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# Comparison of different materials used for railway track for to identify corrosion problem and their methods of prevention

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**Abstract - In this paper we focus on reducing corrosion problem on railway track because it is one of the reason of failures of track and number of accidents. We identify most of the reason of forming corrosion and as well as to develop solution to prevent from them. Comparison between acidic and marine environment with respect to increasing corrosion rate Corrosion Criteria & preventive measure of corrosion are mentioned in table, Comparison of various combination of material where we found that C-Mn material is good for prevent corrosion due to less amount of carbon percentage but one disadvantage of this material is having low strength due to which not able to bearing heavy loads for this fracture is found on track.**

**Keywords: Comparison of Steels with respect to corrosion rate, Locations and Causes of Corrosion, Preventive measure to reduce corrosion of rails**

## I. INTRODUCTION

Corrosion problem in railway tracks is also a major concern because the corroded rails have to be replaced frequently, disturbing traffic as well as resulting in economic loss. Moreover, sudden failure of rails is a major safety concern [2]. In Corrosion fatigue is an important point in the evaluation of the structure integrity of railway axles. In fact several recent axle failures have been attributed to the presence of corrosion pits and axle surface corrosion.

*Fig1: Photograph of unused rail track due to corrosion problem*

The most common form of corrosion of rails is atmospheric corrosion. The residence time of moisture on the surface, and the frequency of wetting and drying determine the severity of atmospheric corrosion. Corrosion will be more severe for longer moisture residence time and more frequent wetting and drying. The “good” feature of atmospheric corrosion is that the resulting corrosion is generally uniform in nature. [11] Atmospheric corrosion of rails does not really pose a safety problem.

However, economic loss due to corrosion is still an issue since one would like to delay rail replacement as much as possible. Pollutants and contaminants in the environment dictate the severity of atmospheric corrosion. Uniform corrosion will be aggravated in the presence of chloride ions because they destabilize the protective rusts on the surface. For this reason, rails laid near coastal regions are more prone to atmospheric corrosion, warranting more frequent replacement than rails in a dry climate.

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Toilet discharge on to the rails and collection of moisture from the atmosphere cause intense localised corrosion under the liners [6]. This leads to the thinning and perforation of the rail foot under the liners, resulting in premature failure of the rails, which is a significant safety concern. This localised corrosion below the metal liners is commonly referred to as crevice corrosion. A crevice is any location in the system that has limited access to the atmosphere.

## II. LITERATURE REVIEW

**[1] John Rudlin, Dorothee Panggabean, Antonietta Loconte, and Angelique Raude (2014):** In this paper describe the pattern observed and results of inspections of various axles demonstrating the feasibility of the instrument. The study of growth of fatigue crack from corrosion pits has enable patterns in the development of corrosion fatigue that give an idea of remaining life of an axle.

**[2] B.Balasubramaniam, and R.K.Rathi (2011):** In this paper the significance of crevice corrosion at the rail foot locations under the liners of the rails fastening system has been particularly emphasized with special reference to corrosion caused by discharge from the toilets, The superior crevice corrosion resistance of the novel Cr-Cu-Ni rail compared to the standard C-Mn rail has been verified.

**[3] Jingyi Yue, Yan Cao (2015):** In this paper the corrosion resistance of selected aluminium alloys with various combinations of commercial coating was investigated using the tafel electrochemical method in water and simulated salt water enviornments. The microtopography of the surface of the metals and applied coating was tested using atomic forces force microscopy and optical microscopy analysis.

**[4] S.Samal, and S.K.Mittra (2011):** In this paper to find out the effect of environment corrosion on the common used pearlitic steel. It has been found that in marine environment both the yield strength and tensile strength decrease with increasing corrosion rate. In acidic environment yield strength increased with increased corrosion rate, although the tensile strength decrease with increased corrosion rate.

