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Geophysical and geotechnical site characterisation for sustainable maritime dredging projects. The example of Port of Langosteira (A Coruña, Spain)

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***Abstract* – The knowledge of the marine subsoil is a fundamental fact for the correct development of a modern and sustainable dredging project. An accurate definition of all geological deposits and their dredgeability is directly related to a realistic cost estimation and to the employment of the most efficient equipment. In this sense the combination of geophysical and geotechnical techniques allows optimizing marine investigation surveys and obtaining more precise subsoil models in terms of morphology and dredgeability properties of the different units involved. The experience in this kind of projects in different sea conditions and a widely range of soil/rock has allowed defining the most appropriate research techniques as well as the suitable equipment and the necessary type of vessel. This paper also presents some brief results of a geophysical and geotechnical marine investigation carried out in the Port of Langosteira (A Coruña, Spain) for dredging works in a rocky seabed.**

***Keywords* –** *marine geophysics, marine geotechnics, sustainable dredging, seafloor characterization*

I. INTRODUCTION

The correct description of soil and/or rock material is one of the most important elements for the planning of maritime dredging operations, as the material to be dredged determines the selection of dredging equipment and drives the productivity computations [1]. In addition to this, there are several parameters than are also relevant in main processes related to a dredging project: excavation, transport, unloading and potential re-use of the dredged material. Thus, the more suitable and reliable available information of the soil and rock, the more specific and sustainable the dredging project will be.

The combination of geophysical and geotechnical research techniques for maritime investigations allow obtaining an accurate subsoil model. Nevertheless, the use and adaptation of these techniques for the high technical and QHSE requirements of dredging projects is not a short term task. Not only the work methodologies have to be mastered, but also the personnel must be highly qualified. Therefore, it takes time to achieve enough level to carry out highly demanded marine geophysical and geotechnical surveys for dredging projects in often complex working areas.

II. GEOPHYSICAL AND GEOTECHNICAL TECHNIQUES

There are numerous methodologies that allow obtaining direct and indirect information about soil/rock dredgeability, its behaviour during transport and the suitability for its re-use. The most common investigation techniques are listed below. It must be pointed out that the applicability of each of these techniques has to be evaluated for any particular project.

Geophysical techniques

Marine geophysics allows covering large areas with fairly light equipment and vessel. Therefore, it provides a large amount of subsoil information in a short period of time and at a very competitive cost. In order to obtain high-quality data that reaches the target depth for each project, a proper selection of the suitable techniques is a key factor. Here below some common techniques that can be used for marine dredging projects:

- Seabed investigation: Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS) and magnetometry.
- Sub-surface investigations: Sub-Bottom Profiler (SBP), seismic reflexion and seismic refraction.

Geotechnical techniques

Marine geotechnical studies allow obtaining subsoil models based on morphology and in-situ physical and mechanical properties of the successive layers below the seabed. Sampling for a further laboratory tests campaign is also a key objective. Moreover, they are also an useful tool for calibrating the geophysical models previously performed. The selection of the most suitable equipment is directly related to the type of project and the expected soil and/or rock to be investigated. Here below some of the most commonly used for maritime dredging projects:

- In-situ tests: Cone Penetration Tests with pore water measurements (CPTU).
- Sampling: Grab samples, Vibrocoring for soils and submarine drilling rigs for rocky seabed.

III. MARINE SOIL INVESTIGATION IN THE PORT OF LANGOSTEIRA

A geophysical and geotechnical site characterisation was carried out in the Port of Langosteira (Northwest of Spain) with the aim to provide precise subsoil information for the development of a dredging project for the deepening the access channel. Two main areas were investigated: (i) exterior of the port with water depths ranging between 22 and 26 m and (ii) interior with water depths between 11 and 15 m. The marine geophysical survey provided a first qualitative model of the entire project site. It consisted on:

- MBES in the channel access area.
- Seismic reflexion and refraction survey with a streamer fit out with 24 hydrophones and a Sboom as an energy source.

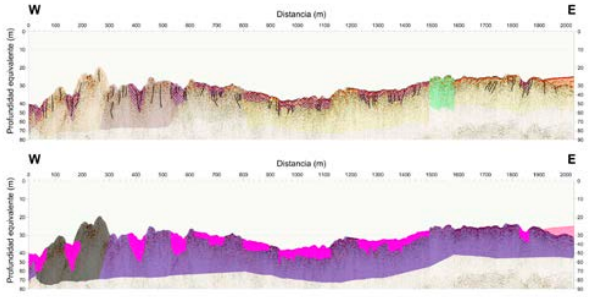

Fig 1. Seismic profile with geological interpretation (up) and with levels based on dredgeability based on [1] (down)

The marine geotechnical survey provided accurate information of the selected investigation points which was then used for the calibration of the preliminary model, based on geophysical results. It consisted on:

- 13 rotary boreholes with a remotely operated submarine drilling rig. The maximum achieved depth was 2.7 m.
- Laboratory tests on rocky samples recovered during field works: UCS, vp determination, Young and Poisson Modulus and Cerchar abrasiveness, among others.

Fig 2. Remotely operated submarine drilling rig used for rotary boreholes

The combination of all these techniques and data sources allowed defining a 3D geological model as well as the main mechanical and classification properties of involved levels and their dredgeability, based on referenced documents such as [1].

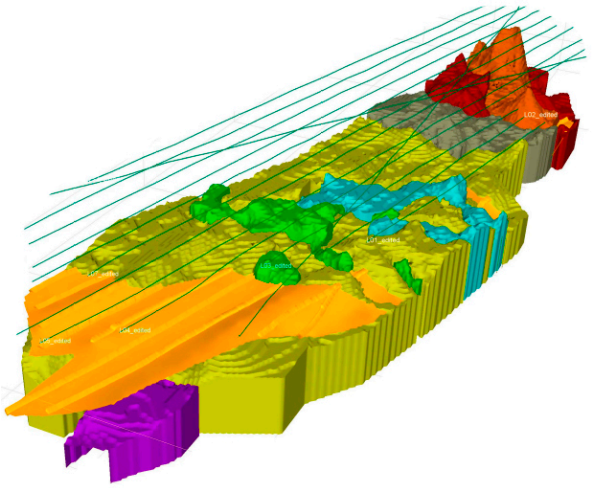

Fig 3. 3D model with different rock units based on its dredgeability

IV. CONCLUSIONS

An accurate subsoil model is a key factor for developing a proper and sustainable maritime dredging project. The selection of the suitable dredging equipment and the productivity computations are directly related to the ground conditions. In this sense, the combination of marine geophysical and geotechnical techniques is a suitable methodology when a soil and/or rock investigation is required. These different data sources allows not only optimizing marine investigations surveys but also obtaining precise subsoil models in terms of morphology, mechanical properties and dredgeability.

V. ACKNOWLEDGEMENTS

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REFERENCES

[1] PIANC, *Classification of soils and rocks for the maritime dredging process*, PIANC Report nº144, 2016.