"SEISMIC ANALYSIS OF MULTI-STOREY BUILDINGS WITH COMPOSITE COLUMNS AND RCC BEAMS"

Shariq Mir
College of Engineering and Technology, BGSBU, Jammu and Kashmir.

Abstract - In this work, a study was conducted on the behavior of composite columns, which are called reinforced concrete columns (SCC). The structure is exposed to a zone 5 seismic load according to IS 1893: 2016 and combinations of dead loads have been considered. The results of the bending moment and the lateral deformation of the frame are compared with the SAP 2000 software.

In this study, an analysis of the two-span structure with a composite column with a seismic zone five according to IS 1893: 2016 was carried out and a comparison was made between bending moments, section modulus, deflections, shear force for seismic load and dead load.

Key words: composite section, steel girder, seismic load, SAP 2000, 5 story building, 9 columns, Fe-250.

I. INTRODUCTION

Designing multi-storey buildings has always been a social challenge. With the difficulty of land supply, modern society is shifting from single-family houses to skyscrapers. In the design of skyscrapers, lateral loads (ie, wind loads and earthquakes) began to dominate, which led to an increase in the size of columns and beams. In earthquake-resistant structures, there is a new method of designing strong columns and weak beams so that they will not collapse immediately due to the fracture of the beam in an earthquake.

In large buildings, steel and concrete are usually combined in the form of composite beams or composite columns. Concrete can provide composite quality, stiffness and compressive strength, and reduce bending and vibration of the floor. The steel element gives the column tensile strength, the ratio of strength to weight is excellent, and the construction time is short.

Next, choose a combination of structural concrete and steel and built a composite structure called a composite structure. Civil engineers worked hard to keep the size of the cylinder small and make it strong. Therefore, composite columns can be used to overcome this requirement.

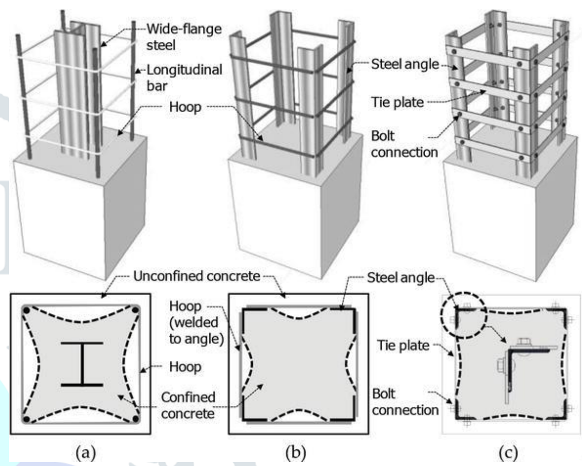

Fig 1 Column Composite Section (A) I Girder (B) Angle at Corners (C) Angle at Center

II. ADVANTAGES OF SCC 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. Minimum disturbance to traffic in bridge construction.

III. DESIGN OF PROPOSED WORK

Different structural systems is employed currently on a daily basis to fulfill performance and stability, Composite construction is wide utilized in structural systems to achieve

- Long spans

- Lower story heights
- Provide extra lateral stiffness
- More purposeful space by reducing the dimensions of columns.

Composite construction uses the structural and constructional benefits of each concrete and steel.

A model of 9 columns and 2 bay structures having 5 floors analyised. **F**oundation support conditions have been assumed to be fixed type. Modeling and analysis of the structure is done with advance structural engineering software SAP 2000 developed by CSi.

