

## Product Safety: Instructions & Warnings on the use of steel wire rope

### **⚠ WARNING**

**Failure to carry out or pay attention to any of the above could result in a loss of strength and/or a reduction in performance. In extreme cases the rope may be unfit for safe use.**

### 2. Certification and Marking

Make sure that the relevant Certificate has been obtained before taking the rope into use for a lifting operation. (Refer to statutory requirements)

Check to verify that the marking on the rope or its package matches the relevant Certificate.

*Note: The rating of a component part of a machine or lifting accessory is the responsibility of the designer of the machine or accessory. Any re-rating of a lifting accessory must be approved by a competent person.*

Retain the Certificate in a safe place for identification of the rope when carrying out subsequent periodic statutory examinations in service. (Refer to statutory requirements)

### 3. Handling and Installation

**3.1** Handling and installation of the rope should be carried out in accordance with a detailed plan and should be supervised by a competent person.

### **⚠ WARNING**

**Incorrectly supervised handling and installation procedures may result in serious injury to persons in the vicinity of the operation as well as those persons directly involved in the handling and installation.**

**3.2** Wear suitable protective clothing such as overalls, industrial gloves, helmet, eye protectors and safety footwear (and respirator, particularly where the emission of fumes due to heat is likely).

### **⚠ WARNING**

**Failure to wear suitable protective clothing and equipment may result in skin problems from over exposure to certain types of rope lubricants and dressings; burns from sparks, rope ends, molten lubricants and metals when cutting ropes or preparing sockets for re-use; respiratory or other internal problems from the inhalation of fumes when cutting ropes or preparing sockets for re-use; eye injuries from sparks when cutting ropes; lacerations to the body from wire and rope ends; bruising of the body and damage to limbs due to rope recoil, backlash and any sudden deviation from the line of path of rope.**

**3.3** Ensure that the correct rope has been supplied by checking to see that the description on the Certificate is in accordance with that specified in the purchaser's order.

**3.4** Check by measurement that the nominal diameter of the new rope conforms to the nominal size stated on the Certificate.

For verification purposes, measure the diameter by using a suitable rope vernier fitted with jaws broad enough to cover not less than two adjacent strands. Take two sets of measurements spaced at least 1 metre apart, ensuring that they are taken at the largest cross-sectional dimension of the rope. At each point take measurements at right angles to each other.

The average of these four measurements should be within the tolerances specified in the appropriate Standard or Specification.

For a more general assessment of rope diameter use a rope calliper. (See Fig 1)

**3.5** Examine the rope visually to ensure that no damage or obvious signs of deterioration have taken place during storage or transportation to the installation site.

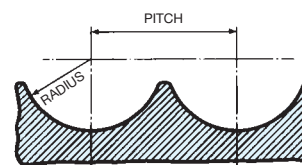
**3.6** Check the working area around the equipment for any potential hazards which may affect the safe installation of the rope.

**3.7** Check the condition of the rope-related equipment in accordance with the OEM's instructions. Include the following -

#### Drum

Check the general condition of the drum.

If the drum is grooved, check the radius and pitch and ensure that the grooves will satisfactorily accommodate the size of the new rope (see Fig 3)



Check the condition and position of the kicker plates or wear plates, if fitted, to ensure that the new rope will spool correctly on the drum.

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### Sheaves

Ensure that the grooving is of the correct shape and size for the new rope

Check that all sheaves are free to rotate and in good condition.

### Rope guards

Check that any rope guards are correctly fitted and are in good condition.

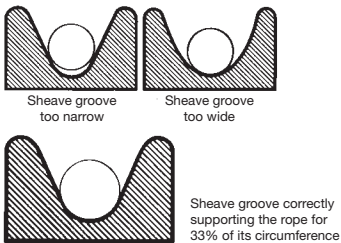
Check the condition of any wear plates or rollers which are protecting structural members.

### **WARNING**

**Failure to carry out any of the above could result in unsatisfactory and unsafe rope performance.**

*Note: Grooves must have clearance for the rope and provide adequate circumferential support to allow for free movement of the strands and facilitate bending. When grooves become worn and the rope is pinched at the sides, strand and wire movement is restricted and the ability of the rope to bend is reduced. (See Fig. 4)*

Fig 4



When a new rope is fitted a variation in size compared with the old worn rope will be apparent. The new rope may not fit correctly into the previously worn groove profile and unnecessary wear and rope distortion is likely to occur. This may be remedied by machining out the grooves before the new rope is installed. Before carrying out such action the sheaves or drum should be examined to ensure that there will be sufficient strength remaining in the underlying material to safely support the rope.

The competent person should be familiar with the requirements of the appropriate application/machinery standard.

*Note: General guidance to users is given in ISO 4309 Code of practice for the selection, care and maintenance of steel wire rope.*

Transfer the wire rope carefully from the storage area to the installation site.

### Coils

Place the coil on the ground and roll it out straight ensuring that it does not become contaminated with dust/grit, moisture or any other harmful material. (See Fig. 5)

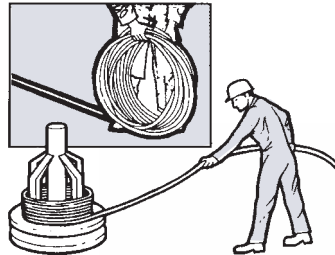


Fig 5

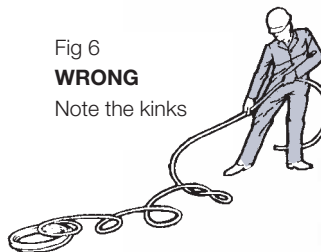
If the coil is too large to physically handle it may be placed on a 'swift' turntable and the outside end of the rope pulled out allowing the coil to rotate. (See Fig. 5)

### **WARNING**

**Never pull a rope away from a stationary coil as this will induce turn into the rope and kinks will form. These will adversely affect rope performance. (See Fig. 6)**

Fig 6

**WRONG**  
Note the kinks



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### Reels

Pass a shaft through the reel and place the reel in a suitable stand which allows it to rotate and be braked to avoid overrun during installation. Where multi-layer coiling is involved it may be necessary for the reel to be placed in equipment which has the capability of providing a back tension in the rope as it is being transferred from reel to drum. This is to ensure that the underlying (and subsequent) laps are wound tightly on the drum. (See Fig. 7)

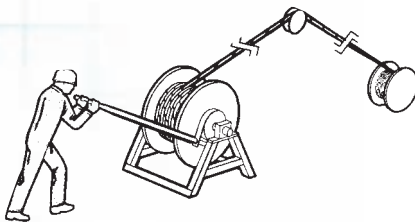


Fig 7

Position the reel and stand such that the fleet angle during installation is limited to 1.5 degrees. (See Fig. 8)

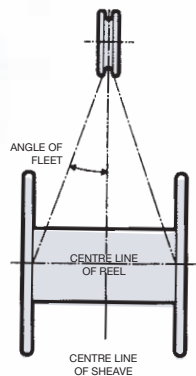


Fig 8

If a loop forms in the rope ensure that it does not tighten to form a kink.

### **WARNING**

**A kink can severely affect the strength of a six strand rope and can result in distortion of a rotation-resistant or low rotation rope leading to its immediate discard.**

Ensure that the reel stand is mounted so as not to create a reverse bend during reeving (i.e. for a winch drum with an overlap rope, take the rope off the top of the reel). (See Fig. 7)

**3.9** Ensure that any equipment or machinery to be roped is correctly and safely positioned and isolated from normal usage before installation commences. Refer to the OEM's instruction manual and the relevant 'Code of Practice'.

**3.10** When releasing the outboard end of the rope from a reel or coil, ensure that this is done in a controlled manner. On release of the bindings and servings used for packaging, the rope will want to straighten itself from its previously bent position. Unless controlled, this could be a violent action. Stand clear.

### **WARNING**

**Failure to control could result in injury.**

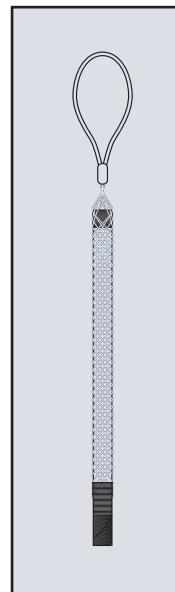


Fig 9

Ensure that the as-manufactured condition of the rope is maintained during installation.

