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Influence of Quality of Recycled Fine Aggregate on Properties of Mortar

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Synopsis

Recycled fine aggregates can be produced from producing recycled coarse aggregates. However owing to sub-standard qualities of the recycled fine aggregates, those have received little attention for use as aggregate for concrete. The purpose of this study is to investigate the influence of qualities of recycled fine aggregates on the properties of mortar. Recycled fine aggregates were blended with a river sand and properties of mortar with the recycled fine aggregates were investigated. The compressive strength of mortar with recycled fine aggregate decreased with increasing the average water absorption. Furthermore, the grading of the river sand was divided into three ranges and each range of particle size was substituted for the same one of the recycled fine aggregates. Then the influence of the range of the recycled fine aggregate on properties of recycled mortar was investigated. The results showed that, in the making of the mortar with the recycled fine aggregates, particles of less than 0.6mm influence properties of the mortar.

KEYWORDS: recycled fine aggregate, average water absorption, mortar, particle size range

1. Introduction

To be estimated that the amount of a demolished concrete will continue to increase, many energetic investigations have been carried out to make use of the demolished concrete as the recycled aggregates for concrete. The utilizations of the demolished concrete as the recycled coarse aggregates are partially in practical use[1]. But in the process of producing and improving on qualities of the recycled coarse aggregates, a lot of particles of less than 5mm in diameter, which are too poor in quality to recycle into concrete, are produced[2]. In this study, the influences of qualities of the recycled fine aggregates on mortar were investigated.

2. Test Procedures

Mortar was made of the normal portland cement and was mixed according to JIS R 5201. The qualities of the mortar were examined through air content test of fresh mortar, compressive strength test and drying shrinkage test of hardened mortar. Properties of fine aggregates used this study are summarized in Table 1 and Mix proportions for mortar in Table 2. The grading of the recycled fine aggregates was adjusted to that of the river sand (F.M.=2.79).

Specimens sizes were set 5 ϕ x10cm

Table 2 Mix proportions of mortar (in volume)

W/C (%)	W (l/m³)	C (l/m³)	S (l/m³)
40	305	242	454
50	305	193	502
60	305	161	534

Table 1 Properties of fine aggregate[3]

Specimen	Type of aggregate	Summary	Density in saturated surface-dry condition	Average water absorption (%)
River sand	River sand	Original natural fine aggregate	2.61	1.8
RF0	Recycled fine aggregate	Crushed original concrete[1]	2.18	13.1
RF3		Improved quality of RF0[2]	2.31	9.5

Note 1] Crushed by Jaw crusher and Cone crusher
2] Improved at three rimes by mechanical grinding method revolving vertically

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Table 3 Mixture ratio of aggregate shown in table 1. and aggregate water absorption

Percentage occupied in all volume of recycled fine aggregate (%)	River sand	100	67	33	0	0	0	0
	RF3	0	33	67	100	67	33	0
	RF0	0	0	0	0	33	67	100
Average water absorption (%)		1.8	4.3	7.0	9.5	10.7	11.9	13.1
Percentage occupied in all volume of recycled fine aggregate (%)	River sand		75	49	24	16	8	
	RF0		25	51	76	84	92	
Average water absorption (%)			4.6	7.6	10.4	11.3	12.2	

cylinders for the compressive strength test and 4x4x16cm prisms for the drying shrinkage test. Prisms specimens were kept 20℃ just after stripping and the drying shrinkage with contact-type strain gauge was measured at once.

3. Results and Considerations

3.1 Relations between Average Water Absorption and Properties of Mortar

In the beginning, relations between average water absorptions of recycled fine aggregates and qualities of mortar with those were investigated. The recycled fine aggregates with various average water absorptions were made of mixtures of the river sand, RF0 and RF3 in different ratio listed in Table.3. The properties of the mortar with the recycled fine aggregates were investigated. Water absorption of the recycled fine aggregates is defined average water absorption because recycled fine aggregates are composed of particles with different properties. Fig.1 shows the result of the air content. The air content increased with increasing the average water absorption. While differences of the qualities of the recycled fine aggregates had little influence on the air content. Changes of W/C make no difference with there tendencies (data not shown). Fig.2 shows the result of the compressive strength at 28 days after. The compressive strength decreased with increasing the average water absorption. Mechanical grinding treatment had no influences on the compressive strength when the average water absorption was over 7 %. Moreover, when W/C took small value, the decrement of compressive strength due to the increment of the average water absorption remarkably increased. Fig.3 shows the results of the drying shrinkage test at 168 days after. The drying shrinkage became large with increment of the average water absorption and did larger when mixed the recycled fine aggregate of lower quality. When W/C was small, differences in quality of the recycled fine aggregate on drying shrinkage also became small.

