Windows of Opportunity

How to Choose the Best Window System for Your Replacement Project

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Selecting the right replacement window type for a building can be challenging. There are several factors to consider: cost, performance, operation, size, safety, glazing requirements, finish, durability, maintenance, aesthetics, and location. The correct balance of these factors is necessary to select the most appropriate window type for each building or application.

It is common to base a window replacement design on the original windows; however, with advances in performance, durability, and aesthetics, there may be better choices available. It is beneficial to explore all options before selecting the window, glass, and operation type for your building.

WINDOW SYSTEM COMPARISONS

There are four window product types commonly used in commercial, educational, and residential buildings:

- Extruded aluminum
- Wood
- Rolled steel
- Vinyl

Each type has its own physical properties and proven performance characteristics.

ALUMINUM WINDOWS

Aluminum windows are manufactured using extruded aluminum alloy sections that are custom fabricated to a variety of lengths and sizes to accommodate an assortment of configurations. Aluminum windows provide a durable frame system that can withstand heavy use while spanning large openings without extensive frame modifications. Aluminum windows will not rust or rot, reducing maintenance costs over their expected service life of 30-plus years. In most instances, the need for replacement is typically associated with failed glazing, hardware, and/or weather-stripping, and not due to deterioration of aluminum components.

Aluminum frames can accommodate various operable sashes, such as double- or single-hung units, casement, sliding (horizontal and vertical), and projected (awning and hopper) types. Aluminum can accept different glazing thicknesses, ranging from noninsulated units to triple-glazed insulated glass.

Aluminum can also accommodate a variety of finishes, such as anodized, high-performance, and organic coatings. Coatings provide color permanence, require minimal maintenance, and deliver exceptional weatherability.

A unique advantage to using aluminum windows for replacement is that they can accommodate detailing features that replicate historic wood windows. By integrating extruded aluminum scroll panning to represent brick molds, sloped glazing stops to mimic glazing putty, and exterior mounted aluminum muntins, aluminum windows are a typically less-expensive/lower-maintenance alternative to replacing or repairing wood windows, while maintaining their historic appearance.

A disadvantage of aluminum is its high thermal conductivity. Aluminum readily conducts heat and cold, which reduces thermal performance. To accommodate this, aluminum extrusions are manufactured with self-contained structural thermal breaks, both in the frame and operable sashes, so as to reduce thermal transfer of heat and cold through the conductive metal. The thermal break reduces energy costs by increasing the thermal performance of the aluminum frame by as much as 19 percent over nonthermally broken extrusions.

Recent advances in the development of thermal breaks, insulated glass units, glass coatings, and spacers have significantly increased the thermal efficiency of aluminum windows. However, even when thermally broken, aluminum will not approach the thermal performance of vinyl or wood window products.

Although durable, aluminum frames and sashes are not easily repaired if damaged and often require complete replacement. Replacing sashes is easier, since they are independent of the window frame.

VINYL WINDOWS

Vinyl windows are made from polyvinyl chloride (PVC) extrusions with welded frame corners for structural and thermal performance. Vinyl windows have a high resistance to heat, cold, and humidity. Since the frames are made of PVC, they are more resistant to deterioration. Vinyl windows are most commonly constructed as single- or double-hung or casement units, and are readily available in standard sizes. Custom sizes typically require significant cost upcharges and manufacturing delays. Vinyl windows do not easily form to complex shapes, such as arches or polygons.

Vinyl windows have a relatively low conductivity, therefore in-frame thermal breaks are not necessary. In general, vinyl windows are approximately 20 percent more efficient than thermally broken aluminum window systems. The result is higher thermal efficiency and increased energy savings.

Aluminum window, curtain wall, and insulated metal wall panel replacement.

Vinyl windows are considered the least durable window products. Without inner-frame reinforcement, they cannot accommodate large-sized openings. This may require the placement of additional mullions (horizontal and vertical). Maximum opening dimensions typically cannot exceed 80 in. in height. As with the other window products, vinyl can accept a variety of different glazings but typically uses glazing less than 1 in. in thickness.

Depending on a window's size limitations and profile, vinyl windows are typically the least expensive window product. They require little maintenance of frames and sash members, but can suffer from deterioration of seals, weather-stripping, and glazings similar to what can occur in aluminum products. Vinyl windows have had a history of deformation over time under exposure.

WOOD WINDOWS

Wood windows are easily formed to complex shapes and decorative profiles because they can be custom fabricated. Wood frames can accommodate large-scale openings and complex shapes without added supports or stiffeners. However, larger spans may require thicker wood members to accommodate the span, which can reduce the amount of glass and result in increased sight lines. When damaged, wood windows are easily repaired. Depending on the magnitude of damage, it is possible to replace the damaged member only, rather than the entire window.

