A type of polycarboxylate superplasticizer used in high performance self-compacting concrete

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Abstract. In this study, a kind of polycarboxylate superplasticizer used in high performance self-compacting concrete was synthesised. The examined properties included workability, T500, compressive strength,etc. Workability of the fresh concrete was determined by using both the slump-flow test. The results showed that it was possible to successfully use this polycarboxylate superplasticizer in producing SCC.

1 Introduction

Self compacting concrete is a type of concrete that is highly fluid allowing it to self-level, penetrate into complicated areas and formwork, through complex reinforcement and much more[1]. Despite its increased fluidity, self compacting concrete maintains the high quality demanded by today's building industry, presenting both flexibility as well as incredible strength. Its flexibility lies in the fact that there are multiple admixtures that can be added when designing the mix to create a final product that is suitable for the end result.

Many case studies of applications of self-compacting concrete (SCC)[2]have been analysed from 1993 to nowadays, increasingly widespread use of SCC in many countries.They were selected for analysis on the basis of including details of concrete formulations and properties. The ranges of properties, component materials and mix proportions show the diverse nature of SCC, and confirm that it should be considered as a family of mixes suitable for a wide range of applications with widely varying requirements[3].

High water reducer – superplasticizer. This is an admixture that is used in all types of self compacting concrete because it is what gives it its flowability. Essentially, this admixture reduces the quantity of water needed to achieve the same consistency as traditional concrete meaning that if the same quantity of water is used then the resulting material will be much more fluid and easy to work with. Therefore, polycarboxylate superplasticizers are sidely used in self-compacting concrete.

2 Experimental

2.1 Chemicals and Equipment.

Prenyl alcohol ethoxylates (TPEG, Taijie Chemical Co. LTD), Acrylic acid (AA,Wuhan Zhonghua Yongye Chemical Co. LTD), Ammonium persulfate (APS, Wuhan chemical Co. LTD), Chain transfer agent (TGA, Changzhou Yurong Chemical Co.LTD) , sodium hydroxide(NaOH), HuaXin cement,P.O42.5 ， WuGang II flyash, WuXin S95 silica fume. Cement paste mixer,NJ-160A,WuXi JianYi equipment Co. LTD ; Single horizontal-axis laboratory concrete mixer,HJW-60,ShenYang JuLin equipment Co. LTD.

2.2 Synthesis Process.

Put water and TPEG into a flask, and stirried until the end of experiment; wait until TPEG dissolved, and dripped the mixture of APS and AA , separately dripped TGA solution; keep stirring for certain hours, then added the sodium hydroxide and water, and adjusted pH of the new product about 7; The new product would been gotten and its solid content was 40%.

2.3 Measurement.

The fluidity of cement slurry was tested according to Chinese Standard (GB/8077-2000).The water-cement ratio is 0.29,PCs dosage is 0.13%.

3 Results and Discussion

3.1 The dose of use in various types of concrete

Table.1 Mix ratio of concrete

strength-grade	cement	ash	Mineral powder	Silica fume	sand	stone	water	dose%
C70	390	100	85	45	660	990	135	2.2
C80	400	50	140	50	660	980	130	2.4
C100	450	50	115	65	650	960	130	2.6

Table.2 Fluidity of cement paste with different superplasticizer

strength-grade	superplasticizer	0h mm	1h mm	3h mm
C70	Ordinary	260/700	235/595	215/490
	our	260/710	260/690	260/690
C80	Ordinary	265/720	230/580	210/500
	our	260/730	255/720	265/735
C100	Ordinary	260/725	235/620	230/510
	our	260/735	260/710	265/720

Table.2 shows that our is superior to the ordinary superplasticizer, self-compacting concrete has better fluidity when the same dose of admiture is added.

