Materials and accessories

Density of materials

DENSITY OF MATERILS

SINKING MATERIALS

■ **Metals**

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
aluminium	2.5	0.60 +	0.59 +
brass	8.6	0.88 +	0.88 +
bronze	7.4	0.86 +	0.86 +
	to 8.9	0.89 +	to 0.88 +
cast iron	7.2	0.86 +	0.86 +
	to 7.8	0.87 +	0.87 +
copper lead	8.9	0.89 +	0.88 +
	11.4	0.91 +	0.91 +
steel	7.8	0.87 +	0.87 +
tin	7.2	0.86 +	0.86 +
zinc	6.9	0.86 +	0.85 +

■ **Textiles**

Type	Density (g/cc)	Multiplicatio n factor*	
		freshwater	sea water
aramide (kevlar)	1.20	0.17 +	0.15 +
cotton	1.54	0.35 +	0.33 +
hemp	1.48	0.32 +	0.31 +
linen	1.50	0.33 +	0.32 +
manilla	1.48	0.32 +	0.32 +
polyamide (PA)	1.14	0.12 +	0.10 +
polyester (PES)	1.38	0.28 +	0.26 +
polyviny alcohol (PVA)	1.30	0.23 +	0.21 +
polyvinyl chloride (PVC)	1.37	0.27+	0.25 +
polyvinylidene	1.70	0.41 +	0.40 +
ramie	1.51	0.34 +	0.32 +
sisal	1.49	0.33 +	0.31 +

■ **Other Materials**

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
brick	1.9	0.47 +	0.46 +
chalk	2.4	0.58 +	0.57 +
concrete	1.8	0.44 +	0.43 +
	to 3.1	0.68 +	0.67 +
earthenware	2.2	0.55 +	0.53 +
glass	2.5	0.60 +	0.59 +
rubber	1.0	0.00	0.03 -
	to 1.5	0.33 +	0.32 +
sandstone	2.2	0.55 +	0.53 +
stone	2.5	0.60 +	0.59 +
ebony	1.25	0.20 +	0.18 +

' *Multiplication factor used to calculate the weight in water' of different materials, as shown on page 4.*

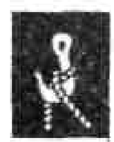
FLOATING MATERIALS

■ **Wood**

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
bamboo	0.50	1.00-	1.05-
cedar, red	0.38	1.63-	1.70-
cedar, white	0.32	2.13-	2.21-
cork	0.25	3.00-	3.10-
cypress	0.48	1.08-	1.14-
fir	0.51	0.96-	1.01-
oak, dry	0.65	0.54-	0.58-
oak, green	0.95	0.05-	0.08-
pine	0.65	0.54-	0.58 -
pine, Oregon	0.51	0.96-	1.01-
pine, poplar	0.41	1.44-	1.50-
oplar	0.48	1.08-	1.14-
spruce	0.40	1.50-	1.57-
teak	0.82	0.22-	0.25-
walnut	0.61	0.64-	0.68-

■ **Fuel**

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
petrol (normal or super)	0.72	0.39 -	0.43-
petrol for lamps	0.79	0.27-	0.30-
diesel fuel	0.84	0.19-	0.22-
crude oil, heavy	0.86	0.16-	0.19-
crude oil, light	0.79	0.27-	0.30-
fuel oil, heavy	0.99	0.01-	0.04-
fuel oil, intermediate (merchant vessels)	0.94	0.06-	0.09-



■ **Textiles**

Type	Density (g/cc)	Multiplicatie factor*	
		freshwater	sea water
polyethylene	0.95	0.05-	0.08-
polypropylen e	0.90	0.11-	0.14 -
polystyrene, expanded	0.10	9.00-	9.26-

■ **Others**

ice	1 0.95	0.11-	0.14- I
oil	0.90-0.95		

Examples of loss of buoyancy as a function of duration of immersion:

after	0 days	10 days	15 days
cork	4.5 kgf	4.0	
wood	2.0 kgf	1.0	0

Weight in water, with examples for materials and for a rigged gillnet

$$P = A \times \{1 - DW/DM\}^*$$

where :

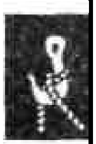
P = weight (kg) in water

A = weight (kg) in air

DW = density (g/cc) of water (freshwater 1.00; sea water 1.026)

DM = density (g/cc) of material

* The term in brackets, the multiplication factor, has been calculated for the materials most commonly used in fisheries, with the results given in the tables on pages 2-3. The factor followed by a + sign indicates a sinking force. The factor followed by a - sign indicates a buoyant or floating force. To obtain the weight in water of a certain quantity of material, simply multiply its weight in air by the factor.



Example a:
1.5 kg of cork in air The table on page 3 gives the multiplication factor for cork:

freshwater : 3.00(-)
sea water : 3.10(-)

so,

1.5 x 3.00(-) = 4.5 kg flotation in freshwater

1.5 x 3.10H = 4.65 kg flotation in sea water

Example b:
24.6 kg of polyamide (nylon) in air The table on page 3 gives the multiplication factor for polyamide:

freshwater : 0.12(+)
sea water : 0.10(+)

so,
24.6 x 0.12(+) = 2.95 kg flotation in freshwater

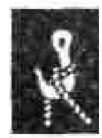
24.6 x 0.10(+) = 2.46 kg flotation in sea water

■ **Example c: Calculating the weight in water of a bottom gillnet**

component	weight(kg) in air	weight (kg) in sea water
ropes: 2 x 90 m PP Ø 6 mm	3.060	-0.430 -
netting: 900 x 11 meshes 140 mm stretched mesh PAR 450 tex with bolchlines	1.360	+ 0.136 +
floats: 46 corks x 21 g (in air) (or 50 floats of 60 gf each)	0.970	- 3.000 -
sinkers: 180 lead sinkers, 80g each (in air) (1	14.400	+13.100 +
or 111 stones, avg. weight 200 g (2)	22.200	
TOTAL	(1)19.790	
	(2) 27.590	9.806 +

The weight of a gillnet in water is calculated by adding the weights of the different components, taking into account the sign of the factor. The sign of the total indicates the type of net we have made; thus, this gillnet with a + sign would be a bottom net with a sinking force of 9.806 kg.

Safe working load, breaking load, safety factor



■ **Definitions**

— Safe working load (SWL), is the maximum load that an item is certified to lift in service. Another equivalent term in use is *Working load limit.*

— Breaking load (BL) is the maximum load that an item can hold with a static load before it breaks. Another equivalent term in use is *Breaking strength.*

— **Safety factor**

$$= \frac{\text{breaking load}}{\text{safe working load}}$$

Very important : The loads used in these calculations *are* static loads. Dynamic or shock loads increase the stress considerably, and thus increase the possibility of breakage.

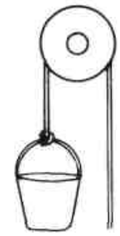
■ **Values of the safety factor**

(a) For ropes

Diameter (mm)	3-18	20-28	30-38	40-44	48-100
Safety factor	25 (est)	20	15	10	8

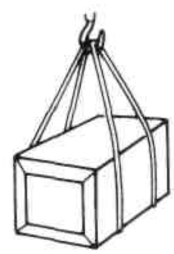
(b) For wire ropes and metal hardware : safety factor about 5—6.

■ **Safe working load**



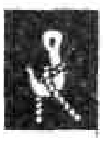
Weight held by one line
SWL

Weight held by 2 lines
SWL × 2



Weight held by 4 lines
SWL × 4

SYNTHETIC FIBRES



Synthetic fibres and commercial names

■ Polyamide (PA)

Amilan (Jap)
Anid (USSR)
Anzalon (Neth)
Caprolan (USA)
Denderon (E. Ger)
Enkalon (Neth, UK)
Forlion (ltd)
Kapron (USSR)
Kenlon (UK)
Knoxlock (UK)
Lilion (ltd)
Nailon (ltd)
Nailonsix (Braz)
Nylon (many coun)
Perlon (Ger)
Platil (Ger)
Relon (Roum)
Roblon (Den)
Silon (Czec)

■ Polyethylene (PE)

Akvaflex (Nor)
Cerfil (Port)
Corfiplaste (Port)
Courlene (UK)
Drylene 3 (UK)
Etylon (Jap)
Flotten (Fran)
Hiralon (Jap)
Hi-Zex (Jap)
Hostalen G (W. Ger)
Laveten (Swed)
Levilene (ltd)
Marlin PE (Ice)
Norfil (UK)
Northylen (Ger)
Nymplex (Neth)
Rigidex (UK)
Sainthene (Fran)
Trofil (Ger)
Velon PS (LP) (USA)
Vestolen A (Ger)

■ Polypropylene (PP)

Akvaflex PP (Nor)
Courlene PY (UK)
Danaflex (Den)
Drylene 6 (UK)
Hostalen PP (Ger)
Meraklon (Ital)
Multiflex (Den)
Nufil (UK)
Prolene (Arg)
Ribofil (UK)
Trofil P (Ger)
Ulstron (UK)
Velon P (USA)
Vestolen P (Ger)

■ Copolymers (PVD)

Clorene (Fran)
Dynel (USA)
Kurehalon (Jap)
Saran (Jap, USA)
Tiviron (Jap)
Velon (USA)
Wynene (Can)

■ Polyester (PES)

Dacron (USA)
Diolen (Ger)
Grisufen (E. Ger)
Tergal (Fran)
Terital (Ital)
Terlenka (Neth, UK)
Tetoron (Jap)
Terylene (UK)
Trevira (W. Ger)

■ Polyvinyl alcohol (PVA)

Cremona (Jap)
Kanebian (Jap)
Kuralon (Jap)
Kuremona (Jap)
Manryo (Jap)
Mewlon (Jap)
Trawlon (Jap)
Vinylon (Jap)

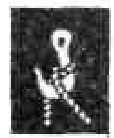
■ Commercial names of combined twines for netting

Kyokurin	Cont. fil PA + Saran
Livlon	Cont. fil PA + Saran
Marlon A	Cont. fil PA + St. PVA
Marlon B	Cont. fil PA + Saran
Marlon C	Cont. fil PA + Cont. fil PVC
Marlon D	Cont. fil PA + Saran
Marlon E	St. PA + St. PVA (or PVC)
Marumoron	Cont. fil. PA + St. PVA
Polex	PE + Saran
Polysara	PE + Saran
Polytex	PE + cont. fil. PVC
Ryolon	Cont. fil. PES + Cont. fil. PVC
Saran-N	Cont. fil. PA + Saran
Tailon (Tylon P)	Cont. fil. PA + St. PA
Temimew	St. PVA + St. PVC

Cont. fil. = continuous fibres
St. = staple fibre

Synthetic fibres: physical properties

■ **Nylon, polyamide (PA)**	Sinks (density = 1.14) Good breaking strength and resistance to Abrasion Very good elongation and elasticity
■ **Polyester (PES)**	Sinks (density = 1.38) Very good breaking strength Good elasticity Poor elongation (does not stretch)
■ **Polyethylene (PE)**	Floats (density = 0.94-0.96) Good resistance to abrasion Good elasticity
■ **Polypropylene (PP)**	Floats (density = 0.91-0.92) Good breaking strength Good resistance to abrasion
■ **Polyvinyl alcohol (PVA)**	Sinks (density = 1.30-1.32) Good resistance to abrasion Good elongation



