DMDR 3.0 – UPDATED AND EXTENDED DMRC DESIGN RULE CATALOGUE

Design rules for additive manufacturing (AM) processes are important for the acceptance of these technologies and are required by the industry. Furthermore, design rules are necessary to provide and teach the design freedoms of AM to users of these technologies as well as to students. The project "Updated and Extended DMRC Design Rule Catalogue – DMDR 3.0" is aimed to extend the exisiting DMRC Design rule catalogue by six machine-material-parameter-combinations of the participating industry partners.

PROJECT OVERVIEW

DURATION

01/2019 – 12/2019

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FUNDED BY

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Objectives

The aim of the projects "Direct Manufacturing Design Rules" (DMDR 1.0 and 2.0) is to develop design rules for additive manufacturing processes and to make them accessible to a broad spectrum of users ranging from the scientific community and the industry to students.

To reach this goal, standard elements were defined in the DMDR 1.0 project in 2008. These are geometrical elements which are frequently used in the design of technical products. Based on these elements, a process-independent method for the development of design rules was set up. Using this method, design rules were developed for laser sintering, laser melting and fused deposition modeling processes. Different machines, materials and process parameters were used at the DMRC for this purpose. Because of their dependance on these parameters, the developed design rules are only applicable to the described boundary conditions of cases which were considered in the DMDR 1.0 and 2.0 projects.
The scope of the developed design rules can be extended by considering changed boundary conditions. This is the objective of the research project "Direct Manufacturing Design Rules 3.0".

Using the method provided by the DMDR 1.0 project, the range of validity is extended by new combinations of material, manufacturing machines and parameters. Thus, the DMRC Design Rule Catalogue is enhanced by six further pillars of the project DMDR 3.0 (Figure 1).To extend the range of validity, the following work packages are defined:

Work package 1: Extension of the range of validity for six new machine-material-parameter-combinations

The DMRC selects the most relevant design rules from the method of DMDR 1.0. The industrial partners select on free choice six preferred combinations, which they frequently use in their companies or intend to use in the future.
After the definition of all boundary conditions the process specific CAD-Files and a description of the manufacturing of the test specimens are sent to the participating industry partners, in order to guarantee the same methodical procedure for manufacturing. Thus the selected test specimen are ranked into uncritical and critical. Taking this differentiation into account, two build jobs are created and the related test specimens are placed on the building platforms. This allows failure-free manufacturing of the non-critical test specimens and simultaneous monitoring of all critical test specimens.

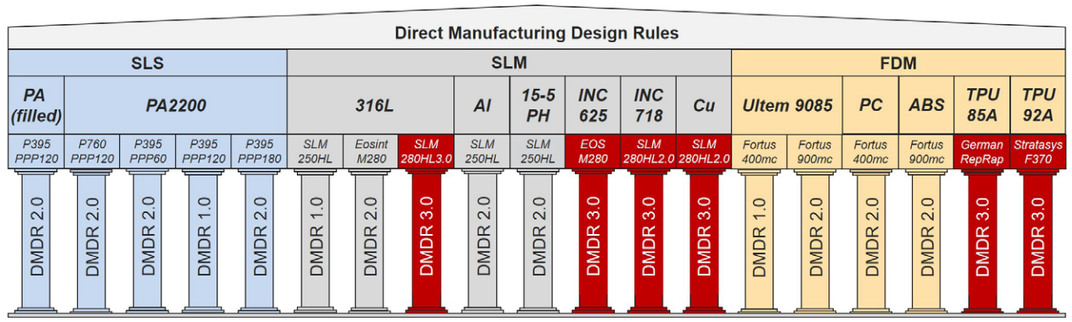

FIGURE 1 Schematic display of the range of validity for the design rules developed in projects DMDR 1.0 and DMDR 2.0, enhanced by the design rules of project DMDR 3.0

In order to enable a statistical evaluation and to increase the significance of the results, the test specimens are build in triplicate and shipped to the DMRC. The DMRC determines the respective measured variables of the test specimens according to the methodical procedure and subsequently evaluates them.

Work package 2: Adaption of the design rule catalogue

As part of the second work package, the DMRC design design rule catalogue developed in DMDR 1.0 and 2.0 is adapted to the results of the DMDR 3.0 project. The results of work package 1 are integrated into the respective design rules with a note on the respective combination. This process is accompanied by the analysis whether the respective design rule is relevant for the examined boundary conditions. If necessary, the previous design rule catalogue is also extended by further design rules for required combinations.

The result of the project DMDR 3.0 is a design rule catalogue with an extended range of validity (Figure 1). With the design rules and the specific limit values it is possible to realize a robust component design for a multitude of combinations. The catalogue forms a current basis for the handling and training of additive manufacturing.

In addition, components can be optimized for additive manufacturing using the updated and extended design rule catalogue. Furthermore, this offers the possibility to reduce time and therefore costs by the conscious approach during the component design.

Machine-material-parameter-combinations

The six machine-material-parameter-combinations of the participating industry partners in DMDR 3.0 are listed below. Both metallic materials and plastics are investigated.

Laser Beam Melting

- 316L / SLM 280 HL 3.0 / 60 µm
- Copper / EOS M290 / 50 µm
- Inconel 625 / EOS M280 / 50 µm
- Inconel 718 / SLM 280 HL 2.0 / 60 µm

Fused Deposition Modeling

- TPU 92A / Stratasys F370 / 250 µm
- Ultrafuse TPU 85A / German RepRap / 200 µm