Evaluation of dew condensation of steel girder using weather data

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1.Introduction

Steel structures are aging nowadays in Japan, because most of them constructed within the period of extremely rapid economy growth. Therefore, fundamental and strategic maintenances are required to deal with this problem. This paper describes environmental corrosion of steel structure due to atmospheric temperature and relative humidity which is one of the substantial corrosion factors of bridge. Evaluation of dew condensation as a result of atmospheric temperature and relative humidity, which cause corrosion of bridge and deterioration of coating was investigated through weather prediction method (WRF) in Aichi Prefecture.

2. Methodology

A wide range of steps kept consider in a sequence to proceed the evaluation in this study, dew point temperature was necessary for the sake of evaluation of dew condensation, also atmospheric temperature and relative humidity were required to obtain dew point temperature itself. Therefore, firstly atmospheric temperature and relative humidity were obtained in each single point throughout Aichi Prefecture by using weather prediction technics (WRF), within range of 136.75 to 137.75 longitude and 34.65 to 35.40 latitude at each center point of 0.05 interval. Then, three domains were set up while running (WRF) program in this study. First domain (1000km×1000km), second domain (300km×300km) and third domain (100km×100km) were created with considering grid interval (25km , 5km and 1km) respectively. Each domain was kept in view 40km vertically as well Fig.1. According to mentioned domain size, grid interval, longitude and latitude, once the temperature and relative humidity found out by WRF then, the dew point temperature ($\mathrm{T_{DEw}}$) was calculated by using the saturated vapor pressure e(hPa) at dew point temperature from atmospheric temperature and relative humidity by Sonntag`s equation as following. Here, y = $\ln\left(\frac{e}{611.153}\right)$.

When $y \geq 0$, $\quad \mathrm{T_{DEW}} = 13.715y + 8.4262\times 10^{-1}y^2 + 1.9048\times 10^{-2}y^3 + 7.8158\times 10^{-3}y^4$ (1)

When $y < 0$, $\quad \mathrm{T_{DEW}} = 13.7204y + 7.36631\times 10^{-1}y^2 + 3.32136\times 10^{-2}y^3 + 7.78591\times 10^{-4}y^4$ (2)

Here, the dew point temperature is calculated either from equation (1) or (2). Then, the dew condensation can be found out easily from equation (Δt=T_DEW-T) and it points out that the dew condensation occur when Δt greater than zero.

3. Weather Research Forecasting Model (WRF)

The weather research and forecasting (WRF) model is a numerical weather prediction system designed for both atmospheric and operational forecasting needs. The model serves a wide range of meteorological applications across scales from ten to thousands of kilometers. It is a collaborative partnership among the National Center for Atmospheric Research (NCAR) and National Center for Environmental Prediction (NCEP). Also it is for prediction of temperature, humidity, precipitation … and sun as a free open source.

Execution Process of WRF

The process of WRF as shown in Fig.2 is WRF preprocessing system (WPS) until the WRF analysis starts running. Firstly analysis domain, analysis period and analysis center point are set by using namelist WPS, then topography and land use are set to execute geogrid. Following by running ungrib, weather data is extracted and intermediate file format is created. Then, topographic data and metrological data are synthesized by running metgrid. After that, by editing namelist input for particular period and physical parameters. The initial value data and initial boundary value data are created. Later on wrfout is created through executing real.exe. Finally, atmospheric temperature and relative humidity are obtained by using Grid Analysis and Display system (GrADS) and by putting (tc or rh, longitude, latitude, start time, ending time) as numerical value.

Keywords: Steel girders, Evaluation of dew condensation, Weather data, WRF
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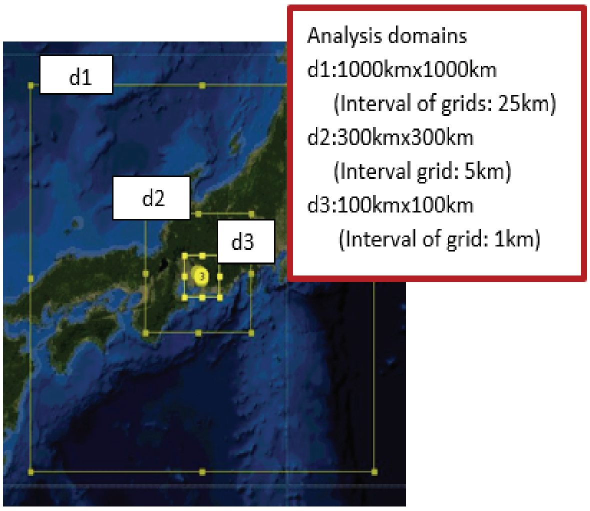

