ISSN: 2455 - 9172

EIJO Journal of Engineering, Technology And Innovative Research (EIJO–JETIR)

Einstein International Journal Organization (EIJO)

Available Online at: www.eijo.in

Volume – 4, Issue –6, November – December -2019 , Page No. : 01 – 10

Seismic Analysis of a Single Bay Structure with Composite Beam and RCC Columns

Kamal Singh Jonwal, M.Tech Scholar, Structural Engineering, Arya College of Engineering & Research Centre, Jaipur

Hemant Kumar Sain, Assistant Professor, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur

Mayank Mehandiratta, Assistant Professor, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur

Abstract

This study has been made on behavior of composite beam known as composite beam section (CBS). Structural engineering Software SAP 2000 developed by CSi used for modeling and analysis of structure is done. Advanced structural analysis and design software “SAP 2000” is used for the results of bending moment & lateral deflection of frame. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software. Compares bending moment and shear force for beam of composite section and ordinary columns. To solve problems, composite structures might be suitable. Wind load and earthquake load starts dominating resulting into increase in size of columns and beams for high rise buildings. In India, Indian standard criteria for earthquake resistant design of structures IS 1893 (PART-1): 2002 is the main code that provides outline for calculating seismic design force. Wind forces are calculated using code IS-875 (PART-3). The results of beams are obtained and discussed. The analysis and design of composite beams are in progress. In this study analysis of single bay structure having composite beam with seismic zone V according to IS 1893:2016 has been carried out and comparison is made between bending moments, shape factor, deflections at various point of beam, shear force for seismic load due to response spectrum, dead load and combination of this.

Keywords: Single Bay Structure, Composite section, steel girder, seismic load, SAP 2000, Fe-250.

Introduction

Multistory building has always reminded a challenge in design for society. As the availability of land is becoming difficult modern societies are moving detached houses to high rise buildings.

Wind load and earthquake load starts dominating resulting into increase in size of columns and beams for high rise buildings. The composite sections using Steel encased with Concrete are economic, cost and time effective solution in major civil structures such as bridges and high rise buildings.

On large scale construction work concrete and steel are frequently used in combinations as composite beams or composite beams. Column gives its tensile strength with excellent strength to weight ratios and rapid construction times for steel. The concrete lends the composite mass, stiffness and compressive strength and reduces deflection and vibration in the slab.

Then we choose a combination of structural steel and concrete and form a composite construction called composite structure. Keep small sizes of column & make them strong was major challenge for structural engineers. As such the composite beams can be adopted to overcome this requirement.

Demands in construction industry in now days are

- Strength
- Safety
- Serviceability
- Satisfactory and reliable performance
- Economical

All of these parameters are achieved by steel-concrete composite construction techniques. Structural element composed of two or more non-homogenous materials combined together and act as a single unit is known as composite structure.

Non-homogenous materials are combined to form a composite member does not only combine the collective strengths of the two materials, but also enhances their physical characteristics and makes the composite structure stronger than the sum of their strengths.

Literature Survey

[Prof. Rajendra R. Bhoir[1], Prof. Vinay Kamble[2], Prof. Darshana Ghankute[3], 2017] In this study structure made with steel and concrete where hot rolled steel sections are used as structural members. The use of steel in construction industry is very low in India compared to many developing countries. There is a great potential for increasing the volume of steel in construction, especially in the current development needs India and not using steel as an alternative construction material and not using it where it is economical is a heavy loss for the country. Two residential G+15 storied Composite and RCC structure are analyzed and designed in ETAB software with two different story heights, 3m and 4m. It is found that the depth of beams in composite structure is lesser than of RCC structure, which results to also reduce the sizes of columns in composite structure. It is also seen that the concrete and steel consumption in composite structure is less but as we are using hot rolled sections the structural steel consumption is increased.

[Mahesh Suresh Kumawat[1] and L G Kalurkar[1], 2018] In this study steel concrete composite with RCC options are considered for comparative study of G+9 story commercial building which is situated in earthquake zone-III and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software. Equivalent Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Composite and RCC structures. The results are compared and found that composite structure more economical).

[T.G.N.C.Vamsi Krishna, S.V.Surendhar, M. Shiva Rama Krishna, 2019] In this study, comparison of an RCC structure and a composite structure is obtained for parameters like time period, storey displacement and storey drift, base shear, bending moment and shear forces of the structure. From the observed results, it may be clearly inferred that a steel composite, performs well in-terms of structural integrity when compared with an RCC structure. In high rise RCC structures, the size of structural members (column, beam, and slab) increases. Due to this, self-weight of the structure also increases. Steel structures on the other hand, are ductile in nature and parameters like deflections, drifts, displacements are more compared with RCC structures. To solve problems, composite structures might be suitable. A geometrically irregular residential building (G+18 storey) is designed and analyzed for both cases of RCC and composite structures (considering earthquake zone III) using ETABS software. The structure is analyzed using linear static, linear and non-linear dynamic methods, such as equivalent static method, response spectrum method and time history method.

Proposed Work

Planned framework for work is depicted in beneath recorded steps. One by one procedure is characterized in these means. Assign parameters for a Single Bay Structure (SBS) in SAP 2000.

Step:-1 Assign size of beam and columns.

Step:2 Assign Concrete Property of beam and column .

Step:-3 Assign Steel Property of beam and column.

Step:-4 Section Properties as Defined in SAP 2000.

Step:-5 Load Defining in SAP 2000.

