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NOISE EVALUATION IN A RACE-TRACK: MEASUREMENTS, SOFTWARE ANALYSES AND NEED OF CONTINUOUS MONITORING. COMPARISON AMONG THE RESULTS.

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Abstract

Noise pollution caused by the activities in a race-track can affect wide spaces. First steps towards a reduction of noise levels are afforded by the international sport organisations that admit only silenced super-bikes in the competitions and that have put further reduced noise emissions requirements starting from the end of 2007.
An experimental analysis on a racing track approved for international racings was performed with the circulation of various kinds of racers. After the calibration by means of measured data, the software model simulations of various race conditions were analysed.
The results were compared with the experimental monitoring performed by a recently developed system that permits to register and to send directly all the results to a remote server in real time. The analysis has highlighted on one side some situations of exceeding noise that can be detected only by a continuous monitoring, on the other side the conditions in which the track can be used without overcoming limiting values.
The noise maps taken by the software simulations have highlighted suffering conditions in some critical points around the track.
The noise propagation investigation represents the basis of the noise pollution reduction studies performed to reach the best conditions in the surroundings of the race-track. Acoustic barrier attenuation, ground and vegetation absorption, better track configuration (bend, straights, etc) can be considered in the software simulations and analyses to compare the efficacy of the noise reduction measures.

1. INTRODUCTION

Sport attractions and races in a race-track cause high noise pollution in the surroundings. Race tracks are widely distributed in the countries and differentiate one another for the kind of route and of motorbikes (motard or supermoto, grand-prix, etc) that can circulate.

Supermoto (also called Supermotard due to its strong foothold in France) is a cross-over of motocross and road racing. Races are commonly held on road racing tracks between 800 and 1700 metres' length with an off-road section in the infield; approximately 70% tarmac (bitumen) and 30% dirt. The dirt section may also have small jumps in it but it's basically a smooth surface.

The machines used are the 'off road' dirt bikes or motocross bikes that usually have 'road bike' type wheels. Unlike normal motorcycle racing, the emphasis lies on slower (160 km/h), short and twisty tracks, with heavy braking at tight corners where skill matters far more than outright machine performance.

This kind of sport is widely diffused in Italy, where a large number of race-tracks are utilised during the week for training sessions and in the week-end for competitions. They are usually located in the middle of the countryside and they can distribute the motorbike noise in wide spaces.

The emissions from a motorbike are strongly variable depending on accelerations and decelerations following the shape of the path. They produce intermittent noise in the environs that can be even more irritating than a continuous one.

First steps toward the reduction of noise levels are afforded by the international sport organisation (FIT) that admits only silenced super-bikes in the competitions and that has put further reduced noise emissions requirements starting from the end of 2007.

In some cases motorbikes must use a dB killer that is an insert which can be mounted into the muffler to reduce the sound level (3 dB approximately, depending on motorcycle model).

To estimate other noise reduction strategies, accurate investigations are needed based on monitoring and sound propagation evaluations. Each monitoring technique presents some strong points and weaknesses: a comparison among different noise evaluation systems applied to a case-study is presented in the following.

2. THE RACE-TRACK

An experimental analysis on a race-track approved for international racings was performed.

The aim was to characterise the emissions and the noise propagation outside and to quantify the possibilities to determine the annoyance in the surroundings of the circuit. The measurements have been performed in a race-track used by supermotos.

The circuit is located in a country area and it is characterised by a sequence of narrow bends and limited straights as shown in Figure 1a,b.

