APPROPRIATE SHAPE OF TIMBER FOR THE RAIN

Tadahiko Mizutani¹, Hiroki Ishiyama²

ABSTRACT: In this study, in order to achieve a long term use of the wooden structures, appropriate shape of timber for the rain is examined. We made the rainfall simulator that can make real rainfall, and place the various shape specimens in it. The validity of the shape were evaluated by measuring the moisture content of the specimens. As a result, the moisture content ratio of the rhombus is lower than the other forms. Appropriate shape of timber for the rain can realize the long term use of the wooden structure, in addition, the wooden structure can obtain longer life by using chemical treatment.

KEYWORDS: Wooden structure, Durability, Detail design, Rainfall simulation, Moisture content

1. INTRODUCTION

In Japan, there are many examples that, the wooden fence and the bench outdoor did not last due to decay of the wood. Originally, in case of using wood outdoor, the shape of the wood is needed to design not to retain rainwater on the surface of the wood. In addition, painting and chemical treatment is needed. However, in Japan, there are many examples that paint and chemical treatments are taking seriously but without architectural consideration for rain. The wood starts to decay when it is used outdoor for a long period, if it has only paint and chemicals but no architectural consideration. It is because the surface paint often comes off leaving moisture accumulates on the wood over time. Therefore we focus our study on the moisture which has an affect on the decay of the wood and durability of the wood with respect to difference shapes. We think that the shape can affect the durability of the wood and contribute to the longevity of the wooden building, in addition to chemical treatment.

2. OVERVIEW OF STUDY

We establish the specimen under the rainfall simulator and rainfall to the certain period of time. (Figure 3) Thereafter, take out the specimen and cut it in the shape of the block, in addition to measure weight of each, thereafter, put it in thermostat which we set to 105°C at 48 hours to make a dry condition. Measure weight again and measure moisture content. We inspect of appropriate shape for the rain by analyze a change of moisture content of specimen, and calculate a high position of moisture content and define it as shape which easy to decay.

2.1. CREATE RAINFALL SIMULATOR

We created a rainfall simulator to rainfall to the certain amount of specimen. (Figure 4, 5) In the first place, drill under the container and establish extremely thin pipes, to act of making rain artificially, than a study of the reference [1], the inside diameter of an extremely thin pipe assumed it 0.4mm. Established a drain in the container to can keep the constant depth of the water.

Figure 1: Fence in Austria
End surface is protected with a board and that slopes to prevent rainy collect.

Figure 2: Fence in Japan
End surface of the prop of fence is not considered for the rain.

Figure 3: Rainfall simulation

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In this study, an aim is very hard rain of established at Japan Meteorological Agency (50~80mm/h) [2]. In addition, pre-test was conducted for finding properly length and pitch of extremely thin pipe, and depth of the water. (Figure 6) Show the result of the experiment in Figure 7~10.

As a result of changed precipitation every one pipe and checked a change of the precipitation by the number of time of use, was able to control precipitation by changing length of extremely thin pipe and depth of the water. In addition, the reduction of the precipitation by the use count to was not seen. Therefore, we made the length of extremely thin pipe is 120mm, the depth of the water is 100mm, pitch to establish is 130mm.

2.2. SPECIMEN

Used the cedar of 105cm *105cm for specimen. In addition, use a thing with end matching as every specifications from the same cedar, to reduce the difference of the individual. The surface of specimen makes no processing, to analyze difference in moisture content by shape. In this study, inspect a change of moisture content by the sectional shape of the horizontal bracing. Therefore, perform waterproofing with oily varnish so that water does not enter at end surface. In addition, using waterproofing tape and calking material, and lengthen specimen to prevent a rise of moisture content from end surface. (Figure 12) Also, prepare for three specimens that cut from centre about each shape.

2.3. KIND OF SPECIMEN

In this study, made eight kinds of specimens. Show a list of shape in Figure 13.

Type A1: Rectangular solid and top is sap side.
Type A2: Rectangular solid and top is heart side.
Type B1: Top is small slope (22°).
Type B2: Top is lager slope (66°).
Type C: Top is single flow.
Type D: A rhomboid.
Type E: An octagon.
Type F: Top is flat, but bottom is groove shape.
Specimen of Type A1 and A2 both are flat, but compare the difference in penetration of the water, in case of takes water from sap side and heart side. Specimen of Type B1 and B2, compare the difference of moisture content by the angle. Specimen of Type B1 and B2 and C and D, we think that, because top is sloping, so the water does not collect, and hard to penetrate in the top. Specimen of Type D and E and F, we think that, because a bottom becomes the shape as the cutwater, so the water is easy to finish flowing and hard to penetrate in the bottoms. Therefore we think that, these shape that a wood is hard to decay.

