Hindcasting the waves at the Mulberry Harbours

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The Harbours

The Mulberry Harbours were temporary harbours used to support Operation Overlord during the Second World War. Two harbours were constructed: Mulberry A in the American sector and Mulberry B on the British beach off the village of Arromanches. Both harbours were to be twice the size of Dover harbour, to be operational 14 days after D-Day and to have a design life of 90 days.

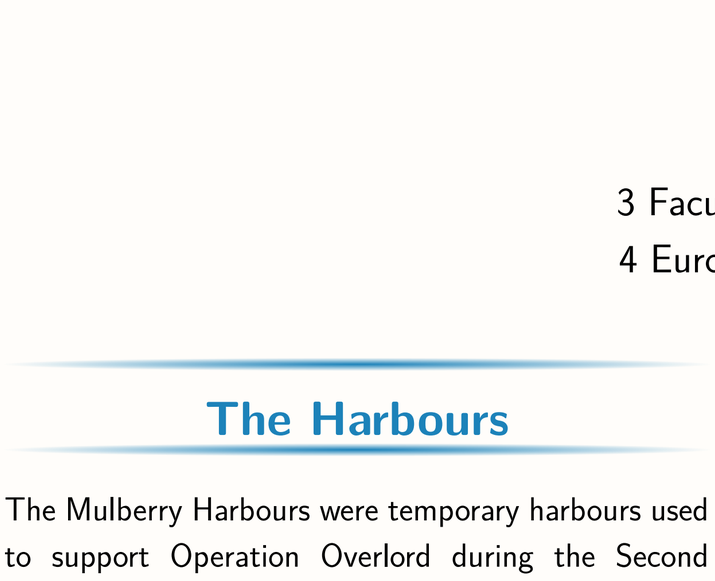
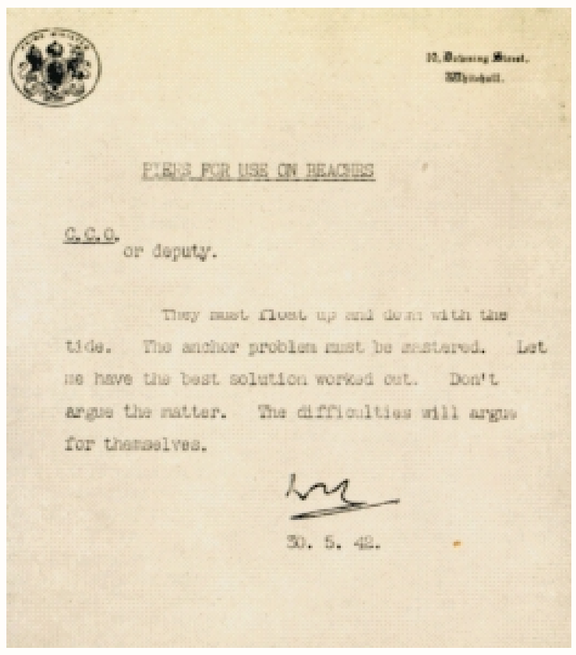


Figure 1: D-Day beaches and locations of the Mulberry Harbours.

The initial designs for the harbours consisted just of piers following Churchill's famous memo (Figure 2).



PIERS FOR USE ON BEACHES

C.C.O. or deputy.

They must float up and down with the tide. The anchor problem must be mastered. Let us have the best solution worked out. Don't argue the matter. The difficulties will argue for themselves.

30. 5. 42.

Figure 2: Churchill's memo from May 1942.

Running up the beach were floating roadways ('Whales') over which transport vehicles and tanks could drive. These were designed to be compliant so that they would move with the waves and tide rather than trying to resist the motion. These connected to pierheads ('Spuds') which could be raised and lowered with the tide in a similar manner to a modern jack-up rig.

A variety of approaches were used for the breakwaters. In relatively shallow areas old ships were scuttled. In deeper water 'Phoenix' caissons were used. These were towed across the channel and sunk in place. Finally, an outer floating breakwater (the 'Bombardons') was used to give extra protection and increase the area of tranquil water.

