MEASUREMENT OF AIR PERMEATION PROPERTY OF COVER CONCRETE

The University of Tokyo, JSCE Member, Phan Huu Duy QUOC
The University of Tokyo, JSCE Member, Toshiharu KISHI

Abstract: The performance of cover concrete, which acts as a shield again the ingress of deleterious substances, is governed by not only the initial mix proportion, but also the construction conditions such as placing, curing, etc. This research investigates the use of a non-destructive method in measuring air permeation property. Results show that the air permeation coefficient varies in a wide range. An alternative parameter, air permeation index, was introduced for overall quality estimation

1. Introduction

Currently, the actual and future performance of concrete in structure cannot be properly evaluated due to inappropriate system and lack of technical tools. The verification of concrete durability using specimens cured under standard conditions fails to consider the effect of construction on concrete quality while common visual inspections just point out visible defects like cold joint, crack, etc. Therefore, it is necessary to select proper measurable-at-site criteria representing the quality of in-place concrete, not specimens. Undoubtedly, one of the most important criteria must be the resistance of cover concrete again the ingress of harmful environment. Due to various reasons, the quality of cover concrete tends to be lower than that of inner part (Fig. 1). It has been reported that bad curing will results in drastical change in air permeation property [1]. In this research, a nondestructive method was used for studying the air permeation property of cover concrete.

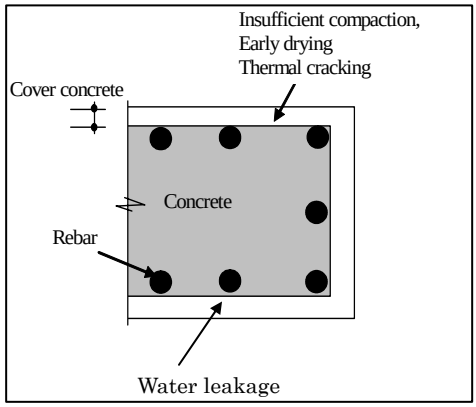

Figure 1: Factors influencing the quality of cover concrete

2. Experiment outlines

The measurement was carried out on two 6-year old concrete walls. Especially, the second wall has a side processed with coating material (side A) but the other side (side B) is not coated. The purposes were to (a) understand the inhomogeneity of concrete reflected in air permeation property. (b) Investigate the effect of coating on air permeation property

2.1. Apparatus for measurement

In this method, a double chamber is pressed to the concrete target to suck out air in pore system using a vacuum pump. By measuring the outward flow of air from concrete, the air permeation coefficient is calculated. Special features of this method are the use of a double chamber and being non-destructive. The outer chamber plays the role of a guard ring to ensure a one-dimensional outward air flow in the inner chamber (Fig. 2). The measuring time varies from 1.5 to 12 minutes, depending on concrete quality.

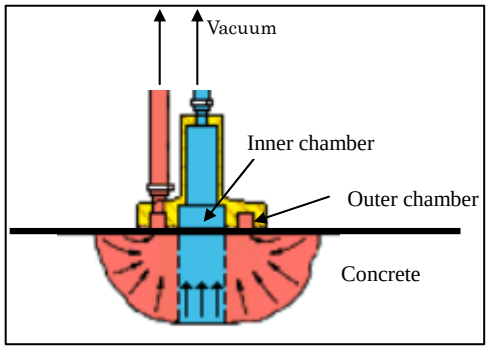

Figure 2: Principle of the non-destructive air permeation measurement apparatus

2.2 Quality classification based on permeation coefficient

According to Torrent's proposal [2], concrete quality is classified in 5 classes based on the coefficient of air permeation. Each class has a corresponding quality index and a range of air permeation coefficient. In Table 1, K_T is the coefficient of air permeation. This classification can be used for draft evaluation of concrete quality.

