Import Substitution of Combination Wire Rope. Part I. Design, Production and Evaluation of a Prototype Combination Wire Rope

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Model combination wire ropes with different covering materials were prepared and worked out specification for the prototype. A table model hand operated wire rope twisting machine was also developed for this. Prototype combination wire rope was twisted in collaboration with M/s. South India Wire Ropes Ltd., Alwaye. Specification details, properties and field performance of the prototype studied are reported.

In the present context of Government of India's effort for the exploitation of the fishery resources of the middle and distant waters of the Exclusive Economic Zone, import substitution of the combination wire rope is of much importance. When a single material cannot satisfy certain specific requirement, it is a general practice to go in for combining materials of different properties to have at least the near desired qualities. It is in this context that combination wire ropes were made and used as framing ropes for heavy duty trawls.

Ropes are used either to withstand or to transmit force. A rope may be of high breaking strength and resistance to loadings without any appreciable extension as in the case of steel wire ropes or with comparatively low breaking strength and low resistance to stretch but with high degree of load absorption and shock resistance as in the case of fibre ropes (Klust, 1983). The former is best suited for rigging masts, booms, trawl winches, sweep lines, bridles etc and the latter is used for lines where a high degree of work absorption and shock loading is required. However, both types are not suitable as framing ropes of nets. The desired qualities for framing ropes are high breaking strength, very low extension at sustained loading, medium flexibility, medium mass volume ratio and roughness to maintain original size and shape of gear without being elongated under sustained loading and slippage.

A steel wire rope while satisfying low extension and high breaking strength will have very low diameter,extra stiff and smooth and is highly susceptible to corrosion. Fibre ropes have comparatively low breaking strength, specific gravity and high extensibility. A combination wire rope of steel wire and natural or synthetic fibre can provide high breaking strength, low extension, stiffness and mass. The fibre component can reduce the stiffness and mass making the rope flexible and thicker with rough surface and can protect the steel component from accelerated corrosion in the marine environment. A rope thus made will have all the required qualities of a framing rope.

Even though India is an exporter of different types of wire ropes and have sufficient infrastructural facilities, import combination wire ropes for fishing purposes mainly due to the present low intake and lack of expertise and standard. Consequent on the declaration of EEZ and the high priority in deep sea fishing, the intake of combination wire rope will be manyfold in the near future. Even on a very conservative estimate the annual requirement will be about 0.5 million metres by the turn of the century and at the present rate the cost will be over Rs.15 million in foreign exchange. It is in this connection that Central Institute of Fisheries Technology took up research and development programme for the combination wire ropes for fishing operation.

Materials and Methods

A table model hand operated wire rope twisting machine (Fig. 1) was designed and developed for preparing combination wire

rope. The hand operated model wire rope twisting machine has got provision to twist a wire rope of six strands with central core. The six spools of the strands and the spool of central core are spring loaded to attain even rate of tension. The central core passes through a GI pipe and the six strands with the core converge at a nozzle for closing the wire rope. The twisted rope is got wound in a reeling drum. The twisting operation is done manually with a handle and cycle chain arrangement. Model combination wire ropes were prepared using 0.32 mm GI wire and different types of covering materials like polyamide yarns, polyethylene tapes and monofilament polypropylene (PP) yarns and PP tape. The abrassion resitance of twisted tape

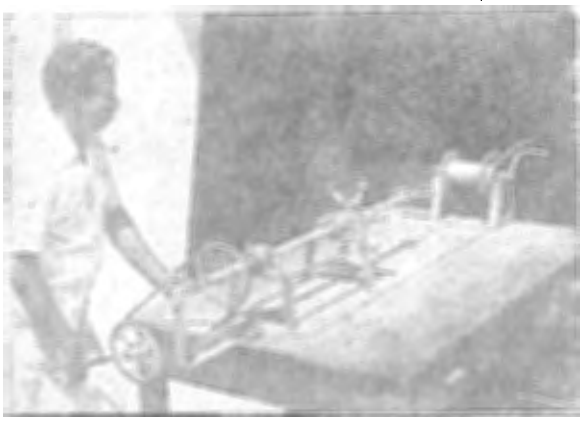

Fig. 1. Table model hand operated wire rope twisting machine

yarn was also studied by abrading selected samples of 1.7 mm dia twisted tape yarn in wet condition over oil stone upto a period of 10 min of continuous abrasion with stages of 1 min interval. 1.5–2 mm dia PP twisted tape yarn was observed to be best suited and was selected as covering material and 3.4 mm dia 3 stranded PP tape yarn twisted rope as central core for the prototype combination wire rope.

