Impact of construction materials on urban heat island and buildings energy demand

École Nationale Supérieure d'Architecture de Nantes

AL-HAFIZ Bisam

Supervisor

MUSY Marjorie

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Summery

1. Problem statement,
2. Objectives
3. Case study
2. Methodology of the research
3. The simulation

- Problem statement

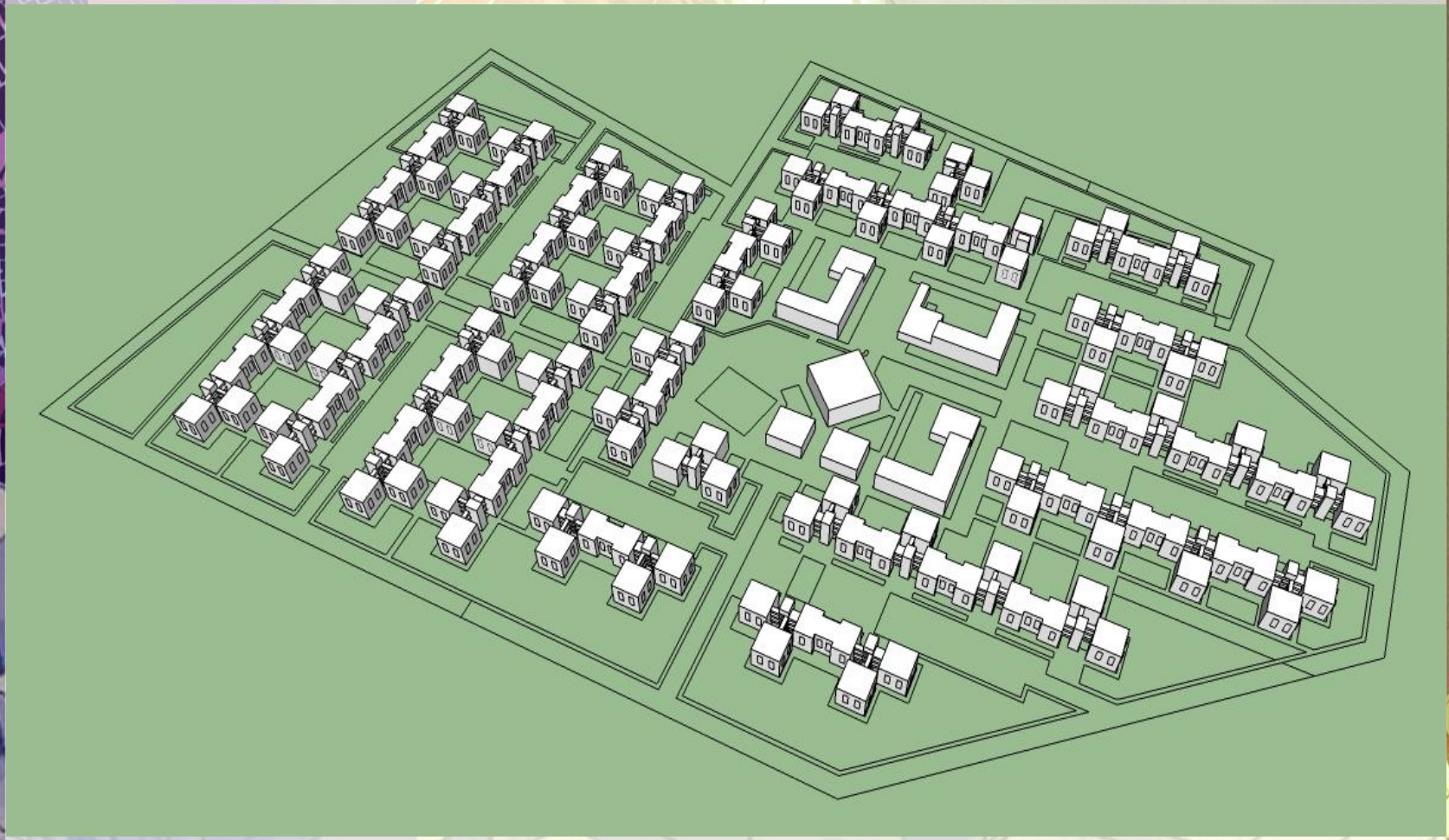
Urbanization, increase the world's population lives in cities, cities are warmer than rural areas (UHI), as a result of gradual surface modifications that include replacing the natural vegetation with buildings and roads

- Objectives

1. Overcome the current environmental problems generally, and urban heat island especially.

2. Reduce the energy needed to provide thermal comfort (indoor).

Al Hadba Residential Complex



The basic hypothesis :

The basic hypothesis is that urban, in both ambient air temperatures and energy needed can be significantly lowered by controlling;

Controlling the interior/exterior surface temperatures through using a good insulator material,

Enhancing the solar reflectivity of exterior surfaces, and provide a protection from a direct solar radation

Finally a good distribution of trees and green areas.

