Meeting the challenge: expansion of the Port of Colombo

The Port was almost at full capacity, so a huge expansion project was begun

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Introduction

In 2000, the existing Port of Colombo, Sri Lanka, was expected to reach full capacity within 10 to 20 years, due to high levels of growth. This limit was recognized by the Government of Sri Lanka through Sri Lanka Port Authority (SLPA). They therefore appointed URS/Scott Wilson to prepare market forecasts for the port facilities, review existing operations to improve efficiency wherever possible, and to recommend a forward implementation program for improvement of existing facilities as well as any port expansion required.

Market study

The market study concluded that

- Colombo enjoys a strategic position close to East/West trade routes; adjacent to the Indian Sub-Continent. This pivotal location is ideally suited to serve transshipment traffic.
- 75% of the total throughput is transshipment
- The economies of the region are set to rapidly expand.
- Domestic imports/exports would increase from 0.55 million TEU in 2002 to 2.3 million TEU in 2020, and 4.3 million TEU in 2030.
- Total throughput would rise from 1.8 million TEU in 2002 to 6.5 million TEU by 2020, and 19 million TEU by 2030
- The existing port will reach capacity by 2010 (without efficiency improvement)
- Expansion would be needed for transshipment traffic and to retain hub status

Port planning and optimization

Port planning and optimization studies recommended that development of a new outer harbor (the South Harbor Development), with nine new container berths suited to the largest container ships, would be the optimum solution. This would involve a protective breakwater and reclamation to enclose a nine-berth terminal, in three phases of three berths each.

Separate optimization measures within the existing port facilities increased port capacity by some 50%, which indicated that port capacity would potentially be reached in 2015. These measures included modifications to quay lengths; crane heights/reaches, yard layout and equipment, removal of non-essential operations to the hinterland, new inland road access for trucks to new inland container depots, advice on changes to port legislation, and so on.

It was agreed that the port expansion would ideally progress with Sri Lanka Port Authority as Landlord. An Asian Development Bank (ADB) loan (US$300 million) would partly fund harbor infrastructure works (approximate cost: US$400 million), with South Container Terminal first on a Build Own Transfer (BOT) basis 35-year concession from the effective date. This follows the public-private partnership initiative business model employed successfully for the South Asia Gateway Terminal at the Port of Colombo. The operator will pay for quay, yard, equipment and topside infrastructure, and payment would be by means of annual lease and TEU royalty, while SLPA revenue would cover the ADB loan and interest. The overall project cost was estimated as US$1.6 billion.

Existing port facilities

The existing port facilities are as follows:

Jaya Container Terminal
- 4 berths along 1,290m; 12-15m depth
- Cross feeder berth
- 14 gantry cranes
- 9,800 slots; RTG operation + 4 RMGs

Unity Container Terminal
- 2 berths along 340m; 9-11m depth
- 3 gantry cranes
- 1,020 slots; RTG operation

South Asia Gateway Terminal
- 3 berths along 940m; 15m depth
- 10 gantry cranes
- 5,430 slots; RTG operation

Construction of the major US$330 million harbor infrastructure works is due to be completed in 2012 by contractor Hyundai.

Design of the port expansion

In 2003, URS/Scott Wilson was appointed as Consultant to the Sri Lanka Ports Authority to prepare designs for the development of the outer Colombo South Harbor, under joint funding from the Asian Development Bank and the Government of Sri Lanka.

Detailed fieldwork (geotechnical, metocean, environmental) followed, as well as port planning, coastal numerical modeling (wave transformation; harbor disturbance/downtime, harbor resonance, hydrodynamic, sediment, ship motion, ship maneuvering, water quality) and other planning studies were conducted, with physical modeling for final optimization and verification. An extensive environmental impact assessment was carried out, considering appropriate environmental mitigation and management measures.

The overall Colombo South Harbor development project comprises over 6km of breakwater (main breakwater 5km; secondary breakwater 1km long, enclosing a small boat harbor), and dredging of a new two-way approach channel to -20m to enclose and protect a harbor basin area of 285ha. This is sufficient for the development of three full container terminals (total capacity 7.2 million TEU), each with a quay length of 1200m and a land area of 62ha, designed for vessels up to 400m length. Dredged material would be re-used for reclamation. This will bring the total to five container terminals in the Port of Colombo, with a capacity of some 14 million TEU per annum. The Colombo South Harbor project will more than double the size of the Port of Colombo.

