Design Project - SIE 2014

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Analysis of cooling strategies for a medical warehouse in Juba

Operating in conflict zones, the ICRC relies heavily on logistics to provide assistance to people affected by war. A key component of this logistics network relies on the local storage of the relief equipment in facilities like “Medical store 2”, a medical warehouse in Juba, South Sudan, where it faces extreme meteorological conditions such as high temperatures and relative humidity.
This project will focus on studying applicable structural solutions for “Medical store 2” and evaluating its cooling energy requirements.

Objectives

- Maintaining internal temperatures below 30ºC at all times in Medical store 2.
- Evaluation of energy requirements for air conditioning.
- Elaboration of a best performance scenario

Figure 1: Situation of Medical store 2. Source: Google Earth

Figure 2: Exterior and interior view of Medical store 2. Source: ICRC

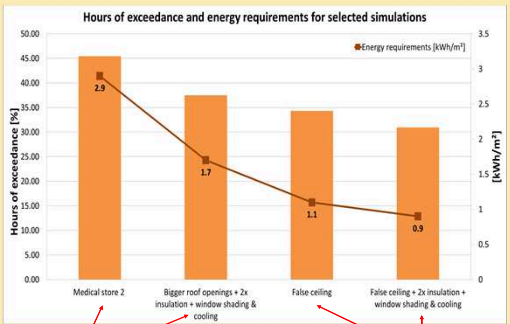
Methodology

- Simulation of different scenarios for Medical store 2 using the Dial+ software over a warm period of the year (April 11th to May 1st).
- Analysis of the scenarios to find easily applicable and energy efficient solutions for Medical store 2.

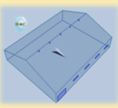
MEASURED EXTERIOR TEMPERATURE →
- SOLAR GAINS
- THERMAL MASS (MATERIALS AND INSULATION)
- SHADING AND COOLING STRATEGIES

→ SIMULATED INTERIOR TEMPERATURE

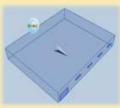
Figure 3: Percent of hours above 30ºC over the study period and energy requirements to achieve objective with air conditioning.



Medical store 2 model



False ceiling model



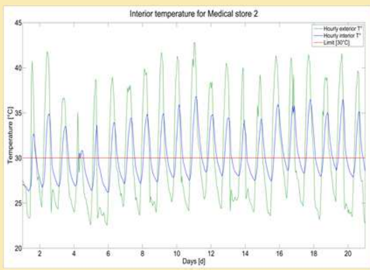


Figure 4: Simulation of the situation in Juba.

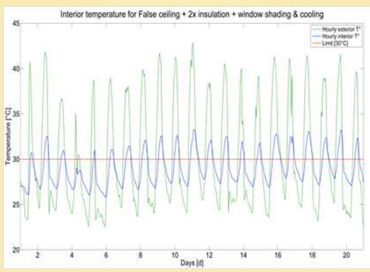


Figure 5: Simulation of best scenario for Medical store 2 with false ceiling.

Results

Medical store 2 model:

- **Simulation of the situation in Juba**

Starting point of the analysis. Figure 4 shows the external temperature measured in the field and the simulated internal temperature. Daily exterior and interior temperature vary between 23 and 43°C and 26 and 37°C respectively which coincides with the day and night cycle.

- **Best scenario for Medical store 2**

This simulation aims to lessen solar gain by increasing insulation and mimicking shutter protection. At night, the warehouse benefits from natural cooling by using windows and roof openings as heat sinks. The roof openings were enlarged to improve nighttime airflow.

False ceiling model:

- **Simulation adding a false ceiling**

The false ceiling is designed to reduce the heat transfer from direct radiation on the roof and the volume of air to cool. This was done by using a 4m high rectangular structure and lowering the roof outer absorption coefficient from 0.6 to 0.1.

- **Best scenario for Medical store 2 with false ceiling**

The final simulation combines the false ceiling structure and the temperature control strategies described in «Best combination for Medical store 2», but without any roof openings. This combination decreases the number of exceeding hours by 32% and the cooling energy required by 69%. (See Figure 5).

Conclusion

The study has shown that relatively simple adjustments, such as daytime solar protection, nighttime ventilation, increased insulation and simple structural changes, can significantly reduce the inside temperature and the energy required to maintain it under 30°C.