Gunsite flood alleviation project, St Aubin's Bay, Jersey

A coastal mass concrete WWII defence wall in Jersey has been successfully raised and reshaped to become part of the island's infrastructure. This project has alleviated flooding behind the wall and preserved the historic heritage of the original concrete structure. Modern surveying and construction techniques were used to overcome the unusual problem of securing new concrete to concrete that is over 60 years old, having been hastily constructed by prisoners during a blockade. ***Steve Hold*** *of* ***Steve Hold Consulting Civil Engineering*** *reports.*

The sea wall at the Gunsite Café is located in St Aubin's Bay on the south coast of Jersey. The wall was originally built as a military defence structure by the Germans to resist amphibious landings in World War II. The requirement from the States of Jersey engineers was to extend the life and function of the existing mass concrete wall and to upgrade it into a coastal sea defence to alleviate the frequent flooding that occurs behind the wall.

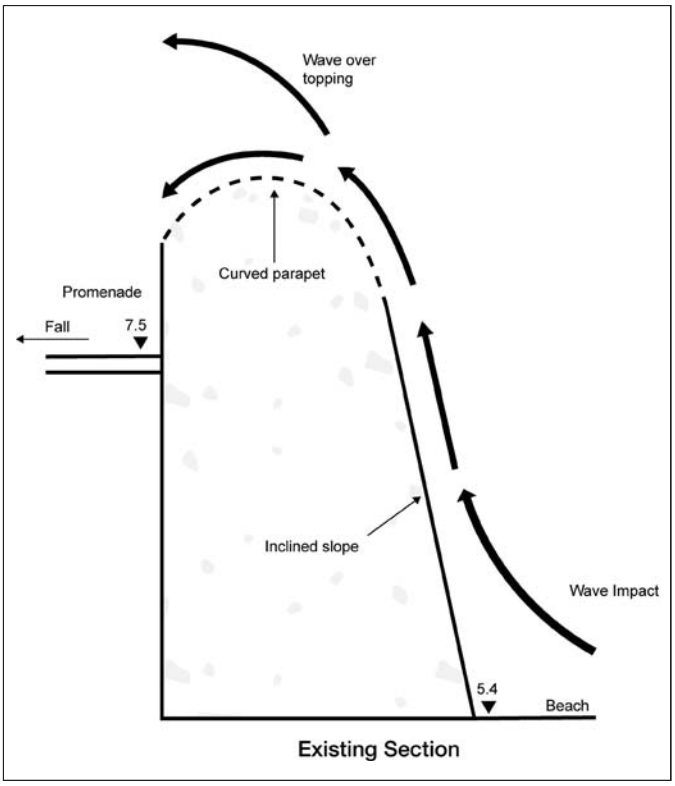

Figure 1: Graphical assessment of overtopping.

Original wall

One of the most significant elements contributing to the flooding was wave overtopping of the sea wall due to its low height, its inclined slope and a rounded top in one particular section close to a slipway, and a large WWII concrete gun emplacement structure now used as a café.

Studies were carried out to consider raising the height of the wall and forming a recurve with the new concrete to reduce the overtopping further. A recurve produces a reflected wave from the wall, which impacts with the next incoming wave, thereby reducing the wave energy impact at the wall.

It was anticipated that between 2014 and 2064, sea level rise would be in the region of 0.3m; the general current theory at the time was that this rise could be between 0.3 and 0.7m over a 50-year period. The study concluded that with a recurve built into a raised height of wall, the new reconfigured structure would offer an 80% reduction in overtopping and significantly reduce the flooding.

Other factors

After consultations with planning and local politicians, it was decided that the raised new height profile should not be as high as 9.0 above ordnance datum (AOD) because the 'promenade experience' would be diminished. It was therefore decided that only 8.7m AOD would be the initial height of the raised concrete addition. The changed design was therefore to have an allowance for 'futureproofing' predicted sea level rise increases by allowing for the casting of new concrete capping beams onto the new raised level if required in the future. This was achieved by building in the facility to use 'couplers' on the stainless steel threaded tension bars in Cintec anchor socks to tie the new concrete beam above to the existing WWII mass concrete wall below.

Figure 2: Concrete splitters used to take rounded top off existing WWII wall concrete.

Figure 3: Concrete ready to be lifted off in one section – environmentally friendly.

Figure 4: Ready for new concrete pour with Zemdrain on outer formwork and couplers on Cintec anchor tie bars into WWII concrete below.

Existing wall study

In 2014, a LiDAR survey was carried out to provide accurate levels for the existing promenade area, the sea wall, the beach and the surrounding roads inland that were being flooded. Initially, a rounded 'bulb shape' of recurve was selected by the design team, as detailed in CIRIA Guide No C674[1].

Cores for strength

In order to raise the level of the sea wall and to change the geometry with a recurve, it was vital to know the integrity of the mass concrete constructed in haste by the German military during WWII in 1942. There was anecdotal evidence that due to blockading, there were shortages of cement and the use of forced labour and prisoners of war meant sabotage during construction was a possibility. Therefore, three cores were taken entirely through a cross-section of the wall to assess the various strength characteristics.

