International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 13 Issue 11 ǁ November 2025 ǁ PP. 15-23

Analysis of Multi-Storey Building with Cross Laminated Timber Panel

Vinita Jadhav, Prof. Roshni john
*[*1] Student, Department of Civil Engineering, University of Mumbai, Maharashtra, India*
[2] Professor,Department of Civil Engineering, University of Mumbai, Maharashtra, India

Abstract
Today, countries all around the world are affected by climate change, which causes increasingly extreme weather patterns, rising sea levels, and previously unheard-of greenhouse gas emissions. Notably, more than 40% of the world's CO2 emissions come from the construction sector. Using sustainable building techniques and materials is crucial to lowering its carbon impact. An inventive kind of engineered wood called mass timber provides improved structural qualities appropriate for large, weighty buildings. But there are drawbacks to employing timber alone in high-rise structures, such as increased floor accelerations because of its greater flexibility, low fire protection, and lightweight nature. Modern multi-story structures can effectively handle these problems with CLT-steel hybrid features. Cross-Laminated Timber's (CLT) seismic performance in a variety of multi-story buildings is investigated in this study. The seismic behavior of concrete-steel and CLT-steel composite slabs under lateral seismic events is compared using models of a 11-story structure. We can conclude from the study that CLT improved structural qualities, which makes it good material to use for building big and tall structures.

Keywords: *cross laminated timber, mass-timber, sustainable, steel hybrid.*

Date of Submission: 25-10-2025 | Date of acceptance: 05-11-2025

I. INTRODUCTION

In medium-rise applications, cross laminated timber (CLT) has emerged as a significant substitute for conventional reinforced concrete slabs in North America. The better structural strength and reduced embodied energy of this engineered wood product provides it a competitive edge. CLT panels are adaptable elements that can be utilized as shear walls or floor slabs in multi-story constructions. The cross-laminating method, which is made by adhering layers of timber planks that are 90 degrees to one another, improves stability and makes it possible to prefabricate long, wide floor panels and extended one-story walls. Even in tall building systems, CLT has established itself as a reliable component for walls, roofs and floors because of its exceptional mechanical qualities, ease of prefabrication and lightweight nature. In the past, European CLT buildings changed from being three-story to five-story between 1995 and 2005. Higher-rise applications started to appear in Sweden, Germany, Italy, and the United Kingdom by 2008. Australia finished a 10-story CLT skyscraper in 2013, indicating the material's increasing use in taller buildings. Now that production methods have advanced significantly, CLT can be employed in heavy structural applications with thicknesses up to 500 mm. Furthermore, CLT is comparatively lightweight while providing great stiffness and strength when compared to reinforced concrete slabs.

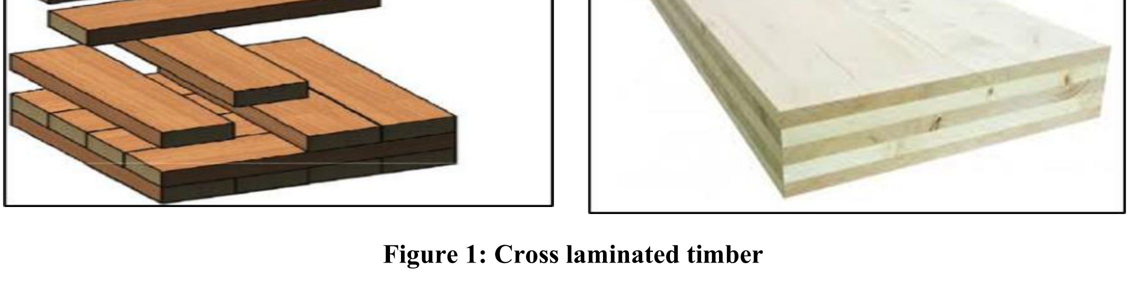


Figure 1: Cross laminated timber

1.1.1 Aim and Obective

Analyzing how a steel and CLT steel hybrid structure react to seismic stresses in seismic zones IV and V with medium soil conditions is the aim of the current study. The following goals will help the project reach its goal.

- compare the following building configurations:
  1.Steel frame with RCC slab (without X bracing)
  2.Steel frame with CLT slab (without X bracing)
  3.Steel frame with RCC slab (with X bracing)
  4.Steel frame with CLT slab (with X bracing)
  5.Steel frame with CLT slab and CLT shear wall
  6.RCC frame with CLT slab and CLT shear wall
- To use response spectrum analysis to examine the structure.
- Compare the many scenarios for various parameters, such as storey displacement, storey shear, and storey drift.

