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Simulation of Hydrodynamics Pressure to Determine the value of Von-Mises Stress, Displacement and Strain of the Geotube

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Abstract; To prevent coastal sand erosion, geotube technology was invented in the late 1950s. My Flexitank Industry (MYF) Sdn. Bhd. contributed the resources for this study which focuses on modelling, simulating and analyzing geotube constructions under hydrodynamic pressure changes (LLDPE). The aim of this study is to use Solidwork 2021 software to model the geotube structure based on the diameter provided by MY Flexitank Industry (MYF) Sdn. Bhd. and determine the maximum value of Von-Mises's stress, displacement and strain. Excess water is removed from the porous geotextile layer of the Geotube by the dewatering process, which increases expense and takes a long time to complete. In light of this, linear low-density polyethylene (LLDPE) plastic is the substance utilized to create the new geotube material. For a successful transition from the geotube's dewatering to non-dewatering method, further study is required. The value obtained from the simulation according to the data does not exceed the theoretical value of the LLDPE characteristics. The geotube did not fail or burst under the imposed pressure throughout the simulation, according to the results. To obtain a more accurate result value, however another engineering design tool such as ANYSYS or ABACUS software can be utilized.

Keywords: Geotube, Low- linear Denstity Polyethlene (LLDPE), Simulation, Non-Dewatering Process.

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1. Introduction

The geotube are also known as geobags used for sludge dewatering project of different sizes because of their simplicity and low-cost factor [1]. It is a container that have a hydraulically pumped slurry of sand and water. Sand is forced down the tube by hydraulic pressure, water is drained from the area by permeable fabric and finally the sand settles out in the container due to gravity. Geotube assist in recovering islands, preventing coast line erosion, and reclaiming coast lines that have been destroyed by waves. Geotube is a method of coastal management are constructed parallel to the shoreline to reduce wave energy and prevent coastal erosion. They also aid in the building of oyster reefs and act as a place for the dumping of dredging rubbish.

The erosion of public properties along Malaysia's coastline caused by coastal erosion has always been a serious problem. The non-dewatering method is more effective, quicker, and less expensive. My Flexitank Sdn. Bhd. has created a new Geotube using Linear Low Density Polyethelene(LLDPE). GT-750 Engineered tube is combination fiber and chemical to create material that outperform existing altervatives. In comparison to GT750 designed tube, LLDPE is a more cost-effective material to use as a geotube structurer and improves geotube functionality. In order to study stress, displacement, and strain development and to detect potential structural bursts and leaks in geotube structures, the hydrodynamics will be investigated in a simulation environment with a configurable setup using the SolidWork 2021 programmed.

The development of a geotube structurer for simulation purposes is the goal of this project. In order to see the Von-Mies stress, strain, and displacement effect, it is then necessary to determine the nominal hydrodynamics wave impact in Malaysia's coastal area and to simulate the hydrodynamics wave impact for the modelled geotube structurer.

2. Materials and Methods

2.1 Materials

LLDPE is produced by polymerization of ethylene (or ethane monomer) with 1-butene and smalleramounts of 1-hexene and 1-octene, using Ziegler-Natta or metallocene catalysts. The figure 1 and table 1 show the raw material of LLDPE plastic with the specification of the LLDPE material [2]. For this study, LinearLow-Density Polyethylene (LLDPE) plastic Material was chosen by MY Flexitank (MYF) Sdn.Bhd tobe used as a new geotube material to replace the previous material. The LLDPE plastic material is suitable to be used for non-dewatering process due to its properties. LLDPE is very flexible with high impact, excellent for mild and strong buffer, good chemical resistance. It also translucent and natural milky color, good water vapor and alcohol barrier properties and lastly good stress crack and impact resistance [3].

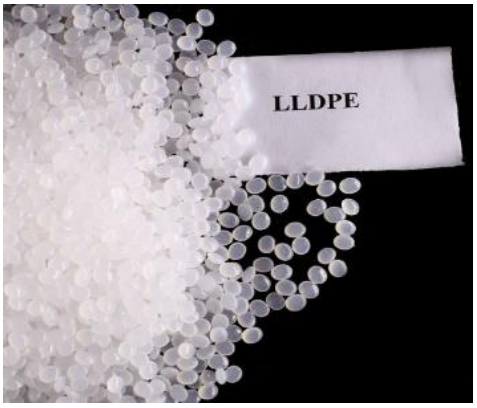


Figure 1: Raw material of linear Low-Density Polyethene (LLDPE)

Table 1: Resin specifications of LLDPE

[a] Speed test = 50mm/min

Mechanical Properties	ASTM Method	Value
Melt index	D 1238	4.2 g/10min
Density	D 792	0.935 g/cm^3
Flexural strength	D 747	450 Mpa
DSC peak melting	DSC[b]	123.4°C
Tensile strength at break	D 638[a]	22 Mpa
Elongation at break	D 638[a]	1080%
Impact strength	D256	180 J/m

[b] Heating rate = 10°C/min

2.2 Methods

SOLIDWORKS, a solid modeling computer-aided design and computer-aided engineering program,is one of the most popular software options for mechatronics engineers [4]. For this study the Solidwork2021 software was used to obtain the value of the Von-mises stress, displacement and strain of the geotube. Figure 2 show the green arrows are indicated the position of geotube which are place at the sea sand surface while the red arrow is indicated the position of where the wave impact hit the geotube. The internal pressure in the geotube is 137kPa and wave pressure that hit the geotube is 70kPa.

