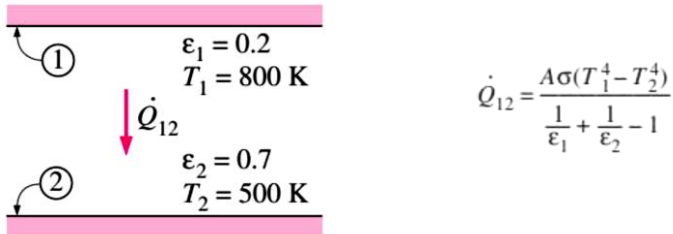


### Exercise:

Heat exchange between the two parallel plates:

How many shields with  $\epsilon=0.1$  should we add in order to have the new heat transfer rate to be 1% of the case without shields?



$$\dot{q} = \frac{\dot{Q}}{A}$$

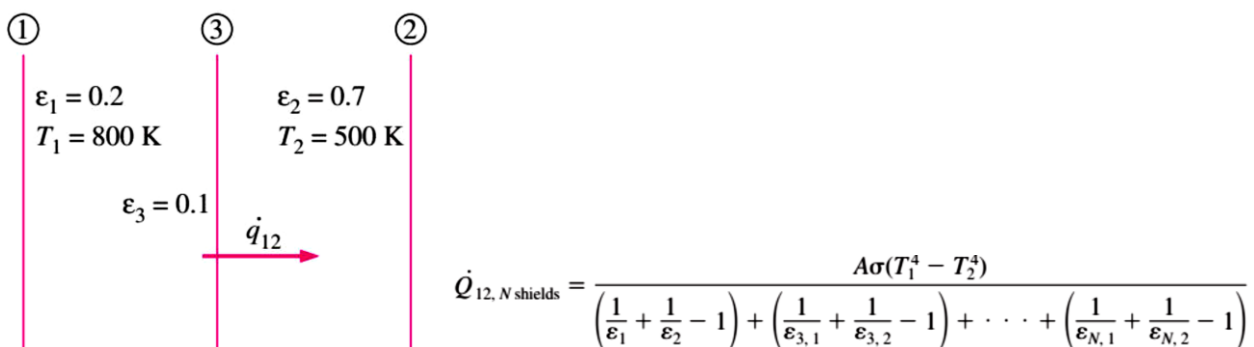
$$\dot{q}_{12} = \frac{5.670 \cdot 10^{-8} \cdot (800^4 - 500^4)}{\frac{1}{0.2} + \frac{1}{0.7} - 1} = \frac{19680,57}{5.4286} = 3625,35 \quad [\text{W}]$$

If the two emissivities of the plates are 0.1:

$$\dot{q}_{12} = \frac{5.670 \cdot 10^{-8} \cdot (800^4 - 500^4)}{\frac{1}{0.1} + \frac{1}{0.1} - 1} = \frac{19680,57}{19} = 1035,82 \quad [\text{W}]$$

With the same area and variation of temperature, if I used a very low emissivity material ( $\epsilon=0.1$ ) I can reduce the heat transfer of 3 times.

Another solution to reduce the heat transfer is to put a shield between the two parallel plates. (multiple radiation shields)



$$\dot{q} = \frac{\dot{Q}}{A}$$

$$\dot{q}_{12,1\text{shield}} = \frac{5.670 \cdot 10^{-8} \cdot (800^4 - 500^4)}{\left(\frac{1}{0.2} + \frac{1}{0.7} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right)} = \frac{19680,57}{5.426 + 19} = \frac{19680,57}{24.429} = 805.623 \text{ W} \quad \text{using 1 shield}$$

$$\dot{q}_{12,n. \text{ shields}} = \frac{5.670 * 10^{-8} * (800^4 - 500^4)}{\left(\frac{1}{0.2} + \frac{1}{0.7} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right)} = \frac{19680,57}{5.426 + 19 + 19} = \frac{19680,57}{43.429} = 453.167 \text{ W}$$

using 2 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{5.670 * 10^{-8} * (800^4 - 500^4)}{\left(\frac{1}{0.2} + \frac{1}{0.7} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right) + \left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right)} = \frac{19680,57}{5.426 + 19 + 19 + 19} = \frac{19680,57}{62.429} = 315.247 \text{ W}$$

using 3 shields. With these 3 shields, I have reduced the heat transfer od 10 times.

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 4)} = \frac{19680,57}{81.429} = 241.690 \text{ W}$$

using 4 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 5)} = \frac{19680,57}{100.429} = 195.965 \text{ W}$$

using 5 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 6)} = \frac{19680,57}{119.429} = 164.789 \text{ W}$$

using 6 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 7)} = \frac{19680,57}{138.429} = 142.171 \text{ W}$$

using 7 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 8)} = \frac{19680,57}{157.429} = 125.012 \text{ W}$$

using 8 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 9)} = \frac{19680,57}{176.429} = 111.550 \text{ W}$$

using 9 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 10)} = \frac{19680,57}{195.429} = 100.704 \text{ W}$$

using 10 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 11)} = \frac{19680,57}{214.429} = 91.781 \text{ W}$$

using 11 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 12)} = \frac{19680,57}{233.429} = 84.311 \text{ W}$$

using 12 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 13)} = \frac{19680,57}{252.429} = 77.965 \text{ W}$$

using 13 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 14)} = \frac{19680,57}{271.429} = 72.507 \text{ W}$$

using 14 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 15)} = \frac{19680,57}{290.429} = 67.764 \text{ W}$$

using 15 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 16)} = \frac{19680,57}{309.429} = 63.603 \text{ W}$$

using 16 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 17)} = \frac{19680,57}{328.429} = 59.923 \text{ W}$$

using 17 shields

$$\dot{q}_{12,n. \text{ shields}} = \frac{19680,57}{5.426 + (19 * 18)} = \frac{19680,57}{347.429} = 56.646 \text{ W}$$

