Canada Wood
Produits de bois canadien

Wood Trusses

Strength, Economy, Versatility

INTERNATIONAL
Building series NO. 2

Introduction

Wood trusses are engineered frames of lumber joined together in triangular shapes by galvanized steel connector plates, referred to commonly as truss plates.

Wood trusses are widely used in single- and multi-family residential, institutional, agricultural and commercial construction. Their high strength-to-weight ratios permit long spans, offering greater flexibility in floor plan layouts. They can be designed in almost any shape or size, restricted only by manufacturing capabilities, shipping limitations and handling considerations.

Metal plate connected roof trusses were first introduced into the North American market in the 1950's. Today, the majority of house roofs in Canada and the United States are framed with wood trusses and increasingly, wood floor trusses are being used in residential and commercial applications.

Wood truss use is not limited to North America. They are gaining acceptance around the world and are widely used in Europe and Japan.

We've Come a Long Way

The first light frame trusses were built on site using nailed plywood gusset plates. These trusses offered acceptable spans but demanded considerable time to build.

In the 1950's the metal connector plate transformed the truss industry by allowing efficient prefabrication of short and long span trusses.

In North America the wood truss industry has grown to the point where more than 60% of residential roofs are now built with wood trusses. In Canada, approximately 95% of new houses are built with wood roof trusses.

When the advantages of wood trusses are considered, it is not surprising that their use is increasing throughout the world.

- **Strength:** Trusses provide a strong and efficient wood system specifically engineered for each application.

- **Economy:** Through efficient use of wood and by providing a system that is quickly installed in the field, wood trusses provide an economical framing solution.

- **Versatility:** Complex shapes and unusual designs are easily accommodated using wood trusses. The versatility of wood trusses makes it an excellent roof framing system in hybrid construction where wood trusses are commonly used with steel, concrete or masonry wall systems.

- **Environmental:** Wood, the only renewable building material, has numerous environmental advantages. Wood trusses enhance wood's environmental advantages by optimizing wood use for each specific application.

Improvements in materials, design and manufacturing technologies have increased wood truss competitiveness.

- **Research** has led to improved materials, design procedures and manufacturing technologies for wood trusses.

- **Truss** plates used to connect the wood pieces together have been optimized for strength and cost.

- **Lumber** manufacturing and grading technologies have evolved to allow more efficient use of the wood resource.

- **Computers** have been widely used to optimize truss design and make the manufacturing process more efficient.

Wood Truss Technology

There are a number of steps involved in the production and installation of a truss. A truss is designed for a specific application, manufactured in accordance with the truss design, delivered to the building site and safely installed in accordance with the design.

