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ZERO-ENERGY-AND-EMISSION-BUILDING-LABORATORY QATAR

Experimental Study on Building Envelopes under outdoor exposure

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1. Introduction

Intelligent building envelopes can significantly reduce the environmental impact of our buildings during their life cycle.
Intelligent means that user comfort is reached through subtle use of façade properties to manage indoor climate (temperature, air quality, humidity and light) in the most energy-efficient way while involving outdoor conditions.
The **ZERO ENERGY AND EMISSION BUILDING LABORATORY** of SAPA Building Systems has been set up at Qatalum, Mesaieed in the end of 2012, to do research that will help reduce the energy consumption and improve the energy efficiency of buildings.

Figure 1:
ZERO ENERGY AND EMISSION BUILDING LABORATORY, Qatar

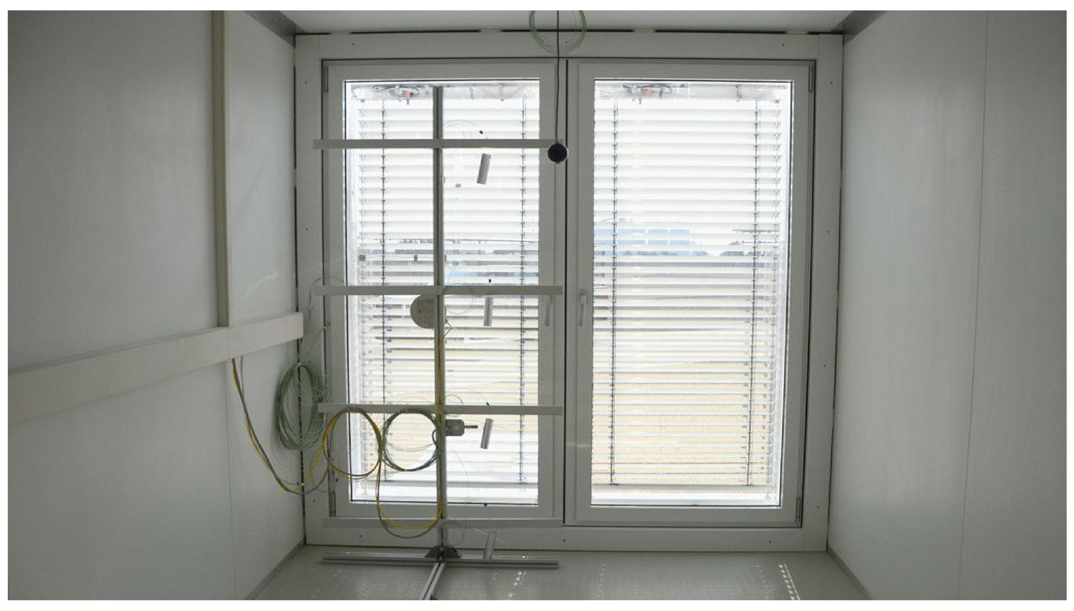

Figure 2:
Interior view of one test room with an installed façade

2. Objectives

The target of the measurement is analyzing the energetic efficiency of four different types of façades using calorimetric measurements to compare the energetic behaviour of different types of building envelopes from standard curtain walls to high insulated ones with motorized venetian blinds passing through dynamic double skin windows, in hot climate countries.

Smart building technology is aiming to keep the building services as basic and user-friendly as possible without compromising energy efficiency and minimize environmental impact at the same time. This is achieved through active control of the building envelope, adapting it to the constantly changing outdoor conditions. This approach not only fits to new buildings, but can be implemented on existing building stock as well as in the context of a renovation/refurbishment project.

3. Methods

The measurements were done in the ZERO ENERGY AND EMISSION BUILDING LABORATORY, Qatar.
The Laboratory consists of two independently operated containers and a detached chiller station.
Each of the containers comprises two test chambers representing a single office room. Each office room has an open front surface that allows the installation of different types of building envelopes, it can also be individually cooled, artificially lighted and mechanically or naturally ventilated.

Calorimetric measurements were done on four types of building envelopes at a room temperature of 20 °C:

1. **Reference** is a **Structural-Sealant-Glazing-Façade** (SSG) with insulating double glazing (U_{cw} = 1,4; g-value = 0.16). A motorized external venetian blind can be activated in addition.
2. SSG façade identical to the reference façade, fitted with a fixed external Brise-Soleil made up of aluminum blades (U_{cw} = 1,4; g-value = 0.16).
3. High insulation stick façade with triple glazing and motorized venetian blind in the glazing interspace (U_{cw} = 0,9; g-value = 0.15).
4. Box-type window with turn/tilt sash inside and parallel outward sash outside with a venetian blind fitted in between (U_{cw} = 1,2; g-value = 0.15).

Figure 3 represents the cooling energy consumption versus time and temperature for a single test room for one day. Similar analysis graphs such as this one were used to calculate the average energy consumption obtained in figure 4.