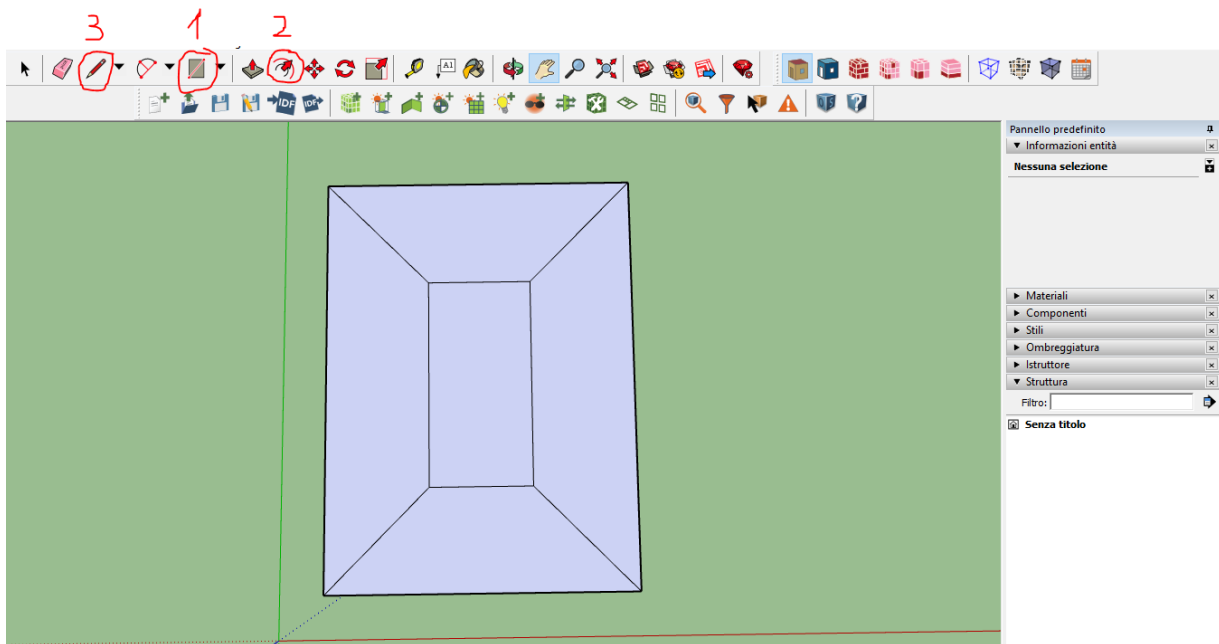
using 18 shields

...

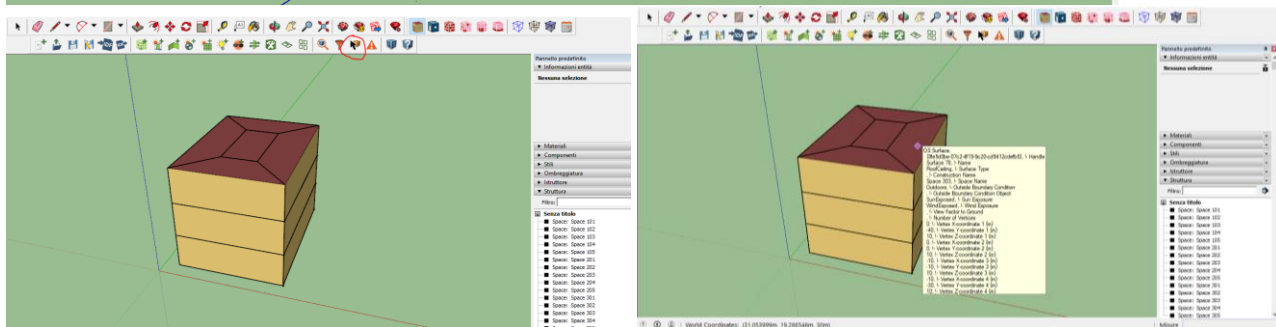
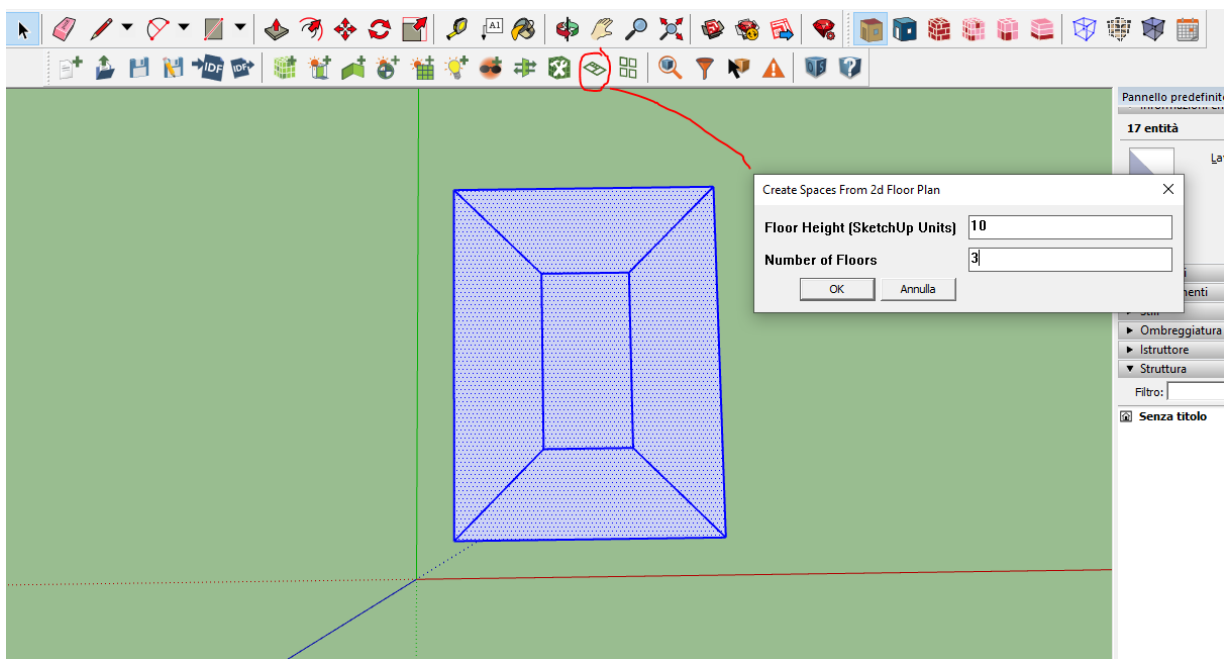
$$\dot{q}_{12, \text{ n. shields}} = \frac{19680,57}{5.426 + (19 \cdot 29)} = \frac{19680,57}{537.429} = 36.620 \text{ W} \quad \text{using 28 shields}$$

