केवल कार्यालयीन उपयोग हेतु
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भारत सरकार - GOVERNMENT OF INDIA
रेल मंत्रालय - MINISTRY OF RAILWAYS

ध्वनि अवशोषित सामग्री
SOUND ABSORBENT MATERIALS

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Indian Railways
Centre for Advanced Maintenance Technology

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प्राक्कथन

यह अनुभव किया है कि ध्वनि के रूप में शोर उन निर्मित क्षेत्रों के लिए एक बहुत ही गंभीर समस्या है जो राजमार्गों और रेलवे पटरियों के पास स्थित हैं। इन स्रोतों से होने वाला अत्यधिक शोर मानसिक और शारीरिक स्वास्थ्य समस्याओं को जन्म दे सकता है।

शोर के बुरे प्रभावों से छुटकारा पाने तथा बेहतर ध्वनिक माहौल बनाए रखने के लिए, यह अनिवार्य है कि ऐसी सामग्री *(materials)* को उपयोग में लाया जाय जो इनडोर और आउटडोर स्थितियों में अवांछित ध्वनि को अवशोषित करती हों।

यह आशा की जाती है कि कैमटेक द्वारा तैयार पुस्तिका सिविल संरचनाओं के रखरखाव एवं निर्माण गतिविधियों में लगे भारतीय रेलवे के इंजीनियरिंग कर्मियों को काफी उपयोगी होगी।

कैमटेक, ग्वालियर **(ए. आर. तुपे)**

अक्टूबर, 2016 **कार्यकारी निदेशक**

Foreword

It is experienced that the sound in terms of noise is a very serious problem in built-up areas situated near highways and railway tracks. Excessive noise from theses sources can lead to mental and physical health problems.

To get rid of evil effects of noise and to maintain better acoustical environment, it is imperative to use such materials that absorb the unwanted sound in indoor and outdoor situations.

It is expected that the booklet prepared by CAMTECH will be quite helpful to the engineering personnel of Indian Railways engaged in maintenance and construction activities of civil structures.

CAMTECH, Gwalior ***(A.R. Tupe)***
October, 2016 ***Executive Director***

भूमिका

एक बड़ा संगठन होने के नाते भारतीय रेलवे के पास सिविल इंजीनियरिंग संरचनाओं और इमारतों की विशाल सम्पदा मौजूद है जिनकी सेवा अवधि के दौरान रखरखाव की आवश्यकता होती है।

'***ध्वनि अवशोषित सामग्री***' पर यह पुस्तिका उन सामग्रियों के बारे में सूचनात्मक जानकारी प्रदान करने के उद्देश्य से तैयार की गई है, जो अवांछित ध्वनि को अवशोषित कर इनडोर और आउटडोर स्थितियों में ध्वनिक वातावरण बनाए रखने के लिए उपयोग में लायी जाती हैं। यह पुस्तिका, रखरखाव एवं निर्माण गतिविधियों में शामिल सिविल इंजीनियरिंग स्टाफ के मार्गदर्शन के लिए है।

यह पुस्तिका वैधानिक नहीं है तथा इसमें दी गई सामग्री का उद्देश्य केवल मार्गदर्शन है। अधिक जानकारी के लिए, विषय पर उपलब्ध प्रासंगिक कोड, मैनुअल और रिपोर्ट का अध्ययन संदर्भ रूप में किया जाना चाहिए।

हम आगे सुधार के लिए पाठकों से किसी भी सुझाव का स्वागत करते हैं।

कैमटेक, ग्वालियर ***(डी. के. गुप्ता)***

अक्टूबर, 2016 ***संयुक्त निदेशक / सिविल***

Preface

Indian Railways is a big organization having large assets of civil engineering structures and buildings, which require maintenance throughout their service life.

This booklet on *'Sound Absorbent Materials'* is prepared with the objective to provide informative details about those materials, which are used to maintain the acoustic environment in indoor and outdoor situations by absorbing the unwanted sound (i.e. noise). The booklet is meant for the guidance of civil engineering technical staff of Indian Railways involved in maintenance and construction activities.

This booklet is a reference document, which is not statutory and contents are only for the purpose of guidance. For more in-depth information, the relevant codes, manual and reports on the subject may be referred.

We welcome any suggestions from our readers for further improvement.

