



The International Marine
Contractors Association

Guidance on The Use of Cable Laid Slings and Grommets



The International Marine Contractors Association (IMCA) is the international trade association representing offshore, marine and underwater engineering companies.

IMCA promotes improvements in quality, health, safety, environmental and technical standards through the publication of information notes, codes of practice and by other appropriate means.

Members are self-regulating through the adoption of IMCA guidelines as appropriate. They commit to act as responsible members by following relevant guidelines and being willing to be audited against compliance with them by their clients.

There are two core activities that relate to all members:

- ◆ Safety, Environment & Legislation
- ◆ Training, Certification & Personnel Competence

The Association is organised through four distinct divisions, each covering a specific area of members' interests: Diving, Marine, Offshore Survey, Remote Systems & ROV.

There are also four regional sections which facilitate work on issues affecting members in their local geographic area – Americas Deepwater, Asia-Pacific, Europe & Africa and Middle East & India.

IMCA M 179

This guidance reproduces and updates that originally provided by the UK Health & Safety Executive (HSE) in its Plant & Machinery Guidance Note 20 (PM20), which was developed by a cross-industry working group.

Prior to publication by IMCA, the guidance has been reviewed and agreed by the Association's Marine Division Management Committee, in conjunction with its Safety, Environment & Legislation (SEL) Core Committee.

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The information contained herein is given for guidance only and endeavours to reflect best industry practice. For the avoidance of doubt no legal liability shall attach to any guidance and/or recommendation and/or statement herein contained.

Guidance on the use of Cable Laid Slings and Grommets

IMCA M 179 – May 2005

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I Introduction

This guidance is intended to replace guidance previously published by the UK Health & Safety Executive (HSE) in the form of Guidance Note PM20 (Plant & Machinery Series 20). HSE has advised that, although it no longer issues this type of guidance, it would not be adverse to operational practices which followed the guidelines formerly available in PM20. With the approval of HSE, IMCA has therefore reproduced an updated version of PM20 to provide guidance on good practice in the use of cable-laid slings and grommets.

The guidance was originally prepared by a working group of experts in 1987 and was intended to be mainly of assistance to those concerned with the use of cable laid slings and grommets in very heavy lifting operations. Such operations often use cable laid slings and grommets of 100mm diameter and over, as developed for use in the offshore oil industry. These are generally too large for existing test equipment to be used to test the rope sample to destruction. This note, therefore, gives advice on their construction, rating, testing, certification, examination and use.

There is a European standard for grommets and slings, which is European Standard EN 13414-3:2003. That standard states that it “covers ferrule-secured cable-laid slings up to 60mm” (diameter), although it does include some information about larger sizes; but will in any event **not** apply to most IMCA members because, as stated in Annex ZA to that standard, those **excluded** from the standard include “(8). - means of transport, i.e. vehicles and their trailers intended solely for transporting passengers by air or on road, rail or water networks, as well as means of transport in so far as such means are designed for transporting goods by air, on public road or rail networks or on water [vehicles used in the mineral extraction industry will not be excluded.], (9). - seagoing vessels and mobile offshore units together with equipment on board such vessels or units”.

The original working group membership for PM20 was as follows:

- ◆ British Ropes Ltd
- ◆ Brown and Root Ltd
- ◆ UK Department of Energy
- ◆ UK Department of Trade & Industry
- ◆ Gebr Henschel
- ◆ UK Health & Safety Executive
- ◆ Heerema Engineering Service
- ◆ Lloyds Register of Shipping
- ◆ McDermott Hudson Engineering Ltd
- ◆ Micoperi
- ◆ Noble Denton
- ◆ Shell Expro
- ◆ United Ropeworks Ltd

The working group for the review and updating of this publication comprised:

- ◆ IMCA Safety, Environment & Legislation (SEL) Committee
- ◆ IMCA Marine Division Management Committee
- ◆ Heerema Marine Contractors Nederland BV
- ◆ Hendrik Veder
- ◆ J Ray McDermott Inc.
- ◆ Saipem
- ◆ Seaway Heavy Lifting Engineering
- ◆ UOS/Henschel

2 Cable Laid Slings

2.1 Construction

Cable laid slings are formed from wire rope constructed of six unit ropes laid as outers over one core unit rope, with a termination at each end, usually in the form of a spliced eye, as illustrated in Figure 1 and Figure 2.

