21 October 2024

WRL Ref: WRL2024007 LR20241021a JTC

***SUBJECT TO LEGAL PRIVILEGE***

UNSW
Water Research
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Dear Steven,

# RE: Newport SLSC seawall physical model – wave pressures on SLSC wall (0.2 second duration)

## 1. Introduction

This letter provides additional commentary, additional tests and additional analysis undertaken on the same physical model reported in Carley and Doherty (2024), Newport SLSC stepped seawall physical modelling, WRL Technical Report 2024/20, UNSW Water Research Laboratory, WRL's letter report dated 5 September 2024 and WRL's additional letter report dated 21 October 2024 (WRL Ref: WRL2024007 LR20241021 JTC).

The following additional information is presented:

- Wave pressures averaged over 0.2 s duration (for consistency with AS/NZS 1170.2:2021 Structural design actions, Part 2: Wind actions)
- Pressures are presented only for the following design conditions (with an eroded beach state):
    - Wave parapet present in front of existing SLSC building
    - 100 year ARI, 2024
    - 100 year ARI, 2084, 0.53 m sea level rise
- Commentary is provided on the likely change in pressures for setbacks from the parapet of greater than 4 m; noting that tests were undertaken for a 4 m setback, which is the minimum setback for the SLSC building, whereas most of the building face is setback at least 6 m from the parapet

## 2. Existing building force/pressure tests

The figures for each force/pressure test on the existing SLSC building (with a wave return parapet) are listed in Table 2.1. A common Y axis was used for all plots to facilitate comparison between tests and various analyses.

**Table 2.1 Figure numbers for force tests on existing SLSC building – with wave return parapet**

| ARI (years) | Year | SLR (m) | ID | Panel | Entire time series | Pmax event* | 0.2 second average time series | 0.2, 1 and 2 second average Pmax* |
|---|---|---|---|---|---|---|---|---|
| 100 | 2024 | 0 | 0090 | GF bottom | 2.1 | 2.1 | 2.1 | 2.1 |
| | | | 0090 | GF top | 2.2 | 2.2 | 2.2 | 2.2 |
| | | | 0100 | UF bottom | 2.3 | 2.3 | 2.3 | 2.3 |
| | | | 0100 | UF top | 2.4 | 2.4 | 2.4 | 2.4 |
| 100 | 2084 | 0.53 | 0089 | GF bottom | 2.5 | 2.5 | 2.5 | 2.5 |
| | | | 0089 | GF top | 2.6 | 2.6 | 2.6 | 2.6 |
| | | | 0103 | UF bottom | 2.7 | 2.7 | 2.7 | 2.7 |
| | | | 0103 | UF top | 2.8 | 2.8 | 2.8 | 2.8 |

* Note that the short duration Pmax, the 0.2 s, 1 s  2 second average Pmax may be associated with different individual waves, but the figure shown is for the short duration Pmax

