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THE DURABILITY OF HIGHLY FLOWABLE CONCRETE USING UREA

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1. INTRODUCTION

When urea is mixed with concrete, firstly the temperature of that concrete is reduced because of the endorthemic reaction between urea and water, secondly during hydration process urea reacts with some parts of hydration products consequently reducing heat of hydration of concrete. Such property of concrete is very useful in large mass concrete constructions where heat generated during hydration process has to be reduced and where casting is done under high ambient temperatures like in summer. This paper discusses the results of the experiment conducted to study the durability of that concrete. It is hereby clarified that shrinkage and carbonation resistance are greatly improved for concrete in which urea has been used.

2. OUTLINE OF EXPERIMENT

The type of cement used is normal portland cement (specific gravity : 3.15). The fine aggregate is river sand (specific gravity : 2.61; water absorption : 1.61% ; F.M. : 2.51). The coarse aggregate is 20mm crushed stone (specific gravity : 2.75; water absorption : 0.74 % ; F.M. : 6.47). The specific gravity of limestone powder is 2.73 and its specific surface by blaime is 2,800cm^2/g. The specific gravity of urea is 1.34. The drying shrinkage was measured from rectangular shaped specimens of size10cm x 10cm x 40cm. After curing in water for 28 days the specimen were transferred to a room with constant temperature and relative humidity of 19±1°C and 68±7% respectively. Carbonation was measured from Ø10cm x 20cm cylindrical specimens. After being demolded, the specimen were cured in water for 27 days and then kept one day in dry air. After that the specimen were put in chamber where concentration of CO_2 was kept constant at 20%, relative humidity at 60% and temperature at 30 °C. Sulphate resistance was measured from 10cmx10cmx10cm rectangular specimens. After 24 days of curing in water and 4 days in air, the specimen were exposed to weekly cycles of submersion and drying, 3 days in 5% Na_2SO_4 solution then 4 days in air. After that the weight and dynamic modulus of the specimen were measured. Table 1 shows mix proportions of ordinary portland cement concrete whose slump is more than 25cm and whose slump flow is 60~70cm. These mixes were used in conducting the experiment.

3.RESULTS AND DISCUSSION

Figure 1 shows the effect of urea on concrete temperature during hydration. It is clear from the figure that an increase in amount of urea in concrete decreases the heat of hydration of concrete. Furthermore the time to reach the maximum temperature is delayed by the effect of urea. Figure 2 shows the maximum temperatures reached during hydration for different cement contents. It can be observed that the rate of decrease of the maximum hydration temperature of concrete is big when the cement content is large. Fig.3 shows the shrinkage strain of concrete with increasing urea content for different amounts of cement content. The results show that urea reduces the shrinkage strain of concrete and that the relationship between shrinkage strain of concrete and urea is linear and is almost same regardless of the cement content in concrete. Figure 4 shows the relationship between carbonation of at 56 days and urea content. Different levels of cement content have been considered. It can be observed that urea decreases carbonation rate of concrete and that the rate of carbonation reduction in concrete decreases linearly as the amount of urea in concrete is increased. Figure 5 shows the

Table－1 Mix proportion of concrete

Unit weight per volume (k g/m^3)						Admixture(kg/m^3)	
W	C	L f	U	S	G	S. P.	S. R.
155	388	179	0	706	1006	9. 12	1. 5
143		177	27(20)	698	995		
131		175	53(40)	690	983		
119		173	80(60)	682	972		
107		171	107(80)	674	960		
180	300	187	0	706	1006	7. 05	7. 0
165		186	27(20)	701	999		
150		184	53(40)	696	992		
135		183	80(60)	691	985		
120		182	107(80)	686	977		
200	250	0	0	854	1027	0	0
200		176	0	706	1006	5. 88	10. 0
182		175	27(20)	704	1003		
164		175	53(40)	702	1000		
146		174	80(60)	700	997		
128		174	107(80)	698	995		

S.P.:Superplasticizer
S.R.:Segregation reducing agent
( ):Volume (liter)

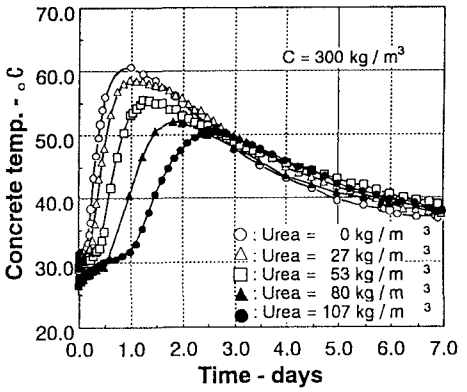

Fig.1 Heat of hydration of concrete.