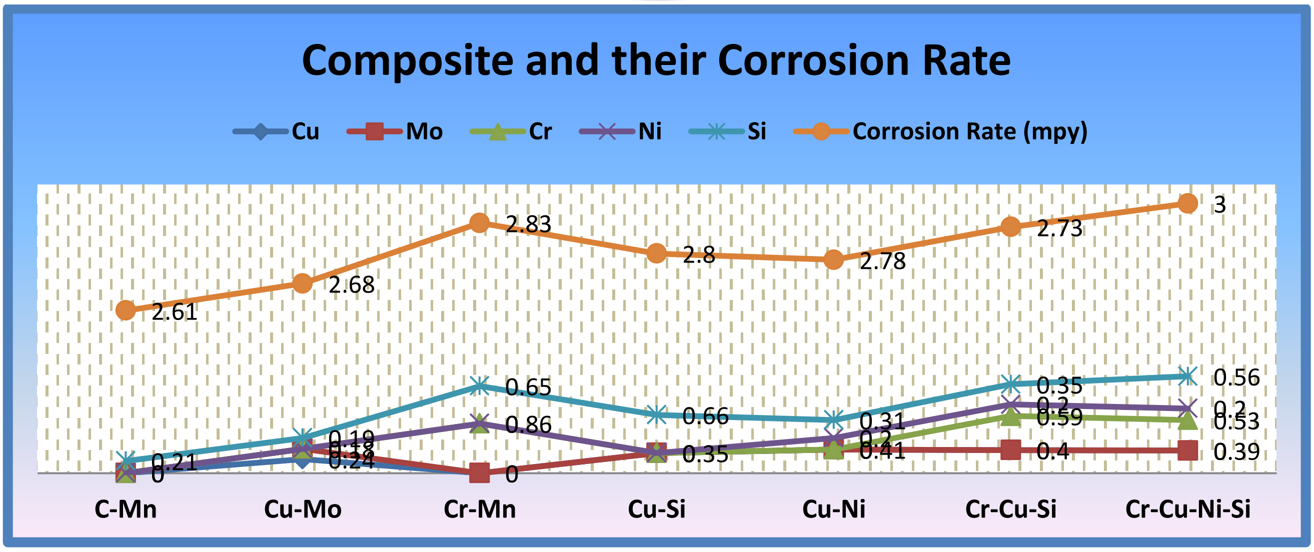
**[5] Bijayani Panda and Gopal Dwivedi (2008):** In this paper Eutectoid rail steel are prone to excessive corrosion in the coastal location in india. In order to minimize this problem, four new rail steel with microalloyiing elements Cu,Cr,Ni and Sr were designed. Impedance spectroscopy showed that the rust formed on Cr-Cu-Ni and Cr-Cu-Ni-Si rail steel resultant in the higher impedance in the high frequency region compared to other rail steels.

**[6] H. Nagano and M.Yamashita (2013):** In this paper deal with the development of a method for acceleration formation of corrosion protective rust on steel with a paint containing inorganic and organic compounds. The paint help corrosion protective rusts grow on metal surface only after a few year exposure in the marine environment. The main constituents of corrosion protective rusts is a fine grained structure of α-FeOOH.

**[7] Toshiyasu Nishimura (2017):** In this paper exposure tests were performed on low alloy steel is high CL and high SOx environment and the structure of the rust were analyzed by TEM (Transmission Electron Microscopy) and Raman Spectroscopy. In the exposure test site, the concentrations of CL and SOx were found to be high. Which cause the corrosion of the steel.

