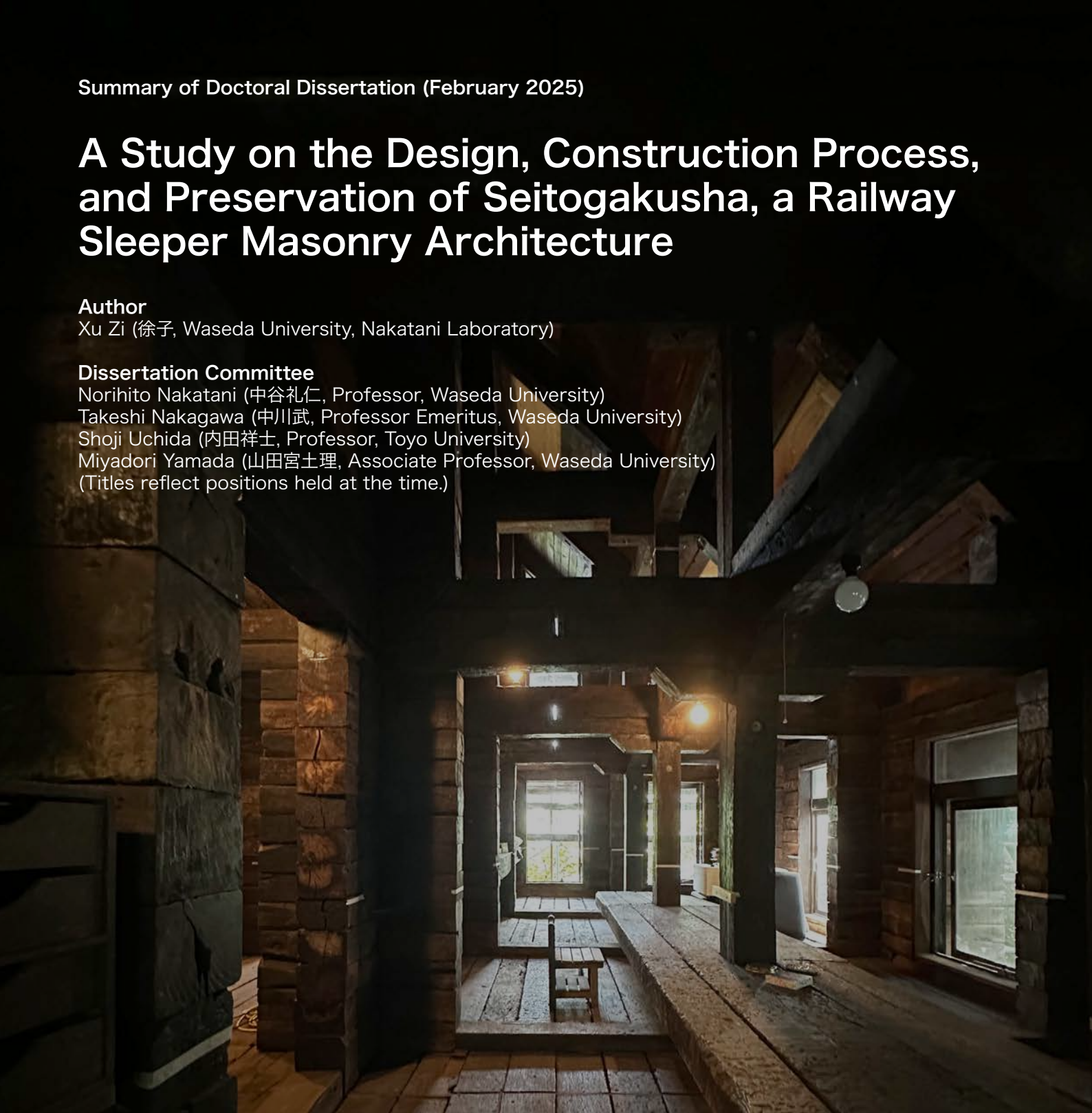
Summary of Doctoral Dissertation (February 2025)

A Study on the Design, Construction Process, and Preservation of Seitogakusha, a Railway Sleeper Masonry Architecture

Author
Xu Zi (徐子, Waseda University, Nakatani Laboratory)

Dissertation Committee
Norihito Nakatani (中谷礼仁, Professor, Waseda University)
Takeshi Nakagawa (中川武, Professor Emeritus, Waseda University)
Shoji Uchida (内田祥士, Professor, Toyo University)
Miyadori Yamada (山田宮土理, Associate Professor, Waseda University)
(Titles reflect positions held at the time.)



