

CHAPTER 20

ALUMINUM

General Comments

Chapter 20 addresses the use of aluminum in building construction. Aluminum may be used for a structure such as a screen enclosure or as a structural element in a building. This chapter does not seek to establish standards for aluminum specialty products, such as storefront framing, architectural hardware, or similar products. The use of aluminum in HVAC and plumbing systems is addressed in the *Florida Building Code, Mechanical* and the *Florida Building Code, Plumbing*, respectively.

The provisions for aluminum screen enclosures contained in Chapter 20 and elsewhere in the code were proposed by the Aluminum Association of Florida (AAF). AAF sponsored research to determine the proper wind loads to be applied to screen enclosure structures. The research entailed wind tunnel studies at Virginia Polytechnical Institute and Clemson University. The

studies included full scale testing and scale model testing in the boundary layer wind tunnel at Clemson University under the direction of Dr. Timothy Reinhold, P.E. The research resulted in the development of Table 2002.4 for inclusion in the code.

Purpose

Aluminum has certain physical properties, structural characteristics and nonstructural characteristics that set it apart as a building material. By utilizing the standards set forth in this chapter, a proper application of this material can be obtained.

SECTION 2001 GENERAL

2001.1 Scope. Provisions of this chapter shall govern the quality, design, fabrication and erection of aluminum alloys used in building construction.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Section 2003.

The exception address buildings and structures located in what's referred to as the High-Velocity Hurricane Zones (HVHZ). Section 202 defines the HVHZ as Broward and Dade Counties. The HVHZ are unique in that these zones are regulated by a separate set of structural code provisions than the rest of the state. Chapters 14 through 16 and Chapters 18 through 26 contain separate provisions for the HVHZ. The scoping sections of each of these chapters directs the user to alternate sections for buildings located in the HVHZ.

The implication of this exception is that buildings and structures built in Miami-Dade or Broward County have to comply with the requirements contained in Section 2003. Section 2002 is not applicable in the HVHZ.

The HVHZ provisions, generally, contain many of the same provisions that are contained in other sections of the code that are applicable to the rest of the state. However, many of the requirements in the HVHZ provisions are somewhat more stringent than the other sections.

SECTION 2002 MATERIALS

2002.1 General. The quality, design, fabrication and erection of aluminum used structurally in buildings or structures shall conform to good engineering practice, the provisions of this chapter and other applicable requirements of this code.

Exception: All buildings located within the high-velocity hurricane zone shall comply with the requirements of Section 2003.

2002.2 Structural aluminum construction. The design, fabrication and assembly of structural aluminum for buildings or structures shall conform to AA ASM 35 and Specifications for Aluminum Structures, Aluminum Design Manual, Part 1-A and 1-B, of the Aluminum Association. The use of aluminum alloys not listed in the manual shall be permitted provided their standard of performance is not less than those required in the manual and the performance is substantiated to the satisfaction of the building official.

The Aluminum Association (AA) *Aluminum Design Manual* (ADM), Part 1-A and Part 1-B is the adopted reference providing guidance for the design of aluminum buildings or similar structures. *The Aluminum Design Manual* Part 1-A pertains to Allowable Stress Design (ASD) and Part 1-B pertains to Load Resistance Factor Design (LRFD). AA ASM 35 sets criteria for the use and installation of flashings, sheet roofing and similar applications. The 2007 *Florida Building Code*, updates the edition of the ADM from the 2000 Edition to the 2005 Edition.

2002.2.1 Definitions

PRIMARY MEMBER. Structural framing members providing structural support to other members and/or surfaces of a structure including, but not limited to beams, posts, columns, joists, structural gutters, headers, eave rail, purlins, roof brace.

SECONDARY MEMBERS. Structural framing members which do not provide basic support for the entire structure, generally including, but not limited to, such members as kickplate rails, chair rails, roof or wall panels, wall brace.

STRUCTURAL MEMBERS. Members or sections that provide support to an assembly and/or resist applied loads.

2002.3 Screen enclosures.

2002.3.1 Actual wall thickness of extruded aluminum members shall be not less than 0.040 inch (1 mm).

The intent of the industry is for extruded aluminum members to have a specified minimum thickness, regardless of industry tolerances. Designers may utilize nominal thicknesses governed by industry tolerances given in the ADM, but all are required to meet the actual minimum thickness of 0.040 inch.

