BRAIDED SYNTHETIC TWINES AND THEIR USE IN THE NEW ENGLAND TRAWL FISHERY

By Michael Ruggiero*

BACKGROUND

The chemical revolution, which has brought about many changes in many industries, has also reached the fishing industry. Its effects can be seen on the decks and in the enginerooms of every vessel of the fishing fleet as well as in every fishery shore installation in the form of improved products, supplies, and materials. The introduction of synthetically-produced or improved fibers is only one part of this major revolution, but a part which will become increasingly important in the future.

Development of practical applications for synthetic fibers was speeded greatly by World War II research, but development of applications useful to the fishing industry was slower, carried out by trial and error, and conducted largely by using materials originally developed for other applications. In the New England trawl fishery, in spite of the recent trend toward increased use of synthetics, natural fibers still provide the bulk of the raw material for twine and webbing manufacture.

Synthetic twines were first introduced to the fishing industry shortly after the war by netting manufacturers who spun and twisted synthetic filament into conventional-type twines. These twines proved to be excellent trawl materials owing largely to their increased strength and longer life as compared with natural twines; but many trawl-fishermen felt that the added advantages were outweighed by the added capital expenditure required, and most webbing made from spun and twisted filament has been used by nontrawl segments of the industry--particularly by seine and gill-net fishermen. It has become apparent to trawl fishermen, however, that there were definite advantages to be gained from the use of synthetic twines, provided the initial cost of the twines could be reduced to compare more favorably with that of the natural-fiber twines currently in use.

DEVELOPMENT OF THE BRAIDED-TWINE INDUSTRY

Trawl fishermen soon found a partial answer to their quest for less expensive synthetics in the 3- to 4-fathom braided cords which could be obtained from surplus Armed Forces parachutes, air-drop cargo nets, and other devices. Application of these surplus synthetic braids to trawl construction was the beginning of a new approach to the manufacture of trawl twines and webbing. The braided material, although too thick for extensive use in nontrawl segments of the fishing industry, was ideal for construction of New England-type trawls. It, however, could not be handled by conventional net-making machinery. Net sections had to be made by hand and were primarily limited to cod-end sections by the size of braid available. New and better, but equally inexpensive, sources for braided synthetics were needed.

Waste material from tire, upholstery, fabric, thread, and firehose manufacturers was tried next. This waste material was hand-braided into a number of sizes of twine suitable for all sections of typical New England trawls, but little attention was paid to blending the yarns or to the uniformity of the final braid and the resulting product did not prove to be as practical as that obtained from Government surplus. Greater selectivity in waste buying and blending was necessary.

Emphasis was then placed on the use of conventional net-making machinery to replace hand labor. This increased the necessity for obtaining a relatively unvaried

