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Technical Comments

*Brief discussion of previous investigations in the aerospace sciences and technical comments on papers published in the **AIAA Journal** are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one **Journal** page including formulas and figures. A discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Comment on "Determination of Slender-Body Aerodynamics Using Discrete Vortex Methods"

Michael J. Hemsch*
Lockheed Engineering and Sciences Company, Hampton, Virginia 23666

IN Ref. 1, Gebert makes the interesting suggestion of using semi-infinite vortex lines rather than the usual infinite lines in the discrete-vortex method (DVM) for simulation of flows about slender airframes. He suggests that doing so eliminates the need to use the so-called vortex reduction factor, which is usually set to 0.6 for subsonic flows.[2] Unfortunately, Gebert did not prove his case by showing results with and without his new model. It would be helpful to the rest of the modeling community if he would present such results.

It should also be pointed out that Gebert is incorrect in his statement that there is no mathematical rationale for the impulsively-started-cylinder analogy, which is basic to his method and to all other versions of the DVM. The analogy has been rigorously derived independently by Klopfer and Nixon[3] and by Dagan and Almosnino.[4] Gebert also seems to be unaware that a uniformly valid composite solution for any angle of attack can easily be constructed that eliminates the logarithmic singularity at infinity.[2,4–6]

References

[1]Gebert, G. A., "Determination of Slender Body Aerodynamics Using Discrete Vortex Methods," *Journal of Spacecraft and Rockets*, Vol. 31, No. 2, 1994, pp. 200–206.

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[6]Hemsch, M. J., "Comparison of High-Angle-of-Attack Slender-Body Theory and Exact Solutions for Potential Flow over an Ellipsoid," *Journal of Aircraft*, Vol. 27, No. 6, 1990, pp. 569–571.

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*Staff Engineer, 144 Research Drive. Associate Fellow AIAA.

Reply by the Author to M. J. Hemsch

G. A. Gebert
Utah State University, Logan, Utah 84322

HEMSCH is correct to point out[1] that Ref. 2 did not make comparisons between the results of the old and the new models. The paper was written stating the details of the body geometries and the flow perturbation necessary to generate the asymmetries. The geometries and flow perturbations can be entered into other discrete vortex method (DVM) codes, and the results can then be compared with those presented in Ref. 2. The thrust of the paper[2] was to give a physical explanation to the "vortex reduction factor" and show the self-consistency of the method.

By replacing the infinite vortex line with a semi-infinite line, the vortex reduction factor is replaced with Eq. (8) of Ref. 2. The part of the equation corresponding to the factor in question takes on values from 0 to 1, but will usually fall in the range of 0.5 to 0.9. The factor changes from point to point in the flow, which causes a different mixing of the vortices than is achieved with a set vortex reduction factor.

A comparison of the old and new models is made now. Figures 1 and 2 are the side loadings computed on a $3.5D$ ogive nose in a flow of Mach number 0.086. The angle of attack is varied from 0 to 55 deg. The computed values are compared with the experimental results of Roos and Kegelman,[3] who actually introduced a small geometric disturbance at the nose tip to generate the out-of-plane loading. Figure 1 shows the results of the DVM with infinite vortex lines and a vortex reduction factor set to 0.6. The results shown in Fig. 2 are generated with the same code except that the semi-infinite vortex line assumption is made. The flow in each case is disturbed by multiplying the strength of the shed vorticity on one side of the body by $1 + f$ for a length 4% down from the nose tip. The different values of f generate the different curves.

An examination of the two figures yields two immediate observations. First, for the present DVM, a smaller flow perturbation is required to generate the out-of-plane loading using the semi-infinite filament assumption. Even when the flow is disturbed by increasing the strength of the vorticies on one side of the body by 30%, Fig. 1 never shows the code predicting the higher-angle-of-attack side loading corresponding to the experimental results. Second, there is apparently a greater cause–effect relationship between the size of the perturbation and the size of the side loading for the infinite vortex line than for the semi-infinite filament. Note that in Fig. 1, up until 45 deg, the larger perturbations generate consistently larger side loadings. Even after 45 deg, the larger perturbations generate more rapid and extreme changes in the loading. This effect is also true for the results shown in Fig. 2. However, it is somewhat less pronounced. Up to 45 deg, in the semi-infinite filament case, disturbances of $f = 0.1$, 0.2, and 0.3 generate nearly the same values, and

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