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International Comparison of Training Goals in Wooden Construction Education: Focusing on the Contents of Wooden Construction Systems for Housing, Commercial, and Public Buildings

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Abstract: This study aims to examine the challenges and future directions of large-scale wooden construction education at universities in Japan and Finland. It compares the wooden construction curricula at universities and the architectural education initiatives undertaken by firms specializing in large-scale wood construction design in both countries. The target applications for large-scale wooden construction are residential, commercial, and public buildings. Comparing university education revealed many commonalities between the two countries, allowing them to be classified into two types: "seminar-centered" and "lecture-centered". Japanese universities are categorized by building type and scale for educational purposes. Finnish universities focus their education on the properties and functions of wood. Based on these results, we infer that incorporating both Japan's architecture-planning-focused education and Finland's materials-focused education into teaching, using familiar housing buildings as a theme, will lead to the wider adoption of large-scale wooden construction.

Key words: Wooden construction education, large-scale wooden buildings systems, housing buildings, commercial buildings, public buildings.

1. Introduction

1.1 Background

To contribute to realizing a decarbonized society, the use of wood in buildings is being promoted worldwide. Wood is the most suitable structural material for the open building concept in terms of adaptability. In recent years, new structures, construction methods, and materials for large wooden buildings have been developed. Support for the acquisition of design, construction, and performance understanding techniques in university education is essential for the introduction of wooden construction. Large wooden buildings in this survey are buildings with a main structure of wood or mixed construction, with three or more floors or a total floor area of 500 m^2 or more.

1.2 History of Wooden Construction in Japan and Finland Background

This study focuses on Japan and Finland. It compares the two countries' approaches to wooden construction education. Japan and Finland share abundant forest resources (forest area as a percentage of land area: Japan (J) 68%, Finland (F) 73%), and a deep history of wooden construction (Fig. 1).

Japan has been using traditional wooden construction methods for about 10,000 years. The Great Kanto Earthquake of 1923 prompted calls for stricter earthquake safety standards. Buildings were to be made incombustible. In 1987, the height restrictions on large-section wooden

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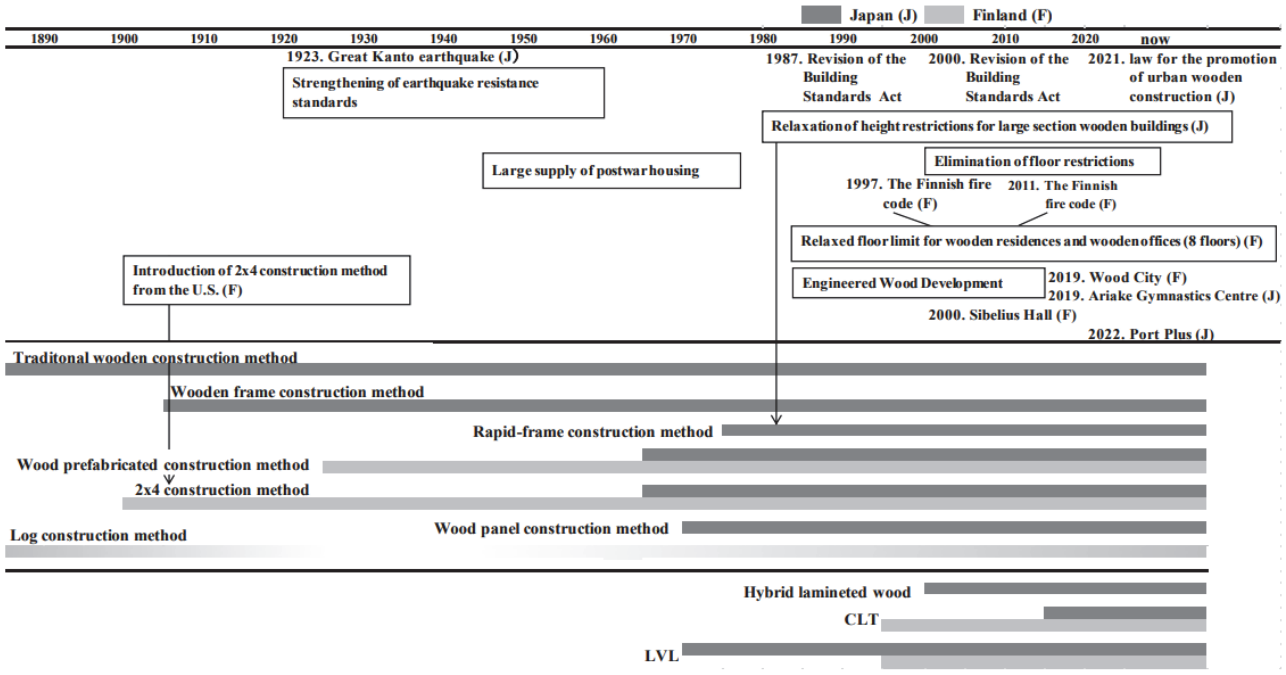