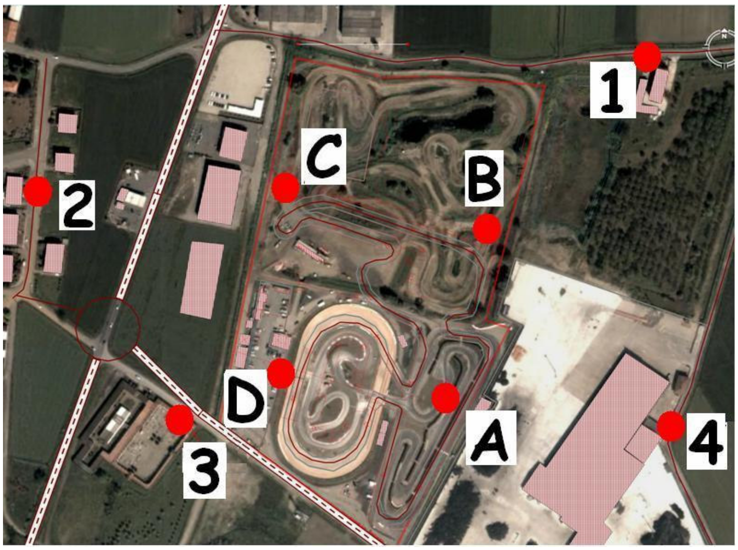
3. SOUND LEVEL MEASUREMENTS

In this first step analysis a SOLO 01dB sound level meter was used. This digital integrating sound level meter, that complies with the latest international standard (IEC 61672-1), allows 1/1 and 1/3 octave real-time frequency analyses, audio files storing on a SD memory card, communications by Bluetooth transmission and data streaming by using a special GPRS router.

Different kinds of measurements were developed. At first, two measurements session, in a midweek day and in a race day, were performed: noise levels of many running bikes were registered in fixed points (close to a straight and to a bend). In Figure 1a the measurement points are indicated as A (straight) and B (bend).

Other measurements were taken outside the circuit to quantify the noise pollution in the surroundings, at least in a few critical points.

The results depend obviously on the number of motorbikes running in the circuit; moreover measurements cannot be made at the same time inside and outside the circuit. In fact, to describe accurately the situation, a large number of microphones, and subsequently of sound level meters, should be positioned inside and outside the track to register contemporarily the emissions and the noise propagation.



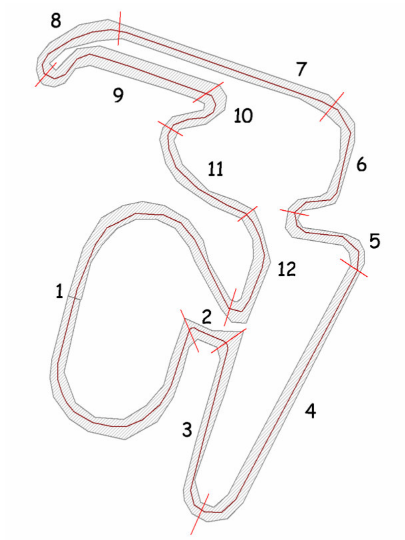


Figure 1 – Race-track layout and measurement points (a) (from GoogleEarth), detail of the course (b)

To better understand the variability of the bike emissions in the various parts of the track, noise production of two motorbikes (Honda CRF 450, Suzuki 450) was registered, fixing the sound level meter on the bikes.

The results allow describing the noise emissions in all the parts of the circuit, depending on increasing and reducing speed to follow the shape of the path.

In Figure 2 the noise emissions registered in a complete loop are represented as function of time: the corresponding parts of the track in which the bike is running are numbered from 1 to 12. In Figure 1b the corresponding zones of the track are pointed out.

