INTERNATIONAL STANDARD

ISO 2415

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Forged shackles for general lifting purposes — Dee shackles and bow shackles

Manilles forgées pour levage — Manilles droites et manilles lyres

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2415 was prepared by Technical Committee ISO/TC 111, *Round steel link chains, chain slings, components and accessories*, Subcommittee SC 3, *Components and accessories*.

This third edition cancels and replaces the second edition (ISO 2415:1987), which has been technically revised.

Forged shackles for general lifting purposes — Dee shackles and bow shackles

1 Scope

This International Standard specifies the general characteristics of forged dee and bow shackles in a range of sizes having working load limits of from 0,32 t to 100 t and in Grades 4, 6 and 8, and presents their performance and critical dimensions necessary for their interchangeability and compatibility with other components.

In the case of dee shackles for use with forged steel lifting hooks in conformance with ISO 4779 and ISO 7597, an intermediate component could be necessary for making the connection.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 261, ISO *general purpose metric screw threads — General plan*

ISO 263, *ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0,06 to 6 in*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 4779, *Forged steel lifting hooks with point and eye for use with steel chains of grade M(4)*

ISO 4948-1, *Steel — Classification — Part 1: Classification of steels into unalloyed and alloy steel based on chemical composition*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 7597, *Forged steel lifting hooks with point and eye for use with steel chains of grade T(8)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
shackle
component consisting of two readily separable parts, the body and the pin

3.2
body
one of the two parts of the shackle, consisting of a bar of suitable section formed or forged to the appropriate shape and terminating in coaxial eyes

3.3
crown
that part of the shackle body opposite the pin

3.4
eye
boss on the end of the body with coaxial hole through which the pin passes

3.5
pin
straight bar of circular section which passes through the eyes, arranged so as to be secure when in position and which can be readily disassembled

3.6
dee shackle
a shackle the crown of which forms a semicircle or internal radius half the width, between the eyes

See Figure 1.

3.7
bow shackle
shackle, the crown of which forms more than a semicircle of internal radius more than half the width, between the eyes

See Figure 2.

3.8
ultimate strength
F_u
maximum force reached during the static tensile testing of a shackle at the end of which the shackle fails to retain the load

3.9
proof force
F_e
force applied as a test to a finished shackle in accordance with Clause 13

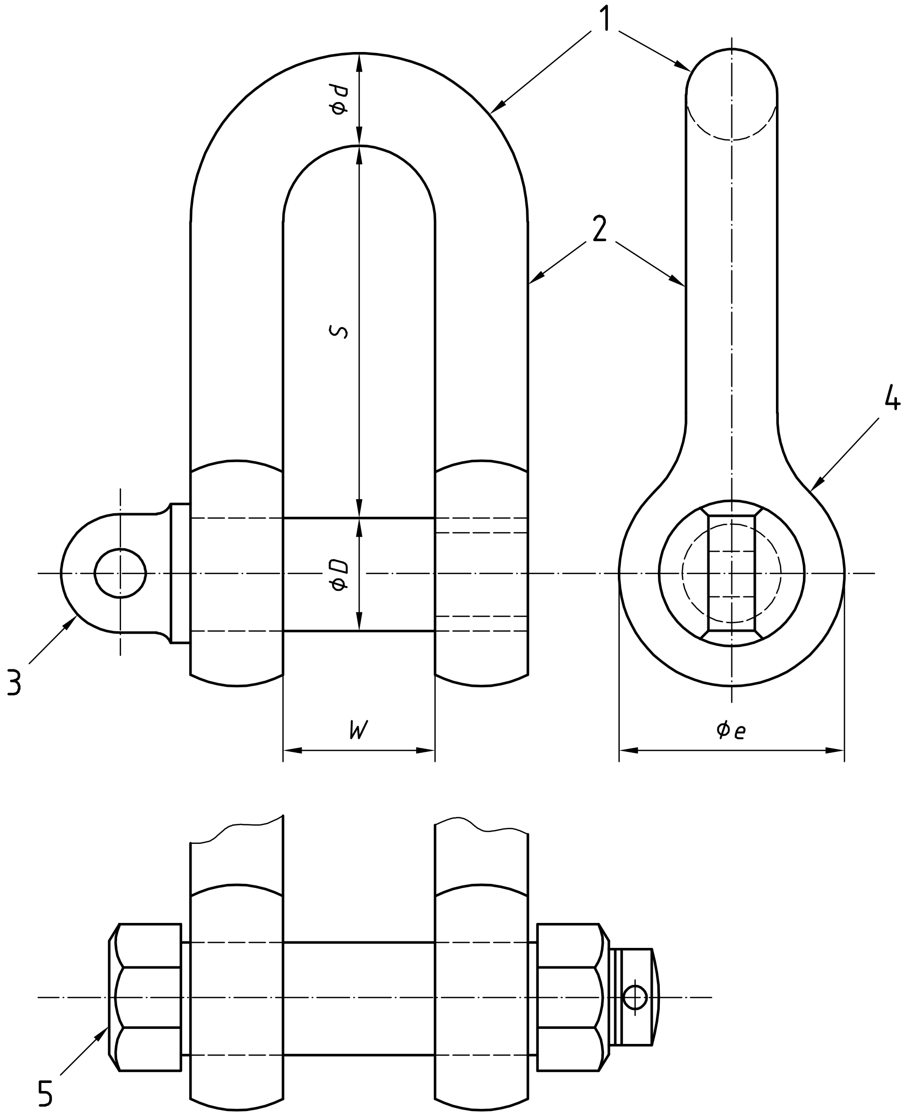
3.10
working load limit
WLL
maximum mass a shackle is designed to sustain in general service

3.11
working load
WL
maximum mass a shackle may sustain in a particular stated service

4 Form and dimensions

4.1 Dee shackles

The dimensions of dee shackles shall be in accordance with Figure 1 and Table 1.



