Canaport LNG terminal

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Canaport is a liquefied natural gas (LNG) receiving terminal located in the Bay of Fundy, Saint John, New Brunswick. Canaport LNG is a consortium between Irving Oil, New Brunswick and Repsol, Spain. The facility is the first LNG terminal to be built in Canada and equipped to receive LNG from the largest tankers in the world. Canaport LNG terminal received its first shipment of LNG in June 2009.

Introduction

Ausenco performed detailed engineering and design of the marine structures of Canaport as part of an engineer-procure-construct contract to the Kiewit-Weeks-Ausenco partnership. The marine structures included 16 offshore jacket steel structures which were fabricated onshore, towed to the site and installed by crane barges to reduce the construction time. Ausenco also completed the detailed engineering and design of the roadway and pipe support trestle sections, the LNG receiving platform, mooring and berthing facilities and catwalk structures.

The water depth at the berthing location is close to 28 metres and the tidal variation is as high as nine metres, therefore, conventional methods of marine construction were not practicable for the Canaport site. The berthing face is located in water sufficiently deep enough to accommodate the full range of design vessels, meaning that dredging of the sea floor to increase water depth was not required. Moreover, the soil at the terminal location consists of layers of soft overburden with very loose silt sand on top of bedrock which made the foundation design even more challenging.

Due to the complex site conditions, a steel jacket system anchored to the bedrock by piles was selected for the marine structure's foundations. These jacket structures are used worldwide for several functions and in various water depths and environments. These structures are typically built onshore in fabrication yards to facilitate quality fabrication and to reduce costs. After fabrication, the structures are loaded on to vessels and transported offshore to the final installation site.

The analysis and design of the jacket structures was completed in accordance with recommendations published by the American Petroleum Institute (API). This was performed taking into account a multitude of parameters such as the environmental, berthing, mooring considerations and soil characteristics.

Design

The Canaport LNG terminal was designed for full compatibility of the entire LNG vessel range from 65,000 to 270,000 m3 and crude vessels from 70,000 to 165,000 DWT.

The Structural Analysis Computer Systems (SACS) suite of programs was used to perform the structural analysis. The global model consisted of the deck panel, jacket and appurtenances with main piles and pin piles. The Pile Soil Interaction (PSI) program which does the non-linear structural analysis was used.

For the steel jacket structures a number of analyses were carried out including; In-service analysis consisting of Inplace, Seismic and Fatigue analysis; Pre-service analysis consisting of Loadout, Transportation, Lifting and On-bottom analysis. The tubular joints of the jacket are subjected to repetition of stress due to the cyclic nature of wave loading. A deterministic fatigue analysis was performed, based on the stress ranges determined for waves from various directions.

Below is a summary of the major modules designed and constructed as part of the Canaport marine structures;

Steel Jackets

A total of 16 jackets were used for various water depths and load conditions. Five jackets support the trestle structure, six jackets were designed as mooring dolphins, four jackets were designed as berthing dolphins and one jacket was used for the unloading platform. These jackets are made out of tubular steel conforming to API specification. The combined weight of these jackets is 2,440 tonnes.

Permanent Piles

There are a total of 60 permanent piles installed for the jackets. The pile lengths vary from 34 metres to 67 metres and weigh between 24 tonnes and 76.5 tonnes.

Deck Panels

Four major deck panels were installed at the Canaport LNG project. One of the deck panels is located at the second trestle bent jacket, the second one is located on the loading platform, and deck panels are also located on two berthing dolphins. The largest and consequently heaviest deck

Canaport LNG terminal, the Bay of Fundy, Saint John, New Brunswick.

Aerial view of the Canaport site.

Sunset at the Canaport LNG terminal

panel is located on the loading platform and weighs approximately 260 tonnes.

Trestle Sections

There are six roadway trestle sections and six pipe support trestles. The roadway sections were installed in sections of 44.5 metres and 49.7 metres. Pipe support sections were placed with piping already installed in sections varying from 44.5 metres to 49.7 metres.

Berthing and Mooring system

Air block fender units, measuring some 3.2 metres in diameter, with closed steel frame protector panels and UHMW facia were used to accommodate the berthing of vessels. Vessels are moored using Quick Release Mooring Hooks (QRMH). The total structural steel weight of the marine structure is 7,500 tonnes and there are 2,000 cubic metres of concrete forming part of the road and platform deck panels. Installation of jackets, deck panels, pile driving, rock drilling and grouting operations were completed using crane barges.

Fabrication and Installation

Final fabrication and load out of the jackets took place at the Kiewit Offshore Services fabrication facility in Marystown, Newfoundland.

Two methods were used for load out of the steel jackets at the fabrication facility. The first method used multi-wheel trailers to carry the jackets onto the supply barges. The second method involved up righting the steel jackets at the fabrication yard and placing them vertically on the load out vessels.

At site, the jackets were placed onto temporary piles, which had been installed earlier. Stabbing guides were than welded to the bottom of the jacket after surveying the temporary pile locations.

Ausenco was also responsible for the quality assurance and control during fabrication and construction of the offshore modules for the project.

Conclusion

A steel jacket type of structural system was adopted due to the water depth, significant tide range and challenging soil characteristics at the Canaport LNG location. Since the structures were fabricated onshore as modules it was subjected to a very systematic quality assurance and control programme.

This project demonstrated that cost effective concepts can be designed and built in a relatively short timeframe, despite challenging conditions. Quality was critical for the structure to withstand the tough environmental conditions of the northern Atlantic coast at the Bay of Fundy with strong winds, salty water and extreme winter conditions. All fabrication works had to comply with rigorous offshore fabrication industry specifications. Weld quality and coatings were especially crucial and were subjected to rigorous quality control.

About the author

Hebbale is a structural engineer with more than 25 years of international experience in analysis, design, detailing and inspection of steel structures for various offshore oil and gas platforms, port & marine structures, industrial structures and petrochemical plants in highly seismic zones and subject to significant ice and wave loads. In addition, his responsibilities have included Project Engineering, preparation of specifications, purchase requisitions, technical evaluations and coordination with clients and consultants.

About the organisation

Ausenco is a diversified engineering company operating worldwide in the marine, bulk handling, mining infrastructure, oil & gas, power and industrial sectors. Ausenco provides unbiased, independent engineering and management services for projects of all sizes. From mines to pipelines, ports, bulk terminals and infrastructure, Ausenco delivers ingenious solutions to optimise clients' resources.

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