

The Static Strength of Uniplanar Tubular Steel X-Joints Reinforced by a Can

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ABSTRACT

Nineteen finite element analyses are carried out in order to investigate the influence of the can length on the static strength of compression loaded uniplanar X-joints. The influence of the can length on the static strength is shown. The ultimate load values obtained from the numerical analyses are compared with the IIW, API and the AWS formulae. It appears that, for uniplanar X-joints with β -values below 1.0, the API gives minimum required can lengths which are too small, resulting in unsafe design strengths. The AWS gives a good approximation for the reduction in joint strength with reduction in can length.

NOMENCLATURE

- d_0 : outer diameter of chord
 t_0 : wall thickness of chord
 t_{can} : wall thickness of can
 d_1 : outer diameter of braces
 $f_{y,0}$: yield stress of chord member
 $f_{u,0}$: ultimate tensile stress of chord member
 l_0 : length of chord
 l_{can} : can length
 t_1 : wall thickness of braces
 F_u : ultimate axial force on braces
 α : geometric chord length parameter $2^*l_0/d_0$
 β : diameter ratio d_1/d_0
 γ : chord radius to thickness ratio $d_0/2^*t_0$
 τ : wall thickness ratio t_1/t_0

computer programme MARC has been used for the numerical work. The numerically determined ultimate loads are compared with the values recommended by API (1987), AWS (1988), IIW (1989) and Kurobane (1980, 1981).

RESEARCH PROGRAMME

The research programme is summarized in Table 1. The configuration of the X-joints is shown in Fig. 1. The study consists of 19 finite element analyses on tubular X-joints subjected to compressive brace loading. Five can lengths have been considered for four β -values ($\beta = 0.25, 0.48, 0.73, 1.0$). For the joints with $\beta = 0.25$ and 0.48, the thickness ratio τ is set to 0.5, while for the joints with $\beta = 0.73$ and 1.0, τ is taken as 1.0. In all the cases considered, $\alpha = 11.5$, $2\gamma = d_0/t_0 = 50.8$ and $t_{can}/t_0 = 2.0$. Therefore, $d_0/t_{can} = 25.4$. This d_0/t_{can} ratio is in the middle of the range of

INTRODUCTION

In the past, many questions arose regarding the influence of the can length on joint strength. The AWS (1988) gives recommendations for the reduction in joint strength as a result of a reduction in can length. The API (1987), on the other hand, only takes the influence of the can into account if the can length is above a specified value. However, the minimum required can length recommended by API is significantly less than that required by the AWS. In order to investigate the influence of the can length on the static strength of uniplanar X-joints for β -values other than 0.48, as done by van der Vegte (June 1991), additional nonlinear finite element analyses on tubular X-joints, subjected to compression loading, have been performed. The general purpose finite element

Joint	Nominal dimensions [mm]							Non-dimensional parameters			
	Chord		Braces		t_{can}	l_0	l_{can}	α	β	2γ	τ
d_0	t_0	d_1	t_1								
X1	406.4	8.0	101.6	4.0	16.0	2342	0	11.5	0.25	50.8	0.5
X2 *	406.4	8.0	101.6	8.0	16.0	2342	305	11.5	0.25	50.8	1.0
X3	406.4	8.0	101.6	8.0	16.0	2342	610	11.5	0.25	50.8	1.0
X4	406.4	8.0	101.6	8.0	16.0	2342	1219	11.5	0.25	50.8	1.0
X5	406.4	8.0	101.6	8.0	16.0	2342	2342	11.5	0.25	50.8	1.0
X6	406.4	8.0	193.7	4.0	16.0	2342	0	11.5	0.48	50.8	0.5
X7 *	406.4	8.0	193.7	8.0	16.0	2342	397	11.5	0.48	50.8	1.0
X8	406.4	8.0	193.7	8.0	16.0	2342	610	11.5	0.48	50.8	1.0
X9	406.4	8.0	193.7	8.0	16.0	2342	1219	11.5	0.48	50.8	1.0
X10	406.4	8.0	193.7	8.0	16.0	2342	2342	11.5	0.48	50.8	1.0
X11	406.4	8.0	298.5	8.0	16.0	2342	0	11.5	0.73	50.8	1.0
X12 *	406.4	8.0	298.5	16.0	16.0	2342	486	11.5	0.73	50.8	2.0
X13	406.4	8.0	298.5	16.0	16.0	2342	610	11.5	0.73	50.8	2.0
X14	406.4	8.0	298.5	16.0	16.0	2342	1219	11.5	0.73	50.8	2.0
X15	406.4	8.0	298.5	16.0	16.0	2342	2342	11.5	0.73	50.8	2.0
X16	406.4	8.0	406.4	8.0	16.0	2342	0	11.5	1.0	50.8	1.0
X17 *	406.4	8.0	406.4	16.0	16.0	2342	610	11.5	1.0	50.8	2.0
X18	406.4	8.0	406.4	16.0	16.0	2342	1219	11.5	1.0	50.8	2.0
X19	406.4	8.0	406.4	16.0	16.0	2342	2342	11.5	1.0	50.8	2.0

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KEY WORDS: Tubular joints, uniplanar X-joints, cans, numerical simulation.

* For these joints, can length is equal to minimum can length according to the API specifications.

Table 1 Summary of geometries investigated