Breaking Glass Ceiling Around Fearless Girl

Sophie Pennetier, Enclos
Merica May Jensen, OBJ

Abstract

OBJ in collaboration with Sophie Pennetier, Paul Laroque and Michael Ludvik designed a shattered glass ceiling that surrounded the Fearless Girl statue (Kristen Visbal, 2017) in front of the New York Stock Exchange for International Women's Day, 2021. The work was a snapshot of motion – a still of glass in mid-fall, mid-break – and came with a message: Today's broken glass ceilings are tomorrow's stepping stones.

01 Introduction

OBJ Architects, in collaboration with Sophie Pennetier, Paul Laroque and Michael Ludvik designed a shattered glass ceiling that surrounded the Fearless Girl statue (Kristen Visbal, 2017) in front of the New York Stock Exchange for International Women's Day, March 8th, 2021. The work, envisioned and commissioned by State Street Global Advisors through the agency McCann World Group, came with a message: Today's broken glass ceilings are tomorrow's stepping stones (Figure 1).

The naturally reflective piece is dynamic and performative, changing as the sun moves across the sky and as pedestrians move around the street. Taking in the reflections of the surrounding context, the New York Stock Exchange is broken into fractured reflections below Fearless Girl's feet.

Using the beauty and power of a simple pile of glass, the piece reflects that society's glass ceiling has not been fully shattered yet. The work explores the process of glass breaking and expresses that motion in time. OBJ wanted the work to read "as if [the glass elements] were still falling, like a snapshot of movement. The challenge became how to realize the concept: how to support floating pieces of glass on a public street in NYC."

02 Design Process

The 350 polygonal glass panels were designed using 12mm annealed clear soda lime glass with 1mm arrisses and polish on all edges.

Figure 1: Fearless Glass Ceiling Installation facing the New York Stock Exchange.

Some panels laid flat on the ground, and some were propped up with a glass kickstand, similar to a picture frame, with a transparent glass connection.

The Design Team experimented with breaking glass in different ways, evaluating how glass shards play with light and shadow, and looking to emulate the breakage patterns with the overall installation made of fabricated glass. This desire for transparency favored a study of discrete assembly techniques for the larger glass kickstands, such as point fixing, interlocking machined glass key, glass welding, ionomer "T" connection, these were forgone, and the fully transparent UV-cured liquid adhesive was selected (Dymax 429 Gel, 0.5mm thickness).

The UV light cured adhesive was chosen for its optical and mechanical properties both in stiffness and strength, deemed adequate for the 2-day installation in the spring of NYC.

The architectural design as well as the structural engineering processes were completely parametric and developed remotely. Using Grasshopper and Karamba, the engineers prepared a script toolbox for the architects to use in order to achieve the maximum effectiveness of the shape, size, and layout of each of the shards. The scripts allowed for the validation of overturning load cases under dead, live and wind loads (Figure 2), as well as the validation of maximum weights and approximate stresses in the glass. Equipping the designers with a script toolbox enabled a dynamic design process which transcended the traditional linear back and forth between the architects, the clients and the engineers. If used with relevant instructions, trust and the necessary caution associated with its circumstantiality, a script toolbox allows for a fast-paced creative and integrated design process.

Once the general layout, geometries and orientations had progressed, a Finite Element Analysis loop in Strand7 was leveraged to accurately confirm the principal stresses in the glass and adhesive bonding elements, as well as the maximal deflections under long term and short-term loads.

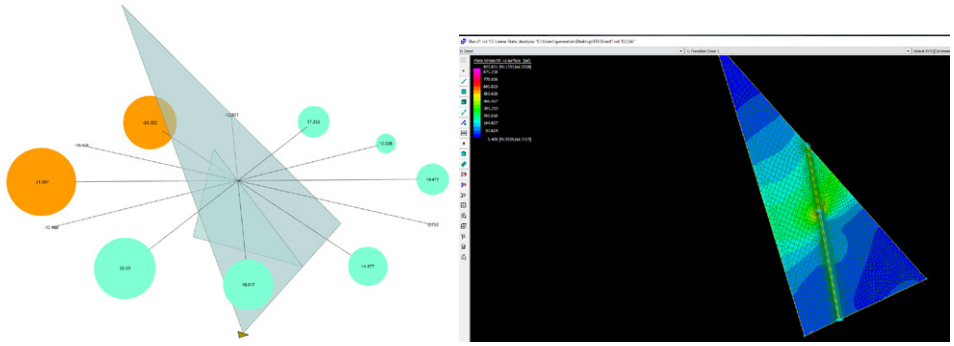

Figure 2: Left: Grasshopper Script Toolbox. Right: Strand7 Finite Element Analysis.

