

WAVE APPLICATIONS in DESIGN, INSTALL, OPERATE FPSO/FLNG

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OFFSHORE

A SHIP IS

SAFE

IN HARBOR BUT ...

THAT'S NOT WHAT

SHIPS

ARE BUILT FOR

FPSO Cde Ilhabela (2014)
150,000 bbls oil/day
30 risers, 16 umbilicals
Petrobras
Brazil
Water depth 2,140 m





SBM
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SBM Offshore

We design, built, install and operate FPSO units ... worldwide



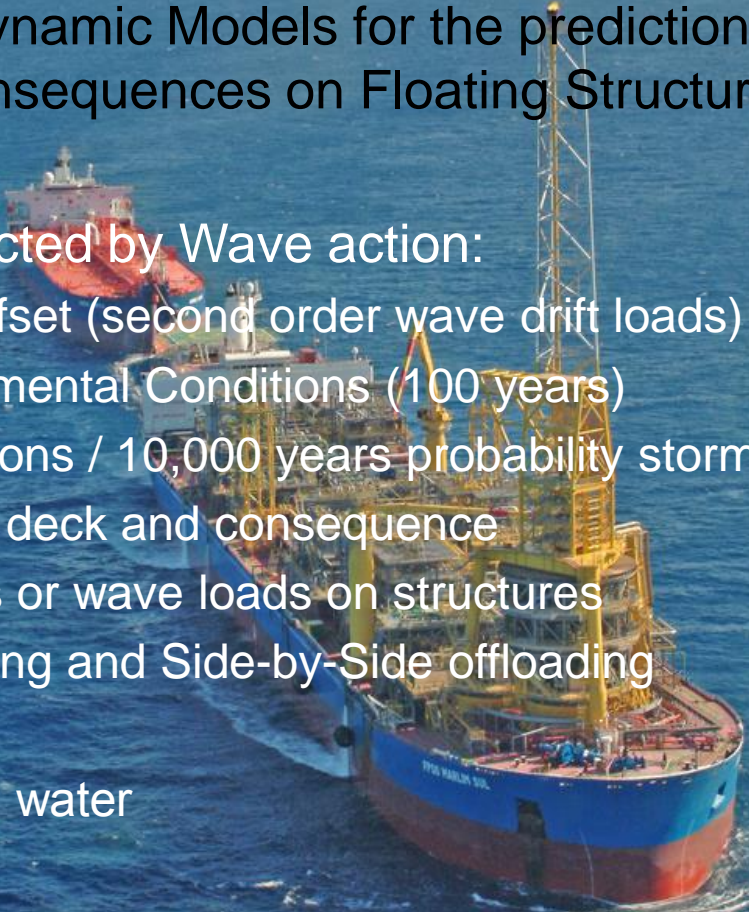
17 units
in Lease & Operate

5 units
Under construction

LPG FPSO Sanha (2005)
37,300 bbls LPG/day
3 risers, 1 umbilical
Chevron
Angola
Water depth 58 m



