

# GFRC vs. Green Wall Systems

Which works more efficiently?

Mujun, Jin, Walkiria

# Definition

## GFRC

The term is abbreviated from the term Green Fiber Reinforced Concrete. This is basically a concrete panel slightly different from its original Precast concrete panel. In that this concrete system is lightweight and uses less materials and takes less and looks more efficient.



## Green Wall Systems

This system is a system which serves in many purposes. It acts as a protective barrier from solar radiation and heat penetration. It is quite similar to the Terra Cotta system in that it naturally absorbs and filters out rain water that is designed to collect.



# Construction Time & Cost

## GFRC

- ▶ Often cost by square foot on an “FOB Job Site” (materials only) or “Installed” cost basis (Materials and Installation).
- ▶ Generally depends on the number of factors, including the project size, the size and complexity of the panels, and repetition of the skins.
- ▶ Also will depend on Location of site. Interestingly, NYC is more expensive than Dallas.
- ▶ An estimated material cost would be \$30-\$35 per square foot.

## Green Wall System

- ▶ The value of a building with a Green wall system is very valuable it adds 15% to 20 % to a buildings value.
- ▶ The cost of a vertical garden per say is \$65 per square foot. Very expensive compared to GFRC
- ▶ It's easy to install a green wall.
- ▶ The process is similar to
  - ▶ Protection of all floors and surfaces
  - ▶ Install frames
  - ▶ Install irrigation controller and hardscape
  - ▶ Install pre-planted panels
  - ▶ Install irrigation drip lines and sensors
  - ▶ Test the irrigation system of the living wall construction
  - ▶ Initiate plant maintenance

# Construction Time & Cost

GFRC



Zaha Hadid Architects

Green Wall System



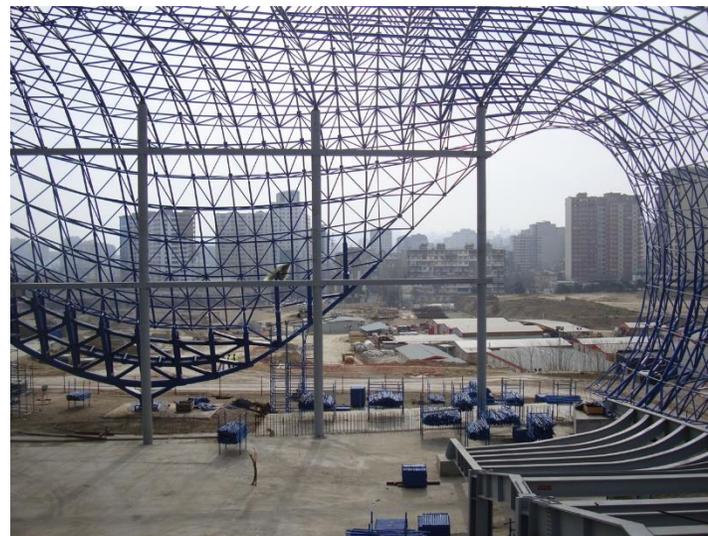
Patrick Blanc

# Zaha Hadid's Heydar Aliyev Cultural Centre

Zaha Hadid Architects designed a mixed use venue featuring a conference hall, library, and a museum. This project is located in Baku, Azerbaijan. This building is famous for its curvature forms and engineering solutions. As you can see in the images they used concrete as the core of the building and it is Green Fiber reinforced concrete. This building was a response to the topography of the site and where the project was located. The material of this project was a challenge to work with because the architects needed to design accordingly to seismic loads without relying on interior columns.

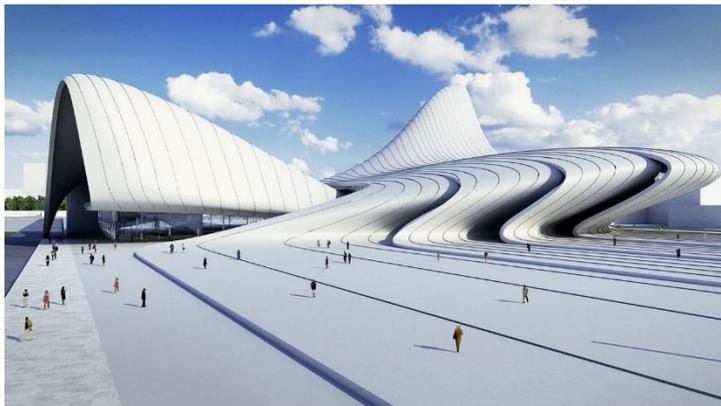
*"We focused, for example, on easy-to-clean external cladding materials because of the heavy air pollution... There are oil refineries and such nearby, and the cladding is white. That's how glass fiber reinforced plastic (GFRP) came up, which is dirt-repellent itself. In general, all building systems are chosen to have high durability and a long lifetime and low maintenance efforts."*

*- Thomas Winterstetter, Werner Sobek*



# Rendering and Inner Finish Material

## Zaha Hadid's Heydar Aliyev Cultural Centre



# Patrick Blanc's Green Wall/Living Wall

“Replanting the World's Concrete Jungle, One Wall at a Time

Patrick Blanc is a French botanist and designer who invented the concept of a vertical garden. He calls a green wall a “hymn to biodiversity”



He designed the green wall in L'Oasis d'Aboukir on the side a residential building in Paris. The design has a wave pattern to it that relates to how the street moves at the corner intersection of streets in Paris.

