BRITISH STANDARD

BS 3551:1962

Incorporating amendment issued August 1963 (PD 4964)

Specification for

Alloy steel shackles

[UDC 621.885.7:669.15]

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

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Association of Lifting Tackle Makers
British Constructional Steelwork Association
Chain & Anchor Manufacturers Association
Chain Testers Association of Great Britain
Dock & Harbour Authorities Association
Federation of Civil Engineering Contractors
Federation of Wire Rope Manufacturers of Great Britain
Honourable Company of Master Mariners
Institute of Welding
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Machine-made Chain Manufacturers' Association
Ministry of Aviation
National Association of Drop Forgers and Stampers
North East Coast Institution of Engineers and Shipbuilders
Shipbuilding Employers' Federation
Trinity House
Individual Manufacturers

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

The following BSI references relate to the work on this standard:
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Amendments issued since publication

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Contents

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 825[1)], and in BS 3032[2)].

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 3458[3)]. 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.

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.

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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:

a) The diameter of the material of the body shall be not less than ¼ inch, nor exceed 4 inches.

b) The diameter of the pin shall be not less than ⅜ inch, nor exceed 4¼ inches.

c) The safe working load of the shackle shall not exceed the least value obtained from formulae (1), (2*a*) or (2*b*), given in Appendix B.

d) 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.

e) In no case shall the pin diameter (*D*), be less than the body diameter (*d*).

f) In no case shall the measurement across the eye (*e*), be less than 2*D*.

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 240-1[4)], 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 860[5)].

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 $^{3}/_{4}$ inch diameter hole	+ $^{1}/_{32}$ in – 0 in;
$^{7}/_{8}$ inch, up to and including $1^{3}/_{4}$ inch diameter hole	+ $^{3}/_{64}$ in – 0 in;
over $1^{3}/_{4}$ inch diameter hole	+ $^{1}/_{16}$ 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*".

9 Bolts and nuts

The length of the plain portion of the bolt shall be such that the nut will jam on the inner end of the undercut (see Clause **11**), and not on the outside face of the shackle body. The bolt shall be cross-drilled for the split cotter pin, positioned outside the nut.

10 Finish

Alloy steel shackles shall normally be supplied in the self-colour condition. If a special corrosion resistant finish is required, phosphating to BS 3189[6], or zinc or cadmium electroplating according to BS 1706[7] may be applied.

11 Screw threads

The screw threads shall conform to BS 1580[8], or alternatively to BS 84[9].

Screw threads to BS 1580 shall be of Class 1A and Class 1B, and shall be either UNC, UNF, UNS or UN.

Screw threads to BS 84 shall be of the Free Class and Normal Class, and shall be either B.S.W., B.S.F., Whit. S, or Whit.

In the case of the bolt and nut pin, Type 3, the inner end of the thread shall terminate in an undercut and fillet in accordance with the appropriate recommendations in BS 1936[10], to conform to the standard undercut, Form A, Grade 1.

It is recommended that where applicable, the screw threads be gauged with an appropriate gauge constructed in conformity with the specifications in BS 919[11].

12 Proof loading

Each shackle, after manufacture and subsequent heat treatment, shall be subjected to a proof load at the centre of the pin equal to twice the safe working load (see Table 1 and Table 2 and Clause **3**), which it shall withstand without showing permanent set.

After the removal of the proof load, each shackle shall be thoroughly examined by a competent person, and complies only if found free from visible flaw or defect.

13 Marking

The body of each shackle and the head of each pin shall be legibly marked with the quality mark "06". The mark shall be enclosed in a circle.

Each shackle body shall be permanently and legibly marked with the safe working load given in Table 1 or Table 2 (see also Clause **3**).

The body shall also be permanently and legibly marked with such marks and symbols as will allow identification with the certificate of test and examination.

