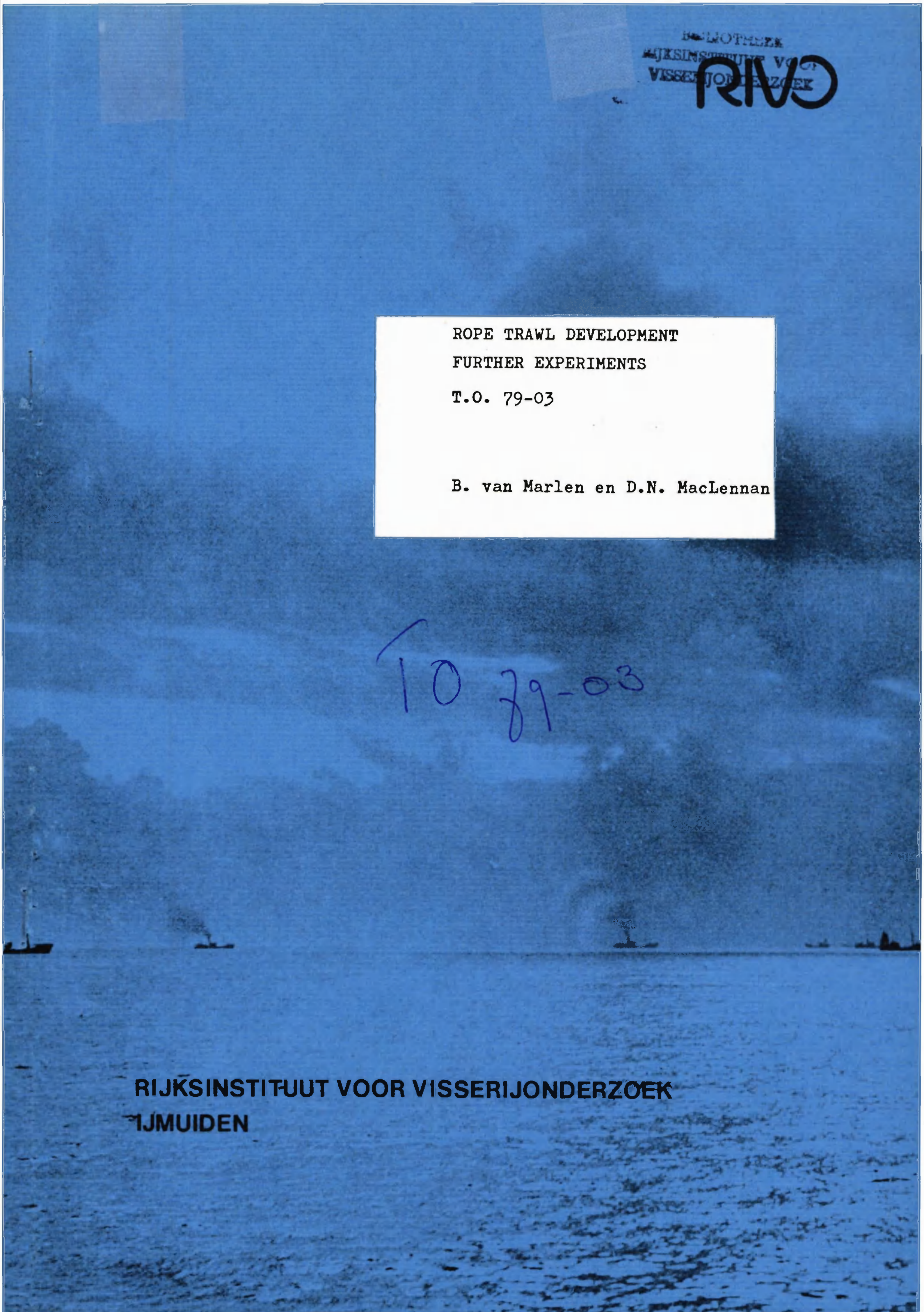

ROPE TRAWL DEVELOPMENT

FURTHER EXPERIMENTS

T.O. 79-03

B. van Marlen en D.N. MacLennan

TO 79-03

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Contents Page

SUMMARY

As a follow-up of the experiments on rope trawls during November 1977 on RSV "Tridens" similar experiments were done in November 1978, involving the same rope trawls (nets A, B and C) and a rope trawl with a heavy cod-end for blue whiting fishery (net D). In order to compare the performance of these rope trawls with the conventional type of pelagic trawl, the original trawl, from which the design of the rope trawls was derived, has also been tested.
The experiments were done in co-operation with the Marine Laboratory of Aberdeen (Scotland) and the White Fish Authority-Industrial Development Unit, Hull (England), which institutes supplied staff and, in the case of the first mentioned, also a considerable amount of instruments.
In order to overcome some problems, encountered on the 1977 experiments, several measurements of speed were taken simultaneously and the Süberkrüb doors have been checked thoroughly.
In addition a set of symmetrical Süberkrüb doors of the same size has been tested. These doors have the advantage of being interchangable between the port and starboard side.
The trials technique was modified in comparison with 1977.
It became standard procedure to have at least five different speed values for each haul and less variation in warplength (mostly just one value per haul). Also it was decided to do measurements on reciprocal courses to take the effects due to tide and currents into account.
Beside the rope trawl tests some experiments were done with the vessels' warps to determine the drag coëfficients.
For these tests a length of 1000 m was used. There was no load on the lower end of the warp. The resultant force and the declination angle were measured at various speeds up to six knots.
The pressure drag and skin friction coëfficients obtained from these experiments were used in the calculations to analyse the results.
The difference between the performance of the rope trawls and the conventional one seems to be quite small and very sensitive to some parameters of the rigging in particular the bridle weights.
The best swept volume index was achieved by the rope trawl with floatation on the headline and 750 kg bridle weights, while with 600 kg weights the conventional trawl showed the best results.
In order to create a rope trawl, suitable for the Dutch fishing industry, a design should be made and tested of a bigger trawl (2700 meshes). The fishing efficiency of this kind of trawls should be tested by comparative fishing experiments.
Most of the questions that will arise from these experiments can only be solved by direct observation.
It is recommendable to involve the use of low light television camera's in future research trips.

I. INTRODUCTION

Several problems were encountered during experiments done with rope trawls on the RSV "Tridens" in November 1977.
From heel and pitch readings it showed that the Süberkrüb doors were not behaving properly. Also it was found that there was a great amount of scatter in the data. In particular the speed readings of the Doppler log did not seem to be very accurate.
In order to overcome these problems it was decided to do some more experiments with the same nets as used on the 1977 cruise and on the same co-operative basis involving both the Marine Laboratory (Aberdeen) and the White Fish Authority (Hull).
The main objective of these experiments was to extend the amount of data on these rope trawls.
In addition some new configurations were tested such as a rope trawl with a heavy cod-end for blue whiting fishery, and a new set of symmetrical Süberkrüb doors.
The claim of the rope trawls having considerably less drag than conventional ones has not been checked thoroughly in the past and therefore the performance of the fully meshed trawl, from which the rope trawls were derived, was also analysed.
The reading of the instrument traces and the analysis of the data have been done both at the Netherlands Institute for Fishery Investigations and the Marine Laboratory Aberdeen, which computer facilities were used like with the analysis of the results of the 1977 tests.

2 EQUIPMENT AND MEASURING TECHNIQUES

2.1 Gears tested

On this trip the same trawls were tested as on the November 1977 cruise, namely:
Net A : Rope trawl with meshed upper square;
Net B : Standard rope trawl;
Net C : Rope trawl with floatation on the headline.
In addition the standard rope trawl was fitted with a heavy cod-end for the blue whiting fishery (see figure 2.4)
This version is denoted as Net D.
In order to compare the drag and the geometry of the rope trawls with the conventional fully meshed trawl, it was derived from, some tests were included with the original 1637 mesh pelagic trawl, that will be referred to as Net E (see figure 2.5)
A more detailed description of these gears is given in (1).
Two types of Süberkrüb doors were tested.

Type I (3.50x1.36 m) 4.76m^2 asymmetrical doors as used on the cruise of November 1977. These were checked on dimensions and centre of gravity. Slight deformations were corrected.

Type II (also 3.50x1.36 m) 4.76 m^2 symmetrical doors (see figure 2.7). The great advantage of this type is the possibility to use them on both port and starboard side. Instead of with two spare doors as usually taken one can cover the loss of either of the port or the starboard door with just one spare. The performances of these doors are compared by analysing the results of hauls T78/14,15 and T78/22,23.

The rigging and its dimensions are given in figure 2.7

2.2 Trials technique

Table I summarises the parameters varied and the instrumentation used on this cruise.

Parameters varied:
1) Warplength (450)-550-650-(750)-(850) metres
2) Bridle weights 600-750 kgf (5886-7357.5 N)
3) Horse-power setting 600-1400 hp (441.6 kW-1030.4 kW)

The trials technique was somewhat different from the 1977 experiments.

- On most hauls reciprocal courses were used in order to take the effect of tide, currents and waves into account. Although the speed at a certain hp-value differs quite a lot from one course to another the H/L centre depth readings indicate a minor difference in speed, certainly less than 0.1 knots. In the analysis the results of reciprocal hauls are combined in the regression formulae.
- Except for the repeated hauls of November 1977, the hauls were mostly done with only one warplength for a range of speeds.
  The difference between two adjacent hp-settings is made as big as possible to be able to distinguish the load cell traces.

- The influence of extreme warplengths was tested on haul T78/10, where the warplength was increased to 850 m in steps of 100 m.
- In one occasion the point of attachment of the warp to the door was varied (see figure 2.7)

2.3 Instrumentation (see figure 2.6)

The instruments used are described in (1).*
There were some additional instruments on this cruise:

- An impeller log, mounted on the port side of the vessel.
- A time counter to measure the interval between two readings of the mile-counter of the Doppler-log, one taken at the start of a block and the other at the end.
  From these readings the average speed can be derived for each block of measurements.
- An angle of attack meter mounted on the top of the starboard door near the leading edge.
  This instrument could be connected with the heel/tilt/depth-meter on the door to ensure the recording of the signal on a cassette tape.
- Four small load cells (500 kgf) were used to measure the forces in some ropes of the upper panel (see figure 2.8)
- The multi-netsonde arrangement was extended with two channels to measure the height and the spread of the section where the ropes are connected to the netting.
- Two Japaneze depthmeters were used to measure the depth of the upper wing-ends.

(1)* "Rope trawl development", B. van Marlen, April 1978

2.4 Data Analysis

The quantity of data collected was sufficient to provide more than one estimate of certain parameters, and the data presented in this report represent the best estimates after cross checking where appropriate. In other cases when instruments failed or produced dubious results, it was sometimes possible to obtain calculated values for the missing measurements based on the data recorded for related parameters.

The depth of the port door was measured by a self-recording angle/depth meter and also by a netsonde transducer. The starboard door depth was only measured by a self-recording meter. Since the netsonde readings were considered to be the more accurate, they were used to calibrate the self-recording meters. The regression equations obtained to give the depths in metres were:-

Red meter: actual depth = 0.974* (indicated depth) - 1.31

Yellow meter:actual depth = 0.983* (indicated depth) + 0.16

For some hauls no measurements of the sideline spread were obtained, and calculated values based on wing-end spread measurements have been used instead. Sideline spread measurements from other hauls with the same net were used to calculate a regression on the wing-end spread, and this regression equation was then applied to calculate missing data points.

The trawling speed was measured by a towed propeller log and also by timed readings of the distance indicator on the ship's Doppler log. The towed log was calibrated against the Doppler log during the first few hauls, and the average of the Doppler speed and the calibrated towed log reading was used as the best estimate of speed. This estimate was also checked against readings from the "Tridens" Hewlett Packard Recorder which was connected to the Doppler instrument. Thus the Doppler log was used as the primary speed measuring instrument, but the use of the independent towed log helped to reduce the digital measurement error inherent in the reading of the Doppler distance indicator.

The deck-tension meters were calibrated three times during the cruise, first before measurements began, then in mid-cruise and finally at the end of the tests.

The starboard cell showed a large shift between calibrations (up to 18% at 6 tonnes load) but the port cell had a better performance (calibration shift ca 8% at 6 tonnes load).

It should be borne in mind that a frequent calibration of the load cells is of vital importance to the quality of the results obtained. If possible this calibration should be done in port to reduce the effect of ship movement and to ensure better accuracy.

For hauls T 78/1-8, the first calibration (9 November 1978) has been used, for T 78/9-17 the second (20 November 1978) and for T 78/18-23, the last one (24 November 1978). This was decided from an examination of the zero shifts between hauls since a large zero shift would suggest the likely time of a change in the instrument calibration.

The IPTAR8 suite of programs used to analyse the data is essentially the same as that used after the 1977 tests reported in reference 1. The programs use measured data to calculate for example the net drag which is the sum of horizontal components of the sweep tensions. Tables produced by IPTAR8 now include additional columns for the section spread and height, and for the starboard door angle of attack which was measured in 1978 for the first time. The programs have also been amended to calculate warp drag coefficients from the formulaedescribed in section 6 below.

The wing-end depth is required for the calculation of gear geometry. Since this parameter was not measured directly, it has been assumed to be the same as the headline centre depth, except for net C where the floatation would be expected to lift the headline. In the latter case, the wing-end has been assumed to be lm below the headline centre.

3 COMPARISON WITH PREVIOUS RESULTS

In order to compare the measurements taken in November 1977 and November 1978 the horizontal netopening and the headline height are plotted for nets A, B and C in figures 3.1 – 3.5)
For net A the results agree very well, the horizontal netopening being slightly smaller, while the headline height does not appear to be notably different.
The horizontal netopening for net B seems to be appr. 4 m smaller for the 1978 experiments but the headline height is in good agreement.
Net C appears to be more sensitive to shooting and hauling.
In general the horizontal netopening is somewhat smaller for the 1978 trials, which is probably due to the door spread being slightly bigger for the 1977 experiments.
There is a fair amount of scatter in the data, partly because the results for all the different warplengths are plotted in the graphs.
Especially during the 1977 cruise the warplength was varied over quite a range (from 450 m up to 650 m).
Conclusively one can state that the results are well reproduced during the latest trials taking in mind that it is very hard to avoid any small changes in the setting of a fishing gear from one haul to another.

4. COMPARISON OF THE VARIOUS NETS TESTED

4.1 General

Tables IV - XXI list the most significant measured data and computed performanc parameters for each haul. In figures 4.1 - 4.48 each graph shows the results for all hauls on which a particular net was used with each haul indicated by a different symbol. While all the results are listed in Tables IV - XXI a few cases which are clearly anomalous have been omitted from the graphs and these cases are indicated by an asterisk in the tables.

A linear regression analysis has been used to express the dependence of the main performance parameters upon speed. The actual variation of most parameters with speed may well be non-linear, but scatter in the data and the narrow range of speeds tested do not allow the form of such relationships to be determined explicitly. However, the linear relationships worked out by regression analysis can be regarded as reasonable descriptions of how the gears behave in the range of speeds tested and within the constraints of experimental error. Results which are clearly anomalous have been omitted from the calculation of the regression lines shown on the graphs.

The regression equations have been used to calculate best estimates of the main performance parameters at 4 and 5 knots which are listed in Tables II, III for all five nets. Also, in the case of drags and swept volume indices, the regression lines for all the nets have been plotted together in Figures 4.6;4.7;4.42;4.43. Thus tables II , III and figures 4.6;4.7;4.42;4.43 present a summary of the results for ease of making comparisons between the different nets.

4.2 Net and Gear Drags

Figures 4.1 to 4.5 show the drag results for each net. Any dependence of the drag on the bridle weight has been obscured by scatter in the data, so the results for both bridle weights have been combined in calculating the regression equations. The net drag regression lines for all the nets are plotted in Figure 4.7 , and similarly the gear drag in figure 4.6.

Variations in drag between the five nets tested appear to be marginal. At 5 knots, the standard rope trawl had the lowest net drag (10.19 tonnes), and the conventional pelagic trawl had the highest drag (12.14 tonnes), a range of only 18%. Since no significant difference in drag was found between nets B and D it is concluded that the effect on the total net drag of greatly increasing the codend size is negligible, although as described below there does appear to be a significant effect on the opening area of the nets.

Comparison of the results for nets A and B shows that the use of a meshed square in place of the top rope panel increases the drag, at least at the higher speeds. At 5 knots, the net A drag is 10% more than that of the standard rope trawl and it is even slightly higher than the drag of the rope trawl with floatation. At 4 knots, however, the differences in drag between nets A, B and C are much smaller. Thus the drag increase in the case of nets A and C relative to net B only appears to be significant at the higher speed.

The total drag of a rope trawl will be the sum of contributions from the rope and the netting sections. The angle of incidence of the ropes to the water flow, calculated from height and spread measurements, is in the range 5–10°. The drag on the ropes at such small incidence angles will be almost entirely due to skin friction forces. The value of the skin friction coefficient (C_f) appropriate to polypropylene ropes is uncertain, but using a value of 0.027 which would apply to stranded wire cable, the drag contribution of all the ropes in net B has been calculated to be 0.29 tonnes at 4 knots. This is less than 3% of the total drag of net B, and while the calculated rope drag can only be regarded as a rough estimate, it is clear that the total drag of the rope trawl is almost entirely due to forces on the netting sections.

The cross-section area of the netting twine in net A is 16% more than that in net B because of the meshed square, a proportion of the same order as the increase in drag noted above. It is reasonable to assume therefore that the higher drag of net A arises from the contribution of the meshed square which has much more drag than the corresponding rope section.

Net C also has a high drag relative to that of the standard rope trawl. This result is explained by the effect of the floatation which increases the mouth area and hence the average angle at which the netting is inclined to the flow and by the resistance of the floats themselves.

Theory suggests that the gear and net drags should be proportional to a power of the speed between 1 and 2. While the drag of a rigid body may vary as speed squared, the reduction in the frontal area of a net should lead to a less rapid increase in the drag with speed. A comparison of the results in Tables II, III at 4 and 5 knots suggests that the power of speed appropriate to each net would be:-

Net	A	B	C	D	E	Mean
Net Drag	1.63	1.06	1.33	1.30	1.37	1.34
Gear Drag	1.28	0.91	1.33	1.12	1.44	1.22

The mean value of 1.34 in the case of net drag is in good agreement with previous results for other gears, and we note that there is no significant difference between the results obtained for the conventional pelagic gear and the rope trawls. The powers of speed indicated for gear drag are rather low however, except for nets C and E, which may be due to erratic behaviour of the otterboards.

4.3 Net Geometry

The measured headline heights of each net are plotted in Figures 4.8 to 4.12 with separate regression lines showing the different effect of 600 and 750kg bridle weights. The sideline spreads are plotted in Figures 4.13 to 4.17 but the bridle weight was found to have no significant effect on the horizontal opening and so all the sideline spread data have been used to compute one regression line for each net.

The sideline spread does not vary much with speed in any of the nets tested with the exception of net E, where it tends to increase more rapidly with speed.
It is around 27 m for all the rope trawls, and about 31 m for the conventional pelagic trawl. There is of course a marked reduction in the opening area of all the nets as speed increases, and this is due almost entirely to the reduction in headline height.

The headline height of the conventional pelagic trawl at 4 knots (20.2m) is much more than that of net B, but it decreases more rapidly with speed, down to 14.9m at 5 knots which is nearly the same as that of nets A and B. Comparing nets B and C, the use of floatation with 600kg weights has increased the headline height by 3.7m at 4 knots and 1.9m at 5 knots. On the other hand, the use of a meshed upper square does not appear to improve the headline height which is quite similar between nets A and B.

The large codend net D with 600kg weights has a headline height 2.4m lower than the standard rope trawl B at 5 knots, but at 4 knots the heights are nearly the same.

The cross-section areas at three positions (wing-end, headline centre and net section) are plotted in figures 4.18 to 4.26 for each net and bridle weight combination.

The wing-end area of all the rope trawls is much greater than the headline area, in contrast with the conventional trawl in which these areas are quite similar especially with 600kg bridle weights. This suggests that the surface shape of the rope trawls is flatter than that of the conventional trawl, implying that ropes in the forward part of a net are less able to support the vertical headline opening compared with a fully meshed net, but this deficiency can be compensated by the use of floatation and/or additional weight on the lower wires. It is relevant to note in this context that the flatter shape of the rope trawl may be an advantageous feature, since sudden changes in the shape of a net may prompt fish escape reactions.

A comparison of the results for nets B and D shows that the larger codend, while having little effect on the wing-end area, does appear to constrict the body of the net. At 5 knots, the wing-end area is reduced by only 2%, while the headline and net section areas are both reduced by some 16%, when the larger codend is used on otherwise similar nets. The total drags of nets B and D are much the same, as noted above, but the distribution of stress along the net must be quite different in the two cases. It is reasonable to suppose that the larger codend applies more force to the body of the net, thus constricting the body so that the main netting sections have less drag, resulting in a similar total drag for the codend plus net.

Increasing the bridle weight from 600 to 750kg has little effect on the headline opening area of the conventional trawl, although the wing-end area is improved by 9% at 4 knots. The effect of the same weight increase on the rope trawls is more dramatic however, and the wing-end and headline areas are both increased by some 15% at 4 knots. At 5 knots the increase in opening area with weight is much less, except in the case of net D where the extra weight appeared to counteract the constriction due to the large codend at all speeds.

The addition of floatation also improves the opening areas. Nets B and C are similar except for the headline floatation on the latter (190 floats having a total buoyance of 330 kg). Comparing the results for these two nets, the floatation increased the headline area by 15% at 4 knots and 10% at 5 knots. The wing-end areas also increased by similar proportions. It will be seen from these results that the addition of 300 kg in the total bridle weight gave the same improvement in headline opening area at 4 knots as 330 kg of floatation, but the floatation better maintained the opening areas at higher speeds.

4.4 Relative Position of Net and Doors

The average height of the otterboards above the headline centre is plotted for each net in Figures 4.27 to 4.31, and separate regression lines have been calculated for the 600 and 750 kg bridle weight cases.

For all the nets tested it was found that the headline centre was always rather deeper than the otterboards, indicating a vertical angle of the upper bridle in the range 3-9°. Such a configuration would be expected on account of the total bridle weight being a significant fraction of the net drag. All the nets fished even deeper relative to the boards, on average some 3m deeper, with the heavier weights.

It was also found that the two doors tended to fish at different depths, although both were almost always above the headline centre. In most cases the port door, to which a netsonde cable was attached, was above the starboard door which had no such attachment. These cases might be explained by the lifting effect of the netsonde cable, but for some hauls when the reverse applied (port door deeper) no obvious explanation for this asymetrical behaviour has been found. To put the matter into perspective, the measured differences between the depths of the two doors were quite small compared with other dimensions of the gear, and they would imply differences in the vertical angles of the upper bridles of no more than a few degrees. Thus the effect of asymetric otterboard behaviour on the performance of the net should be quite small.

Comparing the results for 600 kg weights, it will be seen that nets B and D fished some 13m below the average door position, while the height difference for nets A, C and E is only 6.5m. The height difference decreases with speed except in the case of net E when it increases slightly between 4 and 5 knots. It would be expected that the increase in net drag with speed should raise the net relative to the doors, and the anomalous result in the case of net E with 600 kg weights is probably due to scatter in the data. The results do correlate sensibly with the conclusions on net drag, since nets B and D have a lower net drag than the others at 5 knots (although the differences are less significant at 4 knots).

4.5 Headline depth

The depth of the headline centre is plotted for each net against speed in Figures 4.32-4.36, and the effect of bridle weight is shown by the separate regression lines calculated for the 600 and 750 kg cases. These graphs are not directly comparable for the different nets since the warp length is not always the same. The data for nets B and D relate to 650m warp, and those for the other nets to 550m warp. An approximate comparison can be made by reducing the indicated depths for the longer warp length by 14% to provide estimated values at 550m warp. This leads to the conclusion that at 4 knots and for the same warp length, nets B and D would fish at about the same depth as net E and some 15% lower than the other rope trawls.

It should be noted that the headline depth is not only determined by the properties of the net, since lift forces generated by the doors will also affect this parameter. The depths of the four rope trawls A-D at the same speed and warp length correlate sensibly with the net drags, but the conventional net E fishes deeper than would be expected on account of its higher drag. This suggests that the lift forces generated by the doors are less in the case of the rope trawls.

4.6 Swept Volume Index

The swept volume index, a measure of the mechanical efficiency of each net, is plotted in Figures 4.37 to 4.41 . Separate regression lines are shown for the two bridle weights, combined in figures 4.42, 43 for all nets.

The results show that the heavier bridle weights greatly improved the swept volume index of all the rope trawls, by 30% or so at 4 knots, but they had no significant effect on the conventional pelagic net. In fact, with the 600 kg weights, the swept volume index of the conventional net is higher than that of the rope trawls in most cases, and the reverse is true with 750kg weights. The best performance was found in the case of the rope trawl with floatation (net C) and 750 kg weights whose swept volume index compared with the conventional net E was 18% higher at 4 knots and 13% higher at 5 knots.

With the 600 kg weights, the swept volume index for net A is about 10% lower than that of the standard rope trawl at all speeds. The heavy codend net D has a very similar index to the standard net at 4 knots but a much lower value at the higher speed. With the 750 kg weights, net A had the lowest swept volume index of all the gears tested. No data were obtained for the standard rope trawl with the heavier bridle weights.

4.7 Towing power

In figures 4.44,48 the shaft horsepower and the gear horsepower, indicating the work to be done to drag the gear through the water, are given. The gear horsepower seems to be approximately 25% of the power delivered to the propeller shaft of the ship. The rest is used for the propulsion of the ship's hull and superstructure through the water (including the effect of wave- and wind resistance).
The scatter in the shaft h.p. is caused by different weather conditions and also by the course of the vessel (following seas or head seas).
The standard net (B) has the lowest values of gear h.p. and the fully meshed trawl (net E) the highest ones.
The values of the other nets are in between, as can be aspected from the drag-curves.

5 OTHER RESULTS

5.1 Comparison of two types of Süberkrüb doors

The performance of the two types of doors (I = asymmetrical; II = symmetrical door) can be compared for haul T78/14,15 and haul T78/22,23 (see Table I, and figures 5.1 and 5.2).
There seems to be no significant difference in the door spread and wing-end spread values.
The angles of heel are slightly smaller (2°-3°) for type II and the tilt angles of this type are bigger for the starboard door, but not at all for the port door.
The angle of attack for the starboard door seems to be somewhat bigger for type II.
In conclusion one can state that the difference in performance of both types of doors is very small indeed. The advantage of reducing the necessary amount of spare doors by making them symmetrical and therefore interchangable is however worthwhile.

5.2 Effect of warp attachment point on the behaviour of the doors

A variation of the point of attachment of the warp to the door (type I) was done in haul T78/12 and 13. The attachment point closest to the surface of the door (a2) leads to better results for the full range of speeds (see figure 5.3).
The spread of the doors is increased with ca. 3.75 m in comparison with the middle attachment point (b2).
The wing-end, headline and section spread prove to be ca. 1 m bigger.
The angle of heel shows no significant difference for the various attachment points both for the port and the starboard door, while the tilt angle is smaller for the position denoted as a2.
A peculiar effect is the increase in the angle of attack for position a2 in comparison with b2.
From the door spread traces it can be seen, that the variation in spread is much smaller for a2. This indicates the doors to be hydrodynamically more efficient in this case.
The b2 attachment point probably causes the doors to be at a "near-stall" attack to the flow, although the average angle of attack is bigger for a2.

5.3 The effect of increasing warplength on door and net spread

In (1) it is indicated that a maximum obtainable spread of the door will exist when increasing the warplength to extreme values.
This has been checked in haul T78/10. The warplength is increased by steps of 100 m, starting at 550 m and ending at 850 m, at a nearly constant speed of 3.75 kn.
The doorspread increases from 88 m at 550 m warplength to 97.5 m at 850 m. From figure 5.4 it can be seen that at 850 m the maximum value is almost reached.
The wing-end and sideline spread follow the same pattern, achieving near maximum values at 850 m warplength.
The increase in doorspread is well transferred to the net, the wing-end spread, being the most sensitive of both parameters has an increase of approximately 3 m.
The sideline spread is increased with 2.0 m.
For all of these measured parameters the maximum increase is found from 650 m to 750 m warplength.

5.4 Load measurements in some ropes

Small self-recording load-cells (500 kg) were placed in four ropes of the starboard side panel during hauls T78/16 and 17.
Their exact position is given in figure 2.8
From top to bottom they are in ropes 1, 3 , 7 and 9. These ropes were shortened to compensate for the length of the load-cells.
The results of these tests are plotted in figure 5.5 including the upper and lower sweep tensions T3US and T3LS (for the lower sweep also behind the bridle weights T6S).
The upper sweeps take more load then the lower ones (about 0,5 tonne at 5 knots), which is also transferred to the ropes in the side panel (T7S1 and T7S3 are higher than T7S7 and T7S9).
The distribution of the load of the ropes seems to be asymmetrical for the sidepanels, with the upper part heavier loaded.
This conclusion coincides with the results of the rope-elongation tests of November 1977 (T77/7).

6 WARP DRAG EXPERIMENTS

The hydrodynamic forces acting on the trawl warps contribute to gear drag and they also influence the horizontal opening of the gear. These forces cannot be estimated accurately from measurements while towing a gear, since the calculation depends upon the small difference between the towing loads at the upper and lower ends of the warp.

An experiment was therefore carried out using a 'streamed' warp, that is to say a length of warp towed with no load on the lower end, to provide more reliable data on the hydrodynamic forces. In this case, only the hydrodynamic forces and the weight of the warp in water contribute to the towing load at the ship.

The resultant hydrodynamic force is composed of (1) the pressure drag, which acts normal to the warp and in the plane containing the warp and the direction of motion, and (2) the skin friction drag which acts opposite to the direction of motion. According to the usual practice, these force components are expressed in terms of dimensionless drag coefficients based on a characteristic length. The pressure drag coefficient C_d is based on the warp diameter, while the skin friction coefficient C_f is based on the warp circumference. The forces and the coefficients are related by the equations;-

$$\text{Pressure drag/unit length} = \tfrac{1}{2}\rho C_d D(V \sin\theta)^2$$

$$\text{Skin friction/unit length} = \tfrac{1}{2}\rho C_f \pi D V^2$$

Where ρ is the density of seawater, D is the warp diameter, V is the towing velocity and θ is the declination angle.

The maximum length of warp (1 000 m) available from one of the 'Tridens' winch barrels was towed at various speeds up to 6 knots. The load at the top end was measured by connecting a strain gauge tension meter to the warp, and a pendulum angle meter was attached to the warp to measure the declination angle.

It was found that the pressure drag and skin friction coefficients could be expressed as functions of the towing speed according to the following equations where the speed V is in knots:-

$$C_d = 2.11 - 0.1517\,V$$

$$C_f = 0.0611/V^{1.2}$$

The 'Tridens' warp had a nominal diameter of 26 mm, while the average diameter from measurements on a number of samples was 24.1 mm. The difference between the nominal and actual diameters is assumed to be due to the warp having been compacted by use. The weight in air was 2.2 kg/m, and the weight in water was 1.72 kg/m.

The streamed warp experiment and the derivation of these equations will be described more fully in a later report, but the results have already been applied in the analysis of gear performance data presented in this report.

7. SUMMARY OF CONCLUSIONS

7.1 Performance measurements were made over two separate hauls for each net and bridle weight combination. There was a fair amount of scatter in the data but the most significant discrepancies were found in comparing one haul with another or when the warp length had been changed. These results cannot be explained by measurement error alone, and they suggest that large pelagic gears may settle into different configurations depending on how the gear was short or following the gear being disturbed for example by changing warp length. Nevertheless, meaningful performance comparisons can be made using averaged results for each net, and for this purpose regression equations were computed to show the variation of the most significant parameters with speed.

7.2 Using the swept volume index as a measure of the mechanical efficiency of each net, the best result was achieved by the rope trawl with floatation and 750 kg bridle weights. The index for this trawl compared with that of the conventional pelagic trawl was 18% higher at 4 knots and 13% higher at 5 knots. On the other hand, the rope trawls without floatation and those using 600 kg bridle weights had a lower swept volume index than the conventional trawl, primarily because the smaller mouth opening area of the rope trawls more than offset the reduction in drag.

7.3 The use of ropes in the forward parts of a trawl appeared to be less able to sustain the vertical opening compared with a fully meshed net, although the opening can be increased by adding floatation or heavier bridle weights. This effect resulted in the surface shape of the rope trawls being flatter, that is to say the angle of incidence of the various parts of the trawl to the water flow was more uniform, compared with the fully meshed trawl. The flatter surface shape could be an advantageous feature in applications where fish are likely to react to changes in the netting angle of incidence.

7.4 The rope trawl with the meshed upper square had a poorer mechanical efficiency than the fully roped trawls. The drag of the former would be significantly increased by the contribution of the meshed square, but there was no evidence of any compensating improvement in the opening area.

7.5 The large codend of net D did not cause a significant increase in the total net drag, but it had the effect of constricting the body of the trawl particularly at high towing speeds. Thus the expected increase in drag arising from the large codend must have been offset by a reduction in the drag of the body of the net compared with the standard rope trawl.

7.6 Measurements were made of the hydrodynamic force coefficients appropriate to the "Tridens" towing warps. Both the pressure drag and skin friction coefficients were found to decrease with speed, and the results have been applied in the analysis of data presented in this report.

7.7 Measurements of heel/tilt and attack angles of the doors (attack only on starboard side) indicate a far better behaviour of both doors on these trials. In some cases the heel angles show to be excessive (over 45 degrees) especially at high speeds. The lifting effect of the doors will be quite considerable at these heel values.
The tilt angles show to be positive in most cases ($\approx 10^\circ$) having the doors leaning backwards. Only net E has small tilt values (even negative).
The angle of attack was measured on the starboard side only and always positive (from 20°-40°).

7.8 The question whether the use of rope trawls will be suitable for the circumstances found in the Dutch fishing industry can not be answered from these experiments alone, although the results do indicate a fair chance for these nets to be useful. Especially the configuration of a rope trawl with heavy bridle weights (750 kg) and floatation on the headline seems to be successful.

7.9 From actual fishing test however, it was not found that the rope trawls do have a better fishing efficiency. There are indications, that fish escape by diving through the ropes of the lower panel.
Experiments of fish reactions to this kind of trawls therefore need to be extended. It is hopeful to note that a remote controlled towed vehicle carrying low-light television camera's is under development at the Marine Laboratory (Aberdeen).
Such a device would create the possibility of observing fish reactions at normal trawling conditions without the restrictions on speed, depth and duration of observations put upon the use of divers.

7.10 The design of the 1736 meshes pelagic trawl and the derived rope trawls was initiated some years ago when this size of trawl was quite commonly used in the Dutch fleet. The size of ships and gears has been extended since.
As a follow-up of these experiments one might choose the design and testing of a bigger rope trawl (2700 meshes) more suitable to today's large stern trawlers.

7.11 Apart from the goal of designing a suitable rope trawl with the advantages of having less drag and the possibility of fishing close to the bottom without heavy net damage, another result came out of these tests, namely the improvement of measurement techniques. Not only did the amount of parameters measured increase considerably over the past two years, but also some basic procedures did receive the attention they need such as a frequent calibration on instruments, like deck load cells for instance.
The trials technique improved by sailing reciprocal courses in order to eliminate tidal effects and by having at least five different speed settings during each haul.

haul nr.	type of net	bridle ex.	bridle weight	heel tilt meter depth	angle of attack stbd	towed log	log on net	Jap. depth meter	horsepower	warplength	T1	T2	T3 U	T3 L	T5	T6	course	doors	door net-sond
1	A	4.4	600	*	-	-	-	-	860	550	-	-	-	-	-	-	235°	I/b2	-
2	A	4.4	600	*	-	*	-	-	890-1090	450/550/650	*	*	*	*	-	*	235	"	*
3	A	4.4	600	*	-	*	-	-	1280-1265	450/550/650	*	*	*	*	-	*	235° 50°	"	*
4	A	4.4	750	*	-	*	-	*	680-780	550	*	*	*	*	-	*	235°	"	*
5	A	4.4	750	*	*	*	-	*	732-1318	550	*	*	*	*	-	*	235°	"	*
6	A	4.4	750	*	-	*	-	*	745-1320	550	*	*	*	*	-	*	50°	"	*
7	C	4.4	750	*	*	*	*	*	660-1262	550	*	*	*	*	-	*	238°	"	*
8	C	4.4	750	*	*	*	-	*	700-1320	550	*	*	*	*	-	*	60°	"	*
9	C	4.4	600	*	*	*	-	*	697-1350	550	*	*	*	*	-	*	248°	"	*
10	C	4.4	600	*	*	*	-	*	686-1290	550/650/750/850	*	*	*	*	-	*	68°	"	*
11	B	4.4	600	*	*	*	-	*	840-1020	450/550/650	*	*	*	*	-	*	240°	"	*
12	B	4.4	600	*	*	*	-	*	800-1378	650	*	*	*	*	-	*	299°	"	*
13	B	4.4	600	*	*	*	-	*	815-1220	650	-	-	-	-	-	-	100°	I/a2	*
14	D	4.4	600	*	*	*	-	*	874-1280	650/550	*	*	*	*	-	*	144°	I/b2	*
15	D	4.4	600	*	*	*	-	*	875-1216	650/550	*	*	*	*	-	*	324°	"	*
16**	D	4.4	750	*	*	*	*	*	1058-1410	650	*	*	*	*	-	*	114°	"	*
17**	D	4.4	750	*	*	*	-	*	930-1348	650	*	*	*	*	-	*	290°	"	*
18	E	2.0	750	*	*	*	-	*	1010-1375	550	*	*	*	*	-	*	114	"	*
19	E	2.0	750	*	*	*	-	*	904-1270	550	*	*	*	*	-	*	300	"	*
20	E	2.0	600	*	*	*	-	*	880-1034	550	*	*	*	*	-	*	106	"	*
21	E	2.0	600	*	*	*	-	*	850-1236	550	*	*	*	*	-	*	284	"	*
22	D	4.4	600	*	*	*	-	-	785-1110	650	-	-	-	-	-	-	127	II/b2	*
23	D	4.4	600	*	*	*	-	-	760-1148	550/650	-	-	-	-	-	-	295	II/b2	*

** = load cells in ropes

TABLE I SUMMARY OF EXPERIMENTS

* = instrument used
\- = instrument not used
I = asymmetrical doors
II = symmetrical doors

17

	Net A		Net B		Net C		Net D		Net E		Units
Speed	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	knots
Net drag	7.80	11.23	8.05	10.16	8.07	10.86	7.75	10.35	8.87	12.04	tonnes
Gear drag	9.47	12.59	8.75	10.73	9.26	12.46	9.13	11.71	9.28	12.81	tonnes
Shaft HP	903	1282	872	1212	940	1254	979	1296	975	1425	HP
Gear HP	262	417	231	363	254	390	247	393	250	420	HP
Headline (a)	17.1	14.7	17.2	14.8	20.9	16.7	17.3	12.4	20.2	14.9	M
Height (b)	20.1	15.1	—	—	23.8	17.9	20.1	16.1	19.6	14.6	M
Sideline spread	26.3	26.7	27.5	27.5	26.8	26.8	27.8	27.7	30.7	32.3	M
Headline (a)	133.8	72.7	180.7	116.6	134.6	72.1	179.8	101.9	156.7	108.9	M
Depth (b)	157.4	80.0	—	—	158.1	77.7	215.0	125.7	172.7	122.2	M
Warp length	550	550	650	650	550	550	650	650	550	550	M
Height of (a)	7.13	6.26	13.43	11.57	6.76	6.53	14.66	12.20	5.92	6.37	M
Boards above (b) the headline	12.98	8.50	—	—	9.58	8.55	15.14	12.85	9.55	7.26	M

Bridle weight

(a) = 600 kg

(b) = 750 kg

TABLE II PERFORMANCE COMPARISON OF THE FIVE NETS TESTED DRAGS AND DIMENSIONS

	Net A		Net B		Net C		Net D		Net E		Units
Speed	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0	knots
Wing-end (a)	581.2	538.5	583.0	516.0	679.1	583.9	614.0	500.5	619.2	506.5	m^2
Area (b)	677.0	561.0	—	—	793.7	583.1	701.8	585.5	674.1	589.3	
Headline (a)	447.3	394.1	474.0	406.5	544.6	446.3	480.0	337.5	615.4	477.0	m^2
Area (b)	530.6	407.1	—	—	632.0	484.3	563.6	450.0	611.6	470.0	
Net section (a)	305.8	284.5	349.0	290.5	343.6	335.5	314.8	245.0	424.0	317.5	m^2
Area (b)	363.6	304.5	—	—	414.0	357.0	369.6	308.5	438.8	351.0	
Swept volume /Unit time /Unit load (a)	107.0	93.4	124.5	104.1	139.0	106.0	125.6	84.6	143.9	100.3	$\frac{m^3}{sec.tonne}$
(b)	144.4	89.4	—	—	170.3	107.5	155.7	111.0	144.5	95.3	

Bridle weight

(a) = 600 kg

(b) = 750 kg

TABLE III — PERFORMANCE COMPARISON OF THE FIVE NETS TESTED OPENING AREAS AND SWEPT VOLUMES

HAUL NUMBER : T78.2 RUN ON 28-MAR-79

TABLE IV

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)	STBD DOOR ATTACK (DEG)
2	450	600	4.16	84.2	34.2	26.1	22.2	90.0	98.6	104.0 *	17.6	18.2	14.2	29.3	24.6	14.0	11.0	
3	550	600	4.11	89.0	34.8	25.8	22.7	114.5	124.9	127.0	16.5	17.0	13.6	28.2	25.7	15.0	10.0	
4	650	600	4.01	93.0	34.8	26.7	23.2	145.0	158.0	160.0 *	16.9	16.3	13.1	28.7	25.1	14.5	10.5	
5	450	600	4.65	83.5	33.9	25.8	22.6	58.0	69.4	72.5 *	17.0	14.9	12.3	37.9	31.6	16.0	10.5	
6	550	600	4.65	88.0	34.6	26.5	22.8	86.0	96.7	97.0	16.6	16.0	13.3	35.9	27.7	16.0	9.5	
7	650	600	4.58	89.0	34.8	26.5	23.2	105.0	121.0	120.0 *	16.0	15.2	12.6	38.2	28.6	17.0	10.0	

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)
2	450	600	4.16	5.20	5.06	10.26	9.90	0.41	0.23	8.62	0.90	0.93	0.48	0.48	0.85	0.54
3	550	600	4.11	5.43	5.00	10.43	10.02	0.61	0.54	8.58	0.92	0.90	0.51	0.50	0.77	0.39
4	650	600	4.01	5.32	5.06	10.38	9.91	0.51	0.42	8.37	0.88	0.89	0.54	0.53	0.83	0.34
5	450	600	4.65	5.84	6.08	11.92	11.67	0.49	0.37	9.87	1.00	1.06	0.54	0.55	1.17	0.65
6	550	600	4.65	5.84	5.82	11.67	11.36	0.40	0.49	9.80	1.01	1.02	0.60	0.58	0.97	0.40
7	650	600	4.58	6.10	5.71	11.81	11.46	0.74	0.66	9.77	0.95	0.97	0.58	0.57	1.14	0.42

