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Seismic Behavioural Analysis of One Bay Structure with Composite Beam and RCC Columns

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Abstract

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.

There is a great potential for increasing the volume of Steel in construction, especially the current development needs in India exploring Steel as an alternative construction material and not using it where it is economical is a heavy loss for the country. Also, it is evident that now-a-days, 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.

In the past, for the design of a building, the choice was normally between a concrete structure and a masonry structure. But the failure of many multi-storied and low-rise R.C.C. and masonry buildings due to earthquake have forced the structural engineers to look for the alternative method of construction. Use of composite or hybrid material is of particular interest, due to its significant potential in improving the overall performance through rather modest changes in manufacturing and constructional technologies.

Advantages of Steel Concrete Composite Structure

- Most effective utilization of materials means concrete for compressive stress and steel for tensile stress.
- Steel is highly ductile in nature hence better seismic resistance of the composite section.
- Steel component has the ability to absorb the energy released due to earthquake forces.
- Ability to cover large column free area.
- Faster construction by utilizing rolled and/or prefabricated components.
- Keeping span and loading unaltered, smaller sections are required compared to non-composite construction.

Literature Survey

Preetha et. al. 2020 [1], presented the genuine expectation of steel-substantial composite development has been acknowledged all over the planet as an option in contrast to supported concrete and unadulterated steel development. The act of composite components in the development business is extremely low in India contrasted with many agricultural nations. There is incredible potential for expanding the volume of steel in development, particularly in the present advancement needs. Composite development lessens the extra weight of the design, which thus diminishes development work time. In the current review, the multi-story building G + 10 made out of RCC sections and two unique composite segments viz. The typified segment and rectangular filling tubes are broke down utilizing ETABS programming. In this review, a correlation was made to research the variety of soil float, soil shear, time-frame and building removal with RCC and composite sections.

Dahale et. al. 2019 [2], Discussed composite steel and concrete development is broadly acknowledged all throughout the planet as an option in contrast to unadulterated steel and unadulterated concrete development. The utilization of steel in the development business is extremely low in Nepal contrasted with many non-industrial nations. There is extraordinary potential for expanding the volume of steel in development, particularly in the present advancement needs. Not utilizing steel as an elective structure material and not utilizing it where it is affordable is an incredible misfortune for the country. The utilization of composite materials is exceptionally compelling, because of its huge potential for working on generally speaking execution through rather unassuming changes in assembling and development innovations. The composite steel and concrete development implies that the concrete section is associated with the composite pillar utilizing shear connectors to go about as a solitary unit. In the current work, the steel-concrete composite (both composite and semi-composite) with RCC choices is considered for the near investigation of the seismic conduct of 10 multi-story business structures (4 stories, 5 stories, 6 stories, 7 stories, 8 stories) floors, 9 stories, 10 stories, 12 stories, 16 stories and 20 stories which is situated in seismic zone V and for seismic burdens the arrangements of IS: 1893 (Part 1) - 2002 are made into account. composite constructions and RCC, SAP2000 programming is utilized. The steel and concrete composite development framework is a productive, conservative and imaginative strategy for the seismic opposition of multi-story structures. The same static seismic investigation strategy is utilized in model examination. The examination of boundaries, for example, time-frame, hub power, shear power, bowing second, diversion, soil deviations, base shear, soil firmness is done for complete composite constructions (radiates - composite post), semi-composite (made out of posts) and RCC. They analyzed the outcomes and tracked down that the composite design is better severally. **Krishna et-al. 2019 [3], i**n this study, comparisons between the RCC structures and the composite structures were obtained using parameters such as the time period of the structure, the plane displacement and drift, the basic cut, the bending moments and shear forces. It can be clearly inferred from the observation results that compared to RCC structures, steel composites perform well in terms of structural integrity. In an RCC structure with increased height, the size of the structural elements (columns, beams and slabs) increases. Therefore, the weight of the structure will also increase. On the other hand, steel structures are ductile in nature. Compared to RCC structures, there are more parameters such as deflection, drift and displacement. To solve these problems, composite structures may be appropriate. The RCC and the composite structure (taking into account the earthquake in zone III) of the geometrically irregular residential buildings (floors G + 18) were designed and analyzed using the ETABS software. Structural analysis is using static linear, linear and nonlinear dynamic methods (such as equivalent static methods, response spectrum methods and time history methods).

