Committee on the Quantitative Estimation of Salt-damaged Environments (348)

In order to predict the deterioration of concrete over time, it is necessary to quantitatively estimate the deterioration environment (deterioration external forces and various factors affecting them). Its importance has been well recognized for some time. However, there are many environmental factors that are directly or indirectly related to concrete deterioration. In addition, a method for quantitatively estimating these effects and incorporating them into a method for predicting the progress of deterioration has not been established.

However, there is a strong demand for long-life structures and proper maintenance of existing structures. For this reason, we thought that it was necessary to reconfirm the current situation as well as discuss the direction of future research and the specific content to be addressed. Therefore, this committee focused on salt damage in various degraded environments with the theme of its quantitative estimation. The committee began its work in 2013 and was active for about four years over two terms.

In the first term (2013-2015), we investigated the current status of salt-damaged environment assessment from the viewpoints of action and response, micro- and macro-environments, and research. In particular, it is one of the unique aspects of this committee that the scope of the survey was not only salt damage in the concrete engineering field (civil engineering and architecture) but also salt damage in other fields, such as agriculture and power transmission. In addition, in order to quantitatively estimate salt damage, it is important to promote and continue efficient research, including exposure tests of specimens, accumulation of investigation data of structures, and the sharing of such information. For this reason, this committee constructed a database of salt exposure test sites using Google Earth and shared these data in the committee.

Moreover, based on the above survey results, we made the following recommendations for an ideal salt damage environment assessment: system/role assignment, utilization method for design, specific measurement/estimation method and validation method, engineer training, etc.

The committee's activities in the second term (2016-2018) created a foundation for creating the ideal form proposed by the committee based on the results of the first term.

Salt damage is evaluated using meso and micro environment scales. These scales target the differences in the environment of individual structures and each part of the structure. In particular, this committee targeted meso-micro environments with salt damage that have not been adequately examined and have little data. In addition, the results, specifically the content related to the salt damage environment evaluation and the durability design/maintenance management using it, will be published in future guidelines and specifications.

Specific activities were carried out in the WG. The activities of each WG were as follows.

(1) Scenario WG: Scenario for using salt damage environment assessments

The results of the salt damage environment assessment for each part of the structure are summarized for the following items. LCC (Life Cycle Cost) comparison, utilization for deterioration prediction, utilization of repair design, etc. Fig.1 shows an example of the estimated results of LCC based on a prediction of deterioration.

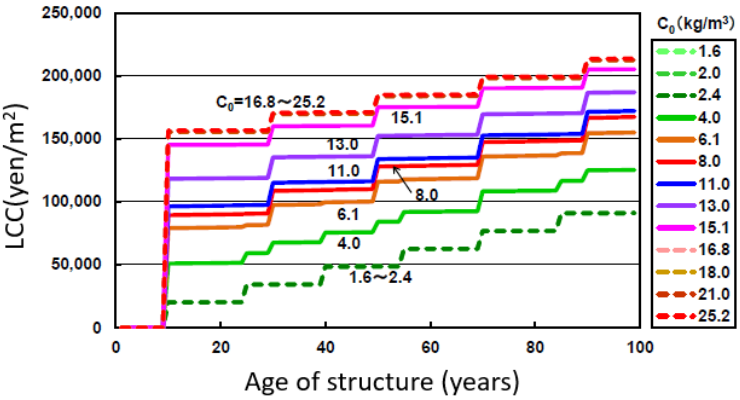
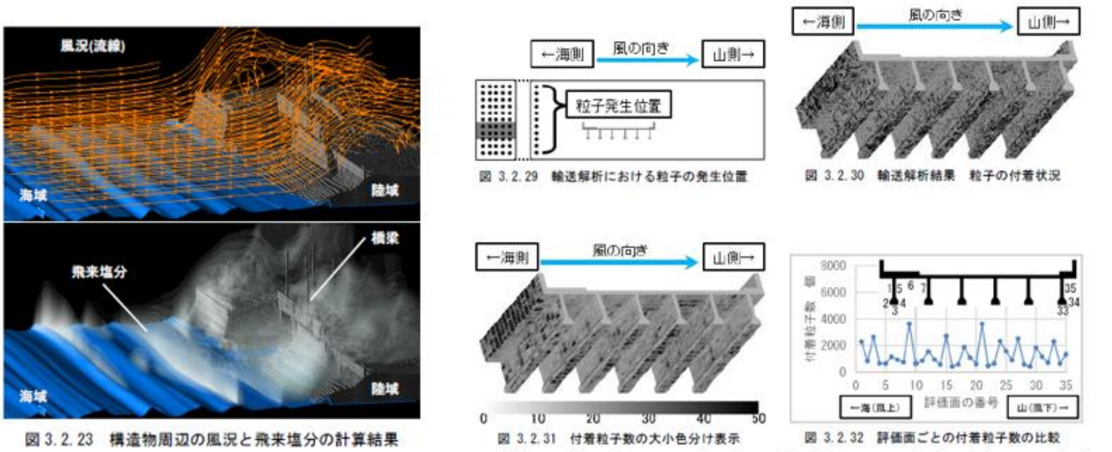


