Refined Strengths of Fibreglass Doors

New technology changes the playing field

All images courtesy Duxton Windows & Doors

By Al Dueck

Design-driven product changes are inevitable, as applied ingenuity advances the construction industry's capabilities through material and technology innovations. In this regard, exterior fenestration components have considerably evolved in terms of :

- material types (from aluminum to pultruded fibreglass);
- finishes (types and quality of coatings and laminates); and
- performance capabilities (frame, panel, and high-performance glass).

While they may have lagged behind windows in terms of progress, door systems have also experienced significant advances in recent years. Not only are frame systems now available in a wider range of material types, but door panels also come with increased choices in panel styles, sizes, finishes, and more recently, the option of pultruded rails and stiles. These product advances have allowed designers to solve retrofit and new building requirements more easily and with more esthetically satisfying solutions.

Whether the desired doors are swinging or sliding, the maturing marketplace has been seeking fenestration components with greater durability (*e.g.* material and finish), more environmentally responsible characteristics (*e.g.* lower embodied energy, as well as thermal efficiency), and generally higher performance characteristics (*e.g.* airtightness, structural rigidity, and finish flexibility). Although traditional materials have offered these attributes in varying degrees, relatively newer products like fibreglass are providing design professionals with further options.

Material choices

Changing technology has impacted door systems from several different directions. Frames and sash have generally been produced with aluminum, wood, polyvinyl chloride (PVC), or even steel (as in the case of insulated door panels). While these materials have their individual advantages, they also come with their own limitations and drawbacks.

Aluminum, as an example, has many fine attributes, but it is highly conductive and requires thermal breaks to achieve lower U-values and reduced condensation in cold climates. Wood frame and sash materials are esthetically attractive, but are relatively more costly and generally considered less durable. Further, wood is not considered as low in maintenance as other materials, and requires on-site finishing.

When compared to glass, vinyl has relatively high rates of expansion and contraction and also has limitations when it comes to finish selection—dark colours and real wood laminates are not available at this time. The material also has considerably lower levels of rigidity and stiffness when compared to other frame materials. As illustrated in Figure 1, newer composite materials such as fibre-reinforced polymer (FRP) products can offer design teams inherent advantages, including low expansion/contraction levels (*i.e.* 3.8 x 106 in./in. F) that are similar to glass, low conductivity compared to metals (*i.e.* 2.08 Btu/sf/hr/F), and excellent strength and rigidity.

This article provides an overview of the different technologies involved in creating the base materials for these fibreglass door systems. Door frames and some sash are created with pultruded fibreglass lineals. Fibreglass-insulated door panels, on the other hand, are created with FRP compression (instead of pultrusion) moulded skins.

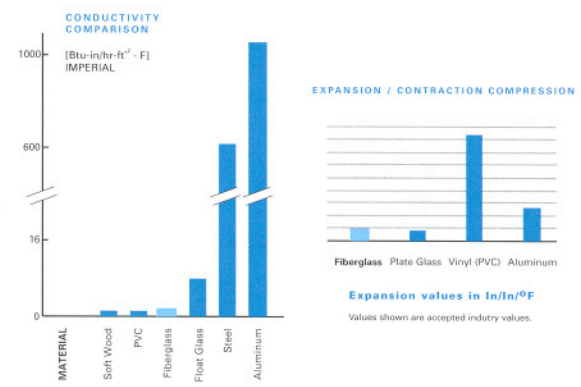
Power of pultrusion

The first patents for pultruded fibreglass lineals were issued in 1946. As their name suggests, these products are made through a process called 'pultrusion'—where glass fibres (created from silica sand) consisting of roving and mat forms are pulled through a resin impregnation station. (In comparison, aluminum and vinyl profiles are usually created through the process of extrusion, where the material is pushed through a die.)

The thermosetting resin and fibre mixture are assembled by a forming/shaping guide, and the combination of heat and pressure yields a thin wall profile. While the typical thermoplastic resins of PVC become unstable at 68 C (155 F), pultruded fibreglass retains its physical properties up to about 177 C (350 F).

Pultrusion lineals need a finish coat, generally a baked on two-part polymer paint applied by the pultruder or to custom demand by the door fabricator. A set of typical standard hues is generally complemented by fabricators with a full range of colour match capabilities. For an additional cost, split finish options—one colour to the exterior and another colour to the interior—are also possible.

Figure 1



A comparison of conductivity, expansion, and contraction.