Before



After

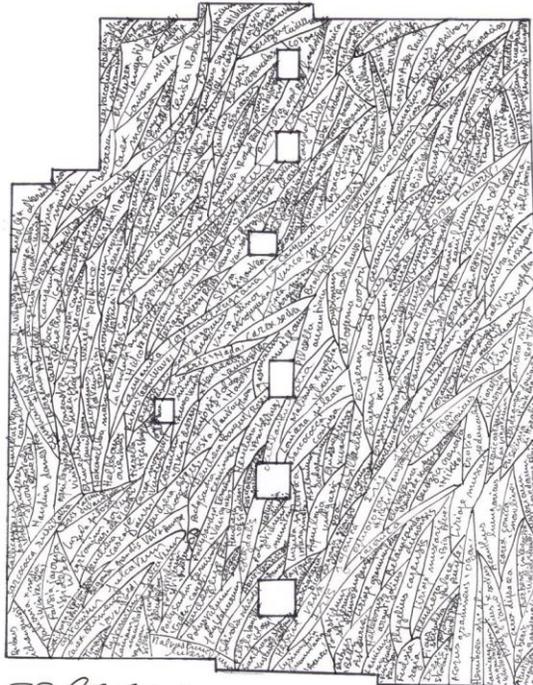


# L'Oasis d'Aboukir

## Design and Installation Process

Vertical gardens are built typically on solid metal, PVC and non-biodegradable felt frame that prevents damage to walls and allows plants to grow on the wall without the need of soil. They have built in water systems and require limited maintenance.

LE MIRAGE VERT  
- Rue d'Aboukir - PARIS



# Environmental Implications & Sustainability



## Green Wall System

- ▶ Reduction of thermal loading to buildings, Low heating and cooling cost for the building.
- ▶ Reduction of heat island effect
- ▶ Air purification- plants are efficient filters the pollution of the surrounding air
- ▶ Plants are capable of cleaning indoor air of toxic chemicals that are common on modern buildings.



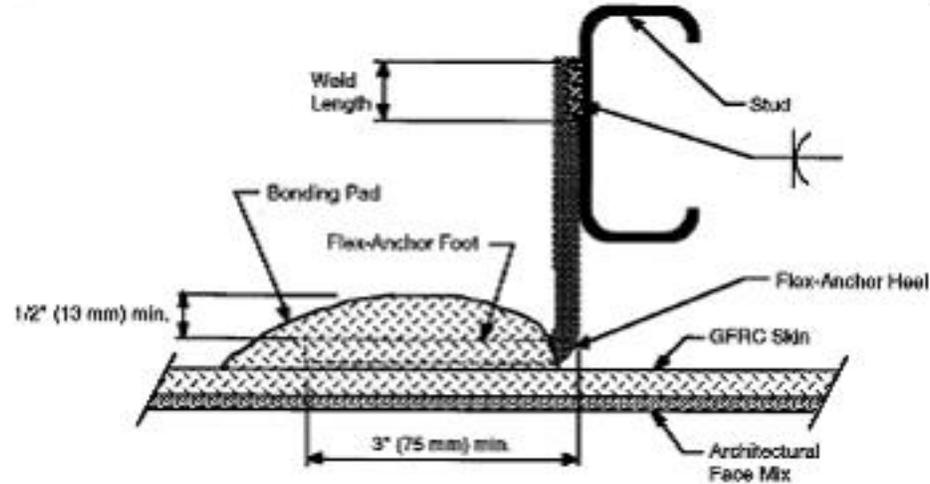
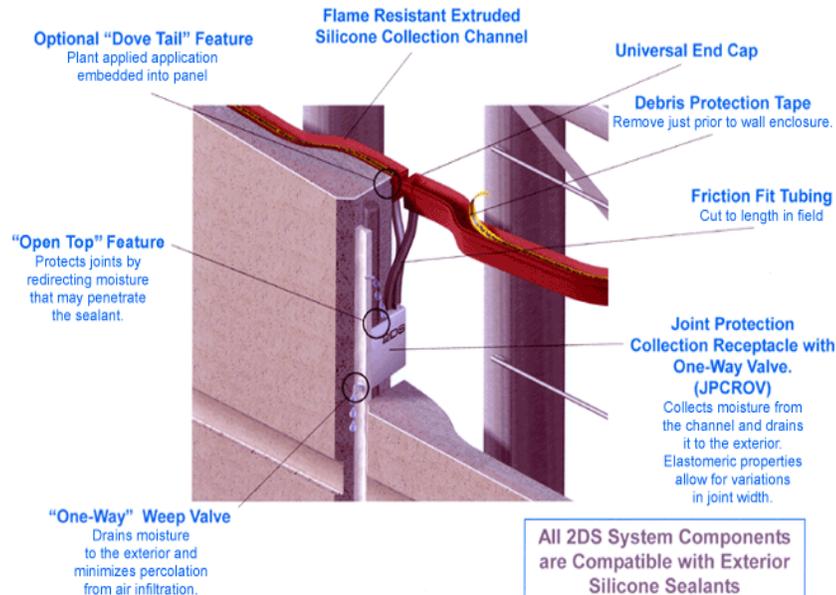
## GFRC

