Group 1: Dave Buonconsiglio, Richard Harrell, Devon Moore, Traveon Williams,

MET 330

Dr. Ayala

October 21, 2021

HW #2.2

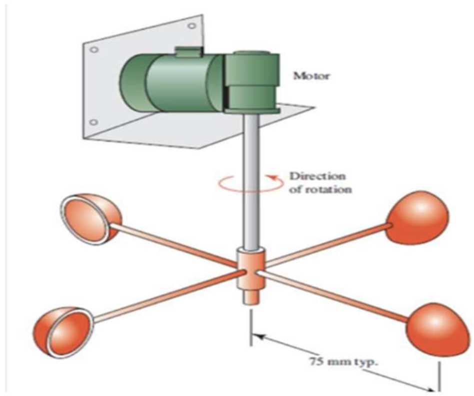
Devon Moore: The lecture on drag and lift was particularly interesting to me because I hope to work in the motorsports industry which deals a lot with aerodynamics. I'd heard of drag and lift and knew what they meant in terms of day-to-day life, but I had never understood them at a fundamental level. The problem solved in the lecture helped cement these fundamentals further. One thing I learned from the solved problem was how important the shape of the object is to the drag coefficient; this is shown in table 17.1 and it varies widely for standard shapes. The drag coefficient can also be calculated by finding the Reynolds number based on fluids velocity and viscosity in combination with the diameter of the object. Once the drag coefficient is given variables and Bernoulli's can be used to find the drag force acting on an object and the reaction to that force.

Dave Buonconsiglio: I truly enjoyed the lectures this week, as an aviation and automotive performance enthusiast, drag and lift hold special meaning to me. I was aware of the coefficient of drag and lift previous to this class, but the math behind it was new to me. Admittedly, the formula for coefficient of drag from the wind data is daunting, and I am glad there are computers and software to calculate all of that to tell us how aerodynamic designs are. I also enjoyed talking about the vortices and how they advance to turbulent flow. If there are particles in the air, this can be seen in jet exhaust as a plane takes off, watching the air swirl behind the engines. I am looking forward to see how this fits in as we progress deeper into how fluids act.

Richard Harrell:

Traveon Williams:

17.11



V = Liner $V_{cups} = V = r\omega = 0.075\left(\dfrac{20\times 2\pi}{60}\right) = 0.157\ m/s$

$A = \dfrac{\pi D^2}{4} = \dfrac{\pi (0.025)^2}{4} = 0.00049\ m^2$

$C_D = 1.32$

$\rho = 1.16$

$F_D = C_D\left(\dfrac{\rho V^2}{2}\right)A = 1.35\left(\dfrac{1.16(0.16)^2}{2}\right)(0.00049) =$

$0.0000095\ \dfrac{kgm}{s^2}$

$9.5\ \mu N$

$Torque = 4F_D r = 4(9.5)(0.073) =$

(c)

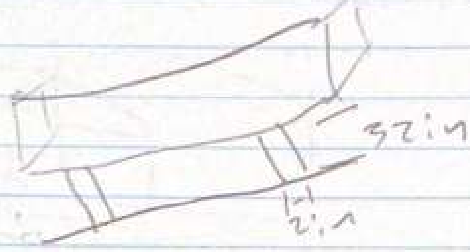
$\rho = 680$

$F_D = 1.35\ \dfrac{(680)(157)^2}{2} = 0.0056\ \dfrac{kgm}{2} =$

$Torque = \dfrac{T_c}{T_D} = \dfrac{0.00167}{0.0000285} = 586$

17.14

14.



air @ −20°F

$\rho = 2.8 \times 10^{-3}$ slugs/ft^3

$\nu_{viscosity} = 1.16 \times 10^{-4}$

$V = 150$

$$C_D = \frac{F_D/A}{\frac{\rho_f V^2}{2}} \quad \to \frac{2\,in}{12} = 0.1674\,ft \times \frac{64\,in}{12} = 0.8962$$

