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

Manilles forgées pour levage — Manilles droites et manilles lyres

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ISO 2415:2022

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 2415:2004), which has been technically revised.

The main changes are as follows:

- modification of the grades to 6, 8 and 10;
- corresponding adaption of preferred dimensions, heat treatment and mechanical requirements;
- selective method to ensure product material toughness; and
- including the guidance for safe use of shackles in [Annex B](#).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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

1 Scope

This document specifies the general characteristics of forged dee and bow shackles in a range of sizes having working load limits from 0,5 t to 120 t and in grades 6, 8 and 10, and presents their performance and preferred dimensions necessary for their interchangeability and compatibility with other components for use in the temperature range of -20 °C to 200 °C.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

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 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

EN 10228-1, *Non-destructive testing of steel forgings - Part 1: Magnetic particle inspection*

EN 10228-2, *Non-destructive testing of steel forgings - Part 2: Penetrant testing*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1

shackle

component consisting of two readily separable parts, the *body* (3.2) and the *pin* (3.5)

3.2

body

one of the two parts of a *shackle* (3.1), consisting of a bar of suitable cross section formed or forged to the appropriate shape and terminating in coaxial *eyes* (3.4)

3.3

crown

part of the *shackle* (3.1) body opposite the *pin* (3.5)

**3.4
eye**

boss on each end of the *body* (3.2) with coaxial holes through which the *pin* (3.5) passes

**3.5
pin**

straight bar of circular cross section which passes through the *eye* (3.4) holes and secured in a manner that can be readily disassembled

Note 1 to entry: Some types may have additional components, for example: a nut.

**3.6
dee shackle**

shackle (3.1), the *crown* (3.3) of which forms a semicircle with an inner radius of half the width between the *eyes* (3.4)

Note 1 to entry: See [Figure 1](#).

**3.7
bow shackle**

shackle (3.1), the *crown* (3.3) of which forms more than a semicircle with an inner radius of more than half the width between the *eyes* (3.4)

Note 1 to entry: See [Figure 2](#).

**3.8
breaking force**

F_b
maximum force reached during a static tensile test before the assembly being tested fails to retain the load

**3.9
proof force**

F_e
force applied as a test to a finished *shackle* (3.1)

Note 1 to entry: See [Table 2](#).

**3.10
working load limit
WLL**

maximum mass a *shackle* (3.1) is designed to sustain in general service

**3.11
working load
WL**

maximum mass a *shackle* (3.1) may sustain in a particular stated service

**3.12
finished condition**

state of the surface after forging, heat treatment, machining and surface treatment

Note 1 to entry: Examples of surface treatment are descaling, electroplating, hot dip galvanizing, painting, etc.

**3.13
lot**

specified number of *shackles* (3.1) from which samples are selected for testing purposes, and which have been manufactured from the same cast of steel and subjected to the same heat treatment process

