

HOT CLIMATE DOUBLE FAÇADES: AVOIDING SOLAR GAIN

TERRI MEYER BOAKE, PROFESSOR
SCHOOL OF ARCHITECTURE, UNIVERSITY OF WATERLOO, CANADA



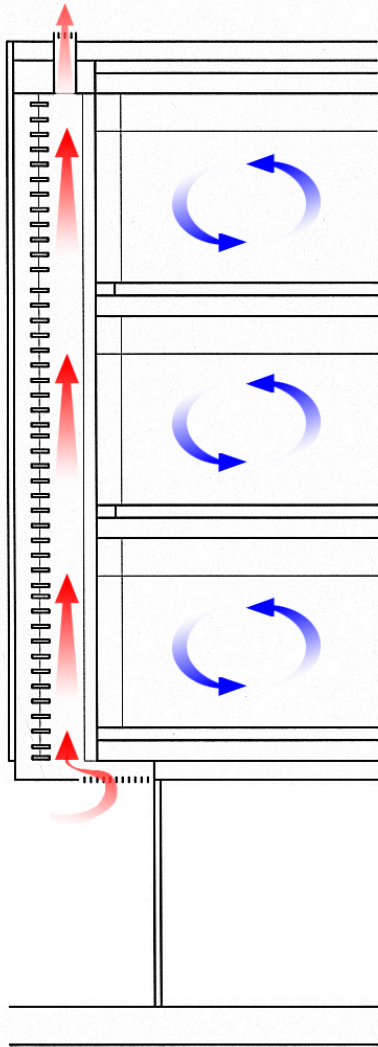


Introduction

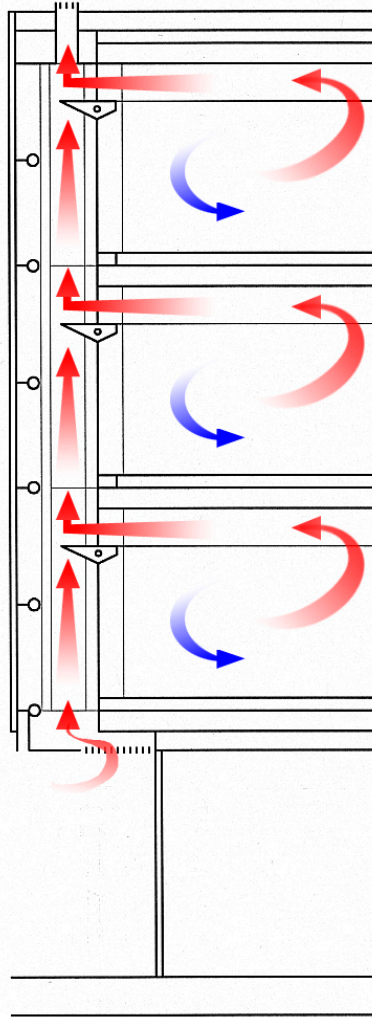
The construction of double façade envelope systems has continued to increase and *persist* in spite of the lack of conclusive hard data to prove the energy benefits. This may be due in part to

- an architectural infatuation with tectonics and appearance,
- a desire to believe in the technological/environmental benefits of the system and
- an appreciation of many practical benefits that may not be readily quantifiable but are nonetheless easily understood.

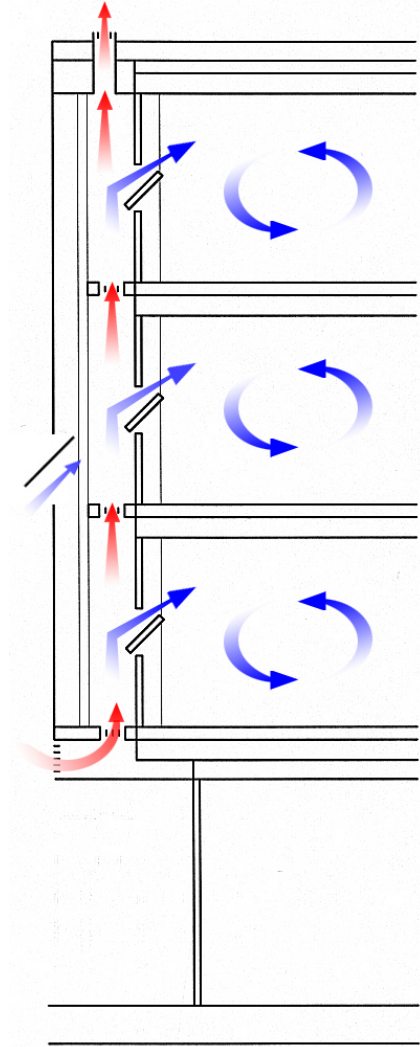
Early research into double façade types



Buffer Façade




Extract-air Façade



Twin Face Façade

Typical Placement of Shading

- Early double façades tended to be constructed in temperate and then colder climates
- Value was sought for their ability to provide additional insulation and slow heat transfer
- The cavity was seen as a great place to locate the shading system as it could be protected from snow, ice and wind
- The virtual exterior location of the shades placed them in a position where they could be of greatest benefit in preventing unwanted solar gain in the summer.



CCBR, University of Toronto, Canada



Hot Climate Issues

This presentation/paper focuses on recent developments in the adaptation and application of double façades in hot climates.


Given that hot climates need not respond so such extreme swings of temperature and seasonal changes, hot climates have focused performance criteria towards their biggest concern,

SOLAR AVOIDANCE

Bioclimatic design strategies

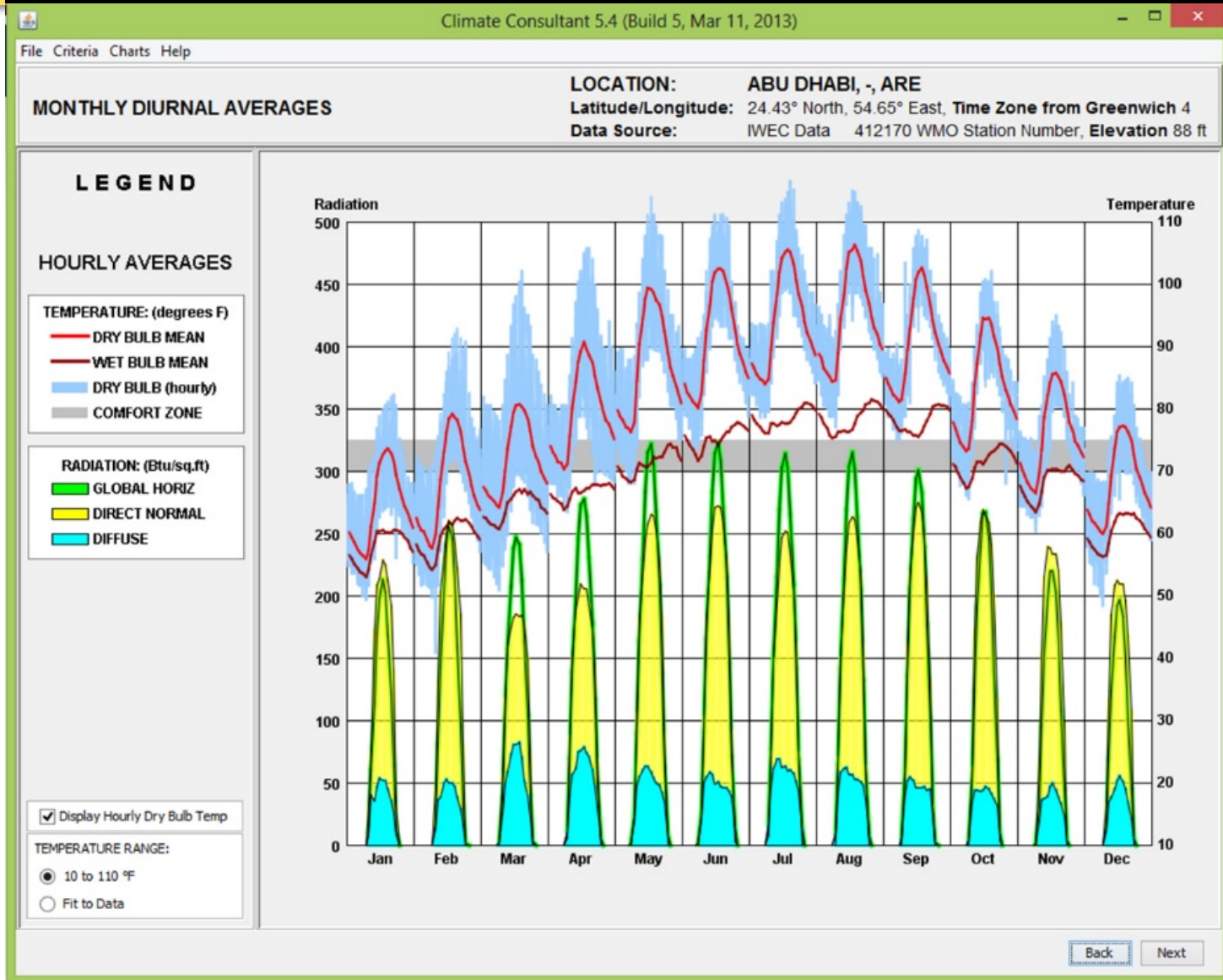
Although the tightly clustered towers of Dubai, with their small floor plates may seem extraordinarily dense to the Western eye, the density succeeds in providing shading of the streets as well as for large portions of the exposed façades to also be shaded.

