Experimental Study on Influence of Baume Degrees on Double Liquid Grouting Material's Consolidation Strength

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Abstract. In the premise of selecting different consistency of cement slurry, deploy different concentrations of Sodium silicate, design 16 groups of ratio, design and test research on cement and Sodium silicate double liquid grouting material mixture ratio, through the collation and analysis of experimental data, obtained the relationship of the Sodium silicate Baume influencing on cement-Sodium silicate double liquid grouting material's consolidation strength.

Introduction

With the rapid development of the research methods of building materials and testing technology, in the collapsible loess's foundation reinforcement, the formulation composition, construction technology and using performance of grouting material have been greatly developed and improved. Cement-Sodium silicate grouting material in this research (i.e. C-S double liquid grouting material) is one of the advanced grouting materials commonly used in building foundation reinforcement engineering. It uses cement, Sodium silicate as the main agent (if necessary, adding additives), will both proportionally and respectively pump mixed, then injection of grouting process of formation.

Test Materials and Equipment

Raw Materials. The main test parameters of raw materials used in this project and its basic properties(Table 1).

Table 1 Raw materials

Name of the raw materials	Manufacturers	Performance parameters of raw materials
P·O 42.5 cement	Zhangjiakou jinyu cement co., LTD	3d: f_{tm}=5.0MPa, f_c=23.8MPa 28d: f_{tm}=8.0MPa, f_c=47.0MPa
Sodium silicate	Zhangjiakou qiaoxi yongsheng chemical plant	Modulus n=2.8, Baume ^{0}Bé=37

Equipments. The main equipments used in this subject(Table 2).

Experimental Research

Test scheme. In the actual application in construction engineering, in order to make the C-S double liquid grouting slurry material have good sealing effect, in addition to control the gel time of C-S double solution grouting slurry, still need to strictly control the consolidation strength of the grouting concretion body. The consolidation strength is connected with the types of cement, cement slurry consistency (i.e., water cement ratio, W/C), the concentration of Sodium silicate (i.e. Baume ^{0}Bé), cement and Sodium silicate volume ratio, the types and admixture of additives and admixture and species of admixture and other factors. The subject of experimental research on mixture ratio design: select the P·O 42.5 cement, cement and Sodium silicate volume ratio is 1:1, cement slurry W/C is 0.6, 0.7, 0.8, 0.9, ^{0}Bé of Sodium silicate is 21, 25, 29, 33, combine into 16 groups ratio for determination of consolidation strength.

Table 2 Equipments

Name of equipments	Specification	Manufacturer
Medical balance	HC·TP11B·10	Beijing Medical Balance Factory
Cement paste mixer	ST-160	Shenyang Beifang Testing Instrument Factory
Baume meter	^{0}Bé:0-70, length: 23cm	Huanghua Automation Instrument Factory
The cement triple test mortar	40×40×160	Hebei Beifang Building Instrument Manufacturing Limited Company
Standard temperature and humidity curing box	HY-40B	China Botou Kexi Instrument Equipment Factory
Standard curing room constant temperature and humidity Automatic equipment	HWB-6	Beijing Jingqiang Equipment Factory
Electric bending apparatus	KZJ-5	Shenyang Precision Instrument Factory
Electro hydraulic pressure testing machine (precision of 1 grade)	WAY-600	Wuxi Tin Instrument Building Material Factory

Experimental Data. The designed mixture ratio of C-S double liquid grouting material(Table 3), by the experimental study of double liquid grouting materials 7d and 28d consolidation strength measured(Table 4 and Table 5).

