BRITISH STANDARD

BS 6166-1: 1986

Lifting slings —

Part 1: Methods of rating

UDC 621.86.065

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Mechanical Handling Standards Committee (MHE/-) to Technical Committee MHE/11, upon which the following bodies were represented:

British Ports Association and the National Association of Ports Employers
Chain Testers' Association of Great Britain
Engineering Equipment and Materials Users' Association
Health and Safety Executive
Ministry of Defence

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Chain Manufacturers' Association
National Coal Board

This British Standard, having been prepared under the direction of the Mechanical Handling Standards Committee, was published under the authority of the Board of BSI and comes into effect on 29 August 1986

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The following BSI references relate to the work on this standard:
Committee reference MHE/11
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Amd. No.	Date of issue	Comments

Contents

Foreword

This Part of BS 6166 has been prepared under the direction of the Mechanical Handling Standards Committee. The purpose of this standard is:

a) to provide methods of rating for BSI Committees responsible for various types of lifting slings;

b) to provide a specification for the marking of lifting slings (see BS 6166-2);

c) to provide guidance to designers, manufacturers, importers, suppliers and users and to all who are concerned with the rating, selection and safe use of lifting slings (see BS 6166-3[1)]).

While there is a wide range of materials and constructions for lifting gear, there are certain factors relating to terminology and safe usage that should be specified on a common basis in the individual standards in order to assist the user. It is implied that the methods of rating will be adopted both in future revisions and in new British Standards in the field of lifting gear.

Account has been taken in preparing the methods of rating of the latest developments in the international standardization of lifting slings, such as ISO 4778, which is identical to BS 6304, for welded chain slings and ISO 4878, which is related to BS 3481-2, for flat woven webbing slings, together with some which are in preparation including ISO/DIS 7593[2)] for chain slings assembled by methods other than welding and ISO/DIS 7531[3)] for wire rope slings for general purposes, characteristics and specifications, and at national level the draft British Standard for round slings made of man-made fibre.

This standard, with Part 2, supersedes BS 6166:1981 "Rating of lifting gear for general purposes" which is withdrawn. It also deals with the subject matter of PD 6464 "Slinging practice" which was withdrawn in April 1978.

This revised edition of BS 6166 is published in the following three Parts.

— *Part 1: Methods of rating;*

— *Part 2: Specification for marking;*

— *Part 3: Guide to selection and safe use*[1)].

BS 6166-3 gives principles for the selection and use of general purpose slings and is based on appendix 1.6 of the Code of Practice for safe use of lifting equipment published by the Chain Testers Association of Great Britain to whom acknowledgement is made. Users wishing to obtain more detailed information are recommended to refer to the code which is obtainable from the Chain Testers Association of Great Britain, 21/23 Woodgrange Road, Forest Gate, London E7 8BA.

Attention is also drawn to a publication entitled "Recommendations for safe slinging" available from National Association of Port Employers, Commonwealth House, 1-19 New Oxford Street, London WC1A 1DZ or the General Council of British Shipping, 30/32 St Mary Axe, London EC3.

Commentary on legal requirements

Section 6 of the Health and Safety at Work etc. Act 1974 gives details of the general duties of manufacturers, etc. as regards articles and substances for use at work to ensure that as far as is reasonably practicable the article is so designed and constructed as to be safe and without risks to health when properly used. These duties include carrying out tests and examinations as may be necessary.

[1)] In preparation.

[2)] ISO/DIS 7593 Chain slings assembled by methods other than welding. [Grade T(8)] (in preparation)

[3)] ISO/DIS 7531 Wire rope slings for general purposes — Characteristics and specifications (in preparation)

Section 26(1) of the Factories Act 1961 requires that a table showing the safe working load of every chain, rope or lifting tackle in use, and, in the case of a multi-legged sling, the safe working load at different angles of the legs is posted in the store in which the chains, ropes or lifting tackle are kept and in prominent positions on the premises, and that no chain, rope or lifting tackle not shown in the table is used.

Section 26(2) stipulates that the requirements of Section 26(1)(b) do not apply to any lifting tackle if its safe working load, or, in the case of a multi-legged sling, the safe working load at different angles of the legs, is plainly marked upon it.

Regulation 38 of the Shipbuilding and Ship Repairing Regulations 1960 includes similar requirements to Section 26 of the Factories Act 1961.

