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Introduction to concrete curing effect on the early performance of modern concrete

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Abstract
In order to meet the requirements of the modern structure of concrete performance, the composition of modern concrete produced bigger change, this inevitably made an impact on the other properties of concrete. Especially the change of cement fineness and composition, a large number of add mineral admixtures, and the widespread use of high efficiency water reducing agent, has a great influence on the early performance of concrete, especially on the early shrinkage performance, which affect the early cracking of concrete. By collecting and analysising relevant test result, The article summarizes the characteristics of the early performance of modern concrete and their requirements of early curing environment.

Keywords: modern concrete, early cracking of concrete, early curing environment

I. The early performance characteristics of modern concrete

Modern concrete is a delegate with industrialized production of premixed concrete, with the change of the fineness of cement, mineral admixture and the use of high performance water reducing agent for the characteristics of the concrete. The characteristics of modern concrete performance in the improvement of the permeability and the early strength of concrete, the hydration reaction time is shorter, reduce the reliance of the concrete strength for concrete strength, and its workability is invested by harsh concrete into the plastic concrete, make the rheological properties of modern concrete mixture more evident, under the same water cement ratio have higher strength and better compactness, thus ensuring workability and durability of concrete structure is increasing day by day. The most important characteristics is high homogeneity ,it can also according to the needs of the actual project to add a special components meet the performance of the special requirements, such as high performance concrete, concrete, lightweight concrete, etc.

Concrete composition and the change of the composition also cause a certain influence on the hydration and shrinkage deformation properties, mainly displays in the early concrete strength development, early hydration heat and shrinkage deformation of concrete, concrete early performance become more sensitive to changes in environment, etc. Especially cement particles become fine and the use of high efficiency water reducing agent and an increase in early shrinkage deformation of concrete at the same time, also makes the performance even more dependent on the development of early concrete curing environmental conditions.Lack of maintenance or maintenance, it's often easy to cause early concrete structural cracks, thus influence on the performance of the concrete durability. Second, the extensive use of mineral admixtures in concrete, decrease water/cement ratio,leads to the increase the autogenous shrinkage of concrete.When lack of

necessary early concrete curing conditions, excessive autogenous shrinkage is one of the main reasons of concrete early crack. Therefore, compared with the traditional concrete, Early curing environment has a very important role on early performance of modern concrete, especially the early crack resistance, reasonable early maintenance is the key of modern concrete strength and durability.

II. The influence of maintenance on the early concrete performance

Change of concrete, at the same time in the meet the performance requirements of concrete, has also changed the early shrinkage deformation of concrete performance.Maintenance as effective measures to control the quality of concrete, with the composition of concrete has become the two major factors influencing the performances of concrete early shrinkage deformation. In order to guarantee the anti-cracking performance of concrete, The change of concrete composition must put forward new requirements to the maintenance method and maintenance environment.There are different ways of curing and curing environment of the influence of early shrinkage of concrete were studied.

2.1 Under different humidity conditions affect on the early shrinkage of concrete that water reducing agent

The text research on two concrete with water cement ratio of 0.5, one concrete has no admixture (J series), another for mixing 0.75% FND (F series).Two kinds of concrete mixture ratio, and slump are shown in table 2.1.

Table 2.1 The mix of J and F series concrete

series	Material usage of each side concrete (kg/m3)					slump (mm)
	cement	water	sand	gravel	FDN	
J	352	176	751	1126	0	30
F	352	176	751	1126	2.64	150

Using flat shrinkage cracking test method for measuring the early shrinkage of concrete, measured series of J and F series concrete initial setting time were 4.5 and 5.6 h.Test using both open and sealed curing way, Open maintenance modes means the specimen surface is open, still with plastic film wrapped around;Seal curing refers to the specimen is three layers of plastic film package. Curing room temperature control in (19 ± 1) ℃, relative humidity (RH) by (45 ± 5) %, (55 ± 5) % and (65 ± 5) % to control.According to the different ways of curing and the conditions of different humidity of concrete Numbers are shown in table 2.2, the test results as shown in table 2.3.

