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The European
Stainless Steel
Development Association

Green Walls in Stainless Steel

Building Series, Volume 17

Euro Inox

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Green Walls in Stainless Steel
First edition 2012 (Building Series, Volume 17)
ISBN 978-2-87997-052-3

Czech version	ISBN 978-2-87997-063-9
Dutch version	ISBN 978-2-87997-058-5
Finnish version	ISBN 978-2-87997-055-4
French version	ISBN 978-2-87997-056-1
German version	ISBN 978-2-87997-053-0
Italian version	ISBN 978-2-87997-057-8
Polish version	ISBN 978-2-87997-059-2
Spanish version	ISBN 978-2-87997-060-8
Swedish version	ISBN 978-2-87997-061-5
Turkish version	ISBN 978-2-87997-062-2

Publisher
Euro Inox
Diamant Building
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art aqua (top right); Mitsumasa Fujitsuka (bottom right)

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Introduction

Green walls are not a new phenomenon. For centuries, people have been growing plants up house walls, using a variety of techniques. Now, however, the idea is starting to catch on in our cities. No longer restricted to residential buildings, 'vertical gardens' are enhancing the façades of museums, office buildings, luxury hotels, restaurants and shops.

Photo: Jakob AG

Plants climbing up stainless steel cables in an inner courtyard in Zurich. Client: West-Park Zürich AG; Landscape architects: raderschall ag, Meilen

The current debate about sustainability is playing its part in promoting greener cities, because planted façades have a positive effect on the microclimate in the urban environment. Vegetation helps even out temperature fluctuations, it insulates because of the air pockets enclosed within it and it has a cooling effect as a result of the cold produced through evaporation. Furthermore, it helps protect against solar radiation and wind, as well as absorbing sound.

Even when covering a large area, the plants on a green façade take up little floor space. This is another reason why they are suited for use in built-up areas as a way of improving both air quality and the whole experience of city living. And, with increasing urbanisation, we are already seeing green walls being used to grow edible plants, which supply food for city-dwellers.

Along with these economic and environmental aspects, new design opportunities are emerging for architects tasked with integrating these vertical green spaces into designs for modern buildings. Without assistance, most plants will not clothe an entire façade, so some kind of support is needed. These days various options are available, ranging from tensile cable systems and lattice frames to rows of containers or ventilated panels distributed right across the façade. All the systems need to have a space between the building and the plants, to avoid damage to the building structure by penetrating roots and shoots.

When designing a green façade, due consideration has to be given to wind, snow and ice loads, as well as to the weight of the plants themselves, which of course increases as the plants develop and grow. In tensile cable

systems the top-most fixing points take up all the vertical loading, wind load is distributed between both the upper and lower fixing points. Because of the high stresses involved, molybdenum-alloyed stainless steel is generally used in these applications, as it has both high strength and good corrosion resistance. But whatever the system employed, it is important to ensure the support construction will outlast the lifetime of the plants by using the right materials. Stainless steel is an excellent choice, in particular for the backing frame and other difficult-to-access areas, thanks to its ease of maintenance, longevity and resistance to environmental influences.

Photo: Patrick Blanc

French botanist Patrick Blanc was one of the pioneers of vertical gardening. This is his now iconic green wall on the Musée du Quai Branly in Paris.
Client: Etablissement public du musée du quai Branly; Architects: Atelier Jean Nouvel, Paris/ Patrick Blanc, Paris

Different kinds of plants can be used, depending on the particular application or system.

Photos:
Daniele Domenicali (left);
Limeparts NV (right)