Fig. 1 Changes in wooden construction methods in Japan and Finland.

buildings were relaxed, making it possible to construct buildings using the wood frame construction method. In 2000, restrictions on the number of floors in wooden construction were relaxed to allow 4-story wooden buildings. This accelerated the movement toward the realization of mid- to high-rise wooden buildings. In recent years, new wood materials such as hybrid laminated wood and CLT (Cross Laminated Timber) have been developed. Wooden construction has entered a new phase, with the construction of large wooden buildings becoming possible.

In Finland, traditional wooden construction built of logs has been the norm since the 1st century BC. In the 20th century, the 2x4 construction method introduced from the United States began to spread. Since the 1990s, industrialized prefabricated construction methods using laminated lumber such as CLT and LVL (Laminated Veneer Lumber) have been developed, and wooden construction of two or more stories has been actively experimented with. Later, amendments to the Finnish fire code in 1997 and 2011 allowed the construction of wooden houses and wooden offices up to eight-stories, respectively.

As described above, we decided to compare Japan and Finland, which have a deep history of wooden construction and share similarities in that both countries have been working to reform their laws since around 1990.

1.3 Accreditation Requirements for Architectural Education in Japan and Finland

The accreditation requirements for architectural education in both countries are presented for architects and architects as defined by each country. The Japanese Architectural Education Accreditation requires that students acquire at least 60 credits (one credit is equivalent to 45 hours) in architecture-related subjects such as “architectural design and drafting,” “architectural environmental engineering,” and “structural mechanics,” which are “subjects related to architecture designated by the Minister of Land, Infrastructure, Transport and Tourism” in order to be eligible to take the architectural examination [1]. In 2012, JABEE revised its accreditation criteria in order to ensure international architectural education standards and established its own accreditation category “Bachelor/Master of

Architecture" to accredit six-year educational programs combining undergraduate and graduate programs in accordance with the UNESCO-UIA Charter of Architectural Education, an international standard specialized for architectural design and planning required by UNESCO-UIA. The classification "Bachelor/Master of Architecture Program" was thus established [2]. This program accredits a six-year educational program combining undergraduate and graduate programs specializing in architectural design and planning in accordance with the UNESCO-UIA Charter on Architectural Education.

In Finland, on the other hand, the accreditation of architectural education was revised in the early 1990s so that a bachelor's degree in architecture alone is no longer sufficient for graduation, but a master's degree or higher is required. The standard program for the Master of Architecture consists of 160 credits (1 credit = 40 hours) and includes 2 to 10 credits (1 credit = 3 weeks) of practical training, including on-the-job training. The master's degree can be obtained in five years according to regulations. The Building Code under the jurisdiction of the Ministry of the Environment has no provisions regarding architects [3].

1.4 Purpose

Through a comparison between Japan and Finland, which have similar backgrounds regarding forest resources and wooden construction, this study will clarify the following three points. In doing so, the project will provide challenges and directions for large wooden buildings education in universities in both countries.