$\to 220\,ft/s$

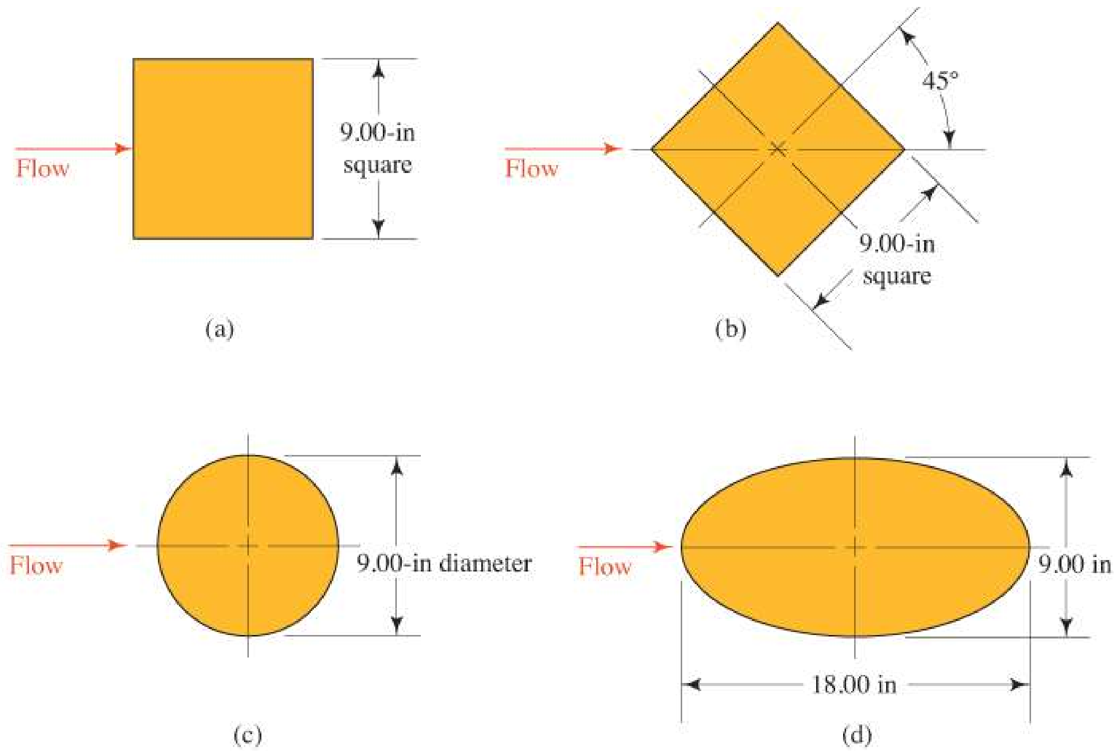
$$N_R = \frac{VD}{\nu} = \frac{220 \cdot 0.167}{1.16 \times 10^{-4}}$$

$N_R = 316724 = C_D = 0.5$

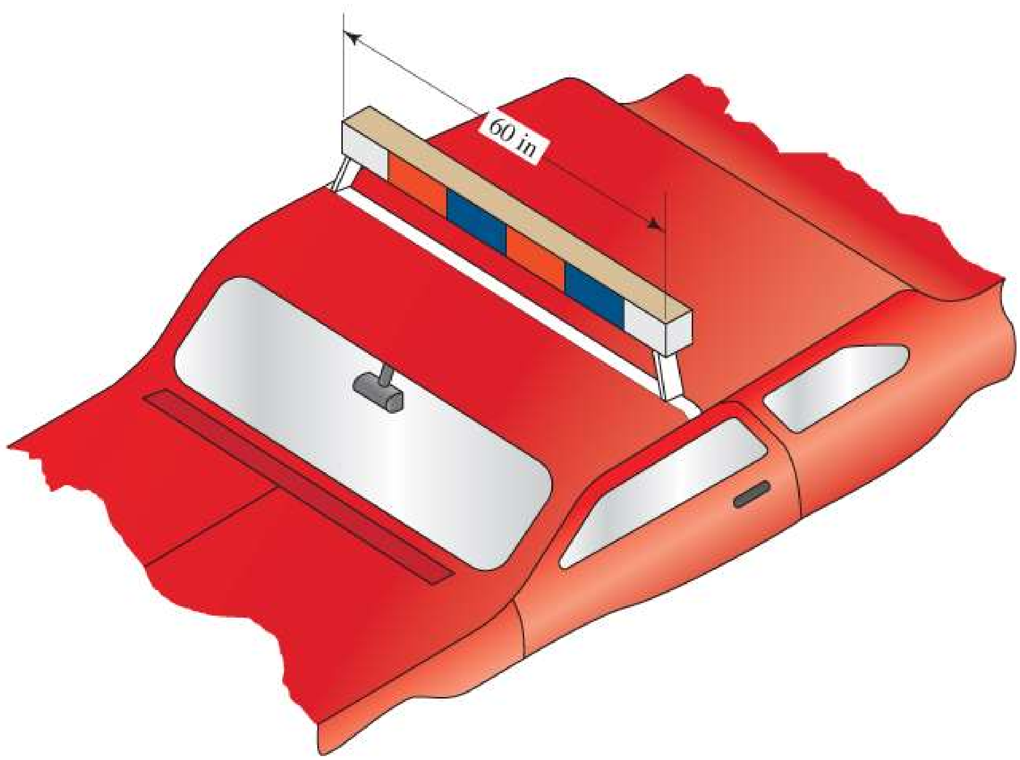
$$0.58 = \frac{\left(\frac{F_D}{0.89}\right)}{\frac{2.8 \times 10^{-3}(220)^2}{2}}$$

$F_D = 48.2\,lb$

17.16



Flow
9.00-in
square
(a)
Flow
45°
9.00-in
square
(b)
Flow
9.00-in diameter
(c)
Flow
9.00 in
18.00 in
(d)



