Transactions of the Materials Research Society of Japan 29[5] 2495-2498 (2004)

Variation in Moisture Content of Sugi Boxed Heart Timber during Kiln Drying under High Temperature and Low Humidity

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The variation in moisture content of sugi boxed heart timber was examined during high temperature and low humidity drying. The moisture contents in surface layer were decreased remarkably during the early drying temperature stage of 120℃. It was found that the moisture content in the inner layer of the heavy timber (group b) was higher than that of light timber (group a), and the drying of this inner layer with high moisture content was difficult to achieve even by high temperature and low humidity method.

Key words: sugi, boxed heart timber, high temperature, low humidity, drying.

1. INTRODUCTION

The moisture content in sugi (Japanese cedar, *Cryptomeria japonica*)) usually varies from heartwood to sapwood. Moreover, sugi often contains black heartwood with high moisture content. So, it is difficult to dry boxed-heart square timbers of sugi uniformly, even if by kiln drying. The structural members of sugi for the Japanese traditional construction have large dimensions and include pith. Therefore, surface checks occur easily on these timbers during drying.

Recently, the high temperature and low humidity drying method has been popularized [1]. This method can dry the boxed heart timbers while controlling the surface checks. But the drying schedule suitable for this method is still in the development, and there has been little research in the moisture content distribution in each drying stage of timber.

In this study, the changes in moisture content and moisture content distribution of the sugi boxed heart timbers according to green timber weight were investigated in the drying stage of dry-bulb temperature of 120℃, 110℃ and 105℃.

2. MATERIALS AND METHODS

Fourteen green boxed-heart square timbers of sugi (130×130×3000mm) produced in Miyazaki Prefecture were prepared. These timbers were divided into two groups according to the weight measured immediately after lumbering. Group a and b included seven timbers of the weight range from 34kg to 36kg and from 37kg to 39kg respectively. About 95cm length specimens were made from these timbers as shown in Fig.1. Drying schedule in this test was as follows.

(1) Initial steaming at 90℃: 6 hr, (2) Dry-bulb

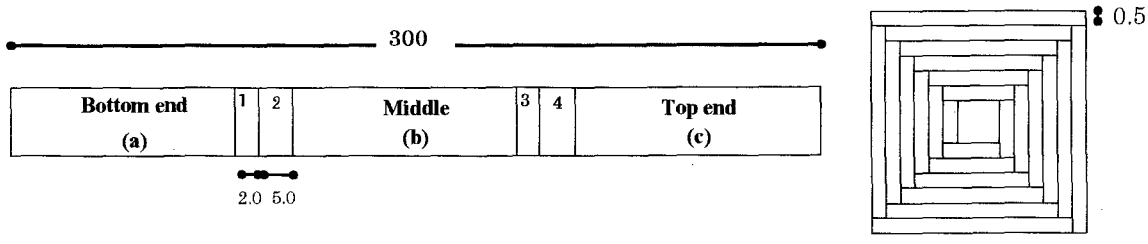

Fig.1 Cutting diagram of specimen.
a,b,c: Test specimens,1,2,3,4: MC specimens,
2,4: Divided layer of a specimen
Unit:cm

temperature (DBT) 120℃ and wet-bulb temperature (WBT) 95℃: 22 hr, (3) Steaming at 95℃:15 hr, (4) DBT 120℃ and WBT 95℃: 24 hr, (5) DBT 110℃ and WBT 90℃: 72hr, DBT 105℃ and WBT 90℃: 72hr.

The moisture content distributions of three specimens in each group were measured by oven-dry method in 28hr, 43hr, 67hr, 98hr, 170hr and 211hr after drying was started. At each time, the weights of the other three specimens in each group were measured, and finally each moisture content was measured by oven-dry method.

