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# Comparative Performance of Rectangular, Low and High Aspect Ratio Cambered Otterboards

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The performance of two cambered otterboard types (low and high aspect ratio) when used with 17 m and 24 m demersal trawls were measured. The parameters included were loads on different points, total load, vertical opening, door and wing-end spreads and angle of attack, heel and tilt of door. The vertical opening of the trawls were 1.5-1.6m. The vertical curved board spread the net more. The sheer force calculated was between 70 to 140 kgf for the high aspect ratio board and was between 45 to 98 kgf for the other. Based on the study, the cambered board of high aspect ratio is recommended as an efficient substitute for rectangular flat otterboard in common use.

Trawl performance is traditionally evaluated based on operating parameters like door or wing spread, total towing pull and catch. Model testing of a 31m trawl has been carried out in India by Perumal *et al.* (1973). Crewe (1964), Carrothers *et al.* (1969) and Mac Lennan & Galbraith (1979) have used engineering principles of measurement and calculation. Electronic telemetering instruments have been developed for engineering studies of otter trawls (Sivadas *et al.*, 1982). The aim of the present study was to measure and compare the operating parameters of two different otterboard types in combination with two demersal trawls using indigenously developed telemetering instrumentation.

## Materials and Methods

Two trawls of headline length 17 and 24m (Kunjipalu, K.K., *per. comm.*) made of PE netting yarn were used. Rectangular cambered doors, one of low aspect ratio (Mukundan *et al.*, 1967) of size 120x60 cm, weighing 55 kg each and other of high aspect ratio-Suberkrub (Scharfe, 1959) of size 130x90 cm weighing 58 kg each (Fig. 1), both rigged for bottom trawling were tested. Fishing operations were carried out from a 9.76m LOA vessel powered with a 52 hp engine. The winch carried 14 mm dia towing warp.

The parameters viz., i) fore and aft tilt, (ii) angle of attack and iii) heel of the door; iv) underwater loads, v) warp load before gallows, vi) towing speed and vii) vertical opening were measured by using the instruments described by Sivadas (1981) and Sivadas *et al.* (1982).

Fig. 2 shows the position of instruments during trawling. Telemetering cables from different sensors were led to the multiplexer unit fitted on the door. The telemetering cable connecting the multiplexer with the onboard readout unit was handled by a simple reel. During the operation, sufficient length of cable was released to avoid strain. The speed log was mounted onto the side of the boat. For reading the headline height the telemetering cable was connected to the echosounder display unit. The sensor measuring total load was mounted onto the warp between gallow and winch. The load measurement readings were recorded continously for five min and the average was taken.

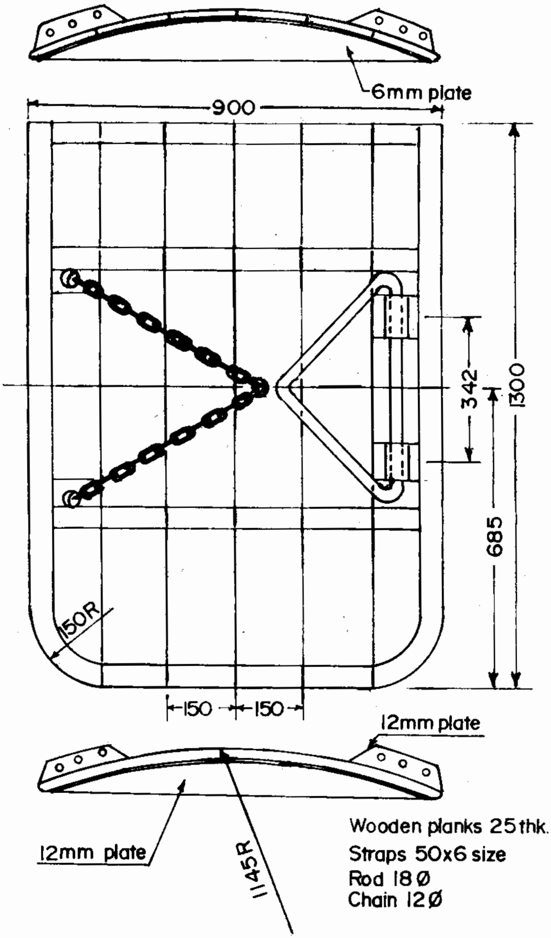


Fig. 1 Construction drawing of 1300x900 mm rectangular cambered high aspect ratio otterboard. All dimensions are in millimeters.

The spread between trawl boards and between wing ends were estimated by the method of Deshpande (1960) and Perumal *et al.* (1973). The sheer and drag forces were calculated using the method described by Anon (1974) from the measured values of loads at fore and aft of the door.

