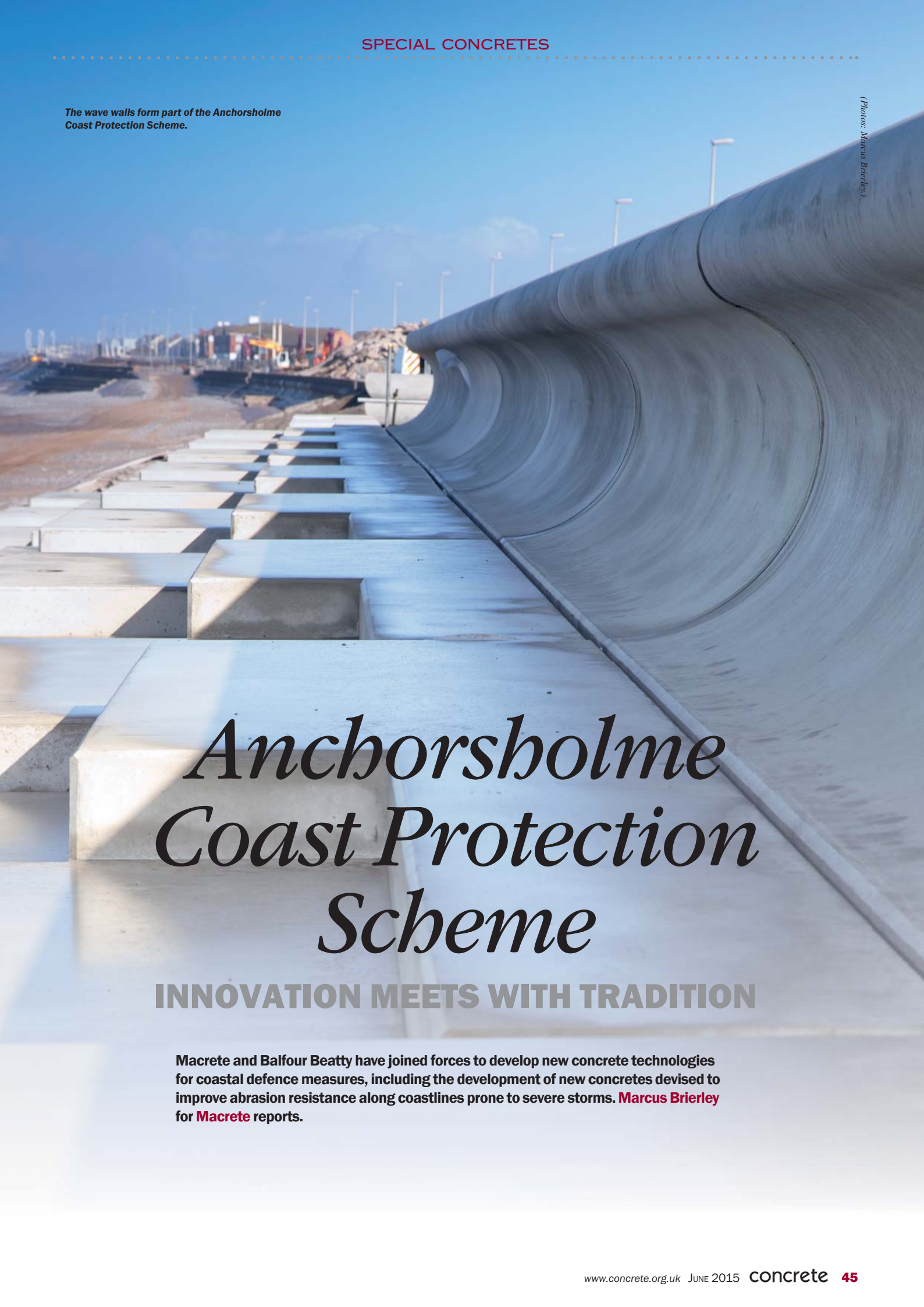

The wave walls form part of the Anchorsholme Coast Protection Scheme.

(Photos: Marcus Brierley.)

Anchorsholme Coast Protection Scheme

INNOVATION MEETS WITH TRADITION

Macrete and Balfour Beatty have joined forces to develop new concrete technologies for coastal defence measures, including the development of new concretes devised to improve abrasion resistance along coastlines prone to severe storms. Marcus Brierley for Macrete reports.

Anchorsholme Coast Protection Scheme wave breaker revetments.

The new coastal defence construction currently underway on the Fylde Peninsula at Anchorsholme, adjacent to the promenade travelling due north from Blackpool, extends for approximately 1km before bordering with the concrete sea defences at Cleveleys, which was completed in 2009.

Potential for failure

The new scheme commenced in March 2014, with funding of approximately £20 million supplied by a consortium consisting of the Environment Agency, Defra and Blackpool Council. As the original sea defences were showing significant signs of abrasion, decay and potential for failure, the decision was taken that in order to provide a general defence against coastal erosion, together with improved flood protection to local infrastructure and over 4000 homes, early replacement was a priority.

This stretch of Irish Sea-facing coastline is prone to severe storm conditions during the winter months. As a result the new defences were designed to withstand a 1-in-200-year critical storm event with a 100-year design life – the heavy storms of winter 2014 on this coast were assessed to be in the order of a 1-in-500-year storm event. From a visual and practical design perspective, the structural concept of the new installations was to mirror the existing Blackpool sea defences to the south of the Anchorsholme site. These comprise lower sloping revetments, wave breaker revetments and wave-return walls, with a promenade behind.

