CESM SOCCER CENTER IN MONTREAL – TIMBER ENGINEERING CASE STUDY

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ABSTRACT: A new soccer center is being constructed in Montreal. Completion is due in December 2014. The flat roof of the building, spanning 68.5 meters is constructed with an innovative glue-laminated structure. This paper outlines the structural systems used for the main box-girder beams and the transportation joint connections developed. It also provides a brief description of the fabrication process and erection procedure.

KEYWORDS: CLT, glue laminated wood, box-girders, transportation joints, long span beams

1 INTRODUCTION

The CESM soccer center is a new sports complex located in the Villeray, Saint-Michel, Parc-Extension borough in the heart of Montreal, Quebec. It houses a standard size soccer pitch, seating for 750 spectators, training facilities, public spaces, offices and changing rooms. The building is 110 m long, 78 m wide, 18 m high and is constituted of a wood-steel-concrete hybrid structure. The flat roof, spanning 68.5 m over the playing field, is constructed of a glue-laminated wood structure, supported by steel columns. The other sectors of the building are constructed of a traditional steel and concrete structure.

This unique building concept was developed by the architectural firms Saucier+Perrotte and Hughes Condon Marler, winners of an architectural design contest, organized by the city of Montreal. The structural engineering firm of reference on the project is NCK inc. They are responsible for the overall design of the building; however, the wood structure was tendered out as a design-build project, to be integrated into the structural and architectural concept. Nordic, a glue-laminated manufacturer, supported by SNC-Lavalin for the engineering and FGP construction for the erection, was selected for the contract.

Figure 1: Architectural render of the final building [1]

The overall cost of the project is 39.4M$, with the wood structure representing 8.3M$. The construction started in June 2013 and is expected to be completed by December 2014. The general contractor responsible for the construction is TEQ.

2 WOOD STRUCTURE

The main part of the roof is constituted of 12 principal beams girders spanning 69 m. Each beam is supported by steel columns spaced at an interval of 8 m. The beams are on an angle such that the supports on either ends of the beams are on different column grid lines. Decorative beams attached to the lower end of the primary beams,
placed in a diagonal pattern, provide the checkered visual effect desired in the architectural concept.

### 2.1 PRINCIPAL BEAMS

The principal beams are constructed from glue-laminated beams and CLT panels glued together to obtain box girders. These girders have a clear span of 69 meters. The architectural concept required us to adopt box girders dimensions of 500 mm in width by 4000 mm in height.

![Figure 2: Profile of a principle beam](image)

As illustrated on figure 3 below, the beam glulam flanges have a height of 1200 mm and 1400 mm for the top and bottom flange respectively. The CLT webs were constituted of 3 ply, 105 mm panels for the central section of the beam. Due to the increased shear stresses in the exterior beam sections, 5 ply, 158 mm CLT panels were used as the webs. Cut-outs were sawed on the glulam flanges, 300 mm and 200 mm in height respectively for the exterior and central sections, to create a lip, in order to glue the CLT webs to the glulam flanges.

![Figure 3: Cross-section through principal beam](image)

### 3 CONNECTIONS

#### 3.1 PRINCIPAL BEAM TRANSPORTATION JOINTS

The most critical and complex assembly detail on the project was the transportation joints for the principal beams. The 69 meter span beams were divided into 3 sections for ease of fabrication, transportation and erection. Two transportation joints were thus required at 1/3rd and 2/3rd of the beam span. The maximum factored moment and shear forces at these locations are 33 000 kNm and 650 kN respectfully. The transportation detail developed is illustrated in figure 4 below.

![Figure 4: Transportation joint](image)

The tension connection (bottom of the girder), supporting loads in excess of 10 000 kN, is composed of the wood-screw-steel assembly. The concept involves the installation of long, high capacity, wood screws at a slight angle of 15° in the end grain of the glulam beam. The intension is to provide adequate embedment strength in the wood substrate to develop the full capacity of the steel shaft of the screw in tension. An elaborate screw pattern was established, to maximize the number of screws in the narrow 500 mm by 1100 mm glulam bottom flange of the box girder, while respecting the minimum screw pitch and edge distances. In total, 416 screws, 14 mm in diameter by 550 mm in length were required.

Laboratory tests were realized at the Material Laboratory of the University of Stuttgart in Germany to validate the performance of the tension connection. A test protocol was developed using Nordiclam sample beams fabricated in Quebec and shipped to Germany. The connections were tested to failure and results demonstrated validity of the theoretical calculations.

### 4 CONCLUSIONS

The CESM soccer stadium is an impressive construction which pushed the limits of timber construction. Innovative details were developed using project specific laboratory testing, in order to support the design process.

### REFERENCES

[1] Render produced by Architects Saucier+Perrotte and Hughes Condon Marler