WHY FACADE RETROFIT?

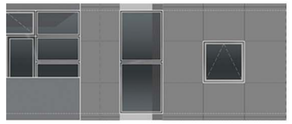
- NEARLY 50% OF THE GLOBAL ENERGY USE IS ACCOUNTED TO RESIDENTIAL AND COMMERCIAL BUILDINGS
- A BUILDING CONSTRUCTED BEFORE 1945 USES ALMOST TWICE AS MUCH ENERGY IN COMPARISON TO A BUILDING CONSTRUCTED AFTER 2006
- CURRENTLY BUILDINGS USE MOST ENERGY FOR HEATING AND COOLING, FOLLOWED BY MATERIALS, HOT WATER, ELECTRICITY, PROCESS ENERGY AND LIGHTING
- THE FACADE HAS THE HIGHEST POTENTIAL WHEN OPTIMIZING ENERGETICALLY A BUILDING; THE BEST WAY TO REDUCE THE ENERGY CONSUMPTION FOR HEATING AND COOLING IS TO IMPROVE THE PERFORMANCE OF ITS FACADE
- TODAY THE MAIN ENERGY ISSUE IN BUILDINGS IS THE FACADE (OPERATING ENERGY); IN THE FUTURE THE MAIN ENERGY ISSUE WILL BE THE AMOUNT AND THE TYPE OF BUILDING MATERIALS USED (EMBODIED ENERGY)
- FACADES HAVE A SIGNIFICANTLY LOWER LIFE EXPECTANCY IN COMPARISON TO THE STRUCTURE OF BUILDINGS

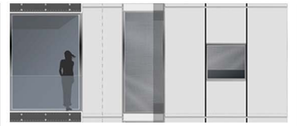
PROJECT GOALS:

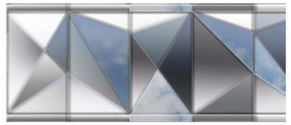
- QUESTION WHAT IS THE VALUE OF FACADE RETROFIT - RELATIONSHIP BETWEEN PERFORMANCE, WEIGHT (EMBODIED ENERGY), ASSEMBLY EFFORT, COST AND SAVINGS - DATA CHART
- DESIGN A FACADE SYSTEM WHERE HIGH PERFORMANCE, WEIGHT, EMBODIED ENERGY AND RECYCLABILITY ARE CRITICALLY EVALUATED
- DESIGN A FACADE SYSTEM THAT CAN RESPOND TO TRANSFORMABLE INTERIOR SPACES, I.E. TO BE ADAPTIVE TO INTERIOR CONDITIONS
- REESTABLISH THE RELATIONSHIP BETWEEN THE BUILDING INHABITANTS AND THE BUILDING SKIN

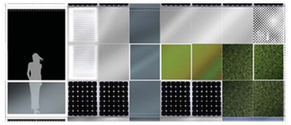
PROJECT STRATEGY:

- 4 DIFFERENT FACADE SYSTEMS ARE ANALYZED AND COMPARED IN THE CONTEXT OF AN EXISTING BUILDING
- ONE OF THE SYSTEMS IS INSTALLED ON THE EXISTING BUILDING AND HAS BEEN RECENTLY RETROFITTED, WHILE THE OTHER THREE ARE DESIGN PROPOSALS
- SYSTEM_01 FOLLOWS A RATHER CONVENTIONAL APPROACH, WHERE PERFORMANCE AND DAYLIGHT CONDITIONS ARE IMPROVED BY THE INTRODUCTION OF SYSTEMS AND MATERIALS THAT ARE CURRENTLY AVAILABLE
- SYSTEM_02 IS MAINLY FOCUSED ON MINIMIZING THE STRUCTURE THAT IS NECESSARY IN ORDER TO ACHIEVE MAXIMIZED TRANSPARENCY AND MINIMAL WEIGHT
- SYSTEM_03 IS THE DESIGN SOLUTION THAT FOCUSES BEYOND THE CONVENTIONAL PERFORMANCE PARAMETERS ON ASSEMBLY METHOD, EXCHANGABILITY, ADAPTIVENESS BOTH TO THE EXTERIOR AND THE INTERIOR OF THE BUILDING, RECYCLABILITY AND ON THE RELATIONSHIP BETWEEN THE INHABITANT AND THE SKIN OF A BUILDING

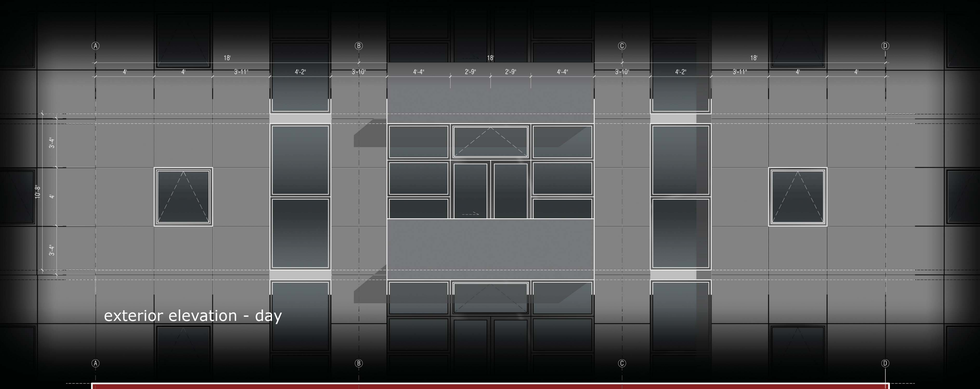




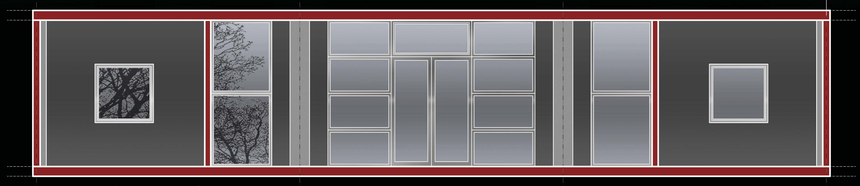




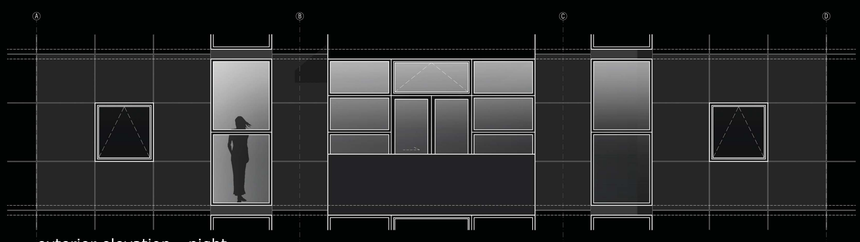
	EXISTING FACADE	S_1 PERFORMANCE AND DAYLIGHT	S_2 FOLDED TRANSPARENCY	S_3 ADAPTIVE SKIN - TRANSF. SPACE
u-value (W/m²K)	EIFS 0.5 windows 2.8	0.75 (sliding unit) 0.2 (aerogel 70 mm) < 0.2 (VIP 60 mm)	0.65	goal: 0.2
g-value (-)	70%	0.37 (aerogel 70 mm)	0.54	varies
module dim (mm by mm)	1219 by 1219 1219 by 3048	2133 by 3048 (sliding unit) 1219 by 3251	1829 by 3251	914 by 1084
thickness (mm)	155 (opaque) 108 (glazing)	51 (sliding unit) 79 (aerogel panel) 60 (VIP panels)	40	76
weight	windows (per appartment) 1000 kg EIFS on metal frame 2.5 kg/m²	60 - 80 kg/m³ (aerogel) 160 - 180 kg/m³ (VIP) 200 kg per 1219 by 3251 unit	320 kg/facade unit	goal: 35 kg/m²
assembly time (time per appartment)	2 weeks	2 weeks	1 day (crane needed)	1 day (no crane needed)
uninterrupted building use (yes/no)	yes	no	yes	yes
cost ($/m²)	100	250	500	500 $ per panel (20 000 $ per appartment)
savings potential (kWh per year)	energy simmulation necessary	energy simmulation necessary	energy simmulation necessary	energy simmulation necessary
comfort (-)	low	high	medium	high
embodied energy	glass 14 MJ/kg expanded polystyrene 108 MJ/kg steel studs 20.1 MJ/kg gypsum 1.8 MJ/kg	aluminium frame 155 MJ/kg aerogel 53 MJ/kg	polyester 115 MJ/kg	varies
CO_2 (kg)	glass 0.85 per kg expanded polystyrene 2.55 per kg steel studs 1.37 per kg gypsum 0.12 per kg	aluminium frame 8.24 MJ/kg aerogel 4.2 per kg	polyester 4.68 MJ/kg	varies
recyclable (yes/no)	partially (difficult disassembly)	yes	yes	recyclable / reusable
other (-)				leasable



exterior elevation - day



interior elevation - day



exterior elevation - night

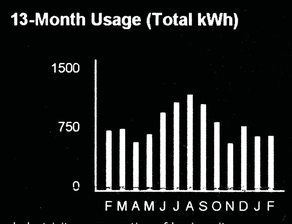
EXISTING CONDITION ANALYSIS

advantages:

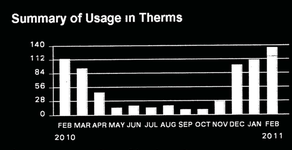
- relatively low E consumption in winter due to heat gain through the facade with west exposure
- daylight conditions in living space
- acceptable design solution

disadvantages:

- insufficient daylight in two smaller spaces
- thermal discomfort in all spaces both in winter and summer
- strong air current through window frames
- condensation at glass surface and window frames during winter
- thermal bridges at slab edge and balcony
- design and daylight disruption of balcony railing
- high E consumption during summer due to overheating



annual electricity consumption of basic unit



annual gas consumption of basic unit

THE BASIC UNIT

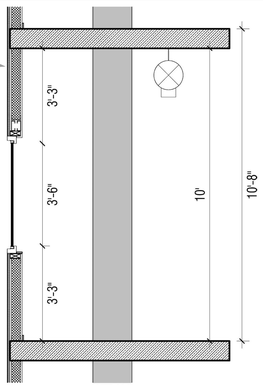
The basic unit in the building consists of three major spaces - the living and kitchen area, the bedroom, and the multi-use room. The plan of the unit functions well as the area for circulation is minimized and incorporated into the living space and the exposure of every major space to the exterior wall is maximized through the reasonable depth and extended length of the unit as a whole.

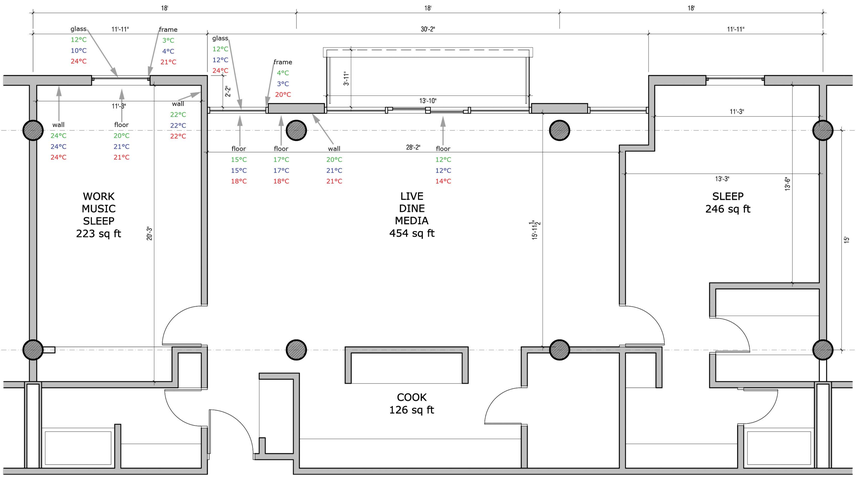
Surface temperature fluctuation during the course of a winter day in a west exposure unit:

green - t° measured at 7.00 h, outside t° -7°C
blue - t° measured at 12.00 h, outside t° -5°C
red - t° measured at 15.00 h, outside t° -4°C

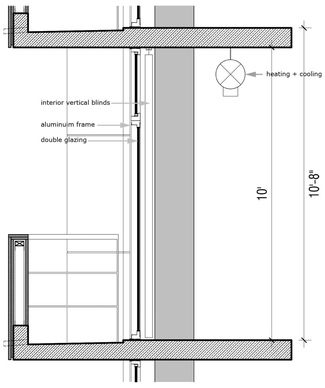
EXISTING EXTERIOR WALL ASSEMBLY
(EXTERIOR INSULATION FINISH SYSTEM)