This cladding system is a sustainable assembly simply because it includes materials taken from the soil and there never is an effect on this cladding arrangement for the environment. Compared to the mix of regular reinforced concrete this concrete mix uses lightweight and recycled materials. It is durable and the materials last a long time. It reduces the time for replacement, maintenance and repair. The lightweight panels use 80% less material than precast. Reduces fuel and cost of transportation to job site. A study was done by United Kingdom's DETR/Concrete Industry Alliance Partners in Technology project compared GFRC to traditional precast concrete and found that is a much lower environmental impact by a factor of 60%

# System Joints and Connections

## GFRC

### 2DS SYSTEM FEATURES GFRC PANEL JOINT CUT-AWAY

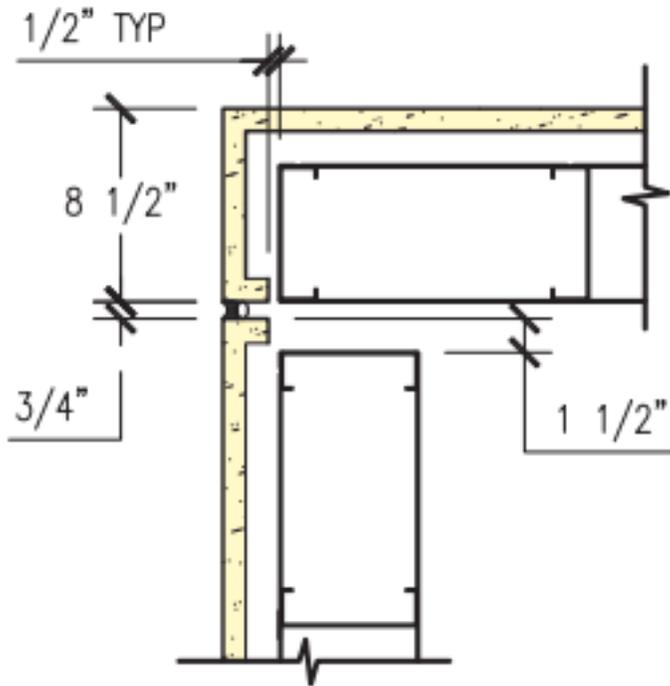


These connection details show the connection of a GFRC panel it is connected by the bonding pad to keep it straight while the Flex anchor heel keeps it steady and from shifting. The connections for this wall system is reduced to have less structural load this makes it appear lightweight and beautiful.

