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Full Length Research Paper

Landscaping in reducing traffic noise problem in cities: Ankara case

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Cities have been getting overloaded due to the intense immigrations to urban areas and the population growth as a result of them, requiring new equipments and services, as the present infrastructure is insufficient. Besides, a host of problems arise in transportation and traffic infrastructure along with the corruption emerging in urban quarters as a result of socio-economical and technological changes. In big cities, ring roads aimed to increase the speed and capacity of transportation and highways reducing the transportation time between cities have been creating negative impacts as well as leading to facilities in terms of service functions, causing visual and audial pollution in urban areas. In this article, definitions regarding noise and its sources have been made and the precautions to be taken against noise have been mentioned earlier with the adverse effects of noise. Landscape design approaches and suggestions concerning the kinds to be used, which are peculiar to Ankara, have been developed, discussing the role and the function of plant material in reducing the noise of the traffic.

Keywords: Ankara, landscaping, landscape design, plant material, noise.

INTRODUCTION

The increasing population and improving technology have brought about changes in the economic and social structure of societies and partition from ruricularly developing countries like Turkey, owing to the immigration from rural areas to urban areas problems in transportation and traffic have arised as well as the deteriorations in physical environment.

Motor vehicles designed as a result of technological improvements and the newly-constructed highways provide a safe and enjoyable travel opportunity for drivers and passengers, decreasing the transportation processes between cities. Yet, this situation is leading to a different circumstance for the inner city and the close neighborhood. Due to the fact that the number of vehicles joining the city traffic is increasing day by day, (According to data from Ankara Police Department, the number of cars joining the city traffic in Ankara per month is 350), however roads capable of carrying this increasing volume of traffic aren't being constructed at the same speed, motor vehicle traffic, notably in metropol cities, pose a chief problem causing physical pollution. The increasing number of cars the newly-constructed roads lead to ever-increasing complaint about traffic noise in the city day by day. The ring roads constructed so as to raise the transportation capacity and speed in big cities are also appealing as accommodation area since they provide facilities in transportation of the entrances and exits of the city and in the other service functions. The nearby areas of the courses of ring roads' becoming accommodation areas doesn't only reduce the speed of transit traffic suitable for the basic aim of the given roads but also brings about an increase in our pollution as well as noise level in these accommodation areas. Individuals and/or instutions regarding air pollution arising from traffic as an important problem do not consider noise pollution stemming from traffic as serious as that of air pollution and the studies similar to the ones conducted in developed countries aren't carried out in under-developed countries and Turkey. This article is based on the trials and findings regarding the ongoing updating studies of the research by Yazgan, with the topic of 'Utilizing plant material in the noise problem posed by the accommodation areas near the main roads exiting from Ankara and in its solution, which is one of the first aimed at benefiting from plant material so as to prevent noise pollution.

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MATERIALS AND METHODS

The main component of the research is Ankara City. Apart from that, every kind of literature data regarding the topic and plant material used within the context of the study constitute the other research material. At the first stage of the research carried out in two phases, noise and plant types providing the suction of noise have been evaluated through literature study and at the second stage, selecting definite types for the city of Ankara, trials have been conducted at the exit of Ankara on the highway of Ankara-Istanbul. The plant selection for the research have been done, taking the state of the leaf, its size and the frequency of leaf and coniferous properties into consideration. When the growing conditions are regarded in relation to these general factors, the types used for trial are shown in Table 1.

Within the context of the research at the exit of Ankara, on the highway of Ankara-Istanbul, a linear plant curtain with 3 bands 30 m in length has been established, bringing together parcels which are arranged as 1 m wide and 5 m long. Plants are brought to the site in containers and selected species were planted in the area as three rows in which deciduous trees were planted in the first and the third rows and conifer trees were planted in the second row (Figure 1) (Original, 2006).

While the types at the first and second row are 1.50 - 1.80 m in length the ones with the needle at the second row are determined to be 3.00 m in length. The plants are located as modules of six in the way given in shape 1, about 5 m behind from the expropriation band which is at the back of the road in the places where vehicle traffic is dense. About 5 m behind the plant band, necessary noise measurements have been carried out with sound level meter. Within the context of the research carried out in September 2006, measurements have been performed for a whole day.

