# Dynamic Motion Analysis of Catenary Moored Spar Wind Turbine

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**Floating Wind Turbine,
Based on a
Catenary Moored Spar Platform**

**The NREL 5 MW Wind Turbine has been chosen and mounted on a 120 meters spar platform.**

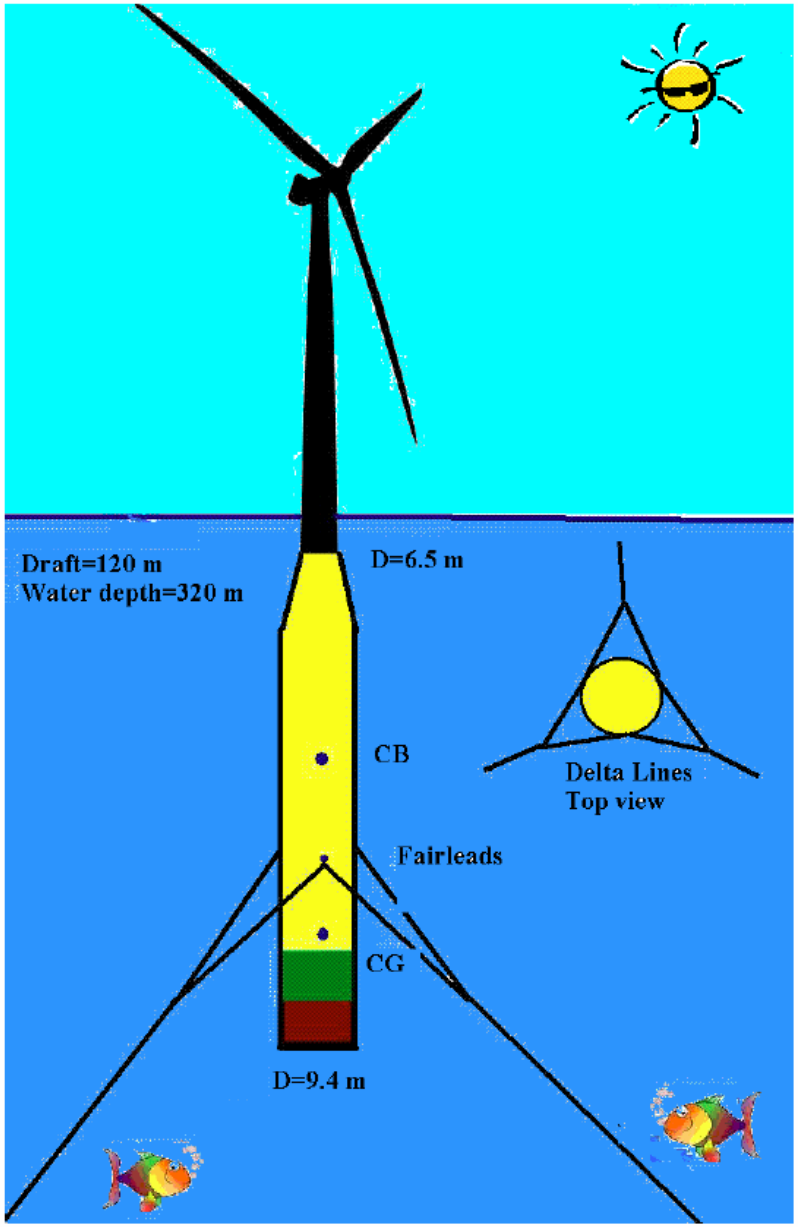


Figure 1: Catenary Moored Spar Floating Wind Turbine



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Table 2: Spar (Platform) Characteristics

| | |
|---|---|
| Total Draft | 120 m |
| Diameter Above Taper | 6.5 m |
| Diameter Below Taper | 9.4 m |
| Mass, Including Ballast | 7593,000 kg |
| Centre of Gravity, CG | -92.58 m |
| Roll Inertia about CG | 4.489E+09 kg•m2 |
| Pitch Inertia about CG | 4.489E+09 kg•m2 |
| Yaw Inertia about Centerline | 1.672E+08 kg•m2 |

Table 3: System Mass Properties

| | |
|---|---|
| TOTAL MASS | 8329,230 kg |
| Centre of Gravity, CG | -78.61 m |
| Pitch Inertia about Origin | 7.34E+10 kg•m2 |
| Yaw Inertia about Centerline | 1.68E+08 kg•m2 |