Purpose 1: To understand the educational content of wooden architecture in universities in both countries;

Purpose 2: To understand the methods of architectural education by firms specializing in the design of large-scale wooden buildings in both countries and the educational content required for design education at universities;

Purpose 3: To discuss the characteristics and challenges of design education for wooden architecture in both countries.

2. Literature Review

Recent studies have shown an increasing international trend toward integrating sustainability and experiential learning into architectural education. Antonini et al. [4] examined innovative teaching approaches emphasizing collaboration and real-world experience, while Gomes et al. [5] demonstrated that students can effectively apply Life Cycle Assessment (LCA) and circular design through a learning-by-doing approach.

Also Frank et al. [6] published a comparison of the current state of planning education in European countries, including Spain, Portugal, and 10 other countries, showing that the educational model is increasingly diversified. However, no studies have been conducted specifically for wooden construction. In a study of wooden construction education, Araya et al. [7] compared wooden construction education in Latin America and found that universities in countries with a well-developed wooden construction industry had an important component of specialized wooden construction courses. However, no studies have specifically investigated this topic in Japan and Finland, both of which have a rich history of wooden construction. Therefore, this study offers novel insights.

In particular, Finland has universities that offer specialized education for working professionals, and there are wood programs that specialize in wooden construction. Japan, on the other hand, has traditional wooden construction techniques. For this reason, it is significant that this study focuses on Finland, which has focused on wooden construction education, and Japan, which has a deep history of wooden construction.

3. Research Methodology

In this study, a syllabus survey was conducted to achieve Purpose 1, and an interview survey technique was used to achieve Purpose 2.

3.1 Purpose 1: Methodology for Syllabus Survey

A syllabus survey was conducted to understand the educational content of Japanese and Finnish universities that offer wooden construction education. In Japan, 131 universities offering architecture degrees are eligible. In Finland, the program will cover three universities offering degrees in architecture and one university of applied sciences offering educational programs specializing in wooden construction. For this study, three universities were selected from each of the two countries that focus on wooden construction education, in descending order of the percentage of hours of study in wood-related classes. The Japanese syllabus survey was conducted using the 2024 syllabus search function on each university's website, searching for the keyword "wooden construction". The following five items were extracted from the search results. The extracted information is the course title, grade level, number of credits, class formation, and number of class study hours for classes with content related to wooden construction. The number of class study hours is the sum of the number of class hours and the number of hours for self-study such as preparation and review. The class formation was divided into three categories: lecture, exercise, and design practice, and the total number of study hours for each was converted. Lectures are a form of teaching in which knowledge is acquired through explanations by the teacher and study centered on the textbook. Exercises are a form of class in which students apply the knowledge they have learned and acquire practical skills by actually solving problems and conducting experiments. Design practice is a form of class in which students experience the design process and develop their design skills by actually creating drawings and models based on the design theory learned in lectures. Then, the percentage of hours of study in wooden construction-related classes was converted. The syllabus survey of Finnish universities was conducted in the same way as in Japan, with five items selected. The number of class hours was converted to the number of study hours per ECTS (European Credit Transfer and Accumulation System) credit.

3.2 Purpose2: Methodology for Interviewing Companies Survey

Interviews were conducted with firms involved in large-scale wooden construction and engineering to determine what type of architectural education they provide and what type of architectural education they require from universities. The interviewees were a Japanese organizational design office and two general contractors with experience in large wooden buildings, and a Finnish organizational design office and an architectural design office with experience in large wooden buildings. Interviews with design staff were conducted throughout August and September. Survey items include architectural education provided in the office, specific education methods, education instructors, education targets, and whether outside advisors participate.

3.3 Purpose 3: Methodology for Comparing Wooden Building Design Education in the Two Countries

For each of the six items discussed in Section 4.2, summarize the extent to which the universities discussed in Section 4.1 provide education. For each university, convert the number of hours of item-specific education into total hours of woodworking-related education.

4. Findings

Education in wooden construction can be divided into three categories: quantity, method, and quality (Fig. 2). Quantity refers to the total hours of study in wood-related classes; method refers to the curriculum construction, such as lectures and exercises; and quality refers to the content of classes related to wooden construction. Section 4.1 discusses quantity (hours of study) and method (class formation), and Section 4.2 discusses quality (educational contents).

