Strength Properties of Non-Portland Cement Lightweight Matrix with the Types and Addition Ratios of Alkali Activator

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1. Introduction

Cement and Concrete are the most important construction materials in the world, but manufacturing process of cement is a huge source of carbon dioxide emission. Carbon dioxide(CO_2) is derived during the production of clinker, a component of cement, in which calcium carbonate($CaCO_3$) is heated in a rotary kiln to induce a series of complex chemical[1)]. Carbon dioxide(CO_2) is emitted as a by-product when calcium carbonate ($CaCO_3$) is calcinated and converted to lime(CaO), the main primary component of cement[1)]. There has been a lot of research in order to protect the global environment and to reduce the consumption of cement. The simplified stoichiometric relationship in a rotary kiln is as follows:

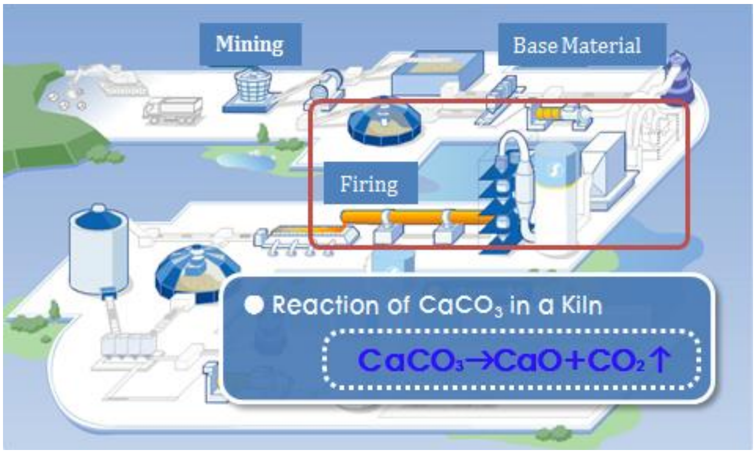

Fig.1 CaO_2 Emission from $CaCO_3$ during Cement Production by Fossil Fuel

Meanwhile, paper sludge ash which is the by-product of paper manufacture does not react with water directly. But, it is known that paper sludge ash hardened when there is alkali activator. This study carried out a basic experiment to develop non-portland cement lightweight construction materials. Blast furnace slag and paper sludge ash were added using alkali activator and compressive strength and bulk specific gravity of resultant non-portland cement lightweight matrix was analyzed.

2. Experimental plans and methods

2.1. Experimental Plans and methods

This study aimed to review strength and reaction of non-portland cement lightweight matrix by types and addition of alkali activator, whose experiment level and factor are described in Table 1. NaOH, Na_2SiO_3, Na_2SO_4 and $NaCO_3$ were used as alkali activator, the addition rates of alkali activator based on 100% of by-product were 0% and 15%. The test items of this experimental research were set in two levels including compressive strength and bulk specific gravity. As for the mix, blast furnace slag and paper ash were added by water and alkali activator. Materials were mixed for 30 seconds in 10rpm, 30 seconds in 20rpm and 30 seconds in 30rpm. After total 150 seconds mix, it was discharged to make the test specimen. Compressive strength and bulk specific gravity were measured by creating on 40×40×160 ㎜ mold as cement strength test methods(KS L ISO 679), and it was cured for 3 days with relative humidity 80±5% and temperature 20±2℃.

[Table 1] Experimental Program

Factors	Levels
Inorganic Composite	Blast furnace slag, Paper ash
Alkali Activator	NaOH, Na_2SiO_3, Na_2SO_4, $NaCO_3$
Additon Percentage of NaOH	12.5%
Additon Percentage of Alkali Activator	0, 15 (%)
Curing Condition	RH 80±5%, Temperature 20±2℃
Test Items	Compressive Strength, bulk specific gravity

2.2. Materials

The chemical properties of blast furnace slag and paper ash are presented in Table 2. The blast furnace slag used in this experiment has the density of 2.91g/cm^3 and fineness of 4,464cm^2/g. The paper ash used in this experiment has the density of 2.70g/cm^3 and fineness of 3,600cm^2/g.

[Table 2] Chemical composition of using materials (%)

Component	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	TiO
BFS	34.39	14.47	0.63	41.67	6.49	-	0.36	1.20	-
PA	13.0	10.1	0.9	65.7	4.4	1.7	-	-	0.4

3. Conclusion

As the result of the compressive properties of non-portland cement lightweight matrix with types and addition ratios of alkali activator, NaOH and Na_2SiO_3 specimens had high strength in this experimental study. Also, it was observed that sodium hydroxide(NaOH) addition ratio of 12.5% shows the lowest density at 1.13g/cm^3 and decreasing ratio 40.45%. Compressive strength of this specimen developed relatively high strength compared to density. It was judged that experiment results of non-portland cement matrix with specific waste resources and alkali activators were useful as basic data for mixtures design and evaluation properties of lightweight non-portland cement building material.

4. Acknowledgement

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5. References

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