Table 4: System natural periods

| **Motion** | **Natural Period (s)** |
|---|---|
| Surge | 136 |
| Sway | 149 |
| Heave | 31.5 |
| Roll | 29 |
| Pitch | 29 |
| Yaw | 7 |

Table 7: Elastic Modes of parts

| **Elastic Mode** | **Frequency (rad/sec)** |
|---|---|
| Tower first | 2.37 |
| Tower second | 17.78 |
| Spar first | 15.01 |
| Spar second | 34.18 |
| Blade first Flap wise | 4.22 |
| Blade first Edge wise | 6.78 |
| Blade second Flap wise | 12.12 |

Table8: Elastic Modes of System

| **Elastic Mode** | **Frequency (rad/sec)** |
|---|---|
| Inland System first (fore-aft, side-to-side) | 1.89, 1.88 |
| Inland System second | 3.98, 3.82 |
| Floating System first (fore-aft, side-to-side) | 2.95, 2.89 |
| Floating System second | 4.2, 3.95 |

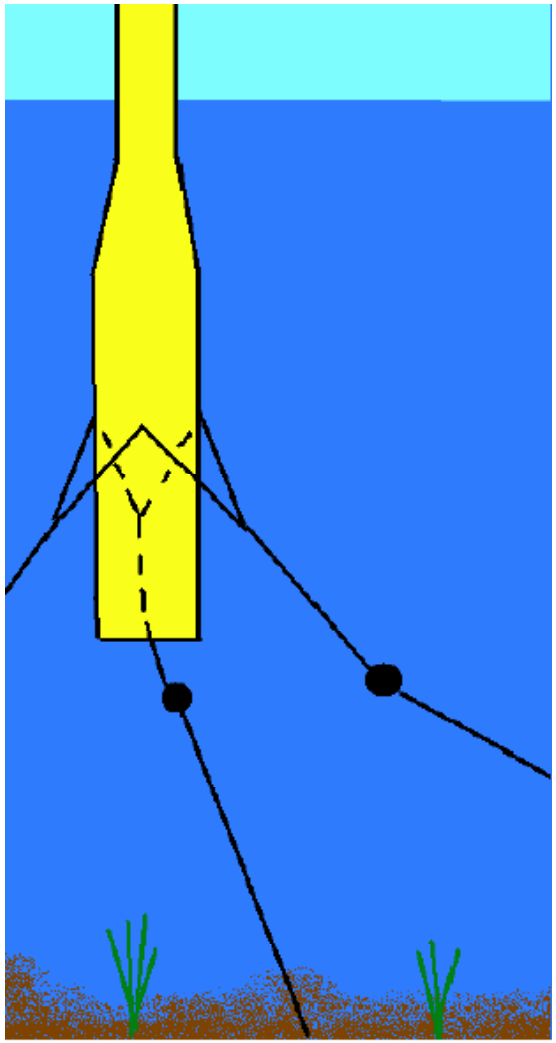


Figure 2: Mooring system

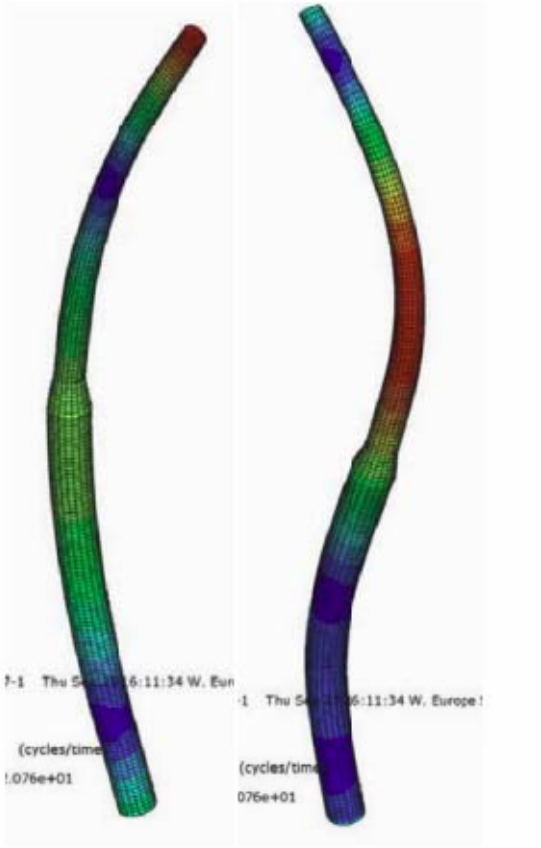


Figure 2: First and Second Elastic Modes
(Shell modeling in ABAQUS)

