Development and Characterization of Soil-Cement Slurry

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Abstract

Soil-cement slurry is a combination of soil, Portland cement, and adequate amount of water so that the mixture has the consistency of a thick liquid. In this form, the slurry flows readily into openings, filling voids, and provides a hardened material that has a strength greater than the untreated soil used in the mix. Compressive strength tests and flowability tests were performed to assist in the design of the soil-cement slurry mix and to serve as the control technique during construction. High-range water reducer (superplasticizer) was added to reduce water to cement ratio and increase the slurry flowability. To study the mechanical behavior of the slurry, specimens of different mix were tested and the compressive strength and flowability were related to specimen mixtures. Typically, the slurry had a 28 day compressive strength of 100 psi with superplasticizer while tested on the 1.5"x3" cylinders and 100% flowability when used flow table equipment.

1. Introduction

Soil-cement slurry is referred to as plastic soil-cement, soil-cement grout, or CLSM (controlled-low-strength-material). It is typically used as a backfill material around structures, particularly in confined or limited spaces. Typically, soil-cement slurry contains about 5 to 10% cement. One of the definite advantages is that the soil-cement slurry may be produced using local soils. The soil for the soil-cement slurry can contain up about 20 to 25% nonplastic or slightly plastic fines. For the required flow properties, the soil-cement slurry typically has a water-cement ratio of about 4 to 7. For maintaining good compressive strength and flow characteristics, the superplasticizer was added to the mix.

2. Testing program

The typical soil-cement slurry was a mixture of soil, Portland cement, superplasticizer and water. The mix was proportioned at a water to cement ratio of 4 to 7. Following are the details of the slurry mix.

Type	Mix 1	Mix 2
Blasting sand	80%	80%
Portland cement	5%	5%
Kaolinite clay	20%	20%
Superplasticizer (SNF)	None	0.5%
Water	35%	20%
W/C	7	4

Specimens were cast to obtain 1.5"x3" to do the compressive strength tests. The flowability tests were done using flow table (ASTM C 230).

3. Results

The flowability tests were done on the slurry mix following the ASTM C 230. In the test, raise and drop the table 10 times in 6 seconds by rotating the handwheel continuously at a uniform rate. And calculate the flowability as a percentage using the following relation:

This test gave a result as the Mix 1 had the 100% flowability as the Mix 2. One type of superplasticizer-

SNF (sulfonated naphthalene-formaldehyde condensates) were added in the Mix 2 to reduce the water-cement ratio but keep the same flowability as the Mix 1. The superplasticizer mixed to make the slurry flowable seemed to affect the material properties considerably. The dosage of the superplasticizer was 0.5% by weight of soil.

According to the ASTM C 39, the compressive strength was tested from 3 days. The pulse velocity was measured before the compressive test. With the different properties of slurry, pulse velocity, compressive strength and initial modulus, the Mix 2 (w/c=4, with SNF) is stronger than the Mix 1 (w/c=7, without SNF). The 1.5"x3" cylinders had a strength of 140 psi after curing for 28 days.

Following are the details of the various tests conducted on the slurry specimens.

Curing
period
Pulse
velocity
(m/sec)

Compressive
strength
(psi)

Initial
modulus
(1x104psi)

(days)
Mix 1
Mix 2
Mix 1
Mix 2
Mix 1
Mix 2
3
1350
2100
10
40
0.05
0.30
7
1400
2200
15
60
0.10
0.70
28
1500
2350
20
140
0.15
1.40
56
1600
2400
28
190
0.12
1.70
70
1610
2402
32
200
0.10
1.75

4. Conclusions

1) Addition of superplasticizer can improve the flowability and compressive strength of the kaolinite soil slurry.
2) The soil slurry with a superplasticizer gained the strength of 140 psi in 28 days.
3) The specified slurry can be used as flowable backfill for pipelines, trench and structure.

5. References

1. ASTM D 4832-88, "Standard Test Method for Preparation and Testing of Soil-Cement Slurry Test Cylinders", Annual Book of ASTM Standards, Volume 04.08, pp. 900-903.
2. ASTM C 230-90, "Standard Specification for Flow Table for Use in Tests of Hydraulic Cement", Annual Book of ASTM Standards, Volume 04.02,.
3. ASTM C 494-92, "Standard Specification for Chemical Admixtures for Concrete", Annual Book of ASTM Standards, Volume 04.02, pp. 254-262.

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