

Biomass Baling Science & Engineering

Technologies to reduce transport and storage costs through the supply chain

forestconcepts



Baling makes a very efficient package for transport, storage, and feeding of fibrous biomass materials. Agricultural baling has been in use since the mid-1800s for hay and other commodities. Cotton bales have a similarly long history. Market-pulp has been packaged and shipped in bales for more than 100 years. More recently, baling of urban recyclables such as newsprint, old corrugated containers, aluminum cans, and plastic bottles became the packaging of choice for the global recycling industry.

Modern agricultural balers incorporate improvements made during the 130-year history of the ag machinery industry. Even then, new crops such as miscanthus and switchgrass have proven challenging to manufacturers. Design of improvements and/or special-purpose machines requires new crop-specific data.

Several efforts to bale woody biomass from urban prunings, orchard prunings, and forest residues have been unsuccessful by others due to a lack of good engineering data.

Beginning in 2005, Forest Concepts developed lab and pilot-scale equipment to quantify baling engineering properties of bulk biomass.

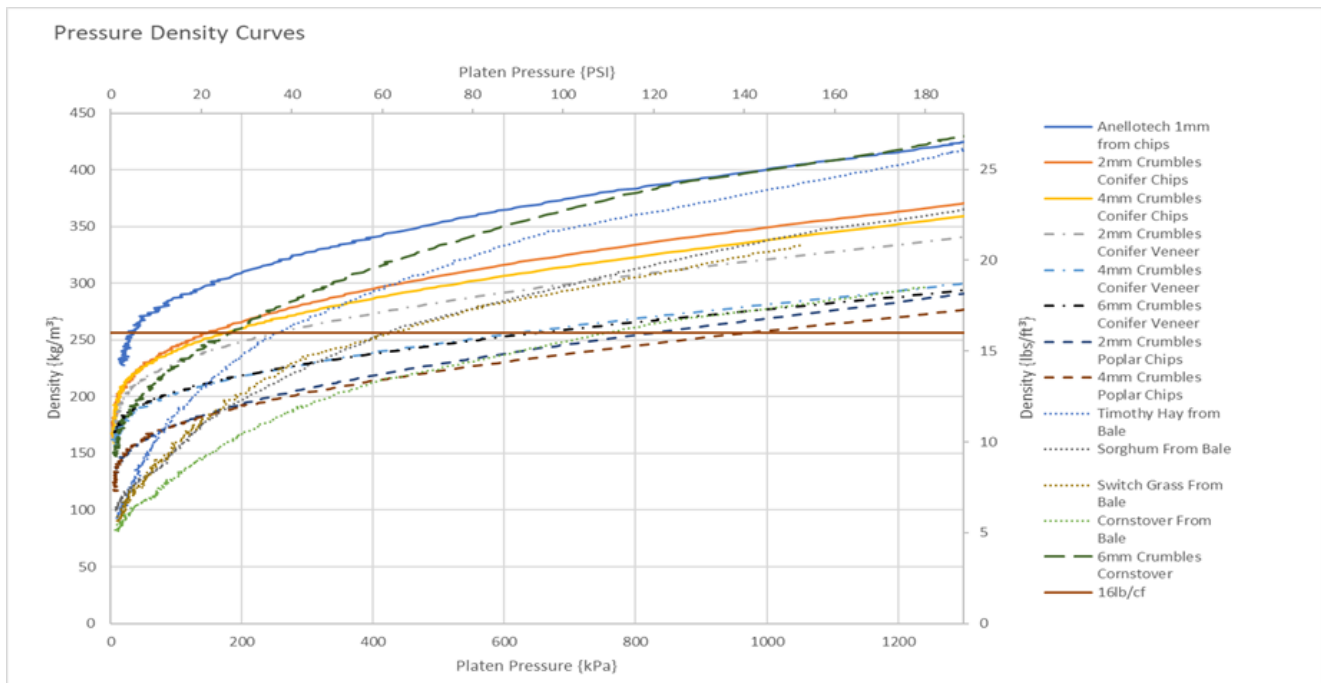
Critical engineering data for biomass materials includes:

- Relationship between platen pressure and resulting bale bulk density
- Relationship between platen pressure and incremental volumetric reduction to choose optimal energy input
- Multi-push bale formation curves
- Poisson's forces as a function of platen pressure
- Stress-relaxation and spring-back curves
- Wall friction

Laboratory-scale data is collected with a fully instrumented horizontal lab baler (above left) that produces an approx. 1cu-ft bale. Those results are validated with a full-scale hydraulic baler with a 32x48 inch platen and more than 100,000 pounds of force.

Incorporation of results from disciplined experiments, engineers at Forest Concepts have produced bales of switchgrass having more than 30 lb/ft³ and forest residue bales having more than 25 lb/ft³.

Data and experimental bales enable designers to reduce the risk for new baler designs, uncertainties about balability of new materials, and selection of bale tying or banding materials.



Laboratory Baling Device:

- 3.5-inch platen cylinder
- 2,800 psi maximum hydraulic pressure
- 11.5 x 11.5 x 18-inch baling chamber
- Sensor suite includes
 - Platen position
 - Sidewall pressure
 - Load cells (8)

Recent Materials Tests:

- Sorghum
- Corn stover
- Sorghum
- Shredded wood chips
- Shredded veneer
- Industrial hemp (green)
- Forest residues

Working with Forest Concepts' Baling Lab

Special-purpose balers such as the chipper-replacement woody biomass baler in the photo above were completely designed and built by Forest Concepts.

Many tests are conducted to develop engineering data sets for others to use as they design or adapt balers for new bulk biomass materials.

Researchers may want to quantify the differences in balability between new and existing crop varieties.

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