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	450	600	4.16	104.3	9.0	601.9	475.0	14.317	18.140	118.1	890.0	278.6	1.15	0.96
3	550	600	4.11	127.2	6.6	574.2	438.6	14.939	19.557	108.2	890.0	278.7	1.21	1.01
4	650	600	4.01	159.7	7.8	588.2	435.2	14.226	19.223	107.4	890.0	269.0	1.25	0.99
5	450	600	4.65	71.4	8.1	576.3	384.4	17.120	25.664	93.3	1095.0	367.3	1.14	0.91
6	550	600	4.65	96.7	5.0	574.4	424.0	17.065	23.118	103.5	1085.0	357.4	1.02	0.87
7	650	600	4.58	119.6	6.3	556.8	402.8	17.549	24.256	97.2	1085.0	355.3	1.20	0.90

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.3

TABLE V

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	450	600	5.17	85.0	34.8	26.5	22.0	41.0	53.9	58.0 *	15.6	13.2	11.4	42.9	25.7	21.5	10.0	
2	550	600	5.05	89.0	36.1	27.1	24.7	58.5	66.2	70.0	15.2	14.3	12.0	41.4	30.6	16.0	10.5	
3	650	600	5.17	89.5	35.7	26.9	24.0	92.5	98.6	100.0 *	15.5	16.3	13.1	36.0	30.6	15.5	10.5	
4	450	600	4.79	80.5	33.9	26.4	22.8	57.0	63.2	65.5 *	14.5	15.2	12.9	38.7	27.6	17.0	10.0	
5	550	600	4.77	87.0	35.5	27.1	23.1	72.5	79.0	83.0	14.5	15.0	11.7	38.8	32.5	16.5	11.0	
6	650	600	4.50	87.0	35.1	26.5	22.9	85.0	94.7	95.0 *	14.8	15.8	12.2	40.7	32.5	17.5	11.0	

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	450	600	5.17	5.77	6.70	12.47	12.28 *	0.72	1.22	10.60 *	1.07	1.22	0.56	0.60	1.51	0.81
2	550	600	5.06	5.84	6.48	12.33	12.12 *	0.61	1.21	10.68 *	1.10	1.14	0.62	0.61	1.32	0.88
3	650	600	5.17	6.25	6.00	12.25	11.96 *	0.63	0.71	10.79 *	1.06	1.07	0.65	0.64	0.97	0.72
4	450	600	4.79	6.49	6.15	12.64	12.40 *	0.62	0.83	11.24 *	1.11	1.15	0.58	0.58	0.95	0.64
5	550	600	4.77	6.51	6.16	12.67	12.41 *	0.52	0.84	11.34 *	1.14	1.15	0.66	0.64	1.10	0.77
6	650	600	4.50	6.51	6.26	12.78	12.49 *	0.70	0.90	11.35 *	1.06	1.09	0.65	0.65	1.16	0.67

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	450	600	5.17	56.8	9.9	542.9	349.8	19.532	30.310	87.8	1290.0	429.7	1.13	1.08
2	550	600	5.06	69.6	6.9	548.8	387.6	19.458	27.550	94.5	1290.0	414.9	1.08	1.12
3	650	600	5.17	100.4	3.7	553.3	438.5	19.497	24.605	108.2	1270.0	418.4	0.89	0.84
4	450	600	4.79	65.9	4.7	491.5	401.3	22.867	28.010	88.0	1260.0	402.1	1.05	1.03
5	550	600	4.77	83.2	6.6	514.7	406.5	22.027	27.893	88.0	1265.0	400.6	1.11	1.08
6	650	600	4.50	95.5	4.5	519.5	418.7	21.846	27.106	85.5	1267.0	380.4	1.29	1.18

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.5

TABLE VI

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	550	750	4.09	88.0	34.8	26.5	24.0	138.0	139.8	151.0	19.6	19.4	15.5	23.5	17.8	12.5	9.0	
2	550	750	4.70	86.0	34.6	26.4	23.3	76.8	80.7	88.3	16.9	15.9	13.5	40.7	26.8	17.0	7.5	
3	550	750	3.74	86.0	34.2	26.2	23.3	172.0	173.8	171.0	19.6	20.7	15.8	14.8	10.4	10.5	6.0	
4	550	750	4.51	90.0	34.8	26.5	24.4	116.0	120.3	133.0	17.0	16.0	13.0	28.3	20.8	14.0	8.0	
5	550	750	5.11	87.0	34.8	26.5	23.7	74.0	77.5	85.0	15.3	15.3	12.4	34.4	28.4	16.0	6.0	

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	550	750	4.09	4.36	5.22	9.58	9.12	0.28	0.81	7.85	0.82	0.86	0.45	0.46	0.74	0.57
2	550	750	4.70	5.46	6.65	12.10	11.84	0.37	1.06	10.34	0.99	1.09	0.58	0.60	1.15	0.95
3	550	750	3.74	4.11	4.69	8.79	8.21	0.44	0.80	6.90	0.71	0.75	0.37	0.37	0.05	-0.10
4	550	750	4.51	5.12	5.66	10.78	10.38	0.36	0.73	9.11	0.98	1.01	0.56	0.55	0.97	0.74
5	550	750	5.11	6.42	6.34	12.77	12.50	0.23	0.02	11.97	1.19	1.17	0.70	0.70	1.16	1.03

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	550	750	4.09	150.9	11.4	682.0	514.1	11.506	15.264	137.9	840.0	252.5	1.03	1.19
2	550	750	4.70	87.8	8.8	584.8	419.8	17.673	24.620	98.3	1180.0	376.5	1.08	1.23
3	550	750	3.74	171.5	-2.7 *	670.3	542.3	10.290	12.717	151.4	732.0	207.8	0.91	1.20
4	550	750	4.51	132.5	14.1	591.6	424.0	15.394	21.478	108.1	1000.0	316.9	1.07	1.08
5	550	750	5.11	85.0	8.6	532.5	405.5	22.481	29.522	89.1	1318.0	432.4	0.97	0.91

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.6 RUN ON 28-MAR-79

TABLE VII

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)	STBD DOOR ATTACK (DEG)
1	550	750	3.54	86.0	33.5	25.8	22.0	191.0	183.6	205.0	22.7	22.6	17.2	6.4	10.4	9.5	6.5	
2	550	750	4.16	94.0	35.7	26.9	23.5	129.0	126.1	137.5	20.6	20.6	15.6	16.7	16.4	11.0	5.5	
3	550	750	3.77	85.0	33.9	26.0	22.6	164.0	159.2	176.0	17.2	22.0	17.0	9.9	12.9	10.0	5.5	
4	550	750	4.42	91.0	35.7	26.9	23.6	108.0	105.7	119.0	18.4	18.4	14.6	19.7	21.4	11.0	6.0	
5	550	750	4.62	90.0	35.7	26.9	23.8	94.0	89.1	102.0	16.6	17.4	14.0	22.5	23.9	12.0	5.5	

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	550	750	3.54	4.20	4.51	8.71	8.06	0.51	0.78	6.17	0.68	0.67	0.35	0.35	0.35	0.57
2	550	750	4.16	5.20	5.44	10.64	10.19	0.86	1.08	7.80	0.93	0.93	0.50	0.49	0.54	0.68
3	550	750	3.77	4.66	4.75	9.41	8.85	0.55	0.71	7.07	0.74	0.74	0.39	0.40	0.44	0.64
4	550	750	4.42	5.60	5.93	11.53	11.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	550	750	4.62	6.08	6.23	12.31	11.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	550	750	3.54	205.0	17.0	760.5	583.1	8.109	10.575	172.3	745.0	193.1	1.11	1.43
2	550	750	4.16	137.5	9.2	735.5	554.2	10.607	14.078	152.1	1015.0	286.9	1.21	1.39
3	550	750	3.77	178.4	13.7	583.1	572.0	12.118	12.352	157.1	876.0	225.8	1.09	1.30
4	550	750	4.42	119.0	11.4	656.9	495.0	0.000	0.000	0.0	1160.0	333.5	0.00	0.00
5	550	750	4.62	102.4	9.7	592.6	468.1	0.000	0.000	0.0	1320.0	374.7	0.00	0.00

HAUL NUMBER : T78.7 RUN ON 28-MAR-79

TABLE VIII

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)	STBD DOOR ATTACK (DEG)
1	550	750	4.40	86.5	33.0	26.8	22.9	116.0	117.4	127.0	20.4	20.4	16.8	27.0	21.8	12.0	8.5	28.0
2	550	750	4.03	88.0	33.0	27.0	22.6	149.0	150.5	162.0	23.3	23.3	18.6	19.7	14.4	11.0	6.5	29.0
3	550	750	3.54	82.0	31.1	26.0	21.6	196.0	192.3	210.0	25.3	25.3	19.5	9.4	8.0	7.5	5.5	32.0
4	550	750	4.75	88.0	33.0	27.3	23.2	93.0	92.1	101.0	18.7	18.7	16.0	29.9	26.8	13.0	8.0	29.0
5	550	750	5.00	85.0	32.0	26.2	21.8	78.0	75.5	86.0	18.9	18.9	15.8	32.8	28.3	13.5	8.0	29.0

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	550	750	4.40	5.38	5.67	11.05	10.65	0.15	0.25	8.77	0.90	0.91	0.53	0.55	0.94	0.79
2	550	750	4.03	4.66	5.00	9.67	9.16	0.09	0.36	7.31	0.77	0.80	0.45	0.45	0.80	0.66
3	550	750	3.54	4.00	4.21	8.21	7.57	-0.01	0.19	5.83	0.58	0.60	0.33	0.34	0.61	0.62
4	550	750	4.75	6.00	6.15	12.15	11.83	0.16	0.38	10.23	1.06	1.06	0.63	0.62	1.00	1.00
5	550	750	5.00	6.31	6.52	12.84	12.57	0.25	0.53	10.79	1.07	1.08	0.64	0.63	1.15	1.26

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	550	750	4.40	127.8	10.3	673.2	546.8	13.024	16.037	141.2	995.0	317.0	1.03	0.97
2	550	750	4.03	162.8	12.2	768.9	629.1	9.507	11.620	178.5	830.0	249.8	1.04	1.03
3	550	750	3.54	210.8	15.8	786.9	657.8	7.413	8.867	205.5	660.0	181.3	1.02	1.07
4	550	750	4.75	101.8	8.4	617.1	510.5	16.580	20.042	122.0	1156.0	380.2	0.99	1.01
5	550	750	5.00	86.8	9.2	604.9	495.2	17.841	21.791	118.1	1262.0	425.5	0.97	1.06

HAUL NUMBER : T78.8

TABLE IX

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	550	750	3.44	84.0	32.0	26.0	19.7	201.0	201.0	210.0	30.1	28.0	22.1					
2	550	750	4.00	90.0	32.9	27.2	21.8	134.0	134.0	142.5	27.4	23.8	19.7					
3	550	750	3.69	88.0	33.5	26.7	21.0	161.5	161.5	170.0	26.1	26.4	21.2					
4	550	750	4.39	91.0	33.9	27.2	22.8	105.5	105.5	114.5	20.5	21.5	17.7					

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	550	750	3.44	3.94	3.84	7.79	7.13	0.79	0.52	6.05	0.67	0.68	0.33	0.36	0.10	0.15
2	550	750	4.00	4.91	4.99	9.90	9.44	0.83	0.47	8.46	0.94	0.96	0.51	0.56	0.52	0.57
3	550	750	3.69	4.41	4.35	8.76	8.22	0.70	0.40	7.33	0.80	0.82	0.43	0.46	0.38	0.42
4	550	750	4.39	5.61	5.66	11.27	10.90	0.92	0.73	9.68	1.08	1.08	0.59	0.62	0.80	0.79

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 COFFF	STBD DOOR NORMAL COEFF
1	550	750	3.44	209.7	7.5	961.7	728.0	6.296	8.317	212.9	700.0	165.9	1.33	1.11
2	550	750	4.00	141.5	7.0	900.8	647.4	9.390	13.067	157.6	968.0	255.5	1.29	1.15
3	550	750	3.69	170.9	7.0	876.0	704.9	8.366	10.397	182.7	830.0	205.3	1.26	1.12
4	550	750	4.39	115.8	7.5	694.0	584.8	13.949	16.552	136.5	1136.0	323.9	1.28	1.20

HAUL NUMBER : T78.9 RUN ON 28-MAR-79

TABLE X

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)	STBD DOOR ATTACK (DEG)
1	550	600	3.61	84.0	32.0	26.0	20.0	165.5	168.0	174.5	22.5	23.6	18.7	18.2	13.9	11.0	8.5	35.2
2	550	600	4.35	85.0	32.2	25.9	22.0	100.5	104.7	110.0	20.4	19.3	16.0	30.8	22.8	13.0	8.0	35.7
3	550	600	4.07	82.0	32.0	25.7	21.0	125.0	130.0	135.0	20.8	20.8	17.4	25.5	17.8	12.0	8.0	34.0
4	550	600	4.76	88.0	33.0	26.8	22.7	75.0	81.3	85.0	18.6	17.9	15.3	35.2	24.9	13.5	6.5	42.4
5	550	600	5.18	87.0	33.0	26.6	22.6	57.0	58.9	66.6	16.4	15.8	13.4	37.2	30.8	14.0	7.0	40.5

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	550	600	3.61	3.77	4.47	8.23	7.70	0.23	0.70	6.58	0.66	0.71	0.37	0.37	0.54	0.34
2	550	600	4.35	4.75	5.77	10.52	10.18	0.45	1.05	8.83	0.84	0.97	0.49	0.50	0.89	0.71
3	550	600	4.07	4.44	5.35	9.78	9.36	0.38	0.92	8.27	0.76	0.86	0.43	0.44	0.77	0.50
4	550	600	4.76	5.50	6.31	11.82	11.55	0.36	1.04	10.34	1.04	1.12	0.62	0.60	1.17	0.84
5	550	600	5.18	6.65	6.77	13.42	13.21	0.82	0.93	11.33	1.19	1.18	0.69	0.67	1.29	1.24

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	550	600	3.61	175.8	7.0	720.0	613.6	9.144	10.730	173.2	697.0	188.1	1.03	1.23
2	550	600	4.35	110.2	6.7	656.9	499.9	13.443	17.666	126.8	975.0	299.8	1.05	1.28
3	550	600	4.07	135.8	6.8	665.6	534.6	12.431	15.478	135.4	880.0	257.8	1.05	1.24
4	550	600	4.76	85.4	6.1	613.8	479.8	16.843	21.548	113.7	1145.0	372.2	1.08	1.17
5	550	600	5.18	67.1	7.9	541.3	420.3	20.940	26.967	98.9	1350.0	463.3	1.10	1.10

HAUL NUMBER : T78.10

TABLE XI

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	550	600	3.09	84.0	32.0	26.1	14.0	178.0	182.6	188.0	22.7	24.6	19.6	12.3	8.0	11.5	5.5	22.5
2	550	600	3.80	88.0	32.9	27.1	0.0	136.5	140.7	146.0	21.5	21.1	17.6	18.1	17.3	13.0	8.0	21.0
3	550	600	4.45	85.0	33.1	26.7	0.0	94.0	95.0	101.0	19.2	19.2	15.8	26.3	25.3	14.5	8.0	20.0
5	550	600	3.97	90.0	33.5	27.4	0.0	116.5	121.3	125.0	20.7	20.9	17.2	21.0	18.9	13.0	6.5	19.5
6	650	600	3.74	90.0	33.7	27.3	0.0	150.0	153.4	160.0 *	20.7	19.7 *	16.0	20.1	18.9	12.5	7.0	20.5
7	750	600	3.64	94.5	35.1	28.0	0.0	185.0	187.5	195.0 *	20.4	19.6 *	15.9	18.1	17.4	12.0	6.0	21.5
8	850	600	3.67	97.5	35.9	28.6	0.0	220.0	220.0	232.0 *	20.7	19.9 *	16.1	18.5	16.4	13.5	6.0	21.0

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	550	600	3.09	3.62	4.16	7.77	7.17	0.17	0.10	6.49	0.64	0.66	0.36	0.37	0.55	0.32
2	550	600	3.80	4.28	4.75	9.03	8.57	0.20	0.31	7.82	0.82	0.83	0.47	0.47	0.70	0.45
3	550	600	4.45	5.09	5.60	10.69	10.38	0.25	0.42	9.65	0.95	0.95	0.56	0.54	0.90	0.80
5	550	600	3.97	4.47	5.09	9.56	9.17	0.25	0.23	8.43	0.88	0.92	0.51	0.53	0.82	0.55
6	650	600	3.74	4.77	5.13	9.90	9.43 *	0.45	0.41	8.41 *	0.85	0.86	0.51	0.53	0.77	0.59
7	750	600	3.64	4.98	4.89	9.87	9.34 *	0.49	0.47	8.42 *	0.88	0.87	0.55	0.55	0.72	0.62
8	850	600	3.67	5.21	4.83	10.04	9.46 *	0.62	0.56	8.28 *	0.87	0.86	0.56	0.56	0.74	0.80

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	550	600	3.09	189.7	6.3	726.5	642.1	8.928	10.101	157.5	686.0	149.9	1.36	1.18
2	550	600	3.80	146.6	5.9	707.4	571.9	11.053	13.673	143.1	880.0	220.4	1.16	1.04
3	550	600	4.45	101.8	5.1	635.5	512.6	15.186	18.826	121.7	1160.0	312.6	1.03	1.01
5	550	600	3.97	125.9	4.7	693.4	572.7	12.157	14.720	130.8	982.0	246.4	1.19	1.05
6	650	600	3.74	160.3	6.9	697.5	537.8	12.064	15.646	123.0 *	985.0	238.8	1.34	1.22
7	750	600	3.64	195.4	7.3	716.1	548.8	11.764	15.352	122.1 *	983.0	230.1	1.42	1.34
8	850	600	3.67	232.4	10.5	743.1	569.2	11.140	14.545	129.9 *	984.0	235.0	1.47	1.47

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.11 RUN ON 28-MAR-79

TABLE XII

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)	STBD DOOR ATTACK (DEG)
1	450	600	4.13	91.0	33.3	27.5	0.0	112.0	111.5	128.0 *	17.5	16.7	13.5	24.0	24.8	12.5	8.0	
2	550	600	4.01	92.0	33.9	27.5	0.0	138.0	142.7	157.0 *	17.5	16.2	13.2	24.9	22.8	13.0	8.0	
3	650	600	3.72	90.0	33.3	27.5	0.0	182.5	184.6	199.0	17.4	16.6	13.5	17.1	18.8	13.0	7.5	
4	650	600	4.38	94.0	33.9	27.5	0.0	147.0	146.6	163.5	15.3	15.2	12.8	24.8	27.2	14.5	9.0	
5	650	600	4.68	94.5	34.0	27.5	0.0	129.0	130.0	142.0	16.4	16.0	13.3	28.4	30.2	12.5	9.0	

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	450	600	4.13	4.06	4.40	8.46	8.06 *	0.02	0.70	7.49 *	0.94	0.90	0.51	0.46	0.82	0.70
2	550	600	4.01	4.11	4.50	8.61	8.17 *	0.10	0.67	7.52 *	0.87	0.85	0.50	0.47	0.95	0.62
3	650	600	3.72	4.27	4.51	8.78	8.25	0.07	0.46	7.74	0.82	0.80	0.50	0.48	0.78	0.58
4	650	600	4.38	5.00	4.81	9.81	9.39	0.23	0.21	8.92	1.00	0.95	0.61	0.61	0.96	0.98
5	650	600	4.68	4.96	5.01	9.97	9.61	0.11	0.26	9.09	1.02	0.97	0.64	0.62	1.00	0.92

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	450	600	4.13	127.6	15.5	582.7	459.2	12.846	16.300	130.4	840.0	225.2	1.11	1.19
2	550	600	4.01	156.4	15.9	593.2	445.5	12.676	16.879	122.3	840.0	221.8	1.23	1.18
3	650	600	3.72	198.6	14.7	579.5	456.5	13.355	16.953	113.0	846.0	207.7	1.25	1.20
4	650	600	4.38	163.4	16.0	518.7	418.0	17.187	21.328	105.7	1020.0	278.3	1.11	1.09
5	650	600	4.68	141.8	11.7	557.6	440.0	16.309	20.670	116.6	1077.0	304.3	0.99	0.95

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.12

TABLE XIII

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	650	600	3.72	92.0	32.0	27.5	22.8	179.0	185.5	193.0	19.0	19.5	16.4	21.7	16.4	10.5	7.0	30.0
2	650	600	4.30	92.0	32.9	27.6	22.0	138.0	140.7	152.0	16.6	16.9	13.6	25.5	28.7	12.5	9.0	27.5
3	650	600	4.34	93.0	33.9	27.3	23.0	154.0	159.2	168.0	17.8	17.9	15.0	25.5	21.3	11.5	8.0	28.0
4	650	600	4.99	89.0	32.6	27.0	23.2	103.5	104.7	114.5	15.8	15.6	13.0	34.7	32.2	14.0	8.5	28.0
5	650	600	5.32	90.0	33.9	27.8	24.0	79.0	80.4	92.0	14.3	13.2	11.2	40.6	33.2	14.5	8.0	30.5

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	650	600	3.72	4.45	4.46	8.91	8.38	0.65	0.52	7.27	0.79	0.81	0.46	0.47	0.66	0.47
2	650	600	4.30	5.63	4.77	10.40	9.98	0.28	0.48	9.04	1.00	0.91	0.61	0.55	0.94	0.88
3	650	600	4.34	4.49	4.80	9.29	8.85	0.53	0.51	8.48	0.93	0.91	0.53	0.53	0.88	0.63
4	650	600	4.99	5.44	5.44	10.87	10.58	0.47	0.62	9.94	1.03	0.99	0.63	0.60	1.09	1.07
5	650	600	5.32	6.00	6.04	12.03	11.80	0.43	0.66	11.17	1.15	1.09	0.71	0.67	1.39	1.35

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	650	600	3.72	193.2	10.0	608.1	536.3	11.949	13.549	141.3	800.0	211.0	1.34	1.18
2	650	600	4.30	152.1	11.9	546.1	466.5	16.544	19.369	114.3	1010.0	290.5	1.15	1.11
3	650	600	4.34	168.0	10.6	603.4	488.7	14.056	17.355	128.7	940.0	260.0	1.12	0.98
4	650	600	4.99	114.4	9.6	515.1	421.2	19.294	23.598	108.9	1184.0	357.2	0.96	0.97
5	650	600	5.32	91.5	11.6	484.8	367.0	23.038	30.434	90.0	1378.0	424.7	1.00	1.00

HAUL NUMBER : T78.14

TABLE XIV

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	650	600	3.41	94.5	34.4	28.7	23.0	203.0	203.0	219.0	20.0	20.3	15.7	18.5		13.0		
2	650	600	3.76	91.0	31.7	27.1	22.6	183.0	183.0	197.0	18.8	19.1	15.2	19.9		14.0		
3	650	600	3.94	94.0	34.4	28.0	23.1	160.0	160.0	178.0	19.0	18.9	14.7	25.8		14.5		
4	650	600	4.33	92.5	33.9	28.0	23.0	133.0	133.0	144.0	17.0	16.7	13.4	30.1		15.5		
5	650	600	4.50	95.0	34.0	28.2	23.5	123.0	123.0	135.5	16.9	16.4	13.3	30.2		14.5		
6	550	600	4.09	90.0	33.9	27.5	22.8	125.5	125.5	141.0	18.9	18.7	14.9	29.9		13.0		

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	650	600	3.41	4.23	4.52	8.75	8.13	0.54	0.58	6.88	0.78	0.78	0.45	0.45	0.57	0.54
2	650	600	3.76	4.51	4.68	9.19	8.64	0.39	0.46	7.58	0.83	0.81	0.50	0.49	0.63	0.60
3	650	600	3.94	4.59	4.81	9.40	8.93	0.66	0.60	7.66	0.85	0.86	0.49	0.50	0.91	0.92
4	650	600	4.33	5.18	5.35	10.53	10.13	0.62	0.55	9.04	0.96	0.96	0.58	0.58	0.83	0.81
5	650	600	4.50	5.30	5.40	10.69	10.33	0.81	0.60	9.13	1.00	1.01	0.59	0.61	0.96	0.95
6	550	600	4.09	4.44	5.20	9.65	9.23	1.16	0.93	7.80	0.85	0.94	0.44	0.49	0.78	0.83

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	650	600	3.41	219.2	14.6	686.0	582.6	9.998	11.807	148.7	874.0	187.6	1.44	1.46
2	650	600	3.76	197.2	12.5	596.0	517.6	12.721	14.647	132.1	973.0	219.9	1.20	1.19
3	650	600	3.94	177.9	16.5	653.7	529.2	11.723	14.480	140.1	1020.0	238.1	1.38	1.36
4	650	600	4.33	143.9	9.5	576.3	467.6	15.684	19.330	115.3	1200.0	296.9	1.15	1.11
5	650	600	4.50	135.2	11.0	588.2	462.5	15.515	19.729	117.4	1280.0	314.5	1.21	1.13
6	550	600	4.09	140.9	14.1	640.7	514.2	12.178	15.174	138.8	1064.0	255.5	1.49	1.42

HAUL NUMBER : T78.15

TABLE XV

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	650	600	3.94	93.0	33.9	27.7	23.2	167.5	173.8	188.0	18.2	16.2	12.5	21.8	21.2	15.0	10.0	24.0
2	650	600	4.47	90.5	33.8	27.4	23.2	117.0	122.2	134.0	15.8	13.5	11.2	34.6	29.5	18.0	11.0	24.0
3	650	600	3.82	92.0	34.0	27.4	22.6	185.0	189.4	206.0	17.8	16.2	12.8	21.4	16.8	14.5	8.0	25.0
4	650	600	4.40	94.0	34.0	27.6	23.4	153.5	162.2	176.0	17.5	14.7	12.0	26.6	20.3	16.0	9.0	26.0
5	650	600	4.81	86.5	32.8	27.0	22.5	100.5	98.9	113.0	14.8	13.2	11.0	33.8	37.9	17.0	12.0	23.0
6	550	600	4.31	92.3	34.2	28.0	23.0	115.5	116.4	131.5	17.2	14.7	12.0	25.8	27.1	14.0	10.0	24.0

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	650	600	3.94	4.85	4.72	9.56	9.06	0.78	0.51	7.63	0.85	0.86	0.49	0.51	0.83	0.65
2	650	600	4.47	5.72	5.45	11.17	10.81	0.65	0.64	9.39	0.99	0.97	0.61	0.59	1.10	0.92
3	650	600	3.82	4.63	4.71	9.34	8.78	0.67	0.52	7.09	0.78	0.79	0.45	0.47	0.72	0.61
4	650	600	4.40	4.98	5.20	10.18	9.72	0.64	0.64	7.99	0.89	0.92	0.53	0.54	0.99	0.63
5	650	600	4.81	6.35	5.69	12.04	11.74	0.47	0.71	10.27	1.07	0.93	0.67	0.57	1.07	1.21
6	550	600	4.31	5.16	5.15	10.32	9.93	0.70	0.57	8.46	0.97	0.97	0.54	0.55	0.85	0.89

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	650	600	3.94	187.0	16.6	617.0	448.8	12.362	16.996	119.3	875.0	241.5	1.39	1.16
2	650	600	4.47	132.8	13.7	534.1	369.9	17.591	25.400	90.6	1087.0	327.0	1.23	1.12
3	650	600	3.82	205.2	18.1	605.2	443.9	11.711	15.968	123.2	811.0	226.9	1.31	1.18
4	650	600	4.40	174.6	17.5	595.0	405.7	13.429	19.692	115.0	960.0	289.4	1.16	1.01
5	650	600	4.81	112.2	12.6	485.5	356.4	21.157	28.818	85.9	1216.0	382.2	1.05	1.11
6	550	600	4.31	130.3	14.8	588.2	411.6	14.384	20.557	107.9	980.0	289.6	1.20	1.17

HAUL NUMBER : T78.16 — RUN ON 28-MAR-79

TABLE XVI

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)	STBD DOOR ATTACK (DEG)
1	650	750	4.39	98.0	34.8	28.5	23.4	162.0	162.0	178.0	19.8	18.4	14.6	18.7		11.0		
2	650	750	4.19	97.3	34.8	28.5	22.5	192.0	192.0	209.0	20.2	19.5	15.6	13.8		9.0		
3	650	750	4.69	95.2	34.2	28.5	23.4	150.0	150.0	164.5	18.5	16.9	13.7	21.0		12.5		
4	650	750	4.57	98.0	33.9	28.6	23.1	177.0	177.0	193.5	20.0	18.3	15.5	15.8		10.0		
5	650	750	4.79	96.0	34.8	28.4	23.5	118.0	118.0	129.0	17.9	16.3	13.7	30.4		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	650	750	4.39	5.16	5.21	10.38	9.89	0.50	0.68	8.61	1.03	0.98	0.61	0.58	0.80	0.75
2	650	750	4.19	4.74	4.77	9.50	8.94	0.51	0.59	7.63	0.91	0.89	0.52	0.51	0.61	0.58
3	650	750	4.69	5.69	5.35	11.04	10.58	0.67	0.75	9.54	1.10	1.05	0.65	0.61	0.75	0.75
4	650	750	4.57	4.96	5.01	9.97	9.45	0.36	0.34	8.39	0.99	0.98	0.59	0.59	0.68	0.68
5	650	750	4.79	5.93	5.74	11.67	11.30	0.56	0.63	10.33	1.16	1.12	0.71	0.68	0.92	0.91

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	650	750	4.39	177.3	14.5	689.0	524.4	12.502	16.427	137.6	1211.0	293.7	1.10	1.11
2	650	750	4.19	208.6	15.5	702.9	555.8	10.860	13.736	157.0	1058.0	253.4	1.05	1.05
3	650	750	4.69	163.7	13.0	632.7	481.7	15.082	19.812	121.9	1310.0	335.8	1.03	1.03
4	650	750	4.57	192.7	15.0	678.0	523.4	12.373	16.030	146.8	1156.0	292.4	0.91	0.90
5	650	750	4.79	128.2	9.5	622.9	463.0	16.590	22.322	110.5	1410.0	366.5	1.05	1.05

HAUL NUMBER : T79.17 RUN ON 28-MAR-79

TABLE XVII

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)	STBD DOOR ATTACK (DEG)
1	650	750	4.42	92.0	33.3	27.3	22.1	162.5	162.5	179.0	19.8	18.5	16.2	23.1		11.0		
2	650	750	4.75	93.0	33.3	27.8	23.3	135.0	135.0	150.0	17.7	15.9	12.9	25.9		13.0		
3	650	750	5.20	90.0	33.3	27.2	23.2	89.0	89.0	101.5	16.4	15.7	12.6	38.6		14.5		
4	650	750	4.73	92.5	33.3	27.6	22.5	136.0	136.0	152.0	18.5	18.5	14.9	27.0		12.0		
5	650	750	5.18	92.0	33.3	27.6	23.0	89.0	89.0	105.5	16.8	15.6	13.0	38.1		14.5		
6	650	750	4.26	93.0	33.3	27.6	22.8	164.0	164.0	179.0	19.4	19.6	15.6	19.7		10.5		
7	650	750	4.12	93.0	33.3	27.0	22.5	171.0	171.0	187.0	19.2	19.5	15.7	17.3		10.0		

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	650	750	4.42	5.01	5.16	10.17	9.69	0.51	-0.16	8.12	0.81	0.90	0.48	0.57	0.79	0.94
2	650	750	4.75	5.94	5.79	11.73	11.31	0.40	0.41	9.76	1.05	1.04	0.65	0.63	0.91	0.94
3	650	750	5.20	6.49	6.51	13.01	12.73	0.15	0.56	11.42	1.19	1.10	0.76	0.69	1.31	1.25
4	650	750	4.73	5.56	5.63	11.19	10.78	0.28	0.34	9.21	0.98	0.97	0.61	0.60	1.03	1.04
5	650	750	5.18	6.24	6.51	12.75	12.48	0.15	0.34	11.04	1.14	1.13	0.74	0.71	1.48	1.48
6	650	750	4.26	5.08	5.40	10.48	9.97	0.24	0.15	8.39	0.88	0.91	0.55	0.56	0.80	0.82
7	650	750	4.12	5.04	5.39	10.43	9.89	0.23	0.24	8.24	0.88	0.89	0.54	0.54	0.78	0.79

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	650	750	4.42	178.4	15.0	659.3	505.1	12.310	16.068	141.6	992.0	289.9	0.97	1.02
2	650	750	4.75	149.1	13.5	589.4	442.1	16.554	22.070	110.8	1186.0	363.5	0.98	0.98
3	650	750	5.20	101.2	11.0	546.1	427.1	20.914	26.742	100.1	1286.0	448.0	1.00	0.99
4	650	750	4.73	152.0	14.5	616.1	510.6	14.953	18.041	135.0	1100.0	345.0	0.99	1.00
5	650	750	5.18	104.9	15.0	559.5	430.6	19.729	25.635	104.0	1348.0	437.4	1.06	1.07
6	650	750	4.26	179.1	13.5	646.0	540.9	12.980	15.502	141.5	957.0	287.5	1.02	1.03
7	650	750	4.12	187.1	14.5	639.3	526.5	12.893	15.655	135.5	930.0	275.8	1.07	1.09

IAUL NUMBER : T78.18

TABLE XVIII

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
2	550	750	4.03	88.0	36.0	31.4	27.4	166.0	166.0	174.0	21.5	23.2	19.0	6.0		1.0		
3	550	750	4.28	87.5	36.4	31.5	27.6	142.0	142.0	149.0	18.9	20.2	17.4	9.5		1.5		
4	550	750	4.74	90.0	36.9	31.9	28.0	124.5	124.5	133.0	16.6	17.7	15.0	13.5		2.5		
5	550	750	4.14	86.0	36.3	31.3	26.8	151.0	151.0	162.5	19.7	21.5	18.4	9.5		1.5		
6	550	750	4.38	91.0	36.5	31.6	28.4	129.0	129.0	136.0	17.5	18.2	16.5	10.5		1.5		

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)
2	550	750	4.03	4.89	4.56	9.45	8.88	0.77	0.09	8.33	0.83	0.89	0.42	0.49	0.23	0.35
3	550	750	4.28	5.66	5.40	11.06	10.53	1.03	0.20	9.80	0.96	1.03	0.49	0.57	0.24	0.37
4	550	750	4.74	6.40	6.07	12.47	12.00	1.26	0.20	11.41	1.15	1.22	0.58	0.69	0.36	0.51
5	550	750	4.14	5.34	5.23	10.57	10.02	1.34	0.13	9.15	0.87	0.98	0.42	0.55	0.32	0.53
6	550	750	4.38	6.38	5.89	12.28	11.78	1.00	0.28	11.22	1.16	1.20	0.61	0.67	0.30	0.41

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	550	750	4.03	174.8	6.5	773.8	728.6	10.771	11.440	181.3	1010.0	242.2	1.08	0.90
3	550	750	4.28	149.6	5.5	687.8	636.3	14.255	15.408	143.0	1178.0	305.1	1.19	0.92
4	550	750	4.74	133.6	7.0	612.4	564.6	18.634	20.210	120.7	1375.0	384.9	1.18	0.91
5	550	750	4.14	163.4	10.0	715.0	673.0	12.802	13.601	156.7	1068.0	280.7	1.45	1.00
6	550	750	4.38	136.4	5.5	638.6	575.1	17.571	19.511	115.6	1336.0	349.1	1.24	1.03

HAUL NUMBER : T78.19 RUN ON 28-MAR-79

TABLE XIX

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)	STBD DOOR ATTACK (DEG)
1	550	750	4.38	91.0	38.0	31.4	27.4	152.0	157.3	165.5	17.0	17.9	14.0	6.0	-0.5	2.0	-2.0	18.5
2	550	750	4.61	90.0	38.0	31.8	28.0	134.0	132.0	142.5	16.0	15.2	12.4	3.0	6.5	0.5	-0.5	18.5
3	550	750	4.04	86.5	36.0	31.2	26.4	169.0	172.9	182.5	18.1	18.4	14.6	3.0	-5.0	1.0	-2.5	18.5
4	550	750	4.43	89.5	37.4	31.6	27.6	150.5	153.4	163.5	16.7	16.4	13.3	4.0	0.0	2.0	-2.0	18.5
5	550	750	4.67	89.5	37.2	31.8	27.9	131.0	132.0	142.0	16.0	14.9	12.0	5.0	4.0	1.5	-1.5	18.5
6	550	750	4.38	89.5	36.8	31.5	27.9	138.0	138.8	148.0	17.0	15.2	12.4	3.0	4.5	1.0	-1.5	18.5
7	550	750	3.87	90.0	31.3	31.0	27.2	159.0	164.1	174.5	18.4	16.5	13.5	6.5	-5.5	2.5	-3.0	18.5

FORCES

BL NO	WARP LENGTH (M)	BRIDLE HEIGHT (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	550	750	4.38	5.48	5.11	10.59	10.03	0.60	0.18	9.26	0.93	1.03	0.49	0.56	0.41	0.28
2	550	750	4.61	6.34	5.82	12.17	11.66	0.61	0.35	10.81	1.09	1.12	0.59	0.61	0.25	0.52
3	550	750	4.04	5.01	4.89	9.90	9.29	0.62	0.27	8.19	0.79	0.88	0.41	0.48	0.30	0.22
4	550	750	4.43	5.65	5.39	11.04	10.48	0.52	0.29	9.76	0.99	1.01	0.52	0.55	0.42	0.32
5	550	750	4.67	6.55	5.97	12.51	12.00	0.61	0.32	11.14	1.13	1.14	0.62	0.63	0.38	0.48
6	550	750	4.38	6.35	5.83	12.19	11.65	0.54	0.34	10.83	1.10	1.11	0.60	0.62	0.29	0.38
7	550	750	3.87	5.40	5.23	10.63	10.01	0.53	0.21	9.20	0.97	1.06	0.55	0.62	0.43	0.29

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	550	750	4.38	166.0	10.1	646.0	562.1	14.329	16.467	136.9	1027.0	297.5	0.93	0.85
2	550	750	4.61	142.1	8.7	608.0	483.4	17.786	22.370	106.1	1250.0	363.8	0.91	0.92
3	550	750	4.04	182.6	10.8	651.6	574.1	12.568	14.264	145.8	904.0	253.9	0.98	0.88
4	550	750	4.43	163.3	10.8	624.6	518.3	15.634	18.841	121.0	1070.0	314.1	0.92	0.85
5	550	750	4.67	141.5	9.7	595.2	473.8	18.718	23.514	102.2	1270.0	379.4	0.93	0.89
6	550	750	4.38	147.1	8.8	625.5	478.8	17.309	22.611	99.7	1185.0	345.2	1.00	0.97
7	550	750	3.87	173.6	12.2	576.0	511.5	15.969	17.981	110.8	950.0	262.3	1.20	1.14

HAUL NUMBER : T78.20

TABLE XX

RUN ON 28-MAR-79

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)	STBD DOOR ATTACK (DEG)
1	550	600	4.00	85.5*	33.5*	29.5*	25.6*	181.0*	181.0*	184.0*	19.2*	24.2*	18.8*	6.0*		2.5*		
2	550	600	4.14	89.0	35.1	30.3	27.0	153.0	153.0	158.0	17.2	20.6	15.4	11.0		3.5		
3	550	600	4.16	92.7	36.5	30.5	27.8	139.0	139.0	145.0	16.1	18.5	14.0	8.5		1.5		
4	550	600	3.56	87.0	34.2	29.8	25.9	184.0	184.0	189.5	19.2	24.0	19.6	6.5		2.0		
5	550	600	4.03	89.0	35.4	28.9	27.2	152.0	152.0	157.5	17.9	21.4	16.0	7.0		2.0		
6	550	600	4.15	90.0	35.7	29.3	27.4	144.0	144.0	150.5	17.4	19.8	15.2	8.5		2.0		

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	550	600	4.00	4.12	4.31	8.43	7.85*	0.48	0.06	7.43*	0.71	0.80	0.36	0.43	0.10	0.11
2	550	600	4.14	4.82	4.95	9.77	9.24	0.71	-0.08	8.94	0.86	1.00	0.45	0.57	0.22	0.26
3	550	600	4.16	5.41	5.34	10.74	10.24	0.67	0.08	9.84	1.02	1.09	0.55	0.62	0.29	0.36
4	550	600	3.56	3.98	4.19	8.17	7.56	0.54	0.03	7.10	0.68	0.79	0.35	0.44	0.21	0.21
5	550	600	4.03	4.82	4.74	9.55	9.03	0.59	0.11	8.69	0.88	0.92	0.47	0.52	0.27	0.35
6	550	600	4.15	4.92	4.78	9.70	9.21	0.46	-0.01	9.09	0.93	0.97	0.50	0.56	0.35	0.42

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	550	600	4.00	186.5	1.5 *	643.2*	713.9*	11.556*	10.411 *	197.8 *	880.0	212.4	0.82	0.77
2	550	600	4.14	159.7	3.5	603.7	624.2	14.815	14.328	148.7	1022.0	258.9	1.01	0.92
3	550	600	4.16	146.2	4.5	587.6	564.3	16.752	17.444	122.8	1120.0	288.2	1.10	1.01
4	550	600	3.56	191.9	4.0	656.6	715.2	10.813	9.927	184.6	790.0	182.2	1.07	0.98
5	550	600	4.03	159.2	4.0	633.7	618.5	13.720	14.057	147.6	980.0	246.4	1.02	0.93
6	550	600	4.15	151.7	5.0 *	621.3	580.2	14.637	15.674	136.3	1034.0	258.6	0.96	0.93

* = EXCLUDED FROM GRAPHS

HAUL NUMBER : T78.21 RUN ON 28-MAR-79

TABLE XXI

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)	STBD DOOR ATTACK (DEG)
1	550	600	4.02	87.0	37.0	30.7	26.8	149.0	145.6	156.5	15.8	20.1	15.5	7.0	-1.0	3.5	-2.0	20.0
2	550	600	4.14	89.5	37.4	31.5	27.4	141.0	138.8	149.0	15.6	18.4	14.4	6.0	0.5	3.5	-2.5	20.0
3	550	600	4.37	92.5	37.0	32.1	28.0	127.0	128.1	136.0	15.0	16.8	13.3	10.0	-0.5	4.0	-3.0	20.0
4	550	600	3.59	89.0	38.6	30.8	27.2	159.0	153.4	165.0	17.4	21.0	16.3	3.0	2.0	2.0	-2.0	19.5
5	550	600	4.01	88.0	37.5	31.2	27.0	144.0	140.7	149.0	16.5	19.5	15.2	6.0	1.5	3.0	-3.0	19.5
6	550	600	4.52	90.0	37.7	31.4	27.4	125.0	120.3	134.0	15.2	18.6	14.4	10.5	1.0	4.0	-2.0	19.5

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	550	600	4.02	4.26	4.76	9.01	8.54	0.20	0.01	8.54	0.80	0.83	0.43	0.46	0.49	0.73
2	550	600	4.14	4.83	5.05	9.88	9.40	0.17	-0.03	9.54	0.93	0.96	0.51	0.54	0.47	0.69
3	550	600	4.37	5.39	5.46	10.84	10.40	0.33	0.04	10.41	1.07	1.10	0.59	0.63	0.54	0.62
4	550	600	3.59	4.28	4.66	8.94	8.41	0.18	0.16	8.32	0.80	0.82	0.43	0.44	0.38	0.69
5	550	600	4.01	4.58	5.15	9.74	9.25	0.34	-0.12	9.14	0.84	0.91	0.45	0.51	0.38	0.64
6	550	600	4.52	4.83	5.83	10.66	10.25	0.36	-0.14	9.94	0.94	1.03	0.51	0.59	0.64	1.04

