Renovating Modern Heritage – The Upgraded Façade of Commerzbank Düsseldorf

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Abstract
The post-war building stock is increasingly being transformed. Even at objects protected as listed heritage, renovation usually results in a high degree of material exchange and replacement. This is especially the case in regard to historic curtain wall constructions. Based on the case study of the Commerzbank High-rise and original planning documents by Gartner, the paper focuses on the applied strategy of disassembling and reassembling the curtained aluminium sandwich elements, and the resulting upgrading of the original façade with a newly installed interlayer for insulation. The paper discusses the possible transfer of this strategy, which largely depended on the existing high quality of the aluminium components, their corrosion-resistant properties and low weight. The case study of the former Commerzbank High-rise indicates that a long-term preservation of post-war modern building stock can be achieved without wholesale replacement of original building components. The reuse of existing materials and components represents a promising approach.

Keywords
façade renovation, reuse, retrofitting, aluminium curtain wall, Josef Gartner GmbH, modern building heritage conservation

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1 INTRODUCTION

The post-war building stock is currently being heavily transformed, repaired, and upgraded. Increasingly stringent requirements and regulations, especially in regard to energy savings, render modern structures unsustainable. After half a century of use, post-war modern structures seem to become obsolete. It does not help that they are generally considered as irreparable. Even with objects protected as listed heritage, renovation usually results in a high degree of material change and replacement. This is especially true in the case of historic building envelopes. In Germany, prominent recent examples of thorough replacement of "light" curtain wall façades through improved replicas include the listed HVB Tower in Munich (1975–1981, architects Walther and Bea Betz), where between 2013 and 2015 the double-pane insulating glass façade has been updated to a box window façade with a total of four layers of glass, while retaining the external appearance (Henn Architects with the support of façade planners R+R Fuchs). Similarly, the listed BMW-Vierzylinder High-rise, BMW's headquarters in Munich (1968–1972, architect Karl Schwanzer) was re-clad with a new façade between 2004 and 2006 by architects Schweger Associates, copying the original one. The façades of the double high-rises of the Deutsche Bank in Frankfurt (1979–1984, architects Hanig, Scheid, Schmidt) were also replaced by seemingly identical replicas in 2011 (technical architects Volkwin Marg and Hubert Nienhoff, gmp). The new construction allows for the hydraulically assisted opening of windows. With an almost 90% reduction of carbon-dioxide emissions, the renewed edifice was certified LEED Platinum and DGNB gold.

To the passer-by, these new façades are not recognizable as such. In all cases, the greatest attention was paid to preserving the external appearance of the listed buildings. However, it is questionable whether replacing the building fabric so extensively after only 30 to 40 years of service is really sustainable. Arguably and probably, the new façades will hardly last longer. The common approach also contradicts the usual high regard towards historic materiality in Building Heritage Conservation. Conservation and restoration of modern building heritage started in the 1980s and 1990s. Projects concerned largely on iconic buildings from the Modern Movement of the interwar period. Early on, "light" metal-glass-façades were taken care for, like in the prominent examples of Zonnestraal Sanatorium (1927–1931, architects Jan Duiker, Bernard Bijvoet, and Jan Gerko Wiebenga, restoration between 1995 and 2008) and its contemporary Van Nelle Factory (1925–1928, architects Johannes Brinkman and Leendert van der Vlugt, restoration 1998 - 2004), both in the Netherlands, the latter a UNESCO World Heritage Site since 2014. Through trial and error, such projects helped to define conservation approaches which could be applied to "everyday modern" buildings of less historic importance (Jonge, 2017). Based on practical experience, Wessel de Jonge, an authority on the restoration of modern architecture, distinguishes between three principal approaches in dealing with historic light façades. First, the improvement of thermal characteristics by adding secondary glazing or altogether replacement of glazing, resulting in complete change in appearance and considered unsuitable for protected façades. Second, an upgrade of the historic façade itself, retaining some of the original components. And third, by adding a secondary layer on the interior (Jonge, 2017, p. 100). Whereas the restored Zonnestraal Sanatorium is merely a representation of the original idea and design intent, rather than original in material (Meurs & van Thoor, 2010), the restoration of the Van Nelle Factory resulted in a more conservative approach. Here, a secondary internal façade was added which allowed for the buildings' authentic glazed envelope to be retained in place, as a simple screen against wind, rain, and noise (Kuipers, 2017; Ayón et al., 2019, p. 114-121). In regard to the preservation of post-war high-rise buildings in Germany, a similar development can be traced regarding the eminent restorations of the "Dreischeibenhaus", the Thyssen High-rise in Düsseldorf (1957–1960, architects HPP), which was renovated in 1994 and again in 2015 by HPP. Whereas the façade, after several previous repairs, was replaced completely by a replica of similar appearance to the original, but different, construction in the 1990s (Fürst, 1998), the recent renovation was careful not to replace the façade again and instead enhanced it with a new interior layer for isolation.

