***Standard 7-22***
***Minimum Design Loads and Associated Criteria for Buildings and Other Structures***

# SUPPLEMENT 1

Effective Date: 3/21/2023

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## Chapter 6

***6.8.3.3 Load Combinations*** Principal tsunami forces and effects shall be combined with other specified loads in accordance with the load combinations of Equations (6.8-1a) and (6.8-1b):

$$0.9D + F_{TSU} + H_{TSU} \quad (6.8\text{-}1a)$$

$$1.2D + F_{TSU} + 0.5L + \sout{0.2}\ \underline{0.125}S + H_{TSU} \quad (6.8\text{-}1b)$$

**6.17 CONSENSUS STANDARDS AND OTHER REFERENCED DOCUMENTS**

**AASHTO ~~M288-06. 2006~~ M288-17. 2017.** Standard Specification for Geotextile Specification for Highway Applications. American Association of State Highway and Transportation Officials.
*Cited in*: Section 6.12.4.4

**ASCE/SEI ~~41-13. 2014~~ 41-17. 2017**. Seismic Evaluation and Retrofit of Existing Buildings. ASCE.
*Cited in*: Sections 6.8.3.5.2.2 and 6.13.2.1

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## Chapter 14

~~**14.4.4 Modifications to Chapter 6 of TMS 402**~~
~~**14.4.4.1 Reinforcement Requirements and Details**~~
~~Delete TMS 402, Section 6.1.2.2, and replace with:~~
~~*6.1.2.2 The nominal bar diameter shall not exceed one-quarter of the least clear dimension of the cell, course, or collar joint in which it is placed.*~~

**14.4.4 Modifications to Chapter 6 of TMS 402**

**14.4.4.1 Reinforcement Requirements and Details**

~~Add the following sentence to the end of TMS 402, Section 6.1.2.4:~~

~~The area of reinforcing bars placed in a cell or in a course of hollow unit construction shall not exceed 4% of the cell area.~~

*14.4.4.1.~~2~~1 Splices in Reinforcement...*

~~***14.4.4.1 Reinforcement Requirements and Details***~~

~~*14.4.4.1.1 Reinforcing Bar Size Limitations* Delete TMS 402, Section 6.1.2.1, and replace with:~~

~~*6.1.2.1 Reinforcing bars used in masonry shall not be larger than No. 9 (M#29).*~~

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# Chapter 15

**15.4.1 Design Basis**

2. For nonbuilding ~~systems~~structures that have ~~an R value~~ a response modification coefficient, R, provided in Table 15.4-2, the minimum specified value in Equation (12.8-5) shall be replaced by

$$Cs = 0.044 S_{DS} I_e \qquad (15.4\text{-}1)$$

The value of $C_s$ shall not be taken as less than 0.03.

And for nonbuilding structures that have a response modification coefficient, R, provided in Table 15.4-2 and are located where $S_1 \geq 0.6g$, the minimum specified value in Equation (12.8-6) shall be replaced by

$$Cs = 0.8 S_1/(R/I_e) \qquad (15.4\text{-}2)$$

**15.5.3.1 Steel Storage Racks**

Steel storage racks supported at or below grade shall be designed in accordance with ANSI~~/RMI~~ MH 16.1, its force and displacement requirements, and the seismic design ground motion values determined according to Section 11.4.~~, except as follows:~~

**Delete Sections 15.5.3.1.1 and 15.5.3.1.2 in their entirety**.

***15.5.3.2 Steel Cantilevered Storage Racks*** Steel cantilevered storage racks supported at or below grade shall be designed in accordance with ANSI~~/RMI~~ MH 16.3, its force and displacement requirements, and the seismic design ground motion values determined according to Section 11.4, except as follows.