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 COFFF	STBD DOOR NORMAL COFFF
1	550	600	4.02	158.2	8.4	621.6	617.0	13.738	13.841	149.5	920.0	232.4	0.90	1.04
2	550	600	4.14	150.4	8.3	583.4	579.7	16.352	16.458	129.5	1030.0	263.5	0.94	1.05
3	550	600	4.37	136.9	7.7	555.0	539.3	18.762	19.308	116.5	1150.0	307.5	0.99	1.01
4	550	600	3.59	166.8	8.0	671.7	646.8	12.382	12.858	143.7	850.0	204.4	1.07	1.27
5	550	600	4.01	150.5	5.8	618.7	608.4	14.777	15.027	137.4	965.0	251.1	0.93	1.06
6	550	600	4.52	135.7	10.6	573.1	584.0	17.347	17.022	136.7	1128.0	313.4	0.89	1.09

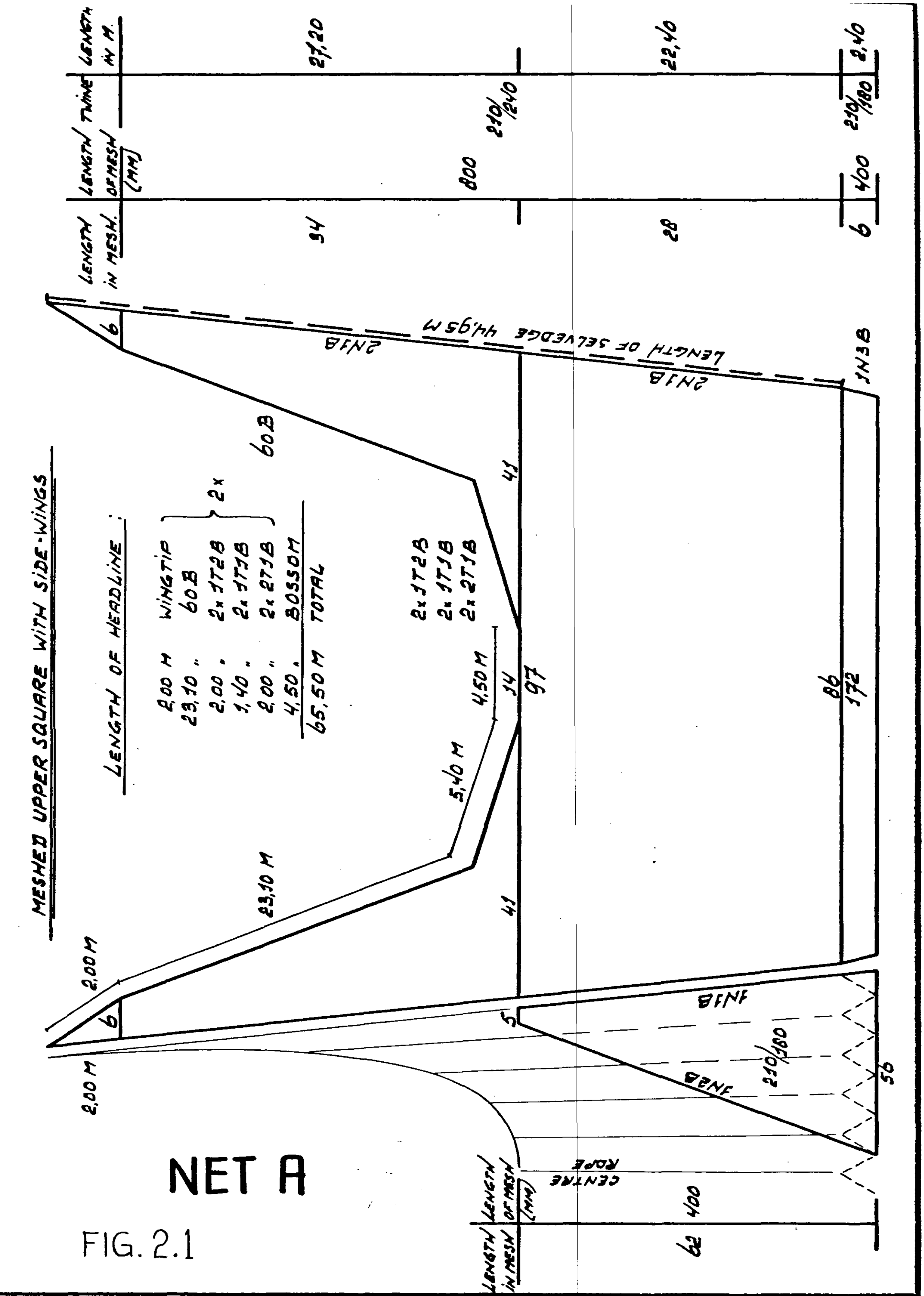
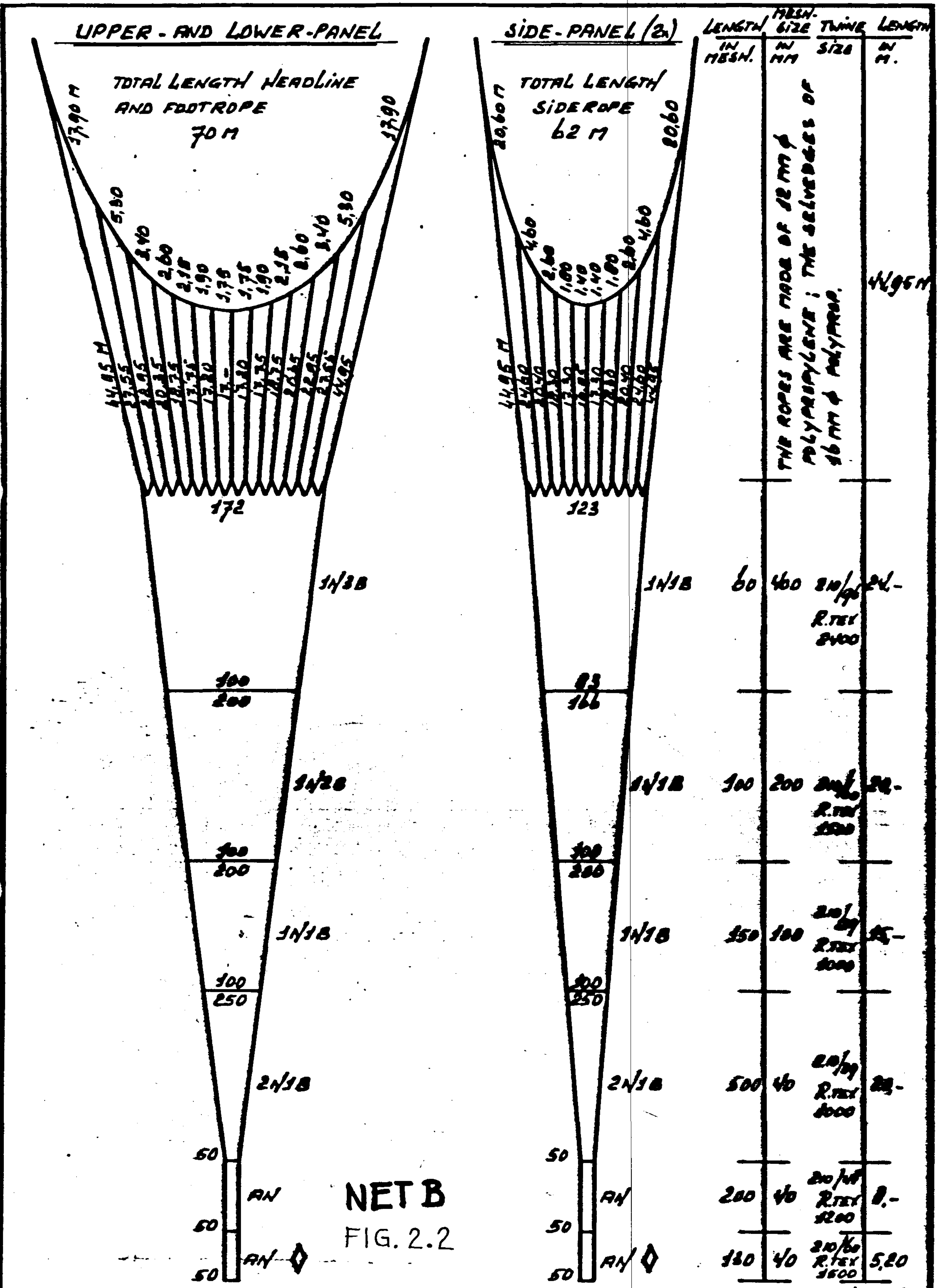


FIG. 2.1

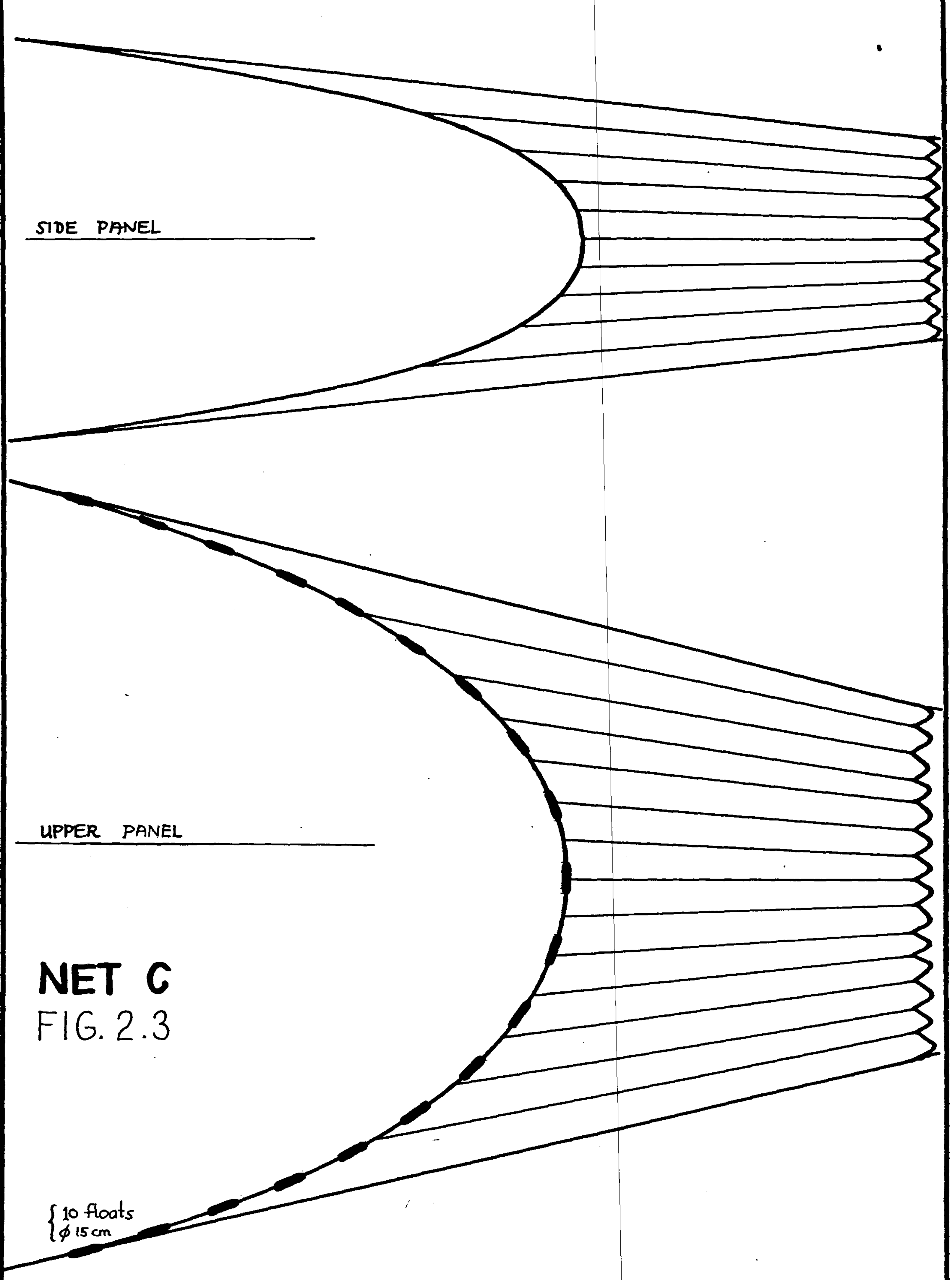
Benaming MESHED UPPER SQUARE WITH SIDE-WINGS FOR ROPE-TRAWL		BELONGS TO A4/734[c]
TECHNICAL RESEARCH DEPARTM.	Schaal 1:300	Gecontroleerd
Auteursrecht voorbehouden volgens de wet	Getekend	Gezien 13-10-'78
Formaat A4	754[c]	Rangschikmerk 38



NET B

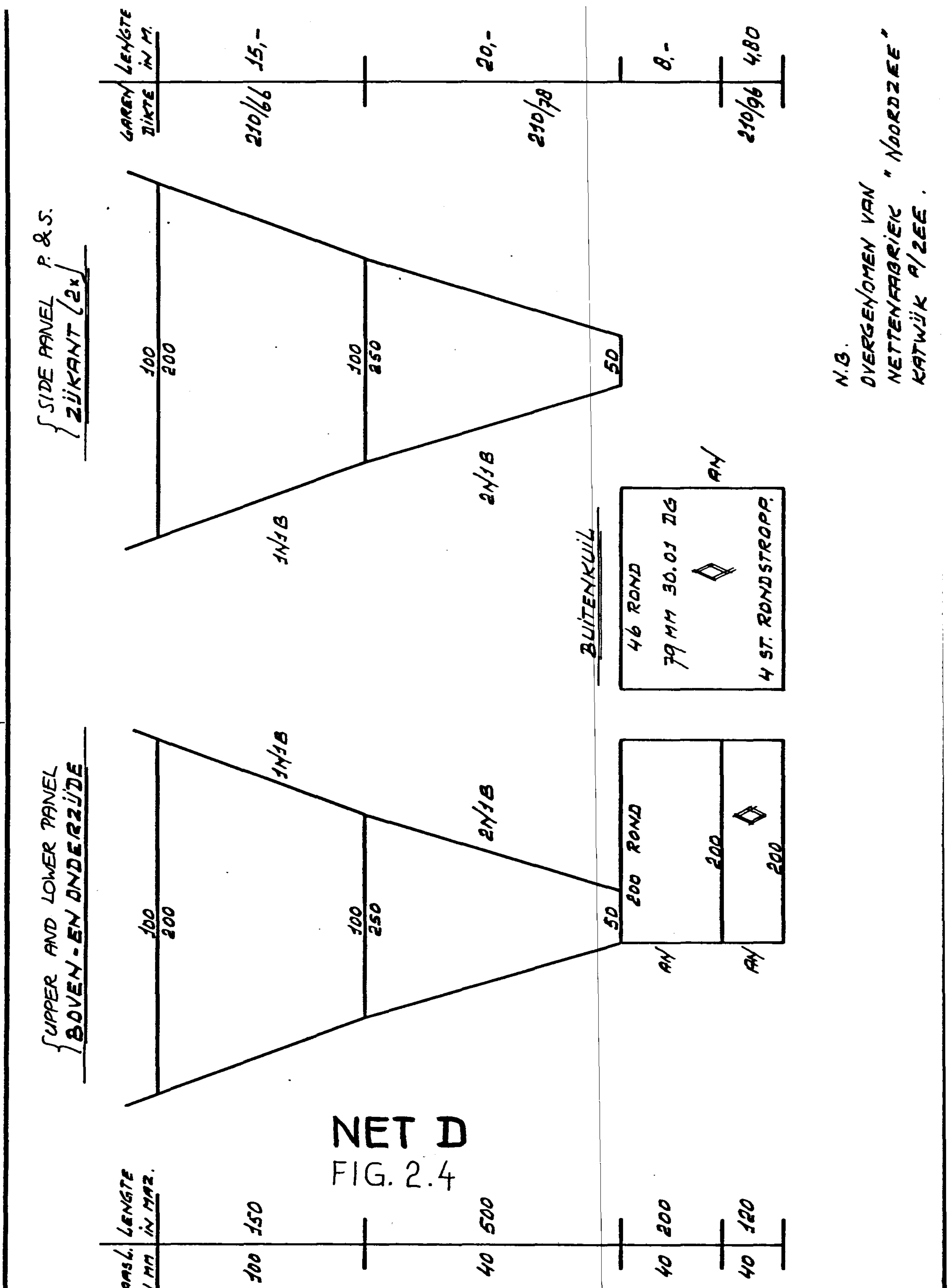
FIG. 2.2

Benaming	ROPE - TRAWL	DERIVED FROM A4 263
	1000-1200 HP.	Formaat A4 — 734 d
RIVO TECHN. RES. DEP.	Schaal 1:500 — Gecontroleerd	39



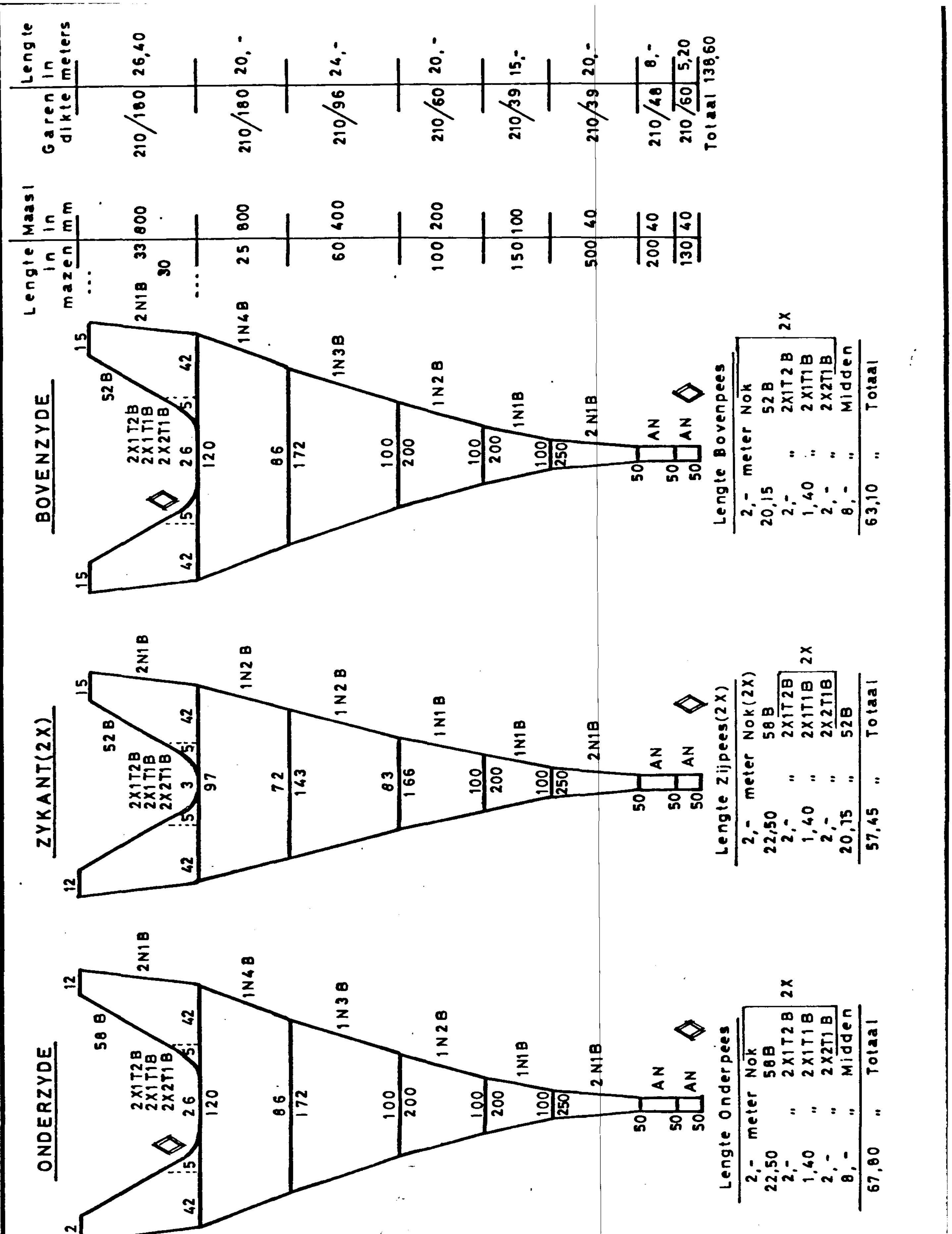
NET C
FIG. 2.3

Benaming	DIMENSIONS OF ROPES FOR A ROPE-TRAWL PLACE OF FLOTATION ON THE HEADLINE		Formaat A4
TECHNICAL RESEARCH DEPARTMENT	Schaal	Gecontroleerd	
	Getekend BVM	Gezien 8-2-'78	Rangschikmerk 40



NET D
FIG. 2.4

Benaming COD-END FOR BLUE WHITING FISHERY AANGEPAST ACHTERNET VOOR PELAGISCH NET (434 MAZ. À 80 CM) T.B.V. BLAUWE WIJTING VISSERIJ.			BEHOORT BIJ AY 263
			Formaat A4 / 263 A
RIVO AFD. TECHN. ONDERZ.	Schaal -	Gecontroleerd	
	Getekend A. Verbaan	Gezien 24-10-'78	Rangschikmerk 41



NET E FIG.2.5

Benaming **PELAGISCH NET**

Net van 434 mazen omtrek à 80 cm = 1736 mazen à 20 cm.
Voor schepen met motoren van 1100 - 1300 pk.

TECHNISCH VISSERYONDERZOEK	Schaal 1:1000	Gecontroleerd	Formaat A4 - 263 42
	Getekend W.Toet.	Gezien	Rangschikmerk 70-A-05-07-30

1.2 : {DIEPTELOOP BOVENPEES ; {VERTICALE NETOP. VG
{H/L CENTRE DEPTH ; {H/L HEIGHT

3 : {HORIZONTALE NETOPENING
{SIDELINE SPREAD

4 : {VERTICALE NOKAFSTAND
{W/E HEIGHT

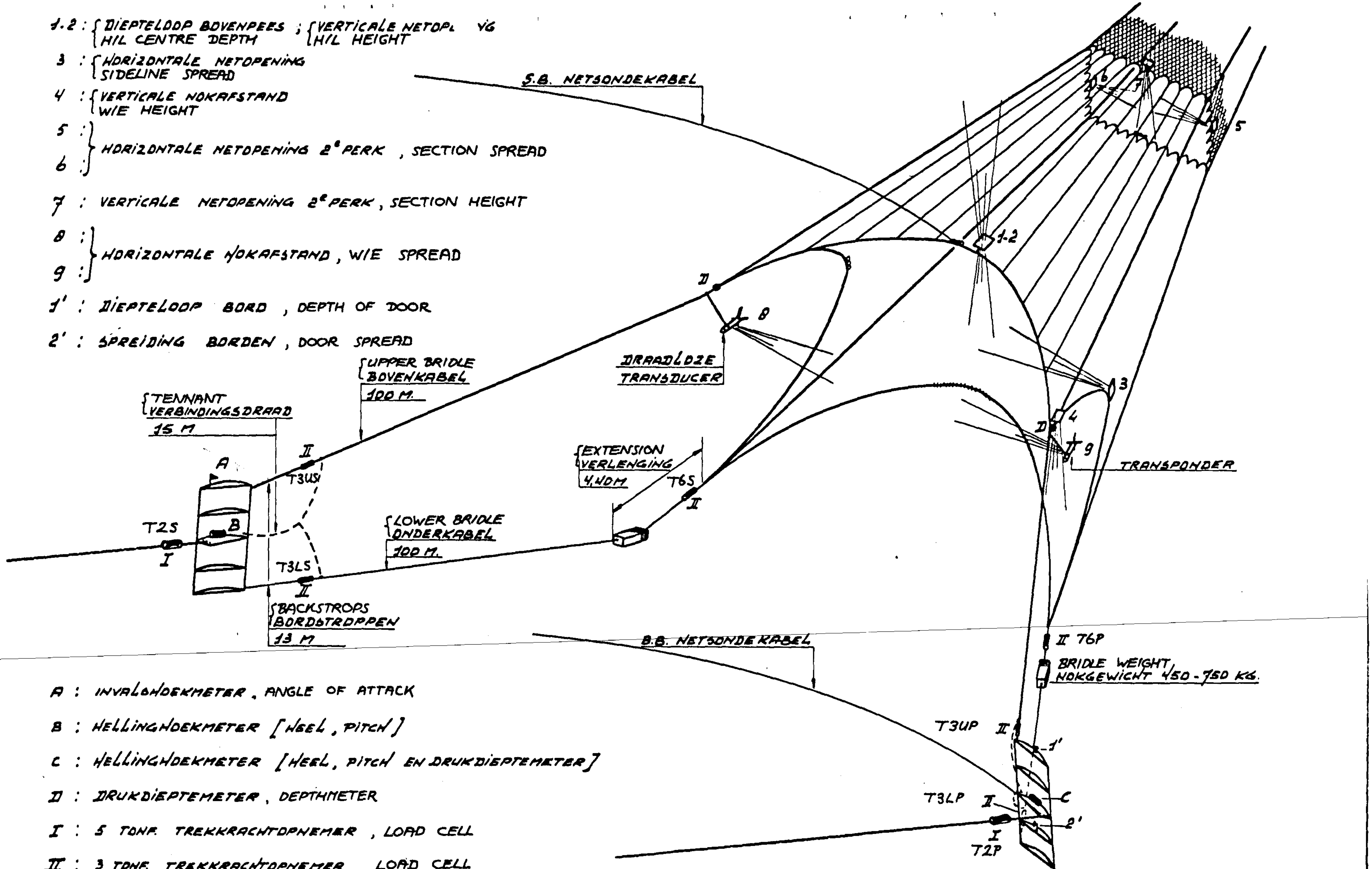
5 : } HORIZONTALE NETOPENING 2^e PERK , SECTION SPREAD
6 : }

7 : VERTICALE NETOPENING 2^e PERK , SECTION HEIGHT

8 : } HORIZONTALE NOKAFSTAND , W/E SPREAD
9 : }

1' : DIEPTELOOP BORD , DEPTH OF DOOR

2' : SPREIDING BORDEN , DOOR SPREAD



A : INVALSHOEKMETER , ANGLE OF ATTACK

B : HELLINGHOEKMETER [HEEL , PITCH]

C : HELLINGHOEKMETER [HEEL , PITCH EN DRUKDIEPTEMETER]

D : DRUKDIEPTEMETER , DEPTHMETER

I : 5 TONF. TREKKRACHTOPNEMER , LOAD CELL

II : 3 TONF. TREKKRACHTOPNEMER , LOAD CELL

INSTRUMENTATION

Benaming OVERZICHT MEET- EN REGISTRATIE APPA-RATUUR IN LIJNENTRAWL EN VOORTUIG		Formaat A3	FIG. 1.6
RIVO AFD. TECHN. ONDERZOEK	Schaal	Gecontroleerd	
Auteursrecht voorbehouden ... de wet	Getekend A. Verhaan	Gezien 21.12.'70	Bouwschikmark

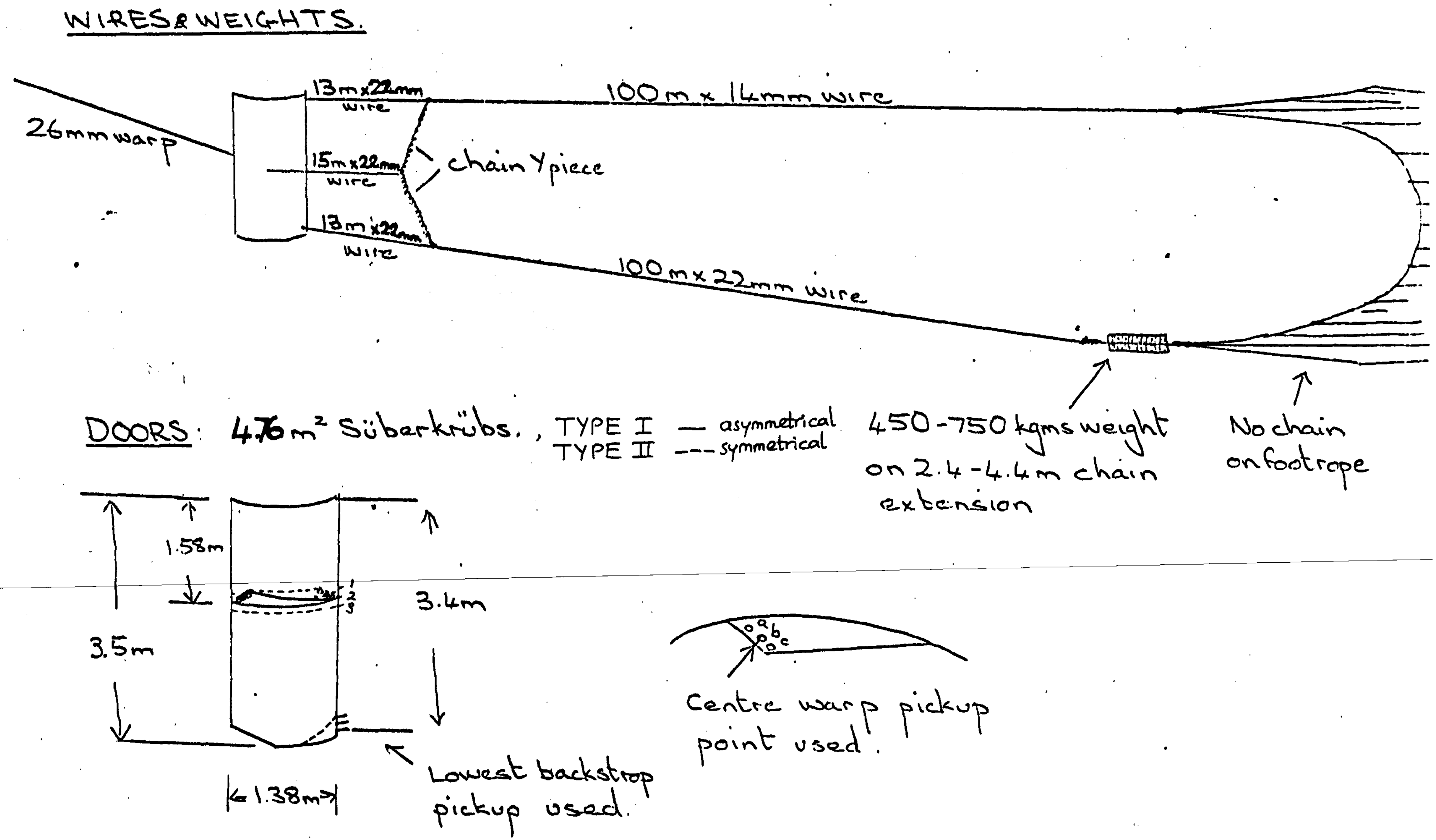
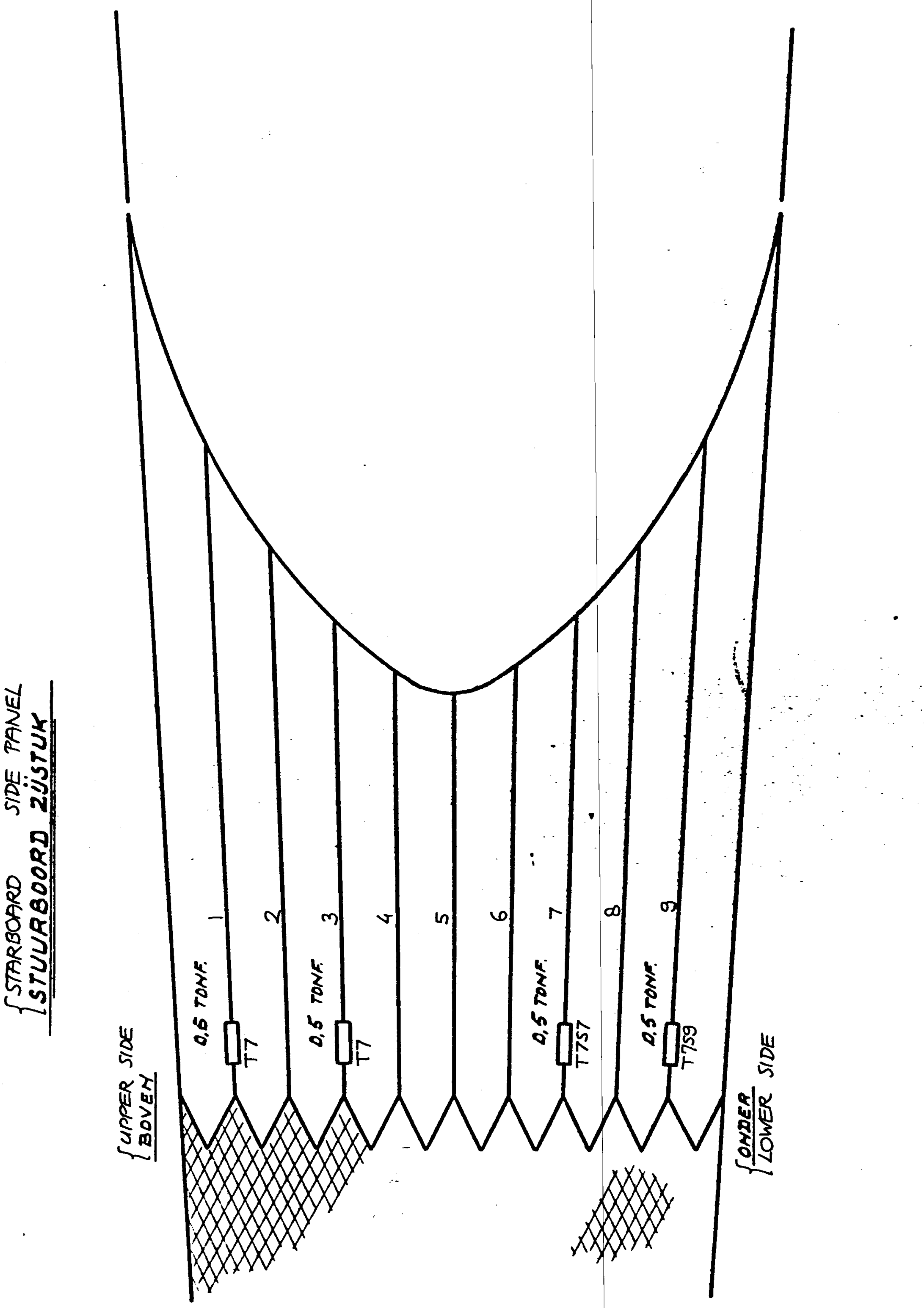


FIG 2.7
RIGGING



Benaming { PLACING OF LOAD CELLS IN ROPES / PLAATS TREKKRACHTOPNEMERS IN LIJNENNET			
		Formaat A4	FIG. 2.8
RIVO AFD. TECHN. ONDZ.	Schaal	Gecontroleerd	
Auteursrecht voorbehouden volgens de wet	Getekend A. Verbeem	Gezien 27-12-'78	Rangschikmerk 45

FIG. 3.1 COMPARISON OF RESULTS OF 1977 AND 1978 EXPERIMENTS.

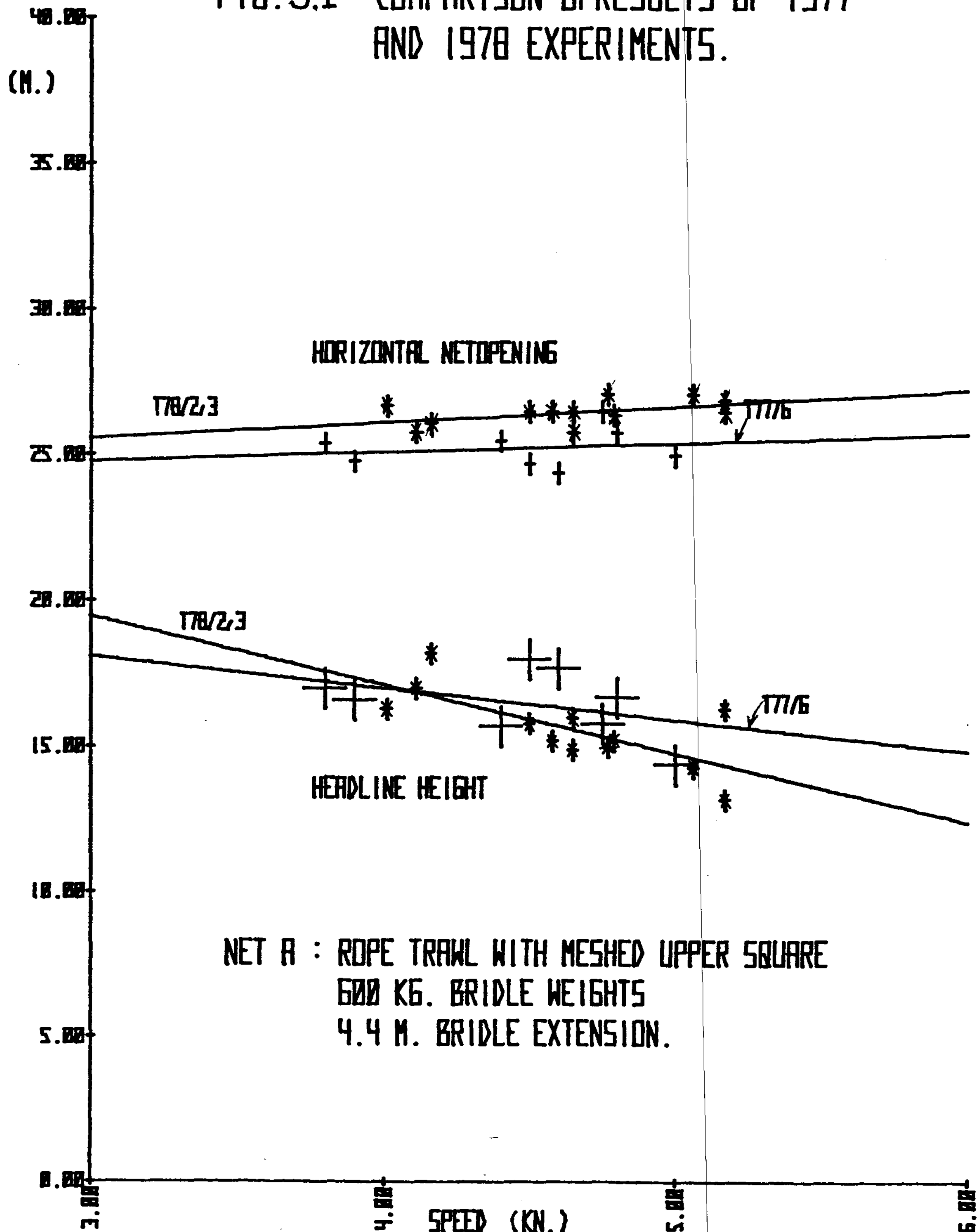
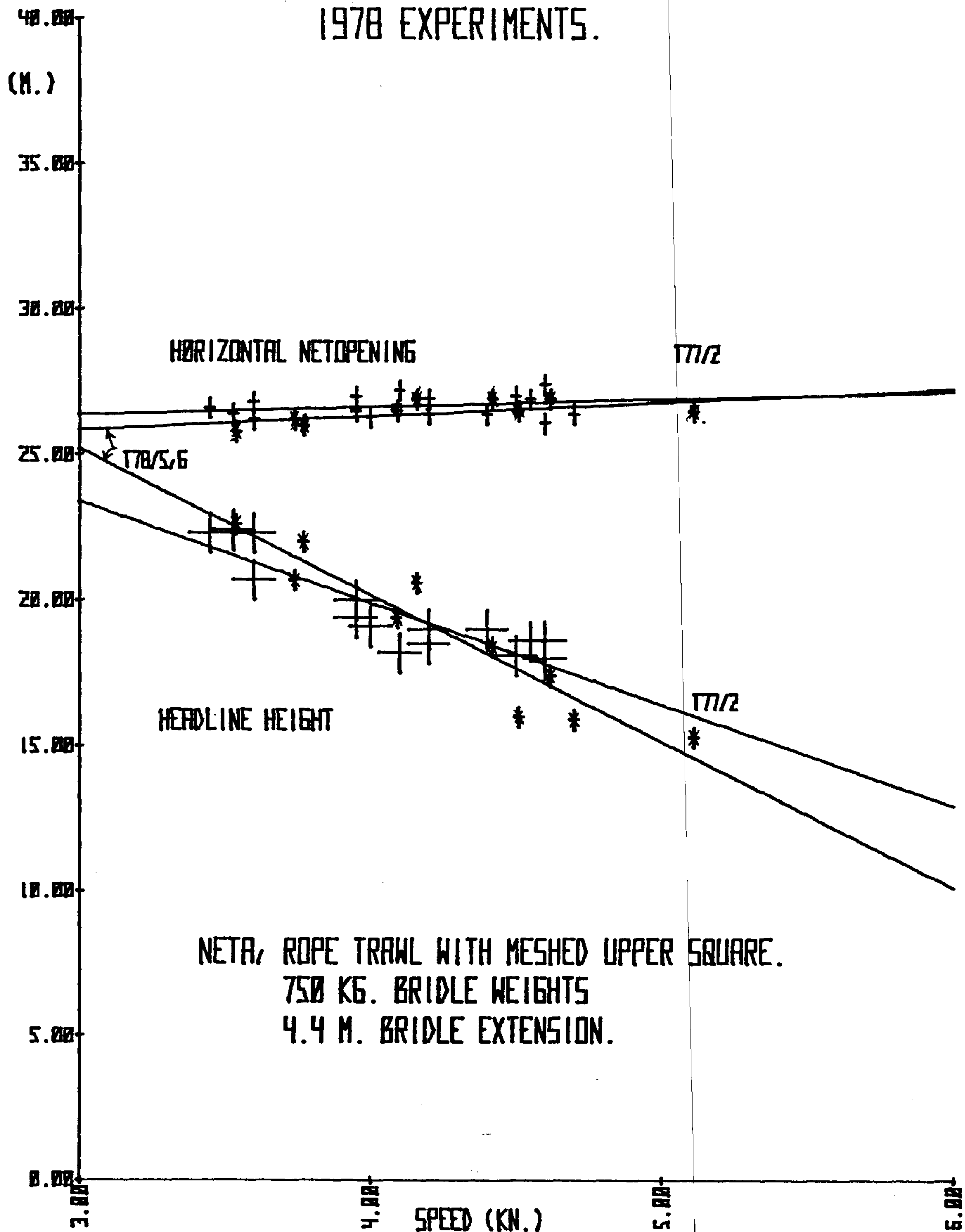


FIG.3.2 COMPARISON OF RESULTS OF 1977 AND 1978 EXPERIMENTS.



