COURSE TITLE
BUILDING TECHNOLOGY

Chapter 1 - (Week 2)
FUNCTIONAL REQUIREMENT OF BUILDING (PART 2)

LECTURE – 2
Ventilation , Sound, Light , Moisture movement

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Thailand, Bangkok (photo credit:Abhinay Kushwaha)

LEARNING OUTCOMES

1. Ventilation and air conditioning
2. Lighting
3. Sound and Acoustic
4. Moisture Movement
5. Dampproofing

At the end of the session students will get acquainted to:

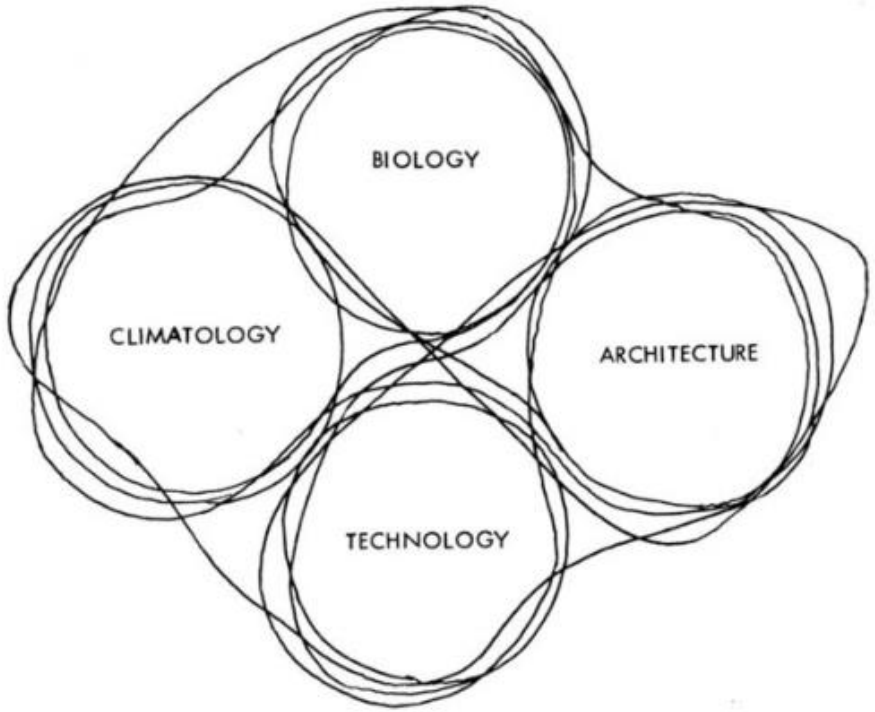


Figure: Design influences(Source: Stouhi, 2021:Online), https://www.archdaily.com/963706/back-to-basics-natural-ventilation-and-its-use-in-different-contexts?ad_source=search&ad_medium=search_result_articles

VENTILATION

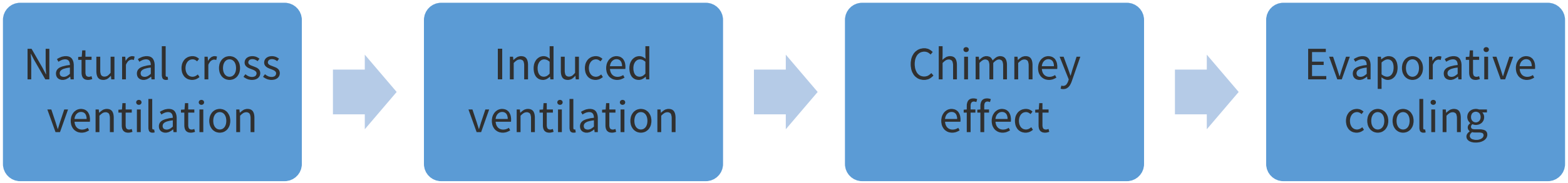
Ventilation:

The process of supplying fresh air and removing contaminated air by natural or mechanical means to or from a room is termed as Ventilation.[1]

Air-Conditioning:

The simultaneous control of temperature, humidity, air motion, and air purity is known as air-conditioning. [1]

A series of ventilation systems can help in the projects:



VENTILATION

For designing ventilation following parameters should be considered:

- Meteorological data of the locality
  - Temperature , humidity, air direction
- Ventilation requirement of different seasons, for different type of occupancies.
- Types of use of room space
- Suitable design of ventilation system

NECESSITY OF VENTILATION

To create air movement

To prevent an undue accumulation of carbon dioxide and moisture.

To prevent depletion of oxygen content in air.

To prevent flammable concentration of Gas vapour or dust.

To prevent an undue concentration of body odours, fumes, dust , other industrial products and Bacteria carrying particles.

To prevent condensation in the building.

To remove body heat and heat liberated by other equipments.

To remove suffocating conditions in committee halls, cinema halls and other types of assembly

FUNCTIONAL REQUIREMENT OF VENTILATION

Air changes or air movement

- Air movement is necessary for proper ventilation.
- If the rate of air change is less than one per hour ,there will be no ventilation. If the rate of air change is more than sixty per hour discomfort condition may occur due to high air velocity.[3]
- Cross Ventilation is provided to increase the rate of air movement naturally.

Humidity

- Relative Humidity within the range of 33 to 70 percent at the working of 21 ℃ is considered to be desirable.[3]
- For higher temperature low humidity and greater air movement are necessary from removing greater portion of heat from the body.

Quality of air

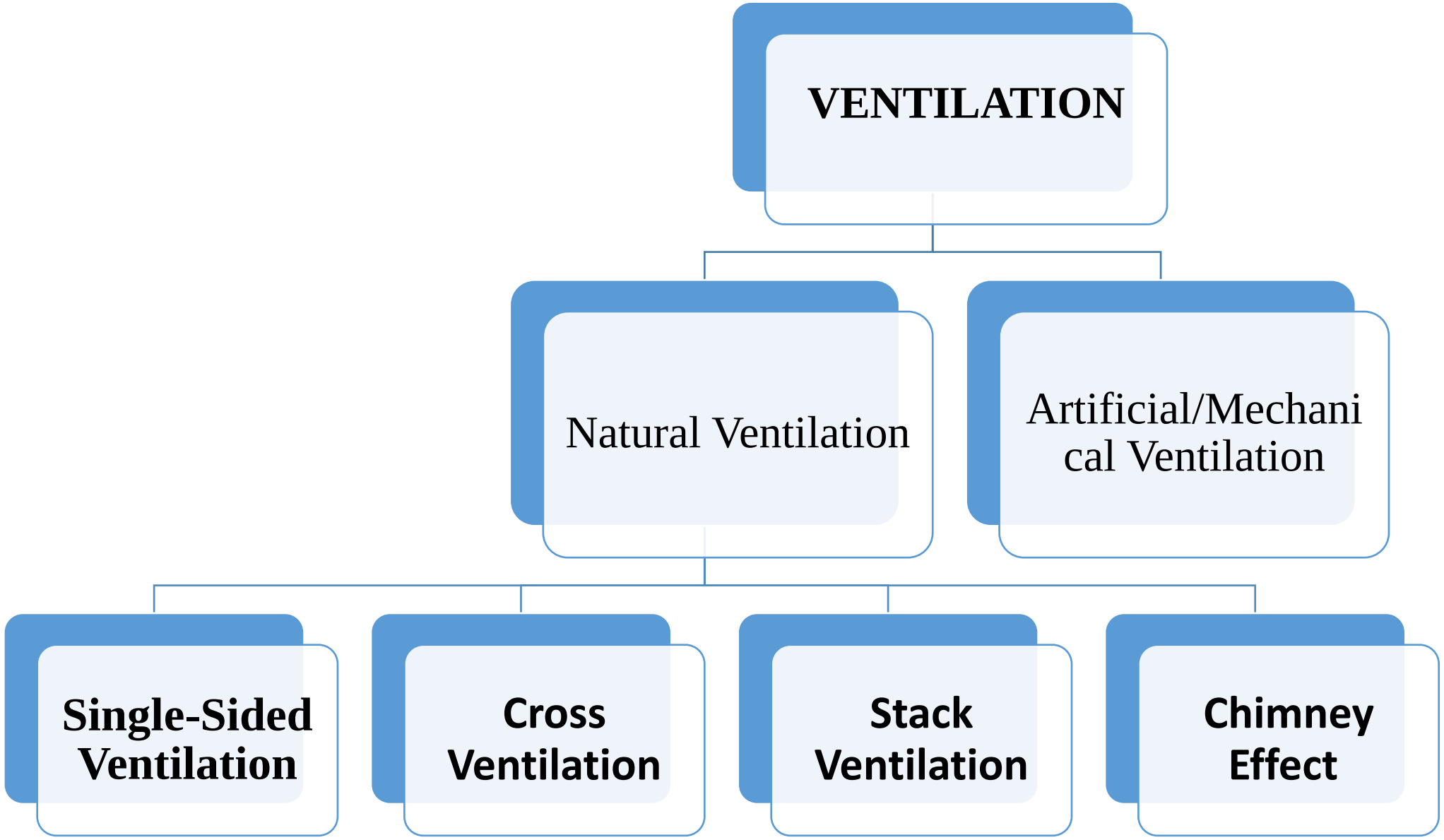
- Air containing less than 0.5 mg of suspended impurity, per m^3 and less than 0.5 part per million Sulphur dioxide is considered to be clean and does not require further treatment.[3]