2002.3.2 Reserved.

2002.3.3 Vinyl and acrylic panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall essentially state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

Vinyl and acrylic panels are an inexpensive feature allowing the use of screen enclosures during inclement weather such as windy or rainy days. The panels are not considered to be windows, but, perform as wind breaks. The panels are not intended to perform as structural elements and are required to be removable. Permanent decals are required advising the building owner to remove the panels when wind speeds are expected to exceed 75 mph. Decals are required to be installed in a visible location with the panel in the installed position.

2002.4 Loads. Structural members supporting screened enclosures shall be designed for wind in both of two orthogonal directions using the pressures given in Table 2002.4. Each primary member shall also be designed for a 300 pound (1.33 kN) load applied vertically downward along any 1 foot (305 Mm) of any member, not occurring simultaneously with wind load.

While this section said that structural members supporting screen enclosures have to be designed for wind in either of the two orthogonal directions, the intent is that the structural members be designed in both of the two orthogonal directions but not concurrently with one another. This clarification has been included in the Glitch Amendments by requiring that structural members be designed for wind in "both" of two orthogonal directions.

In the 2004 *Florida Building Code, Building*, this section required structural members to be designed to support the loads specified in Table 2002.4 but not

less than 10 psf. This requirement has been removed. However, ASCE 7 still requires all structural members (vertical projection of MWFRS and all components and cladding) to be designed for a minimum 10 psf wind load regardless of the calculated analytical value. This minimum wind pressure is not intended to apply to interaction effects such as required by Note e or Table 2002.4 where horizontal pressures are required to be applied simultaneously with the vertical pressures. The tabular values are to be used for simultaneous horizontal and vertical wind pressures.

The 300 lb point applied vertically downward along any one foot of any member is to account for construction, maintenance, or repair loads associated with workers on the roof.

2002.4.1 The following design guides shall be accepted as conforming to accepted engineering practices:

AAF Guide to Aluminum Construction in High Wind Areas.

The *AAF Guide to Aluminum Construction in High Wind Areas* is a prescriptive document for constructing screen enclosures without the involvement of the professional design community. Structures within the parameters of the Guide may be constructed without the involvement of an engineer.

**TABLE 2002.4A
HEIGHT ADJUSTMENT FACTORS**

MEAN ROOF HEIGHT	EXPOSURE	
	B	C
15	1	0.86
20	1	0.92
25	1	0.96
30	1	1.00
35	1.05	1.03
40	1.09	1.06
45	1.12	1.09
50	1.16	1.11
55	1.19	1.14
60	1.22	1.16

The values shown in Table 2002.4 are for a screen enclosure with a mean roof height of 30 feet or less. For mean roof heights other than 30 feet, multiply the values in Table 2002.4 by the applicable height adjustment factor in Table 2002.4A.

2002.5 Wall panels. The minimum thickness for formed sheet aluminum structural wall panels shall be not less than 0.024 inch (0.6 mm), subject to approved tolerances.

2002.6 Sunrooms. Sunrooms shall comply with AAMA/NPEA/NSA 2100 with the structural requirements and testing provisions of Chapter 5 modified to incorporate ASCE

**TABLE 2002.4
DESIGN WIND PRESSURES FOR ALUMINUM SCREENED ENCLOSURES^{a,b,c}**

SURFACE	BASIC WIND SPEED (mph)											
	100		110		120		130		140		150	
	Exposure Category (B or C) Design Pressure (psf)											
	B	C	B	C	B	C	B	C	B	C	B	C
Horizontal Pressure on Windward Surfaces	12	17	13	18	15	21	18	25	21	29	24	33
Horizontal Pressure on Leeward Surfaces	10	13	10	14	13	17	14	19	15	23	18	27
Vertical Pressure - Screen Surfaces	3	5	4	5	4	6	5	7	6	8	7	9
Vertical Pressure - Solid Surfaces	10	14	11	15	13	18	15	21	17	24	20	28

For SI: 1 pound per square foot = 9.479 kN/m².

NOTES:

- Pressures include importance factors determined in accordance with Table 1604.5.
- Pressures apply to enclosures with a mean enclosure roof height of 30 feet (10 m). For other heights, multiply the pressures in this table by the factors in Table 2002.4A.
- Apply horizontal pressures to the area of the enclosure projected on a vertical plane normal to the assumed wind direction, simultaneously inward on the windward side and outward on the leeward side.
- Apply vertical pressures upward and downward to the area of the enclosure projected on a horizontal plane.
- Apply horizontal pressures simultaneously with vertical pressures.
- Table pressures are MWFRS Loads. The design of solid roof panels and their attachments shall be based on component and cladding loads for enclosed or partially enclosed structures as appropriate.
- Table pressures apply to 20x20x.013" mesh screen. For 18 x 14 x 0.013" mesh screen, pressures on screen surfaces may be multiplied by 0.88. For screen densities greater than 20 x 20 x 0.013", use pressures for enclosed buildings.
- Table pressures may be interpolated using ASCE 7 methodology.

