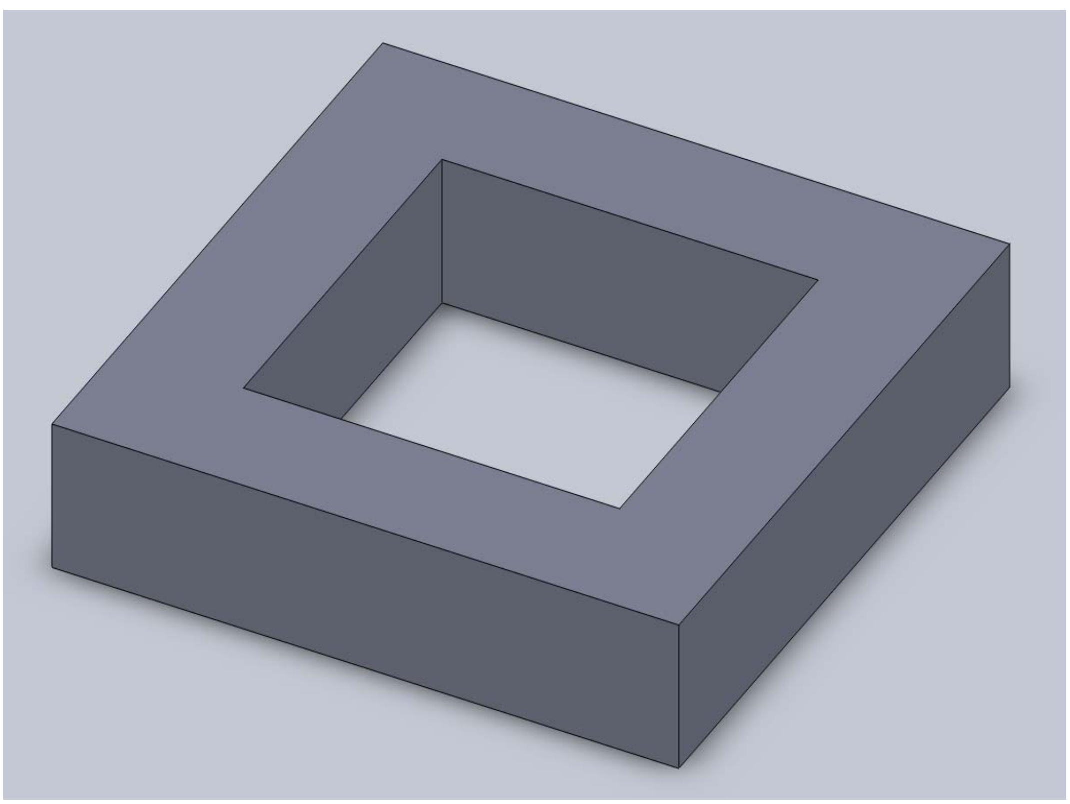
NAME: ____________________________________________________________

A square aquaculture barge is shown in the sketch below. Derive an equation for the location of its roll metacentre relative to its deck. Let its depth of submergence be h and its free board be d. Let the distance between its outer edges be 2H and its inner edges be 2G. [40] BONUS: Where is the pitch metacentre of the barge located?



