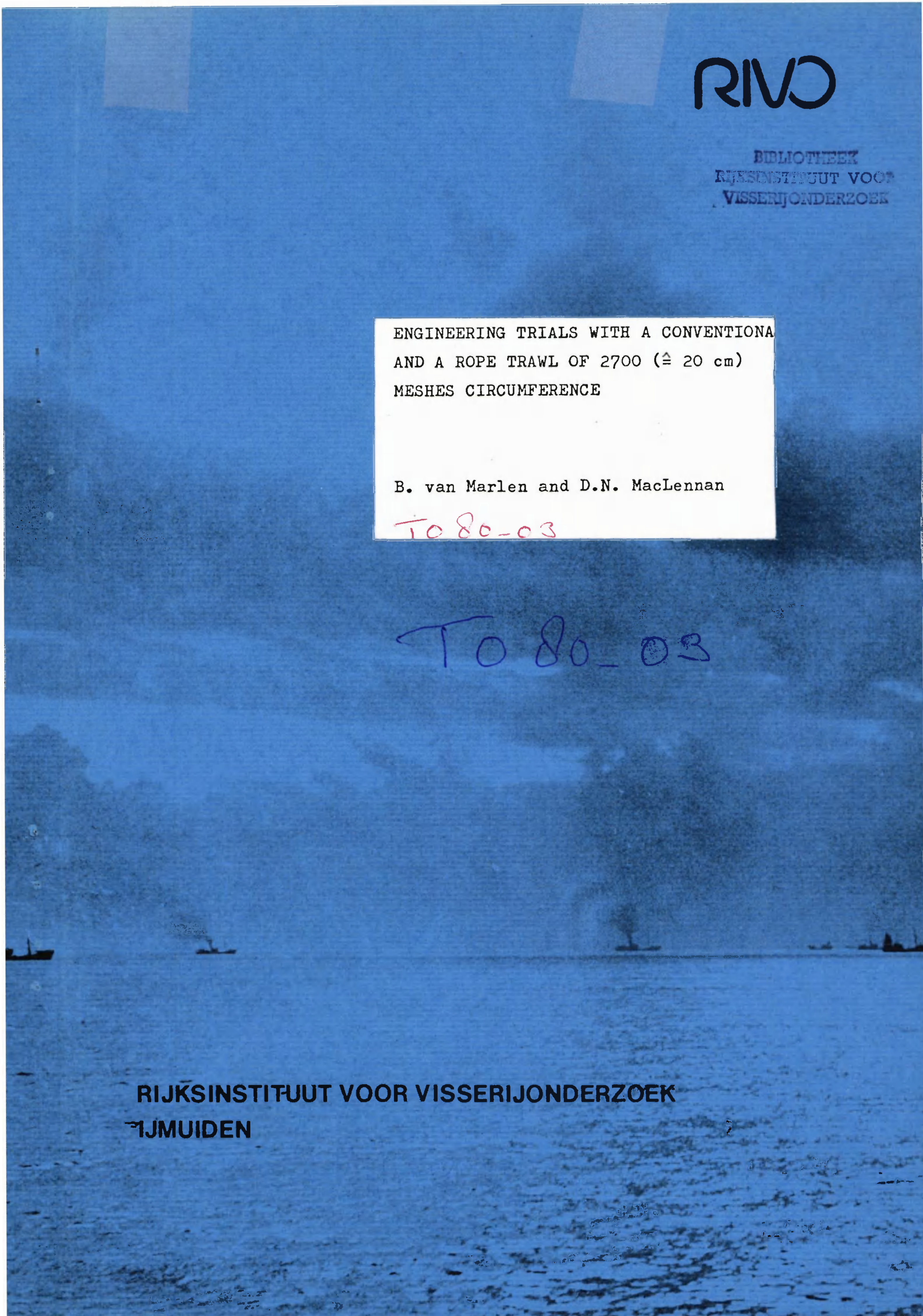

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ENGINEERING TRIALS WITH A CONVENTIONA
AND A ROPE TRAWL OF 2700 (≙ 20 cm)
MESHES CIRCUMFERENCE

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	Page
Contents	1
List of figures	2
SUMMARY	4
1. INTRODUCTION	6
2. EQUIPMENT AND MEASURING TECHNIQUES	6
2.1. Gears tested	6
2.2. Trials technique	7
2.3. Instrumentation	8
2.4. Data analysis	8
3. COMPARISON OF GEARS TESTED	10
3.1. General	10
3.2. Drag forces and towing power	10
3.3. Net Geometry	11
3.4. Door and net depth	12
3.5. General Performance Indicators	13
4. ADDITIONAL EXPERIMENTS AND RESULTS	13
4.1. Door performance	13
4.2. Load distribution in the ropes	14
4.3. Warp length variation	14
5. WARP DRAG EXPERIMENTS	14
6. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS	15
REFERENCES	18
TABLES I - XXII	
FIGURES 1 - 53	

LIST OF FIGURES

LIST OF FIGURES

SUMMARY

During November 1979 engineering experiments were done on 2700 meshes (equal to 20 cm) circumference pelagic trawls, a size commonly used on Dutch stern trawlers today.
The set of trawls tested consisted of a conventional net and a rope trawl designed at the "V.E.B.-Fischkombinat" at Rostock. This trawl and the licence to built it was purchased by a Dutch firm called "Jaczon", partly subsidised by the Dutch Government.
Like in previous years the tests were done on board of the fishery research vessel "Tridens", involving both the Netherlands Institute for Fishery Investigations in IJmuiden and the Marine Laboratory situated in Aberdeen.
Both gears were tested with the same rigging i.e. the same set of Süberkrüb doors (7 m^2) and the same bridles (71 fms (=129,93 m) for the upper one and 70 fms (= 128.10 m) for the lower one) and bridle weights varying from 720 kg (7063 N) to 1100 kg (10791 N). The rope trawl was also tested with floats on the headline (230 "Nokalon" floats of 2 ltr. volume each).
For most hauls the warplength was kept constant at 600 m, apart from three hauls where a warplength variation up-to 900 m was included.
The warps were attached to two different points on the doors in order to determine their most efficient angle of attack. Reciprocal courses were sailed to take account of the effect of tide or currents.
Basicly the same set of instruments has been used as during the 1978 trials (see reference (1)). In addition new load cells, recording on a cassette tape were used enabling longer hauls to be made without having to replace them. There was no variation in the length of the bridle extension. The length of the chain weights had not been altered.
Several hauls were done with the mere objective to determine the load distribution among the ropes of the rope trawl. It turned out, that the centre ropes of the top and bottom panels were heavier loaded than the ropes at the sides. For the side panels it was found, that the tension in the ropes near the toppanel was slightly higher than that in the ropes near the bottom panel. The load in the top ropes was also more dependent on the speed.
At a speed of 4.5 knots the ropes in the top and bottom panels accounted for 56% of the total load, those in the side panels took 31% and the selvedge ropes 13%.
The measurements were read from the instrument traces, calibrations were applied and the results stored in the Marine Laboratory gear trials data bank.
The addition of 480 kg of weight per side caused the net drag to increase some 5% for both the conventional and the rope trawls.
The addition of 230 floats to the rope trawl increased its drag by 13%. This trawl and the conventional one had nearly the same drag with 1100 kg bridle weights. The proportion of the shaft horsepower used to tow the gear seemed to be very consistent for all the gears at the same speed (On average 28% at 4 knots and 32% at 5).
As could be expected, adding bridle weight introduced more headline height for both trawls; this improvement was greater at higher speeds. The addition of floats with the rope trawl caused the headline height to increase proportionately more at lower speeds. The side line spread of both nets did not vary much. The cross section areas of the conventional net decreased starting from the wing end going to the codend as would be expected with this type of net.
The rope trawl behaved differently in this respect, having a cross-section area at the beginning of the netting panels greater than the headline centre area, a fact that could be caused by slack netting in the bottom panel. The rope tension tests seem to indicate in this direction.

From these tests it can also be concluded, that the rope trawl was slightly overspread. A smaller set of doors could have been used for this net.
The floatation on the headline of the rope trawl did cause this gear to fish higher relative to the doors.
A measure to compare the performance of different trawls is the net drag per unit area. Compared with the conventional net and with the same weights this quantity was 26% less at 4 knots and 33% less at 5 knots for the rope trawl without floatation. The floats on the latter trawl increased the net drag per unit area by 10% with 1100 kg bridle weights. The performance of trawls can also be judged from the towing speed multiplied by a cross section area and divided by the net drag, i.e. the "swept volume index" and for this parameter it was also found, that the rope trawl was much superior to the pelagic trawl, irrespective of the bridle weight used.
The doors showed a consistent performance with much less asymmetry than that reported in previous years. With the low bridle weights (720 kg) the doors came near the surface at the higher speeds, indicating this weight to be too low for both gears with these Süberkrüb doors of 7 m^2.
The attachment point of the warp to the door seemed to be of small influence on the behaviour of the doors, with the point closest to the door surface slightly in favour, because of the less varying door-spread as seen on the echo-sounder traces.
The heavier weight lead to smaller heel angles for both doors.
A warplength increase from 500 m up to 900 m did not seem to have a great effect on the horizontal dimensions of the gear.
For North Sea conditions the length of the warps paid out will mostly be determined by the depth of the seabed.
In addition to tests done in 1978 with a 26 mm diameter warp, this year trials have been conducted with a thinner warp, namely of 16 mm diameter.
The pressure drag and skin friction coefficients did not depend significantly on the diameter. There exists a speed dependance however, probably caused by the vibration of the warp, excited by vortex shedding and not by differences in the Reynold's Number.
For all warps commonly used in fishery the following empirical formulae could be derived:

$$C_d = 2.078 - 0.2984 * V$$

$$C_f = 0.00625 + 0.02702/V^{2.465}$$ with V being the speed in m/s.

These coefficients have been used in the analysis of the data described in this report. Conclusively one can state, that rope trawls can be favoured from an engineering point of view, but problems may arise with the handling of these nets and the fishing capability.
Comparative fishing tests will be done in March 1980 on "Tridens" to complete this study.

1. INTRODUCTION

The rope trawls tested in the previous years on FRV "Tridens" were rather small in comparison with the pelagic trawls used on Dutch stern trawlers at the present time.
The opportunity arose to test a rope trawl, designed at the "V.E.B. Fischkombinat Rostock" for the Dutch firm Jaczon (Scheveningen).
This design was based on a pelagic trawl of 2700 meshes (20 cm) circumference, a very common used size in the Dutch fleet.
The aim of the research programme of November 1979 was to analyse the behaviour of this rope trawl and to compare it with its fully meshed counterpart.
During the November cruise the main topic was to determine the geometry and the drag characteristics of both gears.
At a later stage (March 1980) this study will be completed with comparative fishing tests.
The need for a reduction in drag and the possibility to fish on the bottom without substantial net damage still stands in a period like this with sharply increasing fuel costs and costs of materials.
One way of achieving these goals is to replace netting-panels by rope-panels.
Like in previous years the cruise of November 1979 was a co-operative work of the Netherlands Institute for Fishery Investigations in IJmuiden and the Marine Laboratory situated in Aberdeen, which institutes supplied staff and instrumentation.

2. EQUIPMENT AND MEASURING TECHNIQUES

2.1. Gears tested

Two different nets were tested during the trip:
- A 2700 meshes circumference conventional pelagic trawl, as used by the Dutch firm Jaczon on their stern trawlers (see figures 1, 2 and 3). This trawl will be denoted as Net C.

- From this net a 2700 meshes rope trawl was designed at the "V.E.B. Fischkombinat Rostock". The purchase of this net by Jaczon and the licence was partly subsidised by the Dutch government. The forward part of the net was constructed at Rostock and amended to the netting part, after which it has been send to Holland.
Special braided material is used for the ropes and the selvedges. These ropes have a diameter of 10 mm and the selvedges are measuring 16 mm in diameter. The details are given in figures 4 and 5.
Interesting points to mention are the narrow bands of smaller mesh size at the attachment of the ropes to the netting panels. The cutting of the so-called "Shark-teeths" has been designed with a catenary sort of shape, which turned out to be the most suitable from experiments in windtunnels at the Rostock Institute. For the upper and the lower panel the design of the selvedge was based on having a discontinuity at the junction of the ropes to the netting. The selvedge of the rope panel is set at a small angle to the selvedge of the netting panel. A design experimentally justified by windtunnel tests.

The design openings for this net are:
- wing-end spread: appr. 50 m
- wing-end hight : appr. 30 m

These are slightly bigger than the openings of the 2700 meshes pelagic conventional trawl, but the aim of the designers was directed to a bigger mouth-area instead of less drag. This is merely a matter of design policy. Another possible objective will be to reduce the net drag while maintaining the same net openings. The 2700 meshes rope trawl will be denoted as Net A in this report and the same net with floatation on the head-line (230 floats of 2 litres each) will be called Net B.

Doors

Symmetrical and therefore interchangeable between port and starboard side, Süberkrüb doors of 7 m^2 (4,05 m x 1,73 m) have been used on the trials. The doors were new and had not been used before. The port door weighs 1140 kg in air (≙11183.4 N) and the starboard one 1150 kg (≙11281.5 N).
These doors are fitted with four different positions to attach the warp to, only two of which have been used during the tests (denoted as (a) and (b) in the report, see figure 6).
(a) being closest to the surface of the door, (b) next to that.
The lower bridle is 70 fms (128.10 m) long and has a diameter of 22 mm. The upper one measures 71 fms (129.93 m) with a diameter of 14 mm. Both bridles were attached to the backside of the door by backstrops with a length of 13 m.
The length of the chainweights at the lower wing-ends was 6.30 m leading to a "bridle extension" of 4.47 m for the rope trawl and 9.82 m for the pelagic trawl, which has a longer lower panel. Details are given in Figure 7.

2.2. Trials technique

The research programme and the variables chosen are given in Table I.
The main parameters varied are:

1) The speed of the vessel (by means of different values of the horse-power delivered to the propeller shaft).
For most hauls five different values were taken to obtain a reasonable accuracy. These h.p.-settings were chosen to get a maximum difference in readings between two adjacent blocks in order to identify these blocks from the instrument traces.

2) The magnitude of the weights at the lower wing-ends was also varied, The lowest value to be used was 720 kg (7063.2N) and the highest under consideration 1100 kg (10791.0N).

3) The warplength was kept constant during almost the entire research programme, at 600 m length.
For some hauls a warplength variation has been added towards the last couple of blocks and three hauls with a warplength variation (500 m up to 900 m) were made.

4) The attachment point of the warp to the doors was varied in a few occasions (see figure 6).

5) The course of the vessel has been changed quite often. In fact most hauls did have a reciprocal one added to determine the effect of tide or current.

6) Due to the fact, that new load cells, being self-recording on cassette tape, have been used, the duration of the hauls could be extended more than in previous experiments.
In many cases only the load cells at the backstrops were changed after a couple of hauls, allowing the gear to be down longer and consequently avoiding the risk of any damage to the netsonde cables, which mostly occurs during the hauling and shooting process.
The gear had to be heaved up to the doors only when the ship had to turn 180° or when the door load cells had to be replaced.

7) The bridle extension was kept constant during the entire test programme. Table I is misleading in this respect, the different extension for Net C arises from the fact that this net was constructed with larger wings at the lower panel (see figures 1,2 and 3).

2.3. Instrumentation

Basicly the same set of instruments has been used during these experiments as compared with the 1978 trials.
(See reference(I)).
As regards the load cells, instead of the paper tape recording type, new load cells with the possibility to record on a cassette tape have been used. These instruments showed a better reliability and accuracy and in addition to that they allowed longer hauls to be made (from 3 1/2 hrs to 12 hrs).
As a result of this the gear need not to be heaved in to the wing-ends after each haul to interchange the load cells.
On several occasions (hauls T79/17-23) an angle of attack meter was attached to both the starboard and the port door.
During hauls T79/12, 13, 14 and 15 the tensions in different ropes of the rope trawl were measured using self recording paper tape load cells. The positions of these load cells are given in figure 8. On haul 16 the tensions in the four selv-edges were measured.

2.4. Data analysis

The procedures used were essentially similar to those applied in the analysis of the 1978 rope trawl experiments (reference (1)). However, improved instrumentation has provided more precise data from the 1979 tests. In particular, the new underwater load cells which record onto magnetic tape are for more accurate than the older chart recording types. Thus it has become possible to measure quite small differences between gears such as the change in net drag with bridle weight.

As before, the measurements were read from the instrument traces, calibrations were applied and the results stored in the Marine Laboratory gear trials data bank. A suite of programs (IPTAR 9) was then run to calculate parameters such as net drag that are not measured directly and to produce a tabulated output for each haul. Graphs were prepared and regressions of various parameters upon speed were computed as a means of describing the average behaviour for each gear configuration. The mass of data obtained has been summarised in graphs and tables of parameter values at 4 and 5 knots, calculated from the regression analysis.

When sufficient data are available, a separate calculation is done for each side of the gear. However, in the event of a wire tension or depth being available only on one side, through instrument failure, the IPTAR 9 programs assume symmetry to allow the computation to proceed. Often this is a reasonable assumption, but sometimes it is evident from examination of the results that the gear is not symmetrical. For example it may happen that the wire tensions on one side are systematically higher than the corresponding readings on the other side. Then if one wire tension should be missing, the assumed values are the corresponding readings from the opposite side multiplied by a factor which takes account of the difference between other matched pairs of tensions.

The gear and door drags were based on the underwater load cell recordings unless the latter were too few for the purpose in which case the warp loads were computed using the ship board tension meters. This procedure was adopted because of doubts about the accuracy of the latter. The tensions recorded on the ship were often less than those measured in front of the door, in spite of frequent calibration. This problem could have been caused by friction in the pulleys along the warp run, or by a minor change in the position of the transducer in its mounting due to vibrations of the ship hull. In previous cases moisture in the transducer turned out to change its behaviour.

The warp shape was calculated from tension, speed and depth readings, using hydrodynamic force coefficients predicted by the formulae described in Section 5. The water density which also appears in the calculation was taken to be 1028 kg/cu.m. This is slightly less than the densities typical of northern waters, but the sea temperature off Madeira was relatively high, around 17°C at the average gear depth.

The door instrument set measured up to 3 angles describing the orientation of the door. However, the instrument does not measure the "true" heel and attack angles as defined below. It measures other angles which are subsequently used to calculate the true parameter values.

The true heel is the angle between the plane of the door and the vertical. It is a function of two of the measured angles. The true attack is the angle between the plane of the door and the direction of motion. It is a function of all three measured angles. The pitch, defined as the angle between the leading edge and a pendulum moving in the plane of the door, is measured directly.

There is an inherent difficulty here in that should any of the angle meters fail, the other data will be less useful because precise calculation of the true angles is no longer possible. Therefore attack values have not been quoted, unless all three of the meters worked. In the case of heel however the calculation depends on the cosine of pitch, a slowly varying function within the range of typical pitch angles. It was reasonable to compute the heel using an assumed pitch of 12.5 degrees in the absence of a pitch measurement.

In some blocks the "measured" heel exceeded 45 degrees, the full scale reading. Corrections were not applied to such results, and they are simply entered in the tables at the full scale value.

3 COMPARISON OF GEARS TESTED

3.1 General

The complete results for each haul and block are presented in Tables XIX - XXII including those for hauls when the warp length was varied. However, most of the work was done using the same warp length (600 m) to facilitate the comparison of the gears.
The following paragraphs will refer mainly to figures 9-53 and Tables XIX-XXII, which describe the main performance parameters for each net, for different bridle weights and so forth. These figures and tables contain data for the 600 m warp length blocks only. The behaviour of the gears at different warp lengths is discussed later (Section 4.3).
For each of the parameters discussed below, the relevant graphs show results for individual blocks plotted against speed together with regression lines for each gear configuration. The values from the regression equations at 4 and 5 knots representing the best estimates for the gear behaviour at those speeds will be found in the corresponding table. A linear regression calculation has been used throughout. It is likely that some parameters will have a non-linear variation with speed, but the scatter is too great for useful comments to be made about this except in the case of net and gear drags.

3.2 Drag forces and towing power

Figures 9-13 and Table XX show the gear and net drag together for each net and bridle weight combination. The difference between the two is around 1 tonne per side, arising mainly from door drag plus a smaller contribution from the warps. Since the door orientation was not the same for all gears (see below), differences in door drag would also be expected, but the door drag results (which depend on the difference between two nearly equal tensions) are too scattered to demonstrate this effect.
A single regression for the door drag was therefore calculated, combining data for all the gears, leading to the estimate quoted in Table 4.
The net drag was found to increase with the bridle weight for both the pelagic and rope trawls, however the drag penalty from adding 480 kg of weight per side was only some 5%. On the other hand, the addition of 230 floats to the rope trawl increased the drag by 13%. The rope trawl with the floats attached and the pelagic trawl using 1100 kg weights had nearly the same drag.
These drag differences must, apart for the drag of the floats themselves, arise from changes in the netting geometry, particularly the inclination angle of the netting to the flow.
Larger weights and added flotation both increase the headline height and, therefore, the average inclination angle of the netting.
The twine area of the conventional pelagic trawl was 306 sq.m. excluding the cod-end, while that in the rope trawl was 215 sq.m. and the cross section area of the ropes was 12 sq.m.
Thus the cross section area of material in the pelagic net was half as much again as that of the rope trawl, a proportion much greater than the drag difference.

Again, this result points to the netting geometry of the two types of trawl being markedly dissimilar.
Theory predicts that the net and gear drags should be proportional to speed raised to the power "n", where "n" is between 1 and 2. Although the results in the Tables were obtained by linear regression, and there is no evidence of curvature in the graphs over the range of speeds used, an estimate of "n" can be obtained by including a point at zero speed when of course the drags will also be zero. The value of "n" corresponding to the various gear and weight combinations was as follows:

Net	A		B	C	
Weights	720	1100	1100	720	1100
n (net drag)	1.60	1.42	1.42	1.05	1.54
n (gear drag)	1.42	1.34	1.39	0.95	1.54

These indices are all in good agreement with previous results for other gears, except for the pelagic trawl with 720 kg weights where "n" is rather low.
The small weights proved to be insufficient to hold this gear down at the highest speeds and on one or two occasions a door was actually on the surface. It is quite likely that peculiar behaviour resulting from the gear being too close to the surface has distorted the results in this particular case.
The shaft HP measured on the ship and the power applied in towing the gear are shown in figures 14-16. The proportion of the shaft HP usefully applied as gear towing power is remarkably consistent (to within 1%) for all the gears at the same speed. This proportion is on average 28% at 4 knots and 32% at 5 knots.

3.3 Net Geometry

Results for all the geometric parameters have been summarised in Table XIX. The effect of added bridle weight introducing more headline height has been clearly demonstrated (figures 17-19). For the rope trawl, the improvement in height with the heavier weights was 10% at 4 knots and 30% at 5 knots.
The height always decreased with speed, so it could be said that the potential for improvement was greater at the higher speed. On the other hand, the addition of 230 floats to the rope trawl increased the headline height proportionately more at the lowest speeds, by 20% at 4 knots against 12% at 5 knots, using 1100 kg weights.
The side line spreads (figure 20-22)did not vary much.
The difference between gears was not significant except that the spread of the pelagic trawl with 720 kg weights was low, again due to the doors being on or near the surface at high speeds.
The height and spread at the wing ends, the headline centre and the net section (aft end of the first net panel) are shown in Table XIX together with the corresponding cross section areas. The areas for each block are simply the product of the relevant spread and height measurements, and the areas plotted in figures 23-27 are these products. However, the areas quoted in Table XIX are not identical to the relevant spread and height product. The small discrepancy is merely a consequence of the regression analysis in working out "best estimates" for each parameter.

The cross section areas of the pelagic trawl (C) are much as would be expected with this type of net. The height, spread and area all decrease from the wing end backwards. This shape corresponds with observations of pelagic trawls in flume tanks and on underwater television recordings. But the results for the rope trawls are quite different and they exhibit some pecular features. Again, the area at the wing ends is always greater than at the headline centre, as would be expected, and the change in spread is proportionately more than the change in height.
On the other hand, the net section area of the rope trawls is often greater than the headline centre area. This strange result has arisen from the section height being more than the headline height, while the spreads behave in a more normal manner.
It should be born in mind, that the section areas of the rope trawl and the pelagic trawl were not measured in corresponding places, for the rope trawl at the end of the rope section (10 m behind the headline centre) and for the pelagic trawl further back (63 m behind the headline centre).
It is inconceivable that the netting should rise behind the headline, but uneven stress distribution could result in slack netting in the bottom panel which would tend to fall below the footrope. It is a reasonable inference from the results that there was some such distortion in the net, but little more can be said in the absence of direction visual observation.
The wing end spread assumed in the design calculation of the rope lengths was 50.0 m and the wing end height was taken as being 30.0 m, whereas the measured spreads were about 10% more than this. The measured heights were on average about the same for 1100 kg and a few metres smaller for 720 kg. Also it was found that the rope tensions in the top and bottom panels were not uniform, being higher in the centre ropes (see section 4.3.).
It is fairly clear from all this that the rope trawl was overspread and a smaller set of doors might have produced a geometry better fitted to the design requirements. On the other hand, it seems unlikely that as little as 10% extra spread could cause severe distortion in the net. An alternative explanation may lie in the design in the side panel ropes which seems to have been based on a rather low hanging ratio: 0,33.
Longer connecting ropes in the side lines might allow the net to open better.

3.4 Door and net depth

The headline depth is shown in figures 28-30 and Table XIX.
The addition of 420 kg at the lower wing ends caused gear A to fish some 50 m deeper at 4.5 knots and gear C approximately 40 m deeper. There is no comparison for gear B since only the 1100 kg case has been tested.
At speeds below 4.5 knots the rope trawl will be slightly deeper than the fully meshed trawl. This difference diminishes as the trawling speed is increased and above 4.5 knots it is neglectable.
The door depths have not been plotted separately but they have been used to calculate the mean door height above the headline as shown in figures 31-33. The difference in depth between the two doors was generally much less than the door to headline height.
The doors were much closer to the headline depth in the case of the rope trawl with flotation compared with trawls A and C, showing that the flotation was having the desired effect of raising the headline relative to the rest of the gear.

3.5 General Performance Indicators

Two quantities have been computed as a means of comparing the mechanical performance. The "net drag per unit area" is simply the drag divided by a particular cross section area of the net and The "swept volume index" is the towing speed multiplied by a cross section area and divided by the net drag, that is to say the volume swept per unit time per unit net drag. When based on the same cross section area, these quantities are not independent measures of performance. A higher swept volume index corresponds to a lower net drag area, both indicating better mechanical performance.

The cross section chosen for these calculations should in principal represent the area that is effective in catching fish.

It may be argued that the most appropriate cross section would be intermediate between the wing end and headline centre areas, since all fish passing through the latter but only a proportion of those passing through the wing end area would come close to ropes or netting. But in the absence of quantitative information about how well fish are herded by ropes, it is not possible to define an effective fishing area in more precise terms.

With this in mind, the net drag per unit area (figures 34-35) has been based on the headline centre cross section, and the swept volume index (figures 36-37) on the wing end area. Separate graphs have been prepared for each bridle weight and the results are summarised in Table XX.

The performance of the rope trawl was much superior to that of the pelagic trawl irrespective of the bridle weight used.

For the same trawl, added bridle weight improved the performance.

The flotation added to the rope trawl with 1100 kg weights made little difference to the swept volume index, but it increased the net drag per unit area by 10%. Thus the best performance was shown by the rope trawl (A) with 1100 kg weights and no flotation. Compared with the pelagic trawl (C) and the same weights, the net drag per unit area of trawl (A) was 26% less at 4 knots and 33% less at 5 knots.

4 ADDITIONAL EXPERIMENTS AND RESULTS

4.1 Door performance

The door spreads have been plotted in figures 44-45 and the heel, tilt and attack angles in figures 38-43. Differences were often observed between the two doors particularly in the heel angle, but the asymmetry was rather less than that reported in previous tests (Reference (1)) when smaller doors were used.

The door spread of both the pelagic and the rope trawls with 720 kg weights (figures 44-45) was reduced at high speeds. This anomalous behaviour was caused by the doors being too near the surface as discussed in Section 3.1.

Changing the warp attachment point appeared to produce little difference in the door performance. The marginal change in attack angle (Table XXI) is in the expected direction, attachment point (a) being the one closest to the door, but the difference is not statistically significant.

Süberkrüb doors work most efficiently at the smallest attack angle which avoids instability in shooting. Since no shooting problems were experienced, it was concluded that the warp attachment point nearest to the door was the best choice for the particular gears examined in these tests.

From the echo-sounder traces it was found that in the case of attaching the warps to point (a), the spread was varying less. The heavier bridle weights had the effect of making the doors operate in a more upright position with lower tilt and attack angles. Again, this result indicates that the 1100 kg per side was the more suitable weight for both trawls.

4.2 Load distribution in the ropes

The tension in individual ropes of the top and bottom panels is shown in figure 46. The number of available load cells was insufficient to measure the tension in every rope, but a consistent pattern emerged showing that the load was not uniform.
The load in central ropes was about 50% more than that in ropes near the panel edges. The same pattern is evident at all towing speeds.
The possibility that the gear was overspread has already been discussed (Section 3.3.). It is reasonable to suppose that increasing the spread would pull the central ropes forward relative to the side ropes, so increasing the central rope tensions, and this is perhaps the only mechanism by which the results can be explained. Nevertheless, it is rather surprising that a modest spread increase should apparently cause a substantial non-uniformity in the rope tensions. The tensions in the side panel ropes were reasonably uniform (figure 47).
An interesting feature illustrated by the graphs is that tensions in the lowest ropes vary hardly at all with speed, in contrast to those in ropes near the top of each side panel.
Tensions in the selvedge ropes were also measured (figure 48). They were found to be about twice the load in the adjacent top/bottom panel ropes.
The distribution of load around the net was calculated on the assumption that missing rope tensions would be similar to those of adjacent ropes in which measurements were made. At a towing speed of 4.5 knots, the ropes in the top and bottom panels account for 56% of the total load, those in the side panels 31% and the selvedge ropes 13%.

4.3 Warp length variation

The influence of a warp length variation on the dimensions of the gear has been studied on hauls T79/5, 19 and 21 (figures 49,50,51).
The range of warplenghts used varied from 500 m to 900 m.
For all of these hauls the door spread did not reach its maximum value at the highest warplength (900 m) and the same applies to the wing-end spread and the sideline spread. The section spread reaches its peek at approximately 850 m for both the rope and the pelagic trawls. The increase in spread is too small however to justify the use of these long warplengths with the consequence of a time loss during shooting and hauling. In many practical fishing applications the depth of the sea puts a restriction on the length of warp paid out.

5. WARP DRAG EXPERIMENTS

An experiment was carried out to determine the hydrodynamic forces acting on a 16 mm nominal diameter trawl warp. This was done by streaming a warp 875 m in length at various speeds while the tension in the warp and the declination angle were measured at the top end. The objective was to obtain a comparison with the earlier 26 mm warp results described in reference (2).

The previous work had shown that both the pressure drag and skin friction coefficients decrease with speed. If this variation was due to the change in the Reynolds number (which is proportional to the product of speed and diameter), then the coefficient values at a given speed should be larger for the smaller diameter warp. However, the recent experiment showed that there is no significant difference in either coefficient between the 16 and 26 mm warp sizes. At all speeds in the range 1-3 m/s, the respective coefficients of the two warps differed by less than the experimental error. It is concluded therefore that the speed dependence is not determined by te Reynolds number. Probably it is caused by the vibration of the warp which is excited by vortex shedding.
The actual diameter of the thinner warp, the mean of several caliper measurements was 15.4 mm and the weight in water was 6.79 N/m.
A full description of the results for this warp will be found in reference (3).
Since the force coefficients do not depend significantly on the diameter, empirical formulae have been fitted to the combined data for the two warps:

$$\boxed{C_d = 2.078 - 0.2984\ V}$$

$$\boxed{C_f = 0.00625 + 0.02702/V^{2.465}}$$

where V is the towing speed in m/s. In the absence of better information, these formulae may be taken to apply to all warps commonly used in commercial fishing. They have been used in the analysis of gear performance data described in this report.

6. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

6.1.

A cooperative research programme like this, involving several institutes (The Netherlands Institute for Fishery Investigations and The Marine Laboratory) proves to be benificial for both. The quality and quantity of measurements done is increasing from year to year, leading to a better reliability and less scatter in the graphs of the report of the 1979 experiments. The cooperation also reduces costs of buying or developing instrumentation for each institute involved. As a by-product some very interesting experiments like the warp-shape experiments could be done merely due to the fact that the trials took place in a very suitable physical environment having both a great depth and a calm seastate.
It would be wise to continue and extent such cooperative programmes in the near future leaving room for each party involved to fill in their own needs.

6.2.

For both gears 720 kg bridle weights seemed to be too little. The doors will get at the surface at higher speeds (around 5 knots). The vertical opening of the nets can be improved considerably by adding more weight (1100 kg), although this will cause the gears to fish deeper. In order to overcome this, floats can be mounted on the headline with the penalty of having more drag.

6.3.

The 7 m^2 Süberkrüb doors on these gears showed a better performance than found in previous years with the smaller types (4.7 m^2).

The best attachment point of the warp turned out to be the one closest to the door surface giving a very smooth hydrodynamical performance. At bigger angles of attack the doors will probably show flow separation at the leading edge resulting in an instable run through the water. With 1100 kg the heel angles of the doors are smaller reducing the tendency of the door to reach the surface at high speeds.

6.4.

The warplength had a minor influence on the geometry of the net mouth. The length needed will depend mostly on the depth of the seabed in practical applications.
The highest values of door spread/w.e-spread/side line spread will be found at warplengths above 900 m ($\hat{=}$ 492 fms), but it does not seem worthwhile to use these length because of the time loss during shooting and hauling.

6.5.

From the rope tension tests it was found, that the ropes were not equally loaded. The centre ropes of the top and bottom panels were heavier loaded, indicating the gear to be overspread. For the side panels it was found, that the ropes in the top parts were heavier loaded. These loads were more dependent on speed than those of the lower ropes.
At 4.5 knots the total load was distributed as follows:

- top and bottom panel 56%
- side panels 31%
- selvedges 13%

6.6.

From an engineering point of view the rope trawls seemed to have a superior performance. This is hopeful keeping in mind the main objectives of this research programme i.e. to develop a trawl gear with less drag than that of the conventional types and with the possibility to fish close to or on the seabed without suffering net damage. The first mentioned criterion is related to the fuel consumption of the fishing vessel. This will have an important bearing on the economy of fishing operations.

The second criterion applies to costs of material and repair also related to the overall economy of fishing.
Both costs aspects need to be cut down in order to survive as a fishing industry.
On the other hand one needs to catch fish to earn money and the fishing efficiency of the gear should be comparable to commonly used types. Only by comparative fishing tests an insight into a gear's fishing capability can be found. That is why such tests are planned with these rope trawls during March 1980 on FRV "Tridens".
A delicate balancing of the costs-saving aspects and the fishing efficiency (including size and species selectivity) of these new gears is needed to determine whether this development will be feasible.

6.7.

In addition to the warp shape tests done in 1978 with a 26 mm warp, experiments were done with a 16 mm warp this year.
A suitable set of formulae could be derived for the prediction of skin friction and pressure drag coefficients for trawl warps commonly used in fishery, namely:

$$C_d = 2.078 - 0.2984 * V \qquad \text{with V in m/s}$$

$$C_f = 0.00625 + 0.02702/V^{2.465}$$

6.8.

Fishing tests with smaller (1736 meshes) rope trawls in 1979 casted doubt on the herding effect of ropes at least when fishing close to the bottom.
Direct observations from divers on rope trawls lead to the conclusion that the foreward movement of almost parallel ropes can hardly be spotted.
Small fishes did not seem to react to the ropes at all.
It could be worthwhile to develop a gear with the advantages of the rope trawls such as drag reduction and less damage when having bottom contact and some means to have a better herding effect of the rope panel like arranging the ropes in a lattice with transverse connections.

