

Otterboards - Types and Functions

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Otterboards are devices used for stabilising the trawl nets rigged with them and are also hydrodynamically dependant means of holding the net mouth open. Horizontal opening of the trawl is attained by these devices towed ahead of the gear systems and set at an angle of attack to the towing direction which provides the outward force or the shearing force to spread the wings of the trawl which are attached by way of bridles. Fixed between the towing warps and the wing ends they have attachment points chosen to set them at angle to the direction of tow so that the water force pushed them outward and held the trawl gear open in a horizontal direction. In earlier times, the boards were directly connected to the wings but it is now common to have bridles or sweeps between otterboards and net. This facilitates opening up the gear horizontally, to sample an effectively increased volume of water or area of bottom per unit of fishing time. Successful trawling operation to a great extent depends on the size, shape, weight and behaviour of the boards under actual tow. The weight in relation to the size of the doors is an important factor contributing to their functional efficiency in as much as the ground shearing forces are directly dependent on it.

Before the advent of otterboards, the net mouth was kept open by a rigid and self supporting structure, the resultant gear being known as beam trawl. Introduction of steam power to fishing vessel permitted faster and better controlled towing speed in comparison to the wind energy and this development opened up introduction of otterboards as spreading devices to replace the rigid beam.

Initially, the shape of the boards were rectangular and were equipped with flat shoes to avoid ploughing and to minimise the frictions with the sea bottom so that the boards would keep a more stable course in relation to the towing direction. Over the years there have been many improvements to the design of

otterboards. New shapes and materials have been introduced to suit a much wider variety of fishing conditions and methods including trawling in column waters. The choice of shape will depend on a number of factors whether it is to be used on or off bottom, type and nature of ground to be fished, size of trawler and her towing power and the cost. The size of the otterboard must be related to its required reaction to the water flow forces which push it outward in opposition to the inpulling forces from the warp and the net. The points where warps and bridles to be attached must be chosen so that the balance of forces holds the otterboards in the position which allow it to operate at the best average efficiency. Materials and thickness must be chosen to suit the imposed stresses and strain, the required overall weight and the distribution of weight for good stability.

General Principle of Otterboard Dynamics

An otterboard has no power of its own. Its ability to *spread the net* is derived from the interaction of external forces. That is how well the forces are harnessed to it. The main forces to be considered are:

- i) Towing power of trawler: The towing force or pull of the trawler is transmitted to the otterboard through the warps.
- ii) Drag of the net: The drag of the net comprises of hydrodynamic forces acting on the netting, the net appendages, the ground rope, the hauling ropes and the bottom friction where there is ground contact.
- iii) Hydrodynamic forces of water flow, gravity and bottom friction.

In the towing condition the water forces act on the otterboards in opposition to the in pull components of the tension in the warps and bridles. The magnitude of these forces depends on the density of sea-water, the towing speed, the size and shape of otterboards and their angle of attack (Angle between the direction of tow and the plane of otterboard)

If the otterboard is heeled inward or outward, some hydrodynamic spread is sacrificed by an amount depending on the degree of heel.

Tilt of the otterboard also significantly influence its performance particularly on the bottom. Positive tilt favours light bottom contact, negative tilt favours digging in. Usually a slightly positive tilt is desirable as it facilitates passing over obstacles.

The efficiency of an otterboard can be conveniently expressed by means of two forces. The outward spreading force which is at right angles to the direction of motion and the drag force or resistance to motion which acts backward directly against the pull of the ship. An efficient otterboard will have large spreading force and a low drag.

Otterboards for Demersal Trawling

There are three types of otterboards commonly used for bottom trawling.

Standard rectangular flat board used since the advent of trawling. These boards are considered conventional. Flat oval doors which were developed and are popular in the erstwhile Soviet Union and increasingly adopted by other countries. V form boards recently developed and already used extensively

In selecting any one of these boards, consideration must first be given to the ground condition in the area to be fished. Oval doors can ride over ground obstacles more easily than rectangular flat boards with their curved leading edges. The design of V form boards has advantages for rough bottom and in addition is less liable to dig or to become fast in soft ground.

An easily remembered approximation of rectangular flat board's weight is 1 kg/hp of the towing vessel (Portier, 1967).

Flat oval doors are used on variety of forms. They can be either single slotted or multislotted - the advantages of using slotted boards being an improvement in the drag to spreading force relationship.

