Import Substitution of Combination Wire Rope - Part IV. A Guide - line for Standardisation of Combination Ropes

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Consolidating and computing the observations and results of earlier works, 192 specifications of combination ropes were worked out as a guideline for standardisation. The combination ropes are basically of six strand construction with steel/fibre core. The core is either 6 (6/1) steel wire or 3 stranded PP tape ropes. The rope strands are either with single layer of wires with a fibre core (8/f and 12/f) or with an outer thicker and inner thinner layers of wires of same tensile designation with a fibre core (9/6/f, 12/6/f, 12/9/f and 15/9/f). The rope strands are covered with 8 strands of PP soft twisted tape yarns. Specifications of 96 ropes with fibre and steel wire core separately using wires of 120, 140 and 160 tensile designation and nominaldiameter ranging between 0.5 and 1.0 mm and computing the rope diameter, mass and breaking load are presented.

Standardisation is an attempt at perfection, of codifying industrial practices with accepted norms for streamlining production process, introducing quality control and striving towards excellence, guaranteeing quality and fitness to the consumer. The ISO Council meeting and 13th triannual general assembly held in Tokyo during September 1985 emphasised the need for complete product specification prescribing quality and performance at national and international level (Anon, 1985).

Combination wire ropes are the most important item for deep sea trawling requiring special attention at both national and international level. This paper presents the R & D programmes of evolving national standard of combination wire rope for fishing purpose. The programme was carried out in three stages, namely, development of a primary prototype (Meenakumari & Panicker, 1988), development of a primary standard (Meenakumari & Panicker, 1989 a) and comparison of efficiency of primary standard with imported samples (Meenakumari & Panicker, 1989 b).

Materials and Methods

Meenakumari & Panicker (1988, 1989 a, 1989b) have discussed in detail the sequence of R & D programme comprising of development of prototype, development of primary standard and comparative efficiency of primary standard with imported samples. Specification and construction details of combination ropes of different sizes were worked out. The ropes are grouped under six major types based on strand construction with steel wires of 120, 140 and 160 tensile designation and 192 ropes are suggested with different rope diameters. The ropes are basically six stranded with central core of either steel wire or PP tape yarn twisted rope. The strands are either of single layer of wires with a central PP tape yarn twisted core of 8/f or 12/f construction or of two layers of wires with an outer thicker and an inner thinner wires of the same tensile designation, also with PP tape twisted core of 9/6/f, 12/6/f, 12/9/f and 15/9/f construction. The steel wire core also has a six strand of 6/1 construction with a central PP core. The specification of wire component of the core confirms to that of strand/outer layer when the rope strand is double layered. The rope strands are covered with 8 strands of soft twisted PP tape yarns.

The pitch values of the rope and at different stages of rope formation are computed and the optimum pitch fixed in relation to diameter. The nominal diameter, mass and minimum breaking load of all the specifications were worked out and presented.

The flexibility being an important factor for framing ropes of fishing gear, assuming easeness of bending as the flexibility index, flexibility chart of all the prototypes worked out in Zwick 1484. The total work done is calculated for bending the combination rope to arrive at the flexibility index.

Results and Discussion

A perusal of the tensile and other properties of the primary prototype (Meenakumari & Panicker, 1988) indicates clearly that there is ample scope for improvement in the tensile properties. Eventhough there is a definite reduction in the strength at various stages of twisting, the comparatively low reduction of 15.5 to 16% of the aggregate strength of components at the rope closing stage is due to the combined effect of steel and fibre. The comparatively low reduction of 11.0–11.2% of the aggregate strength of steel wires for the combination rope when compared to 14–21% reduction in wire ropes is mainly due to the effect of fibre component. The nature of superficial damage and reduction of tensile properties (Meenakumari & Panicker, 1988) of the primary prototype after field trials is very low and comparable to imported samples.

