
INTERNATIONAL STANDARD



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Shackles — General characteristics

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2415 was drawn up by Technical Committee ISO/TC 111, *Round steel link chains, chain wheels, lifting hooks and accessories*, and circulated to the Member Bodies in August 1971.

It has been approved by the Member Bodies of the following countries :

Austria	Ireland	South Africa, Rep. of
Canada	Italy	Sweden
Egypt, Arab Rep. of	Netherlands	Thailand
France	New Zealand	Turkey
India	Romania	United Kingdom

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Belgium
Japan
U.S.A.

Shackles — General characteristics

0 INTRODUCTION

The characteristics described in this International Standard are applicable to shackles of any form or dimension. Other International Standards have been prepared for shackles of particular forms and dimensions.¹⁾

Lifting tackle is made in more than one type of material. The variations of the material impart variations of mechanical characteristics. A shackle having the same working load as another may have smaller body and pin diameters, owing to the greater strength which results from the material used and its subsequent treatment, especially heat treatment. In order to give an indication as to the grade of chain hook, shackle, etc. relative to others, a system of grade letters has been adopted using those characters which are least liable to confusion with others if partially abraded by wear. In this International Standard four grades have been adopted, lettered L, M, P and S in increasing order of strength.

1 SCOPE AND FIELD OF APPLICATION

This International Standard defines the general characteristics of shackles and provides information on proof loading and certification.

2 REFERENCES

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/R 643, *Micrographic determination of the austenitic grain size of steels*.

3 DEFINITIONS

For the purpose of this International Standard the following definitions apply. See also Figures 1 and 2.

3.1 shackle : An assembly accessory formed 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 circular section bent through 180° terminating in coaxial eyes.

3.3 crown : The bent part of the shackle body.

3.4 eyes : Bosses on the end of the body, pierced by coaxial holes through which the pin passes.

3.5 pin : A straight bar of circular section which closes the shackle body, arranged so as to be secure when in position and readily demountable. (See Figure 2.)

3.6 dee-shackle : A shackle whose crown forms a semicircle of internal radius half the width (W) between the eyes. (See Figure 1.)

3.7 bow shackle : A shackle whose crown forms more than a semicircle, of internal radius more than half the width (W) between the eyes. (See Figure 1.)

3.8 breaking load (F_m) : The maximum load which the shackle withstands during the course of a tensile test to destruction.

3.9 proof load (F_e) : The force applied in a static tensile test which the shackle must sustain without showing permanent deformation or other visible defects.

3.10 lifting capacity; working load limit (C_p) : The maximum mass which the shackle is authorised to support in general service, when its axis of traction is vertical.

3.11 working load : The maximum mass which the shackle is authorised to support in a particular stated service, when its axis of traction is vertical.

4 LIFTING CAPACITY AND BASIC DESIGN LOADS

4.1 Lifting capacities (C_p)

The lifting capacities are expressed in tonnes; they follow the R 10 series of preferred numbers (see Table 1). Above 100 tonnes, lifting capacities follow the R 20 series, but with a preference for the R 10 terms. However, it has not been considered necessary to tabulate these values.

1) ISO 2731, *Dee-shackles*, and ISO 2791, *Bow-shackles*.

4.2 Basic design loads

The basic design loads of shackles are equal to the proof loads. Proof loads are expressed in kilonewtons and are given in Table 1, for each standard lifting capacity.

4.3 Minimum breaking load (F_m)

The minimum breaking load of a shackle, for each standard lifting capacity, is given in Table 1.

TABLE 1

Lifting capacity C_p	Proof load F_e	Minimum breaking load F_m
tonnes	kN	kN
1	20	40
1,25	25	50
1,6	32	63
2	40	80
2,5	50	100
3,15	63	125
4	80	160
5	100	200
6,3	125	250
8	160	320
10	200	400
12,5	250	500
16	315	630
20	400	800
25	500	1 000
31,5	630	1 250
40	800	1 600
50	1 000	2 000
63	1 250	2 500
80	1 600	3 200

NOTE — This Table is not in accordance with the ILO Recommendation; see annex C.

5 TYPES OF SHACKLE PIN

The shackle pins illustrated in Figure 2 are typical only and other suitable shapes are acceptable. The dimensions are based on the shackle dimensions.

6 MATERIAL

6.1 Grades L, M and P

The steel shall be produced by the open hearth process, the electrical process, or by an oxygen top-blown process.

In its finished state, as supplied to the shackle maker, it shall meet the following requirements as determined by a cast or check analysis on the bar or on the finished shackle (see also B.2).

It shall be fully killed, shall be suitable for forging and shall be capable of being heat treated to obtain the mechanical properties required by the relevant International Standards.

