

Code of practice for

The selection, care and maintenance of steel wire ropes

UDC 679.73

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- Department of the Environment (Property Services Agency)
- Federation of Manufacturers of Construction Equipment and Cranes
- Federation of Wire Rope Manufacturers of Great Britain
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- Institution of Mechanical Engineers
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- Ministry of Defence
- National Association of Lift Makers
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This British Standard, having been prepared under the direction of the Mechanical Engineering Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 October 1986

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The following BSI references relate to the work on this standard:
Committee reference MEE/18
Draft for comment 81/78288 DC

ISBN 0 580 14259 0

Amendments issued since publication

Amd. No.	Date of issue	Comments
5737	September 1987	Indicated by a sideline in the margin

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Rope construction and characteristics	1
3 Rope terminations	5
4 Associated equipment	9
5 Rope selection	14
6 Handling, storage and installation	16
7 Examination, maintenance and discard criteria	18
Appendix A Publications giving guidance on specific usage of wire ropes	21
Appendix B Assessment of rope condition and discard criteria	21
Appendix C Diagrammatic illustration of possible defects to be considered during examination, with reference to different areas	24
Figure 1 — Components of a rope	1
Figure 2 — Examples of typical rope constructions	2
Figure 3 — Typical Seale strand rope	2
Figure 4 — Typical filler wire rope	2
Figure 5 — Typical Warrington-Seale strand rope	2
Figure 6 — Typical triangular strand ropes	3
Figure 7 — Examples of multi-strand ropes	3
Figure 8 — Ordinary lay rope	4
Figure 9 — Lang's lay rope	4
Figure 10 — Aide memoire to designations of lay	4
Figure 11 — Measuring one rope lay in a six-stranded rope	5
Figure 12 — Thimbles	6
Figure 13 — Stirrup	6
Figure 14 — Hand spliced eye	6
Figure 15 — Bordeaux connection	7
Figure 16 — Ferrule-secured eye termination	7
Figure 17 — Correct method of fitting wire rope grips	7
Figure 18 — Examples of swaged or pressed terminations	8
Figure 19 — Open conical socket	8
Figure 20 — Closed conical socket	8
Figure 21 — Wedge socket	9
Figure 22 — Proper method of locating rope anchorage point on a plain drum	11
Figure 23 — Drum groove design	12
Figure 24 — Sheave groove	13
Figure 25 — Sheave rope guard	13
Figure 26 — Maximum angle of fleet	14
Figure 27 — Correct methods of paying out rope	17
Figure 28 — Serving of ropes (before cutting)	17
Figure 29 — Transferring rope from reel to drum	18
Table 1 — Approximate efficiencies of wire rope terminations	5
Table 2 — Permanent constructional extension	15
Table 3 — Generally distributed broken wires: six and eight strand ropes in metal sheaves	22
Table 4 — Broken wires: multi-strand ropes in metal sheaves	23
Publications referred to	Inside back cover

Foreword

This code of practice has been prepared under the direction of the Mechanical Engineering Standards Committee. It gives guidance to users on the selection, care and maintenance of general purpose steel wire ropes, used on equipment or in industries not otherwise covered by specific British Standards and codes of practice.

A considerable proportion of wire rope usage is in the field of raising, lowering and suspending people or goods, but large quantities of rope are also used for supporting, winching and other general purposes. Most general purpose wire ropes are specified in BS 302, to which this code refers, but its recommendations are also applicable to other ropes used for general purposes.

The code also contains much that may be of use to designers of rope-using machinery.

The method of rating lifting slings is given in BS 6166-1, guidance on the safe use of wire rope slings for general lifting purposes in BS 6210, and on the safe use of cranes in BS 5744.

This code makes use of the internationally promoted designations for steel wire ropes as given in ISO 3578, and of the vocabulary of terms given in ISO 2532, published by the International Organization for Standardization (ISO).

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 24, 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.

1 Scope

This code of practice describes rope constructions, rope terminations and associated equipment and gives guidance on the selection, care and maintenance of general purpose steel wire ropes where they are used in circumstances not covered by other British Standards. Where British Standards exist for specific applications they should take precedence (see appendix A).

