"Influence of 3D printing parameters on operational characteristics of selected ship's machinery part"

This dissertation aimed to calculate the effect of printing parameters on the performance of a ship's pump. The paper covers two basic theses. The first strives to determine if a 3D-printed composite replacement could provide the performance and durability properties capable of replacing a damaged pump component in the event of a failure at sea. The second thesis investigates the effect of changing certain printing parameters and modifying the GCOD software on the properties of the selected filaments.

The dissertation employed a variety of research methods, including systematic literature review, experimental method, observation, testing, statistical and computer simulation.

Through a systematic literature review, the paper analysed current scientific articles on modern materials, technologies, and scientific research related to 3D printing. This enabled the correct formulation of the research questions and interpretation of the results obtained.

In the case of the experimental method, the printing parameters were modified with the GCOD software to obtain a printed part of the best possible quality, i.e. with a dimensional reproduction and geometric surface structure close to the reference unit, namely a tin bronze impeller.

The scope of the observational method studies included fracture test analyses of test samples using a scanning microscope and tests related to moisture absorption in a climate chamber.

Using the testing method enabled a thorough understanding of the strength and performance properties of the materials applied. Several tests were conducted using modern machinery and equipment, e.g. tensile, bending, absorption and pump test benches.

The computer simulation method was used several times in the dissertation. A reverse engineering process was carried out to reconstruct the damaged pump impeller. The model was scanned with a 3D scanner and the geometry was recreated in CAD software for final printing. An important issue was the analysis of the deviations in impeller dimensions and shapes compared to the mapped geometry of the reference unit. A finite element method was also implemented to simulate the tensile process and verify the data.

Statistical analysis was performed on the measurement data concerning the filament density parameter. Histograms were developed and Gaussian distributions produced for the samples.

The paper comprises an introduction, a conclusion and six chapters. Chapter One provides an overview of the incremental techniques used in 3D printing. The choice of additive technology was also made on the basis of a multi-criteria analysis and filaments for testing, using SWOT analysis. Chapter Two formulates the research problem. Chapter Three covers experimental studies on the properties of selected filaments and presents the research programme, the measurement procedure and the analysis of the experimental results. Carbon-fibre reinforced polyethylene terephthalate glycol (PETG CF) was the choice of filament for printing the mechanical part. Chapter Four discusses the identification of the research object's functional characteristics, and Chapter Five maps the geometry, presents the impeller printing process and verifies the accuracy of the mapping. Chapter Six discusses the experimental tests conducted on a rotodynamic pump test bench. When the following parameters were applied during printing – i.e. the height of the filament layer of 0.12 mm, 100% filling of the sample and four outer outlines – the characteristics obtained during operation correspond to those of the reference tin bronze impeller, ensuring continuous operation of the ship’s pump for 48 hours.