The proportions of sulphur and phosphorus should be limited as follows :

	Cast analysis	Check analysis
Maximum sulphur :	0,045 %	0,050 %
Maximum phosphorus :	0,040 %	0,045 %

The steel shall be made in conformity with a suitable deoxidation practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO/R 643. This could be accomplished, for example, by ensuring that it contains sufficient aluminium or equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement. A minimum of 0,02 % of metallic aluminium is quoted for guidance.

Within the above limitations, it is the responsibility of the shackle maker to select the steel so that the finished shackle, suitably heat treated, meets the mechanical properties required by the relevant International Standards.

6.2 Grade S

The steel shall be produced by the open hearth process, the electrical process, or by an oxygen top-blown process.

In its finished state, as supplied to the shackle maker, it shall meet the following requirements as determined by a cast or check analysis on the bar or on the finished shackle.

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

For example the steel for Grade S shackles should contain at least one of the following elements :

nickel	} or their equivalent
chromium	
molybdenum	
boron	

Neither manganese nor silicon should be considered in this context as alloying elements.

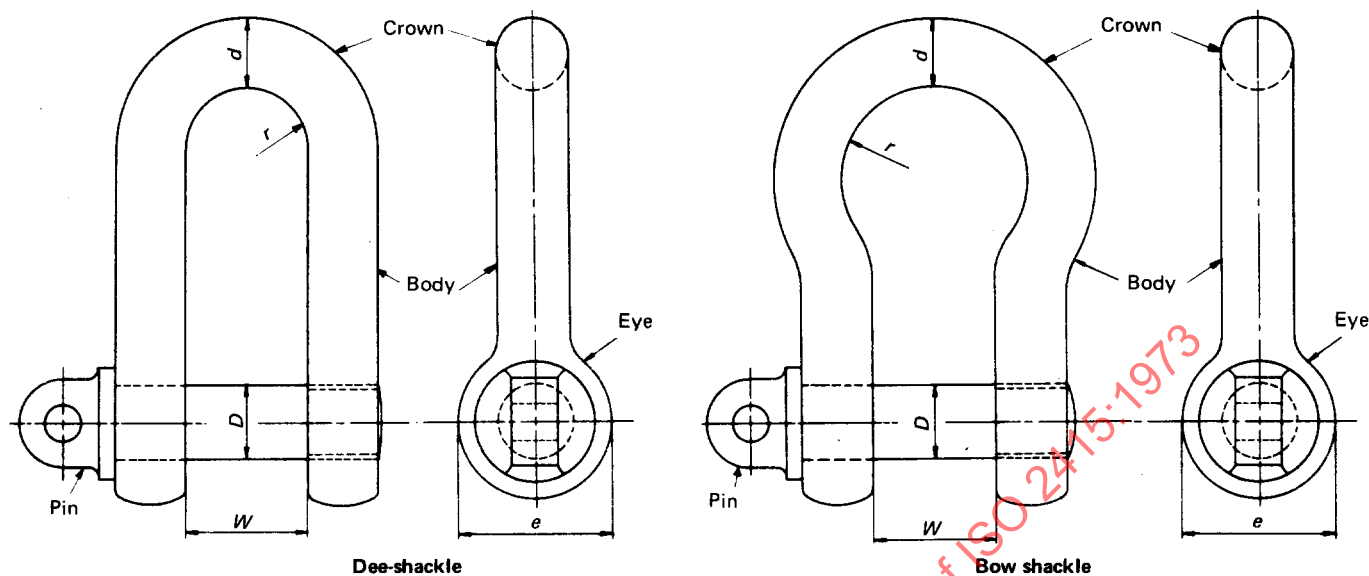


FIGURE 1 — Forms of shackle

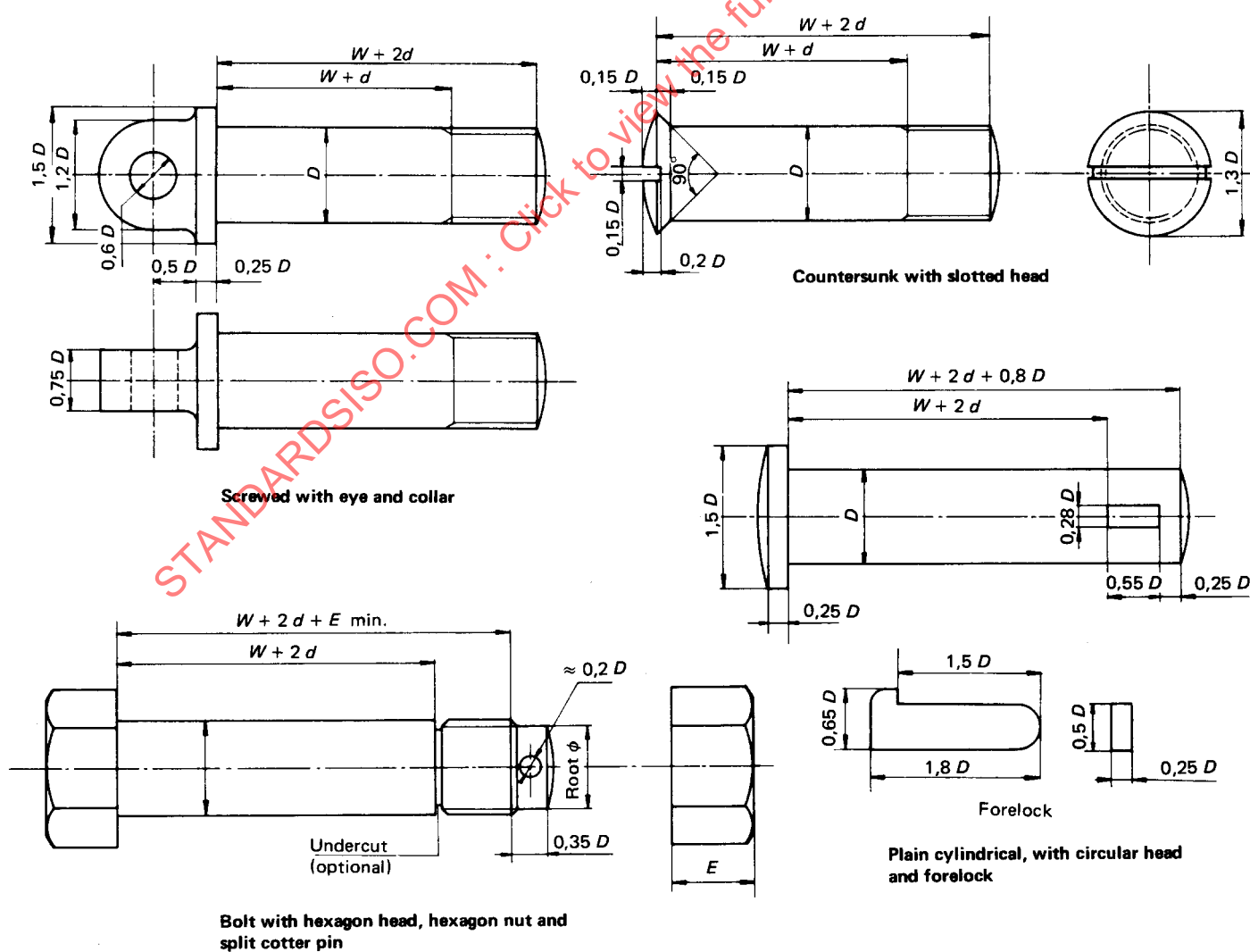


FIGURE 2 — Forms of shackle pin

The proportions of sulphur and phosphorus should be limited as follows :

	Cast analysis	Check analysis
Maximum sulphur :	0,035 %	0,040 %
Maximum phosphorus :	0,035 %	0,040 %

The steel shall be manufactured in accordance with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO/R 643.

This could be accomplished, for example, by ensuring that it contains sufficient aluminium or equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement. A minimum of 0,02 % is quoted for guidance.

