ITALIAN EXPERIENCE ON TRANSPORT ROAD AND RAILWAY NOISE

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APAT

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Summary

1. Noise Emission from Roadway and Railway Traffic
2. Legislative Framework for Traffic Noise Management
3. Traffic Noise Analysis
4. Traffic Noise Abatement Procedures
5. Evaluation of a Traffic Noise Management Plan

1 – NOISE EMISSION FROM ROADWAY AND RAILWAY TRAFFIC

- *Road noise*

Traffic noise is the sum of the noise produced by vehicles in a traffic stream

The levels of traffic noise depend on factors such as the composition of the traffic, vehicle speeds, vehicle ages, driver behaviors, the type of road surface, surrounding topography and the grade of the road

Noise monitoring

Measurements must be carried out in accordance with Italian Decree 16 march 1998 “Acoustic pollution measurement methods”:

- The Noise descriptor adopted is L_{Aeq}
- The duration must be not below seven days
- The monitoring points must be at 1 m from the building that is most exposed to traffic noise and at a height 4 m above floor level

- *Railway noise*

Railway traffic generates noise mainly by the roughness on the *wheel* and *rail* surfaces.

Other sources of railway noise are *auxiliary equipments* – compressor, ventilation and brake systems - and the passage of the train through air, whose contribution to the total noise increases with speed (*Aerodynamic Noise*)

Noise monitoring

Measurements must be carried out in accordance with DM 16 march 1998 “Acoustic pollution measurement methods”:

- The Noise descriptor adopted is L_{Aeq}
- The duration must be not below 24 hours
- The monitoring points must be at 1 m from the building that is most exposed to traffic noise and at a height 4 m above floor level

2 – LEGISLATIVE FRAMEWORK FOR TRAFFIC NOISE MANAGEMENT

- **L. 447 26 october 1995**: “Law about acoustic pollution”
- **DM 16 march 1998** “Acoustic pollution measurement methods”
- **DPR n. 459 18 november 1998** “Regulation about noise pollution from railway traffic”
- **DM 29 november 2000** “Criteria for the arrangement of noise reduction plans by Public Transport Authority”
- **DPR n. 142 30 march 2004** “Provisions for the containment and prevention of noise pollution from roadway traffic”

in particular :

- *DM 16 march 1998* defines the **monitoring criteria** of Traffic Noise: noise descriptors, duration and location of measurements
- *DPR 459/1998* defines the "**acoustic pertinence areas**" of railway noise and the **immission limit values** inside and outside these areas
- *DPR 142/2004* defines the "**acoustic pertinence areas**" of roadway noise and the **immission limit values** inside and outside these areas
- *DM 29/11/2000* establishes the **criteria for predisposition**, by the societies of transport or road and railway infrastructures, **of the plans for measures of containment and abatement of traffic noise** and fixes the **modality and the terms for the presentation of these plans**

