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USE OF CLT (CROSS LAMINATED TIMBER) IN CIVIL ENGINEERING

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ABSTRACT: In order to utilize CLT in the civil engineering, prototype CLT plates, snow fences and railway platforms were produced and compared with existing steel plates, steel snow fences and RC(reinforced concrete) platforms, respectively. The CLT plates were trialed at civil engineering construction sites and related materials and equipments were developed. The snow protection function of the CLT snow fences was confirmed by wind tunnel tests, before being trial installed on a public road. A model railway platform was also prototyped, and load tests were conducted to confirm that it fully met the strength standards. After that, CLT platform was installed at the actual railway station.

KEYWORDS: civil engineering, CLT (Cross Laminated Timber), plate, snow fence, railway platform

1 – INTRODUCTION

Japan is a "forestry nation" with forests covering 70% of the country's land area, and utilizing wood as a domestic resource leads to regional development. As part of this, CLT (cross laminated timber) has come to be widely used as a structural and interior material for buildings. However, it has not been used much in civil engineering structures. In response to this, the Japan CLT Association has launched the project for utilizing CLT in civil engineering. Here, as part of this research, we report on products of plates, snow fences, and railway platforms made by CLT.

2 – PLATES

2.1 COMPARISON OF CLT PLATE AND STEEL PLATE

Conventional steel plates used at construction sites are laid as material carrying roads and work floors. They protect the ground, provide a foothold for heavy machinery, and distribute weight across the ground. However, because they are made of steel, they are heavy and not easy to transport or lay. They also have disadvantages such as a loud impact noise when a heavy object falls on them, and are prone to rusting and slipping. CLT plates compensate for these disadvantages of steel plates, and have the

Table1: Comparison of CLT plate and steel plate

Item	CLT Plate	Steel Plate	Reasons for Evaluation
Workability	◎	○	CLT floor plates are lightweight (1/16 the weight of steel ones), making them easy to transport and install.
Strength	○	◎	Heavy loads may cause the surface or sides of CLT plate chipped.
Heat Capacity	◎	○	CLT plates are easier to handle than steel ones because they are less hot in summer and less cold in winter.
Environmental Performance	◎	○	The life cycle CO_2 emissions of CLT plates are smaller than those of steel ones.
Durability	○	◎	If CLT plates are used for a long period of time, there is a possibility of rotting.
Quietness	◎	○	When a heavy material is dropped, the impact noise from the CLT plates is smaller than that from the steel plates.
Anti-Slip	◎	○	The coefficient of slip resistance (CSR value) of CLT plates in wet conditions is higher than that of steel plates, making it less slippery.

◎:very good, ○:good

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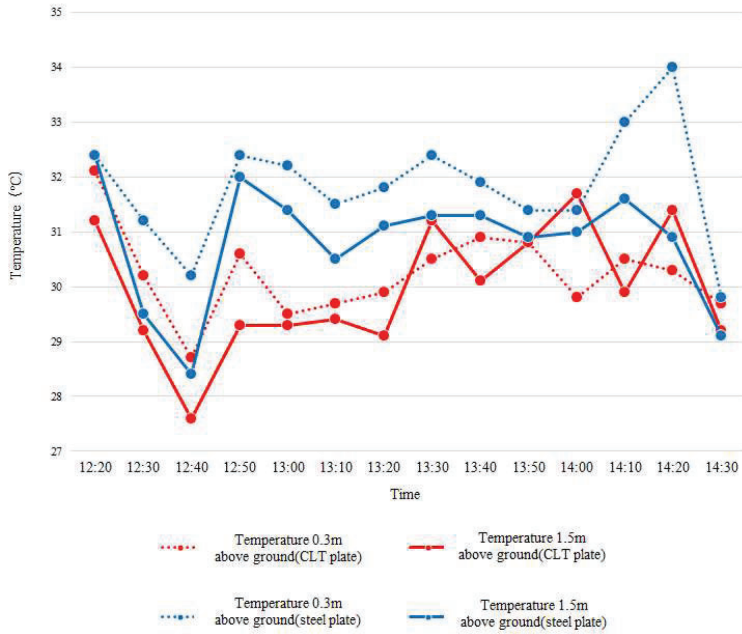

Fig.1: Temperature of CLT plate and steel one (Experiment date: August 31, 2023)

advantages of being anti-slip and quiet (Table 1). Fig. 1 shows the temperatures at 0.3m and 1.5m above the CLT plates and steel plates in summer, respectively. The CLT plates are cooler than the steel plates therefore they are more suitable for work on them.

