On Towing Depth of Isaacs-Kidd Mid-water Trawl Net

Kei NAKASAI

Abstract

The author has been studying on the simple estimation of working depth of mid-water trawl and had drawn a chart considering that the warp in operation takes of a circular arc.

The chart was applied to the field experiments of mid-water trawl and plankton net, and considerably good results were obtained.

This time, the author applied the chart on Isaacs-Kidd mid-water trawling. The net was towed by a fine towing warp which differs from the ones that were employed in previous experiments.

It was clarified that the diameter of the towing warp in operation has some influence upon the shape of the warp within a relatively low towing speed range, and that the chart is helpful for simple estimation of working depth of the gear within the practical towing speed range.

Introduction

In the preceeding paper,[1] the author applied the chart,[2] which is to estimate the working depth of the mid-water trawl net, to the plankton net, and concluded that the chart is helpful for simple estimation of working depth of the gear within the practical towing speed range. As a matter of course, it is necessary to know the working depth of the gear at the time of trolling and it is desired to have an easier way of knowing it. The author as well as other scientists wanted to know easily the depth of the gear in operation. Therefore, the author studied the matter by means of the chart and carried out a series of experiments.

This time, Isaacs-Kidd mid-water trawl net was employed and studied. The reason why the Isaacs-Kidd mid-water trawl net was employed is that the gear differs from other types of mid-water trawl net; the mouth of the net is fixed by a depressor plate and there is a net ring at the net, and accordingly the shape of the net does not change along with the change of towing speed. The towing warp was also considerably different in its diameter from those used in the former experiments.

It was made known as the result of the experiments that the towing depth of the gear in operation towed by a fine towing warp can be estimated by considering that the warp is straight at the towing speed of below 2 knots. It was also clarified that the chart is handy for simple estimation of working depth at the towing speed of above 2 knots.

Experiments

The experiments were carried out in the Indian Ocean during 14 to 18 August 1967 on board the Nagasaki Maru, 563 gross tons, of Nagasaki University.

The details of the gear are depicted in Figs. 1 and 2. The figure in the parentheses shows the number of meshes upon completion. The lacing line to sew the webbing was nylon rope of 6mm in diameter. The dotted line in part B shows a lapel to sew pieces of webbing together.

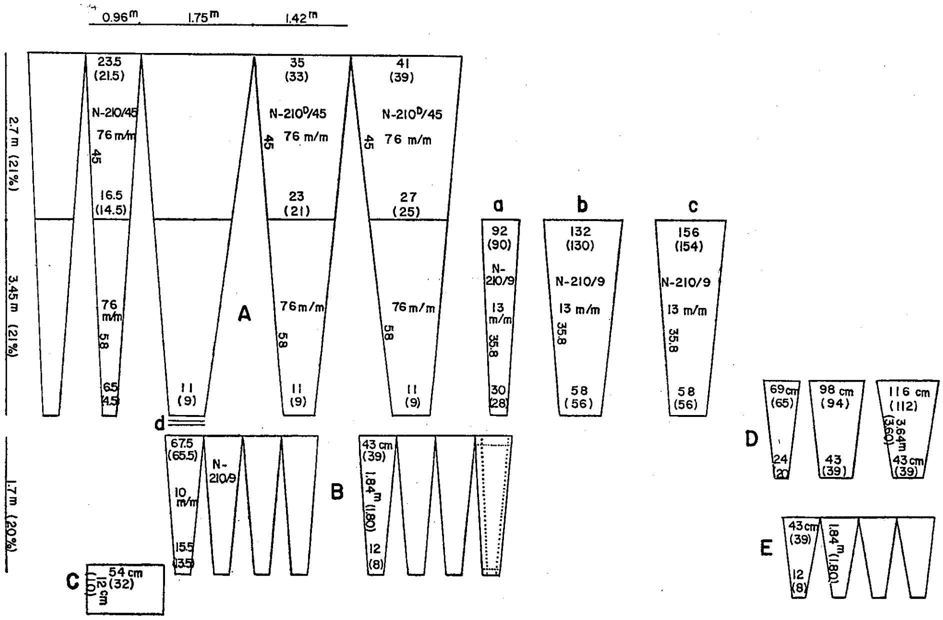

Fig. 1. Design of the net.
Note : A, Nylon webbing; B, Minnow netting of Kuremona webbing, C, Canvas; D, Minnow netting of Kuremona webbing; E, Silk cloth; a, Ventral netting: b, Dorsal netting; c, Lateral netting; d,Rings.