Tensile Cable Systems

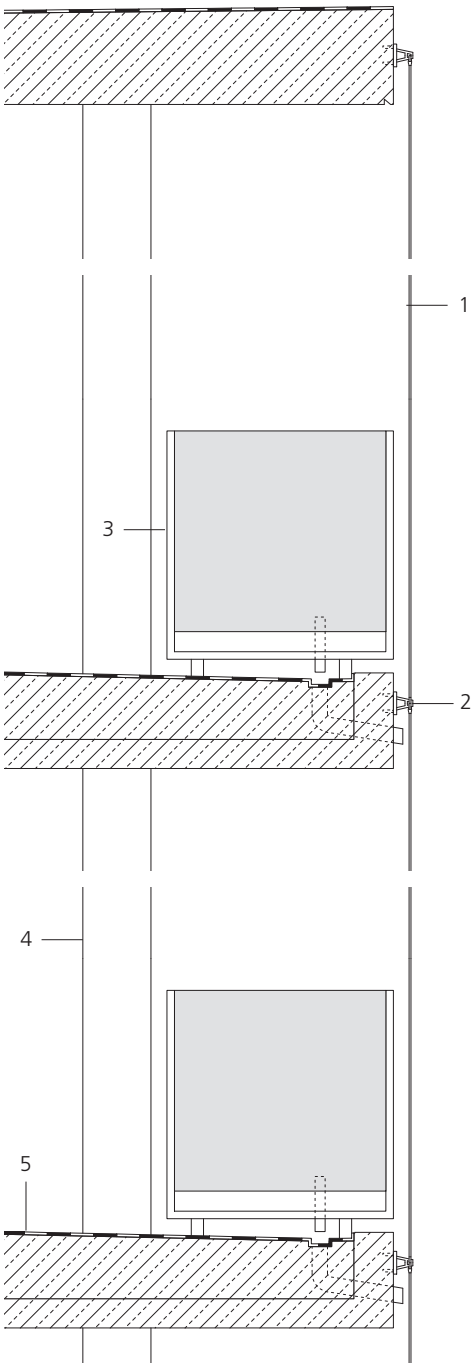
Shopping Centre in Basel, Switzerland

Client:
Swiss Prime Site AG, Olten
Tivona Eta AG, Basel
Architects:
Diener & Diener Architekten, Basel
Design of planted façade:
Fahrni + Breitenfeld
Landschaftsarchitekten, Basel

This new shopping centre in Basel was built at the interface between a residential district and an industrial estate. Previously the unused site had been designated as green space. In compensation for building on this open area, the design for the centre incorporated not only a planted roof but also green façades. On the west side, the steel stairs of the emergency exit are screened by a veil of many different climbing plants such as ivy, evergreen clematis and Russian vine. And on the south façade, planters are lined up along each of the four levels. Cables span from floor to floor, acting as a climbing support for the plants. The overall effect of this arrangement of different plants resembles that of the array of products on the shelves inside a supermarket. The plant boxes are finished in various shades of green, to harmonise with the seasonal changes in the plants themselves.

The mix of hanging, upright and climbing plants gives a very lively and ever-changing impression to the façade.

Photos: Christian Richters (top); Fahrni + Breitenfeld (bottom)



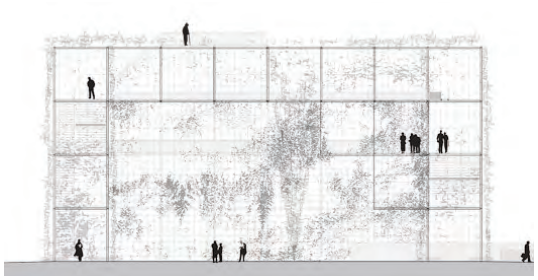
Vertical section, scale 1:20

1 Ø 5 mm cable support, stainless steel EN 1.4401
2 Cable clamp, stainless steel EN 1.4404
3 Planter, glass-fibre-reinforced plastic
4 Column, Ø 180 mm precast reinforced concrete
5 150 mm waterproof concrete, on slim 60 mm concrete slab

Photo: Fahrni + Breitenfeld

Careful colour design lies behind the harmonious look of this full-height living screen.

After just a few years, the frame is almost covered in lush green.



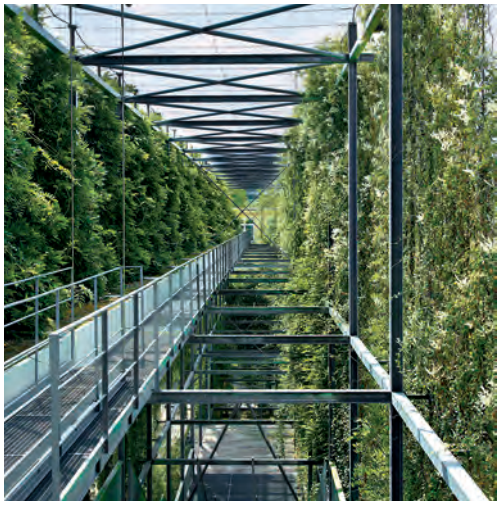
Cross section, scale 1:600

MFO Park in Zurich, Switzerland

Client:
Grün Stadt Zürich
Design:
Burckhardt + Partner AG Architekten, Zurich/
raderschallpartner ag landschaftsarchitekten, Meilen
Structural engineers:
Basler & Hofmann, Zurich

The residential and business quarter in the north of Zurich in which this new-style urban park is located was formerly an industrial district. This particular plot used to be occupied by a factory of the engineering firm 'Maschinenfabrik Oerlikon' (MFO). The four-storey openwork steel frame around the park is 100 m long, 34 m wide and 18 m high, echoing the dimensions of the former factory.

