Statement of Company Experience in Offshore Structures

PROJECTS IN OFFSHORE STRUCTURES

Geotechnical Engineering Services on Pile Foundation Design for Lufeng 7-2 Oilfield Development

South China Sea, China

Client: China Oilfield Services Limited (COSL)

Dates: August 2011 to February 2012

Lymon C. Reese and Associates, Inc. (LCR&A) in Austin, Texas was retained by China Oilfield Services Limited (COSL) to review geotechnical investigation reports and provide assessments of soil-response curves (*t-z*, *Q-z* and *p-y* curves) and group effects of pile foundations for the proposed new offshore platform LF7-2 in the South China Sea. The water depth at the proposed platform location is approximately 107 meters. The soil report indicates interbedded layers of silty fine sand and clays ranging from firm to hard consistency.

The scope of services from LCR&A includes discussion and recommendations on soil-response curves (*t-z*, *Q-z* and *p-y* curves) developed by COSL, assessment of axial displacement and lateral deflection of pile groups, generating *z*-modifiers (for *t-z* data) and *y*-modifiers (for *p-y* data) to be served as part of recommendations on the sub-structure input data for structural analyses of the platform. The engineering services from LCR&A also include the discussion of a potential punch-through failure in the sandstone layer and of general practices for selections of pile penetrations and wall thicknesses in the various pile sections.

Preliminary Structural and Geotechnical Design of Foundations for Tension Leg Platforms in the Browse LNG Development

Offshore Western Australia

Client: Wison Floating Systems (Woodside Energy Ltd)

Dates: August 2010 – October 2010

A combined gravity/suction base was proposed for the tension leg platform (TLP) for the Brecknock and Calliance Dry Tree Units, with a center caisson and six other caissons layed out around the central caisson in a hexagonal pattern. The caisson diameters were designed at 12 m with also 12 m skirt length around each caisson. Three levels of load were evaluated: operating, extreme, and survival with respective safety factors of 2.0, 1.5, and 1.0. The base was analyzed for its load carrying capacity, installability, and settlement and consolidation considerations. In general, conservative soil properties were selected because of the significant uncertainty inherent in the calcareous silts at the site.

A preliminary front-end engineering design has been performed for the foundation structure in this project. Four controlling environmental loading demands to the foundation system were selected for

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these preliminary analyses. A suitable foundation system was proposed for evaluations of overall impact in costs. Sizes, welds and layout of main structural elements were also evaluated for purposes of constructability (fabrication).

Conceptual Study of Medium and Long Term Development Facilities for Coveñas and TNP Oil Terminals in Colombia

Port of Cartagena, Republic of Colombia

Client: Gault International and Ecopetrol

Dates: February 2010 – April 2010

Engineers from LCR&A formed part of an engineering team that performed an in-depth review and analysis of the Ecopetrol S. A. petroleum export and import facilities at Coveñas and Terminal Néstor Pineda (TNP). The objective was to assess the capabilities of the current facilities to determine the bottlenecks and upgrades needed to support a future export of 1 million barrels of crude oil per day and facilitate the exports/imports necessary to support expanded operations at the Cartagena refinery. The analyses performed consisted of hydraulic analyses of the Coveñas and TNP installations, tanker traffic analysis at both facilities, and simulations of export operations at both facilities. Solutions and cost analyses were provided for both facilities.

Review and Verification services of Geotechnical Investigation Reports for Lufeng 13-2 Oilfield Development Phase II

South China Sea, China

Client: China National Offshore oil Corporation (CNOOC Ltd.)

Dates: January 2010 to March 2010

Technical review of geotechnical engineering reports and validation of recommendations of soil parameters and soil response curves (t-z, Q-z and p-y curves) to be used in the design of pile foundations for a new offshore platform in the South China Sea. The water depth at the proposed platform location is approximately 132 meters. Project site predominately consists of cohesive fine-grained soils with several interbedded layers of coarse to fine sand and silt.

Suggestion for preliminary p-y Curves for Cyclic Loading on Offshore Risers in Bahia, Brazil

Offshore Risers in Camamu Bay, Bahia, Brazil

Client: Starmark Offshore

Dates: January 2002 to February 2002

The services from Lymon C. Reese and Associates, Inc. (LCR&A) were requested for the recommendation of preliminary p-y curves for a project in Brazil. In general, the consulting project from Starmark Offshore consisted of evaluating offshore risers in the general area of Camamu Bay, State of Bahia, Brazil. The general site in Camamu Bay is formed predominantly by calcareous soils of

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different grain sizes and cementation. LCR&A made a historical review of deep foundations in such difficult sites and also prepared a recommendation for p-y curves to be used in preliminary analyses.

Study of Structural Well Casings for Offshore Risers

Austin, Texas

Client: Marathon Oil Company, Houston, Texas

Dates: December-1999 to February-2000

Structural casings are commonly used as one of the foundation components for offshore wells in the oil industry. The design of these casings must consider drilling and production loads (life-cycle loads) in static and cyclic modes. The practices for the design of these casings for offshore platforms are outlined by the American Petroleum Institute in recommendations from API RP 2A.

Modern concepts of soil-structure interaction were developed by LCR&A in order to study the response of structural casings. The new method developed for Marathon Oil Company considers the lateral resistance of the soil as a nonlinear function of the deflection of the casing while analyzing the effects of various axial loads placed at different levels above the wellhead (using p-□ effects). A commercial software program was developed by engineers from LCR&A, and results from this new program compared very well with results obtained from very complicated and costly finite-element models prepared by other consulting firms.

