Deepening of the Port of Santos – Brazil

Dredging to Results

5 000 km surveyed

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SUMMARY

Deepening of the Port of Santos is the major dredging project in the Growth Acceleration Program PAC (Plano de Aceleragao de Crescimento) of the Brazilian government. The dredged material had a volume of about 20 million cubic meters.

The Port of Santos is located at the bay of Santos, coastal of Sao Paulo, in south-east of Brazil.

The first historical dredge work did happen between 1891 - 1909.

The goal of the Deeping was to dredge the 22.5 km long harbor channel from 12 meters to a depth of 15 meters for the complete 22.5 km channel.

Also the channel width was expanded from 150 meters to 220 meters. The new and wider channel allows vessel up to 9.000 TEUs to navigate simultaneously in the channel. Before the dredge work happened it was only permitted that one vessel up to 5.500 TEUs could navigate in the channel at once.

In February 2010 the Deeping process and expansion of the channel started and finished in January 2012. The two years of work included main dredge work and also the removal of two big rocks lateral the channel, operated by another company.

For now, there is only channel maintenance to do.

The dredging work in the Port of Santos was a significantly milestone in the national economy, due the increased capacity for large vessels and increased sharing of the channel by ships. The capacity of the Port of Santos will increase by 30% through the dredge works.

The dredging and result of dredging as provided in the contract are definite through bathymetric contours until the maximum depth of the project was achieved. The bathymetric systems of multi beam and single beam echo sounders are used for the control, monitoring and validation during the deepening process.

Each of the systems is implemented in a specific way but with controversy. These differences, advantages and disadvantages are discussed in this study. Two hopper dredges with a capacity of 5.000 cm³ and 13.500 cm³ were applied at the deepening project.

The dredge work was monitored weekly with a single beam echosounder system and the surveyed distance was 5.400 km from beginning to end of the dredge work. The single beam surveys were necessary to get valid information from bottom inside and sediment thickness.

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Natural effects like storm surge and the continued harbor traffic and still operating port complicated the dredge work.

The storm surges returned dumped material and refilled already dredged areas with new sediment. It causes that the refilled area had to be dredged again.

Because of the vessel traffic in the harbor of Santos, the dredge and also bathymetric surveys were under high pressure to guarantee safety and efficient dredge work.

The Brazilian environmental authority allocated a dumping area 6 km away from the coast. The dumping has a depth of 22 meters. The dredged sediments were examined in a laboratory, also they did biological analyzes and monitored dredge effects and influence along the beachside and maritime fauna.

Something interesting: a local fishing club reported that they had an increasing quantity and new fishes in their area of fishing, close to the dredged channel.

Figure 01: Difficult – Buoy

1. INTRODUCTION

The figures of this work are expressive about the reality of the Brazilian dredge market, as well as its risks. The silting before achieve a project level, intense vessel traffic and bad sea conditions are risks assumed by the dredging company. For that reason I considered to do a "surgical dredging." The dredging operations have to be constantly monitored by bathymetric surveys with high accuracy, also the phenomena of silting has to be continuously monitored.

Principally unexpected difficulty are metallic objects cause damage to the teeth and dredge heads. Furthermore, interdiction areas due to archaeological searching and sea storms. The Port of Santos has historic wrecks, mainly ones who are inside the project area and impede the progress of work.

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Figure 02: Last stage of deepening - Low quality material.

The first bathymetric survey, called “LHPRE” (Levantamento Hidrográfico Primitivo) was done to provide support for the project executive, including the calculation for the expected volume of material, which has to be dredged. The dredging company gets the volume according to the agreement, if the contractual milestones are achieved. If on a given section the desired depth is 15 meters, the executor of the dredge work can only finalize the job and get the volume, when inside the complete section the depth of 15 meters is achieved (Table 01). Then the executor will be paid for his dredge work. But he only gets the salary for the volume, which was (pre-) calculated after the LHPRE, and not what he really dredged throughout the project.

The advantage is that the first survey (LHPRE) was done with a multi beam echo sounder, which had a good data accuracy. The disadvantage is that the silting phenomena happens before the dredging started. The company will not easily receive the goal, so they have to dredge much more to achieve the same depth.

For bathymetric monitoring, or rather to provide the dredges with information and to monitor the progress of work, the surveys were almost done daily with a single beam echo sounder. To penetrate into the bottom layers, to check fluid mud and suspended material, an echo sounder with 200/24 kHz dual-frequency and simultaneously data registration was used.

To complete the dredge work an ultimate bathymetric survey was done. The LHPOS (Levantamento Hidrográfico Pos dragagem) was surveyed with the same equipment and configuration as the LHPRE. Both data were analyzed and used for the official volume calculation for the deepening project of the Port of Santos.

