

Meyerson Atrium Design

Environmental Systems I - 10/29/2017
Elizabeth Heldridge

For the atrium analysis of Meyerson, I tried to see what simply changing the shape would accomplish. This analysis was completed without the use of night-flush, and standard window / glazing ratio values. Overall, the building maintained a reasonable level of comfort throughout the July day of occupancy, however critically the lowest floors on the west and east sides, but specifically the west, experienced high levels of discomfort and would require extensive air conditioning to maintain the 80/20 comfort ratio.

To improve this analysis further, I would have looked at increasing the roof opening of the chimney, or increasing the height of that space, allowing the hot air to move upwards. I also would have increased the inlet dimension on the first floors, hoping to allow the hot air to escape more easily.

FileUnitsHelp

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint:

2688.0 m²

Occupied area per floor:

2048.0 m²

Glazing-to-wall ratio per floor:

45 %

Opening-to-wall ratio per floor:

15 %

Ratio of roof opening to roof area:

0.2 %

Number of floors:

4

Floor length:

32 m

Floor (bay) width:

32 m

Floor-to-floor height:

4 m

Floor-to-ceiling height:

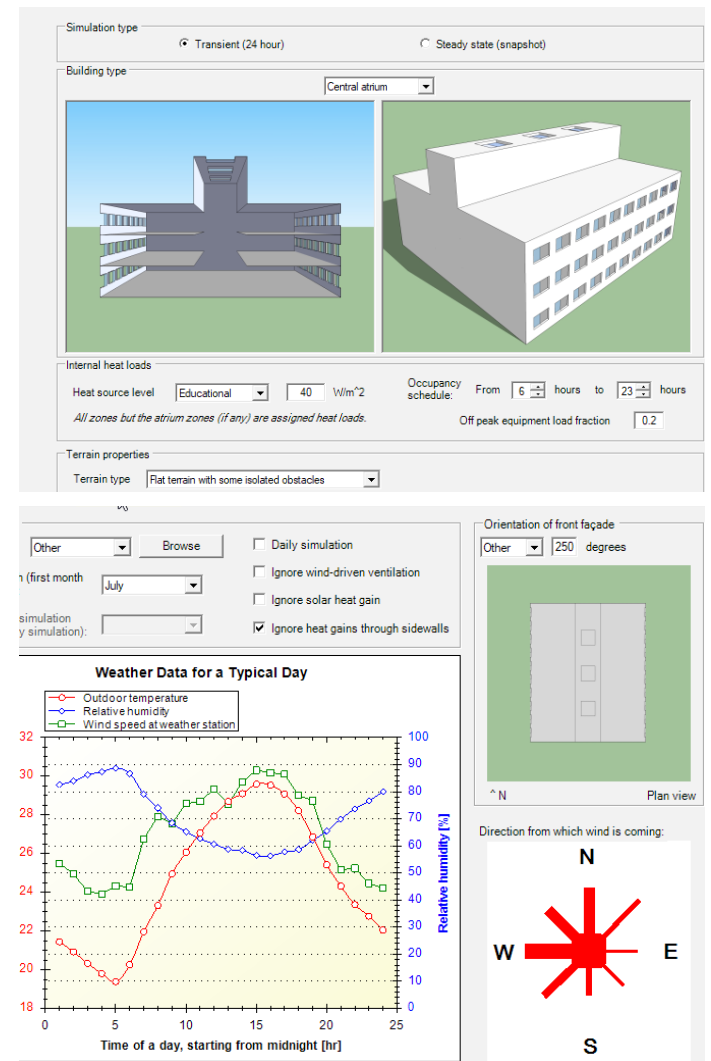
3.5 m

Chimney width:

20 m

Chimney height:

5 m

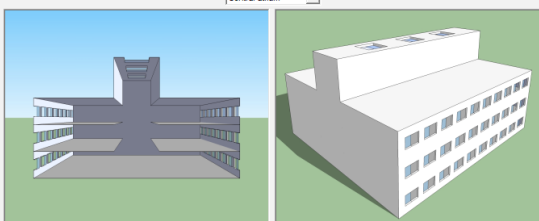


MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Simulation type: ☒ Transient (24 hour) ☐ Steady state (snapshot)

Building type: Central atrium



Internal heat loads

Heat source level: Educational 40 W/m²

Occupancy schedule: From 6 hours to 23 hours

All zones but the atrium zones (if any) are assigned heat loads.

