Fishing Gear Materials

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Textile fibres form the basic material for the preparation of netting yarns. These can be broadly classified as natural fibres and man made fibres. Natural fibres are grouped into two, fibres of animal origin and vegetable origin of which the latter alone has significance in the fishing industry. Man made fibres are classified as natural polymers manufactured by the alteration of natural polymers like cellulose and protein and synthetic polymers obtained by synthesis or chemical process of which synthetic polymers are used for netting yarns.

Textile fibers

Vegetable fibres are classified by the source of origin as seed fibre, bast fibre obtained from the stalk or stem of certain plants, leaf fibres, fruit fibres, etc.

Source	Common name	Scientific name
Seed fibre	Cotton	*Gossipium herbaceum*
Bast fibre	True hemp	*Cannabis sativa*
	Indian hemp	*Crotalaria juncea*
	Flax	*Linum usitatissimum*
	Jute	*Corchorus capsularis*
Leaf fibre	Abaca (Manila)	*Musa textiles*
	Sisal	*Agave sisalana*
Fruit fibre	Coir	*Cocos nucifera*

These fibres are extracted from the surrounding tissues by mechanical process/retting.

Vegetable fibres consist mainly of cellulose and hence are attacked by cellulose consuming bacteria especially during immersion in water. The disadvantage with vegetable fibres is their short useful lifetime. This was overcome by the introduction of synthetics, which are practically rot proof. Vegetable twines are not used by the fishing industry now.

Synthetic fibres

Production of macromolecular compounds i.e., compounds in which a number of simple molecules of a monomer are combined by polycondensation or polymerization is the principle involved in the preparation of synthetic fibres. The raw materials for the production are simple substances like petroleum, coal, coke, lime and hydrocarbon.

The steps involved in the preparation are:

i. From simple raw materials like coal, oil, lime, petroleum etc., the monomer needed to build up the macromolecule is made by chemical processes.
ii. Polymerisation or polycondensation (formation of the chain of macromolecule or polymer from the monomer).
iii. The polymer at this stage is in the form of a ribbon which is cut into chips.
iv. The threads are stretched to 3-5 times their original length i.e. by drawing, by which they obtain final fineness, strength and extensibility.

Synthetic fibres are known by the type of polymer.

i. Polyamide (PA) fibres are manufactured in two different types, PA 66 and PA 6. These are two components from hexamethylene diamine and adipic acid each containing 6 carbon atoms. PA 6 is built from one monomer caprolactum, which contains 6 carbon atoms. In India only PA 6 is produced for fishing net purposes in the trade name Nylon.
ii. Polyester fibres are manufactures from polycondensation of terephthalic acid and the alcohol, ethylene glycol. Chemical compounds of an acid and alcohol are known as esters. The trade name is Terylene.
iii. Polyethylene is an additive polymer of the monomer ethylene, which is normally obtained by cracking petroleum.
iv. Polypropylene is the additive polymer of propylene obtained in the same way.

Yarns

The simplest continuous thread composed of fibres is the yarn, which indicates a general textile term covering all linear textile products. Among vegetable fibres, cotton is an example of spun or staple yarn where fibres of short staple length by spinning form the continuous thread. Bast and leaf fibres come under long vegetable fibre, which is twisted to form the yarn.

All synthetics can be made into four different types of yarn.

i. Spun yarn or staple yarn: by twisting together fibres of small staple length e.g. 40-120 mm, a spun yarn is made.
ii. Multifilament yarn: a group of fine filaments of continuous infinite length collectively form a yarn
iii. Monofilament yarn: a single yarn of sizable thickness and of indefinite continuous length form a yarn.
iv. Split fibre yarn: produced from oriented tape (flat tape) which are stretched during manufacture with such a high draw ratio that the fibre splits longitudinally when twisted under tension and contains fibres of irregular fineness resembling natural hard fibres.

For convenience only certain types of yarns are made with each polymer.

PA : Multifilaments, staple, monofilaments as singles; no split fibres.
PES : Multifilaments; no split fibres.
PE : Monofilaments (twisted); no staple fibres; no multifilaments. Split fibres are available but not common.
PP : Multifilaments, split fibres and monofilaments for ropes.

Yarn numbering system

The size of the yarn is given by yarn numbering system. This is based on the length-weight relationship of the yarn. There are two types of yarn numbering systems.