*15.5.3.2.1* Modify Section 8.5.1 of ANSI~~/RMI~~ MH 16.3 as follows:

***8.5.1 Anchor Bolt Design***

*Anchorage of steel cantilevered storage racks to concrete shall be in accordance with the requirements of Section 15.4.9 of ASCE/SEI 7. The redundancy factor in the load combinations in Section 2.1 and 2.2 shall be 1.0. Design forces that include seismic loads for anchorage of steel cantilevered storage racks to concrete or masonry shall be determined using load combinations with overstrength provided in Sections 2.3.6 or 2.4.5 of ASCE/SEI 7.*

*If shims are used under the base plate to maintain the plumbness and/or levelness of the steel cantilevered storage rack, the shims stacks shall be interlocked or welded together in a fashion that is capable of transferring all the shear forces at the base. Bending in the anchor associated with shims or grout under the base plate shall be taken into account in the design of anchor bolts.*

***15.5.3.3 Alternative*** As an alternative to ANSI~~/RMI~~ MH 16.1 or 16.3, as modified, storage racks shall be permitted to be designed in accordance with the requirements of Sections 15.1, 15.2, 15.3, 15.5.1, and 15.5.3.3.1 through 15.5.3.3.4 of this standard.

**Table 15.4-1. Seismic Coefficients for Nonbuilding Structures Similar to Buildings.**

| | | | | | Structural Height, $h_n$, Limits (ft)[a] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nonbuilding Structure Type | Detailing Requirements | R | $\Omega_0$ | $C_d$ | B | C | D | E | F |
| Steel storage racks: | | | | | | | | | |
| Moment frame | 15.5.3.1 | 6 | 2 | 5.5 | NL | NL | NL | NL | NL |
| Braced frame | 15.5.3.1 | 4 | 2 | 3.5 | NL | NL | NL | NL | NL |
| Steel cantilever storage racks hot-rolled steel:[e] | | | | | | | | | |
| Ordinary Moment Frame (cross-aisle) | 15.5.3.2 and AISC 360 | 3 | 3 | 3 | NL | NL | NP | NP | NP |
| Ordinary Moment Frame (cross-aisle)[d] | 15.5.3.2 and AISC 341 | 2.5 | 2 | 2.5 | NL | NL | NL | NL | NL |
| Ordinary Braced Frame (down~~cross~~-aisle) | 15.5.3.2 and AISC 360 | 3 | 3 | 3 | NL | NL | NP | NP | NP |
| Ordinary Braced Frame (down~~cross~~ -aisle)[d] | 15.5.3.2 and AISC 341 | 3.25 | 2 | 3.25 | NL | NL | NL | NL | NL |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Cantilever Storage Racks<br><br>Cold-formed Steel[e] | | | | | | | | | |
| Ordinary Moment Frame (cross-aisle) | 15.5.3.2 and AISI S100 | 3 | 3 | 3 | NL | NL | NP | NP | NP |
| Ordinary Moment Frame (cross-aisle) | 15.5.3.2 and AISI S100 | 1 | 1 | 1 | NL | NL | NL | NL | NL |
| Ordinary Braced Frame (downcross -aisle) | 15.5.3.2 and AISI S100 | 3 | 3 | 3 | NL | NL | NP | NP | NP |
| Ordinary Braced Frame (down-aisle) | 15.5.3.2 and AISI S100 | 1.5 | 1 | 1.5 | NL | NL | NL | NL | NL |

**15.7.7.2** ***Bolted Steel***

(b) For Type 6 tanks, the overturning ratio, J, as determined using AWWA D103, Equation (14-3228) shall not exceed 0.785.

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# Chapter 23

**ACI 313**, *Design Specification for Concrete Silos and Stacking Tubes for Storing Granular Materials and Commentary*, American Concrete Institute, 20162019.
*Cited in*: Sections 15.7.9.3.3, 15.7.9.6, 15.7.9.7

**ANSI/AISI S310**, North American Standard for the Design of Profiled Steel Diaphragm Panels, 2020 Edition, with Supplement 1, 2022 Edition, AISI S310-20 w/S1-22, American Iron and Steel Institute.
*Cited in*: Sections 14.1.1, 14.1.5

**ANSI/RMI MH 16.1**, Specification for the Design, Testing, and Utilization of Industrial Steel Storage Racks, Rack Manufacturers Institute, 20212012.
*Cited in*: Sections 15.5.3.1, 15.5.3.1.1, 15.5.3.1.2, 15.5.3.3

**ANSI/RMI MH 16.3** Specification for the Design, Testing, and Utilization of Industrial Steel Cantilevered Storage Racks, Rack Manufacturers Institute, 2016.
*Cited in*: Section 15.5.3.2, 15.5.3.2.1, 15.5.3.3