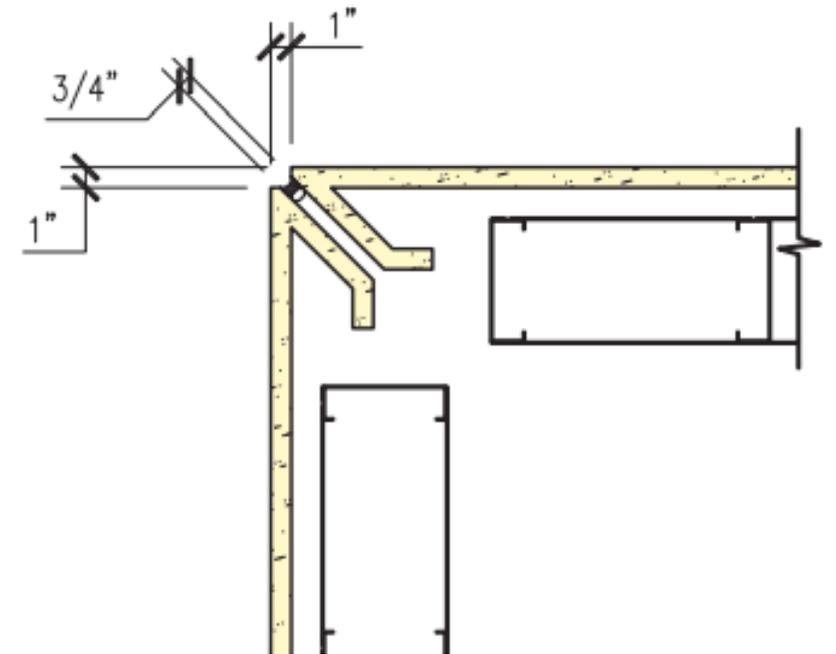
# System Joints and Connections

## GFRC

OPTION 1  
TYPICAL CORNER DETAIL

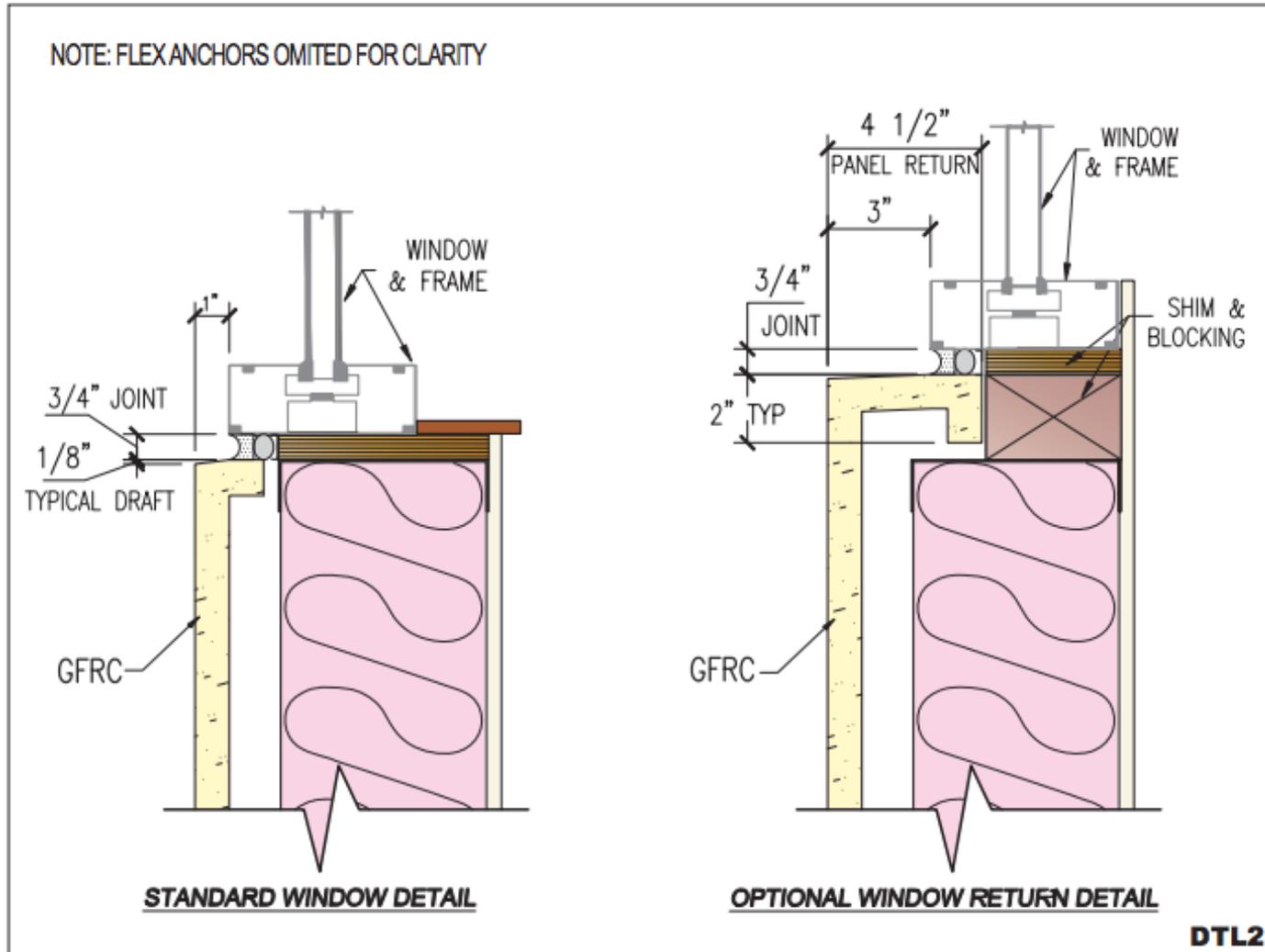


OPTION 2  
MITERED CORNER



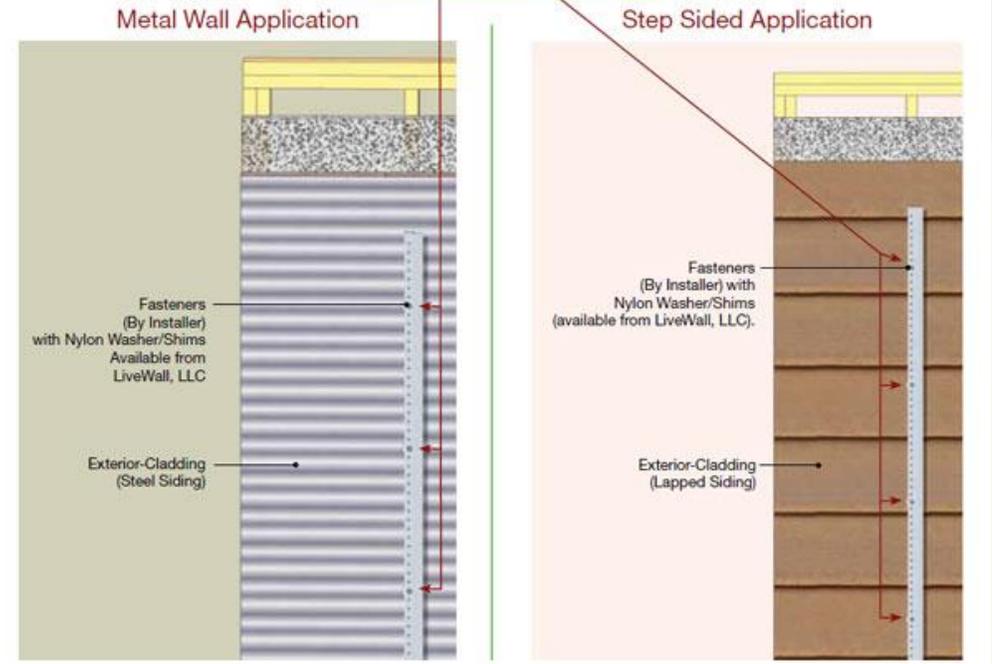
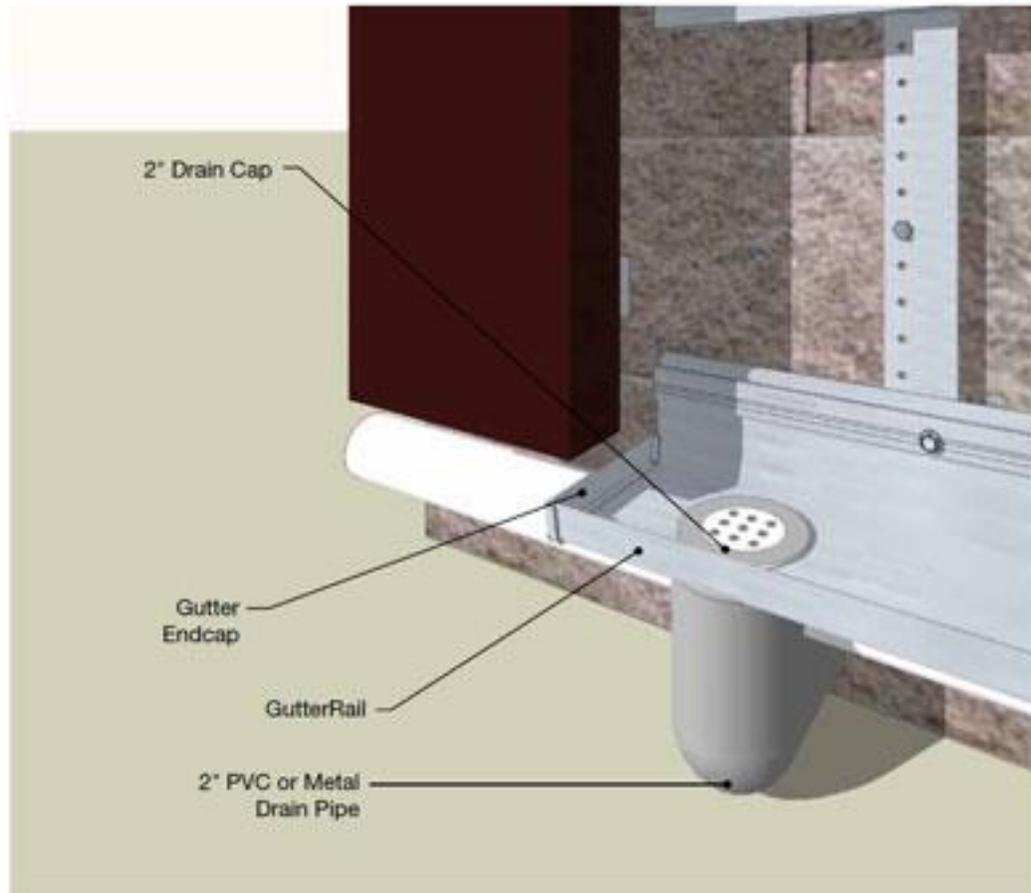
# System Joints and Connections

## GFRC



# System Joint and Connections

## Green Wall Systems



# System Joints and Connections

## Green Wall System

- ▶ Typically, there is a vast amount of space between the building wall and the green wall or sometimes referred to as living wall. Those components consist of
  - ▶ Supporting Framing - Vertical metal channel, tubing, Unistrut, wood framing or a material that is similar.
  - ▶ Backing Board - Durable water resistant PVC sheathing
  - ▶ Drainage Mat - Impermeable, high-flow dimpled composite bonded with filter fabric layer
  - ▶ Battens - Horizontal rails of PVC sheathing which hold the irrigation lines
  - ▶ Drip Irrigation System - Flexible tubing with pressure-compensating, self-cleansing inline emitters.
  - ▶ Tiles - preformed plastic shell containing inorganic Grodan growing media and capillary drainage strips.