Seitogakusha (生闘学舎・자립) , a self-built architecture located on Miyake Island, constructed using approximately 5,000 repurposed railway sleepers (枕木, makura-gi) as the primary building material. This building project was led by Masao Takano (高野雅夫, 1939-), a figure without formal architectural training, alongside participants of the night school movement and the Zenkyoto (All-Campus Joint Struggle League). They commissioned the design from architect Susumu Takasuga (高須賀晋, 1933-2010) and sought construction guidance from master carpenter Hideo Miyashita (宮下英雄, 1914-unknown). The construction, which spanned from 1976 to 1980, was characterized by collaborative, non-professional efforts. Despite winning the Japan Institute of Architects Award in 1981 and being recognized as a significant piece in the history of modern Japanese architecture, the building remained largely unexplored in academic studies for over four decades. Today, more than 40 years after its completion, the building is maintained by Tadazo Tozawa (戸沢忠蔵, 1944-), a master carpenter who has continued the original construction philosophy, including efforts to replace the aging roof structure.

This research aims to clarify the design and construction process of Seitogakusha, an architectural structure from a historical architectural perspective and proposes conservation strategies for its future preservation.

Main Hall (June 2023)

Entrance (June 2023)

Attic (June 2023)

1970s Tokyo[1]

Construction Site of Seitogakusha[2]

Old Railway Sleepers

Backgroud

Self-Build

In the 1970s, as Japan experienced rapid industrialization in its construction sector, the broader social context also saw the decline of the student protest movements. Amid these changes, self-build emerged as a significant architectural trend, reflecting a critical response to the highly industrialized and standardized methods of modern architectural production. Seitogakusha, completed between 1976 and 1980, stands as a prominent example of this movement, embodying the spirit of autonomous construction.

Rebirth of the “Defeated”

Following the decline of student movements in the 1970s, some participants from the night school movement and the Zenkyoto began to see themselves as “defeated”. Influenced by the philosophy of self-reliance, they sought to build their own school as a means of reclaiming autonomy and creating a space for independent learning and survival.

The chosen site for this endeavor was Miyake Island (三宅島), historically known as a place of exile. The primary construction material was approximately 5,000 reused railway sleepers, known for their twisted, deformed, heavy, and hard nature, with a persistent odor from creosote and other preservatives. Each sleeper weighs between 50 and 70 kg, making them extremely challenging to process. The construction process, characterized by prolonged, physically demanding labor, became a literal “struggle” for the builders.

Upon completion, the structure was officially named “Seitogakusha,” signifying “life, struggle, and self-reliance.” In 1982, the builders documented this intense and challenging construction process in a publication titled The Rebirth of the Defeated: Seitogakusha Construction Record (敗者復活戦 生闘学舎・자립建設記録, 修羅書房, 1982).

Reuse of Railway Sleepers

With the expansion of global railway networks in the early modern period, wooden railway sleepers were widely used and eventually replaced, resulting in numerous reuse cases worldwide. Among these, Seitogakusha stands out not only for the sheer volume of sleepers used but also for the formation of a tightly-knit construction community centered around the labor-intensive processing of these materials. This aspect sets it apart as a unique example within the broader category of railway sleeper architecture.

(Chapter 1)

Design Principles Based on the Living Quarters Design Drawings (Chapter 2)

The design drawings produced by Susumu Takasuga for Seitogakusha were collected, organized, and systematically analyzed to clarify the design concepts formulated during the planning stage from 1975 to 1976. This analysis reveals the architectural intentions and the social context underlying the design of Seitogakusha, which can be summarized in the following two key principles:

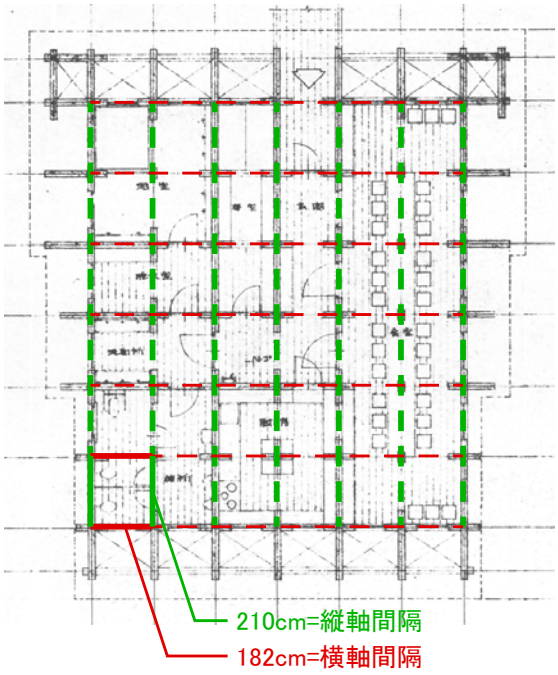
Relationship Between External Support Walls and Building Regulations

