PHYSICS FOR CIVIL ENGINEERING – PH 8201

UNIT – I THERMAL PERFORMANCE BUILDINGS

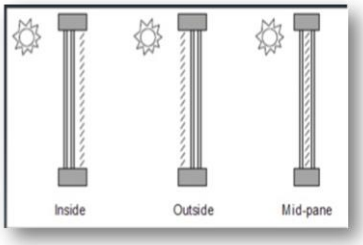
Study Material - Part - 2

9. Shading Devices

- Sun shading devices inhibit solar radiation incident on a building and are using internally, externally or in between the planes
- They can be mechanical movements, Projections, Cantilevers, louvers, fins and Jails or even textiles
- Primary objective is to create comfortable internal environment.

9.1. Types of shading devices

9.1.1. Based on the position;



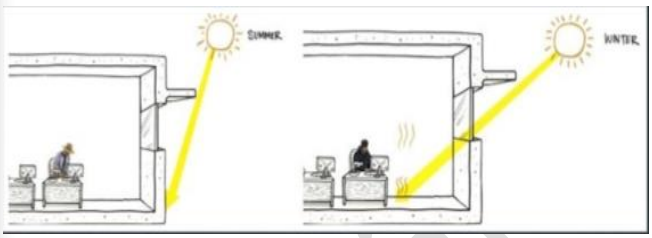
- Internal shading devices
- External shading devices
- Mid-Pane/Interpane shading devices

9.1.2 Based on the orientation;

- **Vertical shading devices:** Primarly used for east - west exposure of sun. It improves the insulation value of glass in winter months by acting as a wind break.

Vertical Shading Devices

- **<u>Horizontal shading devices:</u>** To shade a window during hot summer months, but to allow sunlight through the window in winter to help for warm building.

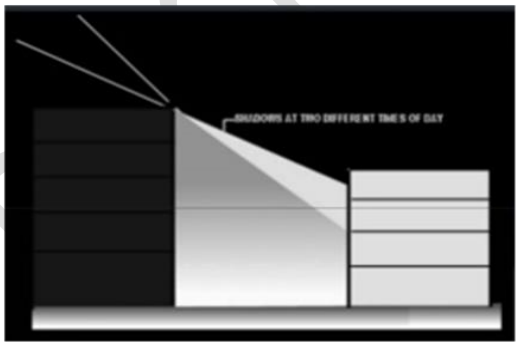


Horizontal Shading Devices

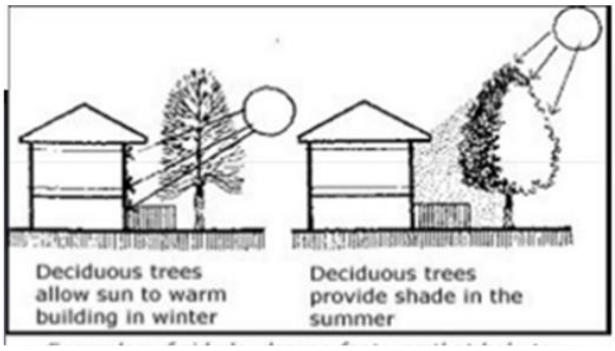
- **<u>Egg-Crate shading devices:</u>** A combination of horizontal and vertical shading elements commonly used in hot climatic regions because of their high shading efficiencies. The horizontal elements control the ground glare from reflected solar radiations.

Egg-crate Shading Devices

9.1.3. Shading from external environment



Shading from buildings



Shading from Vegetation

10. Ventilation Systems

Ventilation is the process of providing fresh air to the indoor spaces. It removes moisture, odours, heat, smoke, dust, air borns bacteria. Types of ventilation;

- Natural ventilation
- Mechanical ventilation

10.1.1. Natural Ventilation

Natural ventilation is the process of supplying and removing air through an indoor space by natural means, without the use of a fan or other mechanical system. It uses outdoor air flow caused by pressure differences between the building and its surrounding to provide ventilation and space cooling

