Numerical Modelling of Disconnectable Turret Mooring Systems

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Outline





Hurricane Katrina



With the large number of hurricanes in the GOM the DTM concept is being looked at with strong interest



DTM System

VENTUR

Disconnectable Turret (BHPB Stybarrow)

Swivel Stack

Riser Deck -

Main Bearing

Risers & Umbilicals

2015

Spider Buoy -

Anchor Legs



Global Analysis Basic Design Basis

- FPSO to disconnect from mooring and risers to avoid cyclones
- FPSO to stay on station during the 100-year non-Cyclonic (winter) storm
- 12 risers and umbilicals
- 15 year design life
- Mooring system design
 - maintain adequate offsets for riser system
 - optimize mooring, riser and spider buoy system to meet spider buoy and turret requirements

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Design Environmental Criteria

- 1) FPSO Connected
 - 100-year non-cyclonic
 - Cyclone environment: Hs=6m
 - Maximum offloading seastate: Hs=3.5m
- 2) Max Disconnect Environment
 - Cyclonic storm: Hs=6m, Tp=11.3 sec, Vw=19.5m/s, Vc=0.8m/s
- 3) Max Reconnect Seastate
 - Hs = 3.0m
- 4) Disconnected Buoy
 - Design: 100-year Cyclonic Storm: Hs=12.6m, Tp=14.1sec
 - Survival: 10,000-year Cyclonic Storm: Hs=17.3m, Tp=16.5 s



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Things to be considered...

- Hydrodynamic Loads on Spider Buoy
- Buoy Disconnect from FPSO
- Disconnected Buoy Motions
- Buoy Reconnect Analysis





Approach: Numerical Simulations Verified by Model Tests

Model Tests:

- MARIN ocean basin
- Scale 1:81
- Complete model of system
- Wind, waves and current



Mesh Generation for Hydrodynamic Force Calc



Hydrodynamic Loading on SB BEM; Pressure Integration



Spider Buoy Drop Test





Buoy Drop Depth Comparison between Model Test (markers) and Prediction (solid line)



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Buoy Drop Velocity Comparison between Model Test (fluctuating lines) and Prediction (smooth line)



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Validation of Spider Buoy Disconnection





Validation of Spider Buoy Disconnection



Validation of Disconnected Buoy Motion



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Validation of Spider Buoy Reconnection





Example: Actual DTM System

Summary of DTM FPSO

Newbuild FPSO

- Lpp = 264m, B = 48m, D = 23.2m
- Max Displacement = 181,000 MT
- 1,000,000 barrels of oil storage
- Turret Location
 - 110m forward of midships
- Spider Buoy
 - Max Diameter: 14 m
 - Height: ~14.7 m
 - Displacement: ~ 1400 MT
 - Weight: ~ 750 MT



Cyclones around Australia

MV11 @ Mutineer/Exeter Field



Research has shown that cyclones in the Australian region exhibit more erratic paths than cyclones in other parts of the world. A tropical cyclone can last for a few days or up to two or three weeks. Movement in any direction is possible including sharp turns and even loops.



Reference: Australian Government, Bureau of Meteorology http://www.bom.gov.au/info/cyclone/#severity

Cyclones over Mutineer/Exeter Field 2006-07

Name	Period	Year	Max Category
Clare	Jan 7 – 10,	2006	³ 36666
• Daryl	Jan 18 – 23,	2006	2
• Emma	Feb 27 – 28,	2006	1
• Floyd	Mar 21 – 26,	2006	
• Glenda	Mar 27 – 31,	2006	5
Hubert	Apr 6 – 7,	2006	2
• Isabel	Jan 2 – 4,	2007	SCHEC
George	Mar 6 – 10,	2007	4
• Jacob	Mar 9 – 11,	2007	3
• Kara	Mar 25 – 28,	2007	3





Floyd: 21 – 26 March 2006 No Disconnection



Glenda: 27 – 31 March 2006 Disconnection



Final Remarks

- Disconnectable Turret Moorings (DTM) are proven technology for mooring FPSOs in Hurricane environments
- Various numerical models are required to solve DTM engineering problems
- Presentation showed ability of analysis to model complex operations like disconnection, disconnected buoy response in 100-year typhoon seas, and reconnection





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Thank you!