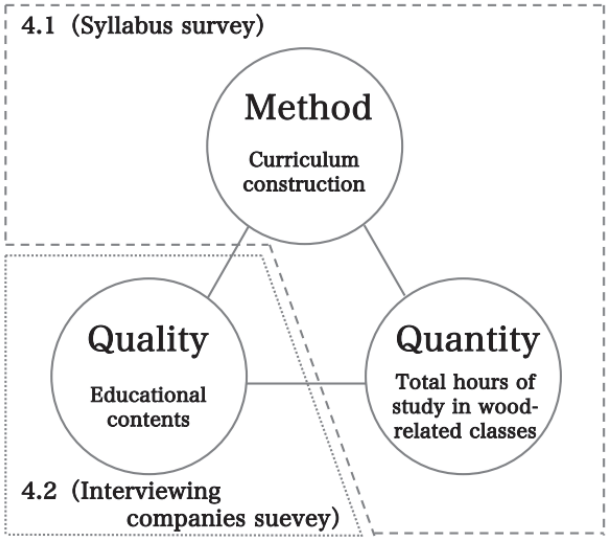

Fig. 2 Category of wooden construction education.

4.1 The Educational Content of Wooden Construction in Universities

Table 1 shows the results for each of the three universities that had the highest percentage of hours of study in wood-related classes in both countries. F-b-s university in Finland is F-b university's program for working professionals, which is a one-year intensive study of wooden construction. F-b-s university had a particularly high percentage of hours of study in wood -related classes, at 79.0%. It is clear that program is focusing on education related to wooden construction, with 1,308 hours devoted to wood-related classes during the one-year period of study.

We also compared the percentages of time spent studying lectures, exercises, and design practice at each university (Fig. 3). As a result, F-a university has the highest total number of hours of study in wood-related classes, with 1,836 hours. The trend in the ratio of hours of study in lectures, exercises, and design practice is similar for J-a university and F-b-s university. F-a university and J-b university differ in the total number of study hours. However, the percentage of time spent studying lectures is very large, at 48% at F-a university and 64% at J-b university.

These results indicate that there are differences in the total number of hours of study in wood-related classes at Japanese and Finnish universities. However, similar trends were observed in the distribution of the number of hours of study for lectures, exercises, and design practice. Specifically, they can be classified as follows: "lecture-centered," which emphasizes lectures as in F-a and J-b universities; "exercise-centered," which emphasizes exercises as in F-b and J-a universities; "design-centered," which emphasizes design exercises as in J-c universities; and "balanced," which distributes each class type equally as in F-b-s universities.

Table 1 Percentage of hours of study in woodworking-related courses at each university.

	University	Name of Department	Number of students per grade	Number of teachers who teach wood-related classes / Number of teachers in the	Total hours of study in wood-related classes (hours) (a)	Study hours equivalent to graduation credits (hours) (b)	Percentage of hours of study in wood-related classes (%) (a) (b)
Finland	F-a university	Faculty of Technology (With wood technology course)	-	6/51	1,836	6,480	28.30%
	F-b university	School of Arts, Design and Architecture	39	7/13	566	4,806	11.80%
	F-b-s university	School of Arts, Design and Architecture (Wood program)	-	7/7	1,308	1,655	79.00%
Japan	J-a university	Faculty of Technologists, Department of Building Technologists (With wooden construction course)	150	7/8	1,052	5,580	18.90%
	J-b university	Faculty of Engineering, Department of Architecture	150	17/14	622	5,580	11.20%
	J-c university	School of Art and Design, Department of Art and Design	110	7/6	589	5,580	10.60%

