PROPERTIES OF CONCRETE CONTAINING GLASS FIBER MANUFACTURING WASTE

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Abstract
This paper describes an experimental study that investigated the influence of vitreous calcium aluminosilicate (VCAS), a pozzolanic material produced from glass fiber manufacturing waste, on concrete. The advantages of VCAS modified concrete include improved workability, enhanced compressive strength and increased chloride penetration resistance. The disadvantage found in this study was increased shrinkage.

Introduction

Many industrial wastes demonstrate pozzolanic behavior. In recent years, use of these industrial wastes in concrete has become very common. In concrete, a part of portland cement is replaced by these materials. It has been found that they improve the strength and durability of concrete (*1,2)*

Among the various industrial wastes used to enhance the performance of concrete, the vitreous calcium aluminosilicate (VCAS) is a relatively new one. VCAS is a white pozzolanic material produced from glass fiber manufacturing waste. It is processed by grinding waste glass fibers to a fine powder form that effectively demonstrates pozzolanic behavior (2). This paper describes a study in which a series of experiments was performed to investigate the properties of concrete containing VCAS.

Materials and Mixture Proportions

Table 1 Chemical Compositions of VCAS

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	MgO (%)	SO_3 (%)	Na_2O (%)	K_2O (%)
52	17	<1.0	22	<1.0	<0.1	<1.0	<0.2

Loss in ignition < 0.5%

Table 2 Mixture Proportions (units are in kg/m^3)

	Sand	Coarse Agg.	Cement	Water	VCAS
w/b = 0.4					
Plain	862	895	427	171	-
VCAS-6	860	894	402	171	26
VCAS-9	859	892	389	171	38
VCAS-12	857	890	363	171	64
w/b = 0.5					
Plain	862	895	375	187	-
VCAS-6	860	894	352	187	22
VCAS-9	859	892	341	187	34
VCAS-12	857	890	318	187	56

Several concrete mixtures were made with Type I cement and VCAS as the binding materials. Table 1 shows the chemical properties of VCAS used in this study. The mixture proportions are shown in Table 2.

Experiment and Results

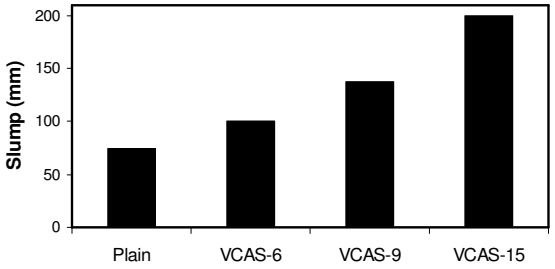
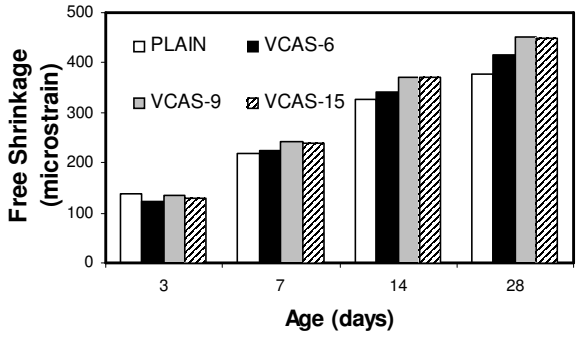
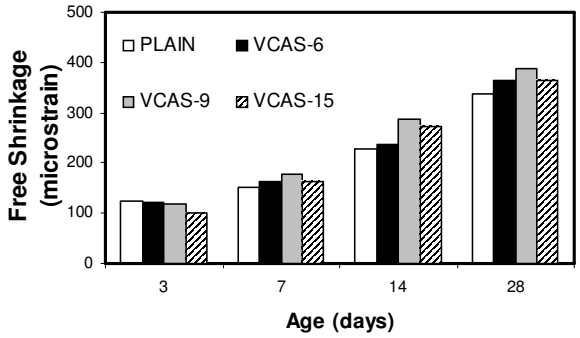


Fig. 1 Slump of different concrete mixtures.