Step:-6 Response Spectrums Define in SAP 2000.

Step:-7 Numbers Assigned to in Columns, Beams and Joints.

Step:-8 Load Case Defined in SAP 2000.

Step:-9 Nodes or Joint Assign SAP2000 for Deflection Results.

Result Analysis

Bending Moment and Shear Force due To Dead Load, Seismic Load, and Combination of Dead and Seismic Loads

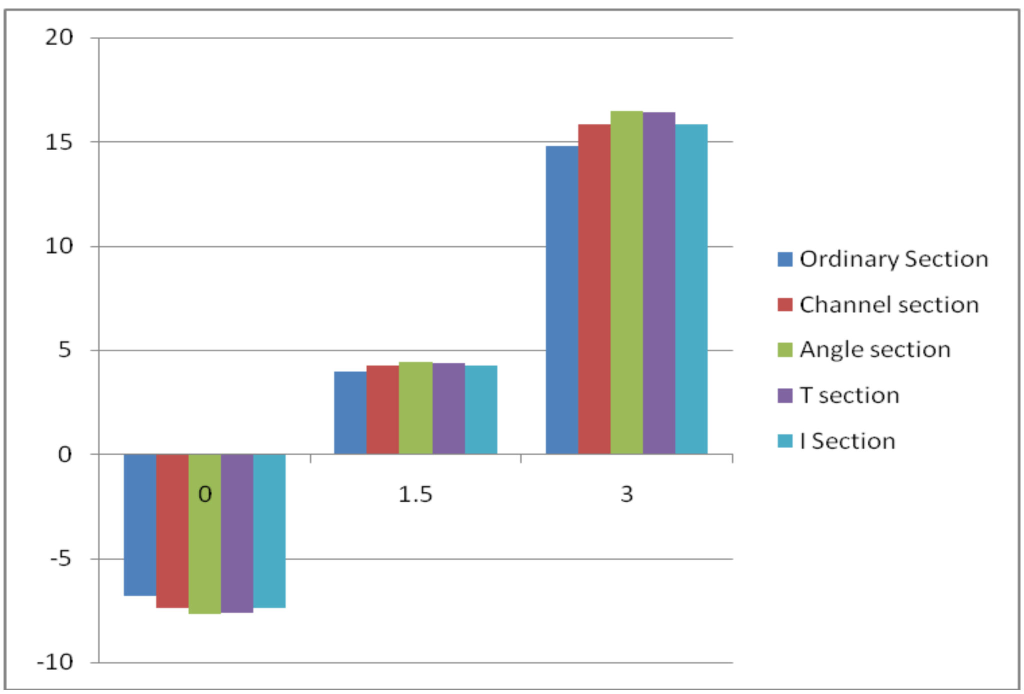

Fig 1: C1 Bending moment due to Dead Load

Due to dead load maximum bending moment occur in angle section i.e. 16.4682 KN-m and minimum bending moment occur in ordinary section i.e. 14.7632 KN-m at a section 3m in C1.

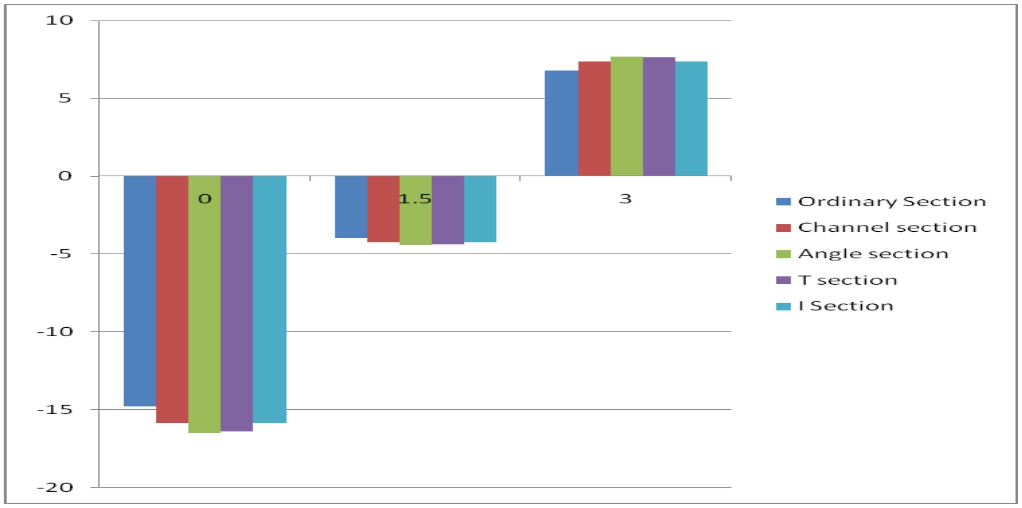

Fig 2: C2 Bending moment due to Dead Load

Due to dead load maximum bending moment occur in angle section i.e16.4682KN-m and minimum bending moment occur in ordinary section i.e. 14.7632 KN-m at a section 3m in C2.