## III. MATERIALS AND METHODS

**3.1.1. Comparison of Steels with respect to corrosion rate.**




**Graph1: Comparison of composites with respect to Corrosion Rate.**



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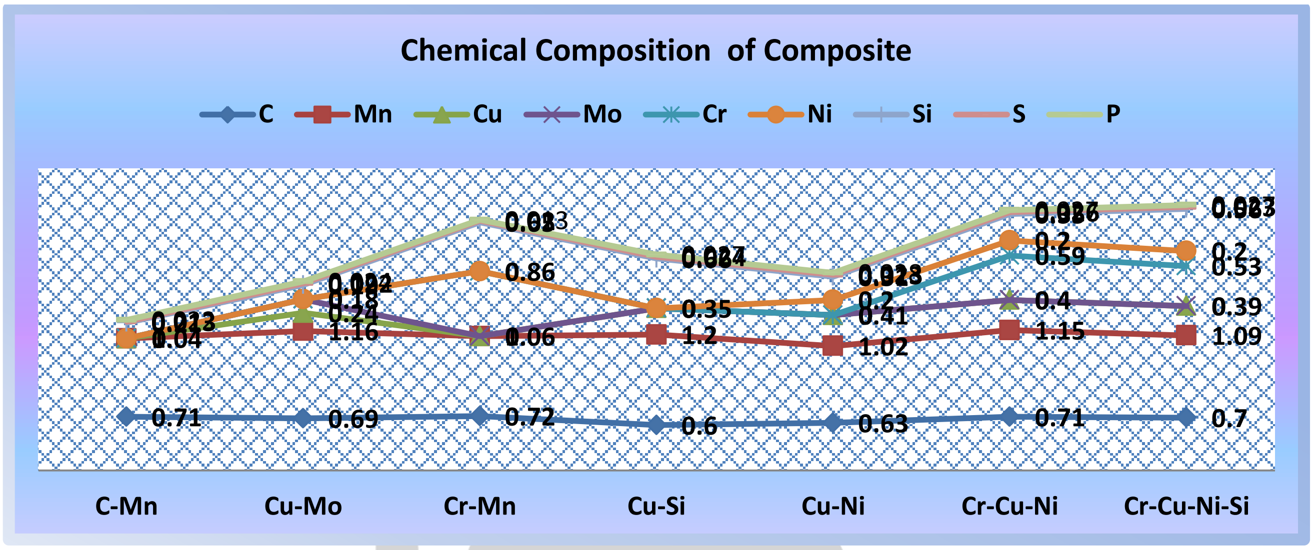
It shown that when we increased the composition for improved material quality it is observed that due to increased more compostion carbon percentage is also improved due to caused high corrosion rate so in various compostion we found that Cr-Cu-Ni-Si are the caused to increased more corrosion rate instead of C-Mn composition. So generally in railways C-Mn composition steel is used to prevent corrosion but it reduced high strength due to less carbon no high capacity to bearing stresses.




**Graph2: Chemical Composition of Composites**

It is must important to select material for track manufacturing, here various composition are shown. We study about their chemical compositions in (wt) due to identify best one of them. As we know that if carbon percentage is increased then strength is high but one disadvantages we found that due to increasing carbon percentage in composition the corrosion properties is enhanced and it's damage track or high amount of losses we faced so we try to identified best composition form all of them and we found that Cu-Si having low carbon compositions but other other composition is high. Where C-Mn composition is also having low carbon form but due to low carbon its strength is not high for bearing stresses, One more important

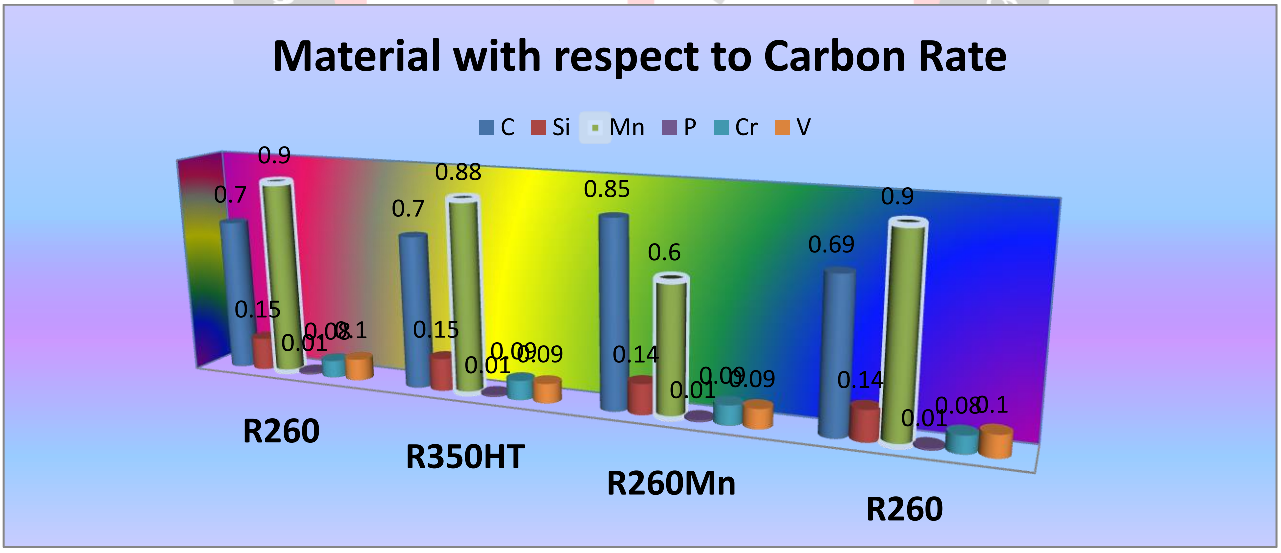



**Chart1: Material with respect to carbon rate**

There are many grades of steels as per requirement we used specific grade according to our applications or needs where this mentioned grades of steel used as a manufacturing track for that we just study about their composition for finding out the rate of carbon because our main focus on this work is to how to prevent from corrosion. Where out of these four material R260Mn found that high carbon contained but lowest amount of Phosphorus (P). Instead one more thing is observed that one common contained found phosphorus is less in all materials (0.01). So finally R260Mn are caused corrosion if we used to manufacturing track.

