

Effectiveness of Bent Plate Connection for End Cross-frames in Skewed Steel Bridges

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Abstract

Cross-frames are essential to the stability of straight steel girder bridge systems. They help resist lateral torsional buckling during construction as well as prevent failure under horizontal loading conditions. However, due to fabrication complexities, construction fit-up issues, and service fatigue problems, these braces often contribute a large percentage to the overall bridge cost. Furthermore, in bridge systems with skewed supports, cross-frames can transmit large forces between members due to differential deflection of adjacent girders.

Skewed supports (see Figure 1) are required in straight girders when the bridge span is not perpendicular to the roadway below.

Currently, detailing specifications for the end cross-frame require the brace to be placed in line with the support, and hence at an angle to the girders. To prevent welding issues during erection, plates, bent to match the skew angle, are used to connect the cross-frames to the stiffener (Figure 2).

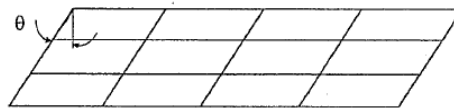


Figure 1: Plan View of Skewed Bridge with Example Bracing Layout

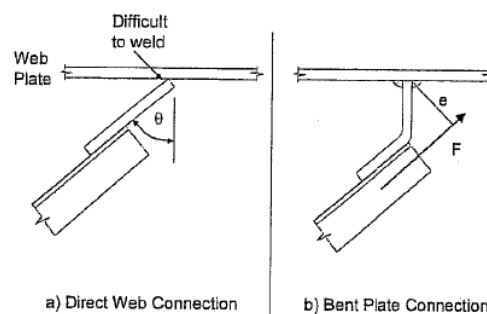


Figure 2: Straight Connection vs. Bent Plate Connection

While the bent plate connection makes construction easier, the flexible connection may compromise the effectiveness of the cross-frame. A TxDOT sponsored research study is underway at the University of Texas to investigate the impact of the connection detail between cross-frames and diaphragms on the girder behavior. Field measurements on stresses in an end

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cross-frame with bent plate connections have recently been obtained from the 19th Street overpass at US-82 in Lubbock, Texas, which has a skew angle of nearly 60 degrees. Laboratory tests are also underway to measure the stiffness of bent plates at various skew angles. The laboratory results will be used to validate finite element models on which parametric studies will be conducted.

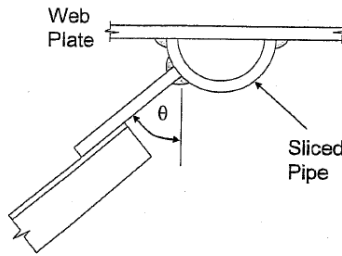


Figure 3: Proposed Pipe Connection

Additionally, a better alternative to the bent plate connection may be a section of steel pipe (see Figure 3). The circular nature of the pipe would allow the cross-frames and diaphragms to connect perpendicular to the pipe despite the skew angle, making the welded connection easier to perform. Furthermore, the circular cross-section of the pipe would provide a warping restraint for the girder, allowing longer unbraced lengths in design. This potential replacement connection will be presented, and any related laboratory findings discussed.