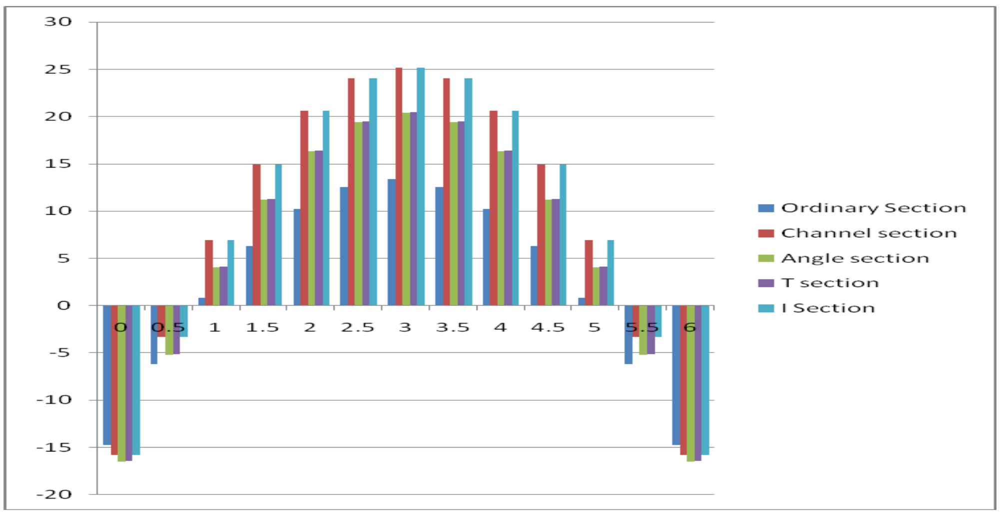

Fig 3: B1 Bending moment due to Dead Load

Due to dead load maximum bending moment occur in Angle section i.e. -16.4682 KN-m and minimum bending moment occur in ordinary section i.e. -14.7632 KN-m at a section 6m in B1.

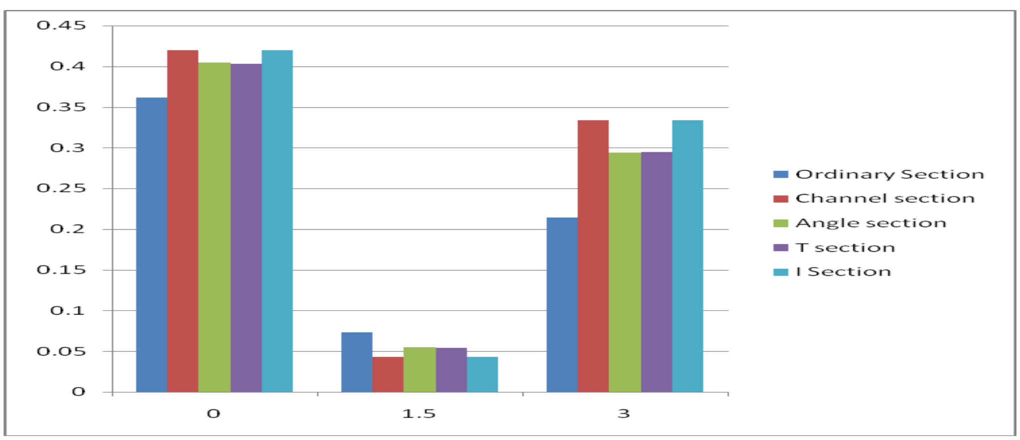

Fig 4: C1 Bending moment due to Seismic Load

Due to seismic load maximum bending moment occurs in Channel and I sections i.e. 0.4195 KN-m and minimum bending moment occur in ordinary section i.e. 0.3616 KN-m on a section at 0m in C1.

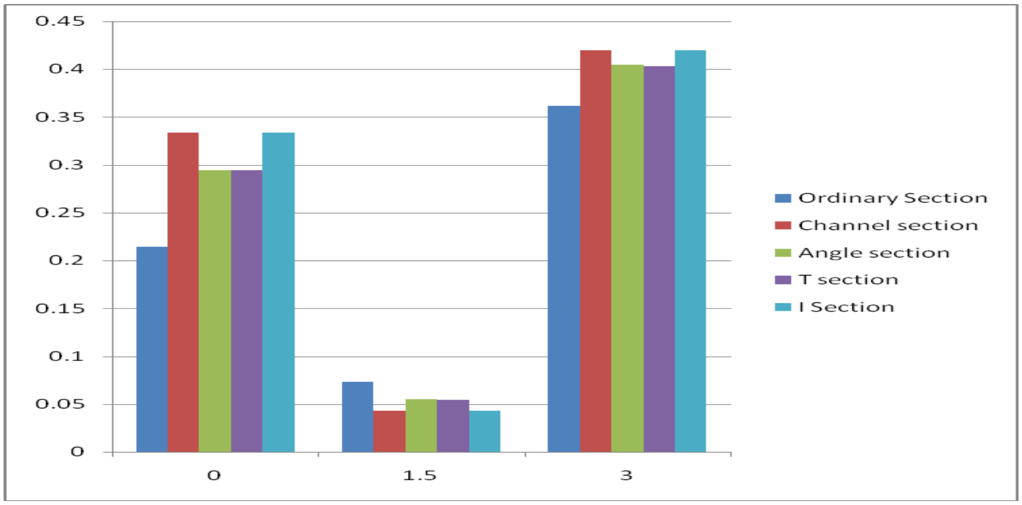

Fig 5: C2 Bending moment due to Seismic Load

Due to seismic load maximum bending moment occurs in Channel and I sections i.e. 0.4195 KN-m and minimum bending moment occur in ordinary section i.e. 0.3616 KN-m at a section 3m in C2.

