BUILDING ENCLOSURE DESIGN GUIDE – WOOD FRAME MULTI-UNIT RESIDENTIAL BUILDINGS

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Summary

1. Introduction

Building enclosure performance problems have been experienced in low-rise wood-frame buildings, as well as high-rise buildings, in the coastal climate of British Columbia. The most significant symptom of these performance problems in low-rise wood-frame buildings has been the occurrence of extensive wood decay. The *Survey of Building Envelope Failures in the Coastal Climate of British Columbia (Survey)* identified key aspects of the design, construction, operation and maintenance which led to the problems. *Woodframe Envelopes in the Coastal Climate of British Columbia – Best Practice Guide Building Technology, 1999 and 2001 (CMHC-BPG)*, was published by Canada Mortgage and Housing Corporation (CMHC) to provide the design and construction industry with the basis and impetus to avoid these performance problems in new construction. The document that is the subject of this paper, *Building Enclosure Design Guide – Wood-Frame Multi-Unit Residential Buildings (Guide)*, builds on this previous work with updates and knowledge gained over the past 10 years.

2. The Guide

The *Guide* is intended to provide guidance, primarily to designers, for the design of the building enclosures of multi-unit wood-frame residential buildings in British Columbia. The *Guide* may also be useful for builders, consultants and contractors, and should also be useful for buildings of other occupancies, providing that they do not exceed certain height, size and occupancy limitations.

Although the *Guide* is intended to reflect good practice in general, its primary focus is on the management of heat, air and moisture transfer, since moisture-related performance problems prompted this initiative. The *Guide* therefore does not deal specifically with structural, acoustic, fire and a variety of other parameters that may also have an impact on the design of the building enclosure.

The *Guide* reflects current good practice in design and construction. Good practice in the context of this *Guide* means the balanced application of currently available technology, materials, and normal skilled workmanship to the design and construction of affordable and durable housing.

The *Guide* reflects the requirements in the current *National Building Code of Canada* which is the model for the *British Columbia Building Code 2006 (BCBC)*. The *BCBC*, including the energy efficiency provisions (Part 10) introduced in 2008, is the primary building code document referenced in the *Guide*. Differences between *BCBC* and the 2007 *Vancouver Building By-Law (VBBL)* requirements are noted where appropriate.

The *Guide* is organized to take the user from an understanding of the behaviour of wood as a material, the fundamentals of heat, air and moisture control, and energy provisions for the building enclosure, prior to presenting design guidance specific to assemblies, details, components and materials. The final chapter addresses planning for maintenance and renewal of the building enclosure over its service life.

While the *Guide* has been generally updated from early versions of the *CMHC-BPG* publications, there are several key areas that have dictated some significant changes. These areas of change include the following:

- B.C. building code allows wood frame construction to extend to 6 stories impacting wind and rain loads, impact of shrinkage, and access for maintenance and renewals.
- Impact of heating and ventilation systems, interior space design, and occupant use on the performance the building enclosure is addressed.
- Energy efficiency has become a priority in the design of new buildings. This change in priorities has created some significant changes for wood frame buildings.
- Information regarding windows has been updated to be consistent with the soon to be published *Windows Best Practice Guide*, as well as new code requirements for windows.

Behaviour of Wood

Wood construction has been widely used in residential construction because it has a proven record of performance under a wide range of climates throughout North America, when it is used in an appropriate manner with attention to detailing and durability.

Basics properties and behavior of wood in construction are described. In particular issues related to moisture accumulation and shrinkage in wood are addressed. While the construction of multi-unit wood-frame buildings is similar to single family wood-frame construction in many ways, there are also some key differences that are reflected within this *Guide*.

Multi-unit buildings are taller; in fact five and six-storey wood-frame buildings are now possible. This means that cumulative frame shrinkage will be greater and that access for maintenance and renewals will be more difficult. As a result, design and construction of the building enclosure for multi-unit wood-frame buildings generally must accommodate greater shrinkage movement, and be more resistant to moisture sources and/or be more durable. See example in Figure 1.