Fig.1 Analysis region plotted in WRF (Aichi Prefecture)

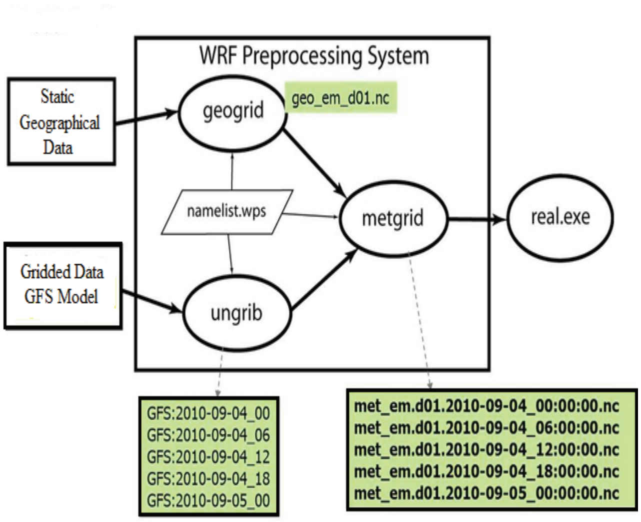

Fig.2 Excution Process of WRF

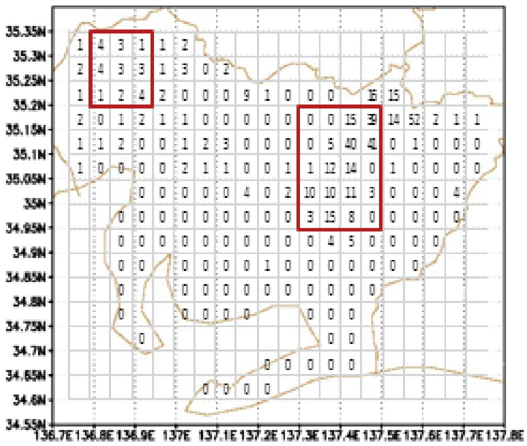

Fig.3 Evaluation of dew condensation (Case-1, FEB-2017)

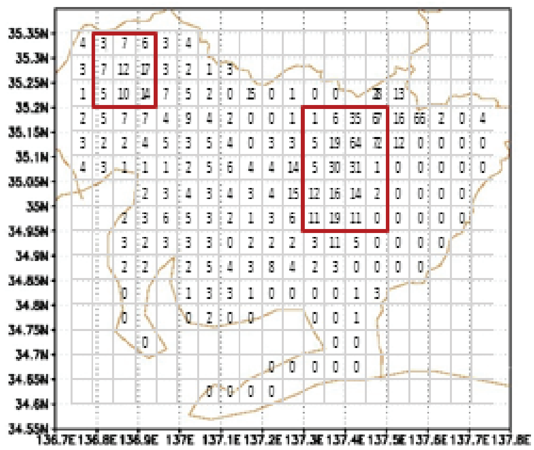

Fig.4 Evaluation of dew condensation (Case-2, FEB-2012)

4. Result and Discussion

Evaluation of dew condensation was carried out across the Aichi prefecture. Case-1 as shown in Fig.3 illustrates the frequency number of dew condensation in the whole month in February 2017. Then, Case-2 shown in Fig.4 depicts the frequency of dew condensation in February 2012. In both cases the dew condensation is occurred similarly in the northwest and northeast of Aichi prefecture with high amount. Whereas the frequency number of dew condensation in Case-2 as shown in Fig.4 is higher compare to Case-1. That it might be due to annually atmospheric weather variations.

5. Conclusion

This study aimed at clarifying the corrosion of steel structures due to atmospheric temperature and relative humidity. The Entire condition of dew condensation was investigated in Aichi prefecture and summarized as following

1. The proposed method using WRF is effective for dew condensation evaluation.
2. To investigate the corrosion of steel structures due to atmospheric temperature and relative humidity is suitable.

6. References

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