Preservation of modern architectural icons in general in recent years has proven the significance of original building materials to their conservation, despite them often being machine-made and industrially mass fabricated. Such materials can hardly be reconstituted today and are of essential historic and artistic value to these objects. Considerations of preservation are less alien to the subject of curtain-walled façade and high-rises than one might at first assume. According to a hitherto unpublished analysis of their protection status, the proportion of listed buildings among historic high-rise offices in Germany is higher than average (Rung & Putz, 2021). Of more than 400 such structures built between 1950 and 1980, about a quarter is today legally protected as heritage. Only 10% have been demolished. The extent of the protected fabric is even higher if one looks at envelope surface instead of building units, as mostly large and prominent high-rises have been considered for protection. These results correspond with a parallel statistical survey, also unpublished thus far, of curtain-wall façades built by the prominent manufacturer Josef Gartner GmbH between 1955 and 1985, of which about 10% are currently legally protected as building heritage (Grom, 2021). It is expected that the number of protected edifices of this kind will rise in coming years due to ongoing inventorisation.

With the high percentage of protected heritage objects among curtain-walled high-rise buildings, and increased attention given to the preservation of original appearance and materiality, we conclude that new approaches for the upgrading and conservation need to be developed, but in such a way that these approaches also allow for necessary energy and comfort related improvements. The recent renovation of the former Commerzbank High-rise in Düsseldorf might show a feasible way. Designed by architect Paul Schneider-Esleben and built in the period 1959-1962, it was renovated and preserved in 2021 as one of the city's most outstanding post-war architectural monuments. Whereas the interior was converted into a hotel and lost its original features, the façade was renovated according to building conservation standards. Planned by HPP architects, an office strongly engaged in adaptive reuse and conversion of existing structures in recent years, with the support of Bollinger+Grohmann for structural engineering and façade engineering, the upgrading of the façade was carried out by the same company responsible for the original construction, renowned façade manufacturer Josef Gartner GmbH. It was possible to maintain the original components and appearance while still meeting increased building physics requirements. With its reused and upgraded envelope, the new hotel high-rise was certified as DGNB platinum in 2021.

2 CONSTRUCTION HISTORY

In a brief historical outline, the development of panel constructions is described to place the Commerzbank's façade within the history of construction. In curtain wall construction, a series of developments in the post-war decades basically resulted in two feasible types of construction: stick systems or ladder systems and panel constructions, from which mullion-transom façade systems and unitized systems have been developed. In America, the development of these types of construction took place almost simultaneously, while in Europe, stick systems were increasingly used, mainly due to economic reasons. A façade in stick system construction can be produced economically without expensive machines and in smaller series. For panel elements made of sheet metal, large punches and presses with expensive tools are necessary, which are only worthwhile for large buildings with very high quantities of elements (Gockell, 1964, p. 8).

After World War II, the steel skeleton construction method with a curtain-wall façade of extruded aluminium profile frames – infilled with panels of aluminium sheets and glass – became established in high-rise building construction in the US for weight reasons. Panel constructions made of metal, in aluminium or steel, have been used there since the early 1950s. In Germany, comparable façade constructions made of panels can only be observed a decade later. The architect Schneider-Esleben gained inspiration from various building projects on a study trip to the USA. He ultimately broke away from the idea of a conventional grid façade, as can be seen from numerous preliminary designs. The idea of the Commerzbank façade can probably be traced back to the Alcoa Building in Pittsburgh (USA), designed by the architects Harrison & Abramovitz, which was built between 1950 and 1953 (Gartner, 2021). The Alcoa façade is one of the first high-rise façades worldwide consisting of storey-high anodised aluminium sheet panels with punched-out window openings. Reversible sashes with frames made of extruded profiles are inserted into the openings; the corners of the openings and reversible sashes are rounded and sealed with a compressed air hose. The vertical joints of the panels are made of panel edges butt-screwed together, which allow a component movement when the length changes. At the horizontal joints, the panels overlap. Overall, a fairly even joint pattern is created despite the different joints. The panels are fastened to the faces of the floor slabs with steel brackets. The sheet metal shells are backed with lightweight concrete for thermal insulation, creating a ventilated space between them. In addition, the metal sheets have a striking design feature. They are embossed with a prismatic concave pattern, two square embossments per panel element, which simultaneously create spatial rigidity against wind loads (Schaal, 1961, p. 214). Other American examples of metal panel façades were also mostly made of single-layer sheet metal, stiffening profiles, and initially without integrated insulation. In comparison, the Commerzbank façade of 1962 in Düsseldorf is one of the first examples with a completely prefabricated and flat façade consisting of insulated panels without stiffening profiles or a frame construction. Regardless of this, the French architect, metal construction pioneer and inventor, Jean Prouvé, had already been experimenting with insulated elements made of sheet steel in the 1930s. A first significant application can be found at the Maison du Peuple in Clichy in France from 1935–1939 by architects Eugène Beaudouin and Marcel Lods. The first curtain wall "mur Rideau" made of industrially produced, double-skin panels of formed and folded sheet steel is installed in the office wing of the building, to which the Alcoa façade in Pittsburgh surprisingly bears some similarities. Prouvé's façade was well known among American architects (Sulzer, 1991, p. 23). Prouvé designed the first noteworthy aluminium façade in Europe in 1951 for the Fédération du Bâtiment building in Paris (France), consisting of insulated, completely prefabricated wall units equipped with horizontal sliding windows and ventilation strips (Aluminium-Zentrale e.V., 1959, p. 12).