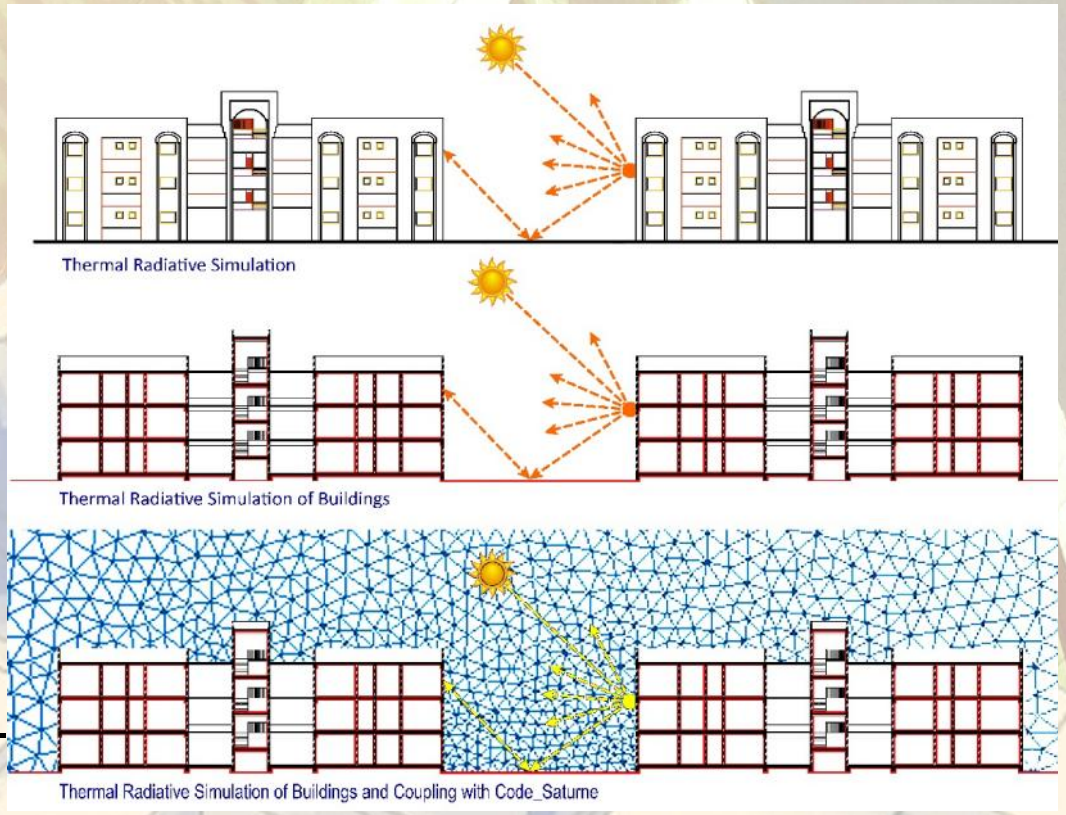
3. Methodology of the research:

To achieve the objective of this research, I will make simulation by using urban microclimate simulation software SOLENE-Microclimate.

Step one ----------

Step two ----------

Step three ----------



Step A …

Simulation by using Radiative and Thermal model
To find exterior (Tse) and interior (Tn1) surface temperatures

Step 3	walls with thickness 12 cm
Step 4	walls with thickness 30 cm
Step 5	Cavity walls - air
Step 6	Cavity walls - Rockwool

Simulation each step with all types of Materials from 1- 7

Materials 1	Heavy weight concrete block
Materials 2	light weight concrete block
Materials 3	Reinforcement concrete self-compaction
Materials 4	concrete/mixed with straw
Materials 5	concrete rubber aggregates with radius 0
Materials 6	concrete rubber aggregates with radius 30
Materials 7	pumice block

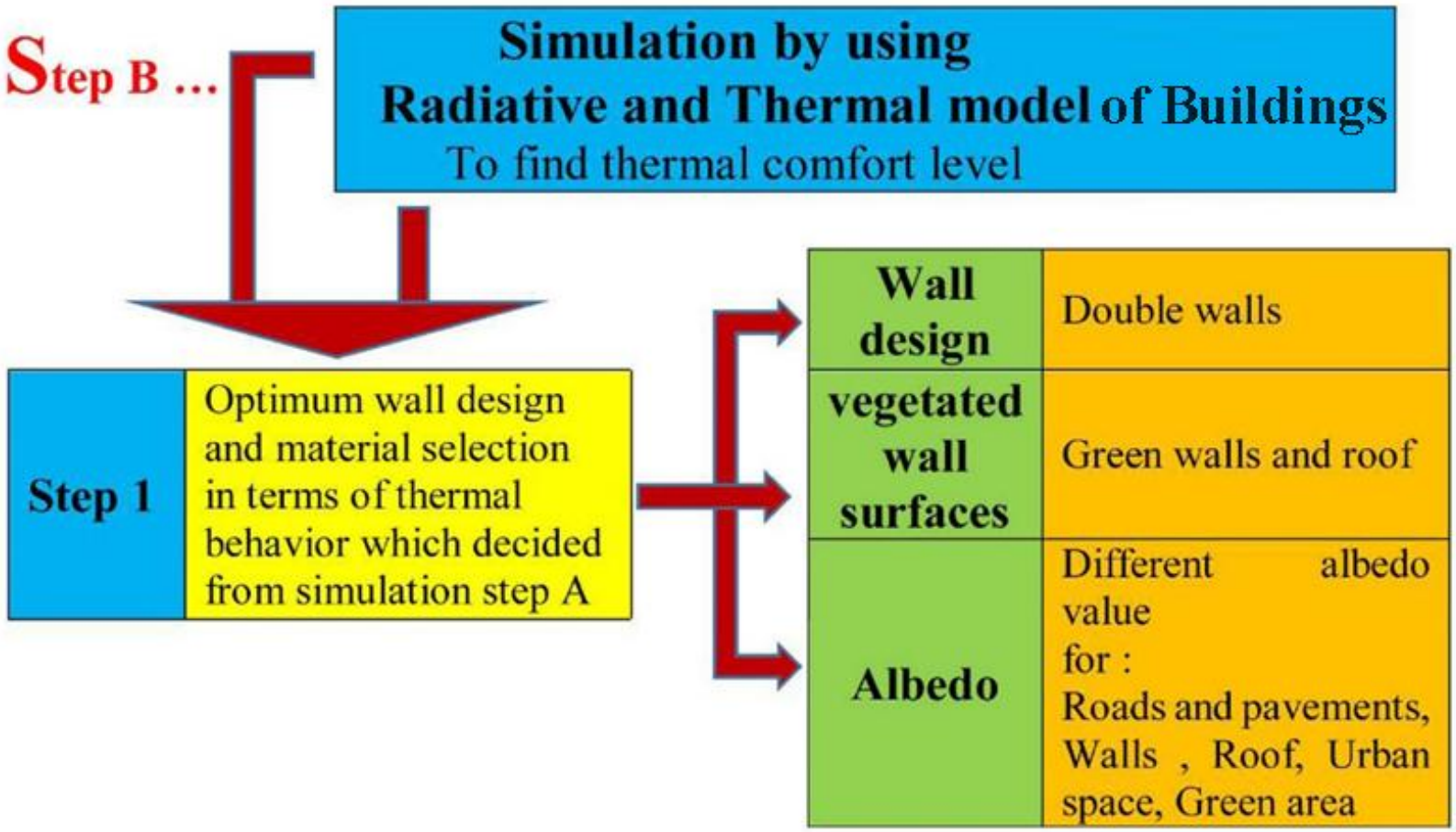
Result of first step (step A) :