The nominal diameter of the core unit rope should be at least 12% but not greater than 25% larger than the nominal diameter of the outer unit ropes.

The lay length of the cable laid rope should be a minimum of six times and a maximum of seven-and-a-half times its nominal diameter.

Cable laid ropes should be manufactured right or left hand lay in accordance with one of the combinations of unit rope constructions and cable lay factors, as specified in Appendix 6.

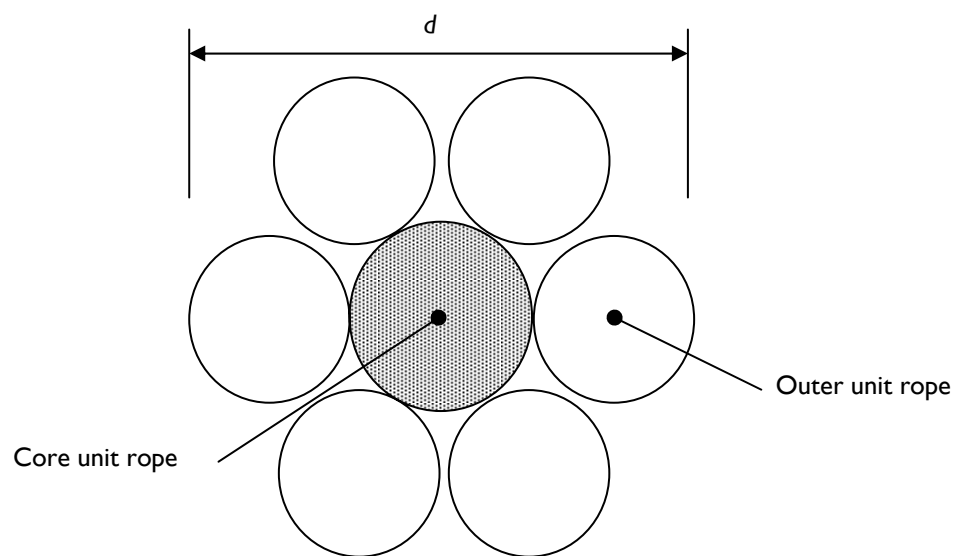


Figure 1 – Cable laid rope construction

2.2 Length of Sling

The nominal length, L_1 of a sling is the length between the insides of the sling eyes bearing points as shown in Figure 2 measured under a tension of 3% cable laid rope breaking load (CRBL). Dimension w should be in accordance with Table 1 with h at least $2w$.

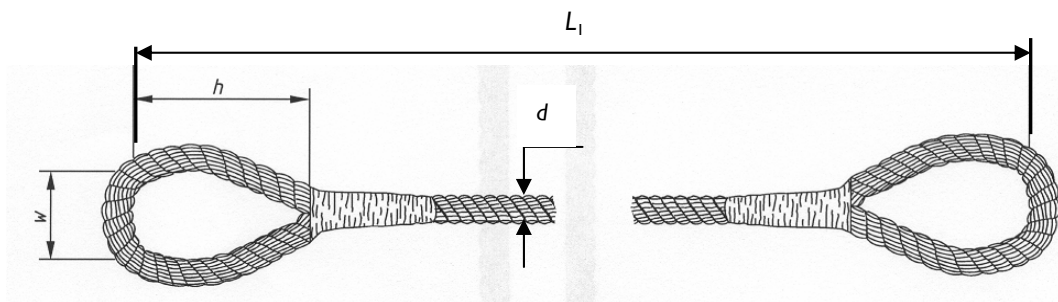


Figure 2 – Cable laid sling

Fabrication tolerance on the length shall be $\pm 1.5d$. The difference in length between slings of matched pairs should not exceed $0.5d$ unless specified otherwise. After length measurement, the sling should

be permanently marked with a longitudinal line to show its alignment when the original length measurement was made.

Diameter of cable laid rope	Pin diameter
100-150 mm	250 mm
151-250 mm	500 mm
251-375 mm	750 mm
376-500 mm	1000 mm

Table 1 – Pin Diameters

If measurement under conditions different from the above is required, the customer should state the requirements on the order and the details should be shown on the Certificate of Dimensional Conformity (Appendix 3A).

