# Evaluation of Dynamic Response of the Beam Column Connection with RCC and Composite Structure with FEM Tools

Mr. Misal Sanjay Bhojling[1], Prof. Y. P. Pawar[2], Prof. G. D. Lakade[3]
*Student, M. Tech Structural Engineering, SKN Sinhgad College of Engineering, Korti Pandharpur [1]*
*Professor, Dept. of Civil Engineering, SKN Sinhgad College of Engineering, Korti Pandharpur [2]*

**Abstract - A good technique for steel construction or concrete blocks in high-rise structures is the composite system, which combines steel floors, steel beams, and concrete. The finite element method (FEM) is the most widely used simulation technique for predicting the behaviour of objects and structures. In order to produce composite and hybrid designs that are more efficient than these materials alone, engineers have combined reinforced concrete and steel structures to create buildings. More knowledge on the relationship between reinforced concrete and steel structures in construction is crucial, as recent research have shown. A system like that. Exposure of the steel structure to pressures like collision or fracture will result in the gradual collapse of the entire structure. Particularly significant is the beam-column nodes' contribution to the structure's overall strength. This research will use the structure's dynamic response to examine how the beam-column connection behaves.**

**Keyword: RCC, ANSYS, Composite, Steel. Dynamic, FEM.**

## I. INTRODUCTION

Composite construction exists when two different materials are bound together, it acts as a single entity forming a strong bond among them from structural point of view. The reason why composite construction is often so good can be expressed in one simple way i.e., concrete is good in compression and steel is good in tension. The aim is to achieve a higher performance level with both these elements after its execution, than it would have acted individually. This paper deals with a new concept of Steel Concrete Composite structures, its advantages, types, composite construction scenario in India and focuses on need for the development of Indian standard code of practice for its implication in Indian construction sector. The experience of recent years in the field of prefabrication makes it possible to create a very effective and cost-efficient systems to be developed. . Composite slab system provides a solution to speed-up the construction process by eliminating or reducing form work and making construction sites cleaner and safer for workers to execute a project. Metal decking in composite slab system acts as long-lasting framework for the concrete, eradicating the need for props, and as a malleable reinforcement for the slab. Key concepts of Composite construction in high rise residential towers is that, it should be economical, functional, and architecturally flexible as per design and ease of assembly

A. Steel Beam with Concrete Column

The use of hybrid structures has gained popularity in the last twenty years. One of the most efficient hybrid systems is represented by RCS frames, which consist of reinforced concrete (RC) columns and steel (S) beams. In RCS frames, the advantages of reinforced concrete and steel structures are combined to form a cost- and time effective type of construction. RC columns are more cost effective in terms of axial strength and stiffness than steel columns [Sheikh et al. 1987]. Also, they offer superior damping properties to the structure, especially in tall buildings. On the other hand, steel floor systems are lighter and require little or no formwork, reducing the weight of the building and increasing the speed of the construction. Despite the advantages offered by RCS structures, their use has been restrained primarily to low and moderate seismic risk regions because of the lack of design provisions that consider the behavior of these hybrid systems under large load reversals. In addition, the study of RCS joint behavior has been limited primarily to interior connections. Therefore, an experimental and analytical program was undertaken at the University of Michigan to develop information on the inelastic cyclic response of RCS joints, especially in exterior RCS connections. In this paper, the behavior of nine exterior RCS joints is discussed. Also, a shear strength model is proposed for both interior and exterior RCS joints.

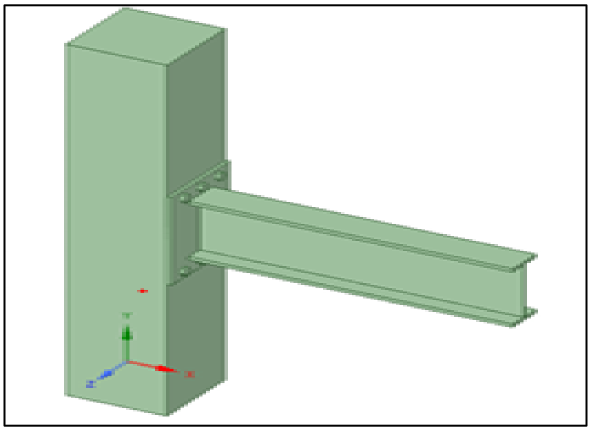

Fig 1 Steel Beam with Concrete Column

## II. METHODOLOGY

1. The project study had two stages. Primary data will be collected through a literature survey focused on web searches and reviews of e-books, manuals, codes and journals.
2. After review, the problem is defined and 3 samples are taken for detailed study and analysis.
3. Then study time history analysis and data collection from Sesmic website and official site.
4. Prepare ANSYS Modeling of RCC and various composite structures and perform time history analysis on it.

