CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 General

In this study both experimental and numerical investigation were conducted to study the behavior and load carrying capacity of concrete filled stainless steel tubular (CFSST) column. For experimental study, total twenty-four (24) CFSST columns including six (6) hollow specimens were prepared to examine the behavior, load carrying capacity and failure characteristics and compared with the numerical analysis with the same geometrical and mechanical properties. During this study experimental results of recently published data also used to compare the numerically simulated CFSST columns of same geometrical and mechanical properties. Both the experimental results (current-experimental and Tao et al 2011 experimental) were very close to the FE analysis thereby numerical results (load carrying capacity, behaviour and failure modes) were well validated.

During analysis of the column, nonlinear finite element (FE) models have been developed, material nonlinearities of high strength stainless steel tubes and confined concrete have been carefully considered. The column strengths, deformed shapes and axial shortening behavior of the columns have been predicted using the FE model.

Extensive parametric study is conducted with the particular section for evaluation, define the parameter range, specify the design constraints, and analyze the results of each parameter variation. Total three hundred twenty-six (326) no's of 450 mm x 450 mm CFSST columns were simulated for parametric study with varying geometric and material properties subjected to concentric and eccentric load. In the numerical analysis, results were obtained from 3D nonlinear finite element analysis using ABAQUS finite element software. The geometric variables were percentage of depth to thickness (D/t) ratio ranging from 30 to 90, column slenderness (L/D) ratio ranging from 3 to 20 and eccentricity (e/D) ratio ranging from 0.05 to 0.25. The material variables were concrete strength (30

MPa, 45 MPa, 60 MPa, 80 MPa, 100 MPa and 120 MPa) and proof strength of stainless steel (448 MPa, 497 MPa, 536 MPa, 622 MPa and 707 MPa) in CFSST columns. Concrete compressive strength 30 MPa, 45 MPa were considered as normal strength, 60 MPa, 80 MPa were considered as medium strength and 100 MPa and 120 MPa were considered as high strength concrete. On the other hand, yield strength of steel 448 MPa, 496 MPa were considered as normal strength, 536 MPa medium strength and 622 MPa and 707 MPa were considered as high strength of stain-less steel. Finally, the load capacities obtained from numerical studies were compared with the predicted values using the guidelines given by the AISC-LRFD 2010 for concentric and eccentric axial load with various strength of materials.

7.2 Conclusions

Experimental data from self-study as well as recently published study were numerically simulated and compared with experimental results and modes of failure. The experimental and numerical specimens were rectangle, square and circular in sizes with same steel thickness, slenderness ratio and steel strength consisting of various concrete compressive strength to validate the FE models. Within the limited range of experimental study and wide range of parametric analysis the following conclusions can be drawn based on the whole this study:

a. Experimental and Numerical study

   i. In experimental study the axial compressive strength of stainless-steel tube without concrete infilled (hollow) is considerably less than that of CFSST columns.

   ii. Numerical models can predict the experimental behaviour of CFSST columns under concentric gravity loads with the accuracy of 0.996 for peak load.

   iii. The code (AISC-LRFD 2010) predicted capacity is 6-10% conservatives than numerical and experimental capacity.

b. A detailed parametric analysis was performed to study the behaviour of CFSST columns subjected to concentric and eccentric axial loads. The influences were observed with respect to the peak axial load, failure mode and overall column load deformation responses. The findings of the study are presented below:

i. Axial capacity of CFSST column increased by 30%, 63%, 108%, 151% and 184% for concrete strength 30 MPa to 45, 60, 80, 100 and 120 MPa respectively with steel grade of 448 MPa.

ii. Axial capacity of CFSST column increased by 26%, 55%, 87%, 130% and 169% for concrete strength 30 MPa to 45, 60, 80, 100 and 120 MPa respectively with steel grade of 707 MPa.

iii. Axial capacity of CFSST columns increased by 3%, 7%, 10% and 16% for steel strength 448 MPa to 497, 536, 622 and 707 MPa respectively with concrete strength 30 MPa.

iv. The axial capacity of CFST columns increased by 6%, 12%, 14% and 17% for steel strength 448 MPa to 497, 536, 622 and 707 MPa with concrete strength 120 MPa.

v. Axial capacity of CFSST column increased (f'_c = 30MPa) by 11%, 41%, and 96% when the eccentricity (D/t) ratio decreased from 90 to 75, 50 and 30 respectively. In fact, percentage of incremental rate of column capacity is decreasing with the increment of D/t ratio

vi. Axial capacity of CFSST column decreased by 11%, 20%, 27% and 36% when the eccentricity (e/D) ratio increased from 0 to 0.05, 0.10, 0.15 and 0.20, respectively. Higher eccentricity (e/D) ratio reduced the load capacity significantly.

vii. Axial capacity of CFSST column decreased by 2%, 4%, 12%, 21% and 35% when the slenderness (L/D) ratio increased from 3 to 5, 7, 10, 15 and 15, respectively. Higher slenderness (L/D) ratio also reduced the load capacity significantly

viii. Based on the overall studies the compressive resistance for the square CFSST column can be expressed as the co-relation of $P_0 = A_s\sigma_{0.2} + (D/t)^{-0.014} A_c f'_c$.

7.3 Recommendations for Future Research

The following recommendations are made for future investigations.

a. The current numerical model was developed for monotonic loading conditions only. Effects of cyclic loadings may be addressed in future research work.

b. Similar study can be carried out for concrete filled stainless steel frame structure like strut, ties, bracing members etc. and their combinations.

c. More similar study can be carried out on CFSST to establish design rules for axial and bending capacity as well as combined effect of bi-axial moment.

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