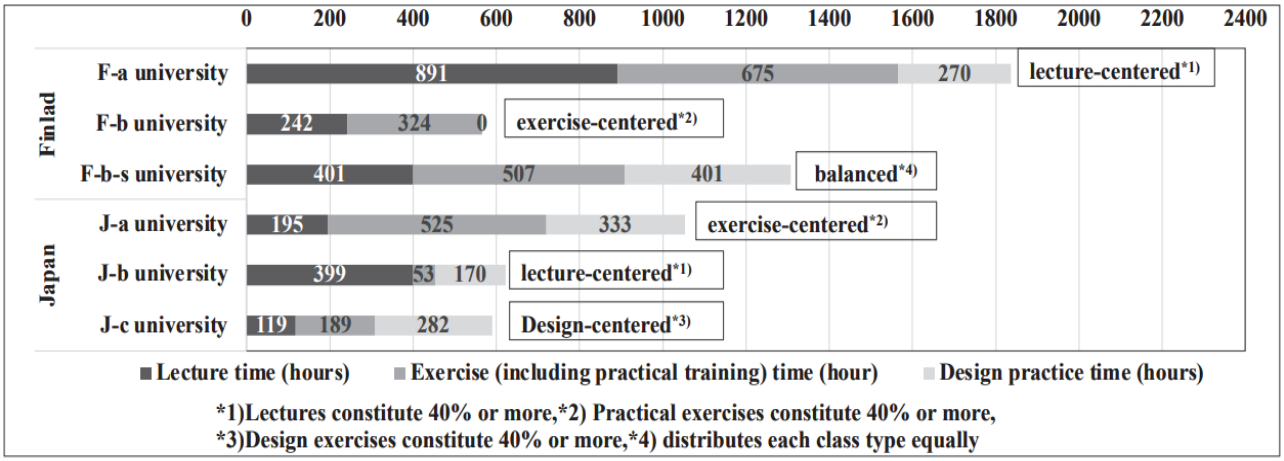

Fig. 3 Percentage of time spent studying lectures, exercises, and design practice at each college.

Looking at the content of the lectures and exercises for each type, at the "exercises-centered" J-a university, students learn about wood splitting and straightening, construction methods, new wooden structure methods, wood frame construction methods, conservation and restoration, and building regulations in the lectures; wood foundation and practice, wood stress and practice, wooden structure and experiment, wooden structure design exercise, and wooden structure design in the exercises; and basic design drafting and practice, wood house design and practice, and applied building design and practice in the design practices. At the "lecture-centered" F-a university, students learn about forest and raw materials, wood technology physics, wooden construction, joinery industry, furniture industry, sawmill industry and further processing, plywood and LVL industries, other engineered wood products and wood products in the building industry in the lectures; woodworking and work safety, glueing, surface treatment, drying and thermal modification, and industrial processes and production in the exercises.

4.2 Methods of Architectural Education by a Firm Specializing in the Design of Large Wooden Buildings and the Educational Content Required for Architectural Education at Universities

The results of the company interviews are shown in Table 2. Table 2 shows that Japanese firm J-1 conducts seminars for all employees involved in design and engineering, J-2 conducts lectures for employees involved in wooden projects, and J-3 conducts study sessions for employees involved in planned projects. This is why each Japanese company provides in-firm architectural education. On the other hand, both F-1 and F-2 companies in Finland conducted architectural education within project teams in collaboration with other companies, mainly through discussions. However, only J-3 companies utilized their own manuals.

Interviews were conducted with each company regarding the abilities and knowledge they wanted students to acquire at university. J-1 Company asked the audience to "understand the difference between wood, reinforced concrete, reinforced concrete and steel, wooden construction, fireproofing, construction methods, correct drawings/fireproofing: fireproofing vs. quasi-fireproofing, interior restrictions, etc." and a requested knowledge of wooden structure and construction methods and laws related to wooden structures. Designers at F-2 company commented on the need for knowledge about the properties of wood, stating, "It is always a question of how to use a material that is completely different from what is used in a wood-frame building compared to a concrete or steel-frame building." Based on the above results, six items were identified: a. properties of wood; b. manufacture of wood products; c. knowledge of wooden structure and construction methods; d. knowledge of laws related

to wooden construction; e. history of wooden construction; and f. industrial production of wooden construction.