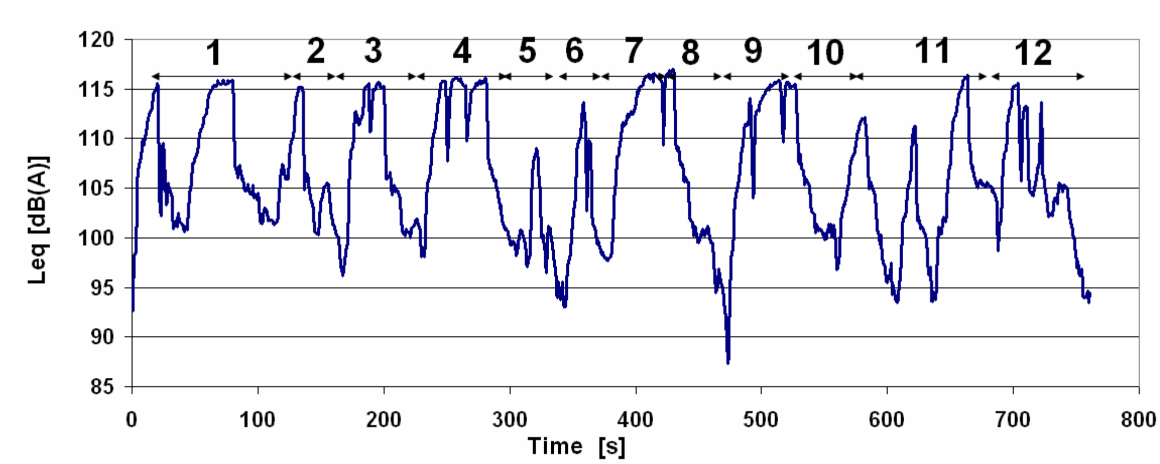


Figure 2 - Noise emissions registered in a complete loop (Suzuki 450)

In Figure 3 the performances of the two motorbikes running in front of the point A (equivalent level on the basis of 1 second time) and the average equivalent levels in midweek and in a race day (registered in a period of 10 minutes) are compared.

While the mean noise levels are lower and quite well distributed in frequency, higher levels are registered on the noise source while running near the same point.

The noise variations that can be heard in the surroundings may produce more annoyance than a continuous noise. This fact should be considered in the judgment on the noise pollution produced in the land, as the receiving points are often considered not only the buildings located in the surroundings but also all people that may stand in the same environment not continuously.

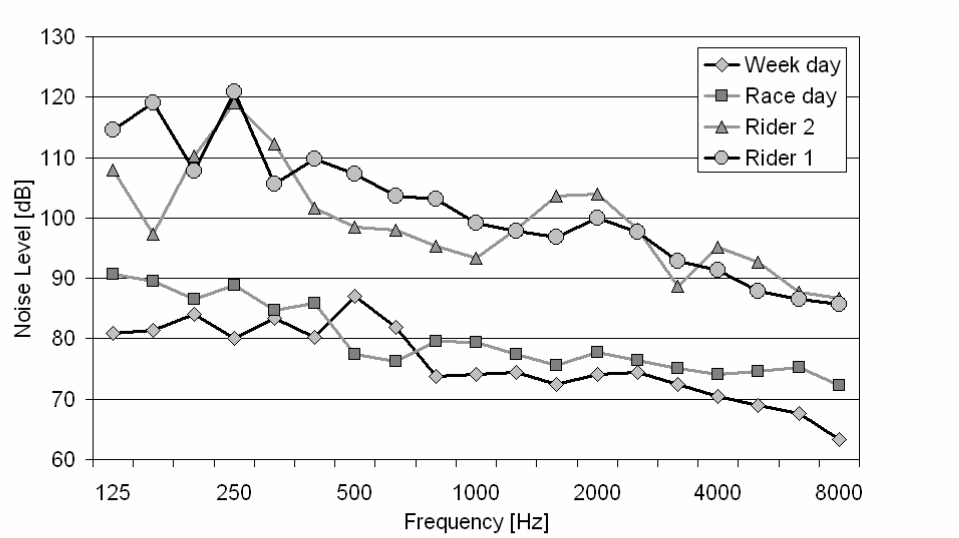


Figure 3 – Comparison among noise emissions in different conditions (point A)

4. SOFTWARE EVALUATIONS

CadnaA software was used for the noise mapping of the area. This noise evaluation program can calculate and predict noise pollution in the neighbourhood according to national and international standards and regulations.

After the calibration by means of measured data, the software model simulations of various race conditions were analysed. Starting from noise emission spectrum of many sources passing through the points A and B and the measured noise levels in the points outside the track, the noise spreading in the area was calculated and represented in a coloured map to easily identify the most critical zones.