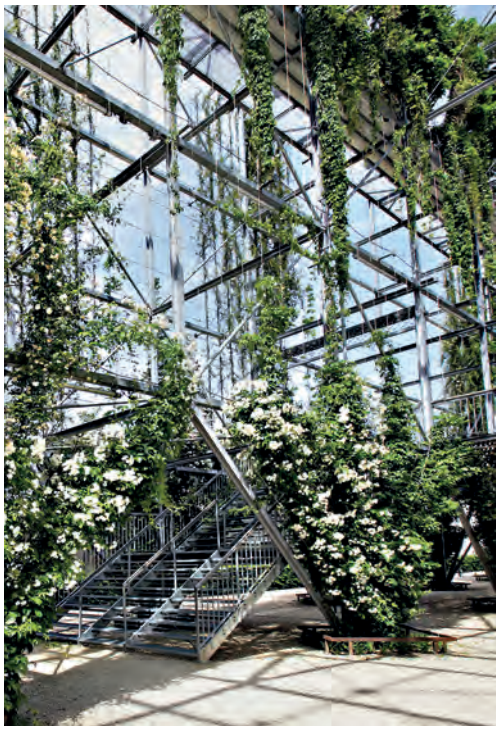
Photos: Jakob AG

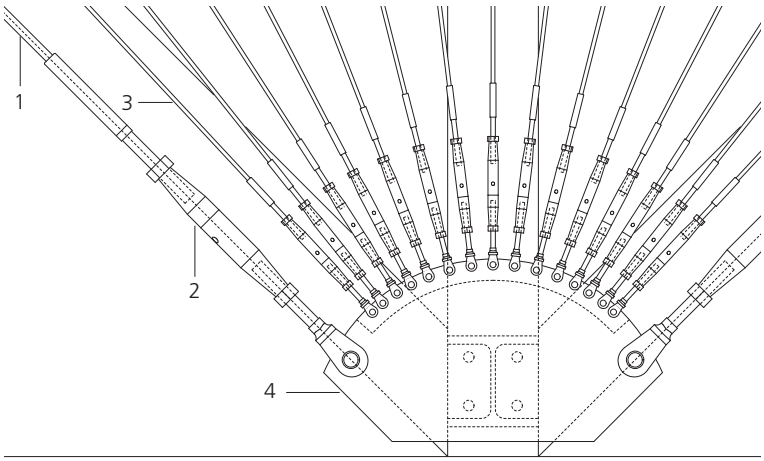


The spaces between the two layers of the 'walls' are interspersed with steps, covered walkways and projecting balconies.

The envelope of steel profiles is built up of two layers. Suspended in the spaces in between, flights of steps, galleries and projecting balconies invite visitors to explore the various levels. Fixed on the outer side of the steel frame, with a 30 cm gap, is a network of tensioned stainless steel cables, which provides support for a wide range of climbing plants. At floor level, the cables are gathered into a fan-like arrangement, but higher up the cable grid becomes orthogonal. The mesh broadens in size in the upper section, to bring more light down into the interior. The space inside this 'green hall' is occasionally used as a venue for cultural events.

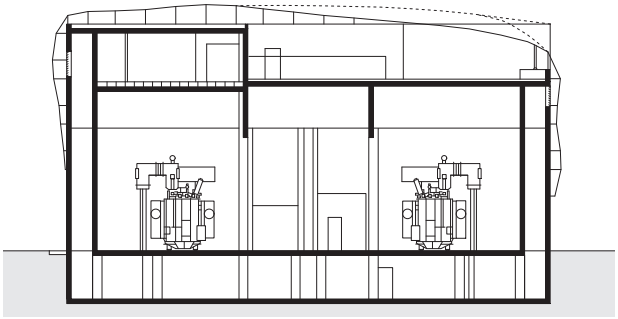
Photos: raderschallpartner ag (top left),
Jakob AG (top right, bottom)





Connection of cables to the base of the steel frame, scale 1:10

1 Ø 12 mm edge cable, stainless steel EN 1.4401
2 Turnbuckle, stainless steel EN 1.4404, with clevis end, swaged
3 Ø 5 mm cable, stainless steel EN 1.4401
4 Connector plate, galvanized steel, attached to load-bearing frame via steel bracket



Cross section, scale 1:500

Electricity Substation in Barcelona, Spain

Client:
Endesa Energía
Architects:
Rahola Vidal arquitectes, Barcelona

Even from afar, it is easy to spot this electricity substation thanks to its copper-coloured façade. A new building, the substation is located in the regeneration district of El Poblenou, which is now attracting a range of businesses in the communication sector.
The monolithic structure of fair-faced concrete is enclosed in a delicate diamond-patterned trellis of stainless steel cables which supports the wisteria as it grows up the façade. The cables are attached to brackets made of stainless steel bars of varying lengths embedded in the façade at regular intervals.

Over 900 stainless steel brackets fix the grid of stainless steel cables to the concrete façade.

