

Historical Buildings as Resources for Paleo-Studies: A Case Study on Tree-Ring Dating of Keunjungjeon Hall in Seoul*

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ABSTRACT

The purpose of this study is to identify the species and to date the woods used in the Keunjung-jeon Hall, main building of the Kyungbok palace in Seoul. Samples (144) were divided into two parts, pillars (52) and other wood materials (92). Only two species were identified. They were *Abies holophylla* Max. and *Pinus densiflora* Sieb. et Zucc. Eleven among 20 Pyungju (outer pillars) were *Abies holophylla*, and 9 were *Pinus densiflora*. Seven among 12 Naejinkoju (inner pillars) were *Abies holophylla*, and 5 were *Pinus densiflora*. Three among 4 Gwikoju (inner corner pillars) were *Abies holophylla*, and one was *Pinus densiflora*. In the other wood materials, only 2 of 92 were *Abies holophylla*, and the others were *Pinus densiflora*. Tree-ring dating proved that this building was reconstructed during late 1860s. It also revealed that the old woods cut in the 17th century were reused.

Keywords : wood identification, *Pinus densiflora*, *Abies holophylla*, Korea traditional buildings, dendrochronology, tree-ring chronology

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Introduction

A few studies reported on the species of Korean historical buildings (e.g., Park S. et al. 1999, Park W. et al. 2002). They surveyed limited numbers of wood elements, mainly pillars because they could not access to the interior of the building structure. Our laboratory has conducted several tree-ring dating researches on the buildings under repair since 1999. During the dating survey, we could obtain appropriate

numbers of samples for the species identification too. The present study about Keunjung-jeon Hall is one of our early studies on the species of Korean traditional buildings.

Keunjung-jeon (Fig. 1) is the main building of Kyungbok Palace, one of four existing palaces in Seoul, which was the capital city for over 500 years during the Chosun Dynasty (A.D. 1392-1910). Kyungbok Palace was constructed at the beginning of the Chosun Dynasty during the late 14th century, but was com-

