RECLAMATION
Managing Water in the West

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Bottom Line

This research project helped determine whether CLSM produced with native soils containing sulfates will break down over time with or without using Type V cement.

Better, Faster, Cheaper

Depending on the location, ready mixed concrete suppliers have to pay more for Type V cement, in addition to the inconvenience of providing two separate storage silos for cement. If Reclamation can determine that there is not an advantage of using Type V cement in CLSM, then there would be a cost savings on Reclamation pipeline projects.

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Is Type V Cement Needed for Controlled Low Strength Material in High Sulfate Soils?

Determining whether controlled low strength material will break down over time with or without using Type V cement

Problem

Sulfates can break down cement in a chemical process, and this sulfate attack could cause the concrete to crack or expand and break down the bond between the cement paste and the aggregate stones in the concrete.

Portland cement has five types, ranging from general use to addressing various needs such as avoiding heat buildup or providing high early strength. Many cement manufacturers make Portland cement, but not every manufacturer makes every type. Further, Type V cement can be more costly than regular Type II cement. Type V Portland cement is used when concrete needs to have resistance to high levels of sulfates in the surrounding soils, along with a minimum ratio of water to cementitious materials as specified in the American Concrete Institute requirements.

CLSM is being placed about the pipe using a pump truck, Yuma Projects Office.

Controlled low strength material (CLSM), also known as flowable fill, is a mixture of aggregates and water with just enough cement and fly ash to hold it together. The compressive strength of CLSM is similar to compacted soil. CLSM makes an excellent bedding material for pipe, because the mixture easily fills voids beneath the conduit and provides uniform support. Since CLSM is mixed with high sulfate soils and placed at a high water-to-cement ratio, there may not be a benefit in using Type V cement and the extra expense of the specialty cement may not be needed.

Solution

To begin to determine if using Type V cement provides benefits in CLSM, this Reclamation Science and Technology Program research project tested various mixtures of CLSM with increasing amounts of sulfates.

Several trial batches were produced to identify the optimum proportions of CLSM and Type I/II cement (i.e., a 7-day compressive strength between 50 and 150 pounds

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per square inch, with an 8- to 10-inch slump without adding sulfates to the mixture). Once the optimum proportions were identified using both Type I/II and Type V cements, control mixes were batched. Additional CLSM mixtures were proportioned using the control proportions and increasing amounts of sulfates.

For each batch, cylinders were cast using American Society for Testing and Materials (ASTM) D4832-10, "Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders." Cylinders were kept in their molds and placed in a fog room for standard curing until time of testing. The batches were labeled using the following format: CLSM-(type of cement)-(percentage of sulfate added). For example, CLSM with the label "CLSM-I/II-.70" contains Type I/II cement and 0.70 percent additional sulfates.

Application and Results

From the data produced during the 3-year testing period, initial results suggest that as long as the CLSM is not exposed to excess water, either Type V or Type I/II cement could be used for "moderate" sulfate exposure with soils containing less than 2.0 percent by mass of water-soluble sulfate, or less than 150 parts per million of dissolved sulfate in water. The 2-year strength of the CLSM made with Type V cement and sulfates in this range appeared to decrease slightly.

However, as tests were performed with moderate sulfate exposure, further testing would be needed to determine results in soils with higher levels of sulfates. Therefore, further investigation (such as petrography of the CLSM specimens) would be necessary to determine the effectiveness of either type of cement to mitigate sulfate damage to the cement paste when using soils with high sulfate contents.

Future Plans

Further investigation of CLSM for a longer duration and in moist environments is recommended, along with petrographic investigation.

Contractor placing CLSM around a new 66-inch penstock bypass pipeline. Battle Creek Salmon and Steelhead Restoration Project, Coleman Diversion Dam/Inskip Powerhouse, California.

"These initial results provide a better knowledge base for CLSM with high sulfate soils."

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More Information

http://www.usbr.gov/research/projects/detail.cfm?id=2840

ASTM International. 2010. "Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders" (Standard D4832-10). In Annual Book of ASTM Standards, Volume 04.08: Soil and Rock (I). West Conshohocken, Pennsylvania.

For printable version see: www.usbr.gov/research/docs/updates/2016-15-clsm.pdf