)

BUTT WELD BEND TEST — METHOD OF PREPARATION AND TESTING

H-1 PREPARATION OF TEST PIECE

H-1.1 Parent Metal

The parent metal for plates used for making test pieces shall be in accordance with Annex F. The specimens shall not be subjected to any mechanical or thermal treatment other than that required under this Annex.

H-1.2 Test pieces shall be as shown in Fig. 14 by welding together two plates of suitable length to allow the cutting out of test specimens of specified size. The dimensions of the assembly are given in Table 15.

H-1.3 Plates may be preset to allow for slight distortion after welding.

H-1.4 The welding procedure followed in making the test pieces should be as set out in Table 6 according to the position of welding. In all cases the backing runs shall be made with 4·0 mm electrodes in the weld position applicable to each test piece after cutting out a groove to a depth of 3 mm if such groove is considered necessary (*see* Fig. 15).

Table 15 Dimensions for Bend Test Assembly

(*Clause* H-1.2)

All dimensions in millimetres.

Length	Width, *W*	Angle	Root Face, *F*	Root Gap, *G*	Thickness, *d*
(1)	(2)	(3)	(4)	(5)	(6)
180 *Max*	100 *Min*	60° –70°	3 *Max*	3 *Max*	15 — 20

H-1.5 The welding current used shall be within the appropriate range recommended by the manufacturers. The open circuit voltage shall not be less than that specified by the manufacturer. The welding current shall be a. c. if the electrode can be used with positive polarity, when the electrode can be used with both d.c. negative and positive polarity.

H-1.6 After welding the test piece shall be cut by sawing or machining to form one face bend and one root bend test specimen as indicated in Fig. 14. The specimen shall then be subjected to a temperature of 250° C for a period of not less than 6 hours and not more than 16 hours for hydrogen removal prior to testing. After the soaking period, the specimen shall be withdrawn from the furnace and allowed to cool slowly, protected from droughts and chilling.

H-2 BEND TEST

H-2.1 Each bend test specimen shall be 30 mm in width. The upper and lower surface of the weld shall be filed ground or machined level with the respective original surface of the plates. Where the surface of the plates are not level with each level, provided that the thickness of the plate is not reduced by more than a total of 1 mm. Tool marks should be avoided as they lead to localisation of stresses and may cause premature failure. For this reason, direction of machining of surfaces should be along the specimen and transverse to the weld. The sharp corners of the test specimens shall be rounded to a radius not exceeding 10 percent of the specimen thickness.

H-2.2 The test specimen shall be bent through an angle of 180° in accordance with IS 1599 : 1985. Method for bend test over a mandrel having a diameter equal to three time the thickness of the specimen. One test specimen should be tested with face of the weld in tension and one with the root of the weld in tension. The electrodes should be

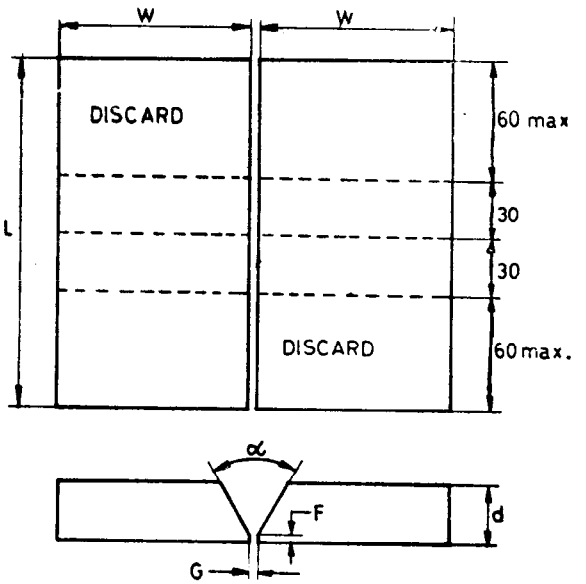


FIG. 14 PREPARATION OF BEND TEST PIECE

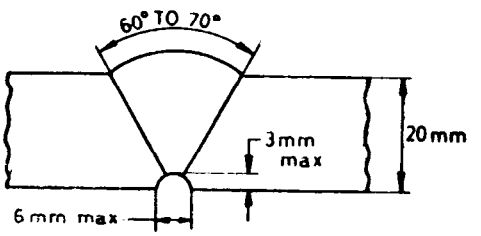


FIG. 15 GROOVE PREPARATION FOR DEPOSITION OF SEALING RUN

deemed to be satisfactory, if on completion of the test no crack or defect at the outer surface of the test specimen is greater than 3 mm measured across the test specimen or 1·5 mm measured along the length of the test specimen. Premature failure at corners of the specimen shall not be considered a cause for rejection.

