

CONTAINER MODULAR SYSTEM

SOCIAL HOUSING IN RIO DE JANEIRO



Container

Modular System

for social housing in

Rio de Janeiro

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The goal of my project is to provide comfort using container units in combination with traditional brick construction for social housing in Brazil, Rio de Janeiro.

The challenge of this study includes proving that cooling in tropical countries can be fulfilled using a variety of passive strategies, questioning the typical approach for air conditioned spaces and its relevance when it comes to adaptive comfort.

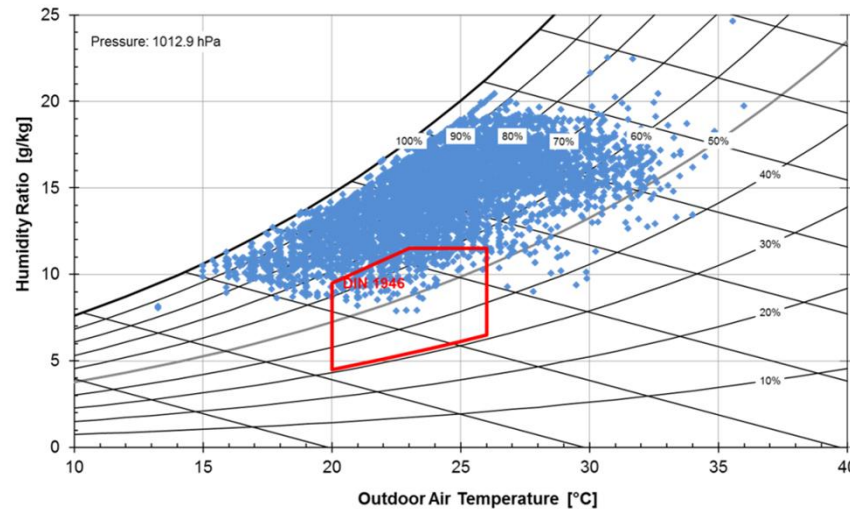
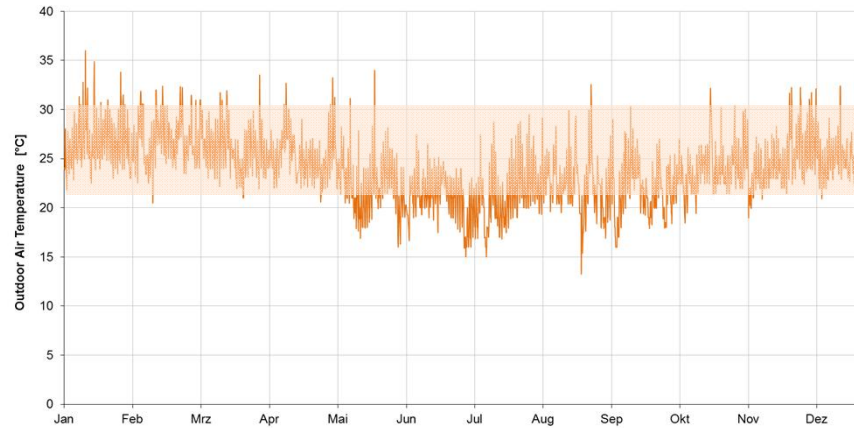
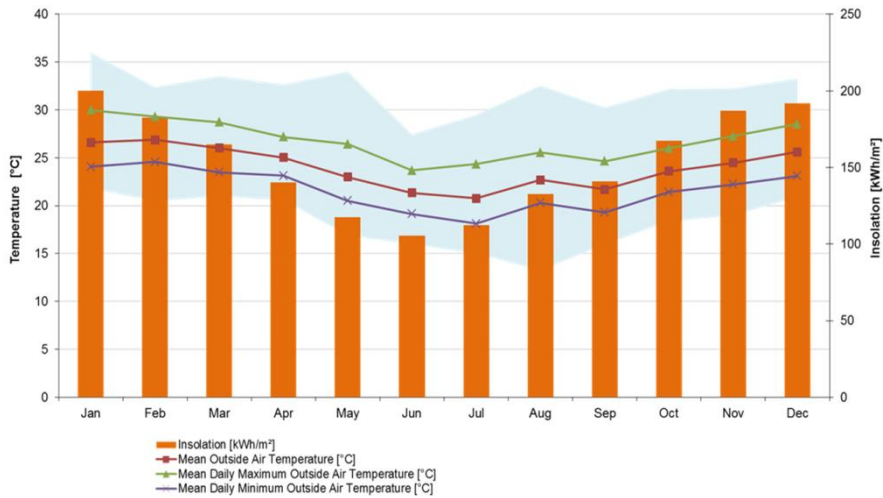


In the city of **Rio de Janeiro**, 22% of the population lives in **FAVELAS**.

This term represents informal settlements in **Brazil**. Favelas are located in areas occupied irregularly on the hillsides, the banks or streams, rivers etc. The houses are built of wood or brick, many with more than one floor and no spacing between each other, creating a densely populated area.

RIO DE JANEIRO CLIMATE OVERVIEW

TEMPERATURES



Rio de Janeiro is

located on the South

Hemisphere.

