Fifth International Conference on Sustainable Construction Materials and Technologies. http://www.claisse.info/Proceedings.htm

INFLUENCE OF INTERFACIAL TRANSITION ZONE AT AGGREGATE SURFACE CAUSED BY BLEEDING ON PERMEABILITY

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ABSTRACT

Bleeding occurs due to the different density of concrete materials. The internal bleeding water is a part of the bleeding water restrained on the lower surface of the aggregate. By creating porous zone after concrete hardening, it becomes a penetration path of deterioration factors, which leads to a decrease in the durability of concrete. In this research, the purpose is to clear the influence of changes in the aggregate interface in concrete accompanying bleeding on permeability. Concrete with different amount of bleeding was prepared and air permeability test was carried out. Furthermore, air permeability test was performed the pore existing on the lower surface of the aggregate, which was made by internal bleeding water. As a result, the air permeability increased in the tests penetration through the pore on the lower surface of the aggregate.

Keywords: Aggregate, porous zone, permeability, concrete

1. INTRODUCTION

Bleeding occurs due to the different density of the concrete materials. Water with the lowest density rises to the upper surface, and a material with high density such as cement and aggregate sinks to the bottom. Therefore, the water/cement (W/C) ratio partially rises, causing negative effects such as cracking and performance decrease. Part of the bleeding water is restrained on the lower surface of the aggregate and is called internal bleeding water. After hardening this water-reach zone generates pores, becomes a migration path of aggressive agents, and leads to concrete durability decrease. Since the durability of concrete depends on its porosity, it is necessary to clarify the influence of the mix proportion of the pores at the aggregate/cement interface on the permeability. The purpose of this study was to prepare concrete with different amount of bleeding and to understand the influence of the change of aggregate interface in the concrete due to bleeding on the material permeability.

2. EXPERIMENT

2.1. Outline of Experiment

Table 1 shows the planned mix proportion of mortars. In this study, to change the amount of internal bleeding, experiments were carried out by preparing a mortar containing concrete and coarse aggregate in which fine aggregate amount/fine aggregate and course aggregate amount (s/a) was changed with the unit water amount kept constant (s/a = 100%).The prepared concrete and mortar were subjected to sealing curing for 7 days in a constant temperature and humidity chamber (temperature 20℃, RH 60%).

Table 1 Mix proportion of mortars

			Unit amount (kg/m^3)		
W/C(%)	s/a(%)	air(%)	W(kg) Water	C(kg) Cement	S(kg) Fine aggregate
50	30	4.5	170	340	532
70				243	557

Table 2 Mix proportion of concrete

			Unit amount (kg/m^3)			
W/C(%)	s/a(%)	air(%)	W(kg) Water	C(kg) Cement	S(kg) Fine aggregate	G(kg) Course aggregate
50	30	4.5	170	340	532	1280
	40				710	1097
	50				887	914
70	30			243	557	1338
	40				742	1147
	50				928	956

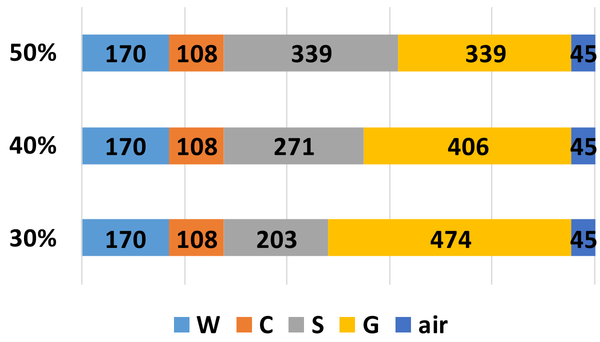

Figure. 1 Mix proportion of concrete

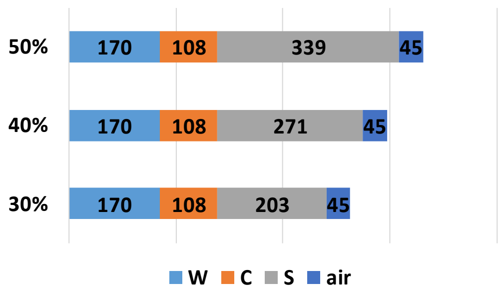

Figure. 2 Mix proportion of mortar

2.2. Bleeding Test

Bleeding tests were conducted with reference to JIS A 1123 (JIS is the Japanese Industrial Standards). A cylindricalφ100×200mm mould was used and the concrete surface was leveled so that it was 15 ± 3mm lower from the edge of the mold. Bleeding water that leaked out to the upper surface of the concrete was measured every 30 minutes until bleeding water cannot be seen from implantation. Using this cumulative volumetric amount of bleeding water, the bleeding ratio was calculated by taking the average of the bleeding water of two concrete specimens.