The need for a more advanced FEA package in addition to the scripts was necessary to accurately model the adhesive. The outcome of this last FEA loop resulted in minor alterations of the length of the largest kickstand assemblies.

The structural design was based on ASTM E1300-12 "Glass in Buildings" and ASCE07-05 "Loads for Buildings and Other Structures". The Structural Basis of Design was based on the following conditions:

- The project lasted only 2 days which allowed for wind loads significantly lower than typically used in buildings or any other permanent installations: the sculpture was designed for a 3 second wind gust of 40mph (64 km/h).
- Access to the glass panels was limited by the presence of security professionals onsite, which allowed for low exceptional loads of up to 5lbs (2kg) for the kickstands taller than 2ft (0.6m) and 3lbs (1.4kg) for the smaller ones.

The design continued to evolve once the glass manufacturer came on board, with further input from fabrication lead times, costs, and transportation. In-depth collaboration between designers, clients, engineers, manufacturers and installers was essential to strengthen and deliver the design vision. The entire project happened remotely, as most of the world was still in lockdown and travel was limited.

03 Procurement and Fabrication

Agnora, located near Toronto, was selected to manufacture the glass parts, which were assembled into kickstand assemblies by the team at The New Motor In New York, who also installed the exhibition.

As usual, tight schedule and budget goals tested the creativity of the Design Team. In order to expedite parts drawings, the design team parametrically produced the cut files information directly into Agnora's glass cutting equipment file format. The handoff from the architects was 100% paperless and essentially consisted of live spreadsheets. Upon joining the team, Agnora's diligence and patience was mirrored with a high level of leeway from the architects, open to impactful feedback throughout the latest stages of design.

The architects were very keen on understanding the full life cycle of the glass sheets throughout procurement and fabrication. After inquiring Agnora about the size of glass sheets they were intending to use, the designers decided to adapt the geometry of the panels to minimize the scrap to limit

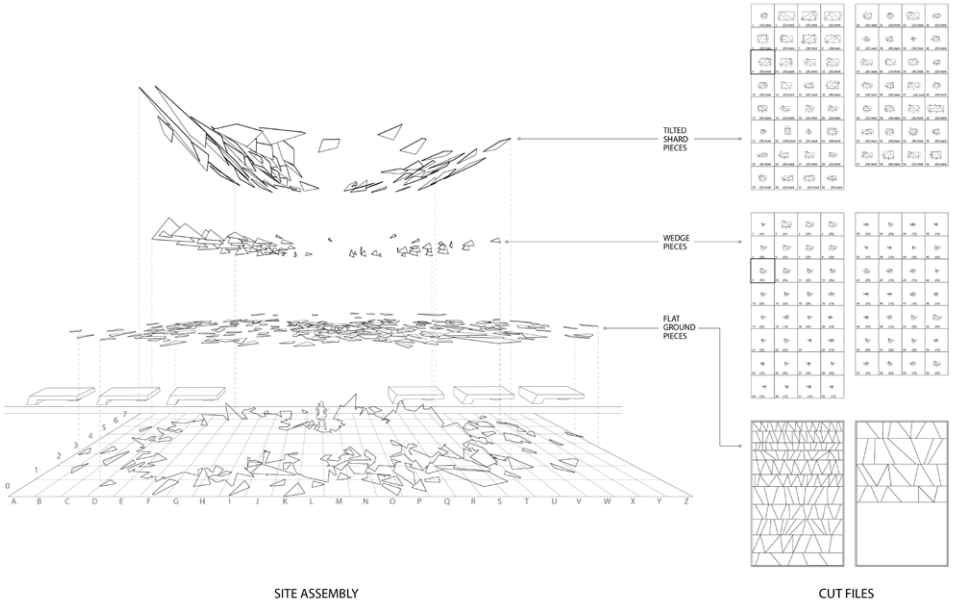

Figure 3: Cutting Layout from 1.5 Jumbo Glass Sheet.

