Individual Analysis

# Introduction

The project is to design a traffic sign cleaner which can easily clean the sign boards without disturbing the traffic flow. This is the major thing that we need to develop such a device that will not interfere the traffic flow and it will clean the sign boards therefore we will use the flying drone that will clean the sign board through the shower and brushes. The drone will fly in the air and it will rotate the shower and brush for cleaning purpose.

In this paper I am doing the analysis on the brush to use for cleaning purpose as we have to understand the strength of each material and see which material is good to use with the strength that will not break easily but flexible as well as soft enough to make the brush. This analysis will help the team in finalizing the design for the brush and also will help them in selecting the material of brush.

# Assumptions

For doing this analysis following assumption are going to take place:

The force that need to test the materials is

$$F=10 N$$

And the area under the calculation is considering

$$A=0.3 m^{2}$$

And the length to calculate the analysis is considering

$$L=0.2 m$$

The change to consider in polyester

$$∆L=0.00032 mm$$

The change to consider in nylon

$$∆ L=0.00090 mm$$

The change to consider in acrylic

$$∆ L=0.00080 mm$$

# Equations and Formulas

For this analysis the equation we are going to use

Strain equation

$$ε=\frac{∆L}{L}$$

* $∆L is change of length$
* $ε is strain$
* L is Length

Stress Equation

$$σ=\frac{F}{A}$$

* F is Force
* A is Area
* $σ is Stress$

Strength of the material can determine from the yield because it tells the flexibility and breaking strength of material higher the yield strength makes the material stronger, less flexible and difficult to break.

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

Density is another factor which provide details about the material like mass of the material

$$Density=\frac{Mass}{Volume}$$

# Physical Modeling

For the purpose of physical modeling we actually need to develop the brushes that can form and develop accordingly to test in different conditions, so the physical modeling has not done for it.

# Governing Calculations

For doing the analysis following three materials are going to analyze and the best option will select on the basis of results.

1. Polyester
2. Nylon
3. Acrylic

## Polyester

The polyester stress and strain can calculate using the following quantities

$$F=10 N, A=0.3 m^{2}$$

For the stress we only need the force and area so the stress is

$$σ=\frac{F}{A}$$

$$σ=\frac{10}{0.3}$$

$$σ=33.333\frac{N}{m^{2}}$$

For the strain we need the length and the change is length

$$L=0.2 m, ∆ L=0.00032 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00032\*10^{-3}}{0.2}$$

$$ε=1.6\*10^{-6} $$

When stress and strain has obtained, now put the values in the yield strength equation

$$Yield=\frac{33.333}{1.6\*10^{-6}}$$

$$Yield=20.8331 MPa$$

## Nylon

The nylon stress and strain can calculate using the following quantities

$$F=10 N, A=0.3 m^{2}$$

For the stress we only need the force and area so the stress is

$$σ=\frac{F}{A}$$

$$σ=\frac{10}{0.3}$$

$$σ=33.333\frac{N}{m^{2}}$$

For the strain we need the length and the change is length

$$L=0.2 m, ∆ L=0.00090 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00090\*10^{-3}}{0.2}$$

$$ε=4.5\*10^{-6} $$

When stress and strain has obtained, now put the values in the yield strength equation

$$Yield=\frac{33.333}{4.5\*10^{-6}}$$

$$Yield=7.4073 MPa$$

## Acrylic

The nylon stress and strain can calculate using the following quantities

$$F=10 N, A=0.3 m^{2}$$

For the stress we only need the force and area so the stress is

$$σ=\frac{F}{A}$$

$$σ=\frac{10}{0.3}$$

$$σ=33.333\frac{N}{m^{2}}$$

For the strain we need the length and the change is length

$$L=0.2 m, ∆ L=0.00090 mm$$

Strain can calculate as

$$ε=\frac{∆L}{L}$$

$$ε=\frac{0.00080\*10^{-3}}{0.2}$$

$$ε=4.0\*10^{-6} $$

When stress and strain has obtained, now put the values in the yield strength equation

$$Yield=\frac{33.333}{4.0\*10^{-6}}$$

$$Yield=8.3332 MPa$$

The yield strength of polyester is highest, acrylic is at second number and nylon is at the third number. Hence the difference between nylon and acrylic is not much but still nylon has lowest strength between these three materials which makes the nylon a flexible material and the value of strength shows that it will not easily breakable but it will give more flexibility to the material so the analysis suggests to use nylon for the brush.

**Density comparison**

Density of each material has given in the following table

Table 1: Materials Density

|  |  |  |
| --- | --- | --- |
| Material | Density | Link |
| Polyester | 1.38 $\frac{g}{cm^{3}}$ | http://www.tregaltd.com/img/density%20of%20plastics.pdf |
| Nylon | 1.15 $\frac{g}{cm^{3}}$ | https://www.bpf.co.uk/plastipedia/polymers/polyamides.aspx |
| Acrylic | 1.18 $\frac{g}{cm^{3}}$ | https://www.aqua-calc.com/page/density-table/substance/acrylic-blank-polymer |

The density comparison has shown that nylon is lightest material among all the three materials and the lightest material is easy to use for the brush and being strong material it can use in the project.

# Conclusion

In this paper the analysis has done about the brush materials that will going to use in the design project traffic sign cleaning, and the brush will use to clean the boards. Three different materials have tested in this assignment and from the analysis it is clear that nylon is light in weight and lightest value of strength which makes this nylon material useful in the project. This analysis will help the team in selecting the final material for the brush while manufacturing the device.

# References

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