



Al Dar Headquarters

Abu Dhabi – United Arab Emirates

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Introduction

- Architects: **MZ Architects**
- Location: **Abu Dhabi - United Arab Emirates, Al Raha Beach**
- Project Manager: **Al Dar Laing O'Rourke Construction**
- Civil, Mechanical and Electrical Engineer: **ARUP**
- Facade Design and Construction: **Josef Gartner**
- Total built-up Area (including basement): **123,000 sqm**
- Height: **121m (23 Floors Office Space)**
- Cost: **AED 1,000,000,000**
- Owner & Developer: **Al Dar Properties**
- Project Year: **2010**



Introduction

- Awards :

Best Futuristic Design

- The Building Exchange Conference

Best Office Development

- Arabian Property Awards

Tekla Middle East BIM Awards

- Canopy

Highly Commended , Building and Structures Category

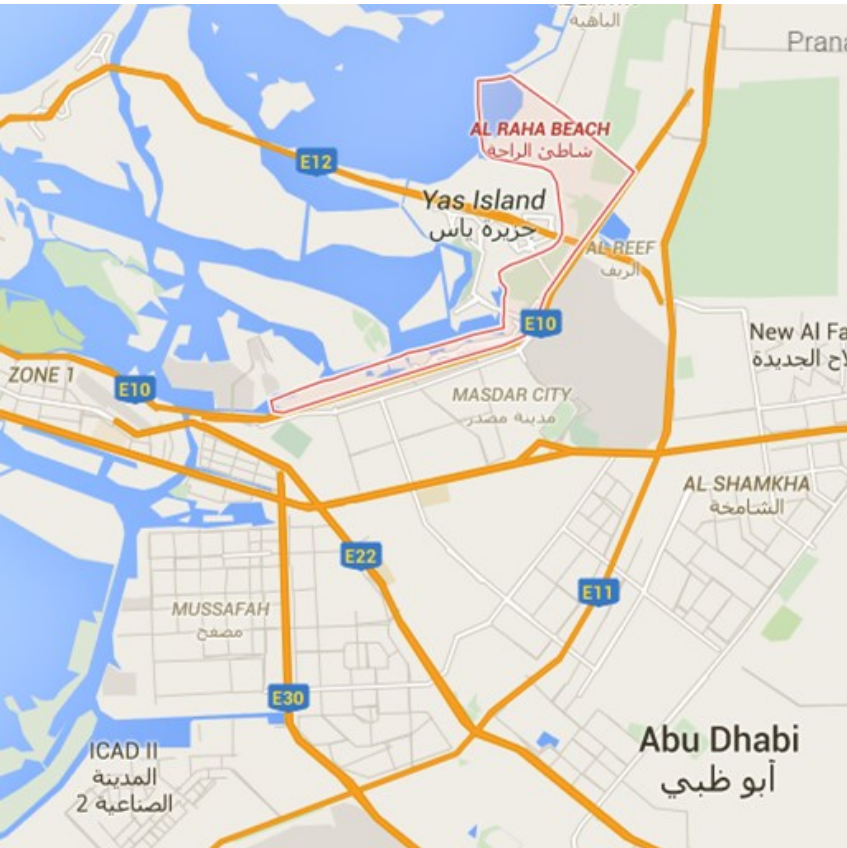
- Engineers Australia NSW Excellence Awards

Silver LEED rating

- Green Building Council (USA)



Background



- On the outskirts of Abu Dhabi lies a new city - Al Raha Beach. It will house about 120,000 people on completion.
- It was envisioned as a city on the sea and the biggest project to be attempted in the history of Abu Dhabi.
- With many iconic buildings in the nearby areas, there was an effort made to define 'the new extraordinary'.
- Al Dar group, which is one of the largest developers in the Middle East and North Africa region, accepted the challenge of creating an iconic and complex project.
- They partnered with the Abu Dhabi government and aligned their business with the Emirate's "Vision 2030" strategy of economic diversification and social infrastructure development.

Background

Al Raha Beach was to be put on the world map and attract investors by creating an identity for itself. This gave rise to an idea of building a signature iconic skyscraper.

Muhammad Al Mubaraq (Project in charge) states “**Vision of Aldar was to create almost a mini city where people can live, study, play and work in one destination**”

Lebanese Architect - Marwan Zgheib was selected to do the design.



https://www.youtube.com/watch?v=-oqsClf_rzw



https://www.youtube.com/watch?v=-oqsClf_rzw

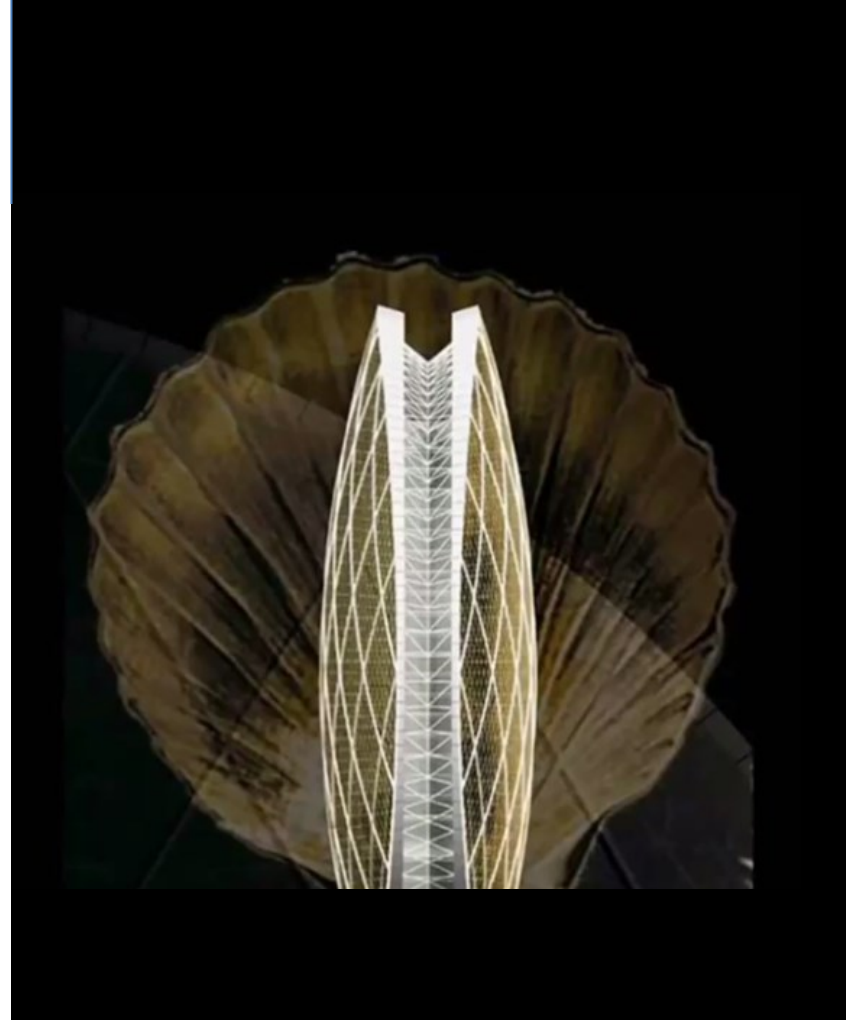
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Concept:

- Abu Dhabi has a sea faring heritage. Hence the building had to be relevant to its context.
- Architect Marwan Zgheib's thinking about Architecture –

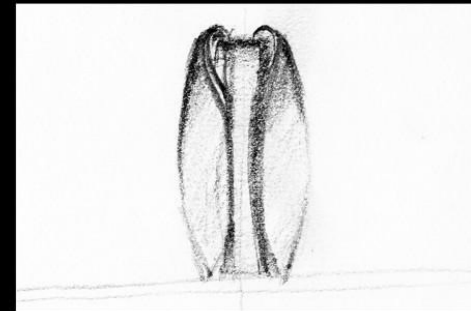
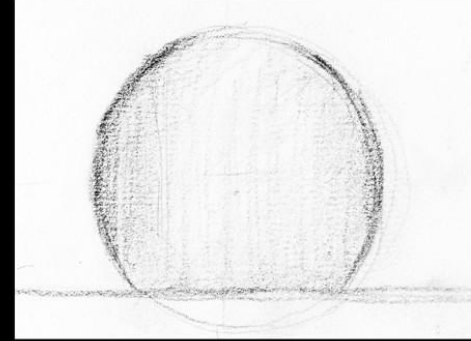
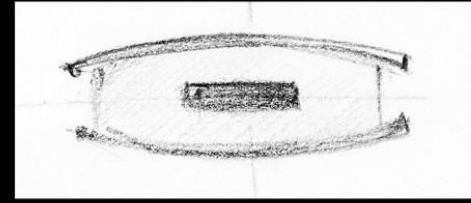
“Simple can be powerful sometimes, especially in Architecture. Architecture is nothing but imitation of nature”

- Getting inspired by clam shells and understanding the importance of geometric round shape, he sketched the idea of this iconic skyscraper.
- He conceived it as two large glass facades being held together vertically as an open shell.