This selection of examples can be used to demonstrate the basic construction types of panel constructions. The sheet metal panel of the Alcoa façade stands at the beginning of the constructional development. Here, the embossing stiffens the panel. It has no frame and no insulating layer. The wall units of the Jean Prouvé in Paris are built from a stiffening frame construction, while the insulation is integrated into the panel in spaced shells. The façade of the Commerzbank represents another stage of development, the panel is constructed as a composite element without a frame, the insulation layer alone serves to stiffen it. On closer inspection, however, the Alcoa façade in Pittsburgh is actually a simple cladding made of aluminium sheets, which at first glance can hardly be distinguished from a classic curtain wall. The even more ground-breaking wall unit of the Jean Prouvé in Paris is a skeleton infill, as it was placed between the storey ceilings and not curtained. The façade of the Commerzbank however is a real curtain wall made of sandwich elements.

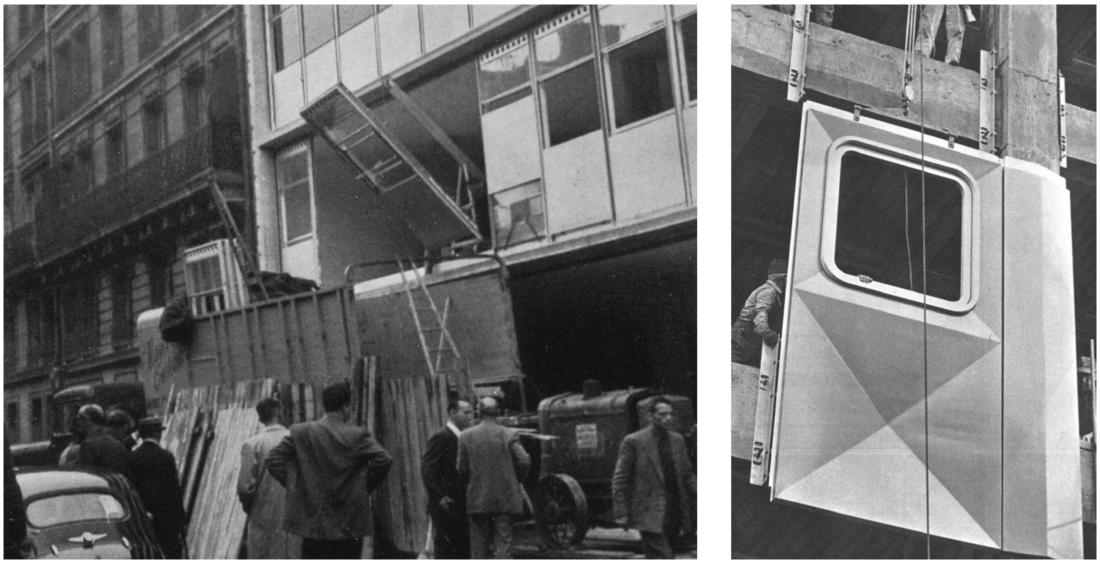

FIG. 1 Mounting of the wall elements in Paris in 1951. Photo in Aluminium-Zentrale e.V., 1959, p.12. (left). Mounting of the wall elements in Pittsburgh in 1953. Photo in Schaal, R. 1961, p. 217. Photo: Alcoa Pittsburg Pa. USA. (right)

In contemporary literature, the façades of these three examples are typologically assigned to panel constructions (Schaal, 1961, p. 213-235; Hofmann, Griese & Meyer-Bohe, 1973, p. 140-141), which, however, are referred to as façade elements or unitized systems according to today's general understanding. However, the designation "façade element" alone says nothing about the constructive structure, the degree of prefabrication and the assembly, because façade elements can also be made from muntin constructions. Rolf Schaal wrote in 1961 that "the construction elements of the panel constructions - like the panels - (...) are in principle enlarged panels of a similar type to those used in muntin constructions. Their construction is essentially the same as that of the panels. In contrast to muntin walls, where the panels rely on the load-bearing and connecting effect of the muntins, the panels are joined together directly without the aid of a visible and dividing muntin framework." (Schaal, 1961, p. 213) The term panel construction is used here to refer to a second type of construction of façade elements. (Gockell, 1964, p. 7) The curtain wall systems that emerged in Germany from the mid-1950s onwards are mostly made of muntin constructions, which are either assembled from individual components or from prefabricated frames. Over the decades, the prefabricated frames, which are possible in a wide variety of variations, have been developed further to create façade elements as we know them today. Unitized systems or façade elements are characterized by a high degree of prefabrication. They are either partially or completely prefabricated, depending on the panel or frame construction. They thus enable an assured quality of production in the factory. They are usually storey-high and one window axis wide. Faster assembly on site is possible with a small number of personnel compared to pure muntin constructions.