# Case Studies

GFRC



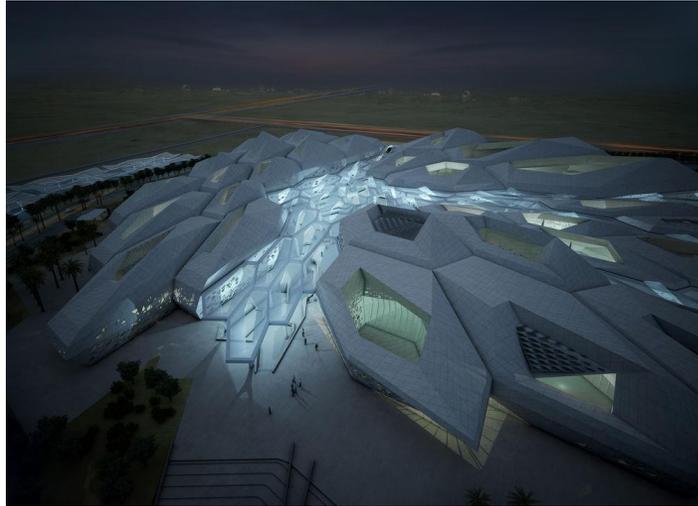
King Abdullah Petroleum Studies

Green Wall System



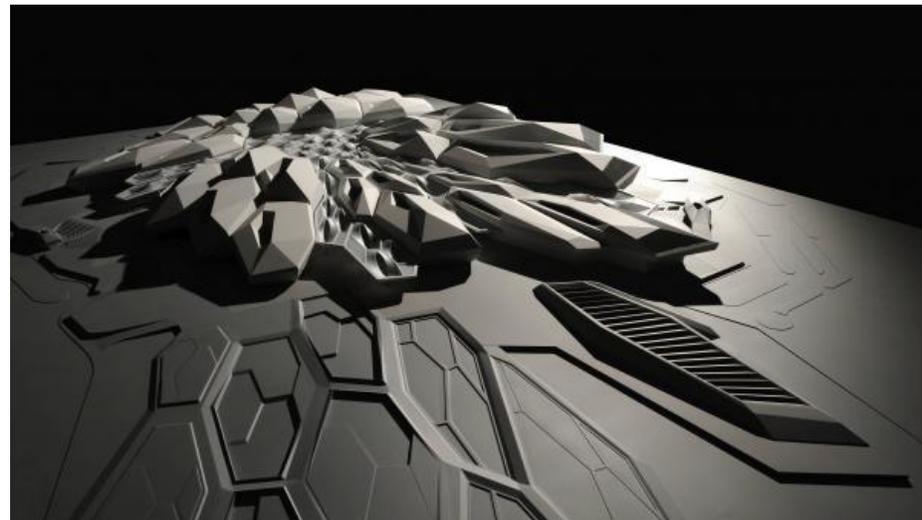
London's Mint Hotel

# King Abdullah Petroleum Studies



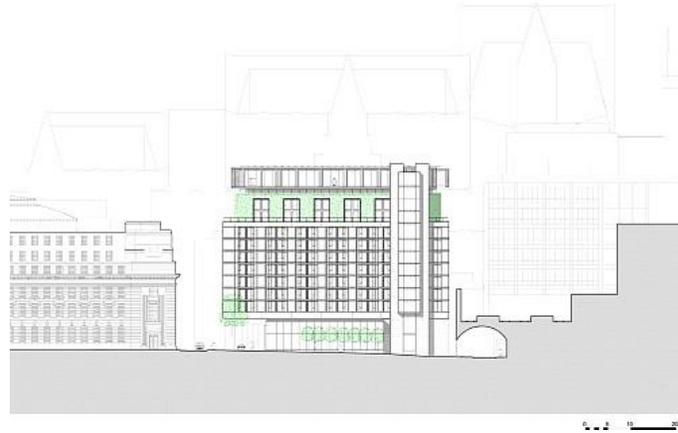
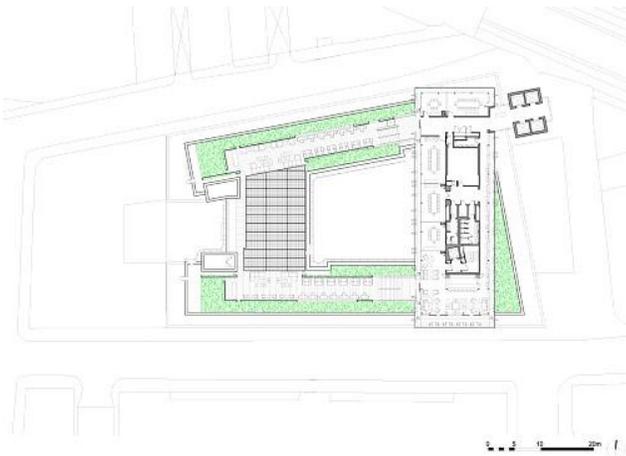
## GFRC - Wall System

Orientation of this building was selected in this particular way because the cells create a constant air circulation. They used GFRC as part of an architectural decision because it creates a maximum protection against solar radiation. The material doesn't heat the building up too much there is a comfort temperature once GFRC is installed.



