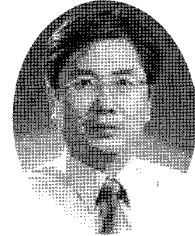


대나무 접합물을 이용한 목조건물의 새로운 접합 시스템의 적용에

Application of New Connecting System of Wood Structures Using Bamboo Connector



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요 약

최근 환경문제에 대한 해결책으로 목조건물의 해체 및 목재의 재사용에 대한 관심이 높아지고 있다. 목조건물을 접합철물에 의해서 접합할 경우에는 건물의 해체에 철재를 사용하지 않아 목부재의 절단이 매우 용이하고 목재의 재사용이 용이하도록 하는 장점을 가지고 있다. 대나무의 높은 인성은 목재 접합부의 강도와 안정성 확보를 가능하게 해주고 있다. 대나무 접합물은 2005년 일본 Aichi 세계박람회에서 Japan pavilion Nagakute 전시관 건물이 대나무 접합부를 사용한 목조건물이다.

1. Introduction

The rubbish disposal and waste problem should be solved in various fields. Since the technology to promote recycling building waste is not yet established recently. Recycling of construction waste is less promoted than other waste. It is said that the waste discharged by demolition of a wooden residence is behind other structures. One of the reasons for that problem is that it is hard to classify the steel and the wood used for the joint.

The "connecting method using metal connector

and adhesives⁽¹⁾⁻⁴⁾ developed by authors is applied in the existing timber structures and we started to develop the connector technology for timber structures using the natural bamboo instead of the metal connector to promote the easy dismantling for wooden houses. From the previous study⁸⁾, we concluded that high strength performance of joint was obtained by getting rid of a bamboo outer skin.

However, it is very difficult to get a number of "medake" whose shape and intensity are almost equal in the case of using natural "medake" as a connector. Moreover, in order to improve the bonding performance of the connector surface, much time is needed for removing the outer skin

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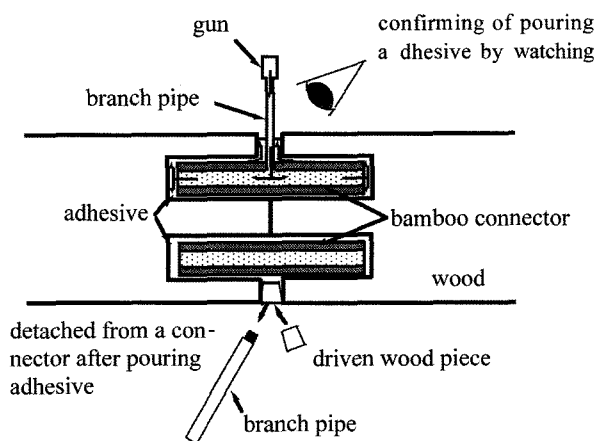
of natural bamboo.

In this study, the laminated bamboo connector is produced to solve the problem mentioned above. Especially in this research, the production method of the laminated bamboo connector from round bamboo is proposed. Moreover the tests for the tension strength of timber joint are carried out.

2. Connecting Method Using Bamboo Laminated Connector and Adhesive

The assembly process of the bamboo connecting system is as follows and shown in <Fig. 1>. The connecting method by bamboo connector is based on the "connecting method using metal connector and adhesives ¹⁾⁻⁴⁾ which was developed by the authors.

- (1) Holes for bamboo connector are drilled using an electric drill at both butted faces of splice. Hole diameters are about 3mm larger than that of the connector diameter.
- (2) A hole for a branch pipe is drilled using an electric drill for a hole mentioned above, respectively. The hole diameter is 3mm larger than the branch pipe diameter.
- (3) Bamboo connector with branch pipe is inserted into the hole.
- (4) The both faces are butted and attached each



<Fig. 1> Assembly process of connecting system

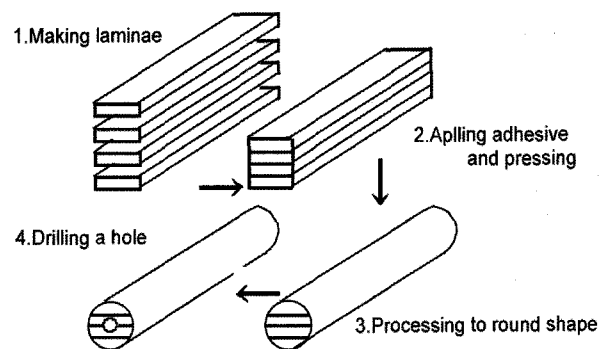
other temporarily using by nails and wood plates.