Synthetic fibres: identification

Properties	PA	PES	PE	PP
Floats	No	No	Yes	Yes
- Appearance - Continuous fibres - Short (staple) fibres - Monofilament - Sheets	 X (X) (X) 	 X (X) (X) 	 - - X (X)	 X (X) (X) X
Combustion	Melts following short duration of heating - forms molten droplets	Melts and burns slowly with bright yellow flame	Melts and burns slowly with pale blue flame	Melts and burns slowly with pale blue flame
Smoke	White	Black with soot	White	White
Smell	Celery-like fishy odour	Hot oil faintly sweet	Snuffed out candle	Hot wax/ burning asphalt
Residue	Solid yellowish round droplets	Solid blackish droplets	Solid droplets	Solid brown droplets

X = Commonly available

(X) = Material exists but is less common

\- = Not available

Twine: number, tex, denier, metres/kg, diameter

TWIN

■ Simple fibres

Titre (denier) : Td = weight (g) of 9000 m of fibre
Metric number : Nm = length (m) of 1 kg of fibre
English number for cotton : Ne_c = length (in multiples of 840 yd) per lb
International system: tex = weight (g) of 1000 m of fibre

■ Finished twine

Runnage, metres/kg : m/kg = length (m) of 1 kg of finished twine
Resultant tex : Rtex = weight (g) of 1000 m of finished twine

■ Equivalents and conversions

Textile\system	PA	PP	PE	PES	PVA
Titre/denier	210	190	400	250	267
International tex system	23	21	44	28	30

$$\text{tex} = 0.111 \times \text{Td} = 1000/\text{Nm} = 590.5/\text{Ne}_c$$

$$\text{Rtex} = \frac{1\,000\,000}{\text{m/kg}} = \frac{496\,055}{\text{yd/lb}} = 0.132 \times \text{Td}$$

$$\frac{\text{kg/100 m}}{25} = \text{lb/fathom (approximate)}$$

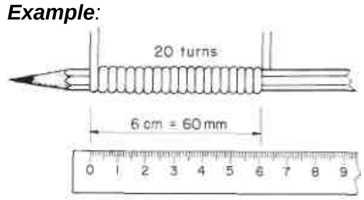
$$\text{kg/m} = 1.5 \times \text{lb/ft (approximate)}$$

$$\text{kg/m} = 0.5 \times \text{lb/yd (approximate)}$$

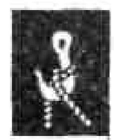
■ Estimating the diameter of twine

In addition to precise measurements from instruments such as micrometer, magnifying glass and microscope, there exists a quick method of estimation. Roll 20 turns of the twine to be measured around a pencil and measure the total length of the turns.

***Example**:*



If 20 turns of the twine measure 6 cm, then the diameter of the twine = 60 mm/20 turns = 3 mm
Note : *The strength of twine or rope depends not only on its thickness, but also on the method and degree of twisting or braiding its yarns.*



TWIN

Twin : calculation of tex

■ **Calculation of Resultant tex (Rtex) of twine**

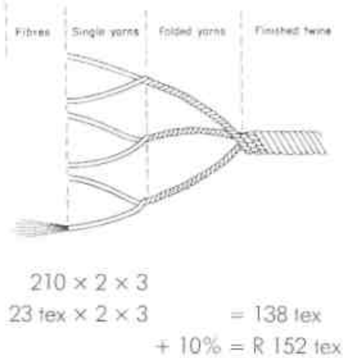
Case 1 : When the structure of the twine is known

Example*:*
Netting twine made of nylon (polyamide), with 210 denier single yarns, 2 single yarns in each of the 3 folded yarns (strands) which make up the twine.

210 x 2 x 3 = 23 tex x 2 x 3
= 138 tex

To find the Resultant tex (Rtex) we have to apply a correction to the calculated value, taking into account the structure of the finished twine (twisted, braided, hard lay, degree of twist, etc.). A rough estimation of Rtex can be found by adding 10% to the value calculated above:

138 tex + 10% = R 152 tex (estimate)



Note : *in view of the complex structure of braided twines, it is the general practice in fisheries for the gear designer to use the Rtex value without going into detail.*

Case 2 : A sample of twine is available for evaluation

Example ;
5 m of twine, placed on a precision scale, weigh 11.25 g. We know that twine of R 1 tex weighs 1 g per 1000 m, and the weight per metre of the sample twine is 11.25/5 = 2.25 g/m. So, 1000 m of the sample would weigh 1000 x 2.25 = 2250 g, or R 2250 tex

Note : *The strength of twine or rope depends not only on its thickness, but also on the method and degree of twisting or braiding its yarns*

Twine: equivalents of numbering systems

Eg.: twisted nylon (polyamide) twine

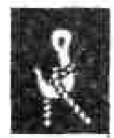
m/kg	Rtex g/1000m	yds/lb a/
20 000	50	9 921
13 500	75	6 696
10 000	100	4 960
6 450	155	3 199
4 250	235	2 180
3 150	317	1 562
2 500	450	1 240
2 100	476	1 041
1 800	556	893
1 600	625	794
1 420	704	704
1 250	800	620
1 150	870	570
1 060	943	526
980	1 020	486
910	1 099	451
850	1 176	422
790	1 266	392
630	1 587	313
530	1 887	263
400	2 500	198
360	2 778	179
310	3 226	154
260	3 846	129
238	4 202	118
225	4 444	112
200	5 000	99
180	5 556	89
155	6 452	77
130	7 692	64
100	10 000	50

a/ yds/lb = approx. (m/kg)/2

m/kg = approx. (yds/lb) x 2

No of yarns denier	No. of deniers Td	Tex
210x2	420	47
3	630	70
4	840	93
6	1 260	140
9	1 890	210
12	2 520	280
15	3 150	350
18	3 780	420
21	4 410	490
24	5 040	559
27	5 670	629
30	6 300	699
33	6 930	769
36	7 560	839
39	8 190	909
42	8 820	979
45	9 450	1 049
48	10 080	1 119
60	12 600	1 399
72	15 120	1 678
96	20 160	2 238
108	22 680	2 517
120	25 200	2 797
144	30 240	3 357
156	32 760	3 636
168	35 280	3 916
192	40 320	4 476
216	45 360	5 035
240	50 400	5 594
264	55 440	6 154
360	75 600	8 392

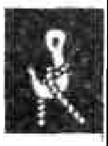
Note: 210 denier = 23 Tex



TWIN

Twines: nylon (polyamide PA), multifilament twisted or braided

A = breaking load, dry without knots (single twine)
B = breaking load, wet, knotted (single twine)



■ Twisted, continuous filament

m/kg	Rtex	Diam. mm	A kgf	B kgf
20 000	50	0.24	3.1	1.8
13 300	75	0.24	4.6	2.7
10 000	100	0.33	6.2	3.6
6 400	155	0.40	9	6
4 350	230	0.50	14	9
3 230	310	0.60	18	11
2 560	390	0.65	22	14
2 130	470	0.73	26	16
1 850	540	0.80	30	18
1 620	620	0.85	34	21
1 430	700	0.92	39	22
1 280	780	1.05	43	24
1 160	860	1.13	47	26
1 050	950	1.16	51	28
970	1 030	1.20	55	29
830	1 200	1.33	64	34
780	1 280	1.37	67	35
700	1 430	1.40	75	40
640	1 570	1.43	82	43
590	1 690	1.5	91	47
500	2 000	1.6	110	56
385	2 600	1.9	138	73
315	3 180	2.0	165	84
294	3 400	2.2	178	90
250	4 000	2.4	210	104
200	5 000	2.75	260	125
175	6 000	2.85	320	150
125	8 000	3.35	420	190
91	11 000	3.8	560	250

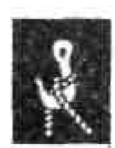
■ Braided, continuous filament

m/kg	Rtex	Diam. Appox. mm	A kgf	B kgf
740	1 350	1.50	82	44
645	1 550	1.65	92	49
590	1 700	1.80	95	52
515	1 950	1.95	110	60
410	2 450	2.30	138	74
360	2 800	2.47	154	81
280	3 550	2.87	195	99
250	4 000	3.10	220	112
233	4 300	3.25	235	117
200	5 000	3.60	270	135
167	6 000	4.05	320	155
139	7 200	4.50	360	178
115	8 700	4.95	435	215
108	9 300	6.13	460	225
95	10 500	5.40	520	245
81	12 300	5.74	600	275
71	14 000	5.93	680	315
57	17 500	6.08	840	390

Twine, nylon (polyamide PA), monofilament and multimonofilament, Japanese numbering system

A = breaking load, dry without knots (single twine)
B = breaking load, wet, knotted (single twine)

Diam. mm	m/kg	Tex*	A kgf	B kgf
0.10	90 900	11	0.65	0.4
0.12	62 500	16	0.9	0.55
0.15	43 500	23	1.3	0.75
0.18	33 300	30	1.6	1.0
0.20	22 700	44	2.3	1.4
0.25	17 200	58	3.1	1.8
0.30	11 100	90	4.7	2.7
0.35	8 330	120	6.3	3.6
0.40	6 450	155	7.7	4.4
0.45	5 400	185	9.5	5.5
0.50	4 170	240	12	6.5
0.55	3 570	280	14	7.5
0.60	3 030	330	17	8.8
0.70	2 080	480	24	12.5
0.80	1 670	600	29	15
0.90	1 320	755	36	19
1.00	1 090	920	42	22
1.10	900	1 110	47	25
1.20	760	1 320	55	30
1.30	650	1 540	65	35
1.40	560	1 790	75	40
1.50	490	2 060	86	46
1.60	430	2 330	98	52
1.70	380	2 630	110	58
1.80	340	2 960	120	65
1.90	300	3 290	132	72
2.00	270	3 640	145	75
2.50	180	5 630	220	113



Japanese numbering system for Monofilament

N' Japan	Diam. (mm)	N" Japan	diam. (mm)
	0.20		0.55
2	-	12	-
	0.25		0.60
3		14	
	0.30		0.70
4	-	18	-
	0.35		0.80
5	-	24	
	0.40	30	0.90
6	-		
7	0.45		
8	0.50		
10	-		

■ Multimonofilament

Diameter* x number of (mm) filaments	m/kg	A Kgf
0.20 x 4	6 250	9
0.20 X 6	4 255	14
0.20 x 8	3 125	18
0.20 x 10	2 630	24
0.20 x 12	2 120	26

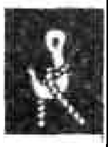
** for monofilament, tex and Rtex are the same.*

Twine: polyester (PES), polyethylene (PE), polypropylene (PP)

TWIN

A = breaking load, dry without knots (single twine)

B = breaking load, wet, knotted (single twine)



POLYESTER (PES)

■ **twisted, continuous filaments**

m/kg	Rtex	Diam. mm	A kgf*	B kgf
11 100	90	0.40	5.3	2.8
5 550	80	0.50	10.5	5
3 640	275		16	7.3
2 700	370	0.60	21	9.3
2 180	460	0.70	27	12
1 800	555	0.75	32	14
1 500	670	0.80	37	16
1 330	750	0.85	42	18
1 200	830	0.90	46	20
1 080	925	0.95	50	22
1 020	980	1.00	54	24
900	1 110	1.05	60	26
830	1 200	1.10	63	28
775	1 290	1.15	68	29
725	1 380	1.20	73	30
665	1 500	1.25	78	32
540	1 850	1.35	96	40
270	3 700	1.95	180	78

POLYETHYLENE (PE)

■ **twisted or braided thick filaments**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
5 260	190	0.50	7.5	5.5
2 700	370	0.78	10	7
1 430	700	1.12	27	19
950	1 050	1.42	36	24
710	1 410	1.64	49	35
570	1 760	1.83	60	84
460	2 170	2.04	75	54
360	2 800	2.33	93	67
294	3 400	2.56	116	83
225	4 440	2.92	135	97
190	5 300	3.19	170	125
130	7 680	3.68	218	160
100	10 100	3.96	290	210

POLYPROPYLENE (PP)