Project implementation

Construction of the major US$330 million harbor infrastructure works commenced in April 2008 and is due to be completed in 2012 by contractor Hyundai, using a conventional FIDIC contract. The concession for the first container terminal (South Container Terminal) will be awarded to a joint venture including China Merchant Holdings and Aitken Spence, and is due to be operational in 2013. The program allows for the handover of the SCT area to the operator after 23 months, when 2km of the breakwater will have been completed.

New approach channel

The existing entrance to the Port of Colombo is relatively narrow, and requires a sharp last minute turn, and is poorly sheltered during the SW monsoon. There is a second North entrance, which recently opened for smaller vessel traffic since the cessation of hostilities with the LTTE. Vessel moves through these entrances are increasing in number, as are main line vessel calls.

The new approach channel is 570m wide and designed for two-way traffic into the outer CSH harbor basin, for a design vessel overall 400m in length, with beam 55m, and draft 16m. As the outer approach is exposed to the SW monsoon, an under-keel clearance of 1.25m is used, giving a declared depth of 20m for the outer channel.

The CSH harbor entrance faces north so as to give shelter to vessels approaching the breakwaters in monsoon storm conditions. From the -20m contour, the approach channel alignment is to the southeast, bringing vessels to an easy bend to the CSH entrance. This southeast alignment is chosen so as to avoid an extended or hard bend, and also to provide clearance for vessels between the two SPBM moorings within Port of Colombo limits for crude oil and oil product deliveries to Sri Lanka.

In the detailed design of the channel, particular attention had to be given to several aspects to ensure both the continuation of service to the Port during construction of the CSH, and to

The 6km-long breakwater was constructed using an under-layer of dredged sand and Core-Loc™ single-layer concrete armor units.

provide a simple and effective navigation layout in the final scheme. These included:

- Detailed layout of bend, channel buoys, lead lights, and the three-way channel intersection.
- Relocation of the 10km-long crude oil pipeline from the SPBM, which was too shallow to be retained.
- Sequencing of dredging and temporary diversion of the existing navigation.

Main breakwater design

The harbor infrastructure development is constructed seaward of the existing breakwaters into deep water (-18m). The harbor layout is optimized to balance the use of the 15 million m^3 of sand arising from dredging the new two-way approach channel to -20m, with the initial reclamation required for the port access roads, common user areas, and breakwater construction.

Supply of rock armor in large volumes is not an easy task in Sri Lanka, due to the strict environmental controls on quarry operations, and the allocation of suitable haul routes. To mitigate this issue, the two fundamental choices were made for the design of the main breakwater:

- Use of dredged sand in the breakwater core was maximized.
- Use of Core-Loc™ single-layer concrete armor units for the primary armor.

The breakwater structure is designed for a 200-year return period storm (Hs 7.7m, Tp 14s); both for the structural stability of the Core-Loc primary armor, and for the required wave wall crest elevation to control wave overtopping. Hydraulic model testing (2D Flume) confirmed 8.5m^3 Core-Loc units are required for the primary armor, and a +14m crest elevation along the wave wall. The Core-Loc armor extends down to the toe of the main breakwater revetment, and a 4H:3V slope is used to limit the number of Core-Loc rows to 18 in the revetment. Rock armor reinforcement is provided at the toe of the Core-Loc slope on top of the toe scour apron.

Construction – main breakwater revetment

The entire site area was sea, and therefore the first priority was to create sufficient reclamation in order to start Core-Loc production. The overall requirement is some 30,000 units over the four-year construction period, requiring a daily production rate of 62 units and storage area for some 8,000 units.

The required rate of placing Core-Loc is similarly high throughout the construction period. Also visibility during placing is limited, due to the ongoing reclamation works and

UCT terminal improvements within the existing port.

Courtesy: Google Maps.

An overview of the port expansion.

the sea conditions, which can become unworkable during the SW monsoon period when wave overtopping is hazardous. The contractor has therefore opted to use leading-edge solutions to overcome the associated problems of safety, quality and productivity, irrespective of visibility levels.

In order to comply with the precise requirements imposed by single-layer block techniques, the contractor is using two Posibloc™ systems to place the Core-Loc blocks on the prepared rock armor under-layer.

Summary

The Port of Colombo expansion project is now well under way, and an operator has been appointed for the first terminal (SCT). The market study has proven remarkably accurate and, thanks to the project, the Port of Colombo now appears well placed to take advantage of its strategic location. The project is expected to create 3,870 permanent jobs and trigger far wider economic growth.

ABOUT THE AUTHORS

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