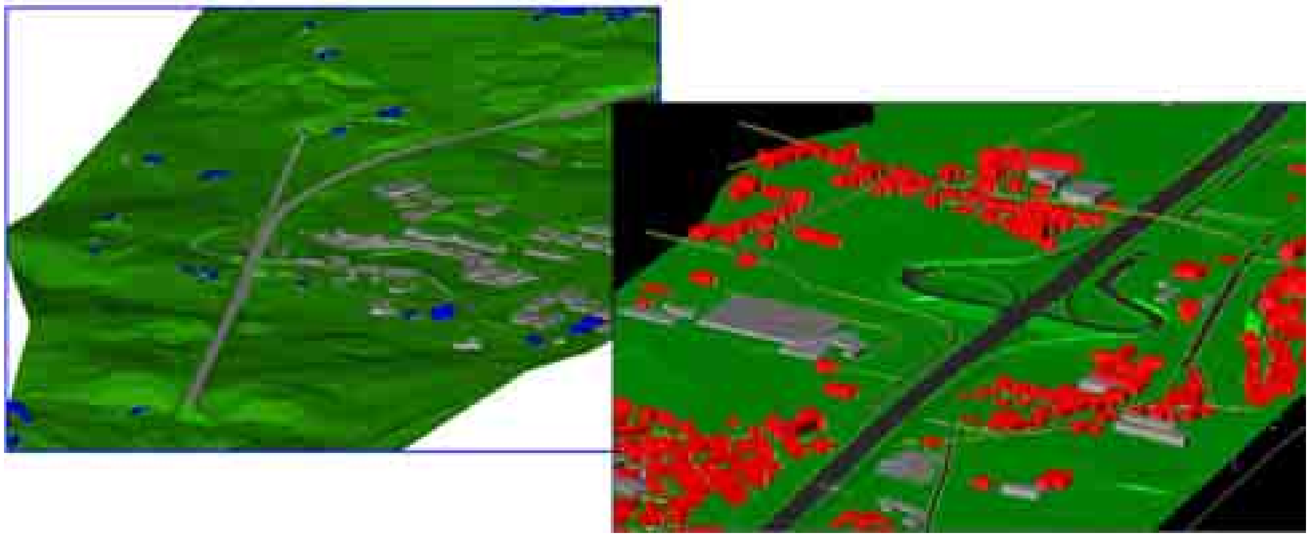
3 – TRAFFIC NOISE ANALYSIS

- Step 1 – Define the cartographic framework
- Step 2 – Define the Traffic Noise Interested Area
- Step 3 – Identify all Noise Receivers and the Noise-Sensitive Receivers
- Step 4 – Identify other Traffic Noise Sources
- Step 5 – Measure Existing Noise Levels
- Step 6 – Predict Future Noise Levels
- Step 7 – Evaluate Noise Impacts: the Priority Index

❖ Step 1 – Define the cartographic framework

For noise evaluation, the road and railway territory is illustrated by aerophotogrammetries and regional technical papers

LIDAR system (Laser Impulse Detection And Ranking) may be used to model the area in 3D



Images from *Piano degli interventi di contenimento ed abbattimento del rumore – DM 29/11/2000* – Autostrade per l'Italia

❖ Step 2 – Define the Traffic Noise Interested Area

- The *Noise Interested Area* is the Area of land within the *nominal roadway or railway noise corridor – "acoustic pertinence areas"* (defined by Italian legislation on traffic noise: DPR 459/1998 for Railway Noise and DPR 142/2004 for Roadway Noise)

- The *noise corridor* may be divided into two segments

For example:

existing highway (DPR 142/2004)

"Fascia A": area within 100 m of the road alignment with L_{Aeqday} limit value: 70 dBA and $L_{Aeqnight}$ limit value: 60 dBA

"Fascia B": area extended to 150 m from "Fascia A" (within 250 m of the road alignment) with L_{Aeqday} limit value: 65 dBA and $L_{Aeqnight}$ limit value: 55 dBA

