BRITISH STANDARD

BS 2772-2: 1989

Colliery haulage and winding equipment —

Part 2: Specification for wrought steel

Confirmed January 2010

UDC 669.14 – 13:622.67

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Iron and Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/31, upon which the following bodies were represented:

British Chain Manufacturers' Association
British Coal Corporation
British Forging Industry Association
British Industrial Fasteners Federation
British Steel Industry
Cold Rolled Sections Association
Department of Trade and Industry (National Physical Laboratory)
Engineering Industries Association
Federation of British Engineers' Tool Manufacturers
Institution of Production Engineers
Lloyds Register of Shipping
Ministry of Defence
National Association of Steel Stockholders
Road Vehicle Spring Society
Society of Motor Manufacturers and Traders Limited
Stainless Steel Fabricators' Association of Great Britain

This British Standard, having been prepared under the direction of the Iron and Steel Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 29 September 1989

First published September 1956
First revision December 1977
Second revision September 1989

The following BSI references relate to the work on this standard:
Committee reference ISM/31
Draft for comment 87/35666 DC

ISBN 0 580 17095 0

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

This revision of this Part of BS 2772 was prepared under the direction of the Iron and Steel Standards Policy Committee. It supersedes BS 2772-2:1977 which is withdrawn.

Major changes have been introduced into this standard. In order to allow greater freedom in the selection of steels, chemical analysis requirements are no longer specified and steel selection is based on mechanical property requirements. Five groups of steel materials are specified, based on ascending levels of tensile strength. An appendix to provide guidance on chemical composition for each of the five groups is included. Requirements for steel plates have been introduced for the first time. It should be noted that the specified mechanical properties relate to limiting ruling section and that for plate material where the properties are obtained on quenched and tempered test pieces, this will be greater than the actual plate thickness.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 2772 specifies requirements for wrought steel plates, blooms, billets, slabs, bars, forgings and drop forgings to be used for colliery cage suspension gear, colliery tubs, mine-car drawgear and couplings and rope sockets. Details of information to be supplied by the purchaser are given in Appendix B. Appendix C gives guidance on chemical composition for each of the five groups of steels considered.

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 2772 the following definitions apply.

2.1
limiting ruling section

the largest diameter in which certain specified mechanical properties are achieved after a specified heat treatment for a particular composition of steel

2.2
equivalent diameter

the equivalent diameter of any product, or part of a product, is the diameter at the time of heat treatment of a hypothetical very long bar effectively of infinite length of uniform circular cross section which, if subjected to the same cooling conditions as the product, i.e. same initial and final temperature and same cooling medium, would have a cooling rate at its axis equivalent to that at the slowest cooling position in the product or relevant part

2.3
test sample

that portion of the material selected for testing

2.4
test bar

the test sample after preparation for heat treatment

2.5
test piece

the test sample or test bar as finally prepared for mechanical testing

3 Steelmaking process

Any steelmaking practice except the air or mixed air/oxygen bottom blown basic converter process shall be used.

The steel shall be fully killed and made to a fine-grained practice.

4 Chemical analysis

The ladle analysis of the steel shall be subject to the restrictions given in Table 1. Boron shall not be deliberately added to the steel.

The minimum ratio of aluminium to nitrogen shall be 2 : 1.

NOTE Appendix C gives guidance on the selection of steels.

Table 1 — Restrictions on ladle analysis

	(% max.)
Phosphorus	0.04
Sulphur	0.04
Nitrogen	0.012

5 Freedom from defects

The material shall be free from pipe, segregation, cracks, laminations or surface flaws. Defects shall not be repaired by welding.

NOTE 1 In practice, the material needs to be free from such defects as might preclude its use for its intended purpose.
NOTE 2 BS 6512 gives guidance on surface discontinuities for plate material.

6 Sizes and tolerances

6.1 Sizes and tolerances of plate shall comply with BS 4360.

6.2 Sizes and tolerances of blooms, billets, slabs and bars shall comply with BS 970-1.

6.3 Sizes and tolerances of drop and press forgings and upset forgings made on horizontal forging machines shall comply with BS 4114.