The main requirements were to assess the strength of the concrete in both compression and, more significantly, in tension. It was necessary to accommodate the 'uplift force' between the existing and new concrete during storm events from waves running up the inclined face of the wall and hitting the new overhang of the recurve at the junction of the two concretes.

The compressive strength of the concrete cores varied from the equivalent of 34 to 45MPa and the tensile testing of the samples indicated that a 1.15–2.55MPa tensile strength could be mobilised in the old WWII mass concrete.

New profile

Placed vertically, Cintec anchors have a large diameter of bond contact with the existing concrete and so provided a solution that would efficiently bond the two concretes together. This method would mean less drilling and installation work compared with a conventional method of drilling and fixing many dowel bars.

With the range of concrete qualities obtained from the cores, a consistent depth of 500mm of anchor embedment was calculated as necessary for the anchors. The diameter of the drill hole for the Cintec sock was 76mm, with a 20mm-diameter stainless steel threaded bar in the centre of the grout, forming the basis of the Cintec anchor principle.

The concept of a threaded bar allows for couplers to be added to the top of the bar in the future so that the height of the wall above the current 8.7 AOD can be raised to suit the future sea level rise.

Innovation

The contractor employed innovative techniques for the cutting and removal of the rounded top of the existing concrete using hydraulic splitters (rather than conventional cutting or hydro-demolition), which proved to be very efficient.

This method is less noisy, and less dust is created and it is much easier to remove and lift large sections of cut concrete for disposal, thus considerably reducing environmental impact damage to the beach (Figures 2 and 3).

Figure 5: Project concreting sequence in 9m lengths.

Figure 6: Top profile and site access problems.

Figure 7: Outer surface of new concrete and wall awaiting repairs.

Figure 8: Work progressing and spray concrete repairs.

Finish

In order to provide the new concrete capping beam with the best wave impact and abrasion resistance – required because the waves include shingle, floating debris and other abrasive materials – a Zemdrain fabric was applied to the steel shutter on the seaward face of the wall, which produces a hard, durable concrete surface. The contractor, Geomarine (Jersey), had designed a steel shutter to provide the amended angular profile shape preferred by the States of Jersey Engineers, who wanted to mirror the angular WWII concrete anti-tank climbing overhang at the slipway adjacent to the Gunsite at the beginning of the wall.

Access

However, accessing and moving materials to the site across the esplanade, and the ongoing construction work, all posed several practical difficulties for the contractor because the promenade is used heavily by walkers, cyclists, runners and a tourist mini-train that runs regularly throughout the summer season. (Figures 7–9).

Futureproof

The Cintec threaded anchors bars had protective plastic caps placed over them before concreting so that in future, raising the wall using couplers to join additional bars for a new lift of capping beam could be constructed.

The surface of the original WWII concrete on the seaward side of the existing sea wall had areas where the concrete was in poor condition and had honeycombing, loss of cement and inclusions (Figure 7). The contractor's preferred method, using concrete splitters, meant that mobilising hydraulic demolition at the site was unnecessary. Manual cutting out was used on areas of the existing walls that were in poor condition, prior to applying a spray concrete repair material, Sika 133F (Figure 8).

Performance

When close to completion, Storm Brian provided an early test for the new shape and height of the wall, while further storms in December 2017 and January 2018 further tested the design principles of reflecting the incoming wave back in the direction of the next wave, reducing the wave energy impact at the wall (Figure 9).

The completed project has been acclaimed by both the Jersey public and the politicians, with corresponding good press (Figure 10). ■

Reference:

1. CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION. *The use of concrete in maritime engineering – a good practice guide.* Guide C674, CIRIA, London, 2010.

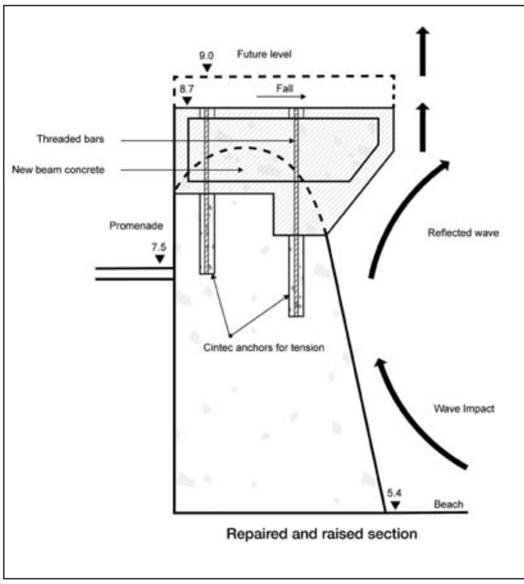

Figure 9: Design concept for new 'recurve' capping beams.

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Lead designer/project manager (for Arup)	Steve Hold (formerly Arup now Steve Hold Consulting Civil Engineering)
Contractor	Geomarine (Jersey)

Figure 10: Wave impact and return performance.