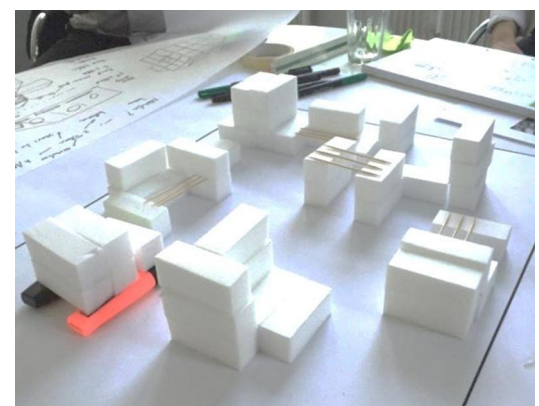
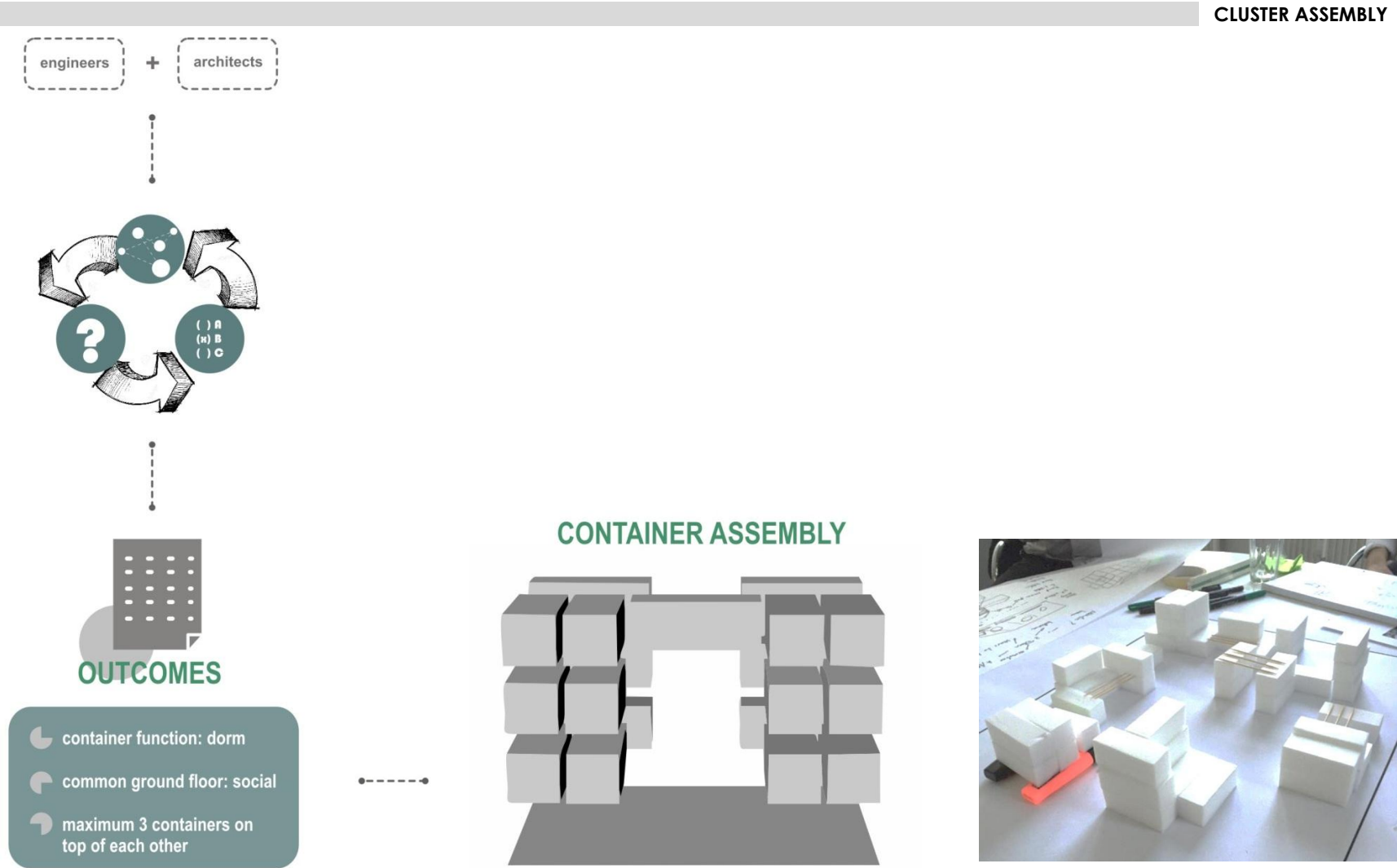
Characterized as **HOT** and
HUMID, semi tropical
climate.

Temperatures varying
between 16 to 37 degrees
Celsius.

No heating
required.

- South hemisphere
- Hot and humid climate
- **24°C yearly average**
- No heating requirement

MODEL



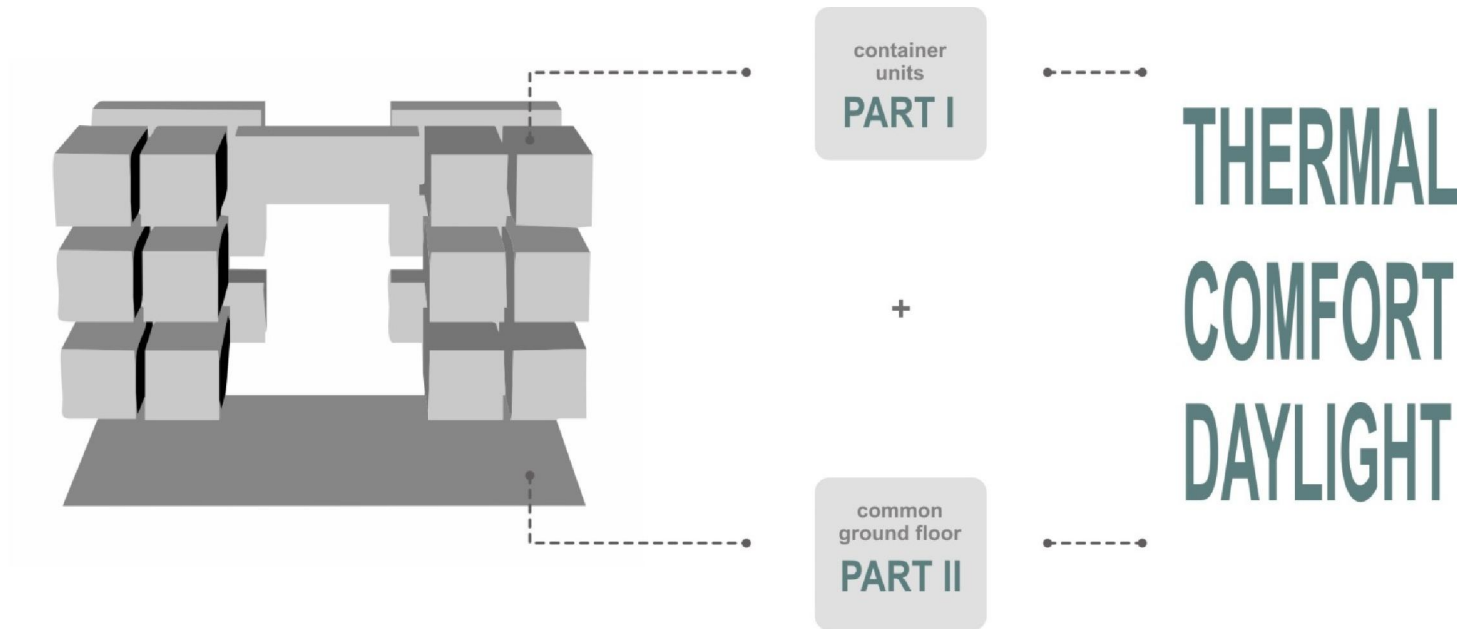
Brazilian experiences have shown great progress in slums upgrading.

