Minimal Structures for Marginal Nova Scotia Developments

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Cameron Dunn
may not be quite what the client had in mind.
Minimal Structures Project

NSDOE working to make the Nova Scotia Offshore (NSO) more attractive for development

How? – By decreasing risk and providing lower cost development options.

Martec to investigate the use of Minimal Platforms, Local fabrication and Marginal Field Development.
Minimal Structures Project

• Phase 1: Minimal Structures Research
  – Research Structures
  – Conceptual Field Development Cases
  – Production Process Cases
  – Local Fabrication Assessment

• Phase 2: Economics Model
  – Structures Trending
  – Refining of Structures, Concept Field Developments,
    Production cases
  – Estimator for Physical Facilities
Phase 1 – Nearing Completion

Martec and Mustang (Houston) have been working together for over 10 years on Multiple Offshore Oil&Gas Projects. Mustang provided Production, Field and Structural Review support for this work.
Minimal Structures

Should reduce development costs by:

– Reducing steel weight
– Simplification of Fabrication
– Local Fabrication
– Reduction of Production Equipment
– Reduce Installation Costs
Minimal Structures

Our Definition:

– No Heavy Lift Vessel (HLV)
– Not Usually Manned (NUI)
– Maximum use of Existing Infrastructure (tie-back)

1990 -2000
SLP Harvester Platform (SNS) would not be a Minimal Platform to us, it needs an HLV
Global Minimal Structures Review
Reduced to
1. Single Caisson
2. Jacket Type
3. Self-Elevating
NS Waves and Ice

Cat. 3 Hurricane Juan 2003
THE PERFECT STORM

RENT OR BUY IT ON VHS AND DVD!
NS Waves and Ice

Reality:

- Design waves not driven by Hurricane events, but storms of long duration, generating deep ocean waves which ‘steepen’ on the approach to Sable Island

- Free ice (pan or bergs) are very low probability south of Nova Scotia.
NS Waves and Ice

For Study:

– Waves have been estimated from existing metocean studies (no common source)

– Free Ice has not been considered.

– Spray Ice has been included.
So what if we compare NS wave loading to Gulf of Mexico loading?

For the same exposed area the NS conditions are up to 5 times more severe, compared to GoM.
Single Caisson

Case study:
- 20m (66ft) water depth
- 14.7m (48.2ft) wave height
- 41.6 m/s (93 mph) reference wind speed
- 300mm (~1ft) Ice Spray Thickness
- 100mm (~4inches) Marine Growth
- Dense Sand
- Caisson Steel = 140 tonnes
- Diameters from 2000mm to 950mm
- Topsides Total Weight of 77 tonnes supported
- Installed by Jack-up Drilling Rig
• Single Caisson Type Suitable for single well tie back, very minimal topsides equipment.

• Anticipated equipment weight of 10 – 20 tonnes for Gas tie back.

• Single Caisson is the most prolific ‘Minimal’ Structure in use, over 800 in GoM.
Barge Assisted Jacket

Key Features

– Designed to use standard cargo barge to provide buoyancy during transportation and installation.
– Platform fully complete prior to sail-away
– No offshore lift
The concept is certainly unconventional but not without precedent. Below is the inspiration of this design, while showing one method of fabrication and installation.

Courtesy of ARUP Energy
Case Study:

- 60m (197ft) water depth
- 28.2m (92.5ft) wave height
- 41.6 m/s (93 mph) reference wind speed
- 300mm (~1ft) Ice Spray Thickness
- 100mm (~4inches) Marine Growth
- Dense Sand
Results:

- 940 tonne tower/topside steel
- 1460 tonne base steel
- 500 tonne estimate of piles
- Supports 1100 tonnes of topside loading (700 tonnes of equipment)

Robust Platform Possible
Application:

- Minimal Satellite – Semi Processing - Gas
- Multiple Wells, separation, Metering, Hydrate Inhibition, Water treatment
- When Tie-Back not sufficient due to Flow Assurance Problems.

Will be suitable for majority of marginal gas fields for Sable Area.
Self-Elevating

Key Features:

- Platform self-installs using lift mechanism at offshore site.
- Foundations typically gravity based
- Suitable for larger, heavier equipment requirements.

Courtesy of SPT

Note Suction Piles (Shown) would not provide adequate foundations for Sable’s sandy soil conditions
Self-Elevating

• No Case study Performed As Deep Panuke (2010) proves platform type for NS Waters.