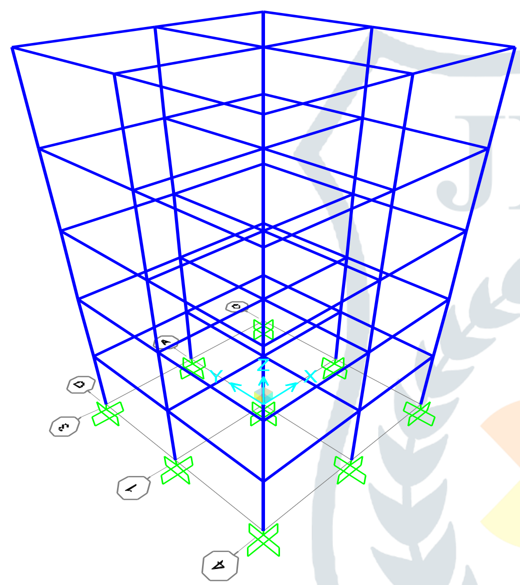

Fig 2 3-D Model of 5 Storeys

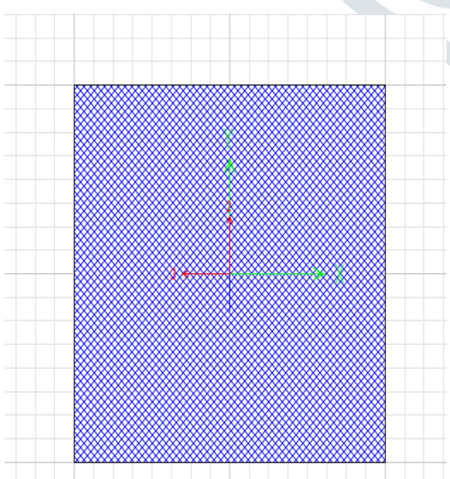

Fig 3 Window Tab in SAP2000 for Section Designer Ordinary Column Concrete

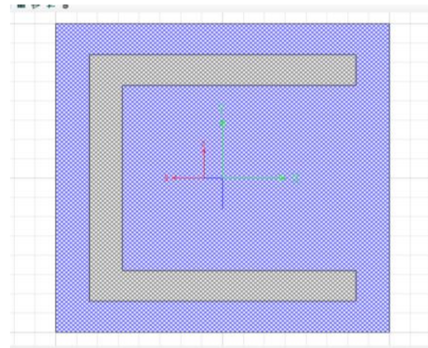

Fig 4 Window Tab in SAP2000 For Section Designer Column Channel

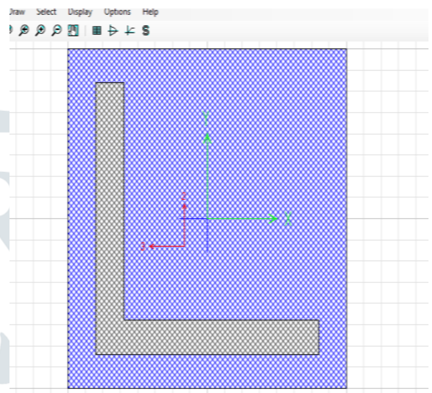

Fig 5 Window Tab in SAP2000 for Section Designer Column Angle L

Table 1: Geometry & Sectional Properties of Composite Sections

Section	Material	Shape	Area	Torsion	Moment of inertia
		Section design	m2	m4	m4
Column Channel	M30	SD Section	0.616746	0.017032	0.014183
Column Concrete Simple	M30	SD Section	0.25	0.008805	0.005208
Column Double Angle	M30	SD Section	0.588682	0.01135	0.01085
Column I	M30	SD Section	0.616746	0.012982	0.014183
Column L Angle	M30	SD Section	0.500054	0.013398	0.009751
Column T	M30	SD Section	0.500054	0.011005	0.009751
Beam 500*500	M30	Square	0.25	0.008802	0.005208