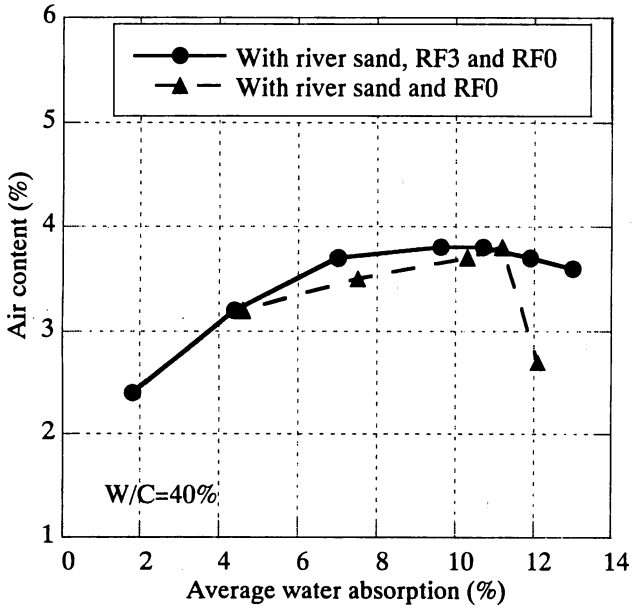

Fig.1 Relations between air content of mortar and average water absorption of fine aggregate

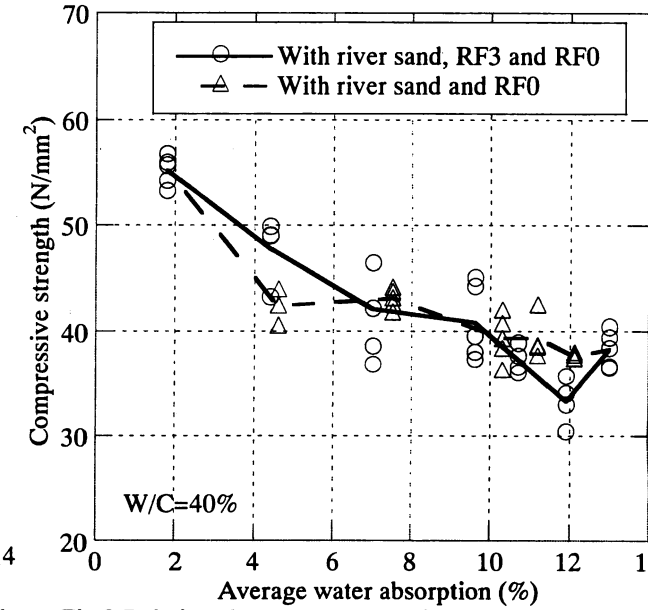

Fig.2 Relations between compressive strength of mortar and average water absorption of fine aggregate

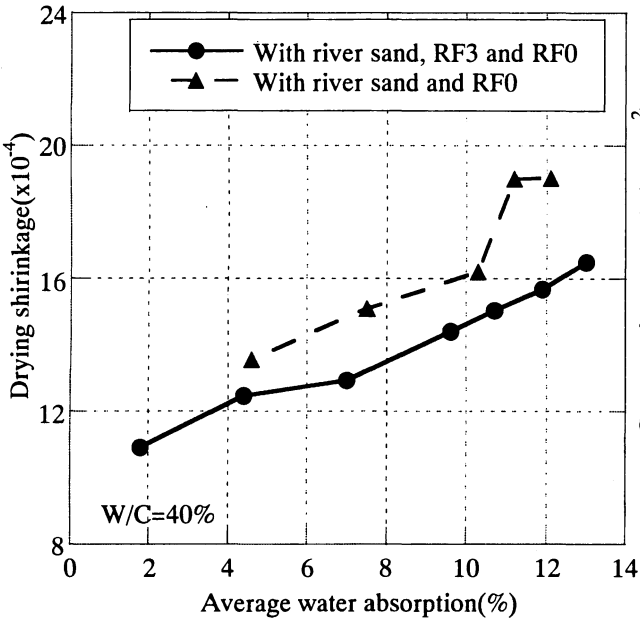

Fig.3 Relations between drying shrinkage of mortar and average water absorption of fine aggregate