7 Condition of material on delivery

Plates, blooms, billets, slabs and bars shall be delivered "as rolled" or "as forged".

Forgings and drop forgings shall be delivered in the condition stated on the order.

8 Grain size

In order to demonstrate that a fine-grained steelmaking practice has been employed, the material shall exhibit either:

a) a minimum of 0.015 % soluble aluminium content on ladle analysis; or

b) a grain size of 5 or finer which, in cases of dispute, shall be tested in accordance with Appendix A.

9 Mechanical properties

The mechanical properties obtained from test pieces selected, prepared and tested in accordance with Appendix A shall meet the requirements given in Table 2.

For the Charpy V-notch impact test (see **A.3.2**), the average value of the three tests shall meet the value given in Table 2. Not more than one individual value shall be lower than the value given in Table 2 and it shall be not lower than 70 % of that value.

If retesting is necessary (see **A.3.2**) the average value of the six tests shall meet the value given in Table 2. Not more than two of the individual values shall be lower than the value given in Table 2 and not more than one shall be lower than 70 % of that value.

NOTE Mechanical properties quoted in Table 2 are related to limiting ruling sections. Figure 1 of Appendix A, derived from BS 5046, should be used to determine the equivalent diameter and test bar size and hence the applicability of the properties quoted.

10 Manufacturer's statement

The manufacturer shall supply a certificate giving details of the ladle analysis of the material, the method of steelmaking and the results of the mechanical tests.

Table 2 — Mechanical properties

Group of steel	Product form	Limiting ruling section	Minimum values of mechanical properties			
			Tensile strength R_m	Yield strength R_e	Elongation on $5.65\sqrt{S_o}$	Minimum Charpy V-notch impact test values at – 20 °C
		mm	N/mm²	N/mm²	%	J
1	Plate	⩽ 100	490	340	24	80
	All other forms	⩽ 100	540	340	24	80
	All forms	> 100 ⩽ 150	490	310	23	60
	All forms	> 150	430	280	22	55
2	All forms	⩽ 150	540	340	24	68
	All forms	> 150 ⩽ 250	540	340	20	55
3	All forms	⩽ 150	620	435	19	47
	All forms	> 150 ⩽ 250	620	435	19	37
4	All forms	⩽ 63	770	540	17	40
5	All forms	> 63 ⩽ 150	850	680	15	55
	All forms	> 150 ⩽ 250	850	650	15	20

Appendix A Methods of test for mechanical properties

A.1 Selection and preparation of samples

A.1.1 *Material not supplied in the finally heat-treated condition*

A.1.1.1 *Blooms, billets, slabs, bars, forgings and drop forgings.* Where the ruling section of the material does not differ appreciably from that of the forging or parts to be produced, test samples shall be taken either:

a) directly from the material and heat treated in the original size; or

b) where the results of heat treating in the original size would be obtained on the forgings or parts to be produced, by forging and/or machining to test bars of a diameter equivalent to the ruling section of the forgings or parts at the time of heat treatment.

Test bars shall be given the representative heat treatment for the parts concerned. One tensile test and three Charpy V-notch impact tests shall be made on any batch of material of similar ruling section from the same cast. For the purpose of subsequent orders, these tests shall be taken as representing all sizes of material from the same cast where the ruling section of the forgings or parts does not exceed the ruling section of the test bar already tested.

A.1.1.2 *Plates.* A test coupon shall be taken from a plate from each cast and water-quenched and tempered. The size and ruling section of this coupon shall be in accordance with Figure 1. If the plate tested is 50 mm thick or greater, this shall cover all thicknesses rolled from that cast. If the plate tested is less than 50 mm thick, this shall cover plates from that cast up to 50 mm thick. If, subsequently, plates thicker than 50 mm are produced from that cast, then a further coupon shall be taken from a plate 50 mm or thicker and quenched and tempered.

