Analysis of Extremal Currents and Fatigue Current Profiles at the Merah Besar and Ranggas Locations in the Makassar Strait

Project Characteristics:

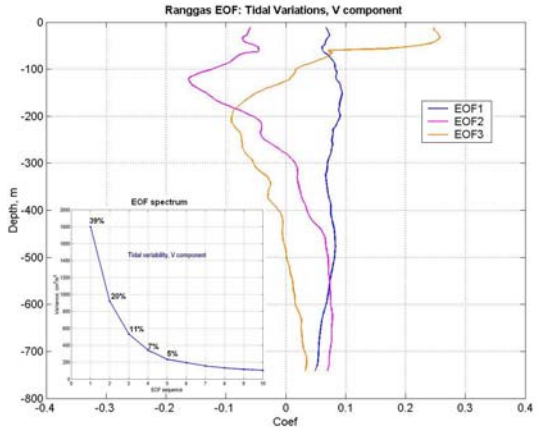
- *Offshore structure (TLP) and riser design/reponse analysis*
- *Oceanography of the western Makassar Strait*
- *Extreme current analysis*
- *Flow field variability*
- *Space-time scales of low frequency and tidal oscillations*

Unocal required extremal and operational current profiles at the Merah Besar and Ranggas sites in support of their oil exploitation activities in Makassar Strait and requested Woods Hole Group to analyze oceanographic processes and forecast extreme current events for both locations applying a consistent methodology that can be used with confidence in the future at these and other sites. The primary objective of the analysis was to apply knowledge of the physical processes to compensate for the lack of observational data used in a purely statistical approach. The information was also required to evaluate performance of TLPs and riser systems.

Methodology comprised spectral analysis, extreme event forecasting (extrapolation to long return periods) for each current component, separation of the barotropic and baroclinic currents, empirical orthogonal functions (EOF) analysis, lag-correlogram, and tidal harmonic analyses.

A generalized spectrum of ocean current variability in the area is formed by oscillations in three major frequency bands. These are long-term variations in throughflow intensity, low frequency (periods approximately from 15 to 60 days), and internal waves (periods from minutes to about ten days), dominated by diurnal and semi-diurnal tides. Since tidal and low frequency currents are driven by different forces the joint probability of occurrence of an event resulting from the combination of these processes is simply the product of their individual probability distributions. That makes Woods Hole Group's approach powerful, because it permits estimation of low-probability combined events from the observed frequency-of-occurrence statistics of each process.

An advantage of such technique is that estimation of low probability combined events reduces errors of extrapolation that may arise from the uncertainties of fitting a data set to a probability density function.



Vertical Structure of the First Three EOFs Describing Tidal Flow Variability

In the absence of transient surface currents, the vertical structure of the first empirical orthogonal function in the western Makassar Strait resembles the structure of the barotropic dynamical mode, which characterizes unidirectional flow over the entire water column. The second EOF has the structure of a first baroclinic mode and the third EOF has two zero-crossings. It is shown that the kinematic structure of the flow in the western Makassar Strait is formed by a superposition of the basin-scale, formed by open-channel dynamical modes, and local-scale surface flows, driven by the wind or/and by horizontal density gradients associated with river runoff. The boundary layer dynamics plays a role in shaping the horizontal kinematic structure of the basin-scale flow field modified by its interference with bottom topography.

Locations:	Makassar Strait, Indonesia.
Dates:	September 2003 – March 2004
Client:	Unocal Corporation 14141 Southwest Freeway Sugar Land, TX 77478

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