Within the above limitations it is the responsibility of the shackle maker to select the steel so that the finished shackle, suitably heat treated, meets the mechanical properties required by the relevant International Standards.

7 HEAT TREATMENT

After forging, the shackle shall be heat treated in accordance with the quality of the material.

8 FORMS AND DIMENSIONS

Forms and dimensions are specified in the International Standards for each type of shackle.

The dimensions are calculated from the basic design loads specified in 4.2 and are such that the shackle does not show any permanent deformation when subjected to the proof load.

9 TOLERANCES

The diameter of the body of the shackle and the diameter of the shackle pin shall not be less than the nominated dimensions. The internal dimensions, jaw width (W), internal length (S) and crown radius (r), of the shackle shall not be less than the nominated dimensions and shall not exceed them by more than 5 % or 1 mm, whichever is the greater.

The diameter of unthreaded pin holes is subject to the following tolerances :

- diameter up to and including 20 mm : $D \begin{smallmatrix} +1 \\ +0,5 \end{smallmatrix}$ mm
- over 20 mm up to and including 45 mm : $D \begin{smallmatrix} +1,5 \\ +0,5 \end{smallmatrix}$ mm
- over 45 mm : $D \begin{smallmatrix} +2 \\ +0,5 \end{smallmatrix}$ mm

where D is the pin diameter.

10 WORKMANSHIP

The body shall be forged in one piece without weld. Pin or bolt holes shall be produced in axial alignment central to the outside diameter of the eyes.

The pin shall be forged and machine finished, machined from the bar, or, subject to agreement between purchaser and manufacturer, as forged and suitably 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 screwed home, the length of thread which remains visible between the jaws of the shackles shall be as small as possible.

