

SESSION ON HYDRODYNAMICS OF HIGH SPEED MARINE
VESSELS

Chairman: Mr. W.A.Crago



Presidium of the Session.

*Discussion of the Report and Draft Recommendations of the Panel on High Speed Marine
Vessels*

I. DISCUSSIONS

K.TAMURA - Nagasaki Technical Institute,
Mitsubishi Heavy Industries, LTD., Japan

*ON THE TOWING SETUP OF A HYDROFOIL CRAFT
MODEL*

In the report of the Panel it is stated
that the towing setup of a hydrofoil

craft model is the same as semidisplacement hull models. The model shown in the report has an inclined shaft system. In this case the towing rod can be arranged inside the model and in the direction of propeller axis.

However, there is a case where the towing rod cannot be arranged inside the model and in the direction of propeller thrust, e.g. for a model of hydrofoil craft of z-drive system.

For the towing test of such models two examples of towing setup experienced in Nagasaki Experimental Tank are shown in Figs. 1 and 2. ¹⁾ The method shown in Fig. 1 is suitable for a small model, the weight of which exceeds the design displacement. In this figure, w is the weight to compensate the difference between the weight of the model W and the design displacement. The pulleys P_1 and P_2 are fixed on the towing carriage and P_3 on the model. The towing rope is connected to the weight w at one end and to the resistance dynamometer at the other. Placing the pulley P_3 in such a way as $AQ_3 = AH$ and towing the model in parallel with the propeller axis NM , we can give the model the same moment as the propeller thrust. The limitations of this method are that the balance weight w should be larger than the towing force T and that a slight deviation of the cord AB from the

vertical line leads to the error of thrust in proportion to the angle of deviation; the latter limitation can be relieved by using the additional pulleys as shown on the right part of the figure.

The method of Fig. 2, on the other hand, is suitable for a large model and is free from those limitations. In this method the difference of the moment given by propeller and by the towing rope (difference of moment = Th , h being the distance between the propeller axis and the towing rope) is compensated by the shift of the weight w with a spring having the spring constant w/h . It should be noted that here again the towing rope should be so adjusted that it is in parallel with the propeller axis.

REFERENCE

1. Taniguchi, K. et al., Comparison of Propulsive Performance between model and Ship of a Hydrofoil Boat, Proceedings of Symposium on Test Techniques in Ship Cavitation Research, SKIPS-MODELLTANKEN, Trondheim, 1967.

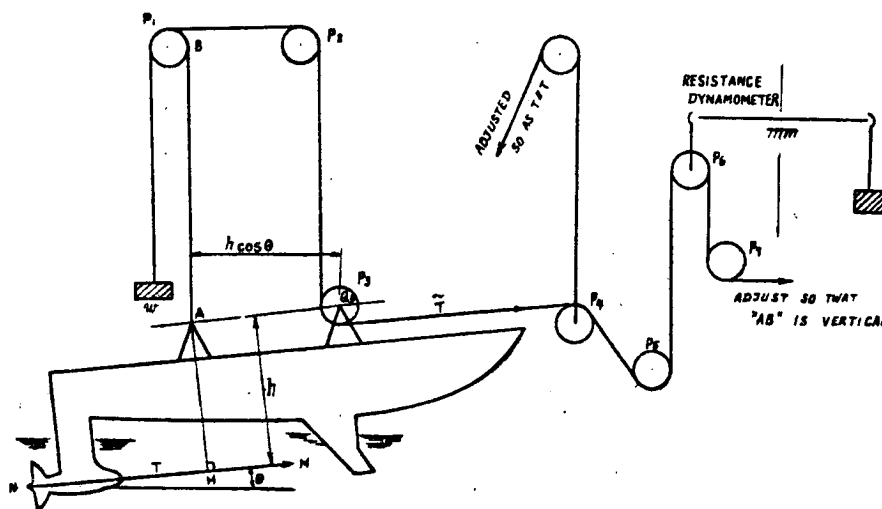


Fig. 1 Towing device yielding the same force and moment as in self-propelled condition for a small model

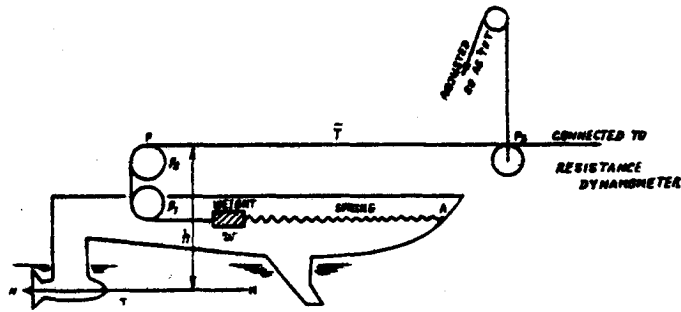


Fig. 2 Towing device yielding the same force and moment as in self-propelled condition for a large model

Table 1 Principal Dimensions of a Planing Hull Model

L_{WL}	2.020 m
B	0.490 m
d	0.0799 m
Δ	40.01 kg
S	0.922 m ²
L_{WL}/B	4.122
B/d	6.137
$10^2 \nabla/L_{WL}^3$	0.485

Table 2 Water Depth (h_{mean}) of Tanks and Related Parameters

Larger Tank (Tank breadth $b_L=12.5$ m)

	Ordinary Level	First Level	Second Level
h_{mean}	6.268 m	4.186 m	3.685 m
h_{mean}/L_{WL}	3.103	2.072	1.824
$v_c/\sqrt{gL_{WL}}$	1.762	1.440	1.351

Smaller Tank (Tank breadth $b_S=6.09$ m)

	Ordinary Level	First Level	Second Level
h_{mean}	3.555 m	1.473 m	0.972 m
h_{mean}/L_{WL}	1.760	0.729	0.481
$v_c/\sqrt{gL_{WL}}$	1.327	0.854	0.694

K.TAMURA - Nagasaki Technical Institute,
Mitsubishi Heavy Industries, Ltd., Japan

*SHALLOW WATER EFFECT ON RESISTANCE OF A
PLANING HULL MODEL*

In the report of the Panel it is stated that the scale of planing hull models is selected such that the hump speed is less than the critical speed of the tank to minimize shallow water effects.