(a)



(b)

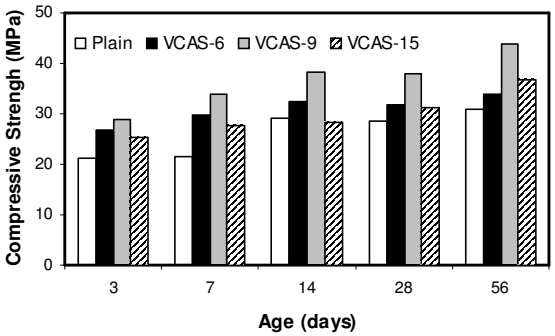
Fig. 2 Free shrinkage of concretes with w/b of: (a) 0.40, (b) 0.50

A series of experiments was performed to investigate the influence of VCAS on the properties of concrete including workability, free shrinkage, compressive strength, and resistance to chloride permeability (RCP).

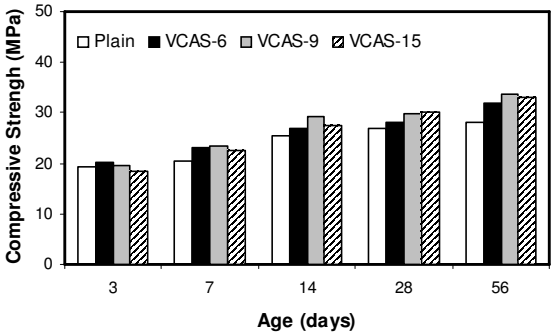
Workability of fresh concrete mixtures was measured according to ASTM C-143. According to this

method, the slumps of mixtures with w/b of 0.50 were measured. The result of the slump test is shown in Figure 1. It is evident from the figure that the addition of VCAS increased the slump of the mixtures, making them easy to transport, place and compact.

The free shrinkage strains of standard concrete prisms were measured according to ASTM C-157. Figure 2 demonstrates the free shrinkage of different mixtures used in this study. The figures show that the addition of VCAS increased the shrinkage level in all the concrete mixtures, especially at later ages (7 day and later).



(a)



(b)

Fig. 3 Compressive strengths of concretes with w/b of: (a) 0.40, (b) 0.50

Compressive strengths of concrete cylinders at different ages were measured according to ASTM C-39. It is evident that (Figure 3) concrete mixtures containing VCAS demonstrate higher strength from an early age (3 day). The implication is that this pozzolan can be used in structures, where a delay in construction may cause significant inconvenience to the public.

The rapid chloride permeability test (RCPT) was carried out on 0.4 w/b concrete as per ASTM C 1202-07. It is evident from Figure 4 that chloride permeability decreased with increasing VCAS content, providing indication of the densification of the material microstructure of modified concretes. Therefore, VCAS modified concrete can be used to protect reinforced concrete structures from chloride-induced corrosion in aggressive environments.

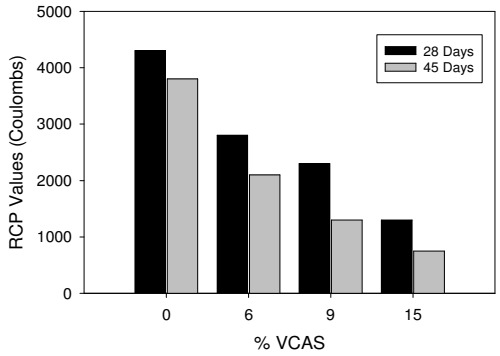


Fig. 4 RCP values of concretes containing VCAS

Conclusions

Based on the results of the experimental investigations described in this paper, the following conclusions are drawn:

(i) VCAS increases the slump of fresh concrete mixtures indicating a low water demand. Due to its reduced water demand, VCAS can be used to proportion concretes of lower w/b, or with higher cement replacement levels, both of which impacts the long term performance of structures beneficially.

(ii) Addition of VCAS increases the free shrinkage of concrete. Therefore, proper precautions should be taken if this is to be used in concretes for concrete structures that have a tendency to develop shrinkage cracking.

(iii) VACS increases the short and long term compressive strength of concrete. Therefore VCAS, offers tremendous potential for use in transportation structures where both short and long term strengths are important.

(iv) Incorporation of VCAS as a replacement of cement results in increased chloride penetration resistance of the concrete.

References

1. Malhotra, V.M., and P.K. Mehta. Pozzolanic and Cementitious Materials, Advances in Concrete Technology, Gordon and Breach, London, 1996.
2. Hossain, A.B., Shirazi, S., Persun, J. and Neithelath, N., "Properties of Concrete Containing Vitreous Calcium Aluminosilicate Pozzolan", Transportation Research Record, Journal of the Transportation Research Board, No. 2070, 32-38, 2008.