FINAL TECHNICAL REPORT
November 1, 1999, through July 31, 2001

Project Title: **RAPID-SETTING CEMENT MANUFACTURE USING FGD SLUDGE**

ICCI Project Number: 99-1/2.1C-1
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ABSTRACT

The Interim Final Technical report was submitted on October 31, 2000. A six month project extension was requested in order to investigate the commercial production of rapid-setting cement clinker using sulfite sludge at Heartland Cement in Kansas. Approximately 300 tons of dry sludge was to be shipped to the cement plant. Collection of sulfite sludge by the side of a pond within the premises of the power plant was arranged. The sludge collection was done in three parts: the first step required drainage of part of the water from the sludge; the subsequent step was to spread the sludge on high ground for further draining of water; and the final drying step performed at an asphalt concrete plant.

First, the partially dried sludge was placed in a gravity-fed hopper, whose function was to control the flow of sludge onto a belt that carried the material to the drier. The drier was a 10 m long x 3 m diameter drum, where the material is fed from one end, while the natural gas and air are combusted at the other end. Initially, the flow of material appeared to be slow, but acceptable. The flow gradually slowed down and the hopper was hit with hammers to dislodge built-up material. Application of vibration by attaching a vibrator on the side of the hopper did not improve the situation, but actually resulted in compaction of the sludge inside the hopper.

Some dry material was nonetheless transported by truck to the railcar loading facility. As opposed to getting stuck in the hopper, the dried sludge particles got separated from one another (possibly as a result of static electricity buildup) to the extent that it turned into a free flowing powder. This characteristic caused a handling problem at the rail car loading facility opposite to that encountered at the asphalt concrete plant. Either the hopper buildup problem or the free flowing characteristics of the dried material probably would also impose difficulty at the cement plant, where raw ingredients need to be carefully, uniformly, and appropriately proportioned for successful manufacture of rapid setting cement.

At this stage all work was halted and the team submitted a revised scope of work to address the issue of handling the sludge and request another project extension. The ICCI denied the request and asked CTL to finalize the project report for this phase of the study. This summary was compiled by the ICCI project manager from the monthly progress reports.

EXECUTIVE SUMMARY

The Interim Final Technical report was submitted on October 31, 2000. A six month project extension was requested in order to investigate the commercial production of rapid-setting cement clinker using sulfite sludge at Heartland Cement in Kansas. Approximately 300 tons of dry sludge was to be shipped to the cement plant.

Collection of sulfite sludge by the side of a pond within the premises of the power plant was arranged. The sludge collection was done in three parts :

- the first step required drainage of part of the water from the sludge.
- the subsequent step was to spread the sludge on high ground for further draining of water.
- final drying step at an asphalt concrete plant.

Upon initial draining of water by a pond, several tons of sludge were placed on high ground for further draining of water prior to the final drying at the asphalt concrete plant.

The cold weather conditions in the Midwest during December to March 2001 delayed this drying process significantly. The team visited Marion, IL several times to make alternative arrangements for drying of sludge, such as the renting of a covered facility for preliminary drying of sludge prior to final drying at the asphalt plant. Meetings took place with the officers of two organizations, which owned covered facilities in Carterville. The goal was to move the material in that facility to prevent it from getting wet from rain. The facility owners asked that corrosion tests and chloride analysis be performed to assess any corrosive properties with steel. The chloride content in the free liquid accompanying the sludge was 0.11% by mass, and the corrosion potential of unprotected steel was found not to be alarming. These results were presented to these individuals. However, due to the unrealistically high rental cost, this possibility was not given further consideration.

Dry weather in southern Illinois facilitated the drying of the sludge at the power plant, and approximately 240 tons of sulfite sludge were moved to the asphalt concrete plant for further drying. The sludge needed further drying in air to reach a consistency that would allow passing through the hopper in the asphalt concrete plant. Precautions were taken to prevent the material from getting wet again, and the material was turned for faster drying. In the meantime three rail cars were ordered and the use of a trans-loading (belt-elevator) facility were arranged.

Upon several days in the sun the sludge dried out significantly and it was decided to dry the sludge in the drier. First, the partially dried sludge was placed in a gravity-fed hopper, whose function was to control the flow of sludge onto a belt that carried the material to the drier. The drier was a 10 m long x 3 m diameter drum, where the material is fed from one end, while the natural gas and air are combusted at the other end. Initially, the flow of material appeared to be slow, but acceptable. The flow gradually slowed down and the hopper was hit with hammers to dislodge built-up material. Application of vibration by attaching a vibrator on the side of the hopper did not improve the situation, but actually resulted in compaction of the sludge inside the hopper. This reduced the material flow

significantly as the feed rate fell to approximately 6 tons per hour as opposed to the normal operating rate of 100 tons per hour.

The dry material was nonetheless transported by truck to the railcar loading facility. As opposed to getting stuck in the hopper, the dried sludge particles got separated from one another (possibly as a result of static electricity buildup) to the extent that it turned into a free flowing powder. This characteristic caused a handling problem at the rail car loading facility opposite to that encountered at the asphalt concrete plant. Either the hopper buildup problem or the free flowing characteristics of the dried material probably would also impose difficulty at the cement plant, where raw ingredients need to be carefully, uniformly, and appropriately proportioned for successful manufacture of rapid setting cement.

At this stage all work was halted and the team submitted a revised scope of work to address the issue of handling the sludge and request another project extension. At the same time the principal investigator S. Bhattacharja left CTL.

The ICCI reviewed the status of the project and concluded that the new scope of work would extend the project unnecessarily. The ICCI denied the request and asked CTL to finalize the project report for this phase of the study. CTL submitted an estimate of over $5000 to write this report, and after consultation with DCCA, ICCI informed CTL that the money does not justify the final report, which would contain little technical information.

Please refer to the Interim Final Technical report for the period November 1, 1999, through October 31, 2000 for a detailed account of the research conducted in this project.

This summary was compiled by the ICCI project manager from the monthly progress reports.