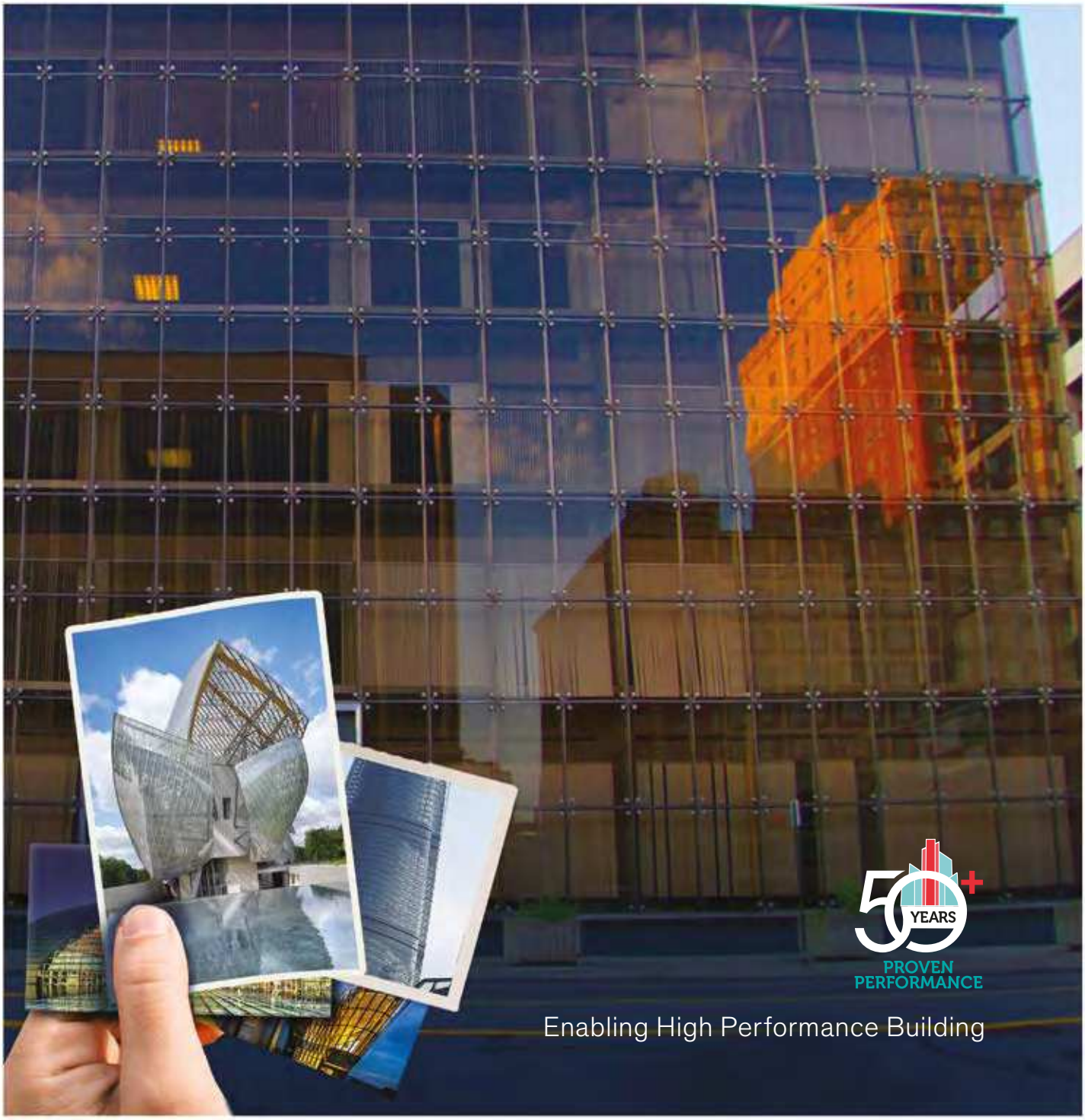
DOW CORNING

50+ Years of Proven Silicone Performance



Changing the Face of World Cities

In the 1950s and 1960s, Dow Corning was a pioneer of technologies that opened the eyes of architects to a new way of designing and realizing pure glass aesthetics, first with long-lasting weatherproofing sealants, and then with revolutionary silicone structural glazing (SSG).

