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PROJECT: PRINCE CHARLES WHARF EXTENSION PORT OF DUNDEE

VALUE:	£7,000,000
ROLE:	MAIN CONTRACTOR
START DATE:	DECEMBER 2016
COMPLETION:	JANUARY 2018

CLIENT: PORT OF DUNDEE LTD
STANNERGATE ROAD
DUNDEE
DD1 3NA

- Design and Build
- 200m Quay Extension
- 248no tubular steel piles installed
- Heavy load area (20t/m2)
- Quayside Furniture

- Live port environment
- Challenging ground conditions
- Involvement of Abertay University
- Innovative temporary works
- Incorporation of existing structure

The Port of Dundee is sheltered within the Firth of Tay and is strategically located to serve the North Sea decommissioning and renewable energy markets, which provide a major contribution to both the local and national economy. In accordance with the increasing demands of these key markets, a decision was taken by the port to significantly increase its capacity by constructing a new 200m by 40m quay extension to the existing Prince Charles Wharf, comprising of 'normal' and 'heavy' lift areas. The project is one of the largest investments in the history of the port and has provided it with one of the strongest quaysides in Scotland. Procured as a design and build scheme, this unique and challenging project involved construction above an existing quay. It is known that upon completion of the former structure, constructed only 10yrs ago, failure of a number of structural elements resulted in the quay being deemed unusable.

Upon completion of the former structure failure of a number of structural elements resulted in the works being deemed unusable.

DESIGN

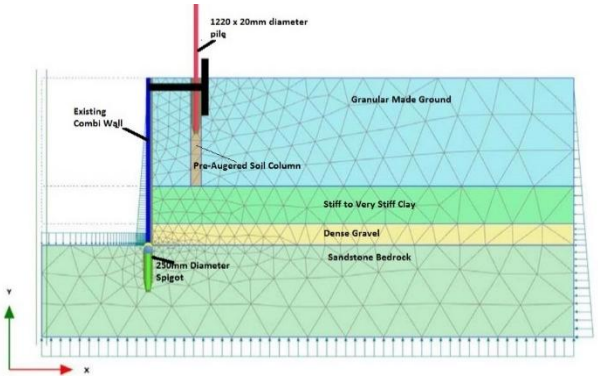
Our design considered reuse of as much of the existing structure as far as possible and involved the construction of a new combi wall to the rear of the existing quay wall, allowing our client to maintain the existing berthing line.

The existing quay wall was known to have structural design and workmanship issues, which was a key consideration in the design of the works. Following assessment, Fairhurst established that forces exerted at the toe of the existing combi-wall were considerable and that the existing dowels were inadequate. The existing front combi-wall was deemed sufficient at the western end (only) but had little remaining capacity to support ground surcharges to the rear and so any vertical load in the Permanent Works must be carried through axial bearing piles.

The detailed design aimed to rectify the residual issues and achieve the increased capacity through provision of a new combi wall, installed behind the existing wall where the dowels were deemed inadequate. The existing structure was left in place; however, the existing tie bars were cut to install the new sheet piles of the combi wall following extensive temporary and permanent works. Additional vertical bearing piles were installed to the rear and a new reinforced concrete slab was constructed above. New ties and an anchor wall system provide long term stability, mitigating the use of the existing ties.

ONSITE CONSTRUCTION

Initial works included the excavation of approximately 10,000m³ of material which was processed into suitable 6F2 material for re-use within the permanent works. This allowed for the installation of 208no 508mm diameter bearing piles and 40no 1220mm diameter anchor piles. Prior to installation of these piles, pre-auguring was undertaken to reduce the vibration impact on the existing structure. The piles were driven to refusal using a variety of vibration and impact hammers and were tested using CAPWAP analysis.



Plaxis modelling was used to assess the impact of vibration on the existing combi wall.

The existing combi wall was deemed structurally suitable across an 80m length, therefore only requiring new tie bar head restraint. The remaining length of 120m required a new combi wall which was installed to the rear of the existing combi wall with toe fixity into the competent rock head and new tie bar head restraint. The 1220mm diameter combi piles, which ranged in length from 16m to 22m, were installed using traditional double piling gate. The material within the pile was then removed using a rotary bored rig to remove the overburden / weathered rock within the pile to the design level. We employed specialist subcontractor Albion Drilling to install 40no 550mm diameter rock sockets at 4m depths, this ensured adequate embedment.

In order to install the sheet piles associated with the new combi wall, the existing ties were removed. A bespoke solution was developed in order to transfer the load from the existing combi wall into the new combi tubes and back to the sheet pile anchor wall through the new permanent ties. This involved the use of temporary bracing which was left in place until the new concrete deck was poured which acted as a restraint to the combi wall. Over 300m of sheet piling was installed to complete the combi and anchor wall systems.

The new deck slab consists of precast concrete coping units which provided a safe working platform for the installation of rebar, anchor ties and ultimately for pouring of the in-situ concrete deck. The deck slab was overlain with a reinforced granular pavement which required layering of geogrids and in excess of 1m thick class 6F2 engineered fill. The new concrete deck includes a heavy load area measuring 50m by 40m with the ability to cater for significant crane loads as well as blanket loading of up to 20t/m². Across the deck at 15m centres a series of 50 tonne mooring bollards were provided. Ladders and access chambers were also incorporated into the new deck. To ensure economic slab design, innovative structural analysis techniques were utilised with FE analysis software for the suspended deck slab under numerous crane and blanket loading combinations.

Existing quayside furniture including the fendering system was maintained with elements replaced where deemed necessary. In order to protect the existing quay wall from further corrosion a new cathodic protection system was provided in addition to blasting and painting of piles across the quay front. As part of a separate contract Southbay successfully replaced 21no. existing fenders across the whole of Prince Charles Wharf including the newly constructed extension.

PROGRAMME

Works were continuously progressed under difficult ground conditions. The presence of largely unknown made ground was particularly challenging. Due to this, the piling programme was extended beyond the original programme duration, with the project team continuously looking for ways reduce delays, through measures such as increasing the deck pour sizes and reducing the number of deck pours from 7 to 6, ranging from 350m³ to 600m³. This approach allowed the programme dates to be met in line with our client's requirements. All adopted methodologies allowed for flexibility throughout the project, notably ensuring mooring lines could be maintained to the adjacent quay. This ensured the port could keep the berth operational and meet the demands of their clients.

HEALTH AND SAFETY

An excellent standard of health and safety was maintained throughout the duration of the project, with no lost time or RIDDOR reportable accidents, which included working close to 200,000-man hours. Such high standards were only possible through constantly challenging working practices which resulted in several examples of best practice. Such examples included using a DOKA access system when accessing the quay face. This system provided a fully enclosed mobile access platform which could be transported across the entire length of the quay. In addition, the piling gate used included fully enclosed walkways and a running line which allowed the use of harnesses when working at height, adding an extra layer of protection.

SOCIAL VALUE

Throughout the construction period a close working relationship was maintained with Abertay University. This included offering work placement opportunities to third year students. To this end student Richard Craic completed a 12-week work placement before being invited to remain until the completion of the project. Richard played a key role in undertaking various site surveys and setting out. Those studying media at the university were also invited to film various stages of progress, aimed at promoting the regeneration of the city and its infrastructure. A significant effort was made to reinvest in the local economy, this included employing local labour and suppliers from across the Dundee area.

The finished scheme has been shortlisted as a finalist within the 2018 Ground Engineering and Saltire Awards.

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