भारतीय मानक **IS 9944 : 2023**

Indian Standard

वस्त्रादि — प्राकृतिक और मानव निर्मित रेशे की रस्सी स्लिंग — सुरक्षित कार्य भार के लिए अनुशंसाएँ

(दूसरा पुनरीक्षण)

Textiles — Natural and Man-Made Fibre Rope Slings — Recommendations for Safe Working Loads

(Second Revision)

ICS 59.080.50

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Cordage Sectional Committee, TXD 09

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards after the draft was finalized by the Cordage Sectional Committee and approved by the Textiles Division Council.

Safe Working Load (SWL) sometimes stated as the Normal Working Load (NWL) is the maximum safe force that a piece of lifting equipment, lifting device or accessory can exert to lift, suspend, or lower, a given mass without fear of breaking.

This standard was first published in 1981 and subsequently revised in 1992. This revision has been made in the light of experience gained since its publication and to incorporate the following major changes:

a) References to Indian standards have been updated; and
b) Foreword has been modified.

The composition of the committee responsible for the formulation of this standard is listed in Annex C.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Indian Standard

TEXTILES — NATURAL AND MAN-MADE FIBRE ROPE SLINGS — RECOMMENDATIONS FOR SAFE WORKING LOADS

(Second Revision)

1 SCOPE

1.1 This standard specifies the maximum safe working load for slings made from polyamide, polyester, polypropylene, sisal and manila ropes.

1.2 This standard also specifies recommendations for the selection, safe use, inspection, care and storage of fibre rope slings.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

3.1 For the purpose of this standard the following definitions along with those given in IS 3871 shall be applicable.

3.1.1 *Sling* — Flexible component for connecting the hook of the final element of the lifting apparatus and the load to be lifted during handling and lifting.

3.1.2 *Slinging* — Sling in the form in which it is used with certain modalities for lifting the load.

3.1.3 *Single Sling* — A sling consisting of a rope having a spliced eye at each end with or without end fittings.

3.1.4 *Endless Sling* — A length of rope formed into a sling by having its ends joined together by a short splice.

3.1.5 *Spliced Eye* — Loop at the end of a rope obtained by splicing.

3.1.6 *Leg of a Sling* — In the case of slings consisting of more than one rope, which are completely equal and independent and which terminate with one extremity into a single end fitting, the various ropes are called legs.

3.1.7 *Effective Length* — The distance between the bearing points of the sling stretched out by hand on a flat surface.

3.1.8 *Minimum Breaking Strength of the Rope* — The breaking strength of the rope from which the sling is made, as given in relevant Indian Standards for the rope of which the sling is made.

3.1.9 *Reduction Factor* — The factor used to derive the working load limit of a single part of spliced rope from the minimum breaking strength of the unspliced rope. It takes into account loss of strength due to splicing and also of increasing susceptibility to mechanical damage with decreasing rope size.

3.1.10 *Working Load Limit* — The maximum mass, in kilograms or tonnes, which a single part of the spliced rope is permitted to sustain in straight tension.

3.1.11 *Mode Factor (M)* — The factor which takes into account the geometry of the assembly, the multiplicity of parts and empirically determined constants. It is constant by which the working load limit in straight pull of a single part of spliced rope is multiplied to give the maximum safe working load of the sling.

3.1.12 *Maximum Safe Working Load (Maximum SWL)* — The maximum mass in kilograms which the sling is permitted to lift in a given mode (subject to consideration of **3.1.13** not applying/after applying mode factor to the working load limit.

3.1.13 *Safe Working Load (SWL)* — The maximum mass in kilograms, which a sling is permitted to lift in use, taking account of exceptional and/or environmental conditions which may affect adversely the sling (for example, heat, abrasion, chemical contamination, etc). The safe working load never exceeds the maximum SWL.