One tensile test and three Charpy V-notch impact tests shall be made on each test coupon.

A.1.2 *Bars for machining as supplied in the finally heat-treated condition*

The samples shall be cut from the heat-treated bars and shall not be subject to further heat treatment nor, except for that required to prepare the test piece, to further mechanical working.

One tensile test and three Charpy V-notch impact tests shall be made on each batch of bars of similar size which have originated from the same cast and have been heat treated together.

A.1.3 *Forgings, drop forgings and machined parts*

Samples for mechanical testing shall be taken by one of the following methods.

a) For forgings and drop forgings with a ruling section equivalent to a diameter greater than 29 mm, a prolongation shall be provided on a representative proportion of the forgings or drop forgings. The prolongation shall have a diameter equal to the ruling section of the forging or drop forging at the time of heat treatment and shall not be finally severed until after heat treatment.

b) Where integral test pieces are not practicable, for forgings and drop forgings with ruling sections equivalent to a diameter of 29 mm or less and for parts machined from bars not finally heat treated, separate test pieces shall be provided. These shall be provided from the bars or billets from which the forgings, drop forgings or parts are made, or from additional forgings, drop forgings or parts. The test samples shall be forged and/or machined to test bars of a diameter equivalent to the ruling section of the forgings, drop forgings or parts and shall be heated with the material they represent.

A.1.4 *Samples for grain size test*

Where a grain size test is required (see clause **8**), one test sample for the determination of austenitic grain size shall be selected for each cast.

A.2 Location of tensile and Charpy V-notch impact test pieces

Tensile test pieces shall be taken in the longitudinal or transverse direction. Charpy test pieces shall be taken longitudinally.

For ruling sections up to and including 25 mm, the test piece shall be machined co-axially from the heat-treated test bar.

For ruling sections over 25 mm, the longitudinal axis of the test piece shall be 12.5 mm from the surface of the heat-treated test bar.

A.3 Test methods

A.3.1 *Tensile test*

The tensile test shall be carried out in accordance with BS 18.

Tensile test pieces shall be machined from plates, blooms, billets, slabs, bars, forgings and drop forgings to the dimensions of the largest, practical, round test piece, from those specified in BS 18 that can be obtained having a gauge length equal to $5.65\sqrt{S_o}$.

NOTE For material not greater than 50 mm in diameter or width across flats, unmachined test pieces having a gauge length equal to $5.65\sqrt{S_o}$ may be used.

If any of the original test results fail to meet the values specified in Table 2, twice the original number of test samples shall be selected for retesting.

One of these shall be taken from the plate, bloom, billet, slab, bar, forging or drop forging from which the original test sample was taken unless that item has been withdrawn by the manufacturer.

In the case of material supplied in the heat-treated condition, the manufacturer shall have the right to re-heat treat the material and to resubmit it for testing.

If any of the retests fail, the material represented shall be deemed not to comply with this Part of this British Standard.

A.3.2 ***Charpy V-notch impact test***

The Charpy V-notch impact test shall be carried out in accordance with BS 131-2 at a temperature of – 20 °C. The individual results of the three tests shall be recorded and the average value calculated.

If the average of the original three impact values is lower than the value specified in Table 2, or if any one value is lower than 70 % of that value, three additional test pieces shall be taken from the sample and tested.

With material supplied in the heat-treated condition, the manufacturer shall have the right to re-heat treat the material and resubmit it for testing.

If the requirements of clause **9** are not fulfilled, the material represented shall be deemed not to comply with this Part of BS 2772.

A.3.3 ***Grain size test***

When required (see clause **8**), a grain size test shall be carried out in accordance with the McQuaid Ehn method given in BS 4490.

If the test sample fails to meet the requirements specified in clause **8** b), a second sample shall be tested. If this retest confirms the failure, the material represented shall be deemed not to comply with this Part of BS 2772.

