

# Study on the Development Direction of the Use of Wood as a Landscape Material\*<sup>1</sup>

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## ABSTRACT

The main purpose of this study was to propose the development direction and application method of wood as a landscape material by analysis and investigation of the present condition and characteristics of wood, which is a quite interesting natural material for its beauty as an exterior material. This study is based on the relationships between the establishment of development direction and practical use of exterior wood as a landscape material. The research method used was fieldwork and data analysis. On the analysis of the present condition of wood utilization, it was investigated to need of complement of a design aspect, use method, the limit of use type, and use range. The direction of a durable design for the practical use of exterior wood as landscape materials was established. On the use of exterior wood, first, the characteristics of wood have to be understood. Then exterior wood can be used while preserving its safety and beauty over a long time by physical and chemical treatment. At the same time, an application plan for the practical and effective use of wood as an outdoor landscape material, we concluded that future research in design aspects is needed in consideration of physical, chemical, and structural properties of durable wood materials used in outdoor facilities.

*Keywords:* Using plan, exterior wood, landscape materials, biomaterial, durable design

## 1. INTRODUCTION

Since the beginning of the 21st century, there has been an increase in the interest of preserving space in the environment in order to preserve the current way of life. The creation and preservation of desirable landscape are very important regional subjects. Many people would like to live in a comfortable environment. The consideration of landscape design and a desire to use space in an economical way are essential

at this time.

The definition of landscape or street landscape is the combination of nature and building construction. It is, furthermore, an arrangement of materials or manufactured goods itself. While an environmentally friendly landscape is the main goal, the buildings that compose the landscape are just as important. When we select landscape materials, we hesitate whether in our decision because there are so many materials to choose from a use and selection of the appro-

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appropriate materials for human's life is a previous decision point for better landscape formation.

It is well known that wood is an important environmentally friendly material. For this reason, it has been mentioned often the words, "return to a natural material". Wood is very different from artificial industrial materials such as metal and glass. We can feel and remember these characteristics through experience. Wood is, therefore, very convenient material with a unique combination of beauty and durability. It can be used in various applications as a raw solid material. In spite of these merits, wood has many disadvantages. Knowledge of wood as a landscape material is more important now than ever.

The purpose of this study is to propose the idea of wood as a landscape material.

## 2. RESEARCH METHODS

An investigation was carried out to examine the using point of wood materials as a landscape material. First, we have investigated the type of exterior facilities in construction. Second, the other materials were observed as landscape materials. The practical application of exterior wood was investigated. The investigation period was from October 2000 to June 2001. Detailed investigation and analysis of this study was centered on what is the condition of exterior wood as a final goal.

## 3. RESULTS and DISCUSSION

### 3.1. Landscape Materials

#### 3.1.1. Investigation of composition elements in the outdoors

Outdoor facility is defined as a life device used in the outdoors that can contribute to the

livelihood of people. Effective value and function of outdoor facilities is higher than that of indoor facilities, because it affects everyone. Therefore, it assists in the functions of life and regulates human's behavior (Lee K.I. 1996). For these reasons, the function and characteristics of outdoor facilities is different in terms of location, materials used, and its' shapes and dimensions. Furthermore, outdoor facilities are an important role in the landscape effect and quality of space.

The public uses outdoor facilities. Many factors have to be taken into consideration such as convenience and safety. When planning, the designer has to consider the appearance, structure, and the function of facilities (Korean Institute of Landscape Architecture. 1999). Furthermore, the decision has to take into consideration friendly environmentally materials, regional characteristics of landscaping, and cost of facilities, degree of utilization, durability, and management factors.

Outdoor facilities are divided into four types: environment molding facilities, illumination facilities, guidance facilities, and benefit facilities. Recently, in addition to these, there has been an increase in the numbers of sports and leisure facilities.