Rings inserted in front of the codend are made of brass and weigh 2.3kg. The weight of depressor is 44.7 kg in the air and 39.0kg in water. The sckematic view of the gear in operation was shown by SHIBATA.[3)]

The towing depth of the gear was observed by Gyoken V type wireless net-sonde, the

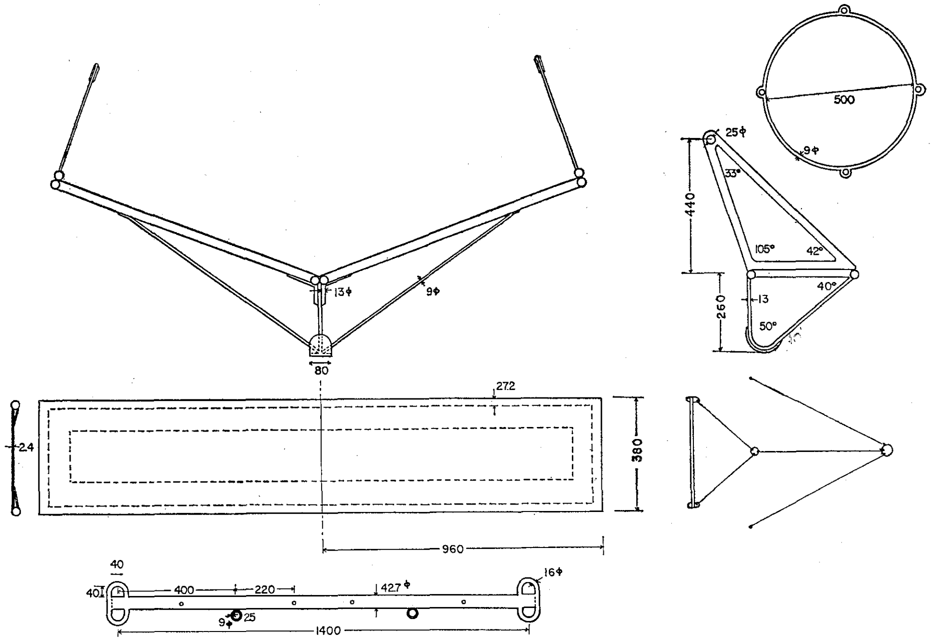

Fig. 2. Depressor plate and net ring.

same apparatus as in the previous study, whose transmitter was installed on the bridle of the net and receiver was hauled from the poop of the vessel and connected to the laboratory.

The method of experiment was the same as the former experiments [1,2] . The revolution number of the main engine of the vessel and pitch of the screw were fixed and the wire, Hi-tension wire measuring 6mm in diameter, was paid out for L=0-350m at intervals of 25m, and the tilt angle of wire and the towing depth of gear were measured for various units of length at various towing speeds. There are, indeed, some exceptions concerning the intervals of the length of wire: The interval in the first experiment was 50m, but sometimes when the length of the wire was 25m the depth of the gear was too shallow to measure exactly on account of the fault of the apparatus as pointed out in the former paper [1].

Results and Discussion

Results obtained are shown in Table 1.

Here; **V** is ship's speed in knot, **L** is length of wire, **h** is working depth of gear measured by the apparatus, θ_s is angle between wire and horizontal plane at the sea surface.

Table 1.

