BRITISH STANDARD

BS EN
757 : 1997

Welding consumables — Covered electrodes for manual metal arc welding of high strength steels — Classification

The European Standard EN 757 : 1997 has the status of a British Standard

ICS 25.160.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee WEE/39, Welding consumables, upon which the following bodies were represented:

Aluminium Federation
Association of Welding Distributors
British Association for Brazing and Soldering
British Compressed Gases Association
British Constructional Steelwork Association Ltd.
British Iron and Steel Producers' Association
Electricity Association
Lloyds Register of Shipping
Magnesium Industry Council
Power Generation Contractors Association PGCA (BEAMA Ltd.)
Process Plant Association
Safety Assessment Federation Ltd.
Stainless Steel Wire Industry Association
Welding Institute
Welding Manufacturers Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on
15 September 1997

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference WEE/39
Draft for comment 92/76974 DC

ISBN 0 580 27987 1

Contents

National foreword

This British Standard has been prepared by Technical Committee WEE/39, and is the English language version of EN 757 : 1997 published by the European Committee for Standardization (CEN). It partially supersedes BS 2493 : 1985 which will be withdrawn on publication of BS EN 1599.,

Cross-references

Publication referred to	Corresponding British Standard
EN 499 : 1994	BS EN 499 : 1995 *Welding consumables — Covered electrodes for manual metal arc welding of non alloy and fine grain steels — Classification*
EN ISO 13916 : 1996	BS EN ISO 13916 : 1997 *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*
EN 22401 : 1993	BS EN 22401 : 1994 *Covered electrodes — Determination of efficiency of metal recovery and deposition coefficient*
ISO 31-0 : 1992	BS 5775 *Specification for quantities, units and symbols* Part 0 : 1993 *General principles*

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 8, an inside back cover and a back cover.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 757

February 1997

ICS 25.160.20

Descriptors: Arc welding, manual metal arc welding, welding electrodes, covered electrodes, filler metal, weld metal, high yield strength steels, classifications, symbols

English version

Welding consumables — Covered electrodes for manual metal arc welding of high strength steels — Classification

Produits consommables pour le soudage — Electrodes enrobées pour le soudage manuel à l'arc des aciers à haute résistance — Classification

Schweißzusätze — Umhüllte Stabelektroden zum Lichtbogenhandschweißen von hochfesten Stählen — Einteilung

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 121, Welding, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 1997, and conflicting national standards shall be withdrawn at the latest by August 1997.

Annex A is informative and contains a bibliography.

In normative references, reference is made to ISO 3690. It should be noted that a European Standard is under preparation for the same subject in CEN/TC 121/SC 3.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

Introduction

This standard proposes a classification in order to designate covered electrodes in terms of the yield strength, tensile strength and elongation of the all-weld metal. The ratio of yield to tensile strength of weld metal is generally higher than that of parent material. Users should note that matching weld metal yield strength to parent material yield strength will not necessarily ensure that the weld metal tensile strength matches that of the parent material. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to column 3 of table 1.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify the electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode diameter, width of weave, welding position and parent material composition.

1 Scope

This standard specifies requirements for classification of covered electrodes based on the all-weld metal in the as-welded or stress relieved conditions for manual metal arc welding of steels with a minimum yield strength higher than 500 N/mm^2.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 499	*Welding consumables — Covered electrodes for manual metal arc welding of non alloy and fine grain steels — Classification*
prEN 759	*Welding consumables — Technical delivery conditions for welding filler metals including type of product, dimensions, tolerances and marking*
prEN 1597-1	*Welding consumables — Testing for classification — Part 1: Test assembly for all-weld metal test specimens in steel, nickel and nickel alloys*
prEN 1597-3	*Welding consumables — Testing for classification — Part 3: Testing of positional capability of welding consumables in a fillet weld*
EN ISO 13916	*Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature* (ISO 13916 : 1996)
EN 22401	*Covered electrodes — Determination of the efficiency, metal recovery and deposition coefficient* (ISO 2401:1972)
ISO 31-0 : 1992	*Quantities and units — Part 0: General principles*
ISO 3690	*Welding — Determination of hydrogen in deposited weld metal arising from the use of covered electrodes for welding mild and low steels*

3 Classification

The classification includes all-weld metal properties obtained with a covered electrode as given below. The classification is based on the electrode diameter 4 mm, with the exception of the symbol for welding position which is based on prEN 1597-3.

