Fluid Mechanics
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DESIGN PROJECT – FALL 2020

The construction of a dam is being considered in a small state to generate hydroelectric power. This dam provides jobs to the local community during and after the construction process as well as provides additional water for agricultural purposes. However, the construction of this dam also displaces some of the families located on the floodplain and reduces the stream flows to the residents of the state currently residing downstream of the dam. The state has asked your company to complete an impact analysis on the construction of the dam. They have picked two proposals as follows: [Assume a width of river = 6 m]

Proposal I: Concrete dam

Density of concrete = 2400 kg/m^3
Height of the dam = 24 m
The base width of the dam = 8 m
Height of the water = 19 m

Proposal II: Earth Dam (mix of different types of clay loams)

Average density = 1650 kg/m^3
Height of the dam = 24 m
The base width of the dam = 10 m
Height of the water = 19 m

DELIVERABLES

(1) Pick a name for your company **[5 points]**

(2) Write a memorandum detailing whether the proposals satisfy the following requirements **[2 pages maximum without appendix – 85 points]**

a. Do these two proposals satisfy the criteria for tipping over due to water pressure? An example problem is provided on the next page. Attach calculations as an appendix **[50 points]**
b. Pick a proposal and justify your selection **[15 points]**
c. Discuss some of the advantages and disadvantages of building a dam. What are some of the environmental impacts of the dam? [this is a general discussion] **[20 points]**

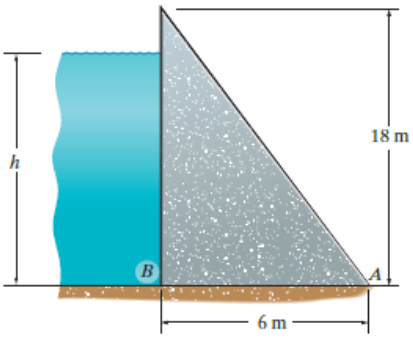
(3) Ethics discussion – Review the ASCE Code of Ethics here: https://www.asce.org/code-of-ethics/ **[10 points]**

a. Summarize all the canons in a short paragraph
b. Discuss the utility of a dam after reviewing the code of ethics. In particular, discuss if it changed your mind.

FORMATTING – Single-spaced, 12-point font size, Times New Roman font type, No pictures. Note that this is a theoretical problem and some of the heights & lengths may exceed regulatory limits.

Unless otherwise stated, take the density of water to be $\rho_w = 1000\,\text{kg/m}^3$ and its specific weight to be $\gamma_w = 62.4\,\text{lb/ft}^3$. Also, assume all pressures are gage pressures unless stated otherwise.

2–51. Determine the critical height h of the water level that causes the concrete gravity dam to be on the verge of tipping over due to water pressure. The density of concrete is $\rho_c = 2.40\,\text{Mg/m}^3$. *Hint*: Work the problem using a 1-m width of the dam.



SOLUTION

We will consider the dam having a width of $b = 1$ m. Then the intensity of the distributed load at the base of the dam is

$$w_B = \rho_w g h b = (1000\,\text{kg/m}^3)(9.81\,\text{m/s}^2)(h)(1\,\text{m}) = (9810h)\,\text{N/m}$$

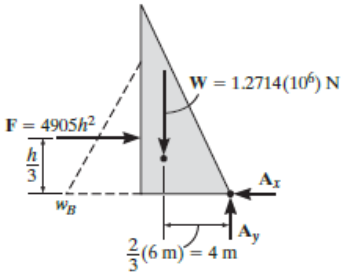
The resulting triangular distributed load is shown on the FBD of the dam, Fig. *a*, and its resultant is

$$F = \frac{1}{2}w_B h = \frac{1}{2}(9810h)h = (4905h^2)\,\text{N}$$

The weight of the concrete dam is

$$W = \rho_C g \mathcal{V} = (2400\,\text{kg/m}^3)(9.81\,\text{m/s}^3)\left[\frac{1}{2}(6\,\text{m})(18\,\text{m})(1\,\text{m})\right]$$

$$= 1.2714(10^6)\,\text{N}$$



(a)

The dam will overturn about point A. Write the moment equation of equilibrium about point A by referring to Fig. *a*.

$$\circlearrowleft + \Sigma M_A = 0; \quad [1.2714(10^6)\,\text{N}](4\,\text{m}) - 4905h^2\left(\frac{h}{3}\right) = 0$$

$$h = 14.60\,\text{m} = 14.6\,\text{m} \qquad \textbf{Ans.}$$

Ans:
$h = 14.6\,\text{m}$