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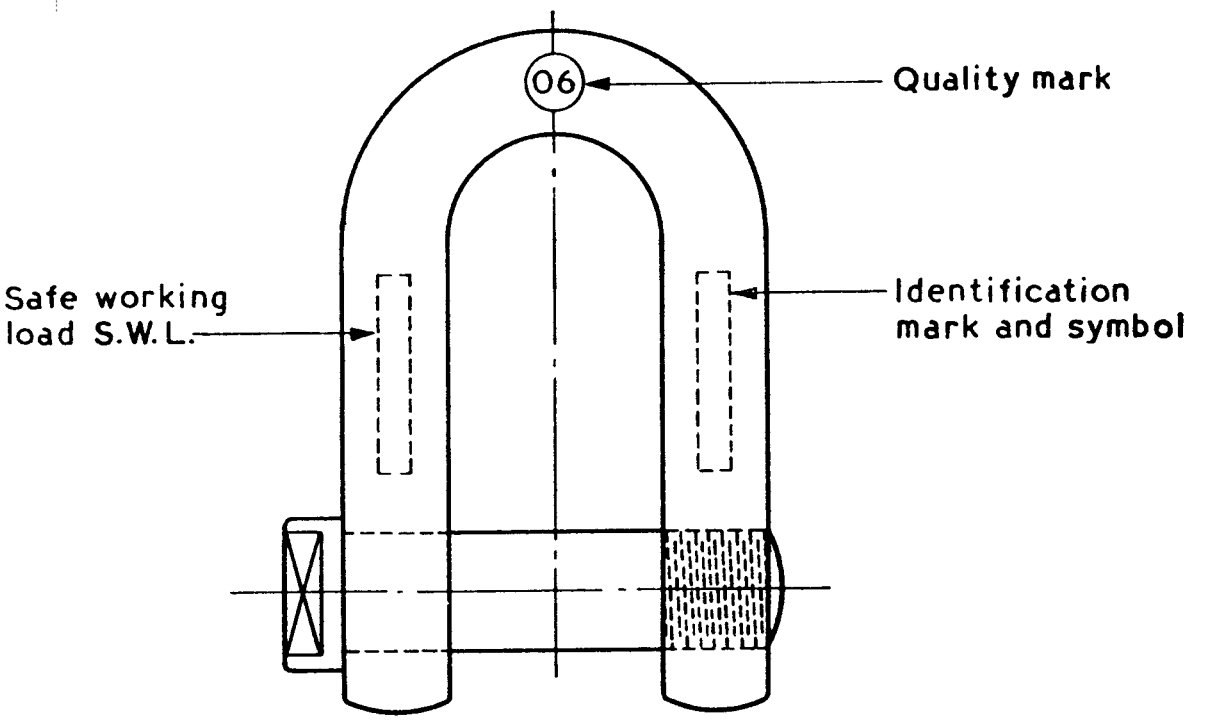
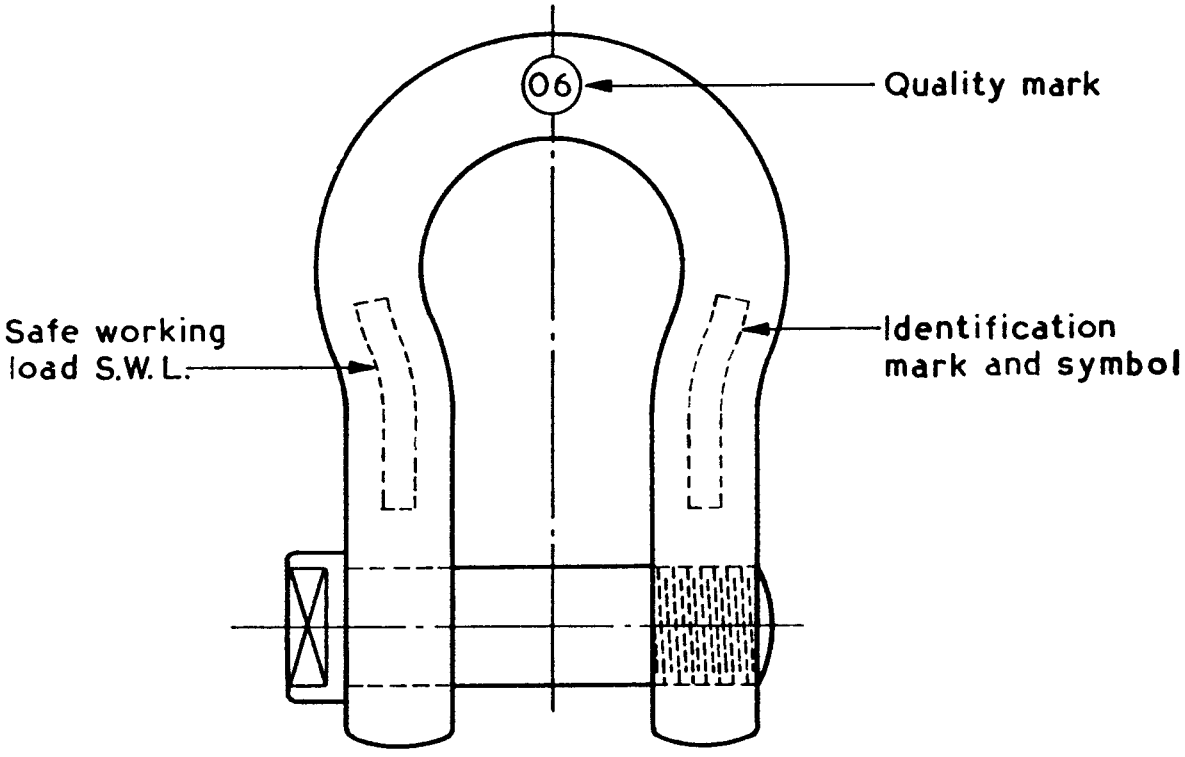
[6] BS 3189, "*Phosphate treatment of iron and steel for protection against corrosion*".
[7] BS 1706, "*Electroplated coatings of cadmium and zinc on iron and steel*".
[8] BS 1580, "*Unified screw threads (with metric equivalents)*".
[9] BS 84, "*Parallel screw threads of Whitworth form*".
[10] BS 1936, "*Undercuts and runouts for screw threads*".
[11] BS 919, "*Screw gauge limits and tolerances*".



Recommended position for marking dee shackles



Recommended position for marking bow shackles

Marking of shackles (Clause 13)

Care shall be taken that the stamps have a concave surface and that the indentations are neither too sharp nor excessive in depth.

Identification mark on the pin is not required: but the pin may be marked provided that the quality mark is not obscured.

Recommended sizes of marks are as follows:

Diameter of material in shackle body	Size of mark
in	in
Up to and including $^1/_2$	$^1/_8$
Over $^1/_2$, up to and including 1	$^3/_{16}$
Over 1	$^1/_4$

14 Certificate

The manufacturer or supplier shall provide a certificate with each consignment of shackles, giving the following information for each one:

type of material and details of heat treatment;

distinguishing mark (to enable the particular shackle to be identified);

proof load applied (Clause **12**);

safe working load (Table 1 or Table 2, or Clause **3**).