The classification is divided into nine parts.

1) The first part gives a symbol indicating the product/process to be identified.

2) The second part gives a symbol indicating the strength and elongation of all-weld metal.

3) The third part gives a symbol indicating the impact properties of all-weld metal.

4) The fourth part gives a symbol indicating the chemical composition of all-weld metal.

5) The fifth part gives a symbol indicating the type of electrode covering.

6) The sixth part gives a symbol indicating the stress relief treatment in case this is applied.

7) The seventh part gives a symbol indicating the weld metal recovery and type of current.

8) The eight part gives a symbol indicating the welding position.

9) The ninth part gives a symbol indicating the hydrogen content of deposited metal.

In order to promote the use of this standard, the classification is split into two sections.

a) Compulsory section.

This section includes the symbols for the type of product, the strength and elongation, the impact properties, the chemical composition and the type of covering, i.e. the symbols defined in **4.1**, **4.2**, **4.3**, **4.4** and **4.5**.

b) Optional section.

This section includes the symbols for the stress relief treatment, the weld metal recovery, the type of current, the welding positions for which the electrode is suitable, and the symbol for hydrogen content, i.e. the symbols defined in **4.6**, **4.7**, **4.8** and **4.9**.

The full designation (see **8**) shall be used on packages and in the manufacturer's literature and data sheets.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the covered electrode used in the manual metal arc welding process shall be the letter E.

4.2 Symbol for tensile properties

The symbol in table 1 indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or, if a T is added in the designation, after stress relief treatment described in **4.6**, determined in accordance with clause **5**.

NOTE. Stress relief treatment can alter the strength of the weld metal from that obtained in the as-welded condition.

Table 1. Symbol for tensile properties

Symbol	Minimum[1] yield strength N/mm^2	Tensile strength N/mm^2	Minimum elongation[2] %
55	550	610 to 780	18
62	620	690 to 890	18
69	690	760 to 960	17
79	790	880 to 1080	16
89	890	980 to 1180	15

[1] For yield strength the lower yield (R_{eL}) is used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) is used.
[2] Gauge length is equal to five times the test specimen diameter.

4.3 Symbol for impact properties of all-weld metal

The symbol in table 2 indicates the temperature at which an average impact energy of 47 J is achieved under conditions given in clause **5**. Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J. When an all-weld metal has been classified for a certain temperature, it automatically covers any higher temperature in table 2.

Table 2. Symbol for impact properties of all-weld metal

Symbol	Temperature for minimum average impact energy 47 J °C
Z	No requirements
A	+20
0	0
2	−20
3	−30
4	−40
5	−50
6	−60
7	−70
8	−80

NOTE. Stress relief treatment can alter the impact properties of the weld metal from that obtained in the as-welded condition.

4.4 Symbol for chemical composition of all-weld metal

The symbol in table 3 indicates the chemical composition of all-weld metal determined in accordance with clause **6**.

Table 3. Symbol for chemical composition of all-weld metal

Symbol	Chemical composition[1] [2] [3] % (*m/m*)			
	Mn	Ni	Cr	Mo
MnMo	1,4 to 2,0			0,3 to 0,6
Mn1Ni	1,4 to 2,0	0,6 to 1,2		—
1NiMo	1,4	0,6 to 1,2		0,3 to 0,6
1,5NiMo	1,4	1,2 to 1,8		0,3 to 0,6
2NiMo	1,4	1,8 to 2,6		0,3 to 0,6
Mn1NiMo	1,4 to 2,0	0,6 to 1,2		0,3 to 0,6
Mn2NiMo	1,4 to 2,0	1,8 to 2,6		0,3 to 0,6
Mn2NiCrMo	1,4 to 2,0	1,8 to 2,6	0,3 to 0,6	0,3 to 0,6
Mn2Ni1CrMo	1,4 to 2,0	1,8 to 2,6	0,6 to 1,0	0,3 to 0,6
Z	Any other agreed composition			