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E-mail: quoc@iis.u-tokyo.ac.jp, Tel: 03-5452-6393, Fax: 03-5452-6395

3. Results of measurement

3.1 In-homogeneity of concrete reflected in air permeation

The measured results show that air permeation coefficients of concrete vary widely (Fig. 4) and that their normal average values have low accuracy (Table 2). It means that to estimate the overall performance of a structure, the number of measurements must be large enough to consider the inhomogeneity of concrete. Therefore, selecting non-destructive and repeatable device for measurement is required.

Table 1: Quality classification

K_T	Quality index	Quality class
0.001-0.01	1	Very good
0.01 – 0.1	2	Good
0.1 – 1	3	Normal
1 – 10	4	Bad
10 – 100	5	Very bad

Table 2: Comparison between air permeation coefficients and air permeation indices

Measured Case	Air permeation coefficient (E-16m2)		Air permeation index		Permeation coefficient (converted from index)
	Normal average	Standard Deviation	Geometric Average	Standard deviation	
First wall	2.37	139.21%	2.156	18.42%	1.41
2nd wall, coated side	0.996	121.20%	1.84	18.61%	0.43
2nd wall, Non-coated side	7.769	80.31%	2.70	17.32%	4.96

3.2 Geometric average and air permeation index

The logarithm of air permeation has been reported having close relationship with durability properties [2], so it is defined as air permeation index. As shown in Table 2, the geometric average or air permeation coefficients, which means the average of air permeation indices, has higher accuracy compared with air permeation coefficient.

3.3 Effect of surface coating

Table 2 shows that the air permeation coefficient of the non-coated side is one order higher than that of coated side though they are made of the same concrete. Coating “up-grade” and makes the concrete apparently homogeneous as reflected in air permeation property (Fig. 3).

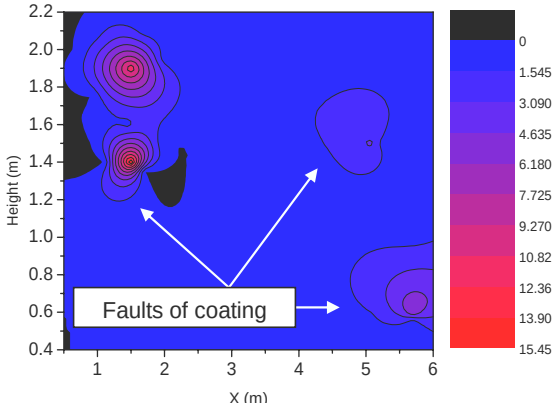

Figure 3: Results of air permeation coefficient measured on coated side

4. Conclusions

1) For overall evaluation of structure, the number of measurement should be large enough to take into account the inhomogeneity of concrete. The geometric average of air permeation coefficients, air permeation index, is recommended for overall estimation of concrete quality.

2) The coating of concrete surface apparently results in a “homogeneous” concrete but the coating is not always perfect. Plotting the contour of permeation coefficient, one can find un-satisfactory positions of coating.

3) Many issues, such as the effect of temperature and moisture condition, the relationship between transport and durability properties, model for performance prediction remains the challenges for the coming time.

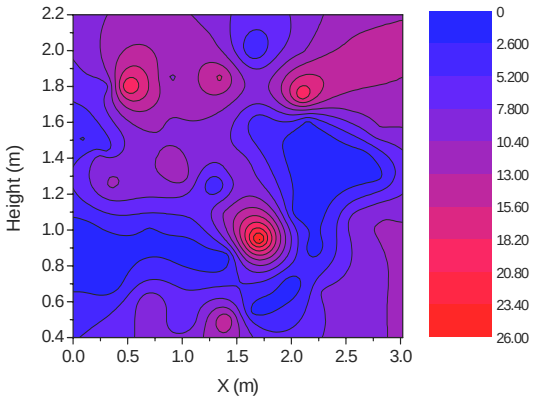

Figure 4: Result of the air permeation coefficients measured on non-coated side

Acknowledgements

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