THE DESIGN OF ANCHOR ELEVATION PLATFORMS FOR CUTTER SUCTION DREDGE D'ARTAGNAN

'LAST MEN STANDING'

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ABSTRACT

When dredging hard materials with a cutter suction dredge (CSD), the side wire forces are decisive for production. So in order to dredge efficiently, a high 'holding' force of the side anchors is necessary. Since DEME's new cutter suction dredge d'Artagnan is equipped with the strongest swing winches in the world, they have asked VOSTA LMG to develop, design and manufacture an anchoring system that is capable to meet all the requirements modern dredging vessels nowadays ask for.

In general two different working principles of side anchors are used, knowing anchors that dig themselves into the soil. (E.g. Delta, Stevin) and anchors that work on the principle of gravity, or in other words they are kept in place due to their own weight (e.g. box anchors, anchor platforms). For these gravity anchors the simple principle is: the higher the weight, the higher the allowable side wire forces.

In case of dredging hard material the gravity type anchors are generally used since conventional anchors can not penetrate (or not deep enough) into the soil anymore. In dredging practice, most of the time simple 'box type anchors' are applied. These are steel boxes with a lot of scrap in it, to which the side wires of the CSD are connected. Lifting and positioning of these boxes is done by means of 'multicats'. Although cheap and simple, both the minimum draft and crane capacity requirements for the multicats increase with increasing anchor weight.

An alternative can be found in the use of so-called 'anchor elevation platforms'. These are almost fully self-supporting, can be executed extremely heavy and are still able to work in shallow waters.

This paper briefly describes the working principle and history of this concept, followed by a description of the new design. It can be concluded that though the basic concept of the anchor elevation platforms is still the same as it was in the seventies, the new features of the 2006 version make them promising equipment both on an operational level as in transport.

Keywords: Swing winches, dredging rock, containerised

INTRODUCTION

In actual operation, a cutter suction dredger (CSD) swings from side to side using a vertical spud as a pivot point. The action (swing or sweeping) of the dredger is controlled by swing winches which are attached to side anchors by means of side wires. When dredging hard materials, high side wire forces are necessary to pull the cutter from one side to the other, especially in under-cutting mode. So in order to dredge efficiently, a high 'holding' force of the side anchors is necessary.

Looking to the working principle, basically two types of anchors are being used. Well known are the often used anchors of the 'conventional' type. These anchors create the holding force by digging themselves into the soil. When penetration into the soil is difficult or impossible, gravity type anchors are being used.

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For these anchors the weight is decisive for the holding force[1]. A combination of both working principles can be found in the large variety of different anchors in the market nowadays, all with their own advantages and disadvantages in specific working conditions.

Focussing on the side wire anchors of a CSD, in case of dredging the hardest materials. Since sufficient penetration into the soil is not possible anymore, the conventional anchors will start to ‘scrape’. Or in other words they are not able to withstand the high side wire forces, necessary for pulling the cutter head trough the rock. As a result production will decrease. In this case the only way to maintain this level, the method of having a lot of weight on the end of the side wire, hence the concept of the gravity anchors is used.

This paper describes the use of gravity anchors for the side wires of CSDs in general, and focuses on an anchor elevation platform type of gravity anchor. A brief history is described in chapter 2 followed by a description of the anchor platforms developed and built for DEME’s d’Artagnan, one of the strongest rock CSDs in the world in chapter 3. Chapter 4 describes a few of the special features of this new design, wrapping up with the conclusion and prospects in future developments in chapter 5.

ANCHOR PLATFORMS, HISTORY

With a cutter power of 1323 kW, the ‘Beverwijk 31’, was one of the biggest CSDs in the beginning of the seventies. Consequently, harder materials than ever before could be dredged. Between 1970 and 1973 she gained experience in dredging rock. Amongst others, it was noted that side wire forces where more decisive for production compared to dredging softer materials. In order to deal with these high forces, anchor holes where blasted into the sea- or riverbed in order to anchor the side wires. In other words conventional anchors could not be used anymore and different ways of anchoring needed to be explored. It was in this period that the first anchor elevation platforms and other gravity anchors where constructed.

In Figures 1-3, several examples of gravity anchors from that time are shown. For example the BLUBNIX gravity anchor; this was a very shallow draft (0.5 meters) but limited in working depth. By means of pumping water into or out of the “hull” this could be lowered or floated. The same concept applies for the SEGA (Self Elevating Gravity Anchor), in case of which the water was pumped out or into its 3 legs. In both cases 2 functions where integrated, knowing the generation of as much weight as possible and lowering and floating of the anchors. In case of the IDEFIX, these functions were separated. That is the necessary weight is created by the steel weight, and hoisting and lowering the platform is done mechanically by means of winches.