- Air within the room containing 0.06 percent CO2 may be considered vitiated but with 0.09 or 0.1 percent, it becomes stuffy and unbearable. Hence the air in habitable rooms should never contain more than 0.06% of CO2.[3]

Temperature

- It is desirable that the incoming ventilating air should be cool in summer and warm in winter before it enters the room. The general temperature difference between inside and outside is kept not more than 8° C. [3]
- Effective temperature is an index which combines single value, the effect if air movement, humidity and temperature. [3]
- The valve of effective temperature from human comfort point of view depends upon the type activity, graphical conditions, age of occupants amount of heat loss from the body etc. [3]
- The common values of effective temperature in winter and summer are 20° c and 22° c respectively. [3]

SYSTEM OF VENTILATION



Natural Ventilation:

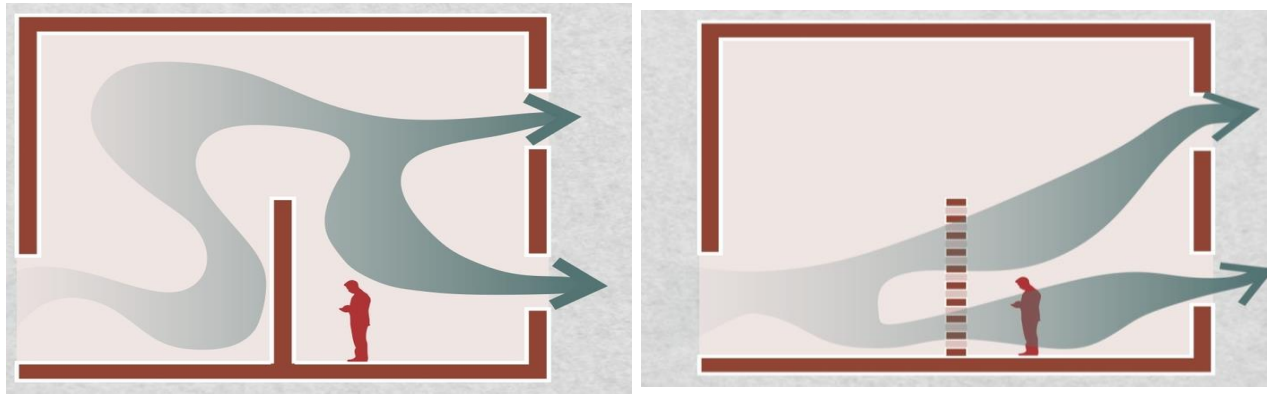
It is the supply of outside air ,into a building through windows or other openings due to wind outside and convection effects arising from temperature or vapour pressure differences (or both) between inside or outside of the building. [2]

It is affected by doors, windows, Ventilators, skylights and other openings in the building. [3]

Natural cross ventilation : when openings in a certain environment or construction are arranged on opposite or adjacent walls, allowing air to enter and exit. [4]

Induced natural ventilation : thermal induction systems use to conduct air cooling.

In this system, openings are positioned close to the ground so the cold air enters the space by pushing the mass of warm air above, where air outlets are positioned in the ceiling such as sheds and clerestory. [4]



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Types of Natural Ventilation

Single-Sided Ventilation

- Single sided ventilation is the use of openings on one side of a building.
- It is used to naturally ventilate the space of projects with limited area.
- They are also used in projects where cross ventilation cannot be provided, due to structural or environmental constraints.
- This ventilation generates the least air circulation when it comes to natural ventilation systems. [4]

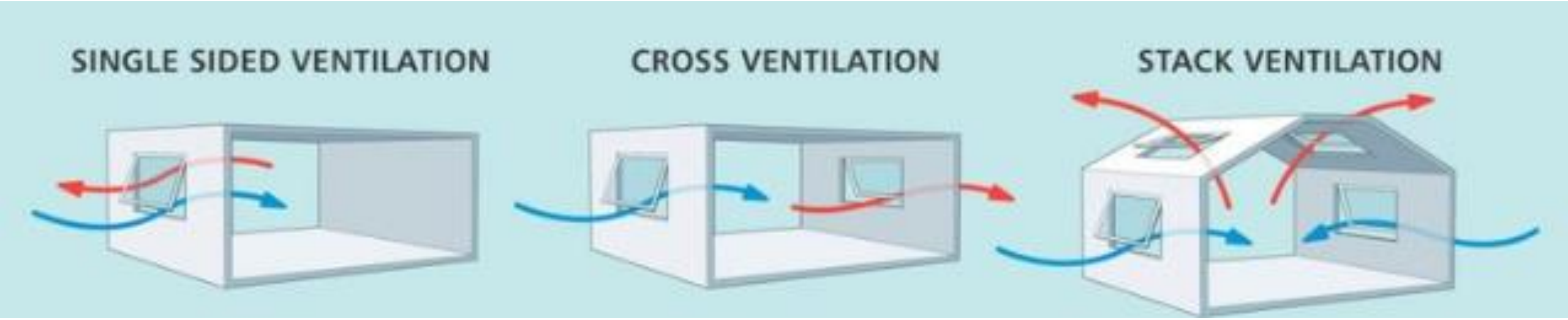
Cross Ventilation

when the openings in a structure are arranged on opposite or adjacent walls, allowing air to enter from both sides, cross the space, and exit from the opposite direction. [4]

This system is usually used in buildings located in climatic zones with higher temperatures, as it creates constant air renewal within the building, reducing the internal temperature. [4]

Stack Ventilation

- It introduces cooler air from the outside into the building at a low level, which gradually becomes warmer as it gets exposed to heat sources within the space. This causes the warm air to rise and leave the space through openings situated at a higher level. [4]
- It is more effective in tall buildings with central atriums ,
- It is used in buildings where cross ventilation is not able to penetrate sufficiently throughout the space.
- for this ventilation system to work properly, the indoor temperature must be higher than the outside.



