Experimental Study on Corrosion of Galfan-Coated Full-Locked Coil Ropes in a Natatorium Environment

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Galfan-coated full-locked coil rope is widely applied in long-span spatial structures because of its high strength and lightweight. However, the corrosion problem is relatively serious in the natatorium, which affects the structure’s durability. To deeply reveal the corrosion mechanism of Galfan-coated cable, this study first measured the natatorium on-site, and the results indicated that the natatorium environment can be simulated by a constant temperature and humidity environment in engineering. Then, the constant temperature and humidity corrosion test was carried out to simulate the corrosion of Galfan-coated cable with a certain amount of chloride ions on the surface, and the early corrosion rate was obtained. Later, the neutral salt spray accelerated corrosion test was carried out to predict the corrosion rate of the cable in the natatorium environment in the middle and late periods. The specimens included no-stress unprotected coating cable, high-stress unprotected coating cable, and high-stress protected coating cable. The results show that high stress will accelerate the corrosion, and a protective coating can effectively prevent the corrosion. Finally, the linear model, bilinear model, and bilinear model considering chloride ion accumulation were proposed to study the corrosion of the Galfan coating. The results show that the linear model overestimates the corrosion rate, and the bilinear model considering chloride ion accumulation are practical. Meanwhile, corresponding maintenance suggestions were given for the natatorium project to improve the structure’s durability.

1. Introduction

Long-span space structure is one of the important symbols of the development level of national building science and technology. Full-locked coil rope is widely used in long-span space structures because of its high strength, lightweight, and high fatigue strength [1–3]. However, corrosion is a classic problem that cannot be ignored. The corrosion of cable will cause the degradation of mechanical properties and then affect the durability and service performance of the structure [4, 5]. The more significant part of the literature on cable corrosion is extensive and focuses mainly on bridge engineering. Jiang et al. [6] had carried out experimental research on the fatigue performance of corroded high-strength steel wires used in bridges, and the results show that corrosion could cause a significant decrease in the fatigue life of corroded steel wires. Nakamura and Suzumura [7] carried out fatigue tests of corrosion fatigue of corroded bridge wires. The results indicated that fatigue strength did not change when only the galvanized layer was corroded, but it significantly decreased after corrosion of the steel below the galvanized layer progressed.

Much of the current literature on full-locked coil rope pays particular attention to its mechanical properties. Maljaars and Misiek [8] had collected fatigue test data on full-locked coil ropes and employed a semiempirical model to extrapolate the test results to complete failure of the rope. The resulting S-N curve was being adopted to revise the European standards. Nakamura et al. [9] produced corroded galvanized steel wires at different corrosion levels and...
investigated their mechanical properties and remaining strength. It was found that the actual tensile strength of corroded wires does not decrease, whereas the elongation, torsional, and fatigue strength decrease sharply.

However, there is little research on the corrosion performance of full-locked coil rope after long-term service in a natatorium environment. The natatorium environment is a C4 high corrosive environment [10]. After the air conditioner is closed in summer, the indoor temperature rises, and the cable is in a high temperature, high humidity, and high chloride environment; when the air conditioner is turned on in winter, the cable is easy to condense, and the cable is in high humidity and high chlorine environment [11]. The corrosion problem is relatively prominent in the natatorium environment compared with other structures [12]. Galfan-coated full-locked coil ropes (starting now referred to as cable) are commonly used in engineering and are in a high-stress state during service. Therefore, it is of great significance to investigate the corrosion mechanism of Galfan-coated full-locked coil rope in a natatorium environment under high stress.

