

USK Noise Barrier Systems vs. Traditional Noise Control Methods

Lifecycle Cost & Performance Analysis:

An evaluation of acoustic integrity, structural durability, and economic efficiency in highway and railway infrastructure.

REPORT:

1. Executive Summary

Noise pollution is identified as the second most significant environmental risk factor threatening human health in Europe, following air pollution. Transport-related noise causes tens of thousands of premature deaths and billions of Euros in economic loss annually. This report, in light of scientific data, presents the definitive protection provided by acoustic noise barriers by intercepting noise on the propagation path rather than at the source, their material-based life cycle advantages, and their superiority over alternative measures.

2. Current Situation: The Devastating Impact of Noise on Health and Economy

The necessity of noise barriers is directly proportional to the magnitude of the devastation caused by noise:

- **Health Burden:** Long-term noise exposure in Europe causes approximately 12,000 premature deaths and contributes to 48,000 new cases of ischemic heart disease annually. Additionally, 22 million people suffer from chronic high annoyance, and 6.5 million suffer from chronic high sleep disturbance.
- **Child Development:** Reading and learning difficulties have been detected in 12,500 school-aged children due to aircraft and traffic noise.
- **Economic Loss:** The annual cost of noise pollution to the European economy due to healthcare expenditures and productivity loss is estimated to be at least €95.6 billion.

3. Working Principle and Technical Advantages of Acoustic Barriers

Noise barriers create an "acoustic shadow" by placing a physical obstacle between the noise source (road/vehicle) and the receiver (residence/school). They offer the following advantages over other measures (source reduction or building insulation):

3.1. Definite and Measurable Results

- **Immediate Effect:** While measures like quiet asphalt or electric vehicle conversion may take years to show impact, barriers can reduce noise by 5-15 dB(A) immediately upon installation.

- **Outdoor Protection:** While building insulation (double glazing, etc.) only protects the interior, noise barriers render gardens, parks, and outdoor living areas free from noise.

3.2. Acoustic Performance (Absorption and Insulation)

Quality barriers fulfill two fundamental acoustic functions:

- **Sound Insulation (Airborne Sound Insulation):** The capacity to prevent sound from passing through. An effective barrier must transmit significantly less sound through it than what passes over it (diffraction); as a rule, the Transmission Loss (TL) of the barrier must be at least 10 dB higher than the targeted noise reduction.
- **Sound Absorption:** Reflective barriers (e.g., flat concrete or glass) can bounce sound to buildings on the opposite side. Absorptive barriers convert sound energy into heat, preventing the "reverberation effect" and the reflection of noise across the road.

4. Material-Based Comparison and Life-Cycle Cost Analysis (LCCA)

The economic and technical advantages of barriers vary significantly based on the chosen material. Solutions that appear "cheap" can turn into the most expensive options in the long run.

4.1. Earth Berms

- **Advantage:** Excluding land costs, they offer the lowest Life-Cycle Cost (LCCA) as they require no maintenance and have a very long lifespan.
- **Disadvantage:** They require a very large area (right-of-way), making them impossible for urban applications.

4.2. Concrete Barriers

- **Advantage:** Due to high mass, they provide excellent sound insulation and have a service life exceeding 50 years.
- **Disadvantage:** Being heavy, they require expensive foundations and their reflective surfaces can bounce sound to the opposite side. Additionally, sealing issues at joints and connection points can degrade performance.

4.3. Aluminum and Metal Cassette Systems

- **Advantage:** They are lightweight, making them suitable for bridges and viaducts (reducing static load). Thanks to their modular structure, damaged parts are easily replaceable. Models with high sound absorption capacity are available.
- **Economic Efficiency:** Although the initial investment cost is higher, aluminum systems reduce maintenance costs significantly, offering a total ownership cost advantage over concrete systems.

4.4. Wooden Barriers

- **Risk:** While the initial installation cost seems low, wood's tendency to dry and crack leads to acoustic leakage. Due to maintenance and replacement costs, they become an expensive solution in a 25-year projection.

4.5. Transparent (Polycarbonate/Acrylic) Barriers

- **Advantage:** They do not cut off visual contact, prevent the tunnel effect, and preserve the landscape.
- **Safety:** PMMA and Polycarbonate sheets are much more durable than glass, and the risk of falling debris is minimized in case of breakage.

5. The Hidden Cost of "Cheap" Barriers

Focusing solely on initial installation costs in tendering processes leads to serious technical and economic damages:

- **Post Densification Cost:** If the wind load resistance of low-quality panels is weak, post spacing (e.g., from 4 meters to 3 meters) must be reduced. This means 25% more foundation excavation and post costs.
- **Acoustic Leakage:** Even a small gap of 1.5% in poor quality systems (especially wood or poorly assembled concrete) can drop insulation performance from 20 dB to 11 dB, rendering the barrier ineffective.

6. Conclusion and Recommendations

Acoustic noise barriers are the most effective direct intervention method to achieve the EU's "Zero Pollution" goals and protect public health. In light of the analyses:

1. **Correct Material Selection: Absorptive** aluminum or composite panels should be preferred in urban areas to prevent reflection.
2. **Long Life:** Investment decisions should be based on 40-50 year **Life-Cycle Cost (LCCA)** rather than just installation cost; in this analysis, concrete and aluminum/earth berms are more advantageous than wood.
3. **Compliance with Standards:** It is essential for efficient use of public resources that barriers are certified according to EN 1793 (Acoustic) and EN 1794 (Mechanical/Safety) standards.

Summary: A high-quality noise barrier system is not just a construction cost; it is a strategic investment that reduces health expenses, protects real estate value, and increases social welfare.