The improvement incorporated for optimum conditions of tensile properties and efficiencies have shown both positive and negative effect when taken individually, but as a whole have certainly improved the quality of the rope. Substitution of 0.71 mm dia steel wire of tensile strength 1.60 KN/mm^2 and 4.89% extension at break with 0.57% carbon content by 0.80 mm dia steel wire of 1.7 KN/mm breaking strength and 5.21% extension at break with 0.72% carbon content has improved the tensile strength of rope from 0.224 KN/mm^2 to 0.29 KN/mm^2. The slight increase in the extension at break from 11.5 to 12.67 is mainly due to the increase in pitch coupled with the soft twist of PP covering material.

The reduction of one strand in the PP cover from 8 to 7 has slight swing towards the negative side in the homogenity and insulation properties of the covered rope strand but the soft twisting of the PP compensated this to a great extent in the finished rope. However, reversion to 8 stranded cover is a better proposition and is recommended. In respect of the abrasive property (Meenakumari & Panicker, 1989 b) the improved PP cover is comparable with imported samples.

Incorporating the above construction details of typical six stranded combination rope with steel and fibre core separately and construction details of different rope strands are given in Fig. 1.

The relation between the pitch and the tensile properties of rope and different components are presented in Fig. 2 and methodology adopted for flexibility test is given in Fig. 3. The flexibility chart showing force expended at different stages, in respect of prototype Cift-CWR are given in Table 1. Relation between pitch and tensile strength and pitch flexibility clearly indicates a similar pattern reaching an optimum at 107 mm for 17 mm dia rope. In the case of pitch and tensile strength, the tensile strength increases as the pitch decreases and reaches the maximum at 107 mm (66.17 KN) and drops

Table 1. *Comparative flexibility chart-prototypes combination wire ropes Cift CWR 1 - 6*

Reduction of length between grips in mm	Bending force for the respective 10 mm stage in N																F max N	W Nm
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160		
Cift CWR1 125 mm pitch	131.04	130.00	129.44	128.72	124.48	126.64	122.76	120.56	120.04	121.60	123.56	125.64	128.50	130.72	133.04	135.36	138.92	20.86
Cift CWR2 112 mm pitch	146.92	149.44	151.26	153.17	155.82	154.68	151.32	150.54	148.12	149.30	147.28	146.72	145.53	143.80	141.38	144.32	157.32	25.41
Cift CWR3 109 mm pitch	152.66	154.28	155.86	158.41	160.20	161.28	163.04	162.24	157.88	155.40	149.88	149.44	149.30	150.54	148.11	147.28	164.28	32.40
Cift CWR4 107 mm pitch	232.40	235.25	230.98	236.21	235.36	235.41	233.18	231.26	229.36	228.16	228 01	227.81	228.20	231.18	230.33	229.40	240.18	34.70
Cift CWR5 103 mm pitch	273.44	271.12	270.16	268.88	270.10	271.21	272.16	273.76	276.60	272.28	279.04	281.68	284.24	286.64	288.88	281.76	290.38	38.50
Cift CWR6 93 mm pitch	289.12	280.00	275.36	273.92	272.73	273.60	271.20	272.16	276.36	279.52	281.28	284.24	286.64	288.88	291.76	290.76	308.38	40.44

Table 2. *Specifications, mass and breaking loads of CWR of different construction and sizes*

