Exercise Poti (Georgia)

Course year 2010

The city of Pot – Georgia lies at the mouth of Georgia's largest river, the Rioni, and has been an important centre of trade since ancient history. Since the early 19th century many plans were developed to create a major sea port and in the 1850's construction began of the main breakwater that is still protecting the port today.

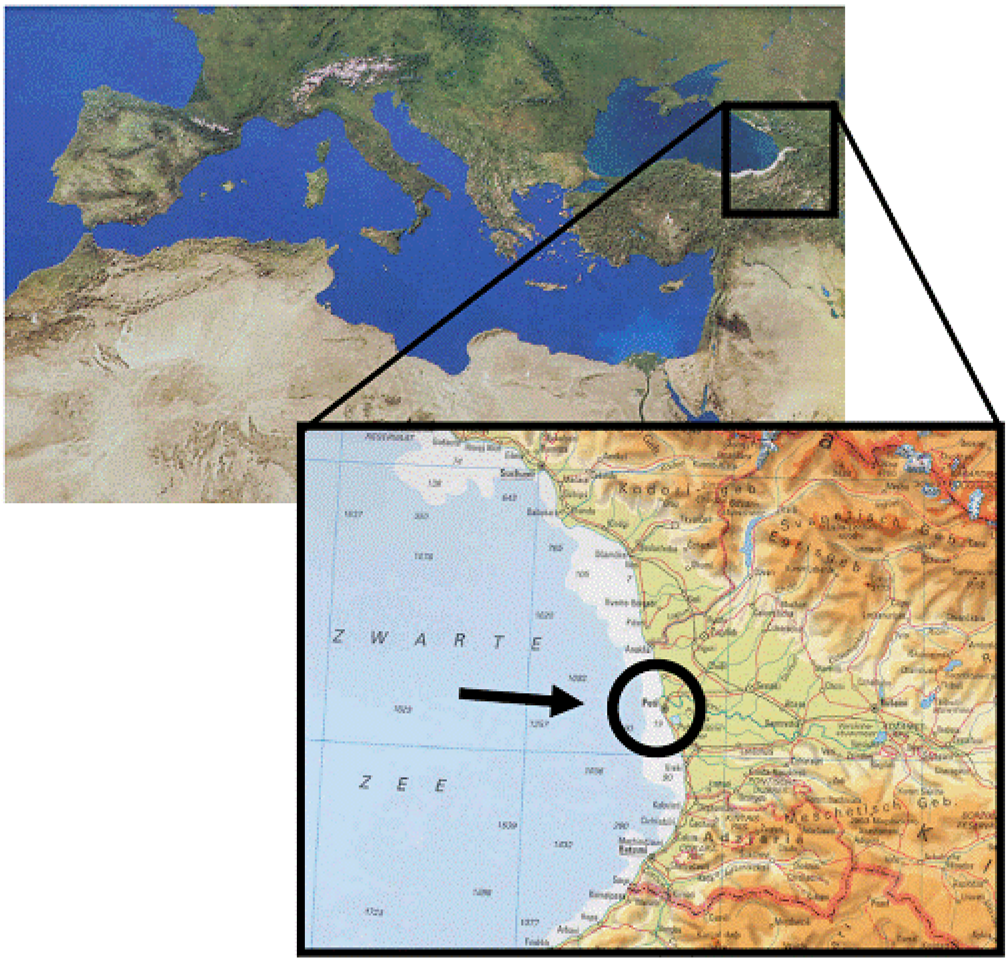

Figure 1: Location of the port

The existing breakwater has a total length of 1810 m and has been built in various stages. Figure 3 presents the layout of the breakwater including typical cross sections and construction stages. The position on the breakwater is indicated by chainages.

The breakwater alignment can be divided into five main sections:
1. From root to chainage 330 m is a straight line with an orientation of about 70°N;
2. Chainage 330 m to 570 m is an arc shaped section in which the structure changes direction of approximately 90° northward;
3. Chainage 570 m to 1050 m is a straight section with orientation of 15°N;
4. Chainage 1040 m to 1510 m is a straight section with orientation of 344°N;
5. Chainage 1510 m to 1810 m is a straight section with orientation of 325°N.

