



Lebanon

Fact File

Country Name:	Republic of Lebanon
Population:	4.125.247 (July 2010 est.)
Land Area:	10.452 km ²
Official Language:	Arabic with both English and French widely spoken
Currency:	Lebanese Pound = 100 Piaster
Main Cities:	Beirut (Capital)



Ongoing dredging and reclamation works for Quay 16 container terminal extension (Nov 2010).

Port of Beirut Development: Container Terminals

Norbert Peetz,
Sellhorn Ingenieurgesellschaft

The Republic of Lebanon can be considered as a very special place for various reasons, but mainly due to its unique mixture of cultures, history, religions, and politics. Despite its history, and what Lebanon has gone through, the country is coming up. Not only tourism is recovering and attracting more visitors, the economy is thriving – and with it the demand for import and export of goods and cargos.

Some Facts and History

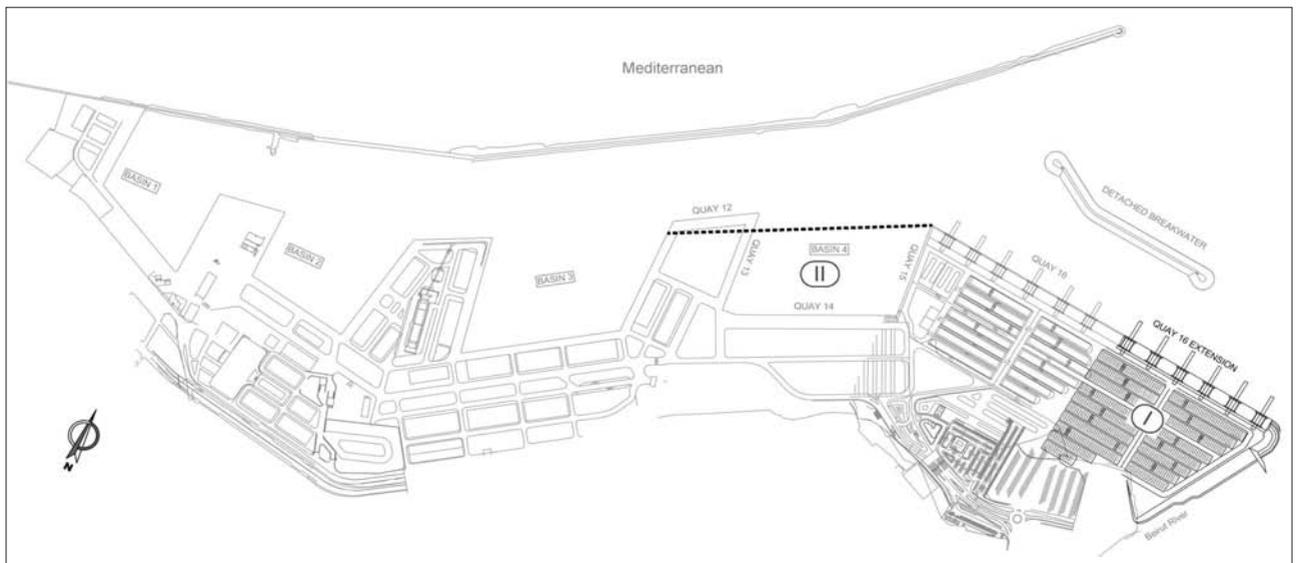
The main gateways to Lebanon are the capital's two ports, which are Beirut International Airport and the seaport, Port of Beirut.

The history of Port of Beirut reaches back to the 15th century, and has seen many changes and expansions since that time. In 1990, with the end of the Lebanese civil war, a temporary committee was appointed to manage the Port of Beirut. Since then the port has gone through a major updating and expansion programme with the rehabilitation of existing port facilities, the construction of new administration buildings and the construction of a new container terminal. Today's key facts for Port of Beirut are as follows:

- 16 berths with a total length of approximately 5,155 m
- Water depth at berth maximum: 15.5 m (Quay 16)
- 4 basins
- Main breakwater of 2,775 m length
- Detached breakwater of 550 m length
- Annual throughput: 5,769,000 t (2009)
- Container handling: 994,601 TEU (2009)

Ensuring the Country's Future Demand for Container Handling Facilities

In 2005, the Port of Beirut started operation at its new modern container terminal at Quay 16, which was designed to cope with an annual throughput of 750,000 TEUs (Twenty-foot Equivalent Units). It is the port's priority to



Overview of Port of Beirut with ongoing terminal extension (I) and future new container terminal (II).

ensure the country's import demand which shows an average annual growth of 5% during recent years. Furthermore, Port of Beirut is also attracting major shipping lines and serves as considerable container transshipment hub. With such positive developments, it quickly became apparent that the available capacity would not be sufficient to handle the potential demand, and only by special arrangement to use other areas within the port an annual throughput of nearly 1 million TEU could be achieved in 2009.

Being aware of the need for additional container handling and storage capacity, the Port of Beirut – which is represented by Gestion et d'Exploitation du Port de Beyrouth (GEPB) – launched a tender for consultancy services in 2005 to investigate and prepare for the extension of a short- and medium-term solution for extending container terminal throughput capacities.



Cranes at work: floating crane, dynamic compaction, piling crane.

Study Phases

It was only in 2007 when Sellhorn Ingenieurgesellschaft mbH had been appointed as port and marine consultant for GEPB. Those consultancy services were basically split into three phases:

- I. Layout alternatives and cost estimates
- II. Optimisation of construction techniques and construction cost
- III. Design drawings, tender documents, B.O.Q., and cost estimate

As many other projects, this study phase for the port extension project was scheduled on a very ambitious time scale of seven months only.