2”	exterior insulation and finish system - two layers, second one applied after facade refurbish
5/8”	exterior gypsum board with “TYVEK” wrap
3 5/8”	metal studs at 16” o.c.
3 1/2”	insulation with vapor barrier
5/8”	gypsum board





basic unit: plan

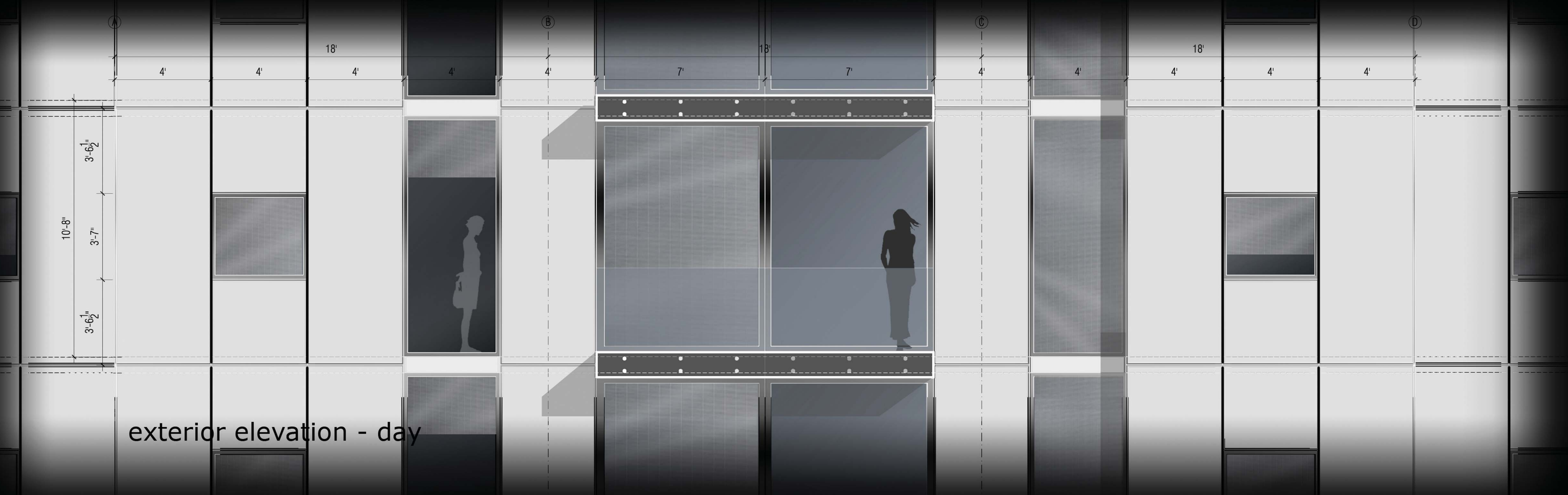


basic unit: facade sections

EXISTING BUILDING

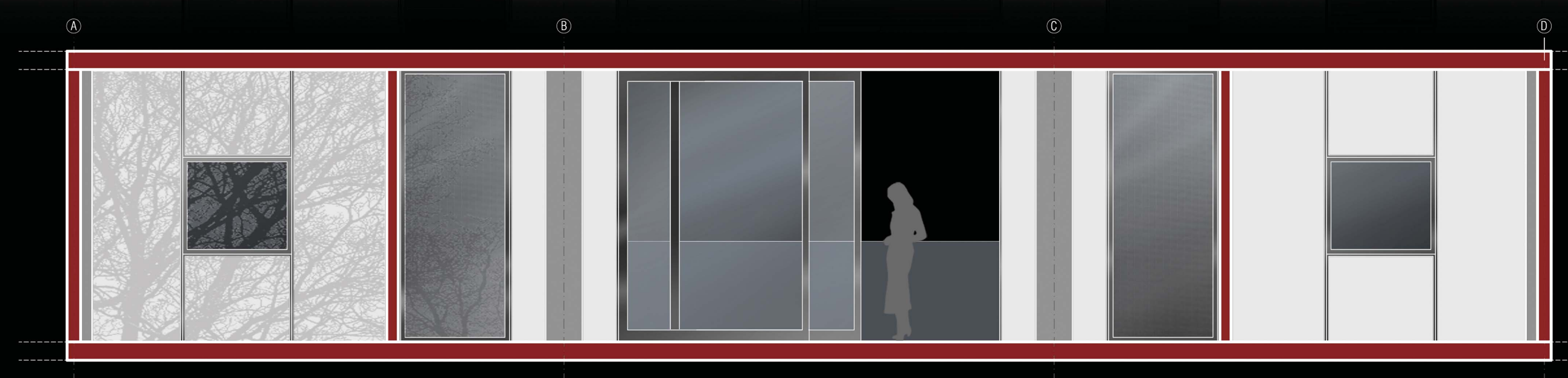
939 W HURON STREET, CHICAGO

SYSTEM_1: PERFORMANCE + DAYLIGHT

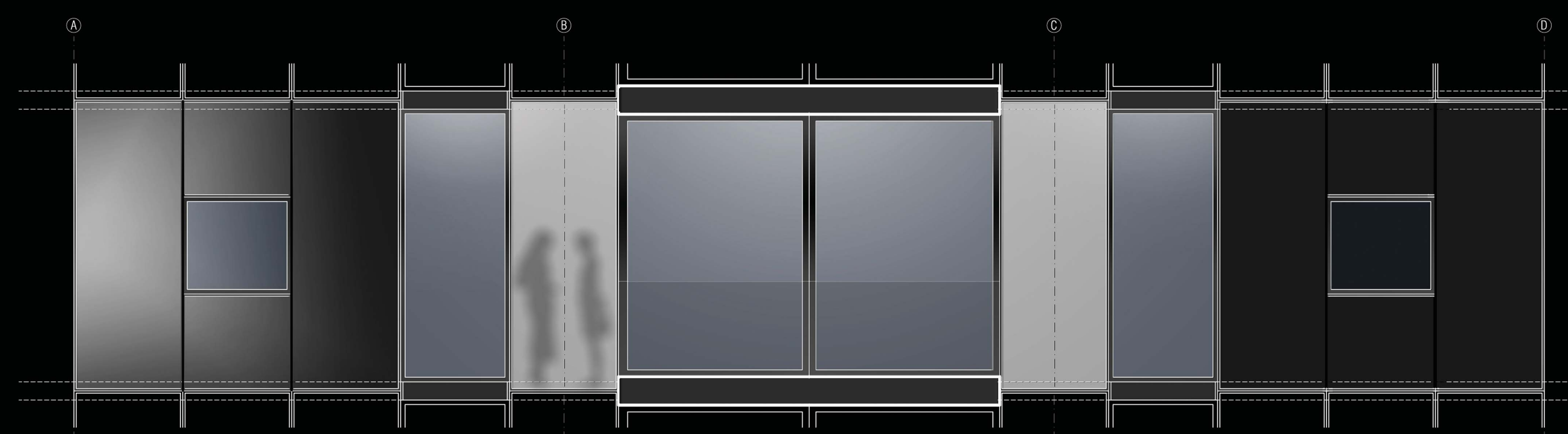


exterior elevation - day

This facade system serves two main goals. First, to achieve a significantly **higher performance** values than the existing facade and second, to bring into all spaces of the residential unit sufficient amounts of **daylight**. The system is **constructable with materials that are currently available** on the market, such as translucent aerogel glass panels, VIPs, triple glazed windows and exterior shading out of stainless steel rods.
Architecturally the solution follows the **existing facade design** as it maintains the position of transparent glass elements and the overall module of 4'.
Additional daylight is introduced through the translucent panels that allow for the facade to be animated throughout the course of the day and simultaneously maintain a level of privacy required by residential use.