The steel wire component for the prototype was selected in consultation with M/s. South India Wire Ropes Ltd., Alwaye – a leading wire rope manufacturing firm in the area, and collaborated with them in the production of the first prototype as per the specification evolved by the authors. The rope diameter was fixed as 16 – 18 mm with an approximate aggregate breaking

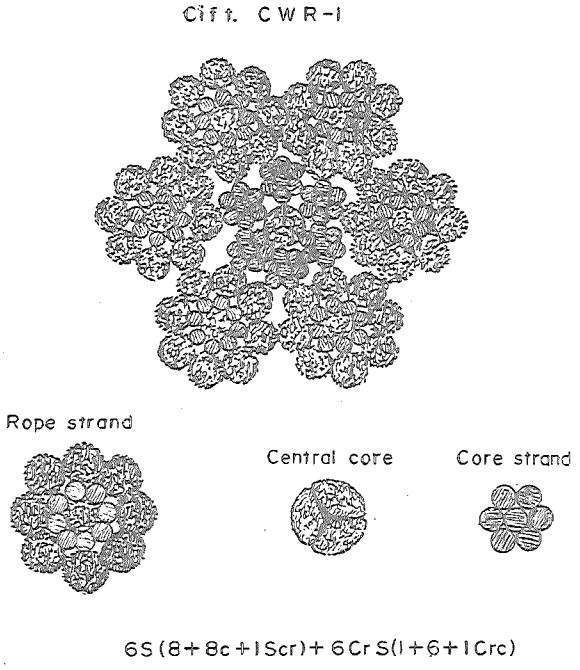

Fig. 2. Construction details (diagramatic) of combination wire rope (Cift-CWR I)