To carry out this change, engineers and architects worked together to shape a creative and responsible container assembly.

The main drivers were: containers being used just as dorms units; common space for social interaction; maximum 3 containers on top of each other.

MODEL

ANALYSIS



The analysis process

was divided into:

CONTAINER UNIT

and **COMMON**

GROUND FLOOR.

For each of them the

daylight condition,

thermal

performance and

comfort levels were

set as main parameters to

be optimized reaching

standard acceptable rates.

NO AC UNITS. IS IT POSSIBLE?

CONTAINER UNIT

PART I



cross
ventilation

+



fans
0.1 - 1.2 m/s

+



80% ext
shading

+



3 persons
0.5 clothing
factor

+

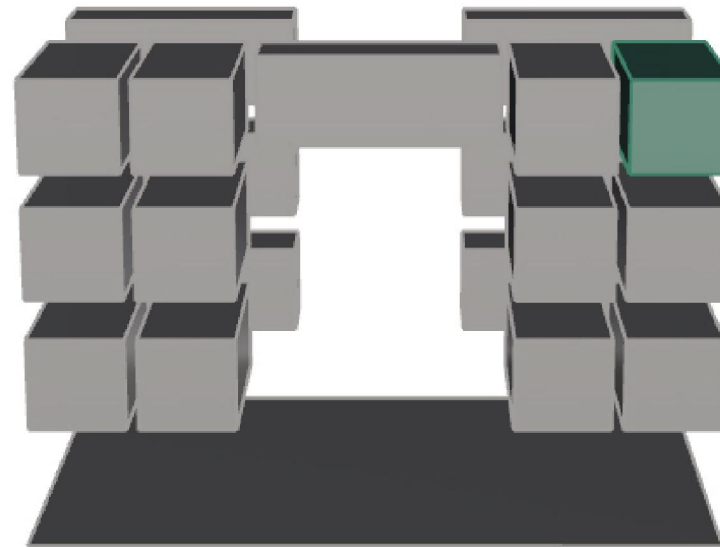


base case

+



10pm - 8am



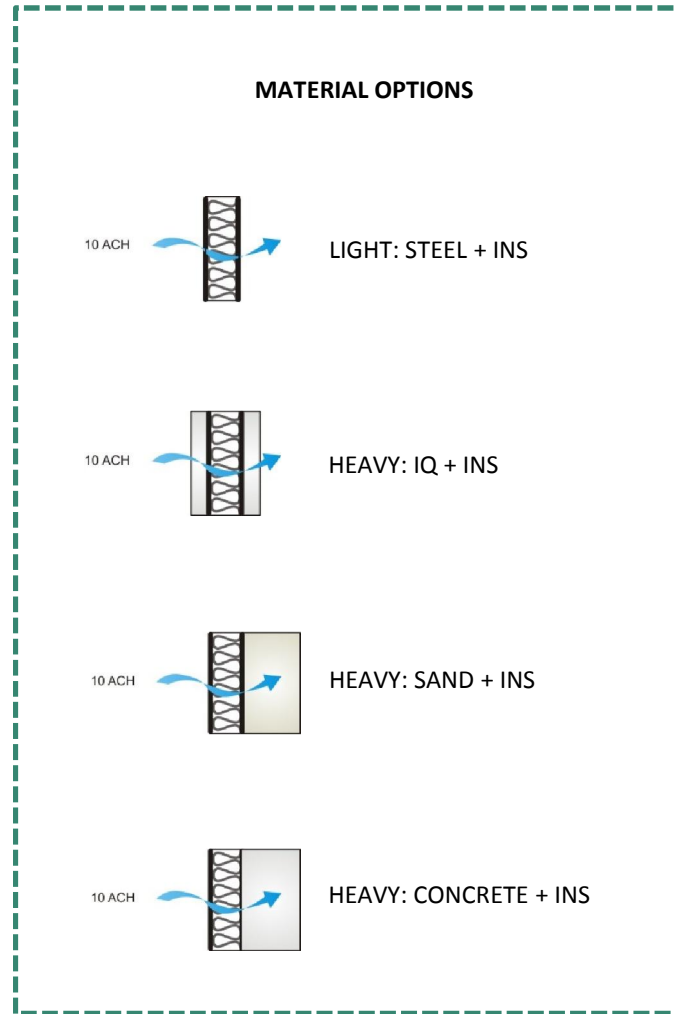
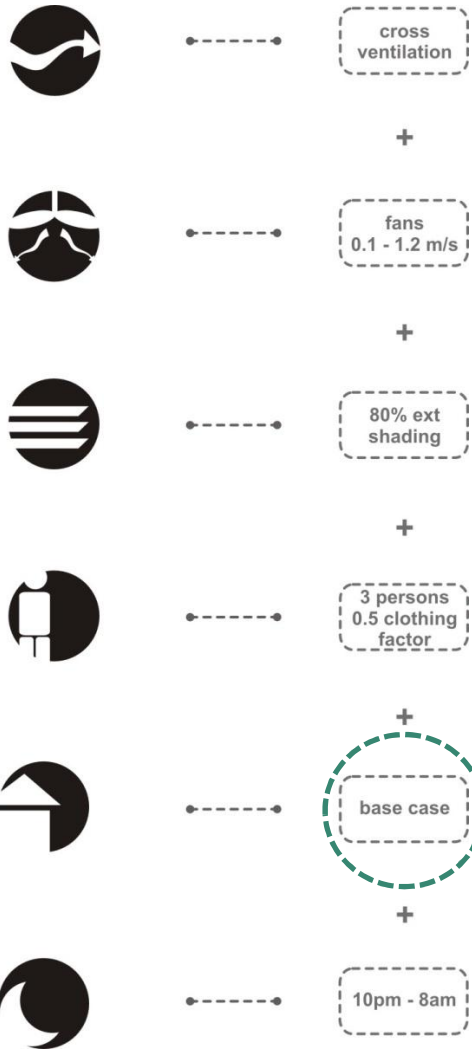
According to the composition of containers and location of the project, the **NORTH WEST CORNER** was considered the worst case scenarios for future analysis.