High sun angles also make it easier to incorporate shading devices as the required length of projection is minimized.

A photograph of the Dubai Marina skyline, featuring several tall, modern skyscrapers with glass facades and unique architectural details. The buildings are situated along a waterfront with a marina filled with yachts. In the foreground, there is a paved walkway with palm trees and a few people walking.

Marina Bay, Dubai, UAE

Typical Climatic Conditions in the Gulf Region



Taken using Climate Consultant 5.4



Economic justification

A focus on solar avoidance makes it easier to quantify the benefits.

Shading devices are more easily incorporated into current energy modeling software.

Accuracy is good.

If A/C can be downsized, there is benefit.

Issues with embodied energy, maintenance and related costs will continue to be problematic.


Al Bahar Towers, Abu Dhabi
Aedas Architects w/Arup

Humidity + Dust

One of the most difficult environmental issues in the Gulf Region that must be addressed is the combination of high humidity and dust.

This construction image of Capital Gate in Abu Dhabi demonstrates the severity of façade cleaning issues.

There is no fresh water available so all water must be desalinated. This is very costly and impacts the frequency of cleaning operations.



Capital Gate, Abu Dhabi,
RMJM Architects

Cleaning

Always must be a consideration, particularly with odd shaped geometries and difficult to access façade configurations.



Mashrabiya - A Culturally Acceptable Screen



Masdar City, Foster + Partners, Abu Dhabi, UAE

Masdar City



Masdar City, Foster + Partners, Abu Dhabi, UAE

A Modernized Screen



The Souk, Foster + Partners, Abu Dhabi, UAE

The prevalence of screens



The Souk, Foster + Partners, Abu Dhabi, UAE

Traditional-based types

1. Those that use a more traditional approach (buffer, twin-face or extract-air) where the exterior layer is glazed and where

- The air corridor is usually wide enough to allow cleaning access without interfering in the interior spaces.
- The air corridor is used to buffer the temperature extremes.
- The air corridor may or may not form part of the cooling system.
- The shading devices are not normally positioned in this cavity if it is not sealed.

A tall, curved skyscraper with a blue glass facade, known as Capital Gate in Abu Dhabi. The building has a unique, twisted design. The image shows the building from a low angle, emphasizing its height and curvature. The sky is clear and blue.

Capital Gate, Abu Dhabi,
RMJM Architects

The Hybrid-based type

2. Those that employ a shading screen (mashrabiya) as the exterior face coupled with a high performance curtain wall system as the interior layer of the façade, in which

- A second layer of glass is not used to provide the outer layer.
- The layers tend to be separated by a wide air corridor to provide access for cleaning.
- The exterior shading layer is either fixed or responsive.
- The shading layer must be very durable to withstand exposure to the elements as well as cleaning.

Doha Tower, Qatar
Ateliers Jean Nouvel

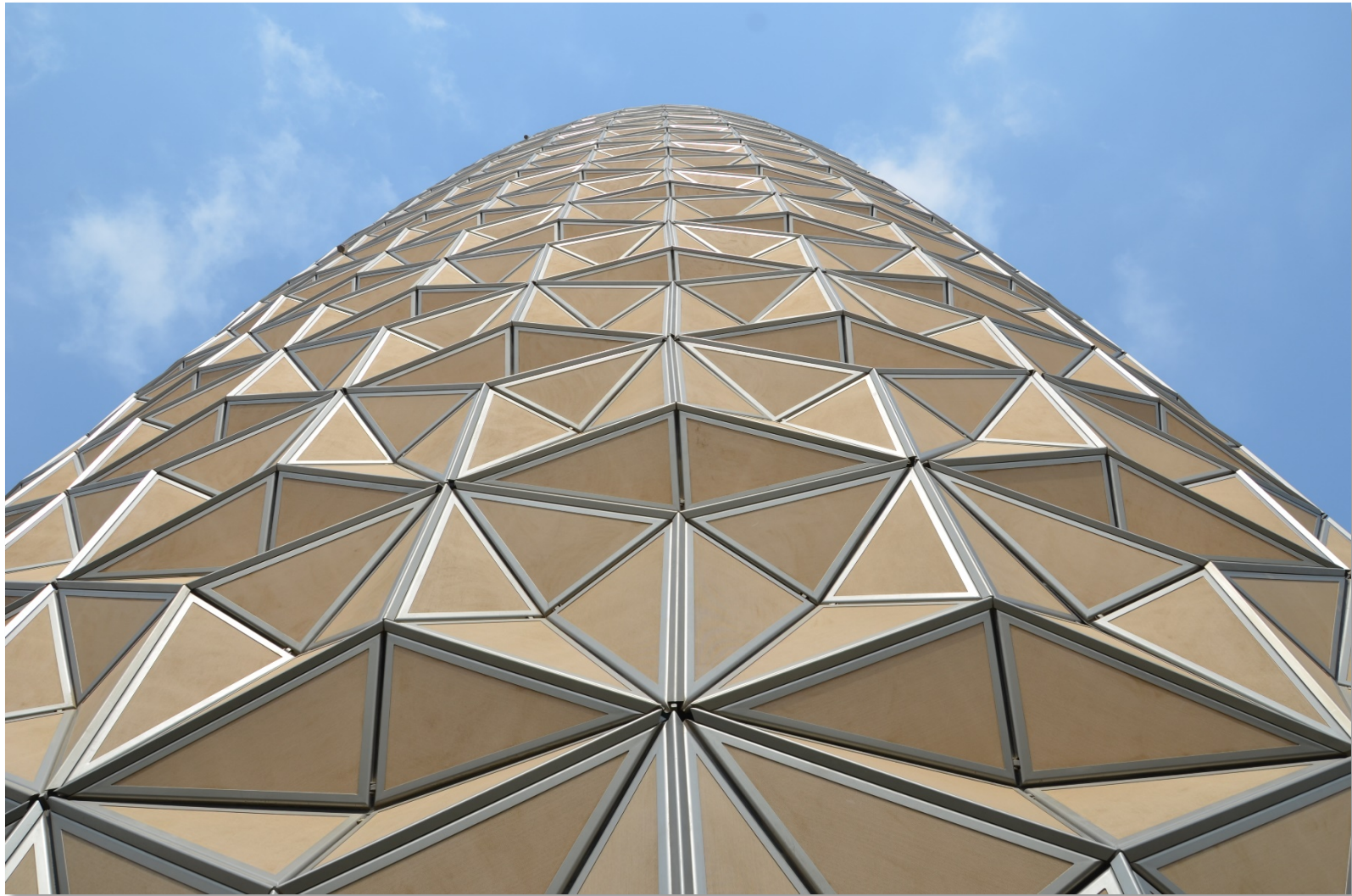


Al Bahar Towers

The Al Bahar Towers in Abu Dhabi
Aedas Architects w/ Arup

- Private client, Islamic bank
- Mashrabiya type double façade on south, east and west portions
- North façade left open due to minimized solar issues and to allow for a primary view to the city beyond
- Responsive system that opens and closes according to solar path