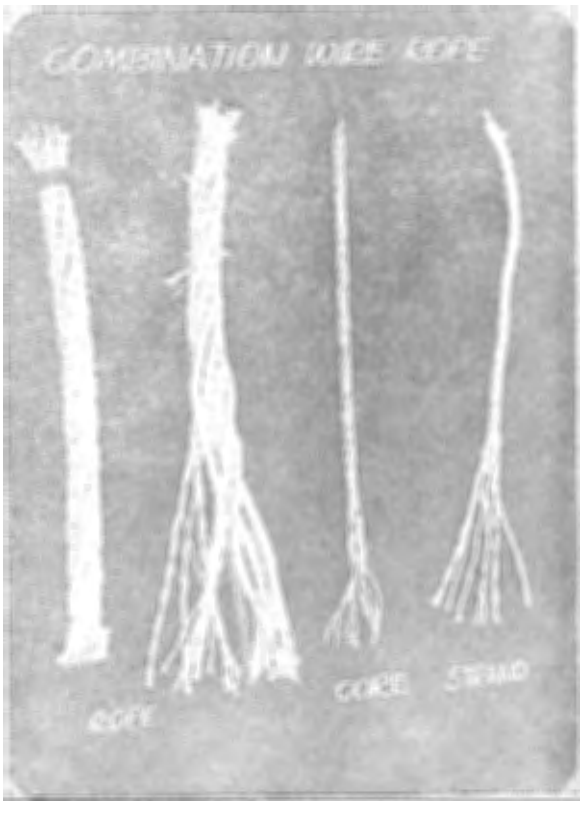

Fig. 3. Components of the combination wire rope

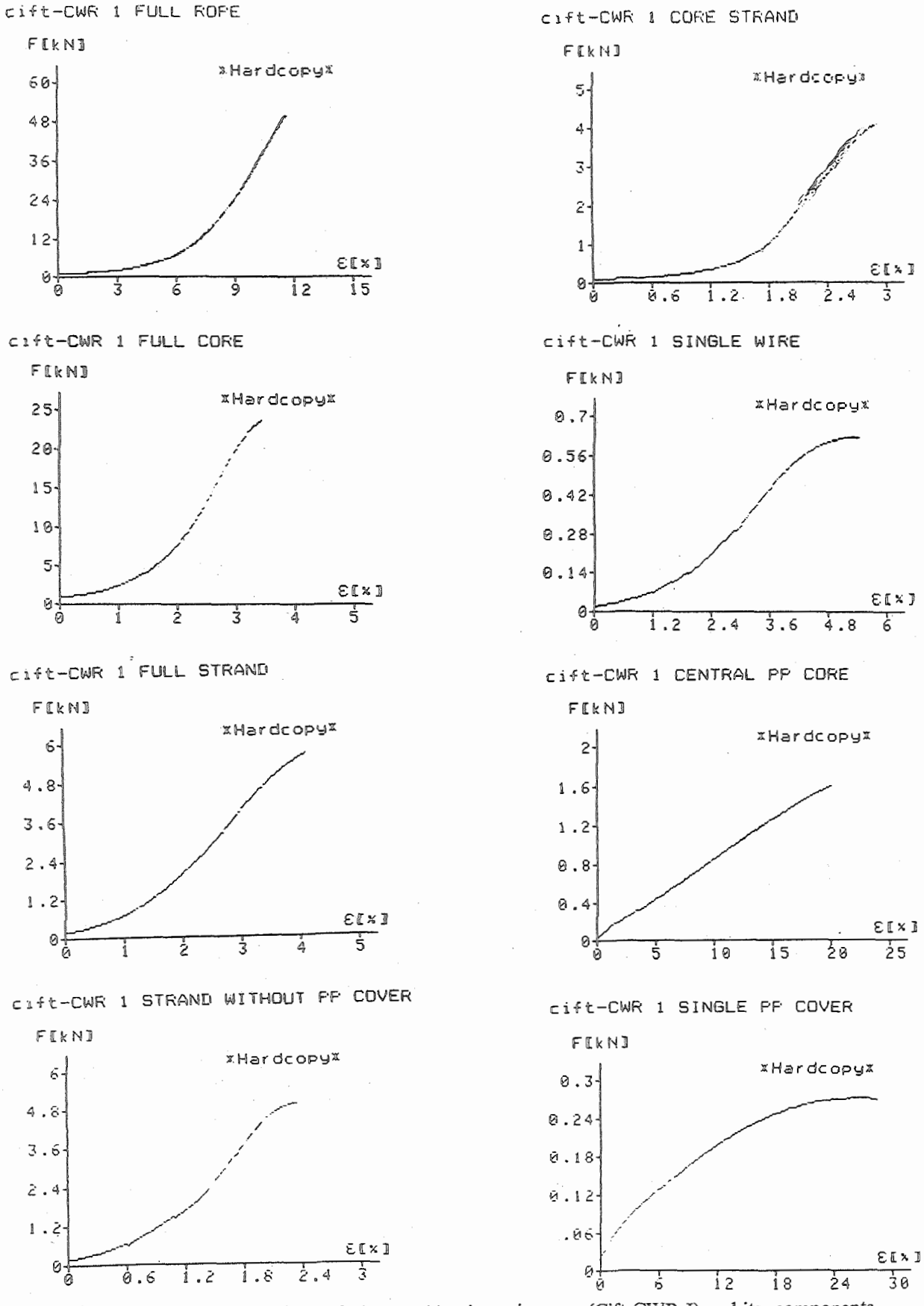

Fig. 4. Load-elongation curve of the combination wire rope (Cift-CWR I) and its components.

strength of 50 – 55 KN. The first batch of 500 m prototype combination wire rope (Cift - CWR I) was prepared in April 1986 by M/s. South India Wire Rope Ltd., Alwaye.