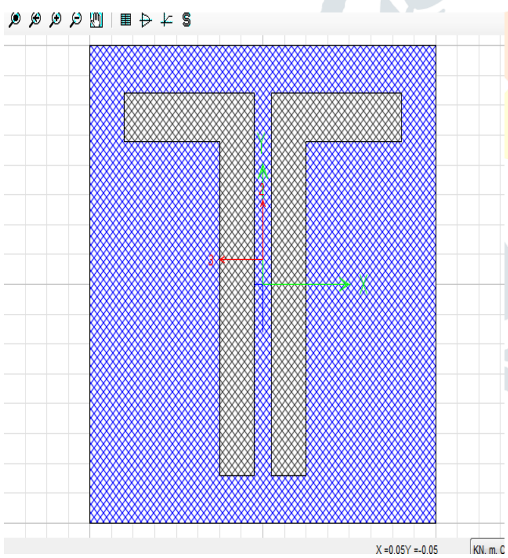

Fig 6 Window Tab in SAP2000 for Section Designer Double Angle Column

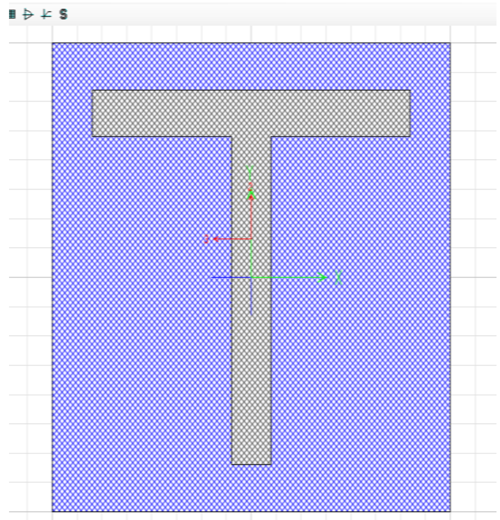

Fig 7 Window Tab in SAP2000 for Section Designer Column T Section

IV. RESULTS AND DISCUSSION

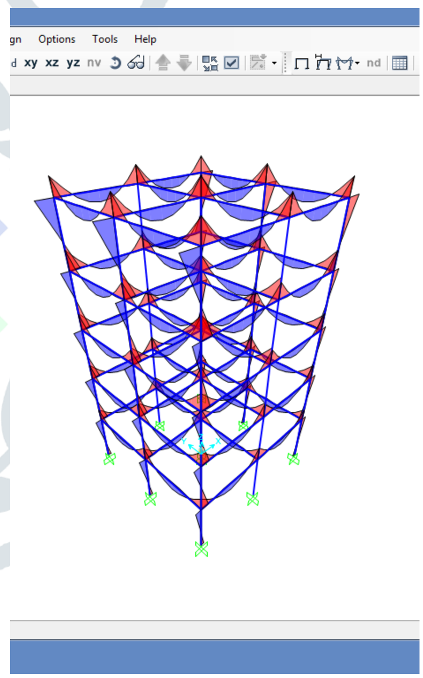

Fig 8 SAP2000 Showing Bending Moment Variation

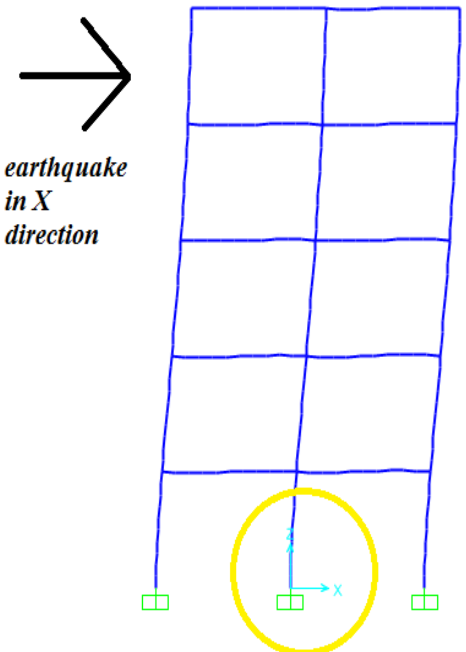

Fig 9 Deflected Shape of Model Due To Various Loading

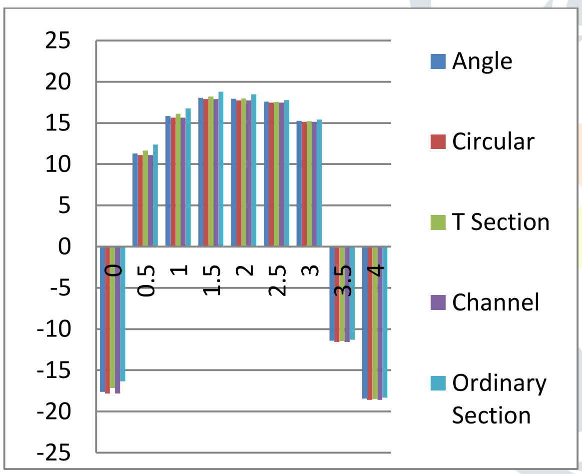

Fig 10 B11 Bending moment due to Dead Load and Seismic Load

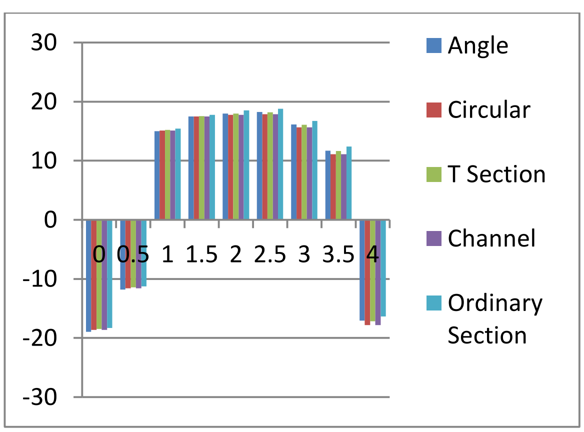

Fig 11 B12 Bending moment due to Dead Load and Seismic Load

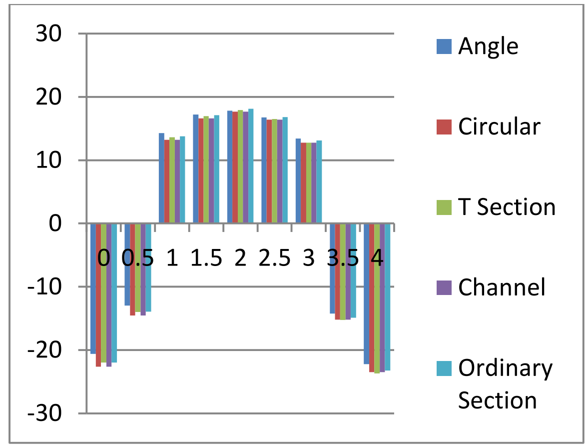

Fig 12 B13 Bending moment due to Dead Load and Seismic Load

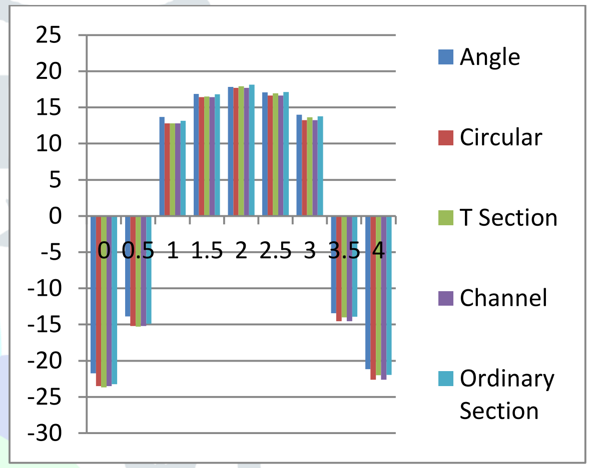

Fig 13 B14 Bending moment due to Dead Load and Seismic Load

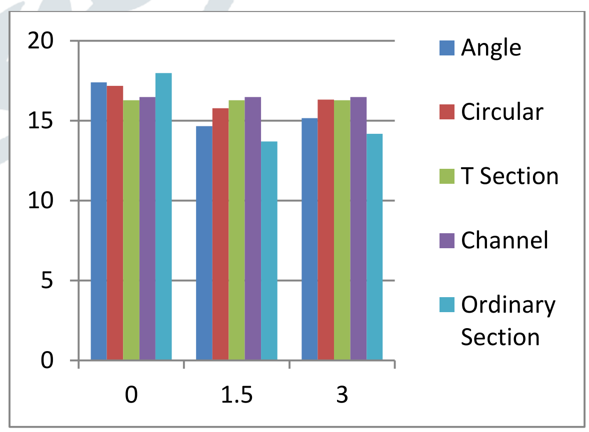

Fig 14 C11 Bending moment due to Dead Load and Seismic Load

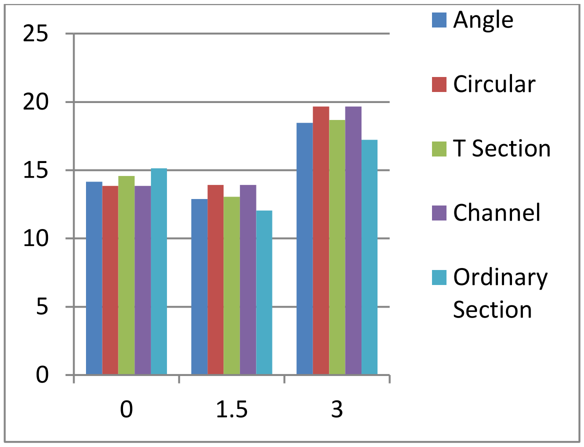

Fig 15 C12 Bending moment due to Dead Load and Seismic Load

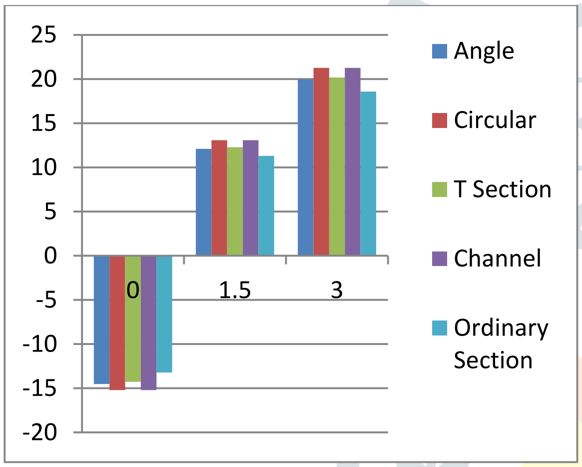

Fig 16 C13 Bending moment due to Dead Load and Seismic Load

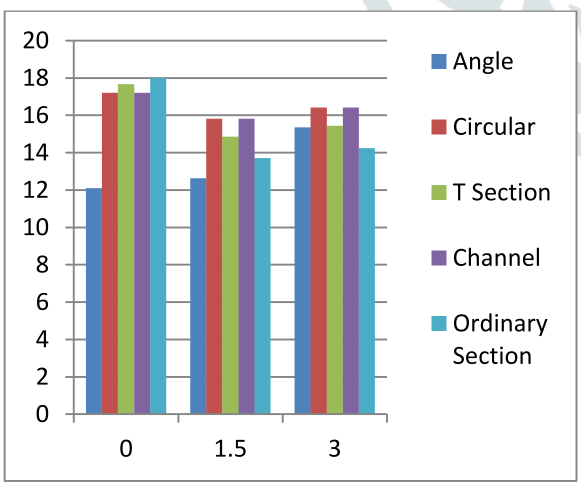

Fig 17 C14 Bending moment due to Dead Load and Seismic Load.