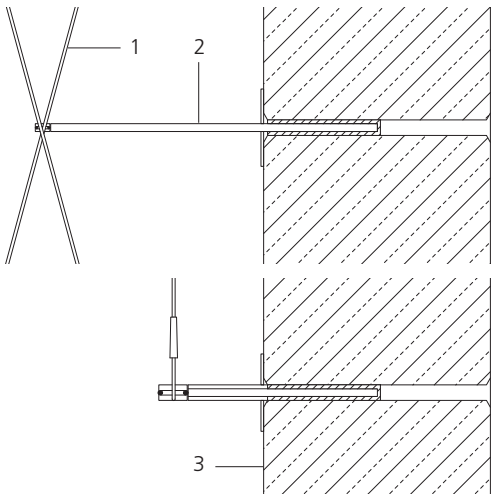
Photo: José Hevia Blach

8,000 metres of cable were used in the trellis, which extends across all sides of the building. The substation's roof, too, is treated like a fifth façade and also clad in vegetation.

The openings in the façade take their design cue from the grid of the climbing frame. Like the diagonally aligned cables, they also form different patterns made up of juxtaposed triangles. These geometrical shapes, coupled with the green envelope, present a most unexpected impression for a building of this type.

Photos: Martina Helzel

In just a few years, the climbing plants were able to 'clothe' almost the entire substation.



Vertical sections, scale 1:10

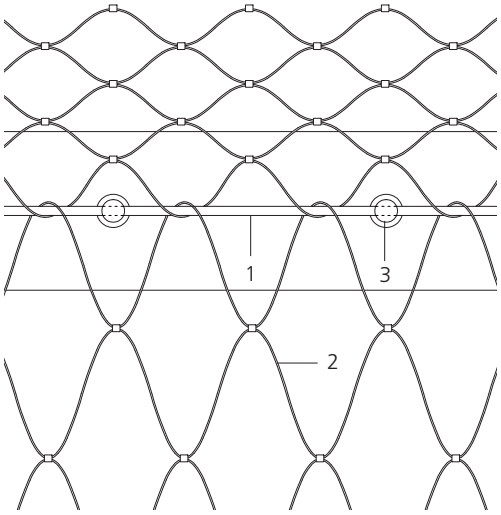
1 Climbing support, Ø 4 mm stainless steel cable, EN 1.4401
2 Bracket, Ø 10 mm stainless steel bar, EN 1.4404
3 30 cm concrete, copper-red pigmented

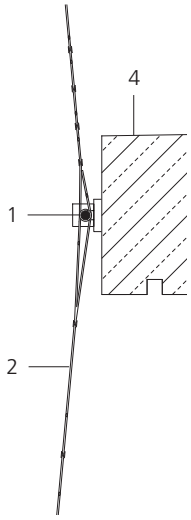
The cable net and the vegetation growing up it wrap around the outside of the cantilevered floor slabs.

Student Housing in Garching, Germany

Client:
Studentenwerk München
Architekten:
Fink + Jocher, Munich
Structural engineers:
Joachim Eiermann, Munich

Two new residential blocks for students have been built on the Garching campus of the Technical University of Munich, to provide additional accommodation for the ever-increasing number of students. A noticeable feature of the blocks is the arrangement of the exterior corridors cantilevered out from the storey floors to provide access to the individual apartments. In place of conventional parapets around these corridors, each building is instead wrapped on all four sides in a net of stainless steel cable.





Sectional detail, elevation scale 1:10

1 Ø 12 mm edge cable, stainless steel EN 1.4401
2 Ø 3 mm cable net, stainless steel EN 1.4401
3 Guide for cable, cylindrical, stainless steel EN 1.4404
4 External corridor floor, precast reinforced concrete

The net, made up of 3 mm stainless steel cable, provides an almost invisible climbing support for the Virginia creeper while also doubling as a guardrail. Up to normal parapet height, the mesh size is narrower, widening out above that. The cable net is affixed to the ends of the floor slabs via 12 mm thick horizontal cables. Vertical edge cables, extending the full height of the building, brace the structure at the corners.

Throughout the year, the façades present an ever-changing picture – in summer the vigorous Virginia creeper clothes the building in lush, shading green, in autumn in a spectrum of red. And in winter, after the leaves have fallen, light can penetrate through to illuminate the apartments behind.

At the corners of the buildings, the edge cables are secured with threaded bolts.

A lively contrast is set up between the Virginia Creeper and the various shades of grey in the façade and concrete floors.

Photos: Martina Helzel

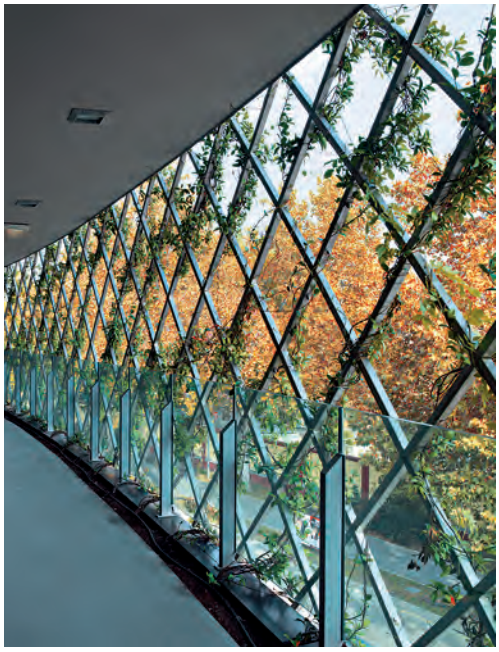
Frame Systems

A lattice of stainless steel profiles wraps around the façade, acting as a support for summer-flowering star jasmine.

