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To: Patio Cover Manufacturers and other Interested Parties

From: ICC-ES

Date: February 6, 2009

Subject: Technical Review of Patio Cover Engineering Analysis in Accordance with the ICC-ES Acceptance Criteria for Patio Covers (AC340)

MEMO

The purpose of this memo is to identify discrepancies that ICC-ES staff have encountered in our review of engineering analyses submitted for ICC-ES evaluation report applications for patio cover enclosures evaluated under AC340. Our intent is to alert design professionals preparing calculations and plans for ICC-ES reports of these issues so they can ensure the issues are addressed in the submitted plans. Staff also seeks industry input on measures to simplify or clarify specific requirements that are often misunderstood or misapplied.

Due to changes that evolved in the codes regarding patio cover structures, AC340 was developed to provide guidance in establishing equivalent design forces (dead, live, wind, seismic, snow, and rain) amongst patio cover report holders. The criteria also establishes requirements to determine the capacity of the horizontal diaphragms to resist lateral wind and seismic forces.

The following technical issues have been discovered through our review of some of the submitted engineering analyses for patio cover structures:

1. IBC Section 1603.1 states, “the design loads and other information pertinent to the structural designed by Sections 1603.1.1 through 1603.1.8 shall be indicated on the construction documents.” Some of the submitted construction documents do not provide the information required by IBC Section 1603.1, such as missing information on Section 1603.1.5 for earthquake design data, incomplete information on Section 1603.1.4 for wind design data, and incomplete information on Section 1603.1.3 for roof snow load.

2. In accordance with Sections 3.1.4, 3.1.5, 3.1.6, and 3.2 of AC340; Sections 1609, 1613, and Section I104 of IBC; and Section AH104 of the IRC, patio covers need to be designed to resist wind and seismic loads. In accordance with Section 1609.1.1 of the IBC and Section 12.5 of ASCE 7, wind and seismic loads need to be applied in both longitudinal and transverse directions (i.e., both parallel and perpendicular to the face of the existing building to which the patio cover is attached, for attached patio covers). The main-wind force resisting systems (MWFRS), as described in Section 1.4.5 of AC340,

and the Seismic Force-Resisting System (SFRS), as described in Sections 11.2 and Table 12.2-1 of ASCE 7, need to be specified on the construction documents (engineered plans) for each principal direction, and designed according to applicable provisions identified in the beginning of this paragraph. The following conditions need to be considered when designing the SFRS/MWFRS of the patio cover structure:

a. For attached patio cover structures, in the longitudinal direction, it may be that the SFRS/MWFRS is provided by a structure system complying with Table 12.2-1 of ASCE 7 (such as a cantilever column system) in the exterior wall line, and by the existing building at the interface between the patio and existing building (with the patio cover roof diaphragm acting as simply supported horizontal diaphragm); or the total lateral wind/seismic loads being supported by the existing building (with the rotation mechanism by the patio cover roof diaphragm). In the transverse direction, the total lateral wind/seismic load from the patio cover structure may be transferred to the existing building.

b. For freestanding patio covers, the total lateral wind/seismic loads need to be resisted by SFRS/MWFRS complying with Table 12.2-1 of ASCE 7, including corresponding horizontal diaphragm requirements.

c. For SFRS/MWFRS as required by Item 2a and 2b, above, structural analysis and construction documents need to be submitted to show compliance with the applicable code requirements, such as member and connection design and connection details (including connection to foundation).

d. For lateral wind/seismic (total or portion) to be resisted by the existing building, the analysis needs to specify the design assumptions for the existing building, such as: response modification factor(s), R, and seismic coefficient(s), C_s. The design must also identify the magnitude and direction of loads (in a table or diagram format) being transferred to the existing building, so the design assumptions and requirements on the existing building can be verified by the code official. Please note that patio cover design may be governed by wind load and the existing building may be governed by seismic load. Therefore, both wind and seismic loads need to be identified.

e. Please refer to item 5, below, for diaphragm requirements.

