

# Wood-steel Hybrid Fire-resistant Column That Uses Laminated Japanese Cedar Lumber to Achieve One-hour Fire Resistance

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## Abstract

*Nippon Steel Corporation is targeting public buildings where the use of timber is being promoted by the enactment of the Act for Promotion of Use of Wood in Public Buildings. We have developed a wood-steel hybrid fire-resistant column with a fireproof coating of Japanese cedar.*

## 1. Introduction

Amidst the move toward the realization of a decarbonized society in recent years, the “Act for Promotion of Use of Wood in Public Buildings” was enacted in 2010, and the promotion of use of timber for domestic public buildings is underway. In response to this move, Nippon Steel Corporation has put into practical use the wood-steel hybrid fire-resistant column where a square steel pipe and cedar material are applied in a composite manner. The wood-steel hybrid fire-resistant column contains the square steel pipe, which is dominantly used in steel structures, covered for fireproof purposes with cedar that grows widely in Japan. It is a product equipped with the strength of steel as well as the designability of wood, and contributes to the reduction of environmental load.

## 2. Outline

**Figure 1** shows the outline of the structure of a wood-steel hybrid fire-resistant column. This fire-resistant column is a square-sectioned one-hour fire resistant column of a cold roll-formed square pipe (BCR) for architectural structure use covered with 60 mm thick laminated cedar lumber or cedar laminated veneer lumber (LVL) and a 15 mm thick reinforced gypsum board. The Japan Laminated Wood Products Association, the National LVL Association (a general incorporated association) and Nippon Steel have jointly acquired the Fireproof Construction Recognition of the Minister of Land, Infrastructure, Transport and Tourism (Recognition No. FP060CN-0765), and the fire-resistant hybrid column is authorized for application to the columns of mainly up to four-story buildings requiring one-hour fire resistance.

## 3. Features

Use of the 60 mm thick cedar material (laminated cedar lumber

or LVL) working as a fireproof cover, and for the interior finish provides a robust and warm atmosphere, and additionally, by being combined with a steel column superior to wooden material in terms of unit strength, realizes a slender column. By strengthening the fireproof ability with the use of reinforced gypsum board, a wood-steel hybrid fire-resistant structure employing the material of cedar that grows widely in Japan for interior finishes as well has been realized. As the cedar material does not require flameproof treatment, it is therefore economical. The covering material consisting of cedar material and reinforced gypsum board can be installed on the steel column at the construction site in a way similar to that of the general interior finish work after the erection of the steel frame is completed, thus simplifying the installation work. In addition, since there is no need to install the wooden material on the steel column in a steel frame processing plant, such work as transporting the steel column processed in the plant to a wood processing plant is avoided.

From the structural viewpoint, by designing the wooden material to function as a covering material only without supporting any load, the structural design concerns only the general-purpose cold forming square pipe column, and therefore the structural design is also simplified.

## 4. Outline of Structure

**Table 1** shows the outline of the wood-steel hybrid fire-resistant column. As the steel column, a cold roll-formed square pipe (BCR) for architectural structure use, a cold press-formed square pipe (BCP) for architectural structure use, and four-face-welded square section steel ranging in size from 350 mm in outer dimension with 12 mm thickness up to 600 mm in outer dimension with 100 mm thickness are applicable.

