

# OPERABILITY INVESTIGATION OF A MIDWEST WESTERN AUSTRALIAN MARINA SUBJECTED TO GRAVITY, INFRAGRAVITY, AND TRANSMITTED WAVES

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## INTRODUCTION

Batavia Coast Marina (BCM) in Geraldton, Midwest WA is one of 50 Department of Transport (DoT) coastal facilities spanning Western Australia from Wyndham to Esperance. Since construction of BCM was completed in 1995, there have been significant operability issues in the form of excessive motion of moored vessels, mooring line breakages, and damage to pens at the facility. This was in part addressed by the addition of the Northern Breakwater in 2000 as seen in Figure 1.



Figure 1 - Batavia Coast Marina

BCM is subjective to persistent southwesterly swell energy from the Southern Indian Ocean as well as sea waves associated with sea breezes particularly during summer. Due to a relatively wide, shallow reef extending 5km offshore, significant infragravity (IG) wave energy is released into the nearshore environment. This IG energy adversely impacts operability at nearby Geraldton Harbour and therefore has been widely investigated including an IG wave mitigation symposium hosted by Mid West Ports in Geraldton in 2014. IG energy is prevalent along the coast of WA, and poses an issue for many DoT facilities.

## OBJECTIVE

The objective of the study is to investigate the causes of BCM operability issues including Gravity and IG wave penetration, transmission through the breakwater, and basin resonance. This is accomplished by a comprehensive 3-year data collection program of strategically placed instrumentation including 3 Acoustic Wave and Current (AWAC) devices, 6 pressure sensors, an Aquadopp, Waverider, vessel motions, and structural inspections. Results from IG wave modelling are also assessed.

## METHODOLOGY

The datasets collected from multiple instruments have been analyzed and compared to empirical/analytical methods to investigate the relative contribution of each

potential cause of the operability issues. For example, concurrent wave measurements at four different locations are compared to expected diffraction predictions to assess the relative contribution of gravity wave penetration versus transmission. Other Examples are provided below.

The relative contribution of IG waves is determined by assessment of power spectral density (PSD) of water levels from concurrent measurements from four pressure sensors inside and outside of the marina. This allows comparison of incident IG energy and IG energy at nodes/antinodes that may be triggered by the longitudinal and transverse natural oscillatory frequencies of the BCM basin due to its geometry. These are also successfully correlated to analytical IG wave prediction such as Merian's formula.

Additionally, an Aquadopp with sampling regime tailored to measure instantaneous currents rather than mean currents is used to assess oscillating currents that occur due to gravity and IG waves. This allows for a direct comparison of oscillatory current PSD in both the longitudinal and transverse basin axes as well as assessment of relative contribution of gravity waves, IG waves, and wave transmission to the PSD of currents as seen in Figure 2.

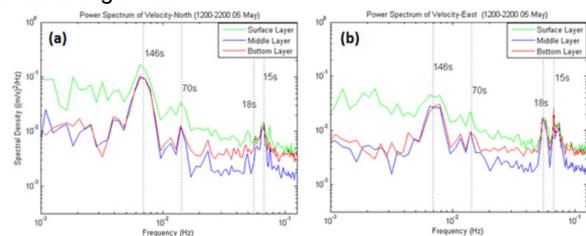


Figure 2 - Spectral Density of longitudinal (left) and transverse (right) currents derived from Aquadopp data

## RESULTS/CONCLUSION

The investigation of BCM operability has leveraged a comprehensive data collection program to formulate a credible explanation of the causes of operability issues. This has included novel and complementary data analysis methodologies including comparisons of gravity and IG wave PSD, transverse and longitudinal PSD of currents, as well as correlations to analytical methods and vessel motions. Once the causes have been determined, the path toward operability improvement is elucidated. This investigation provides a template for future investigations.

## REFERENCES

Mid West Ports (2014) Technical Symposium Long Period Wave Mitigation - Geraldton Harbour May 2014 - Proceedings and Papers.