1. INTRODUCTION

In Italy, the question of railway traffic noise pollution has been dealt with organically, in terms of legislation, through the issue of detailed standards.

Indeed, as contemplated by art. 11 of Law no. 447 dated 26th October 1995, the “Outline Law on noise pollution”, the decree implementing regulation noise produced by railways was issued on the 18th of November 1998 (DPR no. 459).

As a consequence, the criteria and methodology relative to the scale of works for the mitigation of noise produced by railway infrastructures has undergone a substantial revision.

The purpose of the revision was to check respect of the limits contemplated by the new standards at the same time as producing clear, easily interpretable documentation to provide the local authorities, and thus the citizens concerned, with information on the impact of the new lines planned and to assess the envisaged mitigating works.

2. THE STANDARDS

DPR no.459 defines standards for the prevention and mitigation of noise pollution generated by railway and surface metropolitan system infrastructures (the latter excluding trams and cable-cars).

These standards apply to existing infrastructures, variants of the same, new lines flanking existing ones, and completely new infrastructures.

They establish corridors of railway infrastructure territorial pertinence measured from the centre of the external rail on each side and with the following widths:

- 250 meters for infrastructures with speed rating not exceeding 200 kph. This corridor is divided into two parts, the first, nearest the railway infrastructure, of width 100 meters, denominated zone A, and the second, further away from the line, of width 150 meters, denominated zone B.
- 250 meters for infrastructure with speed ratings greater than 200 kph
For infrastructures with design speeds greater than 200 kph, the absolute limits for railway infrastructure noise emissions are as follows:

- 50dB(A) Leq diurnal, 40dB(A) Leq nocturnal for schools, hospitals, nursing and retirement homes. For schools only the diurnal limit applies
- 65dB(A) Leq diurnal, 55dB(A) Leq nocturnal for other receptors

The observance of the above limits within and outside the corridors, and observance of the values established by DPCM 14/11/1997, is checked by measurements made over the whole reference period (day and night), at the face of the buildings, at 1 meter from the same and at the points of greatest exposure.

In cases where it is technically impossible to achieve the above values, or where technical, economic or environmental appraisals indicate the need to intervene directly on the receptors themselves, observance of the following limits must be ensured:

- 35 dB(A) Leq nocturnal for hospitals, nursing or retirement homes
- 40dB(A) Leq nocturnal for other receptors
- 45 dB(A) Leq diurnal for schools.

### 3. ACOUSTIC DESIGN ACTIVITIES

Italferr is responsible for the design of new railway lines and for the upgrading/functional rationalization of the major railway nodes in Italy; following the enforcement of the Regulations governing the noise generated by railway traffic all new lines must comply with certain maximum noise limits.

Due to the special orographic characteristics of the country and to the widespread anthropization of the country, this is determining the need to put up extensive sections of noise barriers for protecting the receivers living along the track-sides.

The study method adopted in the preparation of acoustic projects, according to the Italian railways, is aimed at achieving the following objectives:

- to isolate the source of railway noise from all the other sources present (motorways, state highways, provincial highways, industry, etc.);
- to undertake a detailed survey within the study corridor of 250 meters per side, and up to 500 meters per side in the presence of schools, hospitals, nursing and retirement homes; in densely built areas, and with receptors positioned adjacent to the railway, the study is limited to within an area delimited by the noise level curve corresponding to the limits established by the standards;
- to identify any potential expansion of buildable areas within the study corridors already earmarked such on Urban Development Plans, or generalised variants to the same;
- to generate numerical models to forecast future levels of rail traffic induced noise, capable of considering the environmental propagation conditions that significantly influence the process of noise diffusion. These models can also be used to forecast future increases or decreases in rail traffic.

The models used are suitably calibrated by on-site sound level readings taken the vicinity of more exposed receptors. In addition, experimental acoustic characterisation in undertaken on the various types of train envisaged for the new lines.
These measurements are made at a horizontal distance from the railway centerline of 25 meters (or 7.5 meters) and at a height of 3.5 meters from track level, in compliance with DM 16.3.98 “Specification for measurements”.

On the basis of the results given by simulations, and having made all the necessary confrontations with the limits set by standards, the scale of mitigation works required is determined indicating the type and characteristic of the same.

The technical characteristics of the infrastructure, the insertion of the line into the environment and the results of noise surveys are just a few of the parameters considered in determining the scale of noise barriers.

The variety of barrier types available on the market, their particular noise insulation or absorption characteristics, aesthetics and technical specifications, not to mention cost in terms of purchase, installation and relative foundation and maintenance complete the designer’s parametric frame of reference.

For all types, and in particular for those in concrete and aluminium, specific architectural designs are drawn up defining from, colour and material alternation both of the panels and supporting structures, aimed at improving environmental insertion of the works in architectural/landscaping terms.

In particular, acoustic barriers require:

- adequate aesthetic/architectonic quality of the barriers system in its entirety according to the environmental quality of site crossed by the infrastructure;
- visible dialogue between the various structural and aesthetic elements, alternating their role according to the overall design and the surrounding environment;
- constructional variants to allow optimal insertion of elements even with differing material and geometry, to offer a range of configuration options;
- prefabricated concrete facing elements with surfaces either smooth and/or structured with the aid of colour and/or geometric variants

this kind of action is aimed at qualify the design of the barriers and thus the infrastructure itself, not the other way round.

Barriers, however, also have a certain visual impact on their surroundings, which cannot be neglected. The problem is especially significant in Italy, because the high-speed railways cross natural areas, and especially towns and cities, of considerable architectural and natural worth.

Therefore, to improve the environmental impact of these railways, Italferr is developing design solutions which, besides complying with the requirements of screening efficiency and cost-effectiveness, also takes account of style, use of suitable materials, surface treatment and colour schemes, to make landscape-friendly railway noise barriers.

Of special importance is the design of the track-side noise barriers for the cities of Rome and Florence, consolidated and delicate made-made environments, where it is necessary
to choose among a limited range of solutions which must be, at one and the same time, uniform yet diversified, according to the peculiar characteristics of the context.

The project is also an opportunity to improve the deteriorated areas in the outskirts of these cities. What must be done in these areas is to either enhance or minimize the impact of the barriers, in consideration of the non-uniformity of the environment crossed by the railways.

In the poster details of the railway noise barriers designed for these cities are shown, describing the methodological and design approach followed.

This is based on a detailed analysis of the landscape and the natural characteristics of the locations, highlighting the architectural characteristics of the track-side buildings, the prevailing colours, the materials used, the urban fabric and the reference visuals.

About the city of Florence, as shown in the picture above, the idea of this project comes out from the image which represents this city in the world: Brunelleschi’s cupola in S. Maria del Fiore, whose characteristics are ribs in sight of its shell-vault.
In noise barrier project the characteristic of this cupola is reproduced by ribs, which have the function of main bearer.

4. CONCLUSIONS

The Italian State Railways and Italferr in particular, are currently engaged in research to raise design standards for the new barriers to be adopted on new railway lines.

At present, between design and construction works in progress, Italferr is currently “dealing with” around one million square kilometers of noise barriers; a considerable number that demands a design approach aimed at improving the environmental quality of railway infrastructures.

5. REFERENCES