Cedar material is applicable either in the form of laminated lum-

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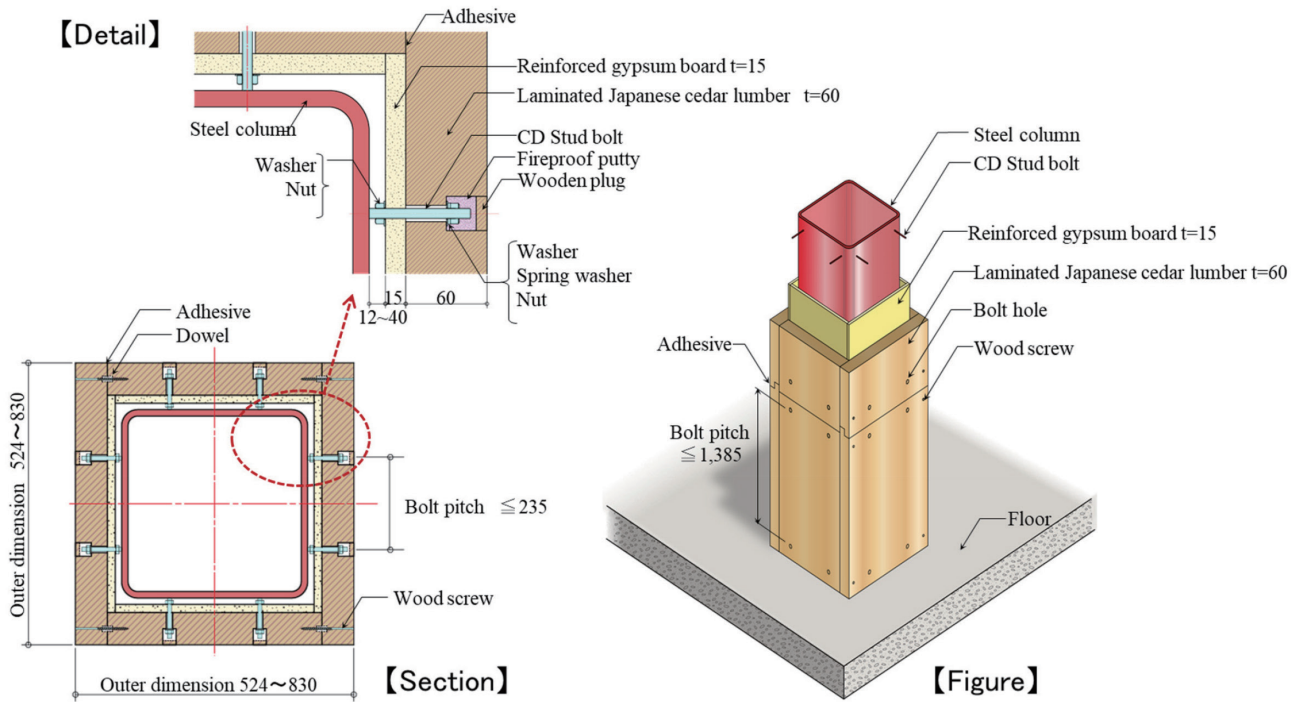


Fig. 1 Figure, cross-sectional, and detailed drawings

Table 1 Specifications of hybrid column

■ Dimensions and figures		
Section:	Rectangular	
Dimension:	524~830 × 524~830 × H (H: Floor height)	
● Steel column		
Dimension	□-350 × 350 × 12 ~ □-600 × 600 × 100	
Specifications	Cold formed column	BCR295, UBCR365 BCP325, BCP325T, BCHT325TF, BCHT400, BCHT385
	Build up box column	SN490, SM520, BT-HT325, 355, 385, SA440, etc.
Thickness ratio	Categories of column	FA, FB, FC
● Inner covering material: Reinforced gypsum board		
Thickness	15 mm (JIS A 6901 GB-F)	
● Outer covering material: Japanese cedar		
Specifications	Laminated lumber (Notification No. 1152 of the Ministry of Agriculture, Forestry and Fisheries, 2007) or in the form of LVL (Notification No. 701 of the Ministry of Agriculture, Forestry and Fisheries, 2008)	
Thickness	60 mm	

ber (Notification No. 1152 of the Ministry of Agriculture, Forestry and Fisheries, 2007) or in the form of LVL (Notification No. 701 of the Ministry of Agriculture, Forestry and Fisheries, 2008), and a thickness of 60 mm is specified. In addition, coating is also applicable on the surface of wooden material. The outer dimension of the column becomes 524 mm to 830 mm. The cedar material, the reinforced gypsum board, and the steel column are joined via on-site welded CD stud bolts and nuts. The CD stud bolts are installed on

the steel column by a special welder at intervals of 1385 mm or less in the vertical direction and 235 mm or less in the horizontal direction. Washer and nut for fixing the covering materials are positioned so as to form a space of 12 mm to 40 mm between the outer face of the steel column and the inner face of the gypsum board, onto which the reinforced gypsum board and the cedar material are placed with the stud bolts being inserted through the through-holes previously provided on the gypsum board and the covering material. The structure is then tightened with the fixing nut on the outer face of the cedar material. The fixing nut and the stud bolt are hidden by a wooden plug so that they are not observable from the outside (Fig. 2).