In my opinion, however, this statement seems to be fairly optimistic and further study will be necessary to understand shallow water effects on planing hull models. As a reference to this study, I present here a result of shallow water tests of a planing hull model conducted in our Institute.

The towing tank of Nagasaki Experimental Tank consists of two sections, i.e. two towing tanks of larger and smaller cross sections are connected longitudinally. The towing carriage of the larger tank can run all over the length of both tanks. The difference of the resistance due to different tank section can be measured with high reliability and accuracy by towing a model through both tanks at a time. Thus, the experimental study on blockage effect was conducted by use of these special features of tanks as reported before ¹⁾

REFERENCE

- 1) Tamura, K., Study on the Blockage correction, Journal of the Society of Naval Architects of Japan, Vol. 131, 1972.

Among these studies in our Institute, shallow water effect was also examined by reducing tank water level. The results of resistance tests on a planing hull model is shown in Fig. 1. The principal dimensions of the model and the water depth of

tanks and their related parameters are given in Table 1 and 2 respectively.

From Fig.1 it is evident that the resistance measured in the larger tank at two kinds of reduced water levels coincides with each other. On the other hand, the resistance measured in the smaller tank at both reduced water levels is increased by two or five percent of total resistance below the critical speed. The resistance is decreased by one or two percent above the critical speed in both water levels.

The difference of the resistance measured in the larger and smaller tanks also contains the component due to blockage effect. However, the blockage of the model used for the present tests is rather small even in the smaller tank with the reduced water level and it is reasonable to consider that the main cause of the difference of resistance comes from the shallow water effect.

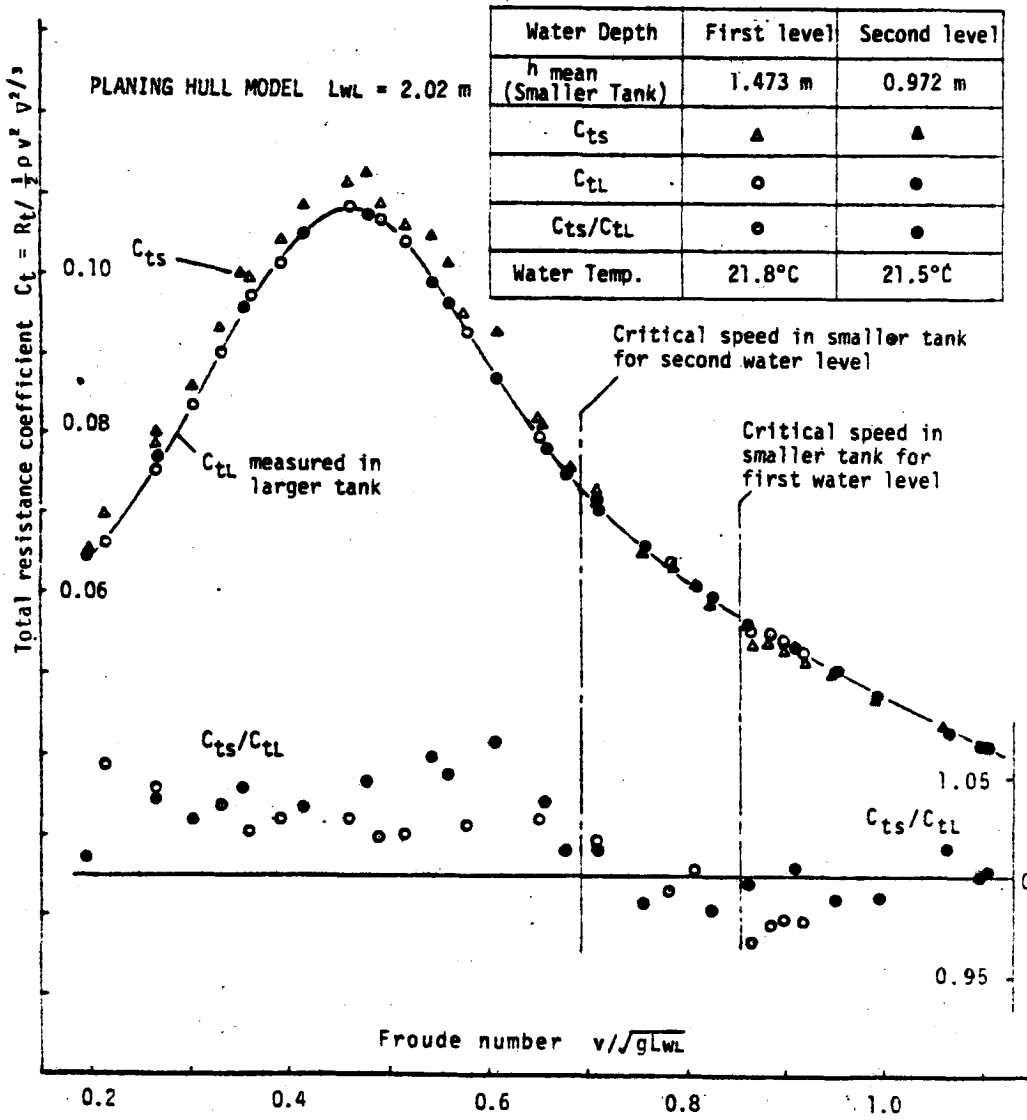


Fig.1 Shallow Water Effect on Resistance of a Planing Hull Model

YU ZHONG - DE-Marine Design and Research
Institute of China, Shanghai. China

EFFECT OF FIXED BOW FINS ON SIDEWALL
HOVERCRAFT

This paper introduces briefly the model experiments made by MARIC upon fixed bow fins, with an aim to investigate their

effects on the longitudinal motions and mean resistance in waves for the sidewall hovercraft. Results indicate that bow fins are beneficial. The model tested represents a practical design, and is shown schematically in fig.1. A list of model particulars is given in table 1. Nine variants of fins have been tested, the particulars of which are given in table 2.