CAMTECH, Gwalior ***(D. K. Gupta)***
October, 2016 ***Joint Director/Civil***

संशोधन पर्चियों का प्रकाशन

इस लघु पुस्तिका के लिए भविष्य में प्रकाशित होने वाली संशोधन पर्चियों को निम्नानुसार संख्यांकित किया जाएगा ।

केमटेक/सि/2016/एसएएम/1.0 सीएस # XX दिनांक ----------

जहाँ "XX" संबन्धित संशोधन पर्ची की क्रम संख्या है (01 से प्रारम्भ होकर आगे की ओर)

प्रकाशित संशोधन पर्चियाँ

क्र.सं.	प्रकाशन की तारीख	संशोधित पृष्ठ संख्या तथा मद संख्या	टिप्पणी

ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/C/2016/SAM/1.0/CS # XX date .....

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

S. No.	Date of issue	Page no. and Item No. modified	Remarks

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1.0 सामान्य / General

The booklet on "Sound Absorbent materials" is intended to provide the reader with a general understanding of materials, which are used to maintain the acoustic environment in indoor and outdoor situations by absorbing the unwanted sound (i.e. noise). In fact, millions of people are affected by constant traffic noise that impacts more than any other environmental noise source.

It is experienced that the excessive noise and poor speech may lead to frustration on the part of the passengers in a confined area, such as the station building. In fact, traffic noise can affect the ability to work, learn, rest, relax, sleep, etc. Excessive noise can lead to mental and physical health problems.

As per "***Manual of Standards and Specifications for Railway Stations (Vol 1 of 2), June 2009",*** it is advised that within the station building, the following should be taken care of –

- The acoustic design of stations must provide a good aural (sense of hearing) environment, in which people can communicate clearly and easily, and the build-up of excessive noise is suppressed.
- Public Address announcements must be easily heard and understood.
- A comfortable acoustic environment must also be provided for the employees in the non-public areas, such as in offices and administration areas.

Most of the common building materials absorb sound to a small extent and hence, for better acoustical requirement, some other materials are to be incorporated on the surface of the room. In recent years, sound absorbing materials are finding many applications in noise control abatement schemes and also used to improve the acoustics in indoor and outdoor situations.

2.0 ध्वनिकी / Acoustics

- Acoustic is a branch of Physics that studies sound.
- The science of acoustics spreads across many facets of human society i.e. music, medicine, architecture, industrial production, etc.
- The application of acoustics is present in almost all aspects of modern society with the most obvious being the Audio and Noise Control Industries.

3.0 ध्वनिकी में प्रयुक्त शब्दावली / Terminology used in Acoustics

- **Reverberation:** The sensation of sound persists in our brain for about 0.1 sec, when the reflected sound wave reaches ear in less than 0.1 sec after the original sound wave, the original sound wave is still in memory. There is no time delay between the perception of the reflected sound wave and original sound wave. The two sound waves tend to combine as one very prolonged sound wave. Such repeated reflection that results in the persistence of sound is called reverberation.

- **Echo:** If we shout or clap near a suitable reflecting object such as a tall building or a mountain, we will hear the same sound again a little later. This sound which we hear is called an echo.

  To hear a distinct echo the time interval between the original sound and the reflected one must be at least 0.1sec. If we take the speed of sound to be 344 m/s at a given temperature, say at 22 ºC in air, the sound must go to the obstacle and reach back the ear of the listener on reflection after 0.1sec. Hence, the total distance covered by the sound from the point of generation to the reflecting surface and back should be at least 344 m/s X 0.1 sec = 34.4 m.

Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, i.e. 17.2 m. This distance will change with the temperature of air.

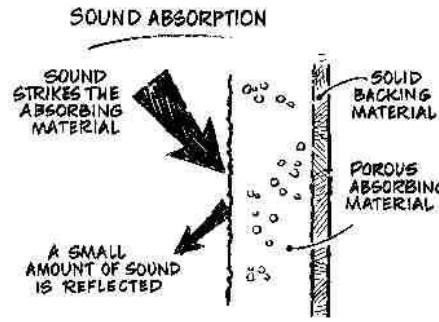
- **Sound Foci:** Sometimes shape of the hall makes sound waves to concentrate in some particular areas of hall creating a sound of large quality. These spots are called sound foci.

- **Dead Spot:** This defect is the outcome of formation of sound foci of high concentration of reflected sound at sound foci, there is deficiency of related sound at some other points. These spots are known as dead spots where sound intensity is so low that it is insufficient for hearing. Some areas are made for dead spots for little amount of sound.