Bhoir et. et. 2017 [4] in this study, steel and concrete structures use hot-rolled steel structural sections as structural elements. Compared to many developing countries, India's use of steel in the construction industry is very low. The potential for increasing structural steel is enormous, especially in India's current development needs, not using steel as an alternative building material and not using it in a cheap place would result serious losses for the country. Two residential structures composed of G + 15 and RCC were analyzed and designed in the ETAB software, and their latitudes were 3 m and 4 m respectively. It has been found that the depth of the beam in the composite structure is less than the depth of the beam in the RCC structure, which results in a reduction in the size of the columns in the composite structure. We can also see that the consumption of cement and steel in composite structures is low, but because we use hot rolled profiles, the consumption of structural steel will increase.

Cristina et-al, 2015 [5], describes the experimental aspects of steel-concrete columns with coated steel profiles. On the other hand, it emerges from the curve and the HIC parameters that the column with HSC has a higher energy absorption capacity, and even if the mode of rupture is fragile, this solution can be recommended for construction in areas seismic. Structurally, composite columns with a concrete category of C70/85 offer significantly better performance for the structure, with almost all the parameters analyzed considerably increased. The fully embedded composite column solution is a competitive solution in the seismic and non-seismic fields, thanks to its excellent seismic performance (from the experimental tests provided) and better fire resistance. The results obtained on high-resistance concrete pillars show improved performance, in particular resistance. Due to the brittle fracture of high strength concrete, further experimental and numerical studies are still required.

Kumawat et-al, 2014 [6], observe, a strengthened concrete compound with RCC alternative turned into studied to behavior a comparative examine of the 9 storey G + located in seismic zone III, and the provisions of standard IS: 1893 (part 1) have taken into account) -2002. With the assist of the SAP 2000 software For 3-dimensional modeling and structural evaluation, a parabolic constant evaluation method, a reaction spectrum evaluation approach for the composite structure, and RCC evaluation are used. By comparing the results, he observed that compound formulations were cheaper.

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.