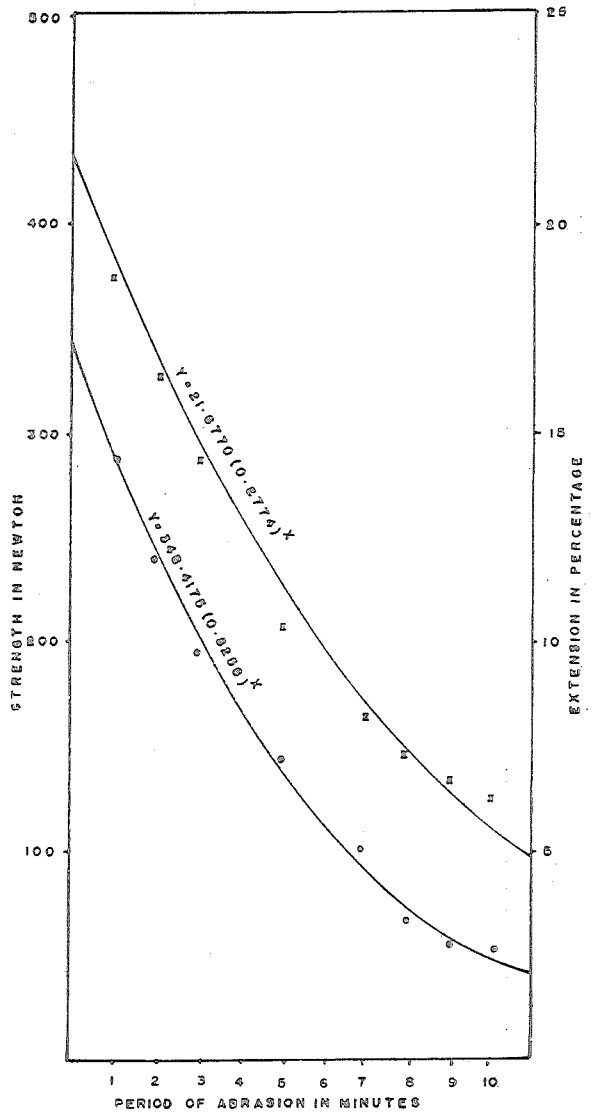

Fig. 5. Relation between retention of strength and stretch with period of abrasion.

All testings were carried out in Zwick 1484 Material Testing System. Different components were tested for breaking strength and stretch and the average value of ten test results was taken.

The prototype was also rigged as head and foot ropes of high speed demersal trawls and put under extensive field trials at speeds upto 5 knots from the research vessel FORV Sagar Sampada. Samples of head and foot ropes were drawn at regular intervals of 30 days of continuous operation upto 90 days and tested for strength retention.

Results and Discussion

The construction details are given in Figs. 2 and 3. The specifications and test results of the rope and various components of the combination wire rope are presented in Table 1. The lowest strength and stretch values of the full rope and its different components (Load - elongation curve) are detailed in Fig. 4.

The abrasion resistance of the PP twisted yarn covering material is given in Fig. 5.

The final strength of combination wire rope is lower than the aggregate strength of the wire components except in the case of rope strand stage due to the PP core component. The ranges of percentage reduction are:

i) Aggregate of wire and PP component to final rope 34–35

ii) Aggregate of wire components to final rope 11.0–11.20

iii) Strand covered + Central core to final rope 15.5 – 16.0

iv) Strand uncovered + Central core to final rope 9.0–9.5

v) Aggregate of wires to central core 6.5 – 7.0

vi) Aggregate of wires + PP core to central core 12.0 – 12.50

vii) Aggregate of wires + PP core to rope strand 4.0 – 4.20

viii) Aggregate of wires to rope strand 2.0 – 2.30

ix) Aggregate of wires to core strand 5.0 – 5.50.

From the above it can be concluded that even though there is a definite reduction in strength at various stages from the aggregate strength of wire component, the comparative low reduction at the final stage is mainly due to the influence of combination of steel and synthetics – a hard and soft material rather than the influence of strength of the latter.