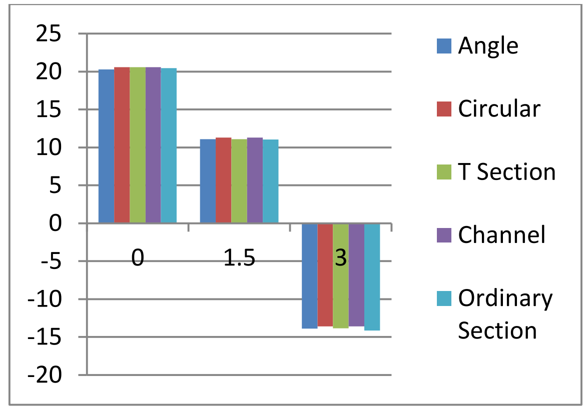

Fig 18 C21 Bending moment due to Dead Load and Seismic Load

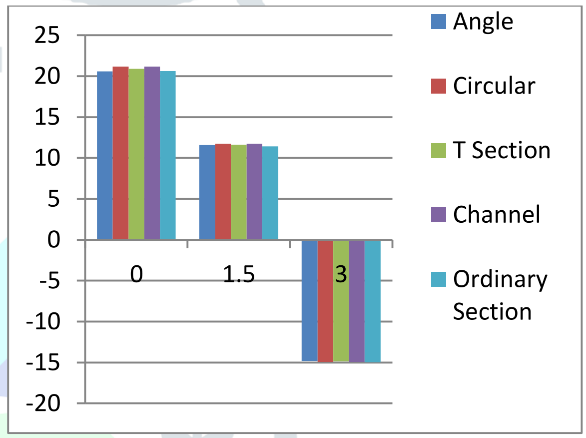

Fig 19 C31 Bending moment due to Dead Load and Seismic Load

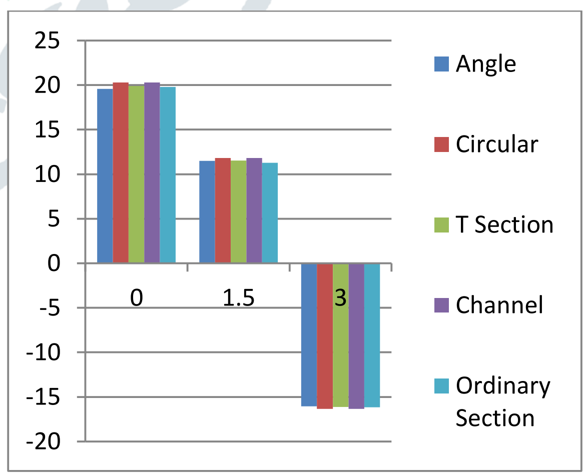

Fig 20 C41 Bending moment due to Dead Load and Seismic Load

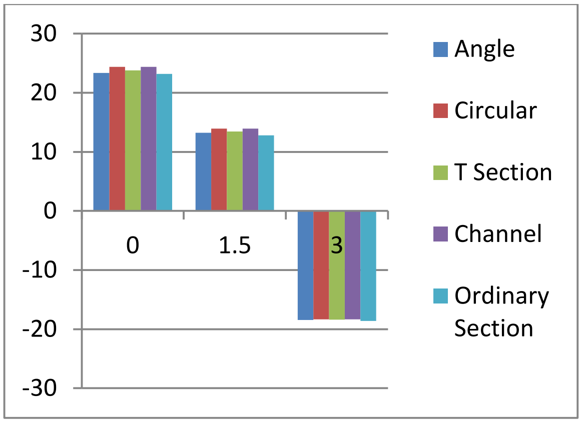

Fig 21 C51 Bending moment due to Dead Load and Seismic Load

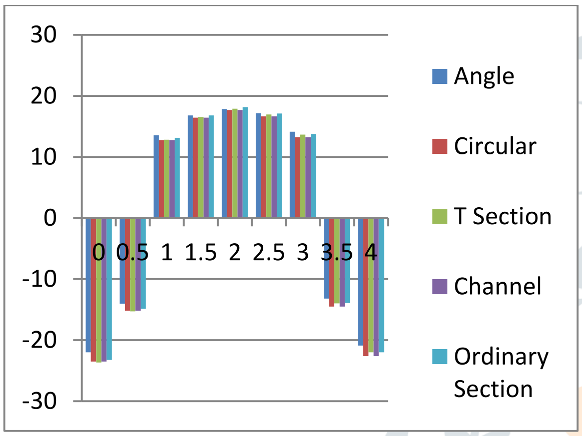

Fig 22 M11 Bending moment due to Dead Load and Seismic Load

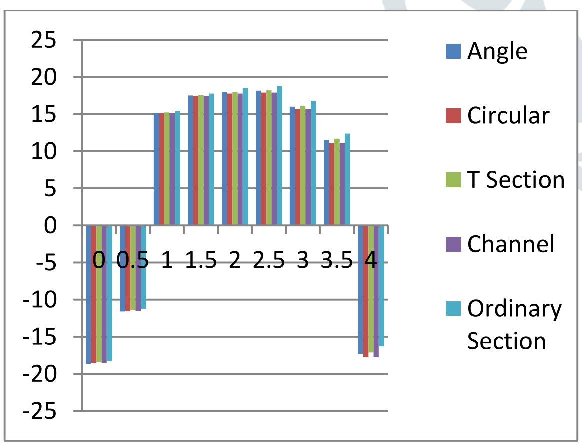

Fig 23 M12 Bending moment due to Dead Load and Seismic Load

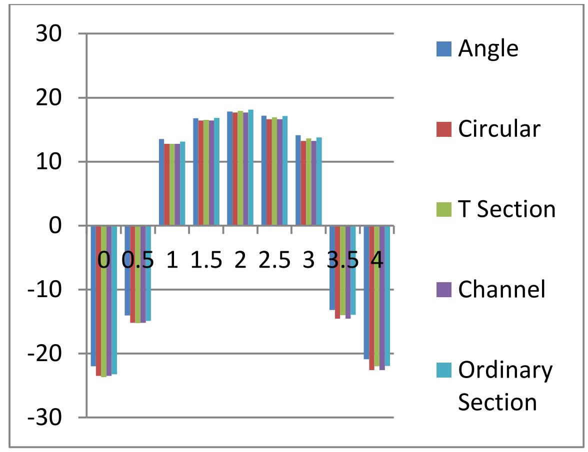

Fig 24 M13 Bending moment due to Dead Load and Seismic Load

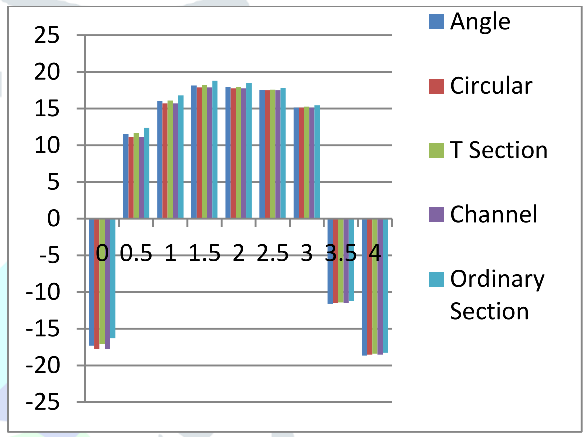