The units are equipped according to the description.

For the container unit, the night schedule was chosen.

CONTAINER UNIT

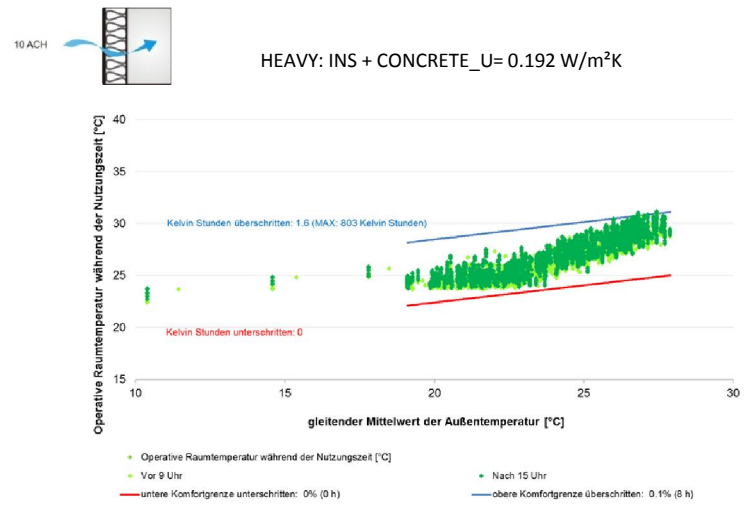
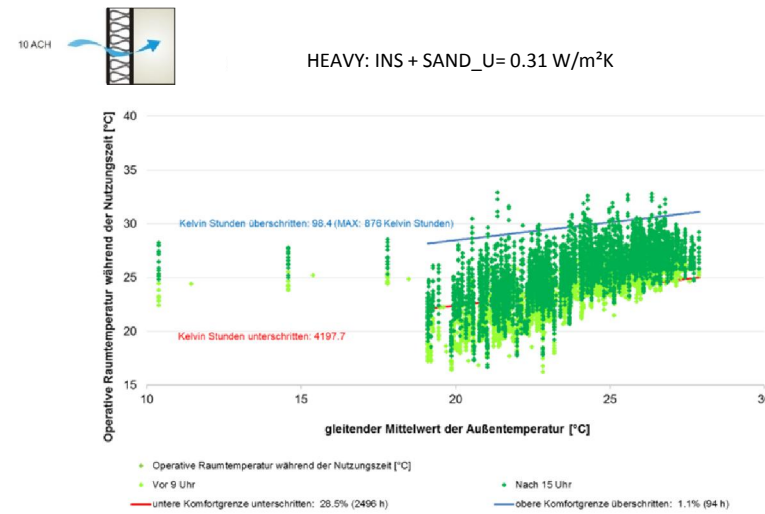
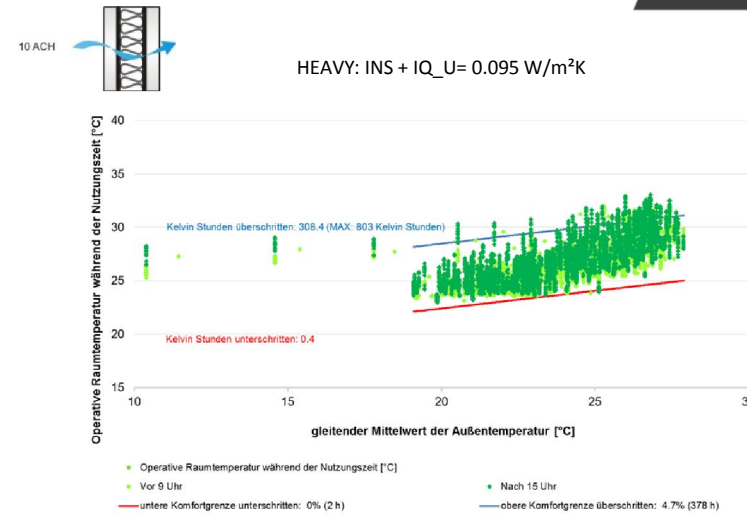
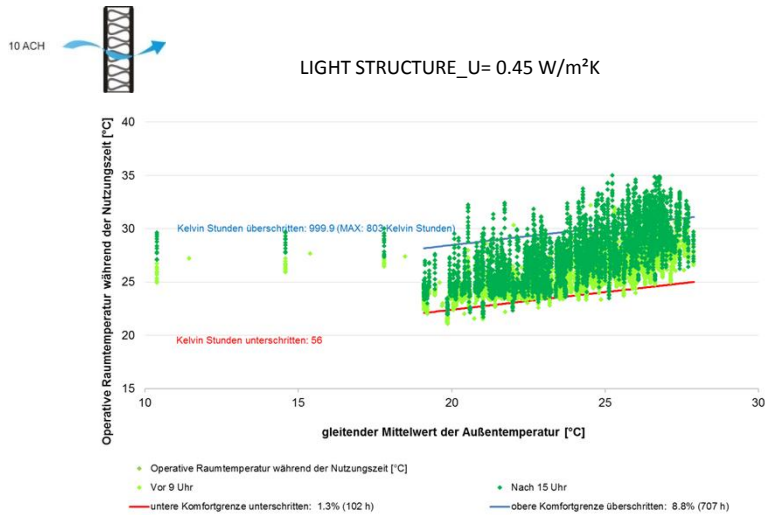
PART I



