

The Value and Versatility

By Christopher Edwards

of Vinyl Windows

In windows, vinyl can offer the same performance and design flexibility specifiers rely on from traditional materials, with the added benefits of excellent insulating value, low maintenance requirements, and resistance to impact, abrasion, and moisture. Easily cleaned with soap and water, vinyl windows are impervious to rot, rust, corrosion, blistering, flaking, and insect infestation.

Vinyl is often specified on commercial light frame construction (*i.e.* wood/steel stud) projects incorporating a mounting flange window. Available in casement, fixed, horizontal sliding, hung, projected awning, and combination bow-and-bay styles, the windows also can be found in various shapes, ranging from arches and ellipsicals to gothic and circles. Some window manufacturers also offer vinyl-clad windows, which comprise wood frames with a top layer of vinyl. Profile dimensions are generally 1.5-mm to 2.3-mm (0.06-in. to 0.09-in.) thick.

Photo courtesy Mikron Industries Inc.

The vinyl recipe

While vinyl window formulations tend to be proprietary, most material comes from an 80 percent vinyl resin. Some of the additives commonly used in vinyl window profiles include:

- Stabilizers, which can help minimize vinyl degradation during exposure to high temperatures in the manufacturing process. They also assist with cracking, splitting, pitting, peeling, and chalking prevention.
- Pigments, which help provide color consistency, and can provide screening/absorption of the ultraviolet (UV) radiation that otherwise causes rapid degradation.
- Modifiers, which can help improve impact strength and resistance to cracking during the fabrication process (*i.e.*, sawing, routing, punching). These additives can also help improve resistance to general abuse during transportation, storage, and installation.

Vinyl windows are fabricated by cutting approximately 5-m or 6-m (16-ft or 20-ft) lengths to size, and assembling the pieces into complete sash and frame units. Sash and Frame corners are fusion-welded for maximum strength and protection against air/water infiltration. To provide a required level of structural performance, vinyl sections are often larger than their aluminum counterparts, with sizes closer to the dimensions of wood frames. However, larger vinyl units may need to be reinforced.



Photo courtesy Mikron Industries Inc.

Whether in the cold, harsh, Alaskan environment experienced by the Klondike Inn, located at the foothills of the Chugiak Mountains, or the warmer climes of Bellevue, Washington, vinyl windows boast the same performance and design flexibility as traditional materials.

Specifying specific systems

Vinyl is a heat-sensitive thermoplastic resin with a coefficient of expansion accordingly greater than that of wood or aluminum. It is important the vinyl window system design/assembly is specified to accommodate thermal movement, which is generally controlled through multi-chambered or 'honeycomb' designs.

Excellent performance comes from profiles having at least two (and preferably three) chambers between their interior and exterior faces. Some profiles are also shaped and designed to 'weep,' that is, to direct moisture away from all window components, such as anchorage, fasteners, hardware, weather stripping, sealants, and glazing.

Vinyl windows can be designed to resist water/air infiltration, and sometimes rely on metal reinforcement to resist higher wind loads (which is enclosed/isolated in a separate chamber to inhibit rust). Some manufacturers use foam insulation in the profile chambers to enhance thermal performance. One unique feature of vinyl windows is their interlocking meeting rail joining the two sashes together, which can create a solid barrier to air and water.

Thanks to their excellent resistance against expansion and contraction, light colors (*i.e.*, white, beige, and ivory) are the primary vinyl window models on the market. Product manufacturers can ensure the performance of darker hues by verifying the compound formulation provides some resistance against excessive heat buildup, expansion, and warping. Unlike applied finishes that may flake off, vinyl's colors are homogenous throughout the profile, making reapplication during the product's use phase unnecessary.