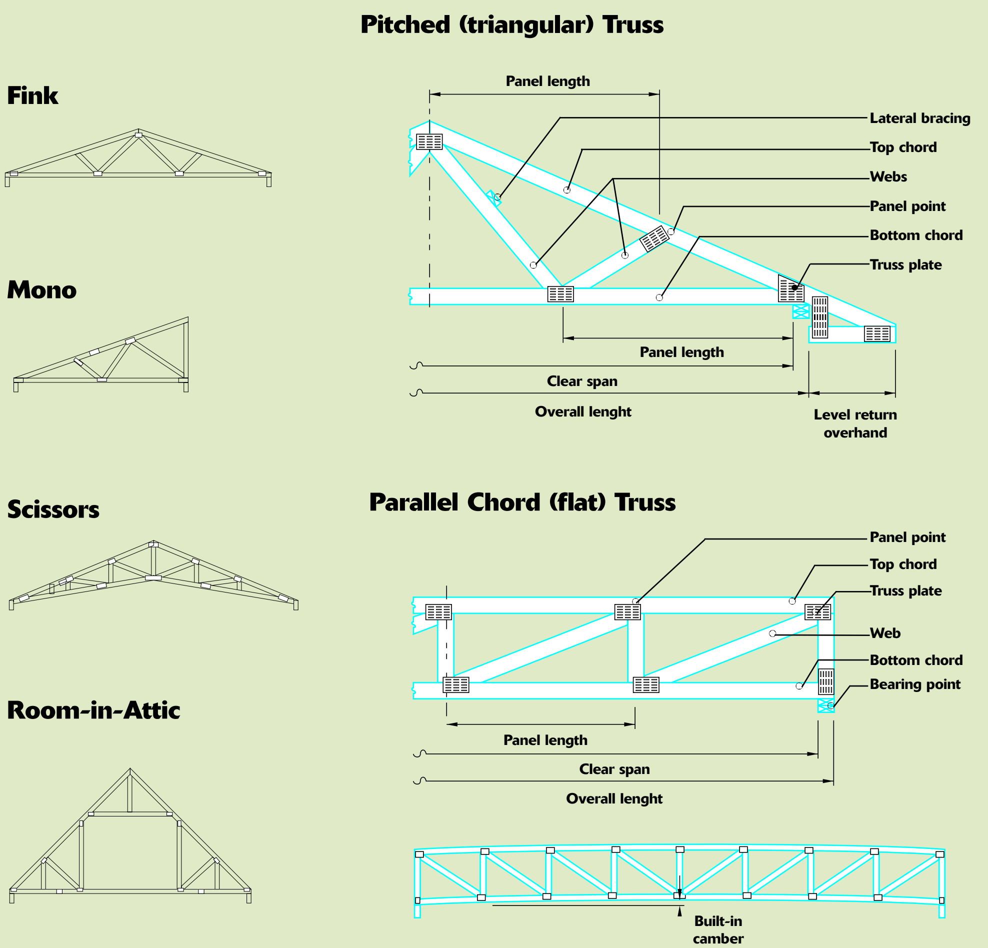
Truss Design

The truss design is initiated by the building designer who must specify; the shape and span of the truss, where the truss will be supported and what the loads on the truss will be.

Typically, the building designer or builder will contact the truss fabricator who will supply a fully engineered truss. The truss plate manufacturer usually designs the truss on behalf of the truss fabricator.

In North America, designs are based on the structural requirements of the Building Codes using design standards referenced in the Building Codes and approved material properties:

FIGURE 1: Truss Nomenclature and Common Truss Shapes



Roof Trusses:

Light trusses are manufactured to suit virtually any roof profile. Pitched or flat, they are only limited to the load arrangements and the support locations.

Flat Trusses:

Flat trusses, also known as parallel chord trusses, are an alternative to conventional wood floor joist systems and are a competitive option to open web steel joist systems.

Parallel chord floor trusses may be designed with varying chord and web arrangements and bearing support details.

Structural analogues and methodology have been developed and standardized by the National Associations representing the manufacturers of the metal plate connectors.

Lumber design values are determined in accordance with the wood design standards.

Truss connector plates are proprietary and each plate has different structural properties. Design values for truss plates are developed through tests and analyses in accordance with referenced standards. Approval of the design values is overseen by National certification organizations.

Truss design is facilitated by the use of computer software that designs all truss members and connections and produces a design drawing with all the essential truss information. Included on the drawing (see Figure 2) is:

- The truss geometry,
- The loads used in the truss design,
- Species, size and grade of all wood members,
- Size and location of all connector plates,
- Truss bearing and uplift requirements, and
- Truss member bracing requirements.

Truss Materials

WOOD

All lumber used in trusses is graded using either a visual process or machine stress rating in accordance with national standards. In the visual grading process, each piece of lumber is visually examined and the wood grade is based on the size of growth characteristics that could affect the strength and stiffness of the member. Each piece of machine stress rated lumber undergoes a stiffness evaluation in addition to a visual evaluation.

The minimum size of lumber used is 38 x 89 mm for chords and 38 x 64 mm for webs. The size of the members increases according to loading, span and truss spacing. In some long-span applications, multi-ply trusses are used to increase capacity.