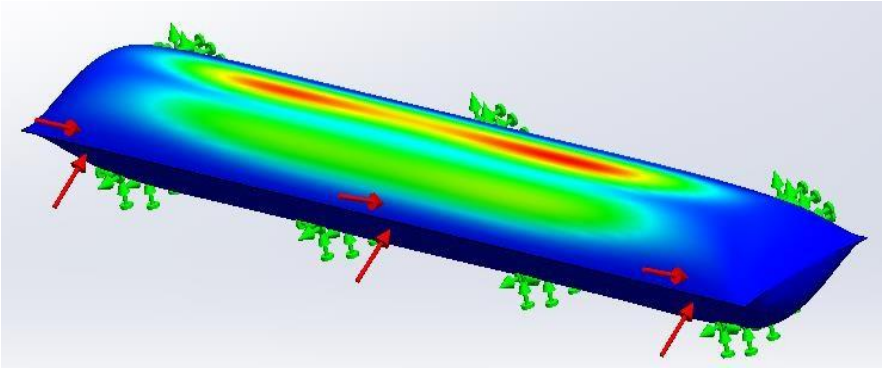


Figure 2: Geotube modelled by Solidwork 2021software

2.3 Calculation of wave pressure

Wave energy readings are taken through the surf-forecast website where this page will show wave energy readings according to the selected place and time within Malaysia and can also be used for wave readings abroad. Global-Pacific wave (swell) map for surfers, windsurfers and sailors showingopen ocean wave size, wave period and wave energy [5]. The wave energy needs to convert to force before convert to wave pressure. The value applied to the simulation is 70Kn/m^2.

2.4 External pressure in geotube

Eq 1 show the pressure tank formula [5], which can be used to calculate the external pressure in a geotube. eq 2 and eq 3 provide the formulas for the volume of a horizontal elliptical vessel [6] and the area of a geotube [7]. To get the external pressure of the geotube, the values of eq 2 and eq 3 must be inserted into eq 1.

P=p x V x g /A……eq 1

p = Density of sludge (1400kg/m^3)
V = volume of geotubeg = gravity
A= Area of the geotube
P=p x V x g /A

V= pi x A x B x Length / 4…….eq 2

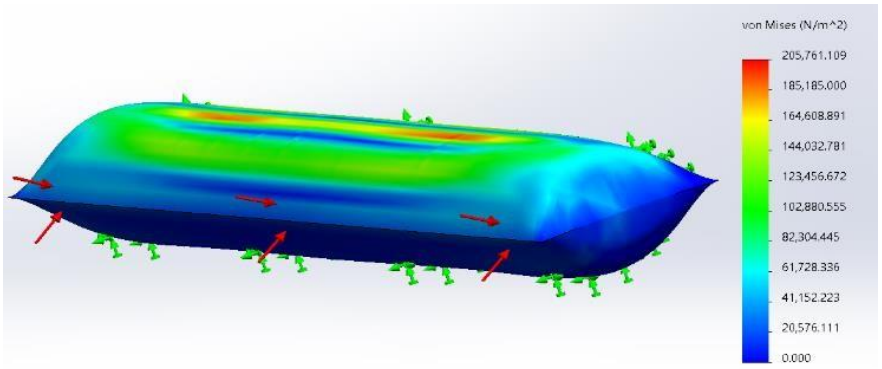
A= Height of the geotube
B=Width of the geotube

A=
a= width of the geotube
b= Height of the geotube

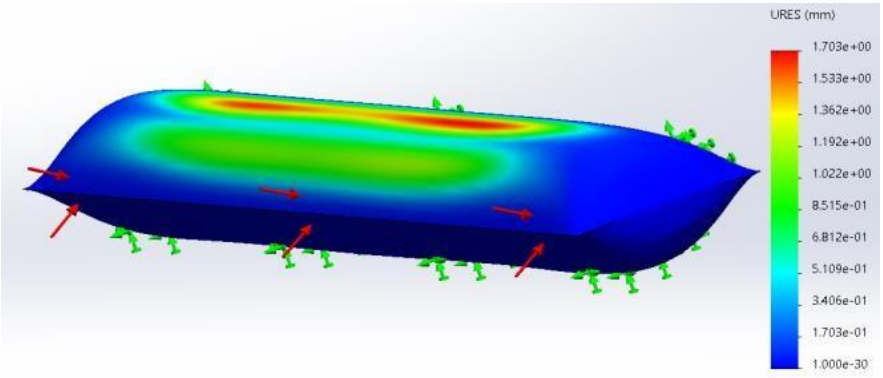
3. Results and Discussion

This process is carried out after the design of the geotube has been done with the thickness of 0.3 mm and linear low-density polyethylene (LLDPE) as the material. All the value of the pressure is fix according by the thesis before and this research it required to determine the maximum value of Von- mises stress, displacement and strain to show maximum durability that the geotube could withstand.

