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Development of Cross-Laminated Timber and Current Standards in Türkiye

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Abstract– Cross-laminated timber (CLT) has gained prominence in the construction sector in recent years. In addition to eliminating most of the known disadvantages of wood, providing advantages such as earthquake resistance, lightness, fast application, etc.; its effects on climate have also increased the use of cross laminated timber. First used in the 1990s, CLT has seen its highest usage in the last decade. Various countries now use CLT for buildings of different functions and heights. However, there are still limited examples of CLT structures in Türkiye. This study examines the development of CLT, international and Turkish standards, and examples of its use. The study aims to contribute to future research on CLT in Türkiye.

Keywords – Cross-laminated timber, CLT, Mass timber, Standards, TS 647

I. Introduction

Mass timber is industrial products designed to reduce the inherent disadvantages of wood, such as decay, cracking, bending, and flammability. These materials play an important role in the construction sector of the 21st century due to their high earthquake resistance, ease of transportation, lightness, standardization in production, and their contribution to indoor comfort.

Mass timbers are made by processing wooden, combining them with adhesives and special techniques. Cross laminated timber (Cross Laminated Timber-CLT/X-Lam), Glued Laminated Timber (GLT), Nail Laminated Timber (NLT) and Dowel Laminated Timber (DLT) are the most commonly used mass timber materials.

II. Cross Laminated Timber-Clt

Cross-laminated timber was developed in the 1980-1990s and the first houses using CLT were built in 1995. Its use became widespread in the early 2000s and today its use in construction has increased due to international energy and incentive policies [1].

Cross-laminated timber panels are usually composed of three, five or seven layers of timber joined together diagonally at 90° angles according to TS EN 16351 standard (Figure 1) [2]. Certified adhesives and finger jointing techniques are used in the manufacturing of CLT, enhancing its strength [3], [4].

Fig. 1st Cross laminated timber [4]

The length of the panels depends on the production facility and the size of the transportation vehicle. CLT panels are used in walls, floors, curtain walls, elevator shafts, and staircases. Their high strength allows for their use in mid- and high-rise buildings, particularly in earthquake-prone areas [1].

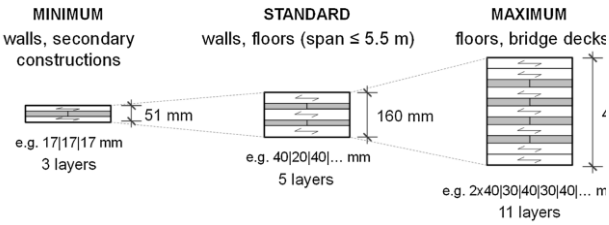

Fig. 2nd CLT layup examples [1]

In the production of CLT panels; there are stages such as cutting, drying, classifying the timber according to their properties, finger jointing, planing of the formed layers, application of certified glues to the layers, placing the layers crosswise and joining them under pressure, sizing the prepared panels according to the needs and transportation (Figure 3) [5].

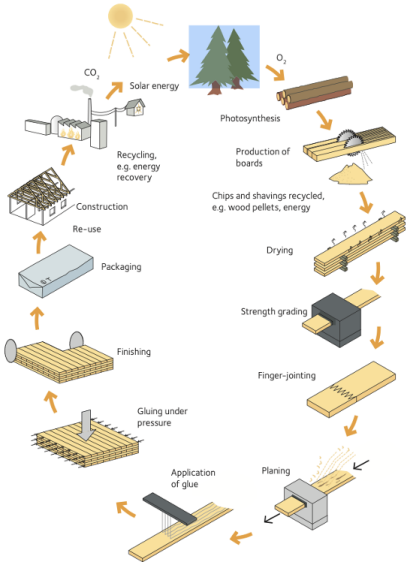

Fig. 3rd Cross laminated timber production process [5]

Cross laminated timber is used in walls, floors, curtain walls, cantilever floors, elevator shafts and stairs. High strength properties also allow CLT panels to be used in medium and high-rise buildings. Especially in earthquake zones, the use of CLT is encouraged [3]-[7].

III. Global Development of Cross Laminated Timber

Research on CLT began in the 1980s in Switzerland, Germany, and Austria. Cross-laminated timber, which is produced close to the technology used today, first entered the literature in Germany under the name "Brettsperrholz" (BSP) [8]. In 1990, studies on cross-laminated timber started at the Technical University of Graz in Austria [1], [8].

Around the same time, the Wiki House was built in Switzerland in 1993 using panels produced by Pius Schuler, called "Blockholz" and similar to the cross-laminated timber technology used today (Figure 4-5) [8].