## Results and Discussion

Results of experiments and the derived values for drag and sheer forces are presented in Tables 1 & 2. The measured speed during experiments was found to be between 1 and 1.5 m.s$^{-1}$.

Both boards were found operating with a nose up tilt and it varied between 0.5$^{o}$ to 5.5$^{o}$ and 2.5$^{o}$ to 5.25$^{o}$ for the low and high aspect ratio boards respectively.

The heel was positive, that is towing bracket was facing up and varied between 0.5$^{o}$ to 10$^{o}$ for the low aspect ratio board. Heel was generally negative for the suberkrub board but changed from 1 to 4$^{o}$ either side. The heel and tilt were within the range observed by other workers (Crewe, 1964; Mac Lennan & Galbraith, 1979).

Operating angle of the horizontal curved board was found to vary between 36 to 42.5$^{o}$. But in certain cases the value obtained was 85$^{o}$ which may be due to defective functioning of the sensor. In the case of suberkrub otterboard it was between 18$^{o}$ to 37$^{o}$ with 17 m trawl and 27.5$^{o}$ to 45$^{o}$ with the 24m trawl. Generally, it can be stated that this board operated between 20$^{o}$ to 30$^{o}$ angle

Table 1. *Performance of 1200x600 mm rectangular cambered (low aspect ratio) otterboard when operated using 17m trawl*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth,m | 9.00 | 9.00 | 9.00 | 9.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Warp, m | 47.00 | 44.00 | 50.00 | 50.00 | 55.00 | 50.00 | 60.00 | 70.00 |
| Tilt nose up,deg | 0.50 | 0.50 | 0.50 | 0.50 | 0.00 | 0.00 | 1.75 | 5.50 |
| Heel positive,deg | 5.00 | 3.50-5.00 | 0.50-1.50 | 0.50-2.50 | 0.00 | 0.00 | 10.00 | 0.00 |
| Angle of attack deg | 85.00 | 85.00 | 85.00 | 85.00 | 40.00 | 35.00 | 42.00 | 40.00 |
| Speed, m.s$^{-1}$ | 1.28 | 1.28 | 1.47 | 1.54 | 1.20 | 1.26 | 1.10 | 1.00 |
| Vertical opening, m | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | - | - |
| Door spread,m | 14.00 | 13.50 | 14.50 | 15.00 | 20.15 | 18.32 | 20.52 | 21.60 |
| Wing-end spread, m | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 |
| Total tension, kgf | 460.00 | 470.00 | 485.00 | 490.00 | - | - | 517.00 | 467.00 |
| Net drag, kgf | 150.00 | 134.00 | 100.00 | 104.00 | 34.00 | 47.50 | 128.00 | 96.00 |
| Net & door drag, kgf | 218.00 | 214.00 | 183.00 | 191.00 | 161.00 | 188.00 | 216.00 | 221.00 |
| Door drag force, kgf | 69.95 | 79.70 | 84.04 | 88.38 | 128.17 | 145.71 | 101.46 | 136.65 |
| Door Sheer force, kgf | 71.14 | 59.59 | 51.02 | 55.74 | 45.30 | 50.06 | 98.25 | 84.14 |

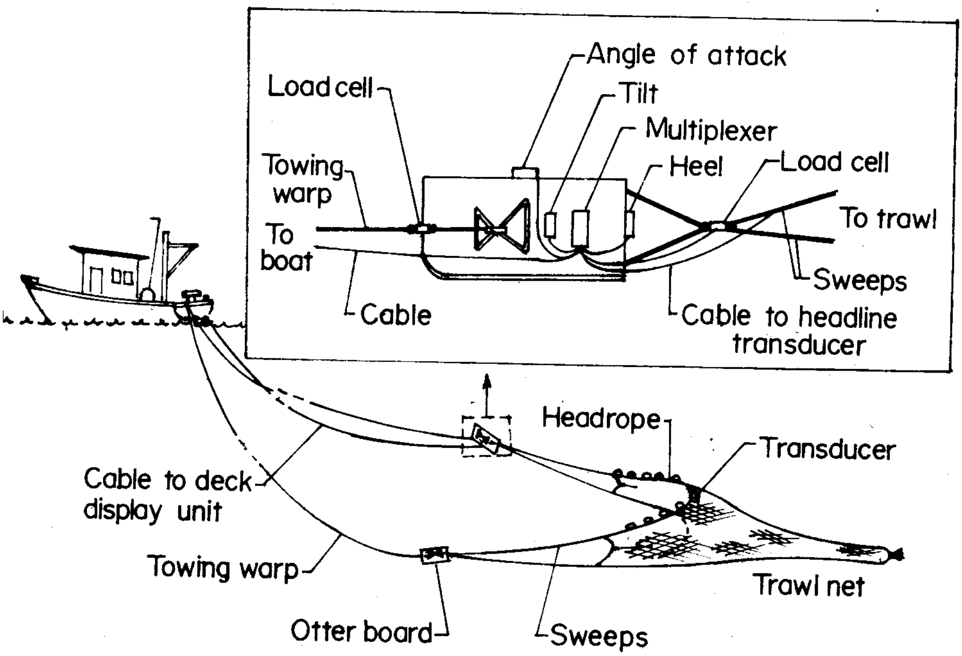


Fig. 2. Arrangement of trawl telemetering instrumentation for measuring drag, heel, tilt, angle of attack of otterboards; and vertical opening at trawl mouth