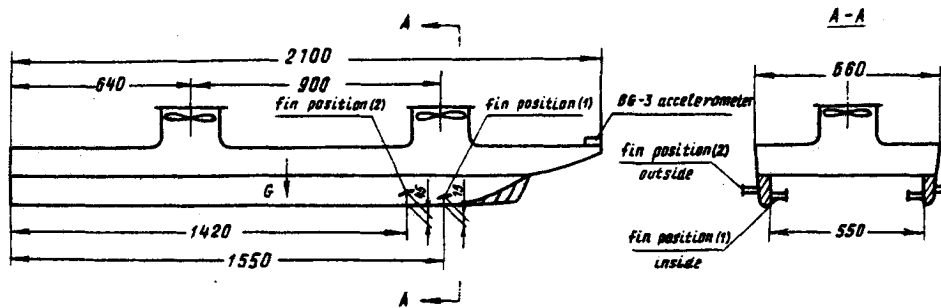


Fig.1.

Table 1.	Model	Particulars	
Length overall	2.1m	Air cushion mean length	1.83m
Beam overall	0.66m	Air cushion beam	0.55m
Height overall	0.34m	Air cushion mean pressure	30kg/m ²
Length of sidewall	2.01m	Breadth of sidewall	0.06m
Height of sidewall	0.1m	Model-ship scale	1:10
Longitudinal centre of gravity from stern	99.6 cm		
Centre of gravity above moulded base	15.44 cm		
Longitudinal moment of inertia	113.48 kg.c.s ²		
Longitudinal gyradius coefficient	0.276		

All experiments were conducted in head waves. The model was towed at speeds ranging from 0 to 4m/s. Wave lengths were 1.8 - 7.5m, wave heights were kept constant at 45mm.

The experimental results are as follows.

1. Model experiments in regular head waves indicate that bow fins have

favourable effects on longitudinal seakeeping performances (Fig.2). Reduction in pitch is about 30 - 40%, the maximum being 50%. Reduction in heave is about 20 - 30%. Bow vertical acceleration may be reduced by 25%, the maximum being 40%. Mean resistance increase in waves may be reduced by 40 - 50%, the maximum being 65%. Nearly all variants have favourable effects in peak regions of response curves. It should

be emphasized that the fins were not in their optimum states during the tests, and better results may be achieved.

2. Experiments with various fin aspect ratio (i.e. $\lambda = 1-3$) indicate that fins with larger λ are better. However, fin variant IV ($\lambda = 1$) is better in short waves.

3. When $\lambda = 2$, the ratio between fin area and cushion area should not be too large. It is preferred that this ratio be taken around 2%.
4. In contrast to displacement ships, tip fences show significant adverse effects on sidewall hovercraft.
5. Experiments with variants I and IX indicate that the effect of fin section cannot be neglected.

Table 2 Bow Fin Particulars

Span mm	Chord mm	Aspect ratio	Fin area	Tip fences*	Section**	Position of installation***
			Cushion area	length X width	Shape	
142	71	2	0.02	71 X 24	A	Inside of sidewall, Position(1)
142	71	2	0.02		A	" "
1735	58	3	0.02	58 X 19	A	" "
100	100	1	0.02	100 X 23	A	" "
1725	87	2	0.03	87 X 29	A	" "
100	50	2	0.01	50 X 17	A	" "
100	50	2	0.01	50 X 17	A	Inside of sidewall, Position(2)
100	50	2	0.01	50 X 17	A	Outside of sidewall, Position(2)
142	71	2	0.02	71 X 24	-B	Inside of sidewall, Position(1)

Note:

* All of the tip fences are 1mm thick, with smooth edges.

** Section A is the profile of Göttingen 12k. Section B is the profile of Göttingen 417a.

*** Positions of installation are referred to fig.1. Angles of installation all equal to 5°.

6. Although variant VI is fitted farther to the bow than VII by 30%, its effect is only about one-half of the latter. This is mainly due to bow seal interference, sidewall wavemaking and instability of bow cushion pressure. Therefore, bow fins should not be installed in the vicinity of bow seal. Besides, the reduction in pitch amplitude by variant VII is as high as 51.5%, and is by far the best of all

variants.

It is well known that bow fins have induced horizontal bow vibration on displacement ships. However, the bow of sidewall hovercraft is blunt enough so as to reduce horizontal vibrations within acceptable limits. As we are going to make full-scale experiments, this point will be examined closely.

The author is indebted to his colleagues for their assistance in conducting the experiments.

