ANCHORAGE OF MEP COMPONENTS TO THE BUILDING STRUCTURE

D2.1 – 9.1 Introduction:

The anchorage, or attachment, of the MEP components and their seismic restraints to the building structure has always been a gray area generally left to the installing contractor with little or no guidance from the design professionals responsible for the MEP systems or the building structure. ASCE/SEI 7-05 does give some general guidance for the making these attachments. However, the design professionals involved with the MEP systems and the building structure must share the responsibility for ensuring the adequacy of these attachments. This section will cover the guidance provided to the design professionals of record in ASCE/SEI 7-05.

D2.1 – 9.2 General Guidelines for MEP Component Anchorage (Section 9.6.1.6 and 9.6.3.4) [Section 13.4][1]:

1. The MEP component, its supports, and seismic restraints must be positively attached to the building structure without relying on frictional resistance generated by the dead weight of the component. The following are some of the acceptable ways and means of attachment.
   a. Bolting
   b. Welding
   c. Post installed concrete anchors
   d. Cast in place concrete anchors
2. There must be a continuous load path of sufficient strength and stiffness between the component and the building structure to withstand the expected seismic loads and displacements. This means that when cable restraints are used for distributed MEP systems, the cables can not bend or wrap around any other component or structure in a straight line path between the component and the structure.

[1] References in brackets (Sections 9.6.1.6 and 9.6.3.4) [Section 13.4] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

KINETICS Noise Control
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
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3. The local areas of the building structure must be designed with sufficient strength and stiffness to resist and transfer the seismic restraint forces from the MEP systems and components to the main force resisting structure of the building. It is at this point that the design professional of record, and the installing contractor for the MEP system must work closely with the structural engineer of record to make sure that the intended anchorage points for the MEP system seismic restraints have sufficient capacity.

D2.1 – 9.3 Anchorage in (Cracked) Concrete and Masonry (Section 9.6.1.6) [Section 13.4.2]:

1. Anchors for MEP component seismic restraints and supports are to be designed and proportioned to carry the least of the following:
    a. A force equal to 1.3 times the seismic design forces acting on the component and its supports and restraints.
    b. The maximum force that can be transferred to the anchor by the component and its supports.
2. $\boldsymbol{R_P \leq 1.5}$ will be used to determine the component forces unless:
    a. The design anchorage of the component and/or its restraints is governed by the strength of a ductile steel element.
    b. The design of post installed anchors in concrete used for the anchorage of the component supports and restraints is prequalified for seismic applications according to ACI 355.2.
        i. Anchors that have been prequalified per ACI 355.2 will have an ICC-ES ESR Report issued for that anchor stating the fact that it is suitable for seismic applications for the current version of IBC. It will also give the allowable loads, embedments, and edge distances pertinent to the allowable loads.
        ii. Anchors from different manufacturers may not be directly substituted on a one-to-one basis. Each manufacturer will have a different design that will have different allowable loads when tested under ACI 355.2. The allowable loads for equivalent anchor sizes may be radically different.

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E-mail: sales@kineticsnoise.com

c. The anchor is designed in accordance with Section 14.2.2.14 of ASCE 7-05.

For 2000 IBC, ASCE 7-98, the "cracked" concrete anchors are not required, and standard post installed wedge type anchors may be used for seismic restraint as long as there is an ICC Legacy report stating that the anchors may be used in seismic applications. For 2003 IBC, ASCE 7-02, there are no specific statements in ASCE 7-02 that require the use of "cracked" concrete anchors in seismic applications. However, ASCE 7-02 Section 9.9 adopts ACI 318-02 as a reference document. ACI 318-02 specifies that the post installed anchors meet ACI 355.2 and "are required to be qualified for moderate or high seismic risk zone usage." ACI 355.2 is the test standard by which post installed anchors are to be pre-qualified for seismic applications in cracked concrete. So, by inference, "cracked" concrete anchors should also be used for 2003 IBC. However, that has not yet been widely enforced since few if any post installed anchors had been qualified to this standard before 2006 IBC was issued.

D2.1 – 9.4 Undercut Anchors (Section 9.6.3.13.2-c) [Section 13.6.5.5-5]:

For both 2000 IBC, ASCE 7-98, and 2006 IBC, ASCE 7-05, post installed expansion, wedge, anchors may not be used for non-vibration isolated mechanical equipment rated over 10 hp (7.45 kW). However, post installed undercut expansion anchors may be used.

For 2003 IBC, ASCE 7-02, post installed expansion, wedge, anchors may not be used for non-vibration isolated mechanical equipment. However, post installed undercut expansion anchors are permitted.

D2.1 – 9.5 Prying of Bolts and Anchors (Section 9.6.1.6.3) [Section 13.4.3]:

The design of the attachment of the MEP component supports and restraints must take into account the mounting conditions such as eccentricity in the supports and brackets, and prying of the bolts or anchors.

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E-mail: sales@kineticsnoise.com

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D2.1 – 9.6 Power Actuated or Driven Fasteners (Section 9.6.1.6.5) [Section 13.4.5]:

Power actuated or driven fasteners, such as powder shot pins, may not be used for tensile load applications in Seismic Design Categories D, E, and F unless specifically approved for this application.

D2.1 – 9.7 Friction Clips (Section 9.6.3.13.2-b) [Section 13.4.6]:

Friction clips may not be used to attach seismic restraints to the component or the building structure. A typical example would be the attachment of a cable restraint to a structural beam with a standard beam clamp. A beam clamp with a restraint strap or safety strap, capable of resisting the applied seismic load that will ensure that the clamp will be prevented from walking off the beam may be used.

D2.1 – 9.8 Summary:

Attachment of the MEP components and their seismic restraints to the building structure is of the utmost importance to maintaining the building function following an earthquake. It is the responsibility of the design professionals of record for the MEP systems to work with the structural engineer of record and the architect of record for the building to ensure that the anchorage points for the MEP component supports and restraints have been properly designed to transfer the design seismic loads as well as any other dead weight and service loads.

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