SAWDUST-CEMENT CONCRETE

By Forest Products Laboratory[1]
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The Forest Products Laboratory has conducted no research on the use of sawdust in mixture with cement for the production of structural concrete. Numerous inquiries on this matter, however, are received at the Laboratory, and this report gathers together some of the findings reported by others.

Investigations on sawdust-cement concrete have been carried out by the Building Research Station in England (a government institution); University of New Hampshire; Department of Engineering Research, University of Michigan, in cooperation with the Office of Production Research and Development of the War Production Board; Minnesota Agricultural Experiment Station, University of Minnesota; and by various other agencies and individuals. References to some of the publications resulting from this work will be given later in this report. Numerous experiments with sawdust and cement or other mineral and synthetic mixes are no doubt under way at present under the stimulus of building-material shortages and high prices.

Reports of the success attained with sawdust-cement concrete vary somewhat, but there seems to be general agreement on the nature of the problems encountered in using sawdust to modify the properties of concrete or simply to take advantage of the apparent availability and low cost of sawdust in many parts of the country.

The technical problems reported are consistent with all that is known about the properties of both sawdust (wood) and concrete. It is probably not too pessimistic to state that sawdust does not lend itself to rough-and-ready methods of use with concrete.

The aim in mixing sawdust with cement is to produce a concrete enjoying the desirable attributes of concrete with some of the inherent merits of wood. A light-weight concrete is sought, with better insulating qualities than normal concrete. For instance, the desire is to produce a floor material that will not conduct heat too rapidly away from living quarters, or a wall material that will meet modern insulating standards. Resilience is also sought in sawdust-cement-concrete floors both for dwelling use and in poultry and dairy barns. The possibility of nailing and sawing the modified concrete is also being investigated by those who are looking for new wall, floor, and roof materials. Along with these newer properties, it is the intent to retain as much as possible of the characteristic strength properties of concrete.

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[1] Maintained at Madison 5, Wis., in cooperation with the University of Wisconsin.

Strength

The weight of sawdust-cement concrete is reported to run from 100 pounds for the 1:1 mixture to 40 pounds for the 1:5 (cement:sawdust) mixture. Summarizing several properties and probably referring to an alkali-treated mix, the Building Research Station makes the following statement: "Cement-sawdust proportions of from 1:3-1:2 represent probably the most useful range, giving products weighing 60-80 pounds per cubic foot, which are nailable, having crushing strengths of 600-2,000 pounds per square inch and transverse strengths in the range of 400-750 pounds per square inch at 28 days. ...."(1)[2]

Skelton of the University of New Hampshire states (2) that the strength of a 1:3 or 1:3-1/2 mixture will average 300 to 400 pounds per square inch.

The Portland Cement Association, in its Circular CP-48, "Sawdust Concrete" (3), in citing work done at the University of Minnesota (4) states "Experiments at the University of Minnesota have shown that sawdust concrete has only 10 to 20 percent of the strength of normal sand-and-gravel concrete."

Insulation

Skelton (2) makes the following statement regarding insulating qualities: "The material is warm and is an excellent insulating agent. The coefficient of thermal conductivity varies from 0.60 to 0.70 for a mixture as recommended herein. Various commercial insulating materials in sheet form have similar coefficients of 0.25 to 0.40, that of wood being 1.00, and that of concrete 8.00."

Portland Cement Association Circular CP-48 (3) quotes a University of Wisconsin thesis (5) on sawdust-cement concrete as follows: "A 2-inch thickness of the 1:3 mix sawdust-concrete has an insulating value approximately equal to that of 1/2 inch of fiber insulating board."

Shrinking and Swelling

The Building Research Station (1) gives a shrinking-swelling figure of "0.2 to 0.55 percent depending on the cement-sawdust ratio." That agency emphasizes at some length the difficulties encountered with lean (high-sawdust) mixes with respect to shrinking and swelling and the resulting effects, such as cracking and lifting of floor surfaces and warping of precast panels. In panel materials the Building Research Station (1) has suggested the use of bituminous coatings to prevent changes in moisture content and resulting dimension changes.

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[2] Numbers in parentheses refer to Literature Cited at the end of this report.

Nailing and Sawing

The Building Research Station (1) reports that the leaner mixes can be sawed and nailed readily. There seems to be agreement that mixes richer than 1:3 do not saw or nail readily when fully cured and that in the leaner ranges (1:4 and 1:5) splitting may occur in nailing.

Wearing

Reports (2, 3, 4) on the wearing qualities of sawdust-cement concrete, for instance in livestock shelters, vary from very poor to extremely good over a long period of years. This variance may illustrate, basically, difficulties in reproducing recommended mixing and laying conditions.

Mixture

The mix favored by most experimenters seems to be within the 1:3-1:3-1/2 range, with the water added varying from 4-1/4 gallons to 10 gallons with the 1:3-1/2 by volume mix, as the sawdust varies from 27.5 pounds to 10.5 pounds per bushel according to moisture content. These figures are from Skelton (2), who has tabulated a scale of water components based upon the wetness of the sawdust as indicated by its weight.

There is some agreement among investigators that the amount of water is extremely critical.

Coarse sawdust, such as would come from a head saw and that would pass a 1/4-inch screen, but with no fineness limit definitely specified, seems to be essential.

Kind of Sawdust

There have been ample indications that sawdust from softwood species is preferable, if not essential. Extractives in the wood, especially those of an acid nature, such as are found in oak and in other hardwoods, have been found to interfere seriously with the chemistry of cement setting. The British experimenters (1) have dealt with this effect by adding hydrated lime amounting to 1/6 to 1/3 of the volume of cement. Most of the experimenters recommend that only sawdust that has been allowed to stand in the open for a year (in order to leach out the harmful extractives), be used. It is said that European practice recommends a 2-year conditioning period.

The recommendation has also been made that the sawdust be placed in boiling water and then washed in cold water (1), a suggestion that would seem to be less practical from the cost standpoint.

The Forest Products Laboratory has no further literature on sawdust-cement concrete and no authoritative first-hand information on the subject.

It is reported that experiments have been conducted on floors for livestock at various agricultural establishments, and additional work has no doubt been conducted by other agencies and individuals on floors and on other structures. A system of house construction in which sawdust concrete is used is reported to be employed with success by a California builder (6). Only recently a composition flooring containing sawdust, asbestos, and various chemical ingredients for mixing with water and trowel application over subfloors, has been reported (7) in the East.

It should be pointed out that many references have been made here to the work at the University of New Hampshire and that a number of other investigators seem to have based their work upon the efforts there.

The University of Wisconsin thesis of Bartel, Davy, and Plog (5) is available only for reference at the University of Wisconsin Engineering Library, but it is one of the carefully conducted technical investigations.

In addition mention should be made of "The Properties of Assorted Light Weight Aggregate Materials," by Corwin D. Willson (8), a report based on cooperative work between the Department of Engineering Research, University of Michigan, and the Office of Production Research and Development of the War Production Board in 1944. This report, prepared under the supervision of a competent ceramic specialist, deals with a wide range of mixtures of natural fibers and mineral fibers and aggregates, including sawdust in a few of the mixtures. It is probably too technical for the layman experimenter, but it does express optimism regarding the possibilities of fiber-and-mineral aggregates. The report may still be obtainable through the Department of Commerce.

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