2.3. Air Permeability Test

For the test specimens, a concrete was made using a mould of 150×150×150mm, the curing described in chapter 2.1 was carried out, then the core collected at diameter 100mm in the horizontal direction and vertical direction to the casting surface. It was cut with a concrete cutter so as to have a specimen of a diameter 100 mm and 50 mm as height. Figure 3 shows this test flowchart. It was left in a drying oven until the sample weight reached a constant value; air at a pressure of 0.2MPa was then forced into the sample and the new specimen weight was measured by a water replacement method and a measuring cylinder.

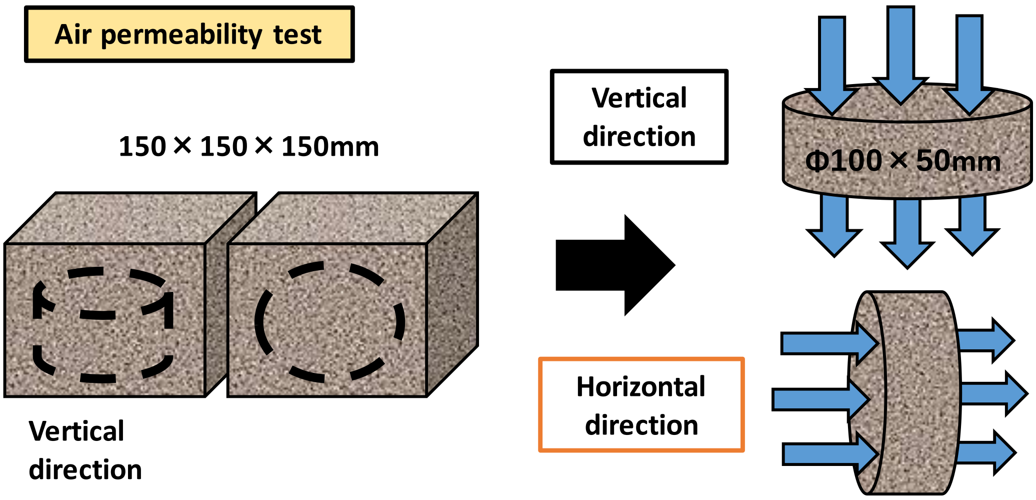

Figure. 3 Test flowchart

3. RESULTS AND DISCUSSION

3.1. Bleeding Test

Figure. 4 shows the results of the bleeding test. When the water/cement ratio was constant, the lower the s/a was the higher the bleeding ratio. Comparing the bleeding rate of concrete and mortar, the bleeding rate of mortar tended to be higher than that of concrete. It is thought that the coarse aggregate in concrete suppressed the rise of bleeding water.

Figure. 5 shows the results of calculation of the internal bleeding water obtained by subtracting the bleeding rate of concrete from the bleeding rate of mortar in the same mix proportion. In the case of the same water cement ratio, the internal bleeding amount increases rapidly as s/a become 30%. The coarse aggregate in the concrete increases the internal bleeding because the internal bleeding ratio increases in the mix proportion with high s/a and coarse aggregate in a large amount.