2.2 TRIAL USE AT CIVIL ENGINEERING CONSTRUCTION SITES

CLT plates were laid at civil engineering construction sites as work yards for heavy machinery such as backhoes, and as transport routes for dump trucks. Three-layer, three-ply CLT made from cedar, cypress, and larch was used as the CLT plates, and tests were conducted mainly on CLT which size is 3.5m long x 2m wide x 9cm thick. They were laid on site using an attachment furnished to a hydraulic excavator (Fig.2). Although there were some damages caused by the laying work and the operation of construction vehicles, and damage and dirt occurred to the surface and corners, there were generally no problems with their functionality as plates (Fig.3).

2.3 DEVELOPMENT OF RELATED EQUIPMENT AND MATERIALS

To prevent the CLT plates from individual shifting, we prototyped a connector that uses a sling belt (Fig.4). In the past, when used at civil engineering construction sites,

Fig.2: Installation of CLT plates

Fig.3: Use CLT plates in heavy machinery work yards

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the edges of CLT plates tended to be damaged more frequently than other parts. To prevent this, four sides of the surface were chamfered (Fig.5). We also prototyped an L-shaped steel frame (Fig.6) that was hot-dip galvanized to provide strong protection for the edges. We also attached IC tags to the CLT plates (Fig.7). The IC tag system stores information such as the manufacturer, manufacturing date, start and end dates of use, user, and location of use. This will make it easy to understand the usage history when repurposing CLT plates.

3 –SNOW FENCE

Fig.4: CLT plate joints

Fig.5: Chamfering

Fig.6: Edge protection frame

Fig.7: IC tag attached to CLT plates

3.1 COMPARISON OF CLT SNOW FENCE AND STEEL SNOW FENCE

In cold regions such as Hokkaido in Japan, snow fences are installed to reduce snow accumulation on roads, increase visibility, and prevent traffic accidents. Here, we focus on a wind-stop type snow fence [1] (Fig. 8), which is composed of a vertical section, a sneak-back section, and an overflow guide section. The conventional steel wind-stop type snow fence is shown in Fig. 9. The vertical section of CLT snow fence is made of CLT (made of larch, 3 layers, 3 plies, 6 cm thick), and the overflow guide section and sneak-back section are made of laminated timber (Fig. 10). Table 2 shows a comparison of CLT wind-stop type snow fence and steel wind-stop type snow fence. CLT is lightweight, easy to install, and has low thermal conductivity, which helps to alleviate the heat island effect. CLT also has better life cycle CO_2 emissions than steel, and being made of wood also has an amenity effect. However, it is inferior to steel in terms of strength and durability.

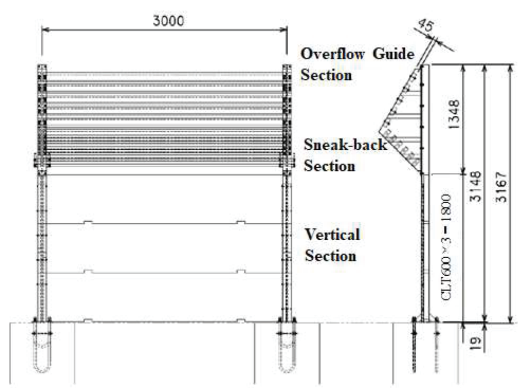

Fig.8: Schematic diagram of wind-stop type snow fence)