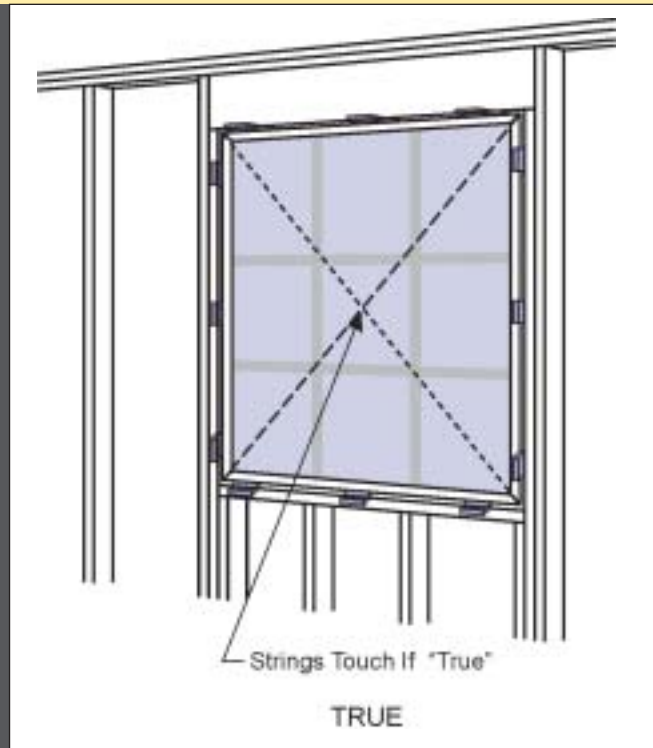
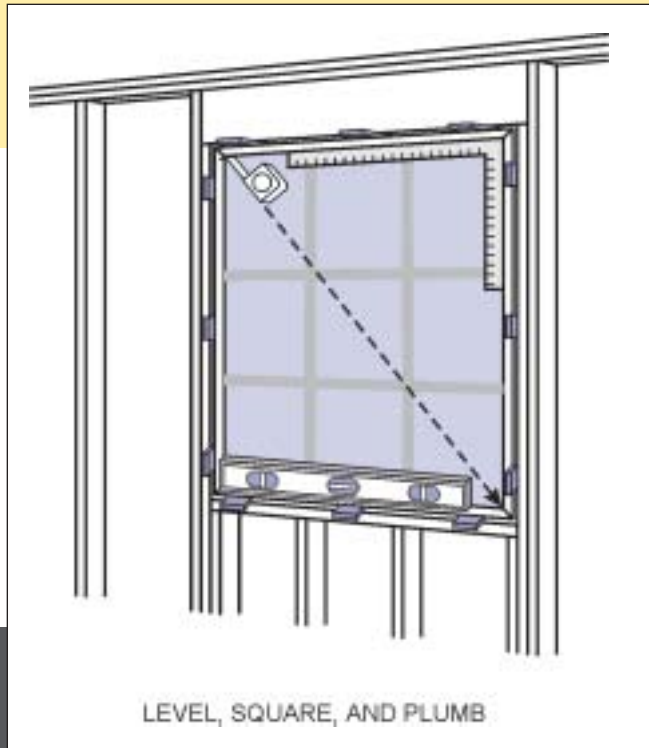
Aside from the demands of local code requirements, the proper window product to specify depends on the type of building it is installed in, along with other factors, such as the building's orientation, geographic location, wind zone, exposure, and terrain.

Codes, standards, and third parties

As with any building component, familiarity with some of vinyl's inherent characteristics and specific performance capabilities is key to managing design liability and avoiding risk—drawings and

Photo courtesy VEKA Inc.





Vinyl windows require appropriate clearance between the frame and the rough opening. The architect/engineer (A/E) should use appropriate tools to ensure windows are being installed level, square, and plumb. For helping to determine whether a window is 'true,' the string method can be used, as show above.

specifications can also be used to document the choice of any window product and its installation method. Fortunately, many industry organizations provide guidance.

ARCOM and the American Institute of Architects (AIA) have issued Section 08561-Vinyl Windows to Masterspec® subscribers, while material-neutral standards are being developed by groups such as the American Architectural Manufacturers Association (AAMA), the Window & Door Manufacturers Association (WDMA), and the Canadian Standards Association (CSA).

The detailing of components (*i.e.*, glass, sealants, hardware) and the requirements for wind load, structural load, and water resistance are spelled out in ANSI/AAMA/NWDA 101/IS 2-97, *Voluntary Specification for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors*.¹ An updated version, the *North American Fenestration Standard (NAFS)*, or ANSI/AAMA/NWDA 101/IS 2, *Voluntary Performance Specification for Windows, Skylights and Glass Doors*, adds unit skylights.

A newer standard under development is AAMA/CSA/WDMA 101/IS 2/A 440, *Specification for Windows, Doors and Unit Skylights*, to be submitted for inclusion in the 2006 *International Building Code (IBC)* and *International Residential Code (IRC)*. It is expected to be approved jointly by the three 'sponsoring' organizations in early to mid-2005. (The currently excluded side-hinged exterior door will also be addressed in this standard.)

AAMA promulgates standards providing third-party validation of product performance and quality. For example, the AAMA PVC (polyvinyl chloride) Profile Certification Program is a longstanding initiative allowing manufacturers to self-certify their products.

Inaugurated in 1962, it comprises ongoing laboratory and weatherability testing of extrusions randomly selected by AAMA to determine compliance with AAMA 303, *Voluntary Specification for [PVC] Exterior Profiles*.