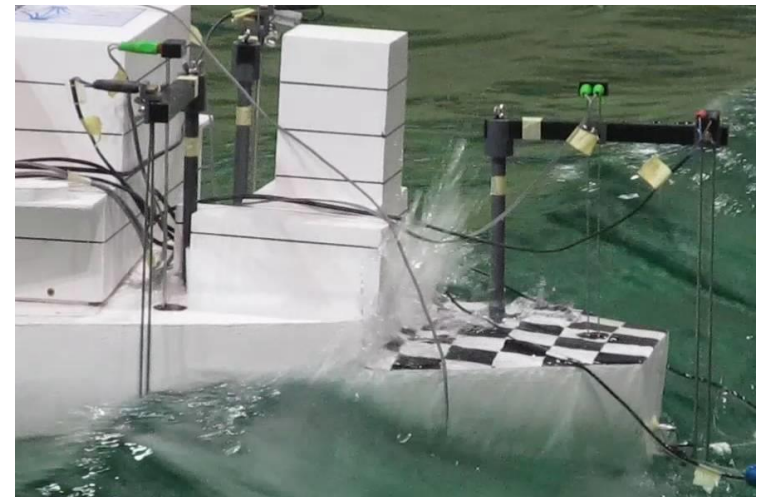
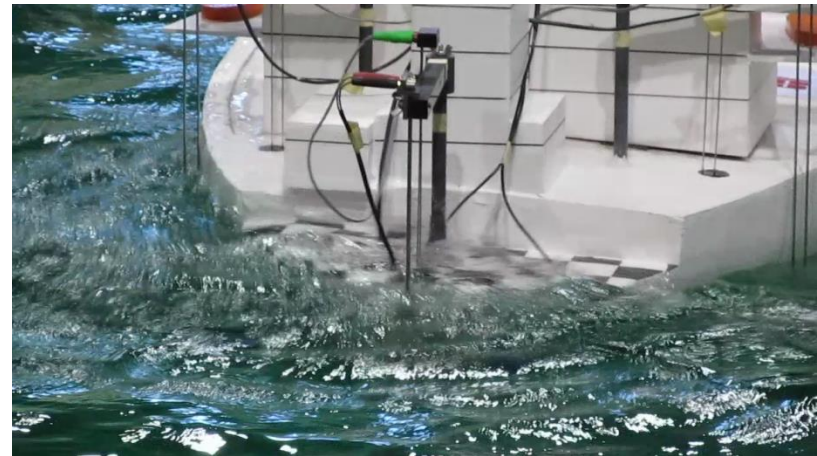
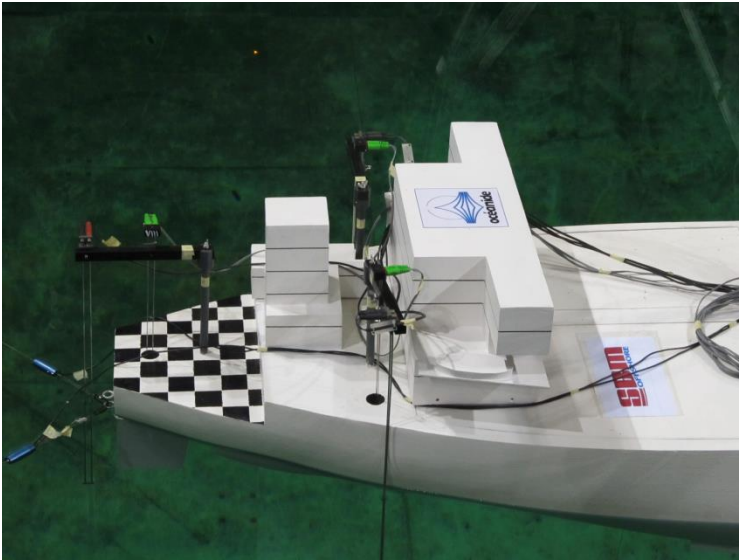
- What we do:
 - Apply Hydrodynamic Models for the prediction of Wave Loads and Wave Consequences on Floating Structures (FPSO)
- Many Topics impacted by Wave action:
 - FPSO vessel offset (second order wave drift loads)
 - Design Environmental Conditions (100 years)
 - Cyclone Conditions / 10,000 years probability storm
 - Green water on deck and consequence
 - Slamming loads or wave loads on structures
 - Tandem offloading and Side-by-Side offloading
- Today's topic: Green water



FPSO Marlim Sul (2004)
Max 100,000 bbls oil/day
17 risers, 10 umbilicals
Petrobras
Brazil
Water depth 1,015 m

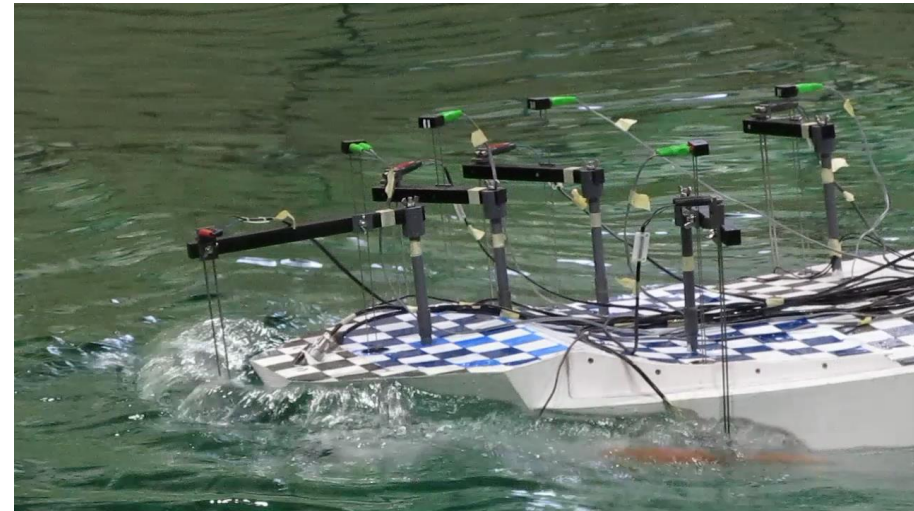


- Engineering question: Do we need to raise the lowered aft-deck in view of possible green water and related safety issues?





