Engineering Aspects in Port Planning

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The Port of Bourgas (POB) is one of the two main seaports of Bulgaria. It is located on the west coast of the Black Sea, close to the Bosporus strait, Fig. 1. Due to its favorable geographical location, the POB presents the shortest possible distance for transportation of cargoes from Central and Eastern Europe to the Caucasian region and the Middle East. The hinterland of the POB comprises southern Bulgaria, Macedonia and Serbia including some land locked countries. The start of port operation has officially declared in 1903.

In the past, the POB handled up to 7.5 million tons of general and bulk cargo as well as 15.0 million tons of imported crude oil. Following the political changes in 1989, the cargo throughput of the Port; except for liquid cargoes; decreased to around 50 %. However, the bulk cargo throughput has been on the upward trend since 1991 and in the future new cargo demand is expected to be generated.

The POB handled about 13.0 million tons cargo in 1998 with 1,790 ship calls. Further, about 3.9 million tons of bulk cargo were handled in 1998 with 208 bulk carriers. The maximum vessel size of bulk carrier presently calling in the POB is about 98,000 DWT, but loaded only to 10m draft since there is not enough water depth provided along the port wharves.

Recently conducted studies [1][1] have concluded that the construction of a New bulk cargo Terminal 2A at the POB is mandatory to meet future demand of bulk cargo handling capacity since the recent bulk cargo volume has reached to about double of the maximum capacity of the existing bulk cargo terminal. Thus; the POB has planned to construct Terminal 2A as new Bulk Terminal including the East breakwater and related port facilities such as the approach channel and port basin, Fig. 1.

This paper presents the engineering aspects/factors that the Consultants have taken into account in developing the detailed designs of major civil works under the current expansion phase of the project. It is worth to mention here that total time allocated for finalizing the detail design stage including site surveys, various simulations, detail designs drawings and bidding documents was only six (6) months.

Simulations and Surveys

The following simulations and surveys were conducted during the study course to update and supplement the existing data and information necessary for the engineering designs of project various elements.

Simulations

- Ship Handling Simulation (SHS)
- Oceanographic Simulation
- Environmental Simulation (ES)

This SHS was conducted to support the design process for the POB expansion project. The objective of this study was to identify the properties of the proposed marine facilities by means of ship handling simulation from the viewpoint of safe navigation that includes:

- Effective width of approach channel;
- Effective width of port entrance and its shape;
- Effective dimension of turning basin;
- Effective arrangement of aids to navigation; and
- Advise for safe port operation.

The Consultants developed simulation models in their facilities and scripts to satisfy the different demands of the study with the discussion and the cooperation of POB.

As for oceanographic simulation, numerical models were used to study wave transformations that occur as deep-water waves approach the port area from different directions, using the energy balance model of Karlsson (1969). Operational as well as design wave characteristics were determined in front of the new East breakwater. Further, wave agitations under existing conditions and after future expansion were also estimated using numerical models for operational wave conditions.

Dredging (8 MCM[2]) and reclamation (2 MCM) are very significant activities of this project principally due to their

