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Task1:

Provide a summary of the main concepts that went through about solar radiation (formulas are not needed).

1. Solar radiation density

Solar radiation means that the sun transmits energy in the form of electromagnetic waves.

The maximum yearly average solar density is the solar constant ($1367W/m^2$) ,which is the solar radiation by unit of receiving surface placed out of the atmosphere. (The max yearly average power density on the earth's surface is $1000W/m^2$.)

2. Solar radiation spectrum

Wavelength field: 0.3-2.5 micrometer, the maximum value is reached at 0.5, before which the solar radiation density increases with increasing wavelength, and then decreases.

3. Solar radiation characteristics

When solar radiation crosses the atmosphere to reach the earth's surface , it will be modified due to the dispersion and absorption phenomenon.

(1) Direct (beam) and diffuse radiation

Direct solar radiation means that unblocked radiation will always remain in the incident direction.

Diffuse solar radiation is the back reflection of part of incident radiation on the

atmosphere forward sidereal space, which occurs in all directions.

(2) Atmospheric absorption

Solar radiation absorption is due to some atmospheric components (ozone, water and carbon dioxide), which absorb the incident radiation in specific wavelength bands consequently modifying its energetic spectrum. And water vapor has important absorption bands in the infrared field (1.0, 1.4e 1.8μm,over 2.5μm the atmosphere becomes practically opaque).

The absorbed solar energy is transferred into internal energy and therefore reemitted in long wave in all the directions.

4. Air mass

The sun perpendicular to the horizon passes over the smallest thickness of the atmosphere, while the sun rays at normal angles to the horizontal plane pass through a large thickness of the atmosphere.

The effect of changing the air mass is that the atmosphere has a scattering effect on solar radiation. The larger the solar angle at which the sun is normal to the horizontal plane, the greater the amount of solar radiation intercepted.

5. Solar energy: availability

It depends on:

the sun position in the sky (altitude & azimuth angles)

the weather condition

the site altitude over the sea level

day length

6. The terrestrial axis inclination

The angle between the earth's axis and the ecliptic plane (the orbital plane of the earth orbiting the sun), which is 23.5°.

(1) Solar declination estimation

The sun's declination gradually increases from January to June, reaches a maximum in June, and gradually decreases from July to December.

(2) Solar height and solar zenith angle

The solar height angle is the complementary angle to the solar zenithal angle.

(3) Solar zenith angle calculation

The cosine of the solar zenith is equal to the product of the latitudinal cosine and the declination cosine plus the product of the latitude sine and the declination sine.

7. Radiation over tilted surface

(1) The hour angle

The solar flux distributed on the surface is inversely proportional to the zenithal angle.

(2) The hour angle

It is the angle between the Sun Ray and the local meridian.

Due to the Earth rotation, the angle increases by 15° per hour, positive to West, negative to East.

(3) Solar azimuth angle

For the Northern Hemisphere, when the solar declination is greater than 0°, the

sun rises from the east to the north. At this time, the azimuth angle is less than 90°, 180° at noon, and the angle is greater than 270° at sunset.

8. Measurement

(1) Instruments

Pyranometer : direct + diffuse

Pyranometer with shadow band : diffuse

Normal pyranometer : direct

(2) Measured quantities

Irradiances are the usual measured quantities on the horizontal plane.