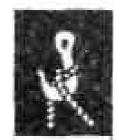
■ **twisted, continuous filaments**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
4 760	210	0.60	13	8
3 470	290	0.72	15	9
2 780	360	0.81	19	11
2 330	430	0.90	25	14
1 820	550	1.02	28	15
1 560	640	1.10	38	19
1 090	920	1.34	44	23
840	119011	1.54	58	30
690	10	1.70	71	36
520	1 920	1.95	92	47
440	2 290	2.12	112	59
350	2 820	2.32	132	70
300	3 300	2.52	152	80
210	4 700	2.94	190	100
177	5 640	3.18	254	130

■ **twisted staple fibres**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
4 760	210	0.60	9	6
3 330	300	0.73	13	9
2 560	390	0.85	18	12
1 250	800	1.22	32	22
1 010	990	1.36	38	24
720	1 390	1.62	57	36
530	1 900	1.94	73	46
420	2 360	2.18	86	54
325	3 070	2.48	100	59
240	4 100	2.90	150	88
185	5 400	3.38	215	120
150	6 660	3.82	300	170

Vegetable fibre ropes*



Tarred Cotton		
Diameter mm	kg/100 m	R kgf
3.0	1.056	45
3.5	1.188	55
4.0	1.320	66
4.5	1.585	77
5.0	1.915	88
5.5	2.448	100
6.0	2.905	113
6.5	3.300	127

Sisal				
	Standard		Extra	
Diameter mm"	kg / 100 m	R kgf	kg/ 100 m	R kgf
6	2.3	192	3.3	336
8	3.5	290	4.7	505
10	6.4	487	6.4	619
11	8.4	598	9.0	924
13	10.9	800	11.0	1 027
14	12.5	915	14.0	1 285
16	17.0	1 100	17.2	1 550
19	24.5	1630	25.3	2 230
21	28.1	1 760	29.30	2 390
24	38.3	2 720	39.5	3 425
29	54.5	3 370	56.0	4 640
32	68.0	4 0501	70.0	5510
37	90.0	5 220	92.0	7 480
40				
48				

R = Breaking strength, dry Safe working load, see page 5
" In English-speaking countries the size of a rope is sometimes measured by its circumference in inches (in.)
or by its diameter in inches Diameter of rope 0 *(mm) = approx. 8 x c (inch)*
Example: 0 *(mm) of a rope of 2.25 inch circumference*
0 *(mm) = 2.25 x 8=18 mm (approximate)*

Hemp				
	Standard		Extra	
Diameter mm"	kg/ 100 m	R kgf	kg/ 100 m	R kgf
10	6.6	631	7.8	600
11	8.5	745	10.0	708
13	11.3	994	13.3	944
14	14.3	1 228	17.0	1 167
16	17.2	1 449	20.3	1 376
19	25.3	2017	29.8	1 916
21	30.0	2318	35.4	2 202
24	40.2	3 091	47.4	2 936
29	59.0	4 250	70.0	4 037
32	72.8	5 175	86.0	4916
37	94.8	6 456	112.0	6 133
40	112.0	7 536	132.0	7 159
48	161.0	10 632	190.0	10 100

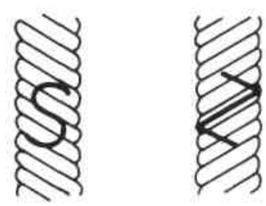
Manilla				
	Standard		Extra	
Diameter mm"	kg/ 100 m	R kgf	kg/ 100 m	R kgf
10	6.2	619	6.2	776
11	9.15	924	9.25	1 159
13	11.2	1 027	12.4	1 470
14	14.2	1 285	15.0	1 795
16	17.5	1 550	18.5	2 125
19	25.5	2 230	26.65	2 970
21	29.7	2 520	30.5	3 330
24	40.5	3 425	41.6	4 780
29	58.4	4 800	59.9	6 380
32	72.0	5 670	74.0	7 450
37	95.3	7 670	98.0	9 770
40	112.5	8 600	115.8	11 120
48				

Synthetic fibre rope*

Diameter mm"	Polyamide kg/100	(PA) R kgf	Polyethyene kg/100m	(PE) Rkgf	Polyester kg/100 m	(PES) R kgf	Polypropyene Kg/100m	(PP) Rkgf
4	1.1	320			1.4	295	_	.
6	2.4	750	1.7	400	3	565	1.7	550
8	4.2	1 350	3	685	5.1	1 020	3	960
10	6.5	2 080	4.7	1 010	8.1	1 590	4.5	1 425
12	9.4	3 000	6.7	1 450	11.6	2 270	6.5	2 030
14	12.8	4 100	9.1	1 950	15.7	3 180	9	2 790
16	16.6	5 300	12	2 520	20.5	4 060	11.5	3 500
18	21	6 700	15	3 020	26	5 080	14.8	4 450
20	26	8 300	18.6	3 720	32	6 350	18	5 370
22	31.5	10 000	22.5	4 500	38.4	7 620	22	6 500
24	37.5	12 000	27	5 250	46	9 140	26	7 600
26	44	14 000	31.5	6 130	53.7	10 700	30.5	8 900
28	51	15 800	36.5	7 080	63	12 200	35.5	10 100
30	58.5	17 800	42	8 050	71.9	13 700	40.5	11 500
32	66.5	20 000	47.6	9 150	82	15 700	46	12 800
36	84	24 800	60	11 400	104	19 300	58.5	16 100
40	104	30 000	74.5	14 000	128	23 900	72	19 400

R = breaking strength, dry

Direction of twist of twines, ropes and cables

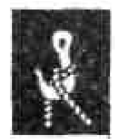


Left hand laid   *Right hand laid*

' *Safe working load see page 5*

" *Conversioninch-mm, seepage 15*

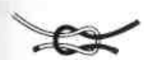
Rope: joining knots and loops



Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

■ Joining two cords

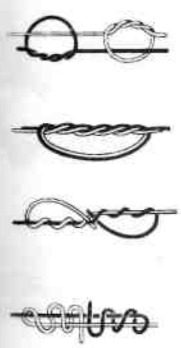
Two cords of the same diameter, multifilament



Reef knot

Fisherman's knot

Two cords of same diameter, monofilament



Two cords of different diameters or different types

Double sheet bend

Sheet bend (sufficient if the two ends are tied)

Sheet bends are also useful for joining two identical cords

■ Loops

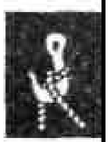
Fixed loop

Simple bowline

Chair knot

Running loop

Running bowline



Knots for stoppers and mooring

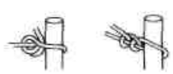
Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

■ **For stopping a rope from running through a narrow space** (i.e. sheave)

Figure of eight

■ **Knots for mooring**

Clove hitch



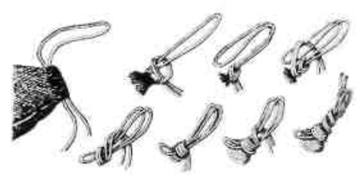
Round turn and two half hitches

Double sheet bend

Anchor bend

■ **To close the codend of a trawl**

(codend knot)



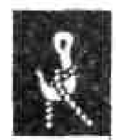
■ **To shorten a rope**

Sheepshank

(not effective with monofilament)

Knots for hitches and stoppers

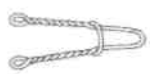
ROPE



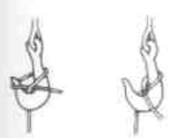
Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

Single or double blackwall hitch

Mousing a hook



A catspaw



Midshipman's hitch

Catspaw

Rolling hitch

Timber hitch

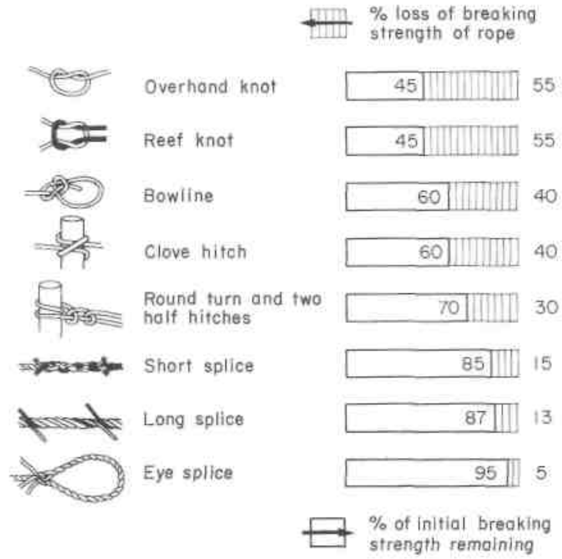
Cow hitch
(sling looped around load)

Becket hitch
(often used to lift codend)

Timber hitch

Stopper hitch

Loss of breaking strength due to knots and splices



Combination wire (1)*

■ Steel - Sisal 3 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
10	0.094	1 010	0.103	910
12	0.135	1 420	0.147	1 285
14	0.183	1 900	0.200	1 750
16	0.235	2 400	0.255	2 200
18	0.300	3 100	0.325	2 800
20	0.370	3 800	0.405	3 500
22	0.445	4 600	0.485	4 200
25	0.565	5 700	0.615	5 300
28	0.700	7 500	0.760	6 700
30	0.820	8 400	0.885	7 600

■ Steel - Sisal 4 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
12	0.135	1 420	0.147	1 285
14	0.183	1 900	0.200	1 750
16	0.235	2 400	0.255	2 200
18	0.300	3 100	0.325	2 800
20	0.370	3 800	0.405	3 500
22	0.445	4 600	0.485	4 200
25	0.565	5 700	0.615	5 300
28	0.700	7 200	0.760	6 400
30	0.775	8 400	0.840	7 600

R = Breaking strength dry

**Safe working loads, see page 5*

22 Combination wire (2)*

■ Steel -Manilla B, 4 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
12	0.138	1 500	0.150	1 370
14	0.185	2 000	0.205	1 850
16	0.240	2 500	0.260	2 350
18	0.305	3 300	0.335	3 000
20	0.380	4 000	0.410	3 800
22	0.455	5 000	0.495	4 600
25	0.575	6 200	0.630	5 700
28	0.710	7 600	0.775	6 900
30	0.790	8 900	0.860	8 200
32	0.890	9 500	0.970	8 750
34	1.010	11 200	1.100	10 200
36	1.140	12 000	1.235	11 000
40	1.380	15 000	1.495	14000
45	1.706	18 500	1.860	17 500
50	2.045	22 500	2.220	20 000

■ Steel - Polypropylene

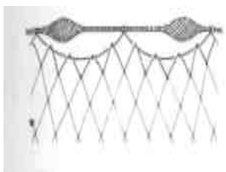
Diameter (mm)	Number of strands	kg/m	Rkgf
10	3	0.105	1 230
12	3	0.120	1 345
14	3	0.140	1 540
16	3	0.165	2 070
18	3	0.240	3 000
14	6	0.250	4 000
16	6	0.275	4 400
18	6	0.350	5 300
20	6	0.430	6 400
22	6	0.480	7 200
24	6	0.520	7 800
26	6	0.640	9 700

R = Breaking strength dry

** Safe working loads, see page 5*

Floatlines and leadlines

■ **Floatline (with floats inside)**



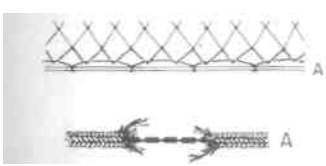
Principal advantages (1) and disadvantages (2)

1) Ease of rigging; less entanglement in the meshes.
2) Need to calculate the rigging as a function of the distance between the floats; fragility of some types of float when passing through certain gillnet haulers.