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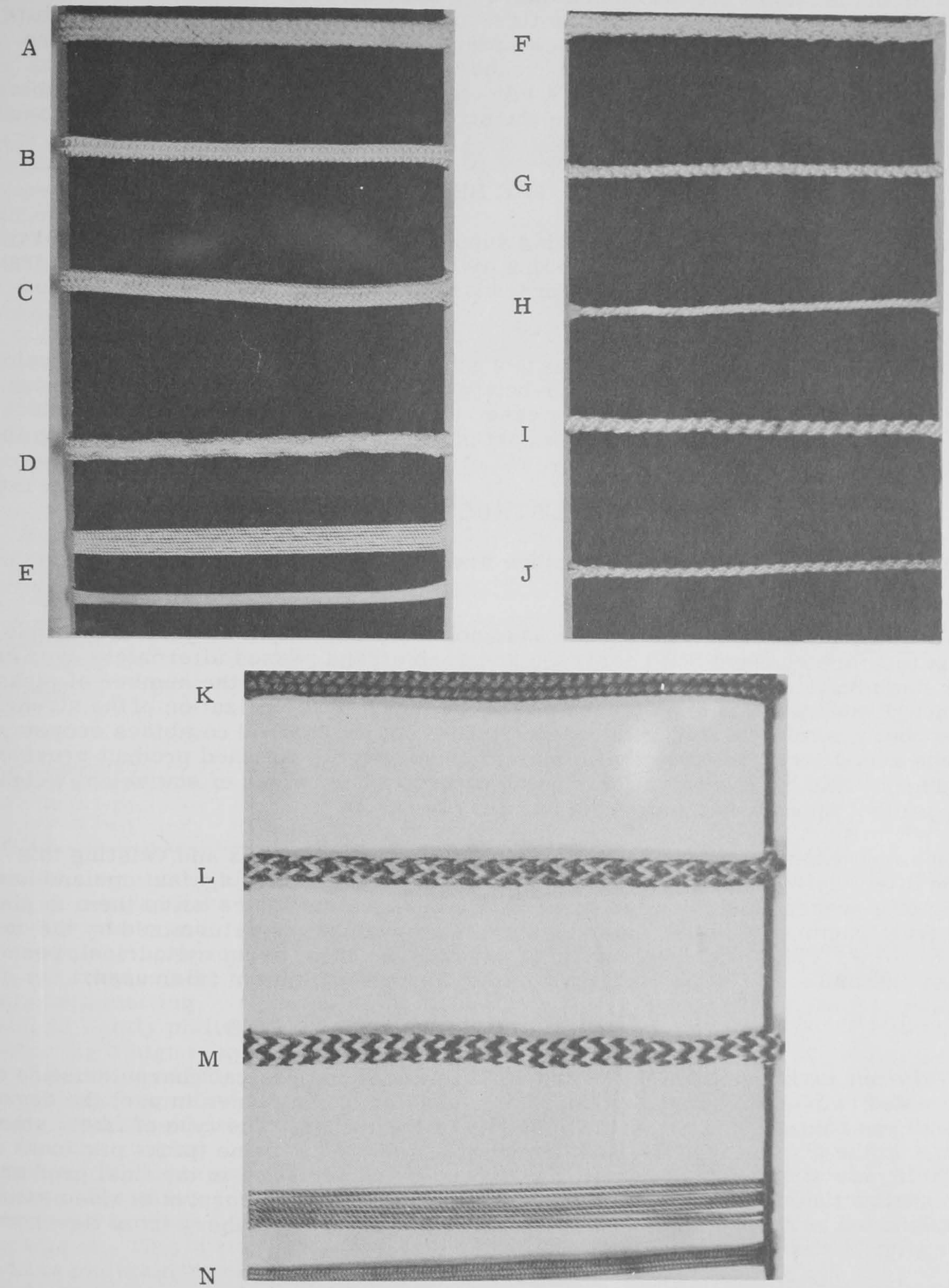


Fig. 1 - Synthetic braids and twines in common use aboard trawlers of the New England Fleet: (A) Westerbeke's No. 2 heavy nylon braid; (B) Lambeth Rope Company heavy nylon braid; (C) Westerbeke's No. 1 medium nylon braid; (D) Levine Marine Supply heavy nylon braid; (E) Armed Forces surplus Para-cord No. 550; (F) Levine Marine Supply Heavy nylon-Dacron braid; (G) Grimsby's heavy Terylene twisted twine; (H) Grimsby's light Terylene twisted twine; (I) Linen Thread Company No. 200/3 twisted nylon twine; (J) Linen Thread Company No. 400/3 twisted nylon twine; (K) Armed Forces surplus cargo netting No. 1,000 nylon braid; (L) Levine Marine Supply heavy Dacron-nylon braid; (M) Levine Marine Supply heavy braid; (N) Armed Forces surplus "Para-cord" No. 400 nylon braid.

source of waste supply for the manufacture of uniform braid. A suitable waste supply was found to be available from the tire-cord industry. Tire-cord manufacturers use high-quality synthetics; their specifications are rigid; and lot samplings are performed routinely to determine adherence to standards for several important qualities. An abundant supply of cord, rejected for tire manufacture, but suitable for twine manufacture is one result of the strict adherence to rigid specifications designed to maintain tire quality.

PRESENT CONDITION OF THE BRAIDED-TWINE INDUSTRY

At the present time, braided netting suppliers: (a) purchase waste tire cord; (b) braid the cord and knit it into webbing by machine; (c) cut the webbing into trawl sections. The only exception to that procedure occurs with heavy braids for cod ends. These are still knit by hand.

Compared with spinning, braiding is a simple operation, and the cost of braids made from manufacturing waste is far below the cost of twisted twine made from original synthetic filament. In many cases the cost of the finished braid produced by the braid suppliers is less than the cost of the original raw filament used by the tire-cord manufacturers.

CONSTRUCTION

Two general methods of manufacture are employed by the twine industry--braiding and spinning.

