ABSTRACT: Creep and duration of load characteristics of cross laminated timber (CLT) were evaluated from the test results of creep and duration of tests. Japanese Ceder (Cryptomeria japonica) was chosen for the species for the laminations of the test specimens and API was chosen for the adhesive. The results are summarized as follows: (1) The creep factor [i.e. (Initial deflection + Creep deflection) / Initial deflection] for CLT was evaluated to be 2.0 and was almost equivalent to the creep factor commonly known for solid lumber. (2) The duration of load factor [i.e. Strength for 50 years duration of load / Strength for 10 minutes duration of load] of CLT was evaluated to be 0.66 and was almost equivalent to the duration of load factor measured for solid lumbers.

KEYWORDS: Cross Laminated Timber, Creep Factor, Duration of Load Factor

1 INTRODUCTION

Cross laminated timbers are composed of longitudinal layers and cross layers. As the bending properties of cross laminated timbers are affected by the cross layers the long term behaviour of the cross laminated timbers are also supposed to be affected by the cross layers [1].

In Japan the duration of load factor 0.55 for lumbers and wood based materials was derived from the formula proposed by Wood [2]. And the creep factor 2.0 for lumbers and wood based materials was derived from the results of a series of creep tests conducted in the past.

The Japanese Building Standard Law [3] provides the testing and evaluation method to derive the creep and duration of load factors for newly developed wooden materials. This testing and evaluation method generally requires full scale long term loading test in a conditioned chamber. To derive the duration of load factors the test specimens have to be loaded to failure at least at three stress levels. And to derive the creep factors the test specimens have to be loaded at the stress level equivalent to 33% of the maximum stress at least for 5 weeks.

Recently the Japanese Agricultural Standard for cross laminated timber has been drafted. And the cross laminated timbers are expected to become one of the major wooden structural materials in Japan. To enable the use of cross laminated timber as structural materials in Japan the creep and duration of load characteristic of the cross laminated timber has to be clarified as one of the significant material characteristics.

This paper gives the creep factor and duration of load factor evaluated for cross laminated timber by adapting the testing and evaluation method stipulated in the Japanese Building Standard Law.

2 TESTING

The long term loading tests for creep and duration of load were performed according to the testing methods stipulated in the Japanese Building Standard Law. The specification of the test specimens and the testing methods are as follows.

2.1 TEST SPECIMENS

Cross laminated timbers produced from Japanese Ceder were chosen for the test specimens. The size of the test specimens were 3000mm in length, 300mm in width and 150mm in depth. The test specimens had 5 layers of laminations and the layers on the surface and center were...
parallel to the longitudinal direction of the test specimens and the other 2 layers were cross banded.

The structural grade of laminations was common to all layers. The MOE of the laminations was 6.0GPa or higher and the average MOR of laminations were supposed to be 30.0 MPa or higher. The laminations were finger-jointed and glued-laminated with aqueous polymer isocyanate adhesive (API).

2.2 TESTING METHOD

2.2.1 Creep Test

The test specimens were loaded at the 33% level of the average bending capacity that corresponded to the allowable strength of the materials for long term loading. The dead load was loaded by third point loading with 2730mm span. And the test was conducted in a climate chamber that was controlled to 20 °C, and 65% R.H.

2.2.2 Duration of Load Test

The test specimens were loaded at the stress level of 80%, 75% and 70%. The dead load was loaded by third point loading with 2700mm span in a climate chamber that was controlled to 20 °C, and 65% R.H.

3 RESULTS

3.1 CREEP FACTOR

The creep factor [i.e. (Initial deformation + Creep deformation) / Initial deformation] was evaluated by calculating the creep deformation caused by 50 years duration of load and Equation (1) was applied for the calculation.

\[ d(t) = A t^N \]  

where \( d(t) \) = creep deformation at duration of time \( t \), \( t \) = duration of time, \( A \) and \( N \) = constant derived from the test results. Figure 1 gives the typical creep deformation curve for CLT. The creep factor for 12 test specimens ranged from 1.3 to 2.6 and the average value was 2.0 that was almost equivalent to the creep factor commonly known for solid lumber.

3.2 DURATION OF LOAD FACTOR

The duration of load factor [i.e. Strength for 50 years duration of load / Strength for 10 minutes duration of load] was evaluated by calculating the stress level that corresponds to the 50 years duration of time. The dotted line given in Figure 2 gives the linear regression line of the test results. The stress level for 50 years duration of load was evaluated as 66%. And the duration of load factor for CLT was evaluated as 0.66. This value was almost equivalent to the duration of load factor for solid lumbers evaluated by the same testing and evaluation method.

The solid line in Figure 2 represents the Madison Curve. And the symbol “+” gives the average values for time to failure for each stress level. Except for the stress level 70% the test results showed conservative time to failure compared to the Madison Curve. For the stress level 70% more than half the test specimens have not failed at this moment and the average time to failure is expected to become longer than the current test results.

4 CONCLUSION

(1) The creep factor for CLT was evaluated to be 2.0 and was almost equivalent to the creep factor commonly known for solid lumber.

(2) The duration of load factor of CLT was evaluated to be 0.66. This value was equivalent to the test results for solid lumbers.

REFERENCES