1.1.2 Problem statement

In this study, a (G+11) steel building and a (G+11) hybrid building are selected for analysis. The hybrid structure is formed by incorporating Cross-Laminated Timber (CLT) with steel. dynamic analysis of multistorey building is done for seismic zone IV and v with medium soil condition.

1.1.3 Input parameters

Table 1: properties of structure

Parameters	Steel Structure	CLT - Structure
Type of Structure	Residential	Residential
Type of Frame	SMRF (Bare Frame)	SMRF (Bare Frame)
	SCBF (Braced Frame)	SCBF (Braced Frame)
Plan area	12m* 9m	12m* 9m
Number of story’s	11	11
Height of Building	25.5 m	25.5 m
Height of each floor	3 m	3 m
Depth of foundation	1.5 m	1.5 m

Table 2: Mechanical properties of CLT materials

Parameters	Concrete	Cross laminated timber
Directional Property	Isotropic	Orthotropic
Density (Kg/M^3)	2400	400
Elastic Modulus (Gpa)	25	E_1= 9, E_2 = 4.5, G_{12} = 0.5
Poisson’s Ratio	0.25	N_{12}= 0.3

Notation: E = modulus of elasticity; G = modulus of rigidity; 1 = CLT major direction; 2 =CLT minor direction; t = tension; c = compression

Table 3: Section properties

Parameters	Steel	CLT -steel
Thickness of slab	75mm	250mm
Beam size	ISMB 300	ISMB 250
Column size	ISHB300 with additional plate 400 width, having thickness 25mm	ISMB300 with additional plate 350 width, having thickness 25mm
External wall thickness	230mm	230mm
Internal wall thickness	230mm	230mm

