Traffic noise in urban and regional roads and impact on the administrative facility P+30 in Prishtina

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ABSTRACT

Many current problems are related to noise, which in many cases may be undesirable factor for the daily activities and work conditions. This is especially evident in urban areas, where is a rapid growth of traffic including the number of vehicles, especially in peak time. Orientations and knowledge bases for the noise will take an important place in this paper, with the right understanding of this phenomenon.

Till now in our country that is not taken into account in road and urban analyses. In this paper we will orient the potential impact of noise in the administrative building in Pristina with P +30 floors, which is very close to the roundabout as a major source of noise. Such an output data, based on present measurements of the number of vehicles, made in a different specified period of time according to standards, and those elements will be interlinked with other geometric and material parameters. All the analyses will show a result of the intensity of the noise in dB. To analyze these parameters, intensity of the noise will be taken as the workload of analyzed building. Also the result of unwanted intensity will be the factor for the designed dimensions and the calculation of the sound barriers in the roundabout, taking into account the incorporation in the environment and the urban planning of that part.

The result will be presented as a 3D animation for this urban part and the impact of noise as an important factor, since we are dealing with a large concentration of administration in this building.

INTRODUCTION

It is important to have some understanding of the nature of sound, because every noise is a type of sound. Noise is usually defined as unwanted sound. Thus it can present with variations in magnitude that may be temporal or spatial in nature or a combination of both. A particular type of noise is known as environmental noise which is noise that is generated by a variety of outdoor sources and then propagates from outdoors to receivers that may be situated either indoors or outdoors. In turn, road traffic noise is one type of environmental noise.

Noise is a serious issue that should be considered in all stages of transportation system projects, from original design and construction to modifications. Transportation-related noise affects millions of people and, in many cases, requires local, state, and federal governments to provide noise abatement to help improve or restore their quality of life.

There are many textbooks available which provide detailed treatments of the nature and physics of sound, but some of the key features of relevance to the present abstract are summarized below.

- Sound is an elastic wave disturbance.
- It occurs in any medium that has the properties of both mass and stiffness.
- The most common medium in which environmental sound (noise) occurs is air, where it travels as pressure fluctuations above and below atmospheric pressure.
- The magnitude of these pressure fluctuations is termed the "Sound Pressure." It is generally measured in micro Pascals (Pa).
- Sound pressures of typical sounds might range from 20 Pa to around 200,000,000 Pa.

In the other hand we will concentrate a little in the designing of noise barriers, which is an exterior structure designed to protect sensitive land uses from noise pollution. Noise barriers are the most effective method of mitigating roadway, railway, and industrial noise sources – other than cessation of the source activity or use of source controls.

At the end we have taken a "case study", in which we have taken an example and made a study of the traffic noise, where source is a very dense Roundabout, impacting an Administrative and Trade Center in Prishtina about 10-15 meters close.

1. SOUND

Sound is a vibratory disturbance created by a moving or vibrating source. Examples of transportation sound sources include steady traffic on a highway, construction equipment used to build a highway or bridge, and a jet flying overhead. Each sound source can be described by its associated spectrum, amplitude, and time history.

The amplitude of a sound indicates its volume; in general, higher amplitudes indicate louder sounds. The amplitude of a sound can be measured as a sound pressure level with a microphone/sound level meter or spectrum analyzer system. Time-averaged sound levels or maximum sound levels are metrics often used to quantify sound, the associated quantities presented in units of decibels (dB). A decibel level is a logarithmic representation of sound energy and is calculated using a medium-dependent (e.g., air or water) reference energy level. Sound reference level changes are presented in the table.

Sound level change	Descriptive change in perception
+20 dB	Four times as loud
+ 10 dB	Twice as loud
+5 dB	Readily perceptible increase
+3 dB	Barely perceptible increase
0 dB	Reference
-3 dB	Barely perceptible reduction
-5 dB	Readily perceptible reduction
-10 dB	Half as loud
-20 dB	One quarter as loud

TABLE 1.1: *Perceptions of Loudness*

1.1 Noise

Certain sounds are considered to be pleasant and therefore found to be acceptable to a listener; some sounds, on the other hand, are unwanted and therefore considered to be noise. Noise is defined in different ways, depending on the listener.

It is straightforward to measure sound pressure levels in order to quantify sound; however, describing noise involves quantifying its perception. To describe sound levels in a manner that closely approximates normal human hearing, the actual sound levels are typically modified by applying **A** *weighting*. This is a response function that spans the audible frequency range, emphasizing frequencies in the most sensitive range and deemphasizing frequencies out of the sensitive range.