IJmuiden, 23 April 1980

B. van Marlen

and

D.N. MacLennan

/ML

REFERENCES

(1) van Marlen, B & MacLennan, D.N. 1979
Rope trawl developments - further experiments.
Report No. 79-03, R.I.V.O., IJmuiden

(2) MacLennan, D.N. 1979
Hydrodynamic Characteristics of trawl warps.
Scot.Fish.Res.Rep. no 16, 1979

(3) MacLennan, D.N. 1980
Further hydrodynamic force measurements on trawl warps.
Marine Laboratory Working Paper 80/5, March 1980

PLANNING OF EXPERIMENTS

haul	net	weights	ext.	warplength	h.p.-range	doors	course
01	A	720	4.47	350	0950-1600	II/b	155°
02	A	720	4.47	600	0905-1570	II/b	205°
03	A	720	4.47	600	0870-1550	II/b	25°
04	A	1100	4.47	600	0875-1780	II/b	205°
05	A	1100	4.47	600-900	0900-1700	II/b	25°
06	A	1100	4.47	600	0937-1832	II/a	205°
07	A	1100	4.47	600	1000-1790	II/a	25°
08	B	1100	4.47	600	0965-1760	II/a	240°
09	B	1100	4.47	600	0970-1650	II/a	60°
10	B	1100	4.47	600	1000-1700	II/b	260°
11	B	1100	4.47	600	0973-1740	II/b	40°
12	A	1100	4.47	600	1276-1810	II/a	255°
13	A	1100	4.47	600	1300-1840	II/a	255°
14	A	1100	4.47	600	1300-1838	II/a	255°
15	A	1100	4.47	600	1385-1843	II/a	250°
16	A	1100	4.47	600	1344-1825	II/a	250°
	Warp shape exp.						
17	C	720	9.82	600	0960-1700	II/a	260°
18	C	720	9.82	600	0910-1560	II/a	80°
19	C	720	9.82	500-900	1260	II/a	250°
20	C	1100	9.82	600	1135-1770	II/a	265°
21	C	1100	9.82	600-900	1197-1830	II/a	70°
22	C	1100	9.82	600	1190-1825	II/a	250°
23	C	720	9.82	600	0970-1625	II/a	70°

TABLE I

TABLE II

HAUL NUMBER 3 T79.2 RUN ON 29-FEB-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
2	600	720	4.02	143.5	64.0	50.0	54.5	114.0	114.1	121.9	27.3	28.2	30.0		28.8		18.0	35.4
3	600	720	3.68	142.0	64.0	48.0	48.0	183.0	189.0	202.9	31.2	35.2	35.3		18.6		12.5	34.4
4	600	720	4.45	145.0	64.0	50.5	50.6	70.0	77.7	91.9	25.3	25.5	27.3		30.9		17.0	33.4
5	600	720	4.85	140.0	64.0	51.8	49.8	26.0	19.0	39.9	23.5	21.7	23.8		41.3		22.0	33.3

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
2	600	720	4.02	6.04	6.19	12.22	11.79	0.75	0.65	10.05	1.40	1.46	0.69	0.73	1.27	1.36
3	600	720	3.68	5.11	5.19	10.31	9.62	0.64	0.33	8.13	1.15	1.21	0.54	0.59	1.12	1.04
4	600	720	4.45	7.10	6.45	13.55	13.26	1.28	0.34	11.31	1.61	1.62	0.78	0.85	2.21	2.03
5	600	720	4.85	8.17	7.03	15.20	15.05	1.48	0.30	12.95	1.77	1.69	0.86	0.90	2.43	3.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
2	600	720	4.02	122.4	7.0	1747.3	1410.0	5.751	7.126	290.4	1110.0	320.8	1.34	1.38
3	600	720	3.68	204.9	16.0	1996.8	1689.7	4.071	4.811	393.8	905.0	239.6	1.35	1.28
4	600	720	4.45	92.0	17.3	1619.3	1287.8	6.985	8.783	260.8	1310.0	399.2	1.62	1.40
5	600	720	4.85	39.0	16.6	1504.0	1124.0	8.612	11.523	216.7	1570.0	493.9	1.51	1.56

TABLE III

HAUL NUMBER 1 T79.3 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	720	3.92	146.0	64.0	50.0	50.0	128.0	132.4	144.0	28.3	30.8	31.5		21.5		13.0	41.9
2	600	720	3.42	144.0	64.0	48.7	48.2	197.0	202.9	217.0	32.0	34.6	35.8		15.8		10.0	36.1
3	600	720	4.16	143.0	64.2	50.8	54.8	94.0	96.4	112.0	26.0	27.5	28.5		27.7		14.5	34.2
4	600	720	4.69	140.0	63.8	50.0	48.0	38.0	42.9	50.0	23.0	22.0	25.0		31.2		14.0	32.1

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	720	3.92	5.82	6.16	11.98	11.48	0.82	1.03	9.25	1.38	1.43	0.67	0.69	1.44	1.29
2	600	720	3.42	4.77	5.14	9.91	9.16	0.78	0.51	7.33	1.07	1.18	0.49	0.56	1.00	0.87
3	600	720	4.16	6.52	6.63	13.15	12.78	0.98	0.63	10.84	1.50	1.58	0.73	0.81	1.81	1.85
4	600	720	4.69	7.21	7.70	14.91	14.71	0.82	0.64	12.95	1.65	1.80	0.83	0.93	2.19	2.06

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	720	3.92	145.3	12.9	1811.3	1540.1	5.108	6.007	335.9	1110.0	304.7	1.49	1.51
2	600	720	3.42	218.3	16.1	2048.2	1685.1	3.579	4.350	404.7	870.0	212.0	1.51	1.41
3	600	720	4.16	112.8	15.9	1669.3	1397.1	6.494	7.759	276.0	1260.0	359.8	1.56	1.54
4	600	720	4.69	49.5	8.6	1467.5	1100.1	8.821	11.767	285.2	1550.0	467.0	1.38	1.36

TABLE IV

HAUL NUMBER 1 T79.4 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.81	141.0	62.2	49.6	47.6	177.0	182.6	199.0	33.5	35.6	36.4	17.7	16.3	10.0	8.5	28.1
2	600	1100	3.33	136.0	60.4	47.3	46.0	248.0	245.8	269.0	36.2	40.5	40.7	7.5	7.0	6.5	5.5	25.5
3	600	1100	4.32	140.0	62.9	49.8	48.0	138.5	146.4	165.0	30.0	29.0	31.4	26.2	20.2	15.0	10.5	26.3
4	600	1100	4.74	140.0	63.3	50.0	48.6	102.5	108.0	123.0	29.3	27.7	30.5	29.3	25.0	14.0	12.0	24.4
5	600	1100	5.06	144.5	65.3	51.5	51.6	50.0	45.8	67.6	26.0	24.8	27.0	35.7	38.7	17.5	17.0	22.8

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.81	6.04	6.05	12.09	11.35	0.00	1.03	8.92	0.00	1.35	0.65	0.62	0.00	0.97
2	600	1100	3.33	5.26	5.26	10.52	9.47	0.00	0.63	7.50	0.00	1.11	0.51	0.51	0.00	0.76
3	600	1100	4.32	7.06	7.07	14.12	13.52	0.00	0.81	11.08	0.00	1.63	0.75	0.80	0.00	1.33
4	600	1100	4.74	7.65	7.65	15.30	14.86	0.00	0.97	12.16	0.00	1.77	0.83	0.88	0.00	1.63
5	600	1100	5.06	8.01	8.00	16.00	15.77	0.00	1.24	13.79	0.00	1.89	1.06	0.94	0.00	2.75

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.81	200.1	18.3	2084.0	1765.9	4.280	5.051	388.3	1095.0	292.7	0.00	1.43
2	600	1100	3.33	271.2	21.2	2186.7	1915.8	3.431	3.916	437.7	875.0	213.5	0.00	1.42
3	600	1100	4.32	164.5	21.6	1887.2	1444.3	5.871	7.671	289.9	1320.0	395.3	0.00	1.28
4	600	1100	4.74	122.2	16.9	1854.9	1385.1	6.555	8.779	278.0	1533.0	476.7	0.00	1.22
5	600	1100	5.06	67.0	18.9	1698.0	1277.3	8.120	10.794	241.3	1780.0	540.2	0.00	1.48

TABLE V

HAUL NUMBER: T79.5 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.21	130.0	58.5	46.2	44.8	263.0	263.0	287.0	36.3	39.6	43.1	2.0		6.5		
2	600	1100	4.09	144.0	65.5	51.4	49.9	129.0	129.0	151.0	30.2	29.7	31.8	25.3		13.8		
3	600	1100	3.81	146.0	65.7	51.0	50.2	168.0	168.0	188.0	32.1	31.9	33.5	17.7		10.5		
4	600	1100	4.57	144.0	65.8	51.8	51.0	81.0	81.0	99.0	27.1	26.6	28.8	31.1		15.0		
5	600	1100	4.33	145.0	65.5	51.5	50.2	111.0	111.0	126.5	28.4	29.3	30.8	25.4		13.5		
6	700	1100	4.53	149.0	66.2	0.0	51.4	134.0	134.0	153.5	29.1	29.4	31.0	26.7		14.5		
7	800	1100	4.38	152.0	67.1	0.0	52.0	166.0	166.0	184.5	29.2	29.3	30.8	25.8		14.0		
8	900	1100	4.48	152.0	67.1	0.0	51.8	185.0	185.0	204.0	29.4	29.4	31.3	25.3		14.0		

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.21	5.36	5.36	10.73	9.54	0.00	0.68	7.36	0.00	1.06	0.47	0.47	0.00	0.47
2	600	1100	4.09	7.09	7.09	14.17	13.62	0.00	0.99	11.27	0.00	1.63	0.80	0.79	0.00	1.58
3	600	1100	3.81	6.43	6.43	12.85	12.13	0.00	0.85	9.95	0.00	1.50	0.72	0.71	0.00	1.11
4	600	1100	4.57	7.91	7.91	15.83	15.47	0.00	0.90	13.56	0.00	1.86	0.98	0.93	0.00	2.05
5	600	1100	4.33	7.10	7.10	14.20	13.73	0.00	0.72	12.47	0.00	1.70	0.94	0.84	0.00	1.60
6	700	1100	4.53	7.04	7.04	14.08	13.60	0.00	0.70	12.10	0.00	1.62	0.94	0.87	0.00	1.79
7	800	1100	4.38	6.94	6.94	13.88	13.35	0.00	0.61	12.08	0.00	1.55	0.97	0.88	0.00	1.70
8	900	1100	4.48	6.98	6.98	13.95	13.41	0.00	0.43	11.99	0.00	1.51	0.93	0.91	0.00	1.83

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.21	288.7	22.1	2123.8	1829.7	3.468	4.025	410.5	900.0	207.2	0.00	1.38
2	600	1100	4.09	150.7	19.9	1978.3	1526.7	5.697	7.383	285.2	1355.0	377.0	0.00	1.57
3	600	1100	3.81	187.9	18.1	2109.2	1627.0	4.715	6.112	320.9	1182.0	312.7	0.00	1.50
4	600	1100	4.57	98.7	16.2	1783.4	1378.0	7.603	9.840	239.1	1700.0	478.6	0.00	1.48
5	600	1100	4.33	127.0	13.6	1860.4	1509.1	6.704	8.265	269.7	1530.0	402.5	0.00	1.38
6	700	1100	4.53	153.7	17.7	1926.7	0.0	6.282	0.000	0.0	1530.0	417.0	0.00	1.30
7	800	1100	4.38	184.6	16.6	1959.6	0.0	6.163	0.000	0.0	1530.0	395.7	0.00	1.32
8	900	1100	4.48	204.0	17.1	1973.0	0.0	6.077	0.000	0.0	1530.0	406.7	0.00	1.28

TABLE VI

HAUL NUMBER 3 T79.6 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.91	143.5	64.0	51.5	49.8	170.0	170.0	194.0	32.5	31.7	33.6	17.7		11.0		
2	600	1100	3.47	129.8	60.4	47.0	45.2	237.0	237.0	256.0	36.4	37.2	39.1	3.0		7.3		
3	600	1100	4.30	145.0	65.8	52.0	50.6	121.0	121.0	141.0	30.3	28.9	31.4	25.0		12.6		
4	600	1100	4.90	150.0	65.8	54.5	53.2	65.0	65.0	83.5	27.5	27.1	28.8	33.2		14.0		
5	600	1100	4.54	149.0	66.2	52.6	51.6	100.0	100.0	116.0	28.5	29.3	30.3	26.9		13.0		
6	600	1100	5.02	145.0	65.8	53.0	54.0	62.5	62.5	80.5	25.0	24.8	26.8	34.3		13.2		

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.91	6.46	6.46	12.93	12.19	1.21	0.00	9.73	1.44	0.00	0.67	0.72	1.14	0.00
2	600	1100	3.47	5.32	5.32	10.64	9.66	0.95	0.00	8.03	1.02	0.00	0.43	0.55	0.49	0.00
3	600	1100	4.30	7.39	7.39	14.77	14.25	1.40	0.00	11.60	1.68	0.00	0.79	0.86	1.50	0.00
4	600	1100	4.90	8.56	8.56	17.12	16.81	1.58	0.00	13.92	2.07	0.00	1.02	1.10	2.23	0.00
5	600	1100	4.54	8.26	8.26	16.51	16.05	1.50	0.00	12.68	1.96	0.00	0.95	0.94	1.62	0.00
6	600	1100	5.02	9.56	9.56	19.12	18.80	1.53	0.00	15.05	2.24	0.00	1.11	1.04	2.26	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.91	193.6	22.2	2080.3	1632.7	4.676	5.958	337.8	1132.0	322.7	1.53	0.00
2	600	1100	3.47	256.4	17.1	2198.8	1748.5	3.652	4.593	388.9	937.0	226.8	1.30	0.00
3	600	1100	4.30	140.3	17.9	1994.0	1502.9	5.816	7.716	286.9	1360.0	414.6	1.52	0.00
4	600	1100	4.90	83.3	15.6	1809.7	1477.1	7.691	9.423	267.7	1695.0	557.5	1.52	0.00
5	600	1100	4.54	116.4	13.9	1886.9	1541.3	6.720	8.227	284.1	1506.0	493.2	1.52	0.00
6	600	1100	5.02	80.4	15.9	1645.2	1314.5	9.146	11.447	225.8	1832.0	638.7	1.49	0.00

TABLE VII

HAUL NUMBER 1   T79.7   RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.83	139.0	63.1	50.5	48.4	198.0	194.2	217.0	34.4	34.0	35.9	14.8	13.8	10.5	10.5	25.7
2	600	1100	3.61	133.0	60.9	47.8	46.0	233.0	226.3	252.0	36.2	36.4	38.4	7.9	6.9	8.0	8.0	17.3
3	600	1100	4.37	143.0	64.0	51.6	49.6	144.0	144.4	165.0	31.9	29.4	31.8	22.5	18.2	12.5	10.5	22.6
4	600	1100	4.93	145.5	65.8	52.4	51.4	74.0	74.8	92.0	29.5	27.0	29.4	32.2	25.5	14.0	12.0	22.8
5	600	1100	4.57	146.0	65.8	52.0	51.0	114.0	116.5	130.0	30.9	31.2	31.8	25.4	20.2	13.0	10.5	22.6
6	600	1100	4.97	144.5	65.8	52.1	51.4	67.0	70.5	85.5	28.7	27.5	28.5	32.1	26.5	15.0	11.5	23.3

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP FORCE PORT (TON)	SWEEP FORCE STBD (TON)	SPREAD DOOR LIFT FORCE PORT (TON)	SPREAD DOOR LIFT FORCE STBD (TON)
1	600	1100	3.83	6.56	6.55	13.12	12.23	1.52	0.79	9.31	1.36	1.46	0.59	0.69	0.57	1.00
2	600	1100	3.61	5.70	5.69	11.40	10.41	1.09	0.30	8.29	1.13	1.23	0.48	0.59	0.41	0.99
3	600	1100	4.37	7.11	7.19	14.29	13.87	1.58	0.65	10.98	1.57	1.72	0.72	0.86	1.19	1.46
4	600	1100	4.93	8.44	8.42	16.87	16.53	1.70	1.09	13.38	1.94	2.02	0.93	1.02	2.04	2.18
5	600	1100	4.57	7.66	7.48	15.14	14.64	1.50	1.63	11.10	1.76	1.70	0.83	0.79	1.46	1.26
6	600	1100	4.97	8.03	8.54	16.57	16.26	0.94	1.96	13.00	1.93	1.90	0.98	0.89	2.30	1.88

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.83	216.8	20.0	2170.9	1717.1	4.288	5.421	363.7	1105.0	316.9	1.53	1.40
2	600	1100	3.61	252.1	21.5	2204.8	1740.0	3.760	4.764	390.1	1000.0	254.3	1.32	1.31
3	600	1100	4.37	163.7	19.8	2041.8	1517.2	5.377	7.236	310.9	1365.0	404.4	1.40	1.31
4	600	1100	4.93	90.7	16.8	1941.3	1414.9	6.892	9.456	268.4	1707.0	551.6	1.44	1.38
5	600	1100	4.57	130.2	13.6	2033.5	1622.5	5.460	6.843	343.8	1500.0	452.8	1.39	1.35
6	600	1100	4.97	84.0	15.9	1888.7	1432.9	6.885	9.075	281.9	1790.0	546.9	1.35	1.43

TABLE VIII

HAUL NUMBER 1 T79.8 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.74	132.0	60.4	49.5	48.0	153.0	152.3	155.0	36.0	40.0	41.5	21.6	14.8	12.0	9.5	23.6
2	600	1100	3.52	129.0	58.5	46.5	43.8	201.0	207.3	208.0	38.1	45.9	45.9	13.3	8.4	10.0	7.0	16.3
3	600	1100	4.32	138.0	61.3	49.5	48.1	103.0	114.5	117.5	32.8	36.2	36.4	29.1	18.7	15.0	10.0	24.3
4	600	1100	4.90	139.0	62.2	50.6	50.0	64.0	70.7	78.0	29.6	30.5	32.0	36.3	24.6	17.0	10.5	23.0
5	600	1100	4.31	140.5	62.9	50.6	50.0	88.0	95.4	101.0	31.0	33.0	34.0	32.0	20.7	15.5	10.0	24.7
6	600	1100	4.75	135.0	61.1	50.0	48.8	61.5	68.3	74.0	28.7	29.9	31.3	36.4	25.5	12.0	11.5	24.2

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.74	7.57	7.57	15.14	14.42	0.00	0.79	10.83	0.00	1.61	0.59	0.79	0.00	0.82
2	600	1100	3.52	6.26	6.26	12.52	11.59	0.00	0.74	8.99	0.00	1.27	0.53	0.60	0.00	0.35
3	600	1100	4.32	7.91	7.92	15.83	15.35	0.00	0.97	12.49	0.00	1.80	0.83	0.90	0.00	1.21
4	600	1100	4.90	9.17	9.18	18.35	18.03	0.00	1.29	14.58	0.00	2.10	0.99	1.06	0.00	1.86
5	600	1100	4.31	8.50	8.50	17.00	16.58	0.00	1.09	13.32	0.00	1.96	0.89	0.99	0.00	1.50
6	600	1100	4.75	9.33	9.34	18.68	18.37	0.00	1.23	15.19	0.00	2.07	1.00	1.05	0.00	1.81

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.74	157.8	1.5	2174.7	1980.1	4.980	5.469	352.0	1158.0	365.0	0.00	1.50
2	600	1100	3.52	212.7	2.9	2229.1	2134.4	4.032	4.211	430.3	970.0	276.2	0.00	1.30
3	600	1100	4.32	120.0	7.9	2010.9	1792.0	6.213	6.971	319.0	1387.0	448.9	0.00	1.35
4	600	1100	4.90	79.2	9.5	1841.3	1543.4	7.918	9.446	267.0	1705.0	597.9	0.00	1.37
5	600	1100	4.31	102.8	8.2	1950.1	1669.9	6.832	7.979	278.1	1490.0	483.6	0.00	1.54
6	600	1100	4.75	75.4	8.0	1753.8	1495.1	8.660	10.159	240.7	1770.0	590.5	0.00	1.42

TABLE IX

HAUL NUMBER : T79.9 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.85	130.5	58.2	47.4	45.0	172.0	178.8	182.0	37.1	43.2	42.8		9.4		9.5	
2	600	1100	3.50	129.0	57.6	46.0	44.1	201.5	209.8	213.0	39.0	46.9	46.3		5.0		8.0	
3	600	1100	4.15	133.0	60.4	48.2	46.4	143.0	149.3	154.0	34.6	38.5	38.5		11.8		10.0	
4	600	1100	4.31	138.0	61.3	50.5	48.6	96.0	101.0	106.0	31.9	33.1	34.8		15.7		11.0	
5	600	1100	4.29	140.5	61.4	50.5	49.2	99.0	102.9	108.0	31.8	34.4	35.2		18.7		11.0	
6	600	1100	4.70	136.0	61.3	49.6	48.5	82.0	85.5	90.0	30.6	33.9	33.8		23.5		12.0	

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.85	5.53	6.41	11.94	11.24	0.00	0.00	9.94	0.00	0.00	0.61	0.66	0.00	0.00
2	600	1100	3.50	4.91	5.75	10.66	9.85	0.00	0.00	8.90	0.00	0.00	0.54	0.58	0.00	0.00
3	600	1100	4.15	5.99	7.19	13.18	12.59	0.00	0.00	11.54	0.00	0.00	0.70	0.79	0.00	0.00
4	600	1100	4.31	6.56	8.20	14.76	14.35	0.00	0.00	13.32	0.00	0.00	0.84	0.98	0.00	0.00
5	600	1100	4.29	6.69	7.90	14.59	14.17	0.00	0.00	13.47	0.00	0.00	0.91	0.99	0.00	0.00
6	600	1100	4.70	7.51	8.15	15.66	15.31	0.00	0.00	14.94	0.00	0.00	1.02	0.97	0.00	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.85	185.8	5.6	2159.5	2047.8	4.601	4.852	408.5	1150.0	292.8	0.00	0.00
2	600	1100	3.50	217.7	6.4	2246.7	2157.6	3.961	4.125	436.8	970.0	233.3	0.00	0.00
3	600	1100	4.15	156.7	6.9	2090.1	1855.8	5.522	6.219	343.5	1313.0	353.5	0.00	0.00
4	600	1100	4.31	107.4	6.6	1955.7	1671.7	6.811	7.968	278.4	1610.0	418.7	0.00	0.00
5	600	1100	4.29	110.1	6.1	1952.8	1737.3	6.897	7.753	284.9	1468.0	411.5	0.00	0.00
6	600	1100	4.70	92.4	5.3	1876.0	1681.6	7.962	8.883	272.4	1650.0	487.0	0.00	0.00

TABLE X

HAUL NUMBER : T79.10 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.83	133.4	59.4	47.7	45.4	149.0	157.4	162.0	37.0	41.1	41.4		13.8	15.0	10.5	
2	600	1100	3.66	132.5	58.5	46.5	44.6	198.0	206.8	211.5	40.4	45.6	45.2		8.9	11.5	8.5	
3	600	1100	3.87	138.0	60.9	49.6	48.0	127.0	134.8	137.5	35.0	37.5	38.6		16.7	15.5	11.5	
4	600	1100	4.65	143.0	62.4	51.0	50.2	73.3	80.1	87.0	30.8	32.4	33.4		23.5	17.5	13.0	
5	600	1100	4.12	140.0	61.3	49.2	48.4	120.0	128.0	132.0	34.4	37.5	38.2		16.2	15.5	10.5	
6	600	1100	4.92	140.0	62.2	50.0	48.0	90.0	94.9	94.0	29.0	30.6	33.0		23.0	16.0	12.5	

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.83	5.85	5.86	11.71	11.12	0.32	0.00	10.75	1.30	0.00	0.66	0.76	1.41	0.00
2	600	1100	3.66	5.28	5.29	10.57	9.79	0.34	0.00	8.96	1.15	0.00	0.56	0.62	1.04	0.00
3	600	1100	3.87	6.63	6.64	13.27	12.74	0.36	0.00	11.89	1.54	0.00	0.79	0.84	1.45	0.00
4	600	1100	4.65	7.72	7.73	15.45	15.13	0.57	0.00	14.39	1.87	0.00	0.98	1.10	2.14	0.00
5	600	1100	4.12	6.73	6.74	13.47	12.97	0.48	0.00	12.22	1.58	0.00	0.81	0.90	1.58	0.00
6	600	1100	4.92	7.83	7.83	15.66	15.27	0.37	0.00	14.11	1.87	0.00	0.97	0.98	1.40	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.83	164.8	8.0	2198.1	1960.6	4.889	5.481	359.7	1193.0	288.3	1.41	0.00
2	600	1100	3.66	214.9	8.2	2363.7	2120.6	3.790	4.225	445.9	1000.0	242.5	1.26	0.00
3	600	1100	3.87	139.5	5.8	2131.8	1860.1	5.578	6.393	311.6	1300.0	333.6	1.52	0.00
4	600	1100	4.65	88.6	9.5	1922.2	1652.5	7.485	8.706	275.0	1680.0	476.0	1.42	0.00
5	600	1100	4.12	134.3	7.2	2109.0	1845.1	5.796	6.625	320.1	1395.0	361.6	1.43	0.00
6	600	1100	4.92	95.6	0.7	1804.0	1530.1	7.820	9.220	274.7	1700.0	508.6	1.04	0.00

TABLE XI

HAUL NUMBER 1 T79.11 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	3.87	134.0	58.9	47.1	44.4	157.0	163.6	165.0	36.5	41.4	41.2			13.0		
2	600	1100	3.36	127.0	56.7	45.0	43.2	200.0	203.6	204.6	39.5	45.3	44.8			11.0		
3	600	1100	4.05	137.0	60.5	48.4	47.2	126.0	134.4	136.8	33.0	36.1	36.7			15.2		
4	600	1100	4.69	143.0	62.2	50.8	49.2	89.0	89.4	96.5	30.6	33.0	34.4			16.2		
5	600	1100	4.76	139.0	61.3	51.3	50.0	68.0	70.5	76.0	28.5	30.4	32.0			17.0		

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	3.87	5.54	6.59	12.13	11.49	0.00	0.00	10.64	0.00	0.00	0.67	0.73	0.00	0.00
2	600	1100	3.36	5.38	5.38	10.76	9.95	0.52	0.00	9.08	1.08	0.00	0.52	0.68	0.67	0.00
3	600	1100	4.05	6.82	6.83	13.65	13.11	0.42	0.00	12.02	1.56	0.00	0.80	0.82	1.40	0.00
4	600	1100	4.69	7.80	7.80	15.59	15.22	0.51	0.00	13.72	1.90	0.00	0.99	0.97	1.63	0.00
5	600	1100	4.76	8.73	8.74	17.47	17.15	0.44	0.00	15.31	2.07	0.00	1.09	1.01	1.89	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	3.87	168.2	3.8	2150.1	1950.1	4.950	5.458	365.0	1170.0	301.0	0.00	0.00
2	600	1100	3.36	208.3	1.9	2239.9	2038.6	4.052	4.452	388.5	973.0	226.2	1.29	0.00
3	600	1100	4.05	139.1	5.5	1996.7	1747.4	6.017	6.876	303.2	1294.0	359.3	1.39	0.00
4	600	1100	4.69	98.5	6.4	1903.6	1676.5	7.208	8.184	295.0	1574.0	483.0	1.23	0.00
5	600	1100	4.76	77.7	5.9	1747.3	1559.6	8.763	9.817	249.6	1740.0	552.6	1.33	0.00

TABLE XII

HAUL NUMBER 1 T79.17

RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	720	3.88	128.0	53.9	47.0	25.2	66.0	84.3	93.0	25.8	23.7	10.9	45.0	24.8	29.5	14.5	30.3
2	600	720	3.92	132.5	55.8	47.0	25.2	130.0	150.8	157.5	28.5	28.2	13.3	35.6	18.5	21.0	13.5	29.5
3	600	720	4.55	128.5	54.1	46.4	26.0	72.0	77.0	89.0	23.5	21.8	10.8	45.0	32.3	26.0	13.0	29.1
4	600	720	4.71	124.5	53.0	46.4	25.2	20.0	54.9	53.0	22.4	19.5	10.5	45.0	31.5	32.0	11.0	27.2
5	600	720	5.05	114.0	51.2	42.2	24.0	21.4	21.4	26.5	22.4	19.1	10.0		32.3		13.0	28.2

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	720	3.88	6.11	7.11	13.22	12.94	1.32	0.30	11.05	1.23	1.59	0.61	0.86	2.36	1.71
2	600	720	3.92	5.42	5.75	11.18	10.67	1.28	0.11	8.88	1.10	1.33	0.52	0.70	1.71	1.04
3	600	720	4.55	6.95	6.92	13.87	13.59	1.28	0.37	11.62	1.46	1.58	0.73	0.85	1.99	1.87
4	600	720	4.71	6.84	8.34	15.18	15.01	1.37	0.20	13.14	1.30	1.76	0.65	0.96	3.17	1.43
5	600	720	5.05	7.33	8.55	15.88	15.76	1.46	0.41	13.57	1.30	1.66	0.63	0.90	2.10	2.26

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	720	3.88	91.9	18.0	1390.8	1114.0	7.945	9.919	201.4	1140.0	339.7	2.10	1.66
2	600	720	3.92	157.3	17.2	1590.5	1325.5	5.585	6.701	301.1	970.0	283.1	1.66	1.17
3	600	720	4.55	88.1	14.6	1271.5	1011.6	9.135	11.482	204.0	1305.0	418.5	1.43	1.27
4	600	720	4.71	51.5	15.7	1187.3	904.9	11.067	14.522	167.0	1495.0	478.4	1.77	1.09
5	600	720	5.05	24.8	5.1	1147.0	806.1	11.833	16.837	154.4	1620.0	538.6	1.19	1.18

HAUL NUMBER : T79.18 RUN ON 01-MAR-80

TABLE XIII

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	720	3.75	129.0	54.9	48.2	27.0	109.0	115.3	127.5	25.0	23.8	12.0	30.0	25.8	19.5	14.0	32.4
2	600	720	3.09	126.0	53.0	47.0	26.0	188.0	196.4	214.0	28.0	23.5	13.5	23.6	16.6	16.5	13.5	32.3
3	600	720	3.73	127.0	53.9	47.5	26.4	114.0	123.8	135.0	26.0	24.8	12.5	39.0	20.6	21.5	11.5	24.3
4	600	720	3.96	128.0	53.9	48.2	26.8	85.0	101.2	110.0	24.5	23.5	11.6	45.0	23.5	22.0	13.0	25.7
5	600	720	4.46	118.0	51.2	46.0	26.2	79.0	83.5	98.0	23.0	22.0	11.0	45.0	24.3	23.0	14.0	26.5

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	720	3.75	6.62	6.94	13.56	13.12	1.29	0.95	10.57	1.36	1.48	0.67	0.75	1.53	1.37
2	600	720	3.09	5.25	5.90	11.15	10.35	0.83	0.64	8.45	1.06	1.20	0.52	0.60	1.08	0.76
3	600	720	3.73	6.28	7.28	13.56	13.08	1.05	0.90	10.81	1.31	1.53	0.65	0.78	1.63	1.23
4	600	720	3.96	6.73	7.80	14.53	14.16	1.19	0.91	11.75	1.41	1.67	0.71	0.87	2.10	1.37
5	600	720	4.46	7.22	8.16	15.37	15.05	1.38	0.78	12.58	1.38	1.62	0.69	0.85	1.89	1.88

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	720	3.75	126.9	14.6	1372.7	1147.2	7.700	9.213	209.5	1180.0	332.9	1.83	1.68
2	600	720	3.09	211.7	21.0	1484.2	1104.6	5.691	7.646	208.0	913.0	216.5	1.92	1.73
3	600	720	3.73	134.4	15.3	1401.6	1178.1	7.714	9.178	209.2	1250.0	330.3	1.78	1.64
4	600	720	3.96	109.5	16.1	1320.7	1132.8	8.900	10.377	196.4	1370.0	379.4	1.89	1.59
5	600	720	4.46	97.5	16.0	1177.7	1012.1	10.682	12.430	184.7	1560.0	454.3	1.45	1.39

TABLE XIV

HAUL NUMBER 1 T79.19 RUN ON 29-FEB-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	500	720	4.08	118.8	52.1	46.0	25.2	59.0	59.0	81.0	24.0	23.0	11.0	45.0		24.0		15.9
2	600	720	4.02	128.5	54.3	47.5	28.0	72.0	72.0	92.0	23.6	22.7	11.6	42.0		21.0		17.5
3	700	720	4.09	130.0	54.9	48.3	27.0	89.0	89.0	111.5	24.1	23.2	11.4	45.0		23.0		17.8
4	800	720	3.90	135.0	56.7	49.5	27.8	119.0	130.9	138.0	24.0	23.6	11.8	40.8	25.4	22.0	13.0	28.9
5	900	720	4.09	138.0	57.6	50.0	27.4	167.0	194.0	194.0	26.1	26.0	13.1	40.1	17.7	23.0	11.0	32.3

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	500	720	4.08	6.52	7.36	13.88	13.61	0.84	0.40	12.14	1.42	1.63	0.67	0.80	2.16	2.43
2	600	720	4.02	6.96	7.15	14.11	13.82	1.31	0.47	11.77	1.45	1.59	0.73	0.85	2.06	2.35
3	700	720	4.09	6.78	7.54	14.33	14.02	1.04	0.54	12.11	1.37	1.57	0.75	0.90	2.24	2.51
4	800	720	3.90	7.08	7.27	14.35	13.94	1.25	0.33	11.99	1.36	1.53	0.78	0.93	1.97	1.57
5	900	720	4.09	6.72	7.04	13.76	13.23	1.05	0.11	11.55	1.24	1.44	0.74	0.90	2.14	1.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	500	720	4.08	80.5	21.2	1250.6	1058.1	9.707	11.472	183.1	1255.0	375.8	1.73	1.89
2	600	720	4.02	91.5	19.1	1281.6	1078.3	9.183	10.915	189.6	1257.0	376.1	1.86	1.89
3	700	720	4.09	111.0	21.7	1323.3	1120.6	9.149	10.803	194.9	1260.0	388.0	1.79	1.91
4	800	720	3.90	137.8	12.3	1361.0	1168.3	8.808	10.260	195.7	1260.0	368.1	1.88	1.55
5	900	720	4.09	193.9	12.8	1503.5	1300.1	7.681	8.883	237.0	1262.0	366.1	1.71	1.11

HAUL NUMBER 1 T79.20 RUN ON 29-FEB-80

TABLE XV

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	4.24	131.2	54.9	48.7	27.5	128.0	128.0	141.0	28.5	26.8	13.2	28.1	21.1	15.5	11.5	29.1
2	600	1100	3.91	131.0	54.9	48.7	27.0	169.0	170.5	187.0	32.0	31.0	14.5	19.5	19.1	13.5	12.5	32.9
3	600	1100	4.64	131.0	55.0	49.0	27.8	69.0	66.8	84.0	26.0	23.5	12.0	33.9	32.2	16.0	14.0	29.9
4	600	1100	4.62	130.0	55.6	49.0	27.3	105.0	111.9	124.5	28.0	26.0	13.8	28.7	21.1	15.0	11.5	31.5
5	600	1100	4.70	138.0	56.7	51.0	29.0	72.0	70.2	84.5	26.0	23.2	11.9	31.3	27.4	13.0	12.5	30.7

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	4.24	7.24	7.24	14.48	13.95	0.42	0.00	12.81	1.66	0.00	0.88	0.89	1.21	0.00
2	600	1100	3.91	6.14	6.14	12.27	11.59	0.60	0.00	10.09	1.36	0.00	0.68	0.71	1.06	0.00
3	600	1100	4.64	8.37	8.36	16.73	16.43	0.82	0.00	14.40	1.89	0.00	1.01	1.00	1.99	0.00
4	600	1100	4.62	7.57	7.57	15.14	14.69	0.76	0.00	13.16	1.67	0.00	0.86	0.91	1.74	0.00
5	600	1100	4.70	8.32	8.32	16.64	16.32	0.87	0.00	14.99	1.99	0.00	1.06	1.16	1.80	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	4.24	140.2	12.0	1564.8	1305.3	8.164	9.812	222.4	1403.0	400.2	1.24	0.00
2	600	1100	3.91	186.5	16.4	1757.0	1509.8	5.744	6.685	301.1	1135.0	306.6	1.27	0.00
3	600	1100	4.64	82.7	15.2	1430.2	1151.6	10.072	12.508	191.0	1668.0	516.0	1.41	0.00
4	600	1100	4.62	123.5	15.2	1557.0	1274.1	8.454	10.331	230.2	1540.0	459.4	1.26	0.00
5	600	1100	4.70	83.1	12.6	1474.4	1183.3	10.169	12.671	190.9	1770.0	519.2	1.36	0.00

