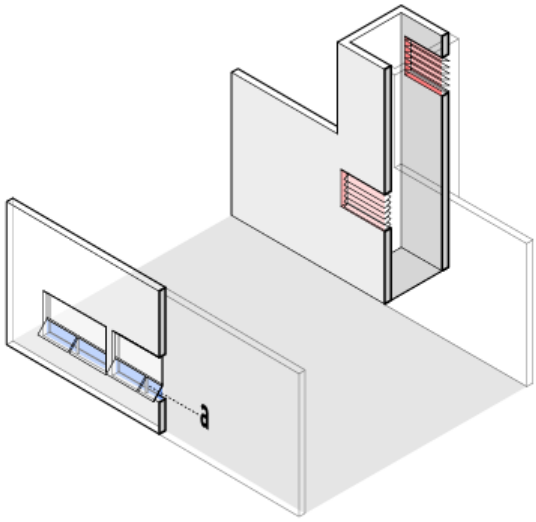
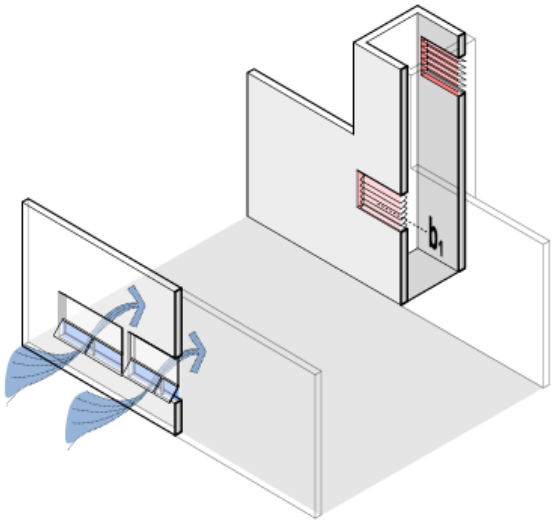
Section 1: Stack Ventilation Shaft

A Stack Ventilation shaft, attached to a space, uses the air's buoyancy effect to remove warm air. Stack Ventilation induces vertical air currents to passively ventilate a space and remove warm air. As warm indoor air rises, it enters the ventilation shaft through an ***intake opening*** and continues to rise until it is evacuated through ***outlet openings*** at the top of the shaft. The warm indoor air displaced from the space draws outdoor cooler air into the space through ***inlet openings***.

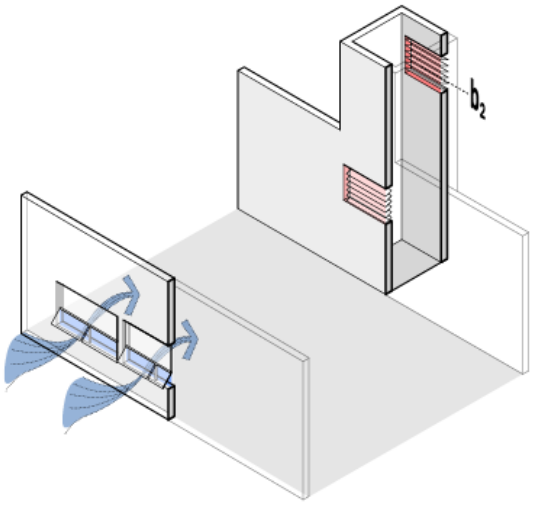
Ventilation Shaft System Design

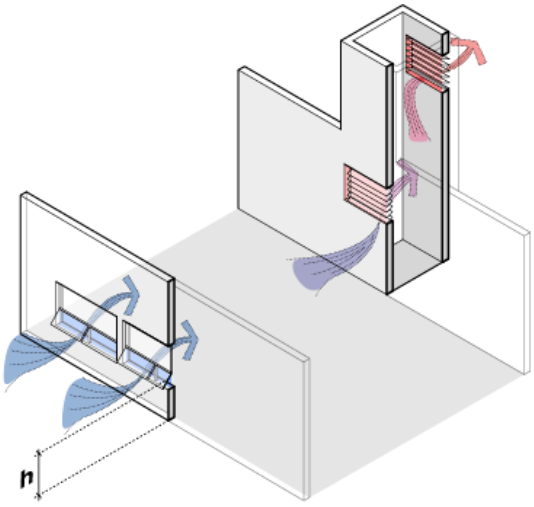
Locate the openings in relation to each other and the height of the space to induce natural wind currents.