Key

1 crown

2 body

3 screwed pin with eye and collar — Type W (example)

4 eye

5 bolt-type pin with hexagon head, hexagon nut and split cotter pin — Type X

NOTE This diagram is intended only to show where dimensions are measured. It does not purport to indicate any detailed design of any part of the shackle.

Figure 1 — Dimensions of dee shackles

Table 1 — Dimensions of dee shackles

Working load limit WLL			d [a]	D [b]	e [c]	S [d]	W [b]
Grade 4	Grade 6	Grade 8	max.	max.	max.	min.	min.
t			mm	mm	mm	mm	mm
0,32	0,50	0,63	8	9	19,8	18	9
0,40	0,63	0,8	9	10	22	20	10
0,50	0,8	1	10	11,2	24,64	22,4	11,2
0,63	1	1,25	11,2	12,5	27,5	25	12,5
0,8	1,25	1,6	12,5	14	30,8	28	14
1	1,6	2	14	16	35,2	31,5	16
1,25	2	2,5	16	18	39,6	35,5	18
1,6	2,5	3,2	18	20	44	40	20
2	3,2	4	20	22,4	49,28	45	22,4
2,5	4	5	22,4	25	55	50	25
3,2	5	6,3	25	28	61,8	56	28
4	6,3	8	28	31,5	69,3	63	31,5
5	8	10	31,5	35,5	78,1	71	35,5
6,3	10	12,5	35,5	40	88	80	40
8	12,5	16	40	45	99	90	45
10	16	20	45	50	110	100	50
12,5	20	25	50	56	123,2	112	56
16	25	32	56	63	138,6	125	63
20	32	40	63	71	156,2	140	71
25	40	50	71	80	178	160	80
32	50	63	80	90	198	180	90
40	63	80	90	100	220	200	100
50	80	100	100	112	246,4	224	112
63	100	—	112	125	275	250	125
80	—	—	125	140	308	280	140
100	—	—	140	160	352	315	160

[a] The formula used to calculate this dimension is given in A.1.1.

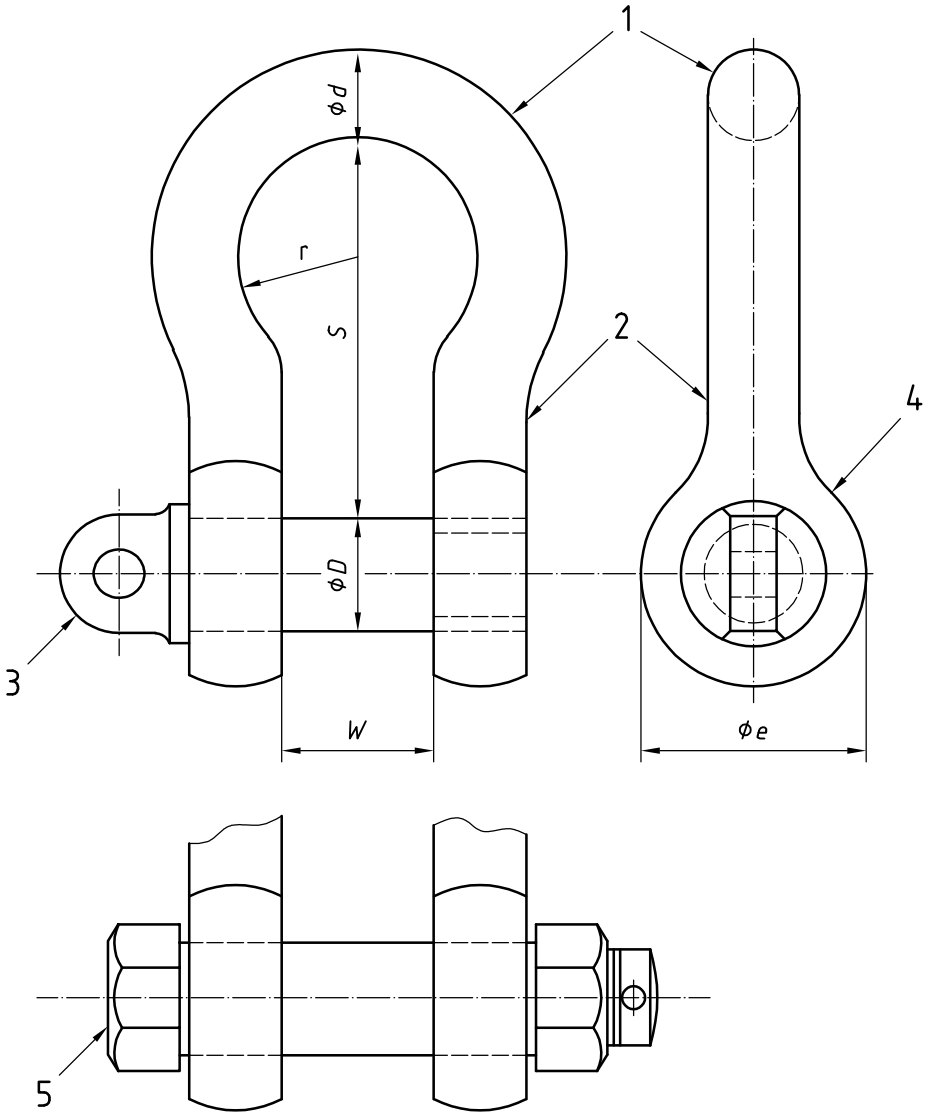
[b] The formula used to calculate this dimension is given in A.1.2.

