BRITISH STANDARD

BS 1290:1983

Specification for

Wire rope slings and sling legs for general lifting purposes

UDC 621.86.065:677.72

Cooperating organizations

The Mechanical Engineering Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

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British Ports Association
British Steel industry (Wire Section)
Bureau Veritas
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Federation of Wire Rope Manufacturers of Great Britain
Honourable Company of Master Mariners
Institution of Mining and Metallurgy
Institution of Mining Engineers
National Association of Lift Makers
National Association of Port Employers

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Contents

Foreword

This revised British Standard has been prepared under the direction of the Mechanical Engineering Standards Committee and supersedes the 1958 edition of BS 1290, which is withdrawn.

This revision introduces a certain degree of rationalization, including the restriction of wire ropes to a limited range of sizes, constructions and tensile grades. The appendices giving details of sling terminations have been replaced by suitable cross-references. In accordance with modern international practice, links have been adopted in this standard in preference to rings. Dimensions of master and intermediate links may be obtained from BS 2902 and BS 3458. Advice on the design of these links in other grades of material is given in Appendix D, which is identical with the annex of ISO 4778:1981 published by the International Organization for Standardization (ISO).

This revision covers slings with both hand-spliced and ferrule-secured eye terminations. Depending on the type of sling required, the ends of the sling legs may be formed with a thimble eye, a soft eye or a soft eye with stirrup or half thimble.

This standard covers only those multi-leg slings that have legs of equal nominal length, construction and diameter. Slings with legs of unequal length may be constructed generally in accordance with the requirements of this standard, but it is emphasized that their rating requires special consideration by a competent person.

Size for size, the SWLs of slings constructed from general engineering ropes (section 2) are approximately 50 % greater than those of slings constructed from galvanized marine ropes (section 3).

Appendix B gives information on the method of calculating SWLs. This method is known as the uniform load method and has been adopted internationally as an alternative to the trigonometric method. It is therefore the preferred method for general purpose multi-leg slings as well as for single-leg slings.

A code of practice for the safe use of wire rope slings for general lifting purposes (BS 6210) is published concurrently with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, 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.

Section 1. General requirements

1 Scope

This British Standard specifies the dimensions, constructions, safe working loads, testing and marking of wire rope slings for general lifting purposes.

Sections 1 and 2 deal with slings having one, two, three or four legs of general engineering wire rope of tensile grade 1 770 N/mm^2 complying with the requirements of BS 302 or BS 3530, with fibre or independent steel wire main core. The legs are constructed in ordinary lay wire rope, in the sizes and constructions specified in clause **12** and in one of the following forms:

a) single-part terminated by hand-spliced or ferrule-secured eyes;

b) double-part hand-spliced or ferrule-secured endless;

c) double-part grommet.

Sections 1 and 3 deal with slings having one or two single-part legs of 6 × 24 construction galvanized wire rope of tensile grade 1 420 N/mm^2 complying with the requirements of BS 365. The legs are terminated by hand-spliced or ferrule-secured eyes.

This standard deals with only those multi-leg slings that have legs of equal nominal length, construction and diameter and that are designed for use with the uniform load method of rating. Such slings are not intended to withstand greater loads at smaller included angles than those specified (see **7.1**).

This standard does not cover slings made from multistrand or triangular strand ropes.

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purposes of this British Standard the following definitions apply.

3.1
safe working load (SWL)

the maximum mass, as certified by a competent person, that an item of lifting gear may raise, lower or suspend under particular service conditions

3.2
minimum breaking load (MBL)

the load below which a rope will not fracture when tested to destruction in the prescribed manner (see ISO 3108:1974). The MBL is calculated from the square of the nominal rope diameter (in mm^2), the nominal tensile strength of all the wires (in N/mm^2) and a coefficient appropriate to the construction of the rope

3.3
load

encompasses the concept of either mass or force and is expressed in the appropriate units

NOTE In SWL, for example, the term "load" denotes a mass quantity, whereas in MBL it denotes a force quantity.

4 Forms of sling assembly

Sling legs and terminal fittings shall be of one of the forms shown in Figure 1.

NOTE 1 Some typical sling assemblies are illustrated in Figure 2 for two-, three- and four-leg slings. The lower terminal fittings may be any of those shown in Figure 1 except soft eyes.

The nominal length of sling assemblies shall be measured between the bearing points.

A thimble shall be used when the sling leg is terminated with a permanently attached link, hook or shackle.

Any welding and/or heat treatment of links shall be completed before the wire rope leg or legs are attached. The legs of two- or three-leg slings shall be joined at their upper ends by a suitable link (see **7.1**).

Each pair of legs of a four-leg sling shall be joined by a suitable intermediate link and the two intermediate links shall be joined by a suitable master link.

The nominal length of slings and sling legs shall be the length between the bearing points of their terminal fittings, whether soft eye, soft eye with stirrup or half thimble, thimble, shackle, hook or link (see Figure 1 and Figure 2). This length shall be measured under no load. In the case of two-, three- and four-leg slings, the discrepancy in length between any of the legs, in millimetres, shall not exceed that given by the equation:

$$\text{Maximum discrepancy} = 9 + \left(\frac{d + 9L}{3}\right)$$

where

d is the nominal rope diameter, in millimetres, and

L is the nominal length of sling leg, in metres.

NOTE 2 This formula is not applicable to spliced endless slings and grommet sling legs.

5 Formation of sling legs

Sling legs shall be formed by one of the methods given in Appendix A. Depending on the type of sling required, the ends of sling legs shall be formed with a thimble eye (which may be attached to other terminal fittings), a soft eye or a soft eye with stirrup or half thimble.