Laboratory Testing of Wood Trusses

TRUSS PLATES

The truss connector plates are proprietary products. They are made of galvanized steel and manufactured by high speed stamping machines that punch out the plate teeth and shear the plate to the required size. Truss plate manufacturers carry out a series of tests to determine the design properties for each type of plate.

Many sizes and gauges of connector plates are manufactured. The most common plates use 16, 18 or 20-gauge (US Standard Gauge) sheet steel, in widths of 25 mm to 250 mm and lengths up to 600 mm.

The stamping results in teeth with dimensions varying from 6 mm to 25 mm.

Truss Connector Plates

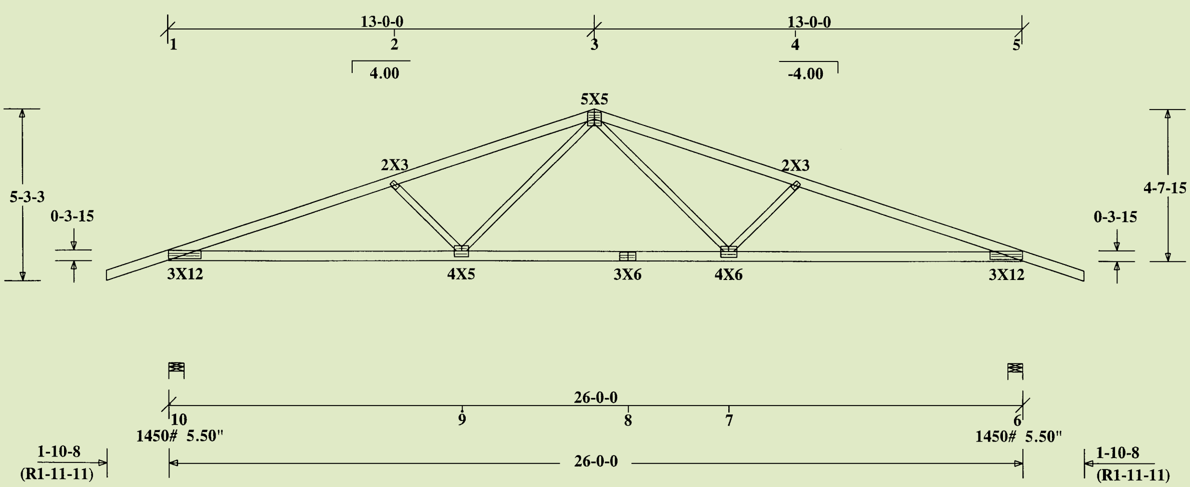
FIGURE 2: Sample of a Truss Shop Drawing

TPIC97 CWC WO: TEST01 TI: CWCTR1 QTY: 1

```
TOP CHORDS: 2x4   SPF #1/#2  (N)
BOT CHORDS: 2x4   SPF #1/#2  (N)
WEBS:       2x3   SPF #1/#2  (N)
All COMPRESSION Chords are assumed to be
continuously braced unless noted otherwise.
MAX LIVE LOAD DEFLECTION:
L/876  at JOINT # 8
L=-0.34" D=-0.11" T=-0.45"
MAX HORIZONTAL DEFLECTION:
T= 0.11"
Defl Criteria based on TPIC: 1.33*LL + DL

RMB: 1.10*(Fb, Fc, Ft, Fv)
Importance Factor: 1.00
TPIC Building Type: HSB
```

```
Analysis based on Simplified Analog Model.
Analysis is based upon MANUALLY entered load
     Top Chord Live Load = 37.0 psf.
CONNECTOR PLATES ARE ForeTruss
FT20 (20ga) and FT18 (18ga)

..TC...FORCE...CSI     ..BC...FORCE...CSI
 1- 2  -4587  0.91     10- 9   4265  0.98
 2- 3  -3983  0.83      9- 8   2776  0.69
 3- 4  -3990  0.83      8- 7   2776  0.72
 4- 5  -4594  0.91      7- 6   4271  0.97
```

```
==============Joint Locations===============
  1)  0- 0- 0     5) 26- 0- 0     9)  8-11- 4
  2)  6-10-14     6) 26- 0- 0    10)  0- 0- 0
  3) 13- 0- 0     7) 17- 0-12
  4) 19- 1- 2     8) 14- 0- 0

------------ TOTAL DESIGN LOADS ------------
Uniform       PLF     From        PLF     To
TC Vert L    -111  -1-10- 8     -111  27-10- 8
TC Vert D      -7  -1-10- 8       -7  27-10- 8
BC Vert D     -25    0- 0- 0     -25  26- 0- 0
----MAX. REACTIONS PER BEARING LOCATION-----
X-Loc       Vert  Horiz  Uplift Y-Loc  Type
 0- 2-12    1449      0       0  BOT    PIN
25- 9- 4    1450      0       0  BOT    H-ROLL
---MAX. LIVE/DEAD LOAD REACTIONS PER X-LOC--
X-Loc      Vert-React    Uplift-React  Y-Loc
 0- 2-12   1100/  349         0/     0  BOT
25- 9- 4   1100/  349         0/     0  BOT
```