Besides the base case, steel
+ 4cm polyurethane,
three other envelope
compositions were
proposed at this point:

- 20 cm of sand + insulation;
- 3cm insulation + silicatum
magnesium + insulation;
- and 20cm concrete +
insulation.

CONTAINER UNIT

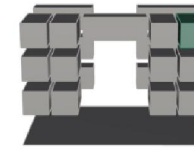


The last three material options listed above can take advantage of thermal mass effect.

In building passive design, thermal mass moderates internal temperatures by averaging out day and night extremes, as it can be seen at the graphs.

But both constructions methods performed well, with HEAVYWEIGHT PERFORMING BETTER than lightweight buildings.

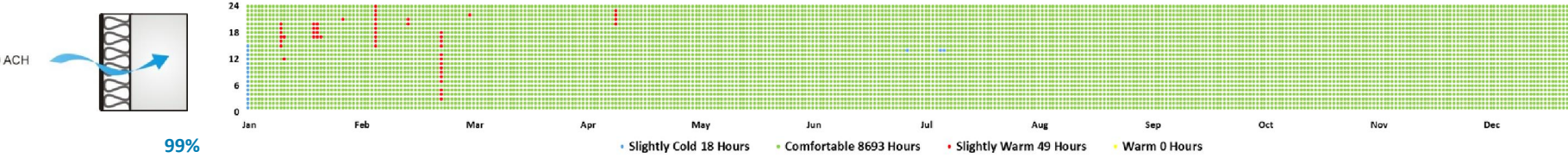
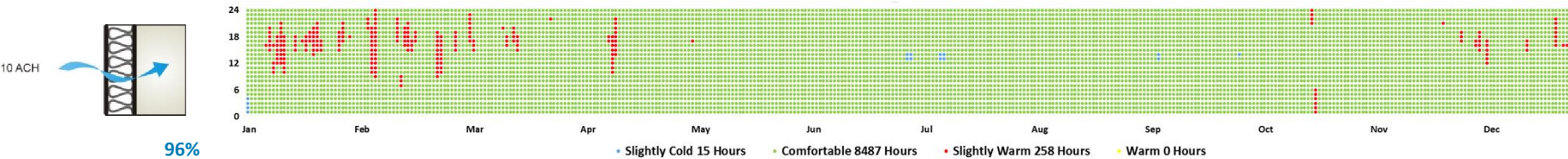
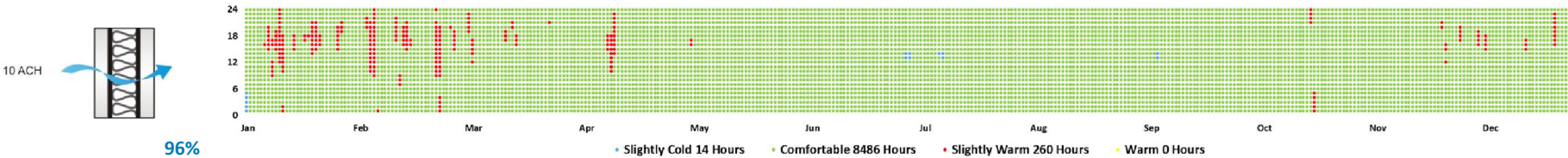
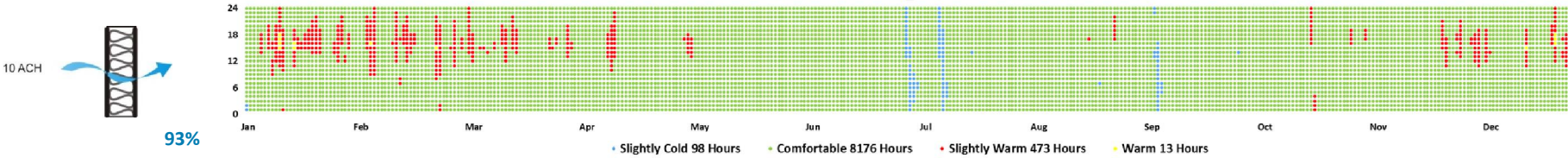
CONTAINER UNIT



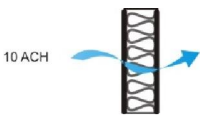
The model used for the comfort analysis is the adaptive PMV, taking into account the effect of air speed velocity, from 0.1 to 1.2 m/s, in the human body.

The graphs reveal the quality and quantity for PMV results throughout the year.

