memo

IAPMO UES

To: IAPMO Uniform ES Evaluation Committee

Construction Professionals interested in earthquake Resistance of Non-Structural Components

From: Brian Gerber

Date: December 7, 2018

Re: EC-037, Evaluation Criteria for Seismic Cable Restraints

The proposed *Evaluation Criteria for Seismic Cable Restraints*, EC-037, was discussed before the IAPMO UES Evaluation Committee at their meetings held on July and August 2018. Based on the input received, the committee supported a revision and reposting of the proposal.

EC-037 has been revised and is available for public comment.

There appears to be some conflicts among the codes and standards pertaining to structural uses of steel cable. The 2018 International Building Code (2018 IBC) references ASCE 7-16. ASCE 7-16 Section 14.1.7 limits use of ASCE 19 to load carrying members only. However, ASCE 7-16 invokes ASCE 19-10 while ASCE 19-16 is referenced under Section 2208.1 of the (IBC-2018). The IBC 2018 does not reference ASCE 19 specific to the seismic restraints for non-structural components. Seismic recommendations that were part of the IBC-2015, subsection 2208.1 seems to be removed. In addition, 2018 IBC Section 2208 is titled Steel Cable Structures, which clouds the applicability of this subsection to cables used for non-structural applications. Therefore, it could be interpreted that the IBC does not require the use of ASCE 19 to qualify steel cable used as seismic restraints for non-structural components. The current ASCE 19-16 added Appendix E for the specific application of small diameter cable to resist earthquake movements. Appendix E is presented as independent of the main ASCE 19 document and is a significant reference in EC-037.

For use as a restraining component, the cables need to be assembled with fittings, creating a seismic cable restraint. Section E3.3.2 of ASCE 19 does provide some general objectives for testing but lacks specific test procedures

to evaluate the fitting capacities. ASCE 19 is not entirely clear on how to qualify seismic cable restraints with different types of fittings.

In EC-037, a performance-oriented path for permitting seismic cable restraints with any fitting design is proposed. Since the usage is limited to earthquake loadings, testing for this condition is offered. The 2016 California Building Code (2016 CBC) mentions FM 1950 as a possible testing methodology to satisfy ASCE 7 Section 13.2.5 for a test-based determination of seismic capacities of for support of non-structural components. Another option, which specifically mentions applicability to seismic cable restraints, is ASHRAE 171.

2016 CBC references FM 1950 as an example of a testing standard and also allows use of similar testing standards. Both ASHRAE 171 and FM 1950 are consensus standards, approved by ANSI.

Here are some observations to make on the proposed evaluation criteria:

Section 1.2: The scope of EC-037 will allow for fitting styles other than swaged types.

Section 3.2: This section proposes that FM 1950-10, FM 1950-13, and FM 1950-16 all be permitted. FM 1950-10 and -13 allow for component and full assembly testing, and FM 1950-16 is limited to component testing only. The determination of the load rating differs. Section 5.4.3 of EC-037, however limits the load rating to that indicated in FM 1950-16 only, since the results will be more conservative than what the earlier editions permitted.

Section 4.1.3: ASCE 19 specifies color coding for field identification of the cable. This practice would be suitable for situations where the cable is prepared at the jobsite. For cable and fitting assemblies, ASCE 19 also allows for listing and labeling by a third party, which is also reflected in this section, since the assembly will occur in a production facility with quality control and quality assurance auditing.

Section 5.1.2: ASTM A1007 is referenced by ASTM A1023 for galvanization of the steel wires. Reference to EN 10244-2 for galvanization has been added as an alternative.

Section 5.3.3: Since ASCE 19 does not provide a specific method for static testing the restraints, ASTM A931 is proposed, which is also the basis of testing the cable under ASTM A1023.

Section 5.3.4: ASCE 19 does not provide methods for testing restraints subjected to earthquake motions. For the purpose of conforming to the test-based provisions of ASCE 7, testing to FM 1950 or ASHRAE 171 are proposed. Use of FM 1950 is referenced by the 2016 California Building Code and is deemed to satisfy the test option for seismic certification. The CBC and ASCE 7 would allow for other test methods such as ASHRAE 171. While FM 1950 is intended for rigid braces, the standard allows for testing other configurations such as tension only cables and would be appropriate for assembly testing. ASHRAE 171 does allow for either tension only and assembly testing.

Section 5.4.2: While FM 1950 and ASHRAE 171 have similar testing methods, loading requirements of ASHRAE 171 are more conservative for the higher load capacity assemblies in comparison with FM 1950. FM-1950 allows initial test load of 1000 lbf for all the expected rated capacities over 1000 lbf; similarly, for the loads under 1000 lbf, the procedures allow the initial loading to be 250 lbf. ASHRAE 171 requires initial loading to be 50 percent of expected rated capacity, which results in more punitive loading, as expected rated capacities goes towards the higher end of both the ranges (0 to 1000 lbf & 1000 lbf and over). The load ratings are computed differently. For LRFD, FM 1950-16 uses $\phi = 0.7$ while ASHRAE 171 uses $\phi = 0.9$; for ASD, FM 1950-16 uses $\Omega = 2.0$ while ASHRAE uses $\Omega = 1.67$. In both standards the failure load cannot exceed twice the starting load used for the testing sequence.
Both the testing standards are ANSI approved consensus standards.

Sections 5.4.3 to 5.4.7: These sections provide a sequence of static and cyclic tests and analysis of results to derive a load rating to be reported in the evaluation report.

Section 5.4.8: The evaluation reports will include the deformations corresponding the load rating. This aspect is not clearly represented in either the test standard or ASCE 19.