4.0 ध्वनिकी में ध्वनि अवशोषित सामग्री की भूमिका / Role of Sound Absorbent Materials in Acoustics

Reverberation can be minimized by using Sound Absorbent Materials.

Mechanism: Acoustic porous materials can have porosity greater than 90%. Common sound absorption materials are open cell foam and fiber. Sound absorption is an energy conversion process. The kinetic energy of the sound (air) is converted to heat energy when the sound strikes the cell or fibers.



5.0 अच्छी ध्वनि अवशोषित सामग्री की आवश्यकता / Requirement of Good Sound Absorbent Materials

All acoustical materials shall comply with the following materials requirements:

- Lightweight
- Good long-term and reliable bond or fixing to surfaces
- Ease of fixing to curved and flat surfaces (horizontal and vertical)
- Not stained by water; tolerance of water absorption
- Rot-proof and odorless; resistant to attack by mold and rodents
- Long service life; cleanable and vandal-resistant
- Stability when exposed to high positive and negative pressures
- Resistant to vibration
- Low flammability; low smoke emission
- Easily replaceable; requiring no maintenance

6.0 ध्वनि अवशोषित सामग्री का वर्गीकरण / Classification of Sound Absorbent Materials

6.1 ध्वनिक गुणों के आधार पर / Based on Acoustical properties

- Sound Absorbers
- Sound Diffusers
- Noise Barriers
- Sound Reflectors

6.1.1 ध्वनि अवशोषक / Sound Absorbers

- These sound absorbing acoustical panels and sound proofing materials are used to eliminate sound reflections to improve

speech intelligibility, reduce standing waves and prevent comb filtering.

- Typical materials are open cell polyurethane foam, cellular melamine, fiberglass, fluffy fabrics and other porous materials. A wide variety of materials can be applied to walls and ceilings depending on your application and environment.

- These materials vary in thickness and in shape to achive different absorption ratings depending on the specific sound requirements.

Common Sound Absorbers are:

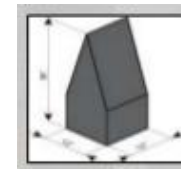
- Acoustic Foam Panels
- White Paintable Panels
- Fabric Wrapped Panels
- Acoustical Wall Coverings
- Ceiling Tiles
- Baffles and Banners for Ceiling

(a) ध्वनिक फोम पैनल / Acoustic Foam Panels: These acoustic foam sound absorbers are used in a wide variety of applications ranging from Recording and Broadcast Studios to Commercial and Industrial Facilities. Available in polyurethane or in Class 1 Fire Rated foam. These products can be applied directly to walls, hung as baffles or used as freestanding absorbers.

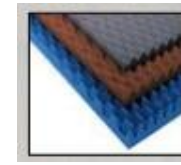
- *Stackable Foam*: Design enables to increase thickness quickly by nesting layers.



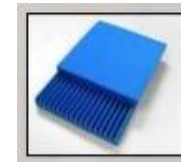
- *Anechotic Wedge*: Anechotic wedges are ideal for controlling low frequency sound to create a room that is perceptually devoid of sound.



- *Standard Polyurethane Foam Patterns*: Standard patterns include wedge, pyramid, max wedge for low frequency absorption, ceiling baffles, Bermuda triangle traps for corners, sounds cylinders free standing absorbers.



- *Cutting Wedge*: Installs to create seamless absorptive walls, and enhance imaging by reducing unwanted reflections. Available in 1'X1'or 2'X4'sheets.



- *Fire rated Foam*: Absorbers are lightweight open cell foams used when a Class 1 fire rated foam is required. Standard patterns include Wedge, Pyramid, Max Wedge, Ceiling Baffles and more. These can easily mount to walls or ceilings.



(b) सफेद मुद्रणनीय पैनल / White Paintable Panels:

- In addition to reduce echo and reverberation, these acoustical panels are used to create unique design and patterns
- Quick and easy acoustical solution
- Soft drywall textures appearance
- Create unique patterns
- Panel size allows for flexible mounting options 2' x 2'
- Paintable and printable finish

(c) कपड़ा चढ़ा हुआ पैनल / Fabric Wrapped Panels: Acoustical sound panels utilize 6-7 PCF (photonic crystal fiber*)* glass fiber material for maximum absorption. Available as wall panels, ceiling tiles, hanging baffles, acoustical clouds and bass traps, with wide range of colours to choose from, these materials will look as good as they sound. The standard sizes and configurations best maximize raw materials, however, many of these products can be customized to meet specific requirements.

