International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

STUDY ON CROSS LAMINATED TIMBER

Arul Mozhi Bharathi D V[1], Dhanalakshmi E[2], Dr. K. Manickam[3]

[1]PG Student & Dept. of Civil Engineering, Veltech Engineering College, Chennai, Tamilnadu, India
[2]PG Student & Dept. of Civil Engineering, Veltech Engineering College, Chennai, Tamilnadu, India
[3]Professor, Dept. of Civil Engineering, Veltech Engineering College, Chennai, Tamilnadu, India

---***---

Abstract - *Building failure due to natural disaster refers to the loss of structural homogeneity and integrity. Then the building components are stressed beyond its strength limit, and building ultimately loses their load carrying capacity. Therefore, buildings are always designed to resist the natural disasters and also for impact loads however sometimes they cannot tolerate the excessive forces of disaster in the end they fail to perform well during the service life. This is the reason that the building should also be designed in such a way that they can resist the high impact forces. To overcome all those disputes we need a right solution or awareness. Hereby introducing new advanced resistant materials such as Cross Laminated Timber (CLT) has emerged in recent years to become a widely recognized mass timber product for construction projects. It is generally believed that newly constructed CLT buildings can be cost competitive than steel and concrete. CLT is most often used in form of floor and wall panels. Favorable environmental, aesthetic and energy qualities further enhance its qualities. CLT provides dimensional stability, strength and rigidity, which helps in many applications. CLT is also scheduled to be included in the International Building Code (IBC) that details the manufacturing and performance requirements for qualification and quality assurance and also demonstrate current production process of various production techniques then technology aspects of CLT. Eventually this paper ready to serves the building life and human lives through the innovating technique of CLT and also discuss the detailed study, Manufacturing, Purpose, features, Dimension and requirements, Characteristics, lateral design and cost is chosen on the basis of construction needs in Engineering.*

Key Words*: *Innovating material, Strength, Impact forces, Cross Laminated structure.

1. INTRODUCTION

Wood-based building materials must be stored properly on the positioning if not used immediately. Planning is most important to make sure that CLT assemblies have the proper handling space and material flow during construction. Stacking of the panels on the event site must match the planned installation sequence to avoid additional costs and to scale back the chance of accidents or breaking. When CLT panels are stored on site, charge must be taken to guard them against the weather in weather and vandalism. If panels must be placed temporarily on the underside before to installation, they ought to put down on skids of sufficient number to shield the panels from standing water. The panels must even be completely protected against the weather by appropriate wrapping or by other measures. CLT may perhaps be a replacement timber technology and its pre-fabricated, engineered wood artifact material with unique and sometimes superior building, aesthetic, environmental, and value attributes. CLT can function a system- based approach for floors, walls, and roofs to form a high- performance, sustainable, and exquisite mass timber building of virtually any type. CLT panels comprises of several layers of lumber boards (at 90 degrees) and glued together on their wide faces and, sometimes, on the narrow faces additionally. Besides gluing, nails or wooden dowels is want to attach the layers. Innovative CLT products like Interlocking Cross-laminated Timber (ICLT) are within the tactic of development. A cross-section of a CLT element includes a minimum of three to five glued layers of boards placed in orthogonally direction to the neighboring layers. In special configurations, consecutive layers could even be placed within the identical direction, giving a double layer (e.g., double longitudinal layers at the outer faces and/or additional double layers at the core of the panel) to induce specific structural capacities. Generally, CLT products are fabricated with an odd number of layers; three to seven layers is common and even more. Lumber within the outer layers of CLT panels used as walls are normally oriented up and down, parallel to gravity loads, to maximize the wall's vertical load capacity.

2. LITERATURE RIVEW

Maria Fernanda Laguarda Mallo, Omar Alejandro Espinoza, CLT as a construction system has been successful in Europe, only a couple of CLT projects are in-built in the U.S. This manuscript presents the results from qualitative research, applied with the target of assessing the market potential and barriers to the adoption of CLT within the U.S. Insights from national and international experts were collected using semi-structured interviews. Topics included perceived benefits and drawbacks of CLT as a construction system, major barriers to its adoption within the U.S., and level of awareness about CLT among the architecture community. **Johannes Schneider, Siegfried F. Stiemer, Solomon Tesfamariam, Erol**

Karacabeyli, Marjan Popovski, describes how the energy-based cumulative damage assessment model was calibrated to the CLT connection and shear wall test data so as to analyze the damage under monotonic and cyclic loading. Comparison of various wall set-up provided a deeper insight into the damage estimation of CLT shear walls and determination of the key parameters within the CLT buildings. **Kell Jones, Dr. Peter Winslow**, This theory is explored in a very case study of first adoptions of cross-laminated timber (CLT) in UK projects, employing a survey and series of semi- structured interviews. This provided designers, who were motivated to use CLT, the chance to push its use within the construction project.