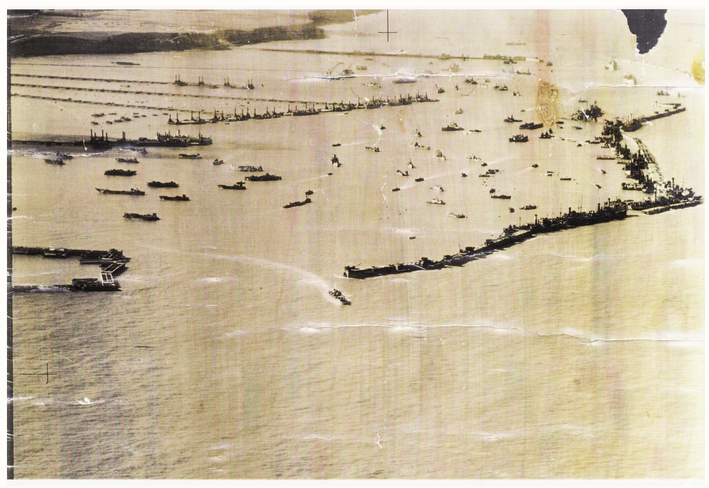


Figure 3: Mulberry B from the air.

The Storm

14 days after D-Day, when the harbours had just been installed, a major storm occurred. The storm destroyed the American Mulberry but, although badly damaged, the British harbour survived. Figure 4 shows one of the floating breakwaters which broke loose near the caissons at the British Mulberry.

Figure 4: A Bombardon broken loose in the storm.

In this study we used SWAN to take the output of a large-scale ECMWF hindcast into the nearshore region. Standard parameters were used for the modelling. Tidal water levels were included in the study but tidal currents were found to have minimal effect on the waves and so were not included in the analysis.

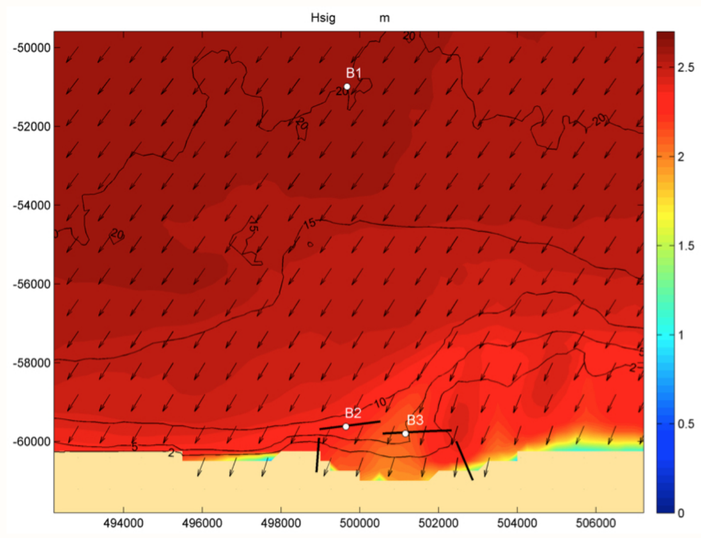


Figure 5: Significant wave height field from SWAN at the peak of the storm at 21:00 20/06/1944. Also shown are the approximate locations of the breakwaters and jetties that formed Mulberry Harbour B at Arromanches.

We found that the American Mulberry experienced slightly more severe waves than the British harbour.

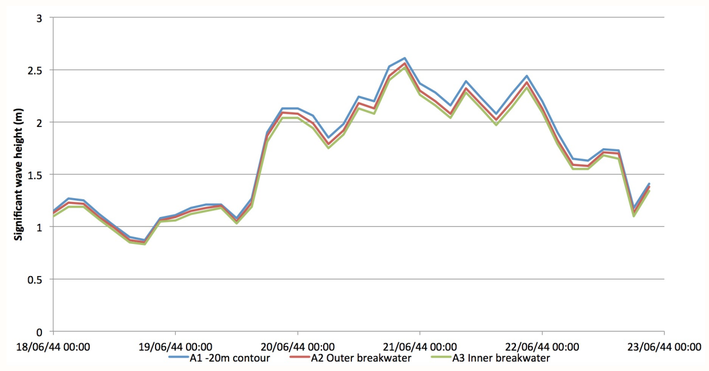


Figure 6: Significant wave height at locations around Mulberry A.

Figure 7: Significant wave height at locations around Mulberry B.

We also considered the return period based on a 36 year hindcast. We found that the commonly used estimate that the storm was a 1 in 40 year event (for a summer) was a reasonable estimate. Whilst for the actual storm which occurred the waves were more severe at the American Mulberry, the British Mulberry would generally have been expected to experience slightly larger waves for a given return period.

Reference

Z. Jackson, S. Grey, T.A.A. Adcock, P.H. Taylor and J.R. Bidlot (2017) The waves at the Mulberry Harbours, Journal of Ocean Engineering and Marine Energy 3(3) 285-292.