1. Direct System

In this system the weight of the yarn for a standard length is taken. For example the length of yarn is kept constant and the weight changes.

i. Denier

9000 m of yarn weighing 1 g is 1 denier
9000 m of yarn weighing 2 g is 2 denier
9000 m of yarn weighing 210 g is 210 denier

This is followed mainly for synthetic multifilament yarns.

ii. Tex

1000 m of yarn weighing 1 g is 1 tex.
1000 m of yarn weighing 2 g is 2 tex
1000 m of yarn weighing 20 g is 20 tex

This is the internationally accepted system of numbering for all textile yarns.

2. Indirect system.

Here the length of yarn for a standard weight gives the yarn number or the weight is kept constant and the length varies.

i. British Count (Ne)

840 yards weighing 1lb is 1 Ne
2x840 yards weighing 1 lb is 2 Ne
20x840 yards weighing 1 lb is 20 Ne

This is commonly used for cotton and synthetic staple yarns.

ii. Metric Count (Nm)

1000 m of yarn weighing 1 kg is 1 Nm

20x1000 m of yarn weighing 1 kg is 20 Nm.

In the direct system of numbering the more the yarn number, the thicker the yarn would be and in the indirect system the more the yarn number, the finer the yarn would be.

Netting yarn

Netting yarn is a textile product suitable for the manufacture of netting and can be knitted into netting by machine or by hand without having to undergo further process. Yarn is made into a netting by twisting or braiding. Monofilaments are used directly for making into netting without further process, hence it follows that monofilament yarn is a netting yarn also.

Twisted netting yarns (netting twines)

- Fibres are twisted together to form a single yarn.
- A number of single yarns are twisted together to form a strand or ply.
- 3 strands or ply are twisted together to form a netting twine.

Braided netting yarns

These are produced by interlacing a number of strands in such a way that they cross each other in diagonal direction. These braids are usually in the form of tubes. The braided netting yarns are available with or without core. Core is the term used for single yarn, twisted yarn or monofilaments which do not belong to the braided tube but fills the space inside the tube.

Specification of netting yarns

- Diameter in mm is commonly followed for monofilaments – single or twisted or braided and for ropes.
- Runnage in $m.kg^{-1}$ or $yd.lb^{-1}$ is commonly used for ropes.
- Size of yarn, number of yarns in one strand and number of strands in the twine are shown in direct numbering system.

For example 210dx3x3 indicates yarn size is 210 denier, there are 3 yarns in one strand and 3 such strands are twisted to form the netting twine.

Identification of synthetic fibres

Different groups of synthetic fibres can be identified by physical and chemical test methods.

Specific gravity

PA	1.14
PES	1.38
PE	0.96
PP	0.91

Burning test

Material	PA	PES	PE	PP
In flame	Melts, burns with light flame, white smoke, melting drops fall down.	Melts, burns with light flame, sooty black smoke, melting drops fall down.	Shrinks, curls, melts and burns with light flame, drops of melting fall down.	Shrinks, melts and burns with light flame melting drops fall down.
After leaving the flame	Stops burning, melting drops can be stretched into fine thread	Stops burning, melting bead may be stretched into fine thread	Continues to burn rapidly hot melting substance cannot be stretched.	Continues to burn slowly hot melting substance can be stretched.

Solubility test

- PA is soluble in 37% Hydrochloric acid in 30 minutes at room temperature.
- PA and PES are soluble in sulphuric acid 97-98% in 30 minutes at room temperature.
- PE and PP are soluble in Xylene on boiling for 5 minutes (Inflammable).

Availability

Not all synthetics are represented in the Indian Fishing Industry. PA is available as multifilament yarns and twisted netting yarns of different sizes and also as single yarn monofilaments of different sizes. Polyethylene is available as twisted monofilament / braided monofilaments of different sizes. Polypropylene as multifilament twisted netting yarns of sizes equivalent to nylon are also available.

Properties of netting yarn

Knowledge of the properties of netting yarns is required for quality evaluation and also for selection of material for different types of gear. The numerical values by which these are specified are determined by standard test procedures.

Diameter

Diameter of a material is dependent on the type of polymer, type of yarn, size of yarn, specification and construction. It is important in the selection of material for a particular gear. For example in the case of gill nets diameter of the twine (d) bears a ratio with mesh bar (l) to have the maximum catch efficiency. In trawl nets finer twines reduce the drag. Diameter is one of the factors to be considered for substitution of one material with another. For a given size of yarn (in tex or denier) different materials will have different values of diameter. A material with lower specific gravity will have more diameter than a material

with higher specific gravity. e.g. 210 d PA yarn of higher specific gravity (1.140) will be equivalent in diameter to 190 or 180 d PP yarns of lower specific gravity (0.91) or 210 d PA will be finer than 210 d PP. Diameter is expressed in mm and is measured using a traveling microscope or with Vernier calipers.

