CLARIFICATION OF IMPELL CTH DESIGN VERIFICATION CRITERIA/METHODS FOR RESOLUTION OF CYGNA AUDIT CONCERNS

Stress Evaluation of Angles

Prepared for:

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0210-040/041

IM-P-012

Revision 0

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Concern:

Impell applies a 1.2 increase factor to the calculated base angle flexural stress. This stress is evaluated based on resolving moments about the geometric axes of the cross-section. The 1.2 factor accounts for any potential differences between flexural stress calculated about the base angle geometric axes and stress calculated about the angle principal axes. CYGNA is concerned that the method used to develop the 1.2 factor may be unconservative, and that the factor may need to be higher.

Background:

Impell evaluates base angle flexural stress using properties that are developed from the geometric axes rather than the principal axes of the angle. A 1.2 factor is applied to the geometric axes stress to account for any potential difference from principal axes stress. In determining the 1.2 factor, maximum flexural stresses due to the separate application of major and minor principle axis bending moments on the angle cross-section were occasionally combined using SRSS in order to envelope the maximum bending stress in the angle [1, Section 11]. CYGNA is concerned that the combination should have been performed using an absolute summation method. An absolute combination may increase the 1.2 factor currently applied to the geometric stress.

Discussion:

Impell Calculation M-15 Section 11 contains the derivation of the 1.2 factor which is applied to the base angle geometric stress. The factor is based on a ratio of geometric and principal stress on the cross-section of a base angle for various loading conditions. Base angle sizes studied are L5x5x3/4, L6x6x3/4 and L6x4x3/4. In Section 11 the maximum bending stresses are calculated by separately applying a moment about each principal axis. These two maximum bending stresses do not occur at the same location. As a result, these two maximum bending stresses are combined using the SRSS method to estimate the maximum combined bending stress across the section. An absolute summation method is not required for combining these stresses since they occur at different locations.

Attachment B has been added to calculation M-15 to provide further justification for the 1.2 increase factor through a more exact approach. In this attachment combined bending stresses are calculated for the critical stress locations. These stresses include the effects of simultaneous bending about both the major and minor principal axes, therefore no SRSS combinations are used. The maximum principal axes stress from this loading is compared to the geometric axes stress, which is calculated in the same manner as done in Impell's stress evaluation computer program for the cable tray hangers, SUPERPOST. Results of the comparison in Attachment B indicate that principal stress values will not exceed geometric stress values by more than a factor of 1.18 for these angle sizes. Therefore, current use of a 1.2 factor multiplied by the geometric stress does envelope the principal stress acting on the base angle cross-section.

Impell calculation M-15 also uses the 1.2 factor when showing that the anchorage is the controlling component of the base angle assembly [1, Section 12]. Attachment B results verify that the bolts are the controlling component for the base angle design. As a result, the previous use of the 1.2 factor and use of the base angle anchorage to qualify the angle are valid.

Conclusion:

Impell applies a 1.2 increase factor to geometric axes bending stress to envelope flexural stress calculated about the principal axes for base angles. This factor was based on separately applying a moment about each principal axis and combining the resulting maximum stresses by SRSS. The factor is also used to show that base angle anchorages are the controlling component in the base angle design. Attachment B of Impell Calculation M-15 uses a more exact method to calculate the maximum flexural stress on the cross section by simultaneously applying bending moments about both principal axes. Results confirm that the current use of the 1.2 increase factor on geometric base angle flexural stress is valid.

References:

1. Impell Calculation M-15, "Base Plate & Base Angle Interaction Diagram Generation", Revision 4, 9/11/87.