ANNEX J

(*Clause* 9.3)

RUNNING PERFORMANCE TEST

J-1 PREPARATION OF PARENT METAL

The parent material should be chosen from any of the steels prescribed in Annex F. The length of the parent material for this test should be such that at least one full straight run of the electrode can easily be accommodated on it. The thickness of the plate/sheet should be within 2 to 3 times the diameter of the core wire of the electrode. If sheet of suitable thickness is not available, plates can be shaped to desired thickness. The plate/sheet should be free from any rust, dirt, moisture, oil, grease or any other contamination before welding.

J-2 Welding should be done in downhand position by stringer bead or, light weaving technique either by touch welding or by keeping the arc slightly open. The weaving should be restricted to 1·5 times the diameter of the electrode (the final diameter including coating) Three full electrodes of the particular size keeping not more than 50 mm stub end should be burnt over the parent metal by using a suitable current within the current range prescribed by the manufacturer. When the electrode can be used both on d.c. and a.c., a.c. should be used with 0CV not less than that prescribed by the manufacturer. When the electrode can be used in d.c. only, the d.c. positive polarity should be adopted. If all the three beads are made on the same plate/sheet, care should be taken that no portion of any bead overlaps with any portion of other beads. The electrodes may be redried before welding as directed by the manufacturer.

J-3 The beads shall be visually inspected and shall be free from porosities, slag inclusions, cracks etc, in the main portion of the beads given in Fig. 16. The beads should be fairly straight and evenly rippled. The slag should be removed with little effort. A length of 15 mm from the start and from finish of the bead should not be considered for visual inspection.

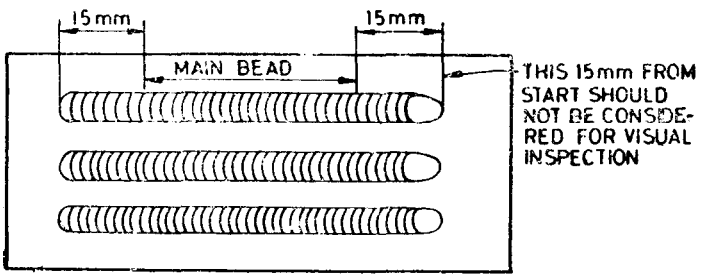


FIG. 16 RUNNING PERFORMANCE TEST

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This Indian Standard has been developed from Doc: No. MTD 11 (3337)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Dee Kay Printers, New Delhi, India

AMENDMENT NO. 1 JANUARY 1994
TO
IS 814 : 1991 COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF CARBON AND CARBON MANGANESE STEEL

(Fifth Revision)

[*Page* 4, *clause* 8.1(f)] — Substitute the existing by the following:

'f) Radiographic quality test for radiographic quality electrodes (*see* 9.6).'

(*Page* 5, *clause* 8.3, *Note* 1) — Delete the following from lines 2 and 3: 'not exceeding 1 000 kg in weight'.

[*Page* 5, *clause* 8.3, *Note* 3 (iii)] — Add 'of the weld metal' after the words 'include chemical analysis' in the sixth line.

(*Page* 5, *clause* 9.1.1) — Substitute the first sentence by the following:

'Two all weld test assemblies shall be prepared one using 4 mm and the other using the highest size manufactured in accordance with the method described in Annex G.'

(*Page* 5, *clause* 9.1.1) — Add the following note at the end of the clause:

'NOTE — In case 3.15 mm is the largest size manufactured, only one all weld test assembly shall be prepared with this size.'