Appendix B Information to be supplied by the purchaser

The following information should be supplied by the purchaser when ordering:

a) the number and Part of this British Standard and the selected group of material;

b) the intended application, e.g. for forging, re-rolling, etc.;

c) the sizes and tolerances of the steel required (see clause **6**);

d) the condition in which the material is to be supplied (see clause **7**);

e) whether transverse tensile tests are required (see **A.2**).

Appendix C Guidance on the selection of steels

C.1 Introduction

This appendix offers guidance to users of this standard with respect to the compositions of steel and heat treatments that might fulfil the requirements. The steels named in **C.2** have been used for many years for colliery haulage and winding equipment and this satisfactory experience provides the basis for the guidance here offered.

C.2 Choice of steels

Steels having the following composition and heat treatments have been found in the past to be capable of meeting the mechanical property requirements of this standard.

Group 1

1.5 % manganese steel 150M12

Element	% min.	% max.
Carbon[a]	0.10	0.15
Silicon	0.10	0.35
Manganese	1.30	1.70
Phosphorus	—	0.050
Sulphur	—	0.050

[a] For ruling sections over 100 mm, carbon up to 0.18 %.

The following heat treatment has been found satisfactory for Group 1:

Harden in water from a temperature of 870 °C to 910 °C. Temper at a suitable temperature between 550 °C and 650 °C.

Group 2

1.5 % manganese steel 150M19

Element	% min.	% max.
Carbon	0.15	0.23
Silicon	0.10	0.40
Manganese	1.30	1.70
Phosphorus	—	0.040
Sulphur	—	0.040

The following heat treatment has been found satisfactory for Group 2:

Harden in water from a temperature of 860 °C to 900 °C. Temper at a suitable temperature between 550 °C and 670 °C.

Group 3

Nickel, chromium, molybdenum steel 806M20

Element	% min.	% max.
Carbon[a]	0.17	0.23
Silicon	0.10	0.35
Manganese	0.60	0.95
Phosphorus	—	0.040
Sulphur	—	0.040
Chromium	0.35	0.65
Molybdenum	0.15	0.25
Nickel	0.40	0.75

[a] For ruling sections over 100 mm, carbon may be up to 0.25 %.

The following heat treatment has been found satisfactory for Group 3:

Harden in water from a temperature of 860 °C to 880 °C. Temper at a suitable temperature between 500 °C and 650 °C.

Group 4

Nickel, chromium, molybdenum steel 806M22

Element	% min.	% max.
Carbon	0.19	0.25
Silicon	0.10	0.35
Manganese	0.60	0.90
Phosphorus	—	0.040
Sulphur	—	0.040
Chromium	0.35	0.65
Molybdenum	0.15	0.25
Nickel	0.40	0.75

The following heat treatment has been found satisfactory for Group 4:

Harden in water from a temperature of 860 °C to 880 °C. Temper at a suitable temperature between 500 °C and 650 °C.