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

2 Rope construction and characteristics

2.1 Make up of a steel wire rope

Wire rope is composed of wires, strands and core. The wires are helically laid together to form a strand. The required number of strands are then helically closed together around the core to form a wire rope (see Figure 1).

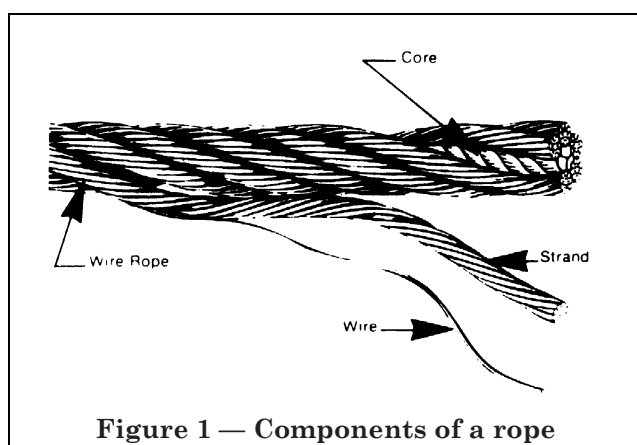


Figure 1 — Components of a rope

2.2 Cores

There are generally two types of core, fibre and steel. Basically each serves the same purpose, to afford support to the strands laid round it.

Fibre cores (FC) can be either natural or man-made fibre. Certain man-made fibres (e.g. polypropylene) have the advantage that they neither absorb nor retain moisture.

A steel core is usually an independent wire rope core (IWRC) around which the outer strands are laid. In rope sizes smaller than 13 mm diameter, however, a wire strand core (WSC) might be used.

Size for size, a rope with a steel core is stronger than a rope with a fibre core. A rope with a steel core is also more resistant to deformation, crushing and stretch than a fibre cored rope.

2.3 Rope construction

2.3.1 General. General purpose steel wire ropes complying with BS 302 are basically of three types: round strand, triangular strand and multi-strand. All three types of rope are made with cores of either fibre or steel.

Strand constructions have traditionally been known by name and by numerical designation, e.g. 6×36 Warrington-Seale, or 6×36 (14/7 and 7/7/1) FC.

This example describes a rope having six strands and a fibre core, each strand comprising 36 wires, with the outer layer having 14 wires, the second layer seven large and seven smaller wires, the inner layer seven wires around one king wire (see 2.3.2).

2.3.2 Round strand ropes. The strands of round strand ropes are of two types, equal lay or cross lay. In equal lay strands, the wires in the outer layer lie either in the valleys between the wires of the inner layer or along the crowns of the underlying wires, Figure 2(a). In cross lay strands, the wires of the outer layer cross over the crowns of the underlying wires, Figure 2(b).

For a given rope diameter and wire tensile grade, equal lay ropes have a higher breaking load, better bend fatigue performance and better resistance to crushing. For general purposes, equal lay ropes have almost entirely superseded cross lay ropes except in the smaller sizes.

The equal lay round strand ropes specified in BS 302 have three basic strand constructions.