$$\dot{q}_{12, \text{ n. shields}} = \frac{19680,57}{5.426 + (19 \cdot 29)} = \frac{19680,57}{556.429} = 35.369 \text{ W} \quad \text{using 29 shields}$$

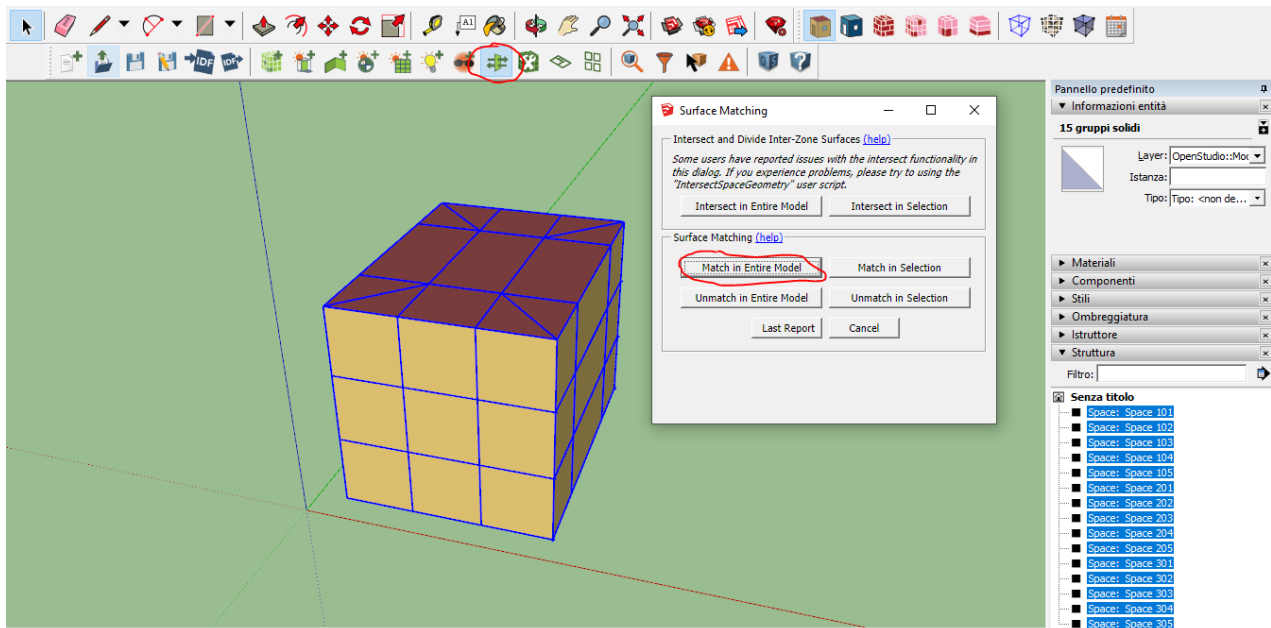
Using 28/29 shields with  $\epsilon=0.1$ , I have reduced the initial heat transfer of 100 times.