The first key design principle concerns the distinctive external buttress walls of Seitogakusha, which project significantly beyond the main structural plane, casting deep shadows along the exterior.
Architect Takasuga based his design on the Building Standards Act and its related enforcement orders that were in effect in Japan at the time. Since no formal technical standards existed for stacked sleeper masonry structures, Takasuga adopted the structural assessment criteria for timber frame buildings with diagonal bracing, which were already established in the regulations. This approach provided a basis for calculating the required wall lengths and structural strength, allowing the design to pass the necessary building permit approvals.

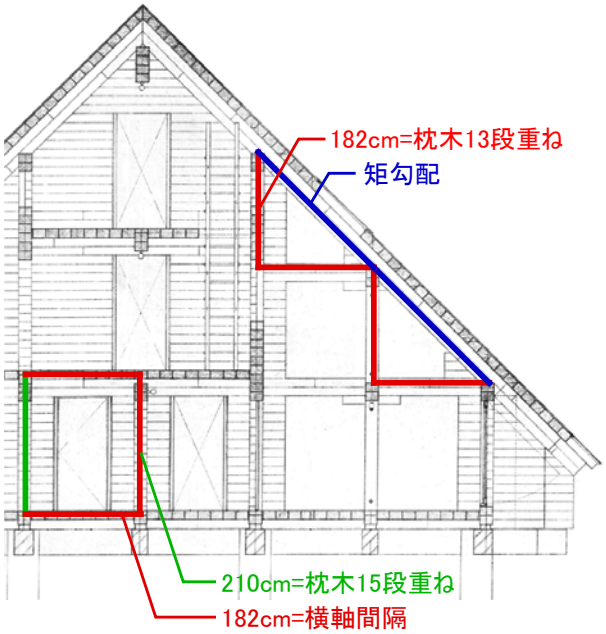
Modular System Based on Standard Sleeper Dimensions

The second key design principle is the use of a modular system based on the standardized dimensions of the railway sleepers (210 cm in length, 20 cm in width, and 14 cm in height) that form the primary structural material of Seitogakusha. This modular approach governed not only the overall floor plan and sectional layout but also the detailed dimensions of doors, windows, beams, and columns. Critical components like joint positions and dowel (ダボ, dabo) placements were also precisely aligned according to this module, ensuring consistency throughout the design.
Moreover, the roof pitch was directly influenced by the height of the sleepers. By aligning the horizontal spans of the building with integer multiples of the sleeper height, Takasuga achieved a perfectly proportional 45-degree roof slope, a key feature of the building's structural logic. This approach resulted in a consistent and repeatable modular framework that extended from the foundational layout to the final roof structure.

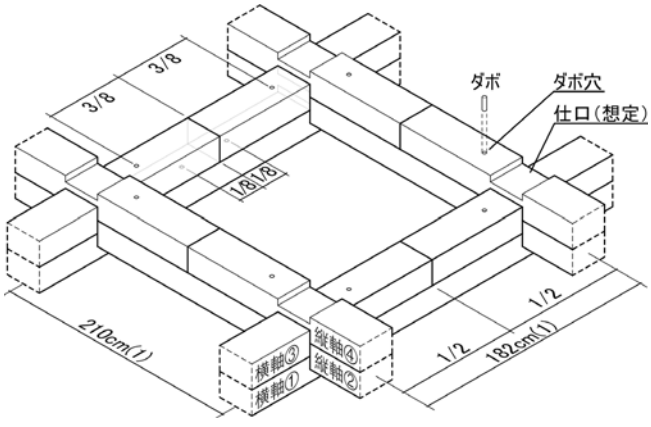
(Chapter 2)