of attack. Anon (1974) and Scharfe (1959) have reported that suberkrub board functions effectively at low angle of attack and as a result, frictional resistance and turbulence are less. It is well known that otterboards operate over a wide range of angle of attack (de Boer, 1959; Crewe, 1964).

The tension for the net alone measured by the load cell mounted between sweepline and backstrop of the otterboard had varied between 34 to 150 kgf, for one side only, when the 17m net was rigged with low aspect ratio otterboard as against 50 to 124 kgf with the suberkrub board. The tension of 17m net and board as measured by the load cell between warp end and door was found to vary between 161 and 221 kgf for the low aspect ratio board and 154 and 244 kgf when rigged with the suberkrub board.

Table 2. *Performance of 1300x900 mm rectangular cambered (high aspect ratio, suberkrub type) otterboard*

| | 17m trawl | | | | 24m trawl | | | |
|---|---|---|---|---|---|---|---|---|
| Depth, m | 11.00 | 9.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Warp, m | 60.00 | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| Tilt nose up, deg | 0.00 | 0.00 | 0.00 | 0.00 | 4.50-5.25 | 2.50-4.00 | 4.50-4.75 | 3.50 |
| Heel, deg | 0.00 | 0.00 | 0.00 | 0.00 | 0.78 | 0.75-4.00 | 0.00 | 0.00 |
| Angle of attack, deg | 37.00 | 20.00-26.00 | 18.00-26.00 | 20.00-21.50 | 30.00 | 29.00-45.00 | 27.50-41.00 | 30.50-41.00 |
| Speed, $m.s^{-1}$ | 1.48 | 1.18 | 1.20 | 1.03 | 1.38 | 1.72 | 1.34 | 1.80 |
| Vertical opening, m | 1.50 | 1.50 | 1.50 | 1.50 | 1.60 | 1.50 | 1.60 | 1.50 |
| Door spread, m | 30.00 | 25.75 | 24.24 | 25.00 | 26.90 | 27.30 | 25.30 | 26.80 |
| Wing-end spread, m | 8.84 | 8.84 | 8.84 | 8.84 | 12.00 | 12.00 | 12.00 | 12.00 |
| Total tension, kgf | 522.00 | 580.00 | 580.00 | 520.00 | - | - | - | - |
| Net drag, kgf | 50.00 | 50.00 | 97.00 | 124.00 | 71.00 | 117.00 | 64.00 | 60.00 |
| Net and door drag, kgf | 154.00 | 196.00 | 224.00 | 244.00 | 154.00 | 198.00 | 181.00 | 186.00 |
| Door drag force, kgf | 122.30 | 152.50 | 157.80 | 141.40 | 91.20 | 97.80 | 120.80 | 131.00 |
| Door sheer force, kgf | 80.20 | 84.80 | 130.00 | 140.00 | 83.60 | 125.40 | 79.71 | 85.40 |

This clearly indicates that despite increase in area, the high aspect ratio cambered board did not register marked increase in load indicating its superiority.

The drag component varied between 69 and 145 kgf for low aspect ratio board and 91 and 157 kgf for the suberkrub board. This indicates that there is no marked increase in drag with the vertical board which can be attributed to its working at low angles of attack. The sheer force which is the final proof of the efficiency of any sheering device was found to be more with suberkrub board (79 to 140 kgf) as against the 45 to 98 kgf of the other establishing the superiority of the former.

The vertical opening of the two nets was 1.5m and on two occasions the 24m net recorded 1.6m. Watson *et al.* (1984) observed vertical openings for shrimp trawls around this value. Perumal *et al.* (1973) for a 31m (53.8 m circumference) net found only 1.7 m which was confirmed by model tests also. Pajot *et al.* (1982) mentioned a vertical opening of 1 m for conventional trawl and 3 m for the BOBP 26.7 m trawl without any reference to the measuring method.

Flat rectangular boards widely used at present are hydrodynamically less efficient (Anon, 1974). High aspect ratio suberkrub type board as indicated by this investigation is much more efficient and can successfully replace the traditional rectangular flat otterboard. The suberkrub type board is easy to construct and costs more or less the same as rectangular flat board.

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