2.3 Types of Unit Rope

The construction of the unit rope should be six or eight strands as specified in either ISO 2408 or EN 12385-4, right- or left hand lay. For core unit ropes also seven strands can be used. All unit ropes should have a steel core. Compacted or deformed unit ropes are not allowed to be used.

The breaking load of unit ropes up to 60mm diameter should be calculated in accordance with the method given in ISO 2408 and for larger ropes EN 12385-4 will be applicable (see Appendix I for method of calculation).

3 Sling Rating

3.1 Calculated Cable Laid Rope Breaking Load (CRBL)

The CRBL is calculated as follows:

$$\text{CRBL} = \frac{\sum F_{\min} \times C_L}{K} \quad \text{Tonnes}$$

where:

- $\sum F_{\min}$ = the sum of the individual minimum calculated breaking loads of the outer and core ropes (in kN) as defined in ISO 2408 or EN12385-4 and calculated in accordance with Appendix I;
- C_L = a factor which allows for the spinning losses in cabling (currently taken as 0.85);
- K = a constant which converts the force units (kN) into the mass units (metric tonnes) used in lifting operations. For these purposes, this is taken as 9.81 m/s^2

3.2 Calculated Sling Breaking Load (CSBL)

The CSBL is calculated as follows:

$$\text{CSBL} = \text{CRBL} \times E_T \quad \text{Tonnes}$$

where:

- CSBL = the calculated breaking load of the sling in tonnes;
- CRBL is as defined in paragraph 3.1;
- E_T = the calculated termination efficiency (currently E_T is taken as 0.75 for a hand splice)
See note 1 to section 3.4

3.3 Working Load Limit (WLL) or Rating

The working load limit is the maximum mass that the sling is designed to raise, lower or suspend. This is calculated as follows:

$$\text{WLL} = \frac{\text{CSBL}}{f} \quad \text{Tonnes}$$

where:

- CSBL is as defined in paragraph 3.2;
- f = a factor which allows for the circumstances of use (safety factor). For these applications, f is taken as not less than 2.25.

3.4 Bending Losses

When a sling is utilised as a doubled sling with the sling body bent over a lift point or crane hook, the WLL of the sling shall be reduced by a bending factor E_b . This bending factor will also be applicable for the bend of the sling eye, although this will often not be governing as the sling load will be divided over the two legs of the eye.

The bending factor (E_b) shall be calculated according to the formula:

$$E_b = 1 - \frac{0.5}{\sqrt{D/d}}$$

where:

d = the sling diameter

D = the minimum diameter over which the sling body is bent when doubled.

Notes:

1 E_T (the termination efficiency) and E_b (the bending efficiency) are not additive. If E_b is lower than E_T , E_b must be used instead of E_T in the base formula of Section 3.2 when calculating the CSBL. WLL will thus be:

$$WLL = \frac{CRBL \times E_T}{f} \quad \text{Tonnes}$$

or if $E_b < E_T$:

$$WLL = \frac{CRBL \times E_b}{f} \quad \text{Tonnes}$$

2 If the sling eye is bent over a diameter less than d then derating is necessary.

3 Under no circumstances should the sling body contact any surface where the radius is less than $0.5d$.

4 Termination

The sling legs should be terminated by hand spliced eyes.

The eyes of a sling leg should be formed by the use of hand splices made in one of the following ways, or by another method which can be demonstrated to be as efficient. The core should be worked in with the splice and not cut out. The length of tails of outer ropes after the last tuck should be at least three times the diameter of the cable laid rope and the tails should be seized to the main body of the sling. The method of splicing must be mentioned on the consolidation test certificate (see Appendix 2).

4.1 Method A

A cross tuck splice which consists of at least five tucks, comprising at least three tucks with the complete outer unit ropes. These tucks should be over and under against the lay of the rope, except that the first tuck only of any one unit rope may be with the lay.

4.2 Method B

At least six tucks (including the start) comprising five tucks with the complete outer unit rope with the lay of the rope and one tuck with the complete outer unit rope against the lay of the rope. The sixth tuck can be made with one half of the strands from the outer unit ropes. All tucks should be over one and under two.

The minimum remaining undistorted sling length between the splices of both sling ends shall, in all cases, be at least $15d$, where d is the nominal diameter of the cable laid rope forming the sling. If the sling body is to be doubled then this minimum length must be agreed by the interested parties, but should not be less than $15d$.

