



*PT-YR: Coastal and Ocean Engineering ENGI.8751 Undergraduate Student Forum
Faculty of Engineering and Applied Science, Memorial University, St. John's, NL, Canada March, 2013*

Paper Code. (PT-2013 - Roberts)

The Study of Coastal Erosion on the Happisburgh Coast

Ryan Roberts

Memorial University of Newfoundland
St. John's, NL, A1C 5S7
ryanr@mun.ca

ABSTRACT

Happisburgh is a small village located in the county of Norfolk, which is situated in the East of England, one of the 9 regions of England. Recently a collection of flint tools has been unearthed in this community that are dated to be over 800 00 years old making this the earliest sign of occupation in the United Kingdoms. While this parish originally was a safe and decent distance from the coast line, coastal erosion has caused the town to be in danger. There are accounts in the history of Happisburgh which indicate that between the years of 1600 and 1850, more than 820ft of land have been eroded and swept away. This means that while the town's area is currently around 117 ft², the number continues to decline with the wave and wind erosion that is occurring.

In 1953 the area was hit with the East Coast flood which claimed the lives of over 300 people, 76 which were Norfolk inhabitants. Due to the receding coast line the village was more vulnerable to the treacherous weather. In 1959, timber defences were installed to help prevent another tragedy of this magnitude, but this was not intended to be a long term solution to the diminishing coastline. For this reason the Coastal Concern Action Group (CCAG) was formed in 1998 to try to come up with solutions. There have been many ideas brought up but very little has come to fruition when it comes to permanent resolutions.

The following paper will highlight the benefits of providing protection to this village and how it can aid other areas of the country, a brief project description, the challenges that have stopped any permanent solutions from occurring, and why coastal erosion is an issue and possible ways the problem can be solved

1 INTRODUCTION

Happisburgh is a civil parish which is located in the English county of Norfolk with a population of 1,372 inhabitants living in roughly 600 homes. The village gained worldwide recognition in 2010 when the earliest signs of human settlements were discovered on local beaches. This was a significant

discovery for archaeologists because the 78 flint tools unearthed showed that humans arrived in Britain approximately 250,000 years earlier than previously believed. Happisburgh is also home to the St. Mary's church, which was built in the 15th century and is used as a landmark to warn vessels of the hazardous sandbanks, and the famous Happisburgh lighthouse (Figure 1). The structure was erected in 1790 as a candle powered lighthouse before being electrified in 1947. While it was to be decommissioned in 1988, the local residents of the village formed a petition to allow the lighthouse to continue its service and it is now the only independently operated lighthouse in Britain. Happisburgh has also been a tourist attraction, with its beautiful coastline and scenery, over the past hundred years. While the village has an area of 117 ft², that number is decreasing annually with the effects of coastal erosion.



Figure 1: Happisburgh Lighthouse and the surrounding area

In the past the village of Happisburgh was once a safe and secure distance from the coast line of the Norfolk County, however more recently is under the danger of coastal erosion. While homes were previously 20 feet or more from the coast, currently they rest on the edge of the land waiting to collapse. In the past the village was actually separated from the coastline by the parish of Whimpwell, however the area has long since been eroded away. The last land of this medieval village was recorded to be in the late 1100's and the name Whimpwell is used for multiple streets in the town of Happisburgh. During the years of 1600-1850, it was discovered that the parish had lost 820ft of land due to the erosion and climate change. The coastline is being rapidly eroded at 39ft per year and more property is at risk of being swept into the ocean (Figure 2).



Figure 2: Erosion of the coastline in Happisburgh

Over the past 5000 years there have been many storms and events that have caused more loss of land including the disastrous North Sea flood of 1953. This storm caused the deaths of over 300 people in various counties, 76 of them were from the Norfolk region. Along with the loss of life, many buildings were destroyed and land lost due to the exceptionally large waves and prevailing winds. While the North Sea flood was the largest storm in Happisburgh in centuries, there have been many less significant storms which have caused the destruction of more homes, businesses, and historical structures such as the “Low Lighthouse”.

