Proceedings of 14th IOE Graduate Conference
Peer Reviewed
Year: 2023 Month: December Volume: 14
ISSN: 2350-8914 (Online), 2350-8906 (Print)

Analysis of Steel Concrete Composite Multistorey Building using Different Types of Column Sections

Nitesh Bhandari [a], Bharat Mandal [b], Sanjay Saha [c]

[a, b, c] *Department of Civil Engineering, Pulchowk Campus, IOE, Tribhuvan University, Nepal*
[a] niteshbhandari665@gmail.com

Abstract

A concrete-steel composite column is a compression member, made up of either a concrete encased steel section or a concrete filled steel tube section. Composite column are generally used in load bearing members. This paper mainly focuses on the static analysis of steel concrete composite multistory building with these two types of columns. The models can be created in the ETABS software. The comparative study between these two column types can be done based on the parameters like deflections, internal forces, storey drift ratios, etc.

Keywords

Composite, ETABS, storey drift ratio

1. Introduction

In Nepal, concrete is the common material in the construction. Nowadays due to overcrowding of city areas, the need of high rise buildings has aroused. When building storey increases, RCC structure becomes uneconomic because of the increased dead load, less stiffness, span restriction and hazardous formwork. So for these type of high rise structures steel-concrete composite sections is best suited to replace traditional RCC construction. The steel and concrete work together perfectly as steel is good in tension and concrete is good in compression and they show same thermal expansion coefficient. Also, concrete cover in SRC and filler in CFT prevent the local buckling of steel frame and in turn, steel hollow section provides better concrete confinement. Speed of construction, performance and value are some of the benefits of composite construction over RCC construction.The composite structures are less expensive, lighter and less stiff. Composite columns can be cast in two ways. They are SRC (Steel Reinforced Concrete) and CFT (Concrete Filled Tube).

In composite construction, first steel section are build up which can bear construction loads easily. Concrete is then placed around the steel section, or filled inside the tubular sections. The concrete and steel are adhered in such a manner that the advantages of both the materials are utilized effectively in composite column. Steel are light, which lowers the weight on foundation. Also, the concrete enables the building frame to easily limit the sway and lateral deflections. Composite constructions are rarely used in Nepal. And where used only SRC (steel-reinforced concrete) is commonly used. The CFT (concrete filled steel tubes) are not used generally due to unavailability of different shape and sizes of steel tube in market. For large columns tube sections are to be custom made. But there are some advantages of CFT over SRC like fire protection, corrosion resistance, reduced formworks, etc. So in this thesis I intend to compare the structural characteristics of high rise composite buildings using these two types of columns.

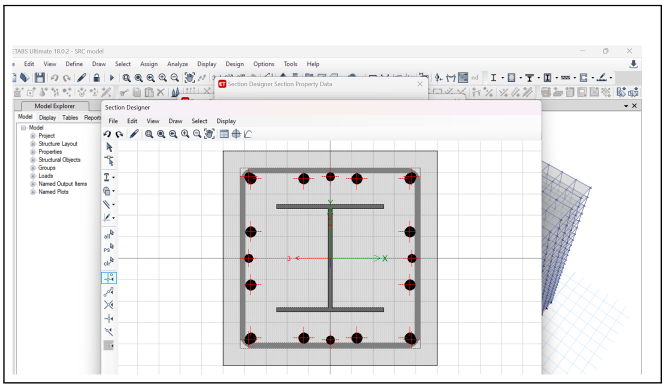

Figure 1: Figure 1. Concrete section with embedded steel section

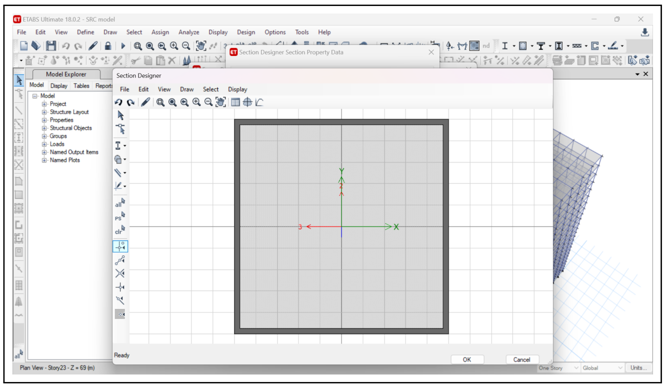

Figure 2: Figure 2.Hollow steel section with concrete infill.