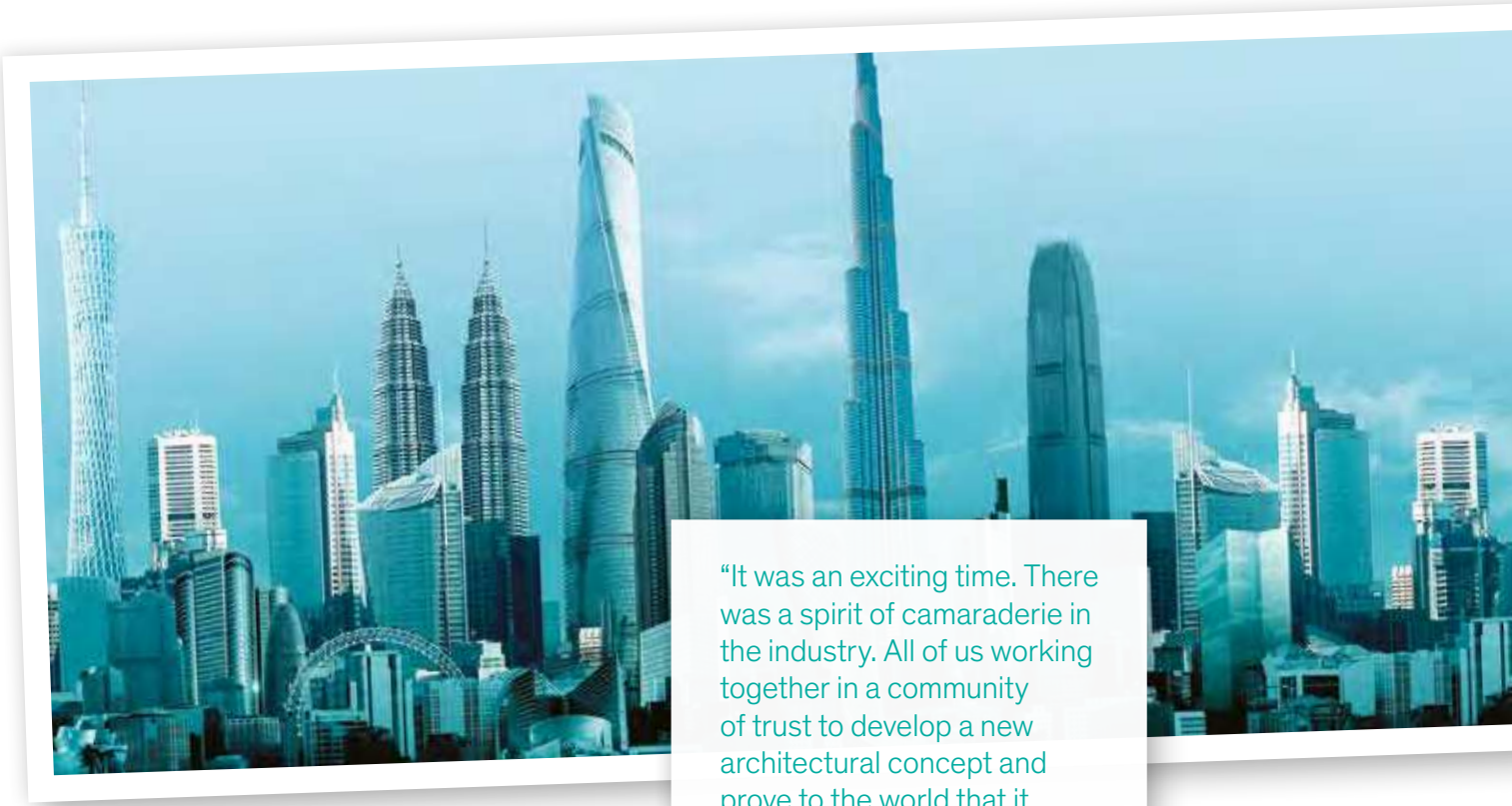
No longer restricted by the need for intrusive mechanical fasteners, the imagination of architects was freed to create structures previously thought to be beyond the realm of possibility.

Designed to accommodate movement and transfer wind loads from the glass to the building framework, SSG systems remain elastic and provide long-term structural capability.

This pioneering work was more than a simple product development. It included significant levels of testing; small-scale mockups on job sites; assessment of adhesion durability, movement capability, fatigue and failure; and a sizeable engineering study to properly analyze designs, stresses and environmental variables. That pioneering work continues to this day, with solutions meticulously engineered using advanced techniques such as finite element analysis (FEA). These innovations include development of high-design-strength sealants, which reduce joint size and increase natural light, and the creation of point-fixed attachments for glass facades, which eliminate gas leakage and thermal bridging.