Linear density

The mass in g of 1000 m length of any sample is its linear density and is expressed as R tex (or resultant denier, if 9000 m length is considered).

Twist

Amount of twist

The numerical value of the amount of twists or turns per unit length is usually referred as per m or per inch. The amount of twist is determined by using a twist counter. The relation between strand twist and yarn twist (outer twist and inner twist) is given by

Inner twist = Outer twist x √Number of yarns

Direction of twist

There are two directions of twist, viz., 'S' and 'Z'. The components of the twisted product resembling the central portion of the letter 'S' or 'Z' is designated as having 'S' twist or 'Z' twist.

Coefficient of twist

This is the measure of twist hardness and is determined by multiplying the t/m by the square root of the count in the direct system of numbering.

$K = (t/m) \times (\sqrt{tex}/1000)$

Four different degrees of twist like soft, medium, hard and extra hard are recognized in giving the twist to a material. Soft twisted multifilament netting yarns of PA have a coefficient of twist 110-140, medium twisted 150-160 and hard twisted 200. The amount of twist is independent of the type of fibre, but dependant on the diameter of the netting yarn. Coefficient of twist for PP medium twisted netting yarns is 130-140 and for PE twisted monofilament 100-120.

Breaking load and elongation

Breaking load is the maximum force applied to a specimen in a tensile test. The test measures the resistance of a material to the force tending to stretch the specimen in one direction. This is expressed in N (1 N = 0.102 kg) ad elongation is the increase in length of the specimen during the test and is expressed as % of test length. This is determined by tensile testing machines or Universal testing machines – by applying increasing force till the sample breaks.

Tensile strength = Breaking load in N/Area of cross section in mm^2, expressed as N/mm^2.

Weathering

A netting yarn experiences wearing due to environment. The term wear includes deterioration caused by mechanical factors such as rubbing against sea bottom surface (abrasion) and chemical factors (ultraviolet rays and microbial attack). Resistance to abrasion is different in different materials. A material with high strength, high elongation and high elasticity possess good abrasion resistance. Resistance to UV rays is dependent on the type of fibres, type of material and specification. It is measured by exposing the samples out doors to sunlight or in controlled conditions in the laboratory to source of UV rays. The mechanical properties of the sample on continuous exposure are recorded periodically and the material is considered unserviceable when 50% of the breaking load is lost.

Table 1 Properties of PA multifilament twines

Specification	Dia. mm	R tex	Runnage m/kg	Twist/m		Breaking load, N	Elongation, %
				Outer	Inner		
210x1x2	0.37	53.0	18870	662	1272	28.19	23.5
210x2x2	0.50	106.4	9400	384	604	54.24	32.2
210x2x3	0.62	155.0	6450	316	588	75.0	32.4
210x3x3	0.76	231.7	4220	275	472	136.50	23.9
210x6x3	1.04	482.3	2070	212	383	255.00	23.9
210x9x3	1.30	724.7	1380	176	320	380.5	26.8
210x12x3	1.54	983.0	1020	178	245	494.5	28.1
210x24x3	2.18	1965.0	510	116	184	907.00	25.7

Table 2 Properties of PA monofilaments

Diameter mm	Size Tex	Denier	Runnage $m.kg^{-1}$	Breaking load, N	Elongation %
0.16	21.3	210	27400	12.80	22.17
0.20	36.5	330	27400	17.65	26.85
0.23	46.5	420	21500	22.12	26.82
0.25	55.5	500	18020	26.75	31.50
0.28	69.3	630		36.77	26.51
0.33	89.4	840		43.77	27.91
0.35	109.3	1050		50.52	25.51
0.40	144.5	1300	6920	62.30	42.90
0.45	190.0	1680		69.43	28.44

Table 3 Polyethylene twisted monofilaments

Diameter mm	R-tex	Runnage $m.kg^{-1}$	Breaking load N	Elongation %
0.75	322	3100	109.00	30.72
1.00	540	1850	171.28	33.90
1.25	628	1590	198.06	30.82
1.50	847	1180	299.76	31.52
2.00	1280	780	401.96	34.50

Table 4 Polypropylene twisted multifilament twines

Specifi-cation	Diameter mm	R-tex	Runnage $m.kg^{-1}$	Breaking load N	Elongation %
400x1x2	0.503	98.4	10160	41.33	23.83
600x1x3	0.780	229.0	4365	88.11	33.29
840x1x3	0.825	324.0	3085	115.28	36.07
1000x1x3	0.950	404.0	2475	186.92	25.14