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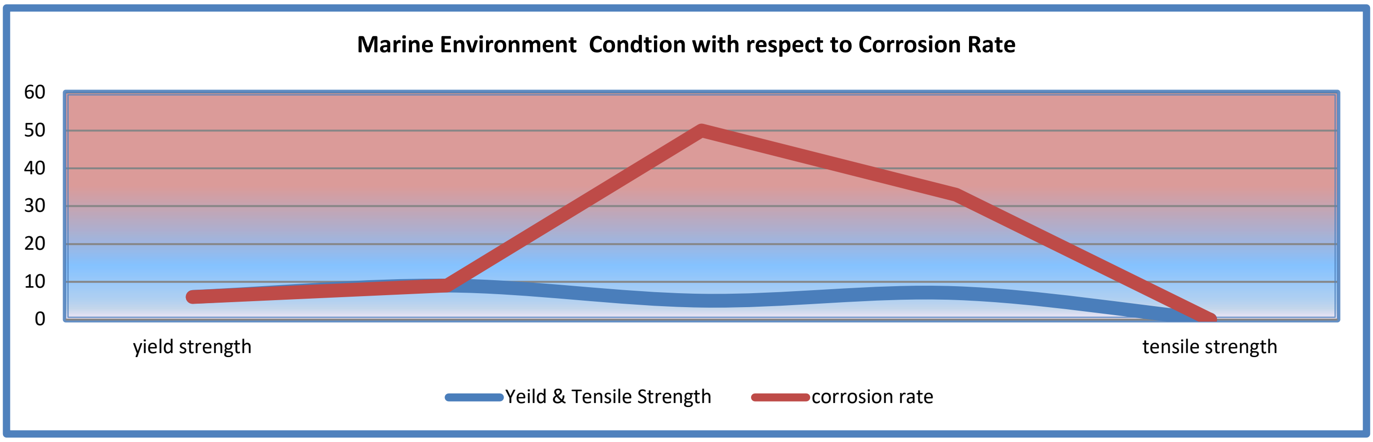


**Chart2: Condition of decrease yield and tensile strength during Marine Environment**

It is investigated that during time of Marine environment both yield and tensile strength decrease but due to decreasing both strength the corrosion rate will increase so for reducing corrosion rate it is requirement to increase yield and tensile strength during marine environment.

