Introduction to Canadian Residential Construction

CANADIAN HOUSING IS ADAPTABLE, FLEXIBLE AND ACCOMMODATES DIVERSE CLIMATES

Course Outline

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CANADA'S CLIMATIC RANGES

Learning Objective:

To understand the range of climates that exist in Canada

There is a misconception in many parts of the world that Canada is strictly a cold climate country when in fact Canada has climates ranging from temperate to continental to artic and at the same time we have deserts (Okanogan Valley of B.C.) and we experience hot humid summers (southern Manitoba to Quebec). Temperature extremes range from minus 60 C in the Arctic to plus 40 C in the Okanogan Valley. Rain fall varies from 2468 mm a year in Prince Rupert B.C. to 267 mm per year in Osoyoos B.C. Wood frame construction has been used successfully for over 100 years in all of Canada's varied climates.

CANADIAN HOUSING IS ADAPTABLE, FLEXIBLE AND ACCOMMODATES DIVERSE CLIMATES

Learning Objective:

To understand that Canadian housing is used successfully in a wide variety of climates
In order to provide shelter a building envelope must withstand a wide variety of climatic conditions. At the same time it must also maintain a comfortable and safe indoor environment for the occupants. Canadian wood frame housing has provided this for over one hundred years in a wide range of climates. It should be noted that Canadian houses are typically entirely space heated and cooled this is in contrast to much of the world where occupants tend to heat and cool on a room by room basis as a measure to save on energy costs. A well-insulated building will allow the entire building to be heated economically while enhancing comfort and helping prevent mold growth which is common in buildings that are heated room by room

PLATFORM FRAME CONSTRUCTION

Learning Objective:

To understand that wood frame construction is the most common method of construction in Canada

A wide range of construction methods are used in Canadian but by far the most common is wood frame construction. Wood frame construction in various forms has been used in Canada since the mid 1800's and plat form frame construction has been in use since the early 1900's. It has been popular because it is based on standardized small dimension lumber, it is a relatively simple form of construction and platform frame construction allows for constructing walls on the flat and level surface of the framed floor. Services can be readily installed in wall cavities and the building frame provides cavities that can be easily insulated.

HEAVY TIMBER CONSTRUCTION

Learning Objective:

To gain an acquaintance with heavy timber construction as used in Canada

Heavy timber or post and beam construction is derived from older wood construction methods and after seeing little application has in the last decade seen an increase in use. Heavy timber homes are often supplied as kits by specialty suppliers and assembled by contractures who specialize in this type of construction. Metal connectors or wood joinery methods are used. Stud wall infill between posts or insulated prefabricated panels are place outside the posts to form the building envelope.

Introduction to Canadian Residential Construction

LOG CONSTRUCTION

Learning Objective:

To gain an acquaintance with log construction as used in Canada

Solid log construction is one of the oldest forms of construction in Canada. Log homes while representing a very small segment of the market are increasingly popular particularly for summer homes. Most log homes are prefabricated with the logs pre-fit and cut and constructed in the log home manufacturer's yard. The home is then disassembled and shipped to the construction site after the foundation has been poured.

LIGHT STEEL FRAME

Learning Objective:

To gain an acquaintance with light steel frame construction as used in Canada

- A small but increasing number of homes are fabricated from light gauge steel framing in Canada.
- Steel's dimensional stability, rot and insect resistance are obvious benefits, although steel can rust when exposed to moisture.
- The flooring system may also be of steel members or maybe wood framed.
- Steel framing while very common in commercial construction tends to become more popular in Canada when the price of lumber is high.
- Use of steel requires changes to framing practices from wood and some retraining of trades
- Steel framed buildings require insulated sheathings to reduce the high thermal conductively of steel.

INNOVATIVE CONCRETE SYSTEMS

Learning Objective:

To gain an acquaintance with insulated concrete forming systems (ICFS) as used in Canada

Over the past decade a number of extruded and expanded polystyrene foam based concrete forming systems have been developed these are generally referred to as insulated concrete forms or ICF's. These range from preformed blocks that can be stacked to plastic ties that can be used with extruded polystyrene foam board to create forms. These systems are used for building insulated foundations as well as entire homes. The foam forms are left in places after the concrete is poured to provide insulation for the building and a substrate for interior and exterior finishes. Some manufactures supply foam forms for poured concrete floors but in most cases framed wood floors and interior partition walls are used. The benefits of ICF's include