9. Solar Irradiance on a Generic Surface

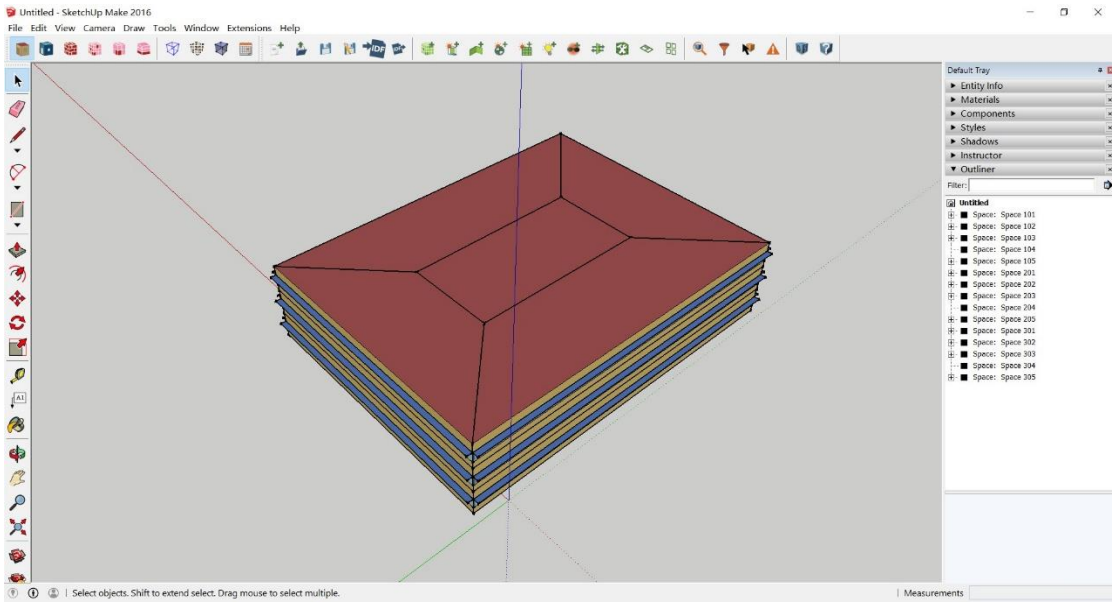
Total irradiance is equal to solar normal direct irradiance plus solar diffuse irradiance (coming from the sky & ground reflected).

Task 2:

You create a pdf file with screenshots of all of the steps we went through in the second lesson on openStudio and explain briefly the reason behind the use of each step (in your own words!).

