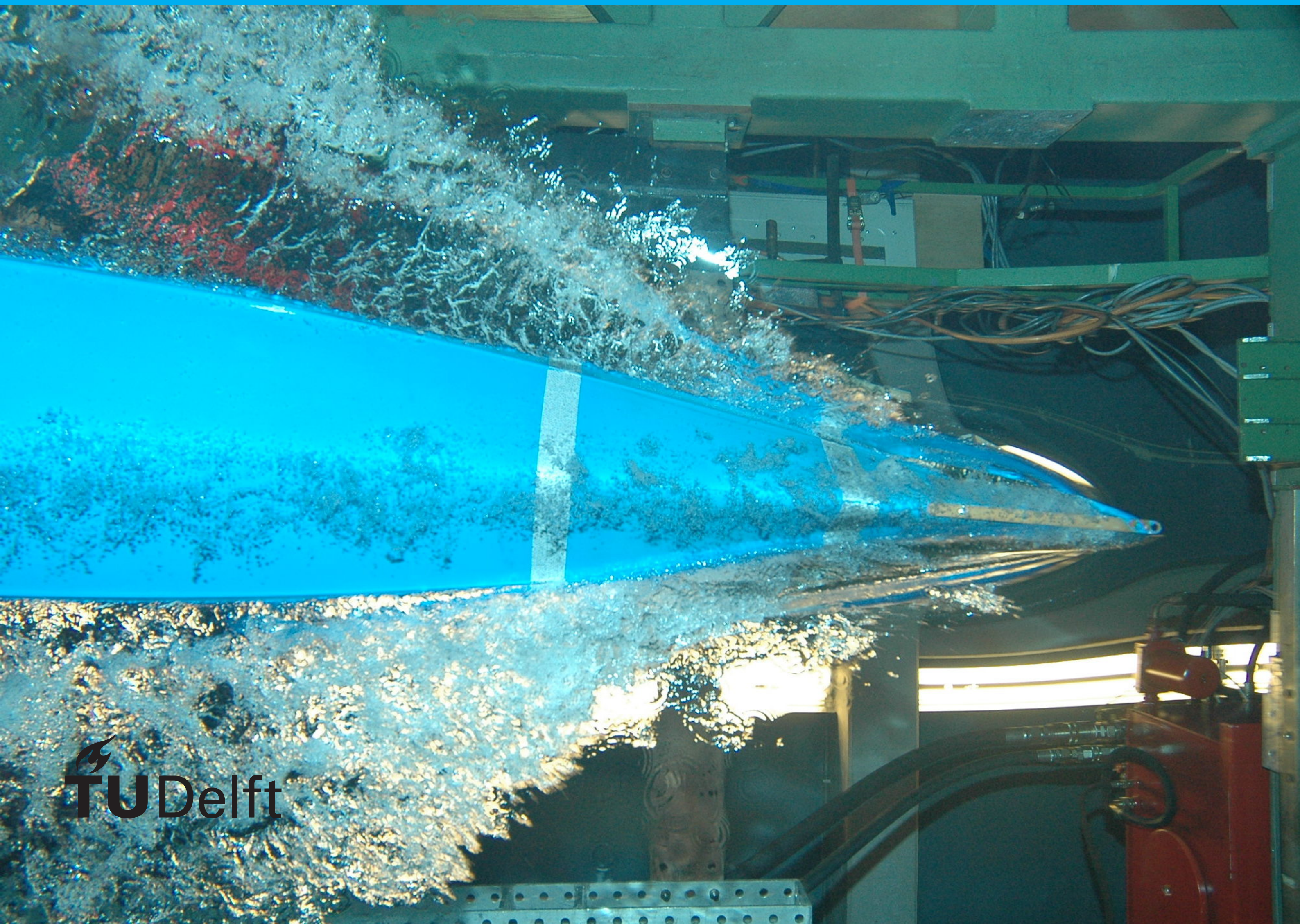
CIE5308

Breakwater Rehabilitation Romano Port

J. Gundlach – C. Rozas – L. Lange

Group 3



TU Delft

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by

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Student numbers: 4450426 – 4519388 – 4512022
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TU Delft

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Introduction

1.1. General Task

By *Group 3* the breakwater in the South is looked at:

