CLIMATE ADAPTATION CONCEPT ON A STADIUM

THE NEW FEYENOORD STADIUM

Reflections

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Building Technology master track focuses on several disciplines, such as climate, façade, structural, zero-energy and computational design with the goal to design sustainable, comfortable and environmentally friendly buildings. By integrating the disciplines together, the gap between architecture and engineer is filled.

My topic focuses on climate and façade design.
In order to guarantee a comfortable indoor climate in a future warmer scenario, it is important to control all the parameters affecting the new Feyenoord stadium both at urban and building scale. Since the very beginning of my research, the envelope resulted to be the element able to affect both the stadium and its surroundings by means of smart design. In this research, sustainability is a key element. Stadiums are, indeed, big consumers and can affect also the indoor comfort and the energy demand of nearby buildings and areas.
The goal of this research is, therefore, to explore possible design strategies to make stadia adaptable to climate change and define the most effective one. In order to guarantee the required comfort to all the users and avoid health issues due to heat, the aim is to design the stadium in such a way that it will allow for temperature control, thus for a comfortable indoor micro-climate. In addition, the newly designed components aim to impact the surrounding urban context to reduce the effect of climate change, therefore reduce the urban heat island effect. By introducing adaptation measures, the stadium guarantees proper livability of users in a future warmer scenario.
The final goal is to create a model that can be replicated in terms of design approach, therefore give guidelines and suggestions on how to better exploit site potentials to deal with future climate scenario.

As previously mentioned, this research aims at guaranteeing proper livability of users while respecting the environment. If the temperature will increase due to global warming, it will be even harder to control the indoor comfort without relying on active cooling, therefore increasing the energy demand. In addition, building sector is already responsible for a high percentage of CO_2 emissions. A smart, conscious design should limit this.

Researches on climate adaptive buildings and smart buildings are today quite common, with many solutions resulting to be successful. However, in the case of stadia, a few examples exist which were built and designed to fit their context and exploit climate potentials.
In this research, the goal is not only to make the stadium climate adaptive by introducing changes to the original design, but make it by integrating passive measures in the design as much as possible when it is feasible, so that the stadium will not have to rely only on active measures, thus increasing sustainability and connection to the context.

The research and its methodology could have an effect both on the built environment and people, raising awareness on climate change. My goal is to intervene on the Feyenoord design in such a way that it could represent a remarkable example for future stadia design, so that climate change adaptability measures will be fully integrated in the sustainable design of such infrastructures. This would be an improvement in the design of stadia as nowadays they are mainly designed to be sustainable but future scenarios are not taken into account yet.

The research methodology was based on research by design and design by research through five steps: knowledge, design exploration, analysis and digital modeling, comparison and evaluation, and final design.
The first phase aimed at providing knowledge about the context, in particular climate change and related consequences, but also about possible adaptation measures and design of stadia around the world.
In the second phase, once the case study was introduced, specific measures were explored, after verification of the effect of different parameters on the case study. This represented the real first step towards the final design as outcomes of calculations set the focus of the design on some specific elements of the stadium. Next to it, simulations were performed to connect the building to its context. Whereas calculations helped understand the behaviour of the stadium under general conditions, simulations helped integrate the building, the context and the outcomes of calculations.
Therefore, the list of possible measures to integrate in the design was first narrowed down by means of calculations to get acquaint with those parameters that can influence users' comfort, namely ventilation, solar gains, and properties of the envelope, such as thermal transmittance. This method resulted to be quite effective as it allows to get the focus on the important elements that actually affect the design. Calculations outcomes, indeed, shown which parameters influence the indoor temperature the most and, by understanding this, it was possible to define design proposals. For example, ventilation is very effective, therefore openings in the façade should be designed in such a way that they allow for enough air to circulate. Or, another possible strategy is to combine operable façade roof to control ventilation inside the stadium. The performed calculations helped in the design phase with the support of digital modeling and simulations.
Whereas calculations did not properly take into account the context, the orientation or the shape of the building, simulations did. Indeed, specific softwares were used to actually check the relation between the stadium and the sun or the stadium and the wind.
Grasshopper's plug-ins Ladybug and Butterfly helped to check relatively the solar radiation on the envelope and the wind flow around and inside the stadium.
With the support of these tools, design could be developed in a coherent way, exploiting the potentials of the site.
Another software that was used to evaluate the design choices, in particular the performance of the façade was ENVI-met, which helped exploring different materials configurations and define the most efficient in terms of urban heat island effect reduction.
Design possibilities were then explored, compared and evaluated based on

their response to the previously obtained results, in order to get to the final design. Design Builder was used as supporting tool to get an idea of how indoor temperature or ventilation would vary if changes are applied to the design.

Last, the final design was developed in such a way that the stadium could adapt to the climatic conditions of the area, exploit the site potentials, and deal with a future warmer scenario.

The whole process was based on design by research and research by design. Indeed, design choices were taken and developed while exploring existing examples and analyzing the specific case study by means of calculations and simulations, whereas calculations and simulations were needed to test the different design possibilities.

Looking at the calculations performed to validate the final design, however, indoor comfort is still hard to guarantee in warm days. The temperature in the semi-outdoor space of the stadium is still likely to be warm when outside is hot. However, according to calculations, indoor temperature now follows outdoor temperature, therefore the space results to be more comfortable to users as human beings tend to adapt themselves to less favorable conditions.
Although the measures might not be as effective as hoped, the whole design can still represent a model for future development of stadia. The goal, indeed, was to create guidelines for the design approach of stadia to make them adaptable to their climate and, especially, future warmer climate.

The followed method, in this context, also shows some drawbacks. As the project is neither built nor finalized, many elements are not defined yet. In particular, the materials choice is still vague, thus not allowing for precise building physics calculations. In fact, many values used for calculations are estimated, based on similar or common cases. In addition, the fact that the project is not finalized yet, makes the communication about my design proposals and calculations very hard.
Not having detailed information on the building elements, such as the material properties, also led to an impossibility in verifying the actual performance of the final stadium design by means of digital simulation. Indeed, for example, a temperatures map could have not been done as the missing information would have, probably, given unrealistic results.
Next to it, an adaptive thermal comfort model does not exist for semi-outdoor spaces, therefore I should rely on the one for indoor comfort conditions, which is more strict in terms of temperature range to be achieved for comfort and represents a quite different scenario.