3 CASE STUDY: COMMERZBANK HIGH-RISE

3.1 THE FAÇADE OF 1962

The new high-rise office building designed by the architect Paul Schneider-Esleben was built between 1959 and 1962 as an extension to the existing Commerzbank headquarters in Düsseldorf from 1912. Next to the new building, a free-standing concrete tower with lift and stairs was attached, which was connected to the existing building opposite with an acrylic covered pedestrian bridge above street level. The building was placed with its narrow side facing the street; the parking areas on the right side of the building interrupted the perimeter development allowing for a free view of the structure, with the neighbouring development also being set back. On the left side of the building, Schneider-Esleben designed a two-storey parking garage with a car workshop attached to the rear. Almost covering the entire site, the parking garage continued in the basement. An open drive-in bank counter was built below the high-rise on the ground floor – the chosen static system meant that it was free of supports – which enabled customers to carry out banking transactions smoothly without having to leave their cars. Only a small part of the ground floor was closed-in or glazed. Access to the underground car park, among other things, was behind the drive-in counter.

FIG. 2 The Commerzbank high-rise in Düsseldorf of 1962 by Paul Schneider-Esleben. Photos in Calendar Josef Gartner GmbH, 1963 April 21.-27. (left) + May 19.-25. (right). Photos: Inge Goertz-Bauer. Gartner archives, Gundelfingen (Donau)

The supporting structure of the high-rise office building consists of a twelve-storey structure elevated on three cantilevered concrete slabs. Allowing for free floor plan division without supports in the normal storeys, reinforced concrete slabs – made of prestressed concrete beams – rest on cantilevered ceiling girders. A circumferential reinforced concrete beam and concrete parapets served to reinforce the edges. All structural shell parts of the building and lift tower were finished in exposed concrete, both inside and out, and the monumental supporting structure remained visible in the plinth area (Lepik & Heß, 2015; Schneider-Esleben, 1963). The façade manufacturer Josef Gartner developed a façade made of aluminium panels according to Schneider-Esleben's ideas, which was new at that time in Germany.

Gartner had been responsible for many inventions and standards in façade construction. Traditionally, Gartner developed a customised façade for each client. Schneider-Esleben had already worked with Gartner on the construction of the Mannesmann high-rise in Düsseldorf in 1958 (Gartner, 2021). The futuristic appearance of the new building was in stark contrast to the neoclassical stone façade of the opposite Commerzbank's main administration building. The anodised aluminium façade consisted of lightweight and storey-high elements that were prefabricated in one piece with integrated windows and insulation, as in car body construction, without an additional frame structure, and hung in front of the reinforced concrete skeleton structure (Schneider-Esleben, 1963).

