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Study of Square Cross Section Concrete Filled Tabular Columns Under Axial Loading

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ABSTRACT —

Despite the excellent engineering properties of Concrete Filled Tubes (CFT), they are not as widely used as traditional steel and concrete members. The aim of this study was to predict the load carrying capacity of concrete-filled steel square structural section for various L/D ratios (8, 10,12,14,16 and 18).An analytical study (ANSYS) was done to compare with the theoretical results (Euro code4), the test were carried out on the steel tubes under axial compression. In this report, tie bars are provided by welding inside the steel tube. Axial compression test is carried out on the test specimens (Hollow, CFT and CFT with tie bars) and the behavior of increase in axial load-carrying capacity was studied. Tie bars were effective to limit the lateral deformation of the core concrete and the steel tube at the location of tie caps when properly combined, steel and concrete can produce synergetic savings in initial and life-cycle costs. This study is mainly focused to increase the composite action of CFT columns by introducing the tie bars. While comparing the load carrying capacity of the CFT columns, the CFT columns with tie bars shown effective and greater results. This is due to the fact that tie bars provided in CFT increased the bond strength and the composite action was enhanced, thereby the load carrying capacity was increased.

Keywords — Column, Concrete, Axial Loading

INTRODUCTION

Composite construction may be considered as a reliable choice of attaining proper requirement between its advantages and the cost. An extensive variety of composite columns and beams are available nowadays, the Concrete Filled Steel Tubular (CFT) columns are most commonly used one. Their structural benefits such as reduced cross section, high strength, improved fire resistance, greater apparent stiffness and excellent seismic resistant structural properties like high ductility and energy absorption, the use of CFT beams and columns has become increasingly popular in construction of building structures. Furthermore, the steel tube of CFT member can serve as formwork during infilling of concrete.CFT member is a hollow tubular member is filled with concrete, used as beams or columns that are appropriate replacement for hot-rolled steel (or) reinforced concrete (RC) members in structural systems of all tall buildings and bridges. This composite system utilizes the compressive strength of the concrete and the steel tube lies in the outer limits contributes a large portion of the stiffness and tensile strength, in addition, it provides required confinement to the concrete core, which increases the compressive strength of the column member. In compression, CFT short column reaches their ultimate capacity when both the steel and the concrete reach their strength limit point, i.e., yielding of the steel and crushing of the concrete and the CFT slender columns are governed by its strength and stability and failed by either elastic or inelastic column buckling. The contribution of the concrete to moment of resistance occurs due to the movement of the neutral axis of the cross section towards the compression face of the beam with the addition of concrete.

LITERATURE REVIEWS

A.S. Shakir, Z.W. Guan, S.W. Jones (2014) This paper presents a three dimensional nonlinear finite element analysis for Concrete Filled Steel Tube (CFST) columns subjected to lateral impact load. The finite element models were developed using commercial code ABAQUS/Explicit, which were validated against the experimental results. The study has been carried out to examine the influence of several parameters such as the length of the tube and projectile configurations the numerical analysis of CFST columns under lateral impact loading. The concrete was molded using an equivalent stress-strain curve for the confined concrete while the steel tube was molded as elastic-perfectly plastic material. The predicted impact force, local displacement and the failure mode using the finite element analysis were compared with those evaluated from the experimental tests of the CFST columns. The comparison between the numerical experimental and finite element results showed a very good agreement for both the force-displacement curves and the deformed shape

J.F. Dong , Q.Y. Wang , Z.W. Guan(2013)[3]This paper presents experimental research on structural behavior of normal and recycled aggregate concrete filled steel tube (RACFT) columns externally strengthened with carbon fibre reinforced polymer (CFRP) sheets and subjected to axial loading. A total of

22 specimens were tested to investigate the influence of the following variables: (1) tube configurations, circular or square, solid or hollow; (2) types of concrete, normal or recycled aggregate concrete; and (3) strengthening arrangements, full wrapping or partial wrapping. The results show that the recycled aggregate concrete may degrade the concrete strength during the curing period for the first 28 days. In addition, theoretical calculations of the bearing capacity of the composite columns are presented and compared with the experimental results.

N. Jamaluddin, D. Lam, X.H. Dai , J. Ye (2013)[6] This paper presents the experimental results and observation of elliptical Concrete Filled Tube (CFT) columns subjected to axial compressive load. A total of twenty-six elliptical CFT specimens including both stub and slender composite columns are tested to failure to investigate the axial compressive behavior. Various column lengths, sectional sizes and infill concrete strength are used to quantify the influence of member geometry and constituent material properties on the structural behavior of elliptical CFT columns. As there is no design guidance currently available in any Code of Practice, this study provides a review of the current design rules for concrete filled circular hollow sections in Euro code 4 (EC4). New equations basedon the Euro code 4 provisions for concrete filled circular hollow sections were proposed and used to predict the capacities of elliptical CFT columns.

CONCRETE FILLED TABULAR COLUMN

Concrete filled tabular columns are clearly intermediate between steel and reinforced concrete columns. However, the design philosophy for each of these two structural members is fundamentally different. Steel columns are treated as concentric in that they are loaded through their centroids, but with the allowances being made for residual stresses. The basis of the design of the steel column is instability or buckling and any moments which act at the ends of the column are preceded by reducing the axial load by way of an interaction equation.

TESTING OF STEEL

Imperfection factor α for the buckling curves

European buckling	A	B	C
Imperfection Factor α	0.21	0.34	0.49

ANSYS ANALYSIS

ANSYS is a general-purpose finite-element modelling package for numerically solving a wide variety of mechanical and structural problems. These problems include static and dynamic, structural analysis (both linear and nonlinear), heat transfer, and fluid problems, as well as acoustic and electromagnetic problems. The mechanical and thermal buckling have been analysed using a finite element (FE) model in ANSYS. In general, a finite-element solution may be broken into the following three stages. Pre-processing: Defining the problem.

The major steps in pre-processing stage are (i) define key points, lines, areas, and volumes, (ii) define element type and material, geometric properties, and (iii) mesh lines, areas, and volumes as required. The amount of detail required will depend on the dimensionality of the analysis, that is, 1D, 2D, axisymmetric, and 3D. Solution: Assigning loads, constraints, and solving Here, it is necessary to specify the loads (point or pressure), constraints (translational and rotational), and finally solve the resulting set of equations. Post processing: Further processing and viewing of the results

RESULTS

This section compares the results from the ANSYS with the theoretical result. The following results are obtained from ANSYS for all the tested specimens.

- Lateral deflection

- Failure load

The failure load for CFT, CFT with tie bars and hollow columns are obtained from ANSYS for both sections and are compared with the theoretical result.

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