2. Objectives

- To compare the structural performance of two types of high rise buildings using parameters like storey displacement, storey drift ratios and time period.
- To compare composite structure with RCC using various parameters in low rise buildings.

3. Literature Review

Toshiaki Fujimoto, et.al. performed the beam column connection in composite construction[1]. Since our paper discusses about composite column only, through column connection is used.

Enrico Spacone, et.al. carried non linear analysis in composite building.[2].

Minae Fukuhara, et.al. performed analysis of composite structure in different manner. They mixed the characterstics of both CFT and SRC in their analysis[3].

Lin-Hai Han, at.al. performed investigation in behavior of thin-walled steel tube confined concrete column to RC beam joints. They permormed this analysis under cyclic loading[4].

Walter Luiz Andrade de Oliveira, et.al. studied about the passive confinement in CFT columns[5].

Dr. S. C. Patodi, et.al. worked on seismic performance of multistorey composite building[6].

Ikhlas S. Sheet,et.al studied steel beam to CFT column connection under cyclic loading experimentally.[7].

Marcela N. Kataoka, et.al. performed parametric study of composite beam-column connections. They used 3D finite element modeling[8].

Qing-Jun Chen, et.al studied about the through beam connection between CFT column and RCC beam[9].

Shweta A. Wagh, et.al performed comparision between R.C.C and Steel Concrete Composite Structures[10].

Prof. S. S. Charantimath, et.al. worked on seismic performance of both R.C.C and composite building[11].

Mark D. Denavit, et.al. worked on the design of composite structures. They also permormed the stability analysis of composite Structures[12].

K. Mukesh Kumar, et.al. also compared RCC with composite structure using seismic analysis[13].

W. Li, at.al. performed seismic analysis of CFT column putting Boxed I-shaped section[14].

Jianguo Nie, at.al. studiedabout the development and application of composite structures[15].

Dr. Rajan Suwal, et.al. worked on the seismic behaviour of composite buildings. They considered both half and full composite section[16]. In this paper we are performing half composite section. Full composite section are those where beams are also made up of composite materials.

Keshab Singh Badal, et.al. compared the performance of RCC and composite high rise building in earthquake zone V[17].

4. Modeling

Same plan, as shown in Figure 3 is used for all types of buildings.

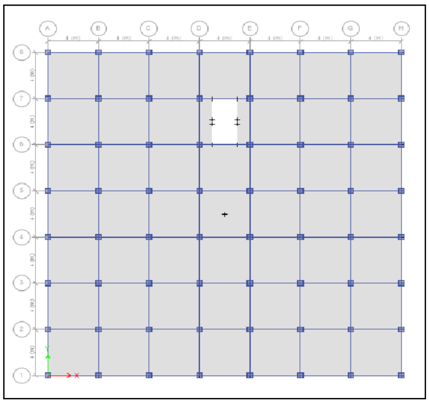

Figure 3: Figure 3.Plan view of building

5. Results

After performing static analysis of building in ETABS software following results were obtained.

Table 1: Table for Max Storey Displacement in RCC

Type	Storey	Direction	Max Storey Displacement
RCC	5	x	45.129
RCC	5	y	42.244
RCC	10	x	79.594
RCC	10	y	76.191
RCC	15	x	89.93
RCC	15	y	82.354

Table 2: Table for Max Storey Drift Ratios in RCC

Type	Storey	Direction	Max Storey Drift Ratios
RCC	5	x	0.003871
RCC	5	y	0.003612
RCC	10	x	0.003511
RCC	10	y	0.003341
RCC	15	x	0.003261
RCC	15	y	0.003074

Table 3: Table for Time Period in RCC

Type	Storey	Direction	Time Period
RCC	5	x	1.124
RCC	5	y	1.062
RCC	10	x	1.762
RCC	10	y	1.593
RCC	15	x	2.47
RCC	15	y	2.38

Table 4: Table for Max Storey Displacement in SRC

Type	Storey	Direction	Max Storey Displacement
SRC	5	x	56.899
SRC	5	y	52.627
SRC	10	x	88.418
SRC	10	y	87.712
SRC	15	x	124.64
SRC	15	y	119.89

Table 5: Table for Max Storey Drift Ratios in SRC

Type	Storey	Direction	Max Storey Drift Ratios
SRC	5	x	0.004799
SRC	5	y	0.004378
SRC	10	x	0.003845
SRC	10	y	0.003642
SRC	15	x	0.003615
SRC	15	y	0.003437

