Lecture Notes

On

Environmental Engineering (MCMC3001)

3rd Year Civil, Electrical, Mechanical, Computer Science Engineering

Module IV: Solid waste Management, Hazardous Waste & Noise

By

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Module-IV

Solid waste Management

Solid waste is defined as the unwanted matter which is generated by the society that does not have any economic value from the point of view of first owner. Per capita waste generated in India is 0.25 to 2.5 kg/ day.

Solid waste management is a comprehensive process about collection, transportation, treatment and disposal of solid materials discarded by human activities.

It aims to minimize environmental impact and promote sustainability by effectively handling waste from various sources like households, industries, and medical facilities

Importance of Solid Waste Management

- **Environmental Protection:** Minimizes pollution and contamination of soil, water and air.
- **Public Health:** Reduces the risk of diseases and improves sanitation.
- **Resource Recovery:** Enables recycling and reuse of materials, conserving resources and reducing the need for landfill space.
- **Economic Benefits:** Reduces the cost of waste disposal and can generate income through waste-to-energy projects.

Sources of solid waste

- Residential
- Commercial
- Industrial
- Municipal services
- Institutional
- Agricultural
- Hospital

Residential

Residences and homes where people live are some of the major sources of solid waste. Garbage from these places include food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes and special wastes like bulky household items like electronics, tires, batteries, old mattresses and used oil. Most homes have garbage bins where they can

throw away their solid wastes in and later the bin is emptied by a garbage collecting firm or person for treatment.

Industrial

Industries are known to be one of the biggest contributors of solid waste. They include light and heavy manufacturing industries, construction sites, fabrication plants, canning plants, power and chemical plants. These industries produce solid waste in form of housekeeping wastes, food wastes, packaging wastes, ashes, construction and demolition materials, special wastes, medical wastes as well as other hazardous wastes.

Commercial

Commercial facilities and buildings are yet another source of solid waste today. Commercial buildings and facilities in this case refer to hotels, markets, restaurants, go downs, stores and office buildings. Some of the solid wastes generated from these places include plastics, food wastes, metals, paper, glass, wood, cardboard materials, special wastes and other hazardous wastes.

Institutional

The institutional centers like schools, colleges, prisons, military barracks and other government centers also produce solid waste. Some of the common solid wastes obtained from these places include glass, rubber waste, plastics, food wastes, wood, paper, metals, cardboard materials, electronics as well as various hazardous wastes.

Construction and Demolition Areas

Construction sites and demolition sites also contribute to the solid waste problem. Construction sites include new construction sites for buildings and roads, road repair sites, building renovation sites and building demolition sites. Some of the solid wastes produced in these places include steel materials, concrete, wood, plastics, rubber, copper wires, dirt and glass.

Municipal services

The urban centres also contribute immensely to the solid waste crisis in most countries today. Some of the solid waste brought about by the municipal services include, street cleaning, wastes from parks and beaches, wastewater treatment plants, landscaping wastes and wastes from recreational areas including sludge.

Treatment Plants and Sites

Heavy and light manufacturing plants also produce solid waste. They include refineries, power plants, processing plants, mineral extraction plants and chemicals plants. Among the wastes produced by these plants include, industrial process wastes, unwanted specification products, plastics, metal parts just to mention but a few.

Agriculture

Crop farms, orchards, dairies, vineyards and feedlots are also sources of solid wastes. Among the wastes they produce include agricultural wastes, spoiled food, pesticide containers and other hazardous materials.

Biomedical

This refers to hospitals and biomedical equipment and chemical manufacturing firms. In hospitals there are different types of solid wastes produced. Some of these solid wastes include syringes, bandages, used gloves, drugs, paper, plastics, food wastes and chemicals. All these require proper disposal or else they will cause a huge problem to the environment and the people in these facilities.

Importance of Classification of solid waste

Classifying solid waste is crucial for effective management, allowing for proper collection, treatment, and disposal, ultimately minimizing environmental impact and maximizing resource recovery. It helps identify hazardous materials, promotes recycling and composting, and facilitates efficient waste stream analysis.