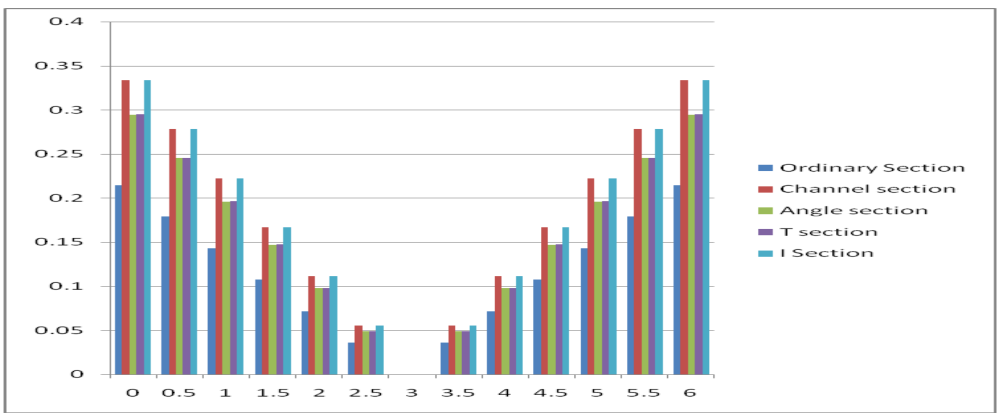

Fig 6: B1 Bending moment due to Seismic Load

Due to seismic load maximum bending moment occurs in Channel and I sections i.e. 0.3335 KN-m and minimum bending moment occur in ordinary section i.e. 0.2146 KN-m at a section 6m in B1.

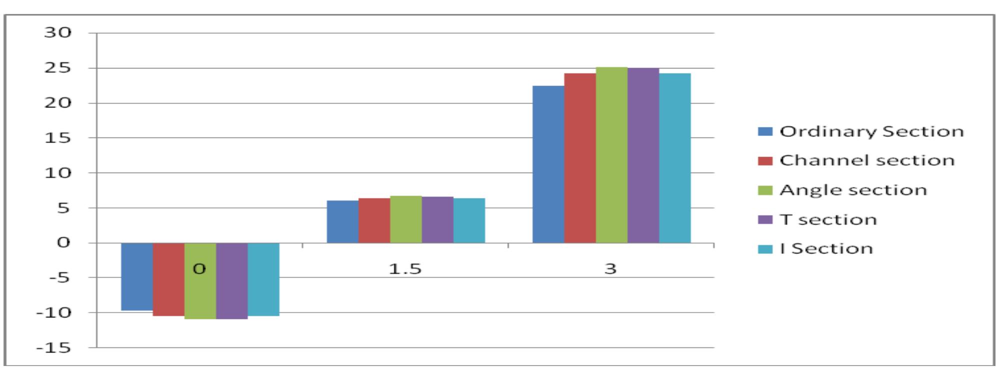

Fig 7: C1 Bending moment due to Dead Load & Seismic Load

Due to dead & seismic load maximum bending moment occur in Angle section i.e. 25.1435 KN-m and minimum bending moment occur in ordinary section i.e. 22.4667 KN-m at a section 3m in C1.

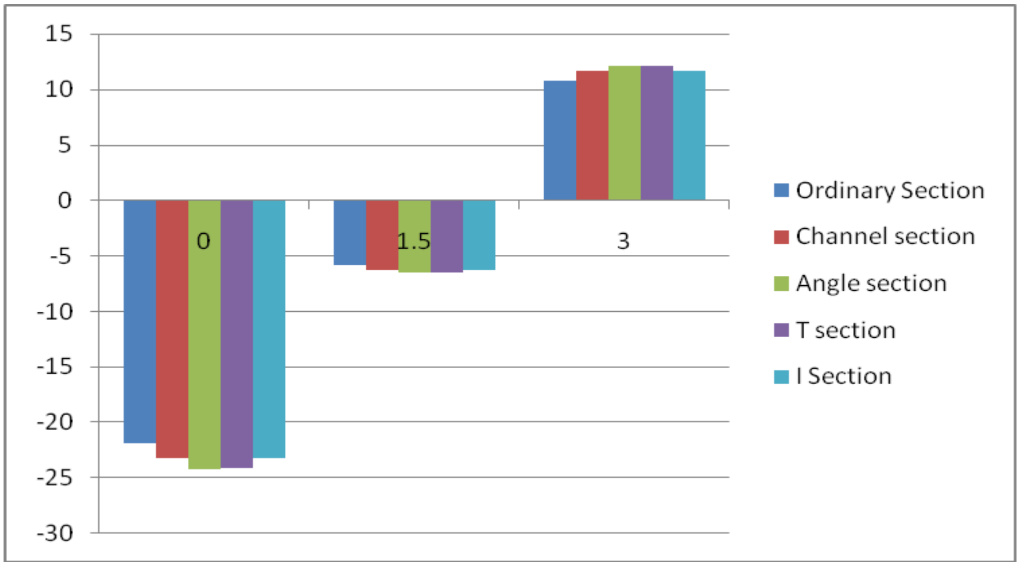

Fig 8: C2 Bending moment due to Dead Load & Seismic Load

Due to dead & seismic load maximum bending moment occur in Angle section i.e. -24.2611 KN-m and minimum bending moment occur in ordinary section i.e. -21.8228 KN-m at a section 3m in C2.

