INFLUENCE OF SHIP-INDUCED CURRENTS ON THE EROSION AND PERMEABILITY OF SAND-MUD MIXTURES IN THE TWENTEKANALEN

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Over the last decades there is a trend of ever growing ships worldwide to increase their transport capacity. However, the dimensions of numerous inland navigation channels do not meet the requirements for these larger ships and high costs are involved to enlarge these channels. Therefore, navigation channels are often designed at minimum dimensions whereas ship-induced flow velocities increase significantly. The latter will seriously exacerbate bottom and bank erosion causing seepage and stability problems. Rijkswaterstaat has decided to enlarge the Twentekanalen, and this research specifically focussed on the bottom erosion and seepage problem in the side channel of the Twentekanalen. Two scale experiments have been conducted and results were translated to the situation in reality.

The first scale experiment was related to ship-induced erosion in order to visualize the development of the erosion profile and to determine the erosion depth in a sand-clay mixture (Figure 2). A model ship was used in a flume (Figure 1) in which the effects of either the propeller wash, sailing speed, or keel clearance were assessed. The erosion experiment is different from previous studies on ship-induced erosion since this experiment is conducted using a sand-clay mixture whereas previous studies focussed on cohesionless soil. Results of the erosion experiments were compared with existing erosion formulas found in literature and showed both similarities as differences.

The second scale experiment examined the permeability of a sand sample on which a clay mixture is poured on top. The effect of clay plastering on the permeability in time is assessed with different clay mixtures. It appeared that the plastering theory of Talmon et al. 2013 is well represented. Furthermore, the composition of the clay mixture is of great importance regarding the permeability. Additionally, stirring the clay mixture with the sand resulted in a significantly lower permeability.

Conclusions: ship-induced flow velocities in the side channel increase up to approximately 20% for the return current and 60% for the propeller wash. Moreover, most likely erosion tracks will become deeper due to the larger vessels. Consequently, a stable sand-mud layer on the bottom to reduce the amount of seepage is rather unlikely. On the one hand ships cause erosion of the seepage reducing clay layer. On the other hand ships could stir the sediment bed that might decrease the permeability.

Figure 1: Model ship (3 x 0.56 m) in flume (30 x 3 x 2 m).

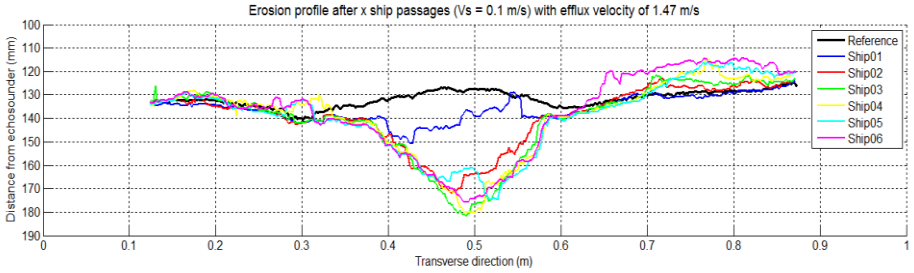

Figure 2: Erosion profile after certain amount of ship passages.

Talmon, A.M., Mastbergen, D.R., & Huisman, M. (2013). Invasion of pressurized clay suspensions into granular soil. Journal of Porous Media, 16 (4), 351 – 365.

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