Fig 25 M14 Bending moment due to Dead Load and Seismic Load

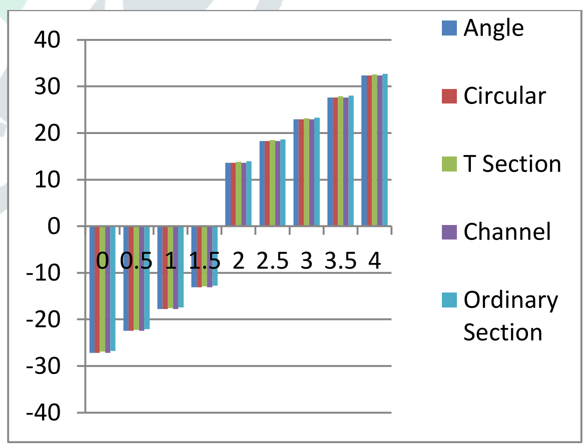

Fig 26 B11 Shear Force due to Dead Load and Seismic Load

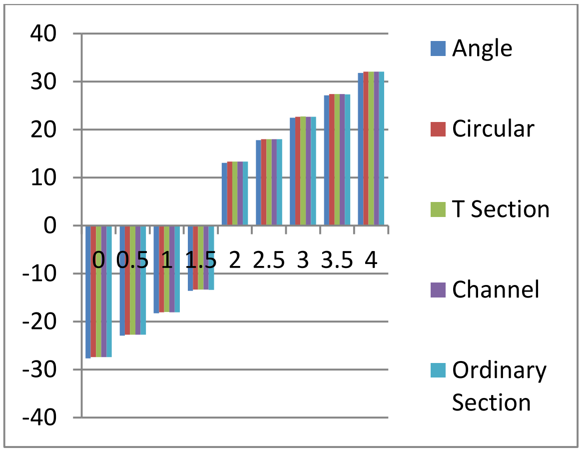

Fig 27 B12 Shear Force due to Dead Load and Seismic Load

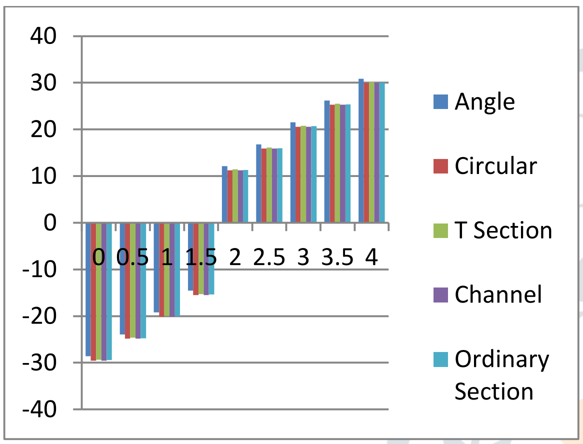

Fig 28 B13 Shear Force due to Dead Load and Seismic Load

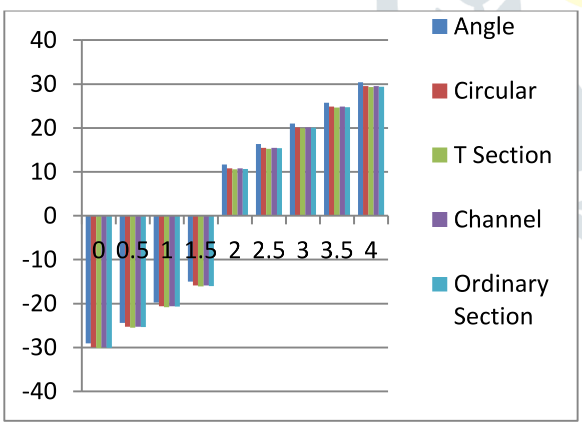

Fig 29 B14 Shear Force due to Dead Load and Seismic Load

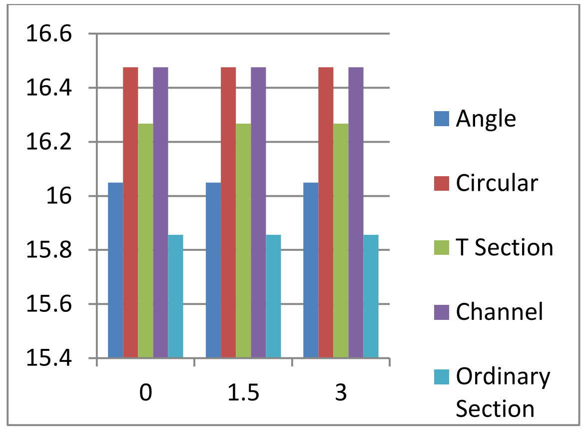

Fig 30 C11 Shear Force due to Dead Load and Seismic Load

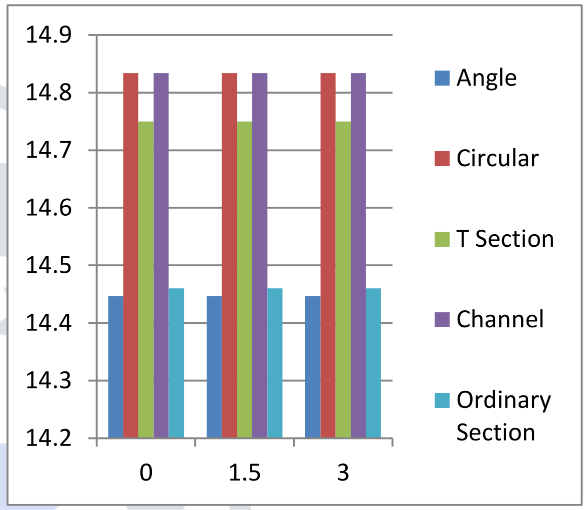

Fig 31 C12Shear Force due to Dead Load and Seismic Load

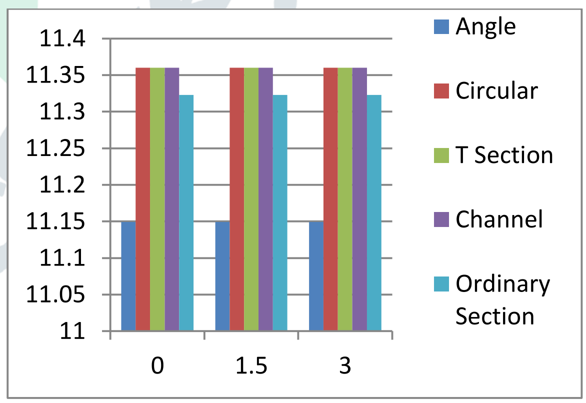

Fig 32 C13Shear Force due to Dead Load and Seismic Load

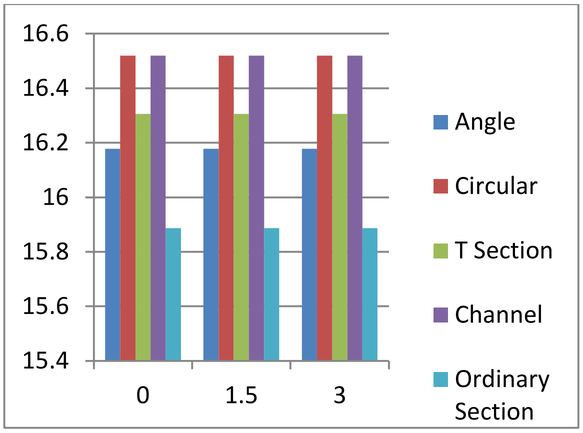

