ABSTRACT: The Auckland Museum of Transport and Technology’s (MOTAT’s) new Aviation Display Hall was completed in May 2011. The building is predominantly one large open space (like an aircraft hanger) but with the fit-out and finishes completed up to museum standards. This paper outlines the structural systems used in the building, including how a clear span of 42 m was achieved that allows aircraft to be suspended from it. The LVL member fabrication, connection details and the assembly process are described and a brief comparison of how this building compares to what could have been constructed using steel is also presented.

KEYWORDS: MOTAT, Museum, LVL, Box sections, Steel gusset plate, portal frame, LVL cross-bracing

1. INTRODUCTION

The Auckland Museum of Transport and Technology’s (MOTAT’s) new Aviation Display Hall was completed in May 2011. The building is predominantly one large open space (like an aircraft hanger) but with the fit-out and finishes completed up to museum standards. The building is 55 m long, 50 m wide, 15 m high and constructed out of laminated veneer lumber (LVL). It will be used to house some of the aircraft in MOTAT’s collection, including both a Solent and a Sunderland (the giant 22 tonne flying boats).

The architects of this project were Studio Pacific Architecture from Wellington; together with the MOTAT Board they made the decision early on to investigate building the new display hall in timber. Holmes Consulting, as the structural engineers on the project were also interested in pursuing a timber option. Carter Holt Harvey also became involved early on, letting the MOTAT Board tour their own LVL buildings so that they could get a feel for what the finished building might be like and providing technical material and construction methodology advice. NZ Strong joined the team as the construction contractor.

2. STRUCTURE

The primary structure is a series of portal frames. Cross bracing is used to form a roof diaphragm and to resist horizontal loads along the building. For visual interest the portals have double legs, the structural ridge line is off centre and the south leg slopes outwards. The portals are constructed from LVL box beams as the span was too far to efficiently use solid rafters. The box beams were glued and screwed together off site using a total of 300 litres of glue and 560 000 nails [1]. Figure 1 shows the building during construction.

Figure 1: MOTAT Aviation display hall during construction

2.1 LVL DETAILS

When designing the box sections there were numerous issues to consider, including potential cupping of the web members which was mitigated by using cross-bands...
in the LVL, a typical rafter cross-section is illustrated in Figure 2.

![Figure 2: Cross-section through typical LVL box beam rafter](image)

The moment connections in the portal frames were one of the most interesting aspects of the design and took numerous iterations to optimise. Two types of moment connections were used: “screw rings” with external steel gusset plates and “nail rings” for hidden timber splice connections at points of contraflexure. The steel gusset connections are shown in Figure 3 and Figure 4. The design procedure for designing nail and screw rings is well published; however, panel shear across the connection was found to govern the nail and screw layout, which is not something commonly checked.

![Figure 3: Steel gusset moment connection structural drawing and on site during construction](image)

It was not just the portal frames that were fabricated from LVL, but also the purlins, girts and even the wall cross bracing. Double timber elements were used as tension braces down the sides of the building with steel flitch plate type connections.

3 CONSTRUCTION

Each portal was transported to site in 8 pieces (the longest segment was 18 m). The rafters were assembled on the ground and segments of roof constructed with purlins, bracing and battens prior to being lifted into the air and connected to the columns by the gusset plates.

4 COMPARISON WITH STEEL

The choice to build from timber has definitely created an aesthetically pleasing, distinctive building that is creating a lot of interest, but it has also been a cost effective and environmentally sustainable solution. How this building compares with what could have been built from steel is also outlined in this paper.

5 CONCLUSIONS

The new MOTAT aviation display hall pushed the limits of a typical timber portal frame and turned a construction type that is often associated with industrial and warehouse type buildings into a building of museum quality. It has also shown that timber can be used to create attractive, cost effective and environmentally beneficial structures on a commercial scale. It is a project we are all proud to be a part of.

REFERENCES