



# Inclination Measurement System

Measure inclination and position while piling

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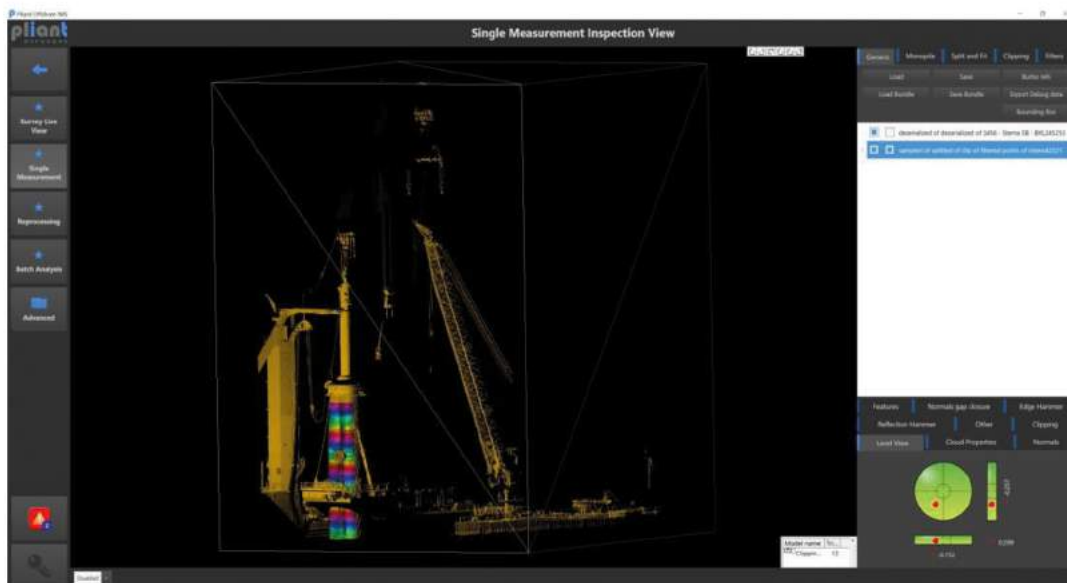
## Introducing the Pliant Offshore Inclination Measurement System

The Inclination Measurement System is developed by Pliant Offshore. The system allows real-time measurement of the inclination and position of structure such as a monopile during installation and is specifically designed for continuous measurements during piling. By using state-of-the-art in-house developed 3D point cloud technology in combination with laser sensors we measure and virtually reconstruct the measured objects. The use of motion compensation in combination with positioning systems allows you to use the system even on a non-stationary vessel.



### Key Features

- Up to 0.05 degree accurate
- Motion compensated
- Reliable in all weather conditions



Seamless merging of online and offline functionality in one program. Being able to quickly inspect a scan in Single Measurement Inspection View gives insight how to improve processing whilst online. And Batch Analysis and Reprocessing can help test new settings/ideas on files for a robust test before starting the next pile.

Client Feedback: "IMS is unquestionably a revolutionary system that contains very powerful tools and features. The reliability of its computations and algorithms have proven to be robust during many hours of development, testing, and real-world operation."

**Jon Southwell - Van Oord**

## Accurate

The system will continuously measure inclination with high accuracy. This allows you to act swiftly as soon as deviations from the target occur. Next to that, the system is able to cope with local deformations of the pile since the system is able to measure deformations in advance and compensate for this deformation during piling.

## Less errors and failures

Not only does the system allow you to complete monopile installation faster, since you don't need to stop piling for an accurate measurement, but by using IMS you will have less chance of installation errors of the monopiles because the system measures position, orientation, inclination and height of the monopile and compares this in real time with the expected design parameters. The IMS is able to deal with deformed piles. Dumps, misalignment and oval piles will no longer result in deviations of the angle. Again this means saving valuable time.

## Robust and proven technology

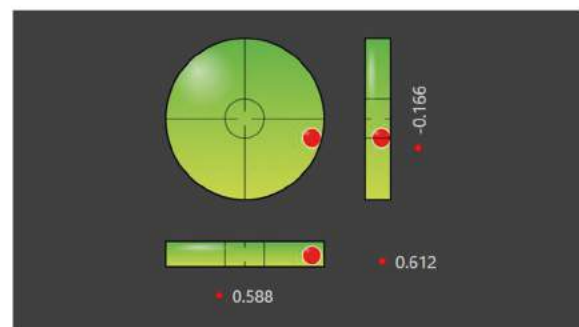
The IMS is successfully used for multiple installation projects on various vessels. It has proven to be robust and very suitable for harsh offshore conditions while maintaining accuracy.

## Faster installation

The IMS can yield higher up-time; during the installation process piling does not have to be suspended for conventional contact measurements. The nondestructive contact-free measurements allow continuous control during installation and piling which can greatly improve the overall time required for installation.

## Cost efficient

The IMS has proven to save  $\pm 0.5$  hour per monopile installation since piling doesn't have to be interrupted. Besides that, it has proven to save significantly on cost for fixing errors.



## Survey

All 3D measurements can be stored, analyzed and played back for offline analysis, survey and quality control of the installed structures and the installation process itself. This information is very valuable for reporting to the client.