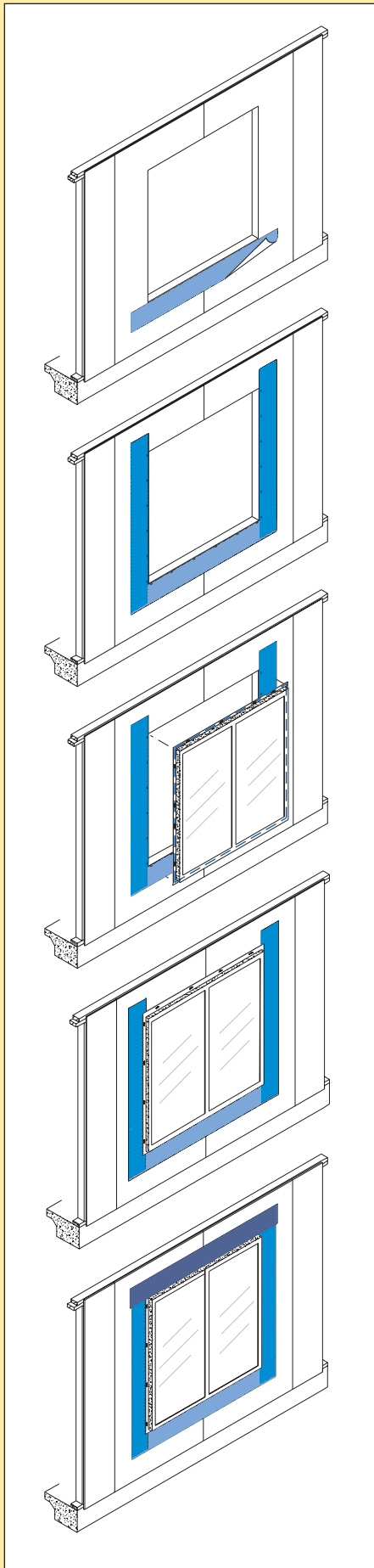
For profiles meeting the standard's minimum requirements, the product receives a certification label authorizing its position as part of a third-party program accredited by the American National Standards Institute (ANSI). An independent, accredited laboratory tests potential products for impact/heat resistance, dimensional stability, weight tolerance, and accelerated outdoor exposure in South Florida, Arizona, and northern industrial climates.²

Performance hinging on appropriate installation

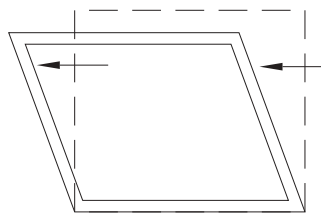
Proper window installation is just as important as its product design and specification. When installed and maintained properly, vinyl window products can help deliver long service and energy savings.³

Knowledge of potential problems during the installation process allows architects/engineers (A/Es) to take steps toward preventing the occurrence of failures. Product measurement and the specification of appropriate accessory components can help promote performance.

As with windows constructed with traditional materials, vinyl windows must be installed level, square, and true, with appropriate clearance between the frame and the rough opening. Failure can lead to a window out of level and/or racked in the opening, which risks expensive water damage to the wall, or window cavity, broken glass, a compromised insulated glass seal, or inoperable windows. This, of course, is coupled with increased heating/cooling costs

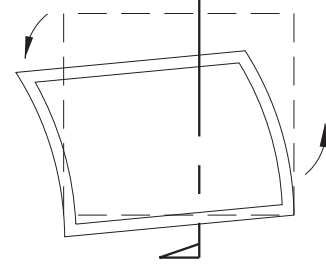


TRUE PLANE (SQUARE)

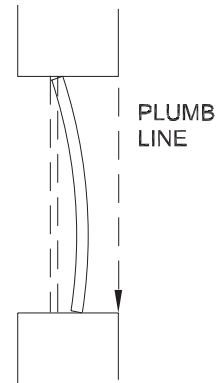


RACKING OUT OF SQUARE
DEFORMED PARALLELOGRAM
IN PLANE

TRUE PLANE (PLUMB)



RACKING OUT OF PLUMB
CORNER RACKED IN OR OUT
OF PLANE FROM PLUMB



SECTION THROUGH WINDOW
RACKED OUT OF PLUMB

Flashing may be installed in 'weatherboard' fashion to help allow residual water entering the wall cavity to exit freely (see left). Accurate measurements can help safeguard against racking out of square and racking out of plumb—vinyl window installation is similar to the setting of traditional materials (see right).

from excessive air infiltration and exfiltration.

It is important to note the following paragraph (and the component suggestions that follow) is only provided as considerations. Specifiers should follow the manufacturers' details when installing vinyl windows.

Nails and screws

Correctly sized nails and screws can provide adequate anchorage, and help prevent frame distortion, leaks, and loosening.

Shims

Vinyl windows can be supported along the sill's full length/width with solid stock, such as flat shims. When spaced shims are used, they should be spaced according to manufacturers' instructions. When shims are applied improperly, the window could be neither level nor true, causing rough operation of horizontal sliders.