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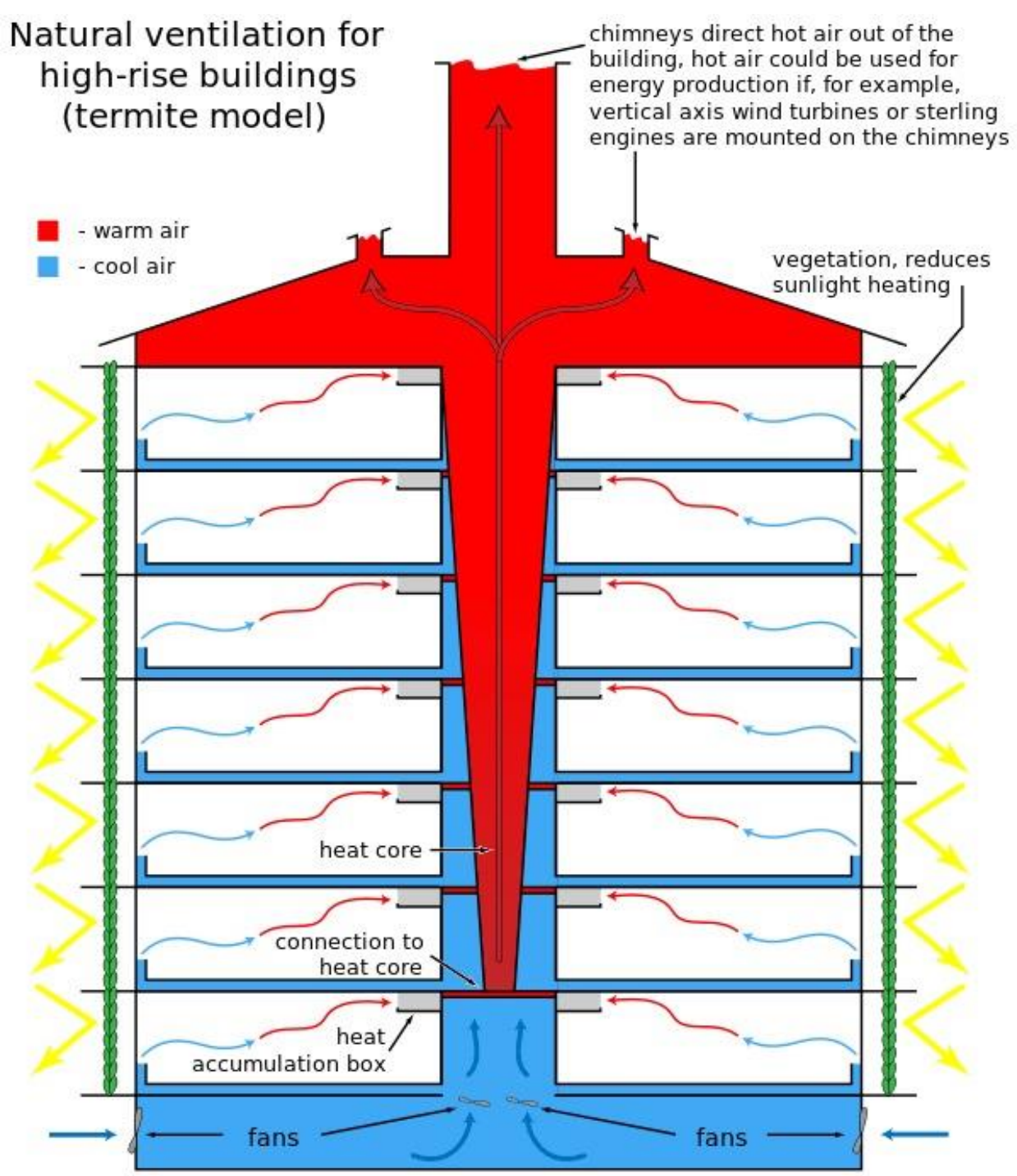


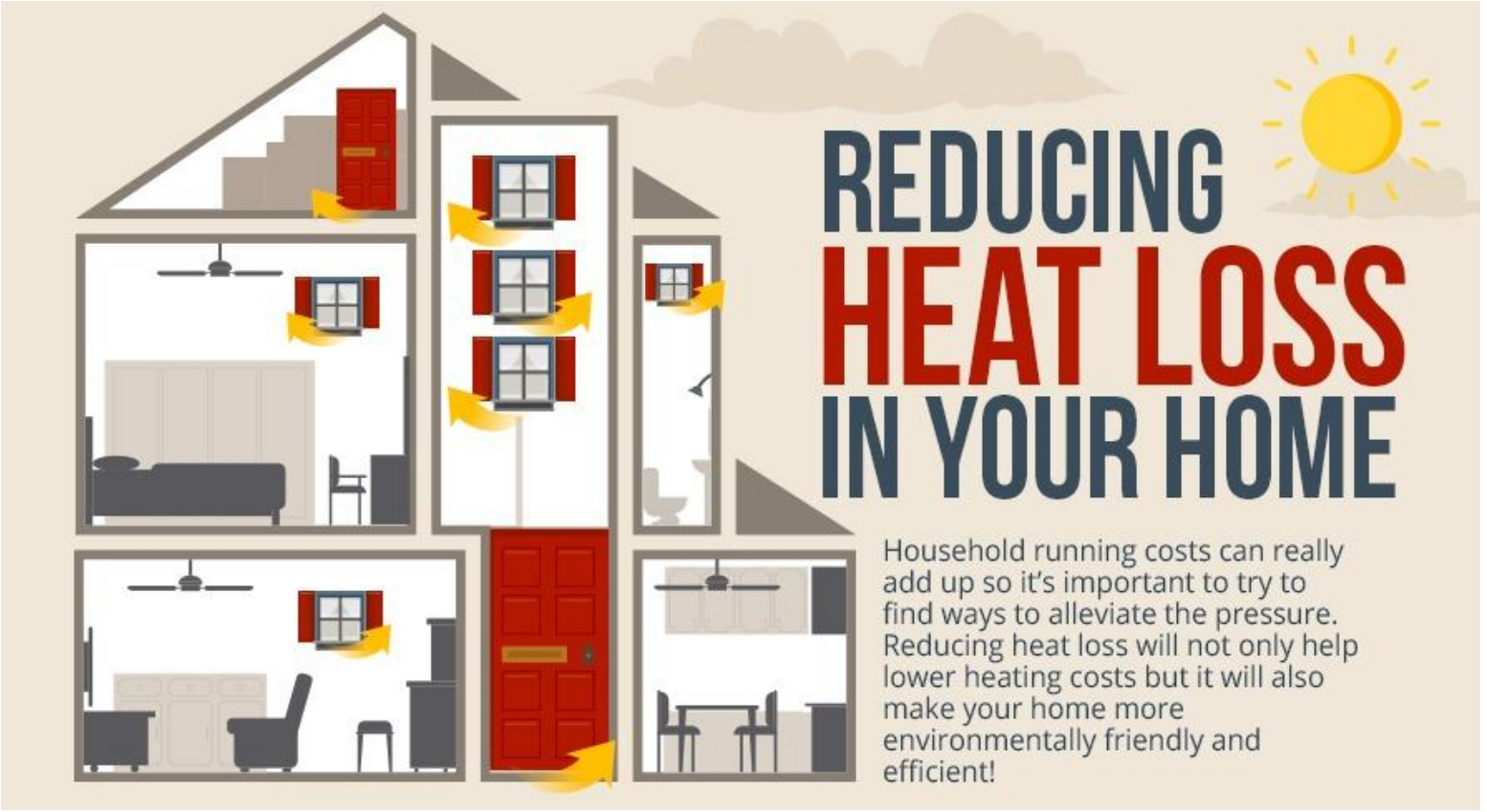
- Chimney Effect

In vertical buildings, the chimney effect is constantly used. Cold air produces pressure under the warm air, forcing it to go upwards. however, opened areas in the project's center or towers allow that same air to circulate throughout the indoor environment, leaving through the roof, clerestory, zenithal openings, or wind exhausts. [4]