**API 12B**, *Specification for Bolted Tanks for Storage of Production Liquids,* 12B, 1716th Edition, American Petroleum Institute, 20202014.
*Cited in*: Section 15.7.8.2

**API 620,** *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 12th Edition, Addendum 32, American Petroleum Institute, 20212018.
*Cited in*: Sections 15.4.1, 15.7.8.1, 15.7.13.1

**API 650,** *Welded Tanks for Oil Storage*, 1312th Edition, Addendum 3, American Petroleum Institute, 20182020 .

*Cited in*: Sections 15.4.1, 15.7.8.1, 15.7.9.4

**API 653,** *Tank Inspection, Repair, Alteration, and Reconstruction*, 5th Edition, Addendum 21, American Petroleum Institute, 20202018.

*Cited in*: Section 15.7.6.1.9, Table 15.4-1

**ASME B31**, Code of Pressure Piping, American Society of Mechanical Engineers (consists of the following sections):

**ASME B31.1**, *Power Piping,* 201820.

**ASME B31.3**, *Process Piping,* 201820.

**ASME B31.4**, *Pipeline Transportation Systems for Liquids and Slurries,* 2019.

**ASME B31.5**, *Refrigeration Piping and Heat Transfer Components,* 2019.

**ASME B31.8**, *Gas Transmission and Distribution Piping Systems,* 201820.

**ASME B31.9**, *Building Services Piping,* 201720.

**ASME B31.12**, *Hydrogen Piping and Pipelines,* 2019.

**ASME B31EaA-2010**, Addenda to ASME B31E-2008 *Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems, Addendum A*, 2010.

*Cited in: Sections 13.6.4.1, 13.6.7.1, Table 13.6-1*

**ASME BPVC,** *Boiler and Pressure Vessel Code*, American Society of Mechanical Engineers (consists of the following sections):

**BPVC-I,** *Rules for Construction of Power Boilers*, 20212019.

**BPVC-IV,** *Rules for Construction of Heating Boilers*, 20212019.

**BPVC-VIII Division 1,** *Rules for Construction of Pressure Vessels*, 20212019.

**BPVC-VIII Division 2,** *Rules for Construction of Pressure Vessels*, Alternative Rules, 20212019.

**BPVC-VIII Division 3,** *Rules for Construction of Pressure Vessels*, Alternative Rules for Construction of High Pressure Vessels, 20212019.

*Cited in*: Sections 13.6.10, 13.6.13, 15.7.11.2, 15.7.11.6, 15.7.12.2

**ASTM F1554-2018,** *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength*, ASTM, 20202018.

*Cited in*: Sections 13.5.3, 15.4.9.4

**AWWA D100-11,** *Welded Carbon Steel Tanks for Water Storage*, American Water Works Association, 201121.

*Cited in*: Sections 15.4.1, 15.7.7.1, 15.7.9.4, 15.7.10.6

**AWWA D103,** *Factory-Coated Bolted Carbon Steel Tanks for Water Storage*, American Water Works Association, 20192009 with Addendum 2014.

*Cited in*: Sections 15.4.1, 15.7.7.2, 15.7.9.5

**AWWA D110,** *Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks*, American Water Works Association, 2013 (Reaffirmed 2018).

*Cited in*: Section 15.7.7.3

**AWWA D115,** *Tendon-Prestressed Concrete Water Tanks*, American Water Works Association, 2020~~2017~~.
*Cited in*: Section 15.7.7.3

**TMS 402**, Building Code Requirements for Masonry Structures, The Masonry Society, 20~~16~~22.
*Cited in*: Sections 13.4.2.2, 14.4.1, 14.4.2, 14.4.3, 14.4.4, 14.4.3.1, 14.4.4.1.1, ~~14.4.4.1.2~~, 14.4.5, 14.4.5.1, 14.4.5.2, ~~14.4.5.3, 14.4.5.4, 14.4.5.5,~~ 14.4.6, 14.4.6.1, 15.4.9.2