Body

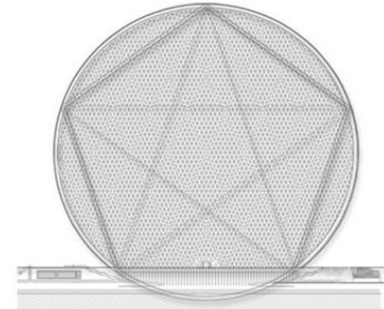
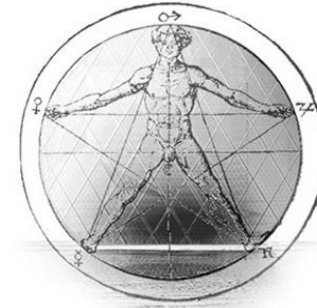
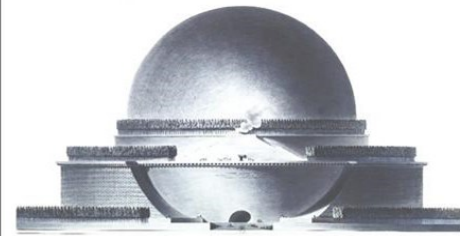
- The circle symbolizes unity, stability, rationality. It is also the symbol of infinity, without beginning or end, the perfection, the ultimate geometric symbol. It represents an integrity that encompasses all space and time. [1]
- The concept sketches (on the right) shows that the building would be like a freestanding coin.
- Aldar HQ was circular in elevation with curved profile on every face of it.
- It is oriented with a East-West facade that allows the sunrise and sunset to be visible in the glass
- Diameter of Aldar HQ was 120.9 meters and the width varied from 10 meters on the ends to 36.4 meters on the middle portion.
- **Stability was a major concern** in turning this idea into reality.



Body

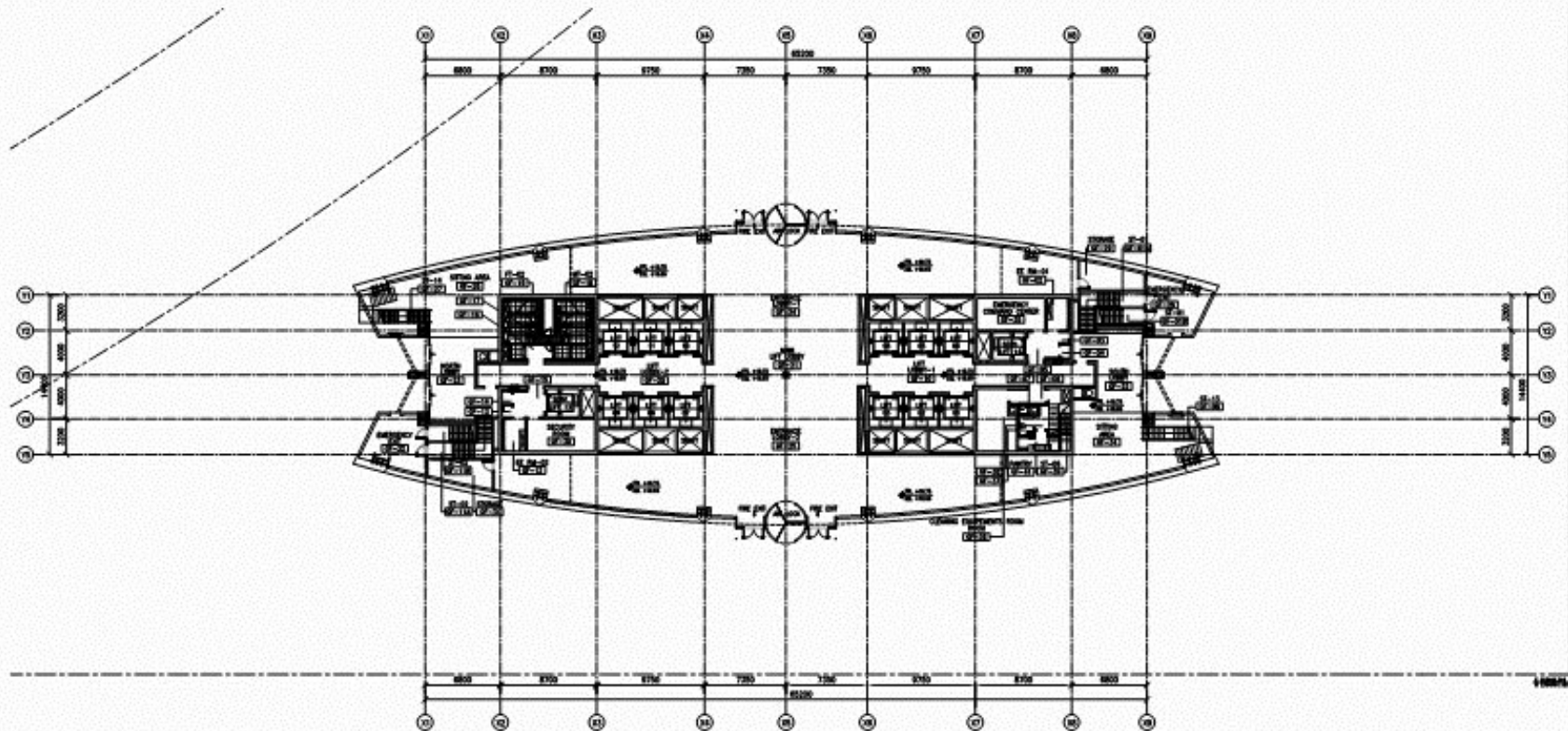
Design:

- Architect referred to the image of human body in circle that inscribed pentagram on another circle.
- Taking clues from it, the issue of stability was resolved. The bottom two points of pentagram were connected to form a firm base for building to stand upright on it.
- The round skyscraper (taller than Statue of Liberty) has a curved glass skin - covering area of 4 football fields.
- Architect wanted to have open plan office spaces with floor to ceiling windows so that people inside could get the panoramic view of the Persian Gulf.
- Also, open plan office spaces were capable of accommodating large number of fit – out options.



