HME09 – NATURAL VENTILATION

Requirement Summary

This measure can be claimed when two conditions are met. The first one is the room depth to ceiling height ratio and the proportion of openings required for a certain floor area. Both conditions should be calculated room by room in order to ensure adequate natural ventilation for the whole home. The methodology for this calculation is explained below.

Intention

A well-designed natural ventilation strategy can improve occupant comfort by providing both access to fresh air as well as reducing the temperature. This results in a reduction of the cooling load, which lowers initial capital and maintenance costs.

Approach/Methodologies

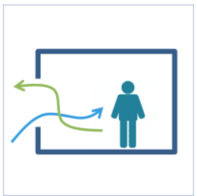
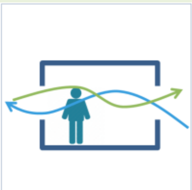
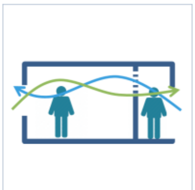
There are no complex units of measurement used to assess compliance with this measure. Instead some simple conditions ("rules of thumb") can be used to help design spaces for the benefit of human comfort. The key factors in deciding the ventilation strategy are room size (depth, width, and height), and the number and location of openings.

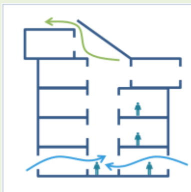
Potential Technologies/Strategies

EDGE uses cross flow ventilation, where fresh air is drawn from outside into the occupied space and the exhaust air is delivered at a different location, as explained in Table 15. This type of ventilation is used for the improved case as it is most effective if the external air temperature is neither too hot nor too cold (temperate climates). As EDGE takes into account the external temperature it is possible to test the potential effectiveness by using the software. If EDGE predicts significant savings, then a suitable strategy should be considered.

There are two basic approaches to the design of cross ventilation: single-sided and two-sided. Two-sided ventilation is used to ventilate single spaces (which have openings on both windward and leeward sides) and double-banked rooms that rely on openings in corridors between rooms. Single-sided ventilation is used where two-sided ventilation is not possible, but the room depth that can be ventilated in this way is much lower.

Table 16: Type of cross ventilation

Type	Image	Description
Single-sided Ventilation		Single-sided ventilation relies on the pressure differences between different openings within a single space. It is more predictable and effective than if there is only a single opening, and can therefore be used for spaces with greater depth. For spaces that only have a single opening the ventilation is driven by turbulence. This turbulence creates a pumping action on the single opening, causing small inflows and outflows. As this is a less predictable method, the room depth for single opening, single-sided ventilation is reduced.
Cross-ventilation - Single Spaces		Cross ventilation of single spaces is the simplest and most effective approach. Cross-ventilation is driven by pressure differences between the windward and leeward sides of the space.
Cross-ventilation - Double-Banked Spaces		Cross-ventilation with banked rooms can be achieved by creating openings in the corridor partition. It is only acceptable where a residential unit has ownership of both windward and leeward sides of the building, as the ventilation of the leeward space relies on the occupant of the windward space. The openings also provide a route for noise to travel between spaces. One potential solution is to provide a channel which bypasses the windward space, allowing the occupant of the leeward space complete control of air flow.

Stack Ventilation		Stack ventilation takes advantage of the temperature stratification and associated pressure differentials of the air. Warm air becomes less dense and rises and the cooler air replaces the air that has risen. This type of ventilation requires atriums or height differences.

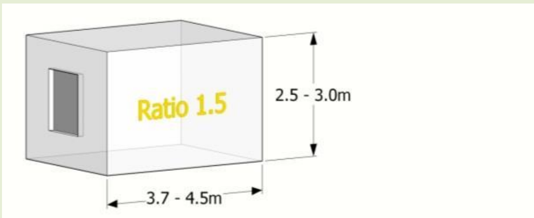
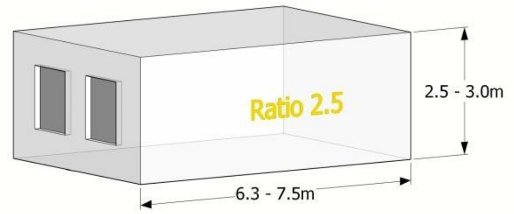
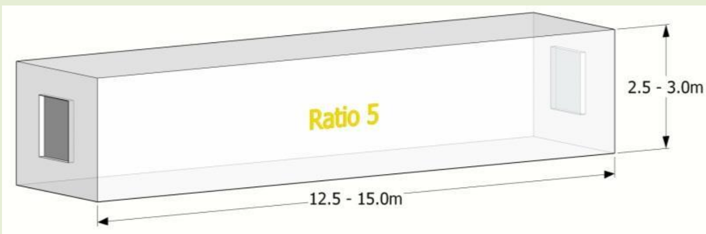
In order to achieve acceptable natural ventilation flow, the following methodology must be considered: i) maximum ratio of floor depth to ceiling height, and ii) the heat gains to be dissipated, which determine the total area of the opening. The latter requires two steps to be calculated, the sum of the heat gains (lighting, occupancy, and equipment) and the window area (this includes external doors or main doors with a security gate which may contribute towards the openable area for the natural ventilation measure).