According to the yearly study done by the Turkish General Directorate of Highways Transportation Study Branch average daily measurements, the traffic volume of the highway of Istanbul is determined to be 11,000 vehicles. According to the measurements performed without the plant material, the noise level of the road is determined to be 80 dBA from 11.00 to 13.00 h when the traffic is dense. When the triple plant curtain was located, the noise level obtained as a result of the measurements performed in this area between the same period of time is determined to be 75 dBA. Within this context, while tested plants have been suggested as types to prevent or reduce noise, the other types suggested in the test area have been recommended as suitable types in general and particularly in Ankara as a result of the evaluation of the literature data.

Table 1. The types of species used for trial.

Conifers	Chamaecyparis lawsoniana
	Cupressocyparis Leylandii
	Cupressus arizonica
	Cupressus sempervirens var. Glauca
	Thuja orientalis
Decidious species	Philadelphus coranarius
	Forsythia intermedia
	Lonicera tatarica
	Cretaegus monogyna
	Pyracantha coccinea

THE DEFINITION OF NOISE AND ITS SOURCES

In this section, the definitions and explanations regarding noise, its sources and the necessary terminology have been mentioned.

Noise

The purpose of Noise Control Regulation which has been prepared on the basis of the article 14 of the Environment Law with the date August the ninth 1983 and issue 2872 is to ensure the development of an environment which won't impair the peace, silence, physical and mental health with noise and in harmony with this purpose to determine the limits to put the noise control into effect by means of the definition of the terms related to noise. In the first part of Noise Regulation, sound is defined as a physical process happening as a result of the fluctuations made by a vibrating source in the air pressure and stimulating the hearing sense in humans and noise is defined as a sound with an irregular structure.

Being affected by the noise

The effects of noise on human health have been categorized in four groups as physical effects observed as hearing disorders, physiological effects observed in body activities, physchological effects such as irritability and being nervous and performance effects like decrease in productivity at work and not being able to understand the voices heard.

Vibration

Mechanic vibrations with low frequency and high amplitude which spreads in solid mediums and can be felt through the sense of touch.

The level of sound pressure

The difference of the atmospheric pressure changes during the spread of noise compared to the balance. Standard reference of sound pressure level which is 0.0002 newton/m2 compared to the logarithm according to 10 base level is called as bell, whereas 1/10 portion of it is decibel.

dBA

A unit of sound evaluation in which medium and high frequencies to which the human ear is the most sensitive is particularly emphasized. The unit dBA often used in reducing or controlling noise, is also related to the subjective evaluation of the height of sound.

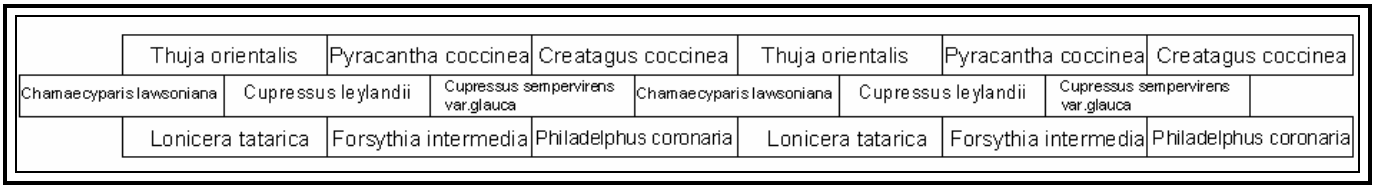


Figure 1. Plantation of the three lined plant barrier and the species used (Original, 2006).

The level of external noise

The noise levels measured or calculated outside the constructions 1000 m far away from the exterior walls.

The physical environment factors

Every kind of noise increasing or reducing element existing in the physical environment through which the sound passes during its transmission from the source to the user, construction or the people who are being affected and influencing the radiation of sound (Anonymous, 1999).

THE SOURCES OF NOISE

Noise comes from various sources. According to the most general classification, noise sources are being categorized into two groups as inside and outside the construction, the inside ones being determined as speaking, step and household items, while the outside ones are determined as transportation, industry, construction, human activities, noise related to entertainment and commerce, animals (wild life).