In this study outdoor facilities were investigated as the following: a park bench, wastebasket, water drink stand, pergola, planter, shelter, illumination lamp, pavement, boundary stone, manhole, tree supporter, tree conservation cover, parking area, over bridge, fence, border, sound isolation wall, bridge, stairway, slope way, outdoor table, arbor, walk, play facilities, hydroponics facilities, retaining wall, and slope.

An investigation was carried out to examine the problems in administration, installation, consideration items in a design, use of materials, and a function on each of the outdoor facilities (Moon, S. K. et al. 1998, Korean

Society of Landscape Architect. 1997, Korea Land Corporation. 1994).

### 3.1.2. Raw materials of outdoors facilities

We investigated the characteristics of the materials that are used in outdoors facilities. Various materials such as glass, cement, fiber reinforced plastics (FRP), stainless steel, aluminum, iron, asphalt, concrete, wood, tile, brick, and stone are used in outdoor facilities. In addition, the data was arranged by the following criteria, use, sort, and characteristics of each material (Table 1)(Moon, S. K. et al. 1998, Bae. H. M., Kim J. H . 2002, Landscape Material Drive Council. 1997).

### 3.1.3. Use of wood in outdoor space

It was found that various kinds of outdoor facilities exist to control the quality and function of the outdoors. Although materials of each facility have to be selected to be the most adequate material by general condition and use, it should also be fully considerate of the esthetic (Do Y. J., Kim H. W. 1999, Lee H. T., Lee J. 2000).

Recently, the public function of outdoor facilities have been increasingly emphasized. Wood, as a natural material, is interesting in its property in outdoor facilities. It was investigated according to materials and classified with regard to the types of outdoors facilities. As shown in Table 1, we could analyze the frequency of use of individual materials and components of outdoors facilities.

There are a variety of outdoor facilities. However, materials used in outdoors facilities were limited. Main materials are stone, brick, wood, concrete, and iron. The use of stainless steel and glass fiber is increasingly becoming more popular.

Next, we investigated facilities that use wood

from Table 1. Among the twenty-nine types of outdoors facilities in the investigation, wood is used in twenty-three types. Although the use of wood is frequent, several problems were found in the administration, safety, and durability of the facilities.

Among the investigated facilities, wood was not found in a water drink stand, pavement, manhole, tree conservation cover, slope way, or a retaining wall. As a result, wood was not found in facilities with water or that required a great deal of strength.

If the weak points of wood could be improved during processing, the application limits of wood in the outdoors are likely to increase.

## 3.2. Present Condition of the Use of Wood

### 3.2.1. Exterior wood

Exterior wood is the meaning of "wood that is used in the outdoors or in a natural environment". The method of using exterior wood is divided into two types. First, it is used as an industrial material such as landslide protection, construction material for building, vertical surface block, protective wall, railroad tie, materials for agriculture and forestry and fishery, and a telephone pole. These fields consume a large quantity of wood, because of low precision in processing and low cost (Fig.1).

Second, it is used as an image expression with a mild and comfortable property such as a building structure and products for amenity improvement. This field requires a higher value-added and harmonic design with landscape such as roads, park facilities, playground equipment, and resting places, etc. In this field, it consumes only a few quantities because of high precision in processing and the high cost involved. Nevertheless, wood materials have recently

Study on the Development Direction of the Use of Wood as a Landscape Material

Table 1. Classification of using materials by types of outdoor facilities.