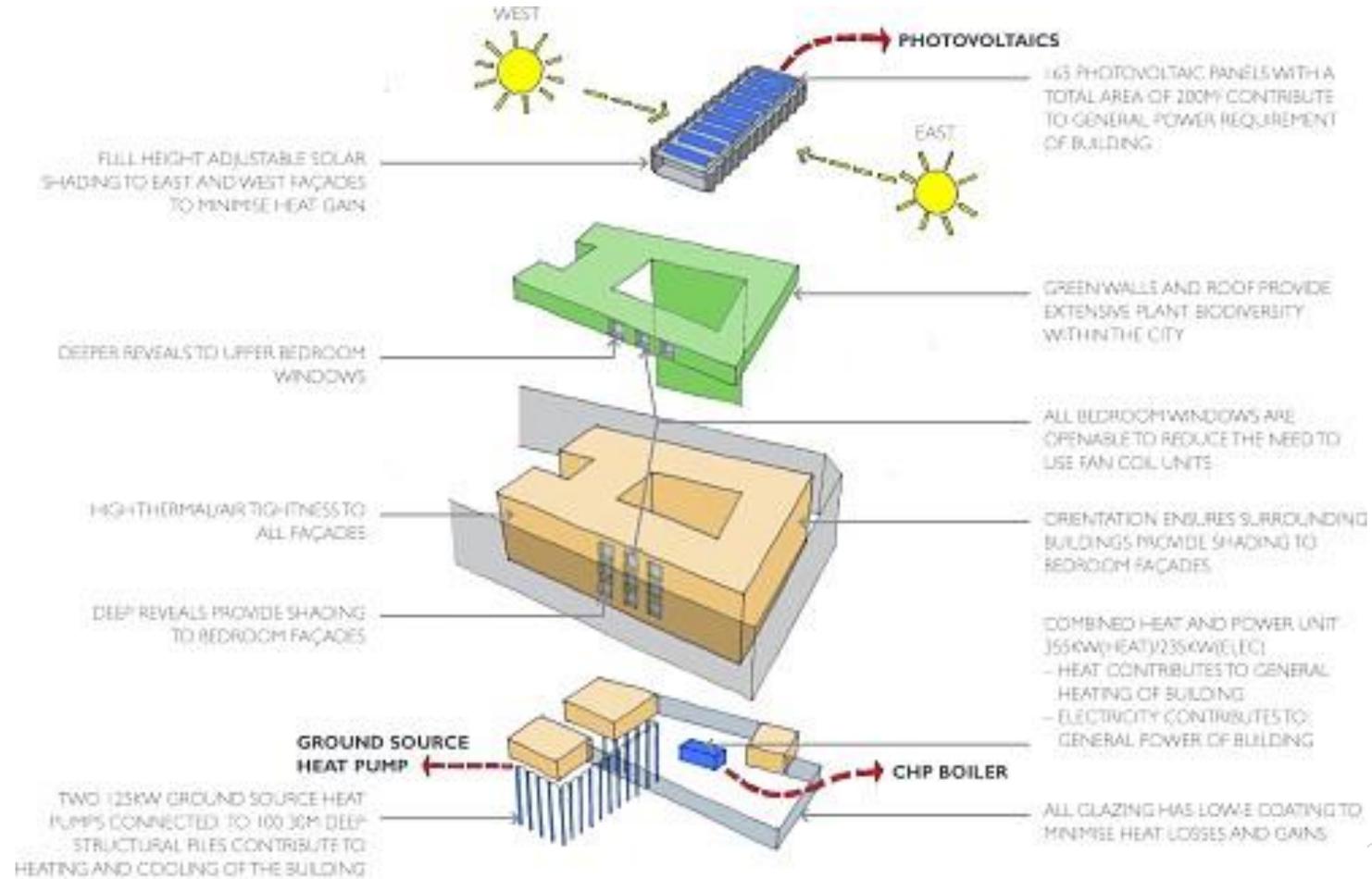
# London's Mint Hotel

## Green Wall System



# London's Mint Hotel

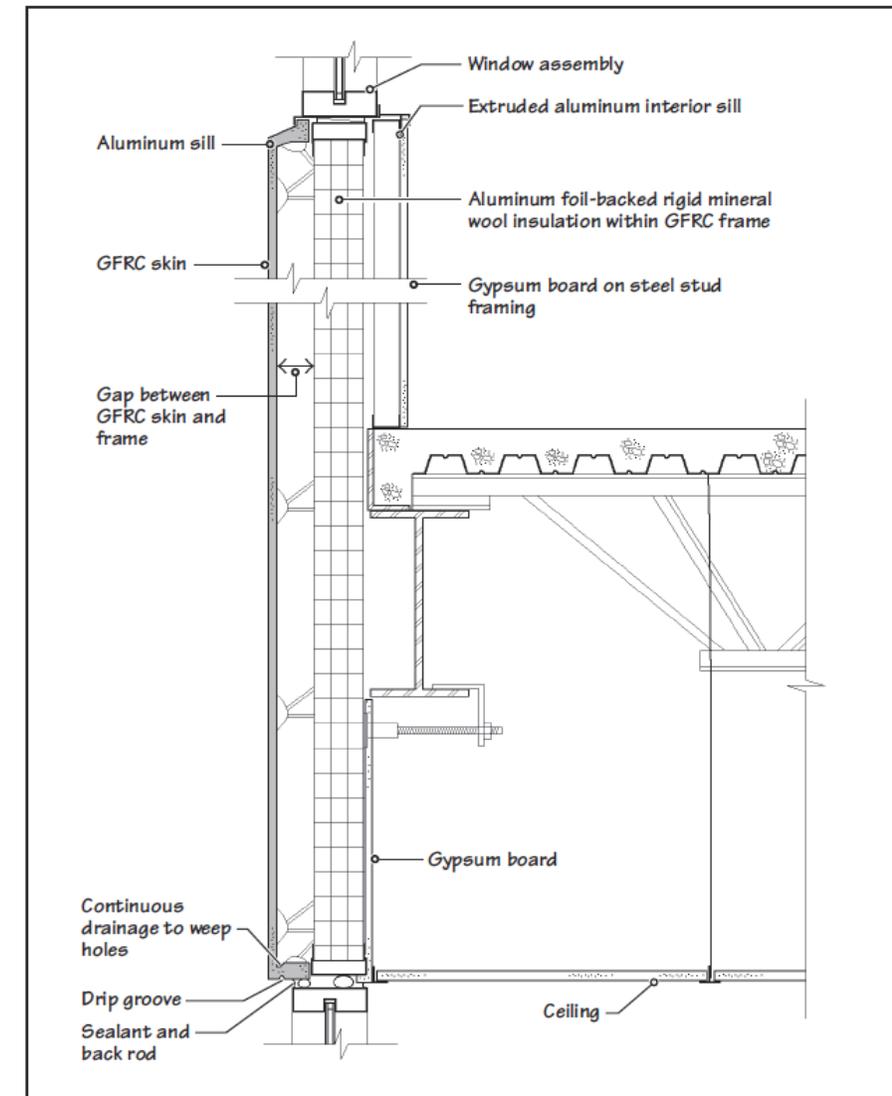
## Green Wall System + Sustainability



# Rain Penetration and Moisture Control

## GFRC

Because the GFRC skin is thin, some form of water drainage system from behind the skin should be incorporated in the panels. Additionally, the space between the GFRC skin and the panel frame should be freely ventilated to prevent the condensation of water vapor. This is generally not a requirement in precast concrete curtain walls. A two-way joint sealant system may be used at panel junctions similar to that for PC curtain walls.