According to the second part of Noise Control Regulation the sources of noise are classified as road vehicles, air vehicles, industrial road and construction machinery. The sources forming the noise are generally classified into three groups as:

i) Noise arising from industry
ii) City/settlement noise
iii) Traffic/transportation noise

The level of noise is increasing or decreasing within the context of some factors. The effect and efficiency area varies in relation to geographical situation, climatic and environmental conditions.

Noise originating from industry

Noise arising from industry is the ones caused by Industrial equipments. Noise caused by mechanical activities like power transmission, cutting machinery, press machines, compressors, counters, fans and the noise caused by electromagnetic powers like transformator, generator are defined as industrial noise sources. According to Noise Control Regulation, continuous noise isn't to exceed 65-55 dBA and sudden noise 70 - 60 dBA. It's prohibited to have the machines which make noise higher than these sound levels without taking the necessary precautions and put them into practice.

City / settlement noise

That is the noise arising from the usages in urban areas. It includes the noise in commercial areas and market places, noise arising from collective uses like sports, school, children playgrounds and noise near settlement areas and construction sites and construction activities nearby. According to Noise Control Regulation, the main criteria for traffic noise in settlement areas is that the noise in such areas should be between 35 and 45 dBA and shouldn't exceed the limits defined in the regulation.

Traffic and transportation noise

Traffic and transportation noise must be assessed mainly in three main groups:

Air traffic

The noise caused by the planes in the airports varying in size and power, used both in air transportation and for military purposes. The noise level felt 150 m far from the runway during the landings and take-offs has been estimated to be 120 dBA on average. Particularly in airports used intensely like Istanbul, Ankara, Izmir or the ones quite near the urban area like in the example of Antalya, the noise level can reach rather disturbing levels. The air vehicles with Turkish and foreign patent must have a noise certificate so as to land in and take off from the airports open to international traffic.

Train and railed services

Trains and rail systems are a major factor in the increasing level of noise (along the routes) particularly in the city. Today despite the fact that they have been silenced thanks to the improving technology, the noise

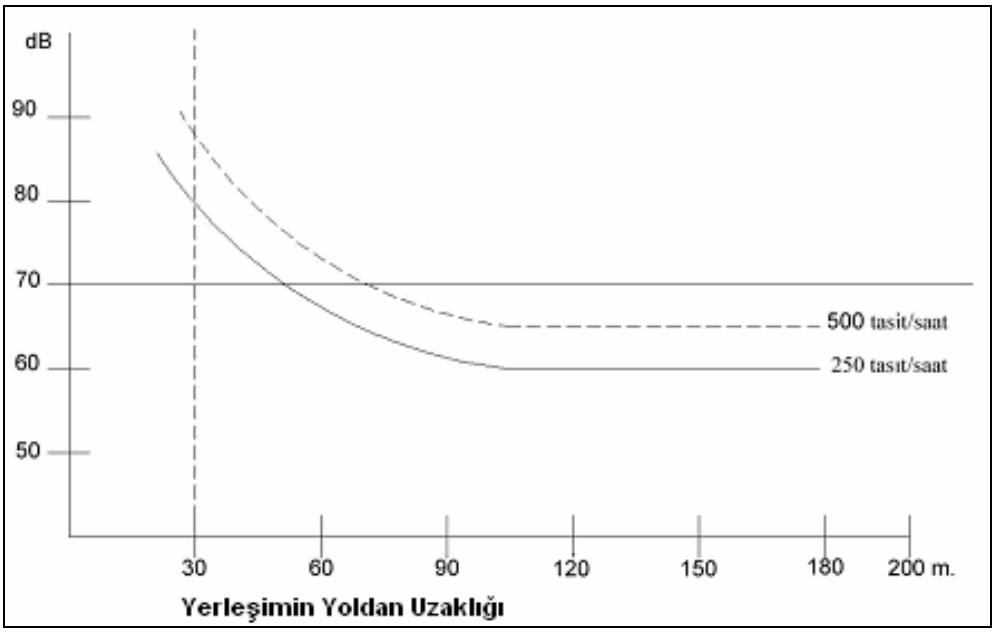


Figure 2. Level of Noise in Highways (Richards, 1967).

level of rail systems is determined to be 80 dBA. (25 years ago this level used to be about 200 dBA) Yet, the noise forming at the base varies depending on the type of the train, the construction style of the rail system and the technology employed. According to the Noise Control Regulation the maximum noise level for the trains between the suburbs and the city centre and from heavy and light subway are determined to be 80 km/h dBA for a locomotive when working in a diesel engine, full power and freight and 85 dBA when the windows are closed while in electrical train locomotives 80 dBA and for wagons 70 dBA.