[c] The formula used to calculate this dimension is given in A.1.4.

[d] The formula used to calculate this dimension is given in A.1.3.

4.2 Bow shackles

The dimensions of bow shackles shall be in accordance with Figure 2 and Table 2.



Key

1 crown
2 body
3 screwed pin with eye and collar — Type W (example)
4 eye
5 bolt-type pin with hexagon head, hexagon nut and split cotter pin — Type X

NOTE This diagram is intended only to show where dimensions are measured. It does not purport to indicate any detailed design of any part of the shackle.

Figure 2 — Dimensions of bow shackles

Table 2 — Dimensions of bow shackles

Working load limit WLL			d [a]	D [b]	e [c]	$2r$ [d]	S [e]	W [b]
Grade 4	Grade 6	Grade 8	max.	max.	max.	min.	min.	min.
t			mm	mm	mm	mm	mm	mm
0,32	0,50	0,63	9	10	22	16	22,4	10
0,40	0,63	0,8	10	11,2	24,64	18	25	11,2
0,50	0,8	1	11,2	12,5	27,5	20	28	12,5
0,63	1	1,25	12,5	14	30,8	22,4	31,5	14
0,8	1,25	1,6	14	16	35,2	25	35,5	16
1	1,6	2	16	18	39,6	28	40	18
1,25	2	2,5	18	20	44	31,5	45	20
1,6	2,5	3,2	20	22,4	49,28	35,5	50	22,4
2	3,2	4	22,4	25	55	40	56	25
2,5	4	5	25	28	61,8	45	63	28
3,2	5	6,3	28	31,5	69,3	50	71	31,5
4	6,3	8	31,5	35,5	78,1	56	80	35,5
5	8	10	35,5	40	88	63	90	40
6,3	10	12,5	40	45	99	71	100	45
8	12,5	16	45	50	110	80	112	50
10	16	20	50	56	123,2	90	125	56
12,5	20	25	56	63	138,6	100	140	63
16	25	32	63	71	156,2	112	160	71
20	32	40	71	80	176	125	180	80
25	40	50	80	90	198	140	200	90
32	50	63	90	100	220	160	224	100
40	63	—	100	112	246,4	180	250	112
50	80	—	112	125	275	200	280	125
63	100	—	125	140	308	224	315	140
80	—	—	140	160	352	224	355	160
100	—	—	160	180	396	280	400	180

[a] The formula used to calculate this dimension is given in A.2.1.

[b] The formula used to calculate this dimension is given in A.2.2.

[c] The formula used to calculate this dimension is given in A.2.5.

[d] The formula used to calculate this dimension is given in A.2.3.

[e] The formula used to calculate this dimension is given in A.2.4.

4.3 Hole diameter

The diameter of the unthreaded hole or holes in the body of the shackle shall not exceed the following values:

a) hole diameter for pins having an actual pin diameter $D \leqslant 20$ mm: $D + 1$ mm;

b) hole diameter for pins having a diameter $D > 20$ mm and $\leqslant 45$ mm: $D + 1{,}5$ mm;

c) hole diameter for pins having a diameter $D > 45$ mm: $D + 2$ mm.

4.4 Types of shackle pin

The threaded shackle pins shown in Figure 3 illustrate only typical examples of pins; other suitable forms of pin are acceptable.

