

RTRI Develops a Program to Predict Frost Formation on the Contact Wire

RTRI Developed a Program to Predict Frost Formation on the contact wire (Fig.1) to accurately predict frost formation on the contact wire on the early winter morning based on the weather data along the railway line. This program will be useful to efficiently implement measures to prevent frost formation on the contact wire.

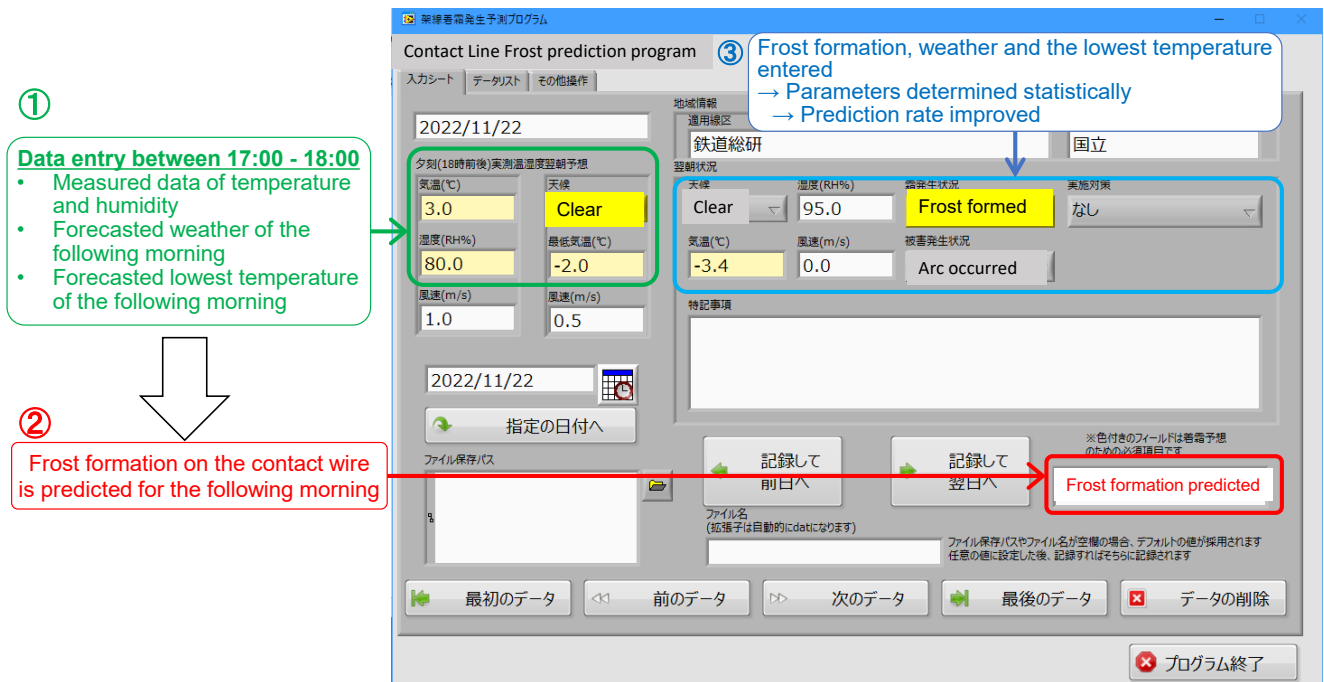


Fig.1 A screen displaying the predicted result of the program

1. Background

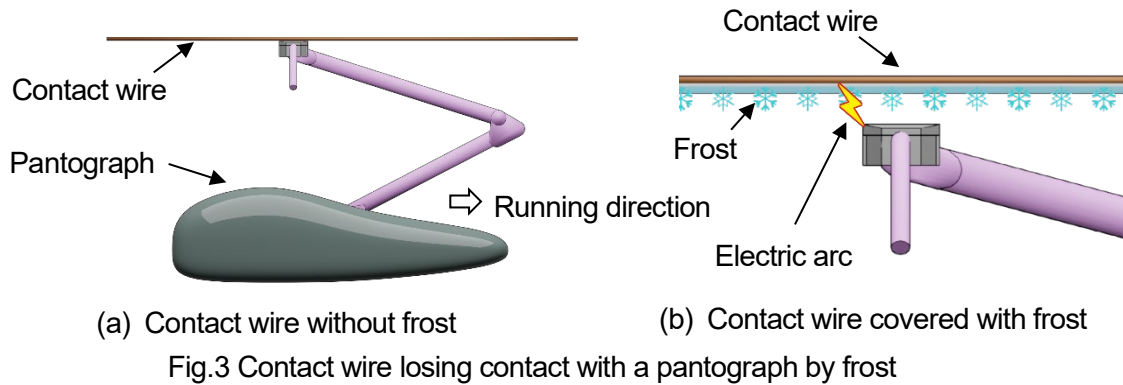
On the morning of a clear winter day, the contact wire tends to be covered with frost (Fig.2). Frost is formed by water vapor that is condensed in low temperatures of the wire surface.

Trains are powered through the contact of pantograph and the contact wire (Fig.3(a)). However, if the wire is covered with frost, the contact may be lost (Fig.3(b)). The contact loss might cause arcing and it may damage pantographs, if it occurs frequently.