Figure 4: Glass Fabrication by Agnora.

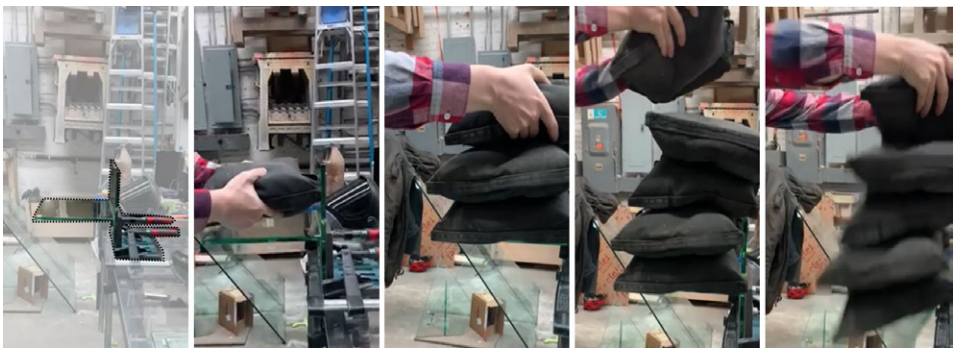

Figure 5: Structural Testing of Adhesive Joint.

the project to one and a half jumbo float glass sheets.

A Visual Mock-Up (VMU) was arranged to validate the fabrication method and visual quality of the adhesive joints. Simultaneously, a handful of small test assemblies were produced to confirm the shear and pull-out resistance of the joints (Figure 5). The tests validated the adequate curing of the adhesive joints as well as the method of assembly itself for the 2-day exhibition. Following the VMU, the team opted to use small rubber shims under the heaviest glass assemblies to avoid any accidental friction between the larger glass kickstands and the pavers on site.

New Motor assembled all kickstands at their shop in Brooklyn, in the weeks preceding the exhibition (Figure 6). It was the first time the team used this assembly method and was easier than expected. No joint failed throughout the shipping, onsite installation, exhibition, and deinstallation of the sculpture.

04 Installation

The glass sculpture was installed by New Motor on the night before the opening, in the presence of members of the architects, engineers, and clients' teams.

A site grid using colored strings was used for layout. Each panel assembly had an ID tag, which was used to locate the assembly on the site grid, using the same approach as for layout of buildings' facades units.

The kickstand assemblies were designed to be handled manually by 2 installers without any additional equipment.

Equipped with an iPad, the designers and clients were able to follow the progress and accuracy of the installation by using an Augmented Reality application. The slope of the site on Broad Street made it difficult to move around the installation and required a reset if the user moved more than a few steps away after indexing the geometry interface. The use of AR was particularly valuable for the simultaneous visualization of layers of inclined transparent glass assemblies and their components, which was particularly challenging to represent and check with 2D drawings (Figures 7 and 8).

As the sun rose on Wall Street, the clients and professional photographers arrived to capture the diaphanous installation in the first lights of the day (Figure 9).

Figure 6: Assembly by The New Motor.

Figure 7: Glass Panels Installation – Transparent Front Elevation.

Figure 8: Fearless Girl view from Wall Street.

05 Exhibition

The 2-day installation, which opened on International Women's Day 2021 was well received by the public (Figure 9).

The security team was equipped with a hand-held anemometer and instructed to monitor and record the wind speed every hour or as soon as higher gusts were to be felt. A safety plan was strategized to secure the sculpture, were the wind to exceed a given threshold. Luckily, the wind speeds did not exceed 10 mph (16 km/h) which was 4 times lower than the design wind loads, and no glass assembly toppled over.

