

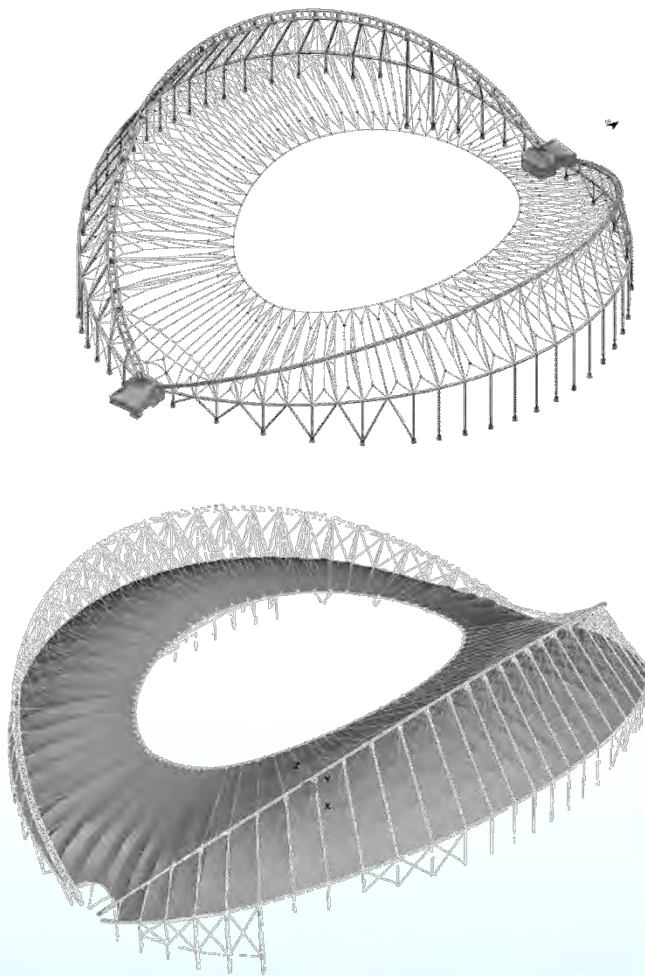
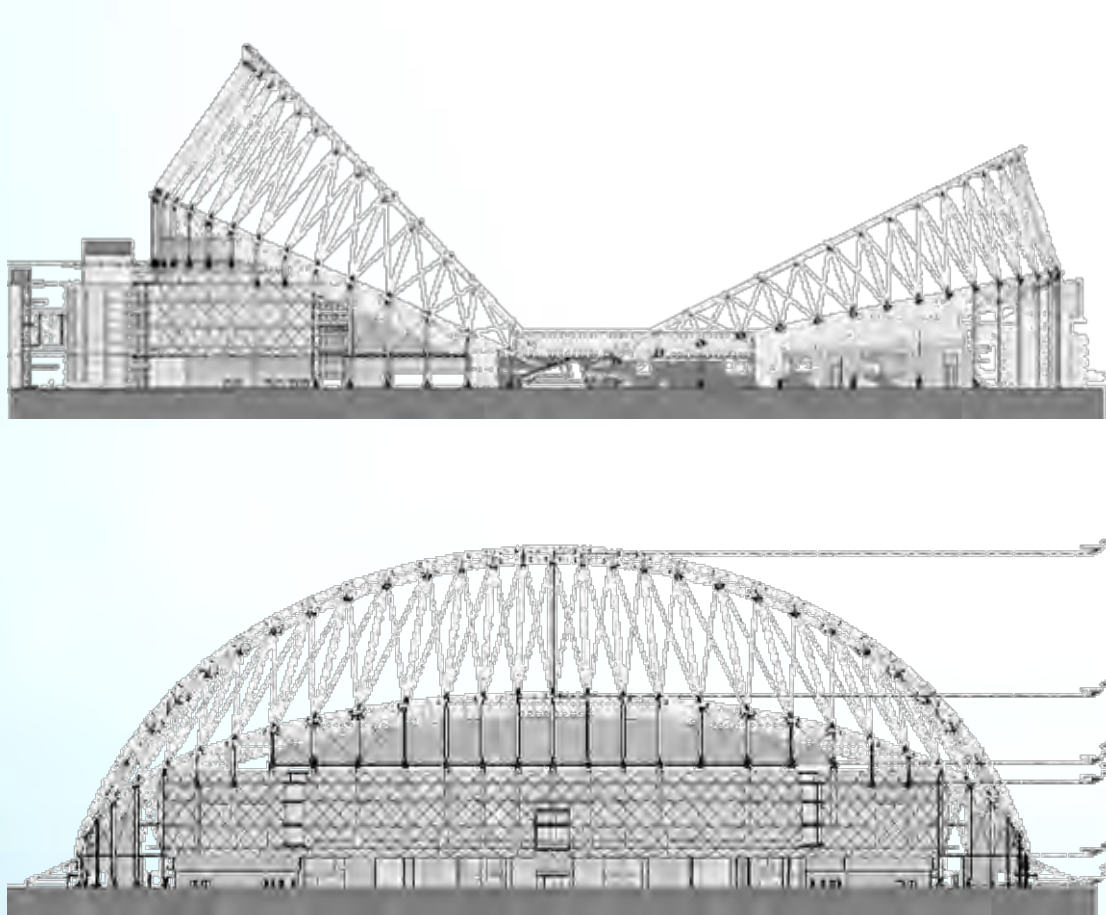
|                     |                                  |
|---------------------|----------------------------------|
| LOCATION            | Doha   Qatar                     |
| YEAR                | 2014                             |
| STATUS              | Completed                        |
| GENERAL CONTRACTOR  | JV Six Construct - Midmac        |
| STEEL CONTRACTOR    | Eversendai Engineering Qatar Wll |
| MEMBRANE CONTRACTOR | Taiyo Middle East                |
| CABLE CONTRACTOR    | Pfeifer Structures Llc           |
| MATERIALS           | Steel   Cables   PTFE   ETFE     |
| SURFACE             | 44,000 m²                        |
| SEATS               | 48,000                           |

# KHALIFA INTERNATIONAL STADIUM

Maffeis' expertise in tension structures and membranes resulted for design of the Khalifa International Stadium roof. This key project in Doha is a multipurpose stadium built specifically for Soccer World Cup 2022. Maffeis participated in three different stages of the project.