- Energy efficiency
- Sound attenuation
- Design flexibility
- Enhanced concrete strength and durability
- Ease of construction
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PANELIZED SYSTEMS

Learning Objective:

To gain an acquaintance with panelized construction as used in Canada

Panelized construction has been used in low rise housing to a limited extent. Panelized systems range from factory assembled conventionally framed walls to stressed skin foam core wall and ceiling / roof panels. Some Canadian companies are specializing in exporting prefabricated wood frame wall panels to America, Asia and Europe**.**

Introduction to Canadian Residential Construction

MODULAR SYSTEMS

Learning Objective:

To gain an acquaintance with modular construction as used in Canada

Modular buildings in Canada typically tend to be an assembly of one storey high wood frame units that are typically 4.25m (14 ft) wide to allow for shipping by truck from the factory to the construction site. The exterior walls and ceilings are wired, plumbed and insulated in the factory. This type of construction has been widely used both in urban and rural locations. The construction of modular homes is governed by a national standard and factories are inspected by certification agencies to ensure the modular units conform to the standard.

CANADIAN HOUSING IS ADAPTABLE, FLEXIBLE AND ACCOMMODATES DIVERSE CLIMATES

Learning Objective:

To gain an acquaintance with some examples of Canadian single family housing

Show the wide variety of styles that are possible using Canadian platform frame construction, Canadian doors and windows and Canadian roof and wall finishes.

FLEX HOUSING

Learning Objective:

To be introduced to the concept of flex housing

Flex housing is housing that can adapt to the changing needs of the occupants over time. These features include moveable walls, stacked closets that allow for later conversion to an elevator shaft, and such wheelchair accessibility features as flush exterior door thresholds, wheel in showers, lower or moveable kitchen counters etc.

Through planning at the design and construction stages and at a relatively low cost walls can be made moveable or re-moveable. The example shown here is a steel stud framed wall that is slightly shorter than a conventional wall and that is wedged in place. Removable baseboard and moldings are used. When the wall is to be moved the moldings and baseboards can be taken off and the wedges are taken from under the wall bottom plate the wall is moved.

ACCESSIBLE AND SENIOR'S HOUSING

Learning Objective:

To acquaint the audience with the concept of elevator conversions

By locating closets of the correct dimensions one above the other and framing the floors to allow for a future opening stacked closets can be adapted in the future as elevator shafts with minimum disruption.

Introduction to Canadian Residential Construction

CANADIAN WOOD FRAME HOUSING

Learning Objective:

To understand that Canadian wood frame construction can be designed and constructed to withstand environmentally imposed structural loads

The structural loads imposed on a building are the dead loads of the building itself, wind loads, snow loads and in some areas earthquake loads. Vertical loads are carried down to the foundation by vertical members such as studs and posts. Where vertical members are not located directly above one another loads are transferred laterally by plates, lintels and beams. Racking strength is imparted to the structure by the diaphragm action of the exterior wall sheathing, roof sheathing and floor sheathing, this will cause the building to resist both wind loads and earthquake loads. Wood frame structures are both strong in compression and tension resulting in an ability to both resist loads and also to absorb energy and rebound from rapid loadings such as those that occur from earthquakes and wind gusts.

A VARIETY OF WOOD PRODUCTS ARE USED TO FRAME A HOUSE

Learning Objective:

To understand that there are a range of wood based products used in wood framing housing

Typically wood frame construction uses dimensioned lumber sawn directly from trees and dried and sheathing materials made from wood veneers and glue (plywood) or chipped wood and glue (OSB). In some cases other man made wood based products are also used.

CANADIAN WOOD FRAME HOUSING

Learning Objective:

To understand that dimension lumber is produced with predictable structural characteristics

Canadian lumber has strength characteristics that reflect the slow growth rate of Canadian trees. Canada has well developed standards and procedures for grading dimension lumber and ensuring predictable structural performance. The performance of dimension lumber is well documented in publications such as Canadian building codes and publications produced by industry associations such as the Canadian Wood Council.

A VARIETY OF WOOD PRODUCTS ARE USED TO FRAME A HOUSE

Learning Objective:

To understand that a range of engineered wood products are available with particular benefits

- The performance of wood as a structural material can be enhanced through fabrication into engineered products such as wood I joist and oriented strand board .
- Wood I joists that typically use an OSB web and dimensioned lumber cords glued together are able to span larger distances than conventional dimensioned lumber. Dimensioned lumber can also be used in open web trusses to allow more efficient use of wood and to span larger distances. Both of these products allow for easier installation of plumbing, wiring and ductwork and are lighter to handle than solid lumber of equivalent structural performance.
- Vibration criteria is normally the limiting factor for spans of engineered floor joists. The long spans that engineered floor joists are capable of are limited by the deflections they require to carry full loads.
- Well developed standards govern the manufacture and use of engineered wood products in Canada

Introduction to Canadian Residential Construction

ENGINEERED WOOD PRODUCTS

Learning Objective:

To understand how the Canadian wood industry is developing new and more efficient ways of using wood fiber.