3. RESULTS AND DISCUSSION

3.1 Change in moisture content distribution

Figure 2 shows the change in moisture content of each layer in cross section of green timber. Large difference of moisture content distribution along the radial direction of the green timber in the longitudinal direction was not recognized in each group. In both groups the moisture contents from the 1st layer to the 5th layer were about 80%. However, the moisture content from the 6th layer to the center in the heavy group b was over 100%. In the light group a, its moisture content showed almost the same value as that of the surface layer.

As shown in Fig. 3, the moisture content of 1st and 2nd layers in both groups decreased in the first stage A. But the moisture content hardly changed from 3rd to center layers. The moisture content of 1st layer was higher in the stage B after the steaming process than in the early stage. However, the moisture content in the inside of the 2nd layer did not change. In the stage C, the moisture content from surface to 4th layer decreased remarkably. But the moisture content around center was almost the same as that of green timber. The moisture content of inner layers decreased with elapsed time of the stage D, E, F, and finally, the moisture content from 1st layer to center layer became about 6% in the group a. As for the group b, the moisture contents of 1st layer and center layer was 6% and 17- 40% respectively.

It was found that the moisture content in the inner layer of the heavy timber (group b) was higher than that of light timber (group a), and the drying of this inner layer with high moisture content was difficult to achieve even by high temperature and low humidity method.

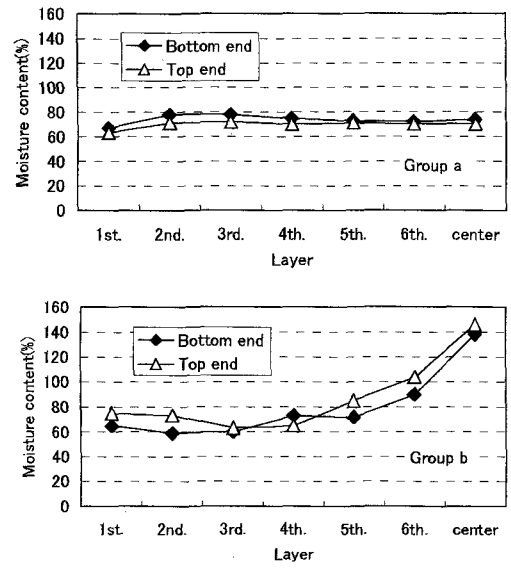

Fig.2 Change in moisture content of each layer in cross section of green timbers.

3.2 Change in moisture content

Figure 4 shows relationship between the moisture content of the weight specimen and the drying process time in the case of initial moisture content of 94%. A decrease in moisture content was 32% in the stage A,