However, the new scheme has required an all-new precast concrete component design, including new concrete mix designs, to provide greatly improved abrasion resistance compared to previous schemes constructed along the coastline. Brian Farrington, coastal technical services lead for Balfour Beatty Construction Services UK, says, "All that has been learned from our past coast protection scheme projects, which include the schemes at Weston-super-Mare, Dymchurch and Redcar, together with some new innovative solutions, have been used in the design and implementation at Anchorsholme."

Steel sheet piles

The components of the scheme comprise sloping revetment units, wave breaker units, wave return wall, raised promenade and rear flood wall – with access steps to the beach at 100m intervals. The works commenced with the installation of a sheet-piled steel retaining wall, using piles of varying lengths from 3.5 to 7m, driven typically to 1.5m below beach level. This was capped with a cast-in-situ macro-synthetic-fibre-reinforced concrete capping beam. Macro-synthetic fibres avoid the need for steel reinforcement bar in a saltwater environment. The steel sheet piles themselves have a sacrificial corrosion allowance of 5.7mm over their design life. The primary function of the sheet-piled wall is to protect against the scouring action of the sea. Additionally, it has a retaining function for the precast units, which are installed above on the slope.

Protection

In preparation for the installation of sloping revetments and wave breaker units, the slope was created with an initial layer of fill to establish an even gradient, followed by a 300mm-deep stone drainage blanket, then 200mm of blinding concrete. This provides the working platform for placing the precast units and also protection for

A wave-breaker is lowered into place using the dual-purpose lifting frame.

Lifting hole plug cast in C-Defence high-abrasion-resistant concrete formula showing cast-in nylon thread.

Sloping revetment units – first line of sea defence.

the drainage blanket from washout. The sloping revetments and the access stairways, all components in the highly abrasive wave zone and designed to maintain the greatest resistance, are the units that have been precast using Macrete's C-Defence formulation. All other components are precast using standard structural concrete.

Line of resistance

The sloping revetment units are the front line of resistance. These are in the form of flat panels, 4.8m long × 2.8m wide and up to 500mm thick. The weight of these units ranges from 12.3 to 13.3 tonnes. There is a sacrificial allowance in the concrete thickness for abrasion over the design life. The second line of resistance is provided by the wave-breaker units, whose job is to reduce wave energy before meeting the wave return walls. These are the same dimension as above in plan, with approximate weight of 20 tonnes per unit. The size and geometric design is in keeping with the historical provision. The wave walls are precast components, on average 4.8m long × 1m wide × 1.6m high, weighing 13.5 tonnes. All components are steel reinforced and have been designed with maximum

economy of transportation from a load perspective, from factory to site. A cast-in-situ foundation strip on the landward side completes the sea defence structure prior to promenade construction.

It was decided not to use the vacuum component lifting device – which had been matched to previous coastal projects – and was suited to stepped revetments, since the two types of revetment designed for this scheme were quite different in shape. Instead, lifting anchors and a specially made multi-purpose lifting frame, capable of lifting from the flatbed transporter and rotating to the correct installation angle, was used.

However, the use of lifting anchors raised concerns about the long-term durability of the lifting anchor holes when under sea stress. The combined efforts of partnership engineers resulted in the development and implementation of a precast lifting-hole plug, cast in the more abrasion-resistant C-Defence concrete. The plug was fitted with a nylon threaded insert, which is screwed into the lifting anchor socket after positioning. A resin grout seals the small annulus between the plug, and the precast unit is then sealed with a resin grout.

All precast units are being manufactured by Macrete (Ireland) at its factory in Northern Ireland and are transported by Ro-Ro flatbed via the port at Heysham to site storage near Preston. The site itself receives and installs on a just-in-time basis. The coast protection barrier will be completed by the construction of a 12m-wide raised promenade with an exposed high-quality in-situ concrete finish, to complement the adjacent Cleveleys scheme, and is due for completion in January 2016. ●

C-Defence concrete

IN RESPONSE to the specification requirements of the Environment Agency for the Anchorsholme project, Macrete began the development of its new product, C-Defence – a silica fume concrete with superior strength and abrasion resistance.

In conjunction with Balfour Beatty and the University of Manchester, 15 different concretes were trialled against the previously established premium concrete standard typically used in sea defence structures.

As the aggregate used in concrete is a key factor in its abrasion resistance, Micro-Deval tests were carried out on all aggregates used by Macrete. These revealed that a limestone aggregate had remarkable abrasion resistance – an almost identical Micro-Deval coefficient to a granite aggregate used in the control-mix.

Of course, concrete abrasion resistance is also influenced by other mix parameters including the shape of the aggregate, the cementitious matrix and its particle density packing.

'Wet' concrete abrasion resistance tests to ASTM C1138M (underwater method)[1] were carried out on concrete discs produced from all trial mixes. The results of these tests indicated that the new product – C-Defence – suffered only half the attrition rate of the control mix. In addition, cube strengths of up to 76MPa were obtained from C-Defence.

C-Defence is now being deployed in precast concrete units for both the sloping revetments and the access stairways at Anchorsholme, as these are in the same zone of wave energy and therefore at risk of maximum abrasion.

Reference

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS, ASTM C1138M–12. *Standard Test Method for Abrasion Resistance of Concrete (Underwater Method)*. ASTM, West Conshohocken, Pennsylvania, USA, 2012.