- *Wall Panels*: Used to reduce echo and reverberation in applications, small and large. These panels are manufactured from a rigid high density (6-7 PCF) glass fiber acoustical board and covered with an acoustically transparent fabric.



- *Ceiling Clouds*: Ceiling clouds reduce reflected sound in areas such as theaters, restaurants, arenas, shopping malls, convention centers, recording and broadcast rooms, or anywhere absorption is required.



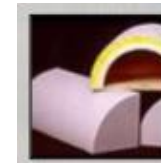
- *Ceiling Baffles*: All surface faces and edges of the glass fiber core are wrapped in fabric to match or accentuate room décor. Ceiling baffles absorb sound on all sides and edges.



- *Ceiling Tiles*: Ceiling tiles are an excellent choice for many ceiling grid applications requiring high absorption.



- *Broadband Absorber*: Sculptured sound absorbing modular units used for walls, as corner traps, bass traps and ceiling applications. Available in half-rounds or quarter-rounds.



(d) ध्वनिक दीवार कवरिंग / Acoustical Wall Coverings: Acoustical wall fabric is a dimensional fabric that offers excellent acoustical properties, unmatched fade resistance, and a fire/smoke retardant class A rating. Sound channels are resistant to moisture, mildew, rot, bacteria, and is non-allergenic. Produced with no voc's (volatile organic compounds), ods's (ozone depleting substances, heavy metals or formaldehyde, it's the perfect acoustic fabric for offices, classrooms, conference centers or any area where speech intelligibility is a critical factor.

Features:

- Lightweight Acoustic Fabric
- Easy to Install
- Class A
- Passes Comer Burn Test
- Available in Many Colours
- Durable/ Abuse Resistant
- Improves Speech Intelligibility



Installations:

- This material is not factory trimmed. It is necessary for the installer to cut a straight vertical edge following the ribbed pattern.

- All edges must be butt joined. Do not overcut edges. Cut material to desired lengths, allowing for top and bottom trimming. Wall carpet should be hung straight up. Do not alternately reverse strips.

- Apply a premixed heavy duty adhesive directly to the wall, allowing it to dry to its maximum tackability without it being overly dry. (Important – Adhesives are ready mixed. Do not dilute adhesive and do not apply adhesive to the back of the wall covering)

- Please be sure to follow instructions as provided by the adhesive manufacturer.

Applications:

- Conference Rooms
- Theaters
- Hospitals
- Municipal
- Office Partitions
- Schools
- Hallways and more

(e) छत टाइलें / Ceiling Tiles: Ceiling Tiles absorb noise and block sound transmission. These ceiling tiles are designed to fit into existing 2'X2'suspended drop tile ceiling grid systems. They may also retrofit in a 2'X 4'ceiling grid by installing cross tees. Ceiling tiles may also be ordered as a full 24" X 24" size, un-backed for adhesive mounting directly to walls or ceilings.

Ordinary ceilings take on new levels of visual excitement with the sculptured tiles. They are available in five different patterns

plus a non-patterned look to enable you to "mix and match" for your own designs.



(f) छत के लिए चकरा और बैनर / Baffles and Banners for Ceiling:

- Baffles hang vertically i.e. parallel with the walls
- Clouds hang horizontally i.e. parallel with the floor
- They offer greater absorptive surface area
- They can be used for "Temporary" installations
- They can be best used in rooms with high ceilings



Precautions to be taken during installation

- Possible interruption of Fire Suppression Sprinklers
- Possibility of effecting light by Casting Shadows

6.1.2 ध्वनि डिफ्यूज़र / Sound Diffusers

These devices reduce the intensity of sound by scattering it over and expand area, rather than eliminating the sound reflections as an absorber.

- *Quadra Pyramid Diffuser*: This generates a uniform polar responds over a broad frequency range using a pre-rotated pyramidal pattern to create 16 angles of reflection.



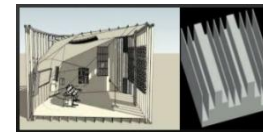
- *Pyramidal Diffuser*: This traditionally work disperses sound uniformly over a broad frequency range. A quick solution to reduce flutter echo.



- *Double Duty Diffuser*: This poly cylindrical diffuser does twice the work. They scatter sound and function as a bass trap.



- *Quadratic Diffuser*: A true quadratic residue diffuser designed for uniform broadband scattering and reducing HIGH-Q reflection.



