pISSN:2349-5707 Volume:13,Issue 2, February -2026 eISSN:2349-5715

ПОВЫШЕНИЕ ЗВУКОИЗОЛЯЦИИ ЗДАНИЙ

BINOLARNING OVOZ IZOLYATSIYASINI OSHIRISH

IMPROVING SOUND INSULATION OF BUILDINGS

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Аннотация. Современные города заполнены шумом городского транспорта, автомобилей а жилые дома ранее построенные подвержены воздействию шума лифтов, кондиционеров и др. которые приводят к повреждениям органов слуха людей. Для повышения звукоизоляции зданий и жилых домов необходимо применять звукоизолирующие материалы и конструкции.

Ключевые слова: воздушные шумы, акустические характеристики, звукоизоляция, минерал ватные плиты, звукоизоляционные материалы, акустика, ударный шум, воздушные звуковые волны, теплозащитные свойства конструкций, акустические свойства, шум современного города.

Annotatsiya: Zamonaviy shaharlar shahar transporti va avtomobillar shovqini bilan to'yingan. Ilgari qurilgan turar joy binolari esa liftlar, konditsionerlar va boshqa texnik qurilmalar shovqinining ta'siriga duchor bo'lmoqda. Ushbu omillar insonlarning eshitish a'zolariga salbiy ta'sir ko'rsatadi. Binolar va turar joylarning ovoz izolyatsiyasini oshirish maqsadida maxsus ovoz izolyatsiyalovchi materiallar va konstruktiv yechimlardan foydalanish zarur.

Kalit so'zlar: havo shovqinlari, akustik xususiyatlar, ovoz izolyatsiyasi, mineral paxta plitalari, ovoz izolyatsiyalovchi materiallar, akustika, zarbali shovqin, havo orqali tarqaluvchi tovush to'lqinlari, konstruksiyalarning issiqlikdan himoyalovchi xususiyatlari, akustik xossalar, zamonaviy shahar shovqini.

Abstract: Modern cities are saturated with noise generated by urban transport and automobiles. Residential buildings constructed earlier are also exposed to noise from elevators, air conditioners, and other technical systems, which negatively affect human hearing. To improve the sound insulation of buildings and residential houses, it is necessary to apply sound-insulating materials and appropriate structural solutions.

Keywords: airborne noise, acoustic characteristics, sound insulation, mineral wool boards, sound-insulating materials, acoustics, impact noise, airborne sound waves, thermal insulation properties of structures, acoustic properties, noise of the modern city.

pISSN:2349-5707 Volume:13,Issue 2, February -2026 eISSN:2349-5715

A significant portion of previously constructed buildings does not meet the requirements of modern standards for sound insulation and thermal protection. To create full comfort during renovation and construction works, various thermal insulation materials are used. However, not all of them meet the necessary sound insulation requirements currently imposed on building structures and constructions of various purposes. This is essential, since we live in a very noisy world and suffer from a huge number of sounds that we are forced to hear constantly. There are more cars on the roads, and in houses there are ventilation systems, air conditioners, and elevators—the life of a modern city is filled with noise. That is why the creation of residential buildings with increased sound insulation is an urgent task for architects, builders, and acoustic specialists.

The average daily noise exposure at the workplace of less than 80 dB (decibels) on the "A" scale (dB) does not pose a threat to human physical health. However, constant exposure to noise levels above 90 dB causes irreversible damage to hearing organs. In some cases, to reduce noise as well as to increase sound insulation, it is much more appropriate to use sound-absorbing materials in structures.

These materials can be used on individual structural surfaces (ceiling, wall), and their effectiveness is proportional to the area they occupy. In addition, sound-absorbing materials and structures are widely used to improve the acoustic characteristics of residential and public buildings.

The main purpose of sound-insulating materials widely used in construction and architectural-building acoustics is to increase the reflection of airborne sound waves and prevent the propagation of structural noise in building constructions. When sound energy enters a material, it is primarily spent on elastic deformation of elements of its structure, which explains the attenuation of sound waves. Therefore, building sound insulation is subject to requirements for elastic properties (characterized by relative compression and dynamic modulus of elasticity).

Sound insulation is characterized by the following values: relative compression under a load of 0.002 MPa (in effective materials—not more than 40%), which characterizes rigid materials with low deformability; semi-rigid materials with medium deformability; and soft materials with high deformability. The value of the dynamic modulus of elasticity, which is the main design characteristic, makes it possible to classify building sound insulation as follows:

▪ The first group includes sound-insulating materials in the form of slabs, rolls, and mats, which are laid as a continuous layer in building structures during installation and are also used for insulating multilayer floors, walls, and partitions.

▪ The second group includes strip and piece gaskets in floor structures between stories with "floating" floors and in multilayer structures.

▪ The third group includes sound-insulating materials used as backfills in inter-floor slabs to improve insulation from impact and airborne noise.