Regulation 34 of the Construction (Lifting Operations) Regulations 1961 requires that all lifting gear is marked in plain legible figures and letters with the safe working load and with means of identification. Rope slings need not be marked with their safe working load if the sling is so identified that its SWL can be ascertained from the report of thorough examination.

Regulation 24 of the Docks Regulations 1934 requires that for chain slings the safe working load is marked in plain figures or letters upon the sling or upon a tag or ring of durable material attached securely to it. Wire rope slings are required to be marked either as for chain slings or notices are to be exhibited stating the safe working loads for the various sizes of wire rope slings in use.

NOTE 1 The Docks Regulations 1934 are under revision.

NOTE 2 The use of tables which may be some distance from the scene of the lifting operations both requires recognition of the sling size, grade of material and, in the case of a multi-legged sling, the sling angle and also requires correct interpretation of the tables before the maximum safe working load can be calculated. It may be considered that this places too much reliance on the human factor. For this reason British Standards normally require that lifting gear be marked with its safe working load; reliance is not placed on tables even though their use is legal.

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 to iv, pages 1 to 10, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Section 1. General

1.1 Scope

This Part of BS 6166 describes methods for the rating of lifting slings having either equal or unequal leg lengths.

Section 1 of the standard includes terminology, units, and general matters relating to rating of lifting slings.

Section 2 describes methods for the rating of lifting slings for multi-purposes based on the uniform load method, while section 3 covers the same subjects relating to lifting slings for a single purpose based on either the uniform load or the trigonometrical methods.

While these methods are primarily intended for lifting slings made in accordance with British Standards, they may also be applied to other lifting slings of a similar type.

Lists of British Standards for lifting slings and associated items are given in Appendix A for reference purposes.

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

1.2 Definitions

NOTE The relationship between the terms defined in **1.2.3** to **1.2.7** and the procedure for calculating the safe working load for either the uniform load or trigonometrical methods, are shown in Figure 1.

For the purposes of this Part of BS 6166 the following definitions apply.

1.2.1
lifting sling for multi-purposes

a sling that is intended for a variety of lifting operations and not designed for one specific lifting application

1.2.2
lifting sling for a single purpose

a sling that has been designed and is dedicated to one specific application and is not used for a variety of lifting purposes

1.2.3
load

load encompasses the concept of either mass or force and is expressed in the appropriate units (see **1.3**)

1.2.4
working load limit (WLL)

the maximum mass that a lifting sling is designed to raise, lower or suspend

NOTE 1 In some British Standards WLL or working load limit is referred to as "maximum safe working load".

NOTE 2 In the case of textile slings, this term is applied only to a single part of spliced rope or the basic configuration of stitched webbing or other material in straight tension and is a step in the calculation of the safe working load of a sling. A "textile sling" is a sling, the leg or legs of which are formed from natural or manmade fibres.

1.2.5
safe working load (SWL)

the maximum mass [as certified by a competent person (see **1.2.8**)] that a lifting sling may raise, lower or suspend under particular service conditions

1.2.6
minimum breaking (or failure) load (MBL)

the minimum load at which representative test pieces or samples are permitted to break as specified in the relevant British Standard from which are derived other values such as working load limit (WLL)

NOTE 1 See Figure 1.

NOTE 2 For some materials the minimum breaking load is specified in the relevant British Standard, e.g. for wire rope, but in the case of other materials it may have to be determined by a tensile test as specified in the British Standard for the finished product, e.g. webbing.

1.2.7
mode factor

a factor that takes into account the geometry of the sling assembly, the number of parts and other constants as specified in the appropriate British Standard for the product

1.2.8
competent person

the person concerned with the testing, examination and certification of a lifting sling, who has the requisite knowledge and experience to certify with confidence whether it is free from patent defect

1.3 Units

NOTE 1 *Units for tensile and/or compressive testing machines.* BS 1610 requires that testing machines employed to exert a tensile or a compressive force be calibrated in SI units of force, i.e. newtons. Machines calibrated in units of mass (either imperial or metric) are nevertheless expected to continue in use for some time, but it is recommended that the appropriate conversion be used and the results recorded in units of force. At a convenient time such machines should be recalibrated in SI units.

NOTE 2 *Units for test weights.* It is expected that the period during which imperial test weights are replaced by weights marked in kilograms or tonnes will be extended over many years. However, as opportunity arises, test weights should be marked in SI units of mass, i.e. kilograms and tonnes.