60 in

17.16 $F_D = C_D \left(\frac{\rho V^2}{2}\right) A$ use fig 17.3

$V = \frac{100}{} \left| \frac{5280}{1} \right| \frac{1}{3600} = 147\ ft/s$

$A = 9 \left(\frac{60}{144}\right) = 3.75\ ft^2$

Design b: $y = 9 \sin 45 = 6.36\ in$

$h = 2y = \frac{2(6.36)}{12} = 1.06\ ft$

$A = h \times l = 1.06(5) = 5.363\ ft^2$

Square cylinder: $L = 9$

$N_R = \frac{VL}{\nu} = \frac{147(.75)}{0.000117} = 942000 = C_D = 2.10$

$F_D = 30.12(2.1)(3.75) = 23716$

Square cylinder $F_D = 23716$

Assume $C_D = 1.6$ — Square cylinder from fig

$F_D = 30.12(1.60)(5.3) = 25616$ Hexagon T

17.16 Circular cylinder: D = 9 = .75 m

$N_R = \frac{VD}{\nu} = \frac{147(.75)}{0.000117} = 942000 \Rightarrow C_D = .3$

$F_D = 30.12(.3)3.75 = 33.9$

Elliptical cylinder = L = 18 = 1.5 h = 9 = .

L/h = 2

$N_R = \frac{VL}{\nu} = \frac{147(1.5)}{0.000116} = 1.880000$ $C_D = .25$

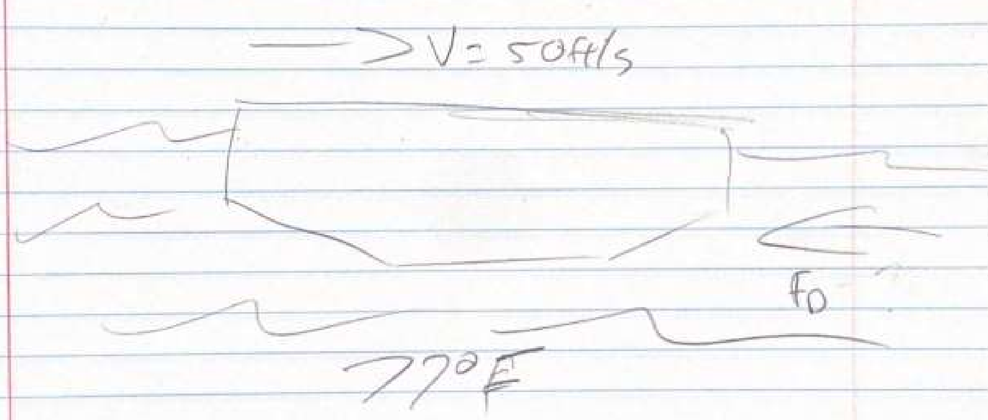
$F_D = 30.12(.25)(3.75)$ 21.216 Lowest

17.26

2a. R = 0.4Δ 125 long tons = 14800 lb

$P = RV = (14800\ lb)(50\ ft/s) = \frac{840000\ lb \cdot ft/s}{550\ lb \cdot ft/s}$

1527 hp.



17.30

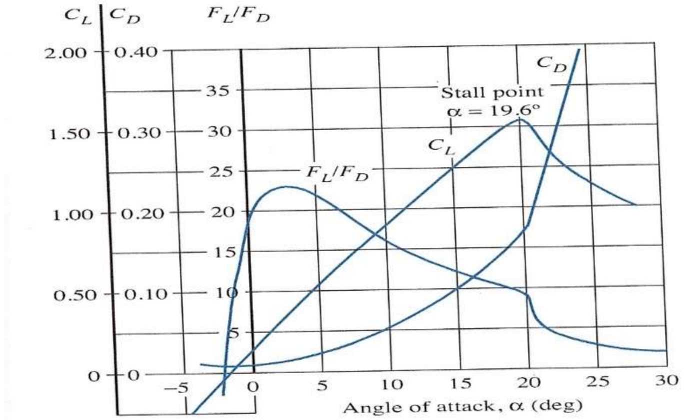


FIGURE 17.11 Airfoil performance curves.

17.30 F_L & $F_D = C_D\left(\frac{\rho V^2}{2}\right)A$

$C_L = .9 \quad C_D = .05 \quad A = bc = (6.8)(1.4) = 9.52\,m^2$

$V = \frac{200}{} \Big| \frac{1000}{1} \Big| \frac{1}{3600} = 55.\bar{5}$ m/s

At 200 m $\rho = 1.25$

$F_L = .9\left(\frac{1.2\,(55.\bar{5})^2}{2}\right)9.52 =$ [redacted] N

$F_D = \frac{.05}{.9}\left(15900\right) =$ [redacted]

AT 10000 m $\rho = .41$

$F_L\ (.9)\left(\frac{.41\,(55.\bar{5})^2}{2}\right)9.52 =$ [redacted]

$F_D = \frac{.05}{.9} \times 5{,}470 =$ [redacted] N