RESEARCH in Progress

Forest Products Laboratory

Development of Wood–Plastic Composite Lumber for Low-Temperature Exterior Applications

The incorporation of wood or other natural fibers into a plastic matrix results in a new type of composite product—wood–plastic composites (WPCs). The result is a composite product that can be processed like a plastic material but commonly includes up to 60% wood. The construction industry has begun to use WPCs in applications such as lumber for decking, siding, and roof tiles. Despite gains in the market, a concern remains about the durability of WPCs exposed to outdoor environments, particularly to ultraviolet (UV) light and low temperatures.

Extrusion of WPC lumber at the University of Maine.

Background

Mechanical property retention after outdoor exposure is a concern to both manufacturers and consumers. Adding wood flour to plastic generally decreases impact strength. Weathering of WPCs also results in a loss of impact strength. (However, WPCs retain more impact strength than the corresponding unfilled plastic exposed to weathering.) Environmental temperature can also influence the properties of WPCs—at low temperatures, plastics and their composites are more brittle. (However, WPCs are less sensitive to low temperatures than are unfilled plastics.)

Concern about the durability of WPC lumber has led researchers to investigate performance, including impact performance, after weathering. Impact tests have been conducted primarily on weathered samples at room temperature. How weathering and low environmental temperatures interact with each other to affect performance of WPCs is not known.

Objective

The objective of this study is to develop a WPC that performs well at low environmental temperatures by

- developing an understanding of impact differences between wood-flour-filled polyethylene (PE) and polypropylene (PP) composites at low temperatures before and after weathering and
- investigating the effects of additives on WPC impact performance after weathering.

Approach

The University of Maine's Advanced Engineered Wood Composite Center will aid in manufacturing full-size WPC lumber. Composites will consist of 50% wood flour added to high-density PE or PP. A coupling agent and two pigments will also be incorporated in some composites. The composites will be evaluated after accelerated and natural weathering.

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WPC test samples will be weathered in a xenon arc light-exposure apparatus. Energy received by the samples during weathering will be monitored. Full-size deck boards will be used to construct wheelchair accessibility ramps at the Forest Products Laboratory in Madison, Wisconsin, where temperatures routinely drop below freezing. Natural weathering will allow for in situ analysis of WPC lumber in low-temperature environments.

After weathering, samples will be analyzed for impact performance. Instrumented impact tests will be run at low and ambient temperatures. Maximum stress and energy to reach maximum stress will be determined from load–deflection curves.

Expected Outcomes

The results of this study will answer the following questions:

- How does environmental temperature affect impact performance of weathered WPC lumber?
- What are the differences in impact performance between weathered wood-flour-filled PP and PE, specifically at low temperatures?

The results of this study will be useful for plastic lumber manufacturers by providing data that will aid in tailoring their product to meet performance requirements. The results may be implemented immediately.

Understanding factors that affect weatherability of WPC lumber will lead to higher quality products, improving consumer acceptance and expanding markets. This research will also benefit the broader forest products industry by providing an opportunity for low-value waste wood to be incorporated into a value-added product.

Timeline

The duration of this project is two years. WPC lumber manufacture is targeted for March 2004. Accelerated weathering and natural weathering installation will be conducted through the remainder of 2004. Impact tests and analysis will be performed during the second year.

Cooperators

USDA Forest Service, Forest Products Laboratory
University of Maine

Contact Information

Nicole Stark, Chemical Engineer
USDA Forest Service
Forest Products Laboratory
(608) 231-9392
nstark@fs.fed.us