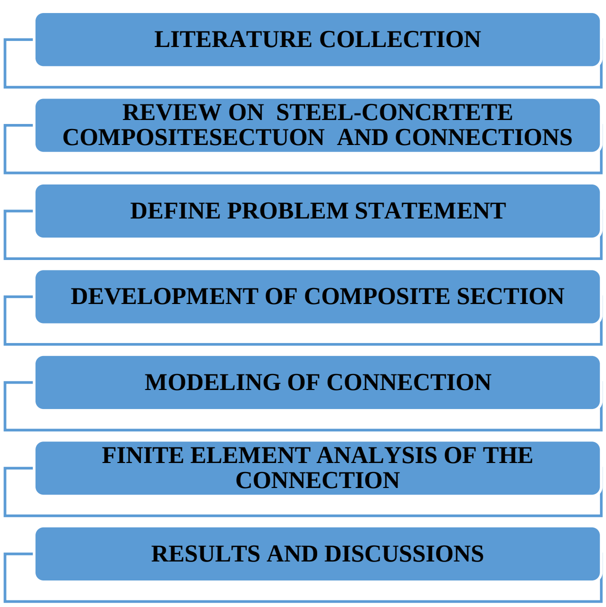


Fig 2 Flow Chart

A. Physical model Analysis

- Column – 150 x 150 x 700 mm
- Grade M30
- I section Data as follow

| Designation | Depth of Section (mm) | Width of Flange(mm) | Thickness of Flange (mm) | Thickness of Web (mm) |
|---|---|---|---|---|
| ISMB – 150 | 150 | 75 | 8 | 5 |

Fig 3 Initial Reading of the deflection is 5.55 mm for load 163 kn

B. ANSYS Model Analysis

Prepare model in ANSYS with same Dimensions as given above, the model in ANSYS are as follow

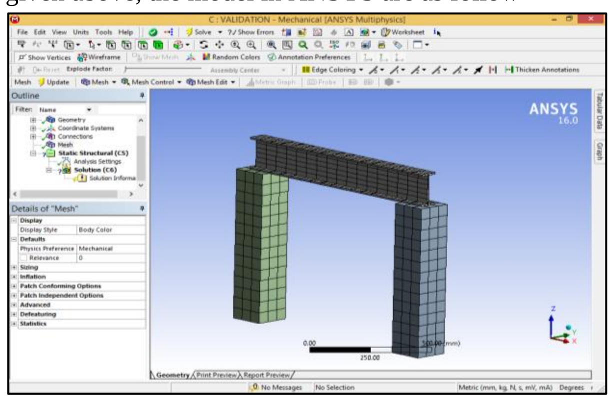

Fig 4 Prepare Modelling in ANSYS

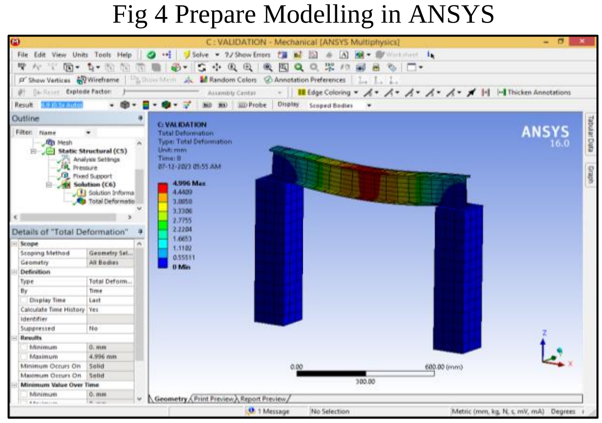

Fig 5 Deflection in ANSYS for load 163Kn is 4.99 to 5 mm

| Deflection in Experimental Analysis (mm) | Deflection in ANSYS (mm) | Percentage Variation (%) |
|---|---|---|
| 5.55 | 5 | 9.91 |

As per the Experimental Analysis and Software analysis, the results for experimental setup are 5.55 mm and for software analysis are 5 mm, as per the results it didn't vary much so we can do our further models in ANSYS