[1] If not specified: C 0,03 % to 0,10 %, Ni < 0,3 %, Cr < 0,2 %, Mo < 0,2 %, V < 0,05 %, Nb < 0,05 %, Cu < 0,3 %, P < 0,025 %, S < 0,020 %.
[2] Single values shown in the table are maximum values.
[3] The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with annex B, Rule A of ISO 31-0 : 1992.

4.5 Symbol for type of electrode covering

The type of covering of these electrodes is basic and the symbol is B.

For cellulosic and other electrode coverings see EN 499.

4.6 Symbol for stress relief treatment

The letter T indicates that strength, elongation and impact properties in the classification of deposited metal are obtained after a stress relief treatment between 560 °C to 600 °C for 1 h. The test piece shall be left in the furnace for cooling down to 300 °C.

4.7 Symbol for weld metal recovery and type of current

The symbol in table 4 indicates weld metal recovery, determined according to EN 22401 with the type of current shown in table 4.

Table 4. Symbol for weld metal recovery and type of current

Symbol	Weld metal recovery %	Type of current[1)2)]
1	≤ 105	a.c. and d.c.
2	≤ 105	d.c.
3	> 105 ≤ 125	a.c. and d.c.
4	> 105 ≤ 125	d.c.
5	> 125 ≤ 160	a.c. and d.c.
6	> 125 ≤ 160	d.c.
7	> 160	a.c. and d.c.
8	> 160	d.c.

[1)] In order to demonstrate operability on alternating current, tests shall be carried out with no load voltage not higher than 65 V.

[2)] a.c. means alternating current; d.c. means direct current.

4.8 Symbol for welding position

The symbol below for welding positions indicates the positions for which the electrode is tested according to prEN 1597-3 as follows:

1) all positions;

2) all positions, except vertical down;

3) flat butt weld, flat fillet weld, horizontal vertical fillet weld;

4) flat butt weld, flat fillet weld;

5) vertical down and positions according to symbol 3.

4.9 Symbol for hydrogen content of deposited metal

The symbol in table 5 indicates the hydrogen content determined in deposited metal from electrode diameter 4 mm in accordance with the method given in ISO 3690. The current used shall be 90 % of the maximum value recommended by the manufacturer.

Electrodes recommended for use with a.c. shall be tested using a.c.. Electrodes recommended for d.c. only shall be tested using d.c. with electrode positive.

The manufacturer shall provide information on the recommended type of current and drying conditions for achieving the hydrogen levels.

Table 5. Symbol for hydrogen content of deposited metal

Symbol	Hydrogen content ml/100 g deposited metal max.
H5	5
H10	10

NOTE 1. Other methods of collection and measurement of diffusible hydrogen can be used for batch testing provided they possess equal reproducibility with, and are calibrated against the method given in ISO 3690. The hydrogen will be influenced by the type of current.

NOTE 2. Cracks in welded joints are caused or significantly influenced by hydrogen. The risk of hydrogen-induced cracks increases with rising alloy content and stress level. Such cracks generally develop after the joint has become cold and are therefore termed cold cracks.

Assuming that the external conditions are satisfactory (weld areas clean and dry) the hydrogen in the weld metal stems from hydrogen-bearing compounds in the filler metals; in the case of basic covered electrodes, the water taken up by the covering is the main source.

The water dissociates in the arc and gives rise to atomic hydrogen which is absorbed by the weld metal.

Under given material and stress conditions the risk of cold cracking diminishes with decreasing hydrogen content of the weld metal.

NOTE 3. In practice, the appropriate hydrogen level will depend on the particular application and, to ensure that this is achieved, the relevant handling, storage and drying conditions recommended by the electrode manufacturer should be followed.

