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UNSW SYDNEY

Water Research Laboratory

Dear Sean,

Coastal Engineer's Assessment of Wave Forces on Boat Shed, 80 Prince Alfred Parade, Newport

1. Introduction

The Water Research Laboratory (WRL) of UNSW Australia is pleased to provide the following advice regarding wave forces on the seaward face of the proposed boat shed at 80 Prince Alfred Parade, Newport.

2. Documents

The following reference documents were considered in assessing the wave forces on the proposed boat shed:

- Australian Standard AS 4997-2005 "Guidelines for the Design of Maritime Structures";
- FEMA (2000, 2011), "Coastal Construction Manual";
- AUS 2004 Bathymetric chart for Broken Bay;
- AWACS (1991), "Design Guidelines for Water Level and Wave Climate at Pittwater";
- Coastal Engineering Manual (2011);
- NSW Government (2011) "Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments";
- Pittwater Council P21 DCP Part B (18 November 2013);
- Pittwater Council P21 DCP Part D (18 November 2013);
- Cardno (2015), "Pittwater Estuary Mapping of Sea Level Rise Impacts"
- Shore Protection Manual (1984).

The following documents (Project Reference: 1734, Date of Issue: 15/03/2019) supplied by the Client were utilised by WRL as input in the calculations:

- Gartner Trovato Architects Drawing A.02[C] SITE PLAN;
- Gartner Trovato Architects Drawing A.03[C] BOATHOUSE & LOWER GROUND FLOOR PLAN;
- Gartner Trovato Architects Drawing A.06[C] WEST ELEVATION;
- Gartner Trovato Architects Drawing A.09[C] SOUTH ELEVATION

3. Site Conditions

The site faces approximately 270° relative to true north (west) on the eastern side of Pittwater Bay. A piled jetty with a deck at about 1.60 m AHD is present to the north of the existing and proposed boat shed and a concrete ramp with a seaward slope of approximately 1V:5H is present to the west of the existing and proposed boat shed. Provided these remain intact, they would provide some protection from storm waves to the boat shed.

As the foreshore seaward of the seawall is sand, any long term change to the sand level may alter the depth limited wave height able to reach the proposed structure.

4. Design Conditions and Parameters

4.1 Design Conditions

Pittwater DCP21 Part B (2013) states that new boat sheds should have a floor level above the "Estuarine Planning Level" (EPL), or if below the EPL, should be designed to withstand the wave forces. The reference EPL for the subject site is 2.64 m AHD (Cardno, 2015). Therefore, with a design floor level of 1.50 m AHD for the proposed new boat shed, the structure needs to be designed for wave forces.

The EPL is based on the following parameters:

- 2050 planning period;
- Nominally 100 year ARI (average recurrence interval) design event;
- Present Day Still water level (SWL) of 1.53 m AHD based on Existing Seal Levels from Cardno (2015);
- Future sea level rise of 0.4 m by 2050, giving a design 100 year ARI SWL of 1.93 m AHD at the end of the planning period.

The EPL also considers wave runup and has an allowance for freeboard.

4.2 Waves

Design wave conditions for 100 year ARI conditions are shown in Table 1 and were determined from the following methods:

- AWACS (1991);
- Simple hindcasting as per SPM (1984) Table 1: Design Wave Conditions.

Table 1: Design 100 year ARI Wave Conditions

Offshore Direction	Hs (m)	Tp (m)
N (0°)	1.8 (a)	3.8 (a)
NW (315°)	1.2 (a)	2.9 (a)
W (270°)	0.7 (b)	2.3 (b)

Notes:

a. Source AWACS (1991)
b. Calculated for this study

The parameters shown in Table 2 were considered as input for the calculations.

Table 2: Design and Input Parameters

Parameter	Value	Source
Location	Eastern Shores E11 & E12 Salt Pan Point (12)	AWACS (1991) Cardno (2015)
Design life	50 years	AS 4997-2005 for normal structure
Design event	100 year ARI	Pittwater P21 DCP
100 year ARI design SWL	1.53 m AHD	Cardno (2015)
Sea level rise	0.4 m	Cardno (2015)
Estuarine Planning Level (without 0.3 m freeboard)	2.34 m AHD	Appendix C – Components Used in Calculation of Estuarine Planning Levels Cardno (2015)
Design significant wave height and period offshore of structure	1.8 m, 3.8 s from N 1.2 m, 2.9 s from NW 0.7 m, 2.3 s from W	AWACS (1991) AWACS (1991) Calculated from SPM (1984)
Bed elevation at seawall toe	0.0 m AHD	Gartner Trovato Architects Drawing A.03[C] BOATHOUSE& LOWER GROUND FLOOR PLAN
Nearshore slope seaward of boat shed	1V:5H	Gartner Trovato Architects Drawing A.03[C] BOATHOUSE & LOWER GROUND FLOOR PLAN
Elevation of top of ramp	Varying from 1.37 m AHD to 1.73 m AHDH	Gartner Trovato Architects Drawing A.03[C] BOATHOUSE & LOWER GROUND FLOOR PLAN
Proposed boat shed floor	1.50 m AHD	Gartner Trovato Architects Drawing A.03[C] BOATHOUSE & LOWER GROUND FLOOR PLAN

5. Wave Forces

5.1 Introduction

Wave forces on the seaward face of the proposed boat shed would consist of a hydrostatic component from water pressure, and a dynamic component due to horizontal wave velocity. Physical model testing is the most reliable method to calculate wave forces, particularly with the complex ancillary structures present, but would generally be considered beyond the resources of a project such as this.