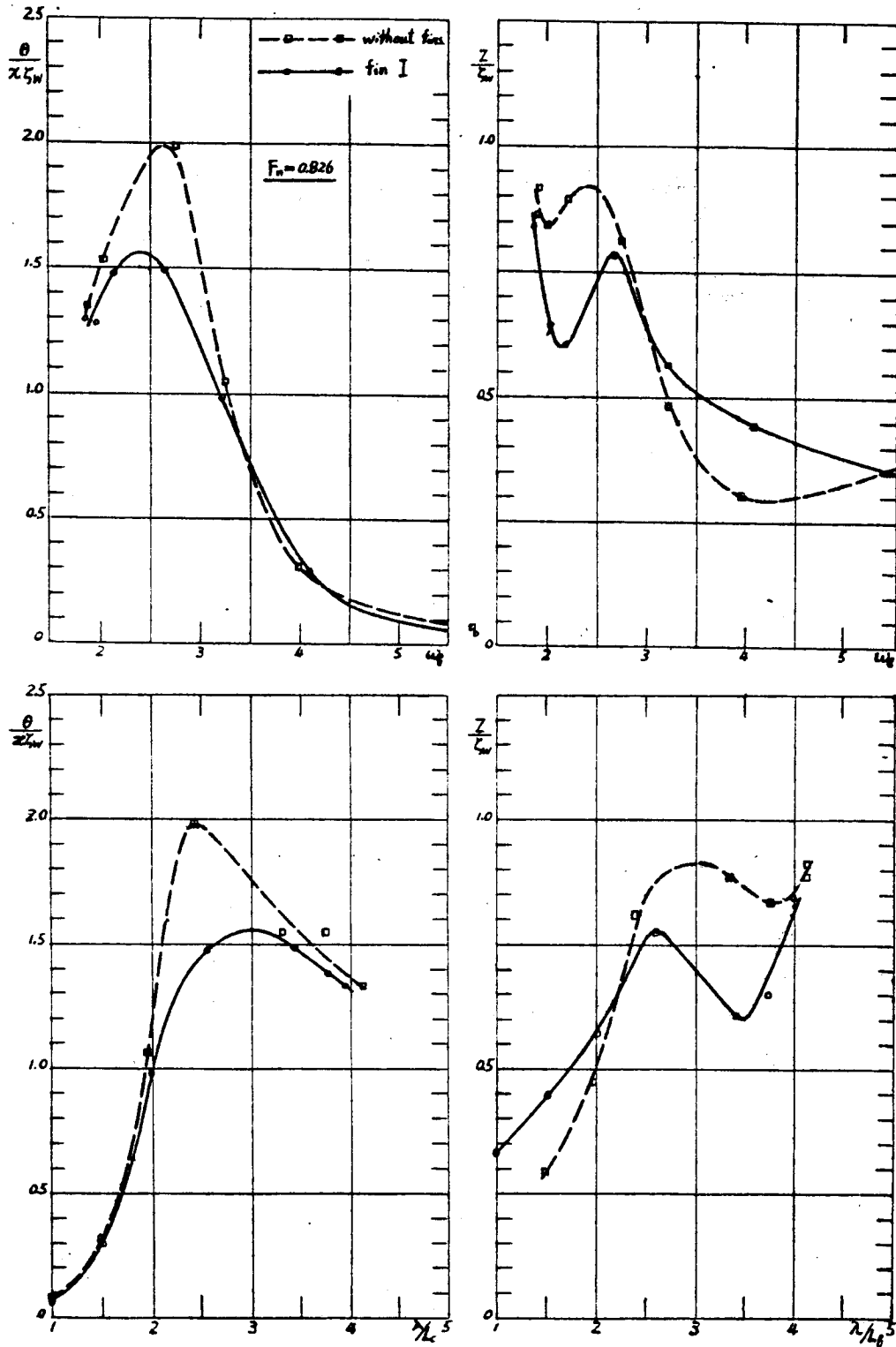


Fig.2 (A)