In Figure 4 the midweek activity is considered to evaluate the noise pollution that can be compared with the national regulations limits.

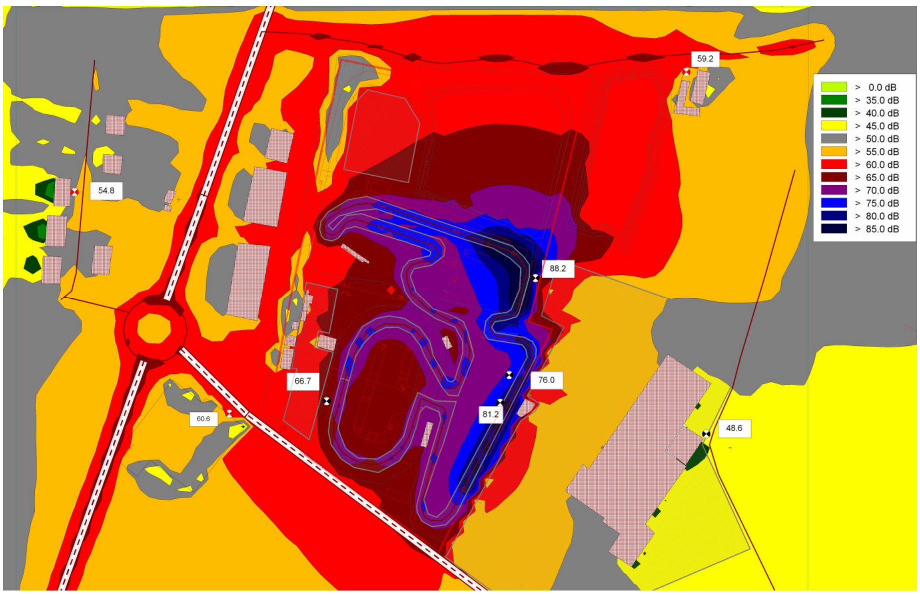


Figure 4 – CadnaA noise mapping

This methodology of investigation supports the most appropriate design of the noise reduction actions. For example, noise barrier design should be evaluated (height, positioning, absorption values) in terms of noise levels reduction in the whole area.

However, with all these measurement and evaluation instruments, the complete control of the noise levels is not guaranteed, as it is extremely variable during the day and from day to day, strongly depending on the number of sources and their characteristics.

5. REAL TIME NOISE MONITORING

To describe in a more complete way the noise pollution in time, a real time noise monitoring is required. In this way any exceeding of the limits can be detected and also visualised in real time. The experimental monitoring was carried out by means of a recently developed system that allows publishing all the results in real time on a public or protected web page.

The system consists in two parts: the noise monitoring station, for noise data acquisition, by means of a 01dB 'SOLO' sound level meter equipped with outdoor microphone, and a central unit for data storage and visualisation, that communicates with the first part by GPRS systems.

Figure 5 – Monitoring unit

In the monitoring unit (Figure 5), a power supply system takes place together with a purposely developed router, which provides the setting up of the sound level meter, the collection of continuous data coming from 'SOLO' to send them to the central unit over the selected transmission channel.

The router takes care also of some data transmission optimizations (i.e. data compression, data flow management, etc) and prevents noise data lack due to some GPRS faults which may occur on the network. The system can operate for 7 days without any cable connection. It can collect a big amount of detailed data, which can be automatically sent to the remote server, as continuous 1 second short L_{eq} 1/3 octave spectra and the overall dBA values.

Moreover, by interfacing this system with CadnaA noise prediction software, that can re-scale and re-combine partially precalculated noise maps, it is possible to visualise, at specific time intervals, the updated global noise map of the monitored area, according to the measured noise values.

The race-track noise analysis has given the results in Figure 6. The monitoring units were placed in points C (close to the external wall) and D (close to the route) indicated in Figure 1a. In the midweek days a constant machinery noise operates over 24 hours. In the weekend a constant noise level of 50 dB is registered in absence of race activities (on the route it is even lower). In the track opening hours (9.30 – 18.30) except for mid-day interruption, the noise levels registered in the midweek are lightly lower than in the competitions.