TABLE XVI

HAUL NUMBER 1 T79.21 RUN ON 29-FEB-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	4.01	130.0	54.9	48.5	27.0	135.5	140.3	156.0	29.0	26.6	13.6	28.1	16.6	16.0	12.0	34.0
2	600	1100	3.66	129.0	54.9	48.5	26.7	160.0	169.0	185.0	30.4	28.3	14.0	24.2	12.8	15.5	10.0	33.4
3	600	1100	4.42	130.0	54.9	49.0	27.6	91.5	100.5	113.0	27.0	24.3	13.0	32.8	21.6	17.5	12.0	32.9
4	600	1100	4.36	130.0	55.4	48.6	27.2	113.0	117.5	132.0	28.3	26.8	13.5	29.1	20.6	15.5	12.0	32.5
5	600	1100	4.62	128.0	54.3	48.0	27.7	77.0	78.2	93.0	25.8	23.9	12.7	35.8	28.5	17.0	12.0	30.5
6	750	1100	4.09	133.0	56.7	50.0	28.0	138.0	150.5	160.0	27.7	26.1	13.5	32.8	17.7	17.5	10.5	32.9
7	900	1100	4.08	140.0	57.6	50.0	28.1	176.5	187.5	198.5	28.0	26.7	14.6	29.9	19.7	17.0	11.0	34.2

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	4.01	6.74	6.74	13.48	12.92	0.44	0.00	12.08	1.52	0.00	0.80	0.85	1.49	0.00
2	600	1100	3.66	6.27	6.28	12.55	11.86	0.37	0.00	11.00	1.38	0.00	0.72	0.75	1.45	0.00
3	600	1100	4.42	7.69	7.70	15.39	15.00	0.33	0.00	14.31	1.77	0.00	0.96	1.00	2.09	0.00
4	600	1100	4.36	7.22	7.23	14.45	13.98	0.39	0.00	13.39	1.64	0.00	0.87	0.95	1.71	0.00
5	600	1100	4.62	8.22	8.22	16.45	16.12	0.34	0.00	15.41	1.87	0.00	1.02	1.06	2.02	0.00
6	750	1100	4.09	7.63	7.65	15.28	14.76	0.54	0.00	14.02	1.58	0.00	0.92	1.02	1.96	0.00
7	900	1100	4.08	7.87	7.88	15.75	15.17	0.43	0.00	13.89	1.64	0.00	1.03	1.04	2.00	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	4.01	154.8	17.3	1592.3	1290.2	7.584	9.360	220.5	1365.0	350.6	1.43	0.00
2	600	1100	3.66	183.9	19.7	1669.2	1372.7	6.591	8.015	235.1	1197.0	293.9	1.62	0.00
3	600	1100	4.42	111.6	16.2	1482.5	1190.8	9.652	12.017	189.3	1640.0	448.6	1.50	0.00
4	600	1100	4.36	131.2	15.9	1568.0	1302.6	8.539	10.279	218.3	1550.0	412.5	1.34	0.00
5	600	1100	4.62	92.0	14.6	1401.1	1147.3	11.000	13.433	177.0	1830.0	504.1	1.38	0.00
6	750	1100	4.09	159.2	14.9	1570.8	1305.1	8.925	10.741	196.0	1600.0	408.7	1.63	0.00
7	900	1100	4.08	197.8	15.7	1613.0	1335.1	8.614	10.407	201.8	1600.0	418.9	1.67	0.00

TABLE XVII

HAUL NUMBER 1 T79.22 RUN ON 01-MAR-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	1100	4.39	128.0	54.1	47.4	26.4	124.0	133.2	145.0	29.5	28.2	15.2	28.4	21.6		12.0	34.5
2	600	1100	4.21	125.0	53.9	47.0	26.0	157.0	167.7	170.5	32.0	31.8	15.7	21.5	17.2		11.5	34.1
3	600	1100	4.43	127.0	54.9	47.6	26.8	99.0	119.7	127.0	29.3	27.1	14.6	30.9	20.6		12.0	33.2
4	600	1100	4.64	136.0	56.7	49.5	28.0	72.0	73.6	88.0	26.2	24.6	14.0	32.4	29.3		14.0	33.3
5	600	1100	4.79	129.0	54.9	49.5	28.0	61.0	61.6	76.2	24.7	22.9	14.0	33.9	31.7		14.5	31.8

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	1100	4.39	6.84	7.28	14.12	13.59	0.55	0.67	11.96	1.52	1.58	0.79	0.82	1.66	1.23
2	600	1100	4.21	6.94	6.78	13.72	13.03	1.23	0.48	10.82	1.37	1.44	0.65	0.72	0.85	0.54
3	600	1100	4.43	6.90	7.66	14.56	14.12	0.53	0.51	12.72	1.50	1.65	0.79	0.86	2.28	1.17
4	600	1100	4.64	8.07	8.72	16.78	16.46	0.45	0.80	14.88	1.96	2.05	1.07	1.09	2.08	2.10
5	600	1100	4.79	8.95	8.92	17.87	17.59	0.58	0.98	15.70	2.03	1.96	1.10	1.03	2.18	2.23

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	1100	4.39	144.3	15.4	1596.1	1336.8	7.494	8.948	252.6	1350.0	403.9	1.28	1.16
2	600	1100	4.21	170.4	7.2	1725.0	1494.7	6.270	7.237	299.5	1190.0	371.3	1.21	0.96
3	600	1100	4.43	125.9	16.7	1608.8	1290.1	7.904	9.856	231.4	1440.0	423.3	1.50	1.13
4	600	1100	4.64	87.2	14.2	1485.7	1217.8	10.016	12.220	195.5	1685.0	516.9	1.43	1.50
5	600	1100	4.79	75.3	13.9	1356.2	1133.6	11.576	13.848	178.1	1825.0	570.2	1.41	1.45

TABLE XVIII

HAUL NUMBER : T79.23 RUN ON 29-FEB-80

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	SECTION SPREAD (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	SECTION HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)	MEAN DOOR ATTACK (DEG)
1	600	720	4.03	130.0	54.9	48.0	27.0	112.0	119.9	130.0	26.0	25.1	12.5	35.1	22.4	18.0	14.0	31.6
2	600	720	3.50	127.0	54.1	47.8	26.0	180.0	181.3	198.0	28.1	27.5	13.3	20.2	17.9	16.5	14.5	35.1
3	600	720	4.02	129.0	54.9	48.0	27.0	92.0	100.5	111.0	25.0	23.5	12.0	38.4	26.7	19.0	15.0	30.9
4	600	720	4.13	129.0	54.9	48.0	27.0	82.5	91.3	101.0	24.5	22.5	11.5	39.4	25.8	19.0	14.5	29.9
5	600	720	4.51	123.0	53.0	47.6	26.4	40.0	59.4	65.5	21.3	19.2	10.5	45.0	26.0	23.0	12.5	26.0

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	600	720	4.03	6.25	6.65	12.90	12.46	0.67	1.01	10.43	1.38	1.42	0.71	0.71	1.58	1.24
2	600	720	3.50	5.43	5.26	10.69	10.00	0.39	0.41	8.74	1.16	1.12	0.59	0.57	0.98	1.05
3	600	720	4.02	6.44	6.88	13.32	12.95	0.79	0.51	11.34	1.40	1.53	0.72	0.81	1.81	1.52
4	600	720	4.13	6.84	6.93	13.76	13.43	0.83	0.56	11.73	1.48	1.54	0.77	0.81	1.89	1.57
5	600	720	4.51	7.94	8.10	16.04	15.83	1.19	0.78	13.57	1.59	1.68	0.82	0.89	2.71	1.72

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	600	720	4.03	129.5	13.2	1427.6	1204.9	7.305	8.655	239.7	1170.0	339.7	1.44	1.40
2	600	720	3.50	197.7	16.5	1520.3	1309.1	5.751	6.679	269.8	970.0	236.9	1.36	1.38
3	600	720	4.02	110.2	14.0	1372.7	1128.1	8.262	10.053	205.8	1275.0	352.3	1.59	1.46
4	600	720	4.13	100.0	13.3	1345.2	1080.1	8.722	10.863	195.7	1352.0	375.3	1.58	1.41
5	600	720	4.51	64.4	15.0	1129.0	914.0	12.016	14.842	156.4	1625.0	483.1	1.76	1.32

	ROPE TRAWL (A)				ROPE TRAWL (B)		PELAGIC TRAWL (C)			
Bridle weights (kg)	720		1100		1100		720		1100	
Speed (knots)	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
wing-end height (m)	28.0	21.5	32.4	26.9	35.1	27.7	25.3	21.5	30.3	24.7
wing-end spread (m)	64.0	63.9	63.2	66.4	59.9	62.9	53.9	52.6	54.7	55.6
wing-end area (sq.m)	1795	1375	2040	1792	2096	1755	1362	1135	1659	1372
headline height (m)	29.7	19.5	32.8	25.3	39.2	28.3	23.5	19.6	28.7	22.5
sideline spread (m)	49.7	51.6	50.0	53.0	48.4	51.6	47.2	45.3	48.2	49.4
h/l centre area (sq.m)	1472	1019	1631	1356	1886	1480	1111	889	1383	1110
section height (m)	31.0	22.1	34.6	27.1	39.6	30.0	11.9	9.9	14.2	12.8
section spread (m)	50.4	50.8	48.6	52.3	46.6	50.6	26.2	25.4	26.8	28.2
section area (sq.m)	1557	1139	1671	1432	1839	1537	311	253	380	361
headline depth (m)	141.6	13.0	187.9	74.5	150.8	58.8	121.9	29.6	167.3	60.4
door height above the headline (m)	14.0	13.1	19.0	16.1	5.8	7.3	15.5	10.7	16.1	13.0

TABLE XIX

COMPARISON OF THE THREE TRAWLS - GEAR GEOMETRY

TABLE XX

	ROPE TRAWL (A)				ROPE TRAWL (B)		PELAGIC TRAWL (C)			
Bridle weights (kg)	720		1100		1100		720		1100	
Speed (knots)	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Net drag (tonnes)	9.73	13.89	10.16	13.94	11.44	15.70	10.97	13.85	11.42	16.10
Gear drag (tonnes)	11.59	15.91	12.55	16.91	12.89	17.59	12.96	16.03	12.57	17.73
Shaft H.P.	1132	1659	1236	1764	1278	1827	1246	1641	1271	1896
Gear H.P.	319	523	348	562	355	581	356	529	341	586
Swept volume index (CV.M/SEC/TONNE)	320	173	338	245	346	233	211	165	251	174
Net drag/area (KGF/SQ.M)	5.60	9.47	5.08	7.72	5.56	8.69	8.24	11.93	6.89	11.47

TABLE XX

COMPARISON OF THE THREE TRAWLS - FORCES AND GENERAL PERFORMANCE

TABLE XXI

	ROPE TRAWL (A)				ROPE TRAWL (B)		PELAGIC TRAWL (C)			
Bridle weights (kg)	720		1100		1100		720		1100	
Speed (knots)	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Door angles (Deg) HEEL	24.6	40.4	17.4	33.9	15.6	29.4	30.3	39.3	20.9	34.3
TILT	14.3	20.1	10.5	14.9	11.7	14.9	17.3	18.2	13.0	14.2
ATTACK	35.5	32.4	23.9	23.3	21.8	25.4	29.5	26.6	33.0	30.8
Door depth (m)	127.6	-0.1(!)	168.9	58.3	145.0	51.5	106.4	18.9	151.2	47.4
Door spread (m)	143.1	140.9	139.9	147.7	134.3	142.2	126.6	120.3	129.1	132.4
Door spread force (t)	1.40	1.85	1.47	2.03	1.53	2.13	1.39	1.61	1.44	2.05
Warp att. point	b		a + b		a + b		a		a	

Combined data for All trawls	Speed (knots)	4.0	5.0
	Door drag (tonnes)	0.77	1.00

TABLE XXI

COMPARISON OF DOOR CHARACTERISTICS-SAME DOORS USED WITH DIFFERENT NETS AND BRIDLE WEIGHTS.
COMBINED DATA FOR BOTH WARP ATTACHMENT POINTS.

TABLE XXII

COMPARISON OF DOOR CHARACTERISTICS FOR DIFFERENT WARP ATTACHMENT POINTS

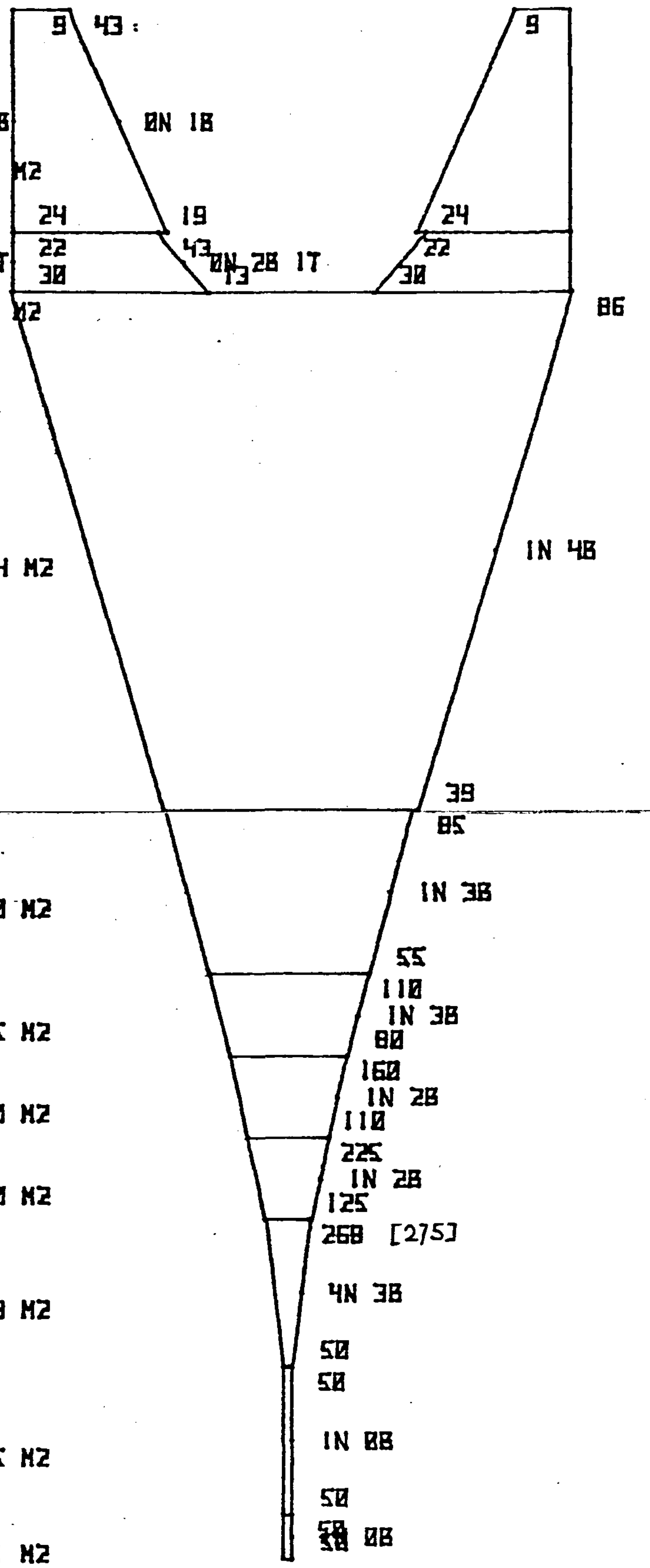
BRIDLE WEIGHTS: - 1100 kg

		Warp att. point	ROPE TRAWL (A)		ROPE TRAWL (B)	
Speed (knots)			4.0	5.0	4.0	5.0
Door Angles (DEG)	HEEL	a	15.6	32.7	15.7	31.4
		b	19.1	36.4	15.2	25.5
	TILT	a	10.3	13.8	10.3	13.6
		b	11.0	16.8	13.2	16.6
	ATTACK	a	21.7	23.4	21.8	25.4
		b	25.9	24.0	-	-
Door spread (m)		a	139.1	148.8	133.5	140.9
		b	140.2	146.1	135.3	143.6

TABLE XXII

LENGTE IN MAZEN	MAASWIJDTE (MM)	BOVENKANT (UPPER SIDE)	GARENDIKTE (MM)	LENGTE GESTREKT (M)
15	1800	IN 08 UI= 0.40 OPP.= 0.864 M2	210/ 8 4.0	27.00
4	1800	IN 08 0T UI= 0.40 OPP.= 0.374 M2	210/ 8 4.0	7.20
35	1800	UI= 0.40 OPP.= 7.854 M2	210/ 8 4.0	63.00
25	800	UI= 0.40 OPP.= 2.100 M2	210/ 8 3.0	20.00
25	400	UI= 0.40 OPP.= 1.235 M2	210/ 8 2.6	10.00
50	200	UI= 0.40 OPP.= 1.350 M2	210/ 8 2.0	10.00
100	100	UI= 0.40 OPP.= 1.750 M2	210/ 8 2.0	10.00
400	45	UI= 0.40 OPP.= 3.293 M2	210/ 8 2.3	18.00
400	45	UI= 0.40 OPP.= 1.035 M2	210/ 8 2.3	18.00
120	45	UI= 0.40 OPP.= 0.311 M2	210/ 8 2.3	5.40

FIG.: 1



BENAMING: 2700 MAZEN NET (JACZON)
LENGTE BOVENPEES: 87.60 M. (HEADLINE LENGTH)

NR.: 800 A

SCHAAL

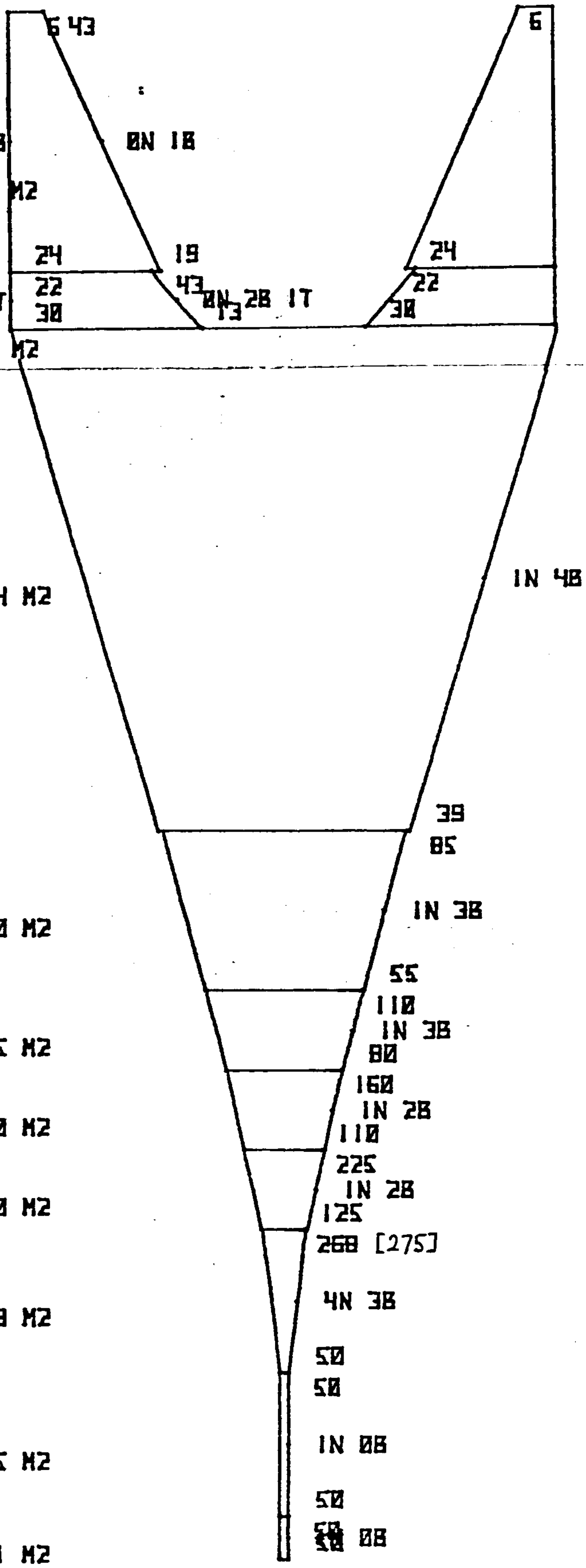
RIVO AFDELING TECHNISCH ONDERZOEK DATUM:

GETEK.: BvM

IN MAZEN	WIJDTE (MM)	LOWER PANEL.	DIKTE (MM)	GESTREKT (M)
18	1800	IN 08 UI= 0.40 OPP.= 0.940 M2	210/ 8 4.0	32.40
4	1800	IN 08 0T UI= 0.40 OPP.= 0.374 M2	210/ 8 4.0	7.20
35	1800	UI= 0.40 OPP.= 7.854 M2	210/ 8 4.0	63.00
25	800	UI= 0.40 OPP.= 2.100 M2	210/ 8 3.0	20.00
25	400	UI= 0.40 OPP.= 1.235 M2	210/ 8 2.6	10.00
50	200	UI= 0.40 OPP.= 1.350 M2	210/ 8 2.0	10.00
100	100	UI= 0.40 OPP.= 1.750 M2	210/ 8 2.0	10.00
400	45	UI= 0.40 OPP.= 3.293 M2	210/ 8 2.3	18.00
400	45	UI= 0.40 OPP.= 1.035 M2	210/ 8 2.3	18.00
120	45	UI= 0.40 OPP.= 0.311 M2	210/ 8 2.3	5.40

FIG.: 2

ONDERKANT



BENAMING: 2700 MAZEN PELAGISCH NET (JACZON)
ONDERKANT
LENGTE GRONDPEES: 98.30 M. (FOOT-ROPE LENGTH)

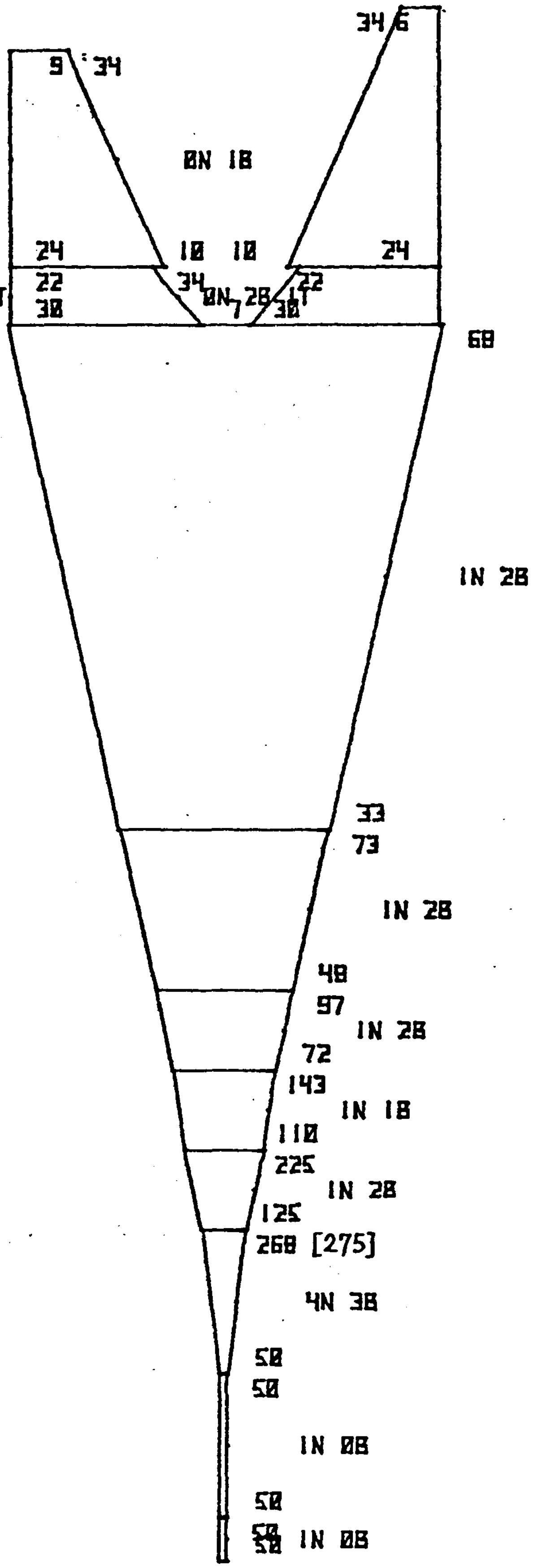
NR.: 800 B

SCHAAL

RIVO AFDELING TECHNISCH ONDERZOEK DATUM: 17 OKT 79 GETEK.: BM

LENGTE IN MAZEN	MAASWIJDTE (MM)	ZIJKANTEN (SIDE PANELS)	GARENDIKTE (MM)	LENGTE GESTREKT (M)
18 15	1000	UI= 0.40 OPP.= 0.891 M2	210/ 8 4.0 210/ 8 4.0	32.40 27.00
4	1000	UI= 0.40 OPP.= 0.374 M2	210/ 8 4.0	7.20
35	1000	UI= 0.40 OPP.= 6.363 M2	210/ 8 4.0	63.00
25	800	UI= 0.40 OPP.= 1.815 M2	210/ 8 3.0	20.00
25	400	UI= 0.40 OPP.= 1.099 M2	210/ 8 2.6	10.00
50	200	UI= 0.40 OPP.= 1.267 M2	210/ 8 2.0	10.00
100	100	UI= 0.40 OPP.= 1.750 M2	210/ 8 2.0	10.00
400	45	UI= 0.40 OPP.= 3.293 M2	210/ 8 2.3	18.00
400	45	UI= 0.40 OPP.= 1.035 M2	210/ 8 2.3	18.00
120	45	UI= 0.40 OPP.= 0.311 M2	210/ 8 2.3	5.40
				194.00

FIG. : 3



BENAMING: PELAGISCH 2700 MAZENNET (JACZON)
LENGTE ZIJPEES 75.00 M (SIDE-ROPE LENGTH)

NR.: 800 C

SCHAAL

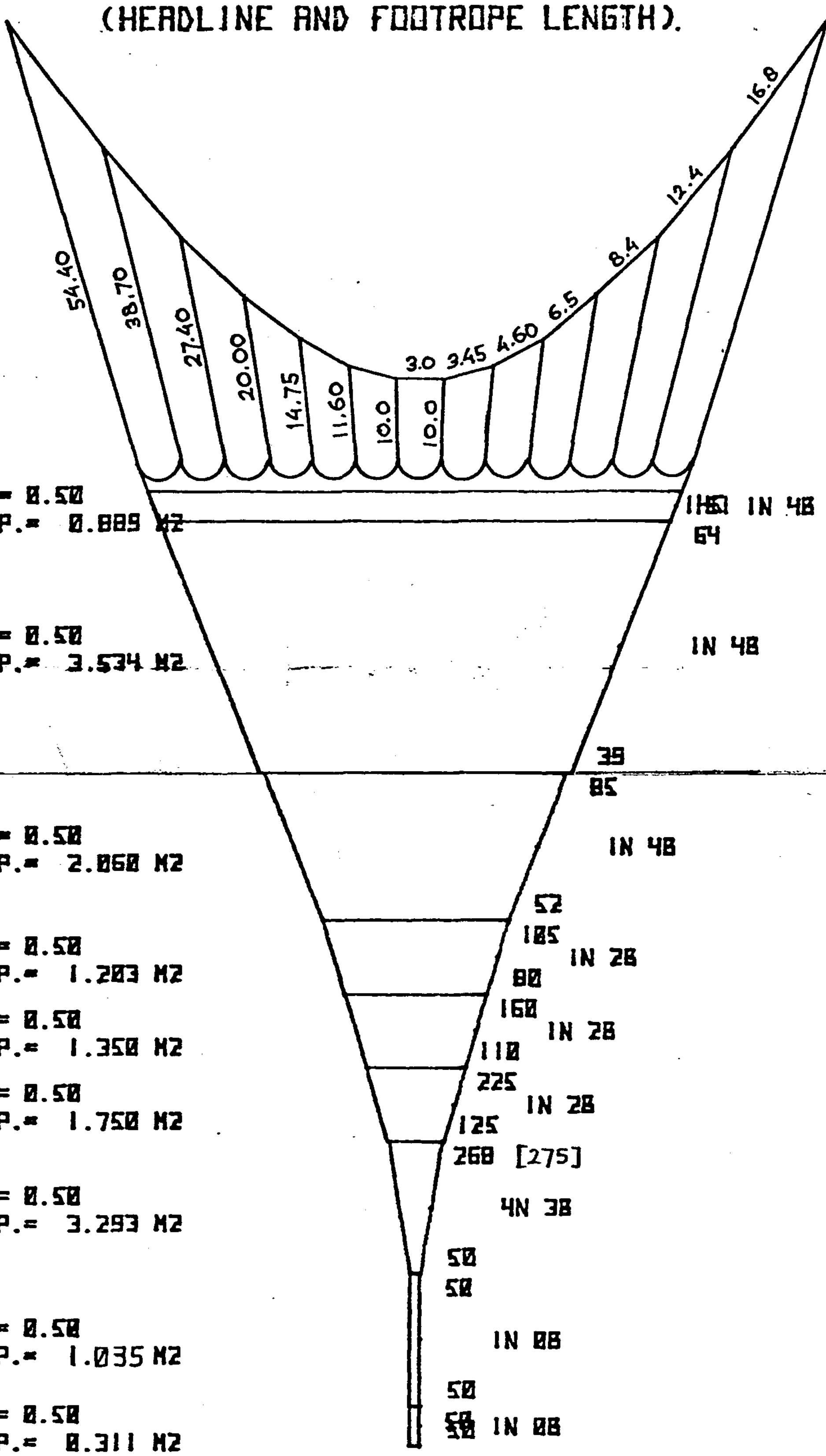
RIVO AFDELING TECHNISCH ONDERZOEK DATUM: 22 OKT.79

GETEK.: BVM

ONDER- EN BOVENKANT FIG.:4

UPPER AND LOWER PANEL

LENGTEBOVEN / ONDERPEES = 107.30 M.
(HEADLINE AND FOOTROPE LENGTH).



LENGTE IN MAZEN	MAASWIJDTE (MM)		GAREN-DIKTE (MM)	LENGTE GESTREKT (M)
				52.00
7.5	400	UI= 0.50	218/ 2.6	3.20
5	800	OPP.= 0.889 M2	3.0	4.00
19	1000	UI= 0.50 OPP.= 3.534 M2	218/ 4.0	34.20
25	800	UI= 0.50 OPP.= 2.060 M2	218/ 3.0	20.00
25	400	UI= 0.50 OPP.= 1.203 M2	218/ 2.6	10.00
50	200	UI= 0.50 OPP.= 1.350 M2	218/ 2.0	10.00
100	100	UI= 0.50 OPP.= 1.750 M2	218/ 2.0	10.00
400	45	UI= 0.50 OPP.= 3.293 M2	218/ 2.3	18.00
400	45	UI= 0.50 OPP.= 1.035 M2	218/ 2.3	18.00
120	45	UI= 0.50 OPP.= 0.311 M2	218/ 2.3	5.40
			TOTAAL	184.80 M

BENAMING: LYNENTRAWL (JACZON), 2700 MAZEN OMTREK
ONTWERP DDR (VEB FISCHKOMBINAT ROSTOCK)
2700 MESHES ROPE TRAWL.

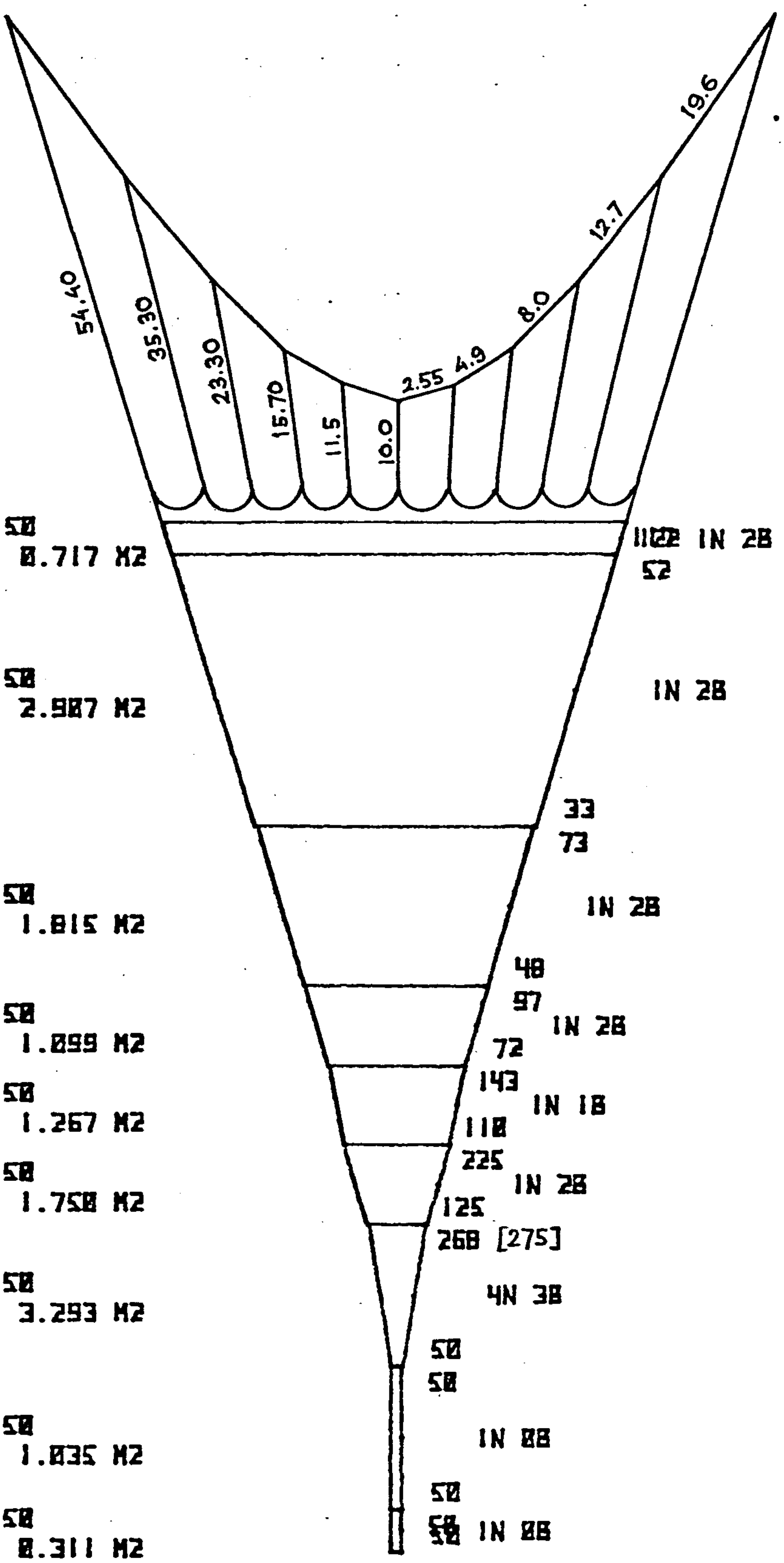
NR.: 001 A

SCHAAL

RIVO AFDELING TECHNISCH ONDERZOEK DATUM: 22 OKT.79 GETEK.: BvM

FIG.5 ZIJKANTEN (SIDEPANELS)

LENGTE ZIJPEES = 95.50 M.
(SIDE-ROPE LENGTH)



LENGTE IN MAZEN	MAASWIJDTE (MM)			GARENDIKTE (MM)	LENGTE GESTREKT (M)
					52.00
7.5	400			2.6	3.20
5	800	UI= 0.50 OPP.= 0.717 M2	1102 IN 28 52	218/ 3.0	4.00
19	1000	UI= 0.50 OPP.= 2.907 M2	IN 28	218/ 4.0	34.20
25	800	UI= 0.50 OPP.= 1.815 M2	33 73 IN 28	218/ 3.0	20.00
25	400	UI= 0.50 OPP.= 1.099 M2	48 97 IN 28	218/ 2.6	10.00
50	200	UI= 0.50 OPP.= 1.267 M2	72 143 IN 18	218/ 2.0	10.00
100	100	UI= 0.50 OPP.= 1.750 M2	110 225 IN 28	218/ 2.0	10.00
400	45	UI= 0.50 OPP.= 3.293 M2	125 268 [275] 4N 38	218/ 2.3	18.00
400	45	UI= 0.50 OPP.= 1.035 M2	50 50 IN 08	218/ 2.3	18.00
120	45	UI= 0.50 OPP.= 0.311 M2	50 50 50 IN 08	218/ 2.3	5.40
				TOTAAL	184.80

BENAMING: LIJNENTRAWL (JACZON), OMTREK 2700 MAZEN VAN 20 CM. ONTWERP DDR
(2700 MESHES ROPE TRAWL)