5 Cable Laid Grommets

5.1 Construction of Grommets

Cable laid grommets should comprise a single length of unit rope laid up in construction six times over one, as illustrated in Figure 3.

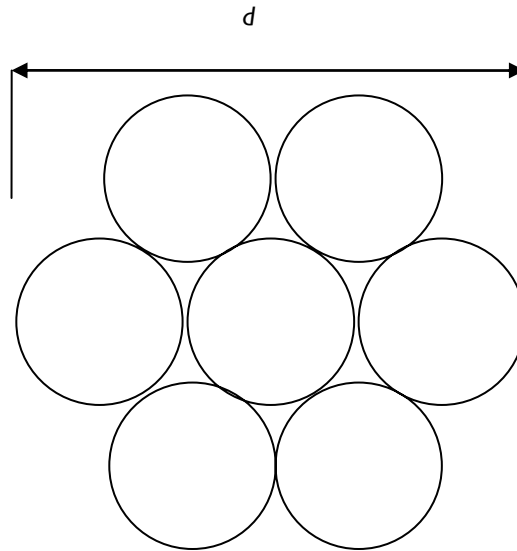


Figure 3 – Grommet construction (single part)

The cable lay factor should be a minimum of six and a maximum of seven-and-a-half times the nominal diameter of the single part grommet.

A grommet contains one tuck splice diametrically opposite the core butt position. This core butt and tuck position should be clearly marked by red paint and should be positioned at approximately 0.25 of the length to ensure the furthest possible distance to the bearing points when used as a doubled grommet. The grommet must never be bent at this marked position.

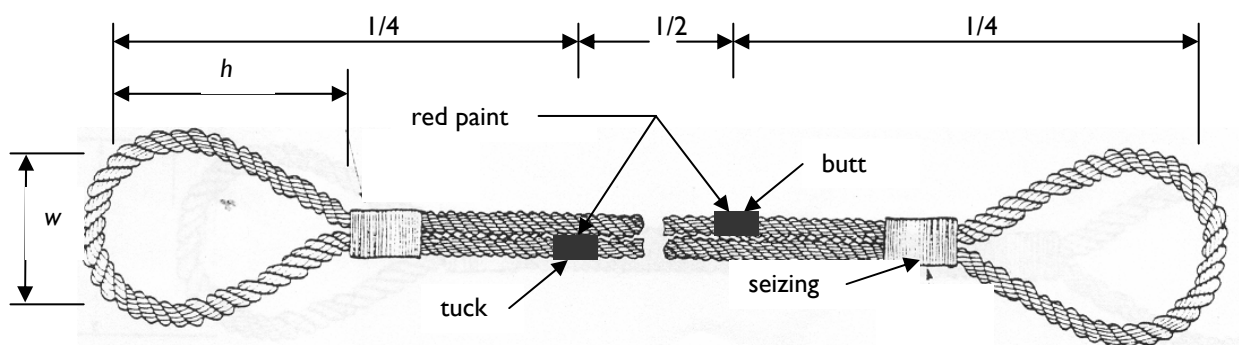


Figure 4 – Position of tuck and core butt in a cable and laid grommet

When a grommet is provided with seized eyes, the seizings should be made from a steel wire strand or rope with a seizing length of not less than twice the diameter of the single part grommet. Dimension h should be at least $2w$.

5.2 Length of Grommet

The nominal length L of a grommet is half the circumferential length measured at the inside of the grommet under a tension of 3% CRBL.

Fabrication tolerance on the circumferential length should be $\pm 3.0d$ (effectively $1.5d$). The difference in circumferential length between grommets of matched pairs should not exceed $1.0d$ (effectively $0.5d$) unless specified otherwise. The length of the circumference should be at least five times the cable lay length.

Unless specified otherwise, when measuring actual grommet lengths, if pins are used, the pin diameter should be as per Table 2.

Diameter of cable laid rope	Pin diameter
100-150 mm	250 mm
151-250 mm	500 mm
251-375 mm	750 mm
376-500 mm	1000 mm

Table 2 – Pin Diameters

If measurement under conditions different from the above is required, the customer should state the requirements on the order and the details should be shown on the certificate of dimensional conformity (Appendix 3B).