Figure: chimney effect(Source: Stouhi, 2021:Online), https://www.archdaily.com/963706/back-to-basics-natural-ventilation-and-its-use-in-different-contexts?ad_source=search&ad_medium=search_result_articles

- Artificial/Mechanical Ventilation

Supply of outside air, by positive ventilation, by infiltration , by reduction of pressure inside due to exhaust air or by combination of positive ventilation and exhaust of air. [2]



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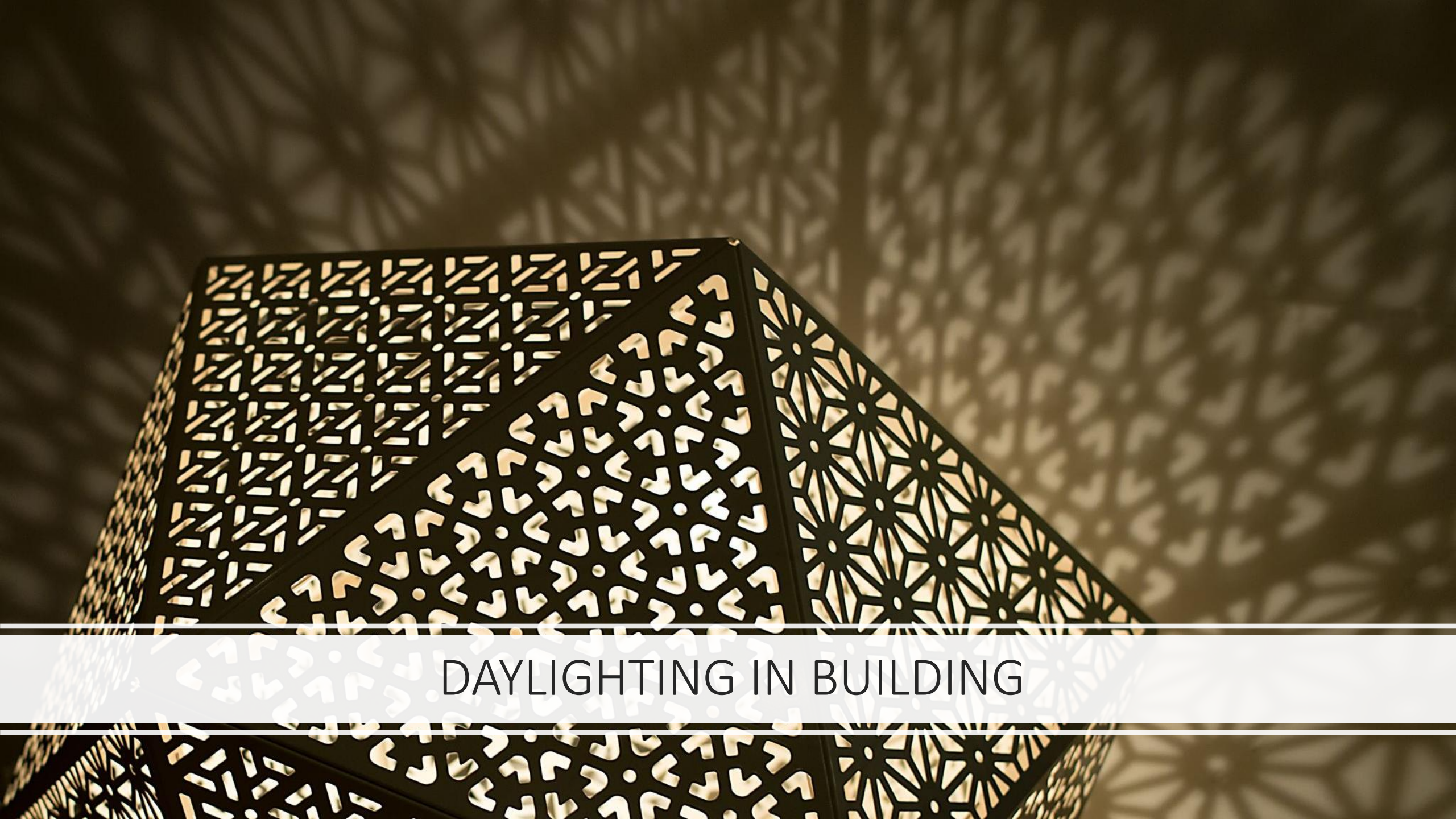


DAYLIGHTING IN BUILDING

DAYLIGHTING

- Daylighting is the controlled admission of natural light, direct sunlight, and diffused-skylight into a building to reduce electric lighting and saving energy.[5]
- It helps to maximize the benefits of natural light, including reduced energy consumption, improved occupant well-being, and enhanced architectural aesthetics. [5]
- By technology and scientific analysis, daylight modeling creates well-designed, sustainable, and human-centric spaces. [5]
- Passive daylighting strategies promote the quantity and even distribution of daylight throughout a building by collecting natural light and reflecting it into darker areas of the building. [5]

Figure: Daylighting(Source: : Ltd, W. e., 2021:Online), Retrieved from linkedin.com: https://www.linkedin.com/pulse/passive-design-strategy-daylighting-/

- Architects use windows, skylights, clear doors, light tubes, mirrors, light shelves and other reflective surfaces to collect and direct light to key areas in the room. [5]

- It involves carefully balancing heat gain and loss, glare control, and variations in daylight availability. [5]

Figure: Daylighting(Source: : Ltd, W. e., 2021:Online), Retrieved from linkedin.com: https://www.linkedin.com/pulse/passive-design-strategy-daylighting-/

SOUND AND ACOUSTICS IN BUILDING

SOUND AND ACOUSTICS

- "Acoustics" in architecture means improving sound in environments. [7]

- There are two technical categories used in acoustics: [7]
  - soundproofing
  - acoustical treatment.

Soundproofing means "less noise" and treatment, "better sound". [7]

- Soundproofing :

It is commonly used in music recording studios ,applied in locations near major avenues like schools, construction zones. [7]

Soundproofing an environment is like protecting it against bad weather: the structure should be as solid as possible and without holes or cracks. [7]

To reduce the noise coming into and going out of a room, one must increase the structural mass of the walls, floor and ceiling, and seal the air gaps surrounding doors and windows, as well as the openings for refrigeration and electrical outlets. [7]

- sound treatments are used to improve sound quality within an environment
- for diners to hear and understand conversations at their tables in a restaurant , for students to understand teachers , for the whole audience to enjoy the music in an auditorium. [7]

- All building materials have acoustic properties as they can potentially absorb, reflect or transmit sounds that reach them. [7]

- When sounds are reflected, they cause an increase in the overall echo and reverberation levels in a space. When treating rooms correctly, echo and reverberation is reduced to treat rooms, there are two methods available: [7]

  - sound absorption
  - diffusion.
- The best treatment strategies combine these two techniques.

Noise.

Unwanted sound reaching the ears is called noise. Unwanted sound may be due to intensity of sound or frequency of sound or both.[1]

Effect of noise on human comfort. [1]

- Noisy condition result in uncomfortable living condition, fatigue, inefficiency and mental strain.
- Prolonged exposure to such conditions may cause temporary deafness or nervous breakdown.

Sound insulation by scientific planning of Buildings and colonies. [1]

- Interposing buffer zones between source of noise and residential area.
- Screening noise

  Less noise vulnerable building is interposed between source of noise and more noise vulnerable building.