Floatline (with floats inside)

Interval between floats (cm)	Flotation gf/100m
52	480
47	500
35	570
20	840
35	2850
20	3 000

■ **Leadline (with leads inside)**



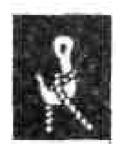
Principal advantages (i) and disad-vantages (2)

1) Ease of rigging; uniform weight of leadline; better hanging; no entanglement in meshes.
2) In the case of breaking, loss of leads; difficult to repair; high cost.

Braided with a centre core of lead

Diameter (mm)	kg/100 m	Rkgf
2	2.3 - 3.5	73
2.5	4.6	
3	6.5-7.1	100
3.5	9.1	
4	11.1 -12.3	200
4.5	14.5	
5	15.2-18.1	300

Diameter (mm)	kg/100m	Rkgf
7.2	7.5	360
8	12.5	360
8	18.8	360
9.5	21.3	360
9.5	23.8	360
9.5	27.5	360
11.1	30.0	360
12.7	37.5	675

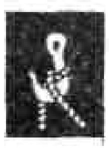


Rope with a lead core in three strands

Diameter	kg/100m	Rkgf
6	8.7	495
7	11.2	675
8	13.3	865
10	21.6	1 280
12	26.6	1 825
14	33.0	2510

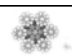
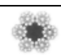
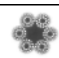
R = breaking strength

there are also leadlines
of 0.75; 0.90; 1.2; 1.5; 1.8 kg/100m



Steel wire rope: structure, diameter and use

Examples of common marine wire rope

Type	Structure and diameter	Example of Use	S
	7x7(6/1) central heart: steel ∅ 12 to 28 mm	Standing rigging	+
	6x7 (6/1) Central heart: textile ∅ 8 to 16 mm	Standing rigging Warps for small trawlers Small coastal vessels	+
	6x12(12/fibre) Central heart, strand cores, fibre ∅ 8 to 16 mm	Bridles and warps for small trawlers moorings and running rigging	++
	6x19 (9/9/1) Central heart of steel or textile ∅ 16to30mm	Trawler warps	+
	6x19(12/6/1) Central heart of textile ∅ 8 to 30 mm	Trawler's sweeps and warps running rigging	+
	6x24(15/9/fibre) Central heart and strand cores of textile ∅ 8 to 40 mm	Purse wire bridles and otter board strops, running rigging moorings and towing	++
	6x37(18/12/6/1) Central heart of textile ∅ 20 to 72 mm	Purse wire moorings and running rigging mooring	++

S = flexibility
+ = poor or average
++ = good

As a general rule, the greater the number of strands, and the greater the number of filaments per strand, the greater the flexibility of the cable.

Galvanised steel wire rope: runnage. breaking strength*

(for structure, see page 24) examples

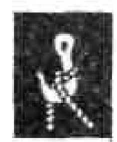
6x7 (6/1)		
diam. mm	kg/ 100 m	R kgf
8	22.2	3 080
9	28.1	3 900
10	34.7	4 820
11	42.0	5 830
12	50.0	6 940
13	58.6	8 140
14	68.0	9 440
15	78.1	10 800
16	88.8	12 300

6x19(9/9/1)		
diam. mm	kg/ 100 m	R kgf
16	92.6	12 300
17	105	13 900
18	117	15 500
19	131	17 300
20	145	19 200
21	160	21 200
22	175	23 200
23	191	25 400
24	208	27 600
25	226	30 000
26	245	32 400

6 x24(15/9/fibre)		
Diam mm	kg/ 100 m	R kgf
8	19.8	2 600
10	30.9	4 060
12	44.5	5 850
14	60.6	7 960
16	79.1	10 400
18	100	13 200
20	124	16 200
21	136	17 900
22	150	19 700
24	178	23 400
26	209	27 500

6x12 (12/fibre)		
diam. mm	kg/ 100 m	R kgf
6	9.9	1 100
8	15.6	1 940
9	19.7	2 450
10	24.3	3 020
12	35.0	4 350
14	47.7	5 930
16	62.3	7 740

6x19(12/6/1)		
diam. mm	kg/ 100 m	R kgf
8	21.5	2 850
10	33.6	4 460
12	48.4	6 420
14	65.8	8 730
16	86.0	11 400
18	109	14 400
20	134	17 800
22	163	21 600
24	193	25 700



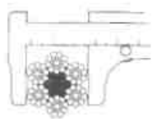
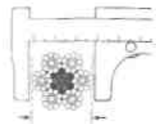
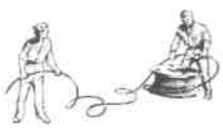
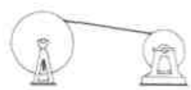
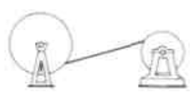
6x 37 (18/12/6/1)		
diam mm	kg/ 100 m	R kgf
20	134	17 100
22	163	20 700
24	193	24 600
26	227	28 900

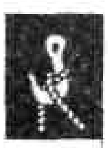
R = Breaking strength

(steel 145 kgf/mm^2)

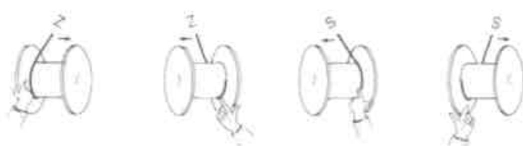
* *Safe Working Loads, see page 5*

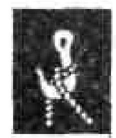
26 Handling wire rope

NO	YES
	
	
	
	
	



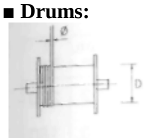
■ **Winding onto a drum depending on the direction of lay in a wire**





Matching wire ropes with drums and sheaves

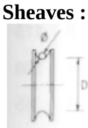
■ **Drums:** **the diameter of a drum (D) relative to the diameter of the wire rope (0) to be held on the drum —**



D/ ∅ depends on the structure of the wire rope, and depending on the particular situation, D should range from 20 ∅ to 48 ∅. In practical use on board fishing vessels, depending on the space available, the following values are common :

D = 14 ∅ or more

■ **Sheaves :** **The diameter of a sheave (D) relative to the diameter of the wire rope (0) to be used with the sheave —**



D/ ∅ depends on the structure of the wire rope, and depending on the particular situation, D should range from 20 ∅ to 48 ∅. In practical use on board fishing vessels, depending on the space available, the following values are common:

D = 9 ∅ or more

Width of sheave relative to the diameter of the wire rope

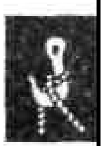
■ **Location of sheave relative to drum**

Maximum fleet angle of a steel wire between a fixed sheave and a drum with manual or automatic spooling gear:

L - C x 5 (or more); C x 11 is recommended

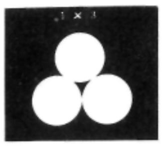
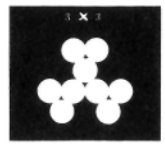
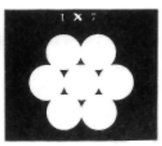
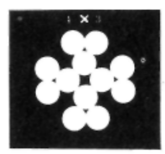
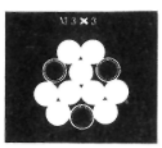
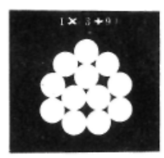
(In order to let a sheave shift with changing wire angles, it is often better to use a flexibly attached block rather than a fixed sheave.)

■ **Cable clamps should be fastened with nuts on the standing part of the wire**



Steel wire rope, small diameter

■ Stainless steel, heat treated and painted (examples)

Construction	diam. mm	R kgf	Construction	diam. mm	R kgf
	1.00 0.91 0.82 0.75 0.69 0.64 0.58	75 60 50 45 40 34 28		2.2 2.0 1.8 1.6 1.5 1.4 1.3	220 180 155 130 115 100 85
	1.5 1.4 1.3 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.6	210 170 155 140 120 100 90 75 65 50 40 30		2.4 2.2 2.0 1.8 1.6 1.5 1.4	290 245 200 175 155 130 110
	2.2 2.0 1.8 1.6 1.5	290 245 200 175 155		1.9 1.8 1.6 1.5 1.3 1.2 1.1	290 245 200 175 155 135 110

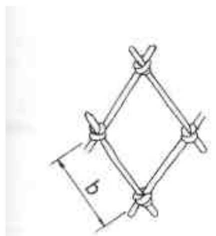
■ Galvanised steel, not lubricated

Diameter mm	Number of		Diameter of wires mm	kg/m	Rkat (steel 80 - 90 kgf/mm)
	Strands	Wires			
2	5	1 plus 6	0.25	0.016	125
3	6	1 plus 6	0.30	0.028	215
4	6	1 plus 6	0.40	0.049	380
5	6	7	0.50	0.081	600
6	6	9	0.50	0.110	775

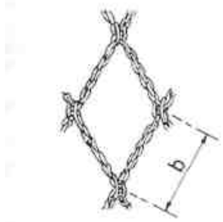
R = breaking stength

Meshes: Definition

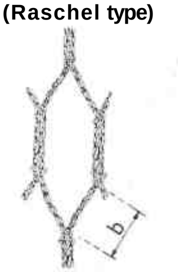
■ **Types of mesh nets**



Knotted netting



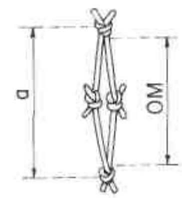
Knotted netting (Raschel type)

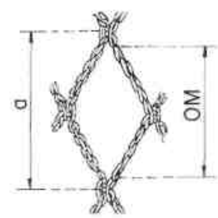


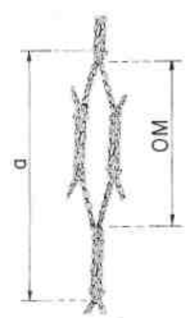
Hexagonal mesh

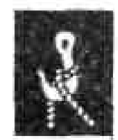
b = bar length

■ **Dimension of mesh, stretched mesh (a), and mesh opening (OM)**





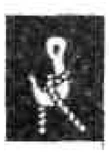




Meshes of metallic or plastic netting
see page 107

Systems of measuring net meshes in different countries

	SYSTEM	PLACES USED	TYPE OF MEASURE
a	stretched mesh	international	distance (N direction) between the centres of the 2 opposite knots of a stretched mesh *
OM	mesh opening	international	maximum inside measure (N direction) between the 2 opposite knots of a stretched mesh *
b	bar length	some European countries	length of one bar of mesh
P	pasada	Spain, Portugal	number of meshes per 200 mm
On	omfar	Norway, Iceland	half the number of meshes per Alen (1 Alen = 628 mm)
Os	omfar	Sweden	half the number of meshes per Alen (1 Alen = 594 mm)
R	rows	Netherlands, UK	number of rows of knots per yard (1 yard = 910 mm)
N	knots	Spain, Portugal	number of knots per metre
F	Fushi or Setsu	Japan	number of knots per 6 inches (6 inches = 152 mm)
	Conversions		
	$a\text{ (mm)} = \frac{200}{P} = \frac{1260}{O_n} = \frac{1190}{O_s} = \frac{1830}{R} = \frac{2000}{(N-1)} = \frac{300}{(F-1)}$		

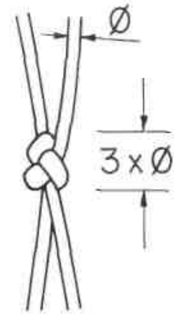


* Note that stretched meshsize is not the same as mesh opening, which is considered in many fisheries regulations.
A simple method of measuring stretched meshsize is as follows: extend a panel of twine fully in the N direction (see page 32 for N direction), and measure the distance between the centres of 2 knots (or connexions) separated by 10 meshes. Then divide this measure by 10.