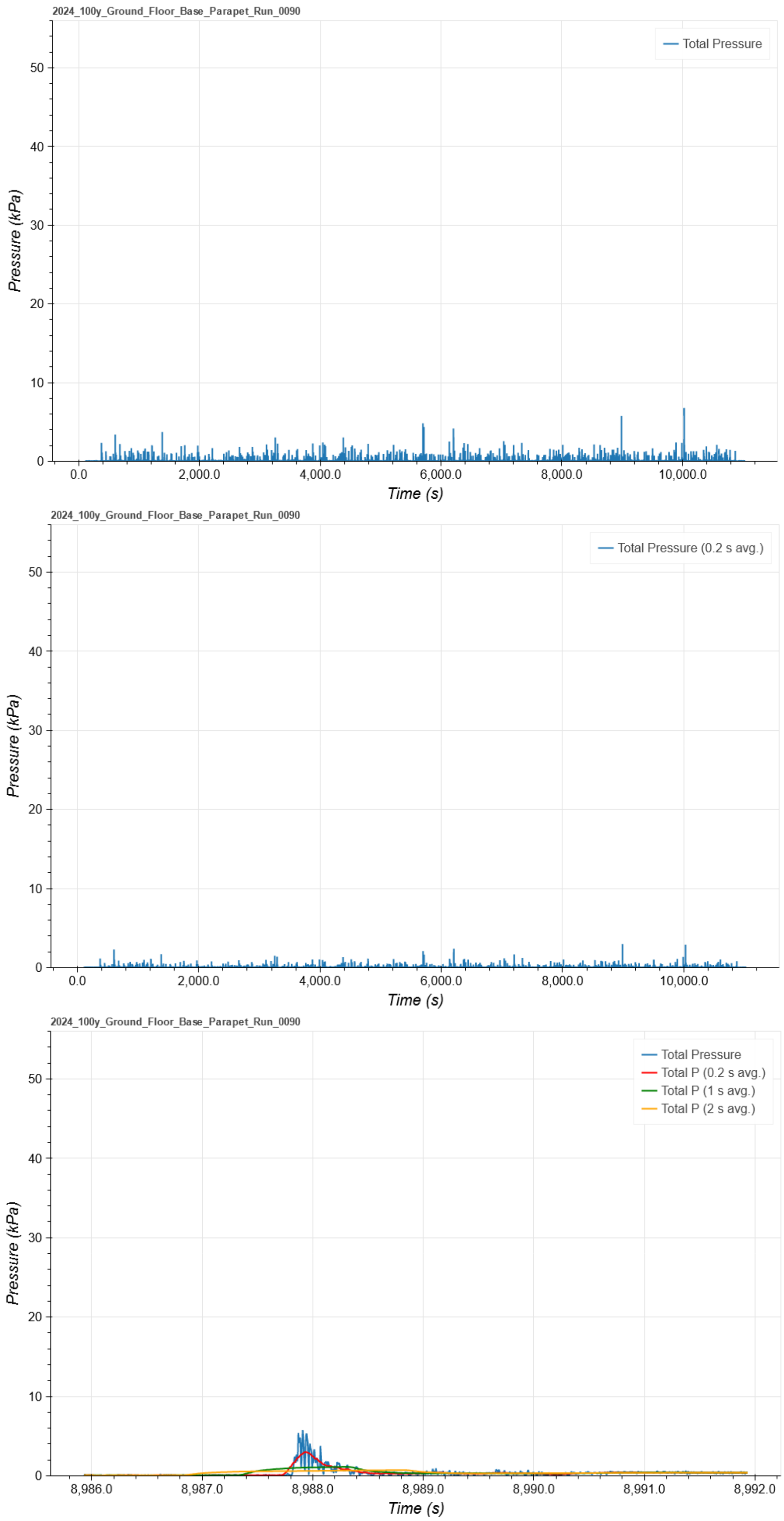



**Figure 2.1 Existing building with parapet, 100 year ARI, 2024, ground floor bottom**

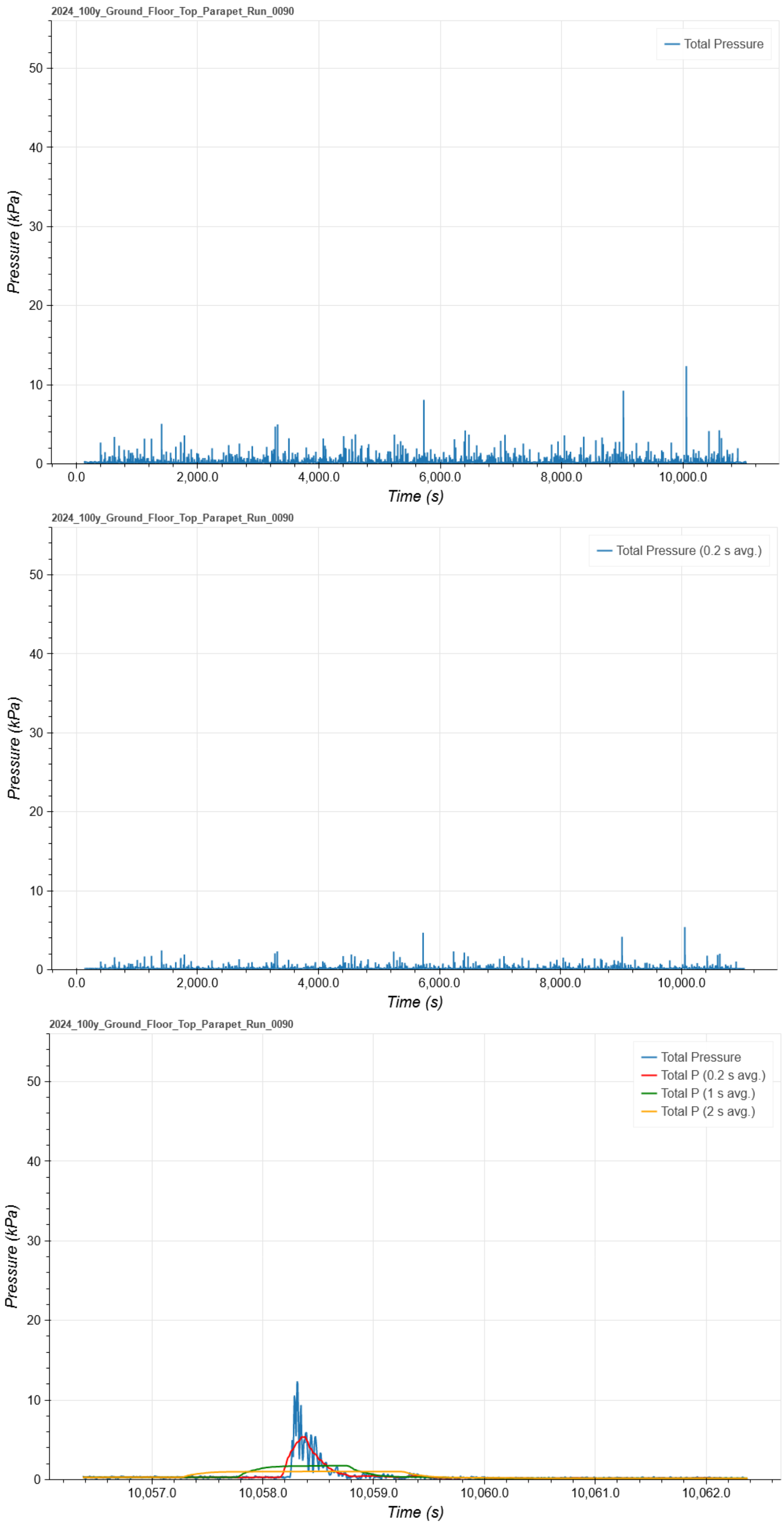



**Figure 2.2 Existing building with parapet, 100 year ARI, 2024, ground floor top**

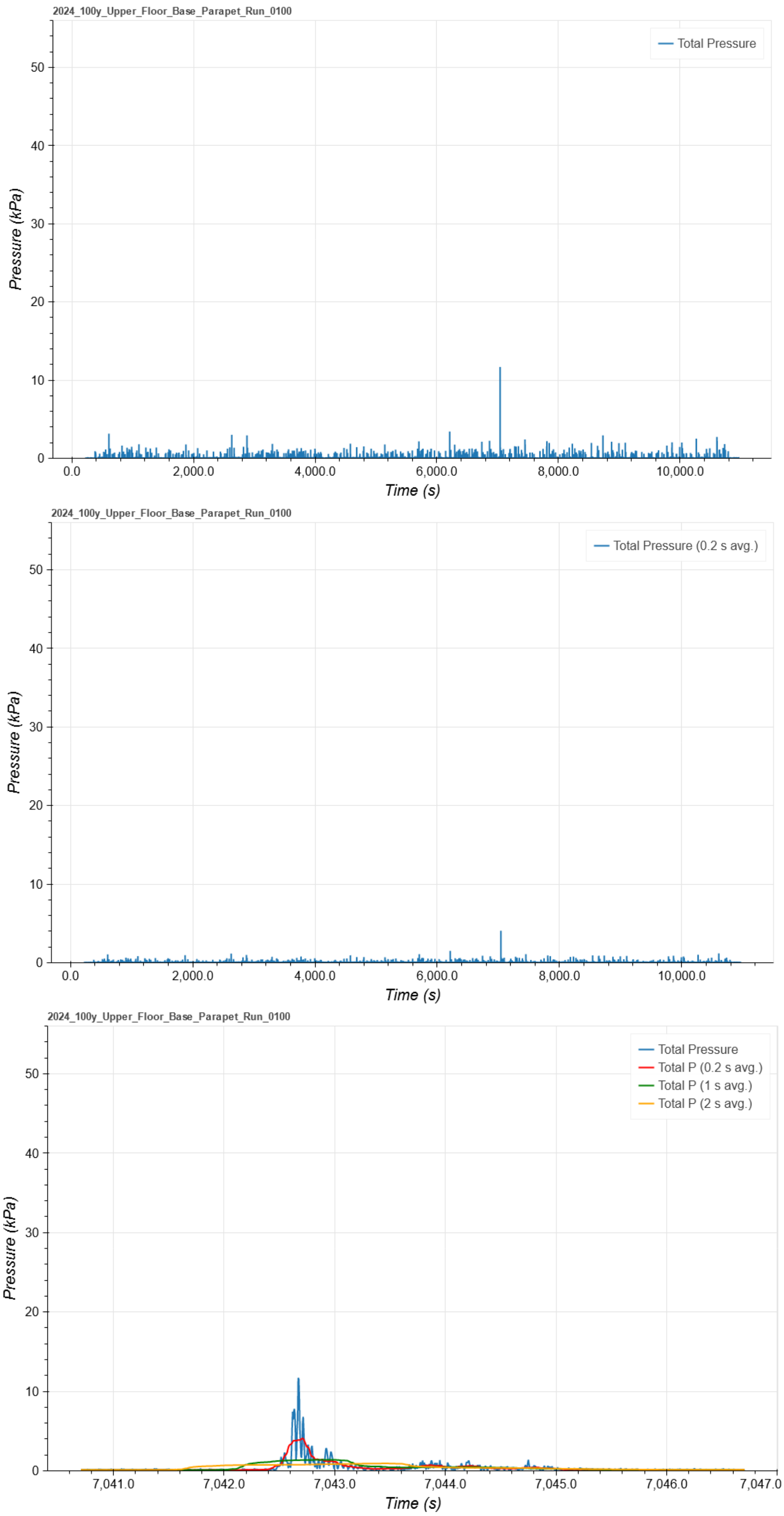



**Figure 2.3 Existing building with parapet, 100 year ARI, 2024, upper floor bottom**

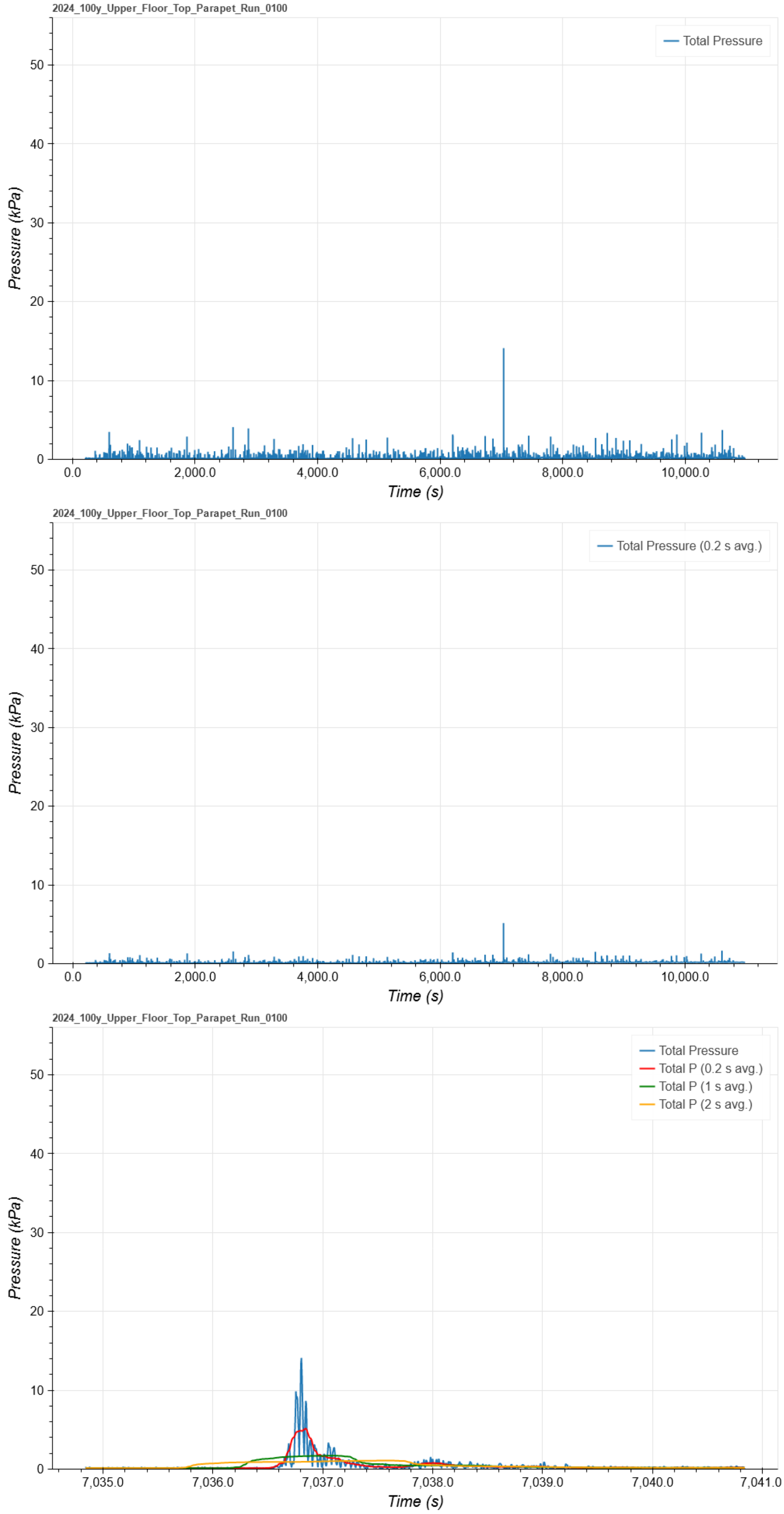



**Figure 2.4 Existing building with parapet, 100 year ARI, 2024, upper floor top**

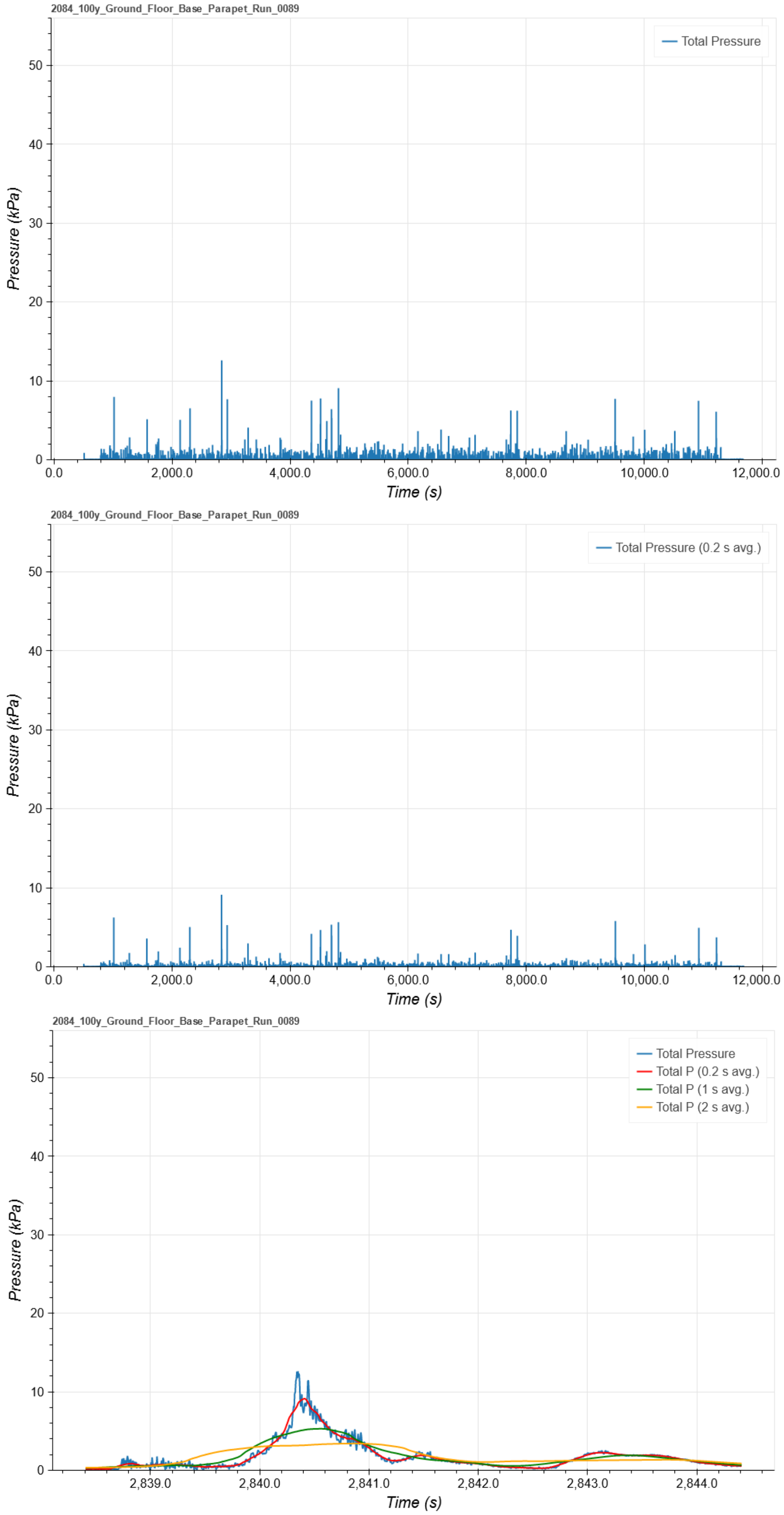