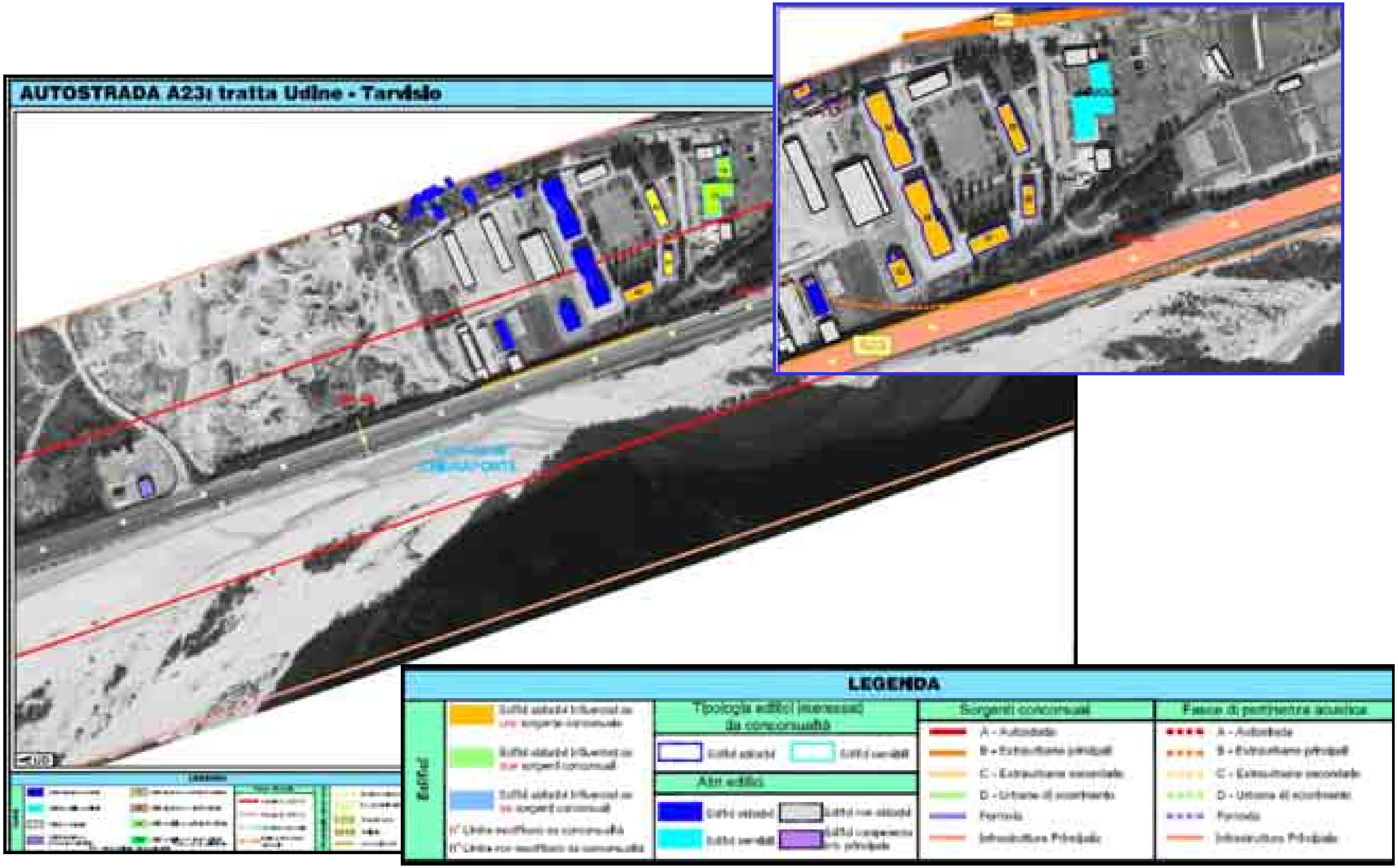
- **Step 3 – Identify all Noise Receivers and the Noise-Sensitive Receivers**

The *Receivers* are places where people are typically located, comprised the relative external pertinence areas, such as residences, hotels, commercial buildings, parks,etc.

The Receivers may be divided in: Residential Receivers, Non Residential Receivers (commercial, industrial buildings) and *Sensitive Receivers* (school, hospitals, nursing home, rest home)

- **Step 4 – Identify other Traffic Noise Sources -*Competitive Sorces-***

In the Noise catchments Area Noise Sources have to be identified, especially other Traffic Noise Sources, defined *Competitive Sources*, that can influence the Acoustic Climate of the interested area



Images from *Piano degli interventi di contenimento ed abbattimento del rumore – DM 29/11/2000* – Autostrade per l'Italia

❖ Step 5 – Measure of the existing noise levels

Field measurements should be carried out along all existing or proposed roadway or railway segments.

Monitor of the existing noise levels is needed:

✓ to assess the existing traffic noise environment referring to current traffic volumes and composition

✓ to determine background sound levels and the contribution of other sources

✓ to calibrate noise prediction models

Noise monitoring may not be undertaken during periods of atypical traffic flows and during periods of extraneous noise

The measurements shall be taken at representative sites of the study area, in accordance with DM 16 march 1998 "Acoustic pollution measurement methods"

❖ Step 6 – Predict Future Noise Levels

The Traffic Noise models are used to determine:

- for an existing infrastructure, the future noise levels projecting the traffic flow to a design year
- for a new infrastructure, the future acoustic climate of the study area