- (5) Adhesive(urethane bond) is pumped into the cavities around the bamboo by using a conventional caulking gun. Pumped adhesive reaches to the cavity through the branch pipe and the inside hole of bamboo.
- (6) Filling up of adhesive is confirmed by watching the adhesive, which comes up through the space around the branch pipe.
- (7) Branch pipe attached to the rod by screw is detached from the bamboo.
- (8) Small wood piece is driven into the hole drilled for branch pipe.
- (9) After curing period(14 days in this test), wood plates nailed are detached from specimens.

3. Process of the Bamboo Laminated Connector

The parameters in the connector specimens are the number of bamboo laminae (4 laminae, 7 laminae) and the kind of adhesives (polyisocyanate, polyurethane resin, urea resin) used for laminating. The machining procedure of a bamboo laminated connector is shown in <Fig. 2>. The production method of the laminated bamboo connector is as follows.

- (1) Shaving the skin of the bamboo board by automatic plane(See <Fig. 3>).
- (2) Application of adhesive to both sides of



<Fig. 2> Procedure of manufacture

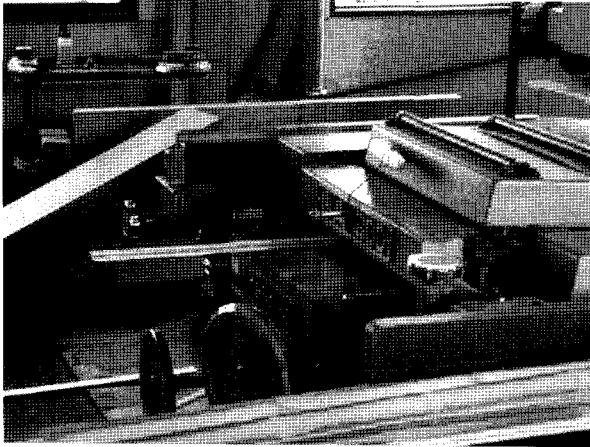
bamboo laminae (See <Fig. 4>).

(3) Press for bonding (See <Fig. 5>).

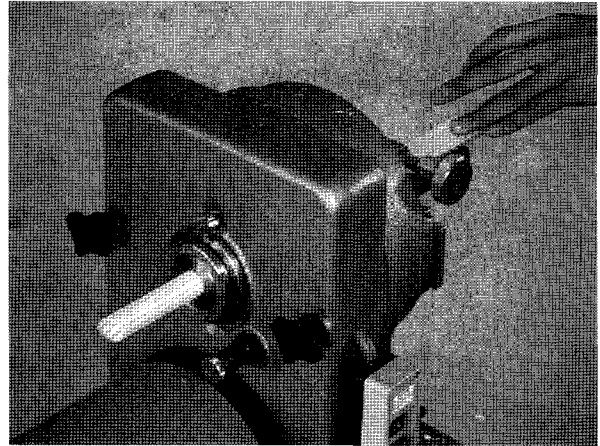
(4) Arranging cross section side by automatic planer.

(5) Processing to round by cutting machine (See <Fig. 6>).

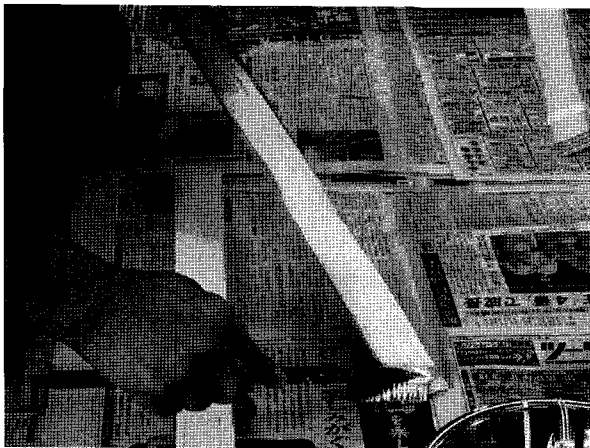
(6) Drilling a hole in the center of round bar