Highway motor vehicles' traffic

One of the sources causing the most noise pollution is the highway motor vehicles' traffic. The majority of highway traffic consists of automobiles, the number of lorries and buses are smaller. These vehicles are making noises at the rate of their speed and power. Factors like the slope and the cover of the roads they use are also factors increasing the noise they make. For instance, if the slope of the road is %3 - 4 the increase in the noise for one vehicle is 2 dBA for %5 - 6 slope it is 3 dBA and for slope of %7 and more it is 7 dBA.

Another significant factor influencing the traffic noise in cities is the 'volume of traffic. After the number of motor vehicles passing from the same point at the different times of the day throughout the year is determined, it is given as daily or hourly value. In this updated research, according to the finalized 2003 averages of General Directorate of Highways, average values, obtained by means of the measurements carried out at the city entrance points of Ankara. Ring Road, the volume of vehicles has been determined as the following:

i) Ankara- Eskisehir Highway 524 m.vehicle / hour
ii) Ankara- KonyaHighway 524 m.vehicle / hour
iii) Ankara- Istanbul Highway 490 m.vehicle / hour
iv) Ankara- Samsun Highway 816 m.vehicle / hour
v) Ankara- Esenboga Highway 742 m.vehicle / hour
(Anonymous, 2005).

In a research carried out in the USA (Figure 2) in a road with a volume of 500 m vehicle per hour, according to a measurement made 30 m far from the noise source the noise level is 78 dBA. According to a measurement made 60 m far it is 72 dBA and according to a measurement 120 m far it is 66 dBA (Richards, 1967).

According to the Noise Control Regulation, the highest levels of noise depending on the type of the vehicle have been determined as 75 dBA for automobiles, 80 dBA for buses run in the city centre and 85 dBA for heavy vehicles and lorries. Here the most important parameter to be paid attention is the noise source. Every time the distance from the noise source becomes the twice of the original one, the decrease observed in the noise is 56 dBA.

THE NEGATIVE EFFECTS OF NOISE

The purpose of Noise Control Regulation which has been prepared on the basis of the article 14 of the environment law with the date August the ninth 1983 and with the

number 2872 is to ensure the development of an environment which won't impair the peace, silence, physical and mental health with noise and in harmony with this purpose to determine the limits to put the noise control into effect by means of the definition of the terms related to noise. Within this context environment pollution has been defined as the upset of ecological balance with the negative developments in the air, water and soil as a result of any kind of activity and the waste, smell, noise and the unwanted consequences in the environment appearing owing to these reasons and some sanctions have been imposed so as to avoid the adverse effects.

The impact of noise on human health

No matter what the level or the exposure period is, the noise has significant effects on human health. The influences of noise on human health may be physical or psychological. The most commonly observed physical effects arising from noise are temporary or permanent hearing loss. In terms of physiology, problems like difficulty in breathing, heart beating disorders, the increase of blood pressure have clinically been determined to emerge. As to psychological effects, there may be several of them and might lead to disorders like behavioral disorders, stress, difficulty in concentration.

Noise which has been defined as the unwanted noise being made up of sound waves which are not sinusoid, particularly affect and disturb people depending on the intensity, spectrum frequency and the period. Besides the fact that sound at a certain level have different influences on different people (reasons like the period of a person's being exposed to noise, personal sensitivity, his age and various ear disorders), distance to the noise source affects each person's perceiving noise and/or the level of being affected.