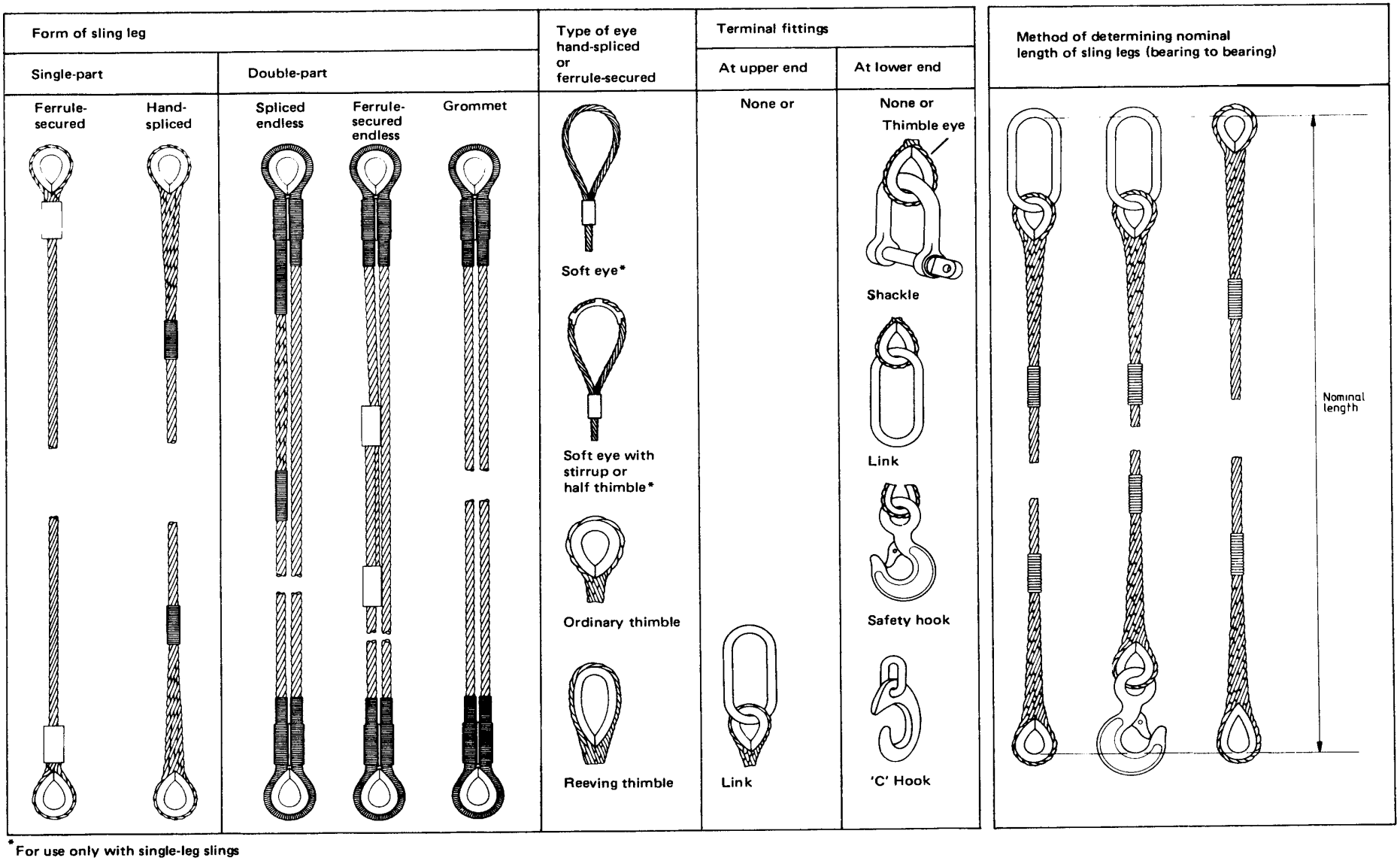
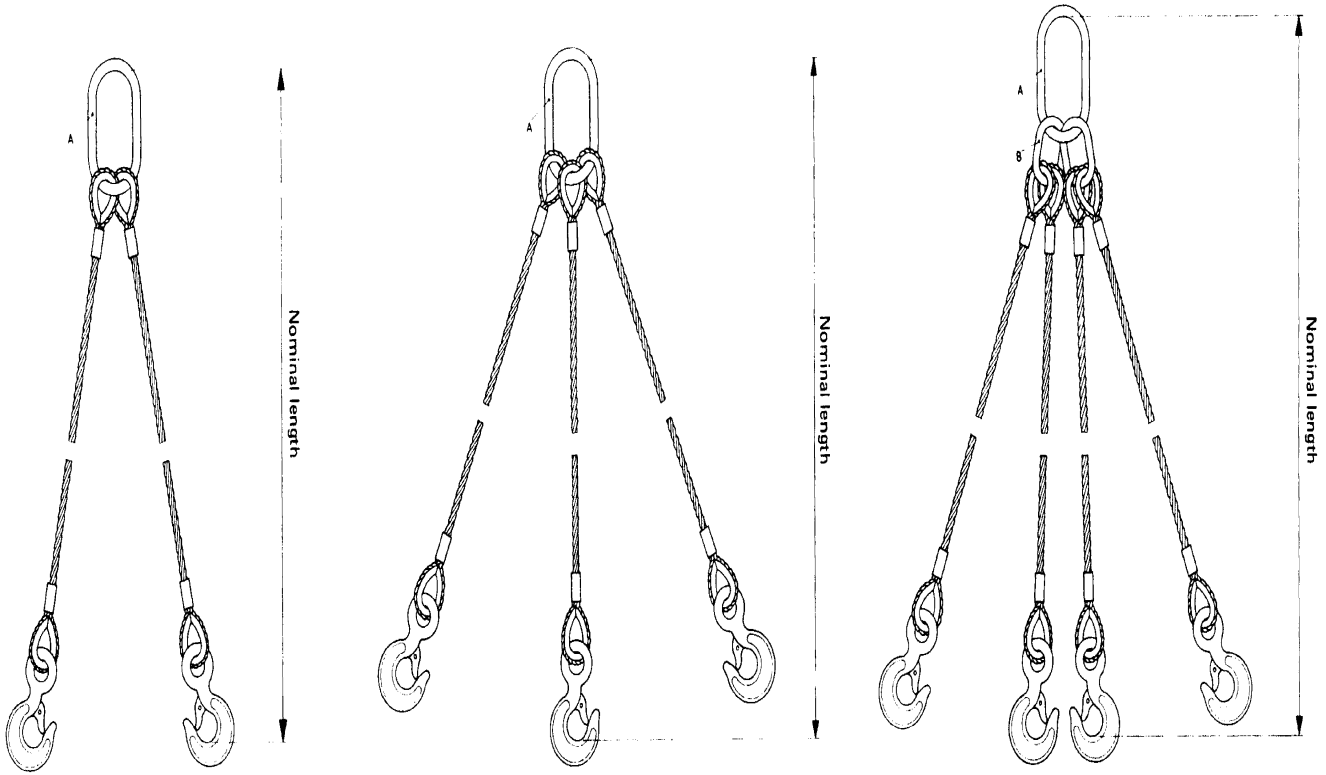