There are two possibilities:

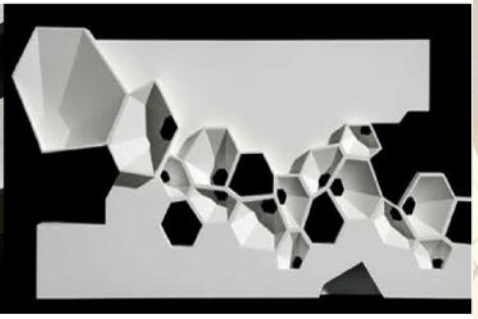
First possibility, materials lead to reduce the external surfaces' temperature but adversely affected the indoor surfaces' temperature and thermal comfort such as heavy weight concrete block materials. So we need to find some ways to maintain thermal comfort inside building spaces, e.g. air conditioning.

Second possibility, materials lead to reduce the internal surfaces' temperature and finally maintain indoor thermal comfort such as a pumice block. So we need to find some methods to reduce the external surfaces' temperature such as using double wall, green wall and roof, shade and shadow and high value of albedo.

This study will adopt the second alternative and selected pumice block as best materials,


Step B …
Simulation by using
Radiative and Thermal model of Buildings
To find thermal comfort level
Step 1
Optimum wall design and material selection in terms of thermal behavior which decided from simulation step A
Wall design
Double walls
vegetated wall surfaces
Green walls and roof
Albedo
Different albedo value for :
Roads and pavements, Walls , Roof, Urban space, Green area

