International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 03 March 2024
Page No: 546 - 550
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0078

# A Review on Comparison of RCC and Steel Multistorey Building with and Without Beam Projections

*Harshita Patil[1*], Jaydeep Chougale[2], Ajay Radke[3]*
*[1]PG Student, Department of Civil Engineering, Vidhyavardhini's college of Engineering and Technology, Vasai, Maharashtra, India.*
*[2]Assistant Professor, Department of Civil Engineering, Vidhyavardhini's college of Engineering and Technology, Vasai, Maharashtra, India.*
*[3]Professor, Department of Civil Engineering, Vidhyavardhini's college of Engineering and Technology, Vasai, Maharashtra, India.*
***Emails:*** *harshita.m220148201@vcet.edu.in[1], jaydeep.chougale@vcet.edu.in[2], ajay.radke@vcet.edu.in[3]*
****Corresponding Author Orcid ID:*** *https://orcid.org/0009-0009-4366-1750*

## Abstract

*Beam projections are mostly used in the balconies and other extensions they are Cantilever beams which are free at the one end and fixed at other end which is used for good aesthetic view of building. The bending moment, torsion in member depends on its projection. For large projection for heavy load the steel member, composite member are the alternatives for RCC. As a result, in RCC beam addition steel may be needed as it adversely effect on cost of the structure. It may have greater impact in areas where projection beams are located more, hence economical beam design is required to lower building costs. This paper presents the comparison of RCC, steel and composite beam projection by studying various research articles.*

***Keywords:*** *cantilever beams, steel beam, RCC beam, torsional buckling*

## 1. Introduction

In a construction, horizontal structural beam element that can withstand applied lateral loads. A beam that can withstand stresses applied to its axis both laterally and transversely. Transverse loads acting on the longitudinal axis result in shear forces and bending moment. A cantilever beam is one that has only one point of support and disperses the weight throughout the unsupported area. [1] The greatest moment in a cantilever beam occurs at the fixed point, and the distance from the extreme point to the neutral axis can be used to compute the maximum stress. [2] Lateral-torsional buckling is a loss for thin structural elements, is the phenomena wherein structural components that are bent about their axis buckle by deflecting horizontal and twisting when the applied load values approach their limitations [3] Cantilevers are frequently employed in constructions. Torsion is often created along with axial forces, shear forces, and bending moments when effects of three-dimensional on structural elements are taken into account. In order to forecast the twisting strength of both plain and RCC elements with horizontal and transverse reinforcements for the cracks, numerous theories have been devised [4]. When it comes to steel members to withstand lateral buckling, steel cantilevers differ greatly from simply supported beams under homogeneous bending. While there are several end restraint criteria for cantilevers, a concentrated end load that results in a linear load is the most crucial loading condition for cantilevers dispersion of moments. Consequently, the more often employed in design elastic lateral buckling formulas for homogenous bending of simply supported beams are not suitable for cantilevers [5].

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 03 March 2024
Page No: 546 - 550
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0078

## 2. Literature review

### 2.1 Steel beams

H. Ozbasaran, et.al (2015) studied and summarized lateral–torsional buckling of cantilever steel I-beams. The load that significantly increases at the free end's torsional rotation and lateral deflection in studies for both elastic and inelastic buckling scenarios is referred to as the critical LTB load. Two I sections take into account of beam. The first is symmetrical, whereas the second has a narrow, wide flange that is compressed. A closed-form formula based on the energy approach is offered for cantilever I-beam lateral-torsional buckling. This formula can be used to determine the elastic critical LTB moment of member during the design phase. The four common basic loading scenarios are intense load at free end, equally load distributed, a mixture of load at free end and equally load transfer and moment. The provided equation and the ABAQUS responses for two unequal sections and lengths are compared. Bending test is conducted by different loading and size of beam by using euro codes and bending test shown in Figure 1.