Obtained Result

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

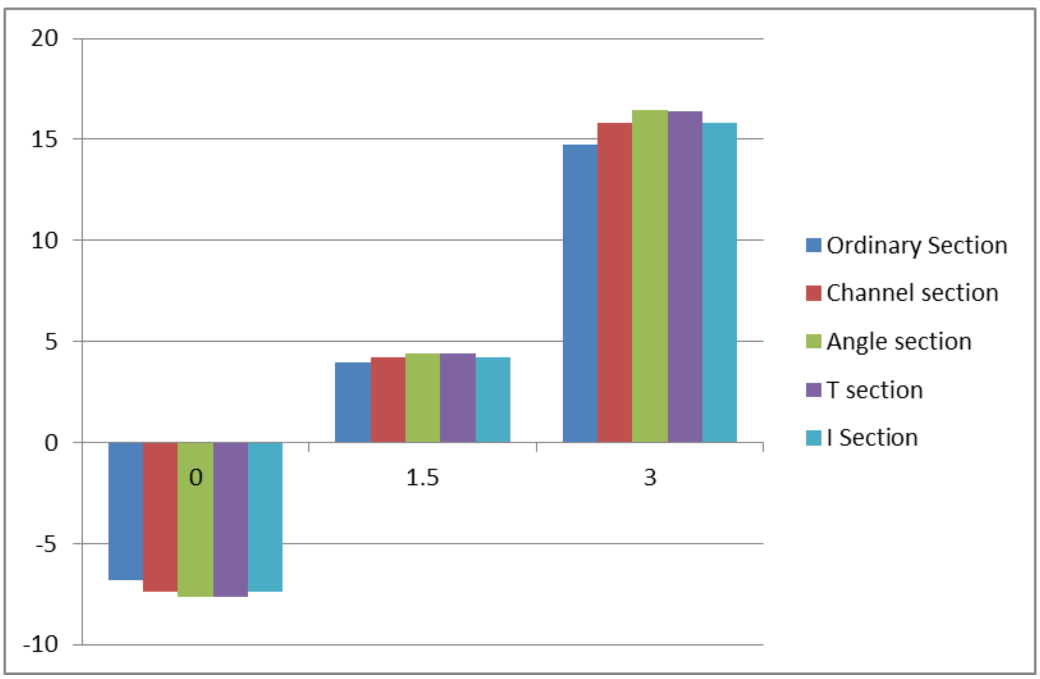

Fig.1: C1 Bending moment due to Dead Load

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.

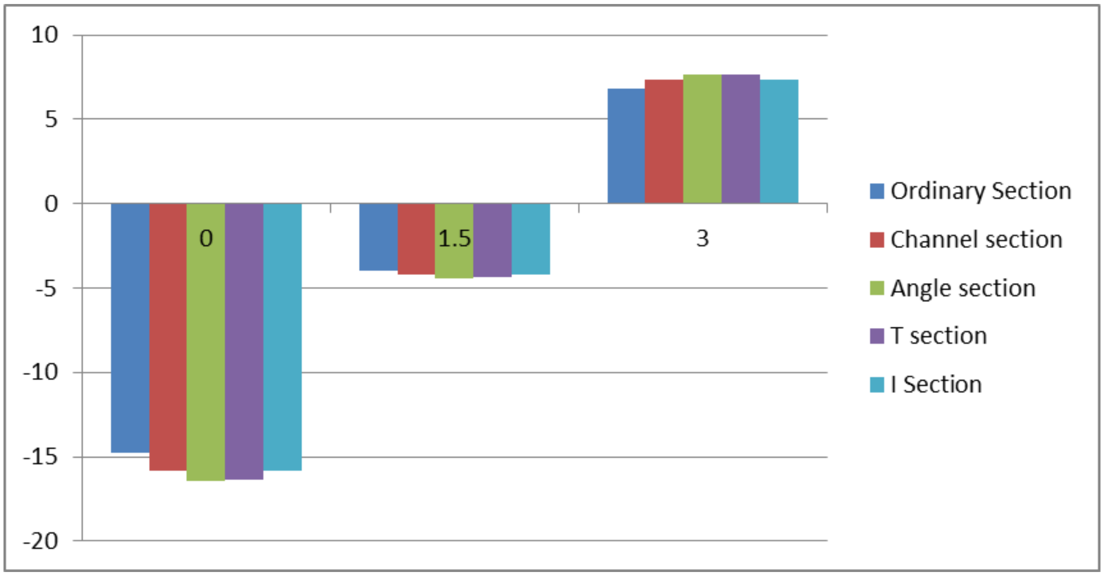

Fig.2: C2 Bending moment due to Dead Load

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.