NR.: 801 B

SCHAAL

RIVO AFDELING TECHNISCH ONDERZOEK DATUM: 22 OKT. 79 GETEK.: BVM

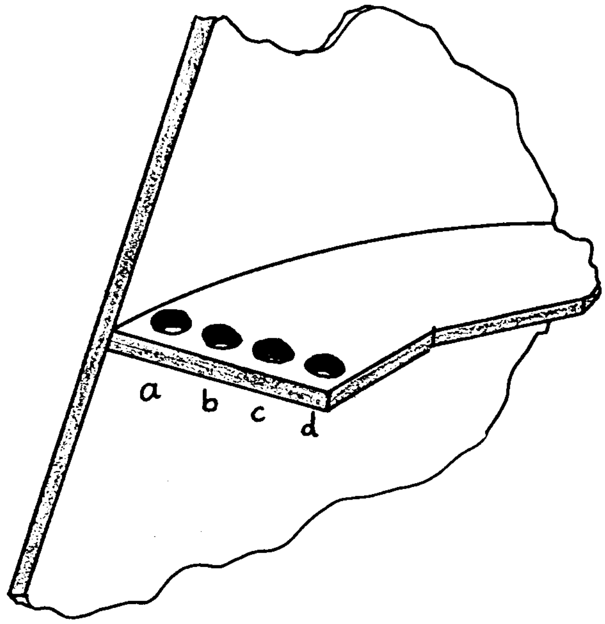
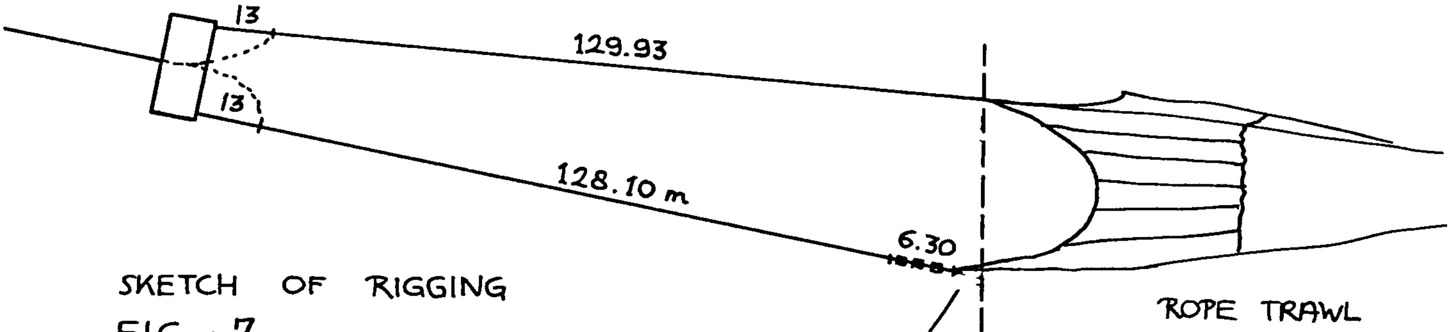
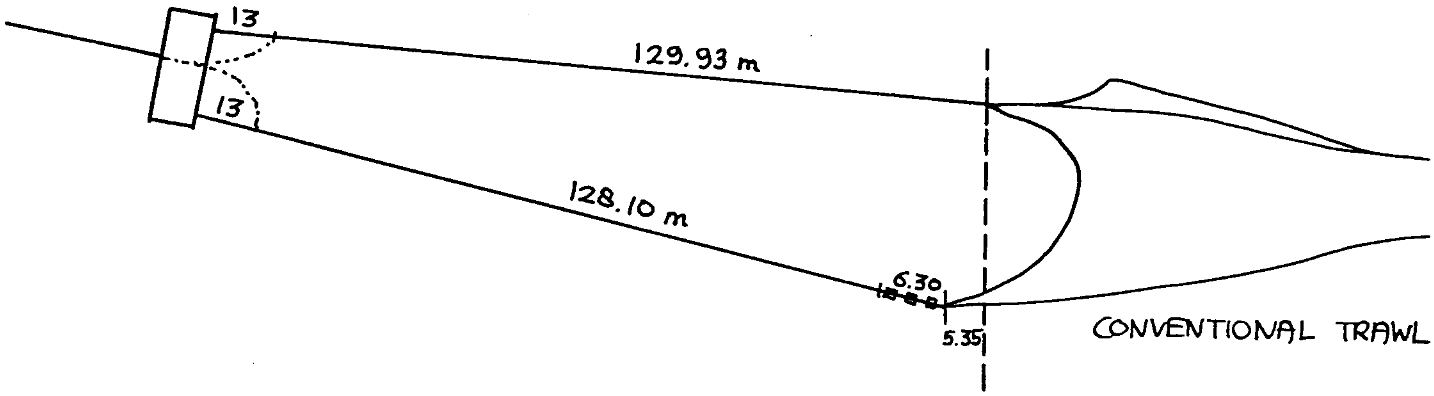


FIG.: 6 WARP ATTACHMENT TO DOORS



SKETCH OF RIGGING
FIG.: 7

BRIDLE EXTENSION : 4.47 m
(128.10 + 6.30) – 129.93



BRIDLE EXTENSION : 9.82 m
(128.10 + 6.30 + 5.35) – 129.93

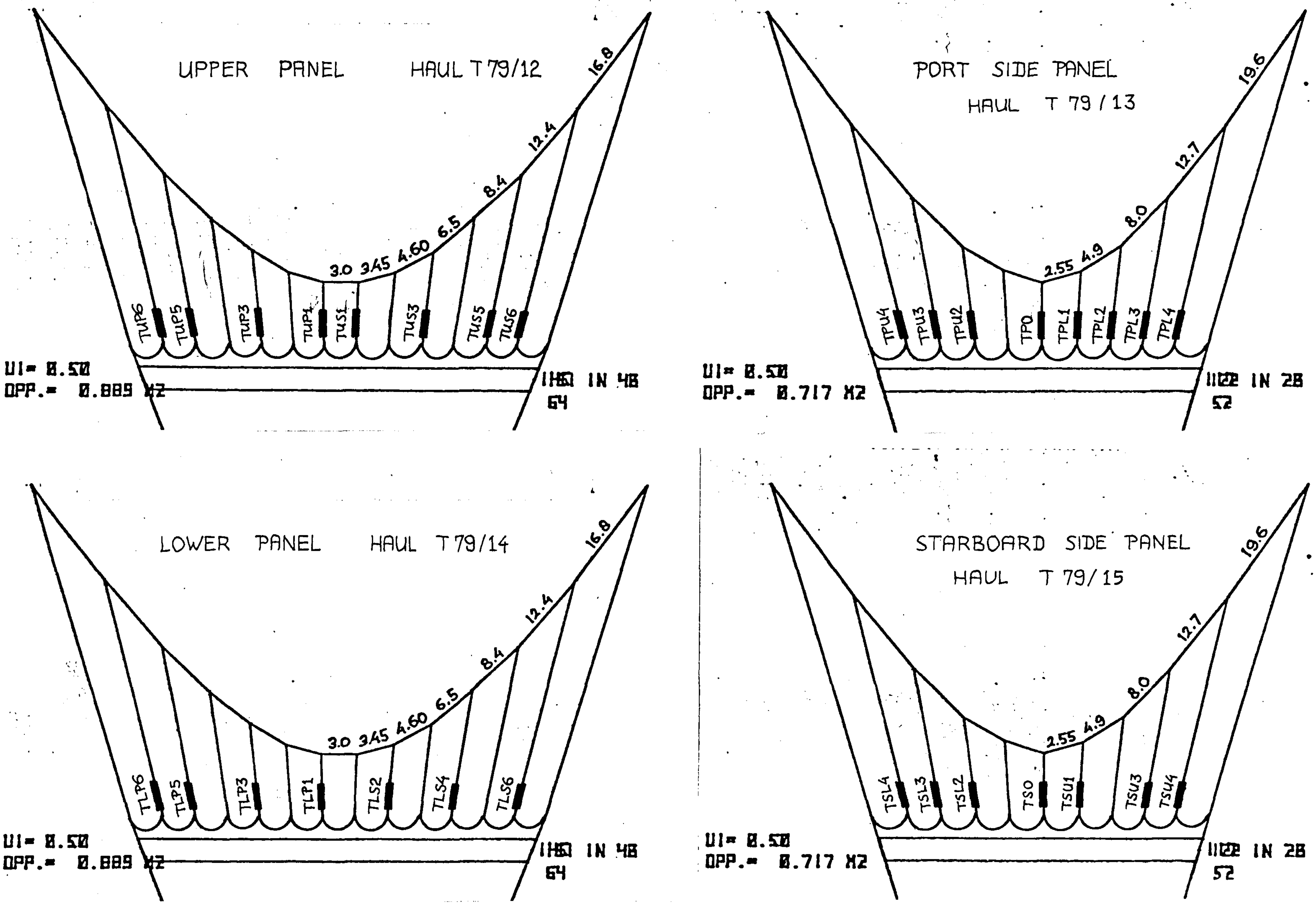


FIG.: 8 ROPE TENSION TESTS , POSITION OF LOAD CELLS.

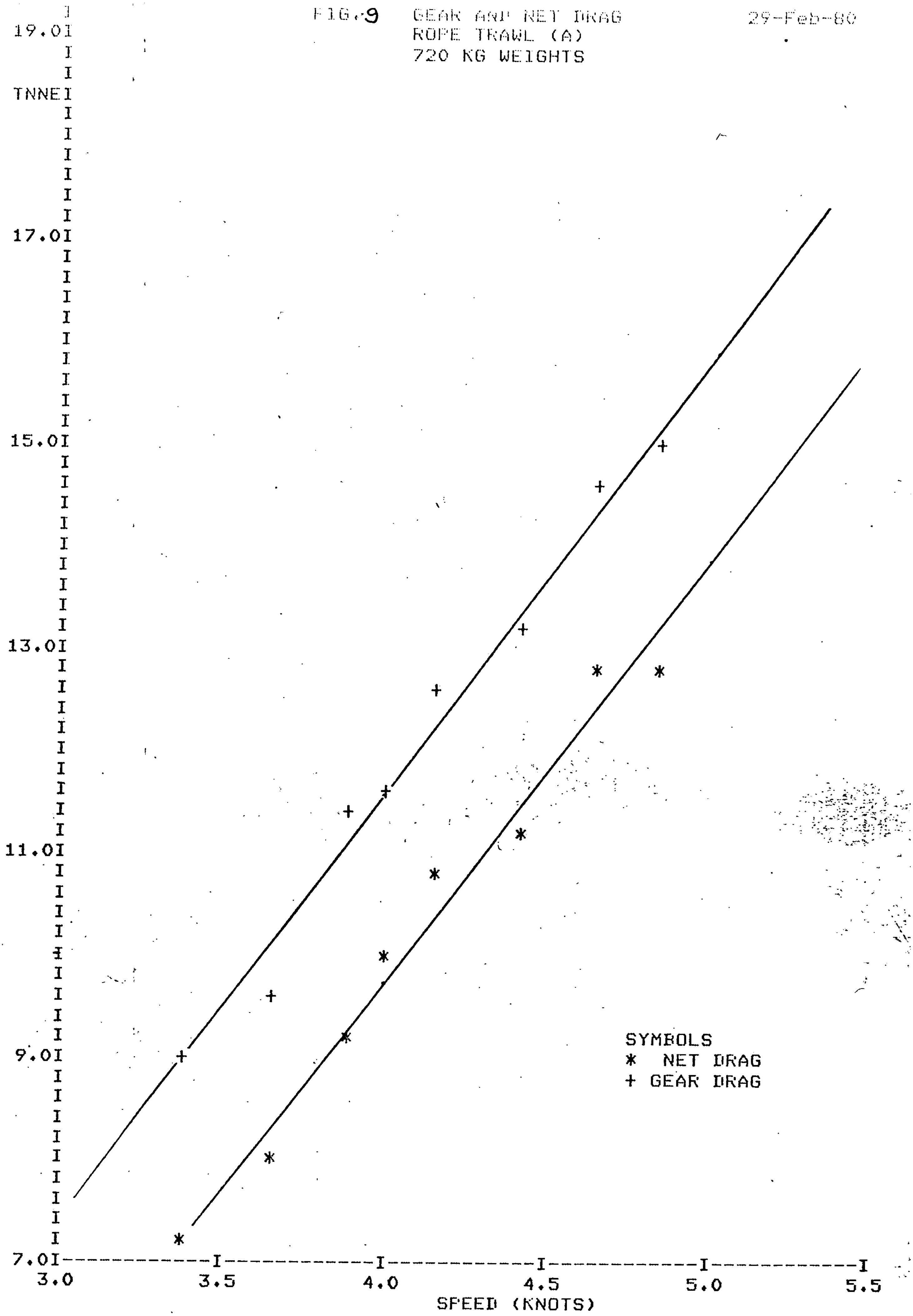


FIG. 9 GEAR AND NET DRAG
ROPE TRAWL (A)
720 KG WEIGHTS
29-Feb-80
TNNE
19.0
17.0
15.0
13.0
11.0
9.0
7.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* NET DRAG
+ GEAR DRAG

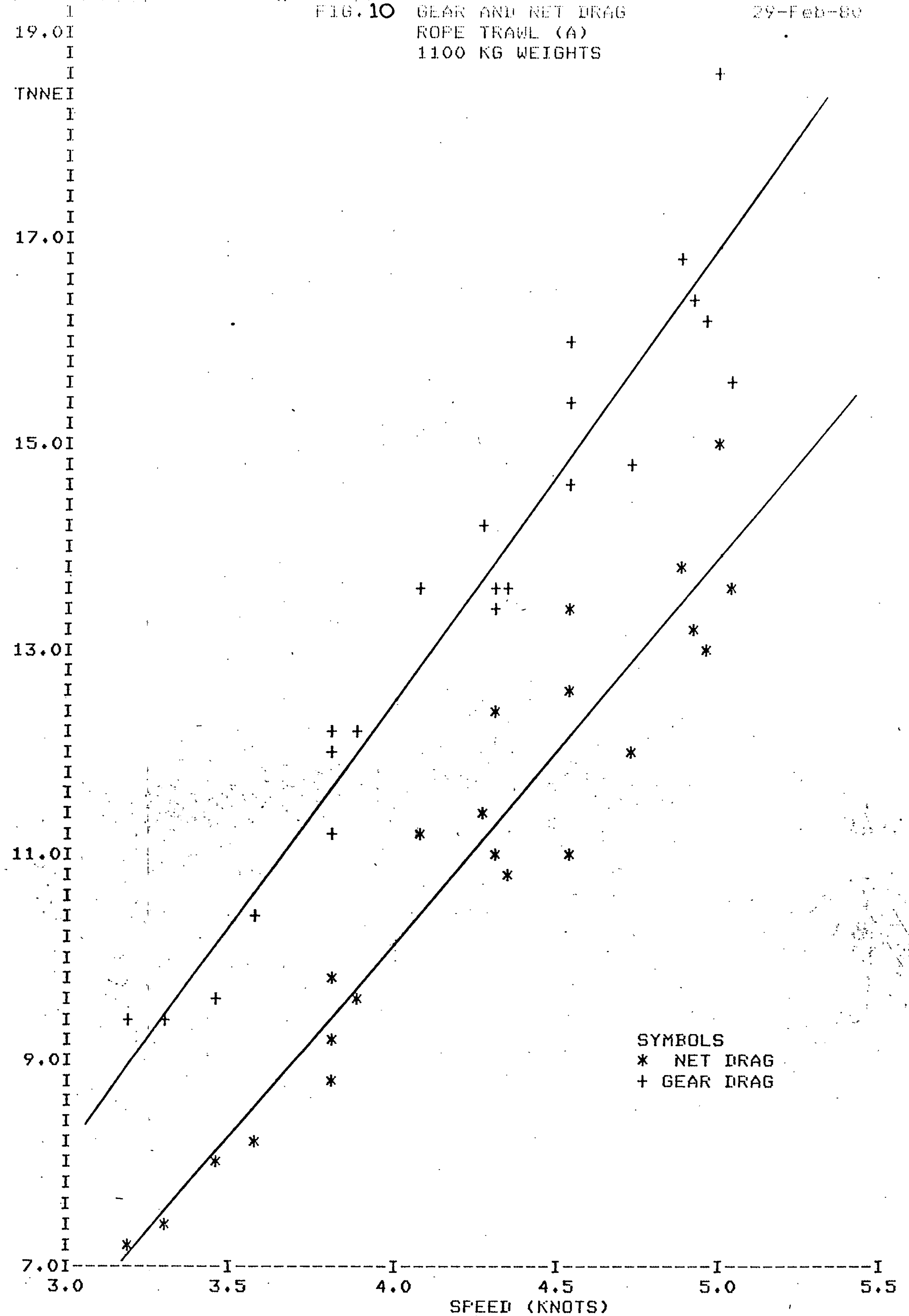


FIG. 10 GEAR AND NET DRAG
ROPE TRAWL (A)
1100 KG WEIGHTS
29-Feb-80
TNNE
19.0
17.0
15.0
13.0
11.0
9.0
7.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* NET DRAG
+ GEAR DRAG

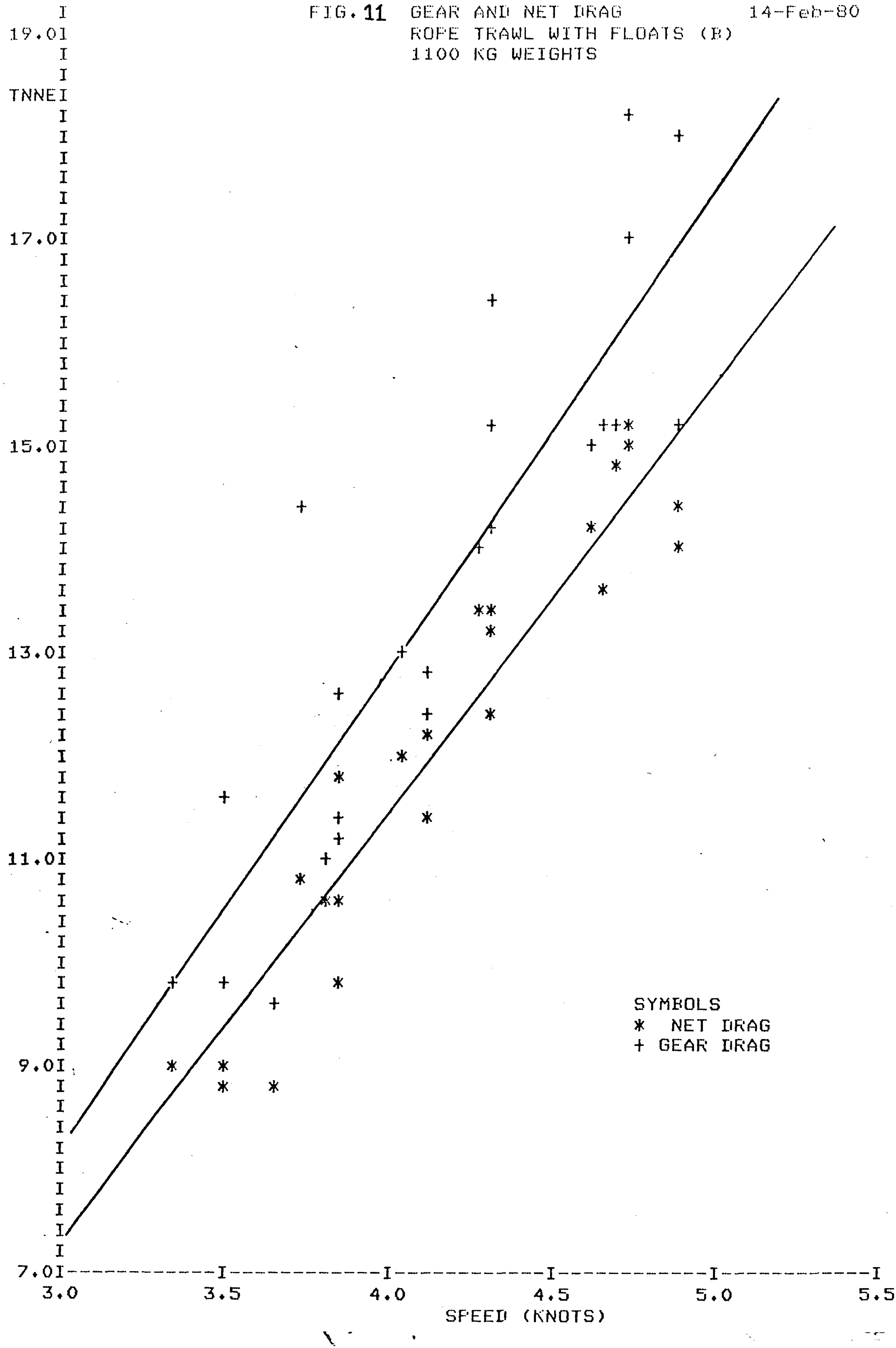


FIG. 11 GEAR AND NET DRAG
ROPE TRAWL WITH FLOATS (B)
1100 KG WEIGHTS
14-Feb-80
TNNE
19.0
17.0
15.0
13.0
11.0
9.0
7.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* NET DRAG
+ GEAR DRAG

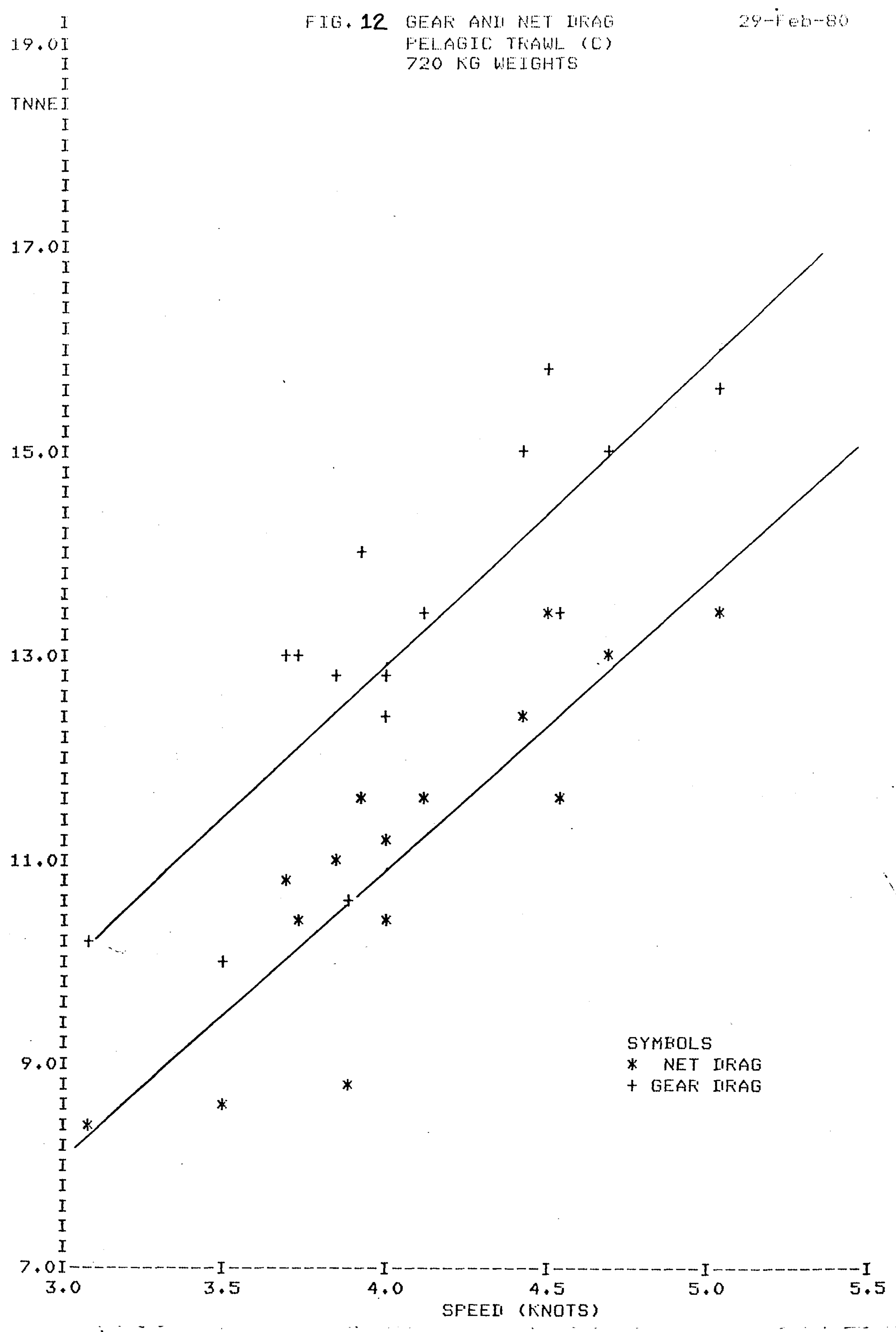


FIG. 12 GEAR AND NET DRAG
PELAGIC TRAWL (C)
720 KG WEIGHTS
29-Feb-80
TNNE
19.0
17.0
15.0
13.0
11.0
9.0
7.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* NET DRAG
+ GEAR DRAG

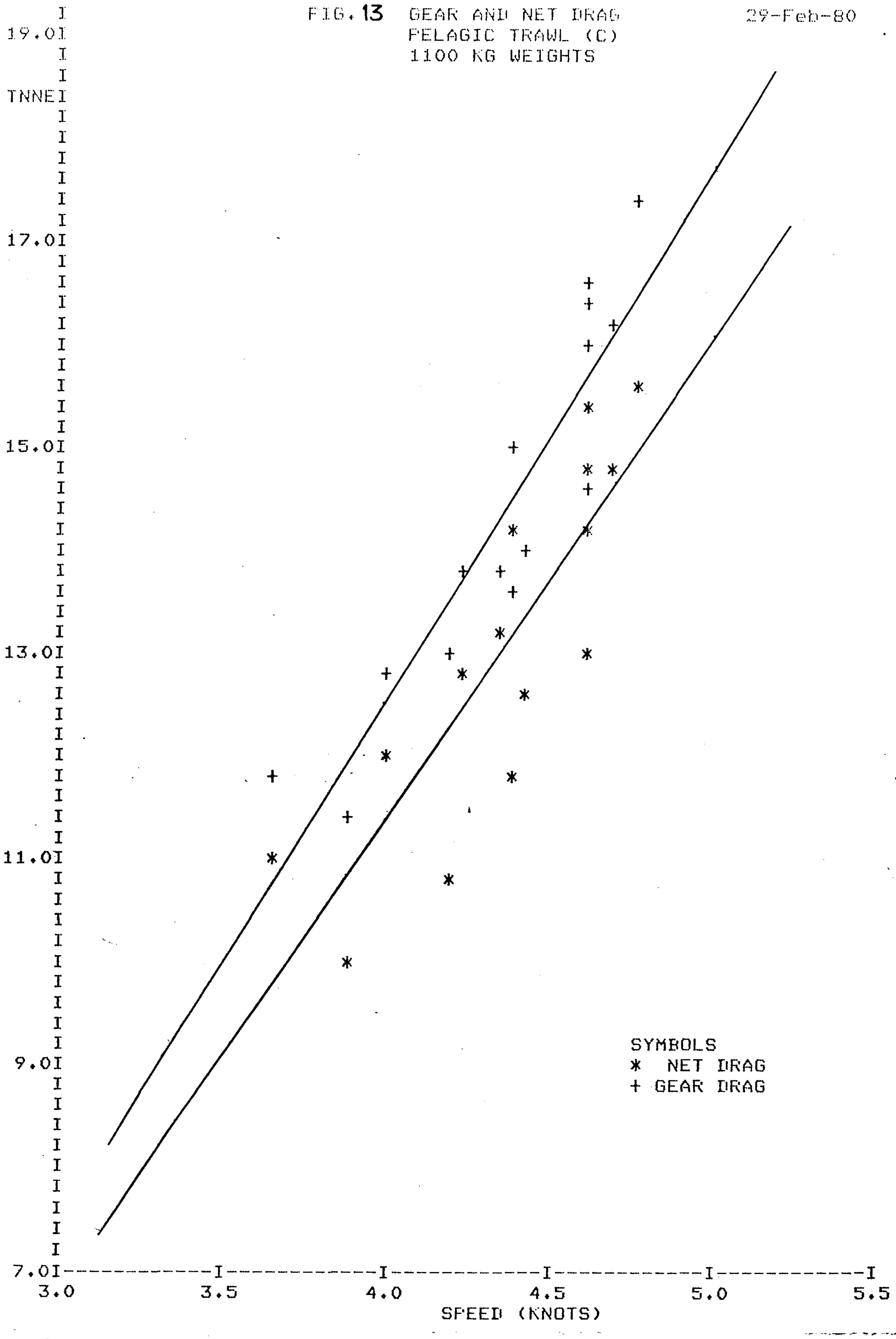


FIG. 13 GEAR AND NET DRAG
PELAGIC TRAWL (C)
1100 KG WEIGHTS
29-Feb-80
TNNE
19.0
17.0
15.0
13.0
11.0
9.0
7.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* NET DRAG
+ GEAR DRAG

FIG. 14 TOWING POWER VS. SPEED 23-Feb-80
ROPE TRAWL (A)

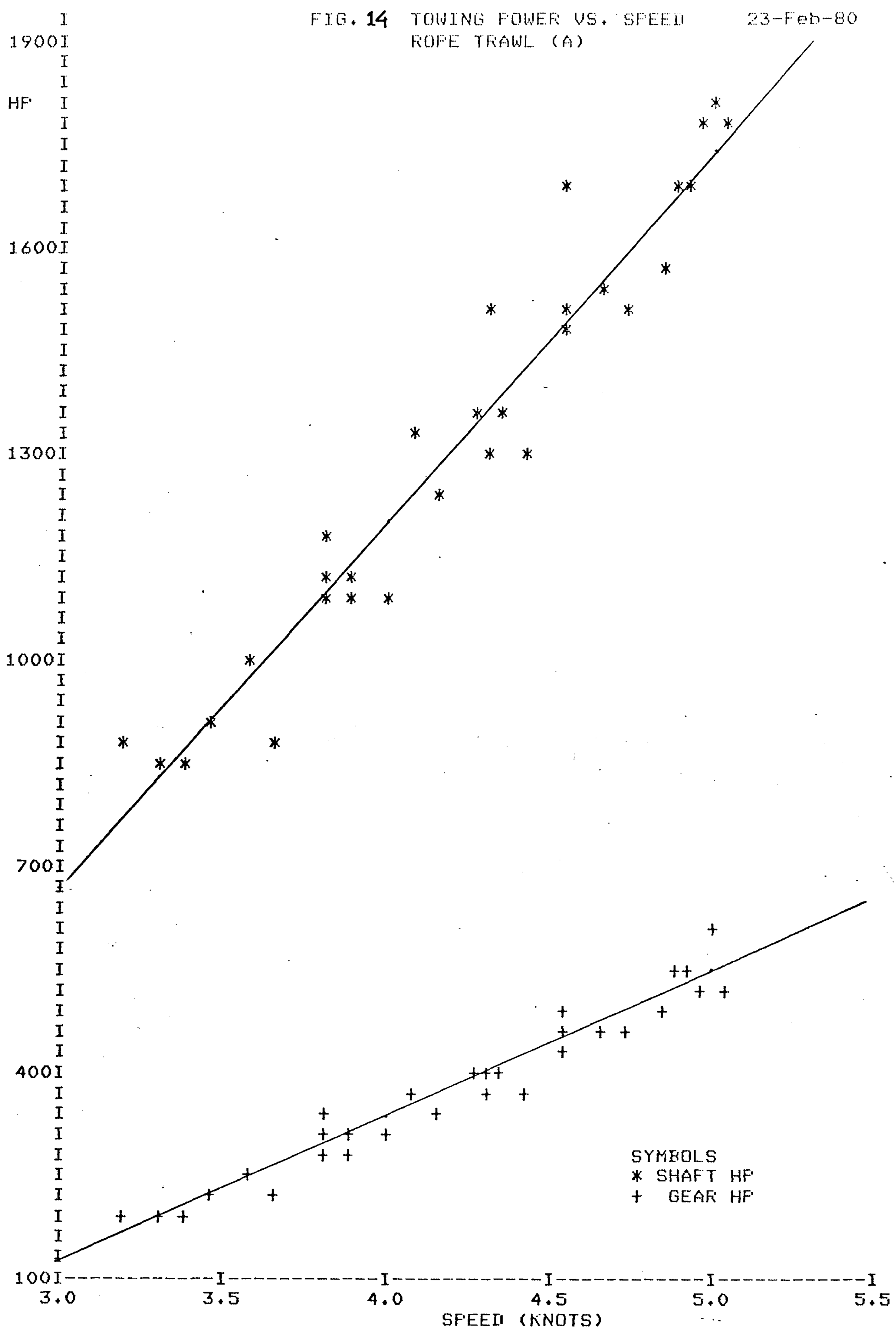


FIG. 15 TOWING POWER VS. SPEED 23-Feb-80
ROPE TRAWL WITH FLOATS (B)

