**UNIT V**

Acoustics - effect of noise - properties of noise and its measurements, principles of acoustics of building. Sound insulation-importance and measures.

**INTRODUCTION:**

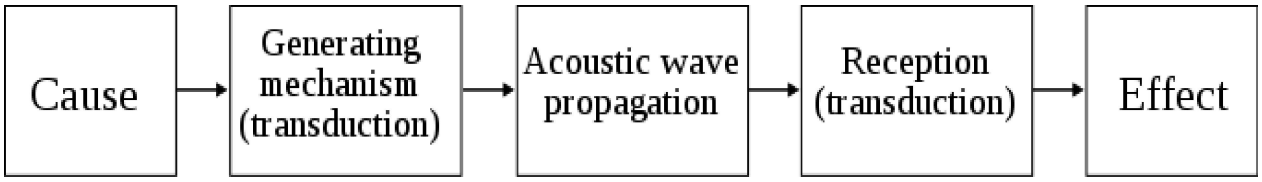
Acoustics is a branch of physics that deals with the study of mechanical waves in gases, liquids, and solids including topics such as vibration, sound, ultrasound and infrasound. A scientist who works in the field of acoustics is an acoustician while someone working in the field of acoustics technology may be called an acoustical engineer. The application of acoustics is present in almost all aspects of modern society with the most obvious being the audio and noise control industries.

Hearing is one of the most crucial means of survival in the animal world and speech is one of the most distinctive characteristics of human development and culture. Accordingly, the science of acoustics spreads across many facets of human society music, medicine, architecture, industrial production, warfare and more. Likewise, animal species such as songbirds and frogs use sound and hearing as a key element of mating rituals or for marking territories. Art, craft, science and technology have provoked one another to advance the whole, as in many other fields of knowledge.

**Acoustics definition:**

Acoustics is defined as (a) Science of sound, including its production, transmission, and effects, including biological and psychological effects. (b) Those qualities of a room that, together, determine its character with respect to auditory effects."

The study of acoustics revolves around the generation, propagation and reception of mechanical waves and vibrations.




The steps shown in the above diagram can be found in any acoustical event or process. There are many kinds of cause, both natural and volitional. There are many kinds of transduction process that convert energy from some other form into sonic energy, producing a sound wave. There is one fundamental equation that describes sound wave propagation, the acoustic wave equation, but the phenomena that emerge from it are varied and often complex. The wave carries energy throughout the propagating medium. Eventually this energy is transduced again into other forms, in ways that again may be natural and/or volitionally contrived. The final effect may be purely physical or it may reach far into the biological or volitional domains. The five basic steps are found equally well whether we are talking about an earthquake, a submarine using sonar to locate its foe, or a band playing in a rock concert.

The central stage in the acoustical process is wave propagation. This falls within the domain of physical acoustics. In fluids, sound propagates primarily as a pressure wave. In solids, mechanical waves can take many forms including longitudinal waves, transverse waves and surface waves.

Acoustics looks first at the pressure levels and frequencies in the sound wave and how the wave interacts with the environment. This interaction can be described as either a diffraction, interference or a reflection or a mix of the three. If several media are present, a refraction can also occur. Transduction processes are also of special importance to acoustics.

**Acoustics in Buildings:**

Building acoustics is the science of controlling sound in buildings. With acoustics services, sound is controlled within specific spaces and noise transmission from one space to the other is minimized. This can be achieved with materials, design and acoustic techniques.

**IMPORTANCE OF BUILDING ACOUSTICS:**

The impact of noise on health and wellbeing is often disregarded because it can't be felt in the same way as, say, water and air pollution.
But acoustics can have a huge impact on health, wellbeing, and productivity. In fact, noise pollution is, together with air pollution and water pollution, the most serious environmental pollution that affects human health. Noise pollution is an annoying and harmful level of noise.

For this reason, acoustic design is a crucial part of the design, construction, and operation of most buildings.

**ACOUSTICS IMPORTANCE IN BUILDINGS:**

Main benefits of building acoustics.

**Health, wellbeing, and comfort**

First, the acoustics in buildings is one of the key considerations of the impact that a building has on building occupants health, wellbeing, and comfort.

Studies show that noise has a major impact on sleep. In fact, noise levels can make our sleeping brains behave as if they are awake**.**

Plus, noise also impacts our health more generally. Noise is the number one cause of hearing loss. Noise leads to mental health problems such as anxiety and mental fatigue and serious health problems. High blood pressure, coronary heart disease, stress, and migraines are just a few such health issues**.**

It's clear that with better acoustics, buildings can be made healthier and that way, more valuable for building occupants, investors, and owners.

**Building occupancy levels and sales prices:**

Noise levels don't directly affect occupancy levels or sales or lease prices. There might be other considerations (such as location) that outweigh noise disturbances.