Figure 1 — Single-leg slings, sling legs and terminal fittings



(a) Two-leg wire rope sling		(b) Three-leg wire rope sling		(c) Four-leg wire rope sling	
Sling leg	As for single leg (Figure 3) but with ordinary thimble at each end	*Sling leg*	As for single leg (Figure 3) but with ordinary thimble at each end	*Sling leg*	As for single leg (Figure 3) but with ordinary thimble at each end
Eyes	Hand-spliced or ferrule-secured at each end	*Eyes*	Hand-spliced or ferrule-secured at each end	*Eyes*	Hand-spliced or ferrule-secured at each end
Links	SWL not less than 1.4 times that of one sling leg	*Links*	SWL not less than 2.1 times that of one sling leg NOTE Ensure that the size of link used will accept without overcrowding the three thimbled eyes	*Links*	Top master link A: SWL not less than 2.1 times that of one sling leg Intermediate links B: SWL not less than 1.4 times that of one sling leg
Hooks	In accordance with BS 2903 (safety or "C" hook). See also **7.2** SWL at least equal to that of the sling	*Hooks*	In accordance with BS 2903 (safety or "C" hook). See also **7.2** SWL at least equal to that of the sling leg	*Hooks*	In accordance with BS 2903 (safety or "C" hook). See also **7.2** SWL at least equal to that of the sling leg

Figure 2 — Multi-leg slings: typical assemblies

6 Terminations

6.1 Ferrule-secured eye terminations. Ferrule-secured eye terminations shall comply with the requirements of BS 5281.

6.2 Thimbles. Thimbles shall comply with the requirements of BS 464. They shall be of the nominal size appropriate to the rope used, except that for double-part endless slings it is permissible for the thimbles to be two, or where necessary three, sizes larger in order to provide effective strength against the increased loading. Reeving thimbles shall be one size larger than the nominal size.

NOTE When thimbles of larger than nominal size are used, the portion of rope that will seat in the thimble groove may be served with spun yarn or other suitable material to ensure a close fit.

6.3 Soft eyes. The minimum length of a soft eye under no load shall be as given in Appendix C.

NOTE A stirrup or half thimble may be fitted to protect the bearing surface of the soft eye.

7 Terminal fittings

7.1 Links. The SWL rating of master and intermediate links shall be as given in Figure 2. Master links shall be large enough to accommodate a crane hook in accordance with BS 2903 rated two steps greater than the maximum rating marked on the sling.

NOTE 1 Master and intermediate links are designed to withstand the rated SWL marked on the sling only within the range of included angle specified, e.g. 0° to 90°. They are not designed to withstand heavier loads at included angles less than 90°.

NOTE 2 Suitable designs for links are given in BS 2902 and BS 3458, and further advice on design is given in Appendix D of this standard.

7.2 Hooks. If hooks are used, they shall comply with the requirements of BS 2903.

NOTE If hooks of higher grade material are fitted, their dimensions may be smaller than those given in BS 2903 for the equivalent rating.

In all cases the SWL of the hook shall be not less than that of the leg to which it is attached.

If required by the purchaser, point hooks shall be fitted with a safety device to prevent displacement of the load.

7.3 Shackles. If shackles are permanently attached to the lower end of the sling, they shall comply with the requirements of BS 3032 or BS 3551.

NOTE If shackles of higher grade material are fitted, their dimensions may be smaller than those given in BS 3032 or BS 3551 for the equivalent rating.

In all cases the SWL of the shackle shall be not less than that of the leg to which it is attached.

7.4 Quality grade and treatment of terminal fittings. Master and intermediate links shall be of the same quality grade and shall be subjected to the same heat treatment.