Classification of solid waste

1. By Source:

- **Municipal Solid Waste (MSW):**

  This encompasses waste from residential, commercial, and institutional sources, including food scraps, paper, plastic, glass, and yard waste.

- **Industrial Waste:**

  Waste generated from manufacturing processes and industrial operation, which can be further categorized as hazardous or non-hazardous.

- **Agricultural Waste:**

Waste from farming activities, such as crop residues, animal manure, and pesticide containers.

- **Construction and Demolition Waste:**

  Materials from building and demolition projects, like concrete, lumber, and metal.

- **Biomedical Waste:**

  Waste from healthcare facilities, including infectious materials and sharps.

2. By Degradability:

- **Biodegradable Waste:**

  Materials that decompose naturally under normal environmental conditions, such as food scraps, yard waste, and some plastics.

- **Non-Biodegradable Waste:**

  Materials that do not decompose easily, such as plastic, glass, and some metals.

3. By Hazard Level:

- **Hazardous Waste:**

  Waste that poses a risk to human health or the environment due to its toxicity, reactivity, flammability, or corrosiveness, including chemicals, pharmaceuticals, and some industrial byproducts.

- **Non-Hazardous Waste:**

  Waste that does not pose a significant risk to human health or the environment, typically including MSW and some industrial byproducts.

4. By Recyclability:

- **Recyclable Waste:**

  Materials that can be processed to create new products, such as paper, plastic, glass, and metals.

- **Non-Recyclable Waste:**

  Materials that cannot be readily recycled, including some plastics and food-contaminated items.

5. Other Classifications:

- **Combustible Waste:**

  Materials that can be burned for energy, such as wood, paper, and some plastics.

- **Non-Combustible Waste:**

  Materials that cannot be easily burned, such as glass, metals, and some types of plastic.

In the US, MSW is commonly called "trash" or "garbage" and consists of everyday items like food scraps, product packaging, newspapers, furniture, and yard waste. It does not include industrial, hazardous, or construction waste. Municipal Solid Waste (MSW) is commonly known as "refuse" or "rubbish" in UK**.** The terms "refuse" and "rubbish" are essentially synonyms in the UK context for this type of general, non-hazardous solid waste. The waste is collected by local authorities or their agents for processing and disposal (which can include recycling, composting, or landfilling).

Characteristics of solid waste

Solid waste is characterized by its composition, which includes a mix of organic and inorganic materials like food scraps, paper, plastics, metals, and glass. It also has varying moisture content, density, and degradability. Some solid waste may contain hazardous substances and can produce odours during decomposition.

Here's a more detailed look at the characteristics:

1. Composition:

- **Organic Matter:** Food waste, yard waste, paper, and other biodegradable materials.
- **Inorganic Matter:** Glass, metals, plastics, ceramics, and incineration-derived ashes.
- **Hazardous Waste:** Batteries, electric light bulbs, automotive parts, discarded medicines, and chemicals.

2. Physical Properties:

- **Density:** Mass per unit volume, varying depending on the waste's composition and compaction.
- **Moisture Content:** The amount of water present in the waste, which can be significant.

$$Moisture\ content\ (\%) = \frac{Wet\ weight\ -\ Dry\ weight}{Wet\ weight} \times 100$$

$$M = \left(\frac{w-d}{w}\right)100$$

Where M = moisture content, %
W= initial weight of sample as delivered, kg
D=weight of sample after drying at 105 ^{0}C, kg

- **Particle Size Distribution:** The range of particle sizes within the waste.
- **Thermal Conductivity:** The ability of the waste to conduct heat.
- **Compaction and Consolidation:** How the waste behaves under pressure.
- **Porosity:** The amount of void space within the waste.

3. Chemical Properties:

- **Volatile Solids:** Materials that can be lost during heating.
- **Ash Content:** The residue remaining after burning.
- **Calorific Value:** The energy content of the waste, which can be a factor in energy recovery.
- **CHNSO Content:** The presence of carbon, hydrogen, nitrogen, sulfur, and oxygen in the waste.
- **Heavy Metals:** Certain metals that can be present in hazardous waste.

