Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 52(11) (2021) 705-706
DOI: 10.22060/ceej.2019.16429.6241

Investigation the behavior of concrete-covered steel columns and retrofitting it with carbon polymer fibers under simultaneous axial loading and reciprocating lateral loading

S. O. Hosseini[1], S. Hosseinaei[1], M. Ghasemi[2*]

[1]Ph.D. Candidate of Structural Engineering, University of Sistan And Balouchestan, Faculty of Civil Engineering
[2]Assistant Professor, University of Velayat, Faculty of Civil Engineering

ABSTRACT: The application of composite sections in recent years is increasing because of its great advantages in advanced countries.The purpose of this study is to investigate the effective parameters on loading capacity of steel columns covered with concrete under the simultaneous impact of axial and cyclic lateral loading, including steel compound shape, concrete strength and retrofit with carbon polymer fibers. The use of a concrete-covered steel column in comparison to a single steel column or reinforced concrete column will increase the capacity of the final capacity significantly. In other words, composite columns have a very high load capacity. for this purpose, in order to study the behavior of steel columns covered with concrete under the simultaneous effect of axial and cyclic lateral loading, After validating the modeling in abaqus finite element software, the behavior of these columns in different cases of steel composite section, 28 day compressive resistance of a different concrete, and impact of retrofitting with carbon polymer fibers on ultimate capacity, is investigated. The results show that the parameters such as the shape and dimensions of section of steel column, the 28 - day compressive resistance of a different concrete and retrofitting with carbon polymer fibers have a significant effect on increasing or decreasing the ultimate capacity of these columns.

Review History:
Received: 2019-06-02
Revised: 2019-07-17
Accepted: 2019-08-09
Available Online: 2019-08-25

Keywords:
Steel column covered with concrete
Axial loading
Cyclic lateral loading
Retrofitting
Capacity

1- INTRODUCTION

Composition of steel and concrete cross sections, makes such columns have a higher capacity than steel and concrete columns and recently, it has attracted the attention of many researchers [1]. In covered - concrete steel composite columns Concrete enclosure is provided by steel sections and reinforcing bars. Flexural behavior of a trapped member, Until maximum resistance is achieved, It's like the behavior of a reinforced concrete member, But it has higher plasticity, Because if the ratios of wide- Thickness of steel sheets- small enough, Steel can also resist after crushing concrete. But for shear strength of a trapped member, some kind of ductile behavior is observed, Even if its failure is shear. The ductility of an enclosed member is due to the interaction between concrete, steel and concrete between steel wings, Which can withstand large strains as a result of the wing locking action. Due to the high strength and deformability and high energy absorption capacity of steel covered steel columns, time consuming and costly to conduct laboratory studies, in this study, it is necessary to investigate numerically and application of concrete covered steel columns with Abaqus finite element software.

2- PROBLEM STATEMENT AND DESCRIPTION OF MODELING

Variable parameters in this study include 28-days compressive strength of concrete, shape of steel cross section and how to resist carbon fiber. A study by Zhu et al., 2016, was used to confirm modeling in abaqus [3] finite element software. The specimens selected from the study are rectangular in size with a concrete cross-sectional area of 200 × 200 mm and a net column length of 700 mm. Also, reinforced concrete cross section has 12 longitudinal reinforcement No. 10 and shear reinforcement No. 6 at 50 mm intervals. The arrangement of the longitudinal and transverse reinforcement, the location of the steel cross-section and the location of loading are illustrated in Fig. 2. This sample is named as the N2 - + - M50 and N2-I-M50 in vitro study [2]. The number 2 indicates the axial load value, which in states 1, 2 and 3, is 0.25% Ag fc, 0.38% and 0.45% , respectively. I and H denote the I and H shape steel crosses, respectively, in cross-sectional specimens the shape is + and the M50 represents rectangular transverse reinforcements combined with 8-sided spacing 50 mm apart.

3- INVESTIGATION OF THE EFFECT OF CONCRETE STRENGTH ON THE FINAL CAPACITY OF SAMPLE N2 - + - M5:

In order to investigate the effect of concrete strength on the final capacity of N2 - + - M50 covered concrete steel column specimens, Concrete with numerical strengths of 30, 50, 70 and 90 MPa was evaluated and the results of numerical analysis were compared with N2 - + - M50 column sample

*Corresponding author's email: m.ghasemi@velayat.ac.ir

with 28 days compressive strength of 105.4 MPa. The results shows that the ultimate strength and hardness of the samples increased with increasing concrete strength. Given that the load applied to the structure is reciprocal, the displacement charge diagram is hysteresis. Hysteresis graphs because they are load-displacement, the higher the area below the hysteresis graph, the more energy the structure absorbs, thus, the degree of structural flexibility is greater. In the hysteresis chart, the symmetry shows that the behavior of tension and strain is the same. The thinner the member, the lower the diagram, and it breaks down in fewer cycles. Also, the more hysteresis graph has more symmetry, That is, the more symmetrical the cochlea is, and the better it will perform against the earthquake. As can be seen, with the increase in concrete strength, the area under the hysteresis diagram has increased. And this indicates that as the strength increases, the concrete becomes more formable and the energy that structure absorbs is greater.

