Center for By-Products Utilization

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Recycling of Pulp and Paper Mill Residuals to Increase Freezing and Thawing Durability of Concrete Pavements

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Abstract: Fibrous residuals generated from several pulp and paper mills were included in concrete. Wood fibers from these residuals were about 0.5 to 1.5 mm in length. By using the proper amounts of the fibrous residuals, water, and high-range water-reducing admixture (HRWRA), concrete mixtures containing the residuals were produced equivalent to a reference concrete (no residuals) in slump and compressive strength. In general, the amount of HRWRA increased in proportion to the amount of wood cellulose fibers incorporated into the concrete. At a somewhat lower level of compressive strength, these non-air entrained concrete mixtures containing the residuals showed equivalent length change (drying shrinkage), and equivalent or lower resistance to chloride-ion penetration and abrasion when compared with the reference concrete. On the other hand, five out of the seven available sources of fibrous residuals greatly improved the resistance to freezing-and-thawing (FT) and salt-scaling for these non-air entrained concretes. An outdoor demonstration slab was also constructed, and test specimens were cast for FT resistance and salt-scaling resistance. Test results again showed that non-air entrained concrete could be made highly resistant to FT with the use of the recycled fibrous residuals from pulp and paper mills residuals. It was concluded that concrete without entrained air or inadequate entrained air content could be made FT resistant; or, FT resistance of air entrained concrete could be noticeably improved with the proper use of micro-fibers from pulp and paper mills.

Keywords: abrasion resistance; chloride-ion penetration; compressive strength; concrete pavements; deicing salt scaling; drying shrinkage; durability; freezing and thawing; recycling; sludge; wastewater treatment; wood cellulose fibers

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