



**STUDY ON RAINWATER EFFECT ON MECHANICAL  
PROPERTIES OF AGEING FS3300PA SLS MATERIAL WITH  
DIFFERENT COATING CONDITIONS**



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**Faculty of Mechanical and Manufacturing Engineering  
Technology**

**Study On Rainwater Effect on Mechanical Properties of Ageing  
FS3300PA SLS Material with Different Coating Conditions**



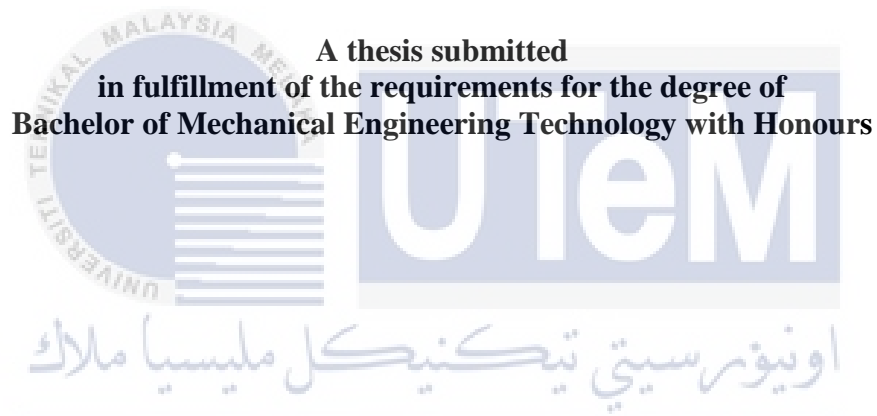
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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2023**

## DECLARATION

I declare that this research entitled “Study On Rainwater Effect on Mechanical Properties of Ageing FS3300PA SLS Material with Different Coating Conditions” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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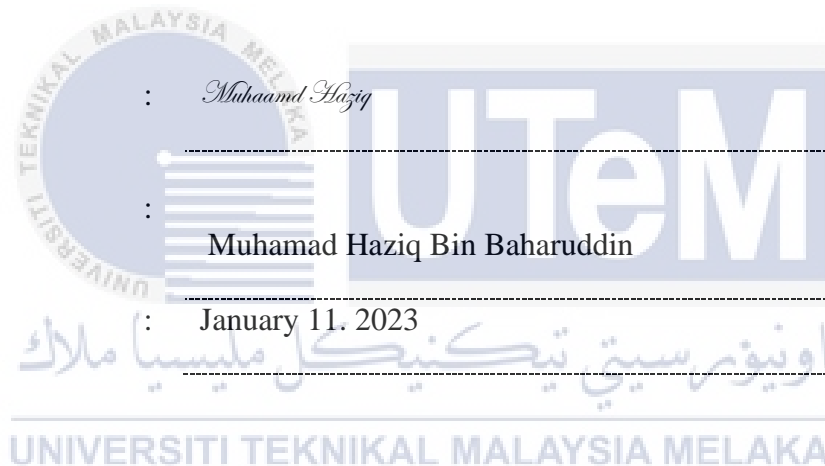
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: January 11, 2023



## APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical and Manufacturing Engineering Technology (BMMV) with Honours.

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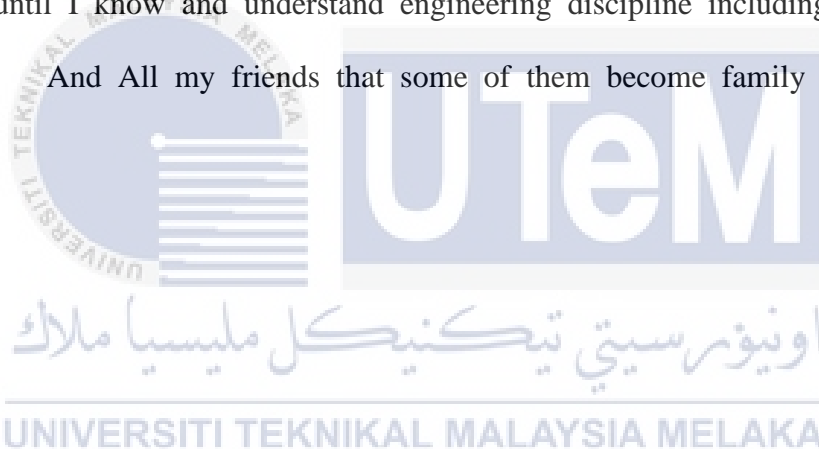
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## DEDICATION

