



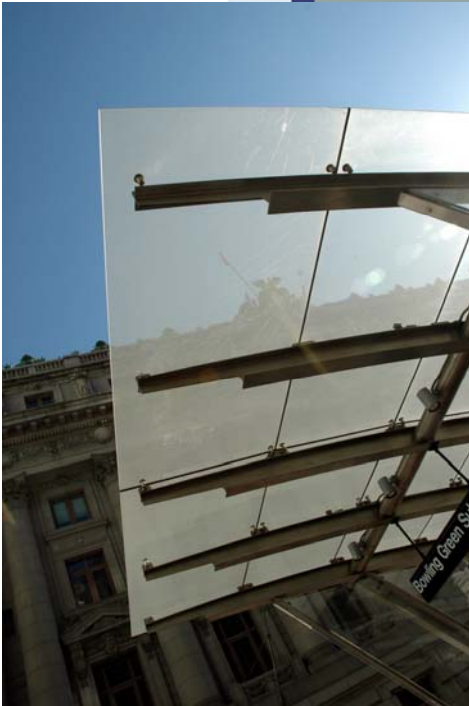
**Bowling Green Subway Station** 4 5

DuPont™ SentryGlas® Case Study

**GLASS CANOPY DELIVERS STRENGTH, SHELTER AND DAYLIGHT AT NEW YORK SUBWAY STATION**



**SentryGlas.**



Sixteen identical glass panels create the 852-sq-ft canopy. Clear sidewall panels use the same glass width and thickness, in lengths tapered to fit the side elevation and radius.



#### Front Cover:

*Bowling Green is the southernmost subway station on Manhattan's Lexington Avenue Line. An all-glass enclosure made with DuPont™ SentryGlas® shelters commuters and protects the escalator from rain and snow.*

### New York Bowling Green Site Rich in Cultural Identity

A landmark location in New York City, Bowling Green is where Native Americans sold Manhattan to Peter Minuit in 1626. It's now where the National Museum of the American Indian is located, with its beaux arts granite building on the National Register of Historic Places. The site is also home to Bowling Green Park, New York's oldest existing public park. So, when designing a cover for a subway station there, architect Dattner Associates had to be sensitive to the site heritage and open space.

The design solution was a frameless glass canopy that shelters the subway entrance while preserving views of the park and historic surroundings. The resulting laminated glass structure is a functional work of art made possible by DuPont™ SentryGlas®, a strong, stiff safety glass interlayer that enables large glass panels, a thin canopy profile, open edges, and excellent transparency..

Natural and artificial light sources shine through the canopy creating a constant variety of looks ranging from crystal clear, to opaque. The ceramic fritting responsible for the effect also helps control heat gain and diffuses UV-rays in the stairwell.

Sixteen identical glass panels create the 852 square foot overhead canopy. The five glass panels on each wall side have identical thickness and width as the canopy, but in progressively smaller lengths to accommodate side elevation and radius. Each side wall measures 141 square feet.

### Escalators and elevators needed weather protection

Bowling Green is the southernmost station on Manhattan's Lexington Avenue Line. The busy terminal has added many commuter-friendly features over the years, including elevators for compliance with the Americans with Disabilities Act and escalators to ease travel for tens of thousands of passengers daily.

