Road Directorate

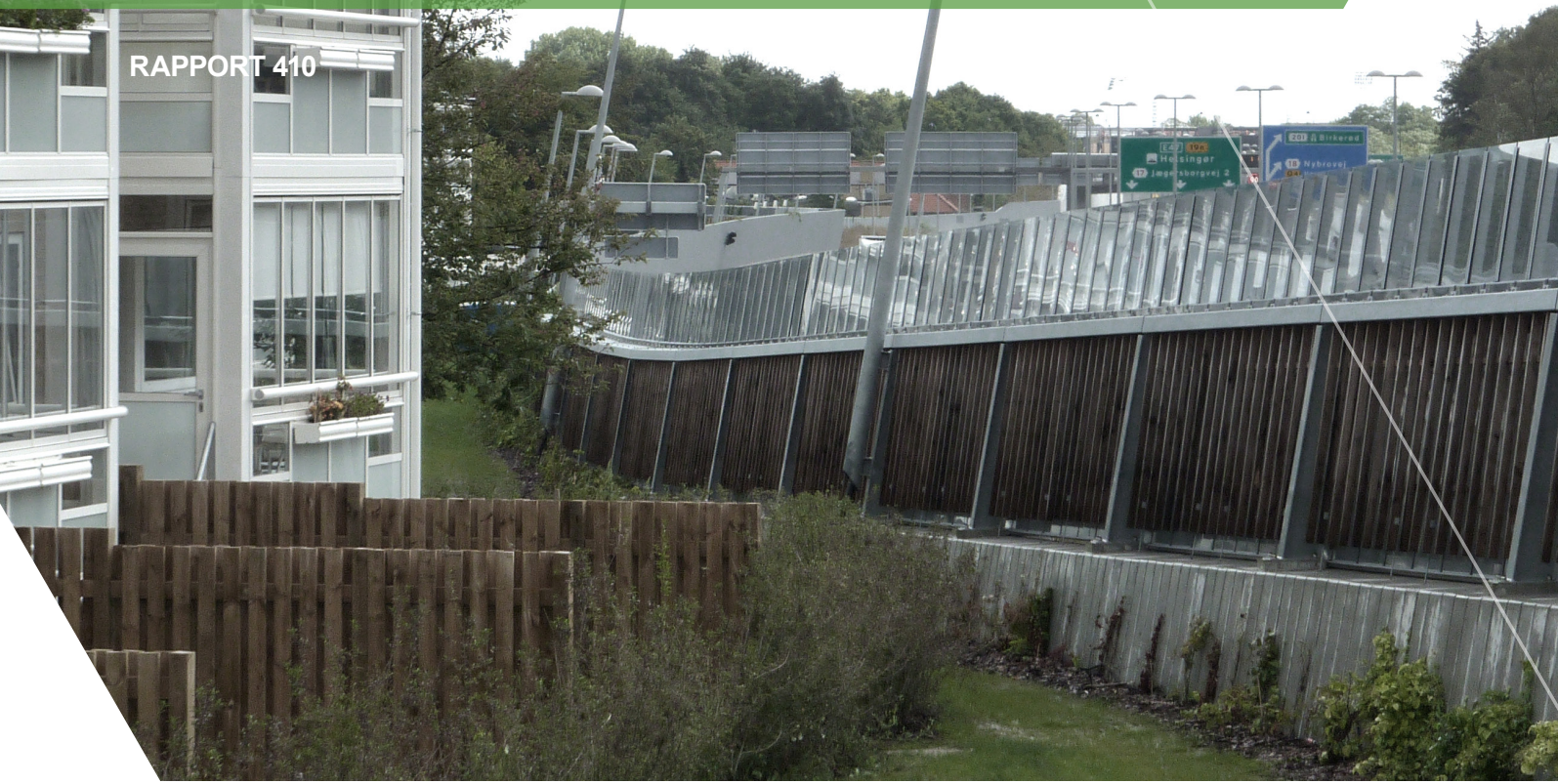
Ministry of Transport

INTRODUCTION

NOISE FROM ROAD TRAFFIC

THE WORK WITH NOISE CARRIED OUT BY THE DANISH ROAD DIRECTORATE

RAPPORT 410



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NOISE FROM ROAD TRAFFIC
The work with noise carried out by
The Danish Road Directorate

RAPPORT 410

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CONTENT

HOW MUCH NOISE IS THERE?

When one knows the course of a road, the traffic and the surrounding terrain, one can calculate how much noise a road emits. The method is good, since it possible to calculate in advance what will happen, if something changes, f x if the amount of vehicles changes or noise barriers are constructed. On noise maps it is possible to see how noise spreads in the landscape.

NOISE MAPS GIVE AN OVERVIEW

A map, which shows how noise is spread in the landscape or in a town, is called a noise map. If you look at Figure 1, the Danish Road Directorate produces noise maps by using a computer model, which can calculate the noise from roads in detail as well as for large areas.

On a noise map one can see how the noise level decreases, when moving away from the road. One can also see f x that buildings function as barriers and lower the noise level.

A noise map with road noise will normally show the total noise from all major roads in an area.

