A Study on Controlled Low Strength Material (CLSM)

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Abstract

There is an increasing interest in developing CLSM that can be excavatable. The aim of this research is to address CLSM's engineering properties and chemical resistance. Various tests were done to quantify the workability, strength and chemical resistance. Cement content was varied between 0 to 3.0% to study the effect of cement. CLSM compressive strength 28-day range from 0.14 MPa to 5.5 MPa (20 to 800 psi). A linear relationship was found between compressive and tensile strength, and the compressive strength was about 8 times of tensile strength. The effect of pH and salt on CLSM properties are ongoing.

1. Introduction

CLSM's engineering properties and labor saving attributes are making it the many of choice for many applications (Bruce W. Ramme, 1998). It can replace compacted soil as structural fill, backfill or void filling in many applications. Because CLSM flows and needs no compacting, it's ideal for use in tight or restricted-access areas where placing and compacting soil or granular fill is difficult or even impossible. Typical CLSM mixture usually consists of 0.5 to 3% of cement, 7-12% of flyash, 70-85% of sand and 7-17% of water, it has a flow spread of at least 8 in., the 28-day compressive strengths range from 0.34 MPa to 1.0 MPa (50 to 200 psi)--more than the strength of most compacted soil or granular fills.

2. Testing program

The flowability was quantified by using flow cylinder method (CIGMAT FF 1-99), the setting time and penetration resistance were determined by using a penetrometer (CIGMAT FF 2-99). 10 kips testing machine were used to determine the compression and tension strength. Nondestructive properties were determined by using pulse velocity meter and impact resonance test machine. At least three specimens tested under each condition.

The chemical test was done by immersing 3 by 6 in. cylinder specimens into 6 types of chemical solutions, HCl (pH=2), H_2SO_4 (pH=2 & 4), 2% NaCl, 0.5% and 2% Na_2SO_4, the solutions were changed at the end of each cycle (every cycle was about a month. At least two specimens tested for each condition, the change of weight and pulse velocity, leaching of Calcium are being monitored with time.

3. Results and Discussion

Good flowability and good compressive strength development are two most important parameters for CLSM. Flow spread of 8 in. from the flow cylinder test method is defined as 100% flowability. Fly ash and water helps improve the flowability. 200 psi and 500 psi of penetration resistance were adopted as the initial and final setting time. The compressive strength depends mainly on cement content, the amount of fly ash (Class F) and water. There is a linear relationship between compressive and tensile strength, the compressive strength was about 8 times of tensile strength. The pulse velocity increased with curing time, mixtures were sensitivity to pulse velocities. It increased with the increase of strength. Dynamic properties such as dynamic modulus, dynamic Poison's ration, damping ration have been quantified.

Due to the porous nature of this material, the water uptake is about 3% of the initial weight within 2 months. There were weight gain in all the cases except the HCl and H_2SO_4 at pH of 2. After three cycles, The weight gain of over 3% of initial weight was observed in the case of Na_2SO_4 and NaCl, whereas the maximum weight loss of 0.9% occurred in the case of H_2SO_4 at a pH of 2 after the first cycle. There were increase of leaching of Calcium in all the cases, the maximum of 0.26% of initial weight (9% of total calcium of the specimen contains) was found in the case of H_2SO_4 at pH of 2, Pulse velocity increased in all cases and the average increase was about 14% of the initial value. The pulse velocity of this material was 2800 m/s, the COV was 2%.

4. Conclusion

1)When the cement content was varied from 0.5% to 1.5%, the 28-day compressive strength of CLSM varied from 0.34 MPa to 1.0 MPa (50 to 200 psi).

2)There are linear relationship between compressive and tensile strength , the compressive strength is about 8 times of tensile strength.

3)CLSM is a porous material with a weight gain of 2.5 to 3.5% in water and chemical solution

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6. References

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If you have any questions, please contact **Dr. C.Vipulanandan**