3.14 grade

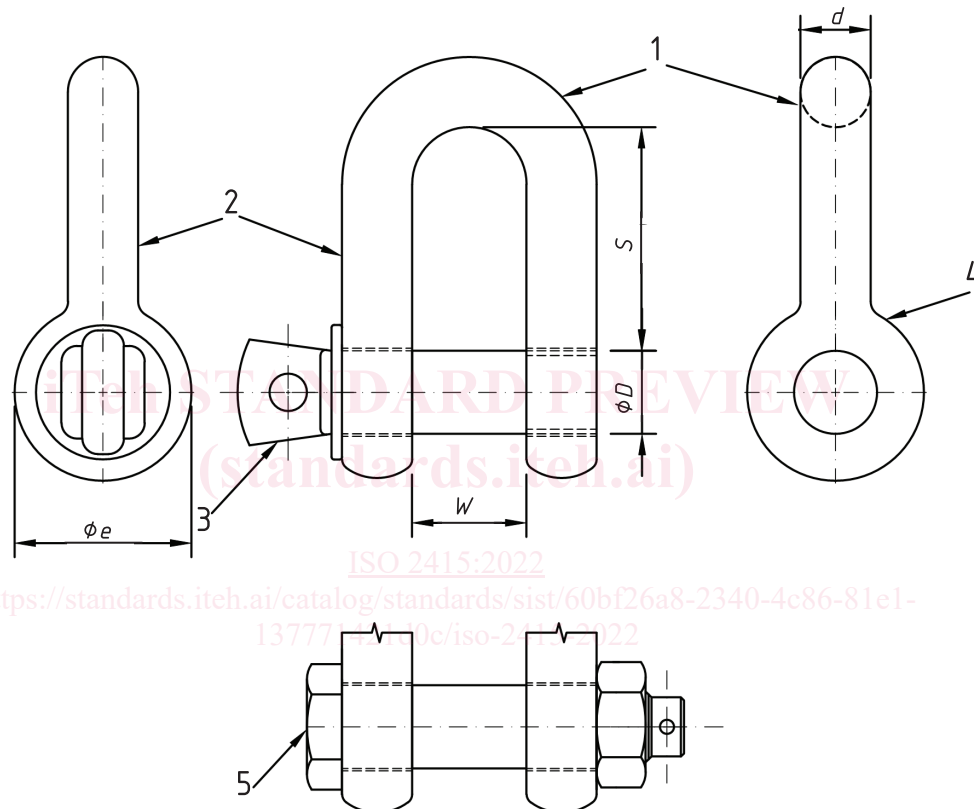
minimum ultimate tensile strength of the material

Note 1 to entry: See [Table 4](#).

4 Form and dimensions

4.1 Dee shackles

The dimensions of dee shackles shall be in accordance with [Figure 1](#) and [Table 1](#).



Key

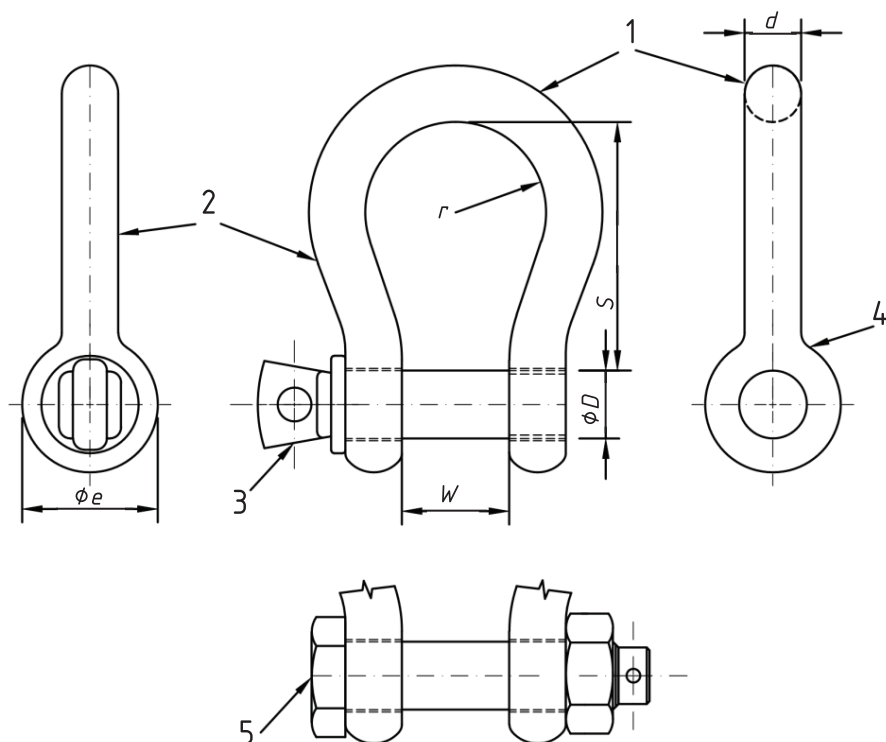
- 1 crown
- 2 body
- 3 screwed pin with eye and collar — Type W (see [Figure 3](#))
- 4 eye
- 5 bolt-type pin with hexagon head, hexagon nut and split cotter pin — Type X (see [Figure 3](#))

NOTE This figure 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

4.2 Bow shackles

The dimensions of bow shackles shall be in accordance with [Figure 2](#) and [Table 1](#).