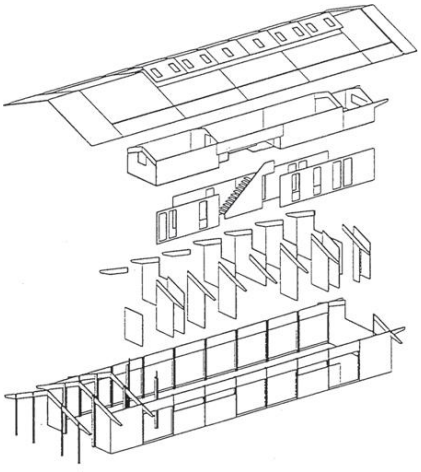

Fig. 4th Wiki House sketches [8]

Fig. 5th Use of Blockholz panels on the roof of Wiki House [8]

In 1995, Aichach Kreisgut residences were built by Karl Moser and Merk-Holzbau in Germany using panels called "Dickholz" (Figure 6,7) [1], [8]. While these buildings were being constructed, the lack of standards and techniques used today required special permits for the buildings. For this reason, these buildings are also considered as experimental studies.

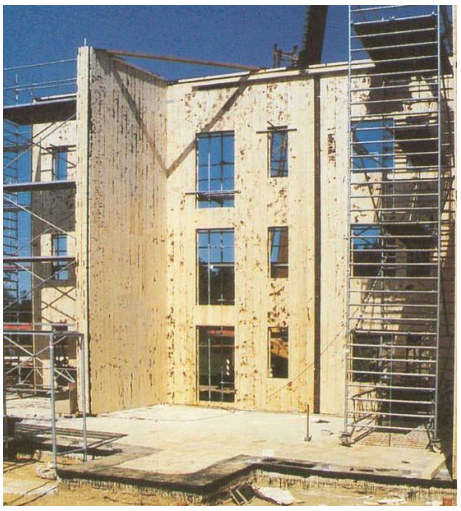

Fig. 6th Aichach Kreisgut houses wall construction [8]

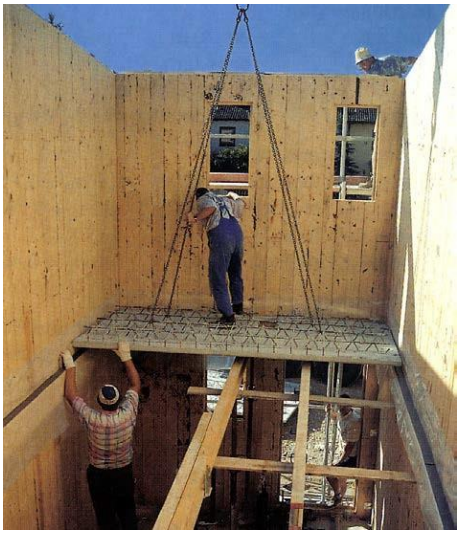

Fig. 7th Dickholz wood wall panels and prefabricated concrete slab [8]

While some sources claim that the first patent for CLT was issued in France in 1985, a 1923 patent from the U.S. is

believed to have played a significant role in the development of today's CLT elements (Figures 8,9) [9].

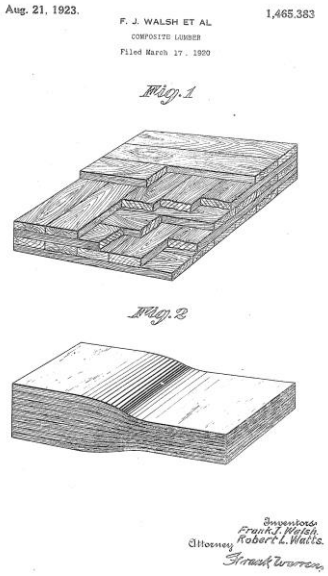

Fig. 8th Composite timber patented by Frank Walsh and Robert Watts in 1923 [10]

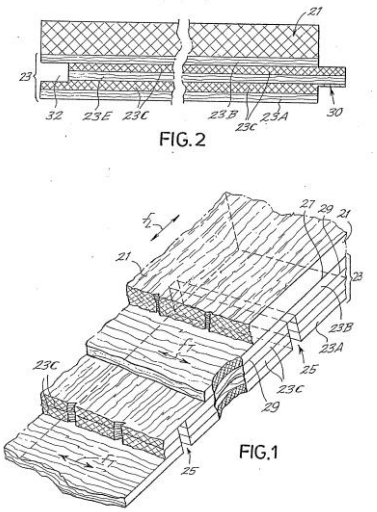

Fig. 9th Composite timber patented by Guglielmo Giordano in 1985 [11]

Since 1998, the first national guidelines were established in Austria, Germany and Switzerland, laying the foundations for the standards used in wood construction today [12], [13]. The most widely used standard for timber construction in Europe is Eurocode 5 [14]. However, these standards do not contain specific rules for CLT material. Therefore; the current standard used in Europe today is EN 16351-2021. This standard deals with issues related to CLT such as production, transportation, design, construction, use. The second generation Eurocode 5-2 standards with details on CLT are expected to be published in 2025-2027 [15].