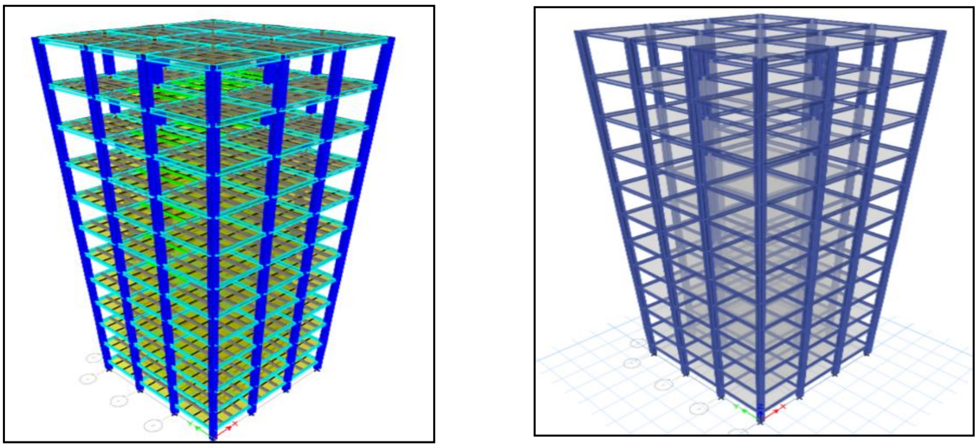


Figure 2: RCC and CLT slab building without bracing

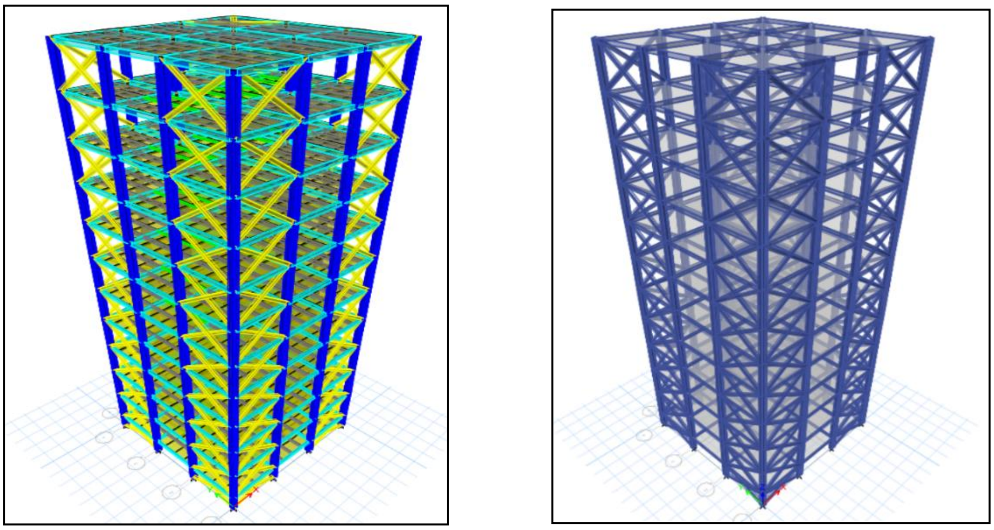


Figure 3: RCC and CLT slab building without bracing

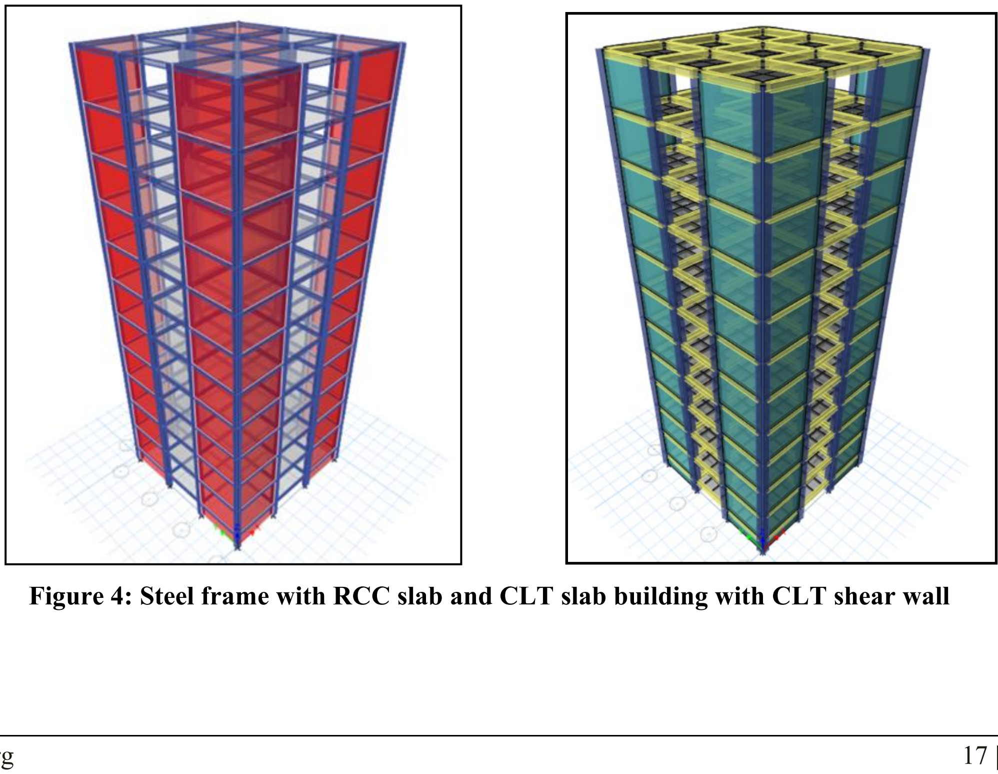


Figure 4: Steel frame with RCC slab and CLT slab building with CLT shear wall

II. Result and Discussion

The results obtained are as discussed below:

1.2.1 STORY DISPLACEMENT

The displacement of a story with respect to the displacement of the bas is known as story displacement.

Table 4: Maximum Story Displacement in X direction

Type of structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	54.193	81.29
Bare Frame (steel frame with CLT slab)	21.695	32.013
X bracing (steel frame with RCC slab)	15.179	20.612
X bracing (steel frame with CLT slab)	5.336	8.894
Steel frame with CLT slab and CLT shear wall	6.291	9.437
RCC frame with CLT slab and CLT shear wall	8.775	9.437

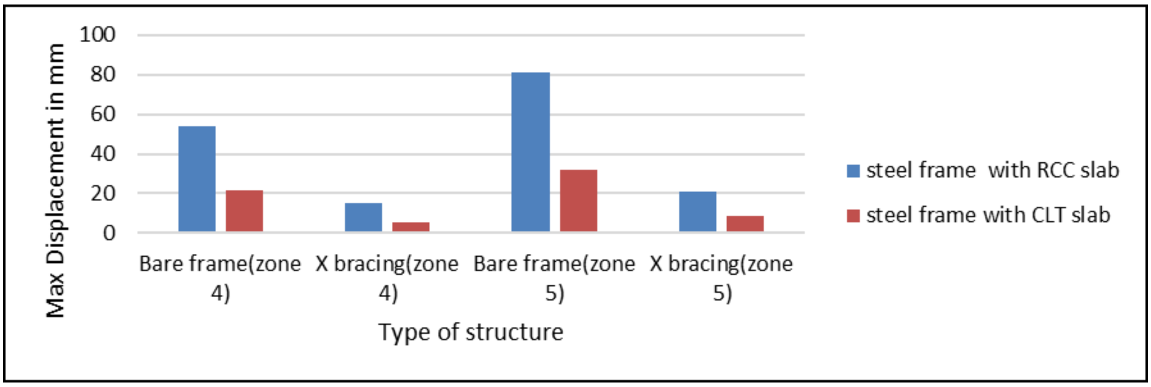


Figure 5: Maximum story displacement in X direction (Seismic zone 4 and zone 5)

