ABSTRACT: This article presents the concept of the stub girder flooring system adapted to timber structures. The floor system consists of LVL beams covered by CLT floor panels separated by a series of short shear connection called stubs. The paper focusses on the analytical development to predict the optimized flooring system dimensions for future experimental tests. The proposed model contains structural parameters such as the main girder and secondary Gerber beam, the stubs and the CLT panel with various materials. This initial investigation into this concept suggests that the flooring system can be a possible alternative for mid to long span frames.

KEYWORDS: Stub girder, LVL, CLT, Gerber beam, load deflection

1 INTRODUCTION

The demand for more economical and efficient timber buildings leads the designers to reduce or eliminate the space for utilities below the floor beam system. The timber stub girder flooring system, shown in figure 1, is a structural concept that attempts to minimise floor to floor heights by incorporating services within the structural depth. The flooring system is composed of LVL beam that are covered by CLT floor panels which are separated by a series of short, typically wide sections called stubs. Examples of such a system in steel structural floor system yielded significant floor-to-floor heights reductions. It is hypothesized that the use of the stub girder floor system adapted for timber floors reduces the amount of structural timber in floor system and the total cost of the floor system [1-6].

A conventional system of composite floor which is common in multi-story timber buildings consists of concrete and timber and the composite action between the timber beams and concrete slab is generally achieved by the use of suitable connectors. The drawbacks of common flooring systems are the cost of cutting holes in the beam and the provision of stiffeners to reinforce the edges of holes to pass any conduits, piping or HVAC ducts. The design is also tedious and limited since ducts can only be placed at limited and predetermined points. Other such systems include composite girders with ducts below the beams or composite trusses with utilities within the truss members. The suspended ceiling is easy to install, but can be expensive in the overall building costs as it may add several centimetres of valuable floor-to-floor height for every storey of the building. For a multi-story building, it is evident that the addition of height for every floor will accumulate, and thus leads to a significant increase in the total height of the building. Recognizing the aforementioned problems and the fact that the timber engineering community is proposing very high hybrid timber buildings leads to this research attempt to develop and examine the potential of the stub girder system in timber construction [1-6].

2 MATERIAL PROPERTIES

2.1 CLT

Cross Laminated Timber (CLT) is a high-performance massive wood product, which its elements are made up of ordinary boards, glued together in a cross layered fashion and typically showing a symmetric layup.
2.2 LVL

Laminate veneer lumber (LVL) is an engineered wood composite made from rotary peeled veneers, glued with a durable adhesive and laid up with parallel grain orientation to form long continuous sections. It is suited to structural applications such as beams in a wide range of industrial and commercial structures.

3 OBJECTIVE

How to get a more effective and efficient design to save money and space without sacrificing construction quality and safety has become a great challenge to the construction field. Therefore, in the present study, the main challenge is to optimise the timber flooring depth and reduce the total thickness at the same time as providing enough space to pass ducts though the floor. To achieve these goals, this study attempts to adapt the concept of the stub-girder system and the Gerber beam system to incorporate the duct work requirements into the timber structural flooring system without increasing the floor-to-floor depth.

4 RESEARCH METHODOLOGY

The adaptation of the stub girder floor system is done through the analysis and design of each separate component and of their potential interaction along with the objective of allowing spaces for utilities.

4.1 STUB GIRDER

The stub girder flooring system being studied consists of the interaction of LVL beams, CLT panels and a series of stubs which result in an increase moment of inertia and consequently moment carrying capacity. Different failure mechanisms are identified in each of the component under loading: CLT failure in bending and axial loading, LVL beam failure has been checked for combined bending, shear and tension forces and stubs failure in shear resulting from the load transferring between the CLT panels and the LVL bottom chord which is shown in more detail in Figure 2.

4.2 GERBER BEAM SYSTEM

The Gerber beam system is used in the secondary beams system to provide deeper space to pass ducts across the secondary beams. As shown in figure 3, the Gerber system is a technique to reduce the bending moment of continuous beams by locating hinges at inflection points of the beam [1-4].

5 RESULT AND DISCUSSION

Preliminary design of the individual structural floor components suggest that the overall composite action of each parts will result in an effective structural system that offers floor-to-floor height advantages.

6 CONCLUSION

Based on work done so far, the timber stub girder flooring system offers an economical design resulting in the reduction of storey heights, and the creation of a series of openings between the stubs which provide convenient passages for utility ducts and intersecting floor beams.

ACKNOWLEDGEMENT

The authors would like to thanks the New Zealand Timber Design Society for supporting this research work.

REFERENCES