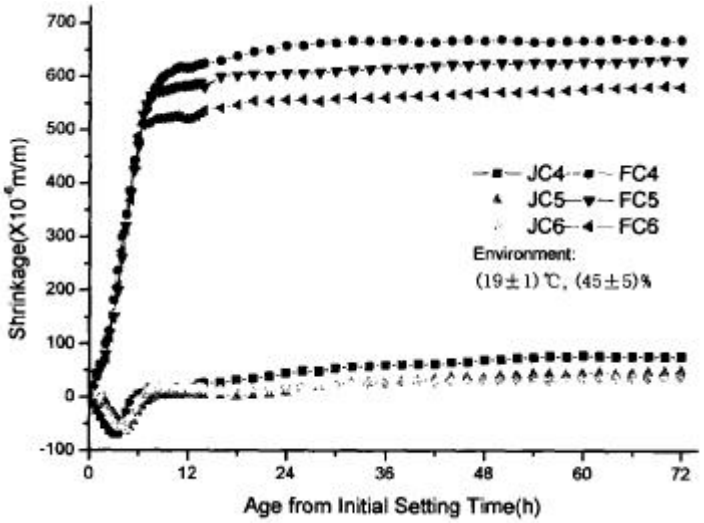
Table 2.2 The serial number of J and F series concrete

series	Maintenance mode	Relative humidity		
		(45±5)%	(55±5)%	(65±5)%
J	open	JC4	JC5	JC6
	seal	JS4	JS5	JS6
F	open	FC4	FC5	FC6
	seal	FS4	FS5	FS6

Table 2.3 J and F series concrete early shrinkage under different humidity

Relative humidity RH	series	Different age shrinkage of concrete（$X10^{-6}$m/m）					
		4h	8h	12h	24h	48h	72h
(45±5)%	JC4	-54	16	16	44	70	76
	JS4	-114	-166	-190	-178	-166	-164
	FC4	300	578	616	658	666	668
	FS4	-98	-66	-48	-12	-10	-6
(55±5)%	JC5	-48	0	4	10	36	50
	JS5	-94	-122	-162	-140	-138	-138
	FC5	262	572	584	606	624	630
	FS5	-22	36	60	78	90	92
(65±5)%	JC6	-52	18	18	20	30	38
	JS6	-116	-116	-194	-186	-158	-148
	FC6	274	520	520	556	570	580
	FS6	-98	-64	-44	-8	6	14

For the convenience of relative humidity on the influence of concrete shrinkage, will open the test specimen under the condition of different relative humidity of concrete shrinkage drawn in one diagram, as shown in figure 2.1.



Picture 2.1 The influence of humidity on early shrinkage of concrete

Comparative the results of table 2.1and figure 2.1 can be found that the humidity has bigger influence on early shrinkage of concrete with water reducing agent, and as the humidity by (65 ± 5) % reduce to (45 ± 5) %, shrinkage value has increased significantly, the biggest difference reached 88 x 10^{-6} m/m. Under the condition of same humidity, shrinkage value differences of open specimen is bigger compared with the closed specimen ,The shrinkage difference of three groups of specimens surpass 500 x 10-6 m/m, and with the decrease of the relative humidity has a tendency to increase. At the same time, The concrete without water reducing agent is affected relatively small, little shrinkage difference under different conditions of relative humidity, the

biggest difference is 38 x 10^{-6} m/m, less than half of the concrete with water reducing agent.

Therefore, Adding water reducing agent makes the concrete becoming very sensitive to its early curing environment , at different relative humidity environment, the shrinkage of concrete performance showed a great difference.Therefore, in order to guarantee the modern concrete has enough early crack resistance, it is necessary to control the humidity of ealy curing environment of concrete with water reducing agent.

6.2 The influence of initial curing age and maintenance methods on the early shrinkage of concrete with water reducing agent

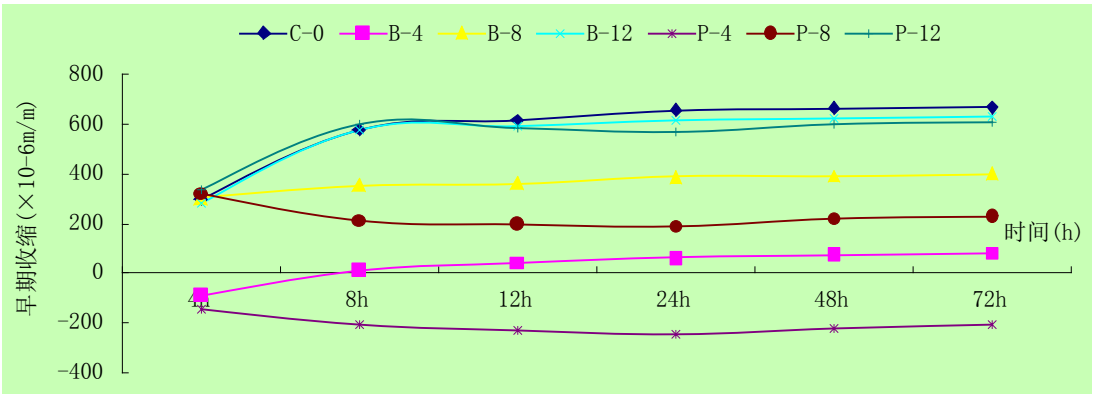
The tests research on the concrete with water cement ratio of 0.5, mixed with 0.75% of FDN powder, respectively adopt membrane curing (number B) and spray maintenance (number P), number C as a benchmark is not maintenance, concrete specimen and Numbers are shown in table 2.4, the results are shown in table 2.5 and figure 2.2.

