The Resistance Committee

Committee Chairman: Dr. Emilio F. Campana
Session Chairman: Dr. In-Young Koh

1. DISCUSSIONS

1.1 Discussion to the 24th ITTC Resistance Committee by Stuart Jessup, Naval Surface Warfare Center, Carderock Division, USA

Please comment on how you plan to monitor the quality and accuracy of the ship model used in the round robin resistance tests. I suggest re-testing and re-measuring the model through the testing period.

Your assessment of present accuracy of CFD is very useful to the community. You also summarized areas where accuracy can be improved. Can you prioritise the various areas for difference hullforms.

Finally can you comment on accuracy of predicting appendage drag?

1.2 Discussion to the 24th ITTC Resistance Committee by Friedrich Mewis, Hamburgische Schiffbau-Versuchsanstalt, Germany

Mr. Chairman, I have a remark about Chapter 10.4/10.5 of your Report, uncertainty of Full-Scale Resistance.

In your example you estimate the mathematical uncertainty of the Prohaska-Plot but not the uncertainty of the form factor estimated according to Prohaska.

The uncertainty of the form factor, estimated by Prohaska-Plot, is very much higher and can lead to poor estimation of the full-scale resistance for different reasons. The bulbous bow form leads at smaller draughts sometimes to wave-crests at the bow with the result of very high form factors. Flow separation in model-scale and transom immersion has the same influence.

I ask you to delete the whole Chapter 10.4/10.5 from the Report because the conclusions are wrong and could be misunderstood.

1.3 Discussion to the 24th ITTC Resistance Committee by Martin Renilson, QinetiQ, United Kingdom

Thank you for a very interesting Report and a most enjoyable and informative presentation.

I was particularly interested in your comments on developments in CFD for resistance prediction. You focussed only on RANS, and seemed to suggest that if there is a large enough computer, RANS will be okay, and other techniques are not required. Can you please comment on this?

I agree with your point that for some cases non-viscous methods, such as panel methods, are adequate for predicting wave wake. Can the Committee give any guidance as to when this is accurate enough, and when viscous effects need to be included?

I note your point about the need for more good quality experimental data for wave wake. I would like to add that this should be in shallow water too. Although a single wave cut is being regarded as part of the current benchmark this is not sufficient, and I recommend that the Committee promotes this in the future.

Finally, I note your confidence in the accuracy of the form factor. Does this apply to high speed craft too? Do either of the models tested have a wet or dry transom? Perhaps you could comment on the whole issue of form factor as applied to high-speed craft.

2. COMMITTEE REPLIES

2.1 Reply of the 24th ITTC Resistance Committee to Stuart Jessup

We thank Dr. Jessup for his comments. The level of accuracy of the model during the campaign has been our concern from the very beginning. Since when we first planned the activity, it was clear to us that it would have been necessary to check the status of the models by measuring the hull at some prescribed points. Initially, we just planned a final check, to be carried out when both the models would have been back to the starting point. However, since many more institutes joined the campaign after it was launched, besides the final verification, we have now introduced several intermediate checks of the hull.

About the second question, it is certainly true that different ship concepts propose different challenges to the numerical solvers. To this regard, the recent CFD workshop in Tokyo represents a useful point of reference. Full forms like tankers, with thick boundary layers, tend to stress differences among turbulence models. Numerical results for slender containerships often display a peculiar clustering of the pressure contours in the stern region, which is captured only when the grid resolution is high enough. The flow around multihull vessels has not yet been explored in detail. Catamarans with large separation between the hulls may be estimated even using potential flow models. However, when hull separation decreases, flow separation may occur from the keel and in the stern region. The flow past appended hulls is always challenging due to the gridding requirements. Accurate description of waterjets seems to unavoidably require the use of unstructured solvers. Finally, for all the concepts, accurate sinkage and trim prediction is often missing.

Regarding the accuracy of appendage drag predictions it is expected that it is more straightforward than the hull itself. This community has largely focused on un-appended hulls for resistance with the main difficulties often being the free surface treatment and sinkage and trim. For an appendage there is the added gridding requirements between the hull and appendages, but other communities, such as aerospace, have been doing appendage calculations routinely. In addition, such calculations are becoming more straightforward with overset and unstructured gridding techniques.

2.2 Reply from the 24th ITTC Resistance Committee to Friedrich Mewis

As it was already pointed out at the Conference, the Resistance Committee Report did not deal with the accuracy of measuring the form factor with the Prohaska approach, but merely with the far more limited task of establishing the uncertainty in the process of regression to determine (1+k) using the least-square method. This is clearly stated in

the introduction of Chapter 10: "Section 10.3 presents the uncertainty associated with the determination of the form factor by using a regression method". Furthermore, in Section 3 it is also explicitly stated that: "only the uncertainty due to the regression method is to be analysed." We believe that this clarifies the point.

2.3 Reply from the 24th ITTC Resistance Committee to Martin Renilson

We thank Dr. Renilson for his comments. Of course, resistance predictions based on the solution of RANS equations are in principle more physics based with respect to those obtained, say, with potential flow models. This is true provided that the RANS solutions are accurately obtained, and, in this regard, the use of Verification and Validation procedures is clearly fundamental. However, as the recent CFD workshop in Tokyo has demonstrated, RANS solver can already accurately deal with a number of complicated flows, including oblique towing, propeller-hull interactions and forced motion in waves. There is a clear trend: RANS solvers, once developed for calm water resistance only, are increasing their complexity by the hour and current generations have started to include unsteady capability. In the near future the same numerical solver will be capable of dealing with resistance, seakeeping and manoeuvring problems.

This does not necessarily imply that other, more simplified mathematical models are not useful in ship design. Low-fidelity models will have a role in the design process still for many years to come, mostly for their speed and because ship designer have been trained in the use of these tools more than in the use of RANS. Finally, we want to stress here that RANS equations are not the most sophisticated available at hand. Higher-fidelity predictions, with respect to RANS, such as Large Eddy Simulations and Detached Eddy Simulations will represent a growing field of research activity and may reveal their effectiveness in some specific problems involving large unsteady separated flows.

Potential flow models have great accuracy in dealing with the prediction of wave wakes. Once generated by the pressure field induced by the motion of the ship, the wave pattern evolves obeying the Laplace equation and viscous dissipative effects are negligible in the near field and very small in the far field. However, potential flow models overestimate the pressure recovery at the stern, so that the stern wave height is typically overestimated, and this is where the viscous effects play a role in the wave wake.

As to the form factor, the Resistance Committee Report did not deal with the accuracy of measuring the form factor, but merely with the far more limited task to establish the uncertainty in the process of regression to determine (1+k) using the least-square method.