- Is the Hose Reel sufficiently protected? Do we need to raise the forecastle deck? Impact loads?





Wave Physics
(Real → Model)

Ship-Wave
Interaction

Freeboard
Exceedence

Water on Deck
Consequence

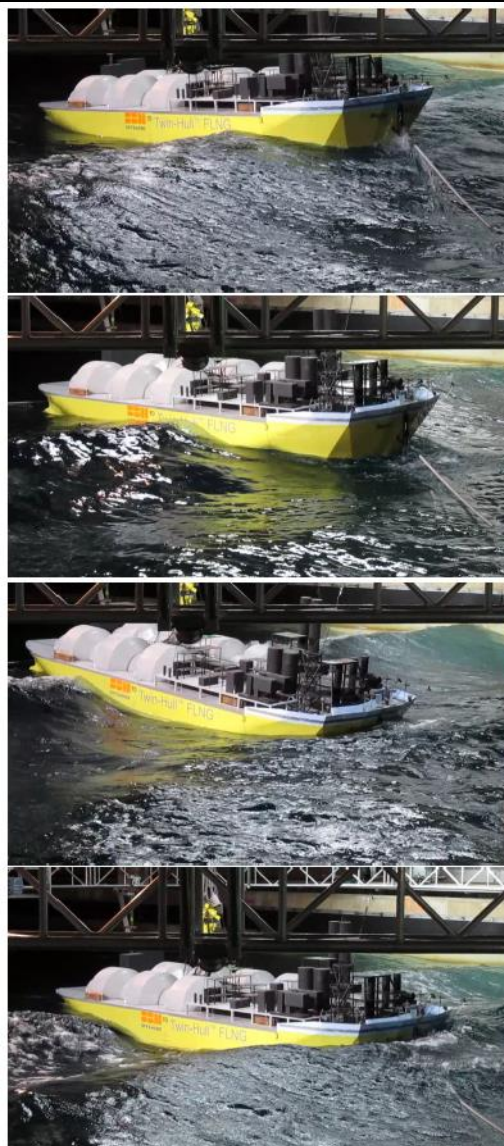


Figure 8: Examples of vessel motion behavior in high wave conditions showing variations in actual wetted surface.

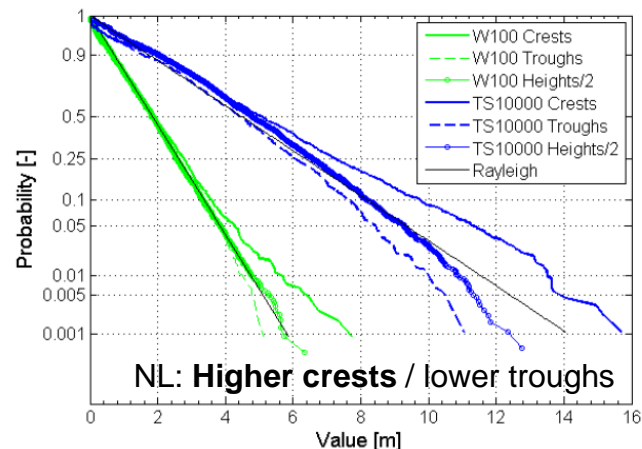


Figure 4: Incident wave Crest, Trough and Height/2 distributions for two sea states, W100 and TS10000.