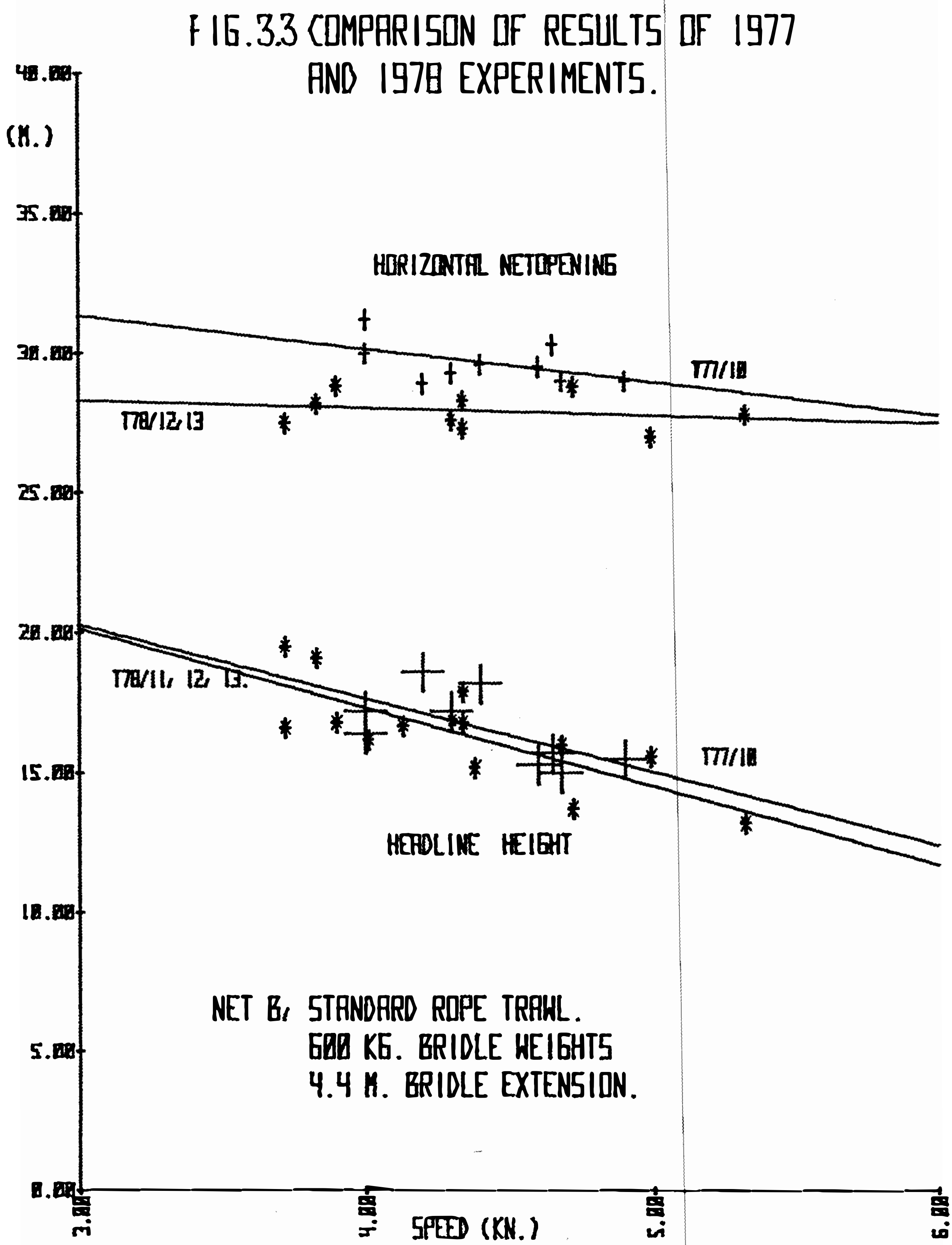
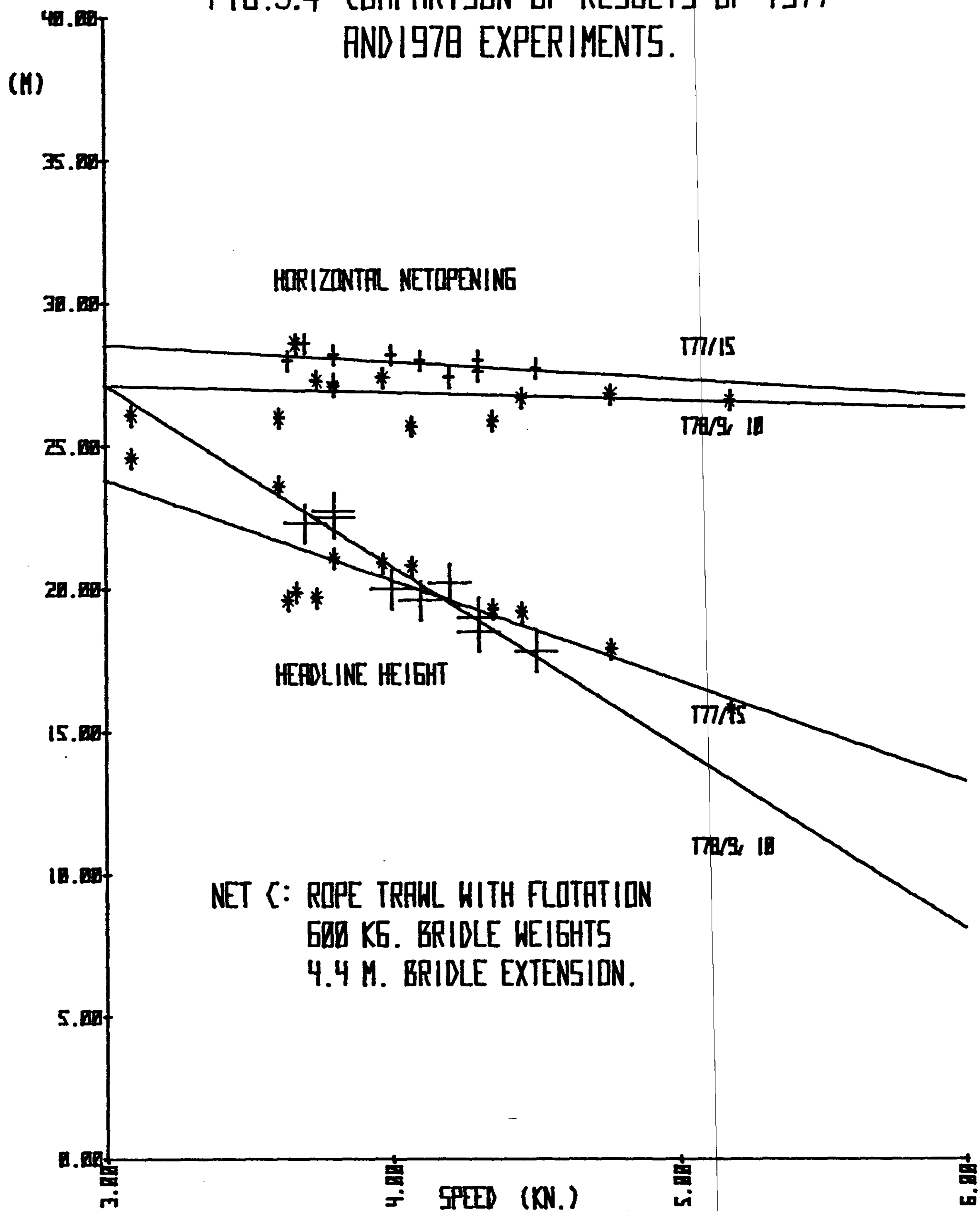


FIG.3.3 COMPARISON OF RESULTS OF 1977
AND 1978 EXPERIMENTS.
40.00
(M.)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
HORIZONTAL NETOPENING
T77/10
T78/12,13
T78/11, 12, 13.
T77/10
HEADLINE HEIGHT
NET B, STANDARD ROPE TRAWL.
600 KG. BRIDLE WEIGHTS
4.4 M. BRIDLE EXTENSION.
3.00
4.00
5.00
6.00
SPEED (KN.)

FIG.3.4 COMPARISON OF RESULTS OF 1977 AND 1978 EXPERIMENTS.



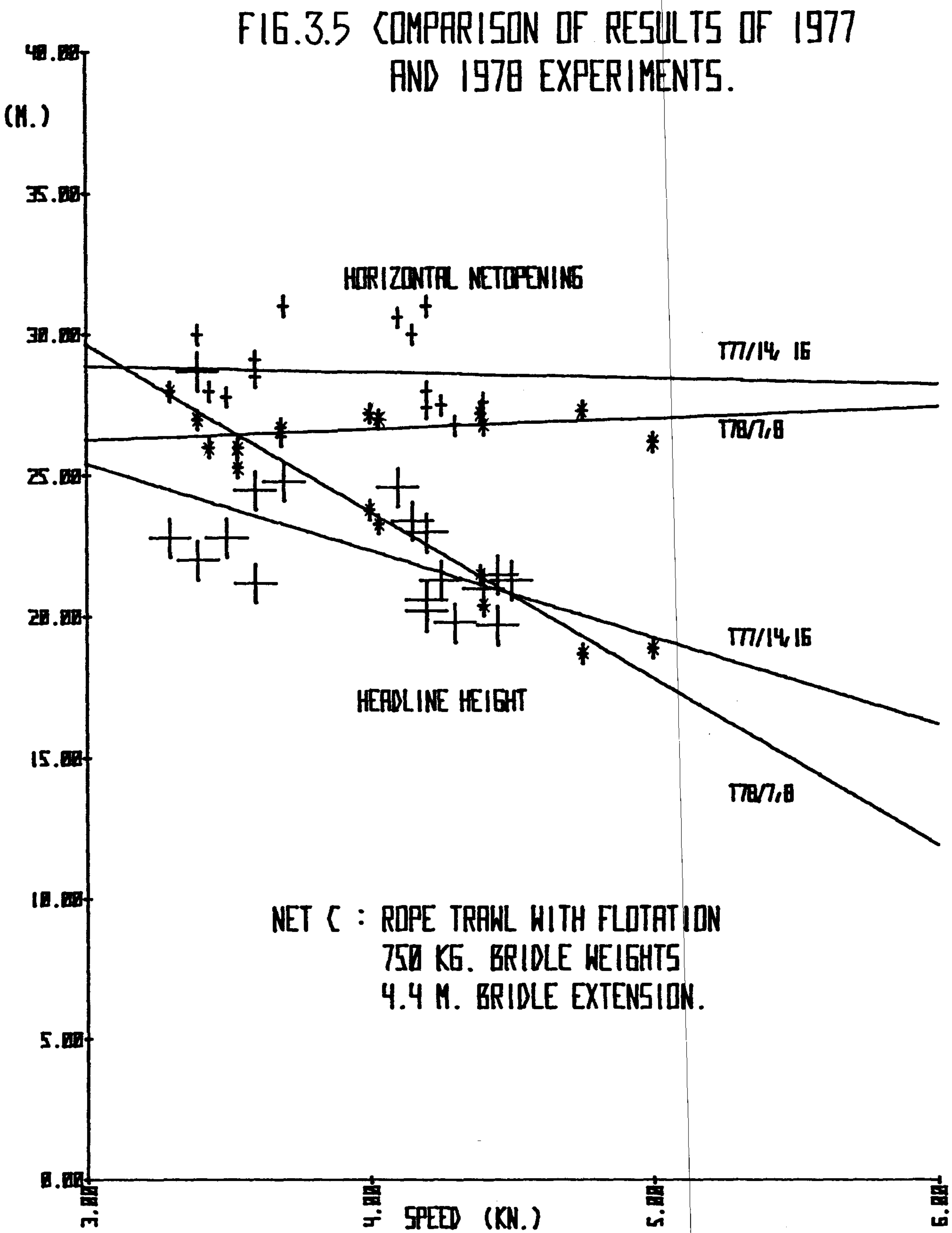


FIG.3.5 COMPARISON OF RESULTS OF 1977
AND 1978 EXPERIMENTS.
40.00
(M.)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
HORIZONTAL NETOPENING
T77/14/16
T78/7/8
T77/14/16
HEADLINE HEIGHT
T78/7/8
NET C : ROPE TRAWL WITH FLOTATION
750 KG. BRIDLE WEIGHTS
4.4 M. BRIDLE EXTENSION.
3.00
4.00
5.00
6.00
SPEED (KN.)

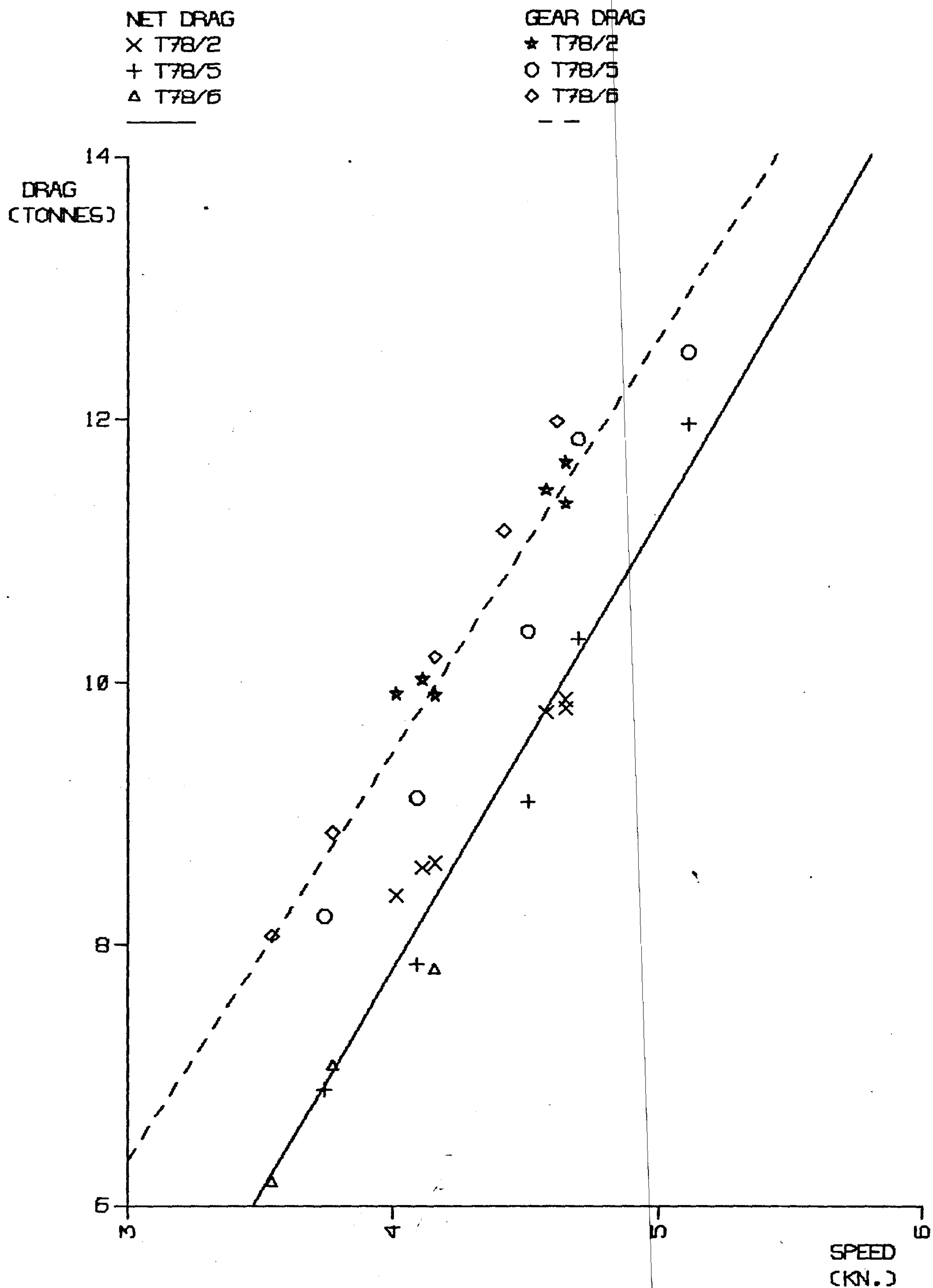


FIG.4.1 NET A - DRAG VS. SPEED

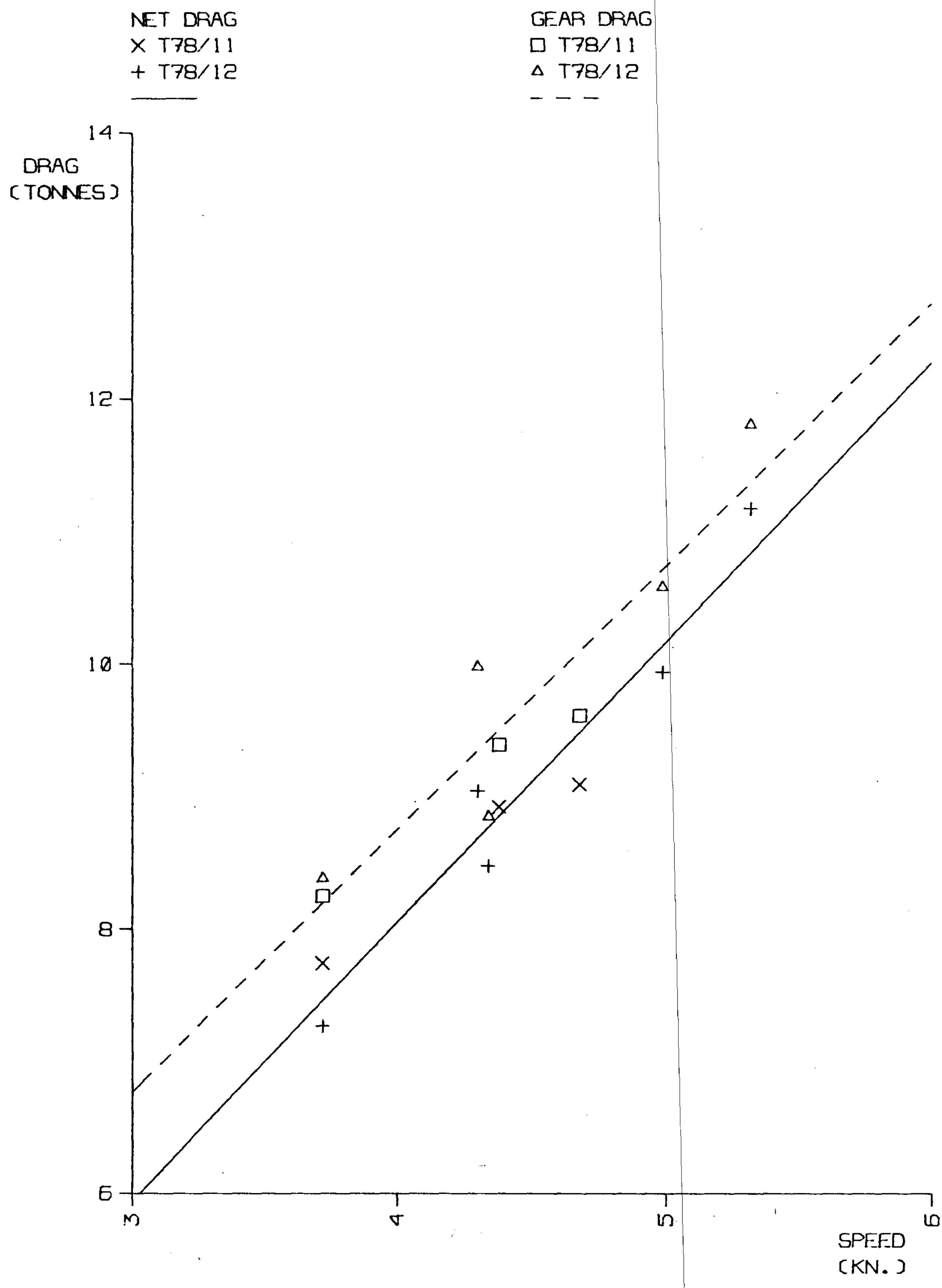


FIG.4.2 NET B – DRAG VS. SPEED

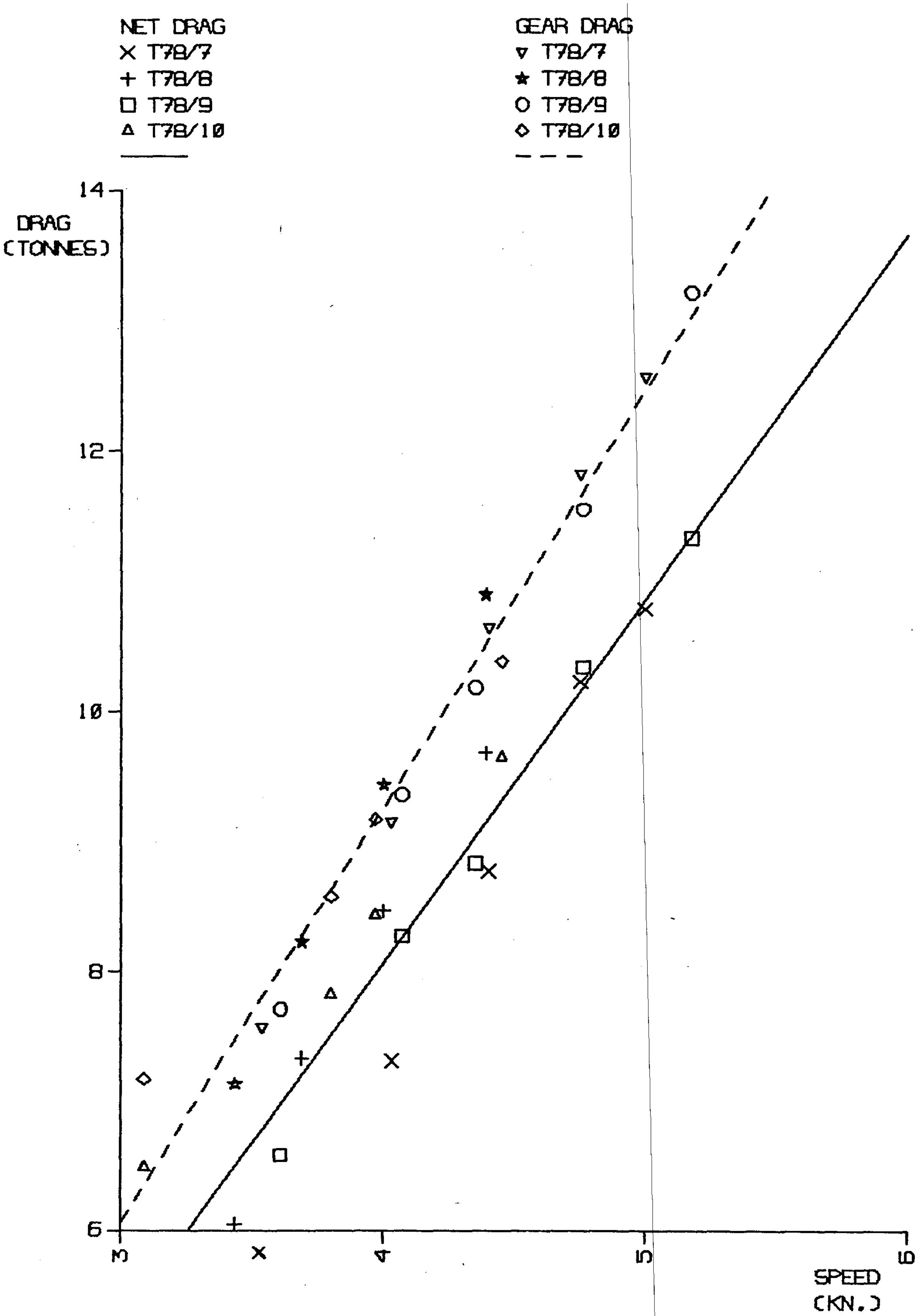


FIG. 4.3 NET C – DRAG VS. SPEED

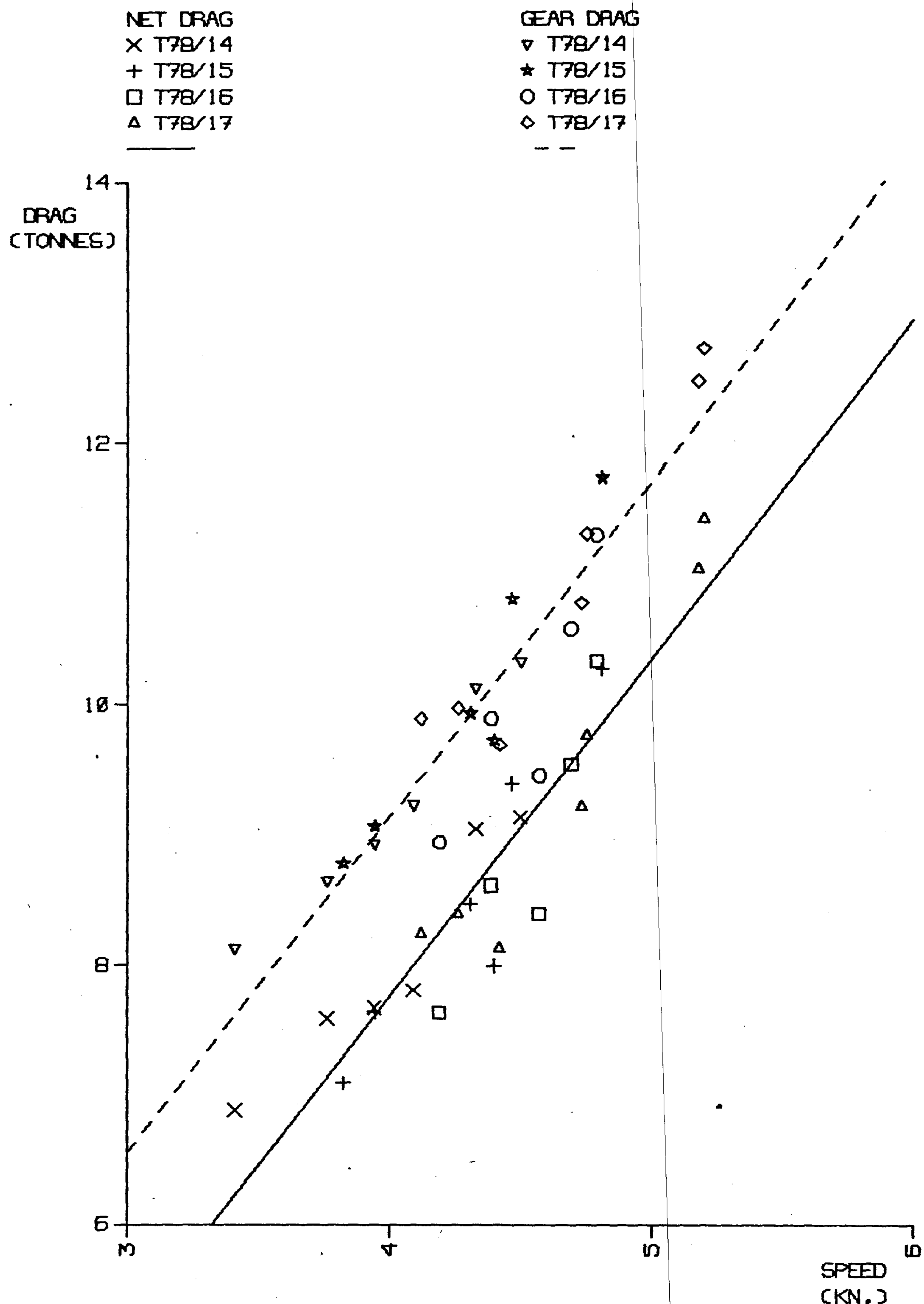


FIG.4.4 NET D - DRAG VS. SPEED

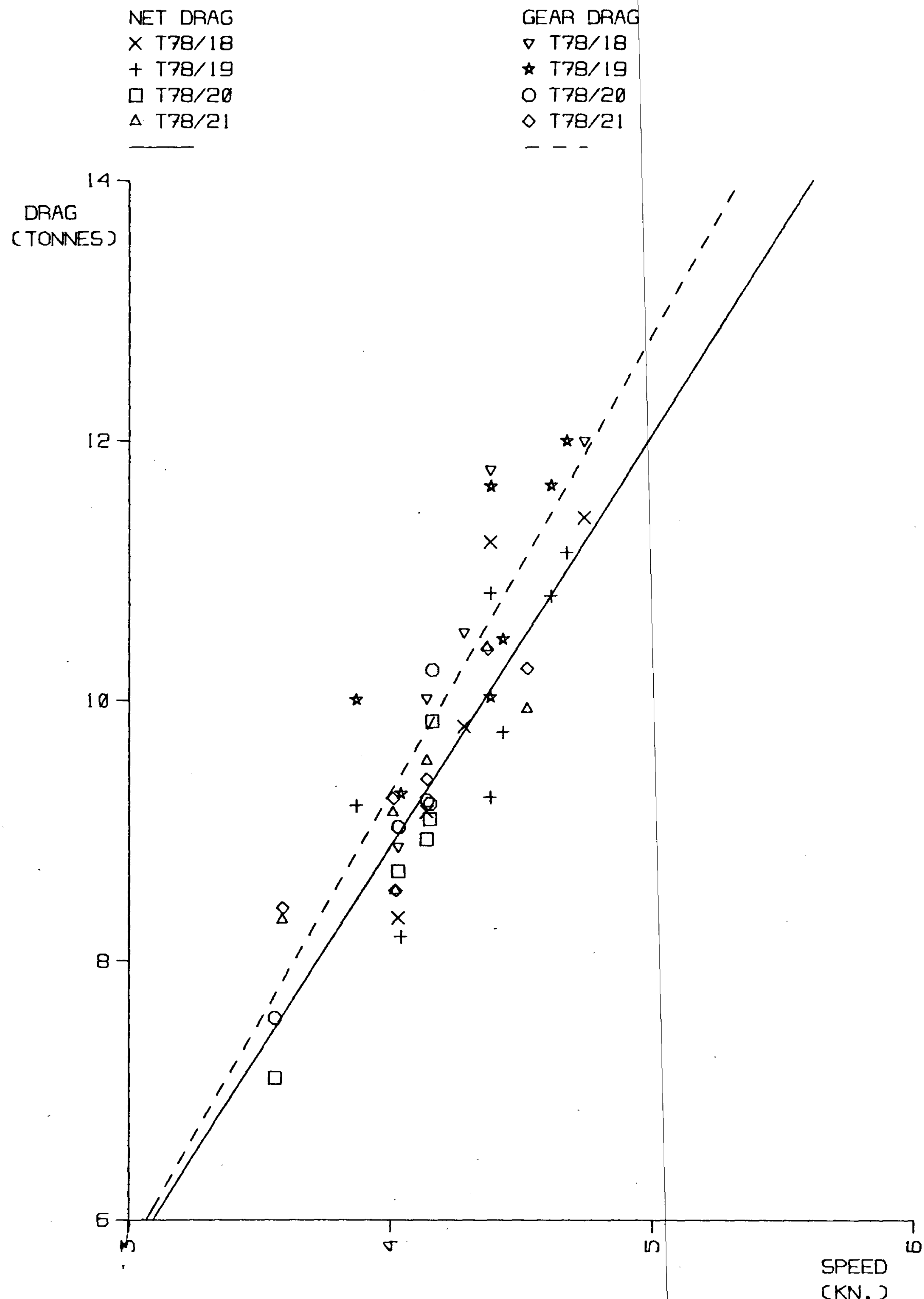


FIG. 4.5 NET E – DRAG VS. SPEED

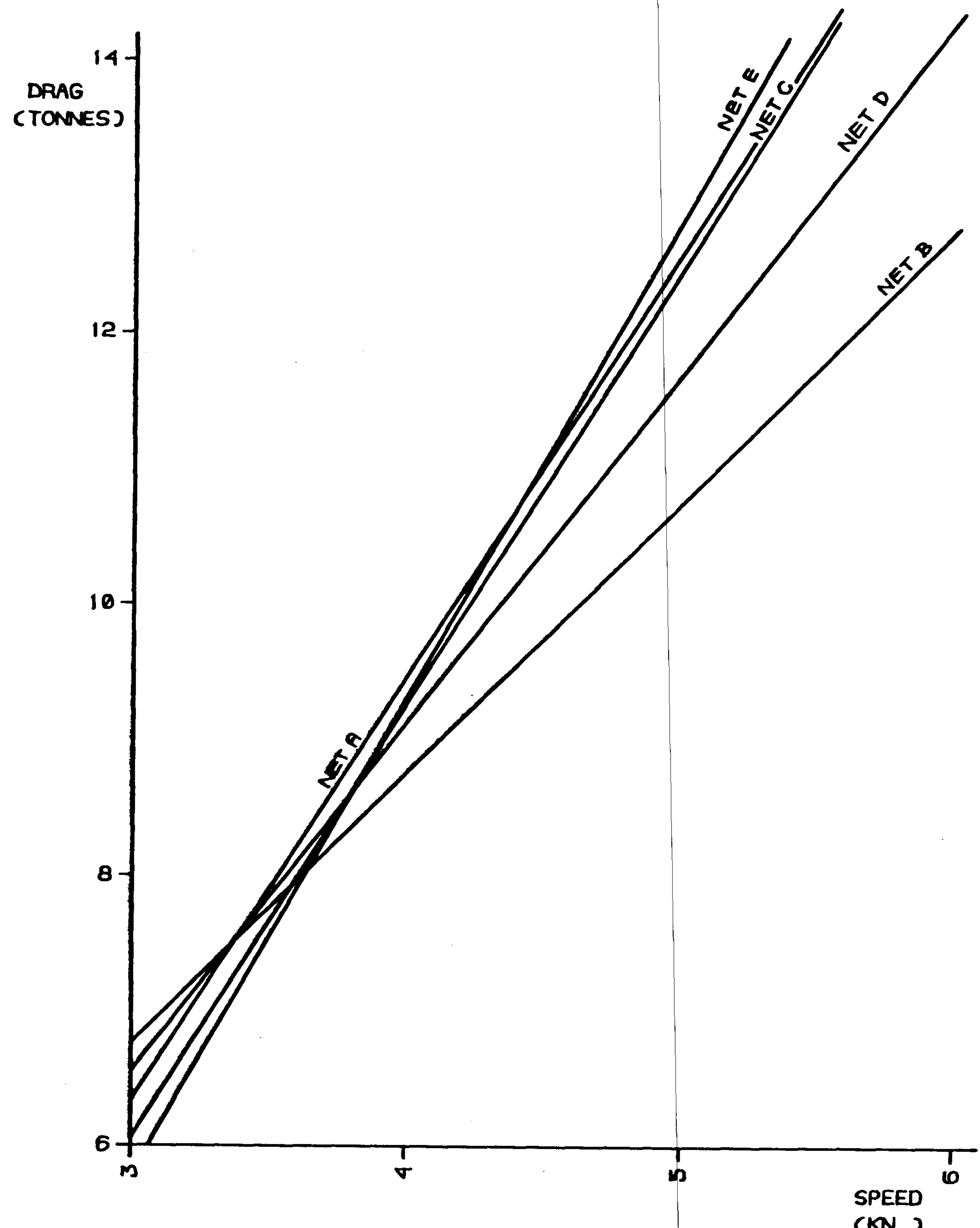


FIG. 4.6 GEAR DRAG REGRESSION CURVES FOR FIVE NETS.
600 KG. AND 750 KG. BRIDLE WEIGHTS.

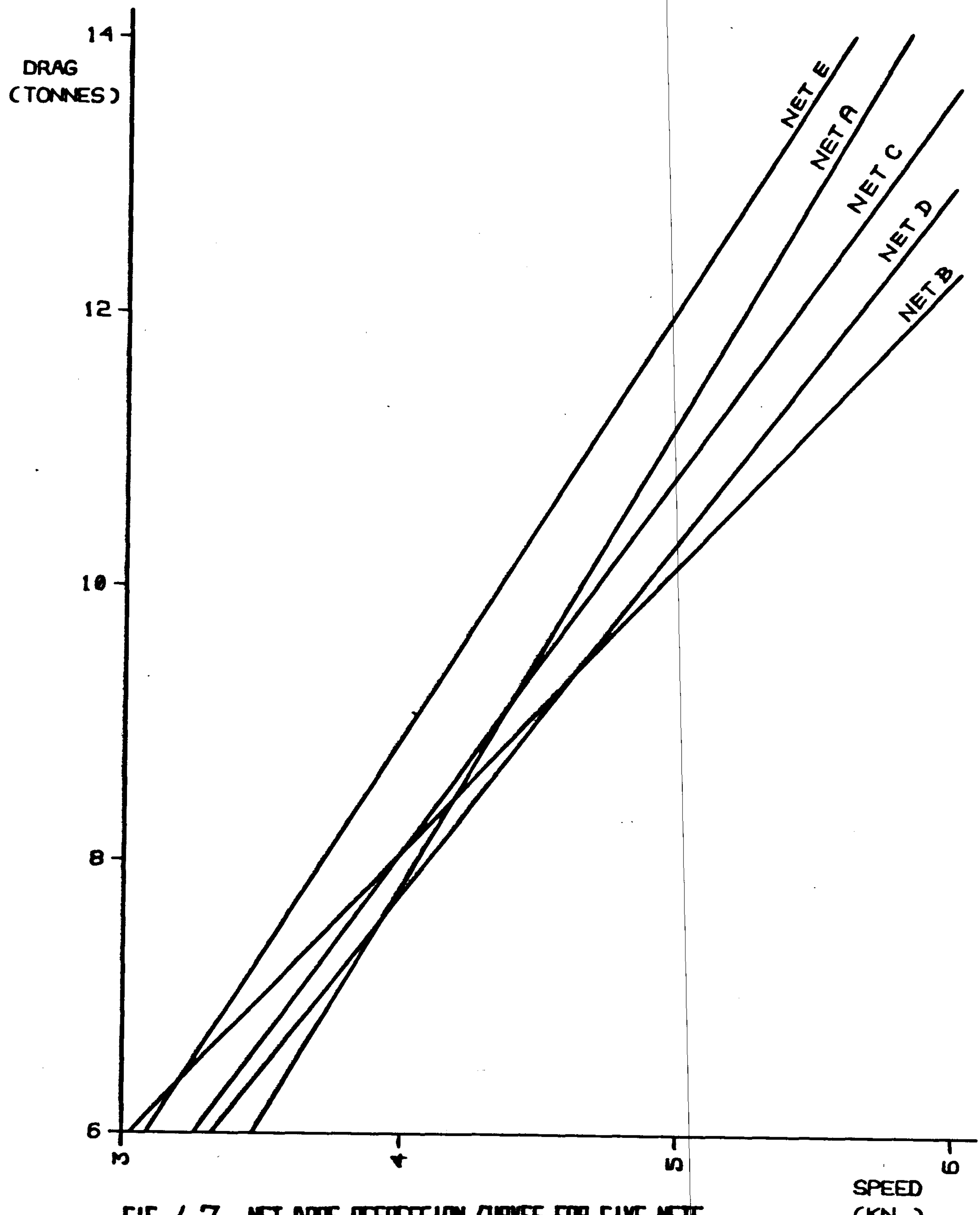


FIG. 4.7 NET DRAG REGRESSION CURVES FOR FIVE NETS.
600 KG. AND 750 KG. BRIDLE WEIGHTS.

