THE QUICK CONNECT MOMENT JOINT FOR PORTAL FRAME BUILDINGS: CASE STUDY AND DISCUSSION OF DESIGN CHALLENGES AND CONSTRUCTION DETAILING

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ABSTRACT: The Quick Connect is a rod based connection which utilizes fully threaded timber screws which has been developed to allow timber construction to move from the traditional model of onsite connection assembly to a construction methodology whereby much of the connection is manufactured offsite. The connection has been developed at the University of Auckland and has been used in a number of buildings in Australia and New Zealand. The first use in a commercial building in Australia is discussed, including design challenges and construction detailing. The issues and findings discussed are applicable to all box beam type timber portal frame buildings, not just those using the Quick Connect.

KEYWORDS: Timber portal frames, screwed connections, moment connections

1 INTRODUCTION

The Quick Connect was developed at the University of Auckland as part of a five year research programme which was aimed at increasing the use of engineered timber materials as the structural system.

This particular segment of the overall research programme focused on timber portal frames, being the traditional form of structure used when maximisation of interior space is required (Leichti et al., 2000).

Through review of literature and contact with industry partners in New Zealand and Australia, it was determined that current moment connections, such as the plywood gusset connection as introduced by Batchelar (Batchelar, 1984) had a number of constructability issues.

The plywood gusset and other traditional moment connections used in timber portal frame structures require significant assembly or manufacture onsite. This ‘traditional approach’ to timber building significantly impacts on critical construction paths and can often result in construction phasing issues.

2 THE QUICK-CONNECT

The Quick-Connect joint is a semi-rigid moment connection which has been developed as an alternative to traditional moment connection solutions. The connection bears some conceptual similarity to the partially restrained bolted connections often used in steel construction. The joint consists of a rod based system as shown in figure 1.

When the structure is loaded, a tensile force is applied to one set of rods whilst the other set remains idle. The compressive force in the connection is taken by the main timber members. This allows a moment couple to be
developed which allows for the transfer of loading across the joint. The rods are housed in U-shaped timber members, hereafter referred to as timber sleeves. Placing the rods on the exterior of the portal members allows for the full bending moment capacity of the members to be developed at the joint.

The timber sleeves are fixed to the main portal members by way of continuously threaded timber screws. The availability of this long, high strength, fully threaded screws which have been designed specifically for high load applications in timber, allows for the creation of efficient connections between the timber sleeves and main members.

In practical terms, the connection can be designed and manufactured without special training. Pre-manufacturing of the connection offsite allows for reduced crane and labour requirements during erection. The slightly higher materials costs when compared to the nailed gusset connection are negligible when compared to the savings in plant and labour onsite.

A full connection design procedure, verified by full scale testing, has been introduced by the authors in a separate paper (Scheibmair & Quenneville, 2012).

3 NETBALL CENTRAL, AUSTRALIA

The Netball Central facility is a New South Wales government funded sports complex in Sydney, Australia. The facility encompasses five practice courts and one show court. The main portion of the structure, housing the practice courts is approximately 140m, with portals spanning 37m spaced at 8.7m.

The portals are of the box beam type, constructed of a mixture of grade 11 LVL and grade 13 LVL and well as cross-banded LVL. The engineered timber material is used for both the column and rafter members.

The Quick Connect is used for the knee and apex joints. Beam splices, placed approximately 12m from the apex, are formed using a screwed connection with some similarity to a rod-less Quick Connect system.

The overall design was managed and performed by Arup in Sydney. The University of Auckland consulted on the design of the knee, apex and splice joints.

3.1 THE IMPORTANCE OF DETAILING

The Netball Central structure is the first to use the Quick Connect system with box beam type members.

A number of issues were faced and overcome during the connection design phase of the project.

High loads in the knee connection area and discontinuities in the member design required careful consideration. The extent of infill materials and the termination of flanges within the connection region required multiple design changes and member design iterations.

In general, compression loading in the Quick Connect is taken by the main portal members at the connection interface. A gap is then left between the member interface and the extreme end fibre of the sleeve to ensure that no compression loading is taken by the sleeves.

Due to the significant moment loading at the knee joints, a portion of the compression loading was assumed to be acting on the sleeves. The design therefore used separate screw groups on the compression side of the connection which were orientated towards or away from the joint depending on the load being resisted. This approach had not been considered before and lead to an improved method of calculating the compression deflections of the system.

4 CONCLUSIONS

The Quick-Connect allows for the majority of assembly work for timber connections to be completed off-site or on ground. Significant savings are seen in crane times. Some interesting design issues have been faced in the first use of the connection with a box beam section, which highlight the need to look beyond simple calculations and take a more global view of the forces present in the high moment zones of portal frame structures. Further, the findings show that careful detailing can overcome most problems in timber design and that efficient connections result.

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REFERENCES