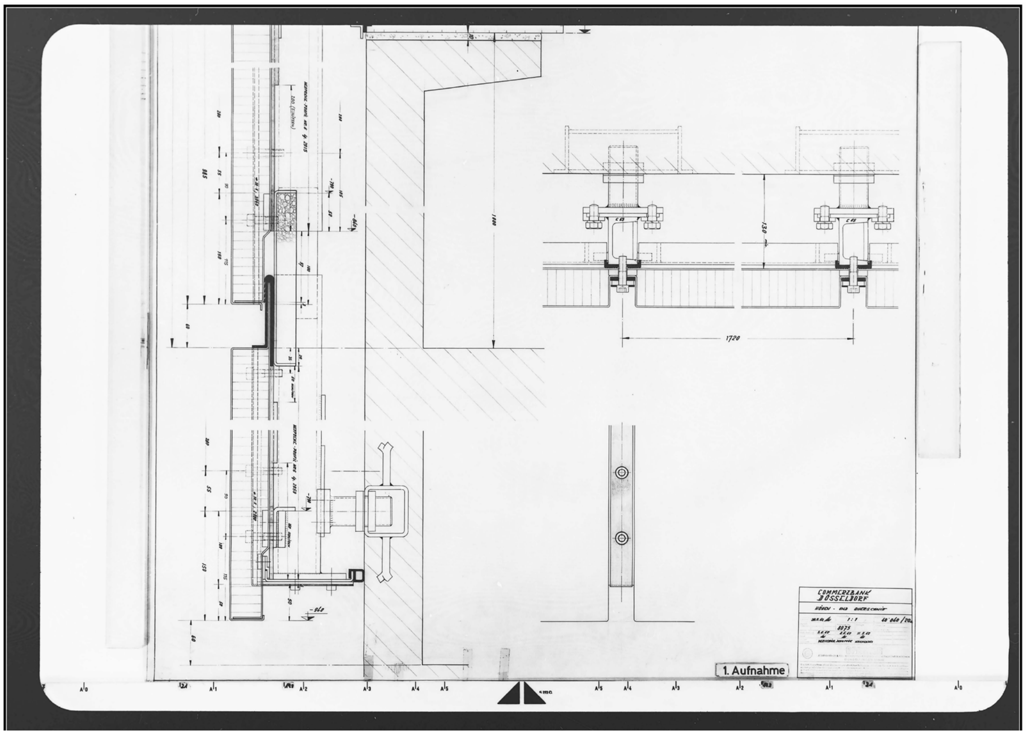

FIG. 3 Working drawings by Josef Gartner GmbH: Horizontal and vertical detail section of the Commerzbank Düsseldorf, 1962. Gartner archives, Gundelfingen (Donau). #40040/20a – 1

The façade of the high-rise consists of 600 identical, 1720 x 3100 mm, flat and jointless wall elements, the inner and outer shells of the elements each made of 2 mm thick aluminium sheets. All aluminium parts are technically anodised in a natural shade of at least 20 µm and are thus particularly resistant to all weathering influences and are maintenance-free. Window openings are pressed out on a factory metal punch and deep-drawn under a press. Air-comb honeycombs from Douglas Air-Craft Corporation, Santa Monica (USA) were used as insulation filling. The paper honeycomb structure was developed for sandwich panels in aircraft construction for its low weight and high rigidity. However, since these panels were less suitable for insulation, the Gartner company developed a process to fill the air spaces of the honeycombs with synthetic resin foam. For the sandwich construction, Gartner built its own heating press to hot-bond the inner and outer shells with the synthetic resin foam-filled Air-Comb honeycomb core to form a thermal insulation panel. The panels achieved an insulation value of 0.05 W/(mK). The stabilizing paper honeycomb core was originally impregnated with phenolic resin, which acted as a moisture and fire retardant. In addition, a concrete parapet was built to prevent fire flashover. The panel shells were edged on all sides in order to achieve the most airtight closure possible through bonding.

The horizontal sliding joints of the panels were sealed with a surrounding neoprene flap and were very wide in order to compensate for possible dilatation caused by the projecting concrete slabs. The horizontal joints were additionally backed with polystyrene boards to compensate for thermal bridges. The sandwich elements, which were only 60 mm thick, were fixed exclusively at the vertical joint using clamping strips enclosed in Neoprene, which were screwed to the flange of a vertically continuous steel U-profile. To compensate for the structural tolerances, a steel façade anchor patented by Gartner was encased in concrete into the edge beam, which also allowed adjustment in all three axes. The resulting gap, an air space of over 130 mm, was closed in the area of the window openings with aluminium profiles and neoprene seals. Rounded “railway windows” were integrated into the punched openings of the aluminium sheets at the corners.