Fig 33 C14Shear Force due to Dead Load and Seismic Load

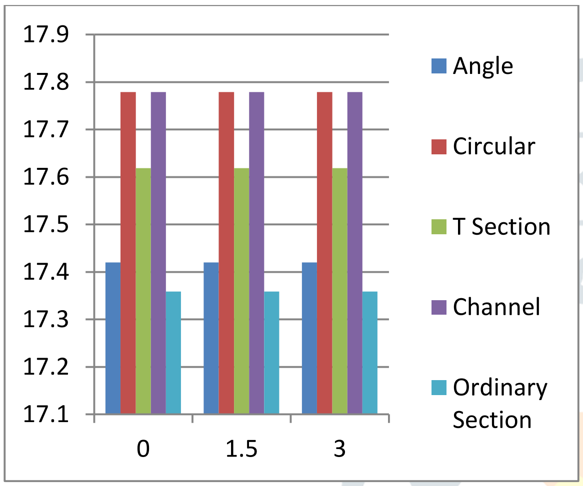

Fig 34 C21Shear Force due to Dead Load and Seismic Load

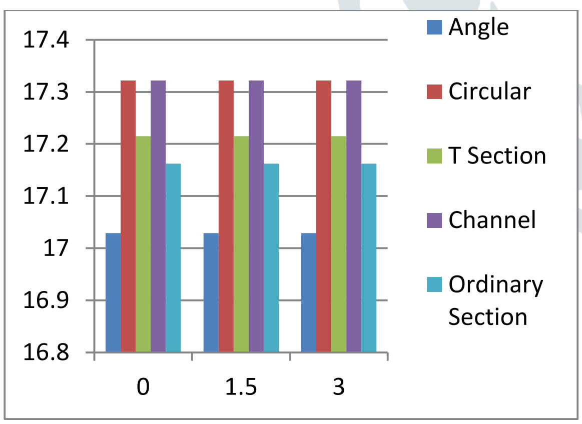

Fig 35 C31 Shear Force due to Dead Load and Seismic Load

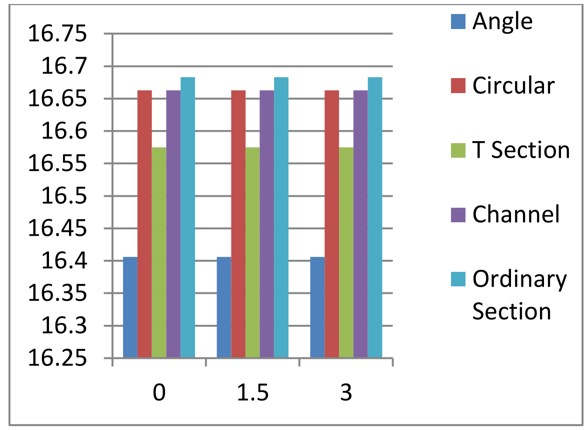

Fig 36 C41 Shear Force due to Dead Load and Seismic Load

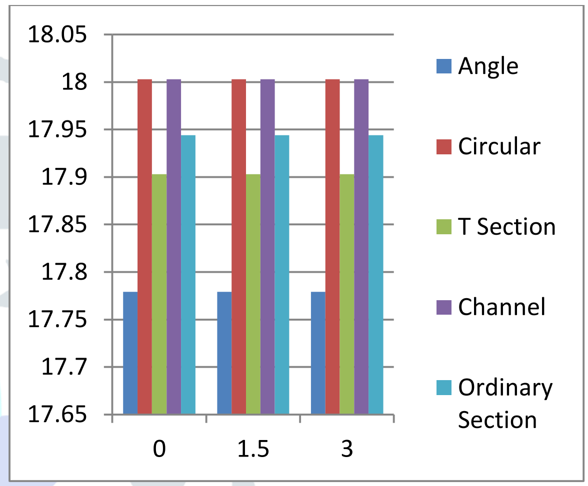

Fig 37 C51 Shear Force due to Dead Load and Seismic Load

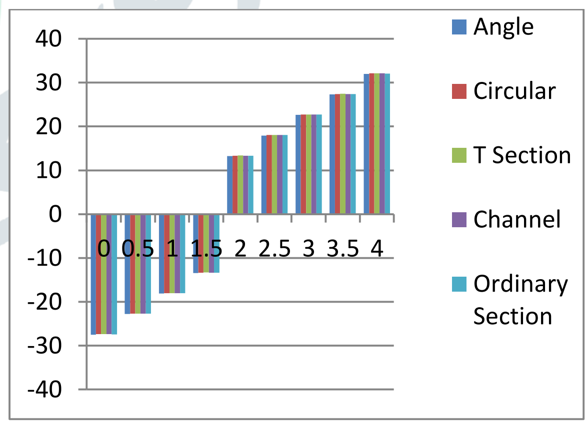

Fig 38 M12 Shear Force due to Dead Load and Seismic Load

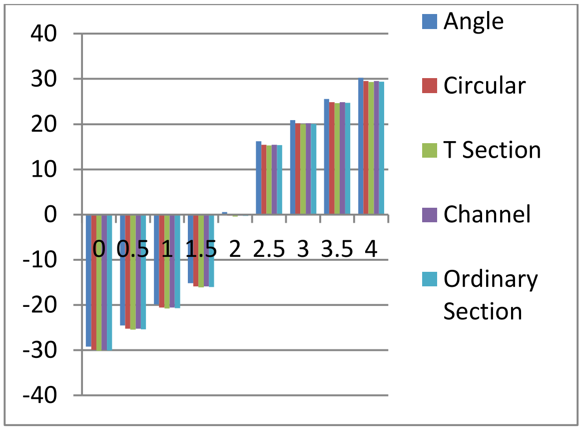

Fig 39 M13 Shear Force due to Dead Load and Seismic Load

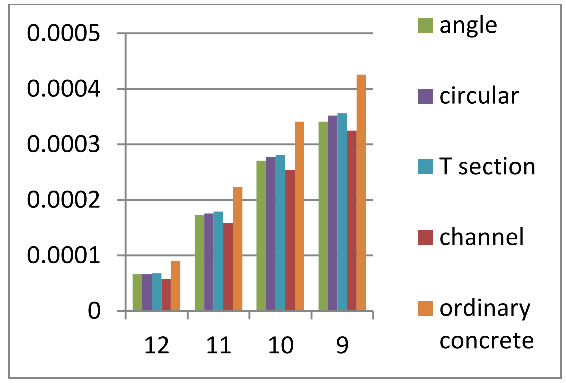

Fig 42 Deflection of Joint Specifies 12, 11, 10 and 9 for All Section at Different Floor