- adjacent to roundhead, axis 315^o
- rubble mound single layer cubes
- rehabilitation
- 100 years design life
- quay wall in future

Parameter	Value	Comment
Design life	100 years	
Annual downtime	3%	
Quay level	AL+2.0m	
Current rock armour (seaward)	3 to 5 tons	
Current rock armour (landward)	0.5 to 3 tons	
Current core material	0 to 1000 kg	quarry run material

Table 1.1: Parameters given by exercise

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Design Criteria

see exercise 3.1

- Earth quakes: slope not steeper than 1:1.5, p. 4 of 5 Memo
- Maintenance road

Requirement	**Return period**	**Verification method(s)**	**Design value**	**Calculated value**
this is supposed to be a verly long text to check whether it will automatically insert a line break	this is supposed to be a verly long text to check whether it will auto-matically insert a line break	this is supposed to be a verly long text to check whether it will automatically insert a line break	this is supposed to be a verly long text to check whether it will auto-matically insert a line break	this is supposed to be a verly long text to check whether it will auto-matically insert a line break
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×
×	×	×	×	×

Table 2.1: List of requirements

3

Boundary Conditions

see exercise 3.2

3.1. Location

The Romano Port is located at the west-coast of Albania in the Adriatic Sea, 7.5 km north from the city Durröes and around 30 km from the capital of Albania Tirana. Albania has a HDI (Human Development Index) of 7.33 which puts the country to the "high human development category" according to the HDI report of the UN 2015 like Algeria, Brazil or Turkey. For construction this is a medium-good working conditions it is recommended to use local available equipment and local workers.

3.2. Subsoil

Subsoil matters are not included in this breakwater design. It is assumed, that the soil can resist all loads and that no soil-improvement needs to be done.

3.3. Bathymetry

Bathymetry data were generated using navionics[1]. The bathymetry from this website was copied in CAD where several bathymetry shots could be combined with each other to get a more detailed bathymetry in the necessary parts. Due to the needed xy-data a line with the exact depth values can be exported from CAD and imported into SwanOne.

3.4. Additional Water Level

Due to the following factors the water level rises for the design conditions with 1.3 m according to the mean water level:

- Tidal differenz: +0.211
- Sea Level Rise: $0.005m/year * 100years = +0.5m$
- Seasonal effects: +0.07
- Atmospheric pressure drop: +0.33 m
- Wind set-up + seiches: +0.17

Which leads to an increase of the water level in a hundred years for the combination of all effects of 1.281 m which will be considered as 1.3 m to get some small extra safety as an engineering approach.

[1] webapp.navionics.com

3.5. Waves

Wave heights and the return period of wave events are essential for determine the dimensions of a breakwater. Especially for estimating the size of the amour layer and hence the size of under-layer material, is the wave hight the dominant parameter. Furthermore the order of the run-up and overtopping magnitude is mainly dependent on the wave hight.

3.5.1. Design storm

The design storm with less than 20% probability of failure of the breakwater within a lifetime of 100 years returns every 500 years. The available 22 years of (modelled) wave data[2] close to the site is analysed in a Peak over Threshold analysis using a threshold of $H_s = 1.5m$, a storm duration of nine hours and a Weibull distribution to extrapolate the data. The wave-data from Argoss were checked for reliability (see appendix). This yields a significant wave height of $H_{ss} = 7.91m$ for a 500 year storm, which is chosen to be the deep water design wave height: $H_{ss,d} = 7.91m$.
According to the distribution of the wave hight over peak wave periods from the wave model of Argoss the peak period was chosen to be 11 seconds. The Distribution of the wind and the wind speed at 10 m hight was created through the Argoss data set too and shows velocities up to 20 m/s with varying directions . The main directions are NW, N, NE, SSE and S but for the model just NW and S winds are considered with 20 m/s because of the influence at the breakwater as a worst case scenario.

