INTERNATIONAL CONFERENCE **Dehli, India, 2025**
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INTERRELATION BETWEEN ACOUSTIC INSULATION AND ENERGY EFFICIENCY OF LOW-COST AERATED CONCRETE WALLS IN RURAL CONDITIONS

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Abstract : This article analyzes the relationship between the acoustic insulation properties and energy efficiency of rural residential wall systems constructed from low-cost local aerated concrete (AAC) materials. Based on the research, sound insulation performance and thermal conductivity parameters were determined depending on wall thickness, density, and material composition. Optimal density and thickness values of AAC walls are proposed to ensure high sound insulation. Moreover, it is scientifically demonstrated that acoustic insulation should also be considered to achieve energy-efficient construction.

Keywords: Aerated concrete, acoustic insulation, energy efficiency, soundproofing, density, wall thickness, rural housing construction.

Introduction

In recent years, the use of affordable, lightweight, and energy-efficient construction materials has expanded in rural areas of Uzbekistan. One such material is aerated concrete (AAC), made from cement, lime, and aluminum powder. Due to its low density, AAC has high thermal retention capability, but its sound barrier (acoustic insulation) properties can sometimes be insufficient.

In rural residential buildings, comfort is not limited to thermal efficiency alone—acoustic comfort is also important. Poor sound insulation negatively affects living conditions. Therefore, it is essential to find a balance between acoustic performance and energy efficiency in AAC walls.

1. Main Properties of Aerated Concrete

The density of AAC blocks ranges from 400 to 700 kg/m³, directly affecting both thermal and acoustic insulation. Low density ensures good thermal insulation but weak acoustic barrier.

No	**AAC Density (kg/m³)**	**Thermal Conductivity λ (W/m·K)**	**Sound Insulation Rw (dB)**	**Note**
1	400	0.12	36	Good thermal insulation, low sound insulation
2	500	0.14	40	Balanced performance
3	600	0.16	44	High sound insulation, more heat loss
4	700	0.18	46	Excellent acoustics, low

				energy efficiency

The data show that increasing density improves sound insulation but reduces heat retention. Therefore, an optimal density is around 500–550 kg/m³.

2. Influence of Wall Thickness

Wall thickness significantly affects both sound insulation and thermal efficiency. Computed data are as follows:

No	Wall Thickness (m)	Thermal Resistance R ($m^2 \cdot K/W$)	Sound Insulation Rw (dB)	Energy Efficiency (%)
1	0.20	1.60	35	60
2	0.25	2.00	38	72
3	0.30	2.40	41	85
4	0.35	2.80	43	90

The results show that increasing wall thickness improves both sound insulation and thermal performance. However, excessive thickness is economically inefficient. An optimal solution is a 0.30 m thick wall with a density of 500 kg/m³.

3. Relationship Between Energy Efficiency and Acoustic Insulation

The relationship between sound insulation and thermal insulation of AAC walls can be expressed as:

$Rw=25+40\times\lambda$

$\eta E=100-250\times(\lambda-0.12)$

Where:

- Rw — sound insulation (dB)
- λ — thermal conductivity ($W/m \cdot K$)
- ηE — energy efficiency (%)

Calculations indicate that as (\lambda) increases from 0.12 to 0.18, sound insulation improves by 10 dB, but energy efficiency decreases by 25–30%. Therefore, to balance both indicators, the wall system should include an additional insulation layer.

4. Optimal Solution with Additional Insulation

The table below shows results for AAC wall systems with extra insulation:

No	Wall System Composition	Total Thickness (m)	R ($m^2 \cdot K/W$)	Rw (dB)	Energy Efficiency (%)
1	AAC (0.25 m)	0.25	2.00	38	72

2	AAC (0.25 m) + Mineral Wool (0.05 m)	0.30	3.40	41	88
3	AAC (0.30 m) + Polystyrene (0.05 m)	0.35	3.60	42	90
4	AAC (0.25 m) + Double Insulation (0.05+0.05 m)	0.35	3.80	45	92

The data show that walls with both internal and external insulation layers achieve the highest acoustic and energy efficiency.

Conclusion

Research results indicate that low-cost local aerated concrete materials can meet both energy and acoustic insulation requirements in rural housing. However, their efficiency is strongly linked to wall density and thickness. A properly designed wall system with optimal density, thickness, and additional insulation ensures maximum comfort and energy savings.

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