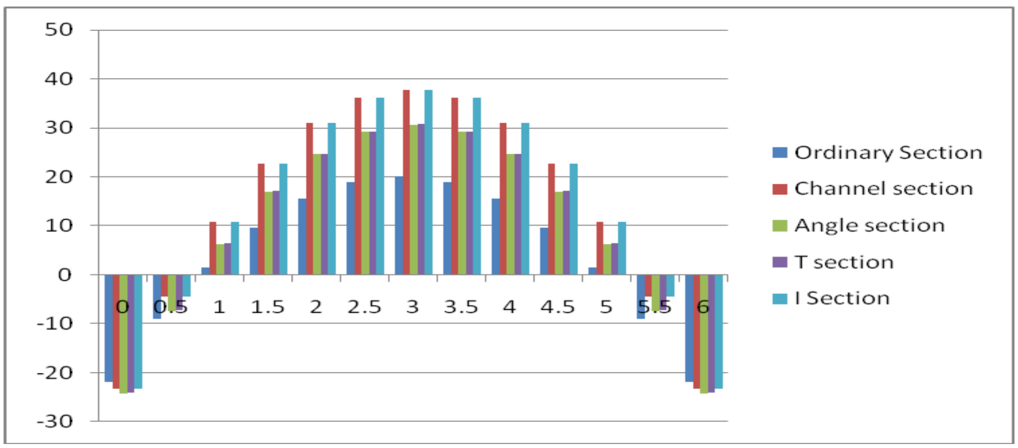

Fig 9: B1 Bending moment due to Dead Load & Seismic Load

Due to dead & seismic load maximum bending moment occur in Angle section i.e. 24.2611 KN-m and minimum bending moment occur in ordinary section i.e. 21.8228 KN-m at a section 0m and 6m in B1.

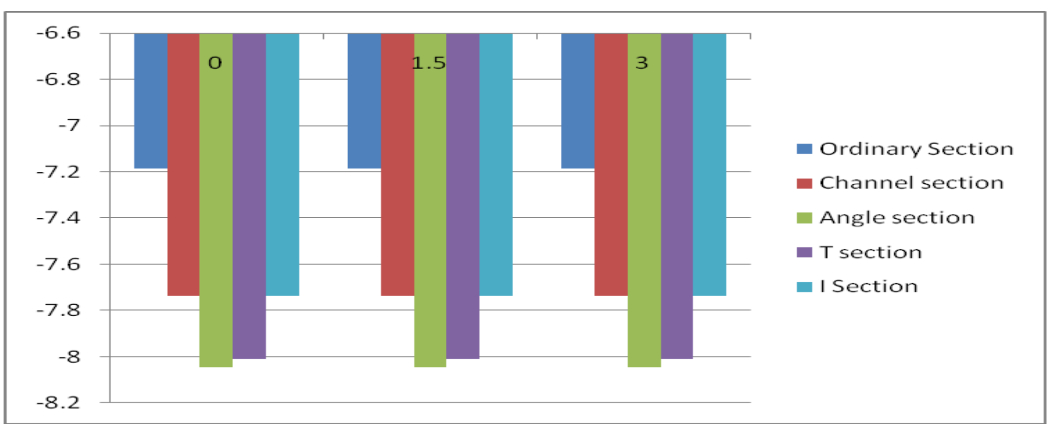

Fig 10: C1 Shear Force due to Dead Load

Due to dead load maximum shear force occur in angle section i.e. -8.045KN and minimum shear force occurs in ordinary section i.e. -7.188KN same at all sections of 3m height in C1.

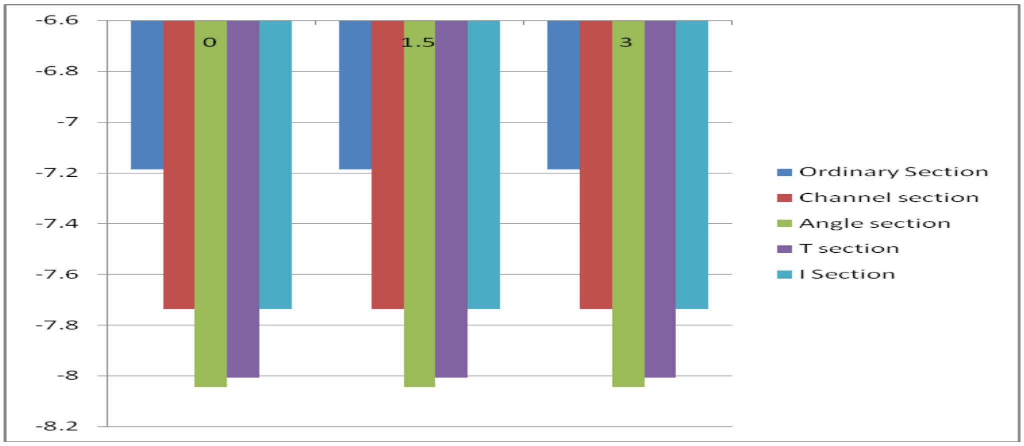

Fig 11: C2 Shear Force due to Dead Load

Due to dead load maximum shear force occur in angle section i.e. -8.045KN and minimum shear force occurs in ordinary section i.e. -7.188KN same at all sections of 3m height in C2.