Braiding consists of weaving the assembled fibers, known as yarn or strands, so that they are crossed and recrossed and each strand passes alternately over and under the others. The tightness of the braid is determined by the number of picks per inch[1/] and by the tension placed on the strands. Full utilization of the strength of the fibers is not realized with braided twine, but the method combines economy with the added strength of synthetic materials so that the finished product provides a stronger twine than was available using natural-fiber twines of equivalent weight at a cost that approaches that of the natural fibers.

Spinning consists of drawing out a ribbon of parallel fibers and twisting this ribbon into a cylinder. The fibers become tightly compressed against one another during this process and the resulting friction between the fibers holds them in place when the structure is pulled under tension. Compactness is determined by the degree of twist. The structure resulting from this process, being cylindrical, possesses maximum attainable strength for the amount and kind of fiber used.

CHARACTERISTICS OF BRAIDED TWINES

Differences in construction result in differences in physical characteristics of the braided twine, and these determine the behavior of the twines in use, the degree of mesh contraction, and the wearing ability of the twines. The type of fiber, amount of twist in the plys or strands, and the compactness of the twine (picks per inch) can have wide variation and can result in different characteristics in the final product. The construction details of a commonly-used Armed Forces surplus braided twine and a braided twine manufactured specifically for the trawl fishery from tire-cord waste (fig. 2) are given in table 1.

The Armed Forces surplus braided cord chosen for comparison was originally designed for cargo netting, to be used in dropping supplies by parachute. It is made up of filaments plyed together with a very low twist. These are then plaited together in a loose fashion to form a very flexible braid capable of high-shock absorptive

1/ Picks per inch: A textile term used in describing compactness or fineness of cloth or cord. Defined as the number of times a specific strand enters the braid in a measured inch of that braid.

ability, high elastic recovery, and great strength. Cod ends made from this material have a longer useful life than those made from any of the other twines obtained. The braid, being flexible, and the component filaments being so formed and positioned that they are almost parallel to one another, causes the outer filaments to curl when broken, thereby protecting the inner filaments from further damage. Breaking of the outer filaments does not weaken the braid below a useful level because of the excessive initial strength of the braid material.

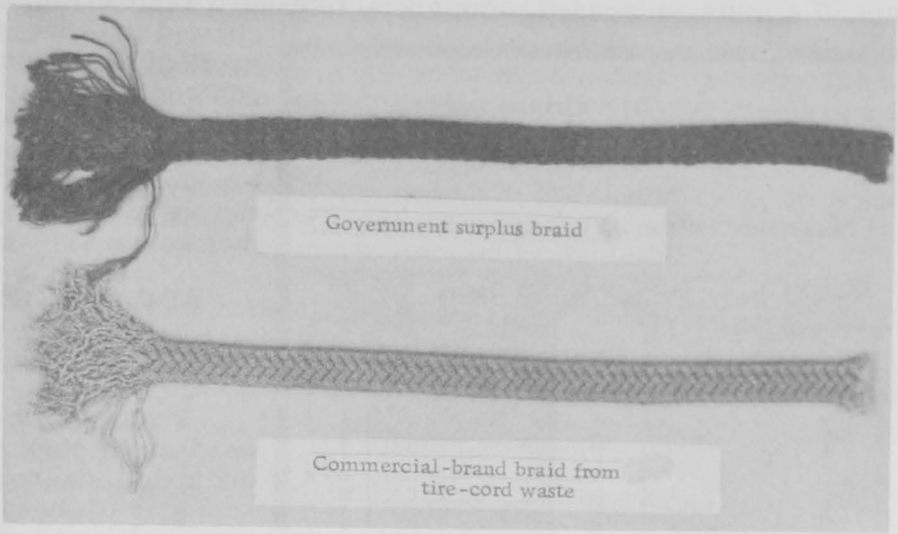


Fig. 2 - Representative braided nylon twines described in table 1.

Because of the looseness of the braid ("low number of picks per inch"), the surplus air-cargo netting braid often becomes infiltrated with sand and dirt. This often causes the braid to swell to a maximum of twice the original diameter thereby contributing greatly to a decrease in mesh size in those sections where the braid is subjected to the greatest wear and exposure to substrate (table 2 and fig. 3).

