
Ballistic impact experiments and numerical modelling of additively manufactured and wrought maraging steel

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Abstract

Additive manufacturing (AM) offers unprecedented opportunities for creating optimised materials and structures tailored for extreme conditions, including high strain rate applications. Maraging steel is a low carbon, high-strength steel, well suited to AM fabrication by laser powder-bed fusion (LPBF). The material takes on ultra high-strength post heat-treatment, making it particularly effective for protective applications. While previous studies have demonstrated promising ballistic performance of AM maraging steel, the tendency for fragmentation following heat treatment raises questions about the influence of AM processing on its ductility.

This work investigates the behaviour of AM maraging steel under high strain rate loading, comparing its performance to that of traditionally wrought counterparts. Both as-printed and heat-treated AM materials were subjected to detailed experimental characterisation, including dynamic tensile testing and ballistic range trials. Despite notable differences in ductility observed in tensile tests, the ballistic limit velocities of AM and wrought maraging steel were found to be comparable across both processing states. Additionally, AM targets often caused greater damage to the projectiles compared to wrought targets, highlighting distinct local responses.

Numerical models were developed in the IMPETUS Solver to simulate the ballistic response of the non-heat-treated material. Using standard material models with some adjustments for AM-specific characteristics, the simulations produced conservative predictions, with ballistic limit velocities agreeing within 10% of experimental results.

This study demonstrates the potential of AM maraging steel for applications requiring high strain rate performance, showcasing its capacity to achieve properties comparable to traditional materials. By additionally leveraging the geometric freedom and customisation enabled by AM technologies, the potential is great for further improvement.

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