(*Page* 6, *clause* 9.3) — Add new clauses as given below and renumber the subsequent clauses:

'9.3 Transverse Bend Test (For Sizes Up to and Including 2.5 mm)

Two sheets of thickness 3.15 mm shall be welded as shown in Fig. 4. The dimensions of the test pieces are also shown in Fig.4. In order that the test plates when completely welded shall be constrained, the test pieces may be given a reverse camber before depositing the weld.

9.3.1 Welding shall be made using electrodes of size 2.5 mm in flat position. The temperature of the parent metal immediately before depositing the weld metal shall be 27± 2°C. After completing the weld on one side of the test piece it shall be cooled down to an about 100°C before depositing weld on the other side. The specimen shall not be subjected to any mechanical or thermal treatment after the welding is completed.

9.3.2 From the test piece so prepared two guide bend test specimens shall be machine cut as shown in Fig. 5. If the gas cutting is adopted the cutting allowance of not less than 3 mm shall be given.

9.3.3 Two bend tests, one with the face and the other order with the root in tension, shall be carried out in accordance with IS 3600 : 1973. The test piece shall develop no crack beyond 1.5 mm or longer or no other harmful defects in any direction on the other surface of the bend shall be visible.'

(*Page* 6, *clause* **9.3**, *line* 5) — Substitute 'Annex H' by 'Annex I'.

(*Page* 8, *clause* **9.6**) — Substitute the existing clause by the following:

'**9.6** All welded test assembly (Fig. 7) after removal of backing strip, shall be machined or ground smooth so as to avoid difficulty in interpretation of radiograph of the weld. It shall then be subjected to radiographic test as per IS 1182 : 1983. The radiograph shall not show crack or incomplete fusion. The radiogrpahic acceptance standard in respect of porosity and slag inclusions is indicated in Table 6. (Renumber the subsequent Tables).

In making the evaluation for radiographic acceptance standard, a length of 25 mm from each end of the welded assembly shall be excluded.

Table 6 Radiographic Acceptance Standard in Respect of Porosity and Slag Inclusion

IS Classification of Electrode	Radiographic acceptance Standard	Type of porosity and /or	Acceptance		Restrictions, if any
			Size in mm (dia or length)	Qty in Nos. (in 150 mm)	
			—		i) Maximum No. of large size indications (1.2 to 1.6 mm) = 3
EA 42XX-X EB 542X-HX EB 542-HJX EB 562X-HX EB 562 X-HJX EB 541X-HJX EB 552X-HJX	Grade 1	Assorted	0.4 to 1.6	10 Nos.	ii) Maximum No. of medium size indications (0.8 to 1.2 mm) = 5 iii) Maximum No. of small size indications (0.4 to 0.8 mm) = 10

IS Classification of Electrode	Radiographic Acceptance Standard	Type of Porosity and /or	Acceptance		Restrictions, if any
			Size in mm (Dia or Length)	Qty in Nos. (in 150 mm)	
		Large	1.2 to 1.6	6 Nos.	Nil
		Medium	0.8 to 1.2	15 Nos.	Nil
		Fine	0.4 to 0.8	20 Nos..	Nil
EC 4 X10-X EX 4 X16-X ER 4XXX-X ERR 4XXX-X ER 5XXX-JX ERR 5XXX-JX ERR 5XXX-KX EB 5XXX-LX EB 5XXX-HKX EB 5XXX-HLX	Grade 2	Assorted	0.4to 2.0	27 Nos.	i) Maximum No. of large size indications (1.16 to 2.0 mm) = 3 ii) Maximum No. of medium size indications (1.2 to 1.6 mm) = 8 iii) Maximum No. of small size indications (0.4 to 1.2 mm) = 16
		Large	1.6 to 2	14 Nos	Nil
		Medium	1.2 to 1.6	22 Nos	Nil
		Fine	0.4 to 1.2	44 Nos.	Nil
ER 41XX ER 42XX ES 41XX	Not required	—	—	—	—

(*Page* 8, *clause* **11.2**) — Substitute 'despatch' by 'date of manufacture' in the sixth line.

