INFLUENCE OF THE TYPE OF FINE AGGREGATEA ON CONCRETE QUALITIES

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1. Introduction

The lack of sea sand and river sand increased the exploitation of crushed sand which occupies now nearly 20% of the whole quantity of fine aggregates. And, the use of crushed sand may be expected to grow continuously in the future. Even if diversified fine aggregates are currently introduced in the manufacture of concrete in Korea, a poor number of researches have been performed to evaluate systematically their effect on concrete. Therefore, this study investigates the effects of the types of fine aggregates on the quality of concrete.

2. Experimental program

In order to assess the effect of the types of fine aggregates on the quality of concrete, concrete specimens using crushed sand (P) in conformity with the KS standards have been designed and manufactured to satisfy slump of 15±2cm and air content of 4.5±1% considering three levels of water-cement ratios (W/C) that are 35, 45 and 55%. Seven categories of fine aggregates have been selected as experimental variables. These categories are sea sand (S), river sand (R), river sand with large quantities of small grain (Rs), crushed sand with defective grain shape (Gs), crushed sand with large grading (FM), mixed sand composed by crushed sand with large grading and river sand with small grading (FR) and mixed sand composed by crushed sand with defective grain shape and natural sand with good grain shape (GR).

The cement used in this study is ordinary Portland cement (OPC, density 3.14g/cm^3) and the characteristics of the aggregates are summarized in Table 1.

3. Test results and discussions

3.1 Properties of fresh concrete

Fig. 1 illustrates the effects of the type of fine aggregates on the fluidity of concrete. Concrete P using crushed sand shows relative degradation of the fluidity compared to concrete S and R. However, the fluidity of Rs, which makes use of river sand with large quantities of small grain, is seen to drop off. FR, the concrete using mixed sand composed by large crushed sand and small river sand, displays fluidity comparable to the concrete using crushed sand (P). The fluidity of GR composed by a mixture of defective crushed sand with defective grain shape and natural sand with good grain shape tends to exhibit increase for W/C ratio ranging between 45 and 55%, while decreases for W/C ratio of 35%.

Table 1 Properties of aggregate

Type of aggregate		Density (g/cm^3)	Water Absorption (%)	F.M.	Amount Passing sieve 0.08mm(%)	Solid volume Percentage for shape determination (%)
Fine	P	2.57	1.50	2.66	3.60	53.4
	R	2.55	1.98	2.67	2.02	57.0
	Rs	2.55	1.98	2.42	2.02	-
	S	2.58	2.04	2.66	1.15	60.5
	FM	2.62	0.69	2.83	2.22	53.9
	GS	2.83	1.52	3.11	3.24	52.0
Coarse		2.67	6.75	6.75	0.1	-

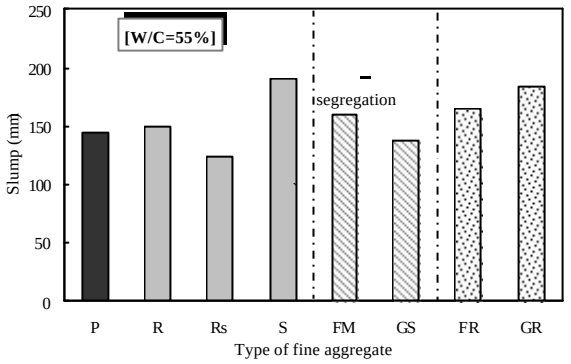

Fig. 1 Effects of the type of fine aggregate on the fluidity of concrete

Fig. 2 plots bleeding test results. The amount of bleed water for concrete P is similar to concrete R using river sand. Concrete S using sea sand is seen to display the largest bleeding compared to crushed sand and river sand, which can be explained by the washout of small grains during the cleaning process.

Keyword: Type of fine aggregate, Fresh concrete, Strength, Durability
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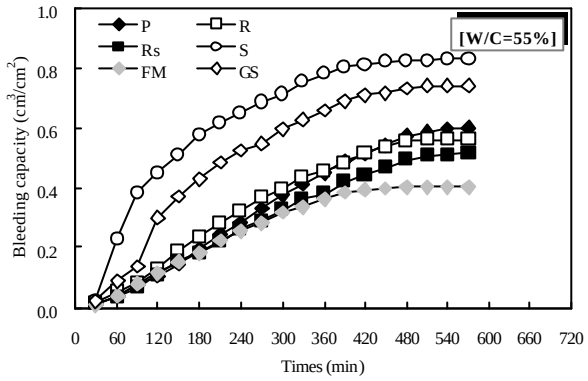

Fig. 2 Effects of the type of fine aggregate on the bleeding of concrete

3.2 Strength

Fig. 3 illustrates the effects of the type of fine aggregates on the compressive strength of concrete. The strength of crushed sand concrete (P) is seen to degrade compared to the concrete using river sand (R) for a W/C ratio of 35%, in particular, the drop of strength appears to be larger with time than river sand. For W/C ratios of 45% and 55%, the compressive strength exhibited by P is similar to concretes using river sand or sea sand.