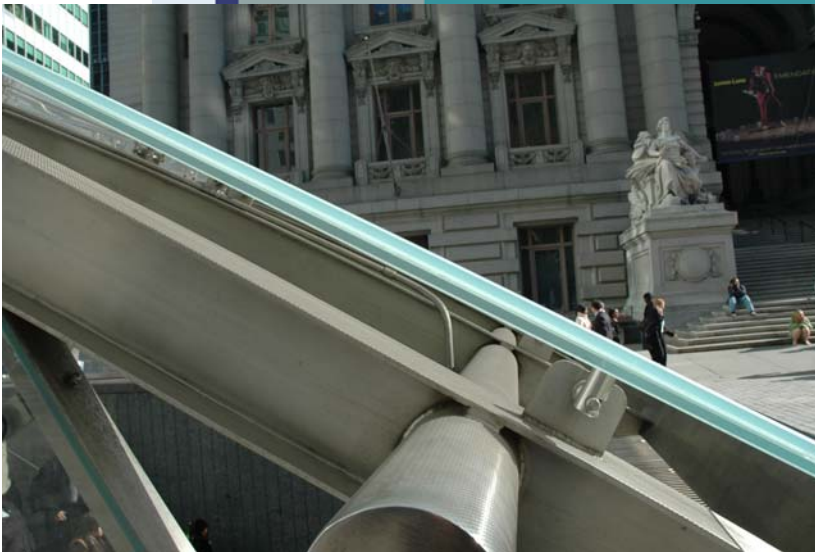
Previous studies had proposed covering the open subway entranceway to shield people and machinery from precipitation and wind using a canopy. When it rained or snowed, the stairs got slippery. The escalators weren't meant for exposure to weather and kept breaking down, so when MTA New York City Transit installed new elevators in 2007, the decision was made to cover the entrance.

William Stein, AIA, principal architect at Dattner Architects, NYC, says, "The real question, considering this highly visible location, was not if the station needs a canopy, but what the canopy should look like and what it should be made of. The city's transit office overlooks the plaza, so the canopy would be a constant reminder of good choices, or bad, to everyone involved in the decision-making process."

Traditional laminated safety glass features framed panels. However, recent advances in glass laminating provide designers with more durable, frameless, clear-edged glass panels that can be bolted directly to modern structural elements.

### Decision Time

Stein recounts, "When we were brought into the project, we discussed the need for design sensitivity for this landmark location. Should the canopy be Victorian? Traditional? Classical? Contemporary? We decided early on to recommend a transparent structure that wouldn't obstruct views of the surrounding sights. We didn't want to compete with or hide the surrounding designs, we wanted to enhance and work with them." A laminated, glazed glass structure seemed the obvious direction to head in. Stein explains, "Glass would allow us to design a canopy that was light, transparent and open. At one point we discussed using framed glass, but a frameless design is much more elegant. The exposed edges on frameless glass are a more natural fit for the canopy's graceful, arcing shape."



The canopy's thin-profile glass panels consist of: 10-mm Optiwhite T-Plus glass; 1.52-mm DuPont™ SentryGlas® interlayer; and 10-mm Optiwhite T-Plus with 40% white dot ceramic frit on Surface 2.

The project team added to their “wish list” frameless glass that was as light and thin as possible. W & W Glass Systems, Inc., the New York metropolitan area's largest architectural glass and metal contractor recommended a structural glass system made with DuPont™ SentryGlas®. Jeff Haber, W & W managing partner, says, “It was important to fulfill the architect's goal for a material that was thin and light, but that also would perform under physical stresses including high winds, snow loads, and, let's face it, whatever New Yorkers can throw at it.”

Ordinary laminated glass with a PVB interlayer has a tendency to wick moisture and discolor at the edges. In contrast, the Pilkington Planar™ SentryGlas® System uses high performance glass without PVB. Haber confirms, “SentryGlas® is more structurally stable and stiffer than PVB. It has improved post-breakage performance. Plus, the Pilkington Planar SentryGlas® System uses an OptiWhite glass that stays crystal clear over time with no green tinge.”

The canopy assembly is engineered to withstand structural loads per A-36042 specifications: wind load, any direction, 30 psf; snow load, 30 psf; point load, 300 lb. Glass support hardware is 316 stainless steel with an as machined

finish. The silicone sealant tolerance is +/- 50% movement; black was chosen instead of white, which tends to discolor. Backer rope is an open cell, non-gassing polyurethane. The overhead canopy and sidewall panels are supported by a framework of steel gussets.