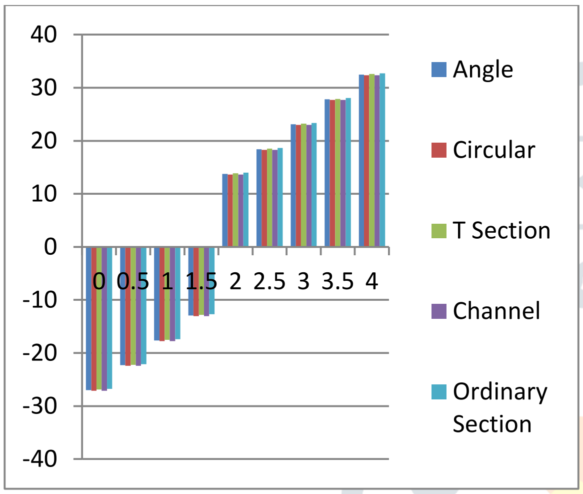

Fig 40 M14 Shear Force due to Dead Load and Seismic Load

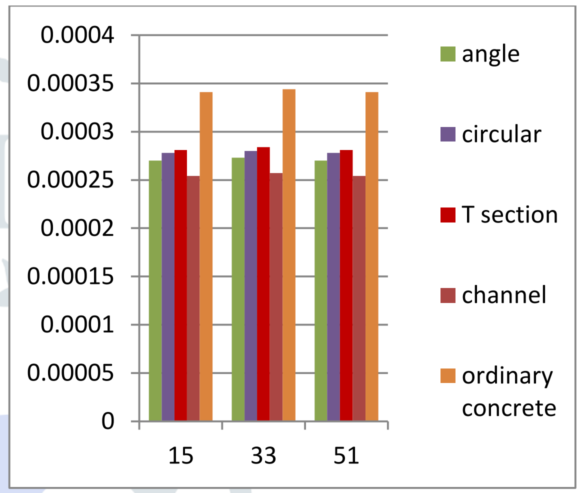

Fig 43 Deflection of Joint Specifies 15, 33, and 51 at Same Floor

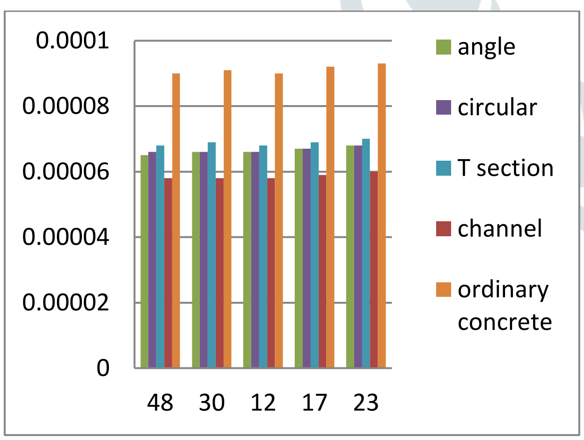

Fig 41 Deflection of Joint Specifies 48, 30, 12, 17, and 23 for All Section

VI. CONCLUSION

Bending Moment:-

The maximum bending moment is observed due to combination of dead load and earthquake load in T section composite columns. The minimum bending moment is found in angle section composite columns. Due to applied load maximum bending moment occur at the end of the span and minimum to the near of center.Sections arrangement according to minimum to maximum bending momentsresults are;