Commercial Building in Rimini, Italy

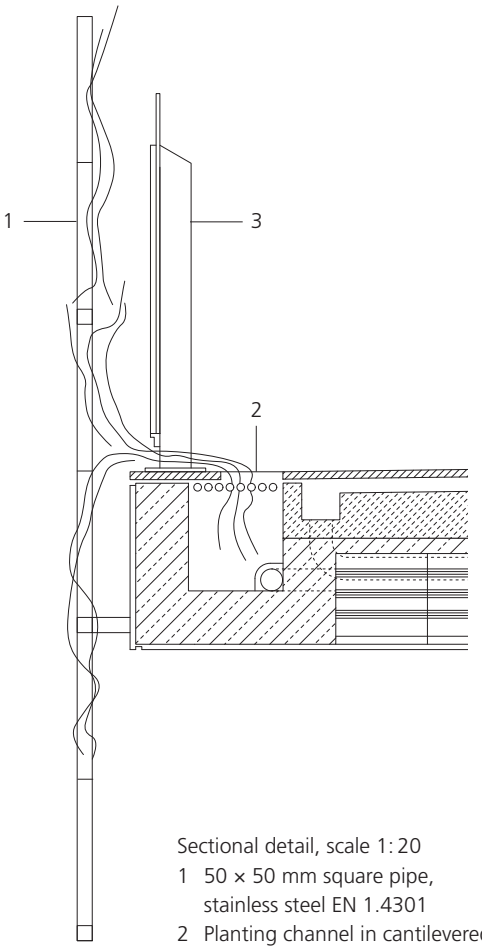
Client:
Edile Carpentieri s.r.l., Rimini
Architects:
Mario Cucinella Architects, Bologna
Structural engineers:
Gilberto Sarti, Fabio Lombardini, Rimini

The 'Centro Direzionale Forum' is located next to a busy road in the south of Rimini. Two virtually symmetrical five-storey blocks are arranged at a right angle to each other and connected via corridors at the deeply incised point of intersection.
As well as the distinctive shape of the building, what strikes the eye is the climbing frame in front of the façades. The frame is made up of lengths of 50 mm square stainless steel pipe fitted together in a diagonal grid with a mesh size of 600 × 600 mm. In order to prevent the climbing plants damaging the building itself, a space is left between the frame and the façade. The grid covers not only the street front, but also wraps around both ends of the building.



The greenery also creates a more intimate environment around the covered corridors on the outside of the different floors.

Because the planting is evergreen, it improves sound insulation all year round, and helps screen the offices behind from the outside, in particular from the sun. Integrated into the base of each parapet is a planting recess, running along the edge. This channel also incorporates an irrigation pipe for watering the plants. Reminiscent of wooden trellises in gardens, the climbing frames are planted with sweet-smelling star jasmine.



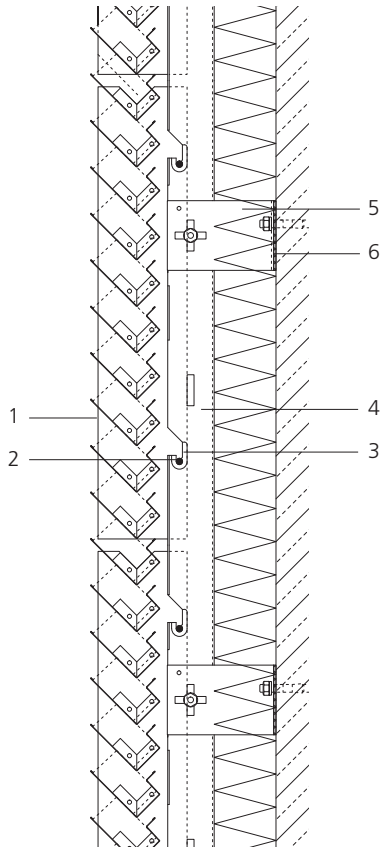
Sectional detail, scale 1:20
1 50 × 50 mm square pipe, stainless steel EN 1.4301
2 Planting channel in cantilevered floor slab
3 Railing with glass panels

Photos: Daniele Domenicali

The vertical greenery on the façades is echoed in the open spaces behind the building.

Planted Walls

The plants on the upper part of the street façade are inserted into a ventilated system of stainless steel panels.