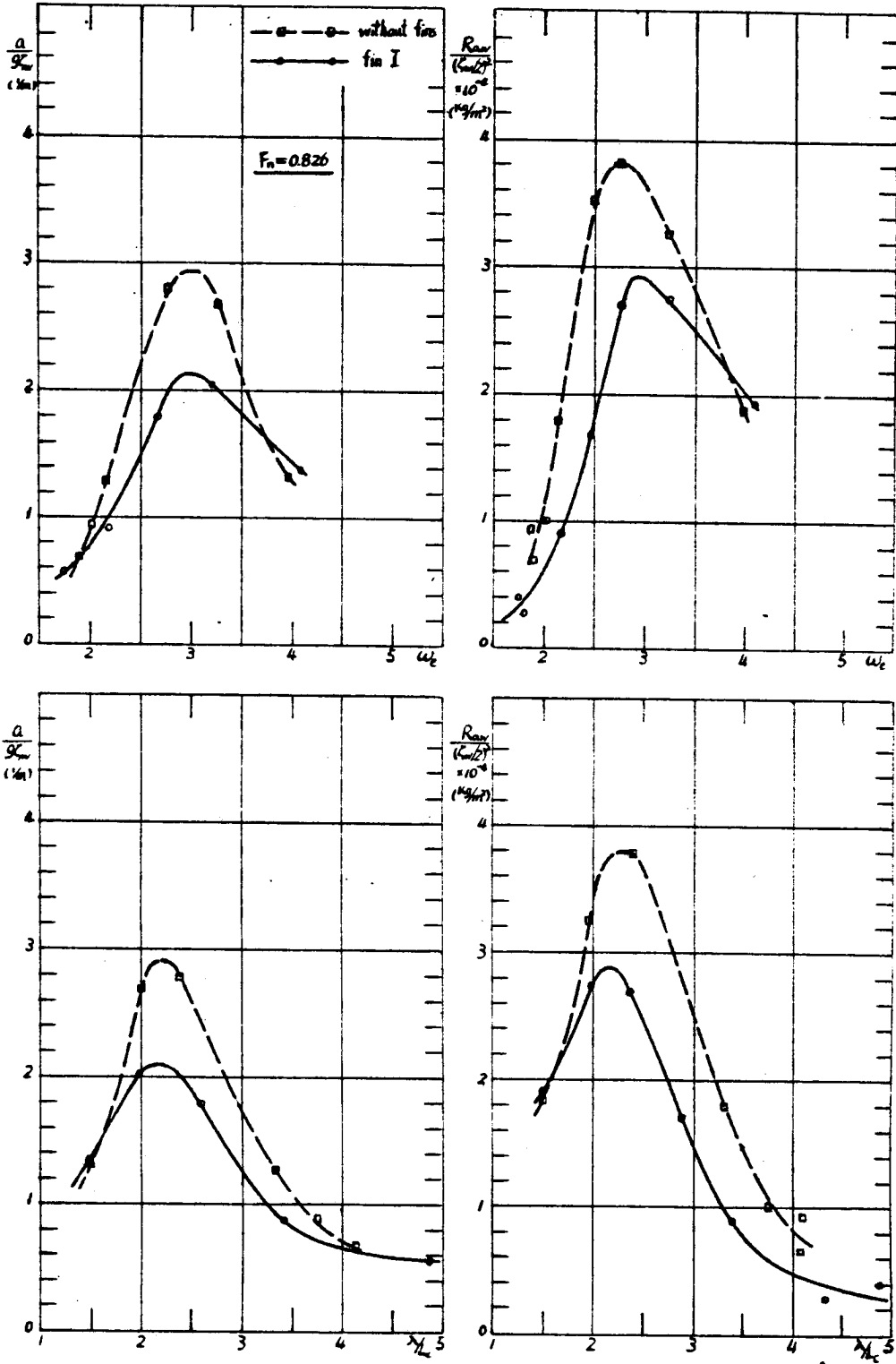


Fig. 2 (B)

P. BOGDANOV, V. HADJIMIKHALEV, P. KOZHUKHAROV - Bulgarian Ship Hydrodynamics Centre, Varna, Bulgaria

PERFORMANCE PREDICTIONS FOR HIGH SPEED SHIPS WITH CAVITATING PROPELLERS

The High Speed Marine Vehicle Panel of 16th I T T C is to be congratulated for the very useful and valuable work in collecting data and outlining the major aspects and problems in the field of high speed ships investigations (1). An outstanding problem in performance investigations, as it is mentioned in the Panel Report, is the necessity of development of power prediction method based on the resistance or propulsion test data for cavitating propellers. In this contribution a brief description of the power predicting procedure (2) developed in BSHC is given. The procedure includes a combined usage of results from resistance and self-propulsion tests in the towing tank and tests of isolated propellers in the cavitation tunnel of BSHC. In most of the cases treated, a cavitating propeller operates in oblique flow, which leads both to change of propeller hydrodynamic characteristics and to the existence of a normal force Y , which is additionally measured during the tests in cavitation tunnels. The net or horizontal thrust coefficient K_T and propeller efficiency η_0 can be determined by the propeller thrust and torque coefficients K_T^* and K_Q and normal force coefficient K_Y , obtained directly from the tests /Fig.1/:

$$K_T = K_T^* \cos \psi - K_Y \sin \psi, \quad \eta_0 = \frac{K_T}{K_Q} \frac{J_0}{2\pi}$$

For each value of test cavitation number σ , corresponding to a given ship speed it is possible to obtain the values of the coefficient K_d' , representing propeller thrust loading:

$$K_d' = J_0 / \sqrt{K_T}$$

and to obtain the relations

$$K_d' = f(J_0) \quad \text{and} \quad \eta_0 = f(J_0).$$

Ship performance calculations are made for a number of speeds, corresponding to the values of the test cavitation number:

$$V_S = \frac{1}{0,5144(1-W_T)} \sqrt{\frac{2(P_a + \gamma J_S - P_V)}{\rho \sigma}}$$

and for each value of V_S the corresponding values of K_d' can be calculated, using results from self-propulsion and resistance tests in the towing tank:

$$K_d' = 0,5144(1-W_T) V_S D \sqrt{\frac{\rho(1-t)}{R}}$$

The actual propeller advance coefficient J_0 and efficiency η_0 , which makes it possible to calculate the engine power and revolution for each speed V_S , can be evaluated using the obtained K_d' values and the relations of K_d' and η_0 versus J_0 , as it is mentioned above.

When using the proposed scheme one peculiarity should be taken into consideration, which arises from the character of cavitating propeller characteristics K_T^* and K_Q and that is: together with the maximum there exists a region almost parallel to J_0 axis (at small advance coefficient values). Due to this, depending on the investigated range of J_0 , the curve $K_d' = f(J_0)$ plotted according to the cavitation test data, may have generally two extreme points (Fig.2), which are obtained by satisfying the condition:

$$J_0 = \frac{2K_T^*}{dK_T^*/dJ_0}$$

That is the main difference in this case in comparison with the noncavitating propellers, for which the curve $K_d' = f(J_0)$ has a monotonic behavior.

It is evident that in this case the line $K_d' = \text{constant}$, characterizing the thrust required for achieving given speed, may cross in three points the curve $K_d' = f(J_0)$, which represents the achieved propeller thrust (Fig.2). In the whole operating range of ship's speed (when the system engine-propeller is in dynamic balance) the advance coefficient changes slightly and an increase in speed is achieved with increasing propeller revolutions. So, when the performance of ships with cavitating propellers is predicted, for reference point 1 (Fig.2), corresponding to the minimum propeller revolutions (maximum advance coefficient).

Having in mind that high speed semidisplacement ships have multipropeller configuration, the cavitation tunnel tests are carried out with isolated propellers. The abovementioned procedure is repeated for every individual propeller using the corresponding values of shaft inclination angles and propulsive factors. An iterative procedure is needed for equalizing the attainable speed for each propeller when the requirement of a given engine power is fulfilled. The latter is achieved by suitable rearrangement of the part of full ship resistance referred to each propeller.