I am dedicating this thesis to my beloved mother, Asmelia Binti Asri, and father, Baharuddin Bin Bachok, who always support and encourage me during prepare this thesis that I involve in and do during the whole time in my life without any doubt. and To all teachers and lectures that have taught me from not knowing an alphabet until I know and understand engineering discipline including about life.

And All my friends that some of them become family



## ABSTRACT

Ninety-eight (98) percent of the fresh water supply that flows in the country comes from rivers naturally. These statistics show that the status and quality of river water needs to be emphasized so that water pollution in the country is always in good condition and ensures the sustainability of community life in the country. Statistics show some of the largest countries in the world such as China, India, and Nigeria are the top three countries that suffer from water pollution problems and have caused a large number of deaths each year. Malaysia is also one of the countries that suffer from water pollution problems that can cause widespread harm to the local community. Furthermore, water pollution can have a negative impact on the health, environment and economy of the country. In addition, in this case as well, water pollution itself will give the effect of climate change that will result in increased water levels, floods and bad weather as well as making the country will be hit by major disasters almost every year. In Malaysia, the tourism, manufacturing and water transport industries are among the industries that result in direct and indirect water pollution. The problem presented also occurs in Melaka which is a Historic City. At this time, Sungai Melaka is also under monitoring due to the pollution that occurred. Although legal action is taken against the offenders who will but as such go unnoticed by the public. Through the implementation of projects to maintain the quality of river water has not yet brought the level of water pollution to a lower level. Therefore, the study of the main causes of water pollution needs to be studied and determined, especially in the spatial variation in the Melaka River. Therefore, this study was conducted to determine the reduction strength of F3300PA nylon by using SS402P 3D Selective Sintering Laser printing machine, which will print some nylon samples to be observed for the tensile test. The nylon material also has been observed the percentage weight increase and percentage expand increase to study the effect of rainwater to the FS3300PA. Material selection Polyamide-12 (PA-12) is a material that has its own properties and withstands pressure when on the surface of water. Among other reasons for choosing this material is because it is suitable for use on the SLS 3D SS402P printing machine that prints this material into three dimensions using a laser due to 70 kilowatts of power generated by the machine. This study will perform field tests to determine the mechanical properties of the new FS3300PA and some different coating condition of it. The dimension of the sample needs to be measured for comparing with the actual dimension. The weight of the sample also has been weighed to observe the percentage weight increase of the material due to soaking into the rainwater. The last methodology of this study is to test the specimen. It will be observing the tensile strength due to the different types of condition by using 100KN Universal Tensile Machine. This project is also expected to help other projects such as Hydro Quality System and River Trash Collector System in testing the types of condition durability and strength of materials and their position among doing printing in the laboratory.