6.1.3 शोर बाधाएँ / Noise Barriers

- These materials range from dense materials to block the transmission of airborne sound to devices and compounds used to isolate structures from one another and reduce impact noise.



- Sound barrier materials are used to reduce the transmission of airborne sound.

- Composite materials are used to block and absorb sound for machine enclosures as well as blocking airborne sound and impact noise.

6.1.4 ध्वनि रिफ्लेक्टर / Sound Reflectors

- They are simply panels of wood that have been carve into a convex shape that will allow them to reflect sound directly into the audience in order to hear whatever is on the stage with even greater clarity.

- Composed mainly of plywood with some gel to make them even more reflective of sound.

6.2 उपयोगों / सामग्री गुणों के आधार पर / Based on Applications/ Material Properties

The materials generally used may be broadly classified into the following categories:

1. Acoustic Plaster
2. Compressed Cane or Wood Fibreboard
3. Wood Particle Board
4. Compressed Wood Wool
5. Mineral/ Glass Wool Quilts and Mats

6.2.1 ध्वनिक प्लास्टर / Acoustic Plaster

Acoustic plaster that absorbs the sound includes granulated insulation material (fibers or aggregate) with cement. If quantity of cement is more than required, the plaster will not have sufficient pores to become



effective for acoustics. If quantity of cement is less, the plaster will not have enough strength. Thus the quantity of cement should be carefully decided.

For thickness of 20 mm and density of 0.10 g/cubic centimeter, the acoustic plaster possesses an absorbent coefficient of 0.3 at 500 cycles per second. They can be fixed on the wall and their coefficients of absorption vary from 0.15 to 0.30.

It is easy to apply and is fireproof but it can be more fragile, being affected by physical stress and humidity. Acoustic plaster is used in construction of rooms which require good acoustic qualities such as auditoria and libraries.

6.2.2 संकुचित केन या लकड़ी फाइबरबोर्ड / Compressed Cane or Wood Fibreboard

Compressed Cane (Sugarcane): From its physical appearances, the sugarcane (waste) consisted of tiny and soft fibres which can potentially be a good sound absorber. The soft fibres might carry the strength problem, but this can be covered if it is coupled with another strong material.



It is found that acoustical performance of the sugarcane absorber with thickness of ½ inch is comparable with that of commercial sound

insulator with average absorption coefficient of 0.65 at frequency 1.2 - 4.5 kHz.

Wood Fibreboard: Fibreboard is a type of engineered wood product that is made out of wood fibres. It is sometimes used as a synonym for particle board, but particle board usually refers to low-density fibreboard.



Medium-density fibreboard, is heavily used in the furniture industry. This material may be imperforated or perforated. The average coefficient of absorption for the former is 0.30 and for the latter is 0.52. It has density of 0.30 g/cubic centimetres.

6.2.3 लकड़ी पार्टिकल बोर्ड / Wood Particle Board

Particle board is an engineered wood product manufactured from wood chips, sawmill shavings, or even sawdust, and a synthetic resin or other suitable binder, which is compressed with glue. In standard particle board, urea formaldehyde is mainly used as glue. The density of particle board varies between 650 and 750 kg/m³, so it is considerably heavier than sawn conifer timber.



This material is provided with perforations and it can be painted also. With a thickness of about 13mm, the average coefficient of absorption is 0.40.

6.2.4 संपीडित लकड़ी ऊन / Compressed Wood Wool

Wood wool slabs meant for sound absorption are often made of finer wood wool (1.5–3 mm). These slabs are visible, and they are often painted for aesthetic reasons. These slabs have very good acoustic properties and are often used to absorb sound in, for example, factories, public gathering places, sports and concert halls.



These slabs are usually 15–50 mm thick. The sound absorption normally increases somewhat with increased thickness, especially for low frequencies. Sound absorption is also affected by proximity to other materials, while painting the slabs has only slight effect.

Wood wool slab is generally used with a thickness of 25mm and it has a density of 0.40 g/cubic centimetre. The average value for coefficient of absorption is 0.20.

One of the most common uses for wood wool slabs is as acoustic ceiling panels in public gathering places, corridors, etc.



The slabs can either be fixed to the roof or suspended. The air space between the slabs and the roof influences the sound absorption.

