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EFFECT OF THE POSITION IN THE BUILD CHAMBER ON THE FATIGUE STRENGTH OF DMLS PRODUCED MARAGING STEEL

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ABSTRACT

Previous studies investigated the effects of build orientation, allowance for machining, heat and surface treatments on the fatigue response of DMLS produced Maraging steel. This work focuses on the potential effect of the position of the built part in the chamber on the generation of powder residuals and consequently on the fatigue strength. The retrieved S-N curves indicate the response keeps unaffected by this factor.

Keywords: additive manufacturing, maraging steel MS1, position in the chamber, fatigue, statistical assessment.

INTRODUCTION

Additive Manufacturing (AM) makes it possible to produce even highly complicated parts in a short time and as a monolithic component. Maraging steel MS1 is one of the most promising materials for use in AM (Brookes *et al.*, 2016) and has good static and fatigue properties (Croccolo *et al.*, 2016; Croccolo *et al.*, 2019; Croccolo *et al.*, 2018), good corrosion resistance and machinability (Kempen *et al.*, 2011). Previous research (Croccolo *et al.*, 2016; Croccolo *et al.*, 2019) investigated the effects of build orientation and allowance for machining on the fatigue strength of DMLS produced samples by EOS M280 machine. The retrieved results indicate that these factors do not have a significant effect, when considering, micro-shot-peened, heat-treated and machined parts. The study (Croccolo *et al.*, 2018) focused on the response of the same material in the "as fabricated" state and on the effects of heat and surface treatments, highlighting the benefits arising from shot-peening run after machining. This study is a follow-up of that put forward in (Croccolo *et al.*, 2018) and deals with the effect of part position in the build chamber on the fatigue response. Previous investigations indicated that powder residuals may detrimentally affect the achievable mechanical response. The presence of residuals may be, in turn, related to the actual position of the built part in the chamber with respect to the inert gas flowing from the back to the front sides. Issues of novelty arise from the lack of studies in the literature dealing with this topic.

EXPERIMENTAL PROCEDURE, RESULTS AND CONCLUSIONS

The present study dealt with DMLS produced Maraging steel MS1 (AISI 18Ni300). The experimental plan investigated in (Croccolo *et al.*, 2018) was extended to the vertically built heat-treated (age-hardening at 490°C for 6 hours) and 0.5 mm allowance machined samples with shot-peening (400 μm shots, 5 bar pressure) run after machining. This treatment combination was split into three different cases (Table 1), accounting for different positions in the build chamber with respect to the gas flow: upstream (backward), midstream and downstream (forward) positions. Twelve samples were considered for each case and fatigue tests were run for determining the three S-N curves in the finite life domain based on ISO 12107 Standard. These curves were then compared by an ANOVA-based statistical method for the comparison of S-N curves (Croccolo *et al.*, 2016; Croccolo *et al.*, 2019; Croccolo *et al.*, 2018). The retrieved curves are plotted together in Figure 1, along with dots indicating the experimental data. The statistical test indicates the differences among the curves are not significant. A unique fatigue limit could then be worked out.

Table 1 - Experimental design (involving MS1 heat-treated machined peened samples)

Position in the chamber		
Upstream	Midstream	Downstream
Set HMP-U	Set HMP-M	Set HMP-D

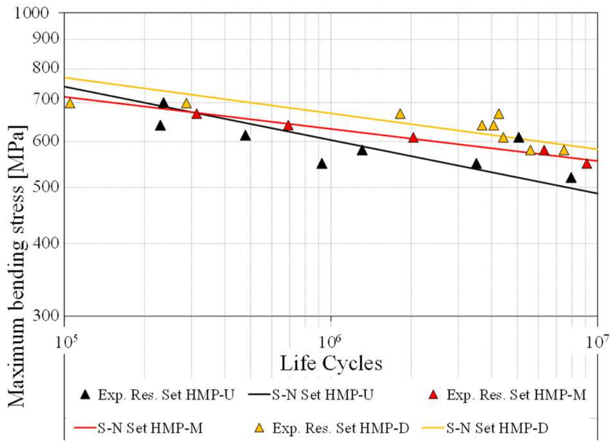

Fig. 1 - Fatigue curves in the finite life domain for the three sample sets

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