Knots and edges or selvedges

■ **Knots**

Sheet bend

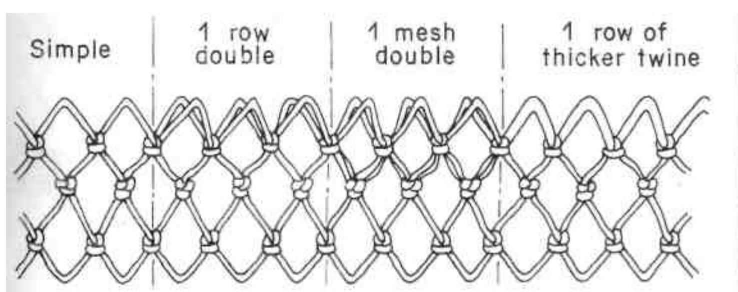


The height of the single knot is approximately equal to three times the diameter of the twine.

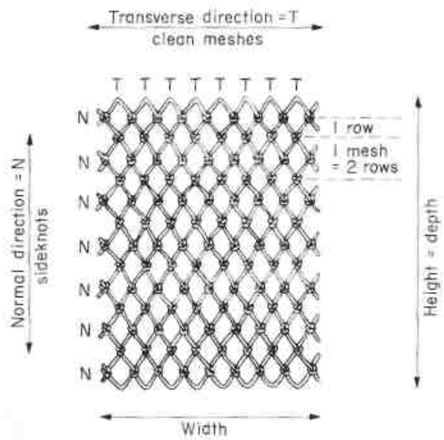
Double sheet bend

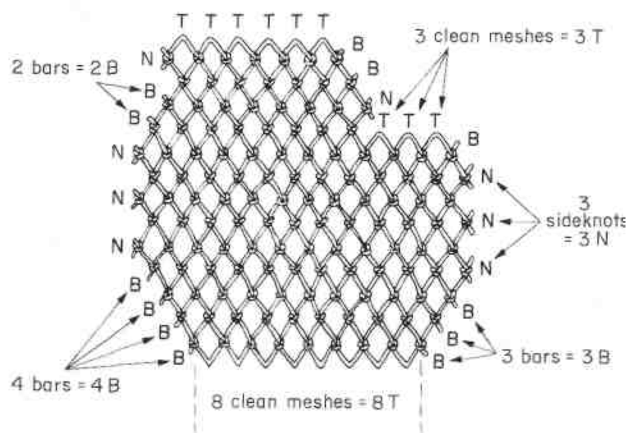
Reef knot

■ **Edges and selvedges**



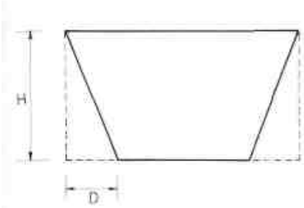
Definition of cuts





Cutting rates

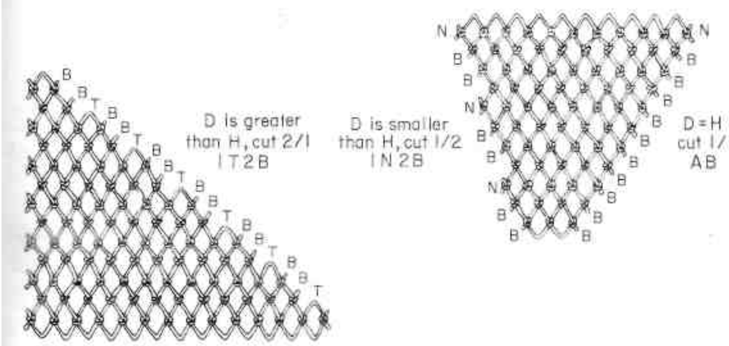
■ Cutting rate

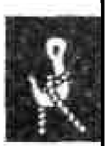


D = number of meshes to decrease
H = number of meshes in height

■ Values of the parts of a cut

	Bars B	Sideknots N	Meshes T	1T2B	4N3B
Decrease in meshes D	0.5	0	1	1 +2x0.5	4x0 + 3x0.5
Height in meshes H	0.5	1	0	0 + 2x0.5	4x1 + 3x0.5
Value $\frac{D}{H}$	0.5 0.5	0 1	1 0	2 1	1.5/ 5.5=3/11





Common cutting rates and tapers

Number of meshes decreasing (or increasing) in width

Number of meshes in height (or depth)

	1	2	3	4	5	6	7	8	9	10
1	AB	1T2B	1T1B	3T2B	2T1B	5T2B	3T1B	7T2B	4T1B	9T2B
2	1N2B	AB	1T4B	1T2B	3T4B	1T1B	5T4B	3T2B	7T4B	2T1B
3	1N1B	1N4B	AB	1T6B	1 T3B	1T2B	2T3B	5T6B	1T1B	7T6B
4	3N2B	1N2B	1N6B	AB	1T8B	1T4B	3T8B	1T2B	5T8B	3T4B
5	2N1B	3N4B	1N3B	1N8B	AB	1T10B	1T5B	3T10B	2T5B	1T2B
6	5N2B	1N1B	1N2B	1N4B	1N10B	AB	1T12B	1T6B	1T4B	1T3B
7	3N1B	5N4B	2N3B	3N8B	1N5B	1N12B	AB	1T14B	1T7B	3T14B
8	7N2B	3N2B	5N6B	1N2B	3N10B	1N6B	1N14B	AB	1T16B	1T8B
9	4N1B	7N4B	1N1B	5N8B	2N5B	1N4B	1N7B	1N16B	AB	1T18B
10	9N2B	2N1B	7N6B	3N4B	1N2B	1N3B	3N14B	1N8B	1N18B	AB
11	5N1B	9N4B	4N3B	7N8B	3N5B	5N12B	2N7B	3N16B	1N9B	1N20B
12	11N2B	5N2B	3N2B	1MB	7N10B	1N2B	5N14B	1N4B	1N6B	1N10B
13	6N1B	11N4B	5N3B	9N8B	4N5B	7N12B	3N7B	5N16B	2N9B	3N20B
14	13N2B	3N1B	11N6B	5N4B	9N10B	2N3B	1N2B	3N8B	5N18B	1N5B
15	7MB	13N4B	2N1B	11N8B	1MB	3N4B	4N7B	7N16B	1N3B	1N4B
16	15N2B	7N2B	13N6B	3M2B	11N10B	5N6B	9N14B	1N2B	7N18B	3N10B
17	8N1B	15N4B	7N3B	13N8B	6N5B	11N12B	5N7B	9N16B	4N9B	7N20B
18	17N2B	4N1B	5N2B	7N4B	13N10B	1MB	11N14B	5N8B	1N2B	2N5B
19	9N1B	17N4B	8N3B	15N8B	7N5B	13M12B	6N7B	11N16B	5N9B	9N20B

N = Sideknots
T = Meshes
B = Bars

Estimation of weight of netting

- **Knotless netting**

W = H x L x Rtex/1000 = H x L x (1000/m/kg)

- **Knotted netting**

W = H x L x Rtex/1000 x K = H x L x (1000/m/ka)

Where

W = H x L x Rtex/1000 x K = H x L x (1000/m/ka)
W = estimated weight (g) of netting
H = number of rows of knots in the height of the netting 2 x number of meshes
L = Stretched length (m) of netting
Rtex and m/kg = the size of twine in the netting
K = knot correction factor to take into account the weight of the knots (single knot); see table below

K = (knot correction factor) for different netting panels

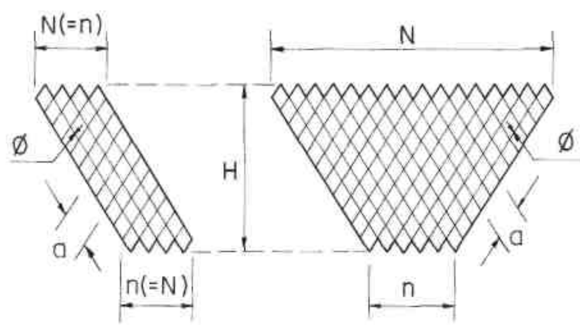
Stretched meshsize (mm)	Twine diameter (d) in mm							
	0.25	0.50	0.75	1.00	1.50	2.00	3.00	4.00
20	1.20	1.40	1.60	1.80	1.80	-	-	-
30	1.13	1.27	1.40	1.53	1.60	2.07	-	-
40	1.10	1.20	1.30	1.40		1.80	-	-
50	1.08	1.16	1.24	1.32	1.48	1.64	1.96	2.07
60	1.07	1.13	1.20	1.27	1.40	1.53	1.80	1.80
80	1.05	1.10	1.15	1.20	1.30	1.40	1.60	
100	1.04	1.08	1.12	1.16	1.24	1.32	1.48	1.64
120	1.03	1.07	1.10	1.13	1.20	1.27	1.40	1.53
140	1.03	1.06	1.09	1.11	1.17	1.23	1.34	1.46
160	1.02	1.05	1.07	1.10	1.15	1.20	1.30	1.40
200	1.02	1.04	1.06	1.08	1.12	1.16	1.24	1.32
400		1.02	1.03	1.04	1.06	1.08	1.12	1.16
800	-	-	-	1.02	1.03	1.04	1.06	1.08
1 600	-	-	-	-	-	1.02	1.03	1.04

Example *:* Knotted netting of twisted nylon twine, R1690 tex (590 m/kg), 100 mm bar length (200 mm stretched mesh length), height 50 meshes, length 100 meshes
50 meshes = 100 rows of knots in height
Stretched length = 100 meshes x 0.200 m = 20 m
Diameter of twisted polyamide twine 1690 Rtex = 1.5 mm (see page 12)
K in the table above =1.12 (stretched mesh 200 mm; diameter 1.5 mm)
W= 100 x 20 x (1690/1000) x 1.12 = 3785 g = about 3.8 kg

Calculating twine surface area

The drag of a net is proportional to the number and type of meshes in the netting, and to the orientation of the net panel(s) in the water.

$$S = \frac{\left(\frac{N+n}{2} \times H\right) \times 2(a \times \varnothing)}{1000000}$$

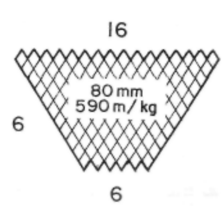


where

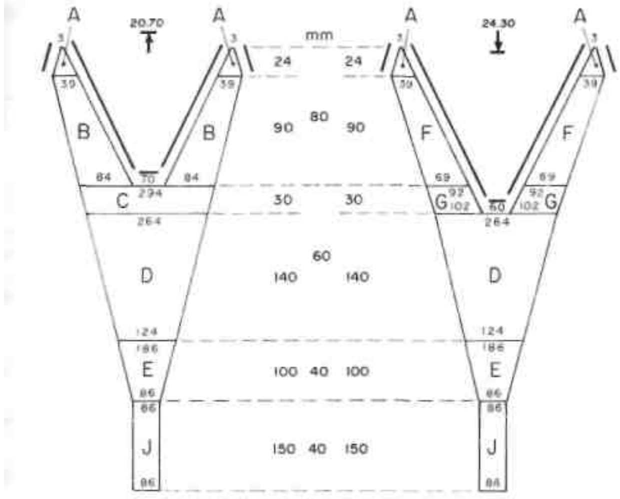
S = twine surface area (square metres)
N = number of meshes at the top of the panel
n = number of meshes at the bottom of the panel
H = number of meshes in the height of the panel
a = stretched mesh (mm)
$\varnothing$ = diameter of twine (mm)

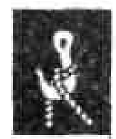
***Example** :* In the piece of netting shown above on the right, if N = 16; n = 6; H = 6; a = 80 mm; 0 = 1.5 mm

$$\text{then} \quad S = \frac{\left(\frac{16+6}{2} \times 6\right) \times 2(80 \times 1.5)}{1\,000\,000} = 0.016 \text{ m}^2$$



Calculating twine surface area of a trawl





■ NET WEBBING: CALCULATING TWINE SURFACE AREA OF A TRAWL

PANEL Surface	No of Panels	$\frac{N+n}{2}$	H	$\frac{N+n}{2}xH$	A (mm)	∅ (mm)	2(a x ∅)	Twine Area
A	4	21	24	504	80	1.13	181	0.36
B	2	61	90	5490	80	1.13	181	1.99
C	1	279	30	8370	60	0.83	100	0.84
D	2	194	140	27160	60	0.83	100	5.43
E	2	136	100	13600	40	0.83	66	1.80
F	2	54	90	4860	80	1.13	181	1.76
G	2	97	30	2910	60	0.83	100	0.58
J	2	86	150	12900	40	1.13	90	2.32

Twine surface area without knots TOTAL S = 15.08 m^2

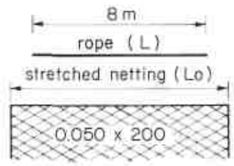
In order to compare the twine surface areas of two trawls, the trawls should be as nearly the same shape as possible. In the case of such comparisons the surfaces of the lengthening pieces and the codend (parts without oblique orientation), will cause no significant drag, and can be disregarded.