In Section 2 of this study, the on-site measurement of the Shanghai Oriental Sports Center Natatorium was carried out. The results show that the natatorium environment can be considered as a constant temperature and humidity environment in engineering. In Section 3, through the constant temperature and humidity corrosion test, the corrosion of the Galfan-coated cable with a certain amount of chloride ion accumulated on the surface in the environmental conditions of the swimming pool is simulated, and the early corrosion law was analyzed. In Section 4, the neutral salt spray accelerated corrosion test was conducted to predict the corrosion rate of the cable in the natatorium environment in the middle and late periods, and the effect of high stress on corrosion was analyzed. Section 5 proposed three models to fit the loss and life of Galfan coating, predict the degradation law of mechanical properties in 50 years, and give suggestions for engineering. Finally, Section 6 summarizes the whole study.

2. On-Site Measurement of Natatorium Environment

In the natatorium environment, the corrosive medium on the surface of the Galfan-coated cables is chloride ion (Cl\(^{-}\)), which mainly comes from the reaction between bleaching powder and water. After Cl\(^{-}\) enters the air, it is attached to the Galfan-coated cable surface through natural sedimentation and condensation. The long-term action makes the Cl\(^{-}\) on the surface accumulate continuously, and corrosion begins when the cable surface contacts enough water and oxygen. To simulate the corrosion of the Galfan-coated cable with a certain amount of Cl\(^{-}\) accumulated on the surface in the natatorium environment, it is necessary to obtain the environmental parameters of the natatorium. Therefore, the natatorium of Shanghai Oriental Sports Center was measured on-site firstly.

The condensed water of the natatorium before and after use was sampled, respectively. The chloride ion concentration in the condensed water on the Galfan-coated cable surface was about 100 mg/L, and the chloride ion concentration in the natatorium water was about 200 mg/L. Meanwhile, the temperature and humidity sensor was arranged to measure that the natatorium’s internal temperature (Temp) was about 24~26°C, and the relative humidity (RH) was 80~90%. Figure 1 presents the temperature and humidity obtained at measuring points 8 and 5. The on-site measurement results indicate that the temperature and humidity of the natatorium environment are relatively constant. Therefore, the natatorium environment can be replaced by the constant temperature and humidity environment, and it is conservative in engineering.

3. Constant Temperature and Humidity Corrosion Test

3.1. Specimen Preparation. The corrosion of Galfan-coated cable with a certain concentration of Cl\(^{-}\) accumulated on the surface in the natatorium environment was simulated through the constant temperature and humidity corrosion test. In the text, the Galfan-coated cable with diameter \(D = 40\) mm is twisted by 77 strands of Z-shaped wires, as shown in Figure 2. The outermost layer (layer O) is 22 strands of Z-shaped wires, the secondary layer (layer C) is 25 strands of Z-shaped wire, and the core layer (layer CO) is composed of four layers of circular galvanized wire with different diameters, with a total of 30 strands. The gap between circular wires is filled with anticorrosion composite. Figure 3 illustrates a cross-sectional diagram, and the cross-sectional areas of the O layer, C layer, and CO layer are 51.9%, 22.5%, and 25.6%, respectively. The base material of Z-shaped wire is alloy steel, and its chemical composition is shown in Table 1. The energy spectrum qualitative and semiquantitative analysis of the surface composition of the coating shows that the coating is zinc-aluminum alloy (Zn\(_{95}\)Al\(_{5}\)). The overall thickness of the scanning electron microscope (SEM) is between 19 and 152 \(\mu m\).

