

# Multichannel Analysis of Surface Waves (MASW) for Offshore Geotechnical Investigations

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## Introduction

The analysis of surface waves has been practised widely in geophysical surveying to determine a number of soil properties. When the elastic properties of near surface materials vary with depth, the propagation velocity of the surface waves change with the frequency and by analysing these dispersions the required soil properties can be acquired.

The Multichannel Analysis of Surface Waves (MASW) technique has developed over the past two decades to reduce the issues posed to other surface wave techniques. Traditional refraction seismic techniques are not useful in marine environments as the compression waves (P-wave) tend to arrive at approximately the velocity through water, due to the saturation of the bed sediments. In addition to this, in seismic refraction, surface waves account for up to two thirds of the energy produced by the source. Another benefit of using the MASW technique is that it can be performed as dynamic MASW, i.e. a streamer can be used for data acquisition and shots are taken as it is towed along the survey line, allowing for the production of 2-Dimensional profiles.

## Objectives

- To generate shear wave profiles from collected data
- To determine small strain shear modulus values
- To compare these results with data obtained from borehole measurements throughout the site
- To identify limitations for using MASW in marine environments (eg. Noise)
- To investigate the feasibility of stationary and/or dynamic MASW

Figure 1: Seismic Shot Record

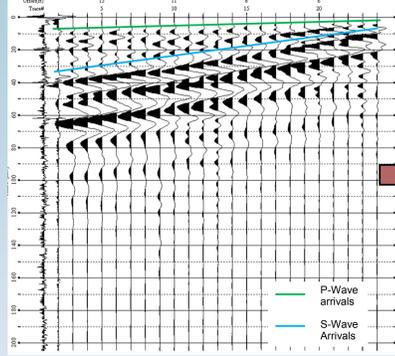


Figure 2: Dispersion Curve

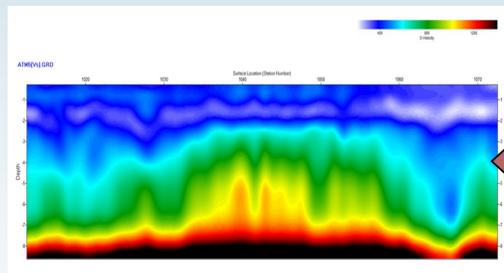
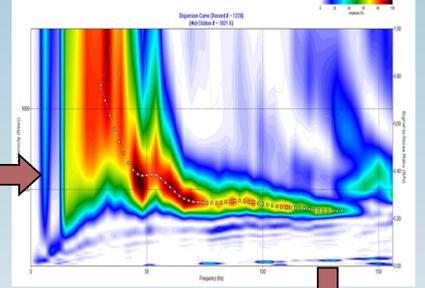