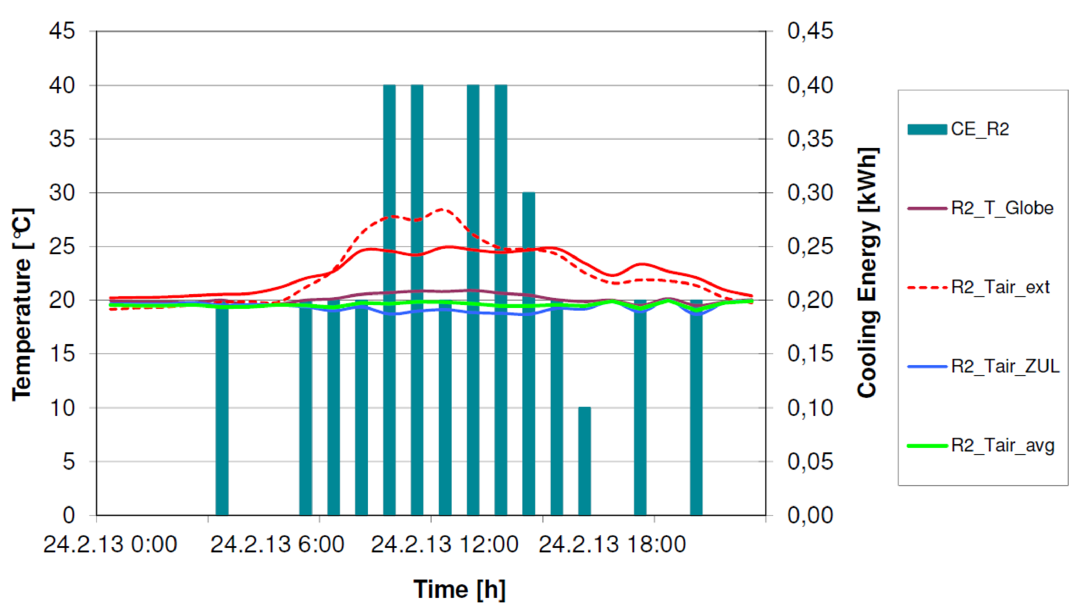

Figure 3:
Cooling energy required on daily basis for one test chamber, where:

CE_R2:	Cooling energy consumption [kWh]
R2_T_Globe:	Globe room temperature [°C]
R2_Tair_ext:	Outside air temperature [°C]
R2_Tair_ZUL:	Supply air temperature (AC) [°C]
R2_Tair_avg:	Room air temperature [°C]

Following energy consumption was obtained for each of the four façades in different conditions:

1. Reference SSG-Façade, no shading
2. Reference SSG-Façade, Venetian Blind 45°
3. Reference SSG-Façade, fixed blades
4. High insulation Façade, no shading
5. High insulation Façade, Venetian Blind 45°
6. Box-type window, no shading
7. Box-type window, Venetian Blind 45°

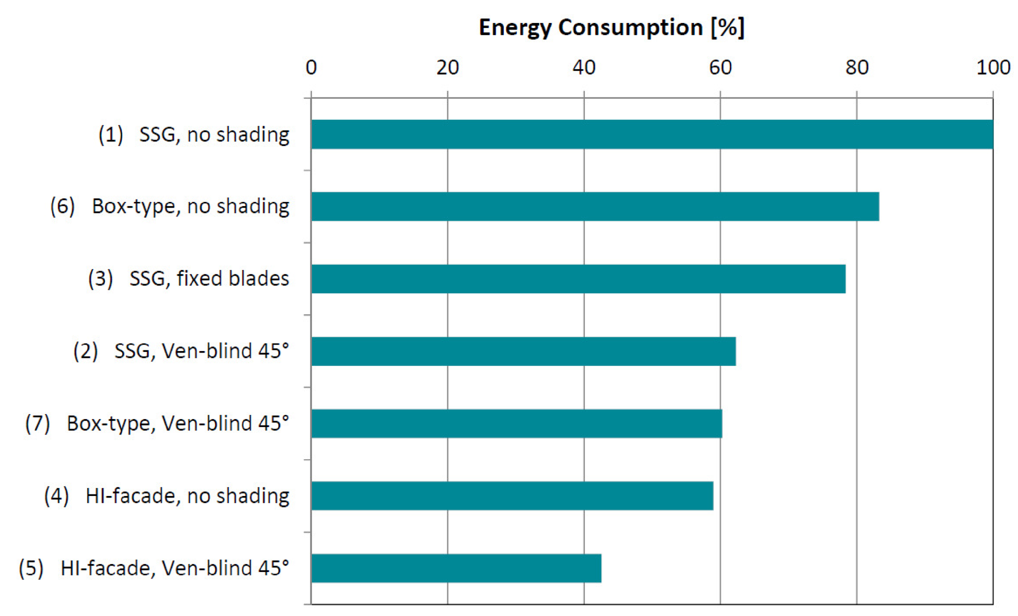

Figure 4:
Energy consumption of different types of building envelopes in comparison with the reference façade (1).

4. Result

The results can be summarized into the following:

- An external venetian blind offers potential savings of approximately 38% (2).
- A fixed brise-soleil (blades) reduces the cooling energy requirements by approximately 22% (3).
- Replacing a standard stick façade with double insulating glass by a high insulation façade with triple glazing the cooling energy consumption can be reduced by 40% (4).
- A glazing integrated sun shading system combined with the high insulating stick façade, cooling energy consumption can be reduce by more than 57% (5).
- A double skin box-type window solution cuts the energy consumption for cooling by 16% (6), with sun protection in the interspace by 40% (7).

Nowadays, global design parameters for windows and façades in Middle Eastern Countries show little insulation values.
On the basis of a comprehensive range of measurements, the results show a clear picture:
"**Windows and façades with high insulated frames are energy efficient in warm climates despite the fact that it is warm all year round.**"

5. Discussion

The measurements show that thermal insulated frames can lower the consumption of cooling energy, especially when using solar shading devices that are appropriately designed for countries with sandy winds.

Future studies will focus on very important topics such as the reduction of cooling energy by using natural night cooling and its effect on the comfort level in the room.
Another topic is the production of energy using PV and solar thermal elements.