4 PRINCIPLE

Safe working loads are chosen in accordance with the following basic principles:

a) The reduction factor applicable to a rope depends on the diameter of the rope;

b) The mode factor (M) applicable to a rope depends on the mode/method of slinging;

c) For a given diameter, the reduction factor should be the same for both natural and manmade fibre ropes;

d) For a given mode/method of sling or sling configuration, the mode factor should be the same for both natural and man-made fibre ropes;

e) The use of ropes under 12 mm diameter is not recommended;

f) The maximum angle between two legs of a sling shall not exceed 90°, except in the case of choke hitches, where the angle cannot be fixed; and

g) When the sling is intended for use in adverse conditions, the advice of the sling supplier shall be sought as to whether it is necessary to derive a safe working load reduced from the maximum safe working load.

5 REDUCTION FACTOR

The reduction factor (*see* **3.1.9**) shall be calculated from the following equation:

$$\textit{Reduction factor} = \frac{72}{d} + 3$$

where

d is the numerical value of the nominal diameter (in mm) of the rope.

6 MODE FACTOR

The mode factor (*see* **3.1.11**) shall be as shown in Fig. 1 for the different sling configurations.

7 SAFE WORKING LOAD

7.1 The safe working load of rope is derived from the minimum breaking strength specified in the relevant Indian Standard as described in detail in **7.2** and **7.3**. The safe working loads for different sling configurations for slings of 3-strand hawser-laid or g-strand plaited polyamide, polyester, polypropylene, sisal and manila ropes are given in Tables 1 to Table 5. The maximum safe working load for slings made from polyamide, polyester, polypropylene, sisal and manila ropes (*see* Annex B).

7.2 Calculation of Working Load Limit

The working load limit (*see* **3.1.10**) of the single part of spliced rope shall be calculated by dividing the minimum breaking strength of the rope as specified in the relevant Indian Standard by the reduction factor (*see* **3.1.9**).

7.3 Calculation of Maximum Safe Working Load

The maximum safe working load (*see* **3.1.12**) of the sling configuration shall be calculated by multiplying the working load limit by the appropriate mode factor given in Fig. 1.

