

STRENGTH OPTIMISATION OF CHAINS AND D-RINGS USING ADDITIVE MANUFACTURING

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GENERAL DESCRIPTION

The Regional Technological Institute in Pilsen investigates the optimisation of chains and D-rings by using additive manufacturing (AM). A traditional chain and D-ring are shaped into loops and closed by a welding operation. The welding operation leaves a welding seam behind that reduces the strength of both products. This defect leads to an early failure in the area of the weld. In the agricultural and transport industry, this can lead to dangerous situations due to the presence of higher loads. At last a price estimation is made to see if the enhanced strength justifies the higher production costs.

ORIGINAL D-RING/CHAIN

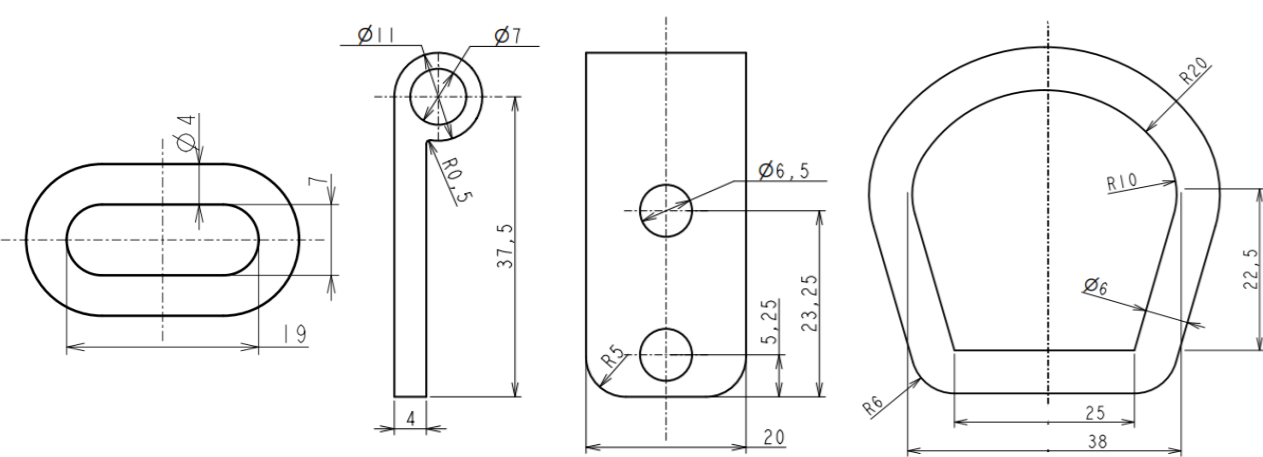


DMLS D-RING/CHAIN



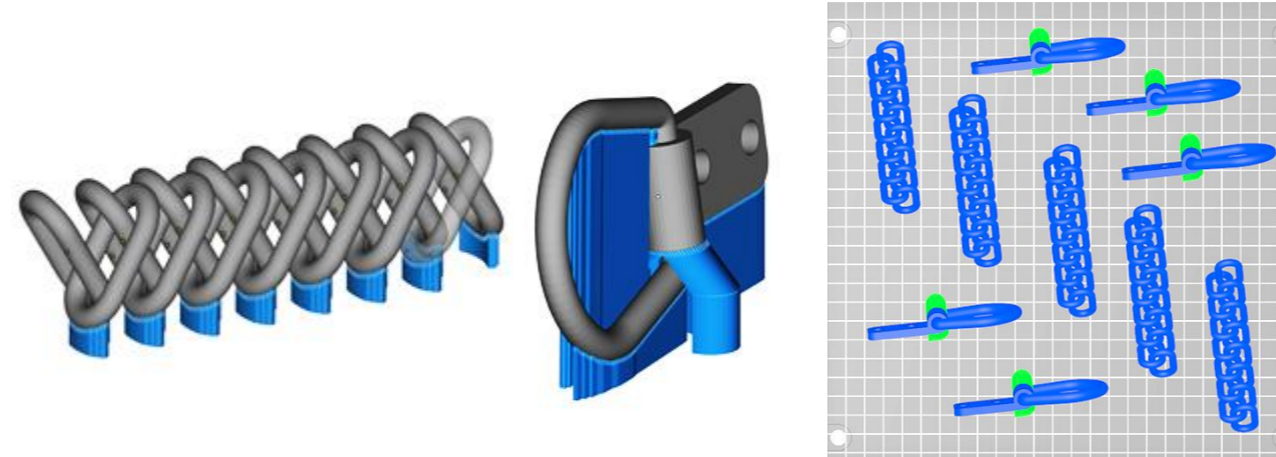
1. MODELLING

The AM parts must have the same dimensions as their traditional variant to be able to make a true comparison. These models were created in *Creo Parametric* and exported as STL-files. The print-preparation is done with *Materialise Magics* and *EOS Print*.