V Knots	θ_s (°)	L m	h m	D (°)	D_C (°)	V_C Knots	θ_n (°)
2.00	34.0	5	0.0	300	356	1.63	34.0
1.80	25.0	50	24.0	〃	〃	〃	24.1
1.40	30.0	100	50.0	〃	〃	〃	25.1
1.10	29.0	150	77.0	〃	〃	〃	26.4
1.10	28.0	200	100.0	〃	〃	〃	26.4
1.30	25.0	250	117.0	〃	〃	〃	25.5
1.10	26.0	300	126.0	〃	〃	〃	26.4
1.70	36.0	5	0.0	〃	300	2.18	36.0
1.50	29.0	50	24.0	〃	〃	〃	24.8
1.50	26.5	75	30.0	〃	〃	〃	24.8
1.80	24.0	100	39.0	〃	〃	〃	24.2
1.50	25.0	125	51.5	〃	〃	〃	24.8
1.55	24.0	150	62.0	〃	〃	〃	24.7
1.55	26.0	175	72.0	〃	〃	〃	24.7
1.55	24.0	200	82.5	〃	〃	〃	24.7
1.50	25.0	225	94.0	〃	〃	〃	24.8
1.50	24.0	250	101.5	〃	〃	〃	24.8
1.50	23.0	275	109.0	〃	〃	〃	24.8
1.60	23.0	300	114.0	〃	〃	〃	24.5
1.70	21.0	325	117.0	〃	〃	〃	24.3
1.70	21.5	350	120.0	〃	〃	〃	24.3
2.20	28.0	5	0.0	330	283	1.46	28.0
2.40	21.0	25	7.5	〃	〃	〃	23.0
2.10	23.0	50	20.0	〃	〃	〃	23.5
2.00	22.0	75	28.0	〃	〃	〃	23.7
2.10	20.0	100	36.5	〃	〃	〃	23.5
2.10	20.0	125	46.0	〃	〃	〃	23.5
2.00	21.0	150	55.0	〃	〃	〃	23.7
2.00	20.0	175	65.0	〃	〃	〃	23.7
1.90	21.0	200	76.0	〃	〃	〃	23.9
2.00	21.0	225	86.0	〃	〃	〃	23.7
2.10	21.0	250	95.0	〃	〃	〃	23.5
2.20	20.0	275	102.0	〃	〃	〃	23.3
2.10	19.0	300	109.5	〃	〃	〃	23.5
2.60	38.0	5	0.0	335	252	1.12	38.0
2.30	28.0	50	19.0	〃	〃	〃	23.1
2.30	23.0	75	28.0	〃	〃	〃	23.1
2.30	23.0	100	36.0	〃	〃	〃	23.1
2.60	24.0	125	44.0	〃	〃	〃	22.7
2.60	20.0	150	51.0	〃	〃	〃	22.7
2.50	19.0	175	60.0	〃	〃	〃	22.8
2.60	19.0	200	69.0	〃	〃	〃	22.7
2.60	18.0	225	76.0	〃	〃	〃	22.7
2.70	16.9	250	83.0	〃	〃	〃	22.5
2.70	19.0	275	89.0	〃	〃	〃	22.5
2.60	18.0	300	96.5	〃	〃	〃	22.7
2.70	17.0	325	104.0	〃	〃	〃	22.5
2.60	17.0	350	110.0	〃	〃	〃	22.7
3.00	28.0	5	0.0	52	276	1.17	28.0
2.90	20.0	50	18.5	〃	〃	〃	22.3
2.80	20.0	75	30.0	〃	〃	〃	22.4
2.80	19.0	100	36.5	〃	〃	〃	22.4
3.00	18.0	125	44.0	〃	〃	〃	22.2
3.00	18.0	150	50.0	〃	〃	〃	22.2
2.90	18.0	175	58.0	〃	〃	〃	22.3
2.90	16.0	200	66.0	〃	〃	〃	22.3
2.90	18.0	225	72.0	〃	〃	〃	22.3
2.90	16.0	250	80.0	〃	〃	〃	22.3
2.80	17.0	275	89.0	〃	〃	〃	22.4
3.00	17.0	300	94.0	〃	〃	〃	22.2
2.90	15.0	325	100.0	〃	〃	〃	22.3
3.00	16.0	350	106.0	〃	〃	〃	22.2

Table 1. Results obtained in the course of experiment.