| Facilities \ Material*  | St | Br | Ti | Wo | Co | As | Ir | Al | Ss | FRP | Gl |
|-------------------------|----|----|----|----|----|----|----|----|----|-----|----|
| Bench                   | ●  |    |    | ●  | ●  |    | ●  |    | ●  | ●   |    |
| Wastebasket             |    |    |    | ●  | ●  |    | ●  | ●  | ●  | ●   |    |
| Water drink stand       | ●  | ●  |    |    | ●  |    | ●  |    | ●  | ●   |    |
| Signpost                | ●  |    |    | ●  | ●  |    | ●  | ●  | ●  | ●   |    |
| Kiosk                   |    |    |    | ●  | ●  |    | ●  | ●  |    | ●   | ●  |
| Shelter                 |    |    |    | ●  |    |    | ●  |    | ●  | ●   |    |
| Illumination lamp       |    |    |    | ●  | ●  |    | ●  | ●  | ●  | ●   | ●  |
| Pavement                | ●  |    | ●  |    | ●  | ●  |    |    |    |     |    |
| Boundary stone          | ●  | ●  |    | ●  | ●  |    | ●  |    | ●  | ●   |    |
| Manhole                 | ●  | ●  |    |    | ●  |    | ●  |    |    |     |    |
| Tree supporter          |    |    |    | ●  |    |    | ●  |    |    | ●   |    |
| Tree conservation cover |    |    |    |    | ●  |    | ●  |    |    | ●   |    |
| Planter                 | ●  | ●  | ●  | ●  | ●  |    | ●  |    | ●  | ●   |    |
| Prking area             | ●  | ●  |    | ●  | ●  | ●  |    |    |    |     |    |
| Overbridge              |    |    | ●  | ●  | ●  |    | ●  |    |    |     |    |
| Fence                   | ●  | ●  |    | ●  | ●  |    | ●  |    |    |     |    |
| Boundary                | ●  | ●  |    | ●  | ●  |    | ●  |    | ●  | ●   |    |
| Sound isolation wall    |    | ●  |    | ●  |    |    | ●  |    |    | ●   | ●  |
| Bridge                  | ●  |    |    | ●  | ●  |    | ●  |    |    |     |    |
| Stairway                | ●  | ●  | ●  | ●  | ●  |    | ●  |    |    |     |    |
| Slope way               | ●  |    | ●  |    | ●  | ●  |    |    |    |     |    |
| Pergola                 | ●  | ●  | ●  | ●  | ●  |    | ●  |    |    | ●   |    |
| Outdoors table          | ●  | ●  |    | ●  | ●  |    | ●  |    |    |     |    |
| Pavilion                | ●  |    |    | ●  | ●  |    |    |    |    |     |    |
| Walkng road             | ●  | ●  |    | ●  | ●  | ●  |    |    |    |     |    |
| Play facilities         | ●  | ●  | ●  | ●  | ●  |    | ●  |    | ●  | ●   |    |
| Hydroponics facilities  | ●  | ●  |    | ●  | ●  |    |    |    |    |     |    |
| Retaining wall          | ●  | ●  |    |    | ●  |    |    |    |    |     |    |
| Inclined plane          | ●  |    |    | ●  | ●  |    |    |    |    |     |    |
| Total number            | 21 | 15 | 7  | 23 | 26 | 4  | 21 | 4  | 10 | 15  | 3  |

Note) \* St: stone, Br: brick, Ti: tile, Wo: wood, Co: concrete, As: asphalt, Ir: iron, Al: aluminium, Ss: stainless steel, FRP: fiber reinforced plastics, Gl: glass

expanded gradually from being an exterior of buildings to being a part of residences (Fig.2)

(Yada S. 1991).

Exterior wood is a part of several disciplines

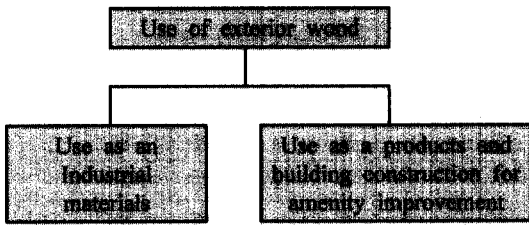
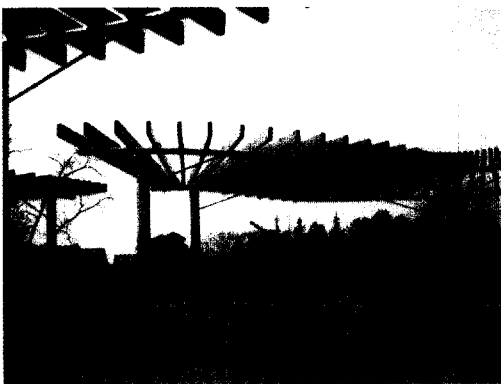


