Irish Standard Recommendation
S.R. CWA 17453:2019

Bionic Aircraft - Optimized ALM support structures made from Al alloys

S.R. CWA 17453:2019

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CEN WORKSHOP AGREEMENT

CWA 17453

September 2019

ICS

English version

Bionic Aircraft - Optimized ALM support structures made from Al alloys

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European foreword

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The final text of CWA 17453 was submitted to CEN for publication on 2019-07-19. It was developed and approved by:

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Comments or suggestions from the users of the CEN-CENELEC Workshop Agreement are welcome and should be addresses to the CEN-CENELEC Management Centre.

Introduction

The goal of the present investigation was to optimize support structures in Laser beam melting of metals and provide yet missing design guidelines for support generation. The latter then set the framework for automated support generation within pre-processing tools for additive manufacturing (AM), which is crucial to speed up the data preparation and pave the way for industrialization of the AM technology for metal parts. Adequate application of supports increases the productivity by preventing build job failures and is one key factor to ensure a reproducible part quality. The research approach aims at an optimization by adequate selection of various support types rather than a parameter optimization of those. Herefore five different support types in total have been chosen and characterized with regard to various target figures: Material consumption, removability and tensile strength of the supports themselves, as well as surface influence on and dimensional accuracy of the supported part. Additionally, novel biomimetic support structures have been developed and tested for material consumption and removability.

Results reveal that proper selection of supports can greatly reduce post processing effort regarding removability of supports and overall material consumption, while the post processing effort for surface finishing is not positively affected. The novel biomimetic support structures show promising results considering material consumption and removability and will therefore be further investigated.

This document represents part of the work as performed in Task ‘Integration of ALM pre-processor in commercial 3D-CAD software’ of WP3’Bionic Design & Optimization’. In the scope of the respective WP3 the design process of parts for additive manufacturing, and more specifically laser beam melting, should be simplified and shortened by developing a software toolkit. This tool comprises all necessary functionalities to achieve a final part design that is Additive Manufacturing (AM-) suitable and allows the needed data preparation in order to obtain an output file that can directly be processed by the AM machine.

This document displays the currently available support structures in laser beam melting (LBM) for metal parts. The need for optimized support structures will be shown with regard to the criteria and requirements that apply. Furthermore, the chosen approaches for achieving optimized support structures are laid out.

1 Scope

This document provides a mutual international understanding of optimized support structures in the laser beam melting of Al alloys. It provides the missing design guidelines for the choice of adequate support types for different use cases. Therefore, five different support types in total have been chosen and characterized regarding various target figures: Material consumption, removability and tensile strength of the supports themselves, as well as surface influence on and dimensional accuracy of the supported part. Additionally, novel biomimetic support types have been developed and tested for material consumption and removability, showing great potential for further optimization.

Adequate application of supports increases the productivity by preventing build job failures and is one key factor to ensure a reproducible part quality. The novel biomimetic support structures show promising results considering material consumption and removability.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 General approach

4.1 General

The respective research method and results are described and summarized in a proposal for optimized support structures.

4.2 Needs and functions of support structures in metal LBM

Support structures are separate structures that are only needed throughout the build job process itself to ensure a stable buildup. They do not belong to the actual part and therefore need to be removed once the part has been manufactured. In metal laser beam melting (LBM) the use of so called support structures becomes necessary for several reasons: On the one hand, they need to compensate mechanical loads and fixate the part on the platform. On the other hand they need to dissipate process heat in order to prevent deformations (refer to TÖPPEL ET AL. 2016). Next to these major functions of support structures there are other requirements posed from a manufacturing point of view: Production time, the amount of material necessary for supports (including possibly enclosed powder) and how to build and remove the support structures (PIILI & SALMINEN 2014).

4.3 Currently used support structures and their downsides

When it comes to data preparation in additive manufacturing there are a few software providers that dominate the market: Materialise, Autodesk, Dassault Systemes and Siemens. Out of these Materialise's software package *Magics* offers the most elaborate choice of support types and adaption of these, which is the reason why the present study has been done based on supports available in *Materialise Magics*.