Shane Homes YMCA Rocky Ridge, Canada & other Projects of Interest

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Figure 1**:** Rocky Ridge Recreation Facility in the Sunset – Image GEC.

1. Introduction

The Shane Homes YMCA Rocky Ridge Recreational Facility (RRRF) project is the result of beautiful architectural design, engineering ingenuity, in-depth project management and unsurpassed team collaboration.

RRRF is the largest freeform timber roof structure in North America, and encloses over 26,300 m^2 of active floor space. The project was erected throughout the winter months of Calgary, Alberta and into the spring. Overall the project came in on time and on budget, further going on to win several international awards.

The success of this project not only represents full integration of complex BIM systems throughout the entire trade scope, but also the success of free form mass timber structures compared to traditional building alternatives (concrete/steel) within a North American context.

1.1. Project Team

The project team on RRRF was extensive and the deployment model used to ensure success was innovative for a project of this scale. The City of Calgary had chose the primary consultants as GEC Architecture and RJC structural consultants. To deliver success on a project of this magnitude, the City of Calgary then engaged Structurlam Mass Timber Corporation as a team member prior to determining the general contractor for the project. Structurlam provided design supply services on the project and brought on ISL Engineering for specialty engineering design services. PCL Construction was brought on as the Project Manager/ General Contractor to coordinate and ensure proper installation of all components. PCL awarded the structural steel contract to Glenmore fabricators who installed steel and the Mass Timber glulam roof system. Glenmore hired a specialty timber installation group, HomeTec, to assist in their installation process.

City of Calgary	– Client
GEC Architecture	– Architect
RJC Engineers	– Primary Structural Engineering
PCL	– General Contractor
Structurlam Mass Timber Corporation	– Mass Timber Design Supplier
ISL	– Mass Timber Specialty Engineering

2. Architecture

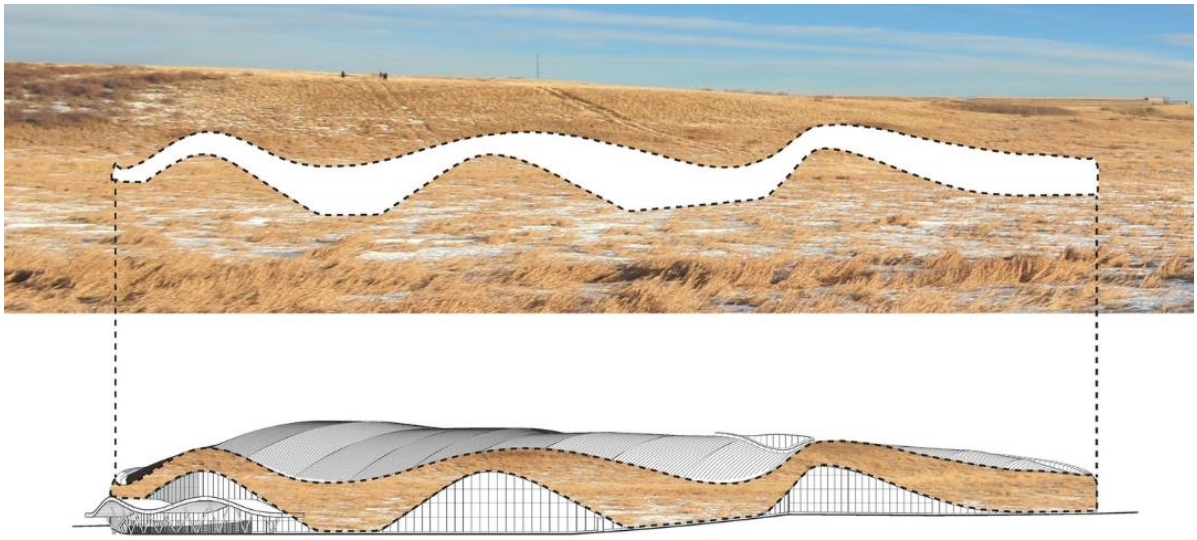

Figure 2: Architectural Inspiration – Image GEC.

"Nestled in the rolling hills of the northwest corner of Calgary, the Shane Homes YMCA at Rocky Ridge is a regional hub of physical activity and a multipurpose gathering space for the community. The aim of this facility is to provide the northwest edge of Calgary with essential health and wellness services. It will provide a place for gathering, for diverse community and arts programs, for health and wellness opportunities, and child care services.

