Problem 1: Consider the three node beam element shown below in which the transverse displacements at the nodes are the degrees of freedom. Using quadratic interpolation with \( X = [1 \ x \ x^2] \) You may wish to use a symbolic math program such as matlab or mathematica to invert the \( A \) matrix:

i) Calculate the shape functions for the element and plot these shape functions.

ii) Calculate the stiffness matrix for the element.

iii) Using a single element of this type, calculate the midspan deflection of a simply supported beam with transverse load \( P \) applied at the mid-element node.

Problem 2: The diagram below shows the cross section of a dam with water impounded on one side. Write down the traction and displacement boundary conditions that are required to solve this problem.
Problem 3:

3.4-3 (a) Two nodes of an isosceles CST element are fixed, as shown. Let $v = 0$, and determine the 2 by 2 stiffness matrix associated with d.o.f. at the unrestrained node.

(b) A plane square region of uniform thickness is divided into eight congruent CST elements, as shown. Load $P$ in the y direction is applied to the node at $x = y = 0$. If $v = 0$, what is the displacement of load $P$?

Problem 4: Consider the two Q4 meshes shown below that each include the same number of elements. Which mesh would you expect to produce a more accurate solution. Explain your answer.