## ABSTRAK

Sembilan puluh lapan (98) peratus bekalan air tawar yang mengalir di negara ini berasal dari sungai secara semulajadi. Statistik ini menunjukkan status dan kualiti air sungai perlu dititikberatkan agar pencemaran air di negara ini sentiasa dalam keadaan yang baik dan menjamin kelestarian kehidupan masyarakat di negara ini. Statistik yang menunjukkan beberapa negara terbesar di dunia seperti China, India, dan Nigeria adalah tiga negara teratas yang mengalami masalah pencemaran air dan telah menyebabkan bilangan kematian yang besar setiap tahun. Malaysia juga antara negara yang mengalami masalah pencemaran air yang mampu mengakibatkan kemudaratan yang menyuluruh kepada masyarakat setempat. Tambahan pula, pencemaran air boleh mendatangkan kesan yang negatif kepada kesihatan, persekitaran dan ekonomi negara ini. Selain itu, dalam hal ini juga, pencemaran air itu sendiri bakal memberikan kesan perubahan iklim yang akan mengakibatkan penigkatan permukaan air, banjir dan cuaca buruk sekaligus membuatkan negara akan ditimpa musibah yang besar hampir setiap tahun. Di Malaysia, industri pelancongan, perkilangan dan pengangkutan air antara industri yang mengakibatkan pencemaran air secara langsung dan tidak langsung. Masalah yang dibentangkan ini juga berlaku di Melaka yang merupakan Bandaraya Bersejarah. Pada ketika ini Sungai Melaka juga di dalam pemantauan disebabkan berlakunya pencemaran yang berlaku. Walaupun tindakan undang-undang dikenakan kepada pesalah yang akan tetapi seperti tidak diberi perhatian oleh orang awam. Melalui elaksanaan projek-projek untuk menjaga kualiti air sungai juga masih belum membawa tahap pencemaran air itu ke peringkat yang lebih rendah. Oleh itu, kajian punca pencemaran air yang utama perlulah dikaji dan ditentukan, terutamanya dalam variasi ruang di Sungai Melaka. Oleh itu, kajian ini dijalankan untuk menentukan kekuatan pengurangan nilon F3300PA dengan menggunakan mesin cetak SS402P 3D Selective Sintering Laser, yang akan mencetak beberapa sampel nilon untuk diperhatikan untuk ujian tegangan. Bahan nilon juga telah diperhatikan peratusan peningkatan berat dan peratusan peningkatan peningkatan untuk mengkaji kesan air hujan kepada FS3300PA. Pemilihan bahan Poliamida-12 (PA-12) adalah bahan yang mempunyai sifat tersendiri dan tahan tekanan apabila berada di permukaan air. Antara sebab lain pemilihan bahan ini adalah kerana ia sesuai digunakan pada mesin cetak SLS 3D SS402P yang mencetak bahan ini kepada tiga dimensi menggunakan laser kerana kuasa 70 kilowatt yang dijana oleh mesin tersebut. Kajian ini akan menjalankan ujian lapangan untuk menentukan sifat mekanikal FS3300PA baharu dan beberapa keadaan salutan yang berbeza padanya. Dimensi sampel perlu diukur untuk membandingkan dengan dimensi sebenar. Berat sampel juga telah ditimbang untuk melihat peratusan peningkatan berat bahan akibat direndam ke dalam air hujan. Metodologi terakhir kajian ini adalah untuk menguji spesimen. Ia akan memerhati kekuatan tegangan disebabkan oleh jenis keadaan yang berbeza dengan menggunakan Mesin Tegangan Universal 100KN. Projek ini juga diharapkan dapat membantu projek-projek lain seperti Sistem Kualiti Hidro dan Sistem Pengumpul Sampah Sungai dalam menguji jenis ketahanan dan kekuatan bahan serta kedudukannya di kalangan melakukan percetakan di makmal.