Figure 2: Port of Poti

The following construction and maintenance stages have been identified:

- **1856-1870**
  Construction of breakwater from root up to chainage 600 m. Furthermore a detached breakwater from chainage 720 to 1040 was constructed. The section consisted of a concrete structure on top of a granular layer. On the seaside a protection was made consisting of concrete cubes. Settlements did occur during and after construction. Furthermore at the sea side the toe of the slope was eroded by wave action. An overall settlement of 1.5 m was observed. Therefore part of the upper structure has been removed and the lower part was refilled.
- **1906**
  Closure of the southern entrance between chainage 600 and 720. Furthermore the breakwater was extended up to chainage 1270 m. The construction consisted of a seawall with a seaside protection of concrete cubes. The extension has not been provided with a crown wall.
- **1929**
  Extension of the breakwater from chainage 1280 up to 1810 m. This trapezoidal section consists of concrete cubes.
- **1957**
  General maintenance of the breakwater by placing massive concrete blocks of 20 to 60 T in front of the structure.
- **1972**
  Maintenance of the weakest parts between chainage 230 and 1810 by placing concrete blocks of 40-60 T.

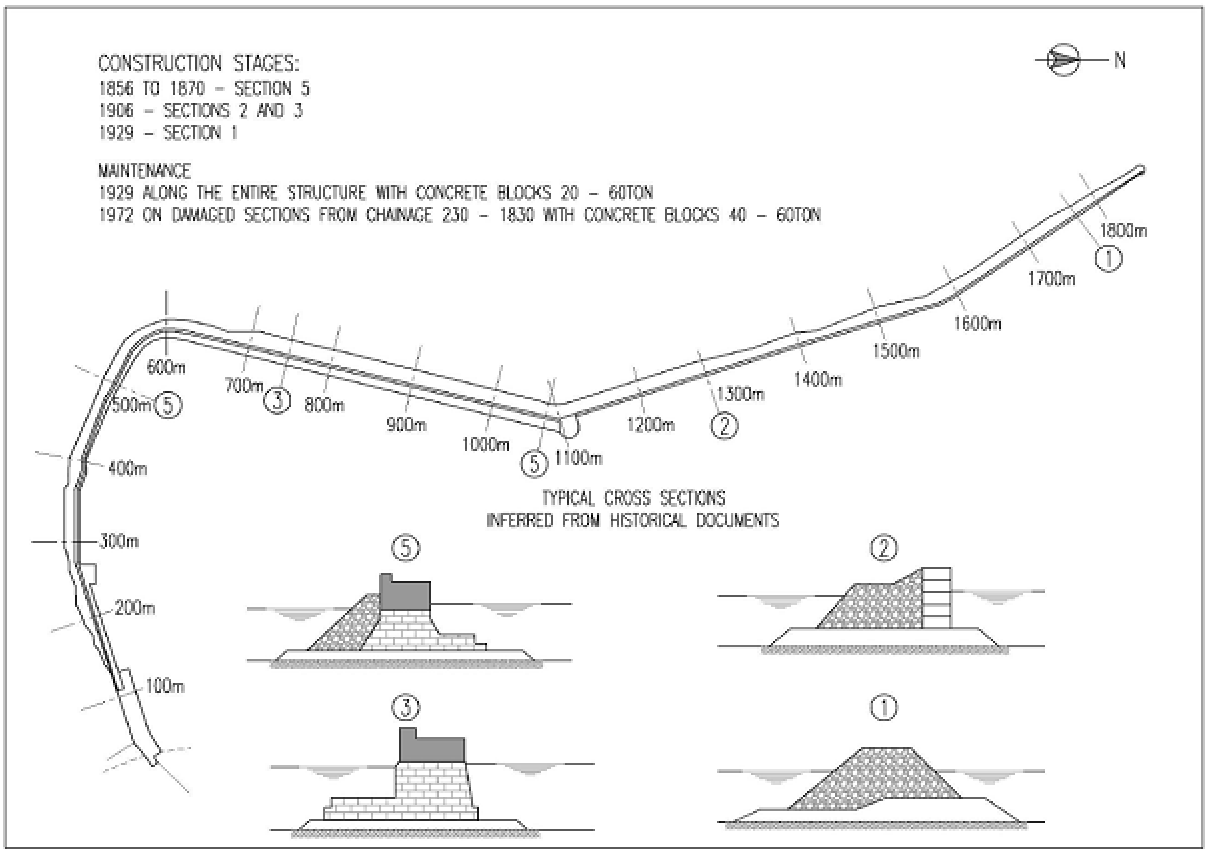

Figure 3: Chainage

Three typical cross sections have been identified:

1. From root to chainage 1040 m the structure is composed of a vertical wall [6 – 10 m wide], provided with a crown wall with an upper level varying between 3.5 and 5 m above Chart Datum. The structure is protected by concrete cubes and 40-60 T concrete blocks that are randomly placed on a slope of approximately 1:1.15.
2. Chainage 1040 m to 1270 m is composed of a vertical wall [in general 6 m wide], with an upper level varying between 2 and 3 m above Chart Datum. The structure is protected by concrete cubes and 40-60 T concrete blocks that are randomly placed on a slope of approximately 1:1.15.
3. Chainage 1270 m to 1810 m is generally trapezoidal, with a base width of approximately 30 m and a crest of 10 m wide. The crest is located at approximately 5 to 6 m above Chart Datum. The structure consists of concrete cubes and 40-60 T concrete blocks that are randomly placed. No core or filter layers have been identified.

