Queensland Beach, NS Coastal Protection

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FACULTY OF ENGINEERING

CBCL

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INTRODUCTION

Queensland beach is a popular barrier beach near Halifax, Nova Scotia. The beach is accessed via Conrads Road which runs adjacent to the beach. Due to its proximity to the water, Conrads Road has been damaged and washed out several times over the years by severe storms due to insufficient protection. Our group was tasked with redesigning the coastal protection for Conrads Road while preserving the integrity of the beach.

Figure 1. January 2018 winter damage to Conrads Road.

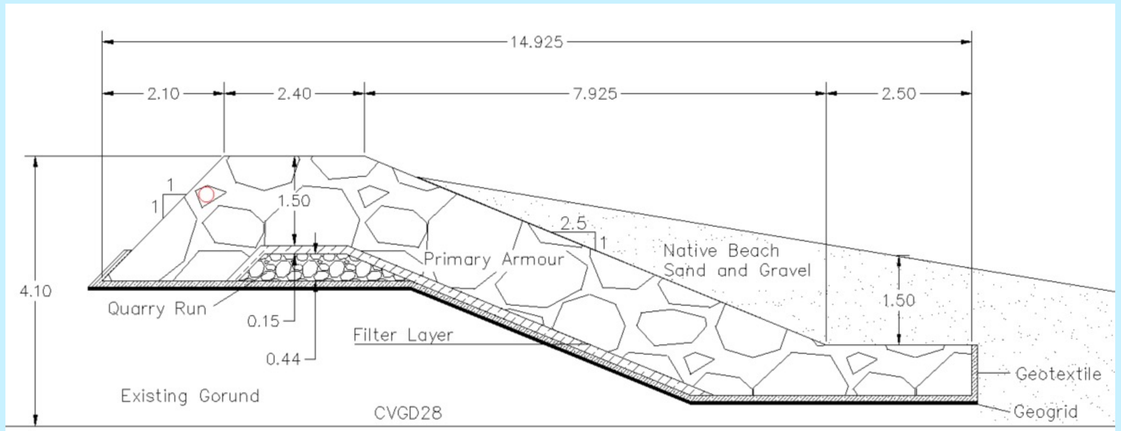
Figure 2. Aerial image of the project site.

DESIGN PROCESS

1. Preliminary Design
- Historical site analysis
- Modelling wind, wave and water conditions
- Options Analysis

2. Detailed Design
- Crest Elevation
- Rock Size
- Sections
- Volumes

3. Project Planning
- Cost estimate
- Construction schedule



WAVE FORECASTING

Offshore wind/wave data was analyzed to determine offshore wave heights and the conditions of the most severe storms. This information was converted into wave conditions at the shore using the wave modelling software SWAN1D. Due to climate change it is expected that not only will there be an increase in mean water levels but also an increase in storm frequency and magnitude.

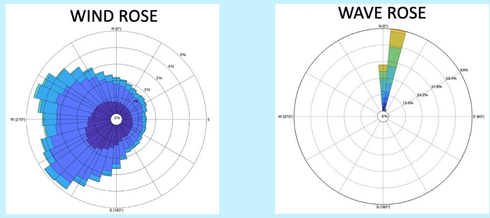


Figure 3. Plotted offshore wind and wave data.

WAVE OVERTOPPING

The crest height of the structure was chosen under the guidance of the EurOtop Overtopping Manual. A design wave with a 50-year return period was selected from the wave model. The key to a good design is finding a balance between the height of the structure and acceptable wave overtopping limits.

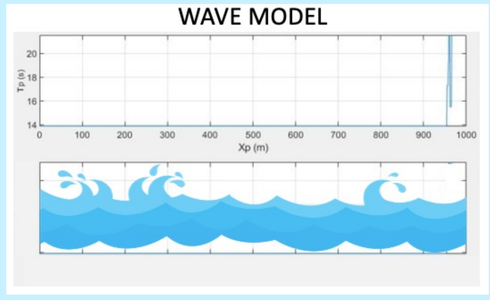


Figure 4. Wave climate was modelled using the software SWAN1D.

ROCK PROTECTION

The outermost layer of the structure consists of large angular armour stone and is designed in such a way that it will hold up against the forces of wave attack. Beach topography and the wave model model indicate that the type of waves hitting Queensland Beach are known as “surging waves”. Armour stone size was determined based on this classification and other geometric site parameters using the criteria set fourth in the CIRIA Rock Manual. The dimensions and grades of all the other layers and materials is a function of the armour layer.

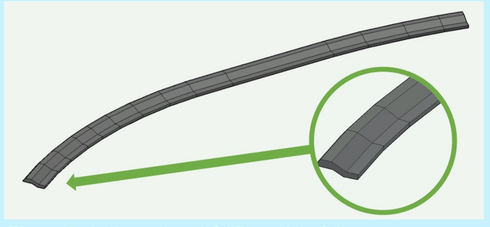


Figure 5. 3-dimensional CAD model of the revetment.

Figure 6. A surging wave shape.

Figure 7. Armour stone material. Image retrieved from CBCL.ca.

STRUCTURE STABILITY

The main cause of revetment failure is undermining due to scour. Scour is the erosion of material around the toe caused by breaking waves. To prevent scour and ensure overall stability of the structure the toe must be placed at a sufficient depth below the existing beach grade and buried under stable beach configuration.

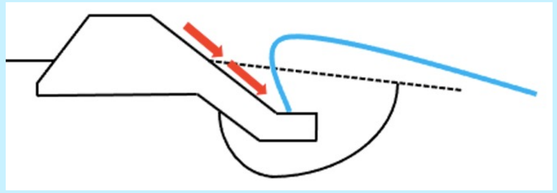
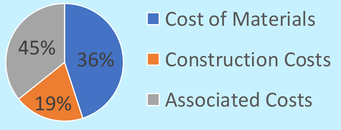


Figure 8. Undermining is the biggest risk to revetment stability.

ACCSESSIBILITY

Figure 9. New road and parking design.

PROJECT PLANNING



Total Cost:
$1.43 million

RECOMMENDATIONS

Perform a geotechnical investigation to get a better understanding of the response of the supporting earth.

References

CIRIA Rock Manual 2007.

EurOtop Wave Overtopping of Sea Defences and Related Structures: Assessment Manual. 2007.

US Army Corp of Engineers Coastal Engineering Manual. 2003.