8 Information to be given with enquiry or order

The following information shall be supplied by the purchaser when submitting an enquiry or order:

a) the group of rope from which the sling is to be manufactured (see clauses **12** and **14**);

NOTE If the group of rope is not specified, then slings made from general engineering rope to BS 302 or BS 3530 should be supplied.

b) the form of the sling leg(s) (see Figure 1);

c) the type of eye at each end (see Figure 1);

d) the terminal fittings, if any, at each end (see **7.2** and **7.3** and Figure 1 and Figure 2);

e) the dimensional details of the crane hook on which the master link is to be fitted (see **7.1** and Figure 3);

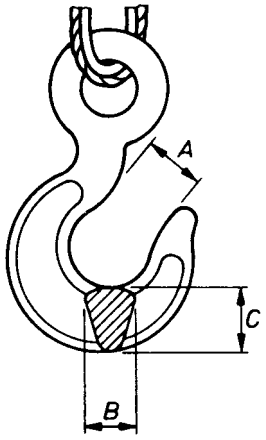
f) the number of legs and angle of use, i.e. 0° to 90° or 90° to 120° (see Figure 5 and Table 1 to Table 3);

g) the nominal length;

h) the SWL, and the factor of safety of the wire rope if greater than 5 (see clause **10** and Table 1 to Table 3);

i) whether SWL marking is required (see **10.5**);

j) whether proof load certificates are required [see clause **11** e)].



A is the throat opening
B is the width
C is the depth

Figure 3 — Crane hook

9 Testing

Before assembly all links and hooks shall have been proof loaded and a sample of the rope tested in accordance with the relevant standard. Where ferrule-secured eye terminations are used, each completed sling leg shall be proof tested to twice the SWL of the equivalent single-leg sling (see Table 1 column B or C, Table 2 column L, or Table 3 column S).

10 Identification and marking of the completed sling

10.1 All marking shall be durable and legible and shall be on

a) a durable tag or label firmly attached to the sling,

b) a durable ferrule securely attached to the sling, or

c) the master link.

10.2 For single-leg slings the marking shall comprise:

a) the numbers and/or letters identifying the sling with the certificate required by clause **11**, and

b) the SWL (see Appendix B).

10.3 For two-, three- and four-leg slings, the marking shall comprise:

a) the numbers and/or letters identifying the sling with the certificate required by clause **11**, and

b) the SWL or SWLs and the leg angle or angles for which they apply (see Figure 4).

NOTE If a multi-leg sling is designed for use at more than one combination of SWL and leg angle, each combination may be marked on a separate tag or label.

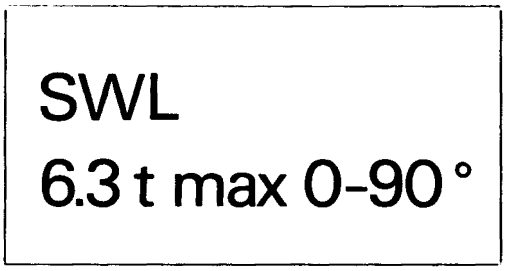


Figure 4 — Typical marking for SWL

10.4 The marking on the ferrule of a ferrule-secured eye termination or master link shall not be such as to impair its strength.

10.5 The manufacturer shall be responsible for the marking specified in **10.2** a) and **10.3** a). The user shall be responsible for ensuring that all other marking requirements are complied with [see clause **8** i)].

NOTE The user may request the manufacturer to carry out this work.

11 Certificate of test and examination

Every sling or batch of slings shall be provided with a dated test certificate(s) giving the following information:

a) the name of the maker or supplier;

b) the number of this British Standard, i.e. BS 1290[1)];

c) description of the sling (see clause **1**);

d) the SWL and the safety factor used to calculate it (see Appendix B);

e) a statement that the maker or supplier holds, and will make available on request, the certificates relating to the proof loading required by clause **9**;

NOTE The appropriate certificates, published by the Department of Employment under the Factories Act 1961, are Form 87 for wire rope and Form 97 for terminal fittings and proof testing.

f) the quality grade of the terminal fittings;

g) details of the tensile test to destruction carried out on a sample of rope from which the sling was made.

Section 2. Specific requirements for slings constructed from general engineering ropes

12 Rope construction

Slings shall be constructed from one of the following ropes, or from other rope complying with the requirements of BS 302 or BS 3530 and having an equal or greater MBL for an equivalent construction.

[1)] Marking BS 1290 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, Quality Assurance Division, BSI, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

British Standard	Construction	Diameter
		mm
BS 3530:1968		
Table 3	6 × 19 (12/6/1) FC	5 to 7
BS 302:1968		
Table 1	6 × 19 (9/9/1) FC	8 to 16
Table 2	6 × 19 (12/6 + F/1) FC	11 to 16
Table 4	6 × 26 to 6 × 41 series FC	13 to 40
Table 10	6 × 19 (9/9/1) IWRC	8 to 16
Table 11	6 × 19 (12/6 + 6 F/1) IWRC	11 to 16
Table 12	6 × 26 to 6 × 41 series IWRC	13 to 40

All constructions shall be ordinary lay.

13 Safe working load

The SWLs of slings constructed from general engineering ropes shall be as given in Table 1 (for fibre cores) or Table 2 (for steel cores).
See also Appendix B.