$$S\ V = 2 \int_0^{+X} x\ x\Theta\ w\ dx$$

$$K = 2 \int_0^{+X} x\ x\ w\ dx$$

## Square Barge

$$X = H \qquad w = 2H$$

$$K = 2 \int_0^{+H} x\ x\ w\ dx = 2\ 2H\ H^3/3$$

$$V = 2H\ 2H\ h$$

## Moonpool

$$X = G \qquad w = 2G$$

$$K = 2 \int_0^{+G} x\ x\ w\ dx = 2\ 2G\ G^3/3$$

$$V = 2G\ 2G\ h$$

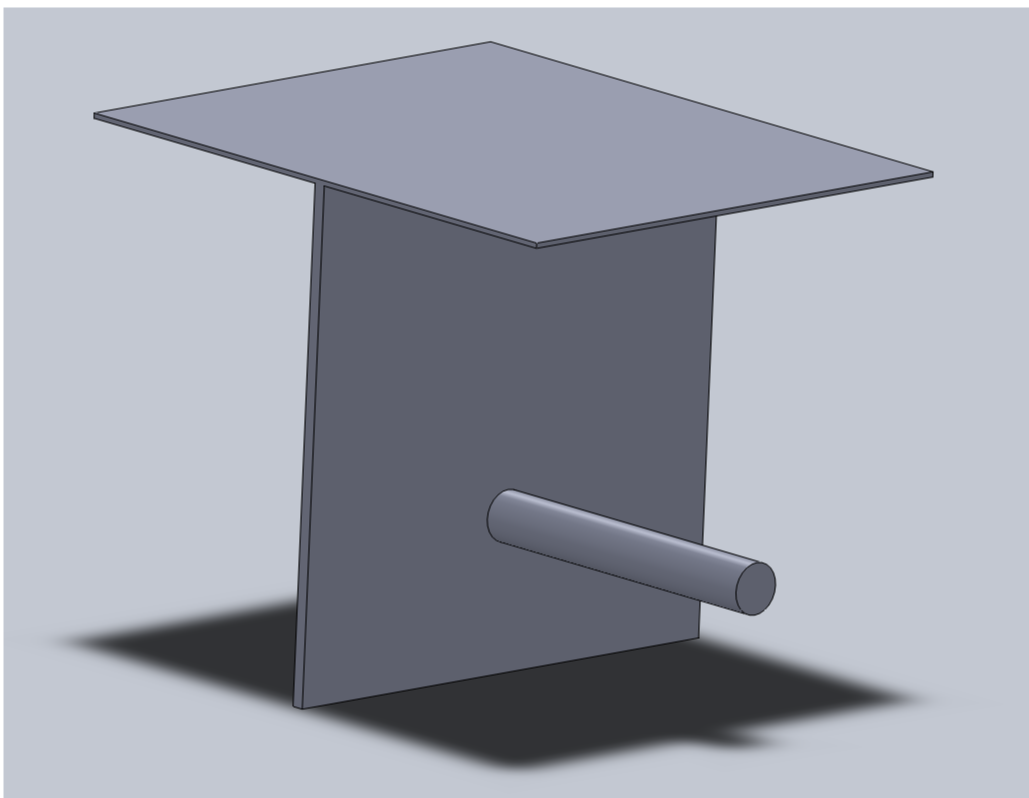
## Metacenter

$$S = R\ \Theta \qquad R = \Delta K/\Delta V$$

$$\Delta K = 2\ 2H\ H^3/3 - 2\ 2G\ G^3/3$$

$$\Delta V = 2H\ 2H\ h - 2G\ 2G\ h$$

A cylindrical tube sticks out from the side of an underwater structure as shown in the sketch below. The tube length is L and its diameter is D. The distance down to its center is H. Determine the loads on the tube. [40]