Otterboards for variable Depth Trawling or Midwater Trawling

Through the years, various otterboard ideas have been tried but because of problems of stability and handling none except the suberkrub doors, developed in Germany in 1930s have been successful. They are stable and versatile in mid water operation and can be fished from trawlers through the complete range of available horse power.

Polyvalent otterboards are comparatively recent development manufactured to perform the dual purpose of on and off bottom fishing. Different types of boards are not necessary for the two sorts of fishing, if performance requirement are moderate and polyvalent doors are upto the mark for the purpose. With polyvalent boards (a combination of cambered and oval board) the correct warp take off position for bottom as well as mid water trawling has to be selected before fishing commences.

HA ratio cambered suberkrub doors have been extensively used in dual purpose trawling with very promising results. They are extremely used in bottom trawling in Japanese fishery and because of their cleanly superior efficiency, they deserve more attention, particularly in trawlers where towing power is the main limiting factor. The power requirement is comparatively less to operate HA ratio cambered suberkrub doors.

There are different relationship between size of trawl, otterboard and engine horsepower.

D) Size of trawl and otterboard $L = \sqrt{415^2 - 1000}$

Where S= area of otterboard in square feet

L = Length in feet of Head rope

and $S = 0.105 P + L$

P = HP of engine.

II) Area of trawl/net and ob

$S = 415S_1 - 1000$, where S = square of HR length in feet representing the area of the net and S_1 = area of otterboard in square feet.

III) Size of otterboard and size of net

$$L = 31.8 + 0.96 L_1 \text{ (Nets having long wing)}$$

$$L = 31.8 + 1.03 L_1 \text{ (for other nets)}$$

where L = length of head rope of trawl and

$$L_1 = \sqrt{2A}$$

A = area of otterboard

IV Length and breadth of Otterboard

The relation between A and B is the case of LA ratio boards is 2:1 (approx)

If L_1 is length, then breadth ' B ' = $L_1/2$ and

$$\text{Area 'A'} = (L_1 \times L_1/2) = \frac{L_1^2}{2}$$

$$L_1 = \sqrt{2A}$$

If ' B ' denotes breadth, length will be $2B$ then ' B ' can be calculated

$$B = \sqrt{\frac{0.105 P + L}{2}}$$

P = hp of engine

V Area of board and horse power

$$S'' = 0.105 P + L$$

S'' = area of board in square feet

P = hp of engine

L = H R length in feet

Vi Weight of otterboard

W = 0.065 (L x B x T)

l = Length and

B = Breadth of otterboard

T = Thickness of material

Fuel Testing Option

A more efficient type of otterboard can lead to a reduction in the fuel consumption of a trawler.

Model tests as well as full scale trawl operation aiming to measure how much of the total drag is due to the different parts of the gear have confirmed the following breakdown of drag even though there is considerable variation depending on trawl size, type of fishing and sea condition.

Warps	9%
Otterboard	25%
Floats	3%
Netting	53%
Sweeps and bridles	7%
Foot rope	8%

While towing approximately 94% of the fuel would be required to tow the trawl and 6% to propel the vessel. There is variation depending upon vessel size and

type of fishery. but typically 70% of the fuel will be used when towing the gear and 3% when steaming to and from the grounds.

The drag of the otterboard is therefore responsible for a contribution of the order of 16% of the total fuel consumption on a typical trawler trip.

It is not unusual to find otterboards working at angles of attack in excess of 40°. Otterboard drag is high and most otterboards work at an angle of attack much higher than that which gives the maximum spreading force. Reducing angle of attack saves fuel hull and for most otterboard types allows a smaller size of otterboard to be used to give the same gear spread.

By reducing 45° to 35° angle of attack would reduce otterboard drag to 72%, 7% saving otterboard drag would result in an estimated reduction of 4% total vessel fuel consumption. It has also been worked out that otterboards which are cambered, fitted with slots or are of multifoil design are fuel efficient than the conventional ones.