If installing the new rope with the aid of an old one, one method is to fit a wire rope sock (or stocking) to each of the rope ends. Always ensure that the open end of the sock (or stocking) is securely attached to the rope by a serving or alternatively by a clip (See Fig. 9). Connect the two ends via a length of fibre rope of adequate strength in order to avoid turn being transmitted from the old rope into the new rope. Alternatively a length of fibre or steel rope of adequate strength may be reeved into the system for use as a pilot/messenger line. Do not use a swivel during the installation of the rope.

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- 3.11** Monitor the rope carefully as it is being pulled into the system and make sure that it is not obstructed by any part of the structure or mechanism which may cause the rope to come free.

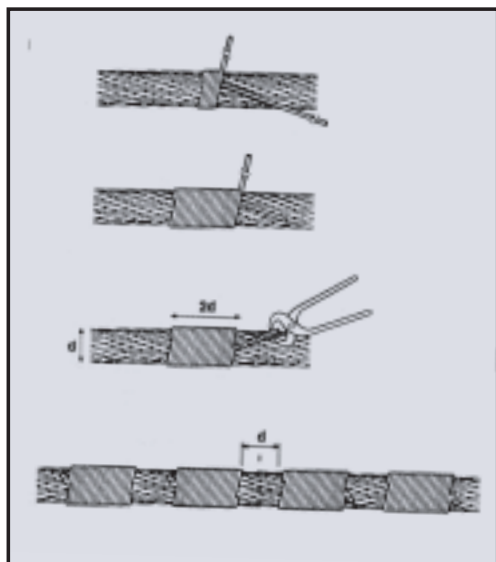


Fig 10

### **WARNING**

**Failure to monitor during this operation could result in injury.**

This entire operation should be carried out carefully and slowly under the supervision of a competent person.

- 3.12** Take particular care and note the manufacturer's instructions when the rope is required to be cut. Apply secure servings on both sides of the cut mark. (See Fig. 10 for typical method of applying a serving to a multi-layer rope.)
- Ensure that the length of serving is at least equal to two rope diameters. (Note: Special servings are required for spiral ropes, i.e. spiral strand and locked coil.)

A minimum of two servings either side of the cut (see fig 10) is normally sufficient for ropes up to 100mm diameter and for larger ropes a minimum of four servings either side of the cut should be applied. It is essential that the correct size serving wire or strand (see fig 10a) is used and that adequate tension is applied during the serving process to ensure the integrity of the rope is maintained. It is particularly important to maintain the integrity of non-preformed ropes, multistrand rotational resistant ropes and parallel closed ropes as failure to do so could affect the ropes breaking strength and performance in service. During the serving procedure, serving mallets and hand operated serving machines can be used to generate tight servings.

### Bridon 'On-site serving instructions'

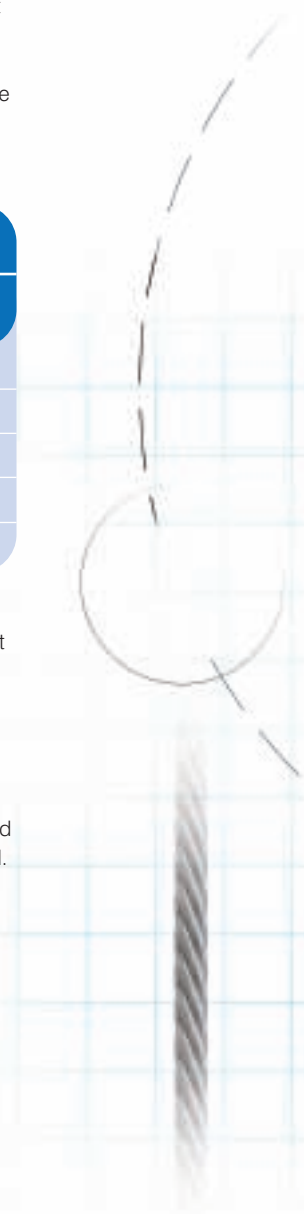
Rope Diameter	Diameter of Serving Wire or Strand	
	Single Wire	1x7 Wire Strand
<22mm	1.32mm	1.70mm
22mm to 38mm	1.57mm	1.70mm
40mm to 76mm	1.83mm	2.60mm
76mm to 100mm	2.03mm	3.00mm
>100mm	n/a	3.60mm

Fig 10a

Arrange and position the rope in such a manner that at the completion of the cutting operation the rope ends will remain in position, thus avoiding any backlash or any other undesirable movement.

Cut the rope with a high speed abrasive disc cutter. Other suitable mechanical or hydraulic shearing equipment may be used although not recommended when a rope end is required to be welded or brazed.

For serving instructions for FL and HL ropes refer to Bridon.



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### **⚠ WARNING**

**When using a disc cutter be aware of the danger from sparks, disc fragmentation and fumes. (Refer 3.2.)**

Ensure adequate ventilation to avoid any build-up of fumes from the rope and its constituent parts including any fibre core (natural or synthetic) any rope lubricant(s) and any synthetic filling and/or covering material.

### **⚠ WARNING**

**Some special ropes contain synthetic material which, when heated to a temperature higher than normal production processing temperatures, will decompose and may give off toxic fumes.**

### **⚠ WARNING**

**Rope produced from carbon steel wires in the form shipped is not considered a health hazard. During subsequent processing (e.g. cutting, welding, grinding, cleaning) dust and fumes may be produced which contain elements which may affect exposed workers.**

The products used in the manufacture of steel wire ropes for lubrication and protection present minimal hazard to the user in the form shipped. The user must however, take reasonable care to minimise skin and eye contact and also avoid breathing their vapour and mist.

After cutting, the rope cross-sections of non-preformed ropes, multi-layer ropes and parallel closed ropes must be welded, brazed or fused and tapered such that all wires and strands in the rope are completely secured.

### **⚠ WARNING**

**Failure to correctly secure the rope end is likely to lead to slackness, distortions, premature removal from service and a reduction in the breaking force of the rope.**

**3.13** Ensure that any fittings such as clamps or fixtures are clean and undamaged before securing rope ends.

Make sure that all fittings are secure in accordance with the OEM's instruction manual or manufacturer's instructions and take particular note of any specific safety requirements e.g. torque values (and frequency of any re-application of torque).

When terminating a rope end with a wedge socket, ensure that the rope tail cannot withdraw through the socket by securing a clamp to the tail or by following the manufacturer's instructions.

(See Fig. 11 for two recommended methods of securing the rope tail of a wedge socket termination).

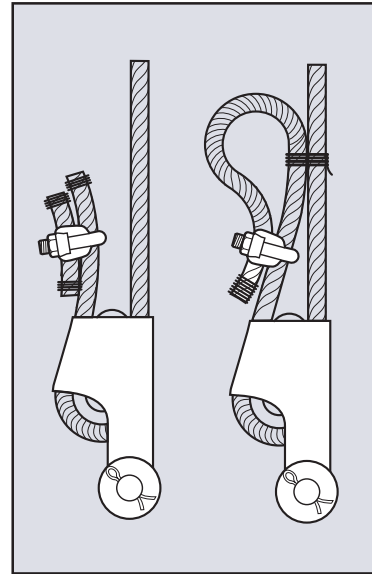


Fig 11

The loop back method uses a rope grip and the loop should be lashed to the live part of rope by a soft wire serving or tape to prevent flexing of the rope in service.

The method of looping back should not be used if there is a possibility of interference of the loop with the mechanism or structure.

### **⚠ WARNING**

**Failure to secure in accordance with instructions could lead to loss of the rope and/or injury.**

**3.14** When coiling a rope on a plain (or smooth) barrel drum ensure that each lap lies tightly against the preceding lap. The application of tension in the rope greatly assists in the coiling of the rope.

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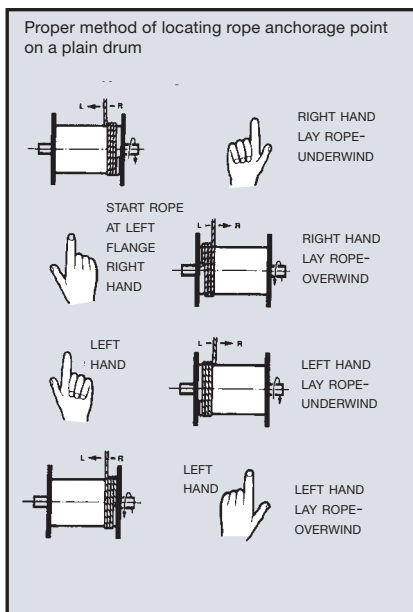
### ⚠ WARNING

**Any looseness or uneven winding will result in excessive wear, crushing and distortion of the rope.**

With plain barrel drums it is difficult to achieve satisfactory multi-layer coiling beyond three layers.