Double Walls



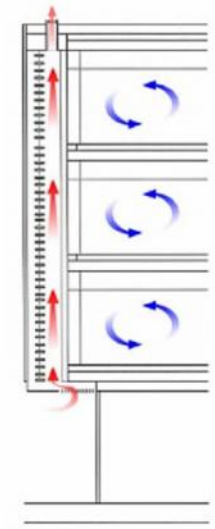


Figure 1:
Buffer System

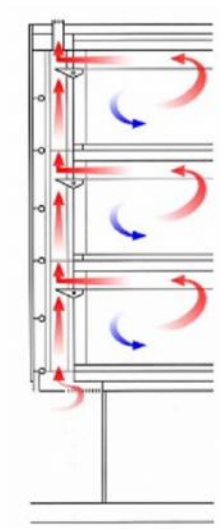


Figure 2:
Extract-Air System

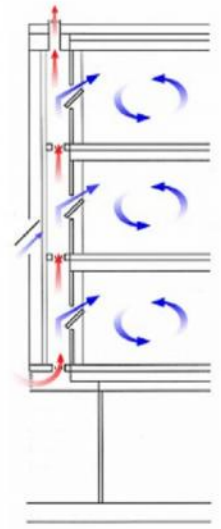
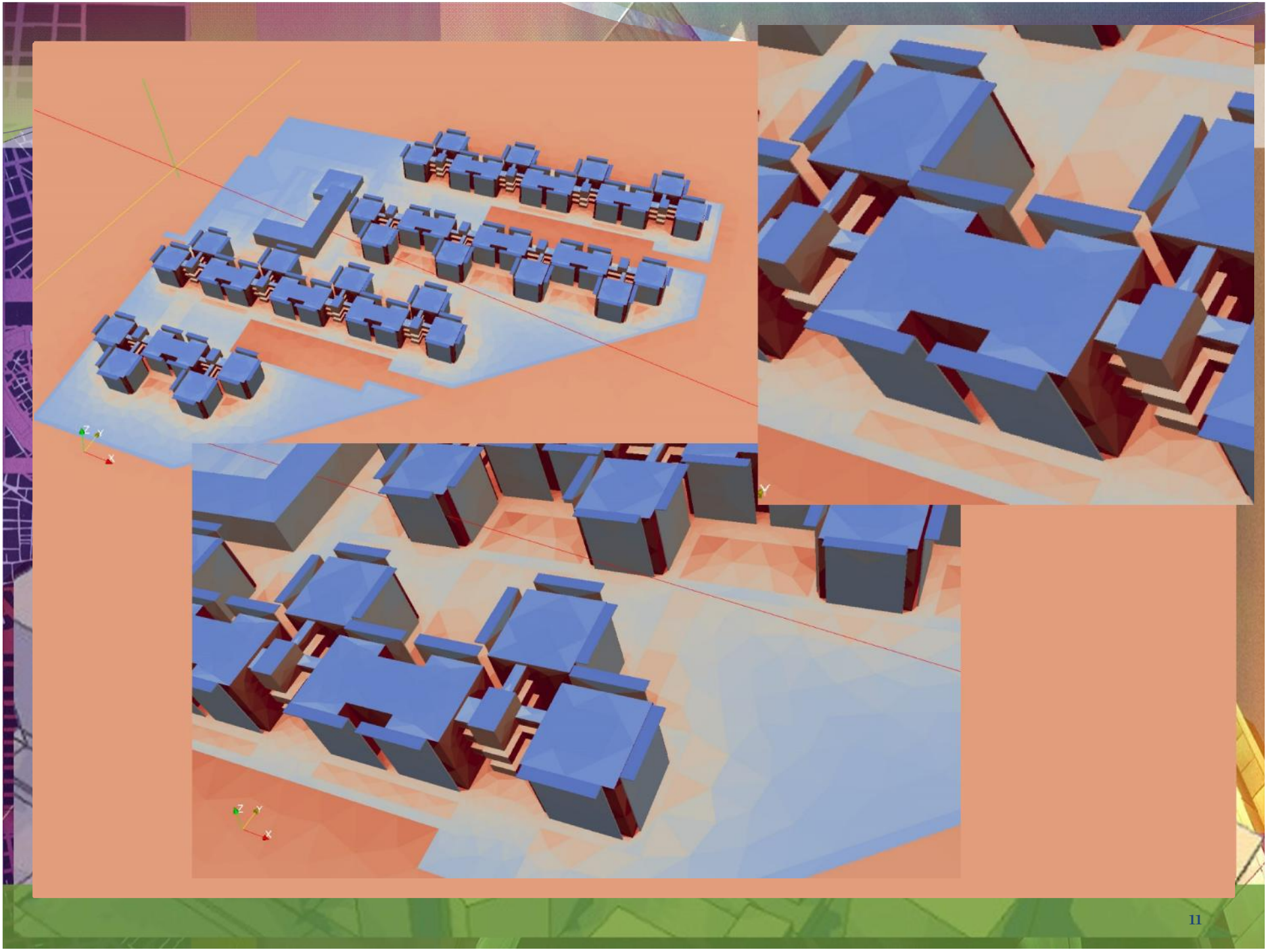
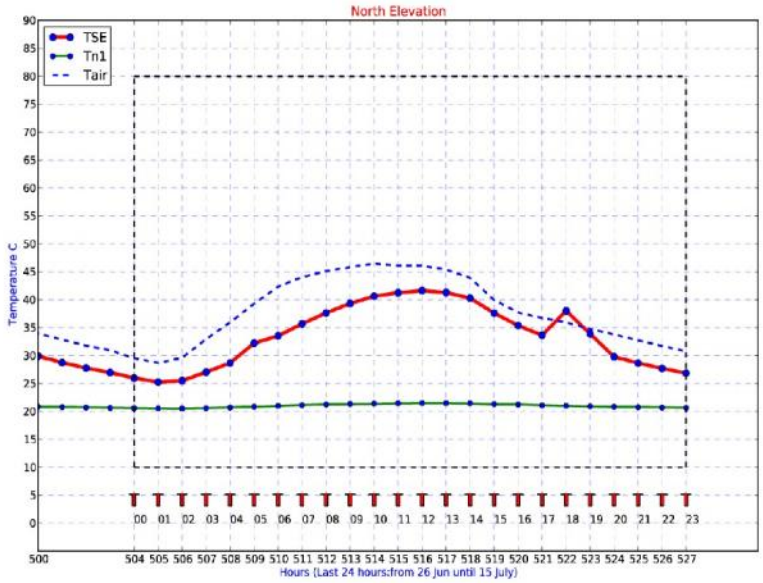
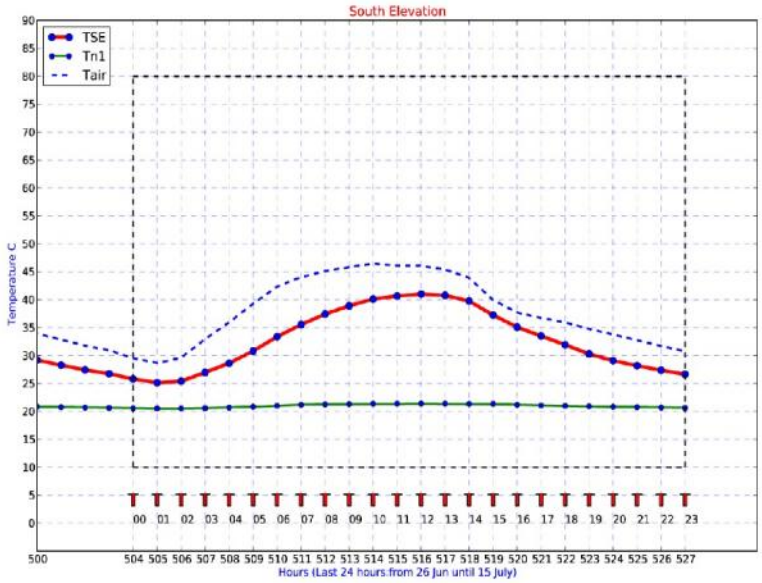