### Low maintenance and energy savings

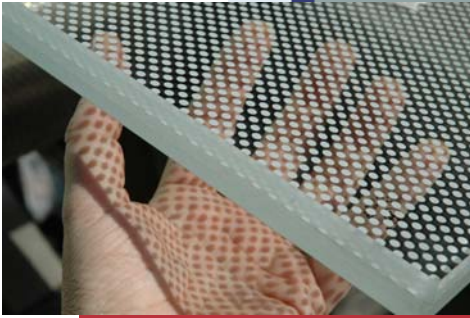
The canopy, completed in 2007, consists of sixteen pieces of frameless, corner-bolted, segmented laminated glass panels. The roof and side wall panels are supported by five stainless steel ribs that project over the entrance. A small but significant detail is the black sealant used at the glass joints. “Black discolors less than white,” according to Stein. “We simply walked around the city to look at other bolted glass structures, and saw that, over time, white sealants get dirty.”

The canopy virtually self-washes with rain water, and only periodic maintenance will be needed for the sealants. The lifespan of the canopy is expected to be approximately 40 years with little to no other maintenance.

Another design detail is the ceramic fritting located between the underside of the glass and the SentryGlas® layer. The 40% dot pattern coverage is enough to enhance maintenance without negatively affecting the adhesion of the glass and interlayer. Stein confirms, “The MTA New York City Transit is very maintenance-oriented and the fritting is a critical dirt-hiding feature.”

In addition to maintenance benefits, the project team at Dattner liked the fact that fritted glass lets daylight in. Daylighting is a sustainable way to reduce lighting energy costs and improve safety. And, although no empirical studies have been conducted by the MTA New York City Transit, Stein and Haber agree that fritted glass creates an effective UV shield that helps control solar gain and increase comfort for commuters using the subway entrance.

“The fritting also subtly distinguishes the overhead roof from the vertical glass on the canopy's sides, and changes translucency throughout the day,” observes Stein. “With changing weather conditions and with various viewing angles, the canopy can look crystal clear, opaque or practically white. It's a very elegant effect, befitting the location.”



White ceramic frit with a 40% dot pattern diffuses sunlight and hides dirt, while protecting the required adhesion of glass and interlayer.

**Coordinated Municipal and Commercial Effort**

There was total top-to bottom endorsement by the MTA New York City Transit for this project. Stein explains, “The project involved close coordination with various public agencies and community organizations, as well as the General Contractor and all the subcontractors and materials suppliers. We really thank New York City Transit for their support and collaboration on this project, considering the unique design, demanding shapes and complex geometry. They went out on a limb with us to do something a little different and everyone’s faith in the outcome has paid off.” Validating their decision is the fact that the canopy is receiving much favorable feedback from the city, the community and fellow architects.

Another measure of the canopy’s success is that MTA New York City Transit is using Bowling Green as the prototype for additional projects. A proposed new subway station at the city’s West 34th Street terminal will be modeled on the Bowling Green design, but with a slightly different shape containing more glass spans and built on a larger footprint. Haber confirms, “Thin, floating glass is gaining in popularity because of the look that can be achieved using the Pilkington Planar™ SentryGlas® System. Architects can rest easy about the structural integrity of their designs, even those using larger-sized panels, thanks to innovations in laminated glass technology.”



The fritted overhead glass helps reduce solar gain, and distinguishes the canopy’s gracefully curved roof, atop its nearly invisible sidewalls.

**Project Details**

**Project Owner:** MTA New York City Transit . David Foell, design manager, Capital Programs Management.

**Architect:** Dattner Architects. William Stein, Principal. Richard Dattner, Lead Designer. Steven Frankel, Project Manager.

**Structural Engineers:** MTA New York City Transit.

**Managing Consultant:** Parsons Brinckerhoff.

**General Contractor:** Citnalta Construction Corporation.

**Glazer:** W&W Glass Systems, Inc. Jeff Haber, Managing Partner.

**Glass System Fabricator:** Pilkington Architectural. Tim Morgan, Designer

More information: [www.sentryglas.com](http://www.sentryglas.com)

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