06 Recycling

After the installation was over, at the end of the second day, the glass pieces were transported off site. A portion of the glass is stored and preserved for future installations, since many glass ceiling remain to be broken. The rest of the glass was recycled.

Acknowledgements

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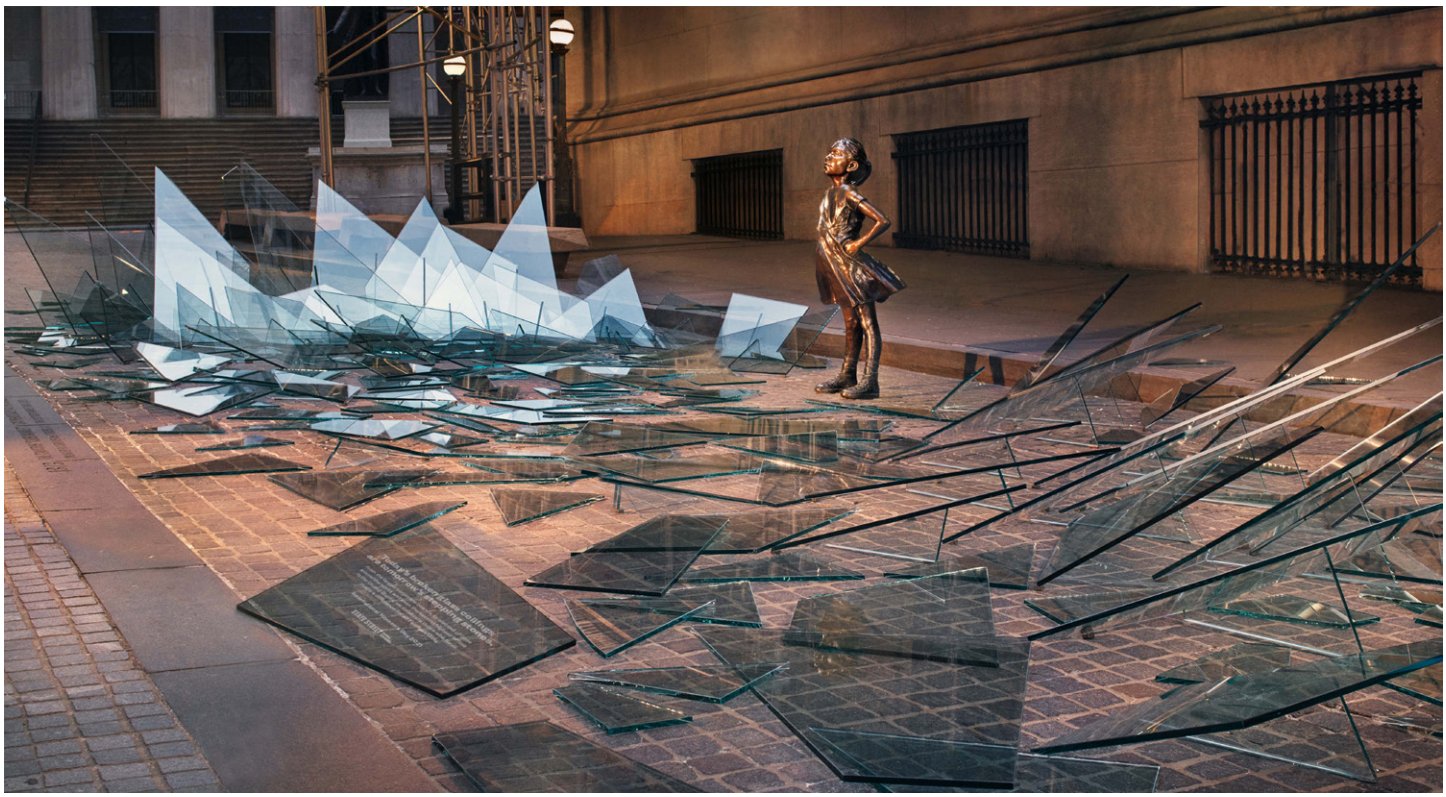

Figure 9: Fearless Glass Ceiling Installation facing the New York Stock Exchange (photo credit: Sophie Holland).