DISCUSSION

Design and Behavior of Multi-Orientation Fillet Weld Connections

Paper by LOGAN J. CALLELE, ROBERT G. DRIVER and GILBERT Y. GRONDIN
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Discussion by ROBERT A. JAMES

The authors present a good discussion on the subject about how the angle of loading affects weld strength. However, there are two comments at the end of the article regarding the fusion area between the fillet weld and base metal that concern me.

The first statement is "Current design procedures limit the use of equations to predict fillet weld strength for any fillet weld orientation by requiring that the strength of the base metal at the fusion face also be checked." To the best of my knowledge, this check has never been a requirement in the AISC *Specification*. I believe this misconception started in the 1978 edition of the *Specification,* as published in the eighth edition of the steel manual. Table 1.5.3 stated "the allowable shear stress on the effective area of a fillet weld is 0.30 times the nominal tensile strength of weld metal, except shear stress on base metal shall not exceed 0.40 times the yield stress of base metal." Many people misinterpreted this mention of base metal to be a requirement that the shear stress along the leg of the weld be checked using the strength of the base metal. However, the base metal check was intended to be a reinforcement of the requirement of Section 1.5.1.2 to limit the shear stress in the *connected parts*, not the weld.

In the 1989 edition of the AISC ASD *Specification,* as published in the ninth edition of the steel manual, the wording to check base metal stress was not included in Table J2.5. Also, Figure C-J2.1 and the corresponding discussion provided a clear explanation to show where weld and base metal checks are to be performed. The weld check is at the throat of the weld.

I am concerned that the 2005 edition of the AISC *Specification,* as published in the thirteenth edition of the steel manual, may have re-introduced the confusion. Section J2.4 states "the strength of welds shall be the lower value of the base material and the weld metal strength." (I believe it would have been more accurate to say "the strength of *connections*" instead of "the strength of *welds*.") Fortunately, Figure C-J2.10 is provided, which also shows the appropriate locations for stress to be checked within the connection.

The second statement in the article is "Many test specimens exhibited a fracture surface that followed the fusion area between the fillet weld and the base metal." It has always been my understanding that unless the weld electrode is more than two strength categories greater than the matching one for the base metal, the welded joint will fail in the weld material. The heat-affected zone between the weld and base metal, due to mixing of the molten material during the welding process, attains superior strength properties to those of the base metal. Consequently, the shear stress along the weld metal-to-base metal interface need not be checked. Also, Table 5.2 in the referenced article by Deng, Grondin and Driver provides the fracture angle determined by other researchers. This shows that the weld failure occurs in the weld and not along the fusion area between the fillet weld leg and base metal.

Although the authors do reach a conclusion that it is not necessary to check the base metal strength on the fusion area, the discussion of the fusion area between the weld and base metal as a possible failure plane is contrary to my understanding of how welds perform. To think that a weld could fail on a fracture plane other than the theoretical throat does not have an impact on my confidence level in traditional weld design the way that the thought the failure plane could be along the leg of the weld does.

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