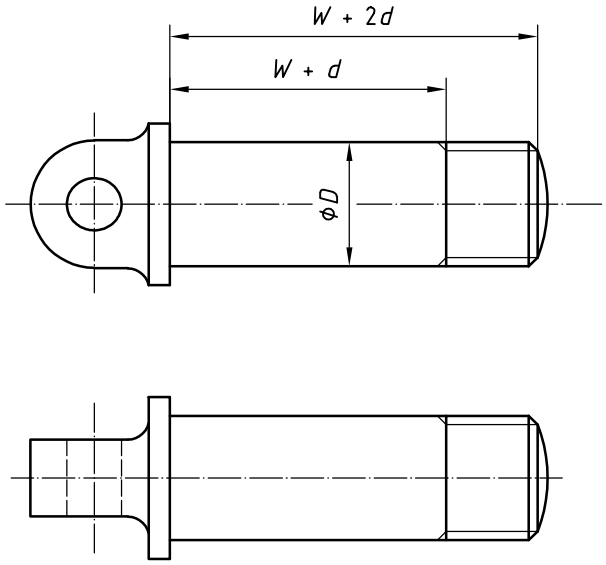
The pins illustrated are of the following types:

— Type W: screwed with eye and collar;

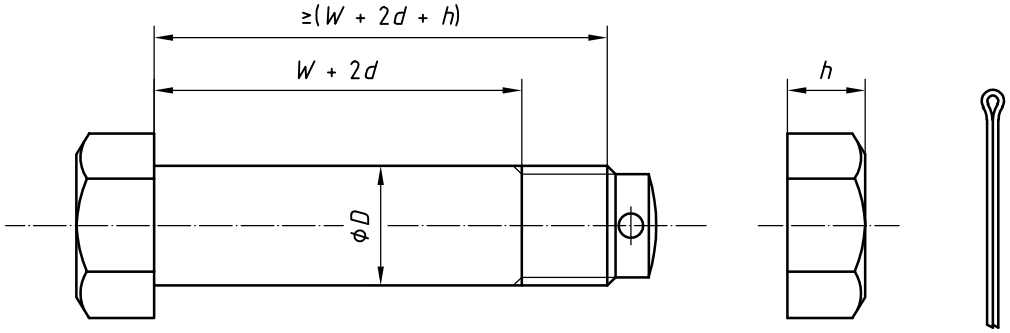
— Type X: bolt with hexagon head, hexagon nut and split cotter pin;

— Type Y: countersunk and slotted head.

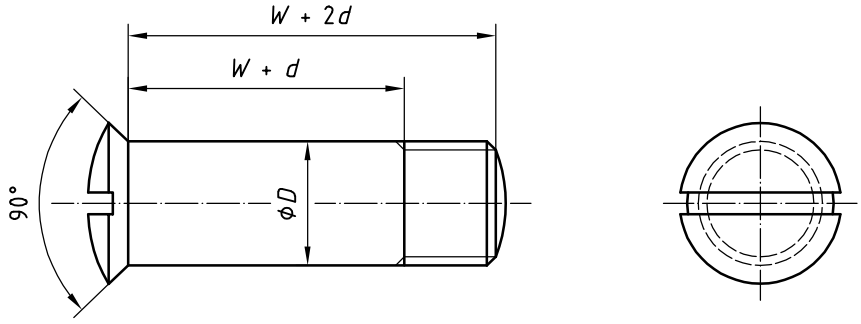
For the purpose of the designation system (see Annex B), all other types of pin are designated as being of Type Z.



a) Type W: screwed with eye and collar



b) Type X: bolt with hexagon head, hexagon nut and split cotter pin



c) Type Y: countersunk and slotted head

Figure 3 — Typical examples of shackle pin types

5 Mechanical properties

5.1 General

The mechanical properties of the shackles in terms of proof force and ultimate strength shall be as specified in Table 3.

Table 3 — Mechanical properties

Working load limit WLL	Proof force F_e	Minimum ultimate strength F_u
t	kN	kN
0,32	6,4	12,5
0,4	8	16
0,5	10	20
0,63	12,5	25
0,8	16	32
1	20	40
1,25	25	50
1,6	32	63
2	40	80
2,5	50	100
3,2	63	125
4	80	160
5	100	200
6,3	125	250
8	160	320
10	200	400
12,5	250	500
16	320	630
20	400	800
25	500	1 000
32	630	1 250
40	800	1 600
50	1 000	2 000
63	1 259	2 500
80	1 600	3 200
100	2 000	4 000

5.2 Deformation resistance test

Three samples shall be tested and each shall be capable of sustaining the manufacturing proof force to 2,0 × WLL without permanent deformation, i.e. no dimension shall alter by more than 1 % of the initial dimension after the proof force has been applied. After removal of the test force, the pin, when loosened, shall turn freely.

5.3 Ultimate strength

Each shackle, when tested in accordance with 11.3, shall have an ultimate strength at least equal to that specified in Table 3.

On completion of the test, each shackle shall show evidence of deformation.

5.4 Fatigue resistance — Grades 6 and 8

Each shackle with a working load limit up to and including 32 t, when tested in accordance with 11.4, shall, after at least 20 000 cycles, be capable of retaining the load.

6 Material

6.1 Grade 4

6.1.1 General

The steel shall be produced by an electric, or by an oxygen-blown, process.

In its finished state, as supplied to the shackle manufacturer, the steel shall comply with the requirements specified in 6.1.2, as determined by a cast or check analysis on the bar or on the finished shackle.

The manufacturer should supply a cast analysis of the steel if required by the purchaser.

6.1.2 Specific requirements

The steel shall be fully killed, shall be suitable for forging and shall be capable of being heat treated to obtain the mechanical properties required by this International Standard. Its content of sulfur and phosphorus shall be restricted in accordance with Table 4.