Table 6: Table for Time Period in SRC

Type	Storey	Direction	Time Period
SRC	5	x	1.45
SRC	5	y	1.336
SRC	10	x	2.112
SRC	10	y	2.05
SRC	15	x	2.645
SRC	15	y	2.62

Table 7: Table for Max Storey Displacement in CFT

Type	Storey	Direction	Max Storey Displacement
CFT	5	x	45.36
CFT	5	y	42.307
CFT	10	x	78.305
CFT	10	y	74.887
CFT	15	x	97.427
CFT	15	y	92.876

Table 8: Table for Max Storey Drift Ratios in CFT

Type	Storey	Direction	Max Storey Drift Ratios
CFT	5	x	0.003887
CFT	5	y	0.003613
CFT	10	x	0.003456
CFT	10	y	0.003286
CFT	15	x	0.00287
CFT	15	y	0.00272

Table 9: Table for Time Period in CFT

Type	Storey	Direction	Time Period
CFT	5	x	1.132
CFT	5	y	1.067
CFT	10	x	1.853
CFT	10	y	1.798
CFT	15	x	2.439
CFT	15	y	2.407

6. Conclusion

From the calculation done it can be said that CFT is better than SRC and composite section is better than RCC in high rise buildings.Since time period is lesser in CFT than SRC we can say that CFT is lighter than SRC. Also storey drift ratios are lower in CFT. So we can conclude that CFT is overall better than SRC structurally after static and LTHA.

References

[1] Toshiaki Fujimoto, Eiichi Inai, Makoto Kai, Koji Mori, Osamu Mori, and Isao Nishiyama. Behavior of beam-to-column connection of cft column system. 2000.

[2] Enrico Spacone and Sherif El-Tawil. Nonlinear analysis of steel-concrete composite structures: State of the art. 2004.

[3] Minae Fukuhara and Koichi Minami. Seismic performance of new type steel-concrete composite structures considering characteristic both src and cft structures. 2008.

[4] Lin-Hai Han, Hui Qu Zhong, Zhong Tao, and Zai-Feng Wang. Experimental behaviour of thin-walled steel tube confined concrete column to rc beam joints under cyclic loading. 2009.

[5] Walter Luiz de OlAndradeiveria, Silvana De Nardim, Ana Lucia H. de Cresce El Debs, and Mounir Khalil El Debs. Evaluation of passive confinement in cft columns. 2010.

[6] S. C. Patodi and D. R. Panchal. Seismic performance of a typical b+g+9 multi-storey building, steel-concrete composite and r.c.c. options. 2010.

[7] Ikhlas S. Sheet, Umarani Gunasekaran, and Gregory A. MacRae. Experimental investigation of cft column to steel beam connections under cyclic loading. 2013.

[8] Marcela N. Kataoka and Lucia H.C. El Debs. Parametric study of composite beam-column connections using 3d finite element modeling. 2014.

[9] Qing-Jun Chen, Jian Cai, Marc A. Bradford, Xinpei Liu, and Zhi-Liang Zuo. Seismic behaviour of a through-beam connection between concrete-filled steel tubular columns and reinforced concrete beams. 2014.

[10] Shweta A. Wagh and U. P. Waghe. Comparative study of r.c.c and steel concrete composite structures. 2014.

[11] S. S. Charantimath, Swapnil B. Cholekar, and Manjunath M. Birje. Seismic performance evaluation of r.c.c and composite building. 2014.

[12] Mark D. Denavit, Jerome F. Hajjar, Tiziano Perea, and Roberto T. Leon. Stability analysis and design of composite structures. 2015.

[13] K. Mukesh Kumar and H. Sudarsana Rao. Seismic analysis of steel concrete composite system and its contrast with rcc structures. 2016.

[14] W. Li and T. Inada. seismic performance of cft column with boxed i-shaped section. 2017.

[15] Jianguo Nie, Jiaji Wang, Shuangke Gou, Yaoyu Zhu, and Jiansheng Fan. Technological development and engineering applications of novel steel-concrete composite structures. 2018.

[16] Rajan Suwal and Sunita Dahal. Seismic behavior analysis of composite buildings with respect to rcc buildings. 2019.

[17] Hari Darsan Shrestha and Keshav Singh Badal. Comparative study of rcc and steel-concrete composite structure under time history analysis. 2020.