Studies on Raschel Knotless Netting

S. GOPALAN NAYAR and K. RADHALAKSHMI
Central Institute of Fisheries Technology, Cochin-682 029

Production of knotless webbings is of recent origin in India. An attempt has been made to evaluate the quality of the product consequent to its introduction in the fishing industry. A method has been presented to fix up yarn specification for Raschel knotless nettings equivalent to a given knotted netting.

Knotless nets as the name implies are nets devoid of knots, the connection between meshes being made up of interlacing of the adjacent mesh bars. Loosely woven Japanese fabric used as minnow nets might have been the forerunner of knotless nets. Obviously, as a first step, its application was mainly in small meshed fine webbings, where hand braiding is laborious. Two types of knotless nets are produced namely, intertwining and Raschel type. Even though Raschel type was produced as early as 1950 in Germany (Viswanathan, 1972) its production in India is of recent origin. The present study is an attempt to evaluate the properties of the Indian knotless nets (Raschel type) produced by four different production units A1 to D1 (Table 1)

Table 1. *Mesh strength and weight of knotless netting*

Samples	Quality number	Mesh size mm	Strength of mesh (wet) kg	Weight of 100×100 meshes g	Knotted Equivalent Specification	Knotted Equivalent Weight of 100×100 meshes g
A 1	1218	10	3.84	23.7	210/1/3	32.25
A 2	1253	51	3.46	102.5	210/1/3	101.82
A 3	1211	10	2.61	26.2	210/1/2+	19.5
A 4	*1211	10	3.02	28.4	210/1/3	32.25
A 5	2416	16	4.58	74.5	210/2/2	59.7
A 6	2415	15	4.68	71.5	210/2/2	59.7
A 7	**24164	15.7	5.48	102.4	210/2/2+	62.0
A 8	2416	15	4.48	73.2	210/2/2	59.7
A 9	*2514	14	3.92	66.2	210/2/2	59.7
A 10	* 2518	18	4.0	84.6	210/2/2	64.2
A 11	*2[illegible]20	20	4.37	74.0	210/2/2	68.75
A 12	*2579	79	6.12	510.8	210/2/3	310.0
A 13	*2597	97	6.69	548.2	210/2/3	370.0
A 14	82151	14.5	12.94	1962.0	210/4/3	1106.5
B 1	2014	12	3.64	48.0	210/1/3	35.6
B 2	2425	23	6.10	90.0	210/2/3	115.5
B 3	2445	45	5.64	156.4	210/2/2+	125.4
C 1	2012	12	3.21	58.0	210/1/3	35.6
C 2	2414	14	4.53	71.2	210/2/2	59.7
C 3	2414	14	5.98	74.9	210/2/3	90.0
C 4	2416	16	4.40	76.9	210/2/2	59.7
C 5	2418	18	4.18	85.9	210/2/2	64.2
C 6	4016	16	7.8	139.0	210/2/3+	97.0
D 1	2415	15	4.44	64.0	210/2/2	59.7

* Polyethylene monofilament mixed
** Hexagonal mesh

The netting is made by special type of machines. The bars are built up by knitted stitches, very much resembling a crochet work, so made by looping of yarns referred to as looped threads (Damiani, 1964). Besides, additional woofs for strengthening are provided by another set of yarns referred to as laid-in-threads or swing threads (Fig. 1).

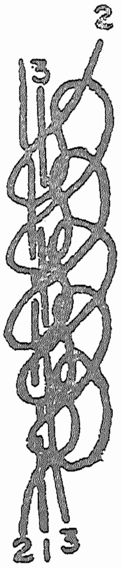

Fig. 1. Laid in threads and looped threads forming a bar in Raschel knotless netting.
1 and 3 laid in threads,
2 looped thread

A variety of difference is possible in the construction of knotless nets, depending upon (i) Choice of yarns used for looped and laid in threads:

Same denier yarn for looped and laid in threads, or finer denier yarns for looped threads and heavier denier for laid in threads or vice versa.
(ii) The method of interlacing of the threads:

Only the looped threads, or also the laid in threads, partially/wholly are entwined in the mesh apex representing the apparent knots.

According to Mugaas (1964) 'the more complex the structure of joints, the stronger and more durable they are, according to whether only the looped threads or also the laid in threads are entwined and depending upon the number of binding points (generally 2 or 4)'.

Materials and Methods

Raschel knotless webbing equivalent to 210/1/2 to 210/4/3 knotted webbings, as specified by the manufacturers, with a range of mesh sizes from 10 to 100 mm (approximately) formed the materials for the investigations. The samples were tested for the wet mesh strength, and weight for a standard dimension of webbing.

Results and Discussion

The mesh strength of the samples together with the weight of 100 x 100 meshes samples as compared to knotted equivalent is tabulated in Table 1.

The popular 210 denier nylon multifilament yarn is used as looped/laid in threads. When used as looped threads, it is paired with either the same denier or heavier denier yarn laid in threads. Samples with 210 denier yarn as laid in threads and finer yarns looped threads are also made. Use of finer denier yarns for looped threads is advantageous, since increase in weight by looping of yarns is reduced.

A knotted net is designated after its twine specification, mesh size, width and length of the webbing. Knotless nettings show quality numbers combined with dimensions of the webbing. The first digit of the quality number expresses the first digit of the denier size of looped thread yarn, the second one denotes the first digit of the denier size of laid in thread yarn and the last two digits, the size of mesh in mm.

Example		Quality No. 1225
First digit	:	First digit of the yarn denier of looped thread –150/110/180
Second digit	:	First digit of the yarn denier of laid in thread –210
Third and fourth digits	:	Mesh size in mm–25

This is the system followed by some of the Indian manufacturers.

