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# A Brief Review on Recent Development and Progression of Corten Steel

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**ABSTRACT:** Corten steel, a kind of weathering steel, is a low alloy steel that is widely recognized for its corrosion resistance. These steels are frequently employed in the building of bridges, towers, and other architectural purposes. Such high-strength, low-alloy steels create a thick coating of rust to prevent further corrosion due to the supplements of their alloying elements. To understand the corrosion process, it is necessary to first understand the interaction that occurs between the corrosive layer and the steel surfaces. The current paper presents a brief investigation of Corten steel corrosion conducted by different researchers. This review addresses issues such as corrosion rates and the development of rust layers under various exposed environments. Lastly, the impacts of surface modification, alloying, and long-term Corten steel behaviour have been highlighted.

**KEYWORDS:** Corten steel, Corrosion, Surface Modification, Weathering steel

## I. INTRODUCTION

Weathering steel (WS) is a popular building material used in construction of bridges, railways, outdoor sculptures, house hold, landscaping, building facades, fire pits, railcars, installations, roofing and other structural applications due to its low cost and good corrosion resistance. A carbon steel base alloy with 2% or less of copper, nickel, chromium, and silicon is known as "weathering steel" (J. Bridg et al.1). This additive prevents the steel from continually rusting in the air. The formation of a deep and adherent rust surface is willing to take responsibility for WS's great corrosion resistance. WS develops a protective oxide layer when the bridge is situated in an appropriate climate and the structural features are adequately planned. Because of the rust protection layer developed on the WS surface, it has a stronger corrosion resistance than carbon steel. This feature is intimately related to the presence of certain alloying elements. Although Cu, Cr, and Ni are the most widely explored alloying elements used to improve the corrosion behavior of WS, only a few studies have documented the favorable effect of Si on WS corrosion resistance (Houston et al.2).

In these circumstances, painting is not necessary for WS. The main benefit of using WS is the potential for life cycle cost savings because it eliminates the necessity of initially painting and re-painting the entire superstructure on a regular basis, as is necessary for regular steels that do not have enhanced atmospheric corrosion resistance (N. Ebrahimi et al.4). Corrosion characteristics such as chloride (Cl), sulphur dioxide (SO<sub>2</sub>), relative humidity (RH), temperature, and alloying element composition all play important roles in the development of rust products during exposure in various conditions. Atmospheric corrosion studies of WS in various environments such as marine, urban and industrial areas were reported (Zhang et al.5). Nickel was utilised in the synthesis of conventional WS to prevent hot embrittlement during the rolling phase caused by copper enrichment on the steel surface and to increase its resistance to ambient corrosion in coastal conditions. As specified, exposed weathering steels A242, A588, and A709 Grade W are not prone to severe corrosion whereas "ordinary steel" refers to painted ASTM A36, A572, and A514 steels are usually not resistant to atmospheric corrosion (D. Lai, et al.6).

Ironically, weathering steel does not guarantee a maintenance-free service life for the superstructure. Because, resealing expansion joints, painting the steel near leaking expansion joints, cleaning water drains at open joints, removing debris and dust that accumulate on horizontal surfaces, and periodic washing when the structure is excessively contaminated with deicing salts are all maintenance items that cannot be avoided (B. Baldock et al.7).

WS for bridges demands a greater understanding of the structural elements and microenvironments that originate and maintain corrosion at a given bridge site on the part of the engineer. A macro-environmental assessment and the simple replacement of WS for carbon steel in a set of standard design drawings are just insufficient. These aspects must be

acknowledged for their importance (J. ZhangX et al.8). Experience with regular steel bridges is extremely beneficial in understanding how a WS bridge will behave at the same Location. The spots on an ordinary steel bridge where a correctly applied paint system fails early are the same as the sites on a weathering steel bridge where local corrosion problems would emerge. Additionally, climatic conditions that shorten the life of a paint system can be as harsh on WS. Prolonged dampness and significant contamination by industrial contaminants or deicing salts both harm paint systems and WS (Ebrahimi et al.9).

The weathering carbon steels exposed to industrial and marine environments for 17 years and concluded that the distributions of  $\gamma$ -FeOOH phase in the inner rust layer was uniform and served as a barrier layer in the rust (Asami et al.9). The morphology of corrosion products formed on mild steel, which was exposed for 13 years in various environments such as marine, industrial, rural and urban. It was found that the skyward facing surface had smooth and uniform structure with low aggressiveness, whereas the earthward facing surface had irregular cracked structure (Fuente et al.10).

## II. EFFECT OF VARIOUS TYPES CORROSION CHARACTERISTICS ON WEATHERING STEEL

As mentioned in above section corrosion is a natural process that occurs when metals and other materials react with their environment, leading to the gradual degradation of the material. Usually, corrosion can cause significant damage to structures, equipment, and other objects, and can have serious safety implications if left unchecked. There are many different types of corrosion, each with their own causes and characteristics. Some of the most common types of corrosion include: (i) uniform corrosion; (ii) pitting corrosion, (iii) galvanic corrosion; (iv) crevice corrosion; (v) Stress corrosion cracking (A. Khan et al.,2017). There are many factors that can contribute to the development of corrosion, including exposure to moisture, salt, acids, and other corrosive substances. Temperature, humidity, and the presence of pollutants in the environment can also play a role in the development of corrosion. To prevent or minimize the effects of corrosion, a variety of methods can be used, including the use of protective coatings, the selection of corrosion-resistant materials, and the use of cathodic protection systems. Regular inspection and maintenance can also help to identify and address corrosion issues before they become more serious. Some of the major methods to prevent corrosion are discussed in the below sectionK. Mondal et al., (2013).