• Additional study to determine how small the platform could be designed, while providing economical benefits.

Deep Panuke PFC, (2010) courtesy of SBM
Other Study Findings

- No Metocean Design Data
  For our study, design data was inferred from known data and designs. A common source for Wave, Wind, Current, Ice and MG are required for the Sable Region.
- Minimal Platforms limited to 80m water, but Subsea Tie Back can extend depth.
- Concept Structures within Local Fabricators Capabilities.
- Alternate Platform Access (no Helideck) will greatly Reduce Platform Requirements, has been achieved in other Regions.
Boat Access – No Helideck
Fabrication Sequences

Caisson Type Platform – Installation

Step 1: Jack-up Drill Rig installs well, conductor and Structural Caisson
Step 2: Jack-Up Rig Lifts Minimal Topsides from Barge using full cantilever reach of Derrick (or Platform Crane)
Step 3: Jack-up Installs Topsides on Caisson
Step 4: Jack-up completes hook-up, installation of umbilical and riser.

Step 2A: Use Lay barge with Crane to complete Topsides lift and Hook-up
Step 3A: Barge with Light crane installs Piled Braces if required, complete with subsea clamp to Caisson
Step 4A: Braced Option: Jack-up completes hook-up, installation of umbilical and riser.

Limitations: Water Depth, Derrick Movement limits topsides dimensions and weight, Light Crane lift for braces, One well, limited access to topside (no Helicopter pad), Topsides deck space limited (7.5mx7.5m), Limited topsides weight (50Tonnes)

GBS Type Platform – Fabrication and Installation

Step 1: Fabrication on Quayside
Step 2: Platform base and Tower Skid Launched to Quayside
Step 3: Heavy Land Lift of Topsides to Top of Platform
Step 4: Towed Platform/Barge to Site
Step 5: Tow Platform/Barge to Site
Step 6: At Site, Lower Platform via barge/charge connection

Limitations: Land Crane Lift Weight and Height – the Barge required Draft and Depth near Quayside

Self-Elevating Platform – Fabrication and Installation – Integrated Deck Option

Step 1: Topsides Structure, Legs and Foundation Cans Fabricated on Quay Side
Step 2: Completed Topsides Loaded by Trailer onto Cargo Barge
Step 3: Leg and Foundation Can assembly, installed onto Topsides at Quay Side
Step 4: Complete platform ready for tow
Step 5: Tow to installation site
Step 6: Lower Legs and Foundation Cans to Seabed with jacking system, ballast or gravity base, support vessel
Step 7: Raise Topsides with jacking system, off of barge and to final elevation, Remove barge, secure legs to topsides with permanent connection, Hook Up and Commission with Support Ship

Limitations: Structural Leg design not as robust at jacket type—water depth
Typically not suitable for wellhead location (elevs and conduits), will require subsea or separate platform.
Note: There are several alternatives to this example, including full gravity base and integrated barge deck, there is also options to fabrication with graving dock

Pile Option – Piles Pre-Stabbed

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Case 1
Tie-back – Gas Production
Platform types include:
- Single Caisson
- Braced Caisson
- Subsea
Topside Weight: <25 tonnes
Water Depths 0-30m
Limitations related to Flow Line assurance, requires processing by others.

Case 2
Satellite Platform – Gas Production – NUI–Semi Processed
Multiple Wells
50 tones to 2000 tonnes
>7m water depth
Required Processing
Dehydration, Separator, M May require Power, MEG supply
NUI status required
Remote Onshore

Case 3 – Oil Development
Multiple Wells, use of remote wellheads, Surface Wellhead for shallow water, subsea for deeper water.
Optional Processing
Water Separation, Oil stabilization, Power, Pumping, storage
Option 1: Jack-Up Support, up to 70m water depth, Processing on jack up, minimal process on Wellhead Platforms.
Option 2: Self-Elevating Platform, >3000 tonnes topsides, <50m water depth, full processing option for storage in platform GBS base

Diagram showing various platform configurations with options for gas and oil production, processing, and storage solutions.
Phase 2

- Work with CNSOPB on Alternative Operations, such as Boat Access
- Structures Trending (Maximum depth to Minimum depth, steel requirements, foundation performance)
- Refining of Structures, Concept Field Developments, Production cases
- Estimator for Physical Facilities
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