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Improving Corrosion Performance of Thermal Sprayed Coatings with a Zn-Mg-Al Alloy

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1 Abstract

Thermal sprayed zinc and aluminum alloy coatings provide corrosion protection to steel structures. A new thermal sprayed coating with 1-2% of each Al and Mg shows up to 3 times the corrosion resistance of the conventional Zn and ZnAl alloy coatings. Arc sprayed Zn-Mg-Al alloy wire and three reference materials, Zn, Zn-15%Al and Al-5%Mg, gave coatings 100 - 150 µm thick, using either compressed air or nitrogen as an atomizing gas. Formation of splats in the arc wire spray process is dependent on wire chemistry, temperature and size of the particle prior to impact on the substrate. Splat appearance can be correlations with deposition efficiency of the different materials. Corrosion testing was carried out using electrochemical polarization in artificial sea water and by long-term exposure for two years on Heligoland Island in the North Sea. Of the investigated Zn-based materials, ZnMgAl forms the most stable corrosion product layer which delays the anodic corrosion reaction. At the same time ZnMgAl provides sacrificial protection of damaged, uncoated areas of up to 5 mm. Although Al-based coatings, like AlMg5, provide cathodic protection to steel, they suffer from pitting corrosion which can lead - when undiscovered - to sudden catastrophic failure of the structure.

Keywords: wire arc spraying, zinc, thermal spraying, cathodic protection, corrosion

2 Introduction

Steel structures including bridges must be coated for protection against corrosion. Organic coatings provide a barrier against the environment. Metallic coatings with a lower potential than the steel can provide active cathodic corrosion protection together with a physical barrier. Such metals include Zn and Al alloys. Zn coating of structural steels is done by batch (hot-dip) galvanizing and thermal spraying (flame spraying, cold spraying, arc spraying). Batch galvanizing is limited to articles less than about 15m in length and can only be applied in the factory. Thermal spraying can be applied both in the factory and on the job site to steel articles of any size. The most productive thermal spray process is arc spraying. Therefore, the presented study focuses on development of arc sprayed Zn alloys.

In wire arc spraying an arc is ignited between the tips of two continuously fed wires. The melted material is then atomized by a gas (mostly compressed air, but other gases can be used) and propelled towards the roughened surface. The single droplets flatten upon hitting the substrate, solidify and interlock with the roughness asperities. The solidified droplets become the coating.

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