All program elements of this building are set beneath a curved, undulating glued laminated timber roof structure that links the spaces together and responds to their individual height requirements. The ribbon-like form of the façade creates large curving expanses of glulam-supported high performance glazing, accommodating key views from within the facility while selectively revealing the activity within to passersby. The glulam glazing supports provide warmth to the interior material palette while their depth and placement reduces glare from low evening sun.

The Shane Homes YMCA at Rocky Ridge has been designed to be an open and active facility, integrated into the regional landscape. Targeting LEED Gold, the facility is taking steps to ensure the greenfield site is carefully enhanced, while continuing to function as habitat for existing wildlife." (GEC Architecture, 2018)

The initial project went through various form finding design considerations. A freeform roof that mirrored the landscape around RRRF was desired, but it was initially unclear what cost impacts this would have on a project of this scale and what structural systems should be delivered to provide this outcome.

A glulam girder and purlin system was quickly identified for its ability to achieve these freeform shapes and do so in a pre-fabricated and cost effective manner.

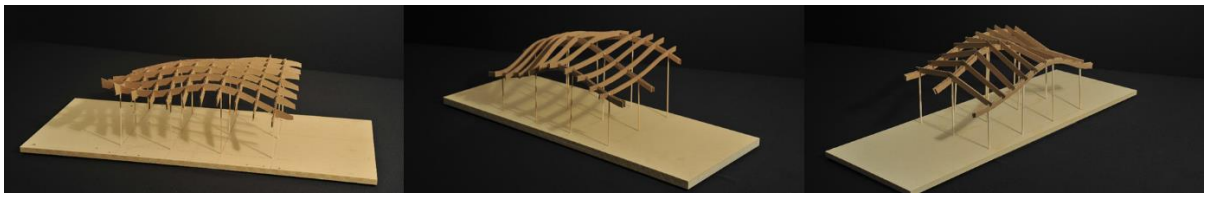

Figure 3: Initial Roof Concepts - Image GEC

To keep costs under control and to ensure fabrication timelines could be met Structurlam worked with GEC and RJC to determine an optimized curved primary beam production system. This involved using one consistent Glulam arch layout and moving sections of the beam in and out along this primary jig line. This movement of location along with a complex surface bevel allowed the roof to follow a freeform shape while working within a cost effective manufacturing boundary. Rhino and grasshopper were used to help develop the top side of rood geometry faces, which was re-informed by CNC practical tool paths to meet final design constraints.

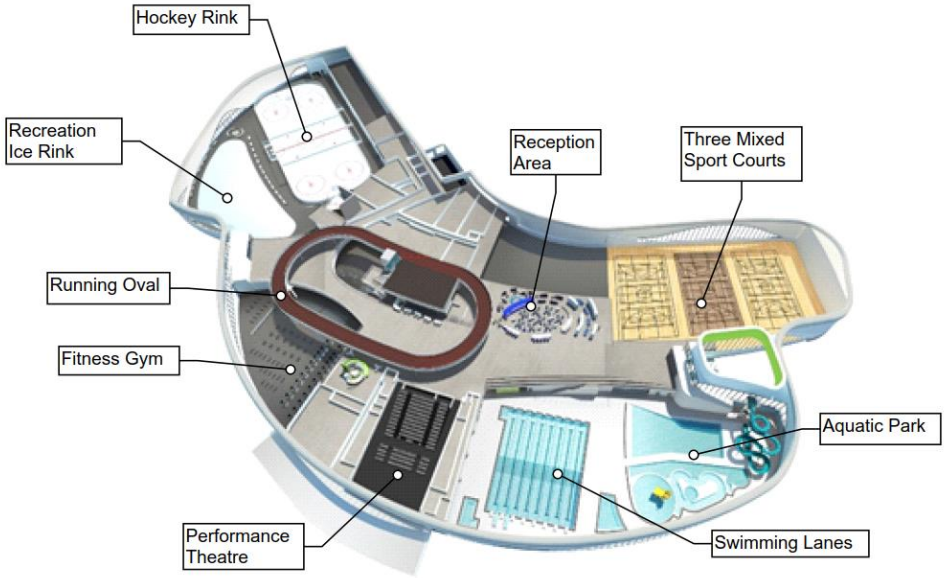

Figure 4: Project Model Overview – Image GEC

Figure 5**:** Interior Over Aquatic Centre – Image GEC

3. Engineering

The structural system works similar to a large tent structure with a roller coaster brace frame around the perimeter. The freeform glulam roof uses a similar arch layout throughout but adjusted on different angles and locations allowing a rolling, freeform roof system to be achieved. Snow drift loads throughout the structure were calculated to ensure adequate performance. Along the perimeter of the building around the parapet this resulted in extremely high loading conditions taking into account potential snow releases. High capacity connections were required along these unique geometry locations resulting in the need for precision coordinated BIM and fabrication delivery systems from all team members.

