

The strengthening of heritage marine structures in Jersey with needling technology



Above North Pier and below St Aubin's Fort.

The three structures are the North Pier and South Pier of St. Aubin's Harbour and the St. Aubin's Fort Breakwater. Both structures are exposed to waves from the south west and act as breakwaters.

In 2001 the North Pier was assessed as being in a state of instability due to movement of its internal wall and apparent settlement of the interior of the pier.

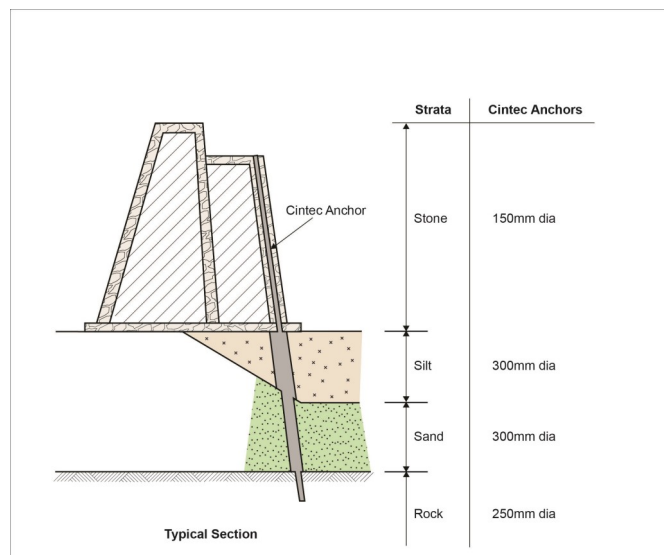
Large cracks had developed and could be seen in the asphalt surfacing indicating a threat of impending wedge failure of a section of the inner wall.



St Aubin's Fort Breakwater has in turn suffered a re-occurrence of masonry movements and loss of pointing at its inner, lower deck wall. In 2008 a bulge was also identified in part of this inner wall which prompted concerns about this part of the breakwater's structural integrity.

The States of Jersey Planning and Heritage Departments, who asked for a 'tying in place' solution to be investigated for stabilising the inner wall. Environmental concerns regarding the endangered mollusc species further reinforced this argument.

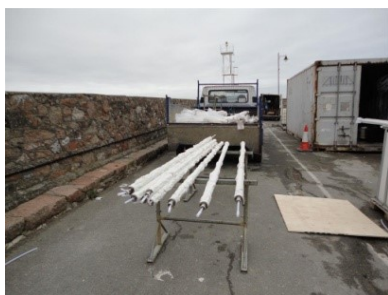
The chosen 'stitching' solution used Cintec anchors consisting of a number of solid stainless bars contained within a fabric sleeve injected with cementitious grout after positioning. The bond of the grout that seeps through the fabric sock used in the anchor between the masonry and the reinforced anchor is very high tying areas of loose masonry blocks together. This 'stitching' methodology was also able to provide a foundation solution; the numerous small diameter vertical anchors become mini piles when drilled down through the granite wall stones, through the beach deposits and into the Jersey rock shale beneath. The natural arching of the



To resist the inner wall overturning, after pinning the base of the wall with vertical mini piles, requires a form of top restraint in the outward direction. The final design consisted of horizontal 'passive' ties from the inner wall to the outer face although inclined raking anchors through the core of the Pier tied into the Jersey rock shale were also considered.

The 'stitching' anchor solution provided clear benefits allowing the structure to be anchored and stitched together without changing its character and with minimal impact. The number and spacing of anchors, was optimised to satisfy the onerous load criteria imposed by the sea conditions in such

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Anchors with coupler



Pre-injection with masking tape



Anchor grouted & expanded

Horizontal ties were inserted through the inner wall of the main breakwater so that the inside face wall of the lower deck was not only tied to the inner bulk of the original wall but also had additional cantilevered 'beam' support.

Not only did the final design solution comply with the planning authority requirements, it furthermore mitigated pollution control concerns by the 'sock' principle of the anchor system where the grout is contained within a small radius of the sock diameter.



At the North Pier the vertical drilling works for the anchors took place through the inner wall concrete up-stand used for vessel mooring. Plugs in the masonry were reinserted to enable invisible fix once the anchor had been installed.

Another valuable aspect of the installation process was that each individual anchor drilling provided its own borehole information. This allowed the length of the anchors to be reduced where, for example, the rock outcrop was found to be at a shallower depth.

From a large machine platform aided by localised, demountable scaffolding the horizontal anchors were drilled and fixed. The number of verticals and horizontals at the inner wall of the Fort Breakwater required careful setting out to avoid conflicts and also to allow for flexibility with respect to deck positioning of the rig on the structure.

The 'stitching' method used to stabilise and strengthen these two marine heritage structures has proved to be effective on a number of fronts. The 'secret' or 'hidden' fix of the structure means that the heritage planning aspects of the strengthening works are achieved. Economically, the costs budgeted for the original rebuilding of the inner wall of the North Pier on a new foundation, were of a similar magnitude to that for the 'stitching' techniques. There is a certainty with respect to the capacity of each anchor or mini pile as the drilling technique means that every element's bearing capacity is known and recorded.