THE GRIZZLY PAW BREWING COMPANY, CANMORE, CANADA*

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INTRODUCTION

The Grizzly Paw Brewery is located in Canmore, near Banff National Park in the Canadian Rocky Mountains. It is touted by its owners as the first brewpub in Canada and the second in North America to can its beers. Opened in 1996, by 2011, demand for its products had led to interest in a new, larger brewery on site. The owners also wanted to expand its appeal with the addition of space for future brewery tours and receptions.

Construction on the new Grizzly Paw Brewery began in 2012 and it was complete by January 2013. The new facility was developed by Russell and Russell Design Studios/Lloyd McLean Architects with the structural engineering expertise of ISL Engineering and Land Services. With a tight budget, the team were tasked with creating a functional, compact brewery that complemented its scenic location.

BUILDING DESCRIPTION

Contemporary and traditional architecture collide to create the new Grizzly Paw Brewery, a unique 1300 m^2 industrial facility that houses brewing, distilling and warehousing functions, and has additional space for an office, future tasting and touring areas. The facility is actually split into two buildings: the brewery (brewhouse, maturation floor, storage, packaging areas, tasting area and function room); and the distillery. The overall facility design incorporates a rhombus plan, as well as a firewall to separate the distillery from the larger building. The exterior timber frame is rod-braced and uses 90,000 bd. ft. (~210 m^3) of Douglas fir glulam timber and heavy timber. Glulam is fire resistant, light, durable and easy to customize. The serrated roof line allows for large windows that provide natural light inside the building and street views of the brewing.

Figure 1. Exterior at night, showing the interior structure and process (Photo: Steve Nagy Photography).

*Copies of engineering details presented in this paper are available from the journal publisher if enlarged versions are required.

This multiple gabled roof is wood decked with 29 mm fire retardant treated, tongue-and-groove plywood. The interior mezzanine floor was constructed of concrete–steel composite materials, elevating some of the process equipment and tanks 6 m above the main slab, while holding the heavy weight and providing a view through the high windows (Figure 2).

CONCEPT

The building frame was originally envisioned to be of steel (Figure 3), as that was expected to be the most cost -effective material for a light industrial building. However, cost estimates for the design came in higher than the budget. The cost of steel, combined with the rhombus layout of the building and the complicated

Figure 2. Interior steel mezzanine and process equipment (Photo: Steve Nagy Photography).

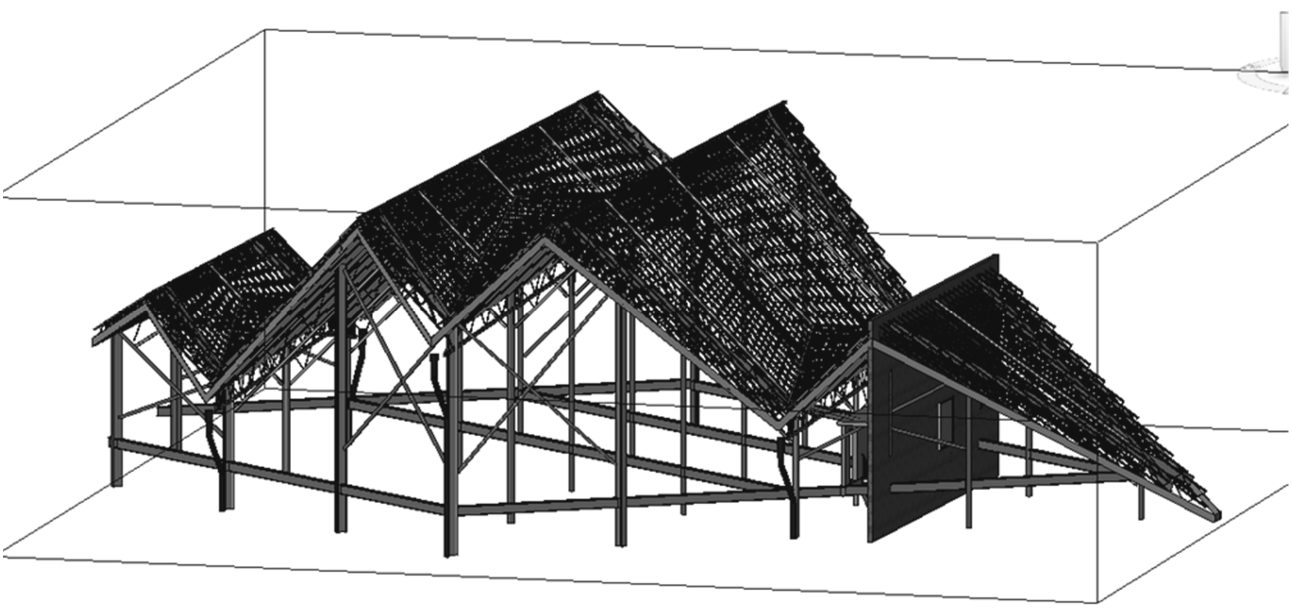

Figure 3. Original steel structure.