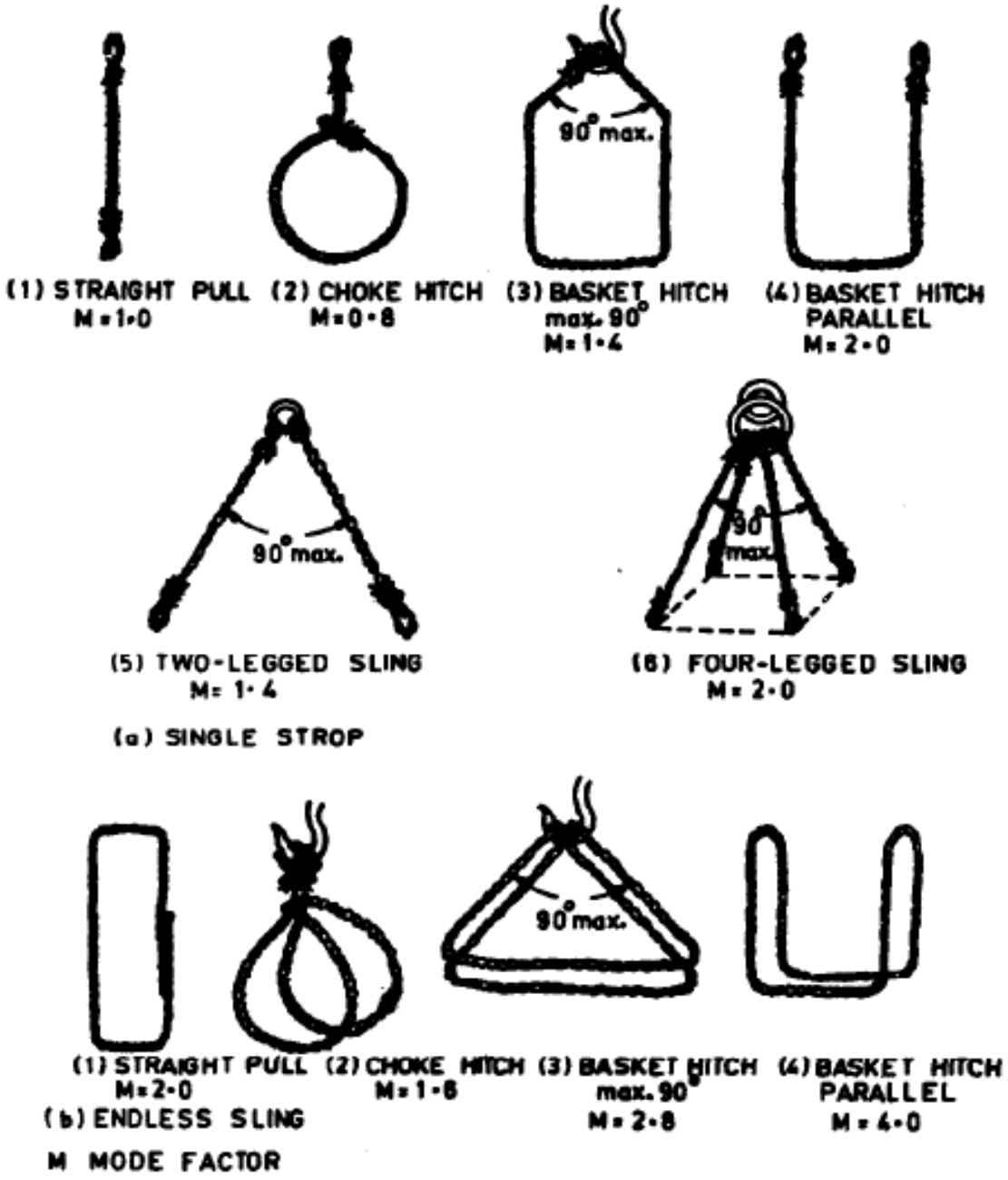

FIG. 1 SLING CONFIGURATIONS

Table 1 Maximum Safe Working Loads for Slings Made for 3-Strand Hawser-Laid and 8-Strand Plaited Polyamide Ropes Conforming to IS 4572
(*Clause* 7.1)

Sl No.	Nominal Dia, mm (Reference Number)	Maximum Safe Working Load, kgf							
		Single Strop Configuration				Endless Configuration			
		Straight pull	Choke hitch	Basket hitch and two legged	Basket hitch Parallel and four legged	Straight pull	Choke hitch	Basket hitch	Basket hitch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12	332.77	266.21	465.80	665.55	665.55	532.43	931.70	1 331.11
ii)	14	502.88	402.30	704.00	1 005.77	1 005.77	804.10	1 408.00	2 011.54
iii)	16	706.66	565.32	989.30	1 413.33	1 413.33	1 130.65	1 978.60	2 826.66
iv)	18	956.42	765.13	1 338.90	1 912.85	1 912.85	1 530.27	2 677.90	3 825.71
v)	20	1 257.57	1 006.05	1 760.50	2 515.15	2 515.15	2 012.11	3 521.10	5 030.30
vi)	22	1 594.38	1 275.50	2 232.00	3 188.77	3 188.77	2 551.00	4 464.00	6 377.55
vii)	24	2 000.00	1 600.00	2 800.00	4 000.00	4 000.00	3 200.00	5 600.00	8 000.00
viii)	26	2 417.67	1 934.13	3 384.70	4 835.35	4 835.35	3 868.27	6 769.40	9 670.71
ix)	28	2 836.62	2 269.29	3 971.20	5 673.24	5 673.24	4 538.59	7 942.50	11 346.49
x)	30	3 287.96	2 630.36	4 603.10	6 575.92	6 575.92	5 260.73	9 206.20	13 151.85
xi)	32	3 809.52	3 047.61	5 329.10	7 619.04	7 619.04	6 095.23	10 658.20	15 238.08
xii)	36	4 980.00	3 984.00	6 972.00	9 960.00	9 960.00	7 968.00	13 944.00	19 920.00
xiii)	40	6 250.00	5 000.00	8 750.00	12 500.00	12 500.00	10 000.00	17 500.00	25 000.00
xiv)	44	7 722.17	6 177.36	10 811.00	15 444.34	15 444.34	12 354.72	21 622.00	30 888.64
xv)	48	9 333.33	7 466.66	13 066.60	18 666.66	18 666.66	14 933.32	26 133.30	37 333.33