6.2.5 खनिज/ ग्लास ऊन रजाई और मैट / Mineral/ Glass Wool Quilts and Mats

Mineral Wool: Mineral wool is a general name for fibre materials that are formed by spinning or drawing molten minerals. Though, the individual fibres conduct heat very well when pressed into rolls and sheets. Their ability to partition air makes them excellent insulators and sound absorbers. Specific mineral wool products are stone wool and slag wool.



- Mineral wool is a porous material that traps the air, making it one of the best insulating materials.
- The porous and elastic structure of the mineral wool absorbs noise.
- Mineral wool is incombustible and does not fuel fire or propagate flames.
- Mineral wool products take various forms: rolls, slabs, pipe sections or loose wool.

Glass Wool: Glass wool consist of fine, long, inorganic fibers bonded together by high temperature binder. These fibers (each of approx. 6-7 micron diameters) are distributed to trap millions of tiny pockets of air in it thereby creating it an excellent thermal and acoustic insulation.

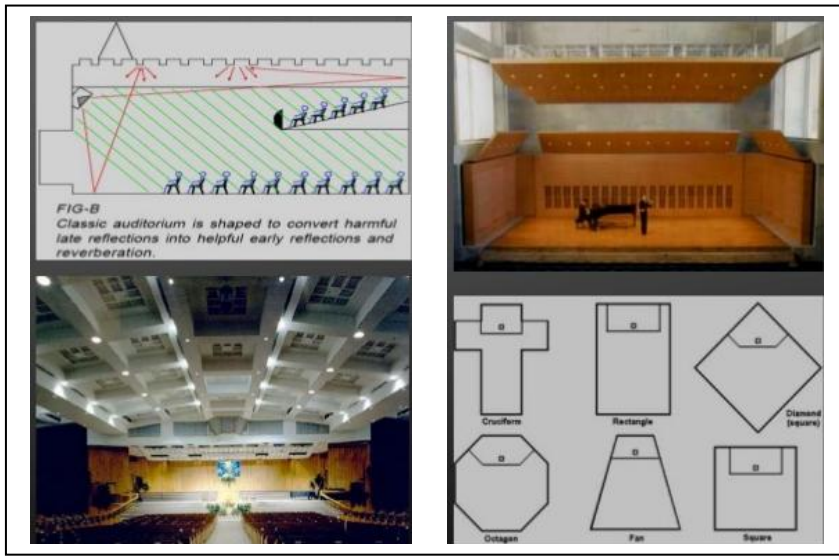
Glass wool is chemically inert and has no impurities such as iron shots, sulphur and chloride. It is manufactured from renewable raw materials and is environmental friendly in every stage.

The absorption coefficients of quilts and mats depend on the thickness, density, perforations, mode of fixing, nature of backing and frequency of sound.

7.0 ध्वनिक डिजाइन की बुनियादी आवश्यकताएँ / Basic Requirements of Acoustical Design

7.1 सभागार की तरह हॉल के लिए / For Hall like Auditorium

- The initial sound from the source should be of adequate intensity so that it can be heard throughout the hall.
- For halls of big sizes suitable sound amplification system should be installed.
- The sound produced should be evenly distributed so that there is no dead spots and sound foci.
- The boundary surface should be so designed that there are no echoes or near echoes.
- Desired reverberation time should be achieved by proper placement of absorbents on wall.
- The outside noise should be eliminated.



7.2 सार्वजनिक स्थानों के लिए / For Public Places

- **By suitable location, orientation in layout and plan:** The most obvious method is to locate the residential buildings in a quiet area away from the noisy surroundings like the industrial area, railway tracks, tramway lines, aerodromes, roads carrying heavy traffic, etc. They shall be adequately set-off from the road and oriented in such a way that doors and windows do not face the source of noise. In case this is found not possible, double doors and windows shall be provided to prevent leakage of sound.

- **By suitable arrangement of rooms within residential buildings:** The bed-rooms which are required to be quieter than the rest of the rooms are best located in the portion farthest from the noise source. Noise reduction is further attained by separating the bed-rooms from other rooms where noisy conditions can be permitted or tolerated.

- **By suppressing noise at the source itself:** Certain types of noise, for example, the operation of mechanical equipment in the building, shall be suitably isolated or enclosed in sound-insulated enclosures so that noise emanating from it is reduced to the minimum.

- **By suppressing or reducing noise after its entry into the room:** The noises, where required could be further suppressed on entry into a room if some sound absorbent material is installed therein. Provision of special material may not be warranted in the case of residential buildings; however, the existence of furnishing material in living and bed rooms help to reduce noise.