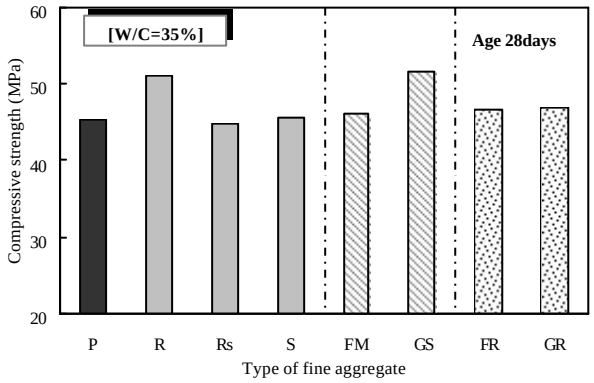

Fig. 3 Effects of the type of fine aggregate on the strength

3.3 Drying shrinkage

Fig. 4 plots results of drying shrinkage test. The drying shrinkage of the crushed sand concrete(P) is seen to increase compared to concrete using natural sand such as river sand(R) or sea sand(S).

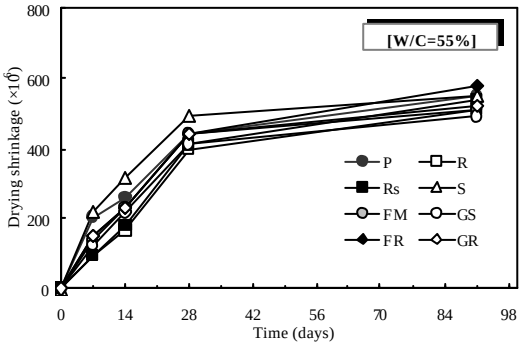

Fig. 4 Effects of the type of fine aggregate on the drying shrinkage

3.4 Durability

Fig. 5 depicts the effects of the type of fine aggregates on the resistance of concrete against the penetration of chloride ions. The resistance of the crushed sand concrete (P) against the penetration of chloride ions is seen to decline compared to concrete using natural sand. Concretes mixed with crushed sand presenting defective grain sizes or shapes exhibit drop of their resistance against salt attack compared with concretes using standard crushed sand. But, concrete using a mixture of such crushed sand and natural sand is seen to display resistance comparable to concretes using standard crushed sand, which demonstrates improvement of the resistance against the penetration of chloride ions.

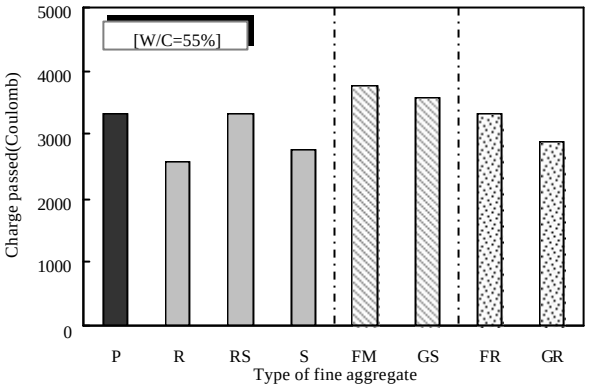

Fig. 5 Effects of the type of fine aggregate on salt damage

4. Conclusion

The effects of the type of fine aggregates on the quality of concrete have been examined experimentally. Test results revealed that concrete using crushed sand exhibits degradation of its performances that are fluidity, bleeding characteristics, strength and durability compared to concrete using natural sand like river sand and sea sand. Especially, concrete using crushed sand with defective grain size or shape displayed notable drop of quality. Consequently, the strengthening of specifications or the quality enhancement of concrete itself should be implemented in order to improve the quality of concretes using crushed sand.

References

1. KICT and KCI, Development of Technologies to Improve the Quality of Concrete with Alternative Aggregates, Construction & Transportation R&D Report, 2004. 8.
2. Yoon, Gi Woon et al., A study on physical and particles properties of crushed sand in Korea, Proceedings of the Korea Concrete Institute Vol.16, No.1, 2004. 5.
3. Koh, Kyung Taek et al., Effect of the grain shape of crushed sand on concrete qualities, Journal of KSCE, Vol.26, No.1A, 2006. 1.