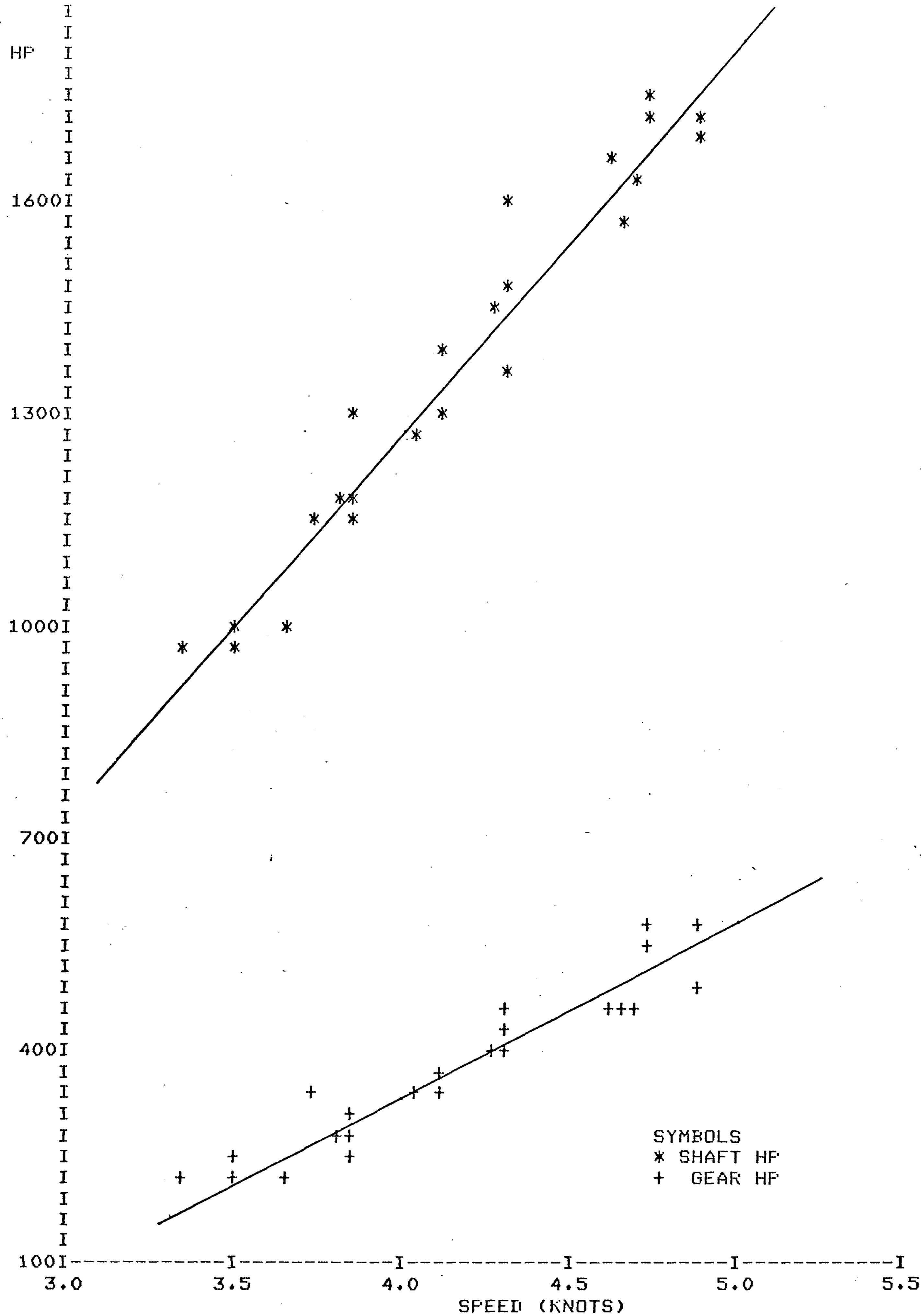
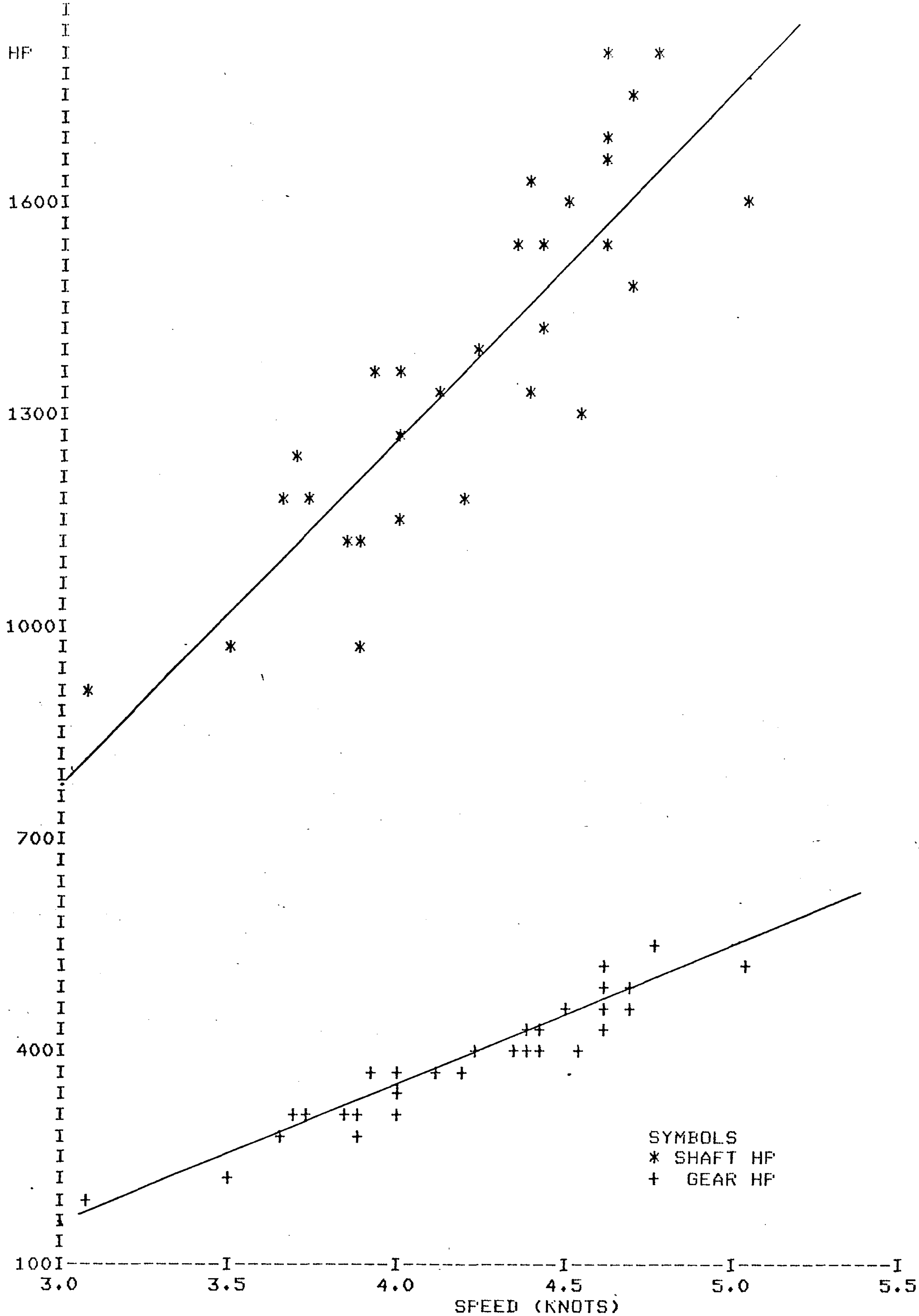


FIG. 16 TOWING POWER VS. SPEED 23-Feb-80
PELAGIC TRAWL (C)



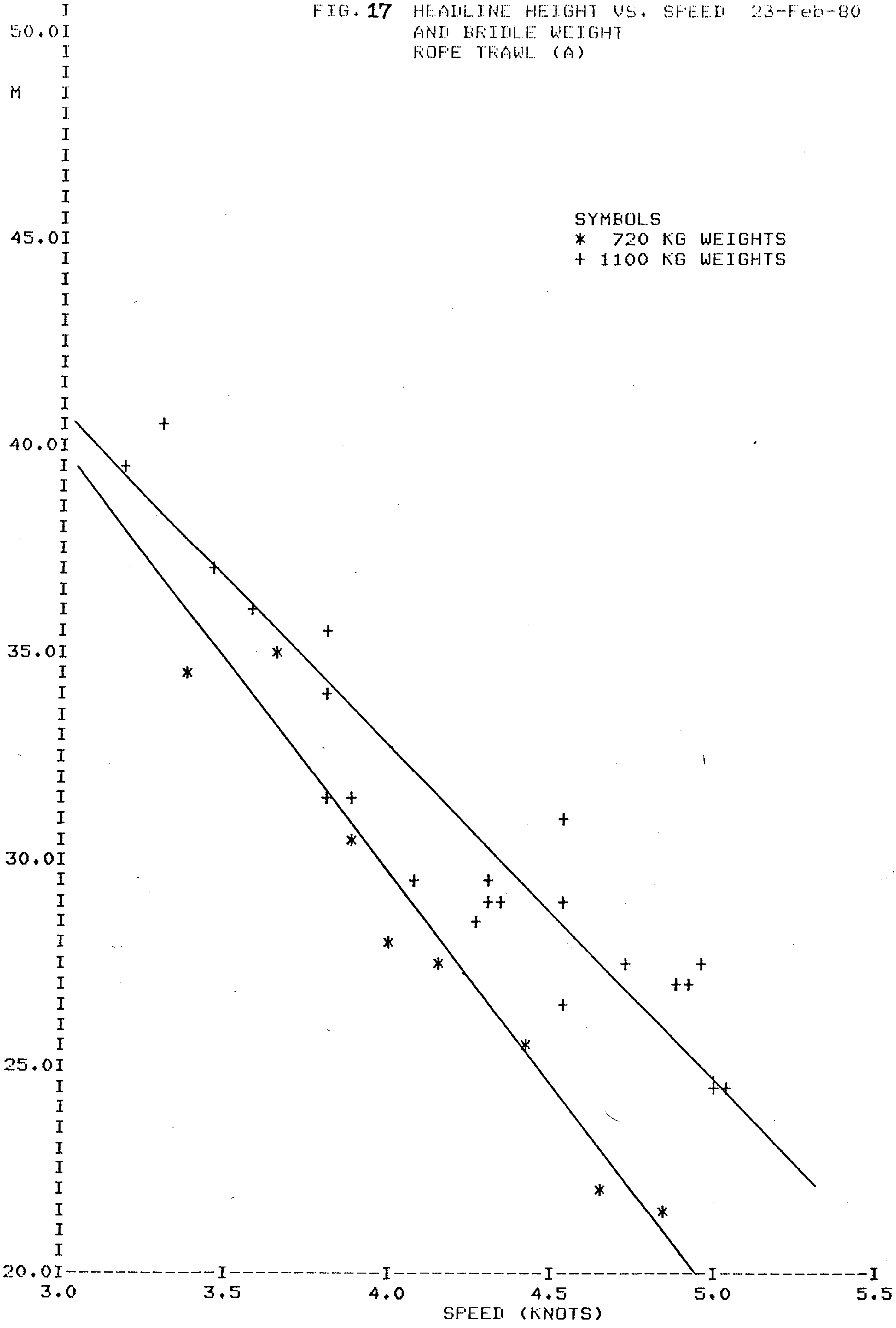


FIG. 17 HEADLINE HEIGHT VS. SPEED 23-Feb-80
AND BRIDLE WEIGHT
ROPE TRAWL (A)
SYMBOLS
* 720 KG WEIGHTS
+ 1100 KG WEIGHTS
M
50.0
45.0
40.0
35.0
30.0
25.0
20.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

FIG. 18 HEADLINE HEIGHT VS. SPEED 23-Feb-80
ROPE TRAWL WITH FLOATS (B)

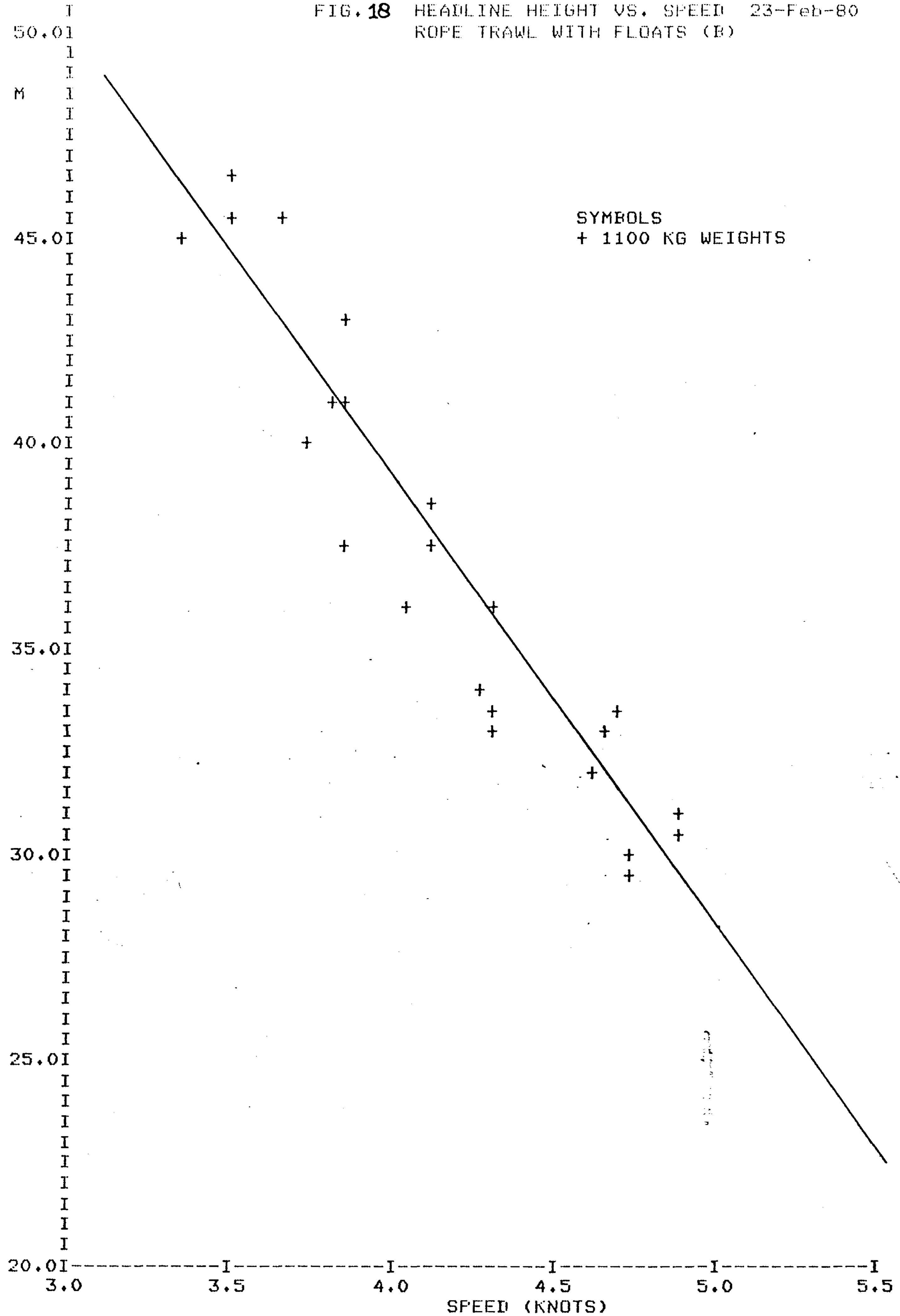
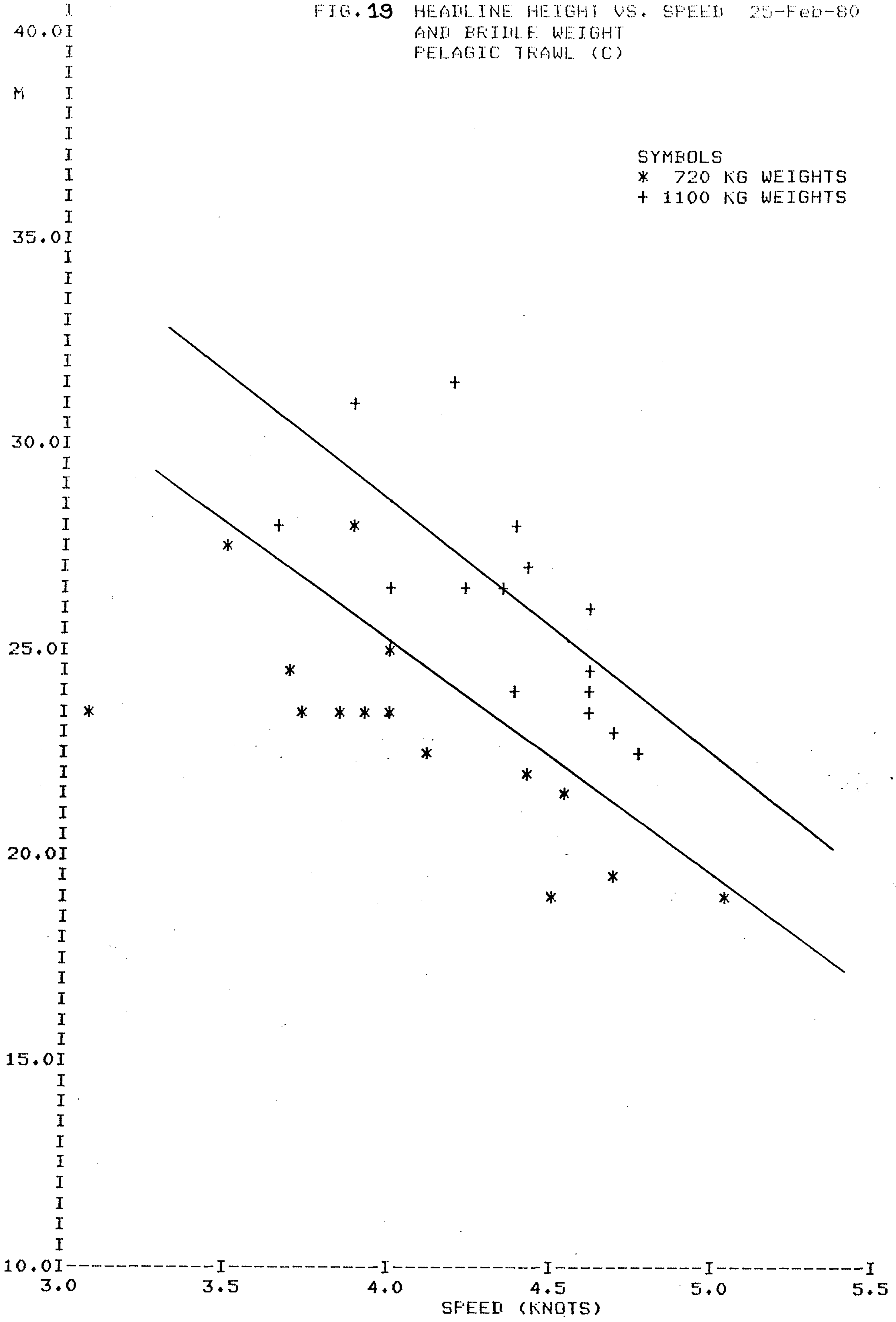


FIG. 19 HEADLINE HEIGHT VS. SPEED 25-Feb-80
AND BRIDLE WEIGHT
PELAGIC TRAWL (C)



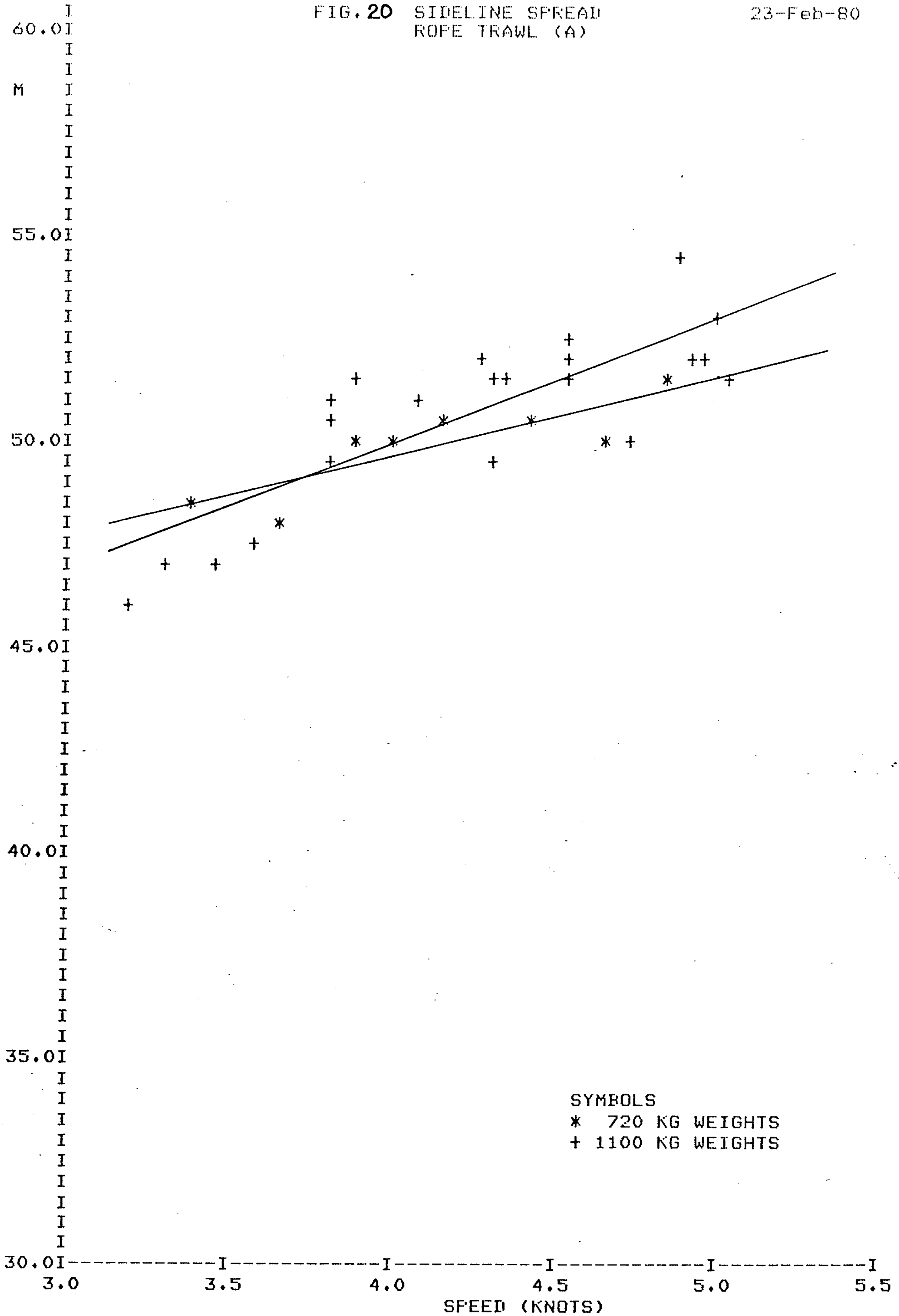


FIG. 20 SIDELINE SPREAD
ROPE TRAWL (A)
23-Feb-80
M
60.0
55.0
50.0
45.0
40.0
35.0
30.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* 720 KG WEIGHTS
+ 1100 KG WEIGHTS

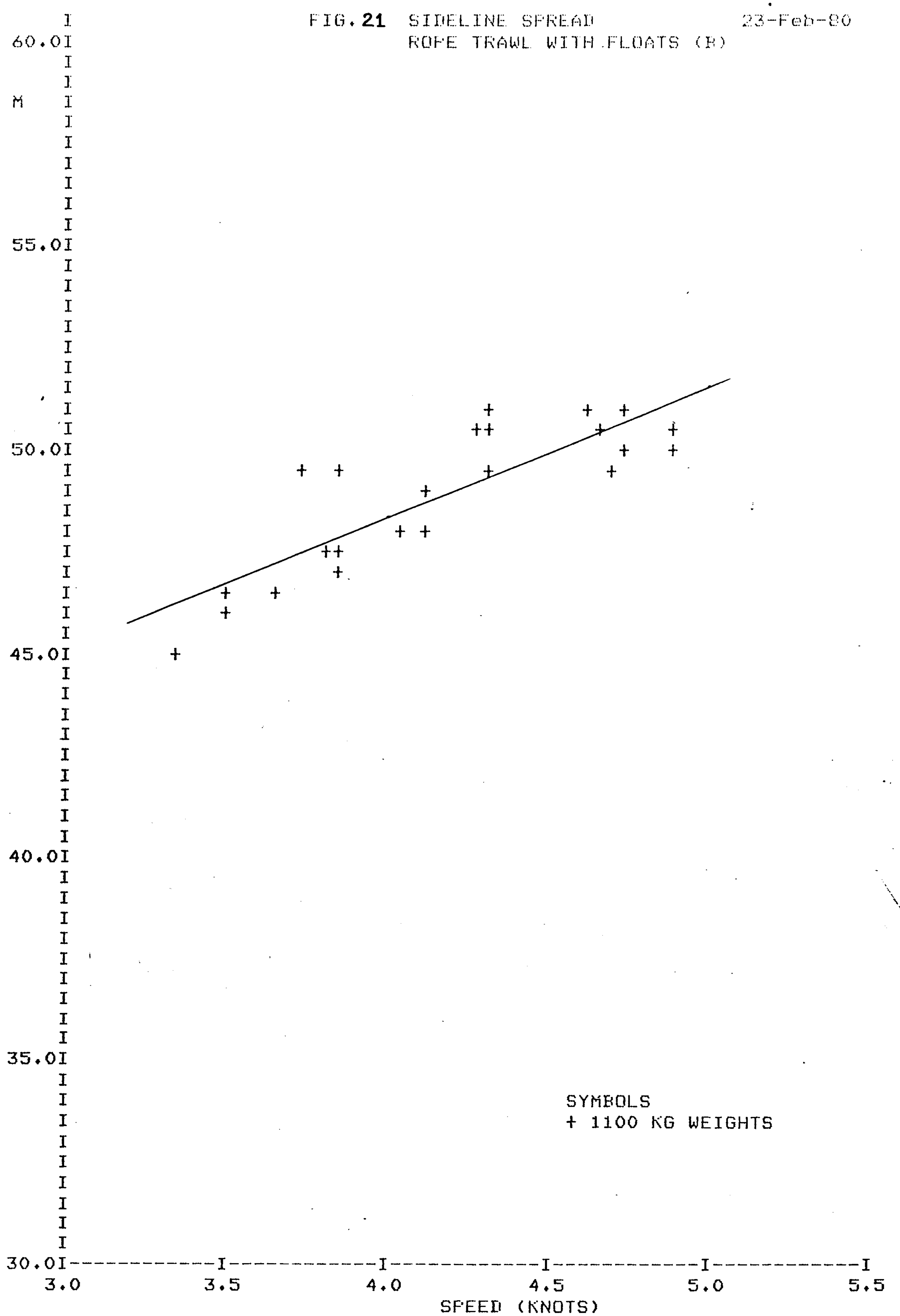


FIG. 21 SIDELINE SPREAD
ROPE TRAWL WITH FLOATS (B)
23-Feb-80
M
60.0
55.0
50.0
45.0
40.0
35.0
30.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
+ 1100 KG WEIGHTS

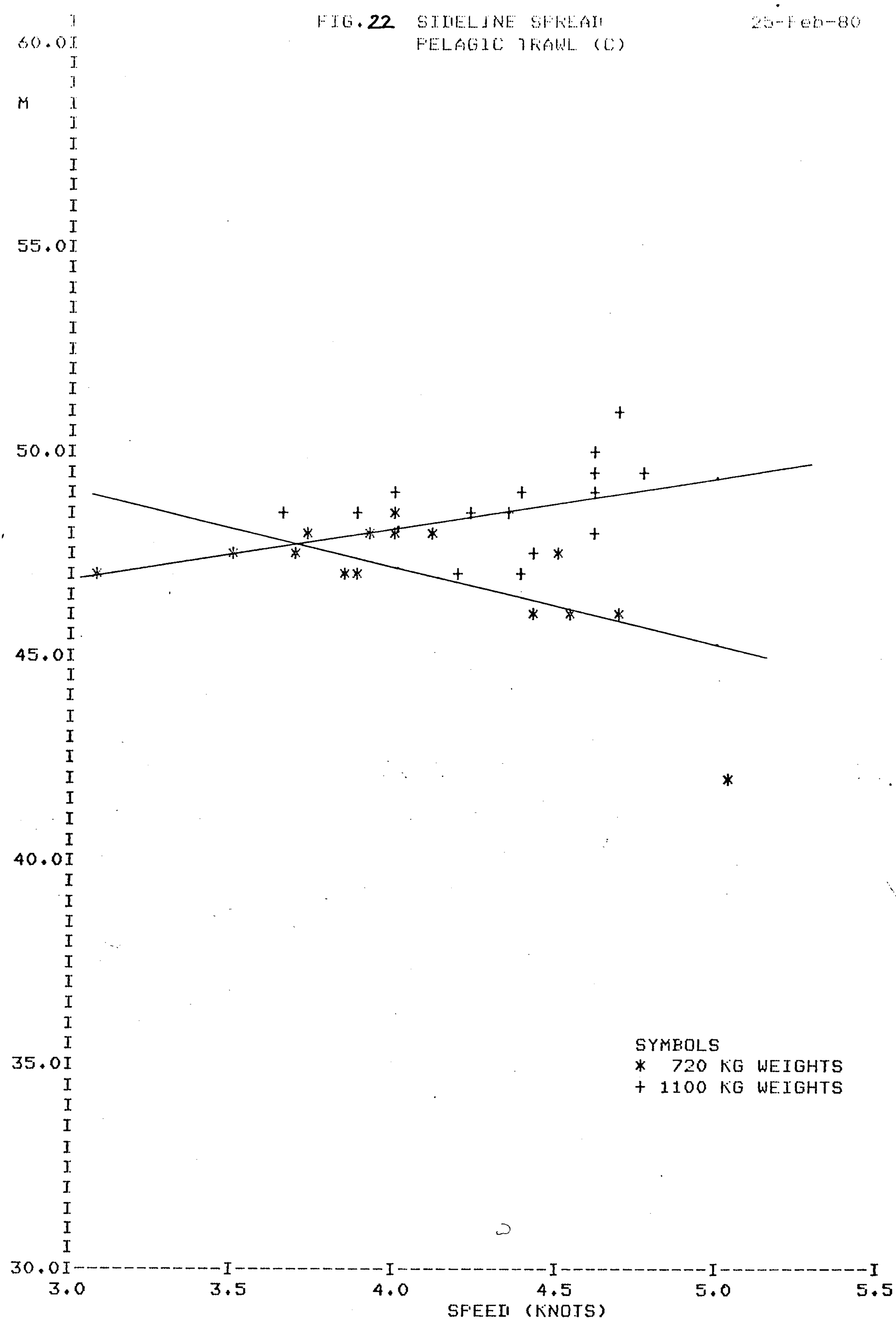
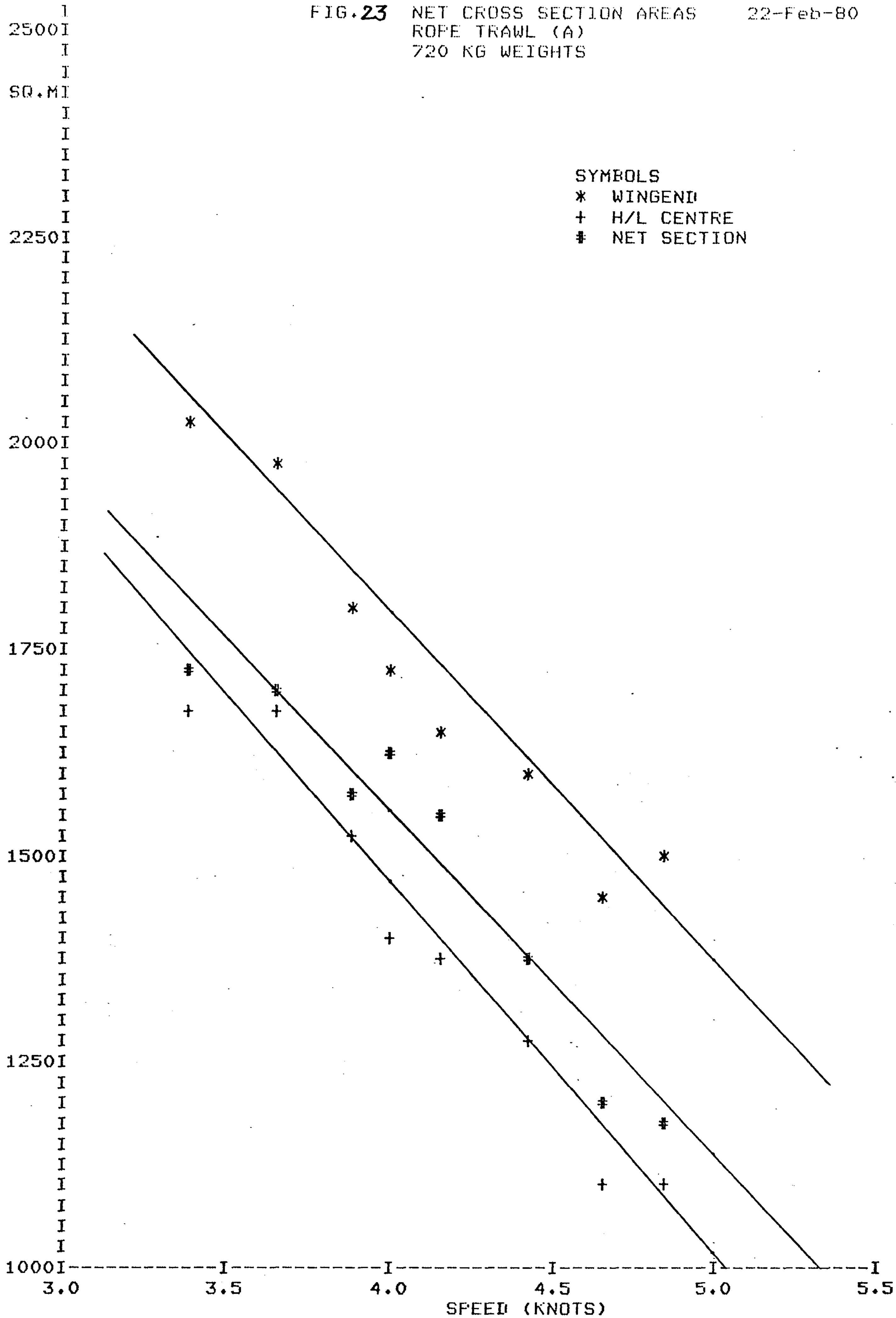


FIG. 22 SIDELINE SPREAD
PELAGIC TRAWL (C)
25-Feb-80
M
60.0
55.0
50.0
45.0
40.0
35.0
30.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* 720 KG WEIGHTS
+ 1100 KG WEIGHTS

FIG. 23 NET CROSS SECTION AREAS 22-Feb-80
ROPE TRAWL (A)
720 KG WEIGHTS



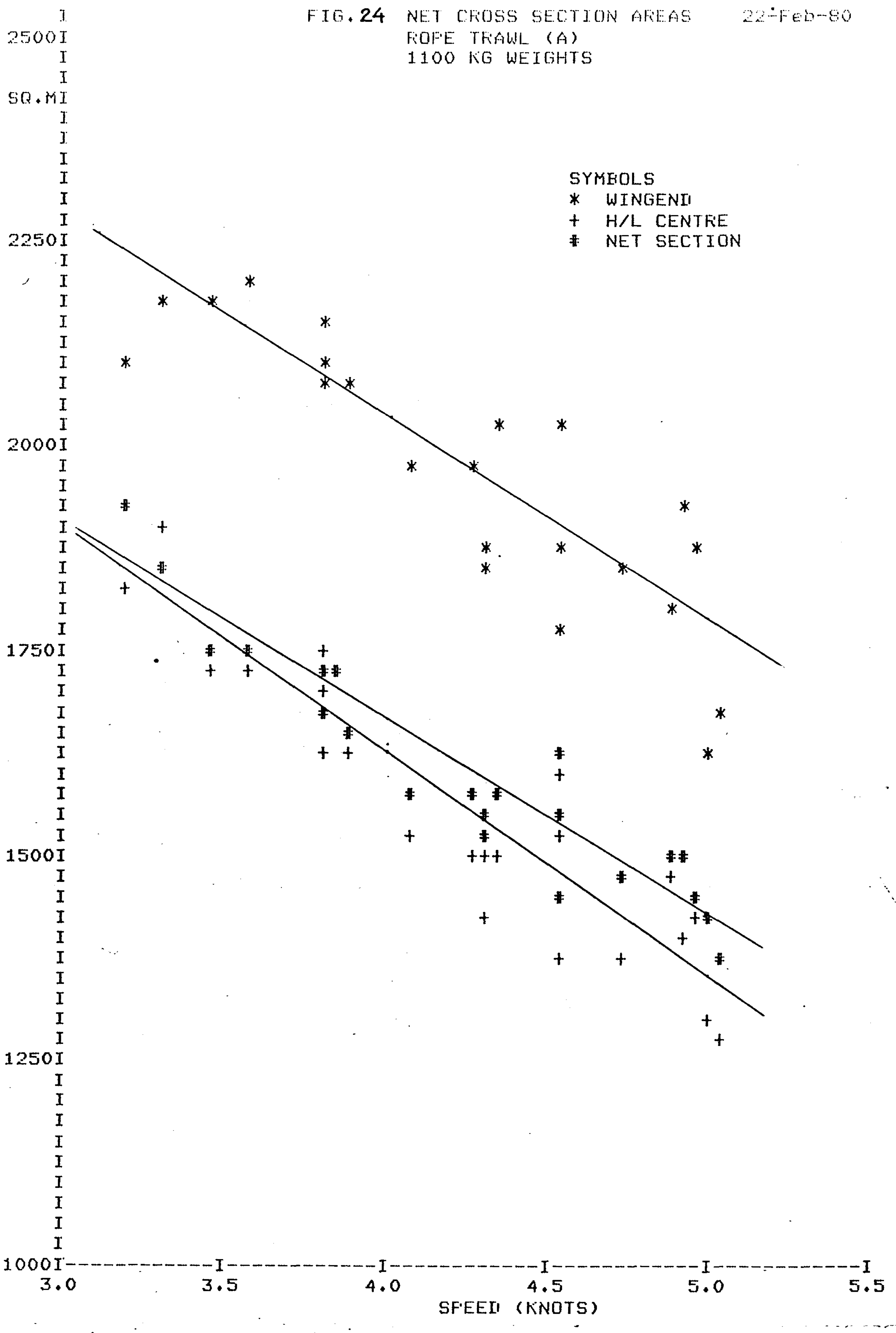


FIG. 24 NET CROSS SECTION AREAS 22-Feb-80
ROPE TRAWL (A)
1100 KG WEIGHTS
SQ.M
2500
2250
2000
1750
1500
1250
1000
SYMBOLS
* WINGEND
+ H/L CENTRE
# NET SECTION
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

