EVALUATION OF AIR PERMEABILITY OF CONCRETE SURFACE USING THERMOGRAPHY

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1. INTRODUCTION

Air permeability alongside with water permeability are recognized as two basic parameters of concrete surface quality specially for structures which are exposed to harsh environment conditions. Indeed, most of the concrete defects like corrosion and cracks are due to migration of chloride and other deteriorating factors through the water and air pores in concrete. Therefore, there is a high necessity for introduction of instruments to evaluate the permeability of concrete surfaces. This paper discusses the application of thermography as a nondestructive tool for evaluation of air permeability of concrete and finds correlation between permeability and thermography patterns. instrument.

2. EXPERIMENTAL PROCEDURES

For the purpose of relating thermography to air permeability, the experiment was based on the studies of Wong (2007) which states that permeable concrete is more resistant to heat flow in comparison with the impermeable one**.** Meanwhile, the studies of Whiting (1988) show that air permeability increases with W/C. Therefore, three specimen having different W/C of 0.5, 0.6 and 0.7 were casted to have specimen with different permeability (Table 1). Then the specimen were subjected to water curing for 7 days just two days after casting. Then, they were taken out of water and put for drying under temperature of 20 ºC and humidity of 60 % for one day. Finally, on the 8th day of curing, their air permeability was first of all measured according to the Swiss Standard 262/1-E using Proceq Air Permeability Tester as done by Kucharczyková et al. (2010). Then each specimen was tested by thermography instrument called as NEC/AVIO Thermo Tracer. The experiment set up as shown in Figure 1 was such that each specimen was initially heated by a 1200 W heater for 11 minutes. Then, the heater was removed and as the cooling process started, thermal images were recorded up to the 25 minutes of cooling down process. Thermal images were taken each 30 sec for initial 5 min, each 1min for next 5 min, each 2 min for the next 10 min and one last image at 25th min. Finally temperature deviation and average temperature on the surface of specimen was calculated. Based on the result of Wong (2007), if we heat the center of two specimen, the more permeable concrete loses less heat to its surrounding area than a less permeable one. As a result, the temperature deviation on the surface is larger along with increment of W/C because the central part of concrete with higher W/C holds more temperature. As for this case, the heater is positioned almost above the center of the specimen and the temperature of concrete surface at the heating area increase upto 40 ºC . Finally, for correlating air permeability with thermography, one big and one almost smaller area of the thermal images near the center part were selected for comparison as shown in Figure 2. And then, the average temperature deviation over the target areas were calculated for whole 25 minutes for each W/C ratio case. Then the area between two deviation curves of same W/C ratio was calculated.

Table1 mix proportion

	W/C	W(kg/m3)	C(kg/m3)	S(kg/m3)	G(kg/m3)
1	0.5	142.5	350.0	745.0	985.0
2	0.6	142.0	292.0	766.9	1011.3
3	0.7	142.5	250.0	782.5	1030.0

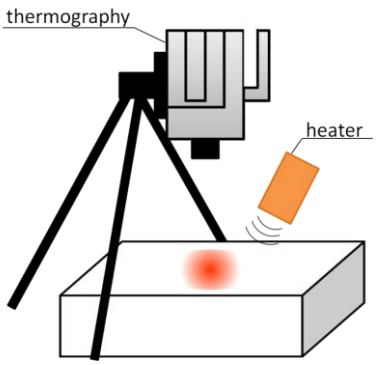
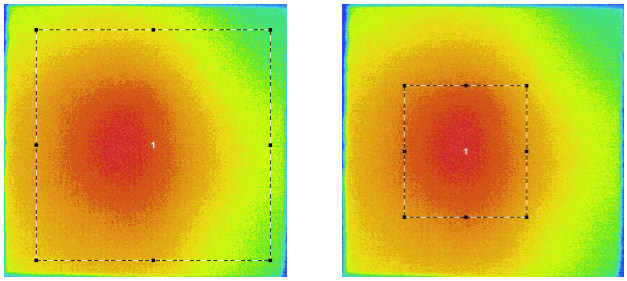