Figure 6: Glulam Roof System and Connections to Rollar Coaster Truss

One of the key components to successful project deployment by Structurlam was the splicing of primary glulam beams. A single beam line across the width of the building was up to 80 m in length. These beam lines ran with two primary structural glulams side by side sitting on steel support posts and brace frames. Beams of this length unfortunately could not be trucked through mountain passes of the Canadian Rockies from Penticton, BC (Structurlam's Manufacturing location) to Calgary, AB. To overcome this Structurlam brought ISL Engineering on as a speciality engineering group and developed large moment splice connections at mid span of glulam beams. The splice connection ranged from 2-4 m in length and were able to reduce the lengths of glulam beams to a maximum of 27 m. These new sizes were much more manageable logistically and also provided substantial cost savings. The location of the splices was optimized to minimize moment design forces within the glulam in conjunction with shipping and fabrication logistics. Ultimately this resulted in a total cost optimization with a final net savings to the client. Each moment connection was individually optimized for screw placement and local forces making design development work a lengthy process. Engineering design and fabrication matrices were used to mitigate complex design processes.

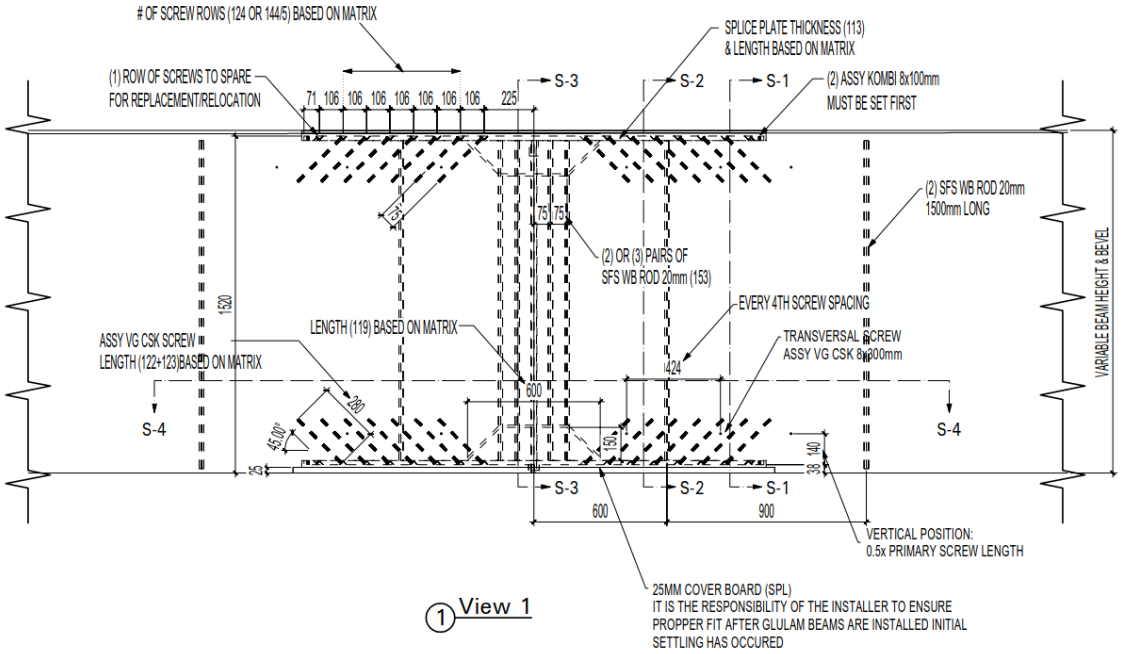

Figure 7**:** Glulam Moment Connection

Paired with the glulam splicing system Structurlam also deployed the use of pre-engineered primary beam to purlin connections. These connections took shape in the form of Knapp Ricons. Based on loading a variety of screw patterns, different Ricon sizes were used in each connection location. The combination of precision alignment and minimal tolerance allowance in each connection made these systems ideal for this project. The use of pre-engineered connections significantly shorted supply lines and made quality assurance easier to achieve. Custom steel connections, which are the norm for North America, would be fraught it individual weld callouts, tolerance issues and variety of unique connection situations. Being able to use a library of pre-engineered connection systems greatly simplified the deployment of this project and reduced overall supply chain risk in delivery.

