The configuration of the slotted test section boundary of the Boeing 8- x 12-foot transonic wind tunnel as furnished by Mr. John Monk of the Boeing Company is indicated in figure 1. The cross-sectional area of the test section is approximately 88 sq ft. However, to obtain a lower limit of the interference assume first a rectangular wind tunnel of 96 sq ft cross-sectional area. The average ratio $r_o$ of open perimeter to total perimeter is about 0.11. With the slots well-distributed about the perimeter, the average open-ratio in the circular wind tunnel from which the rectangular tunnel is obtained by transformation is not much different from that in the rectangular tunnel, because the stretching factors for the slots are nearly the same as those for the adjacent panels. Therefore use

$$r_o = 0.11$$

in figure 11 of reference (a). Then from figure 4 of reference (a)

$$\log_\varepsilon \csc \frac{1}{2\pi r_o} = 1.754.$$ 

Thus

$$c = \frac{2}{16} \times 1.754 = 0.219$$

and

$$\frac{1}{c + 1} = 0.82.$$ 

With the ratio $\lambda$ of test section height to test section width

$$\lambda = \frac{8}{12} = \frac{2}{3}$$

figure 11 of reference (a) shows that the interference factor $\delta_R$ is
\[ \delta_R = -0.157 \]

which indicates a downwash somewhat more than half that which would occur in a completely open tunnel. If \( w \) is the downwash and \( u \) is the tunnel velocity the downwash angle in radians is (see ref. (a), p. 15)

\[ \frac{w}{u} = \frac{SC_L}{C} (-\delta_R) \]

where \( C_L \) is model lift coefficient
\( S \) area on which \( C_L \) is based
\( C \) cross-sectional area of test section

Since the wing area of the Boeing C5-A model is 2.976 sq ft, the downwash angle per unit lift is

\[ \frac{w}{u} = \frac{2.976}{96} \times 0.157 = 0.00487 \text{ radians} \]

= 0.254 degree

For a lift coefficient of 0.5

\[ \frac{w}{u} = 0.127 \text{ deg} \]

A somewhat larger value is obtained if the wing is assumed to be influenced dominantly by the slots directly above and below it. The slot open ratio is then

\[ r_o = 0.141 \]

\[ c = 0.189 \]

The test section is still supposed rectangular, but with the side walls moved in sufficiently to reduce the cross-sectional area to 88 sq ft. Then

\[ \lambda = \frac{8}{12} \times \frac{96}{88} = 0.727 \]

and

\[ \delta_R = -0.154 \]

Then

\[ \frac{w}{u} = \frac{2.976}{88} \times 0.154 = 0.00521 \text{ radians} \]

\[ = 0.273 \text{ degree} \]

For a lift coefficient of 0.5

\[ \frac{w}{u} = 0.136 \text{ degree} \]
For this estimation, the model is replaced by a lifting vortex doublet at the center of the test section. Since the wing tips are relatively far from the side walls, this approximation is believed to be permissible.

Because of the boundary layer at the upper wall, the interference downwash in a slotted wind tunnel is believed to be somewhat greater than the theory indicates. However if the upstream and downstream ends of the slots are not effectively far from the model, the downwash may be less than calculated. For a fully open test section, it is suggested in reference (b) that the test section entrance and exit should each be at least half the test section height from the model position. This criterion is believed to be applicable also to the slotted test section.
Figure 1: Slot configuration in Boeing 8 x 12-ft. Wind Tunnel

- 3" slots at model station

Model position