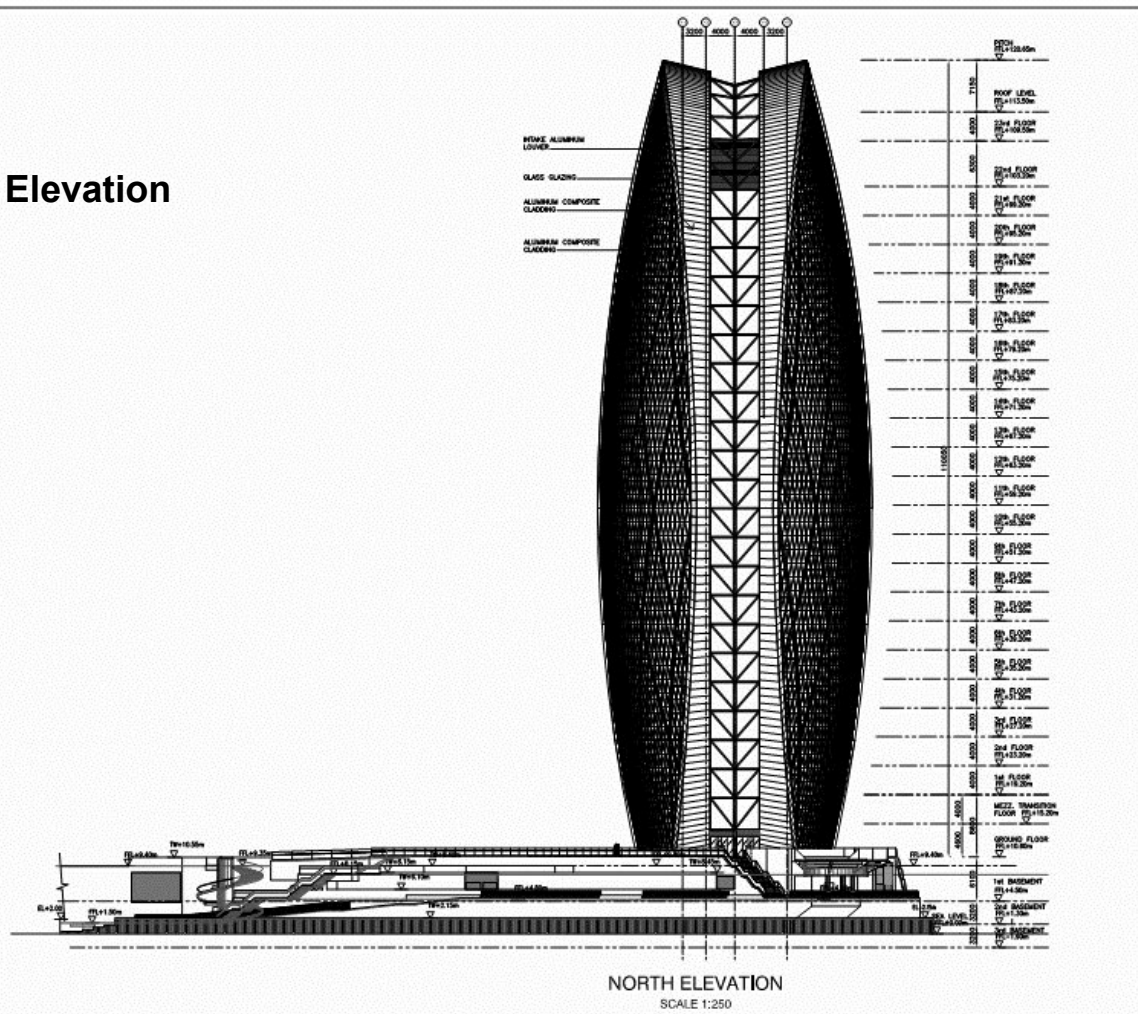
Body

Design Drawings: Plan

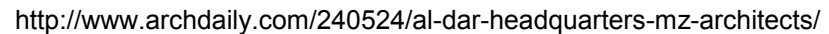


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Design Drawings: Elevation

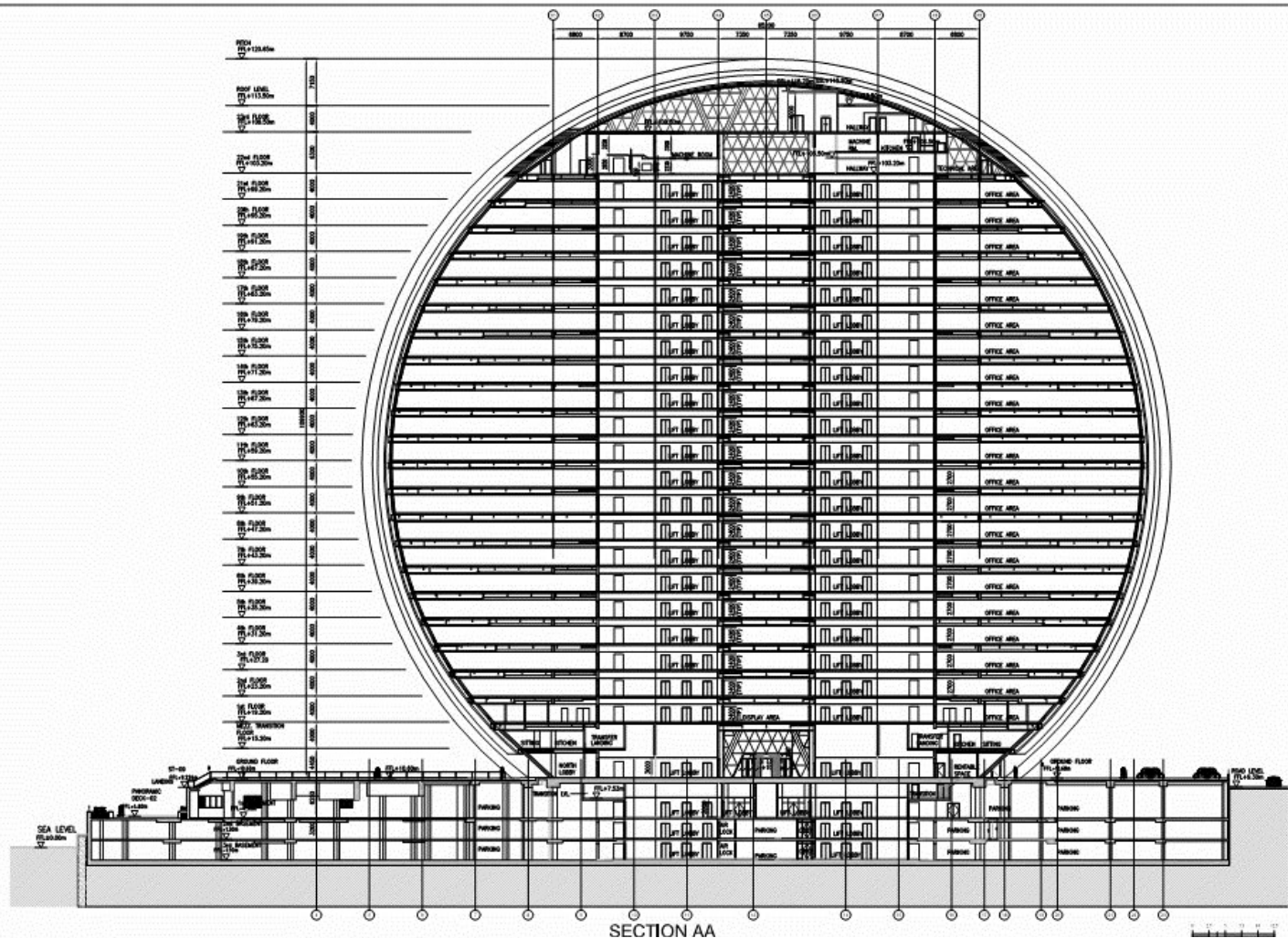


Design Drawings: Elevation



Body

Design Drawings: Section



Body

Site:

- The solid ground didn't exist as the site was in the sea. (700 m in Persian Gulf and 8 m under water)
- Larger grain molecules of marine sand were used to create base as they stick together firmly. In all 20 million cubic meter of sand was used. Sand was pumped through the floating pipes to the construction site.



Body

Site:

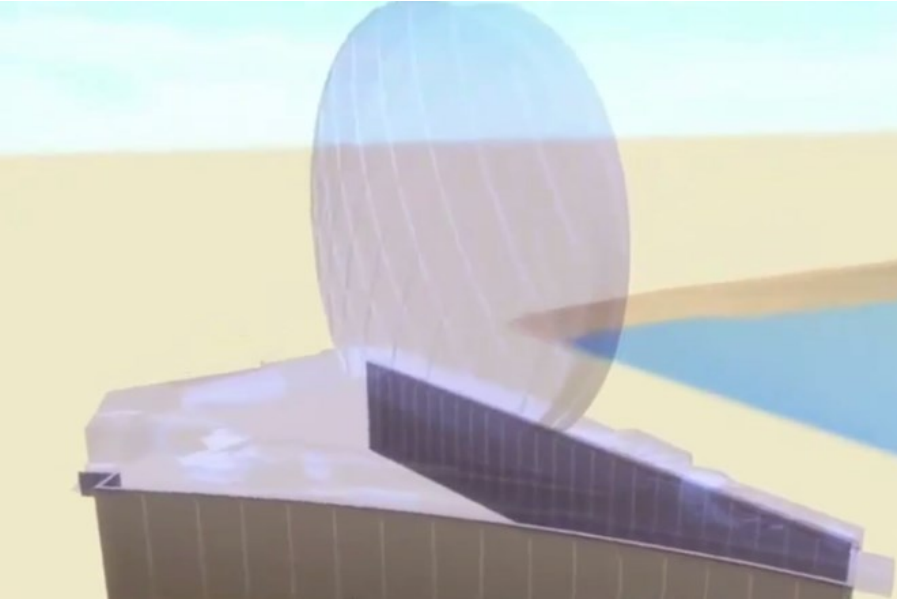
- Abu Dhabi is regularly being hit by high pressure winds that sweep in from the Persian Gulf. Also high chances of dust winds from Thunderstorm can be expected. Winds tend to twist the structure.
- **The curved shape of building was acting like a sail.** Hence, 'Wind Tunnel' tests were done on the building to check the stability of the foundation.
- Being close to the sea, **ground water** acted as an **added pressure on this building**
- Upwards pressure from water and loose sand were causing problems for construction.