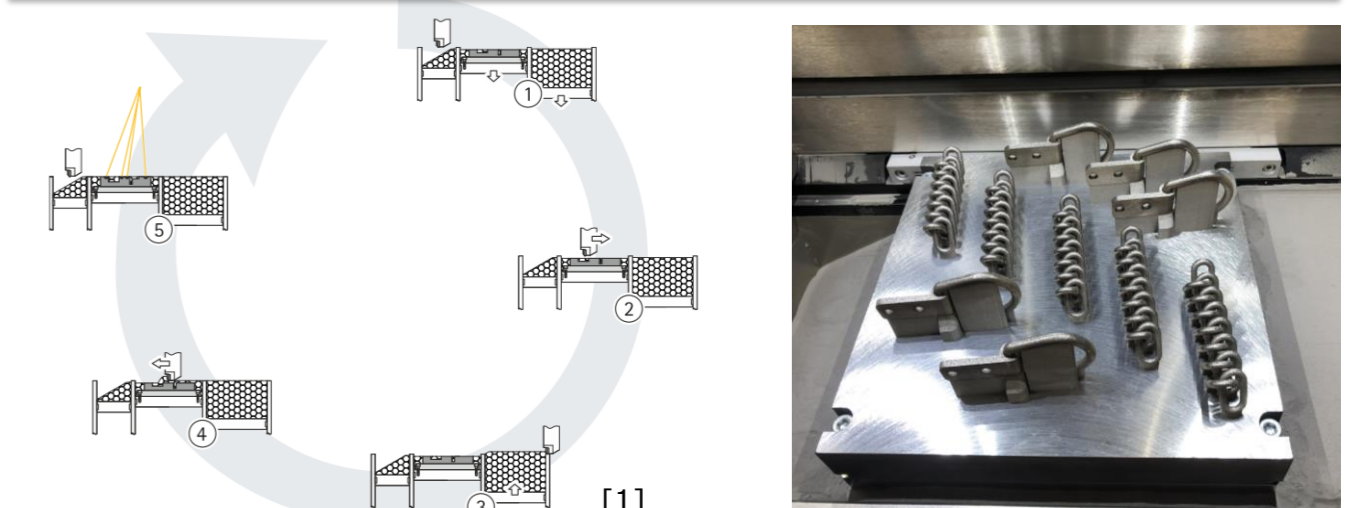
2. OPTIMISATION

The composition, orientation and support structures of the parts have an influence on the printing process. The model preparation is optimised to improve material properties, prevent collisions and prevent other defects during production.



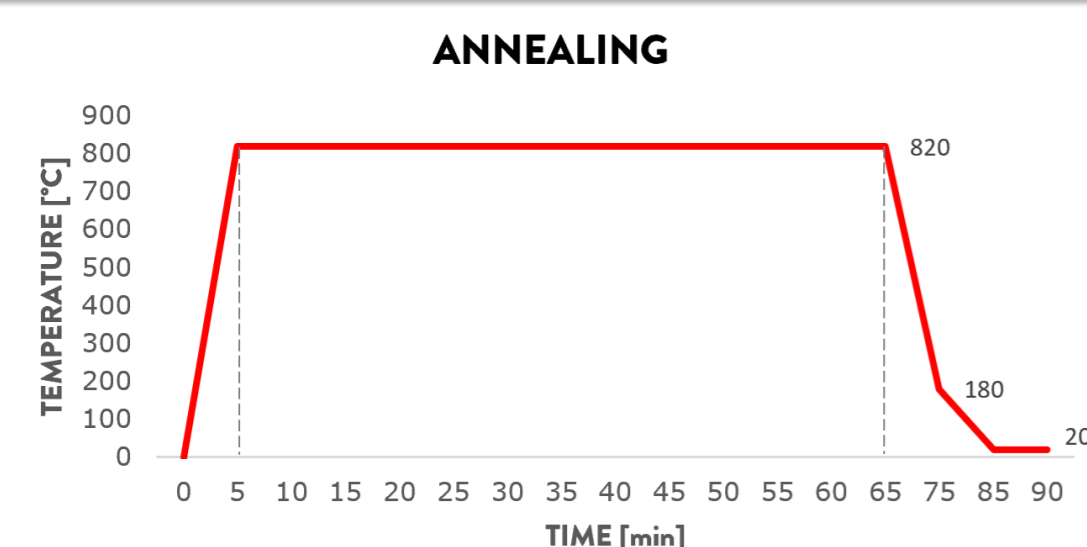
3. DMLS PRINTING

The powder layers of maraging steel are sintered one by one till the whole product is formed. A 400W laser is used for sintering the powder. It melts the powder particles of the current layer to each other and the previous layer. Because of the layers, the final product is not isotropic.



