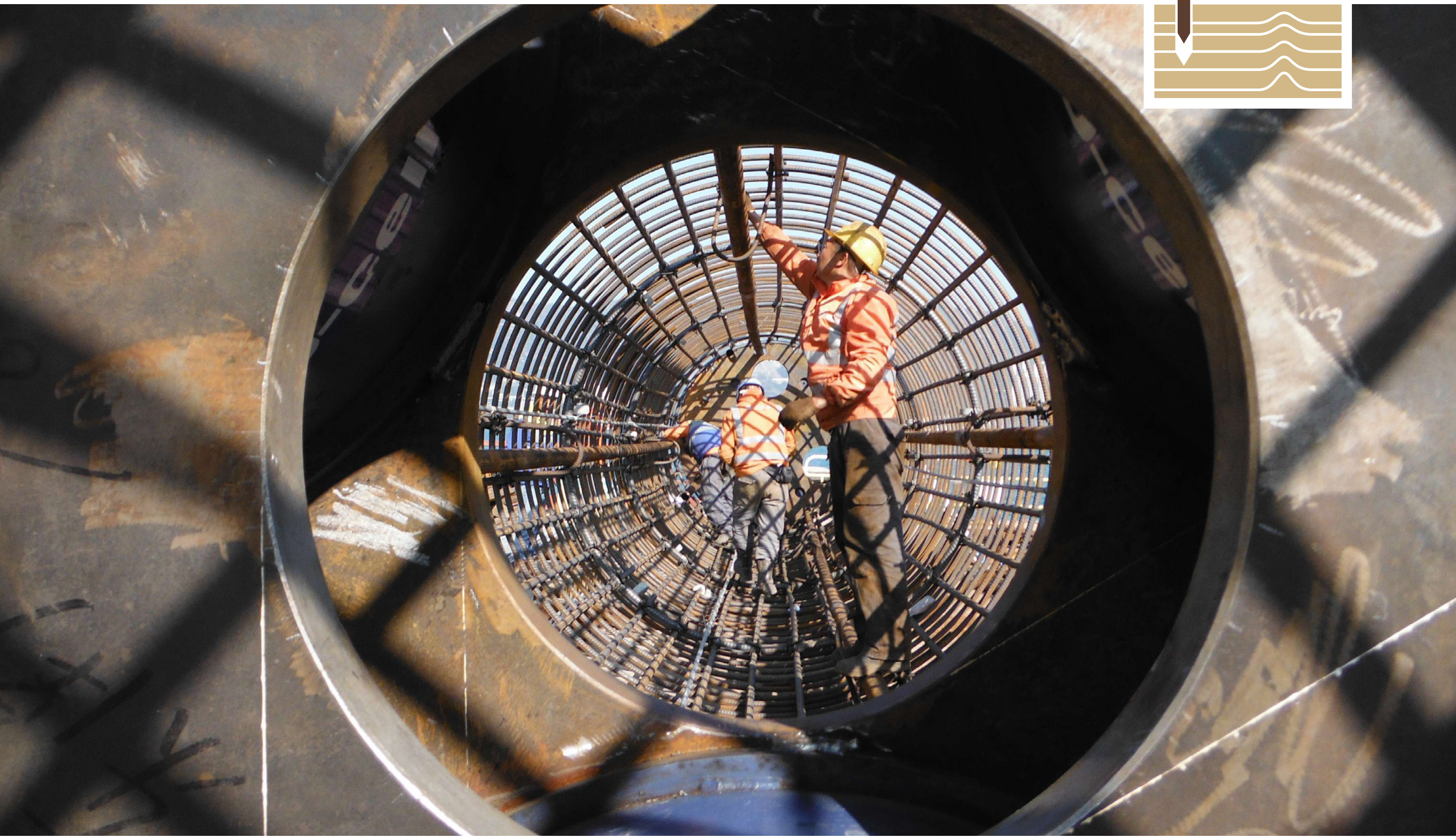


FUGRO
SPECIALIST PILE LOAD TESTING

In order to effectively connect Hong Kong's traffic network directly to the Hong Kong – Zhuhai - Macao Bridge (HZMB), a series of strategic transport facilities will be implemented within Hong Kong territory including the Hong Kong Link Road (HKLR).

THE PROJECT BACKGROUND

As part of the 12 km section connecting the HZMB Main Bridge at the HKSAR boundary with the Hong Kong Boundary Crossing Facilities (HKBCF) at the Hong Kong International Airport, a 9.4 km long viaduct section is being constructed by a Joint Venture of Dragages-China Harbour-VSL.

OSTERBERG TECHNOLOGY

In Hong Kong, with bored piles traditionally founded onto Granite bedrock, the foundation contractor Bauer Hong Kong was presented with a difficult problem. More than 2 km offshore from Lantau Island and with rock head at places not encountered within the 115 m drilling depth of the piling equipment mobilized for the project, constructing the marine piles for the bridge piers would require a change in pile design philosophy from an end bearing pile to a skin friction, shaft grouted pile. However, for piles not founding on Granite rock, a preliminary pile was required to be load tested to confirm the soil strength parameters adopted in the pile design. Besides load capacity, a preliminary pile is to be representative of the construction method for the production piles and to assess, against design predictions, the actual pile head-displacement behaviour of a production pile not founded in rock. Faced with the predicament of loading a preliminary pile to 160 MN of test load over 12 m of water, Bauer Hong Kong contacted Fugro due to their worldwide reputation and experience with pile load testing and a solution adopting Osterberg Cell technology was provided.The Osterberg Cell technology loads the pile bi-directionally without the requirement for an external reaction.