Fig. 1. Use types of exterior wood.



a. Exterior wood as fishery materials



b. Wooden play facility for soft feeling

Fig. 2. Use case of exterior wood.

such as architecture, landscape, urban development, roads, ports, agricultures, forestry, and engineering relations. The types used in concrete are as follows: (Landscape Material Drive Council. 1997, Yada S. 1991, Korean Institute of Landscape Architecture. 1999, Bae H. M. Kim J. H., Kim K. I. 2001).

A building: an open-air theater, hothouse, deck, pergola, telephone box, rest room, villa, and administrative facilities. Play facilities: a slide, seesaw, swing, jungle gym, and compound play facilities. Road and construction facilities: a tree supporter, telegraph pole, illumination lamp, guardrail, and a stairway. Guidance facilities: a signpost, information signboard, gate (entrance), and a tower. Hydroponics facilities: wooden bridge, landing stage, shore protection facilities, swimming pool, and facilities related with a waterfront. Park facilities: a bench, table, wastebasket, water drink stand, planter, and a wall, etc. A symbol molding facilities: a clock tower.

### 3.2.2. Utilization of exterior wood

It was examined that wood is used as an object of outdoors facilities. An investigation of utilization type of wood was carried out and divided into: (1) a use range, (2) a use type, (3) a processing method by the conferences and case investigations.

(1) Utilization of exterior wood by a use range

In this section, exterior wood was classified as material used in outdoors facilities. In this case, the investigation was carried out into two categories, 1) whole utilization and 2) in partial utilization (Table 2 and Fig.3).

(2) Utilization of exterior wood by a use type

In this section, exterior wood was classified as material used in outdoors facilities. In this case, the investigation carried out uncovered three categories of use types such as utilization of log or wooden board and a square lumber or laminated lumber (Fig 4).

(3) Utilization of exterior wood by a wood processing method

In the case of wood used in facilities materials, an investigation was carried out into three categories, 1) by treatment method such as

## Study on the Development Direction of the Use of Wood as a Landscape Material

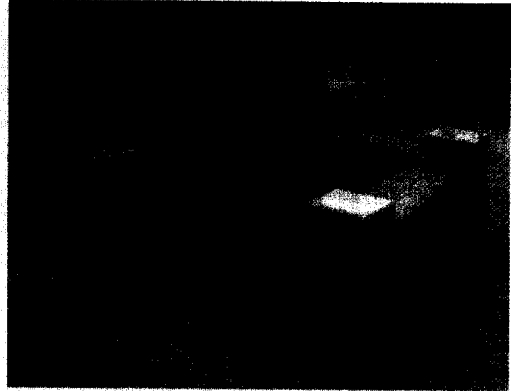
Table 2. Use range of wood by outdoor facilities.

| Wood<br>Facilities     | Use range |      |
|------------------------|-----------|------|
|                        | Whole     | Part |
| Bench                  | ●         | ●    |
| Wastebasket            | ●         | ●    |
| Signboard              | ●         | ●    |
| Kiosk                  |           | ●    |
| Shelter                |           | ●    |
| Illumination lamp      |           | ●    |
| Boundary stone         | ●         | ●    |
| Tree supporter         | ●         | ●    |
| Planter                | ●         | ●    |
| Parking area           | ●         | ●    |
| Overbridge             |           | ●    |
| Fence                  | ●         | ●    |
| Boundary               | ●         | ●    |
| Sound isolation wall   | ●         | ●    |
| Bridge                 | ●         | ●    |
| Stairway               | ●         | ●    |
| Pergola                | ●         | ●    |
| Outdoors table         | ●         | ●    |
| Pavilion               | ●         | ●    |
| Walking road           | ●         | ●    |
| Play facilities        | ●         | ●    |
| Hydroponics facilities |           | ●    |
| Inclined plane         |           | ●    |