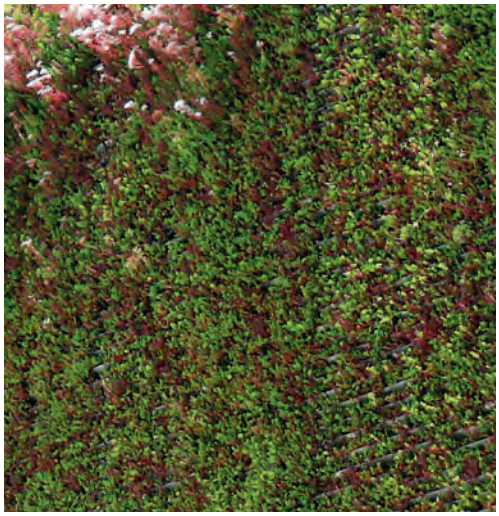


Sectional detail, excl. liners
scale 1:10
1 Planting panel, 7 mm stainless steel sheet, EN 1.4301
2 Suspension bolt, stainless steel
3 Plastic hanger clips
4 Continuous hat profile
5 Wall fixing
6 Neoprene insulation layer

Museum of Natural History in Toulouse, France

Client:
Ville de Toulouse
Architects:
Jean-Paul Viguier et Associés, Paris
LCR Architectes, Launaguet
Landscape architect:
Allain Provost, Paris

As part of a refurbishment programme at the Museum of Natural History in Toulouse, a new building was erected which connects the renovated parts of the complex with the botanical garden within. On the garden side, the new building has a curving all-glass façade in response to the spiral-shaped lay-out of the planting. From the street visitors see a more closed face, yet one that still echoes the theme of nature: the entire length, at first-floor level, is thickly clothed with vegetation.



Photos: Limeparts NV

The planted façade mediates between the existing buildings and the new wing of the natural history museum.

The façade system used here is analogous to a conventional double-skin façade, the outer skin in this case being composed of planted stainless-steel panels. These rectangular panels, 60 cm in height and up to 1.80 m in length, are fitted with rows of bent stainless steel, tilted at an angle of 45 ° to the outside. Once the panels are in position vertically on the façade, the actual plant liners, containing pre-cultivated sedums, are inserted. In the bottom of the liners is a layer of recycled plastic foam, to act as a water store, and above that a substrate of lava and ground terracotta. The vegetation layer of tough, low-growing plants needs little aftercare.

Company Headquarters in Shanghai, China

Client:
Zhongtai Lighting Group, Shanghai
Architects:
Kengo Kuma & Associates, Tokyo
Structural engineers:
Chen Ke

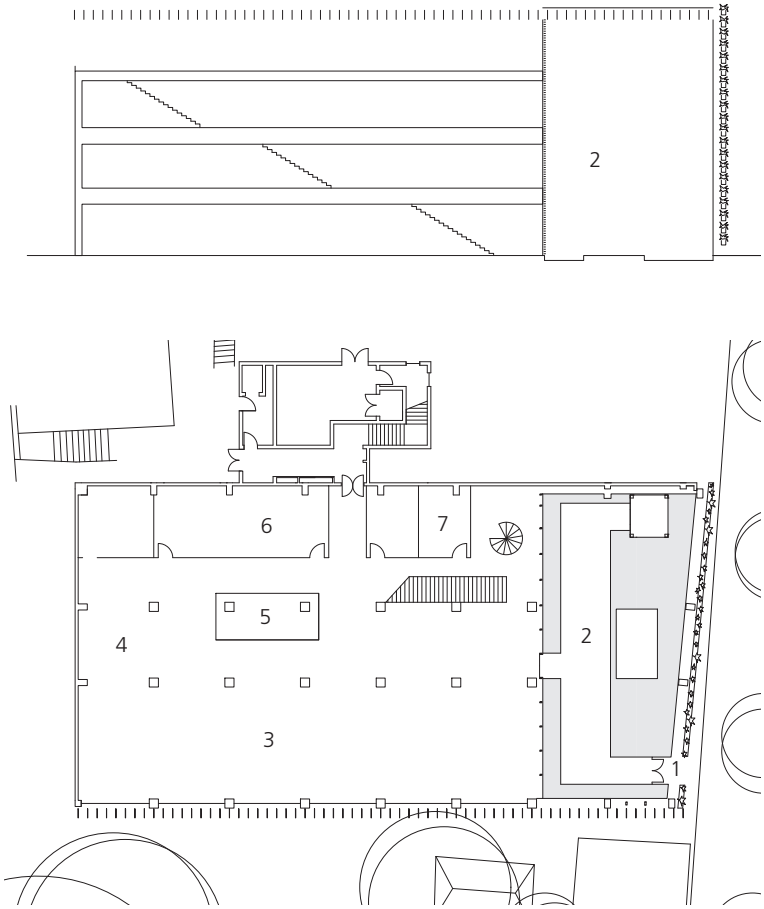
In Fanyu Road, in the east of Shanghai, a former watch factory was transformed into the stylish headquarters of one of China's biggest lighting manufacturers. The street façade is dominated by stacked horizontal layers of stainless steel troughs in which evergreen ivy is planted, the impression of luxuriant foliage being doubled by the mirror-finished planters. Another effect of this finish is to reflect the surrounding buildings and sky on the façade. As such, the building stands out clearly in an otherwise rather unremarkable neighbourhood.
An unobtrusive opening in this green façade leads visitors through into an atrium extending upwards four storeys in height. On the outside, the façade is articulated in horizontal strata; however here attention focuses on

Mirror-finished stainless steel on the façade has a de-materialising effect on this four-storey building.

