Study on the Concentration of Corrosion Inhibitor into the Concrete

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ABSTRACT

After steel bar was corroded it removes concrete contaminated, it does steel bar corrosion protection, repairing method and corrosion inhibitor spreading method are difficult to secure corrosion protection performance. Accordingly, in this research before Research and Development to penetrate corrosion inhibitor to high pressure by steel bar position, it measured concentration of corrosion inhibitor through measurement experiment of nitrite ion in accordance with water-cement ratio, pressure, pressure time and it computed water-cement ratio, pressure, pressure time to be more than 0.6 mol ratio of chloride ion and nitrite to have outstanding corrosion protection performance. As a result of experiment, water-cement ratio gives the biggest influence to concentration of corrosion inhibitor and also the more depth of specimen becomes deep, concentration of penetrated corrosion inhibitor does not equal and becomes low.

KEYWORDS: Corrosion inhibitor, Coefficient of Diffusion, Penetration Depth, Nitrate

1. INTRODUCTION

After harmful ingredients of every kind penetrate into concrete, it causes corrosion of rebar and it reduces not only service lives but also capacity. Durable degradation with steel bar corrosion caused by chloride ion has been occurred frequently within the country. Therefore when chloride ion exceed the chloride threshold level(1.2kg/m^3) it is very important to certainly penetrate corrosion inhibitor until position of rebar. But, new technology development is necessary. Because existing repair method is inconvenient and it is both costly and construction time consuming. In addition the technology of penetration on concrete surface with corrosion inhibitor is difficult to make more than 0.6 mol ratio of nitrate ion and chloride ion having outstanding effect of corrosion inhibition. So, necessary of high-pressure penetration technology development is becoming the main issue and we judged that we need the precedent study about concentration of nitrate ion according to depth. Under this background, when mol ratio of chloride ion and nitrate ion become more than 0.6 we calculate amount of nitrate ion. and then we estimate amount of nitrate ion according to location and we predict pressure and pressurizing time having superb performance of corrosion inhibition and do overall study about concrete penetration of corrosion inhibitor.

2. Concentration measurement experiment of Nitrite by positions

After it manufactures hollow specimens like fig 1 and penetrates corrosion inhibitor, it splits. After it takes a sample using milling machine every 1cm from center of specimen, it dissolves in 50ml distilled water and maintains temperature for 30 minute at 50℃ using water bath. It measures quantity of nitrite ion using colorimeter.

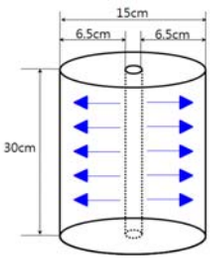


Fig 1. Specimen Fig 2. Permeability Tester Fig 3. Milling Machine Fig 4. Colorimeter

Table 1. Permeability tester

Test Factor	Levels
Water Cement Ratio	65%, 60%, 55%
Pressure	1MPa, 1.5MPa
Pressurizing time	24hours, 48hours, 96hours

Table 2. Mixture proportions

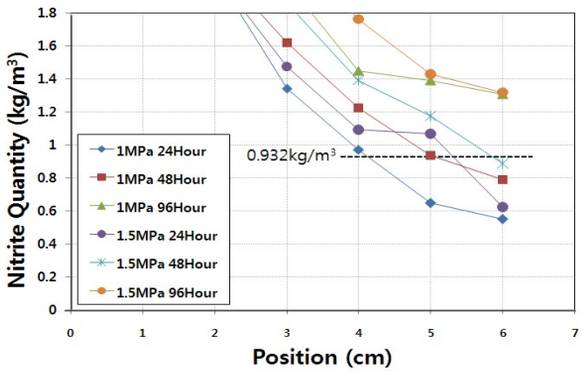
W/C (%)	Unit Weight(kg/m^3)				
	Water	Cement	Fine aggregate	Coarse aggregate	AE agent
65	170	261	902	985	4.74
60	170	283	867	995	5.20
55	170	309	832	1004	5.74

3. RESULT & ANALYSIS

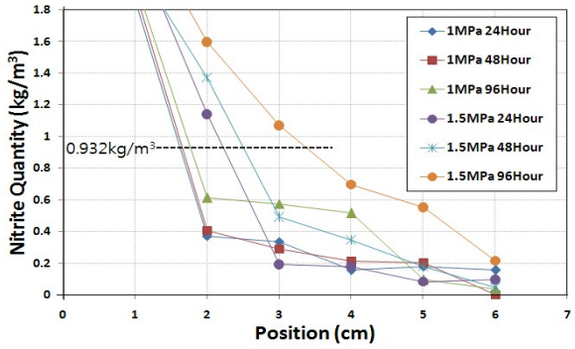
Table 3. Quantity of Nitrite Ion(NO_2^-)

