Function of the Vegetation Along Designed Line Route

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Abstract

The main aim was to find out any realitonships between the vegetations along the route and eliminations of the traffic noise. Other part of the report observes impact of the vegetation season to eliminate the noise by greens. Compares measuring of the noise during a winter season (plants are without any leaves) and during a spring or summer season - vegetation season (plants are with leaves). Species of the plants used for noise eliminate were examinated simultaneously.

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Introduction:

Noise has very important rule in our society. The biggest share in the noise problem has transportation. First of all it is road traffic noise, railway and aircraft noise. City and industrial development are increasing and the call for transportation increase depends on this development. Noise from traffic is one of the sizablest problem for the population which is living close to the routek and higways. There are a lot of types of the sound protection equipments. Most widely used are sound protection walls.These kinds of walls are made up of concrete, wooden, plastic etc. Vegetation could be used as a natural sound protection as well. Traffic induces emissions from engines to the atmosphere. Emission polluted to the atmosphere are: CO_2, CHx, Nox, SOx and Pb. However, plants can be used not only as noise protection, they are utilized although for fytoremediation contamined soil and air. It depends on the types of plants. For fytoremediation are used willows and poplar trees. Since soil along routes is very contaminated of polution from the engines, there was an idea to combinate utilization vegetation both for fytoremediation and noise protection although. Species utilized as a noise protection are recomended with large and hard leaves, orientation of the leaves perpendicular to traffic noise, vegetation season as long-term as possible. There are recomended to use (in our climatic conditions) species as limes, oaks, poplars and platans trees combinated with busch and grass species.

Methods and materials:

Research proceeded along highway D 8 in the Czech republic. There have been taken measurings of the noise from traffic during winter season and vegetation season. Measuring folowed czech standard. [1, 2, 3]

Place of measuring

Designed line route, where the sound was measured is highway D 8 (Figure 1). Concrete place, is on the 10th km from Prague. Red point Figure 2.

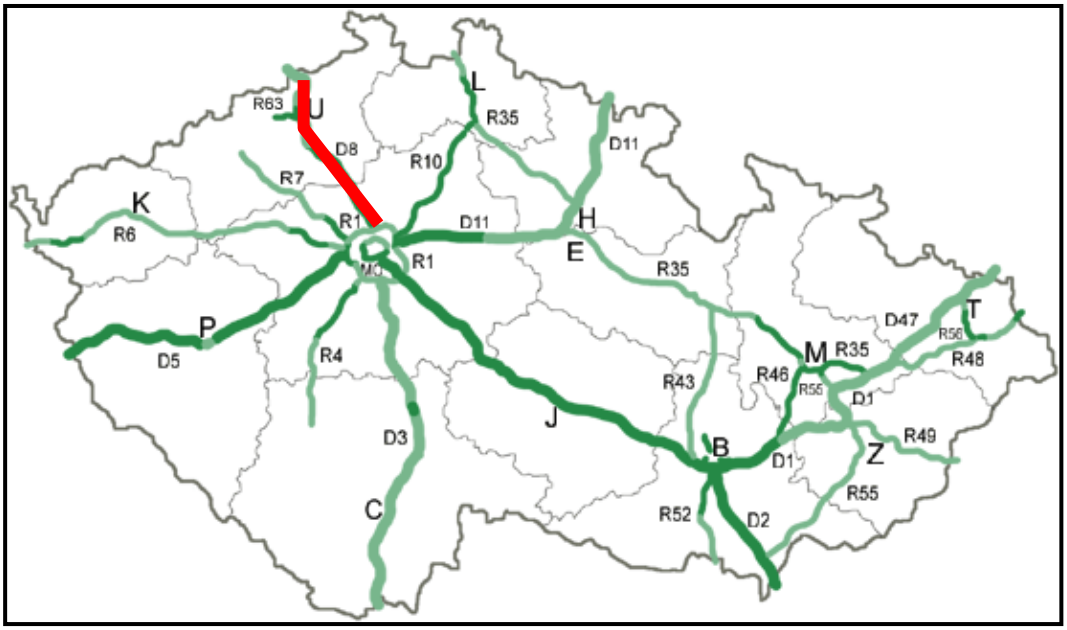


Figure 1 Map of the Czech republic – motorways and main trunk roads [7]

Analysis of the route:

Motorway D 8 – Prague – Lovosice – Ústí n. Labem – Germany

The motorway was build from 1990, now there are 52 km in operation and 40 km are in preparation. Capacity of this motorway near Prague is most 31,5 thousand vehicles per 24 hours. The daily capacity in 2000 was 19 064 cars per 24 hours. This motorway leads from Prague to Germany (the motorway A 17) over Ústí nad Labem. The motorway is built in profile D 27,5/120, it means the roadway is 27,5 meters wide and design speed is 120 km per hour. [8]

Figure 2 Detail of the route – red point – place of measuring

Photograph 1 Place of measurement – winter and vegetation season

Time of measuring:
The noise was measured two times.
1. Winter season: 31 st March 2005
   Time: 2 p.m. to 4 p.m.

2. Vegetation season: 11 th May 2005
Time: 2 p. m. to 4 p.m.

Weather
Winter season: temperature 12 degrees, cloudless, no wind
Vegetation season: temperature 18 degrees, cloudly, windy

Type of Vegetation
Vegetation is representated by hardwood forest. It is placed in the immediate vicinity of the motorway. The most representanion species of vegetations were trees oaks - *Quercus*, birch - *Betula* (Photograph 2) and lilac - *Brugmansia negra (*Photograph 3). Horse-chestnut - *Aesculus hippocastanum* and red ash - F*raxinus angustifolia* were occured although.
Oaks, birch and horse-chesnut form the highest horizon. Lilac, red ash and the other bush form horizont lower. There is grass horizont also. It´s very important to chooce suitable structure of vegetation. Trees could be too hight, so role of bush is undiscussible.

Photograph 2 Birch – *Betula* [6]

Photograph 3 Lilac - *Brugmansia negra* [6]

Using sound meter
The noise was measured by sound meter Bruel & Kjaer *2260 Investigator*. (Photograph 4).
Description of noise meter:

- Sw 7505 for analysis noise
- Sw 7815 for export, processing, evaluation of datas
- audio-noise meter type 1, according to IEC and ANSI standarts
- octave and 1/3 octave analysis in real-time
- complex acoustic measuring
- broadband statistics

Photograph 4 Sound meter Bruel & Kjaer *2260 Investigator*

MEASUREMENTS:
V = frequency weightings C or L
X = frequency weightings A, C or L
Y = time weightings S, F or I
Z = time weightings S, F
N = number

For Display and Storage (Broadband)

Start Date	Start Time	
Stop Date	Stop Time	Measurem. No.
Elapsed Time	No. of Pauses	Overload %
Underrange %	$L_{Apk(MaxP)}$	$L_{Vpk(MaxP)}$
#Peaks A>L	# Peaks V>L	$L_{AE(ASEL)}$
L_{Aeq}	L_{Veq}	L_{AIm}
L_{VIm}	$L_{Veq-LAeq}$	$L_{AIm-LAeq}$
L_{ASTm3}	L_{AFTm3}	L_{AITm3}
L_{VSTm3}	L_{VFTm3}	L_{VITm3}
L_{ASTm5}	L_{AFTm5}	L_{AITm5}
L_{VSTm5}	L_{VFTm5}	L_{VITm5}
L_{ASMax}	L_{AFMax}	L_{AIMax}
L_{ASMin}	L_{AFMin}	L_{AIMin}
L_{VSMax}	L_{VFMax}	L_{VIMax}
L_{VSMin}	L_{VFMin}	L_{VIMin}
L_{XYN1}	L_{XYN2}	L_{XYN3}
L_{XYN4}	L_{XYN5}	$L_{AEP,d}$
Level Distribution	Cumulative Distribution	

For Display and Storage (Octave or $^1/_3$-octave Bands):

L_{Xeq}	L_{XZMax}	L_{XZMin}

Only for Display as Numbers or Bargraphs (Broad-band):

$L_{AS(SPL)}$	$L_{AF(SPL)}$	$L_{AI(SPL)}$
$L_{VS(SPL)}$	$L_{VF(SPL)}$	$L_{VI(SPL)}$
$L_{AS(Inst)}$	$L_{AF(Inst)}$	$L_{AI(Inst)}$
$L_{VS(Inst)}$	$L_{VF(Inst)}$	$L_{VI(Inst)}$
L_{AST3}	L_{AFT3}	L_{AIT3}
L_{VST3}	L_{VFT3}	L_{VIT3}
L_{AST5}	L_{AFT5}	L_{AIT5}
L_{VST5}	L_{VFT5}	L_{VIT5}
$L_{Apk(Peak)}$	$L_{Vpk(Peak)}$	

Figure 3 Metering funds and operating principle with SW 7815

Photograph 5 comparing measuring winter and vegetation season

Noise definition

Noise is definited as each sound, which could be deleterious for human. Most of noises have variable character in the normal background, consequently we use average sum of acoustic energy for measuring of noise level. We call this average energy level as an equivalent level of noise or equivalent level of acoustic pressure L_{Aeq}.

Equivalent level of acoustic pressure $L_{Aeq,T}$ is identified by relation:

$$L_{Aeq,T} = 10 \cdot \log\left\{ (1/T) \cdot \int_0^T \left[\frac{p_A(t)}{p_0} \right]^2 \cdot dt \right\} \quad \text{[dB]} \quad [1]$$

or

$$L_{Aeq,T} = 10 \cdot \log(1/T) \cdot \int_0^T 10^{0,1 \cdot L(t)} dt \quad \text{[dB]} \quad [1]$$

Where:

$p_A(t)$ - immediate acoustic pressure [Pa], frequence-weighted fy filter A,

$L(t)$ - immediate level of acoustic pressure [dB]

T - time for which revers equivalent level

Level of acoustic pressure L_p vztahem is identified by relation:

$$L_p = 20 \cdot \log(p / p_0) \quad \text{[dB]} \quad [2]$$

Where:

p - immediate acoustic pressure [Pa]

p_0 - reference acoustic pressure [Pa]

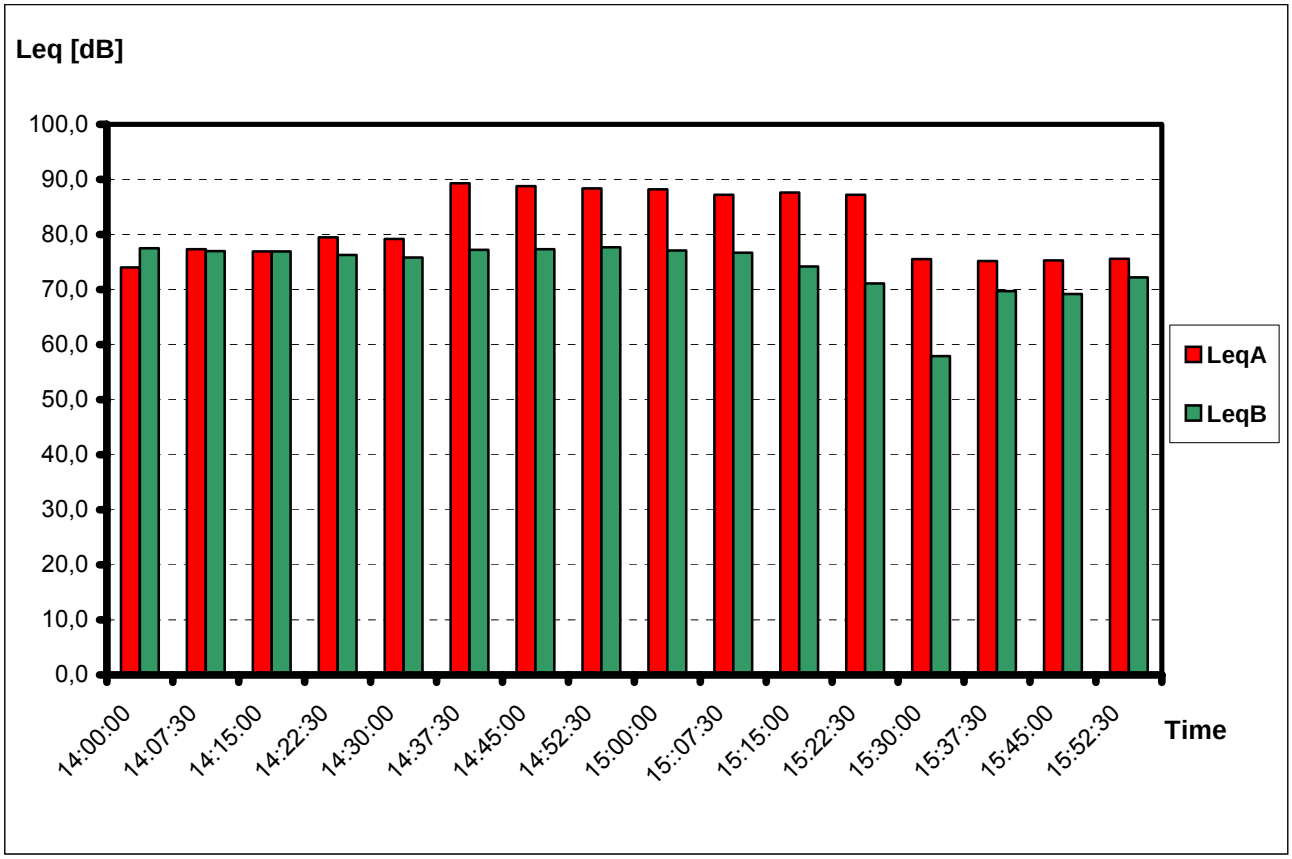
$p_0 = 2 \cdot 10^{-5}$ Pa (for air)

Results of measuring
Measured values are induction in Table 1. L_{eq} A – option winter season – without leaves, withnout any vegetation, L_{eq} B – option spring, or more precisely vegetation season.

Table 1 Measured equivalent level of acoustic pressure $L_{Aeq,T}$ - L_{eq} A – option winter season. L_{eq} B – option vegetation season

Time - start	Time - finish	Leq A [dB]	Leq B [dB]
14:00:00	14:07:30	74,0	77,5
14:07:30	14:15:00	77,3	77,0
14:15:00	14:22:30	76,9	76,9
14:22:30	14:30:00	79,5	76,3
14:30:00	14:37:30	79,2	75,8
14:37:30	14:45:00	89,3	77,2
14:45:00	14:52:30	88,8	77,3
14:52:30	15:00:00	88,4	77,7
15:00:00	15:07:30	88,2	77,1
15::07:30	15:15:00	87,2	76,7
15:15:00	15:22:30	87,6	74,2
15:22:30	15:30:00	87,2	71,1
15:30:00	15:37:30	75,5	57,9
15:37:30	15:45:00	75,2	69,7
15:45:00	15:52:30	75,3	69,2
15:52:30	16:00:00	75,6	72,2

Folowing Graph 1 we can see, values measured in the vegetation season are lower then values during the winter season. It shows, leaves and other part of plants are able to absorb and reflect incoming noise. Accordingly plants could be used as noise protection. As measuring shows it could be problem during winter season, when there are no vegetation which could absorb noise. Comparing both issues we can find, there are not so big diferences, in any case there are some identical values. Is presented, L_{eq} on highways could be more than 100 dB, it means, even plants without leaves protected lower, they still protected.[5]

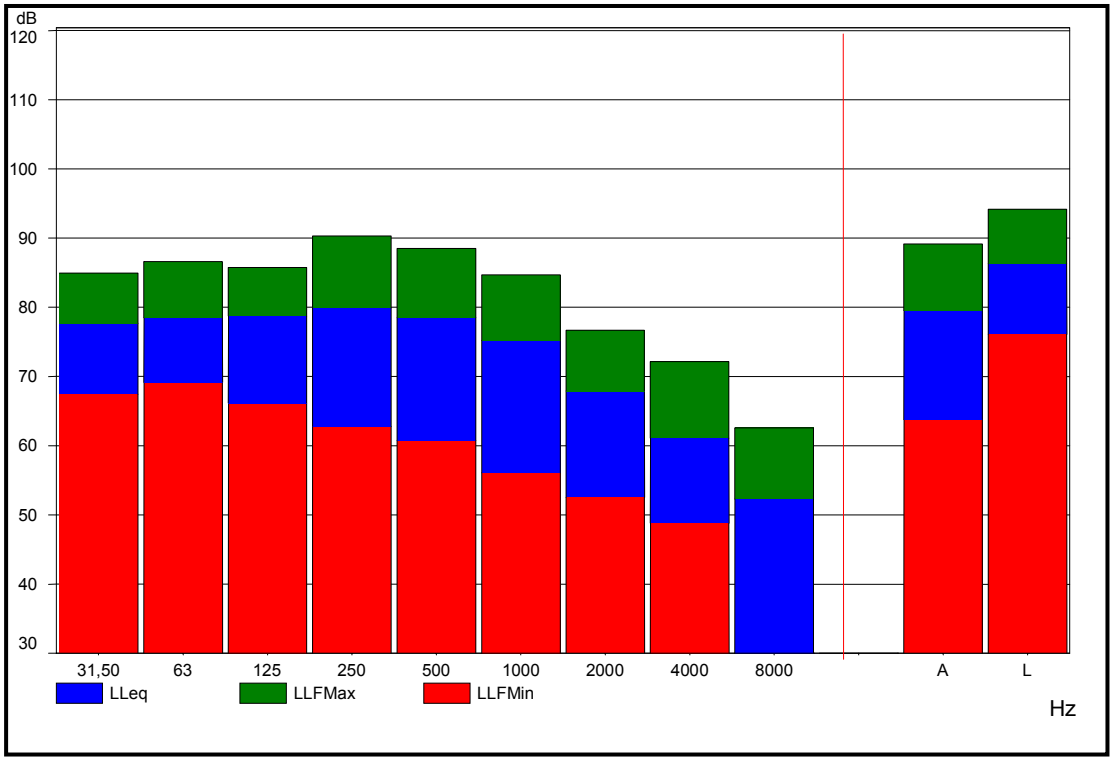


Graph 1 Comparing measuring winter and vegetation season

It was choosen representative sample of measuring in the winter season – it´s on the noise level L_{Aeq} = 79, 5 dB. Table 2 compares noise levels Leq, Lmax, Lmin in diferents frequences. Graphic demontration see in Graph 2.

Table 2 values of noise level in different frequences – winter season

Hz	LLeq	LLFMax	LLFMin
31,50	77,67	84,94	67,38
63	78,48	86,53	69,14
125	78,7	85,69	66,1
250	79,92	90,24	62,77
500	78,45	88,46	60,74
1000	75,19	84,68	56,05
2000	67,84	76,66	52,54
4000	61,1	72,1	48,78
8000	52,28	62,57	---
A	79,51	89,14	63,76
L	86,3	94,1	76,1

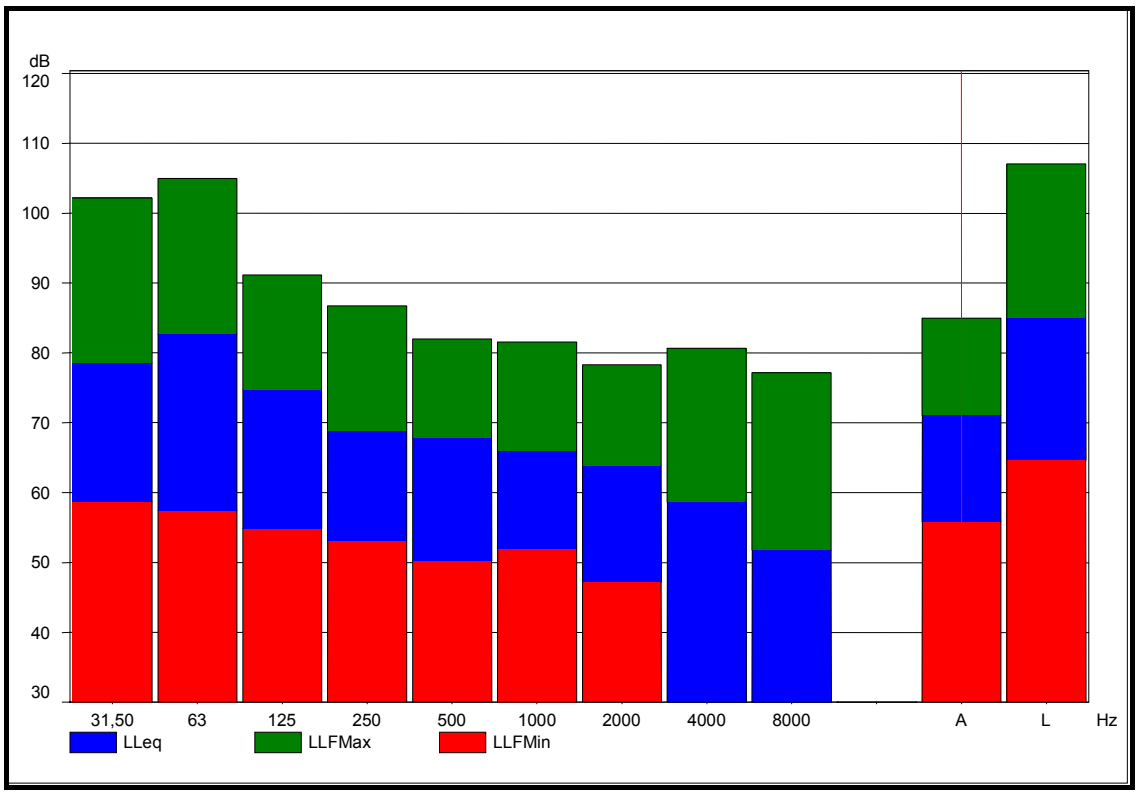


Graph 2 – Representative sample of measuring in the winter season – comparing Leq, Lmax, Lmin in diferents frequences

Table 3 shows representative sample of measuring in the vegetation season – it ´s on the noise level L_{Aeq}=71,1 dB. Table 3 compares Leq, Lmax, Lmin in diferents frequences. Graphic demontration see in Graph 3.