The certificate shall declare that each shackle was proof loaded in accordance with Clause **12**, and was subsequently examined by a competent person, and that it complies with BS 3551. It shall also state the name and address of the testing establishment, and the status of the signatory.

The certificate may be the appropriate Statutory Form, provided that the required information is given.

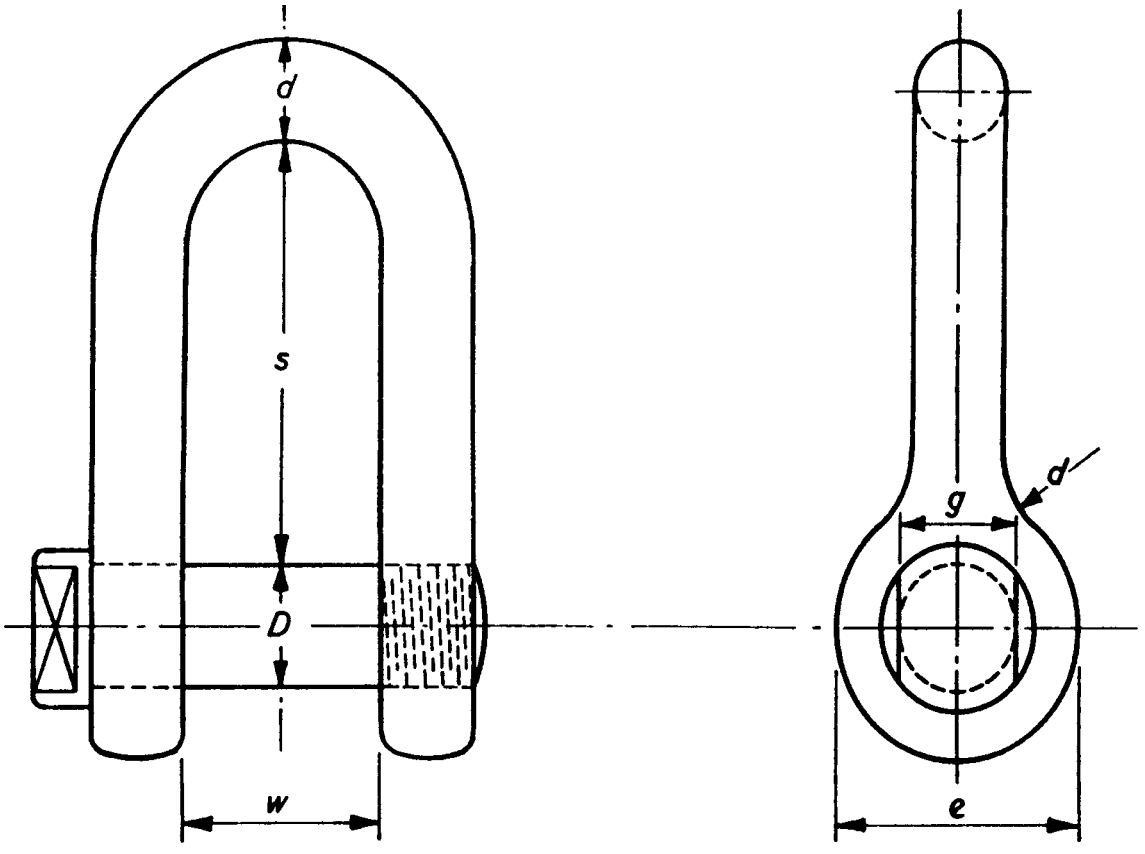


Figure 1 — Dee shackle with screwed pin, Type 2, Figure 4
(For alternative pins, see Figure 3, Figure 5 and Figure 6)

Table 1 — Dee Shackles

W		*d*	*D*	*w*	*s*	*e*	*g*
***W* = safe working load**		***d* = 0·40 √*W***	***D* = 0·45 √*W***	***w* = 0·78 √*W***	***s* = 1·48 √*W***	***e* = 0·90 √*W***	**To suit Unified spanner**
ton	cwt	in	in	in	in	in	in
1	2	½	⅝	1⅛	2⅛	1¼	½
2	5	⅝	¾	1¼	2½	1½	½
3	0	¾	⅞	1½	2⅞	1¾	⅝
4	10	⅞	1	1¾	3¼	2	¾
5	12	1	1⅛	2	3¾	2¼	¾
7	10	1⅛	1¼	2⅛	4⅛	2½	⅞
9	0	1¼	1⅜	2⅜	4½	2¾	1
10	10	1⅜	1½	2⅝	5	3	1
14	5	1½	1¾	2¾	5⅜	3½	1¼
16	15	1⅝	1⅞	3	5¾	3¾	1¼
19	10	1¾	2	3¼	6⅛	4	1¼
21	5	1⅞	2⅛	3⅝	7	4¼	1½
24	5	2	2¼	3⅞	7⅜	4½	1½
27	0	2⅛	2⅜	4⅛	7¾	4¾	1¾
30	0	2¼	2½	4¼	8¼	5	1¾
35	0	2⅜	2¾	4½	8¾	5½	2
40	0	2⅝	3	5	9¾	6	2
50	0	2⅞	3¼	5½	10⅝	6½	2¼
65	0	3¼	3¾	6¼	12	7½	2½
80	0	3⅝	4¼	7	13⅜	8½	3

NOTE Proof load = 2 × safe working load.