Room Depth to Ceiling Height Ratio

EDGE's methodology for natural ventilation first requires that the maximum room depth versus ceiling height is calculated following the ratio in Table 16.

The depth of space that can be ventilated using a cross flow ventilation strategy is dependent on the floor to ceiling height and the number and location of the openings. The rules of thumb below can be used to assess compliance.

Table 17: Depth of floor to ceiling height ratio for different room configurations

Room/Opening Configuration	Image/Example	Maximum Depth of Floor to Ceiling Height Ratio
Single-sided, single opening		1.5
Single-sided, multiple openings		2.5
Cross ventilation		5.0

Minimum Area of Opening

Table **18** indicates the percentage of the opening area required in order to dissipate those heat gains within the space. The area of opening can be calculated following room types and then multiplying the total area of the room by the percentage indicated.

Table 18: Total area of opening as a proportion of floor area for different heat gain ranges.

Room Type	Heat Gains	Total Area of Opening Required as a Percentage of Floor Area
Bathroom	<15 W/m²	10%
Bed Room	15-30 W/m²	20%
Living Room	15-30 W/m²	20%
Kitchen	>30 W/m²	25%

Example:

Q: A living room with 24sqm floor area and ceiling height of 3m has a single window for ventilation. What is the design criteria to ensure compliance with natural ventilation requirements?

A: Depth of floor to ceiling height ratio should be less than 1.5, i.e. the plan can be 6mx4m where 4m is the depth.

As per

Table **18**, 20% of the floor area for living room should be openable which is: 4.8m².

Relationship to Other Measures

Since employing natural ventilation can significantly reduce the cooling load, the impact of more efficient cooling systems is sometimes reduced to an insignificant level. As with all passive design solutions, cross ventilation should therefore be considered before the detailed design of any HVAC equipment.

Assumptions

The base case assumes that ventilation is delivered using mechanical means; however, the cooling load is still calculated and is shown as "virtual" energy on the charts.

The cooling load can be reduced through other passive measures, including improved insulation, reduced window to wall ratio, reduced SHGC, improved solar shading, and specifying ceiling fans. Reducing the cooling load will therefore result in improved performance even when no mechanical cooling is specified.

Compliance Guidance

If this measure is claimed, then the design team will need to demonstrate compliance with the depth of floor to ceiling height ratio and minimum area of opening for all habitable rooms.

Design Stage	Post-Construction Stage
At the design stage the following must be used to demonstrate compliance: · Typical floor plans for every floor showing room layouts and the location of openings; and · Typical sections showing the floor to ceiling height for every floor; and · Calculations showing the room depth to ceiling height ratio and minimum area of opening for each typical space.	At the post-construction stage one of the following must be used to demonstrate compliance: · Confirmation from the project team that there have been no changes to the layout or the floor to ceiling height during the design/construction process; or · As-built drawings including floor plans and sections; and · Photographic evidence to demonstrate that the room layouts and location of openings as specified at the design stage have been constructed.

HME10 – CEILING FANS IN ALL HABITABLE ROOMS

Requirement Summary

This measure can be awarded where ceiling fans have been specified in all habitable rooms. In countries where ceiling fans are standard (such as India) energy-efficient ceiling fans must be installed for this measure to be claimed.

Intention

Ceiling fans are used to increase air movement that aids human comfort by promoting the evaporation of perspiration (evaporative cooling).

Approach/Methodologies

The measure can be claimed if ceiling fans have been installed in all habitable rooms. For India ceiling fans certified by Bureau of Energy Efficiency (BEE) star label of 4 or 5 stars or equivalent rating is acceptable.