Today, industry-standard application engineering requirements and installation processes have been developed, and quality control guidelines – such as Dow Corning's *Quality Bond*™[1] program – that control, monitor and audit application quality and project details help ensure continued SSG success. The proof is on display as designers embrace this technology to push boundaries, creating increasingly beautiful – and sustainable – architectural showpieces.

[1]*Quality Bond*™ is not available in North America.



"It was an exciting time. There was a spirit of camaraderie in the industry. All of us working together in a community of trust to develop a new architectural concept and prove to the world that it would work."

Jerry Klosowski, Klosowski Scientific Inc., regarding the pioneering spirit

On the cover: From the first use of four-sided silicone structural glazing at 455 W. Fort Street in Detroit (large photo) to bold and cutting-edge architecture such as Fondation Louis Vuitton in Paris (primary inset photo), silicone sealants from Dow Corning continue to expand design options for architects.

About Silicone Structural Glazing

SSG is a curtainwalling method that utilizes a structural silicone sealant to adhere glass to metal frames. It is increasingly popular and helps achieve pure glass aesthetics: sleek and flush with no visible mechanical fasteners.

The structural silicone is designed to withstand environmental exposure (e.g., UV radiation, temperature extremes, weathering) and mechanical loads resulting from deadload, temperature, wind, human impact loads and other factors. Common designs use two-sided SSG (vertical joints bonded) or four-sided SSG (both horizontal and vertical joints bonded).

A History of Innovation

SILICONE WEATHERSEALING

Silicone polymers were developed for use in sealants back in the 1930s by Dow Corning and General Electric Corporation, but it was in the mid-1950s when one-part silicone construction sealants entered the marketplace. One of the first single-component silicone sealants was a clear acetoxy sealant from Dow Corning. In 1958, that sealant was used as a weatherseal in a building on the western shore of Lake Michigan.

During a 2013 facade update, it was found that after 55 years of in-place weathering in the Climate Zone 6 environment, the 1958 silicone sealant remained in place and was well-bonded to the glass substrates on approximately 90% of the building. The sealant material generally remained flexible and elastic.

SILICONE STRUCTURAL GLAZING

Silicone structural glazing began in the mid-1960s with glass mullions structurally bonded to external glass to rigidify the facade structure and increase daylight and transparency.

During the 1980s, the SSG curtainwalling concept spread rapidly around the world, as this glazing method allowed architects new levels of design freedom and offered a unique aesthetic appearance. SSG became an outstanding success, with tens of thousands of projects demonstrating its aesthetic and performance benefits:

- Architectural design freedom
- Unique aesthetic appearance
- Inherent simplicity of construction
- Flush, easy-to-clean exteriors
- Improved thermal efficiency of buildings
- Improved performance of blast and impact protective glazing
- Enhanced resilience of glazing in earthquake zones

A major stepping point in the progression of commercial facade construction – four-sided SSG – is still on display today at 455 W. Fort Street in Detroit, Michigan, USA.

1971 – THE "GRANDDADDY" OF STRUCTURAL GLAZING:

The world's first four-sided silicone structural glazing project was designed by architects Smith, Hinchman and Grylls. 455 W. Fort Street in Detroit, Michigan, USA.

"When these products became available, we were all talking about what kinds of information would give people a degree of confidence. Dow Corning started doing various kinds of testing to prove that the materials would work. They did a lot of good basic test work that I'm not aware of anyone else doing at that time. Dow Corning was one of the prime movers in getting properties tested and working with the rest of us at ASTM to develop industry-accepted standards for structural silicone glazing."

Tom O'Connor, FAIA, FASTM, LEED AP, Former Building Technology Studio Director for SmithGroupJJR, architects of the world's first four-sided structural silicone glazing project – the former Smith, Hinchman & Grylls (SH&G) Headquarters building in Detroit, Michigan, USA

Scientific Durability Studies Predict 50-Year Performance

Two separate studies confirm what industry experts have believed for years, and hard data verifies what field performance has long indicated: *Dow Corning*® brand SSG sealants deliver long-term performance and durability.