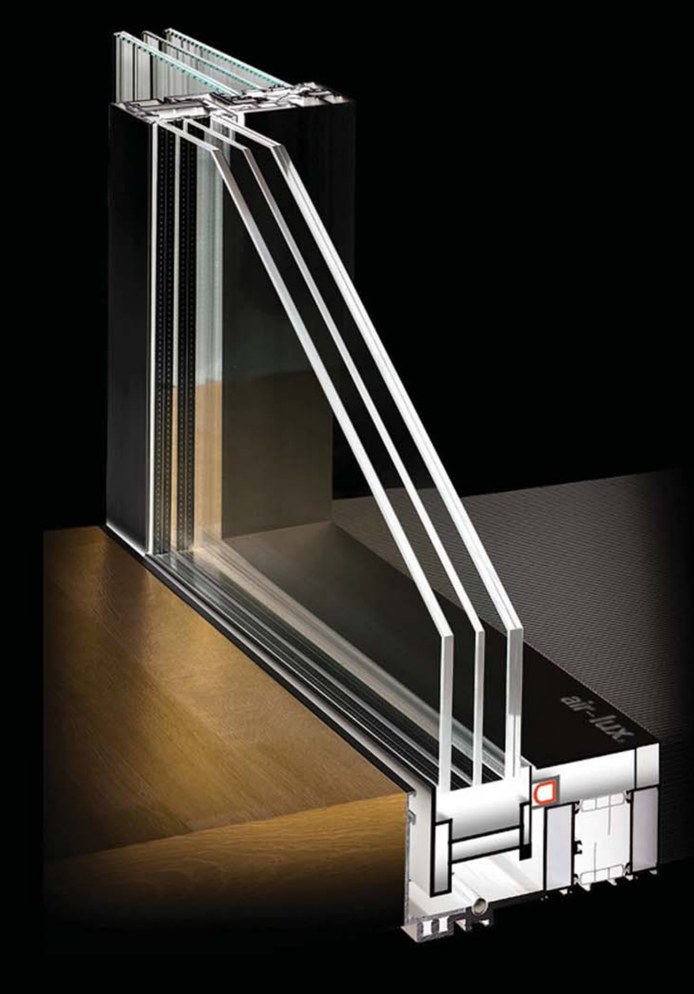


interior elevation - day

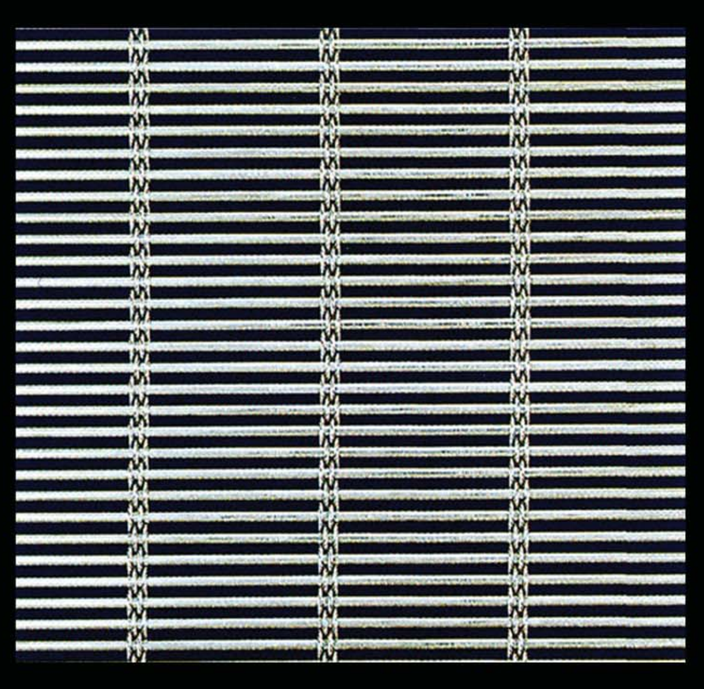


exterior elevation - night

aerogel panel
Solera S®

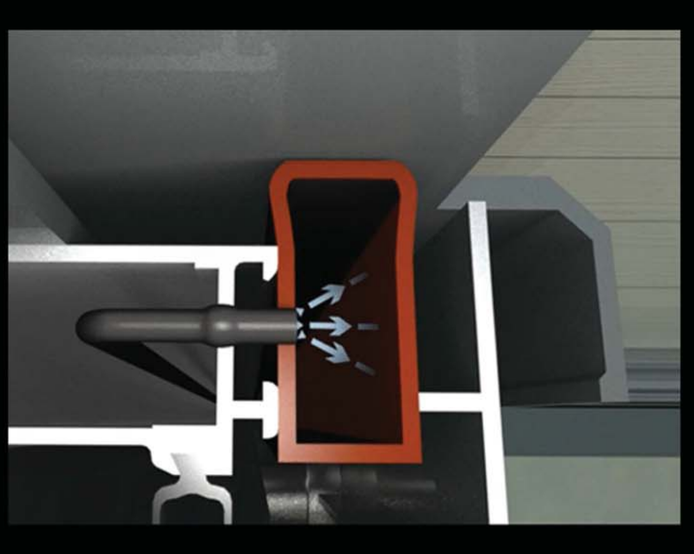


triple glazing
air-lux® system

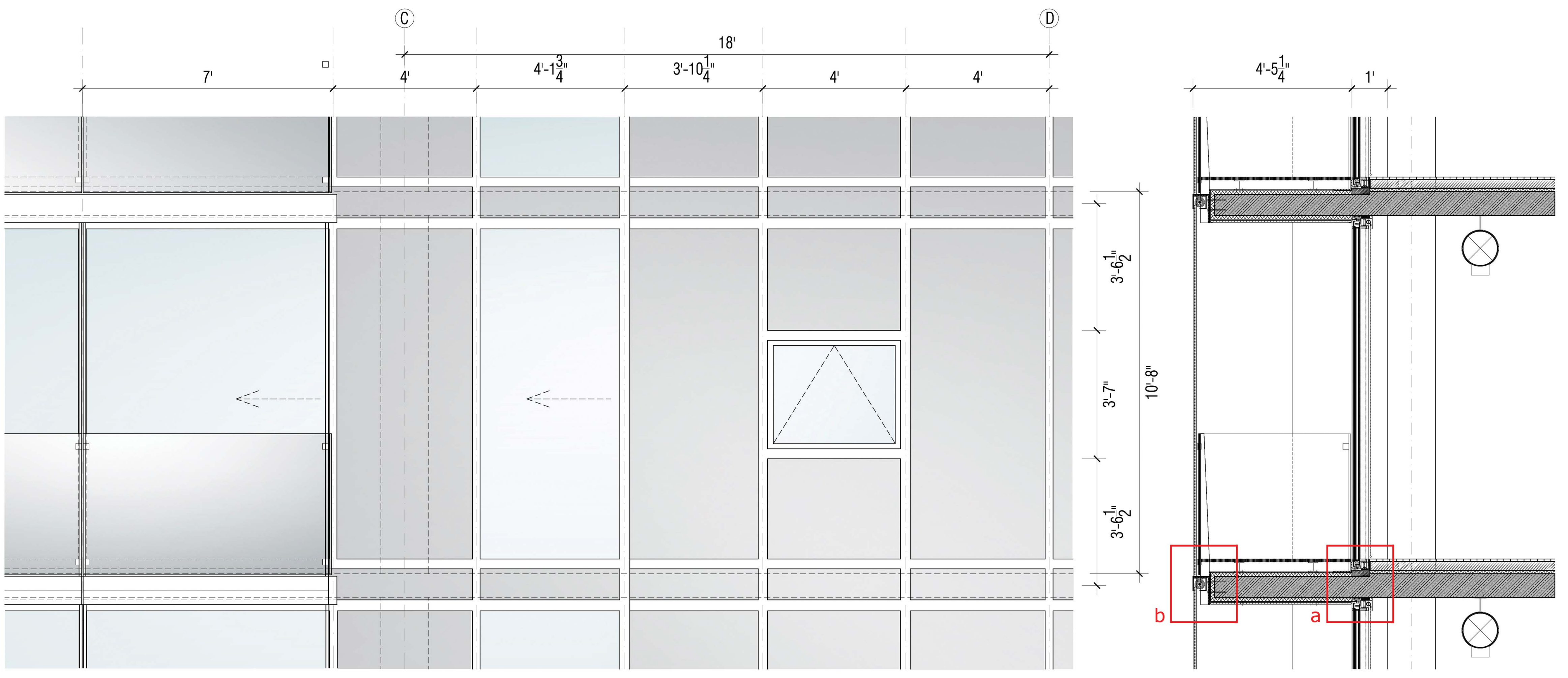


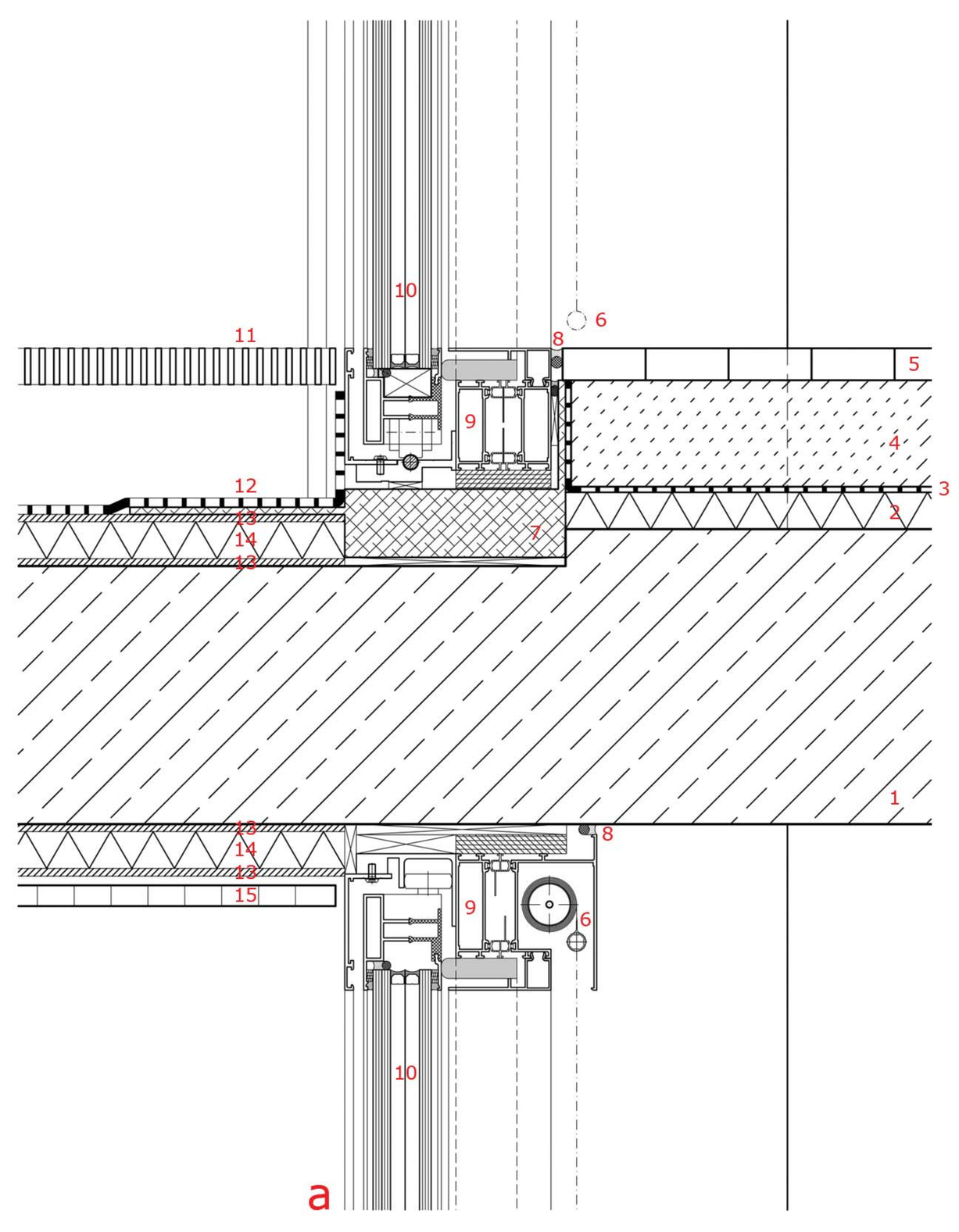
shading -
stainless steel rods

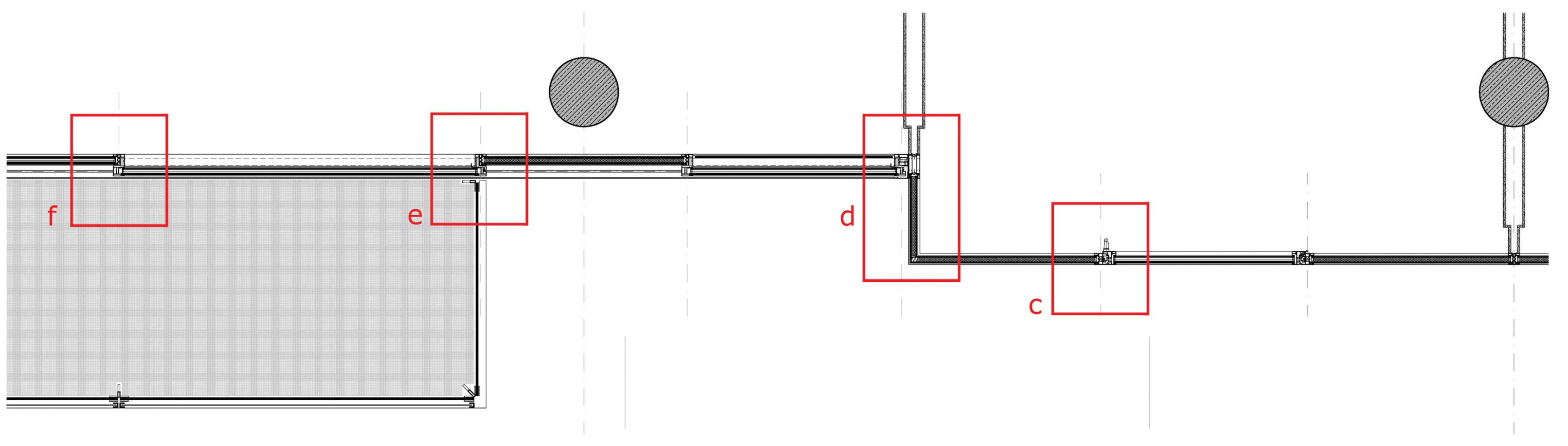
VIPs

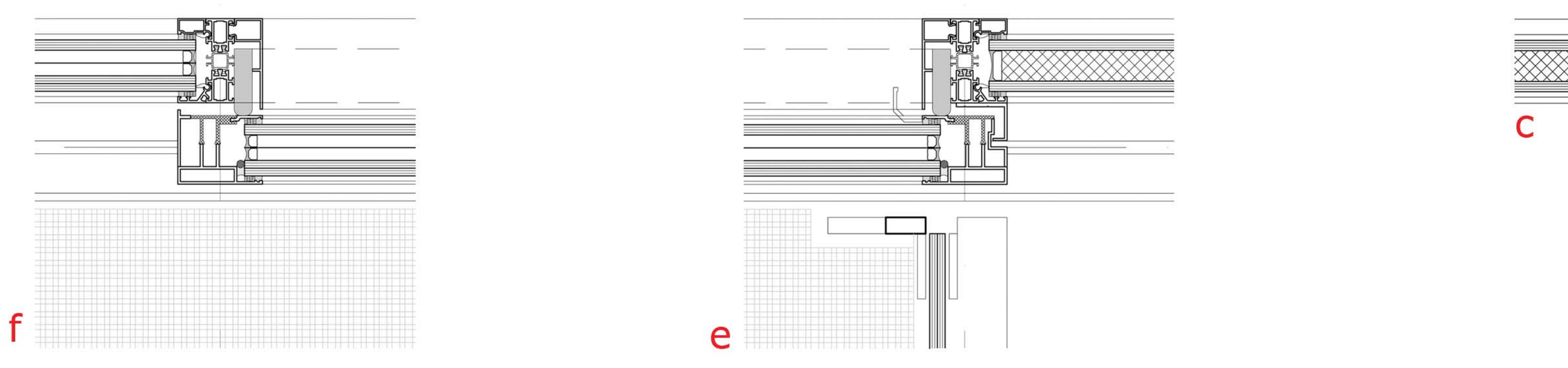


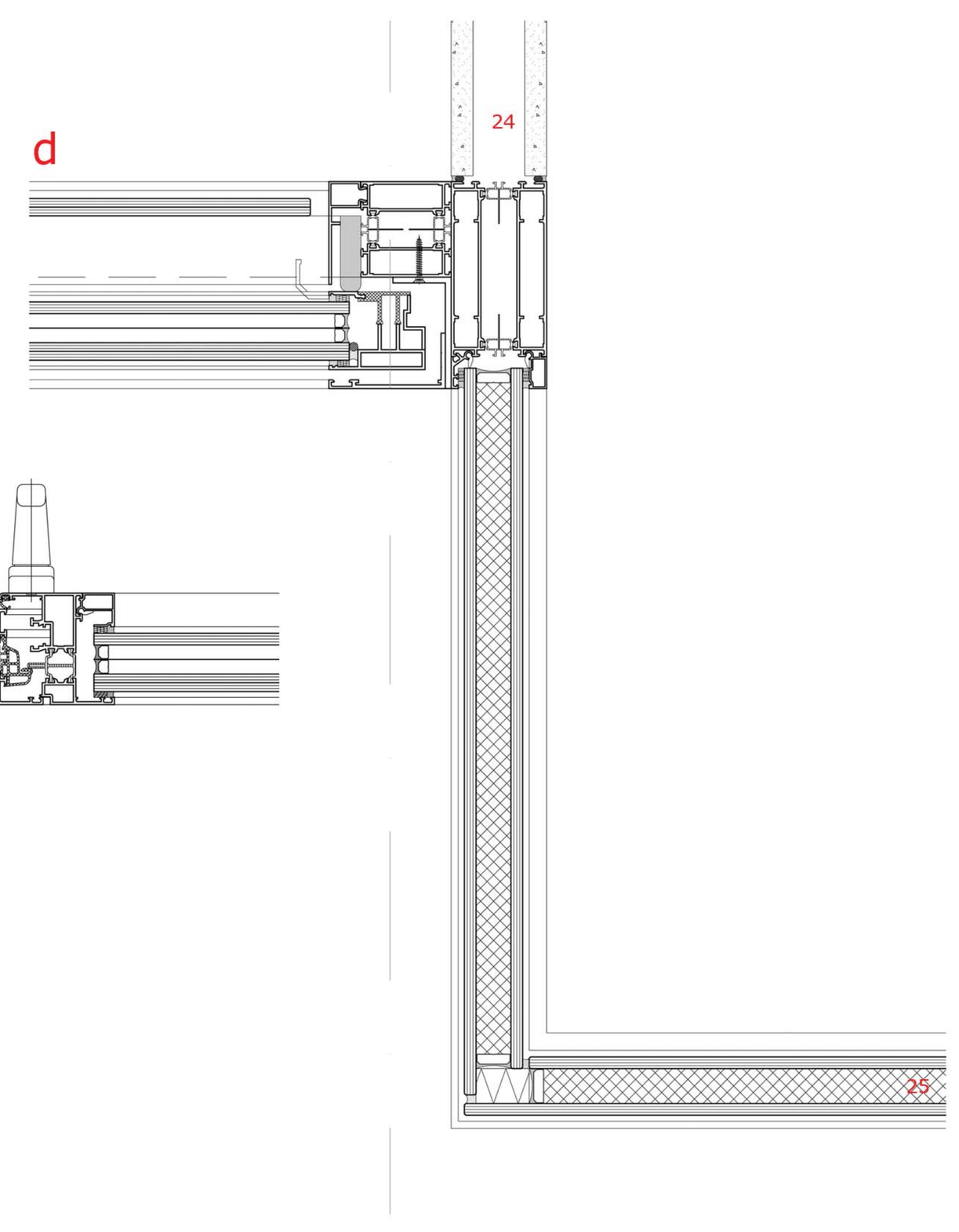
sliding door sealant
air-lux® system

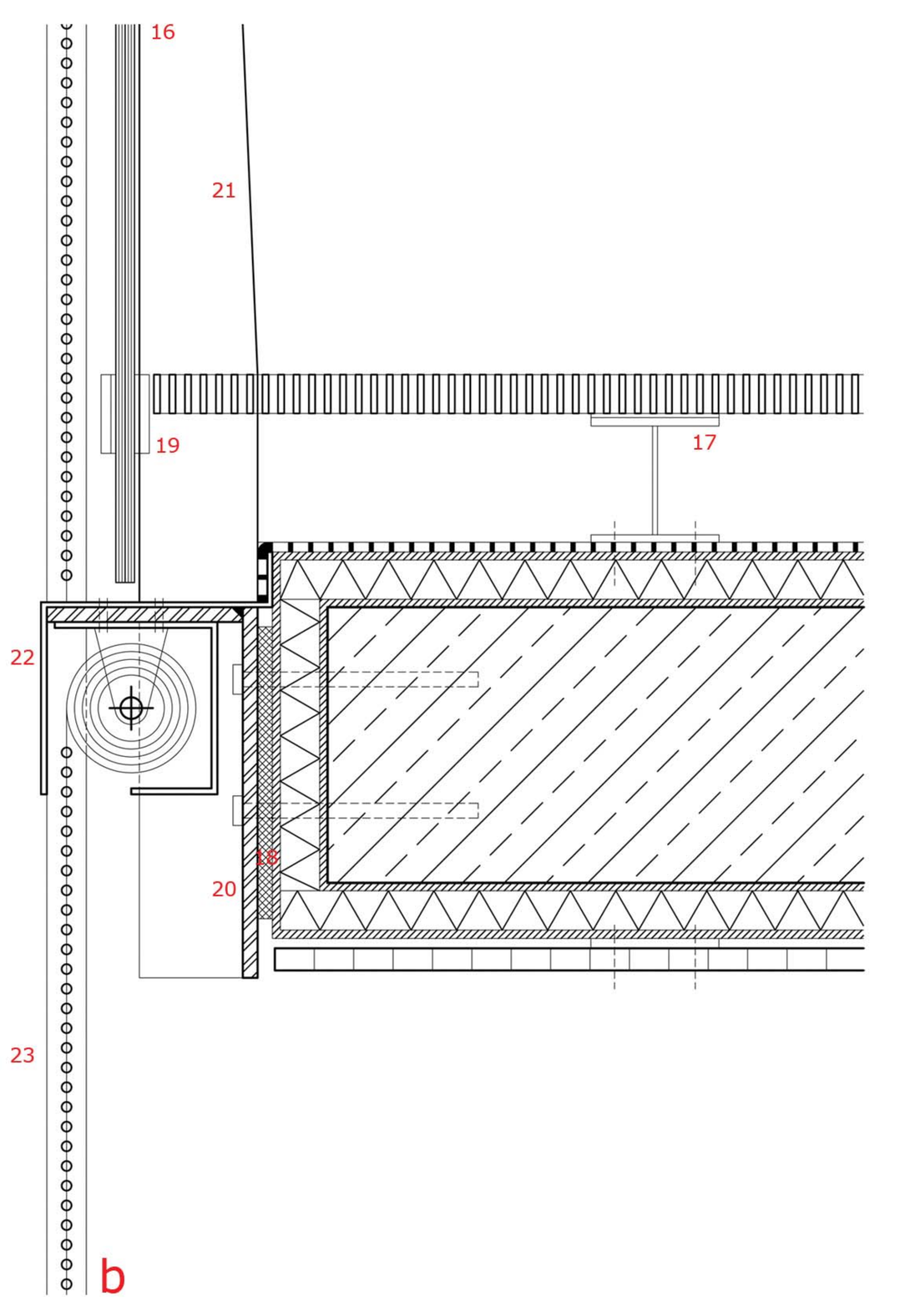




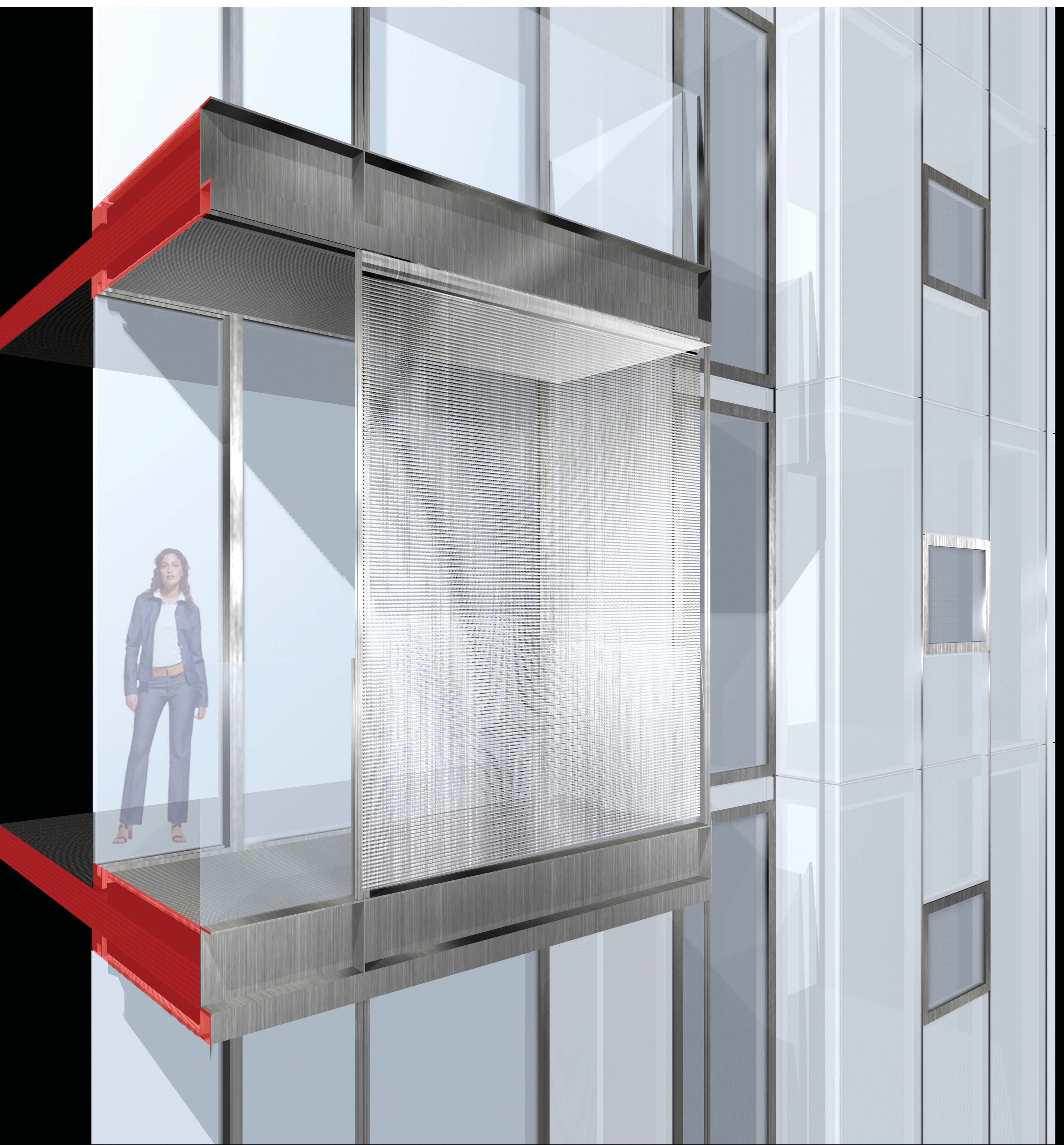


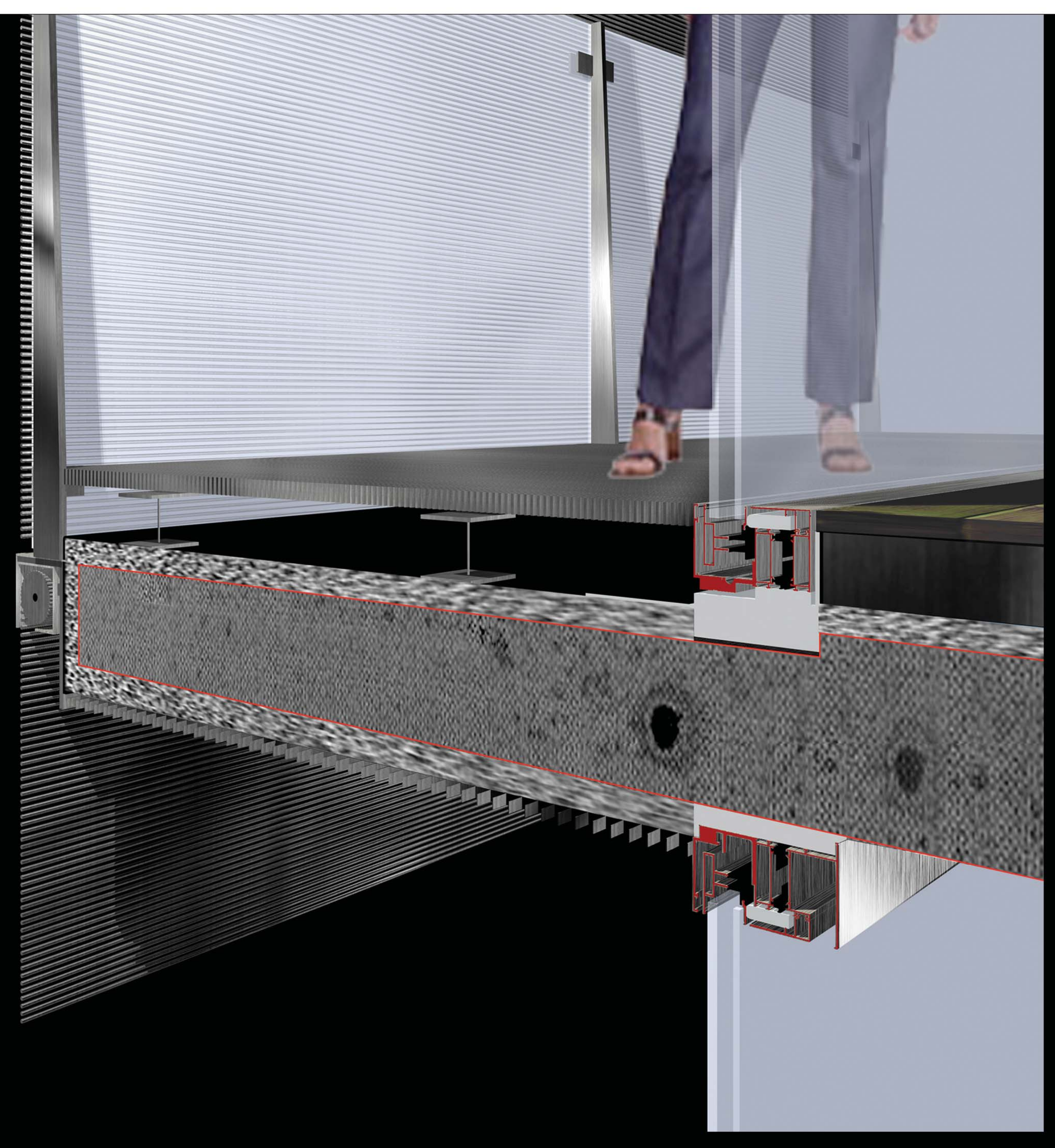






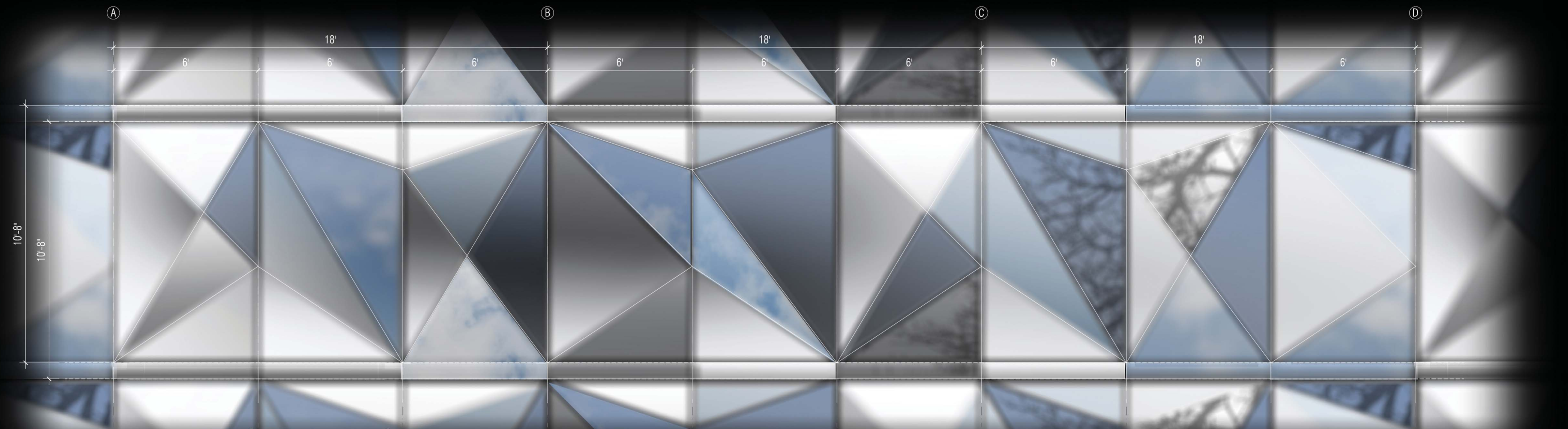
1 existing reinforced concrete slab 8"
2 mineral wool footstep sound insulation 1"
3 polythene sheeting separation
4 cement screed 3"