For the purpose of simulating the accumulation of Cl\(^{-}\) on the Galfan-coated cable surface in the natatorium environment, the specimens were immersed in 5% NaCl for 24 hours and then dried naturally. It is approximately considered that the chloride ion on the Galfan-coated cable surface is equal to the chloride ion accumulation after long-term service in the natatorium environment. The specimens were divided into two types: (1) 10 Galfan-coated cables with a length of \(L = 20\) cm were used to simulate the actual corrosion of Galfan-coated cables in the natatorium environment. The outer surface of the Z-shaped wire in layer C is corroded by direct contact with the environment, while adjacent wires block the other surfaces, so the corrosion environment is different from the outer surface. (2) 30 outermost Z-shaped wires were used to study corrosion when all outer surfaces of the Z-shaped wires are directly exposed to the environment. Combined with the on-site measurement, the ambient temperature was set at 25°C, RH was set at 90%, and then the specimens were put on the carbon fiber frame in the constant temperature and humidity box, as shown in Figure 4.
3.2. Testing Phenomenon. During the test, the specimen ② was randomly selected for testing. The results show that flakes, strips, and pits began to appear on the surface of the specimen with the increase in time, as shown in Figure 5(a). The mass of the wire gradually lost, and the density remained unchanged before and after corrosion. The chemical composition of specimen ② was analyzed by EDAX spectrometer, as shown in Figure 5(b). It was found that Cl, O, and C elements were added, indicating that the Galfan coating had invaded and reacted with the metal to form chloride salts or chlorine-containing compounds; the zinc-aluminum coating undergoes an oxidation reaction, and the metal oxidation products are hydrolyzed and reacted with carbon dioxide (CO$_2$) in the air to form carbonate radicals (CO$_2$$^{3-}$).

3.3. Results and Analysis. Figure 6 displays the 3D laser scanning device. The three-dimensional solid model of Z-shaped wire was obtained. Figure 7 shows the cross-sectional area distribution along the length direction that was analyzed through the program [13]. The minimum cross-sectional area can be obtained in Figure 8. The average cross-sectional area is the weighted average cross-sectional

![Figure 1: Some on-site measured results. (a) Arrangement of sensors. (b) Measured data of sensor.](image)

![Figure 2: Galfan-coated full-locked coil rope.](image)

![Figure 3: Schematic diagram of the cross section.](image)

| Table 1: Chemical composition of Z-shaped wire base material (%) |
|-----------------|---|---|---|---|---|---|---|---|---|
| C               | S  | Si | Mn | P  | Ni | Cr | Mo | Cu | Al |
| 0.77            | 0.003 | 0.29 | 0.66 | 0.009 | 0.025 | 0.074 | 0.013 | 0.019 | 0.029 |
area after considering different lengths of cable wire, and the cable clamping sections at both ends of the cable wire are excluded (about 6 cm). Through comprehensive analysis of all specimens: the average cross-sectional area of the outermost layer wire is about 10.07 mm², and the average cross-sectional area of the secondary layer wire is about 27.39 mm². The tensile test of the electrohydraulic servo testing machine shows the average strength $f_T$ of 1631 MPa and 1684 MPa, respectively.

The corrosion degree of the Z-shaped wires $\eta_m$ was measured by the weight loss and can be calculated by the following equation:

$$\eta_m = \frac{m - m_0}{m_0} \times 100\%,$$  \hspace{1cm} (1)

where $m_0$ is the original mass of the Z-shaped wire and $m$ is the mass weighed after the test. Figure 9 presents the mass change rate $\eta_m$, average cross-sectional area change rate $\eta_A$,
Figure 7: Cable specimens. (a) No-stress unprotected coating Galfan-coated cable. (b) High-stress unprotected coating Galfan-coated cable. (c) High-stress protected coating Galfan-coated cable.

Figure 8: Acquisition of cross-sectional area of wire rope. (a) Distribution of cross-sectional area of wire along the length direction. (b) Distribution of cross-sectional area with the axis.

Figure 9: Corrosion law of Z-shaped wire (specimen ②).
and minimum cross-sectional area change rate $\eta_{A_{\text{min}}}$ of specimen $\bigcirc$ before and after the test. It can be observed that in the constant temperature and humidity environment, there is a linear relationship with time $d$ and $\eta_m$ in the early stage of the test (0–120 d). Fitting with the bilinear model, the corrosion rate (CR) is equal to the slope of the straight line, which is 0.0107%/d. With the development of corrosion, the CR decreased significantly in the later stage of the test (>120 d), which is 0.00155%/d. The main reasons are as follows: (1) the corrosion products adhere to the surface of the cable wire, which delays the development of corrosion to the interior of the cable wire and reduces the CR; and (2) some corrosion products fall off, which reduces the surface $\text{Cl}^-$ concentration and slows down the CR.