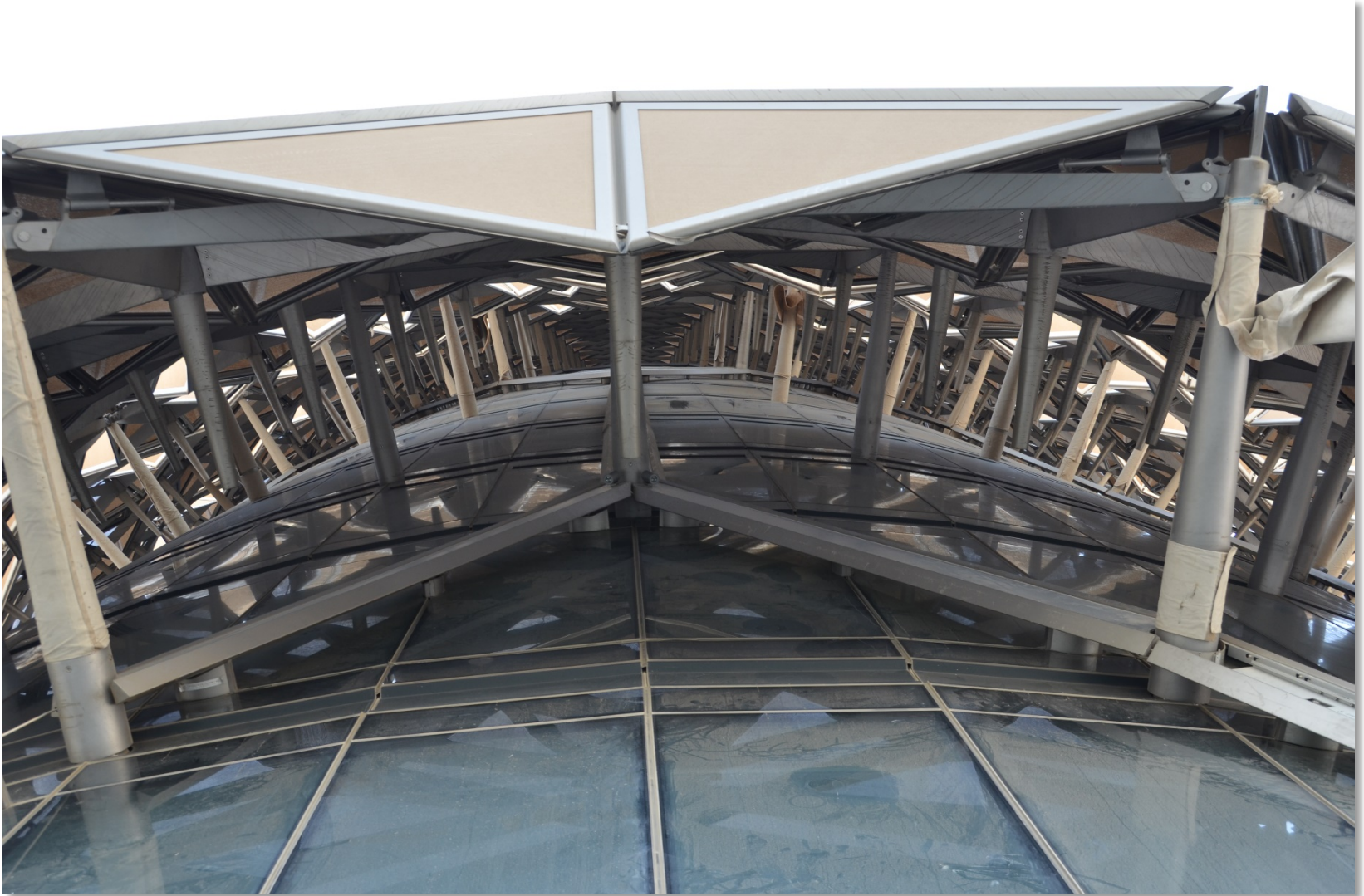
Façade fully closed



View through the PTFE screen



View up air corridor



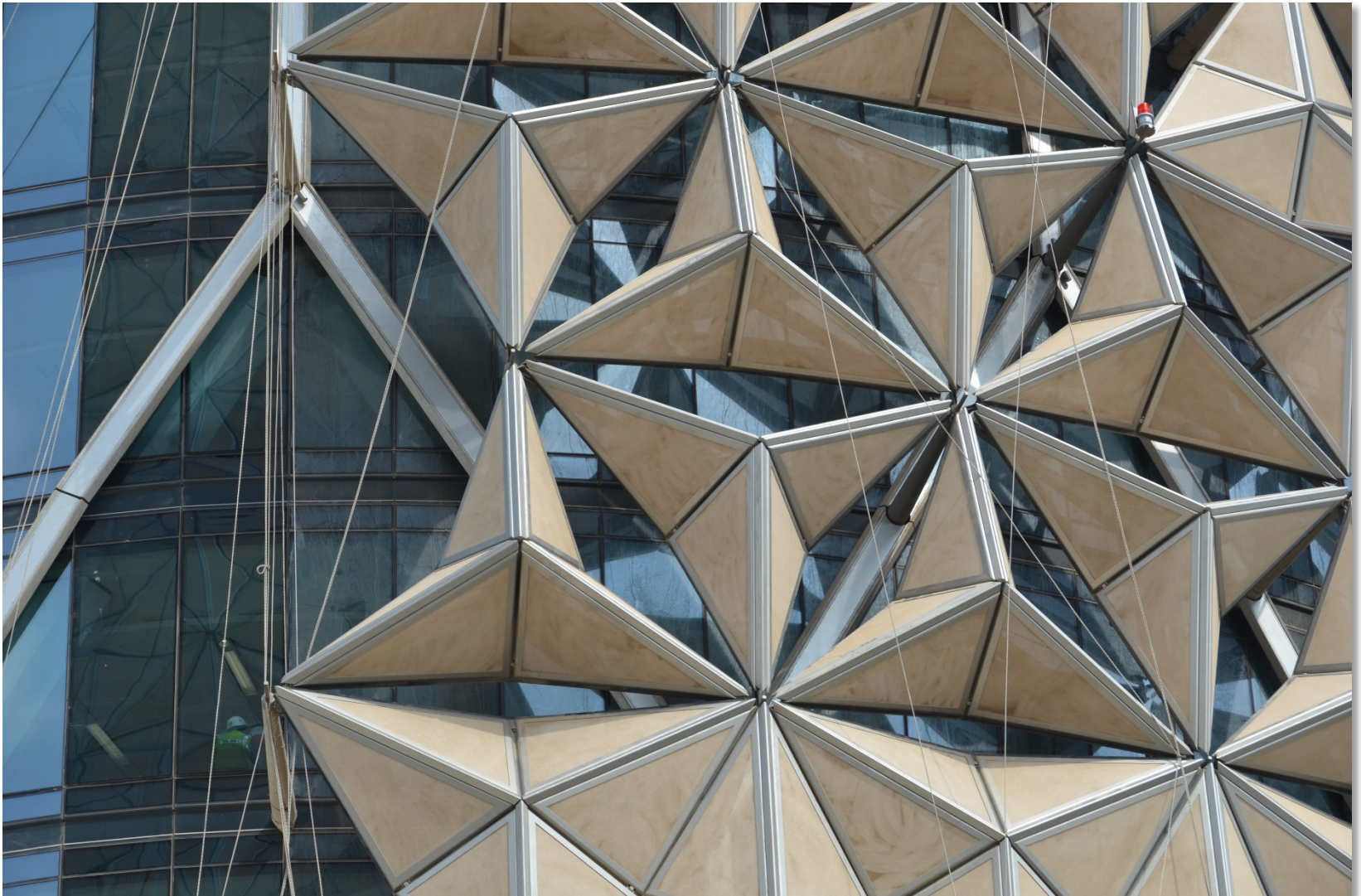
Space required for physical access for cleaning



