Fugro Seacore Ltd

Developments in XL Drilling for Monopiles/Shafts used in the offshore energy sector.

June 2014
FUGRO SEACORE COMPANY PROFILE

- Seacore was formed in 1976
- Acquired by Fugro in 2007
- Approximately 500 employees
- Sales in 2013 were approximately £100m
FUGRO SEACORE PROFILE

- We are a Cornish Company
- Built around local skill base - Mining, Fishing
- 7 acre purpose built facility in Falmouth
- Design, Build and Operate all our own equipment and plant.
- We are a Global business
OVER 35 YEARS EXPERIENCE IN OVERWATER DRILLING

6” Ø Drilling - 1984

6m Ø Drilling - 2008
Our fleet of pile top drill rigs

• We own and operate the largest known fleet of specialist pile top rigs within the market.

• All are fully containerised and modular.

• Flexible reconfiguration for each and every project.

• They provide cost effective solutions for a variety of marine drilling/piling requirements.

• Capable of drilling shafts from half a metre to seven metres in diameter.
# FUGRO-LARGE DIAMETER DRILLING RECORD

Between 1987-2013

<table>
<thead>
<tr>
<th>Diameter Range</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>0.5m Dia - 2.0m Dia</td>
<td>1358</td>
</tr>
<tr>
<td>2.0m Dia - 4.0m Dia</td>
<td>245</td>
</tr>
<tr>
<td>4.0m Dia - 6.0m Dia</td>
<td>102</td>
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Offshore Windfarms
Tidal Turbines
Wave Energy Converters
What we do-Overwater Drilling

- Quick Guide to Reverse Circulation Drilling
Principle of Reverse Circulation Drilling
Installing the Equipment
Add weight and pipe
Connect Power & Air - Commence Drilling
Drill pipe added as drilling progresses

A drill pipe in the rod basket ..

connected to the swivel ..

and lifted out.
To Create a Socket in the Seabed
To Create a Socket in the Seabed

View of drill bit
Inside casing

Drilled Socket in Rock
XL Drilling for OWF foundation Installation

- Development of XL Drilling-4.0m Diameter and above
- Monopile Installation-Up to 30m Water Depth and beyond?
- Drive/ Drill/ Drive Methodology
- For European Offshore Wind Market
Drive/Drill/Drive Technique for Monopile Installation
### BASIC INDUSTRY ECONOMICS - TIME IS MONEY

**Typical Equipment Day Cost for Drive/Drill/Drive**

- Jack-up Barge: 50-100k
- Marine Plant (tugs & Barges): 10k
- Hammer: 20k
- Drill: 10k
- Other Equipment (lifting tools etc): 10k

**TOTAL**: 100-150k

**Or £4,167/Hr (£6,250/Hr)**
First Project-North Hoyle OWF-2003

- First Drive/Drill/Drive project
- 4m Diameter Piles
- Mudstone
- Average Drill Rates: 450mm/hr
Drilling Cost relative to today’s Plant & Equipment

- **Based on 20m of Drilling**
  - 450mm/hr = 45hrs
  - Mob = 6hrs
  - DeMob = 6hrs
  - **TOTAL** = 57hrs

- 57 hrs @ £4,167 = £237,520

Very sucessful project overall cost £125/MW/installed-going the right way

In 2003 the concern was that we need to scale up to 6.0m + Diameter

(North Hoyle turbines 2.3 MW-the future 5-6 MW)

- This will be over 2.5 times the area drilled at 4.0m Diameter.
- Can cost effective drill rates be achieved at this scale.
- How can we prevent Mob/Demob times increasing due to larger heavier items lifted by larger slower cranes.
Our next Challenge: Flamanville EPR 2006

- Create a 5.85m internal diameter shaft 63m deep
- Ground: Iron infused rock
- Will require the world's largest Reverse Circulation Drill
- Down hole equipment capable of drilling to a max of 6.45m dia

Large Diameter Overwater Drilling, Casing Stabilisation, Innovative Solution, High Quality HSEQ standards
BACK TO THE DESIGN DEPARTMENT

- Foundation Drilling
- Jack Up design
- Bespoke Equipment
- Innovative Solutions
- Project Specific Equipment
- Continuous development through operation
Fugro Seacore 6.45m Drill Bit
Flamanville EPR-The Result

- Drilled 6.45m diameter socket ahead of a 6.3m diameter steel casing via under reaming
- Proceed to drill a 5.85m Diameter Shaft 63m deep.
- Average Drill Speed 300mm/hr

**Important Lessons Learnt.**

We need:

- Better Bit Face Flow/Cleaning.
- Faster rotation
- More weight & More Torque to cope
Drive/Drill/Drive-Gyn-Y-Mor OWF, Irish Sea 2013

- 4.3 m Bit opening out to 6.5m.
- Ground- Mudstone similar to previous North Hoyle project

The Plan
- Adapt the Flammanville Equipment
- Add Water Jetting
- Add Weight
- Increase Speed, Torque
- Improve Mob/DeMob times
T90-GyM Drilling Equipment
Gwynt Y Mor OWF 2013/14

The Results

- Faster drilling at 6.0m Dia than we had achieved at 4.0m Dia-Averaging 575mm/h
- Peak at 2.2m/hr in softer ground

GyM Bottom Hole Assembly
Drilling Cost based on Plant & Equipment

- Based on 20m of Drilling

- 575mm/hr = 35hrs
- Mob = 6hrs
- DeMob = 6hrs
- TOTAL = 47hrs

- 47 hrs @ £4,167 = £195,850

- This is approx. £40,000 less than the relative drilling cost in 2003 even though we are now over 2.5 times the diameter.

- But the engineering never stops............
WesterMost Rough OWF 2014

- New Drill-more powerful T120
- New 7.0m Bit design-improved spoil removal
- Modular Conductor-Road Transportable
- Conductor allows vertical storage of Drill bit
- Single mount/demount installation
T120-Modular Conductor & 7m Diameter Drill Bit
The Current Offshore Wind Industry

- Aim-£100/MW installed
- Present-Approx. £150/MW
- Offshore Wind is still developing
- We need to keep engineering solutions

www.seacore.com
For Instance:-

If drilling is included in the methodology from the start

- Reduced hammer size required-this is a reduced day cost and gives more availability
- Reduced stresses on pile-less fatigue-longer life or reduced design.
- Less noise – always an environmental issue.
- OR YOU CAN:
  - Install piles into drilled rock sockets-No hammer cost
  - You will have shorter piles-less material cost
  - Deliver the piles floating and buoyant lift-reduce crane and Jack-up size and cost.
Thank You