CASE STUDY: ENGINEERING OF A EPC 3KM JETTY FAST TRACK PROJECT

by

***Hubert Vander Meulen*[1]**

Keywords: Jetty, EPC, In-house engineering, tight schedule, remote location, seabed reefs

1. INTRODUCTION

Arab Petroleum Pipelines Company (SUMED) has developed a refined product terminal hub at Ain Sukhna, Suez Egypt, adjacent to the existing crude oil terminal, to include the services of storage, loading, unloading and send out of Fuel Oil, LPG and Natural Gas. In addition, SUMED's aim is to make the facilities expandable for future expansions including other refined products.

The BESIX-Orascom Joint Venture has constructed a 3 km F-shaped jetty. The project consists of three berths, including berthing furniture and M&E works. The construction time was less than one year.

The paper will consist in a case study about the fast track engineering study in the framework of a challenging EPC contract with limited information at start of the detailed design. The mains challenges of the project have been:

- Extremely tight construction schedule
- Absence of trustable geotechnical investigation at start of the works
- Top side equipment and layout not fully defined at the start of the detailed design

2. JETTY LAYOUT

Owner considered no dredging for this project. Following constraints have governed the layout of the jetty:

- Vessels sizes, under keel clearance, turning basins requirements
- Exclusion zones between the different berths
- Presence of reefs at the seabed
- Existing SPMs and corresponding pipelines

The adopted layout consists in an "F-shaped" jetty with two Product Berths at the deepest arm and a LNG FSRU Berth at intermediate water depth. The berth orientation matches with the currents while the trestle is perpendicular to the shoreline.

The range of vessel being wide, each berth is fitted with four berthing dolphins and six mooring dolphins. One mooring dolphin has been added to the LNG FSRU berth during construction to cope with the unexpected position of the first FSRU vessel at the loading platforms. The loading platforms are equipped with fenders as well to allow safe berthing of the smallest vessels of the range.

[1] BESIX Engineering Department Belgium, hvandermeulen@besix.com

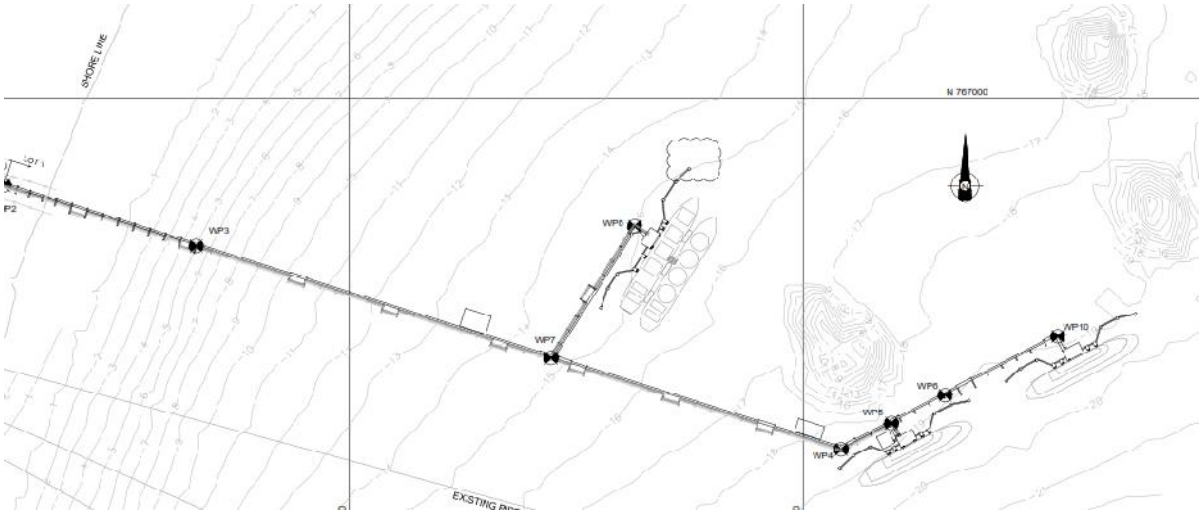

Figure 1: Jetty Layout

3. DESIGN VESSELS

At both Product Berths, the design vessels are ranging from 160,000 DWT Suezmax Fuel Oil to 5,000 m³ LPG Carrier. The FSRU Berth is designed to host a 170,000m³ FSRU vessel hosting a guest 216,000 m³ LNG Carrier in Tandem configuration. This berth is also design for LPG carriers ranging from 82,000 m³ to 5,000 m³

4. ENGINEERING SCHEDULE

The engineering schedule being very tight, a basic design stage with some tangible targets has been prepared immediately after kick-off. Its results with the associated limitations was provided to the procurement team to enable market enquiries while the detailed design was progressing.

5. GEOTECHNICAL INVESTIGATION AND CONSEQUENCES ON DESIGN

A soil investigation campaign was part of the detailed design package. In order to compensate the time required to mobilize a floating equipment in this remote area, the campaign has started with land-based equipment operated from a temporary bund. It has allowed the early identification of a liquefiable layer in the first 300meters of the jetty where a permanent causeway was originally planned. The stability of a traditional rubble mounted causeway was jeopardized by the presence of this layer. Hence, it has been proposed to cast vertical concrete piles through a temporary bund with land-based equipment.

The marine CPTs preformed by the JV indicated a soil profile constituted of alternating weak sand and soft clay layers. The interpretations of the results of the soil investigation lead to very long steel piles to be installed for the jetty (up to 75m). Two static load pile test at two different locations have confirmed the design. At each location, 4 piles where installed: two reaction piles, 1 compression test pile and 1 tension test pile. A spreading beam allowed to test in compression and tension with the same reaction piles.

6. STRUCTURAL DESIGN

The paper will describe structural design of the trestle, platform and dolphins. Pile design was mainly governed by geotechnical bearing capacity and by the combination of axial force and bending moment. The installation of the very long piles with jack-up barges was also carefully designed. The very long stick up portion of their length above the driving gates before start of driving leads to high localized

stress. Finite 3D models where undertaken to check the risk of local buckling inside the gate supports under the combined effects of: self-weight of the pile; weight of the driving equipment and compression wave during driving.

The crosshead beams joining the piles have been designed to work properly in absence of piperack, with 1 or with 2 piperacks. As the jetty has a particular F shape, piperacks are crossing the roadway at some locations. Particular crossheads have been designed to support the piperack bridges at these locations. The roadway spanning from Crossheads to crossheads has been designed as simply supported on a 36m span. It is made of a composite deck. On top ow welded steel beams, precast planks are installed which are connected to the main beams via in-situ concrete and pockets of shear studs. This choice of structural solution has allowed procurement near the site, ensuring guarantee on the delivery.

The loading platforms are supported on a mixture of vertical piles and raked piles, to resist horizontal loads from fenders. Services platforms are supported on vertical piles.

Figure 2: View from Product Berth 2: Product Berth 1 and FSRU berth

7. M&E REQUIREMENTS

In order to allow early exploitation of the terminal, during design to support water piping and gas piping along the jetty. Extension of the bracings of the main roadway girders at the outer side has been designed as support for the piping.

8. CONCLUSION

This case study demonstrates how the detailed design by an in-house engineering department of an EPC contractor has allowed building the jetty in the required period with the selected equipment. Focus has been set on the constructability of the different parts of the project, showing the interconnections between: design; procurement and construction, resulting in a safe and efficient project.