At the same time, building acoustics have a big impact on health and wellbeing and buildings with optimized acoustics are high-performing buildings. That way, there can be some correlation between occupancy levels, sales prices, and acoustics**.**

For office buildings and buildings that depend on good acoustics, such as theaters and concert halls, acoustical considerations are all the more important**.**

**Productivity:**

How do acoustics then affect productivity? If acoustics aren't taken into account, a well-designed workspace can fail to achieve its purpose of being a productive and collaborative space.

For example, bad acoustics can make us distracted and require a lot of our brain capacity. In fact, if someone overhears a conversation at work, the listener will instinctively process the conversation. And with the brain already focusing on one conversation, this employee won't be able to fully focus on the task in front of them.

A study by the American Society of Interior Designers (ASID) shows that 70% of office workers feel that noise affects their productivity. Plus, noise increases absenteeism and illnesses and makes people less helpful and more frustrated.

With this in mind, optimized acoustics can account for huge cost-savings and create a lot of value for companies.

**How does building acoustics work?**

In short, noise can be both airborne and structure-borne. A building's acoustics are influenced by the volume and geometry of that space. Besides this, sound absorption, transmission and reflection characteristics of surfaces that are positioned within and enclose that space impact acoustics.

Plus, other factors are materials that separate the space, generation of sound inside and outside the space, airborne sound transmission and impact noise.

For example, some of the main culprits in most offices are:

- Noisy HVAC systems.
- Improper partitioning of areas.
- Lousy acoustic insulation.
- Improper acoustic design.

There are several different strategies, including:

**Full Building Commissioning:** Building commissioning is a crucial part of making sure that building acoustics are optimized in the right way. A properly commissioned building will significantly reduce the risks of noise pollution.

**Testing and measuring sound levels**: On-site testing and measuring can be done both at the planning and construction phase and the operational phase to make better design choices and fix shortcomings.

**Modeling and simulations**: High-tech computer models help in estimating how your building will work acoustically. This helps you make better decisions about how to optimize your building's acoustics.

**Sound isolation:** Sound isolation is one of the most important considerations for a building and it helps you get rid of unwanted noise that is transmitted through adjoining buildings, walls, floors, and ceilings.

**Monitoring environmental noise:** With short and long-term noise monitoring equipment, the impact of noise can be measured and evaluated. Future noise levels can also be modeled and predicted.

**Equipment noise reduction**: Mechanical and electrical systems might be causing unwanted noise. For this, engineering techniques can be used to reduce the noise and vibration from your building's equipment.

**Room acoustics:** If your space is a theatre, cinema, restaurant or classroom (in short, space where music and speech will be transmitted), balancing sound quality and acoustics is an important consideration.

**WELL certification:** The WELL certification focuses on human health and wellness, including acoustics.

Plus, besides planning and design measures, acoustical soundproofing and barrier construction can be used as more rigorous measures to improve building acoustics**.**

## BUILDING ACOUSTICS FOR DIFFERENT TYPES OF BUILDINGS:

Different buildings have different acoustical needs. Here below are the main considerations for various building types.

### Acoustics in residential buildings and hotels:

Hotels and residential buildings rely on good acoustics for hotel bookings and high building occupancy levels. After all, health, sleep, and comfort are key considerations for hotel and residential building occupants.

In fact, buildings in areas with less noise have been shown to be more valuable than similar buildings in more noisy areas. Acoustics can improve residential buildings in areas with a lot of noise and that way, affect pricing.

Noise is also one of the biggest causes of complaints at hotels. Hotel acoustics affect guests' comfort levels and impact hotel bookings. While soundproofing makes it more expensive to develop a hotel, this cost can easily pay itself back thanks to customer retention and more bookings.

**Acoustics in office spaces:**

Office spaces need to be built to help office workers keep productive. Comfortable and healthy buildings, which are built for better communication, are ideal as offices. And acoustics play a big part in all of it.

As we have seen, poor acoustics can impact productivity, staff retention, and healthcare costs. Sound privacy is another consideration. All in all, you are 66% less productive if you hear other people talk while you're writing or reading. On the other hand, if sound-masking technology is used, employees are 46% better at concentrating and their short-term memory increases by 10%.

Improving office space acoustics can have a major impact on your bottom line.

**Acoustics in schools and medical facilities:**

Public schools and medical facilities depend on comfortable and healthy buildings.

In fact, poor acoustics in schools can negatively affect students by causing cognitive fatigue, increased anxiety, and poorer learning outcomes. In medical facilities, noise levels can impact patient comfort and slow down recovery. Plus, acoustic quality is important from a privacy perspective. Bad acoustics can jeopardize patient privacy.

**Acoustics in buildings with specific acoustic requirements**

Many buildings have specific acoustic requirements because of their intended use. For example, concert halls, conference spaces, recording studios, and cinemas depend on good building acoustics to function properly.