### Figure 13: Shape of specimens

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>SAP SIDE</th>
<th>HEART SIDE</th>
<th>HEART SIDE</th>
<th>SAP SIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A1 (Top is sap side)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type A2 (Top is heart side)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type B1 (Small slope)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type B2 (Larger slope)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type C (Single flow)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type D (A rhombus)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type E (An octagon)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Type F (Groove shape)</td>
<td></td>
<td>11 12 13 14 15</td>
<td></td>
<td>6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

3. **RAINFALL SIMULATION**

In the first place, we establish eight kinds of specimens under the rainfall simulator and rainfall to the certain period of time. *(Figure 14)*

In this study, time of rainfall is 24 hours, 72 hours, 108 hours. After the experiment, specimens cut it in the shape of the block, and measure moisture content. We find appropriate shape for the rain by analyze and compare to difference of moisture content by the shape.

**Figure 14:** Rainfall simulation  
*Figure 15:* Dry condition in thermostat

### Figure 16: Measure moisture content

### Figure 17: The drawing for cut of the specimen

#### 3.1. RAINFALL SIMULATION FOR 24 HOURS

Rainfall on specimens for 24 hours. Show the result of the experiment in Figure 18~21.

As a result of compared Type A1 with A2, difference was seen in moisture content ratio of top of specimens. Because a moisture content ratio is lower approximately 30% Type A1 than A2, we think that, sap side is superior to heart side in the durability. Also, because time to rainfall was short, the tendency of moisture content ratio was not seen in Type B1~F.

**Figure 18:** Moisture content ratio comparison of Type A1 and A2
3.2. RAINFALL SIMULATION FOR 72 HOURS

Rainfall on specimens for 72 hours. Show the result of the experiment in Figure 22~26.

As a result of compared Type A1 with A2, in the top and middle, A2 does not absorb much water. On the other hand, in the bottom, A1 does not absorb much water. Therefore, we think that, sap side is superior to heart side in the durability.

As a result of compared Type B1 with B2, the tendency of moisture content ratio by the difference in angle was not seen.

Also, as a result of compared Type B1~F, we think that, Type D is property shape for the durability, because in the top and middle, a rise of moisture content ratio is low.
3.3. RAINFALL SIMULATION FOR 120 HOURS

Rainfall on specimens for 120 hours.
Show the result of the experiment in Figure 27~31.
As a result of compared Type A1 with A2, in the top, a rise of moisture content ratio of Type A1 is high, and a rise of Type A2 is low. On the other hand, in the bottom, a rise of moisture content ratio of Type A2 is high, and a rise of Type A1 is low.
As a result of compared Type B1 with B2, some differences were seen in the moisture content, but we think that, we are not related to the durability. Therefore, rainfall at longer time, and necessary to confirm the tendency.
Also, as a result of compared Type B1~F, we think that, Type D is property shape for the durability, because moisture content ratio is low.
3.4. COMPARISON BY THE TIME OF RAINFALL

Case of Type B1 and B2, consider the relations of moisture content ratio and time of rainfall.

A result, moisture content ratio of centre was high tendency. (Figure 32)

Also, time of rainfall is long, the moisture content ratio is high, but the tendency that a rise is settled when it gets closer to a constant numerical value was seen.

The tendency of moisture content ratio by the difference in angle was not seen, but we think that, it is caused by the fact that it was originally the wood which has high moisture content.

Figure 31: Distribution of moisture content of specimens

Figure 32: Distribution of moisture content ratio of Type B1 and B2

Figure 33: Relations of moisture content ratio and time of scatter rain of Type B1
4. DRYING AFTER RAINFALL

To confirm drying of specimen after got wet, after rainfall for 24 hours, is dried for 72 hours. The condition of the drying, indoors, temperature is 12°C and moisture is around 40%. Also, dried naturally and avoid direct rays of the sun.

Show the result of the experiment in Figure 36~40.

Type A1 dried from the top, but A2 dried from the bottom, that is, dried from the heart side.

Type B1~F, the moisture content ratio of the middle is high, and top is low.

The centre part of the specimen were not completely dried by the 72 hours drying.

We think that, difference in drying is seen by a shape. But the tendency was not seen.

Therefore, necessary to lengthen time for scatter rain and drying, and to observe.
5. CONCLUSIONS

Shown below is the result of this study. By the rainfall simulation, we establish eight kinds of specimens under the rainfall simulator with rainfalls for 24 hours, 72 hours, and 120 hours.

When the top is flat, because water is easy to collect by surface tension, it contributes to the increase in the moisture content.

A rhomboid (Type C) is the preferred shape of durability, because it is a lower moisture content ratio than other shapes.

Also, sap side is superior to heart side in the durability, because the water moisture ratio is lower on sap side than on the heart side.

When the top is slope rather than flat, moisture content was low. We inferred that slope was effective.

By the drying experiment after rainfall, we confirmed that the difference in the quickness to dry with every shape.

The moisture content ratio of the top was low, and the tendency to dry from the top was observed.

We think the difference in drying is affected by the shape of wood. It is seemed that the specimen did not dry completely because the time of rainfall was too short.

ACKNOWLEDGEMENTS

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REFERENCES


[2] Japan Meteorological Agency. The criteria of strength of rain