DESIGN LOADS SHOWN ARE FACTORED scale = 0.2252

DESIGN INFORMATION

THIS DESIGN IS FOR AN INDIVIDUAL BUILDING COMPONENT AND HAS BEEN BASED ON INFORMATION PROVIDED BY THE CLIENT. THE ENGINEER DISCLAIMS ANY RESPONSIBILITY FOR DAMAGES AS A RESULT OF FAULTY OR INCORRECT INFORMATION, SPECIFICATION AND/OR DESIGNS FURNISHED TO ENGINEER BY THE CLIENT.

ONLY RESPONSIBLE FOR THE STRUCTURAL INTEGRITY OF THIS BUILDING COMPONENT FOR THE CONDITIONS SHOWN ON THIS DRAWING. THE STRUCTURAL INTEGRITY OF THE BUILDING AND THE VERIFICATION OF THE DIMENSIONS AND THE DESIGN LOADS USED ARE THE RESPONSIBILITY OF THE BUILDING DESIGNER.

CODE

THIS TRUSS HAS BEEN DESIGNED IN ACCORDANCE WITH NBC/OBC AND CSA ENGINEERING GUIDLINES.

LUMBER

1. LUMBER USED MUST BE THE SAME GRADE AND SIZE AS INDIQUATED ON THE DRAWING.
2. LUMBER USED MUST NOT BE TREATED BY ANY FIREPROOFING MATERIAL OR ANY OTHER CORROSIVE CHEMICAL AGENTS.
3. LUMBER MUST BE FREE OF SPLITS AND CRACKS.

CONNECTOR PLATTES

1. PLATES SHALL BE LOCATED ON BOTH FACES OF THE TRUSS WITH NAILS FULLY IMBEDED AND SHALL BE SYM. ABOUT THE CENTRE OF THE JOINT.
2. PLATES SHALL NOT BE INSTALLED OVER KNOTHOLES,KNOTS OR DISTORTED GRAIN.

CALCULATION

1. COMPRESSION CHORDS (TOP OR BOTTOM) Are ASSUMED TO BE CONTINUOUSLY BRACED BY SHEATING UNLESS OTHERWISE SPECIFIED.
2. WHERE BOTTOM CHORDS IN TENSION ARE NOT FULLY BRACED LATERALLY BY A PROPERLY APPLIED RIGID CEILING, THEY SHOULD BE BRACED AT A MIN. 10'-0" O.C.
3. USE OF THIS TRUSS IS IN DRY ENVIRONMENT.