3.5.2. Near-shore Wave model

SwanOne was used to estimate the wave development at near-shore. The Input parameters are in this case:

- The generated two dimensional bathymetry
- The additional water level
- The wave hight
- Peak period
- Wind velocity
- Angle of incidence

In the Swan model additional wind was included but the set-up due to wave action was neglected, because it is included in the offshore wave data we gained and currents were neglected due to the location in the Mediterranean See with hardly any currents. Bathymetry,additional water level, wave hight, wind velocity and peak period were determined before, but now different angles of wave attack need to be considered. For determine which angles are of interest for the occurrence of sea and swell waves the Argoss data are checked again . As a result from the analysis the dominant direction for waves to occur are NW and S, which matches with the geographical expectations. Due to the orientation of the breakwater at the coast the waves from NW will arrive with a very large angle close to 90° according to the breakwater why the wave energy attacking the breakwater is quite small. Because of the small fetch length just wave with relative low energy will arrive perpendicular to the breakwater. The biggest influence is expected to come from the south and thus the angle of the waves to attack the breakwater will be around 45° which is the value used for the modulation in SwanOne. The model was simulating with a grid size of around 5.55 m per cell and 10,000 time steps per simulation to get an accurate result. The final Simulation is shown in figure 3.1 and the actual value for the significant design wave hight from a one in 500 years storm at the near-shore in a depth of 12 meter is 5.614 m.

3.6. Reference levels

As shown in table 3.1 the relative Albanian Level (AL) ,which is +0.535 m above Mean Sea Level, leads to the rewriting of tidal elevations. Every water level in this assignment will be given according to AL.

[2] ARGOSS XX

Tide	**Water Level [m AL]**
HAT	-0.324
HHWS	-0.336
MHWS	-0.349
MHW	-0.421
MHWN	-0.476
MLWN	-0.605
MLW	-0.652
MLWS	-0.7
LLWS	-0.71
LAT	-0.722

Table 3.1: Tidal water levels at Durröes

3.7. Summary

Boundary	**Value**
Location	medium-good conditions
Subsoil	Not of Concern
Reference Level	+0.535 m MSL
Bathymetry	see figure 3.1
Additional wwater level	+1.3 m
Design storm	$H_{design} = 7.912m$ $T_{design} = 11s$
Significant wave hight	5.614 m