A further finish option is the lamination of real wood on select interior surfaces of lineals, combined with standard or custom colours to the exterior. In the wood laminate process, specially prepared and backed wood strips are rolled onto lengths of fibreglass lineals pre-coated with an adhesive. The range of wood species currently available includes mahogany, edge grain fir, oak, pine, and cherry. The stability of fibreglass (*i.e.* the material's

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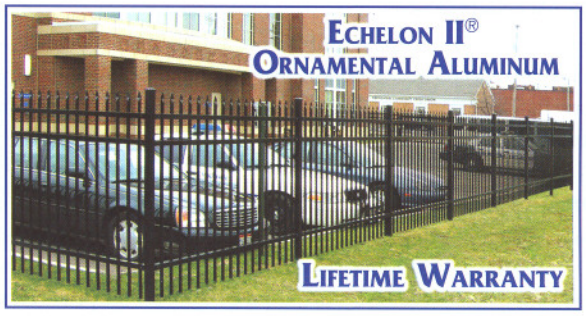

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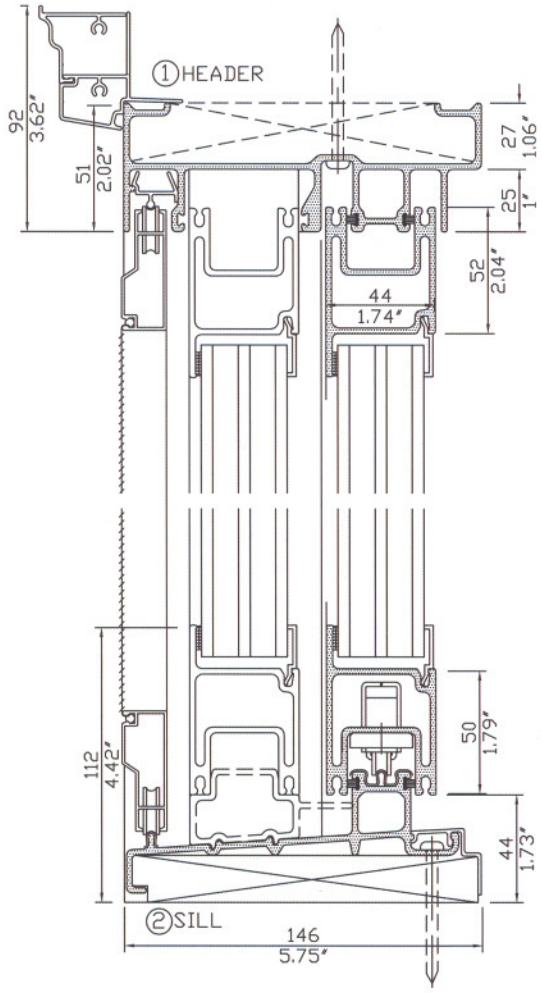
Figure 2



Triple-pane, sliding patio door made of fibreglass.

aforementioned minimal expansion/contraction) creates an ideal base for the wood laminate.

Diamond-bit blades are required to cut the material prior to assembly with mechanical corners. Custom or stock fibreglass lineal dies have been created by several companies allowing the fabrication of swinging or sliding doors.

Understanding moulded panels

A growing number of insulated door panels are being created from fibreglass-reinforced compression moulded skins. Instead of relying on pultrusion, these products are created through a mould production process with the use of fibreglass matting and heat-setting resins. The investment in moulds of various types allows the production of fine details with a considerable range of styles, widths, and heights.

Panels with various species of 'embedded' wood-grain have the reverse 'impressions' placed on the panel surface (although a smooth finish is also possible). The impervious nature of the fibreglass door panel allows staining or painting to highlight the grain for esthetics. Insulated door panels are created when two fibreglass skins are joined and the 44.5-mm (1.75-in.) space in between is typically filled with polyurethane foam. Increasingly, refined use of durable materials in rails, stiles, and lock-blocks ensures greater durability and more effective door performance.

Fibreglass door panels require factory- or site-finishing, which varies from high-performance paints to various wood stains and topcoats for durability. At least one manufacturer has also offered a wide range of 'impregnated' wood grains. Further, specialized door fabricators offer a host of custom capabilities that uniquely take advantage of fibreglass frame and panel capabilities.

Generally speaking, FRP compression moulded skins are expensive to create but can be very effective in producing a relatively high volume of door panels of fixed dimensions and details, increasingly with fine wood-like detailing. Pultruded fibreglass lineals, on the other hand, can be used very effectively at creating custom sizes of window and door frames. It should be noted this line has blurred as pultrusion lineals are also used in sliding and some swinging door panels.

