New insights on the corrosion of the Delhi iron pillar based on historical and dimensional analysis

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The history of the Delhi iron pillar has been critically reviewed to show that the pillar has been exposed to the environment of Delhi for only the last 800 years. Dimensional and historical analyses of the pillar indicate that it was originally raised up to the start of the smooth surface section. The change in the burial level of the pillar over the centuries has been explained. Reasons for the severe rust line occurring at a distance of 1.5 m from the bottom of the pillar have been addressed.

The iron pillar currently situated in the Qutbul-Ud-din mosque (Figure 1) near the Qutb Minar in New Delhi has attracted the attention of metallurgists and archaeologists for its excellent resistance to corrosion. The theories which have been proposed to explain its superior corrosion resistance can broadly be classified into two categories: the environmental and material theories. According to the proponents of the environmental theory, the mild climate of Delhi is responsible for the corrosion resistance of the Delhi iron pillar as it is known that the relative humidity at Delhi does not exceed 70% for significant periods of time in the year, which therefore results in very mild corrosion of the pillar. On the other hand, several investigators have stressed the importance of the material of construction as the primary cause for its corrosion resistance. The ideas proposed in this regard are the relatively pure composition of the iron itself, presence of phosphorus and absence of S and P in the iron itself, slag enveloped metal grain structure, and passivity enhancement in the presence of slag particles. Other theories to explain the corrosion resistance are also to be found in the literature like the mann metal effect, initial exposure to an alkaline and non-sulphurous environment, and surface coatings provided to the pillar after manufacture (burning and slag coating) and during use (coating with clarified butter). That the material of construction may be the important factor in determining the corrosion resistance of ancient Indian iron is attested by the presence of intact massive iron objects found in areas where the relative humidity is high for significant periods in the year. For example, the iron pillar at Dhar in Madhya Pradesh, the iron beams in the Surya temple at Konark in eastern Orissa and the iron pillar at the Bhojeshwar Temple at Kurji situated in the Northern Hills (the Western Ghats).

The Delhi iron pillar is a classic example of the forge welding technique that was employed by ancient Indians to manufacture large iron objects. The area required for fabrication was received in the form of a hoop...