Figure 1. IDEFIX

Figure 2. BLUBNIX

Figure 3. SEGA

[1] The working principle is based on a basic physical concept of friction (static) as per definition: Friction is the force that opposes the relative motion or tendency of such motion of two surfaces in contact. The classical approximation of the force of friction known as Coulomb friction is expressed as: $F_{frict} = \mu_{static} \cdot F_{norm}$, in which mu is the coefficient of friction and *Fnorm* is the normal force to the contact surface. Mu is a dimensionless factor that can be determined empirically and is dependent on the materials used.

In case of the gravity anchor, the necessary weight is determined by the maximum.side wire force. Looking to above basic equation for friction the necessary weight of gravity anchor becomes:

$$Weigth_{anchor} = \frac{F_{sidewire}}{\mu_{static} \cdot g}$$

Box Anchor

Before discussing the anchor elevation platform further, the most used gravity type anchor is described briefly. The simplest and cheapest type of gravity anchor is the so called ‘box anchor’. These are simple metal boxes with a lot of heavy scrap material in it. Placing of the anchors is done by the workboat. If desired cutter teeth can be welded underneath the box to generate more resistance between bottom and box. One of the disadvantages of these type anchors is that with increasing weight, it becomes more difficult for a workboat to lift these boxes with their installed deck cranes. Minimum draft requirement can also become a problem, especially in case of placement of the anchors in shallow waters. Both issues can become limiting factors for the box anchor.

Basic Set up Anchor Platforms

The basic set up of the anchor platforms in combination with a CSD is schematically shown in Figure 4. As can be seen the side wire is not connected directly to the anchor platform but is first connected to a floating pontoon. Placing this pontoon has the following reasons. To make sure that the wire is not lying on the bottom, with high risk of damage (wire brake). Since the platforms are placed at the maximum possible distance from the CSD, in case of changing the side wires (because of wear, or damage) not the complete wire (the not wearing part between platform and side wire connection pontoon) needs to be changed. Arrangement of a towing hook or wedge construction on the side wire pontoon makes easy connection and disconnection of the side wire possible.

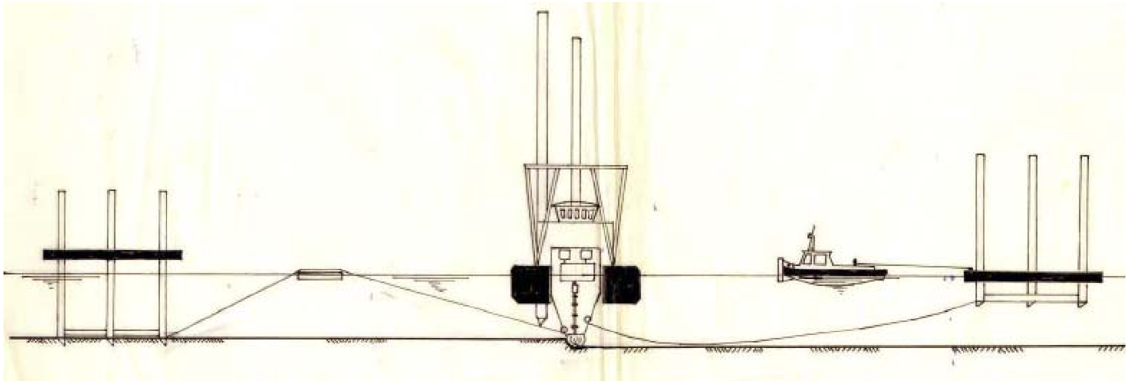

Figure 4. Basic set up of the anchor platforms in combination with a CSD.

The working principle is as follows: In floating position the platform is dragged into position by a tug or workboat. The legs are lowered and eventually the pontoon (platform) is hoisted above sea level. Carefully the side wire force is raised to its set value to make settling (if necessary) of the platform possible. Once in place dredging can start.