- **By reducing the noise transmitted through the structure:** Reduction of air-borne noise through opening, the most common

and major cause of penetration of noise into a room requires that the structure should be made air-tight. The smallest crack or opening would vitiate the effect of insulation provided otherwise. Ventilating ducts, where installed, should be specially designed to minimize transmission of noise.

- **By providing Green Belts and Landscaping:**

a) Where relief from noise is to be provided by means of green belts these may be of considerable width and be landscaped. (In case of railway tracks, a minimum distance of 50 m to 70 m may be provided between the buildings and the tracks.) The extent of relief that may be derived from the above may be estimated only after considering other environmental factors.

Only thick belts of planting (greater than 30 m) are of real value. Strong leafy trees may be planted to act as noise baffles. Shrubs or creepers may also be planted for additional protection between tree trunks; artificial mounds and banks should be formed where practicable. As little hard paving and as much grass as possible may be used.

The creation of green belt is particularly advisable on the perimeter of aerodromes, along railway lines and arterial roads, through or past built-up areas and adjoining noisy industrial zones.



b) Highway Noise Barriers are often the most effective means of reducing traffic noise around residential areas. They have the

great advantage that they generally protect most or the entire site. In nearly all situations, a well-designed barrier of even a modest height (say 3 m) can at least ensure that all areas of open space are free from excessive noise levels.



There are two types of barriers that can be built to protect sites; one which are built solely for the purpose of reducing noise and two, which form part of the building complex (barrier blocks). Free standing walls and artificial mounds are typical examples of the first type while single and multi-storeyed dwellings and/or garages are the most common form of the second. Of the two types, barrier blocks are more widely used because they are cheaper and also tend to form a more effective barrier overall because of their greater height and width.

Barrier walls or mounds are more limited in their effect than barrier blocks for they protect little more than the area of the site close to ground level essentially because of the lack of height, as continuous walls much higher than 3 m are often difficult to construct.



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अनुलग्नक/Annexure – 1

The maximum acceptable noise levels inside buildings from the point of view of comfort, economy and practical considerations under the conditions prevailing in India may be taken as in Table below:

S. No.	Type of Building	Noise Levels in dB
1	Offices	50 to 60
2	Dwellings (houses and flats)	45 to 55
3	Schools (classrooms or lecture rooms)	45 to 50
4	Hospitals	40 to 50

अनुलग्नक/Annexure – 2

Sound absorption co-efficients for building materials and furnishings are listed as under: (As per clause 8.2 of IS: 2526-1963)

S. No.	Material	Absorption co-efficients at frequency of sound in cycles/sec		
		125	500	2000
Masonry and Building Material				
1	Brick wall 40 cm thick	0.02	0.03	0.05
2	Plaster in wall	0.03	0.02	0.04
3	Ceiling, 50 mm plaster of Paris suspended from trusses	0.08	0.05	0.04
4	Plywood on 75 mm air space	0.30	0.10	0.05
5	Wood veneer 10 mm thick on 50X75 mm wood studs at 40 cm c/c	0.11	0.12	0.10

6	Glass against solid surface	0.03	0.03	0.02
7	Marble	0.01	0.01	0.01
Hangings and floorings				
8	Carpet, lined	0.10	0.25	0.40
9	Carpet, unlined	0.08	0.15	0.25
10	Cotton fabric, 475 g/sqm draped to half its area	0.07	0.49	0.66
11	Draperies, velours 610 g/sqm	0.05	0.35	0.38
12	Draperies, as above draped to half their area	0.14	0.55	0.70
13	Stage curtain	0.19	0.20	0.23
14	Linoleum or concrete floor	0.02	0.03	0.04
15	Floor, wood on solid	0.12	0.09	0.09
16	Floor, wood boards on timber frame	0.25	0.13	0.15
Audience, chairs, etc.				
17	Audience seated in fully upholstered seats (per person)	0.18	0.46	0.51
18	Chair, upholstered seat with spring	-	0.16	0.07
19	Seats (unoccupied) fully upholstered (per seat)	0.16	0.40	0.44

अनुलग्नक/Annexure – 3

Sound absorption co-efficients of Indigenous Acoustical materials are listed as under: (As per clause 8.2 of IS: 2526-1963)