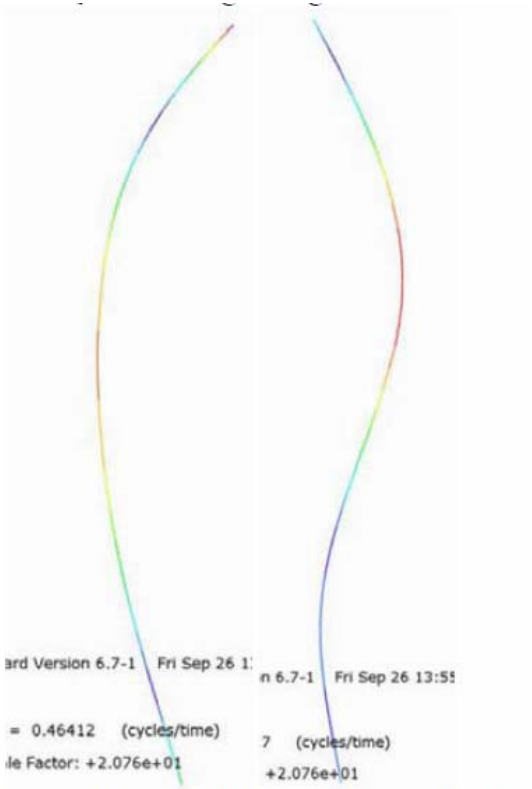
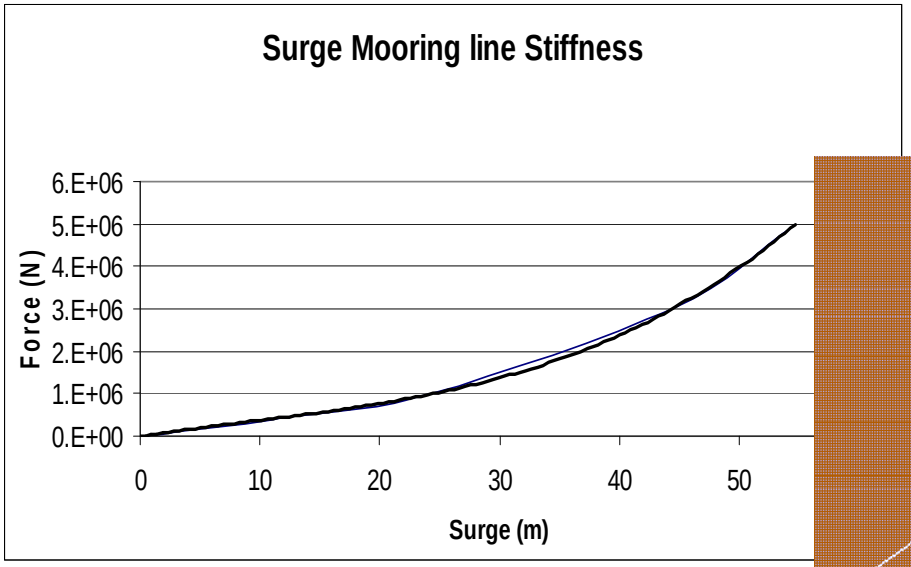
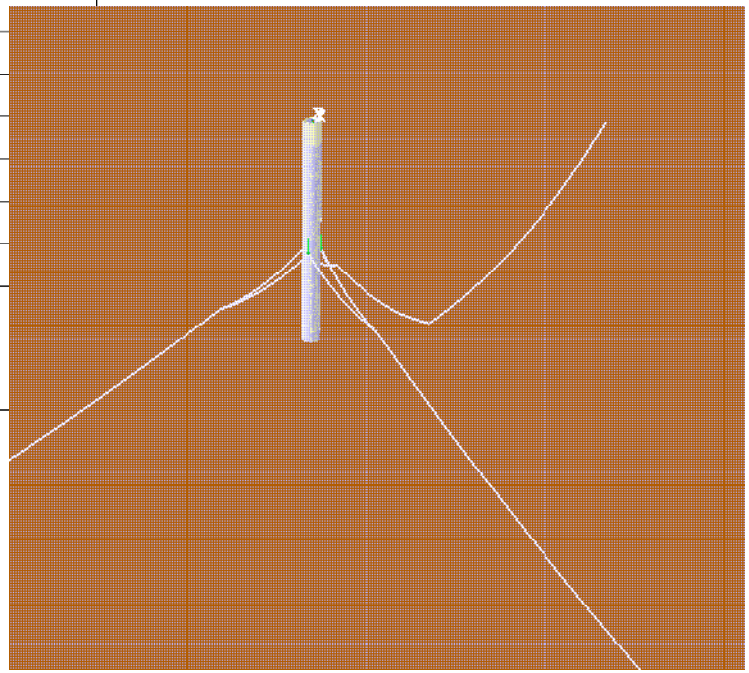