The direction of coiling of the rope on the drum is important, particularly when using plain barrel drums, and should be related to the direction of lay of the rope in order to induce close coiling.

(See Fig. 12 for proper method of locating rope anchorage point on a plain drum.)



When multi layer coiling has to be used it should be realised that after the first layer is wound on a drum, the rope has to cross the underlying rope in order to advance across the drum in the second layer. The points at which the turns in the upper layer cross those of the lower layer are known as the cross-over points and the rope in these areas is susceptible to increased abrasion and crushing. Care should be taken when installing a rope on a drum and when operating a machine to ensure that the rope is coiled and layered correctly.

- 3.15** Check the state of re-usable rope end terminations for size, strength, defects and cleanliness before use. Non-destructive testing may be required depending on the material and circumstances of use. Ensure that

the termination is fitted in accordance with the OEM's instruction manual or manufacturer's instructions.

When re-using a socket and depending on its type and dimensions, the existing cone should be pressed out. Otherwise, heat may be necessary.

### ⚠ WARNING

**When melting out sockets which have previously been filled with hot metal, the emission of toxic fumes is likely. Note that white metal contains a high proportion of lead.**

Correctly locate and secure any connection pins and fittings when assembling end terminations to fixtures. Refer to manufacturer's instructions.

### ⚠ WARNING

**Failure to pay attention to any of the above could result in unsafe operation and potential injury.**

- 3.16** Limit switches, if fitted, must be checked and re-adjusted, if necessary, after the rope has been installed.
- 3.17** Record the following details on the Certificate after installation has been completed: type of equipment, location, plant reference number, duty and date of installation and any re-rating information/signature of competent person. Then safely file the Certificate.
- 3.18** 'Run in' the new rope by operating the equipment slowly, preferably with a low load, for several cycles. This permits the new rope to adjust itself gradually to working conditions.

*Note: Unless otherwise required by a certifying authority, the rope should be in this condition before any proof test of the equipment or machinery is carried out.*

Check that the new rope is spooling correctly on the drum and that no slack or cross laps develop.

If necessary, apply as much tension as possible to ensure tight and even coiling, especially on the first layer.

Where multi-layer coiling is unavoidable, succeeding layers should coil evenly on the preceding layers of rope.



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### **⚠ WARNING**

**Irregular coiling usually results in severe surface wear and rope malformation, which in turn is likely to cause premature rope failure.**

- 3.19** Ensure that the as-manufactured condition of the rope is maintained throughout the whole of the handling and installation operation.
- 3.20** If samples are required to be taken from the rope for subsequent testing and/or evaluation, it is essential that the condition of the rope is not disturbed. Refer to the instructions given in 3.12 and, depending on the rope type and construction, any other special manufacturer's instructions.
- 4. In Service**
- 4.1** Inspect the rope and related equipment at the beginning of every work period and particularly following any incident which could have damaged the rope or installation.

The entire length of rope should be inspected and particular attention paid to those sections that experience has proven to be the main areas of deterioration. Excessive wear, broken wires, distortion and corrosion are the usual signs of deterioration. For a more detailed examination special tools are necessary (see Fig. 13) which will also facilitate internal inspection (see Fig. 14.)

Fig 13

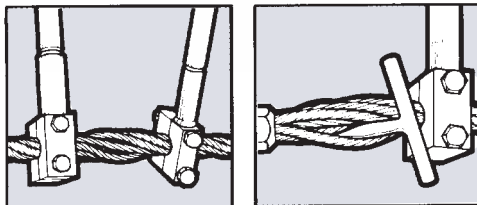
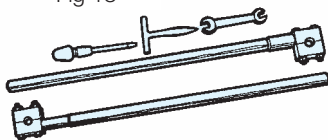


Fig 14

In the case of ropes working over drums or sheaves it is particularly necessary to examine those areas entering or leaving the grooves when maximum loads (i.e. shock loads) are experienced, or those areas which remain for long periods in exposed places such as over a Jib Head sheave.

On some running ropes, but particularly relevant to standing ropes (e.g. pendant ropes) the areas adjacent to terminations should be given special attention. (see Fig. 14).

*Note: Shortening the rope re-positions the areas of maximum deterioration in the system. Where conditions permit, begin operating with a rope which has a slightly longer length than necessary in order to allow for periodic shortening.*

When a non-preformed rope, multi-layer rope or parallel closed rope ie (DSC) is used with a wedge socket and is required to be shortened, it is essential that the end of the rope is secured by welding or brazing before the rope is pulled through the main body of the socket to its new position. Slacken the wedge in the socket. Pass the rope through the socket by an amount equivalent to the crop length or sample required. Note that the original bent portion of the rope must not be retained within the wedge socket. Replace the wedge and pull up the socket. Prepare and cut in accordance with section 3.12. Ensure that the rope tail cannot withdraw through the socket, see section 3.13.

### **⚠ WARNING**

**Failure to observe this instruction will result in a significant deterioration in the performance of the rope and could render the rope completely unfit for further service.**

In cases where severe rope wear takes place at one end of a wire rope, the life of the rope may be extended by changing round the drum end with the load end, i.e. turning the rope 'end for end' before deterioration becomes excessive.

- 4.2** Remove broken wires as they occur by bending backwards and forwards using a pair of pliers until they break deep in the valley between two outer strands (see Fig. 15). Wear protective clothing such as overalls, industrial gloves, helmet, eye protectors and safety footwear during this operation.

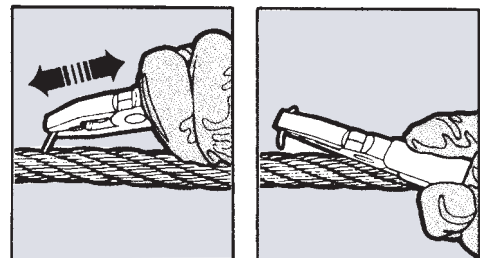


Fig 15

### **⚠ WARNING**

**Do not shear off the ends of broken wires with pliers as this will leave an exposed jagged edge which is likely to damage other wires in the rope and lead to premature removal of the rope from service. Failure to wear adequate protective clothing could result in injury.**

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*Note: Broken wires are a normal feature of service, more so towards the end of the rope's life, resulting from bending fatigue and wear. The local break up of wires may indicate some mechanical fault in the equipment.*

Record the number and position in the rope of any removed broken wires.

- 4.3 Do not operate an appliance if for any reason (e.g. rope diameter, certified breaking force, rope construction, length or strength and type of rope termination) the wire rope and its termination is considered unsuitable for the required duty.
- 4.4 Do not operate an appliance if the wire rope fitted has become distorted, been damaged or has deteriorated to a level such that discard criteria has been reached or is likely to be reached prior to normal expected life based on historical performance data.

### **WARNING**

**Rope distortion is usually a result of mechanical damage and can significantly reduce rope strength.**

- 4.5 An authorised competent person must examine the rope in accordance with the appropriate Regulations.
- 4.6 Do not carry out any inspection, examination, dressing/lubrication, adjustment or any other maintenance of the rope whilst it is suspending a load, unless otherwise stated in the OEM's instruction manual or other relevant documents.

Do not carry out any inspection or maintenance of the rope if the appliance controls are unattended unless the surrounding area has been isolated or sufficient warning signs have been posted within the immediate vicinity.

If the appliance controls are attended, the authorised person must be able to communicate effectively with the driver or controller of the appliance during the inspection process.

- 4.7 Never clean the wire rope without recognising the potential hazards associated with working on a moving rope.

### **WARNING**

**Failure to pay attention or take adequate precaution could result in injury.**

If cleaning by cloth/waste, the material can be snagged on damaged surfaces and/or broken wires. If cleaning by brush, eye protectors must be worn. If using fluids it should be recognised that some products are highly inflammable. A respirator should be worn if cleaning by a pressurised spray system.

### **WARNING**

**Failure to take adequate precaution could result in injury or damage to health.**

Only use compatible cleaning fluids which will not impair the original rope lubricant nor affect the rope associated equipment.