Table 3.2: Summary of all boundary conditions at Porto Romano

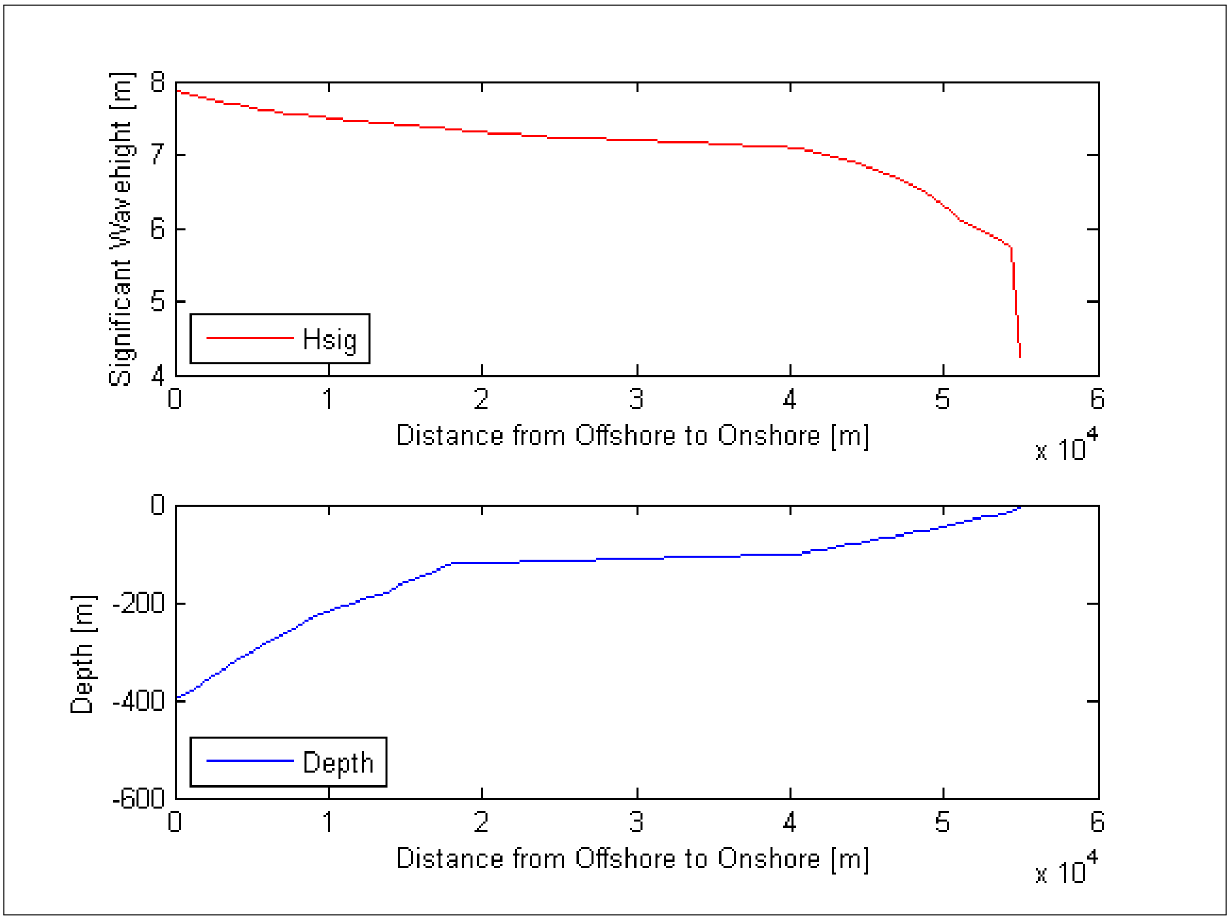

Figure 3.1: Significant Wave Hight and Depth Plot

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Design Calculations

The design has to take into account the presence of a future quay wall. This puts requirements on the space available behind the breakwater and the design of the landward side of the breakwater, in such a way, that it does not hinder the future construction of a quay wall. Especially due to the space requirement a vertical wall would be the best option in terms of the future quay wall (for instance to place a quay wall on piles, put sheetpiles and backfill them etc.). Using a caisson or a concrete wall at the backside of the breakwater might be as costly as any other option, but more severe damage is expected due to an earthquake, which counteracts the demand for a 100 years lifetime and a minimum of maintenance, so these options are not considered further.

5

Drawing

see exercise 3.4

This is one single page, where we can add the folded A3 of our drawing after printing. Included to not interrupt counting of pages.

6

Construction Method and Planning

6.1. Construction Method

The main steps during construction are:

1. Reposition old core
2. Place sublayer
3. Place armour layer on landward side
4. Place toe
5. Place armour layer on seaward side
6. Construct road and top structure

Reposition old core To increase available space on the side of the harbour the old core is repositioned by moving the armour layer on the harbour side to the seaward side. The total width of the old breakwater is about 70m at ground level, which poses restrictions on the equipment, that can be used. Waterborne equipment is not a good choice for this task. The rocks picked up on the one side (for instance by a hydraulic excavator/crane on a pontoon) would need to be transported to the other side (by a barge for instance), since the hydraulic excavator/ crane would not be able to reach all the way over the old breakwater. Therefore a landbased long reach hydraulic excavator is used. For instance Hitachi ZX850 with a reach of 27m and 2m³ bucket capacity could be used[1]. According to of Engineers [3] rocks with 0 to 5t have a nominal diameter of maximum 1.38m, thus an average volume of $\frac{4}{3}\Pi \cdot \left(\frac{1.38m}{2}\right)^3 = 1.4m^3 < 2m^3$, which is smaller than the bucket capacity. Since the old breakwater is in general expected to be not accessible any more a temporary road will be built buy placing gravel with dump trucks and make them even with a bulldozer (starting from the landside and proceeding to tip of breakwater). At the end a place to turn around is built. The width is 8m at least, so two trucks can easily pass each other and a crane or hydraulic excavator at some point does not hinder the truck transport. For parts of the old breakwater, where the damage is even more severe than depicted in cross-section A-A and B-B a hydraulic excavator/crane on a pontoon will be available to move rocks out of reach of the long reach hydraulic excavator inside its reach.

Place sublayer The sublayer is made of rocks up to 2t, which are available via the quarry Krujë [2]. The distance of about 50km (see 6.1) can easily be travelled by trucks.
To show how the different steps given above interlock with each other see Appendix B.

