Technical Analysis

Traffic Sign Board Cleaning

Name

Date

# Introduction

The analysis is about the pipe material for the structure that is going to use in the project of cleaning traffic sign boards. As the project is to clean the sign boards without stopping the traffic and for that purpose the team has decided to make a drone system that will fly in the air and the water will throw on the boards through the nozzle installed on it. The drone design has made up of pipe structure and this pipe structure must be lightweight so that the drone can fly into the air.

For this paper the analysis is to select the best material to use for the pipe structure that will be lightweight and must have high strength. In the analysis, weight to strength ratio will determine for the material as well.

# Assumptions

Assumptions using in this paper are:

Force applied on the material for the stress

$$F=20 N$$

And the area of observation for the material is

$$A=0.2 m^{2}$$

Length of observing material

$$L=0.3 m$$

Changes in the length of each material

$$∆L\_{pla}=0.00032 mm$$

$$∆L\_{abs}=0.00045 mm$$

$$∆L\_{pvc}=0.00029 mm$$

# Formulas

Strain equation

$$ε=\frac{∆L}{L}$$

* $∆L= Length change$
* $ε= strain$
* $L = Length$

Stress Equation

$$σ=\frac{F}{A}$$

* F = Force
* A = Area
* $σ= Stress$

Formula of yield

$$Yield=\frac{stress}{strain}$$

# Physical Modeling

To do the physical modeling for the materials to test, it need to do physically by choosing that material and then apply the stress to it and observe the strain and yield but it has not done in this paper.



# Governing Calculations

Three materials are going to analyze in this paper

1. PLA Plastic
2. ABS Plastic
3. PVC Plastic

## PLA Plastic

In order to determine the stress, strain and yield, apply the following formulas

$$F=20 N$$

$$A=0.2 m^{2}$$

To calculate the stress following formula is going to use

$$stress=σ=\frac{F}{A}$$

$$σ=\frac{20}{0.2}$$

$$σ=100\frac{N}{m^{2}}$$

To calculate the strain, use the following formula

$$L=0.3 m$$

$$∆ L=0.00032 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00032\*10^{-3}}{0.3}$$

$$ε=1.0667\*10^{-6} $$

For the yield following formula has used

$$Yield=\frac{100}{1.0667\*10^{-6}}$$

$$Yield=93.747 MPa$$

## ABS Plastic Pipe

For the abs plastic

$$F=20 N$$

$$A=0.2 m^{2}$$

To calculate the stress following formula is going to use

$$stress=σ=\frac{F}{A}$$

$$σ=\frac{20}{0.2}$$

$$σ=100\frac{N}{m^{2}}$$

To calculate the strain, use the following formula

$$L=0.3 m$$

$$∆ L=0.00045 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00045\*10^{-3}}{0.3}$$

$$ε=1.5\*10^{-6} $$

For the yield following formula has used

$$Yield=\frac{100}{1.5\*10^{-6}}$$

$$Yield=66.67 MPa$$

## PVC Plastic

For the PVC plastic

$$F=20 N$$

$$A=0.2 m^{2}$$

To calculate the stress following formula is going to use

$$stress=σ=\frac{F}{A}$$

$$σ=\frac{20}{0.2}$$

$$σ=100\frac{N}{m^{2}}$$

To calculate the strain, use the following formula

$$L=0.3 m$$

$$∆ L=0.00029 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00029\*10^{-3}}{0.3}$$

$$ε=9.66\*10^{-6} $$

For the yield following formula has used

$$Yield=\frac{100}{1.5\*10^{-6}}$$

$$Yield=103.5 MPa$$

The strength each material is more than 50 MPa, hence the strength of each material is sufficient to use for the pipe structure. The important thing is the weight of each material and it can determine from the density of each material. Now determine each material density through online portals with the references.

**Density comparison**

Table 1 is showing the density of each material.

Table 1: Materials Density

|  |  |  |
| --- | --- | --- |
| Material | Density | Source |
| PLA | 1.24 g/cm3 | <https://all3dp.com/2/pla-density-what-s-the-density-of-pla-filament> |
| ABS | 0.9 g/cm3 | <https://omnexus.specialchem.com/polymer-properties/properties/density> |
| PVC | 1.38 g/cm3 | <https://www.lenntech.com/polyvinyl-chloride-pvc.htm> |

Density is showing that lightweight material is ABS so using the abs plastic pipe will give us the lightweight structure and will make the drone structure light.

# Conclusion

The analysis has performed to determine the best material to make the drone structure, as the drone structure has made using the pipe so this paper has provided the best material to use for the pipe that will be light and strong enough so that drone will be easy lift in the air and strong as well. The analysis has used three materials and from these three materials the best material found is abs plastic pipe, as it is lightweight and strong as well so using this material will keep the overall weight of structure lightweight. This analysis has helped the team in selecting the best material to use for the pipe.

# References

[3] E. Joh, “Polyester Properties and Plastics”, available [online], http://www.tregaltd.com/img/density%20of%20plastics.pdf

[2] G. Fond, “Nylon Materials strength and Density”, available [online], https://www.bpf.co.uk/plastipedia/polymers/polyamides.aspx

[3] F. Louis, “Acrylic Material Properties and Densities”, available [online], https://www.aqua-calc.com/page/density-table/substance/acrylic-blank-polymer