Modelling considerations

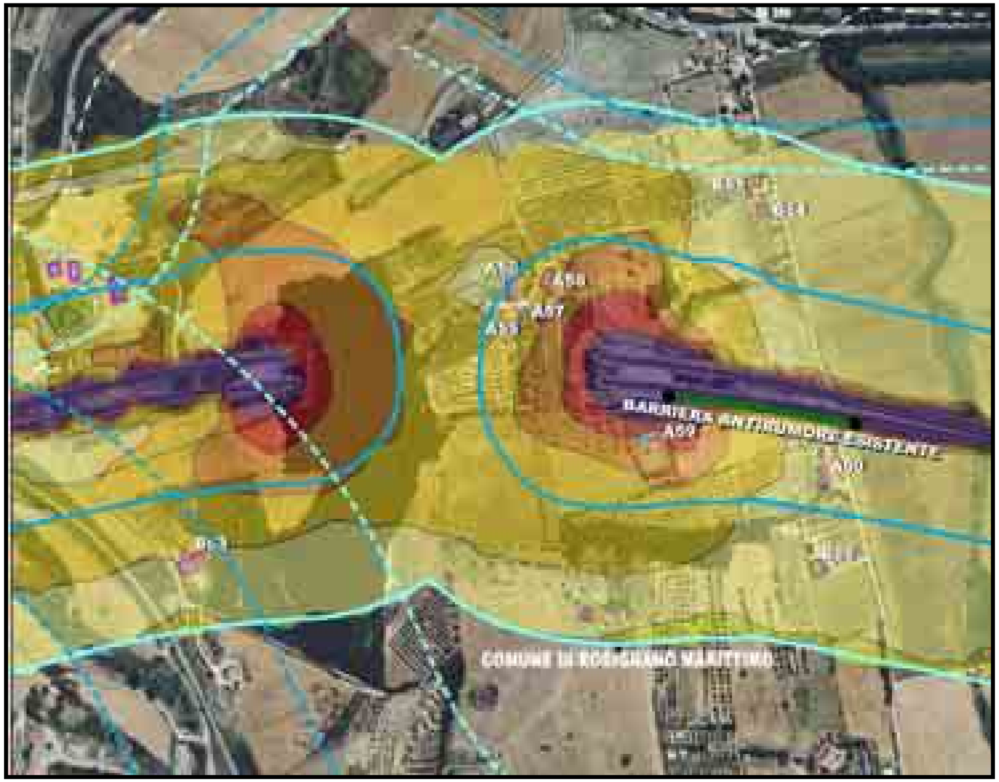
for a road: *traffic flow (% trucks); speed; pavement surface; gradient of road; topographic features; receivers/source distances and height; ground cover; roadside or topographic barriers; reflection form buildings or roadside barriers; noise contribution from other source (…)*

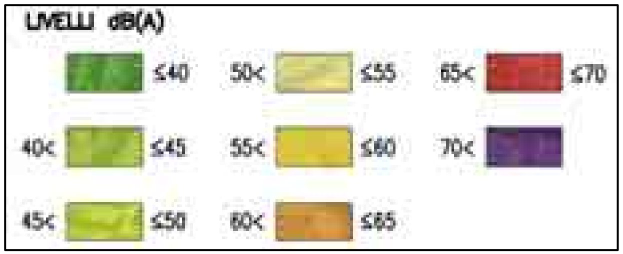
Verification of Traffic Noise Model

The objective of the verification is to demonstrate that the Traffic Model being employed for the study is capable of generating correct outputs

Measured values are used for calibration and validation: modelling of the existing sound level must be within 2 dBA of the measured sound level

The Traffic Model calculates the L_{Aeq} in every point indicated and graphically shows the results by *isophonics,* noise contours for intervals of 5 dBA, overlapping to the topography of the area, or in analytical mode on the single receivers





Images from *Piano di Risanamento Acustico Autostrada A/12 Livorno – Civitavecchia Tratta Livorno Rosignano Marittimo* – S.A.T

❖ Step 7 – Evaluate Noise Impacts: the Priority Index

An “Area” is determined to have Traffic Noise Impacts if the foreseen Noise levels exceed the “*target” noise levels*

This “Area” is defined “*Acoustic Critical Area*”

The “*Target” Noise levels* are the immission limit values:

- inside the Noise Corridor, depend on the distance from the infrastructure
- outside the Noise Corridor, depend on the acoustic zoning of land defined by the municipalities

The Priority Index (*P*) to determine priorities for measures of reducing traffic noise is quantified by the relationship:

$$P = R(L - L_*)$$

where

L = predicted external noise level

L_* = target noise level-immission limit value

R = for residential receiver, number of people exposed; for school, number of student x 3; for hospitals or rest home, number of beds x 4

4 – TRAFFIC NOISE ABATEMENT PROCEDURES

- A – Techniques for reducing Traffic Noise at source
- B – Techniques for reducing Traffic Noise during propagation
- C – Techniques for reducing Traffic Noise at the receiver
- D – Techniques for controlling construction noise

A – Techniques for reducing Traffic Noise at source

A1 – "Low Noise" road surface

The type of road surface can have a significant impact on traffic noise generated by pavement surface/tire interaction

