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Joints Between Plates or I Sections and a Circular Hollow Section Chord

J. Wardenier*
Delft University of Technology, Delft, The Netherlands, and
National University of Singapore, Singapore

G.J. van der Vegte
Delft University of Technology, Delft, The Netherlands

Y. Makino
Kumamoto University, Kumamoto, Japan

Recently the International Institute of Welding's Sub-commission IIW-XV-E drafted new design recommendations for hollow section joints. The joint strength equations for circular hollow section (CHS) joints in these new recommendations are the result of extensive re-analyses. This paper deals with design recommendations for uniplanar T and X joints between plates or I section braces and a CHS chord. While these new design recommendations are directly related to those for CHS joints, small modifications are used in the constants to bring the equations in line with the available test data. The design recommendations for joints loaded by in-plane or out-of-plane bending are related to those for axial loading by simple factors. This paper further shows that considerable differences exist between the results of the various test data, and additional numerical investigations are recommended to solve these contradictions.

NOMENCLATURE

CHS	circular hollow section
FE	finite element
RHS	rectangular hollow section
C_1	exponent in chord stress function
$M_{el,0}$	chord elastic moment resistance for class 3 sections
$M_{pl,0}$	chord plastic moment resistance for class 1 and 2 sections
M_0	bending moment applied to chord
$N_{pl,0}$	chord plastic axial load resistance
$N_{u,k}$	characteristic axial load resistance
N_0	chord axial load
N_1	axial brace load
Q_f	chord stress function
Q_u	function $f(\beta, \gamma, \eta)$ in design strength equations
W_{el}	elastic section modulus (ip = in-plane; op = out-of-plane)
b_1	external width of brace
c_{ip}	coefficient for in-plane bending moment capacity
c_{op}	coefficient for out-of-plane bending moment capacity
d_0	external diameter of chord
f_{y0}	yield strength of chord
h_1	external height of brace
n	nondimensional chord stress ratio
t_0	wall thickness of chord
t_1	wall thickness of brace
β	width ratio between brace and chord
γ	half diameter to thickness ratio of chord, $\gamma = d_0/2t_0$
γ_m	partial factor
η	brace height to chord diameter ratio h_1/d_0
θ_1	angle between brace member and chord

*ISOPE Member.

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KEY WORDS: Plate to CHS joints, tubular joints, static strength.

INTRODUCTION

Recently the International Institute of Welding's Sub-commission IIW-XV-E updated the design recommendations for hollow section joints, designated as IIW (2008). The joint capacity equations for CHS joints in these new recommendations are the result of extensive re-analyses discussed in van der Vegte et al. (2008), Wardenier et al. (2008) and Zhao et al. (2008).

One of the main differences from the previous IIW (1989) design recommendations is that in the new IIW (2008) recommendations, the influence function for the chord stress effect on the joint capacity is based on the maximum chord stress instead of a so-called prestress, i.e. based on the chord loading excluding the effect of the brace loading components. This required a full re-analysis of data, including numerical data. Further, for tension-loaded chords, a strength reduction due to chord stress is included while this was not the case in the 1989 recommendations.

The 2008 recommendations also include strength formulae for plate and I to CHS chord joints, which are the subject of this paper.

CLASSIFICATION OF JOINTS

Table 1 shows the classification of plate and I to CHS chord joints. The classification is similar to that used by Kurobane (1981), Makino et al. (1991), Wardenier (1982) and Wardenier et al. (1991).

BACKGROUND

Kurobane (1981) was the first researcher to collect CHS and XP/TP joint strength data in a systematic way. Based on his data and analysis, followed by the re-analysis by Wardenier (1982), the joint strength equations for CHS joints in the IIW (1989) recommendations were developed. Later re-analyses by the first author, which were confirmed by the research results of Makino et al. (1991), formed the basis for the recommendations for plate