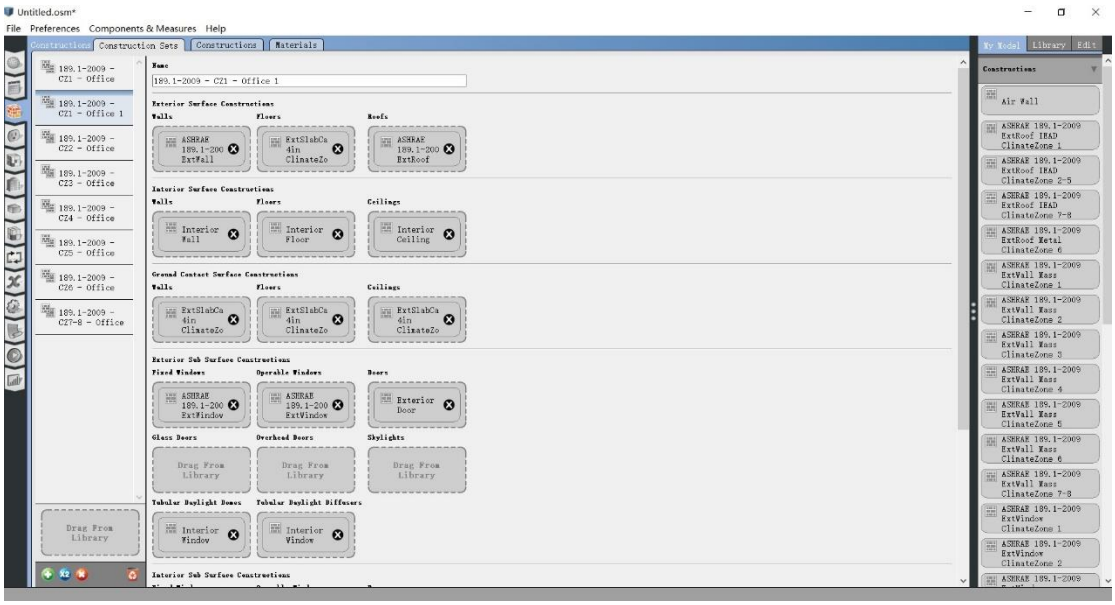
Modifying Construction

1. *Open the model we did last week and launch OpenStudio.*

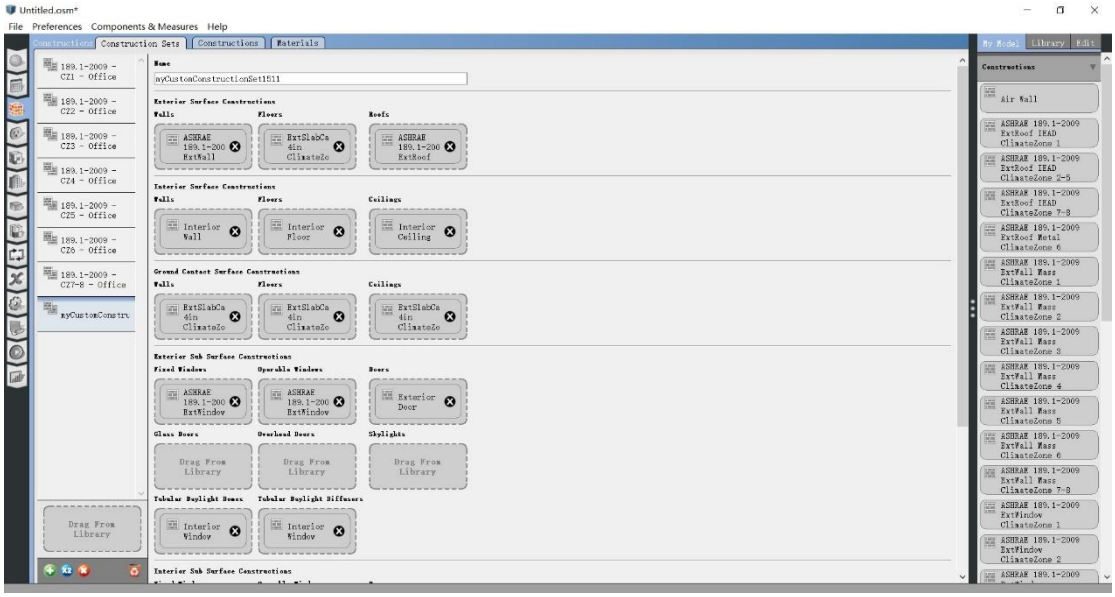


2. *How to create a new construction set.*

- Go to "Construction Sets" tab and copy a set from the existing one