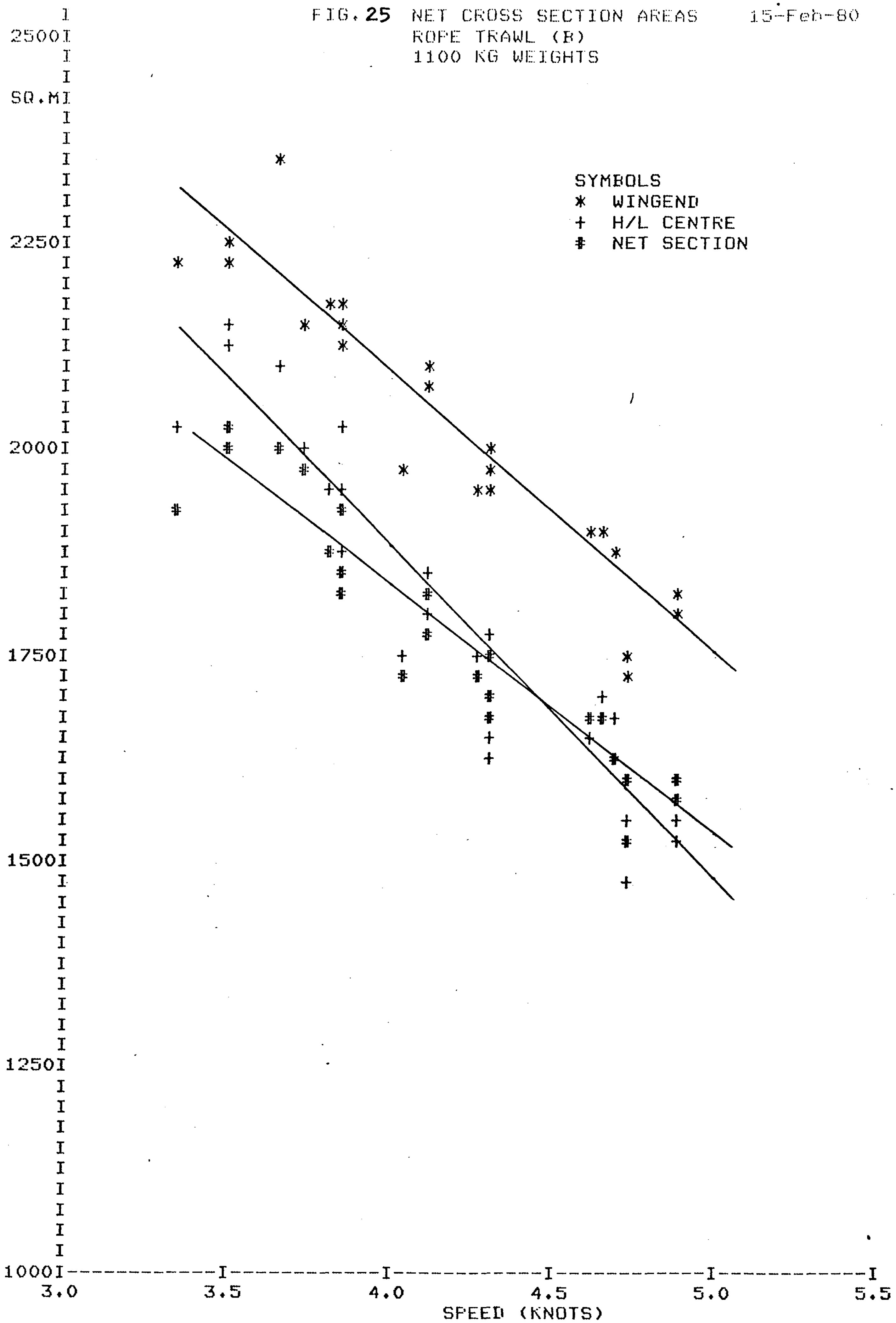


FIG. 25 NET CROSS SECTION AREAS
ROPE TRAWL (B)
1100 KG WEIGHTS
15-Feb-80
SQ.M
2500
2250
2000
1750
1500
1250
1000
SYMBOLS
* WINGEND
+ H/L CENTRE
# NET SECTION
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

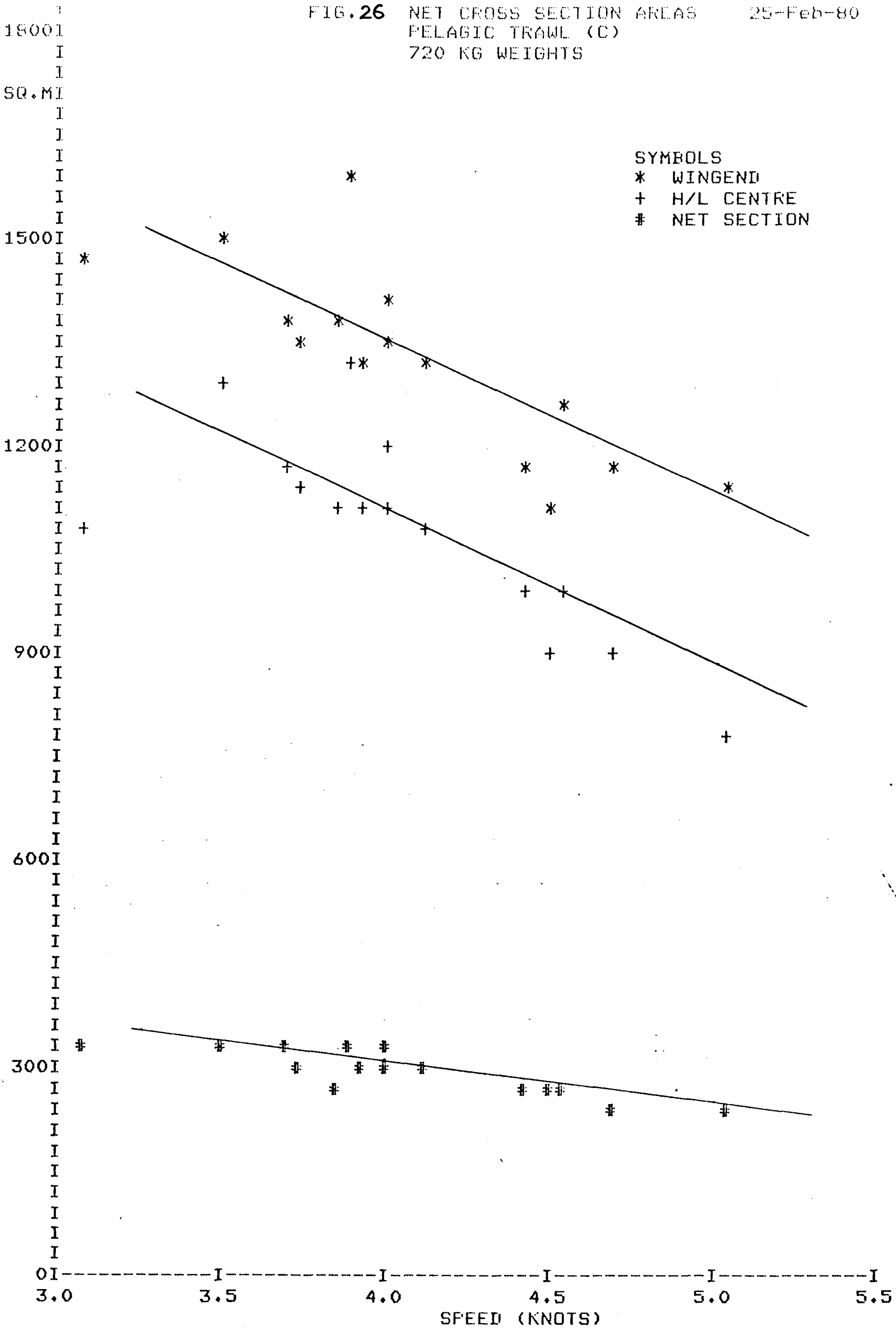


FIG.26 NET CROSS SECTION AREAS 25-Feb-80
PELAGIC TRAWL (C)
720 KG WEIGHTS
SQ.M
1800
1500
1200
900
600
300
0
SYMBOLS
* WINGEND
+ H/L CENTRE
# NET SECTION
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

FIG. 27 NET CROSS SECTION AREAS 22-Feb-80
PELAGIC TRAWL (C)
1100 KG WEIGHTS

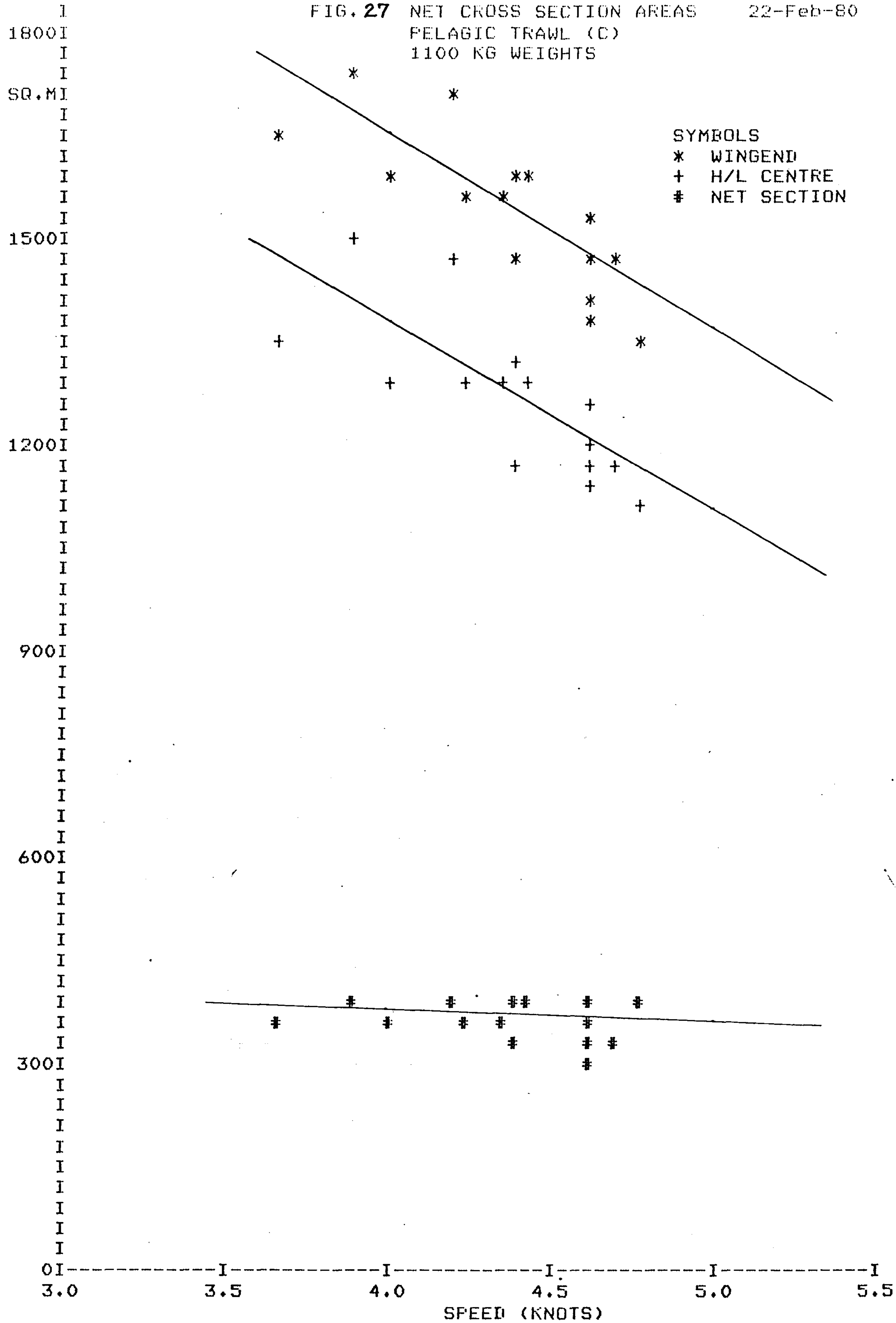


FIG. 28 HEADLINE DEPTH VS. SPEED 23-Feb-80
USING 600 M WARP LENGTH
ROPE TRAWL (A)

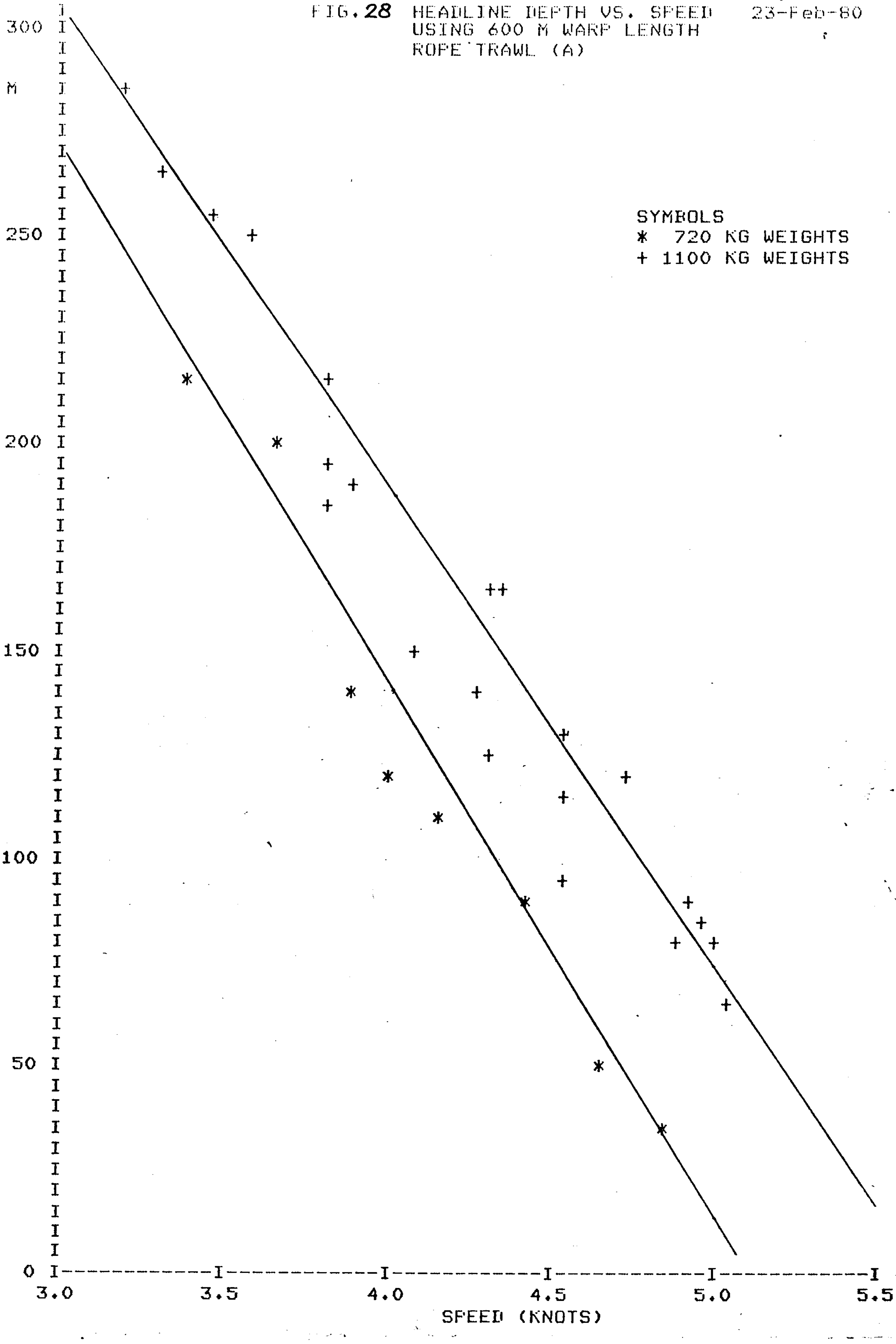
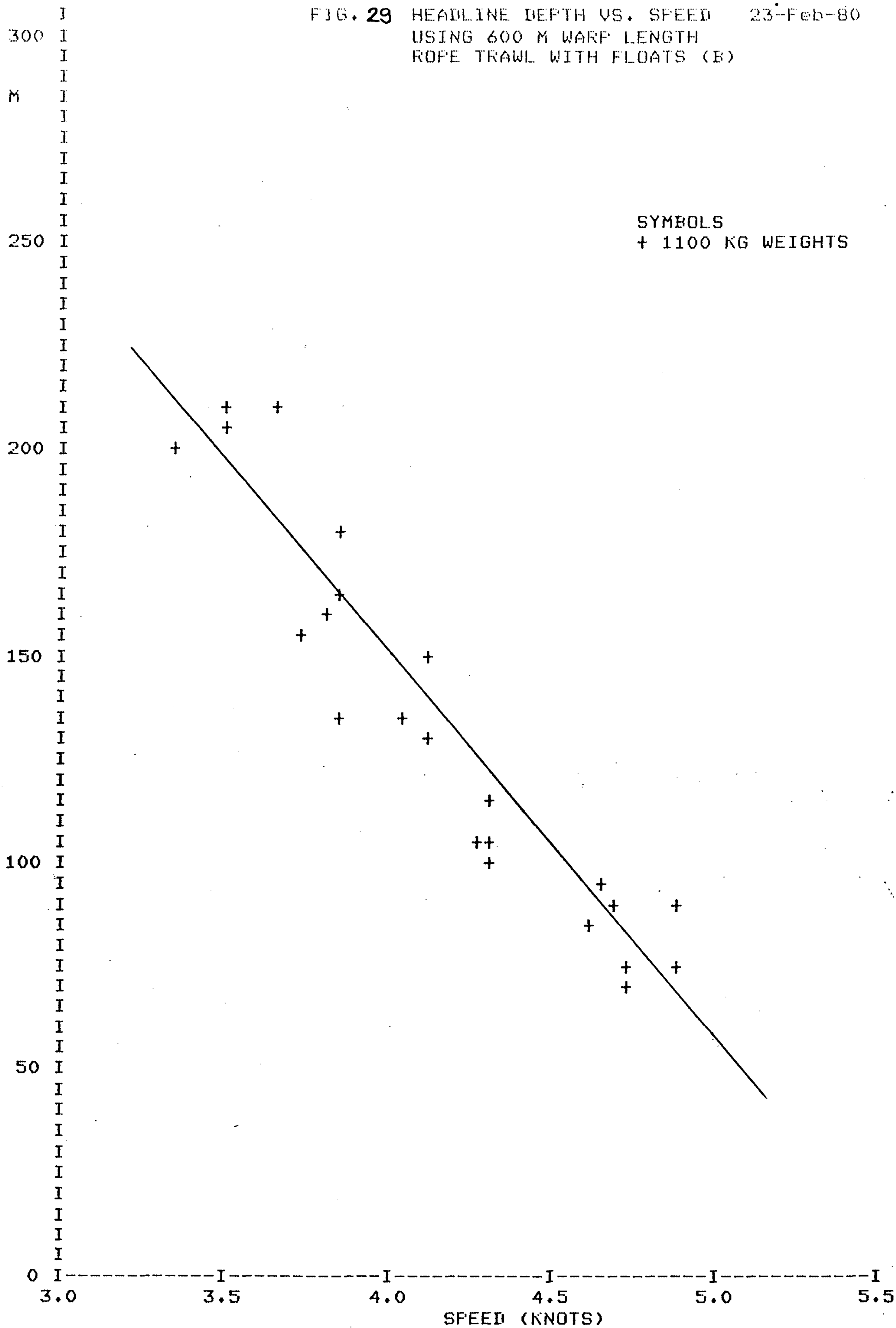


FIG. 29 HEADLINE DEPTH VS. SPEED 23-Feb-80
USING 600 M WARP LENGTH
ROPE TRAWL WITH FLOATS (B)



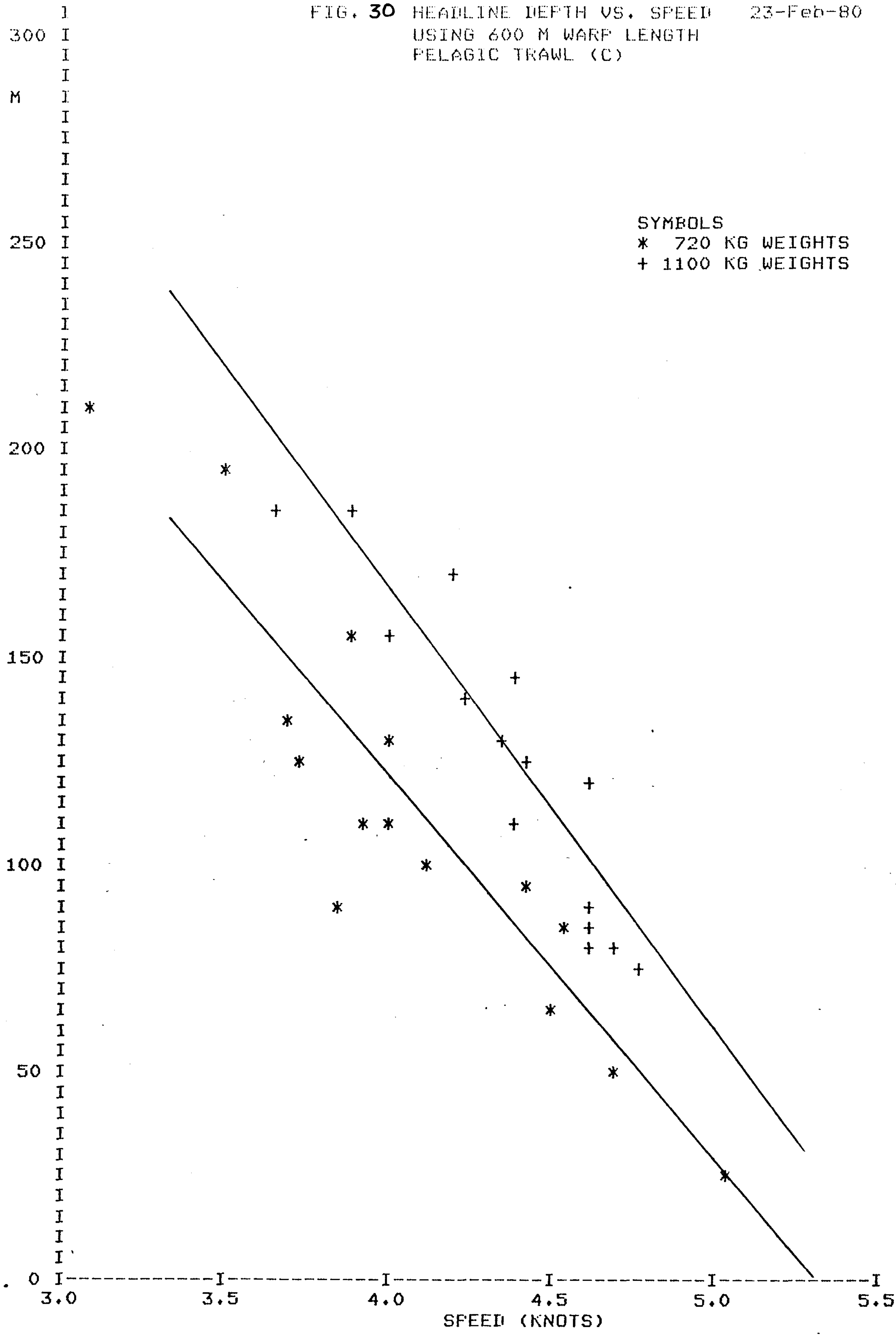


FIG. 30 HEADLINE DEPTH VS. SPEED 23-Feb-80
USING 600 M WARP LENGTH
PELAGIC TRAWL (C)
SYMBOLS
* 720 KG WEIGHTS
+ 1100 KG WEIGHTS
M
300
250
200
150
100
50
0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

FIG. 31 MEAN DOOR HEIGHT ABOVE THE HEADLINE CENTRE ROPE TRAWL (A)

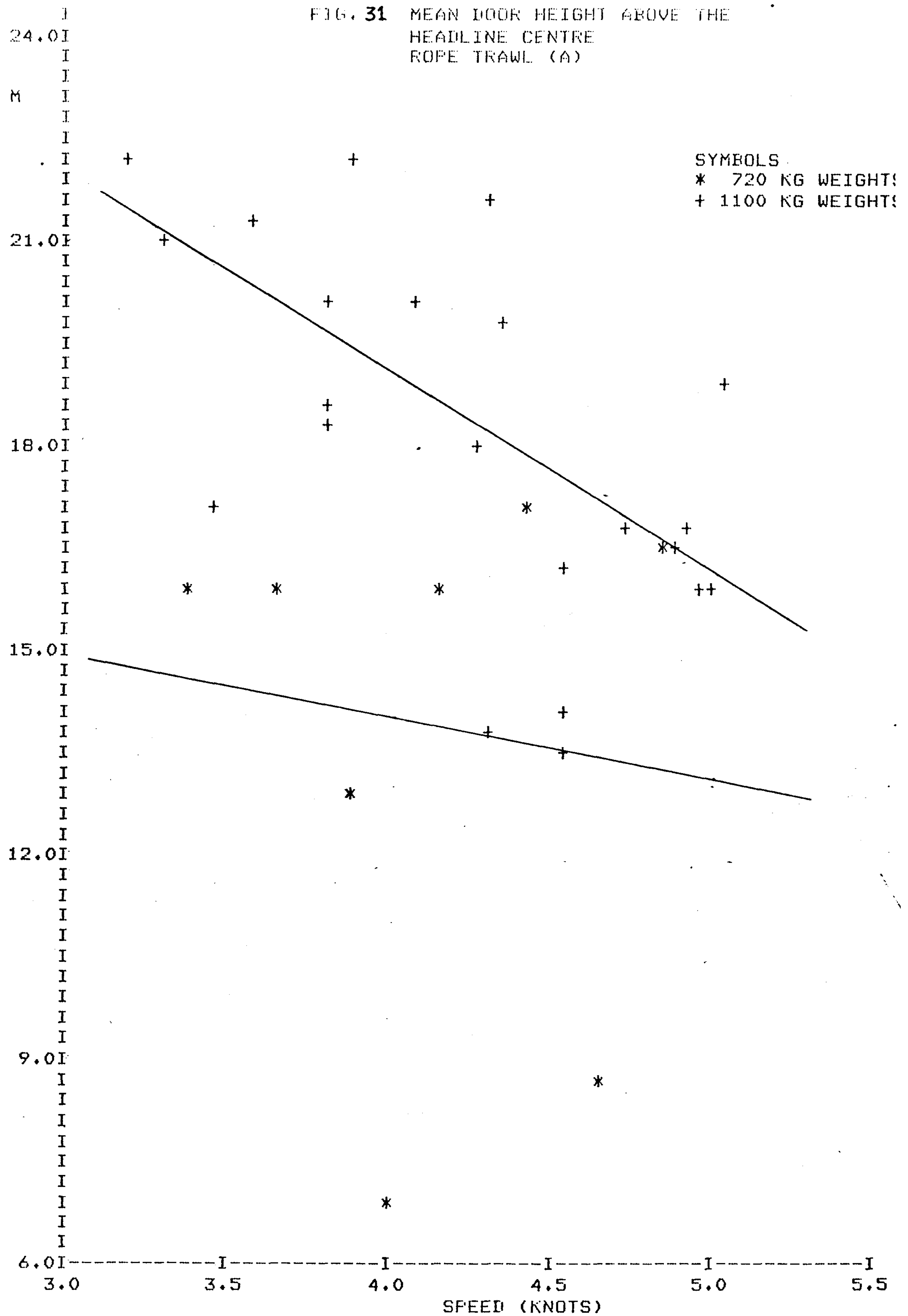


FIG. 32 MEAN DOOR HEIGHT ABOVE THE HEADLINE CENTRE
ROPE TRAWL WITH FLOATS (B)

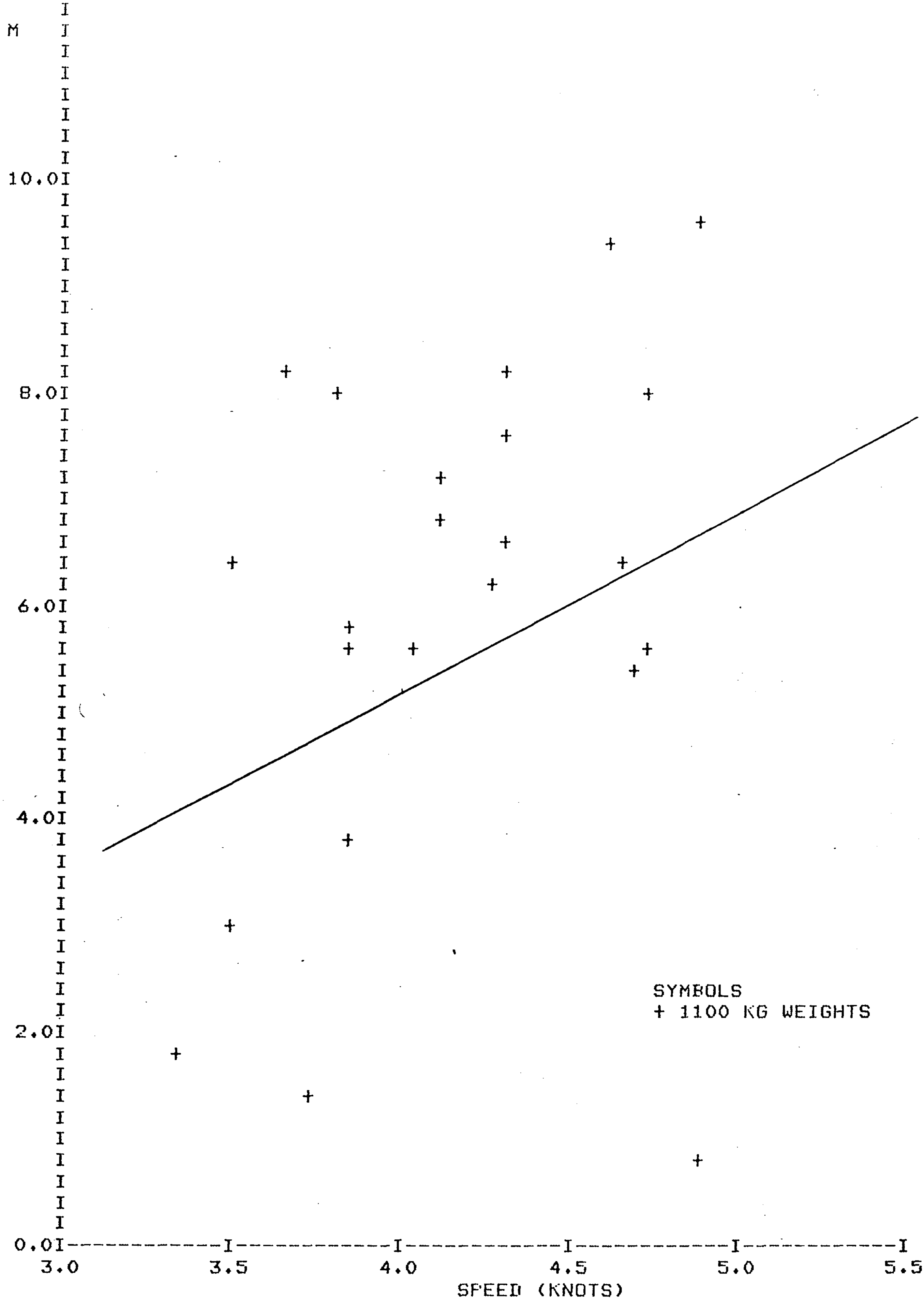


FIG. 33 MEAN DOOR HEIGHT ABOVE THE HEADLINE CENTRE PELAGIC TRAWL (C)