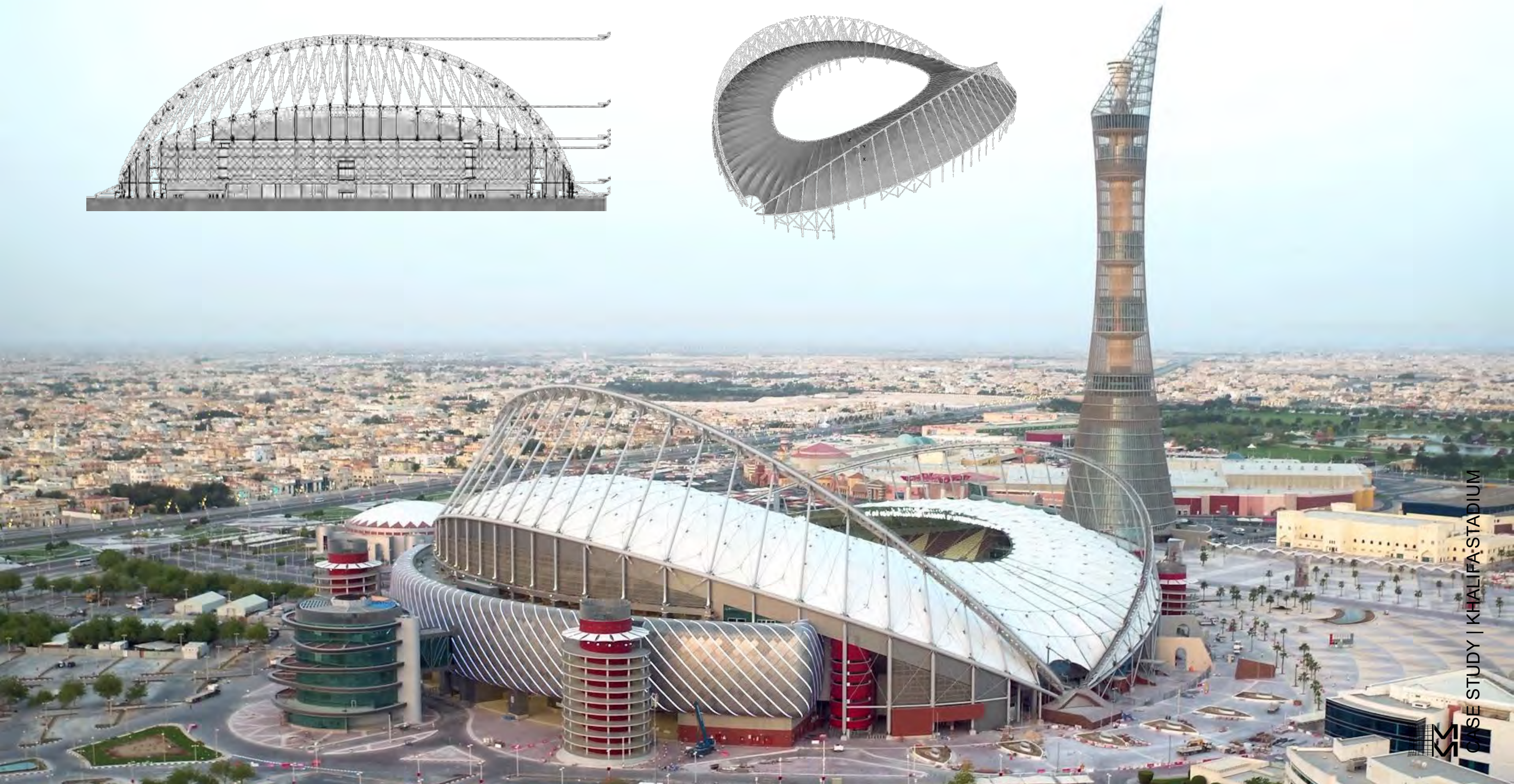
In 2012 the first design stage was developed in conjunction with DAR Architects to provide concept and schematic designs for tender. In 2014 Maffeis started the second stage supporting the General Contractor, MIDMAC-Six Construct JV, for the design of the stadium, including all construction staging. Part of the existing stadium was dismantled and the new ring beam supported roof was designed (IFC stage) to cover the bleachers. An ETFE single skin "half-moon" roof portion was added to the cable net roof during this phase to improve natural growth of the soccer turf. In the third and final stage, Maffeis provided engineering services for JV for the entire construction process, from the design, fabrication, survey checking and 4D construction sequence of the structure. This required daily coordination with the team: contractors, Eversendai (steel), Pfeifer (cables) and Taiyo Middle East (membrane & drainage system).





Khalifa International Stadium has been assigned as one of the stadiums hosting the games for the Football World Cup 2022.

For this purpose, the seats capacity will be extended to 40,000 seats, an air conditioning system will be built to cool all the seats and the field of play and the roof will be extended to cover all the seats.





