PROPOSAL 5-25R (2009)

SCOPE: ASCE 7-05 Table 12.2-1

PROPOSAL FOR CHANGE:

Add to Table 12.2-1 of ASCE 7-05 the following:

Add the following to Table 12.2-1 of ASCE 7-05 (Design Coefficients and Factors for Basic Seismic-Force-Resisting Systems)

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements are Specified	Response Modification Coefficient, R^a	System Overstrength Factor, Ω_0^g	Deflection Amplification Factor, C_d^b	Structural System Limitations and Building Height (ft) Limit [c]				
					Seismic Design Category				
					B	C	D[d]	E[d]	F[e]
A. BEARING WALL SYSTEMS									
1. Ordinary Reinforced AAC Masonry Shear Walls	14.4.5.4	2	2 ½	2	NL	35	NP	NP	NP
2. Plain AAC Masonry Shear Walls	14.4.5.3	1 ½	2 ½	1 ½	NL	NP	NP	NP	NP

Note: New system coefficients are not underlined for clarity.

These system response factors and limitations shall apply to bearing wall systems and building frame systems.

Add the following to ASCE 7-05:

14.4.5.3 Plain (unreinforced) AAC masonry shear walls shall satisfy the requirements of Section 1.14.2.2.6 of ACI530/ASCE 5/TMS 402.

14.4.5.4 Ordinary reinforced AAC masonry shear walls shall satisfy the requirements of Section 1.14.2.2.8 of ACI530/ASCE 5/TMS 402.

Note: Since this proposal is introducing a new system that is not presently in ASCE 7-05, it will have to be determined by the PUC if it will be included in Part 1 of the 2009 NEHRP *Provisions* as an Exception/Add or to be included in Part 3 for new material requirements.

DRAFT COMMENTARY ON PROPOSAL 5-25R

The following information is not intended to be part of Commentary. It is presented for information only, as a Rationale.

Proposal 5-25 deals with seismic design factors and SDC and height restrictions for masonry structural systems made of AAC (autoclaved aerated concrete). It has been thoroughly discussed within the BSSC process and elsewhere. In August 2006, provisions identical to Proposal 5-25R were approved by BSSC PUC in a straw poll. In September 2006, provisions identical to Proposal 5-25R were approved, with the support of BSSC CRSC, for inclusion in the 2007 *IBC Supplement*. In February 2007, Proposal 5-25R was approved by TS-5 with an actual vote of 8-0-0 (one member not voting) and a probable vote of 8-1-0 (the non-voting member was opposed). In May 2007, Proposal 5-25R was balloted by BSSC PUC, with a vote of 17 Y, 0 YR, 3 N and 5 not voting. On April 7, 2008, BSSC PUC found the three Negative votes non-persuasive by a vote of 19-5-1.

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The following information is intended to be Commentary. It is written assuming that Proposal 5-25R will be included in the 2009 NEHRP Recommendations.

The seismic design factors, SDC limits, and height restrictions of these provisions are based on a combination of testing, analysis, underlying consensus standards, experience, and consistency with comparable structural systems.

The testing and analysis, described in Tanner *et al.* (2005a,b) and Varela *et al.* (2005b), began in 1999 and were developed as part of an integrated research strategy. This strategy, presented at ICC-ES hearings in 2003 and affirmed in its essence by the ongoing ATC-63 process1, had as its objective the development of seismic design factors consistent with at most a 10% probability of collapse under the maximum considered earthquake (MCE). That research developed factors of R and C_d equal to 3, with no restrictions on SDC or height. Additional information on that research is presented in the references following this Commentary.

Following the initial presentation of this strategy and its associated proposals in the ICC-ES forum, it was discussed extensively with BSSC PUC and other interested parties, including BSSC CRSC. Those discussions led to a modification of the proposal to R and C_d factors equal to 2, to SDC from A to C, and to height restrictions of 35 ft for SDC C. These values and their associated restrictions are consistent with a probability of failure much lower than 10% under MCE.

Structures of AAC masonry are designed and constructed using US consensus standards, including material standards (ASTM C1386, 2007), design provisions, and mandatory construction requirements (MSJC 2005a,b; MSJC 2008a,b). These US consensus standards are augmented by refereed documents (MDG 2007) and the on-line recommendations of the Autoclaved Aerated Concrete Products Association2.

1 ATC-63 "90% draft" (http://www.atcouncil.org/atc63.shtml)
2 http://www.aacpa.org/

In the US, AAC masonry buildings built with local approvals, under design rules consistent with those consensus standards, and with heights greater than permitted by these provisions, have successfully resisted hurricane winds with no damage.