1.2. Sound Pressure Level

It has been found convenient to use a logarithmic function to quantify sound and noise. This function is termed the Sound Pressure Level (SPL) and it is defined in the equation below. The SPL is a function of the ratio of the square of the sound pressure of a given sound to the square of a reference sound pressure. In fact, the reference sound pressure is the smallest sound that young, good ears can just hear, i.e., 20 Pa. As also shown above, the unit of the SPL is decibels; abbreviated to dB (A dB is a relative scale, in this case relative to P_0, the reference sound pressure)

$$SPL = 10 \log_{10}\left(\frac{p^2}{P_0^2}\right)$$

where SPL is the sound pressure level (dB re P_0), P is magnitude of pressure fluctuations (Pa) and P_0 is the magnitude of a reference pressure is 20 Pa.

Typical values of Sound Pressures and their accompanying SPLs are given in Table 1.2. It is generally accepted that an increase in SPL of 3 dB is about the smallest change that can be detected by the human auditory system.

Apparent loudness	Sound Pressure (^ Pa)	Sound Pressure Level (dB)	Source
Deafening	200,000,000	140	Jet aircraft
		130	Pain threshold
Very loud	20,000,000	120	Loud horn at 1 m
	2,000,000	100	Noisy factory
	200,000	80	Noisy office
Loud		70	Average street noise
	20,000	60	Average office
Moderate	2200	40	Private office
Faint	200	20	Rustling leaves
		10	Normal breathing
Very faint	20	0	Hearing threshold

TABLE 1.2: *Typical Sound Pressures and Sound Pressure Levels*

1.3. Environmental Noise

Environmental noise sources may include one or more of the following attributes.
Propagation paths can vary widely:

- Along roads
- Over parklands and outdoor spaces
- Over barriers, walls or hills
- Through building elements such as windows.

Some descriptors that have commonly been adopted in many countries include the following.

- L_{eq} - The energy equivalent level of the noise being investigated.
- $L_{10(1h)}$ - The noise level exceeded for 10% of a 1-hour period. This is usually regarded as quantifying the average maximum level of the noise being investigated.

- $L_{90(1h)}$ - The noise level exceeded for 90% of a 1-hour period. This is usually regarded as quantifying the background or ambient noise level and is measured in the absence of the noise being investigated.

2. ROAD TRAFFIC NOISE

As set out above, road traffic is a major source of noise to which the community is exposed.

From a technical perspective, road traffic noise maybe regarded as the aggregation of the noise produced by individual vehicles in the traffic stream. The major factors that influence the generation, propagation, and reception of traffic noise are listed in Table 1.3 below.

Technical Aspect of Traffic Noise	*Major Influencing Factors*
Generation	Traffic volume
	Traffic speed
	Traffic composition
	Traffic operating conditions (free or interrupted flow)
	Road type
	Road surface
Propagation	Ground cover
	Source-receiver distance
	Screening
	Weather and atmospheric conditions
Reception	Receiver location (in or outside)
	Ambient noise conditions

TABLE 1.3: *Major Factors Associated With Road Traffic Noise*

2.1. Pavement Effects on Road Traffic Noise

Road type is another important factor in the generation of traffic noise, especially given the significance of tire/road interaction amongst the sources of vehicle noise, as described previously. It is clear that there is a considerable range of noise levels produced by these pavements. Both this range and the relative performance of the pavement types included are comparable and similar to those determined internationally. The pavement types included in Table 1.4 are common and are briefly described below.

Pavement Type	Average Variation in Traffic Noise (dB(A))
14 mm Chip seal	+ 4
Portland cement concrete with lateral tynes and dragged surface finish	+ 2.5
Cold overlay slurry seal	+ 2
Dense graded asphaltic concrete	0
Stone mastic asphaltic concrete	- 2
Portland cement concrete with exposed aggregate surface	3
Open graded asphaltic concrete	- 4

TABLE 1.4 *Average Variations in Pavement Noise*

2.2. Calculation of Road Traffic Noise

There are many traffic noise prediction models and associated computer software packages available around the world. Most of the models perform to a generally similar degree of accuracy. One popular and widely known model is known as CoRTN — the Calculation of Road Traffic Noise. The CoRTN model is relatively simple in construct, is well tried and tested and is rather typical of many traffic noise prediction models available around the world.