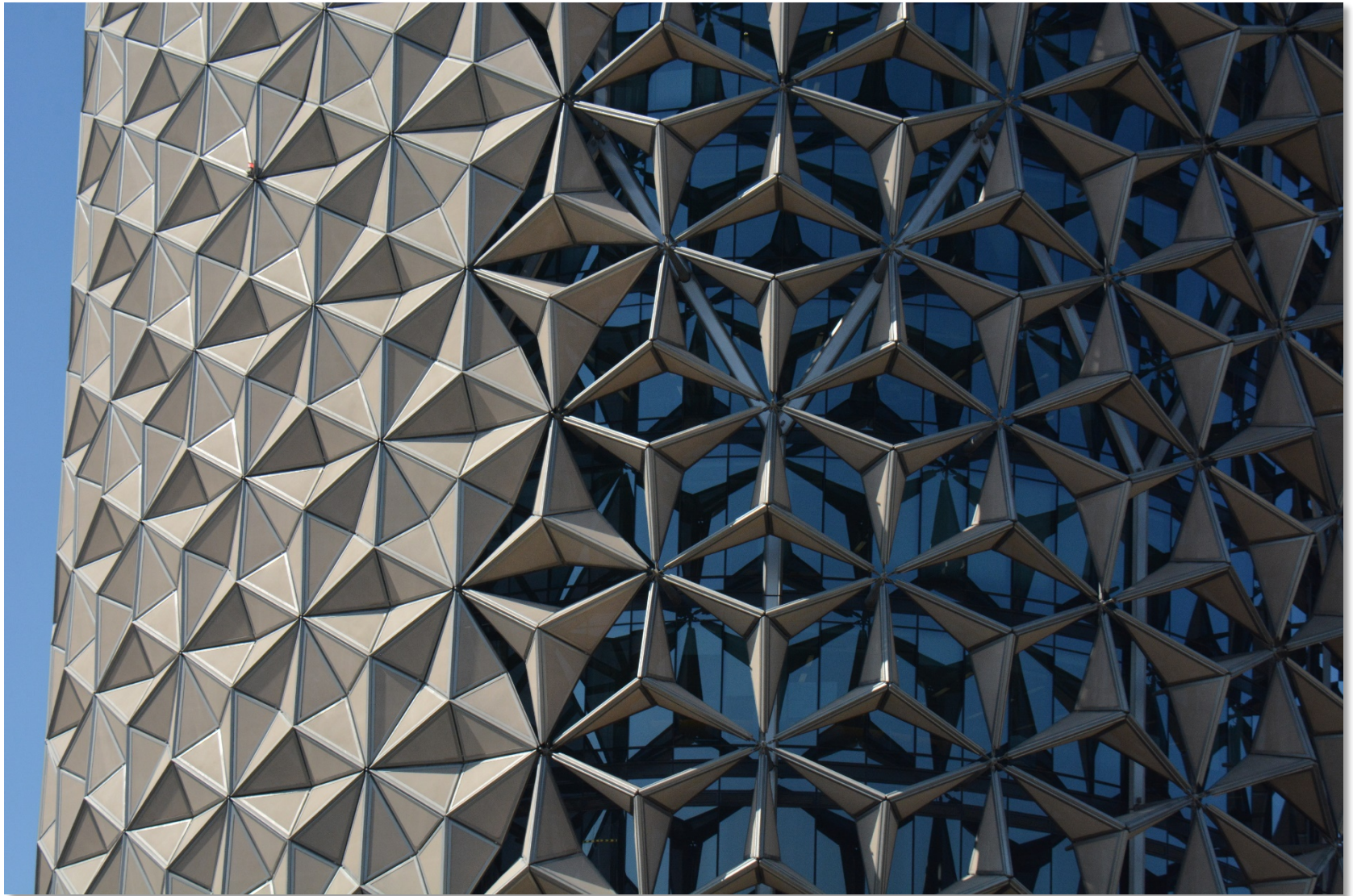
Views from the interior looking out



Façade during testing showing fully open



Operational Façade



O-14, Dubai

O-14, Dubai UAE
RUR Architecture

Located in the Business Bay area of Dubai, this iconic tower has significant exposure to the sun and is not located in a dense tower grouping.

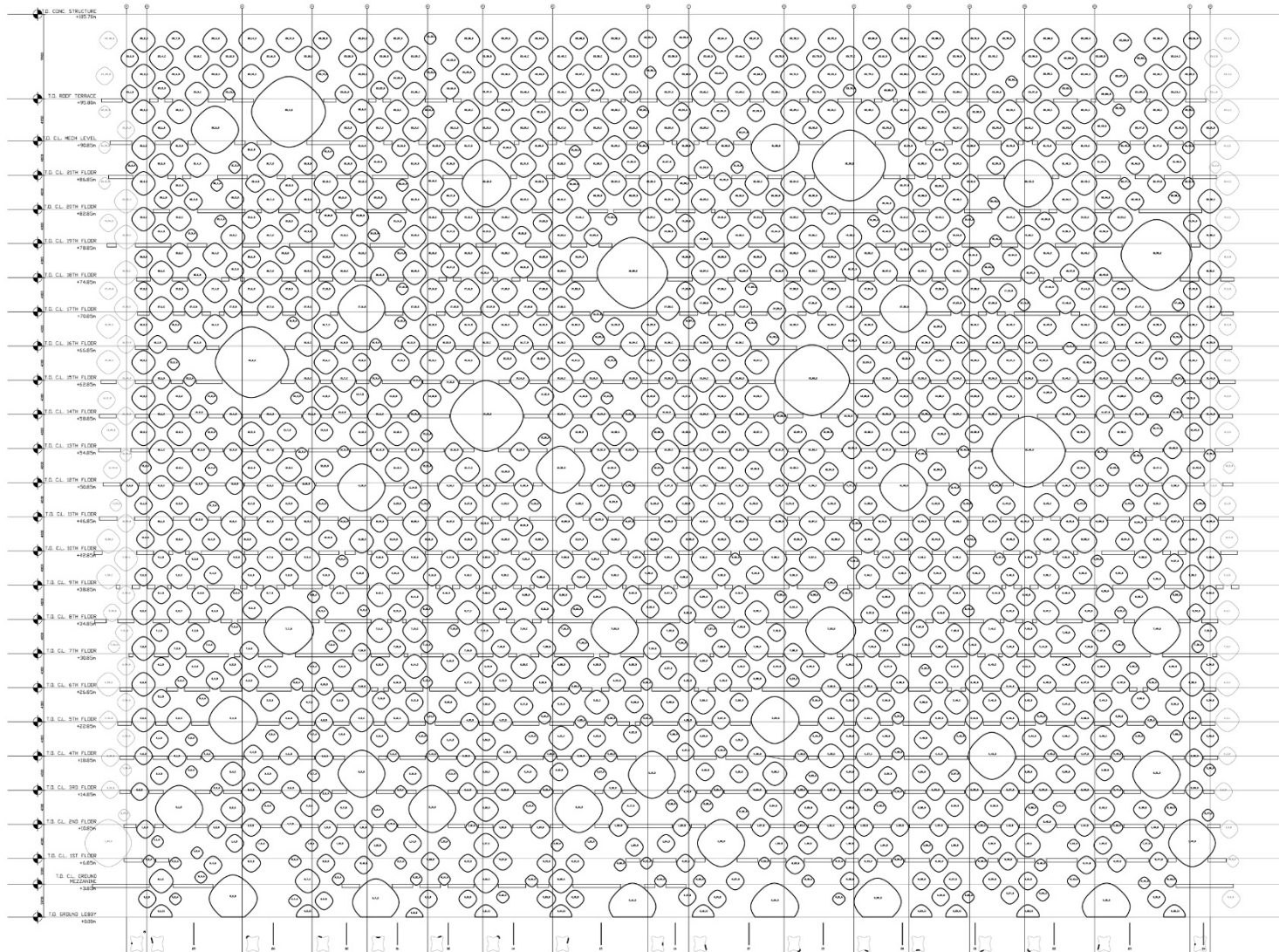
Its exterior shading element is highly unusual in that it is

- Made from reinforced concrete
- Acts as an external structural support for the building
- Acts also as a shading device

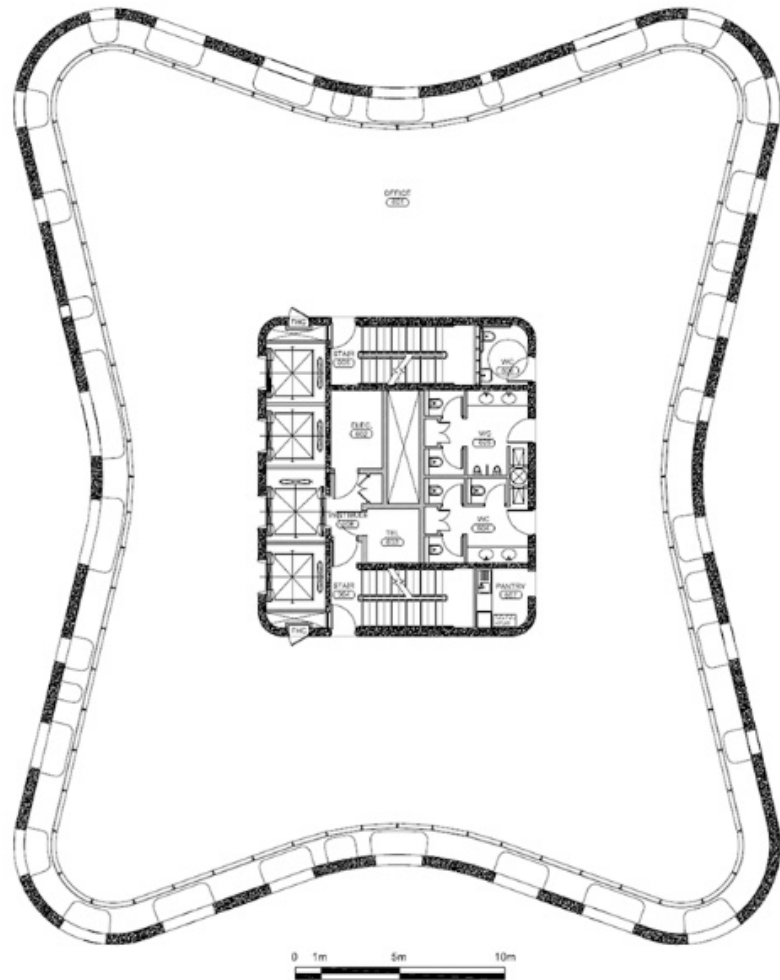
Images and drawings courtesy RUR Architecture