Body

Foundation:

- Concrete barricade of 16 M deep Diaphragm walls was built into the ground and sand between these walls was removed.



https://www.youtube.com/watch?v=-oqsClf_rzw

- 400 Concrete piles were driven into the ground that works in 2 ways.

Half of these piles work on friction with ground to secure structure to sand

Other half piles are driven deep into the ground to transfer immense load of the building to the ground.



https://www.youtube.com/watch?v=-oqsClf_rzw

Body

Foundation:

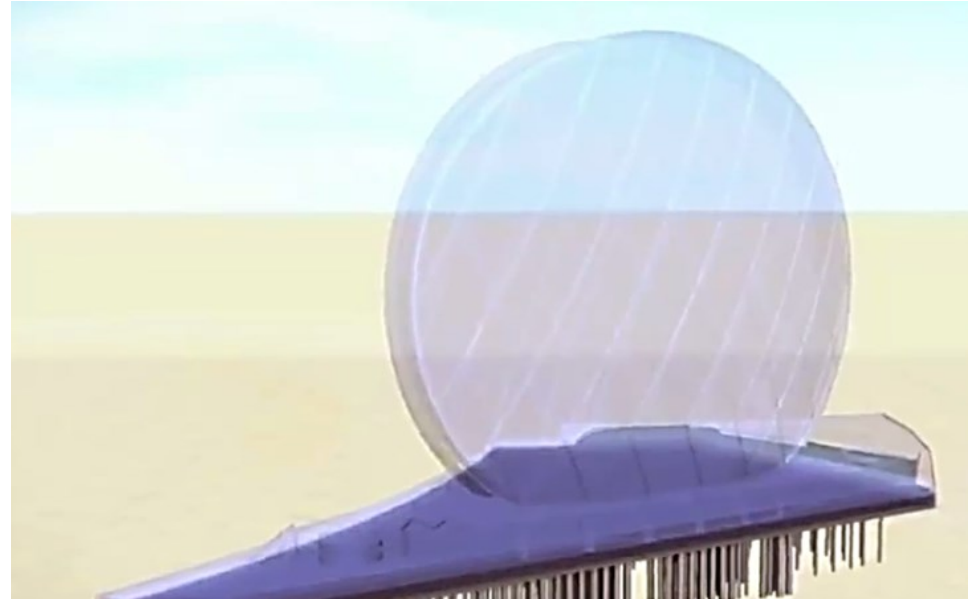
- Water was pumped out continuously from sand into the sea to prevent site from getting water logged.



https://www.youtube.com/watch?v=-oqsClf_rzw

- Raft slab was casted on the piles to make the foundation more strong.

Raft slab creates barrier against surging water, stops piles from punching up through building and acts as a snow shoe. It evenly distributes the weight of Aldar HQ



https://www.youtube.com/watch?v=-oqsClf_rzw

Body

Foundation:

- 12000 cubic meters of Concrete was used to construct this Raft Foundation, which takes the building weight of about 59000 tons



https://www.youtube.com/watch?v=-oqsClf_rzw

Structural designer over engineered the foundations as the design was still in progress

Pile caps were being inspected for their strength. The severe forces from the Raft had to be borne by these piles and transfer them to the earth effectively.



https://www.youtube.com/watch?v=-oqsClf_rzw

Body

Core Structure:

- Two separate pieces of concrete acted as backbone for the building. They transferred loads to the piles.



https://www.youtube.com/watch?v=-oqsClf_rzw

These concrete cores rose from Raft slab till the top level of the building.

These cores were heavily reinforced with steel and were bound together closely. It was a heavy mesh design specified by the engineers.



https://www.youtube.com/watch?v=-oqsClf_rzw

Body

Core Structure:

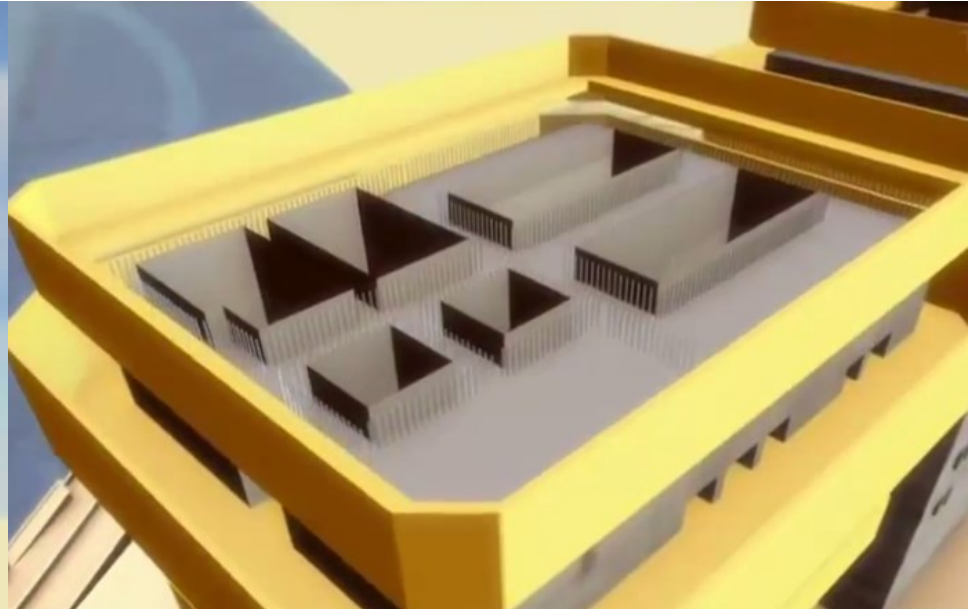
- Slip forms were used to create continuous concrete cores without any joints.
- The forms moved up as the construction proceed

Giant molds take the poured concrete to form the desired shape.

Seamless concrete cores provide the required strength to the cores



https://www.youtube.com/watch?v=-oqsCIf_rzw



https://www.youtube.com/watch?v=-oqsCIf_rzw

Body

External Shell:

- The design of vast external shell had to be heavy to support the wide girth and survive wind load.
- Architect wanted an unobstructed panoramic view of the Persian gulf from the interior.
- **Diagrid system** was thus used as a viable solution. The shape of building will be formed by a muscular but slender steel frame.
- The forces will be channelized to the core by high strength beams and joints.
- It was a first time this system was used in UAE.



Body

External Shell:

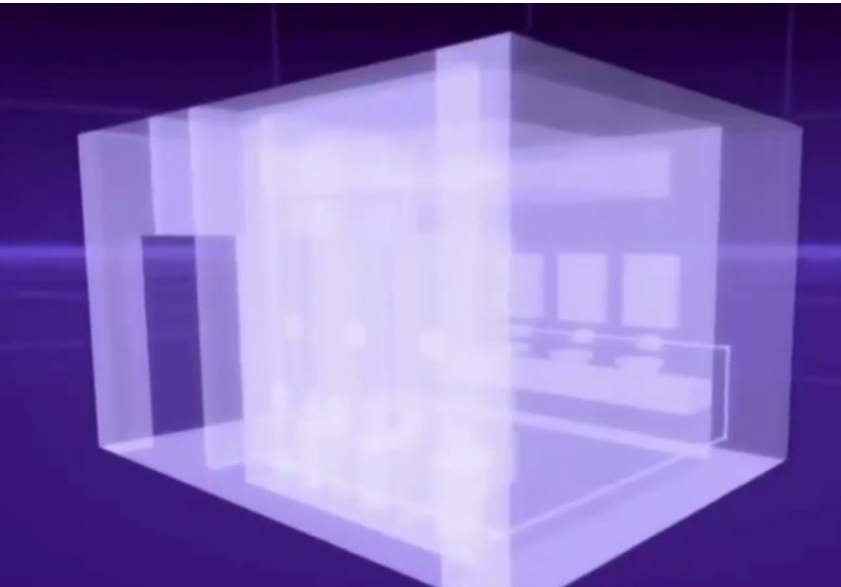
- **“Steel is very strong as single element. But meshing them together gives us this added strength” – Arup Engineer.**
- The A frame are bolted to the base plate. (each weighing 30 tons)
- ‘A’ shaped structures were connected in series to form the signature curves of the structure.
- These A frames were lifted by cranes and put into their desired location where they were being bolted.