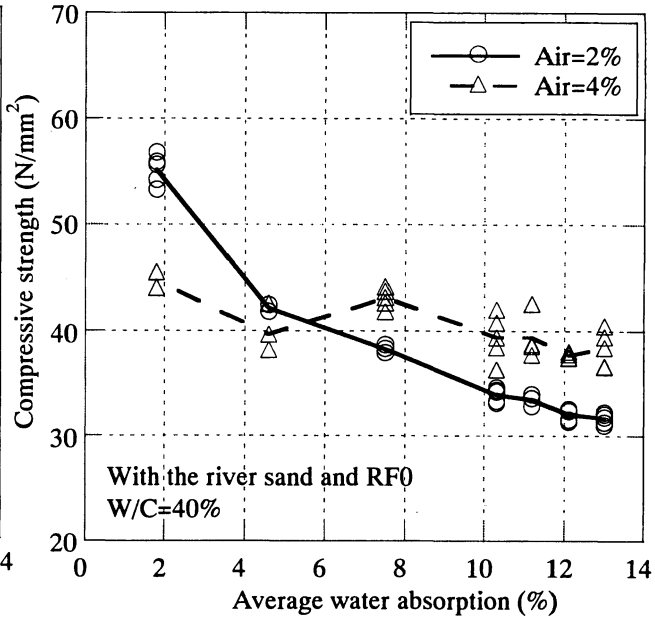

Fig.4 Relations between compressive strength of mortar and average water absorption of fine aggregate at constant air content

3.2 Influences due to Air Content

Judging from the above, let us examine the decrease of the compressive strength due to the increment of the air content. The compression test was carried out against the mortar with the river sand and RF0, where the air content of the mortar was regulated at 2 or 4 % by air entraining agent and. Fig.4 shows the results of the compressive strength at 28 days after. In the case of the mortar with the river sand, where the average water absorption of the river sand is 1.8 %, the compressive strength at air content of 2 % was greater than one at air content of 4 %. But, in the case of the mortar with the recycled fine aggregate, the air content had little influence on the compressive strength. Judging from these results, it is seem the properties of the recycled fine aggregates had influence on those of the mortar.

3.3 Influence of Particle Size Range of Recycled Fine Aggregate

Finally, let us investigate influences particle sizes of recycle fine aggregate on qualities of mortar with recycle fine aggregate. The grading of the river sand was divided into three particle size ranges as shown in Table 4. Each range was replaced with same range of RF0 or RF3 by volume and the properties of mortar with those aggregates were investigated. Fig.5, Fig.6 and Fig.7 show the results of the air content, the compressive strength at 28 days after and the drying shrinkage at 168 days after respectively. In all cases, the air content increased, the compressive strength decreased and the dry shrinkage increased with decreasing the particle size. When the particle size range of 10-2.5mm or 2.5-0.6mm was replaced, the properties of the mortar were improved by the mechanical grinding treatment, but when those of less than 0.6mm were replaced, the mechanical grinding treatment had little effect. For this reason, the particles of less than 0.6mm in recycled fine aggregate have been found to significant influence the properties of the mortar. Therefore, attentions must be paid the particles of less than 0.6 mm in the use of recycle fine aggregates.

Table.4 Percentage that each particle size ranges occupy in all volume of river sand

Particle size range (mm)	Percentage occupying in all volume of river sand (%)
10-2.5	25
2.5-0.6	61
0.6-0	24

4. Conclusions

(1) The compressive strength of the mortar with the recycled fine aggregates decreased with increasing the average water absorption.

