



ASME OMAE[®] 2026

45TH INTERNATIONAL OCEAN OFFSHORE
AND ARCTIC ENGINEERING CONFERENCE[®]

GRAND NIKKO TOKYO DAIBA, GRAND TOKYO, JAPAN

Full-Scale Dynamic Motion Validation of a Moored Cruise Ship at the Port of Napier

Tim Gourlay, Perth Hydro, Australia



ASME

OMAE® 2026

45TH INTERNATIONAL OCEAN OFFSHORE AND
ARCTIC ENGINEERING CONFERENCE®



ASME®
SETTING THE STANDARD

The American Society of Mechanical Engineers®
ASME®



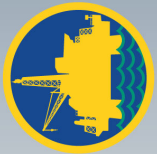
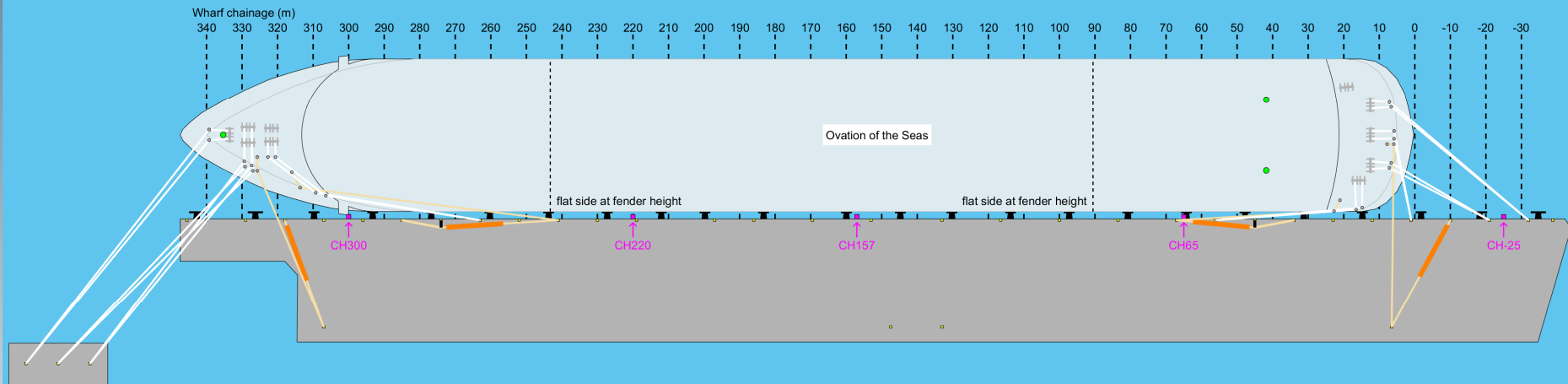
The ship: “Ovation of the Seas”

- Length overall 347.1 m
- Waterline beam 41.40 m
- Design draft 8.50 m
- Valentine’s Day visit to Napier, 14th February 2025



Mooring arrangement

- Port side alongside
- 16 ship's lines
- 4 ShoreTension lines





Mooring lines

	<i>HMPE line</i>	<i>Stretcher</i>
Make	Acera Amundsen 12-strand	Signal Master B5 yarn and polyester
Diameter	44 mm	76 mm
Length	200 m	11 m
MBL (unspliced)	148.9 tonnes	202.4 tonnes
LDBF (spliced)	134.0 tonnes	182.2 tonnes
Elongation	2% @MBL	13% @MBL



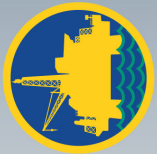


ShoreTension units

ShoreTension units decrease moored ship motions in two main ways:

- Keep pre-tension on lines at all times, using fender friction to dampen surge motions
- Pay out at high tension, and pull in at low tension, taking energy out of the ship's motion through each wave cycle





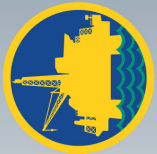
Survey GNSS receivers

- Javad Triumph-2 dual-frequency GNSS receivers
- One receiver on jetty as fixed base station
- Three receivers on ship as roving receivers
- RMS error cutoff 15 mm
- 6-DoF ship motions at 1 Hz