4.3 Characteristics and Issues of Wooden Building Design Education in Japan and Finland

For each of the six items discussed in Section 4.2, Table 3 summarizes the extent to which the universities discussed in Section 4.1 provide education. For each university, the ratio of hours of itemized study to the total number of hours of study in woodworking-related classes was converted. In Japanese universities, emphasis is placed on the acquisition of "c. knowledge of wooden structures and construction methods". In

Table 2 In-firm training by a company specializing in wooden construction design.

		Japan			Finland	
		J-1	J-2	J-3	F-1	F-2
Corporate structure		Organization Architectural Design	General Contractor	General Contractor	Organization Architectural Design	Architectural Design Office
Number of design-related employees (Total number of employees)		226 -363	2,427 -9,253	2,179 -7,786	29	10
Date of interview		Aug. 21, 2024	Sep. 9, 2024	Sep. 12, 2024	Sep. 17, 2024	Sep. 18, 2024
Subjects and Methods of Education	Architectural education (Information sharing and study sessions)	In- company	In- company	In- company	Project team	Project team
	Specific education methods	Seminars	Lectures	Study sessions	Discussion	Discussion
	Education instructors	Design Office Supervisor	Timber Promotion and Design Department	Wooden Construction Promotion Division	–	–
	Education targets	All employees involved in design and engineering	Employees involved in wooden projects	Employees involved in planned projects	–	–
	Whether outside advisors participate	○	×	×	○	×

Table 3 Status of implementation by each university regarding abilities sought by companies.

	Japan						Finland					
	J-a university		J-b university		J-c university		F-a university		F-b university		F-b-s university	
	Hours of study (hours)	Percentage of class hours by item(%)	Hours of study (hours)	Percentage of class hours by item(%)	Hours of study (hours)	Percentage of class hours by item(%)	Hours of study (hours)	Percentage of class hours by item(%)	Hours of study (hours)	Percentage of class hours by item(%)	Hours of study (hours)	Percentage of class hours by item(%)
a. Properties of wood	90	8.60%	215	34.50%	175	29.70%	756	41.20%	269	47.50%	743	56.80%
b. Manufacture of wood products	0	0.00%	23	3.70%	0	0.00%	1,080	58.80%	108	19.10%	67	5.10%
c. Knowledge of wooden structure and construction methods	895	85.10%	317	50.90%	263	44.60%	0	0.00%	189	33.40%	200	15.30%
d. Knowledge of laws related to wooden construction	20	1.90%	13	2.10%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
e. History of wooden construction	29	2.80%	38	6.10%	111	18.80%	0	0.00%	0	0.00%	209	16.00%
f. Industrial production of wooden construction	18	1.70%	17	2.70%	41	7.00%	0	0.00%	0	0.00%	89	6.80%

particular, at J-a and J-b universities, the item accounts for more than 50% of the total number of hours of woodworking-related classes. In Finland, F-b-s university specializes in mastering “a. properties of wood” and F-a university in “b. manufacture of wood products”. These results indicate that the emphasis of wooden construction education differs between Japanese and Finnish universities.

For all 32 items identified as necessary for design education of wooden architecture in Section 4.1, we summarized the status of implementation in companies, the status of implementation in universities, and the educational content that companies require from universities. Japanese firms tend to provide comprehensive education in the areas of planning and design, environment and facilities, regulations, structure, and construction. “A-b. Learning how to read and draw plans such as floor plans, elevations, and rectangular drawings,” “C-a. Law concerning fire resistance of wooden buildings,” and “E-c. Composition of project costs for wooden buildings” have been implemented. The following topics are being implemented. Comprehensive education tends to be provided. At the university, these include “A-g. How to obtain information on the advantages and good practices of wooden construction”, “D-h. How to obtain information on the advantages and good practices of wooden construction”, and “D-h. How to choose a structural type, such as shaft and frame construction methods”. However, “B-d. Methods to ensure sound insulation performance of wooden floors” and “E-c. Composition of project cost for wooden construction” are only partially implemented. In Finnish companies, there are fewer items for internal training than in Japan. At the university, these include “E-b. Review of project schedule according to materials to be used in wooden construction” and “E-e. Establishment of relationships with stakeholders involved in wooden construction projects”.