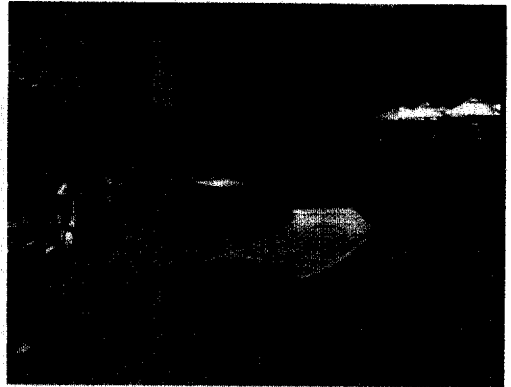
non-processing wood, 2) preservation treatment against decay, and 3) heat treatment processing or a coating processing (Fig 5).

### 3.3. Conditions of Exterior Wood as a Landscape Material

To have a good application of wood, we have to examine whether wood characteristics and materials used in the outdoors and public



a. Partial wood utilization



b. Whole wood utilization

Fig. 3. Classification of use range.

facilities can satisfy criteria for landscape materials. A required condition as landscape materials will be different from a kind of facilities, construction place, and utilization type (use range, use type, processing method) (Bae, H. M. et al. 1999).

It was examined an applicable range and direction and the point of exterior wood at outer space based on wood property.

#### 3.3.1. Necessary condition of exterior wood

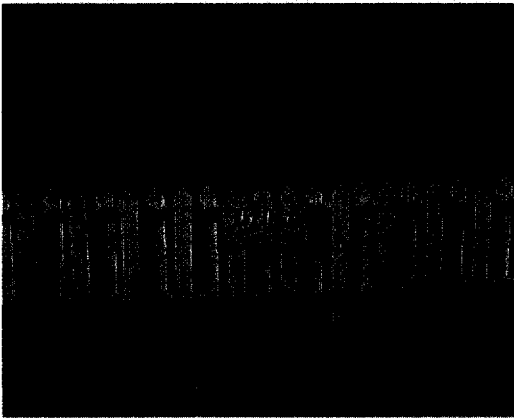
Wood is a natural material, which easily decays. The degree of decay varies with the processing degree and circumference environ-



a. Play facilities using log.



b. Observation deck using square lumber.



c. Fence using wooden board.



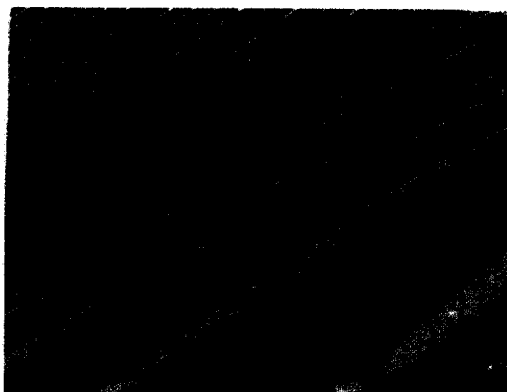
d. Laminated lumber of various types

Fig. 4. Case classification by use type of exterior wood.

ment and construction location when using wood in outdoor facilities (Haygreen J. G., Bowyer J. L. 1982). For these reasons, a sustainable new technology of wood facilities is a very important issue. New technologies for this century in wood protection have been developed in wood preservatives and treatment technology (Barnes H. M., Kim G. H. 1993). For instance, if wood material is rotting away and damaged by insect or fungi, wood facilities will be faced with dangerous conditions such as a reduction in strength, serious safety trouble, and aesthetic problems. The most serious problem of wood as

a landscape material is the phenomena of degradation. For this reason, rot may cause defects such as aesthetical and structural problems. Furthermore, one of the main defects of wood is easily deformed such as a cleavage, warping with moisture troubles. This deformation appears with time after executing the facility construction. This deformation is connected to the deformation of structure itself. Furthermore, wood is flammable. These specific properties of wood are connected directly with the reduction of safety. It is necessary that public facilities ensure peoples safety.