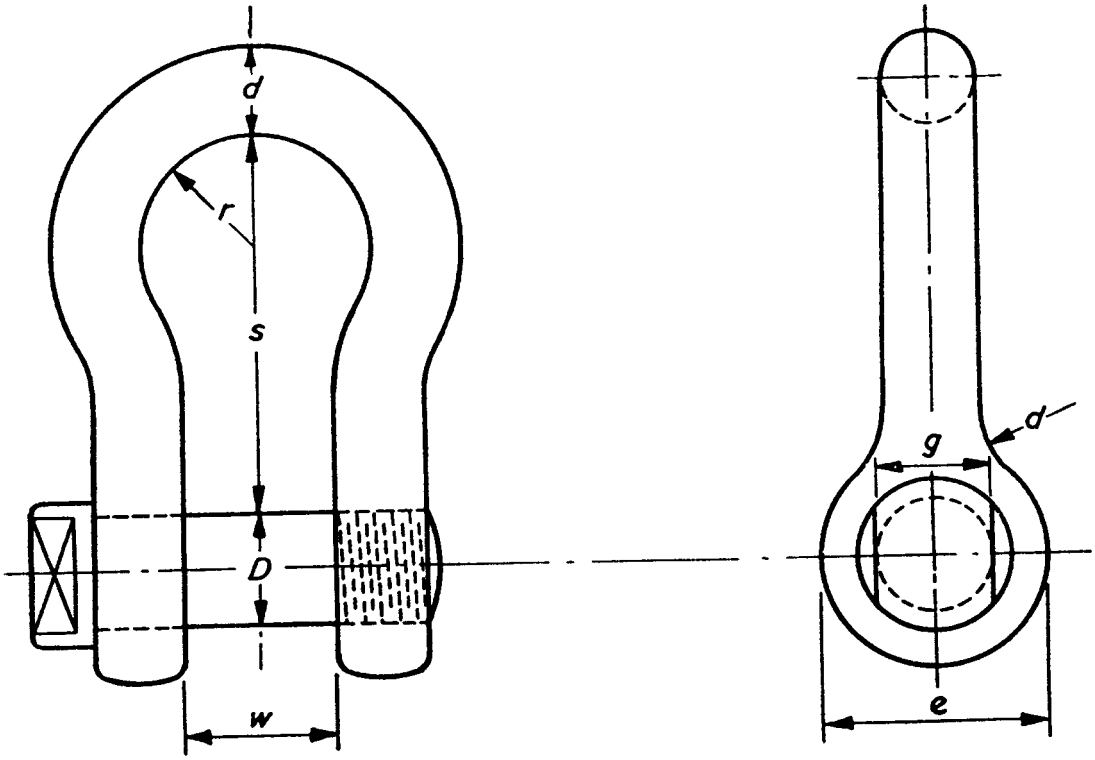


Figure 2 — Bow shackle with screwed pin, Type 2, Figure 4
(For alternative pins, see Figure 3, Figure 5 and Figure 6)

Table 2 — Bow Shackles

W		*d*	*D*	*w*	**2***r*	*s*	*e*	*g*
***W* = safe working load**		***d* = 0·43 √*W***	***D* = 0·46 √*W***	***w* = 0·78 √*W***	**2*r* = 1·14 √*W***	***s* = 1·91 √*W***	***e* = 0·91 √*W***	**To suit Unified spanner**
ton	cwt	in	in	in	in	in	in	in
1	2	½	⅝	⅞	1¼	2⅛	1¼	½
1	17	⅝	¾	1⅛	1⅝	2¾	1½	½
3	0	¾	⅞	1⅜	2	3⅜	1¾	⅝
4	2	⅞	1	1⅝	2¼	3⅞	2	¾
5	10	1	1⅛	1¾	2½	4¼	2¼	¾
7	0	1⅛	1¼	2	2⅞	4⅞	2½	⅞
8	10	1¼	1⅜	2¼	3¼	5⅜	2¾	1
10	15	1⅜	1½	2½	3½	6	3	1
12	15	1½	1¾	2¾	3⅞	6⅝	3½	1¼
14	5	1⅝	1⅞	3	4⅜	7⅜	3¾	1¼
17	5	1¾	2	3⅜	4¾	8⅛	4	1¼
19	10	1⅞	2⅛	3⅝	5⅛	8¾	4¼	1½
22	10	2	2¼	3¾	5½	9⅜	4½	1½
25	0	2⅛	2⅜	3⅞	5⅝	9½	4¾	1¾
30	0	2⅜	2⅝	4⅜	6⅜	10¾	5¼	1¾
35	0	2⅝	2⅞	4¾	7	11⅞	5¾	2
40	0	2¾	3	5	7⅜	12⅜	6	2
50	0	3	3¼	5½	8	13½	6½	2¼
65	0	3½	3¾	6⅜	9⅜	15¾	7½	2½
80	0	3⅞	4¼	7	10⅜	17½	8½	3

NOTE Proof load = 2 × safe working load.