Raschel denier of the netting which is indicative of the weight is derived by adding the denier size of laid in threads, with four times that of the looped threads, since when looped threads stitch the bars, four times the length is utilised for the formation. A

Table 2. *Comparison of theoretical and observed mesh strength of knotless netting*

	Denier		Raschel netting Mesh strength		Denier of knotted equivalent			
					Theoretical		Observed	
Quality number	Nominal	Resultant	Theoretical	Observed	Nominal	Resultant	Nominal	Resultant
12	360	810	3.25	2.61–3.84	210/1/3	756	210/1/2 to 210/1/3	504 – 756
20	420	1050	3.82	3.2–3.6	210/2/2	1008	210/1/3	756
24	630	1260	6.01	4.4–6.1	210/2/3	1512	210/2/2 to 210/2/3	1008 – 1512
40	840	2100	7.64	7.8	210/2/3+	1764	210/2/3+	·1764

Raschel net is economical by weight if the Raschel denier is nearer, equal or is less than the resultant denier of the knotted equivalent. The sum total of the strength of laid in threads and looped threads gives the strength of Raschel netting. Laid in threads are in an almost linear position hence the strength can be equated to the linear strength of the basic yarn. Looped threads follow a complicated path, there is reduction in strength by looping equal to 25% (Tani, 1964). Based on the above assumptions, mesh strength for the different specifications of webbing was worked out and compared to observed values (Table 2).

For a knotless net with looped threads 150 denier and laid in threads 210 denier, the strength varied from 2.6 to 3.8 kg and for a netting with 210 denier and 420 denier for the two components respectively, the variation was from 4.4 to 6.1 kg. A sample with 210 denier yarns for both looped and laid in threads recorded only 3.21 kg which is even less than the values recorded by some of the samples with finer denier looped threads. Von Brandt (1964) has conducted tests with knotted and knotless nets in the range of 20 to 90 mm mesh sizes and concluded that mesh strength is independent of mesh size. It appears therefore that lower values of mesh strength observed in some samples may be due to manufacturing defects or differences in the quality of yarns.

Substitution of knotted nets with knotless nets is based on wet mesh strength (Von Brandt, 1964). It can be seen that in some cases (Samples A1, A2, B2, and C3) the theoretical values of strength (Table 2) coincide with the observed values and the weight is less than the knotted equivalents. This suggests substitution with knotless netting can be economical.

To fix up yarn sizes for exchanging knotted with knotless nets, the following calculations will be of significance.

Let X, be the denier size of nylon multifilament yarn used for looped threads having a tenacity of 6.5 g/denier. There is reduction in strength by wetting and looping of this yarn equal to 20 and 25% respectively.

Strength of looped threads will therefore be

$$= 6.5 \times \frac{75}{100} \times \frac{80}{100} \times X = 3.9\,X$$

Similarly if Y represents the denier size of laid in threads yarn, which experiences reduction in strength by wetting alone, strength will be

$$= 6.5 \times \frac{80}{100} \times Y = 5.2\,Y$$

Raschel denier of the netting $= 4X + Y$

To find equivalent for 210/1/3 *knitted netting*

$$(3.9\,X + 5.2\,Y) \times 2 = 3360$$

$$4\,X + Y = 756$$

3360: Mesh strength in g of 210/1/3 nylon knotted netting.
756: Resultant denier of 210/1/3 nylon twines.

Based on the above, the values of X and Y are got as 133 and 224 respectively. These are adjusted to the nearest available deniers as 150 and 210. Table 3 gives the equivalents worked out for different specifications of knotted netting twines.

Table 3. *Knotless equivalents for substituting knotted netting*

Knotted Twine size	Knotless Yarn size in denier Looped thread	Laid in thread
210/1/3	150	210
210/2/2	210	210
210/2/3	210	420

Substitution with Raschel nets will be economical by weight and strength if the different combinations are made as to possess strength equal to the theoretically estimated values. This is possible, since estimations are made with minimum values of tenacity and maximum value of reduction by wetting.

Anon (1979) has reported the use of hexagonal meshes in seines as successful and economical. Data for a hexagonal webbing tested as compared to equivalent rhombic mesh is given under.

A hexagonal netting of 100 x 100 meshes of specification 24164 (16 mm mesh) weighs 102.4 g covering an area of 0.6975 sq.m.

Knotless rhombic netting of equivalent specification at 30% take up, weights 80 g with an area of 0.6362 sq.m. The same area of 0.6975 sq.m. can be covered by 88 g of the latter, rhombic mesh is less bulkier and its lesser surface coverage is more than compensated by its reduced weight.

In a knotted net, independent of mesh size, machines fabricate a definite number of knots in a given time. But in knotless, the connections as well as bars are knitted from yarns in the machines and consequently as bar size increases output in a given time decreases There is no unanimity of views regarding the mesh size above which production of knotless netting is uneconomical. But the consensus of opinion of the majority is that it is 40 mm. A second school of thought argues that as bar size increases the number of stitches per cm decreases (von Brandt, 1964). Mugaas (1964) emphasises that the coarser the yarn, the fewer are the courses per unit length. For a knotless net of 840 denier yarns (with 8–9 courses per cm), the runnage is two times that of using 210 denier yarns having 13 to 16 courses per cm, with a quantity of net equal to three times the latter.

Knotless nets are made out of yarns directly and not from finished twines. The economical production in knotless machines is achieved by the fact that the yarns for stitching are fed from sectional beams having flange diameter ranging from 355 to 535 mm (Viswanathan, 1972). This can accommodate several thousands of metres of yarn as compared to spools from which twines are fed in a knotted webbing.

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