Figure 4: 2-D Velocity Profile

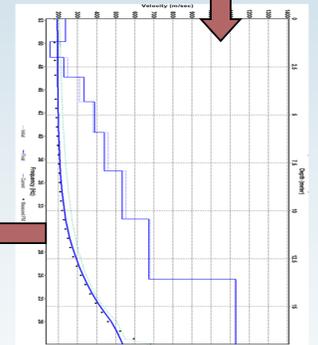


Figure 3: 1-D Velocity Profile

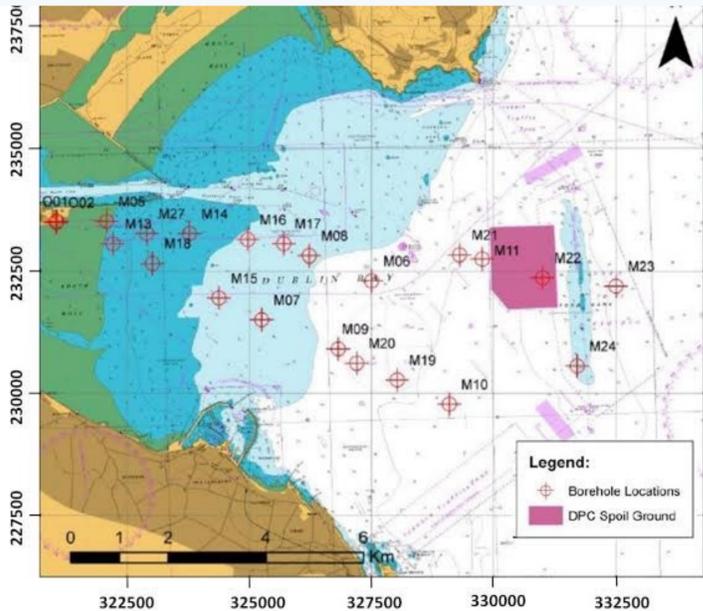


Figure 5: Dublin Bay, with Boreholes



Figure 6: INFOMAR's R.V. Keary

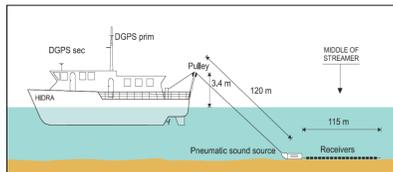


Figure 7: Typical Marine survey set up

## Site

The first stage of offshore practical work is expected to be performed over two 5 day excursions into Dublin Bay, analysing numerous line segments, to ensure a comprehensive survey of the site and to maximise the quality of the data obtained.

Two lines will be investigated (Figure 5), both extending from South Bull Wall by the Poolbeg Generating station. The first line extends from West to East, while the second is in a more South-Easterly direction.

The site was chosen as it provides a variety of subsurface layers with varying soil and properties, as is visible from good geotechnical data for the area, which has been supplied by Geological Survey Ireland.

## Equipment

To access the designated sites in Dublin Bay, INFOMAR have agreed to hire one of their research vessels (the R.V. Keary) for the duration of the project, and with the aid of its crew, will significantly improve deployment of equipment to the designated locations.

The equipment to be deployed include: an air gun to act as a pneumatic source and; a 24 channel hydrophone cable which will be laid on the sea bed to record the transmitted surface waves. See Figure 7 for typical set up.

## Pre-existing Geotechnical information

Ground Models were developed for the Northern and Southern Lines using the information from boreholes drilled by Fugro/CDM (Ireland) Ltd, as provided by the Geological Survey Ireland. From this information, approximate densities for each stratum were extracted, for use during processing, and the stiffness of each stratum were determined from the Standard Penetration Test results, which will be used for comparison post processing. After performing research on the topic, value of the Poisson's ratio for each layer was obtained. This characteristic of soils does not greatly affect the results of an MASW survey, however these values are necessary to assist the processing of MASW data.

Layer	Stratum Thickness Range	Bulk Density	Stiffness	Poisson's Ratio
	m	Mg/m <sup>3</sup>	MPa	
Estuarine Sand	0.00 -> 7.80	2.13	148	0.45
Estuarine Silt	0.00 -> 11.50	1.96	185	0.49
Upper Gravels	0.50 -> 8.50	2.00	270	0.45
Port Clay	0.70 -> 10.85	2.20	145	0.49
Lower Gravels	1.35 -> 9.90	2.00	310	0.45
Glacial Till	0.00 -> 35.00	2.26	245	0.45
Bedrock	N/A	2.14	N/A	0.31

## Acknowledgements

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Figure 8: Ground Model, indicating SPT N values

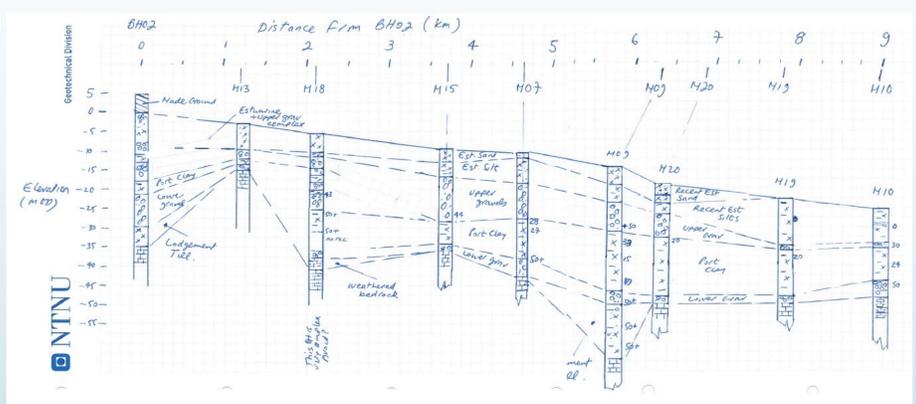


Figure 9: Ground Model, indicating moisture content and SPT stiffness values