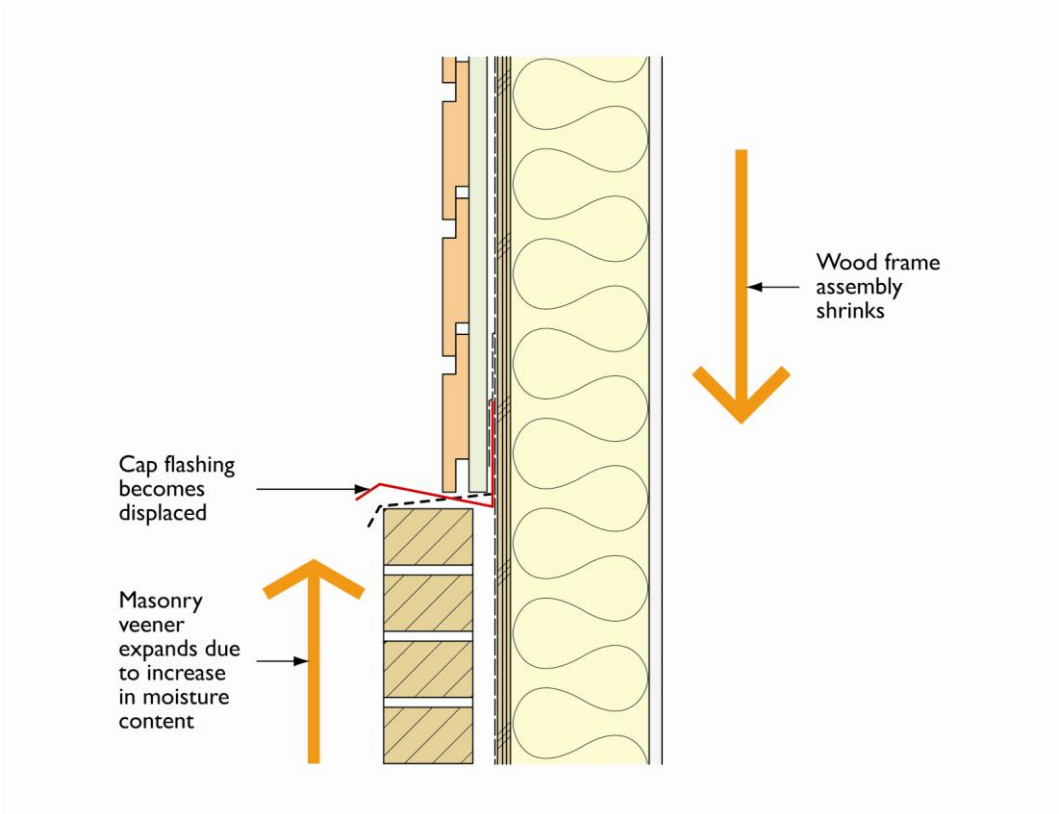

Figure 1: Impact of wood shrinkage at masonry veneer cladding interface with wood siding

Heat, Air and Moisture Control Principles

The building enclosure must perform many functions and of critical importance is the control of heat, air and moisture. This *Guide* presents principles of heat, air and moisture control that can be applied to all of the assemblies, components and details that comprise the building enclosure.

As the primary impetus to the creation of the forerunner to this Guide was moisture problems related to rain penetration control, there is a particular emphasis of this aspect of design and detailing. However, fundamentally the Guide examines the balance of all wetting and drying mechanisms that impact on performance of the building enclosure. Reflecting the emerging energy efficiency priority, as well as the advent of 5 and 6 storey buildings, the *Guide* does provide a greater level of detail concerning these influences.

Energy

Recent changes in building codes have greatly increased the thermal performance requirements for wood frame building in general and wood frame building enclosure asssemblie sin particular. The *Guide* explains the current building code requirements and provides practical guidance regarding how to achieve the new requirements. The increased

performance expectations have resulted in the need to consider assemblies that have not been common in wood frame construction historically, such as walls with continuous exterior insulation. This change introduces additional complexities with respect to Hygrothermal performance and construction detailing.

Assemblies

Considerations for the development of walls, roofs, decks, balcony and window assemblies are presented in a data sheet format. Particular sensitivities and factors affecting long term performance are discussed. Although not part of the wood frame building enclosure, below grade concrete wall assemblies are also presented due to the fact they are an important element of the overall enclosure and interface with other assemblies.

The concept of critical barriers is introduced in the *Guide*. The term critical barrier refers to materials and components that together perform a control function within the building enclosure. It has been common to think of, and define, some critical barriers within an enclosure assembly such as a vapour retarder or air barrier. This *Guide* also refers to a 'water shedding surface' and a 'water resistive barrier' to facilitate a discussion of water penetration control strategies.

Details

The walls, roofs, decks, balconies, windows and other elements are combined in a building project to form a complete and continuous enclosure that separates interior space from the exterior. Key functions such as air barriers, vapour retarders, water resistive barriers and the water shedding surface must be present not only in each assembly of the enclosure, but also at the interfaces between assemblies, as well as at penetrations through these assemblies. This is one of the most common and challenging detailing tasks faced by designers and builders. This *Guide* focuses on appropriate details for building enclosure interfaces and penetrations.

The *Guide* provides sample details for most of the common detailing situations faced in the design of a multi-unit wood frame building. The details are intended to illustrate responses to the building enclosure performance functions discussed in the *Guide*. The particular design parameters are arbitrary. An actual building design would require an analysis of its unique set of conditions. See Figure 2 for a sample detail from the *Guide*.

Components and Materials

The *Guide* provides guidance so informed decisions can be made when selecting or specifying components and materials for the building enclosure. This information is intended to be used to customize commercially available master specifications and links the discussion of materials for assemblies and the drawing details with the project specifications that form part of the construction document packages.