Ground levels for both the North (1.73 m AHD) and South (1.37 m AHD) walls were obtained from Gartner Trovato Architects Drawing A.03[C] BOATHOUSE & LOWER GROUND FLOOR PLAN. It should be noted that these ground levels gradually increase along the alignment of the proposed boat shed on both the North and South sides and therefore the provided values are representative of the maximum expected loading on each of these two side walls.

Finally given the nature of the building assessed, it has been assumed that should Pittwater Bay water levels rise, the doors on the western wall of the boat shed would allow water levels to gradually rise within the building (i.e. the building would be inundated inside), which would reduce the overall hydrostatic loading experienced by the western wall (or doors).

Wave loads were calculated for the following walls of the proposed boat shed:

a. West wall (floor level taken as 1.50 m AHD, equipped with doors);
b. North wall;
c. South wall.

The main method used to calculate wave forces was FEMA (2000, 2011), "Coastal Construction Manual", with other methods used as a cross check. FEMA (2000, 2011) requires a Cp (coefficient of pressure) value (FEMA, 2000 Table 11.1). This can range from 1.6, for a building type "*accessory structure, low hazard to human life or property in the event of failure*"; to 2.8 "*coastal residential building*". While the boat shed may fit the description of an accessory structure, the ARI ascribed by FEMA of 2 years is considered too low by WRL, so the Cp value of 2.8 has been adopted (nominally 100 year ARI). FEMA (2000, 2011) suggests that for sacrificial "breakaway walls", a Cp value of 1.0 can be adopted, which is essentially no factor of safety. The other methods require more complex calculations and were only applied to select cases.

5.2 Results

The method of FEMA (2003) provided the results plotted in Figure 1 with coefficient of pressure Cp. taken as 2.8. For comparison, the maximum calculated dynamic pressure at the still water level (1.7 m AHD) when Cp is set to 1.0 was estimated to be 9 kPa from FEMA (2000, 2011). The higher Cp value adopted from FEMA is akin to a factor of safety.

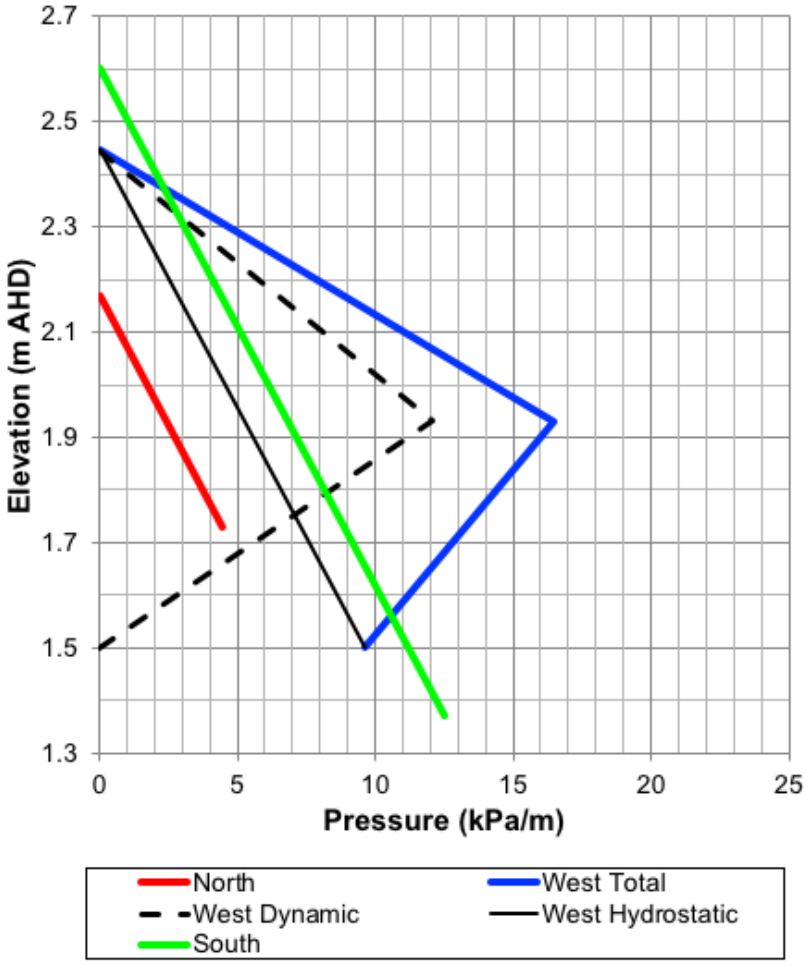

Figure 1: Total Wave Pressure Distribution

Note that due to shelter from direct wave impacts, only hydrostatic forces would apply for the north and south walls.

6. Factor of Safety

There is no explicit factor of safety in the above pressures/forces apart from the Cp value, however, other "conservative" assumptions have been built into the calculations. A reduction in these conservative assumptions is not feasible within the scope and resources of this project.

Examples of conservative assumptions include:

- The design water level utilised includes 0.4 m of sea level rise, which is projected to occur at the end of the planning period.
- The simultaneous occurrence of a 100 year ARI water level with 100 year ARI wind waves from the west would be likely to have an ARI in excess of 100 years, but this scenario is the basis for the estuarine planning level and could not be modified without a substantial joint probability study.

Note that electrical services and storage of any hazardous materials should be located higher than the applicable EPL for a boat shed (2.64 m AHD if including a 0.3 m freeboard or 2.34 m AHD if excluding any freeboard).

7. Summary

Design wave pressures are shown in Figure 1. Please contact James Carley should you require further information.

Yours sincerely,

Grantley Smith
Manager