In these types of buildings, acoustics will directly impact the value of the building and their commercial potential (for example, concert ticket sales).

**EFFECTS OF NOISE:**

When workers are exposed to high noise levels in the workplace, they can suffer from various adverse health effects. These can be caused by a single exposure to a very loud noise or by exposures to raised levels.

The effects of noise on hearing depend on:

- noise intensity or sound pressure (dB)

- frequency or pitch of sound (Hz)
- exposure time
- distance from source
- individual susceptibility (age, disease, genetics etc)  nature of the sound (reverberation, impact noise etc)
- other factors (lifestyle, hobbies).

The most well-known effect of occupational noise is loss of hearing. However, it can also aggravate other health conditions. Some individuals are more sensitive to the effects of noise than others and will suffer harm more readily through noise exposure.

**Physiological effects of noise:**

The effects of noise on the psyche are dependent on the individual and what they consider to be acceptable. Different sounds affect people differently. Noise may startle, annoy, and disrupt concentration. Even nuisance noise can lead to issues with concentration, productivity, irritability, and stress, and must not be confused with excessive or prolonged exposure to noise. Technically nuisance noise is ambient noise levels between 50dB(A) to 60dB(A), which are below the levels that could damage a worker hearing but cause annoyance e.g., dripping tap. They affect individuals in different ways depending on several factors, such as the volume of the noise, how long it occurs, and how long it occurs (continuous or intermittent). Excessive noise can influence occupational accidents rates by affecting the accuracy of movements and perception of auditory signals. For industry loss of attention, work efficiency and productivity are extremely important outcomes of noise expo

## Loss of hearing or hearing impairments:

### Common symptoms of noise induced hearing loss (NIHL)

It's important to spot hearing loss as early as possible because early symptoms can help to identify the problem quickly and prevent permanent hearing losses. Early warnings can include:

- Ringing in the ears (tinnitus).
- Inability to hear soft and high-pitched sounds.
- Muffling of speech and other sounds.
- Trouble understanding conversation at a distance or in a crowd.
- Listening to music or watching television with the volume higher than other people need.
- Difficulty hearing the telephone or doorbell.
- Finding it difficult to tell which direction noise is coming from regularly feeling tired or stressed, from having to concentrate while listening.
- Answering or responding inappropriately in conversations.
- Reading lips or more intently watching people's faces during conversations.
- Feeling annoyed at other people because of not understanding them.
- withdrawal from social interaction and,
- feeling nervous about trying to hear and understand others.

Research suggests it can take 10 years from the time someone notices they have hearing loss before they do anything about it.

Many of the early warning symptoms of NIHL are subtle often causing a worker to ignore them until the damage is done. For this reason, it is important to use audiometry testing as a screening test for hearing losses in the occupational setting. This simple quantitative hearing test can be used to identify early losses or TTS. Once identified this should prompt improved controls to prevent any further or permanent hearing losses.

### Temporary hearing loss:

Known as a temporary threshold sift (TTS) this loss of hearing is due to exposure to noise above the 85dB level but below approximately 100dB or highly hazardous noise. It is in essence an intrinsic form of protection as sensitivity of the Organ of Corti is reduced during TTS, providing a transitory auditory fatigue or temporary hearing loss from which the ear will recover however long it takes. Originally it was the loss which resulted from a day's exposure to noise and from which the ear recovered overnight. In most people recovery occurs in the first hour or two after exposure depending on the level of noise. The extent of the TTS depends on the type of noise responsible. Usually with this type of impairment no physical signs appear, the ears appear normal and there is no pain or dizziness. Early signs and symptoms may be tinnitus or ringing in the ears and a slight muffling sound.

### Permanent hearing loss or noise induced hearing loss

This occurs because excessive and prolonged exposure to noise damages the delicate hearing mechanism of the inner ear (Organ of Corti). Loss in acuity occurs first in 3000-6000Hz band but characteristically at 4000Hz, and with time and continued exposure these frequency losses increase, and the lower frequencies begin to be affected. The losses are subtle and are often unnoticed until the damage is severe and impacts the workers communication skills. Generally, permanent hearing loss tends to be highest after 10 years of exposure and it is known that TTS and permanent hearing loss run parallel. It is the most common preventable occupational health condition across the world.

The level of noise that is likely to damage hearing varies depending on the individuals' characteristics and the duration of exposure to noise. The exposure limits established by countries is deemed to be that level at which unprotected exposure will not cause adverse health outcomes.

Noise induced hearing loss does not only occur at work. Environmental exposures through activities such as carpentry, metal work and attending night clubs are known to expose individuals to noise levels above 95dB causing hearing loss which may exacerbate any occupational exposure to noise.

Noise induced hearing loss is caused by chronic exposure to noise above or more than the upper exposure values. This differs from acoustic trauma which can cause damage from a one-off exposure.