Hanging ratios, definition and calculation

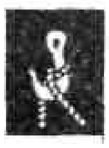
■ **Hanging ratio (E) is commonly defined as** :

F = L / Lo = Length of rope on which a net panel is mounted (L) / Length of stretched netting hung on the rope (Lo)

Example*:* 200 meshes of 50 mm stretched mesh size hung on a rope of 8 m



$$E = \frac{8\ \text{m}}{0.050\ \text{m} \times 200} = \frac{8}{10} = 0.80 = 80\%$$



■ **Other expressions used for hanging ratio :**

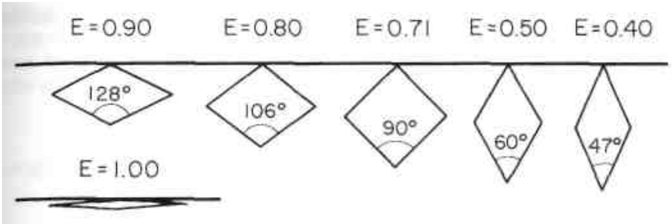
$E = \frac{L}{Lo}$ (hanging ratio)		$\frac{Lo}{L}$ (1)	$\frac{(Lo-L)}{Lo}x100$ (2)	$\frac{(Lo-L)}{R}x100$ (3)	Estimate of the height as mounted % of stretched height
0.10	10%	10	90%	900%	99%
0.20	20%	5	80%	400%	98%
0.30	30%	3.33	70%	233%	95%
0.40	40%	2.5	60%	150%	92%
0.45	45%	2.22	55%	122%	89%
0.50	50%	2.00	50%	100%	87%
0.55	55%	1.82	45%	82%	84%
0.60	60%	1.66	40%	67%	80%
0.65	65%	1.54	35%	54%	76%
0.71	71%	1.41	29%	41%	71%
0.75	75%	1.33	25%	33%	66%
0.80	80%	1.25	20%	25%	60%
0.85	85%	1.18	15%	18%	53%
0.90	90%	1.11	10%	11%	44%
0.95	95%	1.05	5%	5%	31%
0.98	98%	1.02	2%	2%	20%

1) Also called external hanging co-efficient
2) Also called percentage of hanging in — Setting in x 100 — Looseness percentage of hanging — Hang in (Asia, Japan)
3) Also called Hang in ratio (Scandinavia)

Note : It *is recommended that only the hanging ratio E be used*

Surface covered at different hanging ratios

■ **Examples of common horizontal hanging ratios**



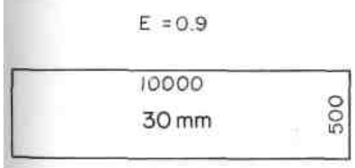
■ **Calculation of the surface covered by a piece of netting**

$$S = E \times \sqrt{1 - E^2} \times L \times H \times a^2$$

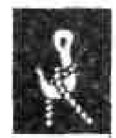
where

S = surface covered by netting (in square metres)
E = hanging ratio (horizontal)
L = number of meshes in length
H = number of meshes in height
a^2 = (stretched mesh size in metres) squared

Example:

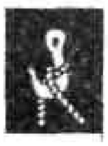


$$S = 0.9 \times \sqrt{1 - (0.9)^2} \times 10\,000 \times 500 \times (0.030)^2 = 1765 \text{ m}^2$$



Note : *The surface covered is at a maximum when E = 0.71, that is when each mesh forms a square*

Mounted height of a net



■ Calculation of mounted height

The actual height of a mounted (rigged or hung) net depends on the stretched height and the hanging ratio. The general formula permitting estimation in all cases is :

$$\text{mounted height (m)} = \text{stretched height (m)} \times \sqrt{1 - E^2}$$

Where E^2 = horizontal hanging ratio multiplied by itself

***Example**:* Given the piece of netting described on the preceding page with hanging ratio of 0.90 :

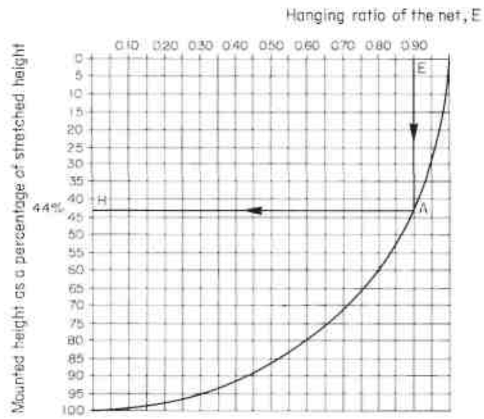
Stretched height of netting

500 meshes of 30 mm, 500 x 30 = 15000 mm = 15 m

Mounted height = stretched height x $\sqrt{1 - E^2}$

$$= 15 \times \sqrt{1 - (0.9)^2}$$
$$= 15 \times 0.44 = 6.6 \text{ m}$$

■ Table for estimating mounted height



Example:

Given the piece of netting described on the preceding page, mounted with the horizontal hanging ratio 0.90, we can deduce from the table above (E to A to H) that its mounted height is 44% of the stretched height.

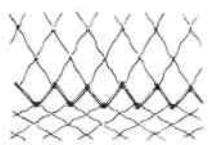
Stretched height = 500 meshes of 30 mm = 500 x 30 mm = 15 m

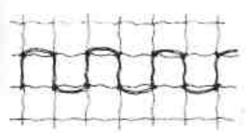
Mounted height = 44% of 15 m = 6.6 m

Joining panels of netting

■ **Netting with straight edges (i.e. AB, AT, and AN)**

Netting having the same number of meshes, and meshes of the same size, or approximately the same size.





Netting having a different number of meshes or meshes of a different size

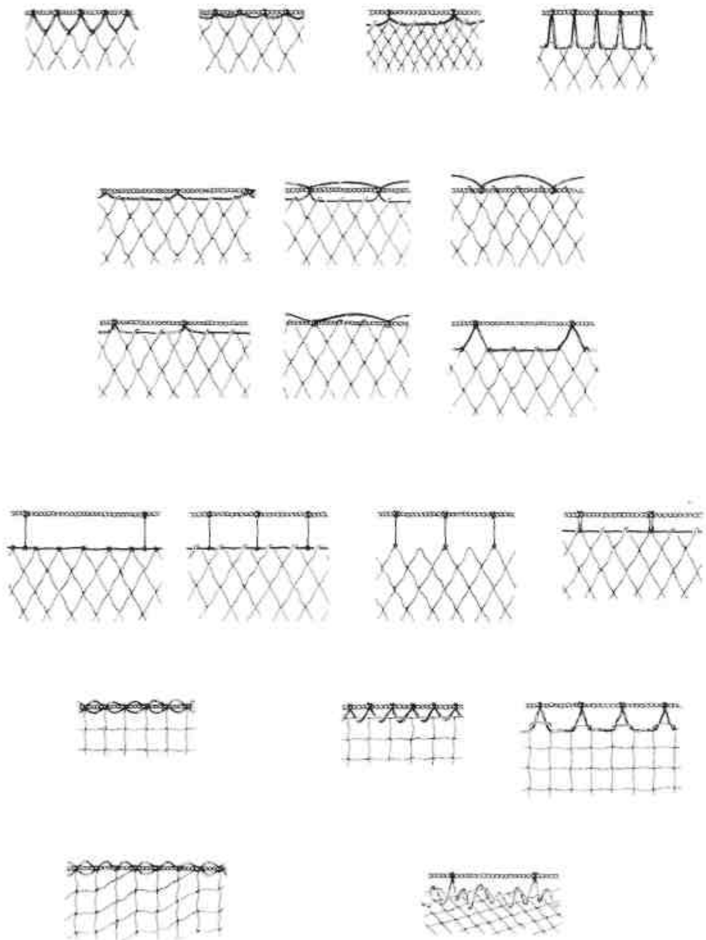
Example of joining 2/3

2 meshes of 45 mm
on 3 meshes of 30 mm
(2 x 45 = 3 x 30)

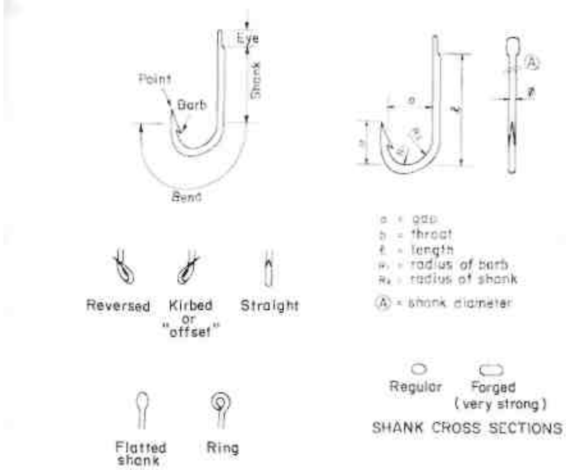
■ ***Netting cut obliquely with a combination of cuts B and N orT Pieces having a different number of meshes and different cuts***

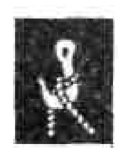
Mounting (hanging or rigging) panels of netting

Examples



Terms for describing fish hooks





■ - **Examples of fish hook characteristics**

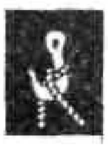
Regular hooks

Number	gap (mm)	Shank diam. (mm)
12	9.5	1
11	10	1
10	11	1
9	12.5	1.5
8	14	1.5
7	15	2
6	16	2
5	18	2.5
4	20	3
3	23	3
2	26.5	3.5
1	31	4
1/0	35	4.5