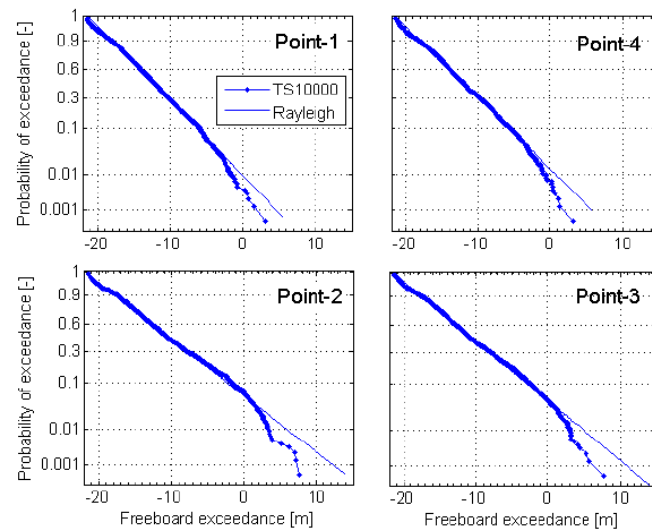
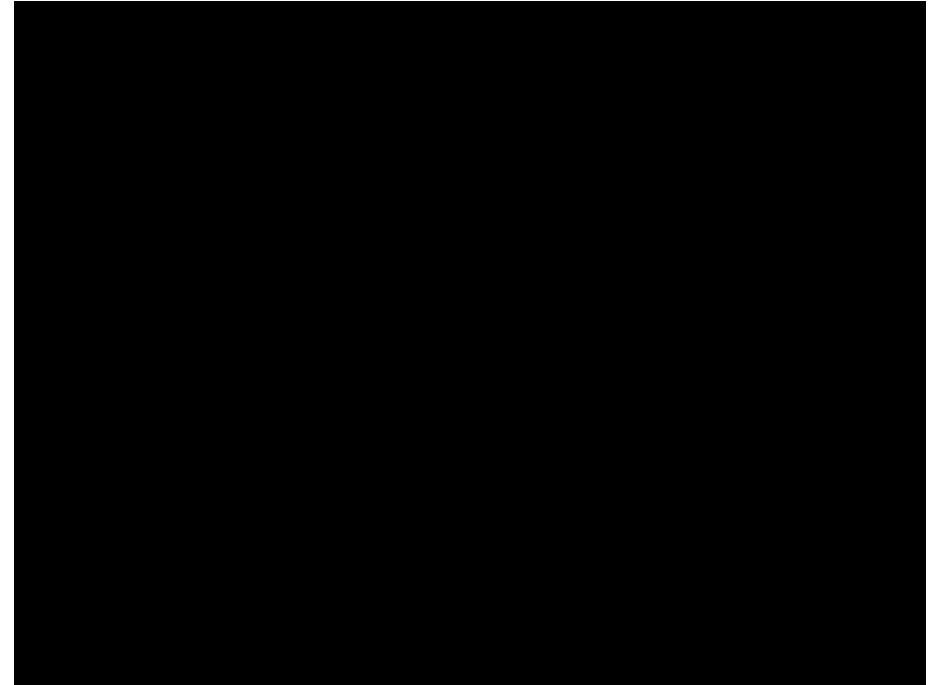
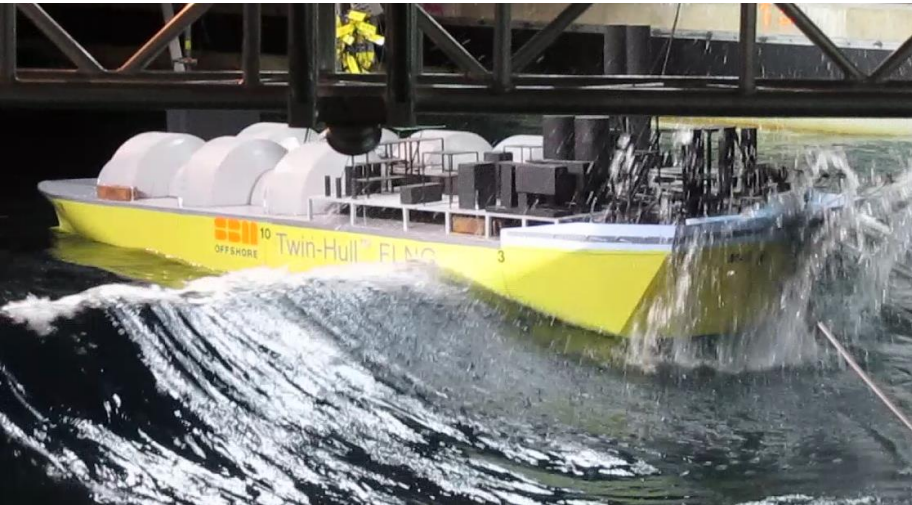


Figure 11: Freeboard exceedance distributions for point-1 to point-4 as obtained in the TS10000 sea state.