3. Sections 3.1.5 and 3.1.6 of AC340 include specific design assumptions to be used in calculating wind forces in accordance with ASCE 7-05. The requirements in AC340 include provisions for attached, freestanding, partially enclosed, enclosed and open structures for the main wind force resisting system (MWFRS) and components and cladding (C&C). Some of the submitted analyses comply with the requirements in ASCE

7-05, but do not include the specific provisions found in AC340, which tend to be more conservative. The following are examples of wind design assumptions presented in some of the submitted analyses that are not in compliance with AC340:

a. For attached patio cover structures, since the conditions identified in Sections 6.4.1.1 and 6.4.1.2 of ASCE 7 can not be fully verified for each existing building to which the patio cover is to be attached, Method 1 as specified in Section 6.4 of ASCE 7 is not applicable. Sections 3.1.5.2, 3.1.5.3, 3.1.6.3, 3.1.6.4 and 3.1.6.5 of AC340 prescribe Method 2 of Section 6.5 of ASCE 7, as the procedure for wind load design. Some of the submitted analyses utilize Method 1, which does not comply with the AC340 identified sections above.

b. For attached patio cover structures, Sections 3.1.5.3, 3.1.6, 3.1.6.3, 3.1.6.4 and 5.3 of AC340 require the design to "consider patio cover as a integral element of the existing building," and state that "the analysis shall establish the maximum length, width and height of the existing building to which the patio cover is to be attached, with the established dimensions specified as limitations of use in the evaluation report." This is due to the fact that wind loads acting on the roof, side walls, and leeward wall of the patio cover are based upon the mean roof height of the overall building, including both the existing building and the attached patio cover. Typically, the mean roof height of the existing building is higher than that of the patio cover. In other words, using the height of the patio cover for wind load analysis typically will result in lower wind loads than the actual applied wind load. Sections 3.1.6.3 and 3.1.6.4 of AC340 also prescribe pressure coefficients and distances for applied wind load so as to clarify the application of AC340. Some of the submitted analyses do not comply with these requirements.

c. In accordance with Section 3.1.5 of AC340, "the buildings (patio covers) shall be classified as open, partially enclosed or enclosed in accordance with Section 6.2 of ASCE 7." Section 6.5.9.4 of ASCE 7 states, "if a building definition complies with both the open and partially enclosed definitions, it shall be classified as an open building." A building that does not comply with either the open or partially enclosed definitions needs to be classified as an enclosed building. Since patio cover enclosure walls, as defined in Appendix I of the IBC and Appendix H of the IRC, can be in open or closed positions during wind load applications, multiple classifications may apply. Section 3.1.5 of AC340 states, "where multiple classifications are possible, the critical case shall apply to the design of the structure." Some of the submitted analyses do not comply with these requirements.

d. IBC Section 1609.1.1 requires that "wind shall be assumed to come from any horizontal direction." Therefore, wind load acting parallel and perpendicular to the

faces of the existing building to which the patio cover is attached shall be considered in the patio design. Specifically, refer to Figure 6-10 of ASCE 7 for the eight basic load cases and torsional load cases, and Figures 6-11, 6-12, and 6-14 for components and cladding pressure coefficients. Some of the submitted analyses do not comply with these requirements.

e. AC340 requires that the importance factor used in wind design be equal to 1.0, which is based on an Occupancy Category II. Some of the submitted analyses are using importance factors based on an Occupancy Category I, which has a lower importance factor. This is prohibited by Section 3.1.5.3.1 of AC340.

f. AC340 prescribes the most critical location for the attachment of the patio cover to the existing structure, which may be near the existing building's corners. Some of the submitted analyses do not take into account the prescriptive measures found in AC340, and may assume that the patio cover structure will be attached in zones having lower pressure coefficients. This is prohibited by Section 3.1.6 of AC340.

g. Some of the submitted analyses do not consider the effects of wind pressure on components and cladding. AC340 requires that elements also be evaluated as components and cladding. Components and cladding may be subjected to higher wind pressures than the Main-Wind Force Resisting System pressures. For example, the roof panel, when used as a diaphragm, could be designed to resist horizontal wind forces as part of the MWFRS wind design, and uplift wind forces as part of a Components and Cladding wind design.