**Client Feedback:** "IMS has consistently proven itself to be a reliable and accurate system throughout the whole piling process, offering a clear advantages over other methods and completely negates the need for the spirit level. IMS provides a level of automation not provided by any other system and removes the potential for user error in determining inclination and direction, reducing the chance of an MP being installed outside specification.

**Jon Southwell - Van Oord**

## Statistics

Based on actual installation data, IMS has proven to have the following statistics relative to the average as built inclination. The following statistics are based on the installation of two complete wind farms. Compare this data with the hammer measurement tool as follows:

Inclination	$\Delta$ IMS vs. Average	$\Delta$ Hammer vs. Average
Average	0.02°	0.05°
Median	0.01°	0.04°
St. Dev. (Prec.)	$\pm 0.04^\circ$	$\pm 0.06^\circ$
Sensor Dev. (Prec.)	$\pm 0.02^\circ$	$\pm 0.05^\circ$

IMS has proven to exceed more conventional methods in both accuracy and precision.

Figure 1

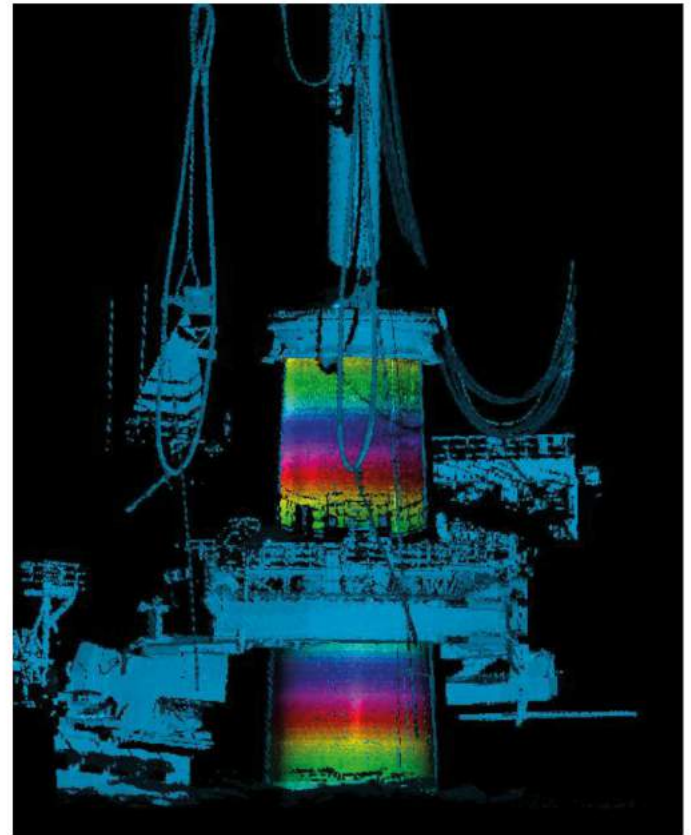
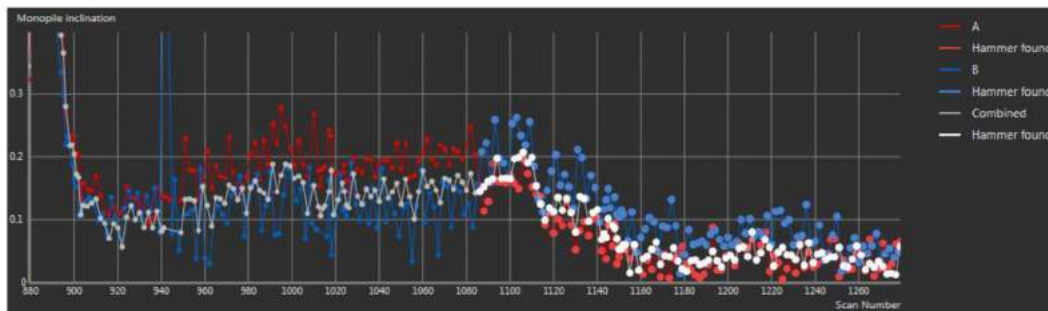


Figure 3



(Figure 1) Example of the 3D coverage of data on the MP. (Figure 2) Close up example of MP fitting performed by the software for inclination calculation. (Figure 3) Example time series of IMS inclination data (from which above 3D scan data was taken).

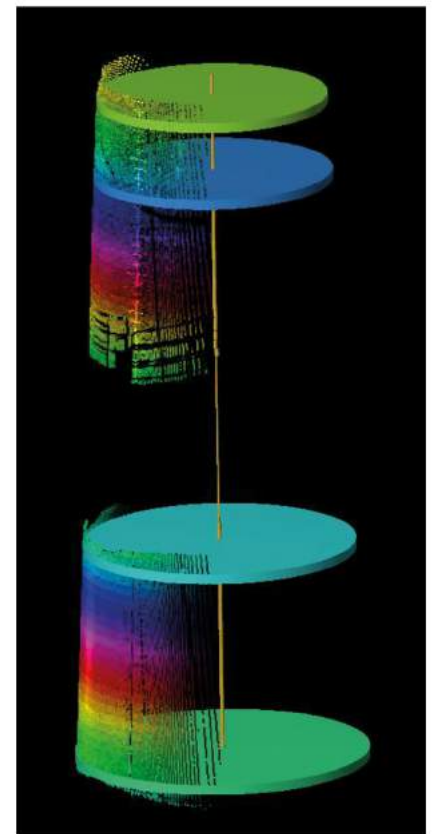


Figure 2

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