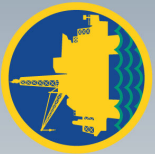
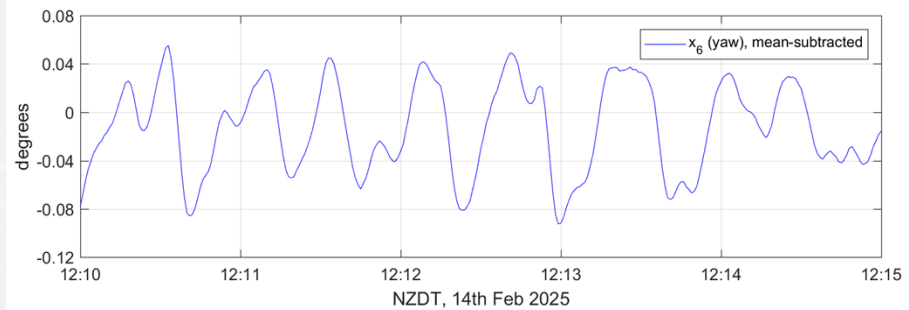
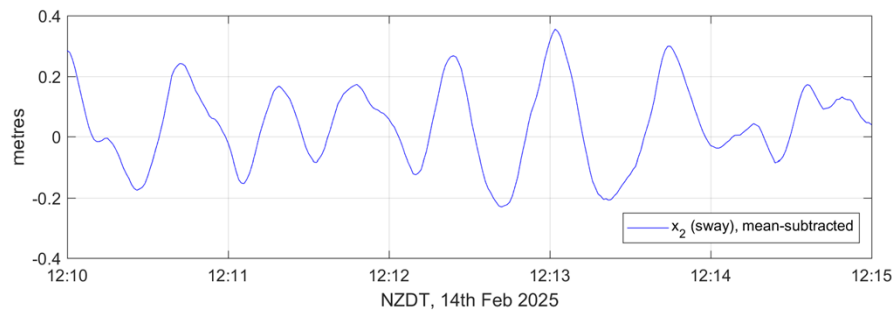
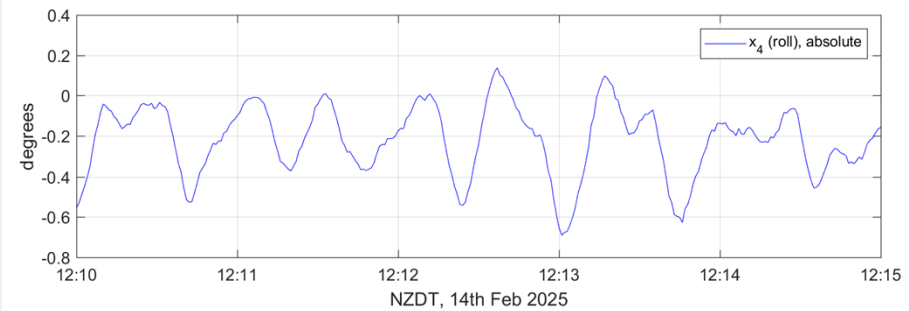
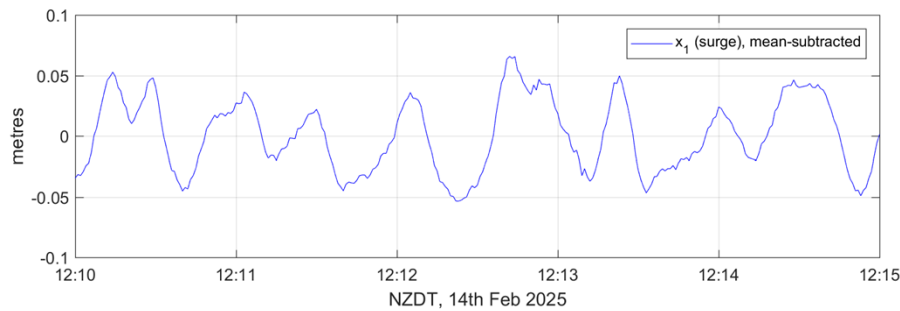


Timing (local time)

GNSS start	2025-02-14, 07:55
Touch fenders	2025-02-14, 08:30
All lines connected	2025-02-14, 09:20
Motions stabilized	2025-02-14, 09:45
GNSS stop	2025-02-14, 18:33