6.2. Production Calculation

[1] http://www.land-water.co.uk/group-services/plant-hire-2/long-reach/zx-850-27m-long-reach-excavator/

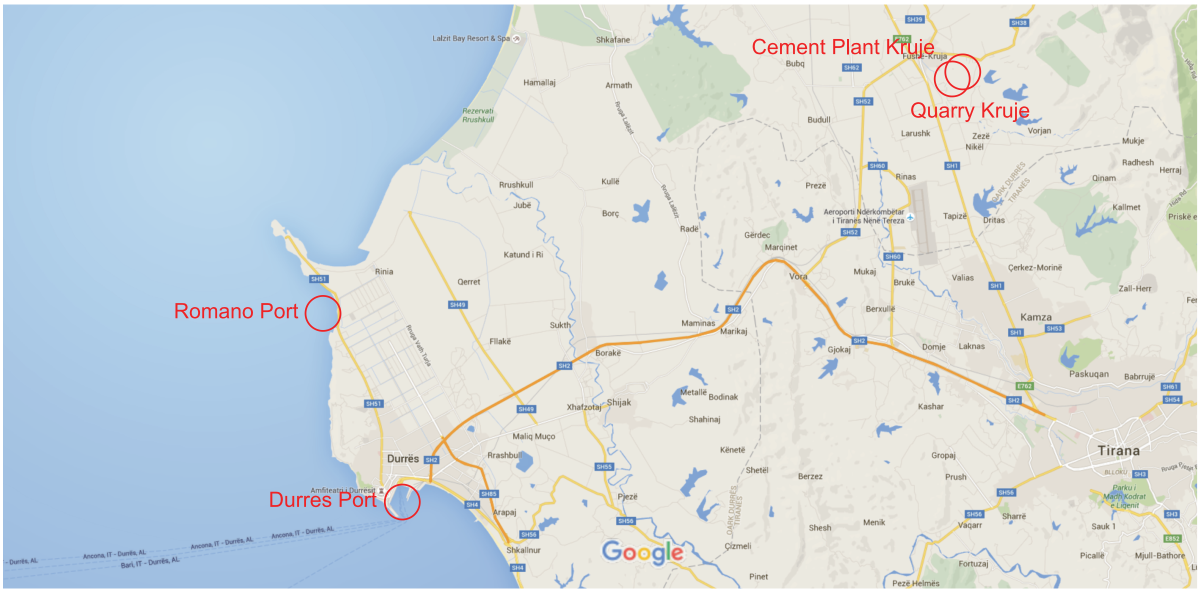

Figure 6.1: Location of facilities needed for construction (map from

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Further Research and Validation

see exercise 3.6

A

Appendix A

A.0.1. Wave-data check

Estimation of fetch-limited Waves; Method of Verhagen and Young:
$\tilde{H} = \tilde{H}_\infty[tanh(k_1\tilde{F}^{m_1})]^p$ with $\tilde{F} = \frac{gF}{U_{10}^2}$ and $H_{m0} = \frac{\tilde{H}U_{10}^2}{g}$
The input:

- $\tilde{H}_\infty = 0.24$
- $k_1 = 4.41 * 10^{-4}$
- $m_1 = 0.79$
- $p = 0.572$
- $F = 1000km$
- $U_{10} = 20\frac{m}{s}$

and the results:

- $\tilde{F} = 25000$
- $\tilde{H} = 0.22$
- $H_{m0} = 8.8m$

8.8 m is the maximum possible wave hight according to the fetch length and the Young/Verhagen method of dimensionless fetch.