Off peak equipment load fraction: 0.2

Terrain properties

Terrain type: Flat terrain with some isolated obstacles

File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

01

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Side windows dimensions

Single opening window

In each floor, there is only one opening per window (see schematic)

In each floor, there are two openings separated vertically per window (see schematic). REQUIRED for single-sided ventilation

Window glazing area per floor per facade, fixed and operable (to calculate solar gains through windows): 30 m²

Operable window area per floor (used to calculate air flowrate): 2 m²

Height from floor to mid-opening (h): 1.75 m

Operable lower window area per floor per facade: 1 m²

Height difference between upper and lower opening (Delta H in figure): 1 m

Roof opening dimensions

Roof operable area: 1 m²

Note: CoolVent does not account for solar heat gains through the roof opening(s)

Internal opening dimensions

Internal opening area per floor: 20 m²

Advanced internal opening options: Advanced...

Additional opening options

More window options and opening specifications: Advanced...

File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

04

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Other Browse

Daily simulation

Ignore wind-driven ventilation

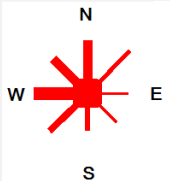
Ignore solar heat gain

Ignore heat gains through sidewalls

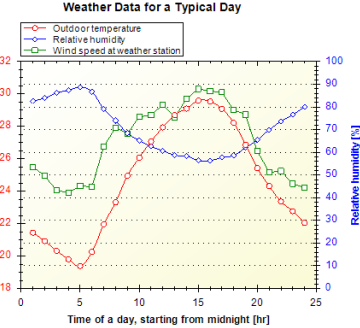
Orientation of front facade: Other 250 degrees

Plan view

Direction from which wind is coming:



Weather Data for a Typical Day



File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

02

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Thermal mass

Include slab thermal mass

Floor / roof slab thickness: 10 cm

Floor slab material: Concrete

Floor type: Exposed

Exposed area: 90 % of floor area

Ceiling type: Exposed

Night cooling

Use night cooling: Windows open at nighttime, when the air is cold enough to cool down the thermal mass. Windows close (down to 10%) during daytime to prevent hot outdoor air from entering the building. If the building has a fan, it will be used to assist night cooling.

Time controlled: close all windows at 7 hours, open windows at 19 hours

Temperature controlled: close windows in zones where temperature is lower than outdoor temperature; close windows otherwise

Window operation

Close windows when the outdoor air temperature drops below 16 °C

Close Window and turn on heating when any internal zone temperature drops below 18 °C

Hybrid ventilation mode

Use hybrid mechanical-natural ventilation

Turn on fan when any internal zone temperature is above 24 °C or humidity ratio is above 0.012 (kg water) / (kg air)

Close windows, turn off fan and turn on AC when any internal zone temperature is above 26 °C or humidity ratio is above 0.012 (kg water) / (kg air)

Allow independent window and AC control in each zone

Define fan / AC operating characteristics: Specify fan / AC

File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

05

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Building dimensions

Number of floors: 4

Floor length: 32 m

Floor (bay) width: 32 m

Floor-to-floor height: 4 m

Floor-to-ceiling height: 3.5 m

Chimney width: 20 m

Chimney height: 5 m

File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

03

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Comfort Model Selection

2010 ASHRAE Standard 55 Thermal Comfort Model

Occupants wear typical clothing for warm environment (0.5 clo of clothing)

Occupants wear typical clothing for cool environment (1.0 clo of clothing)

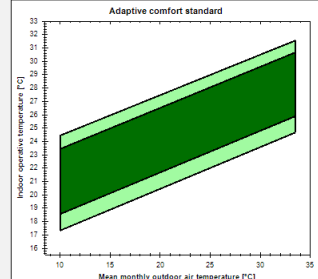
2010 ASHRAE Standard 55 Adaptive Comfort Model - for naturally ventilated spaces

90% Acceptability limits (always included)

80% Acceptability limits (includes 90% limits)

Custom Thermal Comfort Model

Adaptive comfort standard



Note: thermal comfort analysis is performed by rounding the temperature to 1 significant figure after the decimal mark and the humidity to 2 significant figures after the decimal mark (in a unit mass of water per unit mass of dry air basis). For the adaptive comfort standard, the indoor operative temperature is calculated for an occupant in the center of each zone.