FABRICATION HANDLING AND INSTALLATION

1. PRIOR TO FABRICATION, THE FABRICATOR SHALL REVIEW THIS DRAWING TO VERIFY THAT THE INFORMATION IS IN CONFORMANCE WITH HIS PLANS.
2. CALCULATION IS BASED ON A GOOD QUALITY CONTROL AT FABRICATION.
3. MEMBERS SHALL BE CUT FOR TIGHT FITTING WOOD TO WOOD BEARING.
4. NO DRILLING OR CUTTING OF WEBS ARE PERMITTED.
5. HANDLING AND ERRECTION OF TRUSSES MUST BE HANDLED BY QUALIFIED PERSON IN ACCORDANCE WITH "HANDLING, INSTALLATION & BRACING", TPIC..
6. USE CARE DURING BANDING OR BUNDLING, DELIVERY AND INSTALLATION TO AVOID DAMAGE.
7. THIS TRUSS MUST BE FIXED STRAIGHT AND PLUMB TO BEARING PLATE USING MIN. 4-(4-1/2") NAILS.
8. CONNECTION AND ANCHORAGE OF THE TRUSS TO BEARING PLATE ARE THE RESPONSIBILITY OF THE BUILDING DESIGNER.
9. TEMPORARY AND PERMANENT BRACING FOR HOLDING TRUSSES IN A STRAIGHT AND PLUMB POSITION AND FOR RESISTING LATERAL FORCES SHALL BE DESIGNED AND INSTALLED BY OTHERS.

SPLICES

LOCATE 'IN-PANEL' SPLICES AT APPROX. 1/4 OF PANEL LENGTH FROM ADJACENT JOINT AS SHOWN ON TRUSS DRAWING

WARNING: READ ALL NOTES ON THIS SHEET.

A COPY OF THIS DRAWING TO BE GIVEN TO ERECTING CONTRACTOR.

BRACING WARNING

BRACING SHOWN ON THIS DRAWING IS NOT ERECTION BRACING, WIND BRACING, PORTAL BRACING OR SIMILAR BRACING. BRACES SHOWN ON THIS TRUSS DRAWING ARE FOR LATERAL SUPPORT OF TRUSS MEMBERS ONLY TO REDUCE BUCKLING LENGTH.

Eng. Job:
Dwg: LSD
Dsgnr: Chk:

TC Live	37.0	psf
TC Dead	3.0	psf
BC Live	0.0	psf
BC Dead	10.0	psf
TOTAL	50.0	psf

WO: TEST01
Truss ID: CWCTR1
Date: 6-09-97
DurFac - Lbr: 1.00
DurFac - Plt: 0.80
O.C. Spacing: 24.0"
Design Criteria: TPIC
Code Desc: P9-NBC
V:06.03.97- 4456- 6

Truss Manufacture

The factory manufacture of light frame trusses is demonstrated in Figure 3. Since wood trusses are custom made, the variety of roof pitches and location of lumber members entails complex cutting patterns. Each member must fit snugly in place.

The computer design of trusses generates fabrication instructions. These indicate the size and grade as well as the precise cutting patterns for each of the chord and web members. The type, size, location and orientation of the connector plates are also indicated.

Once the pieces have been cut and arranged using a template, identical truss plates are placed on opposing faces at the joints and pressed into the lumber using hydraulic presses or rollers. When the pressing of the plates has been completed, the trusses are checked for plate tooth penetration and moved to a storage area.

Truss Handling, Installation and Storage

Trusses are strong in the vertical position but can be damaged at the plate joints if bent in the lateral direction. Trusses should be unloaded in bundles and stored on level ground, but never in direct contact with the ground. Trusses should always be protected from the elements. During unloading and erection, proper lifting equipment must be used to ensure safety and to prevent damage. Trusses less than 6 m can be installed by hand while trusses over 18 m use heavy rigging equipment.

Groups of trusses can be assembled on the ground and lifted together into position. This prevents lateral strain on the joints and resists wind loads prior to final installation of sheathing or permanent bracing.

Truss Bracing

Trusses must be braced to ensure safety and performance. To do so, trusses are placed according to installation procedures and guidelines provided by the truss fabricator. During construction, the installer provides temporary bracing to keep the trusses plumb and correctly spaced and to prevent damage or collapse caused by lateral loads such as wind. Permanent bracing is also installed according to specifications provided by the truss designer or the building designer. Permanent bracing provides lateral support to compression web and chord members and prevents overall lateral displacement of the roof assembly.