**Acoustic trauma or acoustic shock**

This is caused by short bursts of extremely loud noise in a sudden single exposure such as an explosion or gun shots. It is often associated with a rupture of the ear drum due to the force of the trauma. The hearing loss experienced can be temporary returning to normal or near normal within three months.

**Other effects of noise**

Noise can influence other systems of the body i.e the cardiovascular system, resulting in an increase in blood pressure and the release of catecholamines in the blood (catecholamines are hormones which help the body respond to stress or fright and prepare the body for fight-or-flight reactions8). An increased level of catecholamines in the blood is associated with stress, making people breath faster, raise blood pressure and send more blood to organs such as brain, heart and kidneys. It may also cause ear pain, nausea, reduce muscle control and diminished visual fields both for colour and form. Prolonged exposure over a period may well cause occupational stress in an individual.

Excessive noise can also increase the likelihood of undesired events or incidents by:  distracting workers, such as drivers

- making it harder for workers to hear and understand instructions correctly  masking the sound of approaching danger and warning signals
- contributing to irritation and annoyance that may lead to human error.

Exposure of high noise in pregnant workers can affect an unborn child. Research suggests that prolonged exposure of the unborn child to high noise levels during pregnancy may influence a child's hearing later in life with the low frequencies have a greater potential for harm.

Many chemicals in the workplace are Ototoxic too and exposure to these chemicals even in areas where noise levels are controlled may cause exacerbated hearing loss in workers.

**PROPERTIES OF NOISE AND ITS MEASUREMENT:**

**Properties of Noise:**

Noise is generally defined as unwanted sound. It is emitted from many natural and man-made sources. The degree of disturbance or annoyance from exposure to unwanted sound.

Noise depends upon three factors:

1. The amount, nature, and duration of the intruding noise
2. The relationship between the intruding noise and the existing sound environment; and
3. The situation in which the disturbing noise is heard

Over time, individuals tend to accept the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent use of exterior and interior spaces and has been theorized to pose health risks. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level. Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. The intensities of each frequency add together to generate sound. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all of the frequencies of a sound according to a weighting system. It has been found that the A-weighted filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response of the human ear.

**Measurement of Noise:**

Noise level is measured in decibels (dB). The louder the noise, the higher the decibels. Decibels can be adjusted to human hearing. Noise level is thus described in decibels A (dBA). The effects of noise vary with the noise to which a person is exposed. Prolonged exposure to loud noises (75 dBA over eight hours a day for years) can lead to hearing loss. The body can also respond to lower noise levels: sleep can be disturbed by an outdoor noise of 40 dBA.

In acoustics, **noise measurement** can be for the purpose of measuring environmental noise or measuring noise in the workplace. Applications include monitoring of construction sites, aircraft noise, road traffic noise, entertainment venues and neighborhood noise. One of the definitions of noise covers all "unwanted sounds". When sound levels reach a high enough intensity, the sound, whether it is wanted or unwanted, may be damaging to hearing. Environmental noise monitoring is the measurement of noise in an outdoor environment caused by transport (e.g. motor vehicles, aircraft, and trains), industry (e.g. machines) and recreational activities (e.g. music). The laws and limits governing environmental noise monitoring differ from country to country.

At the very least, noise may be annoying or displeasing or may disrupt the activity or balance of human or animal life, increasing levels of aggression, hypertension and stress. In the extreme, excessive levels or periods of noise can have long-term negative health effects such as hearing loss, tinnitus, sleep disturbances, a rise in blood pressure, an increase in stress and vasoconstriction, and an increased incidence of coronary artery disease. In animals, noise can increase the risk of death by altering predator or prey detection and avoidance, interfering with reproduction and navigation, and contributing to permanent tinnitus and hearing loss.

Various interventions are available to combat environmental noise. Roadway noise can be reduced by the use of noise barriers, limitation of vehicle speeds, alteration of roadway surface texture, limitation of heavy vehicles, use of traffic controls that smooth vehicle flow to reduce braking and acceleration, and tire design. Aircraft noise can be reduced by using quieter jet engines, altering flight paths and considering the time of day to benefit residents near airports. Industrial noise is addressed by redesign of industrial equipment, shock mounted assemblies and physical barriers in the workplace.

Noise may be measured using a sound level meter at the source of the noise. Alternatively, an organization or company may measure a person's exposure to environmental noise in a workplace via a noise dosimeter.

## ACOUSTIC PROPERTIES OF BUILDING:

Acoustic property of building is based on acoustic nature of building materials and how sound is transmitted through the adjacent structural elements. Noise is unwanted sound, that is considered as a nuisance in buildings for residential or domestic purposes. The buildings must possess good sound insulation property to have good acoustic feature. Sound insulation of buildings is a property that must be considered in the initial stages of planning. Planning for the structural elements, to make them sound proof is one of the consideration. And the other one is the planning of the area, where the building should be located. A building planned near to a roadway, which is highly traffic prone, would result in high inconvenience to the occupants residing there.