✓ A <u>rough and irregular surface</u> causes the tire vibration and noise emission

✓ A <u>perfectly smooth surface</u> creates noise, because air trapped between tire and road surface cannot easily escape and the movement of this air causes noise

Road surface noise corrections, relative to dense graded asphaltic concrete			
Surface type (regularly trafficked)	Noise level variation, dB(A)		
	Traffic noise	Individual vehicles pass-by noise	
		Cars	Trucks
14 mm chip seal	+ 4.0	+ 4.0	+ 4.0
Portland cement concrete: tyned and dragged	0 to + 3.0	+ 1.0 to + 3.5	- 1.0 to + 1.0
Cold overlay	+ 2.0	+ 2.0	+ 2.0
Portland cement concrete: exposed aggregate	- 0.5 to - 3.0	- 0.1	- 6.7
Stone mastic asphalt	- 2.0 to - 3.5	- 2.2	- 4.3
Open graded asphaltic concrete	0 to - 4.5	- 0.2 to - 4.2	- 4.9

The road surface correction applied depends on the road surface's porosity, macrotexture, depth and wavelength, the percentage of heavy vehicles and vehicle speeds.

Table from *Environmental Noise Management Manual* – RTA

✓ <u>Fine irregularities or texture</u> within the road surface can assist in the removal of air, reducing noise and vibration of the tire

A1 – Wheel and rail measures

✓ *Roughness measures*

Grinding the rail and the wheel tread to get a smooth surface on both is an effective way of reducing the roughness

Replacing cast iron brake blocks with composite material blocks would be beneficial for all vehicles that travel on the same track

✓ *Wheel and rail damping*

Adding damping to the wheel or the rail makes these structures less resonant, which lowers the vibrations and thus the sound radiation

✓ *Screens close to the wheel/rail*

	Measure	Reduction potential dB(A)
Wheel rail roughness	Regular wheel grinding	10
	Regular rail grinding	10
	Composite brake pads	8
Wheel rail damping	Wheel damping	5
	Rail damping	5
	Pad stiffness optimised for low noise emission	5
Screens close to wheel/rail	Overlapping screens	10
	Screens with gap	3

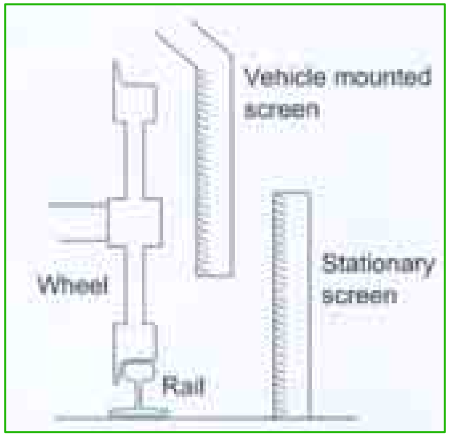


Table and Image from *Noise emission from railway traffic* - VTI for urban road

A2 – Modifying the road gradient

The road gradient reduction can have a positive effect on road traffic levels

A 5% reduction in road gradient reduces L_{Aeq} traffic noise levels by about 1.5 dBA

A3 – Reducing design speeds

On high-speed roads, halving the average speed will lead to a reduction of up to 5÷6 dBA in the traffic L_{Aeq} noise level

Care should be taken to ensure that any potential noise reductions are not negated by increases in acceleration and braking noise

A4 – Traffic management schemes and traffic calming devices

Street closures can be beneficial in diverting traffic from local roads to arterial roads. Heavy vehicle access restrictions are an appropriate mechanism for road noise.

Traffic calming devices such as roundabouts, speed humps, mid-block platforms and chicanes can contribute to a reduction in traffic noise on local roads

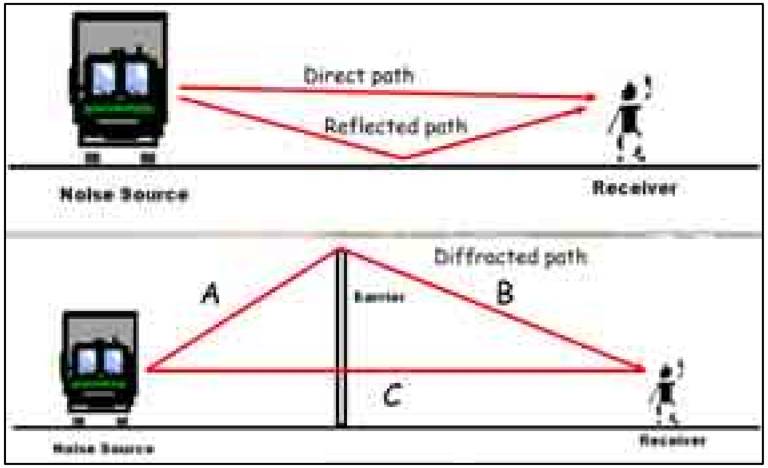
B – Techniques for reducing Traffic Noise during propagation