Fig. 1 Thermography's experimental setting



(a) big area (b) small area

Fig. 2 Image of Paper

Keyword: non-destructive inspection, air permeability, thermography, W/C,
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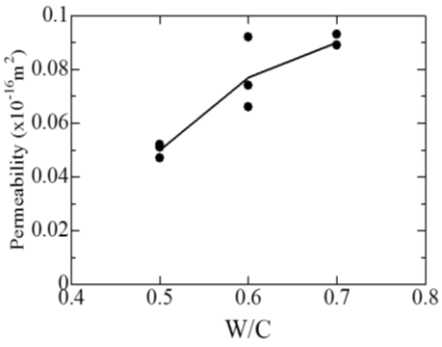

Fig. 3 the relationships between air permeability and W/C

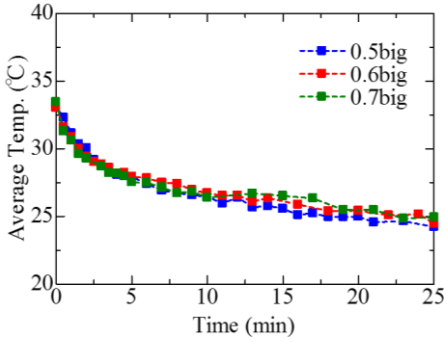

Fig. 4 the change in average temperature

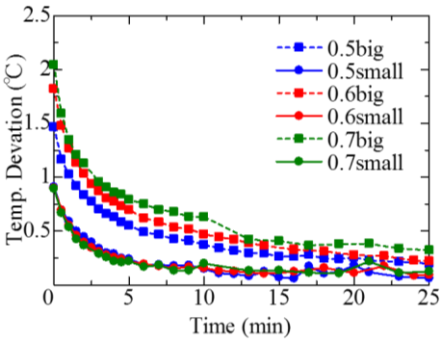

Fig. 5 the change in temperature deviation

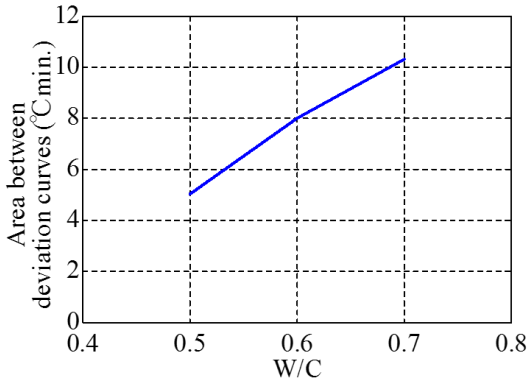

Fig. 6 the relationships between the area and W/C

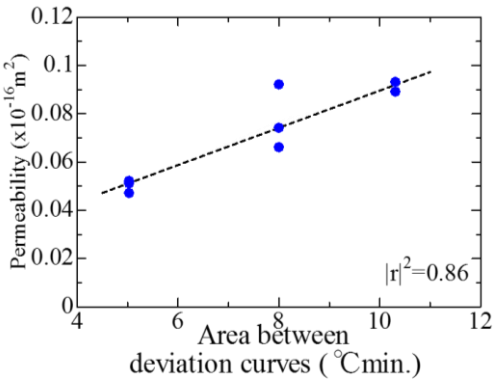

Fig. 7 the relationships between the area and air permeability

3. RESULTS AND DISCUSSION

Figure 3 shows the result of air permeability experiment which confirms the relationship of W/C ratio and air permeability of concrete. It was confirmed that concrete air permeability increases along with increment of W/C. As shown in figure 4, the average temperature during cooling process is almost the same for all three cases. However, as shown in figure 5, temperature deviation in specimen with W/C=0.7 is larger than other two and this relation also corresponds for W/C=0.6 in comparison with W/C=0.5. Meanwhile, if the considered surface area is meant to be the central area, this deviation gets smaller and almost the same for all of them.

Results of the calculations of areas between deviation curves and W/C is shown in figure 6. We can say that the area increase along with the increment of W/C as well as air permeability tendency. Then, the relationship between permeability and area between deviation curves evaluated in figure 7. It was found the area is strongly related to air permeability. Consequently, the research shows that thermography has the capacity to be used as an instrument for evaluation of air permeability of concrete surface.

4. CONCLUSION

In this paper, the correlation between thermography and air permeability was clarified by using three specimen having different W/C ratios. Different relations were found among W/C, permeability and area between temperature deviation curves. It was found that if we compare the area between deviation curves of each specimen, these areas have a strong correlation with permeability and W/C ratio.

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