Key

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

NOTE This figure 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

Dimensions in millimetres

Table 1 — Preferred dimensions of dee and bow shackles

| Working load limit (WLL) [t] | | | <i>d</i> | | | <i>D</i> | | | <i>W</i> | | | <i>e</i> | | | <i>S</i> | | <i>2r</i> |
|---------------------------------|---------|----------|----------|------|------|----------|------|------|----------|------|------|----------|------|------|----------|------|-----------|
| Grade 6 | Grade 8 | Grade 10 | min. | typ. | max. | min. | typ. | max. | min. | typ. | max. | min. | typ. | max. | min. | typ. | min. |
| 0,5 | 0,75 | | 5,5 | 7 | 8 | 7 | 8 | 9 | 9,5 | 12 | 14,5 | 15,5 | 17 | 18,5 | 20 | 27 | 19 |
| 0,75 | 1 | | 7 | 9 | 10 | 8,5 | 9,5 | 10,5 | 11 | 13,5 | 16 | 18,5 | 20 | 21,5 | 25 | 29 | 20 |
| 1 | 1,5 | 2 | 9 | 10 | 11,5 | 10 | 11 | 12 | 14 | 16,5 | 19 | 22 | 23,5 | 25 | 27 | 32 | 24 |
| 1,5 | 2 | 2,5 | 10,2 | 11 | 12,7 | 11,2 | 12,2 | 13,2 | 16,5 | 19 | 21,5 | 25 | 26,5 | 28 | 33 | 39 | 27 |
| 2 | 2,5 | 3,3 | 12,5 | 13,5 | 15 | 15 | 16 | 17 | 19 | 21,5 | 24 | 29,5 | 32 | 34,5 | 38 | 44 | 30 |
| 3,25 | 4 | 5 | 14 | 16 | 19 | 17 | 19 | 21 | 24 | 27 | 30 | 38 | 40 | 43 | 47 | 57 | 39 |
| 4,75 | 6,3 | 7 | 17,5 | 19 | 22,5 | 20 | 22 | 24 | 28,5 | 31,5 | 34,5 | 44 | 46 | 49 | 52 | 65 | 48 |
| 6,5 | 8,5 | 9,5 | 20,5 | 22 | 25,5 | 23 | 25 | 27 | 33,5 | 36,5 | 39,5 | 50 | 52 | 55 | 65 | 76 | 55 |
| 8,5 | 9,5 | 12,5 | 23 | 25 | 28 | 26 | 28 | 30 | 40 | 43 | 46 | 56 | 59 | 62 | 74 | 88 | 64 |
| 9,5 | 12 | 15 | 26,5 | 28 | 31,5 | 30 | 32 | 34 | 43,5 | 46,5 | 49,5 | 64 | 67 | 70 | 83 | 101 | 70 |
| 12 | 13,5 | 18 | 30,5 | 32 | 35,5 | 33 | 35 | 37 | 47,5 | 51,5 | 55,5 | 70 | 73 | 76 | 87 | 108 | 78 |
| 13,5 | 17 | 21 | 33,5 | 35 | 39,5 | 36 | 38 | 40 | 53 | 57 | 61 | 76 | 80 | 84 | 104 | 126 | 85 |
| 17 | 25 | 30 | 36,5 | 38 | 42,5 | 40 | 42 | 44 | 56 | 60 | 64 | 84 | 88 | 92 | 115 | 139 | 94 |
| 25 | 35 | 40 | 43 | 45 | 49 | 49 | 51 | 53 | 70 | 74 | 78 | 100 | 104 | 108 | 139 | 168 | 119 |
| 35 | 42,5 | 50 | 48 | 50 | 52 | 56 | 58 | 60 | 79 | 83 | 87 | 108 | 112 | 116 | 155 | 182 | 130 |
| 42,5 | 50 | 55 | 55 | 57 | 59 | 63 | 65 | 67 | 90 | 95 | 100 | 126 | 130 | 134 | 170 | 205 | 150 |
| 55 | 70 | 85 | 62 | 65 | 68 | 68 | 70 | 72 | 100 | 105 | 110 | 140 | 145 | 150 | 185 | 240 | 170 |
| 85 | 100 | 120 | 72 | 75 | 78 | 80 | 83 | 86 | 122 | 127 | 132 | 157 | 162 | 167 | 205 | 300 | 180 |
| 120 | | | 87 | 90 | 95 | 92 | 95 | 98 | 142 | 147 | 152 | 205 | 210 | 215 | 250 | 370 | 225 |

NOTE Sizes, tolerances and loads in other standards are not specifically excluded by this table and can be deemed compliant.

