FINITE ELEMENT MODELLING OF THE TIDE-CURRENT INTERACTIONS IN THE STRAIT OF GIBRALTAR

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The tidal wave propagation patterns and tide-current interactions in the Gibraltar Strait are examined by means of a quasi-3D finite element model of the shallow water equations (GONZALEZ, 1994). The spectral decomposition of the time-dependent variables allows the transformation of the transient problem into a number of simpler steady-state problems - one per each of the considered harmonic frequencies (see e.g. WALTERS, 1986). As per the residual flow, a 3D numerical approximation has been worked out making use of the ECADIS code developed by ESPINO (1994).

The numerical solutions are in quite good agreement with local observations reported by RICO and RUIZ (1988) and others. The M2 tide is seen to have eastward-decaying amplitude and to propagate southwards at the Mediterranean side of the Strait, just as expected. The solutions for the S2 and N2 tidal waves exhibit a similar character. On the contrary, the K1 co-range lines are parallel to the axis of the Strait, whereas the co-phase diagram indicates that the propagation of this wave is to the east (figure 1).

Figure 2 shows the vertical profiles of the M2 current velocity and phase obtained at a mooring site occupied during the Gibraltar Experiment 1986/87. It can be observed that the inclusion of realistic, vertically-varying density and residual flow distributions is crucial to reproduce the structure of the measured tidal circulation, whose major axis and phase decrease with depth.

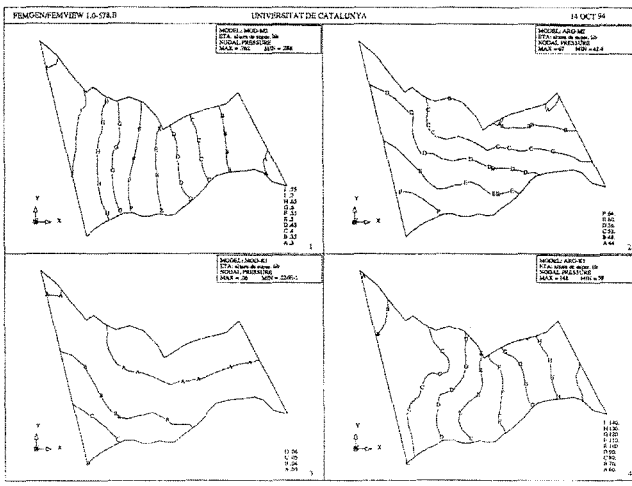

Figure 1. Numerical solutions for the M2 and K1 tides. Upper left: M2 amplitude. Upper right: M2 phase. Lower left: K1 amplitude. Lower right: K1 phase.

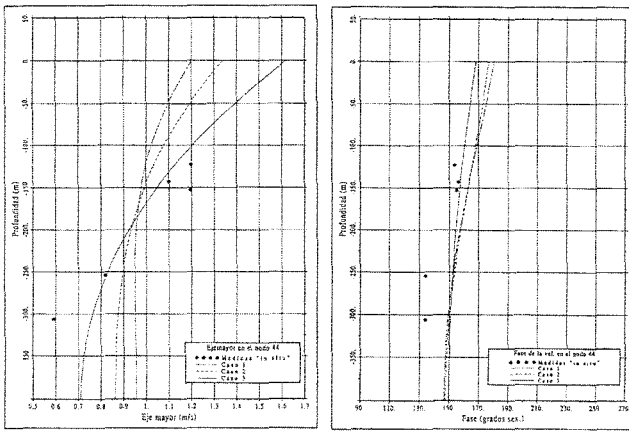

Figure 2. M2 current. Numerical solutions for the major axis (left) and phase (right) with 2 d.o.f. versus measured values on Camarinal Sill.
Case 1: only with bottom friction. Case 2: with friction and vertically-varying density. Case 3: with friction and vertically-varying density and residual flow.

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