### **WARNING**

**The use of cleaning fluids (particularly solvent based) is likely to 'cut back' the existing rope lubricant leading to a greater quantity of lubricant accumulating on the surface of the rope. This may create a hazard in appliances and machinery which rely on friction between the rope and the drive sheave (e.g. lifts, friction winders and cableways).**

- 4.8 Lubricants selected for in-service dressing must be compatible with the rope manufacturing lubricant and should be referenced in the OEM's instruction manual or other documents approved by the owner of the appliance.

If in doubt contact Bridon or your rope supplier.

- 4.9 Take particular care when applying any in-service lubricant/dressing. Application systems which involve pressure should only be operated by trained and authorised persons and the operation carried out strictly in accordance with the manufacturer's instructions.

Most wire ropes should be lubricated as soon as they are put into service and at regular intervals thereafter (including cleaning) in order to extend safe performance.

### **WARNING**

**A 'dry' rope unaffected by corrosion but subject to bend fatigue, is likely to achieve only 30% of that normally attained by a 'lubricated' rope.**

Do not dress/lubricate the rope if the application required it to remain dry. (Refer OEM's instruction manual.)

Reduce the period between examinations when ropes are not subjected to any in-service dressing and when they must remain dry.

*Note: The authorised person carrying out a rope inspection must be capable of recognising the potential loss of safe performance of such a rope in comparison with lubricated rope.*

Clean the rope before applying a fresh dressing/lubricant if it is heavily loaded with foreign matter e.g. sand, dust.





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**4.10** The authorised person responsible for carrying out wire rope maintenance must ensure that the ends of the rope are secure. At the drum end this will involve checking the integrity of the anchorage and ensuring that there are at least two and a half dead laps tightly coiled. At the outboard end the integrity of the termination must be checked to ensure that it is in accordance with the OEM's manual or other documents approved by the owner of the appliance.

Adjust the lengths of ropes in multi-rope systems in order that equal forces (within approved limits) are evident.

If a wire rope needs cutting refer to 3.12.

When securing rope ends refer to 3.13.

When re-usable end terminations are used refer to 3.15.

When re-connecting any end terminations to fixtures refer to 3.15.

### 4.11

#### WARNING

**Damage to, or removal of component parts (mechanical or structural) caused by abnormal contact with wire rope can be hazardous to the safety of the appliance and/or the performance of the rope (e.g. damage to the drum grooving, such that coiling is erratic and/or the rope is 'pulled down' into underlying layers, which might cause a dangerous condition or, alternatively, cause localised rope damage at 'cross-over' positions, which might then radically affect performance; loss/removal of wear plates protecting the structure leading to major structural damage by cutting and/or failure of the wire rope due to mechanical severance).**

**4.12** Following any periodic statutory examination or routine or special inspection where any corrective action is taken the Certificate should be updated and a record made of the defects found, the extent of the changes and the condition of the rope.

**4.13** Apply the following procedures for the selection and preparation of samples, from new and used lengths of rope, for the purpose of examination and testing to destruction.

Check that the rope end, from which the sample will be taken, is secured by welding or brazing. If not, select the sample length further away from the rope end and prepare new servings (see 3.12).

Handle the rope in accordance with the instructions given in section 3. Serve the rope, using the buried wire technique (see Fig. 10) and apply a rope clamp or grip as close to the cut mark as practically possible. Do not use solder to secure the servings.

Ensure that the sample is kept straight throughout the whole procedure and ensure that the minimum sample length is 4 metres for ropes up to and including 76mm diameter and 8 metres for larger diameter ropes.

The rope should be cut with a high speed abrasive disc cutter or an oxyacetylene torch. Weld the rope ends of the sample as described in section 3.12, after which the clamp or grip can be removed.

The identification of the rope must be established and the sample suitably marked and packed. It is recommended that the 3 metre sample is retained straight and secured to a wood batten for transportation. For a 12 metre sample, coil to a diameter as large as practically possible and never less than 2 metres.

*Note: Samples taken for destruction testing are required to be terminated in accordance with a recognised resin socketing standard (e.g. BS EN 13411-4).*

#### WARNING

**Failure to comply with these procedures will result in measured breaking force values which are not truly representative of the actual strength of the rope.**

## 5. Wire Rope Discard

**5.1** Discard the wire rope in accordance with current Regulations and in accordance with the OEM's instruction manual.

*Note: The authorised competent person should also be familiar with the latest versions of International Standard ISO 4309 'Cranes - wire ropes - Code of practice for examination and discard' and B.S. 6570 'The selection, care and maintenance of steel wire ropes' which provide greater detail than that given in the relevant Regulations. Other standards and instructions covering rope discard may also be applicable. In the case of synthetic sheaves (or synthetic linings) refer to the OEM's instruction manual or contact the sheave (or lining) manufacturer for specific discard criteria.*

**5.2** If a wire rope is removed from service at a level of performance substantially different to historically established performance data and without any obvious reason(s), contact Bridon or Bridon's distributor for further guidance.

**5.3** Only qualified and experienced personnel, taking the appropriate safety precautions and wearing the appropriate protective clothing, should be responsible for removing the wire rope.

#### WARNING

**Take particular care when removing ropes with mechanical damage as they may fail abruptly during the change-out procedure.**

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Take the utmost care when removing 'exhausted/failed' ropes from drums and sheaves as they may be grossly distorted, lively and tightly coiled.

### ⚠ WARNING

**Failure to take adequate precautions could result in injury.**

- 5.4 Store discarded rope in a safe and secure location or compound and ensure that it is suitably marked to identify it as rope which has been removed from service and not to be used again.

### ⚠ WARNING

**Discarded rope can be a danger (e.g. protruding broken wires, excessive grease/lubricant and rope mass) to personnel and equipment if not handled correctly and safely during disposal.**

- 5.5 Record the date and reason for discard on the Certificate before filing for future reference.
- 5.6 Pay attention to any Regulations affecting the safe disposal of steel wire rope.

### 6. Rope Selection Criteria

Ensure that the correct type of wire rope is selected for the equipment by referring to the OEM's instruction manual or other relevant documents. If in doubt contact Bridon or Bridon's distributor for guidance.

#### 6.1 Rope Strength

If necessary, refer to the appropriate Regulations and/or application standards and calculate the maximum force to which the rope will be subjected.

The calculation may take into account the mass to be lifted or moved, any shock loading, effects of high speed, acceleration, any sudden starts or stops, frequency of operation and sheave bearing friction.

By applying the relevant coefficient of utilisation (safety factor) and, where applicable, the efficiency of the rope termination, the required minimum breaking load or force of the rope will be determined, the values of which are available from the relevant National, European or International standards or from specific Product Data literature. If in doubt ask for advice from Bridon or Bridon's distributor.

#### 6.2 Bending fatigue

The size and number of sheaves in the system will influence the performance of the rope.

### ⚠ WARNING

**Wire rope which bends around sheaves, rollers or drums will deteriorate through 'bending fatigue'. Reverse bending and high speed will accelerate the process. Therefore, under such conditions select a rope with high bending fatigue resistance. Refer to Product Data Information, and if in doubt ask for advice.**

#### 6.3 Abrasion

Wire rope which is subject to abrasion will become progressively weaker as a result of:

Externally - dragging it through overburden, sand or other abrasive materials and passing around a sheave, roller or drum.

Internally - being loaded or bent.

### ⚠ WARNING

**Abrasion weakens the rope by removing metal from both the inner and outer wires. Therefore, a rope with large outer wires should normally be selected.**

#### 6.4 Vibration

Vibration in wire rope will cause deterioration. This may become apparent in the form of wire fractures where the vibration is absorbed.

### ⚠ WARNING

**These fractures may be internal only and will not be visually identified.**

#### 6.5 Distortion

Wire rope can be distorted due to high pressure against a sheave, improperly sized grooves or as a result of multi-layer coiling on a drum.

Rope with a steel core is more resistant to crushing and distortion.

#### 6.6 Corrosion

Rope with a large number of small wires is more susceptible to corrosion than rope with a small number of large wires. Therefore, if corrosion is expected to have a significant effect on rope performance select a galvanised rope with as large an outer wire size as possible bearing in mind the other conditions (e.g. bending and abrasion) under which the rope will be operating.



## Product Safety: Instructions & Warnings on the use of steel wire rope

### 6.7 Cabling

'Cabling' of rope reeving due to block rotation can occur if the rope is incorrectly selected (see Fig.16). Applications involving high lifts are particularly vulnerable to this condition therefore, ropes specifically designed to resist rotation need to be selected.