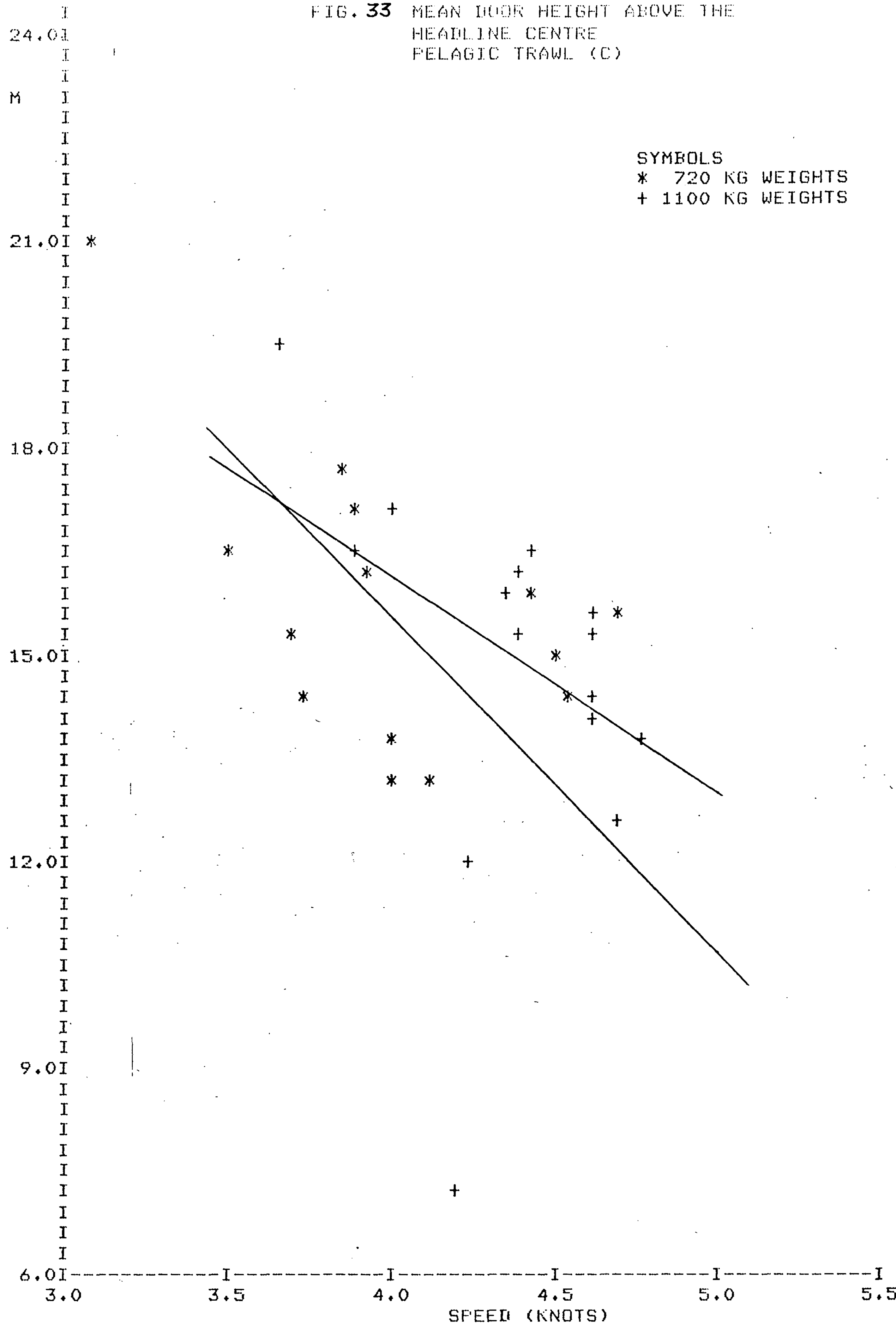


FIG. 34 NET DRAG / CROSS SECTION AREA AT THE HEADLINE CENTRE WITH 720 KG WEIGHTS

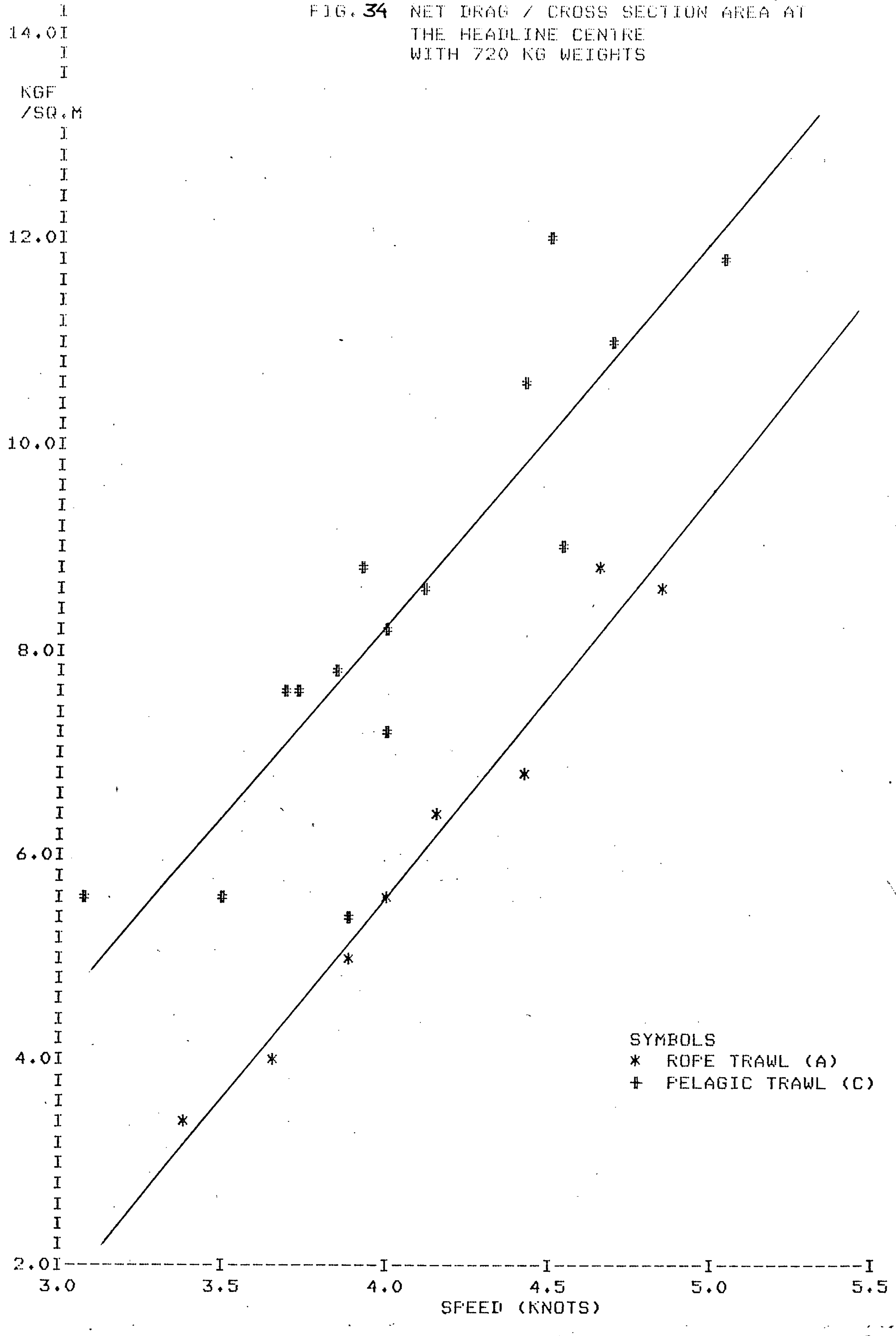
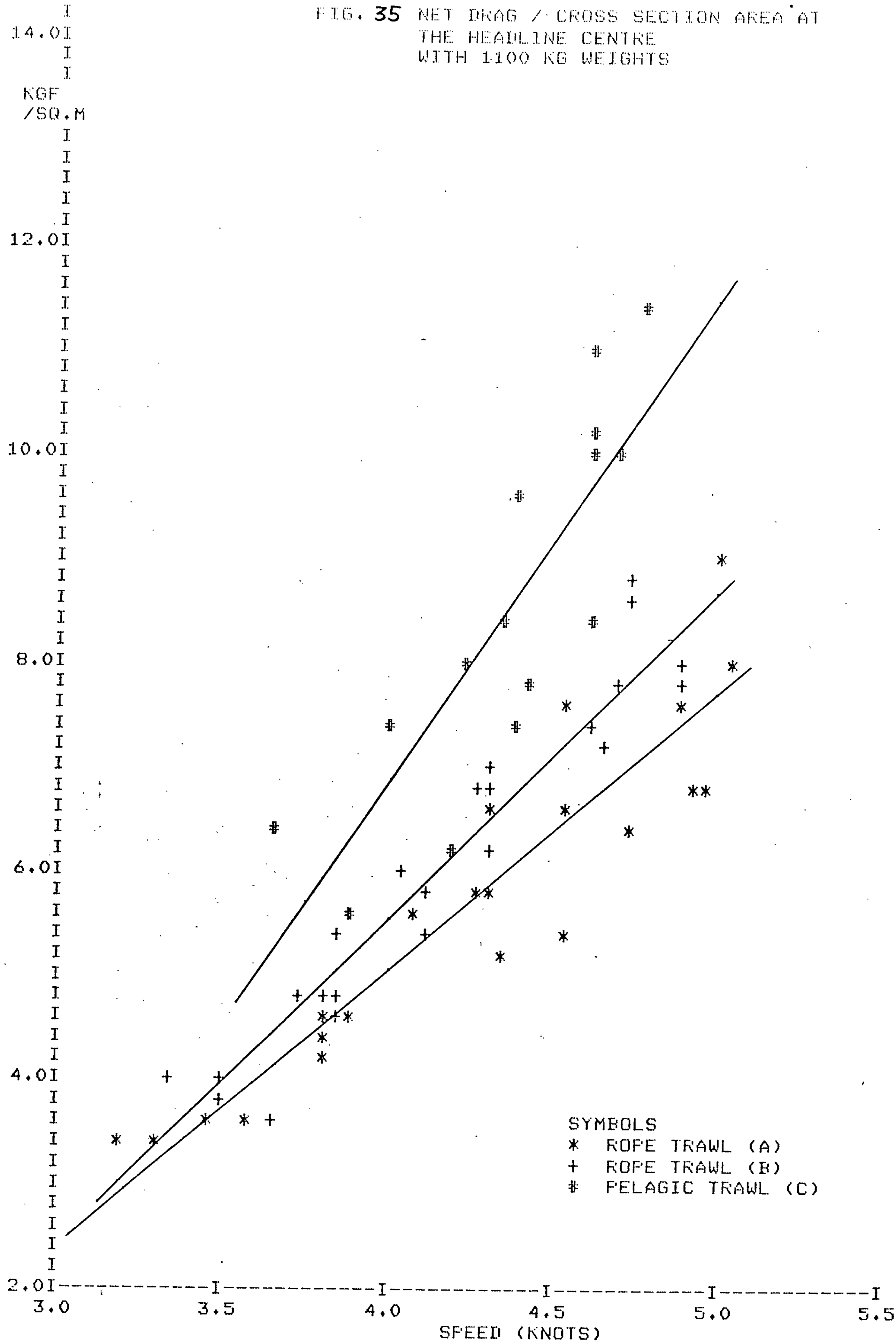


FIG. 35 NET DRAG / CROSS SECTION AREA AT THE HEADLINE CENTRE WITH 1100 KG WEIGHTS



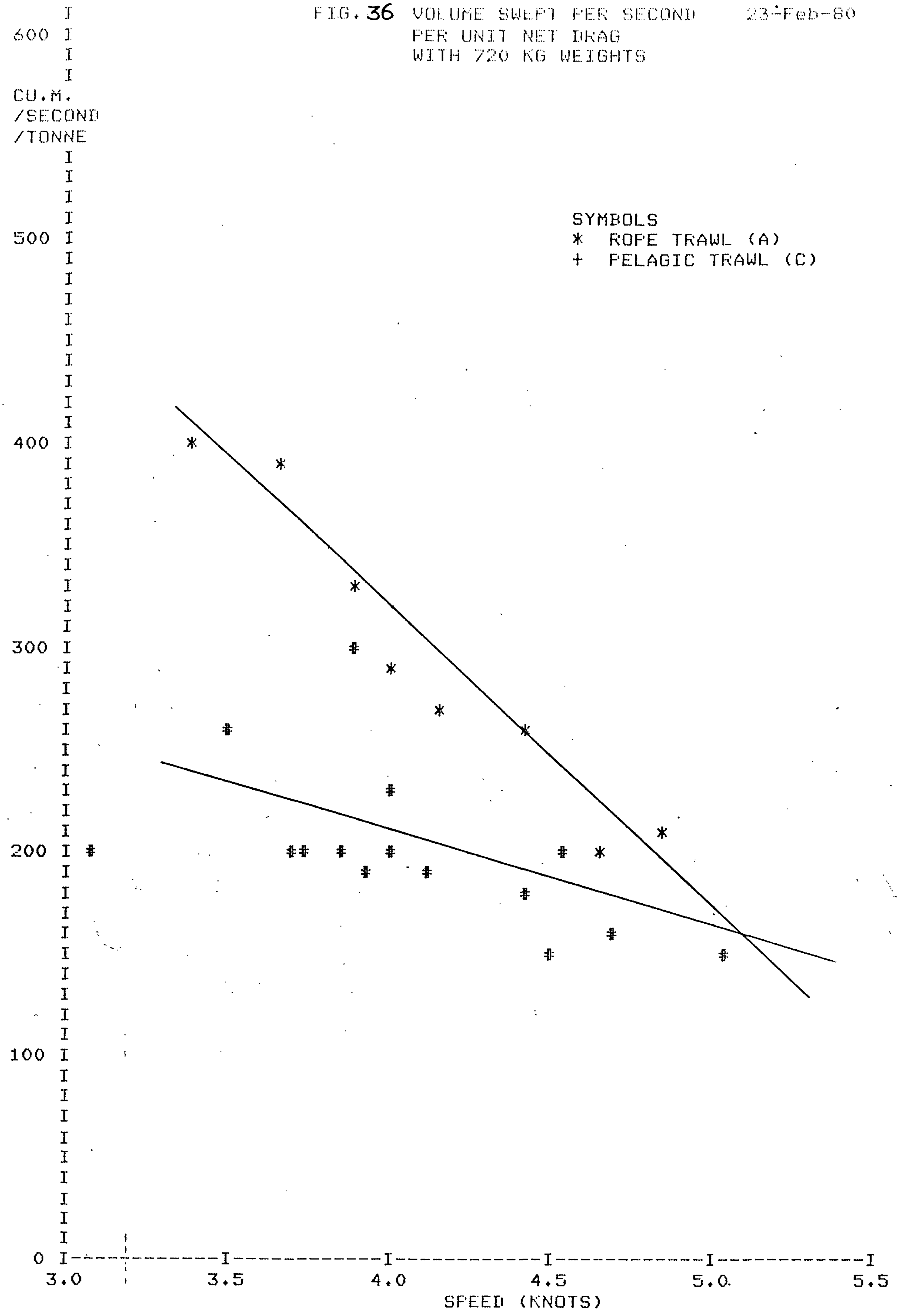


FIG. 36 VOLUME SWEPT PER SECOND
PER UNIT NET DRAG
WITH 720 KG WEIGHTS
23-Feb-80
CU.M.
/SECOND
/TONNE
600
500
400
300
200
100
0
SYMBOLS
* ROPE TRAWL (A)
+ PELAGIC TRAWL (C)
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)

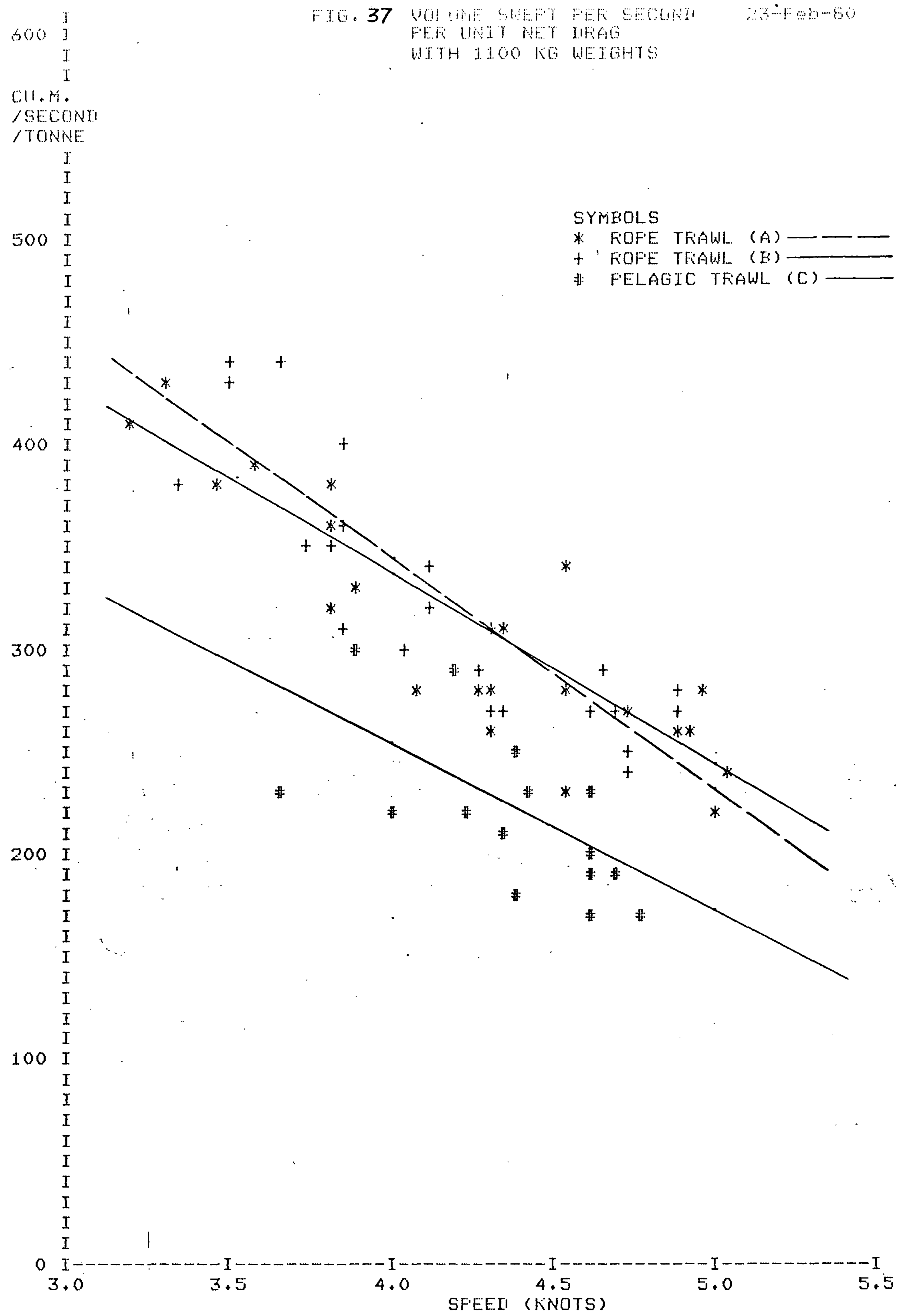


FIG. 37 VOLUME SWEPT PER SECOND PER UNIT NET DRAG WITH 1100 KG WEIGHTS
23-Feb-80
CU.M. /SECOND /TONNE
600
500
400
300
200
100
0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOLS
* ROPE TRAWL (A)
+ ROPE TRAWL (B)
# PELAGIC TRAWL (C)

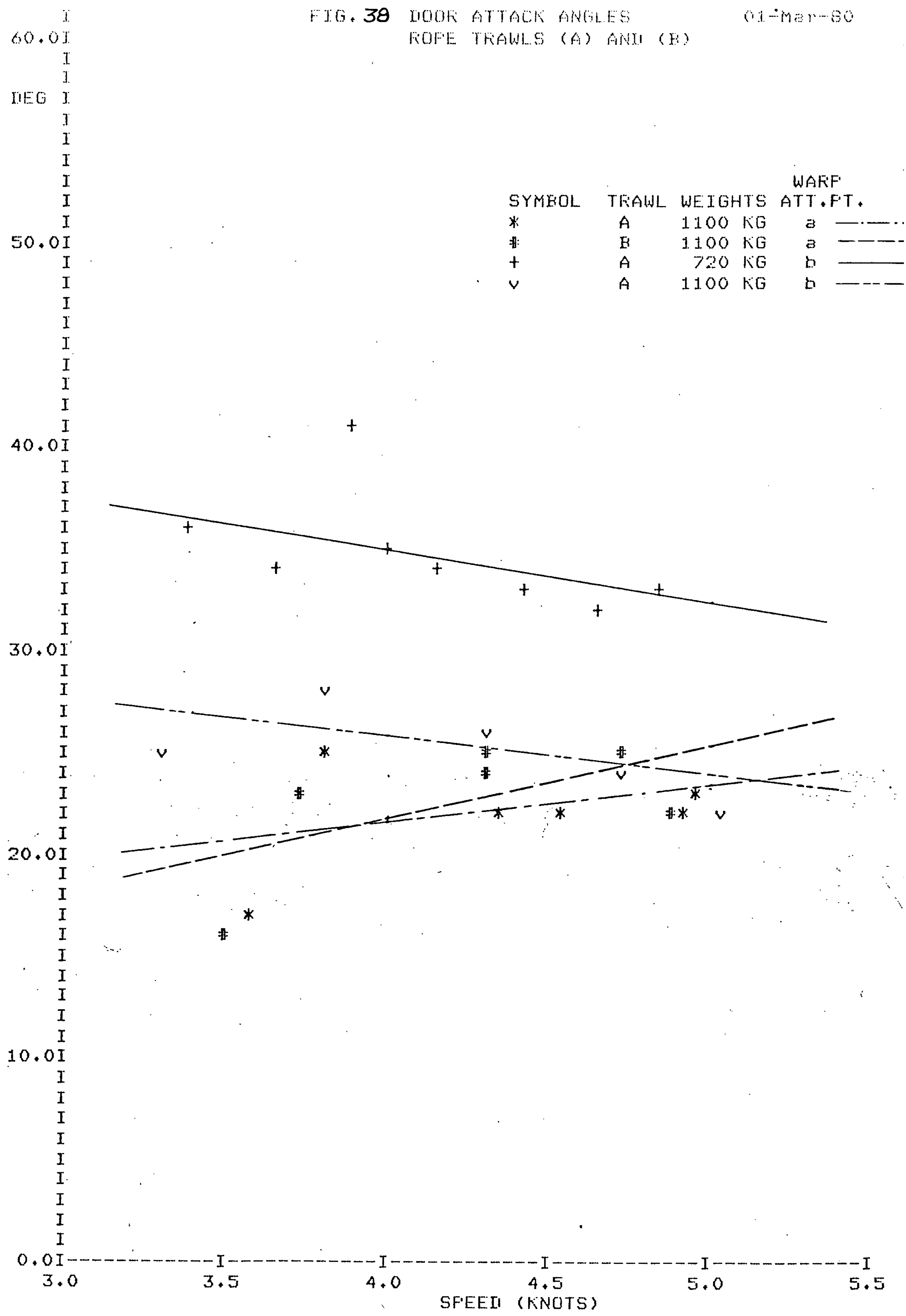
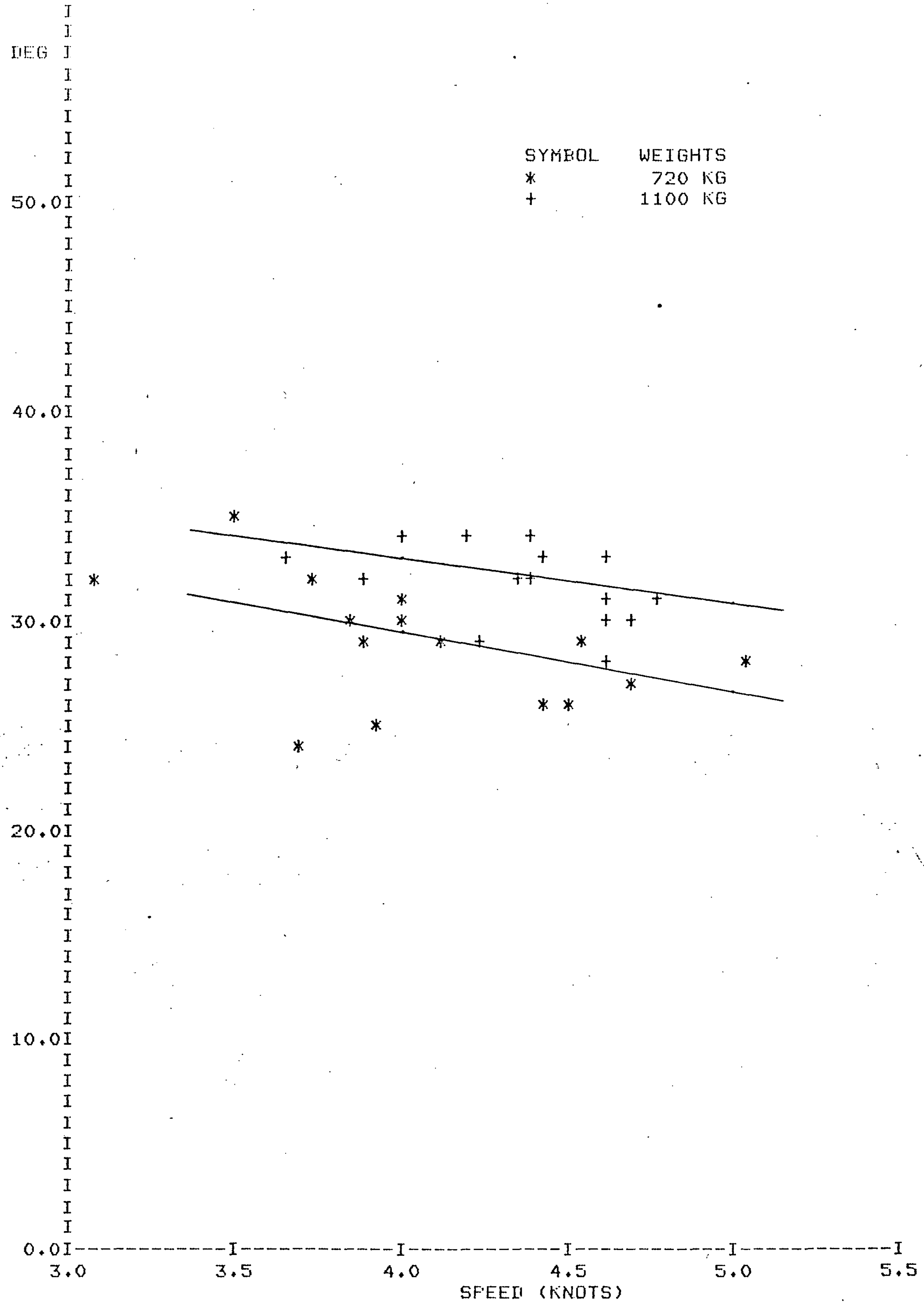


FIG. 38 DOOR ATTACK ANGLES
ROPE TRAWLS (A) AND (B)
01-Mar-80
DEG
60.0
50.0
40.0
30.0
20.0
10.0
0.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOL TRAWL WEIGHTS WARP ATT.PT.
* A 1100 KG a
# B 1100 KG a
+ A 720 KG b
v A 1100 KG b

FIG. 39 DOOR ATTACK ANGLES
PELAGIC TRAWL (C)

01-Mar-80



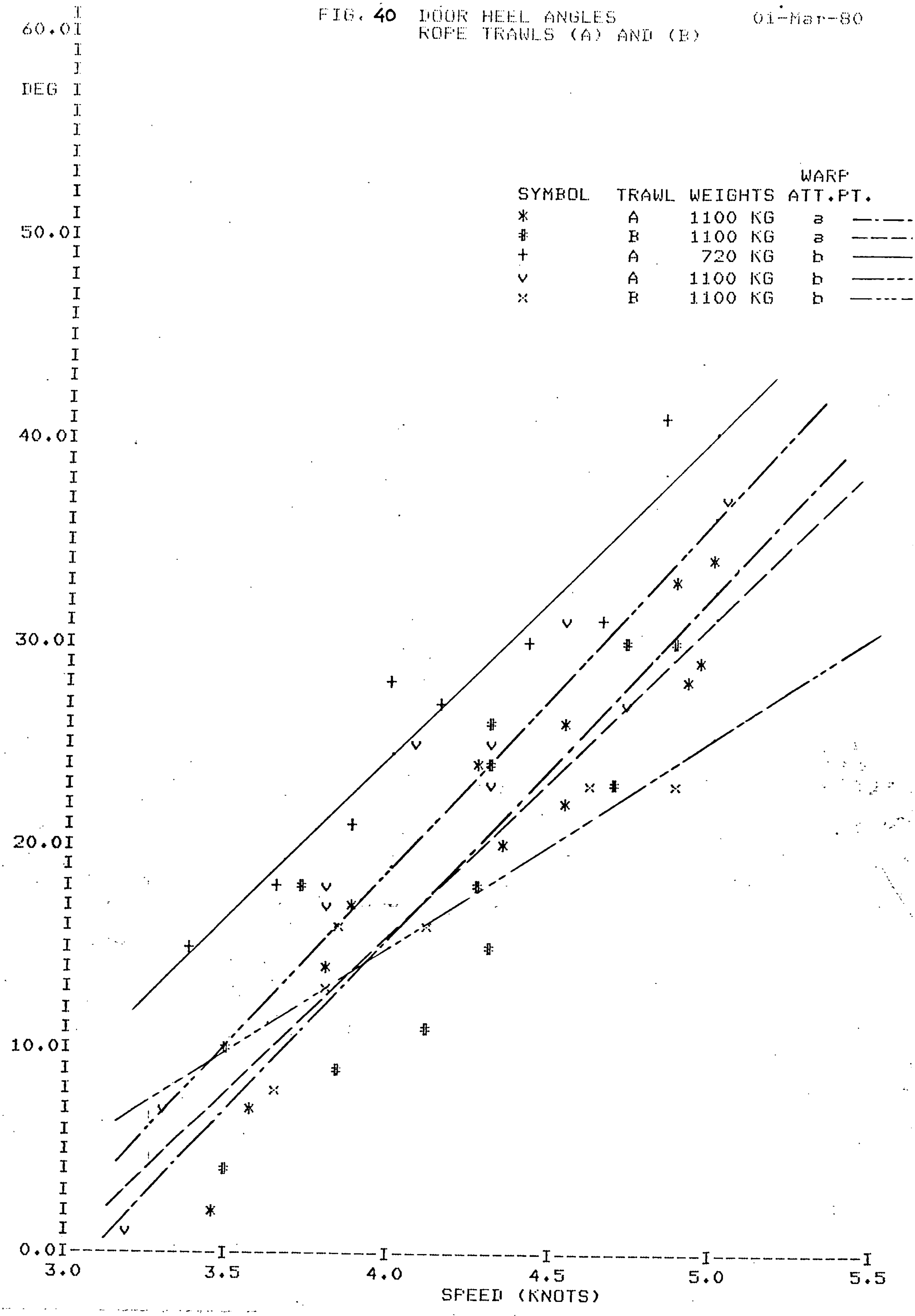
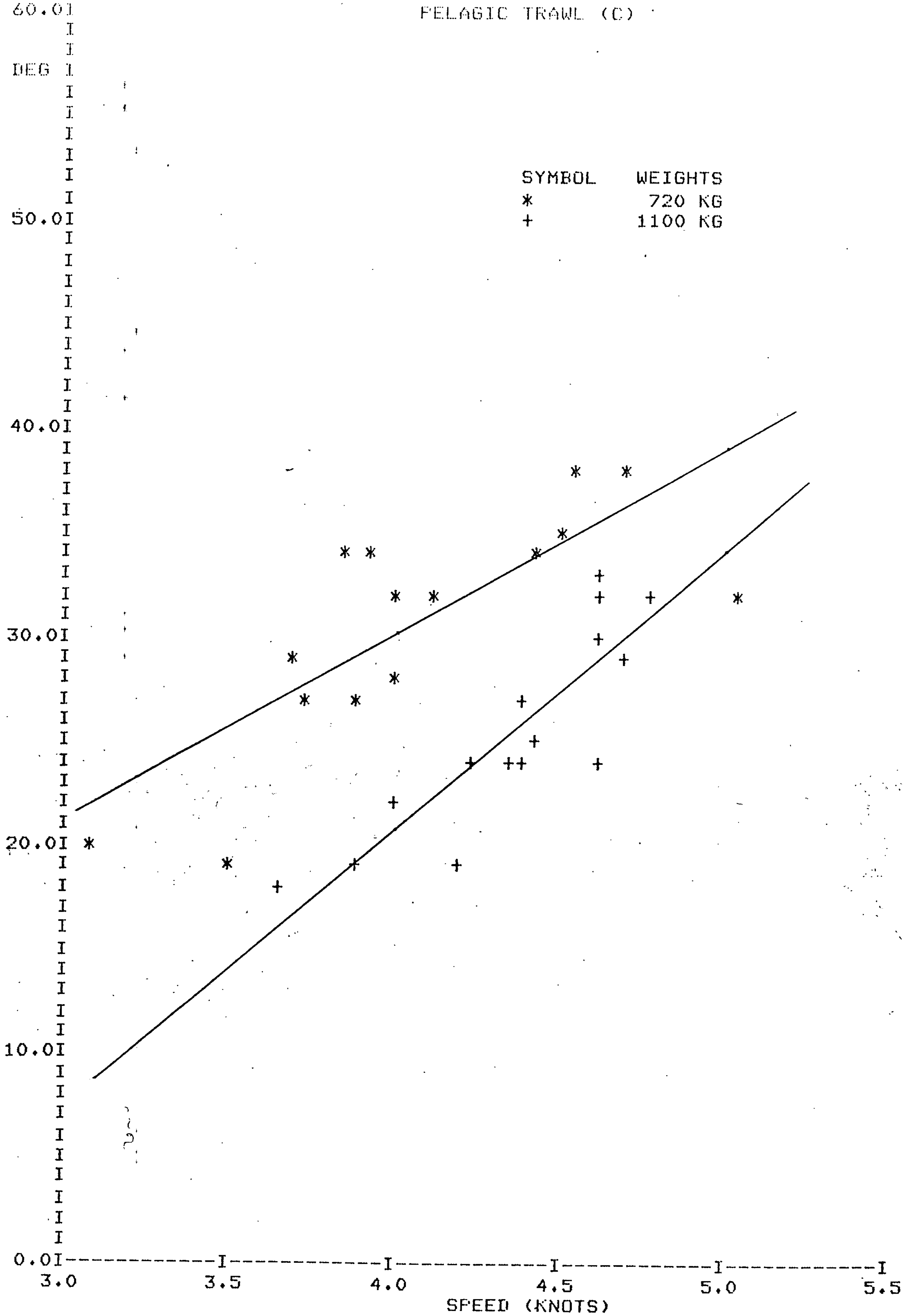


FIG. 40 DOOR HEEL ANGLES
ROPE TRAWLS (A) AND (B)
01-Mar-80
60.0
DEG
50.0
40.0
30.0
20.0
10.0
0.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOL TRAWL WEIGHTS WARP ATT.PT.
* A 1100 KG a
# B 1100 KG a
+ A 720 KG b
v A 1100 KG b
x B 1100 KG b

FIG. 41 DOOR HEEL ANGLES
PELAGIC TRAWL (C)

01-Mar-80



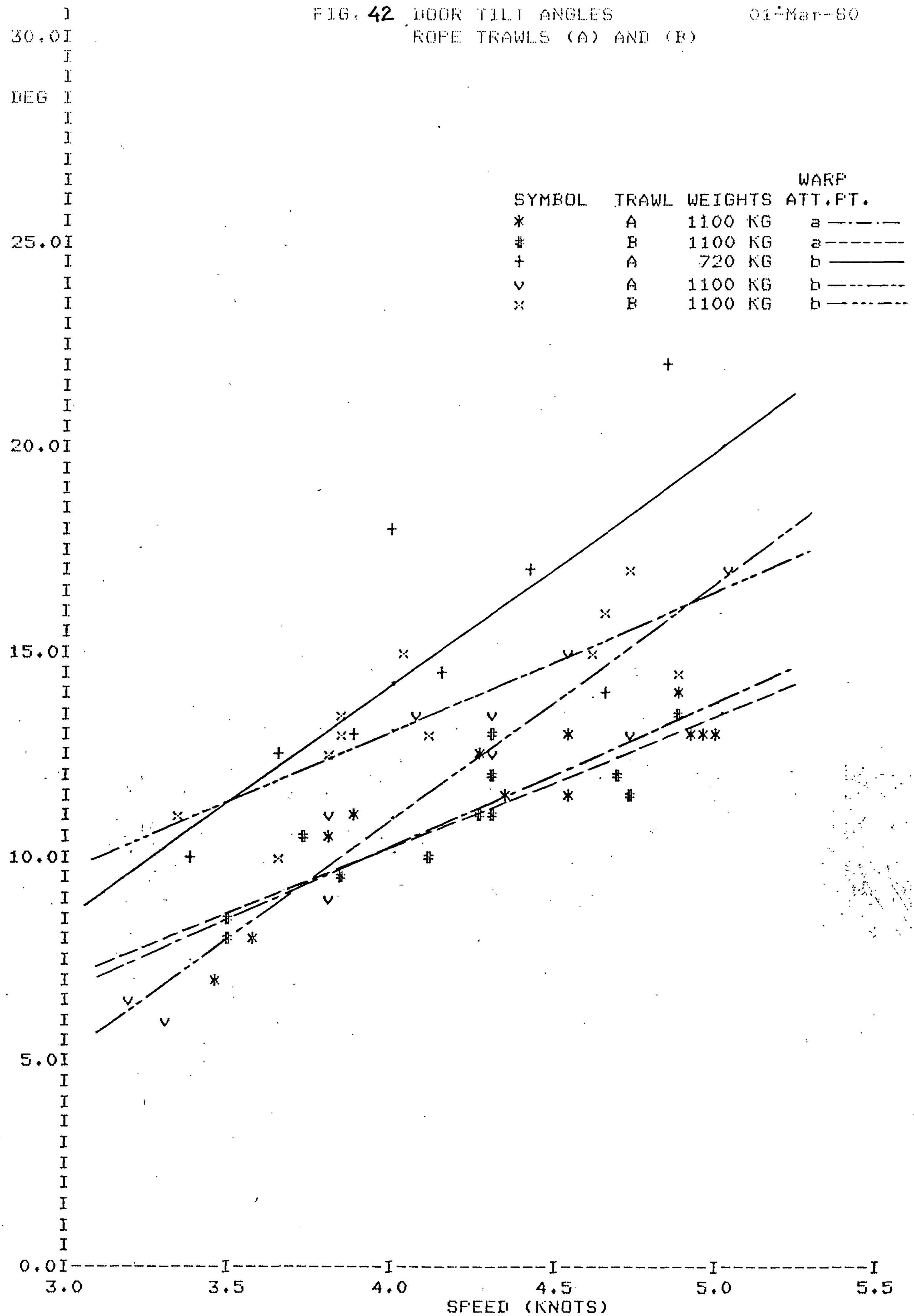


FIG. 42 DOOR TILT ANGLES
ROPE TRAWLS (A) AND (B)
01-Mar-80
DEG
30.0
25.0
20.0
15.0
10.0
5.0
0.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOL TRAWL WEIGHTS WARP ATT.PT.
* A 1100 KG a
# B 1100 KG a
+ A 720 KG b
v A 1100 KG b
x B 1100 KG b