**TMS 602**, Specification for Masonry Structures, The Masonry Society, 20~~16~~22.
*Cited in*: Sections 14.4.1, 14.4.2~~, 14.4.7, 14.4.7.1~~

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# Chapter 26

**26.14 CONSENSUS STANDARDS AND OTHER REFERENCED DOCUMENTS**

**ASTM E330/E330M**, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference, ASTM International, ~~2014~~2021.
*Cited in*: Section C26.5.1

**CAN/CSA A123.21**, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems, CSAGroup, ~~2014~~2020.
*Cited in*: Section C26.5.1

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# Chapter 29

**29.4 DESIGN WIND LOADS: OTHER STRUCTURES**

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Determination of *G*, $C_f$, and $A_f$ for structures found in petrochemical and other industrial facilities that are not otherwise addressed in ASCE 7 is permitted in accordance with Wind Load~~s~~ Design for Petrochemical and Other Industrial Facilities (ASCE ~~2011~~2020). Determination of *G*, $C_f$, and $A_f$ for lighting system support poles is permitted in accordance with ASCE 72.

**29.8 CONSENSUS STANDARDS AND OTHER REFERENCED DOCUMENTS**

The following consensus standards and other documents shall be considered part of this standard and are referenced in this chapter.

**ASCE Task Committee on Wind-Induced Forces**, Wind Load~~s~~ Design for Petrochemical and Other Industrial Facilities, American Society of Civil Engineers, ~~2011~~2020.Cited in: Sections 29.4 and C29.4

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# Chapter C6

### C6.8.3.5.2 Alternative Performance-Based Criteria.

Individual structural components that are part of the lateral-force-resisting system ~~are to~~ should resist their portion of the overall drag force on the structure, concurrently with the drag force on the individual component as specified in Sections 6.10.2.2 through 6.10.2.5. The drag force on the individual component is distributed uniformly along the length of the component and increased monotonically by simultaneously increasing both flow depth and flow velocity in accordance with Figure 6.8-1. The balance of the overall drag force on the structure is applied proportionally to the remainder of the lateral-force-resisting system. These loads can be applied as concentrated loads at each floor level corresponding to the tributary height for that floor level (Figure C6.8-2a), or as distributed loads along the vertical load-bearing structural components (Figure C6.8-2b). Application of this nonlinear static analysis procedure to a prototypical building and its structural components is demonstrated by ~~Baiguera et al. (2020)~~ Baiguera et al. (2022).

### C6.12 Foundation Design

For in-water or over-water structures or barriers, which are beyond the intent of this standard, it is suggested that foundation design may be approached by applying the specified tsunami loads and using appropriate offshore design methods such as USACE CEM (2011), California MOTEMS (California State Lands Commission 2005), California Building Code chapter on marine oil terminals (California State Lands Commission 2016), PIANC (2010), and API (~~2004~~ 2014).

#### *C6.12.1 Resistance Factors for Foundation Stability Analyses*

A review of multiple design standards for various structures, including bridges (AASHTO 2017a), buildings (ASCE/SEI 2017, International Code Council 2018), dams and levees (USACE 1995, 2000, 2005; Bureau of Reclamation 2015), slopes (USACE 2003, WSDOT 2015), foundations (USACE 1991), retaining walls (USACE 1989, 2005), and nuclear facilities (USNRC 1978, 2003, 2013, 2014), indicates different guidance for resistance factors.

***C6.12.4.3 Geotextiles and Reinforced Earth Systems*** Use of geotextiles to provide foundation stability and erosion resistance under tsunami loading provides internal reinforcement to the soil mass through both high- and low-strength geotextiles. They are applied in various configurations, relying on composite material behavior to a predetermined geometry of improved ground bearing on strata that remain stable through the event loading. Broad use in coastal environments has proven their effectiveness, with varying levels of reinforcement used to address varying severity of water and wave loading. They can be effective for creating protective reinforcement of traditional shallow footings, slabs on grade, small retaining walls, berms, and larger structures, up to tall, mechanically stabilized earth walls as used in the transportation industry. Additional guidance for geotextile placement and design is available in FHWA NHI- 10-024 (2010) and AASHTO ~~M288-06 (2006).~~ M288-17 (2017b).