5 wood parquet 1"
6 mechoshade
7 wood setting block
8 sealant
9 sliding door aluminium profile with air inflatable sealant (air-lux Technik AG)
10 glazing 40mm
laminated outer lite (6+6 mm), air space (10mm),
heat mirror film (plastic with low E coating, 0.1 mm), air space (10mm),
tempered inner lite (8 mm)
11 stainless steel grating
12 water barrier
13 protective matting
14 VIP (enabling sill-free balcony construction) 20mm
15 expanded stainless steel mesh
16 glass railing (laminated glass 6+6 mm)
17 grating support
18 neoprene spacer
19 glass stainless steel clips
20 welded steel profile
21 vertical railling strucure - tapering stainless steel blades
22 stainless steel flashing
23 exterior shading - stainless steel rods
24 interior wall construction
25 aerogel translucent insulated unit - aerogel 1"





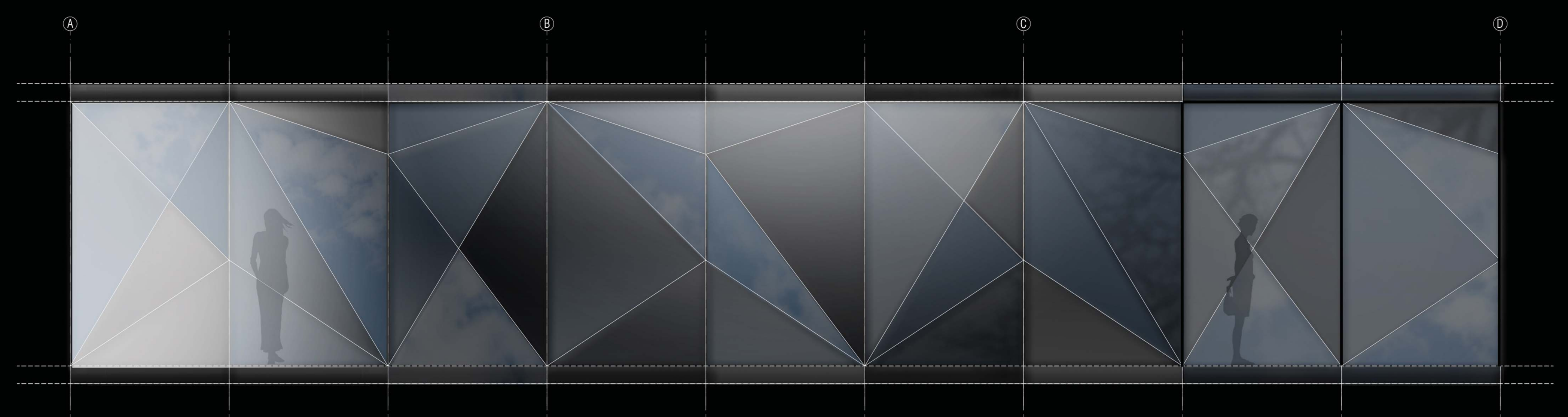
SYSTEM_2: FOLDED TRANSPARENCY

"Folded Transparency" is about achieving the **minimal structure** that is necessary to support a **fully glazed** facade system, which permits **unobstructed views** to the exterior and plenty of **daylight**. The principle of folding a flat surface in order to stiffen it is applied to the glass which results in the opportunity to **eliminate the vertical mulions**. Extra strong plastic extruded pultruded (glass reinforced) horizontal mullions with excellent thermal properties are being used at the slab edge.
Low-E coatings applied to the glass reduce the energy gain in Summer and the energy loss in winter while maintaining a relatively high VLT-value and good view. The resulting outer glass reflectivity of the environment is a desired design effect.

