

SIPs Research and Testing at the National Research Council Canada

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Background

The National Building Code of Canada (NBCC) requires that buildings be designed using limit states engineering. Long term reliability is also part of the code. NRC's current research program is designed to determine how to test SIPs to ensure they will comply with the NBCC so that SIP and SIP component manufacturers can demonstrate that their products will meet code requirements. It is not intended to develop design guidelines or principles for SIPs, but the information and analysis methods being developed will help to underpin future design guidelines. A secondary goal is to make as much information developed in the project as public as possible in order to help building code officials and the broader construction industry understand how to use SIPs. This is being done through formal technical papers, but also through presentations to building code officials.

Panel Testing

Test development has focused on structural tests and durability issues. The structural test development started from the ANSI, ASTM and ISO SIP standards and is intended to cover information gaps needed to demonstrate code compliance in the public literature on SIPs. Testing has been done on OSB SIPs supplied by five different manufacturers using four different foam core materials (EPS 1, EPS 2, polyisocyanurate blown foam, lignin based polyurethane blown foam). Panels have had thicknesses ranging from 4" to 12", but have been restricted in dimensions to 4'x8'.

Structural Tests

Full scale structural tests have included:

- Short term axial compressive loading (56 samples);
- Short term loading in bending (36 samples);
- Long term axial creep (1 year duration / 10 samples); and
- Long term uniform deflection bending creep (1 year+ duration / 10 samples).

The short term tests will be completed the week of January 18th, 2016, while the long term tests are on-going. Video cameras and still photographing were used to record the testing and the panel failure modes. Most tests were done on full size panels without service conduits or skin penetrations, but panels with splines or wall outlets were also tested. Panels were primarily tested concentrically, but also with 1/6, 1/3, and 1/2 eccentric loading.

Each panel has had an OSB facer removed after testing. The exposed face of the facer panels were then photographed and image analysis software used to determine the actual area of the panel that was bonded to the foam. The foam in blown foam panels was also examined to determine if significant holes were present.

In addition to data from the NRC tests, analysis has used data from published research. It has examined the impact of slenderness ratios, combined moment/load behaviour, the effect of bond area on load capacity and the applicability of standard structural analysis to the composite SIPs. Preliminary results have shown that all of the data fits well with standard analysis methods. Technical papers will be produced based on the results during the next few months.

Creep tests will be monitored over the next year. The results will then also be analyzed and published.

Durability Tests

Durability tests are focussed on the question of which SIP component, OSB, insulating foam, or adhesive is the most vulnerable to failure from environmental loading as the SIP ages. The expectation is that SIP-built houses will have the same lifespan as houses built with wood frame construction. There is considerable data available on the aging of OSB over time and it is known how to protect the OSB from failure due to environmental aging. As a result, the durability research and test development is examining whether the foams and adhesives used in SIPs will age more quickly or more slowly than the OSB. This will in turn determine whether or not additional protections will be required to ensure the lifespan of the panels.

There is very little information available in the literature, however, on the long-term aging of SIPs, requiring significant research in this area in order to develop the needed test methods. This part of the project was started by analyzing typical North American climate conditions, classifying them by broad groupings (hot and humid, hot and dry, cold and wet, Arctic, intermediate) and determining the types of environmental loading that would be experienced by SIPs in each condition. A preliminary screening was then done to determine which of the loading conditions would have an impact on the panels. The screening indicated that panels and panel materials needed to be tested under the following types of load:

- High heat;
- Constant temperature and humidity;
- Cyclic temperature and humidity; and
- Freezing and thawing

There are currently over a thousand insulating foam and SIP coupon samples being conditioned under different temperatures in the first three conditions in environmental chambers. As the samples age, groups of them will be removed from the chambers and the tensile behaviour of the samples measured. These measurements will allow the aging rate of the different materials to be determined. The aging times correspond to the equivalent of 5-33 years of aging, depending on the type of aging. This time is sufficient to allow extrapolation of aging behaviour out to 50 years time.

Data Integration and Test Method Development

Once the complete aging data has been collected, one or more aging methods will be developed into a test for the qualification of SIP panels. The information on changes in mechanical performance will also be integrated with the mechanical analysis to allow estimation of panel mechanical strength distributions over time. The test methods will then be formally written up in a technical guide that will describe the procedures to be followed in testing SIPs for NBCC compliance.