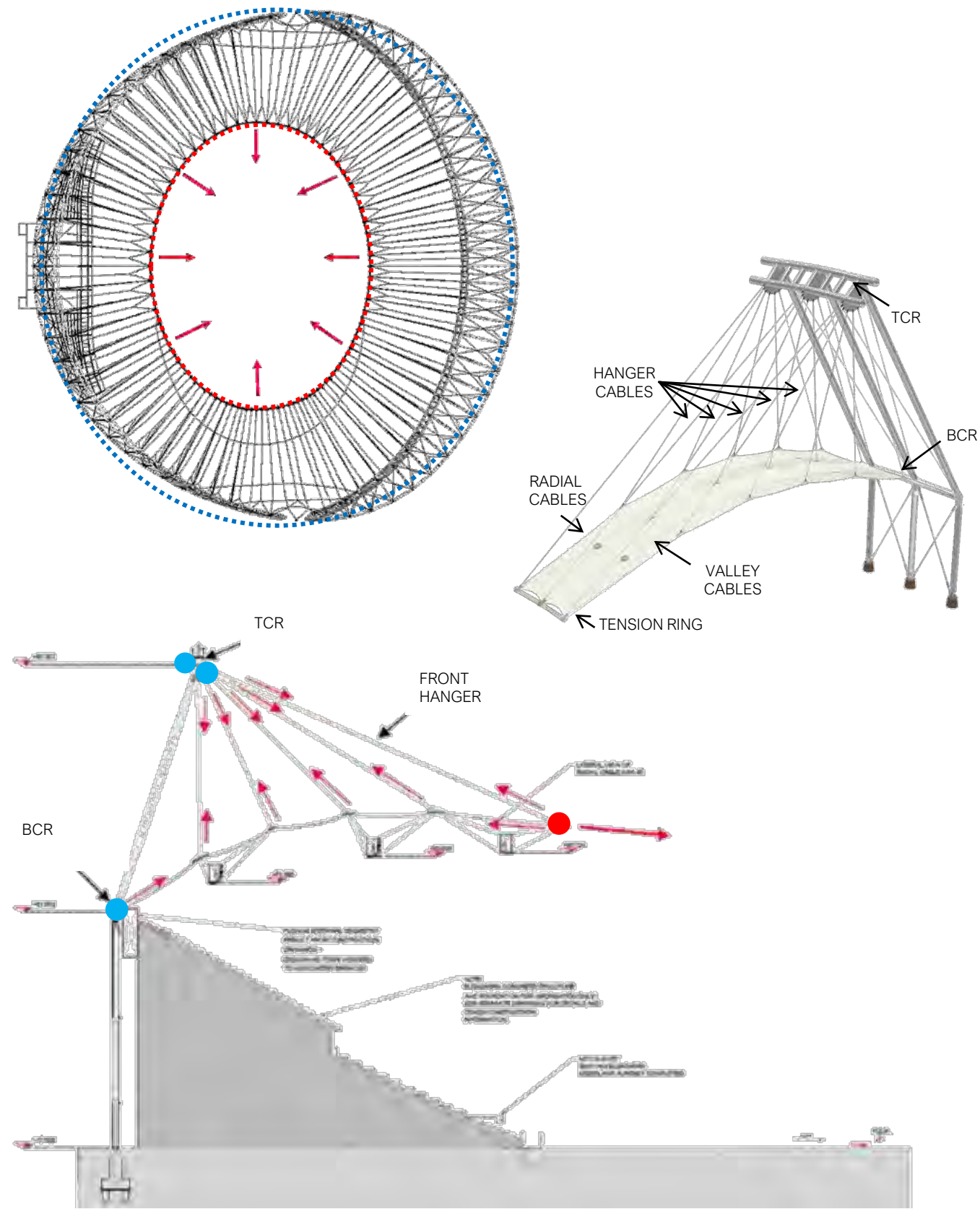
METHOD OF STATEMENT STEEL



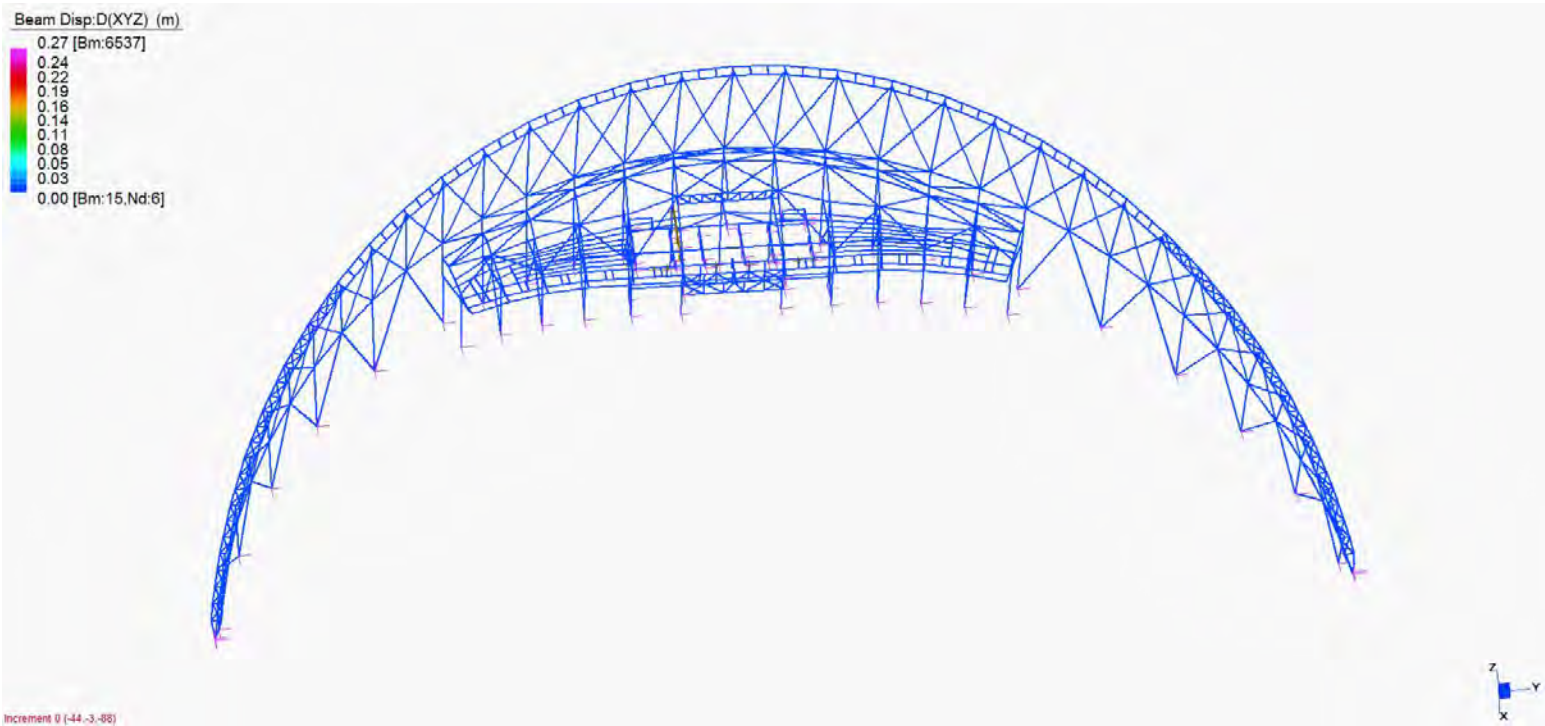


METHOD OF STATEMENT STEEL

INSTALLATION SEQUENCE WEST ARCH



INSTALLATION SEQUENCE CABLE NET

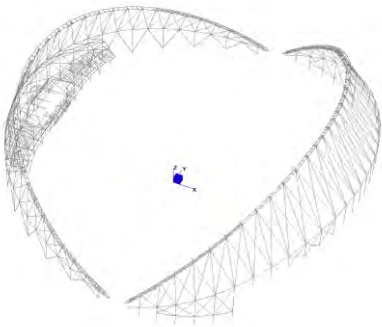




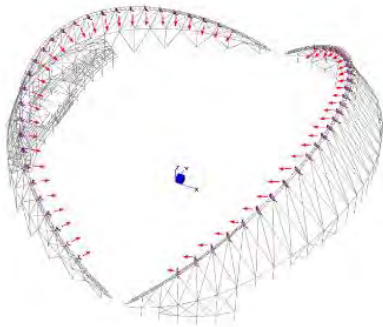
# METHOD OF STATEMENT BIG LIFT

The "Big Lift" numerical model has been defined and calibrated starting from the global model of the whole Stadium. It had high importance in order to evaluate the different installation phases, the cables spatial position and the internal actions of the system.

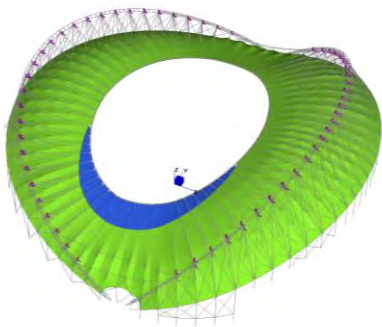
The analysis results have allowed us to provide support on site, constantly comparing the expected values with the measurements until the operations' completion. The ropes have been represented with "cable" type finite element in order to make the solution more realistic by integrating the catenary equation.