During the first study phase, four alternatives for extending the Port of Beirut had been developed and evaluated. Basic objectives were:

- Continuous quay for berthing of two mother vessels, each of approximately 360 m length
- Maximising terminal areas
- Avoiding extension of existing breakwaters because of subsoil conditions and related costs

Due to its central location in Beirut, the only true possible extension of the port is towards the east, which is limited by the existing Beirut River. A seaward extension is not feasible for the presence of the main breakwater as well



Impression reclamation area.

as for the rapid increase in water depth. Extension within the port's boundaries is also limited because of its already constrained navigational situation. Therefore separate comprehensive studies had to be conducted to derive an appropriate and well-defined design basis; those were:

- Container Throughput Study to investigate market potential and terminal requirements
- Wind and Wave Data Study to compile and analyse available data
- Wave Modelling Study to investigate into sheltering effects of existing breakwaters and resulting wave agitation along existing and extended berths
- Nautical Study to analyse options and feasibility of approach and turning for several layout alternatives
- Desk Study on Subsoil Conditions and Seismic Events resulting in elaboration of a design criteria document
- Dredging and Reclamation Study since the availability of reclamation material in Lebanon presents a considerable issue as for many other places in the Mediterranean

Based on the aforementioned studies, four alternatives for extending the port's container terminals were developed and presented to GEPB. Beirut Port Authority decided on the short-term extension alternative and on the medium-term alternative for extending the port.

Due to changeable subsoil conditions in the area of the short-term extension and also because of considerable seismic activities, particular consideration had been given to the design of quay wall structures to cope with those constraints. An in-house developed method for the

analysing of nonlinear behaviour of piled structures was applied to design the quay wall structure accordingly.

Considerable alterations regarding extend and layout of the short-term extension project were incorporated during elaboration of tender design. The final configuration for the so-called Quay 16 Container Terminal Extension project is:

- 500 m additional quay wall for 6 ship-to-shore post-panmax gantry cranes
- 175,000 m² new terminal area
- 3,408 number of ground slots
- 850,000 TEU annual throughput capacity

Tender documents were produced, containing the employer's requirements, in the form of tender drawings and specification of materials and workmanship. Beside the bill of quantities and method of measurements, Sellhorn elaborated the bidding procedure and particular conditions of contract. The basis for the construction contract are FIDIC's 'Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer'.

The tender was launched by GEPB in April 2009 and, due to the great efforts by all involved parties and their commitment to the project, the construction contract for implementation of Quay 16 Container Terminal Extension project was awarded in July 2009.

Implementation Phase

Site mobilisation for execution of construction works for the first phase of the port extension, Quay 16 Container Terminal Extension, started in August 2009. An additional major offshore soil investigation campaign by the contractor took place during the first four months of construction period. Because of alteration and variation in subsoil conditions it proved to be necessary to extract undisturbed soil samples, such as of rock, sand, clay, silt. Thus, some 34 boreholes and 54 cone penetration tests (CPT) had been executed by using three bore ricks and two barges, reaching from sea level down to -65 m.

Based on those results, it was finally determined which areas had to be cleared from unsuitable soft soil. Dredging works began in April 2010, removing mud and soft clay of up to 11 m layer thickness, before major reclamation works started shortly after. The terminal's eastern part will be founded on unfavourable soil layers, such as unconsolidated cohesive strata, reaching down to



Installation of waling at retaining wall before actual quay wall construction will start.



Anchor wall and retaining wall with tie rods before installation of main quay wall (Jan 2011).



Impression anchor wall.

50 m below sea level, resulting in calculated settlements of 1.5 m within eight years. Since it would not be feasible to replace such quantities with appropriate material, it was opted to accelerate settlements by means of vertical drains and surcharge. Installation of vertical drains from the sea requires special expertise and involves considerable costs. Works are due to start in February 2011. Remaining areas which are not prone for settlements are already reclaimed and construction works for quay walls are ongoing.

The interface with the existing block wall construction (a wing wall as block wall structure) is nearly completed and piling works for the sheet pile retaining wall and anchor wall are in progress, while piling works for the quay's main bearing members, tubular steel piles, are due to start shortly. Again, because of variations in soil conditions, tubular steel piles vary in length between 24 and 63 m, increasing from west towards east.

Remaining reclamation works, dynamic compaction and surcharging is scheduled to be completed in 2011, while infrastructure works for electrical network, power transformer stations, storm water system, fire fighting and potable water system, sewage network and concrete pavement are still to come.

Outlook

While Sellhorn is heavily involved in the site supervision of ongoing construction works with a permanent team on site and with the duties of the Engineer per FIDIC definition, the next major phase of the port's development is already under preparation by its designers in Hamburg.

Completion and commencement of Quay 16 terminal extension with a capacity of 850,000 TEU is expected for 2012, and only afterwards the tender documents for the new container terminal at Quay 12/14 will be launched to provide an additional capacity of approximately 1 to 1.25 million TEU. With this second terminal in place, Port of Beirut will in the future be capable to handle approximately 2.6 to 3.2 million TEU per annum at its dedicated container terminals, depending on final operation and equipment setup.

Because Port of Beirut is deemed to serve as an import and export gateway for Lebanon and/or surrounding countries, the hinterland connection of the port remains for the time being an issue which needs to be resolved in the future.



Offshore soil investigation works at night (Oct 2009).