Influence of Ventilation Mode on Passive Cooling Effect

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Passive cooling with Thermal mass and Ventilation

How to reduce the cooling load by adding Mass & Ventilation?

Ventilation mode:

1) Normal mode
   always 0.5 times of room air change

2) 1)+Night Ventilation
   fixed night ventilation time: 20:30, 30 times of room air change

3) 1)+Flex Ventilation
   ventilated depending on ambient temperature
Basic idea of Flex Ventilation System

First Passive Cooling
Then, Air Conditioning, if necessary

(change the paradigm)

Old paradigm
24 hour AC with high efficient AC system, occasionally natural ventilation

New paradigm
Ventilation basically, occasionally AC when needed.
Flex Vent System

Condition

1) Basically, indoor space is open to outdoor environment and fully ventilated, when:

\[ 18^\circ C < \text{Ambient air temperature} < 27^\circ C \]

Room air change rate : 30 times/hour

2) Close indoor space when:

\[ 27^\circ C < \text{Ambient air temperature} \text{ and } \text{Ambient air temperature} < 18^\circ C \]

Room air change rate : 0.5 times/hour

3) AC when:

\[ 27^\circ C < \text{Ambient air temperature} \text{ and } 27^\circ C < \text{Room air temperature} \]

Room air change rate : 0.5 times/hour
Control Process in Flex Vent System

Operation of the Natural Ventilation

18.0 °C < Ambient air temperature < 27.0 °C

Room air change rate
0.5 times/hour

Room air change rate
30.0 times/hour

Operation of the Air Conditioning

Air Conditioning period

27.0 °C < Ambient air temperature

with Air Conditioning

without Air Conditioning
Output of simulations / checked item

1) Hourly room air temperature fluctuation
2) Cooling Load, monthly and yearly
Building model
Single house
Model for Simulation

Thermal Specifics of building elements:
- well-insulated
- with good thermal mass inside
August, Tokyo
With light mass

Room air temperature fluctuation without AC
August, Tokyo
With full mass

Room air temperature fluctuation without AC
Annual Cooling Load, Tokyo
Monthly cooling load
With light mass

(MJ/Mon)

(normal)

(Night Ventilation)

(Flex Vent)
Monthly cooling load
With full mass

- normal
- Night Ventilation
- Flex Vent

(MJ/Mon)

Weekend
- Normal vent + light mass (100%)
- Flex vent + full mass (20%)
Left: Effect of Flex Vent System on annual cooling load (in full- and light mass house)
Right: Influence of ACR in Flex Vent System on annual cooling load (in full- and light mass house)
Influence of boundary temperature setting on room air fluctuation Aug. Tokyo

Influence of boundary temperature setting on annual cooling load. Tokyo
Figure 10 Effects of Flex Vent System on Annual cooling load
Flex Vent System reduces annual cooling load remarkably, especially in the house with thermal mass inside.
Effect of Flex Vent at the case study house
33.5 N
27°C ave. August
2°C ave. Jan.
Passive design – heating + cooling
Room air Temperature fluctuation of the case study house typical 3 days of Aug. Kochi
Room air Temperature fluctuation of the case study house typical 3days of Aug. Osaka
The case study house
Heating- and Cooling Load in different cities in Japan

X10 Mcal /month
How to keep enough room air changes in ventilation mode?

It is another issue of design.
Design Tool;
Passive cooling effect in your own design can be checked easily!!