Natural Ventilation is driven by three basic ventilation principles;

Single sided ventilation

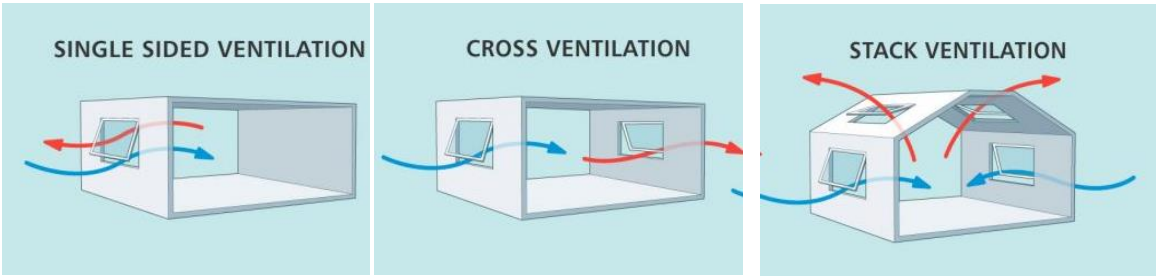
An opening is placed one side of the room. The amount of fresh air coming into the room is limited by single-sided ventilation.

Cross ventilation

Openings in two or more facades can create cross-ventilation in a room. The ventilation is powered by differences in wind pressure on the facades in which the window opening are located

Stack ventilation

It is caused by height difference between openings. The ventilation is primarily driven by warm air rising to the top creating a pressure difference.



10.1.2. Ventilation Measurement

To evaluate the performance of the right ventilation system for both exhausting and dilating pollutions, following measurements can be used.

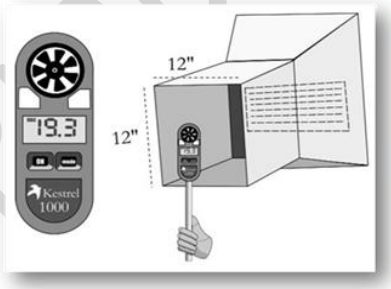
(i) **Smoke tube Method -** To measure airflow

(ii) **Flow hood Method -** To measure air volume

(iii) **Velocity meter method -** To measure air velocity

(iv) **Measuring carbon dioxide -** To estimate the percentage of outdoor air or to generally evaluate outdoor air ventilation.

Smoke Tube Method



Flow hood method

Velocity Meter Method

Infrared sensor for carbon dioxide measurement

10.1.3. Design for natural ventilation

- Maximize wind-induced ventilation by sitting the ridge of a building perpendicular to the summer winds
- Naturally ventilated buildings should be narrow
- Each room should have two separate supply and exhaust openings
- Window openings should be operable by the occupants.
- Provide ridge vents.
- Allow for adequate internal airflow
- Provide attic ventilation

10.2. Mechanical or Artificial ventilation

Mechanical arrangement is provide enough ventilation into the room. Five methods of mechanical ventilation are;

- Exhaust system
- Supply system
- Combination of exhaust and supply system
- Plenum Process
- Air-Conditioning

11. Air conditioning systems

Air-conditioning is the process of altering the properties of air (Primarily temperature and humidity) to the more favorable conditions. The control of these condition may be desirable to maintain the health and comfort of occupants are to meet the requirements of industrial processes irrespective to the external climatic conditions

Principle of Working

Most air conditioning systems have five mechanical components:

- Compressor
- Condenser
- Evaporator coil
- Blower
- Chemical refrigerant

This hot air is drawn from the base of the indoor unit through the grille; the air flows through some of the pipes through which the refrigerant or the cooling fluid is leaking. The refrigerant liquid absorbs heat and becomes hotter than before. In this way, how the weather is removed from the air falling on the evaporating coil. The evaporator coil not only absorbs heat

but also expels moisture from the incoming air, which helps reduce condensation from the room. This hot refrigerant gas is then passed to the compressor located on the external unit in case of split AC. The compressor compresses the cooling gas so that it heats up because compressing the gas raises its heat. This hot, high-pressure gas then moves to the third section called a condense

11.1. Different types of Air-conditioning system

1. **Window Air Conditioner:** This type of unit is designed to cool a single room. In this, components namely the compressor, condenser, expansion valve or coil, evaporator and cooling coil are enclosed in a single box. This unit sits in the window.

