EVALUATION OF THE PERFORMANCE OF A DYNAMIC FACADE USING THE PARAMETRIC TOOL

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1-Introduction

Energy consumption in the building sector in Algeria accounts for 41% of final consumption. In order to reduce this consumption, particular attention must be paid to the building envelope. Building envelope is defined as the interface between the outdoor and indoor environment and thus allows to control the quality of the indoor conditions, important for the occupants comfort. It has a filter role that makes it possible to manage exchanges and limit energy losses. Dynamic facades are an efficient and innovative solution to manage these exchanges.

In order to evaluate the performance of this type of facade under a Mediterranean climate, a parametric approach based on numerical simulations using Rhinoceros 6/Grasshopper and ArhiWIZARD 2021 software is undertaken for an experimental box under climatic conditions of Annaba city, situated in north-East of Algeria. The solar radiations and the cooling needs of the experimental box are calculated for a typical summer day (21 July).

The results confirmed the high performance of the dynamic facades to improve energy efficiency and reduce solar radiations during this period.

2-Methodology and tools

A parametric study of a dynamic façade is undertaken using Rhinoceros 6- Grasshopper parametric design software and Archiwizard 2021 software.

-**Rhinoceros 3D** is one of the most popular 3D modeling software, its success lies in the fact that there is no limit to the complexity or size of the drawings.

-**Grasshopper** is an extension of Rhinoceros 3D that allows to create parametric models through visual programming on Rhinoceros 3D.

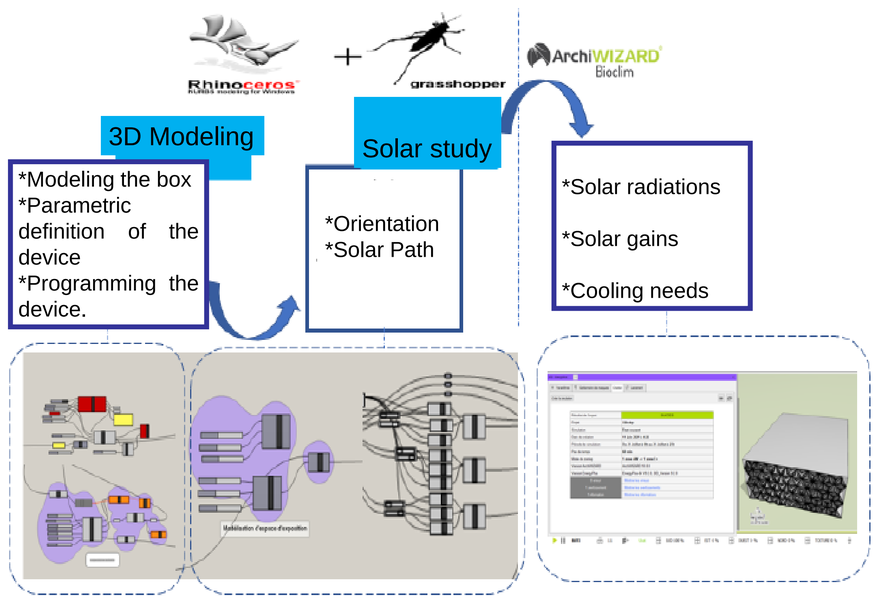
-**Archiwizard** is a building energy simulation software that allows to simulate and demonstrate the energy performance of an architectural project in a 3D environment in direct connection with the digital model.

-Aims of study:

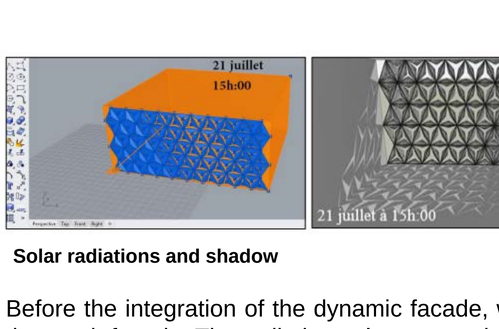
-Parametric definition of a geometric model of a dynamic façade that opens and closes in response to the change of solar radiation during a typical day in the summer period under the climatic conditions of Annaba city.

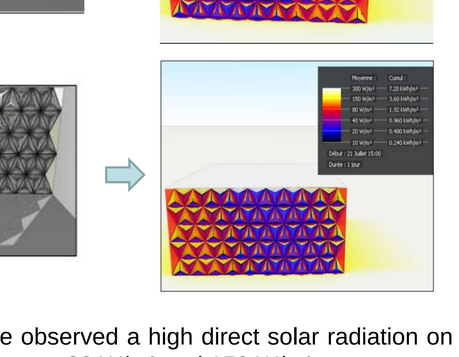
- Evaluate the incident solar radiation on the south dynamic façade and the response of the adaptive module.

-Compare the solar gains and cooling needs of the dynamic façade to a traditional façade during the summer period.