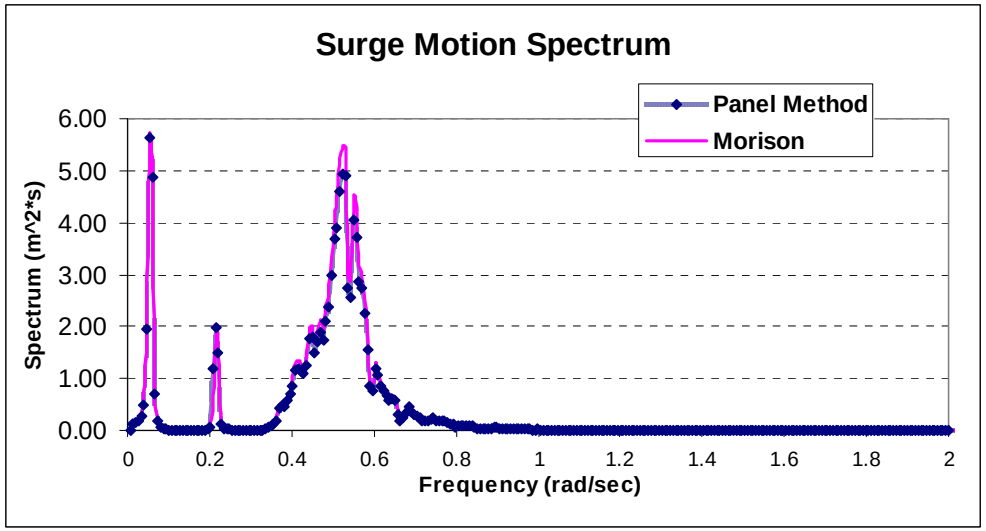

Figure 3: First and Second Elastic Modes
(Beam modeling in ABAQUS)

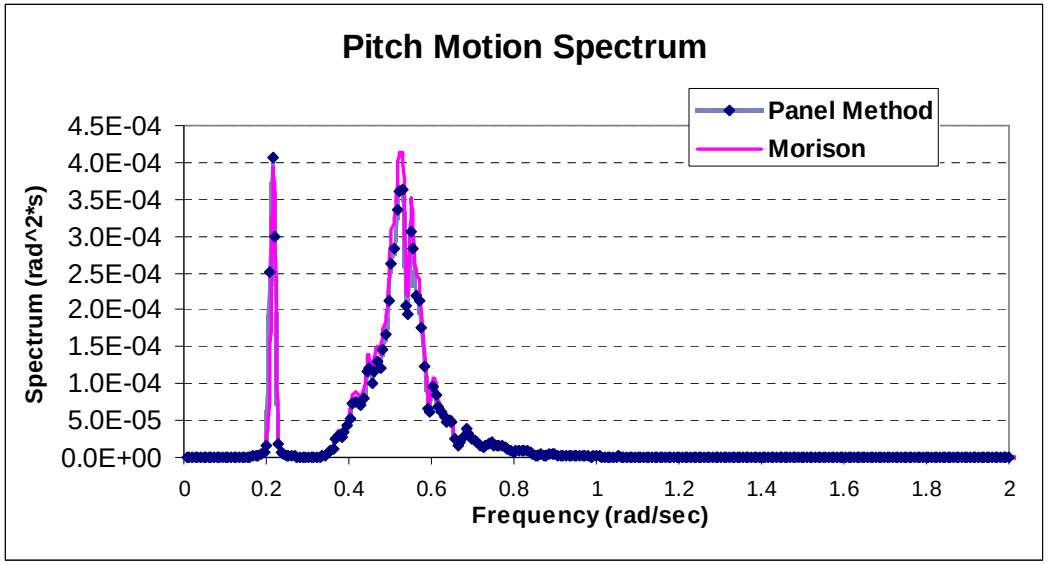
# The FEM model of mooring lines including clump mass and delta lines for nonlinear large deflection has been modeled in DeepC (Simo/Riflex).