Body

Restroom 'POD':

- In all there are 86 Restrooms in the overall building. To speed up construction these were predesigned as a 'POD' with built in fixtures and fitted in the building.



https://www.youtube.com/watch?v=-oqsClf_rzw

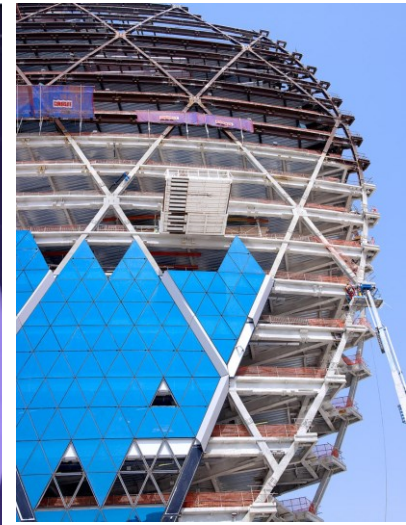
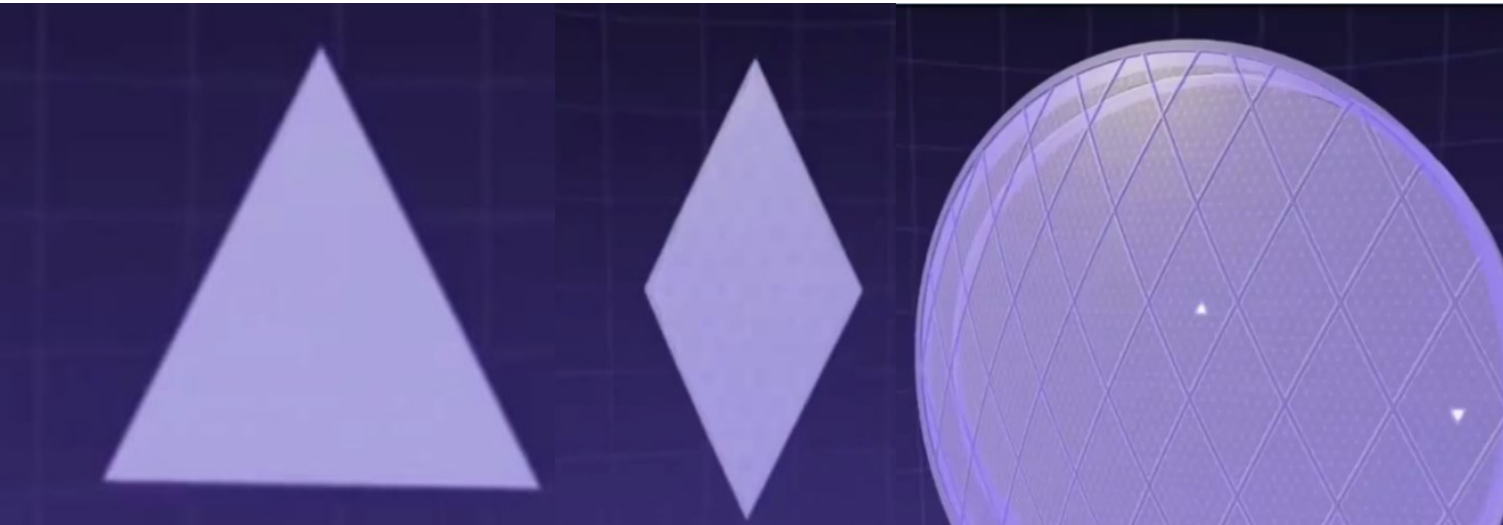
- These predesigned units were inserted from the roof slab opening into the desired location.
- All the fittings and fixtures were installed in the single units of restrooms.
- Their placement looked like the game of Tetris.



Body

Glass Façade Design:

- Triangular pieces were used as a module of glass façade.
- They had an advantage of being able to pivot on three sides to give desired curve
- These triangular pieces had to withstand the wind pressure as the large facades are most likely to cause trouble.
- A glass factory was setup on site to manufacture these special type of glass and also to speed up the construction process as it minimized the transportation time



Body

Glass Façade Design:

A vortex is created on narrow edges of glass where the wind spirals around itself. Strong suction force occurs here. (Fig. 2)

Hence to tackle this issue the glass here was made thicker and frame was made stronger.

Fig.1



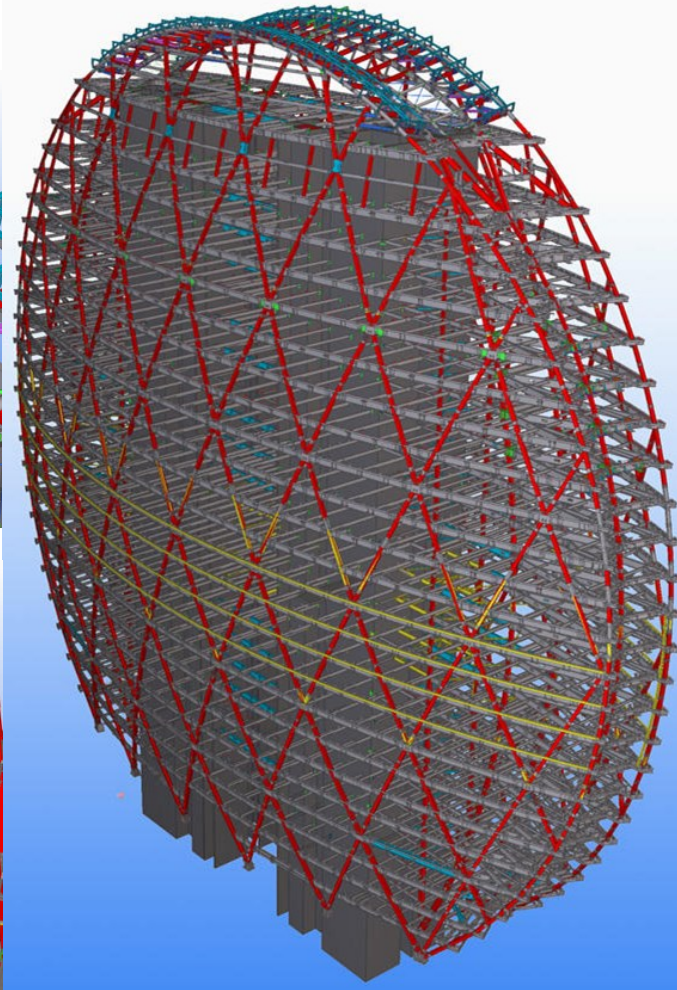
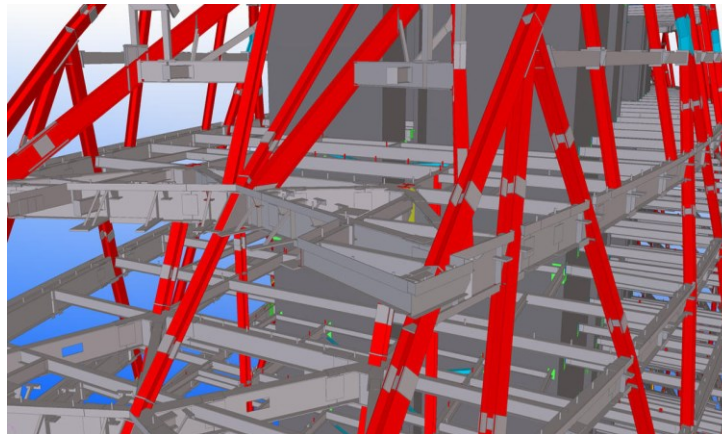
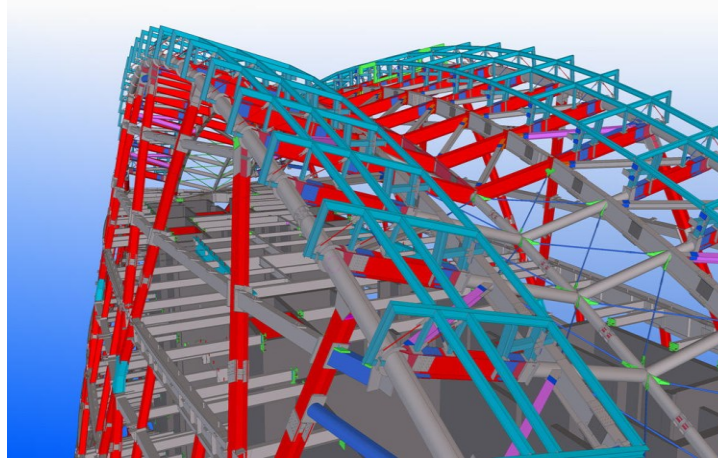
Fig.2



Body

Structural Joints:

- On the right, we can see Tekla BIM models that show pair of concrete cores and steel diagrid.