$\eta_P$ and $\eta_{A_{\text{min}}}$ are shown as triangular points and square points in Figure 9. These points are relatively discrete due to the uneven initial cross-sectional area of the cable wires. By fitting these scatter points, the slope of $\eta_P$ is 0.0098%/d, close to that of $\eta_m$, which can be considered consistent. So, $\eta_P$ is approximately used to characterize the corrosion degree in this study. The slope of $\eta_{A_{\text{min}}}$ is large, up to 0.0311%/d. It is conservative for evaluating the corrosion degree of the wires and can be used as the upper limit of the corrosion degree considering the randomness of corrosion. In conclusion, the corrosion rate of specimen $\bigcirc$ in constant temperature and humidity corrosion environment is 0.0107%/d before 120 d and 0.00155%/d after 120 d.

Similar conclusions can be obtained by analyzing the outermost and the second layers of wire of specimen $\bigcirc$, as shown in Figure 10. The CR of the outermost layer wire is 0.0049%/d, and the CR of the secondary layer wire is 0.0014%/d, which is lower than the CR of specimen $\bigcirc$. The CR of the secondary layer wire is lower than that of the outermost layer wire because the outermost layer plays a protective role. About half the length of both ends of the cable is protected by epoxy without corrosion, so the corrosion rate should be doubled. Therefore, it can be considered that the CR of the outermost layer wire of the cable is the same as that of the single corroded wire, which is 0.0107%/d, and the CR of the secondary layer wire of the cable is 0.0028%/d.

### 4. Neutral Salt Spray Accelerated Corrosion Test

#### 4.1. Test Preparation

For the purpose of speculating the CR of Galfan-coated cable in the middle and later stages of the natatorium environment, a neutral salt spray accelerated corrosion test was carried out to obtain the corrosion behavior under the condition of artificially accelerated corrosion. The specimen includes ten no-stress unprotected coating Galfan-coated cables (W1–W10); three high-stress unprotected coating Galfan-coated cables (WS-1–WS-3); and three high-stress protected coating Galfan-coated cables (TS-1–TS-3), as shown in Figure 7. (TS and WS are 1.2 m long with high stress, and the length of $W$ is 50 cm.)

The environmental control parameters were determined according to the Chinese specification corrosion test in the artificial atmosphere (GB/T 10125-1997) [10] and neutral salt spray test of metal coatings (GB/T 6458-1986) [14], as shown in Table 2. The high stress was prestressed by 600 MPa through the Jack. After being cleaned with alcohol, they were put into the salt spray box. The specimens were not stacked with each other to ensure that the salt spray could settle freely and evenly to the surface.

### 5. Results and Analysis

Prominent red corrosion products were observed on the surface of specimens W-1–W-5 at 133 d, as shown in Figure 11. The corrosion products on the scraped surface and at the junction of the outermost layer and the secondary layer were placed in Bruker D8 Advance X-ray diffractometer for phase analysis. The main components are oxides or compounds of $\text{Zn}$ and $\text{Al}$, and Fe was not detected, indicating that the corrosion only occurs in the Galfan coating and has not yet developed to the internal substrate of the wire.

The outermost layer wire sample was cut off at 133 d to obtain the cross-sectional shape and the SEM images corresponding to each position, as shown in Figure 12. It can be seen that the Galfan coating thickness of the outermost wire is unevenly distributed along the outer edge of the section, and the thickness at the two concave internal corners of the section is the largest, up to 356 $\mu$m. The thickness at the external convex corner is the thinnest, ranging from 14 to 242 $\mu$m. The thickness of the outer surface side of the wire is uneven, and the overall thickness is between 22 and 89 $\mu$m. The surface of the Galfan coating is uneven, the corrosion trace is obvious, and it shows a typical pit corrosion morphology.