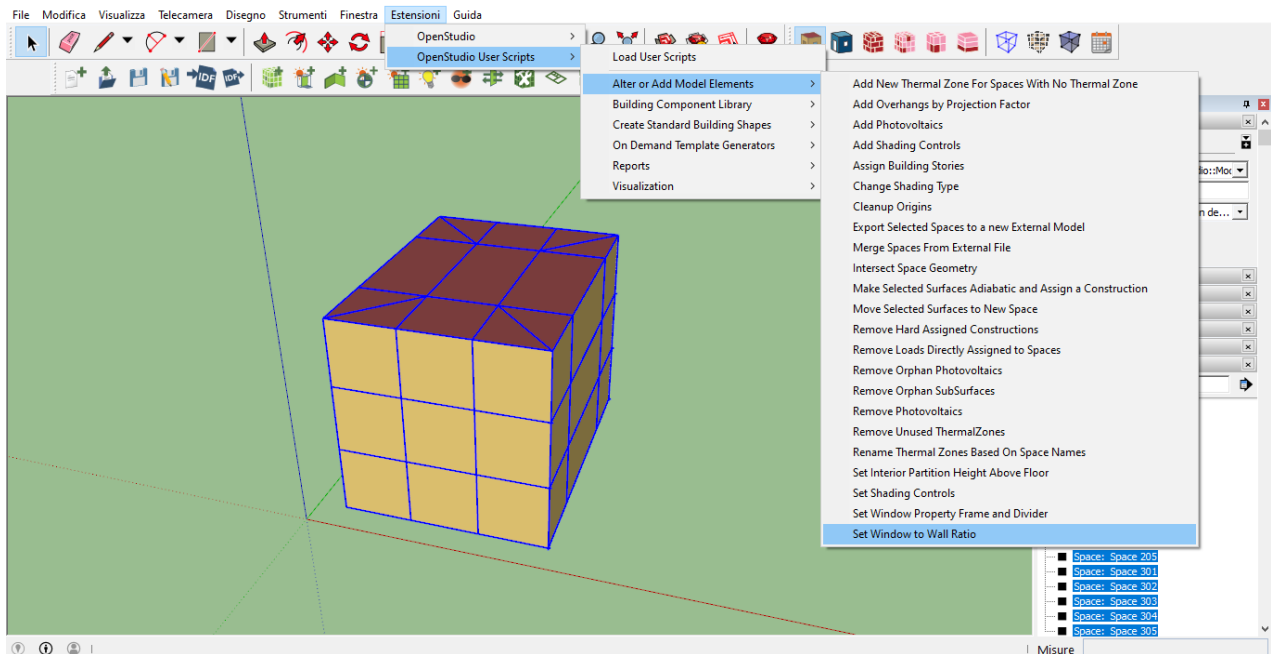
I have created a rectangular with dimension 30x40 cm using as a tool the rectangular size, offset (of 10m through the center) and the pen.

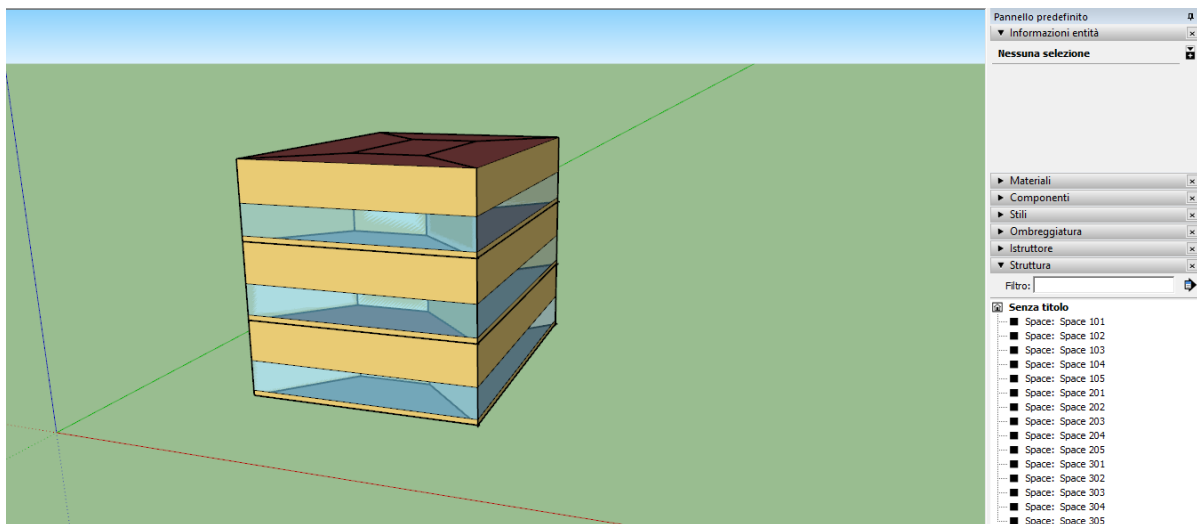
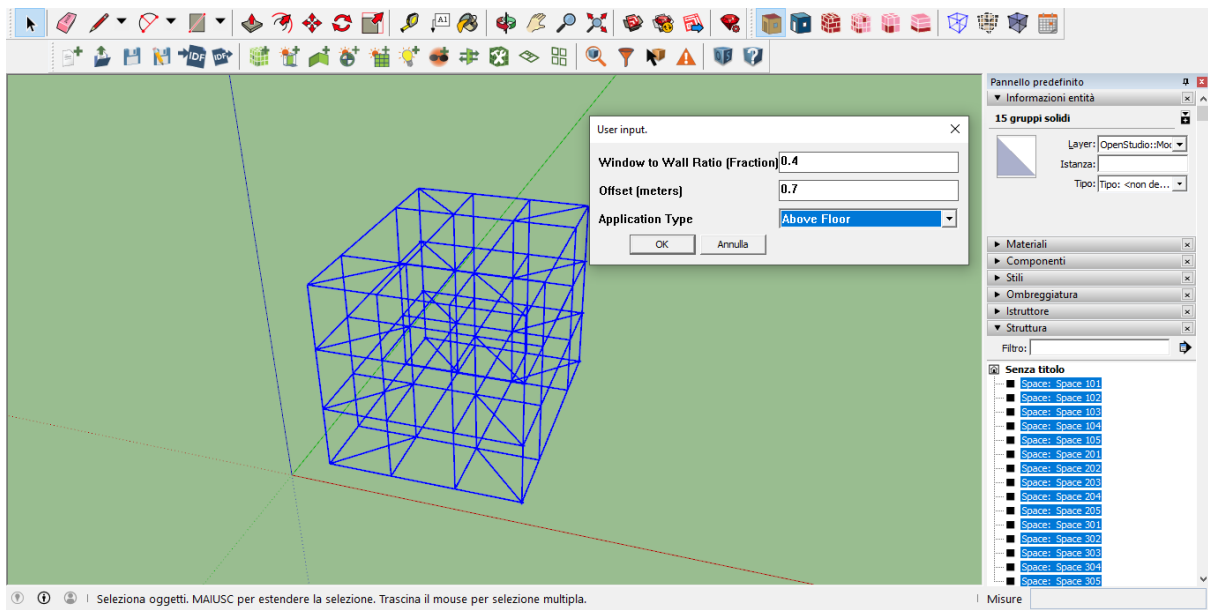