***C6.12.4.4 Facing Systems*** Facing materials in coastal structures and reinforced earth systems are critical to prevent raveling and erosion. ~~M288-06 (2006)~~ AASHTO M288-17 (2017b) provides design guidance for geotextile filter layers assuming high-energy wave conditions. Armor sizing in areas of high Froude number should take into account the high-velocity turbulent flows associated with tsunamis and the height of the incoming waves. FHWA (2009) provides methods appropriate for current flow. Esteban et al. (2014) provides an adaptation of the Hudson equation (USACE 2011) for tsunami waves. Some approaches, such as the Van der Meer equation provided in USACE 2011, recommend armor stone sizing that decreases with increasing wave periods; these approaches should not be used for design of tsunami- resistant facing systems. In areas of low Froude number, the tsunami acts more as current flow, and stone sizing may be treated accordingly using standard methods

***C6.12.4.5* Ground Improvement** Soil–cement ground improvement for foundations is effective under high-velocity turbulent flows such as tsunamis because it provides both strength and erosion resistance to the improved mass. The widely used methods of deep soil mixing and jet grouting can be applied in a variety of geometries and design strengths for particular tsunami loading conditions. These methods, when incorporated in the modeling and analysis methods in this section, can be used to determine the optimal limits of treatment for desired performance levels. Similar applications are used for bridge scour and foundations for levees, dikes, and coastal structures. Additional guidance for soil–cement ground improvement is available in FHWA RD-99-138 (2000), USACE EM 1110-2-1913 (2000, Appendix G), and ~~ASTM D1633-00 (2007)~~ ASTM D1633-17 (2017).

**REFERENCES**

AASHTO (American Association of State Highway and Transportation Officials). ~~2006~~ 2017b. Standard specification for geotextile specification for highway applications. ~~M288-06~~ M288-17. Washington, DC: AASHTO.

API (American Petroleum Institute). ~~2004~~ 2014. “Recommended practice 2A-WSD.” In Section 6, foundation design, ~~21st~~ 22nd ed. Washington, DC: API.

ASTM International ~~2007~~ 2017. Standard test methods for compressive strength of molded soil–cement cylinders. ~~D1633-00~~ ASTM D1633-17. West Conshohocken, PA: ASTM.

~~Baiguera, M., T. Rossetto, and I. N. Robertson. 2020. “Tsunami design using nonlinear push-over analysis.” In Proc., 17th World Conf. on Earthquake Engineering, Sendai, Japan.~~

Baiguera, M., Rossetto, T., Robertson, I.N., and Crescenzo, P. 2022. “A procedure for performing nonlinear pushover analysis for tsunami loading to ASCE 7.” *J. Struct. Eng*. 148(2). https://doi.org/10.1061/(ASCE)ST.1943-541X.0003256.

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# Chapter C12

**C12.3.1**

… Where the design professional uses semirigid modeling, it can be accomplished by a structural model with diaphragm stiffness properties calibrated to those recognized in the ~~American Wood Council’s (2015)~~ AWC Special Design Provisions for Wind and Seismic (SDPWS), Chapter 4….

**C12.10.4.1**

….Item 2 limits wood structural panel diaphragms to those designed in accordance with the AWC ~~(2014)~~ SDPWS standard…

**C12.10.4.2**

…Second, the three term deflection equation of SDPWS, Section ~~4.2.2~~ 4.2.3, overestimates the diaphragm deflection compared to the more accurate four-term equation in the SDPWS Commentary when design shears are below strength level,…..

**C12.10.4.2**

….using the three-term equation of SDPWS Section ~~4.2.2~~ 4.2.3……

**C12.11.2.2.3**

….The requirements of Section 12.11.2.2.3 are consistent with the requirements of AWC SDPWS~~-15 (2014)~~, Section 4.1.5.1, but also apply to wood use in diaphragms that may fall outside the scope of AWC SDPWS….

**REFERENCES**

AWC. ~~2015~~2020. *Special design provisions for wind and seismic*. AWC SDPWS-~~15~~21. Leesburg, VA: AWC.

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# Chapter C13

**C13.4**

Refer, for example, to the anchor design provisions of ACI 318 (20~~14~~19), Chapter 17, for specific provisions related to seismic design of anchors in concrete.