Besides the loss of property, the coastal erosion has negative impacts in other areas of Happisburgh as well. Due to the fear of homes collapsing into the ocean before the problem can be solved the prices of homes have fallen drastically. An extreme example of this is a home on Beach Road which was valued at £1. Additionally this has caused residents to move to a new location which resulted in financial losses for local business owners. The residing coastline has also caused farmland to be lost at sea which hurts their agriculture significantly. Finally the cost of slowing or stopping the rapid decay of the coastline can cause taxes in the county to be increased considerably.

2 COASTAL EROSION

Coastal erosion is the gradual or rapid wearing away of land or the coastline due to various sources which can include; tides, waves, wind, storms and man-made structures or vehicles. Soft land sediments, such as sand, have a low resistance to erosion and can be shaped easily over a short period of time, whereas hard rock has a very high resistance to erosion and can take thousands of years to have a significant change. Many other factors can contribute to the rate of erosion such as the types of waves on the coast, the size of the fetch which determines the size of the wave, human activity, shape of the coastline and the presence of a beach and its slope. In the study of erosion there are four main categories including attrition, abrasion, hydraulic action and corrosion.

Attrition is a type of current erosion where the waterbed erodes itself with the help of wave actions (Figure 3). Rocks and other sediments which can be carried with the force of the current are displaced and collide with the bed. This causes pieces rock to break off and become smaller or smoother. This can also occur within glaciers because boulders and smaller grains will get displaced and strike against landmasses. Attrition will also erode more rapidly when the water’s velocity is higher, due to the greater amount of collisions between sediments.

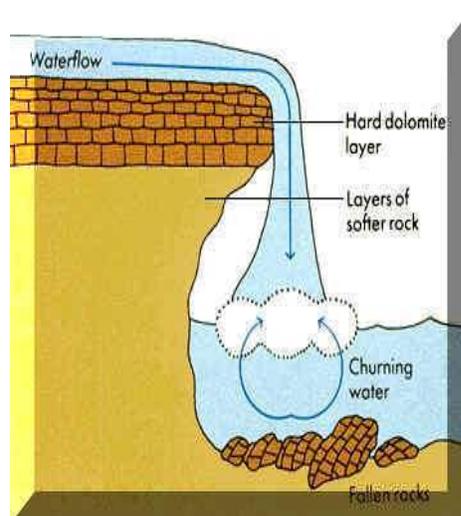


Figure 3: Example of attrition.

The next type of coastal erosion is abrasion which is when sand or boulders are picked up by waves and act like sandpaper against a coastline. The materials that are picked up by the waves, break against cliffs and wear them away. As the supports from the lower areas of the cliff are eroded away the top of the cliff will fall due to gravity, causing a significant change in the landscape.

In many cases coastlines can also be susceptible to corruptions which often occur when materials with low pH chemically erode material with a high pH. This can be an issue for cliff which contain limestone because it reacts with the waters pH level easily. This reaction is again increased by high wave action because the reacted material is carried away leaving more limestone exposed (Figure 4). Seawater can also erode rock quicker because when the water seeps into existing cracks the liquid evaporates causing the salt to crystalize and expand.



Figure 4: Corroded limestone.

The final type of erosion is hydraulic action, which occurs when waves break onto the walls of cliffs. When the waves hit the rock it traps a large amount of air and forces it into the existing cracks in the wall. This causes a large amount of pressure inside the cracks which can break away pieces of the rock. Once the wave moves away from the cliff face, the air suddenly escapes the crack causing miniature decompression which weakens the rock. Overtime this hydraulic action can cause the side of the cliff to collapse if enough erosion occurs. A dramatic land formation that can occur due to hydraulic action is the stack (Figure 5).