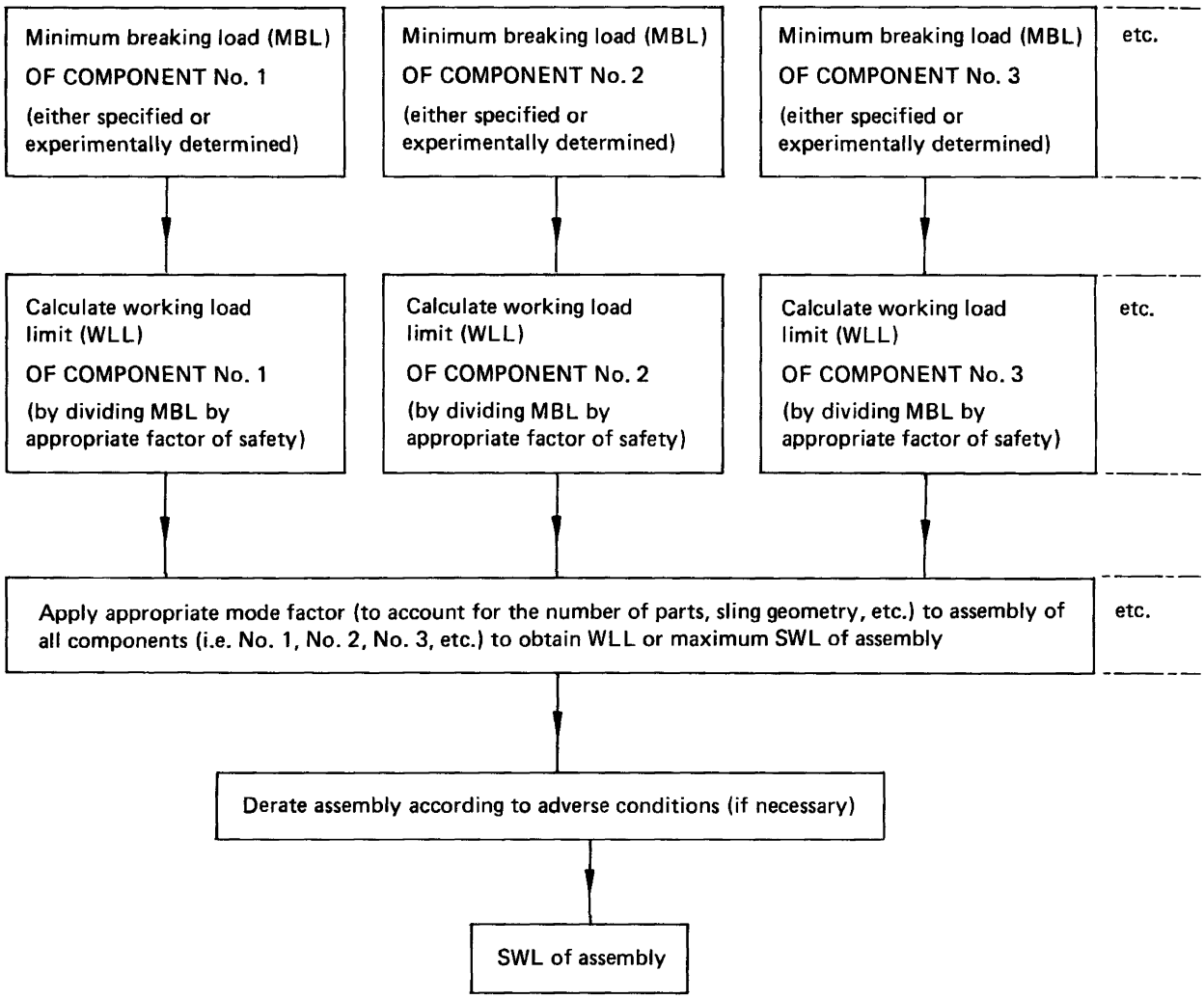
NOTE 3 As 1 tonne = 0.984 imperial tons, the units may be taken as equivalent for practical purposes.

1.3.1 Units on certificates

1.3.1.1 *General.* The requirements of **1.3.1.2** to **1.3.1.5** shall apply equally to statutory forms such as F 87[4] "Certificate of test and examination of wire rope" and F 97[4] "Certificate of test and examination of chains, chain slings, etc.", to certificates required by British Standards, to certificates required by EEC Directives, and to any other certificates unless a specific requirement to the contrary is stipulated.

