RESEARCH in Progress

Coalition for Advanced Wood Structures
a university, industry, government partnership

Hygrothermal Performance of Energy-Efficient Walls Constructed with Wood Structural Panels and Continuous Foam Plastic Insulation

Energy-efficient home construction is mandated by the government and supported by the public. In cold climate zones, such as in Wisconsin, Michigan, and Minnesota, the use of continuous foam plastic insulation in exterior walls is gaining popularity for the construction of energy-efficient walls in compliance with the International Energy Conservation Code.

Popular foam plastic insulation materials used in the United States are extruded polystyrene and expanded polystyrene, which have low permeability compared with wood structural panels (WSPs, such as plywood and oriented strandboard). Low-permeability insulation materials in exterior walls may entrap moisture or water because of the low drying potential and may lead to mold growth or decay of the wood wall. The potential for moisture entrapment has been a major concern by the WSP industry.

Background

Hygrothermal performance of walls constructed with a combination of WSPs and foam plastic insulation has not been well studied. A joint research project between the USDA Forest Products Laboratory (FPL), APA–The Engineered Wood Association, and Washington State University examining field performance of such walls in the Pacific Northwest (Marine 4 Climate Zone) was completed in September 2014. However, comparable data are sparse in colder climate zones.

Objective

The objective of this project is to evaluate the hygrothermal performance of energy-efficient light-frame walls constructed with WSPs and different types of exterior continuous insulation through monitoring of wall performance in the cold climate zone in Madison, Wisconsin, through controlled environmental exposure in the chamber for analytic research on wall assemblies exposed to simulated weather (CARWASh) testing facility at the FPL and through computer modeling.

Test hut for hygrothermal study in Madison, Wisconsin.

Approach

Hygrothermal performance monitoring—Moisture movement through wall assemblies when exterior continuous insulation is installed over WSP sheathing will be studied at a test hut located in Madison. We will investigate both the potential for moisture accumulation from air leakage and vapor diffusion and the drying capability of the walls. Wall assemblies will be constructed to meet the prescriptive insulation requirements of the code. The study will evaluate several key variables in wall assembly design:

- Type of rigid exterior insulation covering a range of vapor permeance (mineral wool, expanded polystyrene, extruded polystyrene)
- Inclusion of a “drainable” membrane between WSP sheathing and rigid exterior insulation

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APA

CARWASh test facility at the Forest Products Laboratory.

A total of 16 wall assemblies (8 facing north, 8 facing south), each 4 ft wide by 7 ft tall, will be installed and tested. Various combinations of interior vapor retarder, water-resistive barrier, and exterior insulation will be used. Walls will be challenged with controlled water injections to simulate rain intrusion. Drying capability of the assemblies will be evaluated in response to these wettings. Indoor temperature and humidity conditions will be maintained in accordance with realistic design values.

Controlled laboratory exposure study—The effect of exterior continuous insulation materials and moisture exposure conditions will be studied to evaluate the drying potential of light-frame walls in different environmental conditions using the CARWASh.

Computer hygrothermal modeling—FPL will evaluate moisture performance of the wall configurations using a one-dimensional computer hygrothermal model (WUFI Pro 5.3). Modeling will be compared with test hut and CARWASh measurements.

Laboratory material tests—Supplemental tests will be also conducted at the FPL and APA.

Expected Outcomes

Results from this study will provide an answer on moisture condensation potential and drying capability for wall assemblies that are expected to be popular in cold climate zones. Moisture movement data collected from this study will be useful for computer modeling with similar wall configurations, which may provide an opportunity to develop energy-efficient wall systems using the combination of WSP sheathing and continuous foam plastic insulation with a low risk of moisture condensation in different climate zones.

Timeline

The study plan was developed in July 2014. The test hut instrumentation and hygrothermal monitoring and CARWASh studies will be completed by July 2016, with a final report prepared by September 2016.

Cooperators

USDA Forest Service, Forest Products Laboratory

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