THE NEW DESIGN

Combining discussions with people who developed and worked with the first anchor platforms in the seventies together with modern requirements for dredging equipment, was the basis of the new design of the anchor elevations platforms for DEME’s d’Artagnan. Design criteria where set on both the level of operation as on (de-)mobilization and transport. The most important ones are:

- able to withstand a side winch force of 1500 and stall force of 1850kN
- work in shallow water
- completely containerized design

Description of the platform

Looking at Figure 5 the following main parts can be distinguished:

- Spud construction
- Pontoons
- Power pack
- Winches

The spud construction consists of 3 main spuds in ‘triangle’ configuration. The spuds are kept on fixed position (equidistant) from each other by means of cross beams on top and bottom of the construction. Holes for security pins are provided in the spuds to make securing/fixing the pontoon to the spuds once in position.

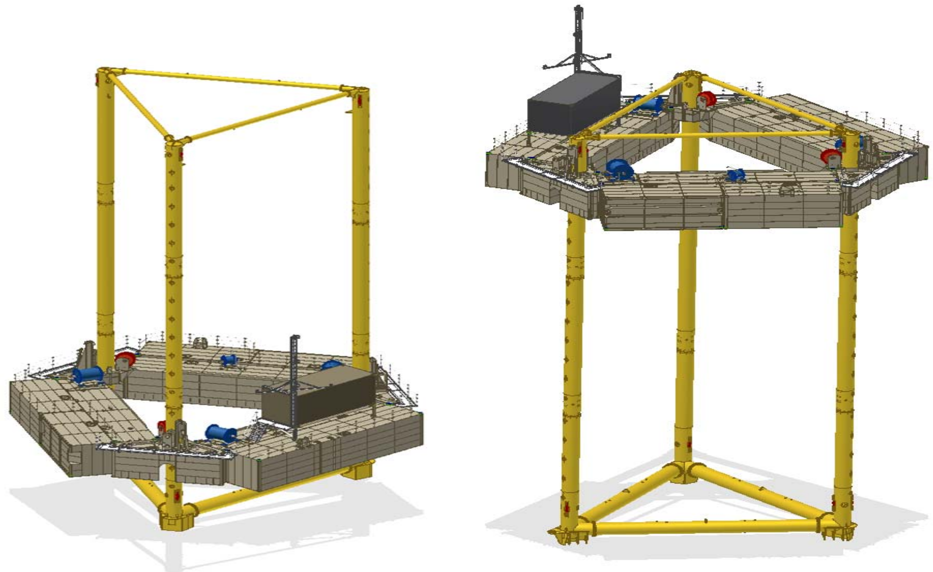

Figure 5. 3D image of anchor platform.

The platform part consists of several (11) pontoons held together via a coupling system for easy assembly. The 11 pontoons are configured in a triangular shape with an ‘open’ middle part. Spud holes are fitted in the corner pontoons and manually operated bottom valves are fitted in the 3 main pontoons in order to ballast the platform when necessary without the need of a ballast pump.

For hoisting of the spuds and platform, 3 hydraulically driven winches are placed on deck. Power generation for the winches is provided by a power pack fitted in a 20 ft container. For hydraulic energy generation, a 189 kW diesel driven hydraulic power pack is installed. The control panel is fitted near the entrance of the container. Movement of the pontoon/spuds is plc-controlled to ensure that in joint operation the offset between the 3 legs is less then 100mm.

Besides the main winches for hoisting and lowering the platform, 2 auxiliary winches are installed. These winches make it possible to drag the platform in position in case of utilization in very shallow water. In these situations, it can be difficult or impossible for a workboat (due to draft restrictions) to position the platforms. In this situation the wires on the winches are connected to simple anchor devices of scrap material placed near the shore.

Table 1. Main particulars.

Total height	33	[m]
Total weight without extra pontoons	192	[ton]
Total weight with extra pontoons (shallow draft version)	205	[ton]
Ballast water	55	[ton]
Maximum working depth	24	[m]
Minimum draft	1.06	[m]
Hydraulic power	189	[kW]
Hoisting winch pulling force (qt. 3)	3x350	[kN]
Line speed hoisting winches	6	[m/min]
Hauling winch pulling force	50	[kN]
Maximum line speed hauling winches (approx.)	80	[m/min]

ANCHOR PLATFORMS SPECIAL FEATURES

One of the important benefits of the new anchor platform is on a logistic level. Big CSDs like D'Artagnan are very suitable for doing short jobs. For these jobs mobilization and demobilization costs are substantial. For this reason the complete anchor platform was designed that it can be transported containerized. The spuds are dismountable in such a way that the parts can be transported in standard ISO containers. The parts of the spuds are coupled by means of a coupling system (coupling bolts), while the crossbeams are connected with flanges.