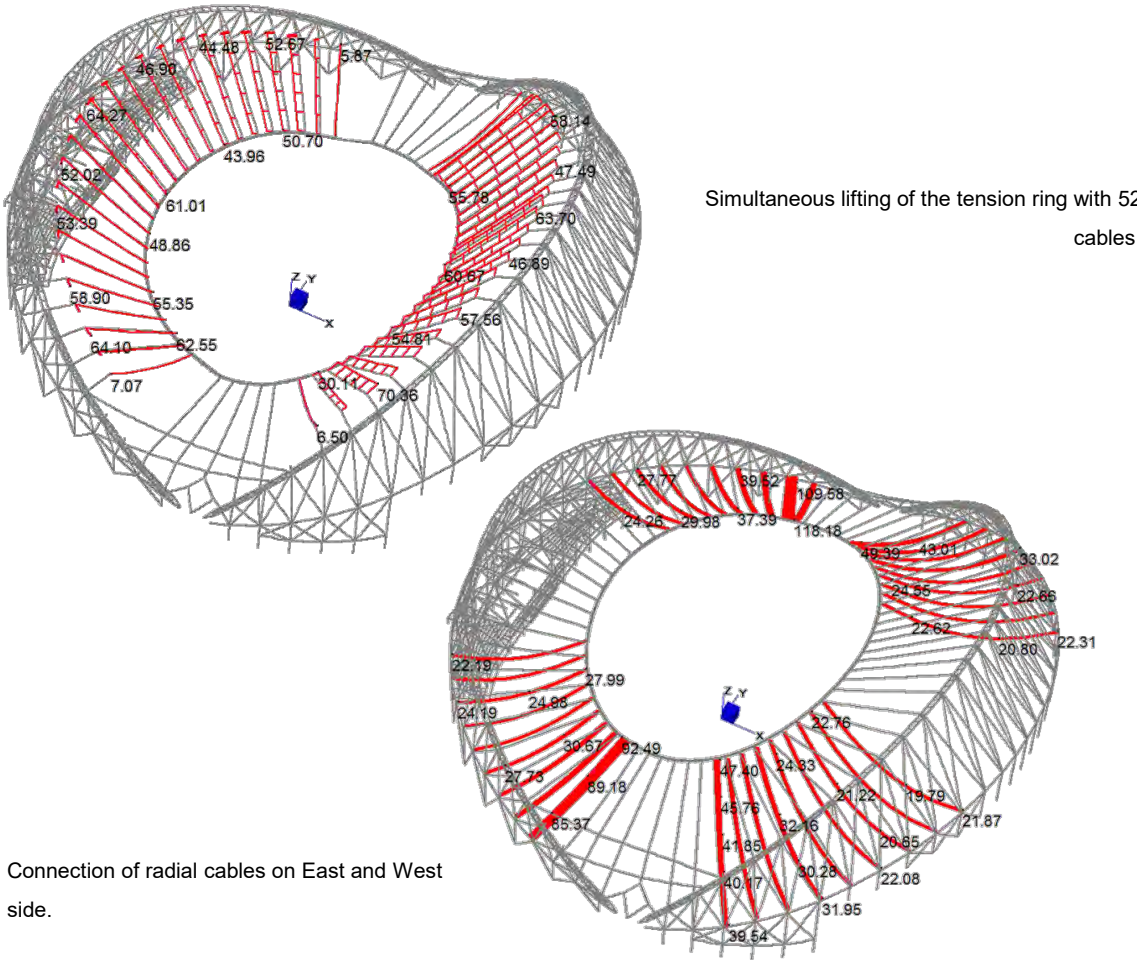
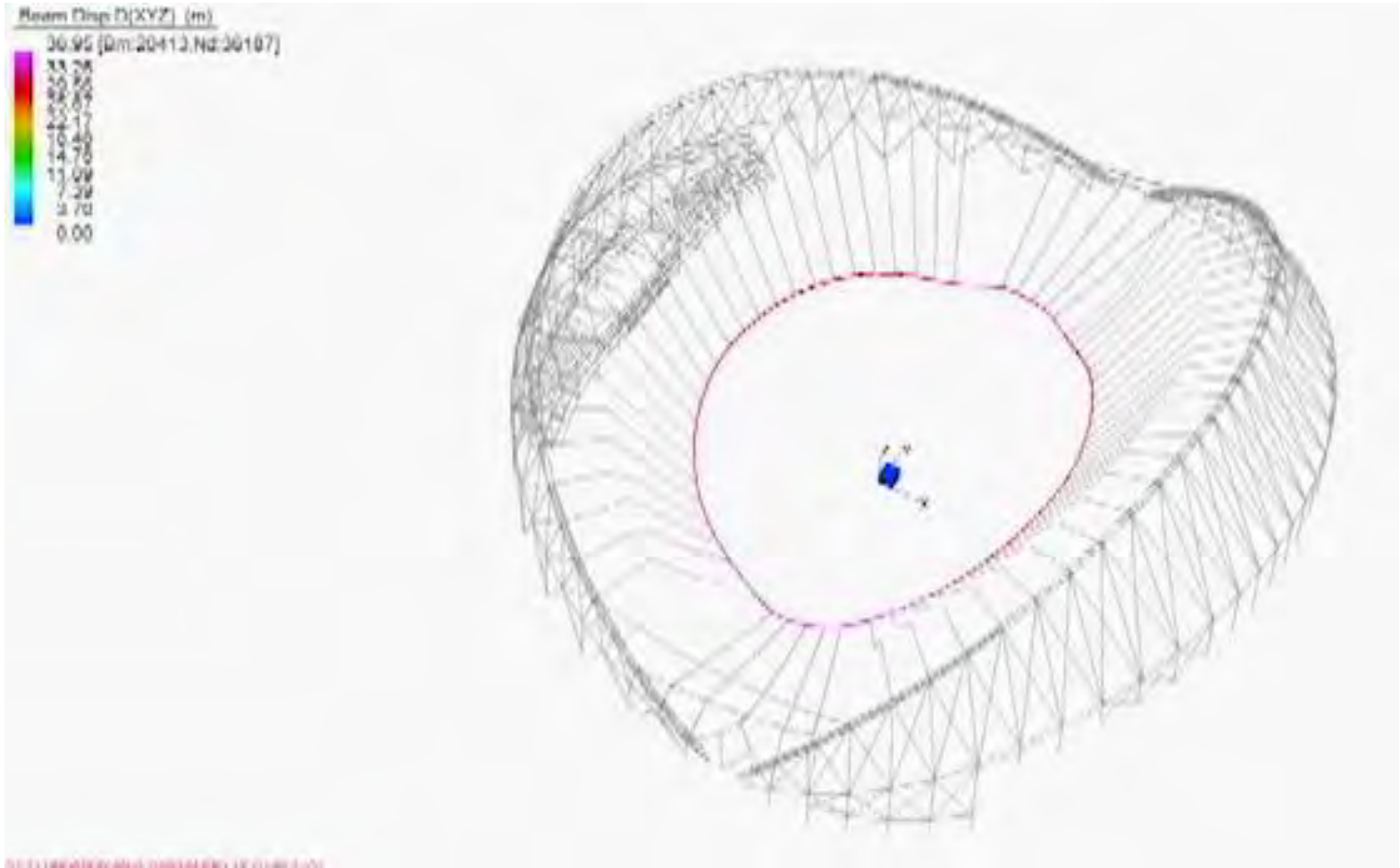