## ACOUSTIC PROPERTIES OF BUILDING MATERIALS:

In many cases help from an acoustic designer is required after the building construction is complete and is occupied to high level of sound. The discomfort faced by the occupant residing or using it, have to go for redesigning the building for noise insulation. So, it is always necessary to have a pre-planning, mainly for the building constructions that are prone to noise disturbances. Now being aware of the acoustic properties of building materials to some extent would help us to have a right choice on the what material to be selected when acoustics is a concerned factor. Some of them are explained below:

### Acoustic Properties of Masonry, Concrete or Stone Materials

Mass and rigidity property are the two factors that make a material to be highly noise resistant. The concrete wall is highly efficient than masonry. Masonry material made floor or wall do perform appreciably. Massive materials like stone, concrete can stop high sound waves that are less resistant to less massive materials. Concrete slabs do perform good in the sound insulation activity.

### Acoustic Properties of Wood and Related Products

These are less dense than masonry. They have a smaller performance in sound isolation. MDF woods are more massive that are added to certain interior walls to increase the massiveness. The most common material plywood, which is used in multilayer in interiors, to make it sound proof. Mainly wood is used in rooms where perfect sounding is required. It can reflect sound which can be considered as an important property for sound treatment. It resonates easily which promotes absorption of sound, some of which pass through the material and some reflects. Therefore, these are used in making of instruments.

### Acoustic Properties of Steel

Based on performance and structure, steel is one of the best material for sound insulation. Because of high cost, it has less application. It is highly dense and massive in nature. Steel carries the sound through vibration within the material. This sound transfer is called as the structure-borne vibration. The normal case is airborne vibration which is not appreciable.

### Acoustic Properties of Glass & Transparent Materials:

The glass is massive in nature. There is a new development of absorptive glass-like materials that have the property to absorb more sound waves instead of reflecting. The material is made from Plexiglas or transparent foil thinner in nature with tiny holes. Their application comes in sound studios.

**Acoustic Insulating Materials:**

Foam, fiberglass, rock wool etc. can be considered as the insulating materials we are familiar. The fiberglass material gains higher sound absorption property. These materials absorb sound by reducing the velocity of particles that carry the sound waves in the air. Under low velocity, the pressure is high. Now wood materials absorb more sound at high pressure. Sound waves gain higher pressure at room boundaries. So, care must be taken in the arrangement of boundaries or walls. For multiple boundaries like dihedral or trihedral walls, the sound waves are at higher pressures.

**Acoustic Properties of Rubber and Plastic**

The known materials are vinyl, neoprene etc. These materials are used to make low cost economical acoustical devices. But their use is almost considered limited. They can be used as mechanical isolators for floating glass, by preventing vibrations of the diaphragm to be transmitted to the walls.

**BASIC PRINCIPLES OF ACOUSTICS:**

More than half the world's population lives in dense urban areas. Uncomfortably loud restaurants, stores, hotels, or offices are enough to keep patrons away. When planning a meeting or even a night out with friends, we are conscious of selecting a location where we can focus and hear one another. The noisier our world gets, the more difficulty we have focusing on the sounds we actually want to hear.

Since the beginning of time, our ears have warned us of approaching danger. While their function remains the same, the dangers of today are different than they were in the past. Unwanted sounds can have serious health effects such as: hearing loss, cardiovascular disease high blood pressure, headaches, hormonal changes, psychosomatic illnesses, sleep disorders, reduction in physical and mental performance, stress reactions, aggression, constant feelings of displeasure and reduction in general well-being. With this laundry list of side effects, it would be foolish to leave the acoustic comfort of our spaces up to consultants alone. When we take acoustic comfort into our own hands, the end result can be quite extraordinary.