Several corrosion traces appeared on specimens WS-1–WS-3 around 13 d. Since then, the corrosion products have increased continuously, and the corrosion phenomenon is apparent. At 136 d, the thickness of Galfan coating is zero, indicating that it has been wholly corroded, and the corrosion has developed to the internal substrate of cable wire, as shown in Figures 13(a)–13(c). A section was randomly cut from the outermost layer wire in the specimen at 136 d. The cross-sectional shape and the corresponding scanning position of the electron microscope at each position are shown in Figures 13(d)–13(e). The observation demonstrates that the thickness of the Galfan coating along the periphery of the section is uneven, and the thickness of the two concave internal corners of the section is the largest, up to 158 $\mu$m. The thickness at the external convex corner is the thinnest, ranging from 0 to 113 $\mu$m, and the coating thickness at the outer convex corner near the outside of the cable wire is 0 $\mu$m. It indicates that the Galfan coating was entirely corroded.

There are no salt crystal adhesion and accumulation on the surface of the specimens TS-1–TS-3 at 120 d, as shown in Figure 14. It can be discerned that the gray part with protective coating has no corrosion, and the surface of the cable head without protective coating has accumulated white chloride crystals and yellow or red corrosion products. The protective coating plays a protective role on the Galfan-coated cable and effectively prevents corrosion. Based on the above research, engineering recommends using similar protective coatings for anticorrosion of cables, cable heads,
and cable clamps in unfavorable positions. Since the protective coating also has specific durability problems, the quality of the coating should be checked regularly during service, and repair measures should be taken.

The $\eta_1$ and $\eta_{A_{min}}$ of the outermost layer wire and the secondary layer wire of no-stress unprotected coating cable and high-stress unprotected coating cable are shown in Figures 15 and 16. It can be discovered that in the neutral salt spray environment, the CR of the wire of no-stress unprotected coating cable is faster in the early stage and gradually slower in the later stage, and the CR of the outermost layer wire is faster than the secondary layer wire. According to the regression curve prediction, the section corrosion of the outermost layer wire and the secondary layer wire is about 20.9% and 13.7% after 40 years, respectively.

The CR of the outermost layer wire of high-stress unprotected coating cable decreases gradually with time, which is fitted by a power function [15]. The corrosion rate of the section is expected to be about 55% in 40 years. The CR of the secondary layer wire can be fitted linearly [16], and the complete corrosion can be predicted in 5.8 years. It can be noted that the high stress accelerates the CR of the cable, and the corrosion rate of the secondary layer wire is faster than that of the outermost layer wire. The cable with high stress and a protective coating has no corrosion in the test.

### 6. Galfan Coating Loss Analysis

#### 6.1. Loss Model of Galfan Coating

It was found that fatigue strength did not change when only the Galfan coating was corroded, but it significantly decreased after the steel corrosion below the Galfan coating progressed [13]. Therefore, it is necessary to reveal further the corrosion law of Galfan coating in the natatorium environment and predict the corrosion of Galfan coating. Assuming that the Galfan coating is evenly distributed around the cable wire, through the mass loss of the specimens, the loss rate $v_d$, of Galfan coating can be calculated as follows:

