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discussion

Linearized Potential Flow Models for Hydrofoils in Supercavitating Flows[1]

B. E. Larock.[2] The discusser would like to thank Professors Nishiyama and Ota for presenting an interesting comparison of several classes of linearized supercavitating foil models. I note with particular interest that the semiclosed model seems to produce good agreement with experiment for rather wide ranges of c/l when the dimensionless cavity halfwidth at termination is assigned a value $t = 0.5$. Is there, perhaps, any physical interpretation that the authors could offer to explain this intriguing result. At the same time I wonder whether application of the theory is not more difficult in regimes where the optimum t-value is changing.

The best wake width in these studies has been found by comparing theory with experimental data in plots which relate cavitation number, pressure distribution, and lift or drag to cavity length. In many studies these are the parameters of greatest interest, but sometimes other parameters, such as cavity shape, are of importance. Did the authors consider cavity shape as a possible criterion for selecting the best wake width; as early linearized theories sometimes did not model cavity shape well, a good result for cavity shape would be noteworthy.

Most of the figures in this paper present comparisons for relatively slender bodies. Only in Fig. 9 are the predictions of both linear and nonlinear theories compared; in this case the subject is the lift of a supercavitating flat-plate hydrofoil at an attack angle of 10 deg. The figure suggests that linear and nonlinear theories disagree by over 10 percent in predicting foil lift. This observation prompts me to ask the authors how wide a range of application they believe, in general, is proper for the current linearized theory.

As all linearized theories are somehow limited in their range of applicability, one must either admit defeat or attempt to cope with nonlinear theory when linear theory is inappropriate. In this regard I do not believe that nonlinear theory is quite so difficult to use as the authors' introduction suggests. Also, I would like to note that an extension (as yet unpublished) of the nonlinear theory reported in reference [3] appears to model successfully the supercavitating flow past a blunt-nosed, cambered foil and give reasonable results on foil shape, lift, drag, and cavity size and shape. This work, in common with the earlier nonlinear theory of Street and Larock, uses a semi-inverse method of determining foil shape and does involve considerable algebra. The concepts are the same as earlier theory, however, and a computer will do the work once the theory is properly programmed.

[1] By Tetsuo Nishiyama and Terukazu Ota, published in the December, 1971, issue of the Journal of Basic Engineering, Trans. ASME, Vol. 93, No. 4, pp. 550–564.

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Authors' Closure

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As the cavity termination approaches, the cavity streamlines are very unstable in space and time and then a definite shape of cavity termination becomes clearly undistinguishable. Besides, the real flow behind the cavity termination constitutes a turbulent wake consisting of small bubble and water mixture. Because of such complexities of real flow in the vicinity of cavity termination, we do not have a decisive physical interpretation for the best flow model explored.

The cavity shape appears to be a less accurately measurable quantity than the pressure distribution and lift. Hence the latter is tentatively preferable to the former, in exploring the best potential flow model. However, there still remains to be solved which quantity is most reasonable for determination of the best flow model.

Experimental data on the lift and drag of supercavitating hydrofoil, compared with that of symmetrical wedge and base-vented hydrofoil, were rather insufficient to definitely decide a best flow model and applicable range of linearized theory. Since accumulation of experimental data is urgently needed before we can determine the best flow model, we are now making some endeavors along these lines.

Generally the linearized theory is comparatively easy to handle and also to insight the characteristics. Hence we have pursued the best potential flow model to fit the linearized theory, which is simpler without lose of essentials of real cavity flows than the precise and complex nonlinear model. These viewpoints will be useful in application to practical problems of the linearized theory.