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Procedia CIRP 59 (2017) 47 – 52

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The 5th International Conference on Through-life Engineering Services (TESConf 2016)

Study of Asset Management Method for Galvanized Steel Railway Electrification Infrastructure in JR-EAST

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Abstract

As sea wind and acid rain gradually corrode galvanized steel, it is necessary for galvanized steel railway electrification infrastructure to be overpainted or rebuilt for long-term use. Maintenance policies such as painting or rebuilding are currently decided by maintenance engineers' experience and knowledge. It is not always cost-effective. Therefore, the authors have studied the application of the asset management methods for galvanized steel railway electrification infrastructure maintenance. We made an experimental asset management calculation tool. Using sample data, we concluded that the asset management methods are helpful in finding the most cost-effective maintenance policies.

Peer-review under responsibility of the scientific committee of the The 5th International Conference on Through-life Engineering Services (TESConf 2016)

Keywords: Asset management; Railway electrification infrastructure; Galvanized steel; Whole life cost;

1. Introduction

Galvanized steel and concrete are commonly used in railway electrification infrastructure. Figure 1 shows an example. As zinc highly effective in preventing corrosion, galvanized steel is superior to steel in terms of resistance to corrosion. However, even so, sea wind and acid rain will gradually corrode it. Therefore, galvanized steel railway electrification infrastructure eventually requires maintenance.

It is difficult to make decisions for the cost-effective maintenance for galvanized steel railway electrification infrastructure for following reasons:

- The corrosion speeds of zinc and steel differ according to place of installation and environment.
- There are many kinds of galvanized steel railway electrification infrastructure.
- Railway electrification infrastructure is easy to rebuild. For this reason, the decision of the maintenance policies includes not only painting but also rebuilding.
- Railway electrification infrastructure often includes transformers, signals, distribution lines, tension balancers, etc. Figure 2 shows such an example. Therefore, painting rebuilding costs differ from case to case.

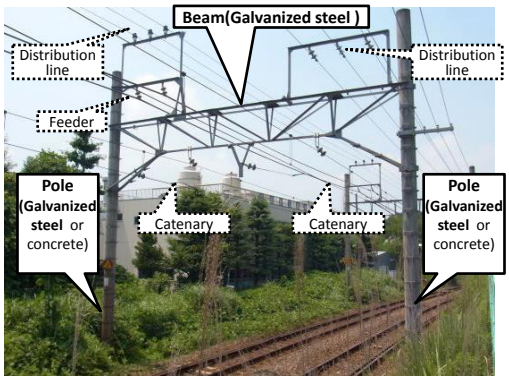

Fig.1. Railway Electrification Infrastructure

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doi:10.1016/j.procir.2016.09.011

Maintenance for galvanized steel railway electrification infrastructure is currently decided upon according to the maintenance engineers' experience and knowledge. However, there is no fixed method to influence decisions in selecting maintenance policies in favor of cost-effectiveness. In addition, JR-East has about 30,000 poles and 60,000 beams of galvanized steel. Figure 3 shows the distribution of galvanized steel beam aging. In the immediate future, huge maintenance costs and extreme construction management capability will be required of JR-East. Therefore, there is every possibility of affecting the annual rebuilding quantity by the cost and the management capability.

Nowadays, there remains an ever-increasing interest and challenge to apply the asset management to the railway infrastructure maintenance [1, 2, 3, 4]. However, as far as we know, there have been few report about application of asset management for galvanized steel railway electrification infrastructure.

The authors have made efforts to find the most cost-effective maintenance policies by applying asset management methods as a part of the Smart Maintenance Initiative [5, 6]. This paper deals with the study of asset management methods for galvanized steel railway electrification infrastructure.

2. Framework of asset management method galvanized steel for railway electrification infrastructure

We used asset management methodology corresponding to the PDCA management cycle [7]. Figure 4 shows the outline of our asset management. There were two issues to deal with in asset management for galvanized steel railway electrification infrastructure.

2.1. Calculation model for galvanized steel degradation

Galvanized steel has a zinc layer and zinc-steel alloy layer covering the steel. Galvanized steel degrades in four phases of corrosion. Figure 5 shows the degradation phases of galvanized steel. In addition to the four phases, galvanized steel has three painted phases as well, such as painted zinc layer, painted alloy layer, and painted steel. Figure 6 shows the cross-section of painted phases. Sometimes, multiple phases appear on one galvanized steel component due to gradational corrosion. Therefore, we defined state of corrosion of galvanized steel in seven phases. Figure 7 shows the seven phases and their relationship.

In asset management, we need to calculate to predict future corrosion of the galvanized steel. The calculation must be simple. For this reason, we apply the "Markov chains" to calculate and predict the future corrosion of galvanized steel and define the phase of degradation for calculation as shown in Figure 7. The elements of the transition matrix are the annual degradation probability at each phase. Therefore, by multiplying the current state of corrosion of galvanized steel by the transition matrix again and again, we can obtain the future states of corrosion.

2.2. Input parameters

Calculation of asset management requires some parameters, such as annual degradation probability, rebuilding cost, paint repair cost, states of corrosion, and risk cost.

First of all, annual degradation probability is set by using the reciprocal of the life-expectancy at each phase. The life expectancy of zinc and steel are attained by corrosive

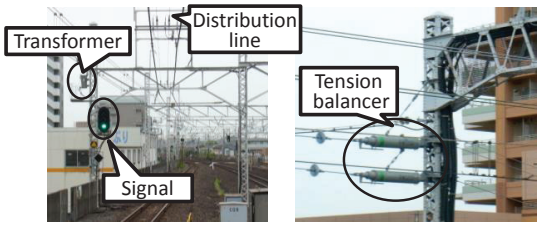

Fig.2. Equipment attached to railway electrification infrastructure

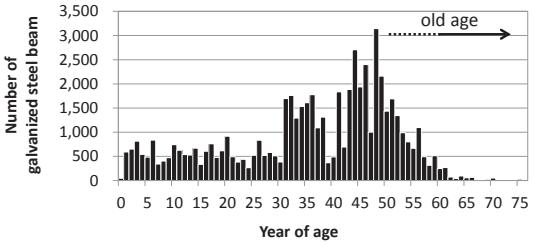

Fig.3. Distribution of distribution of galvanized steel beam aging

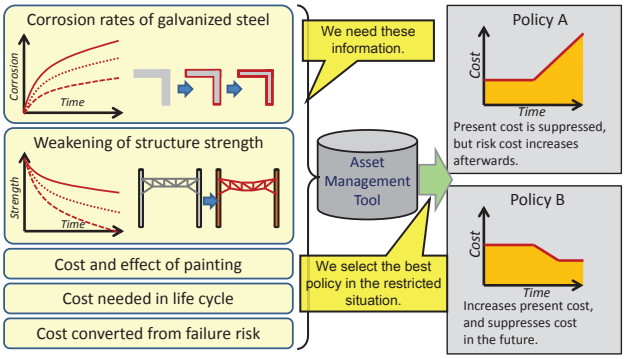

Fig.4. Outline of asset management for galvanized steel railway electrification infrastructure