A Boundary Condition to Exclude Chord Length’s Effect on Axial Compressive T-joints

Lei Zhu1, Ying Gao2
1. School of Civil and Transportation Engineering, Beijing Higher Institution Engineering Research Center of Structural Engineering and New Materials, Beijing University of Civil Engineering and Architecture, Beijing, China
2. College of Materials Science and Technology, Beijing Forestry University, Beijing, China

ABSTRACT

A new boundary condition is proposed in this paper to simulate the axially compressive loading case of the circular hollow section (CHS) T-joint. The chord ends are retrained in radial directions but free in axial direction. The chord bottom line is restrained in the brace axial direction. The brace end is restrained in radial direction. The finite element model of the T-joint is established by ANSYS. To verify the numerical method, the axial compressive strengths of 13 T-joints are calculated and compared with the experiments. A good agreement between the numerical and experimental results is achieved. Then a comprehensive numerical parametric analysis is carried out to evaluate the effect of this boundary condition on the axial compressive strength of T-joints. Four $\beta$ (the brace/chord diameter ratio, 0.2, 0.4, 0.6, 0.8) values and four $\gamma$ values (the chord diameter to thickness ratio, 18.75, 25, 37.5, 50), i.e., 16 T-joints are investigated. Five $\alpha$ (ratio of chord length to radius, 12, 18, 24, 30, 36) values are considered. The finite element results show that the axial strength of each T-joint changes with $\alpha$ very slightly. Therefore this boundary condition is effective to exclude the effect of the chord length on the axial compressive strength of T-joints.

KEY WORDS: Tubular joint; circular hollow section; T-joint; finite element analysis; chord length; boundary condition.

NOMENCLATURE

- $a$: weld width
- $b$: weld height
- $d_1$: brace diameter
- $d_0$: chord diameter
- $l_0$: chord length
- $l_1$: brace length
- $t_0$: chord wall thickness
- $t_1$: brace wall thickness
- $\alpha$: ratio of chord length to radius $2l_0/d_0$
- $\beta$: ratio of brace to chord diameter $d_1/d_0$
- $\gamma$: ratio of chord diameter to twice of chord thickness $d_0/(2t_0)$
- $\tau$: ratio of brace thickness to chord thickness $t_1/t_0$
- $E$: Young’s modulus of elasticity
- $f_y0$: yield stress of chord
- $f_y1$: yield stress of brace
- $F_{u,test}$: ultimate strength obtained from test
- $F_{u,num}$: ultimate strength obtained from numerical analysis

INTRODUCTION

Circular hollow section (CHS) T-joints widely exist in offshore oil platforms. Many researchers have investigated the axial ultimate strength of T-joints through experimental and finite element method. Scola et al. (1990) carried out a test program of 5 circular tubular T-joints subjected by brace axial compressive force. The chord length of each specimen was $2d_0+d_1$ and the chord ends were simply supported with an interior plate at each side. By comparing Scola’s results with other experimental and numerical data, Vegte et al. (2010) found