4. Other Important Characteristics:

- **Biodegradability:**

It means whether the waste can break down naturally or not.

- **Odours and gases:**

Organic waste can produce unpleasant odours. Decomposition releases various odours and gases, some of which are unpleasant or harmful. Common examples include methane, hydrogen sulfide, and methyl mercaptans. Methane is a greenhouse gas, and hydrogen sulfide can be toxic and corrosive.

- **Volume:**

The amount of waste generated, which is influenced by population density and economic activities.

- **Pathogen Potential:**

Solid waste can spread pathogens, including bacteria, viruses, and parasites. Improper disposal can create breeding grounds for insects and rodents, which can further transmit diseases.

- **Nutrient Cycling:**

While decomposition can release pathogens, it also contributes to nutrient cycling. The breakdown of organic matter releases essential nutrients like nitrogen, phosphorus, and potassium, which can be utilized by plants and other organisms.

- **Other Considerations:**

The biological characteristics of solid waste are also influenced by factors like moisture content, temperature, and oxygen availability, which affect the rate and type of decomposition.

Functional Elements of Solid Waste Management

There are six elements of Solid Waste Management

1. Solid waste generation
2. On-site handling and storage
3. Collection
4. Transfer and transport
5. Material and resource recovery
6. Disposal

Solid Waste Generation

In Elements of Solid Waste Management, **Solid waste** generation pertains to the production of waste materials through various activities in residential, commercial, and industrial settings. Understanding the components of Solid Waste Management is essential to formulate appropriate waste management strategies. The estimation of waste generation rates can be achieved using the formula: Waste Generation = Population × Per Capita Waste Generation Rate. Solid waste generation results from natural, human, and animal activities.

Factors influencing generation:

Waste generation rates can vary significantly based on factors like:

- Population size and density.
- Economic activity.
- Consumption patterns.
- Geographical location.
- Lifestyle and cultural practices.

Waste Handling

Waste materials being separated for reuse and recycling, as well as the level of separation from the general waste stream. This process includes tasks like waste segregation, waste minimization efforts, and the use of suitable containers or bins.

Waste Storage

Neglected solid waste or haphazard dumps can give rise to nuisances, attract flies, produce odours, and create various hazards. Hence, focusing on proper on-site storage becomes essential to avoid these issues and initiate effective waste management practices.

Collection

The collection entails the systematic gathering and transportation of waste from diverse sources to a central location or transfer station.

Waste Collection Methods:

Common methods for waste collection include:

- **House-to-house collection:** This involves a waste collection vehicle visiting households to pick up waste.
- **Community bin collection:** This involves placing large bins in specific areas for residents to deposit their waste.

Challenges:

Effective waste collection faces challenges, including:

- Limited infrastructure in some areas.
- Lack of proper waste sorting and segregation.
- Public awareness and participation.

Technological advancements:

New technologies, such as:

- Smart bins with sensors that monitor fill levels.
- Automated waste collection systems.
- GPS tracking of waste collection vehicles.

Storage and transport of MSW

Properly managing Municipal Solid Waste (MSW) requires effective storage and transport. This involves segregating waste at the source, using appropriate storage containers, and utilizing various vehicles for collection and transport. Key steps include:

Storage at Source:

- **Segregation:**

  Waste should be separated into biodegradable, non-biodegradable, and domestic hazardous waste streams.

- **Containers:**

  Different coloured bins (green for biodegradable, white for recyclables, black for other waste) can help with proper segregation.

- **Large containers:**

  Provide large, covered containers that match the local body's transportation system.

Transportation:

- **Primary Collection:**

  This involves collecting waste directly from households, commercial establishments, and other sources.

- **Secondary Collection:**

  This involves transporting waste from collection points (like transfer stations or communal bins) to disposal or processing facilities.