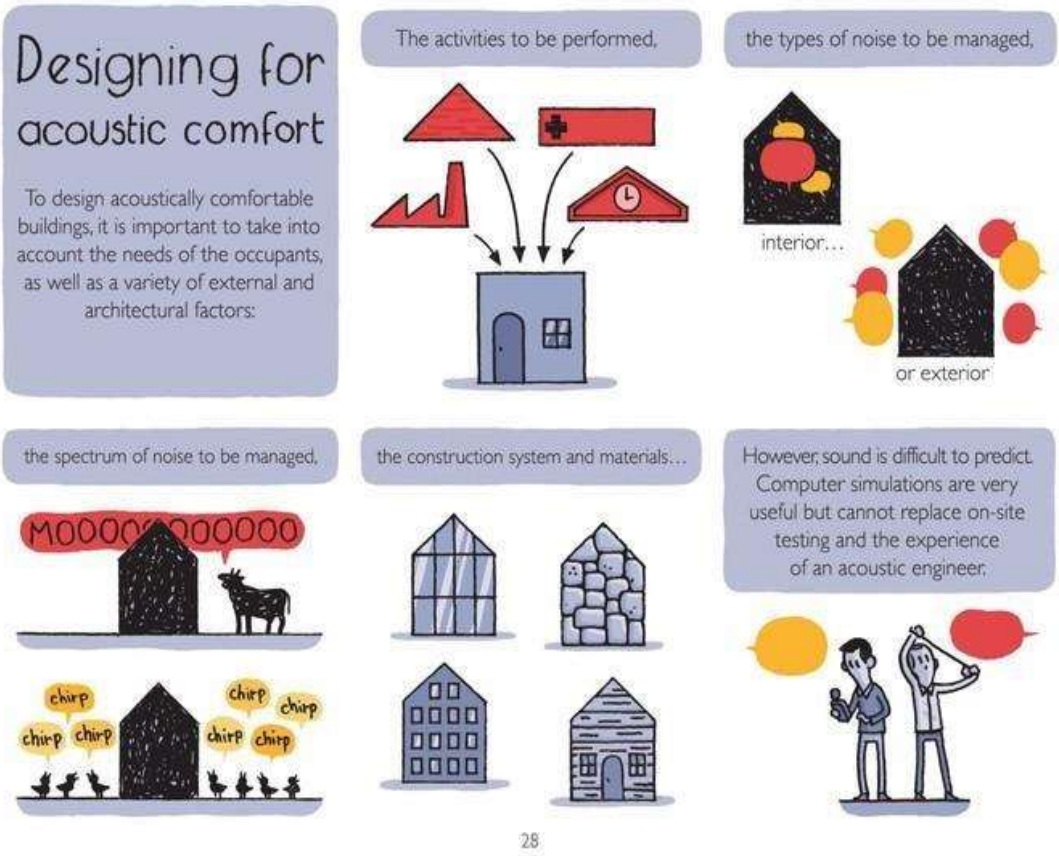
**Acoustic Comfort**:

Even during sleep, our outer, middle, and inner ear, receive, transmit, and detect sound respectively. Sound pressures cause the eardrum to vibrate, stimulating nerves in the inner ear. Differences in pressure determine volume, measured in decibels. Vibration cycles per second determines the pitch, or frequency, measured in Hertz.

Indoor acoustic quality is dependent on how well sound sources are controlled. Exterior, interior, impact, and equipment noises are transmitted through the air or building fabric. How the human ear perceives sound directly depends on levels of reverberation and absorption within the building. To assess a buildings acoustic comfort, sound level and room acoustics are evaluated. Sound level is measured by background versus peak noise levels. Room acoustics are measured by reverberation time, intelligibility level, and privacy level. Depending on the functionality of the building or room, different acoustic requirements will apply.

**Design For Acoustic Comfort**

To design for acoustic comfort, consider occupant needs along with external and architectural factors: the building program, cultural habits, noise types, noise spectrum, construction systems and materials. Sound is challenging to accurately predict. Forecast external noise levels through site analysis and a narrative explaining the building's performance requirements, building fabric, and technical equipment needs. True on-site analysis cannot be replaced by computer simulations, which don't have human ears. Ultimately, acoustic performance comes down to workmanship.




### 5.11.3 Where Should Architects Get Involved:

Once the programmatic needs are known (a n d the correct noise levels are already determined with the help of a specialist) it's time for materials to be selected. This is exactly where architects should be more involved and where they can make a difference in the design and expression of the build ing (inside and out).There is a wide variety of customizable materials available such as acoustic wall and ceiling panels which area a great way to reduce sound reflections. Also acoustic glass integrates a film interlayer to diminish sound transmission without sacrificing transparency, and this can be a great way to create interior sub-divisions in modern cowering spaces, for example. And we should never forget the correct use and application of noise-proofing sealant which prevents unwanted noise from escaping a room through minimum gaps and cracks. Finally, an on-site testing ensures the specified performance is achieved.

Acoustics are a key element in all building types from hospitals, educational buildings, sports centers to residential or working and music venues. Each typology in architecture will have it's own acoustic requirement and that's why architects cannot design a comfortable and sustainable building without the previous research and knowledge.  To achieve a perfect acoustical space we must be aware of the technologically-advanced materials which maintain world-class acoustics. As our cities densify, neighbors grow closer, people work from home, and building types become more and more mixed use, the indoor acoustic landscapes is evolving. Climate change has already raised noise levels by increasing our use of air conditioning systems. Storms are intensifying, bringing about more vibrations. Our buildings will require better insulation to protect occupants from internal as well as external noise. At the end of the day, the way we "hear" in a space not only affects our appreciation of it, but our productivity, our capacity of learning, our sleep, comfort and general wellbeing, as well.