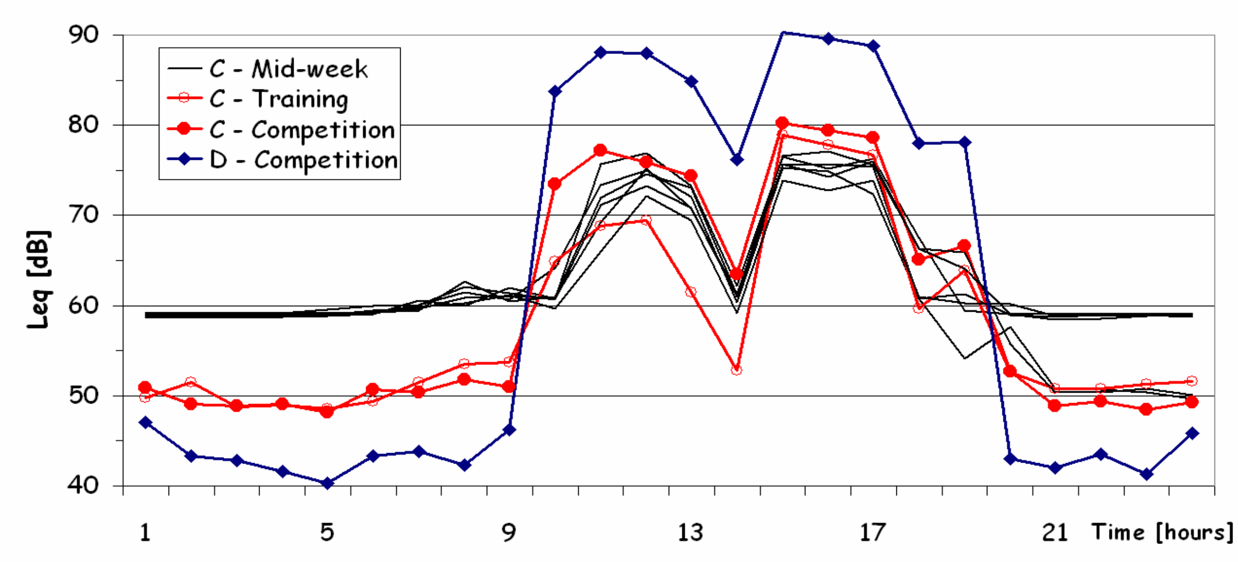


Figure 6 – City Noise monitoring results

6. DISCUSSION AND CONCLUSIONS

Local noise monitoring is useful for preliminary evaluations and controls, while deeper investigations are indispensable for more accurate knowledge of the noise propagation and a suitable design of its reduction.

The analysis has highlighted that some situations of exceeding noise that can be detected only by a continuous monitoring. From these results the conditions in which the track can be used without overcoming limiting values can be identified. The noise maps taken by the software simulations have highlighted suffering situations in some critical points around the track, based on fixed operating conditions.

A useful monitoring procedure could be represented by the connection between the continuous monitoring system and the simulation software that could allow real time visualisation of the noise propagation in the surroundings.

The monitoring system (detailed long term measurements without any needs of human operation) enables to improve the global efficiency of all the noise pollution investigation activities. Moreover, the collection of detailed data allows the identification of various noise sources (as bells, airplanes, traffic, and fortuitous events) that could affect long period measurements.

The web display of acoustic maps (frequently updated) can offer a powerful tool to the control authorities for the protection of the people living in the surroundings. Any noise annoyance situation can be immediately compared with the limits indicated by the Italian Government Decree n. 194/2005 implementing the directive 2002/49/EC.

On another side, the race-track manager can take appropriate actions, when reached by the alarm sent by City Noise. This system indeed can manage alarms in real time and can texting to cellular phone or send a signal to a remote PC before the overcoming of the limits that must be respected in motor racing circuits.

REFERENCES

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