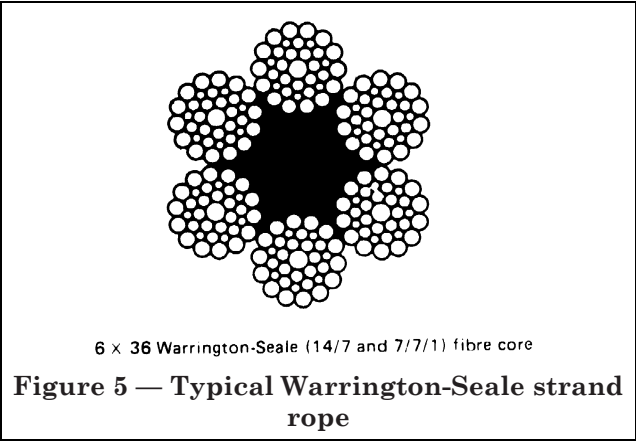
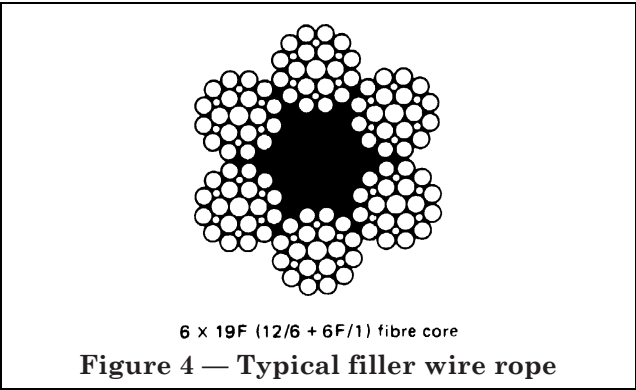
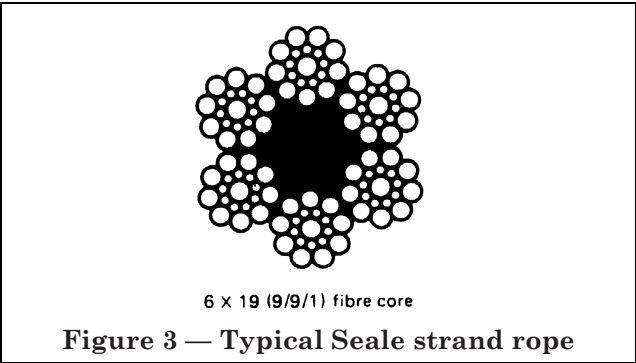
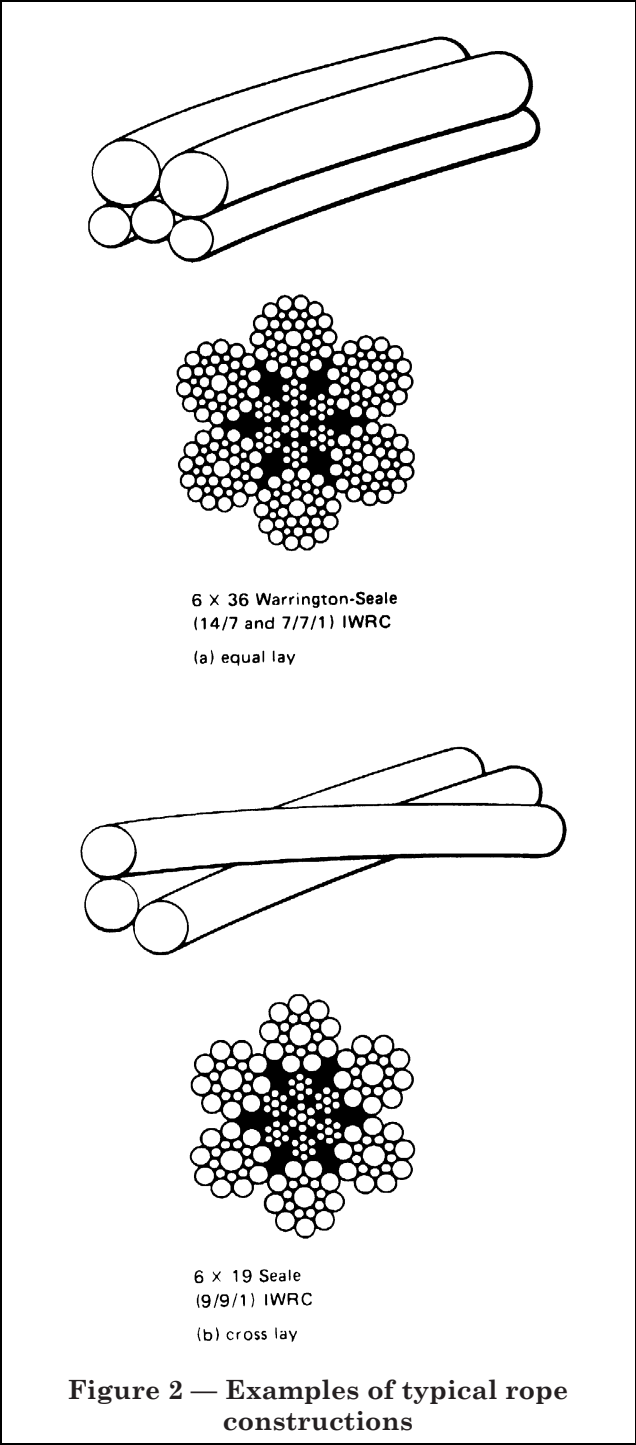
a) *Seale*. In this construction, the strands have two layers of wire around a king wire both layers having the same number of wires and the same length of lay (see Figure 3).