1.3.1.2 *Minimum breaking (or failure) load.* The MBL shall be expressed in the SI unit of force or mass quoted in the relevant British Standard. If a testing machine calibrated in imperial units is used, the result shall be converted to the SI unit of force or mass if this is quoted in the relevant British Standard.

1.3.1.3 *Proof or test load.* When a proof or test load is applied by a testing machine, the load shall be expressed on the certificate in the SI unit of force or mass if this is quoted in the relevant British Standard. If a testing machine calibrated in imperial units is used, the results shall be converted to the appropriate SI unit of force or mass.



NOTE Where components of differing WLL or "max SWL" are incorporated into an assembly the lowest WLL or "max SWL" should be used.

Figure 1 — Relationship between terms

[4] Forms F87 and F97 are under revision at present.

If the load is applied by the use of test weights, the proof or test load shall be shown on the certificate in the SI units of mass quoted in the relevant British Standard. Imperial units shall be converted to SI units of mass, i.e. kilograms or tonnes.

1.3.1.4 *Working load limit.* The WLL shall be expressed in SI units of mass, i.e. kilograms or tonnes.

1.3.1.5 *Safe working load.* The SWL shall be expressed in the same system of units as the WLL (see **1.3.1.4**).

SWLs of less than 1 000 kg shall be marked in kilograms to the nearest whole kilogram. SWLs of 1 000 kg or more shall be marked in tonnes. Only one place of decimals shall be used, except for 1.25 t and 1.75 t; for integral values of SWL, the "0" after the decimal point shall be omitted (e.g. 5 t, not 5.0 t).

1.4 Rating

1.4.1 Methods of rating

The WLL (or maximum SWL where that terminology is used) shall be calculated in accordance with either the uniform load method or the trigonometrical method as appropriate (see sections 2 and 3).

1.4.2 Assumption on which single leg slings are rated

It is assumed that the terminal fittings are connected to the lifting appliance and the load attachment point in such a manner that the sling is not bent across or around the load, choked, back hooked or otherwise prevented from taking up a straight line under load.

1.4.3 Assumptions on which multi-leg slings are rated

The following are the assumptions on which multi-leg slings are rated. If they are complied with they will ensure that all legs of the sling carry an equal share of the load. Any departure from these criteria will usually result in an unequal distribution of load which may lead to one or more legs of the sling being overloaded even though the load lifted may be less than the SWL marked on the sling.

a) The sling legs are identical in all respects except that the lower terminal fittings may vary and also the leg lengths may vary in cases where the points of attachment to the load are not in the same horizontal plane.

NOTE The British Standards for multi-purpose slings normally specify equal leg lengths and identical lower terminal fittings.

b) The terminal fittings are connected to the lifting appliance and the load attachment points in such a manner that the legs are not bent across or around the load, choked, back hooked or otherwise prevented from taking up a straight line under load.

c) All sling legs are at the same angle to the vertical.

d) The angle or range of angles between the sling legs at which the sling is rated are not exceeded, e.g. the uniform load rated sling rated at 0 to 90 is not used at an angle in excess of 90° at that rating, or a trigonometrically rated sling rated at 60° is not used at an angle in excess of 60° at that rating.

e) The sling legs are symmetrically disposed in plan, i.e. three-legged slings, all angles between legs in plan view are equal [see Figure 2(a)] and for four-legged slings, the opposite angles between adjacent legs in plan are equal [see Figure 2(b)].

f) For four-legged slings the length of each leg exactly matches the position of the attachment points. This can be easily achieved in the case of a load which is sufficiently flexible, but more difficult to achieve in the case of a rigid load. If it is not achieved, most or all of the weight will be carried by only two legs of the sling.

1.4.4 Assumptions on which endless slings are rated

Endless slings are treated in two ways:

a) chain and wire rope endless slings where it is assumed that the sling will normally be used in the choked mode;

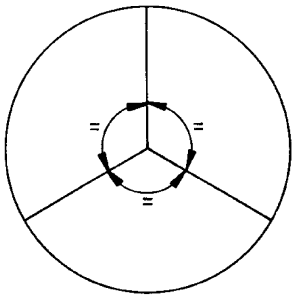
b) the textile slings of either webbing, fibre rope or round sling construction where it is assumed that the sling will normally be used in the in-line mode, i.e. straight pull.

In both cases it is also assumed that at the points of attachment to both the lifting appliance and the load the radii around which the sling passes are large enough to avoid damaging the sling. In the case of chain and wire rope slings the rating takes account of the chain or wire rope being bent around itself on the bight.