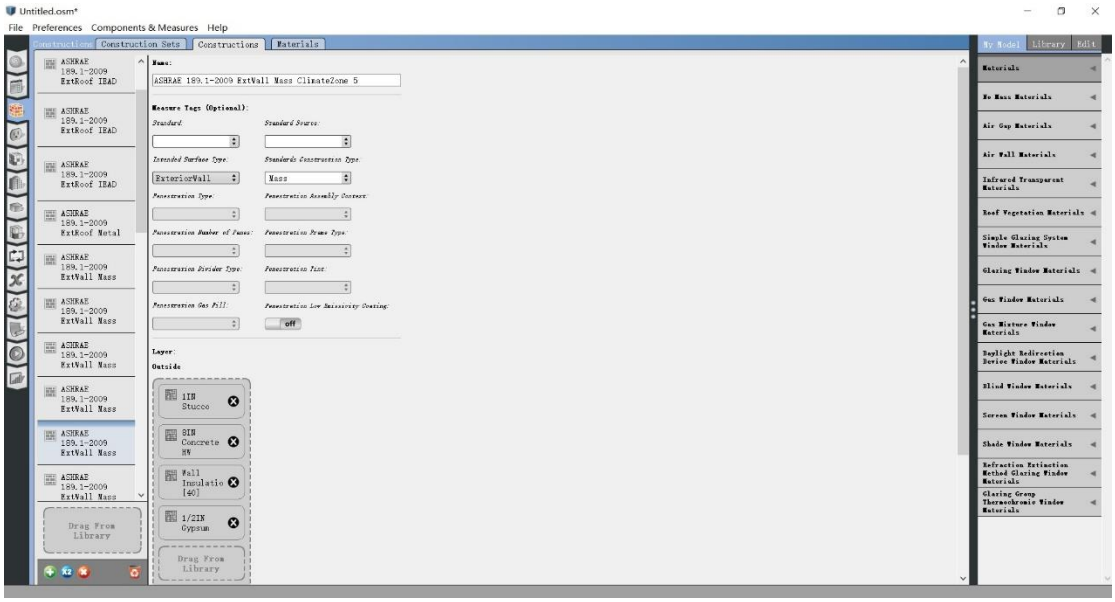


- Rename this set ; drag and drop the elements from the material library

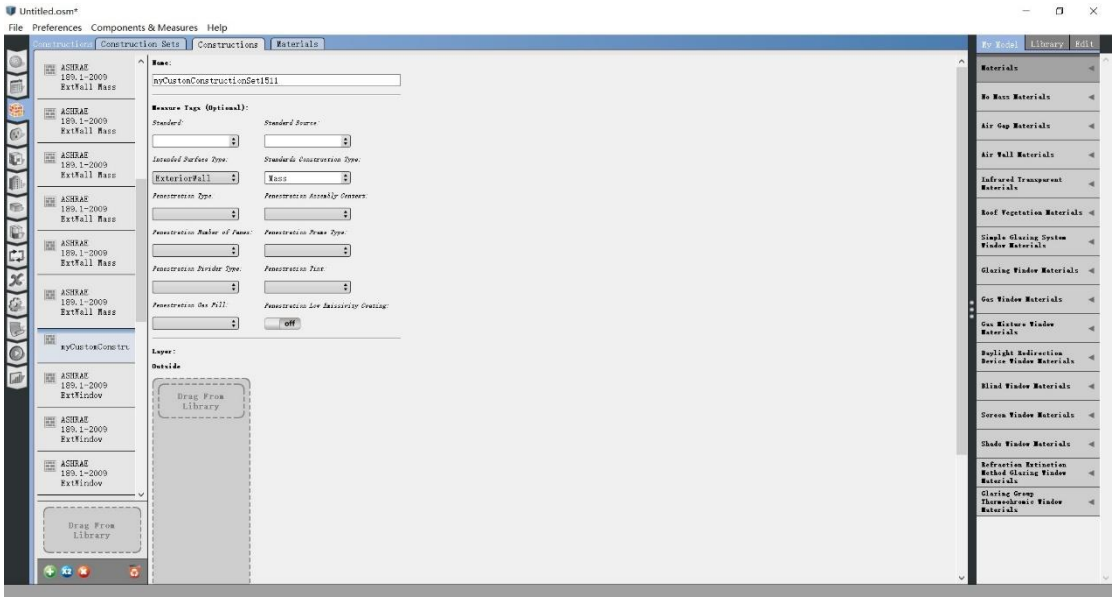


3. <u>How to define a new construction or check the properties of the existing ones.</u>