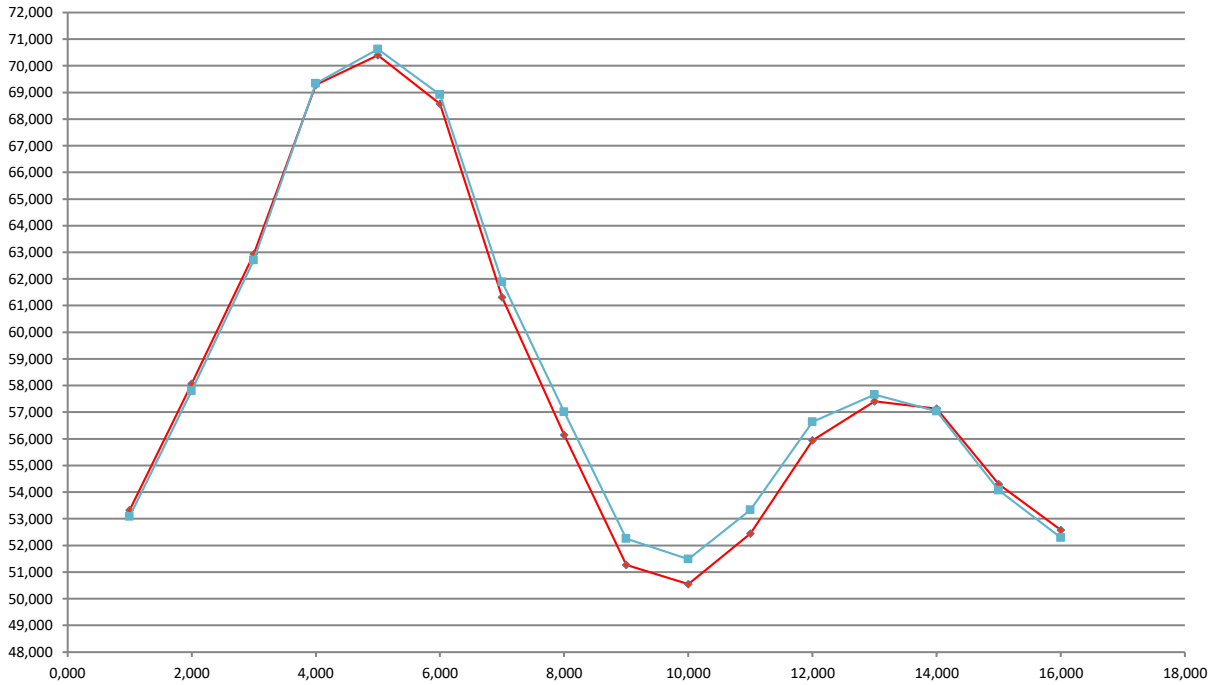
1. Application of only the steel structure's weight