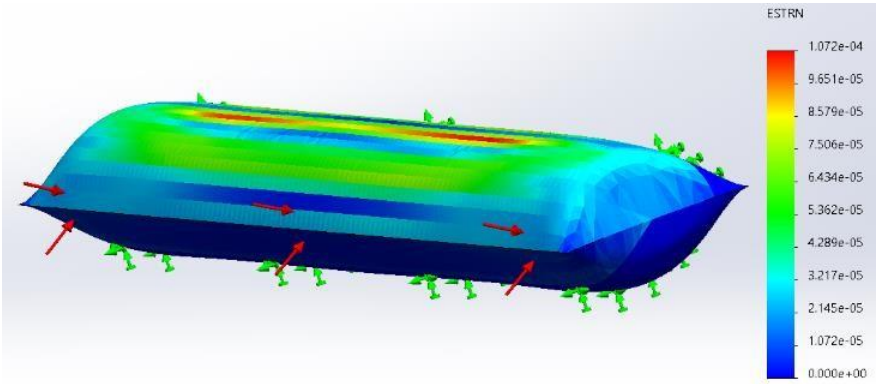
The internal pressure in the geotube is 137 kPa, the value is taken from the calculation that has beenmade previously and for the value of wave pressure that hit the geotube is 70kPa. Figure 3 show the value result for (a) Von-mises stress(N/m^2) is 206 kPa (b) Displacement (mm) is 1.703mm and (c) strain(mm) is 0mm



(a) The value of the Von-mises stress is 206kPa



(b) The value of the displacement is 1.703mm



(c) The value of the strain is 0.0001072mm

Figure 3: The value of Von-Mises's stress, displacement and strain of the geotube

3.1 Discussions

The parameter analysis and results from the simulation are crucial for ensuring the efficacy of the geotube. Three parameters were measured which is Von-mises stress, displacement, and strain. It was measured to determine the efficacy of the new material for the geotube. The pressure that is stamped asthe geotube's maximum pressure must not be exceeded while it is in use. Figure 4 show the green arrowsare indicated the position of geotube which are place at the sea sand surface while the red arrow is indicated the position of where the wave impact hit the geotube.

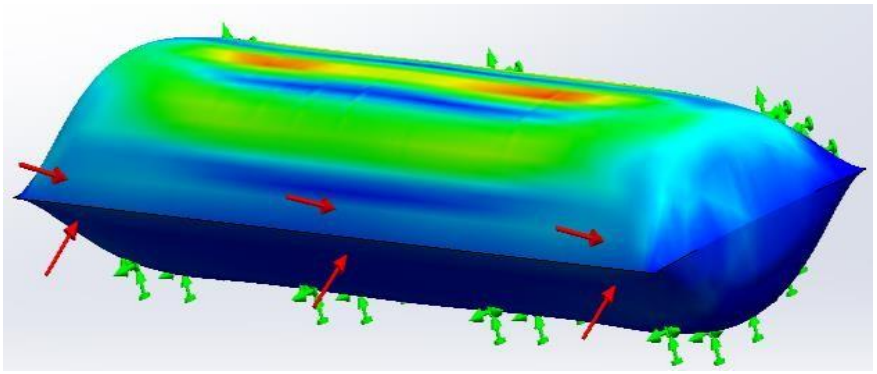


Figure 4: The image of the geotube in Solidwork 2021 software

The internal pressure in the geotube is 137 kPa, the value is taken from the calculation that has beenmade previously and for the value of wave pressure that hit the geotube is 70kPa. Since the data from the surf-forecast web indicates that the maximum wave pressure is 140 kPa, the simulation starts at a value that is half of the maximum wave pressure or 70 kPa.

Based on the result there is no failure or burst effect on the geotube when the applied internal pressure is 137kPa and the value of the wave pressure is 70kPa. This is because the value obtained fromthe simulation is still under the range of LLDPE plastic strength. The recommended LLDPE material for this geotube can withstand the value of wave pressure applied while considering the fact that the highest value of wave effect in the Malaysia coast environment utilized as a reference in this research from surf-forest is 140 kPa.

4 Conclusion

For the conclusion, the objective of this research has been fully achieved where the geotube has been successfully modelled for the simulation using the SolidWork 2021 software to determining the maximum value of the Von-Mises Stress, displacement and strain due to hydrodynamic pressure change. The value obtain for the Von-mises stress is 206kpa, displacement is 1.703mm and the strain is 0.0001072. Improvements must be made in order to obtain better results, such as finding and doing additional study on the issue of wave pressure, geotube pressure and related theories.

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