



# Wind Flow Round Buildings for Natural Ventilation

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Sustainability and Human Response

**INDS 328**

Semester 2

Week 1

Date



# Outline

- Air movement, Wind pressure and Wind Direction
- Wind Shadow.
- The importance of natural ventilation
- The advantages of natural ventilation in built environment
- The chimney effects



# Objectives

When completed this lecture, student is expected to:

- 1-Understand how wind movement is happening on planet earth
- 2- Relate natural ventilation with thermal comfort in built environment
- 3-Understand the chimney effect in building ventilation

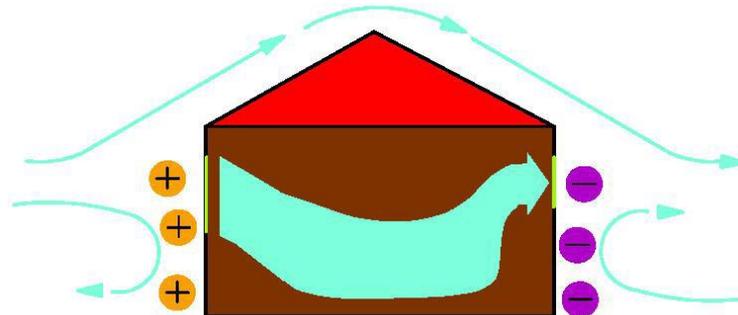


# Air Movement

- The air movement phenomena occurs when there is a pressure difference between different zones on the earth. i.e due to the **Solar Intensity (KW/m<sup>2</sup>)** falling on the parts of the earth.
- **Wind Speed:** due to the pressure difference between the any two zones.
- **The Wind Direction:** is defined by the geographical direction from which the wind comes from and the effect of anti-clock earth rotation round itself.....comment why

# Air Movement

- **Wind High Pressure:** is due to the compression of air layers before barrier or wall.
- **Wind Shadow:** from the high pressure zone the wind will bend round building causing stagnant region on the other side called wind shadow. –ve pressure zone at this zone wind starts to recover its original direction. As shown



*Natural Ventilation: Wind Effect*

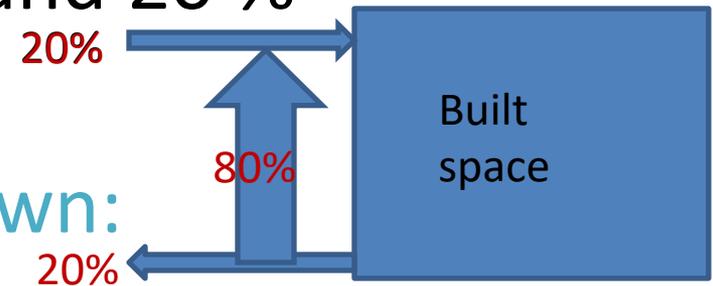
# THE PRINCIPLES CONSIDERED FOR NATURAL VENTILATION



- There are many principles that are needed to be considered in Natural Ventilation, those are:
  - a- **an air change** of the inside air by about 15 to 20% of the total circulated air within the built environment to ensure healthy internal environment .....**comment interior design for high ceiling**
  - b-**the types of the activities** of the occupants within building dictate the amount of fresh air needed.
  - c-**Surgical operations theaters, lab space, and X-ray room** require 100% air change.

- d-**In general about 80%** of air circulated in rooms of normal functions and 20 % exhausted via exhaust fan.

\* **Airconditioned space as shown:**

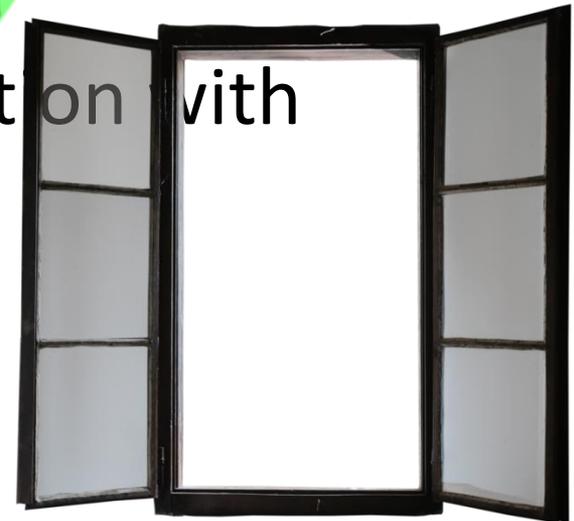
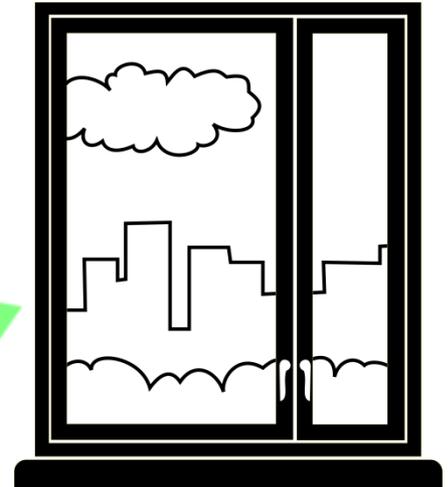