**C13.4.2 Anchors in Concrete or Masonry**

Design capacity for anchors in concrete must be determined in accordance with ACI 318 (2019), Chapter 17. Design capacity for anchors in masonry is determined in accordance with TMS 402 (2022). Anchors must be designed to have ductile behavior or to provide a specified amount of excess strength. Depending on the specifics of the design condition, ductile design of anchors in concrete may satisfy one or more of the following objectives:

**C13.5.6.2 Industry Standard Construction for Acoustical Tile or Lay-In Panel Ceilings**

The key to good seismic performance is sufficiently wide closure angles at the perimeter to accommodate relative ceiling motion, and adequate clearance at penetrating components (such as columns and piping) to avoid concentrating restraining loads on the ceiling system. Table C13.5-1 provides an overview of the combined requirements of ASCE 7 and ASTM E580 (2020~~14a~~). Careful review of both documents is required to determine the actual requirements.

**REFERENCES**

ACI. 201~~4~~9. Building code requirements for structural concrete and commentary. ACI 318. Farmington Hills, MI: ACI.

ASTM 2014~~a~~. Standard guide for structural sealant glazing, ASTM C1401. West Conshohocken, PA: ASTM.

ASTM 20~~14b~~20. Standard practice for installation of ceiling suspension systems for acoustical tile and lay-in panels for areas subject to earthquake ground motion. ASTM E580/ E580M-20~~14~~. West Conshohocken, PA: ASTM.

TMS (The Masonry Society). 2022. *Building code requirements for masonry structures.* TMS 402. Longmont, CO: TMS.

**OTHER REFERENCES (Not Cited):**

~~ACI. 2011a. *Building code requirements and specification formasonry structures and related commentaries*. ACI 530/530.1. Farmington Hills, MI: ACI.~~

~~ACI. 2011b. *Building code requirements for structural concrete and commentary.* ACI 318. Farmington Hills, MI: ACI.~~

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# Chapter C14

## C14.4 MASONRY

This section adopts by reference and then makes modifications to TMS 402 (~~2016~~ 2022a) and TMS 602 (~~2016~~ 2022b). In past editions of this standard, modifications to the TMS referenced standards were also made. During the development of the ~~2016~~ 2022 edition of the TMS standards, each of these modifications was considered by the TMS 402/602 committee. Some were incorporated directly into the TMS standards. Those modifications have accordingly been removed from this standard. Work is ongoing to better coordinate the provisions of the two documents so that the provisions in Section 14.4 are significantly reduced or eliminated in future editions.

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# Chapter C15

**C15.5.3.1 Steel Storage Racks** The two approaches to the design of steel storage racks set forth by the standard are intended to produce comparable results. The specific revisions to the Rack Manufacturers Institute (RMI) specification cited in earlier editions of this standard and the detailed requirements of the ANSI~~/RMI~~ MH 16.1 (ANSI~~RMI~~ 2021~~2012~~) specification reflect the recommendations of FEMA 460 (2005).

~~Although the ANSI/RMI MH 16.1 specification reflects the recommendations of FEMA 460, the anchorage provisions of the ANSI/RMI MH 16.1 specification are not in conformance with ASCE 7. Therefore, specific anchorage requirements were added in Sections 15.5.3.1.1 and 15.5.3.1.2.~~

These recommendations address the concern that storage racks in warehouse-type retail stores may pose a greater seismic risk to the general public than exists in low-occupancy warehouses or more conventional retail environments. Under normal conditions, retail stores have a far higher occupant load than an ordinary warehouse of a comparable size. Failure of a storage rack system in a retail environment is much more likely to cause personal injury than would a similar failure in a storage warehouse. To provide an appropriate level of additional safety in areas open to the public, an Importance Factor of 1.50 is specified. Storage rack contents, although beyond the scope of the standard, may pose a serious threat to life should they fall from the shelves in an earthquake. It is recommended that restraints be provided to prevent the contents of rack shelving open to the general public from falling during strong ground shaking (Figure C15.5-1).