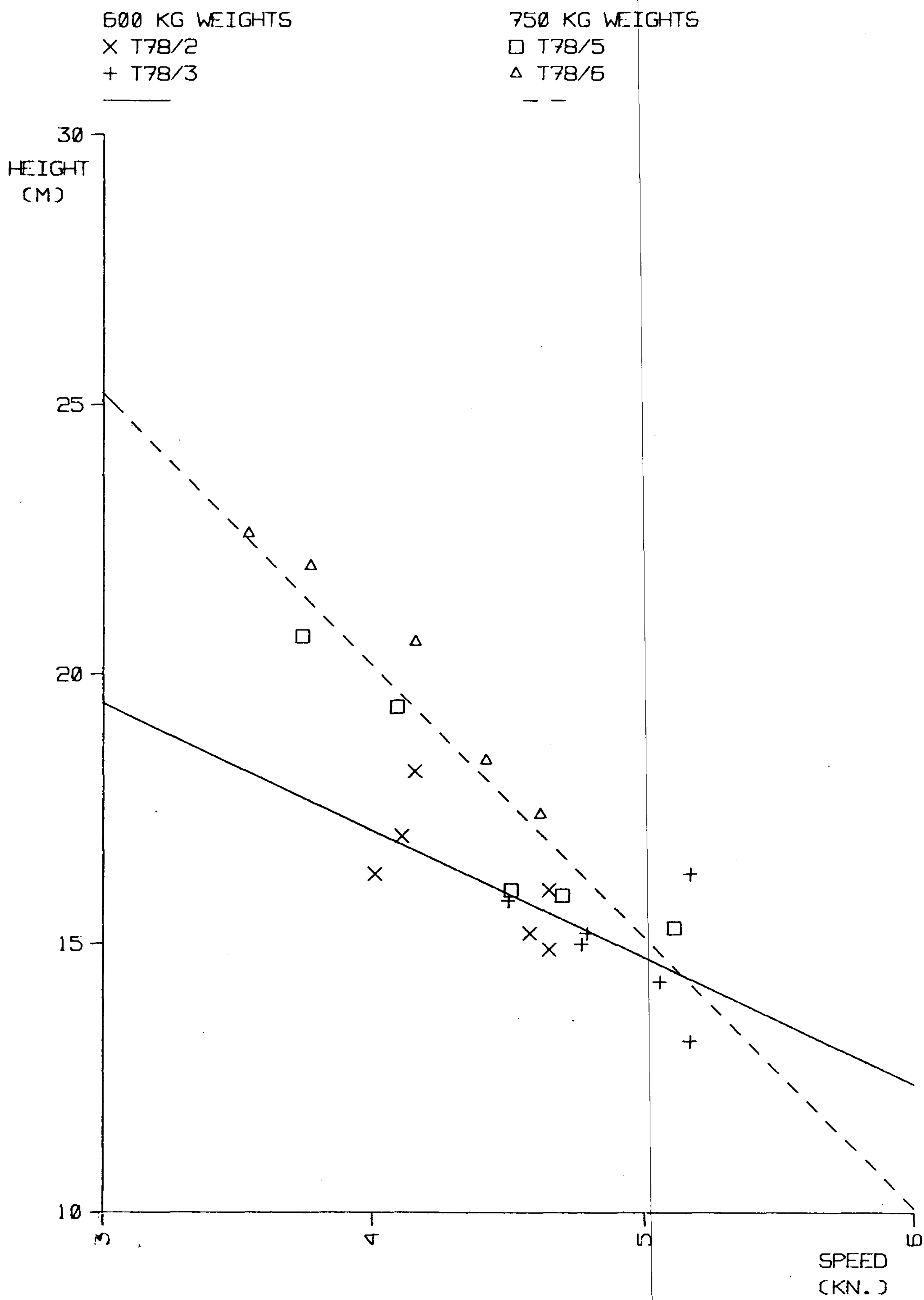


FIG. 4.8 NET A – HEADLINE HEIGHT VS. SPEED AND BRIDLE WEIGHT

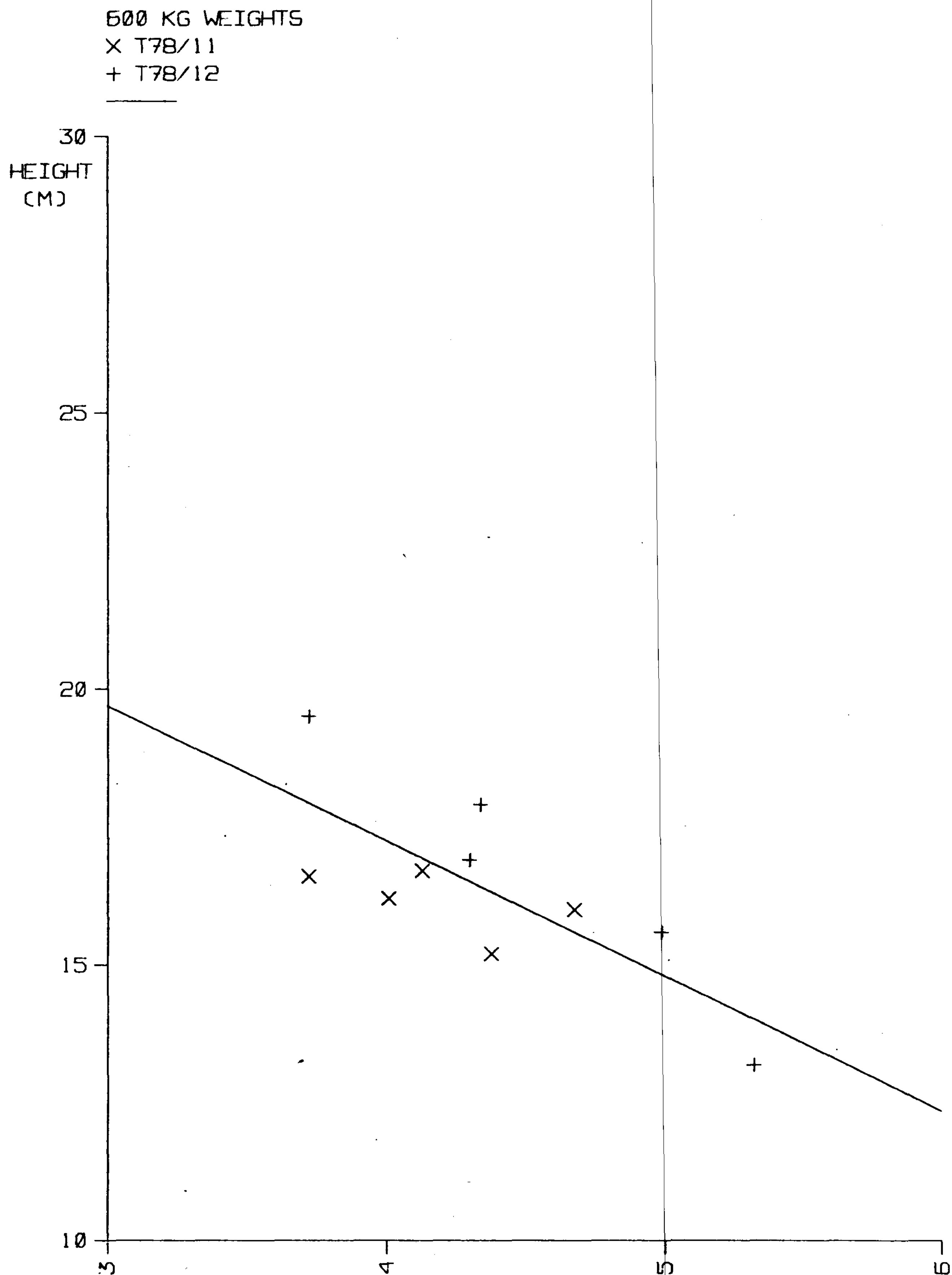


FIG.4.9 NET B – HEADLINE HEIGHT VS.
SPEED AND BRIDLE WEIGHT

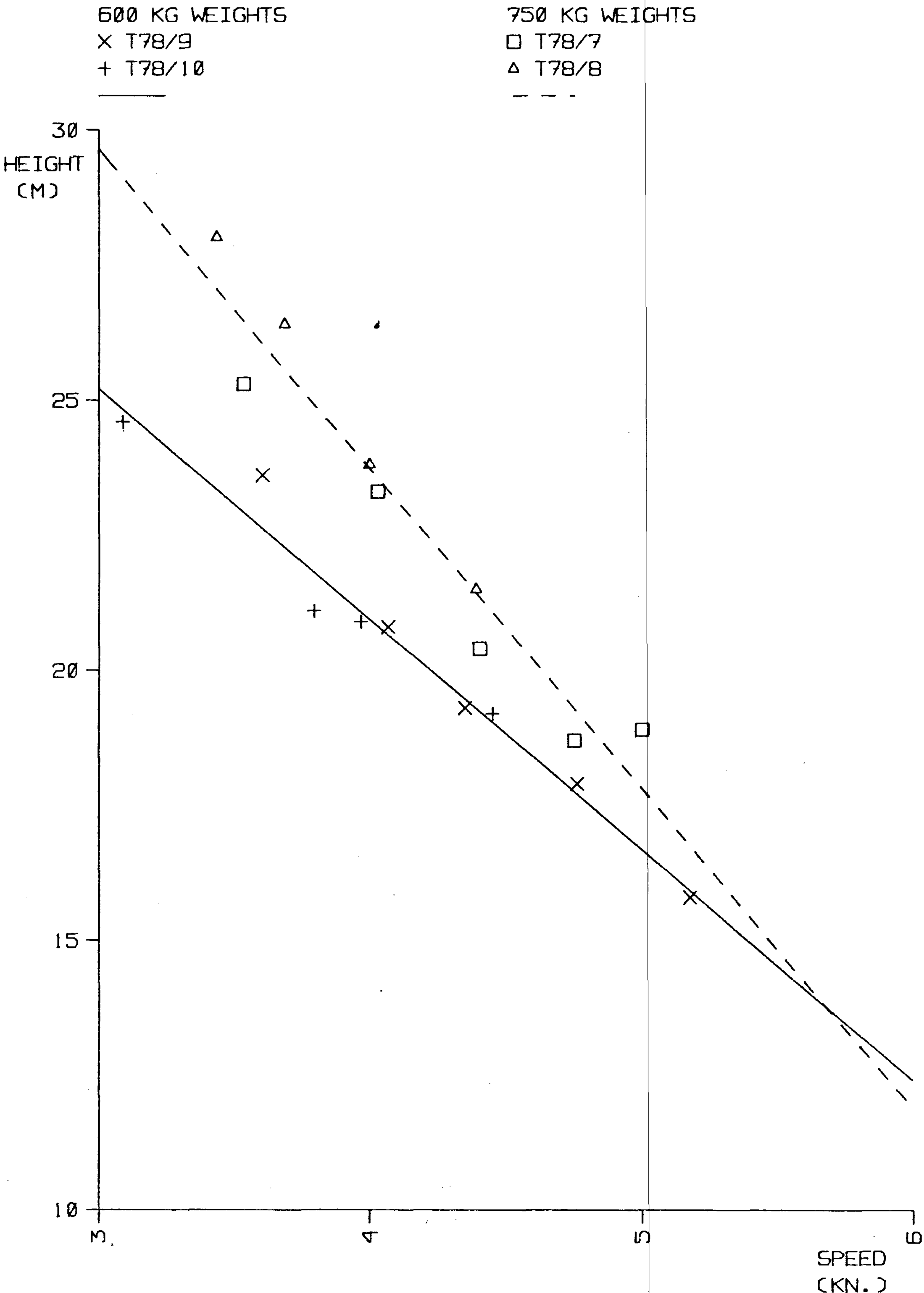


FIG.4.10 NET C - HEADLINE HEIGHT VS. SPEED AND BRIDLE WEIGHT

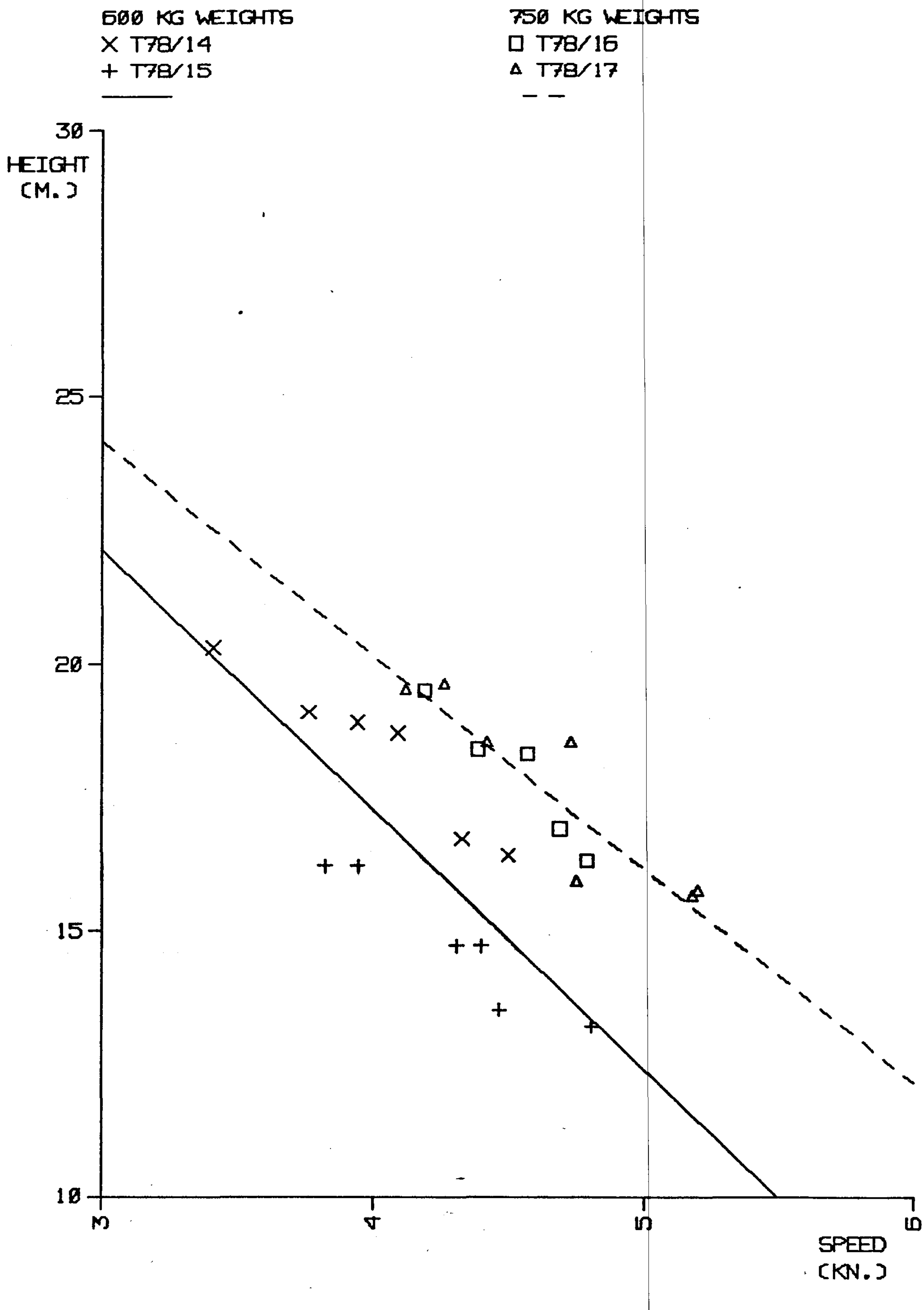


FIG.4.11 NET D – HEADLINE HEIGHT
SPEED AND BRIDLE WEIGHT

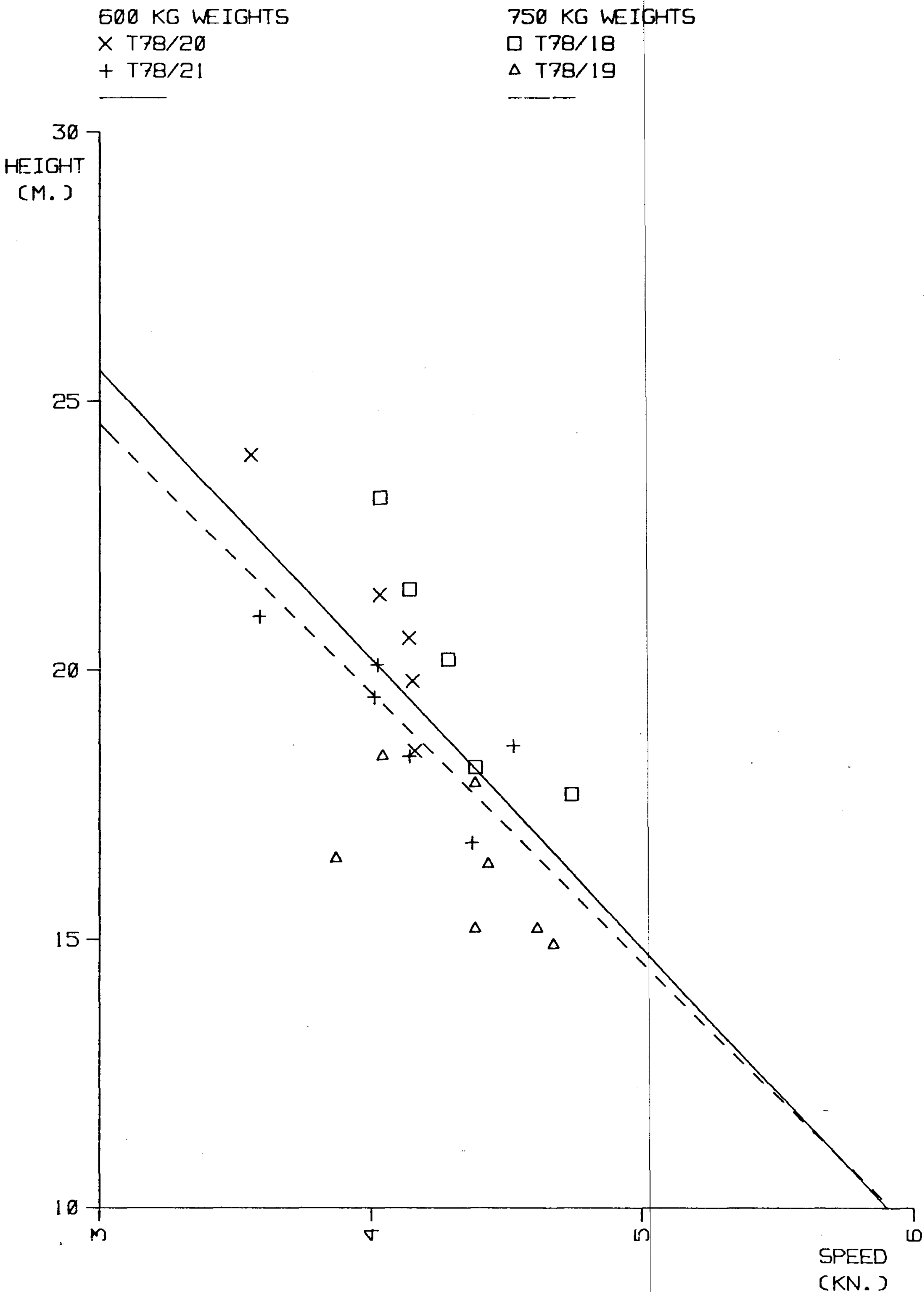


FIG.4.12 NET E – HEADLINE HEIGHT VS. SPEED AND BRIDLE WEIGHT

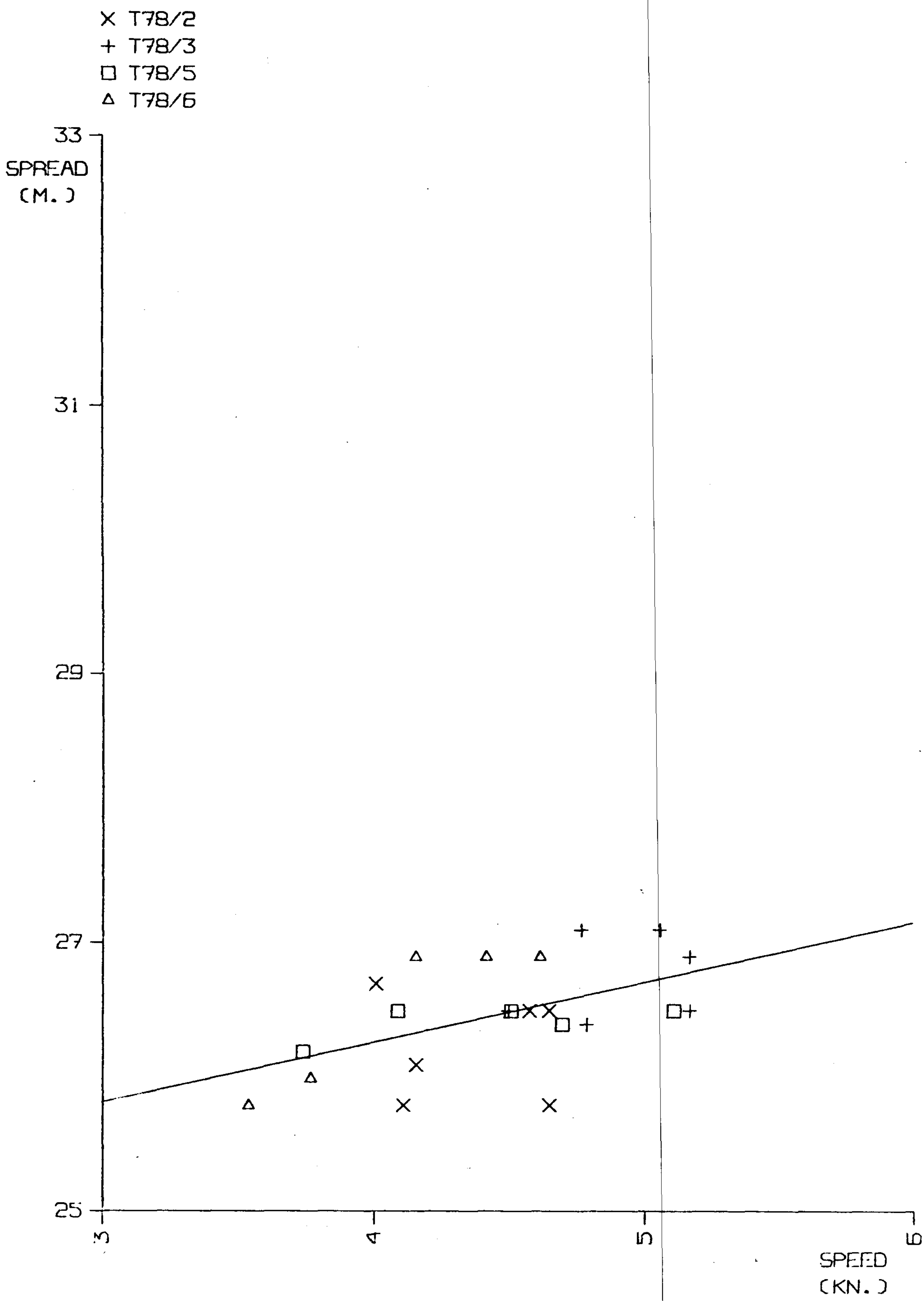


FIG. 4.13 NET A - SIDELINE SPREAD VS. SPEED

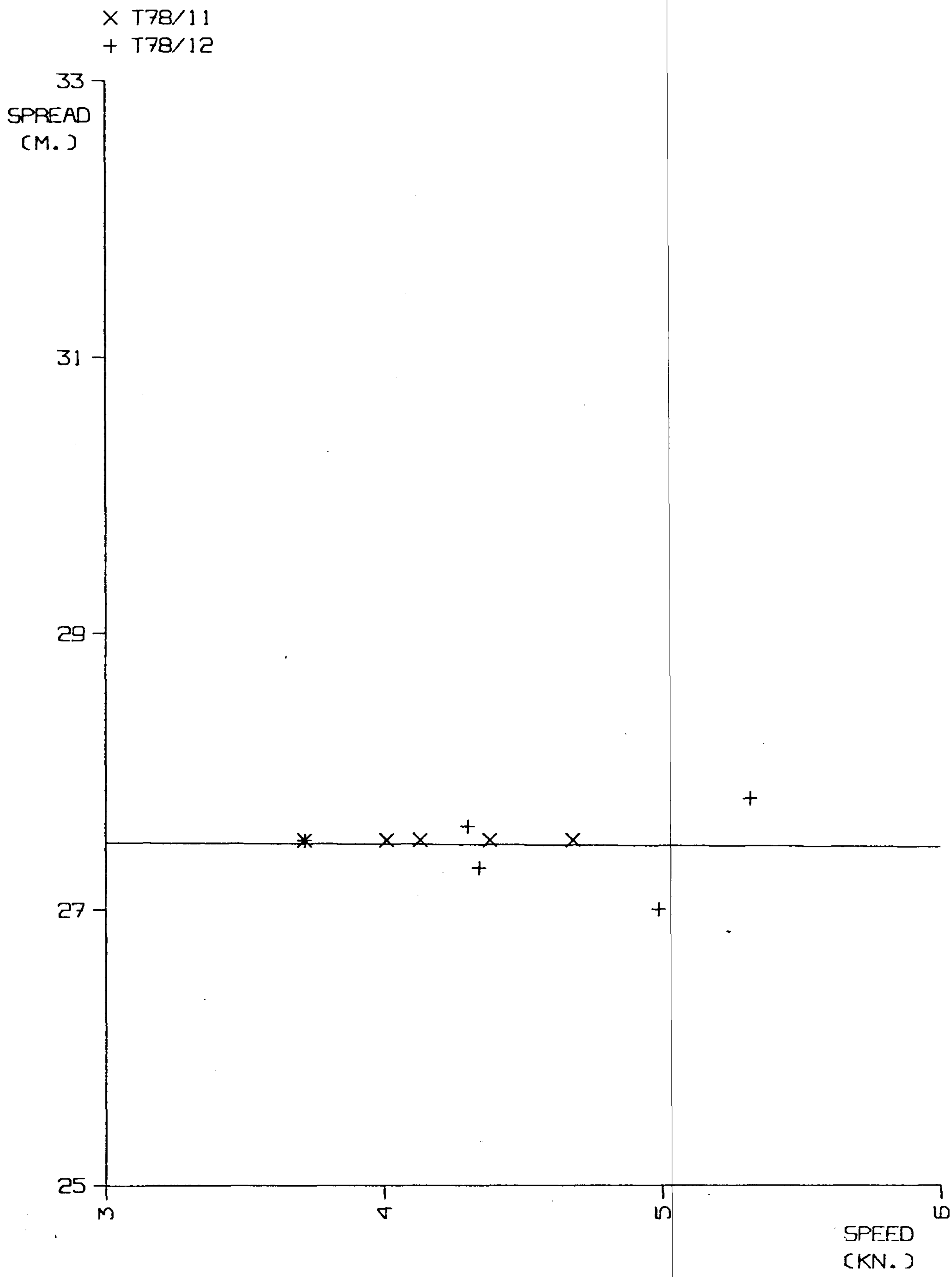


FIG. 4.14 NET B - SIDELINE SPREAD VS. SPEED

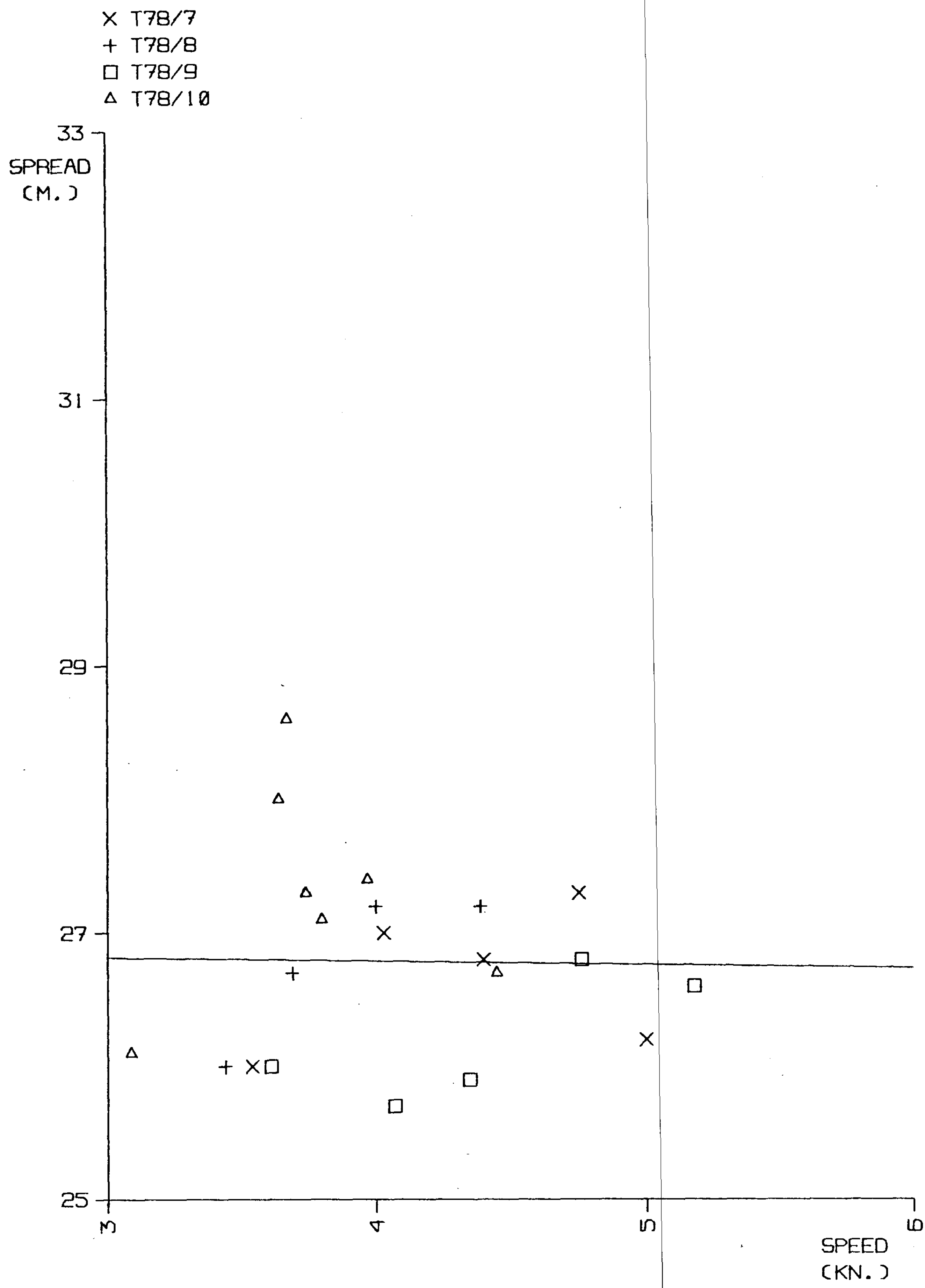


FIG. 4.15 NET C - SIDELINE SPREAD VS. SPEED

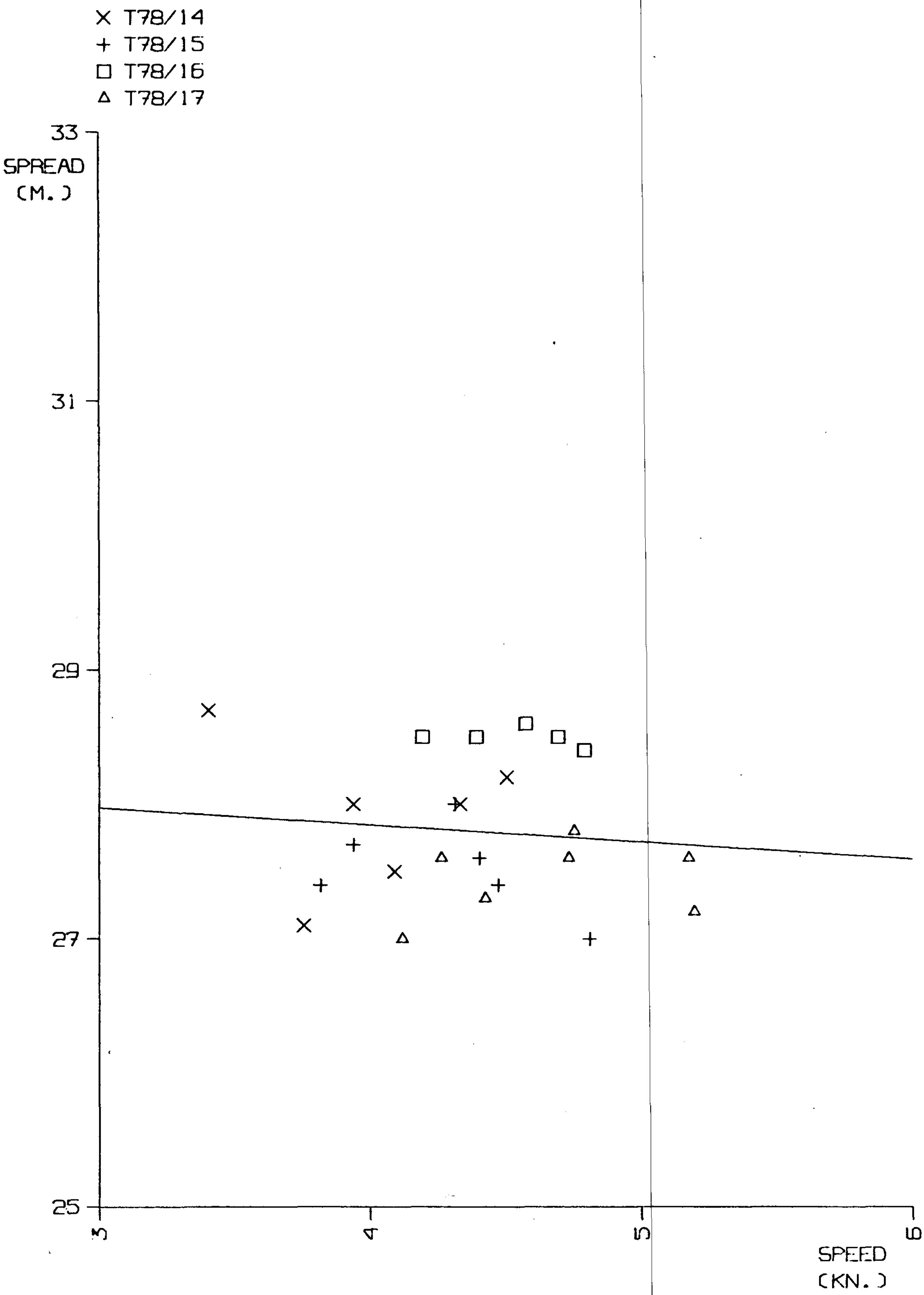


FIG. 4.16 NET D – SIDELINE SPREAD VS. SPEED

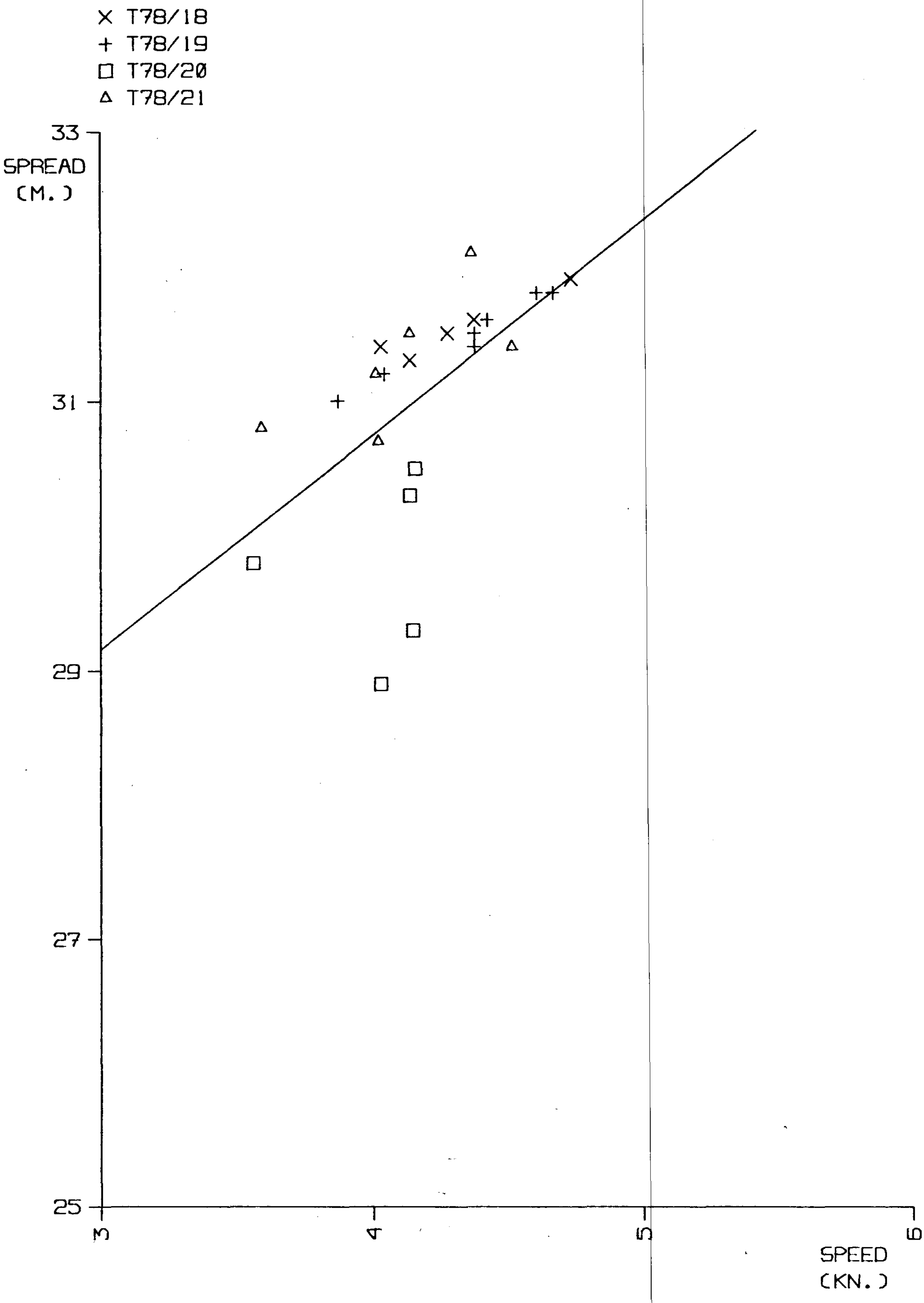


FIG. 4.17 NET E - SIDELINE SPREAD VS. SPEED

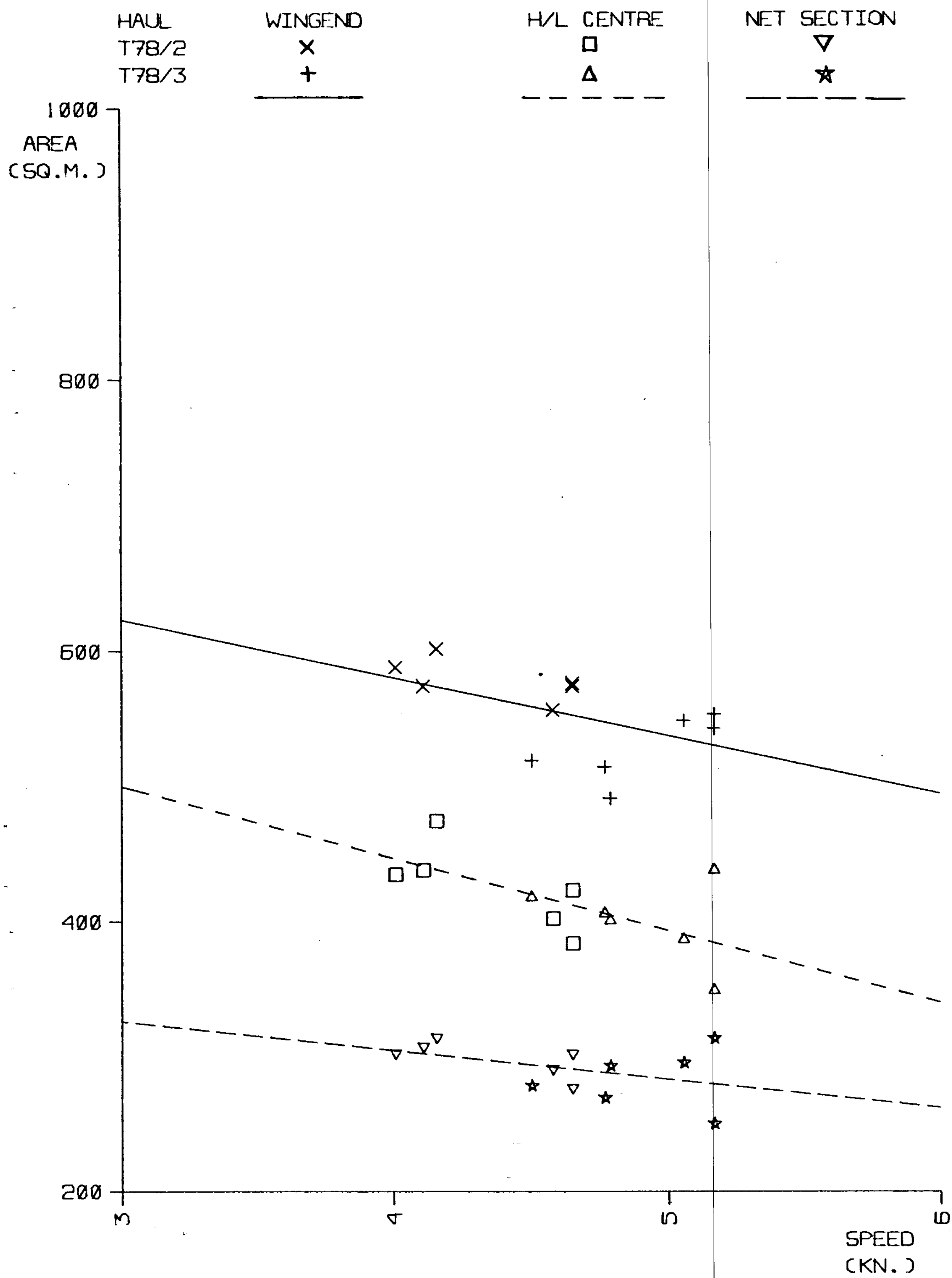


FIG.4.18 NET A – CROSS SECTION AREAS FOR 600 KG BRIDLE WEIGHTS

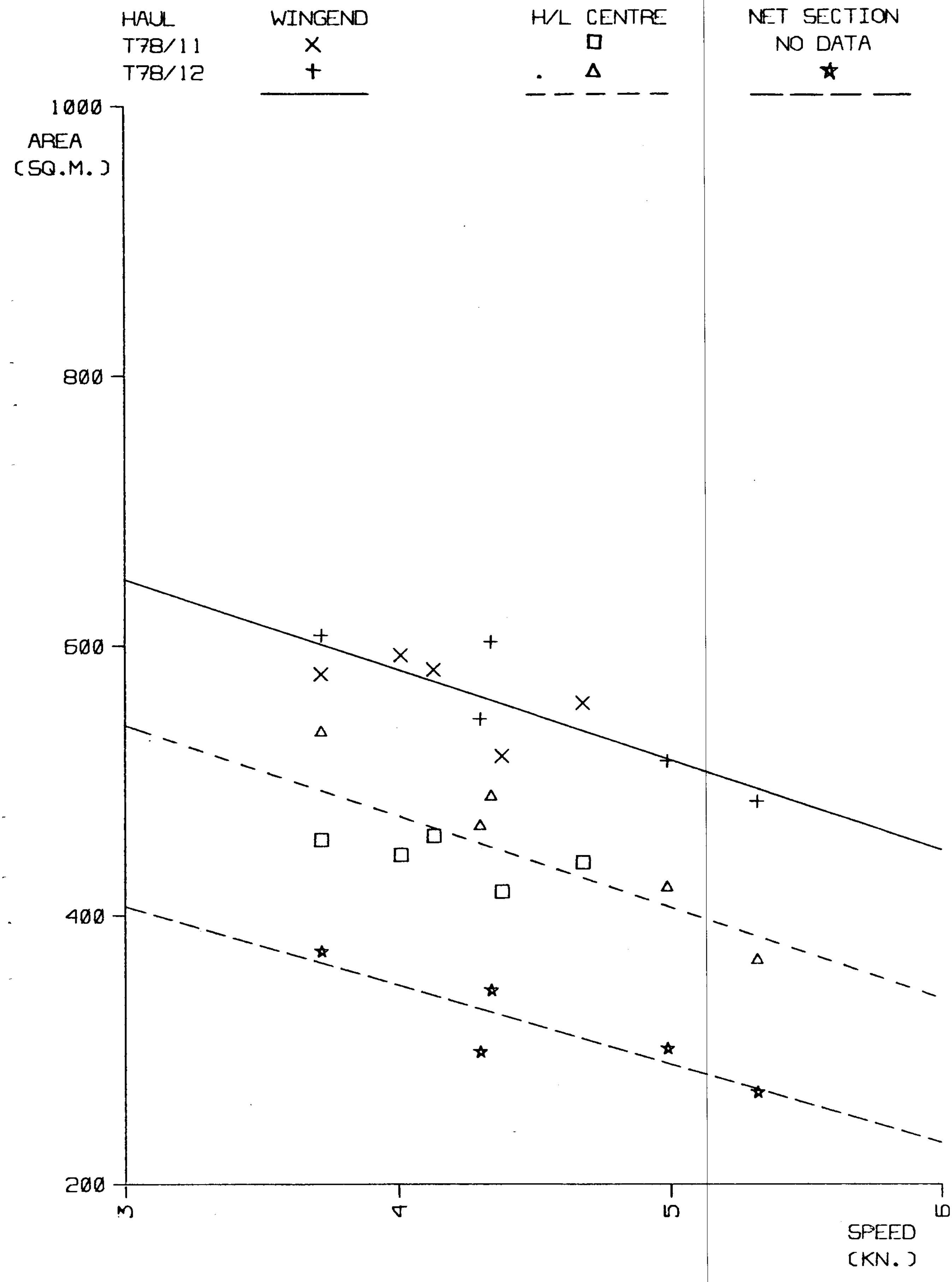


FIG.4.19 NET B – CROSS SECTION AREAS FOR 600 KG BRIDLE WEIGHTS