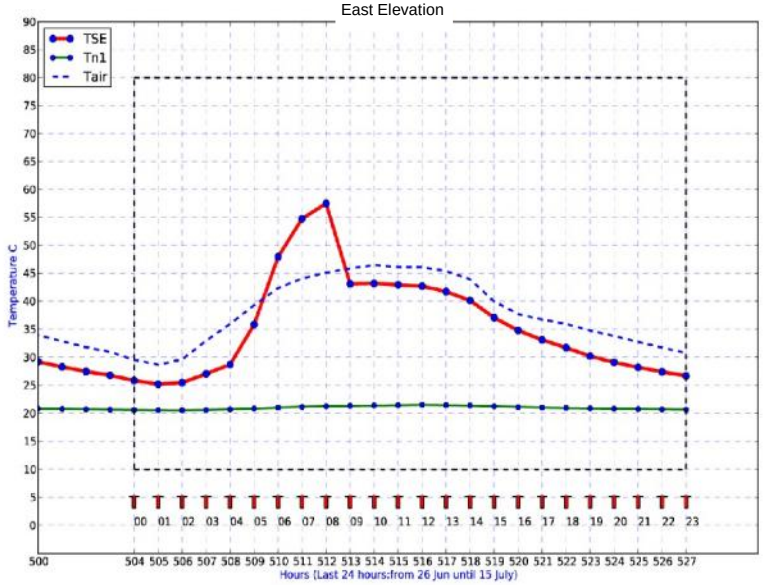
Figure 3:
Twin-Face System

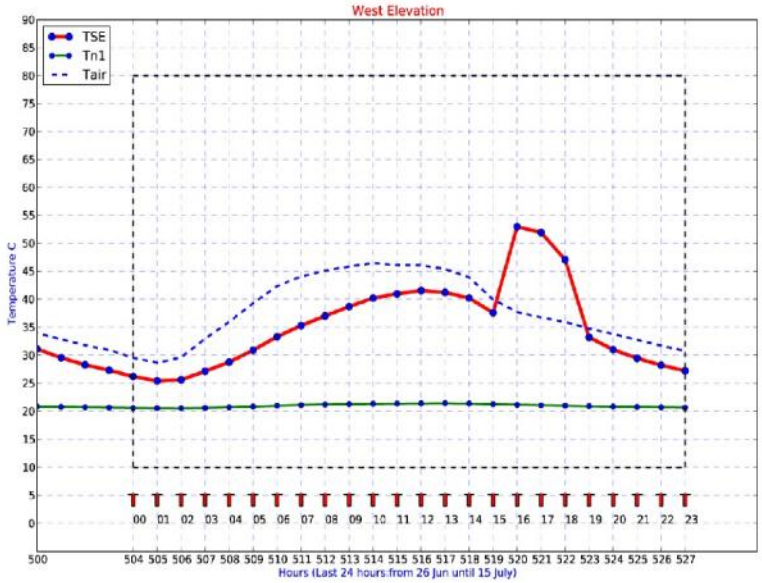






East Elevation





Albedo Value

Case one: albedo value for urban components as a following:

Components	Albedo value	Components	Albedo value
North elevation	0.25	*Roads*	0.25
South elevation	0.25	*Pavements and urban spaces*	0.25
East elevation	0.25	*Roofs*	0.8
West elevation	0.25	*Green area*	0.28

Case two: albedo value for urban components as a following:

Components	Albedo value	Components	Albedo value
North elevation	0.8	*Roads*	0.8
South elevation	0.8	*Pavements and urban spaces*	0.8
East elevation	0.8	*Roofs*	0.8
West elevation	0.8	*Green area*	0.28

Case three: albedo value for urban components as a following:

Components	Albedo value	Components	Albedo value
North elevation	0.8	*Roads*	0.25
South elevation	0.8	*Pavements and urban spaces*	0.25
East elevation	0.8	*Roofs*	0.8
West elevation	0.8	*Green area*	0.28

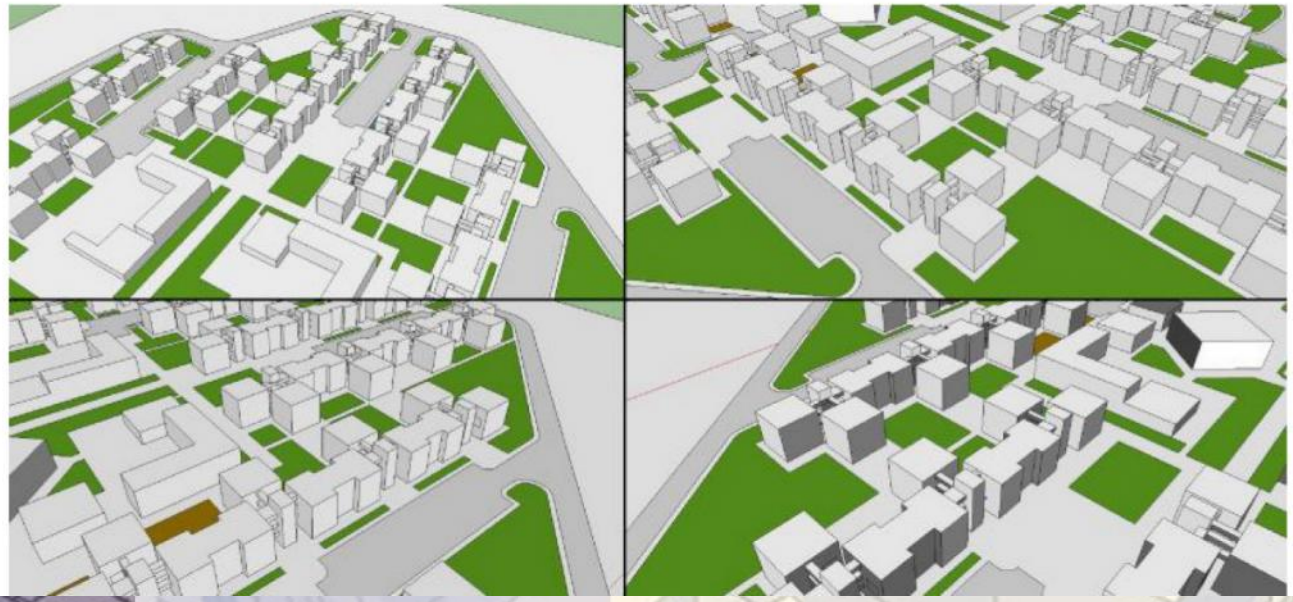
Case four: albedo value for urban components as a following:

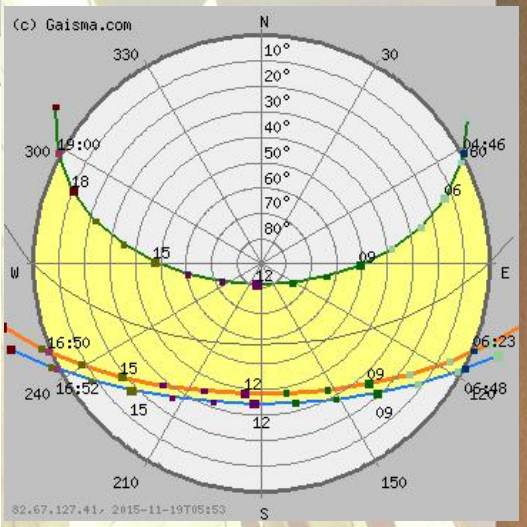
Components	Albedo value	Components	Albedo value
North elevation	0.25	*Roads*	0.8
South elevation	0.25	*Pavements and urban spaces*	0.8
East elevation	0.25	*Roofs*	0.8
West elevation	0.25	*Green area*	0.28

Case five: albedo value for urban components as a following:

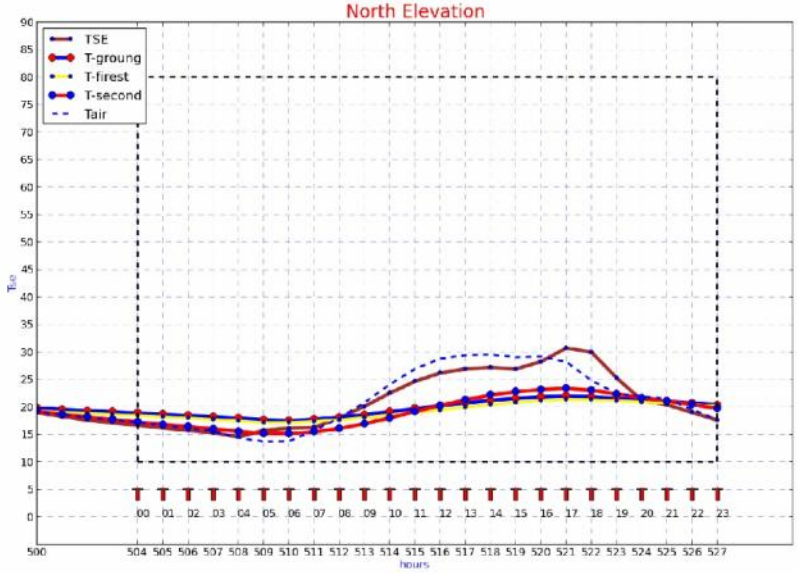
Components	Albedo value
North elevation	0.3
South elevation	0.60
East elevation	0.60
West elevation	0.80

Components	Albedo value
Roads	0.8
Pavements and urban spaces	0.8
Roofs	0.8
Green area	0.28