Table 2 Maximum Safe Working Loads for Slings Made for 3-Strand Hawser-Laid (Special) and 8-Strand Plaited Polypropylene Ropes Conforming to IS 5175
(*Clause* 7.1)

Sl No.	Nominal Dia, mm (Reference Number)	Maximum Safe Working Load, kgf							
		Single Strop Configuration				Endless Configuration			
		Straight pull	Choke hitch	Basket hitch and two legged	Basket hitch Parallel and four-legged	Straight pull	Choke hitch	Basket hitch	Basket hitch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12	245.50	196.40	343.70	491.10	491.10	392.80	687.40	982.20
ii)	14	374.50	299.60	524.30	749.10	749.10	599.20	1 048.60	1 498.20
iii)	16	502.60	402.00	703.60	1 005.30	1 005.30	804.00	1 407.20	2 010.60
iv)	18	687.10	549.60	961.90	1 374.20	1 374.20	1 099.30	1 923.80	2 748.50
v)	20	878.70	702.90	1 230.10	1 757.50	1 757.50	1 495.90	2 460.00	3 515.10
vi)	22	1 109.60	887.60	1 553.40	2 219.30	2 219.30	1 775.30	3 106.80	4 438.70
vii)	24	1 355.00	1 084.00	1 897.00	2 710.00	2 710.00	2 168.00	3 794.00	5 420.00
viii)	26	1 630.80	1 304.60	2 283.10	3 261.60	3 261.60	2 609.20	4 566.20	6 523.30
ix)	28	1 921.00	1 536.80	2 689.40	3 842.00	3 842.00	3 073.60	5 378.80	7 684.00
x)	30	2 259.20	1 807.30	3 162.80	4 518.50	4 518.50	3 614.70	6 325.70	9 037.00
xi)	32	2 571.40	2 057.10	3 599.90	5 142.80	5 142.80	4 114.20	7 199.90	10 285.60
xii)	36	3 386.00	2 708.0	4 740.40	6 772.00	6 772.00	5 417.00	9 480.80	13 544.00
xiii)	40	4 272.90	3 417.60	5 982.00	8 545.80	8 545.80	6 835.20	11 964.00	17 091.60
xiv)	44	5 314.90	4 251.90	7 440.80	10 629.80	10 629.80	8 503.80	14 881.70	21 259.70
xv)	48	6 357.70	5 086.10	8 900.00	12 715.40	12 715.40	10 172.30	17 815.00	25 430.80

Table 3 Maximum Safe Working Loads for Slings Made for 3-Strand Hawser-Laid polyester Ropes Conforming to IS 11066
(*Clause* 7.1)

Sl No.	Nominal Dia, mm (Reference Number)	Maximum Safe Working Load, kgf							
		Single Strop Configuration				Endless Configuration			
		Straight pull	Choke hitch		Basket hitch Parallel and four legged	Straight pull	Choke hitch	Basket hitch	Basket hitch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12	2.47	1.97	3.45	4.95	4.95	3.95	6.91	9.90
ii)	14	3.83	3.06	5.36	7.66	7.66	6.12	10.72	15.32
iii)	16	5.30	4.24	7.42	10.61	10.61	8.48	14.84	21.22
iv)	18	7.11	5.68	9.95	14.22	14.22	11.37	19.90	28.45
v)	20	9.43	7.54	13.20	18.87	18.87	15.08	26.40	37.75
vi)	22	11.91	9.52	16.67	23.82	23.82	19.05	33.34	47.64
vii)	24	14.93	11.94	20.90	29.86	29.86	23.88	41.80	59.73
viii)	26	18.19	14.55	25.46	36.39	36.39	29.10	50.92	72.79
ix)	28	21.54	17.23	30.15	43.08	43.08	34.46	60.30	86.17
x)	30	24.81	19.84	34.73	49.62	49.62	39.69	69.46	99.25
xi)	32	29.33	23.46	41.06	58.66	58.66	46.92	82.12	117.33
xii)	36	38.00	30.40	53.20	76.00	76.00	60.80	106.40	152.00
xiii)	40	48.95	39.16	68.53	97.91	97.91	78.32	137.06	195.83
xiv)	44	60.18	48.14	84.25	120.36	120.36	96.28	168.50	240.72
xv)	48	73.11	58.48	102.35	146.22	146.22	116.97	204.70	292.44