INTERESTING FACTS:

- **Production piles to be founded above granite bedrock head and to depend on skin friction only.**
- **Preliminary pile was load tested over water to 240 MN net load without the need for an external reaction.**
- **Multi-level test method enabled isolation of the CDG and HDG soil stratum layers.**

PILE TEST REQUIREMENTS

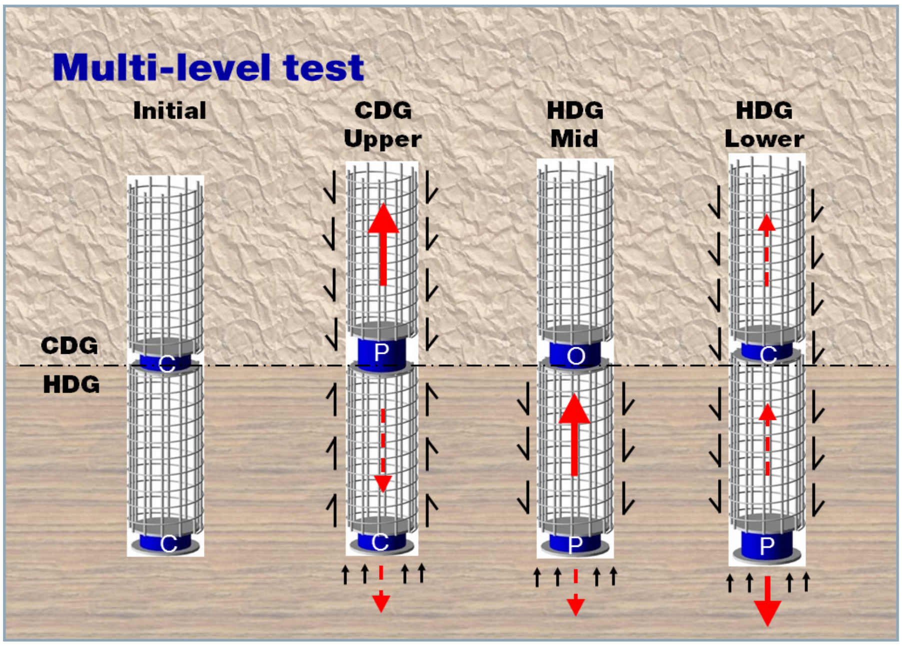
At the location of the test pile, two stratum layers in particular were of interest for the pile designers to determine the ultimate skin friction capacity. These two layers were the Completely Decomposed Granite (CDG) and the Highly Decomposed Granite (HDG).

It was decided to carry out the pile load test using two levels of Osterberg Cells i.e. a multi-level test to ensure that sufficient movement of the pile shaft occurred within each specified stratum to obtain useful geotechnical parameters which would not have been possible with a single evel test alone.The upper Osterberg Cell loading assembly was placed at the top side of the CDG and the lower Osterberg Cell loading assembly at the intersection of the CDG and HDG.

Inspection of loading assembly before cutting Osterberg Cell protection straps required during cage lifting operation

TEST METHODOLOGY

Each Osterberg Cell loading assembly comprised 81 MN of gross pile loading capacity with combined test pile gross loading capacity of 243 MN. Osterberg Cells were welded between bearing plates, allowing the Osterberg Cell loading assembly to be fixed to the reinforcing cage and positioned within the pile excavation at the designated elevation. A discontinuity in the reinforcing cage at each Osterberg Cell loading assembly allows a fracture plane to develop accross the pile when the Osterberg Cell loading assembly is pressurized. Upon formation of the fracture plane, discreet pile sections, either side of the loading assembly are created. Standard Osterberg Cell loading assembly instrumentation to measure pile displacements under load together with extensometers to measure pile toe settlement and strain gauges at multiple levels were fixed to the reinforcing cages and embedded into the test pile to provide additional geotechnical data.



Unlike a conventional multi-level test, the Osterberg Cell loading assemblies were pressurized from top to bottom to ensure sufficient pile movement for ultimate skin friction to occur as shown in the illustration. During the first stage of the test, the upper Osterberg Cell loading assembly was pressurized to fail the pile section in the CDG material above. With a void created in the pile at the CDG-HDG interface and the upper Osterberg Cells free to drain and close, second stage loading commenced by pressurizing the lower Osterberg Cell loading assembly to fail the pile section in the HDG material. Re-engagement of the uppermost pile section by preventing the Osterberg Cells from draining allowed loading to continue to isolate the ultimate skin friction component in the lowermost pile section.

Data from the strain gauges was analysed to further enhance information regarding the distribution of skin friction within each of the three pile sections tested. This allowed optimization of the pile design ultimate geotechnical capacity and load-displacement behaviour to a suitable factor of uncertainty against failure.

Preparation being carried out to protect Osterberg Cell instrumentation before lowering cage to final elevation

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