(*Page* 8, *Annex* A) — Substitute the following by the existing:

IS No.	*Title*
812: 1957	Glossary of terms relating to welding and cutting of metals
1387 : 1967	General requirements for the supply of metallurgical materials
1395 : 1982	Low and medium alloy steel covered electrodes for manual metal arc welding (*third revision*)
1599 : 1985	Method for bend test
1608 : 1972	Method for tensile testing of steel products

IS No	*Title*
1757 : 1973	Method for beam impact test (V-notch) on steel
1977 : 1975	Structural steel (ordinary quality)
2002 : 1982	Steel plates for pressure vessels for intermediate and high temperature service including boilers
2062 : 1992	Steel for general structural purposes (*fourth revision*)
2879 : 1975	Specification for mild steel for metal arc welding electrodes core wire (Amendments 1, 2 and 3)
3039 : 1988S	tructural steels for construction hulls of ships
8500 : 1991	Weldable structural steel (medium and high strength quality)
11802 : 1986	Methods for determination of diffusible hydrogen content of deposited weld metal from covered electrodes in welding mild and low alloy steels
13043 : 1991	Determination of efficiency metal recovery and deposition coefficient of covered manual metal arc welding electrodes

(*Page* 9, *Table* 7, *col* 3, *row* 2) — Substitute '350' by '360'.

(*Page* 10, *clause* B-3) — Substitute '0CV' by 'OCV' in eighth line.

(*Page* 11, *clause* B-3) — In the last line substitute 'EB 5426H2JX' by 'EB 5426HIJX'.

(*Page* 14, *Table* 11, *col* 3):

a) Delete 'IS 226' in line one.

b) Delete 'IS 961 Grade HTW-52' in line five.

(*Page* 21, *clause* J-2) — Substitute '0CV' by 'OCV' in the thirteenth line.

(MTD 11)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 OCTOBER 1995
TO
IS 814 : 1991 COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF CARBON AND CARBON MANGANESE STEEL — SPECIFICATION
(Fifth Revision)

[*Page* 4, *clause* **8.1**(f)] — Substitute the following for the existing matter:

'f) Radiographic quality test for radiographic quality electrodes (*see* **9.6**).'

(*Page* 4, *clause* **8.1**) — Insert 'g) Transverse bend test [for sizes up to and including 2·5 mm (*see* **9.3**)]' at the end of para.

(*Page* 4, *clause* **8.2**) – Substitute the following for the existing clause:

'8.2 Periodic Check Tests

These comprise of the following tests selected from among the initial tests and are meant to be repeated at intervals to provide evidence that the electrodes currently produced possess the properties proved in the initial tests:

a) All weld metal mechanical tests for tensile and impact (*see* **9.1**);

b) Transverse bend test (for sizes up to and including 2·5 mm) (*see* **9.3**); and

c) Running performance test (*see* **9.4**).

Such tests shall be conducted atleast once in a year. These tests shall not apply to the electrodes not manufactured during that period. When production of a type of electrode after stoppage of production for more than six months is restored the initial tests (*see* **8.1**) shall be conducted.'

(*Page* 5, *clause* **8.3**, *Note* 1, *lines* 2 *and* 3) — Delete 'not exceeding 1 000 kg in weight'.

[*Page* 5, *clause* **8.3**, *Note* 3 (iii), *line* 6] — Insert 'of the weld metal' after 'include chemical analysis'.

(*Page* 5, *clause* **9.1.1**) — Substitute the following for the existing first sentence:

'Two all weld test assemblies shall be prepared one using 4 mm and the other using the highest size manufactured in accordance with the method described in Annex G.'

(*Page* 5, *clause* **9.1.1**) — Insert the following note at the end of the clause:

'NOTE — In case 3·15 mm is the largest size manufactured, only one all weld test assembly shall be prepared with this size.'

(*Page* 5, *clause* **9.1.3.1**, *line* 4) — Substitute the word 'discarded' *for* 'disregarded'.

(*Page* 6, *clause* **9.3**) — Insert the following new clauses and figures after clause **9.2.1** and renumber the subsequent clauses and figures:

'9.3 Transverse Bend Test (For Sizes Up to and Including 2·5 mm)

Two sheets of thickness 3·15 mm shall be welded as shown in Fig. 2. The dimensions of the test pieces are also shown in Fig. 2. In order that the test plates when completely welded shall be constrained, the test pieces may be given a reverse camber before depositing the weld.