Design of Oil-Mooring Facility for Tankers up to 250,000 DWT at the Dos Bocas Terminal

Industrial Port of Dos Bocas, State of Tabasco, Mexico

Client: PEMEX - Inopesa, Mexico City, Mexico

Dates: September-1998 to March-1999

Partners of LCR&A were contracted for the complete design and preparation of construction drawings for a complex project of an oil mooring facility at the existing Pemex facilities at the Dos Bocas Port terminal Complex in the Mexican state of Tabasco. The existing Dos Bocas Terminal Complex from Pemex handles near 45% of the petroleum traffic of the country mostly using a system of single buoys. The new design was intended to increase the efficiency of the oil-handling operations since it will be located within the port basin and protected by enlarged breakwaters.

The structural form of the breasting and mooring dolphins as well as that of the operations platform were fixed platforms with steel tubular members, similar to those commonly used in fixed offshore platforms. The project was delivered on time and budget along with approximately 80 sheets of plans and technical specifications.

Foundation Design for ARCO Dock Completion Project

Cherry Point, Bellingham, State of Washington

Client: ARCO and ANVIL Corporation; Bellingham, Washington

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Dates: May-1997 to February-1998

The project was for the extension of existing marine facilities of ARCO at Cherry Point, approximately 15 miles north of Bellingham, in the State of Washington. The new facility was designed for accommodating a range of sizes of ships, tankers, and barges up to 70,000 DWT. The project was developed in closed cooperation Lymon C. Reese, Ben C. Gerwick from San Francisco, California.

LCR&A was retained by the clients to provide complete analyses and design of the foundation system for the dock, including connecting trestle, loading platform, breasting dolphins, mooring dolphins and catwalks. The foundation for breasting and mooring dolphins consisted of 84-inch O.D. steel-pipe piles penetrating 40 feet into stiff glacial till, below 40 to 60 feet of water, total pile length of 120 to 140 feet. The design require careful attention to the installation of this large size piles into the glacial till, composed of sandy gravel with final blow counts in the order of 4-inch penetration for over 100 blows. In order to drive such piles, LCR&A was instrumental in the design of a special marine offshore-type pile driving hammer.

In addition, LCR&A provided its expertise in geotechnical engineering with technical considerations and details related to the construction of the foundation for the marine structures. Construction was completed successfully in December of 2000.

Study of the Behavior of a Suction Pile Using a Finite Element Model and a Pile Group Model

Dutch Sector in the North Sea

Client: K.C.I. BV in Holland

Dates: November, 1995

As authorized by K.C.I. BV in Holland in November 1995, Lymon C. Reese & Associates conducted a study for the behavior of a suction pile. The suction pile was to have a diameter of 9 meters with the wall thickness of 30 mm to 40 mm. One critical element in design of suction piles at different environments is to analyze the penetration needed for the suction piles to sustain wave loads created by the maximum storm.

Two methods were used for this study. One method employed three-dimensional, finite-elements, which can provide detailed distribution of stress-strain in the vicinity of the pile. The other used a simplified pile-group model, which employs well-accepted, empirical soil resistance embodied p-y and t-z curves. The results from both methods seem to be consistent and both are suitable models to study the stability of suction piles. Both methods clearly indicate that a suction pile with a penetration of 9 meters is more stable for the soil conditions at this particular location.

Study of Placement of Conductors at MC-109 and Comments on Placement at VK-989

BP Exploration Projects in the North Sea

Client: British Petroleum; Houston, Texas

Dates: August, 1992

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Associates of LCR&A were invited to evaluate the problems of buckling on conductor piles during installation. An analytical model was used to study the cause of buckling under various stress conditions. A recommendation for quality control during pile driving was presented to the owner for improvement.

Analysis of Grouted Connections for Goodwin "A"

North West Shelf Development Project, Western Australia

Client: Woodside Offshore Petroleum Pty. Ltd.; Western Australia

Dates: 1990

Associates of LCR&A were retained by *Woodside Offshore Petroleum Pty. Ltd.* to make a study of the pile/grout/soil connection with respect to the possibility of creep of the grout and the supporting soil. A study of numerous documents was made. Recommendations were presented in a report.

Engineering Report on Soil Borings and Analyses for the Safaniya Gosp-4 Complex

Arabian Gulf

Client: Rashid Geotechnical and Material Engineers

Dates: 1990

Associates of LCR&A received from *Rashid Geotechnical and Material Engineers*, Saudi Arabia, a report entitled "*Draft Engineering Report, Geotechnical Investigation 1990, Safaniya Gosp-4 Complex, Arabian Gulf,*" and were authorized to prepare a report presenting additional comments on the following topics that related to the design of piles for the subject site: load-transfer curves for axial loading, cyclic effects for lateral loading, drilled-and-grouped piles, and group effects.

Analysis of Piles for North Rankin "A" Platform

Client: Woodside Offshore Petroleum Pty. Ltd.; Western Australia

Dates: 1987

The pile foundations for the *North Rankin "A"* platform were embedded in calcareous soil, and a number of factors indicated the need for strengthening the foundations. Several experts were called in for technical advice. Use of underreams was being considered for improving the foundation. On this project, associates of LCR&A were retained to study the behavior of the groups of underreamed piles under both axial and lateral loadings.

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