5.3 Types of Unit Rope

The construction of the unit rope should be six or eight strands, as specified in either ISO 2408 or EN12385-4, right or left-hand lay. All unit ropes should have a steel core. Compacted or deformed unit ropes are not allowed to be used.

The breaking load of unit ropes up to 60mm diameter should be calculated in accordance with the method given in ISO 2408 and for larger ropes EN12385-4 will be applicable (see Appendix I for method of calculation).

6 Grommet Rating

6.1 Calculated Grommet Breaking Load (CGBL)

The CGBL is calculated as follows:

$$\text{CGBL} = \frac{12 F_{\min} \times C_L}{K} \text{ Tonnes}$$

where:

F_{\min} = the minimum calculated breaking load of the unit rope (in kN), as defined in ISO 2408 and EN12385-4 and calculated in accordance with Appendix 1;

K = a constant which converts the force units (kN) into the mass units (metric tonnes) used in lifting operations. For these purposes this is taken as 9.81 m/s^2

C_L = a factor which allows for the spinning losses in cabling (currently taken as 0.85).

Note: Although the cross section of the grommet comprises a total of 14 ropes, the core section of the unit rope should be discounted in the calculation of the breaking load because the joint is butted and not spliced.

6.2 Working Load Limit (WLL) or Rating

The working load limit is the maximum mass that the grommet is designed to raise, lower or suspend.

This is calculated as follows:

$$\text{WLL} = \frac{\text{CGBL} \times E_b}{f}$$

where:

CGBL = the calculated breaking load of the grommet in metric tonnes;

f = a factor which allows for the circumstances of use (safety factor). For these applications, f is taken as not less than 2.25.

E_b = Bending factor for the bend of a grommet at its ends or when used as a doubled grommet at the grommet body. The bending factor E_b shall be calculated according to the formula:

$$E_b = 1 - \frac{0.5}{\sqrt{D/d}}$$

where:

d = the cable laid rope diameter

D = the minimum diameter over which the grommet end or body when doubled is bent.

Note: Under no circumstances should the grommet contact any surface where the radius is less than $0.5d$.

7 Testing and Certification

Samples from each ropemaking of the unit ropes should be tested to destruction. The actual unit rope breaking load should be equal to or greater than the calculated breaking load in accordance with paragraphs 2.3 and 5.3.

The following certificates should be issued for each sling or grommet and should be available to all interested parties on request:

- i) Consolidation test certificate (see Appendix 2);
- ii) Certificate of dimensional conformity (see Appendices 3A and 3B);
- iii) Certificate of examination (see Appendix 4).

8 Identification and Marking

Each completed sling or grommet should be permanently marked by the maker with a unique identification number, so that it can be identified with its Consolidation Certificate (see Appendix 2). Each cable laid sling should also be marked with a longitudinal line to show its alignment when originally measured (see paragraph 2.2). For a grommet, the core butt position and the tuck position should be marked by red paint (see paragraph 5.1).

9 Inspection and Thorough Examination

9.1 Inspection

An inspection is a visual check carried out by a competent person, who may be either independent or representing the owner of the sling.

Competent person

Designated person, suitably trained, qualified by knowledge and practical experience, and in possession of the necessary instructions to enable the required calculation of WLL and examination to be carried out.

9.2 Thorough Examination

A thorough examination is more detailed and carried out by a competent person independent of the owner of the sling.

An inspection or thorough examination is carried out to identify damage or deterioration which affects fitness for use, such as:

- i) broken or damaged wires;
- ii) distortion of the rope (crushing, kinking, etc.);
- iii) distortion of fittings or terminations;
- iv) corrosive attack;
- v) damage due to weld arcing, etc;
- vi) condition of marking
- vii) paint markings
- viii) tail ends of splices
- ix) number of tucks

Slings and grommets should be inspected by a competent person on each occasion before use.

A thorough examination should be carried out:

- i) at least once in every six months if the sling or grommet is in use;
- ii) before putting the sling or grommet into long term storage;
- iii) if the sling or grommet has been in store for more than six months and is being put into use.

Appendix 5 gives guidance on the assessment of the condition of the sling or grommet and on discard.

A certificate of examination (see Appendix 4) should be renewed after each thorough examination.

10 Record of Lifts

For each sling or grommet a detailed record of lifts should be kept, including the date, calculated sling load, sling or grommet position and angle, etc. for each lift in which it is used.

