

**“Technical Research and Development for Road Policy Quality Improvement”
Study Summary**

No.	Title	Principal Researcher
No.28 - 6	Establishment of cover concrete quality inspection for new concrete structures	Hiroshima Univ. Prof. Kenichiro Nakarai

To construct durable road structures, an inspection method of cover concrete quality for newly constructed concrete structures has been proposed using three types of non-destructive tests. By combining three methods utilizing their own advantages, both simplicity and accuracy can be maintained in the proposed method. Based on laboratory experiments and field surveys, the feasibility of the method has been verified and then guidelines have been prepared to promote applications of the method in construction sites.

1. Backgrounds and Objects

Although cover concrete quality related to transport properties of concrete has a great impact on the durability of road structures, direct inspections are rarely applied in construction sites so far. To solve this problem, we investigated critical issues and future possibilities for developing a new inspection method to ensure cover concrete quality through activities in JSCE technical committee and research in the previous FS study in this project.

In this study, to construct durable concrete structures, an inspection method of cover concrete quality for newly constructed concrete structures has been proposed using non-destructive tests. By combining simple non-destructive tests, advanced non-destructive tests and core-sampling tests, both simplicity and accuracy can be maintained in the proposed method. Based on laboratory experiments and field surveys, the feasibility of the method is verified and guidelines are prepared to promote applications of the method in construction sites.

2. Activities in Research Period

Advantages and disadvantages of several tests such as Torrent's air permeability test and water intentionally spraying test (WIST) evaluating cover concrete quality have been investigated through laboratory experiments and field surveys. In the laboratories, various concrete specimens using different cement types, water-to-cement ratios, sealed curing periods were prepared to verify the applicability of test methods. In the field, the feasibility of the methods was investigated using newly-constructed concrete structures in Gunma, Hiroshima, and Yamaguchi in Japan. The prepared guidelines were used by practical engineers to improve the contents.

3. Study Results

As for a simple non-destructive test, the testing procedure using WIST was discussed comparing with air permeability coefficients obtained by Torrent's air permeability test. The total amount of sprayed water was used as a new index to reduce measurement errors by different devices and different inspectors. In addition, quick evaluation right after demolding at the early ages has been proposed considering the narrow measurement area by WIST.

As for an advanced non-destructive test, long-term measurements by Torrent's air permeability test has been conducted to find appropriate timing for concrete structures constructed in Japan. discussed. testing procedure using WIST has been

improved. Based on the obtained results, some modifications using Swiss standard has been proposed.

As for core-sampling tests, water absorption test based on ASTM standard was firstly used. Problems of linear approximation obtaining initial rate of water absorption on cored samples were discussed and a modification method was proposed. Furthermore, the results were compared with results by other tests such as WIST, Torrent's test, scaling test exposed to freezing-and-thawing cycles, and rapid chloride migration test.

4. Papers for Presentation

1. Nakarai, K., Shitama, K., Nishio, S., Sakai, Y., Ueda, H., and Kishi, T., Long-term permeability measurements on site-cast concrete box culverts. *Construction and Building Materials*, Vol.198, pp. 777-785, 2019.
2. Nguyen, M.H., Nakarai, K., Kubori, Y. and Nishio, S., Validation of simple nondestructive method for evaluation of cover concrete quality, *Construction and Building Materials*, Vol.201, pp.430-438, 2019.
3. Nguyen, M.H., Nakarai, K. and Nishio, S., Durability index for quality classification of cover concrete based on water intentional spraying tests. *Cement and Concrete Composites*, Vol.104, 2019.

5. Study Development and Future Issues

Since guidelines have been prepared in this study, cover concrete quality evaluation/inspection can be conducted by contractors and owners/inspectors. Accumulating measurement results on sites can be used for further improvement of the method. In addition, recorded data regarding initial quality of concrete structures should be utilized for later maintenance works by the owners. On the other hand, the study can be extended to digenesis of existing concrete structures to predict remaining service life.

One of the remaining issues in this study was the rain effects on non-destructive measurement, quality changes due to additional cement hydration, and deterioration process. The purpose and timing of cover quality inspection under the rain effects need to be discussed more with additional field surveys.

Quality control of precast concrete members in plants is another interesting target of the non-destructive tests because acceleration by steam curing may stabilize moisture content at the early ages.

6. Contribution to Road Policy Quality Improvement

The output of this study, in particular, a guideline for conducting water intentional spraying test (WIST), has been already used in one of the local governments in Japan. Quality improvement found in new concrete structures ordered by the local government must be good advertisements to distribute our findings to the practice.

In addition, international activities can be promoted by collaborating Vietnamese universities in Hanoi. Some Vietnamese students and lecturers have already studied the technologies during their studying at Hiroshima University.

7. References, Websites, etc.

A guideline for conducting water intentional spraying test (WIST), which was developed in this study, has been installed into a new guideline for quality control of concrete structures published by Gunma prefectural government in Japan at the end of March in 2019.