Variation on the mashrabiya



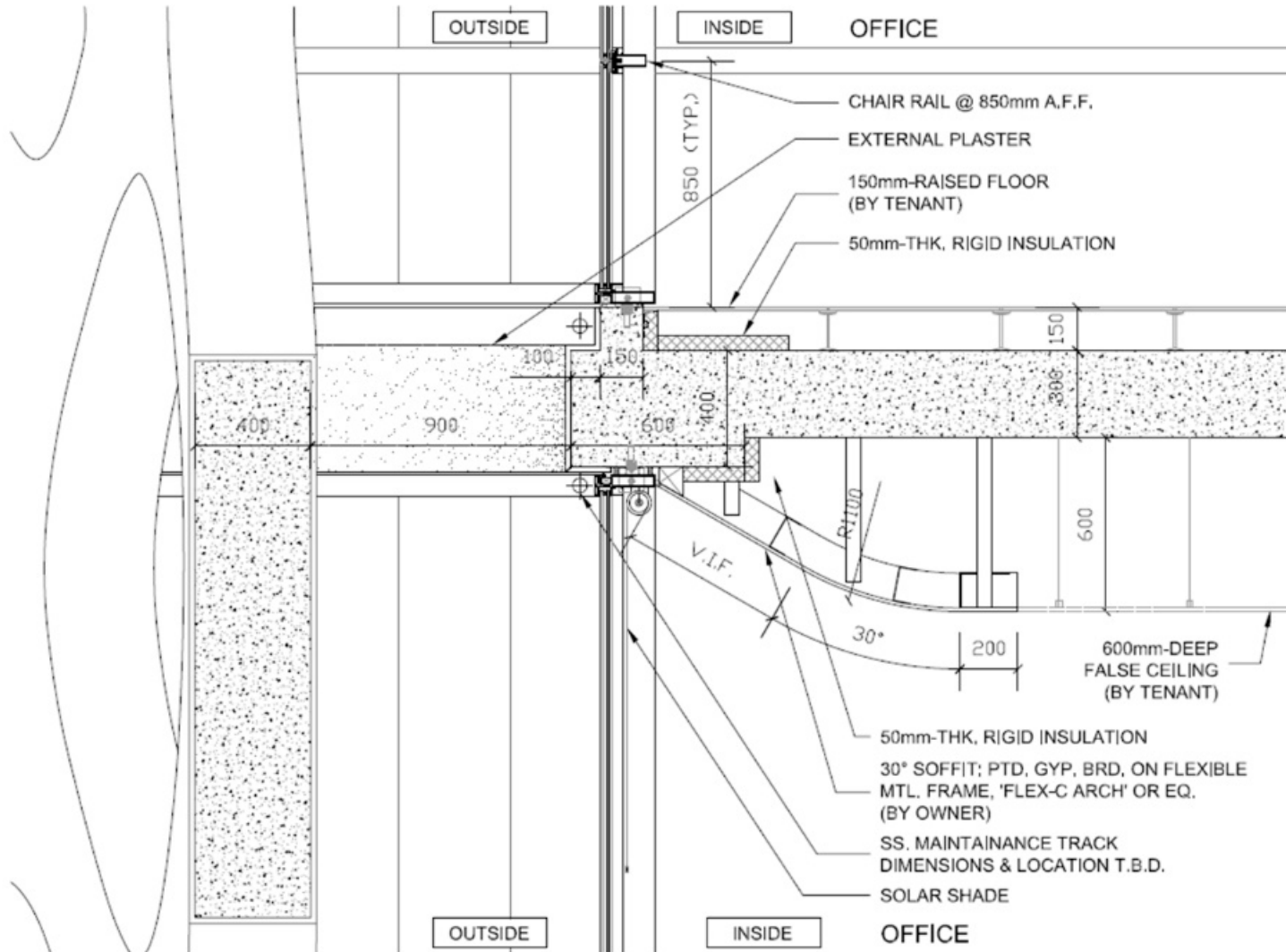
Structure as the exterior layer



Preservation of views



Construction detail



Qatar Foundation Liberal Arts & Science Building



Arata Isozaki for Design
Perkins and Will Architects

<http://www.astad.qa/en/projects/educational-facilities/liberal-arts-science/>

Shading screen





Bonus night lighting



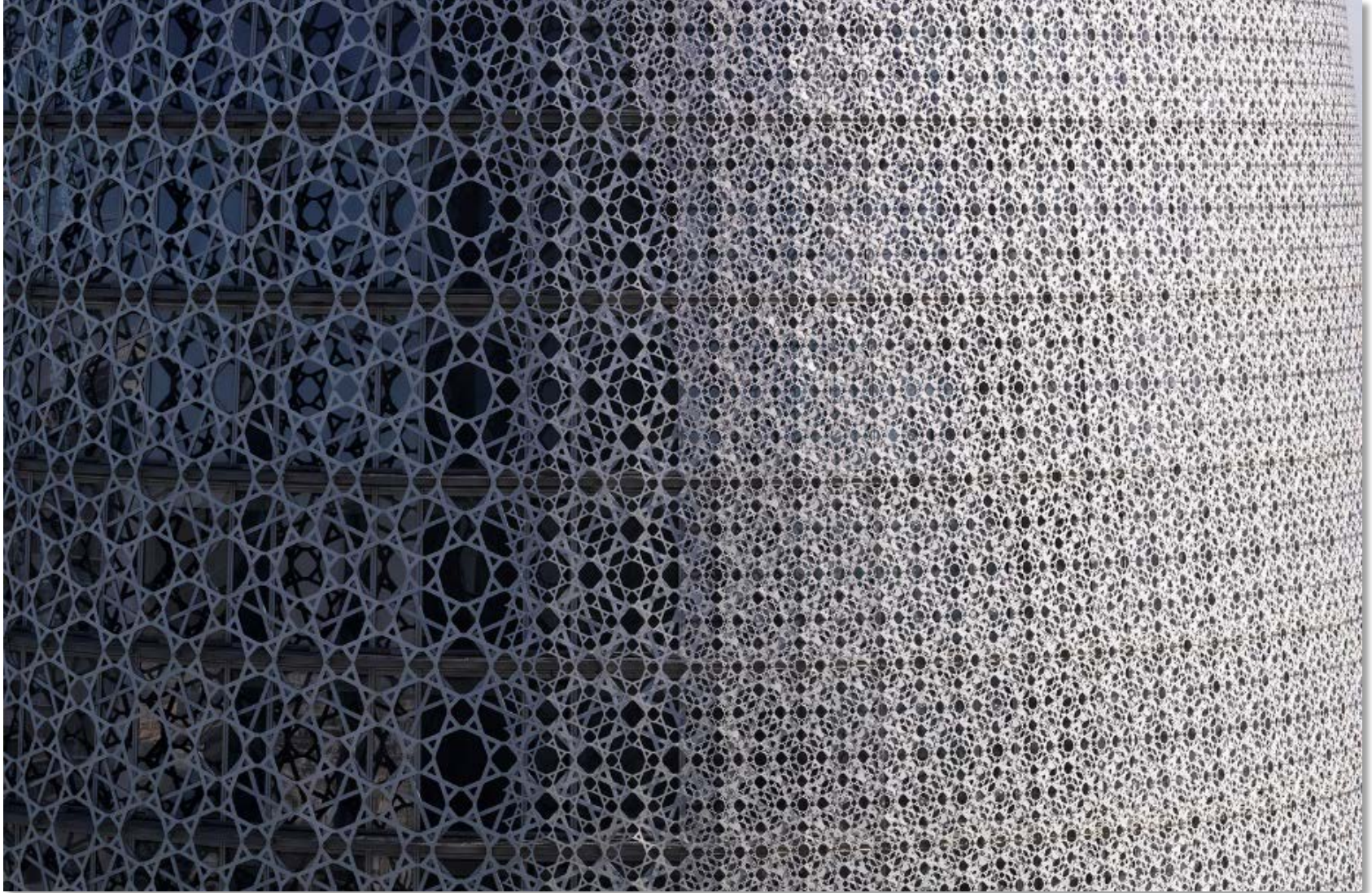


Doha Tower, Qatar

Doha Tower, Doha, Qatar
Ateliers Jean Nouvel

The mashrabiya screen element forms a complete second façade for the building without any large view openings