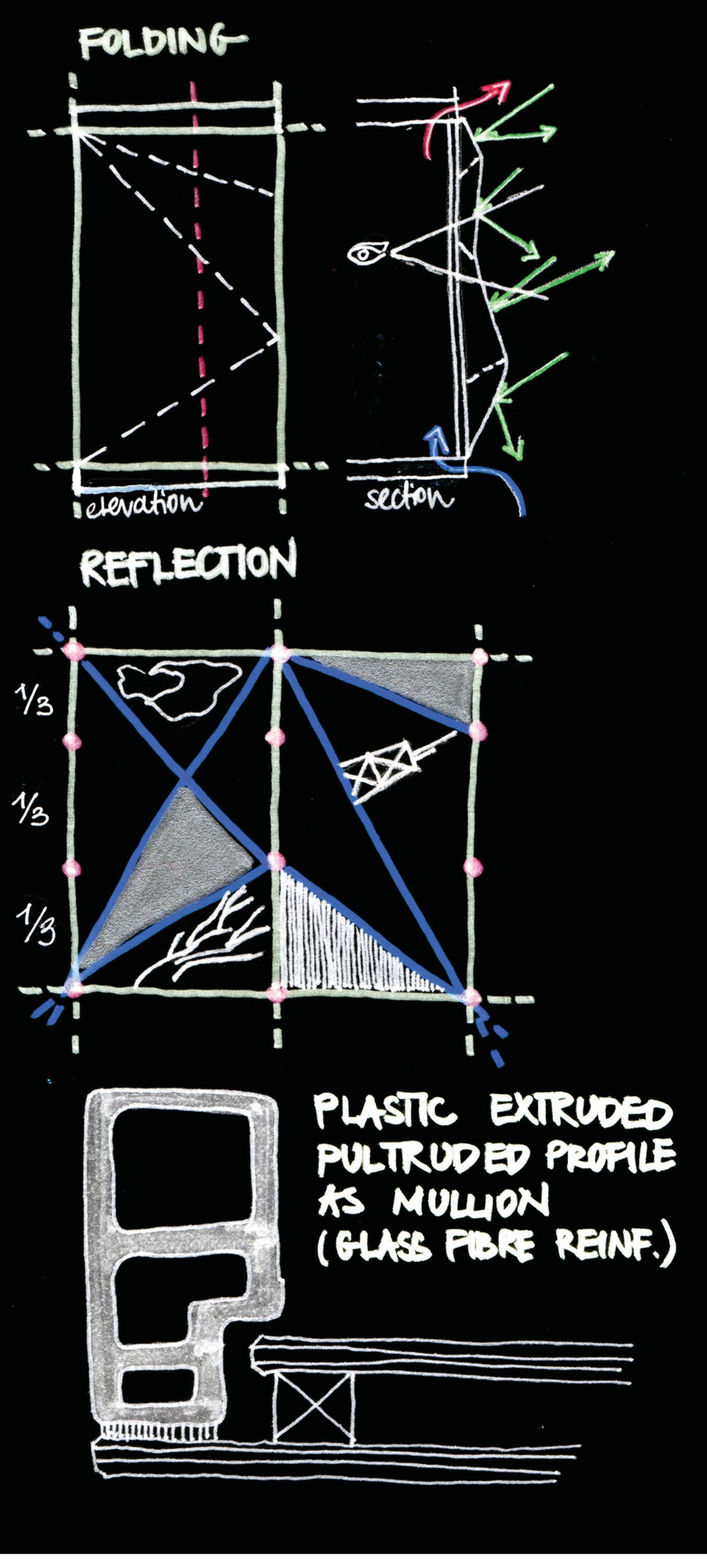


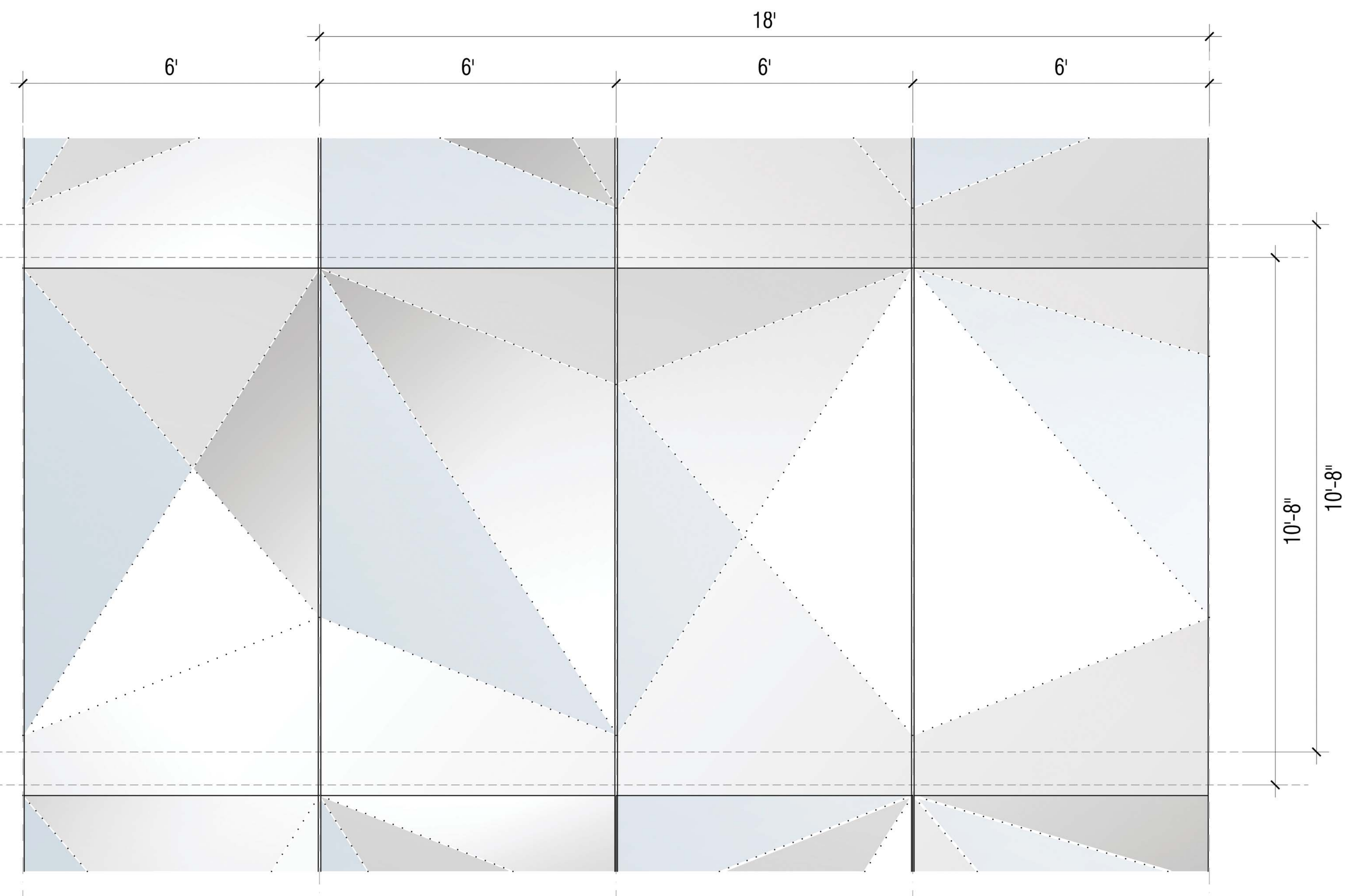
exteroir elevation - day

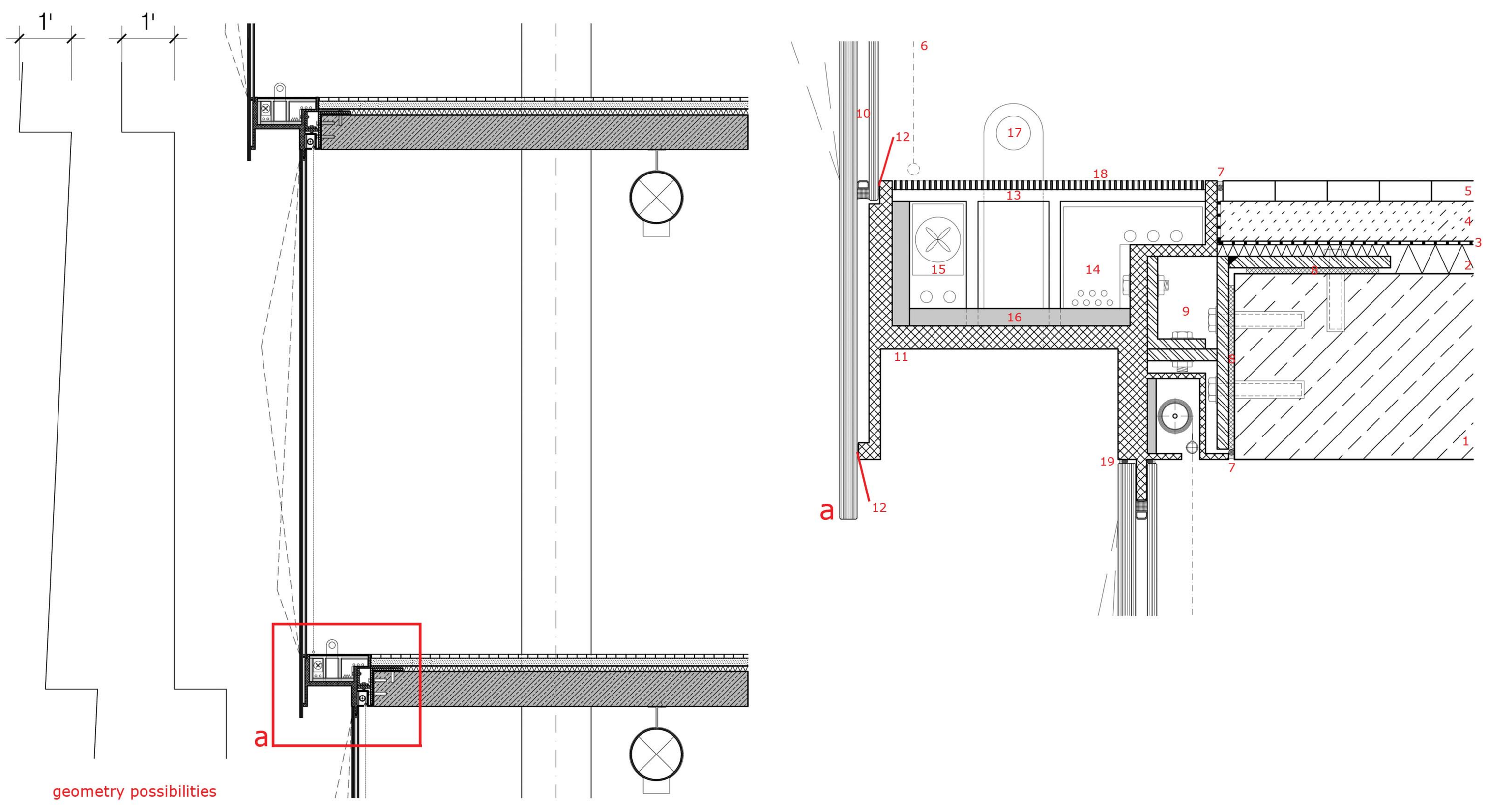
interior elevation - day

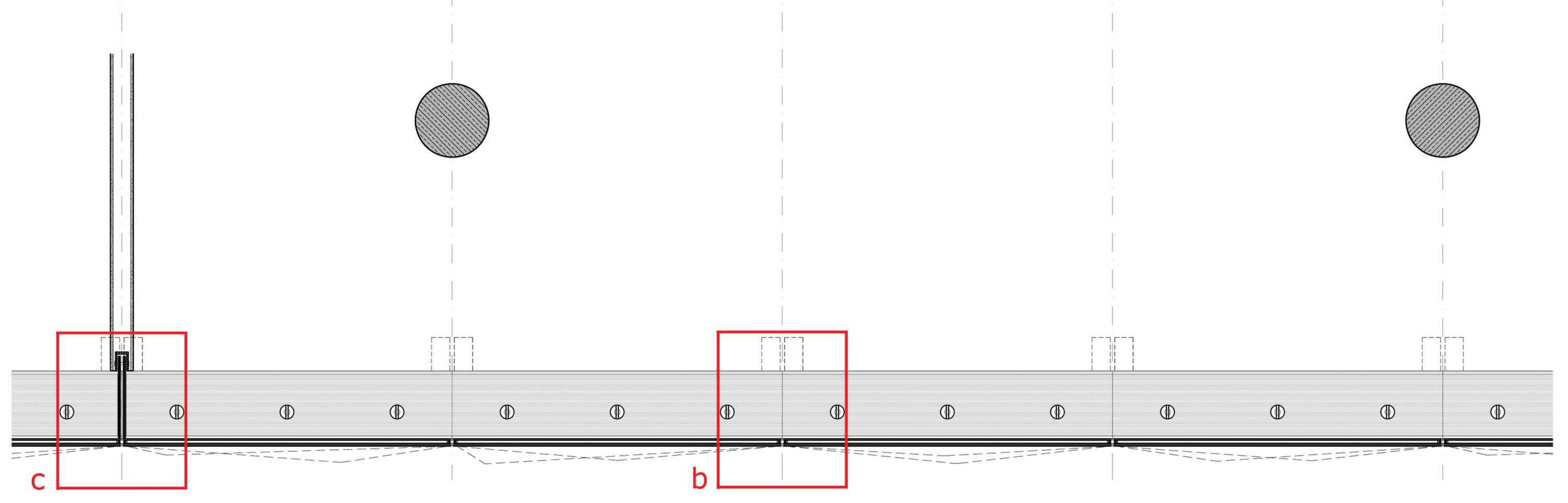


exterior elevation - night

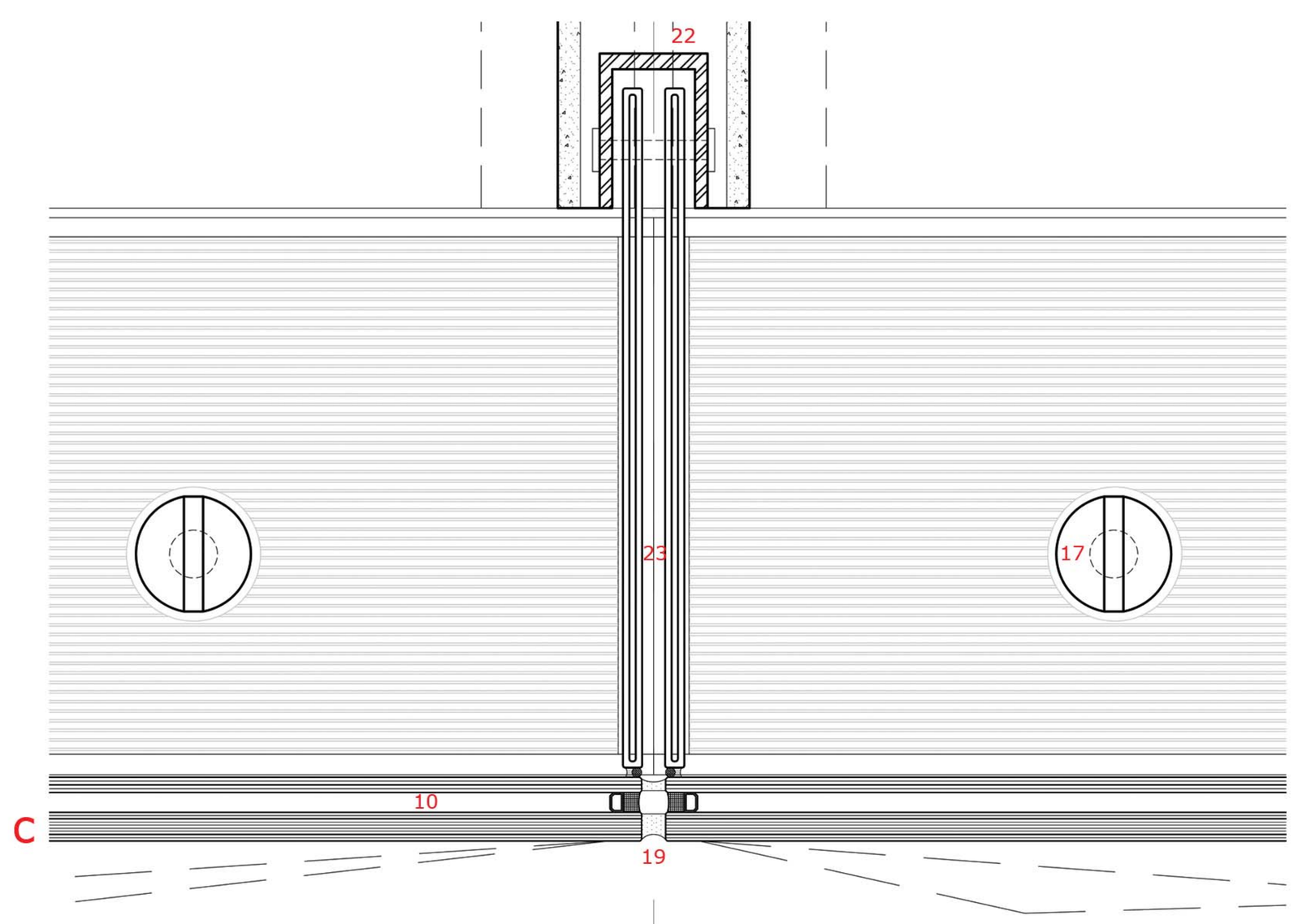


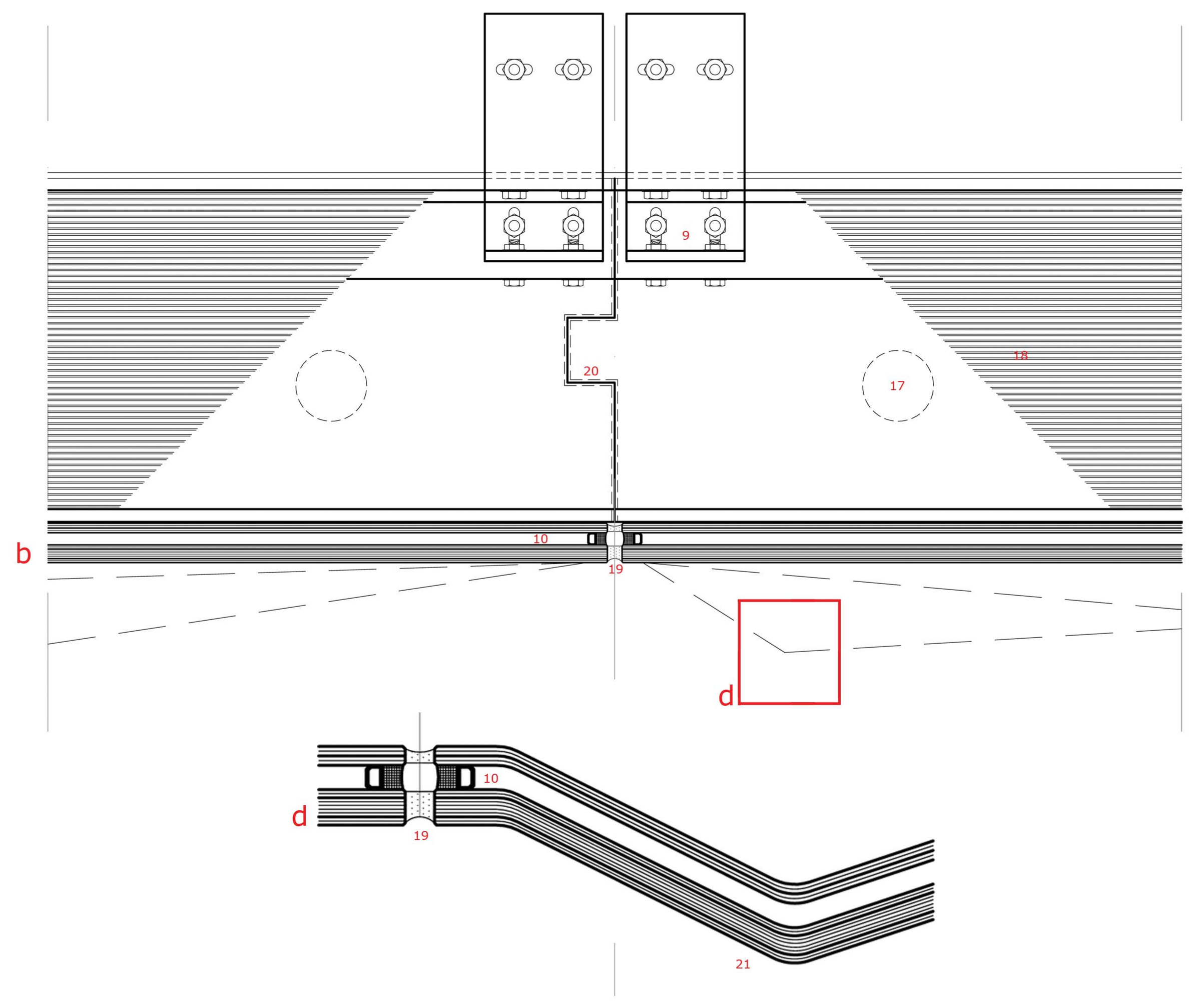


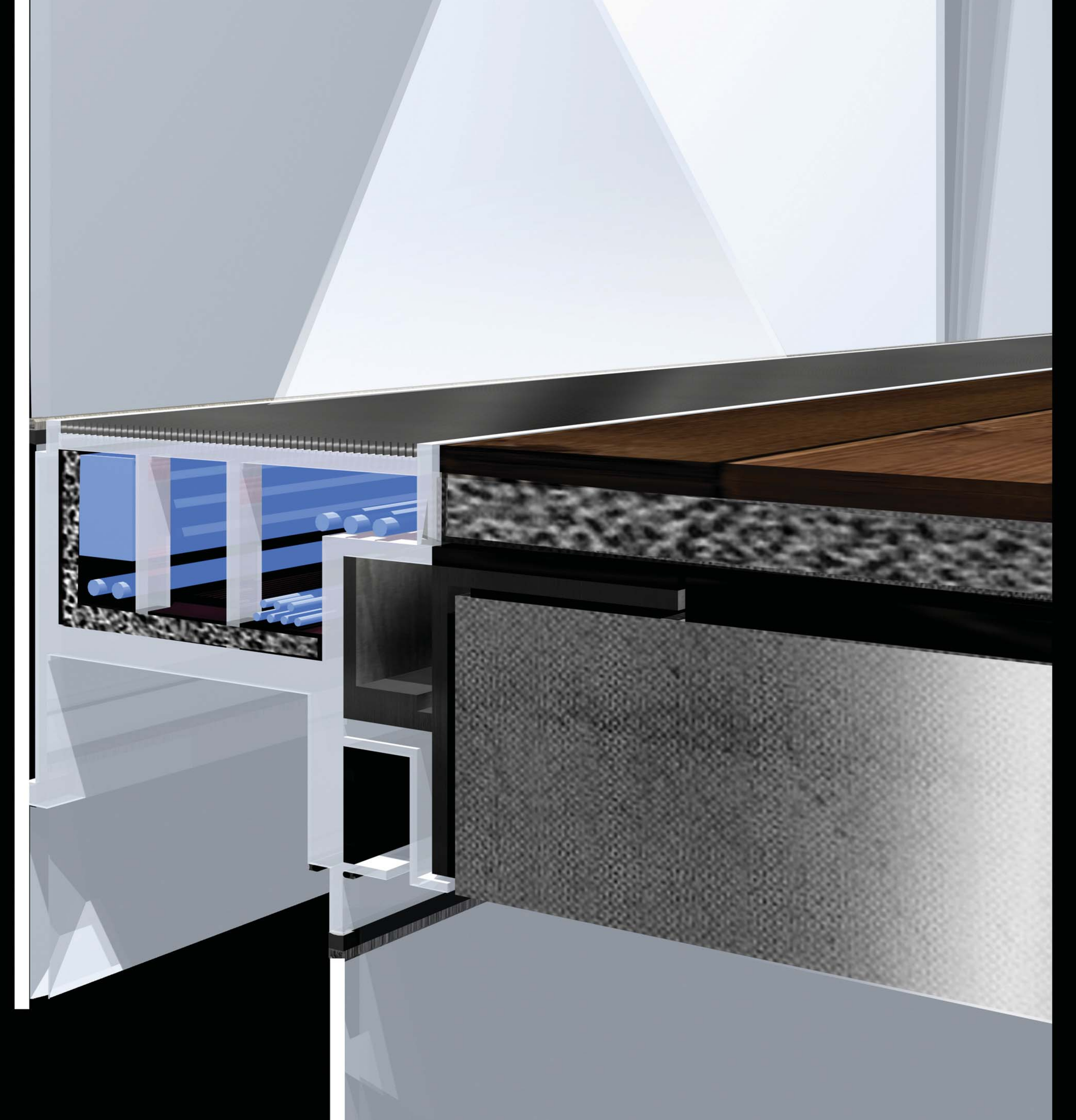




1 existing reinforced concrete slab 8"
2 mineral wool footstep sound insulation 1 1/4"
3 polythene sheeting separation
4 cement screed 2"
5 wood parquet 1"
6 mechoshade
7 sealant
8 neoprene gasket
9 steel plates for anchoring with 3-way alignment possibility
10 insulated glass unit 37mm
"folded" laminated outer lite (8mm + 1.5 mm +8 mm), air space (12mm),
tempered inner lite with low E coating on surface #3 (8 mm)
11 translucent extruded glass fibre reinforced plastic profile "box"
12 epoxy glue
13 non-continuous box extrusions
14 installation box
15 convector, fan
16 VIP
17 natural ventilation "valve"
18 stainless steel grating
19 structural silicone
20 horizontal connection at mullion - preformed gasket at male-female connection
21 horizontal section at glass "folding"