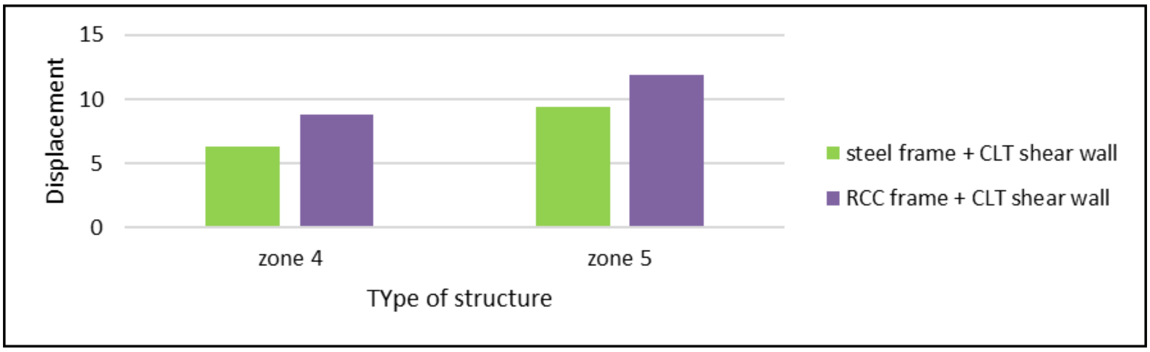


Figure 6 :Maximum story displacement in X direction for shear wall

Table Error! No text of specified style in document.**:Maximum story Displacement in Y direction**

Type of structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	58.051	87.11
Bare Frame (steel frame with CLT slab)	23.828	35.258
X bracing (steel frame with RCC slab)	15.228	20.678
X bracing (steel frame with CLT slab)	5.426	9.043
Steel frame with CLT slab and CLT shear wall	6.735	10.097
RCC frame with CLT slab and CLT shear wall	8.722	10.097

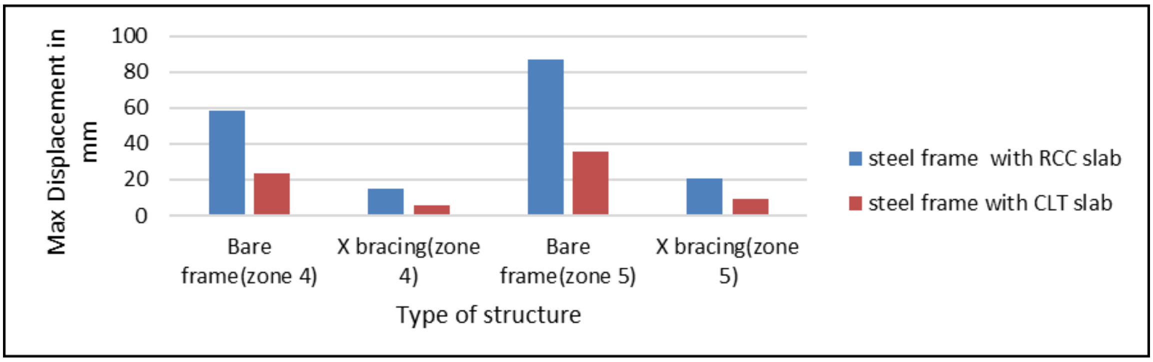


Figure 7: Maximum Story displacement in Y direction (Seismic zone 4 and zone 5)

