OIL & GAS

Site-Specific Assessment of Jack-Ups
Part 1: Jack-Up Basics & Why We Do Site-Specific Assessments

Noble Denton marine services

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Overview

- What are we talking about?

- Why do Site-Specific Assessment Analyses (SSAAs)?

- Some jack-up basics.

- What do we assess?
Definitions

A jack-up (or self-elevating platform) is a buoyant barge-like hull with legs which:

- Are raised above the hull to move from one location to another.
- Are lowered below the hull and founded on the seabed when operating to provide a stable platform for offshore applications such as drilling, work-over, tender assist, accommodation, wind turbine installation, etc., etc.

Figure: Age of drilling jack-ups versus year built.
The First Salt-Water Jack-Up?

William Arrol's Tay Bridge jack-up - 1882
The First O&G Jack-Up

Zapata Scorpion - LeTourneau - 1955
Designs from 1970’s and 1980’s

LeTourneau 116-C

Friede & Goldman L780 Mod II
Designs from the 2010’s

KFELS N-Class

GustoMSC CJ80-X175A
Why do we do Site-Specific Assessment Analyses?

- Site parameters will differ from design assumptions, e.g.:
  - Wave height / Wind speed / Current.
  - Leg penetration.
  - Water depth.
  - Airgap.

- Some aspects cannot be considered in design:
  - Site-specific spudcan foundation stiffness and load capacity.
  - Regulator or hirer requirements differ from those used for Classed approval.
  - Environmental directionality.
  - Changes in technology.

- Other:
  - Required by Insurer or Hirer.
  - Required by Marine Warranty Surveyor (for insurance).

- To safeguard life, property and the environment.
### Site Values vs. Design Values in Marine Operations Manual

<table>
<thead>
<tr>
<th></th>
<th>WD (m)</th>
<th>WH (m)</th>
<th>Wind (m/s)</th>
<th>Curr (m/s)</th>
<th>Air gap (m)</th>
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<tr>
<td>Design</td>
<td>91.4</td>
<td>23.8</td>
<td>51.5</td>
<td>1.03</td>
<td>18.3</td>
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<tr>
<td>Site</td>
<td>91.0</td>
<td>25.0</td>
<td>43.0</td>
<td>0.80</td>
<td>23.0</td>
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</tbody>
</table>
Some Jack-up Basics
Structural System

- A jack-up is a giant portal frame - it relies on the ability of the leg-to-hull connection to carry bending moment:
Foundation Fixity is the Key

- Fixity can roughly halve the bending moment at the hull.
- Increase the sway stiffness by a factor of 4 and halve the natural period.
- Dynamics are important and a function of foundation fixity.
- Foundation fixity can reduce as loads increase (due to yielding of the soil under the spudcans).
Design Variations - from the 1980’s

LeTourneau Gorilla
1983

Friede & Goldman
L780 Mod V
Typical Leg Configurations
Pinions and Rack-Chocks (Fixation Systems)
Transfer of Leg Bending Moment to Hull

\[ R_{UG} = R_{LG} = \frac{M}{L} \]

Lower Guide Reaction, \( R_{LG} \)

\[ R_L = R_R = \frac{M}{W} \]

Pinion Reaction, \( R_L \)

Upper Guide Reaction, \( R_{UG} \)

More moment carried by guides.

More moment carried by pinions or chocks.

Need strong braces (see next).

Leg more robust.

Braces can be less strong.

Leg less robust.
A Softer Vertical Connection Makes Braces & Chords Work Harder

Compression member

Tension member

$R_{LG}$

$R_{UG}$
So Which Rig Is The More Capable?

Jack-up on right has storm capability as good as the one on the left.
What Do We Assess?

- Checks made on:
  - Spudcan penetration & potential for punch-through or rapid penetration.
  - Geometry.
  - Overturning stability.
  - Foundation strength.
  - Structural strength.

- Typically rely on design stage / Class for:
  - Strength of hull.
  - Strength of spudcans.

- Typically rely on Class for:
  - Condition of jack-up.
Site-Specific Assessment Checks

- Checks made on:
  - Penetration & punch-through
  - Geometry
Site-Specific Assessment Checks

- Checks made on:
  - Overturning stability

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Windward leg sliding?

Wind load

Wave & current load

Leeward leg settling?

Weight
Site-Specific Assessment Checks

- Checks made on:
  - **Foundation strength.**

- Install legs by preloading to develop capacity to resist storm loading.

- Preload proves vertical capacity only.

- Horizontal (and moment) loads reduce vertical capacity.

- When capacity is exceeded additional penetration will occur - and the capacity envelope will (usually) expand – with a range of consequences.
Site-Specific Assessment Checks

- Checks made on:
  - **Structural Strength.**

![Diagram of structural loads](image-url)
Conclusions

- History.
- Why we do SSAAs.
- Some jack-up basics.
- What we assess:
  - Spudcan penetration & punch-through.
  - Geometry.
  - Overturning stability.
  - Foundation strength.
  - Structural strength.
Questions?