# Windows and Natural Ventilation

- **The Natural Ventilation influences:**

- window design ( shape)
- Window size
- Window location 
- Window relative location in relation with other windows, doors and air movement.

\* Energy consumption load.



# WINDOWLESS BUILDINGS why?



The 167.5 meter tall skyscraper was built to house telephone switching equipment and was completed in 1974.



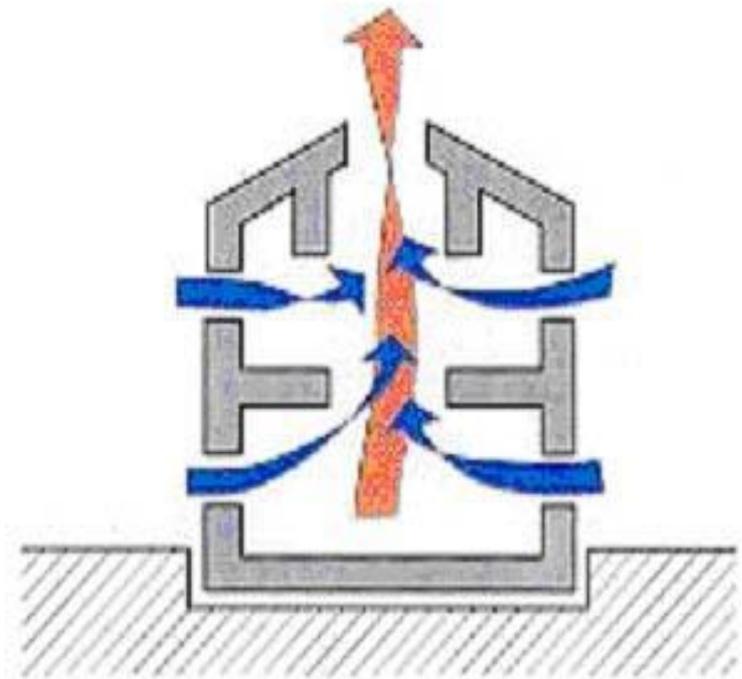
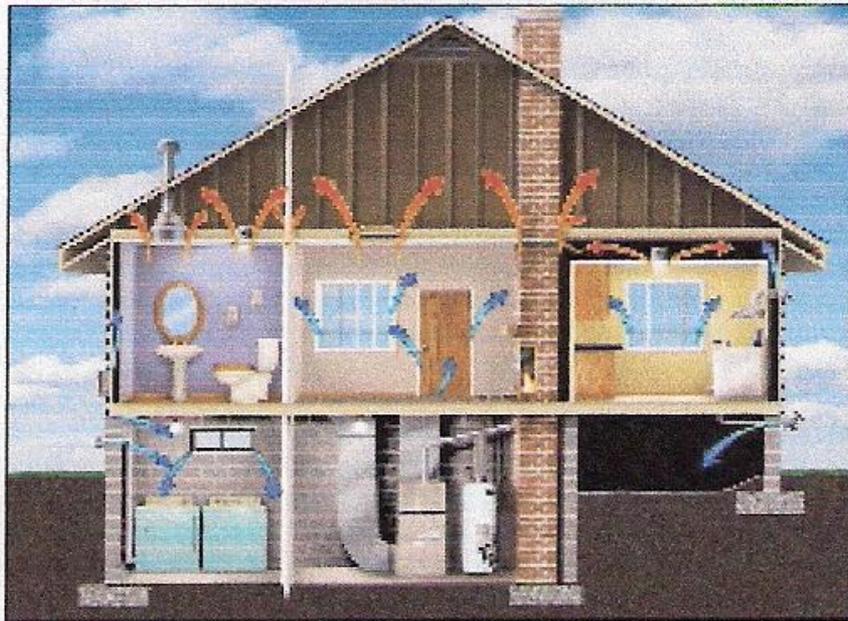
# The Advantages of Natural Ventilations in Built Environment