Controlling noise

- **Controlling noise through design and layout**

The impact of noise can be reduced through building layout and other design elements.[8]

- controlling noise at source;
- increasing distance from the noise source;
- closing potential sound paths (such as openings in walls facing sources of noise); and using mass,
- insulation or buffering to block the noise.
- install sound-absorbent surfaces in rooms that are potential sources of noise such as laundries, children's playrooms, and rooms where loud music or games may be played.[8]

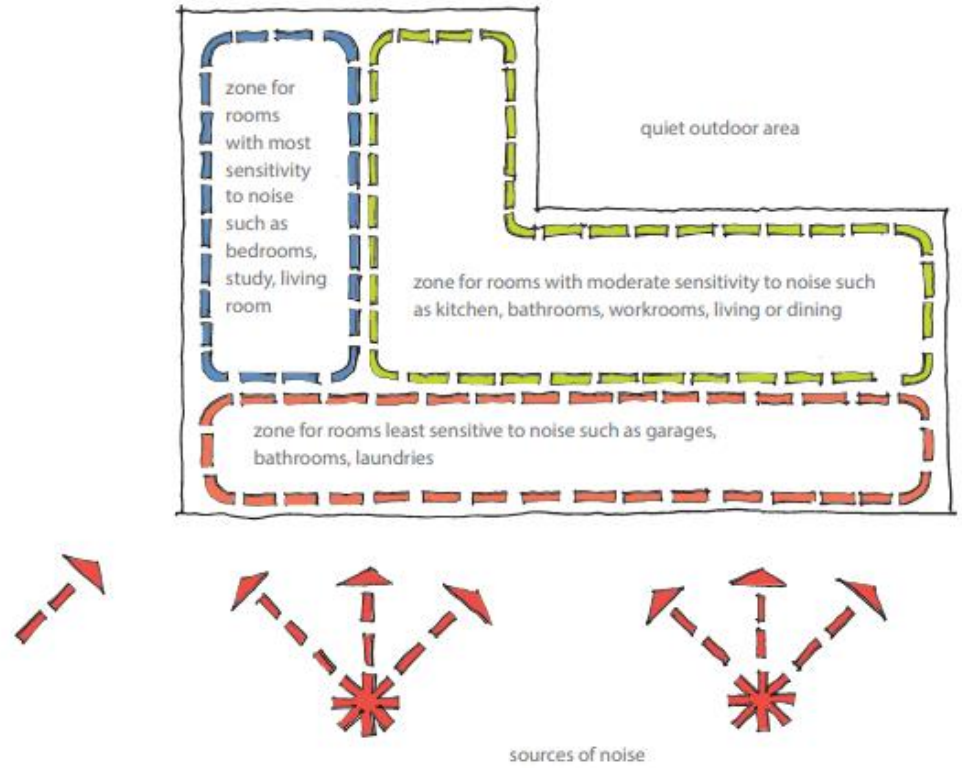
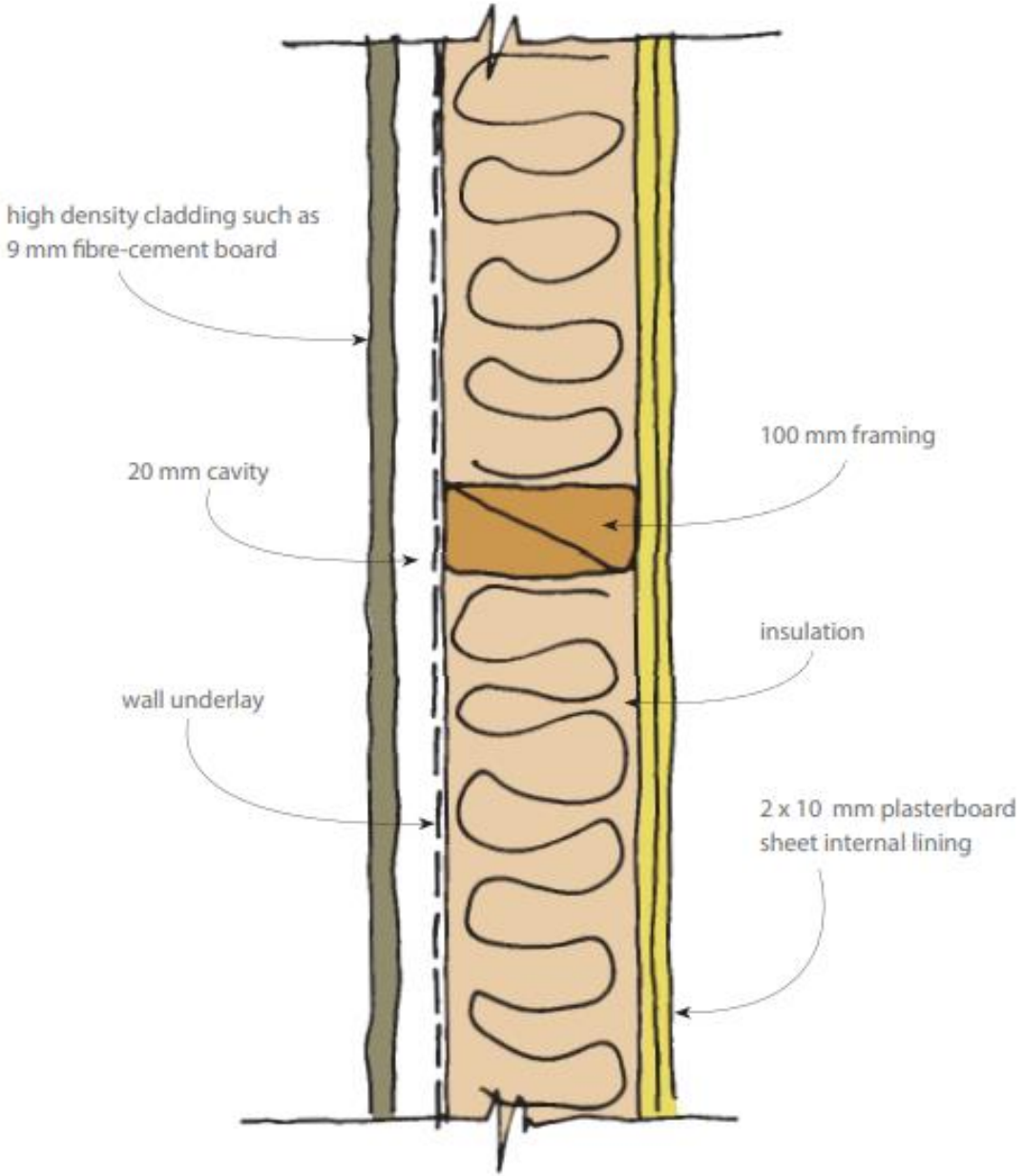


Figure:Insulation(Source:Level:The authority of sustainable buildings, n.d.:online), **www.level.org.nz:** https://www.level.org.nz/passive-design/controlling-noise/controlling-noise-through-design-and-layout/

- Where noise cannot be controlled at source:
- increase the distance between the noise and the location where it will be heard – for example, locate the building as far as possible from a noisy street frontage
- use zones to control noise, by grouping noisy or quiet activity spaces together
- don’t locate windows or doors towards sources of noise
- avoid direct and flanking sound paths by off-setting doors and windows from noise sources
- provide a buffer space or spaces between quiet and noisy spaces – for example, by locating a wardrobe between bedrooms
- incorporate mass into external walls to block external noise, or use fencing or earth mounding
- use sound-attenuating exterior walls or sound-insulated interior partitions to control noise



- External sound envelope (bre-cement cladding) A high-density sheet cladding, with sealed joints, thermal insulation, and sound attenuating interior lining. This will provide sound reduction at moderate cost, using lightweight construction.[8]