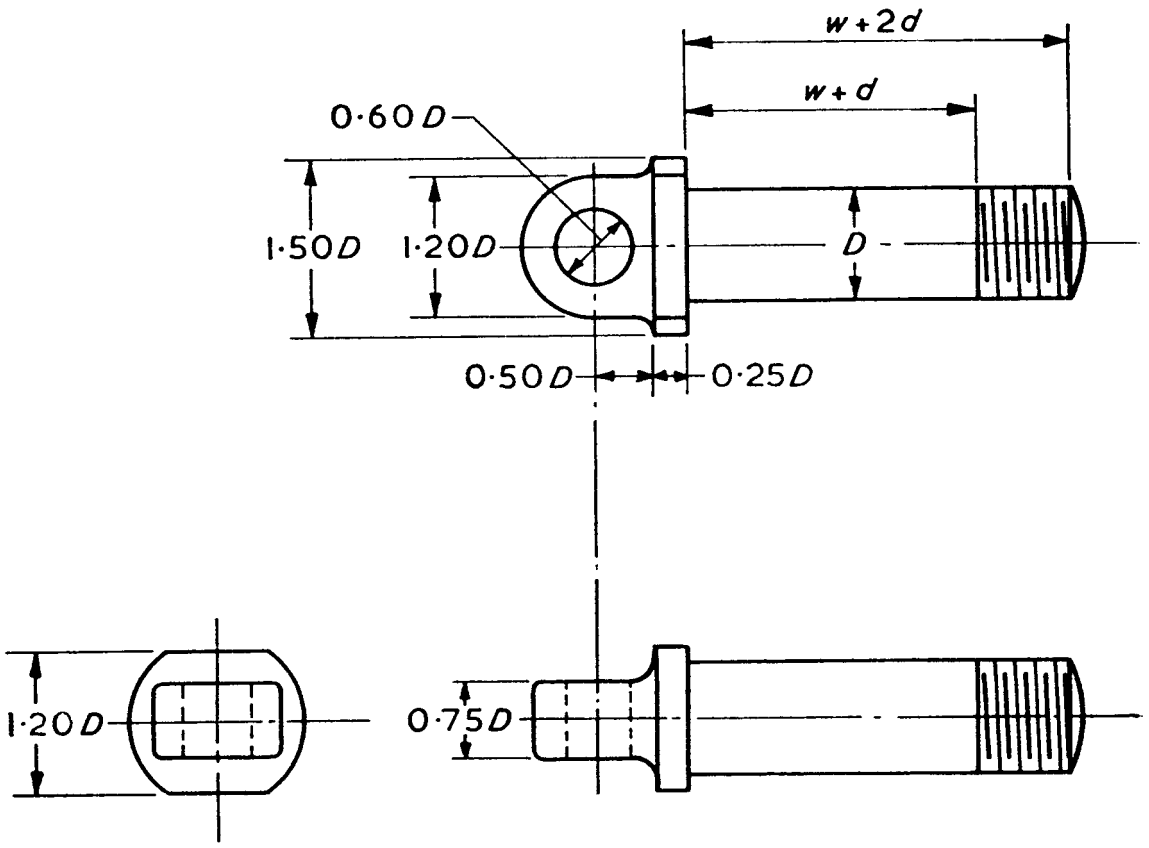


Figure 3 — Type 1. Screwed pin with eye and collar

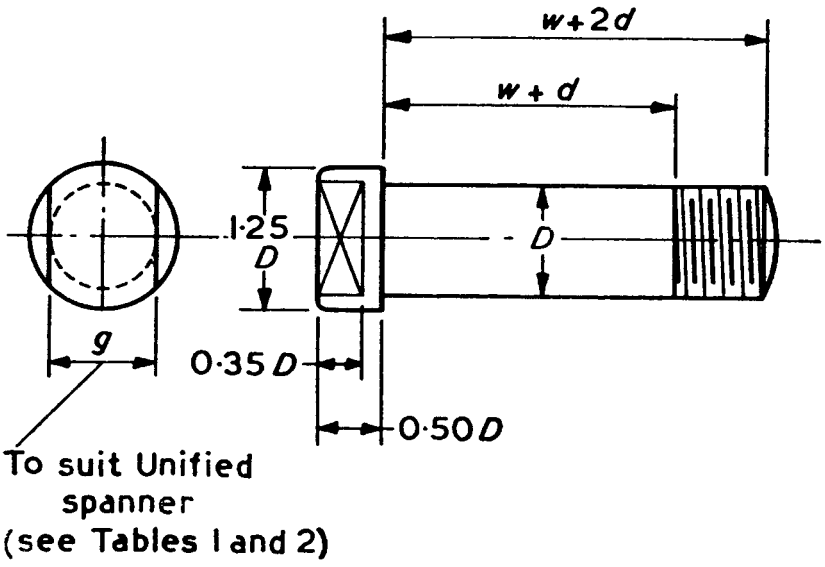


Figure 4 — Type 2. Screwed pin with circular head

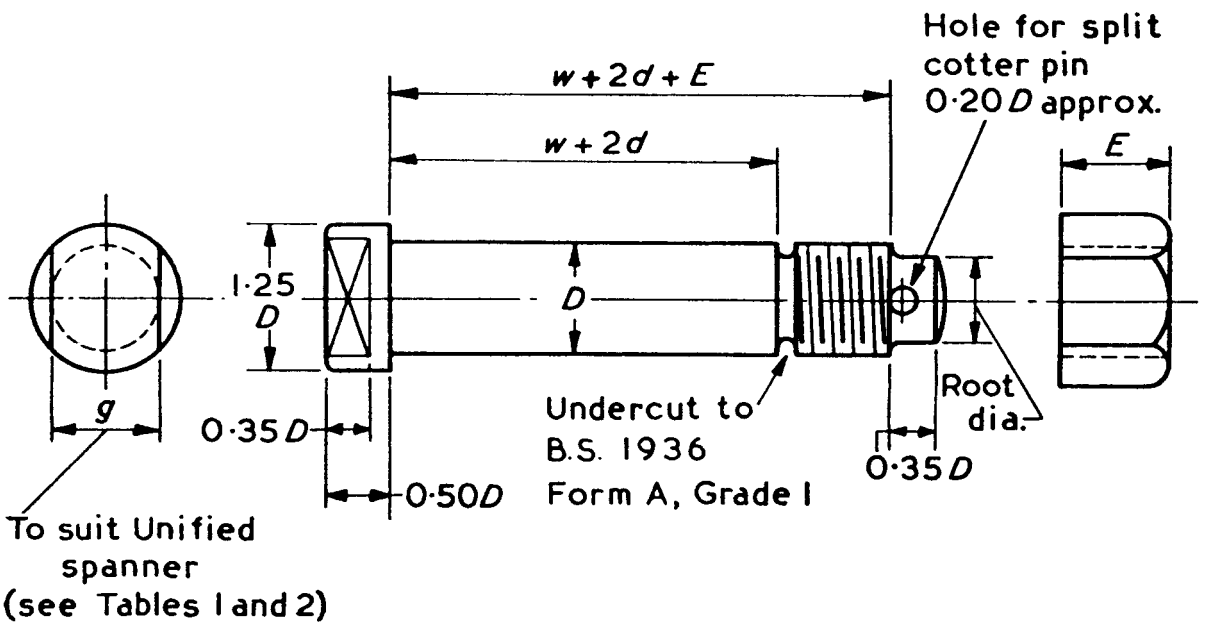


Figure 5 — Type 3. Bolt with circular head, hexagon nut and split cotter pin

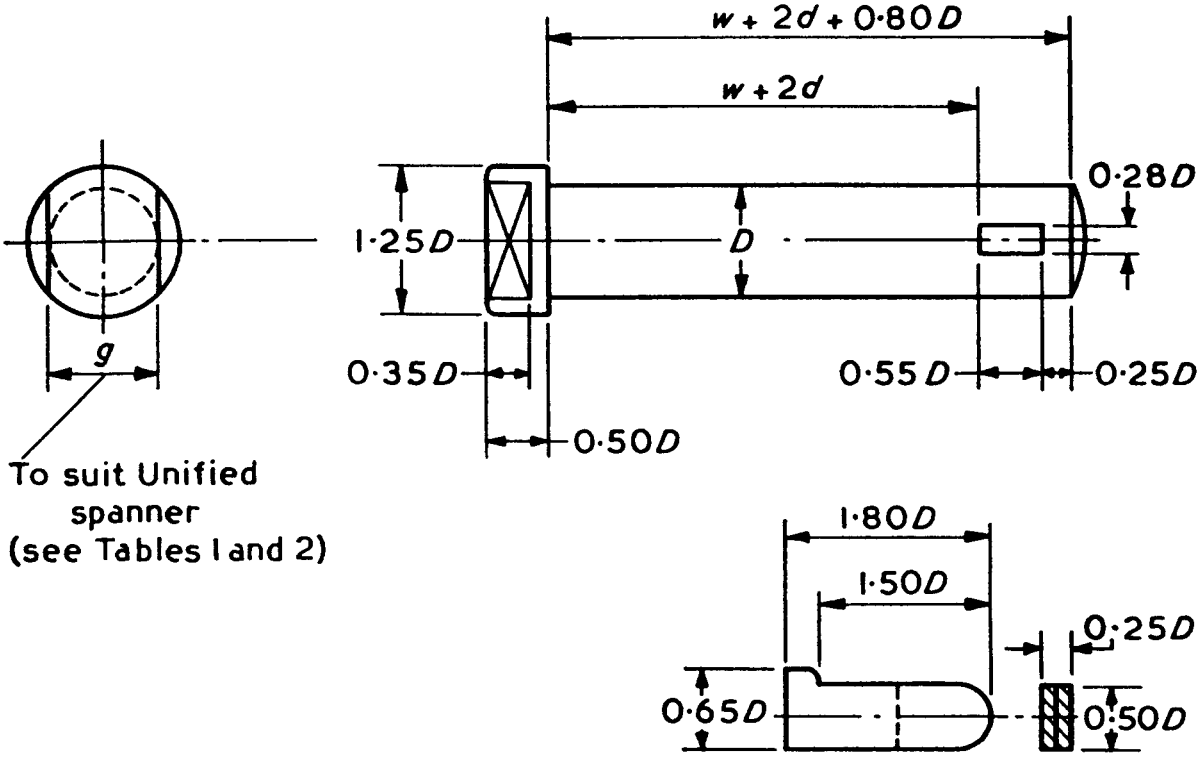


Figure 6 — Type 4. Plain cylindrical pin with circular head and forelock

Appendix A Information to be provided with enquiry and order

The enquiry and order should state:

type of shackle (see Table 1 and Table 2);

type of pin (see Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6);

safe working load;

form of screw thread (see Clause **11**);

further tests or chemical analysis required (see Appendix C).

Appendix B Notes on design

Special shackles whose dimensions differ from those listed in Table 1 and Table 2, may be designed from the following formulae, where W is the safe working load in tons, and the dimensions are in inches.