The 2004-2005 Hurricane seasons revealed a number of shortcomings in the design of aluminum screen enclosures. To some degree this was attributed to a lack of clarity in the use of the pressures by this table. These comments are based upon ongoing work by the AAF, researchers, and the engineering design community in the aluminum industry. The tabulated pressures and notes have been modified accordingly.

The wind tunnel tests on which the loads are based (1999) were performed on scale models of different screen enclosures supported on a force balance in the tunnel floor measuring drag, uplift and overturning simultaneously on the whole structure. That force included drag on walls and roof surfaces parallel with the wind direction as well as drag created by the wind passing through screen surfaces normal to the wind.

The design pressures expressed in Table 2002.4 are wind pressures imparted to screen surfaces which must be transferred to the frame. Table notes c, d, and e describe how these pressures are to be applied. Where a screen roof is not in the horizontal plane, screen roof pressures (vertical) pressures are to be applied simultaneously with the analogous horizontal pressures to both the vertical screen surfaces (walls) and vertical projections of the screen roof. Where the wind must pass through more than one screen surface (wall or roof surfaces), then separate windward and leeward pressures shall be used for each load case (for each distinct wind direction). When there is only a single vertically projected surface, wall or roof, only the windward pressure should be applied.

For the design of the main roof support beams, using simultaneous loading conditions, the bending of the roof member due to the applied vertical pressure will be exaggerated or diminished by the horizontal wind force applied to the vertical projection of the roof, and the pressure applied to a supporting wall element. For the design of screen roof and/or wall bracing, the analogous flow-through condition shall be considered (windward plus leeward pressures) simultaneously with the vertical pressures for each discrete wind direction.

7. Sunrooms shall be categorized in one of the following categories.

Category I: A roof or a covering of an outdoor space. The openings shall be permitted to be enclosed with insect screening or 0.5 mm (20 mil) maximum thickness plastic film. The space is defined as nonhabitable and unconditioned.

Category II: A roof or a covering of an outdoor space with enclosed walls. The openings are permitted to be enclosed with translucent or transparent plastic or glass. The space is defined as nonhabitable and unconditioned.

Category III: A roof or a covering of an outdoor space with enclosed walls. The openings are permitted to be enclosed with translucent or transparent plastic or glass. The sunroom complies with additional requirements for forced-entry resistance, air-leakage resistance and water-penetration resistance. The space is defined as nonhabitable and unconditioned.

Category IV: A roof or a covering of an outdoor space with enclosed walls. The sunroom is designed to be heated and/or cooled by a separate temperature control or system and is thermally isolated from the primary structure. The sunroom complies with additional requirements for forced-entry resistance, water-penetration resistance, air-leakage resistance, and thermal performance. The space is defined as habitable and conditioned.

Category V: A roof or a covering of an outdoor space with enclosed walls. The sunroom is designed to be heated and/or cooled and is open to the main structure. The sunroom complies with additional requirements for forced-entry resistance, water-penetration resistance, air-leakage resistance, and thermal performance. The space is defined as habitable and conditioned.

This section requires sunrooms to comply with AAMA/NPEA/NSA 2100. It also requires that the structural requirements of Chapter 5 essentially be replaced with the loading requirements contained in ASCE 7.

This section also defines the sunroom categories that are also defined in the AAMA/NPEA/NSA 2100 standard. Previously the code did not specifically define these categories. These categories are defined the code primarily to clarify which types of sunrooms are considered habitable spaces. While the code did not specifically require any sunroom to be considered a habitable space, some jurisdictions required all sunrooms to be considered habitable space due to confusion between the code definition of habitable space and the defined categories in the reference standard. The 2007 *Florida Building Code, Building*, in the definition of Habitable Space, states that sunroom Categories I, II, and III are not considered habitable space (See definition of habitable space in Chapter 2). Therefore, this section and the definition of habitable space clarifies which types of sunrooms are to be considered habitable space.

SECTION 2003

HIGH-VELOCITY HURRICANE ZONES—ALUMINUM

2003.1 Design. Aluminum members shall be designed by methods admitting of rational analysis according to established principles of mechanics.