b) *Filler*. In this construction, the strands have two layers of wires around a king wire, with twice as many wires in the outer layer as in the inner layer. Both layers have the same length of lay.

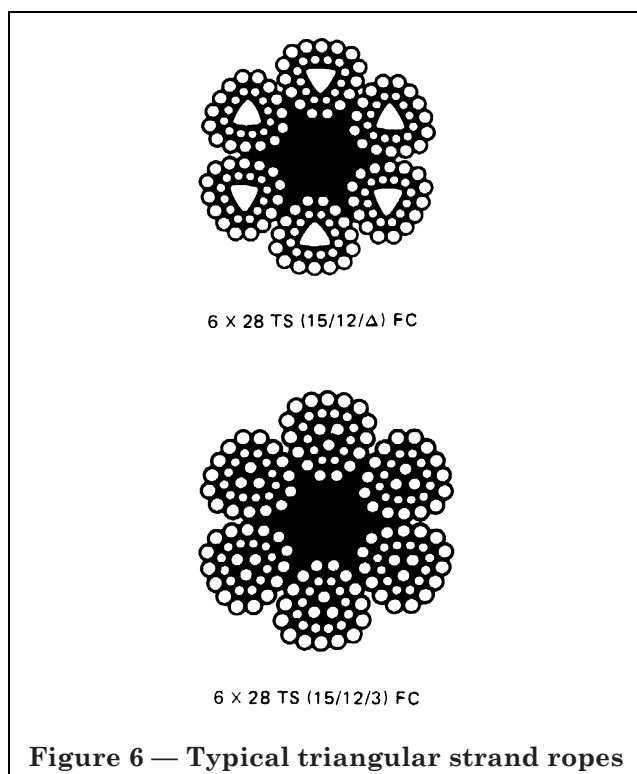
Additional comparatively small wires (filler wires) are incorporated in the valleys of the six inner wires to support and correctly position the outer layer of wires. The filler construction is indicated in designation by the sign “+” (see Figure 4).

c) *Warrington-Seale*. In this construction, the strands have three layers of wire around a king wire. In the 6×36 construction, for example, there are seven wires of equal size in the inner layer, 14 in the intermediate layer, being alternately large and small (Warrington layer) covered with 14 wires all of the same size (Seale layer). All three layers have the same length of lay.

Warrington construction uses the word “and” or “&” in designation to indicate the strand make up (see Figure 5).