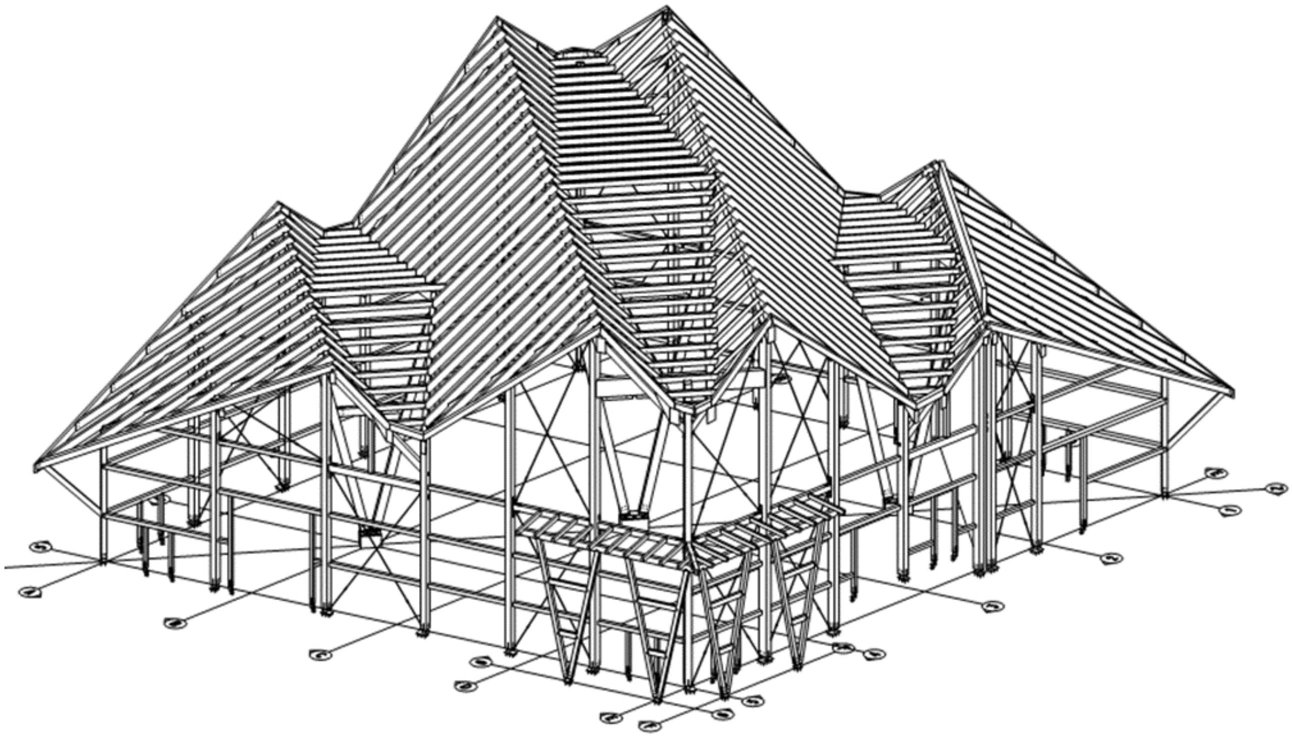

Figure 4. Revised timber structure (2011 Canadian Timber Frames Limited).

geometry of the serrated roof line made it costly to manufacture in conventional open web steel joists and wide flange steel sections. The complicated roof structure is probably the main reason why timber beat out the original pre-engineered steel trusses and steel superstructure in price. In contrast, modern timber software and manufacturing processes make it possible to visualise, design and ultimately fabricate complex shapes in timber.

After the steel budget numbers came in, an alternative conceptual design was proposed to bring the project in on-budget: exposed heavy timber construction (Figure 4). Preliminary sizing and ball park estimates for this alternative looked promising. Timber specialists were brought in for the work, including the heavy timber structural engineering expertise of ISL Engineering and Land Services (then Cascade Engineering).

The greatest contributor to cost in the new design was the volume of lumber. The timber manufacturer, Canadian Timberframes Limited, used Building Information Modelling (BIM) to create a 3D model showing member sizes and connection arrangements. This 3D modelling helped the team calculate costs and assess the cost of changes to the design. The model was used from concept redesign through to fabrication. It contributed to shop drawings, helped the team visualise how the framing fit together to avoid conflicts, and was used to control the Computer Numerical Control (CNC) machinery that fabricated the timber components. Both the labour cost and the cost of fabricating complicated designs were significantly reduced by using this computer-controlled modelling, design and fabrication.

In terms of other software used, the structural engineering team used RISA-3D software for structural analysis. WoodWorks® software was used for member design and connection capacities. The structural drawings were completed in REVIT, while the timber modelling and CNC interfacing was completed in cadwork (3D software for timber construction).

CONNECTIONS

The structural engineering design team and the timber manufacturer collaborated on the design concepts for the heavy timber connections. The concepts for almost all of these connections were worked out in a couple of hours through an in-person meeting using a live model, with sketch pads and calculators in-hand. This design charrette considered the following connection types:

- oak pegged mortise and tenon (Figure 5)
- milled wood dovetails (Figure 6)
- standard birdsmouth notches (Figure 7)
- housings (Figure 8)
- steel shear keys (Figure 9)
- embedded threaded tension rod connections (Figure 10)

- conventional bolted and pinned connections (Figure 11)
- custom fabricated steel brackets (Figure 12)
- European self-tapping timber screws (Figure 13)
- highly engineered milled aluminum dovetail connectors (Figure 14)
- field welded base plate connectors which allowed for adjustment after survey of cast-in weld plates (Figure 15)

Each connection was reviewed for structural capacity, constructability and design appearance in its location. By considering a range of connection types, the integrated design and construction team was able to determine the right connection for the right application, rather than the "one size fits all" approach often employed by engineers. We believe that this approach leads to optimal timber solutions (simple connections where simple makes sense, complex connections only when needed), and ultimately limits the number of custom steel fabrications required and makes the design faster to install.