**C15.5.3.2 Steel Cantilevered Storage Racks** The two approaches to the design of steel cantilevered storage racks set forth by the standard are intended to produce comparable results. The specific development of a ~~new~~ RMI standard~~s~~ to include the detailed requirements of the ~~new~~ ANSI/~~RMI~~ MH 16.3 specification (ANSI~~RMI~~ 2016), reflects the unique characteristics of this structural storage system, along with the recommendations of FEMA 460.

The values of $R$, $C_d$, and $\Omega_0$ added to Table 15.4-1 for Steel Cantilever Storage Racks were taken directly from Table 2.7.2.2.3(1) of ANSI~~/RMI~~ MH 16.3.

The anchorage provisions of the ANSI/RMI MH 16.3 specification are not in conformance with ASCE 7. Therefore, specific anchorage requirements were added in Section 15.5.3.2.1.

These recommendations address the concern that steel cantilevered storage racks in warehouse-type retail stores may pose a greater seismic risk to the general public than exists in low-occupancy warehouses or more conventional retail environments. Under normal conditions, retail stores have a far higher occupant load than an ordinary warehouse of a comparable size. Failure of a steel cantilevered storage rack system in a retail environment is much more likely to cause personal injury than would a similar failure in a storage warehouse. To provide an appropriate level of additional safety in areas open to the public, an Importance Factor of 1.50 is specified. Steel cantilevered storage rack contents, although beyond the scope of the standard, may pose a serious threat to life should they fall from the shelves in an earthquake. It is recommended that restraints be provided to prevent the contents of rack shelving open to the general public from falling during strong ground shaking (Figure C15.5-1).

All systems in ANSI/RMI MH 16.3, Table 2.7.2.2.3(1), are ordinary systems. For all systems in Seismic Design Categories B and C, the values in ANSI/RMI MH 16.3 (ANSIRMI 2016), Table 2.7.2.2.3(1) for $R$, $\Omega_0$, and $C_d$ correspond to the values shown in Table 12.2-1 for steel systems not specifically detailed for seismic resistance, excluding cantilever column systems. No seismic detailing is required. For hot-rolled steel systems in Seismic Design Categories D, E, and F, the values in ANSI/RMI MH 16.3, Table 2.7.2.2.3(1) for $R$, $\Omega_0$, and $C_d$ correspond to the values in Table 15.4-1 for ordinary systems with permitted height increase, except that no height limits apply. The hot-rolled steel systems are detailed to AISC 341. For cold-formed steel systems in Seismic Design Categories D, E, and F, the values in ANSI/RMI MH 16.3 (ANSIRMI 2016), Table 2.7.2.2.3(1) for $R$, $\Omega_0$, and $C_d$ correspond to the values shown in Table 15.4-1 for ordinary systems with unlimited height. Seismic detailing is not required for the cold-formed steel systems.

**C15.7.7.2** ***Bolted Steel.*** A clarification on the ground motions to use in design is added and restrictions are added on the use of Type 6 tanks in AWWA D103 20192009). AWWA D103 refers to ASCE 7-1005 and repeats the ASCE 7-1005 ground motion maps within the body of the document. Therefore, a clarifying statement is added to point the user to the seismic design ground motions in the current version of ASCE 7. A Type 6 tank is a concrete-bottom bolted steel shell tank with an embedded steel base setting ring. Type 6 tanks are considered to be mechanically anchored. There are no requirements for the anchorage design or bottom design (other than ACI 318) in AWWA D103. For the tank to be considered mechanically anchored, the tank bottom cannot uplift. In this case, the tank bottom is the foundation. If the bottom/foundation uplifts, the tank is now a self-anchored tank and the additional shell compression that develops must be taken into account in the design. That is why J in equation 14-3228of AWWA D103 (20192009) is limited to 0.785.

**C15.8 (last paragraph)**

Currently, only four reference documents have been revised to meet the seismic requirements of the standard. AWWA D100, API 620, API 650, and ANSI/RMI MH 16.1 have been adopted by reference in the standard without modification, except that height limits are imposed on “elevated tanks on symmetrically braced legs (not similar to buildings)” in AWWA D100, and the anchorage requirements of Section 15.4.9 are imposed on steel storage racks in ANSI/RMI MH 16.1. Three of these reference documents apply to welded steel liquid storage tanks.