Table 1 - Construction Details of Two Representative Braided Nylon Twines

Construction Characteristic	Surplus No. 1,000 Cargo Cord	Commercial-Brand Cord Manufactured from Tire-Cord Waste
Yards/pound	43.83	38.89
Ends	96	48
Ends/carrier	6	3
Carriers	16	16
Denier/filament/ply	220/84/4	840/140/3
TPI Z-twist in single ply	1.26	12.10
TPI S-twist in 4-ply	3.38	-
TPI S-twist in 2-ply	-	9.9
Picks/inch	8.08	9.0

Braids made from tire-cord waste are made from yarns having a very high twist in both the filament plys and the yarns because of the extreme compactness required by tire manufacturers. The commercial braid made from tire waste and chosen for comparison with the surplus air-drop cargo-netting braid, is tightly plaited (containing a high number of picks per inch) and is therefore more compact but less flexible than the surplus material. It more nearly resembles natural-fiber twine in those characters. This braid tends to maintain a relatively stable mesh size, not being susceptible to the degree of swelling noted in surplus braid. In use, the commercial braid tested reacted in a manner similar to natural-fiber twine and had considerable stretch when subjected to heavy stress and wear.

Table 2 - Mesh Variation Experienced with Trawl Sections Made of Government-Surplus Synthetic Braids (After-Use Variation)1/

Net No.	Construction Material	Avg. Original Mesh Size	No. Trips Made	Avg. Mesh Size After Use
1	Double Parachute Cord No. 550D	4.39 inches	19	4.31 inches
2	" " "	4.41 inches	15	4.31 inches
3	" " "	4.39 inches	15	4.32 inches
4	Nylon Cargo Net Cord No. 1,000	4.63 inches	27	4.23 inches
*5	" " "	4.32 inches	23	3.61 inches
*6	" " "	4.39 inches	17	3.28 inches
*7	" " "	4.38 inches	20	3.90 inches
8	" " "	4.50 inches	25	4.01 inches
*9	" " "	4.26 inches	40	3.84 inches
*10	" " "	4.45 inches	28	3.60 inches

1/Figures used were obtained from certification records and after-use data gathered during 1954-58.
*Net still in use at time of measurement.

After-use measurements of two cod ends were made for comparative purposes. One cod end was constructed of Government surplus cargo netting. The other was made of a commonly-used commercial tire-cord waste braid. The results (fig. 3) showed that the meshes of the cod end made of Government surplus material contracted most in the area of the greatest wear and strain whereas the cod end made from the commercial braid contracted most in an area where the wear and strain were less than maximum.

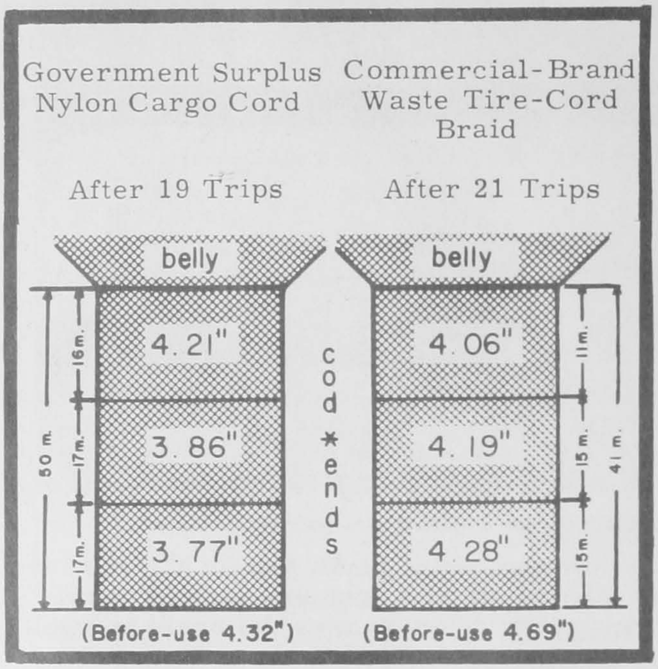


Fig. 3 - After-use measurements of two cod ends constructed of the materials described in table 1. Figures in mesh sections show internal mesh sizes after use. Figures below sections (before-use figures) refer to entire cod-end. Note that the area of maximum contraction varies with the construction material. (m = meshes)

ADVANTAGE OF SYNTHETIC TWINES IN THE NEW ENGLAND TRAWL FISHERY

Synthetic fibers most commonly used in the New England trawl fishery are nylon, dacron, and rayon. Chief advantages of these fibers result from their ability to withstand the effects of micro-organism attack, their high tensile strength, and their low level of moisture absorption. The synthetic fibers lose a greater amount of strength through knotting than do natural fibers, but even with this loss, their strength generally remains above the unknotted strength of natural fibers.