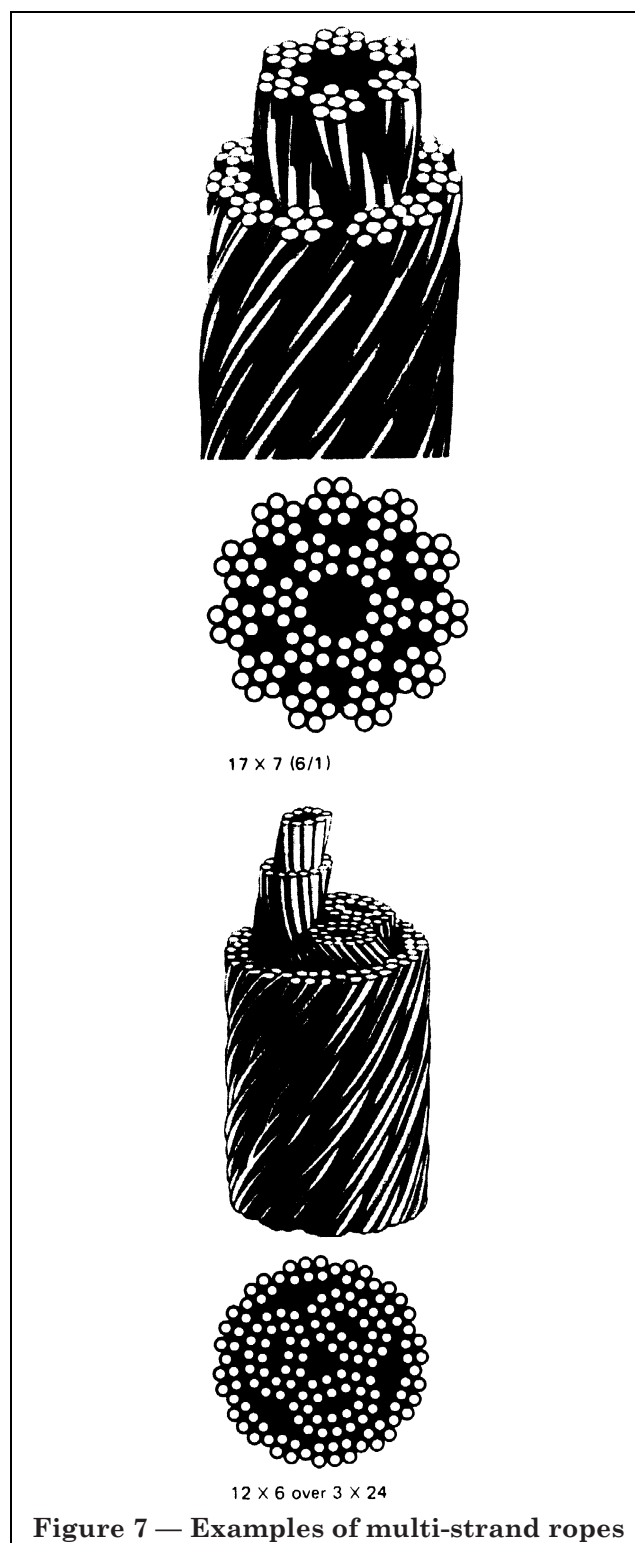
2.3.3 Triangular strand ropes. These ropes are built up from triangular strands and are of Lang’s lay construction (see 2.4.1). The wires forming the strands are laid on a triangular shaped core. The core is formed by a single triangular shaped wire or by using three or more round wires formed into a triangular shape. For construction notational purposes the latter are counted as one wire (see Figure 6).



2.3.4 Multi-strand ropes. This type of rope has two or more layers of strands which are laid in opposite directions so that their rotational tendencies under load act in opposition. The type of lay (see 2.4) in the outer and inner layers is at the discretion of the rope manufacturer (see Figure 7).

Although these ropes are referred to as non-rotating, low rotation, or anti-spinning, it should be recognized that these are relative terms, since all such constructions have some tendency to rotate under load. The preferred term is rotation resistant.

Multi-strand ropes require greater than normal care when being handled, prior to, during and after installation. For advice when fitting multi-strand ropes, see 6.3.2.



2.4 Types of rope lay

2.4.1 *Ordinary lay and Lang's lay ropes.* An ordinary lay rope is one in which the strand wires are laid in one direction and the completed strands are laid in the rope in the opposite direction (see Figure 8).

A Lang's lay rope is one in which the strand wires are laid in the same direction as the strands in the rope (see Figure 9).

The Lang's lay construction exposes the outer wires for a longer length than the ordinary lay and hence gives better wear properties. The ordinary lay is more stable, easier to handle and more resistant to crushing and distortion.

2.4.2 *Right-hand and left-hand lay ropes.* The terms "right-hand" and "left-hand" denote the direction in which the strands are spun into the rope. The majority of ropes are supplied right-hand lay; left-hand lay ropes are supplied only to meet specific requirements.

2.4.3 *Designation of lay.* The directions of lay of wires and strands in a rope are depicted by two letters, Z and S.

The letter Z indicates right-hand lay, and the letter S indicates left-hand lay.