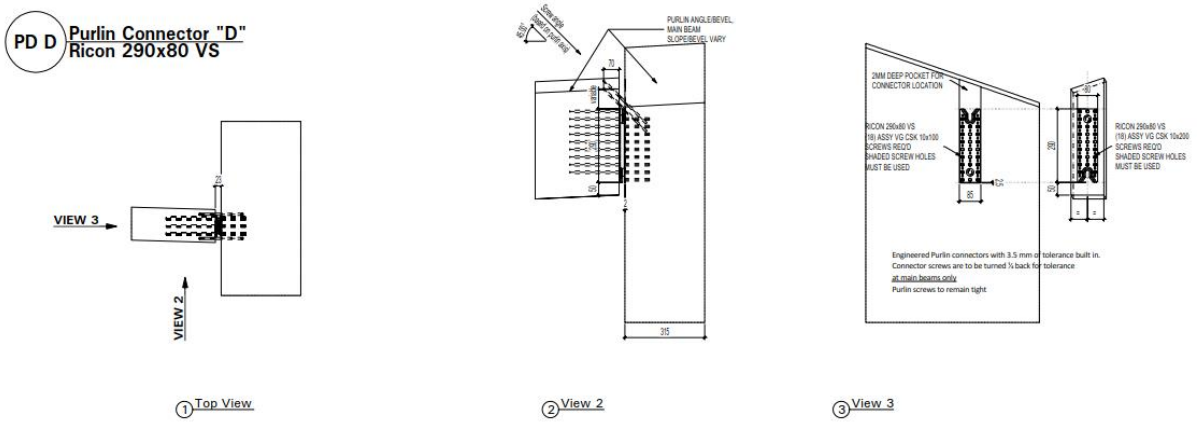

Figure 8: Ricon Purlin Connection

Many concerns were generated over the tolerance of the Ricon connections from gridline to gridline as they connected to a 315 mm wide beam on each end. Season shrinkage was expected in the glulam width over installation and conditioning periods of the building throughout the seasons. Initial designs used for allowed for tolerance bays to be site measured and cut as required, however as installation progressed the dimensional stability of the wood as well as fabrication tolerances were tight enough that clean installation of prefabricated purlins with Ricons preinstalled on each end was not an issue. As an end result, all but one of these tolerance bays were eliminated from the design resulting in

one of the largest freeform roof structures in the world that primarily uses pre-engineered connections. Cumulative tolerance did not end up being a high priority issue.
A tension strap system was also deployed above purlin connections allowing continuous force flow transfer throughout the roof system. Modelling placement size and screw conflicts of these systems would not have been possible without the BIM modelling system used.

Multiple types and sizes of self-tapping screws and fully threaded rods were used to reinforce glulam connections in several conditions. The clean form, shape and smooth installation of this project would not have been possible without the use of these modern timber connection systems. These connections truly resulted in the success of the overall structure.

4. BIM Modelling

Building Information Modelling (BIM) was mandatory on this project and all subcontractors were required to sign up to this process to be a member of the team. BIM 360 was used as a platform for collaboration, this was lead and organized by PCL. Structurlam used CadWork as a primary production software and was able to export .IFC files for upload and incorporation with files to BIM 360. Weekly clash and coordination meetings were held to ensure that MEP systems were routed correctly. More importantly the steel and glulam systems intertwined in a functional manner. These meetings resulted in online Requests for Information (RFIs) being issued directly in the BIM 360 work environment, which is not typical for construction teams. More serious RFIs were issued via conventional communication channels.