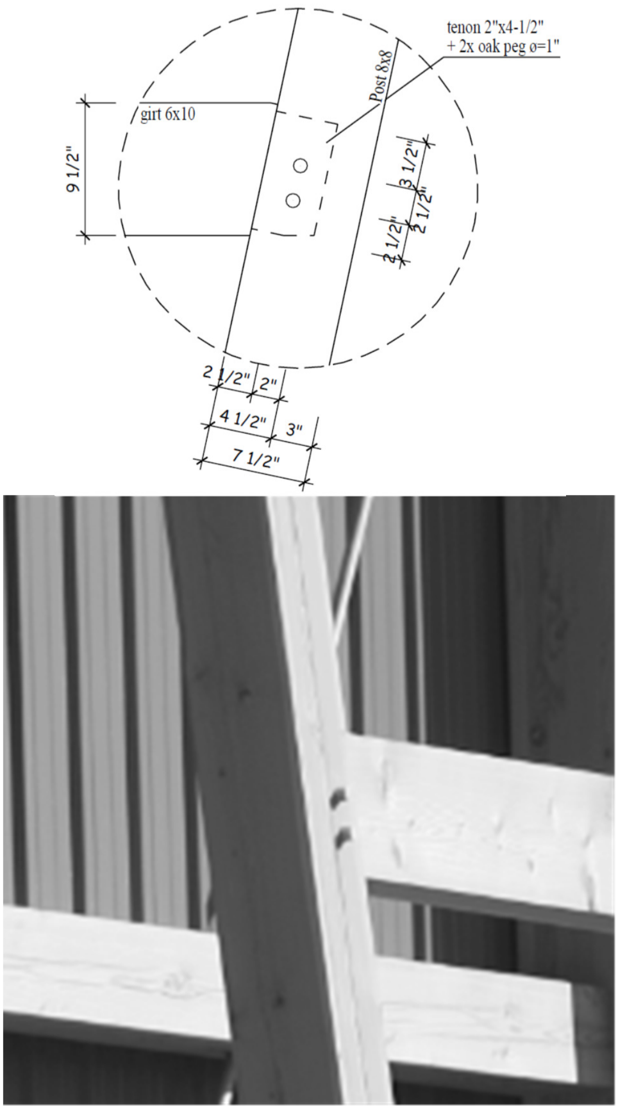

Figure 5. Oak pegged mortise and tenon connection. (Source: 2011 Canadian Timber Frames Limited)

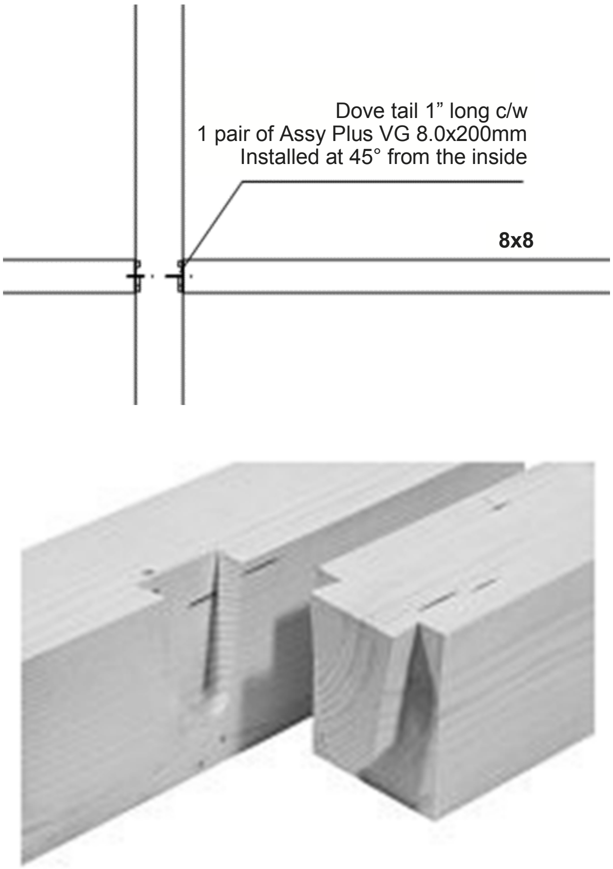

Figure 6. Milled wood dovetails. (Source: 2011 Canadian Timber Frames Limited)

