PROPERTIES OF STEAM CURED CONCRETE WITH MODIFIED FLY ASH CEMENT

Ashikaga University, Student Member, ○ Aghiad Alhafez
Ashikaga University, Regular Member, Shingo Miyazawa

1. INTRODUCTION

Fly ash considered to be a green material, the main reason that fly ash is considered to be eco-friendly when used in construction is because it's a recycled material. The quality of fly ash is important but it can vary. Poor-quality fly ash can have a negative effect on concrete. The unburned carbon content in fly ash affects the properties of concrete and makes the quality control very difficult. A new modified fly ash with low unburned carbon has developed by using electric static separation method. High alite (C3S) cement has also proposed to be used with the modified fly ash. In this research, the effect of this new tape of fly ash cement on pre-cast concrete which is prepared by steam curing was studied. Mechanical and shrinkage properties of the proposed fly ash concrete were compared with those of concrete made by using ordinary Portland cement without fly ash.

2. MATERIALS AND MIX PROPORTIONS

High alite cement (A), Ordinary Portland cement OPC (N), Fly Ash (FA), used for experiments in this study.
Target slump and air content for the experiments was 12±2.5cm and 4.5±1.0% respectively.
The replacement ratio of the Fly Ash in the cement was 18%

Table 1: Physical and chemical properties of binders

Name	Density (g/cm^3)	Blaine fineness (cm^2/g)	f.CaO (%)	Clinker Mineral composition (%)			
				C_3S	C_2S	C_3A	C_4AF
A	3.11	5380	2.1	69.3	2.9	9.4	7.7
N	3.16	3170	0.2	61.6	15.1	8.2	9.1

Table 2: Physical and chemical properties of Fly Ash

Name	Density (g/cm^3)	Blaine fineness (cm^2/g)	SiO_2 (%)	Ig. Loss (%)	Flow, percent of control (%)	Strength Activity Index (%)		
						7days	28days	91days
FA	2.19	3490	65.3	0.9	106	74	84	99

Table 3: Mix proportions of concrete

No.	Proportion	W/B (%)	s/a (%)	Amounts of contents (kg/m^3)						Chemical Admixture (B X %)		
				Water	N	A	FA	S	G	SP	AE303	AE785
1	N	45	45	160	356	---	---	795	993	0.8	0.001	---
2	A+FA		45	160	---	292	64	783	977	0.75	---	0.03
3	N	33	43	160	485	---	---	715	967	0.88	0.0015	---
4	A+FA		43	160	---	398	87	699	946	0.8	---	0.035

3. EXPERIMENTAL PROCEDURES

Fresh concrete properties such as slump, air content, temperature, were measured according to JIS standards. Concrete strain and temperature were measured throughout the experiments using transducer strain gauges installed in central portion of beam molds measuring 100mmx100mmx400mm by connecting to data logger. Compressive strength tests conforming to JIS A 1108 were conducted using cylinder molds (100mm diameter and 200mm height). Immediately after casting, all specimens were sealed and stored in temperature controlled room at 20°C and 80%RH. Some beam and cylinder specimens for 1, 14 and 91 days compressive strength tests were then subjected to high temperature curing 2 hours after casting time. The temperature increase gradually during 2 hours and 15 minutes, up to 65°C for 3 hours, the target temperature used in the experiments was similar to steam curing in general precast concrete factories, but steam was not applied. And then the temperature reduce gradually during 10 hours to stable at 20°C for 6 hours and 45 minutes, the total time for seam curing procedure is 24 hours. Strain and temperature was measured in beam specimens as well. All specimens were demolded after 24 hours. Accelerated cured specimens were then subjected to drying condition in temperature controlled room at 20°C and 60% RH for drying shrinkage and autogenous shrinkage measurement in beams and compressive strength in cylinders. 7, 28, and 91 days compressive strength cylinder specimens were stored in water at 20°C.

Keywords: Fly Ash, Alite, Compressive Strength, Steam Curing, Shrinkage
Contact address: Tochigi-Kin, Ashikaga-Shi, 268-1 Ohmae-Cho, 326-8558, Tel: +81-284-62-0605

4. RESULTS AND DISCUSSIONS

4.1 Compressive strength

It can be seen from Fig. 1 that the steam cured concrete with fly ash and high alite cement develops good compressive strength at one day of age and more than the normal concrete. Under water cured concrete with (N) always shows higher compressive strength than (A+FA).

