The fischer magazine for experts

CONNECT IT

New Porsche Museum in Stuttgart
Undercut anchors hold an inclined glass façade in place

EWI
External Wall Insulation

COMPUFIX 8.3
More options for bonded anchors

Issue 11
New Porsche Museum in Stuttgart

Undercut anchors hold an inclined glass façade in place

Dr. Klaus Fockenberg, PR Officer, fixing systems
Dr. Roland Unterweger, Advanced Curtain Wall Technique

The outer secondary façade is a glass fitting mounted construction using fischer FZP-G
The opening ceremony for the new Porsche-Museum in Stuttgart was held at the end of January 2009. The design by the Viennese architects Delugan Meissl impresses with its array of different geometric shapes which largely do without right angles. The glass façade, inclining outwards and held in place with unique fischer undercut anchors, faces Porsche Square.

The monumental and futuristic building touches the limits of structural design and sets a new architectural highlight in Stuttgart’s cityscape. Built in Stuttgart-Zuffenhausen between the city metro station Neuwirtshaus, Schwieberdinger Strasse and Porsche Square, the Porsche-Museum stretched planners and contractors to their limits. The architects of Delugan Meissl aimed to create a space of sensuous experience which translates into architecture the dynamic nature and philosophy of the Porsche brand.

The outcome is a steel, glass and sheet metal giant weighing 35,000 tonnes, with a 5,600 square metre exhibition space. Floors, ceilings and walls are finished in sober white. Alternating displays of 80 unique vehicles and 200 other small exhibits show Porsche’s impressive history. The museum also houses the company archive, a garage for veteran cars, which is also for the use of private clients, a conference area and a variety of catering establishments.

Structurally highly loaded steel concrete cores

Structurally, the dynamically shaped monolithic building with a total length of 150 metres consists of the Basement and the Flier. The Basement with its three cores carrying the entire weight of the building consists mainly of water-impermeable steel concrete. The cores with their base plates 3.75 metres in thickness rest on large-size piles with a diameter of 1.20 metres. Due to the exceptional weight and geometry of the structure, its walls are up to 75 cm thick in places.

The actual exhibition area is located above the Basement. A complex load-bearing steel structure, with spans of as much as 60 metres and overhangs of as much as 45 metres, rises above a height of 16 metres. Part of the exceptional weight is primarily carried by a circumferential trussed beam with the height of a floor, before the weight is transferred to the ground through the three cores.

The glazed front of the building offers a panoramic view of Porsche Square. The other façades are clad in a white sheet metal skin. The exhibition hall itself also acts as a roof over the entrance lobby.
A challenge for the glass construction

The front façade proved to be a particularly demanding challenge. It is mounted above the main entrance and has been designed as a double façade. The inner insulation glass façade rests on line-shaped bearings all round and forms the actual space closure. The outer, secondary façade was made as a construction with point-to-point in-place fittings. The space between the façades is accessible for cleaning and service work, with the service personnel moving across mobile ladders and equipped with safety ropes.

The façade is inclined by 16.5° from the vertical to the outside and is about 13 metres in height. Its dimensions at the upper edge are 41 metres and 40 metres at the lower edge. The lower edge of the façade is 14 metres, the upper edge 27 metres above the top edge of the building. As a result of this angle, the façade is actually an overhead glazing, according to building laws. The glass joints between the panels were left open.

For this point-held glazing made of laminated safety glass (VSG), the outside consists of 10 mm heat-strengthened glass (TVG), the inside of 8 mm TVG. The individual panes have a maximum width of 3.454 mm and a height of 1.917 mm, each resting at the upper and lower edge of the glass on six fischer FZP-G-Z undercut glass fixings. The edge spacing to the glass edges is only 85 mm.

The dead weight of the construction is absorbed by two steel angle elements. The undercut glass fixings are mounted on to the substructure with steel lugs with large bores to ensure stress-free support for the glazing. The substructure made of S 235 construction steel consists of triangular hollow profile locking elements, stiffened with vertical flat steel posts.

The glass fixing system used

For the first time worldwide, the undercut technology allowed a fixing to be used for glass where the bore hole does not pierce the glass. The glass fixing is installed via a conically undercut blind hole with torque control. This allows glass panes to be anchored to the substructure without any fixings visible from the outside. The smooth outside is aesthetically more pleasing, there are no breaks in the glass to allow penetration of moisture or dirt, and the façade stays cleaner for longer periods.

The fischer FZP-G-Z undercut glass fitting has the general construction authority approval (No. Z.70.2-122) of the Deutsche Institut für Bautechnik (DIBt). The approval is valid for glass panes with a maximum size of 2,000 mm by 3,000 mm. They may be used for rear-ventilated outside claddings under DIN 18516-41 and for room-enclosing vertical glazing, with tempered glass (ESG or ESG-H) and laminated safety glass (VSG). The glass panels can be enamelled or coated, and they may be used as carriers for top-laminated solar panels.

Successful failure load and residual load-bearing capacity tests

The overhead glazing used is subject to special technical rules and regulations for line bearing glazing (TRLV) and the technical rules and regulations for the design and execution of point bearing glazing (TRPV). The focus of these safety considerations is on the residual load-bearing capacity of the glazing in the failure state.

The fischer FZP-G-Z glass fittings conform with the approval. However, the type of glass used (VSG from TVG), the glass size and the method of installation are not regulated.
in the approval. For this reason, the owner applied to the supreme building authority for consent in individual cases, based on an arithmetical feasibility study and the test concept by SuP Ingenieure GmbH of Darmstadt which had been coordinated with the supreme Land building authority.

Proof of the load-bearing capacity was determined by means of failure load test. For this purpose, the façade builders Rupert App of Leutkirch carried out tests at their headquarters in the Allgäu under supervision of the State Material Test Institute (MPA Darmstadt) and the Land building authority of Baden Württemberg. The testing regime to establish the maximum load required a horizontal installation position and loading the glass façade with sandbags. These tests resulted in an adequate minimum safety level of \( \gamma = 4.30 \).

To evaluate the residual load-bearing capacity, the Darmstadt Material Testing Institute carried out the appropriate tests. For the tests, building components were examined in their original installed position at an inclination of 16.5° from the vertical. In line with the test concept, half the wind load was applied on to the test elements by using sandbags. The laminated safety glass panes were then struck at different points inside and out with a pick hammer and destroyed as scheduled. The panes broke into pieces with a breakage picture typical for heat-strengthened glass. No significant deformation was found even after putting the panes under stress in as many as eight different points.

The condition for a successful test: no failure after 24 hours under simulated reduced wind load and dead weight. The simulated wind load was then removed and the construction assessed. No significant changes from the initial situation were found. The construction was then observed for another period of 24 hours, again without any changes worth mentioning from the initial situation. The specifications by the Land authorities were fully complied with. Based on the positive test results and the final expert report given by SuP Ingenieure GmbH, the single-instance approval was finally granted.

Summary

The Porsche-Museum goes to new dimensions of structural engineering. This is also true of the unusual design of the glass panorama façade which is absolutely unique in its present form. The project has been made possible by the close and constructive collaboration between owners, planners, test institutes, experts, building authorities, façade builders and the façade expertise of the fischer group of companies.