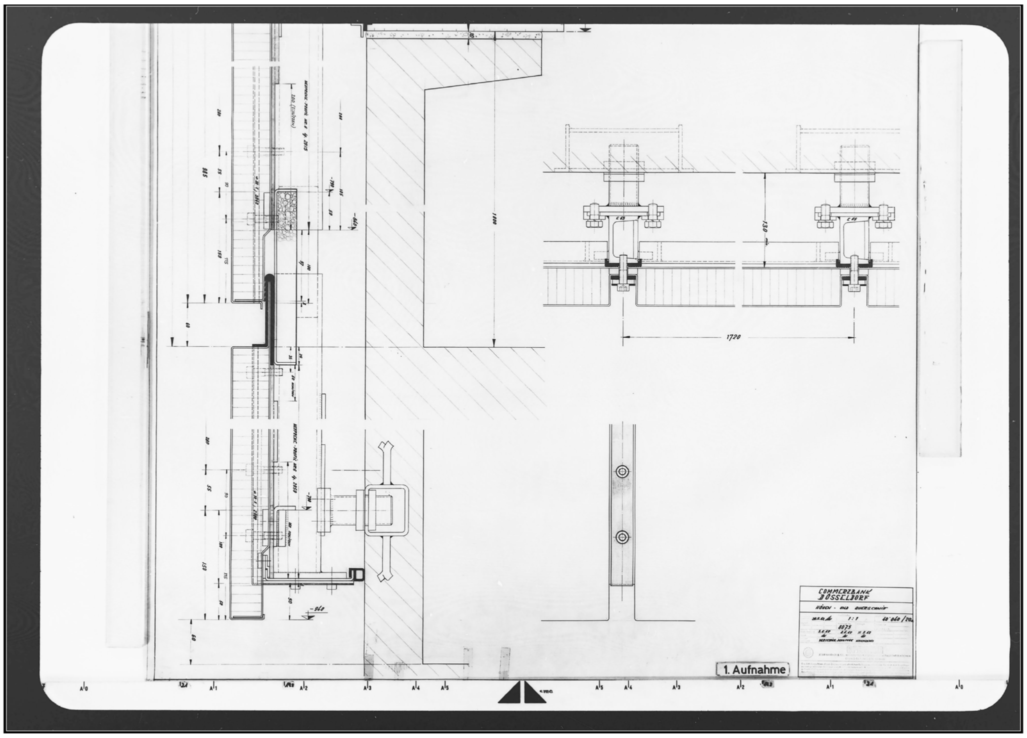

FIG. 4 Working drawings by Josef Gartner GmbH: Horizontal and vertical detail section of the Commerzbank Düsseldorf, 1962. Gartner archives, Gundelfingen (Donau). #40040/20a – 2

The reversible sashes of the windows consisted of single-pane glazing and were dry-glazed with roll-in neoprene profiles; conventional window putty was dispensed with. Plastic external venetian blind slats on the room side served as sun protection. Consistently following the curvature, insulated and round aluminium elements were also developed for the rounded corners of the building. The glazing of the elements was already carried out at the factory in Gundelfingen in Bavaria before being transported to Düsseldorf, where the elements were assembled ready for installation. The assembly work was carried out swiftly using relatively few workers (Schneider-Esleben, 1963).

3.2 RECENT UPGRADING OF THE FAÇADE

Due to its innovative and full-surface aluminium façade, as well as its solitary position in the urban fabric, the Commerzbank Tower was listed as a historical monument in 1998. After remaining vacant for many years, an American investor bought the building in 2015 with the intention of revitalizing it and converting it into a sustainable hotel. The goal and challenge of the revitalization was to preserve the historic appearance of the façade insofar as possible according to its protected status and to upgrade the main components of the structure according to current requirements. The architects who were commissioned for the renovation involved the Josef Gartner company very early on in the redesign process of the façade, and were able to draw on the planning documents from the company's own drawing archive and use them to develop an initial renovation idea (Roming & Rothkopf, 2022). Initially, only the upgrading of the existing façade was discussed. During the planning process, a completely new construction of the façade was also considered, but was rejected for economic reasons. Moreover, an identical reconstruction would hardly have been technically feasible (Roming, 2022).

An initial renovation concept by Gartner considered retaining the existing façade, while adding to it a contemporary layer with appropriate structural-physical properties. For this purpose, new façade elements were to be installed in the 130 mm wide space between the existing panels and the concrete parapet. The existing panels were to be integrated into this to preserve the outer shell. The existing panels were not to be dismantled and the honeycomb insulation would not be exposed. The windows were to be replaced with the same external geometry. For this purpose, parallel opening windows with insulating glazing were proposed. The ready-to-install elements were to be transported to Düsseldorf and installed on site. In order to be able to implement this renovation concept, the shell structure and the existing façade anchors would have to be able to bear the additional loads of the new façade elements, with a higher weight of glazing and an integrated new insulation layer. Before the new substructure was to be installed, the fixings were to be reworked for new structural protection so that they could be used further. The steel substructure was to be completely removed, and the new façade elements were to be hung directly on the façade anchors.