Table 1 — SWLs for slings constructed from ropes with fibre cores

Rope diameter	SWL									
	Single-leg slings		Multi-leg slings							
	Single-part terminated by ferrules or splices	Double-part endless or double-part grommet	Leg angle (see Figure 5) $0° \leqslant \alpha \leqslant 90°$ $0° \leqslant \beta \leqslant 45°$				Leg angle (see Figure 5) $90° < \alpha \leqslant 120°$ $45° < \beta \leqslant 60°$			
			Two-leg		Three- or four-leg		Two-leg		Four-leg	
			Single-part leg	Double-part leg	Single-part leg	Double-part leg	Single-part leg	Double-part leg	Single-part leg	Double-part leg
A	B	C	D	E	F	G	H	I	J	K
mm	t	t	t	t	t	t	t	t	t	t
5	0.276[a]	0.414[a]	0.386[a]	0.579[a]	0.579[a]	0.869[a]	0.276[a]	0.414[a]	0.414[a]	0.621[a]
6	0.398	0.597	0.557	0.836	0.836	1.2	0.398	0.597	0.597	0.895
7	0.542	0.813	0.759	1.1	1.1	1.7	0.542	0.813	0.813	1.2
8	0.762	1.1	1.0	1.5	1.6	2.3	0.762	1.1	1.1	1.6
9	0.962	1.4	1.3	1.9	2.0	2.9	0.962	1.4	1.4	2.1
10	1.2	1.8	1.7	2.5	2.5	3.8	1.2	1.8	1.8	2.7
11	1.4	2.1	1.9	2.9	2.9	4.4	1.4	2.1	2.1	3.1
12	1.7	2.5	2.4	3.5	3.5	5.2	1.7	2.5	2.5	3.7
13	2.0	3.0	2.8	4.2	4.2	6.3	2.0	3.0	3.0	4.5
14	2.3	3.5	3.2	4.9	4.8	7.3	2.3	3.5	3.4	5.2
16	3.0	4.5	4.2	6.3	6.3	9.4	3.0	4.5	4.5	6.7
18	3.8	5.7	5.3	8.0	8.0	11.9	3.8	5.7	5.7	8.5
19	4.3	6.4	6.0	8.9	9.0	13.4	4.3	6.4	6.4	9.6
20	4.7	7.1	6.6	9.9	9.8	14.9	4.7	7.1	7.0	10.6
22	5.7	8.6	8.0	12.0	11.9	18.0	5.7	8.6	8.5	12.9
24	6.8	10.2	9.5	14.3	14.3	21.4	6.8	10.2	10.2	15.3
26	8.0	12.0	11.0	16.8	16.8	25.2	8.0	12.0	12.0	18.0
28	9.3	14.0	13.0	19.6	19.5	29.4	9.3	14.0	13.9	21.0
32	12.1	18.2	16.9	25.5	25.4	38.2	12.1	18.2	18.1	27.3
35	14.5	21.8	20.3	30.5	30.4	45.8	14.5	21.8	21.7	32.7
36	15.4	23.1	21.5	32.3	32.3	48.5	15.4	23.1	23.1	34.6
38	17.1	25.7	23.9	36.0	35.9	53.9	17.1	25.7	25.6	38.5
40	19.0	28.5	26.6	39.9	39.9	59.8	19.0	28.5	28.5	42.7

NOTE 1 The coefficients used in calculating these values are set out in Appendix B.

NOTE 2 A cautionary note regarding the minimum diameter of bearing points for soft eyes is given in Appendix B.

[a] SWLs of less than 1.0 t are normally cited in kilograms (see Appendix B).

Table 2 — SWLs for slings constructed from ropes with steel cores

Rope diameter	SWL				
	Single-leg slings: single-part terminated by ferrules or splices	Multi-leg slings			
		Leg angle (see Figure 5) $0° \leqslant \alpha \leqslant 90°$ $0° \leqslant \beta \leqslant 45°$		Leg angle (see Figure 5) $90° < \alpha \leqslant 120°$ $45° < \beta \leqslant 60°$	
		Two-leg: single-part leg	Three- or four leg: single-part leg	Two-leg: single-part leg	Four-leg: single-part leg
A	L	M	N	P	R
mm	t	t	t	t	t
8	0.822[a]	1.1	1.7	0.822[a]	1.2
9	1.0	1.4	2.1	1.0	1.5
10	1.3	1.8	2.7	1.3	1.9
11	1.5	2.1	3.1	1.5	2.2
12	1.8	2.5	3.8	1.8	2.7
13	2.1	2.9	4.4	2.1	3.1
14	2.5	3.5	5.2	2.5	3.7
16	3.3	4.6	6.9	3.3	4.9
18	4.1	5.7	8.6	4.1	6.1
19	4.6	6.4	9.6	4.6	6.9
20	5.1	7.1	10.7	5.1	7.6
22	6.2	8.7	13.0	6.2	9.3
24	7.4	10.3	15.5	7.4	11.1
26	8.6	12.0	18.0	8.6	12.9
28	10.0	14.0	21.0	10.0	15.0
32	13.1	18.3	27.5	13.1	19.6
35	15.7	22.0	33.0	15.7	23.5
36	16.6	23.2	34.8	16.6	24.9
38	18.5	25.9	38.8	18.5	27.7
40	20.6	28.8	43.2	20.6	30.9

NOTE 1 The coefficients used in calculating these values are set out in Appendix B.

NOTE 2 A cautionary note regarding the minimum diameter of bearing points for soft eyes is given in Appendix B.

[a] SWLs of less than 1.0 t are normally cited in kilograms (see Appendix B).

Section 3. Specific requirements for slings constructed from galvanized marine ropes in accordance with BS 365

14 Rope construction

Slings shall be constructed from 6 × 24 fibre-cored rope of the type given in Table 4 of BS 365:1968.

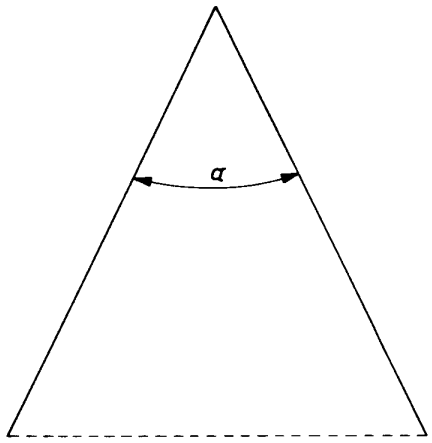
15 Safe working load

The SWLs of slings constructed from ropes in accordance with BS 365 shall be as given in Table 3. See also Appendix B.