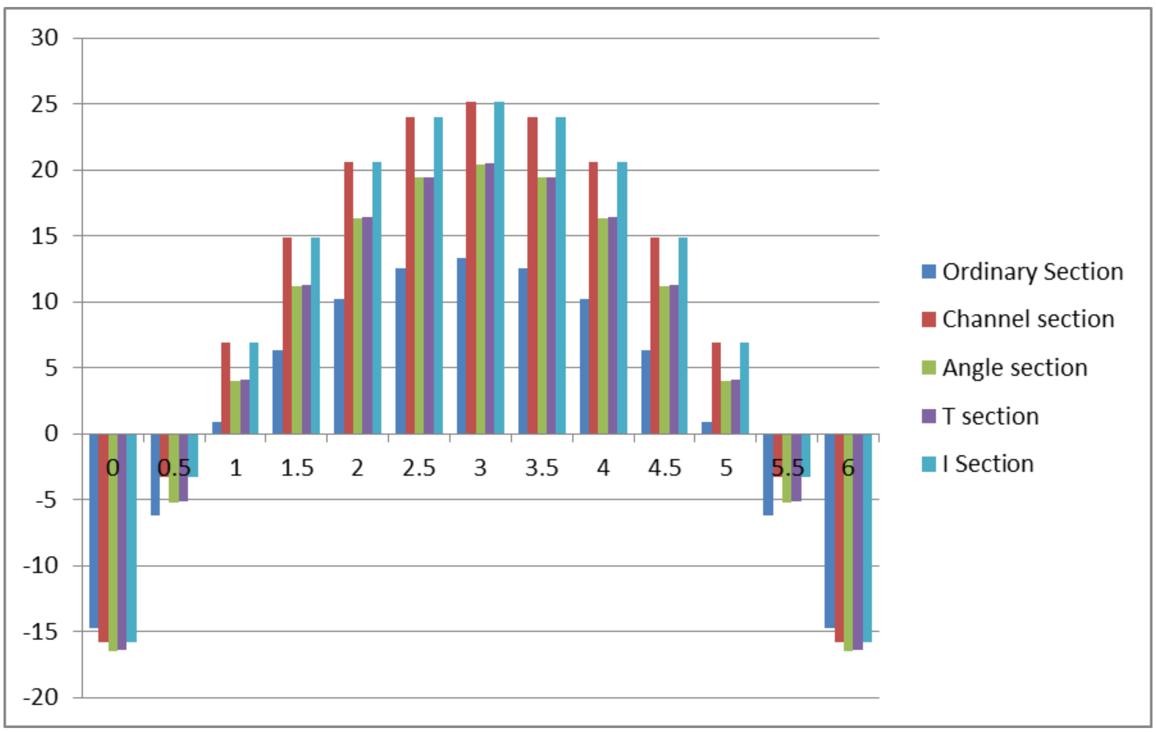

Fig.3: B1 Bending moment due to Dead Load

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.