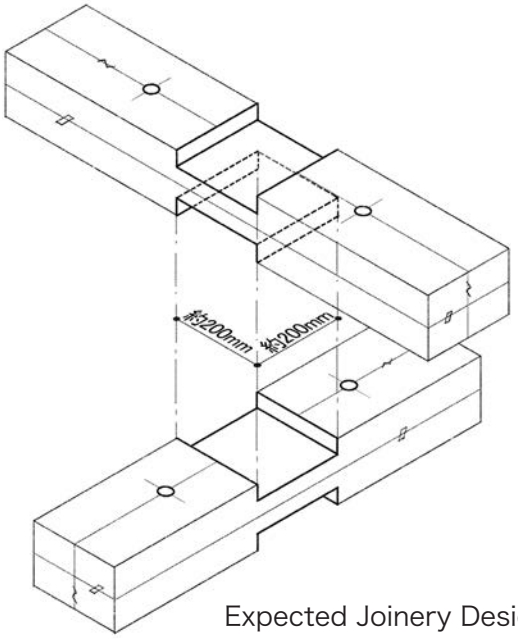
Plan Layout Based on the Drawings[3]



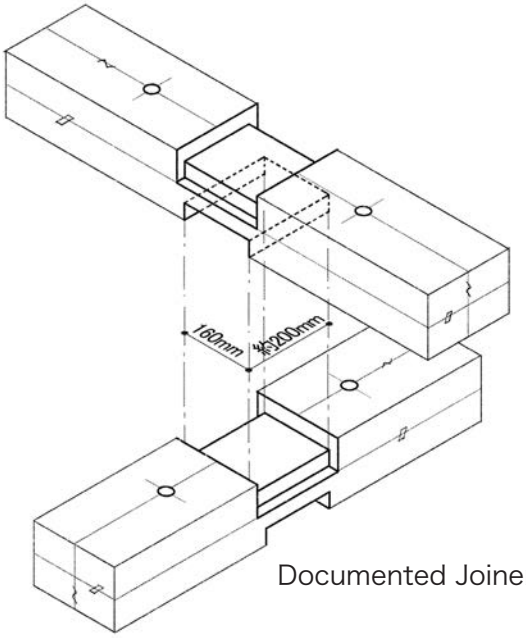
Section Design Based on the Drawings[3]



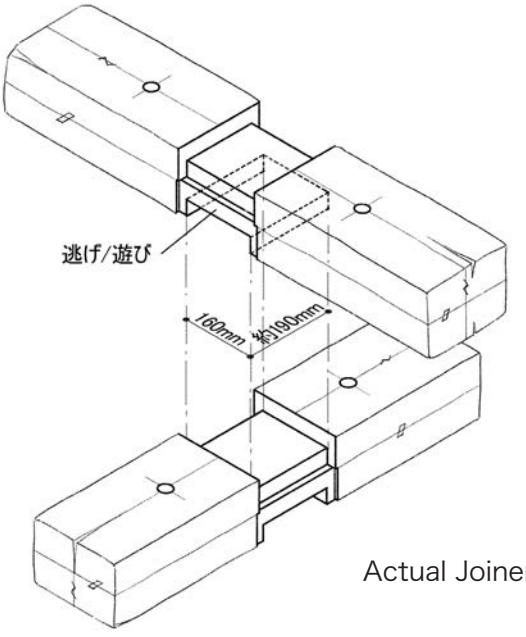
Concept of Railway Sleeper Assembly



Expected Joinery Design



Documented Joinery



Actual Joinery

On-Site Adjustments and Construction Modifications

During the construction phase, several design changes and technical adjustments were implemented, affecting the architectural detailing, structural characteristics, and material processing methods. These modifications were particularly significant in the context of traditional Japanese carpentry techniques, which were introduced under the guidance of the master carpenter responsible for overseeing the construction.

Planing Method

One of the critical adjustments involved the planing of the top and bottom surfaces of the railway sleepers to reduce warping and deformation. This approach allowed the sleepers to be stacked more stably, reducing the gaps between individual members and improving the overall structural integrity.

Improvement of Joinery

The joinery design was also modified during construction. Initially, the joints were planned as “scarf joints” (相欠き), but these were replaced with “through-tenon joints” (渡りアゴ) to improve the stability of the connections. Additionally, the sides of the sleepers at the joint locations were modified to include “clearance gaps” (逃げ), allowing for the absorption of dimensional variations and ensuring both tight connections and a visually cohesive wall finish.