On the basis of the procedure described, a computer program is developed having as an input the direct recordings of the necessary experimental results, which are realized with the automated data acquisition system in the towing tank and cavitation tunnel in the BSHC.

Using this procedure, performance predictions are made for a number of high speed semidisplacement ships.

A high speed towing carriage with $V_{\text{max}} = 20 \text{ m/sec}$ will be put into operation in the near future in BSHC and it will be possible for additional tests to be

carried out for craft which are of special interest to the ITTC High Speed Marine Vehicle Panel.

REFERENCES

1. Savitsky, D. and oth.: "Status of Hydrodynamics Technology as Related to Model Tests of High Speed Marine Vehicles", DTNSRDC Rep.81/026, July, 1981.
2. Hadjimikhalev, V., Kozhukharov, P.: "On the Prediction of Performance Characteristics of Ships Equipped with Cavitating Screw Propellers", to be presented at Scientific Session of High Engineering Institute, Varna, November, 1981 /in Bulgarian/.

$$K_T = \frac{T}{\rho n^2 D^4} \quad K_Q = \frac{Q}{\rho n^2 D^5}$$

$$K_y = \frac{Y}{\rho n^2 D^5} \quad J_0 = \frac{V}{n \cdot D}$$

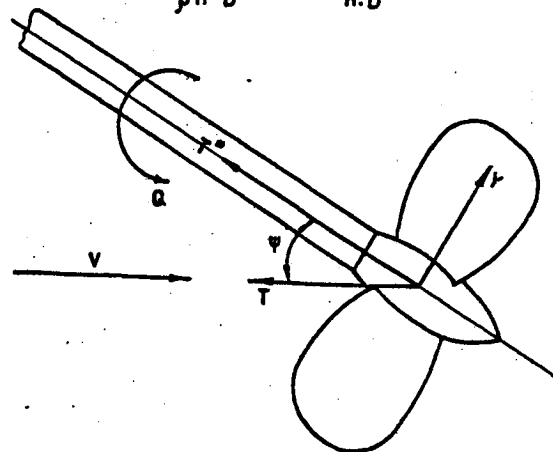


Fig.1

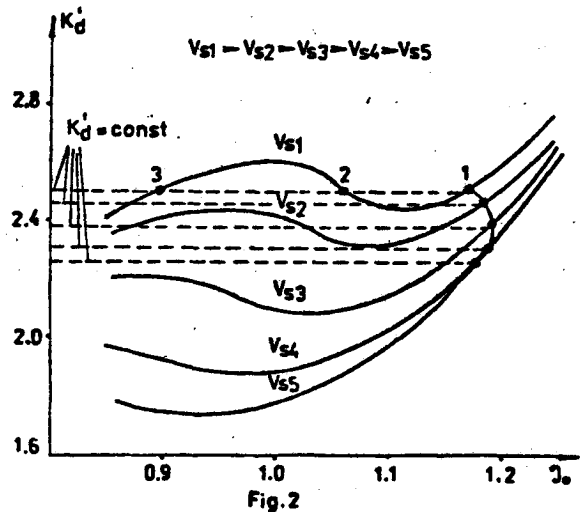


Fig.2

WANG HUAIDU - Marine Design and Research
Institute of China, Shanghai, China

1. We support Panel's recommendation that a High Speed Marine Vehicle Committee should be established.
2. We have a comment on page 584 of Proceeding vol. 1. We propose that hovercraft is to be divided into three kinds, namely, SES, ACV and ram-wing vehicle; and a short description for ram-wing vehicle be inserted accordingly in page 609.
3. A paper on "Effect of Fixed Bow Fins on Sidewall Hovercraft" is offered by us in congratulation of the establishment of this new Panel.

H.MARUO - Yokohama National University,
Japan

In the report of this Panel decompositions of resistance of round bilge semi-displacement hulls and planing hulls are given. Among the resistance components, the spray resistance is defined as the friction in whisker spray area. However, there is some problem in this definition.

The spray resistance seems to have appeared first in the literature by H.Wagner in 1930, and further investigations are observed in my paper on the pressure resistance of a gliding plate in 1947. In these publications, the spray resistance is defined as the reaction by the momentum change of water due to the spray formation. Since this sort of resistance is a part of the pressure drag, it is quite different from what is defined in the panel report.

In order to avoid such confusion, I will recommend that the resistance component which is named spray resistance should be called the spray friction resistance.

W.B.MORGAN - David W.Taylor Naval Ship
Research and Development Center, Bethesda,
Maryland, USA.

I endorse the Panel recommendations with regard to future work. However, I would like the Panel to carefully consider its name and vessels to be considered in the future. For instance, the Panel considered SWATH ships but they are not high-speed ships. I do not mean they should not consider SWATH ships but only that the name of the future committee should reflect their area of work.

B.JOHNSON - US Naval Academy, Annapolis,
Maryland, USA

I would ask that the Panel on High Speed Marine Vehicles propose a list of additional symbols in the standard format including computer compatible symbols and definitions sufficient to describe those symbols.

Please be consistent with existing standard symbols such as R_V for viscous resistance rather than R_F as defined on page 594 and 592. I welcome the return to the use of Δ for displacement weight on page 594. In my experience, it is much preferred to the use of W , especially for hydrostatic stability calculations. I hope we can return to this symbol for displacement, rather than reserving it for displacement mass, which is a seldom used quantity.

A.M.FERGUSON - University of Glasgow,
United Kingdom

In their committee paper on the status of hydrodynamic technology as related to model tests of high-speed marine vehicles, which was issued to delegates of the ITTC, the comment was made that detailed studies

of the effect of shallow water on resistance, squat, and running trim of SWATH ships have not yet been carried out.