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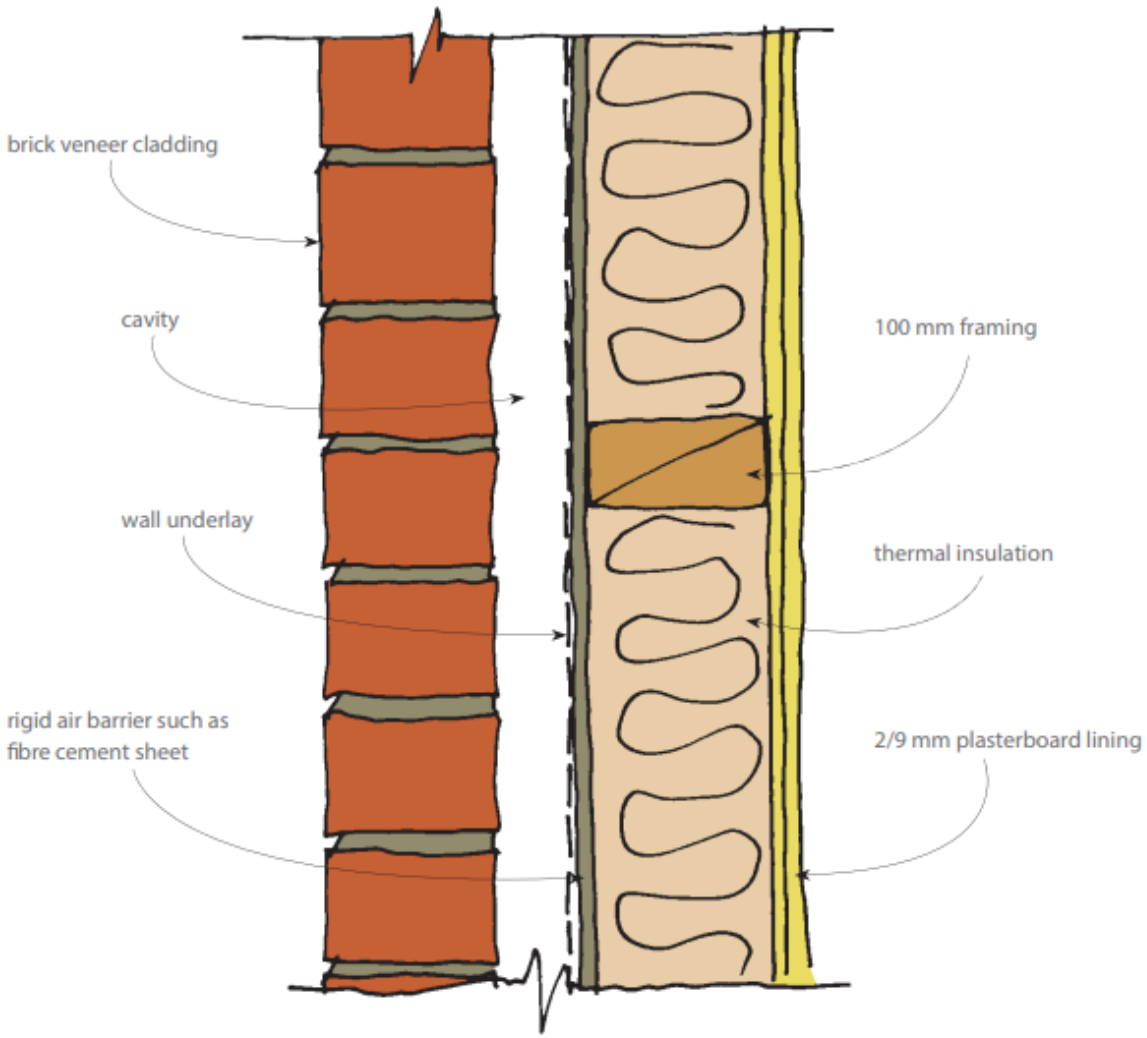

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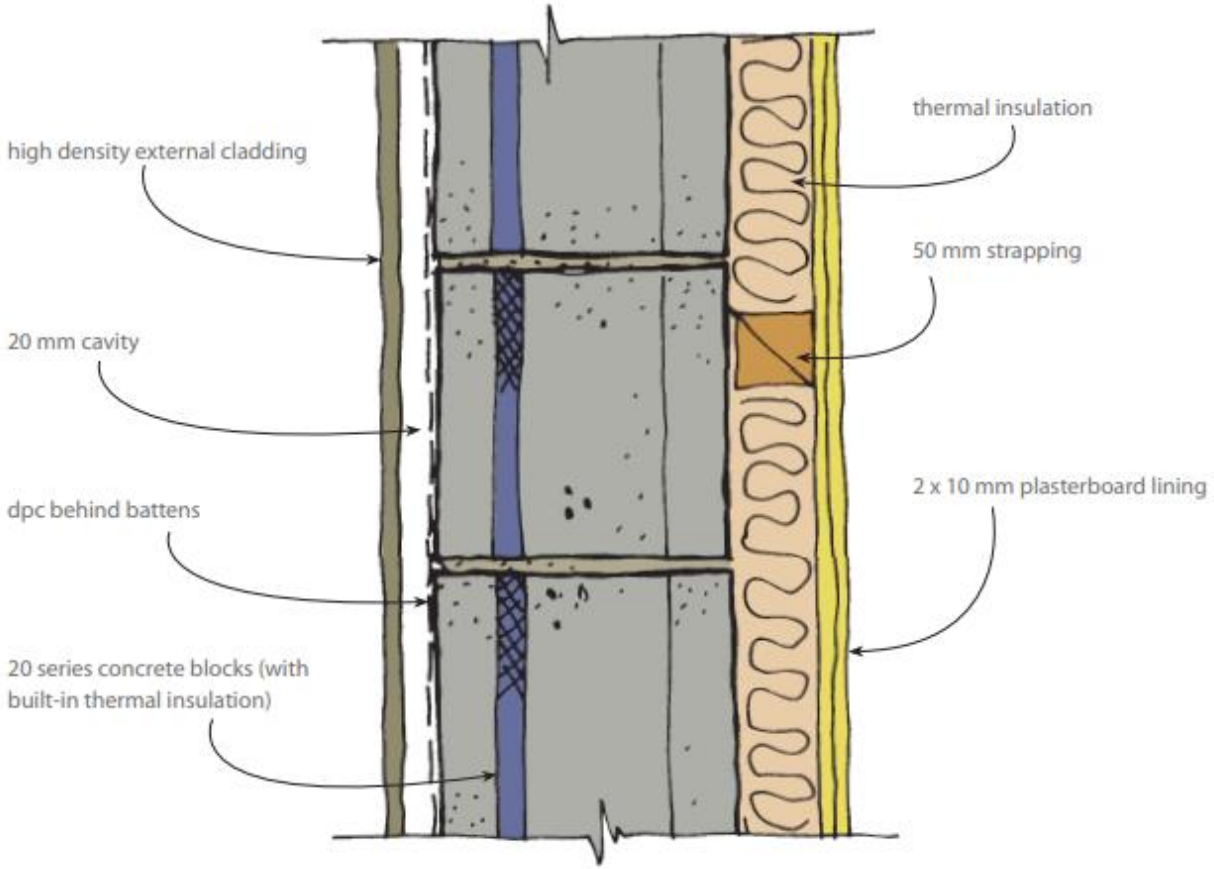
- External sound envelope (brick veneer) A brick or concrete masonry veneer, a rigid air barrier, thermal insulation, and sound attenuating interior lining is an expensive option using heavier weight construction. It will provide eective sound reduction. [8]