$$ v_d = \frac{\Delta m}{\rho A_{ou} T_{test}} $$

where $\Delta m$ is the mass loss of the specimen before and after corrosion (g); $\rho$ is the density of the Galfan coating (approximately equal to the cable density, taking 0.0078 g/mm$^3$); $A_{ou}$ is the average surface area (mm$^2$); and $T_{test}$ is time (d). In the constant temperature and humidity environment, the thickness of Galfan coating loss is obtained by measuring the mass loss of the specimens. Using linear fitting, the loss rate of Galfan coating at the initial stage ($<115$ d) is about $0.1281 \mu m/d$. The measured thickness of Galfan coating and the time required for complete corrosion are shown in column 3 in Table 2 using the linear fitting. The predicted corrosion rate is faster than the actual, and the service life is lower than the actual. Then, the bilinear model is adopted. In the later stage ($>115$ d), the loss rate is about $0.019 \mu m/d$ according to the fitting of 321 d measuring points. The measured Galfan coating thickness and the time required for complete corrosion are shown in column 4 in Table 2. It is more in line with the actual situation, as shown in Figure 17.
In the constant temperature and humidity corrosion test, the chloride ion concentration on the surface of the cable, which is immersed in 5% NaCl for 24 hours and dried naturally, is approximately equal to the chloride ion concentration after long-term accumulation in the corrosive environment of the natatorium. After immersing, the average chloride ion concentration on the surface of the wires is $1.3 \times 10^{-5} \text{g/mm}^2$. However, in the natatorium environment, the accumulation of chloride ions on the cable surface and Galfan coating corrosion occur simultaneously, and the CR will change with the increase in chloride ion concentration, so the accumulation process of chloride ions is not considered in the test.

The natatorium belongs to C4 highly corrosive environment, which is similar to the marine atmospheric environment. The chloride ion accumulation speed is similar to the environment 20 km away from the sea. Figure 18 illustrates the relationship between the salt fog sedimentation speed and the distance from the sea [17]. Therefore, a bilinear model considering chloride ion accumulation was proposed to modify the CR of the Galfan coating. Therefore, the salt fog sedimentation rate in the natatorium environment is approximately $0.212 \text{g/(mm}^2\cdot \text{a)}$, and the chloride ion accumulation rate on the cable surface is $3.9 \times 10^{-9} \text{g/(mm}^2\cdot \text{a)}$. Therefore, it takes 3.3 years to accumulate the chloride ion concentration during the test.

The CR of Galfan coating with different chloride ion concentrations is presented in Figure 19 [18, 19]. Therefore, combined with the corrosion rate of Galfan coating in constant temperature and humidity test, the life of Galfan coating with different thicknesses is predicted, as shown in column 5 in Table 3.

Based on the above analysis, three models of Galfan coating loss rate are proposed: linear model, bilinear model, and bilinear model considering chloride accumulation. The linear model assumes that the corrosion of Galfan coating develops linearly according to the initial CR, and the CR is faster than the actual, which is not in line with reality. The bilinear model considers the decline of Galfan coating corrosion rate in the later stage, and the corrosion in the first and second stages is linear, which is close to the actual situation; the bilinear model considering chloride accumulation is a model considering the nonlinear development of corrosion in the process of chloride accumulation, which is closer to the actual situation. The difference between the bilinear and bilinear models considering chloride ion accumulation is tiny, which can be flexibly applied in engineering.
Figure 13: Corrosion morphology and SEM image of WS-2. (a) 13 d. (b) 42 d. (c) 136 d. (d) Section shape and SEM image position. (e) Composite diagram of SEM images of Galfán coating.
Figure 14: Cable with high stress and protective coating (120 d).

Figure 15: No-stress unprotected coating cable. (a) The outermost layer wire. (b) The secondary layer wire.

Figure 16: High-stress unprotected coating cable. (a) The outermost layer wire. (b) The secondary layer wire.
Considering that the minimum thickness of Galfan coating is 22 μm and the predicted life is 2.5 years, it is recommended that the daily inspection cycle is three months and the complete inspection cycle is one year. When the chloride ion concentration is higher than $2 \times 10^{-7}$ g/mm², it is necessary to clean the surface of the cable effectively.