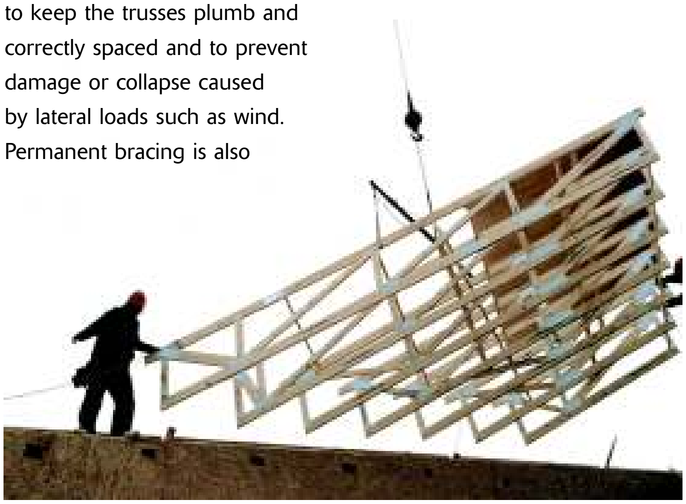
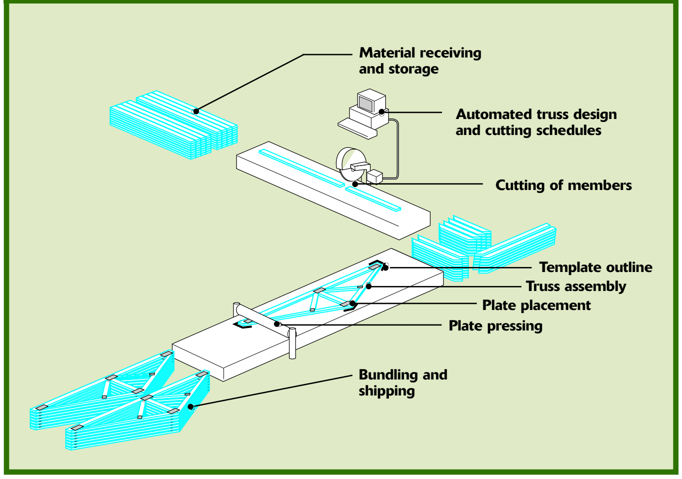


FIGURE 3: Manufacture of Light Frame Trusses



7

Wood Truss Advantages and Applications

Flexibility and Versatility

Long spans without intermediate supports create large open spaces that architects and designers can use with complete freedom. Partitions can be moved without compromising the structural integrity of the building.

1. Truss shapes have almost unlimited variety, thus allowing for distinctive roof shapes.

2. Many restaurant chains choose to expose their corporate identity in the roof design of their buildings.

3. Metal plate connected trusses are used to create arches of all types.

4. Wood trusses used in specialized applications such as agricultural and commercial buildings provide spans exceeding 25 m.

5. As a testament to their strength, wood trusses are used in concrete formwork, scaffolding and falsework for industrial projects.

6. The open web configuration of roof and floor trusses allows easy placement of plumbing, electrical, mechanical and sanitary services.

7. Vaulted ceilings are easily made: bottom chords of pitched trusses can be sloped, or parallel chord pitched trusses bearing on supports at different elevations can be used. Attic trusses are designed to provide living areas within the roof space.

8. Wood trusses are very versatile and compatible with other structural products. They can be connected to other trusses, or combined with other components, such as glulam and steel beams. In North America, wood roof trusses are commonly supported on concrete or masonry walls using simply installed connections to join the roof to the walls.

9. Hinged connector plates used with mono-pitch trusses allow modular homes to be assembled with conventional roof pitches, greatly enhancing their appearance.

1 *WTCA*

3 *WTCA*

2

4

8

8

6

9

5 *WTCA*

7

8

Performance

Since they were first introduced in the 1950's, metal plate connected wood trusses have demonstrated an excellent track record and are recognized in Building Codes throughout North America.