Combinations of these two letters can then be used to designate the four different lay constructions that are available in round strand ropes. The first letter indicates the direction of the strands in the rope, and the second letter the direction of the wires in the strand (see Figure 10).

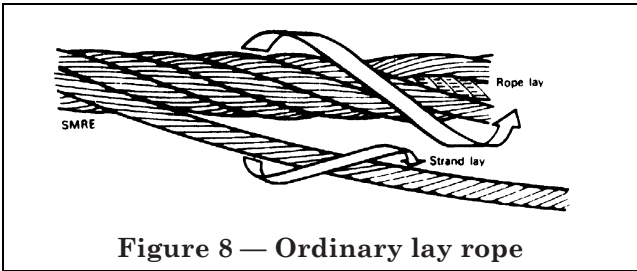


Figure 8 — Ordinary lay rope

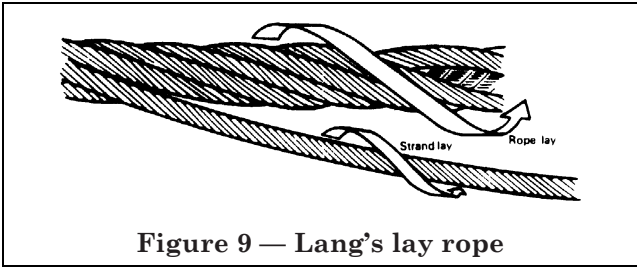


Figure 9 — Lang's lay rope

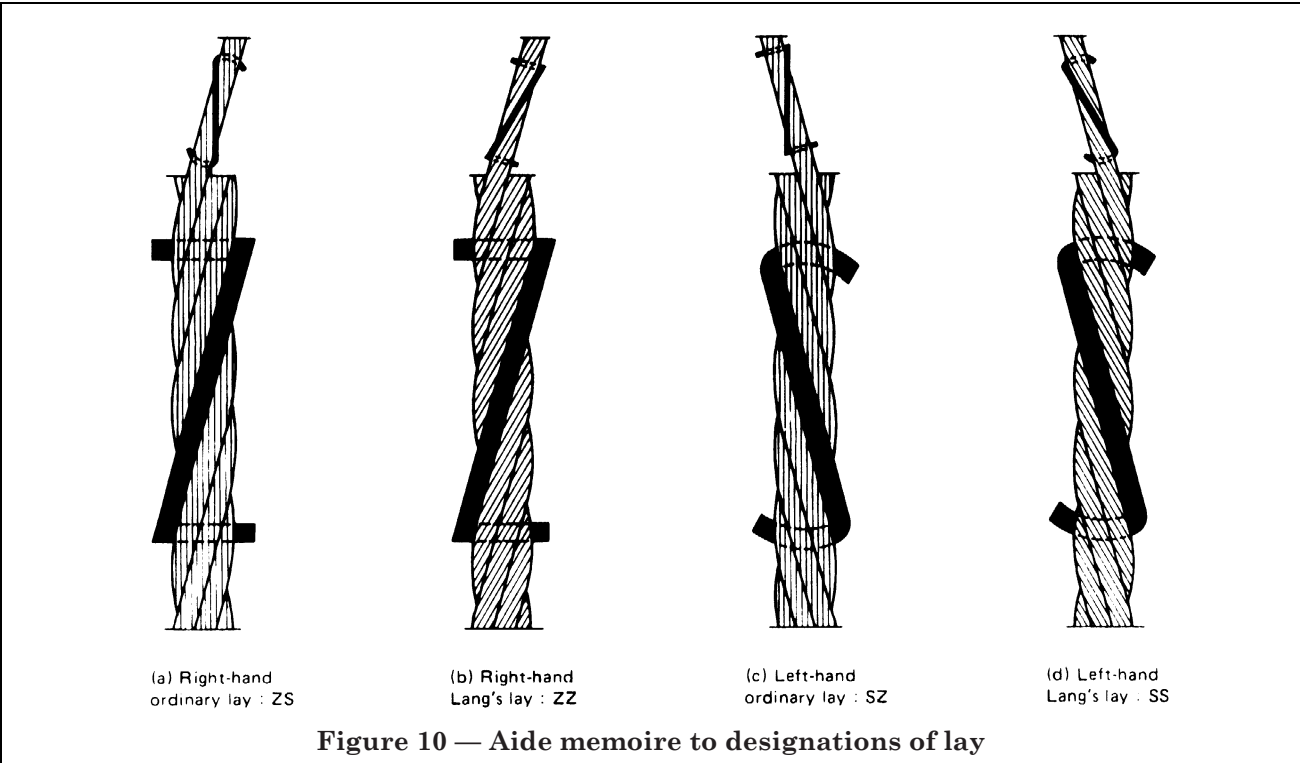


Figure 10 — Aide memoire to designations of lay

2.4.4 Length of lay. The length of lay is the distance measured parallel to the longitudinal axis or centreline of a rope, in which a strand makes one complete spiral around the axis.

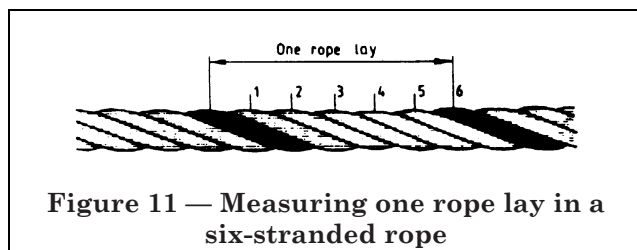


Figure 11 — Measuring one rope lay in a six-stranded rope

2.5 Preformed ropes

In a preformed wire rope, the finished strands are formed into the helical shape they will assume in the finished rope, thus lying naturally in their true position without constraint. All ropes complying with BS 302, with the exception of multi-strand ropes, are supplied preformed unless specifically ordered as non-preformed.

2.6 Wire finish and corrosion protection

For the majority of steel wire ropes the only protection afforded against corrosion is the lubricant introduced during manufacture and the rope dressings applied during the life of the rope.

However, some environments may call for a greater degree of corrosion protection and in these instances galvanized (zinc coated) wires may be used.

3 Rope terminations

3.1 General

There are two forms of rope termination which permit the connection of wire ropes to other components. These are:

- a) by forming an eye at the end of a rope;
- b) by use of fittings attached to the rope.

Eyes are made either by conventional splicing of the rope, or by forming a Flemish eye and securing with a ferrule, or by “turning back” the end of the rope and securing by clamps, grips or ferrules.