The floating parts of the platform consist of several pontoons with standard container dimensions (20 and 40 ft containers) and standardized container-handling provisions (iso-corner castings). In order to be allowed on board of a container ship, sizing and standardization alone is not enough. The pontoons (container) require CSC (container safety convention) certification. Getting CSC plates on the pontoons requires an extended series of load tests to be carried out. Design drawings and load cases need to be approved and tests need to be witnessed by a surveyor of a classification society. Since the corner pontoons are of a triangular shape and therefore do not have the required dimensions, steel filling pieces (adapters) where fabricated in order to make their dimensions equal to that of a standard 20 ft container (see Figure 8).

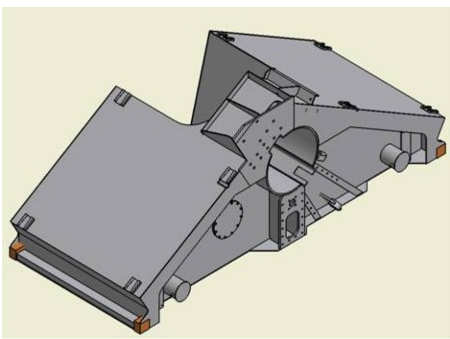

Figure 6.Corner pontoon

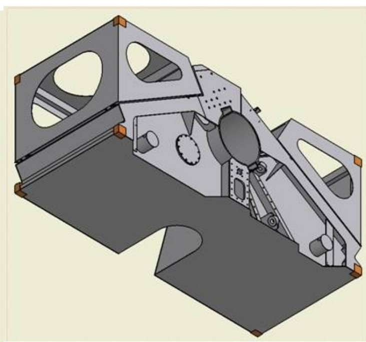

Figure 7.Corner pontoon plus filling piece

Figure 8.Loading on container ship

Working Configurations of the Platform

The anchor platform can work in two different configurations. The first configuration is the shallow draft version. In this configuration, all 11 pontoons are coupled together as can be seen in Figure 6. In this case the draft of the platform with the legs fully pulled up is approximately 1 meter. Due to the open middle part of the platform, the lower part of the spuds is flush with the bottom of the pontoons when fully hoisted. Together with adjustable stairs for access onto the platform, it is ensured that nothing sticks out below the pontoons.

In the second configuration, two of the 20 ft pontoons are dismounted from the platform and coupled to form the side wire connection pontoon (Figure 9) for placement between the anchor platform and the CSD. A quick release hook is installed on one side, to make easy and fast (dis-)connection of the side wires possible (Figure 10).

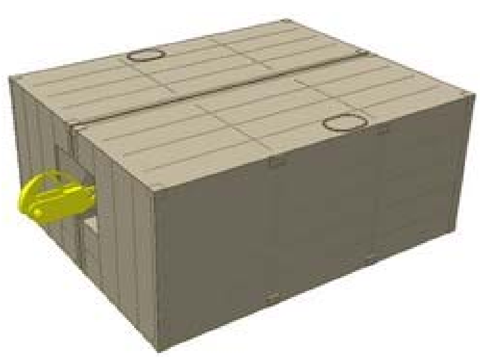

Figure 9. Side wire connection pontoon.

Figure 10. Close up quick release hook.

Controls and Safety

A complete control panel is provided in the first part of the container. For the hoisting winches 3 joysticks are placed for step less control of the speed (from 0-6 m/min under full load conditions). Feedback controlled joint operation is possible at full speed. Separate control of the 3 winches (spuds) is possible at 20% of the maximum speed to make small adjustments possible. The possibility for small adjustments is necessary for fitting the security pins into the spuds. The two hauling winches have a separate joystick; for safety purposes they can not be used together with the hoisting winches.

In addition to the fixed control panel, a remote control is provided with the main controls and one general alarm to make safe operation outside the control container possible.

Special attention was given to heeling measurement of the platform. First of all, 2 autonomously working standard level devices are fitted in the control room from which the angles of heeling can be read. In addition to visual perception of the heeling, an electronic heeling device is installed in the control panel with an alarm set at 5 degrees heeling of the platform. Though the standing stability of the platform in the worst case position (at 24 meters working depth) allows more, a maximum allowable heeling of 5 degrees was set in order to ensure safe operation.

CONCLUSIONS

Though the basic design of the new anchor platform is the same as it was in the seventies, improvements were made on the level of operation, safety and logistics. Feedback from DEME, which is based on experience with the platforms up to now, is already leading to further improvements of the platforms. In the future developments can be expected on the level of fully self-supporting (without workboats) anchor platforms or other anchoring systems that can be controlled from the dredge masters control desk.