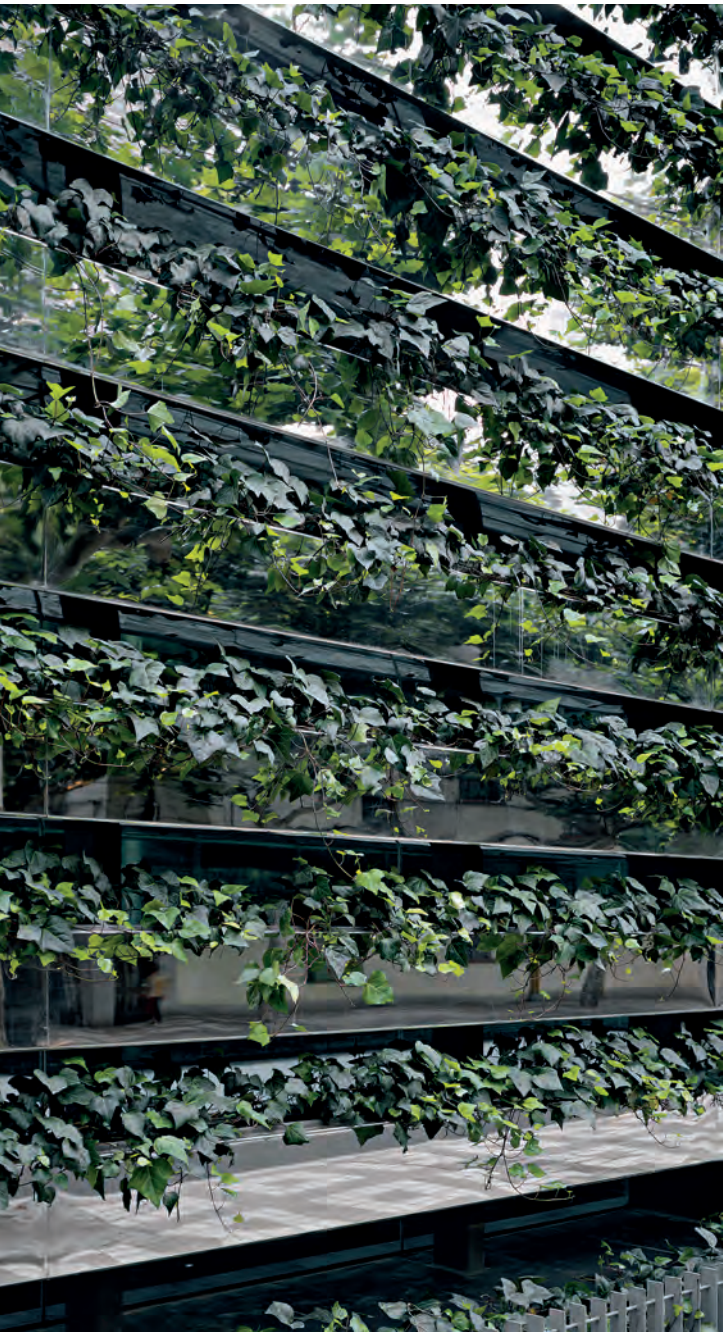
A wall fitted with stacked rows of planters separates the hectic world outside from the calm contemplative atmosphere in the atrium behind.

Photos: Mitsumasa Fujitsuka

the verticality of the space. Particularly impressive is the full-height wall opposite the entrance down which there is a continuous flow of water, its gentle bubbling adding an acoustic dimension to the space. The calm atmosphere here contrasts starkly with the hectic pace of life in this metropolis. The route into the showroom and the office spaces on the floors above leads through this dramatic wall of water.