The pin and the body are treated separately, and the lower of the two values derived from formula (2*a*) or (2*b*) is taken as the safe working load for substitution in formula (1) when estimating the diameter (D) of the pin.

It is to be noted that these formulae are applicable to shackles having proportions within the stated limits of the formulae, and of sizes within the range specified in Clause **2**.

Unless otherwise stated, symbols in the formulae are those used on the figures.

FORMULA FOR THE PINS OF SHACKLES

$$W = \frac{0.393\, f\, D^3}{w + d} \qquad (1)$$

where:

f = nominal extreme fibre stress at safe working load, tonf/in^2,

= 32 tonf/in^2.

FORMULAE FOR THE BODIES OF SHACKLES

Side of body (intrados fibres)

$$W = \left(\frac{0.372\, f\, d^3}{2r - w + 1.2d}\right)\left(\frac{2r}{2r + 0.5d}\right) \qquad (2a)$$

Crown of body (extrados fibres)

$$W = \left(\frac{0.400\, f\, d^3}{w + d}\right)\left(\frac{2r + d}{2r + 0.4d}\right) \qquad (2b)$$

In the case of the bodies of dee shackles, $2r = w$. When w lies between d and 1 36d, formula (2*a*) is applicable, and reduces to:

$$W = \frac{0.310\, f\, d^2 w}{w + 0.5d}$$

When w is greater than 1.36d, formula (2*b*) is applicable, and reduces to:

$$W = \frac{0.400\, f\, d^3}{w + 0.4d}$$

where:

f = nominal extreme fibre (tensile) stress at safe working load, tonf/in^2;

= 36 tonf/in^2.

These formulae, originated by the National Physical Laboratory, are based on two possible conditions of loading:

a) load at centre of pin, reactions taken at inside edges of holes;

b) load at centre of pin, reactions taken at centre of length of holes (probable condition when the shackle has become worn).

In the case of the pin, condition *b* is the more severe; in the case of the body, either of the conditions *a* or *b* may be the more severe, according to the proportions of the shackle.

For this reason, two formulae (2*a*) and (2*b*) are given for the safe working load of the body. These represent, with $2r/d$ greater than unity, very close approximations (within about 2 per cent), to the more complicated expressions derived from the theory of curved beams.

Formula (1) for the safe working load of the pin is applicable without limit to the value of w/d.

In designing shackles below 1 inch size (see Clause **5**), the diameter (*D*) of the pin, obtained from formula (1) should for practical reasons, be multiplied by the correction factor obtained from the appropriate curve in Figure 7, corresponding to the value of $2r/d$ (= w/d in the case of dee shackles).

In no case should the pin diameter (*D*), be less than the body diameter (*d*) nor the measurement across the eye (*e*) be less than $2D$.

The formulae give dimensions of shackles suitable for normal conditions of service; for hazardous conditions, shackles should be designed to a lower design stress, *f*.