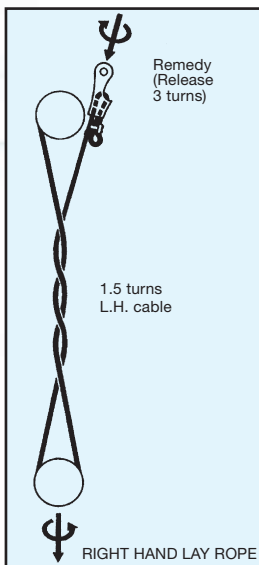


Fig 16

Corrective procedure for cabling, where the rope length involved is relatively short, may be simply to disconnect both ends of the rope and pull the rope out straight along the ground. This will allow any build up of turn in the rope to be released before the rope is re-installed on the crane. If cabling persists, or the rope length involved is relatively long, it may be necessary to correct by releasing or inducing turn at the outboard anchorage. If left hand cabling is produced in the reeving system, correction is usually achieved (on the right hand lay ropes, see Fig. 16) by releasing turn at the anchorage. Effort must be made to work released or induced turn throughout the working length of rope, by operating the crane at maximum height of lift with a light load. It may be necessary to repeat the process until the cabling has been corrected. For right hand cable it will normally be necessary to induce turn at the anchorage.

### 6.8 Fixing of Rope Ends

Ropes which have high rotation characteristics (such as single layer Lang's lay rope and parallel closed rope e.g. DSC) must not be selected unless both ends of the rope are fixed or the load is guided and unable to rotate.

### 6.9 Connecting Ropes

In the event that it is necessary to connect one rope to another (in series) it is essential that they have the required strength, are of the same type and both have the same lay direction (i.e. connect 'right' lay to 'right' lay).

#### WARNING

**Failure to heed this warning could result in catastrophic failure particularly at a termination which is capable of being pulled apart (i.e. splice) due to unlaying.**

### 6.10 Rope Length

Rope length and /or difference in length between two or more ropes used in a set may be a critical factor and must be considered along with rope selection.

#### WARNING

**Wire rope will elongate under load. Other factors such as temperature, rope rotation and internal wear will also have an effect. These factors should also be considered during rope selection.**

### 6.11 Preformed and Non-preformed Ropes

Single layer round strand rope is normally supplied preformed. However, if a non-preformed rope is selected then personnel responsible for its installation and/or maintenance need to take particular care when handling such rope, especially when cutting. For the purposes of this instruction, multi-layer, parallel closed and spiral ropes should be regarded as non-preformed ropes.

### 6.12 Operating Temperatures

Wire rope with a steel core should be selected if there is any evidence to suggest that a fibre core will not provide adequate support to the outer strands and/or if the temperature of the working environment may be expected to exceed 100°C.

For operating temperatures above 100°C de-rating of the minimum breaking force of the rope is necessary (e.g. between 100°C and 200°C reduce by 10%; between 200°C and 300°C reduce by 25%; between 300°C and 400°C reduce by 35%).

Do not use ropes with high carbon wires above 400°C.

#### WARNING

**Failure to observe this general guidance could result in failure of the ropes to support the load.**

For temperatures over 400°C, other materials such as stainless steel or other special alloys should be considered.

#### WARNING

**Rope lubricants and any synthetic filling and/or covering materials may become ineffective at certain low or high operating temperature levels.**

Certain types of rope end terminations also have limiting operating temperatures and the manufacturer or Bridon should be consulted where there is any doubt. Ropes with aluminium ferrules must not be used at temperatures in excess of 150°C.

## Product Safety: Instructions & Warnings on the use of steel wire rope

### ⚠ WARNING

Wire rope will fail if worn-out, shock loaded, overloaded, misused, damaged, improperly maintained or abused.

- Always inspect wire rope for wear, damage or abuse before use
- Never use wire rope which is worn-out, damaged or abused
- Never overload or shock load a wire rope
- Inform yourself: Read and understand the guidance on product safety given in this catalogue; also read and understand the machinery manufacturer's handbook
- Refer to applicable directives, regulations, standards and codes concerning inspection, examination and rope removal criteria

Protect yourself and others - failure of wire rope may cause serious injury or death!

### ⚠ WARNING

#### CAUTIONARY NOTICE – RESTRICTIONS ON THE USE OF LARGE DIAMETER MULTISTRAND ROPES.

All wire ropes are prone to damage if they are not properly supported when used at high loads. Larger Multistrand ropes are particularly susceptible to this form of abuse, due to their rigid construction and the relatively fine wire sizes involved in their manufacture/construction. Instances have been recorded of ropes being heavily worked over plain drums and failing "prematurely", despite the nominal tension being

being in the region of half the breaking strength of the rope.

The best way of preventing difficulties of this sort is to avoid conditions that are likely to generate damagingly high contact stresses. A simple method of assessing the severity of the contact conditions is to firstly calculate the tread pressure based on the projected nominal area and then apply a factor (of say 10\*) to allow for the highly localised and intermittent nature of the actual wire contacts, as indicated below :-

Type of contact	Close-fitting U-groove	Oversize U-groove	Plain drum
Level of support	Good	Fair	Poor
Tread path width	100% of rope dia.	50% of rope dia.	20% of rope dia.
Tread pressure =	2T/Dd	4T/Dd	10T/Dd
Contact stress =	20T/Dd	40T/Dd	100T/Dd

**Note: Contact stresses which exceed 10% of the wire UTS should be considered a cause for concern, especially if the rope is operating at a low factor of safety.**

[\* This is because the true contact area is very much less than the projected nominal area.]

#### Worked example:

Consider case of a 50mm Multistrand rope (MBL=2100kN) operating at a 3:1 factor of safety. Then, for the Contact stress < 200 Mpa say, the following minimum bending diameters are indicated:

Close-fitting groove - 1400mm

Oversize U-groove - 2800mm

Un-grooved drum - 7000mm

## Material Safety Data

### Introduction

Steel wire rope is a composite material and dependent upon its type may contain a number of discrete materials. The following provides full details of all the individual materials which may form part of the finished wire rope.

The description and/or designation of the wire rope stated on the delivery note and/or invoice (or certificate, when applicable) will enable identification of the component parts.

The main component of a steel wire rope is the wire, which may be carbon steel, coated (zinc or Zn95/A15) steel or stainless steel.

The other three components are (i) the core, which may be of steel of the same type as used in the main strands or alternatively fibre (either natural or synthetic), (ii) the rope lubricant and, where applicable, (iii) any internal filling or

external covering. No Occupational Exposure Limits (OEL's) exist for steel wire rope and the values provided in this publication relate to component elements and compounds. The actual figures quoted in relation to the component parts are taken from the latest edition of EH40.

Rope produced from carbon, coated or stainless steel wires in the as-supplied condition is not considered a health hazard. However during any subsequent processing such as cutting, welding, grinding and cleaning, dust and fumes may be produced which contain elements that may affect exposed workers.

The following indicates the order in which specific information is provided:-

Carbon steel wire, Coated steel wire, Stainless steel wire, Manufacturing rope lubricants, Fibre cores, Filling and covering materials, General information

### Carbon Steel Wire - Hazardous Ingredients

Component	% Weight (Max)	Long term exposure limit (8-hour TWA reference period) mg/m <sup>3</sup>	Short term exposure limit (10-minute reference period) mg/m <sup>3</sup>
<b>BASE METAL</b>			
Aluminium	0.3	10	20
Carbon	1.0	None Listed	
Chromium	0.4	0.5	
Cobalt	0.3	0.1	
Copper	0.5	0.2	
Iron	Balance	5	10
Manganese	1.0	5	5
Molybdenum	0.1	5	10
Nickel	0.5	1	
Phosphorus	0.1	0.1	0.3
Silicon	0.5	10	
Sulphur	0.5	None Listed	
Vanadium	0.25	0.5	
Boron	0.1	10	20
Titanium	0.1	10	
Nitrogen	0.01	5	9
Lead	0.1	0.15	
Arsenic	0.01	0.2	
Zirconium	0.05	5	10
<b>COATED</b>			
Sodium	0.5	None Listed	
Calcium	0.5	2	
Boron	1.0	10	20
Phosphorus	1.0	0.1	0.3
Iron	1.0	5	10
Zinc	1.0	5	10
Oil may be applied	5.0	5	10

### Physical Data

Specific Gravity:	7.5 - 8.5	Vapour Pressure:	N/A
Melting Point:	1350 - 1500 °C	Vapour Density:	N/A
Appearance & Odour:	Solid, Odourless Metal	Evaporation:	N/A
Solubility in water:	Insoluble	% Volatiles:	N/A
Flash Point:	None	Boiling Point:	> 2800 °C