Table 3 — SWLs for slings constructed from ropes in accordance with BS 365

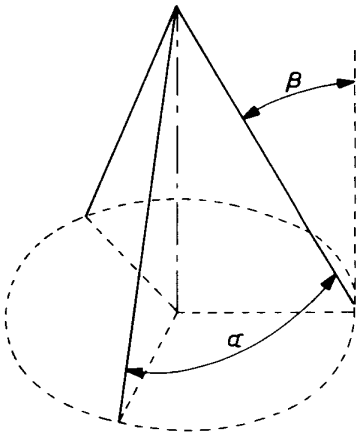
Rope diameter	SWL		
	Single-leg slings: single-part	Two-leg slings	
		Leg angle (see Figure 5) $0° \leqslant \alpha \leqslant 90°$	Leg angle (see Figure 5) $90° < \alpha \leqslant 120°$
A	S	T	V
mm	t	t	t
8	0.520[a]	0.728[a]	0.520[a]
10	0.812	1.1	0.812
12	1.1	1.5	1.1
14	1.6	2.2	1.6
16	2.1	2.9	2.1
18	2.6	3.6	2.6
20	3.2	4.5	3.2
22	3.9	5.4	3.9
24	4.7	6.6	4.7
26	5.5	7.7	5.5
28	6.3	8.8	6.3
32	8.3	11.6	8.3
36	10.5	14.7	10.5
40	13.0	18.2	13.0

[a] SWLs of less than 1.0 t are normally cited in kilograms, to the nearest kilogram.



α is the angle between the legs

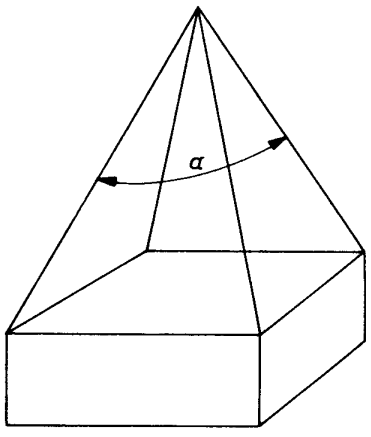
(a) Two-leg sling



α is taken as 2β

β is the maximum angle of any leg to the vertical

(b) Three-leg sling



α is the maximum angle between any two diagonally opposite legs

(c) Four-leg sling

Figure 5 — Leg angles of two-, three- and four-leg slings

Appendix A Forms of sling legs

A.1 Single-part ferrule-secured legs

Single-part ferrule-secured legs shall be formed in accordance with the requirements of BS 5281. The distance between the inside ends of the ferrules shall be not less than ten times the nominal rope diameter.

A.2 Single-part spliced legs

The splice shall have at least five tucks, three tucks with each whole strand of the rope and two tucks with one half of the wires cut out of each strand.

NOTE For ropes of 13 mm diameter and below, it is also permissible, as an alternative, to have four tucks with each whole strand of the rope and then one tuck with three whole strands only, the other three strands having been cut out.

The tucks shall be over and under against the lay of the rope, except that the first tuck only of each strand may be with the lay[2)]. The splice shall be tightly drawn and neatly made. That portion of the splice where the wires protrude shall be covered with serving strand, spun yarn or other suitable material to protect the user during handling. The distance between the tails of the splices shall be not less than ten times the nominal rope diameter.

A.3 Double-part spliced endless legs

The initial length of the straight rope shall be circled with the two ends overlapping. The ends shall then be spliced, each to each with a five tuck splice, making the complete splice ten tucks overall Each five tuck splice shall have three tucks with each whole strand of the rope, and two tucks with one half of the wires cut from each strand. All tucks shall be made over and under against the lay of the rope, except that the first tuck only of each strand may be with the lay.[2)] The splice shall be tightly drawn and neatly made.

At those portions of the spliced endless rope which will seat in the thimble grooves, the single part of the rope may be served with spun yarn to suit the grooves in the oversize thimbles, and to provide a foundation for the throat seizing. The length of each serving shall be such that in addition to the portion in contact with the thimble groove, it shall project three rope diameters beyond the throat seizing. That portion of the splice where the wires protrude shall be covered with seizing strand, spun yarn or other suitable material, to protect the user during handling.

One end of the served splice shall be adjacent to, but clear of, the thimble in the finished sling leg. The spliced endless rope shall have its two parts brought into parallel contact, with the two served portions forming a bight at each end. Thimbles shall be throat-seized close up to their points by means of suitable galvanized seizing strand.

The overall length of the throat seizing shall be not less than ten times the diameter of the single-part rope. The seizing shall be tightly drawn and neatly made. Where the length of the sling leg exceeds 100 rope diameters, a central seizing of not less than 3 rope diameters shall be provided. In the case of longer sling legs such intermediate seizings shall be provided at intervals not greater than 72 rope diameters. The effective length of a double-part endless sling shall be not less than 70 rope diameters when ordinary thimbles are used and not less than 75 rope diameters when using reeving thimbles.

A.4 Double-part endless furrule-secured legs

The appropriate length of rope shall be circled and the two ends overlapped by not less than 10 rope diameters. Two ferrules of a type specified in BS 5281, and appropriate to the diameter of a single-part rope, shall then be placed on to the overlapping ends. The adjacent ends of these ferrules shall be not less than 1.5 ferrule lengths apart and shall be pressed in accordance with the instructions of the ferrule sponsor. The position of the ferrules in relation to the eyes, and the bringing together of the two parts, and seizing shall be as specified in **A.3**.

A.5 Double-part grommet legs

The strand used to form the grommet shall be one of those used to form the ropes specified in Table 3 of BS 3530:1968 or Table 4 of BS 302:1968. The MBL of the strand shall be not less than 17.5 % of the MBL of the equivalent fibre-cored rope. The strand shall be laid into a grommet, the cross section of which shall be six strands over one central strand. Two ends of the strand shall butt in the core of the rope. The tuck shall be well and neatly made. The position of the tuck and seizings shall be as specified in **A.3**.

