USE OF WOOD ASH FOR STRUCTURAL CONCRETE AND FLOWABLE CLSM

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ABSTRACT

The Wisconsin pulp and paper industry generates approximately one million dry tons (or approx. 1.8 million cubic yards) of wood ash (PPM ash) per year. Disposal of PPM ash in landfills costs Wisconsin pulp and paper industry significant direct cost plus unknown future liabilities due to environmental concerns related to such materials in landfills. This project determined the feasibility of future manufacturing of PPM ash concrete (structural grade concrete, compressive strength of up to 5,000 psi) and flowable slurry (Controlled Low Strength Materials, CLSM) through an initial laboratory evaluation.

Five different sources of PPM ash were selected for the project to determine the effects of variability of PPM ash materials. From the five sources, both concrete and CLSM were manufactured in the UWM-CBU laboratory. Seven different types of concrete mixtures were manufactured consisting of three mixtures using up to 35% PPM ash and four mixtures containing a blend of PPM ash and one of two sources of ASTM Class C coal fly ash, with a maximum coal fly ash content of 35 percent. Concrete was tested for both rheological and hardened properties. Properties of concrete mixtures were evaluated as a function of age for compressive strength, splitting tensile strength, and drying shrinkage. Three different series of CLSM mixtures were manufactured for each source of PPM ash. Each series of CLSM mixtures were designed for a different long-term compressive strength, less than 100 psi, 100-500 psi, and 500-1,200 psi. CLSM made with PPM ash were tested for its rheological characteristics (bleedwater, settlement, shrinkage and cracking, and setting characteristics). Fresh and hardened CLSM densities were also measured. Compressive strength of the CLSM was tested up through the age of 91 days. Permeability of the CLSM was also tested at the age of one and three months. All PPM ashes were evaluated for elemental and leachate concentrations specified in DNR NR 538. Tests were also conducted to determine elemental analysis and other standard parameters for the coal ash and cement.

Five sources of PPM ash selected for this project exhibited a wide variation of material properties (fineness, carbon content, reactivity with cement, etc.). Although each source had different physical and chemical properties, results of this project indicate that structural grade concrete can be manufactured with PPM ash as a replacement of cement. Concrete mixtures containing a blend of PPM ash and ASTM C 618 Class C fly ash performed better than mixtures only containing PPM ash. CLSM also was manufactured using PPM ash as the primary component. CLSM containing some of the PPM ash sources exhibited a significant increase in compressive strength between the ages of 14 and 91 days. This should be carefully considered when proportioning fill applications using CLSM containing similar sources of PPM ash.

Due to the success of this laboratory evaluation, a second phase of work is recommended to pursue prototype-scale and subsequently full production-scale manufacturing of

concrete and CLSM using actual commercial production facilities. Activities for this Phase 2 work would include testing and evaluation of mixtures followed by construction demonstration activities.