According to this method it is assumed that:

$$L_{eq} = 0.92 L_{10} + \text{Constant}$$

Or

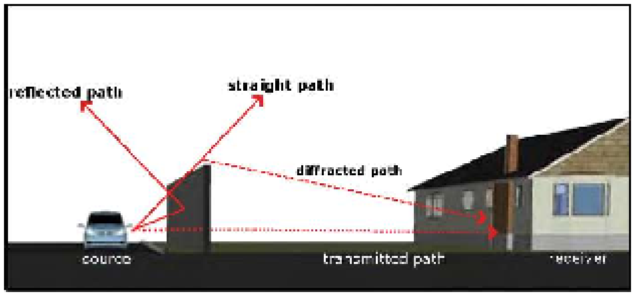
$$L_{Aeq,1hr} = 0.94 L_{A10,1hr} - 0.77\text{dB}$$

3. NOISE BARRIERS

Noise barriers need to be considered in the context of providing effective noise relief, while also addressing issues of appearance, urban design, site constraints, maintenance (including whole-of-life costs), safety, graffiti, cost (value- for-money) and sustainability.

3.1. Location

In principle a noise barrier is most effective located as close to the road as possible (Figure 1.1). However, for a road located in a cutting it is better to place the barrier at the top of the cutting, where it will have a greater effect.



3.2. Height

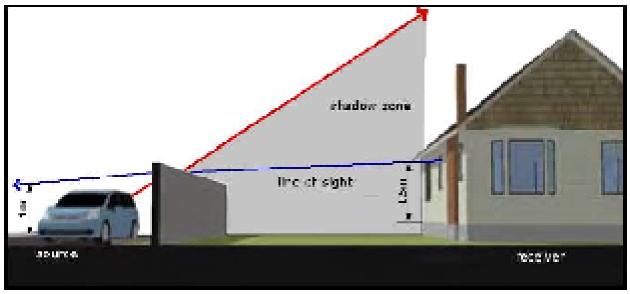


Figure 1.2: *Line-of-sight and the noise barrier shadow*

The height of a noise barrier is also a key parameter. Generally the higher the barrier, the greater is the level of noise reduction. As a general rule, a noise barrier should at least be high enough to block the line-of-sight from a house to the engines of vehicles on a road. This line should be assessed from a point 1.5 meters above the floor of an adjacent house to the furthest point 1 meter above the road surface.

When a noise barrier just breaks the line-of-sight between the noise source and the receiver there is approximately 5 dB attenuation of noise.

For multiple-lane roads, the noise from the furthest traffic lanes will not be reduced by a noise barrier as much as noise from the nearest lanes because of the different path angles, unless the road is on a bridge or embankment above houses.

3.3.Reflections

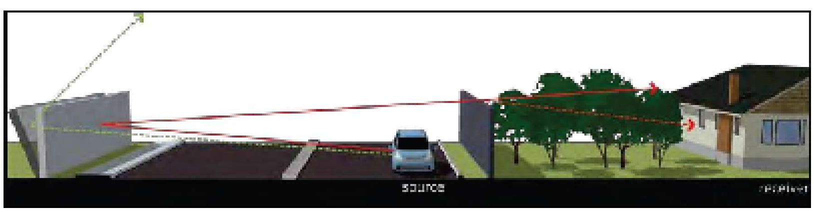


Figure 1.3: *Tilted noise barriers can direct noise away from the receiver*

Multiple reflections between parallel noise barriers, or between barriers and high sided vehicles, can reduce the benefit of a barrier.

It is possible to reduce the acoustic reflectivity of a noise barrier by using an absorptive material (e.g. mineral wool or fiber glass) with an appropriate facing. Alternative absorptive materials include "hard" surfaces that are porous or have resonant cavities. A rule-of-thumb is that sloping a noise barrier outwards by as little as 7° reduces the impacts of reflections. Another approach could be to maintain a vertical barrier but use a relief pattern with angled component geometry to achieve an upwardly dispersed reflection.

3.4.Top shape

Modifying the shape of the top edge of a noise barrier can increase the performance of the barrier without increasing the height and associated visual impacts. Shapes include T-tops, Y-tops, pear-shaped tops, cantilevered walls and others. Given the same total height of wall, these can improve barrier attenuation by 1 to 10 dB. Figure 1.4 shows some different barrier tops.

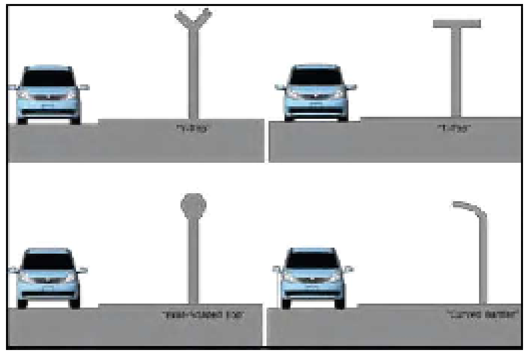


Figure 1.4: *Different top shapes*

3.5.Length

Diffraction of sound occurs not only at the top edge of a barrier but also around the ends. As such, the length of a noise barrier is important.

