Recent Lazy Wave Riser Experience

P. Hopkins

Offshore Pipeline Technology Conference
Feb. 2015
Agenda

- Introduction
  - Background
  - Why lazy wave?
- Lazy wave concept
  - Key parameters
  - How they compare
  - Design challenges
- Case Studies
  - Shallow water
  - Deep water
- Conclusions

Learn more at www.2hoffshore.com
Introduction

Learn more at www.2hoffshore.com
Background

- Design of Flexible & Steel Catenary Risers (SCRs) face increasing challenges in deep water due to:
  - Higher pressures
  - Increased dynamic motions
  - Severe weather conditions

- GoM – SCRs designed with little margin due to the harsh environment
- WoA – SCRs limited CoG proximity of a spread moored FPSO
- Brazil – Flexibles & Rigid solutions limited by fatigue and interference

- Use of freestanding hybrid risers are feasible for many fields in West Africa & Brazil, but have increased fabrication and installation complexity often leading to higher costs
- Flexible risers generally have better dynamic response but are often limited in size, pressure and cost

Learn more at www.2hoffshore.com
Why Lazy Wave?

- Lazy Wave Risers are attractive options and become feasible in deep water because of:
  - Reduced vessel payload
  - Partial decoupling of vessel motions between TDP and hang off
  - Simplified fabrication and installation over freestanding riser solutions

- Development work has made the concept of steel lazy wave risers a reality and allowed flexibles to reach deeper water
  - Followed on from shallow water flexible riser concepts
  - Coupled with improved high quality welding solutions
Lazy Wave Concept

Learn more at www.2hoffshore.com
Lazy Wave
Key Parameters & Optimisation

Learn more at www.2hoffshore.com
Levels of von Mises stress around 0.8 of yield at top and hog bend during 100 year conditions.

As small a section of buoyant units to reduce price

Acceptable levels of bending loads at TDP

Tension at the PLET shall be minimised

Acceptable levels of compression at Flexjoint and sag bend

Sagbend must not touch the seabed

Learn more at www.2hoffshore.com
Lazy Wave – How They Compare

Lazy Wave vs. Catenary

Pros:
- Reduces Top Tension
- Decouples (partially) FPSO and TDP Movements
- More configuration arrangements (for lateral and vertical clearance)
- Reduces tension & displacement at seabed

Cons:
- Hardware and Installation costs
- Increased design complexity

Lazy Wave vs. Freestanding Hybrid Systems

Pros:
- Cheaper
- Much less design complexity
- Easier installation

Cons:
- Interference
- Greater seabed area requirements

Learn more at www.2hoffshore.com
Design Challenges

- Configuration optimisation:
  - Time consuming and costly analysis
  - Optimisation for extreme storm & fatigue cannot overlook interference
  - Interference optimisation must consider all risers and mooring lines
- Susceptible to fluid density variation
- May be susceptible to VIV if not straked
- Flow assurance issues must be considered:
  - Longer length lines
  - Slugging through sag/hog

Learn more at www.2hoffshore.com
Lazy Wave Configurations

- Alternative to Catenary in harsh environments

- Main Configuration Options:
  - “Classic” Lazy Wave
  - Shaped Lazy Wave
  - Low Long Lazy Wave

Learn more at www.2hoffshore.com
Case Studies: Shallow Water

Learn more at www.2hoffshore.com
OGX
OSX2 and OSX3

- Offshore Brazil
- OSX-2: 25 risers, 135m, Waimea
- OSX-3: 23 risers, 105m, Tubarão Martelo
- External Turret Moored FPSO

- Configurations Assessed:
  - Catenary
  - Lazy-Wave
  - Pliant Wave
  - Lazy S (MWA) - selected

Learn more at www.2hoffshore.com
First of its kind: Never before has such large number of risers have been used in shallow waters using turret moored FPSO;

ISOPE “2013-TPC-0501 Challenges in Riser Design for Shallow Water Installed at FPSOs in Campos Basin”
Statoil Peregrino

- Offshore Brazil
- Water Depth: approx. 100m
- Internal Turret Moored FPSO
- Strong Currents & Waves

Key Challenges:
- Lateral walking & interference
- Clearance with seabed & vessel hull

Weight Aided Wave (WAW):
- Provides stabilisation
  - Lateral – drag chaining
  - Vertical – lifting “spring effect”

Learn more at www.2hoffshore.com
Case Studies: Deep Water

Learn more at www.2hoffshore.com
Petrobras Brazil Pre-Salt

- 24+ Floating Production Units (up to 2020)
- Standards:
  - Water Depth: 2100 to 2200m
  - Spread-moored FPSOs
  - All hang-offs at same FPSO Board (up to 55+)
  - Mostly Lazy Wave Risers (flex and rigid)

Learn more at www.2hoffshore.com
Petrobras Brazil Pre-Salt

- Congested riser arrangement
- Alternative to Free Standing Risers
  - FSHR: typically used for Gas Export, large OD
  - BSR: expensive

Learn more at www.2hoffshore.com
Brazil Pre-Salt SLWR Arrangements

- Steel Lazy Wave Riser (SLWR)
  - Being installed on 1st field

- Rigid configurations can be optimised for clearance

Configuration envelope due to fluid variation:
- Interference issue

Configuration envelope optimised:
- Allow crossing without interference

Learn more at www.2hoffshore.com
Optimisation for Clearance

Configuration envelope due to fluid variation

Approx 40m clearance considering 6%1 Methodology

~40m Clearance

Configuration envelope optimised to allow crossing without interference:

Learn more at www.2hoffshore.com
Brazil Pre-Salt Flexible Lazy Wave Arrangements

- Challenges:
  - Fatigue design
    - wave, $\text{H}_2\text{S}$, $\text{CO}_2$
  - Optimisation for Interference
    - Standard “catalog” lines
    - Configurations optimised per supplier

Learn more at www.2hoffshore.com
Conclusions

Learn more at www.2hoffshore.com
Conclusions

- Lazy wave risers are proven technology for shallow and deep water
- Viable alternative to SCRs and hybrid risers
- Better fatigue and strength response in many situations
- Challenges during installation with addition of buoyancy or arches
- Key deep water benefits:
  - Reduced vessel payload
  - Partial decoupling of vessel motions between TDP and hang off
  - Simplified fabrication and installation over freestanding riser solutions

Learn more at www.2hoffshore.com
Thank you