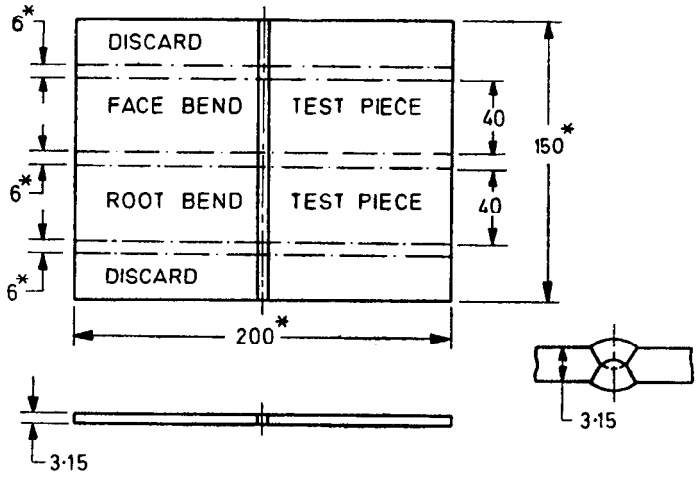
9.3.1 Welding shall be made using electrodes of size 2·5 mm in flat position. The temperature of the parent metal immediately before depositing the weld metal shall be 27 ± 2°C. After completing the weld on one side of the test piece it shall be cooled down to about 100°C before depositing weld on the other side. The specimen shall not be subjected to any mechanical or thermal treatment after the welding is completed.

9.3.2 From the test piece so prepared two guide bend test specimens shall be machine cut as shown in Fig. 3. If the gas cutting is adopted the cutting allowance of not less than 3 mm shall be given.

9.3.3 Two bend tests, one with the face and the other with the root in tension, shall be carried out in accordance with IS 3600 (Part 5) : 1983. The test piece shall develop no crack beyond 1·5 mm or longer or no other harmful defects in any direction on the outer surface of the bend shall be visible.'

(*Page* 6, *clause* **9.3**, *line* 5) — Substitute 'Annex J' *for* 'Annex H'.

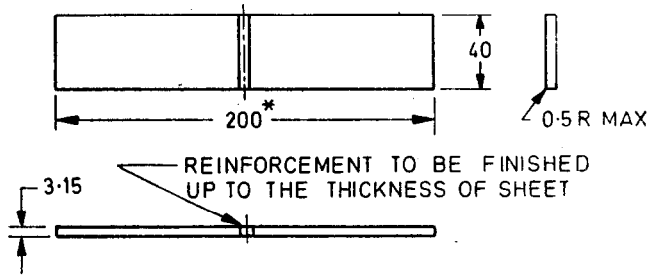
Group 1



*Approximate

All dimensions in millimetres.

FIG. 2 METHOD OF MAKING FACE AND ROOT TRANSVERSE BEND TEST SPECIMEN



*Approximate

All dimensions in millimetres.

FIG. 3 TRANSVERSE BEND TEST SPECIMEN

(*Page* 8, *clause* **9.6**) — Substitute the following for the existing clause:

'**9.6** All welded test assembly [*see* Fig. 7 (renumbered as Fig. 9)] after removal of packing strip, shall be machined or ground smooth so as to avoid difficulty in interpretation of radiograph of the weld. It shall then be subjected to radiographic test as per IS 1182 : 1983. The radiograph shall not show crack or incomplete fusion. The radiographic acceptance standard in respect of porosity and slag inclusions is indicated in Table 7 on page 3 of this Amendment. (Renumber the subsequent Tables.)

In making the evaluation for radiographic acceptance standard, a length of 25 mm from each end of the welded assembly shall be excluded.'

(*Page* 8, *clause* **11.2**):

a) Substitute 'date of manufacture' *for* 'despatch' in line 6.

b) Insert '(*see also* IS 13851 : 1993)' at the end of para.