Table 4 Maximum Safe Working Loads for Slings Made for 3-Strand Hawser-Laid Sisal Ropes Conforming to IS 1321 (Part 1)
(*Clause* 7.1)

Sl No.	Nominal Dia, mm (Reference Number)	Maximum Safe Working Load, kgf							
		Single Strop Configuration				Endless Configuration			
		Straight pull	Choke hitch	Basket hitch and two legged	Basket hitch Parallel and four legged	Straight pull	Choke hitch	Basket hitch	Basket hitch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12	1.00	0.80	1.40	2.00	2.00	1.60	2.80	4.10
ii)	14	1.54	1.23	2.15	3.00	3.00	2.46	4.30	6.10
iii)	16	2.36	1.88	3.30	4.70	4.70	3.77	6.60	9.40
iv)	18	3.00	2.40	4.20	6.00	6.00	4.80	8.50	12.00
v)	20	4.20	3.36	5.88	8.40	8.40	6.72	11.76	16.90
vi)	22	5.32	4.25	7.44	10.60	10.60	8.50	14.88	21.30
vii)	24	6.65	5.30	9.30	13.30	13.30	10.60	18.60	26.60
viii)	26	8.00	6.40	11.20	16.00	16.00	12.80	22.40	32.00
ix)	28	9.37	7.49	13.10	18.70	18.70	14.99	26.20	37.40
x)	30	11.00	8.80	15.40	22.00	22.00	17.60	30.80	44.00
xi)	32	12.80	10.24	17.90	25.60	25.60	20.48	35.80	51.20
xii)	36	17.00	13.60	23.80	34.00	34.00	27.20	47.60	68.00
xiii)	40	21.45	17.16	30.00	42.90	42.90	34.32	60.00	85.80
xiv)	44	26.96	21.56	37.70	53.90	53.90	43.13	75.48	107.80
xv)	48	32.20	25.76	45.00	64.40	64.40	51.52	90.00	128.80

Table 5 Maximum Safe Working Loads for Slings Made for Grade 1 Manila Ropes Strand Hawser-Laid Conforming to IS 1084
(*Clause* 7.1)

Sl No.	Nominal Dia, mm (Reference Number)	Maximum Safe Working Load, kgf							
		Single Strop Configuration				Endless Configuration			
		Straight pull	Choke hitch	Basket hitch and two legged	Basket hitch Parallel and four legged	Straight pull	Choke hitch	Basket hitch	Basket hitch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12	11.66	9.32	16.32	23.32	23.32	18.65	32.64	46.60
ii)	14	17.56	14.00	24.58	35.12	35.12	28.00	49.16	70.21
iii)	16	26.53	21.20	37.14	53.06	53.06	42.40	74.28	106.12
iv)	18	34.28	27.40	47.99	68.56	68.56	54.80	95.98	137.12
v)	20	38.30	38.66	67.66	96.60	96.60	77.32	135.32	193.20
vi)	22	57.20	45.79	80.08	114.48	114.48	91.58	160.16	226.96
vii)	24	74.66	59.72	104.52	149.32	149.32	119.45	209.04	298.64
viii)	26	90.64	72.51	126.89	181.28	181.28	145.00	253.79	362.56
ix)	28	107.36	85.88	150.30	214.72	214.72	171.77	300.60	429.44
x)	30	124.62	99.69	174.46	249.24	249.24	199.39	348.93	498.48
xi)	32	147.00	117.60	205.80	294.00	294.00	235.20	411.60	588.00
xii)	36	189.20	151.36	264.88	379.64	379.64	302.72	529.76	759.28
xiii)	40	245.80	196.64	344.12	491.60	491.60	393.28	688.24	983.20
xiv)	44	301.98	241.58	422.77	603.96	603.96	403.16	845.54	1 207.92
xv)	48	366.66	293.32	513.32	733.32	733.32	586.65	1 026.64	1 466.64