Body

Structural Joints:



https://www.youtube.com/watch?v=-oqsClf_rzw



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Body

Structural Joints:



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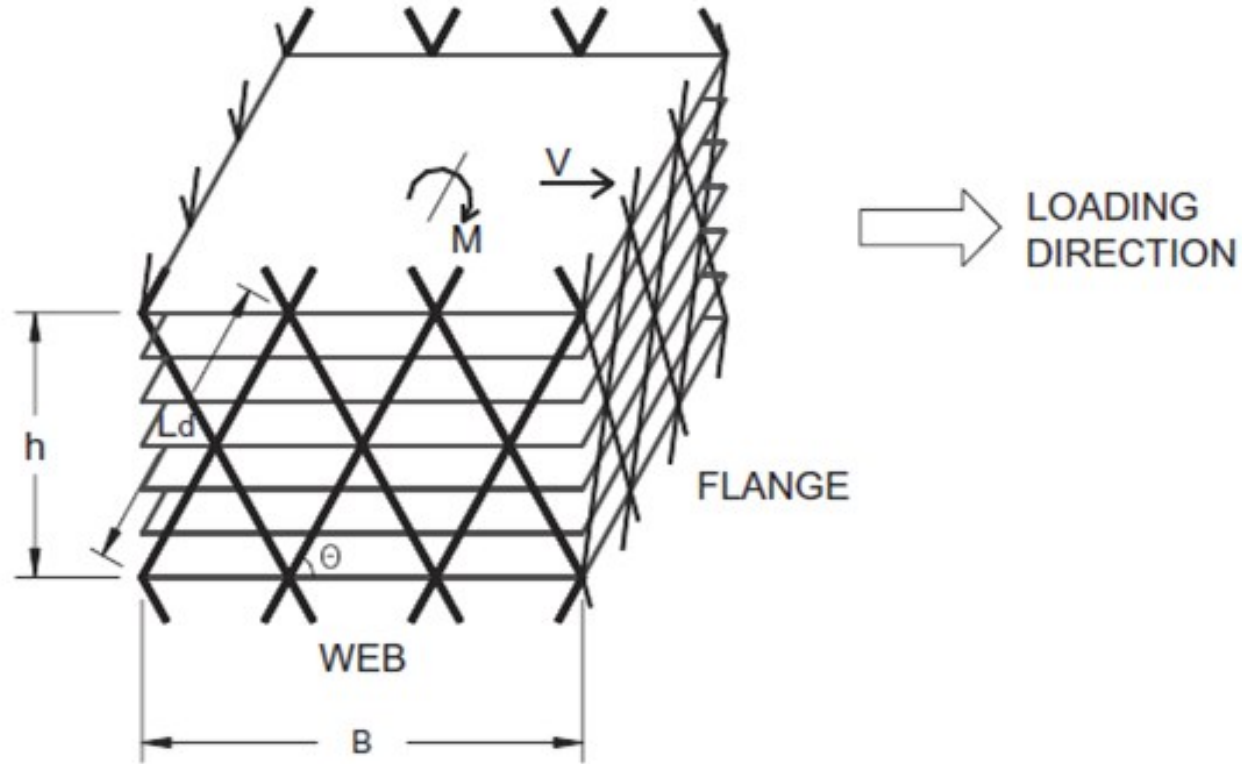


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Body

Diagrid System:

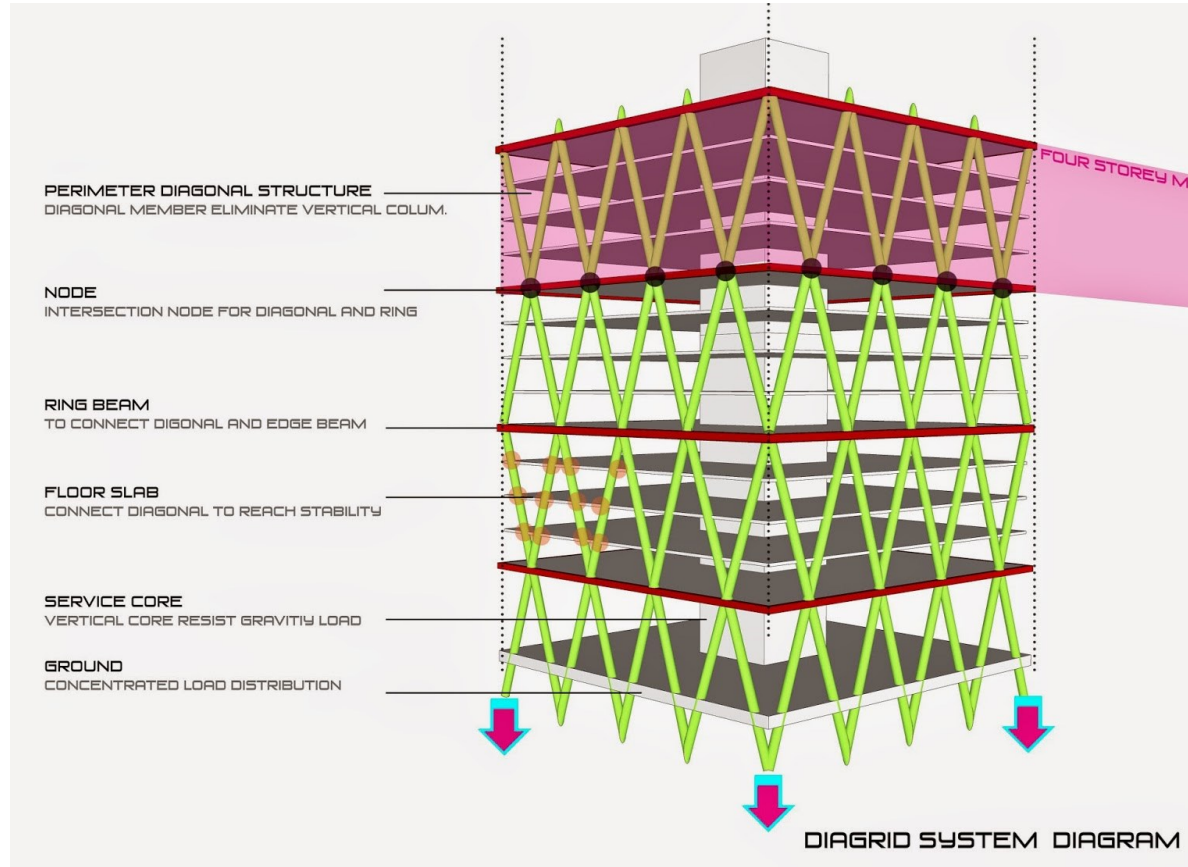
- It is one of the most innovative construction technique to being used in skyscrapers today.
- The triangular configuration of diagrid make it feasible for them to carry both gravity as well as lateral loads and provide the desired stability to the structure.
- As the exterior diagrid tube is comprised of diamond shapes, triangulation is achieved where the floor edge beams tie into the grid [2]



Body

Diagrid System:

