# Numerical tool for fatigue dimensioning of a metal additive manufacturing processed structure

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**ABSTRACT**

Metal Additive Manufacturing (AM) allows many design features (hollow bodies, topological optimization) that can hardly be achieved with classic processes such as casting or machining. AM parts are obtained in a near net shape state, reducing the number of steps to completion. Among the available AM processes, the Wire+Arc Additive Manufacturing (WAAM) is the best suited to very large metallic structures.

The WAAM process builds up the part in a layer by layer fashion, each layer being constituted of juxtaposed weld beads. The resulting product has a complex thermal history, a very marked microstructure and a rough surface that can require machining. This implies strong residual stresses, heterogeneities in elastic deformation, and stress concentrations at the rough surface, which is critical for fatigue.

The aim of this study is to develop a numerical tool for high cycle fatigue dimensioning of WAAM processed structures. The first step is to proceed to material characterization in fatigue through experimental testing (failure mechanism, fatigue limit, …). The self-heating method is used, allowing fast determination of the fatigue properties [1]. Both rough and machined surface states are considered to take into account the heterogeneous nature of the material.

The second step is the identification of a probabilist [2] fatigue criterion parameters based the self-heating tests data and the integration of the criterion in a post-processing tool. This criterion takes into account the surface state, according to the tests results, as well as scale effects, justifying its application on a full scale structure. The resulting numerical tool allows the lifetime determination of the structure and a local failure probability map, highlighting critical zones in fatigue given a geometry, a stress field and a surface condition.

**REFERENCES**

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