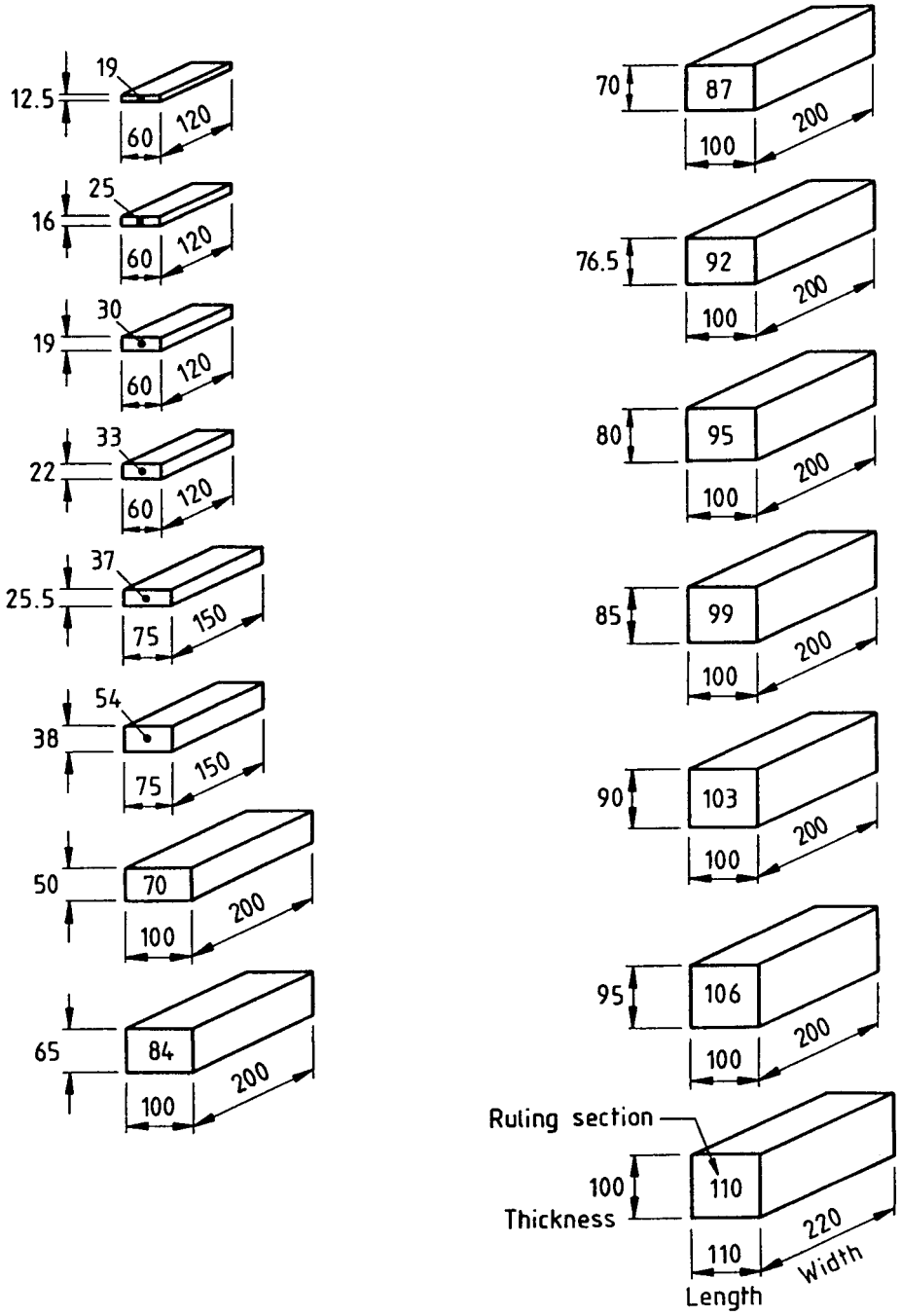
Group 5

Nickel, chromium, molybdenum steel 826M31

Element	% min.	% max.
Carbon	0.27	0.35
Silicon	0.10	0.35
Manganese	0.45	0.70
Phosphorus	—	0.040
Sulphur	—	0.040
Chromium	0.50	0.80
Molybdenum	0.45	0.65
Nickel	2.30	2.80

The following heat treatment has been found satisfactory for Group 5:

Harden in oil from a temperature of 820 °C to 850 °C. Temper at a suitable temperature between 550 °C and 650 °C.



All dimensions are in millimetres.

Figure 1 — Test block dimensions and ruling sections

Publications referred to

BS 18, *Methods for tensile testing of metals.*

BS 131, *Methods for notched bar tests.*

BS 131-2, *The Charpy V-notch impact test on metals.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 970-1, *General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels.*

BS 4114, *Specification for dimensional and quantity tolerances for steel drop and press forgings and for upset forgings made on horizontal forging machines.*

BS 4360, *Specification for weldable structural steels.*

BS 4490, *Methods for the determination of the austenitic grain size of steel.*

BS 5046, *Method for the estimation of equivalent diameters in the heat treatment of steel.*

BS 6512, *Specification for limits and repair of surface discontinuities of hot-rolled steel plates and wide flats.*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL