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URBAN TRANSPORT AND NOISE IMPACT: A PREVENTIVE APPLIED RESEARCH TO CONTROL NOISE IMPACT OF NEW ROAD TO BE BUILD IN CATANIA PROVINCE.

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Abstract

Building a new road means for the country a socioeconomic growth indeed but, in the other hand, could produce negative impact on environment crossed because of noise emissions coming from motor vehicles running.
On this ground an applied research has been carried out both to forecast and to control future acoustic negative effects that could be originate by provincial road "S.P. Misterbianco-Nicolosi" already in last stage of plane. Research has been carried out not only to evaluate any eventual disturbs on the people living in the borders of road but as well as to verify the respect for current Italian regulations about noise pollution. Campaigns of measurement of Leq(A) "*ante operam*" have been done to validate the calculation codes utilized for such an outdoor environment full of anthropic and natural obstacles to noise diffusion. Therefore paper wants to show:

- results of campaigns of acoustical measurements;
- techniques and models of sound diffusion used for forecasting of noise "*post operam*";
- comparison of results of forecast with that ones Leq(A) limits of reference to Italian noise regulations;
- protections works designed to mitigate Leq(A) one higher than that permitted by regulations.

1. PHASES OF RESEARCH

- Identifying the acoustic bands for the project and for the sensitive receivers (D.P.R no. 142 of 30/03/2004);
- Choosing of sites densely populated adjacent to the carriageway (3-dimensional geometric layouts of sites has been constructed);
- Current time traffic flow analyses on existing site roads;
- Measurements of acoustic climate through in situ survey;
- Forecasting of actual environmental conditions by prediction software (MITHRA CSTB, Grenoble);

- Calibration and validation of models by comparing field measurements with that ones forecasted by code;
- Isoconcentration mapping of critical zones.

The data coming from results enable:

- Acoustic characterization of the site;
- Evaluation of the possible inconveniences to the local population;
- Respect for current regulations;
- Predisposition of necessary work for impact mitigation.

2. BASIC KNOWLEDGES

There are main factors concurrent to define noise levels coming from road and in this way people takes in consideration:

- volume of motor vehicle traffic on the road;
- average of velocity of running of vehicles;
- composition of vehicles (motorcycle, light and heavy vehicles);
- kind of road paving.

There are still many parameters characterizing topographical neighbourhood of road that influence propagation of sound generated by vehicles traffic, they have been taken in consideration:

- screenings produced both by natural and anthropic obstacles;
- acoustical absorption of ground on and around road;
- acoustical absorption of atmosphere;
- termoigrometric condition of air;
- intensity and direction of wind;
- divergence phenomenon.

To control noise emissions by suitable protections, people takes in account the limits of value of Leq(A) fixed by current Italian regulations (L.Q. n°447 of October 26 1995 and D.P.R. March 30 2001 n°142). In function of these limits shown in table 1 (Acoustical zonization) people designed too works to reduce noise impact.

Table 1. Acoustical zonization

Zonization	Day Limit	Night Limit
	Leq (A)	Leq (A)
Whole national territory	70	60
A Zone (D.M. n.1444/68)	65	55
B Zone (D.M. n.1444/68)	60	50
Only industrial activities	70	70
Day time: from 6:00 to 22:00 – Night time: from 22:00 to 6:00		

3. STUDY CASE

The research has been carried out on plan of provincial road called “Nord-Sud” linking Misterbianco town with Nicolosi town and crossing also S.Pietro Clarenza and Belpasso towns.

Figure 1 shows a removal of aerial survey of crossed territory.

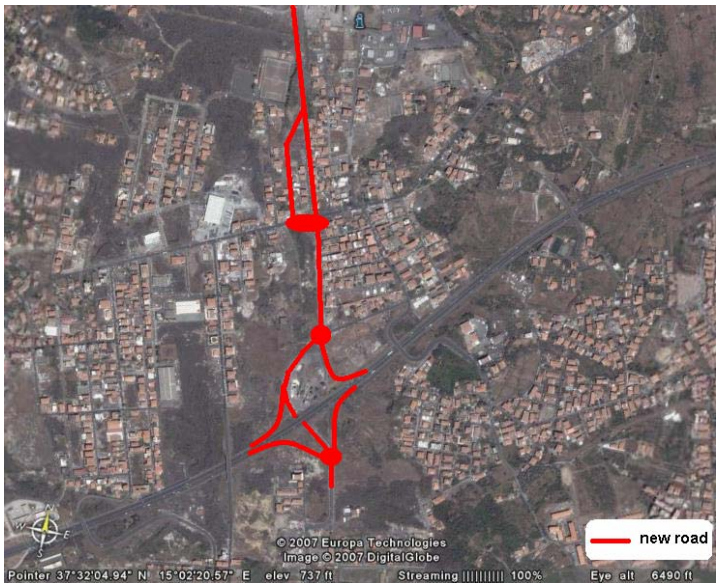

Figure 1. Aerial survey of crossed territory

Figure 2 shows the strip of acoustical competence to be considered for Italian regulations, that is:

- "*strip of acoustical relevance*" at the borders of road wide 2,50 m from each side of carriage way;
- "*acoustical corridors*" wide 5,00 m.

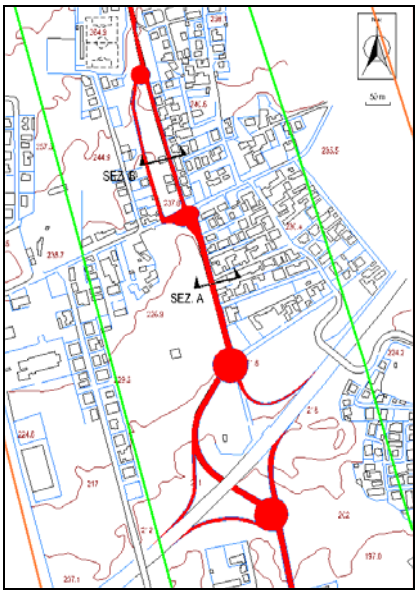

Figure 2. *Strip of acoustical relevance* (——) and *Acoustical corridors* (——)

The new road will be build in many places with extension works of already existing little local roads, in other places building ex-novo the whole big carriage way. In this case Italian regulation (D.P.C.M. march 1 1991) requires more restrictive limits than that shows in table 1, that is 60 dB(A) in day time and 50 dB(A) in night time. Indoor the zone of "*strip of*

acoustical relevance" only two sensible receptors of "first class" have been releved, that is "*Penitentiary Police School*" and "*Elio Vittorini School*", both near S. Pietro Clarenza town. These sensible receptors are related to nn.7 and 9 stations of measurements.

4. EXPERIMENTAL SURVEY

The whole planned route of road has been subdivided in fifteen homogeneous areas with reference to:

- characteristic plano-volumetric both of actual existing routes and that ones of planned route;
- density of buildings around the route of road;
- kind of use of building in the inhabited areas crossed by new road;
- density of inhabitants of buildings.

For each one of previous areas, have been positioned one station of measurement, as showed in table 2 and in accord with following criteria:

- level with sensible receptors in position extimed more subject at noise impact in function of previous experience of authors about matter;
- level with receptors of urban conglomeration in that buildings where could take more significant noise impacts in function both of their position as regard noise sources and geometrical characteristics of buildings;
- level with receptors with single construction subject to significant noise impact.

Table 2. Posts of measurement

POST N°	GEOGRAFIC POSITION
1	NICOLOSI_*Mompilieri*
2	NICOLOSI_*Via Gino Cervi*
3	BELPASSO_*Frumenti*
4	BELPASSO_*Villaggio Le Ginestre*
5	S.PIETRO CLARENZA_*Campo Sportivo*
6	S.PIETRO CLARENZA_*S.P. N3/III*
7	S.PIETRO CLARENZA_*Scuola di Polizia Penitenziaria*
8	S.PIETRO CLARENZA_*Via Siracusa*
9	S.PIETRO CLARENZA_*Istituto Elio Vittorini*
10	MISTERBIANCO_*Via Siracusa ang. Via F. Coppi*
11	MISTERBIANCO_*Via Fausto Coppi*
12	MISTERBIANCO_*Campo Sportivo "T. La Piana"*
13	MISTERBIANCO_*S.P. N12/I*
14	MISTERBIANCO_*Via Amenamo*
15	MISTERBIANCO_*Svincolo Lineri*

For each post of measurement have been done measures in three different days of week: two in working days and one in holiday during the day time intervals shown in table 3.

Table 3. Time intervals of measurements

TO	6.00 - 10.00	12.00 - 15.00	18.00 - 21.00	22.00 - 6.00

For each interval of observation have been done measurements with time of measure (TM) length ten minutes. In addition to surveying of Leq(A) during night time and day time for each one of post of measurements people surveyed data too of traffic flow travelling during the intervals of measure. For each station of measurement people drawn up a measure report as shown in figure 3. The results of whole surveying are shown in table 4.

MEASURE REPORT							
STATION N°	DATE	Tr	To	METEOROLOGY CONDITION TEMPERATURE [°C]	WIND SPEED [m/s]	RELATIVE HUMIDITY [%]	Leq [dB(A)]
(9) San Pietro Clarenza "ELIO VITTORINI SCHOOL"	02/03/2006	24 h	06:00 - 10:00	12	2	55	49,4
			12:00 - 15:00	14	2	47	47,7
			18:00 - 21:00	10	2,5	57	49,2
			22:00 - 06:00	10,5	0,5	65	43,4
	03/03/2006	24 h	06:00 - 10:00	15	1	47	47,6
			12:00 - 15:00	17	0,5	38	47,5
			18:00 - 21:00	11	1	60	46,7
			22:00 - 06:00	10,5	0,5	81,5	43,3
	05/03/2006	24 h	06:00 - 10:00	16	2	50	46,5
			12:00 - 15:00	19	2,5	51	50,6
			18:00 - 21:00	14,5	1	48	48,7
			22:00 - 06:00	14	0,5	56	42,8
Leq (Day) = 46,8 dB(A)				*Leq (Night) = 43,2 dB(A)*			
CHAIN OF EQUIPMENTS							
- Real Team Analyser Norsonic AS118 (Certificate of Calibration n°01180113) - Classe I							
- Microfono Norsonic Type 1225 - Sensitivity 54,1 mV/Pa - Classe I							
- Pistonofono 01dB cal ϕ 01 - Classe I							
MICROPHONE HEIGHT: 1,50 m							

Figure 3. Measure report in post. n°9

Table 4. Comparison between measured Leq(A) and law limit (D.P.C.M. March 1 1991)

POST N°	MEASURED Leq [dB(A)]		LIMIT OF Leq [dB(A)]		Δ = (2) - (1)	
	Day	Night	Day	Night	Day	Night
1	58,5	47,6	60	50	1,5	2,4
2	59,9	49,9	60	50	0,1	0,1
3	46	*	60	50	14	
4	44,7	42,5	60	50	15,3	7,5
5	56	*	60	50	4	
6	66,5	56,8	60	50	-6,5	-6,8
7	53,7	43,3	60	50	6,3	6,7
8	58,8	*	60	50	1,2	
9	48,9	43,2	60	50	11,1	6,8
10	61,4	*	60	50	-1,4	
11	56,5	*	60	50	3,5	
12	54,2	*	60	50	5,8	
13	69	62,1	60	50	-9	-12,1
14	62,2	57,7	60	50	-2,2	-7,7
15	64,4	63	60	50	-4,4	-13

* only day-measure

The results of measurement of actual acoustical climate pointed out already the Leq(A) exceeding that ones allowed by regulations. Exceeding Leq(A) have been founded in stations n°6 (S.P. n°3/III), n°13 (S.P. n°12/I) and nn°14-15 (west bypass of Catania city).

5. FORECASTING OF ACOUSTICAL CLIMATE BOTH "*ante operam*" AND "*post operam*"

The steps to achieve the forecasting have been these following:

- Surveying of traffic flows, both in day time (6:00÷22:00) and night time (22:00÷6:00), that at actual state of present roads run between west bypass of Catania (starting point of new roads) and Nicolosi town (end point of new road). During the surveying people characterized:
  - volume of traffic (number of vehicles in transit);
  - composition of vehicle flow (heavy transports, cars and motorcycles);
  - mean velocity of vehicles flow.

  By this data and by algorithm coming from technical literature about matter, it has been possible to built an "equivalent traffic flow" (ETF).
- Meteoclimatic data acquisition of interested zones, in accord with that ones registered by meteorological steady stations of ENEA and Regional Assessorship of Agriculture and Forest. These data, correlated with that ones measured in situ, allowed to define for the investigated areas following parameters:
  - yearly windiness (main directions and main intensities of wind);

- temperatures (monthly average, minima and maxima of temperature values);
- relative humidity (monthly, minima and maxima values).

▪ Acquisition of natural and anthropic plani-volumetry around the route of areas interested by new road, determining:

- ground orography by curves of ground isolevel;
- geometry of buildings and other anthropic obstacles to noise diffusion by in situ surveying;
- acoustical features of surfaces as like as grounds and building façades;
- acquisition of features of designed road: slope of gradients, profiles of project and acoustical characteristics of wearing surface.

On the basis of previous acquired data, people utilized the already tested 3D code MITHRA, in accord too with instruction of ISO 9613 NORMS to take care of meteorological effects on noise too. In short way, this 3D model MITHRA CODE utilizes a "speedy algorithm" based on technique of "inverse ray tracing" taking in account effects of diffraction, ground absorption and anthropic obstacle interposed between sound source and sound receiver.

In the case of "post operam", on the ground of informations received by road planners, that is the geometrical features of road and its classification as secondary extraurban road of C_1 category, it has been possible to define the maximum hourly flow of equivalent vehicles assignable to the road (600 v_{eq}/h) and to hypothesize the following volumes of traffic:

▪ for the area of Misterbianco-Lineri: day time 600 v_{eq}/h – night time 360 v_{eq}/h;

▪ for the rest of areas of whole road: day time 420 v_{eq}/h – night time 216 v_{eq}/h.

Appling previous data, techniques and model, people has been able to obtain isoacoustic maps at altitude of 1,5 m and acoustic section. For room reason, only few exempla are shown in figures from 5 to 8. More, people compared the difference of acoustical climate between "*ante operam*" and "*post operam*", as shown as exemplum in figure 9.

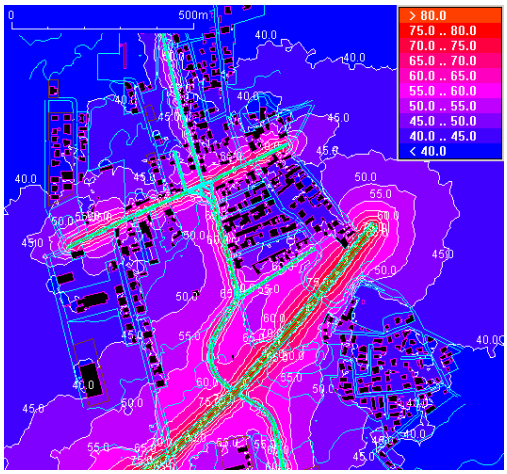

Figure 5. *Ante operam* day-time acoustic map of Misterbianco-Lineri area.

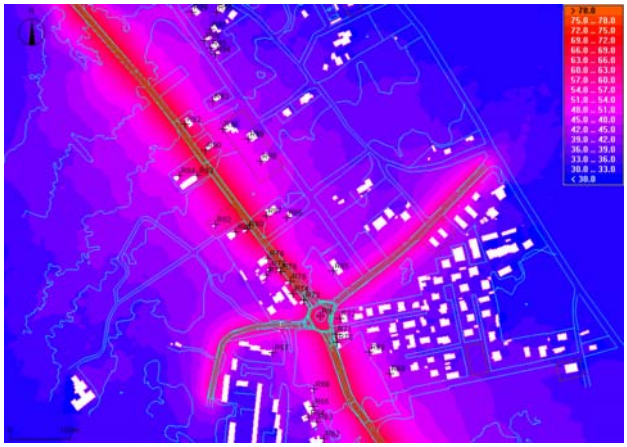

Figure 6. *Post operam* day-time acoustic map of Belpasso area.

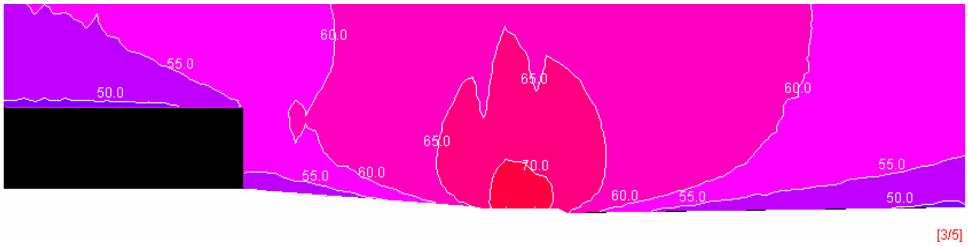

Figure 7. *Ante operam* day-time acoustic section for Misterbianco-Lineri area

Figure 8. *Post operam* day-time acoustic section for Belpasso

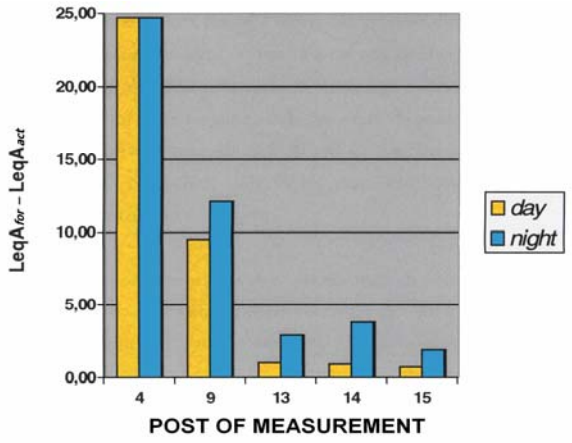

Figure 9. ΔLeqA between a.o. and p.o.

6. INTERVENTION OF CONTROL AND MITIGATION WORKS

The analysis of results of forecasting carried out, noticed that in "*post operam*" there will be the overcoming of limits in more than 80% of acoustical receivers. To bring back the values of noise emissions in all receivers below allowed limits, people chosen commercial acoustical absorptions to the different frequencies as shown in figure 10.

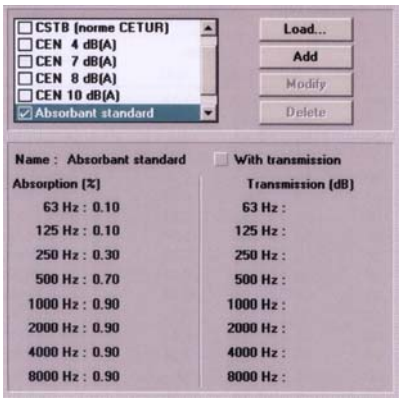

Figure 10. Choice acoustical barrier

People designed too the places along the route of road where barriers must be positioned. By reiterating the whole procedures people calculated values of LeqA in presence of designed barriers obtaining new results as that ones shown for exemplum in figures 11 and 12. It is easy looking to acoustical map post operam to ascertain all the noise emission have been bringing back to the acceptable ones by Italian regulations.

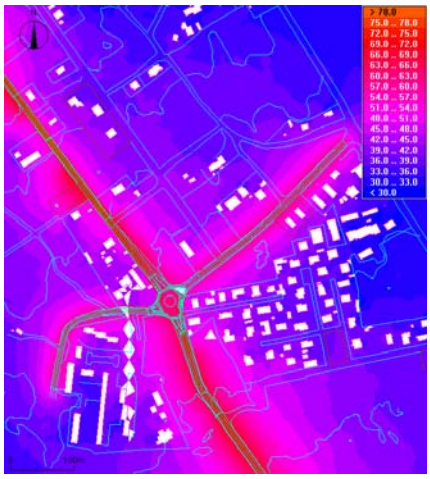

Figure 11. *Post operam* day-time acoustic map in presence of acoustic barriers for Belpasso area.

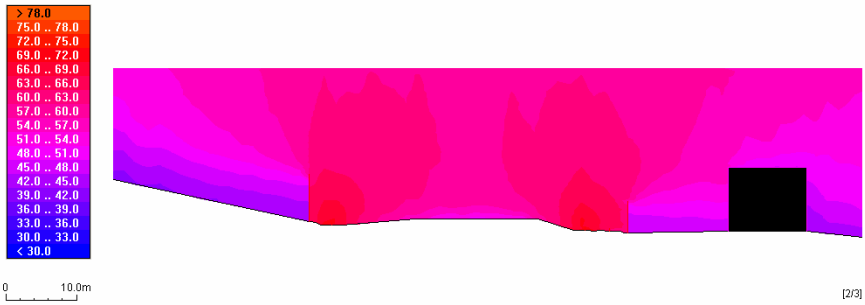

Figure 12. *Post operam* day-time acoustic section in presence of acoustic barriers for Belpasso area

7. CONCLUSION

The research carried out showed indeed that for this kind of sources of noise it is always possible, by mean of actual commercial *status artis* of acoustical barriers, to bring back the LeqA impact on receivers below limits acceptable to human hearth and that the cut in Leq values is function of available funds forecasting in plan phase. On the basis of all previously referred, it seems absolutely necessary, in the case of planning of new road, to carry out in parallel acoustical project to forecast in advance the eventuality to must utilize any kind of acoustical mitigations. The need coming from not only because noise impact originated by flow of motor vehicles can generate negative effects both on activities and health of inhabitants of areas interested by new road, but also because to discover the necessity to put up acoustical mitigations after the construction of road could produce significant negative alteration in the final economic balance with reference to allocation of funds for the buildings of road owing to the not negligible costs of noise control with a twofold damage both of environmental and budgetary kind.

REFERENCES

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