**Figure 2.5 Existing building with parapet, 100 year ARI, 2084, ground floor bottom**

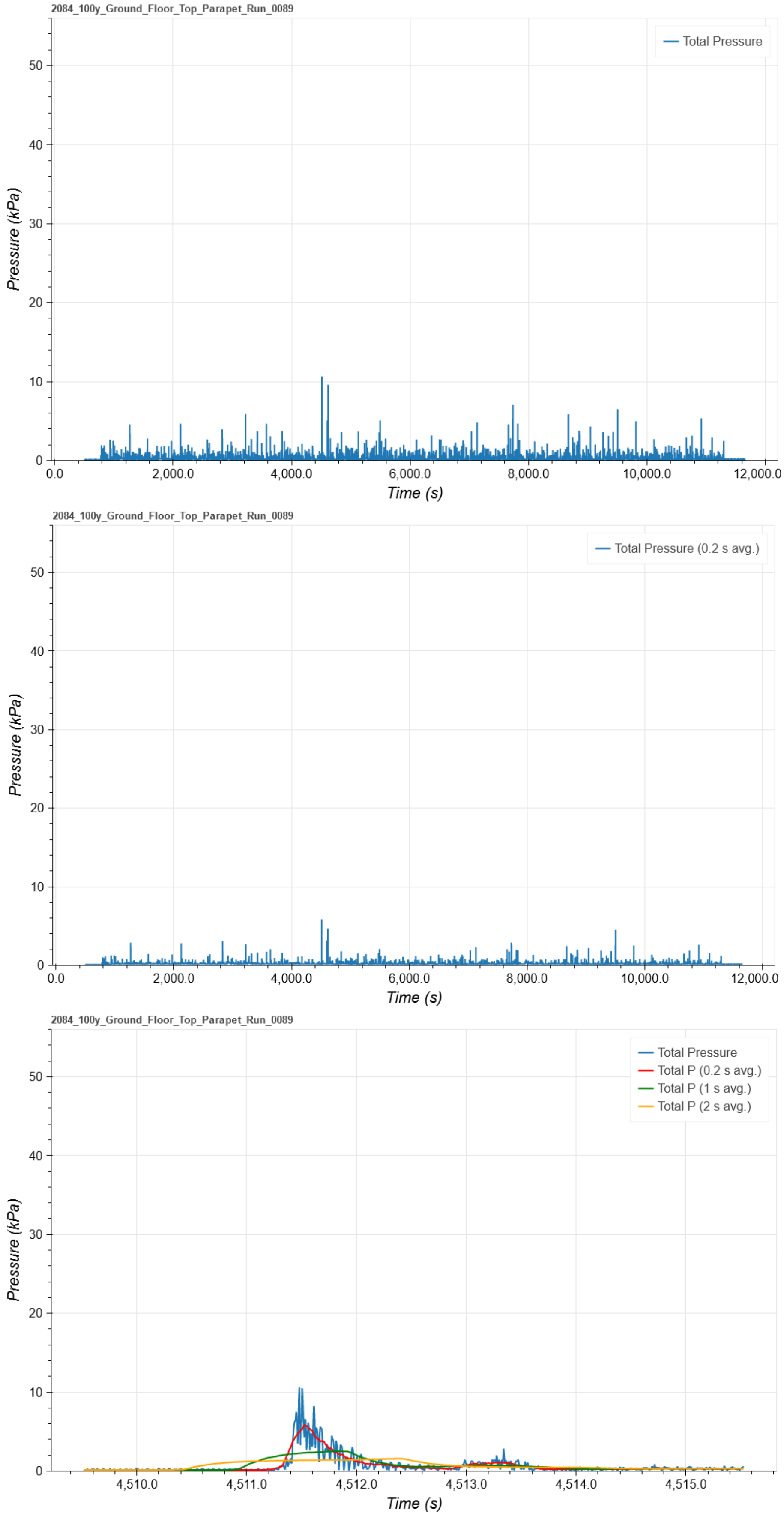



**Figure 2.6 Existing building with parapet, 100 year ARI, 2084, ground floor top**

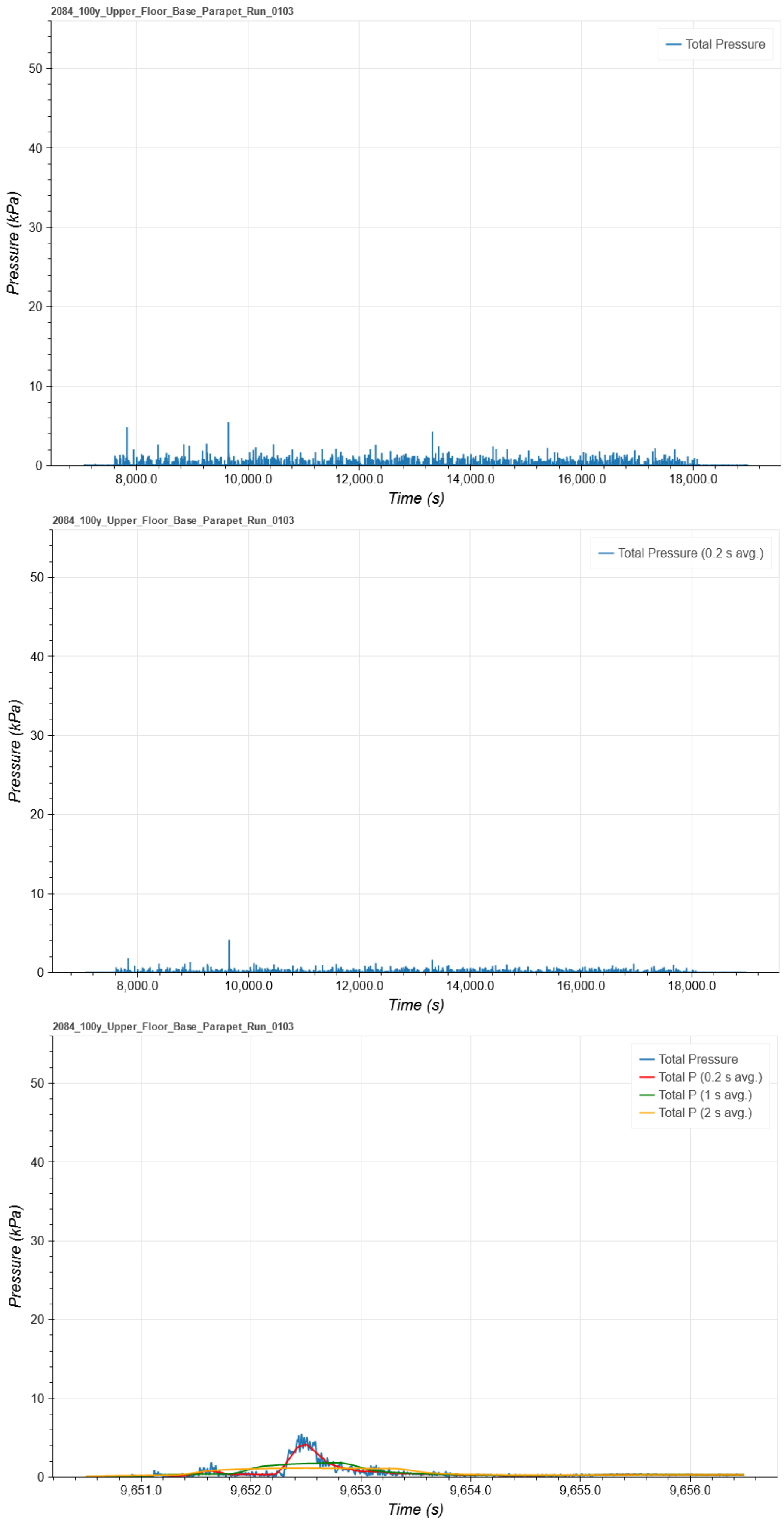



**Figure 2.7 Existing building with parapet, 100 year ARI, 2084, upper floor bottom**

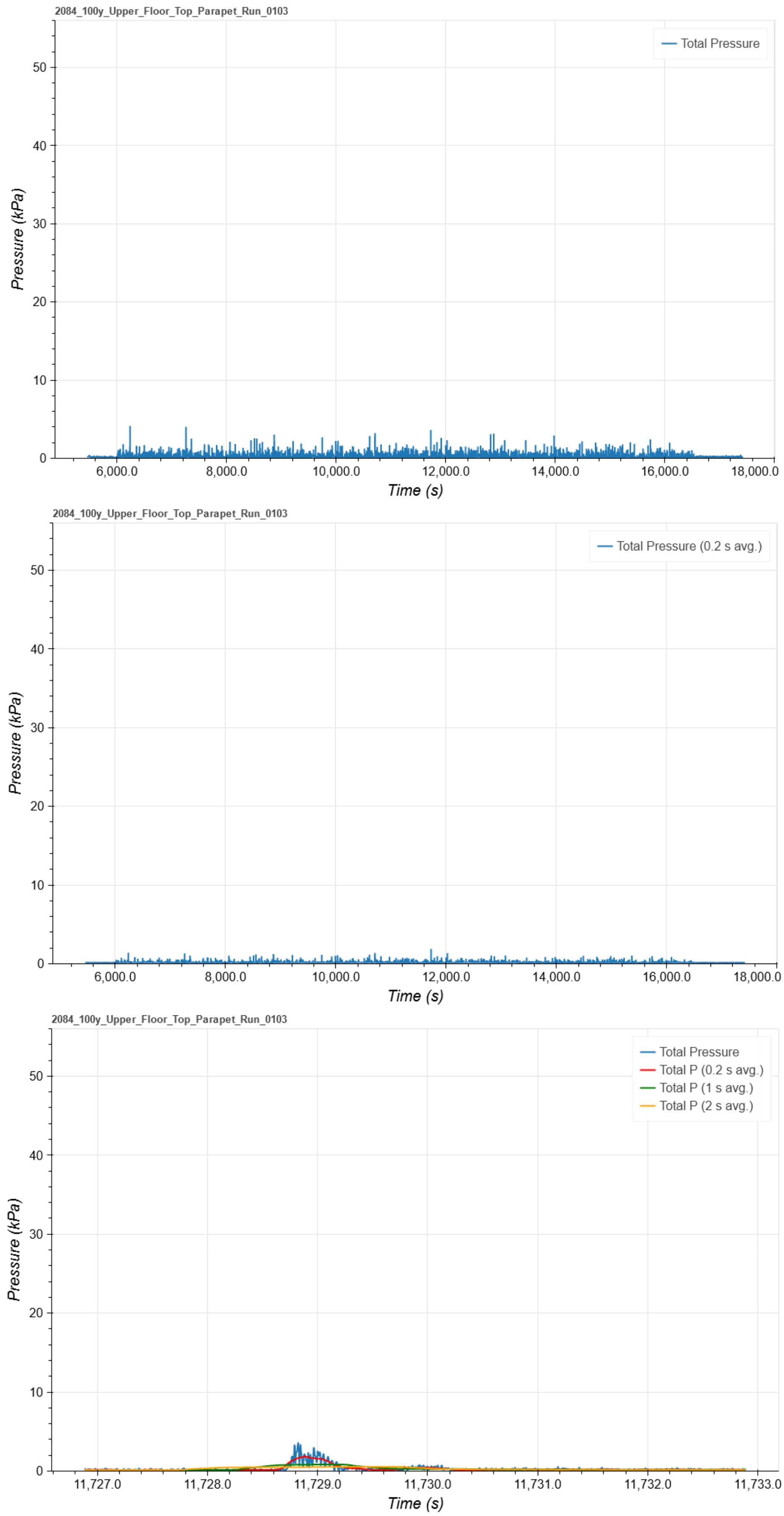



**Figure 2.8 Existing building with parapet, 100 year ARI, 2084, upper floor top**

## 3. Tabulation of pressures

The maximum