I can report to the committee that over the past three years a considerable amount of research has been carried out at the University of Glasgow Hydrodynamic Laboratory on the shallow water performance of SWATH type ships. The research covered the following aspects:

- (a) The shallow water performance characteristics of a 3 hulled SWATH ship in steady motion.
- (b) The effect of a control surface on sinkage, trim and total resistance of a SWATH ship in shallow water.
- (c) The effect of turbulence stimulation on sinkage, trim and total resistance of a SWATH ship in shallow water.
- (d) The effect of changing hull endings on sinkage, trim and total resistance of a SWATH ship in shallow water.

It is hoped that this design of SWATH ship will be built as a full scale research ship. If this does happen it will provide a unique opportunity to obtain full scale correlation of model experiments. Some of this research was repeated on twin and multi hull semisubmersible oil-rig models in the transit condition.

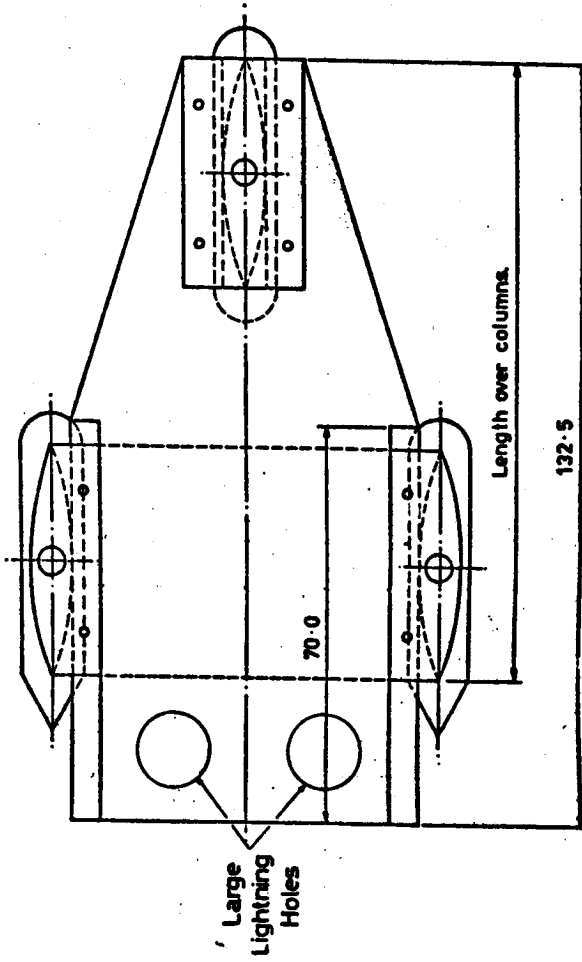
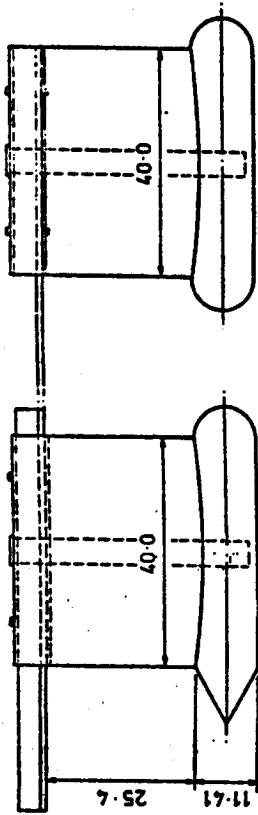
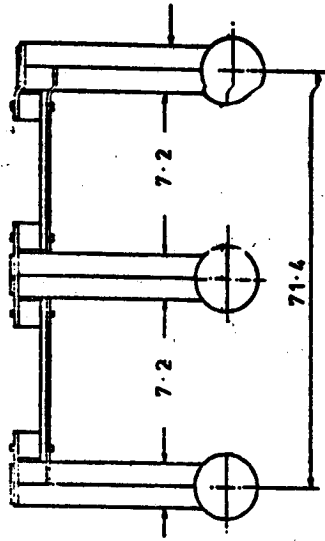
Although some of the oil-platform work is in commercial confidence, reports on the remainder of the research would be available to this committee and members of the ITTC.

REFERENCES

All by Seren D.B., Ferguson A.M. and McGregor R.C.

1. "The Shallow Water Performance Characteristics of a 3-Hulled Semi-Submersible Ship in Steady Motion" - Part I, UOG-NAOE-HL-80-09.
2. Part II - "The effect of a control surface on the sinkage, trim and total resistance" (to be published).

3. Part III - "The effect of turbulence stimulators on the sinkage, trim and total resistance", UOG-NAOE-HL-80-24.
4. Part IV - "The effect of changing hull endings on the sinkage, trim and total resistance" (to be published).



All dimensions are model sizes in cm.
Drawings to model scale 1:10.

Fig. 1

REPLY OF THE PANEL

The Panel thanks *Mr. Tamura* for his contributions describing two examples of towing setups for semi-submerged hydrofoil models.

In response of this paper we like to make some comments on the first example, Fig.1.

1. A hydrofoil model should be large enough to carry its own weight and the measurement equipment, because external forces like the unloading weight can affect the flight position and the running trim of the model. Changes in attitude and trim angle can alter the total resistance of a hydrofoil craft to a great extent.
2. The whole configuration can work correctly only if the cord AB is fixed at the longitudinal center of gravity (LCG).
3. The friction in the 9 pulleys will reduce the accuracy of the measurements.
4. It must be assumed, that several test runs at each speed are necessary to adjust the whole system.
5. It is very difficult to bring the cord AB exactly in a vertical position during the test runs. It must be underlined, that small deviations from this position give rise to errors in the measured resistance.