## Study on the Development Direction of the Use of Wood as a Landscape Material



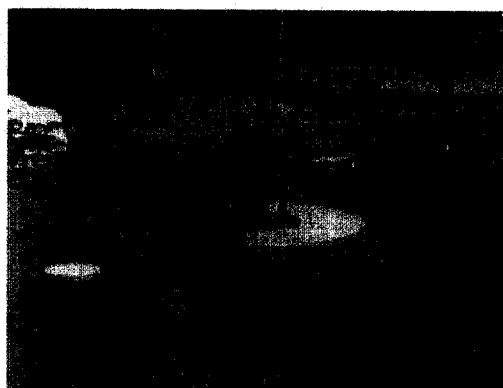
a. Use of raw wood



b. Preservation treatment log



c. Finish by heat treatment



d. Finish by painting

Fig. 5. Case classification by wood processing method.

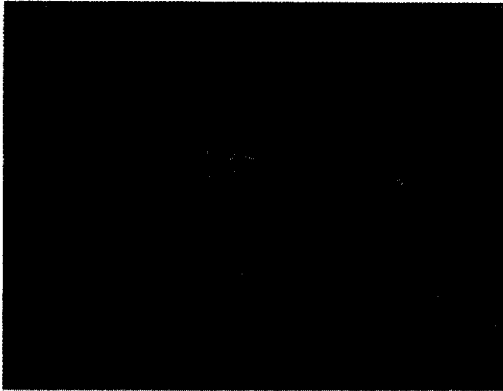
To utilize wood as a landscape material, it has to be closely examined from various angles including surface property, degree of swelling and shrinkage, drying state, retaining strength, durability, and insect damage.

### 3.3.2. Degradation phenomenon of exterior wood

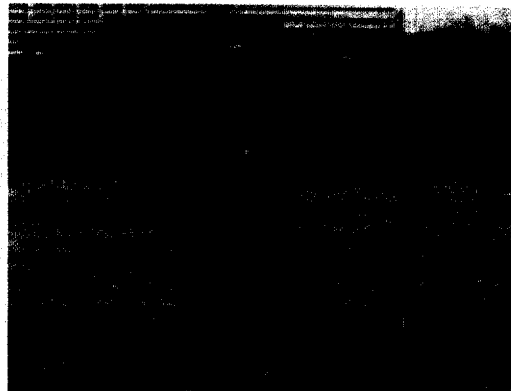
The most serious problem of landscape material is the phenomena of wood decay. This phenomenon is progressed by insect damage, termite damage, weathering degradation, abrasion, erosion, and cracking. Bio-deterioration of wood caused by bacteria, termites, water insects, fungi is a fatal defect which reduces the

woods' strength. The effect of decay on the mechanical properties of full-sized lumber was reported by Kim (Kim G. H., Barnes H. M., Lyon D. E. 1994). Weathering deterioration takes place on a wood surface due to contamination, discoloration, fading, abrasion caused by infrared rays, wind, rain, and sand dust. This phenomenon only occurs on the wood's surface. To a counter this phenomenon, protection of the inner side of wood against aesthetic problems and crack formation will help the wood's exterior. The four elements wood, oxygen, moisture, and temperature are indispensable for life and for cultivating fungi, termites, and water insects. The growth factor of fungi





a. Decay start at cleavage position



b. Crack generation at joint position

Fig. 6. Position of degradation.