The effective length of a double-part grommet sling shall be not less than 40 diameters of the single part of the grommet when ordinary thimbles are used, and not less than 50 diameters when reeving thimbles are used.

NOTE to **A.3**, **A.4** and **A.5**. Thimbles are recommended for use with double-part legs (see **6.2** and **6.3**).

[2)] The starting or locking tuck counts as one full tuck.

Appendix B Basis for calculating the safe working load of wire rope slings

B.1 Coefficients

The SWLs given in Table 1, Table 2 and Table 3 have been calculated using the following coefficients.

Column of table	Base and coefficient
B	MBL × 0.2
C	MBL × 0.3
D	column B × 1.4
E	column C × 1.4
F	column B × 2.1
G	column C × 2.1
H	column B × 1.0
I	column C × 1.0
J	column B × 1.5
K	column C × 1.5
L	MBL × 0.2
M	column L × 1.4
N	column L × 2.1
P	column L × 1.0
R	column L × 1.5
S	MBL × 0.2
T	column S × 1.4
V	column S × 1.0

B.2 Safety factor

In this standard the SWLs for all slings are based on one fifth of the MBL of the rope. For well established technical reasons, the safety factor applied to component fittings such as links, hooks and shackles used for sling assemblies in either 4 or 5 according to the particular specification used.

B.3 Angle of sling legs

For multi-leg slings account has to be taken of the angle at which the sling is used. To obtain the SWL of a multi-leg sling, the SWL of the single-leg sling is multiplied by the appropriate coefficient as shown above. These coefficients have been agreed internationally.

B.4 Soft eyes and minimum diameter of bearing points

The SWLs given are based on the assumption that soft eyes of single-part slings are used over bearing points of not less than twice the nominal diameter of the rope, and that soft eyes of endless slings and grommets are used over bearing points of not less than four times the nominal diameter of the rope.

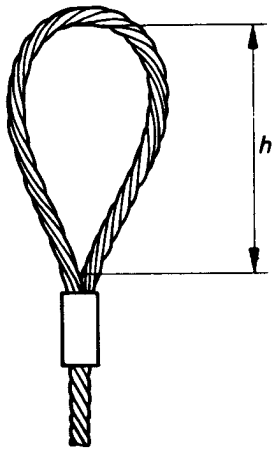
B.5 Source of MBL values

The MBLs on which columns B, C and L are based are taken from Table 3 of BS 3530:1968 (5 mm to 7 mm diameter rope); Table 1 (fibre core) and Table 10 (IWRC core) of BS 302:1968 (8 mm diameter rope); and Table 4 (fibre core) and Table 12 (IWRC core) of BS 302:1968 (9 mm to 40 mm diameter rope). The MBLs on which column S is based are taken from Table 4 of BS 365:1968.

B.6 Units and rounding of values

SWLs of less than 1.0 t are usually cited in kilograms, to the nearest kilogram. SWLs larger than 999 kg are cited in tonnes, to the nearest 0.1 t. Values up to and including 0.07 t are rounded downwards, and values over 0.07 t are rounded upwards.

Appendix C Minimum length of soft eyes



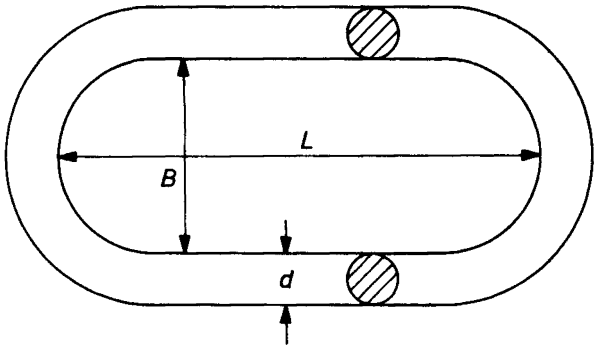
The minimum length of soft eyes, under no load, shall be as follows (see **6.3**).

Rope diameter	Length of soft eye	
	Hand spliced	Ferrule secured
mm	mm	mm
5	50	75
6	60	90
7	70	105
8	80	120
9	90	135
10	100	150
11	110	165
12	120	180
13	130	195
14	140	210
16	160	240
18	180	270
19	190	285
20	200	300
22	220	330
24	240	360
26	260	390
28	280	420
32	320	480
35	350	525
36	360	540
38	380	570
40	400	600

Appendix D Design of master links

NOTE This appendix is identical with the annex of ISO 4778:1981 and, for ease of reproduction, the ISO text has been used. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following. The comma has been used throughout this appendix as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

D.1 Links of circular cross-section



The following simple formulae[3)] may be used to design master links made of a material of circular cross-section; the diameter, d, of the material of the link is the larger of the two values obtained:

$$d = 0{,}2\,AB\left[6{,}7 + A - \frac{B}{L}\right] \quad \text{... (1)}$$

$$d = B\left[0{,}1 + A\,(1 + A) - 0{,}12\frac{L}{B}\right] \quad \text{... (2)}$$

where

L is the internal length of the link;

B is the internal breadth of the link;

$$A = \left[\frac{W}{fB^2}\right]^{1/3}$$

W being the working load limit of the link;[a]

f being the maximum nominal extreme fibre stress in the link under the working load limit.

[a] For the purposes of this British Standard, the working load limit may be taken as equal to the safe working load.

The units of d, L, B, W and f must be self-consistent.

The recommended values of f, in metric units, for the various grades of link are:

grade M: 315 MPa (N/mm^2)

grade P: 400 MPa (N/mm^2)

grade S: 500 MPa (N/mm^2)

grade T: 630 MPa (N/mm^2)

grade V: 800 MPa (N/mm^2)

L, B and d must be in millimetres and W must be in newtons, for the above units for f.