STUDY 1

ETAG 002 TEST ON 25-YEAR-OLD STRUCTURAL SILICONE

In 1985, the southwest-facing bow front facade section of a building was installed at the ift Rosenheim, an internationally renowned authority in the testing of windows and facades. The first generation of SSG, *Dow Corning*® 983 Silicone Glazing and Curtainwall Adhesive/Sealant, was used in a typical toggle-system design.

The three-story-high toggle-glazed SSG system broke new ground, including outer glass that was not fixed with additional mechanical safety retainers nor any deadload support.

From 1985 to 2010, the facade was exposed to:

- Outdoor temperature extremes from -6 to 90.5°F (-21.1 to 32.5°C)
- Solar radiation exposure (annual average) of 1,100 kWh/m²

When the facade was refurbished for improved energy efficiency, the disassembled SSG structure with its structural silicone was reassessed per ETAG 002-1. Approximately 200 specimens were cut from the SSG units and successfully tested to the ETAG 002 specification.

The 25-year-old sealant passed ETAG 002-1, theoretically proving the sealant for an additional 25 years, totaling a 50-year service life.

Toggle-glazed SSG

IFT ROSENHEIM
Rosenheim, Germany

About ETAG 002

European Technical Approval Guideline 002 (ETAG 002), an approval guideline for silicone structural glazing sealants and systems, was developed by the European Organization for Technical Approvals (EOTA) in 1991.

Its comprehensive range of tests and stringent assessment criteria make ETAG 002-1 a very demanding standard for SSG sealants. The standard defines key provisions for bonding strength and durability of bonding strength of the SSG sealant and, notably, mentions that the provisions made in ETAG 002-1 are based on an assumed 25-year service life of the SSG structure.

Karl-Heinz Rückeshäuser, KHR Consulting

"Beside the challenges and hurdles we had to take to establish structural glazing in Europe, it was an exciting time and a pleasure to work with the 'Innovators' on implementing this concept in a quite conservative market environment. I am pleased to see how popular this design concept is now after more than 25 years in Europe."

STUDY 2

50-YEAR SIMULATED SEVERITY TESTING

A test specimen with *Dow Corning*® 993 Silicone Structural Glazing Sealant was simultaneously exposed to artificial weathering and complex, multiaxial mechanical loadings in Federal Institute for Materials Research and Testing (BAM) simulated durability testing. This test is considered to be more severe than the ETAG 002 testing regimen.

The tested sealant completed:
- 50 cycles of testing (assumed to be 50 years)
- One impact load test
- Two additional cycles (equivalent to two additional years)

After testing, *Dow Corning* 993 Silicone Structural Glazing Sealant continued to meet ETAG 002-1 performance criteria for residual tensile strength and adhesion, confirming a robust and outstanding durability and underlining the proven performance track record.

Successful completion of this test corresponds to an anticipated service life of 50 years for *Dow Corning* 993 Silicone Structural Glazing Sealant.

"Structural glazing today provides a powerful tool for architects to achieve the most incredible building designs. Not only is it a proven method of curtainwall construction, this technique works as part of a complete system to facilitate state-of-the-art performance with regards to air infiltration, water infiltration, thermal performance, seismic performance, impact resistance, longevity and design freedom. This high-performance technique is a benchmark for current and future materials regarding sustainability and green construction."

Larry Carbary, Dow Corning Industry Scientist

BAM
Bundesanstalt für Materialforschung und -prüfung

"The severe BAM durability test confirms long-term durability."

Dipl.-Ing. Christoph Recknagel, Project Leader, Bundesanstalt für Materialforschung und -prüfung (BAM)

About the BAM Research Project

The Federal Institute for Materials Research and Testing (BAM) in Germany – a leading research institute for science and technology – developed a performance-based durability test method for SSG sealants in a 2012-2015 research project.

The key challenge of the project was to develop a test method that better reflects an actual service environment, combining conditions resulting from wind, deadload and movement as well as typical environmental exposures, such as temperature, UV radiation, water and chemicals.

The test uses a 24-hour test cycle that is anticipated to correspond to one year of service life. The test specimens were exposed to simultaneous climatic and multiaxial mechanical loads in a climatic chamber.