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Table2: Comparison of CLT wind-stop type snow fence and steel wind-stop type snow fence

Item	CLT Fence	Steel Fence	Reasons for Evaluation
Workability	◎	○	CLT fences are easier to install than steel ones because the materials used are lighter.
Strength	○	◎	Although CLT is stronger than laminated timber or logs, it is inferior to steel.
Heat Capacity	◎	△	Compared to steel, CLT has a lower thermal conductivity and is effective in reducing the heat island effect.
Environmental Performance	◎	△	The life cycle CO_2 of a CLT fence is smaller than that of a steel fence.
Durability	○	◎	If CLT fences are used for a long period of time, they may rot.
Soundproofing	◎	△	The vertical sections of CLT fences have some sound insulation, whereas the vertical sections of steel fences have very little.
Landscape	◎	○	CLT fences are made of wooden materials and offer greater amenity (comfort, etc.) benefits than steel ones.

◎:very good, ○:good, △:poor

Fig.9: Steel wind-stop type snow fence

Fig.10: CLT wind-stop type snow fence

3.2 WIND TUNNEL TESTING

Before installing a CLT snow fence on a public road, model tests were conducted in a wind tunnel to confirm its snow protection function. Firstly, models of CLT and steel snow fences were constructed, and activated white clay was used for the model snow, which has physical properties such as the angle of repose (the angle of the slope at which soil or powder remains stable without spontaneously collapsing when piled up) that are similar to those of natural snow.

In the wind tunnel test device (Fig. 11), a ground snowstorm was reproduced in the wind tunnel, and the conditions in each case of a CLT snow fence, a steel snow fence, and no snow fence were visually confirmed (Fig. 12). Snow accumulation was also reproduced in the wind tunnel, and the snow depth in each case of a CLT snow fence, a steel snow fence and no snow fence were confirmed. For example, at the center line of the model road, the snow depth was reduced to half when a steel/CLT snow fence was installed compared to no.

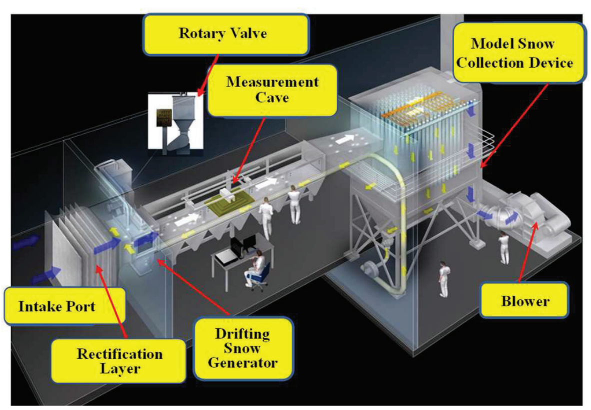

Fig.11: Overall view of the wind tunnel test device

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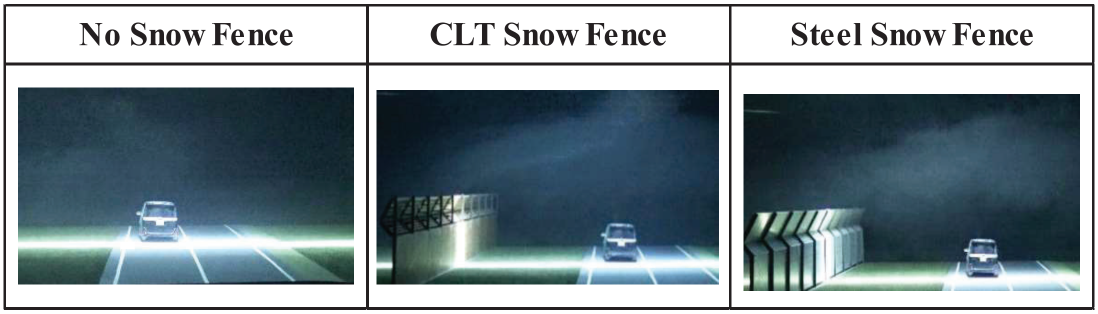