5 Mechanical tests

5.1 General

Tensile and impact tests and any required retests shall be carried out on weld metal in the as-welded or stress relieved condition using an all-weld metal test assembly type 3, in accordance with prEN 1597-1 using 4 mm electrodes and welding conditions as described in **5.1** and **5.2**.

5.2 Preheating and interpass temperatures

Welding of the all-weld metal test piece shall be executed in a temperature range from 125 °C to 175 °C, with the exception of the first layer in the test assembly, which may be welded without preheat.

The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples, see EN ISO 13916.

5.3 Pass sequence

The pass sequence is indicated in table 6.

The direction of welding to complete a layer consisting of two passes shall not vary, but the direction of welding of layers shall be alternated. Each pass shall be welded with a welding current of 90 % of the maximum current recommended by the manufacturer. Welding shall be performed with a.c. when both a.c. and d.c. are recommended, and with d.c. using the recommended polarity when only d.c. is recommended.

Table 6. Pass sequence

Electrode diameter	Split weave		
mm	Layer No.	Passes per layer	Number of layers
4,0	1 to top	2 [1)]	6 to 10

[1)] The top two layers may be completed with three passes per layer.

6 Chemical analysis

Chemical analysis is performed on any suitable all-weld metal test specimen. Any analytical technique can be used, but in case of dispute reference shall be made to established published methods.

NOTE. See annex A.

7 Technical delivery conditions

Technical delivery conditions shall meet the requirements in prEN 759.

8 Designation

The designation of the covered electrode shall follow the principle given in the examples below.

EXAMPLE 1.

A basic covered electrode for manual metal arc welding deposits a weld metal with a minimum yield strength of 620 N/mm^2 (62) and a minimum average impact energy of 47 J at —70 °C (7) and has a chemical composition of 1,8 % Mn and 0,6 % Ni (Mn1Ni). The electrode with basic covering (B) can be used with a.c. or d.c. with a metal recovery of 120 % (3) in flat butt and flat fillet welds (4). Hydrogen is determined according to ISO 3690 and does not exceed 5 ml/100 g deposited metal (H5).

The designation will be:

Covered electrode EN 757 - E 62 7 Mn1Ni B 3 4 H5;

compulsory section:

Covered electrode EN 757 - E 62 7 Mn1Ni B;

or if tested after stress relief treatment:

Covered electrode EN 757 - E 62 7 Mn1Ni B T;

where:

EN 757 = standard number;
E = covered electrode/manual metal arc welding (see **4.1**);
62 = strength and elongation (see table 1);
7 = impact properties (see table 2);
Mn1Ni = chemical composition of all-weld metal (see table 3);
B = type of electrode covering (see **4.5**);
T = stress relief treatment (see **4.6**);
3 = recovery and type of current (see table 4);
4 = welding position (see **4.8**);
H5 = hydrogen content (see table 5).

EXAMPLE 2.

Another basic covered electrode for manual metal arc welding deposits a weld metal with a minimum yield strength of 890 N/mm^2 (89) and a minimum average impact energy of 47 J at −50 °C (5) and has a chemical composition outside the limits given in table 3 (Z). The electrode with basic covering (B) may be used with a.c. or d.c. with a metal recovery of 120 % (3) in flat butt and flat fillet welds (4). Hydrogen is determined according to ISO 3690 and does not exceed 5 ml/100 g deposited metal (H5).

The designation will be:

Covered electrode EN 757 - E 89 5 Z B 3 4 H5;

compulsory section:

Covered electrode EN 757 - E 89 5 Z B;

or after stress relief treament:

Covered electrode EN 757 - E 89 5 Z B T.

Annex A (informative)
Bibliography

A.1 *Handbuch für das Eisenhüttenlaboratorium*, VdEh, Düsseldorf

A.2 BS 6200-3, *Sampling and analysis of iron, steel and other ferrous metals — Part 3: Methods of analysis*

A.3 CEN/CR 10261 ECISS Information Circular 11, *Iron and Steel — Review of available methods of chemical analysis*

List of references

See national foreword.

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