The record of lifts should be kept together with the certificates and made available on demand to the independent competent person and to the statutory authorities.

Method of Calculating Minimum Breaking Force

See sections 2.3 and 5.3

A – ISO 2408:2004 Method for ropes with $d \leq 60\text{mm}$

$$F_{\min} = \frac{d^2 R_t K}{1000} \quad \text{kN}$$

where:

- F_{\min} = the minimum breaking force in kN
- d = the nominal diameter of the rope in millimetres
- R_t = the rope grade of wire in Newtons per square millimetre
- K = the minimum breaking force factor for a given rope class

and:

K factors for the various classes are:

Class 6 x 36 or 6 x 19 unit rope with steel core $K = 0.346$

Class 8 x 36 or 8 x 19 unit rope with steel core $K = 0.346$

For other classes reference is made to ISO 2408

B – EN 12385-4:2002 Method for $d > 60\text{mm}$

$$F_{\min} = 8.55d + 0.592d^2 - 0.000615d^3 \quad \text{kN}$$

where:

- F_{\min} = is the minimum breaking force in kN;
- d = the nominal diameter of the rope in millimetres.

Consolidation Test Certificate

To be completed by the manufacturer

In accordance with the guidance contained in IMCA M 179 – Guidance on the use of Cable Laid Grommets and Slings

Cable laid wire rope slings and grommets

Identification details

- 1 Certificate number
- 2 Customer
- 3 Identification number
- 3a Sling Number
- 3b Grommet Number
- 4 Nominal diameter (give units)
- 5 Details of outer and core unit rope construction
- 6 Nominal length (give units)
- 7 Termination
- 8 Customer's order number
- Supplier's order number
- 9 Weight (mT)
- 10 Name and address of maker or supplier of sling or grommet

Breaking loads

- 10 Outer ropes: identification number
- Outer ropes: calculated breaking load(s)
- Outer ropes: actual breaking load(s)

- 11 Core rope (slings only): identification number
- Core rope (slings only): calculated breaking load
- Core rope (slings only): actual breaking load

- 12 Summary of breaking loads
- 13 Calculated sling or grommet breaking load

- 14 *I certify on behalf of the firm named in 9 above that the above particulars are correct and that the sling or grommet has been made in accordance with the guidance contained in IMCA M 179.*

Signature:

 Date:

15 Ratification by

 Signature:

 Representing:

 Date:

Certificate of Dimensional Conformity – Cable Laid Slings

To be completed by the manufacturer

In accordance with the guidance contained in IMCA M 179 – Guidance on the use of Cable Laid Grommets and Slings

- 1 Certificate number:
- 2 Consolidation certificate number
- 3 Sling number
- 4 Customer
- 5 Measured length (L) *
- 6 Nominal diameter(d)*
- 7 Eye length (h₁) *
- 8 Eye length (h₂) *
- 9 Approximate splice length from beginning of eye to last tuck (S1) *
- 10 Approximate splice length from beginning of eye to last tuck (S2) *
- 11 Tail length (TL1 and TL2) *
- 12 Length between last tucks (LS) *
- 13 Weight (mT)
- 14 Pin diameter (PD) *
- 15 Measuring load *
- 16 Name and address of maker or supplier of sling or grommet

* state units

Certification

17 I certify on behalf of the firm named in 16 above that the above particulars are correct.

Signature:

Date:

9 Ratification by

Signature:

Representing:

Date:

Note: Items 5 to 13 may be illustrated in a sketch.

Certificate of Dimensional Conformity – Cable Laid Grommets

To be completed by the manufacturer

In accordance with the guidance contained in IMCA M 179 – Guidance on the use of Cable Laid Grommets and Slings

- 1 Certificate number
- 2 Consolidation certificate number
- 3 Grommet number
- 4 Customer
- 5 Measured length (L) *
- 6 Nominal diameter(d)*
- 7 Eye length (h^1) *
- 8 Eye length (h^2) *
- 9 Weight (mT)
- 10 Pin diameter (PD) (if specified by purchaser) *
- 11 Measuring load (if specified by purchaser) *
- 12 Name and address of maker or supplier of sling or grommet

* state units

Certification

- 13 I certify on behalf of the firm named in 12 above that the above particulars are correct.

Signature:

Date:

- 14 Ratification by

Signature:

Representing:

Date:

Note: Items 5 to 9 may be illustrated in a sketch.