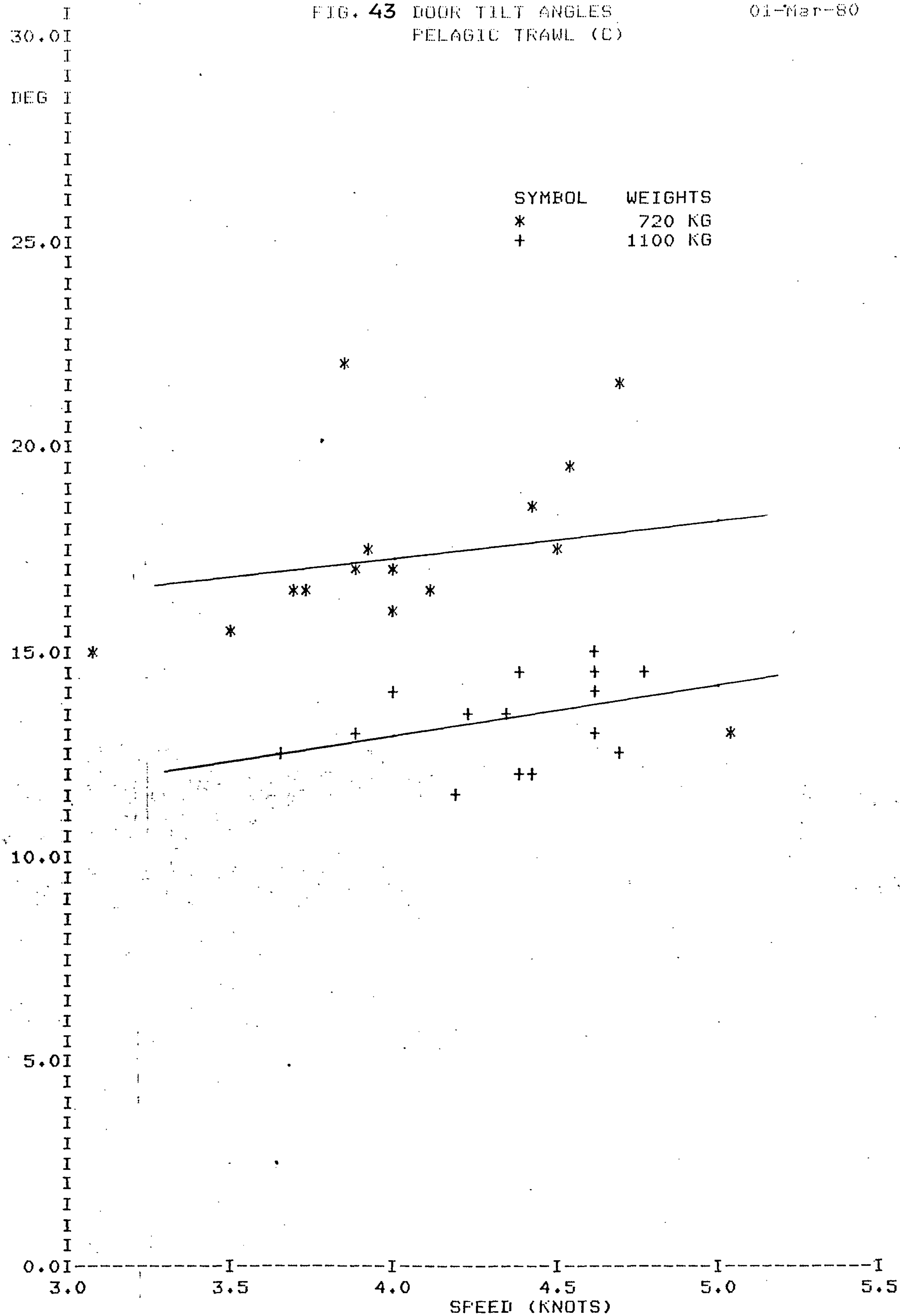
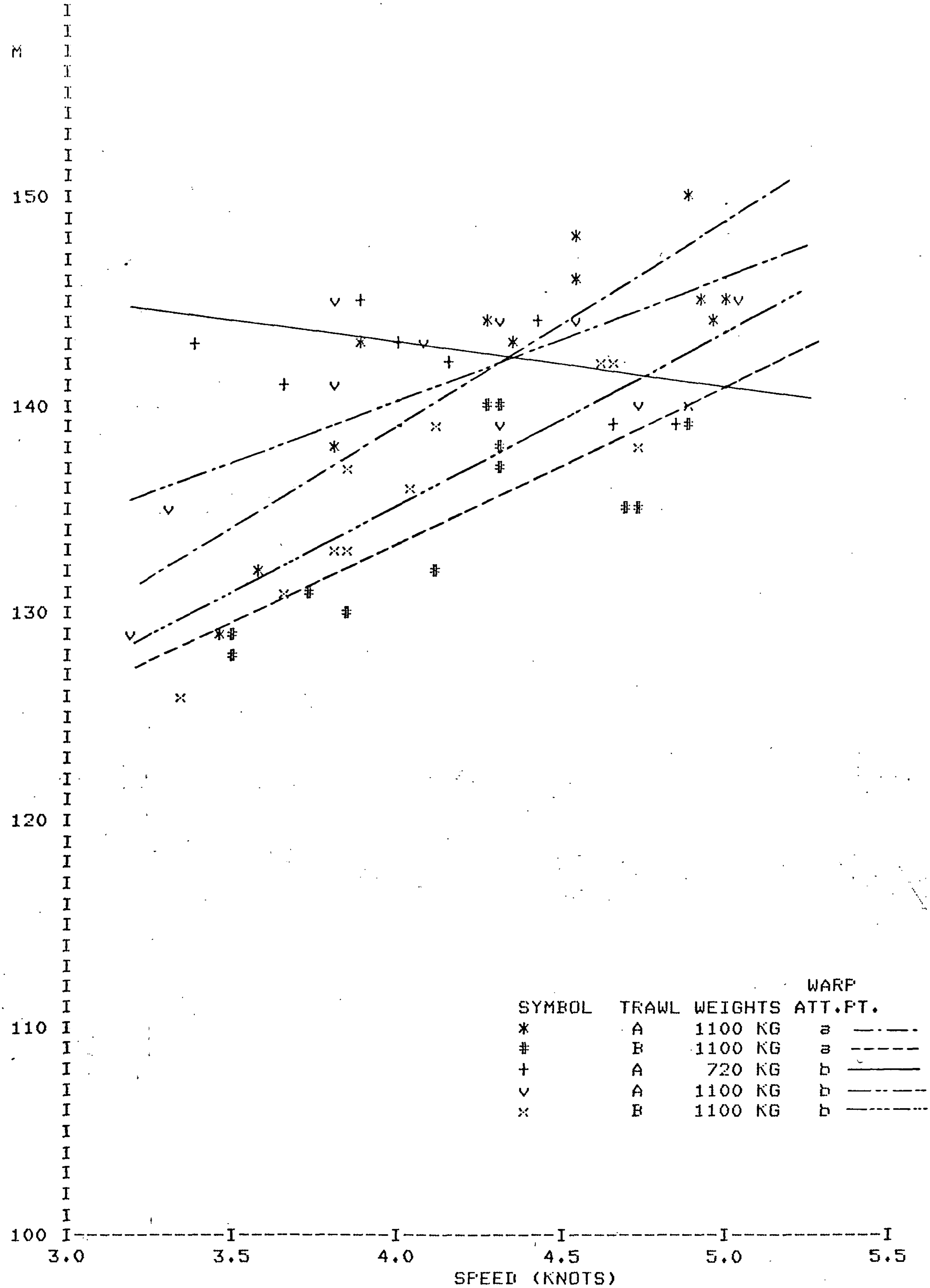


FIG. 43 DOOR TILT ANGLES
PELAGIC TRAWL (C)
01-Mar-80
DEG
30.0
25.0
20.0
15.0
10.0
5.0
0.0
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOL WEIGHTS
* 720 KG
+ 1100 KG

FIG. 44 DOOR SPREAD
ROPE TRAWLS (A) AND (B)



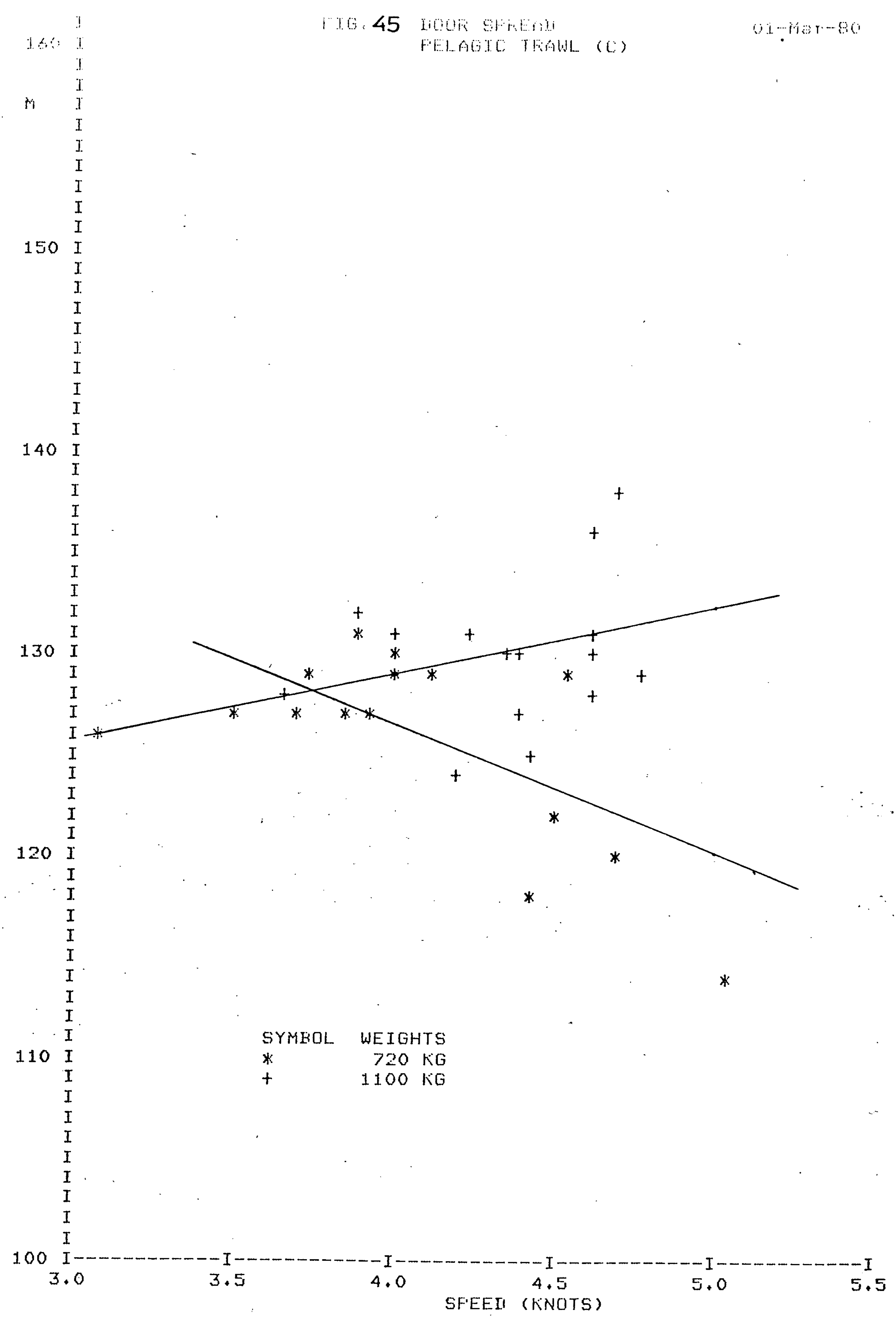


FIG. 45 DOOR SPREAD
PELAGIC TRAWL (C)
01-Mar-80
M
160
150
140
130
120
110
100
3.0
3.5
4.0
4.5
5.0
5.5
SPEED (KNOTS)
SYMBOL WEIGHTS
* 720 KG
+ 1100 KG

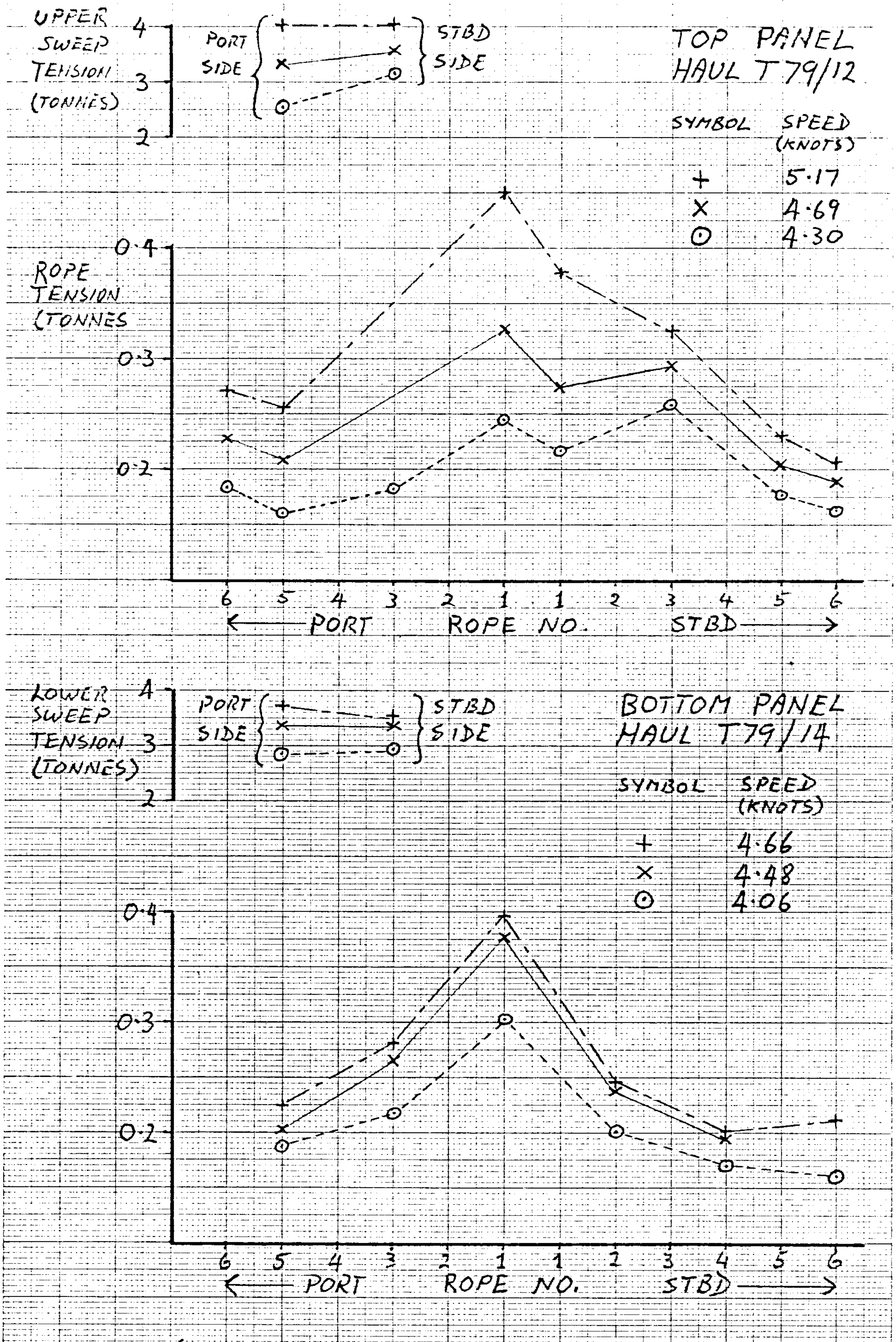


FIG. 46 ROPE TENSIONS IN THE TOP AND BOTTOM PANELS

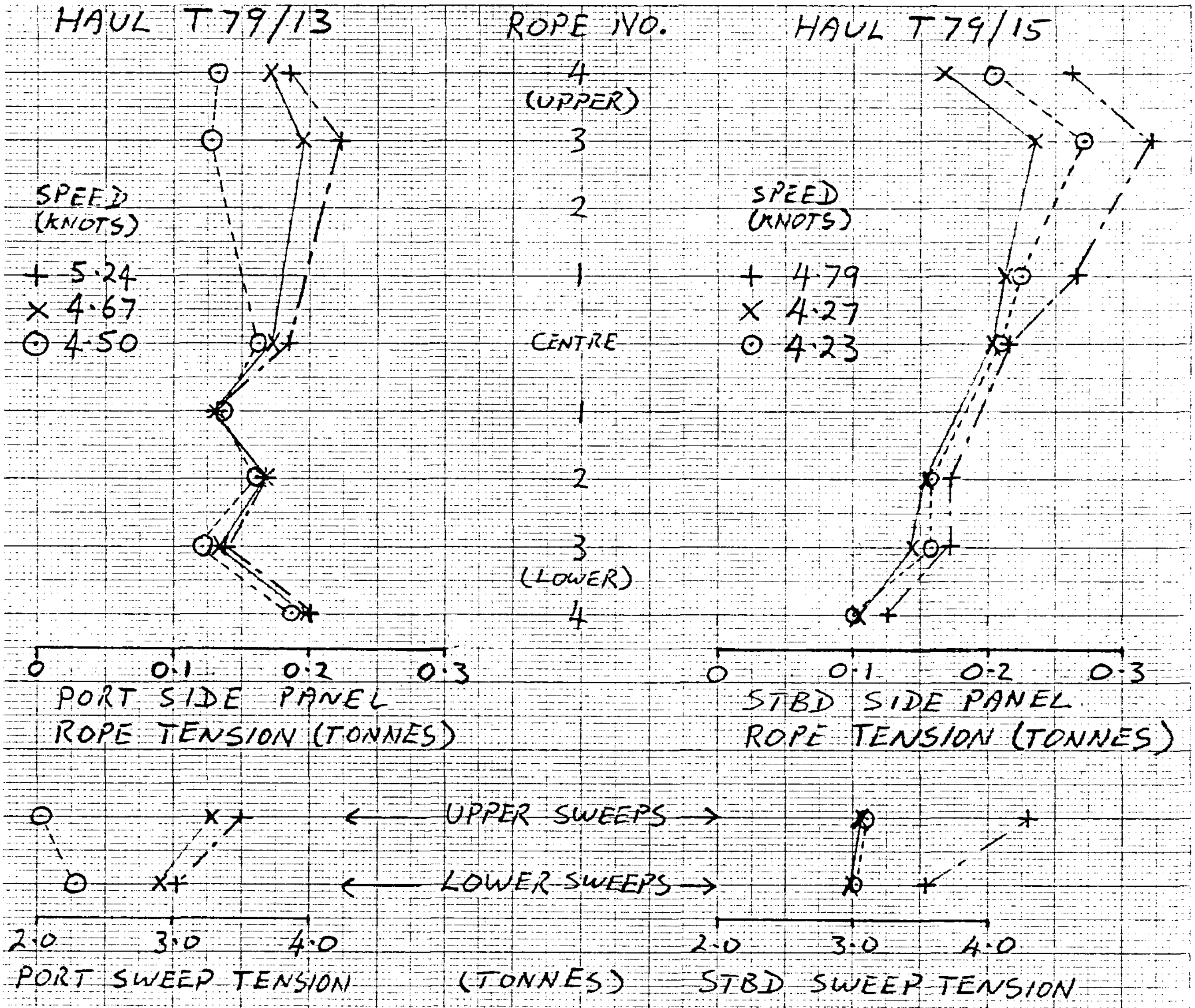


FIG. 47 ROPE TENSIONS IN THE SIDE PANELS

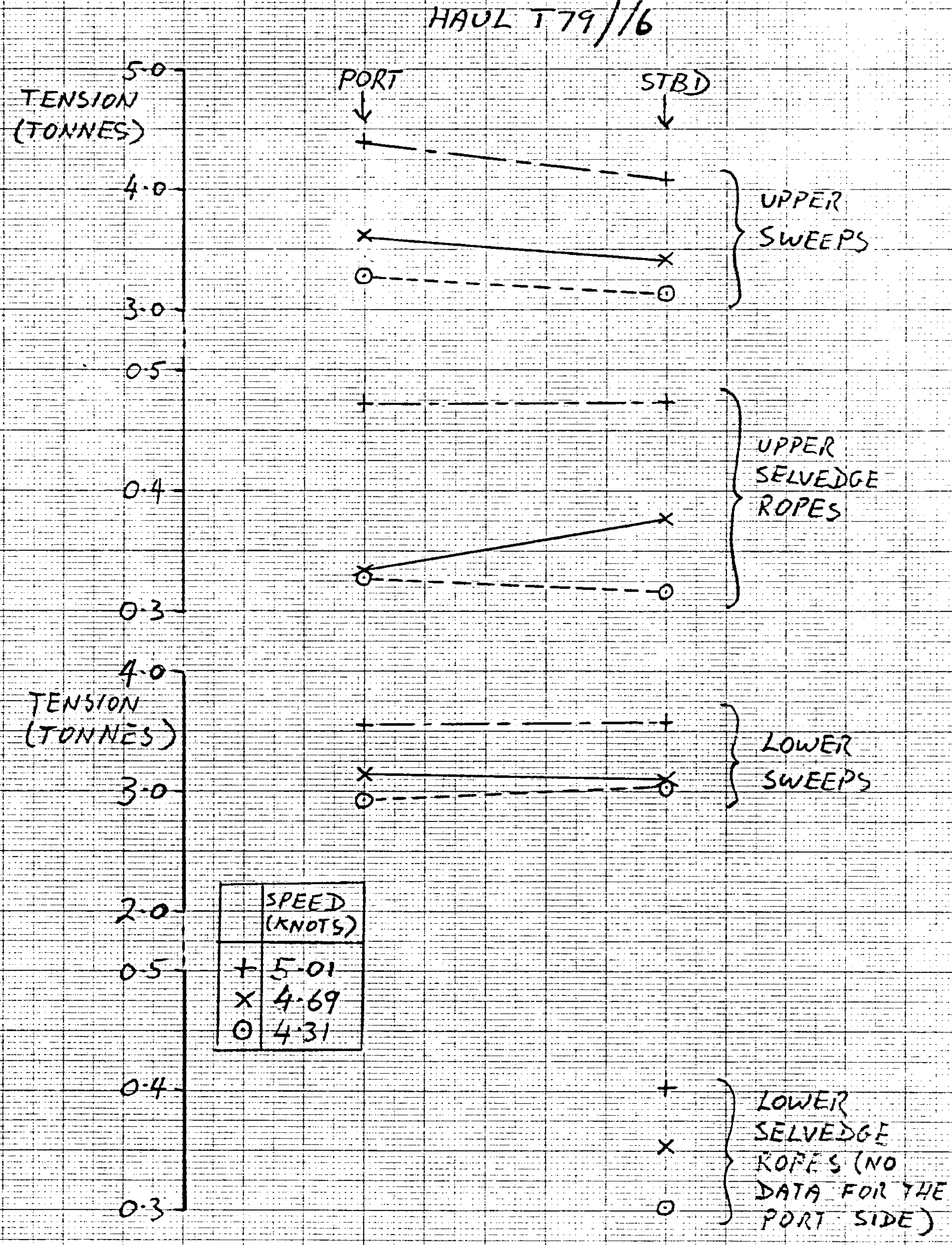


FIG. 48 SELVEDGE ROPE TENSIONS

FIG.:49 :SPREADS VS. WARPLENGTH, ROPETRAWL (A), 1100 KG. BRIDLE WEIGHTS.
HAUL T79/5.

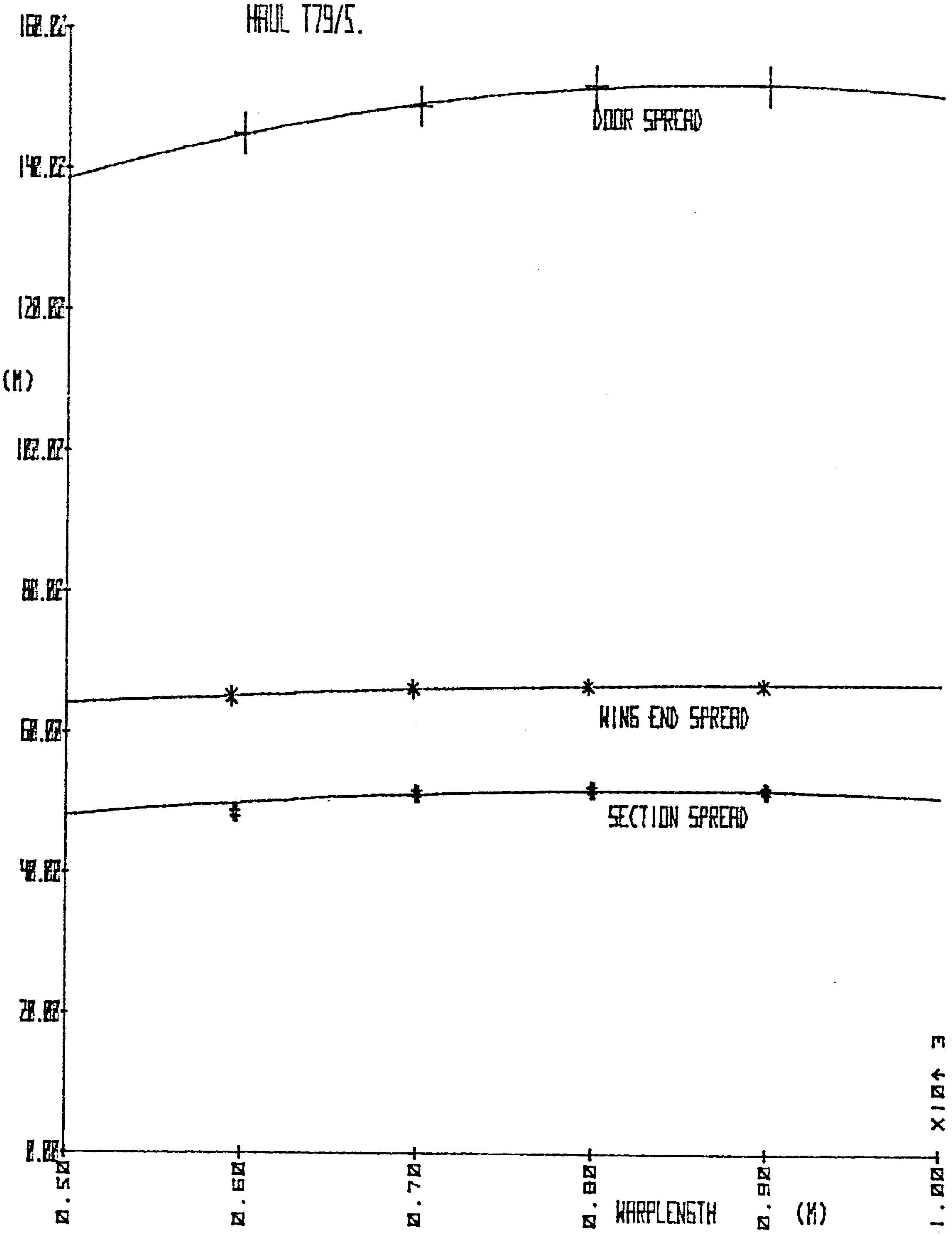


FIG.50 SPREADS VS. WARPLENGTH, PELAGIC TRAWL (C)
720 KG. BRIDLE WEIGHTS, HAUL T79/19.

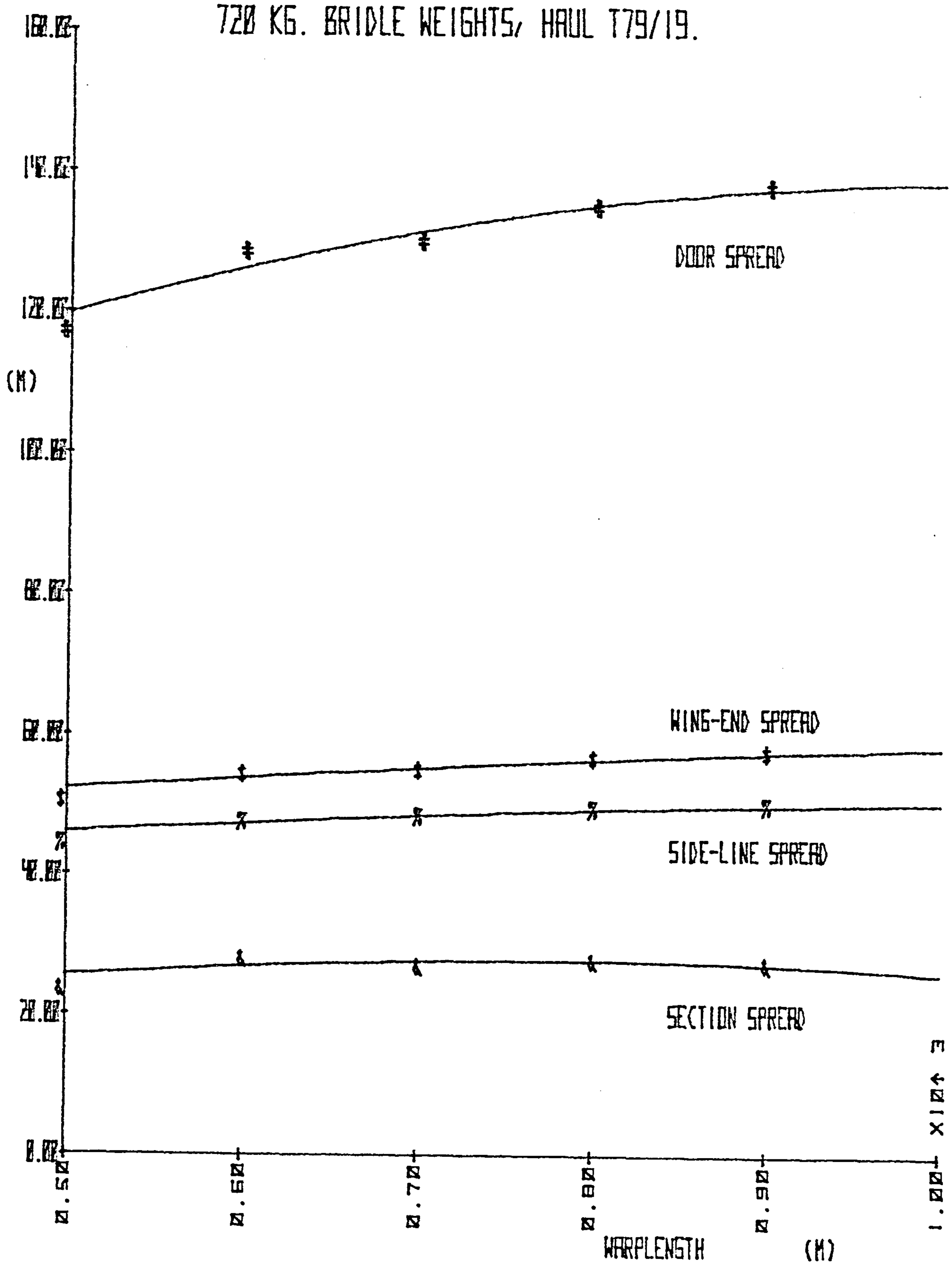


FIG. 51 SPREADS VS. WARPLENGTH, PELAGIC TRAWL (C)
1100 KG. BRIDLE WEIGHTS, HAUL T79/21, BL.1,6,7.

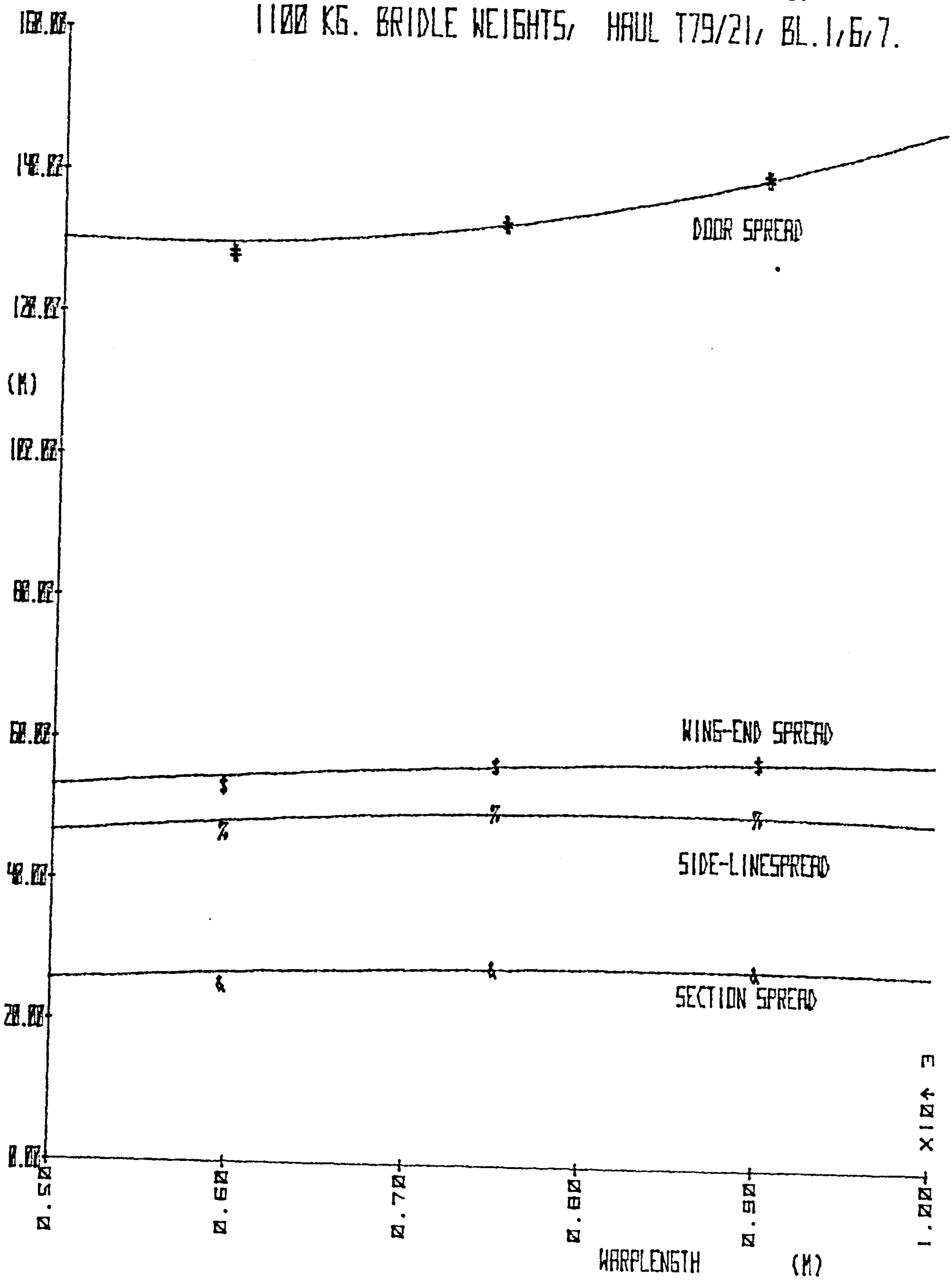


FIG.52 WING-END DIMENSIONS, ROPETRAWL (A),

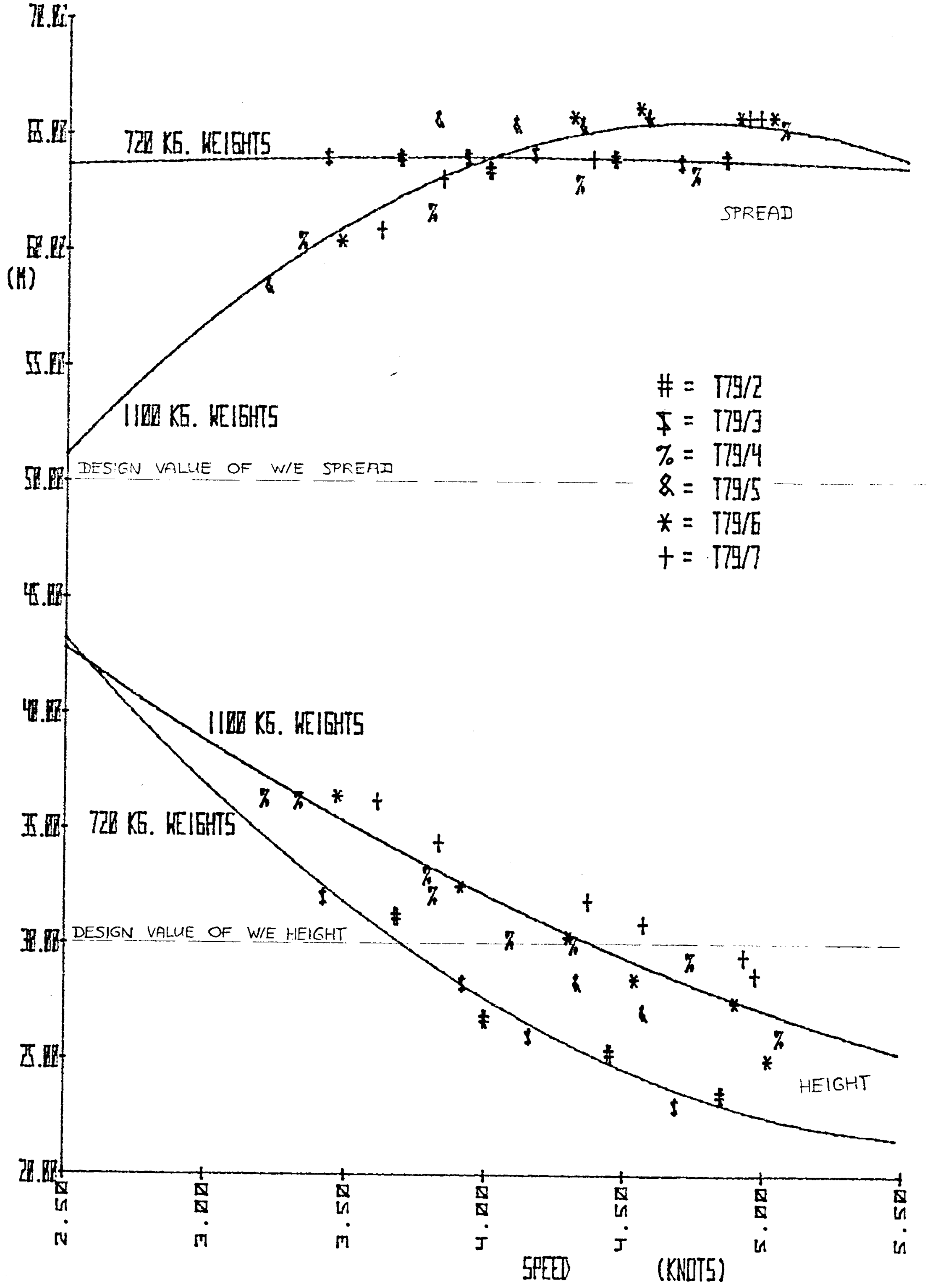


FIG. 53 WING-END DIMENSIONS, PELAGIC TRAWL (C).