4.3 Hole diameter

The maximum diameter of the unthreaded hole or holes in the body of the shackle shall be either $1,1 \times D$ or $D + 1,5$ mm, whichever is greater, where D is the actual pin diameter.

Holes in shackle bodies shall be generally aligned coaxially with each other and concentric to the outside diameter of the eyes. Centre of the shackle eye and centre of the hole to be the concentric within a tolerance of ± 5 % of the nominal diameter of the shackle pin.

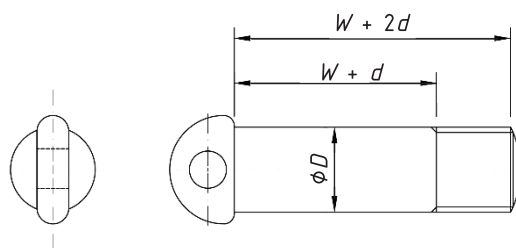
4.4 Types of shackle pin

The threaded shackle pins shown in [Figure 3](#) illustrate only typical examples of pins; other suitable forms of pins are acceptable.

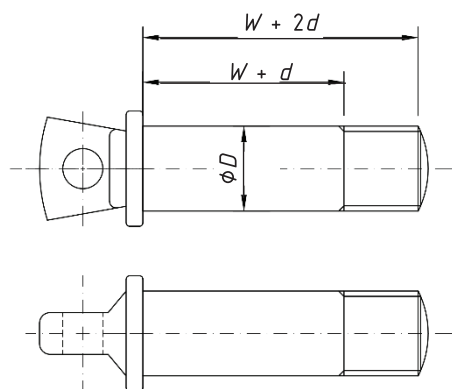
The pins illustrated are of the following types:

- a) Type V: screwed with eye;
- b) Type W: screwed with eye and collar;
- c) Type X: bolt with hexagon head, hexagon nut and a retainer, for example a split pin;
- d) Type Y: countersunk and slotted head.

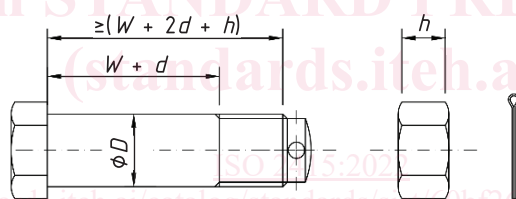
For the purpose of the designation system (see [Annex A](#)), all other types of pins are designated as being of Type Z.



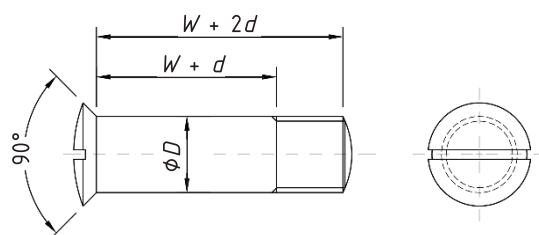
a) Type V: screwed with eye



b) Type W: screwed with eye and collar



c) Type X: bolt with hexagon head, hexagon nut and a retainer: for example, a split pin



d) 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 breaking force shall be as specified in [Table 2](#).

Table 2 — Mechanical properties

| Working load limit (WLL) [t] | | | Proof force F_e [kN] | | | Breaking force F_b [kN] | | |
|------------------------------------|------------|-------------|------------------------------|------------|-------------|---------------------------------|------------|-------------|
| Grade 6 | Grade 8 | Grade 10 | Grade 6 | Grade 8 | Grade 10 | Grade 6 | Grade 8 | Grade 10 |
| See Table 1 | | | Min. 2 times WLL | | | Min. number of times WLL | | |
| | | | | | | 5 or 6 | 5 | 5 |

For grade 6 the breaking force shall be a minimum of 5 or 6 times WLL with the factor as classified in [Table 5](#).