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## LIST OF SYMBOLS AND ABBREVIATIONS

AM	-	Additive Manufacturing
ASTM	-	American Society for Testing and Materials
ANOVA	-	Analysis of Variance
CF	-	Carbon Fibre
CP	-	Composition Percentages
CMM	-	Coordinate Measuring Machine
DoE	-	Department of Environment
DO	-	Dissolved Oxygen
GIS	-	Geographic Information System
GD&T	-	Geometric Dimensioning and Tolerancing
GBs	-	Glass beads (GBs)
HydroQS	-	Hydro Quality System (HydroQS)
IR	-	Infrared (IR)
LGF	-	Long glass fibre (LGF)
MJF	-	Multi Jet Fusion (MJF)
NWQS	-	National Water Quality Standards (NWQS)
NE	-	North East
NEM	-	Northeast Monsoon
PPSPM	-	Perbadanan Pembangunan Sungai dan Pantai Melaka
PA-12	-	Polyamide-12
RTCS	-	River Trash Collector System
SEM	-	Scanning Electron Microscope
SLM	-	Sintering Laser Melting
SLS	-	Sintering Laser Selective
SW	-	South West (SW)
SWM	-	southwest monsoon (SWM)
TEMs	-	transmission electron microscope
TDS	-	Total Dissolved Solids (TDS)
UNESCO	-	United Nations Educational, Scientific and Cultural Organization

WQM - Water Quality Monitoring (WQM)



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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Water is a vital, universal substance that is required by all living organisms. Philosophers, naturalists, and scientists have been attracted by its nature and qualities since antiquity. Water continues to intrigue scientists today since it is still poorly understood despite significant research over many years. According to (Sharp & Johnson, 2001) , because many of the physical and chemical features of water are anomolous Some of water's unique characteristics are essential for life, while others have a substantial impact on the size and shape of living organisms, how they function, and the physical restrictions or constraints they must operate under. (Sharp & Johnson, 2001).

Aside from that, water contamination as a result of the twenty-first century has created some quality and quantity issues that have an impact on humans and have become the greatest concern for today's society. The pollution of the water is not entirely due to climate change, but rather to irresponsible people who cause the water to become contaminated. Manufacturing and agro-based industries, home sewage, animal husbandry, mining activity, and surface runoff resulting from land clearance and earthwork activity are all examples of activities that pollute water (Hua, 2017a). A variety of things can contribute to water contamination. Factory discharges or inadequate water treatment plants, for example, might allow pollution to enter water immediately, either legally or illegally. (Christina Nunez, 2010). Water pollution can have an impact on people who rely on water in their daily lives. There were 579 rivers in 2008, according to statistics provided by the

Department of Environment (DoE) in 2017, but only 477 rivers exist currently.. By following to the (Lee Goi, 2020), Anthropogenic activities are the primary drivers of pollution in the 52 rivers, according to a 2009 report from the Department of Environment (DoE). Pollution has an especially negative impact on the river's ecosystem. Malaysia's enormous aquatic habitats provide everything from water to food to medicine to commercial aquatic resources to energy to transportation to social development.. It also aids in the reduction of flooding, erosion, and erosion of shorelines. (Lee Goi, 2020).

The strength loss and hygroscopic growth ageing of the FS3300PA is material testing that needs to be analysed for the water monitoring quality, according to this project. This project is linked to the River Trash Collector System (RTCS) and Hydro Quality System (HydroQS) projects, all of which have the same goal of reducing river pollution for future research and innovation. The primary purpose of this project, as previously stated, is to reduce water pollution in Sungai Melaka while also raising public awareness about the need of keeping a healthy environment. This research will be carried out in partnership with Perbadanan Pembangunan Sungai dan Pantai Melaka (PPSPM), and will cover a 9-kilometer length of the Sungai Melaka from Batu Hampar in Peringggit to Bandar Hilir's Sungai Melaka mouth.

This way to verify the manufacture of the specimen by using the Sintering Laser Selective (SLS) process, which is to soak it in water and expose it outside under the sun, since this project will collaborate with the other project. The specimen will be subjected to a tensile test in the laboratory, which will lead to the determination of the best position and amount of power provided to the specimen printed in order to manufacture the HydroQS project component. The firmness of the specimen during the tensile test will be considered in this project.