20% of otterboard drag saving would lead to an estimated 3% saving in total fuel consumption. Better use of otterboard can lead to modest savings in fuel consumption. The maximum possible saving would be about 8% in the case where a traditional flat or 'V' otterboard was being used at too high an angle of attack. The main saving would come from reducing to a lower angle of attack of the order of 35°. The angle of attack could be further reduced only if no problem were experienced with otterboard stability. Further fuel saving could be made by changing from a traditional V Form or flat design to a cambered, cambered slotted or multifoil design

Types of Otterboard

1. Rectangular Flat:

A typical rectangular flat otterboard consists of a steel frame with various steel strengthening struts enclosing a fabricated wooden plate. These boards are

regarded as generally inexpensive, not very efficient hydrodynamically, but one of the simplest to handle. The main limitation of this board is that it does not run easily over very rough ground and consequently tends to have a limited life.

2. **Rectangular Flat Wide Keeled:**

This otterboard is light in weight and construction is also simple and used for shrimp trawling. The wide sole plates counteract digging into bottom. The main limitation of these otterboards, apart from their rather low hydrodynamic efficiency, is that they are unsuited for rough ground.

3. **Rectangular cambered (low aspect ratio):**

The outstanding physical features apart from camber is its weight particularly in the larger sizes which have a metal plate overall on the back face. These boards are more expensive than flat rectangular boards, but they are hydrodynamically efficient and durable. Efficiency in terms of spreading force is gained by the water flow following the curved surface round the rear of the board and thus being less turbulent. These boards operate at a smaller angle of attack (of about 30°) which leads to lower towing resistance and may also reduce the tendency of the board to dig into soft ground. These types are better shot at high vessel speeds and more easily executed on a stern trawler than a side trawler. Disadvantage of these boards are their reluctance to right themselves after falling flat which may happen when taking sharp turns. This problem is greatly reduced by ensuring the correct warp and bridle attachment points.

4. **Oval flat slotted:**

The main area of this board is made in 2 parts, the forward and aft section, usually in hardwood, shaped to provide a slot at the required position between the 2 sections. It is expensive to manufacture but has a long life expectancy. These boards are specifically designed for use on rough ground. It has got slightly better hydrodynamic properties than the rectangular flat board. The

rounded lower edge which affects spreading performance adversely, is beneficial to overall performance on very uneven and hard ground, because it reduces ground friction and mechanical stress. The vertical slot opening is intended to increase the hydrodynamic efficiency of the board by reducing the turbulence. The main limitation is its lower spreading force on clean ground as compared to cambered board of same area. This board is not suitable for mid-water trawling.

5. Oval Cambered Slotted (Polyvalent)

These boards are a combination of the oval board and the cambered board giving the increased spreading efficiency of the cambered and the ability to transverse hard ground. The structure is all steel and relatively expensive. They are not as efficient in mid-water as the high aspect ratio cambered boards (eg. Suberkrub type) they are hydrodynamically more efficient than an oval flat board of the same surface area. The polyvalent boards are the easiest of all otterboards to handle onboard and also reduces the tendency for other parts of the gear to become entangled with the board.

6. Vee Type

These boards are appreciated for their good performance on very hard and irregular ground. The structure is made entirely in steel and relatively inexpensive to manufacture and retain a long working life. The interchangeability of the towing bracket to make either a port or star board otterboard is an important factor in favour of this board. This ability to use the boards on either side also means that the keels can be worn evenly by changing the boards over from time to time and thus efficiently prolonging the period between servicing. This disadvantage of these boards i.e., inferior spreading force, and require more storage space than flat otterboards. They are easy to handle and simple to shoot, haul and stow. These boards are heavier in weight than other types of demersal otterboards. This is useful to counteract the specific operational upward sheer component.

7. **Rectangular Cambered (high aspect ratio Suberkrub Type)**

Due to its hydrodynamic superiority over all other types of otterboards, this type commonly known as the suberkrub otterboard (after its design) is at present most popular for one boat mid-water trawling. The all steel suberkrub otterboard is relatively simple to manufacture, comparatively inexpensive and durable. The superior hydrodynamic efficiency and in particular the very low drag, make the high aspect ratio cambered otterboard, the natural choice for low powered trawlers.

8. **Hydrofoil otter board**

This is the main type used in Japan. It has good efficiency for opening the net at low drag. Its handling is easier, but as it has a higher centre of gravity it tends to fall down if trawled at lower speed. To overcome this difficulty the centre of gravity was lowered by attaching a buoyant substance to the upper part of the board. This enabled lowering the centre of gravity down to about 15-20% from the bottom.