The building industry uses lumber in a predictable range of dimensions. To meet the demand for lumber of certain lengths and sizes and to increase efficient use of wood fiber the wood products industry has developed various engineered wood products. These include finger jointed lumber for studs, laminated veneer lumber (LVL) and Timber Strand for beams and lintels and Parallam for beams, lintels and posts. These engineered products also have the benefit of being more dimensionally stable and not warping as some dimensioned lumber will do.

CANADIAN BUILDING CODES

Learning Objective:

To acquaint the audience with Canadian Building Codes

A model national building code is developed by the National Research Council of Canada Institute for Research in Construction every 5 years. NRC IRC is one of the top building science research institutions in the world with over 80 years of experience. The code is then modified and adopted by each province to suit local conditions. The primary focus of the building code is to provide the regulatory requirements for the construction of buildings that protect human health and safety. This means the code addresses such issues as structural requirements, fire safety, ventilation for air quality, condensation control etc. Part 9 of the building code deals with low rise residential and other small buildings and is highly prescriptive in nature. Model energy efficiency codes for both large and small building were also developed by NRC and have been adopted as part of various provincial codes.

PROVEN PERFORMANCE OF LUMBER

Learning Objective:

To understand that Part 9 of the building code is primarily prescriptive with regards to wood frame construction

Part nine of the National and Provincial building codes of Canada deal with house and small buildings. In that section of the code tables and prescriptive requirements are laid out for all structural issues related to wood frame housing. These tables and requirements are based on extensive testing of wood frame components and assemblies

SAMPLE SPAN TABLE

Learning Objective:

To show sample span table for dimension wood joists

This shows a span table taken from the Span Book produced by the Canadian Wood Council.

Note how

- the species of wood is specified in the case spruce, pine or fir
- The grade of lumber is shown
- The thickness of the subfloor is shown
- The types of fasting method (nails or nails and glue) are shown

These are all variables that can affect the structural performance of the joist. This range of options gives the designer and builder an ability to choose the most appropriate method for the particular application

Introduction to Canadian Residential Construction

WOOD-FRAME CONSTRUCTION

Learning Objective:

To provide an overview of wood frame construction. Give a general overview of Canadian wood frame construction for a single story home.

- The foundation is typically poured concrete anywhere from 150mm (6”) to 250mm(10”) in thickness
- A 38mm x 89mm (2x4) sill plate is placed on a roofing felt or a foam gasket strip on the top of the foundation wall
- The floor joists are then laid on the sill plate
- The floor sheathing or plywood or OSB is nailed or screwed and glued to the floor joists
- The exterior walls are then framed and sheathed on the floor and then tilted up and secured
- Roof trusses are placed on the wall top plates and braced
- The roof trusses are then covered with sheathing.

FLOOR FRAMING

Learning Objective:

To understand floor framing

A 38mm x 89mm (2x4) sill plate is typically placed on a capillary break such as roofing felt, polyethylene or a foam sill gasket and then anchored to the top of the foundation wall with metal strapping or bolts. The floor joists typically 38 x 184 (2x8) or 38 x 235 (2x10) are then laid on flat on the sill plate and center support beam or wall in preparation for framing. The rim joists are set on the edge of the sill plate and toe nailed. The floor joists are then rotated to vertical set on the sill plate and end nailed through the rim joist. Cross bracing or solid blocking is placed between the joists at mid span to eliminate the possibility of the joists rotating. Tongue and groove plywood or OSB floor sheathing is laid perpendicular to the direction of the joists and glued and screwed or glued and nailed to the top of the joists. This now provides a flat and level platform for framing the exterior walls.