Fittings attached directly to the ends of wire ropes may be conical sockets, wedge sockets, swaged or pressed terminations.

All types of termination should be made only by properly trained and competent persons and for some types special equipment is needed.

Different types of terminations have different efficiencies, see Table 1.

Table 1 — Approximate efficiencies of wire rope terminations

Type of termination	Efficiency as percentage of the minimum breaking load of the rope
	%
<i>Permanent</i>	
Eyes with hand splicing and Bordeaux connections with hand splicing (BS 461)	70 to 90
Ferrule-secured eye terminations (FSET) (BS 5281)	≥ 90
Swaged or pressed steel terminations	≥ 95 %
Conical sockets, e.g. zinc, white metal or resin (BS 463)	100
<i>Temporary</i>	
Eyes with wire rope grips (BS 462)	See 3.2.5
Wedge sockets (HSE Guidance Note PM 46)	See 3.3.3

3.2 Eyes

3.2.1 General. Eyes can be formed by any of the methods described in 3.2.2 to 3.2.5.

Eyes can be plain, but should be fitted whenever possible with thimbles or stirrups to prevent the rope in the eye being damaged or being bent over too small a radius.

The grooving of a thimble or stirrup should be of the proper size for the rope.

In BS 464 three types of thimble are specified: ordinary, reeving and solid. The general form is as shown in Figure 12(a).

Reeving thimbles are normally used when there is a requirement to pass one eye through the other [see Figure 12(b)].

One object of the use of solid thimbles is to provide a compact connection free from excessive movement. A centre hole, which is unnecessarily large for the relevant pin will not achieve the objective [see Figure 12(c)]. Attention should be paid to this aspect when specifying a solid thimble.

There are also various types of proprietary stirrup. A typical example is shown in Figure 13.