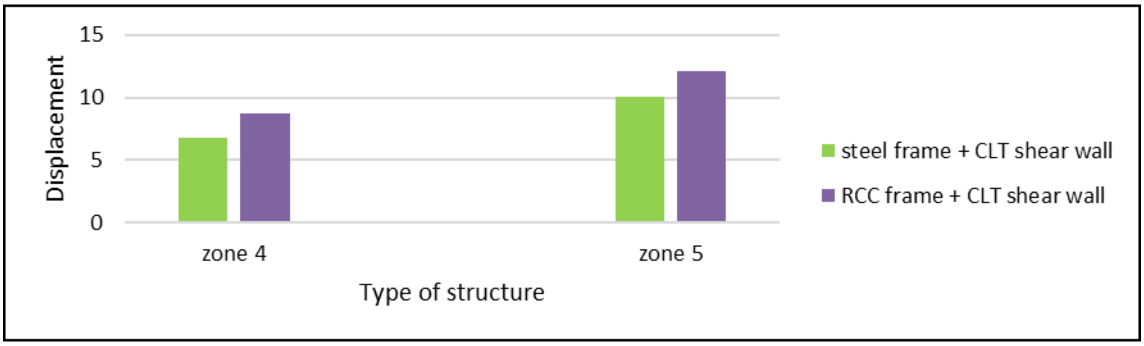
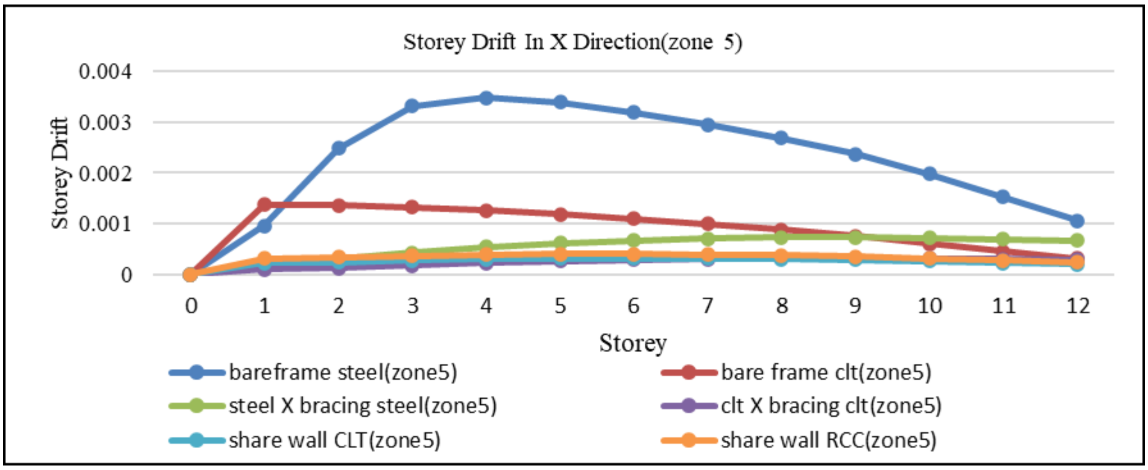


Figure 8: Maximum Story displacement in Y direction for shear wall

1.2.2 STOREY DRIFT

Table 6: Maximum story Drift in X direction

Type of structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	0.002322	0.003483
Bare Frame (steel frame with CLT slab)	0.000935	0.001376
X bracing (steel frame with RCC slab)	0.000538	0.000731
X bracing (steel frame with CLT slab)	0.000191	0.000318
Steel frame with CLT slab and CLT shear wall	0.000213	0.000319
RCC frame with CLT slab and CLT shear wall	0.000299	0.000319



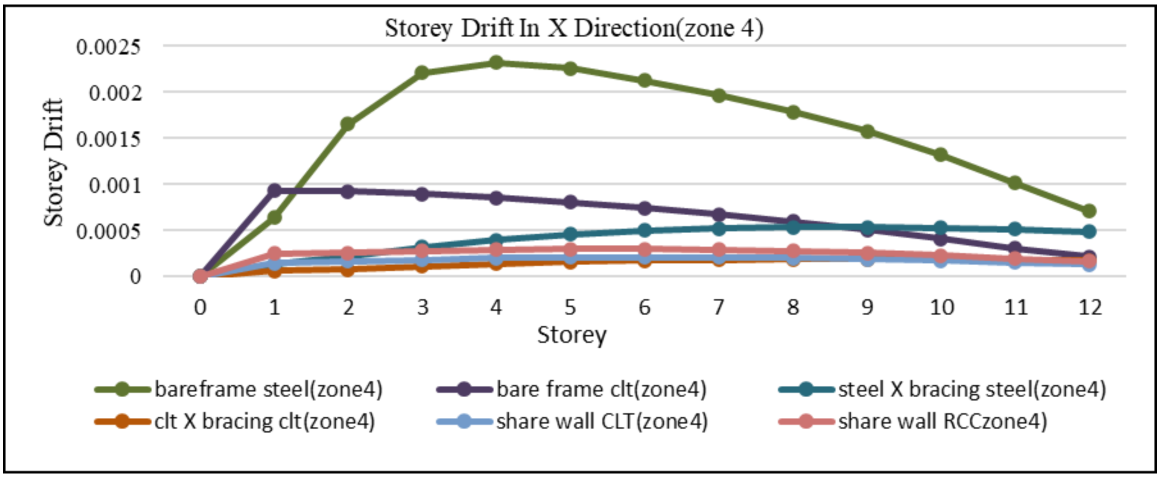


Figure 8: Drift in X direction (zone 4)