File Units Help

Meyerson Atrium

Scenario summary

Simulation type: transient

Building type: central atrium

Building footprint: 2688.0 m²

Occupied area per floor: 2048.0 m²

Glazing-to-wall ratio per floor: 45 %

Opening-to-wall ratio per floor: 15 %

Ratio of roof opening to roof area: 0.2 %

Calculate inputs / Save scenario

Visualize results

06

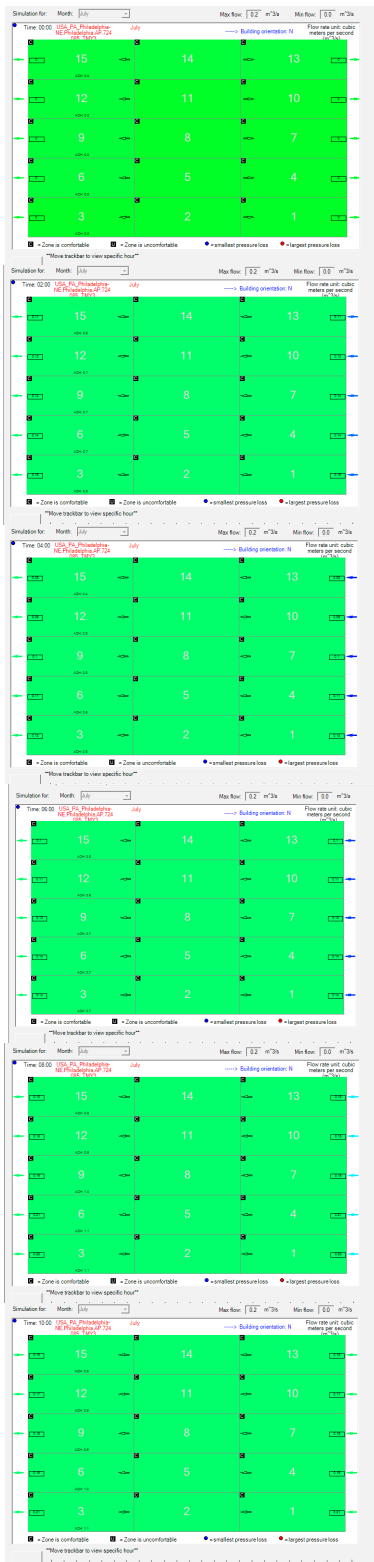
Meyerson CrossVentilation Design

Environmental Systems I - 10/29/2017

Elizabeth Heldridge

For this cross-ventilation analysis, I decided to enable all the options for hybrid cooling, operable windows automatically opening and closing, and increase the square footage of operable facade. I also reoriented the building so that the facades were primarily north and south, rather than east and west. It is possible that this analysis would have led to the values shown on the left, however I am suspicious that something went wrong in the analysis that led to the strange pattern shown here. When I ran the analysis a couple more times, the result did not change, so I decided to include it with the disclaimer that I'm pretty sure something is inaccurate.

If these values were correct though, this design would likely be very successful.



