HYDRODYNAMIC ANALYSIS OF COCKLES THRESHOLD MOVEMENT USING LASER TECHNOLOGIES (PIV)

JOSÉ ANTA ÁLVAREZ[1], ENRIQUE PEÑA GONZÁLEZ[2], JERÓNIMO PUERTAS AGUDO[3], and VÍCTOR VÁZQUEZ ÁLVAREZ[4]

[1] Civil Engineer, PhD student, Civil Engineering School, A Coruña University, Campus de Elviña s/n, 15071 A Coruña, Spain.
(Tel: +34-981-167000, Fax: +34-981-167170, e-mail: janta@udc.es)
[2] PhD Assistant Professor, Civil Engineering School, A Coruña University, Campus de Elviña s/n, 15071 A Coruña, Spain.
(Tel: +34-981-167000, Fax: +34-981-167170, e-mail: epena@udc.es)
[3] Professor, Civil Engineering School, A Coruña University, Campus de Elviña s/n, 15071 A Coruña, Spain.
(Tel: +34-981-167000, Fax: +34-981-167170, e-mail: jpuertas@udc.es)
[4] Civil Engineer, Grant holder, Civil Engineering School, A Coruña University, Campus de Elviña s/n, 15071 A Coruña, Spain.
(Tel: +34-981-167000, Fax: +34-981-167170)

Galicia is a region in Northwest Spain worldwide known as one of the richest zones in seafood and shellfish. The environmental impacts in the river mouths influences the social and economic development of this region because of shellfish's harvesting. In these areas the sediment transport capacity of the river is reduced so sedimentation zones are conformed.

The stoppage in the sand extraction produces an incoming fresh water flow which provokes the variation in the usual collection zones and mortality (Peña et al., 2004). Velocity fields in the closeness of the shells and the different parameters related with limit conditions of the movement must be known to get closer to this particular shellfish bivalves' collecting zones.

A dynamic analysis of the forces over the submerged cockles has been made to determine their threshold movement. The drag coefficient has been calculated from the friction angle between the shells and the sand bed and other hydrodynamic parameters such as the velocity profile and the physic characteristics of the cockle. The theoretical study is based partially on other previous works (Thompson and Amos, 2002).

A sample of 12 cockles of the zone has been studied in the Hydraulics Laboratory of the Civil Engineering School (University of A Coruña). The cockles were placed in a rectangular flume over a bed layer made with sand from the Ulla's dunes. From a situation in which none of the cockles was dragged by the flow, the velocity of the water was increased till the movement of the cockle started.

The forces acting on the cockle are the drag force F_D, due to the fluid, the inmerse weight F_W, the friction drag force with the bed F_F and the normal force F_N. Equilibrium on the cockle at the point of motion while sitting on the bed was calculated using the formula:

$$F_D = \frac{1}{2}\rho_w \cdot U^2 \cdot A_e \cdot C_D = F_F \tag{1}$$

$$F_F = F_W \cdot \tan\phi = (\rho_c - \rho_w)V_t \cdot g \cdot \tan\phi \tag{2}$$

where U is the mean velocity of the flow at the threshold movement, A_e is the area upon by the flow, C_D is the cockle drag coefficient, ρ_w is water density, V_t and ρ_c are cockle´s volume and density and ϕ is the friction angle between the shell and the bed.

The geometric parameters, like V_t y A_e, and other implicit ones in the mentioned formula, were obtained from a deep and detailed cockles' shape and geometry description. Density values of the cockle's body and shell, characteristic longitudes and other parameters were obtained.

In order to determine the mean velocity files obtained from the measurements with PIV were processed. The friction angle was determined by placing the cockle on a bed sediment layer of Ulla's sand sticked on a tilting board submerged in water. The friction angle is defined as the angle of tilt at which the shell begins to slide. With this method, the mean friction angle obtained is 29.1°, therefore, the drag coefficient C_D may be calculated as it the only unknow in Eq. 1. The overall drag coefficient achieved was 0.44. The results reflect interesting differences with regard to the values achieved in previous works, like Thompson and Amos (2002), in which mean values of 0.27 were obtained from the analysis of disarticulated shells in cohesive sediments. In Fig. 1 the pairs of values C_D and grain Reynolds number were represented over the values from other studies with axisymmetric bodies (Franzini and Finnemore, 2002). The obtained results drawn show that the methodology used is on the mark.

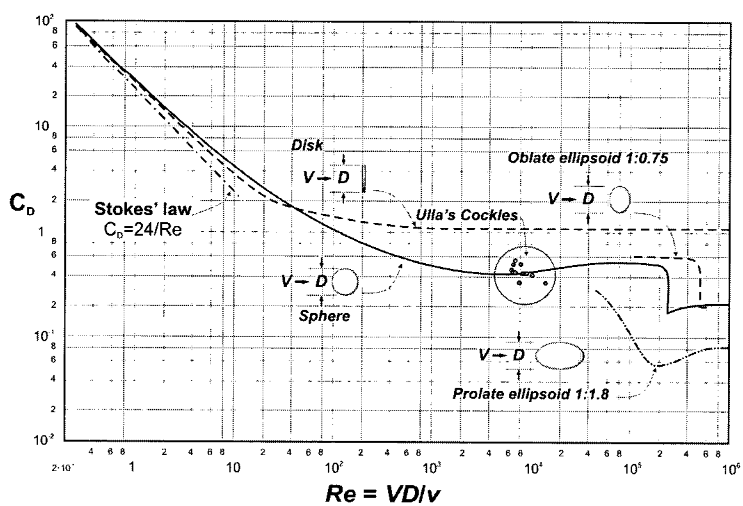

Fig. 1 Drag coefficients for axisymmetric bodies (Franzini and Finnemore, 2002) and for Ulla's Cockles.

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