Experimental Study on the Effect of Fly Ash on Performance of Double Liquid Grouting Material

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Abstract. On the premise of fixed slurry consistency and concentration of sodium silicate, adjust proportion design of fly ash content 8 groups, cement-sodium silicate double liquid grouting material experimental study and mixture ratio design, through the collation and analysis of experimental data, concluded that fly ash on cement-sodium silicate gel time of double-liquid grouting material with consolidation strength of relations.

Introduction

In recent years, while in the booming construction industry, the collapsible loess foundation engineering accident also gradually increased. This project research of the cement-sodium silicate double liquid grouting material (C-S double liquid grouting material) is one of the varieties of the advanced grouting material is commonly used in foundation reinforcement. It was mainly used for cement and sodium silicate in agent adding additives (necessary), after mixing both respectively by certain proportion pumping into strata grouting process.

Test Raw Materials and Equipment

Test raw materials. This project mainly used in the test of raw materials and its basic performance parameters(Table 1).

Table 1 Test raw materials

Name of raw material	Manufacturer	The basic performance parameters
P-O 42.5 cement	Zhangjiakou jinyu cement co., LTD	3d: $f_{tm}=5.0\text{MPa}$, $f_c=23.8\text{MPa}$ 28d: $f_{tm}=8.0\text{MPa}$, $f_c=47.0\text{MPa}$
Sodium silicate	Zhangjiakou qiaoxi yongsheng chemical plant	Modulus $n=2.8$, baume degree $^{\circ}\text{Bé}=37$
Fly ash	Zhangjiakou new constant fly ash co., LTD	II level

Equipments. This project mainly used in the equipment(Table 2).

Experimental Study

Test Plan. In consideration of the cement-sodium silicate double liquid grouting material liquidity requirements, technical economy and water-cement ratio on strength of grouting consolidation on the basis of the experimental study on the water cement ratio design of 0.8 W/C, sodium silicate grout baume degree $^{\circ}\text{Bé}$ at 21, 25, 1.0 times the size of sodium silicate grout volume thinks the cement grout, combined with the actual situation of local resources, set the dosage of fly ash were gelled material quality of 10%, 15%, 20%, 25%, the dosage of four combination into 8 piece together than experiment research.

Table 2 Equipments

The name of the instrument	Specifications	Manufacturer
Balance disc drugs	HC·TP11B·10	Beijing medical balance in the factory
Net cement slurry mixer	ST-160	Shenyang north test instrument plant
Wave the meter	⁰ Bé:0-70,length: 23cm	Huanghua automation instrument factory
Cement mortar joint test	40×40×160	Hebei north building instrument manufacturing co., LTD
The standard constant temperature and humidity curing box	HY-40B	China to potow analysis instrument equipment factory
Standard curing room constant temperature and humidity automatic equipment	HWB-6	Beijing fine instrument equipment factory
Electric bending apparatus	KZJ-5	Shenyang precision instrument factory
Electric hydraulic pressure testing machine precision (level 1)	WAY-600	Wuxi tin instrument building materials factory

Experimental Data. Experiment of adding fly ash C-S double liquid grouting material of design of mixture ratio(Table 3), determination of gel time and consolidation strength(Table 4 and Table 5).

Table 3 Proportion of double liquid grouting material that add admixture

Cooperate with the serial number	The ratio of number	Slurry (1000 ml)		Sodium silicate (ml)	Fly ash (g)
		Cement (g)	Water (ml)		
H09	C8V1.0S21+N	900	720	1000	----
H49	C8V1.0S21+F10	810	720	1000	90
H50	C8V1.0S21+F15	765	720	1000	135
H51	C8V1.0S21+F20	720	720	1000	180
H52	C8V1.0S21+F25	675	720	1000	225
H10	C8V1.0S25+N	900	720	1000	----
H53	C8V1.0S25+F10	810	720	1000	90
H54	C8V1.0S25+F15	765	720	1000	135
H55	C8V1.0S25+F20	720	720	1000	180
H56	C8V1.0S25+F25	675	720	1000	225

Table 4 Gel time of the double liquid grouting material that add admixture

The ratio of the serial number	The ratio of number	Gel time t (s)	The ratio of the serial number	The ratio of number	Gel time t (s)
H09	C8V1.0S21+N	50	H10	C8V1.0S25+N	52
H49	C8V1.0S21+F10	64	H53	C8V1.0S25+F10	34
H50	C8V1.0S21+F15	72	H54	C8V1.0S25+F15	55
H51	C8V1.0S21+F20	85	H55	C8V1.0S25+F20	55
H52	C8V1.0S21+F25	94	H56	C8V1.0S25+F25	66