In order to prevent these phenomena, on the day when frost is expected to be formed, train operators run a so-called “defrosting train” which has a special pantograph to scrape the wire frost prior to the first train, or reduce train speeds in order to save electricity for running.



Fig.2 Frost formation on the contact wire



So far, the decisions to implement these measures have been empirically made based on weather data like temperatures and relative humidity. However, as such an empirical prediction is not so accurate, a more accurate method has been needed.

2. Outline of the program

This program predicts frost formation precisely based upon the mechanism of frost formation and the weather data of the nearby observation points of the Japan Meteorological Agency and other weather forecasting companies. The prediction flow is shown in Fig.4. With this program, the measures can be implemented efficiently.

- In this program, based on the weather forecast data such as the lowest temperature and weather for the following morning, the decision is made on whether frost formation on the contact wire is likely to occur or not, and whether preventive measures will be required or not.
- When frost formation is expected, water vapor concentration is calculated from the temperature and relative humidity at 6 o'clock in the evening at the observation point. The lowest possible temperature of the contact wire on the following morning is also estimated from the lowest temperature and saturated water vapor concentration around the wire is calculated. The prediction of frost formation is finally made by comparing between the water vapor concentration and the saturated water vapor concentration.

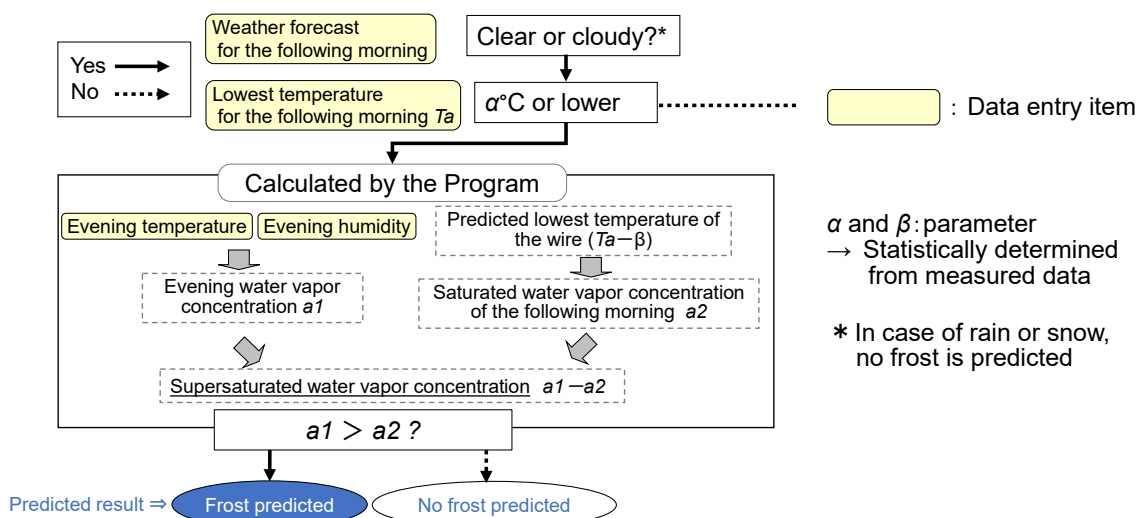


Fig.4 Flow of frost formation prediction

- It was confirmed by the on-site test that the prediction rate of this program is about 80%, 20% more accurate than that of empirical prediction method (Fig. 5 “Initial value of this program”).
- In predicting frost formation using this program, an error might occur due to reasons including distance between the weather observation point and the section where frost formation is predicted. If the actual frost formation data were entered, this program automatically adjusts the parameters (Fig. 4 α and β) in order to minimize such an error margin. It was also verified that the prediction rate can be improved to 90% or higher by accumulating the data for 4 months period (Fig. 5 “This program with adjusted parameters”).
- This program can be run on PC.

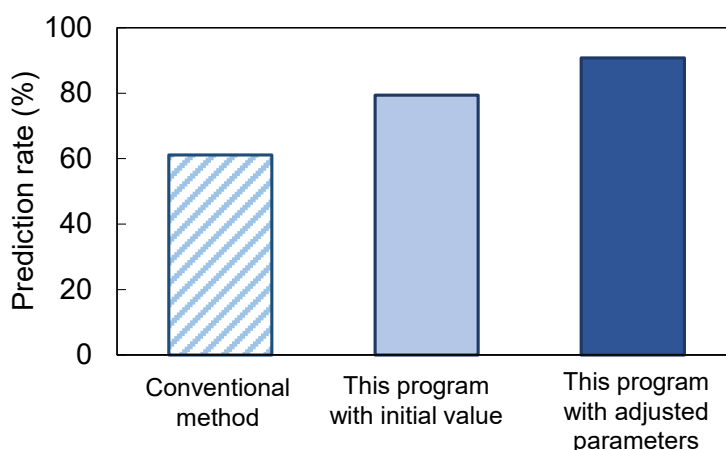


Fig.5 Flow of frost formation prediction

3. Release date

This program became available in January 2023 from TESS Co., Ltd.

Part of the technologies used for this program have been patented in Japan (patent number 6703957).