Whatever XX

Percentage of occurrence of wave height (m) in rows versus peak wave period (s) in columns

	lower	01	02	03	04	05	06	07	08	09	10	11	12	13	
lower	upper	02	03	04	05	06	07	08	09	10	11	12	13	14	total
0.0	0.5	0	3.4	14.3	5.3	1.9	0.6	0.1	0.1	0.0	0.0	0.0	0	0	25.8
0.5	1.0	0	1.9	16.0	8.0	6.6	3.5	0.5	0.3	0.2	0.1	0.0	0	0	37.2
1.0	1.5	0	0	1.9	6.4	4.8	3.8	1.1	0.5	0.2	0.1	0.0	0	0	18.7
1.5	2.0	0	0	0.0	0.8	3.9	2.5	1.1	0.5	0.2	0.1	0.0	0.0	0	9.3
2.0	2.5	0	0	0	0.0	0.7	2.2	0.8	0.5	0.2	0.1	0.0	0.0	0	4.5
2.5	3.0	0	0	0	0	0.1	0.9	0.6	0.5	0.2	0.0	0.0	0.0	0	2.3
3.0	3.5	0	0	0	0	0.0	0.2	0.4	0.4	0.2	0.0	0.0	0.0	0	1.2
3.5	4.0	0	0	0	0	0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0	0.6
4.0	4.5	0	0	0	0	0	0	0.0	0.1	0.1	0.0	0.0	0	0	0.3
4.5	5.0	0	0	0	0	0	0	0	0.0	0.1	0.0	0.0	0.0	0	0.1
5.0	5.5	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0.0
5.5	6.0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0.0
6.0	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
total		0.0	5.4	32.2	20.6	18.0	13.8	4.7	3.0	1.5	0.6	0.2	0.0	0.0	100.0

Your choices :

Model output point is 40° 00'N, 19° 15'E
Season is all year
First and last year analysed 1992-2014
Variables are wave height (m) and peak wave period (s)
Data source is wavemodel
Results are based on 67168 model records