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 1084 : 2005	Textiles — Manila ropes — Specification (*fifth revision*)
IS 1321 (Part 1) : 2003	Sisal ropes — Specification: Part 1 Untarred varieties (*fourth revision*)
IS 3871 : 2013	Fibre ropes and cordage — Vocabulary (*third revision*)
IS 4572 : 2022	Fibre ropes — Polyamide — 3-, 4-, 8- and 12- strand ropes (*fifth revision*)
IS 5175 : 2022	Fibre ropes — Polypropylene split film, monofilament and multifilament (PP2) and polypropylene high-tenacity multifilament (PP3) – 3-, 4-, 8- and 12-strand ropes (*fourth revision*)
IS 11066 : 2022	Fibre ropes — Polyester 3-, 4-, 8- and 12- strand ropes (*third revision*)

ANNEX B
(*Clause* 7.1)

RECOMMENDATIONS ON THE SELECTION, SAFE USE, INSPECTION, CARE AND STORAGE OF FIBRE ROPE SLINGS

B-l SELECTION

Among the factors which should be taken into consideration while selecting materials are the following:

a) Rope slings are liable to wear and mechanical damage, and can be weakened by agencies such as chemicals, heat and light (*see* **B-3.2**);

b) Rope slings made from man-made fibres are generally more durable than natural fibre rope slings. The vulnerability of rope slings to wear and mechanical damage increase inversely with the cross-sectional area; and

c) It is recommended that a user should consult with the supplier to ensure that the material from which the sling is made and the design of the sling itself is suitable for the intended use.

B-2 SAFE USE OF ROPE SLINGS

The following factors illustrate good and bad practices in use but these are not exhaustive:

a) Rope slings should be protected against friction (heat generating), cutting or damage at all points where the sling is in contact with sharp edges or rough surfaces, and they should not be dragged from under loads;

b) No knots or hitches should be made in rope slings. Splices should be located at all times clear of the hook, load or point of choke;

c) The diameter of a component bearing on a soft eye of a sling should not be less than that of the rope and preferably at least twice the rope diameter;

d) The included angle between the two parts of the rope forming a soft eye should not exceed 30° at the splice which in use (*see* **B-3.2.1**);

e) Where more than one sling is used to lift a load, each sling should be identical;

f) Tilting of loads should not exceed 50 and the included angle between the legs (or opposite legs) should not be less than 30°. These limits are based upon practical experience and calculations of the forces arising from asymmetrical loads;

g) Ensure that angles for two-legged and four-legged slings do not exceed 90°;

h) Rope slings should never be overloaded. They should only be used to lift loads not exceeding the safe working load;

j) Rope slings should never be dried or stored near any source of heat. Contract with the hot surface should be avoided, as should exposure to hot gases, such as those from blow lamps or welding torches;

k) When using basket hitch (*see* Fig. 1) care should be taken to ensure that the load is secure since there is no gripping action as with choke hitch. Slings used in pairs with a spreader bar are recommended; and

m) All types of fibre rope slings should be the subject of frequent and regular inspection, in addition to the statutory thorough examination by a competent person (*see* **B-3**), and withdrawn from service in any case of doubt.