2. Application of the nodal forces due to the cablenet installation

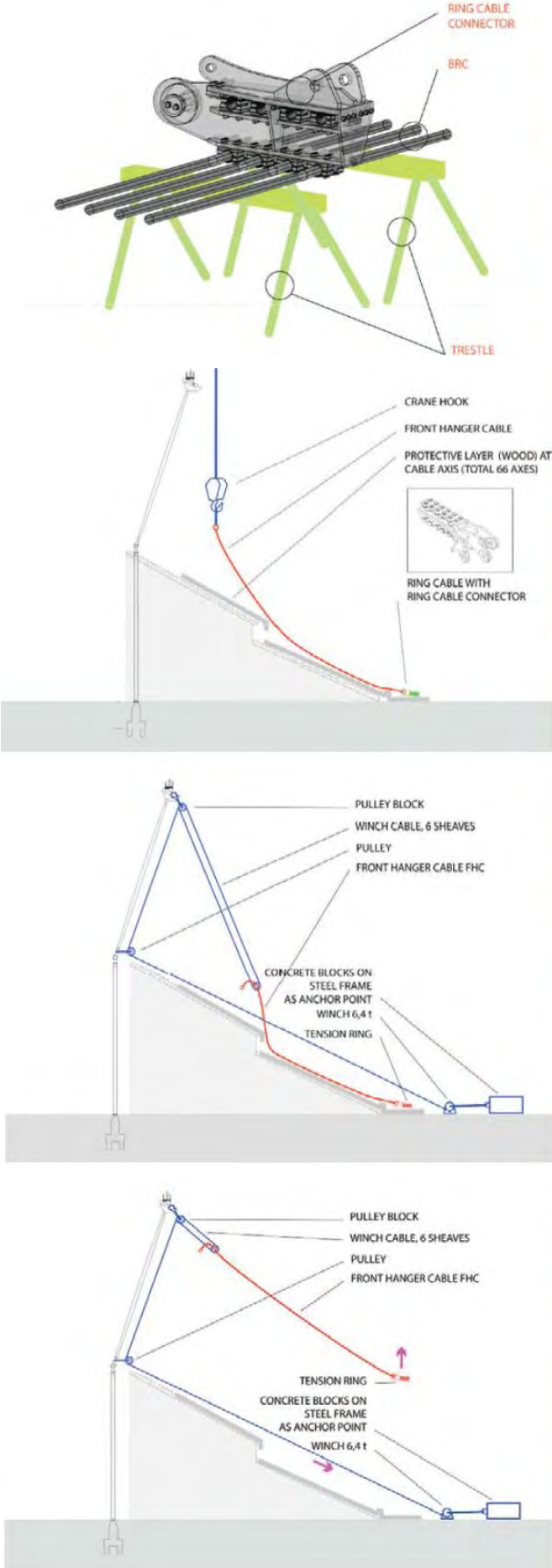


3. Introduction of cablenet and fabric with MORPH tool





