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ORIGINAL ARTICLE

Self-healing of polymer modified concrete

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KEYWORDS

Cracks;
Self healing;
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Damage

Abstract Self healing phenomenon of concrete has been observed in traditional, fibrous, self compacting concrete. This phenomenon occurred mainly due to the presence of unhydrated cement particles in the presence of water. Mechanism of polymer in concrete depends on creating a layer and net of polymer around cement particles which enhances the properties of polymer modified concrete. This mechanism may affect the self healing of this type of concrete. This work aims to study the presence of the self healing phenomenon in polymer modified concrete and the related parameters. An experimental investigation on self healing of polymer modified concrete was undertaken. In this research work, effect of polymer type, polymer dose, cement content, cement type, w/cm ratio and age of damage were studied. The healing process extended up to 60 days. Ultrasonic pulse velocity measurements were used to evaluate the healing process. Results indicated that, the self healing phenomenon existed in polymer modified concrete as in traditional concrete. The increase of polymer dose increases the healing degree at the same healing time. This increase depends on polymer type. Also, the decrease of w/cm ratio reduces the self healing degree while the use of Type V Portland cement improves the self healing process compared with Type I Portland cement. Cement content has an insignificant effect on healing process for both concrete with and without polymer. In addition, the increase of damage age decreases the efficiency of self healing process.

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1. Introduction

Concrete in service cracks due to direct stress and substress caused by many kinds of reasons, such as changes of temperature and humidity, inhomogeneous sinking and external loading (dynamic or static loading). Cracks not only influence the service durability of concrete structure, but also are harmful for the structure safety [12].

Self-healing phenomenon has been observed in cementitious materials for many years. One such example is on a famous bridge in Amsterdam, where micro cracks were self-healed by the recrystallization of calcite [8]. Self healing phenomenon also was observed in some other concrete structure

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Table 1 Description of used concrete mixes and studied parameters.

Mix no.	Polymer type	W/cm ratio	Polymer dose (%)	Cement content (kg/m ³)	Cement type	Studied parameters
1	SBR	0.40	0	500	Type I	Effect of dose of polymer (main group)
2	SBR	0.40	5	500	Type I	
3	SBR	0.40	10	500	Type I	
4	SBR	0.40	15	500	Type I	
5	SBR	0.40	0	600	Type I	Effect of cement content
6	SBR	0.40	10	600	Type I	
7	SBR	0.50	0	500	Type I	Effect of w/cm ratio
8	SBR	0.50	10	500	Type I	
9	SBR	0.40	0	500	Type V	Effect of cement Type
10	SBR	0.40	10	500	Type V	
11	ACR	0.40	0	500	Type I	Effect of type of polymer
12	ACR	0.40	10	500	Type I	
13	SBR	0.40	0	500	Type I	Effect of age of deterioration
14	SBR	0.40	10	500	Type I	

Table 2 Ultrasonic pulse velocity test results.

Mix no.	Specimen no.	UPV before healing (km/s)			UPV after healing (km/s)		
		Initial UPV	UPV after cracking	Damage level (%)	After 20 days	After 40 days	After 60 days
1	1	4.691	2.489	46.9	4.159	4.234	4.285
	2		2.862	39.0	4.311	4.364	4.391
	3		3.535	24.6	4.391	24.6	4.447
2	1	4.582	3.047	33.5	4.311	33.5	4.464
	2		1.425	68.9	2.688	68.9	3.391
	3		2.446	46.3	3.626	46.3	4.135
3	4	4.449	3.483	24.0	4.337	24.0	4.532
	1		3.822	14.1	4.291	14.1	4.364
	2		2.934	34.1	4.110	34.1	4.208
4	3	4.419	2.862	35.7	4.010	35.7	4.135
	1		3.009	31.9	4.040	31.9	4.337
	2		3.319	24.9	4.260	24.9	4.419
5	3	4.842	3.449	21.0	4.470	21.0	4.503
	1		3.721	23.2	4.479	23.2	4.634
	2		4.208	13.0	4.568	13.0	4.769
6	1	4.475	2.851	36.3	3.842	36.3	4.159
	2		2.751	38.5	3.781	38.5	4.089
	3		3.243	27.5	4.110	27.5	4.391
7	1	4.682	3.571	23.7	4.217	23.7	4.420
	2		3.214	31.4	4.210	31.4	4.261
	3		3.994	14.7	4.285	14.7	4.410
8	1	4.424	2.784	37.1	3.658	37.1	4.063
	2		2.898	34.5	3.761	34.5	4.115
	3		2.590	41.5	3.483	41.5	3.972
9	1	4.823	2.571	46.7	4.087	46.7	4.475
	2		2.909	39.7	4.237	39.7	4.651
	3		3.761	22.0	4.591	22.0	4.944
10	1	4.621	2.874	37.8	3.801	37.8	4.208
	2		3.047	34.1	4.063	34.1	4.447
11	1	4.567	3.228	29.3	4.264	29.3	4.411
	2		3.863	15.4	4.364	15.4	4.583
	3		3.415	25.2	4.337	25.2	4.559
12	1	4.394	3.128	28.8	4.135	28.8	4.370
	2		3.021	31.2	3.950	31.2	4.364
	3		2.828	35.6	3.850	35.6	4.235
13	1	4.538	4.100	9.7	4.510	9.7	4.600
	2		2.142	52.8	4.150	52.8	4.301
14	1	4.227	1.425	66.7	3.115	66.7	3.590
	2		2.682	37.3	4.087	37.3	4.331
	3		3.078	28.0	4.390	28.0	4.570

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