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ANALYSIS & TESTING OF TUBE SYSTEM FOR FALL-ARREST SUPPORT

Summary

Chicago Clamp Company offers a tube system to transfer suspended loads, due to fall-arrest, to joists. This system consists of steel components: End Clamps, framing members (tubes), hanger-clamp assembly, eye bolt and hardware. The End Clamps connect the tubes to the joists' top chords.

A test was conducted with the hanger-clamp assembly near the end of the tubes and touching one pair of End Clamps. The maximum static-test reaction was 7,280 lbs. This value consists of 3,640 lbs per End Clamp. The End Clamp's static fracture load was not reached. Analysis of the End Clamps (one per tube end) indicates that a pair have a nominal strength that significantly exceeds the maximum reaction due to the OSHA load (5,000 lbs) applied near a support. Analysis and testing included consideration of both shear in and bending of the bolts that transfer load from the tubes to the clamps. The bolts are SAE J429 (Grade 5), tightened to a usual snug condition. Analysis and testing were based on the worst-case position of support. In that case, the center of the support is 5" from the near edge of the clamp's deep section (i.e., the shallow section spans 5").

Analysis of the hanger-clamp assembly, including the plate, indicates a nominal static strength of at least 5,000 lbs (the OSHA load), as limited by plate bending. However, a maximum static test load of 9,930 lbs was applied to this assembly, via the eye bolt, with no failure. The eye bolt has a rated (allowable) load of 7,200 lbs and a stated safety factor of five.

The tested framing system consisted of a pair of tubes, each of which was a cold-formed HSS 4" x 2" x 1/8" (4" vertical, weighing 4.75 pounds per foot and conforming to A500 Grade B [46 ksi minimum yield]). A maximum static test load of 9,930 lbs was applied at the center of an 8' span, which was the largest tested span. This load resulted in gross yielding of the tubes and formation of plastic hinges at midspan. Testing was terminated at this load due to the tubes' bending stiffness having reached nearly zero. The tubes' deflection was linear up to approximately 8,000 lbs. In the comparison of analysis to testing, the maximum test loads were adjusted downward to account for possible differences between minimum and actual values of yield stress and of thickness.

For 4" x 2" rectangular tubes (HSS) with nominal wall thicknesses of 1/8", 3/16" and 1/4", the analyses for nominal strength were based on the 2010 edition of the AISC Specification (14th edition of the Steel Construction Manual). Nominal bending strengths conservatively account for lateral-torsional buckling of rectangular tubular members with relatively long spans, per the AISC Commentary and the 1993 LRFD Specification.

Tubes in the analysis are considered to be braced only at the ends. Deflection is not a criterion for support of the fall-arrest load.

The Engineer of Record is responsible for the design adequacy of the joists or beams that support the tube system.