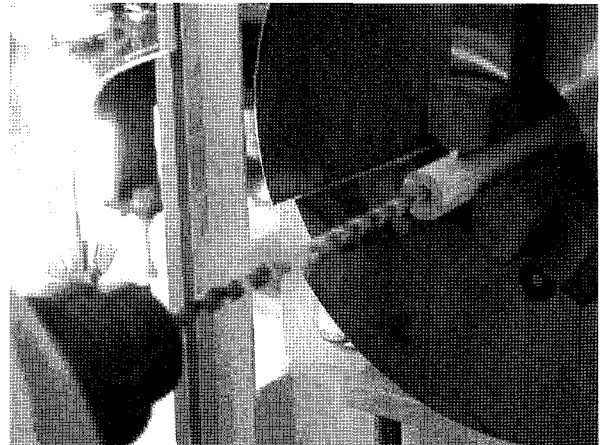
<Fig. 3> Processing laminae made from bamboo



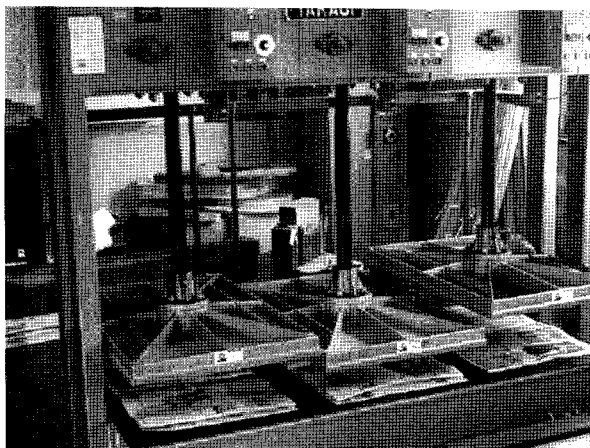
<Fig. 6> Processing to round by cutting machine



<Fig. 4> Applying adhesive



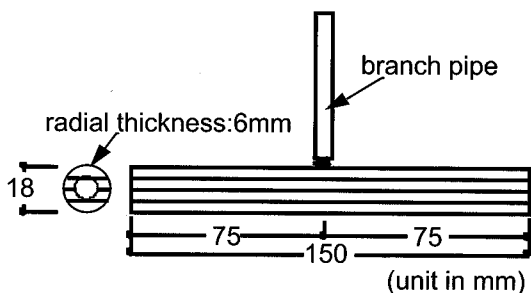
<Fig. 7> Drilling a hole



<Fig. 5> Press for bonding



<Fig. 8> Finished product of bamboo laminated connector



<Fig. 9> Shape and size of bamboo laminated connector

with a drilling machine (See <Fig. 7>).

- (7) Drilling a hole in the mid-point of round bar for the branch pipe by electrical drill (See <Fig. 8> and <Fig. 9>).

4. Application of Bamboo Connector to Japanese Government Pavilion

The 2005 international exposition is held from 25th March to 25th September in 2005 at Nagoya Japan. In the venue of the exposition, the Japanese government pavilion was constructed as the main facility. In this building, the bamboo connector system is adopted as the connecting device to connect the timbers and bamboos.

The pavilion is a fuge timber structure covered by bamboo cage shown in <Fig. 10>. The total floor area is about 6000m². In this pavilion, the bundled



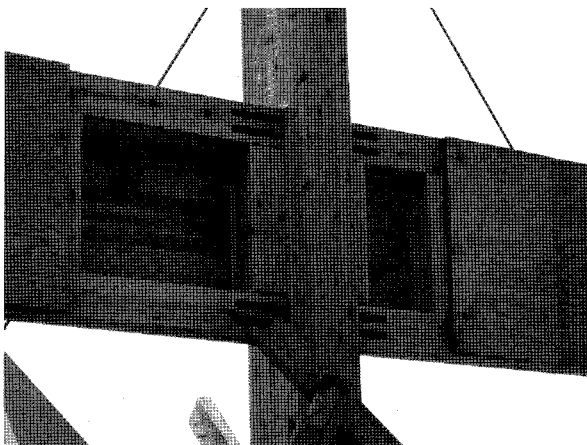
<Fig. 10> Whole view of the pavilion

wooden columns and boxed wooden beams are used (see <Fig. 11> and <Fig. 12>). A long passageway with roof to guide visitors was constructed.

Many bamboo connectors are used in the bamboo connection of the the passageway (see <Fig. 13> and <Fig. 14>). Over 6000 bamboo connectors are used in the facility. The photos under construction and after completion of the pavilion are shown in <Fig. 15>~<Fig. 19>.