Criteria for Selecting the Right Noise Barrier & Analysis of USK Products

The selection of the correct noise barrier is a critical engineering decision in terms of the project's life-cycle cost, acoustic efficiency, and environmental sustainability. Below is the analysis prepared in light of USK Noise Barrier technical datasheets and general scientific literature:

1. Criteria for Selecting the Right Noise Barrier

Three main performance indicators must be considered in barrier selection:

A. Acoustic Performance (EN 1793 Standards)

- **Sound Insulation (Airborne Sound Insulation - D_{Lr}):** The capacity of the barrier not to transmit sound through it. For an effective barrier, the **D_{Lr}** value must be at least **24 dB (Category B3)**. Barriers with low insulation (gaps or lightweight) leak sound to the rear.
- **Sound Absorption (Sound Absorption - D_{La}):** The capacity of the barrier to dampen sound. Reflective (concrete/glass) surfaces bounce sound to the opposite building. In urban and highway settings, absorption values of **8-11 dB (Category A3)** or higher (**Category A4**) should be preferred.

B. Economic and Structural Criteria (EN 1794 Standards)

- **Life Cycle Cost (LCCA):** Not just the initial installation cost, but 40-50 years of maintenance and repair costs must be calculated. While wood barriers seem cheap, their maintenance cost is high; concrete and aluminum systems are more economical in the long run.
- **Mechanical Stability:** Resistance to wind load, stone impact, and pressure from snow clearing vehicles (EN 1794-1) is mandatory.

C. Environmental Factors

- **Sustainability:** Use of recyclable materials (Aluminum is 100% recyclable) and low carbon footprint in production are important.

2. Which is the Most Correct Choice?

According to scientific data and life-cycle analyses; **"High-Performance Aluminum Cassette Systems"** (with Absorptive features) stand out as the most correct choice in urban and highway applications.

- **Why?** They are as long-lasting as concrete but much lighter (suitable for bridges). They do not rot or leak sound like wood. Thanks to their modular structure, damaged parts can be easily replaced, and they can reach high sound absorption values (Class A4).

3. Advantages of USK Noise Barrier Products Compared to Alternatives

When USK Noise Barrier technical datasheets are examined, the advantages provided by the products compared to standard concrete or low-quality metal barriers on the market are listed item by item as follows:

A. Superior Acoustic Sealing (EPDM Gasket Technology) While sound leakage occurs at panel joints in many alternative products, USK products use a **double-sided EPDM rubber seal system**.

- **Advantage:** Even a 1.5% gap can drop barrier performance from 20 dB to 11 dB. USK's EPDM gaskets reduce this leakage to zero, ensuring laboratory values are achieved in the field.

B. Record Level Sound Absorption (DLa) While standard barriers generally provide 8-11 dB (Class A3) absorption, the **USK Single Side** model has a sound absorption value of **20 dB**.

- **Advantage:** This value is far above **Class A4 (the highest class)** according to the EN 1793-1 standard. It prevents noise from reflecting (echoing) to the opposite lane or buildings 2 times more effectively than competitors.

C. Corrosion and Environmental Durability USK panels are produced from aluminum alloy resistant to sea water and coated with electrostatic polyester powder paint.

- **Difference from Alternatives:** While galvanized steel barriers may rust over time or wood barriers may rot from moisture, USK products have passed salt water tests and offer a long life requiring no maintenance (maintenance-free).

D. Structural Rigidity and Drainage System USK barriers feature an "Optical and acoustic integrated drainage system." Additionally, the lower and upper profiles possess high rigidity thanks to the riveted system.

- **Advantage:** In cheap metal barriers, the internal filling material (rock wool) gets wet and slumps over time. USK's drainage system and special black glass tulle covered rock wool ensure water drainage, guaranteeing that acoustic performance remains the same even after 10-20 years.

E. High Insulation and Safety in Transparent Panels The **USK ACR / SLD** (Transparent) series provides **30-31 dB (DLr)** sound insulation despite being transparent.

- **Advantage:** While standard glass or thin plexiglass remains in the 20-25 dB band, USK products provide insulation in Category B3 (High Performance). They also possess special strips to prevent bird collisions (bird protection strips) and safety standards against falling debris (EN 1794-2).

F. Environmental Sustainability USK products are produced from **recycled aluminum** materials.

- **Advantage:** Compared to the high carbon footprint of concrete barriers, USK products are eco-friendly and earn points in "Green Building" (LEED/BREEAM) projects.

G. Compliance with Railway Standards Especially **USK Double Sided** and **Single Sided Double (RW)** models have been specially tested for railway noise (High-Speed Train) and documented to provide **31 dB** insulation.

- **Advantage:** Resistant to high aerodynamic pressure generated on high-speed train lines.

Summary Comparison Table

Feature	Standard Concrete Barrier	Standard Metal Barrier	USK Aluminum System (Single Side)
Sound Absorption	Low (Reflective)	Medium (8-10 dB)	Very High (20 dB - Class A4)
Sealing	Risky at joints	Gasket wear over time	Double EPDM Gasket (Full Sealing)
Corrosion	Reinforcement corrosion risk	Rust risk	Sea Water Resistant Aluminum
Internal Filling	None	Wetting/Slumping risk	Water Repellent & Integrated Drainage Rock Wool
Installation	Heavy / Crane Required	Medium	Light / Modular / Fast

Conclusion: USK products, especially with EPDM sealing technology, integrated drainage system, and sound absorption performance above Class A4 (20dB), are **the safest and most economical (in terms of LCCA) solution technically for long-term public investments and prestigious projects.**



USK Noise Barriers