1. Angle section **(minimum)**
2. Ordinary section
3. Channel section
4. T section.**(maximum)**

Shear Force:-

Maximum shear force is observed due to combination of dead load and earthquake load in ordinary section. Minimum shear force is found in angle section composite column. Due to applied load maximum shear force occur at the end of the span and minimum to the near of center. Section arrangement according to minimum to maximum to Shear force results are;

1. Angle section **(minimum)**
2. Channel section
3. T section
4. Ordinary section **(maximum)**

Deflection Results:-

Maximum deflection is observed due to combination of Dead loads and Earthquake loads in ordinary concrete section. Minimum deflection is found in channel section composite columns. At same floor deflection is found nearly same. At bottom floor deflection is found minimum and maximum deflection is found at top floor which is quite evident under seismic load. Section arrangement according to minimum to maximum to deflection results.

1. Channel section **(minimum)**
2. Angle section
3. T section
4. Angle section.**(maximum)**

REFERENCES

1]. Bursi, O.S., Caramelli, S., Fabbrocino, G., Molina, J., Salvatore, W., Taucer, F., (2004). 3D Full scale seismic testing of a steel-concrete composite building at ELSA. Contr. No.HPR-CT-1999 00059, European Community.

2]. CNR 10016 (1999).Strutturecomposte di acciaio e calcestruzzoistruzioni per l'impiegonellecostruzioni.CNR BollettinoUfficiale n.192 – Normetecniche (in Italian).

3]. Cosenza, E., Materazzi, A.L. and Nigro, E. (1994): Resistenza al fuoco di colonnecomposteacciaio-calcestruzzo: analisinormativa e confrontiprestazionali con elementi in acciaio e in cementoarmato, CostruzioniMetalliche, 1 (in Italian).

4]. Galambos, T. V., and Chapuis, J. (1980). LRFD Criteria for Composite Columns and Beam-Columns, Revised Draft, Washington University, Dept. of Civil engineering, St. Louis, MO, December.

5]. Giakoumelis, G. and Lam, D. (2003). "Axial Capacity of Circular Concrete-filled Tube Columns," Journal of Constructional Steel Research, 60(7), 1049-1068.

6]. Han, D. J. and Kim, K. S. (1995). "A study on the Strength and Hysteretic Characteristics of Steel Reinforced Concrete Columns," Journal of the Architectural Institute of Korea, 11(4), 183-190.

7]. Han, D. J., Kim P. J. and Kim K. S. (1992). "The Influence of Hoop Bar on the Compressive Strength of Short Steel Reinforced Concrete Columns," Journal of the Architectural Institute of Korea, 12(1), 335-338.

8]. Han, L. and Yao, G. (2000). "Influence of Concrete Compaction on the Strength of Concrete-filled Steel RHS Columns," Journal of Constructional Steel Research, 59(6), 751-767.

9]. Hardika, M. S. and Gardner, N. J. (2004). "Behavior of Concrete-filled Hollow Structural Section Beam Columns to Seismic Shear Displacements," ACI Structural Journal, 101(1), 39-46.

10]. Leon, R. and Aho, M. (2000). "Towards New design Provisions for Composite Columns," Proceeding of the Conference," Composite Construction in Steel and Concrete , 518-527.

11]. Matsui, C., Mitani, I., Kawano, A., Tsuda, K. (1997). "AIJ Design Method for Concrete Filled Steel Tubular Structure," ASCCS Seminar, Innsbruck, 93-115.

12]. Mirza, S., Hyttinen, V. and Hyttinen, E. (1996). "Physical Tests and Analyses of Composite Steel Concrete Beam-Columns," Journal of Structural Engineering, ASCE, 122(11), 1317-1326.

13]. O'Shea, M. D. and Bridge, R. Q. (1997). "Circular Thin-walled Tubes with High Strength Concrete Infill," Proceedings of the Engineering Foundation Conference, ASCE, 780-793.

14]. O'Shea, M. D. and Bridge, R. Q. (2000). "Design of Circular Thin-walled Concrete-filled Steel Tubes," Journal of Structural Engineering, ASCE, 126(11), 1295-1303.

15]. Roeder, C. W., Cameron, B. and Brown, C. B. (1999). "Composite Action in Concrete filled tubes," Journal of Structural Engineering, ASCE, 125(5), 477-484.

16]. Design Basis Report of Bangalore Metro Phase I (2003). Bangalore Metro Rail Corporation Limited. Bangalore.

17]. Detailed Project Report of Bangalore Metro Phase I (2003). Bangalore Metro Rail Corporation Limited. Bangalore.

18]. Dezi, L. (1985). Aspects of the deformation of the cross-section in curved single-cell box beams. Industria Italiana Del Cemento, 55(7–8), 500–808

19]. Dilger, W. H., Ghoneim, G. A., and Tadros, G. S. (1988). Diaphragms in skew box girder bridges. Can. J. Civ. Eng , 15 (5), 869–878.9ku

20]. Fafitis, A., and Rong, A. Y. (1995). Analysis of thin-walled box girders by parallel processing. Thin- Walled Struct. 21(3), 233–240.

21]. FAM, A. R. M. (1973). Static and free-vibration analysis of curved box bridges. Struct. Dyn. Ser. No. 73- 2, Dept. of Civ. Engrg. And Appl. Mech., McGill University, Montreal. Books reference

22]. IRC: 112-2011 Code of Practice for Road Bridges Indian Road Congress, 2008

23]. IRC: 21-2000 Standard Specifications and Code of Practice for Road Bridges Section: III, Cement Concrete (Plain and Reinforced), Indian Road Congress, 2000