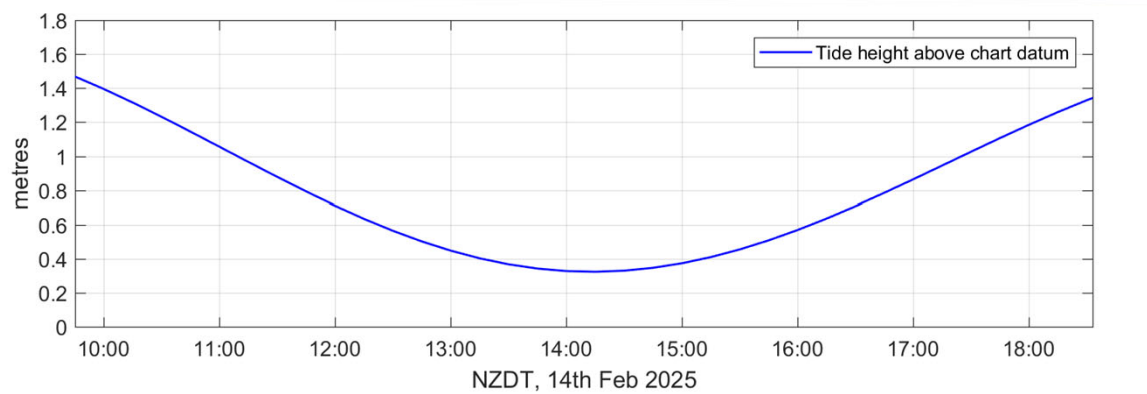


Example 5-minute measured motions

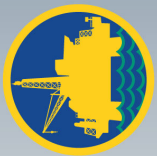
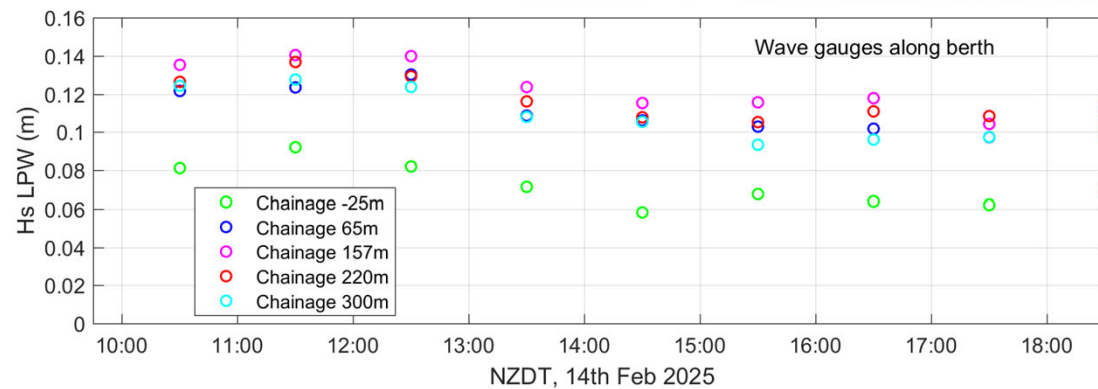
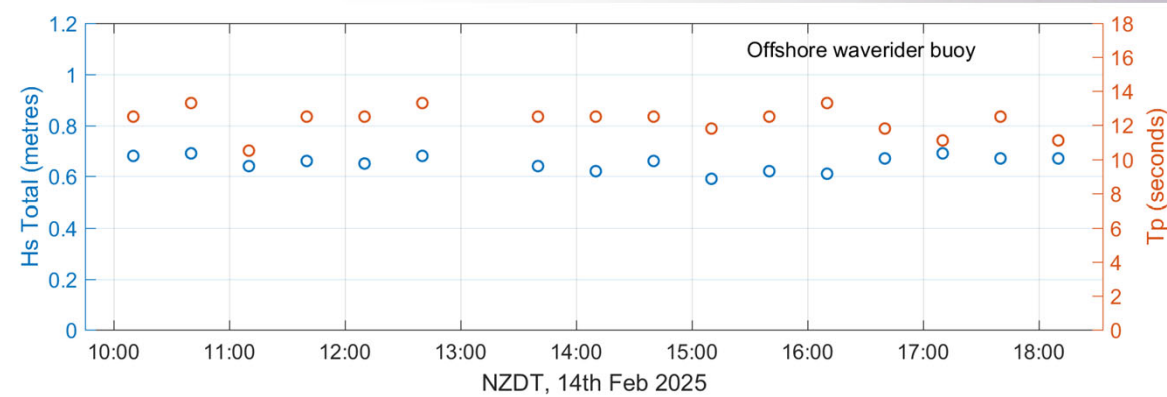