The single beam survey data were used for dredge process monitoring and to support the dredge works with recent data.

The LHPRE and LHPOS were done with a multi beam echosounder because of its 100% bottom coverage which allows a precise and reliable volume calculation for the complete project area.

Table 01: The deepening project of the Port of Santos in facts

DREDGING WORKS OF PORTO DE SANTOS	
DEEPENING DREDGE TO LEVE	13.8 Million cm
LENGHT OF THE CHANNEL	24.600 m
NEW WIDTH OF THE CHANNEL	220 m
AREA 1 – EXTERNAL CHANNEL	
LENGHT	11.560 m
FINAL DEPTH	15 m
MEDIUM DISTANCE TO DUMPING AREA	6,65 nm
VOLUME TO BE DREDGED	4.025.648cm
INTERMEDIATE MARK	14,3 m
FINAL DEPTH	15,0m
MATERIAL TO BE DREDGED	SAND SILT AND CLAY
AREA 2 – INTERNAL CHANNEL	
LENGHT	4.340 m
FINAL DEPTH	15 m
MEDIUM DISTANCE TO DUMPING AREA	11,4 nm
VOLUME TO BE DREDGED	2.508.815 cm
INTERMEDIATE MARK	11 - 14,2 m
FINAL DEPTH	15,0m
MATERIAL TO BE DREDGED	SILT AND CLAY
AREA 3 – INTERNAL CHANNEL	
LENGHT	3.340 m
FINAL DEPTH	15 m
MEDIUM DISTANCE TO DUMPING AREA	13,24 nm
VOLUME TO BE DREDGED	1.741.999 cm
INTERMEDIATE MARK	11 - 14,0 m
FINAL DEPTH	15,0m
MATERIAL TO BE DREDGED	SILT AND CLAY
AREA 4 – INTERNAL CHANNEL	
LENGHT	5.260 m
FINAL DEPTH	15 m
MEDIUM DISTANCE TO DUMPING AREA	15,5 nm
VOLUME TO BE DREDGED	5.252.770 cm
INTERMEDIATE MARK	11 – 12,4 14,3 m
FINAL DEPTH	15,0m
MATERIAL TO BE DREDGED	SILT AND CLAY

2. METHOD

2.1 Multi beam

The main advantage of multi beam sounders in seabed characterization is their potential for selecting the exact signal returning at particular angles (Lurton, 2002).

The multi beam system was selected by the awarding authority due to cover 100 % of the area, which has to be dredged and to avoid interpolation of points between sections (Figure 03).

The calculated volumes, based on the multibeam survey with accurate and a substantial quantity of sounding. The equipment used for the LHPRE and LHPOS survey was the ODOM ES3 multi beam system, the ODOM Digibar Pro velocimeters, the motion sensor DMS-05 from TSS and HYPACK software (version 2010).

Figure 03: LHPRE with tide and detailed bathymetric data

The first major difficulty was to find a qualified and experienced engineer to perform the survey within the required standards for data acquisition and fidelity. Many companies invest in new equipment, but do not invest in the training of technicians.

This model of a multi beam system is widely used in the domestic market, because the major objective control activity at dredge works is to verify the dredged depths and the low costs of the device. But, the quantity of sections needed for a full coverage of the seabed are more than with a sophisticated (and more expensive) multi beam system.

2.2 Single beam

The single beam echo sounder is applied to monitor the dredge process, in principle for reasons of economics and secondly the practical assembly of the system. This application has been very effective to verify the dredged volumes. The dual frequency profiles are outstanding compared to the single frequency profiles (Figure 04).

The envelope delay of signals collected by a single beam echo sounder are different at any type of seabeds (Pouliquen and Lurton, 1994). This fact is very important because the dredge process can be differentiated in suspension materials or materials of different densities.

Figure 04: Profile with ODOM MKIII (200/24 kHz) single beam echo sounder

3. Results

The main result of this study is that there is the perfect application for each device and the sureness that one system does not replace the other one. The two systems complement each other. Various features, objects and intrinsic the calculation of volume were better defined by the application of the multi beam system.

The data generated by the single beam echo sounder system allowed to monitor the suspended material and a better understanding of natural phenomena. Finally, the surveys with single beam echo sounder were often operated by the dredgers.

Particularly to detect sediment layers and to have view inside the bottom, single beam echo sounder are still necessary. Even for not to overdredge and to adjust the dredge configuration for the area depending bottom condition.

4. Final Consideration

With about 5400 km surveyed bathymetry data and 20 million cubicmeters of dredged material, the dredge project Port of Santos was the biggest dredge work in the history of Brasil. The application of both echo sounders systems contributed to a very satisfied result.

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For a project of this size, all technology resources of the equipment operate on a high performance within the given project.

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