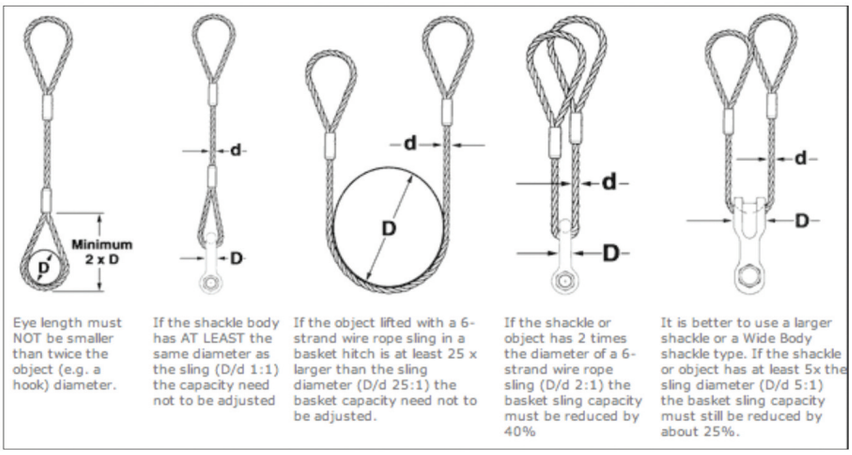


Eye length must NOT be smaller than twice the object (e.g. a hook) diameter.

If the shackle body has AT LEAST the same diameter as the sling (D/d 1:1) the capacity need not to be adjusted

If the object lifted with a 6-strand wire rope sling in a basket hitch is at least 25 x larger than the sling diameter (D/d 25:1) the basket capacity need not to be adjusted.

If the shackle or object has 2 times the diameter of a 6-strand wire rope sling (D/d 2:1) the basket sling capacity must be reduced by 40%

It is better to use a larger shackle or a Wide Body shackle type. If the shackle or object has at least 5x the sling diameter (D/d 5:1) the basket sling capacity must still be reduced by about 25%.

Fig.1 Fig.2 Fig.3 Fig.4 Fig.5

Safe use

of lifting slings and grommets

Richard Krabbendam discusses the guidelines to follow and explains the calculations you should make.

In recent months I have attended the WC&TS (World Crane & Transport Summit) in Amsterdam, the International Marine Contractors Association (IMCA) annual Conference in Rio de Janeiro, and the Heavy Lifting Conference for the Power Sector in Frankfurt. In all these conferences, safety was of prime concern, and so should it be. All the papers presented addressed, in one way or another, the topic of safe working practices.

During my workshop, Setting the Standard for Safety in Heavy Lift Shipping, at the Frankfurt conference, I noticed that safety is not yet part of the daily culture in many companies. Safety is not something you can buy in a store and implement in your company overnight. It is a lot more. It requires first of all the support of management and the necessary investment in training and education of staff, as well as a culture change that does take time. At Jumbo this process was started more then four years ago by introducing the STAY WELL programme.

During the past year, I have shared some of my experience and know-how in safety related articles, and I am continuing this series with this article on the safe use of lifting slings and grommets.

There are quite a few standards and guidelines available, such as the ANSI/ASME B30-9 (1996 USA) and the EN 13414-3 (2003 Europe), as well as guidelines issued by IMCA (IMCA M179), and others.

Rules and regulations

According to ANSI, a design safety factor of at least five shall be maintained for the common sizes of running wire in light load use. Wire ropes with a safety factor of less than five may be used only:

(a) For specialised equipment such as, but not limited to, cranes designed to be used with lesser wire rope safety factors.

(b) In accordance with design factors in standing rigging applications;

(c) For heavy lifts or other purposes, for which a safety factor of five is impracticable, and for which the employer can demonstrate that equivalent safety is ensured.

The EN 13414-3 (2003) states: the coefficient of utilisation (Zp) used in this standard for slings with a diameter greater than 60 mm is lower than that normally used for general service wire rope slings. This is justified for the following reasons.

a) Slings over 60 mm diameter are not intended for general service, and are subjected to special conditions relating to design, construction, frequency of use, service and discard.
b) The mass of the load is generally calculated or measured with considerable accuracy, and as such slings are usually specially manufactured for one or a limited number of special lifts.
c) The lifting operation is controlled and supervised.
d) The dynamic factors (such as shock loading) are limited.