4- THE EFFECT OF DIMENSIONS OF CROSS –SHAPED STEEL

To investigate the dimensions of steel cross section in addition to cross-shaped section steel column with dimensions mentioned in the article, Cross-section steel column consisting of two cross-sections I of perpendicular shape ((In the case of the geometric dimension of cross section I shape, is 9.6 × 6.5 × 68 × 100 mm, In other words, with a 2 mm increase in die life and steel cross wings) Two cross-sections I form perpendicular (The latter has the same area as a single I-shaped cross section) The H-shaped cross section with dimensions of 100. 6× 8 ×6 × 100 mm was also evaluated. It should be noted that the area of the H-shaped cross is approximately equal to the cross-sectional area of the N2 - + - M50 sample. The sample name is N2 - + - M50-1 in the first case and N2 - + - M50-2 in the second case and N2-H-M50 in the third case. The results of comparison of final load and final load ratio of N2 - + - M50, N2 - + - M50-1 and N2 - + - M50-2 and N2-H-M50 samples compared to N2 - + - M50 samples, are explained more in results section.

5- INVESTIGATION THE EFFECT OF CARBON FIBER REINFORCEMENT ON THE FINAL CAPACITY OF SAMPLE N2 - + - M50

5-1 Investigation the behavior of reinforced specimens

Column cracking occurs from the foot of the column holder and continues toward the free end of the column. This means that the column breakdown is at the foot of the column and can increase the final capacity of the sample by carbon fiber reinforcement of the column foot. This section deals with column reinforcement with carbon polymer fibers. The results shows that using carbon fibers which are perfect spiral is much more effective than using band carbon fibers.

6- SUMMARY AND CONCLUSION

The report is based on numerical research conducted with Abaqus Finite Element Software on square-section concrete-covered steel columns. The purpose of this study was to analyze the behavior and properties of concrete-covered columns under the influence of axial force and lateral cyclic loading. To accomplish the above objectives, after validation of the concrete-covered steel column in the abaqus finite element software with laboratory model, 16 square-section concrete-covered steel column specimens were analyzed with abaqus finite element software. In order to investigate the effect of concrete strength, the analysis results show that in low strength concrete which has been affected by the combination of axial load and cyclic lateral load, the final sample capacity has decreased significantly. So that in a sample with a 28-day compressive strength of 30 MPa compared to the N2 M50, the final capacity decreased by about 52%. In order to investigate the effect of steel cross-section dimensions, the cross-section steel is first cross-sectioned with a 2 mm increase in wing thickness and steel cross-section (sample N2 M50 1), the latter having the same area as a single cross-section I (Sample N2 M50 2) and steel cross section H (sample N2 H M50) were investigated. The analysis results show that the final capacity of N2 - + - M50-1 sample has a relatively moderate increase compared to N2 - + - M50 sample. Also, the final capacity of N2 - + - M50-2 sample was moderately reduced compared to N2 - + - M50 sample. The H-shaped sample mentioned above has a relatively slight increase over the N2 M50 section. In other words, the effect of these two sections on the bending state around the strong axis of the H-section is approximately equal. The final capacity of N2 M50 1, N2 M50 2 and N2 H M50 (in off mode) increased by 12%, decreased by 15.5%, and increased by 3.4%, respectively, compared to the N2 M50. In the case of retrofitting, the most effective mode of carbon fiber reinforcement is in perfect spiral, and throughout the column. But the difference in the final load in the full-threaded state and across the full-threaded column with a width of 300 mm at the foot of the fiber in the fiber state is a small layer (26.75 kN) and in the case of fibers it is in the form of two layers of medium (66.5 kN).

REFERENCES

[1] M.F. Belal, H.M. Mohamed, S.A. Morad, Behavior of reinforced concrete columns strengthened by steel jacket, HBRC Journal, 11(2) (2015) 201-212.

[2] W. Zhu, J. Jia, J. Gao, F. Zhang, Experimental study on steel reinforced high-strength concrete columns under cyclic lateral force and constant axial load, Engineering Structures, 125 (2016) 191-204.

[3] C. ABAQUS, Analysis user's manual, in, Version, 2017.

HOW TO CITE THIS ARTICLE

S.O. Hosseini, S. Hosseinaei, M. Ghasemi, Investigation the behavior of concrete-covered steel columns and retrofitting it with carbon polymer fibers under simultaneous axial loading and reciprocating lateral loading, Amirkabir J. Civil Eng., 52(11) (2021) 705-706.

DOI: 10.22060/ceej.2019.16429.6241