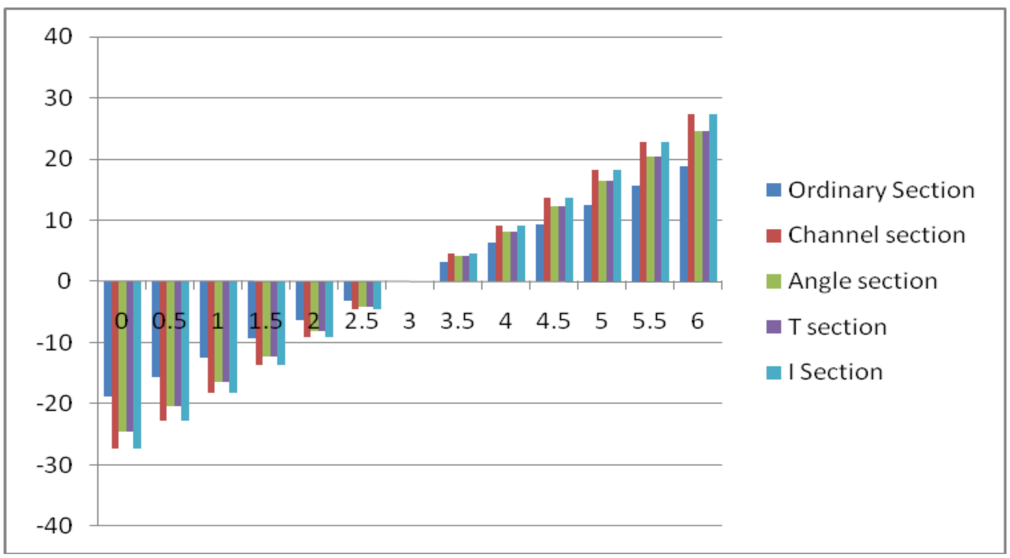

Fig 12: B1 Shear Force due to Dead Load

Due to dead load maximum shear force occurs in Channel and I-section i.e. 27.321KN and minimum shear force occurs in ordinary section i.e. 18.744KN at a section 0m and 6m in B1.

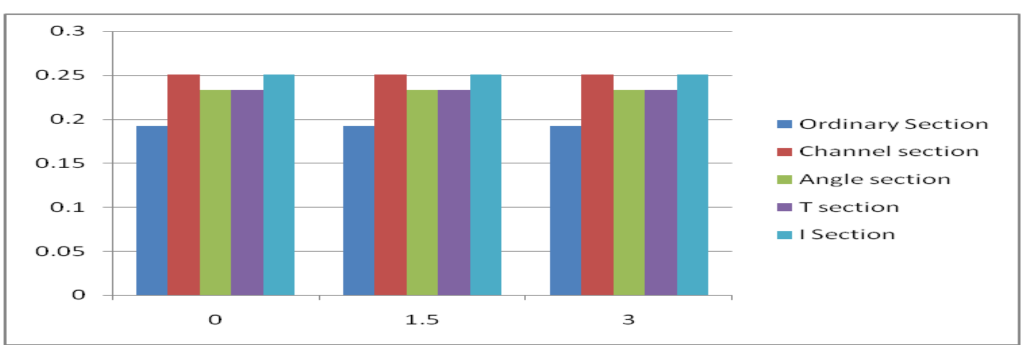

Fig 13: C1 Shear Force due to Seismic Load

Due to seismic load maximum shear force occurs in Channel and I-section i.e. 0.251KN and minimum shear force occur in ordinary section i.e. 0.192KN same at all sections of 3m height of column C1.

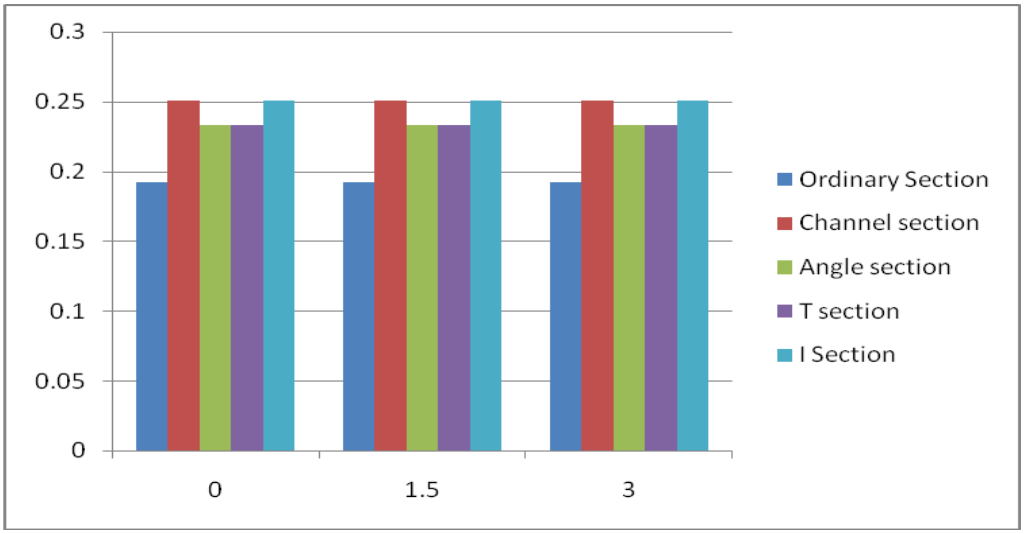

Fig 14: C2 Shear Force due to Seismic Load

Due to seismic load maximum shear force occurs in Channel and I-section i.e. 0.251KN and minimum shear force occurs in ordinary section i.e. 0.192KN same at all sections of 3m height of column C2.

