ASSESSMENT OF CORROSIVE ENVIRONMET AROUND CROSS SECTION OF STEEL GIRDER BRIDGE

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1. INTRODUCTION

It is important to accurately assess corrosion environment of steel bridge for an appropriate corrosion prevention and maintenance management. Corrosion is one of the most important factor of degradation of steel infrastructures which affects their long term performance and durability. This research aims to assess the corrosive environment of steel structures on-site by field measurement. Hence, Evaluation of dew condensation as a results of temperature and relative humidity which is one of the fundamental corrosion factor of steel bridge were carried out at Sanbonmatus Bridge. In addition, in this study girder temperature is assumed equal to atmospheric temperature. Whereas, in reality there exist slight differences between them. Therefore, a temperature modification factor also has been proposed to obtain the actual girder temperature from atmospheric temperature.

2. EVALUATION OF DEW CONDENSATION

In this study, dew point-temperature (T_{DEW}) is obtained step by step as a following:

a) Atmospheric temperature and relative humidity were obtained on-site by field measurement.

b) The dew point-temperature is calculated from atmospheric temperature and relative humidity at saturated vapor pressure by using Sonntag's equation either from equation (1) or (2). Here y= ln (÷611.213).

In case of y ≥ 0;

$$T_{Dew} = 13.715 \times \mathrm{y} + 8.4262 \times (10^{-1}) \times y^2 + 1.9048 \times (10^{-2}) \times y^3 + 7.8158 \times (10^{-3}) \times y^4 \quad (1)$$

In case of y< 0;

$$T_{Dew} = 13.7204 \times \mathrm{y} + 7.36631 \times (10^{-1}) \times y^2 + 3.32136 \times (10^{-2}) \times y^3 + 7.78591 \times (10^{-3}) \times y^4 \quad (2)$$

c) Dew condensation can be evaluated by subtraction of temperature from dew point-temperature ($\Delta t = T_{DEW} - T$). The dew occur whenever Δt is greater than zero.

3. OVERVIEW OF SITE OBSERVATION

On-site observation has been conducted at Sanbonmatus Bridge. (Fig. 1) shows the bridge overview, (Fig. 2) shows the bridge cross section and set position of measuring instruments. This bridge is located in Aichi Prefecture, Japan. This is steel girder bridge with wide of 12m which has been built in 2007.

4. FIELD MEASUREMENT

(Fig. 3) and (Fig. 4) show evaluation of dew condensation in November-2017 and January-2018 respectively. As the temperature differences between girder temperature and the dew-point temperature became small which continuously increase the tendency of dew condensation. The dew principally occur whenever girder temperature falls below the dew point-temperature. From this result of field measurement clearly realize that the dew occur around the targeted bridge and the environment can cause corrosion of steel bridge.

Furthermore, the Atmospheric Corrosion Monitoring (ACM) sensor result can be observed from (Fig. 5). This graph also obviously denotes the dew condensation, because the corrosion current is greater from 0.01. This range is fully states the dew condensation. Hence, the evaluation results by field measurement demonstrates the dew condensation by ACM sensor as well.

5. TEMPERATURE MODIFICATION FACTOR

In this study, girder temperature was assumed equal to atmospheric temperature and based on this assumption evaluation of dew condensation were carried out. To equalize the atmospheric temperature with actual girder temperature a modification factor needs to be proposed.

The analysis results clearly shows that the modification factor can be different seasonally. In this research, we obtained the relation based on the winter season temperature. The temperature differences obtained by calculation of Mean Error (ME) and Root Mean Square Error (RMSE). It is figured out that there is no differences except minimum and maxim points when both temperature reach to the lowest and highest value as shown in (Fig. 6) before and (Fig. 7) after modification. It is found the girder temperature is higher in comparison to air temperature.
The approximately mathematics relation is as following:

$$T_{girder} = T_{atm} + 0.7 \sim 1 \quad (3)$$

Whereas; T_{girder} is temperature of girder and T_{atm} is atmospheric temperature.

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Figure 1: Sanbonmatus bridge overview.

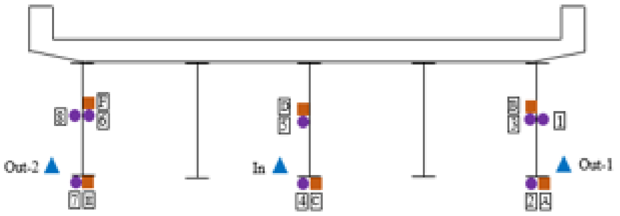

Figure 2: Set position of measuring instruments.

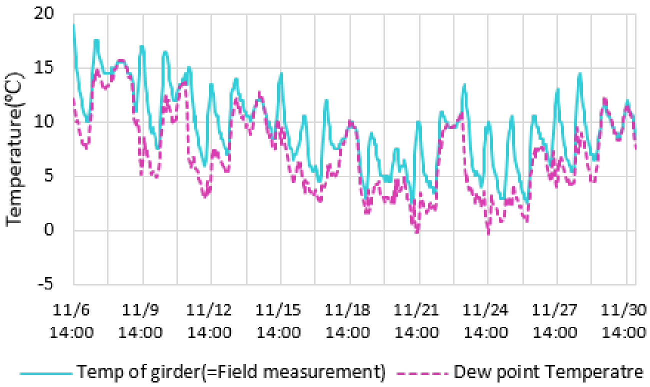

Figure 3: Evaluation of dew condensation by field measurement in Nov-2017.