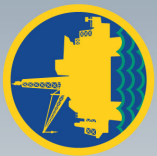
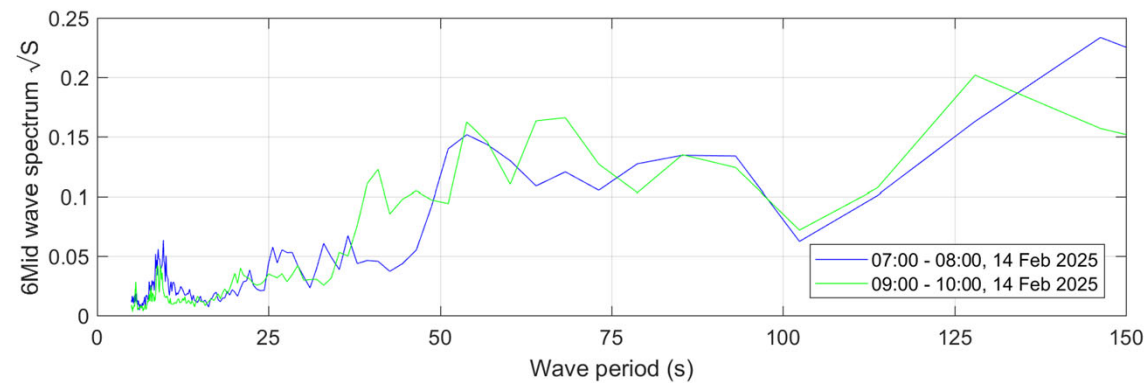
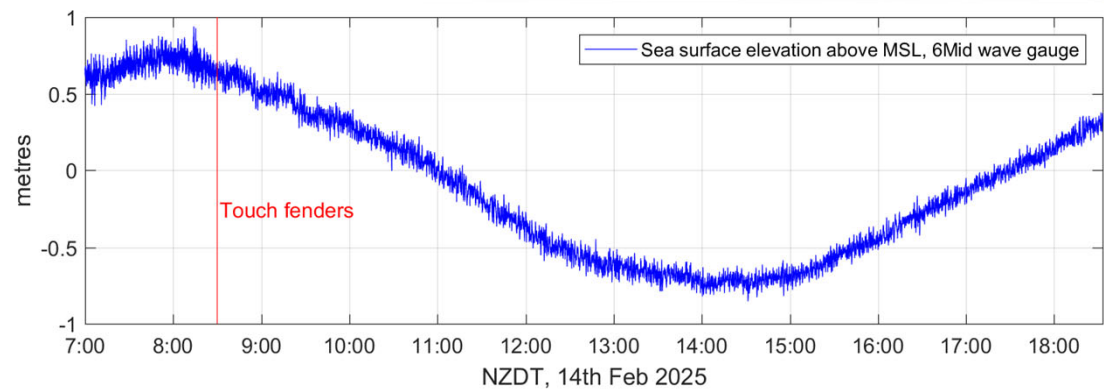
Tide conditions



