Environmental Engineering & Science Seminar Series presents

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on

"Geology and Hydrology of the Genesee Valley, Revised"

Date: Tuesday, February 26, 2002

Time: 3:30 pm

Location: 206 Furnas Hall

Refreshments to follow

Sponsored by
Dept. of Civil, Structural and Environmental Engineering,
Great Lakes Program,
Center for Integrated Waste Management,
Sevenson Environmental Services, Inc. , and
UB Groundwater Research Group

Problem 8.4

a. $V = \left(\frac{49{,}200\ m^3}{1440\ min}\right)(45\ min) = 1{,}537.5\ m^3$

Area of profile section $= \frac{1{,}537.5\ m^3}{27.43\ m} = 56.052\ m^2$

Let x = compartment width and depth

$(3x)(x) = 56.052\ m^2$

$x = \underline{4.32\ m}$

$3x = \underline{12.96 m}$

b. Assume 7 wheels with 150mm x 3.05m blades

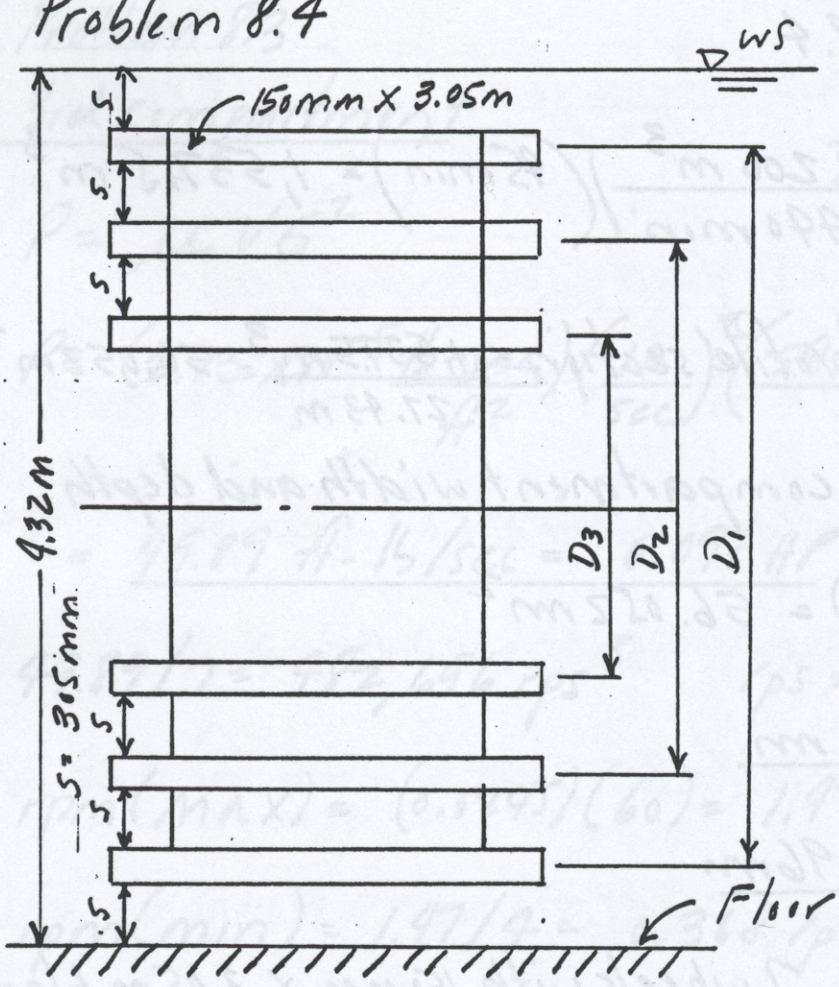
Let spacing between wheels = s and 1/2 s at the wall

$7s + 7(3.05) = 27.43$

$s = 0.869\ m = 869 mm$ which is between 760 and 915 mm.

Try 6 blades per wheel as shown by drawing on following page.