## Material Safety Data

### Coated (Zinc and Zn95/A 15) Steel Wire - Hazardous Ingredients

Component	% Weight (Max)	Long term exposure limit (8-hour TWA reference period) mg/m <sup>3</sup>	Short term exposure limit (10-minute reference period) mg/m <sup>3</sup>
<b>BASE METAL</b>			
Aluminium	0.3	10	20
Carbon	1.0	None Listed	
Chromium	0.4	0.5	
Cobalt	0.3	0.1	
Copper	0.5	0.2	
Iron	Balance	5	10
Manganese	1.0	5	5
Molybdenum	0.1	5	10
Nickel	0.5	1	
Phosphorus	0.1	0.1	0.3
Silicon	0.5	10	
Sulphur	0.5	None Listed	
Vanadium	0.25	0.5	
Boron	0.1	10	20
Titanium	0.1	10	
Nitrogen	0.01	5	9
Lead	0.1	0.15	
Arsenic	0.01	0.2	
Zirconium	0.05	5	10
<b>COATED</b>			
Zinc	10.0	5	10
Aluminium	1.5	10	20
Iron	5.0	5	10
Sodium	0.5	None Listed	
Calcium	0.5	2	
Boron	1.0	100	20
Phosphorus	1.0	0.1	0.3
Sulphur	0.5	None Listed	
Oil may be applied	5.0	5	10
Wax may be applied	5.0	2	6

### Physical Data

Specific Gravity:	7.5 - 8.5	Vapour Pressure:	N/A
Melting Point:	1350 - 1500 °C	Vapour Density:	N/A
Appearance & Odour:	Solid. Odourless Metal	Evaporation:	N/A
Solubility in water:	Insoluble	% Volatiles:	N/A
Flash Point:	None	Boiling Point:	> 2800 °C

## Material Safety Data

### Manufacturing Rope Lubricants

The products used in the manufacture of steel wire ropes for lubrication and protection present minimal hazard to the user in the as-supplied condition. The user must, however, take reasonable care to minimise skin and eye contact and also avoid breathing their vapours and mists.

A wide range of compounds is used as lubricants in the manufacture of steel wire rope. These products, in the main, consist of mixtures of oils, waxes, bitumens, resins, gelling agents and fillers with minor concentrations of corrosion inhibitors, oxidation stabilizers and tackiness additives.

Most of them are solid at ambient temperatures and provided skin contact with the fluid types is avoided, none present a hazard in normal rope usage.

However, to assist in the assessment of the hazard caused by these products, the following table contains all the components which may be incorporated into a wire rope lubricant and which may be considered hazardous to health.

#### Hazardous Ingredients:

Component	Long term exposure limit (8-hour TWA reference period) mg/m <sup>3</sup>	Short term exposure limit (10-minute reference period) mg/m <sup>3</sup>
Oil mist	5	10
Paraffin wax fume	2	6
Bitumen	5	10
Silica, fused		
Total inhalable dust	0.3	
Respirable dust	0.1	
Aluminium flake	10	20
Zinc oxide, fume	5	10
Butane	1430	1780

There are no other known constituents of any wire rope lubricant used that are classified as hazardous in the current edition of EH40.

#### General advice on handling ropes with lubricants

To avoid the possibility of skin disorders, repeated or prolonged contact with mineral or synthetic hydrocarbons must be avoided and it is essential that all persons who come into contact with such products maintain high standards of personal hygiene.

The worker **should**:

- 1) use oil impermeable gloves, or if not available, suitable oil repellent type barrier creams,
- 2) avoid unnecessary contact with oil using protective clothing,
- 3) obtain first aid treatment for any injury, however slight,
- 4) wash hands thoroughly before meals, before using the toilet and after work,
- 5) use conditioning creams after washing, where provided.

The worker **should not**:

- 1) put oily rags or tools into pockets, especially trousers,
- 2) use dirty or spoiled rags for wiping oil from the skin,
- 3) wear oil soaked clothing,
- 4) use solvents such as paraffin, petrol etc., to remove oil from the skin.

Concentrations of oil mists, fumes and vapours in the working atmosphere must be kept as low as is reasonably practicable. Levels quoted in the current edition of HSE Guidance Note EH40 'Occupational Exposure Limits' must not be exceeded.

#### Health Hazards

Inhalation of oil mists or fumes from **heated** rope lubricants in high concentrations may result in dizziness, headache, respiratory irritation or unconsciousness. Eye contact may produce mild transient irritation to some users.

Fumes from **heated** rope lubricants in high concentrations may cause eye irritation.

If **heated** rope lubricants contacts skin, severe burns may result.

Prolonged or repeated skin contact may cause irritation, dermatitis or more serious skin disorders.

#### Fibre Cores

Being in the centre of a steel wire rope, the materials (natural or synthetic) from which fibre cores are produced do not present a health hazard during normal rope handling. Even when the outer core strands are removed (for example when the rope is required to be socketed) the core materials present virtually no hazard to the users, except, maybe, in the case of a used rope where, in the absence of any service dressing or as a result of heavy working causing internal abrasive wear of the core, the core may have decomposed into a fibre dust which might be inhaled, although this is considered extremely unlikely.

The principal area of hazard is through the inhalation of fumes generated by **heat**, for example when the rope is being cut by a disc cutter.

## Material Safety Data

Under these conditions, natural fibres are likely to yield carbon dioxide, water and ash, whereas synthetic materials are likely to yield toxic fumes.

The treatment of natural fibres, such as rotproofing, may also produce toxic fumes on burning.

The concentrations of toxic fumes from the cores, however, will be almost negligible compared with the products generated by heating from the other primary materials, e.g. wire and manufacturing lubricant in the rope.

The most common synthetic core material is polypropylene, although other polymers such as polyethylene and nylon may occasionally be used.

### Filling and Covering Materials

Filling and covering materials do not present a health hazard during handling of the rope in its as-supplied condition.

The principal area of hazard is by the inhalation of fumes generated by heat, for example when the rope is being cut by a disc cutter.

Under these conditions, fillings and coverings, which are generally polypropylene, polyethylene and polyamid (but in some cases may be of natural fibre) are likely to produce toxic fumes.

### General Information

#### Occupational protective measures

- 1) **Respiratory protection** - Use general and local exhaust ventilation to keep airborne dust or fumes below established occupational exposure standards (OES's). Operators should wear approved dust and fume respirators if OES's are exceeded.  
(The OES for total dust is 10mg/m<sup>3</sup> and for respirable dust is 5mg/m<sup>3</sup>).
- 2) **Protective equipment** - Protective equipment should be worn during operations creating eye hazards. A welding hood should be worn when welding or burning. Use gloves and other protective equipment when required.
- 3) **Other** - Principles of good personal hygiene should be followed prior to changing into street clothing or eating. Food should not be consumed in the working environment.

#### Emergency medical procedures

- 1) **Inhalation** - Remove to fresh air; get medical attention.
- 2) **Skin** - Wash areas well with soap and water.
- 3) **Eyes** - Flush well with running water to remove particulate; get medical attention.
- 4) **Ingestion** - In the unlikely event that quantities of rope or any of its components are ingested, get medical attention.

### Safety Information

- 1) **Fire and explosion** - In the solid state, steel components of the rope present no fire or explosion hazard. The organic elements present, i.e. lubricants, natural and synthetic fibres and other natural or synthetic filling and covering materials are capable of supporting fire.
- 2) **Reactivity** - Stable under normal conditions.

### Spill or leak procedures

- 1) **Spill or leak** - Not applicable to steel in the solid form.
- 2) **Disposal** - Dispose of in accordance with local Regulations.

## Rope Terminology

### Wires

**Outer wires:** All wires positioned in the outer layer of wires in a spiral rope or in the outer layer of wires in the outer strands of a stranded rope.

**Inner wires:** All wires of intermediate layers positioned between the centre wire and outer layer of wires in a spiral rope or all other wires except centre, filler, core and outer wires of a stranded rope.

**Core wires:** All wires of the core of a stranded rope.

**Centre wires:** Wires positioned either at the centre of a spiral rope or at the centres of strands of a stranded rope.

**Layer of wires:** An assembly of wires having one pitch circle diameter. The exception is Warrington layer comprising alternately laid large and small wires where the smaller wires are positioned on a larger pitch circle diameter than the larger wires. The first layer is that which is laid immediately over the strand centre.