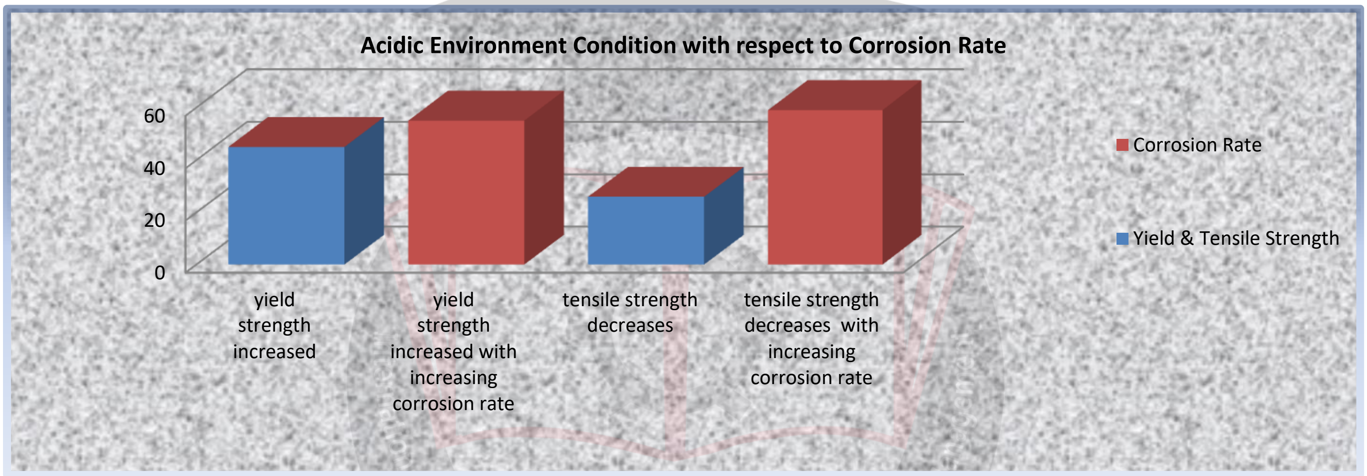


**Chart3: Condition of increase yield and decrease tensile strength during Acidic Environment**

It is investigated that during time of Acidic environment the corrosion rate increased with increasing yield strength. On other side tensile strength decrease but due to decreasing tensie strength the corrosion rate will increase so for reducing corrosion rate it is requirement to increase tensile strength and decrease yield strength during marine environment for preventing from corrosion problem.

### 3.1.2. Locations and Causes of Corrosion

1) In coastal area (due to salinity)
2) In tunnels and cutting (due to dampness)
3) In vicinity of industrial area (due to chemical pollution)
4) In sidings (due to handling of corrosion causing goods)
5) In platforms lines (due to sweeping of dust etc. from the platforms). Corrosion reduced to the cross section area of the rail primarily at the bottom flange.

### 3.1.3. Classification of sections based on corrosion proneness.

The sections of Railway in classified based on corrosion proneness into three groups:

i. Very severe corrosion prone locations.
ii. Severe corrosion prone locations.
iii. Moderate corrosion prone locations.

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**Table 1: Corrosion Criteria & preventive measure of corrosion**

| Sr. No. | Items | Very Severe | Type of Corrosion Severe | Moderate |
|---|---|---|---|---|
| 1 | Classification Criteria | Corrosion more than 3 mm in 4 years | Corrosion between 1 and 3 mm in 2 years | Corrosion less than 1 mm in 3 years |
| 2 | Destressing & longitudinal shifting of linear seats | Once in 3 years | Once in 2 years | Once in 4 years |
| 3 | Painting of rails | Once in a year both inside and outside | Once in a year of welds | Painting of welds on inside once in a year |
| 4 | Greasing ERCs, inserts, liner, seats including sealing of liners | Once in 6 months both inside and outside | Once in year inside only. Once in 3 years on outside along with distressing | Once in 2 year inside only. Once in 4 year on outside along with distressing. |

### 3.1.4. Preventive measure to reduce corrosion of rails

1) **General**
   a) Ensure 100% complete and tight track fastening and earth bonds.
   b) Ensure rail foot is away from stagnated water and ballast.
   c) Ensure that drainage condition is good and anti corrosive treatment is given to all parts offastening of rails, prone to corrosion.
   d) Ensure that corrosion of rail is controlled by various measure such as greasing of liner seats, sealing of liner seats, painting of rails, shifting of linear seats etc.

2) **Shifting of corroded liner seats**
   By shifting the corroded liner seats from its original locations: the locations affected by liner biting where the rail foot got reduced due to corrosion.

3) **Interchanging of rails**
   Interchanging of rails may be done when the rail is relatively old and shifting of liner seat from all sleepers is not practical i.e. where shifting of liner seat will not result in all liner seat got shifted non uniformly during casual renewal, distressing.

4) **Surface Preparation**
   The surface should made free from oil, grease and dust. The surface should be rubbed with wire brush and sand paper.

## IV. CONCLUSION

1) The destroy of railway track is one of the reason is forming of corrosion due to various reasons. We found that toilet discharge on to the rails and collection of moisture from the atmosphere cause intense localised corrosion under the liners. This leads to the thinning and perforation of the rail foot under the liners, resulting in premature failure of the rails.
2) Comparision of various combination of material where we found that C-Mn material is good for prevent corrosion due to less amount of carbon percentage but one disadvantage of this material is having low tensile strength due to which not able to bearing heavy loads for this fracture is found on track.
3) Identified the causes of corrosion in terms of year wise modification were we need to improved quality of railway track.
4) In marine environment the yield and tensile strength both are decreased with increasing corrosion rate. In acidic environment corrosion rate increased with yield strength is increased and corrosion increased with decreasing of tensile strength.

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