Vehicles:

Various vehicles are used for transportation, including:

- **Wheel barrows:** Suitable for primary collection in crowded areas.
- **Donkey carts:** Can be used for primary collection and in some cases, secondary transport depending on distance and road conditions.
- **Flatbed trucks:** Used for secondary collections from transfer stations and communal bins.
- **Compactor trucks:** Used for both primary and secondary collection, compacting waste as it's collected.
- **Non-compactor trucks:** Used for primary collection, especially when labor costs are high.

- **Mobile garbage bins:** Used for community or bulk generator collection.

Transfer Stations:

- **Function:**

Transfer stations can be used to transfer waste from smaller trucks to larger vehicles for longer-distance transport.

- **Types:**

Transfer stations can be direct discharge, platform/pit, or compaction stations.

- **Benefits:**

Transfer stations can improve collection efficiency, reduce costs, and minimize CO2 emissions.

Key Considerations:

- **Distance:**

The distance between the collection area and the disposal or processing facility influences the type of vehicle used and the need for transfer stations.

- **Road Conditions:**

Road conditions can affect the suitability of certain vehicles, such as donkey carts.

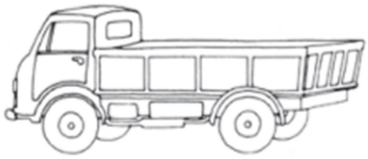
- **Labour Costs:**

Labor costs can influence the choice of vehicle (e.g., non-compactor trucks when labor is expensive).

- **Vehicle Maintenance:**

Regular maintenance of waste collection vehicles is crucial for efficient and safe operation.

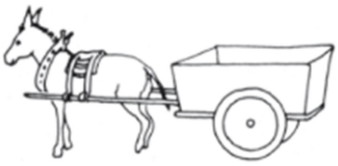
Handcart – human power



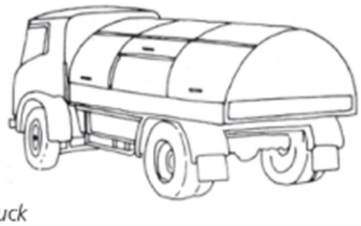
Standard truck

Tricycle – human power

High-sided open-top truck



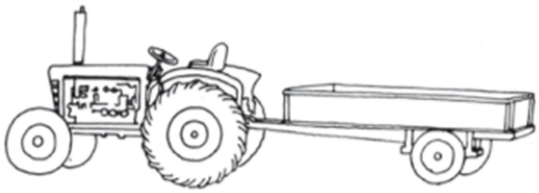
Animal cart



Roll-top truck

Three-wheel auto-rickshaw

Fore and aft tipper



Tractor and trailer

Compactor truck

MSW management

- It is associated with the control of generation, collection, storage, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other

- Effective MSW management includes practices like waste reduction, reuse, recycling, composting, and landfilling.
    - **Waste Reduction and Reuse:** Promoting practices like reducing consumption, using reusable items, and minimizing packaging.
    - **Recycling:** Expanding recycling infrastructure and promoting public participation.
    - **Composting:** Utilizing organic waste for composting to create valuable fertilizers.
    - **Energy Recovery:** Generating energy from MSW through processes like incineration and anaerobic digestion.
    - **Sustainable Landfill Management:** Implementing proper landfill design and management practices to minimize environmental impacts.

Minimization of MSW

Waste minimization techniques aim to reduce the amount and toxicity of waste generated by avoiding waste production, reducing material usage, reusing items, and recycling materials. This can involve strategies like lean manufacturing, engaging employees, conducting waste audits, and implementing the "5 Rs" of waste management: Refuse, Reduce, Reuse, Repurpose, and Recycle.

Here's a more detailed look at some common techniques:

1. Source Reduction (Waste Prevention):

- **Avoiding waste production:**

  This involves designing products and processes that minimize waste generation in the first place.

- **Reducing material usage:**

  Using less packaging, buying in bulk, and opting for durable products are examples of this.

- **Reducing toxicity:**

  Using less toxic materials and processes can significantly reduce the environmental impact of waste.