## PRINCIPLES OF ACOUSTICS IN BUILDING:

From workplaces to domestic and industrial properties, the noise in buildings often needs to be controlled diligently - and that's where an acoustic consultant comes in. A professional acoustics consultant is a master in the art of controlling noise and minimising the transmission of noise where necessary.

When the transmission of noise can be managed effectively - be it by the design of the characteristics possessed by a space or the control of noise levels - a satisfactory environment, free from disturbance and disruption which can cause mental or physical stress, can be created.

### It's all in the design

To guard against unwanted or unbalanced noise levels, sound planning at the design stage is crucial. An acoustics consultant will typically create an acoustic climate which ensures that noise transmission levels are agreeable with the specific usage of the room; be it for every day living or commercial use. Failure to plan ahead in this regard can cost money - if measures have to be taken to remedy a space after it has become occupied, there can be a heavy price to pay, not to mention the potential inconvenience.

### Insulate and absorb

Because building acoustics need to factor in both internal and external sound transmission, sound insulation, as well as absorption, needs to be taken into consideration. Sound insulation is concerned with reducing the sound which passes between two spaces which are divided by a physical presence. Sound insulation design needs to consider two forms of sound energy - that which passes through a divider and that which passes through the surrounding structure, also known as flanking transmission. When a sound insulation project throws up problems, typically an acoustics consultant will set about finding the weak spots in a construction.

The flanking transmission mentioned earlier is a crucial element of the design stage in order to keep acoustic performance levels up. Small gaps and holes in residential buildings, for example, can mean that due to flanking transmission, acoustic performance is not up to scratch. This makes following the relevant guidance and meeting specific criteria such an important part of an acoustics consultant's job.

Meanwhile, when we talk about sound absorption, that refers to the loss of sound energy which occurs on interaction with a surface. Surfaces which are sound absorbent are capable of creating the right acoustic environment when placed correctly. Which materials are used is critical to how much acoustic efficiency an absorbent surface provides. In general, materials which provide softer finishes to a space will provide better sound absorption than those which are harder. It should be noted that the reduction of noise which can be achieved through sound absorption should not be seen as a replacement for proper sound insulation.

### Reverberant energy

Another principle worth touching on is that of reverberant energy, which is the extent to which a sound can be heard after an initial sound has been made. In an enclosed space, echoes can occur, before the noise is absorbed by the surrounding features, as well as the air. The length of the period from the original sound being made, to it echoing, decaying and then dying away, is known as the reverberation time.

**Construction considerations**

There are plenty of best practices to bear in mind when considering the acoustics performance within a building. For example, if attempting to bolster sound insulation using a high performing element such as a partition, perhaps the worst thing you could do is then to position a low performing element within it - a door, for instance. If there is a significant difference between the sound insulation of two elements, the overall sound insulation performance of a space will be affected to a greater degree.

**Go for guidance**

In the UK, there are several relevant standards pertaining to acoustic performance.
Among them is Building Regulations Approved Document E (ADE) – Residential Buildings, which sets out what should be considered a reasonable level of sound insulation between domestic properties. Then there is the Code of Practice entitled 'BS 8233 - Sound insulation and noise reduction for buildings', which provides acoustic ratings which can be applied to different building types. Some types of buildings have their own dedicated guidance, such as Health and Technical Memorandum HTM 08-01 Acoustics - Healthcare Buildings, which recommends levels of sound insulation to be achieved in healthcare environments.

Most of the time we can't see or feel it, but the acoustics in buildings can have a direct impact on life for their inhabitants - for this reason, it is always best to seek the advice of a professional acoustic consultant when undertaking building construction.

**SOUND INSULATION IN BUILDINGS:**

The sound insulation property of building materials is the ability in the reduction of sound across a partition. For a good conventional office building construction, the sound insulation is experienced good when it is in the range of 45dB. This value can be explained as follows. If the room creates a sound of 65dB, then the receiver sitting in the adjacent room receives the sound at 20dB. This value is barely audible. Now if the level increase to 75dB, which is a raised voice, then the sound levels at the adjacent room will be 30 dB, which is clearly audible. We must keep in mind that sound insulation gives the property of how much sound is lost and not the sound regained within the room. The unwanted and unexpected sound is always considered to be a noise and that really is a question of the acoustic property of the building.

**IMPORTANCE OF SOUND INSULATION IN BUILDINGS:**

**A soundly constructed building is an example of fine architecture, mesmerizing facade, and integrated science.**

Noise pollution doesn’t need an introduction as everyone is much aware of its causes and results. By understanding the nuances of sound like quality, pitch, and timbre; you step into the shoes of an acoustic consultant and begin to anticipate soundproofing solutions which fit best in your situation.

The workout of theories and algorithms in the construction process is highly acknowledged to shape a place which is worth living.

While designing a blueprint, an architecture works on measurements, focus on designing and checks on quality understanding the importance of survival.