The horizontal force is pressure at center of the circle times the profile area

$$P = \rho g H \qquad A = \pi D^2/4$$

$$F = \rho g H \pi D^2/4$$

The vertical force is just the buoyancy

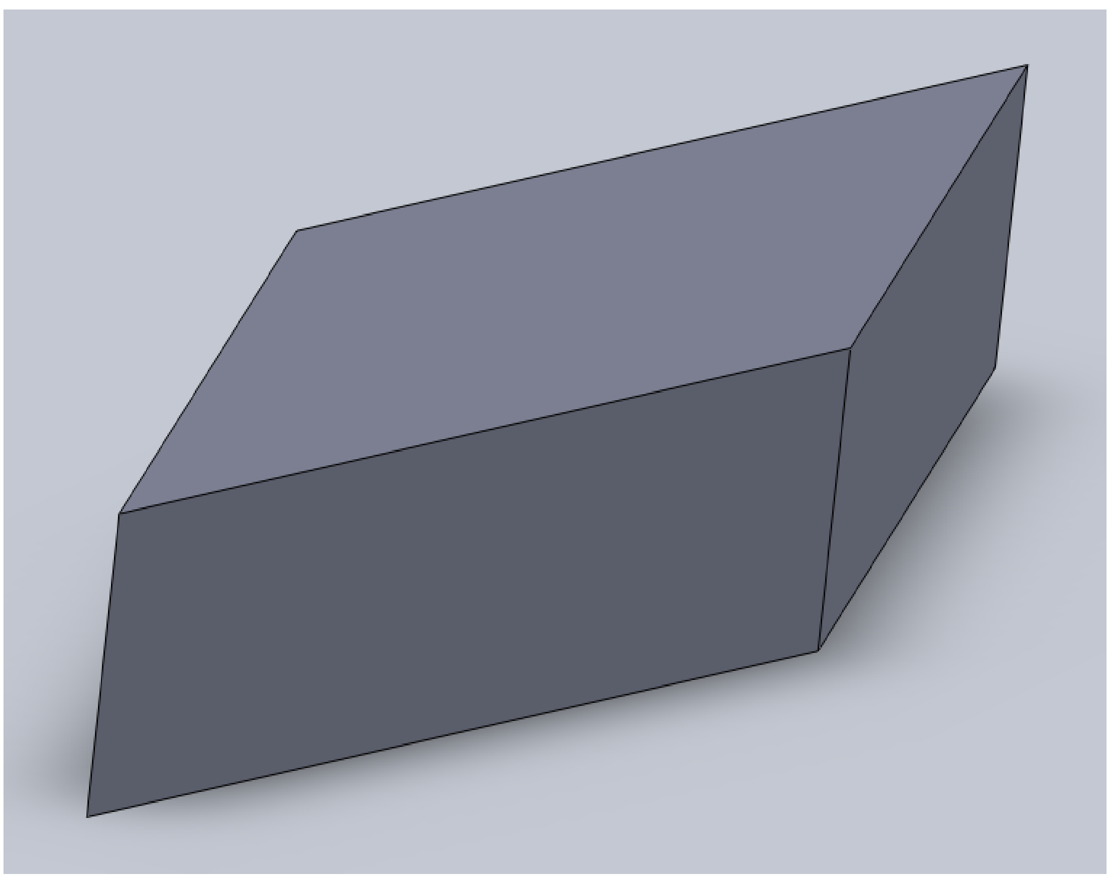
$$B = \rho g V$$

$$V = L A = L \pi D^2/4$$

$$B = \rho g L \pi D^2/4$$

NAME: ____________________________________________________________

The barge in the sketch below has a diamond shaped hull. Let its depth of submergence be h and its free board be d. Let the distance between the tips in roll be 2G and the tips in pitch be 2H. Derive an equation for the location of the roll metacentre relative to its deck. [Hint: The length of a slice of the barge is W = 2H (G-x)/G ] [40]