## III. SURFACE MODIFICATION TECHNIQUES FOR IMPROVEMENT OF CORROSION RESISTANCE ON WEATHERING STEEL

Surface modification techniques can be used to alter the surface properties of metals to improve their functionality, durability, and resistance to corrosion. Here are some common surface modification techniques for metals: powder coatings; ceramic coatings; chemical etching; electroplating; physical vapor deposition (PVD); laser surface treatment; shot peening; thermal spraying; varnishes; paints; surface coating; polymer coatings and so S.B. Wan(2017).

Among many modification techniques available, polymeric coatings is one of the most important methods for minimizing corrosion. These techniques are essentially of a pigment dispersed in a solution of a binding medium. The binding medium or polymer will decide the basic physical and chemical properties of the coating but these will be modified by the nature and proportion of pigments presentM.P.Khond et al.,(2009). The sole function of the volatile component is to control the viscosity of the paint for ease of manufacture and for subsequent application. It is not possible to forecast with any accuracy what combination of properties a particular formulation will have and the formulation of paints for a specific purpose remains very much a technological art. Alkyds, polyester-amides, polyester polyether-amides, polyurethanes, polyols and epoxies are the commonly used polymers in coatings. Epoxy resins due to their excellent chemical corrosion resistance, outstanding adhesion properties and low shrinkage are widely used in coating applicationsM. Yousuf et al., 2017.

## IV. RECENT PROGRESSIONS ON ELECTROLESS COATINGS ON CORTEN STEEL

Wang et al., (2007) investigated the effect of a sequential surface treatment on the adhesion and corrosion resistance of ENP coating on Corten steel. The results showed that the sequential treatment improved the adhesion of the ENP coating and enhanced its corrosion resistance. Kadam and Khond (2009) examined the preparation and characterization of electroless Ni-P-MoS<sub>2</sub> composite coatings on AISI 304L stainless steel. The results showed that the composite coatings exhibited good adhesion to the steel substrate and improved the wear resistance and corrosion resistance of the steel. The effect of electroless nickel plating on the corrosion resistance of Corten steel is investigated and the result



shows a significant improvement in the corrosion resistance than the un-coated steel in both acidic and alkaline environments (Sreekala et al., 2010).

Roy et al., 2013 investigated the tribological properties of electroless Ni-P-MoS<sub>2</sub> and Ni-P-hBN composite coatings on mild steel shows improved wear resistance and reduced coefficient of friction than that of uncoated steel. However, the MoS<sub>2</sub> coating exhibiting slightly better performance than Ni-P-hBN composite coatings. Then, the tribological properties of electroless Ni-P-MoS<sub>2</sub>-hBN composite coating on mild steel exhibited good wear resistance and reduced the coefficient of friction of the steel (Pramanik et al., 2013).

Khattak et al., (2017) evaluated the corrosion protection provided by ENP coating on corten steel in a marine environment. The results exhibited that the ENP coating significantly improved the corrosion resistance of the steel and reduced its corrosion rate. Choi and Cho (2019) studied the deposition of MoS<sub>2</sub>/hBN composite coatings on corten steel substrates by electroless plating. Composite coatings exhibited good adhesion to the steel substrate and improved the wear resistance and friction coefficient of the steel.

## V. CONCLUSION

This paper brought-out the investigation on corrosion characteristics of corten steel conducted by different researchers. This review addresses issues such as corrosion rates and the development of rust layers under various exposed environments. In addition, the influences of surface modification, alloying, and long-term corten steel behaviour have been highlighted. Also, recent progressions on electroless coatings of corten steel are brought-out. From the literature, it is evident that electroless coatings on corten steel exhibits better corrosion characteristics than that of un-coated. Moreover, Ni-P based electroless coatings are one of the advanced coating in arresting the corrosion, nevertheless the hybrid Ni-P coatings produce better corrosion characteristics than monolithic Ni-P and un-coated corten steel substrate.

## REFERENCES

1. S. Sreekala, S. Rajendran, and K. Sivaprasad, "Electroless Ni-P coating on Corten steel for improved corrosion resistance," *Surface and Coatings Technology*, vol. 204, no. 14, pp. 2319-2324, 2010.
2. M. A. Khattak, S. A. Khan, A. Ahmed, and M. Yousuf, "Corrosion protection of Corten steel using electroless nickel plating," *Journal of Materials Engineering and Performance*, vol. 26, no. 6, pp. 2819-2825, 2017.
3. S. B. Wang, W. X. Li, and L. J. Rong, "Electroless nickel coating on Corten steel by a sequential surface treatment," *Surface and Coatings Technology*, vol. 202, no. 5, pp. 758-763, 2007.
4. H. Choi and H. J. Cho, "Deposition of MoS<sub>2</sub>/hBN composite coatings on steel by electroless plating," *Surface and Coatings Technology*, vol. 377, pp. 124973, 2019.
5. P. Pramanik, S. Biswas, A. Bhaumik, and A. K. Mondal, "Tribological properties of electroless Ni-P-MoS<sub>2</sub>-hBN composite coating on mild steel," *Surface and Coatings Technology*, vol. 236, pp. 121-129, 2013.
6. S. Roy, R. Sarkar, A. Bhaumik, and A. K. Mondal, "A comparative study of electroless Ni-P-MoS<sub>2</sub> and Ni-P-hBN composite coatings on mild steel," *Surface and Coatings Technology*, vol. 227, pp. 62-69, 2013.
7. S. S. Kadam and M. P. Khond, "Preparation and characterization of electroless Ni-P-MoS<sub>2</sub> composite coatings on AISI 304L stainless steel," *Surface and Coatings Technology*, vol. 203, no. 21, pp. 3294-3301, 2009.



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