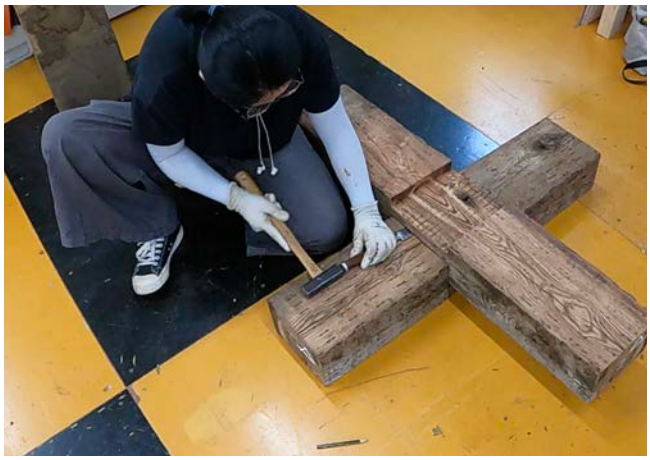
(Chapter 3)

Wall Structure of a Sleeper Cabin in Nagano[4]

Wall Structure of Seitogakusha

Assessing the Twist and Height of Sleepers

Fabricating Joinery



Determining Joint Height Through On-Site Fitting

Trial Assembly

Mock-Up Production for Structural Verification

To verify the processing methods used in Seitogakusha, a full-scale mock-up was produced using reclaimed sleepers. This model aimed to replicate a typical section of the building's wall structure, allowing for a detailed evaluation of the structural characteristics through static horizontal load testing.
The mock-up included a total of 19 individual sleeper components, stacked in 10 layers, faithfully reflecting the primary construction methods used during the original building process. This approach was guided by Tozawa, the current caretaker of Seitogakusha and a renowned Japanese master woodworker, ensuring the authenticity of the reproduction.

(Chapter 3)

Completed Mock-Up

Detail of Assembled Joints

Static Horizontal Load Testing for Structural Evaluation

The mock-up of the Seitogakusha wall structure was subjected to static horizontal load testing using a large-scale biaxial structural testing apparatus. This experiment was conducted under the guidance of Professors Miyadori Yamada, Naoyuki Yoroiishi, and Yasuhiro Hayabe from Waseda University.

Testing Method

The test procedure involved applying vertical loads of 9 kN, 60 kN, and 100 kN to the mock-up, followed by repeated horizontal load cycles at each vertical load level. The horizontal loads were alternately applied in positive (pushing) and negative (pulling) directions, gradually increasing until the set inter-story drift angles were reached. During the test, the relationship between the applied loads and the resulting deformations of the sleeper components was recorded, along with the displacement of individual sleeper layers. After the test, the condition of each component was carefully inspected to assess damage.

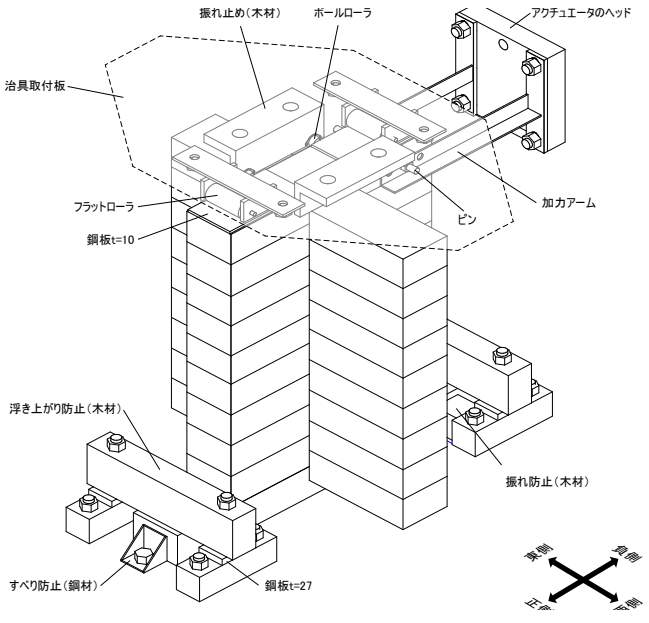
Results

The results demonstrated that the test specimen exhibited exceptional load-bearing capacity, maintaining its structural integrity even after repeated loading cycles. Unlike other timber structures, it did not exhibit the typical strength degradation commonly observed under repeated cyclic loading. This test have important implications for the long-term preservation and structural evaluation of Seitogakusha.