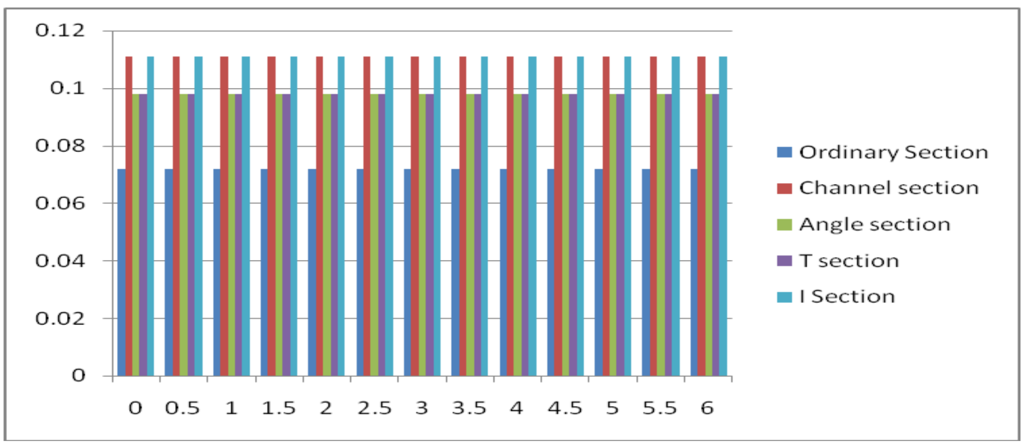

Fig 15: B1 Shear Force due to Seismic Load

Due to seismic load maximum shear force occurs in Channel and I-section i.e. 0.111KN and minimum shear force occurs in ordinary section i.e. 0.072 KN same at all sections of 6m span of beam B1.

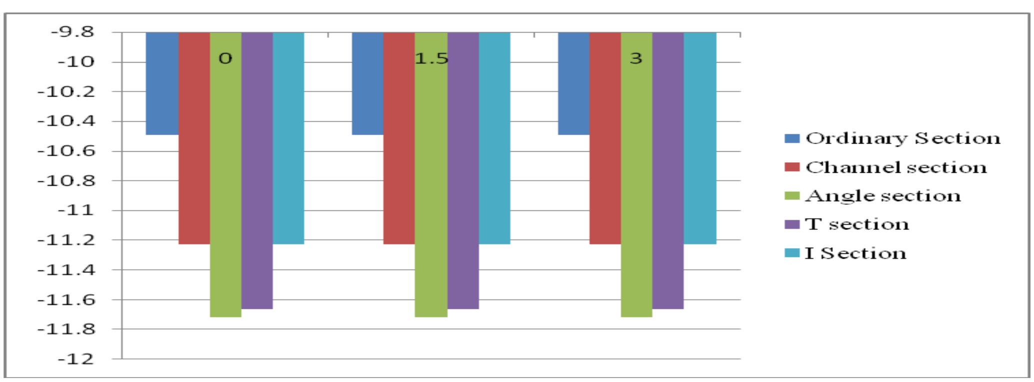

Fig 16: C1 Shear Force due to Dead Load & Seismic Load

Due to dead and seismic load maximum shear force occur in Angle section i.e. -11.719KN and minimum shear force occurs in ordinary section i.e. -10.494 same at all sections of 3m height of column C1.

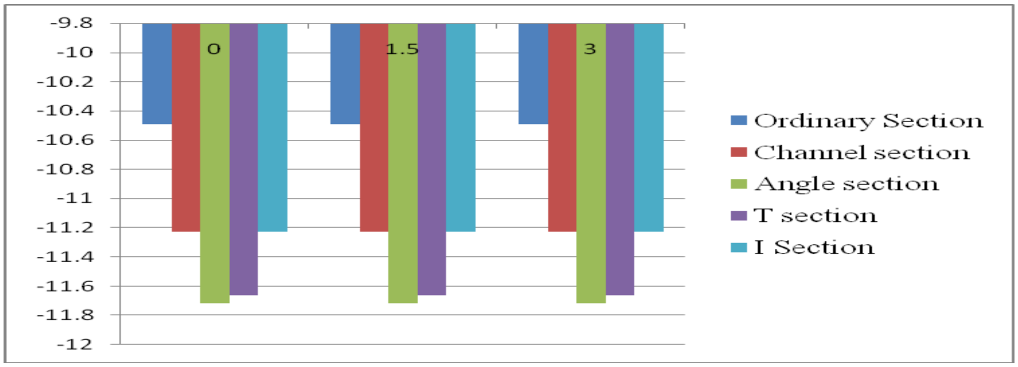

Fig 17: C2 Shear Force due to Dead Load & Seismic Load

Due to dead and seismic load maximum shear force occur in Angle section i.e. -11.719KN and minimum shear force occurs in ordinary section i.e. -10.494KN same at all sections of 3m height of column C2.