Fig.12: Result of the wind tunnel test

snow fence. These wind tunnel experiments confirmed that the CLT snow fence had the same snow protection effect as the conventional steel snow fence

3.3 INSTALLATION ON THE PUBLIC ROAD

CLT snow fences with a wind-stopping function was installed on the public road in Nakashibetsu Town, Shibetsu District, Hokkaido in Japan. 60m section of the existing steel snow fences were replaced with CLT ones. The CLT in the vertical section was surface-coated with polyester resin, and the laminated wood used in the overflow guide section and the snow cover section was pressure-injected with a preservative. Fig.13 shows the installation. When installing a snow fence, it is necessary to measure the wind direction, wind speed, temperature, snow depth, etc. at the site and install it in an area that will provide the best snow protection.

Fig.13: CLT wind-stop type snow fence at the public road

4 – PLATFORM

4.1 COMPARISON OF CLT PLATFORM AND RC PLATFORM

RC (reinforced concrete) is generally used as a platform for station buildings. Table 3 shows a comparison of the

Table3: Comparison of CLT platform and RC platform

Item	CLT Platform	RC Platform	Reasons for Evaluation
Workability	◎	△	CLT is lighter than RC and can be constructed by hand.
Strength	◎	◎	Both CLT and RC fully satisfy the design load requirements for the platform.
Heat Capacity	○	△	Compared to RC, CLT has a lower thermal conductivity and is effective in reducing the heat island effect.
Environmental Performance	◎	△	CLT has a smaller life cycle CO_2 than RC.
Durability	○	◎	Although CLT is treated with preservatives, it is less durable than RC.
Processability	◎	△	CLT is easier to cut and drill on-site than RC.
Landscape	○	△	CLT makes it possible to show the softness of wood on the surface more than RC does.

◎:very good, ○:good, △:poor

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functions of CLT and RC platforms. Compared to RC platforms, CLT platforms are lighter, making them easier to construct and easier to process on site. They also have a lower thermal conductivity and do not heat up as much in summer as RC platforms. Furthermore, because they are made of wood, they are more environmentally friendly and aesthetically pleasing. As described below, the strength of CLT platforms meets the design load, just like RC platforms, and they are comparable in function to RC platforms. However, although CLT platforms are treated with preservatives, their durability is inferior to RC platforms.

4.2 DEVELOPMENT AND DEPLOYMENT OF MODEL PLATFORM

A model platform made of CLT was installed outdoors (Fig. 14). The platform was divided into four sections, with a no protective section and sections with three types of protective coating (exterior protective coating, deck non-slip coating, and sand coating). Three types of Braille blocks (stud, sheet, and resin) were installed on each coating. The layout of the coating and Braille blocks is shown in Fig. 15. After installation in September 2023, the overall deformation of the platform has been checked continuously. In addition, a CLT platform with protective coating (sand coating) and sheet Braille blocks was installed at the actual railway station in March 2024 (Fig. 16).

