Natural Ventilation of Buildings and Spaces

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Many times when clients desire a “green” space or building that connects its occupants to the outdoors, they envision incorporating lots of daylighting and natural ventilation in the architectural design. Certainly, there can be many benefits to be had including lower energy bills, a connection to the outdoors, improved air quality and a supply of fresh air. So is natural ventilation accomplished simply by providing operable (i.e. openable) windows, especially when you are in a mild climate like the Bay Area? Let’s find out…

Natural Ventilation – Cross & Stack

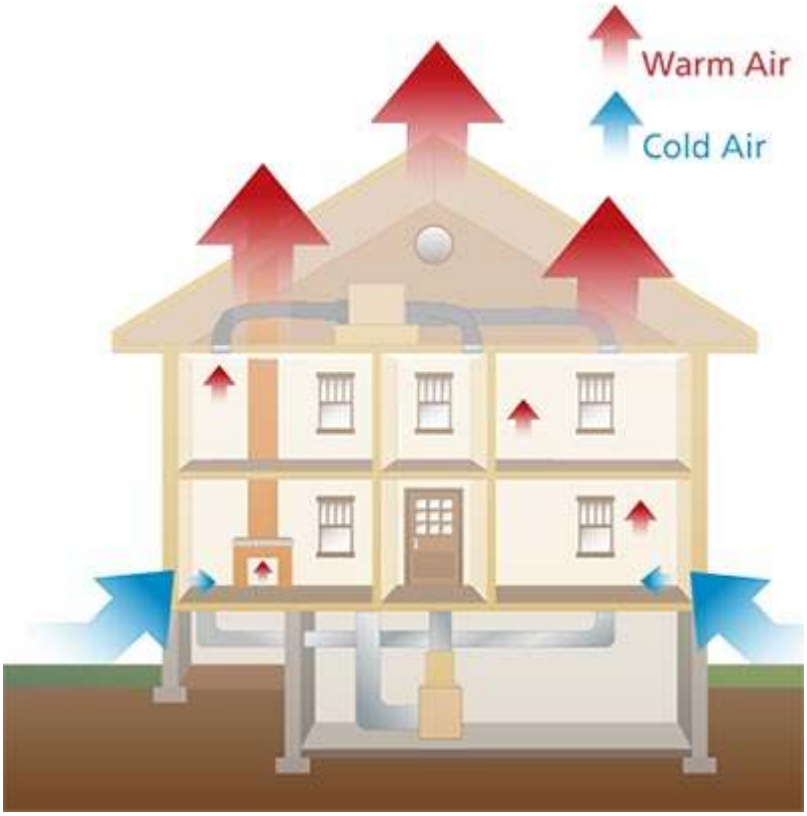
First of all, there are 2 basic types of natural ventilation – cross and stack. For cross ventilation, you need windows on opposite sides, for stack ventilation, they need to be placed high and low. You can combine the 2 strategies and place high and low windows on opposite sides but it’s not guaranteed to work unless you locate the windows correctly in terms of wind directions, time of year, sizing, etc. To ensure that it will work irrespective of wind direction and other factors, you would need to incorporate exhaust fans that kick on when the weather outside is right for cross ventilation to work.

An important thing to consider is that often when the temperature of the air is just right outside (e.g. spring), there is also a lot of pollen in the air.

Buildings can also combine natural and mechanical ventilation strategies, where the window opening/ closing is tied to the HVAC system of the building. These buildings employ a commonly used strategy which is to signal the occupants of the building to open windows when the weather outside is right for natural ventilation. All other times, the windows remain closed and the building gets by on just mechanical ventilation. In these buildings, it helps to have lots of shading in the building design either by way of awnings or trees, to limit the need for active air conditioning or full blown HVAC.

There are many free software available today that can be used to design **natural cross ventilation**, such as Cool Vent (by M.I.T.) andCONTAM (by N.I.S.T.). Climate Consultant (by U.C.L.A.) also a free software, is a great tool for carrying out an analysis of wind patterns, annual temperature and humidity in order to determine the percentage of time when natural ventilation will provide desirable conditions indoors. Computational Fluid Dynamics is a highly accurate method of air and thermal analysis but is expensive to commission and requires hiring a specialist with the right software. Natural ventilation fenestration can also be designed to provide various degrees of passive (i.e. non-mechanical) cooling by focusing on sizing, difference between indoor and outdoor temperatures for the time of year in question, amount of BTUs of heat to be extracted from indoor air, etc. The book Mechanical and Electrical Equipment for Buildings has some great charts and formulae to help with this aspect of design.

It is important to ensure that the floor area/ space to be ventilated, is clear with no intermittent partitions located in the way of the wind flow. With regard to **stack ventilation,** you need to be able to separate the high and low windows by a minimum of 10′ for it to work. And the volume of the space/room will need to be free and clear with no intermittent obstructions that impede air flow. Also please remember that the nature of the screen employed in the window will cut down the available size of the opening and should be taken into account.



Stack ventilation is greatly predictable and preferred over cross ventilation because the former takes advantage of natural buoyancy and is not dependent on direction of wind flow.

Often time, Owners notice existing wind patterns on-site. Can you take advantage of these existing wind patterns?

If you wish to take advantage of this wind, it is important to confirm first if the wind is blowing at a time when the temperature is right to use natural ventilation. It is also very important that the times of year when the wind blows should not coincide with pollen/ allergy season. Once this is confirmed, next steps can be taken to locate and size openings.

Ultimately though, for the natural ventilation strategy to actually be employed once the building is ready and occupied, it's important to think it through with the help of a software and in discussion with the project's mechanical engineer. It is also important to keep in mind the other issues that can crop up with operable windows – equipment inside the building could get wet if the windows are accidentally left open when it rains, or heat escaping from windows in winter. You may also increase chances of break-ins. On

the other hand it might be wise to provide operable windows if not for natural ventilation then just for the ability to use them when the power goes out. They also help future-proof a building against the vagaries of climate change.

I hope this sheds some more light on the issue. If you wish to proceed with employing the natural ventilation strategy, please contact HBS for further help with simulations and calculations.

Thank you for taking the time to read this blog!

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