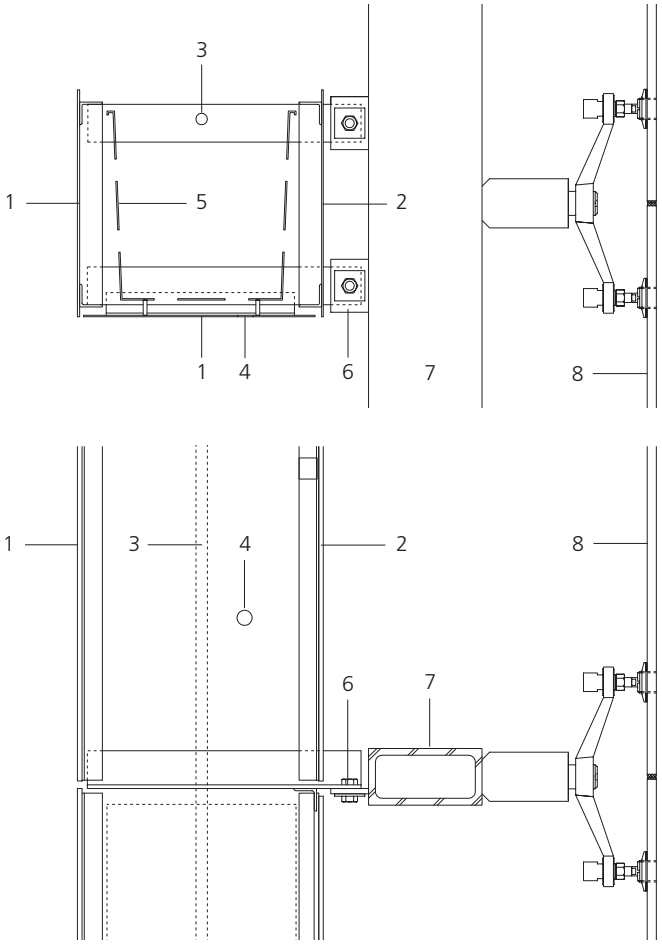


Plan of ground floor · Longitudinal section, scale 1:500
1 Main entrance
2 Atrium with water pool
3 Sales/Showroom
4 Café
5 Bar
6 Lounge
7 Office



Plants in mirror-finished boxes turn the steel and glass façade into a wall of greenery.

Photo: Mitsumasa Fujitsuka



Sectional details, scale 1:10

1 3 mm stainless steel sheet, EN 1.4301, mirror finished
2 3 mm stainless steel sheet, EN 1.4301, coated surface
3 Irrigation pipe
4 Ø 20 mm drainage hole
5 PVC liner for planting
6 Attachment point, 7 mm stainless steel sheet, brushed finish
7 75 × 150 mm rectangular steel profile
8 Glazing

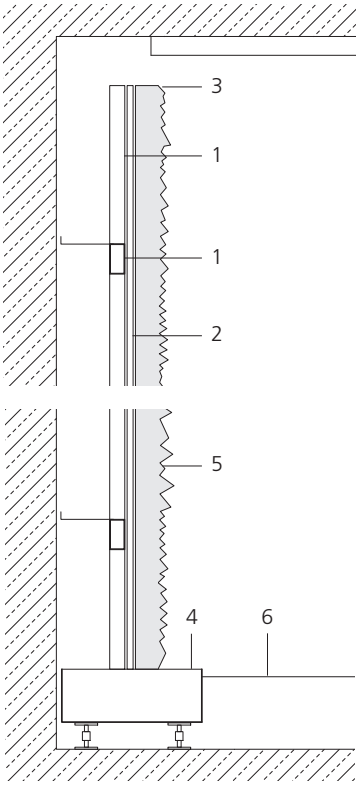
Interiors

Green walls are also increasingly popular for interiors. In homes and offices, public buildings, shops and restaurants vertical planting is being used as a decorative feature. But plants do more than just contribute to an attractive design – they also filter pollutants out of the air, produce oxygen and may even reduce electrosmog. Transpiration through the foliage raises humidity levels in winter and has a cooling effect in summer. As a result, the indoor climate improves, and general wellbeing of the occupants increases.
Also for use in interiors, various systems are available. Before insertion into their final position, the plants are precultivated for a number of weeks in a greenhouse. Once in place, the plants are automatically supplied with water and nutrients. As the support frame is virtually obscured once the planted panels are fitted, durability and corrosion-resistance are important characteristics required of the frame material. Stainless steel is a preferred choice in these situations.

The planted wall in the conference room of a bank improves the acoustics and helps prevent overheating.
Client: HVB Immobilien AG, Munich; Architects: Guido Canali, Parma and Gilberto Botti, Munich

Photos: Christian Richters (top), art aqua (bottom)

The green of the plants forms a pleasing contrast to the product display in this fashion store in Basel.
Client: Merkur Basel; Architects: version B intérieur & architecture SA, Geneva



Vertical section, scale 1:20
1 Support frame, 80 × 40 × 2 mm stainless steel hollow profiles, EN 1.4301
2 Ø 16 mm round bars, stainless steel EN 1.4301
3 Facing on top and sides, 3 mm stainless steel sheet, EN 1.4301
4 Water collection trough with entry and exit holes, stainless steel EN 1.4301
5 40 × 60 cm panel, with backing layer and vegetation mat
6 Floor construction

Light is used to enhance the drama of the living wall in this flagship lighting store.
Client: AML Licht, Munich; Architects: Shirwani + Österle, Munich

Photo: art aqua

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ISBN 978-2-87997-052-3

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