W/C (%)	Water pressure (MPa)	Time (h)	Quantity of Nitrite ion(NO_2^-) (㎎/ℓ) & Unit Weight (kg/m^3)											
			position											
			1cm		2cm		3cm		4cm		5cm		6cm	
65	1	24	150↑	1.8↑	150↑	1.8↑	112	1.34	81	0.97	54	0.65	46	0.55
		48	150↑	1.8↑	150↑	1.8↑	135	1.62	102	1.22	78	0.94	66	0.79
		96	150↑	1.8↑	150↑	1.8↑	150↑	1.8↑	121	1.45	116	1.39	109	1.31
	1.5	24	150↑	1.8↑	150↑	1.8↑	123	1.48	91	1.09	89	1.07	52	0.62
		48	150↑	1.8↑	150↑	1.8↑	150↑	1.8↑	116	1.39	98	1.18	74	0.89
		96	150↑	1.8↑	150↑	1.8↑	150↑	1.8↑	147	1.76	119	1.43	110	1.32
60	1	24	150↑	1.8↑	31	0.37	28	0.34	13	0.16	15	0.18	13	0.16
		48	150↑	1.8↑	34	0.41	24	0.29	18	0.22	17	0.20	0	0
		96	150↑	1.8↑	51	0.61	48	0.58	43	0.52	8	0.10	3	0.04
	1.5	24	150↑	1.8↑	95	1.14	16	0.19	15	0.18	7	0.09	8	0.10
		48	150↑	1.8↑	114	1.37	41	0.49	29	0.35	15	0.18	4	0.05
		96	150↑	1.8↑	133	1.60	89	1.07	58	0.70	46	0.55	18	0.22
55	1	24	98	1.176	71	0.85	57	0.68	21	0.25	10	0.12	7	0.09
		48	123	1.476	66	0.79	62	0.74	35	0.42	6	0.07	0	0
		96	150↑	1.8↑	111	1.33	61	0.73	42	0.50	23	0.28	0	0
	1.5	24	110	1.32	61	0.73	35	0.42	25	0.3	14	0.17	12	0.14
		48	125	1.5	48	0.58	38	0.456	29	0.35	22	0.26	2	0.24
		96	150↑	1.8↑	71	0.85	36	0.432	48	0.58	27	0.32	14	0.17