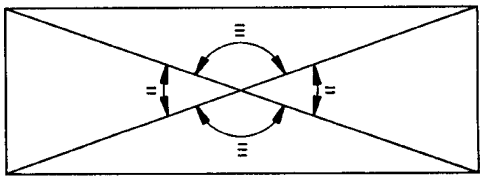
1.4.5 Deviations from assumptions on which slings are rated

In practice it may not be possible to comply with all the assumptions on which the sling is rated.

NOTE Guidance on the effects of deviating from the assumed conditions will be given in BS 6166-3.



NOTE All included angles are equal.
(a) Plan view of three-legged sling



NOTE Opposite included angles are equal.
(b) Plan view of four-legged sling

Figure 2 — Plan view of multi-legged slings

Section 2. Lifting slings for multi-purposes

2.1 Uniform load method

2.1.1 General

Lifting slings for multi-purposes shall be rated by the uniform load method as follows.

A multi-legged sling shall be rated for use at any included angle between the sling legs of up to 90° and for two-legged and four-legged slings, additionally at any included angle between 90° and 120°. The additional rating of three-legged slings at angles greater than 90° shall not be undertaken.

The master and intermediate links of slings designed specifically in accordance with the uniform load method shall be capable of supporting the maximum rated load marked on the sling at any angle between the particular included angles specified. They shall not be used to support greater loads at reduced angles.

NOTE 1 For details on marking of slings rated in accordance with the uniform load method, see clauses **3** and **5.1** of BS 6166-2:1986.

NOTE 2 An example of a lifting sling used for multi-purposes is shown in Figure 3.

2.1.2 Calculation of WLL (or SWL max.)

The WLL (or maximum SWL where that terminology is used) shall be calculated using mode factors as follows.

a) *Two-legged slings* used at an angle (α) between the sling legs (β to the vertical) [see Figure 4(a)]:

1) α not exceeding 90°: ($\beta \leqslant 45$ °C):
mode factor = 1.4

WLL = 1.4 × WLL of a single leg;

2) α between 90° and 120°: ($45° < \beta \leqslant 60°$):
mode factor = 1.0

WLL = 1.0 × WLL of a single leg.

b) *Three-legged slings* used at an angle (β) of any leg to the vertical not exceeding 45° [see Figure 4(b)]: mode factor = 2.1[5)]

WLL = 2.1 × WLL of a single leg.

c) *Four-legged slings* used at an angle (α) between diagonally opposite legs (β to the vertical) [see Figure 4(c)]:

1) α not exceeding 90°: ($\beta \leqslant 45°$):
mode factor = 2.1[5)]

WLL = 2.1 × WLL of a single leg;

2) α between 90° and 120°: ($45° < \beta \leqslant 60°$):
mode factor = 1.5

WLL = 1.5 × WLL of a single leg.

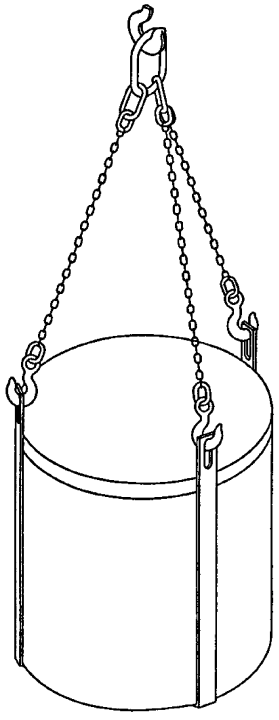
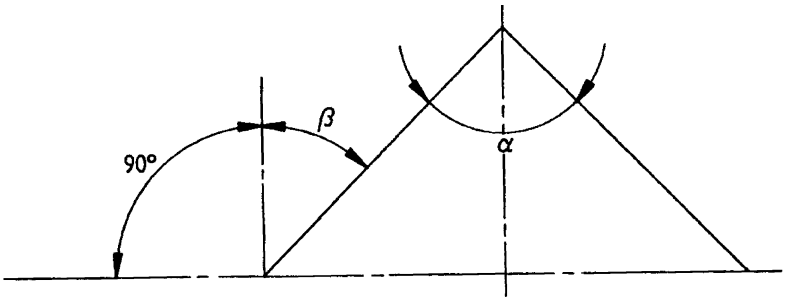