Wood, like vinyl, has a low conductivity, providing approximately 20 percent more energy efficiency than aluminum systems. However, wood windows are limited to glazing thickness ranging from 1/8 in. to 1 in. Due to their construction, thinner glazings are more common than 1-in.-thick insulated glass. This is partially because of the limited strength of the glazing stops and glass bite sections in the frame or sash.

Historic wood windows typically have a single pane of glass and are difficult to incorporate into a thicker glass due to the limited space and strength of the glazing putty. Instead of insulated glazing, storm windows are typically used in conjunction with uninsulated single-pane glass to increase thermal performance. Wood windows typically have a higher material and installation cost than aluminum or vinyl.

Historic replica aluminum replacement windows.

Steel window replacement and restoration.

STEEL WINDOWS

Steel windows are formed from cold- or hot-rolled sections with mitered and welded corners for durability, strength, and weather protection. As the steel frames are rolled, they can be formed into complex shapes and still have welded frame construction. Steel is superior to the other products in strength, so the frames are available in thinner sections, allowing for reduced sight lines. Operable units within steel windows are typically limited to pivot or projected types, which may limit replacement options if the existing windows are to be replaced in kind.

Like aluminum, steel windows have high conductivity, resulting in reduced energy efficiency. Steel windows can accommodate a variety of glazing thicknesses, ranging from 1/8 in. to 1-1/8 in. Glazings are held in place with aluminum alloy glazing beads that can be removed to replace the glass.

While steel windows offer advantages, they are typically more expensive than aluminum or vinyl. This can be offset by the longevity of the window system, since steel window frames can last up to 75 years if properly maintained. However, during that period, maintenance to hardware, finishes, and weather-stripping is required to maintain the window's performance.

WINDOW OPERATION COMPARISON

With each operational type comes a variety of benefits and restrictions that must be considered when making the selection for window replacement. The following five window unit operation types are typically used in commercial or residential applications:

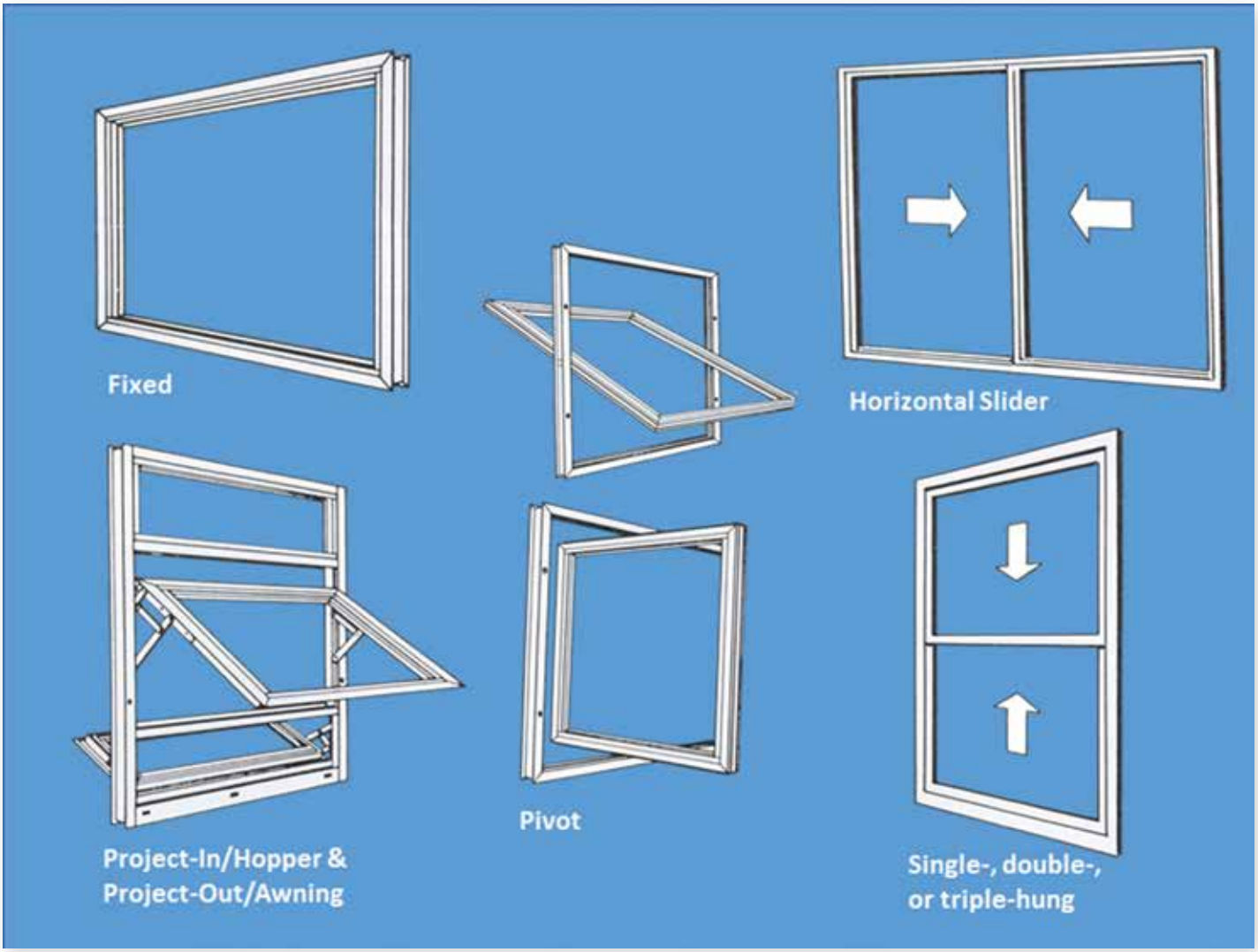
Fixed Windows

Fixed windows offer no ventilation, as the frame is fixed in place. They are typically used for picture or transom windows, or in combination with an operable unit.

Projected Windows

Projected windows are generally easy to operate. Both awning- and hopper-style units offer fair ventilation, as the sash must remain small due to hardware restrictions. Casement units offer the best ventilation per square foot of window opening, because over 90 percent of the window is operable. Projected windows are considered compression sealed and typically have better air- and water-infiltration test results, because the sash is pulled tight against the frame when closed and locked.

Drawbacks to these windows include being difficult to clean from the building interior, since the exterior surface of the glass is out of reach. Projected windows can have safety concerns when fully opened, as the sash projects away from or into the building. Sash limiters can be installed to control the range of operability and reduce safety risks. Projected units tend to be more expensive than other types due to the amount of hardware required to operate the window.



Variety of window operations.

Hung Windows

Hung windows are generally easy to operate using sash balances that reduce the weight of the sash for the user. These windows offer limited ventilation, because generally less than half of the window is operable at one time. Tilt-in sashes allow for easy cleaning of the interior and exterior side of the glass. There are minimal safety concerns, since these windows operate vertically and do not project into or away from the building. Hung windows are considered sliding-seal windows and typically do not perform as well as compression-seal windows for air and water infiltration.

Horizontal Sliding Windows

Horizontal sliding windows are similar to hung windows, except that their sashes slide horizontally. Balances are not utilized to alleviate the weight of the sash, requiring the user to move the full weight of the sash frame and glass. Depending on the size of the unit, this can be considerable. In addition, the horizontal sill slide track located at the bottom of the window may frequently become filled with dirt and debris, impacting ease of operation. Horizontal sliders do not offer tilt-in features, limiting the window area that can be cleaned from the interior.

Pivot Windows

Pivot windows are hinged in the center of the sash on the horizontal (vertical pivot) or vertical (horizontal pivot) surfaces. As with projected units, there are safety concerns with their use because the sash projects away from and into the building. These windows offer excellent ventilation, since over 90 percent of the window opening is operable. Pivot windows can be fully cleaned from the interior.

Glass and Glazing Comparison

Each window type listed above can accept a variety of glazing thicknesses and types. New glazing should consist of 1-in. thick, hermetically sealed, insulated units to increase the thermal performance of the glass by as much as 37 percent over conventional single-pane glass.

Insulated glazing consists of two or more lites of glass sealed together, enclosing a hermetically sealed air space. Glass lites and the air space can vary in thickness to accommodate a variety of window frame configurations or to achieve a desired thermal performance. The glass lites are sealed to a hollow spacer, typically constructed of aluminum or stainless, coated, or galvanized steel to prevent rusting. The hollow core of the metal spacer is filled with a desiccant to absorb limited amounts of moisture within the air space. This structure works to help prevent fogging of the glass unit from moisture trapped between the glass lites.

In a sealed-glass insulating unit, air currents between the two panes of glazing carry heat to the top of the unit, allowing cold pools to develop at the bottom. Filling the space with a less conductive, or slow-moving gas minimizes the convection currents within the space. Conduction through the gas is reduced as well as the overall transfer of heat between the inside and outside.

The space can be filled with a gas such as argon or krypton. Argon offers better thermal performance to air but costs more. Krypton offers an even better thermal performance than argon but is even more expensive. Krypton is most useful when the insulated glass unit is thin and increased thermal performance of the air space is needed.

For additional thermal performance, tinted and reflective glazings are utilized to limit solar heat gain and solar glare. Additionally, low-emittance (Low-E) coatings are applied to the surface of the glass within the insulated unit. Low-E glass reflects heat during the warm months and helps prevent heat loss during the cool months.

GLAZING

There are many glazing options that enhance and improve the security, durability, and effectiveness of windows.

- Security glazing
- Laminated glazing
- Applied security films
- Glass-clad polycarbonate
- Tempered glass

SUMMARY

The variety of window materials, configurations, and glazing compositions are extensive. However, proper design considerations are addressed if the building can give decades of performance combined with aesthetic appeal for the building owner.

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