Certificate of Examination

To be completed by a competent person independent of the owner of the sling following thorough examination

In accordance with the guidance contained in IMCA M 179 – Guidance on the use of Cable Laid Grommets and Slings

Cable laid slings and grommets

Identification (see Consolidation & Conformity Test Certificates)

Certificate number

Sling or Grommet Number	Nominal † Diameter	Nominal † Length	CRBL or CGBL ‡ Nom	Type and Construction	Maker	Consolidation Cert. Number

- † give units
- ‡ CRBL or CGBL = calculated rope or grommet breaking load (see sections 3.2 and 6.1 of IMCA M 179)

Comments (identify location and nature of significant but acceptable damage. Sketches can be enclosed)

.....

.....

.....

.....

.....

I, the undersigned, thoroughly examined the above and certify that they showed no apparent defects or damage which could affect the strength or safe use.

Signed:

For and on behalf of:

Date:

This certificate is valid for a maximum of six months or such lesser period as stated.

Assessment of the Condition of the Sling or Grommet and Discard Guidance

Broken Wires

General

Broken wires are usually caused by mechanical damage, although corrosion may be a significant factor. The appearance of a few well distributed broken wires may have no marked effect on the strength of the sling, but it might be indicative of mechanical or corrosive damage. Generally, the loss of strength caused by the mechanical or corrosive action on the rope as a whole is more critical than the loss in strength resulting from the actual wire breaks.

Randomly distributed breaks

The sling or grommet should be withdrawn from service and referred to an independent competent person for thorough examination if the total number of visible broken wires in any length of six cable laid sling or single part grommet diameters exceeds or seems to exceed 5% of the total number of wires in the unit rope.

Localised breaks

If there are three or more broken wires closely grouped, the effect on the sling or grommet should be assessed by an independent competent person.

Corrosion

The sling should be withdrawn from service and referred to an independent competent person for thorough examination where corrosion detrimental to the strength of the sling is suspected.

Significant distortion of the rope

The sling should be discarded when distortion due to kinking, crushing, core collapse or knotting is identified. In cases where it is difficult to distinguish between detrimental distortion and acceptable deformation, the sling should be withdrawn from service and referred to an independent competent person for opinion or thorough examination.

Damage due to weld arcing, etc.

The sling should be withdrawn from service and referred to an independent competent person for thorough examination, where pitting, arcing or marked discoloration due to overheating are identified.

Damaged or defective terminations

Particular attention should be paid to signs of:

- i) severe crushing or abrasion of the hand splice;
- ii) pulling out of splice;
- iii) concentrations of broken wires near to the splice, or in the splice;
- iv) the effect of bursting stress at the throat of the eye due to the use of a pin of excessive diameter;
- v) fractured wires on the outside surface of the eye;
- vi) mechanical damage on the bearing surface.

The competent person should consider measuring the actual length of the sling or grommet and the length of the splice tails, as this can give an important indication of serious deterioration. In addition, the actual length of the sling is critical if it is used as part of a matched set.

Combinations of Lay Directions and Lay Factors for Cable Laid Slings and Grommets

The cable laid ropes should be manufactured in accordance with the following combinations of unit rope and cable laid rope lay directions and lay factors.

Lay Directions

- ◆ The core unit rope should be right or left hand ordinary lay;
- ◆ The outer unit ropes should be right or left hand ordinary lay;
- ◆ The cable laid ropes should be laid right or left hand.

Lay Factors

For core unit and outer unit ropes:

- ◆ Minimum: 6 x nominal unit rope diameter
- ◆ Maximum: 7 x nominal unit rope diameter

For cable laid rope:

- ◆ Minimum: 6 x nominal cable laid rope diameter
- ◆ Maximum: 7.5 x nominal cable laid rope diameter

References

- ISO 2408 *Steel Wire Ropes for General Purposes*
Minimum requirements
Third edition 2004-02-01
- EN 12385-4 *Steel Wire Ropes - Safety -*
Part 4: Stranded ropes for general lifting applications
November 2002
- ISO 7531 *Wire Rope Slings for General Purposes*
Characteristics and Specifications
First edition 1987-12-15
- ISO 8792 *Wire Rope Slings - Safety criteria and inspection*
Procedures for Use
First edition 1986-12-15