Breakwaters and closure dams CT 5308
Exercise 2011: Pointe Noire, Congo

The town of Pointe Noire is the main port city in the Republic of the Congo and sits on the south-western African coast some 150 km north of the mouth of the Congo River. The harbour is located in a natural bay protected in the south-west by a sand spit. In the 1930s this spit has been protected with revetments on the sea side, and the protection was extended by a 400 m long breakwater in 1944. The last time some repair work was done on this breakwater was in 1968.

At present two developments are taking place:

- The area behind the existing (1968) breakwater is upgraded to create a container terminal. The existing breakwater is in a deteriorated state and must be rehabilitated to offer sufficient protection for this new land use.
- The breakwater will be extended again, by another 300 metres in order to reduce the waves in the bay and improve the navigability of the access channel.

The figures below illustrate the situation.

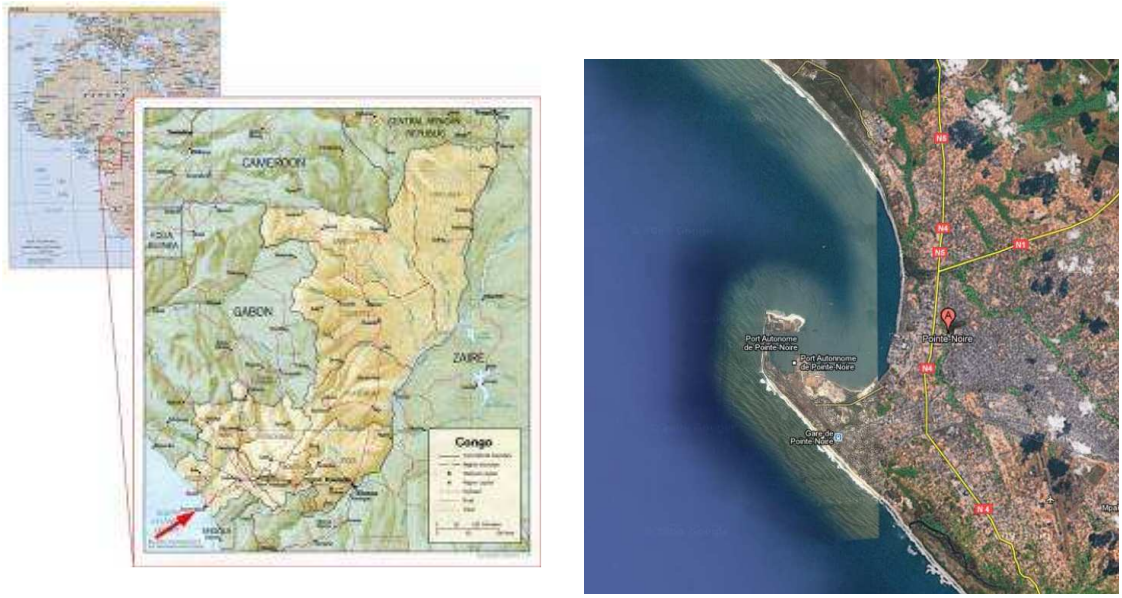

Figure 1: Project location (left)
general situation showing the town, the bay and the port area (right)