Figure A.1: Distribution of peak-period over wave hight

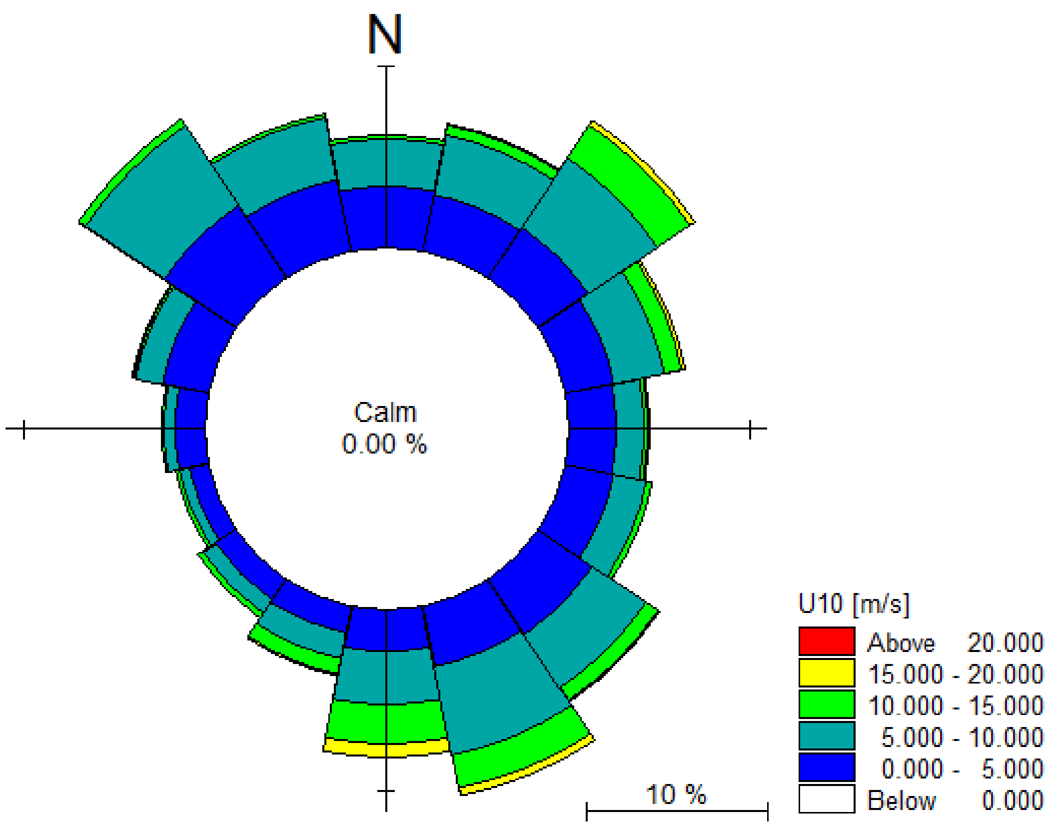

Figure A.2: Rose-diagram with the distribution of the wind

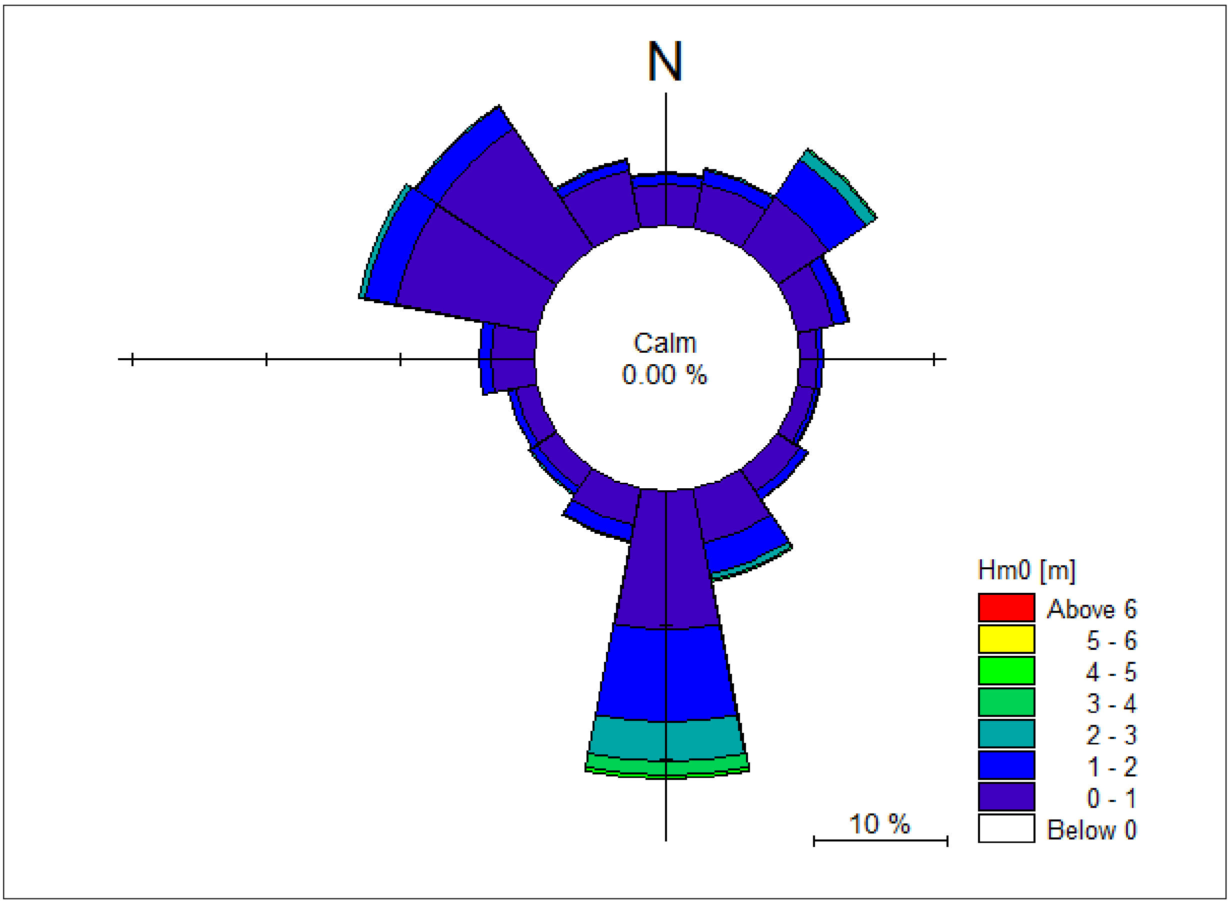

Figure A.3: Rose-diagram with the distribution of the waves

B

Appendix B

XX include clip

Bibliography

[2] M. K. Kersten. Master plan porto romano bay, albania. Master's thesis, Technical University of Delft, 2010.

[3] US Army Corps of Engineers. Coastal engineering manual. pages VI-5-i – Vi-5-158, 2011.