Table 3 Proportion of double fluid grouting material

Serial number of mixture ratio	Number of mixture ratio	Cement slurry(1000ml)		Sodium silicate(ml)
		Cement (g)	Water(ml)	
H01	C6V1.0S21+N	1100	660	1000
H02	C6V1.0S25+N	1100	660	1000
H03	C6V1.0S29+N	1100	660	1000
H04	C6V1.0S33+N	1100	660	1000
H05	C7V1.0S21+N	993	695	1000
H06	C7V1.0S25+N	993	695	1000
H07	C7V1.0S29+N	993	695	1000
H08	C7V1.0S33+N	993	695	1000
H09	C8V1.0S21+N	900	720	1000
H10	C8V1.0S25+N	900	720	1000
H11	C8V1.0S29+N	900	720	1000
H12	C8V1.0S33+N	900	720	1000
H13	C9V1.0S21+N	850	765	1000
H14	C9V1.0S25+N	850	765	1000
H15	C9V1.0S29+N	850	765	1000
H16	C9V1.0S33+N	850	765	1000

Description: meaning of symbols in the number of mixture ratio in the follow:
C--indicate the cement slurry;
6, 7, 8, 9--indicate the cement slurry water cement ratio, that is, W/C are 0.6, 0.7, 0.8, 0.9;
V1.0--indicate the volume of Sodium silicate was 1 time cement slurry;
S--indicate Sodium silicate;
21, 25, 29, 33--indicate the Baume of Sodium silicate, that is ^{0}Bé are 21, 25, 29, 33;
N--indicate donot add additive and admixture.

Table 4 7d consolidation strength of double fluid grouting material

Serial number of mixture ratio	Number of mixture ratio	7d consolidation strength(MPa)		Serial number of mixture ratio	Number of mixture ratio	7d consolidation strength(MPa)	
		Rupture strength	Compressive strength			Rupture strength	Compressive strength
H01	C6V1.0S21+N	0.63	4.4	H09	C8V1.0S21+N	0.59	3.2
H02	C6V1.0S25+N	0.76	4.1	H10	C8V1.0S25+N	0.60	3.3
H03	C6V1.0S29+N	0.92	4.1	H11	C8V1.0S29+N	0.80	5.0
H04	C6V1.0S33+N	0.90	6.5	H12	C8V1.0S33+N	0.51	4.8
H05	C7V1.0S21+N	0.67	3.5	H13	C9V1.0S21+N	0.60	3.4
H06	C7V1.0S25+N	0.56	3.6	H14	C9V1.0S25+N	0.40	3.1
H07	C7V1.0S29+N	0.80	4.6	H15	C9V1.0S29+N	0.56	3.8
H08	C7V1.0S33+N	0.55	4.5	H16	C9V1.0S33+N	0.56	4.9

Table5 28d consolidation strength of double fluid grouting material

Serial number of mixture ratio	Number of mixture ratio	28d consolidation strength(MPa)		Serial number of mixture ratio	Number of mixture ratio	28d consolidation strength(MPa)	
		Rupture strength	Compressive strength			Rupture strength	Compressive strength
H01	C6V1.0S21+N	1.04	5.8	H09	C8V1.0S21+N	0.66	5.1
H02	C6V1.0S25+N	0.80	7.0	H10	C8V1.0S25+N	0.87	5.1
H03	C6V1.0S29+N	1.09	6.4	H11	C8V1.0S29+N	0.87	5.1
H04	C6V1.0S33+N	1.50	8.4	H12	C8V1.0S33+N	1.33	8.3
H05	C7V1.0S21+N	0.98	5.8	H13	C9V1.0S21+N	0.66	5.8
H06	C7V1.0S25+N	0.97	5.3	H14	C9V1.0S25+N	0.73	5.0
H07	C7V1.0S29+N	0.99	6.2	H15	C9V1.0S29+N	0.98	5.4
H08	C7V1.0S33+N	1.26	8.3	H16	C9V1.0S33+N	1.19	4.2