- **Examples:**

  Reducing single-use plastics, using bulk options, switching to digital formats for paper waste.

2. Reuse:

- **Repurposing items:** Giving old items new life by finding different uses for them.
- **Repairing items:** Extending the lifespan of products through repair rather than replacement.
- **Examples:** Using old paper as notepads, reusing containers, donating unwanted items.

3. Recycling:

- **Transforming materials into new products:** Turning waste materials into new products or raw materials.
- **Examples:** Recycling paper, plastic, and metal.

4. Other Important Techniques:

- **Lean Manufacturing:**

  A systematic approach to waste reduction by eliminating non-value-added activities.

- **Employee Involvement:**

  Engaging employees in waste reduction initiatives can create a sense of ownership and responsibility.

- **Waste Audits:**

  Analyzing waste streams to identify areas for improvement and determine the types and quantities of waste generated.

- **Procurement Waste Minimization:**

  Choosing suppliers and products with minimal packaging and implementing waste-reduction strategies throughout the supply chain.

- **Hazardous Waste Management:**

  Specific techniques for minimizing and managing hazardous waste, including neutralization, proper storage, and segregation.

5. The 5 Rs of Waste Management:

- **Refuse:** Avoiding unnecessary consumption and purchases.
- **Reduce:** Using less of a resource or product.
- **Reuse:** Finding new purposes for items or using them again.
- **Repurpose:** Transforming waste materials into something new.
- **Recycle:** Returning materials to the production cycle for reuse.

Waste minimization hierarchy

The term "waste minimization" refers to the process of reducing waste. It is accomplished by implementing techniques to reduce waste generation

Reuse and Recycling

Reuse and recycle are crucial components of solid waste management, offering environmentally and economically beneficial solutions. Reuse involves finding new uses for items without altering their basic form, while recycling transforms waste materials into new products. Both strategies reduce landfill waste, conserve resources, and lower energy consumption.

Reuse

Definition:

Using items again for their original purpose or for a new, different purpose without changing their basic structure.

Examples:

- Reusing glass jars as storage containers.
- Donating gently used clothing.
- Using old tires for creative projects like swings.
- Repairing broken items instead of discarding them.

Benefits:

- Reduces waste generation.
- Preserves resources and energy by avoiding the need for new materials.
- Can be a source of affordable goods for those in need.

Recycling:

Definition:

Processing waste materials (like paper, glass, plastic, and metal) into new products.

Examples:

- Recycling paper into new paper products.
- Recycling plastic bottles into clothing or other products.
- Recycling aluminum cans into new cans or other aluminum products.

Reduce, Reuse, Recycle:

The "3 Rs" are a hierarchy of waste management, with reduction being the most preferred, followed by reuse, and then recycling.

Composting:

A type of recycling that focuses on breaking down organic waste (food scraps, yard waste) into nutrient-rich compost.

Integrated solid waste management

- Integrated solid waste management (ISWM) is a comprehensive system which combines different methods including waste prevention, reuse, recycling, composting and disposal to manage waste in a way which can protect human health and the environment.

- It prioritizes waste reduction and resource recovery before resorting to disposal and the specific strategies are tailored to a community's local social, economic, and environmental conditions.
- The main aim of this system is making sustainable, cost-effective, and socially acceptable approach to handling waste.

Important components of ISWM

- **Waste prevention and reduction:** Minimizing waste at its source through strategies like product design for durability and reducing unnecessary packaging.
- **Reuse and recycling:** Recovering reusable materials from the waste stream and reprocessing recyclables to create new products.
- **Composting:** Processing organic waste (like food scraps and yard trimmings) into a nutrient-rich soil amendment.
- **Energy recovery:** Incinerating waste to generate energy, such as biogas or electricity.
- **Disposal:** Safely managing residual waste that cannot be recycled or composted, typically through controlled and sanitary landfills.

