FATIGUE CRACK GROWTH BEHAVIOUR OF SELECTIVE LASER-MELTED 18NI300 MANUFACTURED AT 0º, 45º AND 90º TO PERPENDICULAR CRACK GROWTH PLANE.

PABLO M. CEREZO[1, 2], JOSE A. AGUILERA[1], ANTONIO GARCIA-GONZALEZ[1], STEVEN MOORE[2], GREG WHEATLEY[2], PABLO LOPEZ-CRESPO[1]

[1] *Department of Civil and Materials Engineering, University of Malaga, C/Dr Ortiz Ramos, s/n, 29071 Malaga, Spain*

[2] *College of Science and Engineering, James Cook University, Douglas, Queensland, 4811, Australia*

[3] *Contact: pm@uma.es*

Keywords: Additive Manufacturing (AM), fatigue, fracture mechanism, maraging steel, Selective Laser Melting (SLM).

Abstract: Selective laser melting (SLM) is a promising method for the additive manufacturing (AM) of high-value objects. Maraging steel's fatigue mechanisms can be better understood by studying its performance when produced at different angles, making it a popular material for AM. Our study analysed the impact of mechanical properties in additive manufacturing by examining existing research on fracture mechanics. Laser-fabricated CT samples were produced at three angles (0°, 45°, and 90°) about the intended crack plane.

Tests show that specimens at a 90-degree angle last longer than those at 0 degrees, with a 20% improvement. However, samples at a 45-degree angle have a 40% reduction compared to 90-degree samples due to differences in texture, leading to quicker cracking. Further research is required

to obtain the da/dN curves and investigate the reasons for the difference in surface area. Additionally, the impact of angle on the fatigue life of additively manufactured materials requires further investigation.

REFERENCES

[1] N. Sanaei and A. Fatemi, "Defects in additive manufactured metals and their effect on fatigue performance: a state-of-the-art review" *Prog Mater Sci*, 2021.
[2] T. Wohlers and T. Gornet, "History of additive manufacturing" *Wohlers report*, 2014.
[3] S. Liu and Y. C. Shin, "Additive manufacturing of TI6Al4V alloy: a review" *Mater Des*, 2019.
[4] P. Li, D. H. Warner, A. Fatemi, and N. Phan, "Critical assessment of the fatigue performance of additively manufactured Ti-6Al-4V and perspective for future research" *Int J Fatigue*, 2016.
[5] A. S. Cruces, R. Branco, L. P. Borrego, and P. Lopez-Crespo, "Energy-based critical plane fatigue methods applied to additively manufactured 18Ni300 steel" *Int J Fatigue*, 2023.
[6] R. Caivano, A. Tridello, G. Chiandussi, G. Qian, D. Paolino, and F. Berto, "Very high cycle fatigue (VHCF) response of additively manufactured materials: A review" *Fatigue Fract Eng Mater Struct*, 2021.
[7] Z. H. Jiao, L. M. Lei, H. C. Yu, F. Xu, R. D. Xu, and X. R. Wu, "Experimental evaluation on elevated temperature fatigue and tensile properties of one selective laser melted nickel based superalloy" *Int J Fatigue*, 2019.
[8] J. Fikes, "Rapid Analysis & Manufacturing Propulsion Technology" 2019.
[9] A. S. Cruces, A. Exposito, R. Branco, L. P. Borrego, F. V. Antunes, and P. Lopez-Crespo, "Study of the notch fatigue behaviour under biaxial conditions of maraging steel produced by selective laser melting" *Theoretical and Applied Fracture Mechanics*, 2022.
[10] A. F. Chadwick and P. W. Voorhees, "The development of grain structure during additive manufacturing" *Acta Mater*, 2021.
[11] ASTM International Committee E08 on Fatigue and Fracture. Subcommittee E08. 07 on Fracture Mechanics, "Standard Test Method for Linear-elastic Plane-strain Fracture Toughness K [Ic] of Metallic Materials" *ASTM international*, 2013.
[12] Z. Xu, A. Liu, and X. Wang, "Fatigue performance and crack propagation behavior of selective laser melted AlSi10Mg in 0, 15, 45 and 90 building directions" *Materials Science and Engineering*, 2021.
[13] D. D. Ben *et al.*, "Heterogeneous microstructure and voids dependence of tensile deformation in a selective laser melted AlSi10Mg alloy" *Materials Science and Engineering*, 2020.