

Fabrication & Installation

The single-skin and double-skin facade designs developed by KSP Jürgen Engel Architekten placed extreme demands on the fabrication process. The individual unitized curtain wall units, infill panels and electrical components were produced and assembled at our Fritzlar plant.

■ Fabrication process and assembly of unitized curtain wall units

The unitized curtain wall units for the office tower facade were fabricated at our Fritzlar plant. All components, including electric drives and infill panels, were factory-assembled.

Given the wide diversity of curtain wall units, each module was individually entered in a database together with its exact position in the facade. This allowed each unit to be treated as a unique component and streamlined the process of allocating accessories to the many different models, thereby simplifying subsequent installation.

The associated fabrication and installation instructions were also assigned to the individual units recorded in the database. The various database entries and allocations were then used by our engineers to generate the fabrication documents.

The fabrication of all curtain wall units was completed within around ten months. The production facilities in our workshops were optimized in line with the specific requirements. The units were fabricated by our skilled team of operatives using a flow production system, with different



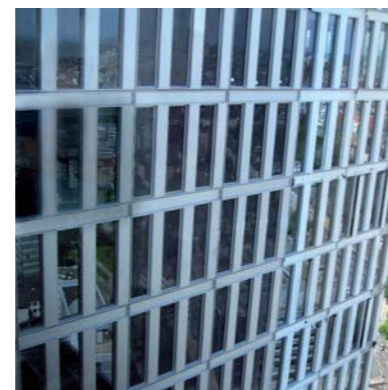
Eastern and western front of office tower with double-skin facade (left) and single-skin facade (right)



operations carried out at each station. The first step was to isomate the inner and outer aluminium sections with thermal-breaks. The isomated sections were then cut to size and CNC-machined. The work was partly performed in three-shifts.

Our operatives then assembled the individual components into unitized modules, complete with accessories.

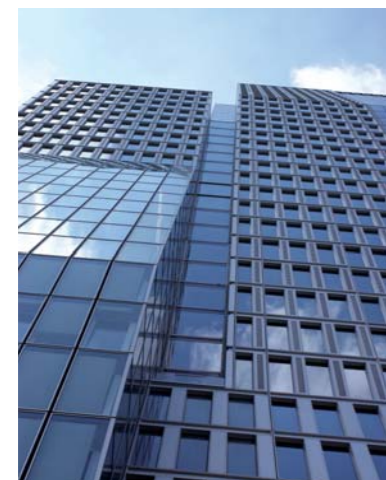
All electrically driven components, such as parallel opening and tilt-and-turn windows, were completely pre-



Detail of unitized double-skin facade

assembled and incorporated in the unitized modules at our workshop. Test runs were then performed. Similarly, all infill panels and glazing units for the curtain walling, apart from some individual façade parts, were preinstalled in the workshop.

The outer glazing of the double-skin facades was also installed and sealed at the workshop. Some of the curtain wall modules (specifically, the corner units) weighed up to 1,000 kg each. The units were moved around the workshop using transport lines and ceiling cranes.



Details of double-skin facade, viewed from below



Fabrication & Installation

The limited storage capacity available for the unitized curtain wall units both at our workshops and on site forced us to develop a project-specific fabrication and installation strategy. This paved the way for the successful fabrication of all components to a tight schedule within a three-day period prior to just in time on-site delivery and efficient installation.

■ Logistical requirements and on-site installation

Given the immense volume (some 3,000) of – in some cases, gigantically sized – curtain wall units, we decided to adopt a just-in-time fabrication system, tailored to the specific site requirements. In most cases, the finished curtain wall units were delivered to the site and installed at the latest three days after production.

This placed extremely rigorous demands on the logistics and installation processes: the lack of on-site storage capacity severely narrowed the time window for delivery of the components.

Some of the curtain wall units assembled at the Fritzlar workshop had to be moved to the site by special trailers. In line with the logistics concept, deliveries had to be made in the late evening or early morning hours.

The use of special transport racks allowed rapid unloading of the components and their immediate transfer to the point of installation. A special logistic team was responsible for the distribution of all curtain wall units, via staging platforms to the individual storeys, where they were then installed.

The following installation procedures were adopted:



PalaisQuartier with office tower

• **Procedure 1:** The curtain wall (double-skin facade) units were delivered and moved across the site in crates, then placed on staging platforms for distribution within the building. Prior to installation, the units were first moved to the edge of the structural floor. Then, they were lifted out of the building using a mini-crane located in the storey above and hooked into the prepared anchor brackets.

• **Procedure 2:** After delivery, the over-size single-skin facade units were stored temporarily on the large staging platforms. They were later moved to the place of installation by using a monorail system mounted at the edge of the building.



Office tower under construction and nearing completion ...



