MODELING LONGITUDINAL TENSILE FAILURE LOAD OF
LARIX GMELINII FINGER-JOINTED LUMBER

Ren Haiqing¹, Guo Yingjie², Zhao Rongjun³, Zhong Yong⁴

ABSTRACT: To establish and verify mechanical model of longitudinal tensile failure load (LTF) of Larix gmelinii finger-jointed wood, the properties of earlywood (EW) and latewood (LW) were involved. Besides, it considered density is the major factor influencing Larix gmelinii mature wood mechanical properties. The results show that it is possible to build mechanical model of LTF based on different properties of EW and LW. The model of finger-jointed LTF is suitable to Larix gmelinii mature wood. In order to promote the model to industry, it requires more verification of various finger-joint figures.

KEYWORDS: Larix gmelinii mature wood; finger-joint; longitudinal tensile failure load; mechanical model

1 INTRODUCTION

Under the ideal process condition, various kinds of failure mechanical models about finger-joint would be able to be established. Due to being considered wood as a homogeneous material, most finger-joint models cannot calculate precisely. Thus, in order to acquire more accurate results, it would be improved the models by taking wood as inhomogeneous substance into account.

Larix gmelinii belongs to the species with no transition area between earlywood (EW) and latewood (LW) in a single annual-ring. The mechanical properties of EW and LW in such type of wood are quite different, which the mechanical performances of LW are stronger than those of EW. Due to those differences, Larix gmelinii would be considered as a kind of inhomogeneous material composed of EW and LW.

In addition, the mechanical models of wood should be able to reflect the variability. While, according to the results of previous studies, density is the major effect affecting the mechanical properties of mature wood [¹]. Therefore, density is going to be involved in the model.

In this paper, before setting up the mechanical model of finger-joint, the properties of Larix gmelinii mature EW and LW were studied. The longitudinal tensile failure load mechanical model was going to be established and verified.

2 PROPERTIES OF EW AND LW

2.1 SPECIMEN OF EW AND LW

The specimen of EW and LW strands were chosen from north sides of lumber. According to the method of study on EW and LW of Loblolly mature wood [²], the numbers of the annual rings were selected, including the fifteenth, the eighteenth, the twenty-first, the twenty-fourth, and the thirtieth. All the strands were separated by blades, then were regulated the thickness with sandpaper. The final shapes of specimen was 70(mm)×10(mm)×thickness of the strand.

Figure 1: Dumbbell-shaped Specimen

After the moisture content of EW and LW specimen was balanced, the mass of specimen was measured. In order to calculating the density of the strands, the geometries were measured. To acquire the longitudinal tensile

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¹ Ren Haiqing, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing, China. Email: Renhq@caf.ac.cn
² Guo Yingjie, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing, China. Email: Annie.gyj@gmail.com
³ Zhao Rongjun, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing, China.
⁴ Zhong Yong, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing, China.
strength of EW and LW, the strands were cut into dumbbell-shaped (Figure 1).

The density of LW was three times as big as it of EW. The longitudinal tensile strength of LW was four times greater than it of EW.

3 MODELING THE LONGITUDINAL TENSILE FAILURE FORCE OF FINGER-JOINT

It is able to analyse forces of one glued-area of the half finger-jointed. And the failure load of the half is value of all the areas to sum up. As a result, it would be focused on the stress analysis of finger jointed slope (Figure 2).

Figure 2: Wood slope Stress analysis of finger-joint and radial tensile shear failure of wood

Finger-jointed lumber is composed of two parts, which are a and b (Shown in Figure 3). In order to solve the failure force, it has to calculate for a and b respectively. The lower one would be the final results of finger-jointed lumber.

Figure 3: Specimen of verification

Taking a for example, it is composed of n glued areas. The expression of the longitudinal tensile failure force of a is as follows:

\[ P_a = \sum_{i=1}^{n} \frac{\rho_{L} F S L H_h}{10 \rho_{L} \sin \theta \cos \theta} \]

(1)

Where \( n \) represents the number of glued-area, \( \rho_{L} \) is the average of LW on the glued-area, \( \rho_{L} \) represents the LW mean density of Larix gmelinii mature wood, \( h \) is the sum of LW, \( H \) is the height of the node. The geometries of node shown in Figure 3 are included under the below:

\( n = 3, \ a = 10(\text{mm}), \ h = 27.5(\text{mm}), \ \angle \theta = 85^\circ. \)

4 RESULTS

For A1, A2, A4, the lower values calculated by expression 1 were rather closed to the one coming from testing. However, the lower value from A3 was far away from the testing result. It indicates that expression 1 was not suitable with A3. The reason is A3 belongs to juvenile wood.

Figure 4: Comparison of calculated and measured values

5 CONCLUSIONS

Under the ideal process, the expression of the longitudinal tensile failure force of a is as follows:

\[ P = \sum_{i=1}^{n} \frac{\rho_{L} F S L H_h}{10 \rho_{L} \sin \theta \cos \theta} \]

Where \( n \) represents the number of glued-area, \( \rho_{L} \) is the average of LW on the glued-area, \( \rho_{L} \) represents the LW mean density of Larix gmelinii mature wood, \( h \) is the sum of LW, \( H \) is the height of the node, \( \theta \) represents acute angle of node.

It has been verified with the parameters included \( H = 27.5(\text{mm}), \ \theta = 85^\circ, \ n = 3. \)

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