**REFERENCES**

ANSIRack Manufacturers Institute (RMI). (20212012). Specification for the dD*esign, testing, and* *utilization of industrial steel storage racks*. ANSI~~/RMI~~ MH 16.1, Washington, DC: ANSI.

ANSI~~RMI~~. 2016. *Specification for the design, testing, and utilization of industrial steel cantilevered storage racks*. ANSI/~~RMI~~ MH 16.3. Washington, DC: ANSI.

AWWA. ~~(~~2019~~2009)~~. *Factory-coated bolted steel tanks for water storage*, AWWA D103, Denver: AWWA.

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## Chapter C26

### REFERENCES

ASTM International. ~~2014~~2021. *Standard test method for structural performance of exterior windows, doors, skylights and curtain walls by uniform static air pressure difference*. ASTM E330/ E330M-14(2021). West Conshohocken, PA: ASTM

CSA (Canadian Standard Association). ~~2014~~2020. *Standard test method for the dynamic wind uplift resistance of membrane-roofing systems*. ~~CSA~~CAN/CSA A123.21-~~14~~20. Toronto: CSA.

### OTHER REFERENCES (NOT CITED)

ASTM International. ~~2006~~2021. *Standard specification for rigid poly (vinyl chloride) (PVC) siding*. ASTM D3679-~~06a~~21. West Conshohocken, PA: ASTM.

ASTM.~~2007~~2020. *Standard test method for wind resistance of ~~sealed~~ asphalt shingles (uplift force/uplift resistance method).* ASTM D7158/D7158M-~~07~~20. West Conshohocken, PA: ASTM.

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## Chapter C29

### C29.4 DESIGN WIND LOADS: OTHER STRUCTURES

Guidance for determining *G*, $C_f$, and $A_f$ for structures found in petrochemical and other industrial facilities that are not otherwise addressed in ASCE 7 can be found in *Wind Load~~s~~ Design for Petrochemical and Other Industrial Facilities* (ASCE ~~2011~~2020).

### REFERENCES

ASCE. 1994. *Minimum design loads for buildings and other structures*. ASCE 7-93. New York: ASCE.

ASCE Task Committee on Wind-Induced Forces. ~~2011~~2020. *Wind load~~s~~ design for petrochemical and other industrial facilities*. Reston, VA: ASCE.

~~SEAOC (Structural Engineers Association of California). 2012. Wind loads on low profile solar photo voltaic system on flat roofs. Rep. No. SEAOC-PV2-2012. Sacramento, CA: SEAOC.~~

SEAOC. 2017. *Wind design for solar arrays*. PV2-2017. ~~San Diego~~ Sacramento: SEAOC.

Standards Australia. 20~~02~~21. *Structural design actions, Part 2: Wind actions*. AS/NZS1170.2: 20~~02~~21. Sydney, NSW: Standards Australia.

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# Chapter C30

## C30.1 SCOPE

**C30.1.1 Building Types**. Guidance for determining *G*, and $A_f$ for C&C structures found in petrochemical and other industrial facilities that are not otherwise addressed in ASCE 7 can be found in *Wind Load~~s~~ Design for Petrochemical and Other Industrial Facilities* (ASCE ~~2011~~2020). The ~~2011~~2020 edition references ASCE ~~7-05~~7-16, and the user needs to make appropriate adjustments where compliance with the ASCE ~~7-10~~7-22 standard is required.

## REFERENCES

ASCE. ~~2011~~2020. *Wind ~~loads~~ design for petrochemical and other industrial facilities*. Reston, VA: ASCE.

ASTM International. ~~2006~~2021. *Standard specification for rigid poly (vinyl chloride) (PVC) siding*. ASTM D3679-~~06a~~21. West Conshohocken, PA: ASTM.

ASTM.~~2007~~2020. *Standard test method for wind resistance of ~~sealed~~ asphalt shingles (uplift force/uplift resistance method)*. ASTM D7158/D7158M-~~07~~20. West Conshohocken, PA: ASTM.

## OTHER REFERENCES (NOT CITED)

SPRI (Single Ply Roofing Industry). ~~2013~~2016. Wind design standard for vegetative roofing systems. ANSI/SPRI RP-14. Waltham, MA: SPRI.