B-3 INSPECTION

B-3.1 Inspection Method

Examination at intervals of about one-third of a metre is desirable, the rope being turned to reveal the whole of the surface and the strands being twisted slightly to allow examination between the strands before continuing. Firm wringing of 3-strand rope and bunching of eight, strand rope at intervals may reveal, in the form of fibre power, denaturing or embrittlement of the fibre; but this should be carried out carefully to avoid disturbance of the rope lay. Fittings and attachment should avoid disturbance of the rope lay. Fittings and attachments should also be examined. In case of doubt, the sling should be taken out of use.

B-3.2 Types of Damage

B-3.2.1 *General External Wear*
General external wear due to abrasion causes breakdown of filaments and fibres, and is readily observed. In ordinary use some disarrangement or breaking of the fibres is to be expected, and is harmless if not excessive.

B-3.2.2 *Mechanical Damage and Localized Abrasion*

Areas of severe abrasion, as distinct from general external wear, caused, for example, by the passage of the rope sling over a sharp edge whilst under tension, will cause serious loss of strength. Serious reduction in the section of one strand would warrant rejection.

The vulnerability of rope slings to wear and mechanical damage increases inversely with cross-sectional area. Smaller ropes have all or most of the yarns on the outside of the strand, and hence the effect of chafing is more severe. Larger ropes have strands composed of concentric rings of yarns and such chafing has to be proportionately deeper to achieve the same effect.

Cuts, which may be difficult to detect when first inflicted, have a serious effect on the strength of the rope, they may be indicated by local fraying of the yarns of strands.

B-3.2.3 *Internal Wear*

Internal wear is caused by repeated loading and flexing of the rope when under tension. It may be accelerated by the penetration of grit or other sharp particles into the rope, and may be indicated by excessive looseness of the strands or by the presence of fibre dust within the rope.

B-3.2.4 *Mildew*

Mildew will attack natural fibre rope slings if stored wet and/or in stagnant air. The mould will live on the cellulose of the rope and in consequence, a loss in strength will occur.

Mildew does not attack man-made fibre ropes, although surface contamination may provide a nutrient which permits the growth of moulds. These do not affect the strength of the rope, and may be removed by washing in water only. Detergents should not be used.

B-3.2.5 *Chemical Attack and Wetting*

If slings are liable to contamination by chemicals, the advice of the supplier should be sought.

The following information is for general guidance only:

a) Cotton has a selective resistance to weak acids, alkalis and solvents;

b) Manila and sisal are very vulnerable to attack from acids, alkalis and solvents;

c) Polyamide (nylon) is virtually immune to the effects of alkalis. It is attacked by moderate strength acids. Attention is drawn to its loss of strength on wetting, which can be of the order of 15 percent;

d) Polyester is resistant to moderate strength acid but is damaged by alkali;

e) Polypropylene is little affected by acids and alkalis and is suitable for applications where the highest resistance to chemicals, other than certain solvents, is required; and

f) Slings suspected of contamination should be thoroughly washed in cold water immediately after use and dried naturally.

B-3.2.6 *Heat*

Charring of natural fibres and fusing of man-made fibres indicate that the sling has been subjected to excessive heat from the method of use, for example, in choke hitch. A rope may be severely weakened by heat without observable indications.

B-3.2.7 *Solar Degradation*

Fibre rope slings are subject to degradation by ultraviolet light, and should be stored away from sunlight and other sources of ultraviolet radiation.

B-4 STORAGE

The following storage conditions are ideal for all types of fibre rope slings, but are particularly relevant to natural fibre:

a) When rope slings are stored, they should be protected from condensation, damp, heat and the effects of ultraviolet light;

b) They should be hung on wooden pegs, galvanized hooks or other non-corroding materials so that air can circulated freely around them. Ideally the temperature of the storage area should be between 10°C and 20°C and the relative humidity between 40 percent and 60 percent;

c) Natural fibre rope slings should not be stored away when wet but allowed to dry in freely circulating air at ambient temperature.

ANNEX C
(*Foreword*)

COMMITTEE COMPOSITION
Cordage Sectional Committee, TXD 09

Organization	*Representative(s)*
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