# Comparison of Panel Method and Morison's Formula in DeepC

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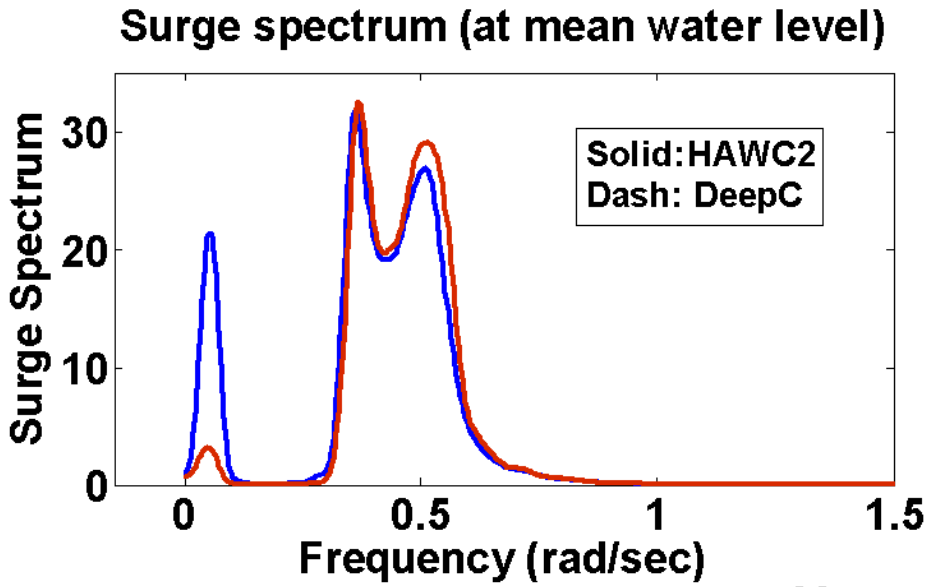
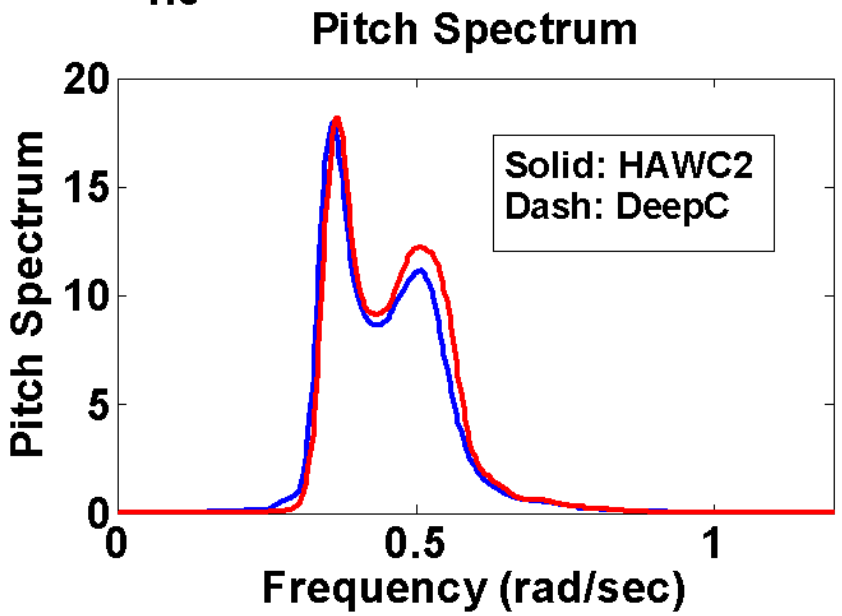
# Comparison of Hydrodynamic models in HAWC2 and DeepC