$$S\ V = 2 \int_{0}^{+X} x\ x\Theta\ w\ dx$$

$$K = 2 \int_{0}^{+X} x\ x\ w\ dx$$

## Diamond Barge

$$X = G \qquad w = 2H\ (G-x)/G$$

$$K = 2 \int_{0}^{+G} x\ x\ w\ dx$$

$$K = 2 \int_{0}^{+G} x\ x\ 2H\ (G-x)/G\ dx$$

$$K = 2 \int_{0}^{+G} 2H\ [\ x\ x - x\ x\ x/G\ ]\ dx$$

$$= 4H\ [\ G^3/3 - G^4/[4G]\ ] = H\ G^3/3$$

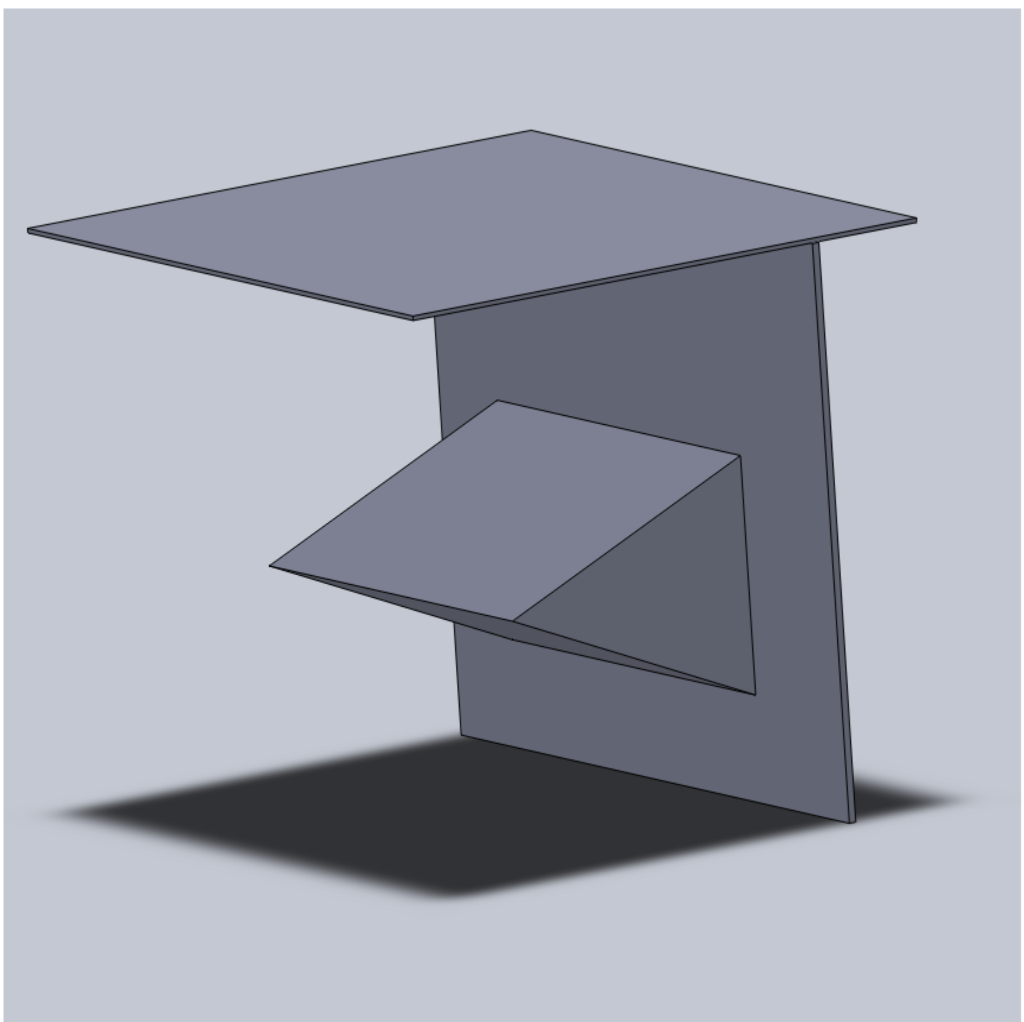
$$V = 2\ 2H/2\ G\ h \quad = 2\ H\ G\ h$$

## Metacenter

$$S = R\ \Theta \qquad R = K/V$$

$$R = [H\ G^3/3]\ /\ [2\ H\ G\ h] = G^2/[6h]$$

A triangular box is attached to an underwater structure as shown in the sketch below. The base of the box is Z, its height is X and its width is Y. The distance down from the water surface to the top of the box is D. Determine the loads on the box. [40] BONUS: Where are the loads located?