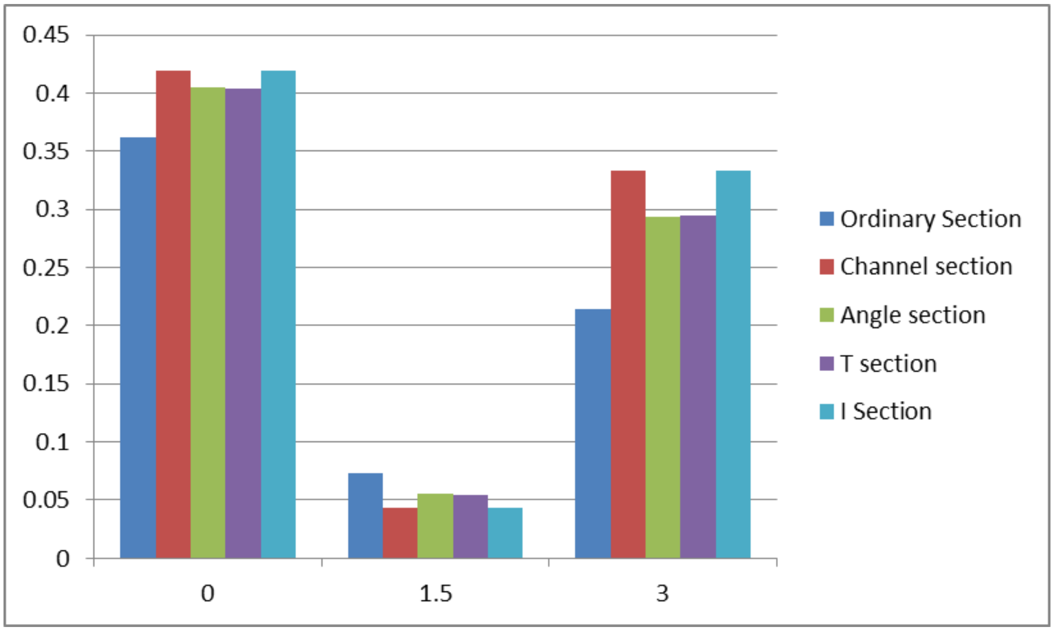

Fig.4: C1 Bending moment due to Seismic Load

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.

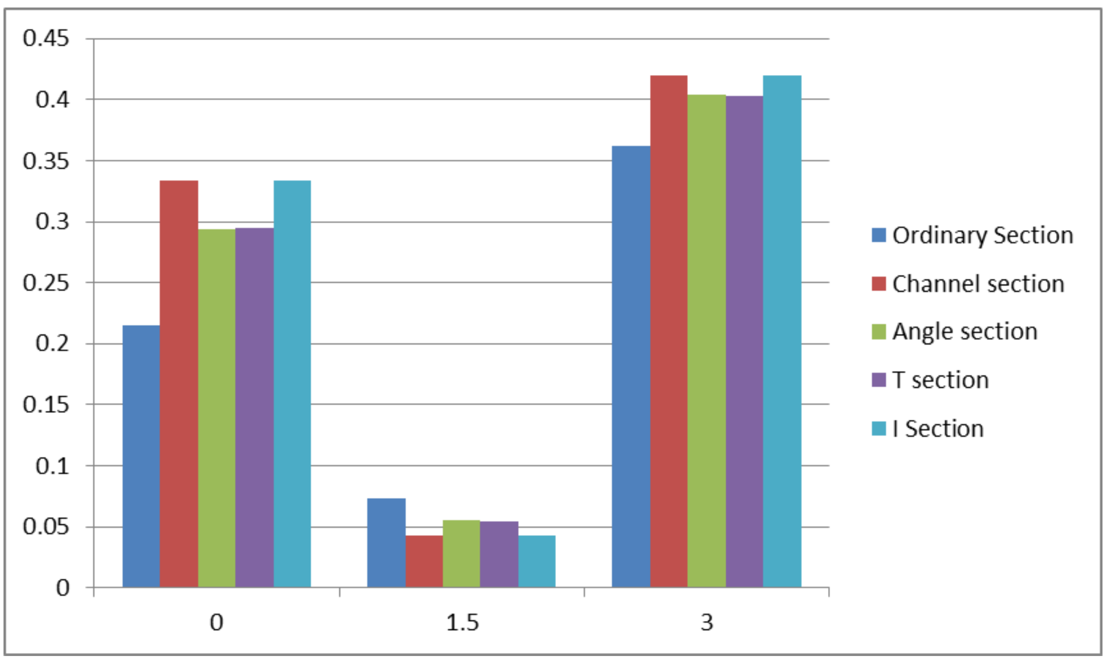

Fig.5: C2 Bending moment due to Seismic Load

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.