Table 4 — Sulfur and phosphorus content — Grade 4

Element	**Maximum content** (% by mass) **determined by**	
	Cast analysis	**Check analysis**
Sulfur	0,035	0,04
Phosphorus	0,035	0,04

The steel shall be made in conformity with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be achieved, for example, by ensuring that it contains sufficient aluminium or an equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement during service; a minimum value of 0,025 % of total aluminium is given for guidance.

Within the limitations specified above, it is the responsibility of the shackle manufacturer to select steel such that the finished shackle, suitably heat-treated, complies with the requirements for the mechanical properties specified in this International Standard for this grade of shackle.

6.2 Grades 6 and 8

6.2.1 General

The steel shall be produced by an electric, or by an oxygen-blown, process.

In its finished state, as supplied to the shackle manufacturer, it shall comply with the requirements specified in 6.2.2, as determined by a cast or check analysis on the bar or on the finished shackle.

The manufacturer should supply a cast analysis of the steel if required by the purchaser.

6.2.2 Specific requirements

The steel shall be fully killed, shall be suitable for forging and shall contain alloying elements in sufficient quantities to guarantee the mechanical properties of the shackle after appropriate heat treatment.

The steel for Grade 6 shackles shall contain at least one of the following elements, in the alloying proportions specified in ISO 4948-1:

— nickel;

— chromium;

— molybdenum

The steel for Grade 8 shackles shall contain at least two of the following elements, in the alloying proportions specified in ISO 4948-1:

— nickel;

— chromium;

— molybdenum.

The sulfur and phosphorus content of the two grades of steel shall be restricted in accordance with Tables 5 to 7.

Table 5 — Sulfur and phosphorus content — Grade 6 — Body

Element	**Maximum content** (% by mass) **determined by**	
	Cast analysis	**Check analysis**
Sulfur	0,035	0,04
Phosphorus	0,035	0,04

Table 6 — Sulfur and phosphorus content — Grade 6 — Pin

Element	**Maximum content** (% by mass) **determined by**	
	Cast analysis	**Check analysis**
Sulfur	0,03	0,035
Phosphorus	0,03	0,035

Table 7 — Sulfur and phosphorus content — Grade 8 — Body and pin

Element	Maximum content (% by mass) determined by	
	Cast analysis	Check analysis
Sulfur	0,025	0,03
Phosphorus	0,025	0,03

The steel shall be made in conformity with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be achieved, for example, by ensuring that it contains sufficient aluminium or an equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement during service; a minimum value of 0,025 % of total aluminium is given for guidance.

Within the limitations specified above, it is the responsibility of the shackle manufacturer to select steel such that the finished shackle, suitably heat-treated, complies with the requirements for mechanical properties specified in this International Standard for the appropriate grade of shackle.

7 Heat treatment

7.1 Grade 4

After forging, the shackle shall be normalized or hardened and tempered.

7.2 Grades 6 and 8

Each component shall be hardened from a temperature above the AC3 point and tempered before being subjected to the manufacturing proof force. The tempering temperature shall be a minimum of 400 °C.

The tempering conditions shall be at least as effective as a temperature of 400 °C maintained for a period of 1 h.

A method of verification is that after the components have been re-heated to, and maintained for 1 h at, 400 °C and then cooled to room temperature; they should conform in the finished condition to columns 2 and 3 of Table 3.

Surface hardening shall not be permitted for load bearing parts of the component.

8 Hardness

8.1 Hardness requirement

The hardness values for the shackles body shall not exceed the values specified in Table 8.

Table 8 — Hardness values

Grade	Brinell hardness HBS	Rockwell hardness HRC
4	217	17
6	300	32
8	380	41

8.2 Hardness testing

In order to determine Brinell hardness numbers, the tests shall be carried out in accordance with ISO 6506-1, using — where practicable — a 10 mm steel ball and a force of 29,42 kN (HBS 10/3 000).

In order to determine Rockwell C hardness numbers, the tests shall be carried out in accordance with ISO 6508-1.

Other methods of determining hardness may be used, provided the values obtained, when converted to equivalent Brinell or Rockwell C values, are in accordance with 8.1.

The surface on which the impression is to be made shall be obtained by filling, grinding or smooth machining, and shall be in a suitable position (as shown in Figures 1 and 2).

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

9 Workmanship

The body shall be forged in one piece without welding. Holes in shackle bodies shall be aligned axially with each other and centrally to the outside diameter of the eyes.

The pin shall be either forged and machine-finished. The screwed portion of the pin shall be concentric with the main portion. The collar or head of the pin shall fit closely against the body of the shackle.

When a threaded pin is fully tightened, the length of thread which remains visible between the jaws of the shackle shall not be greater than one thread (e.g. in the case of Types W and Y pins).

The length of the plain portion of the bolt shall be such that when the nut is screwed onto the bolt, it seats onto the shoulder of the bolt and not on the shackle body (e.g. in the case of the Type X pin).

In all cases when the pin is correctly fitted in the body of the shackle, the jaw width, W, shall not be significantly reduced.

The finished shackle body and pin shall be free from any harmful surface defects, including cracks.

