# Rheological Transition

# Rheocable

# Dredging Strategy

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## 1. Introduction

The current paper discusses dredging strategies applicable on maintenance dredging projects in ports and access channels where liquid mud is present.

The concept of Nautical Depth is relevant in those areas where at the same time fluid mud and consolidated mud are present on the seabed. The existence of liquid mud above the seabed can be made visible for example using a dual frequency echo sounder. The acoustic signals of 210 kHz and 33 kHz each will reveal different depths in the presence of liquid mud; the 210 kHz signal generally reflects the top of the liquid mud while the 33 kHz shows undefined deeper levels.

The dredging strategy pre - supposes the availability of a sounding method, capable of detecting directly and unequivocally the interface between fluid mud en consolidated mud in an area.

Such a sounding method was not available in the past and has been developed recently by **THV Nautic**.

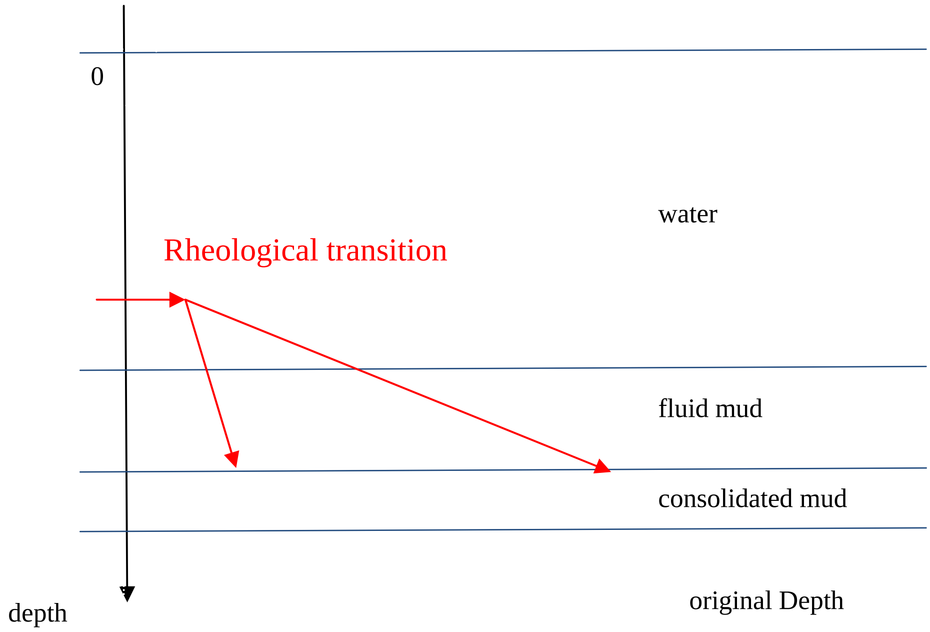
The procedure of sounding the Nautical Depth, as actually applied by a majority of maritime and port authorities, uses the method of sounding a density horizon in the mud, 1.2 in many cases. It is generally accepted that this procedure is not 100% accurate and leaves much to be desired for when used to control/quantify the necessary maintenance dredging works. More specifically it is recognized that problems exist concerning the quantification of quantities dredged and quantities to be dredged.

(Notwithstanding these deficiencies, most authorities are fully capable of running a safe operation, due to their vast experience and careful approach of things.)

But with the availability of the **'Rheocable method'**, a new sounding method capable of accurately defining the true Nautical Depth, a different dredging strategy for the handling of maintenance dredging works can be introduced, leading to more safety and reduced costs.

## 2. A new dredging strategy: the principle

The direct sounding of the Nautical Depth, as made possible by the Rheocable method of THV Nautic, produces the position of the interface between fluid mud and consolidated mud:




This distinction between fluid mud and consolidated mud, made possible by this sounding method, is very important and cannot be obtained by the actual sounding methods in use.

The importance is situated in the fact that, principally, fluid mud doesn't need to be removed from the seabed because it is navigable.[1]

[1] It is true that the sole presence of a fluid mud layer influences a ship's behaviour. These effects are well known: they have been investigated in great detail by the team of Prof. Dr. ir. Marc Vantorre in the laboratories of Flanders Hydraulics Research at Borgerhout, Antwerp, Belgium.

It is sufficient to measure the thickness of the fluid mud layer: a 210 kHz sounding and the sounding of the Rheocable – rheological transition - are needed.

Furthermore, fluid mud is mobile and it can, driven by wind, tide and currents travel over considerable distances. It may even disappear from the area to be dredged under the effect of outgoing tidal currents.

**The dredging of fluid mud is therefore unnecessary and very uneconomical.**

Consolidated mud on the other hand is not navigable, is immobile, will absolutely maintain its position on the seabed, will not disappear with wind, tide or currents. If the guaranteed water depth is situated below the rheological transition in the consolidated mud, this mud needs to be removed.

The keel clearance of a ship with the top level of the consolidated mud is the most critical parameter, of primary importance, with regard to the behaviour and the safety of the ship.

The new dredging strategy proposed in this paper supposes the implementation of two important elements:

- The rheological transition between fluid mud and consolidated mud is the real Nautical Depth and must be accepted and specified as such. (Density horizons must be removed as definitions of the Nautical Depth)

- ignore the fluid mud, remove only the consolidated mud when necessary.