The second system, Fig.2, which does not suffer on all these effects is useful in certain circumstances.

Mr. Tamura's statement that the Panel states "the scale of the planing hull models is selected such that the hump speed is less than the tank critical speed ...etc." is incomplete. On page 591 of our Report on Round Bilge

Semi-Displacement Hulls it is also stated that, to minimize shallow water effects, it is also necessary that the ratio tank depth/model length exceed 0.80. We are sorry that this second criteria was not restated in the discussion on planing hulls where it obviously also applies.

The data presented by *Mr. Tamura* from the small tank experiments are all for ratios of tank depth/model length less than our criteria of 0.80 so that shallow water effects on drag are to be expected. The trends shown by *Mr. Tamura's* data are indeed correct. That is, at low speeds the shallow water drag increases relative to deep water, while at high speed it is actually less than experienced in deep water.

It is further interesting to note that, for all cases presented by *Mr. Tamura*, the tank blockage is less than 1% - a figure that displacement ship researchers are generally comfortable with and hence do not make tank boundary corrections for these test conditions. It may be that these assumptions should be re-examined.

We thank *Mr. Tamura* for his valuable contribution of additional shallow water test data.

The Panel would like to thank *Mr. Wang Huai* and *Mr. Yu Zhong-De* for their contribution pertaining to the use of fixed fins located on the sidewalls of surface effect ships near their bow to reduce the pitch motions and hence reducing the drag of the vehicle. Their experimental results on the length-to-beam ratio 3.3 model, tested in regular, head seas did produce the desired result. I do want to point out however that the speed of the model where the

greater results were achieved was only slightly post hump ($F_w=0.826$), and the wave length to cushion length ratio was approximately 2.5, which is near the point of greatest pitch motion experienced on other low L/B designs, such as the SES-100 A and B. If this is your design condition, then the use of rigid bow fins may have merit. Our experience has shown however that low L/B SES's are usually designed for higher speeds, and in such cases, the bow fins have increased the drag and made the ride more severe. So the designer and experimenter must make sure that he has examined the broad range of operating conditions for the craft before finalizing the design.

The Panel wants to thank *Dr. Bogdanov* and his colleagues for their contribution. It describes one way to carry out the difficult task of determining the propulsive performance of high-speed ships. The difficulty in predicting full scale power, RPM, and speed is due to the fact that the propeller performance is affected by cavitation to such an extent that the results of self-propulsion tests in a normal towing tank without cavitation on the propellers are not applicable.

The method proposed by *Dr. Bogdanov* assumed that the occurrence of cavitation on the propeller as found in a water tunnel in the absence of the ship model and appendages only allows the thrust and torque coefficients to be obtained, and not the thrust deduction, wake fraction, etc. The hull efficiency and relative rotative efficiency values - as found from the self-propulsion tests are assumed to remain the same while the K_T and K_Q values are assumed to be influenced by cavitation.

As a first approximation, this method is sometimes considered sufficient. A more accurate procedure, however, would be to test a complete self-propelled model in

a cavitating environment such as in a high-speed depressurized towing tank or a free-surface water channel.

The High Speed Marine Vehicle Panel recommends that it carry out a detailed survey as to the applicability of the proposed method in the coming years in an attempt to define possible correction factors for the accurate determination of how cavitation influences the performance factors so that conventional towing tanks can continue to be useful in such model tests.

The Panel would like to thank *Mr. Wang Huai* for his contribution and very much welcome his support for our recommendation that a High Speed Marine Vehicle Committee be established.

As regards the proposal that in the vehicle classification on page 584 of Vol. I of the Proceedings the ram wing vehicles be included under the heading of hovercraft, at our very first meeting the Panel considered the various types of high speed marine vehicle in some detail and decided, largely due to considerations of time and space, to limit the present report to the seven vehicle types listed.

The classification was not intended to cover all types of high speed craft but simply those that the Panel proposed to cover in their report. As suggested on page 584 other forms and hybrids, including perhaps ram wing craft, can be examined by a future High Speed Marine Vehicle Committee if such be established.

The third item of *Mr. Huai* contribution has been answered above.

We agreed with *Prof. Maruo* that the spray resistance referred to in our report is the spray friction resistance.

We thank *Dr. Morgan* for his endorsement of our recommendations.

As for the name of our Panel - it was of course a decision of the 15 ITTC. We will indeed re-evaluate its applicability to our work - especially as it relates to SWATH vehicles.

The Panel would like to thank *Prof. Johnson* for his comments.

In writing their report the Panel became aware that the symbols in common use, particularly in the field of ACVs and SESs, were not always the same as those employed by ITTC members for more conventional vessels. No serious attempt was made in writing the report to completely rationalize the symbols employed since it was felt that this should be part of the activities of a future Committee should this be formed.

As indicated in the Panel draft recommendations the Panel is aware that a review of symbols and definitions in the area of high speed marine vehicles is desirable.

The incorrect use of R_F instead of R_V on pages 592 and 594 of the report is in fact due to errors in typing but the Panel is nevertheless grateful to *Prof. Johnson* for pointing this out. The full status report (DWTNSRDC Report 81/026) is correct in this respect.

The use of Δ for displacement weight (as opposed to displacement mass) is common in the high speed field and the Panel is of the opinion that such usage is convenient from the point of view of familiarity. However it is appreciated that this is not strictly in accordance with ITTC procedure but the Panel feels that detailed consideration of the use of the symbol Δ is a matter for the Information Committee.

The Panel thanks *Dr. Ferguson* for his generous offer to supply us with such useful report. We will indeed make the

effort to obtain his references and study them.