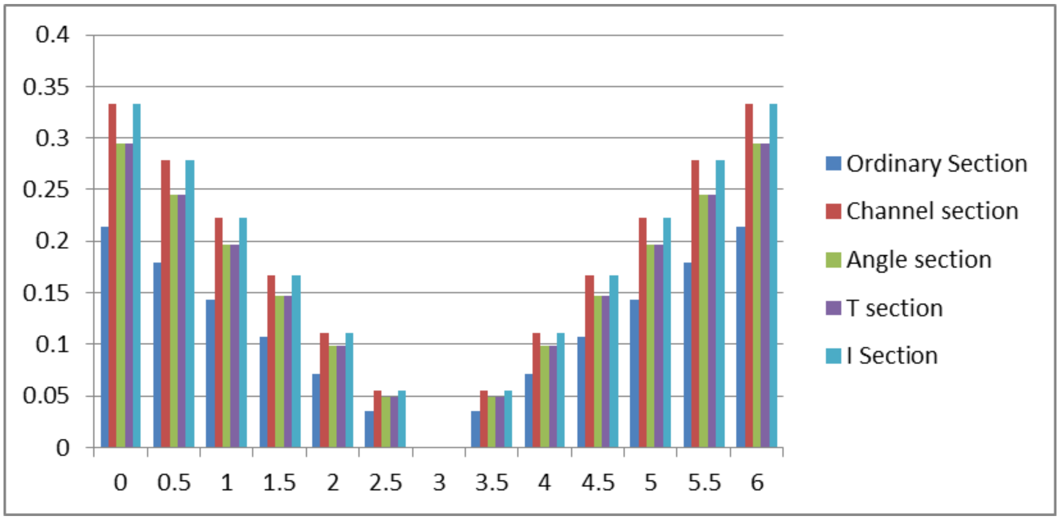

Fig. 6: B1 Bending moment due to Seismic Load

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.

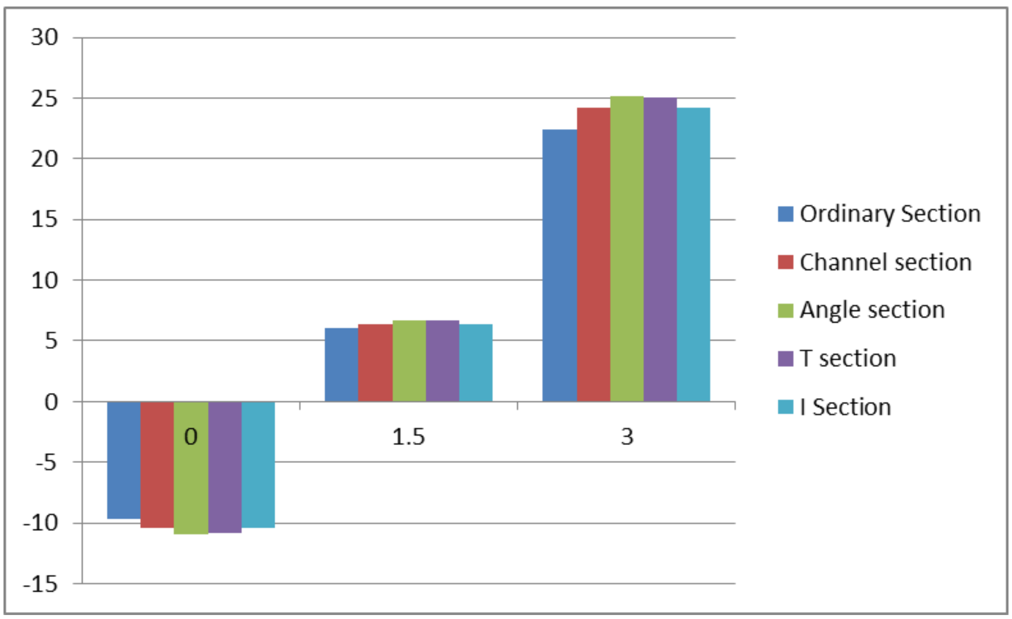

Fig.7: C1 Bending moment due to Dead Load & Seismic Load

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.