Table 7: Maximum Story Drift in Y direction

Type of structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	0.002539	0.00381
Bare Frame (steel frame with CLT slab)	0.001045	0.001541
X bracing (steel frame with RCC slab)	0.00054	0.000733
X bracing (steel frame with CLT slab)	0.000194	0.000324
Steel frame with CLT slab and CLT shear wall	0.00023	0.000345
RCC frame with CLT slab and CLT shear wall	0.000297	0.000345

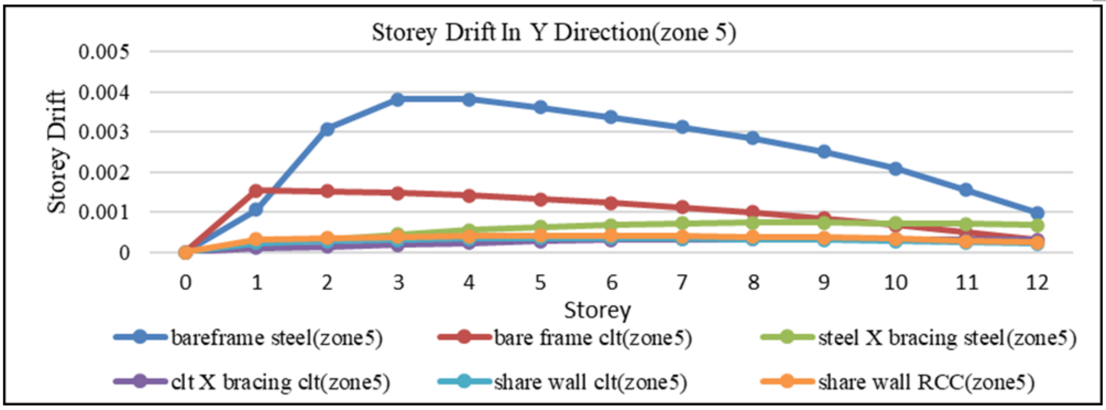
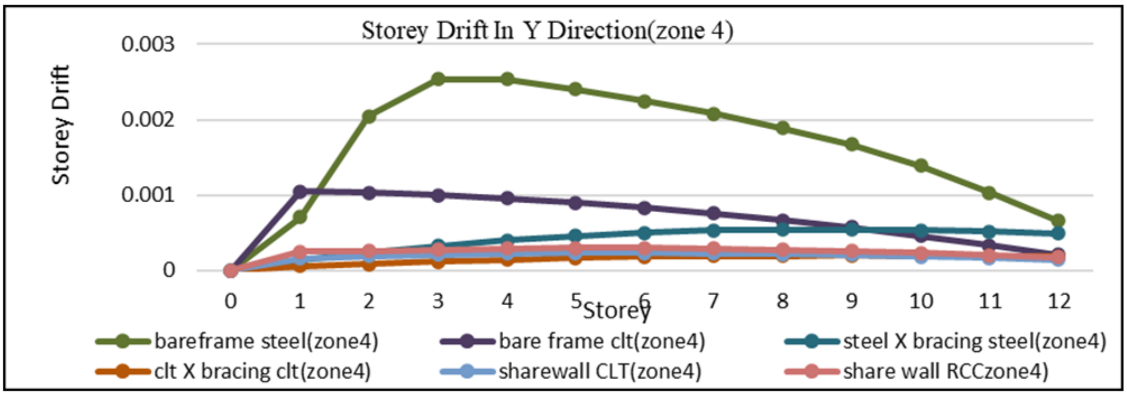


Figure 9 :Drift in Y direction (zone 5)



1.2.3 Storey Shear

Table 8: Maximum Story Shear in X direction

Type of Structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	559.7573	839.636
Bare Frame (steel frame with CLT slab)	156.6011	230.1328
X bracing (steel frame with RCC slab)	646.8412	839.636
X bracing (steel frame with CLT slab)	189.6858	316.143
Steel frame with CLT slab and CLT shear wall	529.9928	312.7806
RCC frame with CLT slab and CLT shear wall	208.5575	312.8365