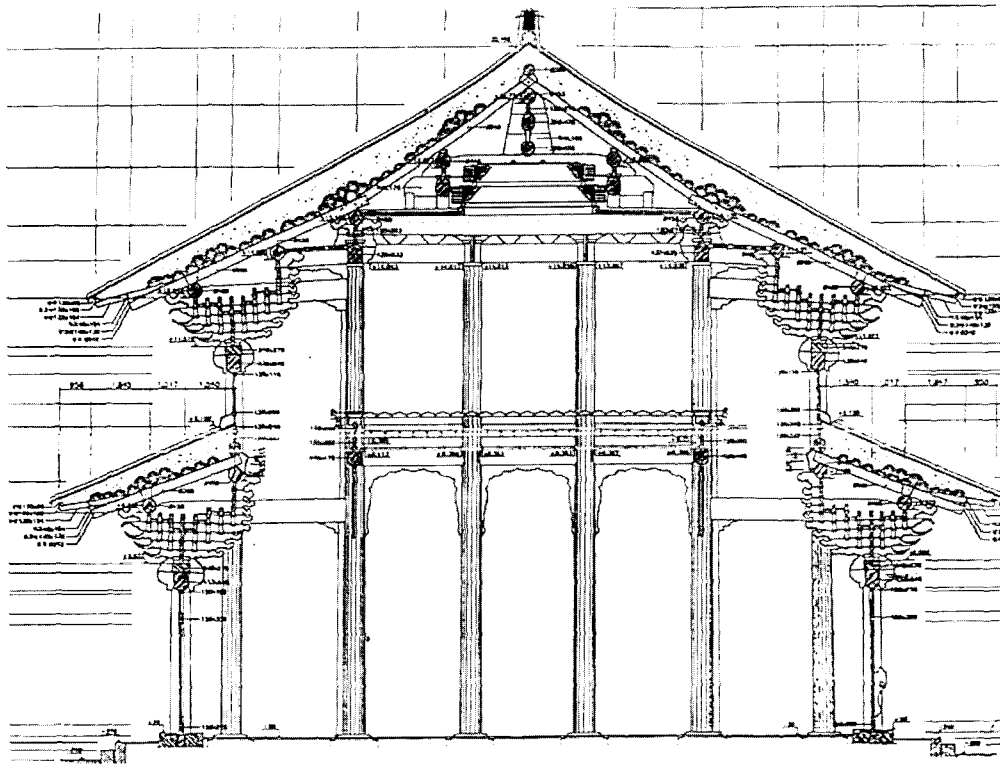


Fig. 1. Side view of Keunjung-jeon Hall in Kyungbok Palace

pletely destroyed during the Korea-Japan war (Imjin-eran, 1592-1599) (Lee 1998). Kyungbok Palace was reconstructed during the 1860s when Daewongun, the father of King Kojong, tried to reinforce royal authority. 'Ilsungrok', the Kings' diary of the Chosun Dynasty, records that the reconstruction of Keunjung-jeon Hall was finished in 1867 (Jang 1963). The purpose of this study is to identify the species of the woods used in the Keunjung-jeon Hall of the Kyungbok palace in Seoul.

Methods and Materials

During the repairing of Keunjung-jeon in 2001-2002, total of 144 samples were collected throughout the buildings. Fifty two samples were pillars and 92 ones were others; 16 rafters, 44 purlins, 8 beams,

6 side panels, 4 gables, 8 shingles and 6 head penetrating ties.

Small cubes of about 5x5x5 mm³ were taken from the samples. Transverse, radial and tangential sections were made from the cubes by hand cut with razor blade. Hand cut produced thin sections as good as microtome cut. Without staining, the sections were mounted on the slide glass with glycerine solution.

Results

Only two species were identified (Table 1 and Fig. 2). They were *Pinus densiflora* Sieb. et Zucc. and *Abies holophylla* Max. *Pinus densiflora* has large vertical and horizontal resin ducts with thin epithelial cells (Fig. 3-Fig. 5). It has window-like crossfield pit and ray tracheids with dentate thickening. *Abies*

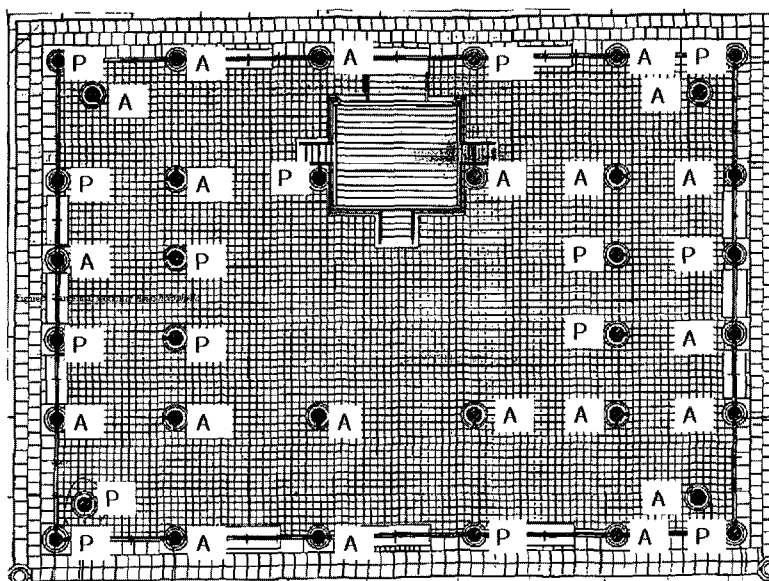


Fig. 2. Species of the pillars in the 1st floor (P: Pinus densiflora, A: Abies holophylla)

holophylla has no resin ducts and it lacks ray tracheids (Fig. 6-Fig. 8). Earlywood/latewood transitions are rather gradual. It has taxodioid crossfield pits and nodular thickening on the end walls of ray parenchyma.

Pillars on the first floor were made from both species (Fig. 2). Eleven among 20 Pyungju (outer pillars) were *A. holophylla*, and 9 were *P. densiflora*. Seven among 12 Naejinkoju (inner pillars) were *A. holophylla*, and 5 were *P. densiflora*. Three among 4 Gwikoju (inner corner pillars) were *A. holophylla*, and one was *P. densiflora*. All pillars on the second floor were made from *P. densiflora*. In the other wood materials, only 2 of 92 were *Abies holophylla*, and the others were *Pinus densiflora*. Two fir woods were found in the purlins.