Measured wave conditions



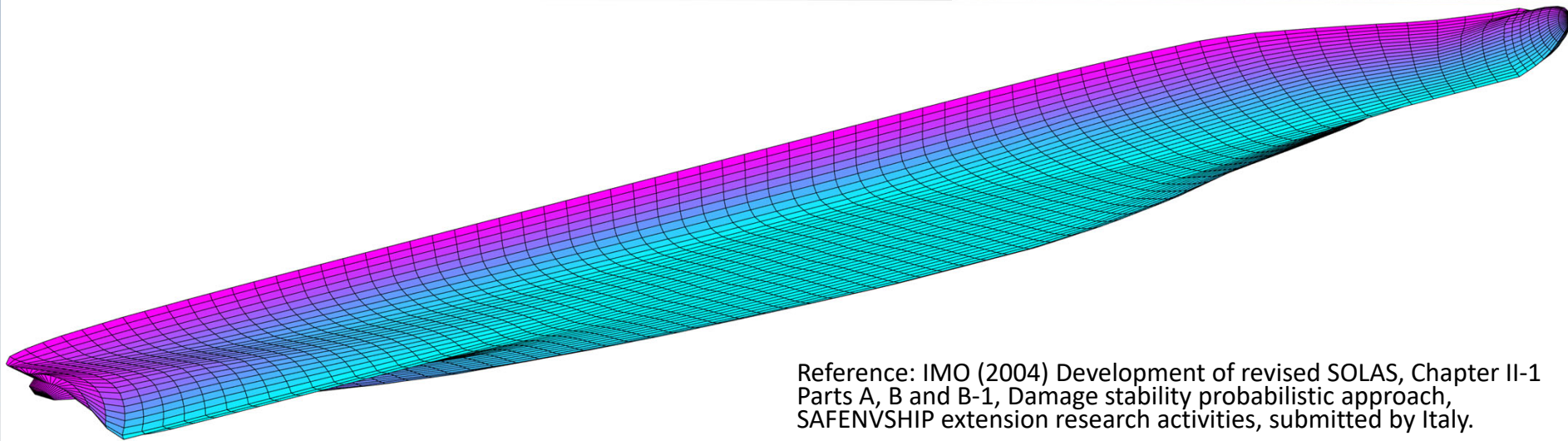
Wave sheltering by the ship



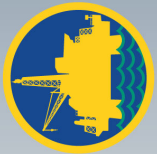
Hull modelling for WAMIT

Right: Fincantieri Cruise Ship, used as parent hull (IMO 2004)

Below: 3780-panel surface mesh, up to design waterline

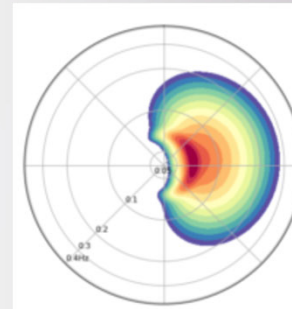


Reference: IMO (2004) Development of revised SOLAS, Chapter II-1 Parts A, B and B-1, Damage stability probabilistic approach, SAFENVSHIP extension research activities, submitted by Italy.

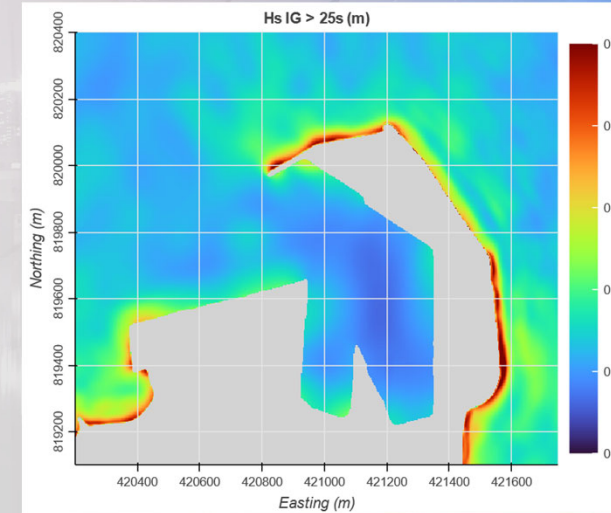
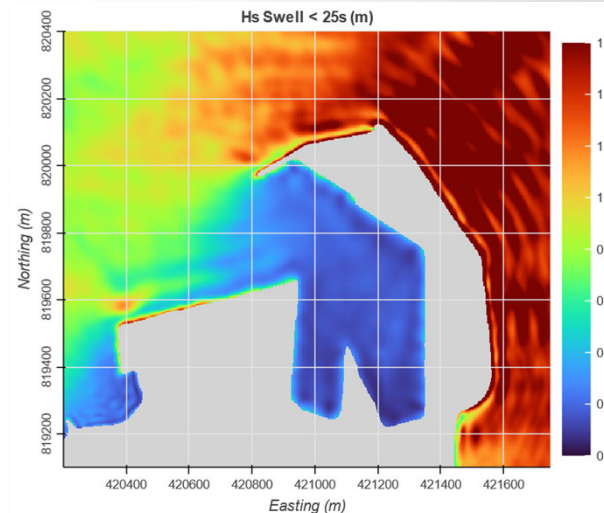
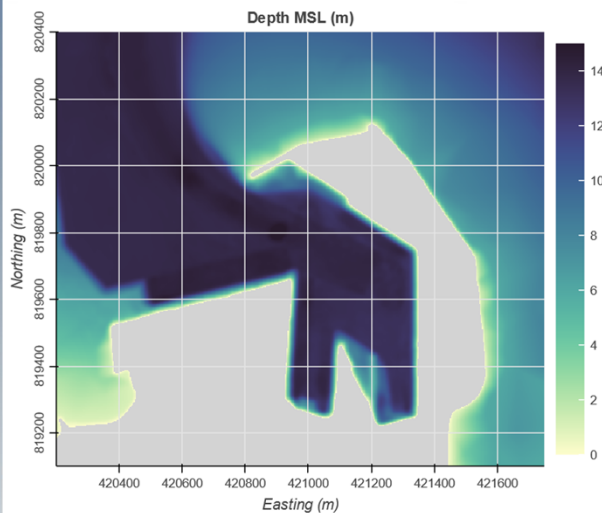