Thermal-sound insulation materials include various types of building materials. The most popular materials on the construction market are mineral wool boards, boards and mats based on fiberglass, various types of panels made of synthetic components, as well as cellular concrete and gypsum board possessing sound-reflecting effects.

In structures, the following are used as sound-absorbing layers:

- mineral wool boards on synthetic binder, semi-rigid, with fiber diameters of 5–10 μm, density 50–100 kg/m³, moisture-resistant, non-combustible;
- mats made of ultra-fine glass fiber with diameters not exceeding 3 μm, density 17–25 kg/m³, not moisture-resistant;
- products made of ultra-fine glass fibers with diameters not exceeding 2 μm, density 7–15 kg/m³, faced on one or both sides with fabric or film, hardly combustible;
- mats made of ultra-fine basalt fiber with density 20–25 kg/m³, in a protective shell of glass fabric, non-combustible, moisture-resistant.

pISSN:2349-5707 Volume:13,Issue 2, February -2026 eISSN:2349-5715

By form, sound-insulating materials and products are divided into piece (blocks, slabs), roll (mats, canvases), loose and bulk (mineral wool, glass wool; expanded clay, slag). At present, the most effective materials with high sound absorption coefficients over a wide frequency band (from 125 Hz to 8000 Hz) are products made of ultra-fine fiberglass. However, their use is permitted only if special coatings are present that ensure a high degree of protection against unwanted emission of fiberglass particles. This problem is known as “noise from upstairs neighbors.” If inter-floor slabs are used improperly (the source may be human movement or an object falling on the floor), practically all known types of acoustic waves characteristic of a solid body begin to propagate in the slab. These waves spread through all structural elements of the building, and the task of noise reduction becomes very difficult. It is much easier to reduce noise of this type “at the source.” Today, the most effective means of combating impact noise is the use of a “floating floor” structure, where a layer of elastic material is installed between the inter-floor slab and the finished floor (parquet, linoleum).

Tests were carried out on samples of a combined sound-insulating layer consisting of basalt cardboard 5 mm thick (upper layer) and a layer of stitched thermal-sound-insulating fiberglass mat PSKhTZI 14 mm thick in order to determine its sound insulation properties. Acoustic tests of samples of combined sound-insulating materials consisting of basalt cardboard 5 mm thick laid over a layer of stitched thermal-sound-insulating fiberglass mat PSKhTZI showed that in terms of dynamic characteristics they belong to the class of effective sound-insulating materials.

The use of combined sound-insulating layers with a total thickness of 19 mm in floating screed structures with slab surface density of at least 80 kg/m² ensures an improvement index of impact noise insulation of floors ΔLnw = 32 dB, which in the vast majority of real cases achieves compliance with regulatory requirements for impact noise insulation in building premises. Placing the cardboard layer between the floor slab and the PSKhTZI layer practically does not change the value of the impact noise insulation improvement index of the floating screed laid over the combined layer, reaching values not exceeding 27 dB.

ThermoZvukoIzol is a three-layer material consisting of stitched fiberglass fabric and a double-sided protective shell made of nonwoven polypropylene material, which completely prevents penetration of fiberglass and glass dust into the environment.

Characteristics of “ThermoZvukoIzol”:

- thickness — 14 mm
- density — 136 kg/m³
- thermal conductivity coefficient — 0.0388 W/m°C
- thermal resistance — 0.129 m²°C/W
- vapor permeability coefficient — 0.50 ml/m·h·Pa
- sound absorption coefficient in the range 500–8000 Hz — 0.22–0.87 (up to 87%)
- average vibration-insulating capacity in the range 60–4000 Hz — 22 dBA, i.e. reduction of impact and vibration noise by 13 times.

Due to the use of fluffed ultra-fine fiberglass as a filler, TZI, despite its small thickness, is characterized by high thermal-physical and acoustic indicators, which allow this material to be widely used in various fields of construction. Calculations show that using only one layer of TZI, for example:

a) in enclosing structures consisting of hollow brick with density 1400 kg/m³ with lime-sand plaster on one side and gypsum board finishing in one layer, makes it possible to reduce the thickness of this structure by a quarter of a brick (6.5 cm) while maintaining the same level of energy saving. At the same time, the heat transfer resistance of TZI is 16 times higher than that of clay brick, 22 times higher than lime-sand plaster, and 6 times higher than dry plaster;

b) as a filler for sound-absorbing aluminum panels of the SPA-1532 type, it makes it possible to increase their sound absorption efficiency from 20% (without filler) to 95% (with filling using ThermoZvukoIzol).

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The most effective protection of buildings from noise is achieved using modern thermal-sound insulation materials. Such materials can be either of natural origin (products based on stone wool, kaolin, expanded perlite, cellulose wool, flax tow, cork sheet) or synthetic (polyester foam, polyurethane foam, polystyrene foam, etc.).