4. AC340 requires that the effects of combined loading be determined in accordance with the IBC. Some of the submitted analyses did not consider some of the load combination equations described in Chapter 16 of the IBC. For example, IBC Equation 16-13 requires that the combined effects of dead load, wind, and snow or roof live load be considered. This combination may occur where a header beam is resisting gravity loads and horizontal wind loads.

5. AC340 requires that a rational analysis or testing in accordance with ASTM E 455 be submitted for the design of a patio cover structure's horizontal diaphragm. Patio cover roof panels are typically laminated roof panels, single-sheet aluminum panels, or lattice covers. The patio cover roof panels are typically used as diaphragms in patio cover structures. Please note that ICC-ES evaluation reports on laminated roof panels typically do not address recognition of the panels acting as a horizontal diaphragm. For the rational analysis method, please provide reference documents which identify all applicable limit states and corresponding design provisions.

6. For attached patio covers, the plans need to include details describing the quantity and direction of applied loads added to the existing building. These loads should include dead, live, snow, rain, wind and seismic loads.

7. Table 1607.1 of the IBC includes a 300-pound load for roofs subject to maintenance workers. We understand that patio cover roofs are not typically walked on, but the IBC does not exclude patio cover structures from being designed for this load. Therefore, it is our opinion that this load needs to be accounted for in the design of the roof covers.

8. For applicants wishing to include recognition under the 2007 *California Building Code*, additional analysis needs to be submitted of the aluminum components, in accordance with the 2005 Aluminum Design Manual.

9. For snow loads in accordance with Section 3.1.3.2 of AC340 and Chapter 7 of ASCE 7:

    a. "Terrain Category" needs to be specified in order to justify the exposure factor, C_e, per ASCE 7 Table 7-2.

    b. "Thermal Factor, C_t" needs to be a minimum of 1.2, as specified in Section 3.1.3.2 of AC340.

    c. "Importance Factor, *I*" needs to be based on Occupancy Category II, as required by Section 3.1.5.3.1 of AC340.

    d. Calculations need to be provided for roof snow loads based on Ground Snow Load.

    e. Provisions are required to show compliance with Sections 7.5, 7.6, 7.7, and 7.9 of ASCE 7.

10. For aluminum member and fastener design per ADM-00:

    a. For flexural member design, calculations need to be provided for the following sections of ADM-00: Sections 3.4.11 through 3.4.14 for beam overall buckling; Sections 3.4.14 through 3.4.18 for local buckling; Section 3.4.20 for shear; Section 4.4 for combined bending and shear at interior support of continuous beams; Section 4.6 for bearing; Section 4.7.2a for weighted stresses; Sections 4.7.5 and 4.7.6 for local buckling, Section 4.7.7 for web crippling; Section 4.7.8 for combined web crippling and bending at interior support of continuous beam; IBC Section 1604.3 for deflection criteria.

b. For compression member design, calculations are required for the following sections of ADM-00: Sections 3.4.7, 3.4.9, and 3.4.9.1 for compression; Sections 4.1.1. and 4.1.2 for combined compression and bending of principal axis (if applicable); and ASCE 7 Table 12.12-1 for lateral drift, if applicable.

c. For mullions consisting of combined members, please provide calculations to justify the following:

   i. Load distribution among individual members.

   ii. Deformation compatibility among individual members.

   iii. Connections among individual members.

d. For screw fasteners, calculations are required to comply with the following Sections of ADM-00: Section 5.3.1, 5.3.1.1 and 5.3.1.2 for shear; and Sections 5.3.2, 5.3.2.1, 5.3.2.2 and 5.3.2.3 for tension.

The items above have been written up to provide information to the patio cover industry and design professionals regarding discrepancies in the submitted data that appear to be common to several applications. These discrepancies are delaying issuance of new ICC-ES evaluation reports. Our goal is to identify these common discrepancies, find a reasonable approach to resolving them, and make this information available to design professionals preparing calculations and plans for patio cover enclosure ICC-ES evaluation reports.

Please feel free to contact Yamil Moya, P.E., staff engineer, at (562) 699-0543 extension 3260, or by email at ymoya@icc-es.org, if you have any questions.

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