Pinus densiflora Sieb. et Zucc. (Japanese red pine), also known as 'sonamu' in Korean common parlance, occurs naturally in Korea and Japan, although rarely in Manchuria, covering a wide ecological spectrum (Yoshioka 1958). This species is one of the most favorite building materials in Korea. *Pinus densiflora*, *Zelkova serrata* and oaks has been known as major species for load-bearing elements in Korean traditional

buildings (Park et al. 1999, Park et al. 2002). Few studies reported that *Abies hollophylla* was used for structural elements. Park et al. (2002) reported that only one pillar of Jungwhajeon Hall, main building of Ducksoo Palace in Seoul, was *Abies hollophylla*, while other pillars were *Pinus densiflora*.

Table 1. Species of wood elements in Keunjungjeon Hall.

Name of Elements	Abies hollophylla	Pinus densiflora	Subtotals
Pillars outer pillars	11	9	20
(1st floor) Inner pillars	7	5	12
Inner conner pillars	3	1	4
Pillars outer pillars (2nd floor)		16	16
(Subtotals)	21	31	52
Others Rafters		16	16
Purlins	2	42	44
Beams		8	8
Side panles		6	6
Gabels		4	4
Shingles		8	8
Head penetratingties		6	6
(Subtotals)	2	142	92

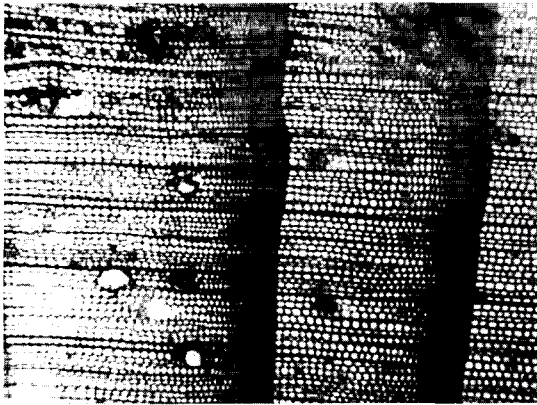


Fig 3. Cross-section of *Pinus densiflora*

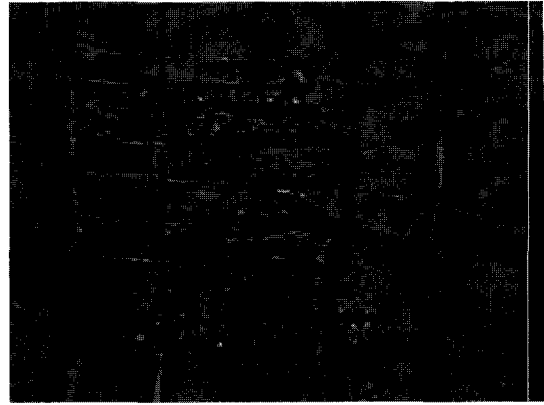


Fig 4. Radial-section of *Pinus densiflora*

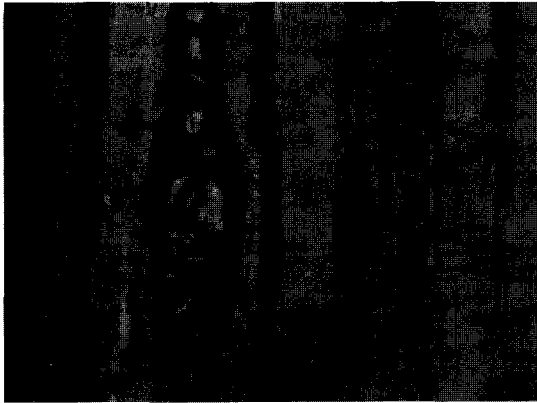


Fig 5. Tangential-section of *Pinus densiflora*



