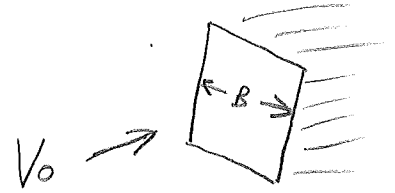


8.9

GIVEN: DRAG TEST OF A SQUARE PLATE.



$V_0 \sim$ FREE STREAM VELOCITY

$B \sim$ PLATE SIDE LENGTH

$\rho \sim$ FLUID DENSITY

$\mu \sim$ FLUID ABSOLUTE VISCOSITY

$u' \sim$ FREESTREAM TURBULENCE INTENSITY

$L_x \sim$ " " " " LENGTH SCALE

FIND: DIMENSIONLESS GROUPS

SOLUTION:

1. SIGNIFICANT VARIABLES: THE ABOVE LIST AND F_D , THE DRAG FORCE.

2. $[F_D] = \frac{m \cdot L}{t^2}$

3. $n - m$

$[V_0] = \frac{L}{t}$

$7 - 3 = 4$

$[\rho] = \frac{m}{L^3}$

WILL HAVE A TOTAL OF 4 DIMENSIONLESS GROUPS.

$[\mu] = \frac{m}{t \cdot L}$

$[u'] = \frac{L}{t}$

$[L_x] = L$

$[B] = L$

4. ONE DIMENSIONLESS GROUP SHOULD BE THE REYNOLDS NUMBER.

$$Re = \frac{V_0 B \rho}{\mu}$$

THE OTHER GROUPS MIGHT BE:

$$\frac{L_x}{B}, \quad \frac{u'}{V_0}, \quad \text{AND} \quad \frac{F_0}{\rho V_0^2 B^2}$$

$$\frac{F_0}{\rho V_0^2 B^2} = f \left(Re, \frac{L_x}{B}, \frac{u'}{V_0} \right)$$

THIS SET OF DIMENSIONLESS GROUPS IS NOT UNIQUE, BUT THERE MUST BE A TOTAL OF FOUR GROUPS AND ALL THE VARIABLES MUST BE USED AT LEAST ONCE.

8.41

GIVEN: MODEL FLOW CONDUIT ON EARTH,

DESIGN TO SIMULATE FLOW ON MOON

WHERE $g_m = \frac{1}{5} g_e$. Fr AND Re ARE

IMPORTANT AND $L_e = L_m$. $\nu_m = 0.5 \times 10^{-5} \text{ m}^2/\text{s}$.

FIND: v_e .

SOLUTION: $Re_m = Re_e$ $\frac{L_m v_m}{\nu_m} = \frac{L_e v_e}{\nu_e}$

$$v_e = v_m \frac{\nu_e}{\nu_m} \quad (1)$$

$$Fr_m = Fr_e \quad \frac{v_m}{\sqrt{g_m L_m}} = \frac{v_e}{\sqrt{g_e L_e}}$$

$$\frac{v_e}{v_m} = \sqrt{\frac{g_e}{g_m}} \quad (2)$$

COMBINE (1) AND (2)

$$v_e = v_m \sqrt{\frac{g_e}{g_m}} = \left(0.5 \times 10^{-5} \frac{\text{m}^2}{\text{s}} \right) \sqrt{5}$$

$$v_e = 1.12 \times 10^{-5} \frac{\text{m}^2}{\text{s}}$$

8.45

GIVEN: $\frac{1}{5}$ SCALE DRAG FORCE TEST OF
SUBMERGED "NOISEMAKER",

$$V_p = 5 \text{ m/s}, \quad F_{Dm} = 868 \text{ N}, \text{ AND}$$

$$V_m = 2V_p$$

FIND: V_m AND F_{Dp}

SOLUTION:

$$Re_m = Re_p$$

$$\frac{L_m V_m}{\nu_m} = \frac{L_p V_p}{\nu_p}$$

$$V_m = \frac{L_p}{L_m} V_p = \frac{5}{1} (5 \text{ m/s})$$

$$V_m = 25 \text{ m/s}$$

FROM EXAMPLE 8.6 WE HAVE THAT

$$F_{Dp} = F_{Dm}$$

$$F_{Dp} = 2400 \text{ N}$$