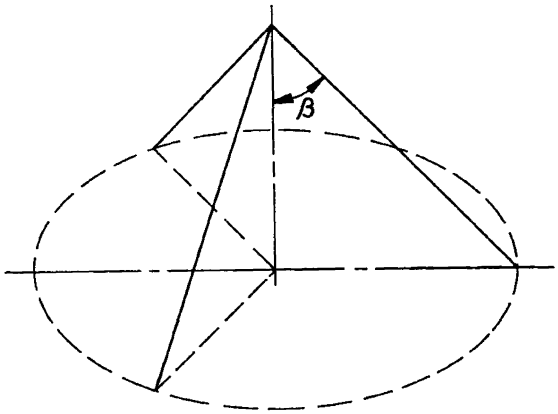
Figure 3 — Example of a lifting sling used for one of a multiple of purposes

[5)] In British Standards covering textile slings, this factor is given as 2.0.



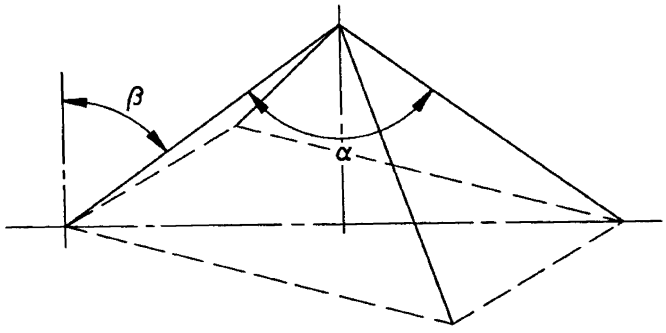
NOTE. $\alpha = 2\beta$
where
α is the included angle;
β is the angle of the leg to the vertical.

(a) Two-legged sling



NOTE. β is the angle of the leg to the vertical.

(b) Three-legged sling



NOTE. $\alpha = 2\beta$
where
α is the included angle between diagonally opposite legs;
β is the angle of the leg to the vertical.

(c) Four-legged sling

Figure 4 — Inclination of sling legs

Section 3. Lifting slings for a single purpose

3.1 General

Rating of lifting slings for a single purpose shall be undertaken by either the uniform load method (see **3.2**) or by the trigonometrical method (see **3.3**).

NOTE An example of a lifting sling used for a single purpose is shown in Figure 5.