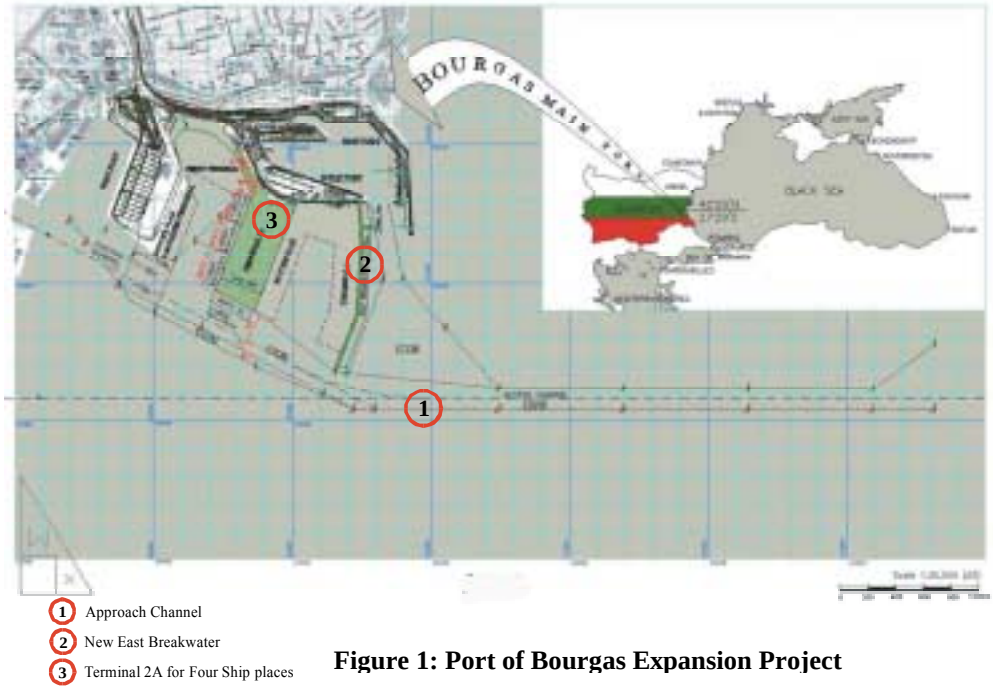

Figure 1: Port of Bourgas Expansion Project

[1] The number in bracket refers to the reference number

[2] Million Cubic Meters

large quantities. Hence, the impacts of disposing dredged materials on the surroundings marine environments have been assessed using both 2D and 3D numerical models.

Surveys

- Topographic Survey
- Hydrographic Survey
- Soil Investigation
- Current Observation
- Seabed Sampling
- Water Quality Sampling

- Topographic Survey: was conducted to check/ verify the coordinates and elevation of existing benchmarks, to specify/setup benchmarks to be used in the course of the project and to update the location of existing facilities.
- Hydrographic Survey: was performed to map existing seabed necessary for dredging and marine construction works and to indicate eventual sunken obstacles.
- Soil Investigation: The main objective of this survey was to verify, update and supplement existing soil surveys. The following tables summarize the activities conducted during the soil investigations.

Table 1: Information of Conducted Soil Borings

Site	Bore-hole No.	Final Depth (m)	S.P.T	Undisturbed Sample
Wharves	B - 1	11.00	6	0
ditto	B – 2	12.17	4	0
ditto	B – 3	23.11	18	1
ditto	B – 4	23.50	18	2
ditto	B – 5	22.15	21	2
ditto	B – 6	19.24	16	2
ditto	B – 7	7.30	6	0
ditto	B - 8	7.00	6	0
ditto	BA - 1	29.05	29	2
Breakwater	BW - 1	7.30	7	1
ditto	BW - 2	10.30	6	1
ditto	BW - 3	11.60	10	1
ditto	BW - 4	23.30	18	2
ditto	BW - 5	21.30	17	3
ditto	BW - 6	26.10	22	2
ditto	BW - 7	27.10	22	3
ditto	BW - 8	28.22	24	3
Access channel	D - 1	23.30	21	2
ditto	D - 2	8.70	7	1
ditto	D - 3	8.80	7	2

- Current Observation: was conducted to collect information about the oceanographic conditions in the Big Bourgas bay and around the POB. These data were used in setting-up and verifying the ES models. Current velocities were collected at six locations. At each location current data were collected at three depths.
- Seabed Sampling: was performed at six locations in and around the project site. Collected samples were subjected to lab analysis to determine their properties.
- Water Quality Sampling was conducted at also six locations and samples were subjected to lab analysis to update and complement existing data. These data were essential for the ES and the environmental impact assessment study.

Table 2: Summary of Performance of the Design Ships in IMO Standard Maneuvering

	Bulk Carrier		Ore Carrier	
	Model	Criteria	Model	Criteria
Tactical diameter in Turning maneuver	2.9L	5.0L	3.2L	5.0L
Advance in Turning maneuver	3.0L	4.5L	3.2L	4.5L
First over shoot angle in 10 degree Zigzag	15.8	20.0	12.3	20.0
Track reach in Stopping maneuver	9.09L	15.0L	9.53L	15.0L

Conclusions

1. The recent bulk cargo volume has reached to about double of the maximum capacity of the existing terminal. Furthermore, with the expected increase in future cargo throughput the POB expansion project is imperative for both the Bulgarian economy in general and for POB in particular if it wants to still be called in.
2. In such type and size of projects a well-planned full investigations program covering all aspects of the proposed project, within allowable time and budget is vital for successful implementation of the project.
3. Impacts of project implementation on surrounding environments should carefully be assessed and clarified using scientific means/tools considering both national and local interests.
4. Impact assessment of the POB expansion project concluded that the project would have positive effects considering both economical and environmental aspects.

References

[1] The Master Plan Study of POB (Development till 2015), March 1995
[2] Preliminary Design Report, POB Expansion Project, PCI, Nov. 1999
[3] Karlsson, T., (1969): "Refraction of continues ocean wave spectra", Proc. ASCE, vol.95, No. WW 4, pp. 437-448