10 Screw threads

Unless otherwise specified, screw threads shall conform to either ISO 261 or ISO 263 and shall be of Class 6g/6H (medium fit) tolerance.

Alternative forms of thread may be used, provided that the strength of the shackle is not impaired.

11 Type testing

11.1 General

Type tests demonstrate that shackles certified by the manufacturer as complying with the requirements laid down in this International Standard possess the mechanical properties specified in this International Standard. The purpose of these tests is to prove the design, material, heat treatment and method of manufacture of each size of finished shackle, including protective coating (if applied). Any change in the design, material specification, heat treatment or method of manufacture — including protective coating (if applied) — or in any dimension outside normal manufacturing tolerances that could lead to a modification of the mechanical properties according to Clause 5, shall require that the type tests specified in 11.2 to 11.4 be carried out on the modified shackle.

All shackles to be type testing shall comply with all the other requirements laid down in this International Standard. The tests specified in 11.2 to 11.4 shall be carried out on each size of shackle of each design, material, heat treatment and method of manufacture, including protective coating (if applied).

In the tests specified in 11.2 to 11.4, the force shall be applied axially without shock to the crown of the body, using a test machine fitting having a diameter not greater than the actual diameter of the shackle pin, and to the centre of the shackle pin, using a test machine fitting having a width not exceeding the actual diameter of the pin.

11.2 Deformation resistance test

Three samples shall be tested and each shall be capable of sustaining the proof force specified for the shackle in Table 3.

After the test force has been removed, the pin shall show no permanent deformation and, after it has been loosened, it shall turn freely. The actual dimension, S, or a similar dimension measured between punch marks on the pin and the crown shall not increase by more than 0,25 % or 0,5 mm, whichever is the greater.

NOTE See also Clause 12 for proof testing of shackles, where required.

11.3 Static strength test — WLL $\leqslant$ 100 t

Three samples shall be tested and each shall have an ultimate strength at least equal to the minimum value specified for the shackle in Table 3.

Each shackle body and pin shall be capable of withstanding the force without fracture or distortion to the extent that the shackle becomes incapable of retaining the load.

This test may be carried out on the same shackles that have been submitted to the deformation test.

11.4 Fatigue tests (Grades 6 and 8: WLL $\leqslant$ 32 t)

Shackles with a working load limit of up to and including 32 t shall be subjected to the fatigue test. Three samples shall be tested.

The range applied during each cycle shall be equal to 1,5 times the working load limit specified in Table 3 for the shackle. The minimum force in each cycle shall be positive and $\leqslant$ 3 kN. The frequency of force application shall be between 5 Hz and 25 Hz. The samples tested shall be capable of sustaining at least 20 000 cycles of the force range specified above without failing to retain the load.

11.5 Acceptance criteria for type testing

11.5.1 Deformation resistance test

All three samples tested shall pass the deformation test in order for the shackle of the size submitted for type testing to conform with this International Standard.

11.5.2 Static strength test and fatigue test

If all three samples pass the test, the shackle of the size submitted for type testing may be deemed to conform with this International Standard.

If one of the samples fails, two further samples shall be tested and both shall pass the test in order for the shackle of the size submitted for type testing to comply with this International Standard. If two or three samples fail the test, the shackle of the size submitted for type testing shall not be deemed as conforming with this International Standard.

12 Proof test

12.1 Each finished shackle (i.e. after manufacture, heat treatment and machining — including protective coating (if applied) — shall be subjected to the appropriate proof force specified in Table 3, applied to the crown of the shackle and to the centre of the pin by test machine fittings having a diameter not greater than the actual diameter of the shackle pin.

12.2 After the proof force has been removed, the pin shall show no permanent deformation and, after it has been loosened, it shall turn freely. The actual dimension, S, of the shackle shall not increase by more than either 0,25 % or 0,5 mm, whichever is the greater.

After proof testing, each shackle shall be examined by a competent person.

13 Manufacturer's certificate

13.1 When the type testing as specified in Clause 11 has been carried out with satisfactory results, the manufacturer may issue certificates of conformity for shackles of the same nominal dimensions, size, material, heat treatment and method of manufacture — including protective coating (if applied) — as the shackles tested.

The manufacturer shall keep a record, for at least 10 years after the last certificate has been issued, of the material specification, heat treatment, dimensions, test results and all relevant data concerning the shackles that have satisfied the type tests. This record shall also include the manufacturing specifications that shall apply to subsequent production.

Any change in material specification, in method of manufacture — including protective coating (if applied) — in heat treatment, or in any dimension outside normal manufacturing tolerances which may lead to a modification of the mechanical properties as specified in Clause 5, shall be considered as a design change. Tests in accordance with Clause 11 shall be required before the manufacture is permitted to issue certificates of conformity for any modified design.

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

a) quantity and description of shackle;

b) grade number, i.e. 4, 6 or 8;

c) traceability code, enabling any particular shackle or batch of shackles in the consignment to be identified;

d) proof force applied (see Clause 12);

e) the working load limit in tonnes, e.g. WLL 10 t.

The certificate shall declare that each shackle complies with this International Standard and is within the manufacturer's specification of the type tested shackle(s). It shall also state the name and address of the testing establishment and the status of the signatory.