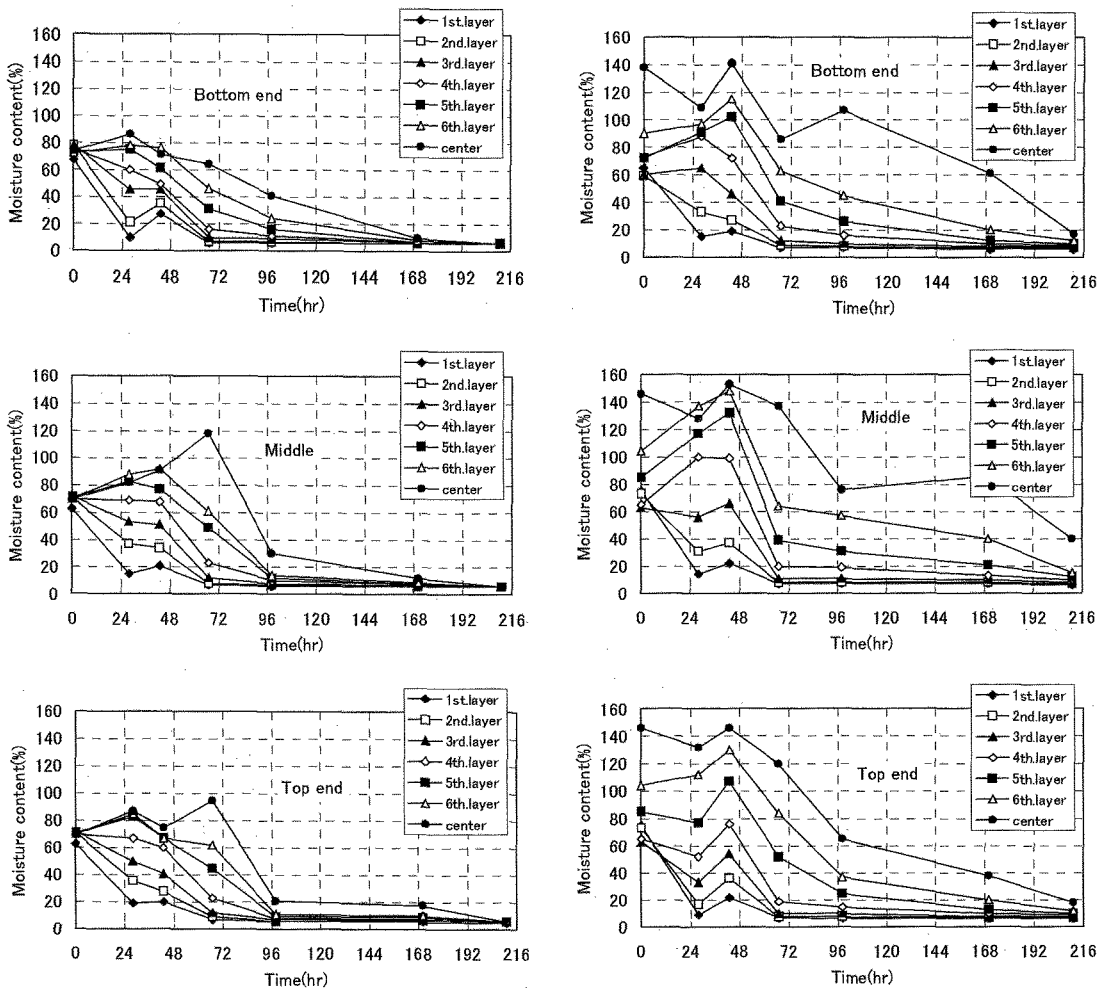

Fig.3 Change in distribution of moisture content during the high temperature and low humidity drying.

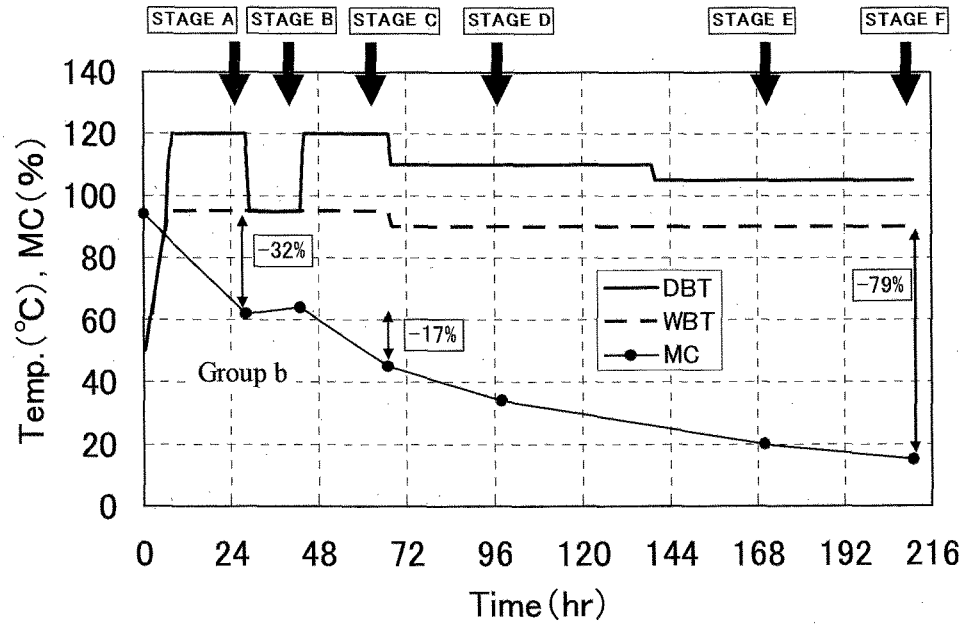

Fig.4 Drying schedule and relationship between moisture content (MC) and drying time in the case of initial moisture content of 94%.