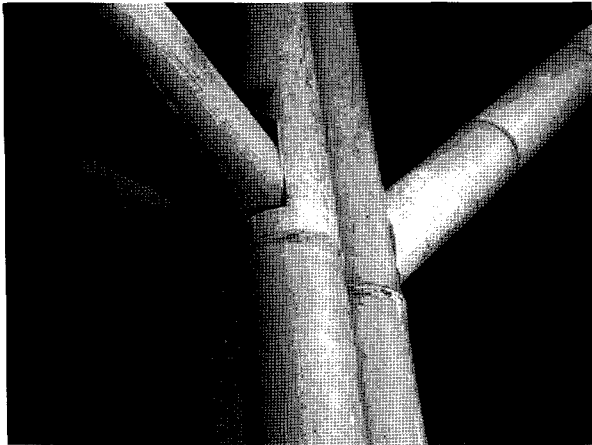
<Fig. 11> Bundled wooden columns(Bamboo cage)



<Fig. 12> Boxed wooden beams



<Fig. 13> Long passageway with roof



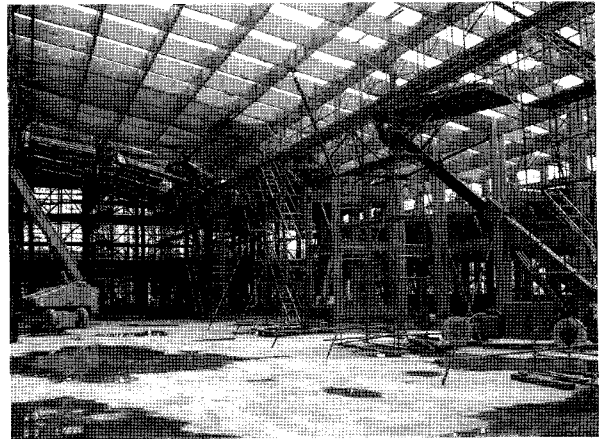
〈Fig. 14〉 Round bamboo connection
(Bundled wooden columns)



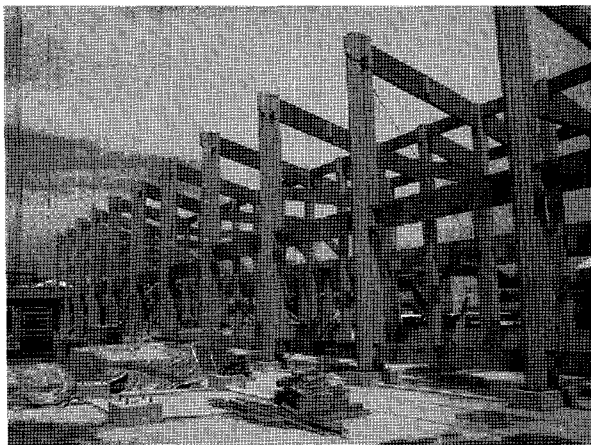
〈Fig. 17〉 Under construction
(Main exhibition hole before assembling
of roof)



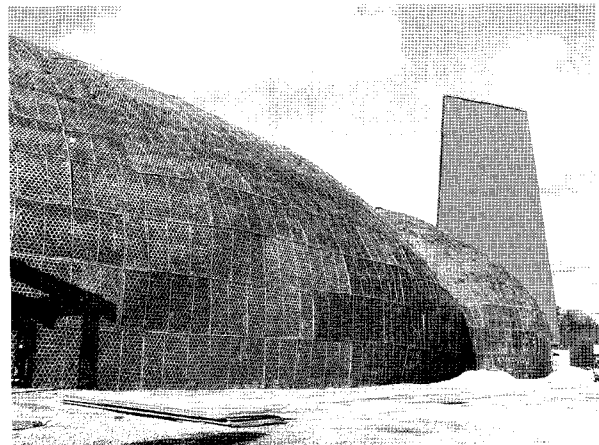
〈Fig. 15〉 Round bamboo-boxed beam connection
with the bamboo connector with the
bamboo connector in the passageway
in the passageway



〈Fig. 18〉 Under construction
(Main exhibition hole after assembling
of roof)



〈Fig. 16〉 Under construction



〈Fig. 19〉 After completion (Bamboocage)

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