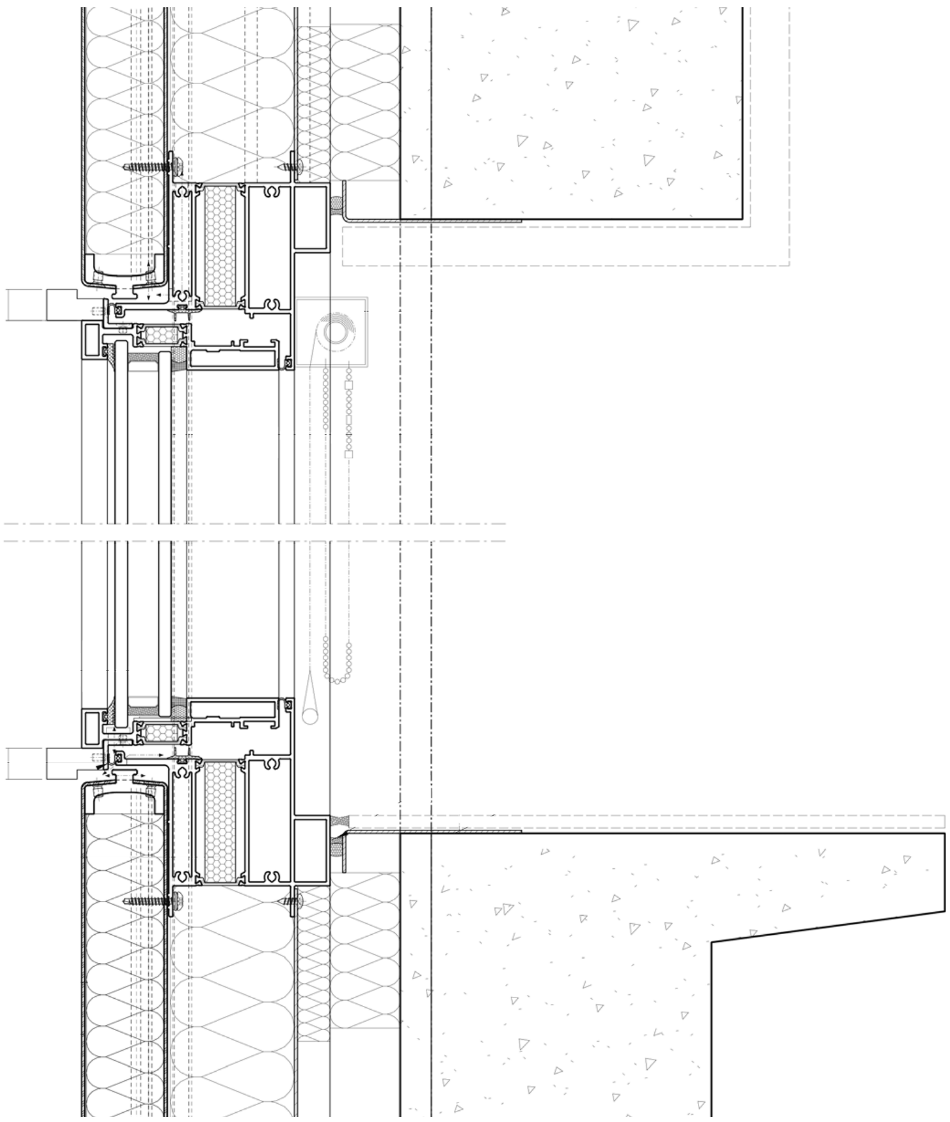

FIG. 5 The upgraded façade. Drawing by Josef Gartner GmbH: Vertical detail section of the Commerzbank Düsseldorf, 2022. Josef Gartner, Gundelfingen (Donau)

In the implementation of this concept, the existing panels would be brought to Gundelfingen, the existing window wings dismantled and disposed of. After inspecting the individual panels for damage, individual panels would be remanufactured. All aluminium surfaces were to be cleaned and resealed. Subsequently, the new façade elements were to be manufactured and the refurbished panels mounted in or on the new façade elements. Before the elements were delivered back to Düsseldorf, the new window sashes were to be mounted. Insulation of panels that could not be reused were to be disposed of (Gartner, 2016).

The renovation concept was not implemented as described because of major deviations in the fixing anchors on site, the position of which did not match the as-built plans, among other things. The new façade could simply not be mounted directly on the old fixing anchors. New façade fixings were required, which then also had to be modified because the concrete structure was dimensionally very inaccurate. Therefore, the façade elements including the steel substructure first had to be dismantled and transported to the main factory site in Gundelfingen. After dismantling and disposing of the existing window casements the elements were opened, disassembled, and inspected for damage. The paper honeycomb construction used for insulation was intact, even after more than 60 years, except for a few damaged panels; these were exposed and could be removed without leaving any residue, and then disposed of according to regulations. Non-combustible and dimensionally stable rock wool insulation panels were now used as new insulation. The aluminium sheets with the aged aluminium surface were resealed after abrasive cleaning. Even though the metal surface could not be compared to the natural and irregular grain of a material such as wood or stone, at the time of completion in 1962 there are nevertheless very slight colour nuances that can be attributed to the chemical surface treatment. After cleaning, however, the differently patinated and aged surface has a detrimental effect on the new façade appearance, which now appears slightly blotchy and less homogeneous in its new shine. After the fabrication of a new aluminium supporting framework, which is thermally broken, the repaired metal sheets could be put back in place.
The shoring is attached to the back of the newly refurbished panels and thus almost completely fills the gap of more than 130 mm between the aluminium panel and the concrete parapet. Prior to this, sealing was carried out inside and outside and a parallel extension sash was installed in the element. After inserting the insulation and inlaying the rubber, the newly prepared elements were sealed. Afterwards, the elements were delivered to Düsseldorf. Before the new substructure was installed, the façade fixings had to be reworked. The elements are now fixed using newly placed stainless-steel anchors. The existing reversible sashes with single-pane glazing were replaced with parallel vent windows with double insulating glazing. This type of window is suitable for natural ventilation concepts; above all, mirror effects in the façade are avoided in comparison to tilt and turn windows. Gartner developed a special fitting here in the form of a xy-scissor, which enables manual operation with a continuously adjustable opening width of up to 200 mm. The old fittings of the reversible sash, which were also part of the façade elevation, were replaced with rubber dummies similar to those of historic appearance. By using the parallel opening windows, it was possible to preserve the very narrow view of the original optics. In total, the area of the new façade covers approx. 3100 m^2, the size of the elements remained unchanged, but they now weigh up to 280 kg. Since the new elements were hung in the same position, the exterior cubature remains unchanged (Roming & Rothkopf, 2022).