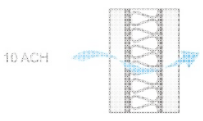
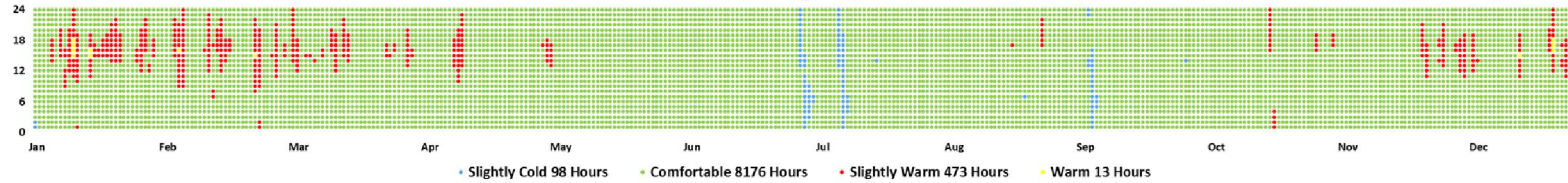
All four types of envelope proposed offer high level of comfort: >90%.



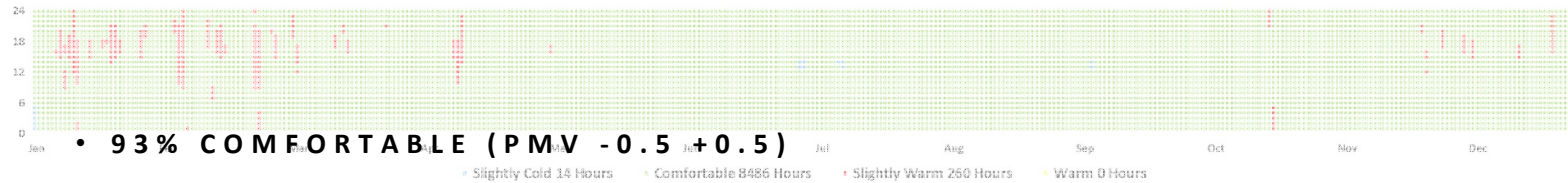
CONTAINER UNIT



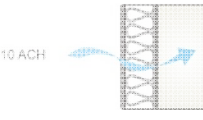
93%



96%



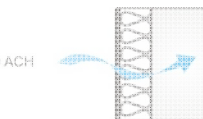
- 93% COMFORTABLE (PMV -0.5 to +0.5)
- COMPROMISES LESS INTERNAL AREA (~ 0.05m wall thickness)



96%



- 517 HOURS LESS COMFORTABLE THAN THE BEST OPTION (HEAVY)
- ALREADY KNOW TECHNOLOGY AND MATERIALS



99%



- MAINLY OCCUPIED DURING COOLER HOURS OF THE DAY

For this particular study, the choice of materials was made based on the counterbalance between thermal performance, comfort levels and affordability.



SECOND PART of this

research consists on the

analysis of the **common**

ground floor of the

container assembly.

During design process this

area was assigned to

provide the dwellers quality

space for socializing and

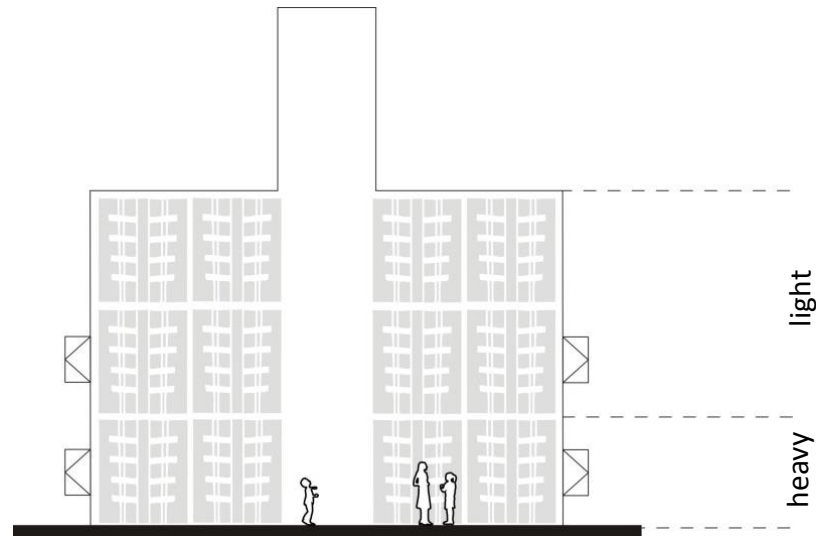
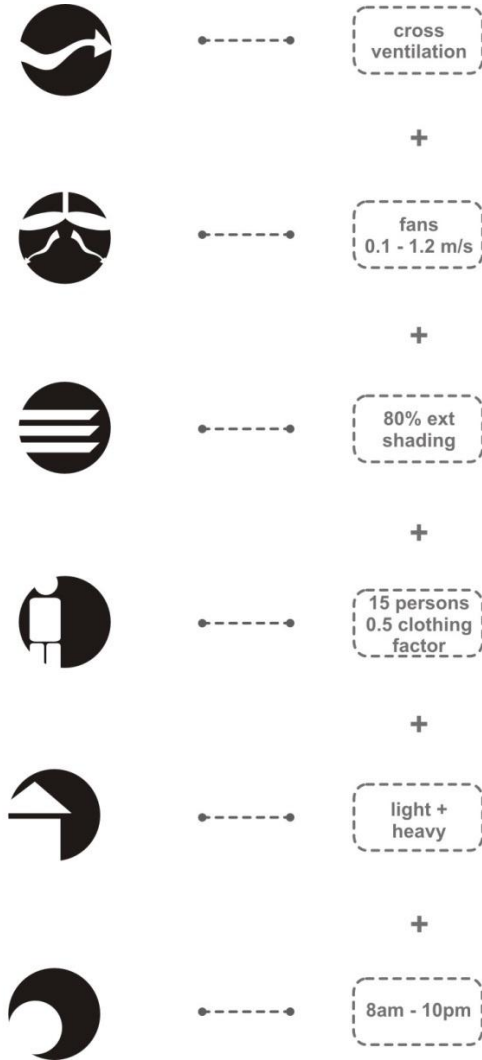
interaction reassuring the

