USING A CURRENT PROFILER TO ASSIST WITH STONE DUMPING

Stone Dumping

The use of real-time flow information is increasing in the marine world. One example is the dredging industry which needs the information for dumping stones at great depths on a relatively narrow spot. The purpose of dumping stones is sea floor protection or the covering of pipes and cables. A problem is that the stones will be taken by the flow and will not fall strictly vertical. Good estimations of the displacement by the current increases effectiveness of stone dumping operations and thus reduces costs. The software tool DredgeADCP uses the measured flow velocities obtained in real time from a current profiler to reposition the stone dumping vessel.

In a typical pipeline project the process of laying the pipe consists of three steps. First, a foundation is made of rock. Then the pipeline is placed on top of the rock layer. Finally the pipeline is covered with stones. Both rock and stone is quite expensive and generally has to be transported to the dumping site. Dumping the material on exactly the right spot is therefore of great interest. In this article we show how dumping accuracy can be improved for several types of vessel using online current information.

Types of Vessels
A dredging company usually has a range of stone dumping vessels available, see Figure 1. The left one is a side dumping vessel. It can dump large amounts of stones by simply shifting the stones from the side of the ship. The dumping process itself only takes a few minutes. Typical dumping depths are between 20 and 150 metres. The positioning of the stones on the sea floor is however more diverged. The mid vessel, the so-called split hopper barge, can also dump very quickly. The last category of vessel is the fall pipe vessel. Stones are dumped through a long pipe which allows accurate placement of the stones. However the dumping process takes much time as the material has to be thrown into the pipe, Figures 2 and 3.

The Influence of the Current
The stones are taken by the current and do not drop exactly vertical. To be able to dump the stones at exactly the right spot the vessel needs an offset in position. Much research was done in The Netherlands around 1980 to identify the important parameters and to formulate the influences mathematically. The displacement of the stones first of all depends on the type of vessel, Figure 4. In a fall pipe vessel the influence of the current is less as the stones are protected by the pipe. In a side stone dumping vessel the stones have an initial velocity and are influenced by the current during their fall from the surface to the seabed. The displacement depends on the density and size of the stones, on the current velocity and direction, on the orientation of the ship with respect to the current and on the length of their fall.

Estimating the Offset
To estimate the offset of the stones we need to know the actual values for the parameters on which the offset depends. Parameters like stone size and density are fixed during a dump. The currents however change over time, depth and position. We use a current profiler mounted on the vessel itself to measure the current velocity and direction vertical profile under the vessel (see the blue vector profile in Figure 4). The profile is available in a number of cells between the instrument and the sea floor. This information is in real time and available for further processing.

Software
DredgeADCP is a software program which has three tasks: operating a current profiler, calculating the estimated offset and presenting the results. The dumping vessel is normally operated 24 hours a day with subsequent frequent changes in operators. The program should therefore perform its tasks automatically and should not require specific knowledge of, and experience with, current profilers. The current profiler is automatically configured on the basis of a small number of requirements. For example, the measured depth cell size is chosen automatically regarding actual depth and instrument acoustic frequency.

Operation
The operator uses a simple information window and a settings window. The settings window allows the control of the parameters which influence the offset and involves parameters like vessel type and stone characteristics. The main information window (see Figure 5) shows the flow profile (top left), used parameters (top right), the necessary offset for the ship (top middle) and information on the current, its quality and the ship offset in metres (bottom). Note that the current profile obtained with the current profiler is automatically extrapolated to the water surface and to the sea floor, regions in which the current profiler will not obtain results. It is now possible to reposition the ship so that the stones will fall to their intended position.

Conclusions
The combination of a current profiler and special software allows dumping of stones while taking the currents into account. Stones can be dumped more accurately. Before these tools existed the operator generally chose to dump only when the currents were small. Now the dumping can continue under less strict conditions. This opens the opportunity to use vessels like a side stone dumping vessel more frequently.

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