3. MANUFACTURE OF CLT

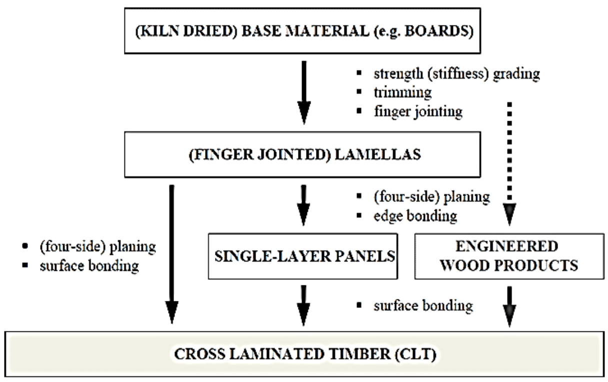

Fig -1: Manufacturing Process of CLT Panel

4. FEATURES OF CLT

- **Waste Reduction:** Usage of Panels in an accurate manner and the process of construction is "PRE-FABRICATION". "LESS" in nature.
- **Flexibility Design:** Design CLT panel in required and accurate shape and dimension even a millimeter plays a perfect role. Cutting is carried out by CNC machines. "ACCURATE" in nature.
- **Insulation:** CLT have thicker panels and it has low coefficient heating transfer value hence it gives good insulation value. "LESS" in nature.
- **Void:** Flow of air is not possible hence CLT panel acts as energy efficiency. "LESS" in nature.
- **Installation Period:** CLT construction is Pre-fabricated construction therefore it speeds up the construction process and quick installation is carried out. "LESS" in nature.
- **Sound Insulation:** Providing sound insulation in CLT building detect the noise occurred by poor workmanship and sound occurred by different media like structural and airborne. "GOOD" in nature.
- **Fire Resistance:** CLT material can resist maximum 60 minutes of fire behaves like stable and it doesn't easy to exposed other surface area. "GOOD" in nature.

5. REDUCTION OF COST

COST EFFCETIVE	% OF SAVING
High Rise building	15%
Mid Rise of Non Residential Building	15-20%
Educational Low Rise Building	15-50%
Commercial Low Rise Building	25%

6. REQUIREMENTS OF CLT

For CLT Wall elements,

- Load bearing capacity (critical criterion) and In-plane and Out-of-plane shear.
- Bending strength.
- Fire performance, Sound insulation and Durability.

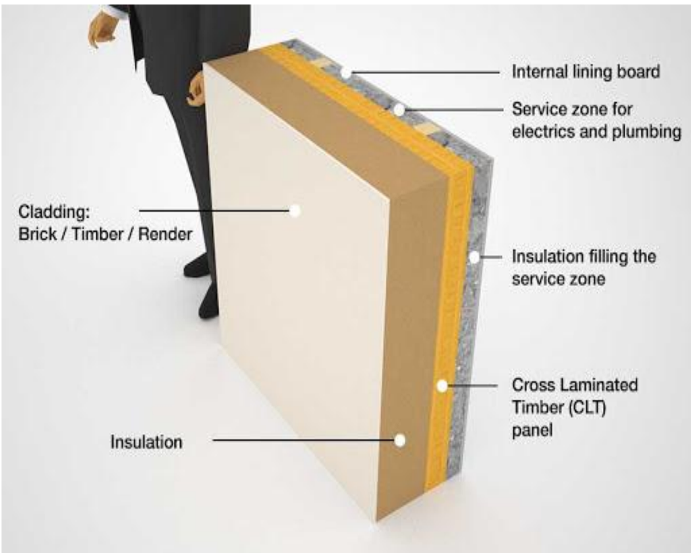

Fig -2: CLT Panel Wall

For CLT Roof & Floor,

- Long term deflection.
- Short term and Long term behavior.
- In-plane and out-of-plane bending strength, shear strength and stiffness.
- Vibration performance of floors.
- Compression perpendicular to grain issues (bearing).
- Fire performance.
- Sound insulation.
- Durability.
- Long-term strength for permanent loading.