Working of ISWM

- **Planning:** Involves assessing local needs, resources, and regulations to create a tailored plan.
- **Collection and transportation:** Establishing efficient systems for collecting waste from its source and transporting it to processing and disposal facilities.
- **Sorting:** Mechanized systems can be used to sort waste into categories like metallic, biodegradable, non-biodegradable, and inert materials.
- **Implementation:** Putting the plan into action, which can include setting up collection programs, building processing facilities, and managing landfills.
- **Public participation:** Educating and engaging the public is vital for the success of ISWM strategies.

Benefits of ISWM

- **Environmental:** Reduces pollution from open burning and uncontrolled dumps, mitigates greenhouse gas emissions, and conserves natural resources.

- **Human health:** Improves air and water quality, reduces disease spread, and ensures safer waste management practices.
- **Economic:** Can create jobs and new industries through recycling and resource recovery, while also being a more cost-effective long-term strategy.

Hazardous waste

- Hazardous waste is any discarded material that poses a threat to human health or the environment due to properties like toxicity, flammability, corrosiveness, or reactivity.
- This can include by products from industrial processes, discarded commercial products like cleaning fluids or pesticides, and even household waste such as old batteries.
- Managing and safely disposing of hazardous waste is crucial to prevent pollution and protect public health.

Definition

- Hazardous waste is defined by its dangerous properties, which can include being:
  - **Toxic:** Harmful if inhaled, ingested, or absorbed through the skin.
  - **Flammable:** Easily ignites.
  - **Corrosive:** Can break down metal or other materials.
  - **Reactive:** Unstable and may explode or produce harmful fumes when exposed to other substances.
- It can be found in various forms: liquids, solids, contained gases, or sludges.

Concept

- **Source:** Hazardous waste is generated by a wide range of activities, from large-scale industrial and manufacturing processes to common household and commercial uses.
- **Examples:** Common examples include used chemicals, heavy metals, radioactive materials, infectious medical wastes, electronics, and certain household products like paint and batteries.
- **Classification:** Regulatory bodies, such as the U.S. Environmental Protection Agency (EPA), classify waste to determine if it is hazardous. This often involves identifying if a waste is "listed" or has certain "characteristics" of a hazardous waste.
- **Management:** Due to its dangerous nature, hazardous waste requires special handling, storage, and disposal methods to prevent harm. This includes using specialized landfills, incineration, or recycling to safely manage the materials and mitigate environmental threats.

Types and nature of hazardous waste as per the HW Schedules of regulating authorities

Hazardous waste is categorized by its inherent characteristics (ignitable, corrosive, reactive, toxic) and by being listed in regulatory schedules, such as those in the Hazardous Waste Management Rules, 2016 (India). Schedule I lists specific hazardous waste streams from industrial processes, while Schedule II classifies waste based on constituent concentration

limits (leachable or total) and reactive characteristics. Schedule III, Part A, lists wastes for import/export, while Part B defines hazardous characteristics.

Types and nature by characteristics

- **Ignitability:** Materials with a low flash point, such as some solvents, degreasers, and compressed gases, that can easily ignite.
- **Corrosivity:** Wastes that are highly acidic or alkaline (e.g., with a pH ≤ 2 or ≥ 12.5) or can corrode steel at a specified rate.
- **Reactivity:** Wastes that are unstable and can explode or react violently with water or other substances.
- **Toxicity:** Wastes that are harmful to human health or the environment, determined through testing for specific toxic constituents.

Types and nature by regulatory schedules

- **Schedule I:** Lists specific waste streams from various industrial processes, such as those in petroleum refining, paint production and aluminum production.
- **Schedule II:** Classifies waste based on testing limits:
    - **Class A:** Based on leachable concentration limits for specific constituents, determined by a Toxicity Characteristic Leaching Procedure (TCLP) analysis.
    - **Class B:** Based on Total Threshold Limit Concentration (TTLC) for certain constituents.
    - **Class C:** Based on hazardous characteristics as defined in the schedule.
- **Schedule III:**
    - **Part A:** Lists wastes subject to import and export regulations.
    - **Part B:** Further defines hazardous characteristics.