Barriers and Mounds

✓ Acoustic barriers provide immediate reductions in road traffic noise

✓ Road traffic noise barriers, in the form of "noise walls" or "mounded earthworks", must break the *lines of sight* between road traffic noise sources and the noise receiver, to gain maximum effectiveness

✓ The acoustic effectiveness of a barrier depends on its density, height, length and location



Unmitigated 70 dBA   Mitigated 63 dBA

Insertion loss = 7 dBA

Reduction in sound level	Reduction in acoustic energy	Degree of difficulty to attain
5 dB(A)	70%	Simple
10 dB(A)	90%	Attainable
15 dB(A)	97%	Very difficult
20 dB(A)	99%	Nearly impossible

Table from *Environmental Noise Management Manual* – RTA

- ✓ The higher the barrier (compared to the direct *line-of-sight* from the source to the receiver) and the closer its location to either the source or the receiver, the greater the noise attenuation provided

- ✓ The barrier also needs to have a sufficient length. Roadside barriers usually have to provide shielding along an appreciable length of road to be effective

- ✓ Roadside barriers can be efficient in providing attenuation to groups of residences, but will not be cost-effective for single building. Barriers close to dwelling may reduce the extent of roadside barrier, and is often the most cost–effective solution for isolated receiver

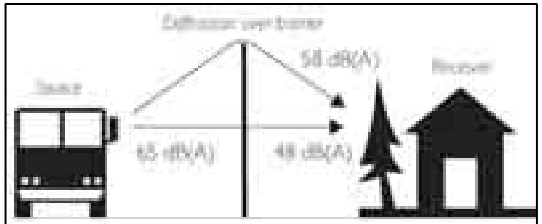


Figure 4.2 A roadside barrier must reduce directly transmitted noise to a level at least 10 dB(A) below that of noise diffracted over the top of the barrier. In this example, the minimum required direct transmission loss is 17 dB(A).

Figure 4.3 A 160° subtended angle at a reception point is generally considered to provide a minimum barrier length. If this barrier attenuated noise by 11 dB(A), an "infinite" barrier (180°) would provide an attenuation of about 16 dB(A).

Images from *Environmental Noise Management Manual* – RTA

✓ The height of barrier can usually be reduced if the road surface is lowered. Opportunities for taking advantage of this should be examined during the earliest stages of planning for new roads

✓ Noise barriers have been constructed using timber, pre-cast concrete panels, lightweight aerated concrete, fiber cement panels, transparent acrylic panels and profiled steel cladding. For significant noise attenuation, a solid barrier is required, while dense vegetation screen planting provides only minor acoustic attenuation, about 1 dB(A) for a 10 m depth

Traffic Noise Model is used to design the features (as *type*, *location*, *height* and *length* of a noise barrier) of the measure for minimizing Traffic Noise Impacts