5. Discussion

The comparison reveals that Japan and Finland take different approaches to timber construction education.

Japanese universities emphasize structural and regulatory aspects, aligning with the national qualification system and professional practice, while Finnish universities focus on material properties and production processes rooted in their forest industry.

These differences indicate that Japan aims for comprehensive practical education supporting architectural implementation, whereas Finland promotes material-based specialization.

The contrast reflects each country’s social and industrial background in wooden architecture.

6. Conclusions and Further Research

A syllabus survey was conducted to understand the educational content of Japanese and Finnish universities that offer wooden construction education. Interviews were conducted with firms to understand the architectural education provided by firms engaged in large wooden buildings and technology and the requirements for architectural education at universities. The results of our analysis based on these surveys are presented below.

In response to Purpose 1, “Educational content of wooden construction in universities in both countries,” the following three points were identified.

1. In terms of the total number of hours of study in wood-related classes at Japanese and Finnish universities, differences were found, with Finnish universities having more hours of study.

2. The distribution of learning time among lectures, exercises, and design exercises tends to be almost the same, with no differences among countries, and can be classified into the following types: “lecture-centered,” which emphasizes lectures; “exercise-centered,” which emphasizes exercises; “design-centered,” which emphasizes design exercises; and “balanced,” in which each class type is equally distributed.

3. In Japanese architectural design education, the focus tended to progress from small-scale projects like houses to larger-scale types such as residential

buildings and commercial facilities. In Finland, design assignments prioritized the properties and functions of wood itself, rather than being tied to specific uses such us housing or offices.

In response to Purpose 2, "architectural education needed by companies involved in the design, construction, and technological development of large wooden buildings" and "requests for architectural education at universities," the following two points were raised.

1. There are differences between Japanese and Finnish companies in the methods and target audiences of architectural education. In Japan, projects are conducted in-house, with education primarily occurring through internal information sharing and study sessions. In Finland, however, designers and engineers from multiple design offices often collaborate on projects, learning through collective discussions.

2. Companies require six competencies from universities: properties of wood, production of wood products, knowledge of wooden structures and construction methods, knowledge of laws related to wooden construction, history of wooden construction, and industrial production of wooden construction.

In response to Purpose 3, "Characteristics and issues in design education for wooden architecture in Japan and Finland," the following two points were raised.

1. The focus of wooden construction education differs between Japanese and Finnish universities. While Japanese universities offered "c. knowledge of wooden structure and construction" through lectures, Finnish universities offered "a. properties of wood" and "b. manufacture of wooden products" through exercises.

2. In-house training in Japan tends to be comprehensive, covering planning and design, environment and facilities, regulations, structure, and construction. On the other hand, university education emphasizes the fields of planning and design, regulations, and structures, and only partially implements the fields of environment, equipment, and construction. In-house education in Finland has fewer items than in Japan, but university education is focused on the construction field.

Based on these results, Japanese wooden construction education comprehensively covers design, structure, relevant laws, facilities, and construction, with a large proportion of content delivered through lectures. To improve architectural education for large- scale wooden structures, it seems necessary to enhance hands-on exercises and design practice to effectively integrate theoretical knowledge.

In contrast, Finland's architectural education for designers and engineers is organized into separate departments. Consequently, departments focused on training designers have a high percentage of design training. Since some corporate designers commented on a gap between their opinions and those of engineers regarding construction, it would be effective to incorporate learning about structure and law into design education.

Furthermore, we infer that incorporating both Japan's architecture-planning-focused education and Finland's materials-focused education into teaching, using familiar house buildings as a theme, will lead to the wider adoption of large-scale wooden construction.

Future challenges include clarifying the roles of in-university and in-company education in wooden construction and optimizing the educational content and goals of each. Then, different educational models should be developed based on the different backgrounds, such as the amount of forest resources, building culture, policies and technological levels in each country.

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