measured pressures (Pmax) for the existing SLSC building (fronted by a wave parapet) for extremely short duration (as little as 0.005 s), 0.2s and 2 s average are shown in Table 3.1. Due to the signal to noise ratio within the load cell, the Pmax was limited to a minimum value of 1.0 kPa.

**Table 3.1 Pmax on existing SLSC building – with wave return parapet**

| ARI | Year | SLR | ID | Panel | Pmax event (kPa) | 0.2 second average Pmax (kPa) | 2 second average Pmax (kPa) |
|---|---|---|---|---|---|---|---|
| 100 | 2024 | 0 | 0090 | GF bottom | 6.8 | 3.0 | 1.1 |
| | | | 0090 | GF top | 12.3 | 5.4 | 1.2 |
| | | | 0100 | UF bottom | 11.7 | 4.1 | <1.0 |
| | | | 0100 | UF top | 14.1 | 5.1 | <1.0 |
| 100 | 2084 | 0.53 | 0089 | GF bottom | 12.6 | 9.1 | 3.4 |
| | | | 0089 | GF top | 10.6 | 5.8 | 1.9 |
| | | | 0103 | UF bottom | 5.5 | 4.1 | 1.1 |
| | | | 0103 | UF top | 4.1 | 1.9 | <1.0 |

## 4. Pressure for setbacks of more than 4 m

Physical model tests were undertaken for a setback of the SLSC building face from the wave return parapet of 4 m. This was so that pressures on the building were tested for the most severe geometry proposed. Most of the building face is setback at least 6 m from the parapet. The implications of this larger setback are discussed below

FEMA USA (2023) provides the following commentary on overtopping flows:

> "3.6.4. OVERTOPPING FLOWS
> When overtopping is in the form of 'green water,' bores or sheets of water can flow over terrain inland of the shore barrier crest. Generally speaking, overtopping flows are driven inland by the momentum contained in the overtopping bore and gravity forces. In some FISs to date, the method proposed in Cox and Machemehl (1986), to calculate the inland limit of the overtopping bore was adapted to compute the bore height and velocity profile overland to account for the slope of the inland terrain. Experimental results of overtopping bore depth and velocities on landward slopes of sea dikes are explained in Chapter 5.5.5 of the EurOtop Manual. This chapter also provides an analytical function of the overtopping flow velocities and sheet flow depth on landward slopes."