6.2. Analysis of Bearing Capacity of Galfan Cable after Corrosion. Figure 20 illustrates the section change trend of the wire in 50 years according to the regression curve obtained from the test. It can be seen that the corrosion rate of the outermost layer wires is generally higher than the secondary layer wires. The CR of the wires is accelerated with high stress, and the section loss of the wire increases significantly after 50 years. In Figure 20, with the increase in time, the corrosion rate of the secondary layer wire is higher and higher, which is much higher than that of the outermost layer wire, which can be explained that the corrosion rate is accelerated under high stress. Moreover, the torsion of the wires after applying high stress weakens the sealing effect of the secondary layer wire due to the short cable in this test.

The Co layer of the cable is protected by anticorrosion filler, which can be considered that it will not corrode. [20] If it is assumed that the corrosion rate of the base material is the same as that of Galfan coating, and the cable wire corrodes at a uniform rate determined by the test, the variation law of the bearing capacity is estimated according to the variation law of the average cross-sectional area. The degradation curve of the residual bearing capacity of the cable with time is shown in Figure 21. The results show that the residual bearing capacity of unstressed and high-stress cables is about 79% and 45% after 50 years of corrosion. It is further verified that high stress will accelerate corrosion.
Table 3: Life prediction of Galfan coatings with different thickness (temp = 25°C, RH = 90%).

<table>
<thead>
<tr>
<th>Measured value</th>
<th>Galfan coating thickness (μm)</th>
<th>Linear model (a)</th>
<th>Bilinear model (a)</th>
<th>Bilinear model considering chloride accumulation (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>359</td>
<td>7.7</td>
<td>49.8</td>
<td>51.4</td>
</tr>
<tr>
<td>Larger value</td>
<td>227</td>
<td>4.9</td>
<td>30.7</td>
<td>32.2</td>
</tr>
<tr>
<td>Average</td>
<td>51</td>
<td>1.1</td>
<td>5.2</td>
<td>6.7</td>
</tr>
<tr>
<td>Minimum</td>
<td>22</td>
<td>0.5</td>
<td>1.1</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Figure 19: Relationship between CR of Galfan coating and chloride ion concentration.

Figure 20: Cross-sectional loss prediction in 50 years. (a) No-stress unprotected coating cable. (b) High-stress unprotected coating cable.
Based on the on-site measurement of Shanghai Oriental Sports Center, this study determines that the natatorium is a constant temperature and humidity environment. Then, the constant temperature and humidity corrosion test simulates the corrosion of the Galfan-coated cable with a certain amount of chloride ion accumulated on the surface in the natatorium environment to obtain its early corrosion rate. Later, the neutral salt spray accelerated corrosion test was carried out to speculate the corrosion rate of the cable in the natatorium environment in the middle and later stages. The following conclusions can be drawn from the field measurement and test data.

1. The on-site measured data show that the temperature in the natatorium environment is about 24–26°C and the relative humidity is about 80–90%. The constant temperature and humidity environment can be conservatively used to simulate the natatorium environment in engineering.

2. In a constant temperature and humidity environment, the corrosion rate of Z-shaped wire alone is 0.0107%/d before 120 d and 0.00155%/d after 120 d. The corrosion rate of the outermost layer wire is 0.0049%/d, and the corrosion rate of the secondary layer wire is 0.0014%/d, which is lower than that of the single wire.

3. High stress will accelerate the corrosion of cables, and a protective coating can effectively prevent the corrosion. It is recommended to use a protective coating for high-stress cables in engineering.

4. The bilinear model and the bilinear model considering chloride ion accumulation can better fit the corrosion rate of the Galfan coating. The minimum thickness of the Galfan coating is 22 μm. The predicted service life is 2.5 years. It is suggested that the daily inspection cycle is three months, and the complete inspection cycle is one year.

5. In the natatorium environment, the residual bearing capacity of no-stress Galfan-coated cable and high-stress Galfan-coated cable is about 79% and 45% of the initial bearing capacity, respectively.

**Data Availability**

We hereby declare that the data used in this manuscript were obtained from the participants’ actual measurements and analysis during the study period, and the data are all true and valid.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

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