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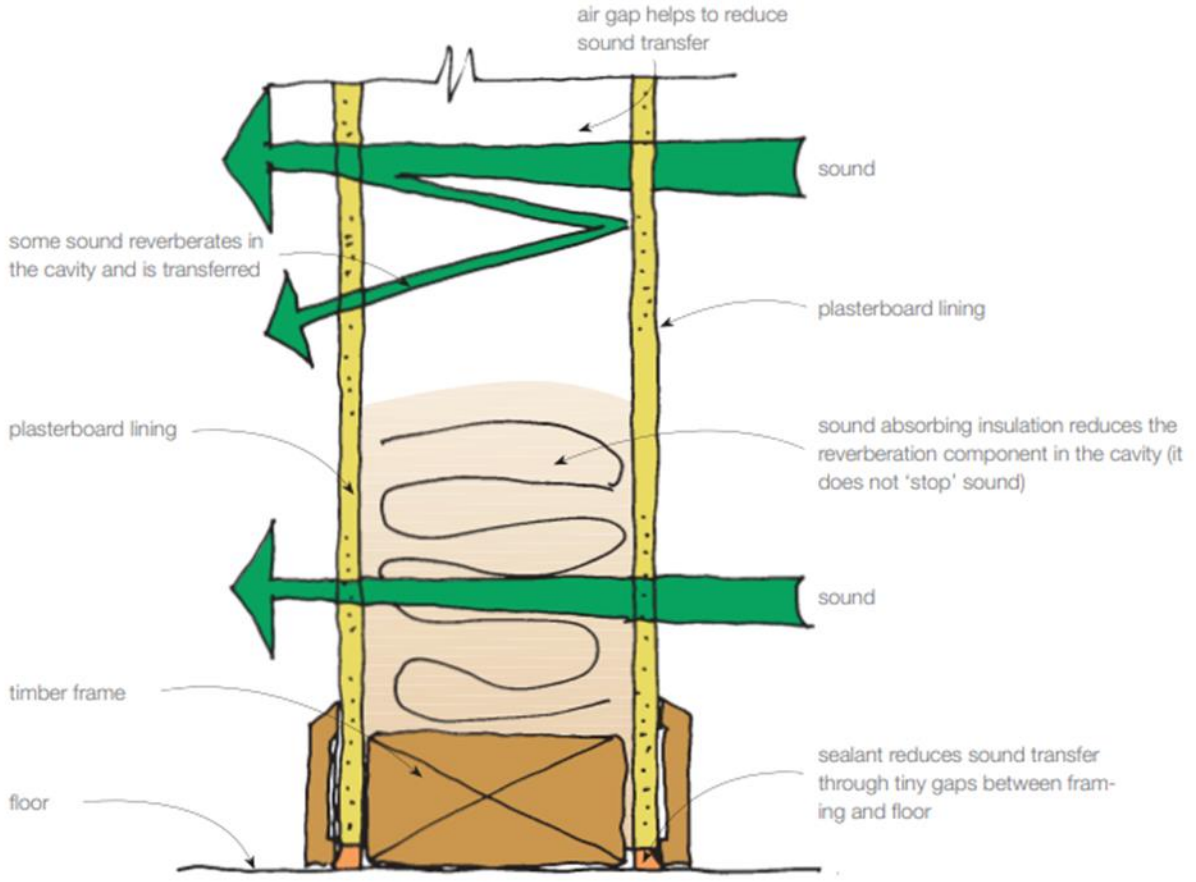
- External sound envelope (concrete masonry) A high density sheet cladding installed over battens, interior strapping, thermal insulation and sound-attenuating interior lining will provide an effective sound barrier. [8]

- Interior noise can be controlled by sealing joints and incorporating sound-absorbing materials.

- In general, internal sound-reducing construction should have mass and sound-absorbent material. All joints should be sealed (to minimise air gaps through which sound might pass), and – as much as possible – the structure between the linings should be discontinued. [8]



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- **Fences, walls and earth mounds as sound barriers**
- High-mass fences or walls, or earth mounds, can reduce external noise as long as the source is lower than or level with the barrier.
- Barriers will not reduce noise that originates from above the barrier.

Design factors for a south sloping site with loud noise source on the north side Where there is noise on the north side, careful design is required to minimise the disturbance caused by the noise while still allowing sun .[8]

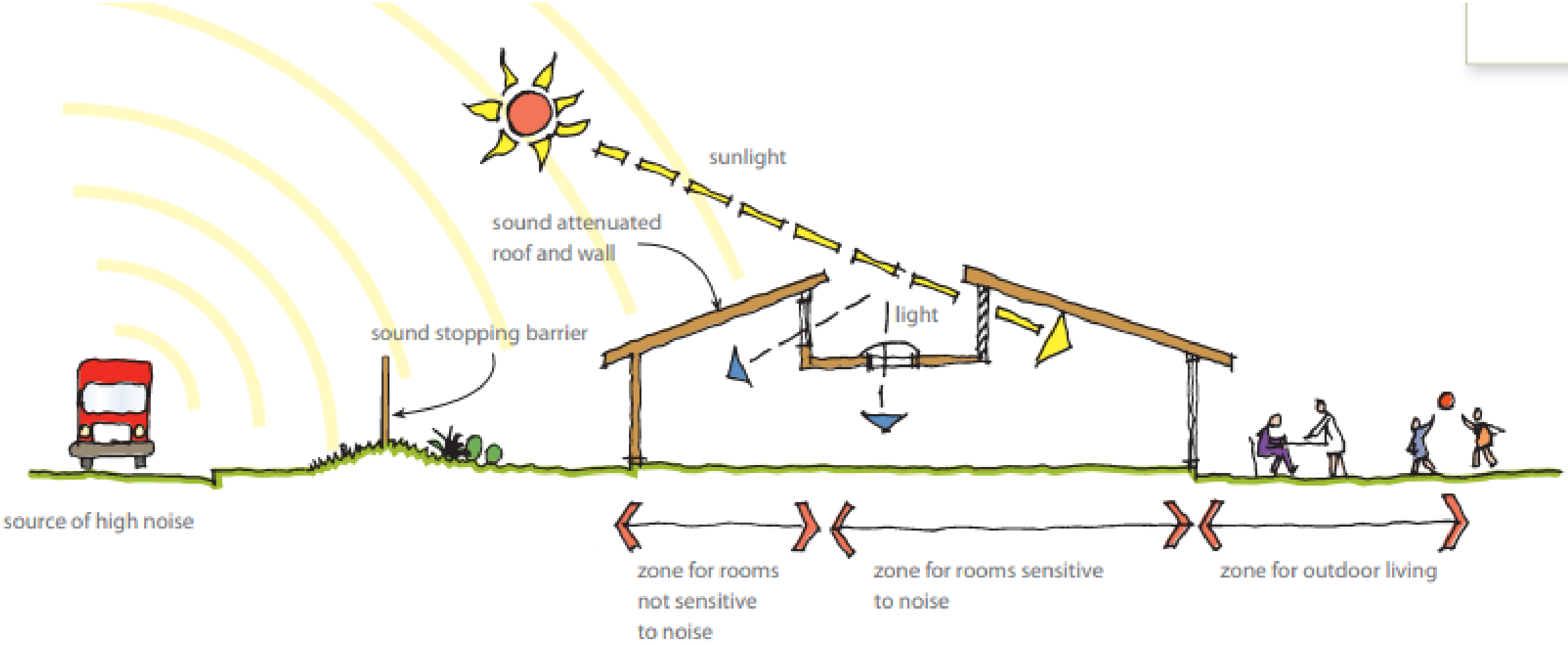

Figure:controlling noise(Source:Level:The authority of sustainable buildings, n.d.:online), **www.level.org.nz:** https://www.level.org.nz/passive-design/controlling-noise/controlling-noise-through-design-and-layout/

MOISTURE MOVEMENT IN BUILDING

- Dampness in a building is the presence of moisture in various parts of building like floor, wall, roof etc. The continuous dampness of building give rise to unhygenic condition.[6]
- Dampness may be caused by:
  - Ground water
  - Rainwater and
  - Leakages from pipes.

