XV International Conference on Durability of Building Materials and Components
DBMC 2020, Barcelona
C. Serrat, J.R. Casas and V. Gibert (Eds)

Post Peak Behavior of Carbonated Concrete Structure - A Case Study of the Former Shime Mining Office Vertical Derrick in Japan

Kaiting Su[1], Kei-ichi Imamoto[2], Takafumi Noguchi[3], Manabu Kanematsu[4], Hitoshi Hamasaki[5], Kohji Teranishi[6], Chizuru Kiyohara[7] and Munenori Yamada[8]

1 Tokyo University of Science, viki417@gmail.com

2 Tokyo University of Science, imamoto@rs.kagu.tus.ac.jp

3 The University of Tokyo, noguchi@bme.arch.t.u-tokyo.ac.jp

4 Tokyo University of Science, manabu@rs.noda.tus.ac.jp

5 Shibaura Institute of Technology, hamasaki@shibaura-it-ac.jp

6 Meijo University, ktera@meijo-u.ac.jp

7 Tokyo University of Science, ckiyo@rs.tus.ac.jp

8 Center for Better Living, m-yamada@tbtl.org

Keywords: *Durability, Historical Buildings, Concrete Spalling, Concrete Moisture, Rebar Corrosion.*

1 Introduction

This paper is a report on the investigation results of the Former Shime Mining Office Vertical Derrick, as shown in Figure 1, which was 75 years old at the time of the investigation and had suffered from severe deterioration including rebar corrosion, which led to large area of concrete spalling. In addition, a possible relation between concrete spalling and rainfall was observed. The proposed equations indicate the possibility to predict spalling area by observing the proportion of wet area affected by rainfall.

2 Approach

To monitor the inner relative humidity evolution where the concrete cover was thin, several thermo-hygrometers were implanted inside the concrete with cover thickness of 10 and 40 mm.

3 Results of Relative Humidity Monitoring, Cover thickness and Concrete Spalling

The results of relative humidity and temperature indicate that places with thinner cover thickness tends to be influenced by whether events such as rain. Furthermore, concrete spalling that led to rebar expose occurs at places where cover thickness was less than 25 mm.

4 Discussion

The relation between rainfall and spalling can be presented as in equation (1) and (2). The percentage of the spalling area and the wet area during rainfall are shown in Table1. While the

value of the empirical coefficient α needs further discussion, in the case of this building, when α=0.006, the correspondence between the spalling area and the wet area is acceptable, as shown in Table 2.

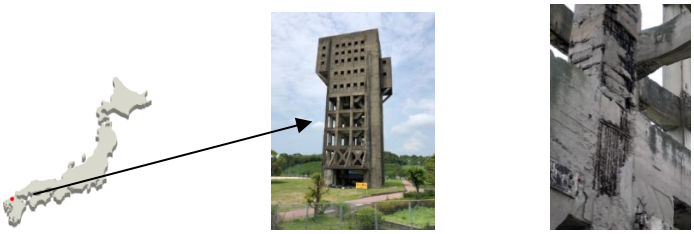

Figure 1. Photo of the Former Shime Mining Office Vertical Derrick.

$$\textit{oefficient of Rainfall} = \textit{Percentage of Wet Area} \times \textit{Number of Days with Precipitation over 10mr} \quad (1)$$

$$\textit{Percentage of Spalling Area} = \textit{Years after Carbonation reaches 25mm} \times \textit{Coefficient of Rainfall} \quad (2)$$

$$\textit{Percentage of Cover Thickness Less than 25mm} \times \alpha$$

Table 1. Percentage of spalling area and wet area.

	West	South	North	East
Spalling area	9.91%	5.20%	9.35%	3.71%
Wet area	78%	19%	70%	36%

Table 2. The estimated and measured value of spalling area of the east and the west side.

Percentage of Spalling Area	East	West
Estimated Value	3.63%	5.45%
Measured Value	3.71%	9.91%

5 Conclusions

Concrete spalling tends to occurs where cover thickness is thinner and there is a possible relation between spalling and rainfall although the relation needs further confirmation.

ORCID

Kaiting Su: https://orcid.org/0000-0003-2503-4154
Kei-ichi Imamoto: https://orcid.org/0000-0001-8174-8827
Takafumi Noguchi: https://orcid.org/0000-0001-6115-2292
Manabu Kanematsu: https://orcid.org/0000-0003-2473-0625
Hitoshi Hamasaki: https://orcid.org/0000-0002-1830-3734
Chizuru Kiyohara: https://orcid.org/0000-0003-1286-9056

References

Kyushu Sangyo University. *The possibility of Reservation of the Former Shime Mining Office Vertical Derrick*

Shimen Town. *Important Cultural Property Plan for Reservation and Utilization of the Former Shime Mining Office Vertical Derrick.*

Tomotaka Ide. (2019) *Investigation of Shime Old Coal Mine Tower-Part 1 Result of the Cover Depth and Rebar Corrosion, and Humidity Change in Concrete, Summaries of Technical Papers of Annual Meeting,pp.807-808,Sep.,2019*