Construction of strand	Range of wire dia, mm	Range of rope dia, mm	Range of mass (kg/100 m) With steel core 6 (6/1)	Range of mass (kg/100 m) With fibre core (3 stranded PP)
6 (8/f)	0.48– 0.51	11.0–12.0	18.72– 21.06	16.20- 17.90
	0.58– 0.61	13.0–14.0	24.57– 26.91	21.90– 23.20
	0.69– 0.71	15.0–16.0	32.76– 35.10	28.06- 30.10
	0.79– 0.81	17.0–18.0	44.46– 47.97	38.10– 41.30
	0.89– 0.91	18.0–19.0	56.16– 59.67	48.20– 51.40
	0.99– 1.01	20.0–21.0	70.20– 73.71	60.30– 63.50
6 (12/f)	0.48– 0.51	13.0–14.0	23.71– 26.67	21.20– 23.77
	0.58– 0.61	15.0–16.0	31.12– 34.08	26.80– 31.20
	0.69– 0.71	17.0–18.0	41.50– 46.46	36.90– 39.55
	0.79– 0.81	19.0–20.0	56.32– 60.76	50.10– 54.20
	0.89– 0.91	21.0–22.0	71.14– 75.58	63.30– 66.50
	0.99– 1.01	23.0–24.0	88.92– 93.37	78.40- 82.70
6 (9/6/f) inner one step down in dia	0.58– 0.61	14.0–15.0	33.70- 37.13	30.18– 33.60
	0.69– 0.71	16.0–17.0	44.77– 48.24	40.07– 43.14
	0.79– 0.81	18.0–19.0	60.53– 65.21	54.14– 57.80
	0.89– 0.91	20.0–21.0	77.69– 82.84	69.88– 73.10
	0.99– 1.01	22.0–23.0	97.34–102.49	87.28– 92.10
6 (12/6/f) inner one step down in dia	0.58– 0.61	15.0–16.0	38.61– 42.51	33.11– 36.31
	0.68– 0.71	17.0–18.0	55.22– 57.32	50.32– 52.62
	0.79– 0.81	19.0–20.0	69.42– 74.80	63.02– 68.00
	0.89– 0.91	21.0–22.0	88.92– 94.77	80.94– 86.25
	0.99– 1.01	23.0-24.0	101.38–105.83	95.40–100.33
6 (12/9/f) inner wire one step down in dia	0.58– 0.61	16.0–17.0	42.33– 46.72	38.85– 42.90
	0.69– 0.71	18.0–19.0	56.24– 60.61	51.85– 55.10
	0.79– 0.81	20.0–21.0	75.97– 81.82	69.60- 75.10
	0.89– 0.91	22.0–23.0	97.81–104.36	89.80– 95.90
	0.99– 1.01	24.0-25.0	122.62–129.67	112.12-119.20
6 (15/9/f) inner wire one step down in dia	0.58– 0.61	18.0-19.0	47.27– 52.10	43.77– 48.30
	0.69– 0.71	20.0–21.0	62.79– 67.63	58.10- 62.65
	0.79– 0.81	22.0–23.0	84.86– 91.42	78.50- 84.65
	0.89– 0.91	24.0–25.0	109.04–116.30	101.04–107.80
	0.99– 1.01	26.0-27.0	136.66–143.91	126.50–133.40