- Advantages of natural ventilation are:
- 1-To provide healthy treated air for occupants- Sick building Syndrome.
- 2-To provide Thermal Comfort: to get rid off the latent ( moisture) and sensible heat from body.
- 3-Structral Cooling ventilation: where there are a reasonable temperature difference between inside and outside environment.
- **Minimum temp?.**

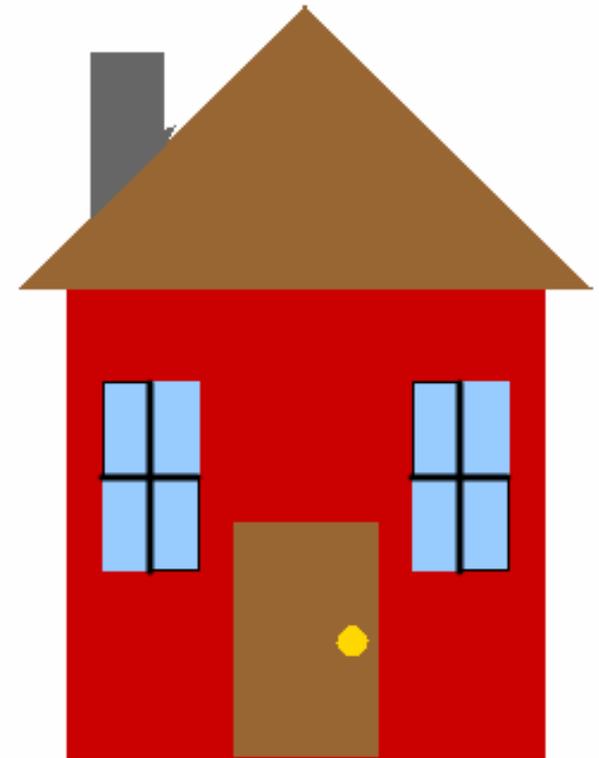
# The Advantages of Natural Ventilations in Built Environment



chimney effects  
Green Mosque application



# Chimney Effect and Natural Ventilation



# chimney effects

## Green Mosque application



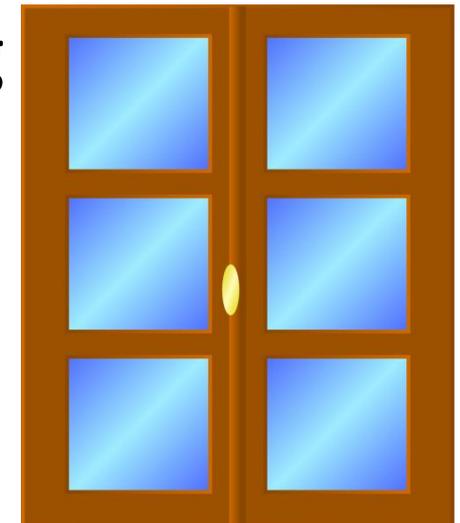
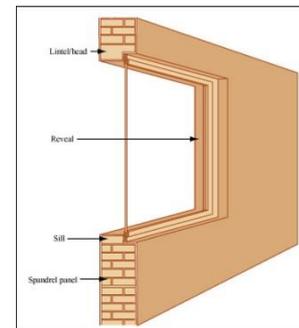


# **WINDOW DESIGN FOR NATURAL VENTILATION**

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# WINDOW DESIGN FOR NATURAL VENTILATION

- External and internal factors influence the air movement and its speed within the built environment, they are:
- Window location
- Orientation of the window opening
- Area of the opening
- Types of window opening



# WINDOW DESIGN FOR NATURAL VENTILATION



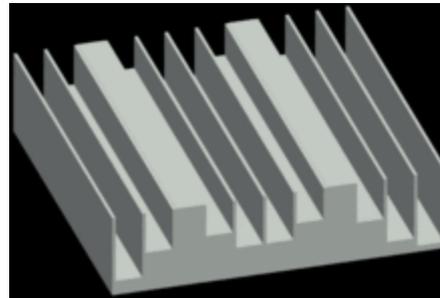
- External Factors are:
- Horizontal extensions, cantilever
- The vertical extensions
- Trees



# WINDOW DESIGN FOR NATURAL VENTILATION



- Internal Factors are:
- Space dimension
- Internal partitions within space.