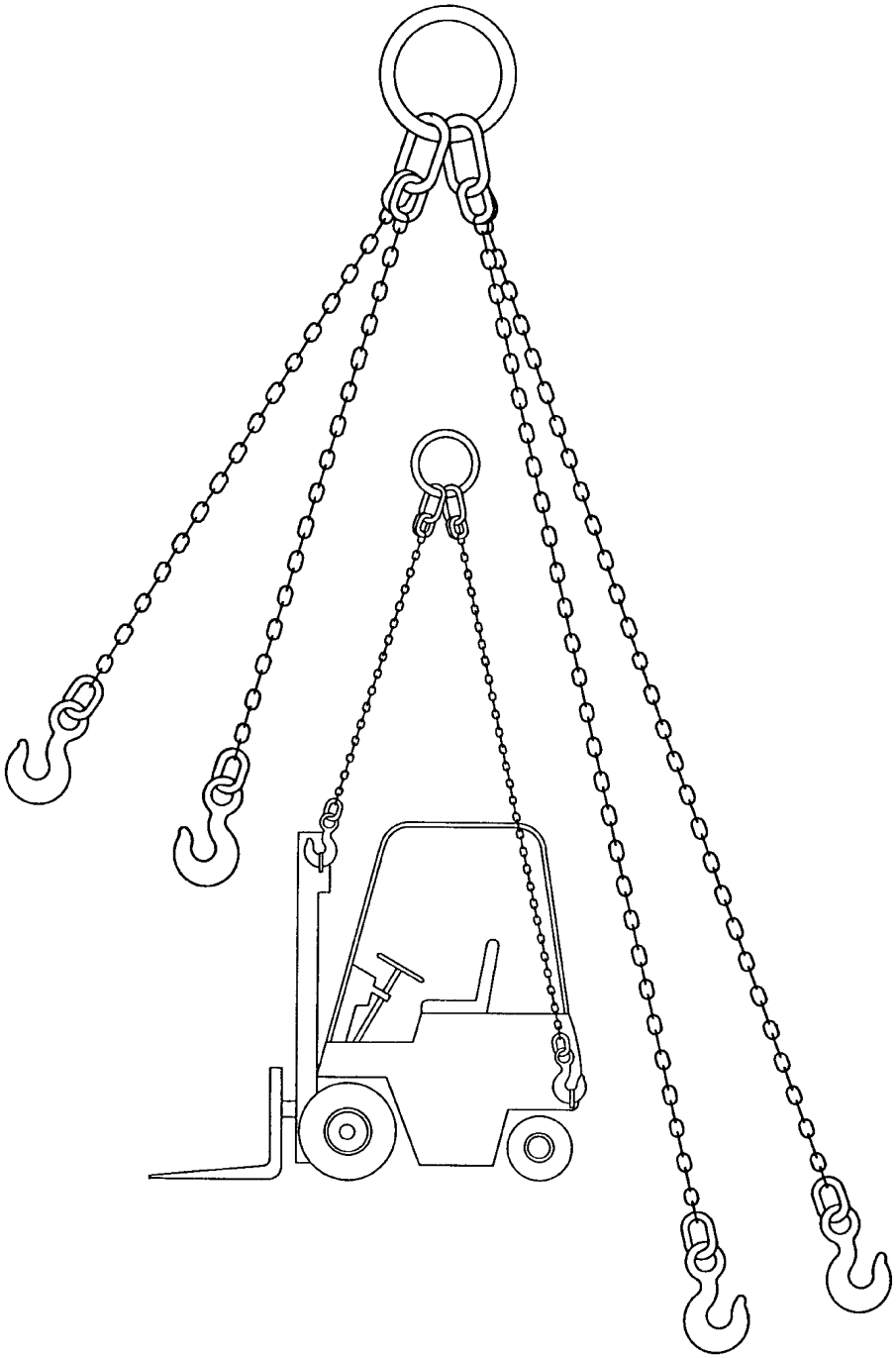


Figure 5 — Example of a lifting sling used for a single purpose

3.2 Uniform load method

3.2.1 General

The rating of lifting slings for a single purpose by the uniform load method shall be undertaken as follows.

A multi-legged sling shall be rated for use at any included angle between the sling legs of up to 90° and for two-legged slings and four-legged slings, additionally at any included angle between 90° and 120°. The additional rating of three-legged slings at angles greater than 90° shall not be undertaken.

The master and intermediate links of slings designated specifically in accordance with this method shall be capable of supporting the maximum rated load marked on the sling at any angle between the particular included angles specified. They shall not be used to support greater loads at reduced angles.

NOTE For details on marking of slings rated in accordance with the uniform load method, see clauses **3** and **5.1** of BS 6166-2:1986.

3.2.2 Calculation of WLL (or SWL max.)

The WLL (or maximum SWL where that terminology is used) shall be calculated using mode factors as follows.

a) *Two-legged slings* used at an angle (α) between the sling legs (β to the vertical) [see Figure 4(a)]:

1) α not exceeding 90°: ($\beta \leqslant 45°$):
mode factor = 1.4

WLL = 1.4 × WLL of a single leg;

2) α between 90° and 120°: ($45° < \beta \leqslant 60°$):
mode factor = 1.0

WLL = 1.0 × WLL of a single leg.

b) *Three-legged slings* used at an angle (β) of any leg to the vertical not exceeding 45° [see Figure 4(b)]: mode factor = 2.1[6)]

WLL = 2.1 × WLL of a single leg.

c) *Four-legged slings* used at an angle (α) between diagonally opposite legs (β to the vertical) [see Figure 4(c)]:

1) α not exceeding 90° ($\beta \leqslant 45°$):
mode factor = 2.1

WLL = 2.1 × WLL of a single leg;

2) α between 90° and 120°: ($45° < \beta \leqslant 60°$):
mode factor = 1.5

WLL = 1.5 × WLL of a single leg.

3.3 Trigonometrical method

3.3.1 General

The rating of lifting gear for a single purpose by the trigonometrical method as given in **3.3.2** shall form the basis of the tables referred to in note 2 of the foreword.

NOTE 1 For details on marking slings rated in accordance with the trigonometrical method, see clauses **3** and **5.2** of BS 6166-2:1986.

NOTE 2 The master link or ring and intermediate links or rings of slings designed in accordance with the trigonometrical method should be capable of supporting increased loads in proportion to the reduction in the included angle, up to the sum of the WLL of each of the legs.

