Preliminary Marine Environmental Study for Underwater Pipeline Projects

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Abstract

The preparation of a project for the construction of a underwater pipeline requires a preliminary study of the marine environment parameters of the installation site.

This information will allow the design optimization of the plant as well as improved budget calculations. Seabed Bathymetric data of the installation site obtained by means of acoustic systems it's always more reliable than information obtained directly from the charts.

Seabed morphology is an important parameter to take into account for desk study preparation. Side Scan Sonar and Multibeam are powerfull techniques to obtain the required data.

Seabed Geotechnical data is also required . In particular the identification of the soft layers interfaces , composition , and grain characteristics. Sub-Bottom profilers and Vibrocorers techniques will be a must to obtain reliable data.

A good engineering project needs to take into account reliable data to facilitate the project execution within the time schedule and design parameters. All the extra expenditure to assure data quality is worth doing and normally represent a small portion of the total project budget.

Key words Project; underwater pipeline.

The preparation of a Project for the construction of an underwater pipeline like a Marine Waste Water Disposal Outfall or a Water Intake for a desalination plant or power station, requires the necessary information about the marine environment where it will be installed. This information can be achieved with on site marine survey and will allow to optimize the design with the best technical solution and adjusting the execution costs.

On most ocasions the only pre-stablished requirements that affect the design of the pipeline route are, the shore end connection point and the minimum possible lenght of pipe due to economical reasons. The last assumption is linked to the construction process and in some ocasions longer routes improve the performance due to a different technique.

The scale on wich the results will be presented and the required degree of detail, are two parameters to be accurately defined when preparing the site pre lay route survey. The scale is usually small and of a high degree of detail due to the need to identify the annex shore instalations.

The first step is to obtain a detailed underwater chart of the proposed pipe route. This can be done with the use of various geophysical instruments like Side Scan Sonar and Multibeam. The principle of these acoustic tools is based on the different acoustic reflective behaviour of the various substracts thus, allowing to obtain data of the substract surface but not of the materials buried beneath.

Taking into consideration the wide range of equipment available on the market is difficult to generalize, but the Multibeam Echosound offer a high degree of numeric detail of the seabed surface, covering wide areas of seabed at great depths. It requires the installation on board medium to big size vessels increasing the costs significantly. The great advantage is to obtain bathymetric data with centimetric resolution, together with charting data.



Multibeam Echosound Image

Side scan sonar image



The Side Scan Sonar, on the contrary, it is more versatile since is possible to be operated from small crafts, with very clear graphic register of the seabed surface but generally without depth data input wich will need to be obtained with the Hydrographic Echosound.

From the data obtained by the use of the two techniques described above, a chart can be produced with the different type of existing seabed substracts and defining those that could be an obstacle during the construction phase, like rocky areas, thus allowing to determine the most suitable route for the pipe installation.

The obtained data also allow to deduct the nature of the benthonic comunities although they should be checked with towed video, remotely operated video or divers. This is important for the assessment of the environmental impact on the construction site.



Diver at work

The information obtained so far refers to the nature of the materials of seabed surface and the depth. Is often necessary to know the type of materials buried beneath the seabed surface as they may present a dificulty during trenching operations or we may need to know the loading capacity of the seabed in order to install structures.

For that purpose various geophysical equipments can be used , all of them based on the different material reactions to low frecuency acoustic waves. Depending on the specific target of the survey, the equipment will be selected from a wide range available. Boomer equipment have a remarcable penetration capacity due to the operation in low frecuency (0.5 - 2 kHz) but resolution is low. By contrast the equipments operating at higher frecuencies (2 - 15 kHz) present a lower penetrating capacity limited to sedimentary materials only, but with high resolution data. The fact to be able to operate from more affordable small crafts and also able to acces to the shallow water areas made the bottom profilers the prefered tool.

All the above described techniques are based on the response of the different materials to the acoustics waves, but many times this is not enough to identify the materials present at the worksite. The data show the different layers thikness but with no information about their mechanical characteristics

To complete this information it is neccesary the extraction of soil samples on wich to do the necessary tests. Is not the same to trench in sand, mud or gravels. The volumes of material to be dredged are different in order to prevent the trench from collapsing.

The extraction of representative samples of the different sedimentary materials is done with equipments capable to penetrate the desired lenght, usually no more than 6m, being the vibrocorers the most popular once. An asimetric device driven by an electric motor induces a vibration capable to fluidize the adjacent sediment allowing the extraction of a core sample and perform a granulometric analysis.



Sometimes the materials subject to dredging operations, show a high degree of consolidation or they are even formed by rocks. In this circumstances the extraction of the core samples cannot be done with vibration equipment. Rotary drills installed onboard Jack Up platforms or diver operated units can be used for this purpose.



Drilling operation

The positioning of all the obtained data is done with last generation GPS that are accurate enough to avoid the traditional use of topography equipment difficult to use on the marine environment.

Although very important, the weather and oceanographic data are not obtain by direct and localized observation. A wide range of series of data are needed to be reliable. Existing general information is collected.

A good Engineering Project need to have in hand the most reliable data so the reality matches the plan. The economic effort to gather all this data is small if compared with the total budget and is always worth spending specially if we take into consideration the ammount of resources that can be saved by preventing unspected circumstances that can alter the work process, the final budget and the time schedule.