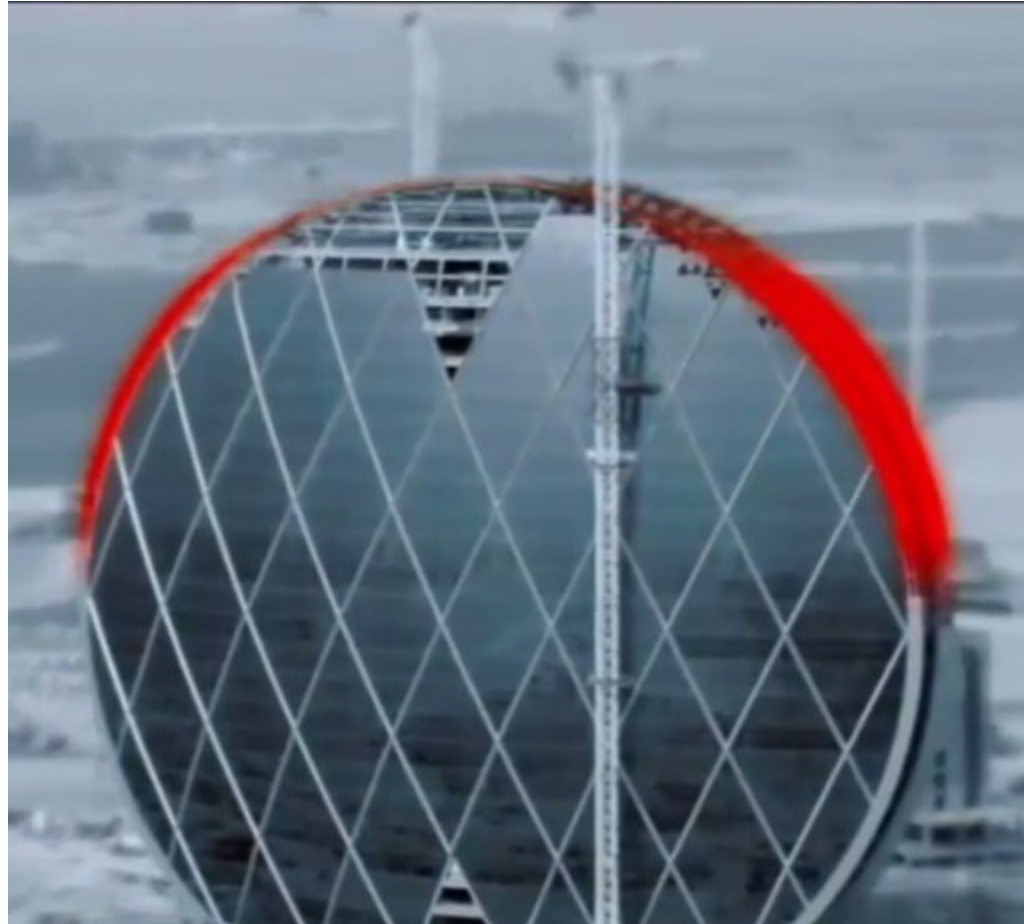
- Tall buildings act as vertical cantilevers
- So taller and slender building have large variations in function of diagrids at the top and the base.
- Amount of steel being used can be reduced with the variations in angle of inclination of diagonal members
- Members at base: Resist Moment
- Members on top: Resist Shear



Body

Diagrid System:

- Ring beams are tied to diagrid at floor edges to transfer loads via floor slabs to the vertical cores.
- In Aldar HQ, 8 floor base module is used to form the desired curve.
- To manage the eccentric loading and keep the building stable, the shape is symmetric.
- The arch part of the building's light weight roof is the crucial component for providing strength
- The foundation receives evenly distributed forces through these curved members



Interiors

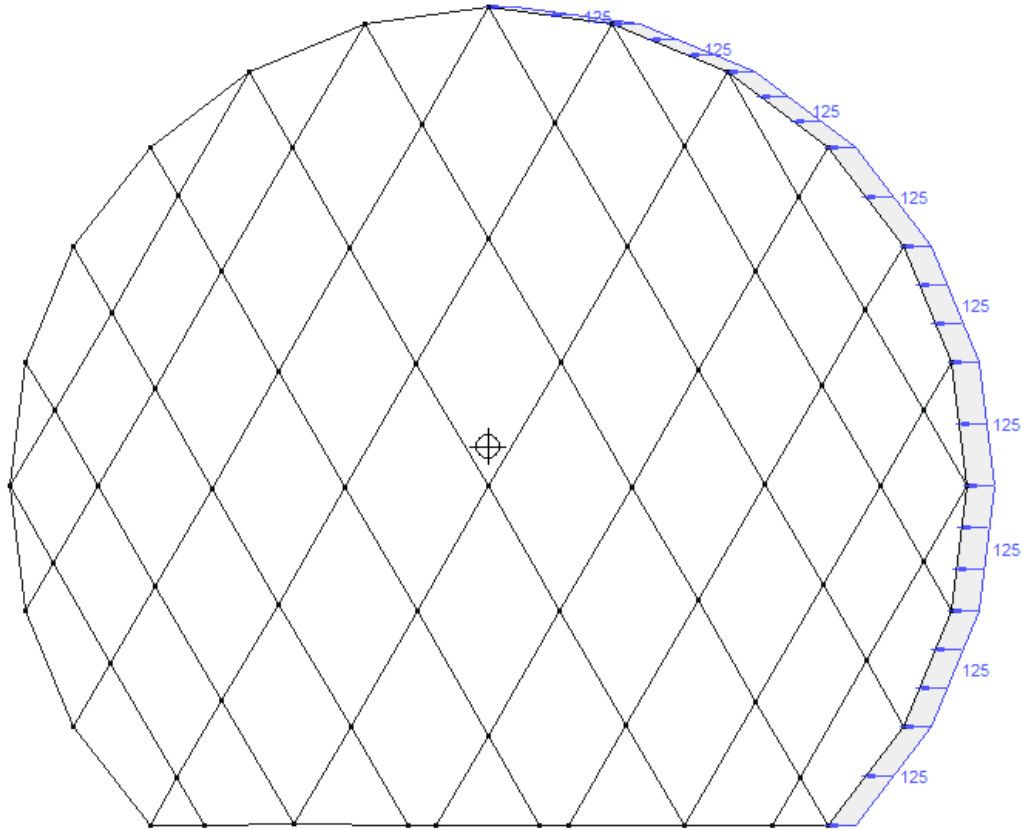


<http://www.laingorourke.com/our-work/all-projects/aldar-hq.aspx>



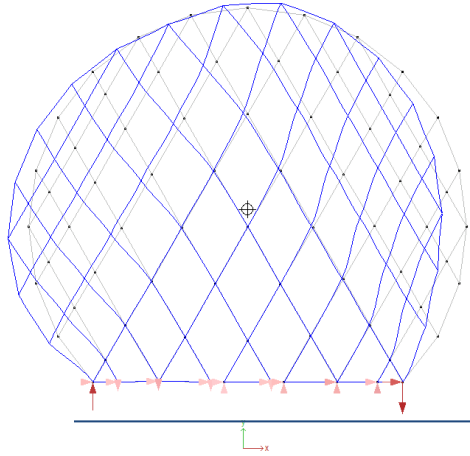
<http://www.laingorourke.com/our-work/all-projects/aldar-hq.aspx>

Multiframe | Parallel Wind Loads

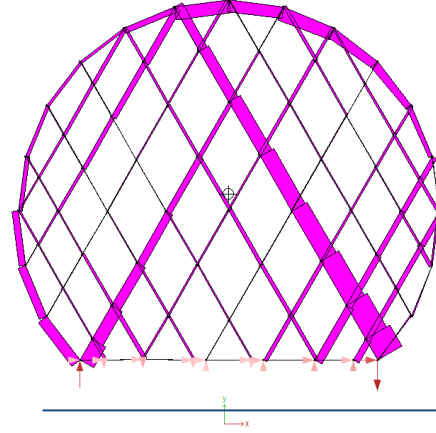


For both structural & cladding pressures, a nominal 50-years period was adopted with a basic 3-second gust wind speed of 38m/s at 10m in open country.

