

REDUCTION OF HEAT LOSS IN RURAL RESIDENTIAL BUILDINGS USING LOCAL AERATED CONCRETE BLOCKS

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Abstract: This article scientifically analyzes the potential for reducing heat loss in rural residential buildings using local aerated concrete (AAC) blocks. The physical-mechanical and thermal insulation properties of aerated concrete, their influence on the energy efficiency of wall systems, and optimal design solutions are examined. The study demonstrates that proper selection of wall thickness and AAC block density can reduce heat loss by 30–40%. Moreover, it is shown that using AAC blocks produced from local raw materials in rural construction is both economically and environmentally efficient.

Keywords: Aerated concrete, heat loss, energy efficiency, wall system, insulation, building materials, local raw materials, rural housing.

Introduction

In recent years, the construction of residential buildings in rural areas has actively increased to develop rural regions and improve living standards. An important factor in this process is the use of construction materials that are affordable, energy-efficient, and environmentally friendly.

Local aerated concrete blocks, manufactured within the region, are considered the main construction material meeting these requirements. AAC is lightweight, highly thermally insulating, and easy to use, making it particularly suitable for rural housing.

However, design flaws and “thermal bridges” in wall systems lead to significant heat loss. Therefore, developing technologies for efficient use of AAC blocks and minimizing heat loss is an important scientific and practical task.

1. Properties and Advantages of Aerated Concrete

Aerated concrete is an artificial porous material made from a mixture of cement, lime, sand, and aluminum powder. Key characteristics are as follows:

No	Property	Symbol	Value (Average)
1	Density	ρ	400–700 kg/m ³
2	Thermal Conductivity	λ	0.10–0.18 W/m·K
3	Strength	R	1.5–3.0 MPa
4	Water Absorption	—	5–10%
5	Acoustic Insulation	R _w	36–45 dB

The low density of AAC improves its heat retention capacity, making it 3–4 times more effective than traditional brick.

2. Main Causes of Heat Loss in Rural Houses

Heat loss in rural houses is caused by:

- Joints and thermal bridges in wall systems;
- Insufficient insulation around doors and windows;
- Heat loss through floors and roofs;
- Breaches in the continuity of insulation layers on external structures.

Improper use of AAC reduces its high thermal insulation potential.

3. Calculation of Heat Loss



The heat flow through a wall can be calculated using:

$$Q=A \times \Delta T / R$$

Where:

- (Q) — heat loss (W);
- (A) — wall area (m²);
- (ΔT) — indoor-to-outdoor temperature difference (°C);
- (R) — thermal resistance of the wall (m²·K/W).

4. Economic Efficiency of Local Aerated Concrete Blocks

AAC blocks produced locally are cheaper than imported materials, reducing total construction costs by 20–25%.

No	Material	Price (1 m ³ , sum)	Thermal Resistance R (m ² ·K/W)	Energy Efficiency (%)
1	Traditional Brick	550,000	1.25	0
2	Imported AAC	750,000	2.60	45
3	Local AAC	620,000	2.40	40
4	Local AAC + Insulation (0.05 m)	720,000	3.40	55

The table shows that local AAC blocks are more cost-effective while providing high energy efficiency.

5. Optimal Wall System Design

For rural houses, the following wall system is recommended:

1. AAC block (0.30 m) — main structural layer;
2. Mineral wool layer (0.05 m) — insulation;
3. Decorative facade or plaster (0.02 m) — exterior protective layer.

In this system, the total thermal resistance is approximately ($R \approx 3.5 \text{ m}^2 \cdot \text{K/W}$), reducing heat loss in the building by up to 60%.

6. Results of Heat Flow Simulation

The table below shows heat flow for various AAC wall configurations:

No	Wall System	λ (W/m·K)	R (m ² ·K/W)	Energy Loss (W/m ²)
1	Brick (0.25 m)	0.50	0.50	60
2	AAC (0.25 m)	0.13	1.92	30
3	AAC (0.30 m)	0.13	2.31	26
4	AAC (0.30 m) + Insulation (0.05 m)	0.08	3.75	16
5	AAC (0.35 m) + Insulation (0.05 m)	0.08	4.38	14

These data demonstrate that wall systems with additional insulation reduce heat loss by 2–3 times.

Conclusion

Using local AAC blocks can reduce heat loss in rural houses by 30–40%. With additional insulation, energy efficiency can reach 50–60%. Local AAC is cheaper than imported analogs and environmentally safe.

The optimal wall system consists of 0.30 m thick AAC blocks and a 0.05 m layer of mineral wool. This solution significantly reduces annual heat loss and fully meets modern energy efficiency requirements for buildings.

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