The corner of the cedar material is fixed with adhesive, and further tightly fixed with dowel pins and/or screws. It is also possible to make horizontal joint of the outer covering material to the longitudinal axis of the column. Since a space is provided between the reinforced gypsum board and the steel column, the absorption of construction errors and the avoidance of weld bead rise-up and the mark-like residual of the cut end of an erection piece on the steel column surface are enabled. Furthermore, as compared with the column structure wherein fire-resistant rock wool is sprayed onto the steel column, on which light-weight steel substrate is built for installing finishing material, the column outer dimension becomes smaller (Fig. 3).

Prior to the construction in an actual project, to confirm the workability and the finishing state, a full-scale mockup was built in a wood processing plant, and satisfactory results were obtained (Photo 1).

## 5. Example of Actual Application

The wood-steel hybrid fire-resistant column was applied for the first time partly to the columns of the “Daiwa House Group Mirai Kachi Kyoso Center” of Daiwa House Industry Co., Ltd. (Head office: Osaka-shi, President: Keiichi Yoshii). The Center is located in

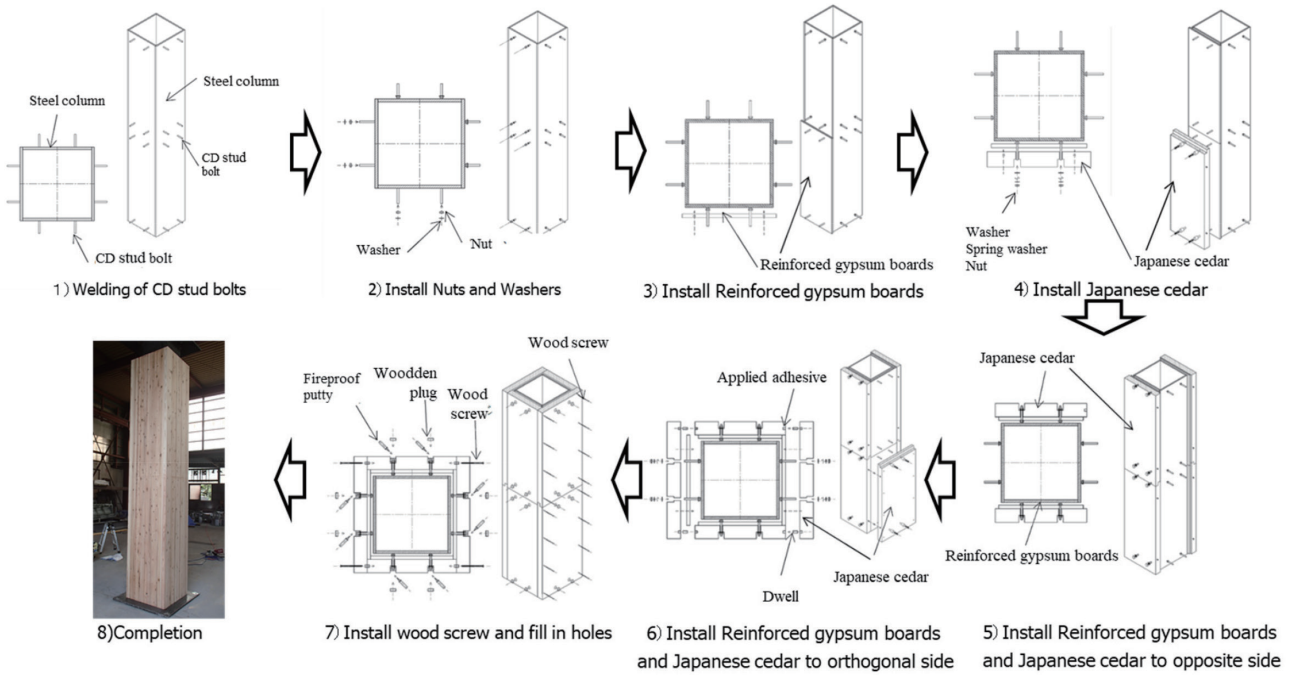


Fig. 2 Construction procedure

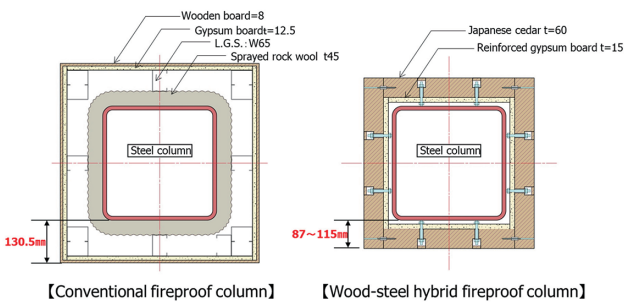


Fig. 3 Comparison of conventional fireproof column and wood-iron hybrid fireproof column

Nara-ken, Nara-shi, has four stories and a floor area of 16977 m<sup>2</sup>, and is designed and constructed by Daiwa House Industry Co., Ltd. and Fujita Corporation of the Daiwa House Group (Photo 2).