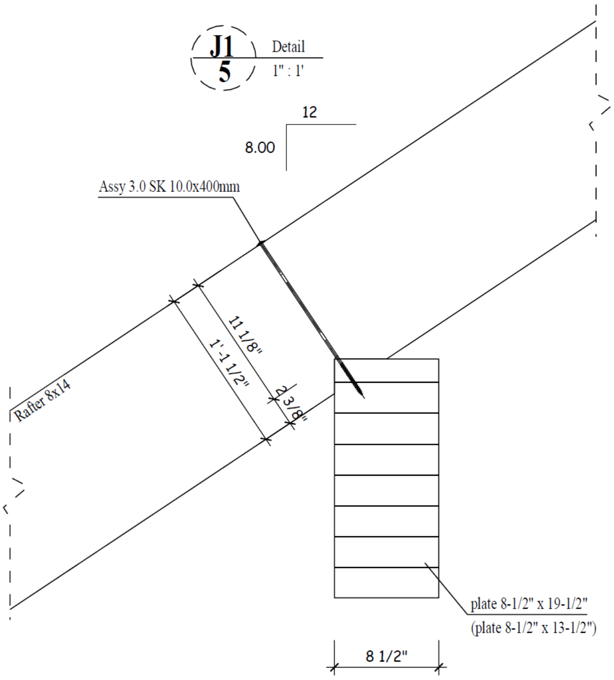

Figure 7. Standard birdsmouth notches. (Source: 2011 Canadian Timber Frames Limited)

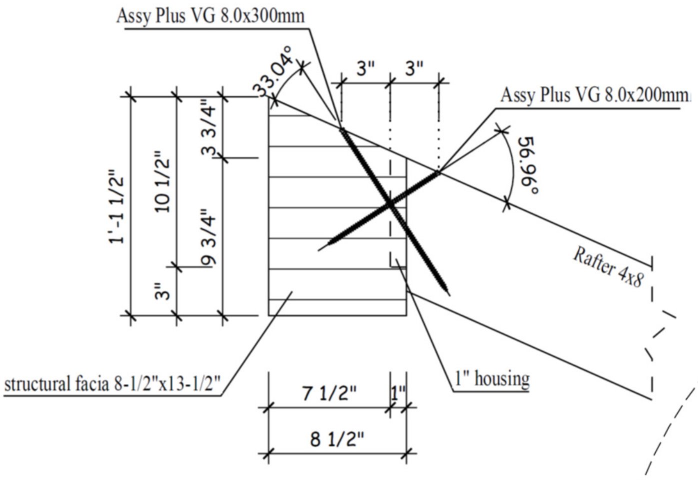

Figure 8. Housings (Source: 2011 Canadian Timber Frames Limited).

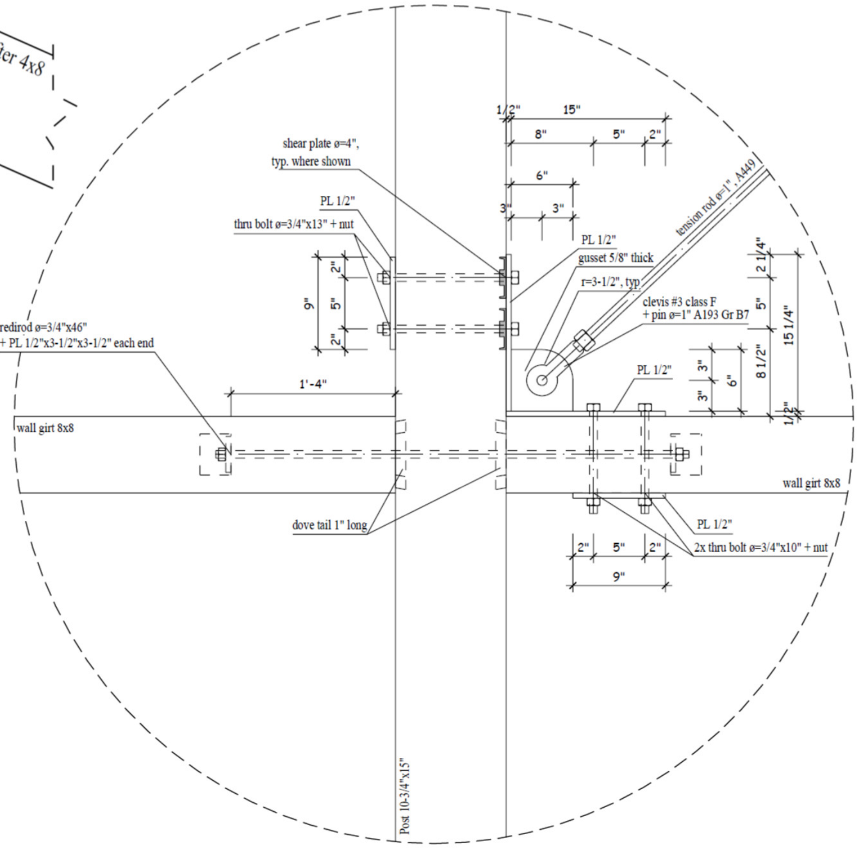

Figure 10. Embedded threaded tension rod connections (Source: 2011 Canadian Timber Frames Limited).