These factors reduce the unknown aspects which dictate that slings in general service require a higher co-efficient of utilisation. Lower co-efficients have been, and are, used with confidence.

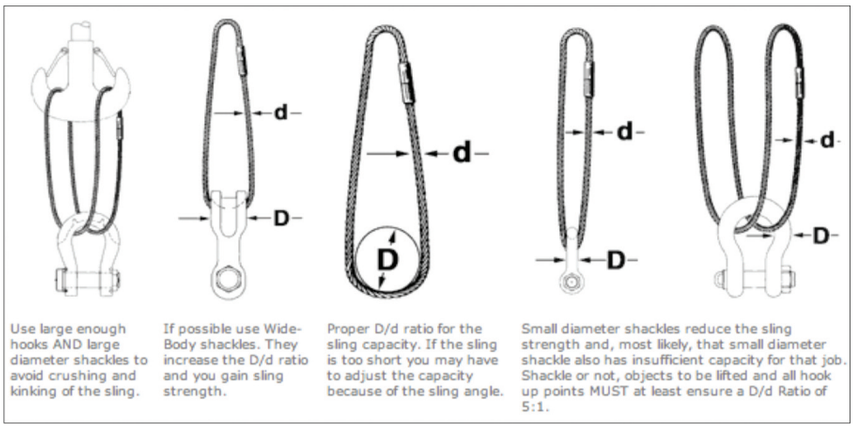
Zp: the co-efficient of utilisation

For cable-laid sling diameters less than 60 mm, Zp shall be five. For cable-laid sling diameters (d) 60 mm up to 150 mm, Zp shall be in accordance with the following equation $Zp = 6.33 - 0.022d$. For cable-laid sling diameters greater than 150 mm, Zp shall be not less than three.

Be aware that this guideline has no limitations regarding D/d ratio. In this context, common sense is the best guideline to extending the service life of your (very expensive) rigging materials, about which the UK HSE published a Guidance Note known as PM 20 (Plant & Machinery Guideline 20). This document has been compiled by IMCA into guideline M179, which clearly defines how cable laid slings and grommets are to be used, especially for the larger rope diameters.

As loads to be lifted are becoming heavier and larger, so are sling and grommet rope diameters, and they often exceed 100 mm or more. These large diameter slings and grommets should generally be used as specified, but should you do it differently, apply the correct safety and de-rating factors. There are different methods in which slings can be used. Various methods of using slings are shown in Figs.1-5 (above). The safe lifting capacity greatly depends on the D/d ratio of pin and rope diameter. This should be at least two or more.

All safety factors mentioned in the guidelines are minimum requirements, which



Use large enough hooks AND large diameter shackles to avoid crushing and kinking of the sling.

If possible use Wide-Body shackles. They increase the D/d ratio and you gain sling strength.

Proper D/d ratio for the sling capacity. If the sling is too short you may have to adjust the capacity because of the sling angle.

Small diameter shackles reduce the sling strength and, most likely, that small diameter shackle also has insufficient capacity for that job. Shackle or not, objects to be lifted and all hook up points MUST at least ensure a D/d Ratio of 5:1.

Fig.6 Fig.7 Fig.8 Fig.9

must be complied with. Larger safety factors are OK, but not smaller. As an example, when the SWL of a grommet as shown is 100 tonnes, the maximum lifting capacity in Figs. 6-9 are: Fig. 6 = 200 tonnes, Fig. 7 = 100 tonnes, Fig. 8 = < 100 tonnes, depending on angle and D/d, and Fig. 9 = < 200 tonnes, depending on the D/d.

The safety factors of slings and grommets are all in relation to the minimum break load (MBL). The minimum break load is the calculated break load of a wire rope. The MBL should always be lower then the actual break load obtained from a destructive test on a wire rope sample. As explained, this is not always possible for large diameter ropes. In that case, the IMCA M179 clearly describes methods of working out the calculated cable laid breaking load (CRBL) and the calculated sling breaking load (CSBL).

The working load limit (WWL) or rating is the maximum mass that the sling is designed to raise, lower or suspend, and is achieved by WWL = $^{CSBL}/_{f}$, in which f is the safety factor that allows for the circumstances of use.