A cold roll-formed square steel pipe with an outer dimension of 500 mm (UBCR365) was used for the steel column, and the laminated lumber of cedar from Nara-ken was applied. As such, the outer dimension of the column became 700 mm. Manufacturing and the work of installing the fire-resistant covering materials were conducted by Saito Wood Industry Co., Ltd. (Head office: Nagano-ken, Chiisagata-gun, Nagawa-machi, President: Saito Takeshi).

This project was awarded with the “Wood Design Award 2021” that is evaluated and selected from the consumer’s viewpoint as the ultimate in excellence from among the products and/or activities which are considered to have contributed to the rediscovery of the superiority and value of wood.

**6. Conclusion**

Targeting public buildings, where the use of wood is being promoted by the enforcement of the “Act for Promotion of Use of Wood in Public Buildings”, we developed a wood-steel hybrid fire-resistant column that uses cedar material, which grows widely in Ja-

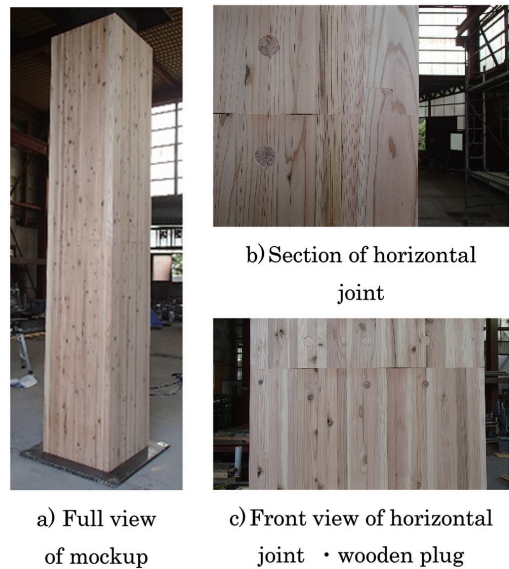


Photo 1 Column mockup



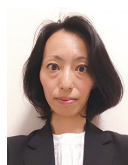
Photo 2 Application example

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pan, to fireproof the square steel pipe columns that are mainly used in steel structures. We acquired the recognition of the Minister of Land, Infrastructure, Transport and Tourism for one-hour fire resistance. The workability was confirmed through a full-scale mockup, and the wood-steel hybrid fire-resistant column was applied to the actual project. Since the employment in an actual project, we have continuously received inquiries and consultations, proving the growing interest in using wooden material. We will continue our technical sales activities toward increasing employment.



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