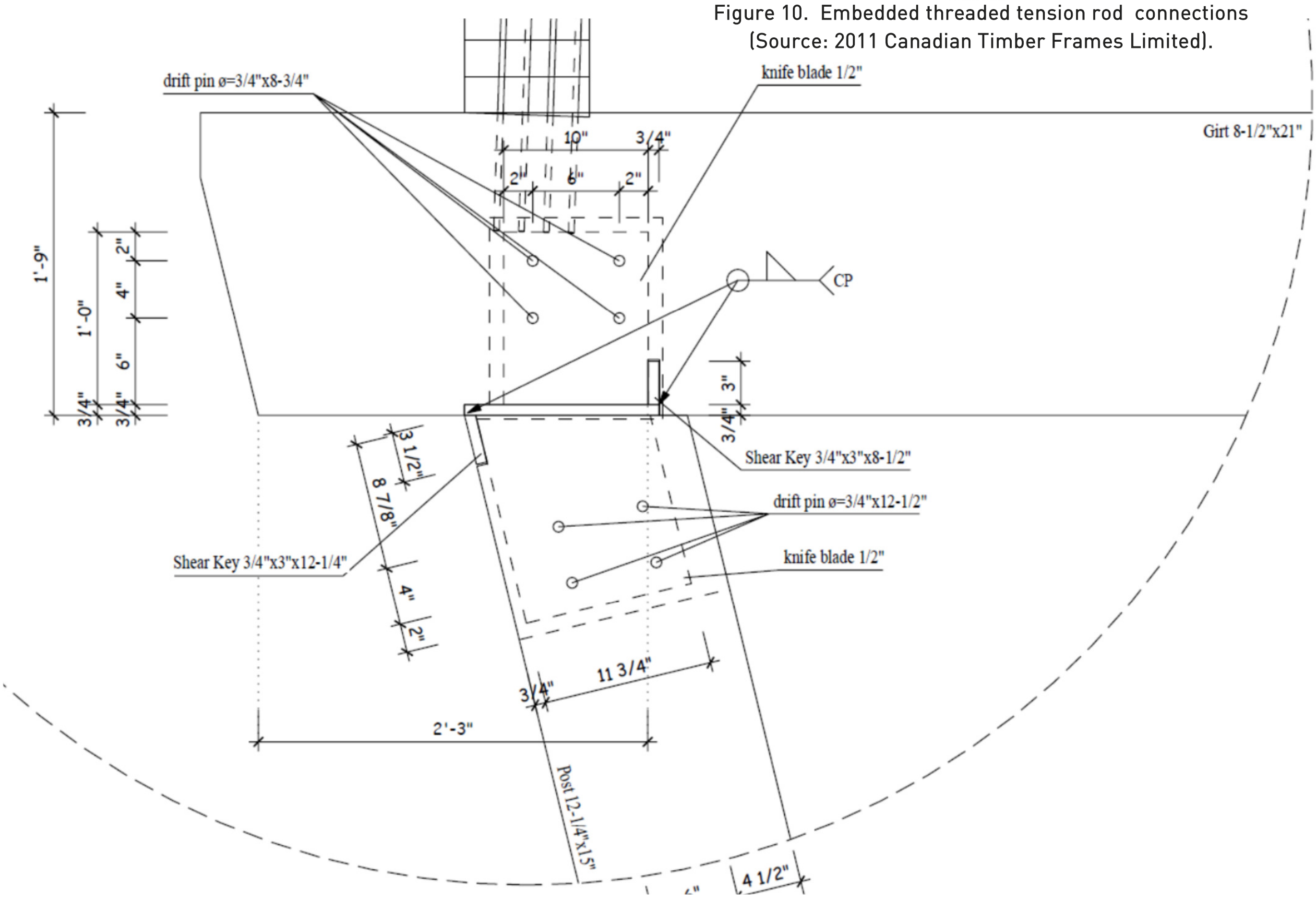

Figure 9. Steel shear keys (Source: 2011 Canadian Timber Frames Limited).

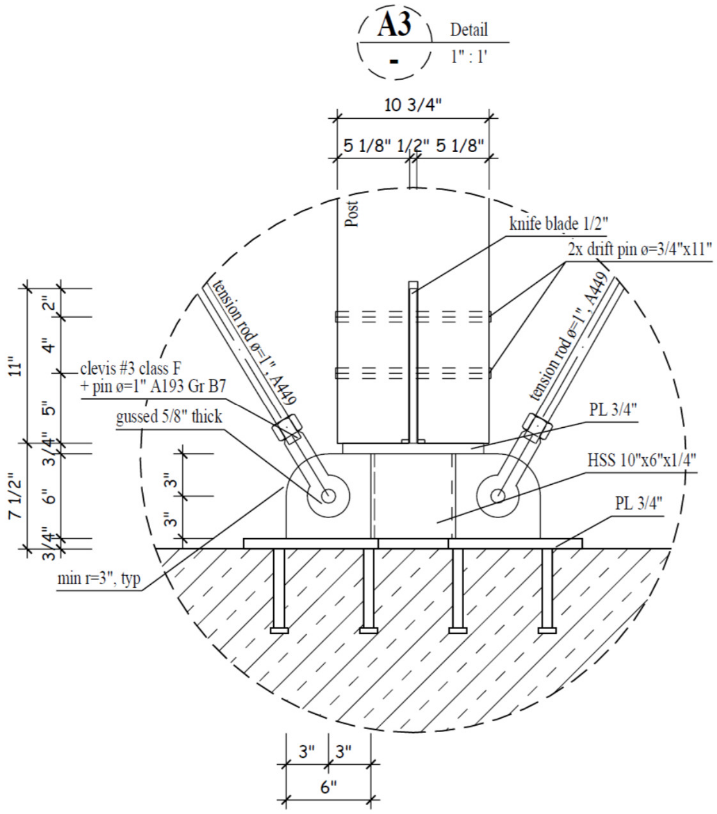

Figure 11. Conventional bolted and pinned connections (Source: 2011 Canadian Timber Frames Limited).