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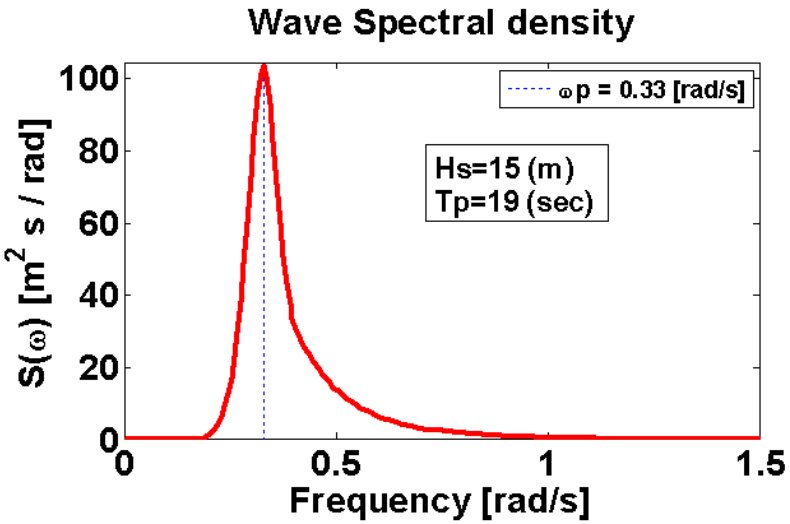
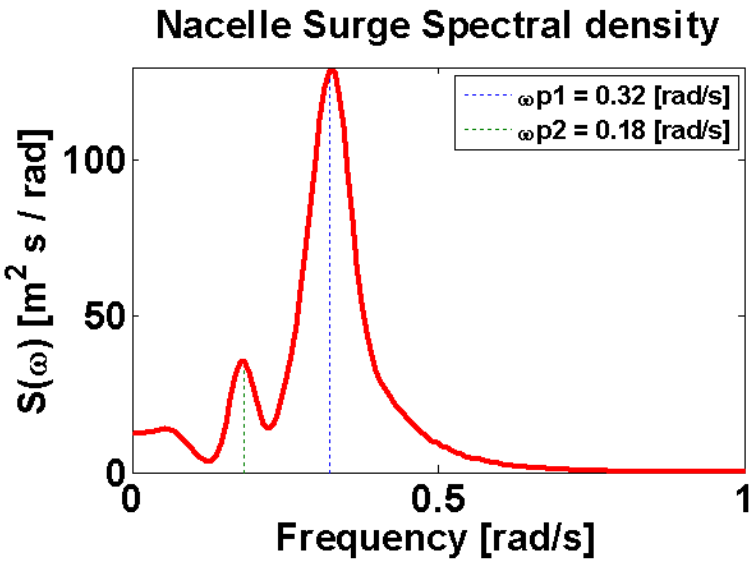
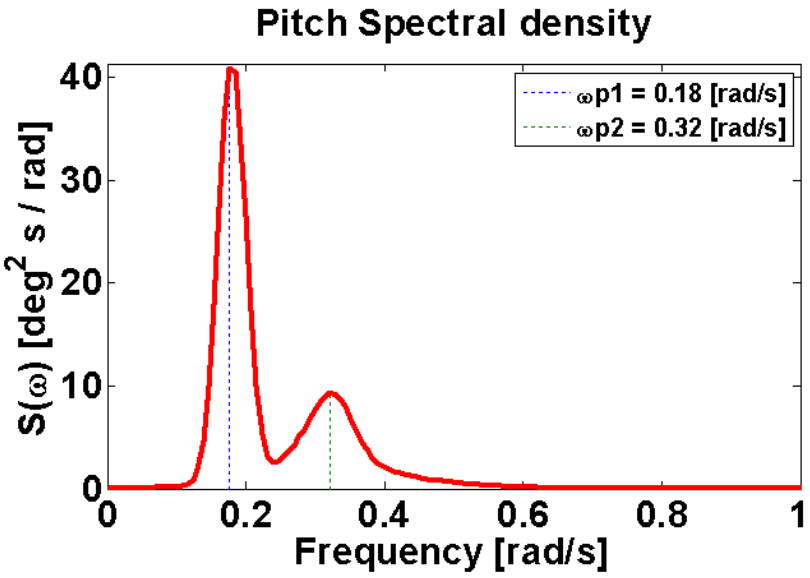
# Dynamic wave induced motion in Harsh Sea (Without wind)

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## Next step:

1) Wave and wind induced motion (General case)
2) Motion response in harsh condition
3) Operational condition
4) Offshore wind conference, Sweden 2009

**Thanks for your attention**