A rule-of-thumb to determine the required length of a noise barrier is that it must cover a horizontal angle of 160 degrees viewed from the receiver (Figure 1.5)

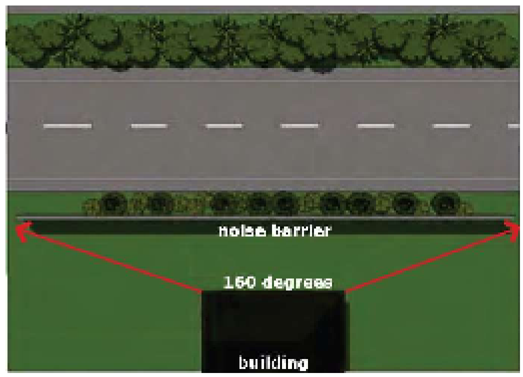


Figure 1.5 *Noise barrier length*

4.MATERIAL SELECTION

The intention of this section is to provide a summary of general design advantages and disadvantages for transparent panels that may be used in noise barriers, because we have taken these panels to be a part of our study.

4.1Transparent panels

Type of Barrier	Advantages	Disadvantages
Polycarbonate	Cost (initial and whole-of-life) Virtually unbreakable uV resistant Self-extinguishes when in contact with fire	Prone to discolorations & yellowing Can be scratched Use of anti-etching films problematic Combustible (emits toxic gases such as carbon monoxide but is self-extinguishing) Permanent proprietary anti-graffiti coatings are expensive (manufacturers' warranties may be affected by use of non-proprietary anti-graffiti coatings) Less established than other transparent materials

Acrylic	Impact resistance - comes with option of filament reinforcement. Scratches can be polished out. May be possible to flame polish. uV resistant Well established internationally for road- traffic noise barriers	Easy to scratch Use of anti-etching films problematic Combustible (burns to completion unless Extinguished) Permanent proprietary anti-graffiti coatings are expensive (manufacturers' warranties may be affected by use of nonproprietary anti-graffiti coatings)
Glass	Harder to scratch than polycarbonate or acrylic Scratches can be polished out Not combustible More compatible with use of anti-etching film Established material for road-traffic noise barriers UV resistant	Relatively easy to smash/shatter Expensive Manufacturers' warranties may be affected by use of nonproprietary anti-graffiti coatings Fire may cause glass to shatter

5.CASE STUDY

ROUNDABOUT NEAR WORLD TRADE CENTER – PRISTINA

As set out above, in this paper is stated and taken into account a critical point and a source of noise in the center of Pristina. It is the main roundabout that interlinks four main roads. In the side of it is being built a huge office and administrative building. The distance between the roundabout and the building is around 10-15 m. Because the distance is too short, and the noise is too high, it was necessary to make an assessment and to calculate the noise pressure in the building.

At the first time, according to studies made before, we have taken some site measurements. Because it is a new thing, and its just an abstract, the device we used to take the measurements was a simple microphone, recording the sound at 48000 samples/sec, and using Android App – Noise Metter for saving the logs. After that, the log was put into an Excel worksheet, and from there built the noise graph with two different values (normal and peak value).
The measurements are taken in the peak hour, when the traffic volume is around 6800 vehicles/hour, and the noise was recorded every two seconds. See the graph below.