Roof Trusses

- Wood trusses eliminate on-site framing problems. Accurate fabrication and constant quality control assure trusses are uniform in size and shape and provide required structural integrity to a building.

- Wood trusses can be constructed and spaced to optimize lumber strength and conserve timber resources. For example smaller dimension lumber is used in the truss webs and the typical roof truss spacing of 600 mm on centre optimizes roof framing.

- When wood trusses are used as the principal framing members, constructing the roof or floor system is simplified. Wood sheathing can be easily attached to the top chord to provide the underlay for the roofing membrane or floor finish. Ceilings can be readily connected to the truss bottom chords and insulation is easily installed in the truss cavity.

Floor Trusses

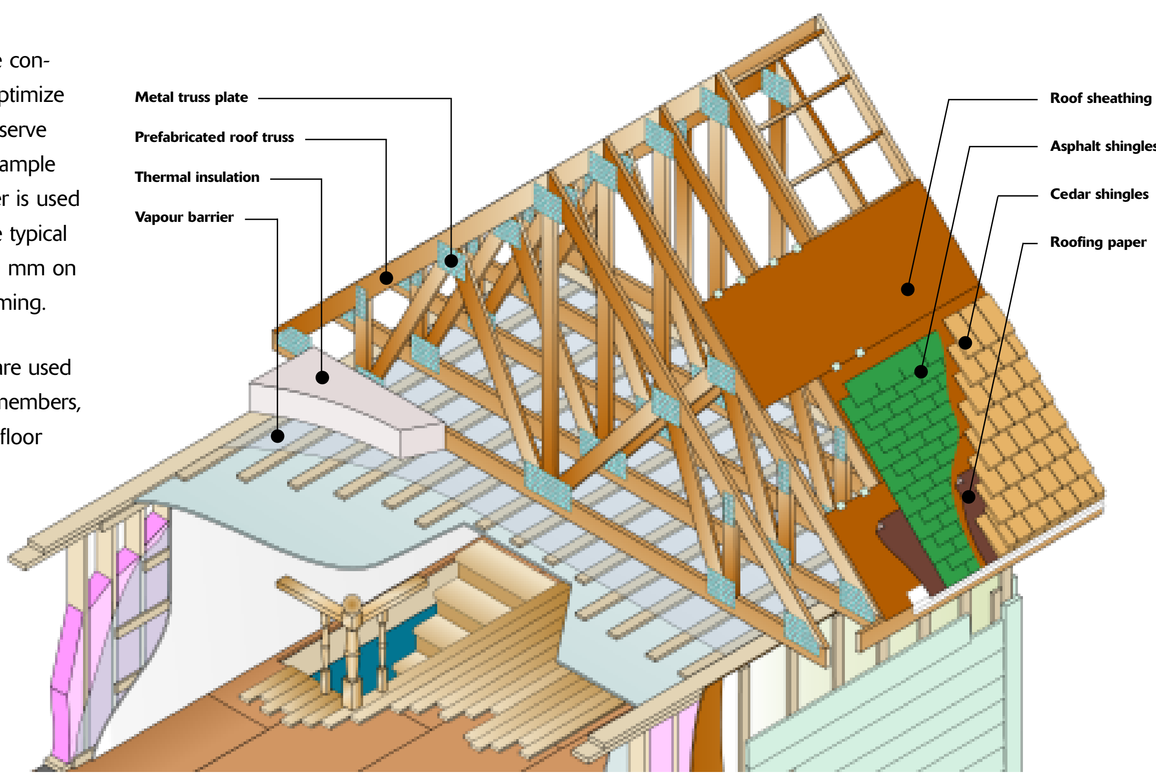
- Top chords of floor trusses provide a wide 89 mm surface for easier nailing and increased glue contact area with the sheathing material. This helps build a floor system that is stable and quiet for the life of the structure.

- Additional stiffness can be built into the floor truss and floor system to reduce floor vibration.