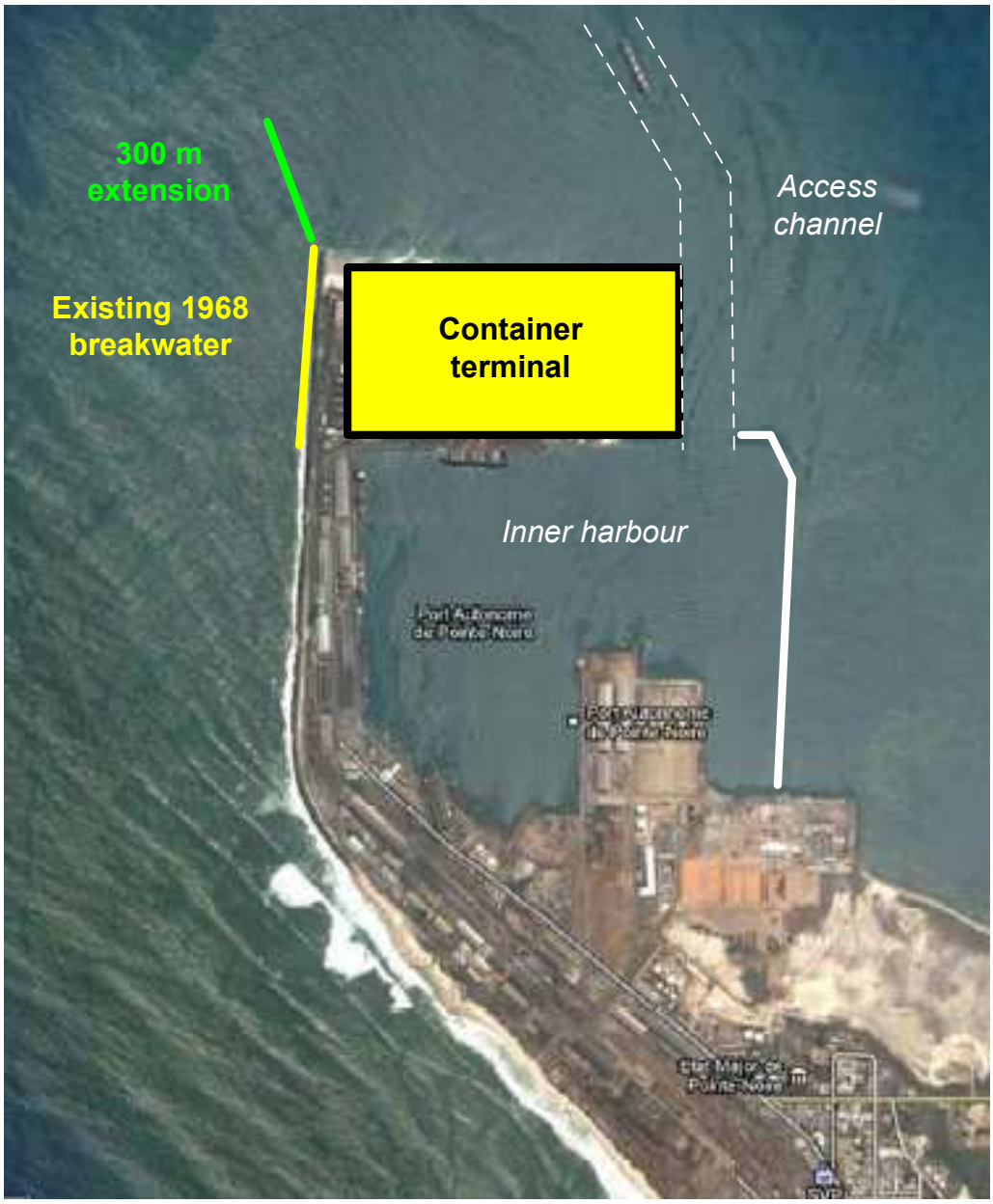

Figure 2: Detail of the harbour with sketch of present developments

Your assignment is as follows:

- make a design for either the rehabilitation of the existing breakwater, or for the new breakwater extension (which of the two depends on your group number)
- determine your own boundary conditions and design criteria
- each group must use a different armour type, see table below
- describe how you would build this breakwater (which equipment type, which building sequence etc) and give a estimate of the time needed to construct it

At the end of the week, on Friday 25.03.2011, you must hand in a report and give a short presentation (10 minutes). Further details are given below.

Boundary conditions

For an overview of internet sources of information is referred to the Virtual Knowledge Centre Water, which you can reach via http://studoc.tudelft.nl. Under the heading "data" information on data sources is available.

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 website of the UK Hydrographic office (only one week) or the French Hydrographic office (only one week ahead, but you may calculate the whole previous year). For some locations in the world T-bone is a good option. You will have to determine your own design water levels.

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.

You should also use the data from "Global wave Statistics", accessible via VKC-water. Click on the right area to download a pdf with data.

For the transformation of waves from deep to shallow water you may use SwanOne or/and the wave ray model built in into the Argoss system.
The Argoss wave ray system is rather time consuming. To divide the load on the server groups A to O should use http://www.waveclimate.com and group P to U should use http://smart4.argoss.nl. Only a limited number of users can use the package at the same time. You may select one of the following 5 usernames:
VerhagenA, VerhagenB, VerhagenC, VerhagenD or VerhagenE

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

All required dimensions, distances etc of the coastline and the port area can be measured in Google Earth or from the nautical maps.

You do not have to consider the quality of the subsoil, so you do not have to make calculations for geotechnical slope stability, bearing capacity, settlements etc. You can assume that the seabed consists of medium coarse sand (400 microns).

Also design guidelines can be found at the VKC-water. Go to the header 'Codes, Standards and Design Guidelines'. All PIANC publications can be found in the VKC-water via "repositories" and then "Digital reports and books".

Local circumstances

The Republic of the Congo is a developing country, so the local circumstances may sometimes be less than ideal for a breakwater construction project. However the port of Pointe Noire itself is relatively well-developed and most common items such as fuel and repair facilities are available. There is also a dock that can be used for the construction of caissons. Other things to consider are:

- the present harbour areas are congested and it may not be possible to find space for e.g. stockpiles.
- the state of the roads is very poor and traffic through the city of Pointe Noire itself is almost impossible at daytime because of traffic jams. There is an old railway connection to the harbour but a serious amount of maintenance is required before it can be used.
- there are rock quarries in the mountains, some 200 km inland from the city. You can assume that these quarries can deliver sufficient quantities of large rocks needed for this project but they can only be reached by badly maintained roads. In particular during the rainy season the state of the roads can be extremely poor.

Also, the western coast of Africa is known for its harsh wave climate and long periods of persistent swell waves. You must take this into account when you determine your construction methods and planning.

The local circumstances are further illustrated by the pictures on the next pages.

Details of the assignment

On Friday every group will:

- 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. All groups present will comment on the presentations of other groups.
- Hand in a report containing:
    - 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 etc
    - 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
    - Additional information, calculations etc plus explanation of the choices. 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 the existing breakwater or on the new breakwater) and 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**	
	Existing breakwater	**New breakwater**	**Existing breakwater**	**New breakwater**
Natural rock	A	G	N	T
Antifer cubes	B	H	O	U
CoreLoc	C	I	P	V
Dolos	D	J	Q	W
X-bloc	E	K	R	X
Berm breakwater	F	L	S	Y
Monolithic caissons		M		Z

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 25 March in room 1.96. The morning groups start at 8:30. The afternoon groups start at 13:00 hrs.

1) Transport road to rock quarry site

2) State of the roads in the rainy season

3) Quarry equipment

4) Quarry equipment

5) Congestion on the roads near Pointe Noire city

6) Access road to existing breakwater

7) State of the rail road at the port area

8) Another view of the rail road

9) View of the container stockyard from the existing breakwater

10) Another view of the container stockyard

11) Wave overtopping on existing breakwater in normal conditions

12) Swell wave at the head of the existing breakwater