The values of θ_n, (angle between wire and horizontal plane at the connecting point of gear) that correspond to respective experimental values were obtained by means of Fig. 3 and are shown in the last column of the table. In addition, towing direction, **D**, direction of the sea current, D_c, and velocity of the current, V_c, measured by GEK in the course of the experiment are shown for information. However, the velocity of current is the velocity in relation to the land, and therefore, it is different from the values of ship's speed.

The relation between ship's speed and θ_n was obtained in the same way as before [1], and is illustrated in Fig. 3.

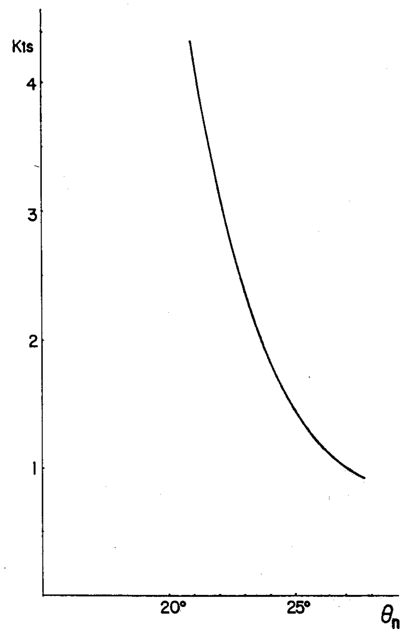

Fig. 3. Relation between ship's speed and θ_n.

To compare both observed values and calculated ones, calculations were made from the chart to provide full particulars in the range of observed values, say, in the range of 21～28° of θ_n and 10～35° of θ_s, and is illustrated in Fig. 4.

The comparison of the calculated value with the observed is shown in Fig. 5.

As seen in the figure, any calculated value agrees to its equivalent observed one within thc range of allowable error, but when the towing speed is relatively slow, that is, ship's speed is within the range of 1.1～1.4 knots, the observed value is much la rger than the calculated one. The disagreement is considered to be due to the fact

