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*Indian Standard*  
SPECIFICATION FOR  
BARE WIRE ELECTRODES FOR  
ELECTROSLAG WELDING OF STEELS

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# Indian Standard

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# *Indian Standard*

## SPECIFICATION FOR BARE WIRE ELECTRODES FOR ELECTROSLAG WELDING OF STEELS

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 30 December 1976, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** Electroslag welding process is becoming increasingly popular in the fabrication of boiler drums, pressure vessels, blast furnace equipment, etc. This standard is intended to serve as a guide for the manufacturer and selection of bare wire electrodes for electroslag welding of carbon manganese and low alloy steels.

**0.3** 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\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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### 1. SCOPE

**1.1** This standard prescribes the requirements of solid bare wire electrodes for electroslag welding of carbon and low alloy steels.

### 2. TERMINOLOGY

**2.1** For the purpose of this standard the definitions given in IS : 812-1957† shall apply.

### 3. SUPPLY OF MATERIAL

**3.1** General requirements relating to the supply of bare wire electrodes for electroslag welding shall be as laid down in IS : 1387-1967‡.

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\*Rules for rounding off numerical values (*revised*).

†Glossary of terms relating to welding and cutting of metals.

‡General requirements for the supply of metallurgical materials (*first revision*).

## **4. DIMENSIONS AND TOLERANCES**

**4.1** The diameters of wires shall be as follows:

2.0, 3.15, 4.0, 5.0 and 6.3 mm

**4.2** The tolerance on diameter of wires shall be  $\pm \begin{smallmatrix} 0 \\ 0.05 \end{smallmatrix}$  mm.

**4.3** The ovality of wire shall not exceed 50 percent of the tolerance on diameter.

## **5. COILS FOR WIRES**

**5.1** The bare wires shall be supplied in coils of internal diameter  $300 \pm 25$  and  $600 \pm 25$  mm. Net weight of the coil shall be  $50 \pm 3$  kg and  $80 \pm 5$  kg, respectively.

## **6. REELING CONDITIONS**

**6.1** Coils shall be properly bound, to prevent entanglement of turns in normal handling and when used, with tied start and finish ends. The finish end of the coils shall be clearly marked for identification. All coils shall contain continuous length of wire made from a single heat or lot.

**6.2** Butt welds present in the wire shall be suitably heat treated so as not to interfere with the uniform uninterrupted feeding of the wire in the equipment.

## **7. CONDITION OF WIRES**

**7.1** Filler wires shall have smooth finish and they shall be free from surface imperfections, corrosion products, grease, excessive oxide or other foreign matter which would affect adversely the properties of the weld or the operation of the welding equipment. Temper and surface conditions shall be suitable for uniform uninterrupted feeding on automatic or semiautomatic welding equipment. Unless otherwise specified the wires shall have a uniform, unbroken well-bonded and smooth copper coating applied onto the thoroughly cleaned wire surface. The copper content of the coated wire expressed as a percentage of the wire and the coating shall not exceed 0.4 percent by weight.

## **8. CLASSIFICATION**

**8.1** The bare wire electrodes shall be classified on the basis of their chemical composition.

**8.2** In classification 'ES-X' the alphabets 'ES' indicate bare solid carbon manganese electrode for electroslog welding. The classification 'ELS-X' is used to indicate low alloy bare solid electrode. The digit 'X' used as a suffix is equal to twice the amount of average manganese content of the wire. The presence of Molybdenum, Silicon, Nickel, etc, is indicated by further suffixes like Mo, Si, Ni, etc.



**8.2.1** For example the IS : Classification 'ES-3Mo' denotes carbon manganese bare electrode for submerged arc welding and contains 1.5 percent average content of manganese and an intentional addition of Molybdenum.

**8.2.2** Similarly, the IS : Classification 'ELS-2Mo Cr' denotes low alloy steel bare wire electrode for electroslog welding and it contains 1 percent average content of manganese and intentional addition of Molybdenum and Chromium.

## 9. CHEMICAL COMPOSITION

**9.1** The chemical composition of filler wires, when analyzed in accordance with IS : 228-1959\*, IS : 228 ( Part I )-1972†, IS : 228 ( Part II )-1972‡, IS : 228 ( Part III )-1972§, IS : 228 ( Part IV )-1974||, IS : 228 ( Part V )-1974¶, IS : 228 ( Part VI )-1974\*\* and IS : 228 ( Part VII )-1974††, shall be as given in Table 1. Where the wire is copper-coated, the analysis shall be made after the copper has been removed.

**9.2** The manufacturer shall carry out the analysis from each cast of steel and when required by the purchaser, supply a certified cast analysis of a sample of steel from each cast.