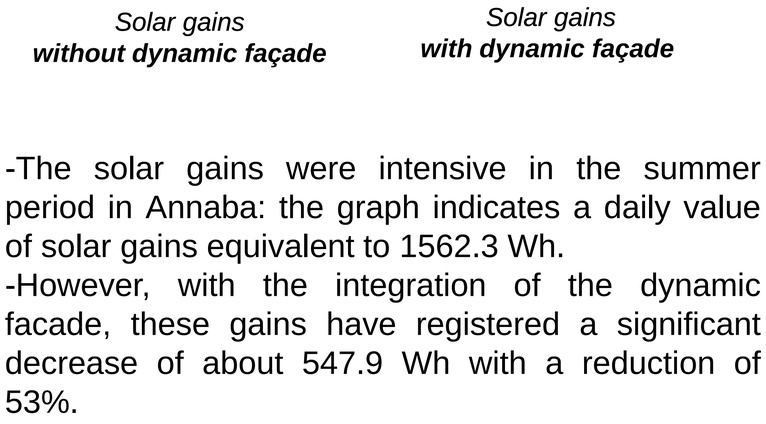


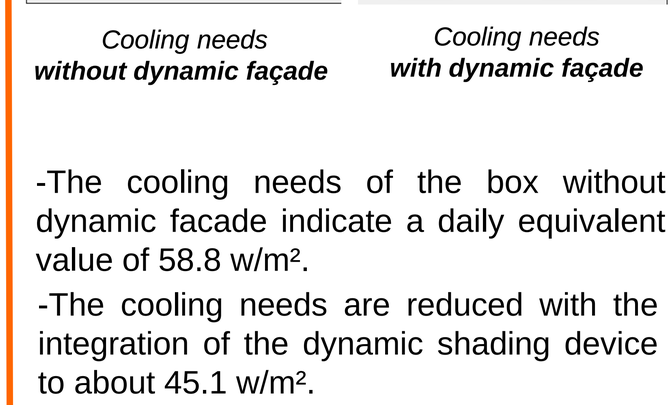
Experimental Box:
10m x 10m x 4m
(in Rhinoceros).





Steps of simulation





General Algorithm in **Grasshopper**

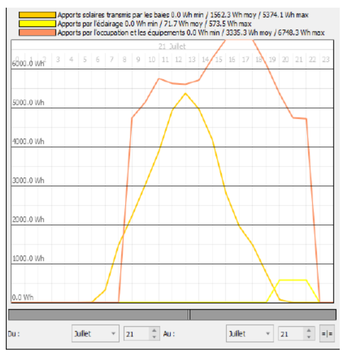
3-Results and Discussion

Solar radiations and shadow

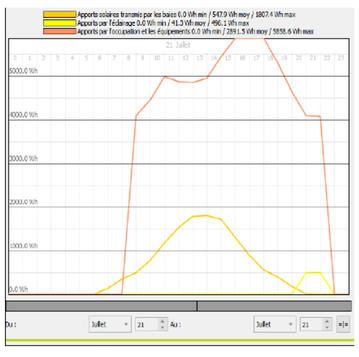
Before the integration of the dynamic facade, we observed a high direct solar radiation on the south facade. The radiation values range between 80 W/m² and 150 W/m².

These excessive radiation values have decreased remarkably with the dynamic protection of about 20 to 40 W/m². This corresponds to a decrease of 27% of direct solar radiation, which proves the effectiveness of the dynamic screen under the climate of Annaba.

Solar gains



Solar gains ***without dynamic façade***



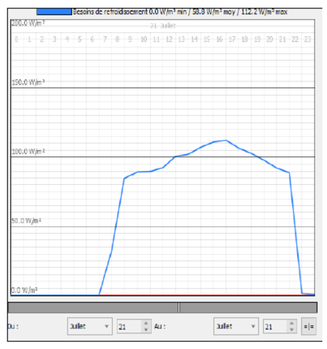
Solar gains ***with dynamic façade***

-The solar gains were intensive in the summer period in Annaba: the graph indicates a daily value of solar gains equivalent to 1562.3 Wh.

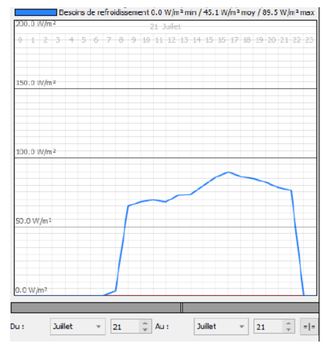
-However, with the integration of the dynamic facade, these gains have registered a significant decrease of about 547.9 Wh with a reduction of 53%.

-The use of dynamic facade has reduce a large proportion of direct solar gains.

Energy consumption (summer period)



Cooling needs ***without dynamic façade***



Cooling needs ***with dynamic façade***

-The cooling needs of the box without dynamic facade indicate a daily equivalent value of 58.8 w/m².

-The cooling needs are reduced with the integration of the dynamic shading device to about 45.1 w/m².

-The energy consumption with dynamic facade is therefore 23% lower than without dynamic facade.

4-Conclusion

The results of the simulations presented in this study show that dynamic facades can be considered as a very efficient solar protection and cooling process.

Indeed, the integration of a dynamic facade was able to decrease the direct solar radiation by 27% with a significant reduction of solar gain of about 53% and cooling needs of 23%.

Through this research, we have confirmed that the dynamic façade is a perfect tool for energy efficiency.