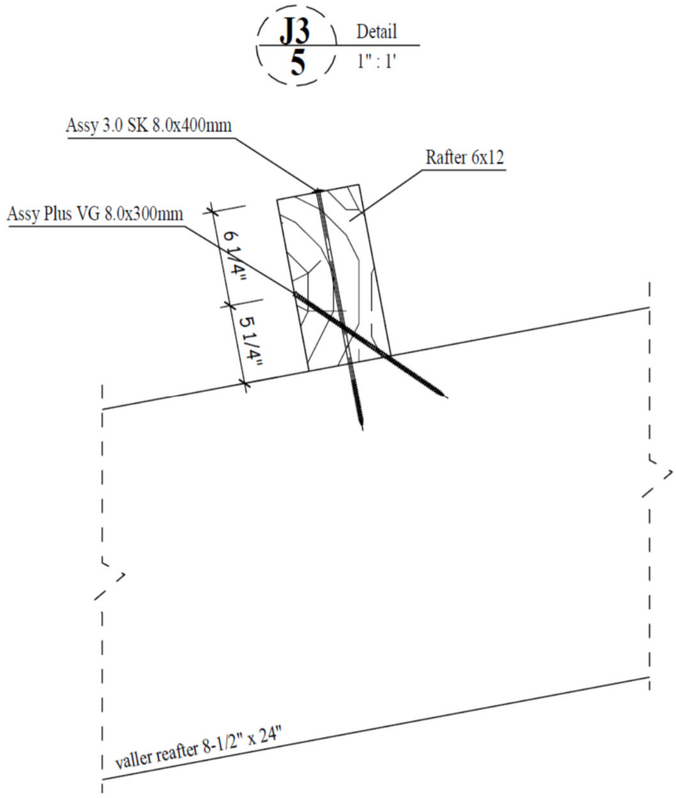

Figure 13. European self-tapping timber screws (Source: 2011 Canadian Timber Frames Limited).

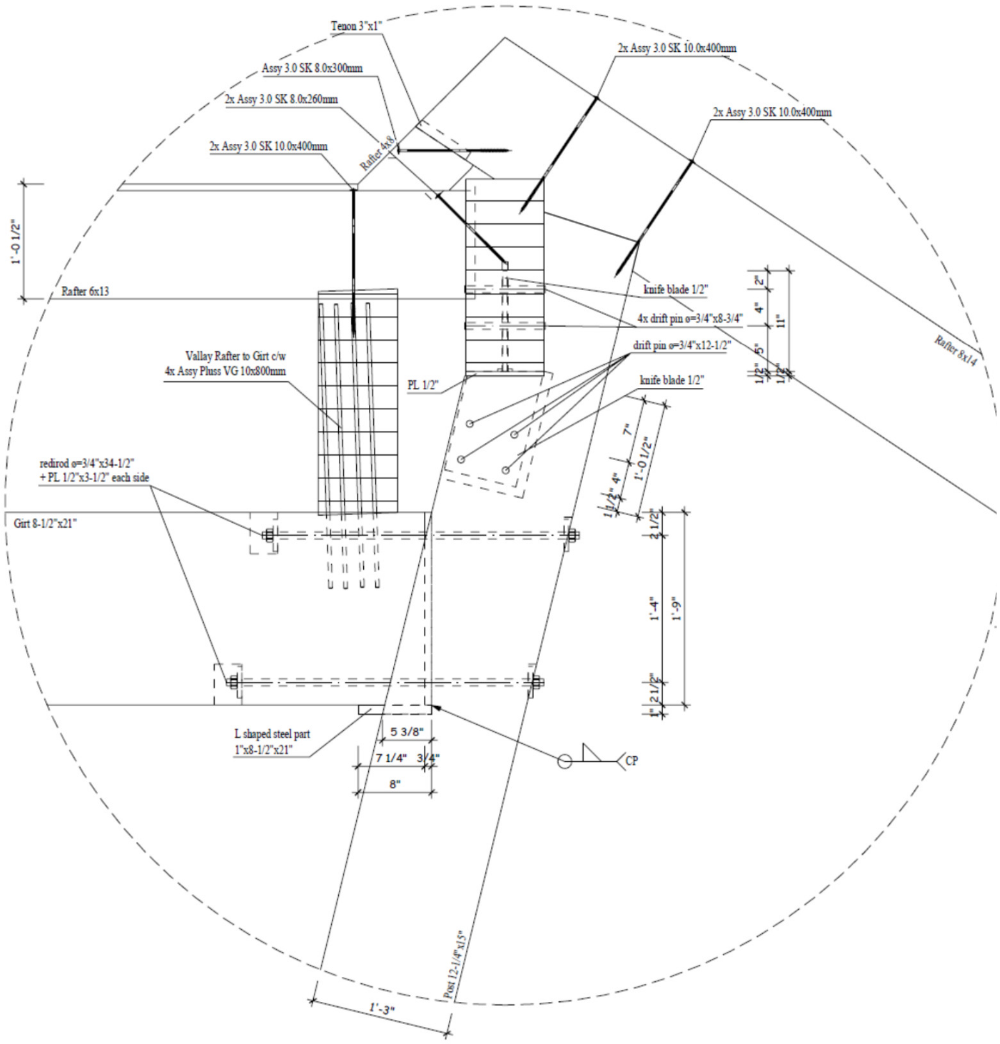

Figure 12. Custom fabricated steel brackets (Source: 2011 Canadian Timber Frames Limited).