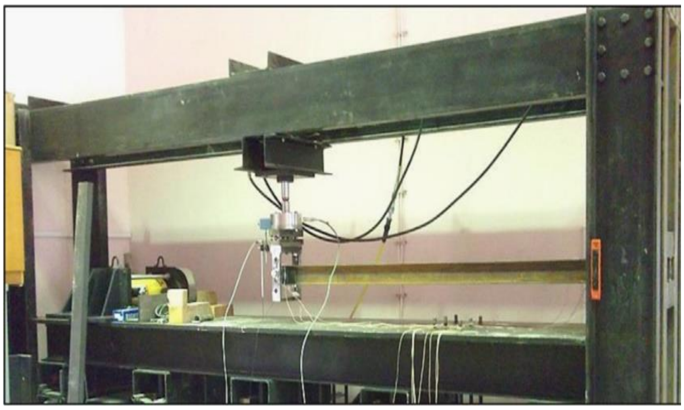

**Figure 1 Bending test [6]**

The different lengths were taken 1m, 2m, 3m for loads applied on shear centre, top flange, and bottom flange. Highest Pcr value for 1m on bottom flange loading in inelastic buckling. The comparison tables show that, in the circumstances where the lateral-torsional buckling is effective, the results produced by the provided equation and the ABAQUS program are almost identical. They have found that design moments procedure introduced the good results. [6]

Lokman Demirhan et.al (2019) study the of inelastic horizontal torsional buckling of I-section cantilevers by experimentation and numerical methods. The author says that design techniques provided by some codes for the supported beams at both ends are not appropriate for the cantilever design because, as opposed to close to the mid-span, the highest displacements and twist rotations happen at the free ends. Thus, when conducting the experiment on steel cantilever beams, it is important to consider the ultimate LTB load during the design phase in along with stress and deformation analysis. Cantilever beams with one section were tested in this study until LTB occurred. Both the load application location and the beams slenderness are altered. Three distinct lengths of 2750mm, 2500mm and 2250 mm of steel cantilevers are tested for axial tensile test and lateral buckling test as shown in Figure 2.

**Figure 2 Lateral Torsional Buckling Test [7]**

The testing done with increasing monotone end-point and ultimate loads, and measurements and analyses were made of the rotational angles, horizontal and vertical free-end displacements, and loads applied from different locations along their cross sections at the shear centre, the flange top, and the flange bottom. The ultimate load capacities increased as the cantilever length decreased, applied to the free-end all increased. When the lengths of the cantilever beams decreased the final load capacities rose by percentage of 26 and 51 for each of the three load-height levels. Increases in cantilever length resulted in 7% and 5% increase in the maximum vertical displacement values. With a decrease in slenderness, the maximum rotational angles and maximum lateral displacement. The maximum displacement rose by 16% and 15% for each of the three load positions when the cantilever length was reduced. The test specimens had rotational angles that ranged from 7.42 to 17.98, with a maximum recorded of 11.77, a torsional angle that was deemed relatively high. [7] Yoshihiro Kimura, et.al (2021) studies based-on flange–web interaction, the I-beam cantilevers' elastic local buckle strength when subjected to shear force and bending moment. Local buckling is a type of loss in which the cross-sectional form of the beam is altered without causing a twist about its axis or a beam's change geometry, such as horizontal displacement. Local buckling is a condition that affects the full member and the structure, resulting in a significant alteration in the capabilities. Furthermore, this work identifies the shortcomings of the earlier methods, such as concentrating on a single area of the section or ignoring the member's length, even though elastic buckling has been the subject of numerous studies. One parameter that hasn't been examined in prior studies on the local buckling of the beam is the member's length. Authors demonstrate the impact of this parameter and take it into account in the equations that are suggested for an accurate assessment of the local buckling capacity of the beam. The elastic buckling load of the entire I-beam cantilever was satisfactorily predicted by combining the results of the beam segment investigations into an equation [8]. N. Schillo et.al (2013) investigates the mode of moment distribution is taken into consideration by the study's global buckle analysis into account for the LTB failure. In corporating local buckling effects is intended to yield a coherent stability analysis framework. In this work, a member is subjected to horizontal and localized rotational buckles in order to assess the effectiveness of the current approach. The member under consideration has a rounded, T-shaped, cantilevered cross-section. They carried out using the finite element program Ansys, seven of the supplied tests were calculated. A short specimen had a height of 30 cm at the end, but the height of the cross-section was consistently 40 cm at the clamped end and 15 cm at the free ends. It was assumed that the two failure modes in that case may be distinguished by a 20% variation in the decrease to the lateral torsional buckling curve. Even though they are usually safe-sided, the differences between estimated ultimate loads and experimental loads, which range from 6% to 44%, are considerable [9]. Mateus Zimmer et.al (2019) investigates the web is not strong enough to prevent lateral bending, it will distort, moving the compressed flange laterally and rotating it. Steel profile's bottom flange is squeezed. These displacements are indicative of the lateral-torsional buckling (LTB) form of instability. With the aid of the software ANSYS, numerical models representing the modal of edge composite beams were created in order to assess the method described in code for determining the rotational rigidity of composite beams with a maximum variance of 7% [10]. Shen Li, et.al studies that specimen having poor connection in which the capacity of the beam is decreased. The thickness of the member is affected by the property which are mechanical in nature [11]. Borna Rahnamay, et.al (2023) studies the varying failure occurs in the member. It becomes challenging work for repair of the member but using numerical equations the problem can be solve [12].