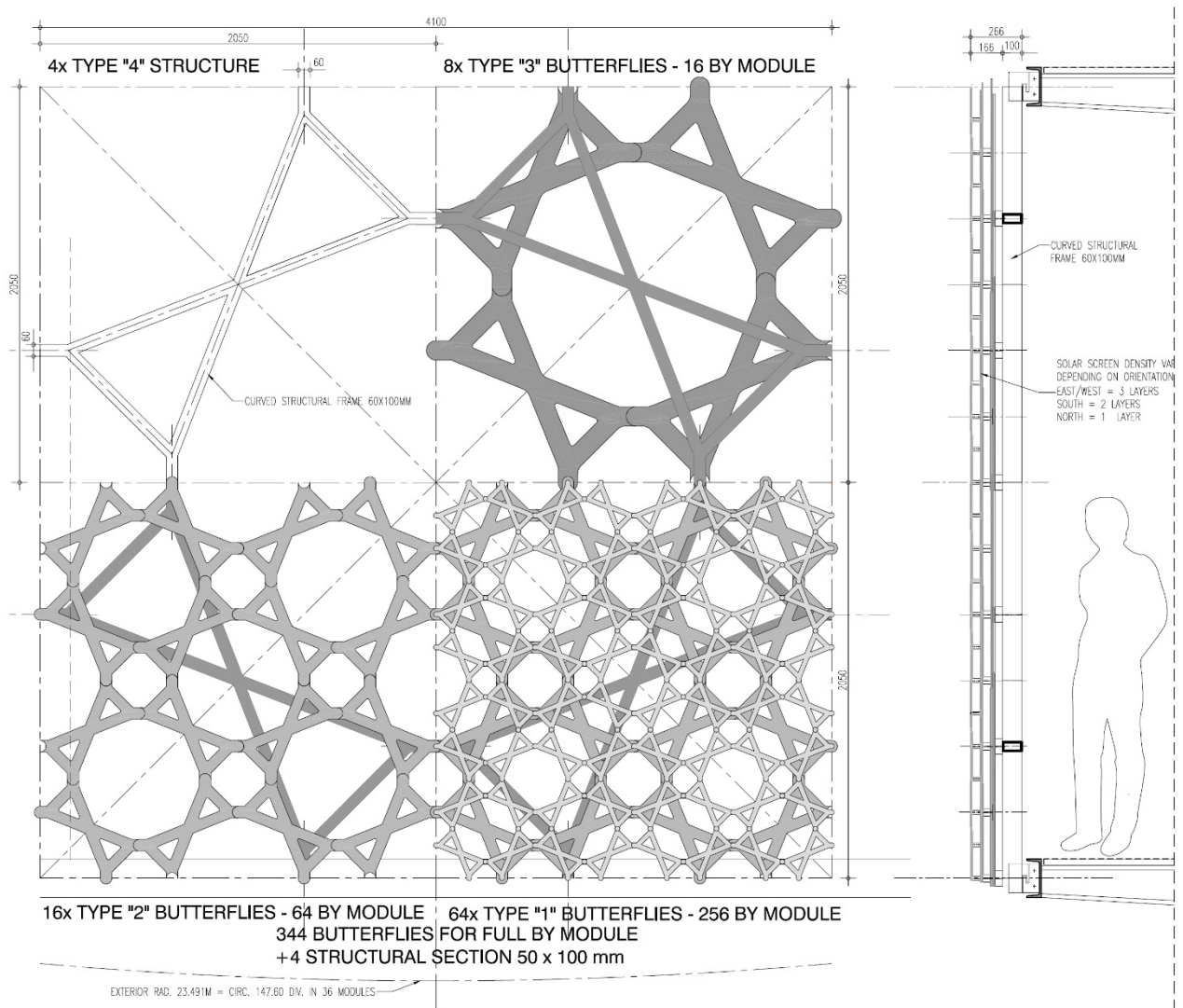
Variation in density



A bright interior

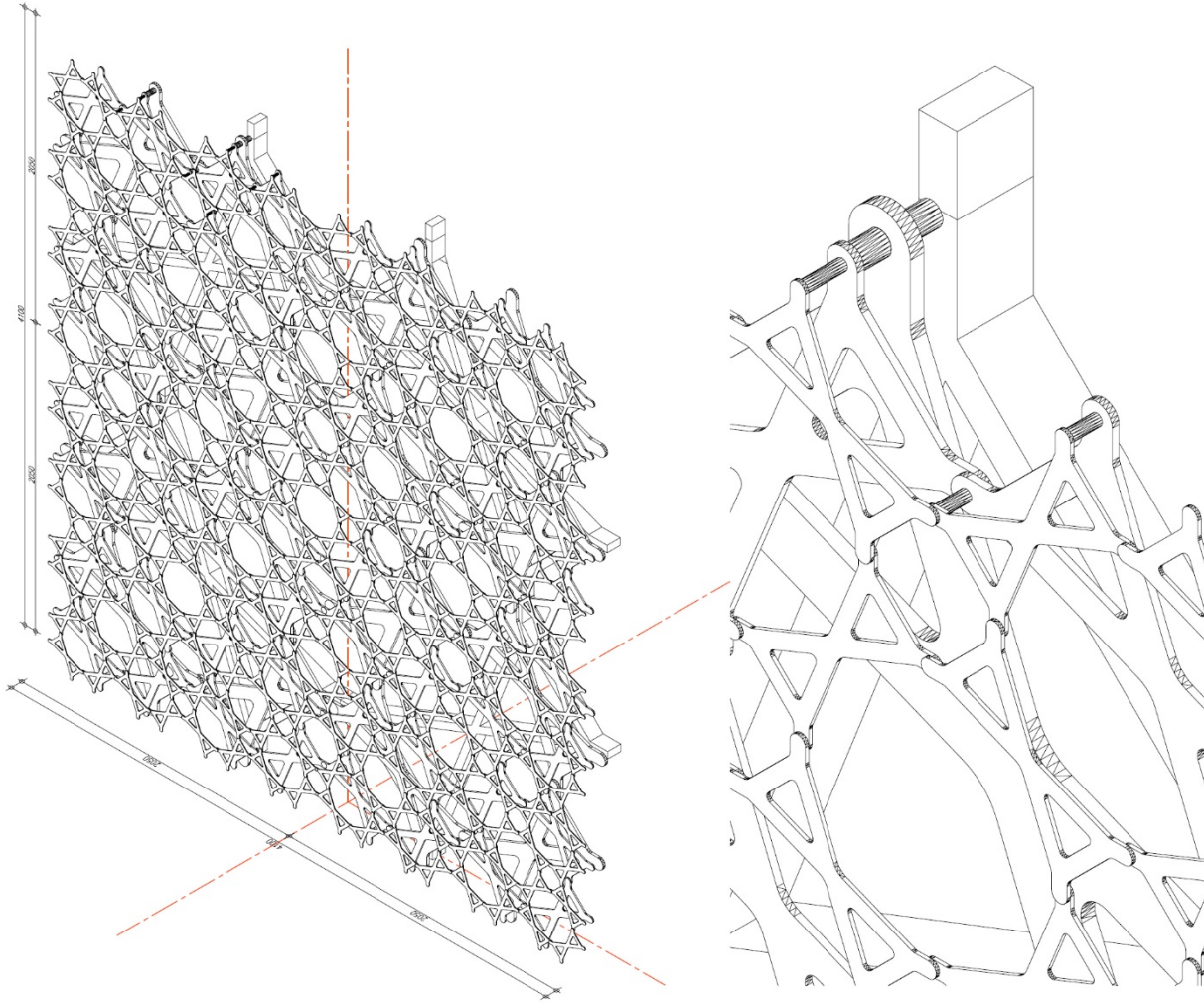


Construction details of the screen



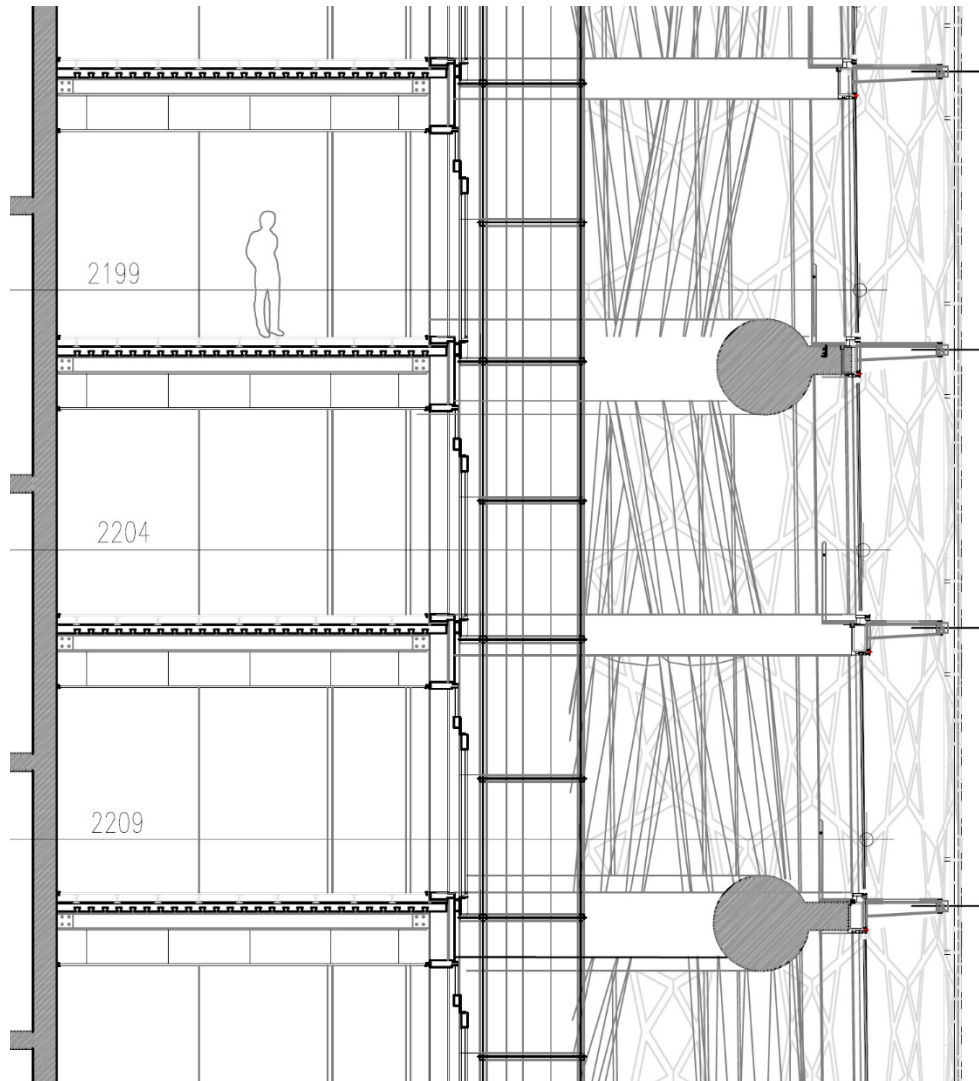
© Ateliers Jean Nouvel

Details of the mashrabiya screen



© Ateliers Jean Nouvel

Sectional view



The fixed mashrabiya screen is situated more than a meter from the high performance curtain wall.

This is to allow for cleaning access to the space.

The metal grating at each floor provides additional shading for the glass.

Inside the air corridor







Traditional-based types

1. Those that use a more traditional approach (buffer, twin-face or extract-air) where the exterior layer is glazed and where

- The air corridor is usually wide enough to allow cleaning access without interfering in the interior spaces.
