Conventional Static Load Tests Solutions For LNG Projects

Project:	**INPEX CVL2 Darwin Ichthys Onshore LNG Facilities**
Location:	Darwin, Northern Territory
Contractor:	JKC (JGC / KBR / Chiyoda JV)
Subcontractor:	Macmahon John Holland Joint Venture

Named after the classical Greek word for "fish", gas from the Ichthys gas field will be transported through a subsea pipeline more than 885 km along to an onshore LNG processing facility at Blaydin Point, Darwin, Northern Territory. The site development civil works package included an advance pile testing program which called for both axial compression and tension load tests, lateral load tests and strain gauge instrumentation.

Strain Gauges Fixed To Test Piles

The first phase of work involved the fixing of Geokon Model VSM 4000 strain gauges to the steel pile elements. The test piles were to be installed by driving method using an impact hammer so the continued operational integrity of the gauges after driving was of utmost concern. A length of channel section was also used to protect the gauges and instrument cables during pile installation.

Strain Gauge Protection Channel

General Arrangement of Compression Test

The load testing program was extremely tight but all equipment was delivered in time to commence the setup for the first test on schedule. Of the five test piles, three were specified to be loaded in axial compression. Reaction beams, load application and measurement devices were setup by the Subcontractor to the layouts provided by Fugro.

Arrangement of Jack and Load Cells

With a maximum test load of 13000 kN, a single 15000 kN load cell and three 5000 kN load cells were used for direct comparison of measurement accuracy. Pile head displacement was monitored using four electronic displacement transducers, dial gauges at each location and also with a digital level.

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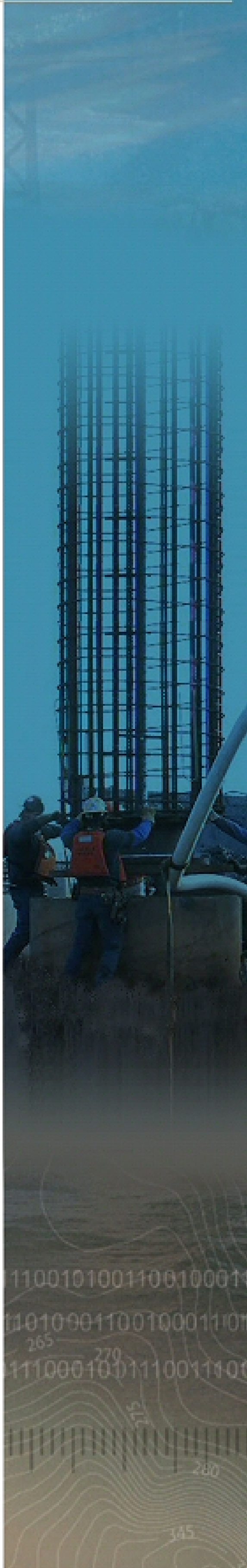

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Typical Setup of Displacement Gauges

Load was applied to the test pile and the reaction frame simultaneously by pressurizing a single 15,000 KN jack. The force applied to the reaction frame during the loading of the test pile was transferred to the four reaction piles through 32 mm diameter Dywidag bars system. A stress limit of 50% of the ultimate strength of the Dywidag bar was taken in the design to limit elongation and more importantly ram stroke in the hydraulic jack and allow for non-uniform distribution of loading and to enable re-use for follow-on tests. With the safety of the reaction setup being of utmost importance, the upward movement of the reaction beam was checked at each load increment using a digital level. Reaction pile movement was monitored by the Subcontractor.

General Arrangement of Tension Test Setup

The reaction setup for the two tension test piles consisted of a 4300 KN hydraulic jack and 5000 KN load measuring cell on top of the primary reaction beam spanning two reaction piles with a steel crown beam above. Connection and thus upward force to the test pile was provided by Dywidag Threadbars connecting the test pile and the steel crown.

Tension tests were carried out up to a maximum test load of 3000 KN.

Upon completion of the axial load tests, three of the five test piles were laterally load tested. Reaction to loading was provided by spanning a primary beam horizontally between two reaction piles. Due to space constraints, the beam was positioned behind the reaction piles with a mechanical locking system using Dywidag bars and locking beams to transfer force from the primary bearing beam to the reaction piles.

Lateral Load Test Setup

For all eight load tests, readings of strain gauges and pile toe telltale displacement gauges were taken automatically by a data acquisition system. Automated readings of pile head displacement gauges, and load was carried out through a separate dedicated Fugro pile testing data logging system.

Strain Gauge Leads Connected To Data Logger

Analysis of the strain gauge data for assessment of load and bending moment distribution along test pile shaft and comprehensive factual reporting and presentation of test pile behaviour was also provided by Fugro Loadtest.

Lateral Load Test - Strain and Deflection Monitoring Solutions for Marine Projects

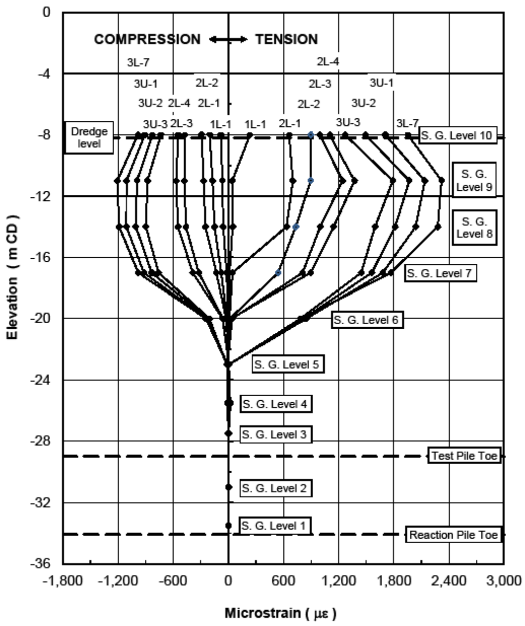
Project:	**QCLNG Project, Jetty Construction**
Location:	Curtis Island, Gladstone, Queensland
Main Contractor:	Bechtel Australia Pty. Ltd.
Subcontractor:	John Holland Pty. Ltd.
Consulting Engineer:	Arup Pty. Ltd.

Arrangement of Lateral Loading Setup

Two test piles were simultaneously subjected to a maintained lateral load test to monitor pile deflection and pile shaft bending strain under lateral load. As each pair of strain gauges needed to be aligned to the direction of loading, care was taken during reinforcement cage installation. Pulling the two test piles together utilizes the reaction of one pile against the other. The loading setup comprised four cylinder jacks bolted to a reaction frame, connected to a collar on each pile. This setup provided suitable load capacity and ram stroke capability for lateral movement of up to 800 mm for each pile. With safety being of paramount importance, each jack was fitted with a one-way valve to prevent any untoward incident due to a sudden loss of pressure.

Measurement of Pile Deflection Using LRDM

Pile head lateral movement was measured using a Geokon Model 4427 long range displacement meter (LRDM) connected to a computer for real time test data recording. Pile deflection and pile creep movement measured was initially assumed to act evenly between the two piles, as both were of similar size and construction, for real time test data on pile behavior under load. For analysis and reporting however, actual movement of each pile after cessation of creep was used, by traditional surveying method as monitored from shore.



Typical Pile Shaft Strain Distribution

Strain gauges cast into the concrete during pile construction were monitored to provide strain measurements along the pile shaft. This data was used for the calculation of bending moment profiles and as a prediction of lateral deflection which compared favourably to deflection profiles taken from cast-in inclinometer tubes. However, strain gauge data should always be considered as a backup secondary means of determining lateral deflection and bending moment profiles.