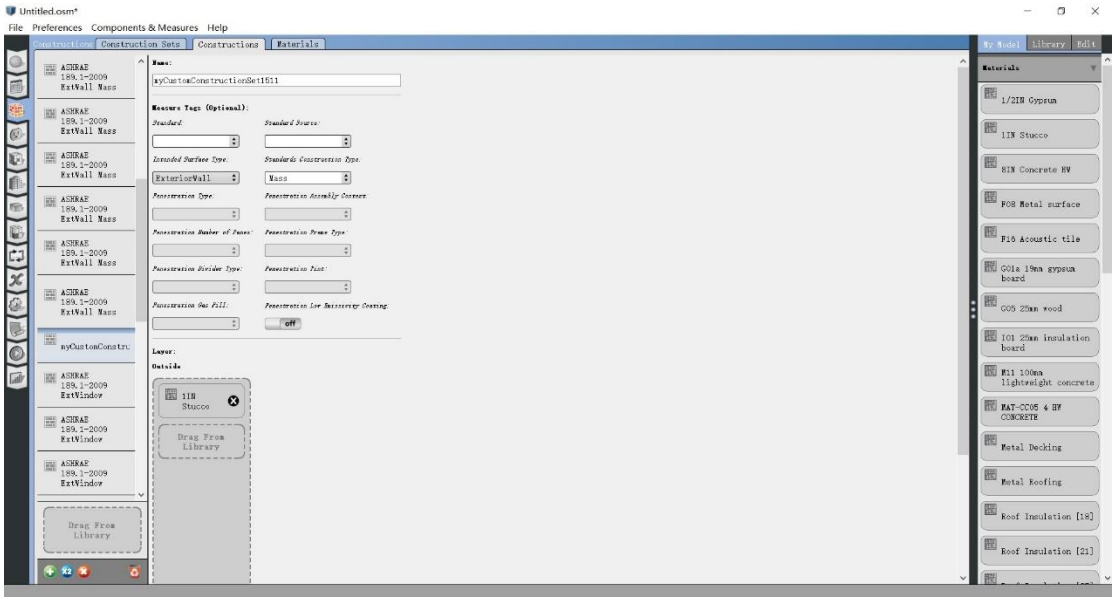
- Go to “Constructions” tab

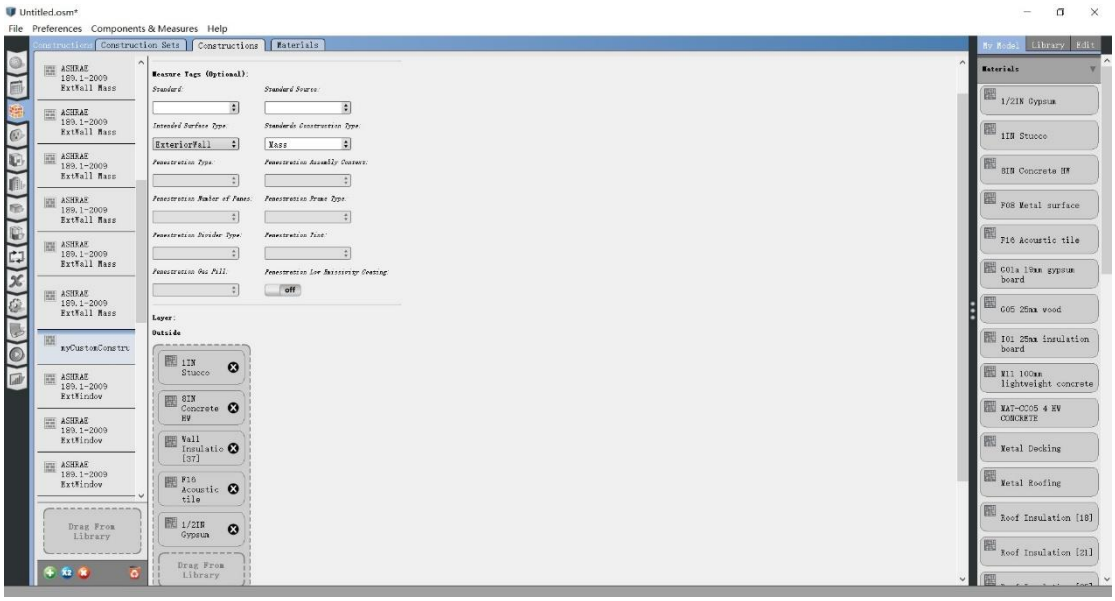


- Use “Duplicate” button and then just remove existing layers



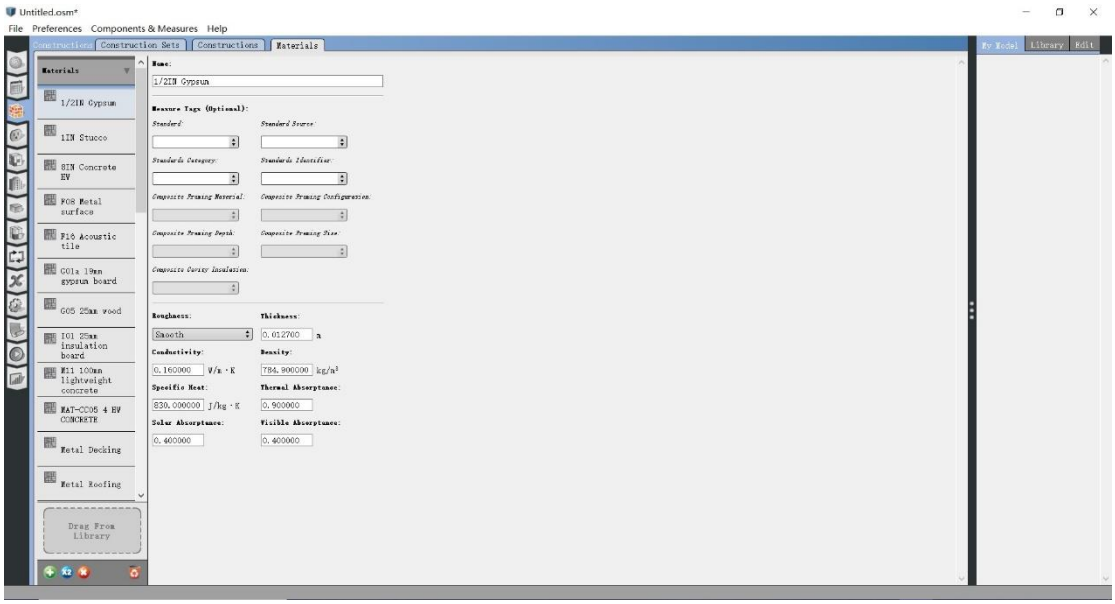
- Drag and drop the materials from the material library on the right to create a custom one. (We should to add these elements from the outside to the inside)