The Polyamide-12 (PA-12) material was chosen for this project because of its exceptional material qualities, including as hardness, tensile strength, and abrasion resistance. Furthermore, the PA-12 has a low water absorption and density, allowing the RTCS and HydroQS to work better in the water, as well as being chemically resistant and stress crack resistant. The performance of the Selective Laser Sintering machine that provided the power to print the specimen will be studied, as will the mechanical properties of the PA-12..

At the end of the project, the specimen will be subjected to undergo the tensile test, as well as measurement after the specimen has been printed using the SLS machine. The optimal position and surface roughness will be evaluated using spider web analysis to determine the best printed qualities of the product that will meet the RTCS and HydroQS development requirements..

## **1.2 Problem Statement**

The contamination of the Sungai Melaka's water will cause the water quality to deteriorate, and the habitat beneath the river would perish. Water contamination happens when dangerous compounds from farmland, municipalities, and industry dissolve and interact with it, polluting the water. According to the (Hua, 2017b), The designation by UNESCO as a World Heritage Site in 2008 was crucial for the economic and population growth of Malacca State. Indirectly, the Malacca River may not have been vulnerable to difficulties of river water contamination in the past. Despite this, the Malacca River has been 'disrupted' as a result of expanding population, uncontrolled rapid growth, and extensive land use. Due to the growing population of tourists, the tourism sector will become the dominant industry in Sungai Melaka, resulting in water pollution from river cruise operations or activities along the river. Because the Melaka River Cruise is a famous tourist attraction,

Melaka officials must keep an eye on the water quality in Sungai Melaka. Unfortunately, the smell of Sungai Melaka has become increasingly disagreeable, and the water quality has deteriorated.

This problem of water pollution should be addressed by presenting a new idea to assist the PPSPM in reducing water pollution along the Sungai Melaka and maintaining the Sungai Melaka's purity. The pH level, water level, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), turbidity, Sungai Melaka current flow speed, water temperature, surface wind flow speed, temperature, and humidity of the surrounding environment are all monitored by this device. This production will be taken seriously because the Polyamide-12 (PA-12) material test is a good technique to provide the best product for moving in the water. The mechanical qualities of PA-12 as a material and the SLS machine as a printing machine are further reasons for continuing manufacturing.

When the sorts of nylon are compared to another material, the development of the specimen utilising nylon material becomes a challenge. The mechanical qualities of the material used in the main quality monitoring equipment can be a reason to improve its development. The most basic and best factors for producing a good gadget are related to the material chosen for the device. Because the gadget will operate owing to the presence of water, the types of water used in this experiment will be put to the test. The field testing of the nylon material soaking into the rainwater to investigate the influence of nylon on the rainwater effect.

If all difficulties that arise during the conversation with the production team and PPSPM, who conduct and monitor the Sungai Melaka, are resolved, the final printed version of the production project will be run. Before going through dimensional checking,

mechanical testing, surface roughness measurement, and field testing, the intended product will be finalised by the Farsoon SS402P SLS machine for prototyping. Apart from referring to the position, power supply, and other requirements for the big project, the results of all the testing and dimensional checking will help to generate the best design.

### 1.3 Research Objective

The primary aim of this research is to reduce water pollution by studying on how to produce the high strength and the best production Nylon FS3300PA material for the HydroQS housing by using the laser sintering method. Specifically, the objectives are as follows:

- a) To define the best position of the Nylon FS3300PA specimen in the Sintering Laser Selective machine that affect the tensile strength.
- b) To analyse the effect of the different condition of the testing for the Nylon FS3300PA when soaking into the rainwater.
- c) To identify the significant different in weight and dimension of the Nylon FS3300PA when it soaking within 1000 hours.

### 1.4 Scope of Research

The following are the scope of this research:

- Literature study of material properties, mechanical properties of hygroscopic aging of FS3300PA nylon powder by using the SLS 3D printer, water pollution and effect of the FS3300PA when soaking into the rainwater.
- Field testing for test samples to be soaking the nylon into the rainwater for further tensile test in for identifying the strength of FS3300PA nylon material