and 17% in the stage C. The moisture content increased a little in the stage B. The moisture content of 49% decreased in 46 hours of the stage A and C. Furthermore, that of 30% decreased in 144 hours of the stage D, E and F. As the final decrease in moisture content reached 79%, two thirds of the whole moisture content decreased in the processing of 120℃. A decrease in moisture content per an hour was 1.4% in the stage A, and 0.7% in the stage C. On the other hand, the latter stage of D, E and F had an extremely small drying rate of 0.2%/hr. One of the causes for this marked decrease of drying rate might be a lowering of drying temperature with a decrease in moisture content.

3.3 Inner checks

The states of the cross section in each stage are shown in Fig.5. Inner checks in both groups began to occur from the stage C, and increased with a progress in drying after this stage. Inner checks showed a tendency to occur more in the light group a than in the heavy group b. This is considered to be due to the occurrence of high tensile stress in the inner layer of the a group with drying to lower moisture content.

REFERENCES

[1] T.Yoshida, T.Hashizume and N.Fujimoto, Wood Industry, 55, 357- 362 (2000).

(Received October 11, 2003; Accepted December 11, 2003)

Group a

Group b

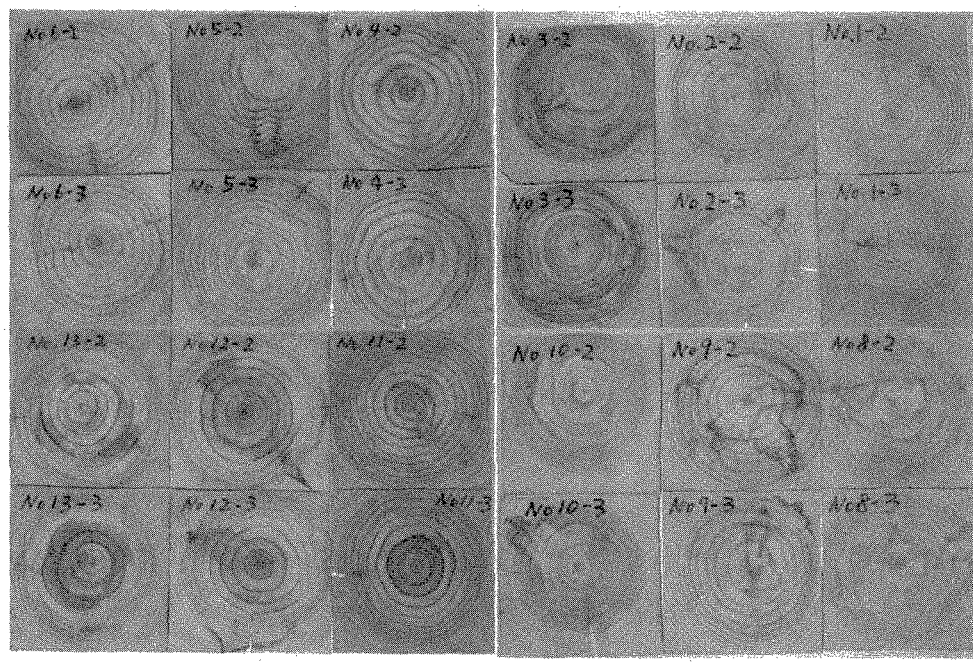

Fig.5 State of cross section in each stage.
(from left to right : stage A,B,C,D,E,F)