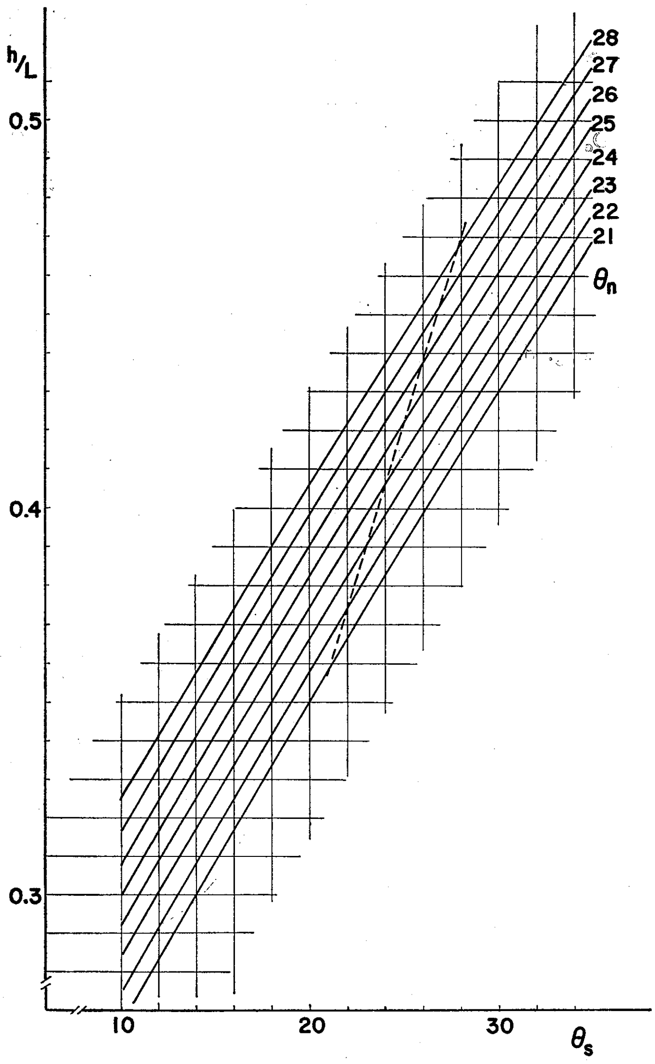

Fig. 4. Relation of h/L with different values of θ_n and θ_s.

that the towing warp used in this experiment is much finer in its diameter than the one used in the former experiments [1,2], and therefore, the towing warp in operation does not form a part of a circular arc which is the fundamental basis of the chart prepared for simple estimation of the working depth. Therefore, when a fine towing warp is used like in this experiment, some modification must be made for the range of low towing speed. For example, if the fine towing warp is supposed to make a form of straight line when towing speed is relatively slow, say, in the range of 1.1 ~1.8 knots; both values better agree to each other as shown in Fig, 6.

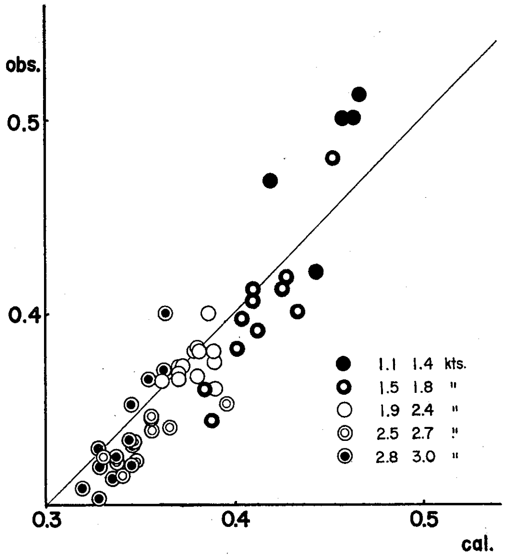

Fig. 5. Relation between calculated value and observed one.

But when the towing speed becomes larger, the shape of the warp aparts from the straight line and is supposed to make the shape of a part of a circular arc.

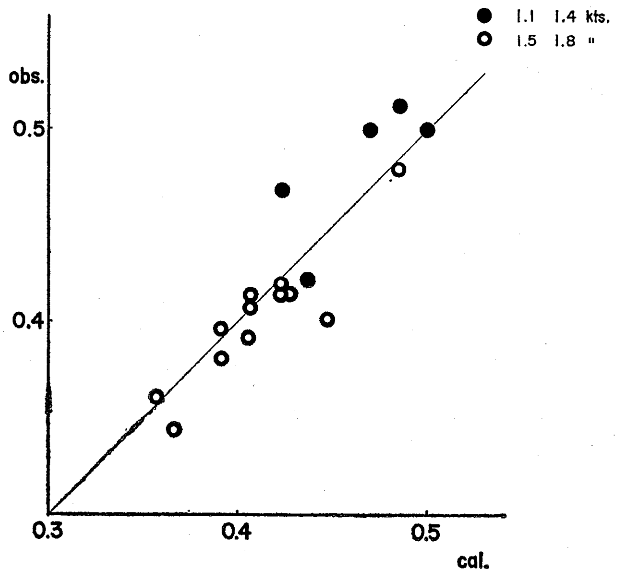

Fig. 6. Relation between calculated value and observed one when warp is presumably a straight line in the towing range of 1.1-1.8 knots.

On the other hand, an ordinary trawl was used in the former experiment [2] and the same result was obtained, that is, the calculated value did not agree to the observed one in the range of relatively low speed. But for that disagreement, it could not be considered that the shape of warp was a straight line.

