<u>The Effects of Geometric Shapes on Reducing Beach Erosion</u>

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Abstract

Erosion is when substances are being damaged by wind, water, or other natural agents. Beaches erode faster than other environments. This is because they consist of small nonadhesive sediments. Waves, longshore currents, storm surges, and hurricanes can cause excessive erosion. This project aims to solve the issue by using geometric objects to prevent the movement of beach sediments, specifically sand. The object, which will be under the sediments, will consist of a tetrahedrals placed in an interlocking formation. The main strategy is to create a foundation where sediments can be replaced. To replicate the water's movement, a gyre pump will be used to create a horizontal current that can be programmed to emulate many coastal water movements. To measure the effects of the erosion a Sense 3D scanner will be used to obtain data. Data will be taken by comparing significant scans of the sediments before and after the simulations. In the future, beach erosion will become the biggest issue coastal nations will face do to sea level rise. Coastal countries like the Republic of Maldives are taking erosion very seriously as their very existence is being threatened.

Introduction Section

Erosion is a natural process however when it interferes with humanity, it is a problem. Long Island is well known for its beautiful beaches from Montauk to Jones Beach. Montauk Point has a famous lighthouse and is regarded as the "Surf fishing capital of the word". The lighthouse was completed in 1796. From before WWII until the late 1980's millions of dollars were spent to keep the lighthouse from being swallowed by the Atlantic Ocean. Currently there are many 15 ton boulders keeping the lighthouse safe.

When speaking to people who grew up on Long Island, enjoying the beaches, they all seem to say the same thing; that the beaches were bigger when they were children. The beaches today are a few hundred feet from the dunes to the water line and there is often a large drop off where the strand line is.

Driving on the beach is like going to a different world. Enjoying the beauty of the beaches without all the masses is mind-altering. Recently beaches like Smith Point and Shinnecock have been closed due to piping plovers and erosion. The local townships almost yearly have to build up the beaches which means they are closed for weeks at a time.

Erosion is not a local problem. It is a global issue. In the 1950's a French Scientist named Pierre Danel invented the tetrapods to use for beach erosion. (Coastal Shore Structure Types) The triangular pyramid shape forces the water to move in various directions which slow it down, preventing erosion.(Coastal Shore Structure Types) Countries like Japan, the United Kingdom, and India, have been using the structures for years to prevent erosion. However, the geometric objects were all placed as barriers like bulkheads, jettys, and groins. It is not believed that the geometric objects have been buried under the sand of beaches. It is believed that if the tetrahedrons are under the sand during a major storm, less sand will be lost due to erosion. Furthermore, the rebuilding process will be less expensive and time consuming because there will be a foundation of these objects that just need to be filled in.

Methods and Materials

A 3'x 4'x 6" hydroponic tray will be set up with three and a half, five gallon buckets of sand from Robert Moses Field two beach. The tray will be filled to emulate a beach environment where there is a supratidal zone, with a natural slope below the water line with about 4" of water covering the emulated intertidal zone. A gyre will be placed on the opposing wall of the beach to simulate wave actions. Control trials will be conducted without any structures where displaced sand will be observed by using a 3D scanner. Control simulations will include a natural tide with no storm action as well as a simulated storm. The experimental trials will consist of placing the tetrapods below the sand and then covering the tetrapods with sand. The gyre will be then set to simulate normal wave action and then simulated a storm surge. The displaced sand will then be scanned by the 3D scanner. Using the CAD exchanger software the amount of sand that has been moved could be measured

Materials:

- 3'x 4'x 6" hydroponic tray
- Sense 2 3D scanner
- Maker Bot 3D printer
- Sand collected from local beach (Robert Moses field 2)
- Salt water for wave simulation
- Maxspect Gyre 200 water pump
- Tinkercad Software
- CAD exchange software

Discussion and Conclusions

Scaling down a natural beach with a non-linear intertidal zone is a difficult task. While the data supports the goal of the research project, there were obstacles to overcome. Actually getting accurate data of the net movement of the sand was difficult. The use of the Sense 3D scanner made the data collection possible. The 3D images were difficult to obtain and transfer to the 3D software programs. Tinkercad was used along with a Maker Bot 3D printer. The 3D objects that were created were very detailed and showed the differences in displaced sand however the objects created were only 5 -7 inches long and 3-4 inches deep. The gyre was powerful enough to simulate storm surges however sand would get stuck in the magnet housing. The gyre had to be taken apart many times and cleaned to get it working again. Foam padding was then put under the gyre to prevent it from sucking in the sand. The Retrofit worked but elevated the gyre changing the wave action. When the waves hit the beach with the tetrahedrons below it, the sand appeared to move above the structures but then settled right down. The sand did not get washed away as much as in the control simulation without the buried structures. It is clear that there was less net sand loss from the simulated beach with the tetrahedral object buried in the sand however improvements can be made.

A larger box can be used. A 6'x 8' or larger box can be built using plywood and waterproof lining. A further study can be done in the field. A drone flying over beaches taking 2D 4K video can be used and converted to 3D imagery. This can be done before and after storm surges and major storms. The 3D printer can be used to print the shoreline on a small scale.

<u>Results (any representations of data findings or mathematical proofs)</u>

The simulation trial for the scenario of the tetrahedryls buried below the sandline showed much the net loss of sand as compared to the simulated beach without the buried geometric objects. The results show promise that if these objects were buried under the sandy beaches, during major storm surges and storms, less erosion will take occur.

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