## 3. A new dredging strategy: implementation.

### 3.1 In – and out survey

The principle characteristic of consolidated mud is its non–navigability. This non–navigability is a consequence of the high energy needed to move/fluidize this consolidated mud.

Other characteristics - as for example density, grain size distribution, sand content and others – are of secondary importance and should not play a role in the handling of maintenance dredging works in areas with mud.

There is no need to measure these characteristics of secondary importance with high frequency: an in–survey of the ‘top consolidated mud’ (Rheocable) is sufficient. This survey will reveal the eventual need for dredging activities: quantities to be removed in $m^3$ can be calculated, the locations etc, taking into account the usual conditions: dredging area, guaranteed water depth, dredging tolerances etc.

Upon completion of the dredging activities, the out–survey, combined with the in–survey, will facilitate the exact calculation of quantities dredged, payable and non–payable.

Intermediate surveys could eventually check the ongoing consolidation of the mud with regard to the guaranteed water depth in the area concerned.

The possibility of using simple in– and out–surveys for the handling and control of dredging activities, offers a considerable number of advantages:

### 3.2 Operational advantages

Control of the dredging activities can be carried out independently of the dredger, simple and efficient:

- Dredged quantities are calculated in $m^3$ using in– and out-surveys

  The measurement of dredged quantities on board of the dredger, such as hopper density and /or TDM (tons of dry material) in case of a trailing suction hopper dredger, is unnecessary. Systems, automatic or not, developed for this purpose, have become superfluous.

The nature of the dredging equipment is no longer relevant: water injection dredger, cutter suction dredger, hopper suction dredger, bucket dredger, plow (with or without jets) … .

Therefore, different dredging techniques can be used in one dredging area without consequences/complications for the control and measurement of the dredge quantities.

Contractors can be charged to carry out intermediate soundings. It is only necessary for the Principal to carry out the in- and out-survey.

- Limited or no supervision on board.

The limitation of the 'suction tube depth' is obtained by not paying, or even, by fining the quantities dredged below the target depth plus tolerance.

'Overdepths' can easily and correctly be detected and quantified using the Rheocable method.

The tendency of dredging contractors to dredge deeper than required, when hopper densities are used for the calculation of dredge quantities, will carefully be avoided by the contractor himself, because he knows it will not be paid for or even be fined. Consequently, supervision on board of the dredger is not required any more.

Dredge quantities located outside the dredging area, when made non-payable or fined, will also easily be detected by the Rheocable method: contractors will spontaneously try to avoid this.

The disposal of dredged material within the specified areas can be checked using registrations of the existing positioning systems on board, controlled eventually by existing radar facilities ashore.

Dredge overflow, in the case of suction hopper dredgers, is not critical within the new dredging strategy and can be left to the discretion of the contractor.

Supervision on board with the purpose of ensuring a tight control of the maintenance dredging activities is no longer required.

## 3,3, More or less maintenance dredging activities?

Comparing dredged mud quantities, measured in tons of dry material (TDM) with dredged in situ mud quantities measured in $m^3$, is impossible by definition.

During the dredging process, mud continually changes density and volume on its way from the seabed up into to the hopper, during the stay in the hopper … and unless the changing densities together with the changing volumes can be measured and recorded - quod non – the exercise of comparing $m^3$ of in situ mud with tons of dry material remains impossible.

Another imponderable element is overflowing.

Anyway, the confusion, caused by the presence of fluid mud, by the resulting diffuse echo sounding data and therefore of the dredging results, disappears when using the Rheocable.

The same applies when the contract uses a density horizon of for example 1.2. This inadequate criterion leads inevitably to more quantities dredged and paid for than strictly necessary.

The Rheocable provides the exact answers.

For ongoing dredging contracts, which have not been defined based on Rheocable determined strategies, the Rheocable method can be used to determine the efficiency of ongoing maintenance dredging activities and also to prepare for contracts based on Rheocable soundings.

Taking into account the principle that fluid mud is not to be dredged, and, consequently, that the quantities dredged are brought down to an absolute minimum – only the consolidating mud - it is reasonable to anticipate a considerable reduction of the dredging effort and of the related budget.

The Rheocable sounding method allows for a much better focus of the maintenance dredging activities.

## Conclusions

The use of a sounding method – **the Rheocable method -** capable of directly measuring the transition between fluid and consolidated mud, allows for a much better focused approach and control of maintenance dredging activities involving mud.

Start, finish and quantities of the dredging campaign will be determined correctly using an accurate sounding method. This will have considerable beneficial effects upon:

- The safety of the ship traffic
- The planning of the dredging campaigns
- The quantities to be dredged
- The production and efficiency of the individual dredgers
- The budget of the maintenance dredging works

Up to this moment, the experience of port principals has played a decisive role in these matters, and, as ship traffic in most places has been going on practically without major problems, this experience has proved itself sufficient.

We would like to pay tribute to those responsible for maintaining maritime access in each of the ports concerned, successfully carrying out this difficult task in spite of inadequate tools and support.

The introduction of the Rheocable sounding method, measuring directly and accurately the interface between fluid and consolidated mud, will provide the Principal with a more adequate tool to support his decisions and it will give rise to considerable cost savings and safety improvement for ship traffic.

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