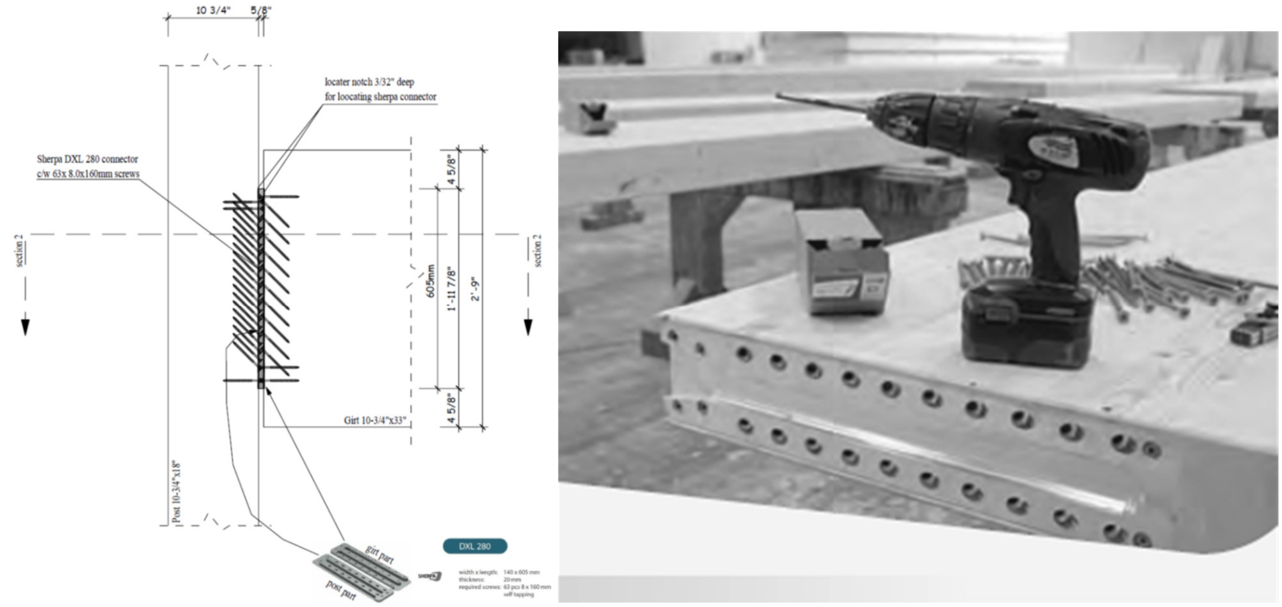

Figure 14. Highly engineered milled aluminum dovetail connectors (Source: 2011 Canadian Timber Frames Limited).

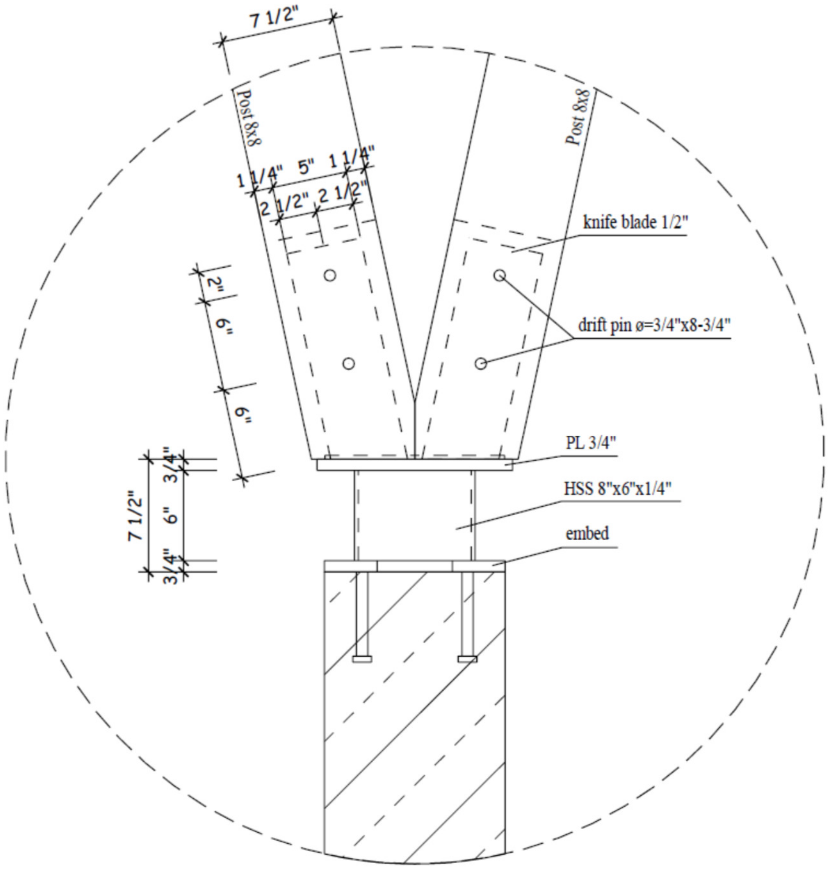

Figure 15. Field welded base plate connectors which allowed for adjustment after survey of cast-in weld plates (Source: 2011 Canadian Timber Frames Limited).