### 2.2 Reinforced cement concrete beams

Liu Jin, et.al (2016) performs an experimental examining the seismic shear failure behaviour of diagonally reinforced RC cantilever beams under small cyclic loads and assess if a size influence could exist on the RC beams' corresponding theoretical shear strength. Experiments the cyclic fatigue loading and the effect of minimal shear strength rcc beams, seismic shear failure of rcc cantilever beams with transverse reinforcement occurs. Five groups of the same rc with heights varying from 200 to 1000 mm and a span of shear ratio were tested. Explores the bearing capacity, ductility capacity, energy dissipation ability, stiffness degradation, failure patterns, and hysteretic properties of seismic shear behaviour. Testing was halted when the RC beams' shear bearing capacity fell to 85% of their bearing capacity or when there was noticeable damage to the RC beams. The transverse reinforcing is brittle, ductility capacity decreased, and the test data is consistent which effect the law of Bazant's size. The failure patterns they obtained are extremely comparable [13]. M.H. Ilkhania, et.al (2019) investigates the new technique for determining the torsional capacity of rectangular reinforced concrete beams. Despite the fact that constructed neural structures may be set up so that their predictions agree with empirical findings, their applicability in engineering design is still restricted because factors, transfer functions, and weights, which complicate the final equations. Neural networks can be used to create design equations and charts in order to solve this problem. This paper gives the final torsional strength of rectangular RC beams an equation next, it was looked into how changes in various parameters affected the network's output. Finally, an equation was developed to estimate the torsional capacity of rectangular reinforced concrete beams. After gathering experimental data, an artificial neural network with a 6.3% error rate was trained. An equation for determining the final torsional capacity of rectangular RC beams with an error of roughly 21.1% was derived using the trained network. Among the input factors examined, the parameter exhibited least relative influence, with a 13.07% effect on the final torsional moment. The values produced by the suggested formula closely match the results of the experiment [14]. Li Sua, et.al (2015) studies Structural dynamic analysis depends on a structure's damping. This research aims to confirm that the damping model can be used to concrete structures and that the model's accuracy techniques for identifying model parameters. The study includes the vibration test of cantilever beams made of reinforced concrete with the same dimensions and experiments with various reinforcement ratios are done. Firstly, the hammer vibration test produces the cantilever beams' first three order frequencies and damping ratios, dampers, and other factors. Second, there is a strong correlation between the experimental findings and the natural frequencies that were discovered using the complicated modal identification method. There are certain variations in the damping ratios among the outcomes determined by both experimental findings and the sophisticated modal identification procedure. Finally, the RC beam damping values determined by the Rayleigh damping model and the damping model are compared using at given datum. The findings demonstrate that the damping model offers a more accurate explanation of the RC's damping property beams with cantilevers, particularly in high order modes because, in contrast to the measured result, the Rayleigh damping model's damping ratio increases as modal frequency increases [15].