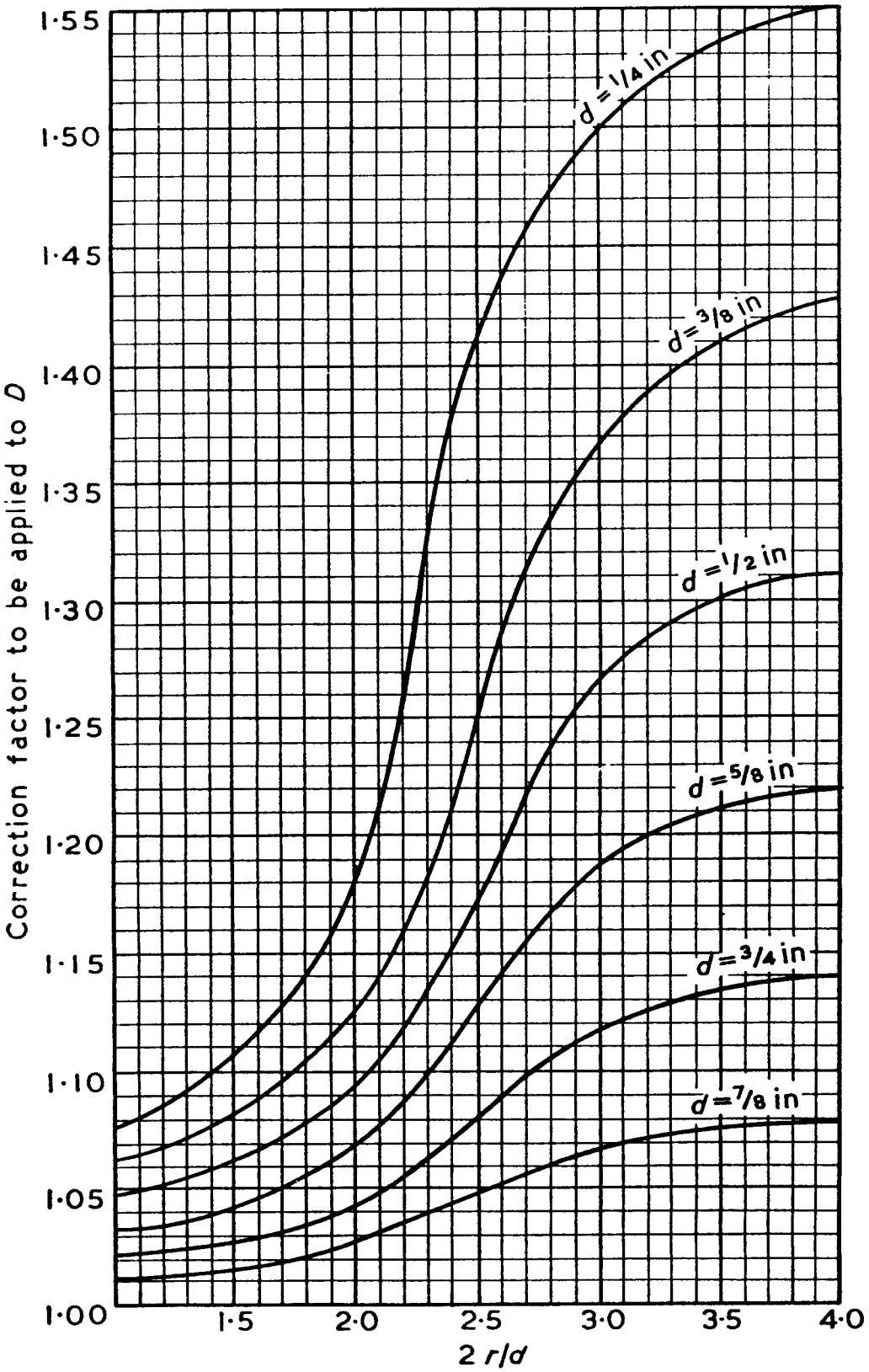


Figure 7 — Correction factor for pin diameters of shackles less than 1 inch nominal size

The proportions of the shackles of Table 1 and Table 2 in terms of the square root of the safe working load, W, in tons, are given in Table A, the dimensions being in inches.

Table A — Proportions of shackles in terms of $\sqrt{W}$, Square root of safe working load in tons

Particulars of dimensions		Type of shackle	
		Dee Table 1	Bow Table 2
Diameter of pin	D	0.45	0.46
Diameter of material in body	d	0.40	0.43
Inside width of jaw	w	0.78	0.78
Inside width of body	$2r$	0.78	1.14
Inside length	s	1.48	1.91
Measurement across eye	e	0.90	0.91

The proportions of the shackles in terms of d, the diameter of the material in the body, are given in Table B.

Table B — Proportions of shackles in terms of body diameter d

Particulars of dimensions		Type of shackle	
		Dee Table 1	Bow Table 2
Diameter of pin	D	1.13	1.08
Inside width of jaw	w	1.93	1.83
Inside width of body	$2r$	1.93	2.67
Inside length	s	3.68	4.50
Measurement across eye[a]	e	2.26	2.16

[a] Limited to a minimum of $2D$.

The proportions in Table A are also given in Table 1 and Table 2 at the head of each column. The actual dimensions in Table 1 and Table 2 are to the nearest one-eighth of an inch, except in some of the smaller sizes (see Figure 7), where practical considerations (e.g. imperfections, corrosion and abuse) necessitate a greater departure.

All the rated safe working loads are based upon the specified dimensions, subject to rounding off where desirable.

Shackles of the proportions given in Table A and Table B will have safe working loads as given in Table C, in which dimensions d and D are in inches and the safe working loads are in tons. (Table D does not take into account the increases in the sizes of the smaller pins called for in Figure 7.)

Table C — Safe working loads (w) in tons of the shackles in terms of body diameter (d), and pin diameter (D)

Dee (Table 1)	Bow (Table 2)
ton	ton
$6.18\ d^2$ $4.85\ D^2$	$5.53\ d^2$ $4.78\ D^2$

The approximate weights of shackles are given in Table D. The coefficients are based on the proportions given in Table A and Table B, and the rounding off from these proportions to approximate fractions of an inch, together with the allowable manufacturing tolerances, will tend to increase the weight of the shackle. These estimated weights should therefore be treated as minimum values.

Table D — Approximate weights of shackles

Type of pin	Type of shackle	
	Dee Table 1	Bow Table 2
	lb	lb
Type 1. Screwed pin with eye and collar	5.1 d^3	5.3 d^3
Type 2. Screwed pin with circular head	5.1 d^3	5.3 d^3
Type 3. Bolt with circular head, hexagon nut and split cotter pin	5.8 d^3	6.0 d^3
Type 4. Plain cylindrical pin, with circular head and forelock	5.2 d^3	5.4 d^3

Appendix C Recommendations relating to contracts

It is recommended that a contract for a supply of shackles to this standard should include requirements on the following lines.

Testing facilities. The manufacturer should provide all labour and appliances required for tests in accordance with this standard. In the absence of facilities at his own works for proof loading (Clause **12**), the manufacturer should bear the cost of proof loading by a recognized testing authority.

Additional tests. If the purchaser requires tests or chemical analysis of the material, or additional tests on the finished shackles, these requirements should be clearly stated in the enquiry and order, and if so desired, the samples should be selected by a person representing or approved by the purchaser.

Inspection. The representative of the purchaser should have access to the works of the manufacturer at any reasonable time. He should be at liberty to inspect the shackles at any stage of manufacture. He should also be at liberty to inspect the testing machine and methods of examination.

Appendix D metric equivalents

$^1/_{16}$ in = 1.6 mm $^1/_8$ in = 3.2 mm

$^1/_4$ in = 6.3 mm $^1/_2$ in = 12.7 mm

1 in = 25·4 mm
1 ton = 1 016 kg = 1.016 tonne
1 tonf/in^2 = 1.6 kgf/mm^2

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