Window Air-Conditioning System

- Windows air conditioner are one of the most commonly used and cheapest type of air conditioners
- To Install one of these units, we need the space to make a slot in the wall, and there should also be some open space behind the wall.
- Window air conditioner units are reliable and simple to install solution to keep a room cool while avoiding the costly construction of a central air system
- When summer heat dies down these units can be easily removed for storages and we can use the window sill for other purposes

2. **Split Air Conditioner:** This unit is comprised of two parts: the outdoor, which houses the compressor, condenser and expansion valve; and the indoor, which is comprised of the evaporator coil and cooling fan. The split air conditioner can be used to cool one or two rooms.

Split Air-Conditioning System

3. Packaged Air Conditioner: This type of unit is perfect for cooling multiple rooms or a large space in your home or office. All the components, namely the compressor, condenser (which can be air cooled or water cooled), expansion valve and evaporator are housed in a single box. The cooled air is thrown by the high capacity blower, and it flows through the ducts laid through various rooms.

Packaged Air-Conditioning System

- The window and split air conditioners are usually used for the small air conditioning capacities upto 5 tons
- The centralized air conditioning systems are used for where the cooling loads extend beyond 20 tons.
- The packaged air conditioners are used for the cooling capacities in between these two extremes.
- The packaged air conditioners are available in the fixed rate capacities of 3, 5, 7, 10 and 15 tons.
- These units are used commonly in places like restaurants, telephone exchanges, homes, small halls, etc.,

4. Central Air Conditioning System: This unit is used primarily to cool big buildings, houses, offices, entire hotels, factories, etc. The central air conditioning system is comprised of a huge compressor that has the capacity to produce hundreds of tons of air conditioning.

Centralized Air-Conditioning System

- The window and split air conditioners are used for single rooms or small office spaces.
- If the whole building is to cool it is not economically viable to put window or split air conditioner in each and every room.

11.2. Protection Against Fire To Be Caused By A.C Systems

Fire Related Units of AC:

1. Condensing Unit (CU): Outer Part of Split AC
2. Fan Coil Unit (FCU): Inner Part of Split AC
3. Isolator
4. Wiring Near CU
5. Wiring near FCU: The FCU fire came when the FCU was not in used but on standby mode
6. Electrical control system

Causes of Fire:

1. Dust or contamination in the airflow path can settle over electrical components and cause tracking faults leading to a high resistance fault that could ignite.
2. Excessive temperatures rise may also occur in compressor and fan motors due to bearing frictions, increase in load or capacitor degradation. Clean or have your interior AC coils cleaned and replace your return air filters regularly. This will prevent the fan motor from being overworked.
3. Motor capacitors can develop internal resistance over time and can cause sufficient heating to self-ignite if encase in PLASTIC
4. Poor or loose connection of the power cord with motor connector, overheating ignition set the combustible plastic shell of air conditioner on fire

Precautions:

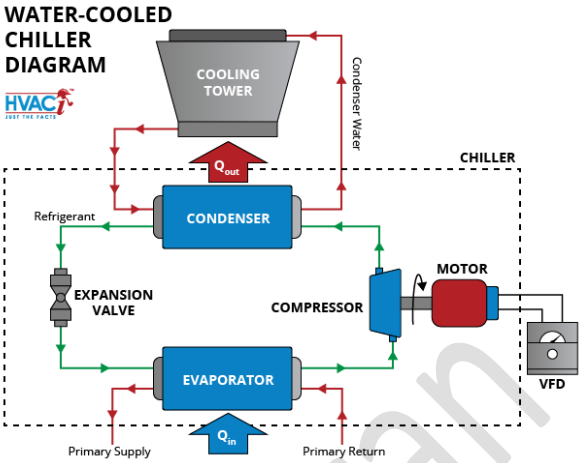
1. Check and Maintain on regular interval by a qualified or Trained A/C Maintainer
2. The poor and loose or long power connection needs to check and re-fixed
3. Switch off the AC when it is not required.
4. Avoid Direct exposure of CU in a high temperature above 40 C
5. Small and handy fire extinguisher should deploy at every AC point at home as a compulsory