In the researches carried out in relation to the noise four noise stages have been determined, making a general classification. According to this classification:

i) The noise between 30 and 65 dBA: 30 dBA is generally the noise level inside and outside at which people do not feel disturbed as long as the period doesn't get longer. Yet, 45 - 65 dBA is a level at which concentration disorder, unwillingness to work, etc. may appear.
ii) The noise between 65 - 95 dBA: At this noise level, psychological disorders may appear in people as the period gets longer.
iii) The noise between 90 - 120 dBA: The noise at this level causes problems in hearing organs as well as psychological disorders. As the existence period in mediums with over 100 dBA gets longer permanent hearing losses start to appear.
iv) The noise over 120 dBA: The noise at this level has negative effects not only on humans but also on a number of living things.

The effect of noise on economy

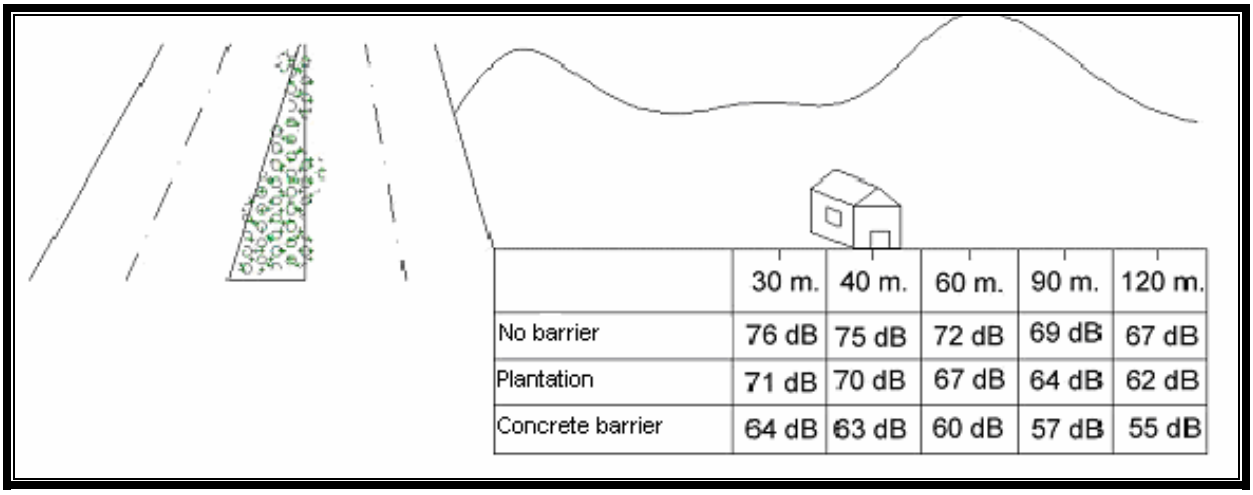
Besides the adverse effects of noise on human health, it also reduces the productivity level of employees at work to a great extent. The researches conducted over this issue in the USA and Japan have indicated as regards to the noise that there has been a decrease of productivity by 30% in blue collars and by 50 - 60% in white collars. That the work accidents are on increase in the industries where the noise is intense is another significant fact.

RESULT

In developed countries, so as to reduce the levels disturbing individuals and societies to optimum level, technical work is crucial as well as legal regulations. Preventing the noise from its source, that's to say, producing noise making machines in a way so that they will create less noise, in construction activities providing inner and outer insulation by using construction items with a high insulation capacity of sound and heat in the facilitations plays an efficient role in solving the problem of noise. By using plant material in the surfaces of the constructions and roof garden practices, the noise in urban areas is likely to be increased. Using suitable plant material in the roads in the city centre and the neighborhood areas will play a role in diminishing the noise.

So as to prevent the noise of traffic, the developing automobile industry has decreased the engine and exhaust noise of the vehicle to 2 - 3 dBA, fulfilling a remarkable step in manufacturing the engine. Even a decrease at such a level reduces the noise perceived by the human ear by 50%. Reducing the slope and curve of new roads as much as possible in order to decrease the noise and promoting the surface covering quality are quite efficient factors in the solution of noise problem.

