AIAA JOURNAL
Vol. 30, No. 11, November 1992

Readers' Forum

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 "Approximate Formula of Weak Oblique Shock Wave Angle"

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Introduction

FOR flow of a supersonic ideal gas with constant specific heats over a wedge, standard analysis[1] shows the relationship between oblique shock angle β, wedge angle θ, incoming Mach number M_1, and ratio of specific heats γ is given by

$$\tan\theta = 2\cot\beta\,\frac{M_1^2\sin^2\beta - 1}{M_1^2(\gamma + \cos 2\beta) + 2} \tag{1}$$

In a recent Technical Note, Dou and Teng[2] give an analysis to show Eq. (1) may be approximated for $\theta \ll 1$ by the following:

$$\tan\beta = \frac{1}{\sqrt{M_1^2 - 1}} + \frac{\gamma + 1}{4}\,\frac{M_1^4}{(M_1^2 - 1)^2}\,\theta \tag{2}$$

However, for high values of M_1, there is an approximation that is both simpler and better. This is given by Liepmann and Roshko[1] for the distinguished limit $M_1\beta \gg 1$ and $\beta \ll 1$ (and, consequently, $\theta \ll 1$):

$$\beta = [(\gamma + 1)/2]\theta \tag{3}$$

The improved approximation (3) cannot be deduced by considering Eq. (2) in the high Mach number limit but requires a return to Eq. (1).

The relative merits of Eqs. (2) and (3) are easily seen when their predictions are compared with the exact solution of

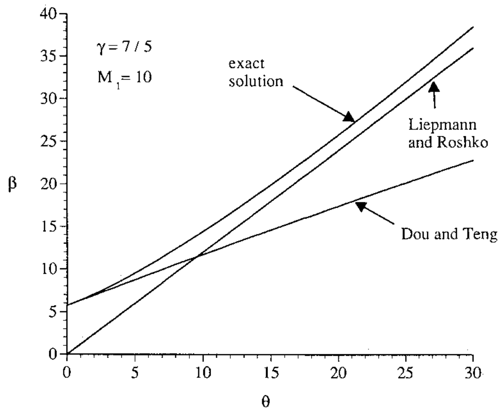

Fig. 1 Wave angle vs wedge angle for fixed incoming Mach number.

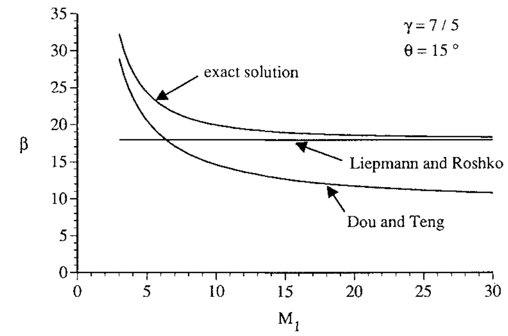

Fig. 2 Wave angle vs Mach number for fixed wedge angle.

Eq. (1) as shown in Figs. 1 and 2. Figure 1 shows β vs θ, with M_1 and γ fixed at 10 and 7/5, respectively. Dou and Teng's formula [Eq. (2)] matches well near $\theta = 0$, whereas Liepmann and Roshko's [Eq. (3)] is superior at higher θ. When β is plotted vs M_1, with θ and γ held fixed at 15 deg and 7/5, respectively, Dou and Teng's approximation is better for low M_1, whereas Liepmann and Roshko's is better for high M_1. Thus, for a given *small, fixed* θ, there are Mach numbers for which Eq. (3) gives a better approximation for β than does Eq. (2). The same conclusions can be reached for Dou and Teng's extension of Eq. (2) to a quadratic expression in θ.

References

[1]Liepmann, H. W., and Roshko, A., *Elements of Gasdynamics*, Wiley, New York, 1957, pp. 84–93.

[2]Dou, H.-S., and Teng, H.-Y., "Approximate Formula of Weak, Oblique Shock Wave Angle," *AIAA Journal*, Vol. 30, No. 3, 1992, pp. 837–839.

Received March 31, 1992; accepted for publication May 29, 1992.

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Introduction

WE would like to thank Professor Powers for his comments on our work. The primary result of Ref. 1 is a quadratic expression in θ [Eq. (13) of Ref. 1], which was

Received April 29, 1992; accepted for publication May 29, 1992.

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