COMPUTERIZED STRUCTURAL DESIGN, S.C.

CONSULTING ENGINEERS

Design of Suspension Clamp System

Summary

The Suspension Clamp System uses back-to-back angles that are spaced apart by the rod fittings. Initially, the allowable load was assumed to be 1,000 lbs for a pair of angles. Analytically, the task then was to find the maximum spans for various sizes of angles. The AISC equations (see Chapter F of the 2010 Specification) were used for a single angle, unbraced for its entire span and supporting 500 lbs at midspan. An unrestrained angle, subject to a vertical force parallel to one leg, will deflect both vertically and horizontally.

Subsequent testing demonstrated that this analytical approach was overly conservative. The rod fitting did provide a substantial amount of bracing.

Thus a more accurate analytical model was considered. This model included the benefit of symmetry: i.e., at the rod fitting, each angle exerted an equal but opposite horizontal force on the other. The net result is no net horizontal movement at the load point (rod). Load-deflection equations, for the principal axes of the angles, were used to find the horizontal force needed to prevent horizontal deflection of a single angle for a given vertical load. This horizontal force is a fixed percentage of the vertical force, for each angle size. For a particular vertical load, this combination of forces resulted in significantly less bending stress, and thus a higher bending strength, as compared to the first approach. In addition, to allow for the fact that the concentrated load could be placed anywhere in the span, the unbraced length was taken as 0.75 times the span. Chapter F of the AISC Specification was also used for this model.

With the second model, the predicted (nominal) load capacity was much closer to, but still less than, the factored maximum-capacity for load at midspan, for a given test span and angle size. A reduction factor (equal to the ratio of the specified minimum-yield stress to test-coupon yield stress for each angle size tested) was multiplied times the test-determined maximum load to determine a reduced maximum-capacity. This reduced maximum-capacity constitutes an expected lower-bound on the actual strength.

The allowable load, based on strength for each span/size combination of angles, was taken to be the calculated, nominal-load capacity divided by a safety factor of 2.0. The unbraced length was taken as 0.75 times the span. For some combinations, the deflection limit of span/240 resulted in an allowable load less than the value based on strength alone.

Design of Suspension Clamp System used as Panel Point Bridge

Summary

The bridge angles utilize a back-to-back configuration. They are parallel to a joist and span between panel points of a joist's bottom chord. The angles are spaced apart horizontally by Suspension Clamps. With standard clamps, a 5/8” clearance is necessary between chord angles to allow for bolt attachment.

The allowable concentrated load, based on stiffness, is 1,000 lbs for a pair of angles. This is the load which results in about 0.04" deflection for a 48" span, if the 3" x 2" x 1⁄4" bridge angles alone resist the load applied at midspan. An allowable load based on strength alone would be greater.

However, in a typical application, there will be some load-sharing between the bridge angles and the joist chord angles. The load percentage carried by each angle pair (bridge and chord) will be in proportion to its relative bending stiffness, assuming that the bridge angles are initially in contact with the chord angles. Each pair's stiffness will be affected by both its section properties and type of span (simple or continuous).

Attention Engineer of Record

It is the responsibility of the project's engineer-of-record (EOR) to consider the joist's design adequacy with regard to the joist's overall structural integrity for all design loads and to local effects on the joist due to the suspended load. Examples of local effects on the joist chord include the effects of axial force (truss behavior of joist), bending stresses (beam behavior of chord due to hanger and end-clamp loads between joist's panel points), shear stress (in chord, due to hanger and end clamps) and bearing of hanger and end clamps on chord angles.