3.3.2 Calculation of WLL (or SWL max.)

The WLL (or maximum SWL where that terminology is used) shall be calculated using mode factors as follows.

a) *Two-legged slings* used at an angle (α) between the sling legs (β to the vertical) [see Figure 4(a)]:

WLL = 2 × WLL of a single leg × cos β
(where the mode factor is 2 cos β).

b) *Three-legged slings* used at an angle (β) of any leg to the vertical not exceeding 45° [see Figure 4(b)]:

WLL = 3 × WLL of a single leg × cos β
(where the mode factor is 3 cos β).

c) *Four-legged slings* used at an angle (α) between diagonally opposite legs [see Figure 4(c)].

WLL = 4 × WLL of a single leg × cos β
(where the mode factor is 4 cos β).

NOTE The mode factor of 4 × WLL of a single leg × cos β referred to in item c) above should only be used for four-legged slings where the centre of gravity of the load is centrally placed with respect to the four attachment points and the load itself is flexible enough to ensure that the load in the four legs is equally distributed. If these conditions are not satisfied, then further consideration should be given to obtaining a sling of appropriate higher rating.

[6)] In British Standards covering textile slings, this factor is given as 2.0.

Appendix A British Standards for lifting slings and their uses

A.1 British Standards for various types of slings

BS 1290, *Specification for wire rope slings and sling legs for general lifting purposes.*

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

BS 3458, *Alloy steel chain slings.*

BS 3481, *Flat lifting slings.*

BS 3481-2, *Specification for flat woven webbing slings made of man-made fibre for general service.*

BS 3481-3, *Disposable flat lifting slings.*

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

BS 6304, *Specification for chain slings of welded construction: grades M(4), S(6) and T(8) (identical with ISO 4778).*

A.2 British Standards for items related to slings

BS 1663, *Higher tensile steel chain Grade 40 (short link and pitched or calibrated) for lifting purposes.*

BS 2052, *Specification for ropes made from manila, sisal, hemp, cotton and coir.*

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

BS 3113, *Alloy steel chain, grade 60. Short link, for lifting purposes.*

BS 3114, *Alloy steel chain, grade 80. Polished short link calibrated load chain for pulley blocks.*

BS 4928, *Specification for man-made fibre ropes.*

BS 4942, *Short link chain for lifting purposes.*

BS 4942-1, *Specification for general conditions of acceptance.* (identical with ISO 1834)

BS 4942-2, *Specification for grade M(4) noncalibrated chain.* (identical with ISO 1835)

BS 4942-3, *Specification for grade M(4) calibrated chain (identical with ISO 1836).*

BS 4942-4, *Specification for grade S(6) noncalibrated chain.* (identical with ISO 3075)

BS 4942-5, *Specification for grade T(8) noncalibrated chain.* (identical with ISO 3076)

BS 4942-6, *Specification for grade T(8) calibrated chain.* (identical with ISO 3077)

BS 6521, *Guide for proper use and maintenance of calibrated round steel link lifting chains.* (identical with ISO 7592)

A.3 British Standards related to cranes

BS 327, *Power-driven derrick cranes.*

BS 357, *Power-driven travelling jib cranes (rail-mounted low carriage type).*

BS 466, *Specification for power-driven overhead travelling cranes, semi-goliath and goliath cranes for general use.*

BS 1757, *Specification for power-driven mobile cranes.*

BS 2452, *High pedestal or portal jib cranes.*

BS 2799, *Power-driven tower cranes for building and engineering construction.*

BS 3579, *Heavy duty electric overhead travelling and special cranes for use in steel works.*

BS 5744, *Code of practice for safe use of cranes (overhead/underhung travelling and goliath cranes, high pedestal and portal jib dockside cranes, manually-operated and light cranes, container handling cranes and rail-mounted low carriage cranes).*

CP 3010, *Safe use of cranes (mobile cranes, tower cranes and derrick cranes).*

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Publications referred to

(See also Appendix A)

BS 1610, *Materials testing machines and force verification equipment.*
BS 3481, *Flat lifting slings.*
BS 3481-2, *Specification for flat woven webbing slings made of man-made fibre for general service.*
BS 6166, *Lifting slings.*
BS 6166-2, *Specification for marking.*
BS 6166-3, *Guide to selection and safe use*[7)].
BS 6304, *Specification for chain slings of welded construction: grades M(4), S(6) and T(8).*
ISO 4778, *Chain slings of welded construction — Grades M(4), S(6) and T(8)*[8)].
ISO 4878, *Flat woven webbing slings made of man-made fibre*[8)].

[7)] In preparation.
[8)] Referred to in the foreword only.

BSI — British Standards Institution

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