Erosion on dikes

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Abstract

Dike erosion is a crucial issue in coastal flood risk management. Because sea levels are rising, dikes are more important than ever. We asked ourselves: “What is the effect of dike incline on the erosion of the dike?”. To test this, we got a rectangular plastic tub in which we can build a dike. To create waves, we use a custom speaker which can push down on plate. That platen creates waves that have an impact on the dike. This research can save a lot of lives by protecting them from the sea.

Dike erosion, water management, land protection

Hypothesis

Based on our basic knowledge, we expect that the steeper the dike, the more force will be exerted on the dike, so we expect this the other way around. This means that less force is exerted on the dike when the dike becomes less steep. in addition, we expect the optimal angle of the slope to be between 45 and 55 degrees because somewhere in the middle should be a sweet spot for the optimal angle.

The purpose of investigation

During the summer of 2021 there were floods all over Europe. These floods were caused by rapid rainfall [1]. Climate change will cause more precipitation[2], which will increase the risk of these kind of floods. These floods have caused billions in damages [3] [4] and had killed over 243 people. Climate change is also causing a rising sea level [5] , over 600 million people living in areas close to the sea [6] and will be at greater risk of floods.

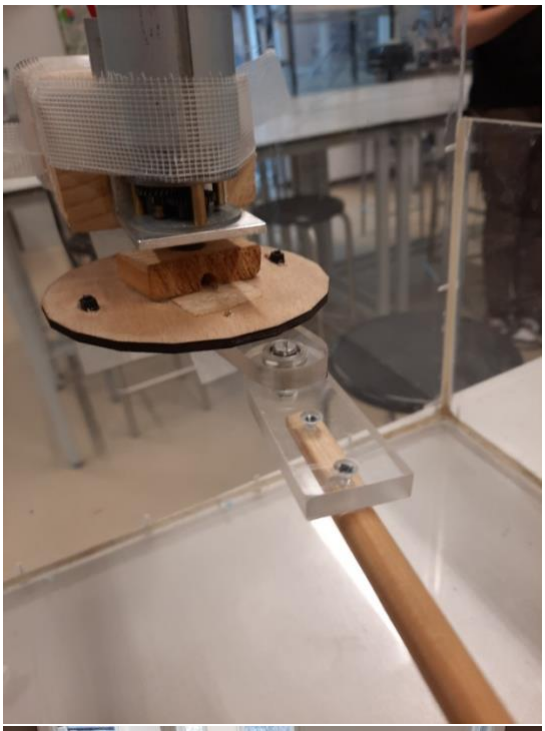
There are different types of coastal protection [7]. Most of them rely on nature, such as coral or mangrove, to protect the coast. But this is not the most reinsuring way to protect the coast and nearby villages and cities. This study focuses on dikes because this is the one of the most effective and used way to protect people from water [8]. furthermore, in the Netherlands we are all about dikes, so having grown up with loads of dikes was definitely a part of the decision making. And knowing over 600 million people live next to the sea it is very important to investigate in what is the most optimal dike.

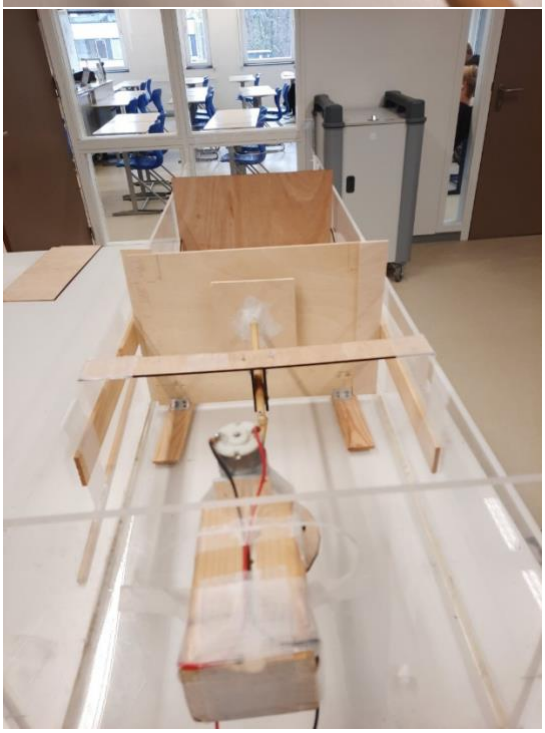
Theory

The erosion is caused by sediment. This study focuses more on the Moderately exposed sandy shores [9]. The most of this sediment is clay or sand. But you also could find a bit of organically sediment. The particles are in the water and the water hits the dike. Because the water hits the dike with a decent amount of speed, the particles will erode the dike because of the impact [10]. There are different factors that participate in the rate a dike erodes. For one the speed of the water. This will cause the particles to hit the dike with greater speed which causes more erosion. Furthermore, the slope of the dike, the material of the dike and the width of the beach [11].

Method of the investigation

The severity of water erosion is influenced by slope, soil type, soil water storage capacity, nature of the underlying rock, vegetation cover, and rainfall intensity and period [12]. In this project the degree of the slope is applicable. How steeper the slope the less water gets over it so when the degree of the slope decreases more water gets over the dike. The force of the dike acts directly against it, how steeper how more force it caches and when the degree of the slope decreases the force decreases with it [13]. In this investigation a tub was used, and wood was cut with a laser cutter so dikes could be recreated. With a servo motor a wooden plank was pushed forward in the water to create the waves. With a force sensor, the force on the dike was measured. In this project we expect to see how much force will be exerted on the dike. It is expected that there is a sweet spot right somewhere between 20% and 60% incline.





Results

Slope rate in %	Force in Newton
90 degrees	11.20 N
60 degrees	9.70 N
55 degrees	9.17 N
50 degrees	8.58 N
45 degrees	7.92 N
40 degrees	7.20 N
35 degrees	6.42 N
30 degrees	5.60 N
25 degrees	4.73 N
20 degrees	3.83 N

Conclusion

From these conclusions we would say that the 20 degrees angle is the best, it is only 34% of the maximum force, but bear in mind that there is a population behind this dike we would suggest more incline in the dike because of huge waves that come with modern day storms. So, to have the least amount of water pouring over the dike and less force on the dike we would suggest an incline of 55 degrees. This incline causes the force to be 81% of the maximal force. This incline in the dike could be combined with wave breakers so it is even more unlikely to pour over water and reduce the force even more. But if you just look at the force of the water it is very clear that there is a downwards trend in force if you reduce the incline in the slope. And

because force is one of the key factors in erosion, it is important to always try to get the incline as low as possible. In our hypothesis we expected the optimal angle to be between 45 and 55 degrees, in our project you could say that this is true because we found 55 degrees the best option to go with.

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