Steel Interchange

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help to solve, please forward it to *Modern Steel Construction*. At the same time feel free to respond to any of the questions that you have read here. Please send them to:

Steel Interchange
Modern Steel Construction
1 East Wacker Dr.
Suite 3100
Chicago, IL 60601

Answers and/or questions should be typewritten and double spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a Wordperfect file or in ASCII format).

The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

Information on ordering AISC publications mentioned in this article can be obtained by calling AISC at 312/670-2400 ext. 433.

The following responses to questions from previous Steel Interchange columns have been received:

What fatigue category is a full penetration weld between a tube column and a base plate?

Although a particular weld detail is not exactly covered in the latest AISC and AASHTO specifications at my disposal, I would feel safe to utilize and classify it as fatigue Category C or D, depending on the conditions summarized below. For high fatigue (versus static) stresses, I would specify geometrical weld details and fabrication procedures that assure Category C performance. For lower fatigue-vs-static stresses, I would specify conditions that assure Category D performance. For both choices, all geometrical weld details and welding procedures must clearly be specified by the designer and carefully be followed by the fabricator.

First, to obtain a full penetration butt (or groove) weld, a continuous backup bar (say 1" by 1/4") that tightly fits to the inside of the chosen column tube needs to be formed and tack welded to the base plate. The tack welds should be placed on the outside of the backup bar so that they will later on be embedded in the butt weld. For some selected column tubes, a 1-inch-long section of the next smaller standard tube size may be used if it fits tightly to the inside of the selected tube column.

Second, all sides of the lower column tube end must be beveled (30°), including the four corners, before the tube is slipped over the backup bar. After the AWS-required gap between the bottom edge of the column tube and the top of the base plate is assured, the weld material for the butt weld and the fillet can be put in place.

Third, a concave fillet must be specified to obtain a smooth transition to the base plate. A convex fillet would increase the stress concentration factor associated with this type of weld. If inspection after welding finds severe undercuts and/or overlays, touch-up welding and/or grinding may be required to provide a smooth contour for the transition between the outer face of the tube and the base plate.

Fourth, a non-destructive inspection of the butt/fillet weld must be conducted. The most economical procedure for this structural detail would be ultrasonic inspection. X-ray inspection is considered meaningless, especially for the corner regions of the column.

In my opinion, the above conditions would qualify the connection to fall under fatigue Category C. Currently, full penetration butt welds for plates and shapes covered in the AISC and AASHTO specifications fall under fatigue Category C when the weld reinforcement (weld excess) of the full-penetration butt weld is left in place. However, the weld excess for such welds is expected to cause a smaller stress concentration factor than a butt weld with a concave fillet, and definitely with a convex fillet. Therefore, a concave fillet must be used and carefully contoured. These conditions are considered necessary for safety reasons even though they may be costly.

But what if the fatigue stresses in the subject connection are relatively low by comparison with the static stresses? In that case it would seem more cost efficient to designate the joint as fatigue Category D. This would allow elimination of costly grinding and non-destructive testing.

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Comments on weld considerations discussed in the April 1993 Steel Interchange:

After reviewing the weld detail in the April 1993 issue, I have two comments.

The first has to do with the way that the welds are called out in the weld detail. It appears to me that the all around call out is incorrect, especially if weld "d" is then called out separately. Weld symbols are the link between design and fabrication and if the weld call out is incorrect, how can the designer expect the fabrication to be correct. Weld symbols don't get

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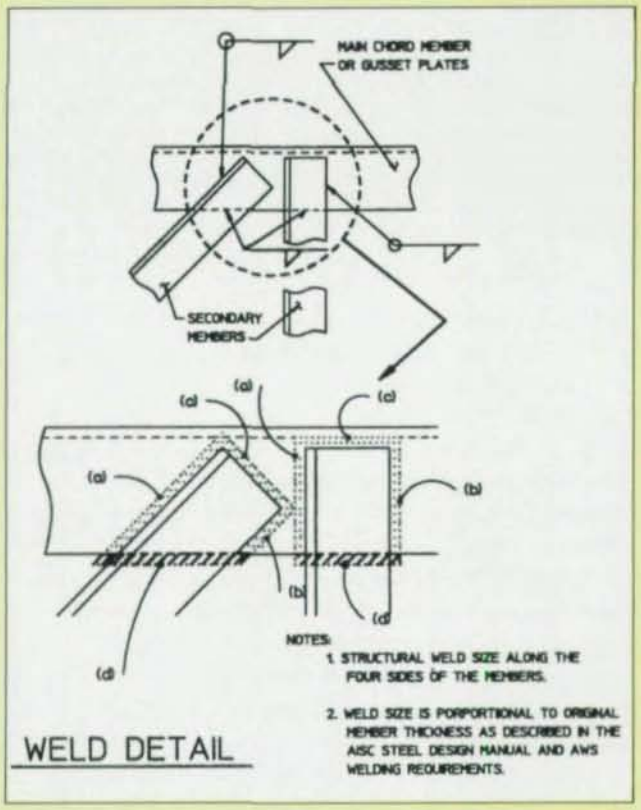

enough respect. I see plans where the engineer calls out welds incorrectly on the structural plans and then approves fabrication plans with different but equally incorrect weld symbols. I think that more care should be taken in calling out welds. Both the AISC and AWS codes are pretty specific in describing the proper way to show weld symbols.

My second comment concerns question B: If weld "d" is used to develop the strength of the connection, are there restrictions or parameters that must be placed on the weld (i,e, placement, size, etc.)? The AWS does place restrictions on fillet welds on opposite sides of a plate and states that the weld should not be continuous to both sides of the plate. It appears to me that if weld "d" is used it should stop short of the edges of the member so that the weld is not continuous to both sides of the element.

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The figure accompanying the *Steel Interchange* discussion on weld considerations (reprinted here) contains one of the most common Code (AWS D1.1-92) violations we find on structural drawings. First, the welding symbol pointing to the hidden side of the joint is redundant with the welding symbol shown to be all-around. More importantly, however, is the fact that the all-around supplementary symbol would require a Code violation of the requirement stated in paragraph 8.8.5. Specifically, such a weld symbol would require an uninterrupted deposit of weld on the opposite sides of a common plane of contact between two parts, which is prohibited. While welds (a), (b), and (c) may be continuous with each other, the code requires that the weld must be interrupted at the corners common to (a) and (d) and to (b) and (d). This is due to the deleterious effects of the resulting weld profile on the weldment.

In regard to the strength of a welded angle-to-gusset plate connection, since there is no provision in the Code which would disallow the use of weld (d), it may be used. However, there are several other Code provisions which should be considered.

While welds (a) and (b) would appear to provide the optimum efficiency in transferring reactions between the elements, weld (c), or plug welds, may be necessary to avoid the potential shear lag effects of using only welds (a) and (b). This consideration is the rationale behind the provision of paragraph 8.8.1 of the Code. Although this paragraph refers specifically to flat bars, it would be prudent to satisfy those provisions for angle shapes as well.

A Code requirement which can easily be misapplied in this situation is paragraph 8.8.6.1. While this paragraph may appear to require returns at the (c) end of welds (a) and (b), paragraph C8.9 of the commentary explains this is not the case.

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New Questions

Listed below questions that we would like the readers to answer or discuss.

If you have an answer or suggestion please send it to the Steel Interchange Editor, Modern Steel Construction, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

Questions and responses will be printed in future editions of Steel Interchange. Also, if you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.

Some Building Codes permit a reduction in NDT for welders with less than a 5% rejection rate. How big a sample is used to get the 5%?

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