## III. ANSYS MODELING

### A. ANSYS MODEL

Details for ANSYS Models for Precast and RCC
Column Size – 300 x 750 mm
Reinforcement for Column –12T – 16No
Beam Size –230 x 450 mm
Reinforcement for Beam – Top –12T -2, Bottom- 12T -2, Shear – 10T@120 C/C
Total Maximum Load –1824 KN
The Maximum BM beam column junction is further modeled in ANSYS

Table 3 Description of RCC and Composite models in ANSYS

| SR. NO. | MODEL NO. |
|---|---|
| 1 | RCC |
| 2 | Composite Model 1 (CM 1) |
| 3 | Composite Model 2 (CM 2) |

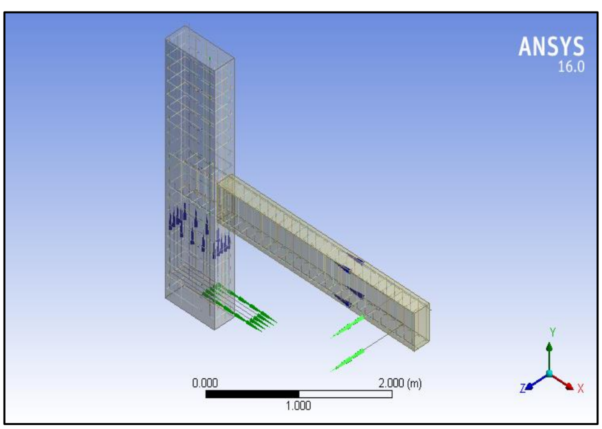


Fig 6 Conventional RCC Model

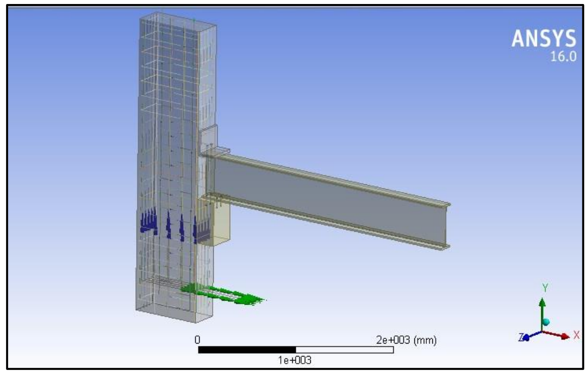


Fig 7 Composite Model 1 (CM 1)

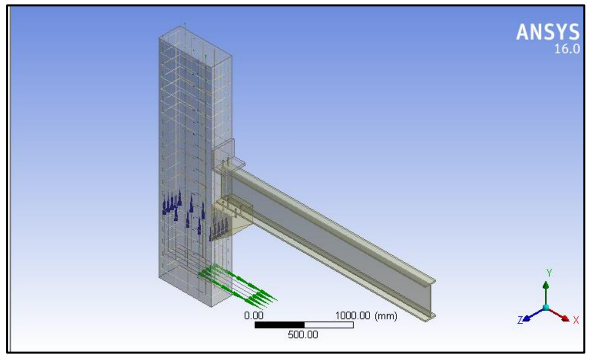


Fig 8 Composite Model 2 (CM 2)

## III. RESULT AND DISCUSSION

### A. Equivalent stress

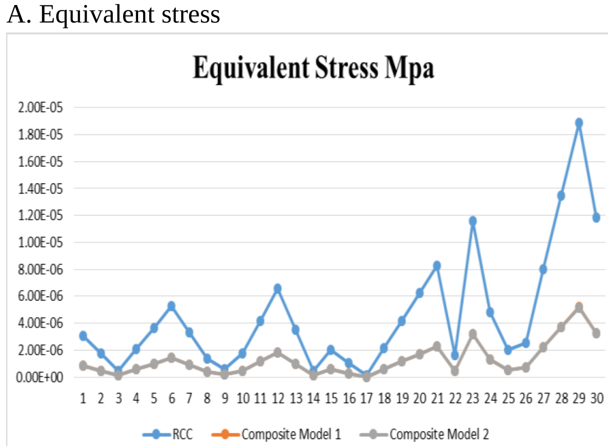


Fig 5.11 Equivalent stress

The above results show the results of equivalent stress for dynamic forces with 30 seconds of vibration. The results for composite structures are less than those for RCC structures by 30–40%. As compared with composite models, the model with a trapezoidal haunch gives better results than a rectangular haunch.