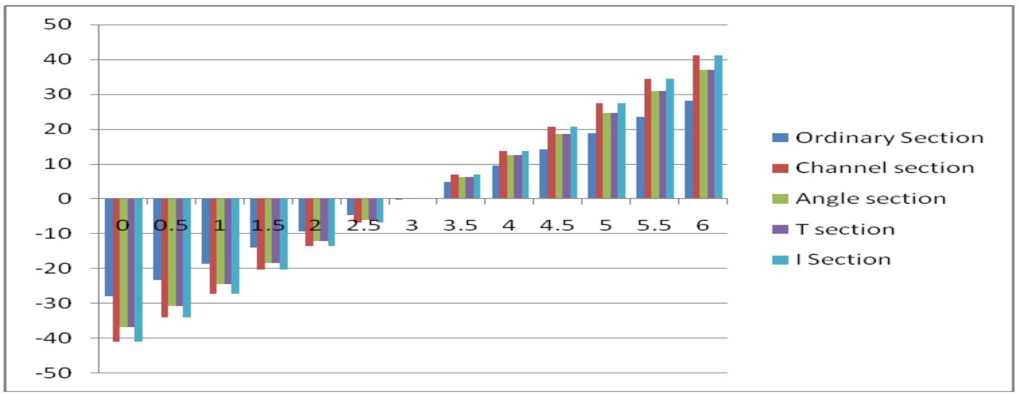

Fig 18: B1 Shear Force due to Dead Load & Seismic Load

Due to dead and seismic load maximum shear force occurs in Channel and I-section section i.e. 41.149KN and minimum shear force occurs in ordinary section i.e. 28.224KN same at all sections of 6m span of beam B1.

Deflection Due To Dead Load

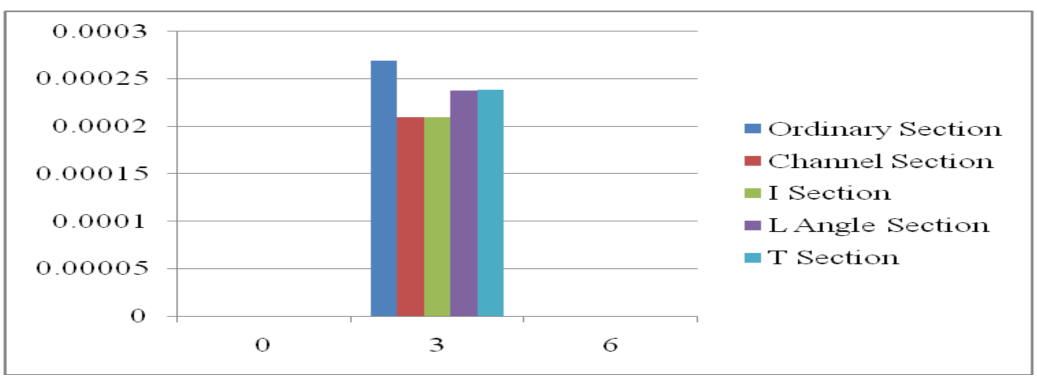

Fig 19: Deflection of Beam of Different Sections

Conclusion

- Maximum bending moment is observed due to combination of dead load and earthquake load in Angle section composite beams.
- Minimum bending moment is found in ordinary section composite beams.

- Due to applied load maximum bending moment occur at the end of the span and minimum to the near of center.
- Maximum shear force is observed due to combination of dead load and earthquake load in Channel and I section.
- Minimum shear force is found in angle section composite beam.
- Due to applied load maximum shear force occur at the end of the span and minimum to the near of center.

References

1. Panchal D. R., Marathe P. M. (2011), “Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building”, International Conference 4 on Current Trends In Technology, pp 01-06.
2. Tedia Anamika, Dr. Maru Savita (2014), “Cost, Analysis and Design of Steel-Concrete Composite structure RCC Structure”, IOSR Journal of Mechanical and Civil Engineering, vol. 11, issue 1, pp 54-59.
3. Koppad Shashikala, Dr. Itti S.V. (2013), “Comparative Study of RCC and Composite Multistoried Buildings”, International Journal of Engineering and Innovative Technology (IJEIT), vol. 3, issue 5, pp 341-345.
4. Wagh Shweta A., Dr. Waghe U. P. (2014), “Comparative Study of R.C.C and Steel Concrete Composite Structures”, International Journal of Engineering Research and Applications, Vol.4, Issue 4, pp 369-376.
5. LIU Jingbo, LIU Yangbing (2008), “Seismic behavior analysis of steel-concrete composite frame structure systems”, The 14th World Conference on Earthquake Engineering.
6. AISC 360-05, Specification of Structural Steel Building, An American National standard, American Institute of Steel Construction, Inc., 2005.
7. Calado L, Simoes da Silva L and Simoes R (2000), “Cyclic Behavior of Steel and Composite Beam-To-Column Joints”, Department Of Civil Engineering, Instituto Superior, Tecnico, Lisbon, Portugal And Universidade de Coimbra, Coimbra, Portugal, pp. 159-169.
8. Christopher J. Earls (2000), “Geometric factors influencing structural ductility in compact I shaped beams”, Journal of Structural Engineering, Vol 126, No. 7, pp. 780-789.
9. Design Aids (for Reinforced Concrete) to IS 456 :1978 ,Special Publication SP : 16, Bureau of Indian Standards, New Delhi, 1980.
10. K.Mukeshkumar, H.SudarsanaRao. “Seismic Analysis of Composite Structures and its Comparison with RCC Structures.” International journal of engineering science and computing (IJESC) (2016).
11. Kumawat, Mahesh Suresh, and L. G. Kalurkar. "Analysis and design of multi-storey building using composite structure." International Journal of Structural and Civil Engineering Research (IJSCER) (2014).
12. Prof. Rajendra R. Bhoir, Prof. VinayKamble, Prof. DarshanaGhankute. “Analysis and Design of Composite Structure & Its Comparison with RCC Structure.” International Journal for Research in Applied Science & Engineering Technology (IJRASET) (2017)
13. D.R. Panchal, P.M. Marathe. “Comparative study of RCC and composite (G+30) story building”, Nirma University, Ahmedabad, India. (2011)