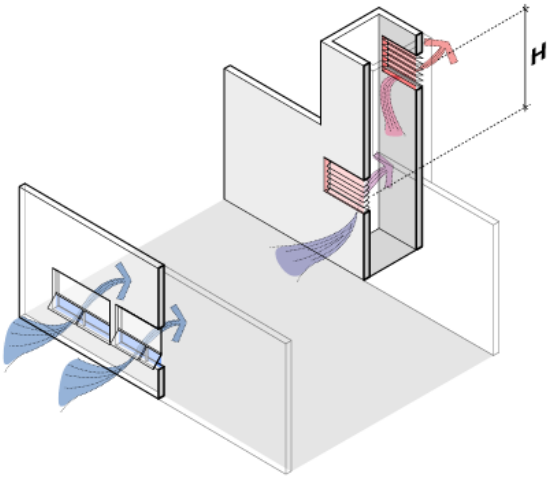


1. Locate the ***inlet openings [a***] towards the vertical center of the space, 0.76 m to 1.37 m (2.5 ft to 4.5 ft) above finished floor.
2. Locate the ***shaft intake opening [b1]*** as high as possible within the space to be ventilated. The shaft intake opening may be placed vertically on a wall surface or horizontally as part of the ceiling.





3. Locate the ***shaft outlet opening [b2]*** as high as possible on the exterior wall of the shaft, opposite from the ***space inlet opening area [a]***.
4. The height of the inlet openings above the ***floor [h]*** should result in a path that allows for appropriate ventilation of occupants' upper bodies (i.e. heads and torsos).



5. The ***ventilation shaft height [H]*** is measured from the center of the shaft intake to the center of the shaft outlet. The total amount of heat removed from a space is proportional to the height of the ventilation shaft. The higher the shaft, the greater the volume of air displaced.

Determining Area of the Openings

The size of the openings is a function of the ***ventilation shaft height [H]*** and the building's classification, based on the summer design dry bulb temperature. Follow the steps below to determine:

i. the building's classification,
ii. the area of the inlet openings [a] as a percentage of the floor area of the space to be ventilated, and
iii. the size of the remaining openings.

Step 1: Determine the Building's Classification

The building's classification is a rough estimate of the amount of heat to be removed from the space. To determine the building's classification, use the summer design dry bulb temperature at the building's location and the tables below. For commercial buildings, also consider the expected amount of internally generated heat from people, equipment, and electric lighting.

Residential Buildings	
Summer Dry Bulb Design Temperature	**Building Classification**
Warm – 29˚C (85˚F)	Low
Hot – 32˚C (90˚F)	Medium
Very Hot – 35˚C (95˚F)	High

Commercial Buildings		
Summer Dry Bulb Design Temperature	**Internal Space Heat Gain**	**Building Classification**
Warm – 29˚C (85˚F)	Small	Low
	Large	Medium
Hot – 32˚C (90˚F)	Small	
	Large	Medium/High
Very Hot – 35˚C (95˚F)	Small	
	Large	High

"High" Classification = heat gain 45 W/m2 (15 Btu/h ft2)
"Medium" Classification = heat gain 38 W/m2 (12 Btu/h ft2)
"Low" Classification = heat gain 30 W/m2 (10 Btu/h ft2)

Step 2: Determine the Inlet Opening Areas

Next, using a preliminary estimate of the *ventilation shaft height [H]*, trace a horizontal line moving toward the right side of the graph below until it intersects with the curve that best describe your building's classification. From the intersection of the horizontal line and the appropriate curve for your building's heat gain characteristics, move vertically toward the bottom of the graph to find the area of the *inlet openings [a]* as a percentage of the floor area to be ventilated. The inlet opening area is the total area of the *inlet openings [a]* as a percentage of the floor area to be ventilated. The inlet opening area is the total area of all inlet openings, whether incorporating a single opening or number of openings.