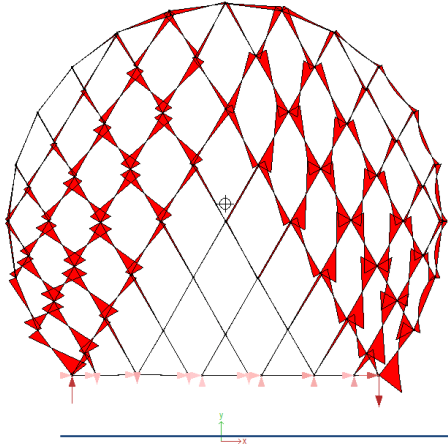
Multiframe | Parallel Wind Loads



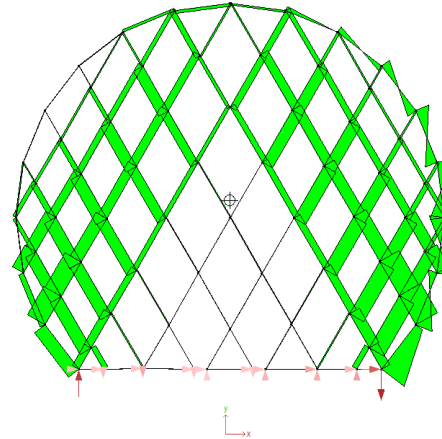
DEFLECTION



P_x' - AXIAL FORCE

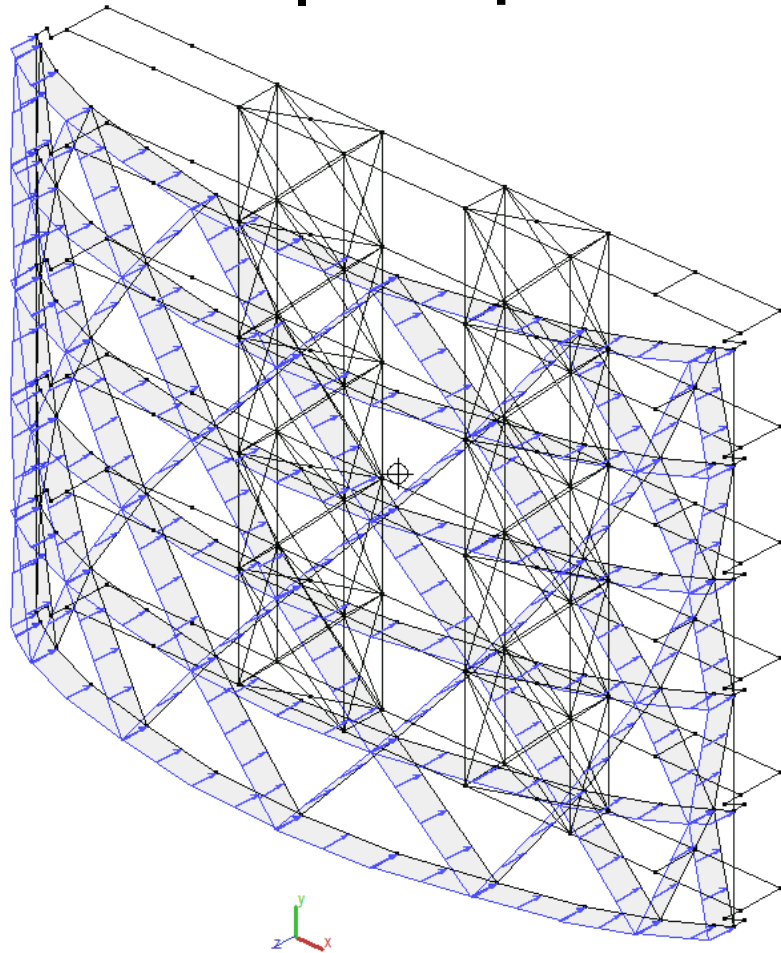


M_z' - MOMENT

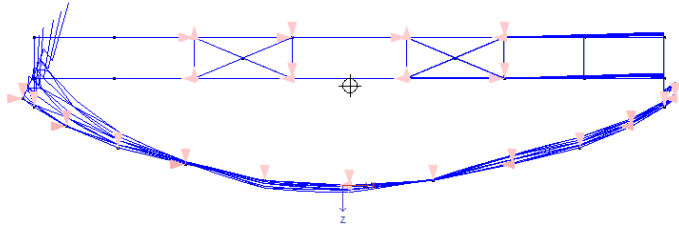


V_y' - SHEAR

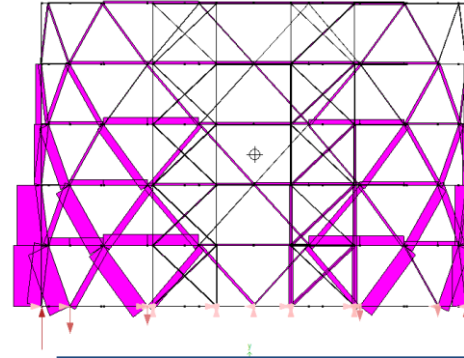
Multiframe | Perpendicular Wind Loads



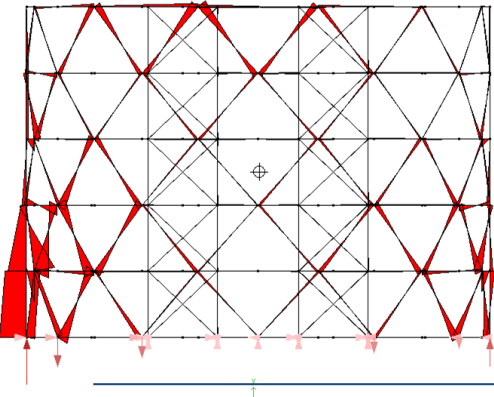
Multiframe | Perpendicular Wind Loads



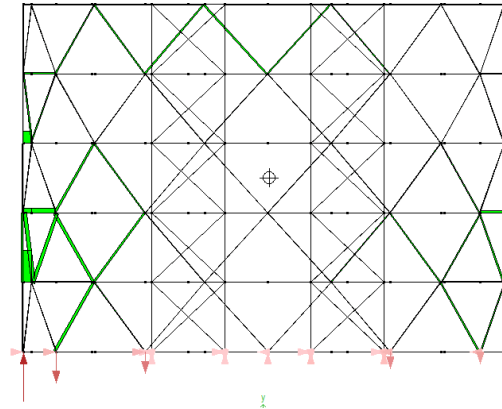
DEFLECTION



Px' - AXIAL FORCE

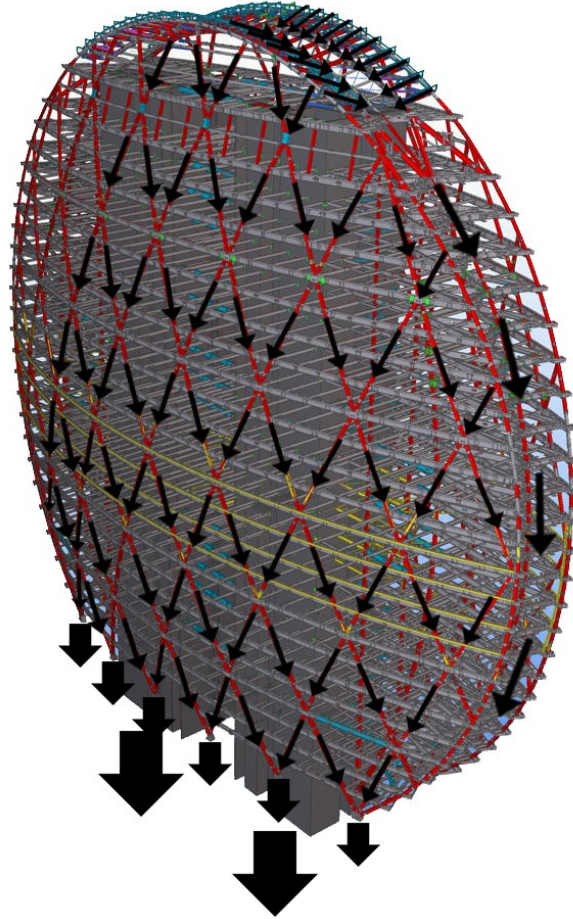


Mz' - MOMENT



Vy' - SHEAR

Load Tracing Diagram



Conclusion

- Aldar HQ is a fine example of transforming breakthrough simple concept into reality.
- It stands firmly on a site formed in the sea by using diaphragm walls, piles foundation and raft slab.
- The key features are two concrete cores and the curved glass façade.
- Zipper like connecting façade binds the two main circular curved disc like façade.
- Diagrid system for façade helps tackle the lateral loads caused by winds and helps to achieve the desired aesthetics of architect.
- The building was completed in 30 months with the coordination between experts from interdisciplinary world of Architecture.



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