The most efficient gear is one which: (a) has the lowest initial cost; (b) has the longest useful life; (c) has the lowest maintenance costs; and (d) catches the most fish--is the most effective device for capture.

Initial Cost: The initial cost of a section of synthetic trawl webbing is still higher than that of an equivalent-size section of natural-fiber webbing, but the costs are more nearly equal now than in the past.

Useful Life: The useful life of synthetic webbing is many times longer than the useful life of natural-fiber webbing largely owing to the susceptibility of the natural-fibers to bacterial-induced rot. This longer life could contribute to a substantial saving in gear bills.

Maintenance Costs: Maintenance of synthetic fibers is simpler and usually cheaper than maintenance of natural-fibers and consists mainly of preventing overlong exposure to sunlight. The need to dry the nets frequently is done away with when using synthetics.

There is also less need for extensive repair when using synthetics as they are more resistant to the force of heavy catches and the blows and snagging effects often encountered in everyday operation.

Effectiveness: The effectiveness of synthetic-fiber gear compared with natural-fiber gear has been the subject of considerable debate. In the gill-net fishery many cases of increased effectiveness have been cited for synthetic nets. Less supporting evidence is available for trawl gear, but it must be assumed that synthetic trawls are, at the very least, as effective as natural fiber trawls.

USE OF BRAIDED TWINES AND WEBBING IN THE NEW ENGLAND TRAWL-FISHING INDUSTRY

Synthetic twines and braids are still used on only a restricted scale in the New England trawl fishery owing to the hazards involved in the trawling operation. In "hard-bottom" fishing for cod and haddock, the bottom sections of the trawls are often subjected to "tear-ups" that may carry away whole sections of webbing--synthetic or natural-fiber--making a complete trawl of synthetic webbing somewhat impractical. Top wings, squares (overhangs), and cod ends are therefore often made of synthetic webbing, but natural-fiber webbing is used frequently for the more vulnerable parts of the net--the lower wings and bottom belly (table 3).

In the flounder fishery, conducted primarily on sand bottom, synthetic webbing is more suitable than natural-fiber webbing because it can withstand the effect of greater loads of sand without tearing up. "Sanding up" is a serious source of net loss with natural-fiber nets.

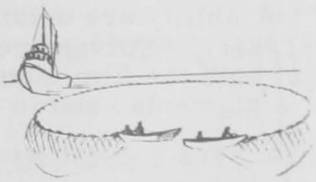
Table 3 - Fibers Used for Trawl Construction in the New England Fishing Fleet in 1958 (Based on a Survey Conducted in May 1958)

Trawl Section	Number of Vessels Using		
	Manila Twine	Cotton Twine	Synthetic Twine
Cod ends	26	-	73
Squares	32	30	37
Top wings	29	30	40
Bottom wings	32	56	11
Top belly	32	44	23
Bottom belly	32	54	13

Experience has shown that it is often preferable to use cotton or manila for lacing and hanging nets to avoid the distortion of a section of webbing which otherwise often results following a hang-up. Use of manila- or cotton-lacing or hanging twine creates a weak point which carries away before serious damage is done to the webbing.

Trawls constructed wholly of 3/16-inch braided nylon cord were recently used in trawling over bottom considered too rough for natural-fiber nets in recent trial-trawling for red snapper in the Gulf of Mexico by the exploratory fishing vessel Silver Bay, under charter to the U. S. Bureau of Commercial Fisheries. Performance of the gear was considered satisfactory with only minor tear-ups recorded and with negligible loss of webbing.

Synthetic fibers will continue to be used in the New England trawling industry in the future, and, as their cost decreases, they will undoubtedly contribute to a greater and greater extent to the over-all efficiency of that fishery. Their place has been assured by industry acceptance of the results of practical application.



SILOS FOR FISH MEAL STORAGE

In Norway, it has been found that bulk storage of fish meal in grain silos is more practicable and cheaper than storage in bags. Distribution costs are also reduced. The meal should be stirred occasionally, which also ensures thorough mixing resulting in a meal of uniform quality. It seems preferable to divide the silos into smaller storage cells (Informationen über die Fischwirtschaft des Auslandes, June/July 1958).