Sketches for defining the effect of setback from a foreshore feature (such as a seawall) are shown in Figure 4.1 and Figure 4.2. These illustrate that overtopping water may have an initial upward (and horizontal) trajectory close to the seawall or barrier, with gravity acting to lower the overtopping water further landward.

Observations of the videos for the Pmax events tested, indicates that for (100 and 1000 year ARI events) with a wave return parapet and a 4 m setback, the overtopping water was either predominantly horizontal or falling by the time it reached the face of the SLSC building (with a 4 m setback).

Thus, for setbacks of approximately 6 m, the horizontal pressures on the upper level of the SLSC building are likely to be lower than for the 4 m setback.

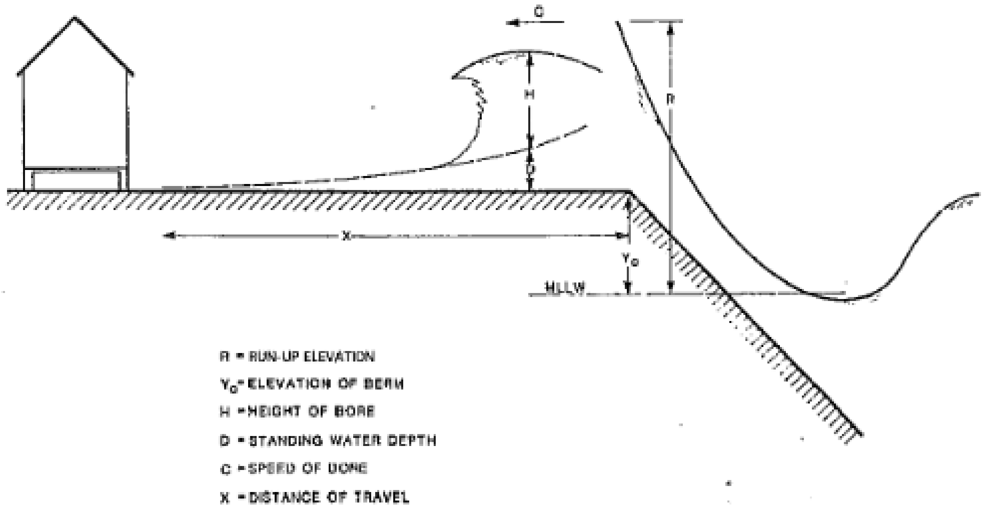



**Figure 4.1 Definition sketch for wave overtopping from Cox and Machemehl (1986)**

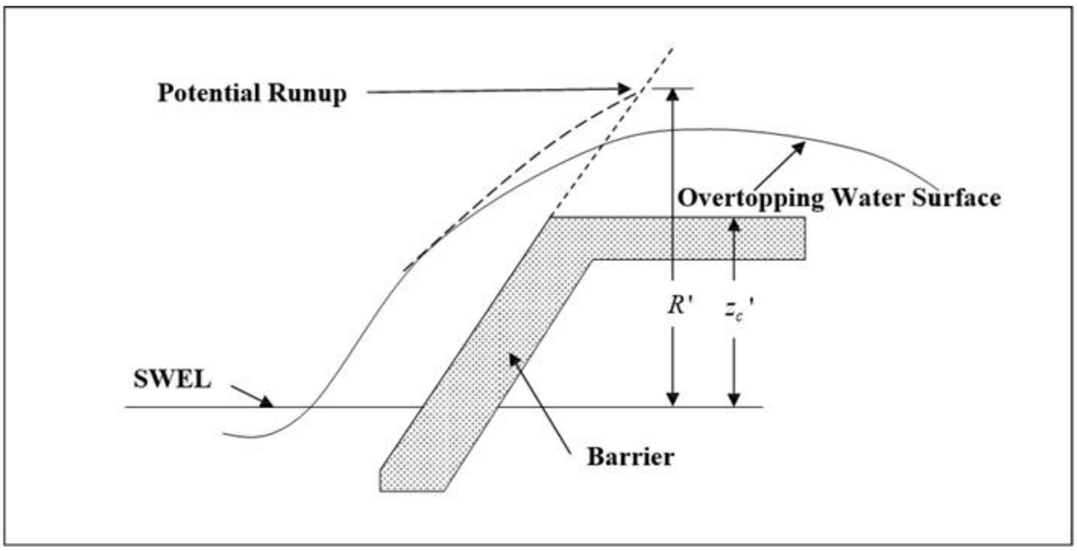
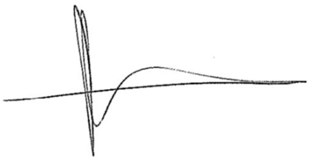



**Figure 4.2 Modified definition sketch for wave overtopping from FEMA (2023)**

## 5. Summary

Please contact James Carley (james.carley@unsw.edu.au ; 0414 385 053) should you require further information.

Yours sincerely,



**Dr Francois Flocard**
Director, Industry Research

## 6. References and bibliography


AS/NZS 1170.2:2021, Structural design actions, Part 2: Wind actions

Cox, J.C and Machemehl, J. 1986, Overland bore propagation due to an overtopping wave. Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 112, pp. 161-163.

FEMA, Federal Emergency Management Agency USA 2023, Guidance for Flood Risk Analysis and Mapping Coastal Wave Runup and Overtopping November 2023

FEMA, Federal Emergency Management Agency USA 2000, Coastal Construction Manual FM55 USA