Minimum breaking load corresponds to tensile designation

120		140		160	
Minimum breaking strength KN		Minimum breaking strength KN		Minimum breaking strength KN	
Steel core	Fibre core	Steel core	Fibre core	Steel core	Fibre core
18.79– 20.67	11.64– 12.80	21.92– 24.12	13.57– 14.93	22.71– 25.06	14.06– 15.51
25.37– 27.25	15.71– 16.87	29.60– 31.79	18.33– 19.68	33.67– 36.02	20.85– 22.00
32.76– 35.58	21.23– 23.27	40.56– 43.85	25.11– 27.15	46.20– 49.33	28.60– 30.54
46.04– 48.86	28.51– 30.25	53.71– 57.00	33.26– 35.29	61.07– 64.99	37.81– 40.24
58.25– 62.01	36.07– 38.40	67.96– 72.35	42.08– 44.79	77.52– 85.22	47.99– 52.36
72.35– 75.17	44.80– 46.54	84.56– 87.70	52.36 - 55.30	96.31-101.79	59.63– 63.02
23.80– 26.18	17.45– 19.20	27.77– 30.55	20.36– 22.39	28.76– 31.74	21.09– 23.27
32.13– 34.41	23.56– 25.31	37.49– 40.27	27.49– 29.52	42.65– 45.62	31.27– 33.45
44.04– 47.61	32.88– 34.91	51.38– 55.54	37.67– 40.72	58.52– 62.48	42.90– 45.81
58.32– 61.89	40.58– 45.38	68.04– 72.20	49.89– 52.94	77.36– 82.42	56.72– 60.36
73.79– 78.55	54.10– 57.59	86.09– 91.64	63.12– 67.19	98.19–104.14	71.99– 73.45
91.64– 95.21	67.19– 69.81	107.11–111.08	78.54– 81.45	121.99–128.93	89.45– 94.54
34.58– 37.33	26.40– 28.58	40.34– 43.55	30.79– 33.34	44.99– 48.44	33.99– 36.72
47.23– 50.99	35.78– 38.83	55.10– 59.49	41.99– 45.30	62.74– 67.02	47.81– 51.09
63.02– 67.15	48.21– 51.49	74.83– 78.34	56.25– 60.07	83.62– 89.05	63.99– 68.18
80.55– 85.69	61.96– 65.88	93.98– 99.97	72.28– 76.87	107.11–113.69	82.55– 87.45
100.47–104.98	77.45– 81.16	117.39–122.48	90.46– 94.68	133.74–141.46	103.08–108.35
39.65– 42.78	32.29– 34.91	46.26– 49.91	37.67– 40.72	51.73– 55.65	41.81– 45.09
54.18– 58.51	44.07– 47.56	63.21– 68.26	51.41– 55.49	71.98– 76.89	58.54– 62.54
72.22– 76.92	58.90- 62.83	84.26– 89.74	68.72- 73.30	95.84–102.05	78.17– 83.26
92.21– 98.09	75.19– 80.28	107.57–114.44	88.06- 93.66	122.62–130.13	102.17–106.53
114.94–120.02	94.25– 98.61	134.30–140.02	110.10–115.04	152.99–154.88	125.44–132.71
43.41– 46.92	36.65– 39.71	50.64– 54.74	42.56– 46.32	56.27– 60.66	47.86– 50.90
59.26– 63.96	49.96– 53.86	69.13– 74.61	58.29– 62.87	78.72– 84.09	66.36– 70.90
79.18– 84.44	76.76– 71.56	92.37– 98.51	78.14– 83.58	105.07–111.92	88.90– 94.72
94.41– 97.87	76.17– 81.63	118.32–125.84	100.54–106.84	131.83–143.13	114.53-121.62
117.59–124.42	101.77–107.01	147.89–154.49	125.88–131.84	168.50–178.20	143.44–151.80
48.48– 52.37	42.54– 46.03	56.56– 61.09	49.63– 53.70	63.00– 67.86	54.90– 59.27
66.21– 71.47	58.03– 62.61	77.25– 83.38	67.70– 73.05	87.96– 93.66	79.08– 82.26
88.39– 94.21	77.66– 82.90	103.12–109.91	90 61– 96.72	117.29–124.91	103.08–109.81
123.07–130.27	99.70–106.08	131.91–140.32	116.32–123.70	150.37–159.48	132.53–140.71
141.66–147.45	124.57–130.46	164.81–172.03	155.51–152.70	187.76–198.62	165.80–175.44

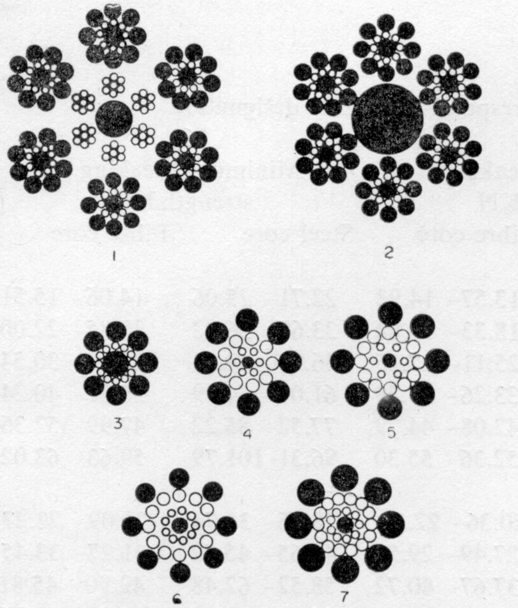

Fig. 1. Construction details of combination wire rope:
1. Combination wire rope with steel wire core.
2. Combination wire rope with fibre core.
3 to 7 Construction details of rope strands.