Fig. 1 Estimated results of LCC based on a prediction of deterioration (when measures are taken 10 years after construction)

(2) Design WG: Concept for incorporating the results of salt-damaged environment assessments

The effects of boundary conditions on the prediction of salt penetration are summarized and brief examples given of methods for determining the surface chloride ion concentration.

Fig. 2 shows an example of a numerical simulation for predicting salt damage that considers the meso/micro environments.



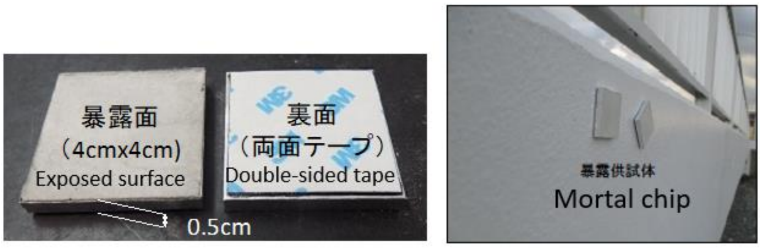
(a) Transportation analysis of airborne chloride

(b) Adhesion analysis of airborne chloride particles

Fig. 2 Numerical simulation for predicting salt damage that considers the meso/micro environments.

(3) Standard WG: Standardization of meso/micro salt-damaged environment assessment method

A draft standard had been proposed for a "mortar chip"(thin mortar specimen) evaluation method, which is expected to be widely used for evaluating the salt-damaged environment of each part of the structure, and for the exposure test method using it. Fig.3 shows a mortar chip that is used as common test by the committee and an example of an exposure test.

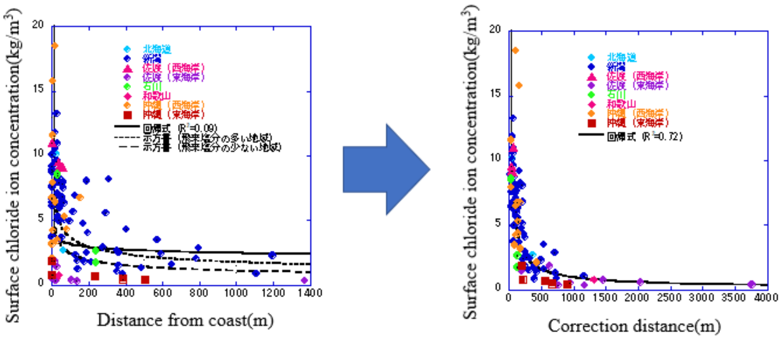


(a) Mortal chip (b) Exposure test situation

Fig. 3 Mortar chip and its exposure situation

(4) Common Test WG: Plan of common test and summary of the results

Exposure tests using the same specimens and test methods were conducted according to the proposed Standard WG on bridges and harbor facilities (pier superstructures) in various parts of Japan. The results were summarized and discussed. In the exposure test on the bridge, the authors tried to estimate the airborne chloride environment from the "corrected distance," i.e., the distance from the coast that is corrected by taking into account the installation altitude of the specimen, wind direction, and wave energy. Various factors affecting the test results for the pier superstructure were examined. Fig. 4 shows the relationship between the corrected distance proposed by the committee and the surface chloride ion concentration.



(a) Before correction

(b) After correction considering influence of elevation, wind direction and wave energy

Fig. 4 Relationship between the corrected distance proposed by the committee and the surface chloride ion concentration

The above activities establish the basis for incorporating salt-damaged environment assessment into actual work. We hope that the results of these activities will be further developed and disseminated and ultimately contribute to the appropriate design and maintenance of structures constructed in salt-damaged environments.