community culture inside

favelas,

COMMON GROUND FLOOR

PART II

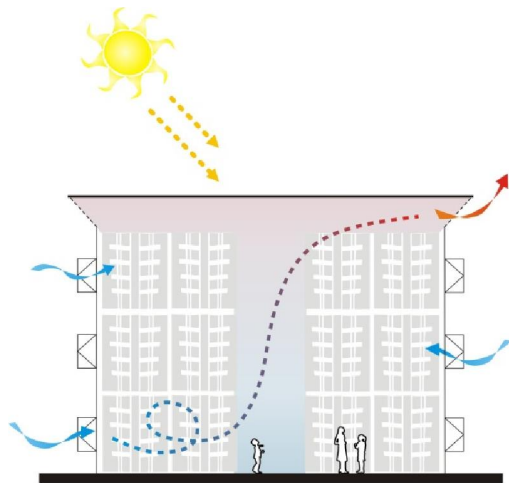


As demonstrated with the container unit, finding the right approach is a process of adjusting variants and compensating pros and cons from the chosen option.

For this second analysis the number of people increased to 15; the schedule changed from night to day; and a mixed used of material was proposed: brick heavy walls on the ground floor and light construction to the rest of floors.

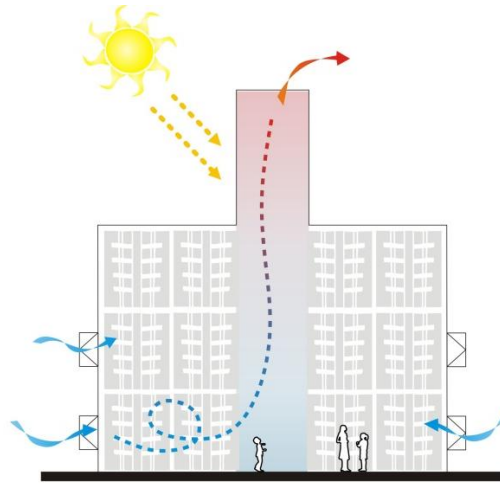
COMMON GROUND FLOOR

PART II



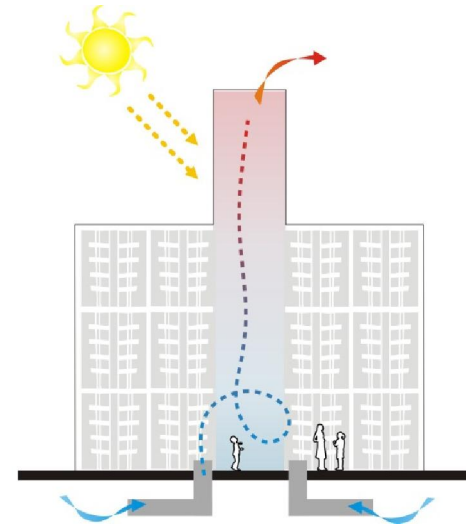
1

NATURAL VENTILATED



2

SOLAR CHIMNEY



3

EARTH DUCT + SOLAR CHIMNEY

The idea of this stage of the analysis is to study affordable and passive solutions for the common ground space.

FULLY NATURAL VENTILATED building is assessed in the first analysis.

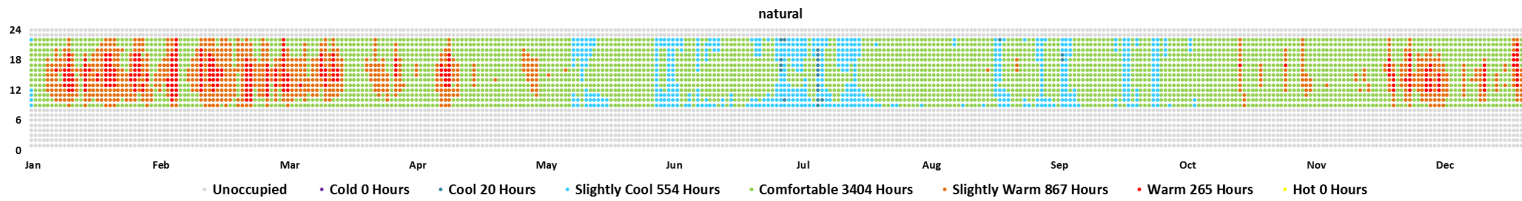
The second analysis introduces the SOLAR CHIMNEY into the assembly.

The third option targets the performance of EARTH DUCTS.