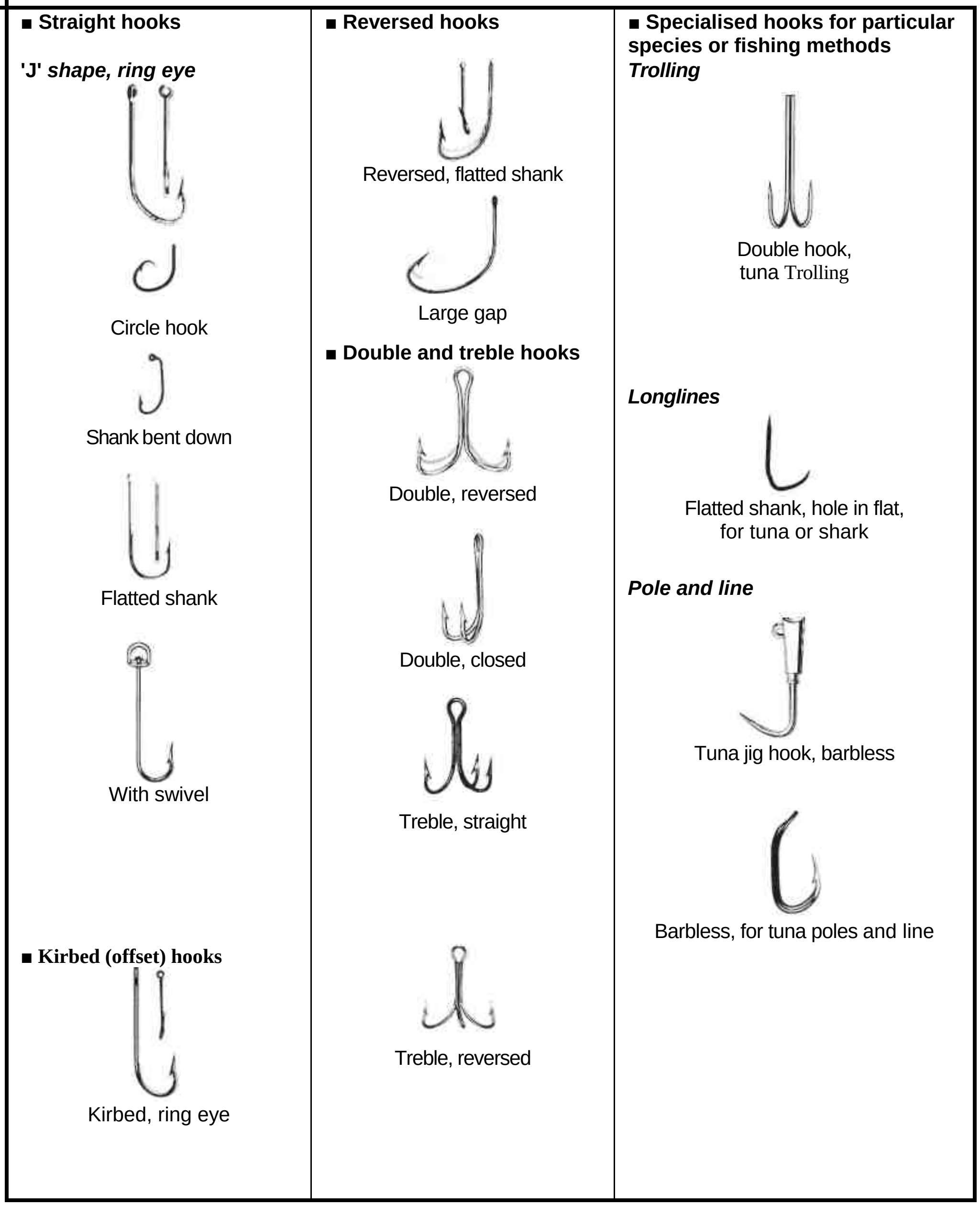
Forged hooks

Number	gap (mm)	Shank diam. (mm)
2	10	1
1	11	1
1/0	12	1
2/0	13	1.5
3/0	14.5	1.5
4/0	16.5	2
5/0	10	2.5
6/0	27	3
8/0	29	3.5
10/0	31	4
12/0	39	5
14/0	50	6

FISH HOOKS



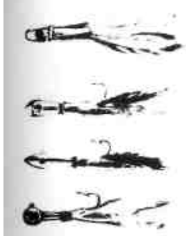
Principal types of fish hooks



Lures, knots for fish hooks

■ **Lures**

Flies



Feathers

Spoons

Jigs

■ **Knots for ring-eyed hooks**

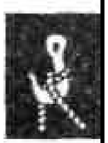
For all twines

For multifilament; (with monofilament increase the number of turns)

Convenient for all types of twine

■ **Knots for flatted shank hooks**

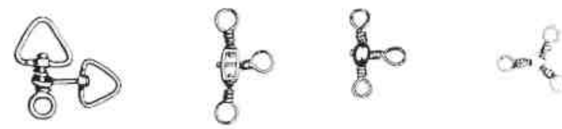
For multifilament



Swivels, snaps, knots for longlines

■ Swivels

■ Three-way swivels

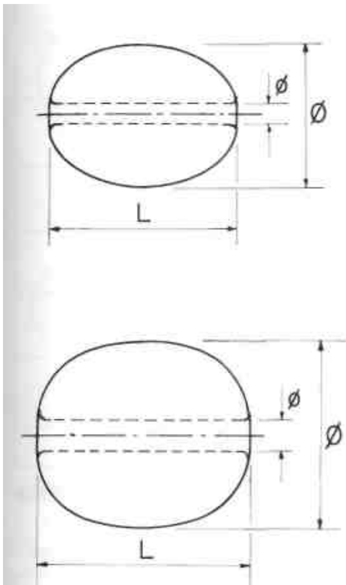


■ Snaps

■ Knots for joining branchline or snood to mainline

■ Knots for joining branchline to snood

Floats for seines: examples



There are a great variety of seine floats, with L ranging from 100 to 400 mm; 0 from 75 to 300 mm; and buoyancy from 300 to 22 000 gf.

Durability is a most important characteristic of a seine float.

Examples : in expanded PVC, two types of manufacture

L	Ø	Ø	Wt. (g) in air	buoyancy kgf
195	150	28	350	2.2
203	152	28	412	2.2
203	175	28	515	3.0

L	Ø	Ø	Wt. (g) in air	buoyancy kgf
192	146	26	326	2.4
198	151	28	322	2.5
198	174	33	490	3.5

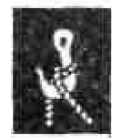
For the dimensions given, the buoyancy varies depending on the material.

Rough estimation of the buoyancy may be found by measuring the float.

$$\text{buoyancy (gf)} = 0.5 \text{ to } 0.6 \times L\,(\text{cm}) \times \varnothing\,(\text{cm})^2$$

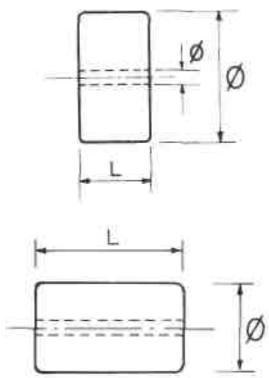
Estimation of the number of floats necessary for a seine :

$$N = \frac{1.5 \times \text{weight of ballasted net in water}}{\text{buoyancy of a float}}$$



Floats for gillnets and seines (1)

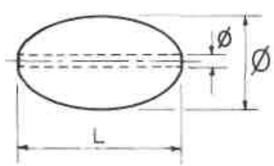
Examples



Cylindrical, expanded PVC

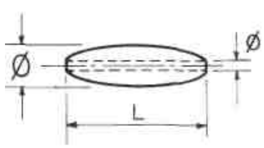
Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
30 x 50	6	30
50 x 30	8	50
50 x 40	8	67
65 x 20	8	55
65 x 40	8	110
70 x 20	12	63
70 x 30	12	95
80 X 20	12	88
80 x 30	12	131
80 x 40	12	175
80 x 75	12	330
85 x 140	12	720
100 x 40	14	275
100 x 50	14	355
100 x 75	14	530
100 x 90	14	614
100 x 100	14	690
125 x 100	19	1 060
150 x 100	25	1 523

Estimating the buoyancy from the size of the Float:
buoyancy (in gf) = 0.67 x L (cm) x $Ø^2$ $(cm)^2$



Ovals, expanded PVC

Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
76 x 44	8	70
88 x 51	8	100
101 x 57	10	160
140 x 89	16	560

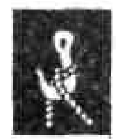


'Cigars', expanded PVC

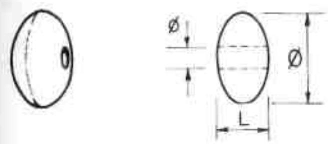
Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
76 x 45	8	70
89 x 51	8	100
102 x 57	10	160
140 x 89	16	560
158 x 46	8	180

Estimation of the buoyancy from the size of a float
buoyancy (in gf) = 0.5 x L (cm) x $Ø^2$ $(cm)^2$
$Ø^2$ = external diameter multiplied by itself

Floats for gillnets and seines (2)

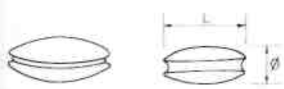


Examples



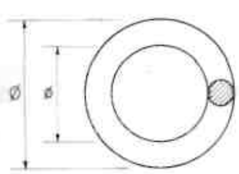
PVC

PVC



Hard plastic

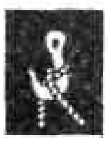
L (mm)	Ø (mm)	Ø (mm)	Buoyancy (gf)
25	32	6	20
32	58	10	60
42	75	12	110
58	66	12	175
60	70	12	200
65	75	12	220
65	80	12	250
58	23		8
60	25		10
72	35		25
80	40		35
100	50		100



PVC rings

Ø (mm)	Ø (mm)	Buoyancy (gf)
146	100	110
146	88	200
146	82	240
184	120	310
184	106	450
200	116	590
200	112	550

FLOATS



Spherical floats and trawl floats

Examples from suppliers' catalogues

		Diameter (mm)	Volume (litres)	Buoyancy kgf	Maximum depth (m)
	plastic, center hole	200	4	2.9	1 500
		200	4	3.5	350
		280	11	8.5	600
	plastic, side hole	75	0.2	0.1	400
		100	0.5	0.3	500
		125	1	0.8	400-500
		160	2	1.4	400-500
		200	4	3.6	400-500
	plastic, with "ears" or lugs	203	4.4	2.8	1 800
	plastic with screw lug	200	4	3.5	400
		280	11-11.5	9	500-600
	Aluminium	152	1.8	1.3	1 190.
		191	3.6	2.7	820
		203	4.4	2.8	1 000
		254	8.6	6.4	1 000

The table below shows that, for floats of equal diameter (200 mm in this case), the volume and buoyancy may vary a great deal, depending on the material and placement of holes or lugs.

Ø 200 mm	Plastic, center hole		Plastic, side hole	Plastic, with screw lug	Aluminium, with lugs
Volume	4	4	4	4	4.4
Buoyancy (kgf)	2.9	3.5	3.6	3.5	2.8

*** Note**: *The maximum effective depth of a float depends on the manufacture, and should be specified by the supplier. It cannot be deduced from the appearance, shape or colour*

Floats (buoys) for marking nets, lines and traps

FLOATS

Examples:

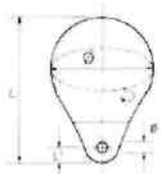
1/ Solid floats (PVC)

Ø (mm)	L (mm)	Ø (mm)	B (mm)	C (mm)	Buoyancy kgf
125	300	25	200	90	2.9
150	530	25	380	100	7.8
150	600	25	450	100	9.2
150	680	25	530	100	10.4
150	760	25	580	100	11.5
200	430	45	290	110	10.5

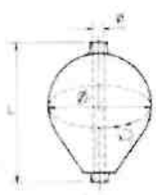
Polystyrene

L (mm)	L (mm)	H (mm)	Ø (mm)	Buoyancy kgf
300	300	200	35	12 – 15
180	180	180	25	4

2/ Inflatable floats

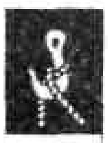


Ø (mm)	Ø (mm)	Ø (mm)	L (mm)	L (mm)	Buoyancy kgf
510	160	11	185	18	2
760	240	30	350	43	8
1 015	320	30	440	43	17
1 270	405	30	585	43	34
1 525	480	30	670	43	60
1 905	610	30	785	48	110
2 540	810	30	1 000	48	310



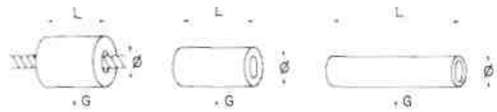
Ø (mm)	Ø (mm)	Ø (mm)	L (mm)	Buoyancy kgf
760	240	38	340	7.5
1 015	320	38	400	17
1 270	405	51	520	33.5
1 525	480	51	570	59

Groundrope leads and rings



Examples

■ **Leads for ropes**



Ø diameter of the hole = diameter of rope + 3 mm approx.