(2) The mortar with recycled fine aggregate had increased the air content but this had little influence on the

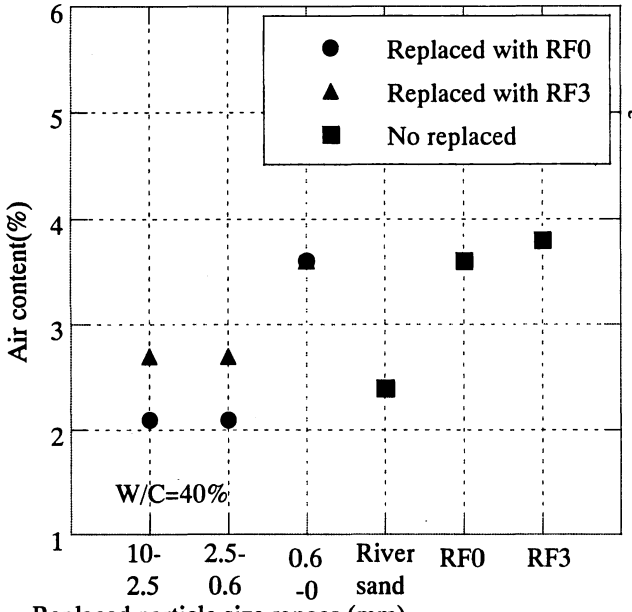

Fig.5 Relations between air content of mortar and replaced particle size range

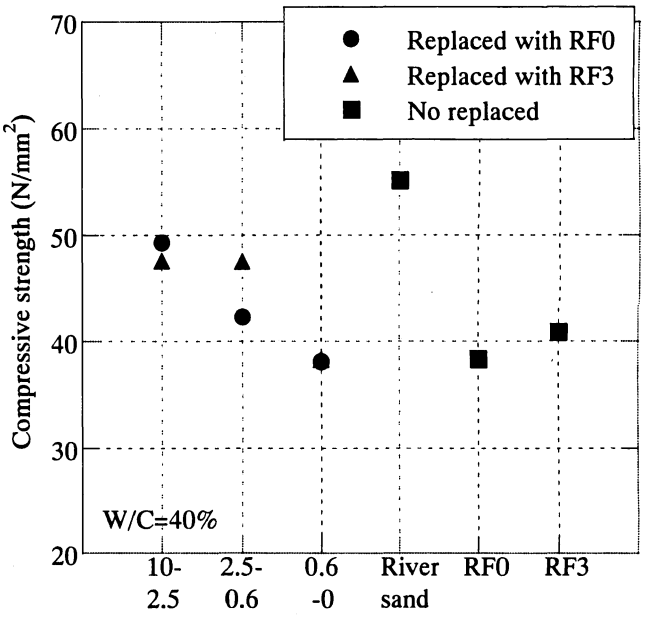

Fig.6 Relations between compressive strength of mortar and replaced particle size range

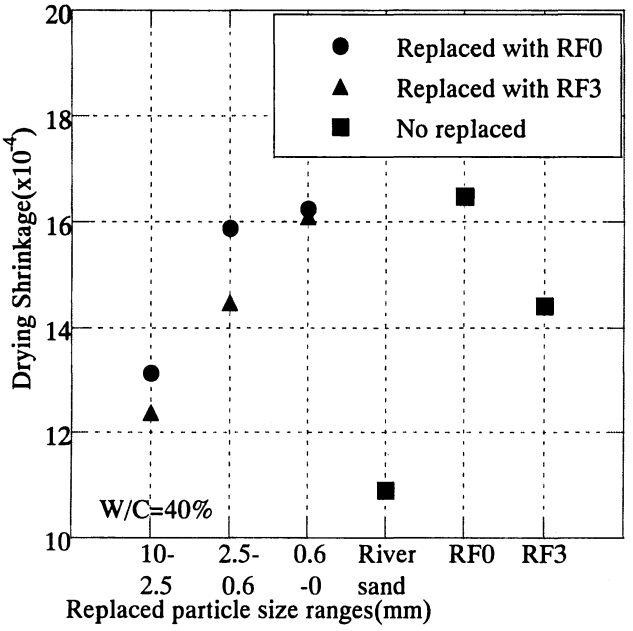

Fig.7 Relations between drying shrinkage and replaced particle size range

compressive strength of the mortar.

(3) In the making of the mortar with the recycled fine aggregates, the particles of less than 0.6 mm had significant influence on the air content, the compressive strength and the drying shrinkage of the mortar.

5.References

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