RESEARCH HIGHLIGHTS

Technical Series 99-113

DEVELOPMENT OF GENERIC ENGINEERED DETAILS FOR THE CONSTRUCTION OF RESIDENTIAL TALL WALLS

Introduction

Over the past several years, exterior walls which are greater than one storey in height, i.e., tall walls, have become increasingly popular among consumers in Alberta. These exterior loadbearing walls can be as high as 20 feet (6095 mm), and can include various configurations of window and door openings, interior appurtenances and attachments such as fireplaces, adjacent stairs, and decorative ledges.

Part 9 of the 1997 edition of the Alberta Building Code (ABC) which governs house construction in Alberta, defines maximum allowable heights for exterior loadbearing walls in terms of stud size and spacing. The ABC, however, only prescribes walls up to 11.8 feet (3600 mm) in height. Walls exceeding that height must be individually engineered. This naturally adds to the price of the home, and can adversely affect the construction schedule.

A significant number of two-storey homes built in Alberta each year contain at least one tall wall which exceeds the limits of the ABC. Significant time and expense could be saved through the availability of generic, engineered data which would allow builders to select appropriate material and installation configurations for the tall walls.

Research Program

The objective of this project was to develop, in a form suitable for review and acceptance by the authority having jurisdiction over the Alberta Building Code, a set of engineered data designed to allow builders to identify and specify structurally appropriate criteria for the construction of tall walls in various configurations, without the necessity of retaining engineering services.

To cover the range of popular choices identified by builders, several general configurations were selected for analysis. These configurations included both solid walls and walls with varying window layouts.

The wall dimensions ranged from 7 to 16 feet (2133 to 4877 mm) in width and 10 to 20 feet (3048 to 6096 mm) in height. Window openings ranged from 4 to 10 feet (1219 to 3048 mm) in width.

A number of appurtenances, such as window ledges, fireplaces and interior partitions were included in the study to determine what effect they have on tall walls.

Structural design work was carried out in accordance with:

- the design requirements contained in Part 4 of the Alberta Building Code, 1997 (as required by Part 9),
- the guidelines contained in Chapter 4 of the Supplement to the National Building Code, 1995, Commentary on Part 4,
- the methods described in CAN/CSA-086.1-94, Engineering Design in Wood (Limit States Design), and
- the consultant's expertise and experience.

Developmental work followed generally accepted principles of limit states design. For this work, load carrying capacity and lateral deflection were selected as the governing limit states. Load carrying capacity ensures that occupant safety aspects are addressed, and deflection considerations address the serviceability aspect. Both of these properties were derived using loading data published in current codes and lumber characteristics tables.

The general design philosophy encompassed examination and classification of live loads throughout the province, and development of tables that link the load classification at a particular location to allowable tall wall characteristics for that location. These approaches responded to the requirements that the data developed be generic in nature, and that solutions to tall wall situations be easily extracted by industry practitioners with little or no structural design expertise.

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Appendix C of the ABC lists snow and wind loads for numerous centres in the province of Alberta. Determination of tall wall properties would normally require a calculation for each location in the province, using the live loads detailed for the location. To ease calculations and reduce the sheer number of resultant tall wall height (and width) tables that would otherwise be required for generic application within Alberta, the ranges of snow and wind loads in Appendix C were divided into 3 categories – Low, Medium, and High. In the case of snow loading, a fourth group, Very High, was added to reflect the high snowfall in the Lake Louise area. Wind load categories were developed on the basis of the 1-in-30 year values. The live load categories were assigned the following limits:

Low Snow = 1.0 to 1.3 kPa
Medium Snow = 1.4 to 1.9 kPa
High Snow = 2.0 to 3.3 kPa
Very High Snow = 3.4 to 6.3 kPa

Low Wind = 0 to 0.46 kPa
Medium Wind = 0.47 to 0.69 kPa
High Wind = 0.70 to 0.93 kPa.

Findings

Two types of tall wall tables were developed. The first case – tables which identify the maximum widths of loadbearing walls of given height – was chosen as a means of addressing the option to construct tall walls in two vertical lifts. The second case – tables that identify the maximum height to which a loadbearing wall may be built – addresses the option of building tall walls with full height studs. In the first case, stress and deflection due to wind loads constituted the governing conditions. Allowable deflection was set at 1/180 of the width of the wall. In the second case, the combination of axial loading and bending moments caused by wind loading was considered, and either stresses or deflections governed the allowable height of the wall, depending on load combination.

The structural contributions of the appurtenant components studied were found to be minimal. From the generic perspective, whatever contributions could be afforded by these items would be lost to design allowances that would have to be made to compensate for the large number of variables associated with their installation. These variables include vertical and horizontal positions on the wall, materials used, and fastening methods used. Details describing these items would have to be intricate and the potential for another field variable – misapplication of intended specifications – would likely be introduced.

Conclusions

The results of the work are in the form of tables, from which competent building practitioners can select appropriate construction details for specific tall wall requirements. The tables apply to wall heights beyond the range of heights presently covered in the ABC, Subsection 9.23.10. The tables in this form, though complete, are presented for illustrative purposes only. They are not to be used for construction, since they cannot serve that purpose until appropriate rulings have been issued by Alberta Labour.

The tables will not apply to all projects. For instance, where any of the design assumptions do not apply to a particular project or region, the tables are likewise not applicable. Further, it has been noted that the structural contributions of particular wall features like ledges have not been included in the tables, because a generic design cannot possibly address all of the variables that can exist. If a particular project includes this type of wall feature and its structural contribution must be identified, individual professional design analysis will be required.

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Research Team: The Alberta Housing Industry Technical Committee

Research Report: Development of Generic Engineered Details for the Construction of Residential Tall Walls, 1999

Research Consultant: Campbell Woodall & Associates Consulting Engineers Ltd.

A full report on this project is available from the Canadian Housing Information Centre at the address below.

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