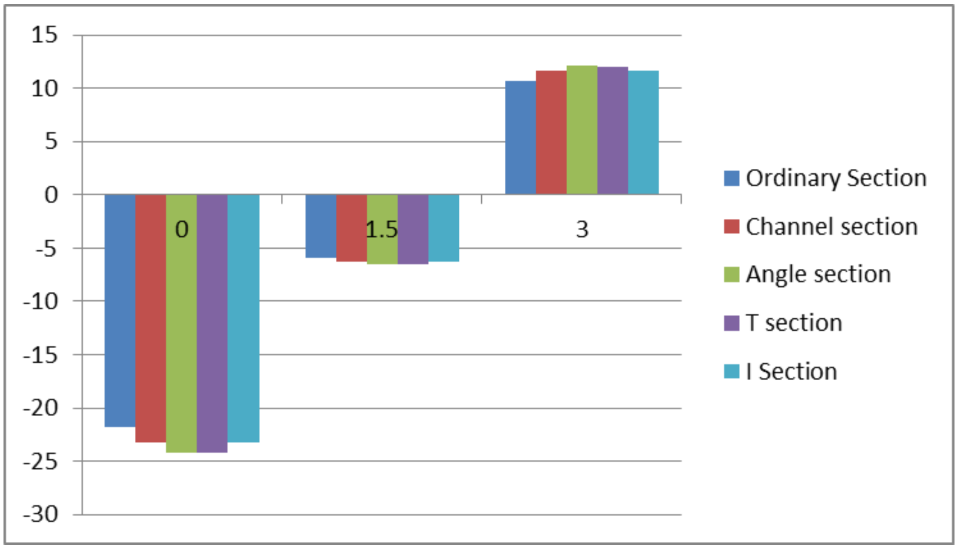

Fig.8: C2 Bending moment due to Dead Load & Seismic Load

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.

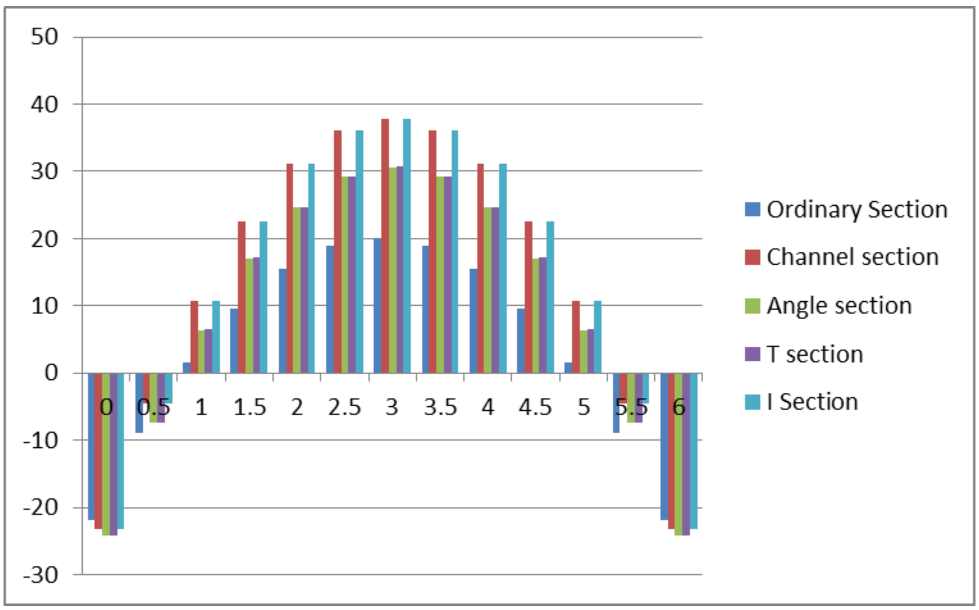

Fig.9: B1 Bending moment due to Dead Load & Seismic Load

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.