The standard protocols of building industry take into account sustainability which means designing buildings which inspire to live. Economically savvy, socially ethical and environmentally benign are the three genres of building process which a builder keeps in mind while working on projects.

**Sound is a reality but peace is the truth**

If a place doesn't deliver a sense of peace, then it isn't generating the total value. A mediocre person finds life at peaceful places where he/she tries to gather the lost energy. Noise is a cause for distraction which takes the focus away and lowers productivity.

Be it working at a place and living in a society; buildings are important to be sound proof. On road construction work, loud parties, and quarreling people are nothing but the reasons for insomnia during nights. The acoustically weak building lets you hear everything that goes next to your room and even can open up confidential information. The sound paves a way to distraction which bogs down overall potential and rail against core interest.

The only solution is turning every corner into a live example of soundproof material. It is essential for the betterment of life, to stabilize nerves and to keep senses calm. A certain degree of high-level noise can grant sleepless nights, regular flights and off track thoughts and you taste the real downfall when you observe the difference in your listening power.

The market is full of sound insulation materials which are affordable to buy and easy to use by following guidelines. Spending a part of the money in sound insulation can save from future disasters and significant losses which can hurt the pocket in an unwanted way.
**Soundproofing is painstaking** for every age group, as students will be able to study without any restlessness, residents will be able to work in peace and moreover managers dont need to resolve any sound issues. An owner should not silently treat architectural, structural and mechanical acoustical solutions as sound insulation is a matter of prime importance to build up noise free areas. Noise control bureau has a set of guidelines which should be interpolated to new constructions while running parallel with technical and economic aspects.

Scientific and practical arenas should primarily encourage sound testing to check the pitch while taking necessary steps to manage the same. Social media platforms are the best to communicate the idea and logic behind soundproofing materials in real time while introducing to the latest insulation materials.

**Direct to reverberant ratio**

Taking a hold over acoustical energy means delimiting the effect of direct radiations while blocking the secondary pathways of its origin.
Direct to reverberant ratio is similar with signal to noise ratio which is purposely calculated to get accurate value of pertaining sound.

A listener is in direct field if D/R ratio is greater than 1. If D/R ratio is less than 1, a listener is in reverberant field. Acoustical control techniques keep all listeners in direct field which save from high pitch sound waves.

The easiest and time saving method to insulate a place is by sealing dead spaces. Distance decides the dissipation of sound energy in the air. With the increase in distance, the intensity decreases and a listener is not able to hear. But over shorter distances, the sound often takes the form of echo and get its other name noise. Root out this problem by closing open penetrations through walls and ceilings which will control reflections and make rooms soundproof.

Another source of sound is vibrating objects which motivate pressure waves in the air. Even sound can render objects to vibrate and restores pressure waves on the objects at different locations but at the lose of acoustical energy. The heavier object requires extra energy to vibrate and leave less energy to restore sound.

Some objects do not answer with vibrations to audible sound thus no pressure waves in the air. That's why mattresses, curtains and pillows suppress instead of regenerating the existing sound. Soundproof windows are constructed with the above method.

**Switch to sound insulation**

It is not necessary to install sound-dampening materials during construction. However, site inspection can give an overview of installation process which you can continue after completion of projects. While soundproofing techniques are out of the eye of many designers, manufacturers believe that remodeling efforts strive to address noise pollution will eventually gain traction with more and more people living in condensed places.

**MEASURES TO REDUCE UNWANTED SOUND IN BUILDINGS:**

Certain physical techniques that are employed by engineers, architects, and builders to reduce noise impacts are explained under this section. Due to the scarcity of land as well as increasing population, the engineers are forced to undertake the available land and treat it as per our need. So, major four actions which can be employed to reduce noise impacts, that are compatible with any type of land, activity or use are:

- Site Planning
- Design
- Methods in Construction
- Barriers in Construction

**Building Site planning**

The site planning method in acoustic property of buildings is to arrange the buildings on a zone of land, that would minimize severe noise impacts. This is done by capitalizing the natural shape as well as contours of the site. One such step is to shield the residential area or other non-sensitive activities from noises by nonresidential land, or an open space or by barrier buildings.

**Building Design**

The architecture design method implements the noise reduction concepts in the details of the individual building elements. This stage is more concerned about the height, the room arrangement, the placement of balconies and the window.

**Method of Construction**

The individual elements of buildings can be improved by the variation of structural element materials or internal design to facilitate good sound insulation. This would reduce the noise transmission through wall, windows, doors, ceiling and floors. New soundproofing concepts have been developed which are related to this stage.

**Barriers for Construction**

Barriers for resisting noise, which is placed in between the noise sensitive areas and the source of noise. Different types of barriers are possible, like walls, fences made of different materials, planting trees and shrubs in thick, making berms out of earth and combination of individual elements.