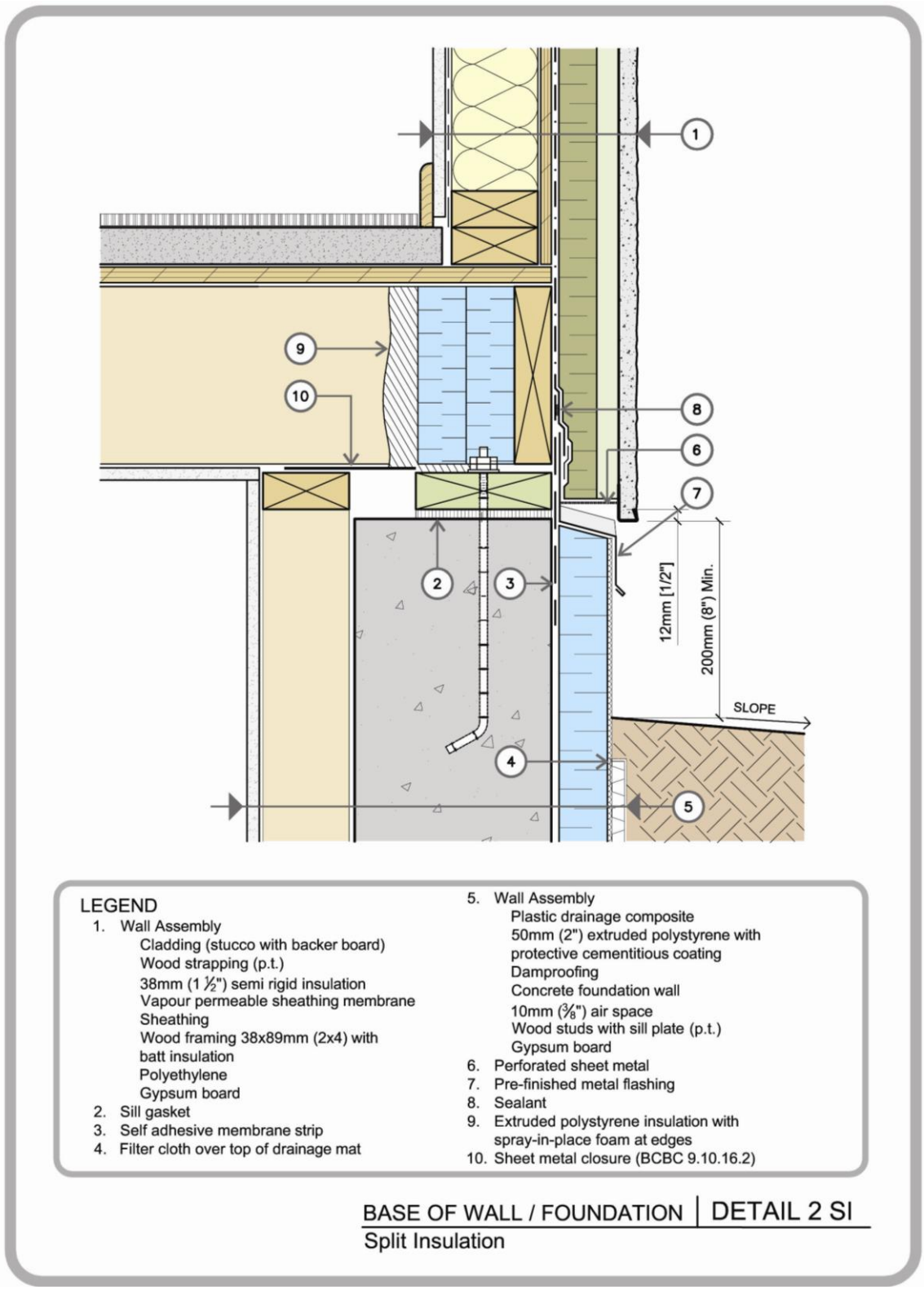

Figure 2: Sample of detail from Guide

Maintenance and Renewals

Achieving durable building enclosure construction and responsible operations, maintenance and renewals expenditures requires good decision-making during the design and construction stages related to assemblies, details and materials. A logical extension of this focus during the initial design and construction is for the design team to provide guidance on maintenance and renewals planning so that the owners of the building can continue to manage their building with durability and long-term performance in mind. The *Guide* addresses both the issue of building enclosure design and planning with effective maintenance and renewals in mind.

3. Conclusions

The design of the building enclosure for multi-unit residential wood frame buildings is a complex and iterative process. However, careful consideration of the various design parameters will lead to the selection of appropriate assemblies and good detailing which in turn will result in a durable, energy efficient, cost effective and maintainable building enclosure. This *Guide* provides an effective roadmap for achieving these objectives.

4. Literature

Best Practice Guide Building Technology: Wood-Frame Envelopes in the Coastal Climate of British Columbia, Canadian Mortgage and Housing Corporation, 2001.

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