

# GRL Services

*by the Foundation Testing Experts*

## Offshore Dynamic Pile Monitoring

*High Strain Dynamic Pile Testing consists of obtaining strain and acceleration measurements during pile driving and analyzing these measurements to evaluate driving stresses, hammer performance, and bearing capacity.*

Pile driving is a major task in the construction of offshore oil platforms and offshore wind farms. Timeliness and flawless installation are directly linked to significant economic savings for these projects, which are built in environments with challenges quite different than on-land jobs. GRL Engineers provide dynamic pile analysis and pile driving monitoring services that greatly contribute to successful pile installation.

### **PRE-CONSTRUCTION DRIVEABILITY STUDIES**

GRL often starts by performing with a driveability analysis with the GRLWEAP Offshore Wave (Wave Equation Analysis of Pile Driving software) The driveability analysis evaluates if the proposed hammer is suitable for the installation, anticipates installation conditions that may require special precautions and calculates combined dynamic and static bending stresses and dynamic compressive stresses on the pile.

### **DYNAMIC PILE MONITORING**

During pile driving GRL monitors the efficiency of the hammer and driving system, as well as the pile stresses, with a Pile Driving Analyzer® (PDA). If necessary, GRL engineers recommend adjustments to the installation process for driving stress control. GRL instruments the pile with two accelerometers and two or four strain transducers attached near the top of the pile section being monitored. The diametrically opposed instrumentation allows GRL to assess bending stresses and calculate the axial strain of the pile by averaging the individual signals. GRL may monitor the entire installation process or instrument only the pile sections near the end of pile installation. Typically the GRL Engineer can attach the measuring instruments without delay to the project, prior to pile hoisting.



*Dynamic pile monitoring on offshore oil platform.*

### **EVALUATION OF STATIC PILE CAPACITY**

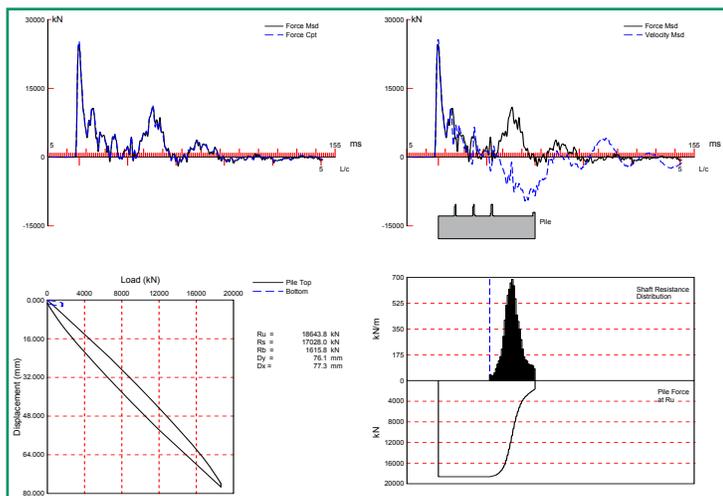
The non uniform cross sections and deep penetrations that characterize offshore pile installations make the use of CAPWAP® signal matching analysis essential for capacity evaluation. GRL generally performs CAPWAP analyses immediately following the pile driving activity, using the force and acceleration signals collected during pile monitoring. This provides an assessment of the shaft resistance, end bearing and stress distribution along the pile length at the time of testing. Tension capacity is often critical when pile refusal occurs significantly before the design penetration depth. GRL engineers may also evaluate uplift capacity with CAPWAP. If necessary, GRL evaluates the gain of capacity due to soil setup during a restrike test, so long term capacity may be estimated.

**GRL** Dynamic  
Measurements  
and Analyses  
**engineers, inc.**

**Quick response . . .  
results you can trust**

## CAPWAP® AND REFINED WAVE EQUATION ANALYSIS

**CAPWAP** utilizes an algorithm that is very accurate for the long and non-uniform piles that are common in offshore installations. It calculates wave equation parameters including soil damping, quake, shaft resistance and end bearing for discrete points along the shaft of the pile. In offshore pile installations, GRL engineers often use site-specific parameters calculated by CAPWAP to repeat the GRLWEAP analysis. This refined wave equation analysis may to resolve discrepancies between predicted and observed blow counts, serve as a basis of pile acceptance in case of early refusal, and improve installation criteria of other piles in similar soils.



Results of CAPWAP analysis on 132.6 m long offshore pile.

## UNDERWATER DYNAMIC TESTING

The foundations of many offshore oil platforms are designed for driving by underwater hammers. GRL has the equipment to perform underwater dynamic testing in these situations. Underwater strain transducers are coated with polyurethane and the internal components of the accelerometers are protected with a waterproof sealer and O-rings to prevent water intrusion.



Offshore Wind Farm; turbines supported by driven piles.

GRL has been performing Offshore Dynamic Pile Monitoring services in major oil fields in the Gulf of Mexico, the North Sea, the Red Sea, the West Coast of Africa, the coasts of Brazil, California and Alaska, the South China Sea, Lake Maracaibo, the waters around Australia and New Zealand, the Arabian Gulf, the Indian Ocean, the Cook Inlet, the Beafort Sea, and the Caspian Sea and more. Offshore wind farm installations present similar challenges as offshore oil platforms.



Underwater pile driving for an offshore oil platform.

CAPWAP and Pile Driving Analyzer are registered trademarks of Pile Dynamics, Inc.



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