## 10. METHOD OF SAMPLING

**10.1** The location and the method of sampling shall be as agreed to between the purchaser and the manufacturer.

**10.2** The area to be sampled shall be obtained from the combined transverse sections by bundling the rods or wires after cutting into suitable lengths or by folding. The area shall be cleaned by grinding. The copper coating shall be removed to expose the base metal before grinding. The sample shall be collected by milling out the areas.

\*Methods of chemical analysis of pig iron, cast iron and plain carbon and low-alloy steels (*revised*).

†Methods of chemical analysis of steels: Part I Determination of carbon by volumetric method ( for carbon  $\geq 0.1$  percent ) (*second revision*).

‡Methods of chemical analysis of steels: Part II Determination of manganese in plain carbon and low alloy steels by arsenic method (*second revision*).

§Methods of chemical analysis of steels: Part III Determination of phosphorus ( alkalimetric method ) (*second revision*).

||Methods of chemical analysis of steels: Part IV Determination of carbon ( gravimetric method ) ( for carbon  $\geq 0.1$  percent ) (*second revision*).

¶Methods of chemical analysis of steels: Part V Determination of nickel by dimethylglyoxime ( gravimetric ) method ( for nickel  $\geq 0.5$  percent ) (*second revision*).

\*\*Methods of chemical analysis of steels: Part VI Determination of chromium by persulphate oxidation method ( for chromium  $\geq 0.5$  percent ) (*second revision*).

††Methods of chemical analysis of steels: Part VII Determination of molybdenum by  $\alpha$ -benzoinoxime method ( for molybdenum above 1 percent ) (*second revision*).

TABLE 1 CHEMICAL COMPOSITION OF BARE WIRE ELECTRODES

( Clause 9.1 )

CLASSIFICATION	CHEMICAL COMPOSITION, PERCENT											
	Carbon	Silicon	Manganese	Molybde- num	Nickel	Chro- mium	Copper	Tin	Alum- inium	Sulphur Max	Phosp- horus Max	Sul- phur+ Phosph- orus Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
ES-2	0.08-0.15	0.05-0.15	0.80-1.20	—	—	—	—	—	—	0.03	0.03	0.05
ES-2 Si	0.08-0.15	0.15-0.40	0.80-1.20	—	—	—	—	—	—	0.03	0.03	0.05
ES-3	0.08-0.15	0.05-0.25	1.30-1.70	—	—	—	—	—	—	0.03	0.03	0.05
ES-3Mo	0.08-0.15	0.05-0.25	1.30-1.70	0.45-0.60	—	—	—	—	—	0.03	0.03	0.05
ES-3 Mo Ni	0.08-0.12	0.05-0.25	1.30-1.70	0.45-0.60	1.30-1.70	—	—	—	—	0.02	0.02	0.05
ES-4	0.08-0.16	0.15-0.25	1.80-2.20	—	—	—	—	—	—	0.03	0.03	0.05
ES-4 Mo	0.08-0.17	0.15-0.30	1.80-2.20	0.45-0.60	—	—	—	—	—	0.03	0.03	0.05
ELS-4	0.08-0.12	0.10-0.30	1.80-2.20	0.015	0.015	0.018	0.015	0.020	0.02	0.015	0.015	—
ELS-4 Mo	0.08-0.12	0.10-0.30	1.80-2.20	0.50-0.70	0.15	0.15	0.15	0.02	0.02	0.015	0.015	—
ELS-2 Mo	0.08-0.12	0.10-0.20	0.90-1.20	0.50-0.70	0.15	1.10-1.50	0.15	0.02	0.02	0.015	0.015	—
ELS-2 Mo Cr	0.08-0.12	0.10-0.30	0.90-1.10	1.10-1.30	0.15	2.30-2.80	0.15	0.03	0.02	0.025	0.025	—

NOTE — Single values shown are maximum percentage except when otherwise stated.

## **11. PACKING**

**11.1** Reels of wire shall be suitably packed to guard against atmospheric influence, damage, contamination or deterioration during storage, transit and inspection.

**11.2** If the condition of the wire is such that special protection during storage or special treatment before use is desirable, the manufacturer shall give details of such special protection or treatment on the package.

## **12. MARKING**

**12.1** Each reel or coil of wire shall be clearly marked with the following information:

- a) Classification coding,
- b) Name of manufacturer,
- c) Trade designation of wire,
- d) Wire size,
- e) Cast number, and
- f) Net weight of the reel/coil.

**12.1.1** The reel may also be marked with the ISI Certification Mark.

**NOTE** — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

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