Therefore, it is considered that the weight of the warp had some influence upon the shape formed by the warp. In this connection, L. PODE [4] pointed out that the gravity force cannot be ignored when the speed of the stream is quite low since such a force is not small in comparison with the hydrodynamic force, and even at a higher speed

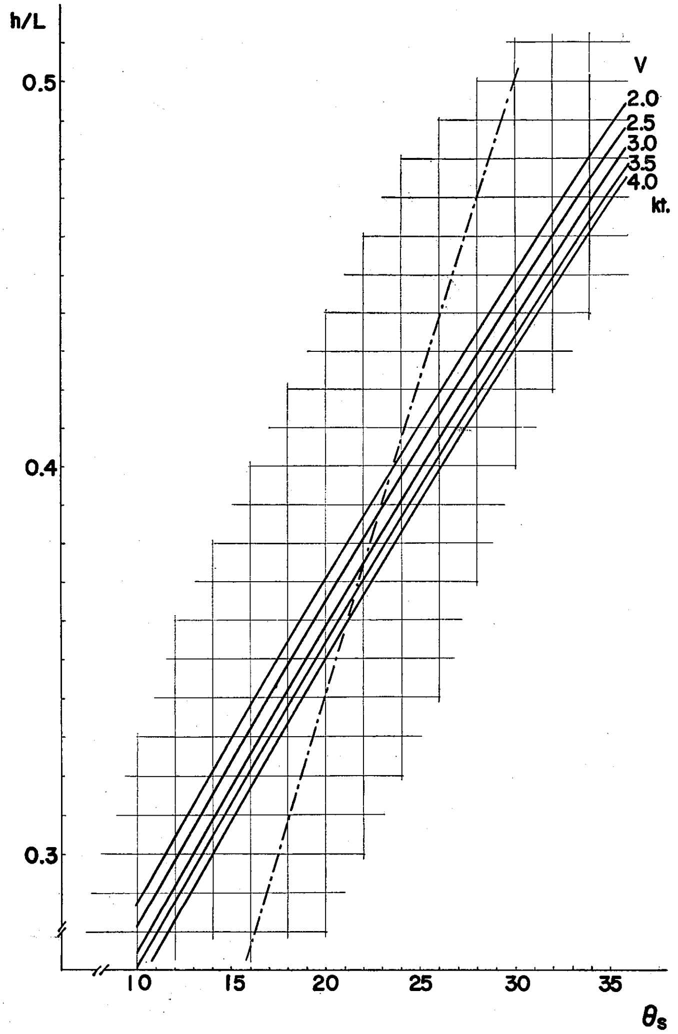

Fig. 7. Relation of h/L with different values of towing speed in knot and θ_s .

the weight of the cable may have an important influence upon the shape formed by the cable.

The influence of the sea current pointed out in the former paper [1], is still uncertain, but it is ambiguously considered that the result is better when the gear is towed in the direction of the current than across the current. Therefore, it is considered that the current has an influence upon the experiment.

After all, the towing depth of the Isaacs-Kidd mid-water trawl net towed by a fine towing warp can be estimated on board by the chart in the towing speed range above 2 knots and by the straight line in the towing speed range below 2 knots.

For the sake of more convenience, Fig. 7 is drawn by Figs. 3 and 4.
The dot-dash line in this chart shows the shape of warp in operation in the towing speed range below 2 knots that is considered to be a straight line. From this chart, the towing depth of the Isaacs-Kidd mid-water trawl net towed by a fine towing warp can be obtained by measuring the ship's speed in knot and the angle between the warp and the horizontal plane at the sea surface.

It must be noted, however, this chart is only available for the Isaacs-Kidd mid-water trawl net towed by Hi-tension wire measuring 6mm in diameter, and when any condition of operation i. e., the gear or towing warp, is changed, the chart must be made according to the method of the original chart. This work can be easily done on board by measuring the relation between the towing speed and θ_n, and by replacing the value of θ_n by the towing speed in the original chart.

Thanks are due to the members of the Nagasaki Maru for their help in the experiment and for their offer of the details of the gear,

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