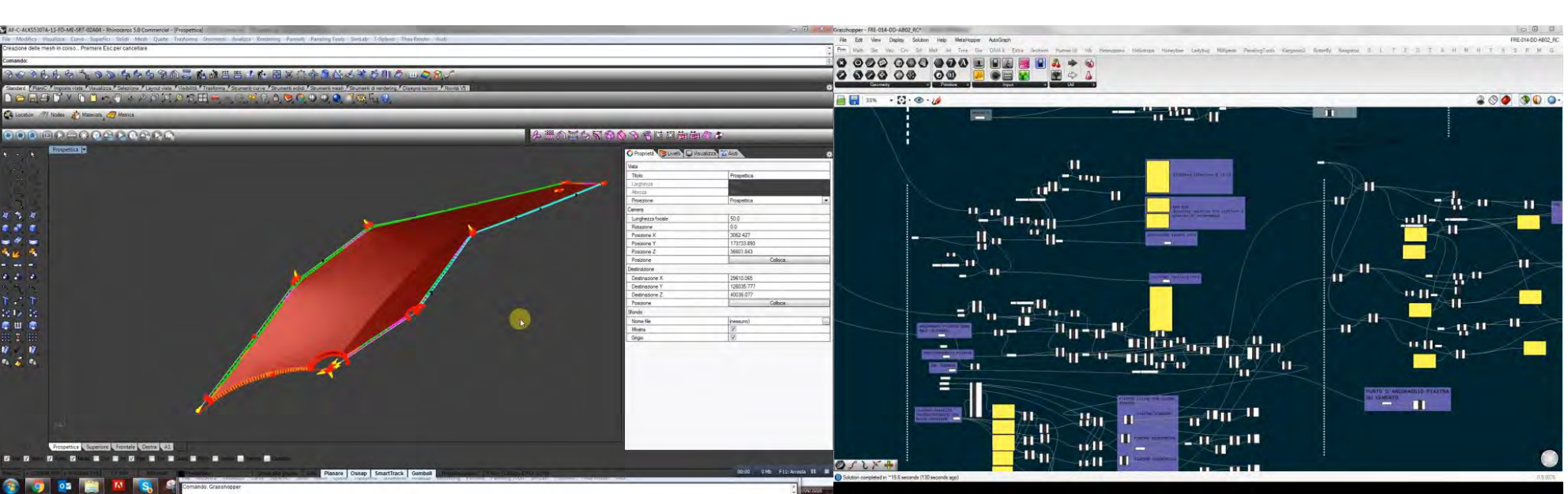
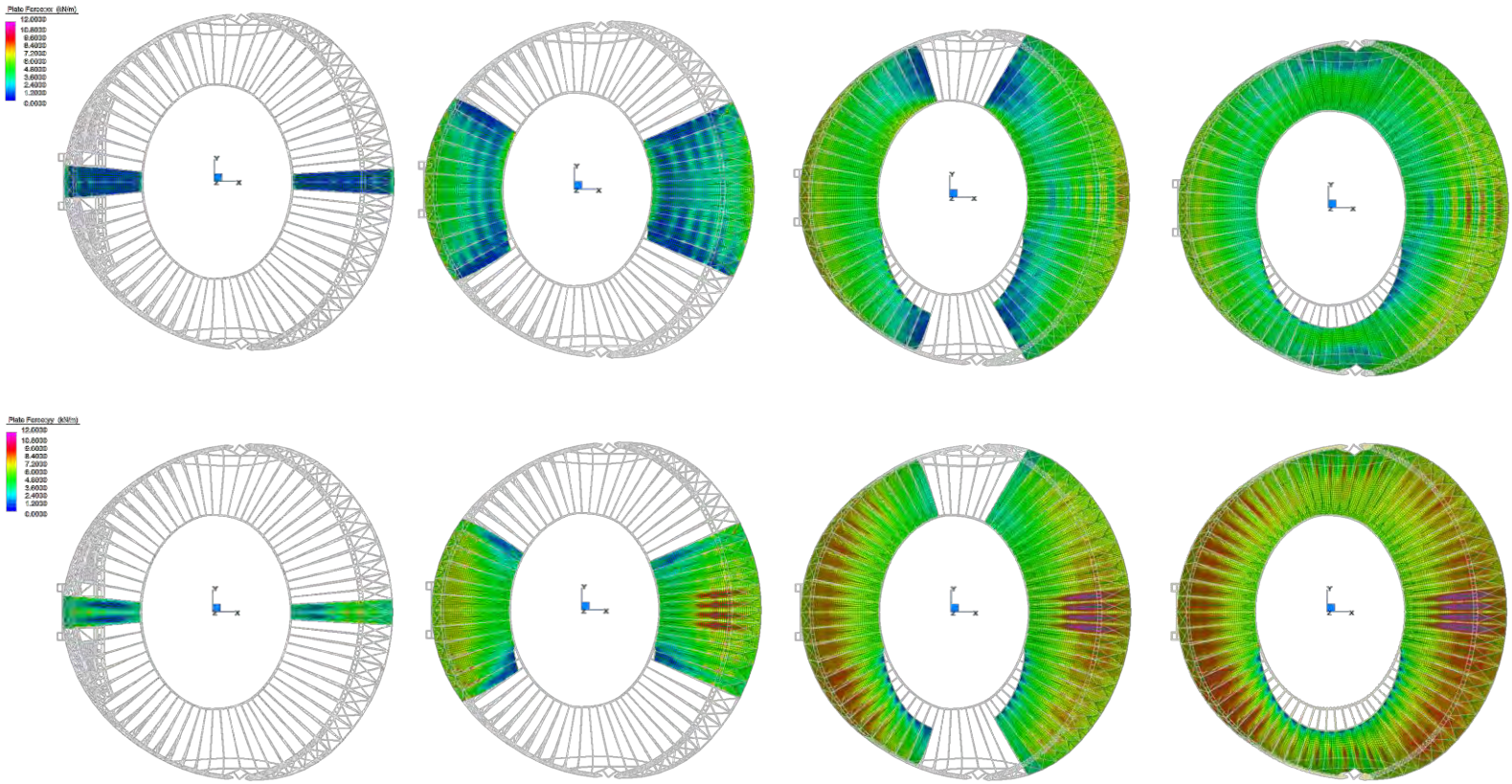
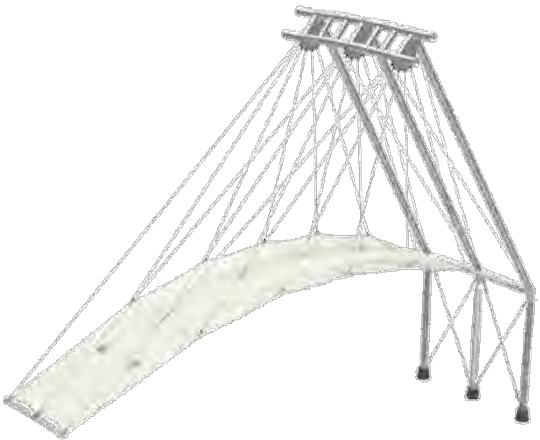
METHOD OF STATEMENT BIG LIFT





