The static equilibrium configuration of the cable is determined by using the following assumptions:

a) The hydrodynamic flow is stationary, with a known profile.
b) We neglect the tangential component of the hydrodynamic force.
c) The weight of the water displaced by the buoy is constant.

2. MATERIALS

A surface buoy Galicia model was selected. This buoy has a depth of 2.20 meters and a reserve buoyancy of 140 kg. It is constructed of polyethylene and its underwater part can be approximated to a cone. On the buoy was installed brand GPS JAVAD with ability to record positions with differential corrections. Anchoring current profiler allows to study variations in the speed with depth. Stranded to the fiber rope, were installed three pressure sensors that recorded the vertical displacements. The cable geometry resulting from this computation is then compared against known displacements.

3. Bibliography

Berteaux H.O. Buoy engineering. NY: John Wiley and Sons. 1976
tive velocity. The drag coefficient is a characteristic dimensionless number for a body, depending on the Reynolds number $Re$ and the direction of the current with respect to the body. Drag coefficient curves for spheres and flat plates are often described in reports of fluid mechanics (Lamb, 1932; Hoerner, 1965; Pierson et al., 1960). When a body heavier than water is left free to sink, it first accelerates under the action of gravity. As its speed increases, its immersed resistance $F_d$ increases. Sooner or later the external forces on the body are equal, and the body sinks with a constant terminal velocity. The balance of the forces at the time is

$$F_d = \frac{1}{2} \rho C_D A V^2 = W - B$$  \hspace{1cm} (2)

where $W$ is the weight of the body and $B$ is the buoyancy of the body. The terminal velocity is

$$V = \sqrt{\frac{2(W - B)}{\rho C_D A}}$$  \hspace{1cm} (4)

when the drag coefficient for the particular body shape is highly sensitive to $Re$ number, then the problem must be solved by trial and error. The terminal velocity is first assumed, the corresponding $Re$ number and coefficient $Cd$ found, and a first computation of the terminal velocity made with this value of $Cd$. If mooring line is inclined from vertical due to horizontal currents forcing, the procedure proposed in this paper is equivalent to that described above where the balance of forces over the buoy is

$$x : \quad T \cos \phi = F_{d_x} = \frac{1}{2} C_D A_N \rho V^2$$

$$z : \quad T \sin \phi = B - W$$  \hspace{1cm} (5)

where $T$ is the tension of the cable and $\phi$ is the inclination of oceanographic mooring line. $AN$ is the frontal area of the buoy. The float is fixed to the bottom as shown in Figure 1. A short piece of wire of small section, inelastic and negligible mass is used. The cable bending stiffness and the torsion stiffness are neglected. When equilibrium is reached, we can obtain $Cd$ as

$$C_D = \frac{2(B - W) \cot \phi}{\rho A_N V^2}$$  \hspace{1cm} (6)

The drag force is assumed to act through the centroid of the projected area, $AN$ (Randall, 1997). For cables the normal and tangential forces are commonly assumed to be proportional to the square of normal and tangential velocity components respectively, with corresponding drag coefficients $CDN$ and $CDT$ taken constant and independent of the angle to flor direction (Finke and Sielder, 1985). In this case drag forces are composed of normal and tangential components. As a simplifying assumption, the procedure does not calculate lift for the elements in the mooring. The experiment is performed in a tidal channel with little depth and width. An ADCP current meter is installed on the bottom records the flow velocity, $V$, during the experiment. The pitch sensor that incorporates the current meter records the angle of inclination. The analytical study of mooring systems behaviour is done by Mooring Design and Dynamics (MDD) software. MDD is a set of Matlab® routines that can be used to assist in the design and configuration of single point or single anchor moorings and the evaluation of mooring tension and shape under the influence of current (Dewey, 2007).

5. BIBLIOGRAPHY


3. THE TESTED MOORING COMPONENTS

As a flotation was selected special buoy, designed by Innova Oceanografía Litoral S.L., with the shape of sunfish to reduce the drag force. For this body the smallest drag is obtained when the long axis is parallel to the flow direction and the blunter end is heading upstream (Fig 2). The mooring line is completed with a short rope and a heavy anchor.

![Figure 1. Forces acting on a buoy](image1)

![Figure 2. SSBO buoy](image2)