ROOF

A combination of glulam timber and solid sawn timber was used to save material costs, according to the availability of section sizes and lengths. Larger section, long-span beams and tall columns were specified to be of Douglas-fir glulam timber, while smaller sections - the wind girts, rafters and drag struts - were to be constructed of heavy, solid sawn timber, which was readily available in the neighbouring province of British Columbia.

Supported by wood beams and purlins, the roof includes the following components:

- roof tiles made of recycled rubber with a slate appearance
- peel-and-stick membrane
- 11 mm OSB sheathing
- air space with 38 x 140 mm wood strapping and counter-strapping

- ISO board insulation
- 29 mm fire retardant treated, tongue-and-groove plywood
- heavy-timber structure

The timber was protected from the elements in a number of ways. Timber on the exterior of the building envelope comprises most of the timber usage, and this is protected by wide overhangs. Details were incorporated in the timber design to prevent water from collecting and causing damage, and the connectors were galvanized. The infill panels are steel stud frame walls with a painted metal skin and insulated with spray foam. The interior timberwork started on concrete pedestals to keep it well above the floor as the floor is sprayed in the cleaning process for the brewery.

FIRE SAFETY

The Grizzly Paw Brewery was designed as two separate buildings in accordance with the province's building code (Alberta Building Code). The brewery building is classified as Medium Hazard Industrial. The smaller building, housing the distillery, is classified as High Hazard Industrial occupancy and is separated from the main brewery building with a core-filled, concrete block wall, which acts as a 4-hour firewall.

Equipment access for fire-fighting is provided on two sides. Automatic fire sprinklers were not needed for the size of the building area and number of storeys. The total building floor area (developed) for the Brewery is 1,295.5 m^2 , with the breakdown as follows:

- Main level - 693.5 m^2
- Middle level (undeveloped) - 432 m^2
- Upper level - 170 m^2

For the Distillery (single-storey, undeveloped), the floor area is 50 m^2.

Most of the structure is constructed of timber. Some timber members were slightly increased in size so that they would qualify as heavy timber construction and provide a charring layer for the fire performance requirements. The size increase allowed them to meet the Fire Code requirements for combustible construction with a 45-minute fire rating.

The timber roof deck uses a thicker 29 mm tongue-and-groove plywood that was specially ordered to meet the required 45-minute fire resistance rating. Thus, this plywood construction meets the minimum requirements for heavy timber construction. Where structural steel was used to support the heaviest process equipment, the required 45-minute fire resistance rating was achieved with a cementitious layer applied by spray.

LOADING

The plywood for the timber roof deck spanned the 1.2 m rafter spacing, and with special valley and ridge fastening was designed to be a large flexible diaphragm delivering the loads to the perimeter walls and rod tension-braced frames. The building needed to withstand the gravity loading of mountain snow with considerable valley drifting accumulations as well as a large tank loading for the brewing tanks on the upper level. Lateral load design was primarily governed by wind, but the large dead load of the tanks and the concrete topping on the upper level brought seismic loading into some governing load combinations. Where there were very high loads, structural steel was used. For example, structural steel was used to support some of the heaviest process equipment on the brewery floor.

SUMMARY

Rather than the "one size fits all" approach often employed by engineers, the collaboration between structural engineer and timber manufacturer enabled the right connection to be selected for the right application. This limited the number of custom steel fabrications required and ultimately made the design faster to install and economically feasible. While the steel fabricators had found the roofline too complicated to be cost effective, the timber manufacturer's experience and computer-controlled shaping equipment made it not only possible but also economical. Computer -controlled modelling, design and fabrication reduced costs for labour and for fabricating complicated designs. Timber was a better fit for implementing the design, suited the mountain architectural style of the town, and provided the brewery with an attractive feature during public tours.

As construction wrapped up in January 2013, even the builder noted, "The building was a positive experience. There were no surprises. The wood construction was 10% more economical than the steel options priced. The assembly of the pre-manufactured members and connections went smoothly. In those rare cases where small adjustments were required on site, they were easy to do. The project could have been completed ahead of schedule but there was a delay in acquiring some of the brewing equipment. (Source: Canadian Wood Council/ Wood WORKS 2013.)

The new Grizzly Paw Brewery opened to production in April 2013 and started running tours in July of that year. The building is functional, compact and compliments its scenic location.

The author would like to acknowledge the Grizzly Paw Brewery case study by Canadian Wood Council / Wood WORKS! ALBERTA (2013), which informed this article.