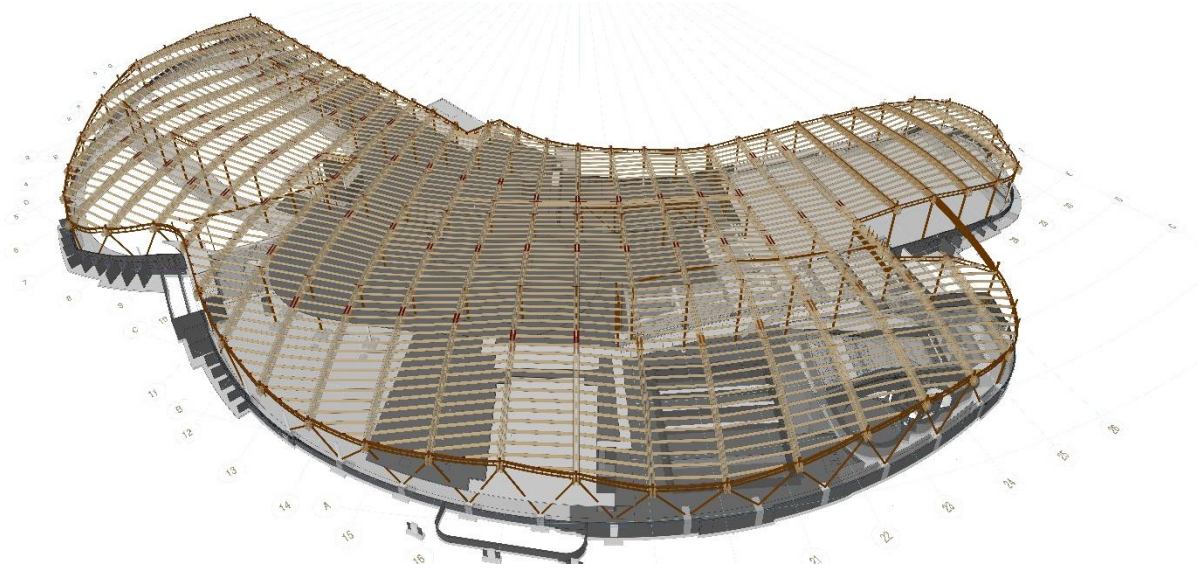

Figure 9: CadWork BIM Model

Structural coordination involved all bolt holes being pre-machined on CNC in Structurlam's facility for final field installation by Glenmore fabricators. The freeform nature of the glulam combined with the roller coaster steel truss around the perimeter made dissimilar connection tolerances difficult to work with. The wood system was +/- 2 mm, while the steel was closer to +/- 6 mm. Compromises had to be made to help ensure structural steel connections would work in conjunction with glulam hole coordination. A mock-up was constructed of one parapet edge condition during which it was determined that steel install and accuracy was a more difficult problem to manage than the mass timber glulam components.

This was the first global project coordinated in BIM 360 between this number of trades on a scale of this size. The BIM deployment method proved to be extremely successful and is slowly becoming an industry standard on projects of this typology. Design work in North America is typically conducted in a shorter timeframe than European counterparts may encounter. This results in many incomplete sets of information that need to be resolved

by multiple team members and coordinated in time for final construction. The use of products like BIM 360 enable a collaborative design system where problems across different stakeholder's scopes can be solved in real time.

5. Fabrication

Primary glulam beams, glulam purlins and steel connections were prefabricated in Structurlam's production facilities. Glulam fibre was composed of Douglas Fir sourced from British Columbia's interior forests. This strong and beautiful fibre was used to build splitlam glulam beams sized at 315 mm wide by 1500 – 1800 mm deep. Components were processed on a variety of CNC machines as required including an overhead Creno gantry machine, a Hundegger K2 and Hundegger PBA.

The project consisted of roughly 160 primary beams and nearly 2000 purlins, due to the freeform nature of the design every single piece in the project was unique based on the fabrication geometry. This meant that a larger portion of the fabrication process was based around logistics and sequencing of materials. Primary glulam members were manufactured months in advance and stored to ensure production schedules would be met.

Single primary glulam members weighed up to 8,000 kg with 14 m^3 of D.fir Glulam in one beam. The shop drawing in Figure 10 shows the number of framing details included on each piece. This amount of framing required detailed quality control procedures to ensure that no detail was missed prior to shipping to site. All holes for connections were drilled and Ricons pre-mounted to beam placement locations.