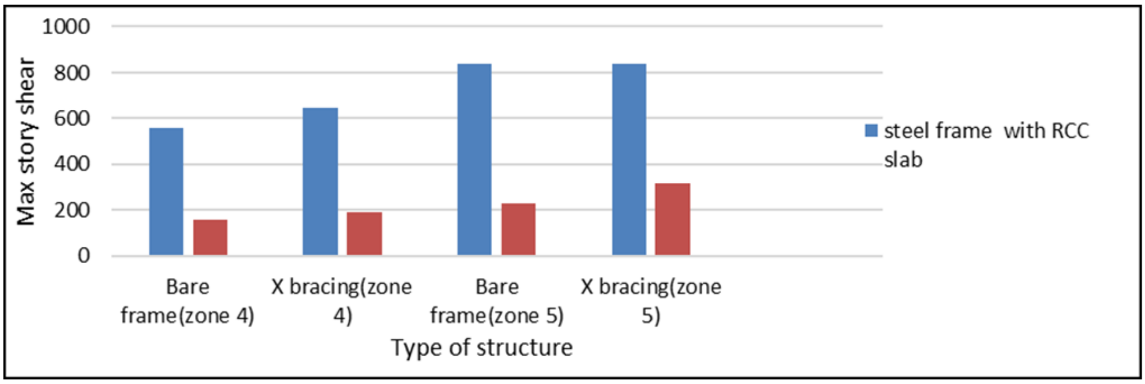


Figure 10: Story Shear in X direction (Zone 4 and Zone 5)

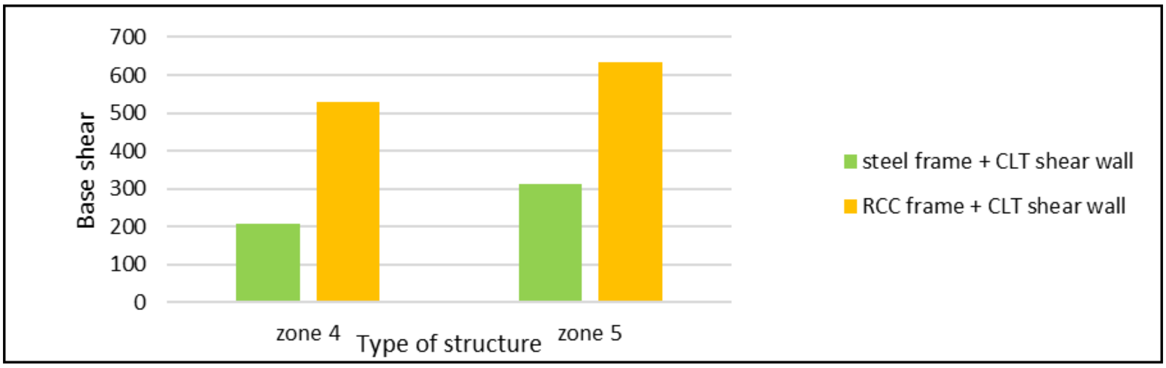


Figure 11: Story Shear in X direction for Shear wall

Table 9: Storey Shear in Y Direction

Type of Structure	Zone 4	Zone 5
Bare Frame (steel frame with RCC slab)	561.8895	843.1598
Bare Frame (steel frame with CLT slab)	156.8248	230.9959
X bracing (steel frame with RCC slab)	646.8337	843.1598
X bracing (steel frame with CLT slab)	189.3756	315.626
Steel frame with CLT slab and CLT shear wall	526.8128	313.025
RCC frame with CLT slab and CLT shear wall	208.8249	313.0667

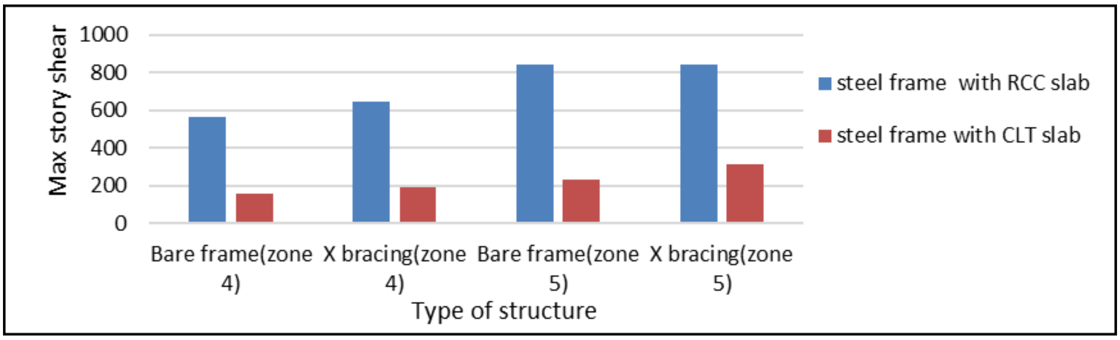


Figure 12 :Story Shear in Y direction (Zone 4 and Zone 5)