An intuitively attractive characteristic of the material is its base material, sand. Glass strands and matting are inert materials created with relatively low embodied energy and provide excellent durability. Some of the most attractive characteristics of the material for building envelope considerations include:

- aforementioned low rates of expansion/contraction, which lead to greater durability and compatibility with glazing;
- low conductivity, which results in more stable frame temperatures and consequently greater energy efficiency (especially with frame insulation) and reduced condensation/frost;
- ability to create larger glass areas for higher energy ratings;
- finish flexibility from dark colours to real wood laminates;
- durability and resistance to corrosion;
- rigidity; and
- greater stability of costs due to lower sensitivity to energy price tag fluctuations.

Pultrusion capabilities have been developed and refined over approximately 50 years. Since the first all-fibreglass window was offered to Canadian fabricators in 1984, custom and standard materials have been components of Division 08, including fibreglass swinging door frame and transoms and sidelites for a range of lineal offerings.

At present, a growing number of manufacturers are actively employing fibreglass components or creating complete windows and doors made of the material. The continued growth and refinements within the fibreglass industry has resulted in the American Architectural Manufacturers Association's (AAMA's) establishment of the Fiberglass Material Council (FMC).

"2005 U.S. Industry Market Studies," a recent report by AAMA and the Window and Door Manufacturers Association (WDMA), based on a Ducker study from 2007, anticipates growth in fibreglass doors and non-residential products, while the overall residential window and door market declines somewhat. Fibreglass entry doors are specifically highlighted as a growth segment due to "the importance of an attractive entrance." Similar growth is expected in Canada.

In pultrusion, glass fibres (made from silica sand) consisting of roving and mat forms are pulled through a resin impregnation station. The thermosetting resin and fibre mixture are assembled by a forming/shaping guide, and the heat and pressure yields a thin wall profile.

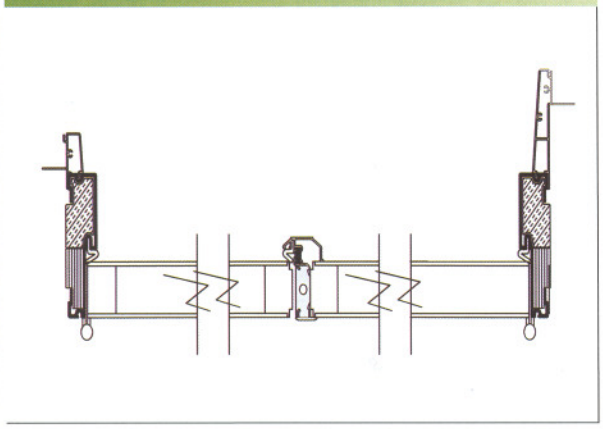
Larry Livermore, technical standards manager with AAMA points out "fibreglass products are estimated to have captured 1.7 per cent of the market in 2006—not a big deal until you consider it is projected to represent 2.4 per cent in 2009, a 41 per cent increase in just three years."

It is also notable AAMA has updated and published performance requirements for fibre-reinforced thermoset profiles used in windows, doors, and skylights as AAMA 305-06, *Voluntary Specifications for Fibre-reinforced Thermoset Profiles.* This document intends to assist design/construction professionals in selecting the material for openings maintaining a standard and superior level of coating performance.

Fibreglass comes of age

An analysis of the components of a fibreglass door system reveals some of the reasons for heightened interest and use in the material. A much greater variety of fibreglass door panels are available from an increasing number of suppliers. Numerous manufacturers across Canada offer a wide selection of door panels, not only in panel types (different wood species and grains), but also sizes. Availability of undersized (less than typical widths of 813 mm [32 in.]) as well as oversized door panels (through to 1016-mm [40 in.] width and 2438-mm [96-in.] height) has made it much easier to complete projects.

Figure 3



Swing double door with astragal (meeting stile seal).

Interest in fibreglass door panels was initially limited due to lack of variety. However, the fundamental advantages of a material with enhanced insulation (thanks to a polyurethane core) when compared to solid wood doors, and greater durability of the fibreglass skin when compared to steel, sustained strong growth, buoyed by an increasing number of finish options. Further, integral flush glazing systems (rather than 'add on' insert surrounds) have yielded sleeker finish details at reduced costs.