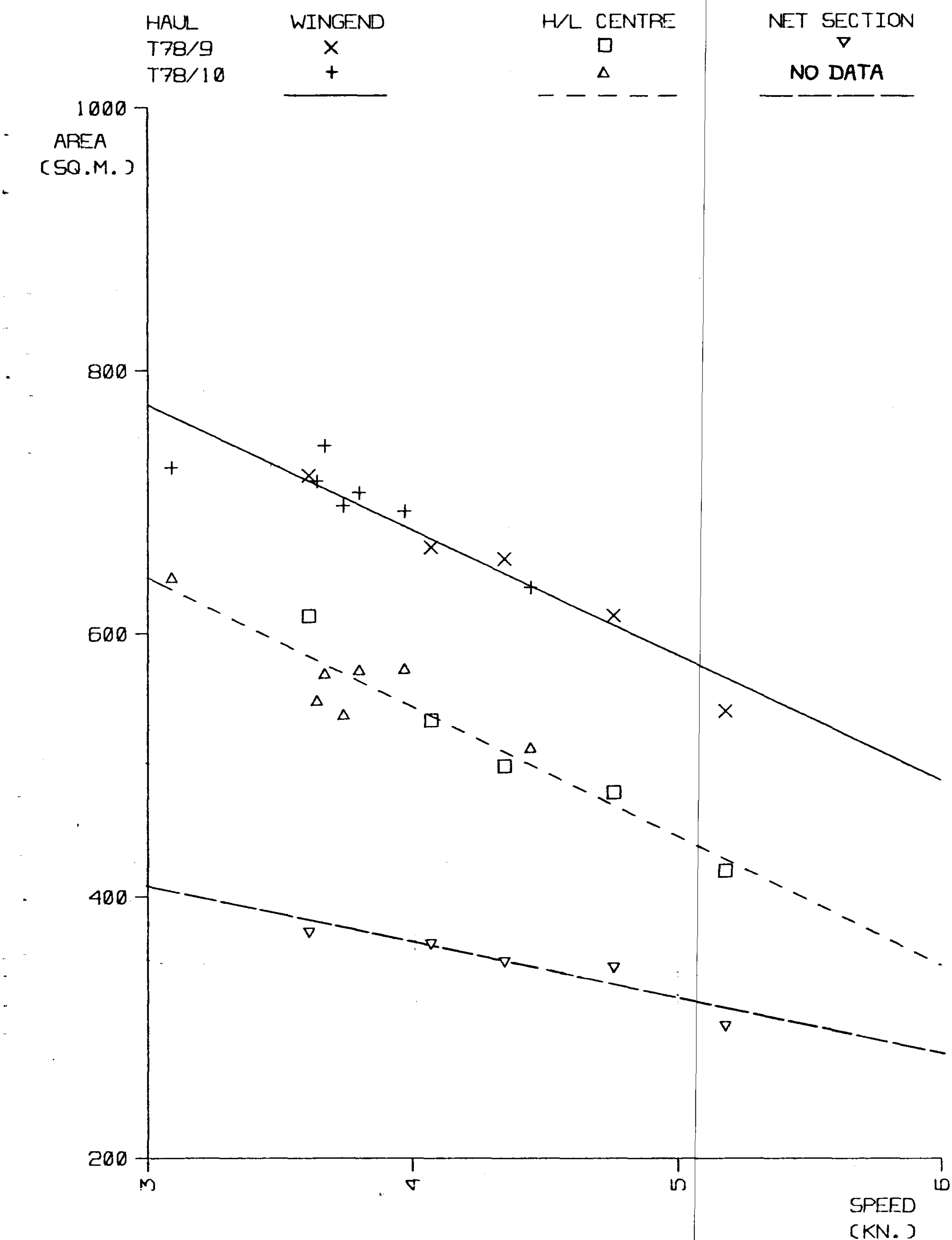


FIG. 4.20 NET C - CROSS SECTION AREAS FOR 600 KG BRIDLE WEIGHTS

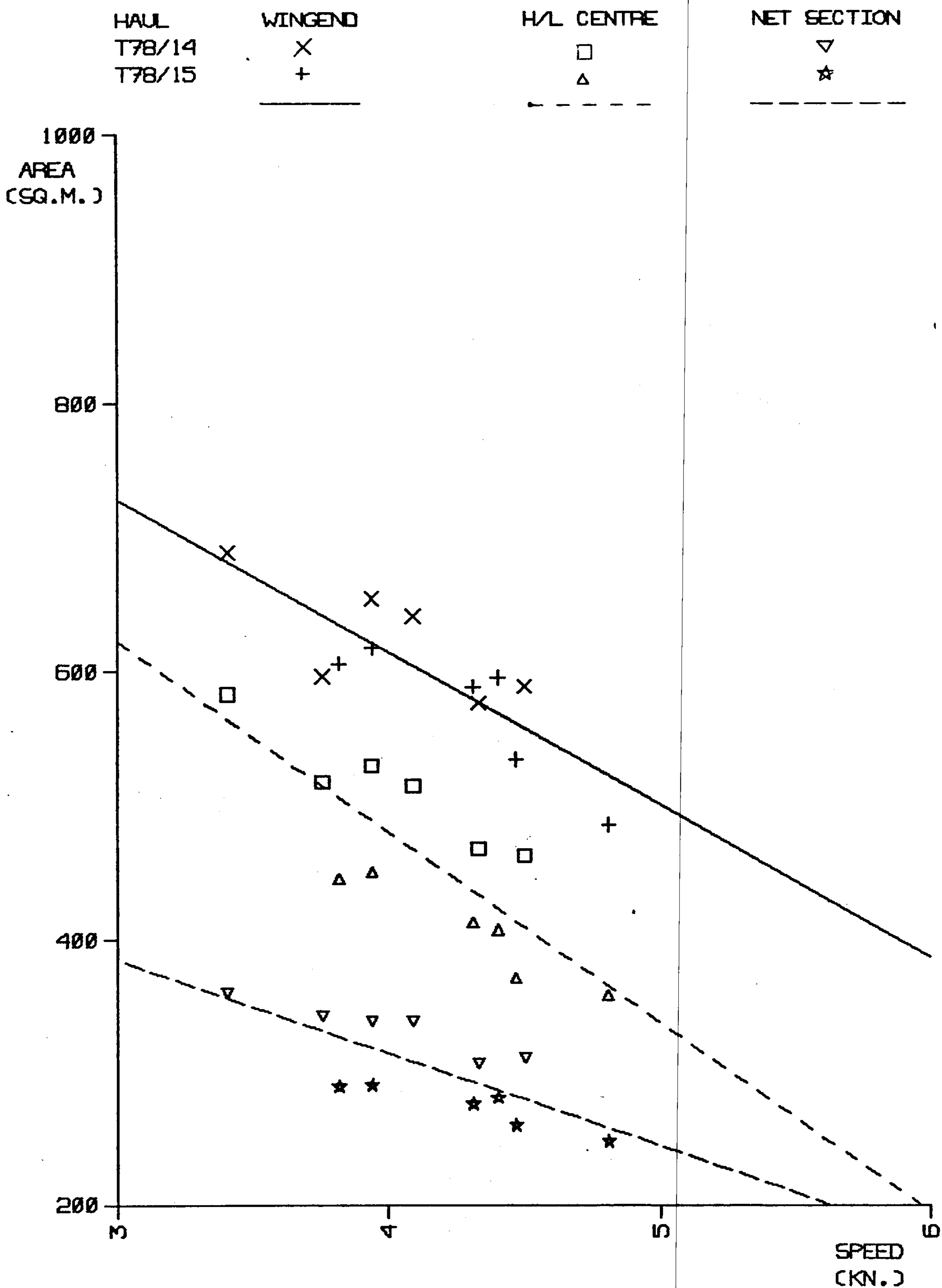


FIG.4.21 NET D - CROSS SECTION AREAS FOR 600 KG BRIDLE WEIGHTS

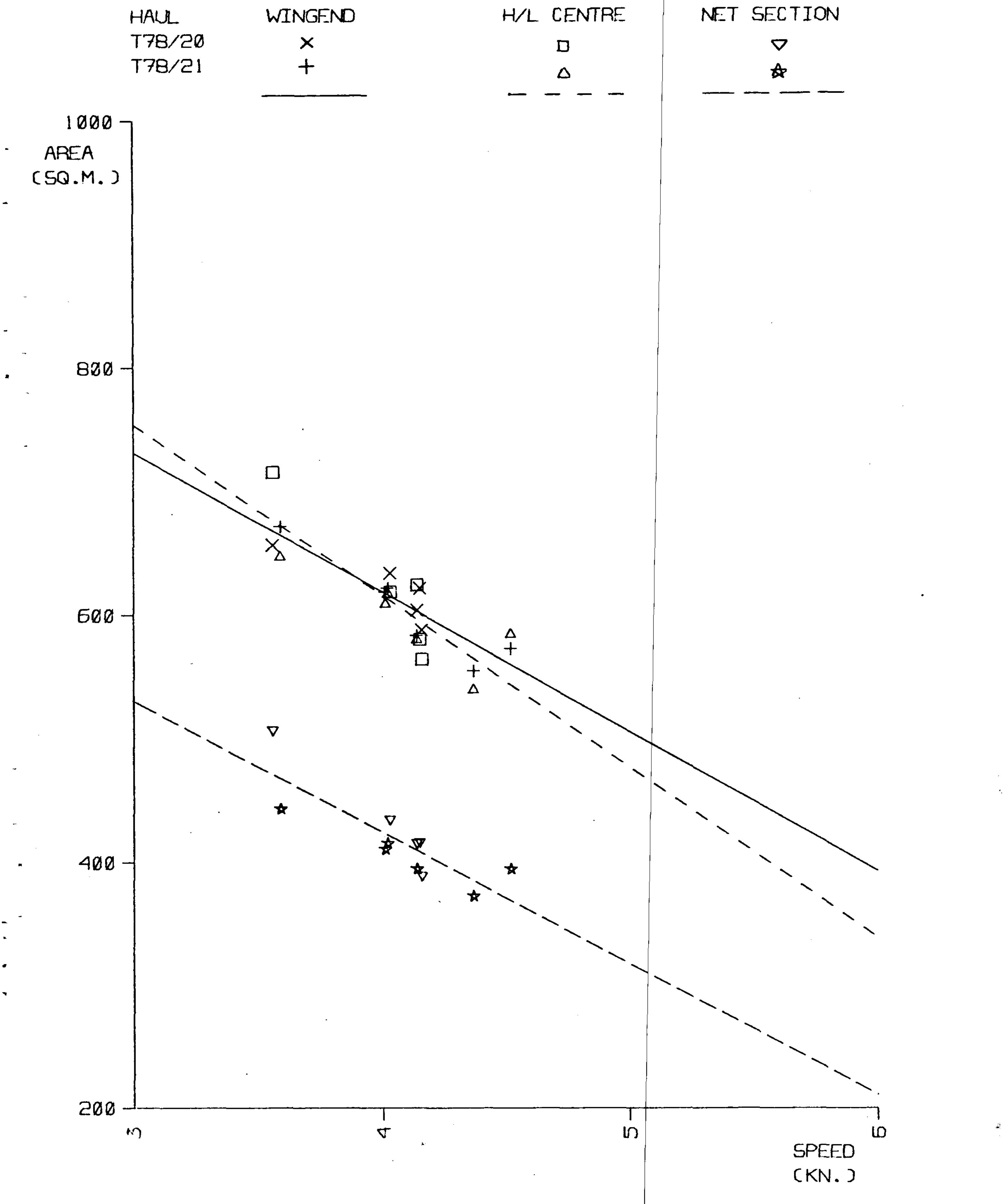


FIG.4.22 NET E – CROSS SECTION AREAS FOR 600 KG BRIDLE WEIGHTS

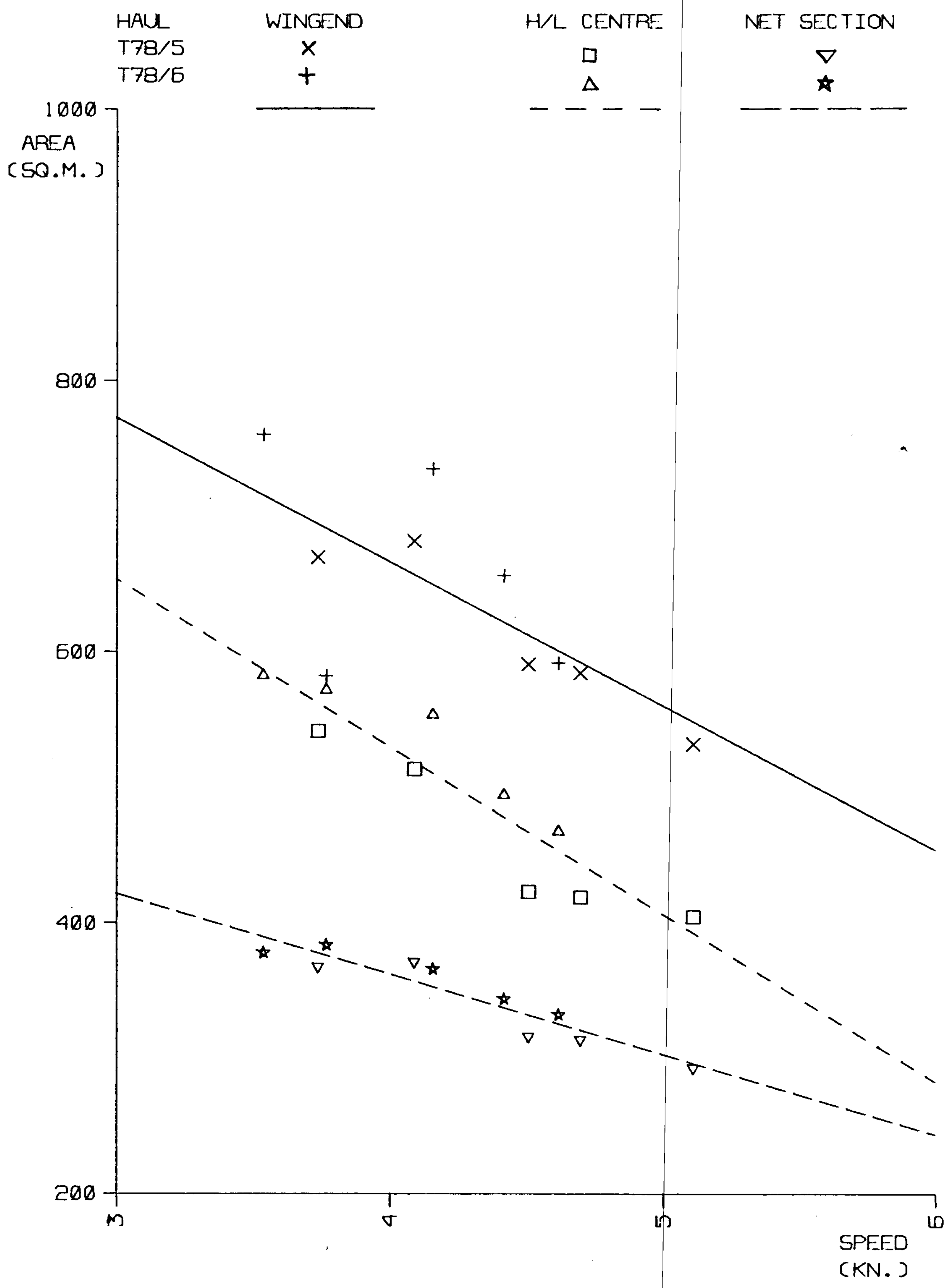


FIG.4.23 NET A – CROSS SECTION AREAS
FOR 750 KG BRIDLE WEIGHTS

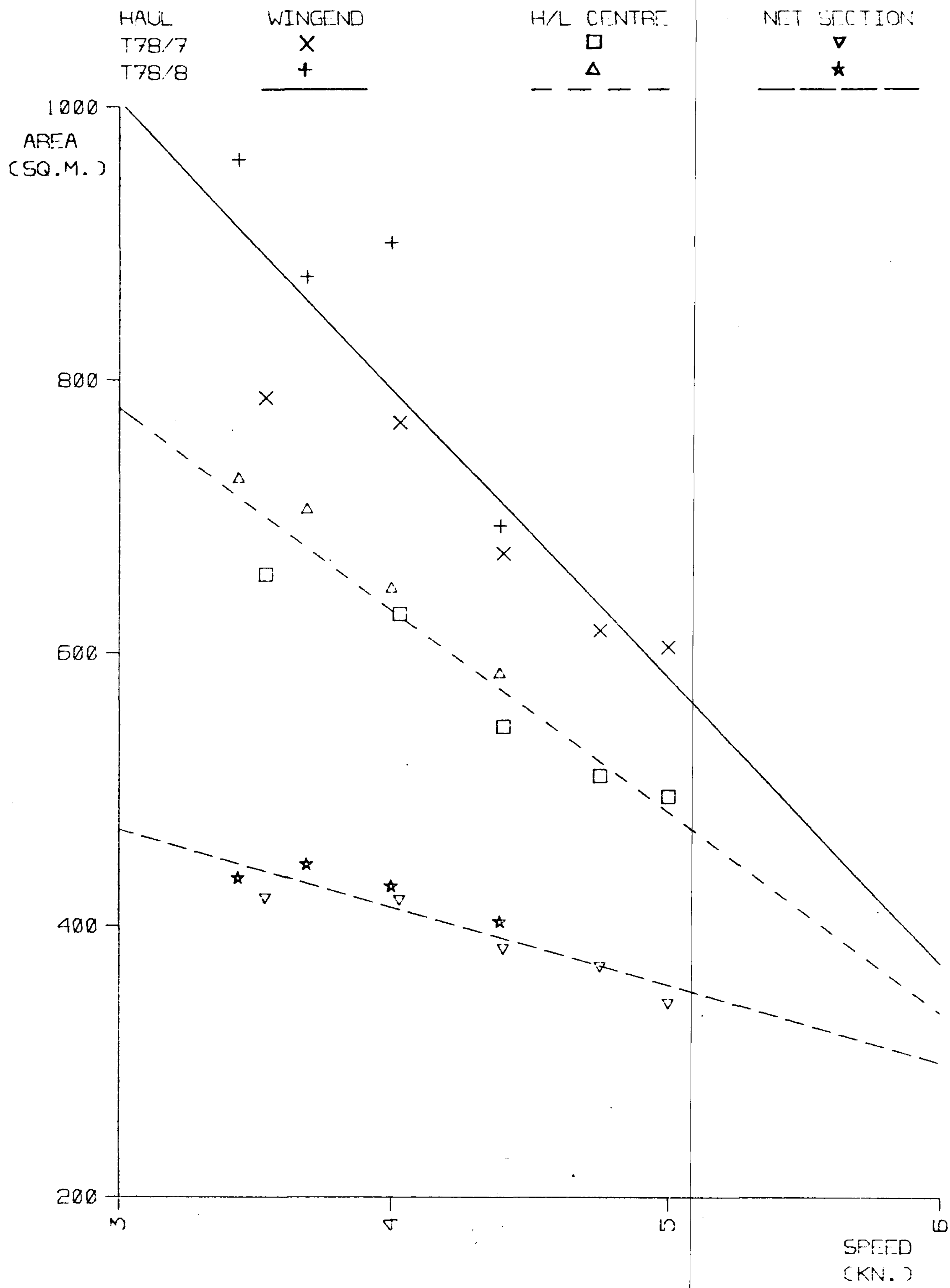


FIG. 4.24 NET C – CROSS SECTION AREAS FOR 750 KG BRIDLE WEIGHTS

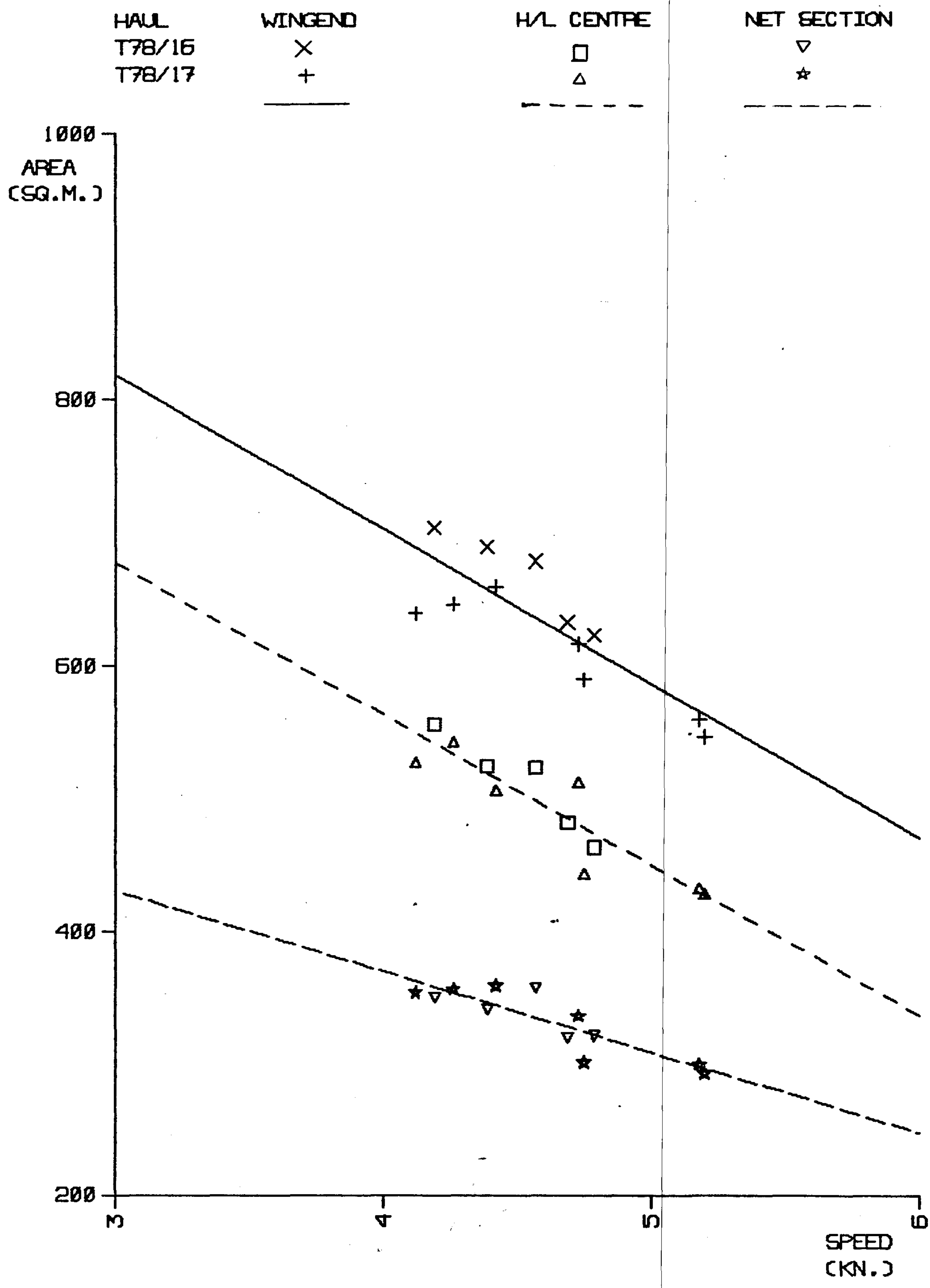


FIG.4.25 NET D – CROSS SECTION AREAS FOR 750 KG WEIGHTS

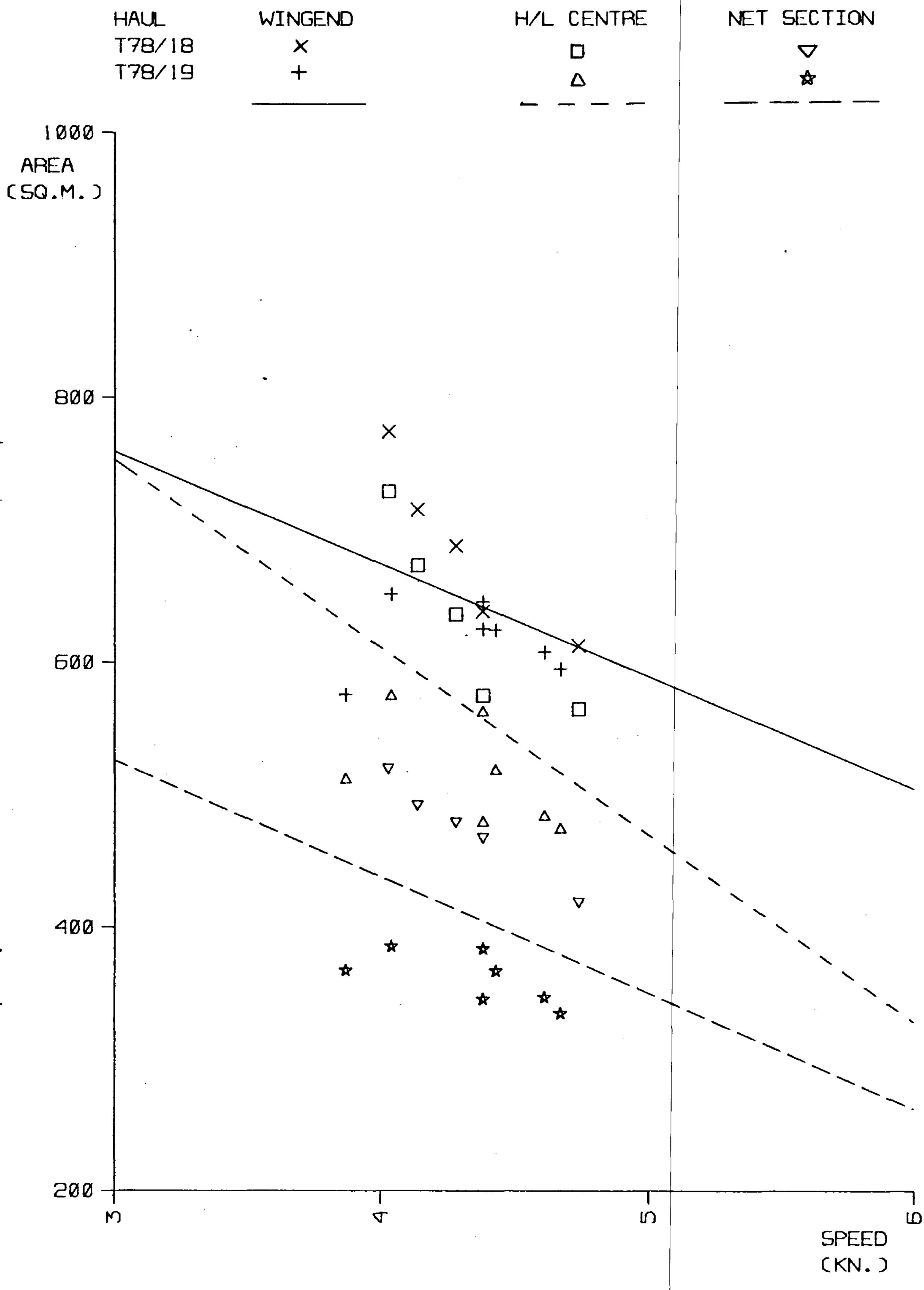


FIG.4.26 NET E – CROSS SECTION AREAS
FOR 750 KG BRIDLE WEIGHTS

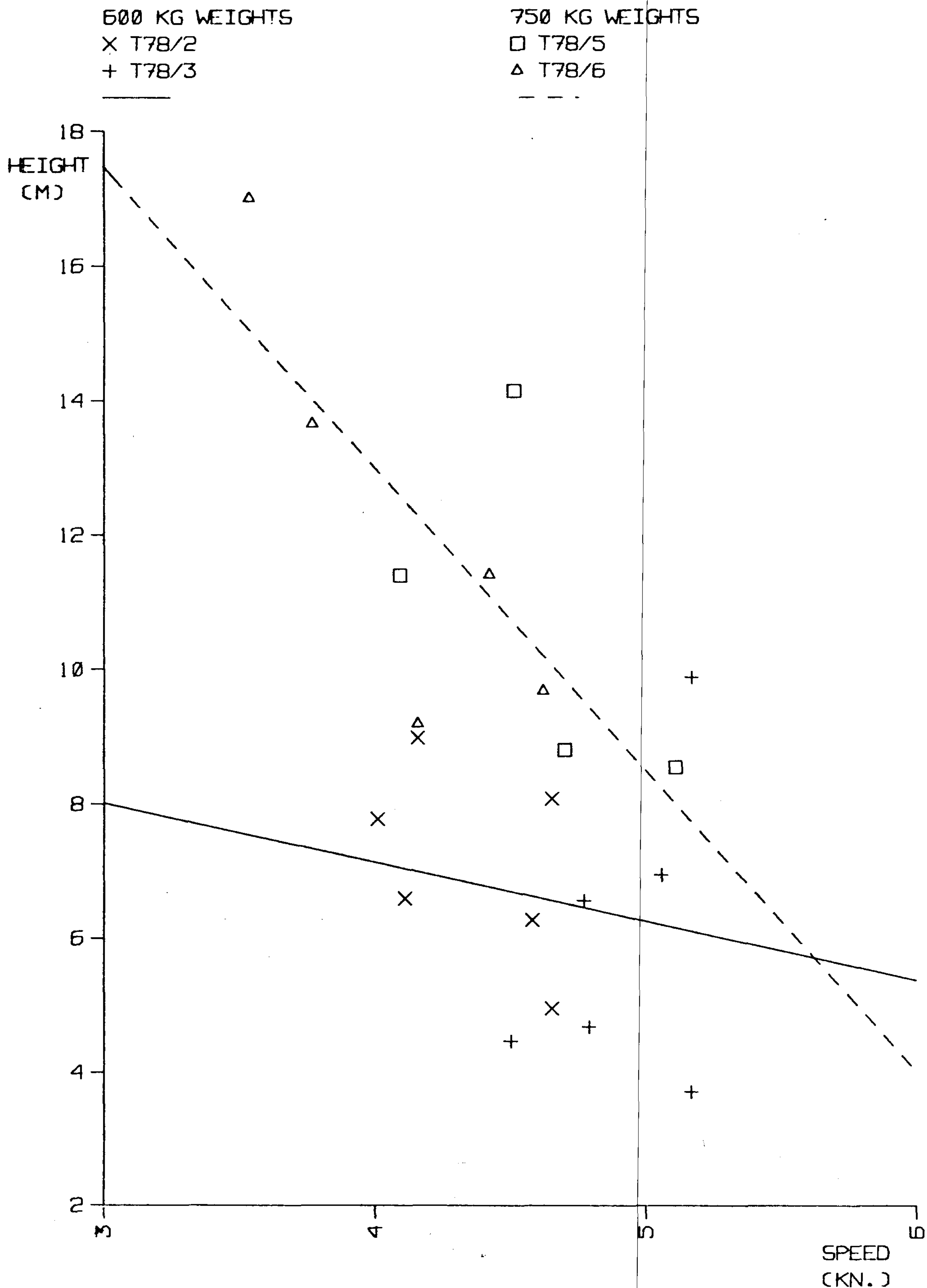


FIG.4.27 NET A – MEAN BOARD HEIGHT ABOVE THE HEADLINE CENTRE

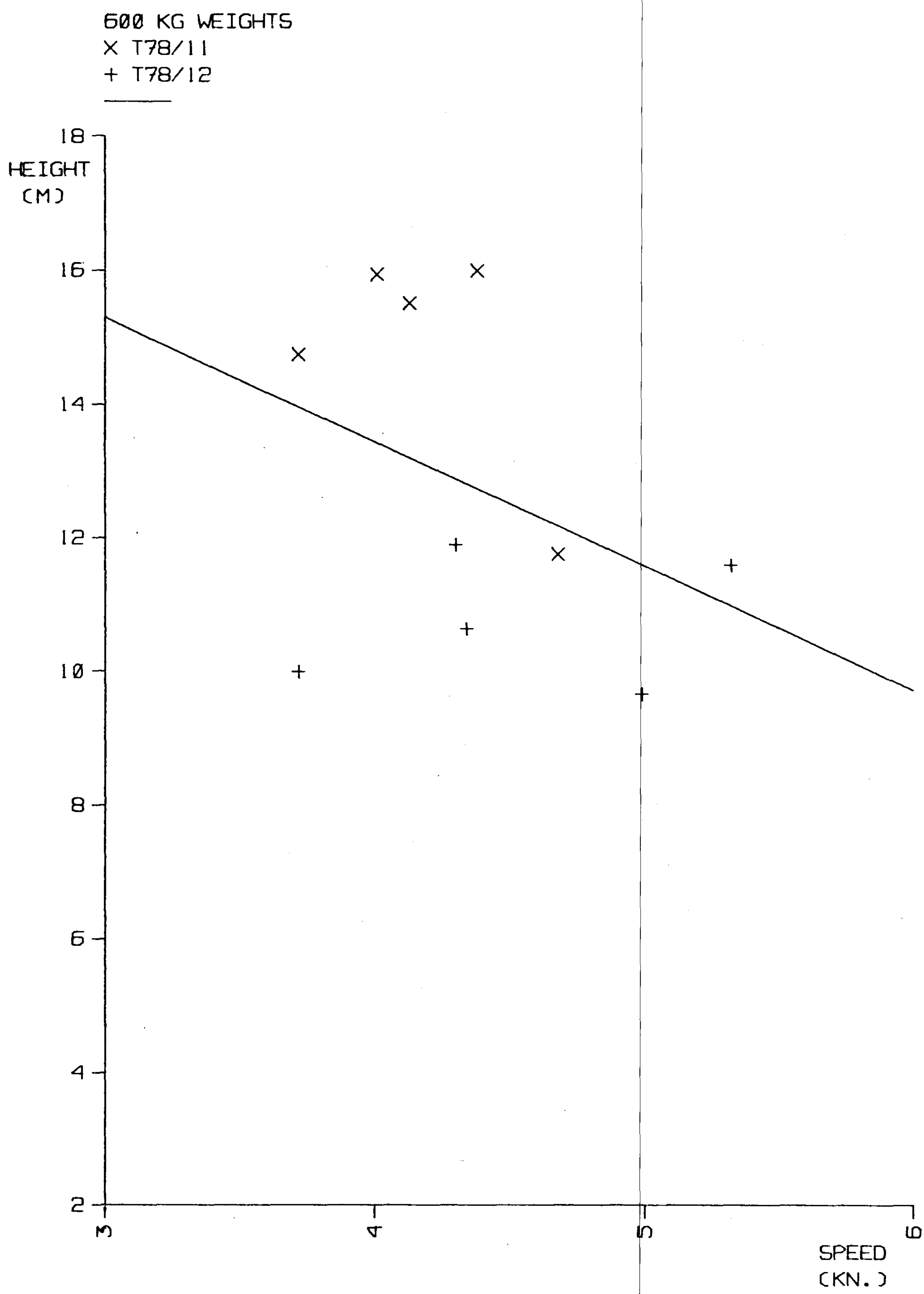


FIG.4.28 NET B – MEAN BOARD HEIGHT ABOVE THE HEADLINE CENTRE

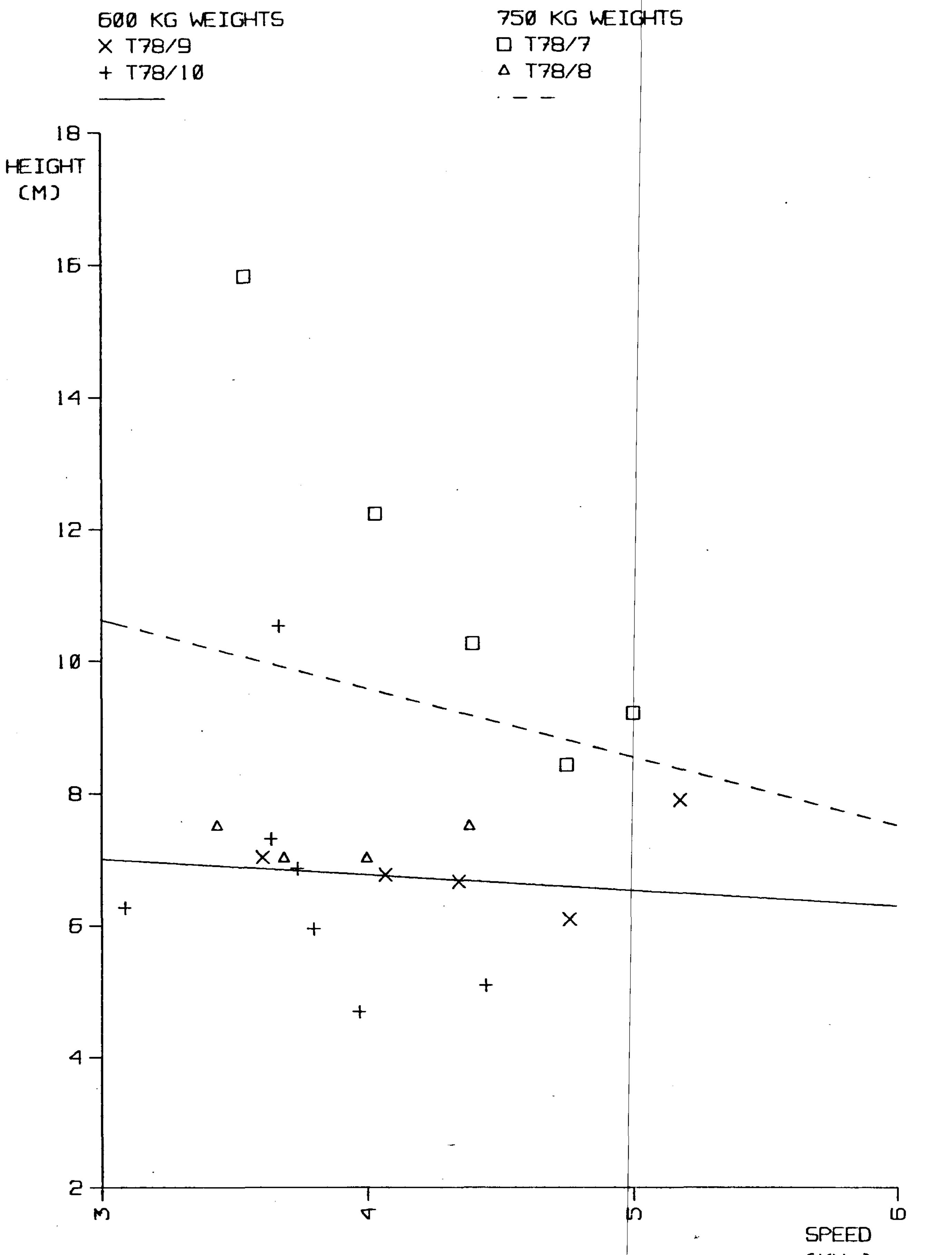


FIG.4.29 NET C - MEAN BOARD HEIGHT ABOVE THE HEADLINE CENTRE

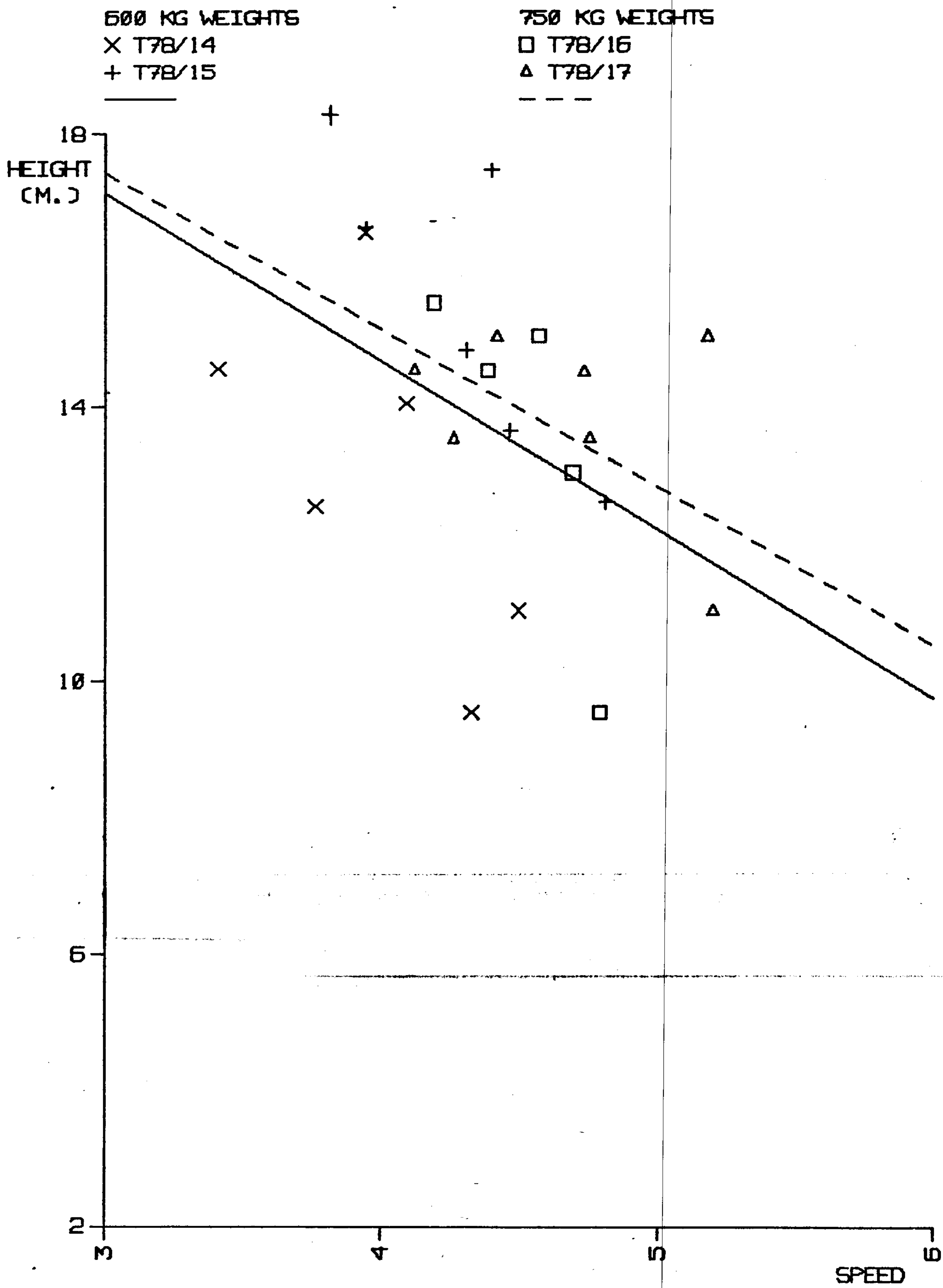


FIG.4.30 NET D – MEAN BOARD HEIGHT ABOVE THE HEADLINE CENTRE

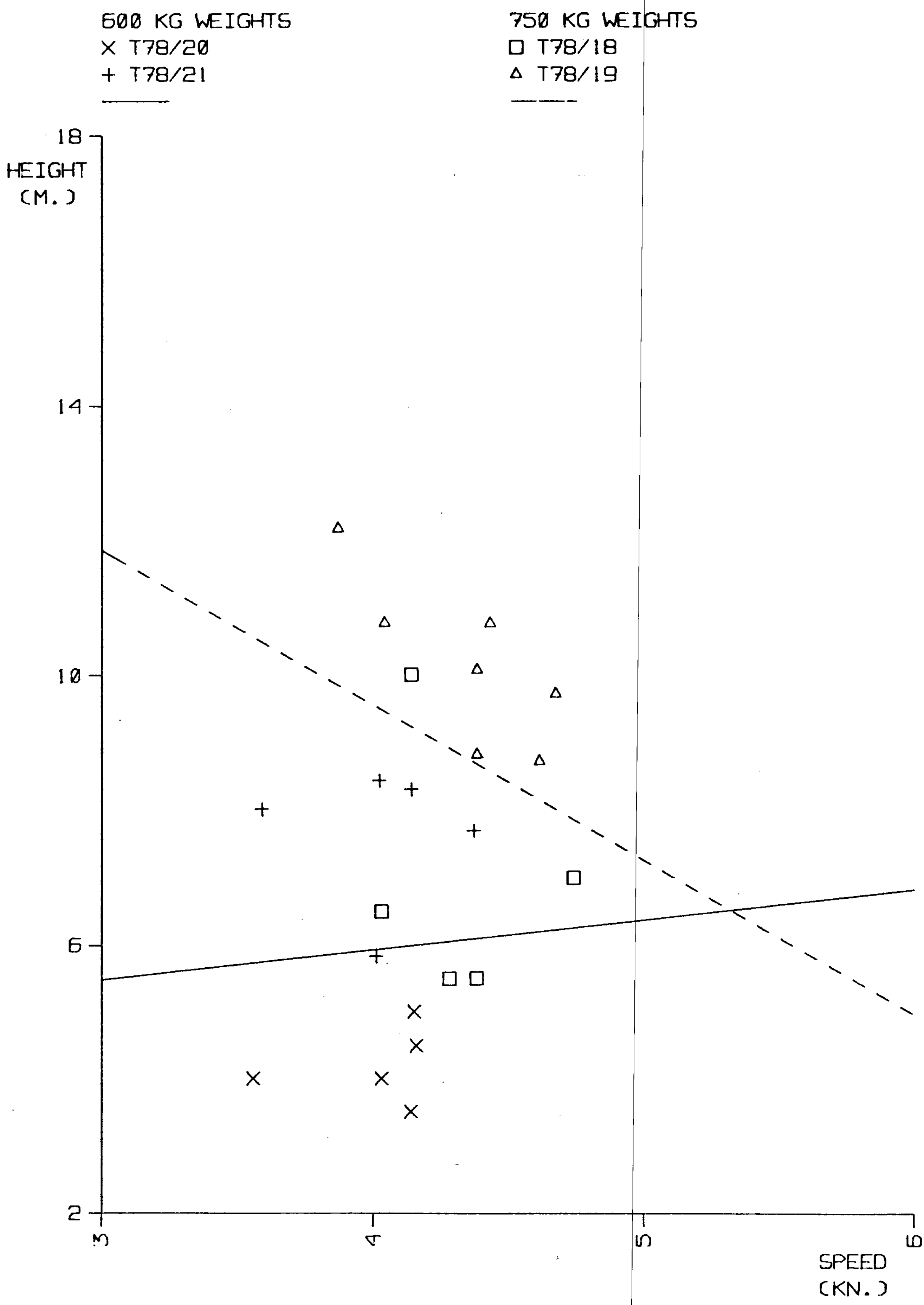