## Conclusion

- The steel cantilever beams showed a greater ultimate load capacity on average by 6% when loaded from their shear centre
- The local buckling curve is tended to be longer and torsional weaker specimens.
- The torsional stiffness prior to cracking is mostly determined by the strength of the concrete, not by the quantity of reinforcing.
- The Rayleigh damping model's damping ratio increases as modal frequency increases.
- Local buckling is a condition that affects the entire beam and the structure, resulting in a significant alteration in the capabilities.

## References

[1]. Trahair and N.S., "Inelastic lateral buckling of steel cantilevers," Engineering Structures, pp. 1-9, 2019.
[2]. J. P. S. d. Oliveira, "Elastic critical moment

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 03 March 2024
Page No: 546 - 550
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0078

of continuous composite beams with a sinusoidal-web steel profile for lateral-torsional buckling," structure engineering, p. 12, 2016.
[3]. Marek, M. Sorf and Jandera, "Lateral-torsional buckling of slender cross-section stainless steel beams," Structures, pp. 1-13, 2020.
[4]. Medina, G. S.A., B. E.V., P.-S. N, A.-G. J and J.A., "Guided Double Cantilever Beam test method for intermediate and high loading rates in composites," International Journal of Solids and Structures, vol. 264, pp. 1-14, 2023.
[5]. H. Leea, Jua and Deuckhang, "Maximum torsional reinforcement ratio of reinforced concrete beams," Structures, pp. 1-13, 2019.
[6]. Ozbasaran, A. H., D. R. and M., "An alternative design procedure for lateral–torsional buckling," Thin-walled structures, vol. 90, p. 8, 2015.
[7]. Demirhan, Lokman, E. E. and H., "Experimental and numerical evaluation of inelastic lateral-torsional," Journal of Constructional Steel Research, vol. 168, pp. 1-13, 2020.
[8]. Yoshihiro, S. Kimura and M. Fujak, "Elastic local buckling strength of I-beam cantilevers subjected to bending Elastic local buckling strength of I-beam cantilevers subjected to bending," Engineering Structures, pp. 1-10, 2020.
[9]. N. N. Schillo a, "Interaction of local buckling and lateral torsional buckling of T-shaped," Elsevier, p. 6, 2013.
[10]. Mateus, A. Zimmer Dietricha, R. Fernanda Grobério Calenzani and H. Fakury, Engineering Structures, pp. 1-15, 2019.
[11]. Shen and e. Li, "Seismic performance of a new assembled beam-column joint with cantilever beam splicing," Engineering Structures, pp. 1-25, 2022.
[12]. Borna and R. Farnod, "Displacement-based structural identification using differentiable physics," Engineering Structures, pp. 1-13, 2023.
[13]. Liu and Jin, "Seismic behavior of RC cantilever beams under low cyclic loading and size effect on shear strength: An experimental characterization," Engineering Structures, pp. 1-15, 2016.
[14]. Ilkhania, N. M.H, K. H and A, "A proposed novel approach for torsional strength prediction of RC beams," Journal of Building Engineering, vol. 25, pp. 1-11, 2019.
[15]. Li, S.-Q. Sua, Y.-H. Mei, Y.-F. Pan and Wang, "Experimental identification of exponential damping for reinforced concrete cantilever beams," Engineering Structures, pp. 1-9, 2019.