Table 5 Consolidation strength of double liquid grouting material that add admixture

The ratio of the serial number	The ratio of number	7d consolidation strength (MPa)		28d consolidation strength (MPa)	
		Flexural strength	Compressive strength	Flexural strength	Compressive strength
H09	C8V1.0S21+N	0.59	3.2	0.66	5.1
H49	C8V1.0S21+F10	0.47	2.2	0.55	5.3
H50	C8V1.0S21+F15	0.37	2.8	0.75	4.8
H51	C8V1.0S21+F20	0.39	2.6	0.75	3.6
H52	C8V1.0S21+F25	0.31	1.9	0.55	5.2
H10	C8V1.0S25+N	0.60	3.3	0.87	5.1
H53	C8V1.0S25+F10	0.49	2.5	0.80	5.7
H54	C8V1.0S25+F15	0.51	2.3	0.86	5.4
H55	C8V1.0S25+F20	0.51	2.4	0.58	6.1
H56	C8V1.0S25+F25	0.37	2.1	0.69	5.2

Data Analysis

C-S Double Liquid Grouting Material Gel Time Analysis. According to table 4 to add double liquid grouting material of fly ash gel time of experimental data, can be made in the water to cement ratio and cement slurry Sodium silicate slurry baume degree certain cases, to the double liquid grouting material dosage of fly ash gel time influence diagram(Fig.1).

Fig.1 Influence of fly ash on gel time

Known from the analysis of Fig.1: when the ratio of cement slurry water must, with the increase of dosage of fly ash, the baume degree $^{\circ}\text{Bé}$ two kinds of sodium silicate grout for 21 and 25, prepared by the double liquid grouting material the influence law of gel time, namely with the increase of dosage of fly ash gel time basic rise; But in the case of the same dosage of fly ash, baume degree $^{\circ}\text{Bé}$ for 21 than 0 be for 25 of the sodium silicate slurry prepared by the double liquid grouting material gel time generally.

C-S Double Liquid Grouting Consolidation Strength Analysis. According to the experimental data in table 5 consolidation strength, respectively made of fly ash grouting material 7d and 28d the flexural strength, compressive strength of influence diagrams(Fig.2).

Known from the analysis of fig.2: when the water cement ratio of cement slurry sodium silicate slurry, when the baume degree $^{\circ}\text{Bé}$ of a certain dosage of fly ash on consolidation affected by the influence of early strength, have caused the early strength is low, but the impact on the later strength is stable, individual appropriate dosage can improve the consolidation strength. Figure a double liquid grouting concretion body in 7 days flexural strength is basically a downward trend with the increase of dosage of fly ash, but in the case of the same dosage of fly ash, sodium silicate baume degree $^{\circ}\text{Bé}$ for 25 than baume degree $^{\circ}\text{Bé}$ double liquid grouting material for the 21st flexural strength be larger; figure b two kinds of the corresponding sodium silicate grout, double fluid grouting concretion body material was prepared by 7 days compressive strength with the increase of dosage of fly ash is basically the same present laws, all appeared the maximum; figure c double fluid grouting concretion body in the 28 days of flexural strength with the change of the influence of dosage of fly ash volatile, but appeared, the appropriate mix content of the flexural strength increased 15%; figure d double liquid grouting concretion body of 28 days compressive strength was relatively stable trend with the increase of dosage of fly ash, the sodium silicate baume degree $^{\circ}\text{Bé}$ for 25 of the double liquid grouting material compressive strength are the sodium silicate baume degree $^{\circ}\text{Bé}$ double liquid grouting material for the 21st compressive strength stability.

Conclusions and Outlook

Through the determination and comparison analysis of C-S double liquid grouting material of gel time and consolidation strength, what can be clearly found is that through the admixture of adjusting fly ash, the gel time of C-S double liquid grouting material increases efficiently, which affects flexural strength of concretion body while the late strength is relatively stable, the study also found that the amount of fly ash with relatively stable performance is 15%~20%.

a: 7d bending; b: 7d compressive; c: 28d bending; d: 28d compressive
Fig.2 Influence of fly ash dosage on the consolidation strength

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