L(mm)	25	38	38	32	32	32	25	45	45	45
Ø (mm)	16	16	13	10	8	6	6	5	5	6
G (g)	113	90	64	56	50	41	28	28	28	16

■ **Leads for lines, examples of shapes**

Range of weights = 7–230 g

Cigar shaped
Range of weights = 57–900 g

■ **Example of mould for leads**

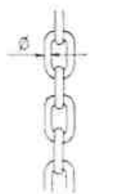
■ **Example of groundrope rings for a gillnet**

Ex:

Ø mm	Ø mm	Pg
210	5	105
220	6	128

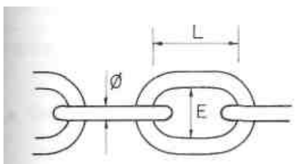
Chains and thimbles*

■ **Chains**



Groundrope chain

Ø mm	Approximate Weight kg/m	Ø mm	Approximate weight kg/m
5	0.5	11	2.70
6	0.75	13	3.80
7	1.00	14	4.40
8	1.35	16	5.80
9	1.90	18	7.30
10	2.25	20	9.00

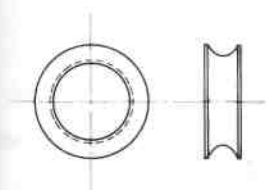


High tensile chain

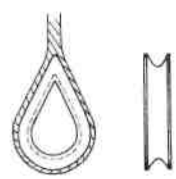
High tensile steel

Ø mm	LxE (mm)	S.W.L. Ton.f	Breaking strength Ton.F	Weight kg/m
7	21 X 10.5	1.232	6.158	1.090
10	40x15	2.514	12.570	2.207
13	52x19.5	4.250	21.240	3.720
16	64x24	6.435	32.175	5.640
19	76 X 28.5	9.000	45.370	7.140

■ **Thimbles**

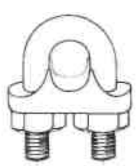


Round thimble



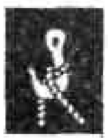
Oval thimble

■ **Clips for wire rope**



Cable clamps or 'bulldog grips'

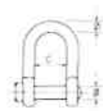
Safe Working Load see page 5

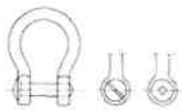


Steel accessories for joining : shackles, links and clips*

■ Shackles


Bow shackle

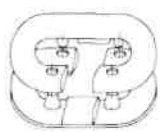

Straight shackle

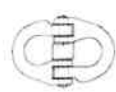

Bow shackle with countersunk screw


Straight shackle with countersunk screw

Ø (mm)	C (mm)	O (mm)	S.W.L Ton.f	B.S. Ton.f
6	12	18	0.220	1.350
8	16	24	0.375	2.250
10	20	30	0.565	3.400
12	24	36	0.750	4.500
14	28	42	1.200	7.250
16	32	48	1.830	11.000
18	36	54	2.200	13.200
20	40	65	2.600	16.000
24	40	75	3.600	22.000
30	45	100	5.830	35.000

■ Links and Clips

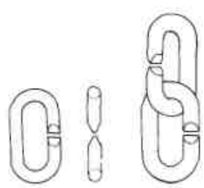

Riveted link

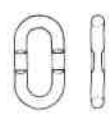

Lock-type connector


Screw link


Spring clip


Straight

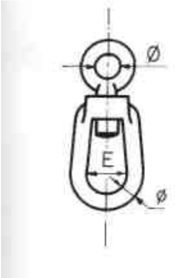

Tapered


Half-cut link

* Safe Working Load see page 5

Swivels

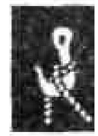
■ Swivel, forged steel



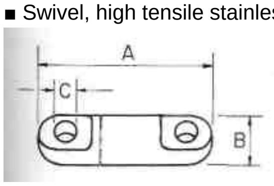
Ø (mm)	E (mm)	Ø (mm)	S.W.L.* Ton.f	B.S.** Ton.f
8	17	14	0.320	1.920
10	25	15	0.500	3.000
12	28	18	0.800	4.800
14	35	20	1.100	6.600
16	35	20	1.600	9.600
18	38	25	2.000	12.000
20	43	26	2.500	15.000
25	50	33	4.000	24.000
30	60	40	6.000	36.000

■ Swivel, tempered steel and hot galvanized

Ø mm	S.W.L.* Ton.f	Weight Kg
8	0.570	0.17
16	2.360	1.12
22	4.540	2.61
32	8.170	7.14

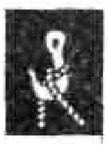


■ Swivel, high tensile stainless steel



A (mm)	B (mm)	C (mm)	S.W.L.* Ton.f	B.S.** Ton.f	Weight Kg
146	48	20	3	15	1.3
174	55	27	5	25	2.1
200	62	34	6	30	2.8

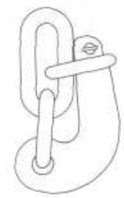
* Safe working load see page 5
** Breaking strength, see page 5



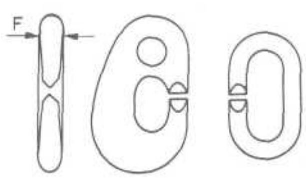
Hooks and 'G' links*

Slip hook

Swivel hook
with spring clip



Stenhouse clip
(quick release)



'G' link with
tapered cut

'G' link with
straight cut

"G" link High tensile steel

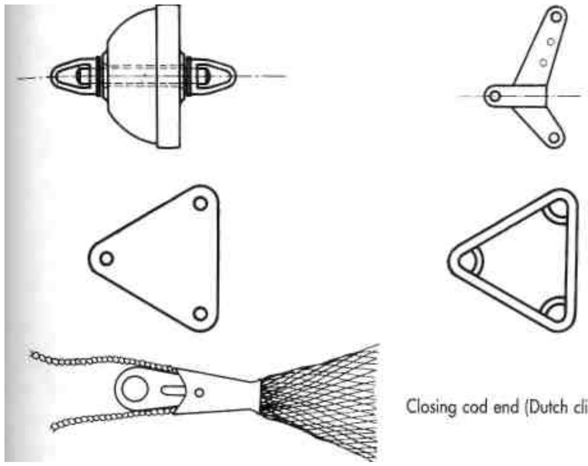
F mm	S.W.L.* Ton.f	B.S.* Ton.f
25	1.1	8
30	3.6	15
34	5.0	25
38	7.0	35

** Safe working load and breaking strength see page 5*

HARDWARE

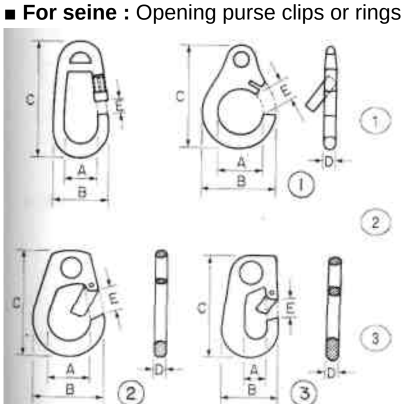
Spreaders, codend release and purse rings

■ **For trawl**



Closing cod end (Dutch clip)

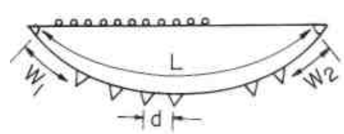
■ **For seine :** Opening purse clips or rings

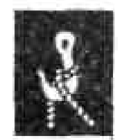


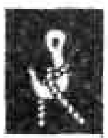
Interior Diam, mm A	Exterior Width mm B	Exterior Length mm C	Thickness Mm D	Opening Mm E	Breaking strength Ton.t	Weight kg
86	128	180	22	34	0.400	1.3
107	172	244	32	47	3.800	4.0
107	187	262	32	52	5.400	5.0
110	187	262	37	53	6.500	6.0
75	128	200	19	40	1.800	2.0
94	150	231	25	47	2.200	3.0
103	169	253	28	50	3.000	4.0
103	169	262	35	53	3.500	5.0
106	175	264	38	53	3.600	6.0
25	65	111	17	17	5.000	0.5
38	80	140	15	25	6.000	0.65
36	90	153	19	29	12.000	1.1

Number of rings required

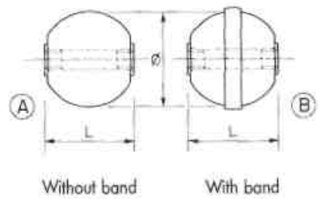
$$N = \frac{L - W_1 - W_2 + d}{d}$$



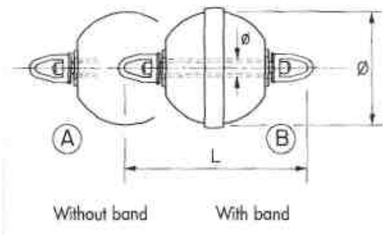




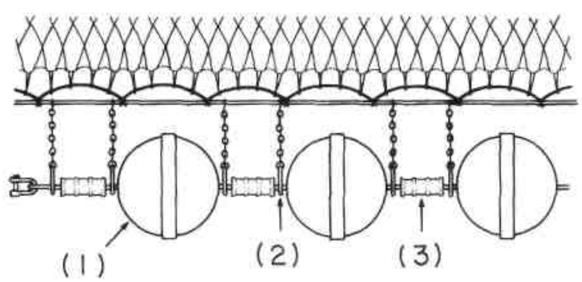
Elements of trawl groundropes: steel bobbins



Ø mm	L mm	A Weight in air Kg	B Weight in air kg
200	165	7.5	9.5
250	215	10	12.5
300	260	18	22
350	310	29	34
400	360	35	40



Ø mm	L mm	Ø mm	A Weight in air kg	B Weight in air kg
200	380	30	12	14
250	570	32	15	17.5
300	610	35	25	29
350	660	60	42	46
400	715	60	51	56



Example of rigging a groundrope with bobbins (1), chains (2} and spacers (3)

Elements of trawl groundropes: steel bobbins

Examples

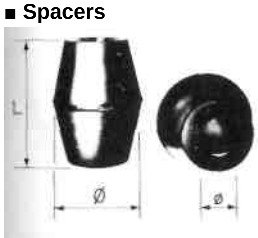
■ **Bunts**

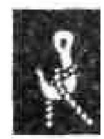
Ø (mm)	229	305	356	406
Wt. in air (kg) per piece	4.40	9.10	11.80	19.50
Wt. in water (kg) per piece	0.98	2.10	2.85	4.4

■ **Bobbins**

Ø (mm)	305	356	406
Wt. in air (kg) per piece	5.10	8.00	11.50
Wt. in water (kg) per piece	1.65	2.20	3.50

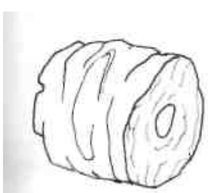
■ **Spacers**





L(mm)	178	178
Ø (mm)	121	165
Ø (mm)	44	66
Wt. in air (kg) per piece	1.63	2.30
Wt. in water (kg) per piece	0.36	0.57

■ **Rings or "cookies" (made from old tyres)**



diameter ext. Ø (mm)	60	80	110
diameter int. Ø (mm)	25	30	30
Weight* (kg/m)	2.3	3.0	7.5

diameter ext. Ø (mm) diameter int. Ø (mm)	200 45	240 45	280 45
Weight* per piece (kg)	5.0	7.0	10.5

* Weight in air

Slings and tackles