DEVELOPMENT OF CLT SHEAR FRAME USING METAL PLATE INSERT CONNECTIONS

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ABSTRACT: The purpose of this study is to develop a high strength leg joint for shear wall made of small size cross laminated timber panel in a simple system. The joint of CLT in which steel plate was inserted in the central slit and fixed by high strength bolt at inside of short steel pipes was proposed. In order to grasp the failure mode and strength of CLT member, material tests on embedment and shear were carried out using small CLT blocks. The test results indicated that there is few reinforce effect by cross bonding of each lamina. It was concluded that the precise estimation of the strength of CLT member is important in order to develop the joint proposed in this paper.

KEYWORDS: Cross laminated timber, Steel connector, Embedment, Shear

1 INTRODUCTION

In response to the increasing attention for timber structure in terms of low environmental impact, the demand to construct large-scale or mid-rise timber building is increasing in Japan. In such buildings the higher strength shear wall is required since lower layer of the building is subjected to the higher earthquake force than the case of conventional timber structures. Cross laminated timber (CLT) has high potential to develop such strong shear wall element. Different from the use in Europe, CLT shear walls made of small sized panel is more reasonable on current situation of Japan in terms of transportation or manufacturing. In this case, strong leg joint is necessary corresponding to the strong shear performance of CLT shear wall. The purpose of this study is to develop a high strength leg joint for CLT shear wall in a simple system. Authors have investigated the structural performance of steel plate insert drift pinned joint[1] and obtained satisfactory high strength and ductility. However it was necessary to drive in multiple number of drift pins to meet the requirement of shear wall strength when common small diameter drift pin was employed. Therefore in this paper the joint with easier assembling ability was developed by using larger diameter dowel type connector. After confirming the basic mechanical properties of CLT member by material tests, tensile test of the developed joint was carried out.

2 MATERIAL AND METHOD

2.1 SPECIMEN

5 layered CLT specimen made of Japanese cedar was employed for the test. The thickness of each layer was 30mm, and the average density and moisture content were 430kg/m³ and 13% respectively.

2.2 MATERIAL TEST

As a preliminary material tests, embedment test and full-scale block shear test were carried out for CLT. On embedment test, steel bar of 12mm in diameter was push into the half cut hole at the top of the CLT block placed on the base by universal testing machine. The load and relative movement between steel bar and top of the specimen were measured. On block shear test, three layered CLT block with 30x30mm notch was set in the shear test apparatus. The top and bottom surface of the specimen was fixed by apparatus while load was applied at notch in vertical direction to the fixed surface. Maximum force was measured.

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2.3 TENSILE TEST OF THE JOINT

The tensile test specimen of the joint is composed of CLT in which steel plate was inserted in the central slit prepared at one end of the specimen. Short steel pipes of which one end is covered by steel plate were inserted in the side hole of CLT members and were fixed to the inserted steel plate by high strength bolt at inside of the pipe. Since the steel pipes and steel plate were rigidly fixed by friction, small deformation occur by embedment of pipe into CLT member. Based on the previous research[2], a ductile slip mechanism was taken into consideration. By forming long hole on the inserted steel plate, the friction slip can be expected without causing brittle failure by shearing or embedment of CLT member.

By clamping the another end of CLT member and inserted steel plate, the tensile force was applied to the joint. The relative displacement between CLT and steel plate was measured.

Similarly, different failure mode was observed between different grain orientation lamina in the case of block shear test. Shear failure occurred along the grain direction on the layer which grain orientation is parallel to the loading direction, on the other hand, obvious shear failure was not found on the layer which grain orientation is perpendicular to the loading direction. Instead, tensile failure from corner of the notch was observed on perpendicular lamina after occurrence of interlayer peeling between cross laminated layers. The shear strength of the specimen was estimated just by considering the shear strength of parallel lamina. This result suggested that the transversal lamina does not work for shear strength of CLT. More detailed investigation is necessary on the mechanism of shear failure of CLT.

3 RESULT AND DISCUSSION

Figure 3 shows the failure modes obtained by material tests. Large ductile deformation capacity was observed in embedment test. Deformation progressed at just under the steel bar on the lamina which grain orientation is parallel to the loading direction, on the other hand, deformation spread externally on the lamina which grain orientation is perpendicular to the loading direction. However as a result, it was able to calculate the ultimate strength of embedment specimen by adding the strength of each layer according to the ratio of the thickness. This indicates that the reinforce effect by cross lamination was not so significant on embedment characteristics.

4 CONCLUSIONS

The material tests on embedment and shear indicated that there is few reinforce effect by cross bonding of each lamina. Therefore it is more important to care for the precise estimation of their strength in order to develop the joint proposed in this paper. Tensile test of the joint is to be carried out by taking material test results into consideration. And its load carrying capacity is discussed.

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REFERENCES