14 Marking

14.1 Shackle

Each shackle shall be legibly and indelibly marked in a manner which will not impair its mechanical properties. This marking shall include at least the following information placed on the shackle by the manufacturer:

a) manufacturer's identification mark or symbol;

b) grade number, i.e. 4, 6 or 8;

c) working load limit in tonnes, e.g. WLL 10 t;

d) traceability code, enabling any particular shackle or batch of shackles in the consignment to be identified.

14.2 Shackle pins

All shackle pins of a diameter greater than, or equal to, 13 mm shall be legibly and indelibly marked with the relevant grade number and manufacturer's symbol such that this marking does not impair the mechanical properties in the pin.

Pins of less than 13 mm diameter shall be marked with at least the grade number.

Annex A
(normative)

Formulae for calculating shackle dimensions

A.1 Formulae used for calculating the dimensions specified in Table 1 for dee shackles.

A.1.1 Formulae used to calculate values of d max.:

— Grade 4: $14\sqrt{\text{WLL}}$

— Grade 6: $11{,}2\ \sqrt{\text{WLL}}$

— Grade 8: $10\sqrt{\text{WLL}}$

A.1.2 Formulae used to calculate values of D max. and W min.:

— Grade 4: $16\sqrt{\text{WLL}}$

— Grade 6: $12{,}5\ \sqrt{\text{WLL}}$

— Grade 8: $11{,}2\ \sqrt{\text{WLL}}$

A.1.3 Formulae used to calculate values of S min.:

— Grade 4 : $31{,}5\sqrt{\text{WLL}}$

— Grade 6 : $25\sqrt{\text{WLL}}$

— Grade 8 : $22{,}4\sqrt{\text{WLL}}$

A.1.4 Formula used to calculate e max.:

e max. $= 2{,}2D$ max.

A.2 Formulae used for calculating the dimensions specified in Table 2 for bow shackles

A.2.1 Formulae used to calculate values of d max.:

— Grade 4: $16\sqrt{\text{WLL}}$

— Grade 6: $12{,}5\ \sqrt{\text{WLL}}$

— Grade 8: $11{,}2\ \sqrt{\text{WLL}}$

A.2.2 Formulae used to calculate values of D max. and W min.:

— Grade 4: $18\sqrt{\text{WLL}}$

— Grade 6: $14\sqrt{\text{WLL}}$

— Grade 8: $12{,}5\sqrt{\text{WLL}}$

A.2.3 Formulae used to calculate values of $2r$ min.:

— Grade 4: $28\sqrt{\text{WLL}}$

— Grade 6: $22{,}4\sqrt{\text{WLL}}$

— Grade 8: $20\sqrt{\text{WLL}}$

A.2.4 Formulae used to calculate values of S min.:

— Grade 4: $40\sqrt{\text{WLL}}$

— Grade 6: $31{,}5\sqrt{\text{WLL}}$

— Grade 8: $28\sqrt{\text{WLL}}$

A.2.5 Formula used to calculate e max.:

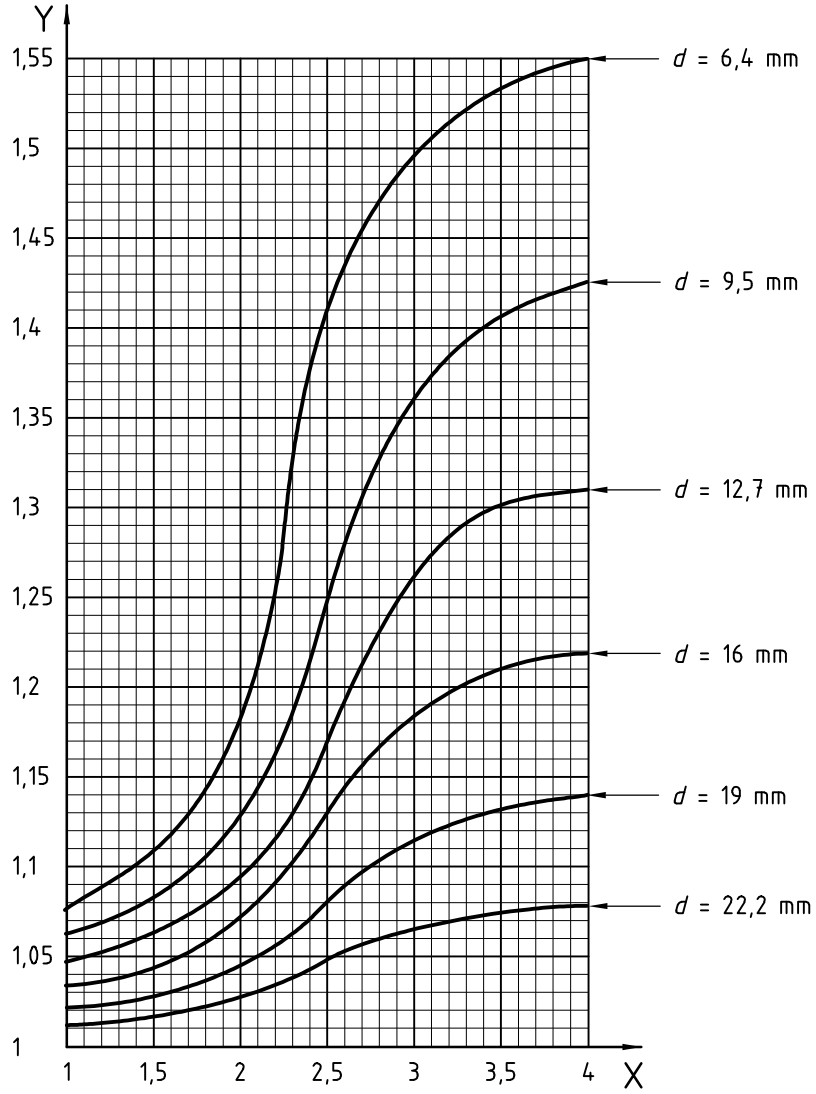
e max. $= 2{,}2D$ max.

