

### Replacement of Bollards and Additional Terminal Investigations

Client: Puma Energy  
Location: Canal di Vridi  
Period: November 2009 to March 2010

#### Replacement of 4 x No 50 tons Bollards with 100 tons and Additional Terminal Investigations of Petroleum Terminal, Canal di Vridi, Port of Abidjan, Ivory Coast

##### Background

Puma Energy is currently operating a Petroleum Terminal located along the Canal di Vridi in Ivory Coast. Due to the existing wave and current regime within the Canal, the terminals have difficulties berthing larger vessels resulting in low operability associated with the high mooring forces. This resulted in the failure of one of the 50 ton bollards located upriver on one of the 14m diameter caisson.

Puma Energy therefore requested PMI to find a solution to replace the failed 50 ton bollard with a 100 ton one, in addition to replacing all 50 ton bollards to 100 ton. Puma Energy further requested PMI to perform additional investigations of the entire jetty structure, find a solution for the berthing of larger vessels vis-à-vis the existing wave and current regime.

##### Scope of Works

The scope of works comprised of the following:

- Preparation of method statement and construction supervision of the replacement of the failed bollard as well as the replacement of the three other existing 50 ton bollards
- Mooring analysis and preparation

of operability tables

- Analyse existing jetty and recommend solutions to enable berthing of larger vessels



##### Replacement of Bollards

PMI prepared a method statement for the replacement of all 4 x 50 ton bollards with 100 ton. PMI mobilized to the site for the replacement of the failed 50 ton bollard with a new 100 ton after which the contractor continued with the replacement of the other three, with PMI managing affairs.

A 2mx2mx1.1m excavation was done by breaking the concrete with a compressor and a hammer. Care was taken not to damage the existing rebar. The new 100 ton bollard was secured in place and installed. C45 premix concrete was used. Cement solution and Sika Latex chemical was applied on the excavated face to ensure proper bonding between the old concrete and the new one.

##### Mooring Analysis & Operability Tables

A provisional mooring analysis was carried out for 10,000 DWT, 45,000 DWT and 70,000 DWT vessels. The results of the analysis including operability tables and the recommendations were issued to Puma Energy. Alternative mooring arrangements were recommended to Puma Energy. The alternatives, when implemented during operations were to reduce the mooring forces significantly.

##### Additional Analysis

PMI also investigated the safety of the entire jetty structure during operations.

The caisson structure was found to be suitable to provide the required resistance for 70,000 DWT vessels.

Analysis of the loading platform however, indicated that it had limited resistance laterally with significant horizontal displacement. PMI therefore recommend stiffening the lattice structures between the loading platform and the caissons.