Potential Technologies/Strategies

Ceiling fans are normally used to reduce cooling energy requirements by introducing higher air velocity. The increased air movement increases the range of temperatures considered to be comfortable by occupants. In order to work in this way, the fan must be installed with the raised edge of the blade on the leading edge. In this mode the effect is on perceived comfort, so if a room is unoccupied the fans should be switched off.

Ceiling fans can also be used to reduce heating requirements by reducing stratification. In this mode the raised edge of the blades should be at the trailing edge.

In order to achieve the levels of air movement assumed by EDGE, Table 19 shows the optimum number of fans and fan diameter (as measured from the center of the fan to the tip of the blade) required in different sizes of rooms. For example, a 6 meters x 6 meters room would require 4 fans with a diameter of 900mm each.

Table 19: Size (m)/Number of ceiling fans required for different room sizes[19].

Room Width	Room Length										
	4m	5m	6m	7m	8m	9m	10m	11m	12m	14m	16m
3m	1.2/1	1.4/1	1.5/1	1050/2	1.2/2	1.4/2	1.4/2	1.4/2	1.2/3	1.4/3	1.4/3
4m	1.2/1	1.4/1	1.2/2	1.2/2	1.2/2	1.4/2	1.4/2	1.5/2	1.2/3	1.4/3	1.5/3
5m	1.4/1	1.4/1	1.4/2	1.4/2	1.4/2	1.4/2	1.4/2	1.5/2	1.4/3	1.4/3	1.5/3
6m	1.2/2	1.4/2	0.9/4	1.05/4	1.2/4	1.4/4	1.4/4	1.5/4	1.2/6	1.4/6	1.5/6
7m	1.2/2	1.4/2	1.05/4	1.05/4	1.2/4	1.4/4	1.4/4	1.5/4	1.2/6	1.4/6	1.5/6
8m	1.2/2	1.4/2	1.2/4	1.2/4	1.2/4	1.4/4	1.4/4	1.5/4	1.2/6	1.4/6	1.5/6
9m	1.4/2	1.4/2	1.4/4	1.4/4	1.4/4	1.4/4	1.4/4	1.5/4	1.4/6	1.4/6	1.5/6
10m	1.4/2	1.4/2	1.4/4	1.4/4	1.4/4	1.4/4	1.4/4	1.5/4	1.4/6	1.4/6	1.5/6
11m	1.5/2	1.5/2	1.5/4	1.5/4	1.5/4	1.5/4	1.5/4	1.5/4	1.5/6	1.5/6	1.5/6
12m	1.2/3	1.4/3	1.2/6	1.2/6	1.2/6	1.4/6	1.4/6	1.5/6	1.4/8	1.4/9	1.4/9
13m	1.4/3	1.4/3	1.2/6	1.2/6	1.2/6	1.4/6	1.4/6	1.5/6	1.4/9	1.4/9	1.5/9
14m	1.4/3	1.4/3	1.4/6	1.4/6	1.4/6	1.4/6	1.4/6	1.5/6	1.4/9	1.4/9	1.5/9

Example: a living room 4 meters by 6 meters would need 2 ceiling fans each with 1.2 meters diameter and a bedroom 3m*4m would require having one ceiling fan with 1.2m diameter.

[19] Source: India National Building Code

Relationship to Other Measures

The installation of ceiling fans to reduce cooling requirements improves occupant comfort without actually cooling the air. They are therefore only beneficial in spaces that have a demonstrable cooling load.

The installation of ceiling fans to reduce heating requirements does not necessarily decrease the heating load, but can improve occupant comfort by increasing the temperature at floor level and reducing the temperature gradient from floor to ceiling.

Assumptions

The base case assumes that no ceiling fans are specified. The improved case assumes that ceiling fans have been installed in line with the above guidance. The assumption is that the efficiency of ceiling fans will be $6W/m^2$ (except in India where the assumed improved case is $4W/m^2$).

Compliance Guidance

In order to verify compliance, the design team must demonstrate that ceiling fans will be or have been installed.

Design Stage	Post-Construction Stage
At the design stage the following must be used to demonstrate compliance: • Mechanical and electrical layout drawings showing the location and number of ceiling fans; and • Manufacturer's data sheet showing the energy consumption and diameter of ceiling fans selected.	At the post-construction stage one of the following must be used to demonstrate compliance: • As-built mechanical and electrical drawings for all floors; and • Delivery notes showing that specified fans have been delivered to the site including the energy label where applicable; and • Photographs of the installed fans for a sample of the units covered by the assessment.