A.3 Correction factors

The formulae given in A.1 and A.2 are based on the condition when the load is at the centre of the pin and the reactions are taken at the centre of the length of the holes.

In designing shackles where $d < 25$ mm, the diameter of the pin, D, obtained from the formulae should, for practical reasons, be multiplied by a correction factor obtained from the appropriate curve in Figure A.1, corresponding to the value of $2r/d$.

The formulae give dimensions of shackles suitable for normal conditions of service; for hazardous conditions, shackles should be designed for a nominal extreme fibre (tensile) stress.



Key

X $2r/D$

Y correction factor applied to D

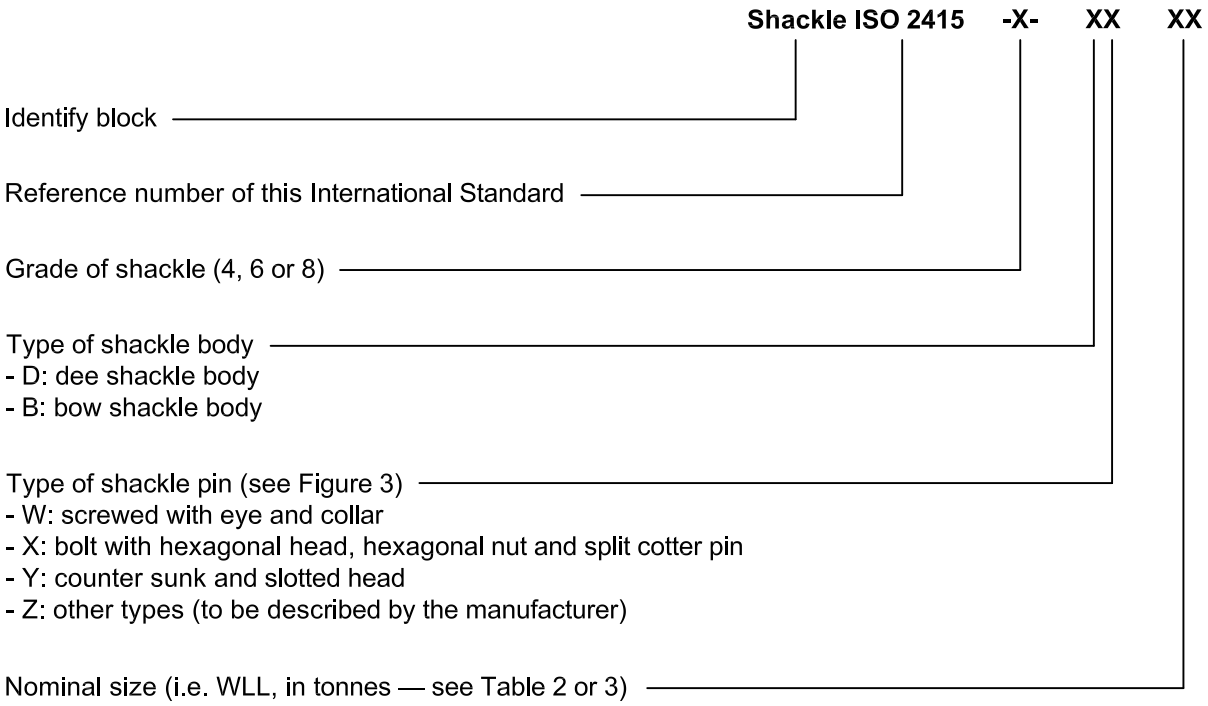
Figure A.1 — Correction factor for pin diameters of shackles $d < 25$ mm

Annex B
(informative)

Designation

For reference and ordering purposes, shackles complying with this International Standard may be designated using the following system.

The following elements shall be used in the order given.



EXAMPLE 1 A dee shackle complying with this International Standard, with pin of Type W, of nominal size 20 t, and of Grade 4, shall be designated as follows:

Shackle ISO 2415 - 4 - DW 20

EXAMPLE 2 A bow shackle complying with this International Standard, with pin of Type X, of nominal size 10 t, of and Grade 8, shall be designated as follows:

Shackle ISO 2415 - 8 - BX 10

ICS 53.020.30

Price based on 20 pages