- The air corridor is used to buffer the temperature extremes.
- The air corridor may or may not form part of the cooling system.
- The shading devices are not normally positioned in this cavity if it is not sealed.

A tall, curved skyscraper with a blue glass facade, known as Capital Gate in Abu Dhabi. The building has a unique, twisted design. The image shows the building from a low angle, emphasizing its height and curvature. The sky is clear and blue.

Capital Gate, Abu Dhabi,
RMJM Architects

Capital Gate, Abu Dhabi

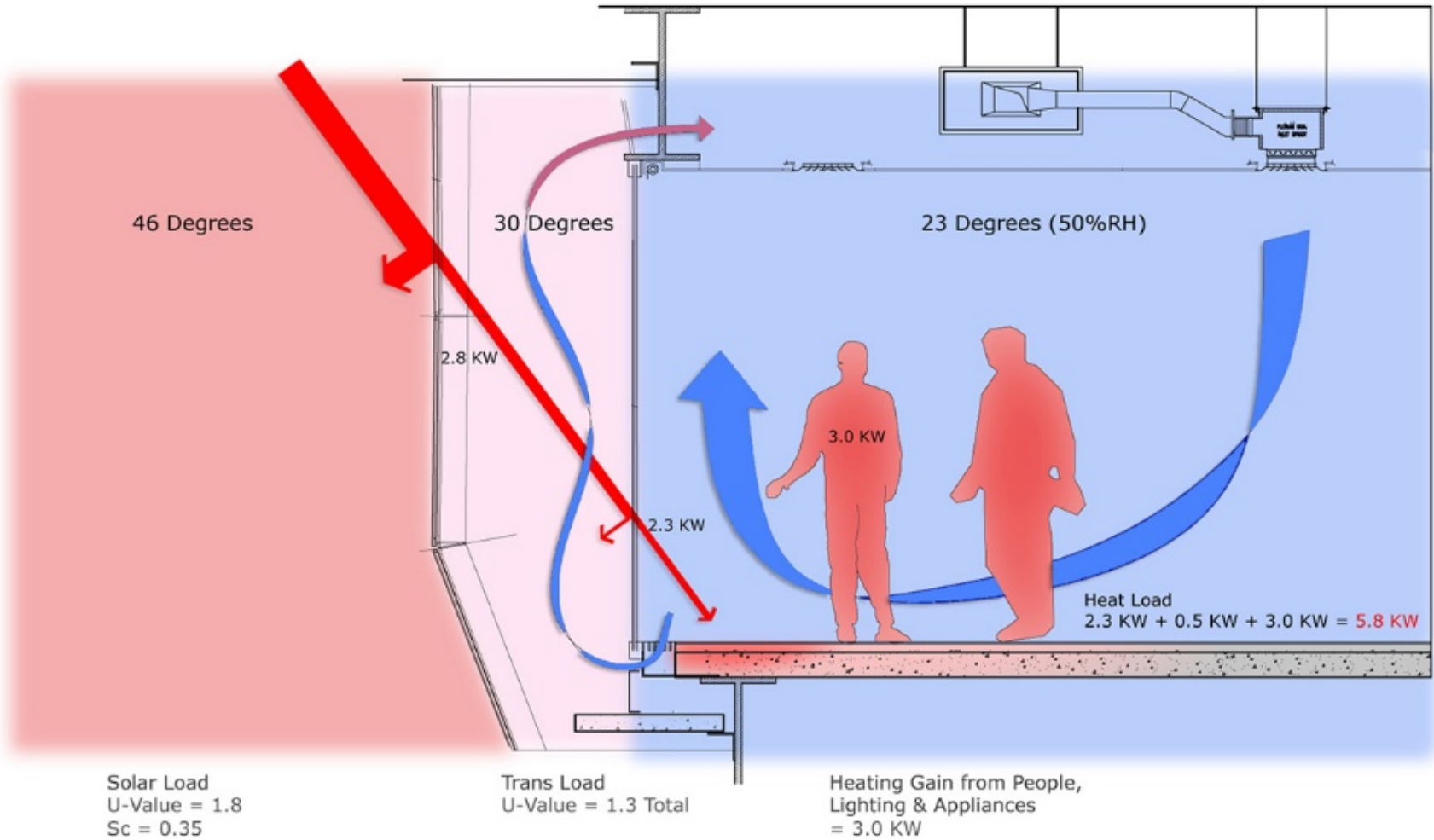
Capital Gate, Abu Dhabi
RMJM Architects

- Iconic freestanding structure
- Sustainable agenda high on the priority list
- Traditional double façade on the upper, hotel portion of the tower
- Screen layer exterior skin on the lower, office portion of the structure