The seismic design factors, SDC limits, and height restrictions of these provisions are consistent (or even more conservative) than those assigned to Ordinary Reinforced Masonry Shear Walls of clay or concrete masonry.

COMMENTARY REFERENCES

ASTM C1386-07: Standard Specification for Precast Autoclaved Aerated Concrete (PAAC) Wall Construction Units, Annual Book of ASTM Standards, American Society of Testing and Materials, West Conshohocken, PA, 2007.

MSJC 2005a,b: MSJC Code and Specification: ACI 530-05 / ASCE 5-05 / TMS 402-05 (*Building Code Requirements for Masonry Structures*) and ACI 530.1-05 / ASCE 6-05 / TMS 602-05 (*Specifications for Masonry Structures*), American Concrete Institute, Farmington Hills, Michigan; American Society of Civil Engineers, Reston, Virginia; and The Masonry Society, Boulder, Colorado, 2005.

MSJC 2008a,b: MSJC Code and Specification: TMS 402-08 / ACI 530-08 / ASCE 5-08 (*Building Code Requirements for Masonry Structures*) and TMS 602-08 / ACI 530.1-08 / ASCE 608 (*Specifications for Masonry Structures*), The Masonry Society, Boulder, Colorado; the American Concrete Institute, Farmington Hills, Michigan; and the American Society of Civil Engineers, Reston, Virginia.

MDG 2007: *Masonry Designers' Guide*, 5th ed., Phillip J. Samblanet, ed., The Masonry Society, Boulder, Colorado, April 2007.

Tanner et al. 2005a: Tanner, J.E., Varela, J.L., Klingner, R.E., "Design and Seismic Testing of a Two-story Full-scale Autoclaved Aerated Concrete (AAC) Assemblage Specimen," *Structures Journal*, American Concrete Institute, Farmington Hills, Michigan, vol. 102, no. 1, January - February 2005, pp. 114-119.

Tanner et al. 2005b: Tanner, J.E., Varela, J.L., Klingner, R.E., Brightman M. J. and Cancino, U., "Seismic Testing of Autoclaved Aerated Concrete (AAC) Shear Walls: A Comprehensive Review," *Structures Journal*, American Concrete Institute, Farmington Hills, Michigan, vol. 102, no. 3, May - June 2005, pp. 374-382.

Varela et al. 2006: Varela, J. L., Tanner, J. E. and Klingner, R. E., "Development of Seismic Force-Reduction and Displacement Amplification Factors for AAC Structures," *EERI Spectra*, Earthquake Engineering Research Institute, Oakland, California, vol. 22, no. 1, February 2006, pp. 267-286.

The following information is presented as additional technical information. It is not intended to be part of Commentary.

TECHNICAL INFORMATION SUPPORTING PROPOSAL 5-25R

MS Theses and PhD Dissertations

Brightman, Matthew, "AAC Shear Wall Specimens: Development of Test Setup and Preliminary Results," MS Thesis, The University of Texas at Austin, May 2000.

Tanner, Jennifer E., "Design Provisions for Autoclaved Aerated Concrete (AAC) Structural Systems," Ph.D. Dissertation, The University of Texas at Austin, May 2003.

Varela, Jorge L., "Development of R and C_d Factors for the Seismic Design of Autoclaved Aerated Concrete Structures," Ph.D. Dissertation, The University of Texas at Austin, May 2003.

Argudo, Jaime, "Evaluation and Synthesis of Experimental Data for Autoclaved Aerated Concrete," MS Thesis, The University of Texas at Austin, August 2003.

Cancino, Ulises, "Behavior of Low-Strength Shear Walls of Autoclaved Aerated Concrete," MS Thesis, The University of Texas at Austin, to be completed December 2003.

Conference Proceedings

Klingner, R. E., Tanner, J. E. and Varela, J. L., "Development of Seismic Design Provisions for AAC Structures: An Overall Strategy for the US," *Proceedings*, 9th North American Masonry Conference, Clemson, South Carolina, June 1-4, 2003.

Tanner, J. E., Varela, J. L. and Klingner, R. E., "Seismic Testing of AAC Shear Walls: Technical Basis for Proposed Design Provisions," *Proceedings*, 9th North American Masonry Conference, Clemson, South Carolina, June 1-4, 2003.

Tanner, J. E., Varela, J. L. and Klingner, R. E., "Seismic Performance of a Two-story AAC Assemblage," *Proceedings*, 9th North American Masonry Conference, Clemson, South Carolina, June 1-4, 2003.

Varela, J. L., Tanner, J. E. and Klingner, R. E., "Development of R and C_d Factors for Seismic Design of AAC Structures," *Proceedings*, 9th North American Masonry Conference, Clemson, South Carolina, June 1-4, 2003.

