STEPS FOR CALCULATING THE HYDROSTATIC FORCE AND THE CENTER OF PRESSURE ON SUBMERGED SURFACES

A	**Calculation of the Horizontal Component of the Hydrostatic Force**	**F_H**
1.	Project the given surface on a vertical plane.	
2.	Find the centroid of the projected vertical surface and calculate its depth (i.e., its vertical distance from the surface of the liquid).	y_{CV}
3.	Calculate the hydrostatic pressure at this point.	$p_C = g\ y_{CV}$
4.	Calculate the area of the projected vertical surface.	A_V
5.	Calculate the horizontal component of the hydrostatic force	$F_H = p_C A_V$
B	**Calculation of the Vertical Component of the Hydrostatic Force**	**F_V**
6.	Calculate the volume of the column of liquid sitting directly on the surface. Divide this volume into convenient shapes (e.g. orthogonal parallelepipeds, triangular prisms, quarter cylinders, etc.), if necessary. If the liquid is under the surface, pretend that the liquid is on the other side and calculate its volume as if it were sitting on the surface.	V_{LA}
7.	Calculate the weight of this column of liquid. This weight is equal to the vertical component of the hydrostatic force on the surface. Keep in mind that if the liquid is under the surface, the vertical force will be pushing the surface upwards.	$W_{LA} = g\ V_{LA} = F_V$
8.	**Calculation of the Total (Resultant) Hydrostatic Force**	**F =** $\sqrt{\left(F_H^2 + F_V^2\right)}$
C	**Line of Action of F_H**	**y_{cp}**

9.	Find the 2nd moment of inertia of the projected vertical surface about a horizontal axis (i.e., parallel to the liquid surface) that runs through its centroid.	I_{CV}
10.	Calculate the depth of the center of pressure, y_{cp}. This will define the line of action of F_H.	$y_{CP} = y_{CV} + \frac{I_{CV}}{y_{CV} A_V}$
D	**Line of Action of F_V**	**x_{cp}**
11.	Find the centroid of the column of liquid sitting directly on the surface. This can be done by taking the moments of the individual weights of the convenient shapes you defined in step 6, about a convenient vertical axis, then solving the moment equation for the unknown x_{cp}. This will define the line of action of F_V.	$\sum M_V = F_V x_{CP} = \sum W_i x_i$
E	**Line of Action of F**	
	An alternate way to define the line of action of the total hydrostatic force F, is to simply calculate the angle its line of action makes with the horizontal.	$j = \arctan \frac{F_V}{F_H}$