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Evaluation of mechanical properties and corrosion resistance of low-pressure cold spray coated high-strength low-alloy steel components manufactured using the Directed Energy Deposition-Arc process

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The Directed Energy Deposition-Arc (DED-Arc) process using high-strength low-alloyed (HSLA) feedstock wire has proven efficacy in manufacturing large-scale connectors between semi-finished steel parts for civil engineering. Traditionally, the energy-intensive hot-dip galvanizing process is used to protect carbon steels against corrosive environments. This study explores the use of low-pressure cold spray (LPCS) as an alternative coating process.

Two sets of straight walled samples were fabricated: one without coating and one with Zinc coating produced from Zn+Al_2O_3 feedstock powder. Prior to mechanical characterization, the initial walls and all specimens were scanned using a 3D laser scanner to evaluate their geometries. To determine the influence of the manufacturing and coating process on the mechanical properties of the base material, uniaxial tensile tests of specimens with machined and with as-built surface were performed. High-cycle fatigue (HCF) tests were carried out on specimens with as-built surface with and without the LPCS protective zinc layer. The corrosion resistance of the LPCS was evaluated through a cyclic corrosion test, followed by HCF testing of the corroded specimens. A four-camera DIC system was employed to monitor the tensile and fatigue testing, enabling full-field measurements of displacements and crack propagation.