Platform Dynamic Motion Monitoring Integrity and Life Extension

Subsea Malaysia
13th July 2017

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Agenda

- Introduction
- Overview of Platform Monitoring
- 2 case studies
- Conclusion
Introduction
Fixed Platforms

In Malaysia

There are over 200 platforms offshore Malaysia, across Terengganu, Sabah and Sarawak waters.

Most of the platforms were installed over 40 years ago, thus exceeding their design life while still operating.
Fixed Platforms

Aging platforms must be maintained using routine inspections and new technology to measure the condition of the structure’s integrity and provide assurance that the platform is safe to operate.

Structural deterioration results from a number of reasons including corrosion, impacts, scouring, subsidence, fatigue and environmental loads (wave, wind).
Overview of Platform Monitoring
Reasons for Monitoring

- Detect structural failures
- Calibrate jackup motion model for future operations
  - Natural period, amplitude
  - Improve fatigue damage predictions using calibrated jackup motion model
- Confirm operations safe on on-going basis and within design margins
- Concerns of long term fatigue and extreme loading
- Reduce inspection costs
Key Integrity Concerns

Wind

Waves

Current

Hotspot

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Understanding the challenge

Mathematic description of challenge

• Dynamic Equation of Motion

\[ [M]\{\ddot{x}\} + [C]\{\dot{x}\} + [K]\{x\} = \{F\} \]

STRUCTURE IDENTITY (Structure ID in real life is different from the FE model)

Mass + Damping + Stiffness

external loading (Environmental forces)

acceleration velocity displacement

STRUCTURE RESPONSE (Measured)

(NOT KNOWN). (Monitored and recorded)
Measured Inputs

What data is required

- Wind Speed (M/S)
- Strain (x/x)
- Wave Height (M)
- Current Speed (M/S)
- Relative Motion (x/x)
Measured Inputs
Equipment installed to deliver data

Riser & conductor strain
Output: actual strain values for riser/conductor fatigue model

Relative motion
Output: relative displacement of structures for global analysis model

Environmental & Metocean
Output: Event correlation with structural measurements to identify drivers of motion
Monitoring Equipment

Overview of sensors

<table>
<thead>
<tr>
<th>Motion</th>
<th>Strain</th>
<th>Dynamic Curvature</th>
<th>Environmental &amp; Metocean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor direction</td>
<td>X, Y and Z</td>
<td>Range [g]</td>
<td>± 2 for X, Y and Z direction</td>
</tr>
<tr>
<td>Cut-off response [Hz]</td>
<td>4.7 default or configurable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution [g]</td>
<td>0.14 mg RMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic acceleration accuracy</td>
<td>± 3.0% of measured acceleration / ±2mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angular Rate</td>
<td>Sensor direction</td>
<td>X-Z, Y-Z planes</td>
<td>Range [deg/s]</td>
</tr>
<tr>
<td>Range [deg/s]</td>
<td>± 4 (nominal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cut-off response [Hz]</td>
<td>4.7*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution [deg/s]</td>
<td>±0.05 RMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy [deg/s]</td>
<td>1% of full range (after calibration)</td>
<td></td>
<td></td>
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Monitoring Equipment
Overview of sensors

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<tr>
<td><img src="image1.png" alt="Image" /></td>
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<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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**Strain Sensor**

- **Strain Measurement Range**: ± 2500 μstrain
- **Strain Sensor Accuracy**: ± 2 microstrain without calibration
- **Strain Sensor Resolution**: <0.5 microstrain
- **Temperature Sensor Range**: -10° to 55°C
- **Pressure**: >3000m

**Protective Coating**

- Prevention of water ingress to 300bar (3 water sealing layers)
- Impact protection (metal & composite layers)
- Materials selected for 20 years lifetime
- Qualified and proven installation procedures

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Monitoring Equipment

Overview of sensors

- Motion
- Strain
- Dynamic Curvature
- Environmental & Metocean

- Wave Height and Direction
- Current Speed and Direction
- Wind Speed
Data Gathering and Display

User interface system

Strain values

Motion values

Environmental values

Serial communication
RS 485 Modbus

Local junction box

User interface system

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Platform Monitoring System

Relevant Track Record

- TOTAL Martin Linge /Maersk Intrepid (NO)
  - Jacket & jack-up motion
- Statoil Gina Krog/ Maersk Integrator (NO)
  - Jacket & jack-up motion / wave height
- Statoil Valemon / West Elara (NO)
  - Jacket & jack-up motion / riser strain / sea current
- Statoil Gulfaks / West Elara (NO)
  - Jack-up motion / riser strain
- E.on Huntingdon / Ensco 100 (UK)
  - Jack-up motion / sea current / wave height
- Dong Hejre Platform Monitoring Package (DK)
  - Platform motion, wave height & direction, wind speed & direction
- Statoil Peregrino Monitoring Platform (BR)
  - Motion monitoring

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Case Study 1
Case Study 1

Project overview

- Water depth: 100-120m
- Concerns over robustness of well design
Case Study 1
Monitoring system

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Case Study 1

Data capture

Sub Cabinet

50/125 Fibre Ring

Sub Cabinet

Sub Cabinet

Sub Cabinet

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Caset Study 1
1 month - Cantilever measurement – few events
Case Study 1

Jacket measurement – 1 month
Case Study 1

Measured Data

Server display at Martin Linge

Data viewer Investigating events
Case Study 1
Data management

- Data quality assured
- Prepared for Analysis by DNV
- Uploaded to FTP as raw data
- System prepared for fatigue calculation
Case Study 2
Case Study 2

System Overview

ATEX Zone 1 stainless steel INTEGRIPod 3DG+3AR with Fibre conversion

Master Control Station
- Server 1 DrillASSURE sw
- Server 2 Wave Guide sw
- Pull out KVM
- Pulse Interface Unit
- Fibre Media Converter

Pulse has also implemented ADCPs on many projects

ATEX Exd Smart Radar in a triangle Constellation (Aluminium) or none ATEX Stainless Steel
Case Study 2
Data on WEB Page

- Log In page – with username and Password control
- Application Information - drw etc.
- Reports according to Service Level
- Multiple Menu system

- Application dependent displays
- Motion and Strain trends
- Metocean sensor trends
- Heat map philosophy

- Historic data for web view
- Historic data for download from FTP
- Contact Information for assistance

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Case Study 2 - Log data storage

File Transfer Protocol (FTP) Easy access to data

Monthly report with link to FTP

FTP – Secure Log on

CSV Files & Crunched data

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Case Study 2

Natural Frequency of the Platforms

The first natural frequency of the cantilever and jacket were estimated to both be approximately 0.15Hz (6.67s)
Case Study 2
Excessive Motion During Storm
Conclusion
Conclusion

- Monitoring the natural frequency can detect a structural failure
- Motion is caused by the impacts of natural forces platforms
- Does not replace inspection but generates savings by requiring less frequent inspections
Questions?

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Thank you!

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