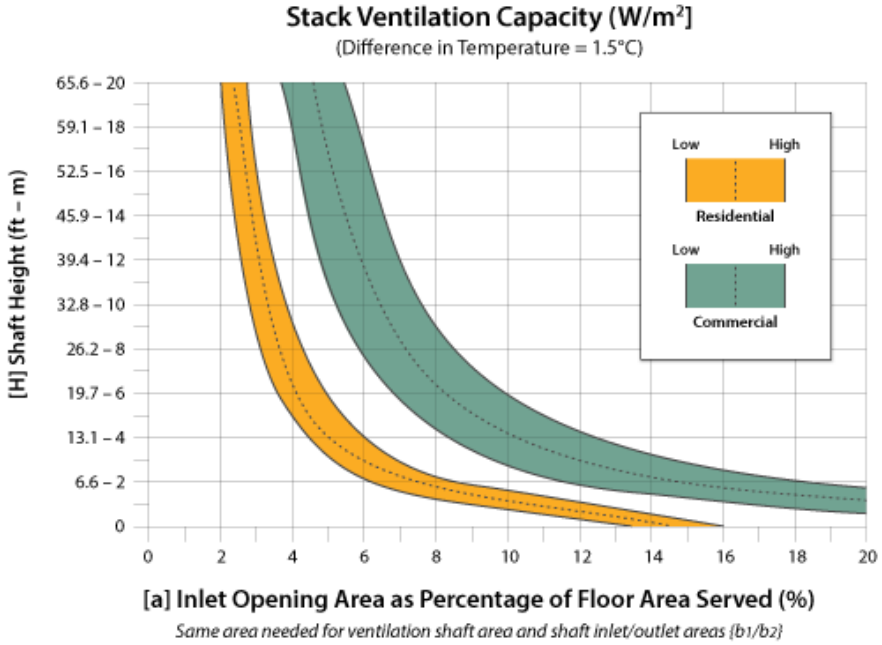


Image Credit: Alfredo Fernandez Gonzalez, UNLV Natural Energies Advanced Technologies Lab

For example, a commercial building with a "Low" Building Classification, and an estimated ventilation stack height of 20 ft (6.1 m), the total area of the inlet opening would equal 6.8% of the total naturally ventilated floor area:

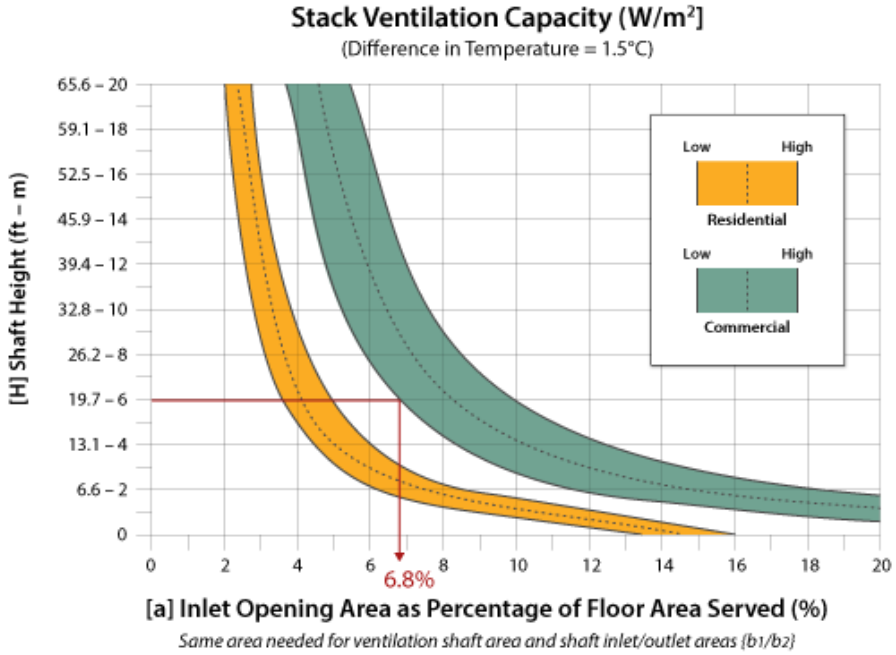


Image Credit: Alfredo Fernández González, UNLV Natural Energies Advanced Technologies Lab

Step 3: Determine the Size of the Remaining Openings

The area of the openings is directly related to the area of the inlet openings [a], once you have determined the size of the inlet openings [a], you can determine the size of the other openings. The area of the shaft intake opening [b1] and the cross sectional area of the ventilation shaft should be the same size as the area of the inlet openings [a]. The shaft outlet opening [b2] should be the same size or bigger than the inlet openings [a]; the larger the ratio between the size of the outlet and inlet openings, the greater the pressure difference and the more cool air that can be pulled into the space.