thereafter, whereas in the case of flexibility, as pitch decreases the difference between the maximum and minimum force expended

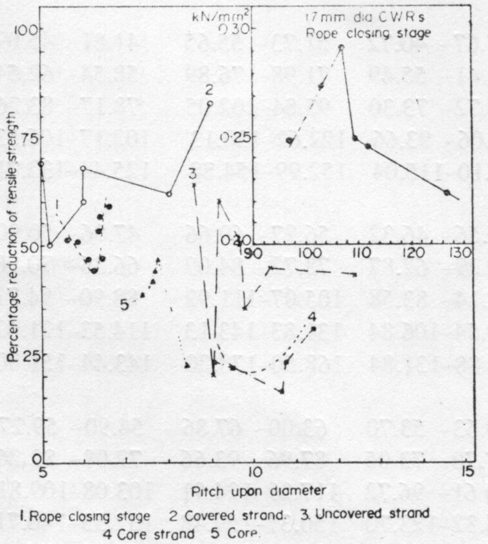

Fig. 2. Relation between pitch and diameter of combination wire rope and components.

reduces and reaches the lowest level of 5.43% at 107 mm pitch from 15.72% at 125 mm and then it increases reaching 13.7% at 93 mm pitch. This lowering of variation is due to the better homogenity and stability of rope. Comparing the above results, the diameter and pitch of standard combination rope is fixed at 1:6.2 to 6.5. The relation between the diameter and pitch at various stages of rope formation are also computed and fixed as 1:5 to 5.5, 1:9.5 to 10.0, 1:7.0 to 7.5, 1:9.0 to 10.0 and 1:7.2 to 8.0 respectively for covered strand, uncovered strand, steel wire core, fibre core and steel wire core strand.

The relation between diameter of steel wire and PP cover is fixed at 1:3.0 to 4.0 or 1:1.75 to 2.0 between uncovered and covered strand and the relation between the diameter of PP cover and PP central core at 1:1.7 to 1.8.

Since the effect of pitch is not producing much variation in the diameter of rope and

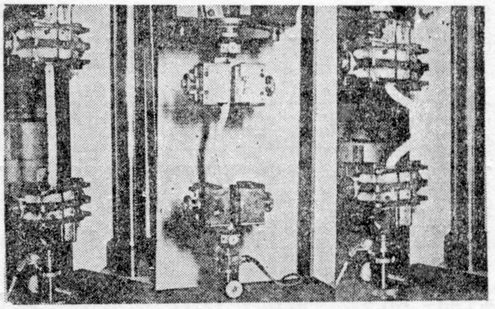

Fig. 3. Flexibility testing of combination wire rope

variation is only within the limits of –1 to 4% stipulated for steel wire ropes as per IS norms, the same is recommended for designating the nominal diameter of combination ropes.

Based on the above observations and computing the results of earlier studies (Meenakumari & Panicker, 1988; 1989 a; 1989 b) specifications incorporating construction details, material specification such as diameter and tensile designation of steel wire, nominal diameter, mass and breaking strength of 96 ropes each with steel wire core and fibre core separately worked out and presented in Table 2 as a guide line for selecting national standards.

The standard rope should confirm in tensile strength within ± 5% of the minimum breaking strength given in the standard and the breaking strength of the rope should never be less than 11% of the aggregate strength of the wire components.

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