Application of Atmospheric Corrosion Sensor Based on Strain Measurement Case study in Da Nang City Vietnam and Yokohama Japan

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ABSTRACT: By using strain gauge to sensitively record the change of bending caused by corrosion progress on a low carbon steel plate, the atmospheric corrosion sensor based on strain measurement (ACSSM) has been successfully employed in the controlled conditions in laboratory. In this study, further applications of ACSSM under practical atmospheric conditions have been carrying out for a long-term monitoring in Da Nang City and Yokohama City. The dummy-active gauge configuration has been applied for temperature compensation. It is observed that there was a great fluctuation of bending strain under out door conditions compared to results tested under ambient conditions. The research is still on progress for at least a period of one year to thoroughly grasp information of atmospheric corrosion.

Keywords: ACSSM, strain measurement, dummy-active gauge

INTRODUCTION

Since the atmospheric corrosion became a part that had to be monitored in inspection field, the study of atmospheric corrosion monitoring is needed. Many studies of atmospheric corrosion monitoring, such as weight loss [1-2], wet candle [3], electrical resistance [4], optical focusing technique [5], electrochemical impedance spectroscopy (EIS) [6] have been used for monitoring atmospheric corrosion. In our group previous study, the ACSSM sensor configuration was designed and tested in laboratory [7,8].
This paper describes the investigation of ACSSM sensor in the outdoor condition in Yokohama, Japan and Danang, Vietnam.

ACSSM PRINCIPLE

The principle of ACSSM sensor that can measure the thinning of test piece based on the compressed after the deformation. The strain and thickness relationship as expressed by [7]:

$$\varepsilon = -\frac{y}{2\rho} \quad (1)$$

Where ε is strain (-), y is thickness of test piece (mm) and ρ is curvature of test piece (mm). If the corrosion occurred, the thickness of the test piece will decrease as Δy and with the assumption that $\rho >> y$, the change in strain is expressed by

$$\Delta\varepsilon = -\frac{\Delta y}{2\rho} \quad \text{and} \quad \Delta y = -2\rho\,\Delta\varepsilon \quad (2)$$

Under the constant ρ, the change of the thickness of the test piece can be measured by the change in strain.

ACSSM SPECIFICATION

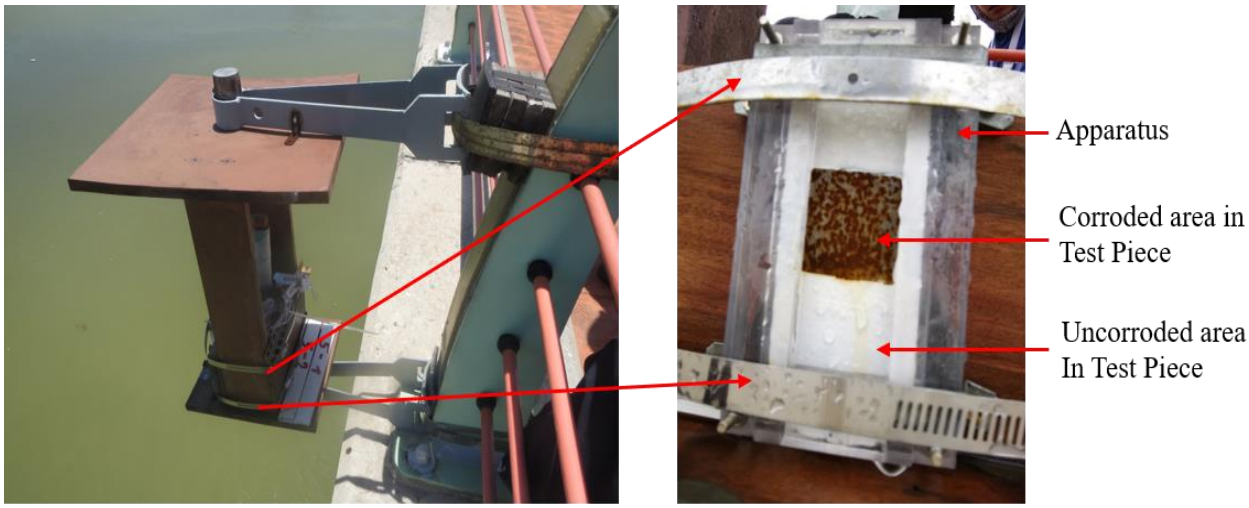
The low carbon steel test piece was 95 mm in length, 45 mm in width and 0.50 mm in thickness was used with the corroded area is 900 mm^2. The apparatus which has ρ = 430 mm in the elastic deformation is expressed as follows using Hooke's law and Equation (1):

$$\rho = \frac{Ey}{2\sigma_y} \quad (3)$$

Where E is Young's modulus and σ_y is a yield stress. The configuration strain gauge on the test piece as dummy-active gauge placed in the function area of the test piece. The active gauge is for getting the signal and touched in the back side of corroded area. The dummy gauge is for temperature compensation and touched in the back side of uncorroded area.

ACSSM PROJECT

The goal of ACSSM project is for monitoring atmospheric corrosion in bridges that is important part of infrastructure system and for measuring the



a b

Fig. 1 a. Monitoring station of ACSSM sensor. b. Apparatus and the test piece

corrosion rate of each monitoring station. As we know that corrosion rate is important parameter for maintenance of infrastructure.

In this project, the ACSSM sensor had been installed at 8 monitoring stations as shown in Figure 1a. There are 6 stations at the bridges in Danang, Vietnam and 2 stations at the outside laboratory, 1 station at Danang University of Technology and 1 station at Yokohama National University.

The location of the ACSSM sensor in Danang, Vietnam is at 6 bridges (deck of Thuan Phuoc Bridge, anchor of Thuan Phuoc Bridge, Song Han Bridge, Rong Bridge, Tran Thi Ly Bridge, Tien Son Bridge) and 1 station at Danang University of Technology, Danang, Vietnam that located 1.3 km from the sea.

The location of the ACSSM sensor in Yokohama is at the outside of NDT Laboratory of Yokohama National University, Kanagawa Prefecture, Japan. This location is located 5 km east of the sea.

In this study, the strain of the sensor will be sampled every week using the strain meter. The strain meter measured the strain gauge in the set of test piece and apparatus as shown Figure 1b. This monitoring had been started since March 2017. The research is still on progress for one year to get the information of atmospheric corrosion.

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