Test Conditions and Assumptions

Designs: single glass, stepped glass and insulating glass
- Units installed at a height of 164 ft (50 m)
- Size: 8.2 ft x 10.5 ft (2.5 m x 3.2 m)
- Four-sided SSG
- Joint dimension: 0.47 in x 0.24 in (12 mm x 6 mm)
- With and without deadload support: Type II and Type IV (ETAG)
- Design stress structural silicone: 30 psi (0.21 MPa)

Load considerations:
- Deadload, wind loads, human impact loads
- Temperature, solar radiation
- Chemical loads resulting from rain and cleaning agents

A Journey of Innovative Silicone Construction

1958

First silicone weatherproofing sealant

1964

First two-sided structural silicone application: "Total Vision" system

1968

Two-sided structural glazing in curtainwalls

1971

First four-sided structural silicone application

455 W. FORT ST.

Detroit, Michigan, USA
Architect: Smith Hinchman & Grylls

1976

First four-sided structural silicone application unsupported

MENTOR MUNICIPAL CENTER

Mentor, Ohio, USA

Constantly curved design

FLAME TOWERS

Baku, Azerbaijan
Architect: HOK International

Complex reflective glass design

HARPA CONCERT HALL

Reykjavik, Iceland
Architect: Henning Larsen Architects, Batteriid Architects

Serigraphed, S-shaped glass panels

MUSEUM AAN DE STROOM

Antwerp, Belgium
Architect: Neutelings Riedijk Architects

2013

2012

2010

2014

Free-form glass panels

FONDATION LOUIS VUITTON

Paris, France
Architect: Frank Gehry

Curved glass and ceramic panels

ICE KRAKOW

Kraków, Poland
Architect: Ingarden & Ewý Architekci, Arata Isozaki & Associates

Crystal clear bonding (exterior)

INSTITUTE FOR RESEARCH AND TREATMENT OF CANCER

Torino, Italy
Architect: Studio Cucchiarati S.R.L.

Megatall, high energy efficiency

SHANGHAI TOWER

Shanghai, China
Architect: Gensler

First four-sided structural glazing in Hong Kong

CAMERON CENTRE

Tsim Sha Tsui, Hong Kong

1984

First generation of fast-curing two-part structural silicones

1985

Protective glazing for seismic loads

CENTER TOWER

Costa Mesa (Los Angeles), California, USA
Architect: CRS Sirrine

1989

Protective glazing for bomb blast and hurricane loads

1992

2002

Dramatic and imposing entrance facade

OLD TRAFFORD

Manchester, United Kingdom
Architect: AFL

Curved glass, daylight opening

NATIONAL GRAND THEATER OF CHINA

Beijing, China
Architect: Paul Andreu

2008

Clean sealant technology

PIER 1 IMPORTS

Fort Worth, Texas, USA
Architect: Kendall/Heaton Associates Inc.

2004

2003

Impact-resistant glazing

WESTIN DIPLOMAT RESORT & SPA

Hollywood, Florida, USA
Architect: Nichols, Brosch, Sandoval and Associates

Gridshell glass roof

CHADSTONE SHOPPING CENTRE

Melbourne, Victoria, Australia
Architect: CallisonRTKL, The Buchan Group

2015

XXL glass structurally bonded

CORNING MUSEUM OF GLASS

Corning, New York, USA
Architect: Thomas Phifer and Partners

2016

2017

High-rise construction

PING AN INTERNATIONAL FINANCE CENTER

Shenzhen, China
Architect: Kohn Pedersen Fox Associates

2020

Planned as world's tallest building

JEDDAH TOWER

Jeddah, Makkah, Saudi Arabia
Architect: Adrian Smith + Gordon Gill Architecture LLP

INFLUENCE ON LONGEVITY

Dow Corning® brand structural glazing sealants are designed and tested to withstand harsh climatic conditions and mechanical loading and to meet existing established global and local standards. However, it is important to carefully consider factors that might have an impact on durability, such as:

- Joint design and dimension
- Chemical compatibility with adjacent materials
- Substrate quality and conformity
- Quality of workmanship

To enable a high level of quality, we provide extensive technical support, including the *Quality Bond*™ program, to properly track, monitor and control application quality.

LEARN MORE

Talk to a representative to learn how you can put our long history of innovative solutions to work for your construction challenge. Find local contact information at **dowcorning.com/ContactUs**.

Dow High Performance Building solutions include proven and innovative materials for structural and protective glazing, weatherproofing, insulating glass, high-efficiency insulation, and window and door fabrication. To learn more, visit **dowcorning.com/50plus**.

50+ YEARS
PROVEN PERFORMANCE

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