(*Page* 8, *Annex* A) — Substitute the following for the existing entries:

IS No.	*Title*
812 : 1957	Glossary of terms relating to welding and cutting of metals
1182 : 1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates (*second revision*)
1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
1395 : 1982	Low and medium alloy steel covered electrodes for manual metal arc welding (*third revision*)
1599 : 1985	Method for bend test (*second revision*)
1608 : 1972	Method for tensile testing of steel products (*second revision*)
1757 : 1988	Method for charpy impact test (V-notch) for metallic material

1977 : 1975	Structural steel (ordinary quality) (*second revision*)
2002 : 1992	Steel plates for pressure vessels for intermediate and high temperature service including boilers (*second revision*)
2062 : 1992	Steel for general structural purposes (*fourth revision*)
2879 : 1975	Specification for mild steel for metal arc welding electrodes core wire (*second revision*)
3039 : 1988	Structural steels for construction hulls of ships (*second revision*)
3600 (Part 5) : 1983	Methods of testing fusion welded joints and weld metal in steel : Part 5 Transverse root and face bend test on butt welds (*second revision*)
8500 : 1991	Structural steel-micro alloyed (medium and high strength quality) (*second revision*)
11802 : 1986	Methods for determination of diffusible hydrogen content of deposited weld metal from covered electrodes in welding mild and low alloy steels
13043 : 1991	Determination of efficiency metal recovery and deposition coefficient of covered manual metal arc welding electrodes
13851 : 1993	Storage and redrying of covered electrodes before use — Recommendations'

(*Page* 9, *Table* 7, *col* 3, *row* 2) — Substitute '360' *for* '350'.

(*Page* 10, *clause* **B-3**, *line* 8) — Substitute '**OCV**' *for* '0CV'.

(*Page* 11, *clause* **B-3**) — Substitute '**EB 5426H1JX**' *for* '**EB 5426J2JX**' in the last line.

(*Page* 14, *Table* 11, *col* 3) - Delete 'IS 226' and 'IS 961 Grade HTW-52'.

(*Page* 21, *clause* **J-2**, *line* 13) — Substitute '**OCV**' *for* '0CV'.

(*Amendment No.* 1, *January 1994*) — Withdrawn.

Table 7 Radiographic Acceptance Standard in Respect of Porosity and Slag Inclusion

(*Clause* 9.6)

IS Classification of Electrode	Radiographic Acceptance Standard	Type of Porosity and/or	Acceptance		Restrictions, if any
			Size in mm (dia or length)	Quantity in No. (in 150 mm)	
EA 42XX-X EB 542X-HX EB 542-HJX EB 562X-HX EB 562X-HJX EB 541X-HJX EB 552X-HJX	Grade 1	Assorted	0·4 to 1·6	18 No.	i) Maximum No. of large size indications (1·2 to 1·6 mm) = 3 ii) Maximum No. of medium size indications (0·8 to 1·2 mm) = 5 iii) Maximum No. of small size indications (0·4 to 0·8 mm) = 10
		Large	1·2 to 1·6	8 No.	Nil
		Medium	0·8 to 1·2	15 No.	Nil
		Fine	0·4 to 0·8	30 No.	Nil
EC 4X10-X EC 4X16-X ER 4XXX-X ERR 4XXX-X ER 5XXX-JX ERR 5XXX-JX ERR 5XXX-KX ERR 5XXX-LX EB 5XXX-HXX EB 5XXX-HLX	Grade 2	Assorted	0·4 to 2·0	27 No.	i) Maximum No. of large size indications (1·16 to 2·0 mm) = 3 ii) Maximum No. of medium size indications (1·2 to 1·6 mm) = 8 iii) Maximum No. of small size indications (0·4 to 1·2 mm) = 16
		Large	1·6 to 2·0	14 No.	Nil
		Medium	1·2 to 1·6	22 No.	Nil
		Fine	0·4 to 1·2	44 No.	Nil
ER 41XX ER 42XX ES 41XX	Not required				

(MTD 11)

Printed at New India Printing Press Khurja, India

AMENDMENT NO. 3 OCTOBER 1997
TO
IS 814 : 1991 COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF CARBON AND CARBON MANGANESE STEEL — SPECIFICATION

(Fifth Revision)

(*Amendment No.* 2, *October* 1995, *Page* 3, *Table* 7, *col* 3, *Title*) — Substitute **'Type of Porosity and/or Slag Inclusion'** *for* **'Type of Porosity and/or'**.

(MTD 11)

Reprography Unit, BIS, New Delhi, India