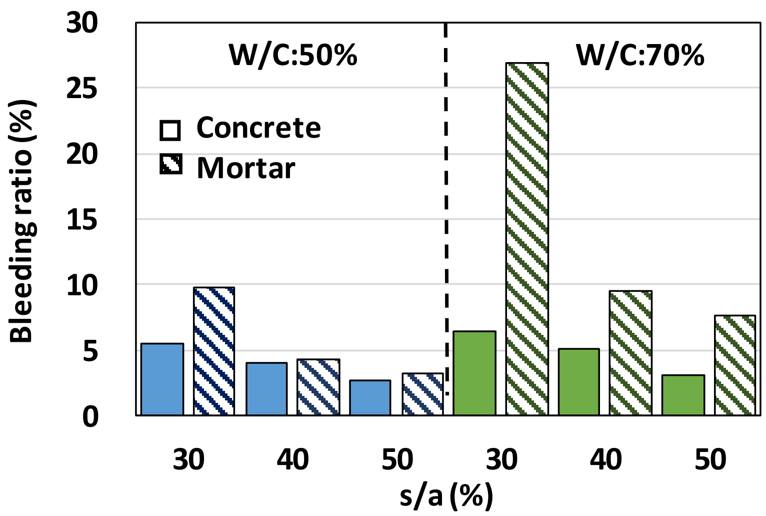

Figure. 4 Results of the bleeding test

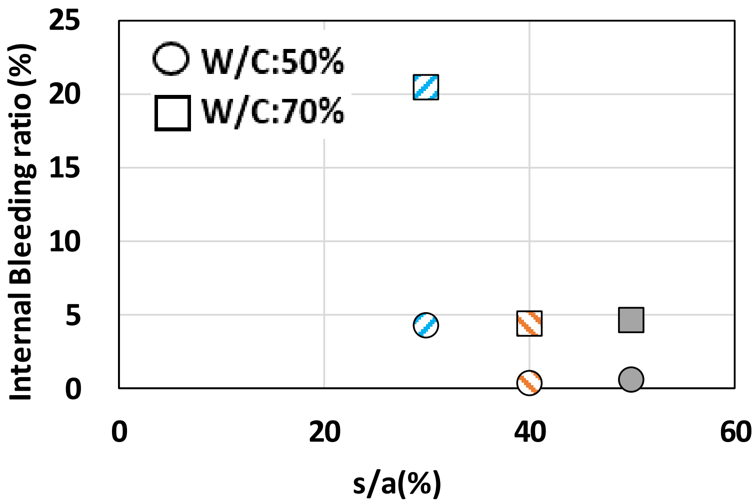

Figure. 5 Internal bleeding water ratio for different s/a values

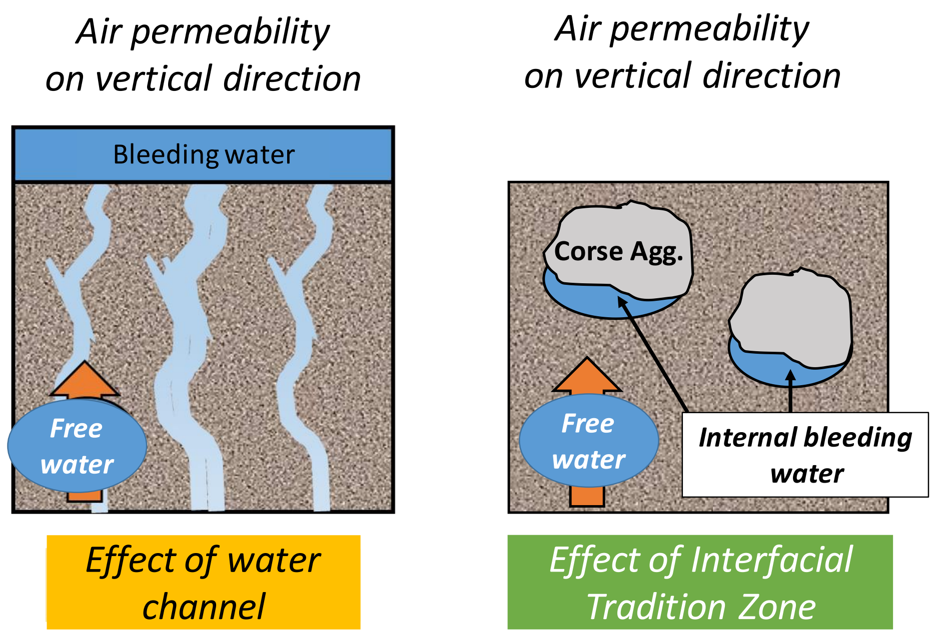

Figure. 6 Image of occurring gaps mechanism on different causes
(Left: effect of water channel right: effect of bleeding for ITZ)

3.2. Air Permeability Test

To investigate the influence of this internal bleeding on material permeability, an air permeability test was conducted. In the previous study, it was reported that when a split tensile test on a rectangular parallelepiped concrete was carried out, higher values were obtained when loading in the horizontal direction than when loading in the vertical direction compared to the casting surface. According Figure. 6, it is pointed out that there is a defect group on the lower surface of aggregate due to bleeding. Therefore, an air permeability test was conducted on the specimens in the horizontal and vertical directions to the concrete casting surface. Figure. 7 shows the results. It can be seen that the permeability is influenced by both the air direction and the proportion of the concrete mix. In the mix proportion with s/a of 30%, the permeability in the horizontal direction was higher than in the vertical direction. It is considered that concrete with a small s / a and a large aggregate volume has a high percentage of aggregate interface void due to a high internal bleeding rate. However, when s/a is 50% and the coarse aggregate volume is small, the ratio of aggregate interface pores is small and the influence is considered to be smaller. In particular, when W / C is 70%, a large amount of bleeding water is generated, and water permeability is generated, and in the air permeability test, it is considered that the amount of air permeability in the orthogonal direction is increased due to the superior effect of water polarity. When s / a is 50% and W / C is 50%, the influence of water is small because there is little bleeding water, and it is thought that the amount of air permeability in the orthogonal direction and in the vertical direction is comparable.