B. Total Deformation

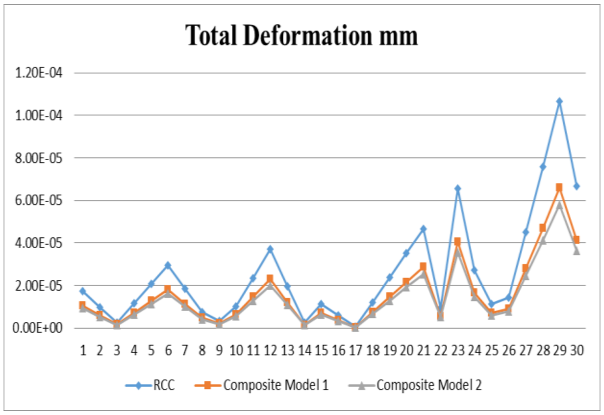


Fig 5.15 Total Deformation

The above results show the results of Total Deformation for dynamic forces with 30 seconds of vibration. The results for composite structures are less than those for RCC structures by 20-25%. As compared with composite models, the model with a trapezoidal haunch gives better results than a rectangular haunch.

C. Normal Stress

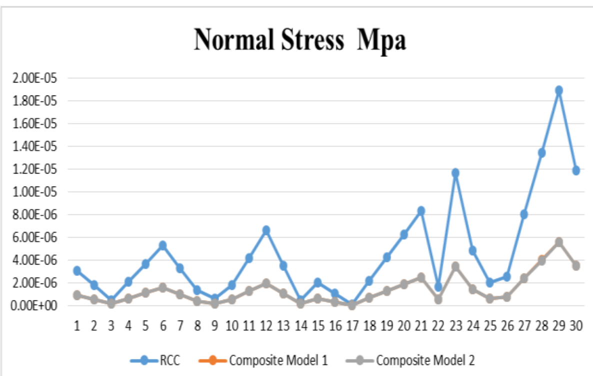


Fig 5.19 Normal Stress

The above results show the results of Normal Stress for dynamic forces with 30 seconds of vibration. The results for composite structures are less than those for RCC structures by 30-35%. As compared with composite models, the model with a trapezoidal haunch gives better results than a rectangular haunch.

## IV. CONCLUSION

The seismic performance of a Composite and precast design is heavily reliant on the flexibility of the joints framed by the beams and columns. The main aim of the study is to study the behaviour of the Beam Column connections and analysis of composite members used in that composite beam sections for different configurations under dynamic loading conditions. As per the Experimental Analysis and Software analysis, the results for experimental setup are 5.55 mm and for software analysis are 5 mm, as per the results it didn’t vary much. After review And experimental analysis the problem is defined and 3 models are taken for detailed study and analysis, RCC Beam Column Joint (RCC) , Steel Beam And RCC Column With Rectangular Haunch (CM 1) , Steel Beam And RCC Column With Trapezoidal Haunch (CM 2). For the dynamic Analysis Time history analysis dynamic forces with 30 seconds of vibration are applied on each model, From the Dynamic analysis it is conclude that the composite structure have better in performance, As compared with composite models, the model with a trapezoidal haunch gives better results than a rectangular haunch.

## REFRENCE


[1] Kang Chen et. al. “Behaviour of composite beam-column joint with fin plate connection subjected to impact loads” Engineering Structures Volume 273, 15 December 2022

[2] Gustavo J. Parra-Montesinos and James K. Wight, “Behavior and Strength of RC Column-to-Steel Beam Connections Subjected to Seismic Loading”, Journal of Structural Engineering, Vol. 126, October 2000. ©ASCE

[3] Hiroshi Noguchi and Kazuhiro Uchida, “Finite Element Method Analysis of Hybrid Structural Frames with Reinforced Concrete Columns and Steel Beams”, Journal of Structural Engineering, Vol. 130, February 2004. ©ASCE

[4] Bahman Farahmand Azar, Hosein Ghaffarzadeh and Nima Talebian, “Seismic Performance of Composite RCS Special Moment Frames”, KSCE Journal of Civil Engineering (2013)

[5] O. Mirza and B. Uy, “Finite Element Analysis of The Behavior of Composite Beam-to-Column Connections Subjected to Seismic Loading”, 2010 Structures Congress © 2010 ASCE

[6] Omid Rezaifar et. al. “Finite element study the seismic behavior of connection to replace the continuity plates in (NFT/CFT) steel columns” Steel and Composite Structures, Vol. 21, No. 1 (2016)

[7] Shweta A. Wagh et. al. “Comparative Study of R.C.C and Steel Concrete Composite Structures” Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 4(Version 1), April 2014

[8] S. B. More et. al. "Analysis and Design of Composite Structures With Steel Castellated Beams" International Journal of Creative Research Thoughts Volume 10, Issue 7 July 2022

[9] Il-Seung Yang et. al. "Steel-concrete composite beam-column connections utilizing prefabricated permanent steel form" Journal of Building Engineering Volume 46, 1 April 2022.

