

# In-situ sediment measurements for field trial in the port of Delfzijl 'Manoeuvring with negative UKC'

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## Introduction:

Sedimentation in the tidal port of Delfzijl restricts shipping. In the 4km long entrance channel a sediment layer of several meters thick has been observed in the survey data (210kHz) single beam and sub bottom profiler. To determine the safe nautical depth in the harbor in the spring of 2015 a field trial was performed with a ship manoeuvring with negative underkeel clearance in this sediment layer.

## Sediment characterization methods:

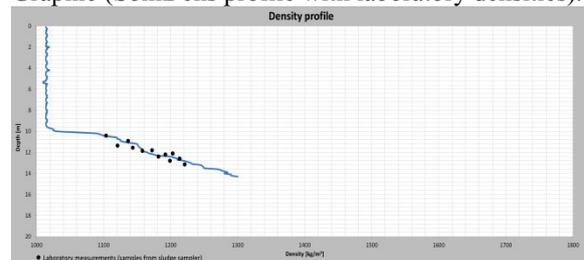
Several surveys (210 kHz) and in-situ measurements were performed to characterize the sediment layer before, during and after the field trial. The in-situ density profiles were measured with a SoniDens (figure 1). The device uses ultrasound to determine the density of the sediment. For validation of the in-situ density measurements and further characterization of the sediment samples were taken using a recently in-house developed Sludge Sampler (figure 2) and tested in our laboratory.



Figure 2: 'Sludge Sampler' for sampling the sediment

## Results:

Graphic (SoniDens profile with laboratory densities).



Rheological properties of the sediment mud.

Density	Flow point stress	Viscosity
[kg/m <sup>3</sup> ]	[Pa]	[Pa.s]
1160	40	17
1170	55	41
1180	151	22
1190	200	36
1200	280	19

## Discussion:

By a full scale field test in the port of Delfzijl it was demonstrated that safe shipping was possible with a negative underkeel clearance.

To determine the nautical depth in shipping channels and ports, characterization of the sediment layers is essential. In situ measurements and laboratory tests before – during and after the field trial provides more insight in changes in characteristics of sediments as a result of sailing through mud.

The results of the in-situ measurements and laboratory tests will be used to validate the 3D model of the port of Delfzijl and to optimize the current dredging regime.

## References:

- Duurzaam havenbeheer Fase 1, Haalbaarheidsstudie voor het succesvol implementeren van de KSN/methode in de haven van Delfzijl, 52471-1, 07-06-2011.
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