depends on water and temperature. Water in wood is divided into bound water and free water. Decaying fungi cannot use the bound water in wood, air-dried wood at around 10% or 15% moisture content (MC) cannot decay easily. In general, there is very little danger of decay if wood is below the fiber saturation point (about 28% MC). A few fungi are able to grow slowly at moisture contents slightly less than this MC. Wood scientists recommend that wood be treated with preservatives if it is to be used under conditions where it will be above 20% MC continuously. In most cases, wood facilities can be designed to avoid conditions where the MC of wood will exceed this amount. But under hygroscopic environment of the saturation state, bound water in wood becomes capillary condensation, which is free water. In this state, some fungi can develop under high humidity and wood decay can be quickly generated. On the other hand, fungi activity is reduced above 150% MC because of the lack of oxygen. Therefore, wood as an interior material in buildings and water saturated wood cannot be easily decayed for these reasons (Japan Wood Construction Organization. 1990, Japan Wood Products- Information & Research Center. 1999, Yada S. 1991).

### 3.3.3. Complement direction of exterior wood

From the above analysis, problems with wood as a landscape material were as follows:

Durability problem due to decay, insect damage, etc. Treatment of connecting joints between wood and different materials, and processing parts. Treatment of wood in contact with soil or water. Deformation by exposed environmental change. Irregular wood quality and restriction of construction. Difficulties on maintenance and administration of public facilities. Difficulties on amendment and change in future, but easily processing.

Therefore, in the case of using wood in outdoor facilities, a protection method against degradation has to be prepared. Effective treatment method of wood preservation against fungi and insects should be studied. Nowadays, research and development of processing technology for exterior wood and effective protection method on wood degradation is most required.

## 4. CONCLUSION

In analysis of use conditions of wood, wood was used with various types not only in indoor

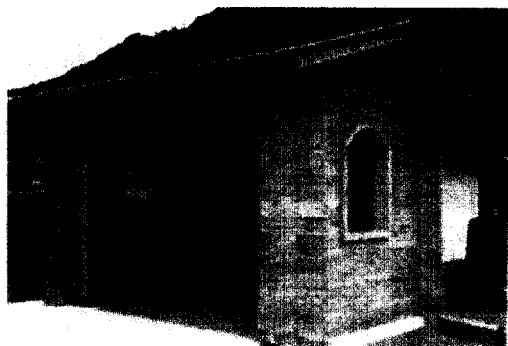


Fig. 7. Impression of this facility is dry, although wood was used.

but also outdoors equipment. In the case of wooden facilities, wood can be utilized quite differently by use range, use type, and use method. Use of the wood material is often restricted in use range and use shape. In addition, a use case of ready-made products was much easier to see than that of the place conditions, surroundings environment, and design aspects of wood. In Fig.7, we found that wood as a landscape material is frequently dry, although it is used as a material for outdoor facilities. From this result, it was considered that the assessment of the facilities atmosphere is not determined by only the choice of materials. Therefore, development of materials for facilities is very important. But in this case, we found that material design is in harmony with the surroundings. Research and development of various wood products should be carried out to cover as many cases of the facilities as possible. Therefore, a development direction of wood materials is a variety of wood components than complete wood articles. By these considerations, the best design and construction of facilities can be achieved.

In direction set-up of durable planning for use of exterior wood, it is important to consider the direction establishment of durable design and planning of wood for outdoor facilities.

Wood materials used as landscape facilities can be exposed to combinations of weathering and some fungi. But several attempts have been made to overcome such disadvantageous characteristics. A point to the satisfactory use of wood as landscape facilities is an understanding of the agents and degradation conditions. Wood property as exterior material has to become more durable against various decaying agents. The research on wood protection for outdoor facilities as landscape materials covers the following categories: Adoption of adequate treatment methods to constrain degradation: wood surface coating treatment. Chemical modification: introduction of chemical treatment and use method in consideration of wood features. Wood preservation treatment: wood preservatives. Biological control: microbiological study of wood decaying fungi. Isolation of durable trees: develop wood preservatives from anti-corrosion properties of wood and use naturally decay-resistant tree species. Improvement of durability through a planned conservation administration

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