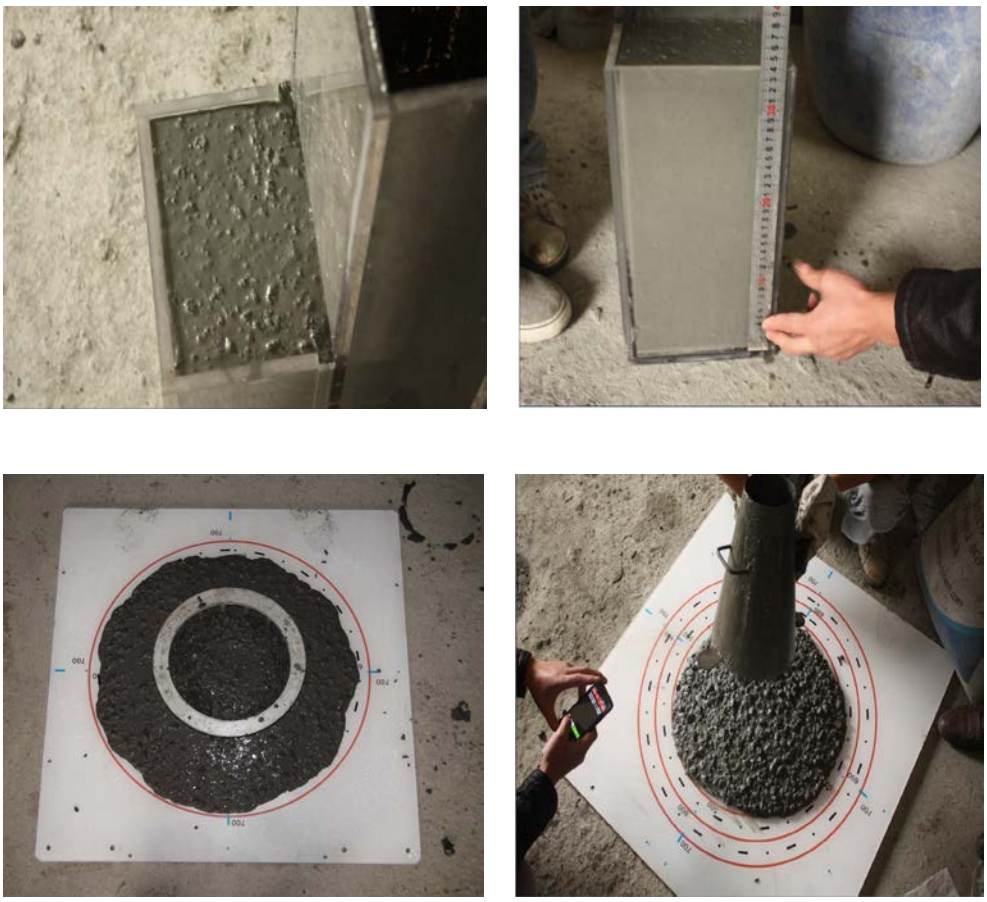

Fig3. Pictures of the test

Table.3 Effect on C70 concrete

types		time/s	T_{500}/s	slump/ mm	J-loop /mm	unit weight / Kg/m3	U box/m m	rate of segregation
our	0h	5.71	4.5	265/720	690	2410	335	7.8%
	3h	5.55	4.0	270/730	685		340	7.4%
ordinary	0h	4.92	4.8	265/730	700	2410	340	7.9%
	3h	5.73	5.2	265/700	670		335	7.5%

Table.4 Effect on C80 concrete

types		time/s	T_{500}/s	slump/ mm	J-loop /mm	unit weight / Kg/m3	U box/mm	rate of segregation
our	初始	5.33	4.4	265/730	700	2420	340	7.6%
	3h	5.71	3.8	270/695	695		340	7.0%
ordinary	初始	4.22	5.0	265/720	690	2420	340	8.2%
	3h	5.87	6.8	260/700	680		330	7.1%
	3h	7.06	8.7	260/705	685		320	6.1%

T500、J-loop、U-box、unit weight and rate of segregation are tested in in various types of strength-grade concrete， Table1-4 show that our performances are better than ordinary superplasticizers.

Table.5 Effect on strength of C70-C10

strength grade	types	initial setting time /h	final setting time /h	R_7 /MPa	R_{28} /MPa
C70	our	12	14.5	73.5	85.1
	ordinary	11.5	14	70.2	81.2
	others	11.5	14.5	69.5	80.1
C80	ZJSS-II	13.0	15	83.3	95.6
	ordinary	12.5	15	78.6	92.3
	others	12.5	14.5	77.2	90.5
C100	ZJSS-II	13.5	15	102.5	123.2
	ordinary	13.5	15	98.3	121.4
	others	13.0	14.5	97.6	120.7

Table5 shows that our product is superior than ordinary products in the market . The strength of 7days and 28days used with our superplasticizer is a little higher than ordinary superplasticizers .

4 Conclusion

T500、J-loop、U-box、unit weight and rate of segregation are tested in in various types of strength-grade concrete， the results show that our performances are better than ordinary

superplasticizers.By discussing various factors that impact the performance of PCs, we confirm a kind of polycarboxylate superplasticizer used in high performance self-compacting concrete.

References

[1] Alireza K, John L et al. Effect of molecular architecture of polycarboxylate ethers on plasticizing performance in alkali-activated slag paste [J]. J Mater Sci, 2014(49):2761–2772.
[2] Alone M, Palacios M, et al. Compatibility between polycarboxylate-based admixtures and blended-cement pastes [J]. Cement and Concrete Composites, 2013, (35):151-162.
[3] Yamada K, Takahashi T, Hanehara S, et al. Effects of the Chemical Structure on the Properties of Polycarboxylate-type Superplasticizer[J]. Cement and Concrete Research, 2000, 30(2): 197-207.