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Forging and Corrosion Resistance of the Delhi Iron Pillar

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Abstract

The effect of manufacturing methodology on the corrosion resistance the Delhi iron pillar has been addressed. The distribution of entrapped slag particles, surface stress state, surface finish and local surface compositions have been discussed. The presence of elongated slags in the microstructure and compressive stresses on the surface are beneficial for the adherence of the protective passive film. The benefits of enrichment of P that occurs on the surface due to the relatively high temperatures employed to soak and then forge-weld the phosphoric iron have been described. The significant contributions of the manufacturing technology, imparting favorable material structures and compositions in the surface regions, in enhancing the corrosion resistance of the Delhi iron pillar have been highlighted.

Introduction

The iron pillar (Figure 1) located in the courtyard of the Quwwat-ul-Islam mosque, adjacent to the Qutub Minar, in New Delhi is world famous for its exceptional resistance to atmospheric corrosion. Moreover, the pillar's exquisite artistic construction continues to marvel present-day visitors. Metallurgists, corrosion scientists and archaeologists have evinced great interest in the pillar, keen on unraveling the hidden mysteries of the pillar[1,2]. The pillar was built during the reign of Chandragupta II Vikramaditya (375-413 AD) of the Imperial Gupta dynasty and it was originally installed in front of a Vishnu temple in Udayagiri in Central India[3]. It was moved to its current location in Delhi sometime in the 13th Century AD by Iltutmish[4].

The intimate relationship between processing methodology and the ensuing material properties is well known in materials engineering. Additionally, the structure and performance of the engineering product is also related to these two factors. It is, therefore, important to explore the effect of the forging methodology employed to construct the Delhi iron pillar on its excellent atmospheric corrosion resistance. The present communication will address and discuss the effect of forging methodology on the corrosion resistance of the Delhi iron pillar.

Corrosion Resistance

The pillar obtains its excellent corrosion resistance due to the formation of a protective passive film on the surface. The constituents of the protective passive film have been identified by modern state-of-art characterization methods[5]. The protective passive film consists of crystalline iron hydrogen phosphate hydrate