*Note: Filler wires do not constitute a separate layer.*

**Tensile strength grade of wires:** A level of requirement of tensile strength of a wire and its corresponding tensile strength range. It is designated by the value according to the lower limit of tensile strength and is used when specifying wire and when determining the calculated minimum breaking force or calculated minimum aggregate breaking force of a rope.

**Wire finish:** The condition of the surface finish of a wire, e.g. bright, zinc coated.





## Rope Terminology

### Strands

**Strand:** An element of rope usually consisting of an assembly of wires of appropriate shape and dimensions laid helically in the same direction in one or more layers around a centre.

*Note: Strands containing three or four wires in the first layer or certain shaped (e.g. ribbon) strands may not have a centre.*

**Round strand:** A strand with a cross-section which is approximately the shape of a circle.

**Triangular strand:** A strand with a cross-section which is approximately the shape of a triangle.

*Note: Triangular strands may have built-up centres (i.e. more than one wire forming a triangle).*

**Oval strand:** A strand with a cross-section which is approximately the shape of an oval

**Flat ribbon strand:** A strand without a centre wire with a cross-section which is approximately the shape of a rectangle.

**Compacted strand:** A strand which has been subjected to a compacting process such as drawing, rolling or swaging whereby the metallic cross-sectional area of the wires remains unaltered and the shape of the wires and the dimensions of the strand are modified.

*Note: Bridon's brands of Dyform rope contain strands which have been compacted.*

**Single lay strand:** Strand which contains only one layer of wires, e.g. 6-1.

**Parallel lay strand:** Strand which contains at least two layers of wires, all of which are laid in one operation (in the same direction), e.g. 9-9-1; 12-6F-6-1; 14-7+7-7-1. Each layer of wires lies in the interstices of the underlying layer such that they are parallel to one another, resulting in linear contact.

*Note: This is also referred to as equal lay. The lay length of all the wire layers are equal.*

**Seale:** Parallel lay strand construction with the same number of wires in each wire layer, each wire layer containing wires of the same size, e.g. 7-7-1; 8-8-1; 9-9-1.

**Warrington:** Parallel lay strand construction having an outer layer of wires containing alternately large and small wires, the number of wires in the outer layer being twice that in the underlying layer of wires, e.g. 6+6-6-1; 7+7-7-1.

**Filler:** Parallel lay strand construction having an outer layer of wires containing twice the number of wires than in the inner layer with filler wires laid in the interstices of the underlying layer of wires, e.g. 12-6F-6-1; 14-7F-7-1.

**Combined parallel lay:** Parallel lay strand construction having three or more layers of wires, e.g. 14-7+7-7-1; 16-8+8-8-1; 14-14-7F-7-1; 16-16-8F+8-1.

*Note: The first two examples above are also referred to as Warrington-Seale construction. The latter two examples are also referred to as Seale-Filler construction.*

**Multiple operation lay strand:** Strand construction containing at least two layers of wires, at least one of which is laid in a separate operation. All of the wires are laid in the same direction.

**Cross-lay:** Multiple operation strand construction in which the wires of superimposed wire layers cross over one another and make point contact, e.g. 12/6-1.

**Compound lay:** Multiple operation strand which contains a minimum of three layers of wires, the outer layer of which is laid over a parallel lay centre, e.g. 16/6+6-6-1.

### Ropes

**Spiral Rope:** An assembly of two or more layers of shaped and/or round wires laid helically over a centre, usually a single round wire. There are three categories of spiral rope, viz. spiral strand, half-locked coil and full-locked coil.

**Spiral Strand:** An assembly of two or more layers of round wires laid helically over a centre, usually a single round wire.

**Half-locked Coil Rope:** A spiral rope type having an outer layer of wires containing alternate half lock and round wires.

**Full-locked Coil Rope:** A spiral rope type having an outer layer of full lock wires.

**Stranded Rope:** An assembly of several strands laid helically in one or more layers around a core or centre. There are three categories of stranded rope, viz. single layer, multi-layer and parallel-closed.

**Single Layer Rope:** Stranded rope consisting of one layer of strands laid helically over a core.

*Note: Stranded ropes consisting of three or four outer strands may, or may not, have a core. Some three and four strand single layer ropes are designed to generate torque levels equivalent to those generated by rotation-resistant and low rotation ropes.*

**Rotation-resistant Rope:** Stranded rope having no less than ten outer strands and comprising an assembly of at least two layers of strands laid over a centre, the direction of lay of the outer strands being opposite (i.e. contra - lay) to that of the underlying layer of strands.

**Low Rotation Rope:** Rotation resistant rope having at least fifteen outer strands and comprising an assembly of at least three layers of strands laid over a centre in two operations.

*Note: this category of rotation resistant rope is constructed in such a manner that it displays little or no tendency to rotate, or if guided, generates little or no torque when loaded.*

## Rope Terminology

**Compacted Strand Rope:** Rope in which the outer strands, prior to closing of the rope, are subjected to a compacting process such as drawing, rolling or swaging.

*Note: Bridon's products containing compacted strands are identified by "Dyform".*

**Compacted Rope:** Rope which is subjected to a compacting process after closing, thus reducing its diameter.

**Solid Polymer Filled Rope:** Rope in which the free internal spaces are filled with a solid polymer. The polymer extends to, or slightly beyond, the outer circumference of the rope.

**Cushioned Rope:** Stranded rope in which the inner layers, inner strands or core strands are covered with solid polymers or fibres to form a cushion between adjacent strands or layers of strands.

**Cushion Core Rope:** Stranded rope in which the core is covered (coated) or filled and covered (coated) with a solid polymer.

**Solid Polymer Covered Rope:** Rope which is covered (coated) with a solid polymer.

**Solid Polymer Covered and Filled Rope:** Rope which is covered (coated) and filled with a solid polymer.

**Rope Grade (R):** A number corresponding to a wire tensile strength grade on which the minimum breaking force of a rope is calculated.

*Note: It does not imply that the actual tensile strength grades of the wires in a rope are necessarily the same as the rope grade.*

**Preformed Rope:** Stranded rope in which the wires in the strands and the strands in the rope have their internal stresses reduced resulting in a rope in which, after removal of any serving, the wires and the strands will not spring out of the rope formation.

*Note: Multi-layer stranded ropes should be regarded as non-preformed rope even though the strands may have been partially (lightly) preformed during the closing process.*

**Rope Class:** A grouping of rope constructions where the number of outer strands and the number of wires and how they are laid up are within defined limits, resulting in ropes within the class having similar strength and rotational properties.

**Rope Construction:** System which denotes the arrangement of the strands and wires within a rope, e.g. 6x36WS, 6x19S, 18x7, 34xK7.

*Note: K denotes compacted strands.*

**Cable-laid Rope:** An assembly of several (usually six) single layer stranded ropes (referred to as unit ropes) laid helically over a core (usually a seventh single layer stranded rope).

**Braided Rope:** An assembly of several round strands braided in pairs.

**Electro-mechanical Rope:** A stranded or spiral rope containing electrical conductors.

### Strand and Rope Lays

**Lay direction of strand:** The direction right (z) or left (s) corresponding to the direction of lay of the outer layer of wires in relation to the longitudinal axis of the strand.

**Lay direction of rope:** The direction right (Z) or left (S) corresponding to the direction of lay of the outer strands in relation to the longitudinal axis of a stranded rope or the direction of lay of the outer wires in relation to the longitudinal axis of a spiral rope.

**Ordinary lay:** Stranded rope in which the direction of lay of the wires in the outer strands is in the opposite direction to the lay of the outer strands in the rope. Right hand ordinary lay is designated sZ and left hand ordinary lay is designated zS.

*Note: This type of lay is sometimes referred to as 'regular' lay.*

**Lang's lay:** Stranded rope in which the direction of lay of the wires in the outer strands is the same as that of the outer strands in the rope. Right hand Lang's lay is designated zZ and left hand Lang's lay is designated sS.

**Alternate lay:** Stranded rope in which the lay of the outer strands is alternatively Lang's lay and ordinary lay. Right hand alternate lay is designated AZ and left hand alternate lay is designated AS.

**Contra-lay:** Rope in which at least one inner layer of wires in a spiral rope or one layer of strands in a stranded rope is laid in the opposite direction to the other layer(s) of wires or strands respectively.