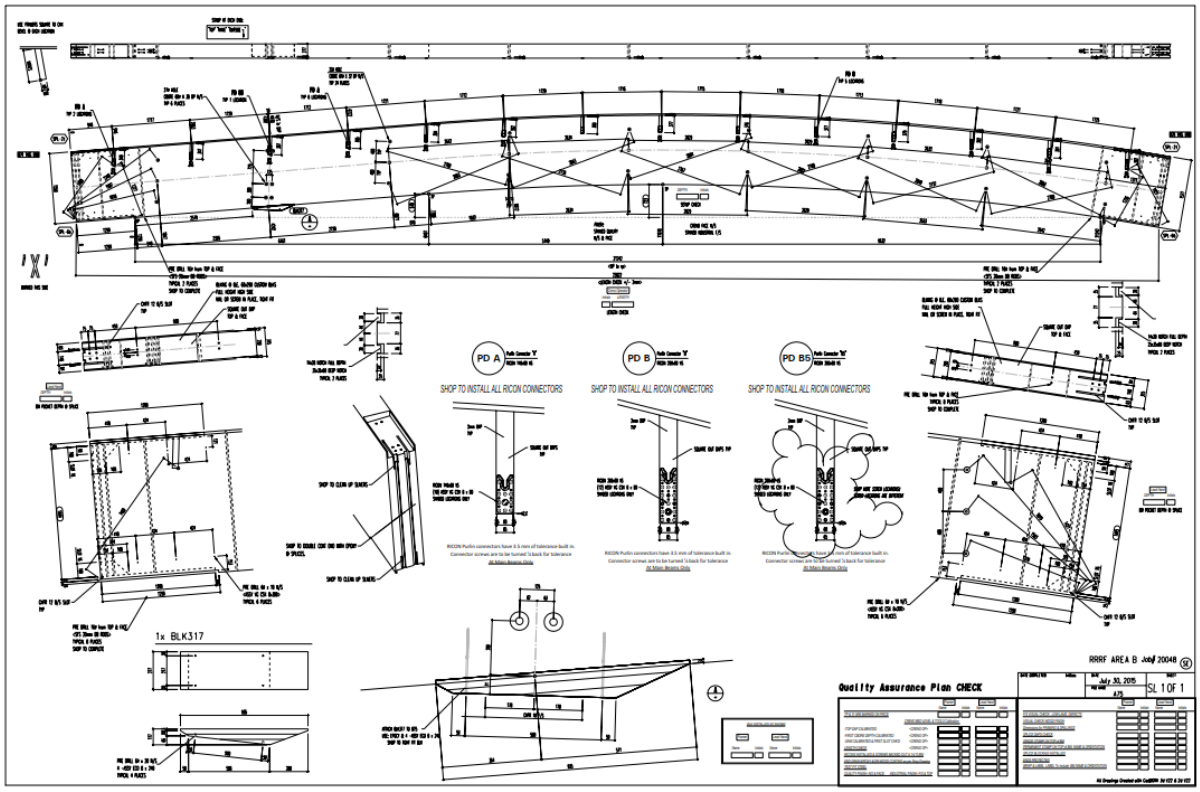

Figure 10: Primary Beam Shop Drawing

Reinforcing rods along glulam splice connections proved difficult to install in sections of less than 200 mm in width and over 1700 mm in depth. The rods would find and follow softer patches of wood. Specialty drilling equipment had to be procured and modified to help ensure reliance on straight install of these reinforcement rods.

6. Conclusion

The Shane Holmes YMCA Rocky Ridge Recreation Facility is a one of a kind project that demonstrates the success of prefabrication, BIM modelling and Mass Timber production systems. The early involvement of a Mass Timber supplier as a design member allowed the project to be driven to success in terms of schedule, engineering and fabrication techniques. A combination of innovative moment splice connections and pre-engineered purlin to glulam connections allowed this project to come in on-time and on-budget. We success stories like this we have already seen an increase in similar mass timber projects move forward in development stages.

Figure 11: Construction Overview – Image PCL

7. Other Projects

Please view Nicholas's presentation to learn about other projects of interest by Structurlam including:

- First tech Credit Union – The Largest CLT structure in North America
- Carbon 12 – The Tallest Hybrid Mass Timber in the United States
- Brock Commons – The Tallest Hybrid Mass Timber building in North America
- East 6th Street – The Largest Steel frame, CLT floor plate building in the world
- Mountain View Campus – The Largest Concrete Composite CLT office in the world