Wave modelling by Oceanum

- FUNWAVE Boussinesq wave propagation analysis for different offshore wave spectra
- Example offshore spectrum (right) and wave conditions in harbour (below)



	Boundary
Time	2009-08-30 15:26
Hs	1.64 m
Tp	15.4 s
Dpm	81 deg

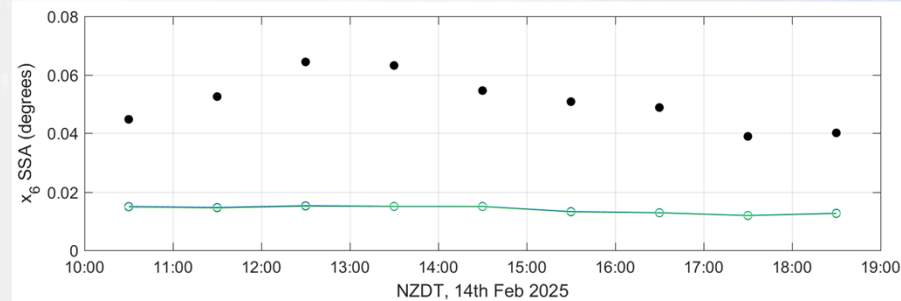
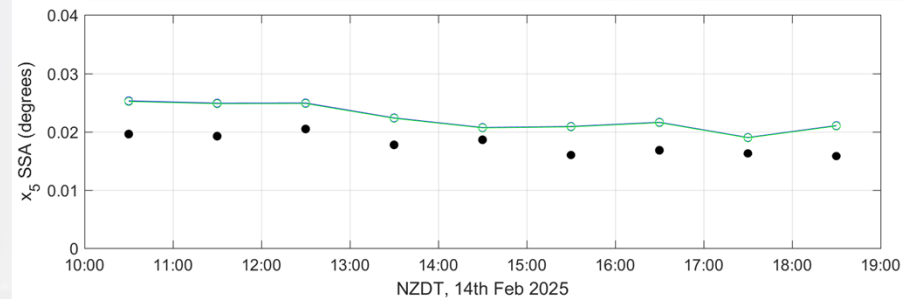
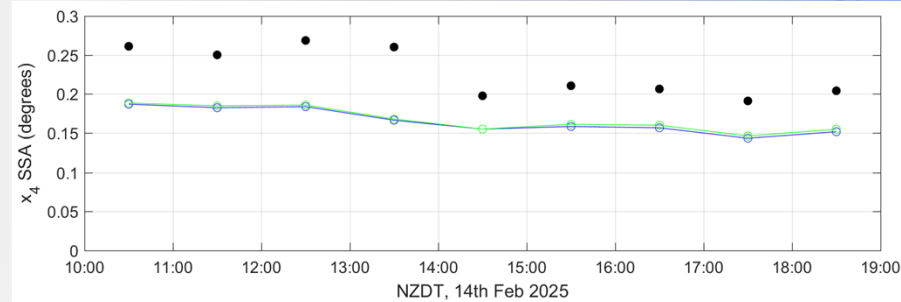
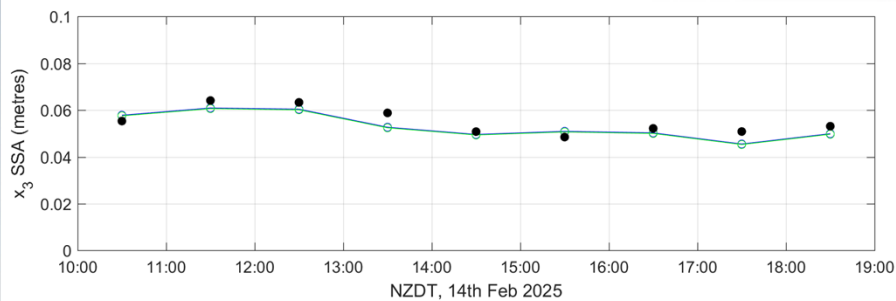
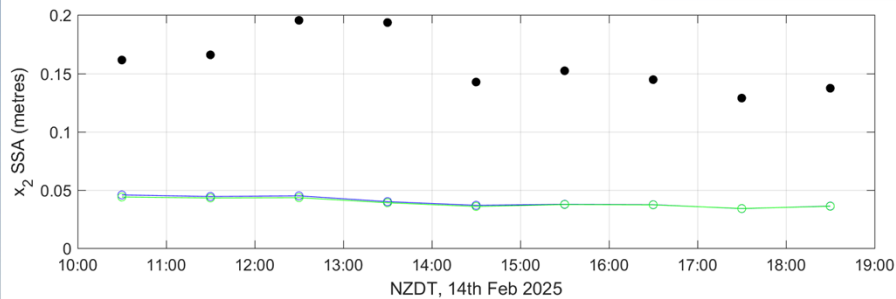
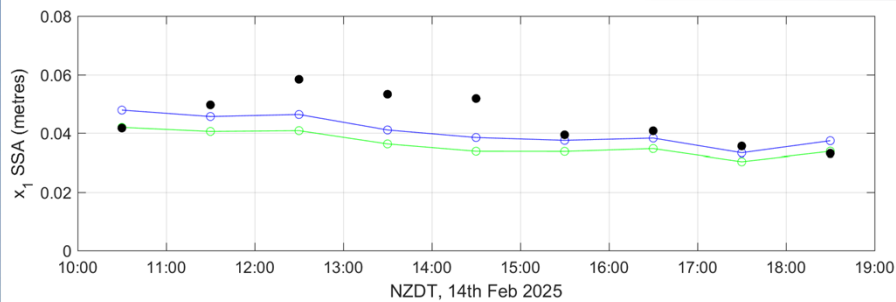