... at dawn



... stunningly lit, by night



Design Architect: *KSP Jürgen Engel Architekten, Frankfurt/Main*
 Client: *Bouwfonds MAB Development GmbH, Frankfurt/Main branch*
 General contractor: *BAM Deutschland AG, Frankfurt/Main branch*
 Curtain wall package: *Anders Metallbau GmbH, Fritzlar*

Mission

The PalaisQuartier complex in Frankfurt/Main boasts an unmistakable identity. Adjoining the shopping mall and reconstructed baroque palace, the Thurn und Taxis Palais, two high-rises designed by internationally distinguished architectural practice KSP Jürgen Engel Architekten dominate the skyline.



© Photo: PalaisQuartier GmbH & Co. KG

Architectural concept: PalaisQuartier high-rises

The outstanding office high-rise stands to the rear of the reconstructed historic palace, overlooking a newly designed public square, the Thurn-und-Taxis-Platz. The building comprises a podium plus 32-storey office tower, whose architecture echoes that of the neighbouring hotel tower. The design created by architect KSP Jürgen Engel Architekten responds to the various urban geometries: while the emphasis of the shopping mall is on horizontality, the high-rise buildings, set back from the street, add a vertical focus. In their height, both towers refer to Frankfurt Cathedral. While the architectural ensemble makes no attempt to compete with the German financial centre's other high-rise clusters, it nonetheless asserts its own unique identity as an urban landmark.

Office tower at Thurn-und-Taxis-Platz: attractive workplaces for global players

In styling the new office tower, KSP Jürgen Engel Architekten employed a variety of miscellaneous features. Through their gentle inward and outward inclination, the elegant aluminium and glass facades enhance the sculptural quality of the architecture. With a total floor area of 48,000 sqm, spread over 32 storeys, the bright and airy interiors behind the distinctive envelope afford the tenants magnificent views of the Frankfurt skyline. The spacious, transparent lobby area affords the prestige value appropriate to global corporations. Roof terraces, opening windows and over three-metre-high spaces offer a comfortable and exclusive working environment. All office areas can be flexibly configured as cellular, team or open-plan spaces in line with particular needs. The sizes of the lettable office units range from a minimum 350 sqm to a maximum 1,200 sqm.

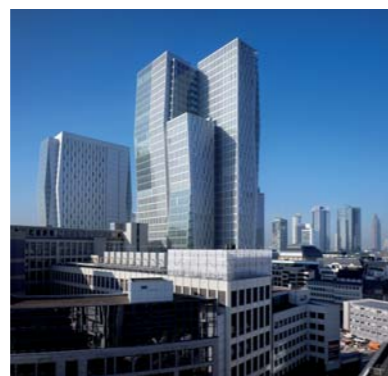
Intelligent energy concept

The external envelope was designed by KSP Jürgen Engel Architekten, depending on orientation, as a single-skin facade

or a double-skin facade with integrated sunshading. This arrangement promotes energy efficiency while providing effective sound control for occupants. The use of geothermal energy, as a renewable energy source, for heating in winter and cooling in summer cuts energy consumption and duly lowers the tenant's utility costs.

Anders Metallbau – expert curtain wall provider

In May 2007, we were appointed by general contractor BAM Deutschland AG to provide the double-skin facades and unitized curtain walls (some with radar-absorbent areas), sunshades and wall claddings. The challenging contract was completed to the full satisfaction of the entire project team only 24 months later, in May 2009.



Top: PalaisQuartier in heart of Frankfurt/Main; Bottom: office tower with skyline in background

Structural & Facade Design

The new office tower at Thurn-und-Taxis-Platz in the centre of Frankfurt/Main offers an attractive home for global corporations. The architecture, featuring miscellaneous elements that include inwardly and outwardly inclined facades, proved a tough test for our engineering team.

Design work underpinned by component tests

Given the stringent technical requirements and aesthetic criteria, comprehensive component tests were needed to obtain the required certifications.

Bonding:

The main purpose of the extensive test series was to clear the way for the use of bonding technology to fix aluminium-sheet panels to the facade exterior. We commissioned the Materials Testing Institute University of Stuttgart (MPA Stuttgart) to perform far-reaching tests on the loadbearing capacity of the bonded assembly and the chemical and environmental resistance of the associated adhesives. The MPA Stuttgart also conducted long-term tests.

Wind noise:

We appointed Büro Wacker Ingenieure to investigate the wind noise resulting from the use of slotted metal panels.

Radar absorption:

We mandated the EADS to perform component tests and measurements that allowed us to verify compliance with the required radar absorption values in the slotted panel areas.

Condensation and thermal control:

To guarantee the facade's long-term performance, calculations and tests were carried out to demonstrate compliance with thermal insulation and condensation control requirements.

Air permeability, watertightness, wind load tests:

Wind tunnel tests were conducted ahead of the design phase to determine the loads acting on the facades. These results fed into the structural calculations. The requirements were simulated during component tests on original curtain wall units. CE certification was then granted on the basis of the test results and verified characteristics. This certification chiefly relates to air permeability, watertightness and wind load tests. All tests were successfully completed.