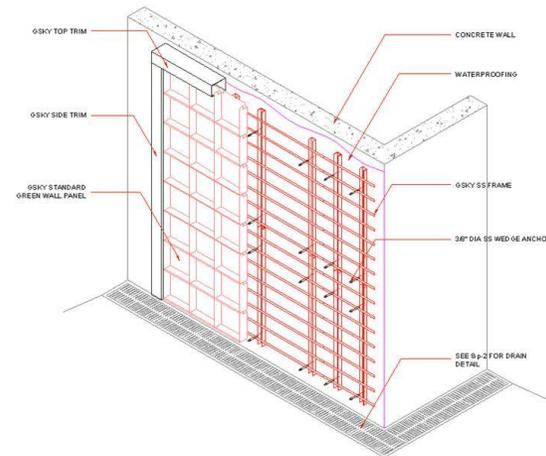


Schematic detail of an exterior wall with GFRC spandrel panels and ribbon windows.

# Rain Penetration and Moisture Control

## Green Wall System

Since new technology is used in Green Wall System such modular trellis systems, cables, and netting, there is a certain distance green wall system and the building. The rain penetration of Green Wall System really depends on the base wall system, such as concrete wall.



# Hydronic System

It is a hydroponic system fed by nutrient rich water which is re-circulated from a manifold, located at the top of the wall, and collected in a gutter at the bottom of the fabric wall system. Plant roots are sandwiched between two layers of synthetic fabric that support microbes and a dense root mass. These root microbes remove airborne volatile organic compounds (VOCs), while foliage absorbs carbon monoxide and dioxide. The plants' natural processes produce cool fresh air that is drawn through the system by a fan and then distributed throughout the building. A variation of this concept could be applied to green façade systems as well, and there is potential to apply a hybrid of systems at a large scale.



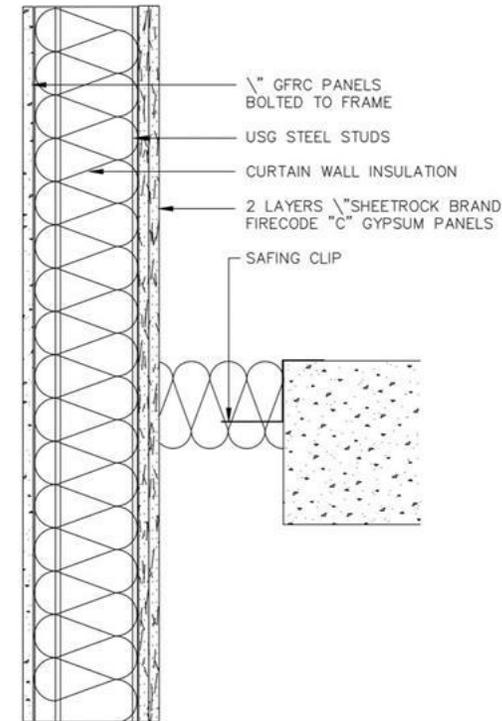
# Thermal Insulation & R values

## GFRC

- ▶ The R-value of GFRC system really depends on the thickness of the wall. The thicker wall the more R-value will have.
- ▶ Thermal conductivity of GFRC is dependent upon composite density and moisture content. The typical range of thermal conductivity is 3.5 to 7.0 BTU/in./hr./ft.<sup>2</sup>/deg F.



GFRC SPRAY UP PROCESS



CURTAIN WALL  
GLASS FIBER REINFORCED CONCRETE SP      ANDREL  
SCALE: 3/8"=1'-0"      DATE: 8/20/91      (DETAIL SHEET)

UNITED STATES GYPSUM COMPANY  
The CURTAIN WALL DETAIL must not be used without a complete modification by owner's design professional to verify the suitability of the design for a given structure.

# Thermal Insulation & R values

## Green Wall System

Although there is no R-value for Green Wall System, vegetation cools buildings and the surrounding area through the processes of shading, reducing reflected heat, and evapotranspiration.

- ▶ Promotes natural cooling processes
- ▶ Reduces ambient temperature in urban areas
- ▶ Breaks vertical air flow which then cools the air as it slows down
- ▶ Shading surfaces/people



# Benefit of Green Wall System



\*Urban beautification



\*Health and Wellness



\*Branding



\*Improve air quality



\*Building Protection



\*Urban wildlife



\*sound insulation



\*Temperature Regulation



\*Property Value

# Bibliography

- ▶ <http://www.strombergarchitectural.com/materials/gfrc-lead>
- ▶ [http://www.slate.com/blogs/the\\_eye/2013/09/18/patrick\\_blanc\\_s\\_newest\\_vertical\\_garden\\_greening\\_urban\\_walls\\_around\\_the\\_world.html](http://www.slate.com/blogs/the_eye/2013/09/18/patrick_blanc_s_newest_vertical_garden_greening_urban_walls_around_the_world.html)
- ▶ <http://www.ambius.com/green-walls/services/installation/index.html>
- ▶ <http://www.ambius.com/green-walls/index.html?gclid=Cljy3tDtm7oCFROZ4AodWiYAoQ>
- ▶ <http://gfrccladding.com/?&p=faq&q=400>
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