However, the conversion of the office tower into a hotel brought with it a number of constraints. Newly required ventilation ducts were laid in two shafts on the western front sides of the building, and the service core originally located there was removed and now provides a new room for housekeeping. A new second escape staircase in accordance with fire protection regulations is located on the south-west side, resulting in the breaking through of all ceilings. The integration of

the new, necessary staircase into the building also means a loss of over 130 sq.m of hotel space. The free-standing lift tower next to the building was also upgraded and continues to be used for access to the individual floors.
The formerly open ground floor now contains the hotel lobby with reception and dining area. It was enclosed with a 6 m high fully glazed façade with stiffening glass gravity beams. Following the rounded corners of the upper storeys, curved glass was installed in the corners of the ground floor glazing. The thick glass wall and glass fins are connected to each other via special toggle brackets. The frameless glass construction creates a quite homogeneous glass band, and the vertical joints are thus almost completely recessed. The refurbished exposed concrete supporting structure was selectively covered with acoustic panels in a few places; the character of the monumental supporting structure remains somehow intact and visible. The idea of a base that is as glazed as possible is understandable, but the new glass envelope set flush with the outer edge of the aluminium elements completely changes the original appearance and design intention of the elevated structure.

FIG. 6 The former Commerzbank high-rise after the recent upgrade and conversion, 21.11.2021. Photos: Rouven Grom

4 CONCLUSIONS

The 1960s façade of the Commerzbank in Düsseldorf was remarkable for its significant innovations in façade construction. The Josef Gartner company developed one of the first elemental façades of its kind in Germany. At the time, specially developed insulation was bonded between two aluminium sheets. A special feature is the façade skin, which was completely insulated at a very early stage and runs in one plane. The panel construction can hardly be compared with the frame constructions common at the time, referred to in a broader sense as “façade elements”. In the 1960s, stick systems or ladder systems were very common in Germany. In comparison, thermally broken profiles were only increasingly used from the 1970s onwards. Gartner is known for its high-quality façade constructions, and this façade also proved to be particularly durable. For the most part, the old façade was still functional at the time of the renovation, but no longer complied with updated thermal insulation regulations. The preservation of the shell and the façade could be achieved with a minimally invasive intervention within the existing gap between raw structure and envelope, leading to little replacement and loss of original material substance. The façade was indeed refurbished according to heritage conservation aspects, and, according to a rough calculation, a value of more than 200 tons of carbon dioxide was saved by reusing the existing aluminium sheets.[1] This value is even higher when considered in terms of the transport and further processing of aluminium from the semi-finished product to the finished element. Carbon-dioxide of approximately 600 tons bound in the raw structure of the tower also contributes positively to the ecological balance.[2]

In order to be able to discuss the transferability of the executed façade renovation concept, we define the following conditions and criteria that should be fulfilled. First, the building's owner and involved planners must, in general terms, aim for the preservation of the existing building; in the case of the Commerzbank, this meant a voluntary, and probably also financial, additional effort for the investor, who was comfortable with the conservation of the façade. Another driving force was the existing monument protection of the property, which additionally obliges the owner to care for the edifice. Demolition is actually only permitted if the costs of renovation cannot be recovered, or if the property is in poor structural condition. Responsible protection agencies should ask for preservation of material and structural properties and not just aesthetics. A historical and constructive understanding on the part of all those involved in the planning and construction process is of absolute importance. In addition, historical investigation and a thorough building survey on site are necessary to clarify the façade system and the condition of the façade. It must be possible, as has been the case in Düsseldorf, to dismantle the façade. High quality building components in good condition and of sufficient material thickness are helpful. In Düsseldorf, the aluminium sheets, for example, showed corrosion-resistant properties and were of low weight, and thus offered great potential for further reuse. Inserting a new layer for isolation as substructure asks for sufficient space between raw structure and original skin, a feature which often can be found in curtain walled façades of that period. However, irregularities and tolerances of the concrete structure are common and have to be identified in advance. Last but not least, it should also be mentioned that the builder, in this case the façade company, must have a high degree of professional and technical know-how in order to be able to plan and implement this type of special solution at all. Even if these conditions cannot be met in all respects, the reuse of existing materials and components for future renovation tasks represents a promising and transferable approach.

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1 A standard aluminum sheet wall element of the Commerzbank has an area of approx. 7 m^2. The density of aluminum is 2,700 kg/m^3. A 2 mm thick aluminum sheet weighs approx. 5.4 kg/m^2. The production of 1 kg of aluminum generates approx. 8-10 kg of CO_2.

2 The structure of the building has a volume of approx. 1,800 m^3. The production of 1m^3 of reinforced concrete emits approx. 320 - 340 kg of CO_2.

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