Acoustic performance of wood-frame buildings

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Abstract: Commercial and multi-family residential construction represents a growth area for the Canadian wood products industry. To capitalize on this opportunity, a thorough understanding of the necessary products and system attributes will be essential. Adequate levels of noise/sound control in multi-family buildings are mandatory requirements of building codes in Canada, the United States, Europe, and most developed Asian countries. In many jurisdictions, these requirements are as strictly enforced as those for structural sufficiency and fire safety. Much effort has been spent on evaluation of sound transmission class (STC) and impact sound insulation class (IIC) of floor and wall assemblies and on studies of flanking transmission in multi-family dwellings in Canada. However, continuing occupant complaints of poor acoustic performance in wood-frame buildings that appear to have been built according to wall and floor construction practices recommended in building codes suggest the existence of gaps in current noise control techniques.

Forintek initiated this project to investigate the relative importance of noise transmission in wood-frame residential buildings in comparison with other building serviceability issues, and to conduct a pilot study to examine construction designs of wood-frame buildings that exhibit unsatisfactory and satisfactory noise control and to identify existing gaps in current noise control techniques.

A literature review and survey of 123 occupants of wood-framed multi- and single-family residential buildings was conducted to determine the relative importance of noise transmission in comparison with other building serviceability attributes. Case studies were conducted on construction details and designs of six new wood-frame condominiums and one single family-house that were built according to code requirements and recommendations for controlling noise transmission.

We found that the general public had high expectations regarding adequate acoustic privacy. Even single- family house builders considered low sound transmission important. The multi-family building

considered low sound transmission important. The multi-family building occupants ranked “sound insulation” the most “important” serviceability attribute, while single-family occupants were most concerned with “water penetration and condensation”. The lowest level of “satisfaction” was given by all respondents to “noise transmission” for their current residences, including single-family occupants, who had ranked it as not being so “important”. The case studies revealed that, current construction practices were much more effective in controlling airborne sound transmission than impact noise. The footfall noise transmission from stairs through the walls is still an unresolved issue that is not considered in the current Canadian Building Code. The low frequency footfall noise transmission between vertically-stacked units was the common complaint in some of these buildings. With no requirement for impact sound insulation in the current National Building Code of Canada, and with our existing knowledge gap concerning low frequency footfall noise transmission problems and solutions to control them, builders, acoustics consultants and design engineers have simply tended to blame wood building materials for noise-related complaints.

We concluded that if we are to satisfy the occupants of both single-and multi-family wood-frame buildings and to provide confidence for builders and design engineers in wood-frame construction with satisfactory acoustic performance, a much greater effort is needed to improve sound insulation including development of better sound insulated wood-frame systems and building materials as well as retrofitting techniques. Acoustic performance will be a critical factor for the wood products industry in gaining a greater share of the multi-family construction market and in competing with other building materials.

Acoustic emissions

Documents

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Hardwood Initiative - Part 5: Development of new processes and technologies in the hardwood industry (Project 16) ; Testing the impacts of tree and stand attributes on the variability of acoustic velocity in standing trees (ST300) and logs (HM200)

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Abstract: Hardwood Initiative Project is based on two paradigms. First, the end-use potential and value of a wood product basket can be determined by the properties of its wood and should be quantified as much as possible before trees are harvested. Second, as the correlations between site conditions and wood fibre attributes can be changed by silvicultural treatments, it would be possible to optimize the wood production in terms of quantity and quality through a better understanding of silvicultural impacts on changes in wood fibre properties. This document presents the preliminary results of a research component of the project related to acoustic velocity. It focuses on testing the impacts of tree and stand attributes on the variability of non-destructive velocity (ST300 non-destructive measurement in standing tree) and of destructive velocity (HM200 destructive measurement in log). The acoustic measurements were conducted in 30 plots of sugar maple mixed with yellow birch in New Brunswick. Among the trees measured, 64 trees have been subjected to both non-destructive and destructive velocity measurement. Regression analysis by mixed model showed no significant impact of stand attributes (stand basal area and stand height) on the variation of both velocities. In addition, the defects represented by stem deformation, hole, split, wound, and stump swelling, had no significant impact on both velocities. By cons, the test showed a significant correlation between both velocities and dbh and light crown area of the tree. Non-destructive velocity was better explained by dbh and light crown than the destructive velocity. These results open the potential to produce an equation to predict the non-destructive acoustic velocity of the tree using simple tree attributes (e.g., dbh and light crown) as predictors, and to prescribe the thinning intensity for a desired level of velocity and then a desired level of wood density or stiffness.
Full title: Hardwood Initiative - Part 5: Development of new processes and technologies in the hardwood industry (Project 16) : Testing the impacts of tree and stand attributes on the variability of acoustic velocity in standing trees (ST300) and logs (HM200)

Hardwoods

Acoustic velocity

Documents

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Plan a research program for acoustic performance of

wood-frame buildings

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Abstract:

Acoustic performance is one of the important issues that need to be addressed to help wood compete with other materials in the housing market, especially the multi-family housing market. The 1995 National Building Code of Canada (NBCC) increased the minimum sound transmission class (STC) ratings requirement from 45 to 50 between residential suites, and from 50 to 55 between suites and vertical shafts, against the 1990 NBCC. In a recent survey of prefabricated houses, sound performance was reported to be a key concern for increased acceptance of wood-frame buildings components in foreign markets, particularly Europe and Japan, where the code requirements for sound insulation are more stringent than in Canada. In view of this growing awareness of acoustic performance issues in Canada and elsewhere, and the corresponding evolution of building codes, the wood industry needs to demonstrate that wood-frame buildings can match or outperform buildings using other materials with respect to all major criteria, including acoustic performance.

This report identifies gaps in the sound-transmission research for wood-frame buildings. These gaps are either issues not completely addressed or understood, or they have been ignored by non-wood researchers or the current National Building Code of Canada. The issues identified include: 1) a lack of design information on Field Sound Transmission Class (FSTC) and Impact Insulation Class (FIIC) ratings for wood-frame construction; 2) conflicts between some construction solutions for sound insulation and other performance attributes; 3) a lack of design and construction guidelines for low frequency thumping noises induced by footsteps in wood-frame construction; 4) limited information on the design of wood-frame construction insulated against exterior noises. Forintek lacks the expertise to deal with noise insulation issues in wood-frame construction.

Four potential research projects are proposed to address these issues. It is recommended that Forintek should play an active role in sound insulation research in order to deal with occupant complaints about poor sound performance in wood-frame buildings.

Co-ordination with acoustics experts at the Institute for Research in Construction (IRC) and other institutes, the wood and building industries, and code regulators is necessary to the success of any research to be undertaken to fill these gaps, reinforce the performance attributes of Canadian wood-frame systems and increase their market acceptance.

Wood-frame buildings

Acoustic performance

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