Fig -3: CLT FLOOR & ROOF

CLT panels have a relatively high capacity to store moisture, but relatively low vapor permeability. If exposed to excessive wetting during construction, the panels may absorb a large amount of moisture, which may result in slow drying. CLT is not among the wood products covered in the ANSI/AWC NDS-2012, and consequently there are no load duration and service condition factors specified for this CLT structural elements.

(i) **Service Condition Factor:** For dry service conditions (i.e., moisture content of less than 16%), use the service condition factor of1.0

(ii) **Creep Factor:** The current factor specified in ANSI/AWC NDS-2012 does not account for creep that may occur in CLT. Therefore, the time dependent deformation (creep) factor K_{cr} = 2.0 is recommended for dry service conditions. A creep factor K_{cr} = 2.5 is suggested for wet service conditions,

(iii) **Load Duration Factor:** It is recommended to use the load duration factor (C_D), for ASD as specified (from Table 2.3.2 of ANSI/AWC NDS-2012), or the time effect factor, λ, for Load and Resistance Factor Design (LRFD) as specified (from Table N.3 of ANSI/AWC NDS-20).

For CLT Lumber Boards,

- Dimensions and Dimensional tolerance.
- Laminations.
- Adhesives.
- Phenolic types such as Phenol-Resorcinol Formaldehyde (PRF).
- Emulsion Polymer Isocyanate (EPI).

Fig -4: CLT Buildings

7. LATERAL DESIGN OF CLT

The equivalent lateral force (ELF) is one of the most commonly used analytical procedures for seismic design of buildings. This relies on system-specific seismic design coefficients, R, C_d, and Ω_0 for evaluation of seismic loads and compliance with associated design requirements. While CLT seismic performance has been evaluated, at the system level using multi-story shake table testing, and numerically via structural modeling, there are no recognized seismic design coefficients for CLT in model building codes. Guidance can be derived directly from ASCE 7-10, FEMA P695, and FEMA P795 Quantification of Building Seismic Performance Factors: Component Equivalency methodology. The information on CLT seismic performance taken from testing and results from modelling and it is necessary to discuss on the seismic resistance design for CLT. The main assumptions for CLT shear model include:

- Dynamic response of CLT floor/roof diaphragms can be approximated as responses of rigid plates having 6 degrees of freedom.
- Lateral (shear) resistance of CLT walls can be represented in the model as hysteretic springs.
- Overturning restraint is provided and can be represented in the model as linear springs.
- Effect of finish materials on lateral resistance is not examined in this study.

Bending members of CLT,

$$EI_{eff} = \sum_{i=1}^{n} E_i \, . \, b_i \, . \, \frac{h_i^3}{12} + \sum_{i=1}^{n} E_i \, . \, A_i \, . \, z_i^2$$

Compression members of CLT,

$$P_{parallel} \leq F' A_{parallel}$$

Tension members of CLT,

$$T_{parallel} \leq F' A_{parallel}$$

Maximum Deflection Δ_{max},

$$\Delta_{max} = \frac{5}{384} * \frac{wL}{EI_{eff}} + \frac{1}{8} * \frac{wkL^2}{GA_{eff}}$$

8. MERITS OF CLT

- *Design flexibility*
- *Eco-friendly*
- *Prefabrication*
- *Light building material*
- *Light weight material*

9. CONCLUSION

The outlook for current and future developments as well as the ongoing establishment of the solid construction technique with CLT is given. The product CLT comprises an enormous potential; for timber engineering as well as for society as a prefabrication, joining techniques, building physics and building construction make it possible for timber engineering to achieve worldwide success. This thesis provides an overview of current production of material and characteristics of CLT. It also comprises of manufacturing process of CLT, uses, merits, lateral design and applications of CLT panel elements. CLT was seen as key to successful resolution of project constraints, thereby providing motivation to other project participants to adopt the material in future.

10. REFERENCES

[1] "Cross-Laminated Timber: A Primer" *on 2019-09-02.*
[2] ANSI/APA PRG 320 Standard for Performance-Rated Cross-Laminated Timber.
[3] CLT hand book.
[4] CLT Plant, Lappia, Digipolis, Kemi, February 2016.
[5] Rainer, & E.Karacabeyli. Wood-frame construction-. Canadian Wood Council, 1999.
[6] Mahapatra, Krushna; Gustavsson, Leif (2009). General Conditions for Construction of Multistorey Wooden Buildings in Western Europe. Vaxjo, Sweden: School of Technology and Design, Vaxjo University. pp. 1–47. ISBN 9789176366943.
[7] Thomas; Shah, Darshil U.; Wu, Guanglu; Yu, Li; Fleming, Patrick (February 2017). "The wood from the trees: The use of timber in construction".