When it comes to noise protection in buildings, both sound-absorbing and sound-blocking (or sound-proofing) materials come to mind. Each offers unique properties that make them suitable for specific applications.

### Processes that Govern the Absorption of Sound by Acoustic Materials

First, in porous materials, sound energy is transformed into heat by the viscous forces at work when sound propagates through materials. Second, sound is dissipated by frictional forces when acoustic materials are set into vibration by the incident sounds.

### Types of Noise

**Airborne Noise** – When airborne noise strikes a floor or ceiling, the surface is set to vibration by the fluctuating pressure of the sound waves. This vibration is what radiates sound into the air on the other side.

**Impact Noise** – Impact noise is caused by an object striking or sliding on a floor, such as footsteps, moving furniture or a door slamming. It can also be caused by an appliance, such as a dishwasher or shower, which transmits its vibration to the building structure.

### Measurement Techniques and Units

Reductions in unwanted sound transfer are typically expressed in terms of the Sound Transmission Class (or STC) in the U.S., or the Sound Reduction Index (SRI) outside the U.S. This is an integer rating how well a building partition reduces airborne sound. The STC rating roughly reflects the decibel reduction in noise that a partition provides.

In comparing sound absorbing materials for noise control purposes, the Noise Reduction Coefficient (NRC) is commonly used. NRC is the average usually stated to the nearest multiple of 0.05, of the coefficient at four frequencies 250, 500, 1000 and 2000 Hz.
Perlite in Sound Insulation Applications

Applications

The versatile nature of expanded perlite allows it to be used in the manufacturing process of both sound-blocking and sound-absorbing products globally.

Sound-Absorbing Perlite-Based Products – Expanded perlite is traditionally used as a primary constituent in the production of lightweight sound insulating panels and ceiling tiles. The intrinsic porous nature of lightweight expanded perlite absorbs sound waves and reduces the reverberation time.

Another option is the use of perlite as filler in spray-on absorbers. During spraying, perlite is mixed with a binding agent and water to produce a soft lightweight material with a coarse surface texture and high sound absorption characteristics. In one application, spray-on absorber containing perlite achieved a NRC value of 0.70.

Sound-Blocking Perlite Products – Expanded perlite is an essential constituent of perlite lightweight concrete. Densities greater than 1,000 kg/m³ (62 lb/ft³) offer a higher degree of sound-blocking. By varying the amount of perlite used in the mixture, one can achieve a balance between the weight of the overall structure, and the need for sound blocking levels of sound insulation. For example, the airborne sound insulation per Approved Document E–UK for new dwellings is 45 DnTw + Ctr dB. By definition, this is the weighted Sound Reduction Index (SRI), the greater the reduction in unwanted noise transfer (blue line). (Courtesy of Gulf Perlite LLC, Dubai)

Perlite manufacturers have developed a variety of solutions for harnessing the benefits of perlite lightweight concrete to meet the stringent local building code requirements. For example:

Perlite Lightweight Concrete Floor Sound-Blocking Solutions – Perlite lightweight concrete floor screed is used to reduce unwanted sound transfer between floors in a multilevel building. A typical perlite

Table 1 - Sound performance of wall insulated with perlite lightweight concrete in-fill; effect of partition thickness

(Data Courtesy of Whittemore Company Inc. and Gulf Perlite LLC)
Processes that Govern the Absorption of Sound

When it comes to noise protection in buildings, sound energy is transmitted through three primary processes: dissipation, resonance, and viscous friction.声波在材料中传播时，声能通过三个主要过程被吸收：衰减、共振和粘性摩擦。

1. Dissipation: In porous materials, sound energy is transferred primarily by frictional forces at the material's surface. This process results in the conversion of sound energy into heat, reducing the sound's intensity.

2. Resonance: Sound waves can be absorbed at specific frequencies when the material's internal structure results in standing waves. This process leads to the dissipation of sound energy into heat, further reducing the sound's intensity.

3. Viscous Friction: When sound waves encounter a material, the material's internal viscosity affects the wave's propagation. This process results in the dissipation of sound energy into heat, reducing the sound's intensity.