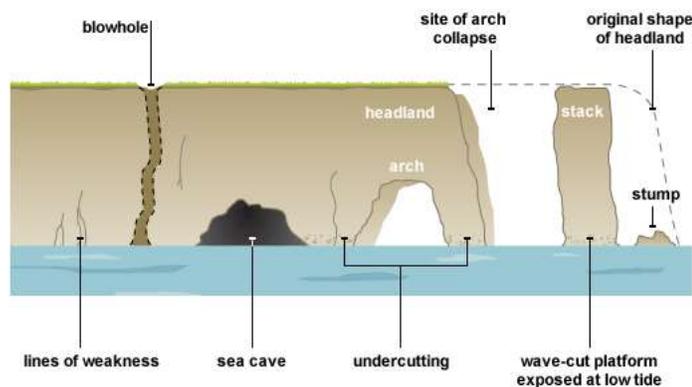


Figure 5: Hydraulic action creating a stack.

3 TYPES OF SOLUTIONS

While the eroding coastal has been a problem for the Happisburgh area for hundreds of years, it was not until the North Sea flood in 1953 that the population started to think of solutions. However, even with the growing concern of losing the entire village, little has been done to fix this problem in the long term. In the years between 1959 and 1961 the first defence against the ocean was constructed, which consisted of timber revetments which were placed along a mile of the coastline (Figure 6). This solution tends to have a low life expectancy, between 5-30 years, but is also a cheap and publically acceptable way to battle erosion. Unfortunately, timber revetments are more effective in areas that only periodically deal with heavy wave action. Therefore, due to the constant battery of the waves and other elements the timber defences began to fail in the 80's and a new solution was required.



Figure 6: Happisburgh timber revetments.

The next solution proposed by the village was to install manmade reefs off the coast to try and lessen the impact of waves onshore. Manmade reefs are commonly made by equipment or ships that are out of commission or damaged at sea but can also be made from debris or concrete (Figure 7). This system has a much longer life expectancy than the timber revetments, sometimes having an unlimited life span. While they can be more effective in normal wave conditions, however they can be less effective in storm surge conditions. Another benefit of the manmade reef is that it creates new intertidal habitat and only mildly disrupts natural processes. Some negative aspects of this solution are that reefs can be quite expensive depending on the size of the area that needs to be protected, and can cause treacherous areas for those navigating on the water. Happisburgh had thousands of tons of rock placed on their coastline in 1992, but they were only mildly successful. The first four reefs that were installed were placed too far apart so the land exposed between them is eroding away, while the remaining barriers only slow the process slightly. There was also debate following the installation of these reefs if the cost and benefits were worth the process.

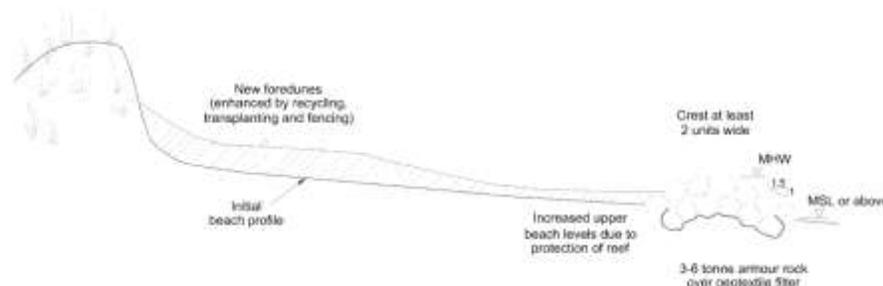


Figure 7: Manmade reef diagram.

The final preventive action that Happisburgh has taken to prevent the further eroding of the coastline was to create a concrete wall which protects the agriculture land next to their beach (Figure 8). Concrete walls used to avert coastal erosion are known as sea walls or impermeable revetments. This preventive measure is often used when an area of high value is being threatened by wave action. In the case of Happisburgh, the agricultural land may not be valued quite as high as the wall that was constructed but it was an important aspect of the community. Seawalls are used to absorb the impact of waves along a smooth and often sloped face to distribute the energy. They must be able to withstand the uplift and pressure of storms to resist failing where natural processes can be completely disrupted. While the construction cost of a concrete wall is quite high the maintenance can be low. However, continuous eroding can cause structural failure if not monitored. The seawall installed in Happisburgh was successful in slowing down the erosion of the coast, however it is now over 50 years old and the government has decided that the cost of maintaining it is not worth it. The wall will be allowed to deteriorate and eventually fail, potentially allowing the farmland to fall into the ocean.