Problem 8.4



$D_1 = 4.32m - (2)(0.305m) - (2)(0.150m/2) = 3.56$

$D_2 = 3.56m - (2)(0.305m) - (4)(0.150m/2) = 2.65m$

$D_3 = 2.65m - (2)(0.305m) - (4)(0.150m/2) = 1.74m$

Area of blades per shaft $= (0.150)(3.05)(6)(7) = 19.22m^2$

Cross-sectional area $= (4.32)(27.43) = 118.50\,m^2$

% area $= (19.22/118.50)100\% = 16.2\%$ which is between 15 to 20%.

Problem 8.4

c and d

$$T = (1537.5\ m^3)\Big/\left(\frac{1440\ min}{49{,}200\ m^2}\right) = 95.0\ min$$

$$GT = (26.7\ s^{-1})(95.0\ min)\left(\frac{60\ s}{min}\right) = 72{,}100$$

which is between 50,000 to 100,000.

$L/W = 3.05/0.150 = 20$, thus $C_D = 1.5$

$V = (rps)(\pi D/rev)(0.75)$

$V_1 = (rps)(\pi \times 3.56)(0.75) = 8.3881\ rps$

$V_2 = (rps)(\pi \times 2.65)(1.75) = 6.2939\ rps$

$V_3 = (rps)(\pi \times 1.74)(0.75) = 4.0998\ rps$

1st Compartment

$P = \mu V G^2$

$$P = \left(\frac{0.00131\ N\text{-}s}{m^2}\right)\left(\frac{50}{s}\right)^2\left(\frac{1537.5\ m^3}{3}\right)$$

$$= 1{,}678.4\ N\text{-}m/s = 1678.4\ J/s = 1678.4\ W$$

$$P = C_D A_1 \rho \frac{V_1}{2}^3 + C_D A_2 \rho \frac{V_2}{2}^3 + C_D A_3 \rho \frac{V_3}{2}^3$$

Problem 8.4

$P = 1678.4/7 = 239.77$ N-m/s per wheel. Since $A_1 = A_2 = A_3$

$$P = C_D A_1 f_2 (V_1^3 + V_2^3 + V_3^3)$$

$$239.77 \text{ N-m/s} = (1.5)(0.15\text{m})(3.05\text{m})(2)(999.7 \text{ kg/m}^3) \times (1/2)[(8.3881 \text{ rps})^3 + (6.2439 \text{ rps})^3 + (4.0998 \text{ rps})^3]$$

$$239.77 = 686.04 (902.53 \text{ rps}^3)$$

$$\text{rps} = 0.0729$$

$$\text{rpm (max)} = (0.0729)(60) = 4.37 \text{ rpm}$$

$$\text{rpm (min.)} = 4.37/4 = 1.09 \text{ rpm}$$

$$V_1 = (\pi)(3.56\text{m})(0.0729 \text{ rps}) = 0.81 \text{ m/s} < 0.91 \text{ ok}$$

2nd compartment

$$P = \mu V G^2$$

$$= \left(\frac{0.00131 \text{ N-s}}{\text{m}^2}\right)\left(\frac{20}{5}\right)^2\left(\frac{1537.5 \text{ m}^3}{3}\right)$$

$$= \underline{268.55 \text{ N-m/s} = 268.55 \text{ J/s} = 268.55 \text{ W}}$$

$P = 268.55/7 = 38.364$ N-m/s per wheel

$38.364 = 686.04 (902.53 \text{ rps}^3)$

Problem 8.4

rps = 0.03957

rpm (max) = (0.03957)(60) = 2.37 rpm

rpm (min) = 2.37/4 = 0.594 rpm

$V_t = (\pi)(3.56\,m)(0.03957\,rps) = 0.443\,m/s < 0.91$ OK

3rd compartment

$P = \mu V G^2$

$= \left(\frac{0.00131\,N\text{-}s}{m^2}\right)\left(\frac{10}{5}\right)^2\left(\frac{1537.5\,m^3}{3}\right)$

$= 67.138\,N\text{-}m/s = 67.138\,J/s = 67.138\,W$

P = 67.138/7 = 9.5911 N-m/s per wheel

$9.5911 = 686.04\,(902.53\,rps^3)$

rps = 0.02493

rpm (max) = (0.02493)(60) = 1.50 rpm

rpm (min) = 1.50/4 = 0.374 rpm

$V_t = (\pi)(3.56\,m)(0.02493) = 0.279\,m/s < 0.91$ OK