

USE OF WOOD ASH IN CEMENT-BASED MATERIALS

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ABSTRACT

Wood ash is a by-product of combustion from wood-fired boilers, at a typical paper mills and other wood burning facilities. Approximately three million tons of wood ash is produced annually in the United States. Approximately 70% of the wood ash is being landfilled, around 20% is being used as soil supplement, and the remaining 10% is being used in miscellaneous applications. Wood ash is composed of both inorganic and organic compounds. The physical and chemical properties of wood ash vary significantly depending upon various factors such as type or species of trees/wood, method and manner of combustion, efficiency of the boiler, and other supplementary fuel used with wood.

Many different sources of wood ash from USA and Canada were tested. They had a specific gravity between 1.6 and 2.8, and unit weight between 365 and 980 kg/m³. The major elements in wood ashes tested were: carbon (5 to 30%), calcium (7 to 33%), potassium (3 to 4%), magnesium (1 to 2%), phosphorous (0.3 to 1.4%), and sodium (0.2 to 0.5%). Wood ash tested had significant variations in its chemical composition: SiO₂ (4 to 60%), Al₂O₃ (5 to 20%), Fe₂O₃ (10 to 90%), CaO (2 to 37%), MgO (0.7 to 5%), TiO₂ (0 to 1.5%), K₂O (0.4 to 14%), SO₃ (0.1 to 15%), LOI (0.1 to 33%), moisture content (0.1 to 22%), and available alkali (0.4 to 20%).

Use of wood ash has been better known as soil supplement, but its possible utilization in cement-based materials has not been explored. In 1995, the UWM Center for By-Products Utilization took a major initiative in investigating the use of wood ash in cement-based materials. Research was carried out to utilize wood ash in making self-compacting controlled low-strength materials (CLSM), air-entrained and non-air-entrained concretes, and bricks/blocks/paving stones. Initial test results indicated that wood ash could be successfully used in making: (1) CLSM (with up to 90 % of total materials); (2) air-entrained structural-grade concrete up to 28-day compressive strength of 50 MPa with wood or its blends (up to 40 %) of wood ash and coal fly ash; (3) non-air-entrained structural-grade concrete (up to 60 MPa 28-day compressive strength) with wood ash or its blends with coal fly ash (up to 40 %) as partial replacement of cement; and (4) good quality bricks/blocks/paving stones with wood ash or its blends with coal fly ash (up to 35%) as partial replacement of cement.