Tanner, J. E., Varela, J. L., Brightman, M. T., Cancino, U. and Klingner, R. E., "Seismic Performance and Design of Autoclaved Aerated Concrete Structural Systems," *Proceedings*, 13th World Conference in Earthquake Engineering, Vancouver, Canada, August 1-6, 2004.

Varela, J. L., Tanner, J. E. and Klingner, R. E., "Development of Seismic Force and Displacement Modification Factors for Design of AAC Structures," *Proceedings*, 13th World Conference in Earthquake Engineering, Vancouver, Canada, August 1-6, 2004.

Klingner, R. E., Tanner, J. E., Varela, J. L. and Barnett, R. E., "Development of Seismic Design Provisions for Autoclaved Aerated Concrete: An Overall Strategy for the United States of America," *Proceedings*, 4th International Conference on Autoclaved Aerated Concrete, Kingston University, London, September 8-9, 2005.

Tanner, J. E., Varela, J. L., Klingner, R. E., Fouad, F. H. and Barnett, R. E., "Technical Basis for US Design Provisions for Autoclaved Aerated Concrete Masonry," : An Overall Strategy for the United States of America," *Proceedings*, 4th International Conference on Autoclaved Aerated Concrete, Kingston University, London, September 8-9, 2005.

Barnett, R. E., Robinson, M. E., Tanner, J. E., Varela, J. L. and Klingner, R. E., "Design Examples for AAC Masonry Structures using US Provisions," *Proceedings*, 4th International Conference on Autoclaved Aerated Concrete, Kingston University, London, September 8-9, 2005.

Fouad, F. H., Klingner, R. E., Barnett, R. E. and Tanner, J. E., "The Proposed ACI Guide for the Use of AAC Panels," *Proceedings*, 4th International Conference on Autoclaved Aerated Concrete, Kingston University, London, September 8-9, 2005.

Refereed Journal Publications

Tanner, J.E., Varela, J.L., Klingner, R.E., "Design and Seismic Testing of a Two-story Full-scale Autoclaved Aerated Concrete (AAC) Assemblage Specimen," *Structures Journal*, American Concrete Institute, Farmington Hills, Michigan, vol. 102, no. 1, January - February 2005, pp. 114-119.

Tanner, J.E., Varela, J.L., Klingner, R.E., Brightman M. J. and Cancino, U., "Seismic Testing of Autoclaved Aerated Concrete (AAC) Shear Walls: A Comprehensive Review," *Structures Journal*, American Concrete Institute, Farmington Hills, Michigan, vol. 102, no. 3, May - June 2005, pp. 374-382.

Klingner, R. E., Tanner, J. E., Varela, J. L., Brightman, M., Argudo, J. and Cancino, U., "Technical Justification for Proposed Design Provisions for AAC Structures: Introduction and Shear Wall Tests," *ACI Special Publication SP 226*, Caijun Shi and Fouad H. Fouad, Editors, American Concrete Institute, Farmington Hills, Michigan, April 2005, pp. 45-66.

Barnett, R. E., Tanner, J. E., Klingner, R. E. and Fouad, F. H. "Guide for Using Autoclaved Aerated Concrete Panels: I - Structural Design," *ACI Special Publication SP 226*, Caijun Shi and Fouad H. Fouad, Editors, American Concrete Institute, Farmington Hills, Michigan, April 2005, pp. 17-28.

Klingner, R. E., Tanner, J. E. and Varela, J. L., "Technical Justification for Proposed Design Provisions for AAC Structures: Assemblage Test and Development of R and C_d Factors," *ACI Special Publication SP 226*, Caijun Shi and Fouad H. Fouad, Editors, American Concrete Institute, Farmington Hills, Michigan, April 2005, pp. 67-90.

Varela, J. L., Tanner, J. E. and Klingner, R. E., "Development of Seismic Force-Reduction and Displacement Amplification Factors for AAC Structures," *EERI Spectra*, Earthquake Engineering Research Institute, Oakland, California, vol. 22, no. 1, February 2006, pp. 267-286.

REASON FOR PROPOSAL:

Resistance-side provisions for AAC masonry, incorporated in Appendix A of the 2005 MSJC Code, have been discussed and supported by TS-5. The general procedure used to propose the *R* and C_d factors in the above table has been discussed and generally supported by TS-5. Specific values of *R* and C_d for AAC masonry were discussed by PUC and approved as a "straw man" proposal by them on August 28, 2006. The proposed values are based on bearing wall systems, and are conservatively proposed for building frame systems as well. This Change Proposal is submitted by TS-5 to formally request reaffirmation of those values by PUC and the BSSC process.