- Design requirements for fire safety in buildings are specified in the Building Codes. Fire-resistance ratings, based on standardized tests, are a measure of the fire resistance of roof and floor assemblies. Depending on sheathing, ceiling construction, and insulation, truss assemblies have achieved fire resistance ratings up to 2 hours.

Not all truss assemblies require a fire resistance rating. The building occupancy, the building size, number of exits and the use of sprinklers will determine what fire resistance rating is required.

- Floor truss assemblies can also be optimized to reduce sound transmission. In apartments, this limits noises from upper or lower units. For further information on fire and sound performance refer to "Fire Resistance and Sound Transmission in Wood-Frame Residential Buildings".



Source: Forintek Canada Corp. and Ministère des Ressources naturelles, de la Faune et des Parcs du Québec

Cost Effectiveness

Wood trusses are often more economical than steel or concrete in pitched or flat roof applications.

- Wood trusses arrive at the job site ready to install, reducing construction time significantly.

For example, framing a house with wood trusses is more than two times faster than with conventional wood framing. Trusses do not contribute to waste generated at the site and make cleanup less costly. Pilferage is also reduced because wood trusses generally cannot be used on other projects.

- In most cases, wood trusses can be installed without the use of heavy machinery. They are light in weight and can be easily handled and lifted into place.

- Wood trusses can be installed by local tradesmen. They require less carpentry labour and, in typical applications, often eliminate the need for iron workers, welders, riggers and other costly trades.

- Truss fabricators and plate manufacturers can provide guidance and technical support to designers or builders confronted with design or installation difficulties. This support helps reduce the time invested in completing a construction project.

Environmental Benefits

All construction has an impact on the environment. We can minimize the environmental burden associated with construction by choosing building assemblies that minimize energy use and emissions.

- Wood is the only renewable construction material. Framing with wood trusses minimizes the depletion of finite natural resources.

- Compared to other building materials, wood takes much less energy to process and minimizes air and water pollution.

- Wood trusses are energy efficient. They have excellent thermal properties, especially when compared with other framing materials such as steel. They create large cavities that are easy to insulate.

Canada Wood
Produits de bois canadien

For more information please contact our office at:

Canada Wood Head Office
Website: www.canadawood.info

Canada Wood Beijing
Suite 12B10, HanWei Plaza
No. 7 Guanghua Road
ChaoYang District
Beijing, China 100004
Tel: (86-10) 6561 1041
Fax: (86-10) 6561 1037

Canada Wood China
9G29 & 9G31, Shanghai Mart
2299 Yan An Road West
Shanghai 200336, China
Tel: (86-21) 6236-2516
Fax: (86-21) 6236-2536
E-mail: wood@cawoodsh.com

Canada Wood Europe
12A Place Stéphanie
B-1050 Brussels, Belgium
Tel: (32-2) 512 5051
Fax: (32-2) 502 5402
E-mail: info@canadawood.info

Canada Wood Japan
Tomoecho Annex-11 9F
3-8-27 Toranomon
Minato-ku
Tokyo 105-0001, Japan
Tel: (81-3) 5401-0531
Fax: (81-3) 5401-0538

Canada Wood UK
Suite 8, St-Albans House
40 Lynchford Road
Farnborough, United Kingdom
GU14 6EF
Tel: (44-1252) 522545
Fax: (44-1252) 522546
E-mail: office@canadawooduk.org

Publications in this series:

1. Moisture and Wood-Frame Buildings
2. Wood Trusses – Strength, Economy, Versatility
3. Fire Resistance and Sound Transmission in Wood-Frame Residential Buildings
4. Sustainability and Life Cycle Analysis for Residential Buildings
5. Thermal Performance of Light-Frame Assemblies

Canadian Wood Council
Conseil canadien du bois
www.cwc.ca

Forestry Innovation Investment Ltd.

Québec

A publication of the Canadian Wood Council. Funding support provided by Canada Wood partners: Canadian Plywood Association • Quebec Wood Export Bureau • SPF Group