[10] Prof. Vijay S Sawant et. al. "Survey on Comparison of Steel and Concrete Composite Beam Column Connections" International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Issue 4, April 2015

[11] Minakshi Vaghani et. al. "Performance of RC Beam Column Connections Subjected to Cyclic Loading" IOSR Journal of Mechanical and Civil Engineering Volume 12, Issue 2 Ver. VII (Mar - Apr. 2015)

[12] 12) Mr. Roshan Onkar Gathekar et. al. "Design and Analysis of Composite Structure, Steel Structure, RCC Structure & Comparison" International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 2, Issue 1, July 2022

[13] Mohd Umeir Qureshi et. al. "A review paper on composite structure used in column for various analysis" International Journal for Research in Engineering Application & Management Vol-05, Issue-04, July 2019

[14] Xi Chen, "Research on Design and ANSYS of Joints between Steel Beams and Reinforced Concrete Columns", Applied Mechanics and Materials, Vols. 744-746 (2015)

[15] Feng Zhou, et. al., "Finite-Element Analysis of a Composite Frame under Large Lateral Cyclic Loading", Journal of Structural Engineering, Vol. 133, (2007)

[16] Xuemei Liang et. al. "Seismic Behavior of Reinforced Concrete Column-Steel Beam Subassemblies and Frame Systems" Journal of Structural Engineering © ASCE / February (2004)

[17] Liquan Xiong et. al. "Configuration Features and Calculation Mechanisms of the Composite RC Column-Steel Beam (RCS) Joints: State of the Art" Hindwi (2022)

[18] Seyed Rasoul Mirghaderi et. al. "Analytical investigation of a new Through-Column-Type Joint for composite reinforced concrete and steel frames" Advances in Structural Engineering and Mechanics (2013)

[19] Yu-Chen Ou et. al. "Seismic behavior of concentric and eccentric New-RCS through-beam joints" Journal of Building Engineering Volume 76, 1 October 2023

[20] Ahmadreza Khodabandehlo et. al. "Seismic Behavior and Study of RCS Composite Frame Composed of Steel Beams and Strong Concrete Column" Civil and Environmental Engineering Volume 15 (2019)

[21] Deepak M Jirage et. al. "Comparative Study of RCC and Composite Multi-storeyed Building" International Journal of Scientific Engineering and Applied Science September (2015)

[22] Meissam Nazeryan et. al. "Seismic Evaluation of the Cheng and Chen Modified Model Using Shear Keys in Steel Beam-to-Concrete Column Connections" Computational Research Progress In Applied Science & Engineering (2022)

[23] Prof. Y. P. Pawar et. al. "Finite Element Modeling for Effect of Fire on Steel Structure: A Review" International Research Journal of Engineering and Technology Volume: 03 Issue: 05 (2016)

[24] Prof. S. S. Charantimath et. al. "Comparative Study on Structural Parameter of R.C.C and Composite Building" Civil and Environmental Research Vol.6, No.6, (2014)

[25] Siddhant D. Shirsath et. al. "Analysis and Design of Steel Concrete Composite Structure and Its Comparison with RCC Structure" International Journal for Research in Applied Science & Engineering Technology Volume 10 Issue VI June (2022)

[26] G. D. Lakade, et. al. "Performance of RC Building under Dynamic Forces and Suitability of Strengthening by FRP Jacketing" International Journal of Civil Engineering and Technology Volume 6, Issue 9 (2015)

IS Codes

- IS 456: 2000 - Plain and Reinforced Concrete Code of Practice? - Bureau Of Indian Standards, New Delhi.
- IS 3935:1966 – Code of Practice for Composite Construction.
- IS 11384:1985 – Code of Practice for Composite construction in structural steel and concrete.
- IS 800: 2007 - Code of Practice General construction in steel?

- IS 875 part I- Dead load
- IS 875 Part II- Live load
- IS 875 Part III- wind load
- IS 875 Part V- load combination