Facade design



The curtain walling installed by Anders Metallbau on the office tower enclosed four high-rise blocks and covered a total facade

area of around 22,000 sqm. The aluminium curtain wall system, developed by us for the entire building envelope, was designed in three basic variants:

- Unitized double-skin facades with integrated sunshading and motorized tilt-and-turn vents
- Unitized single-skin facades with parallel outward-opening windows
- Corridor facades, mainly in the form of single-skin facades with fixed lights and pane sizes of up to 2.7 x 3.7 m.

All the facade assemblies, both vertical and (inwardly/outwardly) inclined, were fabricated and installed by Anders Metallbau. Laminated safety glass in

conjunction with double glazed units, solar-controlled, has been used for the glazing. Some of the external facade and panel surfaces were provided with radar-absorbent coatings.

Design features

In all, the aluminium sections incorporated in the building envelope weighed some 750 tonnes. All curtain wall types used special sections developed from Schüco system assemblies.

The contract also included the installation of around 1,200 motorized parallel opening windows and 350 electrically operated tilt-and-turn windows. These assemblies feature concealed drives and hardware, based on the Schüco Avantec system.

The motorized opening lights are controlled via the building management system (BMS), which was provided by others.

The PalaisQuartier office tower project also marked the first application anywhere in Germany of a special double-sided adhesive tape to fix large-format metal panels on a building exterior.

Wide-ranging tests and verifications were necessary. Overall, around 40,000 m of double-sided adhesive tape was used to clad a facade area of approx. 9,000 sqm with metal panels.



The unitized curtain wall modules ranged from 1.35 x 3.7 m to 4.05 x 3.7 m in size and weighed up to 1.3 tonnes. The unitized modules installed between the ground and third upper floors were up to 5.6 m tall and fitted with burglar-proof glazing. All sections and panel surfaces were E6/EV1 silver-anodized.

Interiors

A combination of imposing architecture, prominent urban location and wide-ranging amenities make the PalaisQuartier office tower a unique working environment. But work is only one of the activities housed at the site: executives, staff and customers also have the opportunity to go shopping, chill out or, if needs be, even stay overnight in the neighbouring hotel.

Unique working atmosphere

The PalaisQuartier office tower stands at the heart of Frankfurt/Main, only a few minutes' walk from the financial district, stock exchange, pedestrian precinct and the city's opera house. The transparent glass architecture generates a supreme working atmosphere. Particularly appealing for international corporations are the spacious interiors and spectacular vistas of the surrounding cityscape. The office high-rise provides a total 35,000 sqm of high-amenity rental accommodation. The entrance lobby and a suite of conference rooms are located on the lower levels. While a fourth-storey link offers employees and visitors direct access to the MyZeil shopping mall, two roof terraces, 90 m above ground level, provide the perfect setting to unwind. The office tower is equipped with a total of nine lift cars and five separate lifts serving the 18th to 32nd floors. The basement levels house Frankfurt's largest underground car park, with capacity for 1,390 cars.



Office on one of top levels, with breathtaking view of Frankfurt's skyline

Facts and figures: the essentials in brief

Employer/architect/project team:

Operator/client:	Bouwfonds MAB Development GmbH, Frankfurt/Main branch
Design Architect:	KSP Jürgen Engel Architekten, Frankfurt/Main
General contractor:	BAM Deutschland AG, Frankfurt/Main branch
Structural checking engineer:	König und Heunisch Planungsgesellschaft, Frankfurt/Main
Curtain wall package:	Anders Metallbau GmbH, Fritzlär
Facade component suppliers:	Schüco International KG, Bielefeld
Sections and hardware:	Schüco International KG, Deggendorf
Sunshading systems:	BGT Bischoff Glastechnik AG, Bretten
Glazing:	
Curtain wall tests/certification and component tests:	IFT Rosenheim GmbH, Rosenheim Schüco International KG, Bielefeld
Technical consulting for metal panel bonding:	3M Deutschland GmbH, Neuss

Bonding component tests and expert reports:

MPA Stuttgart, Otto Graf Institute, Stuttgart

Radar absorption component tests:

EADS Deutschland GmbH, Bremen

Project data:

Total curtain wall area:	Approx. 22,000 sqm
Unitized single-skin curtain walls:	Approx. 14,000 sqm
Unitized double-skin curtain walls:	Approx. 8,000 sqm
Curtain wall units:	Approx. 3,000
Aluminium sections:	Approx. 750 t
Aluminium sheet (2.5 and 6.0 mm):	Approx. 110 t
Solar-control/insulating glass units:	Approx. 3,700
Single-glazed LSG units:	Approx. 1,600
Flat steel frames:	Approx. 6,800 m
Special sections:	Approx. 25 models
Maximum unit size:	4.05 x 3.35 m
Maximum unit weight:	Approx. 1.1 t

Picture sources: The picture rights to all photos marked accordingly reside with PalaisQuartier GmbH & Co. KG. All other photos were taken by our project managers.

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