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The Influence of the Can Length on the Static Strength of Multiplanar XX-Joints

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ABSTRACT

In the past many questions existed regarding the influence of the chord and can length on the static strength. After initial studies on axially loaded uniplanar X-joints reinforced by a can, in this study, extensive numerical analyses have been performed on axially loaded multiplanar XX-joints. The effects of the load ratio (between the loads on the out-of-plane and in-plane braces) and β value on the ultimate strength have been determined for various can lengths. Combining the results of the XX-joints reinforced by a can with the ultimate strengths of XX-joints without a can has led to an expression for the influence of the can length on the static strength of axially loaded multiplanar XX-joints. Furthermore, it has been shown that the expression describing the influence of the can length on the joint strength and the relationship derived for the influence of α (chord length) are in principle identical.

INTRODUCTION

According to the early versions of API recommendations, the influence of the can on the joint strength has been fully developed if the can is extended a minimum of 0.25 d_0 (but at least 12 in) outside the heel of the brace (Fig. 1). In a (numerical) study by van der Vegte (1992) regarding the influence of the can length on the static strength of axially loaded uniplanar X-joints, it was shown that for X-joints with $\beta < 1.0$, these minimum required can lengths were too small, resulting in unsafe design strengths.

In a later version, API (1993) adopted the relationship for the effects of (short) can length on joint strength as recommended by the AWS (1994):

$$F_{1,u}(l_{CAN}/d_0) = F_{1,u}(1)+\frac{l_{CAN}}{2.5d_0}\left(F_{1,u}(2)-F_{1,u}(1)\right) \quad \text{for } l_{CAN}<2.5d_0$$
$$F_{1,u}(l_{CAN}/d_0) = F_{1,u}(2) \quad \text{for } l_{CAN}\geq 2.5d_0 \quad (1)$$

in which $F_{1,u}(1)$ is the strength obtained by using the chord thickness t_0, while $F_{1,u}(2)$ is obtained by using the can thickness t_{CAN}.

Eq. 1 provided a reasonable approximation for the reduction of joint strength with reduction in can length for the uniplanar X-joints considered. According to the results of the numerical analyses on axially loaded uniplanar T-joints reinforced by a can (Madros, 1995), this derating equation can also be adopted for uniplanar T-joints, eventually with the slight modification that full capacity is reached for a can length somewhat smaller than 2.5 d_0, since uniplanar T-joints appeared to be less sensitive to variable can lengths than uniplanar X-joints.

However, although the AWS code gives design guidance for multiplanar interaction effects, no specific recommendations are given for the design strength of multiplanar joints reinforced by a can. Therefore, in the present study, numerical research has been performed on axially loaded multiplanar XX-joints reinforced by a can, whereas 3 β values and 4 load ratios J between the forces on the out-of-plane and in-plane braces have been considered.

After combining the numerical results of the present research with the ultimate strengths of XX-joints without a can, regression analyses have been used to establish an accurate expression for the influence of the can length on the static strength of axially loaded multiplanar XX-joints. In addition, the expression describing the influence of the can length on the joint strength has been compared with the relationship derived for the influence of α (chord length).

RESEARCH PROGRAMME

The configuration of axially loaded multiplanar XX-joints is shown in Fig. 2. For illustration, compressive loads F_1 are applied

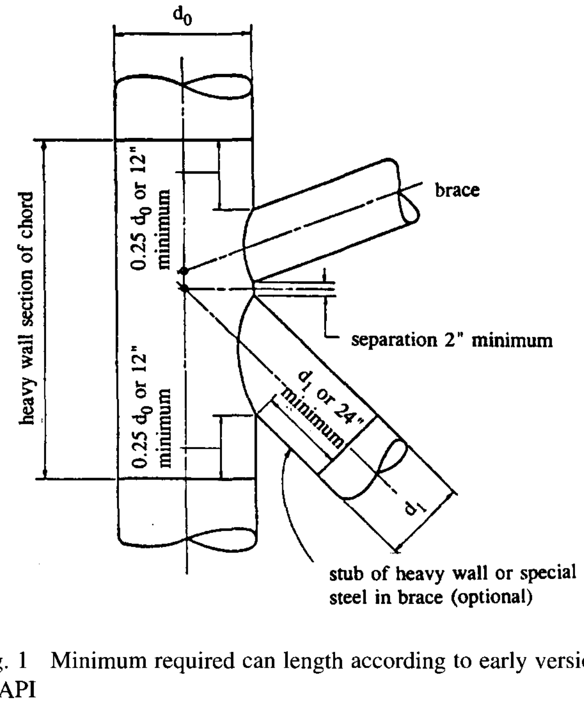

Fig. 1 Minimum required can length according to early versions of API

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KEY WORDS: Static strength, multiplanar tubular steel XX-joints, cans, numerical analyses.