At present, universal sound-insulating materials based on natural raw materials, for example products based on stone wool, are coming to the forefront, since they do not contain binders in the form of formaldehyde resins. Their excellent sound-insulating properties are determined by a specific structure—chaotically oriented ultra-thin fibers, which, rubbing against each other, convert the energy of sound vibrations into heat. The use of such insulation significantly reduces the risk of vertical sound waves between wall surfaces, shortens reverberation time, and thereby reduces sound levels in adjacent rooms. For sound insulation work at facilities of various purposes, it is recommended to use BZM mats possessing very good thermal-physical and sound-absorbing properties.

BZM mats are made of special ultra-fine basalt fiber enclosed on all sides in fiberglass fabric and stitched with glass thread. Their sound-insulating properties include:

- non-combustible, fire-resistant, fire-safe;
- chemically resistant, non-toxic;
- resistant to microorganisms and rodents, do not rot;
- do not increase diffusion resistance of structures;
- have low hygroscopicity (do not absorb moisture from air);
- resistant to vibration;
- perfectly absorb noise and sounds.

Sound insulation of equipment and structures can be used:

- for acoustic cladding of walls and ceilings;
- in sound-insulating screens and cabins;
- for sound insulation in aircraft construction, transport vehicles, metallurgical and chemical industries;
- in muffled chambers for acoustic certification of products;
- for noise silencers in supply and exhaust ventilation systems;
- for air-conditioning systems at gas-turbine and compressor installations.

Sound Absorption Coefficient Indicators of BZM Mats

Table No. 1

Frequency Range	Normal sound absorption coefficient at BZM thickness (mm)		
	50	100	200
Low frequency 100-250 Гц	0,08-0,46	0,21-0,98	0,70-0,66
Mid frequency 250-1000 Гц	0,46-0,73	0,98-0,80	0,66-0,77
High frequency 1000-2000 Гц	0,73-0,86	0,80-0,85	0,77-0,83

Properties of ultra-fine basalt fiber:

pISSN:2349-5707 Volume:13,Issue 2, February -2026 eISSN:2349-5715

- excellent thermophysical characteristics (λ = 0.039);
- operating temperature range from −260 °C to +700 °C;
- environmental friendliness (absence of organic binders);
- elasticity and resilience of the material, no shrinkage;
- mechanical strength and flexibility, allowing insulation of horizontal, inclined, and shaped surfaces;
- resistance to aggressive environments (acidic, alkaline, etc.);
- high vibration resistance;
- unlimited service life of the material.

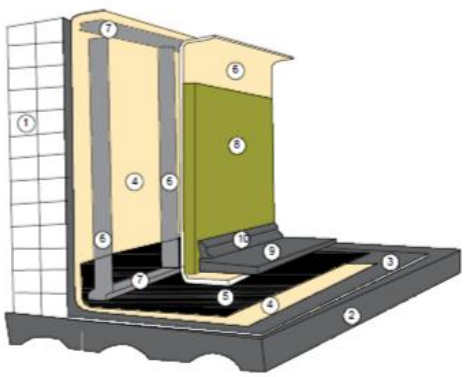
Technical Specifications

Table No. 2

№	Parameters / Characteristics	Units of Measurement	Value
1	Density	кг/м^3	30
2	Average Fiber Diameter	мкм	Not more than 3
3	Moisture / Humidity	%	Not more than 1
4	Service Temperature / Operating Temperature	°C	-269 +700
5	Melting Temperature / Melting Point	°C	1100
6	Flammability Class / Combustibility Group	нг	нг (по ГОСТ 30244 КМК)
7	Thermal Conductivity at 20 °C	Вт/м°C	0,036
8	Thermal Conductivity at 300 °C	Вт/м°C	0,092

Thermal and acoustic insulation is installed according to this diagram.

Application for wall sound insulation.



Recommendations for the installation of a sound insulation structure up to 8 cm thick using the material 'Termozvukoizol', for insulating an apartment, country house, or office from airborne and impact noise.

1 – Interior partition; 2 – Floor slab; 3 – Basalt cardboard, 5 mm thick; 4 – Termozvukoizol, 14 mm thick; 5 – Waterproofing material; 6 – Metal guides (27×60 mm), installed at 60 cm intervals; 7 – Metal guides (27×29 mm) or (50×50 mm); 8 – Gypsum board; 9 – Floor base; 10 – Skirting board.

*5 – Waterproofing is applied if a screed is being installed.

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Inside, MTP-AS (sound-absorbing BZML mats) are laid. To increase the sound insulation index, it is recommended to glue basalt cardboard over the entire surface and lay GVL sheets (gypsum fiber board). Termozvukoizol can be fastened with ordinary nails; if the wall is concrete, use dowels. Use Format No. 6. Install in a random order, avoiding significant sagging of the material.

It is mandatory to use basalt cardboard to create vibration-damping pads when installing the final layer of gypsum board. Pads should be placed at the points where the gypsum board is fastened to the profiles.

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