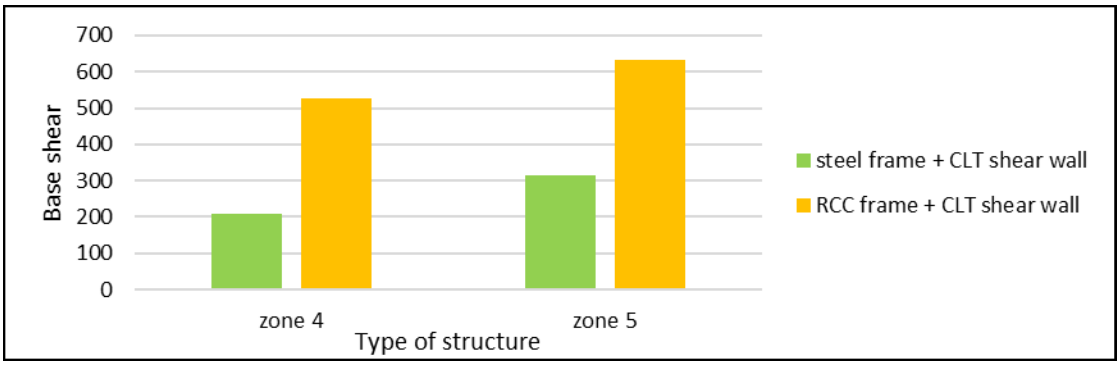


Figure 13:Story Shear in Y direction for story shear

III. Conclusions

In the present study, an attempt is made to study the seismic behavior of RCC and timber steel hybrid building with bracing system. The seismic behavior of building with different bracings in RCC and timber steel hybrid buildings. The storey drift and story displacement and base shear were obtained. The seismic analysis is carried out taking into consideration that all the buildings are located in zone III. The following are the conclusions obtained based on the analysis: -

1.In zone 4 and 5 the steel frame with RCC slab shows significantly higher displacement than the steel frame with CLT slab in both X and Y direction.

2.In Zone 4, the RCC frame with CLT shear wall (8.775 mm) has higher displacement than the steel frame with CLT shear wall (6.291 mm), showing that steel frames are generally stiffer than RCC frames.

3.CLT slab systems exhibit lower drift values than RCC systems due to their lighter weight, which reduces seismic demand in both X and Y direction.

4.A bare steel frame with CLT has reduction in story shear as compared frame with a RCC slab that is approximately 72% in both direction for zone 4 and zone 5, emphasizing the critical impact of material selection.

5.In CLT frame structures located in Zone 5, the introduction of X-bracing leads to a substantial 62.39% reduction demonstrating the effectiveness of bracing in reducing seismic demand by enhancing lateral stiffness and stability.

6.From a purely cost-based perspective, the Steel + RCC slab option is significantly more economical and is the better choice if budget is the main concern.

7.However, if other factors like construction speed, environmental impact, sustainability, or lower dead load are prioritized, the CLT option may offer long-term benefits.

REFERENCES

[1]. Muhammad Nauman, Muhammad Irshad Qureshi,Asif Iqbal, Tahir Mehmood "Feasibility Study of Hybrid Timber-Concrete Tall Buildings" Conference on Sustainability in Civil Engineering (CSCE'21)

[2]. Md. Shahzar, Md. Tasleem, "Comparative Study of Flat Slab Building with Shear Wall and Bracing" Volume 12, Issue 6, 2021.

[3]. Nitin Bhojkar, Mahesh Bagade, "Seismic Evaluation of High-rise Structure by Using Steel Bracing System", International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 3, March 2015.

[4]. Rajesh Goel, Pooja Sharma, "Seismic Coaction of Shear Wall & Reinforced Cement Concrete Bracing System in High Rise Commercial Buildings using STAAD Pro", International Journal for Research in Applied Science & Engineering Technology, Volume 6 Issue V, May 2018.

[5]. 5) Shubham Bhutada, P.D. Pachpor, A.K. Sharma "Research on RCC and Timber Multi-Storey Structures using Response Spectrum Search" Volume-8, Issue-2S3, July 2019

[6]. Sooria raj "Feasibility Study on the Structural Behaviour of Hybrid Wood Steel Structures Using Finite Element Analysis" Volume 7, Issue 5, May-2016