FIG.4.31 NET E - MEAN BOARD HEIGHT ABOVE THE HEADLINE CENTRE

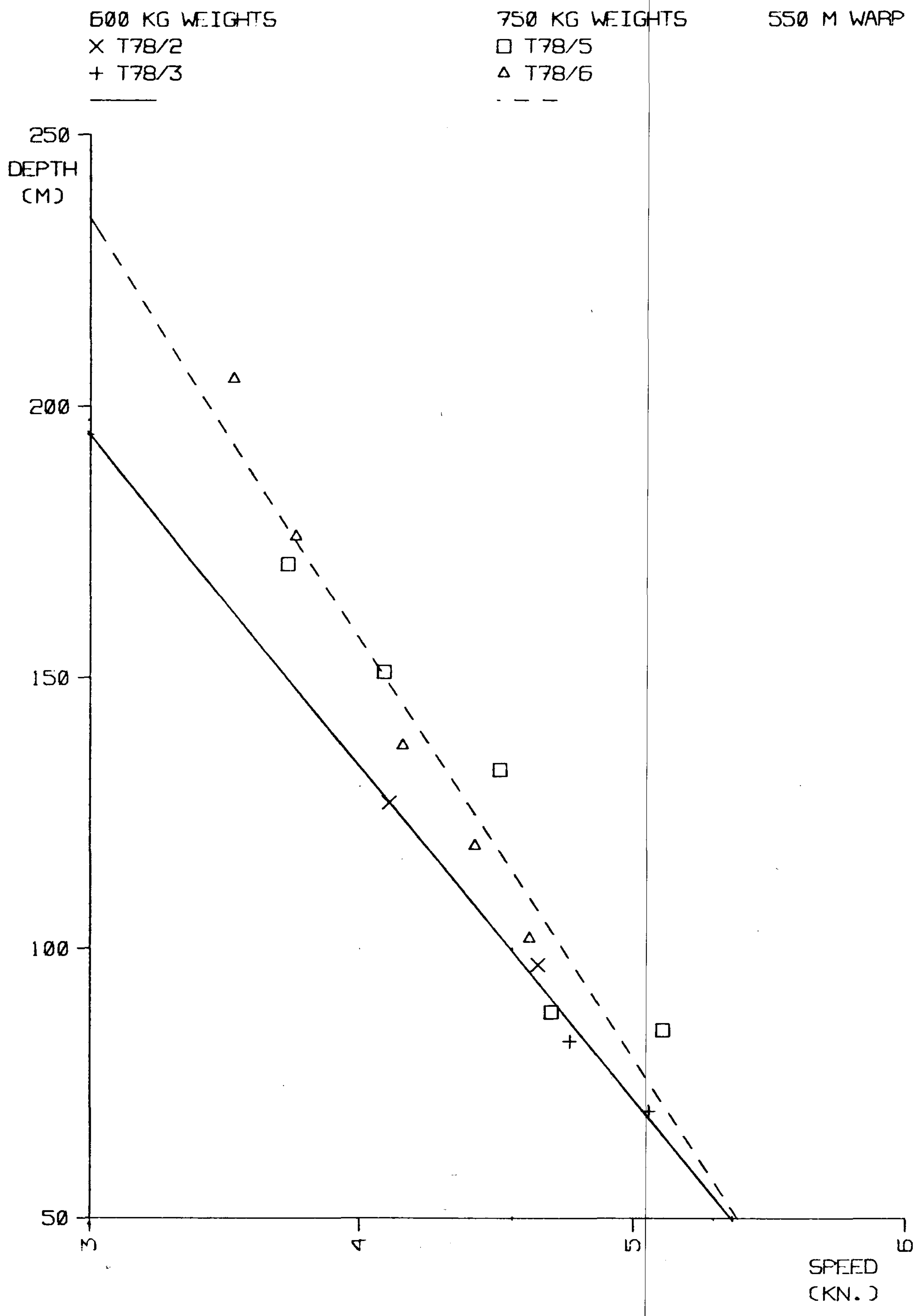


FIG.4.32 NET A - HEADLINE DEPTH VS. SPEED AND BRIDLE WEIGHT

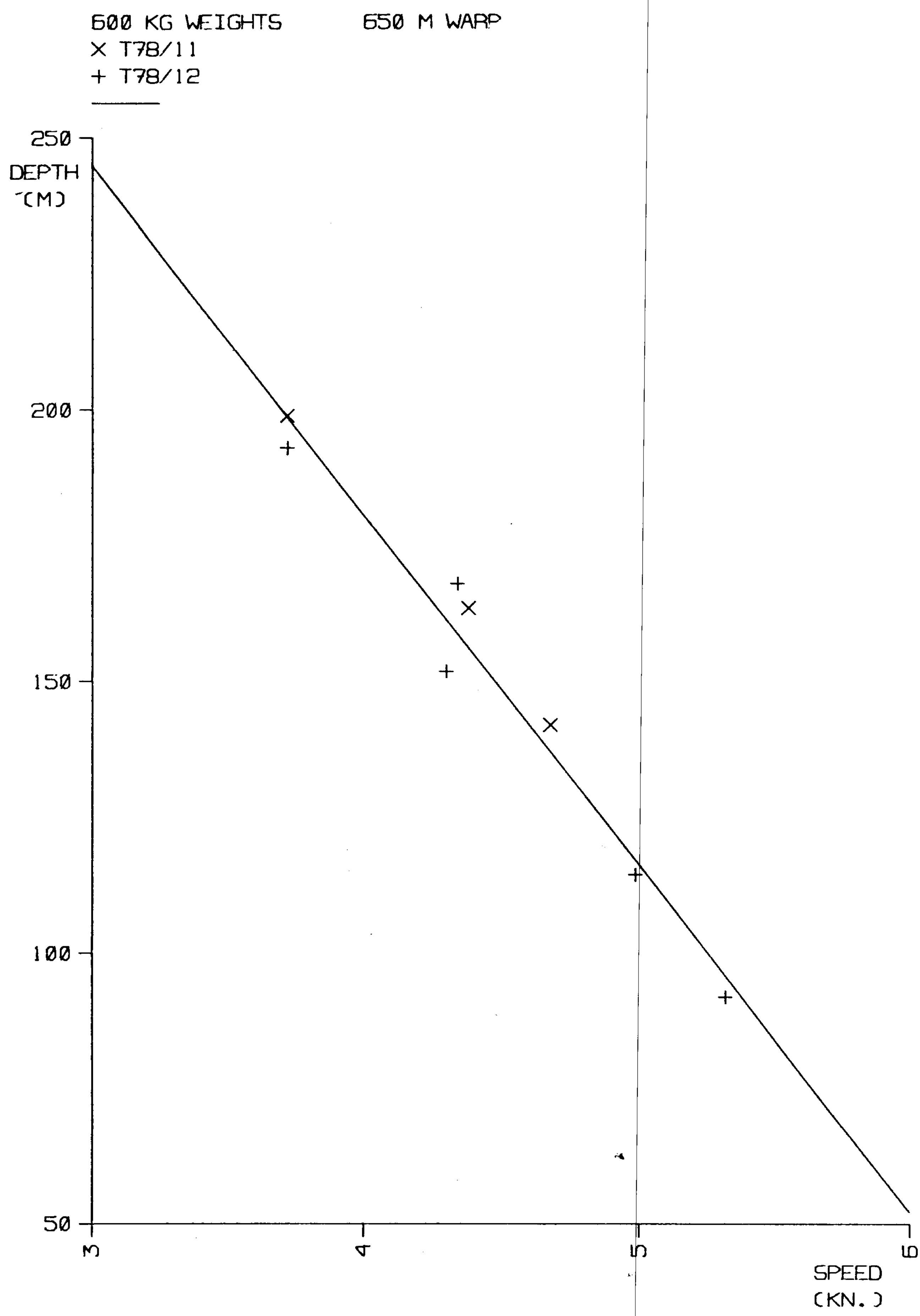


FIG.4.33 NET B – HEADLINE DEPTH VS. SPEED AND BRIDLE WEIGHT

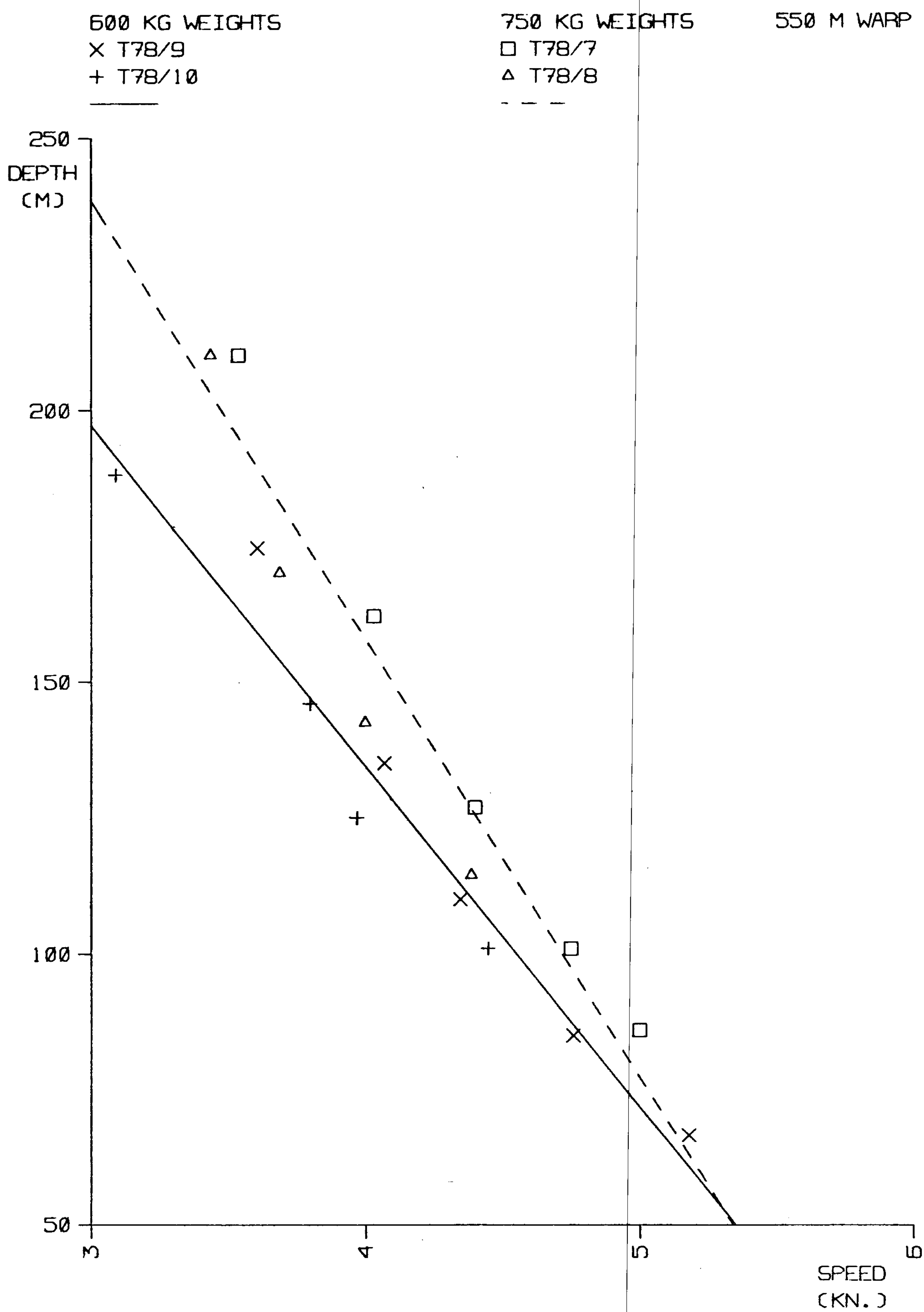


FIG.4.34 NET C – HEADLINE DEPTH VS. SPEED AND BRIDLE WEIGHT

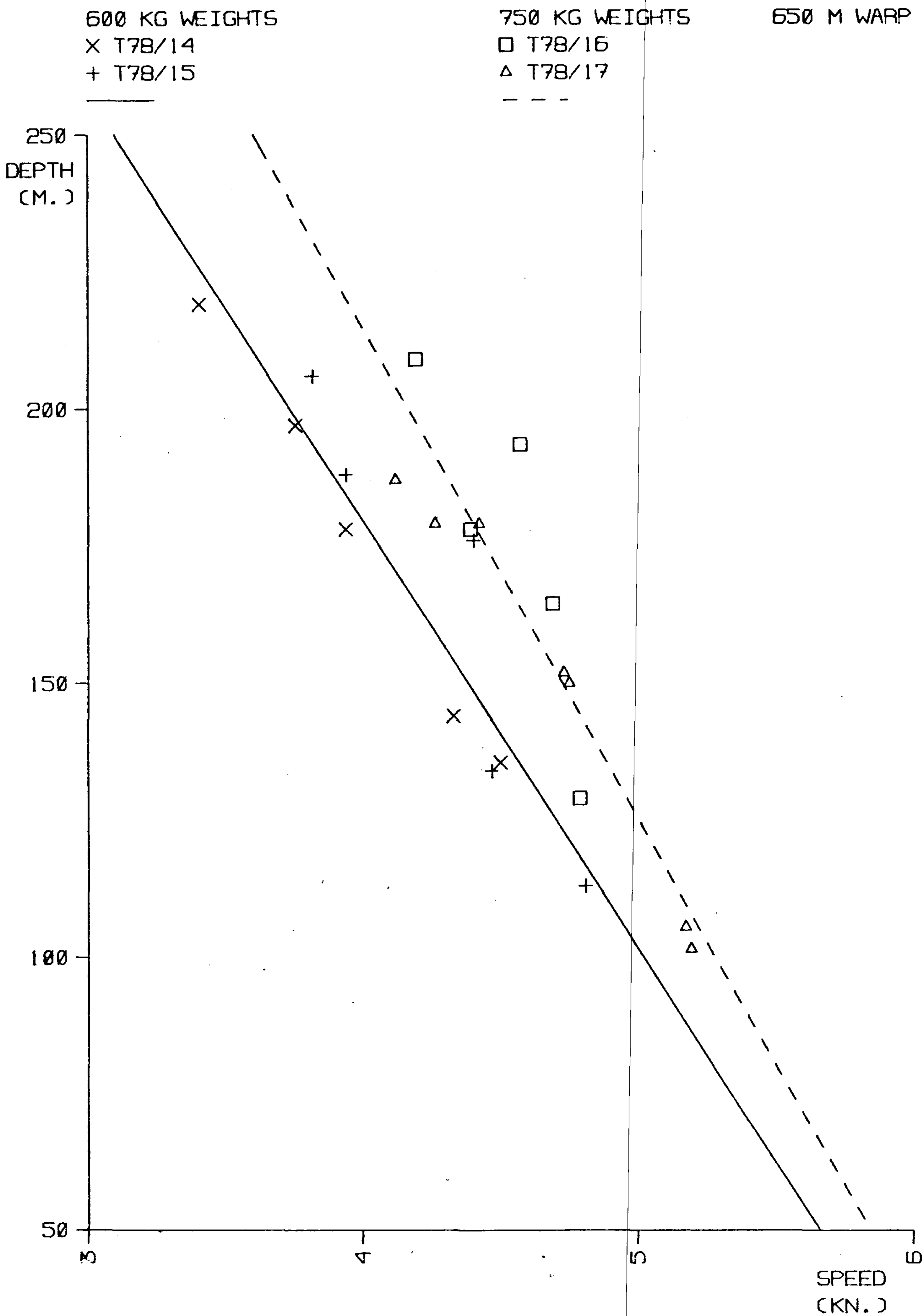


FIG.4.35 NET D - HEADLINE DEPTH VS. SPEED AND BRIDLE WEIGHT

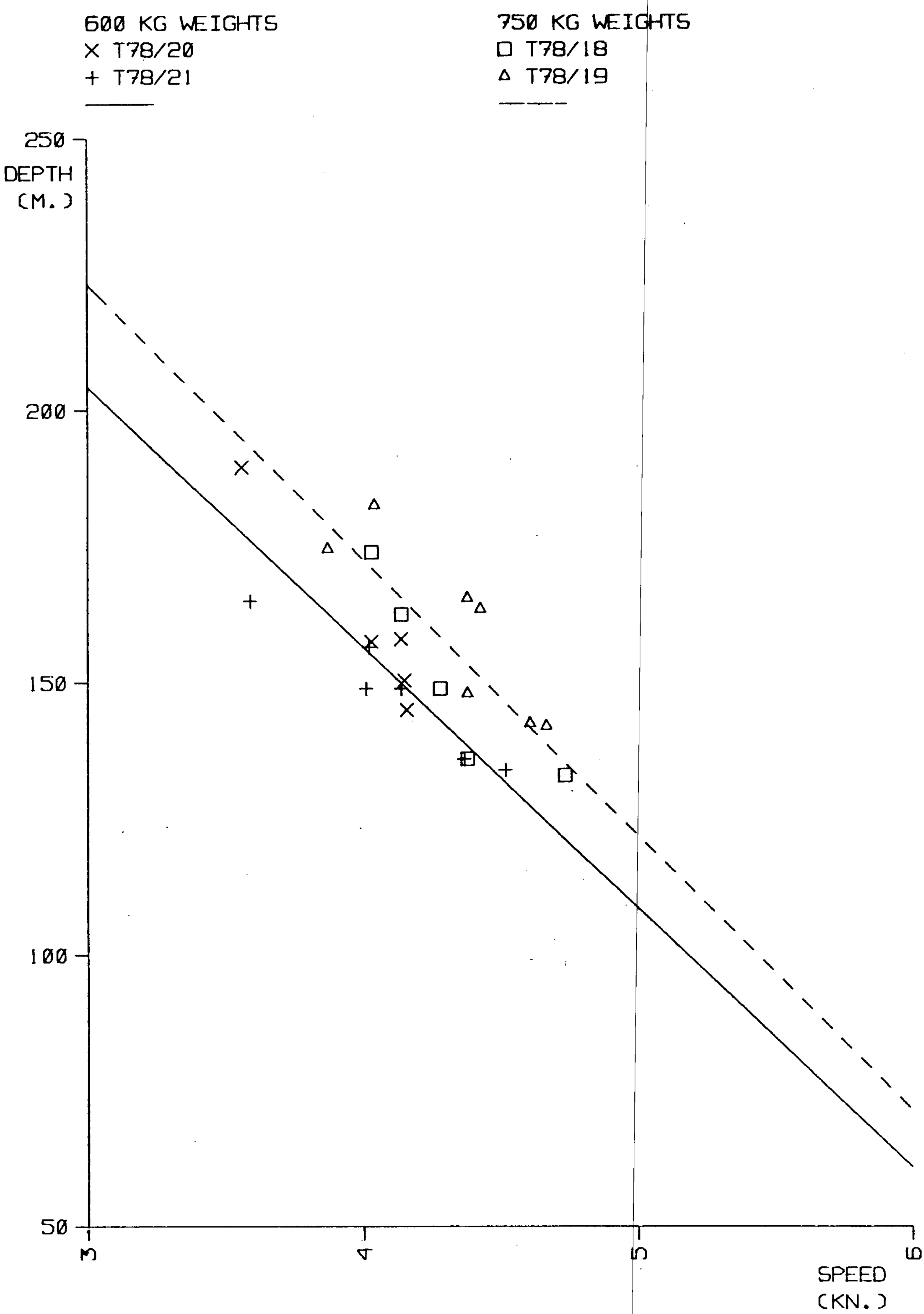


FIG.4.36 NET E – HEADLINE DEPTH VS. SPEED AND BRIDLE WEIGHT

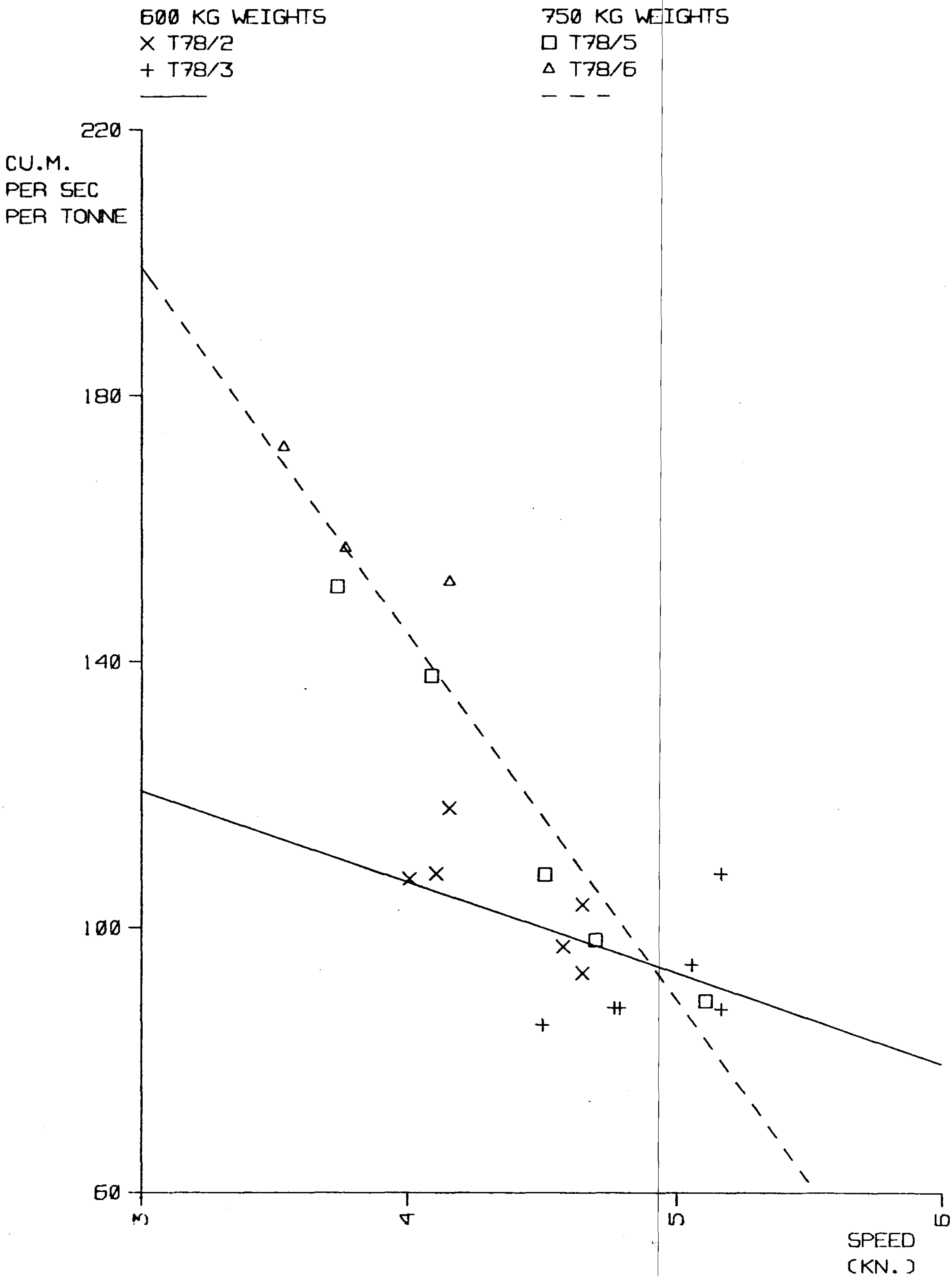


FIG. 4.37 NET A – SWEPT VOLUME PER UNIT TIME PER UNIT LOAD

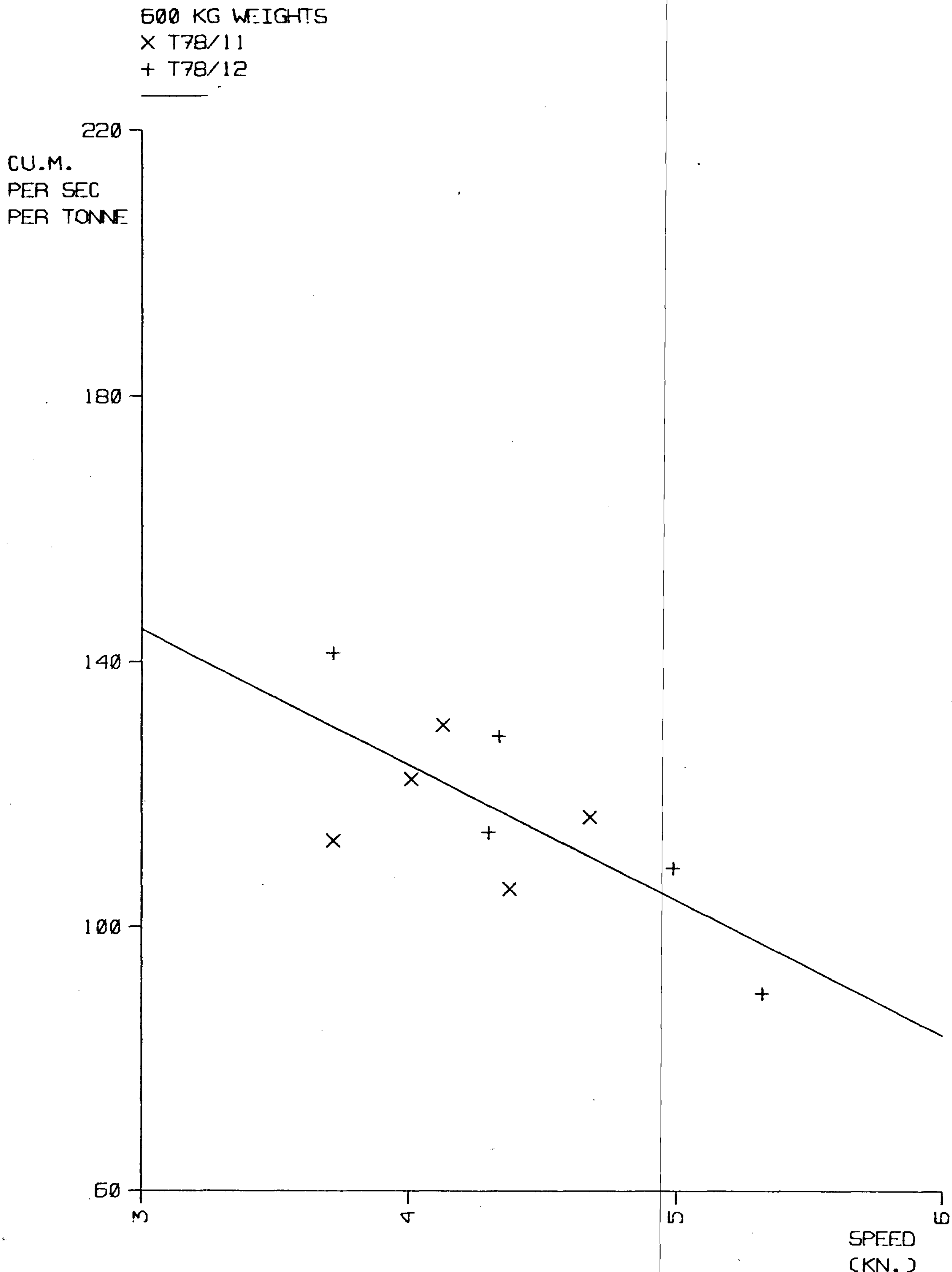


FIG.4.38 NET B – SWEPT VOLUME PER UNIT TIME PER UNIT LOAD

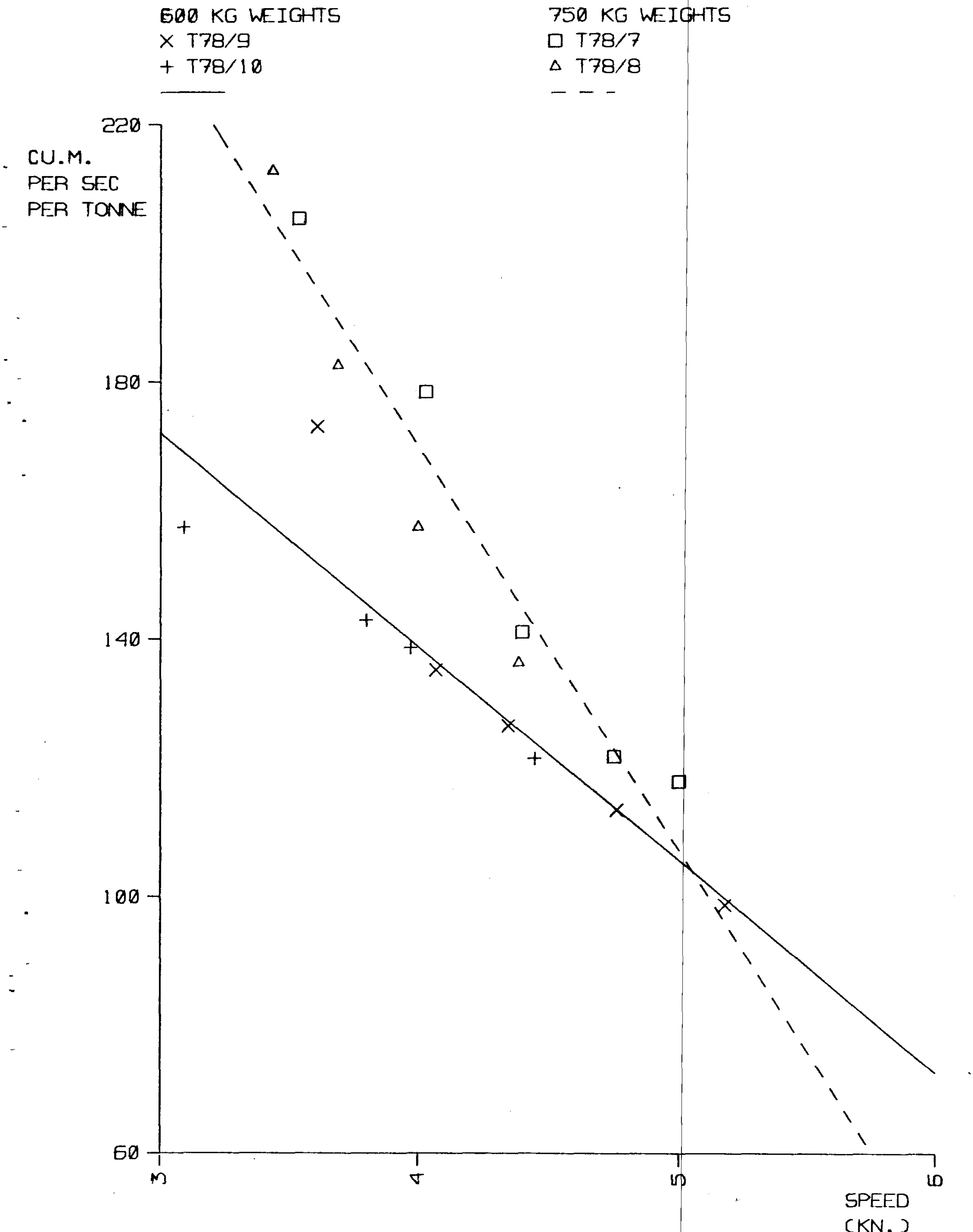


FIG.4.39 NET C — SWEPT VOLUME PER UNIT TIME PER UNIT LOAD

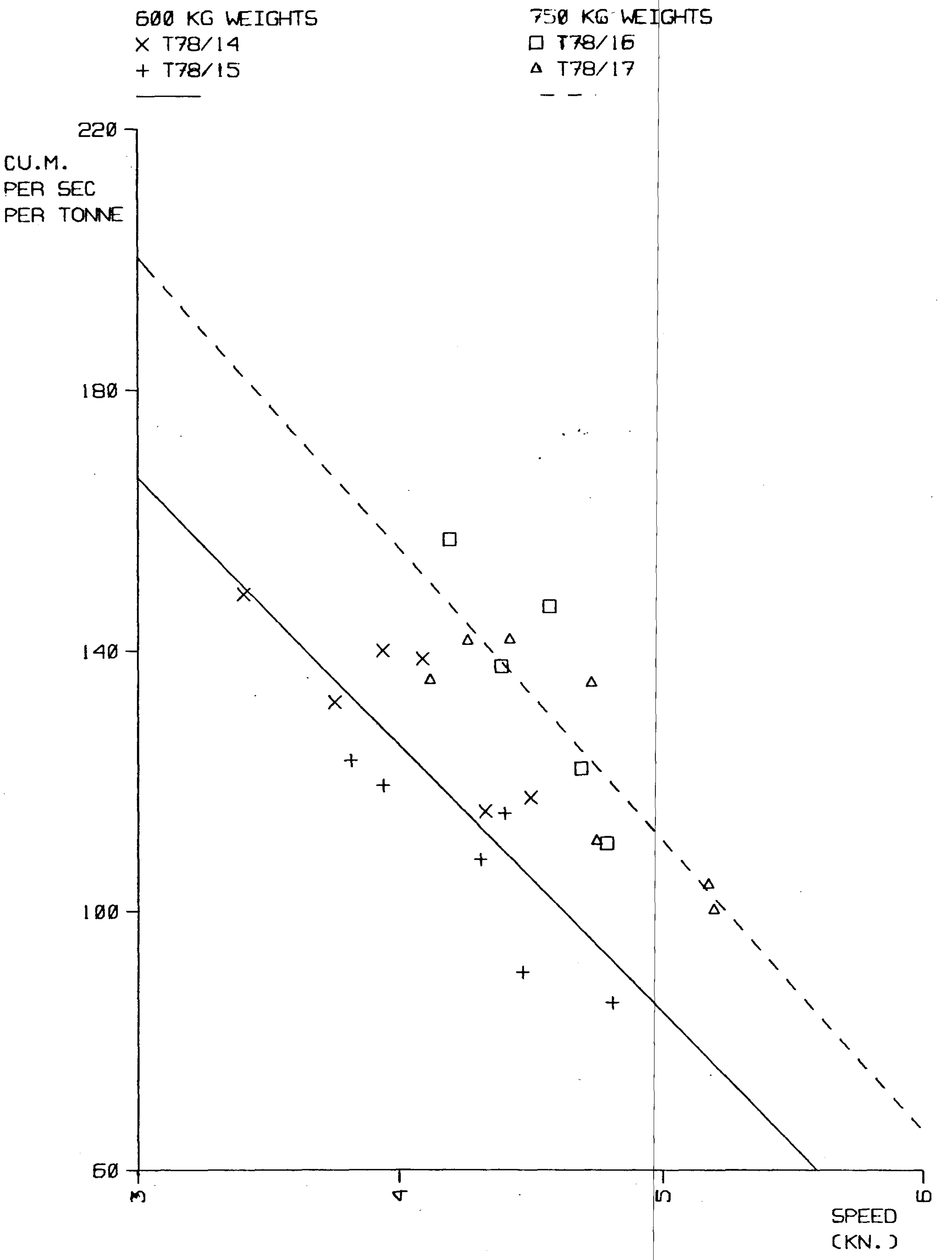


FIG.4.40 NET D – SWEPT VOLUME PER UNIT TIME PER UNIT LOAD

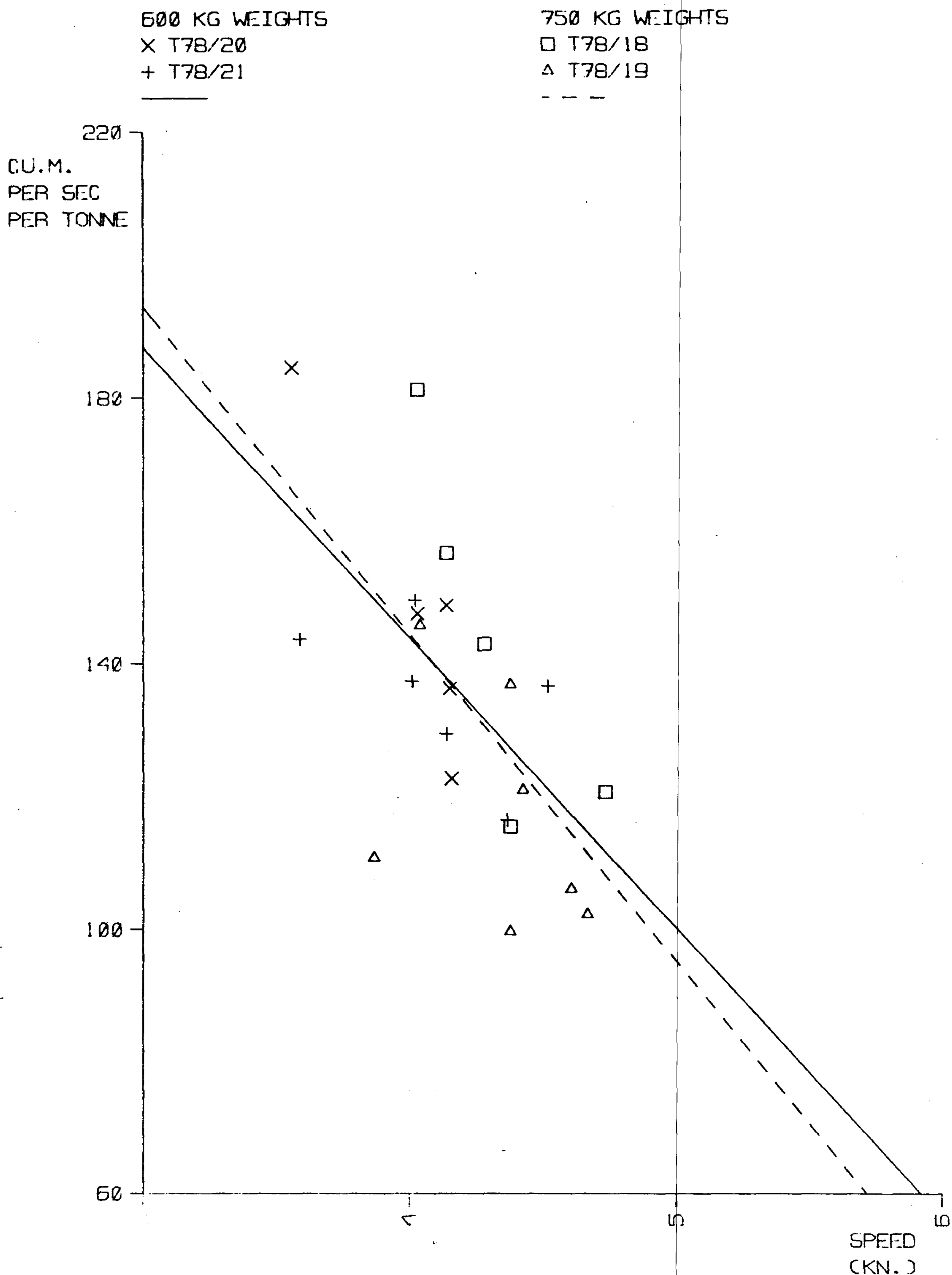


FIG.4.41 NET E – SWEPT VOLUME PER UNIT TIME PER UNIT LOAD

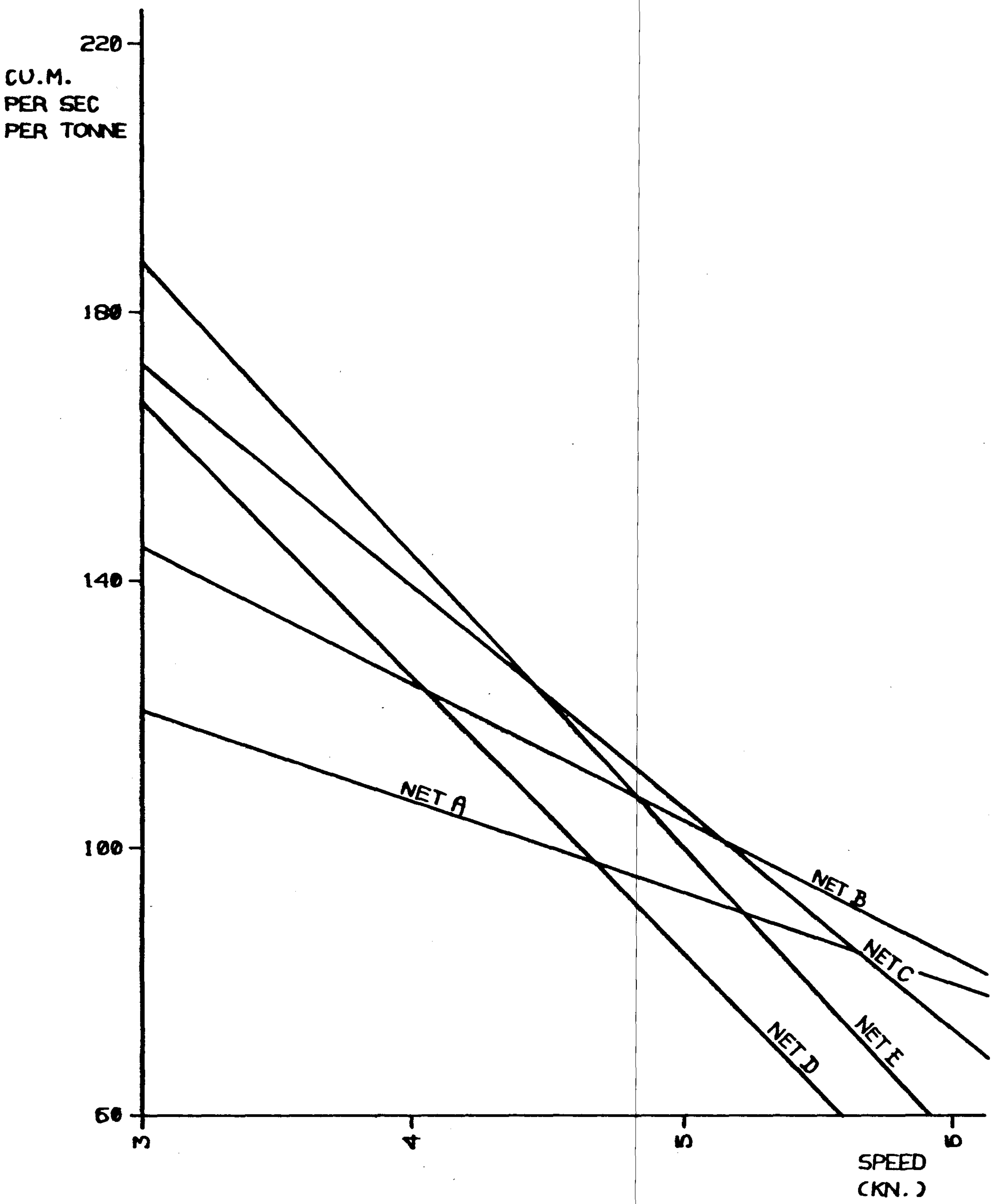


FIG. 4.42 SWEPT VOLUME INDEX VS. SPEED
600 KG. BRIDLE WEIGHTS.