The above method represents the exact analysis of a link to within 2,5 % in all practical cases and the difference is seldom greater than 1,5 %.

The table below is presented as a guide in obtaining the cube root in A.

x	$x^{1/3}$
0,000 343	0,07
0,001 000	0,10
0,008 000	0,20
0,027 000	0,30
0,064 000	0,40
0,125 000	0,50
0,216 000	0,60
0,343 000	0,70
0,512 000	0,80
0,729 000	0,90
1,000 000	1,00

An example of the use of the above formulae is given below, using the following values:

f: 315 MPa (N/mm^2)

W: 126 500 N

L: 203 mm

B: 130 mm

$\frac{W}{fB^2}$: 0,023 76

$\left[\frac{W}{fB^2}\right]^{1/3}$: 0,287 5

Thus

d: 47,44 mm, from formula (1)

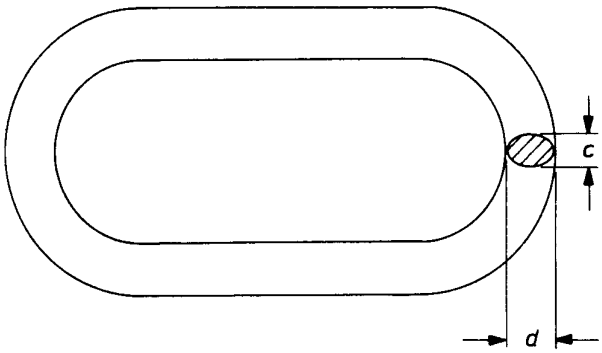
d: 36,76 mm, from formula (2)

The minimum value to use for d is the greater of the above i.e. 47,44 mm. In the majority of cases formula (1) will give a greater value for d than formula (2). However there is no simple rule whereby it is possible to predict the correct formula in any particular case. It is therefore recommended that both formulae be evaluated each time.

[3)] Developed at the National Physical Laboratory, United Kingdom.

D.2 Links of elliptical cross-section

The formulae described in **D.1** can also be used to design links made of a material of elliptical cross-section.



The axes of the ellipse are designated c and d as shown in the figure (c can be greater than or less than d). W, f, L and B are as in **D.1**.

The design procedure is as follows:

a) choose a value of the ratio d/c;

b) calculate A, which for the ellipse,

equals $\left[\frac{W}{fB^2} \times \frac{d}{c}\right]^{1/3}$;

c) calculate d as for the circular cross-section but using the value of A given in b) above;

d) calculate c from the chosen value of d/c;

e) should the above values of c and d not be suitable, a different value of the ratio d/c can be chosen.

Examples:

	a)	b)
f:	315 MPa (N/mm^2)	315 MPa (N/mm^2)
W:	126 500 N	126 500 N
L:	203 mm	203 mm
B:	130 mm	130 mm
$\frac{d}{c}$:	1,5	0,5

	a)	b)
$\frac{W}{fB^2} \times \frac{d}{c}$:	0,035 64	0,011 88

$\left[\frac{W}{fB^2} \times \frac{d}{c}\right]^{1/3}$: 0,329 1 0,228 2

Thus

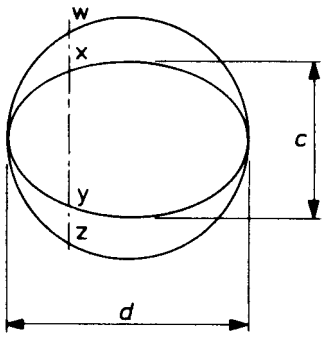
d =	54,67 mm	37,30 mm	from formula (1)
c =	36,44 mm	74,61 mm	
d =	45,50 mm	25,07 mm	from formula (2)
c =	30,34 mm	50,15 mm	

In both cases, the values of d and c found using the formula (1), being the higher, are the values to be used.

NOTE 1 The expressions for d were derived by fitting formulae to data obtained from the analytical stress analysis of links.

NOTE 2 The maximum tensile stress in a link will occur at one of two places, the extrados at the crown or the intrados where the straight and circular parts meet. d from formula (1) represents data for the former point and d from formula (2) for the latter. It is therefore necessary to choose the higher of d from formula (1) and d from formula (2) in order to design the link for the correct maximum stress.

NOTE 3 The use of the formulae for the elliptical cross-section is based on the fact that the stress at any point in a circular section is c/d times the stress at the equivalent point in an elliptical section. Axes c and d are as defined in **D.2** and d must have the same value in the circular as in the elliptical cross-section for the comparison to be valid. Therefore, the stress in the fibre wz of the circular section is c/d times that in fibre xy of the elliptical section, both fibres being the same distance from the axis of bending.



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Publications referred to

BS 302, *Wire ropes for cranes, excavators and general engineering purposes.*

BS 365, *Galvanized steel wire rope for ships.*

BS 464, *Thimbles for wire ropes.*

BS 2902, *Higher tensile steel chain slings and rings, links alternative to rings, egg links and intermediate links.*

BS 2903, *Specification for higher tensile steel hooks for chains, slings, blocks and general engineering purposes.*

BS 3032, *Higher tensile steel shackles.*

BS 3458, *Alloy steel chain slings.*

BS 3530, *Small wire ropes.*

BS 3551, *Alloy steel shackles.*

BS 5281, *Ferrule secured eye terminations for wire ropes.*

BS 6210, *Code of practice for the safe use of wire rope slings.*

ISO 3108, *Steel wire ropes for general purposes — Determination of actual breaking load.*

ISO 4778, *Chain slings of welded construction — Grades M(4), S(6) and T(8).*

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