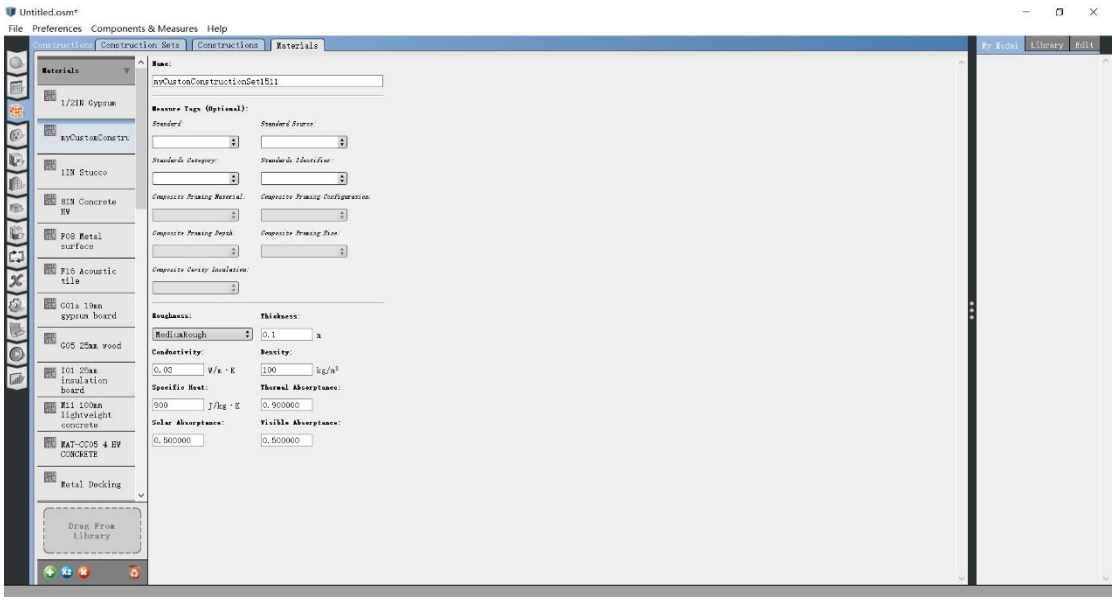


4. *<u>How to define new materials.</u>*

- Go to “Materials” tab

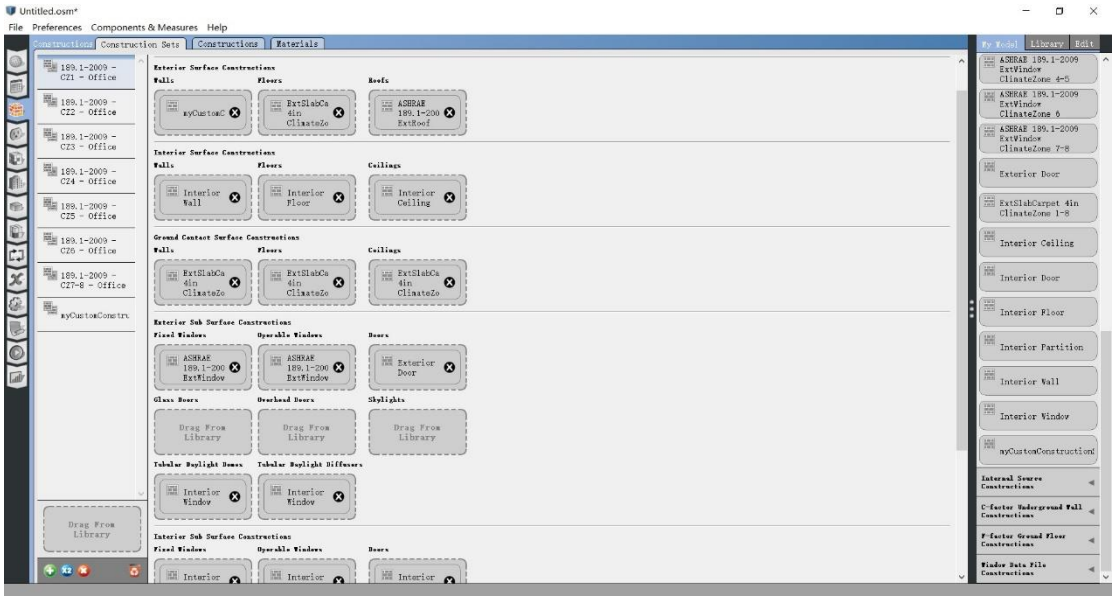


- Use “Duplicate” button again , rename the materials and change the thickness or properties