The following figures show pictures and profile measurements of the typical cross sections of the breakwater as described above.

Figure 4 *Breakwater chainage 0-1040 m*

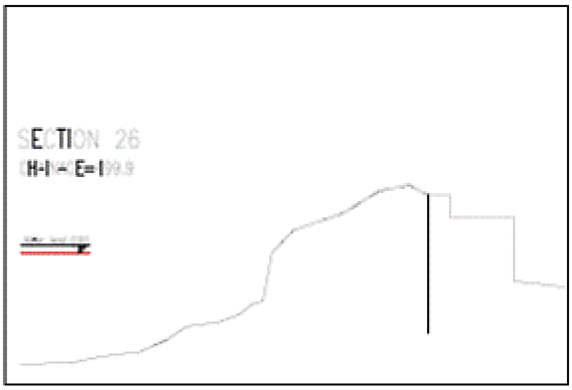

Figure 5 *Typical profile chainage 0-1040 m*

Figure 6 Breakwater chainage 1040-1270 m

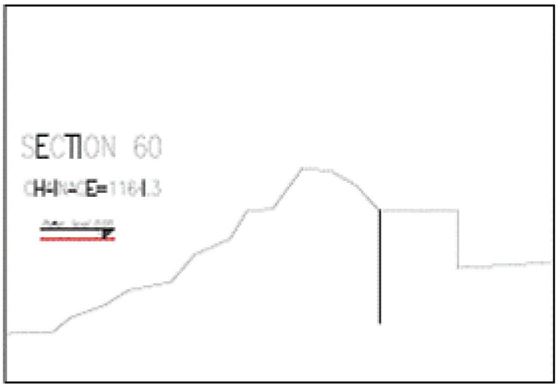

Figure 7 Typical profile chainage 1040-1270 m

Figure 8 Breakwater chainage 1270-1810 m

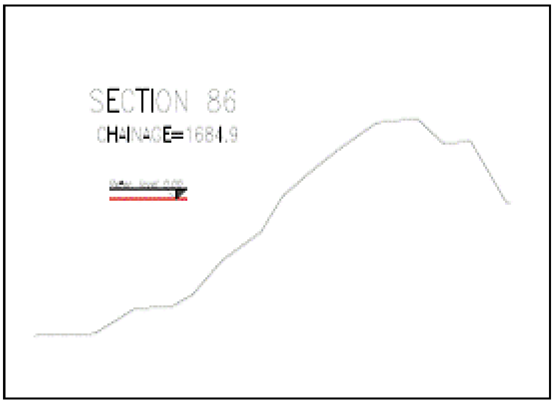

Figure 9 Typical profile chainage 1270-1810 m

It can be concluded that the existing breakwater with its present condition does not comply with the safety requirements due to the following reasons:

- The hydraulic stability of the upper layer concrete blocks of the breakwater is insufficient, the blocks need permanent maintenance.
- The vertical structure of the breakwater is partly damaged due to the pulsatory effects of the sea waves that induce sinking on the structure.
- The capacity of the breakwater to reduce the wave height in the port basin has been decreased due to the above mentioned.

Objective of the study:

The design of the rehabilitation of the breakwater has the following objectives:

- Save the breakwater from collapsing, at least for the next decades, because the collapse of the breakwater will bring the Port operations to severe interruptions.
- Reduce the number of days the Port is not operational due to the poor conditions of the breakwater.

In this exercise we will start with the given layout, as presented above. You have to determine the required boundary conditions and you have to design the breakwater cross-sections with the given breakwater type/armour unit. For the scale of the project is referred to Google Earth; you can determine sizes of the project using the ruler option in Google Earth.

Subsoil

You don't have to consider the quality of the subsoil. You may assume that everywhere is coarse sand with sufficient bearing capacity present. For this exercise the different groups will design a cross section with a given type of armour.