Impact Noise

Impact noise is caused by an object striking or sliding on a surface, such as footsteps, striking a surface, or furniture moving. Impact noise can be significant in buildings and can be a source of annoyance to residents.

Types of Noise

- Impact noise
- Airborne noise
- Structuralborne noise

Sound-Absorbing Perlite-Based Products

Perlite is an excellent material for sound absorption due to its cellular structure, which allows for the dissipation of sound energy. Expanded perlite is often used as a primary sound-absorbing material, while perlite lightweight concrete is used for sound-blocking applications.

Sound-Blocking Perlite Products

Expanded perlite can be used as primary or secondary sound-blocking material. It can be used in the manufacturing process of both sound-absorbing and sound-blocking products. Perlite manufacturers have developed Perlite Lightweight Concrete Floor Sound-Blocking Solutions, which are used to reduce unwanted sound transfer between walls, and intertenancy walls to comply with varying code requirements.

Perlite Lightweight Concrete Floor Sound-Blocking Solutions

- Perlite lightweight concrete is used to reduce unwanted sound transfer between walls and intertenancy walls to comply with varying code requirements.

Perlite in Sound Insulation Applications

Perlite has many applications in sound insulation, including:

- Sound absorption
- Sound blocking
- Fireproofing
- Corrosion resistance
- Low environmental impact
- Cost-effective
- Lightweight

Table 2 - Review of independent research studies that investigate the outstanding sound-absorption/sound-blocking properties of expanded perlite when used as filler in various type of products for different applications.

<table>
<thead>
<tr>
<th>PRODUCT TYPE</th>
<th>COMPOSITION / APPLICATION</th>
<th>KEY FINDINGS</th>
<th>REF.</th>
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</table>
| Cement and/or gypsum based products |  - Lightweight plaster and concrete for construction  
   - Porous sound-absorbing concrete slabs for railways  
   - Spray-on mixture  
   - Formed products (boards, plates, tiles) |  - Reduction of sonic and ultrasonic penetration velocity  
   - Highest NRC compared to ceramsite  
   - TL of 19 dB for 20 mm plaster  
| Underfloor bulk insulation |  - Lightweight concrete block floor  
   - Cross laminated timber and timber-concrete composite floor |  - Expanded perlite can be used as primary or secondary sound insulating material | [11], [12] |
| Composites |  - Colemanite bricks  
   - Geopolymer bricks  
   - Coal/newspaper/ cellulose-based boards  
   - Phosphogypsum based bricks  
   - Polyurethane composites |  - Enhanced acoustic performance and sound insulation  
   - Reduction of sonic and ultrasonic speed  
   - Increase of NRC  
| Substrate on Green walls |  - Green walls for indoor application  
   - Modular system for vegetable panels (facades) |  - Improvement of acoustic performance  
   - Sound absorption coefficient reached 1.0  
   - Reduction of reverberation time (T30) | [21] – [22] |
Perlite in Sound Insulation Applications

lightweight concrete floor installation with an oven dry density of 1,300 kg/m³, at a thickness of 50 mm (2 in.) applied directly (bonded) on 200 mm (8 in.) thick reinforced cement concrete (RCC) slab achieves an airborne sound rating of: Rw (C; Ctr) = 56.1 (-2 ; -6) dB. (Figure 2 and Figure 5).

**Perlite Lightweight Concrete In-Fill Partition Wall Systems** – A sustainable drywall partition developed using perlite lightweight concrete in-fill at a density of 1,000 kg/m³ gives this partition wall system a minimum 4-hour fire rating and complies to 45 DnTw + Ctr dB for intertenancy walls (Figure 3). This is achieved with a thickness of 200mm (8 in.). Table 1 illustrates the sound performance index of the perlite-based partition system with varying thicknesses.

**Further Benefits of Perlite When Used as a Filler in Construction Applications:**
- Excellent thermal insulation
- Lightweight
- Safe to handle; non-toxic, inert and inorganic material
- Fireproof and non-combustible
- Resistance from corrosion from most chemicals
- Cost effective
- Low environmental impact

**BIBLIOGRAPHY**