By using the tool Create Spaces From 2<sup>nd</sup> Floor Plan I have created a building of 3-floor height 10m. Selecting all the buildings and using Info Tool, I can see all the properties of each element that compose it.

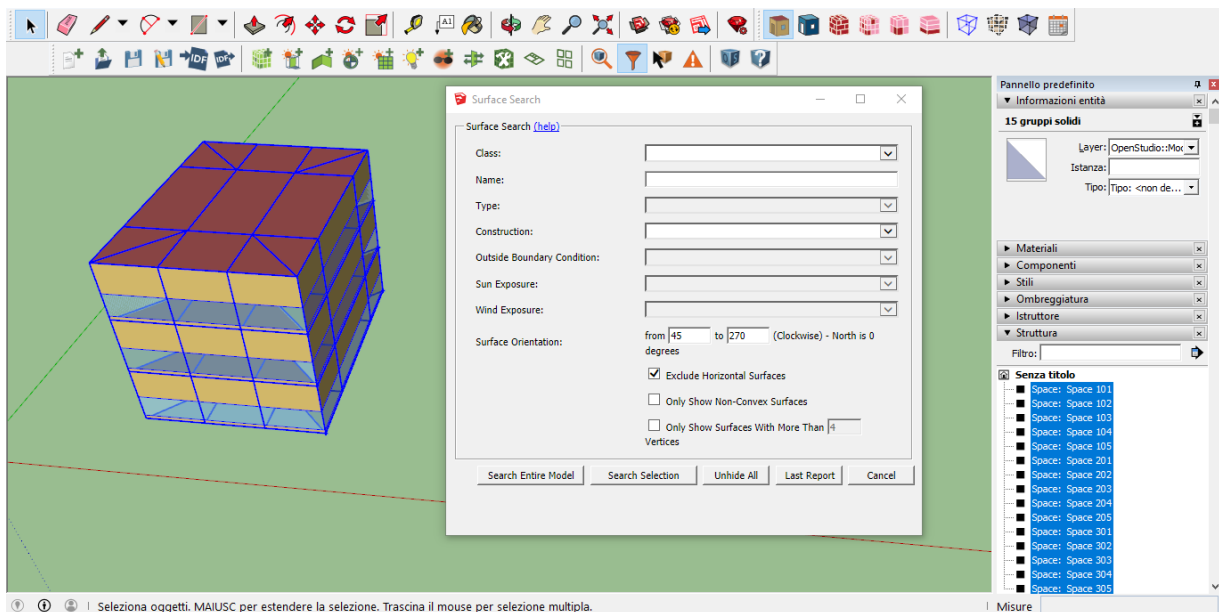


Selecting all the building >> Surface Matching >> Match the Entire Model.  
 Doing these passages, in the following passages I won't create windows inside my building.