22 interior wall construction
23 translucent extruded glass fibre reinforced plastic profile for interior wall connection

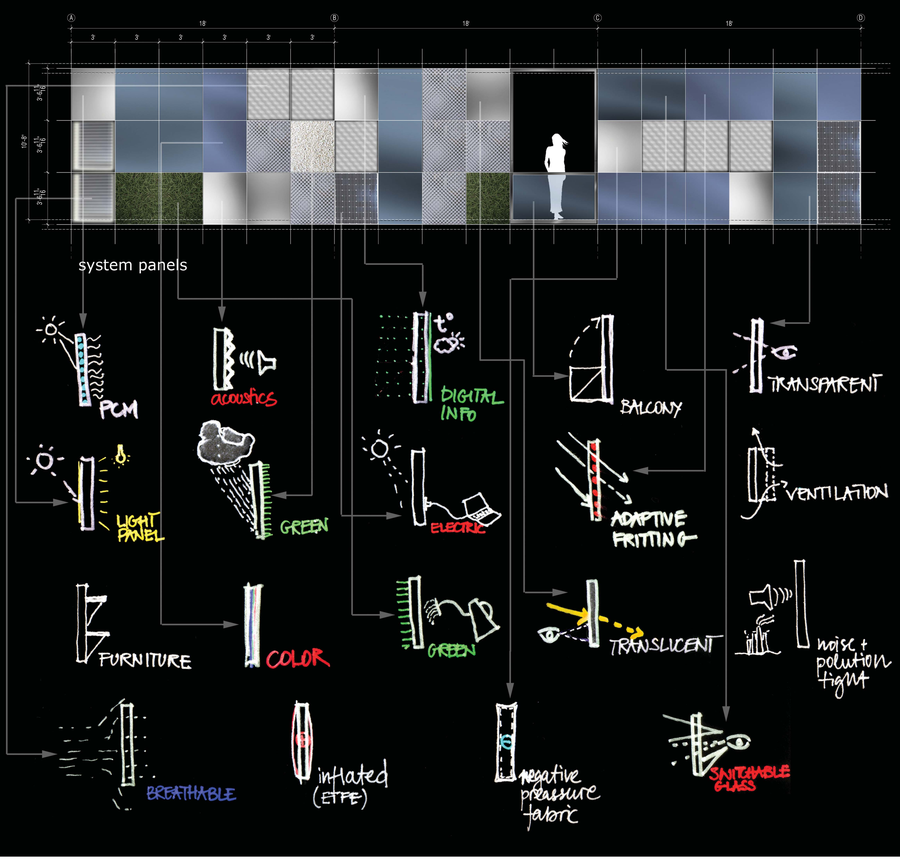


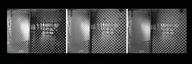




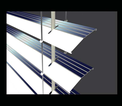
SYSTEM_3:
ADAPTIVE SKIN - TRANSFORMABLE SPACE

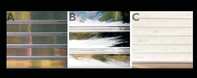
The facade system consists out of **modular panels with different functions**. These panels are user-friendly, leasable, easy to transport and assemble and they can be exchanged with minimum effort. In this way the facade becomes **a surface for manipulation**, where the relationship between the skin of the building and the user is being reestablished.
The panels are **adaptive both to the exterior and the interior** of the building and thus are able to respond to ongoing transformations of the layout, which could allow for efficient use of space where the overall dimension of an apartment unit is minimized. The architectural consequences of a vibrant mixture of functions and their appearance are assumed to be acceptable, especially in the case of a building retrofit.