Table 1. *Details of prototype combination wire rope*

Particulars	Rope	Rope strand (S)				Rope core (Cr)			
		Covered strand (S)	Uncovered strand (S)	Strand Core (Scr) (Scr)	Strand cover (c)	Rope core (Cr)	Core strand (Crs)	Central core (Crc)	Steel wire
Specification	6S (8+8c+ 1Scr)+6Crs (1+6+1 Crc)	8+8c+ 1Scr	8+1Scr	Twisted PP	tape yarn	6 Crs (1 + 6+ Crc)	1+6+ 1Cre	PP tape twisted 3 stranded rope	
Lay	Regular right hand	Regular left hand	Regular left hand	Right hand		Regular right hand	Regular right hand	Right hand	
Pitch (mm)	125.00	41.60	20.80			50.00	21.40	12.50	
Diameter (mm)	17.00	5.50	2.25		1.60	6.50	2.00	3.00	0.71
Strength (KN)	50.80	5.90	5.20	0.34048	0.34048	24.88	4.20	1.73568	0.635
Stretch (%)	11.50	4.20	2.30	26.43		3.44	2.90	38.85	4.89
Weight/100 m (kg)	38.52	3.49	2.56	0.161 each		13.09	1.86	0.425	0.293
Aggregate Strength (KN)	0.635 x 90 =57.15	5.9 x 6 =35.40	5.20 x 6 =31.20	0.34048 x 54=18.385			4.20 x 6 =25.20		0.635 x 90 =57.15

In the case of extension at break there is a definite increase in the extension from basic wire component to the finished product (from 4.5 – 5.0 to 11.5 – 12%). However, this comparatively high extension rate can be attributed to the high pitch

