Design of a laboratory particleboard mat-forming and conveying system

Roy F. Pellerin
Robert J. Ross

Abstract

A particleboard mat-forming and conveying system has been designed and built which will handle a wide variety of furnish sizes and shapes. It consists of a conveying line, a mat-forming head, and a continuous mat weighing mechanism. Mats with uniform density have been produced from a wide variety of particle geometries including drum-cut wafers, disk-cut flakes, ring-cut flakes, hammermilled particles, and planer shavings. The ability to form mats from such varied furnishes makes the system very useful in a laboratory setting.

Manufacturers of particleboard have found by experience that the most important step that must be taken to insure uniform thickness and board properties in the production of any wood-based particle composite is the preparation of a uniform mat of resin coated particles. The ability to fabricate mats with uniform weight distribution is even more critical in a laboratory where consistent research results depend on obtaining minimum within-panel variation. Proven design concepts of large scale, production-type, continuous mat-forming equipment, however, are not readily adaptable to laboratory batch forming requirements. Design of laboratory forming equipment is further hampered by the need to adapt such machinery to a wide variety of materials on a day-to-day basis. Consequently, most composite board researchers are committed to using time-consuming hand layup techniques, prone to human error and variability.

The Wood Technology Section of Washington State University’s Materials Science and Engineering Department in cooperation with the Forest Products Laboratory, USDA Forest Service in Madison, Wis., has designed and built a laboratory-scale particleboard mat-forming system. The system consisting of a conveying line, a mat-forming head, and a continuous mat weighing mechanism permits the rapid formation of research size boards with a minimum of within-panel weight variation. This technical note describes the design and evaluation of the system.

Design of the forming system

The conveying line was designed to carry cauls and molds having a maximum width of 54 inches, back and forth under the mat-forming head (Fig. 1). An adjustable speed constant torque motor is used to drive the line at speeds of from 0 to 700 inches per minute. Automatic reversing mechanisms incorporated in the line’s control system permit repeated passes to be made in both directions.

Particles are metered onto the forming surface by a 38.2-inch diameter hoop grate. Trials with several experimental forming heads showed that a continuous motion characteristic of the hoop grate is superior to oscillating actions in achieving uniform mat weight distribution. The hoop grate consists of 240 1/4-inch square steel bars spaced at 1/2-inch intervals. Every 12th bar is securely welded into place while the remainder of the bars are removable. By simply removing selected bars, the bar spacing of the hoop can be varied to suit a variety of materials (Table 1).

Two interchangeable bins have been designed for use with the hoop grate. A bin (Bin I) which employs a wiping type action to up-end the particles laying on the grate’s surface, thus allowing them to pass through the spaces, works extremely well with small and intermediate sized particles. However, since larger flakes tend to get wedged between the grate and the bin, a modified hopper (Bin II) was built by closing in the ends of the hoop grate and inserting a baffle between the end panels. It utilizes a tumbling action to allow the flakes to pass through the grate’s surface.
Mat weights are continuously monitored by a weighing mechanism that has a total load carrying capacity of 110 kg with a resolution of 0.02 kg. Four load sensors of the mechanism consist of cantilever beams with strain gauges attached to their top and bottom surfaces. The gauges are wired to a conditioner which is electronically compatible with the controls of both the conveying and forming head mechanisms. Because of this feature, process automation techniques can be used to control the entire forming operation since mats are formed by weight instead of by volume.

**Evaluation of the forming system**

The forming system was evaluated using furnish types ranging from disk-cut flakes to planer shavings (Fig. 2). Tables 2 and 3 summarize the optimum bar spacings found for each of the particle types when run through the bin and modified hopper, respectively. The flow rate of furnish passing through the grate was found to be a linear function at grate velocity. For a given particle type, the flow rate increased proportionately as the grate velocity increased.

To verify forming accuracy, several 1/2-inch-thick 40 pcf panels were produced from drum-cut flakes, ring-cut flakes, and hammermilled particles. Stress wave analysis of these panels indicated no particle alignment occurred during the forming operation. Weight profiles were then determined for each panel by cutting them into 3-inch square specimens. Coefficients of variation of the specimen weights ranged from 5.7 percent for the drum-cut flakeboard to 8.6 percent for the hammermilled particleboard.

**Conclusions**

Development of a mechanical former permits laboratory-size panels to be made in quantity while still maintaining weight distribution accuracy. Construction design permits the use of the former with a wide range of particle and flake types. Material deposition rate and desired number of passes is controlled by varying the forming head velocity and the line speed. The built-in weighing system insures accurate batch formation and is essential in the use of process automation techniques to control the entire forming operation.

**Note**

Blueprints are available by writing to either the Wood Technology Section, Washington State University, Pullman, WA 99164-3020, or the Structural Composite Products Work Unit, Forest Products Laboratory, U.S. Forest Service, P.O. Box 5130, Madison, WI 53705.