The horizontal force is pressure at center of the wedge times the profile area

$$P = \rho\ g\ [D + Z/2] \qquad A = Z\ Y$$

$$F = \rho\ g\ [D + Z/2]\ Z\ Y$$

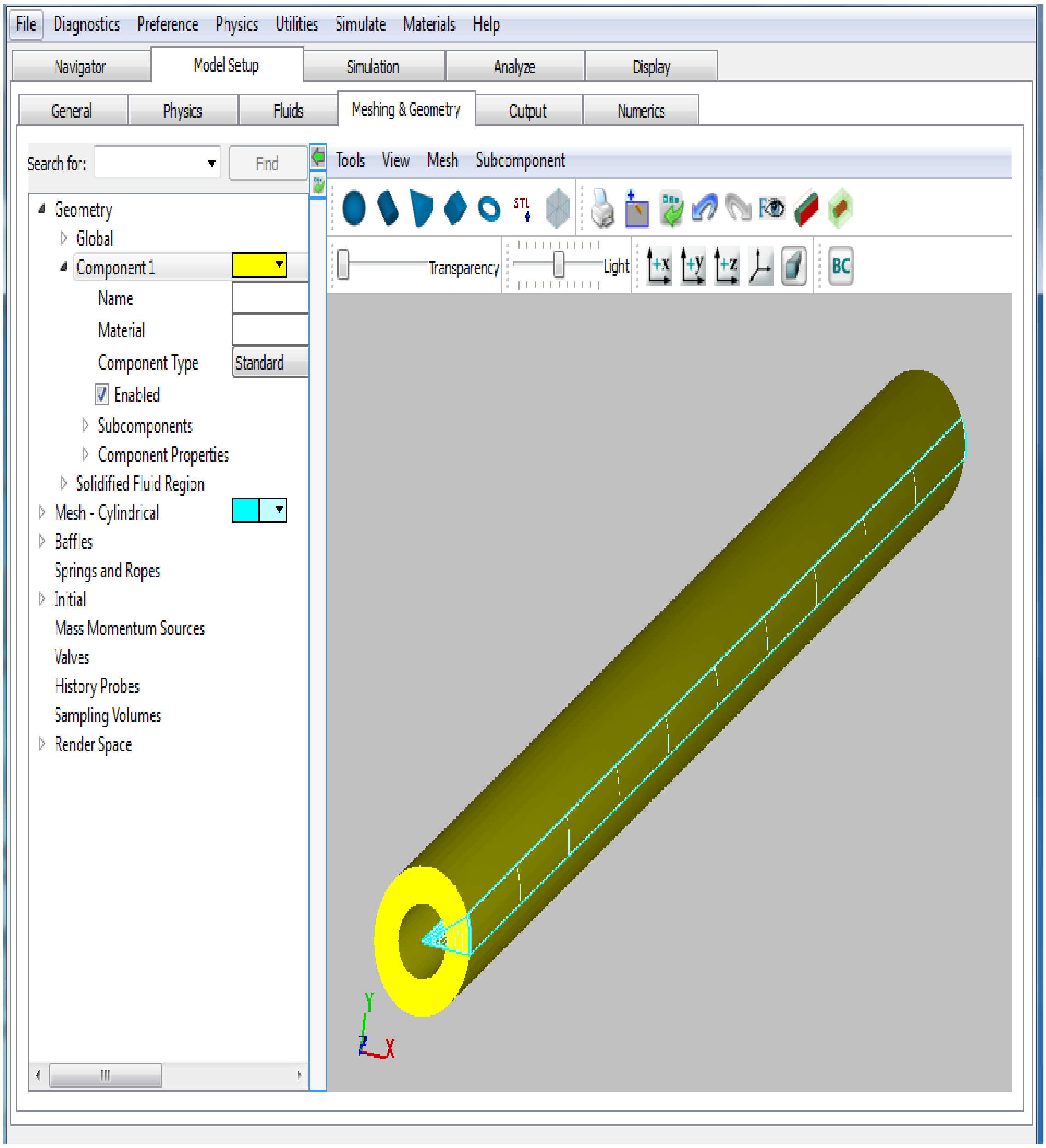
The vertical force is just the buoyancy

$$B = \rho\ g\ V$$

$$V = Z/2\ X\ Y$$

$$B = \rho\ g\ Z/2\ X\ Y$$

A FLOW3D menu is shown below. Briefly explain the purpose of each sub menu. Give answer in bullet form. [20]



$$S\ \rho g\ V = \int_{-G}^{+G} x\ \rho g\ x\Theta\ w\ dx$$

$$S\ \rho g\ V = 2 \int_{0}^{+G} x\ \rho g\ x\Theta\ w\ dx$$

$$S\ \rho g\ V = 2 \int_{H-G}^{H+G} x\ \rho g\ x\Theta\ w\ dx$$

$$S\ \rho g\ V = 2 \int_{-G}^{+G} [H+r]\ \rho g\ [H+r]\ \Theta\ w\ dr$$

$$P = \rho\ g\ h \qquad B = \rho\ g\ V$$

$$F_x = \int P\ n_x\ ds$$

$$F_y = \int P\ n_y\ ds$$

$$F_z = \int P\ n_z\ ds$$