Various barriers are being used to reduce or prevent the noise. In designing noise barriers, constructive elements, plant material or both of them can be used together. The barrier wall used to decrease or prevent the noise is composed of three sections, namely, wall basis, wall surface and the end of the wall/the top point of the wall. The basis of the wall, being a part not to be perceived visually, must have a quality, strong enough in terms of structure and in harmony with the landscape properties of the neighborhood. The wall structure is the most dominant part of the structural element. The material to be used in noise barrier walls may be materials like precast concrete, metal, wood, brick and stone. The quality and character of the wall is directly related to the material used and the texture created. While wood is generally used in rural areas and the suburbs, materials like concrete, stone and metal are preferred in the urban areas. The way the texture properties of the noise barrier walls are perceived directly depends on the speed of the



	30 m.	40 m.	60 m.	90 m.	120 m.
No barrier	76 dB	75 dB	72 dB	69 dB	67 dB
Plantation	71 dB	70 dB	67 dB	64 dB	62 dB
Concrete barrier	64 dB	63 dB	60 dB	57 dB	55 dB

Figure 3. Measured Noise Levels for Different Types of Applications in Highways (Clark, 1974).

observer. Since the textures cannot be perceived clearly at great speeds, in the noise barrier walls to be constructed in areas with high speeds, textures with rough, simple and dark lines must be preferred. On the other hand, particularly due to the fact that actions with low speeds are performed, thinner and more sophisticated textures can be used in noise barrier walls. Using relief in wall structures makes the forming of shadow textures possible at the same time. Such practices don't only contribute to absorb the noise but also creates visual richness. Also, it can be used in noise barrier walls to create contrast or match/camouflage in various colors. The end of the wall must be designed as a finishing element indicating its feature. It must have the feature to be in harmony with the nature and to easily integrate into the wall.

Plant material in reducing noise

Even though planting suitable for the purpose in the parts of the city centre where the density of construction is high is not carried out, refuge, planting trees besides the roads and planting in the city parks are effective in the effect of traffic noise although this effect is not that great. However in the city centre and its near environs where the construction density is low in the parts of expropriation band at the border of highway going along the road to plant suitable plant types so as to reduce the noise is possible (Figure 3).

Plant material is classified as high, chunky, ground covering, wrapping depending on the size and habitat features and as plants with thin, thick and medium textures depending on texture features. For any area, in using preventive plant types, using native plants is both more aesthetic and more economic. In settlements, as a result of the activities like urban development, agriculture and road construction, the unique plant groups are getting damaged. However, the restoration of unique plant groups will provide easier integration with the present landscape and interesting and aesthetic road views will be achieved as well. Wild flowers and meadow areas growing at haphazard, are providing a visual addition by creating a series of texture and smell effect. The types of flowers blooming in different times of the year provide the continuous change in the color of the flowers and different effects as well as stabilizing the soil and decreasing the maintenance costs. USA Wisconsin transportation unit, has conducted a huge project aiming at creating wide meadow areas and wild flowers in the city centre at Highway 51 and has carried out plant practices not only to provide an aesthetic contribution but also to perform research related to the noise barrier. Every part of the plant material habitus is effective at absorbing and spreading the sound. The ability to absorb and to spread the noise is most observed in leaves. That of the branches and the bodies is less. Plant types also vary in decreasing the noise depending on the characteristics of the leaves. The leaves which are long, fleshy and with wide palm are more effective at the reflection and the absorption of the sound.

Another characteristic of the plants used in reducing the noise is that their leaves are evergreen. Another important point to pay attention during plant design aiming at reducing noise is the plant material designed as noise veil's cosiness to the noise source and the distance to the area to be protected from the noise. The plantation height and/or ages and their combinations with each other are as important as their dendrological properties and active values in decreasing the noise. The plants to be used to decrease the noise must be types with quite big and hard leaves have a dense leaf network, be tall and if possible types dangling till ground and to be planted at near distance should be chosen.

Plant material could also be used with noise barrier walls. These kinds of walls can be camouflaged or the

wall effect may be softened with plants. The use of mature tall trees with these walls will contribute to the environment both aesthetically and functionally. The bush and wrapping plants are breaking down the massy nature of the wall surface. Besides being used functionally as noise barrier, plant can be used to create horizontal, vertical and emphasis effect or color and form effect or contrast.