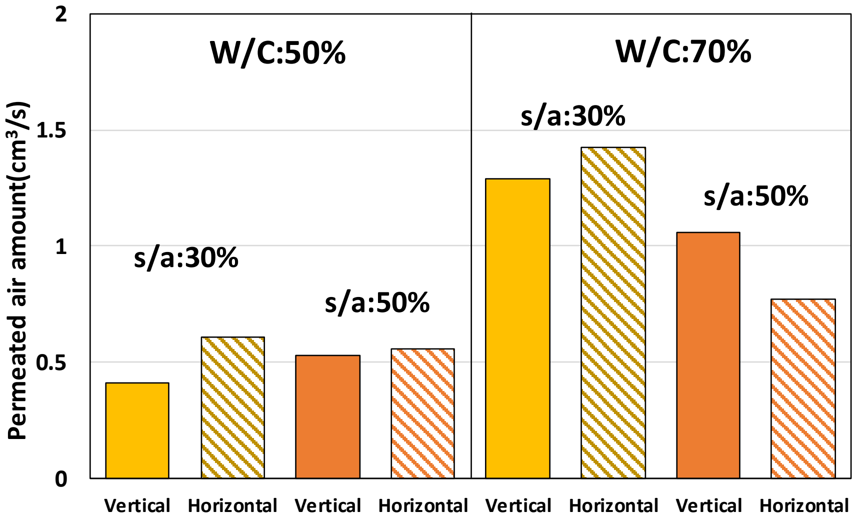

Figure. 7 Amount of permeated air

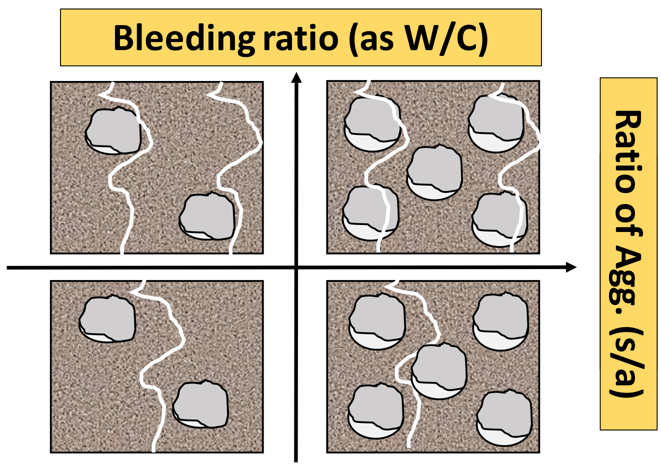

Figure. 8 Image of gaps on concrete depends on course aggregate

4. CONCLUSION

1) According to the result of bleeding test of mortar with coarse aggregate removed

from the combination of concrete and concrete, the bleeding ratio of concrete is smaller when concrete and mortar are compared. Coarse aggregate is considered to be a part of the bleeding water as a factor. Also, the internal bleeding rate increases as the coarse aggregate volume of concrete increases.

2) Coarse aggregate in concrete is a factor that increases internal bleeding because internal bleeding ratio increases in mix proportion containing a large amount of coarse aggregate.

4) The relationship between the amount of air permeability in the vertical direction and the perpendicular direction with respect to the concrete placement surface shows that the concrete is anisotropic because the air amount in the orthogonal direction tends to be larger than that in the vertical direction.

5) The difference in air permeability is larger in concrete with a larger coarse aggregate volume, therefor the formation of aggregate interface void by internal bleeding affects the material permeability.

3) Concrete having a high W/C and a large coarse aggregate volume increases the percentage of interfacial space by increasing the internal bleeding rate, so that the substance permeability in the horizontal direction is higher than in the vertical direction.

ACKNOWLEDGEMENTS

The authors would like to thank Mr. Kouki, T. graduated Shibaura Institute of Technology for his help of this study.

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