Flashing

To allow the free egress of residual water that has entered the wall cavity, flashing should be provided around the entire window perimeter. The specification should indicate flashing is to be installed in 'weatherboard' fashion, with each piece overlapped by the piece above it. Every effort should be made to ensure the flashing is installed during construction.

Sealant

Sealant can help provide a barrier between two adjacent materials against water/air penetration, making it an important product choice. It is important the A/E consults sealant manufacturers, since adverse chemical reactions with the window, mounting surface, and finished wall can compromise the seal and damage materials. Generally, elastomeric joint sealants (i.e., polysulfides, polyurethane, silicone) adhere well and remain flexible, but all products should be checked for compatibility with one another.

The A/E should specify the sealant's

application between the window frame and the rough framing, flashing, and/or house wrap or building paper, integrating all components and providing effective water management. Sealant should also be specified at the joint between the window jambs and sill, reducing the possibility of water entering the wall cavity.

Seeing energy efficiency through commercial windows

In the name of green design, A/Es increasingly specify window products that minimize heating/cooling loads while providing ample daylighting. Tests using the U-factor (the capacity to resist heat transfer out of a building when there is an inside/outside temperature difference) have shown vinyl windows outperforming some competing products in providing resistance to heat transfer (Table 1).

U-Factor Ranges for Various Frame Materials

Frame material	U-factor
Aluminum (no thermal break)	1.7–2.4
Aluminum (with thermal break)	0.6–1.3
Aluminum-clad wood/reinforced vinyl	0.4–0.6
Wood and vinyl ¹	0.3–0.5
Insulated vinyl/insulated fiberglass	0.2–0.4

¹ Not for heavy wind loads.

Table data courtesy J. Carmody et al's *Residential Windows: A Guide to New Technologies and Energy Performance*. 2nd Ed. (October 2000)

Due to this, building owners can expect a quicker return on investment (ROI) compared to projects made from some traditional materials.⁴ Other energy efficiency parameters applied to windows are the solar heat gain coefficient (SHGC), which is an assembly's ability to block warming caused by direct and indirect sunlight, and visible light transmittance (VLT), the percentage of visible light coming through a window.

A new focus on using energy-efficient windows in small to-medium-sized commercial and multi-family dwelling projects is gaining momentum in both construction and remodeling applications. One group leading the discussion on improving the performance of commercial buildings is the Commercial Windows Initiative (CWI), a project of the Northwest Energy Efficiency Alliance (NWalliance).

CWI uses non-profit group National Fenestration Rating Council's (NFRC's) ratings for the three key variables to identify energy-efficient products:

1. U-factor of 0.35 or lower.
2. SHGC of 0.4 or lower.
3. VLT of 0.5 or higher.

NFRC comprises manufacturers, suppliers, builders, A/Es, code officials, utilities, and government agencies who have banded together to provide information for measuring/comparing the

energy performance of window, door, and skylight products.⁵

NFRC, along with CWI, AAMA manufacturer members, and the U.S. Department of Energy (DoE), is developing a viable commercial version of Energy Star®, the U.S. Environmental Protection Agency (EPA)-backed labeling system for energy-efficient products. Under consideration is a system with designations determined by the energy needs of multiple climate zones balancing a number of factors, primarily structural issues and durability.


Given their important contributions to high-performance building, properly selected and installed vinyl windows could certainly assume a prominent position under this proposed system. ☺

Notes

- ¹ The other organizations involved in the standard are the American National Standards Institute (ANSI) and the National Wood Window and Door Association (NWWDA), which has since become the Window & Door Manufacturers Association (WDMA).
- ² A listing of certified extruders can be found at www.aamanet.org by selecting Setting the Standard. Producers do not necessarily certify every one of their products.
- ³ Originally developed by AAMA, the InstallationMasters Institute maintains an installer training and certification program, InstallationMasters™, which provides an avenue by which installers can learn window installation techniques adopted by the fenestration industry.
- ⁴ See National Fenestration Rating Council (NFRC) 100, *Procedure for Determining Fenestration Product U-Factors*, and American Architectural Manufacturers Association (AAMA) 1503, *Test Method for Thermal Transmittance and Condensation Resistance*.
- ⁵ For more information on the CWI, visit www.commercialwindowsinitiative.org.

References

- Masterspec® Evaluation Document for Windows, Section 08515–Windows, and Section 08561–Vinyl Windows. (August 2004)
- Carmody, J. et al. *Window Systems for High Performance Buildings*. (W.W. Norton & Co., 2003)
- Commercial Windows Initiatives (CWIs) *Designer's Guide for Energy Efficient Commercial Windows*. (2003)



Did You Know?

Polyolefin plastic housewrap can reduce air and moisture infiltration. Infiltration of outside air into the average home can be reduced by as much as 10 percent to 50 percent, reducing the energy required to heat or cool the home. (Look forward to more on polyolefins in a future issue of *Modern Materials*.)