2003.2 Standards. The design, fabrication, and erection of structural aluminum shall conform to the Aluminum Design Manual.

2003.3 Workmanship. Aluminum construction shall be in conformance with the tolerances, quality and methods of construction as set forth in Section 2003.2 and the American Welding Society's Structural Welding Code-Aluminum (D1.2).

Following Hurricane Andrew many complaints were voiced after seeing the aftermath. The issue is the ability of a building official to enforce the workmanship section without employing personal experiences and judgment. For that reason the workmanship standards were not expanded to include more requirements than are already stated in the adopted industry standards personal experiences. However the decision of acceptable workmanship is very much in the preview of the building official and work can be disapproved if, in the judgment of such building official it does not meet industry standards. The normal appeal against the judgment of the building official would be the Board of Rules and Appeals.

2003.4 Definitions. Members shall be defined as in Section 2002.2.1.

2003.5 Identification. Aluminum for structural elements shall at all times be segregated or otherwise handled in the fabricator's plant so that the separate alloys and tempers are positively identified and, after completion of fabrication, shall be marked to identify the alloy and temper. Such markings shall be affixed to complete members and assemblies or to boxed or bundled shipments of multiple units prior to shipment from the fabricator's plant.

Exception: Certification by the fabricator and or contractor shall be provided attesting to the alloy and temper of the material.

2003.6 Allowable unit stresses.

2003.6.1 The design, fabrication and assembly of aluminum members for building and other structures shall conform to the standard set forth in Section 2003.2 and as otherwise set forth herein.

2003.6.2 The use of aluminum alloys, other than those listed in the standard shall provide performance not less than those required by the standard and as set forth herein.

2003.6.3 Aluminum members shall be limited by the deflections set forth in Section 1613.

2003.7 The building official may require that any structure using aluminum primary or secondary members be designed by a Florida-registered professional engineer.

2003.7.1 Reserved.

2003.7.2 In addition to flexural and shearing stresses, the critical factors of buckling, fatigue, stress raisers such as notches or

holes or shape re-entrant corners, deflection and connections shall be considered and provided for by proper design.

2003.7.3 All solid roof systems shall be designed for a minimum 30 psf (1436 Pa) live load.

The 30 psf translates into 5 $\frac{1}{2}$ inches of water superimposed on the roof structure. If the configuration of the roof is such that wind driven water can be retained in such a manner as to create greater loads on the roof deck then the larger loads would apply.

2003.7.4 All buildings and structures shall be designed to resist uplift. In the case of placement on existing slabs and foundations, sufficient information and calculations shall be provided by the professional engineer and/or architect to verify the ability of the slab or foundation to resist uplift loads.

2003.7.5 All connection devices shall be rated by load testing by an approved testing laboratory.

2003.7.5.1 All expansion anchors shall not be installed less than 3 inches (76 mm) from the edge of concrete slab and/or footings. All expansion anchors shall develop an ultimate withdrawal resisting force equal to four times the imposed load, with no stress increase for duration of load.

The most frequent case of screen enclosure failure is expansion anchors installed in the patio deck of the facility or residence. Specific attention must be given to the installation and edge distance requirements.

2003.8 Fabrication and construction details.

2003.8.1 Connections. Aluminum members shall be designed as set forth in the standards in Section 2003.2.

2003.8.1.1 Fasteners. Bolts and other fasteners shall be aluminum, stainless steel, hot-dip or electro-galvanized steel. Double cadmium plated steel bolts may also be used.

2003.8.1.2 Painting. Except as prescribed in Section 2003.8.4, painting or coating of aluminum alloy parts shall be required only when called for on the plans.

2003.8.1.3 Welding. Aluminum parts shall be welded with an inert-gas-shielded arc or resistance welding process. No welding process that requires a welding flux shall be used. Filler alloys complying with the requirements of the standard in this chapter shall be used.

2003.8.1.4 Welder qualifications. All welding of structural aluminum member shall be performed by certified welders.

2003.8.1.5 Erection. During erection, structural aluminum shall be adequately braced and fastened to resist dead, wind and erection loads.

2003.8.2 Structural aluminum decking and siding.

2003.8.2.1 Aluminum sections spanning between supports shall be limited in span to satisfactorily support the positive and negative loads set forth in Chapter 16 (High-Velocity Hurricane Zones). The deflection of decking shall not exceed that set forth in Section 1613.