Fig 6. Cross section of *Abies holophylla*

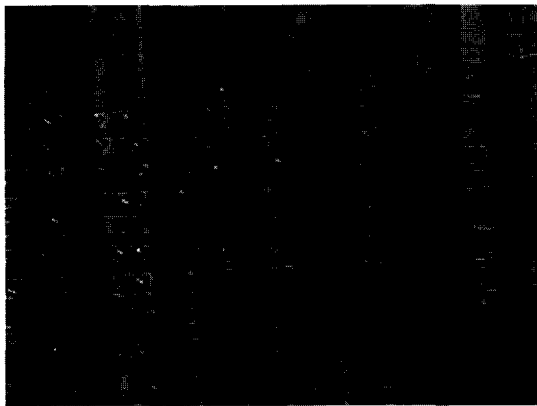


Fig 7. Radial section of *Abies holophylla*

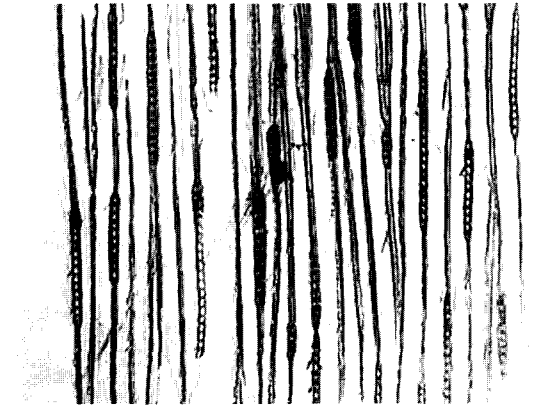


Fig 8. Tangential section of *Abies holophylla*

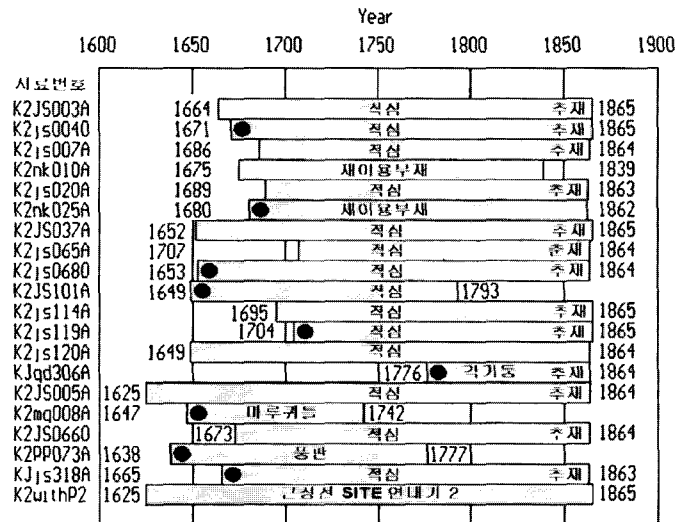


Fig. 9. Chronology II obtained from Keunjung-jeon Hall

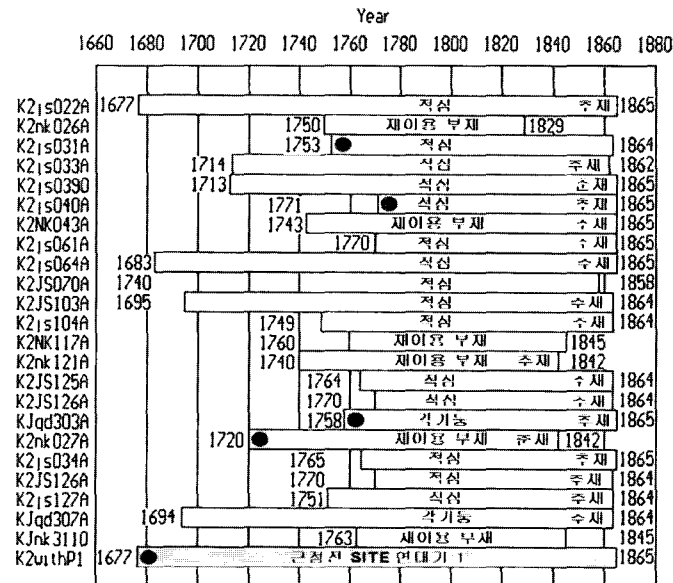


Fig. 10. Chronology I obtained from Keunjung-jeon Hall

The woods of *Abies hollophylla* are not as strong as *Pinus densiflora*. Majority of the first-floor pillars of Keunjung-jeon Hall were made from firs, however, all second-floor pillars were pines. Keunjung-jeon Hall is one of largest buildings in Korea. The pillars on the first floor, particularly inner ones are very

long, almost 15 m in length. We think that long, straight pine logs were not fully available during the reconstruction of Kyungbok Palace in 1860s. The reconstruction included more than 100 buildings. Instead of pine woods, large and straight logs of fir should be used.

Tree-ring dating proved that this building was reconstructed during late 1860s. It also revealed that the old woods in the 17th century were reused.

The results about dating will be also presented and discussed. The tree ring chronologies obtained from the Keunjung-jeon Hall extend the living pine woods back to the early 1700s (Fig. 9 and Fig. 10).

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