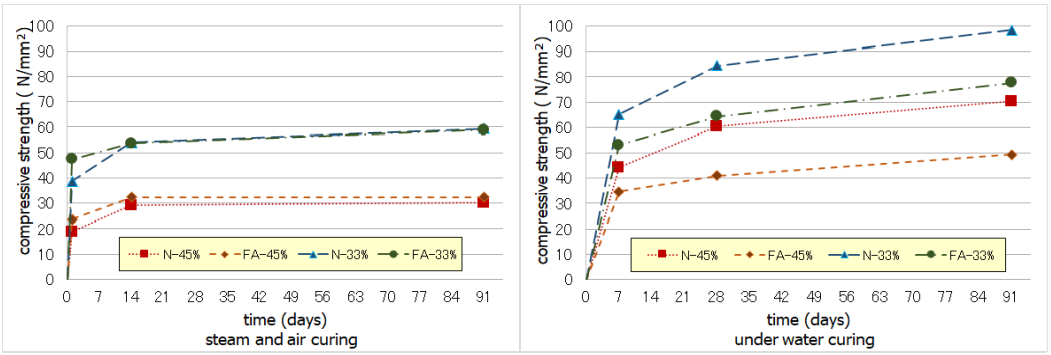

Fig.1: Compressive Strength

4.2 Autogenous and Drying Shrinkage

The initial setting time which is defined as the starting point of autogenous shrinkage was 3.5 hours after casting time. It can be seen from Fig. 2 that mix proportions with (N) showed higher expansion at early age than mix proportions with (A+FA). And then at later age, with (W/B=45%) mix proportion with (N) showed larger drying shrinkage than with (A+FA).However with mix proportions (W/B=33%) it was the opposite thing, (A+FA) showed larger drying shrinkage than (N).

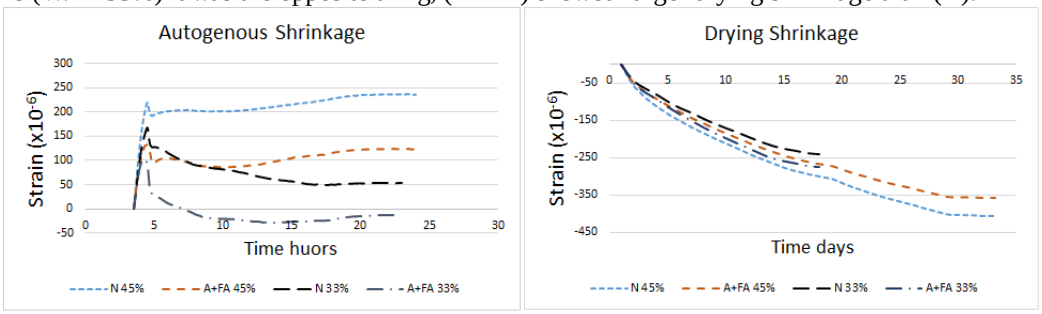

Fig.2: Autogenous Shrinkage and Drying Shrinkage

4.3 Modulus of elasticity

Fig. 3 shows the results of modulus of elasticity comparing with JCI model and AIJ Model, and the results are very close to AIJ model. In the most ceases modulus of elasticity of mix proportions with (N) and with (A+FA) are similar in relation to compressive strength.

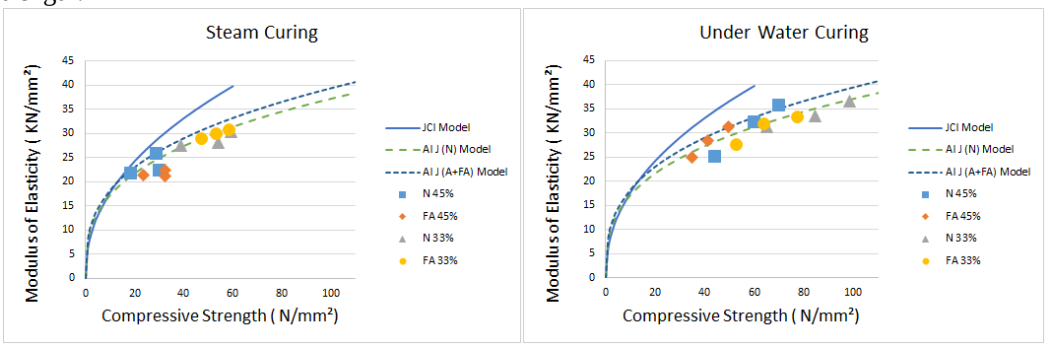

Fig.3: Modulus of Elasticity

5. CONCLUSIONS

1- Steam cured concrete with fly ash and high alite cement develops higher compressive strength at 1 day of age than the concrete with ordinary Portland cement, which is what pre-cast concrete factories looking for, because they want to demolde the concrete as soon as possible without any side effects.

2- Steam cured concrete with fly ash has lower expansion values at the early time, but the specimens with W/C=33% shows a quick drop from expansion to shrinkage that we should study its effect on the cracking of the concrete.

REFERENCES

1) Japan Concrete Institute, 2016. Guidelines for Control of Cracking of Mass Concrete.
2) Architectural Institute of Japan AIJ, 2009. State of the Report on High Strength Concrete.

ACKNOWLEDEMENTS

The study was carried out as the activity of "Technical Committee on AFC for Precast Concrete". The authors express sincere gratitude to the parties concerned.