# CALCULATIONS OF NATURAL VENTILATION FLOW RATE



- VENTILATION ENHANCED IN BUILDINGS EITHER BY:

A-Natural Ventilation due to strong wind.

- $Q = C_v \cdot A \cdot v$
- where  $Q$  = air flow  $m^3/s$
- $A$  = area of inlet opening  $m^2$
- Wind velocity  $m/s$
- $C_v$  opening effectiveness
- 0.5 to 0.6 for perpendicular winds
- 0.25 to 0.36 for diagonal winds

# Chimney Effect and Natural Ventilation

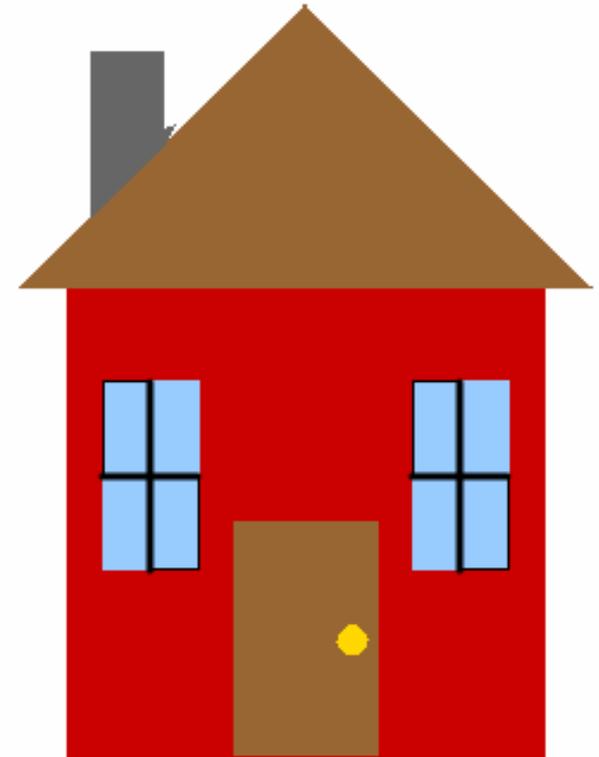
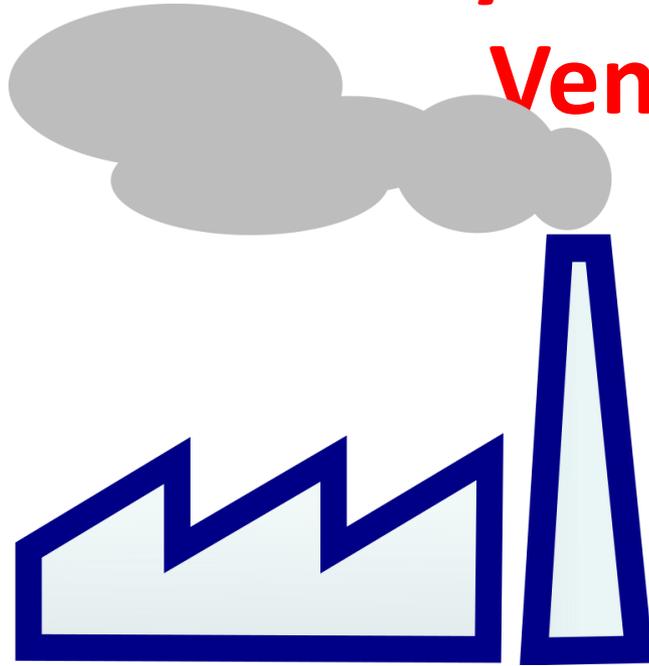
B-The natural ventilation due to air temperature difference between inside and outside of the built space is called buoyancy effect or stack effect or chimney effect as shown in figure

Ex: outside wind speed north-western direction 20 km/hr, area of window crack is .001 m<sup>2</sup> estimate the volume of air infiltrating the through the window.?

$$Q=C_v.A.v \qquad Q=0.3 \times 0.001 \times 20 \times 1000 / 3600 =$$

**0.0017m cub/s i.e 3.6 cfm**

# Chimney Effect and Natural Ventilation



# The Advantages of Natural Ventilations in Built Environment