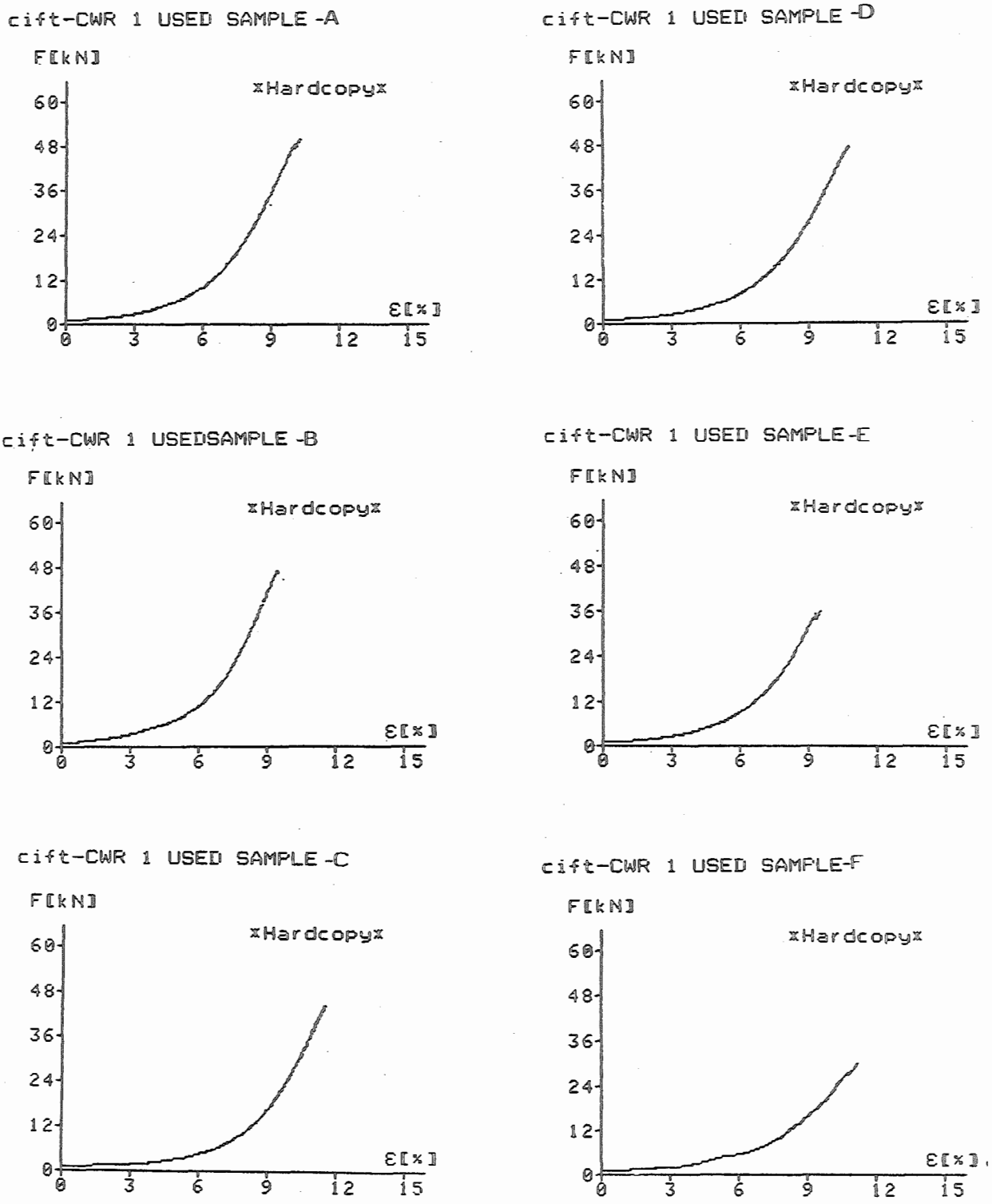

Fig. 6. Load-elongation curve of used samples of combination wire rope (a,b,c used as head rope for 30, 60 and 90 days respectively d, e, f used as foot rope for 30, 60 and 90 days respectively)

Table 2. *Strength retention of prototype combination wire rope after demersal trawling from FORV Sagar Sampada as head and foot rope*

Details	Strength retention Head rope KN	%	Foot rope KN	%
After continuous use for 30 days	50.18	98.78	47.75	94.0
After continuous use for 60 days	47.69	93.88	36.62	72.09
After continous use for 90 days	45.22	89.02	30.50	60.04

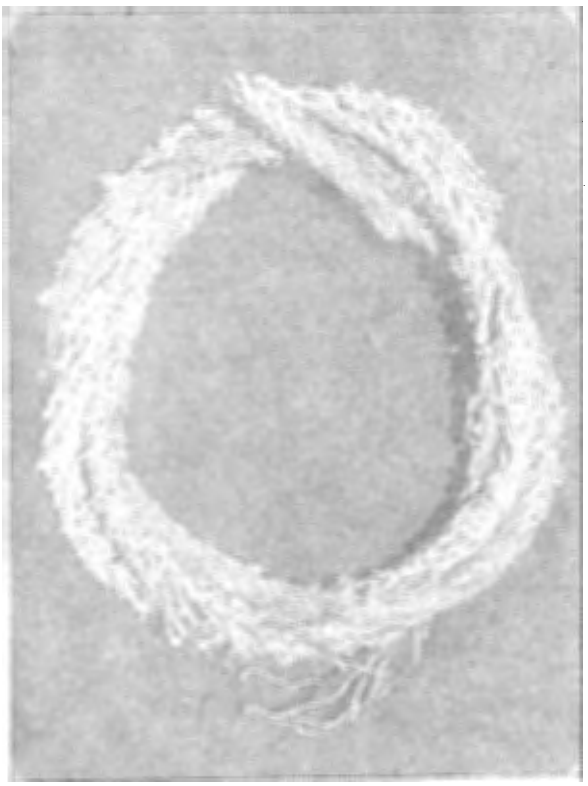

Fig. 7. Combination wi re rope after 90 days operation as foot rope.

value (125 mm) given at the closing stage of rope which can be improved upon by adjusting the pitch at the closing stage. In all the other stages there is a definite reduction in the extension from the basic wire component. Even though this increase, when compared to wire rope, is on the higher side it is negligible when compared to that of fibre ropes.

The strength of PP covering material ranged between 0.27 and 0.34 KN mainly due to non-uniformity of the width of the PP tape yarns and the diameter of the tape varied from 1.5 to 1.7 mm. The exponential relation of abrasion resistance indicates a reasonably good abrasion resistance of the material.

The residual strength of the combination wire rope used as head and foot ropes in the high speed demersal trawls is given in Table 2. Fig. 6 indicates the load-elongation nature of the residual strength and stretch of the rope. Fig. 7 shows the nature and intensity of abrasion of foot rope after 90 days fishing operations. Only a marginal reduction of about 11% in the breaking strength of head rope and about 40% in the case of foot rope is shown after 70 hauls tried for a period of 90 days.

The above study and the results indicate that there is further scope of improvements on prototype (Cift, CWR I) for better efficiency and strength at reduced extension rate. Attempts are being made to improve upon the prototype for standardisation purposes.

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Reference

Klust, G. (1983) *Fibre Ropes for Fishing Gear*. Fishing News (Books) Ltd., England, p. 200.