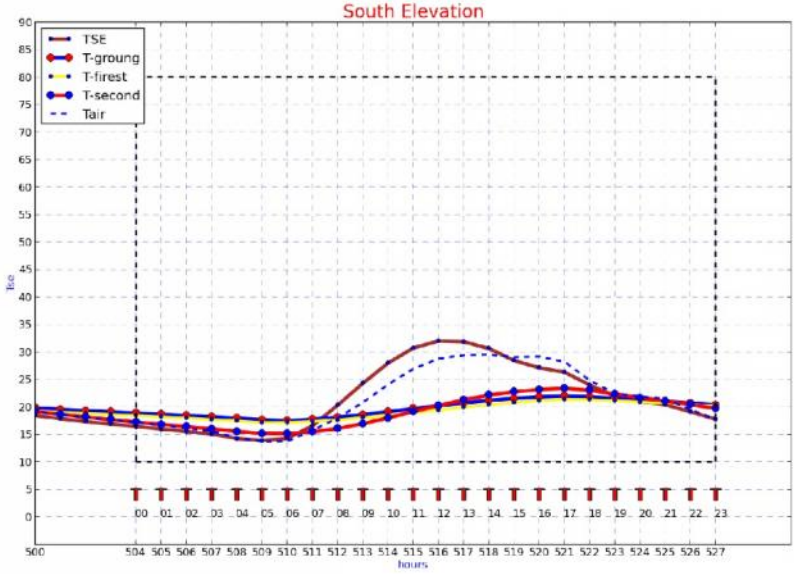




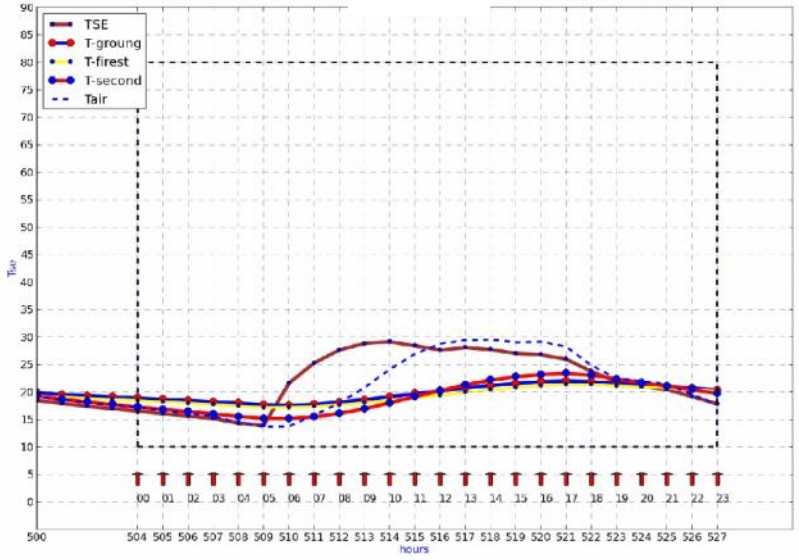
North Elevation



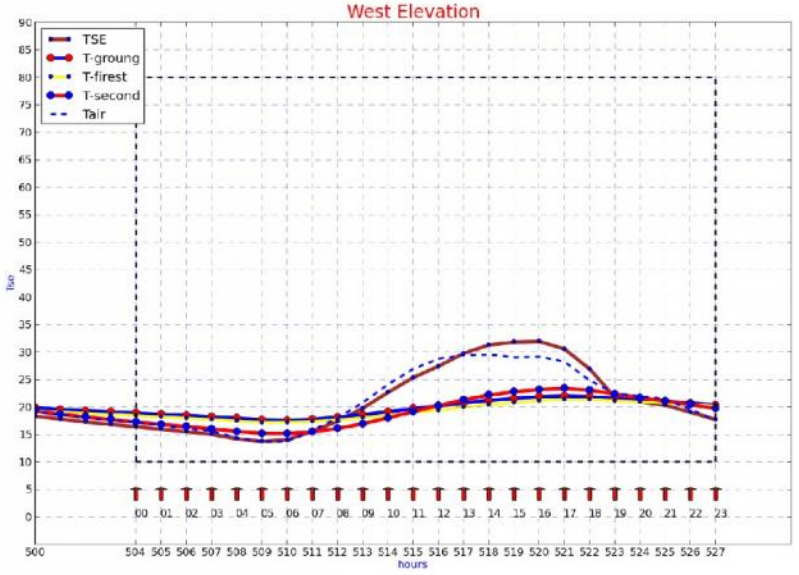
South Elevation

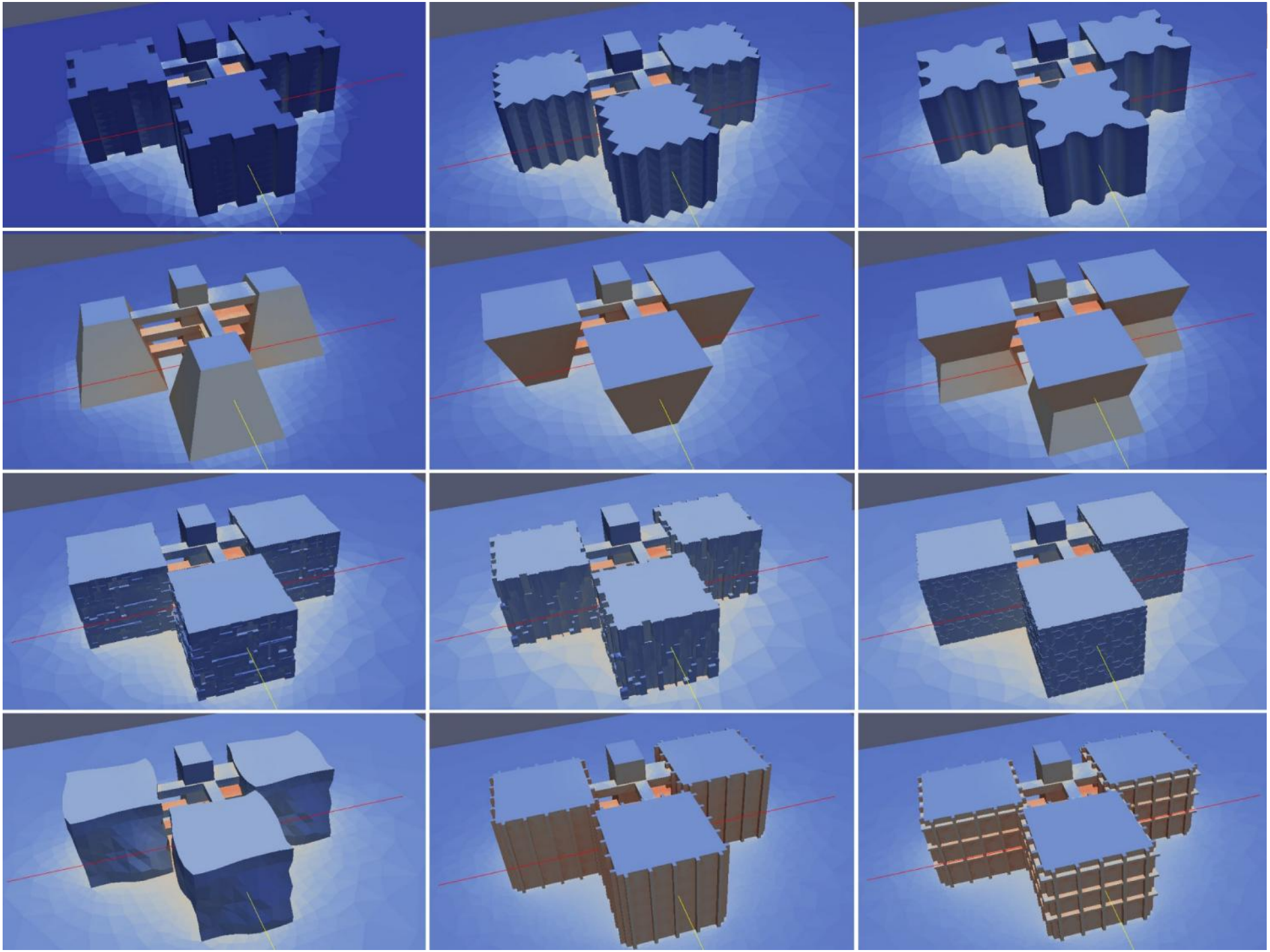


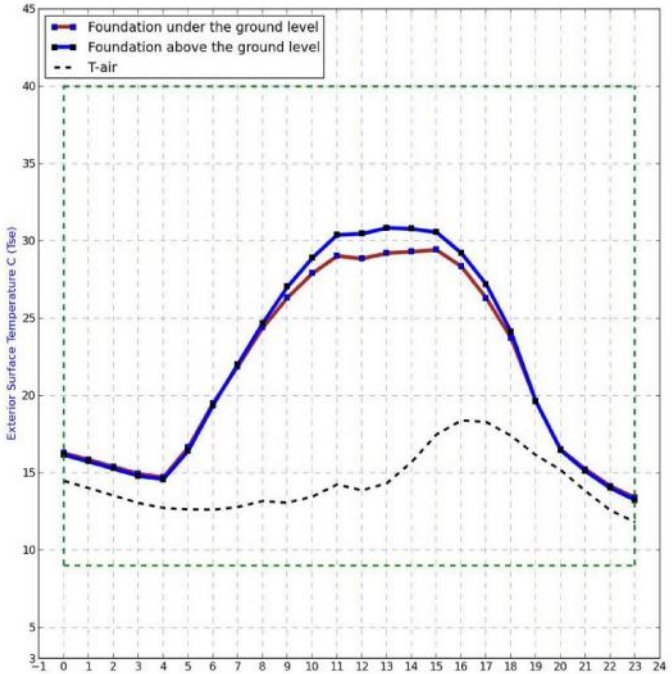
East Elevation

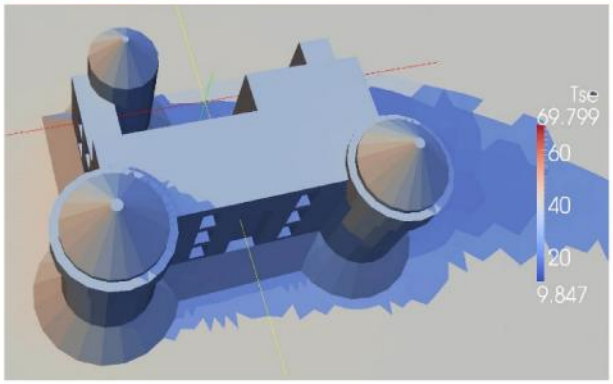


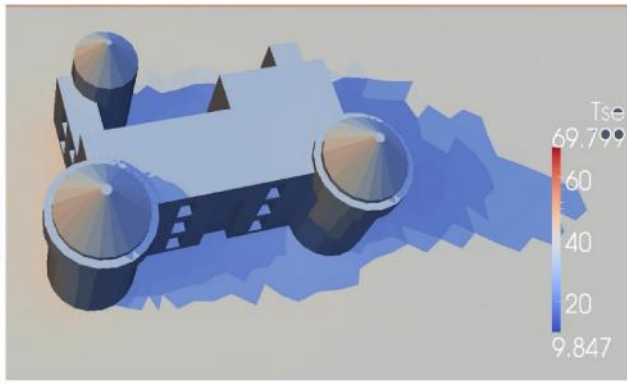
West Elevation