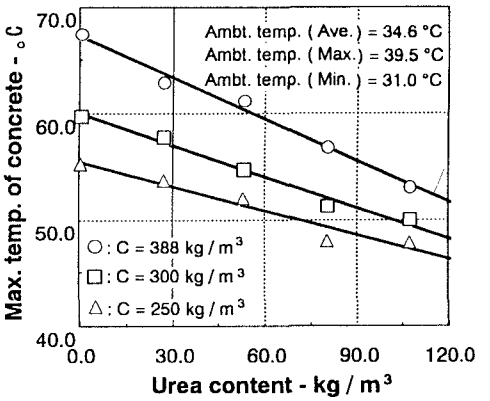

Fig. 2 The maximum temperatures.

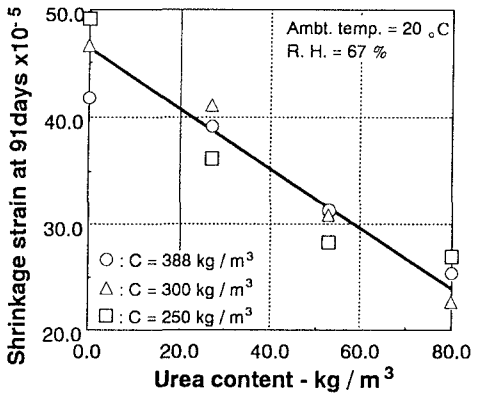

Fig.3 Shrinkage strain of concrete at 91 days.

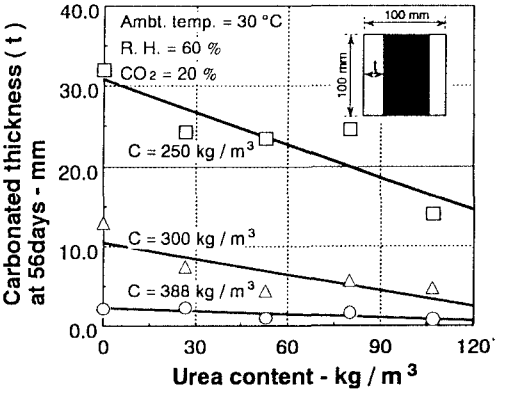

Fig. 4 Carbonation thickness at 56 days.cement

dynamic modulus of elasticity ratio of specimens subjected to sulphate attack for more than 24 cycles. `The concrete without limestone powder was attacked by sulphate and was completely destroyed after 21th cycle but concrete with limestone powder showed some resistance.
It is clear from the results that limestone powder improves sulphate attack of highly flowable concrete, and that the durability for sulphate attack of urea concrete is higher than that of concrete without limestone powder.

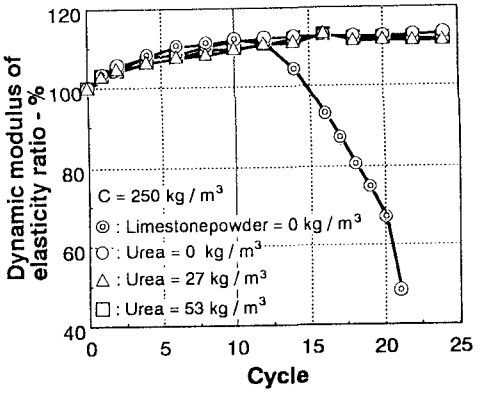

Fig.5 Resistance to sulphate attack.

4. CONCLUSION

In this study we have observed that in a addition to the fact that urea reduces the temperature of concrete it also enhances durability of concrete by reducing carbonation and shrinkage strain of concrete. It is also clear that limestone powder improves the sulphate attack of highly flowable concrete and the durability for sulphate attack of urea concrete is higher than that of concrete without limestone powder.