Pultruded fibreglass lineals and supporting components have also been refined to the point where pre-finished, low maintenance, insulated door frames (swinging or sliding models) have become available (Figure 2, page 56). As an example, complementary sidelite and transom elements can be combined with perimeter and brickmoulds to suit a variety of new construction and retrofit applications. These frames have been created to allow the use of both dual and tri-pane glass with low emissivity (low-e), allowing for considerably lower overall U-values by design requirement.

Helio Rodrigues, architect and owner of House 5 Custom Homes, has harnessed fibreglass door panel and frame products for his projects to achieve specific esthetics.

"We have incorporated some cutting edge contemporary lines in our feature home including exceptional fibreglass doors," he explains. "We really liked the ability to add sidelites and transoms while keeping the minimalist site-lines of the insulated fibreglass frames. The house even features a copper finish entrance system, which is developing a very attractive patina."

Custom size and configured fibreglass swinging doors have also been used in multi-family high-rise applications. Harry Schroeder, a building envelope expert and project manager with the Government of Manitoba, was part of a team that chose this direction.

"We worked with Wardrop Engineering on a building envelope upgrade in Winnipeg and incorporated a full range of new windows and doors," he says. "We felt we could get the best long term durability and energy efficiency for our 12-storey building with fibreglass windows and doors. The swinging doors were a unique solution with good venting capabilities, large glass area, and the insulated fibreglass frame."

Since the first all-fibreglass window was offered to Canadian fabricators in 1984, product offerings have grown, from swinging door frames and transoms to sidelites. The increased variety means choices for architects looking for esthetic and performance options.

Certain sliding door frames and sash show an even more innovative, but practical, use of pultrusion capabilities. A sliding glass door has been produced that offers a unique insulated frame with a high-performance seal to the sash—side jamb, head, and sill (Figure 3, page 58). The sash design has also taken advantage of the thin wall pultrusion detail to allow either dual or true tri-pane insulating glass (IG) units.

A recent home renovation project by Peter Carroll, owner of Carroll Construction, featured a large swinging door assembly. The project included a substantial addition, which resulted in a more typical new construction installation with perimeter and nailing fin (brickmould and expander were added to simulate traditional details).

"The homeowners wanted a door which would blend in with the historical parts of the home while incorporating cutting edge technology," he explains. "The fibreglass door system complete with tri-pane, low-e glass and simulated divided lites was very effective. It was truly a blend of modern technology and traditional detailing."

Lloyd Secter, a Winnipeg-based architect who specializes in the design of high-end, custom residential and vacation properties, has also specified fibreglass doors with fibreglass windows.

"We have used both sliding and swinging fibreglass doors in our projects," he says. "We have chosen these doors—in consultation with our clients—for their versatility in design as well as their flexibility in finish. The custom combination of windows and entry door was also very suitable for a recent design. A double entry door system was mulled directly to a flanking window, allowing us to maximize the glass area and minimize the framing detail."

For fibreglass, a set of typical standard hues is generally complemented by fabricators with a full range of colour match capabilities—like this brick red frame, intended to match the wood walls.

Another Winnipeg architect, Will Richard, has found numerous uses for the material.

"I have used a fibreglass sliding door as an important design element in a number of projects," he says. "It has given me excellent capability to use large panels of glass while achieving high levels of performance and durability. We had not previously been able to customize sliding doors to these specific requirements."

As has been noted, fibreglass products tend to be specified in more discriminating projects and markets at this point in time. Material and fabrication costs (including customization) have resulted in a premium price, ranging from 25 to 40 per cent more than vinyl and comparable in price to high-quality/performance aluminum and metal-clad wood products. The initial cost spread has narrowed somewhat in recent years as technological improvements and mass commercialization reduce the relative cost of fibreglass products.

The very nature of this segment also results in the use of higher performance elements/components including insulated frame sections and specialized glazing options. As discussed, pultruded fibreglass sidelites have often been designed to accommodate either dual or tri-pane glass—this allows even greater customization with lower overall frame U-values and high or low shading coefficients.

Conclusion

Storefront system capabilities have generally not yet been developed by the FRP industry, but this author knows of at least one company based in the United States that now offers fire-rated fibreglass doors. This is a sign that technological advances with the material continue, likely heralding a reduced price point that will open up the product's use in an increasing number of projects.

Al Dueck, MBA, worked as a manager with a national window manufacturer for 13 years prior to founding Duxton Windows & Doors in 1999. A graduate of the University of Manitoba, he is a member of the Canadian Window & Door Manufacturers Association (CWDMA), and focuses on the manufacture of fibreglass windows and doors. Dueck can be contacted via e-mail at apdueck@duxtonwindows.com.