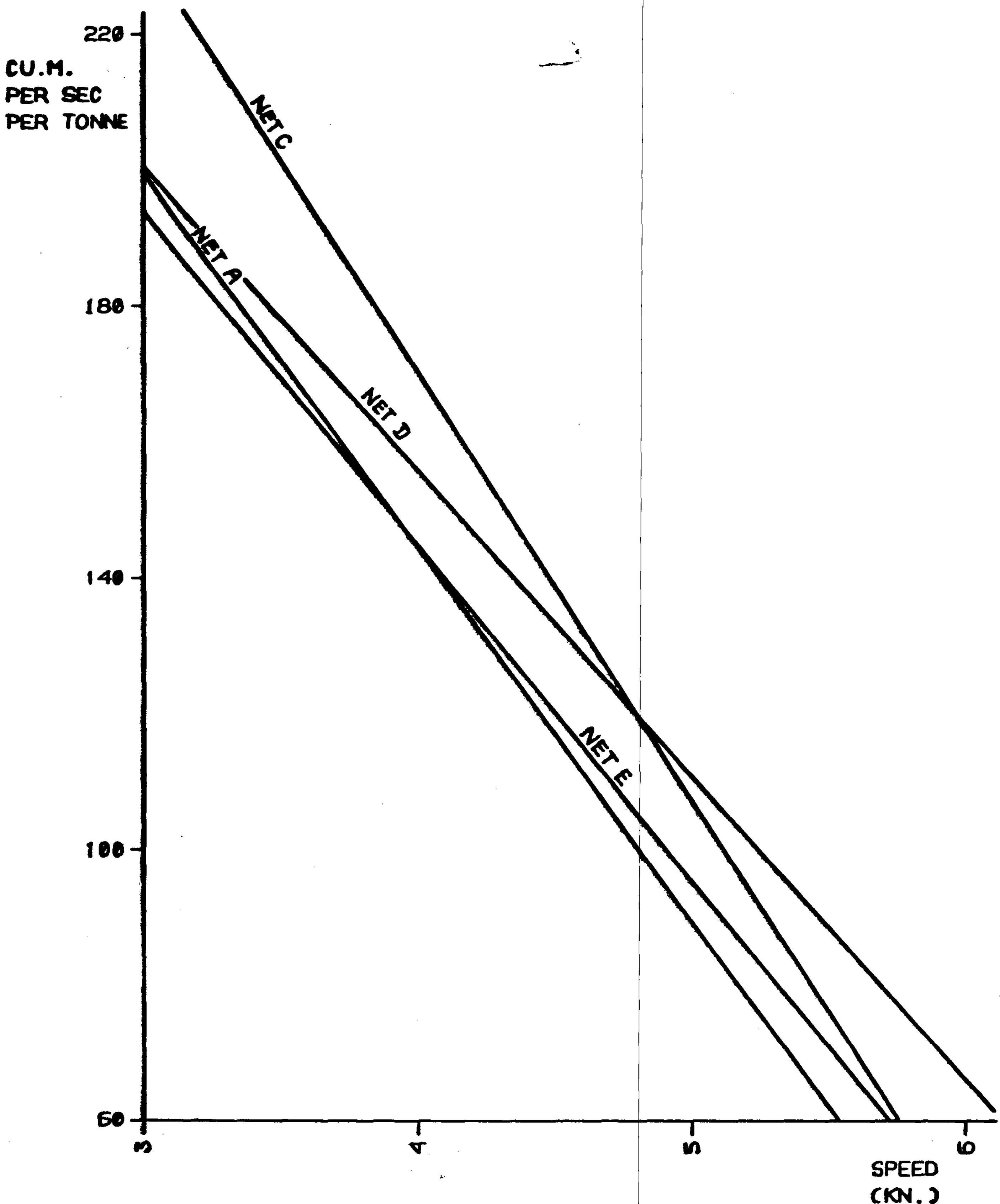


FIG. 4.43 SWEPT VOLUME INDEX VS. SPEED
750 KG. BRIDLE WEIGHTS.

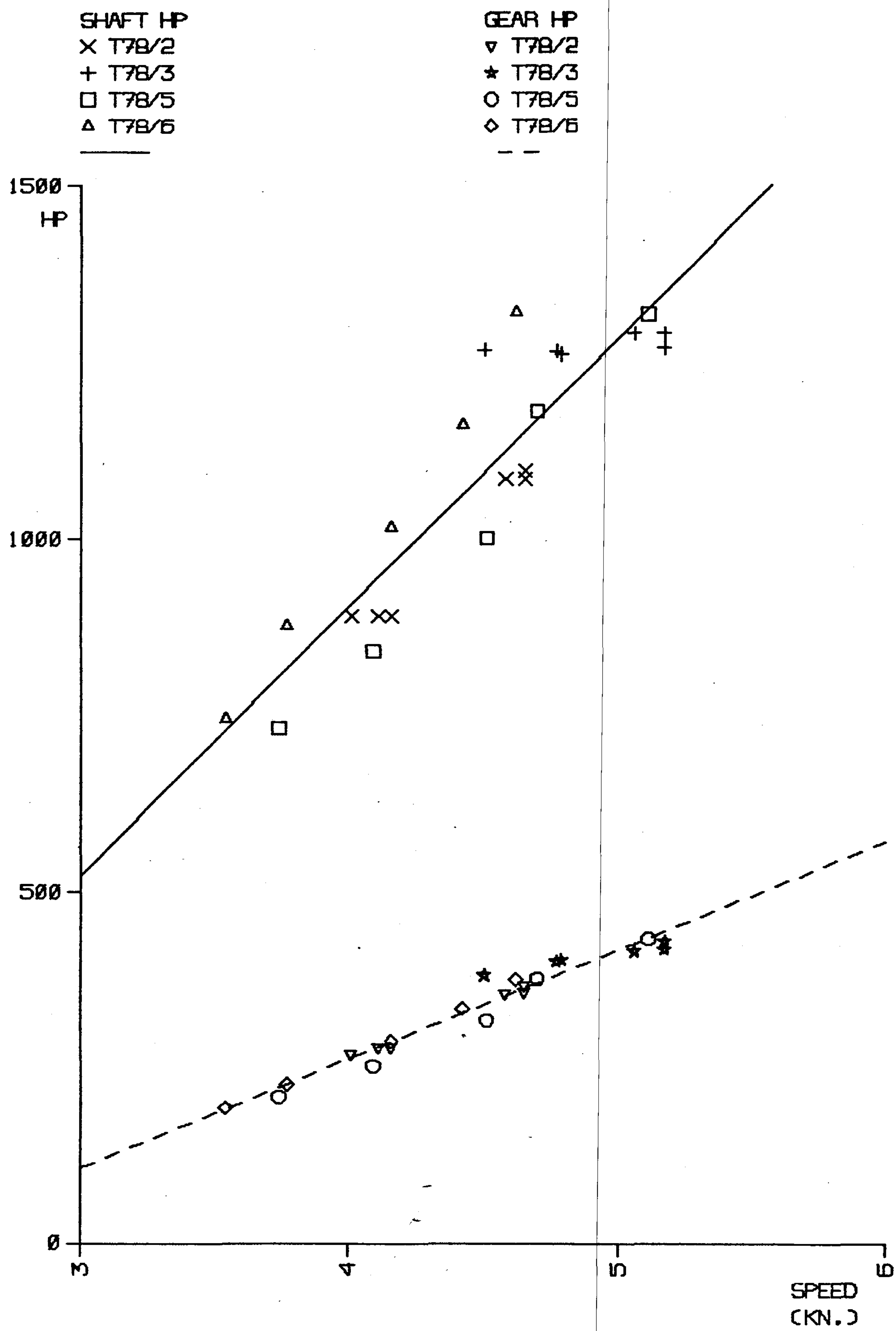


FIG.4.44 NET A – TOWING POWER VS. SPEED

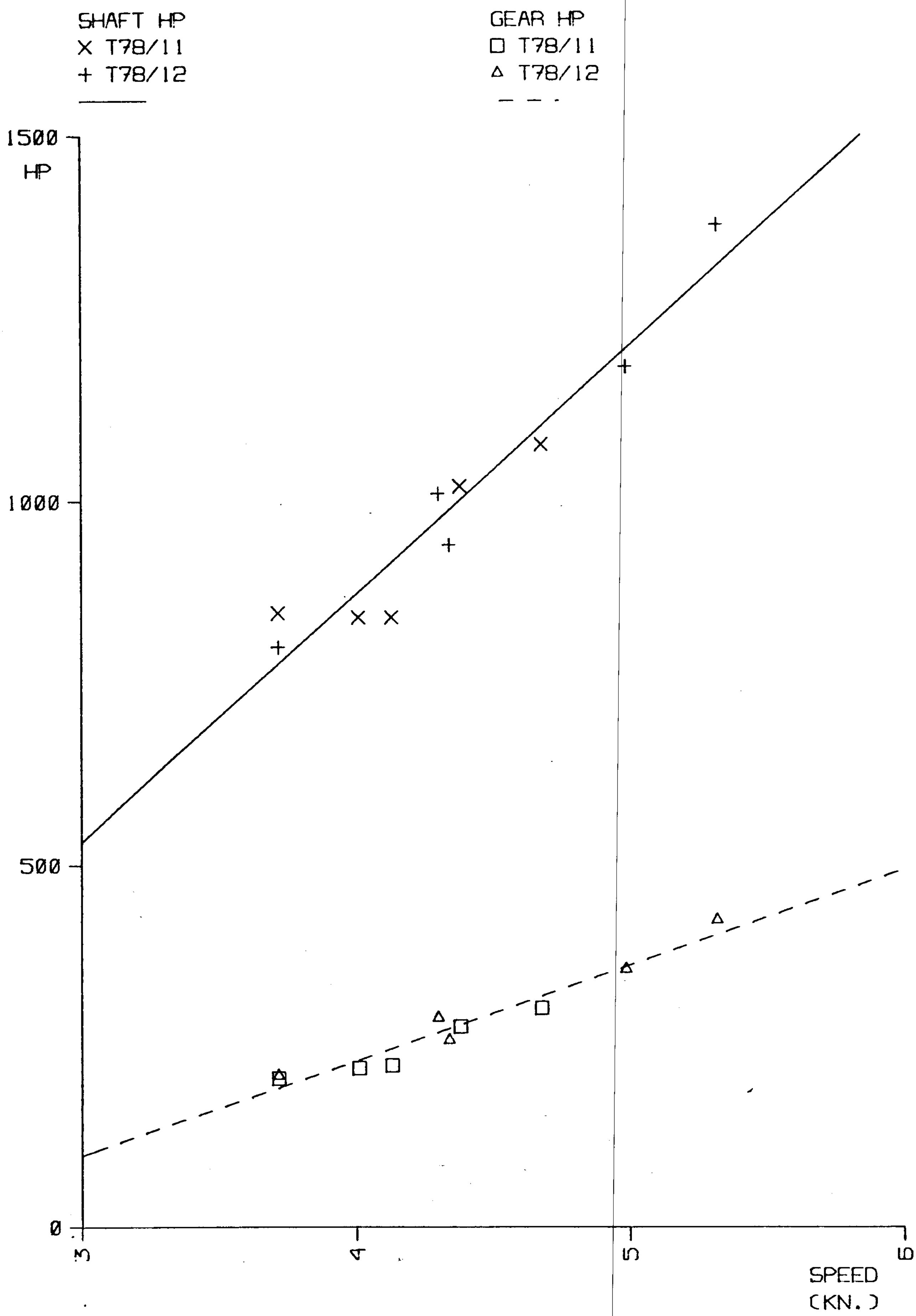


FIG.4.45 NET B - TOWING POWER VS. SPEED

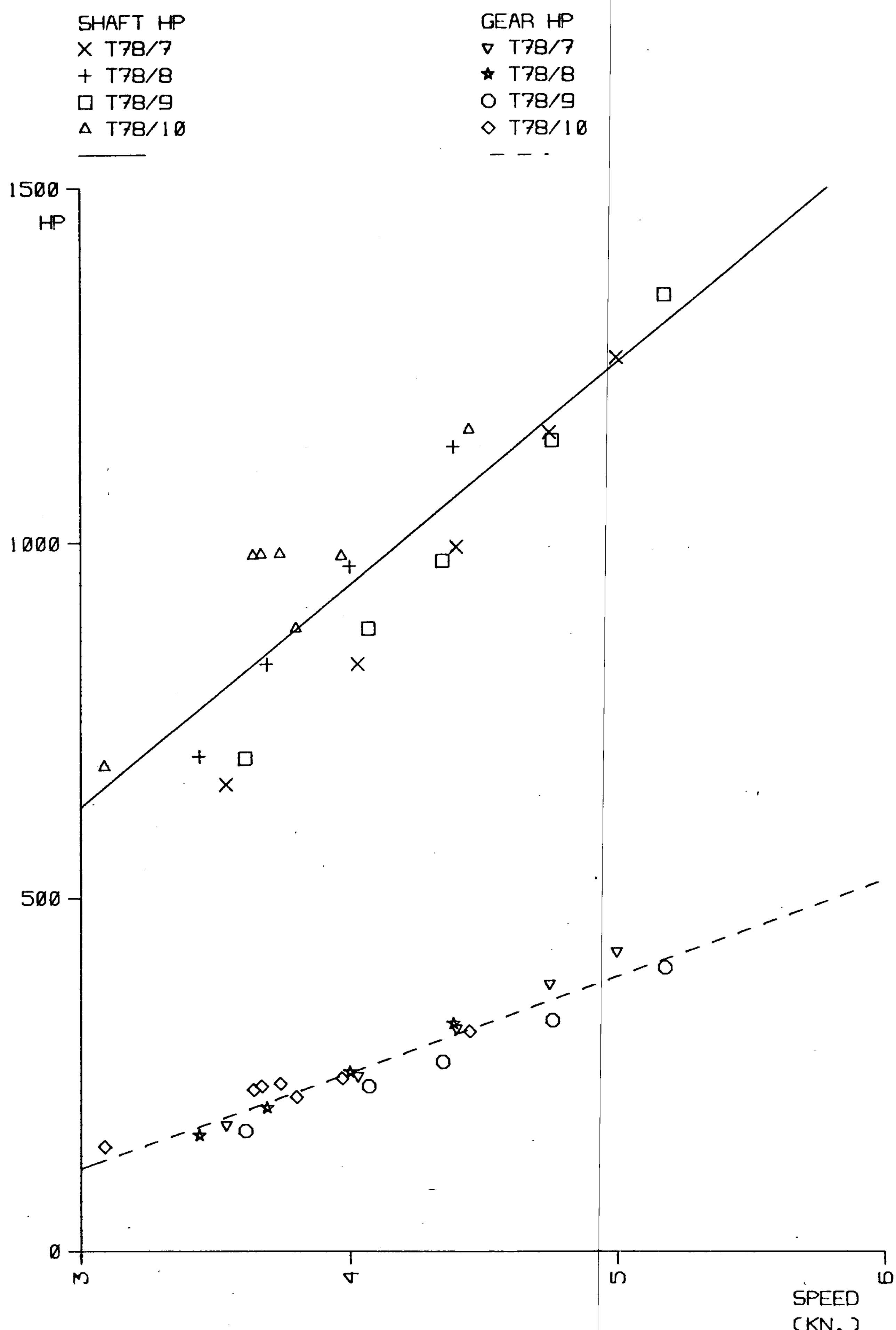


FIG.4.46 NET C – TOWING POWER VS. SPEED

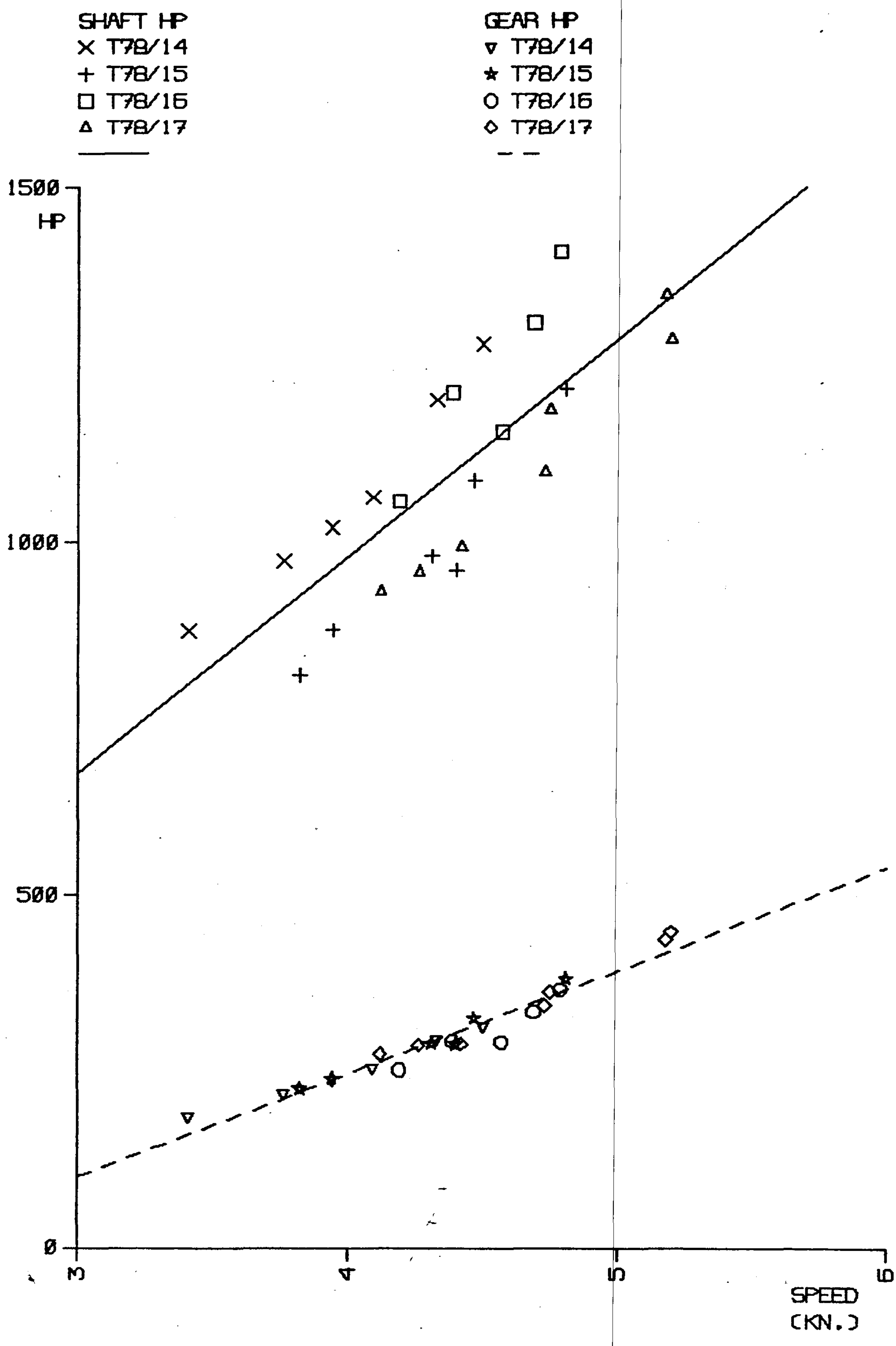


FIG. 4.47 NET D – TOWING POWER VS. SPEED

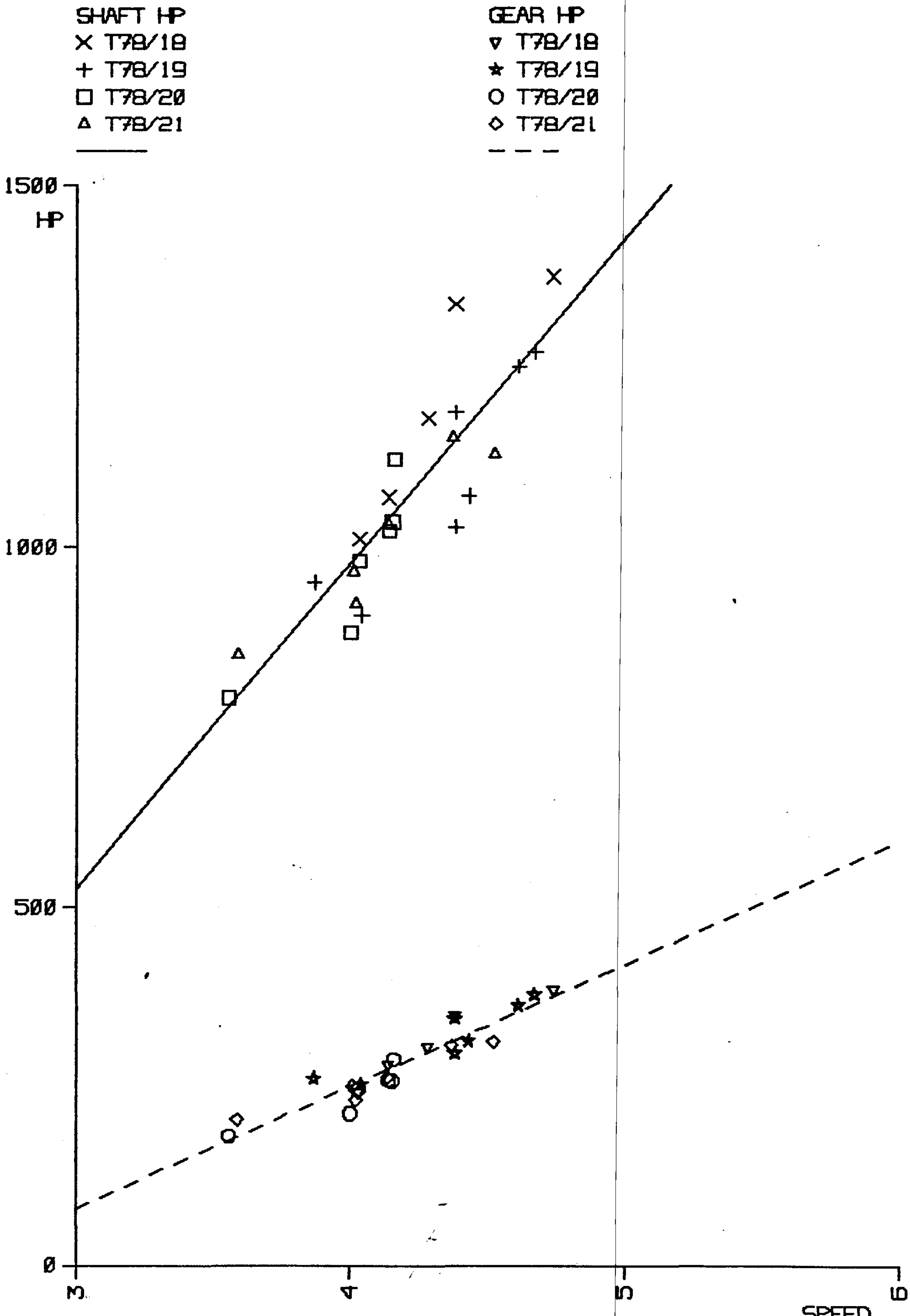


FIG.4.48 NET E - TOWING POWER VS. SPEED

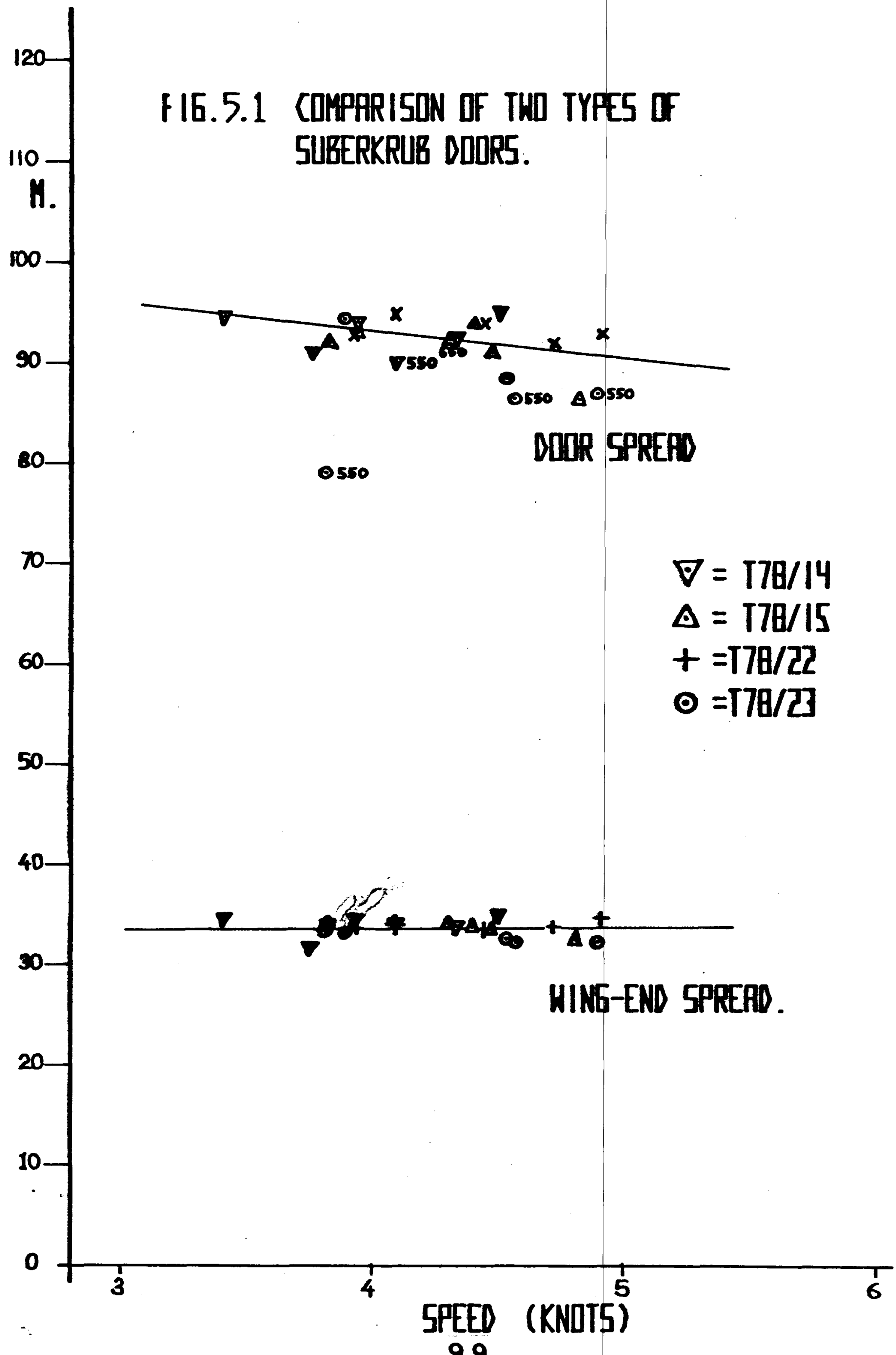


FIG. 5.1 COMPARISON OF TWO TYPES OF SUBERKRUB DOORS.
M.
120
110
100
90
80
70
60
50
40
30
20
10
0
550
DOOR SPREAD
WING-END SPREAD.
▽ = T78/14
△ = T78/15
+ = T78/22
⊙ = T78/23
3
4
5
6
SPEED (KNOTS)

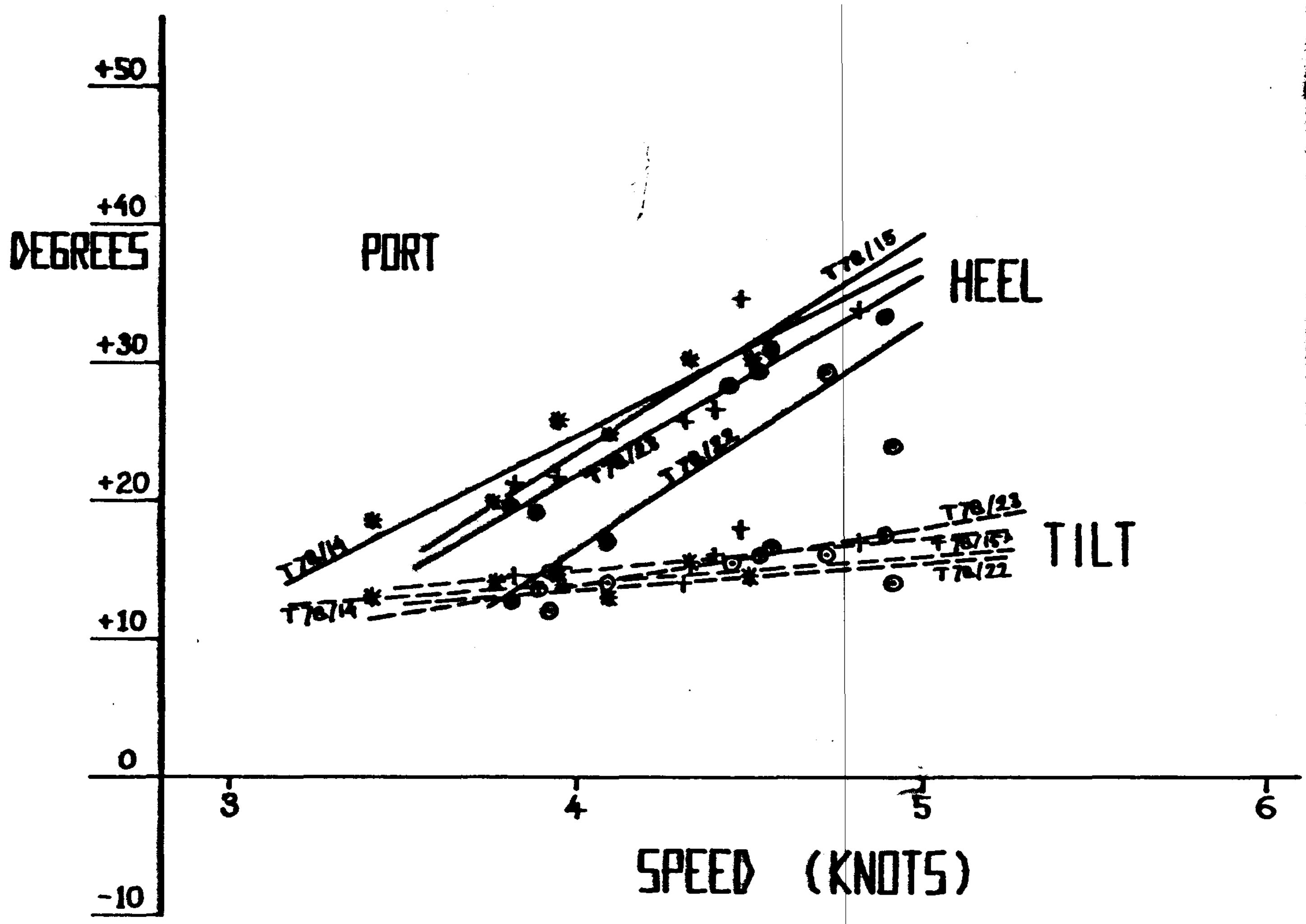
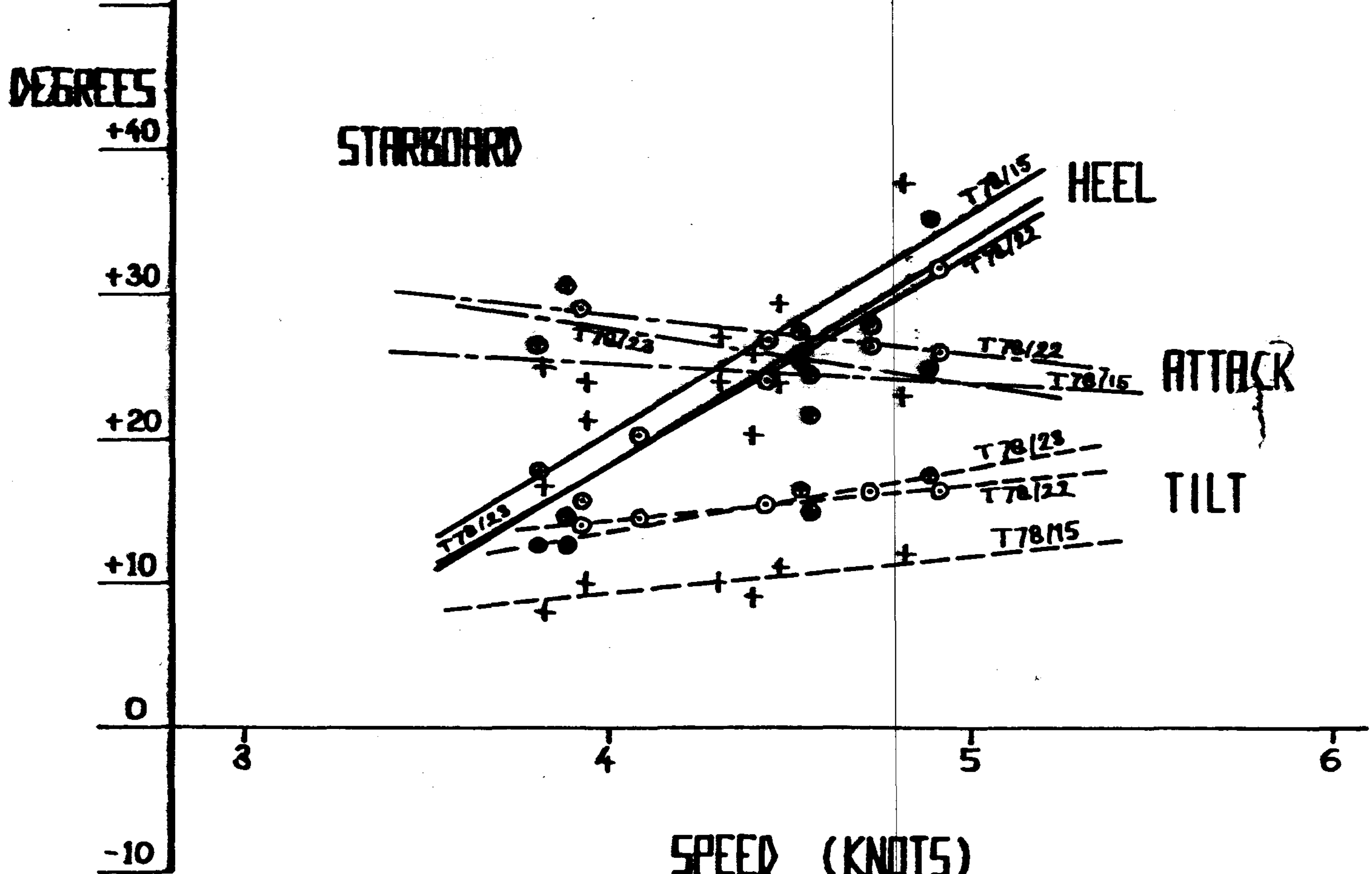


FIG. 5.2 COMPARISON OF TWO TYPES OF SUBERKRUBDOORS.



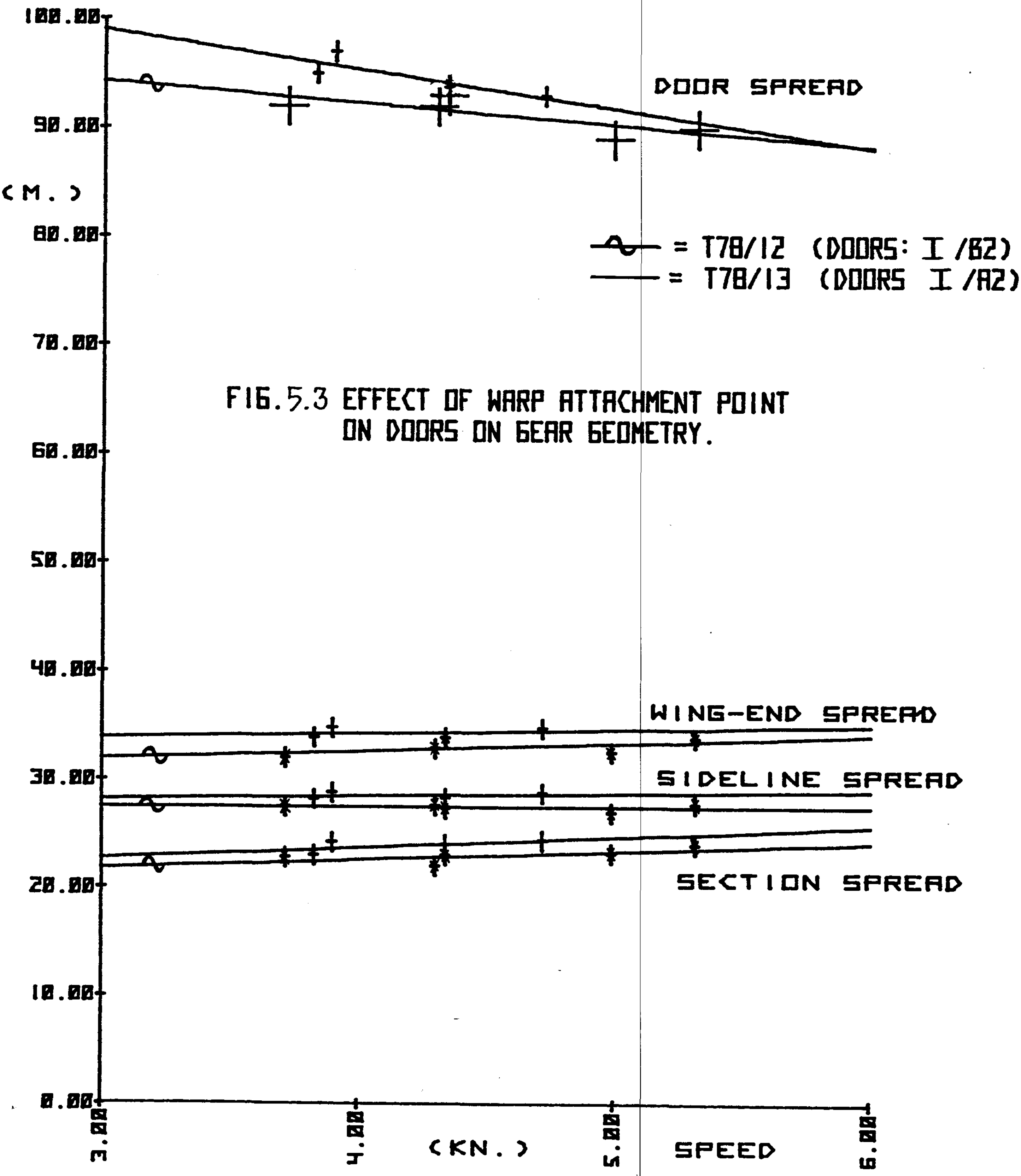


FIG.5.3 EFFECT OF WARP ATTACHMENT POINT ON DOORS ON GEAR GEOMETRY.

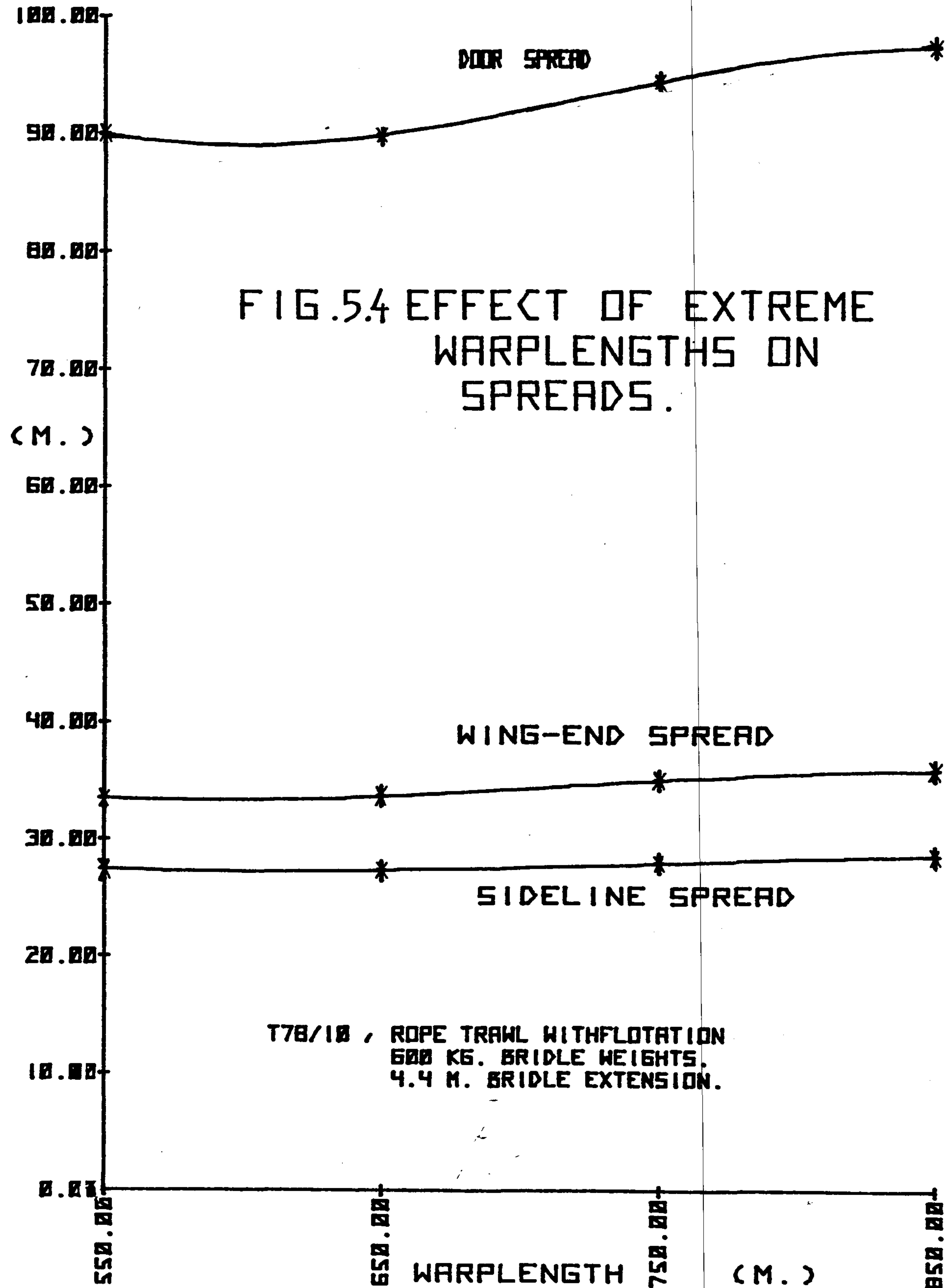


FIG.5.4 EFFECT OF EXTREME WARPLENGTHS ON SPREADS.

FIG. 5.5 LOADS VS. SPEED
HAULS T78/16/17.