The length of the plain portion of the bolt shall be such that when the nut is screwed onto the bolt, it jams on the bolt and not on the shackle body. The bolt shall be cross drilled for the split cotter pin, positioned outside the nut.

11 SURFACE PROTECTION

If protection against corrosion is necessary, it should be the subject of an agreement between the purchaser and the manufacturer and should provide protection appropriate to the conditions of use.

12 SCREW THREADS

Screw threads shall conform to either ISO 261 or ISO 263. The fit of the threads shall be "clearance fit".

13 PROOF LOADING

When required by the purchaser or by national regulations, each shackle after manufacture and subsequent heat treatment shall be subjected to the appropriate proof load (see Table 1), applied at the centre of the pin by means of a round link or pin.

14 INSPECTION

After manufacture, and proof loading if applied, the shackle shall be inspected by the purchaser's representative (see annex B). It complies if found free from visible defect and if the pin, after initial loosening, turns freely by hand (see section 7).

15 MARKING

The body of each shackle and the head of each pin shall be legibly and indelibly marked on parts that are not highly stressed with at least the following information :

- distinguishing mark;
- grade letter;
- any marking required by national standards, statutory regulations or by agreement between the manufacturer and the purchaser.

16 CERTIFICATE OF TEST AND EXAMINATION

The maker or supplier shall provide a certificate with each consignment of shackles, giving the following information for each one. The sections in brackets [] apply only to shackles which are proof loaded (see section 13).

- a) grade letter;
- b) type of material and details of heat treatment;
- c) distinguishing mark (to enable the particular shackle to be identified);

d) [proof load applied (see section 13)];

e) working load¹⁾.

The certificate shall declare that each shackle [was proof loaded in accordance with section 13, and was subsequently examined by a competent person, and that it] complies with ISO 2415 and ISO ...²⁾. [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.

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1) Tables of working loads and proof loads are given in the ISO documents for particular types of shackle. They are based on the ratios recommended by the International Labour Organization (ILO).

2) ISO 2731 or ISO 2791, as appropriate.

ANNEX A

INFORMATION TO BE PROVIDED WITH THE ENQUIRY AND ORDER

The enquiry and order should state :

- grade of shackle;
 - type of shackle;
 - type of pin;
 - working load;
 - form of screw thread (see section 12);
 - whether each shackle is to be proof loaded (see section 13);
 - further tests or chemical analysis if required (see annex B).
 - type of surface protection (if protection is necessary).
- } by reference to national standard or other descriptive document.

ANNEX B

RECOMMENDATIONS RELATING TO CONTRACTS

It is recommended that a contract for a supply of shackles complying with this International Standard should include requirements on the following lines :

B.1 TESTING FACILITIES

The manufacturer should provide all labour and appliances required for tests in accordance with this International Standard. In the absence of facilities at his own works for proof loading, the manufacturer should bear the cost of proof loading by a recognized testing authority.

B.2 ANALYSIS OF THE STEEL

The manufacturer should furnish a cast analysis of the steel if the purchaser requires it.

When an analysis of the steel in a batch of shackles is required, such analysis should be made from millings taken from a cross-section of a sample shackle body or pin selected from the batch by a representative of the purchaser. The cost of such analysis is borne by the purchaser.

B.3 ADDITIONAL TESTS

If the purchaser requires additional tests of the material or of 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 representative of the purchaser. The cost of such tests shall be subject to agreement between purchaser and manufacturer.

B.4 INSPECTION

The representative of the purchaser should have access to the manufacturer's works at any reasonable time suitable to both parties. 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.

The purchaser, if he so wishes, may delegate the shackle manufacturer to inspect the shackle for him.

The manufacturer should give the inspector copies of the reports of the tests made in his presence.

ANNEX C

**RATIO OF WORKING LOAD LIMIT TO PROOF LOAD
AS RECOMMENDED BY THE INTERNATIONAL LABOUR ORGANIZATION (ILO)**

TABLE 2

Working load limit		Excess for proof load		Proof load	
tonnes-force	%	tonnes-force	tonnes-force	kN*	
5	100	5	10	100	
10	100	10	20	200	
15	100	15	30	300	
20	100	20	40	400	
25		25	50	500	
30	85	25	55	550	
35		30	65	650	
40	75	30	70	700	
45		30	75	750	
50	65	35	85	850	
55		35	90	900	
60	60	35	95	950	
65		35	100	1 000	
70	55	40	110	1 100	
75		40	115	1 150	
80	50	40	120	1 200	
85		40	125	1 250	
90	46	40	130	1 300	
95		40	135	1 350	
100	43	45	145	1 450	

* Assuming $g = 10 \text{ m/s}^2$. The usual value of g is $9,81 \text{ m/s}^2$, and so the kilonewton value of the proof load is some 2 % greater than the gravitational value.

NOTE — Up to 25 tonnes the proof load is double the working load.

Above 25 tonnes the rate progressively reduces.