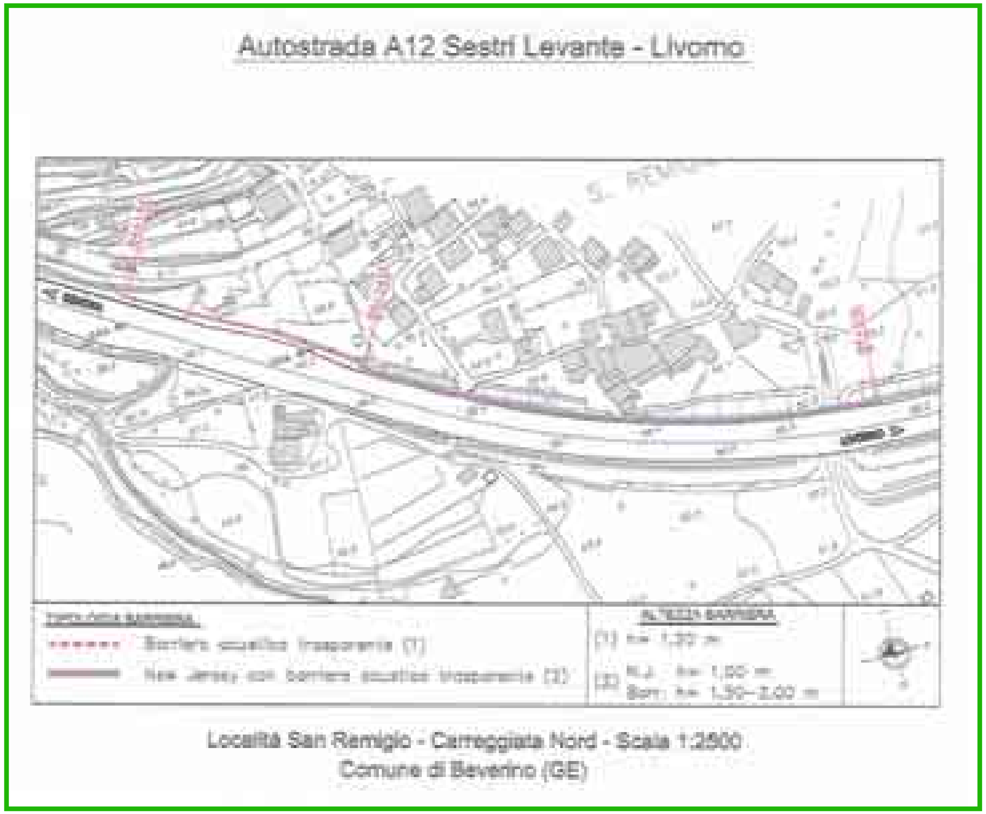


Image from *Piano di contenimento e abbattimento del rumore prodotto dalle infrastrutture in concessione ed esercizio Autostrade Sestri Levante – Livorno* – S.A.L.T

C – Techniques for reducing Traffic Noise at the receiver

C1 – Noise mitigation treatment of existing buildings

Sometimes it is necessary to provide noise control treatments to buildings: *specific treatments of the windows and façades of buildings*

✓ These types of building treatments do not provide any external noise reduction benefit, but the internal noise reductions may be higher than for most external noise barrier solutions

✓ These treatments are expensive as they usually necessitate the provision of alternative ventilation so that the windows can be kept closed during noisier times of the day



Images from *Piano degli interventi di contenimento ed abbattimento del rumore – DM 29/11/2000* – Autostrade per l'Italia

C2 -Relocation of dwellings

If a residence is located on a large block of land, it might be able to be relocated further from the roadway

This approach could be a feasible and beneficial option in rural areas, especially where truck noise at night is a potential issue

D – Techniques for controlling construction noise

- Road construction and maintenance works can generate significant traffic movements, in particular heavy trucks associated with these works can cause adverse impacts
- Construction and maintenance works can also necessitate temporary diversions of through traffic. The potential impacts again need to be assessed and minimized
- The noise and vibration impacts of the construction and maintenance activities can often cause disturbance, especially when maintenance work has to be carried out at night because work during the day would be highly disruptive to traffic flow
- A detailed construction noise may need to be carried out, based on detailed construction work plans

Post-construction noise monitoring
Test of mitigation measures

- Post-construction monitoring is undertaken to determine whether the mitigation measures have been adequate for the predicted design noise levels to be met

- Noise monitoring is carried out once traffic flow have stabilised, in accordance with DM 16 march 1998 "Acoustic pollution measurement methods"

5 – EVALUATION OF A TRAFFIC NOISE MANAGEMENT PLAN

- In accordance with DM 29/11/2000, companies of public transport and management companies of road and railway infrastructures have to present a ***plain*** of containment and abatement of traffic noise to the interested Municipalities, Regions and Ministry of Environment

- A Plain has to describe:

- the infrastructure: type, present and future traffic flow and composition
- the noise interested area by identifying the noise corridor and measuring the existing noise levels
- the noise prediction model used, detailing the model's consideration and the calibration procedure
- the future noise levels, identifying acoustic critical areas and priority indices of the mitigation measures

- the noise mitigation measures, detailing location, realization modality, execution timing and relative costs

*A plan is considered **positively** if it presents in detail as requested - attaching to the descriptions explanatory maps and tables - and if the proposed mitigation measures are reasonable and feasible for the implementation, timing and costs*