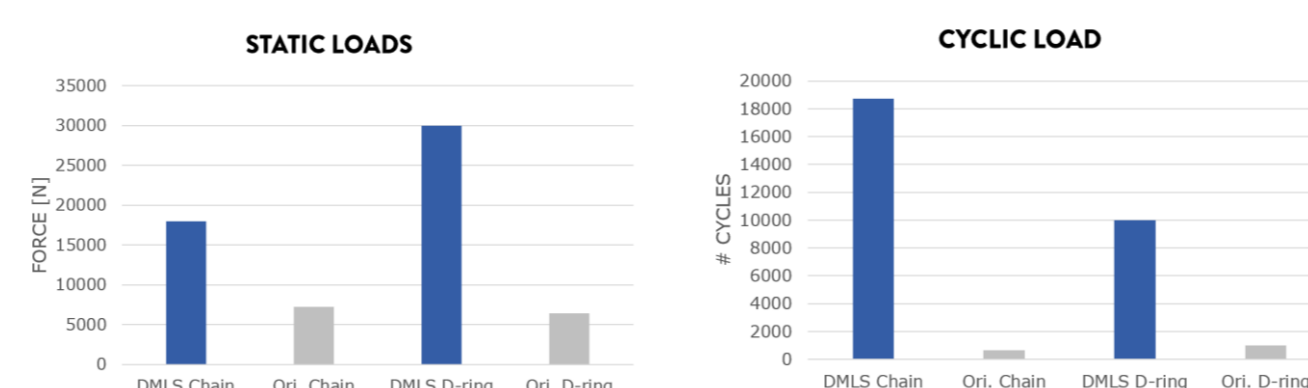
4. POST PROCESSING

An annealing process strengthens, toughens and reduces the anisotropic properties of the AM parts. The parts are exposed to a temperature of 820°C for 1 hour. Afterwards the support structures can be removed. Finally, the AM parts are sandblasted to obtain the desired surface finish.



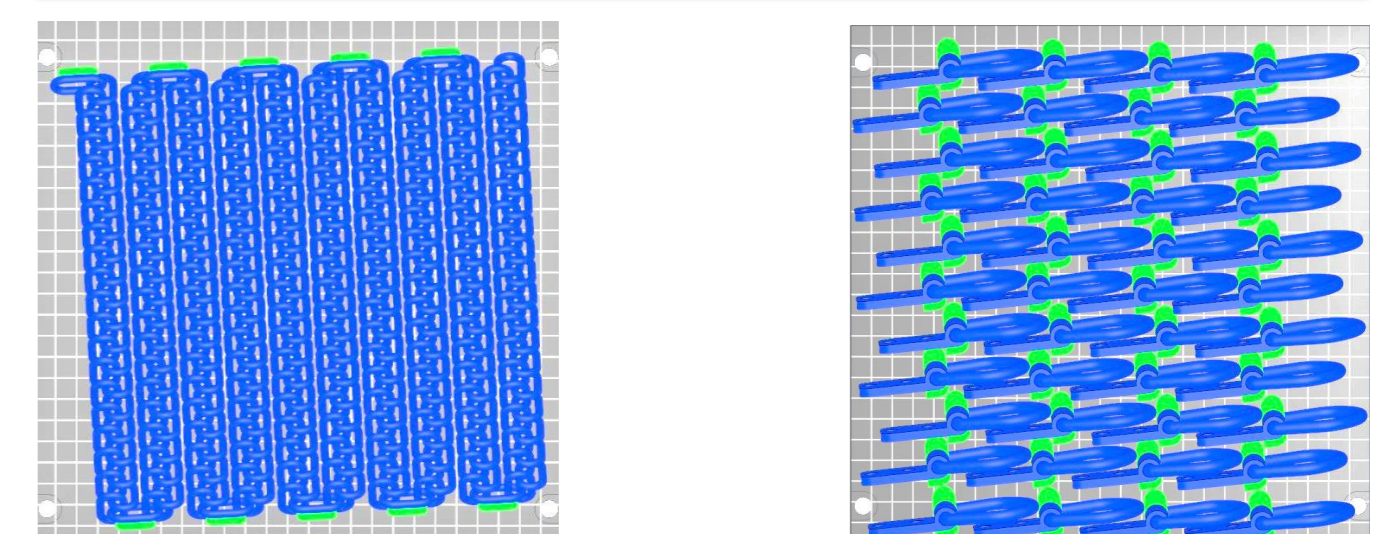
5. STRENGTH TESTS

The AM parts are compared to their traditional variant by exposing them to static and cyclic loads using a UTM. The static load of the D-ring is 5 times greater than its original competitor and the chain is 2,5 times as strong. The printed chain lasted 29 times longer and D-ring 47 times longer in the fatigue tests.



6. PRICE ESTIMATION

The unit price can be decreased by increasing the number of objects per print. 44 D-rings are produced in one print with a resulting price of 831 CZK/unit. It is possible to create a 7,41 m long chain in one print. This results in a price of 3692 CZK/m.



Supervisors / Co-supervisors / Advisors

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[1] EOS GmbH – Electro Optical Systems,
EOS M 290 Basic training, 05.14 ed., 2014