While designing noise barriers, the chief principle is to integrate these elements to the current landscape. The integration of these walls with the current must be either by designing the construction as if it has grown in the landscape or by the plant material and natural environment's becoming a part of the barrier structure. The wall itself can easily be designed by the use of the soil and the plants as construction materials. Noise barrier can be constructed with soil in a way that it will be the thriving atmosphere of the willow trees, which are good at absorbing the noise. To reinforce the soil wall structurally, the use of the wood branches etc. of the willow tree will be more suitable in terms of natural cycle and visual property. Such living barriers containing both plant and construction material are more alluring alternative noise barriers. The plant types to be used in such walls are limited. Yearly plants are the most suitable types in this sense.

According to Urgenc (1990), a young and dense forest's band per meter reduces the noise by 1.16 dBA. Within this context, a dense plantation with a width of 250 m a noise decrease of 40 dBA is achieved. If the fact that in the settlement areas the noise must be maximum 50 dBA during the day and 35 dBA during the night is taken into consideration, this means that a tree band of 250 m. will eliminate the street noise of 80 dBA. Providing a green area with these sizes is not quite possible in the city, however, with green areas to be designed in suitable sizes, the noise can be eliminated to a certain extent.

Yet, the plant types used to create an efficient noise curtain are also of great importance. Noise curtains consisting of types which are tall, huge, which have hard texture and dense peak structure, which reach till ground, which have huge leaves and dense branch and leaf structure. Within this context, since the conifers aren't so efficient, the use of the types with leaves will be more suitable.

According to Yazgan (1976), *Salix elaeagnos, Chamaecyparis lawsoniana cv. Glauca, Taxus baccata, Picea asperata, Buxus sempervirens, Spirea vanhouttei, Cotoneaster multiflorus, Sophora japonica supplies approximately a 2dBA reduce in noise; whereas Ligustrum vulgare, Lonicera tatarica, Crataegus monogyna, Pyracantha coccinea, Sorbaria sorbifolia, Chamaecyparis lawsoniana* supplies approximately 2-4dB a reduce in noise. On the other hand, *Juniperus chinensis pfitzeriana, Betula pendula, Alnus incana, Cornus alba, Cornus sanquinea, Forsythia intermedia, Sambucus nigra, Lonicera tatarica, Acer negundo, Populus canadensis* supplies 4-6dBAreduce in noise level; *Philedelphus pubescens, Carpinus betulus, Syringa vulgaris, Fagus sylvatica, Ilex aquifolium, Ribes divaricatum, Quercus robur, Rhodendron* supplies 6-8DbA reducement; P*opulus borelinensis, Viburnum lantana, Viburnum rhytidophyllum, Tilia platyphyllos* supplies 8-10dBA reducement *Acer psedoplatanus* supplies 10-12dBA reduce in noise level which can be used to eleminate or reduce noise level in general.

According to the researches made by Lorenz the most efficient plant species in blocking noise are determined as *Acer campestre, Acer platanoides, Acer pseudoplatanus, Acer cappadocicum, Alnus glutinosa, Alnus barbata, Arbutus andrachne, Betula verrucosa, Carpinus betulus, Cornus mas, Corylus avellana* (Yazgan, 1980).

In 1976, in a trial which is installed in a plant fence of 7 rows where there are evergreen plants as well, with a distance of 100 cm between rows in pots 6 m from the road according to the measurement values carried out during evening hours when the traffic on Istanbul-Ankara Motorway a decrease between 6 and 8 dBA has been observed when compared to the plantless situation. In 2004, this trial has been organized with three rows and instead of *Pyracantha sp. Pittosporum tobira* instead of *Cotoneaster nummularia Prunus laurocerasus* and at the third row instead of *Acer sp. Cupressus atlantica cv*. 'Glauca' have been used hence with a plant fence having fewer plants and a better appearance a decrease of 5 dBA has been determined in noise (July 2004, Ankara, Karsıyaka-Demetevler Road). As it is stated before, a decrease of 5 dBA in noise provides a decrease by %50 in the noise felt by the ear.

It has been determined that the noise made by the motor vehicles travelling at a speed of 30, 60, 90 km has been absorbed by the fence plant *'Illicium anistatum'* 6 m away, causing a decrease of 3, 6, 10 dBA (Yazgan, 1980).