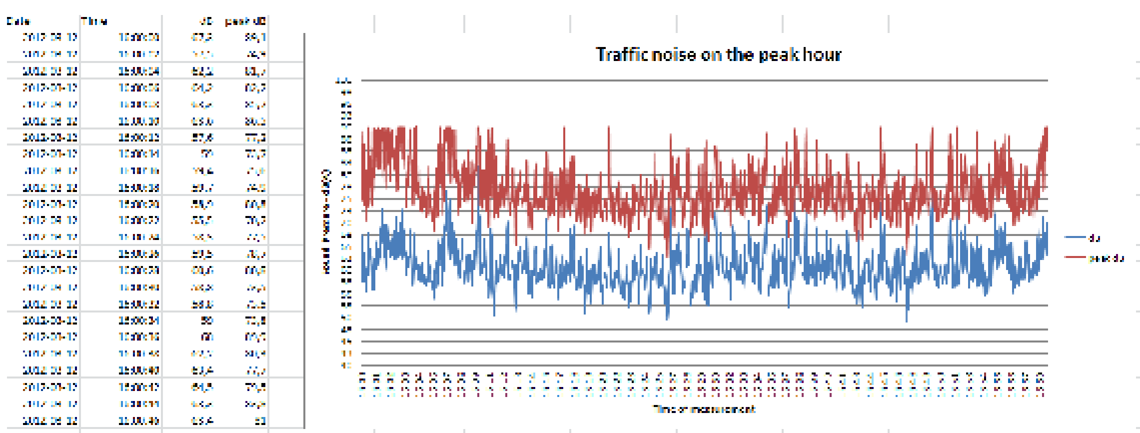
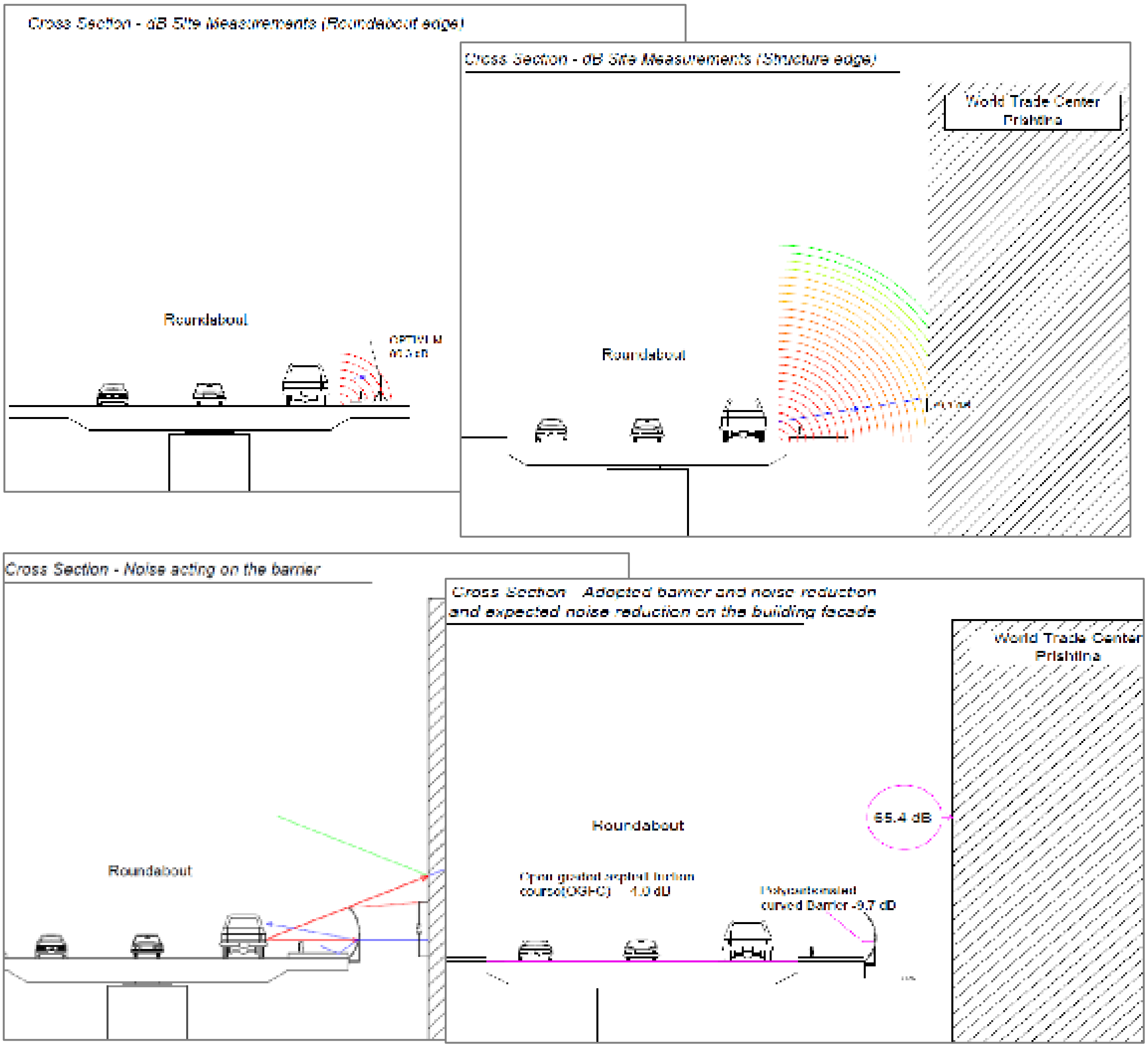


Figure 1.6: *Log and Chart of the Traffic Noise Measurement in the roundabout*

Furthermore, the L_{eq} is calculated using the same equations mentioned above, and at the end, the barrier is designed. The transparent polycarbonate barrier is selected. Below are shown the details of measurement, noise waves acting on building and reduced noise with barrier.



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