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ADVANCED PROCESSING OF TERRESTRIAL LIDAR AND MULTIBEAM DATA FOR BREAKWATER SURVEY

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1. Introduction

The construction of rubble mound breakwaters concerns a complex task. Surveys are required of the rubble mound placed below water level as well as of the rubble mound placed above water level during construction. The surveys allow to see if the material is placed on the right position and possibly to take corrective actions. Geophysical and geotechnical surveys are often used to get this necessary information for the client as well as for the contractor. The currently available technologies allow to locate concrete armour blocks and rocks into great detail.

The company Eurosense developed a novel approach to process the survey data of the armour layer of the Ostend breakwaters into 3D CAD models or GIS models of the concrete armour blocks.

2. Terrestrial lidar and multibeam surveys of the Ostend breakwater

From half 2009 up to the beginning of 2012 the construction of the main body of the two rubble mound breakwaters in Ostend (Belgium) took place (Verhaeghe et al., 2010). The armour layer of the breakwaters consists of a double layer of HAROs, concrete blocks of 15 tonnes each. During the construction of the breakwaters, surveys were performed to check the location of the dumped rubble mound and the concrete armour layer.

The company Eurosense has deployed two high-end techniques to do this. Above water level, the terrestrial lidar technology was used. Below water level, the bathymetric multibeam survey technique was deployed. In figure 1 two images generated from a terrestrial lidar survey of the armour layer of the Ostend breakwaters are shown. The image on the right shows the head of one of the breakwaters.

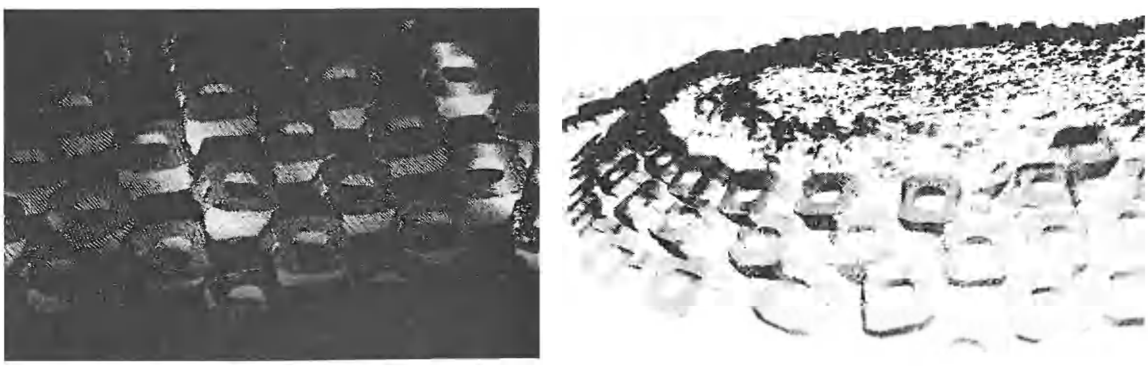

Figure 1. Images of the armour layer of the Ostend breakwaters created using terrestrial lidar.

3. Advanced processing of the survey data

The detailed terrestrial lidar and multibeam surveys lead to huge data files which are not easy to handle. Furthermore it is not always straightforward to interpret the images by just looking at it on a screen. Therefore a method to extract the necessary information from these huge data files was searched for.

The company Eurosense developed a routine to 'find' the armour blocks by fitting a theoretical model of a HARO on the survey data. The method is based on object recognition and least squares approximation techniques developed by the Eurosense Lidar department. Figure 2 shows some HARO models fitted onto the data of a terrestrial lidar survey.

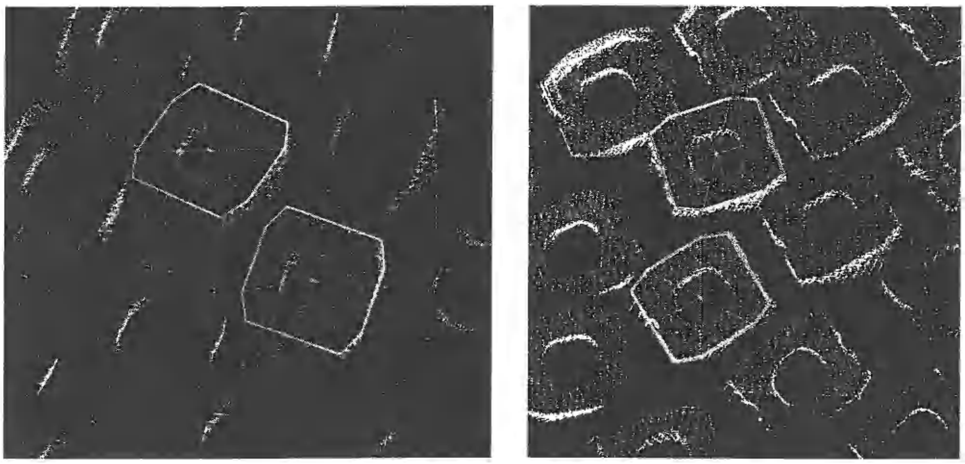

Figure 2. Terrestrial lidar image with theoretical HARO-blocks fitted onto the data.

The many measuring dots of the survey of each detected armour block can be replaced then by the center point of the armour block plus an orientation vector of the armour block. This means that after the routine found all armour blocks, the huge amount of data from the survey can be replaced by a very simple mathematical model, containing only the center points and orientation vectors of each block.

4. Conclusion

The purpose of the process is to deliver highly accurate and easy to use mathematical models of the armour layer of the breakwaters, based on the point clouds produced by lidar and multibeam surveys. Such models are useful during construction of the armour layer of the breakwaters as well as later on, during observing the breakwaters in time.

The as-built characteristics of the armour layers can easily be deducted from the mathematical models. Comparison of the three-dimensional position and orientation of all individual blocks with the design specifications clearly shows where the placement of the armour blocks needs to be adjusted.

The technique is not only useful during the construction of the breakwater, when the correct position of each armour block can be checked, but also later on the technique allows to learn something about the settlement and movement of the armour blocks in time. By repeating the surveys after some time, the movement vectors of each armour block are achieved by extracting the two mathematical models from each other.

The paper will show the processing of more than one survey of the armour layer of the Ostend breakwaters, learning something about the movement of the armour blocks after finishing construction.

References

Verhaeghe, H., Van Damme, L., Goemaere, J., De Rouck, J. and Van Alboom, W, 2010. 'Construction of two new breakwaters at Ostend leading to an improved harbour access', *Proceedings of the International Conference on Coastal Engineering*, vol. 32, 15p.