Data Analysis

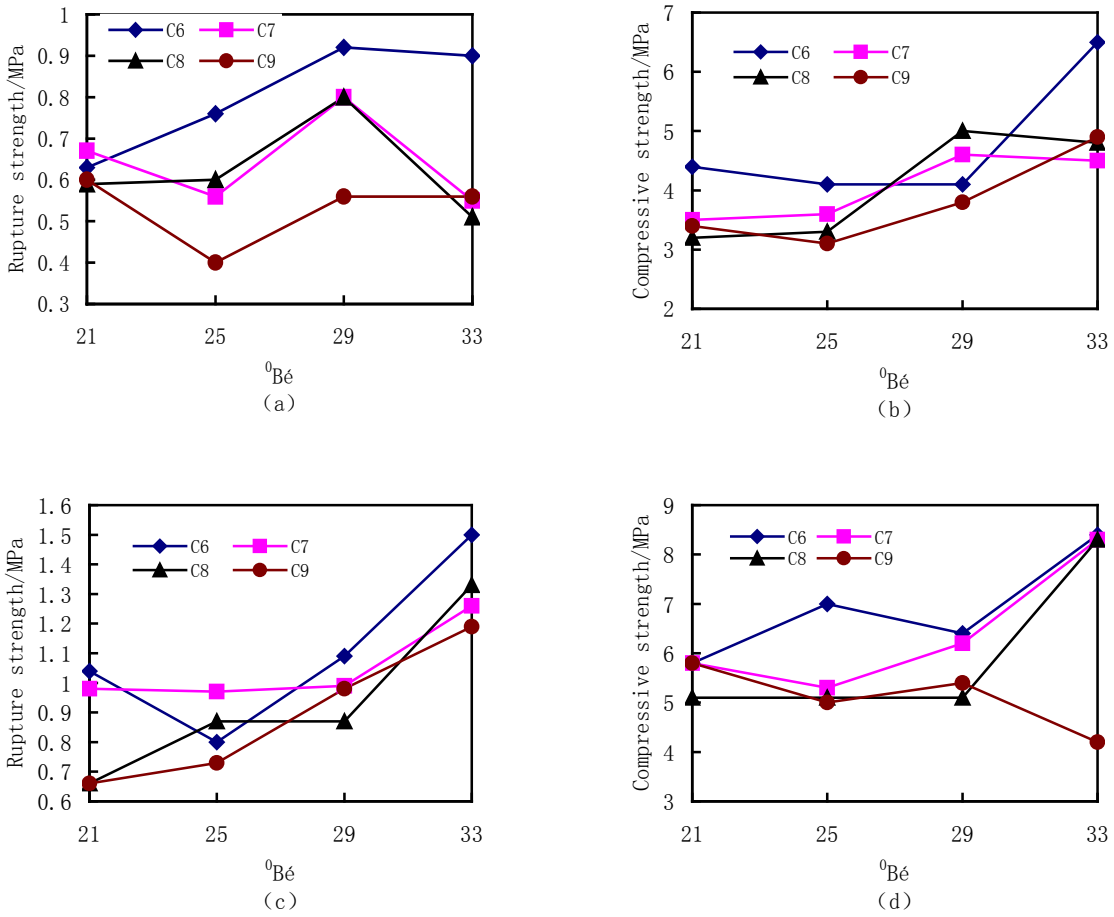
According to the experimental data of consolidation strength in Table 4 and table 5, when water cement ratio is certain, the influence diagram of Baume can be respectively made on 7d and 28d rupture strength, compressive strength of grouting material(Fig.1).

The analysis from fig.1: when the cement slurry water cement ratio is certain, consolidation strength of double liquid grouting material with the increase of Sodium silicate grout Baume shows increasing trend.

The analysis of the phenomenon, Sodium silicate grout plays a procoagulant role in double liquid grouting material, mixing the suitable Baume Sodium silicate slurry and cement slurry can make the degree of consolidation reaction reach the maximum, the concretion body dense, greater consolidation strength, to improve rupture and compressive strength of consolidation body.

Conclusion and prospect

Through the measurement and comparative analysis of C-S double liquid grouting material of consolidation strength, can be clearly found: when change the Sodium silicate grout Baume, the effect on early consolidation strength of C-S double liquid grouting material is obvious, while the later consolidation strength in general is relatively stable. When the water cement ratio of cement slurry are 0.7, 0.8, Sodium silicate Baume are 21, 25, 29, consolidation strength of the prepared C-S double liquid grouting material is relatively stable, can do a further study.



a: 7d rupture; b: 7d compression; c: 28d rupture; d: 28d compression
Fig.1 Effect of ^{0}Bé on the strength of consolidation with different W/C

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