In the tests specified in [5.2](#) to [5.4](#), the force shall be applied to the shackle axially without shock to the crown of the body, using a test machine fixture having a dimension not greater than 60 % of the maximum internal width of the shackle, and to the centre of the shackle pin, using a testing machine fixture having a width not exceeding the diameter of the pin. The fixtures that are used for the deformation resistance test, breaking force test and fatigue test shall be the same configuration.

The test machine used in the tests specified in [5.2](#) to [5.4](#) shall comply with ISO 7500-1 Class 1.

5.2 Deformation resistance test ISO 2415:2022

Each shackle, when tested in accordance with [10.2](#), shall be capable of sustaining the manufacturing proof force to $2 \times$ WLL without exceeding the deformation requirement, as measured between e1 and c, e2 and c, e1 and e2, i.e. no dimension shall alter by more than 2 % (or 0,5 mm whichever is greater), of the initial dimension after the proof force has been applied. After removal of the test force, the pin, when loosened, shall turn freely (see [Figure 4](#)). Small indents from the test tools are allowed.

To remove deformation due to “setting” from a real deformation result, it is allowed to apply an initial load equal to the WLL of the shackle being tested and measure initial dimensions after release of this first load.

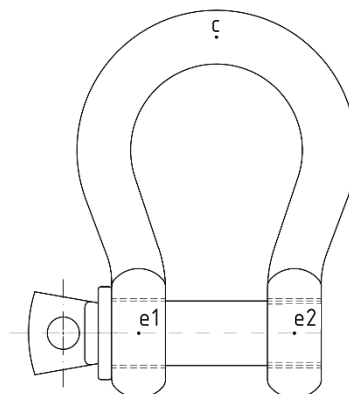


Figure 4 — Positions for measuring deformation

5.3 Breaking force

Each shackle, when tested in accordance with 10.3, shall have a breaking force at least equal to that specified in Table 2.

On completion of the breaking force test, the shackle shall show evidence of ductility. Dee shackles shall have a minimum inside length increase of 5 % for grade 6 and 8, and 2 % for grade 10. Bow shackles shall have a minimum inside length increase of 10 % for grade 6 and 8, and 5 % for grade 10. Measurements are taken from bearing point to bearing point.

If the pin breaks, it shall show a permanent bend of not less than 20° for grades 6 and 8, and grade 10 shall show a permanent bend of not less than 10°. A shackle bow shall show a diameter reduction (contraction) after breaking and there shall be a fine-grained structure in the fracture area.

NOTE 1 This test can be carried out on the same shackles that have been subjected to the deformation test.

NOTE 2 It is not necessary to test the shackle up to its actual breaking force for the mechanical properties specified to be demonstrated.

5.4 Fatigue resistance

Each shackle of grade 6, 8 and 10 with a working load limit up to and including 32 t, when tested in accordance with 10.4, shall, after at least 20 000 cycles, be capable of retaining the load.

Fatigue resistance testing may be conducted on shackles that have passed a proof load test.

6 Material

6.1 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 6.2, as determined by a cast or check analysis on the bar or on the finished shackle.

The steel shall be fully killed, shall be suitable for forming or forging and shall be capable of being heat treated to obtain the mechanical properties required by this document. Its content of sulfur and phosphorus shall be restricted in accordance with Table 3.

Table 3 — Maximum sulfur and phosphorus content

| Element | Maximum mass content | |
|------------|----------------------|----------------|
| | [%] | |
| | Cast analysis | Check analysis |
| Sulfur | 0,025 | 0,030 |
| Phosphorus | 0,025 | 0,030 |

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.

NOTE This could be achieved, for example, by ensuring that the steel contains sufficient aluminium or an equivalent element to permit the manufacture of shackles stabilized against strain-age-embrittlement during service; a minimum value of 0,020 % 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 of the mechanical properties specified in this document.