PULL-OUT STRENGTH OF GLUED-IN ROD JOINT FROM LVL

Kazutoshi Ito¹, Wonwoo Lee², Changsuk Song², Kei Tanaka¹, Mikio Koshihara³ and Masafumi Inoue¹

ABSTRACT: Recently, the Japanese government enacted a new law in order to promote large wooden building. As a result, the momentum in the construction of large wooden building especially multi-stories wooden buildings in local area has been growing rapidly. In order to achieve these buildings, the higher structural performances than that by usual technique are required. GIR joint system is widely adapted for the joint part of wooden structures. Glued in rod joint-system (GIR) have high strength and high rigidity compared to existing joint-system. On the other hand, the structural LVL with the flexibility performance of cross-section and high structural performance is expected as a material for multi-stories wooden building. So, in this study, the pull-out tests of GIR joints inserted to structural LVL are carried out. And structural characteristics of this type of joint is discussed. Maximum strength and allowable load for temporary loading obtained by pull-out tests are presented.

KEYWORDS: Metal connector, Adhesive, LVL, Pull-out test

1 INTRODUCTION

In large wooden building, large span construction such as gymnasium, museum and domed stadium exist. For these buildings, it is difficult to carry out structural design. But, recently, the Japanese government enacted a new law in order to promote large wooden building. As a result, the momentum in the construction of large wooden building especially multi-stories wooden building for local area has been growing rapidly. In order to achieve these buildings, higher structural performances than that by usual technique are required.

¹ Kazutoshi Ito, Kei Tanaka, Masafumi Inoue, Faculty of Engineering, Oita University, 700 Dan-no-haru, Oita, Oita, JAPAN.
Email: v13e6003@oita-u.ac.jp, kei@oita-u.ac.jp, inoue@oita-u.ac.jp
² Wonwoo Lee, Changsuk Song, National LVL Association, Shinkiba1-7-22, Koto-ku, Tokyo, Japan.
Email: w_lee@key-tec.co.jp, c_song@key-tec.co.jp
³ Mikio Koshihara, Institute of Industrial Science, The University of Tokyo, Komaba 4-6-1, Meguro-ku, Tokyo, Japan.
Email: kos@iis.u-tokyo.ac.jp

The structural LVL with the flexibility performance of cross-section and high structural performance is expected as a material for multi-stories wooden building. On the other hand, glued in rod joint-system (GIR) have higher strength and rigidity than that of existing joint-system. So, in this study, the pull-out tests of GIR joints inserted to structural LVL are carried out. From test result, structural performance of the GIR joint will be discussed.

2 SPECIMENS

Table 1 shows the list of specimens. Figure 1 shows the shape of specimens. The LVL is classified as 120E in Japanese Agricultural Standard. It is made from larch. Metal connector with hollow full thread bolt (φ24) is used. Embedded directions of the metal connectors are parallel and orthogonal to grain. Embedded length and the number of connector are shown in table 1. Also, 2 types layout of connectors are fabricated (cf. table 1). The adhesive used in the GIR joints is epoxy resin adhesive. Curing period of adhesive is for 14 days. Number of specimen is 6 in each types.
Table 1: List of specimens

<table>
<thead>
<tr>
<th>specimen name</th>
<th>embedded direction</th>
<th>layout of connector</th>
<th>embedded length (mm)</th>
<th>number of connector</th>
<th>number of specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-A1-100</td>
<td>parallel to grain</td>
<td>[ ]</td>
<td>100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P-A1-200</td>
<td>parallel to grain</td>
<td>[ ]</td>
<td>200</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P-A1-300</td>
<td>parallel to grain</td>
<td>[ ]</td>
<td>300</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P-A2a-200</td>
<td>parallel to grain</td>
<td>[ ]</td>
<td>200</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>P-A2b-200</td>
<td>parallel to grain</td>
<td>[ ]</td>
<td>200</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>O-A1-100</td>
<td>orthogonal to grain</td>
<td>[ ]</td>
<td>100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>O-A1-200</td>
<td>orthogonal to grain</td>
<td>[ ]</td>
<td>200</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>O-A1-300</td>
<td>orthogonal to grain</td>
<td>[ ]</td>
<td>300</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*Note: A direction values are higher 1.2 times than the B direction values.*

Figure 1: Shape of specimens (unit in mm)

3 TEST METHOD

Monotonic tensile loading is applied to specimens by the 2000kN universal testing machine. Loading speed is 0.5mm/min.

4 FAILURE MODE

Photo 1 and 2 show the failure mode in each series specimens. In the case of parallel to grain, specimens show shear failure in timber. In some of the two metal connectors placed A-direction, shear failure in timber occurred with LVL between the metal connectors. (cf. photo 1).

In case of orthogonal to grain, all specimens show similar failure mode. That is surface of base material of specimen is lifted up with metal connector. Inside of the LVL, failure that adhesive is peeled is showed at interface between the adhesive layer and the wood (cf. photo 2).

5 MAXIMUM STRENGTH AND ALLOWABLE LOAD FOR TEMPORARY LOADING

Figure 2 shows the maximum strength and the allowable load for temporary loading (To). Allowable load for temporary loading are given from the lower limit values 2/3 of the maximum strength.

In maximum strength of O-A1 series, as can be seen from Table 2 and Figure 2, it is showed value of relative to embedded length. In maximum strength of P-A2 series, the B-direction values are higher 1.2 times than the A-direction values. In allowable load for temporary loading, it is showed similar behavior with maximum load. However, as can be seen from Figure 2, in the specimens embedded 300mm, value of orthogonal to grain are higher than that of parallel to grain.

6 CONCLUSIONS

In this study, the pull-out tests of GIR inserted to structural LVL are carried out. And structural characteristics of this type joint was discussed. Maximum strength and allowable load for temporary loading obtained by pull-out tests were presented. In maximum strength of P-A2 series, the B-direction values are higher 20% than the A-direction values. In allowable load for temporary loading, it is showed similar behavior to the maximum strength.