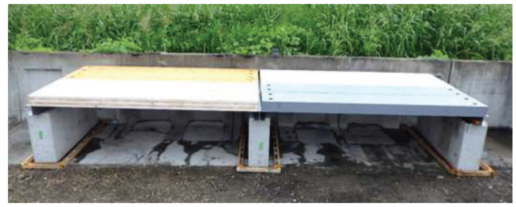

Fig.14: Model platform

Fig.16: CLT platform at the railway station

4.3 LOADING TEST

Bending tests were conducted on the CLT and RC

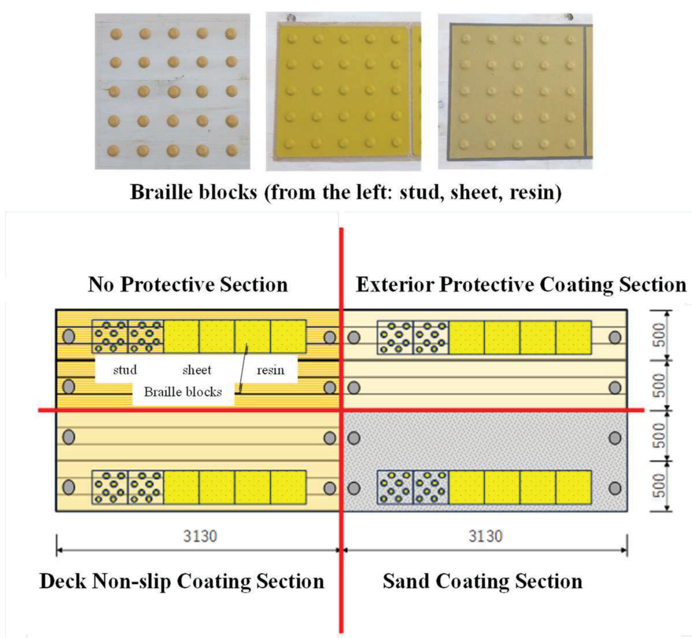

Fig.15: Layout of the coating and Braille blocks on the model platform surface

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specimens using a three-point loading method. Each specimen was fixed with an L-shaped bolt. Fig. 17 shows an overview of the test, and Fig. 18 shows the material design values of the specimens.

The CLT specimens broke when the load reached 100kN (Fig. 19). The RC specimens broke when the load reached approximately 10kN, and the reinforcing bars on the tension side yielded when the load reached approximately 49kN. After that, the load did not increase, and the displacement increased, leading to the breakage (Fig. 20).

The platform design load for crowd and self-weight was 5.6kN [2]. As mentioned above, the CLT specimen broke at 100kN, and the RC specimen broke at 49kN, confirming that both CLT and RC specimens fully met the design load.

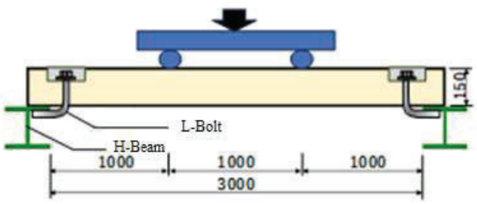
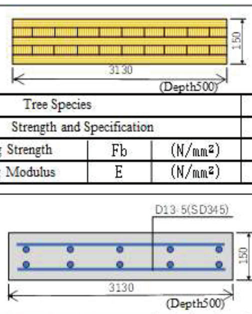


Fig.17: Overview of the loading test



Tree Species			Cypress
Strength and Specification			Mx90-5-5
Design Bending Strength	Fb	(N/mm²)	13.23
Design Bending Modulus	E	(N/mm²)	7080

Design Strength of Concrete	(N/mm²)	40
Design Bending Modulus of Concrete	(N/mm²)	31000
Design Yield Strength of Rebar	(N/mm²)	345

Fig.18: Material design values for the test specimens

5 –CONCLUSIONS

Currently, in Japan, the only guidelines available for designing CLT, such as stress, are those for buildings [3]. When using CLT in the civil engineering field, the

Fig.19: CLT specimen destruction

Fig.20: RC specimen destruction

specifications for appearance, stress, adhesive function, etc. differ from those for architecture. For this reason, there is a need to develop CLT specialized for civil engineering that is cost-effective, for example by using unused materials and lamina that do not meet JAS(Japanese Agricultural Standards). This survey was conducted by the Japan CLT Association with sincere support from the Forestry Agency in Japan.

6 – REFERENCES

[1] T. Ohhiro (RIKEN KOGYO Inc.).” Wind-stop type snow fence composed of a vertical section, a sneak-back section, and an overflow guide section.”, Patent Application Publication Number in Japan 2004-76555, 2004.

[2] Railway Technical Research Institute (ed.).” Design Guidelines for Transfer Overbridges”, 1987.

[3] Japan Housing and Wood Technology Center.” Design and Construction Manual for Buildings Using CLT”, 2021.

https://doi.org/10.52202/080513-0658