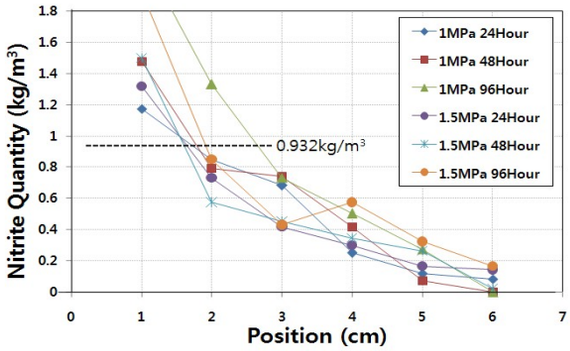
Note) 150↑=> 150 over, 1.8↑=>1.8 over



(a) W/C 65 %

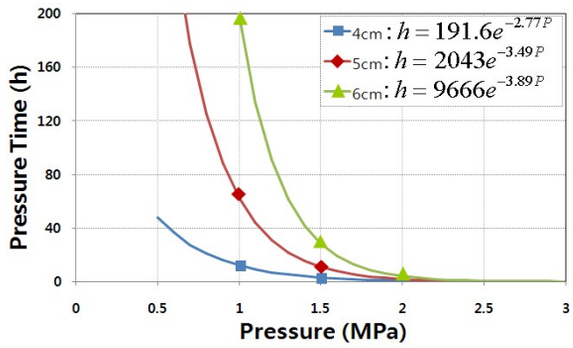


(b) W/C 60%

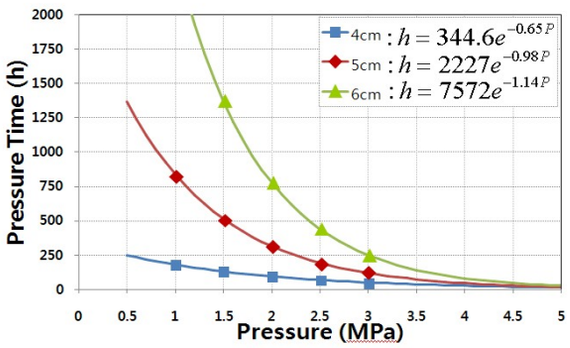


(c) W/C 55%

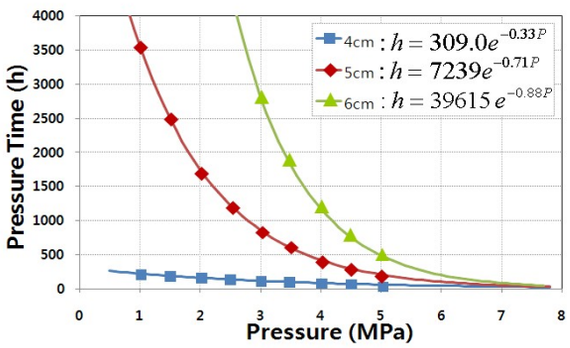
Fig 5. Quantity of Nitrite ion(NO_2^-)



(a) W/C 65 %



(b) W/C 60%



(c) W/C 55%

Fig 6. Pressure and pressuring time having superior inhibition effect

3.1 Result and analysis of nitrite ion measurement

It indicates measured nitrite every position in table 3. Like fig 8 the result of nitrite ion measurement showed up like a corrosion inhibitor penetration experiment that was detected much more nitrite ion the higher water-cement ratio, the higher pressure and the longer pressuring time.

3.2 Examination of optimal nitrite ion

For outstanding effective of corrosion inhibition, mol ratio([NO2-]/[Cl-]) of chloride and nitrite ion should meet more than 0.6. When chloride ion is threshold level 1.2kg/m3 the nitrite ion having 0.6

mol ratio will compute throughout eq.(1), (2). Consequently it could know that the mol figure(χ_2) of nitrite ion is 20.28mol and quantity of nitrite ion(χ_1) is 0.932kg/m^3.

$$\frac{[NO_2^-]}{[Cl^-]} = \frac{\chi_1 kg \div 46g/mol}{1.2kg \div 35.5g/mol} = \frac{\chi_2 mol}{33.80mol} \quad (1)$$

$$0.6 = \frac{\chi_2 mol}{33.80mol} \rightarrow \chi_2 mol \times 46g/mol = \chi_1 \quad (2)$$

As it shows from shaded section of table 8, there is the portion of over the nitrite content 0.932kg/m3. In case of water-cement ratio 60%, 55% most of them were detected excessively at point of 1cm, 2cm and then rapidly declined.

3.3 Penetrated quantity prediction of nitrite ion

It could predict pressure and pressuring time able to obtain quantity of 0.932kg/m3 at each position and indicate relation between two through it draws a trend line from the graph. In case of lower water-cement ratio, it could remedy shortcoming of long pressuring time pressure up.

4. CONCLUSION

1) As a result of nitrite ion measurement by position the more water-cement ratio, pressure is high, pressure time is long, the more quantity of nitrite ion was detected with a result of corrosion inhibitor penetration experiment. However nitrite ion was detected to position of more deep than that of penetrated corrosion inhibitor and the more depth is deep, the more concentration reduce rapidly.
2) When chloride ion comes up to threshold level as a result of computing quantity of $[NO_2^-]/[Cl^-]$ 0.6 to have superior inhibitive effect using eq.(1),(2) it indicates 77.7 ㎎/ℓ , Unit Weight 0.932kg/m^3. It was detected quantity of nitrite ion in excess of 0.932kg/m3 not only almost cover thickness of structure 4cm position but also almost positions in specimen of water-cement ratio 65%.
3) To predict penetration quantity of nitrite ion as a result of prediction quantity of nitrite ion by drawing trend line it can predict pressure and pressuring time to get nitrite ion over 0.932kg/m^3 in specific position by water-cement ratio. In case of below water-cement ratio 60% it could shorten pressuring time by raising pressure.

ACKNOWLEDGEMENT

This work is supported by Sustainable Building Research Center of Hanyang University which was supported the SRC/ERC program of MEST (grant # R11-2005-056-01003-0). And it was researched as an international joint research with Prof. Mohamed Ismail at Teknologi Malaysia

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