

CONFIRMED
DECEMBER 2007

Specification for

Alloy steel shackles

[UDC 621.885.7:669.15]

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This British Standard, having been approved by the Mechanical Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 22nd October 1962

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The following BSI references relate to the work on this standard:
Committee reference MEE/12
Draft for comment AB(MEE)936

ISBN 0 580 35090 8

Amendments issued since publication

Amd. No.	Date	Comments

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Foreword

A complete list of British Standards, numbering over 9,000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 84, *Parallel screw threads of Whitworth form.*

BS 240, *Brinell hardness test, Part 1: Testing of metals.*

BS 825, *Mild steel shackles.*

BS 860, *Tables of approximate comparison of hardness scales.*

BS 919, *Screw gauge limits and tolerances.*

BS 970, *Wrought steels. En series.*

BS 1580, *Unified screw threads (with metric equivalents).*

BS 1706, *Electroplated coatings of cadmium and zinc on iron and steel.*

BS 1936, *Undercuts and runouts for screw threads.*

BS 3032, *Higher tensile steel shackles.*

BS 3189, *Phosphate treatment of iron and steel for protection against corrosion.*

BS 3458, *Alloy steel chain slings.*

This British Standard specifies steel shackles with a higher minimum tensile strength than the shackles specified in BS 825¹⁾, and in BS 3032²⁾.

In terms of body diameter (d), the shackles specified in Table 1 and Table 2 are of similar proportions to the mild steel and higher tensile steel “large dee” and “large bow” shackles, but in terms of $\sqrt{W}$, where W is the safe working load, the internal clearances are somewhat less, owing to the increased safe working load for a given size of shackle.

Four types of shackle pin are specified. Type 1, a screwed pin with eye and collar; Type 2, a screwed pin with circular head; Type 3, a bolt with a circular head, hexagon nut and split cotter pin; and Type 4, a plain cylindrical pin with circular head and forelock. Alloy steel pins can be identified by the special flats on each side of the circular head of each type.

The mechanical properties of the materials from which alloy steel shackles are made are comparable to those of the material used for the terminal components of alloy steel chain slings to BS 3458³⁾. In view of the importance of correct heat treatment, particular attention is drawn to the necessity for strict supervision and control when heat treating the shackles.

Whilst mild steel shackles, etc., may be galvanized or sherardized, too little is known about these finishes on alloy steel shackles to recommend their use at the present time.

In accordance with British Standard practice, the term “British Standard alloy steel shackle” refers only to the shackles listed in the tables of this standard. The specification introduces a term for shackles complying with its requirements except for those relating to the tables of dimensions (see Clause 3).

Each type of shackle in Table 1 and Table 2 is composed of a series of geometrically similar shackles, all the dimensions with the exception of the pins in the smaller sizes (see Figure 7), being proportional to the square root of the safe working load, W .

¹⁾ BS 825, “Mild steel shackles”.

²⁾ BS 3032, “Higher tensile steel shackles”.

³⁾ BS 3458, “Alloy steel chain slings”.

The dee shackle (Table 1) has moderate internal clearances in the body and jaw, and for a given size, a safe working load of approximately twice that of the mild steel large dee to BS 825, and one-and-a-half times that of the higher tensile steel large dee to BS 3032. These shackles are particularly suitable when the pin must be fitted into a hole of limited diameter. The shackles are also suitable for use with the eyes and bodies of hooks, eyebolts, egg links, wire rope thimbles, etc., and for the head fittings of blocks.

The bow shackle (Table 2) has moderate internal clearances in the body and jaw, and for a given size, a safe working load of approximately twice that of the mild steel large bow to BS 825, and one-and-a-half times that of the higher tensile steel large bow to BS 3032. These shackles are particularly suitable when the pin must be fitted into a hole of limited diameter. The shackles are also suitable for use with the eyes and bodies of hooks, eyebolts, egg links, wire rope thimbles, etc., and for the head fittings of blocks.

Specimen shackles representative of the dee and bow shackles specified, have been subjected to static proof loads (twice the safe working load), with satisfactory results.

The safe working loads specified are for normal conditions of service. For specially hazardous conditions, it is desirable that the safe working loads should be reduced.

The committee entrusted with the preparation of the standard desires to record its indebtedness to the Department of Scientific and Industrial Research for help in the theoretical and experimental investigations on which this standard is based.

NOTE 1 Metric equivalents have been given in Appendix D. The figures in British units are to be regarded as the standard. The conversions are approximate. More accurate conversions should be based on the tables in BS 350, "Conversion factors and tables".

NOTE 2 In place of the customary, but incorrect, use of the pound and kilogramme as units of force, the units called ton-force (abbreviation tonf) and kilogramme-force (abbreviation kgf) have been used in this standard. These are the forces which, when acting on a body of mass one pound or one kilogramme respectively, give it an acceleration equal to that of standard gravity.

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 to iv, pages 1 to 16, 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 specification covers shackles in alloy steel.

Material, heat-treatment, workmanship, finish, screw threads, proof loading, marking and certification are specified. Tables of dimensions for dee and bow shackles are given. Design requirements are laid down for special (or unscheduled) shackles whose dimensions differ from those given in these tables.

2 Types of shackle

The shackle comprises body and pin, or body and bolt with nut.

The body shall be one of the following types as specified by the purchaser:

Dee: Table 1, Figure 1;

Bow: Table 2, Figure 2.