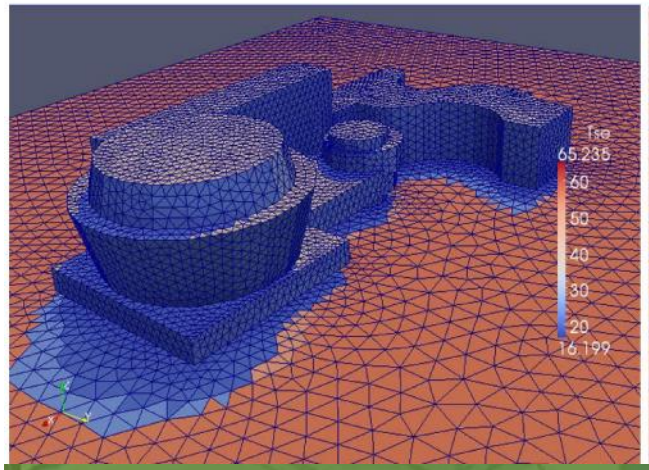


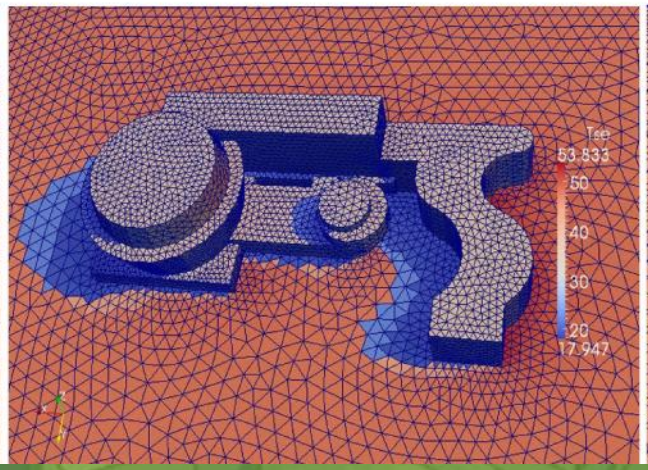


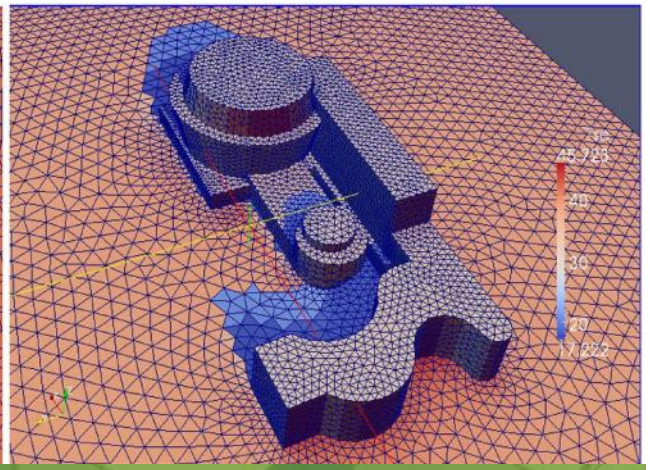

Foundation under the ground level
Foundation above the ground level
T-air
Exterior Surface Temperature C (Tse)


Tse
69.799
60
40
20
9.847


Tse
69.799
60
40
20
9.847


Tse
65.235
60
50
40
30
20
16.199


Tse
53.833
50
40
30
20
17.947



Thank you for your attention