1. Predictability of wave physics and crest distribution

2. Predictability of relative motions and freeboard exceedance probability

3. Predictability of height of water on deck and fluid velocities



1. Predictability of wave physics and crest distribution

OCEANIDE First Basin

Wave Crest Distributions

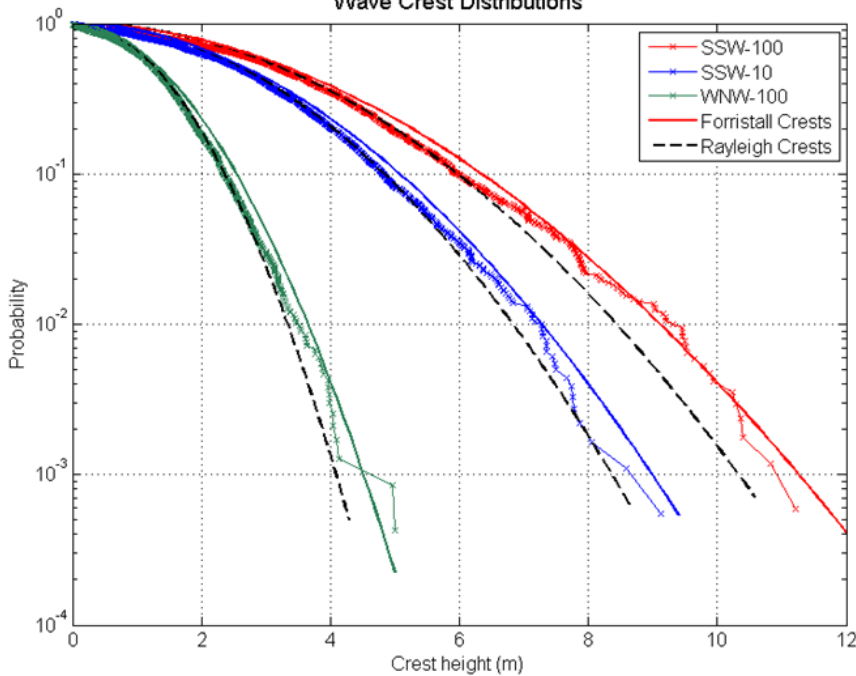


Figure 4: Wave Crest Height distributions

MARIN

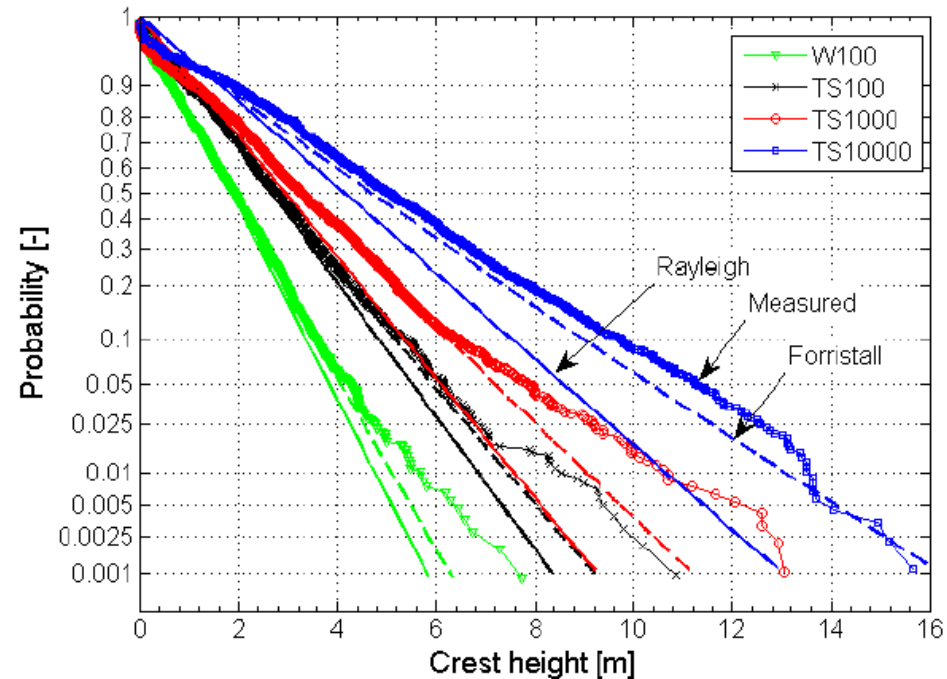


Figure 6: Empirical crest distributions with the associated Rayleigh and Forristall crest distributions



- Wave models:
 - Input for us, but we need to understand the physics.
- Mathematical model for hydrodynamic predictions:
 - Well developed for linear theory
 - No prime priority for application of (complex) non-linear models
- Safety and Green water:
 - Too many unknowns in physics for an accurate prediction
 - Model tests is a solution, but with limitations
 - Requires more research, (preferable) with engineering focus

The image features a background of a technical drawing or blueprint, showing various lines, grids, and some faint text. Overlaid on this background is the SBM Offshore logo and name. The logo consists of the letters 'S', 'B', and 'M' in a stylized, white, sans-serif font. The 'S' and 'B' are composed of rounded rectangular shapes, while the 'M' is formed by two vertical bars with rounded tops. Below the logo, the word 'OFFSHORE' is written in a bold, white, sans-serif font.

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