Noise

Measurement of Noise

Noise can be measured using instruments like a sound level meter to quantify sound pressure in decibels (dB), often with an "A-weighting" to better reflect human hearing (dBA).

Measurements can be taken using different settings, such as "fast" for continuous noise or "impulse" for sudden sounds, and the results are used for environmental or occupational health assessments.

- **Measurement Unit:**

  dB:

  Sound is measured in decibels (dB), a logarithmic scale where a higher number means a louder sound.

  A-Weighting (dBA):

  For a measurement that better represents how the human ear perceives loudness, A-weighting is applied, resulting in a dBA measurement. This is because the human ear is more sensitive to certain frequencies.

  Time Weighting:

  Depending on the type of noise, different time-weighting settings are used:

  - **Fast (F):** For less impulsive, fluctuating sounds.
  - **Slow (S):** For fluctuating noise that is too erratic to measure with a fast response.
  - **Impulse (I):** For short, sharp noises like gunshots or fireworks.

- **Equivalent Continuous Sound Level (Leq):**

  This is the time-averaged sound level over a specific period, often used for long-term environmental assessments.

  Percentile Level (Ln): A statistical measure indicating the sound level that is exceeded for a certain percentage of the time (e.g., $L10$ is the level exceeded 10% of the time).

  Daytime (Ld), Evening (Le), and Night time (Ln): Specific indicators used to evaluate annoyance or sleep disturbance during different parts of the day, as defined by standards like ISO 1996-2: 1987

  How to measure noise?

  Sound Level Meter (SLM):

  - Used to measure the noise generated by a specific source or for noise surveys.

Integrating Sound Level Meter (ISLM):

- Measures the equivalent continuous sound level over a short period and is useful for fluctuating noise.

Noise Dosimeter:

- A wearable device that accurately measures a worker's personal noise exposure over a period, which is useful in occupational settings.

Sound Meter App:

- Mobile applications can measure sound using the device's microphone, though accuracy depends on the phone's microphone quality and calibration.

Various methods of controlling noise pollution

It is done by

- suppressing noise at its source through maintenance and design,
- blocking noise with barriers and soundproofing,
- creating designated quiet zones,
- using personal protective equipment.
- Individuals can also reduce noise by turning down electronic volumes and minimizing horn use.

Control at the source

- **Maintain equipment:**

  Properly lubricate and maintain machinery, vehicles, and home appliances to reduce operating noise.

- **Improve design:**

  Use quieter machinery, silencing devices on exhausts, and design low-noise products.

- **Dampen vibrations:**

  Place a layer of damping material, like rubber, under machines to absorb vibrations.

- **Minimize vehicle use:**

Reduce unnecessary automobile horn use and opt for quieter forms of transport like bicycles or electric vehicles.

Blocking and absorbing noise

- **Install barriers:**

Use noise barriers made of concrete, wood, or fiberglass along roads and around noisy areas.

- **Create green spaces:**

Plant trees and create green belts along roads and around buildings, as vegetation absorbs sound waves.

- **Soundproof buildings:**

Use soundproof windows and doors, acoustic panels, and acoustic sealant to block and absorb noise in homes and offices.

Zoning and regulations

- **Create silent zones:** Establish and enforce quiet zones near hospitals, schools, and colleges.
- **Segregate industries:** Locate noisy industries away from residential areas.
- **Regulate noise levels:** Enforce regulations on the use of loudspeakers and public address systems.

Personal protection and behaviour

- **Use personal protective gear:** Wear earplugs, ear muffs, or headphones in very noisy environments.
- **Manage volume levels:** Keep the volume of TVs, radios, and music systems low.
- **Avoid noisy activities:** Minimize participation in very noisy leisure activities.

CURBING NOISE POLLUTION

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BY

GOVERNMENT BY US BY BUSINESS PERSONS

| | |

- Noise laws - Avoid honking - Use silent machines
- Silent zones - Low volume - Soundproof walls
- Green belts - Follow rules - Follow noise limits