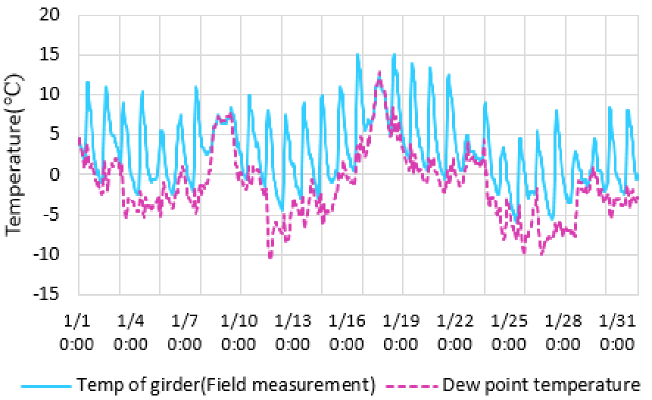

Figure 4: Evaluation of dew condensation by field measurement in Jan-2018.

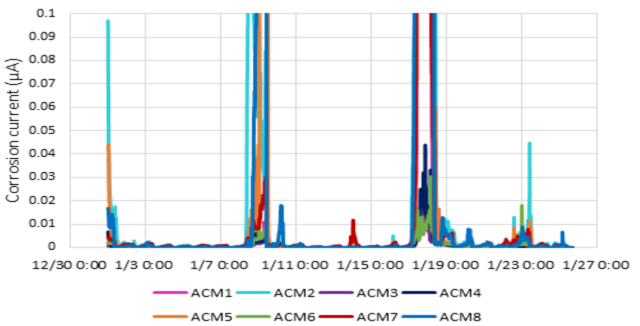

Figure 5: Evaluation of dew condensation by ACM sensor.

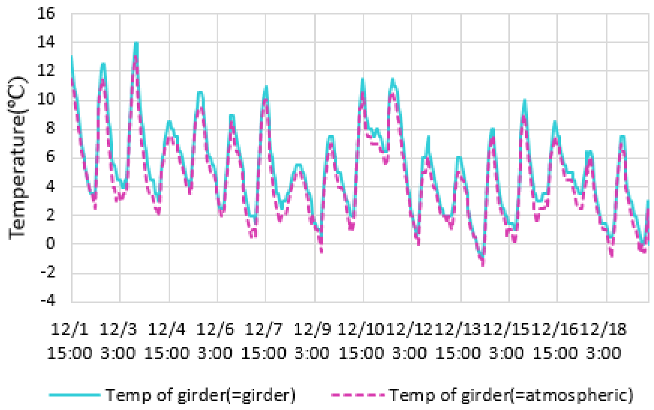

Figure 6: Comparison of actual atmospheric temperature with girder temperature.

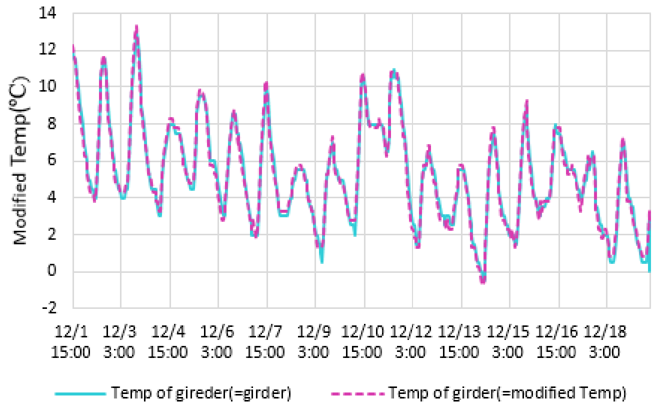

Figure 7: Comparison of modified temperature with girder temperature.

6. RESULTS AND DISCUSSIONS

The frequency number of dew has been counted for (Fig. 3) and it was reached to 51 times in November. Similarly, it counted for (Fig. 4) which reached to 38 times for January. From numerical evaluation results, it is found that dew condensation remarkably occur around the targeted bridge. Additionally, evaluation results by ACM sensor also demonstrates the dew condensation as shown in (Fig. 5). Since, the ACM results are greater than 0.01 for most period of time. Hence, both the high frequency number of dew and ACM results fully confirm the corrosiveness of environment around bridge which cause bridge corrosion.

Finally, the proposed temperature modification factor is quite suitable. Since, the temperature differences as shown in (Fig. 7) is fully minimized after applying the proposed equation (3).

7. CONCLUSIONS

1) It is found from field measurement result that dew condensation occur around the targeted steel girder bridge.
2) The corrosive environment can be simply assessed by numerical evaluation of dew condensation.
3) The actual girder temperature can be obtained from air-temperature by applying proposed modification factor.