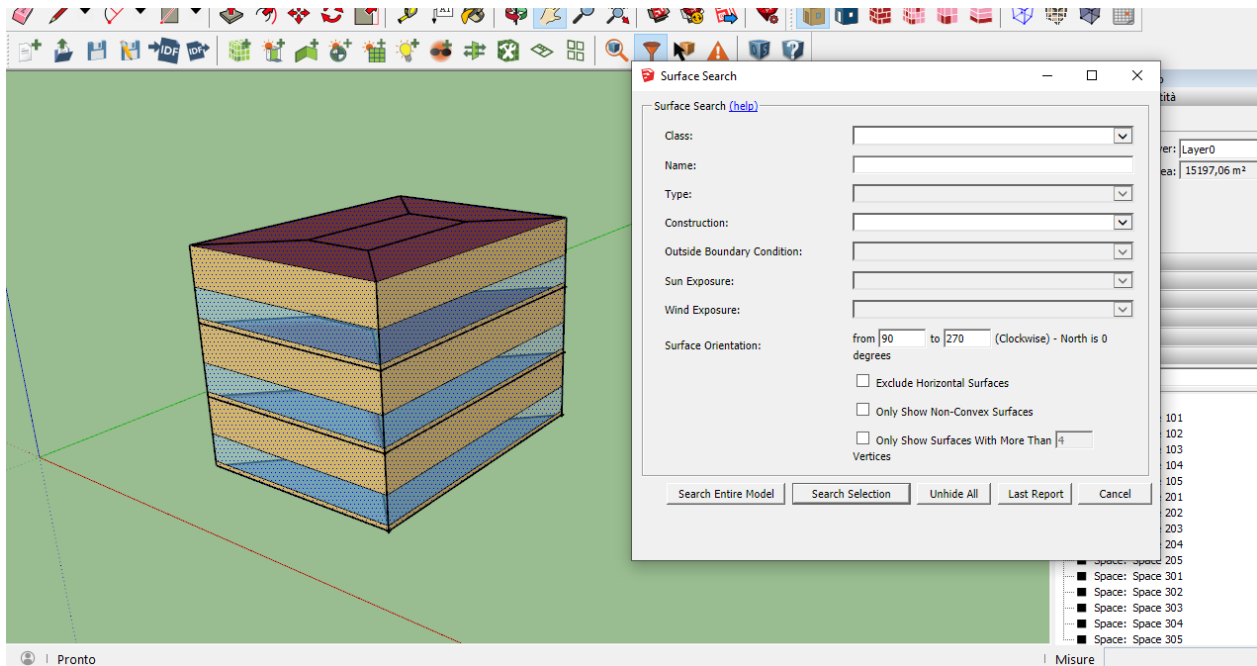




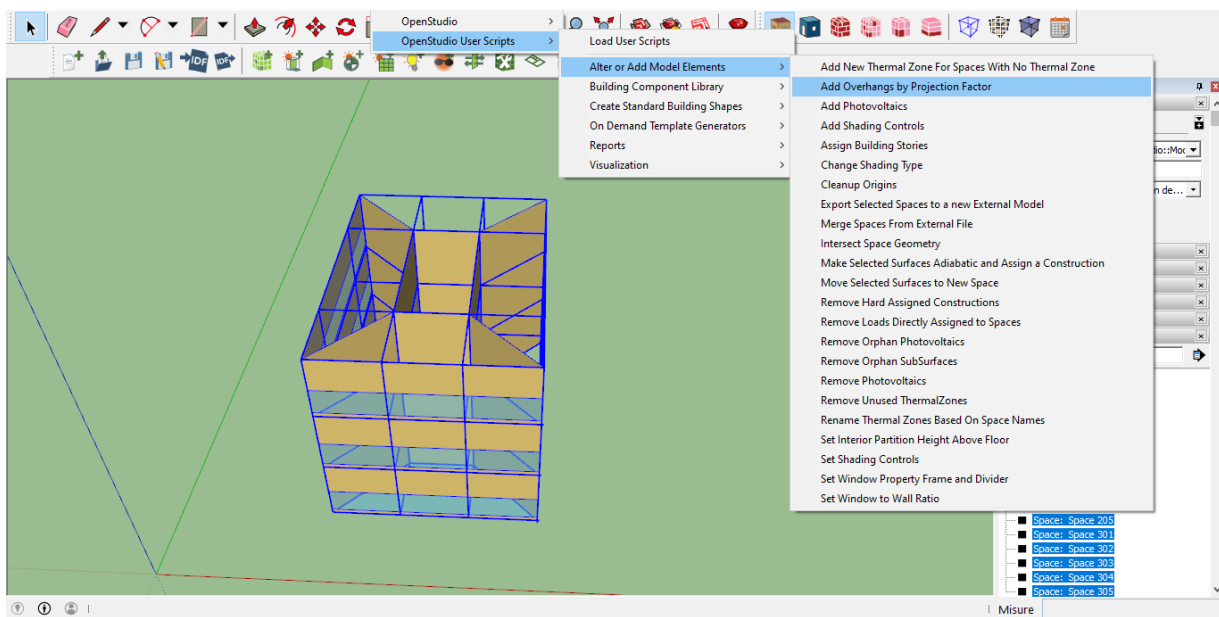
Doing these passages, I have created the windows on each surface of the building.