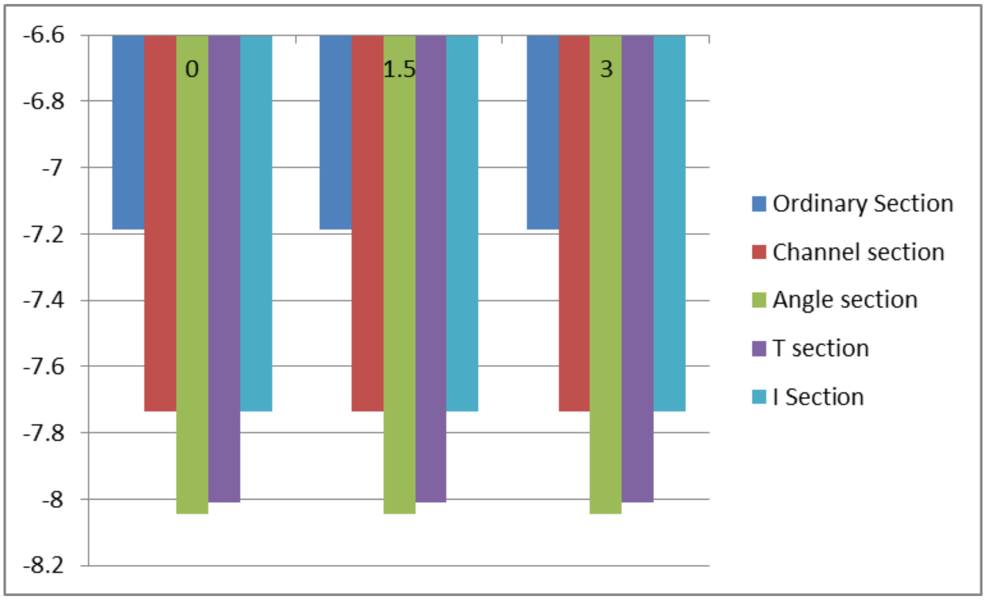

Fig.10: C1 Shear Force due to Dead Load

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.

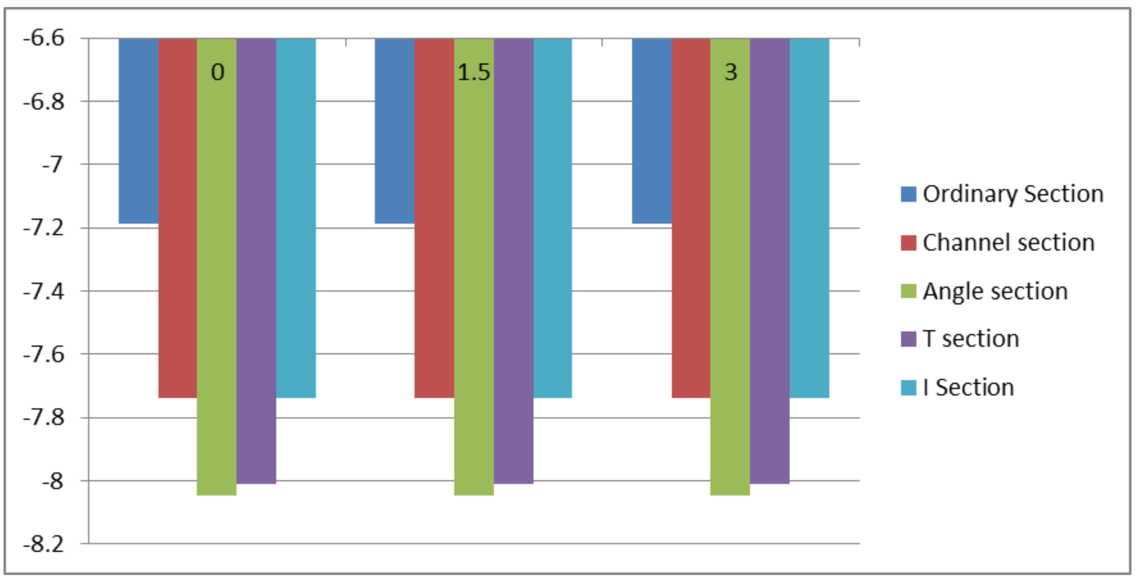

Fig.11: C2 Shear Force due to Dead Load

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.

Conclusion

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. Section arrangement according to maximum to minimum to Shear force results are;

- Channel section

- I Section
- Angle section
- T section
- Ordinary concrete

Due to applied load maximum shear force occur at the end of the span and minimum to the near of center.

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