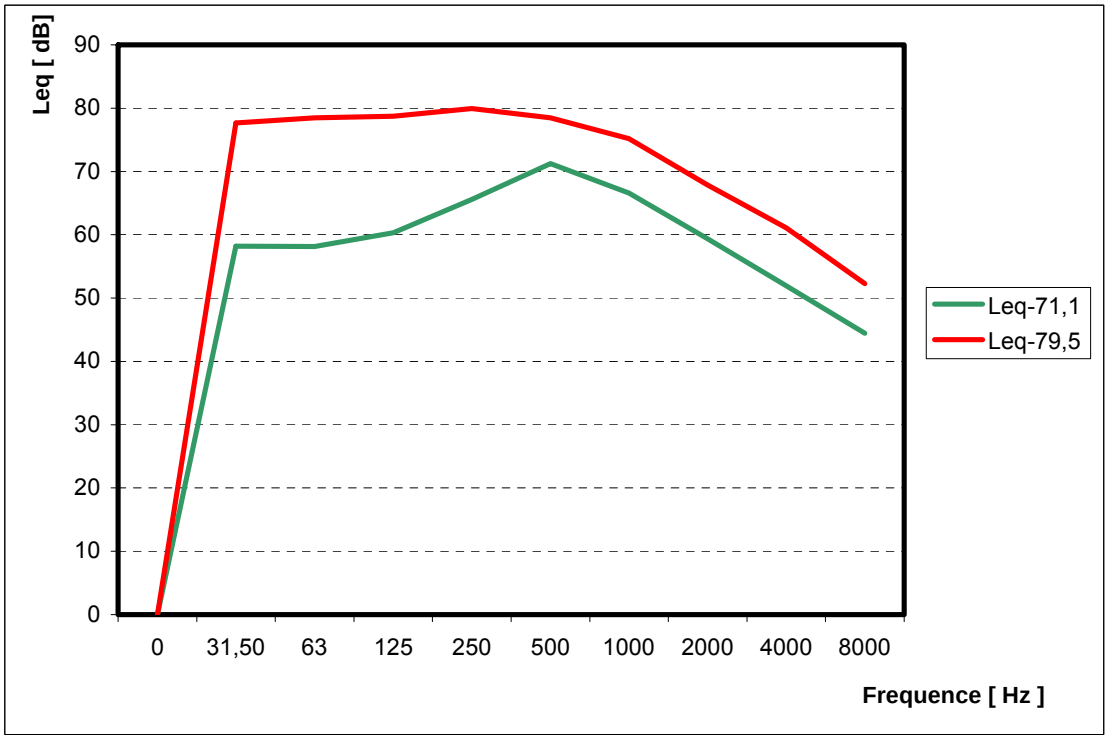
Table 3 values of noise level in different frequences – vegetation season

Hz	LLeq	LLFMax	LLFMin
31,50	58,19	69,56	40,74
63	58,17	70,23	44,57
125	60,3	74,39	40,86
250	65,59	84,1	41,29
500	71,26	87,49	---
1000	66,57	85,19	---
2000	59,38	77,12	---
4000	51,91	73,27	---
8000	44,45	67,92	---
A	71,06	88,18	40,94
L	78,87	91,95	59,21



Graph 3 Representative sample of measuring in the vegetation season – comparing Leq, Lmax, Lmin in diferents frequences

Values presented in Table 2 and 3 are comparing in Graph 4. There are trade off frequency spectrums of different levels of noise in winter and vegetation seasons. It shows, in both case is equivalent level of noise is reducing almost in the same frequency zones.



Graph 4 Frequency spectrum differents levels of noise

Conclusion:
During winter and vegetation season were proceeded researches of traffic noise along highway D 8 in the Czech republic. Issues demonstrates, that vegetation has ability to absorb and reflect noise. Hence, plants could be used as one of possible method as a protection agains noise. To use this method to standart practise and general use, it´s neccesary to do more measuring, statistically significant. Other research, for example, could compare measuring with variation in the same place, but without any plant. Even plants without leaves protected lower, then with leaves, they still protected agains noise in neighbourhood.

References:
[1] ČSN ISO 1996 –1 Acoustics – Destription and measurement of environmental noise, Part 1:Basic qualities and procedures
[2] ČSN ISO 1996 –2 Acoustics – Destription and measurement of environmental noise, Part 2: Acquisition of data pertinent to land use
[3] ČSN ISO 1996 – 3 Acoustics – Destription and measurement of environmental noise, Part 3: Application to noise limites
[4] Neubergová, K.: Ekologické aspekty dopravy. ČVUT, 2005, pp 96 – 107
[5] Rohon, P.: Tvorba a ochrana krajiny. ČVUT, 2001, pp 138 - 139
[6] http://www.kvetena.cz/stromy/
[7] http://www.ceskedalnice.cz/d.htm
[8] http://www.rsd.cz/rsd/rsd.nsf/