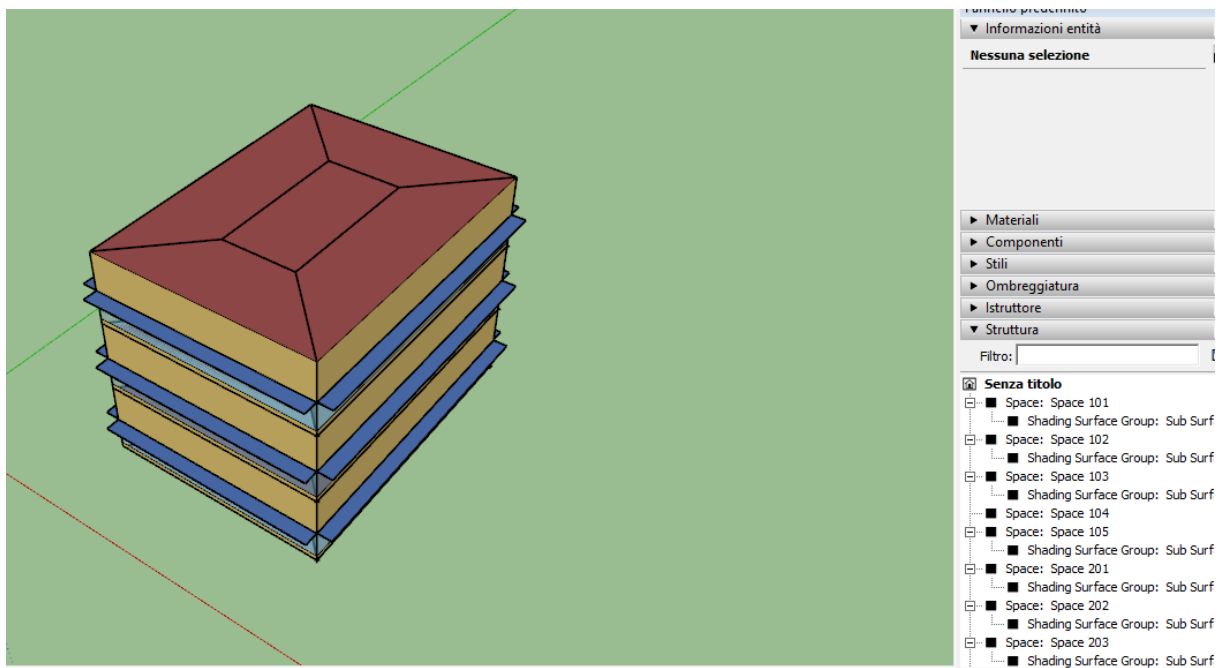
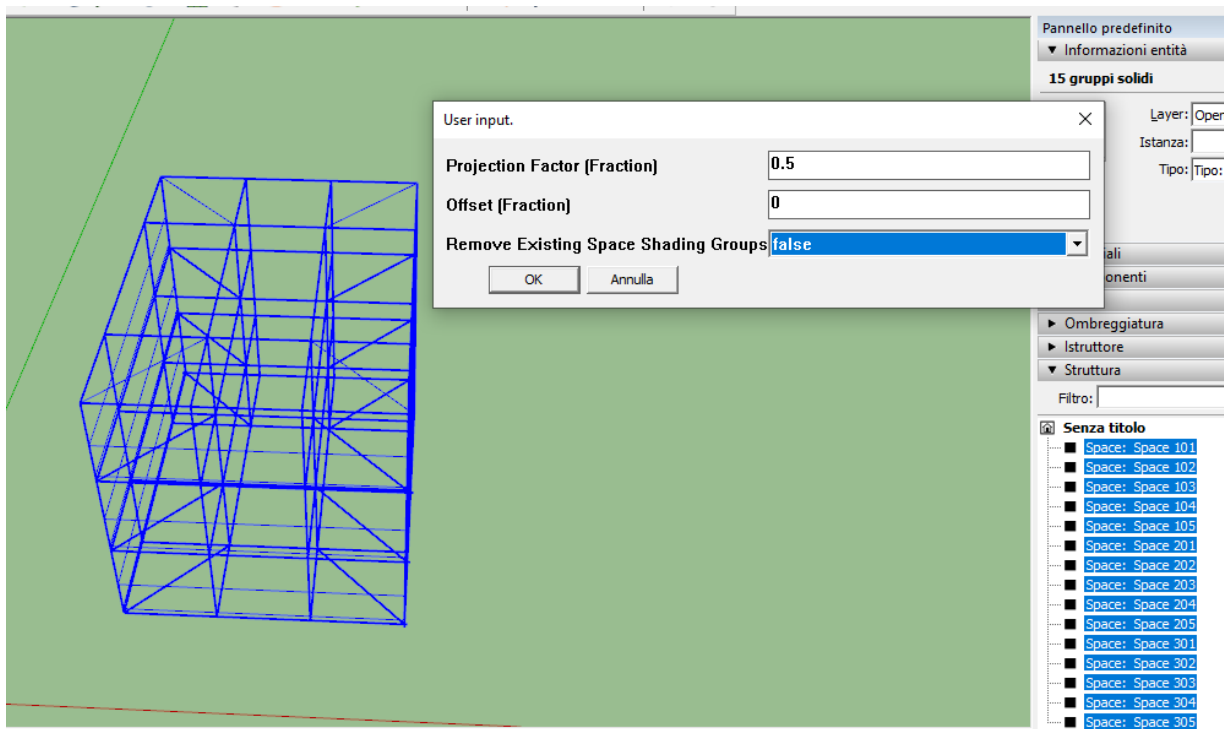


Doing so, and repeating this passage, I can exclude the north facade.



With the tool Search Surface, and pressed Search Selection, I should add external shading on the three surfaces (no on the north because I have excluded it). In my project, I could have missed and get wrong some passage, because I have an overhang on every façade, but during the next lessons I will correct it).

