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TECHNICAL NOTE

DEVELOPMENT OF EARLY DAILY STRENGTH OF HIGH STRENGTH CONCRETE

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ABSTRACT

Classification of different cements, for concrete structures according to relative daily activity with the presence of superplasticizers is presented. The evaluation helps to choose the appropriate cement for developing early daily strength of in-situ concrete with immediate untimbering and slightly warmed-up and non warmed-up precast concrete.

Keywords: concrete, strength, cement, activity, technology, superplasticizers

1. INTRODUCTION

The use of superplasticizers is one of the most effective means to lower the cost and raise the quality of concrete and reinforced concrete units and structures. In spite of half a century experience of modified concrete with dilution additives use, many questions concerning its rational employment are partially studied by [1,2]. Little attention is still paid to early daily strength of plasticizer-modified concrete and its initial strength that is vital to get super-strong in-situ concrete with immediate untimbering of slightly warmed-up and especially unwarmed-up precast concrete [3].

2. CEMENT CLASSIFICATION

The influence of mineralogical and substance content of portland cement clinker on cement systems to dilution additives susceptibility is also partially investigated. It is known that almost all kinds of Russian superplasticizers such as S-3, 40-03, 10-03, LSTM and others cause prolonged blocking effect on the kinetic of initial strength accumulation. A number of cements don't meet the requirements in initial strength though some cements are characterized by high rate of early strength accumulation. Thus, addition of superplasticizer to concrete on certain cements leads to raising both early (24-hours and 12-hours) and standard concrete strength and it is conditioned not only by the function of water reduction, but also by preserving hydraulic cement activity and its strength at the presence of superplasticizer.

Concretes containing other kinds of cements are characterized by fast decline of 24 hour strength and their intensive accumulation in 2-3 days of hardening. Thus, cement classification was carried out at the presence of superplasticizer S-3 and the following criteria were employed:

K_a - coefficient of relative daily cement activity defined from

$$K_a = R_n / R_H,$$

where

R_n, R_H - daily strength of plasticized and non-plasticised mortars;
WI-water reduction index, defined from

and

$$WI = \frac{(WH)_{II} - (WH)_H}{(WH)_{II}} x100\%$$

where $(WH)_{II}$ and $(WH)_H$ and $(WH)_H$-water solid ratio of plasticized and not plasticized dissolved mixture.

3. INFLUENCE OF SUPERPLASTICIZER ON WATER-REDUCTION AND DAILY CEMENT ACTIVITY

More than 10 kinds of different cements for concrete structures were studied in order to evaluate the hydraulic cement activity and rheological superplastisizer effectiveness. Table 1. Comparison of daily strength was done on equally plastic fine grained mixtures content (the diameter of spreading on jarring table is 108-115mm) C/S=1:2 produced without additives and with S-3 additive in quantity 1.0% from the whole cement weight. As we see from Table 1. the action of SP on the rate of cement / sand mortar accumulation differs greatly. Depending on coefficient K_a all the investigated cements are subdivided into 3 grades.

For the grade I the change of K_a is up to 0.5, II grade II-from 0.5 to 1.0, III-more than 1.0. Superplasticizer water-reduction activity always determines the first grade of cement according to hydraulic activity R_a.

Index of relative daily cement activity correlates with kinetic of early concrete strength accumulation. Table 2 shows the kinetic of strength accumulation of highly strong plasticized and non-plasticized concrete, produced on grade 3 cement. To produce 1 m^3 of concrete mixture we need: cement-560kg, sand-560 kg, road metal-M-1200-1300 kg, the content of additive S-3 varies from 0.5% to 1.0%, water was taken in quantity to get equally plasticized by S-3 in quantities-0.5% equals 14.5 on Volsk cement; 13.5 on Starooskol cement, 12.6 on Mordov-cement, with increase of S-3 content up to 1.0% water-reduction index considerably raised. It equalled 23.6 for Volsk cement, 22.3 and 19.9 for Starooskol and Volsk cements.

Table 1. Influence of superplasticizer S-3 on water-reduction and daily cement activity.

No	Cement producers	Cement grade	WI, %	K_a	Cement classification according to daily activity
1	2	3	4	5	6
1	"Bolshevic" Volsk	PC-500 A0	29,4	1,3	
2	"Soda" Sterlitamak	PC-500 A0	21,6	1.22	I
3	Katav-Ivanovsk	PC-500 A0	37,0	1,14	
4	Lipetsk	PC-400 A0	15,6	1,14	
5	Lipetsk	PC-200 A0	0,6	1.2	
6	Sebrjakov-cement	PC-500 A0	19,9	0,77	
7	Starey-Oskol	PC-500 A0	20,8	0,76	
8	Lipetsk	PC-400 A0	15.1	0,83	II
9	Uljanovsk	PC-400 A0	12,5	0,58	
10	Mordov-cement	PC-500 A0	20,5	0,25	
11	Mordov-cement	PC-100 A0	0,20	0,20	III
12	"Bolshevic" Volsk	PC-400 A0	0,27	0,27	

4. DISCUSSION AND CONCLUDING REMARKS

According to Table 2, introduction of S-3 in quantity of 1.0% can both raise and lower daily concrete strength with respect to non-plasticized concrete. Thus, coefficient of daily concrete stength $K_c=R_{II}/R_{II}$ is as following:

For grade I cement-1.53, grade II cement-0/89, grade III cement-0.45, though standard concrete strength at the age of 28 days R_{28}, produced on these cements differs slightly.

Table 2. Kinetics of concrete strength accumulation.

Kind of cement	Cement Grade	Quantity of S-3, additive%	WI, %	Strength Mpa at the age				
				1 day	3 days	7 days	28 days	K_C
Volsk		-	-	23.4	62.4	67.6	88.6	-
PC-500	I	0.5	14.5	32.7	76.0	80.8	99.2	1.40
Ao		1.0	23.6	36.0	80.4	82.0	106.0	1.53
Stary		-	-	23.4	62.4	67.6	88.6	-
Oskol	II	13.51	9.51	30.4	76.0	80.8	99.2	1.3
		1.0	22.2	21.0	73.2	82.0	90.6	0.89
Mordov-		-	-	13.6	34.0	61.0	86.0	-
cement	III	0.5	12.6	14.0	38.6	69.0	98.0	1.03
PS-500AO		1.0	19.9	6.12	40.0	71.0	99.4	0.45

At the same time lowering the quantity of S-additive to 0.5% to the detriment of water-reduction, increases R_c of concrete to 1,3 for grade II cement and 1,03- for grade III cement. Thus for grade II, grade III cements critical superplasticizer dosage, giving primary concrete strength, is between 0.5-0.7%. For Volsk grade I cement S-3 dosage can be raised up to 1.0%.

The use of plasticizers and accelerants in hardening process together with low-temperature concrete warming-up is also an effective technological means which can provide 50-70% of standard daily strength.

Index K_e for warmed-up concrete (t=35°) plasticized by 1.0% of S-3 together with hardening accelerant can be raised up to 1.59-1.91 depending on cement grade.

The research gives an opportunity to choose appropriate cement to form in-situ concrete daily strength with immediate untimbering and slightly warmed and non-warmed up pre-cast concrete.

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