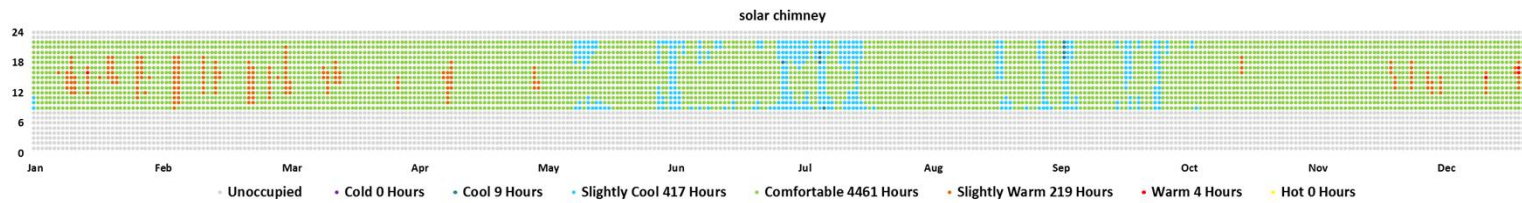
COMMON GROUND FLOOR

PART II

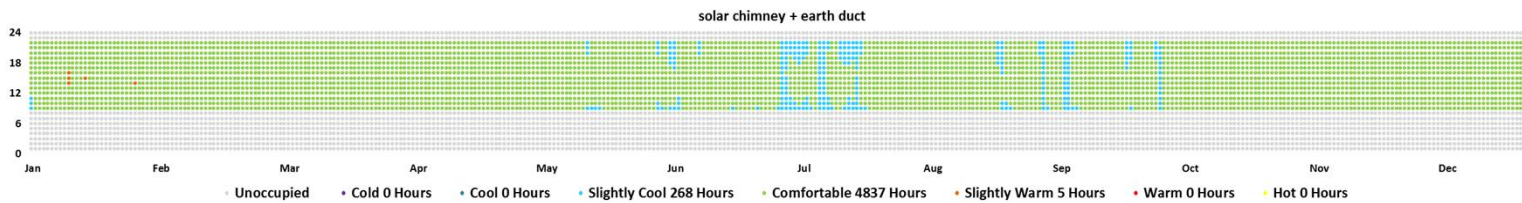
67%



87%



93%



First case, fully natural ventilated building, offers 63% of comfortable hours during the year. In cases like favelas where the wind effect is not well captured, stack ventilation may be a viable alternative as it is shown on the next option.

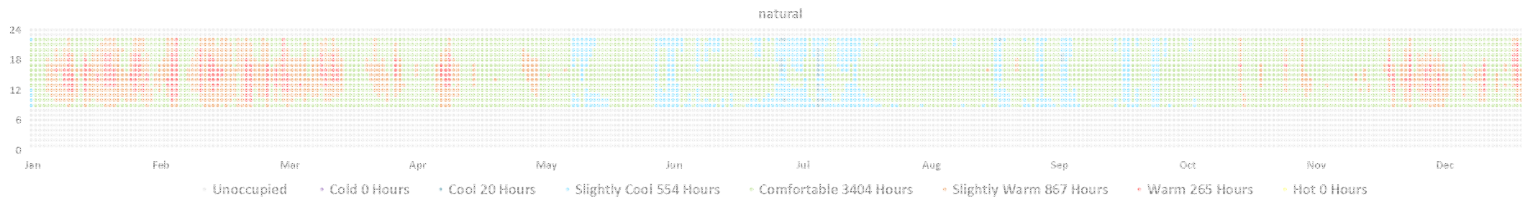
Next, the combination between earth duct and solar chimney was tested.

The biggest challenge related to the applicability of an earth duct in hot climates is the warm soil temperatures through the year.

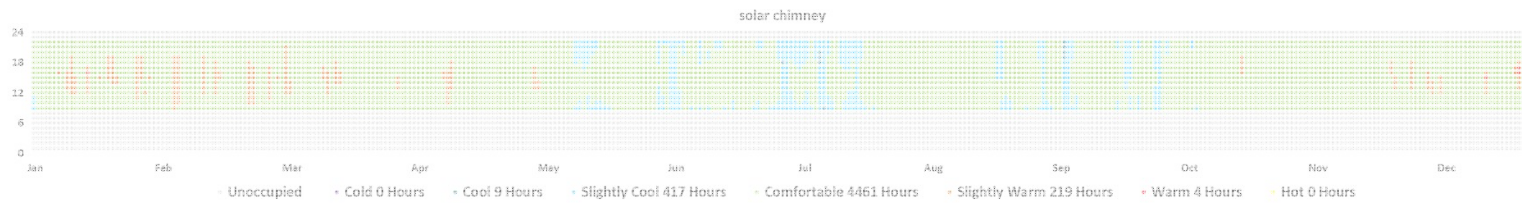
COMMON GROUND FLOOR

PART II

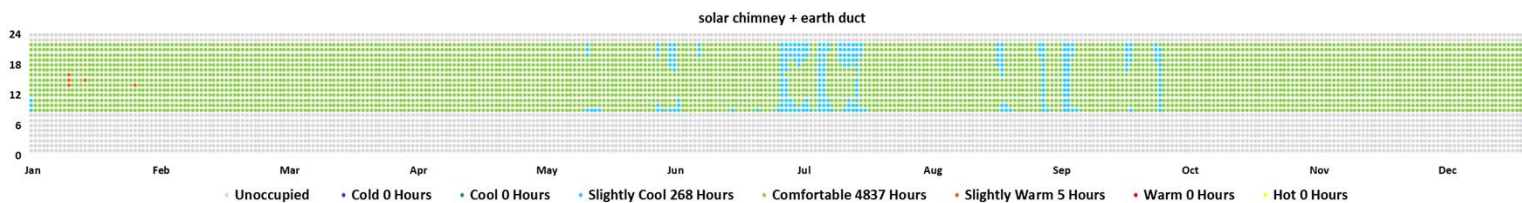
67%



87%



93%



The graph proves the capability of implementing **EARTH DUCT SYSTEM** in Rio de Janeiro, offering high comfort levels when combined with solar chimney and high air speed velocity.

NO AC UNITS were needed to achieve high performance and comfortable assembly.

FINAL THOUGHTS..

- RIO DE JANEIRO: SEMI TROPICAL CLIMATE, NO WINTER
- CONSTANT 0.5 CLOTHING FACTOR THROUGH THE YEAR
- SINGLE GLAZING IS THE MOST COMMON PRACTISE
- CONTAINER AS MODULAR SYSTEM WITH DORM FUNCTION
- NO NEED OF AC UNITS IF SPECIFIC PASSIVE STRATEGIES ARE APPLIED
 - ✓ HIGH AIR SPEED VELOCITY CAN IMPROVE COMFORT
 - ✓ EARTH DUCT 2m BELOW GROUND CAN PROVIDE CONSTANT TEMPERATURES OF 24°C
 - ✓ POTENTIAL FOR THERMAL MASS IF INTERNAL FLOOR AREA IS NOT AN ISSUE

This study tries to reveal the potential to achieve thermal comfort inside favelas in Rio de Janeiro.

When passive design strategies are combined together, taking into account context and climate, comfort spaces can be created without having to rely on the use of AC units.

THANK YOU

...see you