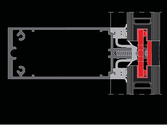

adaptive glass frit
Hoberman Associates

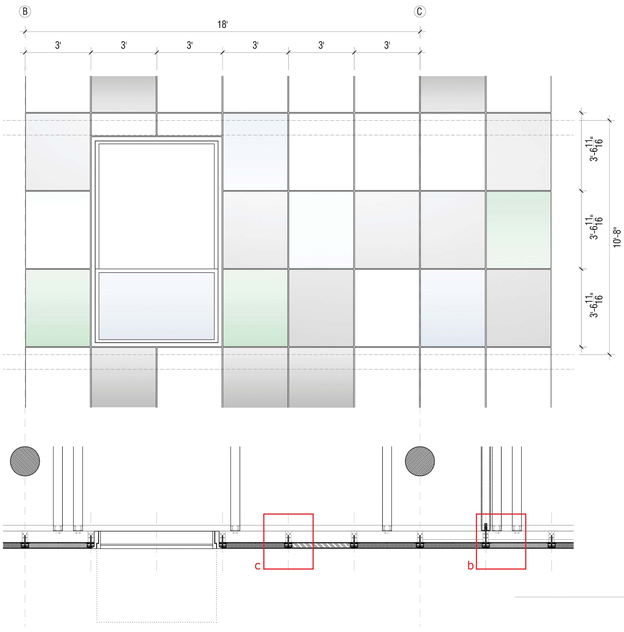

bloomframe balcony
Hurks Geveltechniek

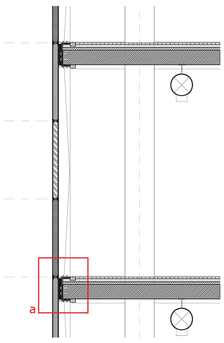

illuminating sunshade
Vincent Gerkens

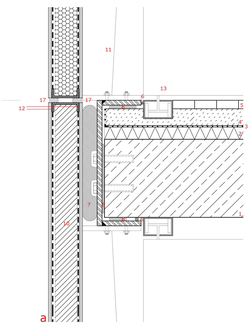

PCM - glassx
Glassx AG


green wall
Ann Demeulemeester Shop in Seoul, Mass Studies


connection between panels
toggle system Raico







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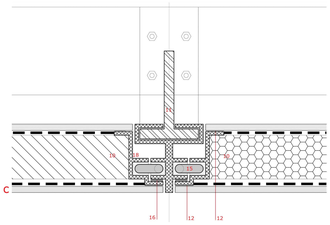
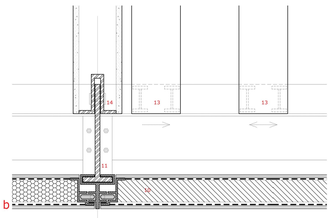
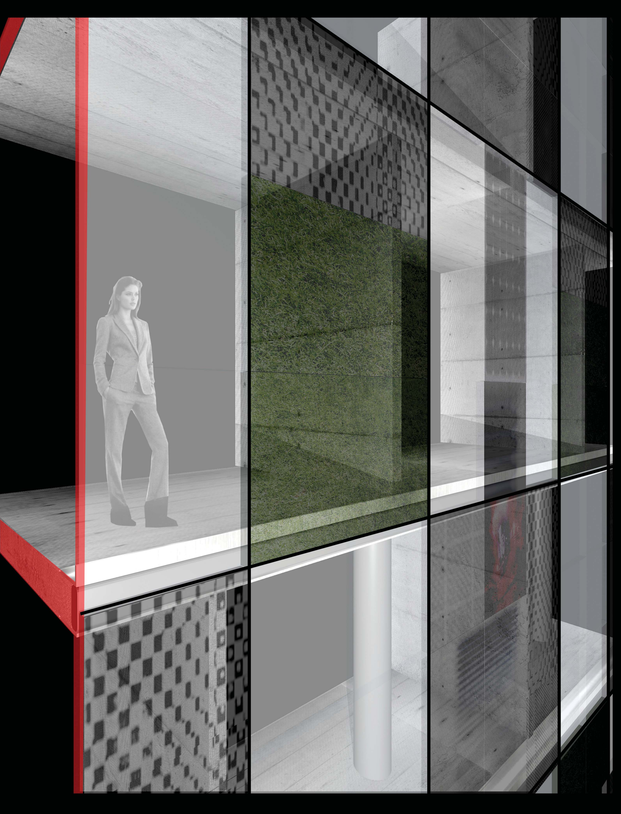
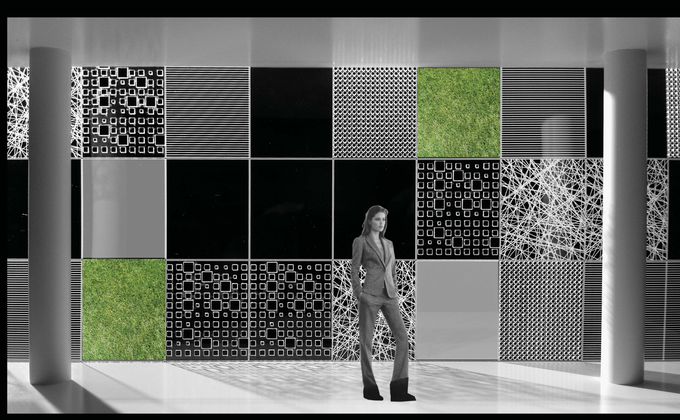
8 neoprene gasket
9 welded steel plate
10 facade panel construction
11 tapering vertical steel blade mullion combined with extruded glass fibre reinforced plastic profile
12 epoxy glue
13 movable interior wall
14 fixed interior wall construction
15 stainless steel toggle system - Raico Bautechnik GmbH
16 flexible gasket - in pressure by activating the toggle system
17 clip-in silicone
18 extruded glass fibre reinforced plastic profile

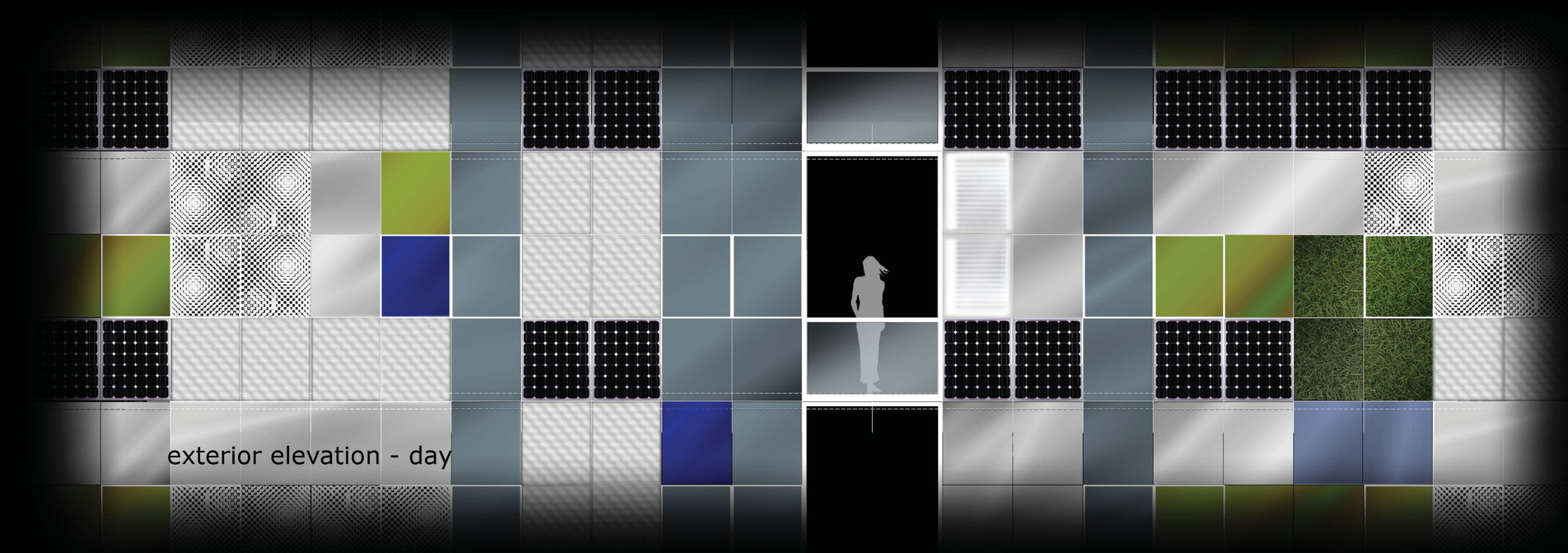


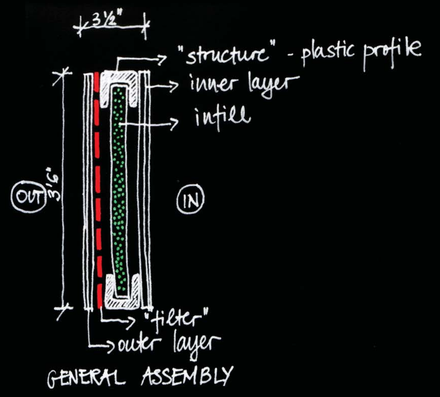


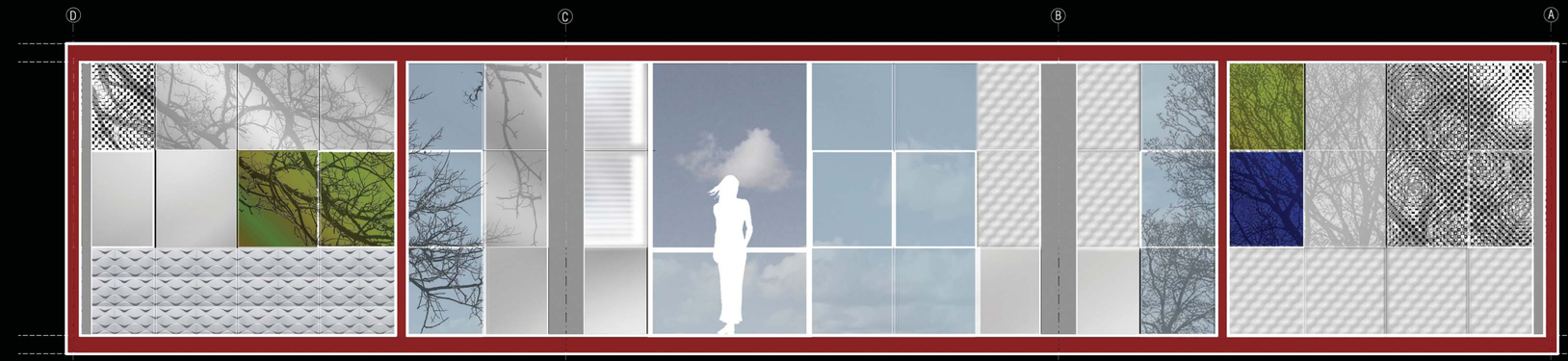




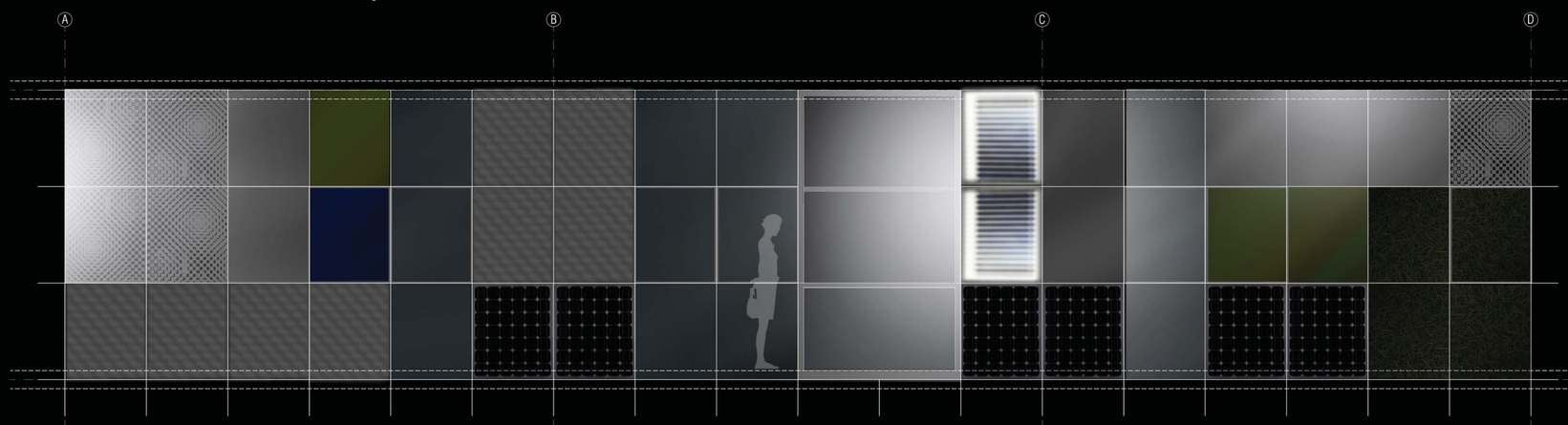
SYSTEM_3:
ADAPTIVE SKIN - TRANSFORMABLE SPACE







interior elevation - day



exterior elevation - night