Quarry material

Rock material is required for use as filter, core and under layer for the breakwater. The rock can be supplied from a quarry located in the Kursebi area at 120 km distance by rail from the Works. The following rock gradings are available:

- 2 - 50 mm filter stone
- 1 - 60 kg filter and work layer material
- 60 - 300 kg filter stone
- 300 – 1000 kg under layer

Figure 10; Drum screen in the Kursebi quarry

The quarry had been used before the start of the project to produce small dimension stones and large size rock for cutting tiles. The existing face is approx. 125 m long and had a maximum height of around 20 m. The top of the quarry is covered with grassland used by cows, some small trees + bushes, soft overburden and was a low quality rock. Survey's established the features in the terrain (levels and distances) and the borders of the concession. The survey can also be used for the design of the haul roads and the development of the working faces in the mine. At various places in the deposit trial holes has to be drilled with the drill crawler to check the thickness and the extend of overburden and bad rock layer. The new face will have a height of approx. 20 m. To keep the face height limited a bench floor has to be created halfway and for a proper working sequence 3 working faces have to be created a) for drilling + blasting; b) for selecting and loading the stones and c) for cleaning and remedial work.

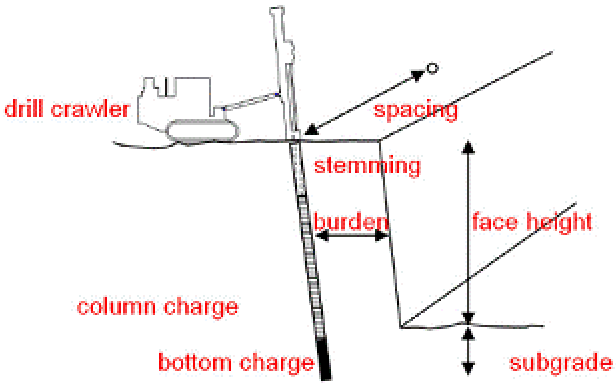

Figure 11: Blasting set-up

Because of the requirement for 60/300 and 300/1000 kg stones the blasting techniques have to be adjusted compared to the techniques previously used in the quarry (i.e. increased burden, reduced spacing, reduced column diameter so that the explosive ratio is reduced). The diameter of the drill holes should be 89 mm. Monitoring of the selection results in relation to the drilling and blasting parameters needs to be carried out to adjust the blast geometry and to obtain the optimum yield throughout the quarry operations.
As the drill holes will contain water, it will not be possible to apply loosely poured ANFO. The water could be blown out of the hole with air but the water returned before firing of the round of explosives could take place. Therefore gelignite (primed with a millisecond delay nonelectric detonator) has to be placed in the drill hole. The top of the hole needs to be stemmed with fine aggregates. During the loading of the explosives continuous checking with special rods has to be carried out to ensure that the explosives are loaded at the correct level inside the drill hole. The initiations of the explosives will be carried out with millisecond delay detonators. The numbers required depend on the vibration measurements made during the test programme. Blasting is expected to be carried out average once or twice per week and the average estimated production is 1200 ton per day.

Rock transport

The main transport of the rock material is by rail. After sufficient stockpile of rock products are available at the quarries, the rail transport can start between the Quarries and Poti. This transport can be separated in three sections:

- Kursabi – Gelati – Kutaisi (length about 15 km single track)
- Kutaisi – Poti siding (length about 100 km)
- Poti siding – Offloading Yard (length about 5 km)

The railway has a small siding into Kursabi, suitable for about 4 wagons. At Kutaisi the wagons are assembled till about 20 wagons for the daily transport to Poti. At the Poti siding the wagons are split in two for the last part towards the offloading area. Once the rock material has arrived in the city of Poti it is unloaded by means of tipping the so called duncan wagons. Once dumped, the rock will be loaded onto 6 to 10 m3 trucks which haul the rock over a purpose built construction road towards the stock pile area close to the port. During the construction of the breakwater rock is transported towards the breakwater by 16 m3 trucks that pass a weighbridge before dumping their load directly on a barge. These barges are towed by a Multi Purpose Vessel to the required location on the breakwater. The loaded barges are moored off on bollards on the inside of the breakwater where the barges are emptied by an excavator CAT375. The excavator deposits the material on the breakwater before it is placed in its designated layer.