In the early 2000s, despite the lack of construction guidelines and standards, structures were started to be built using cross-laminated timber in North America [16]. In 2011, CLT Handbooks were published by FPInnovation. These books are used as a guide for many features of the CLT such as production, transportation, application and use. In 2011, with the publication of the PRG 320 wood standard, an increase in CLT applications was seen in America [7].

In Asia, studies on cross-laminated timbers started in 2012 in Japan, which has an important place in traditional wood architecture [14]. JAS 3079, the standard used today, was published in 2019 [17].

In South Africa, SANS 8892:2020 standards, which came into force in 2020, are used [18]. SANS 8892 determines the rules such as design, construction, quality standards of CLT elements to be used in construction works.

Cross-laminated timber is a material that has been researched and studied since the 1920s, but has come to the forefront in the construction industry, especially in the last decade (Figure 10).

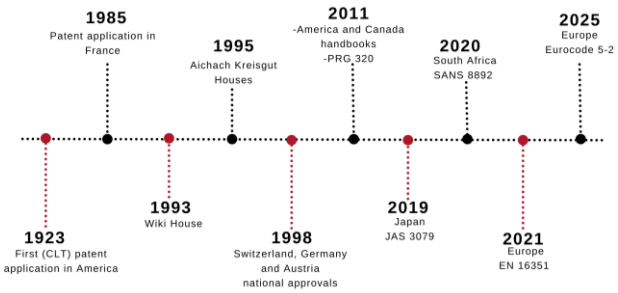

Fig. 10th Historical development of CLT use in the world

Cross-laminated timbers, which are more durable than timber due to their physical, mechanical and chemical properties, have started to be preferred in today's construction sector, especially in high-rise buildings (Figures 11, 12).

Fig. 11th 3 storey Aichach Kreisgut houses (1995) [8]

Fig. 12th The world's tallest wooden structure, the 25-storey Ascent (2022) [19]

IV. Cross Laminated Timber in Türkiye

In Türkiye, CLT is a relatively new product. Due to the absence of production facilities, lack of awareness, insufficient technical personnel, and a lack of education, CLT is used only to a limited extent.

Türkiye signed the Paris Climate Agreement in 2015 and the Glasgow Climate Pact in 2021, committing to significant carbon emission reductions by 2030 and achieving net-zero emissions by the mid-century.

197 countries including Türkiye signed the Paris Climate Agreement in 2015 and the Glasgow Climate Pact in 2021, committing to significant carbon emission reductions by 2030 and achieving net-zero emissions by the mid-century.[20], [21].

There are a few companies in Türkiye that construct buildings using CLT elements. These companies import most of the products. This situation affects the construction cost, construction time and indirectly the preference of wood in the construction sector. Thanks to the government incentives provided to support sustainable building production, it is aimed to increase the number of wooden buildings in our country in the near future. It is predicted that there will be a great change in the construction sector in our country with the start of production of CLT production facilities planned to be opened in Kastamonu and Yozgat provinces [22], [23].

One of the most important reasons why cross laminated timber and other mass timber products are not preferred in the construction sector in Türkiye is the lack of standards and regulations. As a result of the studies carried out within the scope of the "Ahşap Binaların Tasarım, Hesap ve Yapım Esaslarına Dair Yönetmelik" (Widespread Use of Wood Project, the Regulation on the Design, Calculation and Construction Principles of Wooden Buildings) was published in the Resmi Gazete on March 24, 2024 [24]. The regulation, which will enter into force in 2025, includes rules on the application principles of glued laminated timber and cross laminated timber elements.

Since the regulation on the production and application details of mass timber is not yet in force, timber structures in Türkiye are constructed within the scope of TS 647 and Eurocode 5 [25].

The use of mass timber materials, which stand out especially with their high earthquake resistance, has come to the agenda more after the Kahramanmaraş earthquake in Türkiye. The government has been carrying out studies with the support of ministries and non-governmental organizations to promote the use of wood. One of the most important of these efforts is the reconstruction of administrative buildings and lodgings in earthquake-affected regions using mass timbers (Figures 13, 14) [25].

Fig. 13th Mass timber construction in the earthquake zone [25]

Fig. 14th Mass timber construction in the earthquake zone

V. CONCLUSION

Cross-laminated timber (CLT) has emerged as a prominent construction material in recent years. The use of CLT is also of great importance from a sustainability perspective. It can be said that the studies that began in Europe in the 1990s laid the foundation for today's standards. Research on CLT continues in various countries around the world, aiming to reduce its disadvantages and enhance its advantages. Therefore, understanding the history of cross-laminated timber and keeping track of ongoing studies is crucial. In recent years, research on CLT in Türkiye has increased, supported by government incentives, academic studies, and the initiatives of civil society organizations. The use of this material, which has developed since the first patent application, is also expected to increase in Türkiye.

This study examines the development of cross-laminated timber both globally and in Türkiye. It was found that international and national standards play a significant role in the use of the material. This study is expected to contribute to research on the use of CLT in Türkiye.

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