*Note: Contra-lay is only possible in spiral ropes having more than one layer of wires and in multi-layer stranded ropes.*

**Rope lay length (Stranded Rope):** That distance parallel to the axis of the rope in which the outer strands make one complete turn (or helix) about the axis of the rope.

### Cores

**Core:** Central element, usually of fibre or steel, of a single layer stranded rope, around which are laid helically the outer strands of a stranded rope or the outer unit ropes of a cable-laid rope.

**Fibre core:** Core made from natural fibres (e.g. hemp, sisal) and designated by its diameter and runnage.

**Synthetic Core:** Core made from synthetic fibres (e.g. polypropylene) and designated by its diameter and runnage.



## Rope Terminology

**Steel core:** Core produced either as an independent wire rope (IWRC)(e.g. 7x7) or wire strand (WSC)(e.g. 1x7).

**Solid polymer core:** Core produced as a single element of solid polymer having a round or grooved shape. It may also contain internal elements of wire or fibre.

**Insert:** Element of fibre or solid polymer so positioned as to separate adjacent strands or wires in the same or overlying layers and fill, or partly fill, some of the interstices in the rope. (see Zebra)

### Rope Characteristics and Properties

**Calculated Minimum aggregate Breaking Force:** Value of minimum aggregate breaking force is obtained by calculation from the sum of the products of the cross-sectional area (based on nominal wire diameter) and tensile strength grade of each wire in the rope, as given in the manufacturer's rope design.

**Calculated Minimum breaking Force:** Value of minimum breaking force based on the nominal wire sizes, wire tensile strength grades and spinning loss factor for the rope class or construction as given in the manufacturer's rope design.

**Fill factor:** The ratio between the sum of the nominal cross-sectional areas of all the load bearing wires in the rope and the circumscribed area of the rope based on its nominal diameter.

**Spinning loss factor (k):** The ratio between the calculated minimum breaking force of the rope and the calculated minimum aggregate breaking force of the rope.

**Breaking force factor (K):** An empirical factor used in the determination of minimum breaking force of a rope and obtained from the product of fill factor for the rope class or construction, spinning loss factor for the rope class or construction and the constant  $\pi/4$ .

**Minimum breaking force (F<sub>min</sub>):** Specified value, in kN, below which the measured breaking force is not allowed to fall in a prescribed test and, for ropes having a grade, obtained by calculation from the product of the square of the nominal diameter, the rope grade and the breaking force factor.

**Minimum aggregate breaking force (F<sub>e,min</sub>):** Specified value, in kN, below which the measured aggregate breaking force is not allowed to fall in a prescribed test and, for ropes having a grade, obtained from the product of the square of the nominal rope diameter (d), the metallic cross-sectional area factor (C) and the rope grade (R<sub>r</sub>).

**Norminal length mass:** The nominal mass values are for the fully lubricated ropes.

**Rope torque:** Value, usually expressed in N.m, resulting from either test or calculation, relating to the torque generated when both ends of the rope are fixed and the rope is subjected to tensile loading.

**Rope turn:** Value, usually expressed in degrees per metre, resulting from either test or calculation, relating to the amount of rotation when one end of the rope is free to rotate and the rope is subjected to tensile loading.

**Initial extension:** Amount of extension which is attributed to the initial bedding down of the wires within the strands and the strands within the rope due to tensile loading.

*Note: This is sometimes referred to as constructional stretch.*


**Elastic extension:** Amount of extension which follows Hooke's Law within certain limits due to application of a tensile load.

**Permanent rope extension:** Non-elastic extension.

## Conversion Factors S.I. Units

Force				Mass			
1 kN	= 0.101 972 Mp	1 UK tonf	= 9964.02N	1 kg	= 2.204 62 lb	1 lb	= 0.453 592 kg
1 N	= 0.101 972 kgf	1 lbf	= 4.448 22N	1 tonne (t)	= 0.984 207 UK ton	1 UK ton	= 1.01605 tonnes (t)
1 kgf	= 9.806 65 N	1 lbf	= 0.453 592 kgf	1 kg/m	= 0.671 970 lb/ft	1 lb/ft	= 1.488 kg/m
1 kgf	= 1 kp	1 UK tonf	= 1.01605 tonne	1 kg	= 1000 g	1 kip (USA)	= 1000 lb
1 N	= 1.003 61 x 10 <sup>4</sup> UK tonf	1 UK tonf	= 9.964 02 kN	1 Mp	= 1 x 10 <sup>6</sup> g		
1 N	= 0.2244 809 lbf	1 UK tonf	= 2240 lbf	1 tonne (t)	= 9.80665 kN		
1 kgf	= 2.204 62 lbf	1 short tonf					
1 t	= 0.984 207 UK tonf	(USA)	= 2000 lbf	Length			
1 kN	= 0.100 361 UK tonf	1 kip (USA)	= 1000 lbf	1 m	= 3.280 84 ft	1 ft	= 0.304 8 m
1 kN	= 0.101 972 tonne (t)	1 kip	= 453.592 37 kgf	1 km	= 0.621 371 miles	1 mile	= 1.609 344 km
Pressure/Stress				Area			
1 N/mm <sup>2</sup>	= 0.101972 kgf/mm <sup>2</sup>			1 mm <sup>2</sup>	= 0.001 55 in <sup>2</sup>	1 in <sup>2</sup>	= 645.16 mm <sup>2</sup>
1 kgf/mm <sup>2</sup>	= 9.806 65 N/mm <sup>2</sup>			1 m <sup>2</sup>	= 10.763 9ft <sup>2</sup>	1 ft <sup>2</sup>	= 0.092 903 0 m <sup>2</sup>
1 N/mm <sup>2</sup>	= 1 MPa						
1 kgf/mm <sup>2</sup>	= 1 422.33 lbf/in <sup>2</sup>	1 lbf/in <sup>2</sup>	= 7.030 x 10 <sup>-4</sup> kgf/mm <sup>2</sup>				
1 kgf/mm <sup>2</sup>	= 0.634 969 tonf/in <sup>2</sup>	1 tonf/in <sup>2</sup>	= 1.57488 kgf/mm <sup>2</sup>	Volume			
1 N/m <sup>2</sup>	= 1.450 38 x 10 <sup>-4</sup> lbf/in <sup>2</sup>	1 lbf/in <sup>2</sup>	= 6894.76 N/m <sup>2</sup>	1 cm <sup>3</sup>	= 0.061 023 7 in <sup>3</sup>	1 in <sup>3</sup>	= 16.387 1 cm <sup>3</sup>
1 N/m <sup>2</sup>	= 1 x 10 <sup>-6</sup> N/mm <sup>2</sup>	1 tonf/in <sup>2</sup>	= 1.544 43 x 10 <sup>8</sup> dyn/cm <sup>2</sup>	1 litre (l)	= 61.025 5 in <sup>3</sup>	1 in <sup>3</sup>	= 16.386 6 ml
1 bar	= 14.503 8 lbf/in <sup>2</sup>			1 m <sup>3</sup>	= 6.102 37 x 104 in <sup>3</sup>	1 yd <sup>3</sup>	= 0.764 555 m <sup>3</sup>
1 hectobar	= 10N/mm <sup>2</sup>						
1 hectobar	= 10 <sup>7</sup> N/m <sup>2</sup>						

## Good Practice When Ordering a Rope



Basic information to be supplied;	
Application or intended use:	Boom / luffing rope
Nominal rope diameter:	22mm
Diameter tolerance (if applicable):	+2% to +4%
Nominal rope length:	245 metres
Length tolerance (if applicable):	-0% to +2%
Construction (Brand or Name):	Dyform 6x36ws
Type of core:	IWRC (Independent wire rope core)
Rope grade:	1960N/mm <sup>2</sup>
Wire finish:	B (Drawn galvanised)
Rope Lay:	zZ (Right hand Lang's)
Level of lubrication:	Lubricated internally, externally dry
Minimum breaking force:	398kN (40.6tonnes)
Rope standard:	BS EN 12385-4:2004
Supply package:	Wood compartment reel
Rope terminations - Inner end:	DIN 3091 solid thimble with 43mm pin hole
Outer end:	Fused and tapered
Third party authority (if required):	Lloyd's Register
Identification / markings:	Part number XL709 – 4567
Useful additional information;	
Equipment manufacturer:	J Bloggs, Model XYZ crawler crane
Drum details - Grooved:	Yes or No
If Yes:	Helical or Lebus
Pitch of grooving:	23.10mm
20. Spooling – Number of wraps per layer:	32
Number of layers:	Approximately 3 1/2