S. No.	Material	Thickness mm	Density g/cm^3	Absorption co-efficient at frequency of sound in cycles/sec			
				125	500	2000	4000
1	Fibrous (acoustic) plaster	20	0.10	-	0.30	0.50	-
2	Compressed fibre board						
	a) Un-perforated	12.0	-	0.24	0.30	0.20	0.24
	b) Perforated uniformly over part depth (rigid backing)	12.7	0.30	0.06	0.55	0.67	0.76
	c) Perforated randomly over part depth	12.7	0.30	0.15	0.52	0.76	0.58
3	Compressed wood particle board						
	a) Perforated (rigid backing)	12.7	0.37	0.04	0.36	0.78	0.99
	b) Perforated (rigid backing)	19.1	0.34	0.05	0.61	0.91	0.96
	c) Perforated and painted (rigid backing)	12.7	0.40	0.05	0.40	0.82	0.59
	d) Perforated and painted (rigid backing)	19.1	0.38	0.10	0.62	0.74	0.69

4	a) Wood wool board b) Wood wool board (50 mm from wall)	25 25	0.40 0.40	- -	0.20 0.35	0.60 0.35	- -
5	Mineral glass wool quils and mats	25	0.06	0.09	0.17	0.50	-
6	Bonded & compressed minerals/ glass wool tiles	50	0.04	0.12	0.26	0.44	0.80
7	Composite units of perforated hardboard backed by perforated fibre board`	25	0.40	0.25	0.50	0.65	-
8	a) Mineral/glass wool with scrim mat (rigid backing) b) Mineral/glass wool with scrim mat (rigid backing) c) Mineral/glass wool with scrim mat faced with perforated (10% open area) hardboard (rigid backing) d) Mineral/glass wool with scrim mat faced with perforated (10% open area)	25 50 25 50	0.08 0.08 0.08 0.08	0.29 0.57 0.06 0.20	0.85 0.99 0.99 0.99	0.84 0.95 0.49 0.61	0.98 0.99 0.31 0.42

	hardboard (rigid backing)						
9	Miscellaneous						
	a) Strawboard	13	0.24	-	0.30	0.35	-
	b) Strawboard spaced 50 mm from wall	13	0.24	-	0.35	0.30	-
	c) Composite panel 5 mm perforated plywood 50 mm mineral wool and 22 mm cement asbestos (suspended from trusses)	-	-	0.36	0.95	0.67	-
	d) Composite panel 5 mm perforated plywood 50 mm mineral wool and 22 mm cement asbestos (suspended from trusses)	-	-	0.47	0.20	0.09	-
Note: *The absorption co-efficients of materials given in items 2(b), 2(c), 3(a) to 3(d) and 8(a) to 8(d) are based on tests made at the Central Building Research Institute, Roorkee.*							

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संदर्भZ / REFERENCES

S. No.	Description
1.	IS: 1950-1962 (Reaffirmed 1996) - Code of Practice for Sound Insulation of Non-Industrial Buildings
2.	IS: 2526-1963 (Reaffirmed 1996) - Code of Practice for Acoustical Design of Auditoriums and Conference Halls
3.	SP–7:2005 National Building Code of India 2005 – PART VIII BUILDING SERVICES: Section 4 – Acoustics, Sound Insulation and Noise Control
4.	Manual for Standards and Specifications for Railway Stations (June 2009) by Ministry Of Railways (Railway Board) Govt. of India
5.	www.armstrong.co.in
6.	www.sciencedirect.com
7.	www.dreamghar.com
8.	www.scribd.com
9.	www.en.wikipedia.org

✍ टिप्पणी / NOTES ✍

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गुणवत्ता नीति

रेलों में यात्री और माल यातायात की बढ़ती माँग को पूरा करने के लिए गुणवत्ता प्रबंध प्रणाली में अनुसंधान, डिज़ाइनों और मानकों में उत्कृष्टता तथा सतत सुधारों के माध्यम से सांविधिक और नियामक अपेक्षाओं को पूरा करते हुए सुरक्षित, आधुनिक और किफ़ायती रेल प्रौद्योगिकी का विकास करना।

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हमारा उद्देश्य

अनुरक्षण प्रौद्योगिकी और कार्यप्रणाली को उन्नयन करना तथा उत्पादकता और रेल्वे की परिसंपत्ति एवं जनशक्ति के निष्पादन में सुधार करना जिससे अन्तर्विषयों में विश्वसनीयता, उपयोगिता और दक्षता प्राप्त की जा सके।

यदि आप इस संदर्भ में कोई विचार और सुझाव देना चाहते हों तो कृपया हमें इस पते पर लिखें।

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