2003.8.2.2 Aluminum sheet used for roof decking or siding shall be not less than 0.032 inch (0.8 mm) in thickness.

2003.8.2.3 Aluminum sheets shall be secured to the supports to adequately resist positive and negative loads. Attachments

shall be at intervals not exceeding 8 inches (203 mm) o.c. and shall be secured to each other at side laps at intervals as required by rational analysis and/or tests, but shall not exceed 12 inches (305 mm) o.c.

2003.8.2.4 Fasteners shall have a head, and/or be provided with washers not less than $\frac{1}{2}$ inch (13 mm) in diameter.

2003.8.2.5 Fasteners located at end laps shall be placed not more than 2 inches (51 mm) nor less than 1 inch (25 mm) from the end of overlapping sheets.

2003.8.2.6 Where roof or wall cladding is of aluminum, an approved membrane to protect against water intrusion to the interior shall be provided or the aluminum cladding shall be designed and constructed with an approved continuous edge-interlock, overlap or seam to prevent water intrusion.

2003.8.3 Nonstructural aluminum decking and siding.

2003.8.3.1 Nonstructural aluminum sheets shall be backed with cladding as set forth in Chapter 23 and Chapter 24 (High-Velocity Hurricane Zones).

2003.8.3.2 Nonstructural aluminum sheets shall have a minimum thickness of 0.032 inches (0.8 mm).

2003.8.3.3 An approved membrane to protect against water intrusion shall be provided or the aluminum cladding shall be designed and constructed with an approved continuous edge-interlock, overlap or seam to prevent water intrusion.

2003.8.3.4 Nonstructural decking and siding shall be attached as set forth in Section 2003.8.2 except that the attachment of aluminum residential siding shall be by rational analysis and/or tests using a minimum 0.120-inch (3 mm) diameter aluminum nails of sufficient length to penetrate studs a minimum of 2 inches (51 mm). Nails at wood studs shall be as required by rational analysis and/or tests, but spaced not greater than 24 inches (610 mm) o.c. horizontally and no greater than 8 inches (203 mm) o.c. vertically.

2003.8.4 Dissimilar materials.

2003.8.4.1 Aluminum may contact compatible metals such as, but not limited to:

1. Nonmagnetic stainless steel provided the contacting surfaces and any attachments are enclosed for protection from the weather.
2. Zinc.
3. White bronze.

2003.8.4.2 Aluminum contacting metals not considered compatible shall be protected as follows:

1. Painting the dissimilar metal with a prime coat of zinc-chromate primer or other suitable primer, followed by one or two coats of aluminum metal-and-masonry paint or other suitable protective coating, excluding those containing lead pigmentation.
2. Painting the dissimilar metal with a coating of a heavy-bodied bituminous paint.
3. Placing a good quality caulking material between the aluminum and the dissimilar metal.
4. Applying a nonabsorptive tape or gasket.

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5. Hot-dip galvanizing or zinc-plating steel members after fabrication.

2003.8.4.3 Dissimilar metals shall be painted if used in locations where drainage from them passes over aluminum.

2003.8.4.4 Aluminum surfaces in contact with lime-mortar, concrete, or other masonry materials, shall be protected with alkali-resistant coatings, such as heavy-bodied bituminous paint or water-white methacrylate lacquer.

2003.8.4.5 Aluminum in contact with wood or other absorbing materials which may become repeatedly wet shall be painted with two coats of aluminum metal-and-masonry paint or a coat of heavy-bodied bituminous paint, or the wood or other absorbing material shall be painted with two coats of aluminum house paint and the joints sealed with a good quality caulking compound.

2003.8.4.6 Where aluminum is in contact with treated wood, wood shall be treated with pentachlorophenol, 5 percent minimum concentration, creosote, or zinc naphthanate, following the protective measures outlined in Section 2003.8.4.5.

2003.8.5 Expansion and contraction. Aluminum work shall be designed and anchored so the work will not be distorted nor the fasteners overstressed from the expansion and contraction of the metal.

Bibliography

The following resource materials are referenced in this chapter or are relevant to the subject matter addressed in this chapter.

AA ASM 35-00, *Specification for Aluminum Sheet Metal Work in Building Construction*. Washington, DC: The Aluminum Association, 1980.

AA ADM-05, *Aluminum Design Manual*; "Part 1-A: Specifications for Aluminum Structures, Allowable Stress Design" and "Part 1-B: Specifications for Aluminum Structures, Load and Resistance Factor Design of Buildings and Similar Type Structures." Washington, DC: The Aluminum Association, 2000.

AAF *Guide to Aluminum Construction in High Wind Areas*. Boca Raton, FL: The Aluminum Association of Florida, 2003.