Figure: Dampness(source:Daily Civil, n.d.,online), https://dailycivil.com/dampness-in-buildings-causes-sources-prevention/

(a) Dampness due to Ground Water:

Due to capillary action moisture from ground rises into foundation, floor and even in wall.

(b) Rainwater: May enter the building components due to various reasons.

(i) From wall top: If top of wall is not protected with impervious course like concrete, water can enter the wall and keep it damp for a long time.

(ii) From face of external walls: Splashing of outer wall by rain results into moisture entering the wall. Poor plaster coat is the main source of this type of dampness.

(iii) Improper fixing of down take pipes: If down take pipes from roof are not properly fixed, a thin layer of water stagnates near the mouth of down take pipes. This results into entry of rainwater into roof and wall. [6]

(iv) Improper slopes to roof:

If slope is not given properly, water ponds are formed on the flat roof, which results into entry of water into slab.

(v) Defective construction: Imperfect wall joints, improper slopes to chajja, construction joints in roof etc. cause dampness in buildings.

(c) Leakage from Pipes: From over head tanks, pipes are taken over roof and along the wall. From bathrooms, toilets and kitchen water is drained out with different types of pipes. The pipes are joined to get required length and turns. Many time water leaks through joints resulting into moisture in building components.[6]

EFFECTS OF DAMPNESS

Effects of dampness are as listed below:

- Patches develop and destroy the appearance of the building.
- Colour wash, whitewash and paintings are damaged.
- Plaster crumbles.
- Bricks and stones disintegrate endangering the building.
- Steel in the slabs and beam start rusting. It reduces the life of structure.
- Electric short circuits may take place.
- Wooden components of buildings like door frames, cupboard warp.
- Dry rotting of wood takes place.
- Termite becomes active and attack wooden articles.
- Mosquito breeding takes place.
- Darkness along with warmth and darkness breed germs giving rise to many diseases.

METHODS OF DAMP PROOFING

- Providing D.P.C. course
- Providing cavity walls
- Surface treatment
- Integral treatment
- Guniting
- Pressure grouting.

1. Providing damp proof course:

- It consists of providing a damp proof course between the source of dampness and building component.
- The DPC may be with any water repellant material like bitumen, mastic asphalt, cement concrete, metal or plastic sheets.
- DPC should cover full width of wall. It should be laid on levelled surface of mortar. Joints should be minimum and should not be at critical points. [6]
- When horizontal DPC on roof is continued on vertical face of parapet wall, the junction should be filled with about 75 mm fillet of cement concrete[6]

2. Providing cavity wall:

- Cavity wall is constructed to protect foundation masonry and the wall .
- The cavity prevents moisture travelling from outer to inner wall.

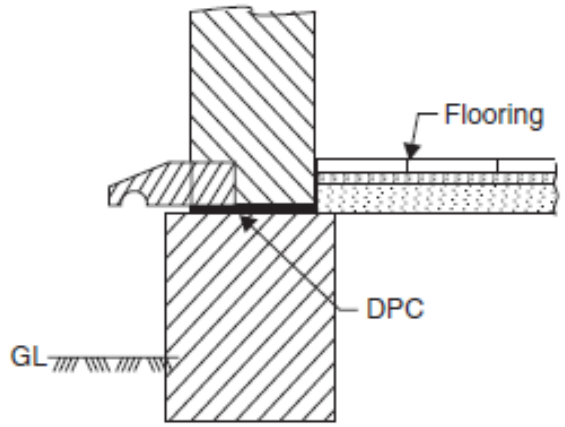

Figure: DPC at plinth level

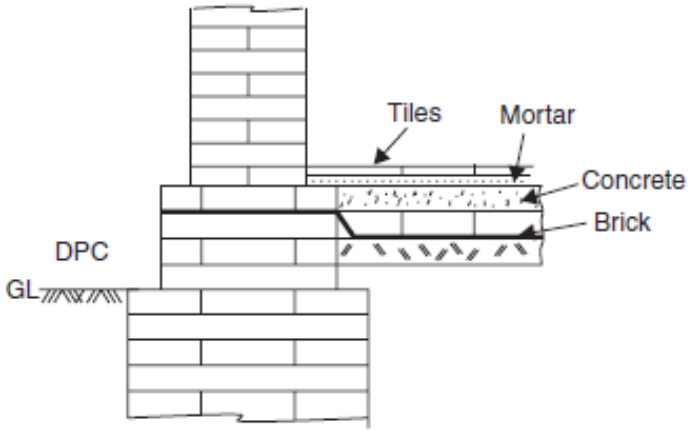

Figure : DPC at floor level

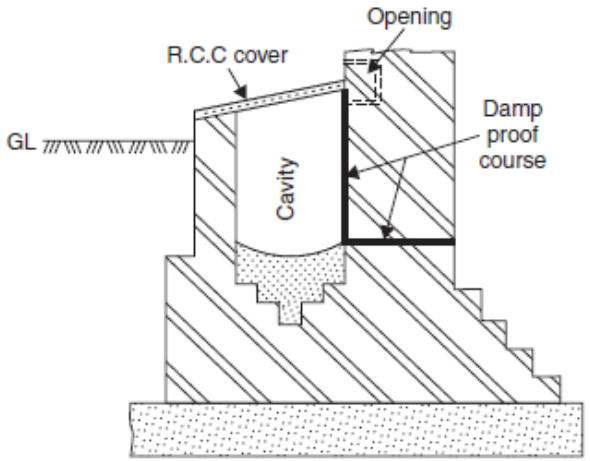

Figure: Providing Cavity wall

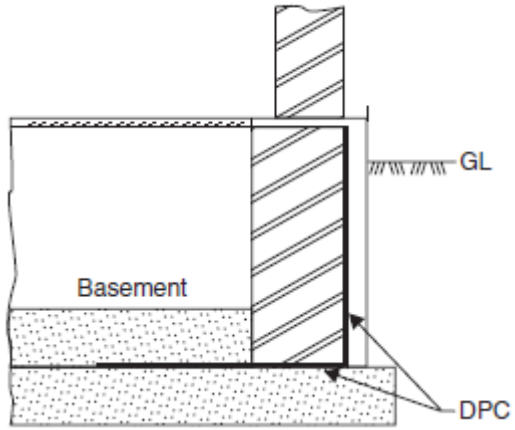

Figure: DPC for basement

Source: Bhavikati, S. (2010). Basic Civil Engineering. new delhi: New Age International (P) Ltd., Publishers.

3. Surface treatment:

- If moisture is only superficial and not under pressure this method is useful.
- It consists of application of layer of water repellant compounds on the surface.
- Some of the water proofing agents used for such treatment are silicates of sodium or potassium and sulphates of aluminium , zinc and magnesium.[6]

4. Integral treatment:

- It consists in mixing commercially available compounds in water before concrete is wet mixed. These compounds are made from chalk, talc, flutter earth or chemical compounds like calcium chloride, aluminium sulphate, calcium chloride etc. Some compounds contain compounds like soap, petroleum oils, fatty acids etc. [6]

5. Guniting :

In this method a mixture of cement and water is forced by cement gun on the surface to be made water proof. Later 1 : 3 or 1 : 4 cement mortar is applied to the surface with pressure using compressed air. Thus an impervious layer of mortar is provided.

6. Pressure grouting: This is the method used to seal cracks in the concrete surfaces. In this method cement grout is forced under pressure. [6]

Figure: Waterproof Concrete

Figure: Membrane Damp Proofing

(source:Daily Civil, n.d.,online), https://dailycivil.com/dampness-in-buildings-causes-sources-prevention/

Figure: Guniting

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