12. Chilled water Plant Systems

The purpose of chilled water system is to provide cold water to Air-Handler Equipment for the purpose of supply cooling air to control space temperature.Water is cooled to a predetermined set point that is set within the chiller itself

Parts of chilled water system

- Water chiller
- Cooing tower
- Evaporator
- Condenser
- Tower by Bass valve
- Air handing unit



Working

Chiller

A device that removes heat from a liquid Via **vapor compression** or **absorption refrigeration** cycle. This cooled liquid flows through pipes in a building and passes through coils in air handlers such as fan coil units to cool the air in the building

Evaporator

Here the refrigeration liquid is converted to gas by absorbing heat from the air in the room

Condenser

Here gaseous refrigerant is converted into liquid by release the heat to the water flowing through it.

Cooling tower

Here the heat absorbed by the water is released or transferred to the atmosphere

Tower Bypass Valve

Controls condenser water flow either over the cooling tower or re-circulates it through the machine

Air Handling unit (AHU)

Air handlers usually connect to ductwork that distributes the conditioned air through the building and returns it to the AHU

Advantages

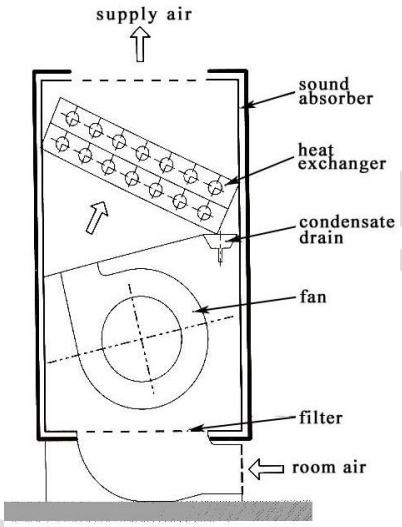
- Chilled water piping loops are easily run very long distances and can service many areas from one chiller Plant
- Chilled water systems have the lowest cost per kW for large installation

13.1. Fan Coil Unit

A fan coil unit (FCU) contains a fan which draws the air in a space into the unit then blows it over a cooling or heating coil. The air comes out of the FCU either cooler or hotter than before. They are used in some office buildings and shopping centres and typically specified where there are multiple small spaces requiring individual control. Typically an individual FCU serves only up to 150m², so there can be tens or even hundreds in a building. FCUs are, however, most commonly used as a supplement to a building for which other HVAC systems provide the majority of the air-conditioning.

FCUs will generally have a chilled water coil for cooling and either a hot water coil for heating or an electric heating element. Chilled water is provided from a chiller located in the central plant, and hot water form a boiler.

Each FCU is provided with a small supply of outside air to ensure adequate ventilation.



Advantages / Disadvantages

- High level of flexibility in terms of subdivision and rearrangement of space.
- Poorly suited to open plan spaces, as adjacent units can operate in conflict
- Does not generally have the ability to use outside air for free cooling, making the system less efficient in cooling particularly in spring and autumn.
- Chilled water valves and hot water valves in ceiling can be a maintenance problem

14. Heating and cooling load

The heating load is the amount of heat energy that would need to be added to a space to maintain the temperature in an acceptable range.

The cooling load is the amount of heat energy that would need to be removed from a space (cooling) to maintain the temperature in an acceptable range

Lower thermal loads indicate that, relatively, the building will require less heating and cooling to maintain comfortable conditions. In practice, the heating and cooling loads may be handled by heating or air-conditioning equipment.