The pin shall be one of the following types:

Type 1. Screwed pin with eye and collar, Figure 3;

Type 2. Screwed pin with circular head, Figure 4;

Type 3. Bolt with circular head, hexagon nut and split cotter pin, Figure 5;

Type 4. Plain cylindrical pin with circular head and forelock, Figure 6.

NOTE Alloy steel pins can be identified by the special flats on each side of the circular head of each type.

3 Special shackles

Special (or unscheduled) shackles whose dimensions differ from those in Table 1 and Table 2, may be designated "Special shackles to BS 3551", subject to the following conditions:

- The diameter of the material of the body shall be not less than $\frac{1}{4}$ inch, nor exceed 4 inches.
- The diameter of the pin shall be not less than $\frac{3}{8}$ inch, nor exceed $4\frac{1}{4}$ inches.
- The safe working load of the shackle shall not exceed the least value obtained from formulae (1), (2a) or (2b), given in Appendix B.
- When the shackle body is less than 1 inch in size, the diameter (D) of the pin, obtained from formula (1), shall be multiplied by the correction factor obtained from Figure 7.
- In no case shall the pin diameter (D), be less than the body diameter (d).
- In no case shall the measurement across the eye (e), be less than $2D$.

4 Material, heat treatment, hardness

a) *Quality of steel.* The bodies and pins of the shackles shall be manufactured from steel produced by the open hearth or electric process.

The steel shall be free from piping, harmful segregation and other defects.

Billets and bars for forging shall be rough machined, chipped, ground or otherwise prepared to remove surface defects which might produce defects in the forgings or drop forgings made therefrom.

b) *Chemical composition of steel.* The chemical composition shall conform to one of the following types:

Element	Steel A ^a		Steel B ^a		Steel C	
	min.	max.	min.	max.	min.	max.
	per cent	per cent	per cent	per cent	per cent	per cent
Carbon	0.30	0.40	0.35	0.45	0.18	0.23
Silicon	0.10	0.35	0.10	0.50	0.10	0.35
Manganese	1.30	1.80	1.20	1.50	0.70	1.00
Nickel	—	—	0.50	1.00	0.40	0.70
Chromium	—	—	0.30	0.60	0.40	0.70
Molybdenum	0.20	0.35	0.15	0.25	0.15	0.25
Sulphur	—	0.050	—	0.050	—	0.050
Phosphorus	—	0.050	—	0.050	—	0.050

Forelocks and nuts may be made of mild steel.

^a The steels Types A and B are respectively equivalent to those of En. 16 and En. 100 of BS 970^b.

^b BS 970, "Wrought steels. En series".

c) *Heat treatment of bodies and pins.* The bodies and pins shall, before proof loading, be heat treated as follows:

Steel A and B. Harden by quenching in oil from 830/860 °C, followed by tempering between 550 °C and 660 °C.

Steel C. Harden by quenching in oil or water from 850/890 °C, followed by tempering between 500 °C and 600 °C.

d) *Hardness of bodies and pins.* The bodies and pins of the shackles after heat treatment shall have a Brinell hardness number between 248 and 302.

Where practicable, the hardness testing shall be carried out in accordance with BS 240-1⁴⁾, using a 10 mm diameter ball, and a load of 3 000 kg.

The surface on which the impression is to be made shall be obtained by filing, grinding, or smooth machining.

Suitable precautions should be taken to ensure that the surface tested is representative of the material, and that its hardness is not affected by decarburization, carburization, or by the method used for its preparation.

If another method is employed, conversion shall be made in accordance with BS 860⁵⁾.

5 Size

The size of the shackle shall be the nominal diameter (*d*) of the material from which the shackle body is made (See Figure 1 and Figure 2).

6 Form and dimensions

The form and dimensions of the body and pin shall be in accordance with Figure 1 to Figure 6, and Table 1 and Table 2 (except for “Special shackles”, Clause 3).

7 Tolerances on dimensions

The dimensions of the bodies (with the exception of the pin diameters and pin holes), shall be not less than the nominal dimensions and shall not exceed them by more than 5 per cent.

The diameters of the pins are subject to the following tolerances:

up to and including 2 inch diameter pin	– 0.003 in to – 0.010 in;
over 2 inch diameter pin	– 0.005 in to – 0.020 in.

The diameters of the pin holes in the bodies of the shackles are subject to the following tolerances:

up to and including $\frac{3}{4}$ inch diameter hole	+ $\frac{1}{32}$ in – 0 in;
$\frac{7}{8}$ inch, up to and including $1\frac{3}{4}$ inch diameter hole	+ $\frac{3}{64}$ in – 0 in;
over $1\frac{3}{4}$ inch diameter hole	+ $\frac{1}{16}$ in – 0 in.

8 Workmanship

The pin shall be forged and machined, or machined from the bar. The screwed portion of the pin shall be concentric with the plain portion.

When pins of Types 1 and 2 are screwed home, not more than one half thread shall be visible between the jaws of the shackle.

The body shall be a solid forging without weld. Pin or bolt holes in the body shall be drilled from the solid, or hot-pierced to two thirds finished size, and drilled or bored in axial alignment at one setting central to the outside diameter of the eyes.

⁴⁾ BS 240, “Method for Brinell hardness test”, Part 1, “Testing of metals”.

⁵⁾ BS 860, “Tables of approximate comparison of hardness scales”.