In the trials to prevent the noise by the use of plant material, one tree and bush have been insufficient in preventing the noise. For the plants to be efficient in preventing the noise they should be as deep as possible and at least 5 m tall. According to another research, for noise, the plantation area has been determined to be at least 7.5 m or more and in the cases where the plant material is inadequate that water surfaces must be included is also stated. It has been established that the reduction of noise level by the use of plant material mostly depends on the structure of the plant.

DISCUSSION

That landscape engineering is defined as 'arranging places/spaces with plants are an incomplete definition. When the practices like planting trees to control siltation and erosion and landscape maintenance works bevel stabilization the plant practices carried out in order to de-

crease noise are taken into consideration, the incompleteness of this definition is understood more clearly.

Another important factor to be paid attention in plant design aiming at preventing noise is the plant material's, designed as a noise curtain, closeness to the noise source and its distance to the area to be protected. It must be designed as near as possible to the noise source, however, at least 30 km far from the area it will protect. The width of the noise curtain may vary between 6 and 30 m. The most efficient types to be used as noise curtain are *Acer pseudoplatanus, Viburnum lantana* and Rhododendron taxons with their wide leaves (Orcun, 1975).

Besides the fact that plant material practices aiming at preventing traffic noise are economically more suitable when compared to nonliving materials such as concrete wall, plastic plate, they should also be preferred due to the fact that they will contribute to the environment aesthetically with the properties of colour and shape changing depending on the season. Since the use of plant material with this purpose hasn't been analysed sufficiently and hasn't been publicised with sample studies, coscious practices cannot be observed on urban, regional and national scales. Plant material, one of the most efficient methods in eliminating the noise, installed on a soil wall consisting of both the noise barrier wall and the plant material, is an approach cotributing the creation of a different visual effect. Besides, the use of natural vegetation as noise barrier is a choice to be considered due to the easy maintenance and economical contributions.

Benefiting from natural vegetation as noise curtain is also possible. Hence, the costs of facility and maintenance can be minimized. At least the use of natural vegetation with suitable types must be considered.

Noise curtains should be installed in a way perpendicular to the direction where the noise comes from and to absorb the noise better, using fragmented band practices rather than only one band, the use of material with a number of bands must be preferred. The spaces in these areas must be enriched with small trees and bushes and the massing of the noise must be made easier by creating a denser structure and texture with the use of plant at every level. Since the evergreens are efficient all throughout the year the use of suitable types is possible. The trees must be planted as close as possible to each other.

The closer the tree and the bush curtain to the noise source and the further it is to the region to be protected, the bigger the noise isolation will be. If the distance between the noise source and the region to be protected is short by covering the surface of the acoustic curtain walls with plant material, an efficient curtaining may be provided. In this case, the use of types such as *Hedera helix, Rubus fruticosus, Polygonum auberti, Parthenocissus quinquefolia,* which are quite wrapping will be efficient (Urgenc, 1990).

According to the results of the research conducted, with a noise curtaining of three rows, the amount of noise has been reduced by 5 dBA, which means the perception of noise by people in a way reduced to half. Within this context with the practices of five, seven or nine the elimination of noise by 80% is possible.

The deciduous plant species that can be used as noise curtain for Ankara and its near environs are as such: *Acer pseudoplatanus, Betula verrucosa, Cornus alba, Corylus avellana, Crataegus monogyna, Forsythia intermedia, Lonicera tatarica, Philadelphus coronarius, Populus tremula, Pyracantha coccinea, Ribes sp, Sambucus nigra, Sorbaria sorbifolia, Syringa vulgaris, Tilia cordata, Tilia platyphyllos and Viburnum lantana.*

Besides these species, some coniferous species that can be used either to mass/absorb the noise or to block the wind effect in Ankara and its near environs are as such; *Cheamacyparis lawsoniana, Cupressocyparis leylandii, Cupressus arizonica, Cupressus macrocarpa, Cupressus sempervirens var. glauca, Juniperus excelsa, Juniperus chinensis var. stricta, Juniperus oxycedrus, Pinus mugo, Pinus mugo var. nigra, Pinus pinaster, Pinus radiata, Pinus silvestris, Thuja orientalis.*

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