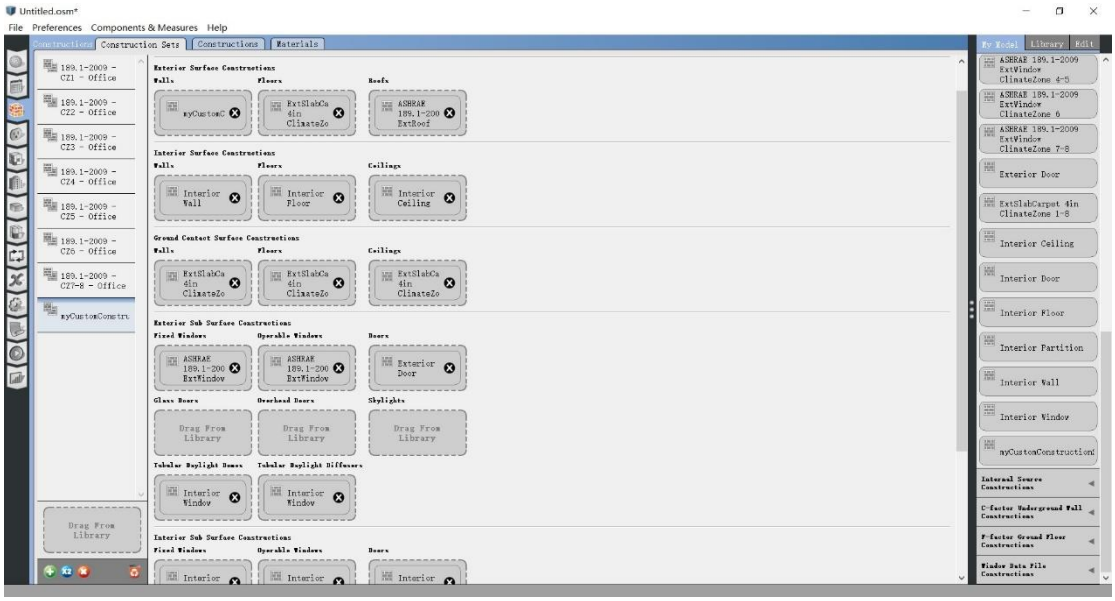


5. *How to use the customized constructions(step3) to modify the customized construction set(step2).*

- Go to "Construction Sets" tab



- Drag the customized constructions from "My Model" and drop in the customized construction set.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File
Preferences
Components & Measures
Help
Constructions
Construction Sets
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Materials
189.1-2009 - CZ1 - Office
189.1-2009 - CZ2 - Office
189.1-2009 - CZ3 - Office
189.1-2009 - CZ4 - Office
189.1-2009 - CZ5 - Office
189.1-2009 - CZ6 - Office
189.1-2009 - CZ7-8 - Office
myCustomConstru
Drag From Library
Exterior Surface Constructions
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ExtSlabCa 4in ClimateZo
ASHRAE 189.1-200 ExtRoof
Interior Surface Constructions
Walls
Floors
Ceilings
Interior Wall
Interior Floor
Interior Ceiling
Ground Contact Surface Constructions
Walls
Floors
Ceilings
ExtSlabCa 4in ClimateZo
Exterior Sub Surface Constructions
Fixed Windows
Operable Windows
Doors
ASHRAE 189.1-200 ExtWindow
Exterior Door
Glass Doors
Overhead Doors
Skylights
Drag From Library
Tubular Daylight Domes
Tubular Daylight Diffusers
Interior Window
Interior Sub Surface Constructions
Fixed Windows
Operable Windows
Doors
Interior
My Model
Library
Edit
ASHRAE 189.1-2009 ExtWindow ClimateZone 4-5
ASHRAE 189.1-2009 ExtWindow ClimateZone 6
ASHRAE 189.1-2009 ExtWindow ClimateZone 7-8
Exterior Door
ExtSlabCarpet 4in ClimateZone 1-8
Interior Ceiling
Interior Door
Interior Floor
Interior Partition
Interior Wall
Interior Window
myCustomConstruction
Internal Source Constructions
C-factor Underground Wall Constructions
F-factor Ground Floor Constructions
Window Data File Constructions