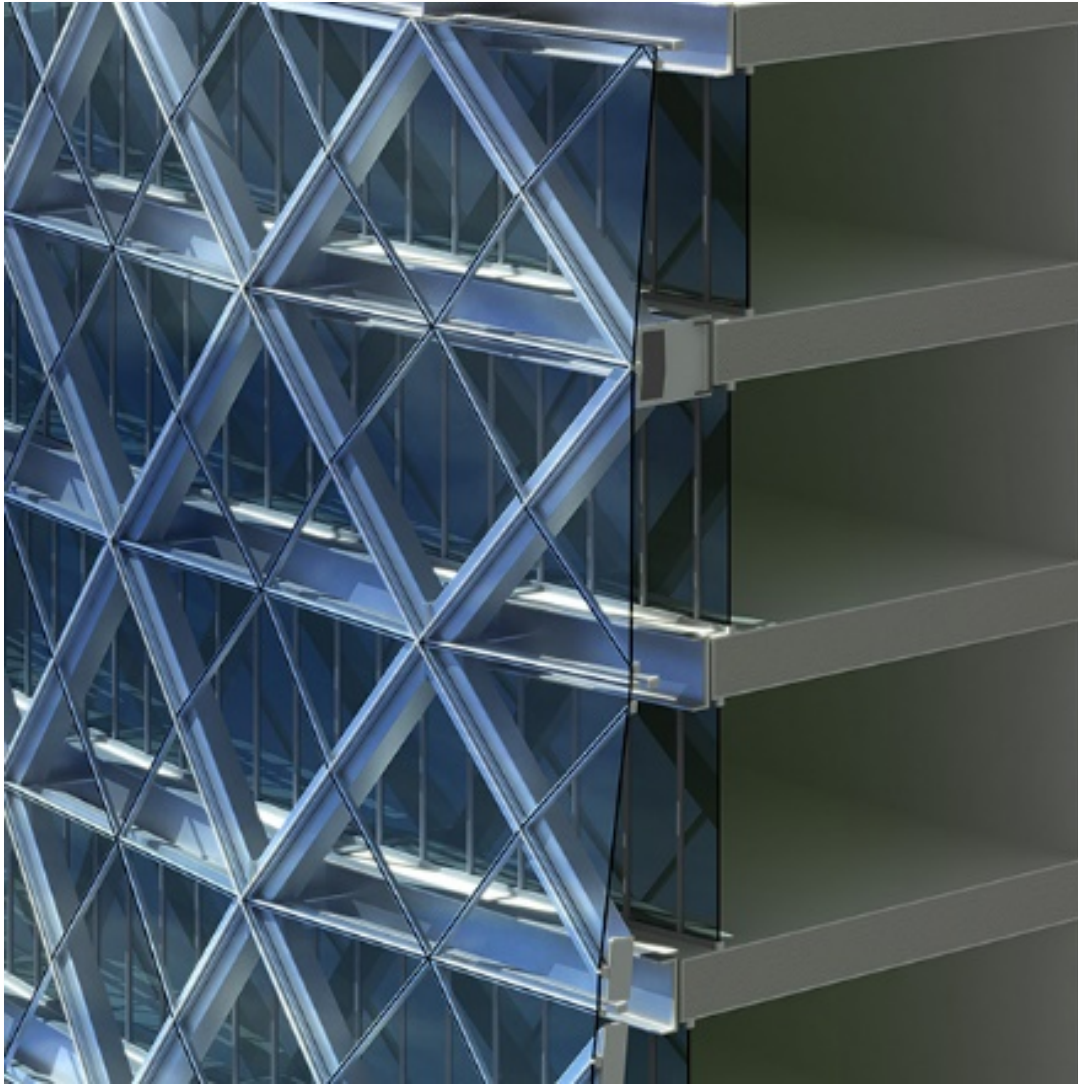
© Jeff Schofield, ADNEC



Modified extract-air façade



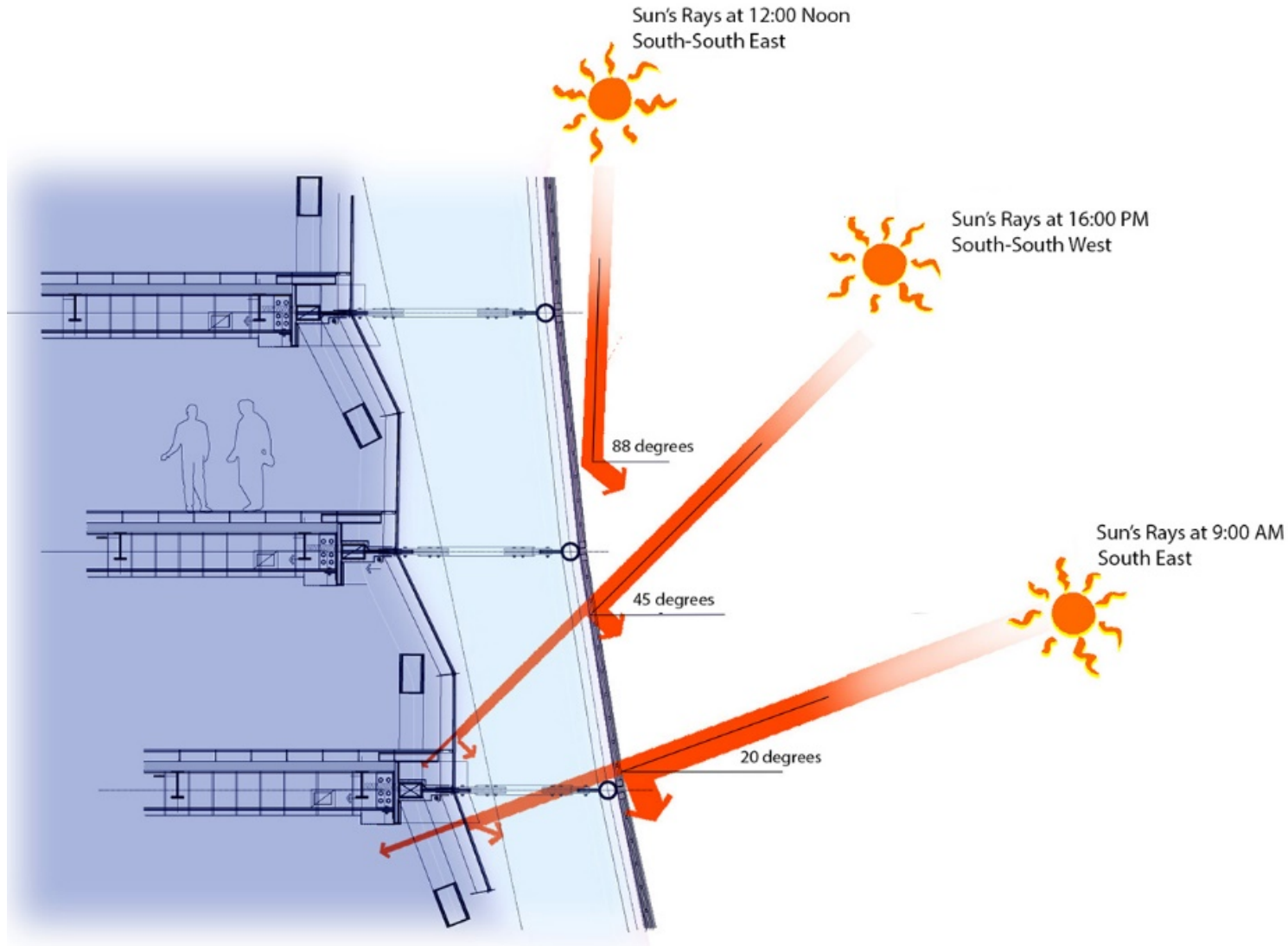
Two glazing systems



A diamond shaped prefabricated curtain wall system is attached to the structural steel diagrid of the tower and forms the outside layer. The interior layer uses a less expensive rectilinear glazing system.

No shading devices in the cavity.

Exterior shading screen for office floors



The “Splash” shading screen



Metal mesh and support system



Façade maintenance





Cleveland Clinic

Cleveland Clinic, Abu Dhabi, UAE
HDR Architecture

- Very large scale traditional glazed double façade system
- Covers almost 100% of the hospital exterior
- Assists in achieving LEED™ Gold
- Does NOT focus on solar avoidance
- Designed to reduce costs of conditioning the air

Construction view 2012



Prefabricated elements



The system is constructed from prefabricated elements.

There is some economy achieved in time and cost through prefabrication and the uniform application of the system around the building.

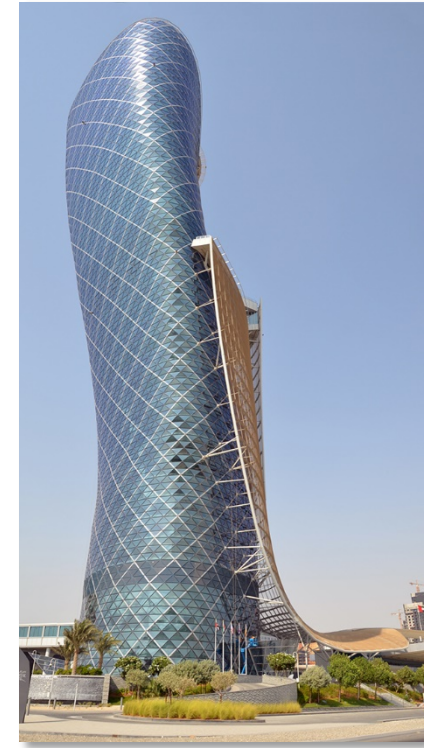
A layered system







Double façades in the Gulf Region



Iconic Architecture....

Sorry, no performance data.