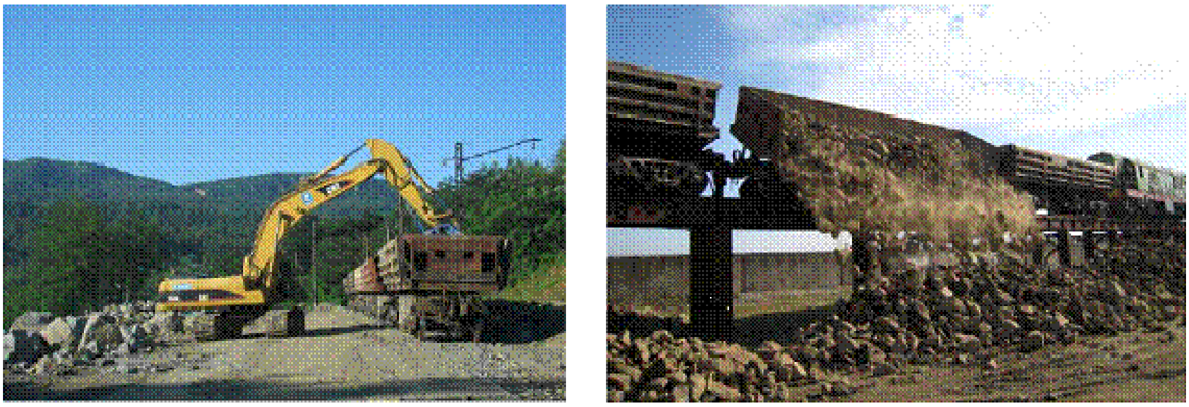

Figure 12: Rock transport

Boundary conditions

For an overview of internet sources of information is referred to the Knowledge Centre Water: http://www.library.tudelft.nl/civiel/information_resources/water/index.htm). Under the heading "data" information on data sources is available

For the actual meteo-situation you may have a look to http://www.dmi.gov.tr/en-US/marine-metu3-detail.aspx. Click on Georgia for details; you may select a wind map and a wave map.

For detailed information regarding the bed topography is referred to the digital nautical map, available in the TU-Delft map room (in the library of the building of Architecture, Julianalaan). Also you may use the printed nautical charts available in the TU map-room

Tidal information is available from various sources, for example the admiralty tide tables (library) or the website of the UK Hydrographic office (only one week) or the French Hydrographic office. You may also find tide info via mobile geographics:
http://www.mobilegeographics.com:81/locations/2890.html
http://www.mobilegeographics.com:81/locations/33.html

The design water levels have been given by the Port Authority:

Return period (y)	Water level (m CD) 1)
1	0.86
10	1.36
100	1.86

1) Levels are relative to Poti Port CD, which is Baltic Sea Level [BSL] -0.861 m.

For waves you should use the Argoss database (www.waveclimate.com)
For the Argoss database a password is required. The password will be given during the instruction session.
For the transformation of waves from deep to shallow water you may use SwanOne.

For the calculation of the armour units you may use Breakwat. In Cress you will also find a routine for application of the Goda method for vertical wall breakwaters. Breakwat can be accessed via the student network
Start ➔ Programs ➔ Delftchess ➔ Breakwat3.1

Assignment details

On Friday every group will:

1. Give an oral presentation, explaining the cross sectional profile of the designed section of the breakwater, including the choices made. The total duration of the presentation should be maximum 10 minutes, followed by 5 minutes of questions by other groups.
2. All groups present will comment on the presentations of other groups.
3. You have to hand in:
   a) a drawing with a design of the cross-sectional profile of the breakwater. On the drawing the contractor has to be able to find sufficient information regarding:
      • weight of armour units
      • slopes
      • crest height
      • toe
      • sub-layers
   b) a project planning for the construction of your section of the breakwater. The planning should contain enough details to understand the various construction activities, sequence and estimated durations
4. Additional information plus explanation of the choices has to be presented in a short report. The total size of the report-text should be in the order of 5 pages text (figures are additional to the 5 pages).

Each group will design a slightly different section, the differences are:

- The main armour type
- The location of the section, either on chainage 800 (where there are quay wall facilities immediately behind the breakwater) or chainage 1600 (where this is not the case)The design lifetime for the breakwater: either 20 years or 50 years

The details for your group depend on your group number, as per the following table:

Armour	design life 20 years		design life 50 years	
	chainage 800	chainage 1600	chainage 800	chainage 1600
Natural Stone	A	H	O	V
Double layer of Antifer cubes	B	I	P	W
Core Loc	C	J	Q	X
Dolos	D	K	R	Y
X-bloc	E	L	S	Z
Berm breakwater	F	M	T	
Monolithic caisson	G	N	U	

Make calculations with a classical approach, see if you can use PIANC guidelines, and see if it is possible (and useful) to make a full probabilistic approach.

Presentations are on Friday 26 March in room 2.98. The morning groups start at 8:30. The afternoon groups start at 13:00 hrs.