# FABRIC MEMBRANE DESIGN

A stress analysis of the fabric panels during the progressive installation phases was performed, basing on a Grasshopper script. It is clear how the stress state grows with the stabilization and tensioning of the cables and membrane system.





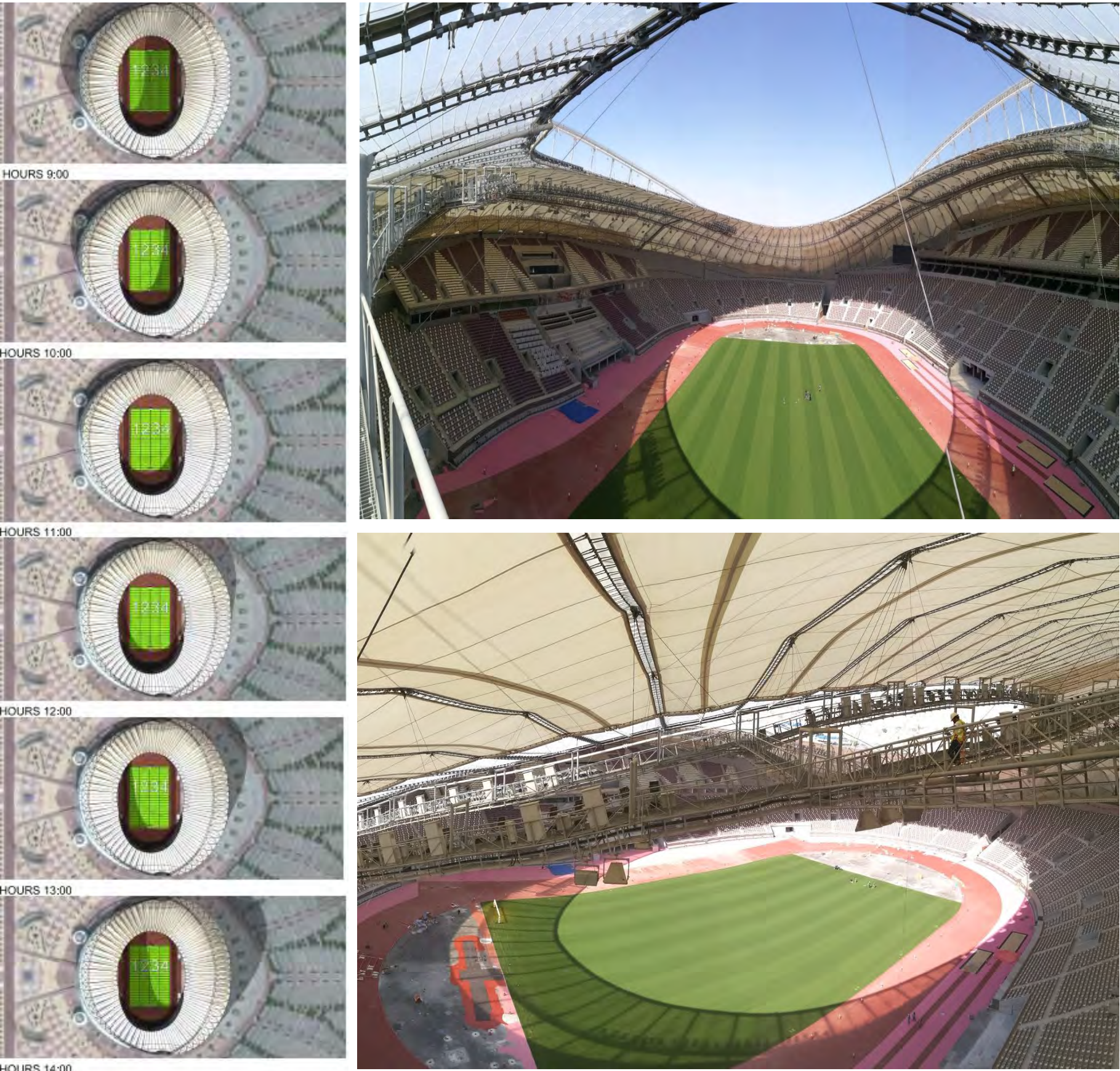
# METHOD OF STATEMENT FABRIC MEMBRANE





# METHOD OF STATEMENT ETFE MEMBRANE

After an extensive solar study was conducted, an ETFE membrane was added to the southern part of the inner roof to improve the stadium's natural lighting.





# KHALIFA BEFORE





# KHALIFA AFTER





## KHALIFA INAUGURATION