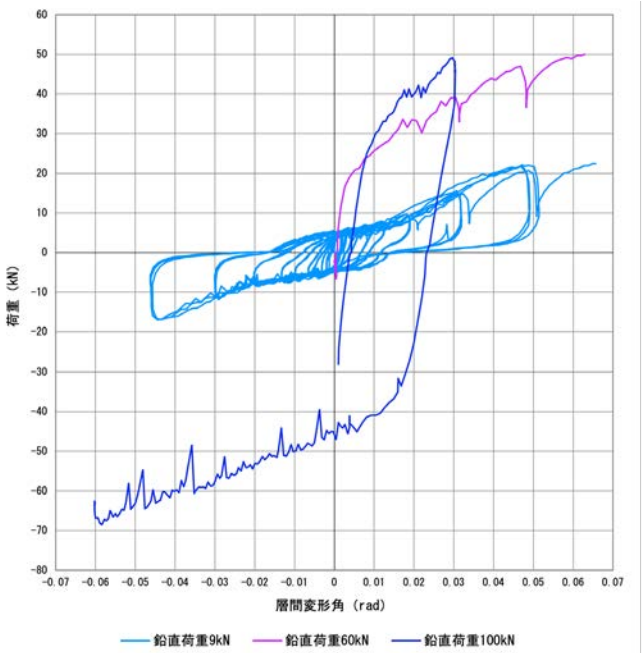
(Chapter 3)

Test Site

Vertical Load 100 kN, Inter-Story Drift Angle 1/15 rad, Negative Direction



Overview of the Loading Apparatus



Load-Displacement Relationship

Poulailler / Isamu Kujirai / 1972-1973 / Materials from U.S. military base, storehouses, and nearby farmhouses[1]

House of Pioneers / Osamu Ishiyama / 1974-1986 / Corrugated pipes[5]

Karasu Castle/ Eiji Yamane / 1970-1972 / Concrete formwork made from steel drums and logs cut and adjusted on site from raw timbe[1]

Proposed Strategies for the Preservation and Maintenance

The preservation of Seitogakusha requires both conceptual and physical approaches. The following strategies are proposed based on current heritage preservation principles and the specific conditions of Seitogakusha.

Preservation and Maintenance Concepts

While Seitogakusha meets the value assessment criteria of existing heritage conservation systems (e.g., UNESCO World Heritage and Japanese Cultural Property systems), these systems may not fully support its long-term maintenance and repair. This challenge also affects other unconventional self-built architecture. Based on this context, the following strategic directions are proposed:

1. Establish a new heritage framework that includes non-typical self-built architecture like Seitogakusha, creating dedicated categories for their preservation.
2. Develop dynamic management models that leverage existing protection systems, ensuring autonomous and sustainable maintenance through self-funded operations.
3. Strengthen collaboration with Miyake Village to promote regional preservation efforts, increase public awareness, and advocate for formal heritage recognition.

Physical Conservation and Restoration Methods

1. Reinforced Concrete Foundation: Regularly assess the seismic performance of the reinforced concrete foundation, conducting periodic inspections and reinforcement as needed to address aging and potential structural weaknesses.
2. Sleeper Walls: Based on mock-up testing, partial disassembly and component replacement are feasible for repair. For areas with fewer stacked sleepers, such as columns, beams, and attic sections, through-bolt reinforcement should be considered to prevent component displacement.
3. Roof Structure: Instead of excessive weight reduction, maintaining a certain roof mass is critical for overall structural stability. A more sustainable roofing approach should be adopted, allowing for periodic updates without strictly adhering to the original, labor-intensive construction method.

(Chapter 4)

Unique Characteristics of Seitogakusha

The realization of Seitogakusha was accomplished through the technical guidance of master carpenters and the collective labor of non-professional builders, reflecting a critical response to modernization. This collaborative construction approach can be seen as a temporary return to the traditional building practices that have been widespread throughout Japanese history.

The architect designed the structure using a simple, repetitive stacking method for sleepers, effectively preparing the project for this form of production. At the same time, without the skilled oversight of the master carpenters, it would have been impossible to achieve the distinctive high quality that defines Seitogakusha.

The study concludes that this unique architecture embodies a certain universality born from the layered and intertwined historical elements within its structure, which forms the core of its historical significance.

(Chapter 5)

Figure: Seitogakusha Roof Construction Site[2]

Figure Sources
[1] 植田実編集. GA Houses 世界の住宅4 日本の現代住宅1970年代, A.D.A.Edita Tokyo, 1978.
[2] 生闘学舎・자림. 敗者復活戦 生闘学舎・자림建設記録, 修羅書房, 1982.
[3] 原図＝高須賀晋1級建築士事務所
[4] ウッディライフ. 1982, vol.61
[5] 土井鷹雄ほか編. 現代建築空間と方法4 石山修武, 同朋舎, 1986.
[6] 写真＝戸沢実

Seitogakusha Roof Dismantling Site, October 2022[6]