Figure 8: Concrete seawall located in Happisburgh

Further possible solutions for Happisburgh would include more hard engineering, such as more seawall construction, gabions and revetments which have deemed to be too expensive or ineffective for the area. Soft engineering, such as beach nourishment, is another way to try and slow coastal erosion, however it would not be appropriate for the site due to the high wave and wind activity. The controversial decision being made for the village of Happisburgh is a control retreat. In 2004 a revised coastal erosion management plan was proposed which stated that the only way to solve the erosion problem in a cost efficient matter, is to migrate all the inhabitants inland. When it comes to preventing coastal erosion most small towns are not worth the cost to construct coastal defences since they do not do well in a cost/benefit analysis. This type of analysis looks at all the profits of completing a project of this scale and will then compare it to the negative costs to see whether it is an advisable action to take. Unfortunately for the town of Happisburgh, the price of saving the village far outweighs the benefits. An argument made by the Coastal Concern Action Group, in the favour of saving the town, is that with the rapid eroding of the village if it were to be a “test bed” for possible solutions in coastal erosion then those procedures can be used in other parts of the world. Happisburgh would be the ideal area to test solutions because while it can take years to predict eroding patterns in most sites, the process is much quicker in Norfolk so the results would be more substantial.

4 CONCLUSION

The town of Happisburgh, located in the English county of Norfolk, is rapidly falling into the ocean as the coastline is eroded away at a rate of 39 feet a year. As the wind and waves break upon the cliffs of the land, more property is lost every year as the ground is swept from underneath. Since the disastrous North Sea flood in the 1950's, the village has tried various erosion defences to try and prevent the loss of any more land. Timber revetments were placed along the coast following the storm and both manmade reefs and seawalls were installed years later. The constant beatings of the waves have completely destroyed the timber, the reefs have not been very effective and the seawall is being left to erode and fail as it is too expensive to maintain. These factors have led to the conclusion that the only way to deal with the eroding coast to move the inhabitants of the village to a new location that is safe from the deteriorating coast. While the site may be ideal to test possible solutions for coastal erosion and global warming, so many properties have been lost, numerous residents have moved and the value of the remaining homes have dropped significantly that it would not be financially feasible to save the site.

REFERENCES

- [1] *Timeline of recent coastal erosion issues at Happisburgh*. Retrieved March 3, 2013, from Happisburgh Village Website: <http://www.happisburgh.org.uk/ccag/timeline>
- [2] *Coastal erosion at Happisburgh, Norfolk*. Retrieved March 2, 2013, from British Geological Survey: <http://www.bgs.ac.uk/landslides/happisburgh.html>
- [3] *A Brief History of Happisburgh Lighthouse*. Retrieved March 2, 2013, from Happisburgh Village Website: <http://www.happisburgh.org/lighthouse/history>
- [4] Jones, J. (2010). *Happisburgh tools: masterpieces with a cutting edge*. Retrieved March 3, 2013, from The Guardian: <http://www.guardian.co.uk/artanddesign/jonathanjonesblog/2010/jul/09/happisburgh-stone-tools-as-art>, 2010
- [5] *Our home value drops to £1*. Retrieved March 4, 2013, from The Sun: <http://www.thesun.co.uk/sol/homepage/news/1392920/Cliff-erosion-washes-away-home-value-to-just-1.html>
- [6] Sunamura, T. (1977). A Relationship between Wave-Induced Cliff Erosion and Erosive Force of Waves. *The Journal of Geology*.
- [7] *Impermeable Revetments and Seawalls*. Retrieved March 2, 2013, from Scottish Natural Heritage: http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/appendix_1.16.shtml
- [8] *Coastal Erosion*. Retrieved March 4, 2013, from BBC: http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/appendix_1.16.shtml