WALL FRAMING

Learning Objective:

To understand how exterior walls are framed

One of the advantages of platform frame construction is that once the floor has been framed it provides a flat and level surface upon which the interior and exterior walls can be framed and erected. The exterior walls are laid out with the locations of the studs marked on the top and bottom plates. The studs, which are usually supplied precut, are then end nailed through the top and bottom plates. A double top plate is usually used at the top to increase it’s ability to carry vertical loads that do not line up directly over studs. Lintels for window and door openings are nailed to studs on either side and rest on cripples that carry the vertical loads. Depending on the air and vapour barrier systems being used a strip of polyethylene or house wrap maybe placed between the double top plates. After the stud and plate framing is complete the frame is covered with sheathing which is nailed in place. After the sheathing is installed the wall is tilted up and nailed to the floor. Interior walls are framed in a similar manner except that they are not sheathed. If a polyethylene air vapour barrier is to be used partition walls located below insulated ceilings will have a strip of polyethylene placed between the double top plates.

Introduction to Canadian Residential Construction

ROOF FRAMING

Learning Objective:

To be acquainted with Canadian roof framing methods

Most wood frame roofs in Canada are constructed with factory made trusses. Trusses are light, strong and efficient. Software has been developed to allow truss plants to easily design and fabricate roof trusses for even the most complex roof forms. Trusses are usually delivered to the site after the walls are framed and many times are placed on top of the walls by the delivery truck mounted crane. The trusses are then placed by the framers and braced with dimension lumber. Following this roof sheathing of plywood or OSB is placed and nailed to the top of the trusses.

In some cases roofs are hand framed using dimensioned lumber or parallel cord trusses

RESISTANCE TO EARTHQUAKES

Learning Objective:

To understand that Canadian wood frame housing is highly earthquake resistant.

The 1995 earthquake in Kobe Japan, which measured 6.8 on the Richter scale and caused wide scale building failures, provided a graphic example of the durability of Canadian wood frame construction. Of all construction methods used in the Kobe area these types of houses survived the best.

FRAMED PANELS TRANSFER ALL LOADS TO THE GROUND

Learning Objective:

To understand the benefits of framed panel walls

The Canadian housing system typically uses the 'platform frame' method of construction which is essentially a series of frames assembled in such a way as to transfer all imposed loads into the ground. Frames are constructed by covering a skeleton of slender wooden members (studs), attached at regular intervals to a top and bottom member (plate), and covered with a thin sheathing panel on one side. Frame members are fastened together with nails. The panels that cover the frame are fastened to each individual member of the frame with nails and/or adhesive, which makes them very rigid. Frames can be constructed in many different sizes and can be used in walls, floors and roofs. Frames are strong in all dimensions. When used in a wall, they carry vertical loads from the floors and roofs above in compression. The shear strength of the frame carries lateral wind loads. The rack strength of the frame carries longitudinal horizontal forces imposed by wind and seismic activity.

METAL FASTENERS, CONNECTORS AND ANCHORS

Learning Objective:

To understand metal anchors used for increasing earthquake resistance

Metal fasteners, anchors and connectors are used to increase the seismic resistance of wood frame construction. A structural engineer and the manufacture of the product should be consulted to ensure the correct product is used for the intended application and that it meets all applicable local codes and regulations. The two products shown here are on the right a tie down and on the left a strap. The tie down anchors vertical wood frame members such as posts, columns or studs directly to the foundation. The strap tie or floor tie anchors tie together the wall framing of adjacent floors to resist uplift and separation.

Introduction to Canadian Residential Construction

RESISTANCE TO WIND

Learning Objective:

To understand that wood frame construction has inherent wind resistance capabilities which can be further enhanced through the use of metal connectors

Platform frame construction consists of a series of panels joined together. These panels act as diaphragms which makes them very strong at resisting racking and shear loads imposed by wind. For this reason wood frame structures are very effective at transferring wind loads to the foundation. Wind also can cause up lift particularly as it travels over a roof for this reason various mental anchors are use to tie components of the building together so they can resist uplift.

METAL FASTENERS, CONNECTORS AND ANCHORS

Learning Objective:

To understand two of the types of metal connectors that are used to resist wind loads

Wind passing over roofs causes a negative pressure on the roof leading to uplift forces. Normal nailing of rafters and trusses to wall top plates and beams may not adequately resist these forces so metal connectors are used to reinforce the connection. Similarly uplift can pull beams of plates from posts or studs so a connector of the type shown on the right would be used.

SUMMARY

Learning Objective:

Most houses are of wood frame construction, these homes are durable and energy efficient and this type of housing is adaptable to wide range of cultural, climatic and physical conditions. Houses are constructed using standard dimensional lumber. Prescriptive building codes allow construction of small wood frame buildings without the need for architects and engineers. Canadian wood frame houses have demonstrated a high resistance to earthquakes and high wind conditions.