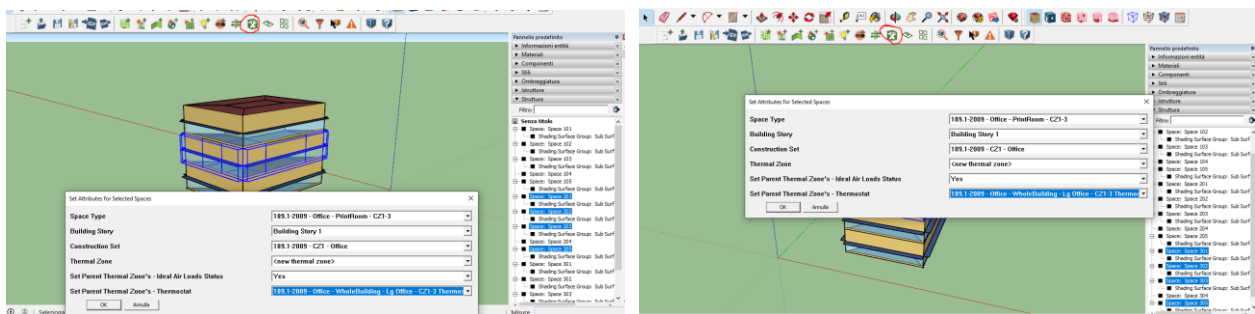
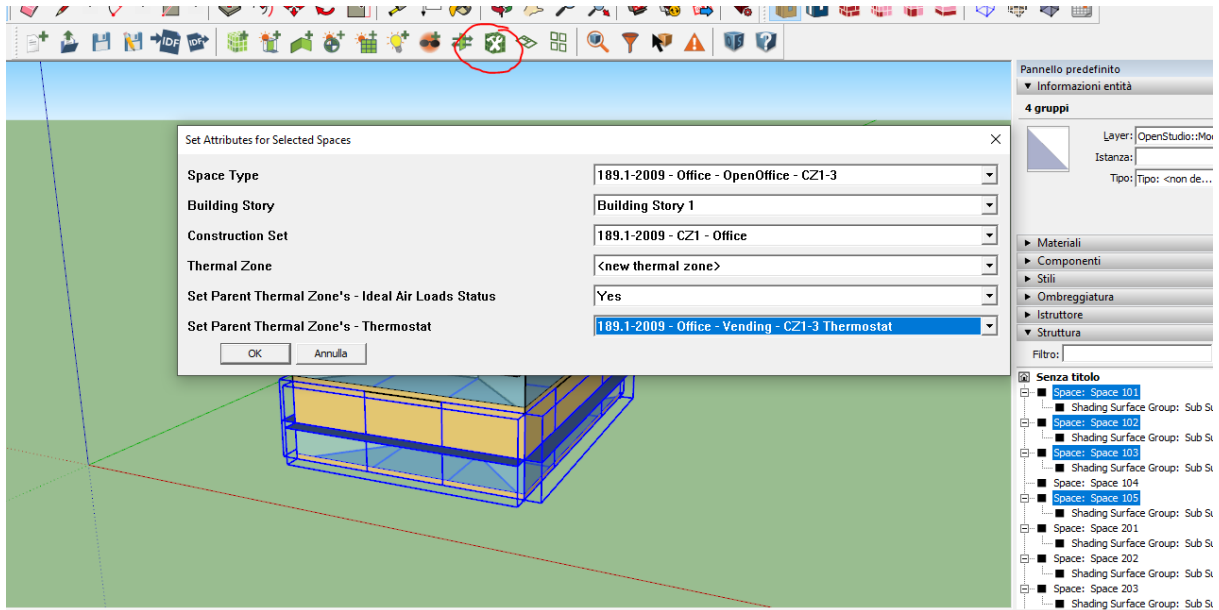




I put now the overhang that should go only on the three facades. (but it goes also on the north facade)

Now I start to select each thermal zone adding the specification: I start from the ground floor (Space 101,102,103,105)





In base of the function I want to put in the building, I can guess the number of people that will be into.

Now I can open Open Studio, insert the Weather File and the Design Days.  
Doing this, I have put the coordination of Piacenza.  
Then, I press Run.

Untitled\*

File Preferences Components & Measures Help

Weather File & Design Days Life Cycle Costs Utility Bills

**Weather File** Change Weather File

Name: Piacenza  
Latitude: 44.92  
Longitude: 9.73  
Elevation: 134  
Time Zone: 1  
Download weather files at [www.energyplus.net/weather](http://www.energyplus.net/weather)

**Measure Tags (Optional):**

ASHRAE Climate Zone  
CEC Climate Zone

**Design Days** Import From DDY

**Design Days**

Date Temperature Humidity Pressure Wind Precipitation Solar Custom

Design Day Name All Day Of Month Month Day Type Daylight Saving Time Indicator

Apply to Selected Apply to Selected Apply to Selected Apply to Selected

File Preferences Components & Measures Help

Results Summary

Reports: EnergyPlus Results Refresh Open DView for Detailed Reports

Program Version: EnergyPlus, Version 9.2.0-921312fa1d, YMD=2019.11.10 18:20 [Table of Contents](#)

Tabular Output Report in Format: HTML

Building: Building 1

Environment: RUN PERIOD 1 \*\* Piacenza - ITA IGDG WMO#=160840

Simulation Timestamp: 2019-11-10 18:20:18

Report: Annual Building Utility Performance Summary [Table of Contents](#)

For: Entire Facility

Timestamp: 2019-11-10 18:20:18

Values gathered over 8760.00 hours

**Site and Source Energy**

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	3222.21	1074.07	1074.07
Net Site Energy	3222.21	1074.07	1074.07
Total Source Energy	9400.04	3133.35	3133.35
Net Source Energy	9400.04	3133.35	3133.35

Here I can see the Results Summary of my building.