Depending on the WLL, the safety factor can vary from five (for slings and grommets up to 25 tonnes), and decreases to not less than 2.25, which is the absolute minimum, where it should be borne in mind that the D/d ratio in most cases is a design factor demand that will out-number the SF required. It is obvious that the sling or grommet lift capacity should be de-rated depending on the bending applied.

The larger the D/d ratio, the better it is for the service life of the sling or grommet, and de-rating will be avoided. See Fig.10.

Bear in mind that the safety factor is just a number, which gives the user some comfort about making mistakes, or misuse, without direct disastrous effects.

In the Lloyd's Register Code for Lifting Appliances in a Marine Environment (CLAME), the safety factor for steel wire ropes changes, depending on the WLL, as per as per Fig.11.

At Jumbo Safety, even more stringent grommet and sling factors are applied. This rule came from the Dutch Dock Labour Inspection, and is still in use today. See Fig. 12. It defines a safety factor of five for a WLL of up to 25 tonnes. This safety factor Sf decreases linearly to 3.33 at 180 tonnes, according to the formula Sf = 5.2688 – 0.01075 x WLL.

Safety factors for synthetic slings in Europe

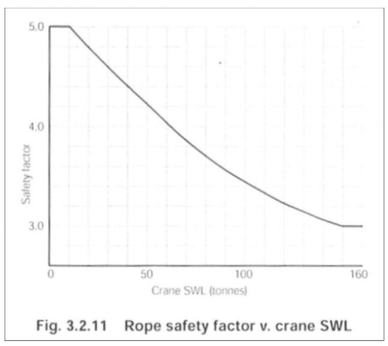


Fig. 3.2.11 Rope safety factor v. crane SWL

Fig.11 Lloyds CLAME Rope safety Factors.

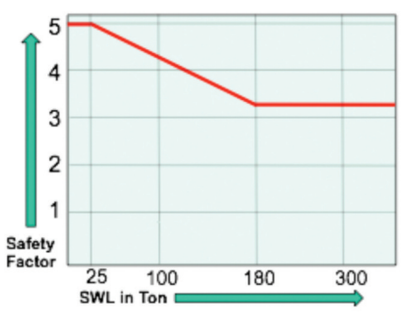
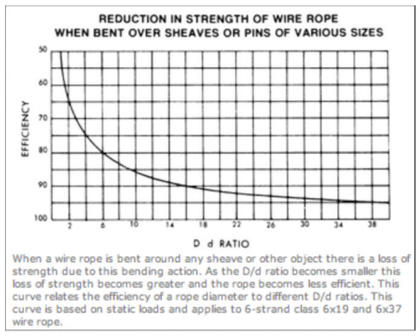


Fig. 12 Jumbo Safety Factors



When a wire rope is bent around any sheave or other object there is a loss of strength due to this bending action. As the D/d ratio becomes smaller this loss of strength becomes greater and the rope becomes less efficient. This curve relates the efficiency of a rope diameter to different D/d ratios. This curve is based on static loads and applies to 6-strand class 6x19 and 6x37 wire rope.

Fig. 10

are seven (Machine Directive 2006/42/EG), while a safety factor of five is applicable in the USA (B30-9).

Lifting beams and spreaders of 10-160 tonnes WLL have to be tested before use, with a proof load required of 10-100 percent extra, depending on the WLL.

This is defined by the following formula: Ltest = 1.04 x WLL + 9.6. Spreaders below 10 tonnes WLL require a proof load of 200 percent. Above 160 tonnes, a proof load of 110 percent is required. The WLL of lifting appliances is sometimes referred to as the safe working load (SWL). One may only use a lifting sling or grommet when:

- There is a valid certificate
- It is still in good working condition (there are no multiple broken wires)
- There is no excessive corrosion
- There is no damage to the end connection
- The end of the cable is not visible at the end connection
- When the load is known and does not exceed the WLL of the sling or grommet
- The rope is not deformed or kinked.

HLPFI

Please note, this article is intended for guidance only. Whilst every care has been taken to ensure the accuracy of the contents, no responsibility will be accepted by the publishers for any errors. Further professional advice should be taken before making any decisions about the use of slings, grommets and shackles

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