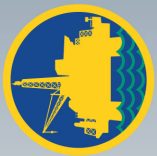


Dynamic mooring analysis

- Ship and harbour modelled as a coupled system in WAMIT, to calculate wave loads on the ship at the berth in any offshore wave conditions
- Offshore wave spectrum tuned to give correct wave spectrum at the berth; wave loads then tuned accordingly
- Wave loads, IRFs, fenders, mooring lines and ShoreTension units modelled in MoorMotions (6-DoF nonlinear time-domain code developed at Perth Hydro, www.moormotions.com)
- 6-DoF ship motions, mooring line and fender loads, ShoreTension line loads and ram displacements, all output at 10 Hz using 1-hour averaged wave spectra
- Ship line pre-tension sensitivity assessed by calculating with 5% pre-tension (green lines) and 15% pre-tension (blue lines).

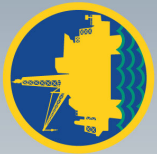
Measured and predicted motions





Conclusions

- Surge, heave, roll and pitch well-predicted by the DMA
- Sway and yaw under-predicted, particularly stern sway
- Asymmetric cruise ship mooring arrangement (long head lines) may be important; corresponding measurements on container ships with symmetric mooring arrangements (<https://www.perthhydro.com/pdf/Gourlay2026Report2026-04.pdf>) showed much better agreement
- Sway and yaw also sensitive to wave directionality; opportunities exist to refine this method (wave refraction and diffraction)



Acknowledgements

- Robbie Jensen and the team at Napier Port
- Peter McComb and the team at Oceanum
- Royal Caribbean cruises