Table 2.4 the mix to the influence of different curing methods on early shrinkage of concrete proportion test

the mix of concrete（kg/m^3）				
cement	water	sand	aggregate	Water reducing agent
352	176	751	1126	2.64

Table 2.5 The influence of different curing methods on early shrinkage of concrete

Serial number		The early shrinkage of concrete（×10^{-6}m/m）					
		4h	8h	12h	24h	48h	72h
C	C-0	300	578	616	658	666	668
B	B-4	-88	14	40	62	74	80
	B-8	302	354	362	388	392	400
	B-12	282	574	590	616	622	632
P	P-4	-142	-210	-228	-246	-226	-210
	P-8	320	212	200	188	220	230
	P-12	338	598	584	572	600	612



Picture 2.2 The influence of different curing methods on early shrinkage of concrete

The figure 2.2 shows that the early shrinkage of concrete which using spray curing are much smaller than membrane curing concrete; Maintenance starting age had a greater influence on the early shrinkage of concrete, as the starting age later, curing of concrete shrinkage effect of stepwise decrease; And with the increase of curing time, the early shrinkage of concrete decreases.Overall, compared with the open without maintenance, using two kinds of maintenance mode can greatly reduce the early shrinkage of concrete.

The change of composition makes the modern concrete becoming more rely on early maintenance poor maintenance, often lead to produce very big early shrinkage deformation of concrete. In terms of modern concrete performance, environment humidity, curing methods and curing time have great influence on the early shrinkage deformation properties.Thus, a reasonable comprehensive maintenance is the key of modern concrete durability.

3、The requirements of modern concrete on early curing environment

The change of composition makes the modern concrete has the advantages of high strength, high durability, high workability, and high homogeneity, but at the same time also makes the early shrinkage deformation and hydration heat, such as the early performance of strengthen sensitivity to the environment .Through the relevant experimental study shows that according to the early performance of modern concrete characteristic, enhance the early concrete curing is to improve the early modern concrete performance, the key to ensure good performance of concrete.

Too early shrinkage deformation and strong early hydration heat tends to produce a large number of concrete shrinkage and temperature cracks, when concrete surface moisture lost faster, modern concrete strong sensitivity of curing environment has greatly contributed to the cracks of the above two. therefore, to reduce the early non-structural cracks of modern concrete, a stability early hydration environment is necessary after concrete casting, try to avoid frequent air flow on the surface of the concrete, and thus reduce the concrete free moisture loss, reduce early drying shrinkage cracks of concrete. Seal curing way such as mulch maintenance has obvious control effect on modern concrete early shrinkage deformation.

Second, compared with the traditional concrete, the early hydration heat intensifying and the decrease of the water/cement ratio, along with the increase of the early temperature contraction of modern concrete, also put forward more strict requirements for its early curing conditions . At the same maintenance environmental conditions, sealing and spray have obviously different effects on the early shrinkage of concrete.By contrast, spray curing are more effective on early shrinkage deformation of concrete. And in terms of the early hydration heat of concrete, and eliminate the concrete temperature control of raw materials, reasonable maintenance method and maintenance time also has a great influence on the early hydration heat of concrete, concrete curing method and time control should be according to the relevant test and software simulation.

In conclusion, given the early performance characteristics of modern concrete, the requirement of concret to curing environment mainly has three points: isolation concrete surface air flow, provide sufficient moisture in the process of concrete hydration and suitable temperature control measures.Thus, through the reasonable maintenance can give full play to modern concrete for the characteristics of high workability and high homogeneity, at the same time to ensure structural durability performance.

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