02

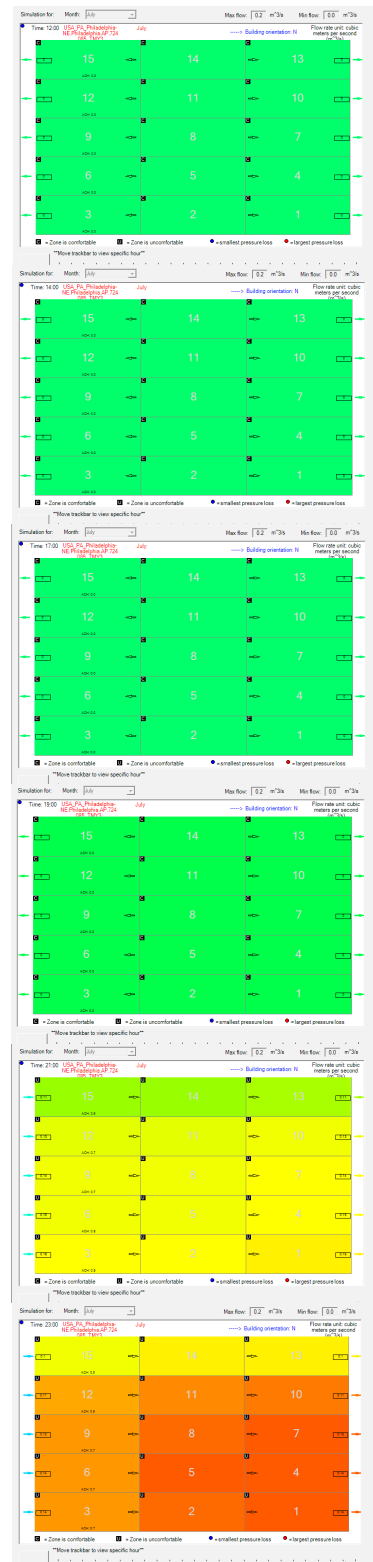
04

06

08

10

12



14

16

18

20

22

24

File Units Help

Meyerson Cross Vent

Meyerson Cross Vent

Scenario summary

Simulation type: transient

Building type: cross ventilation

Building footprint: 600.0 m²

Occupied area per floor: 600.0 m²

Glazing-to-wall ratio per floor: 10.0 %

Opening-to-wall ratio per floor: 2.9 %

Ratio of roof opening to roof area: 0.0 %

Number of floors: 5

Floor length: 20 m

Section width: 10 m

Floor-to-floor height: 3.5 m

Floor-to-ceiling height: 3 m

Simulation type

Transient (24 hour) Steady state (snapshot)

Building type

Cross ventilation

Internal heat loads

Heat source level: Educational 40 W/m² Occupancy schedule: From 7 hours to 24 hours Off peak equipment load fraction: 0.2

Terrain properties

Terrain type: Flat terrain with some isolated obstacles

data

city: Other Browse Daily simulation Ignore wind-driven ventilation Ignore solar heat gain Ignore heat gains through sidewalls

month (first month): July

th of simulation (hourly simulation):

Orientation of front façade

N 0 degrees

Direction from which wind is coming:

W N E S

Weather Data for a Typical Day

Temperature [°C] Relative humidity [%] Wind speed at weather station

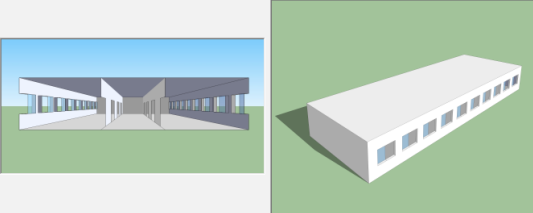
Time of a day, starting from midnight [hr]

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Simulation type: ☒ Transient (24 hour) ☐ Steady state (snapshot)

Building type:



Internal heat loads

Heat source level: W/m² Occupancy schedule: From hours to hours

All zones but the atrium zones (if any) are assigned heat loads. Off peak equipment load fraction:

Terrain properties

Terrain type:

File Units Help

Meyerson Cross Vent

Scenario summary

Simulation type: transient

Building type: cross ventilation

Building footprint: 600.0 m²

Occupied area per floor: 600.0 m²

Glazing-to-wall ratio per floor: 10.0 %

Opening-to-wall ratio per floor: 2.9 %

Ratio of roof opening to roof area: 0.0 %

Calculate inputs / Save scenario

Visualize results

01

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Side window dimensions

☒ In each floor, there is only one opening per window (see schematic)

☐ In each floor, there are two openings separated vertically per window (see schematic). REQUIRED for single-sided ventilation

Window glazing area per floor per facade, fixed and operable (to calculate solar gains through windows): m²

Operable window area per floor (used to calculate air flowrate): m²

Height from floor to mid-opening (h): m

Operable lower window area per floor per facade: m²

Height difference between upper and lower opening (Delta H in figure): m

Roof opening dimensions

Roof operable area: m²

Note: CoolVent does not account for solar heat gains through the roof opening(s)

Internal opening dimensions

Internal opening area per floor: m² Advanced internal opening options:

Additional opening options

More window options and opening specifications:

File Units Help

Meyerson Cross Vent

Scenario summary

Simulation type: transient

Building type: cross ventilation

Building footprint: 600.0 m²

Occupied area per floor: 600.0 m²

Glazing-to-wall ratio per floor: 10.0 %

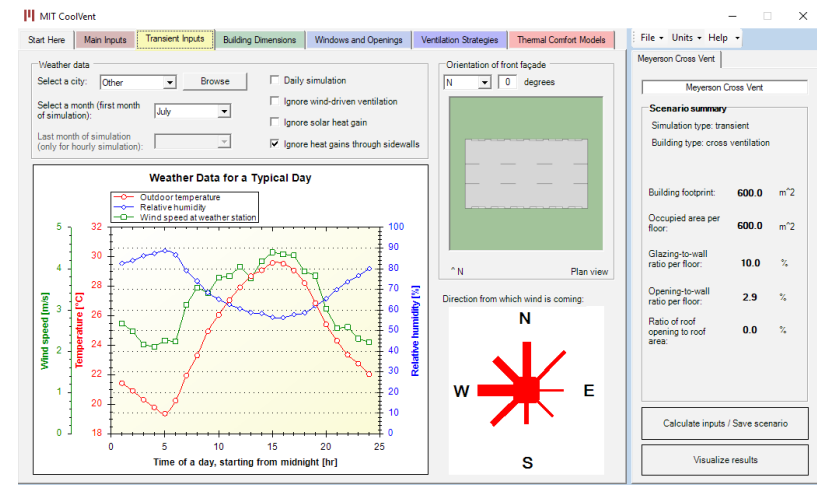
Opening-to-wall ratio per floor: 2.9 %

Ratio of roof opening to roof area: 0.0 %

Calculate inputs / Save scenario

Visualize results

04



02

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Thermal mass

☒ Include slab thermal mass

Floor / roof slab thickness: cm Floor slab material: Floor type: Ceiling type:

Exposed area: % of floor area

Night cooling

☒ Use night cooling. Windows open at nighttime, when the air is cold enough to cool down the thermal mass. Windows close (down to 10%) during daytime to prevent hot outdoor air from entering the building. If the building has a fan, it will be used to assist night cooling.

☒ Time controlled: close all windows at hours, open windows at hours

☐ Temperature controlled: close windows in zones where temperature is lower than outdoor temperature; close windows otherwise

Window operation

☐ Close windows when the outdoor air temperature drops below °C

☐ Close Window and turn on heating when any internal zone temperature drops below °C

Hybrid ventilation mode

☒ Use hybrid mechanical-natural ventilation

☒ Turn on fan when any internal zone temperature is above °C or humidity ratio is above (kg water) / (kg air). Windows will open even if using night cooling.

☒ Close windows, turn off fan and turn on AC when any internal zone temperature is above °C or humidity ratio is above (kg water) / (kg air)

☐ Allow independent window and AC control in each zone

Define fan / AC operating characteristics:

File Units Help

Meyerson Cross Vent

Scenario summary

Simulation type: transient

Building type: cross ventilation

Building footprint: 600.0 m²

Occupied area per floor: 600.0 m²

Glazing-to-wall ratio per floor: 10.0 %

Opening-to-wall ratio per floor: 2.9 %

Ratio of roof opening to roof area: 0.0 %

Calculate inputs / Save scenario

Visualize results

05

MIT CoolVent

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Building dimensions

Number of sections: Help:

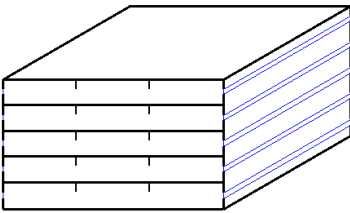
Number of floors:

Floor length: m

Section width: m

Floor-to-floor height: m

Floor-to-ceiling height: m



File Units Help

Meyerson Cross Vent

Scenario summary

Simulation type: transient

Building type: cross ventilation

Building footprint: 600.0 m²

Occupied area per floor: 600.0 m²

Glazing-to-wall ratio per floor: 10.0 %

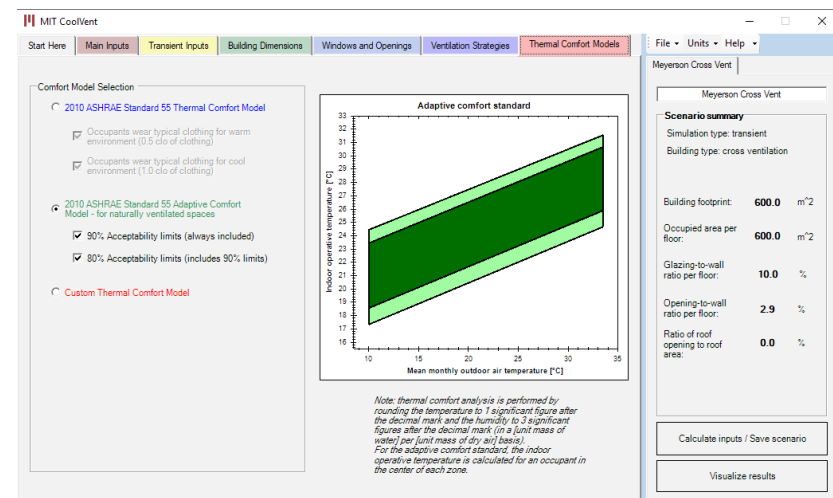
Opening-to-wall ratio per floor: 2.9 %

Ratio of roof opening to roof area: 0.0 %

Calculate inputs / Save scenario

Visualize results

03



06