The greatest advantage of noise maps is that they give an overview. It is quick to see where there is a lot of noise and where there is less noise.

Another advantage of calculated noise maps is that it is easy to make changes in the calculations whereupon one immediately can see what influence these changes have. Figure 2 and 3 show the same area, but in figure 3 a noise barrier has been constructed. By comparing the two maps it can be seen to which extent a noise barrier will lower the noise level. In the same way, it is possible to show what influence an increase in traffic has, if the road gets a new road surface, which reduces noise, etc.

Nord2000: Advanced noise model

The road directorates in the five Nordic countries have in cooperation developed a model to calculate noise from roads. The model is called Nord2000 and is presumably the most advanced model which is used for the evaluation of noise in connection with road projects. Nord2000 takes the following into account:

- Distance to the road
- Weather and wind conditions
- Nature of the surface (f x hard asphalt or grass)
- Buildings and other structures, which shield from noise
- Objects which reflect noise
- The road surface
- Number of passenger cars and delivery vans
- Number of heavy lorries, busses, etc.
- The speed of the vehicles
- The distribution of the vehicles during the day, evening, night

In chapter 3, you can read more about what the parameters mean for the noise you experience in an area with road noise.

WHAT IS HAPPENING NEAR MY HOME?

If you live in an area where construction of a new road is being considered or road noise can change for other reasons, you can use noise maps to see what will happen. Generally, there will be noise maps available which show the area with and without the change.

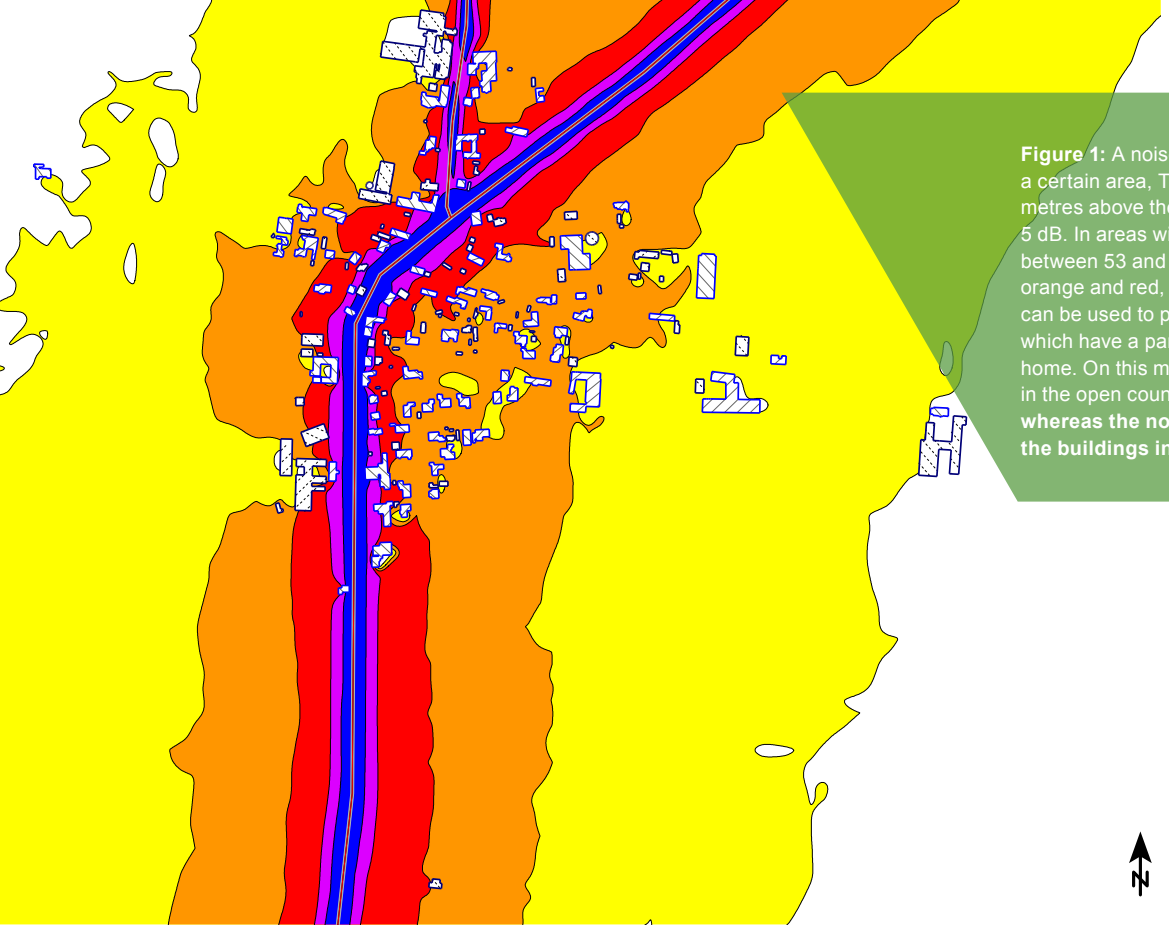


Figure 1: A noise map gives an overview of the noise in a certain area, The map normally shows the noise 1.5 metres above the ground with a different colour for every 5 dB. In areas with an orange colour the road noise is between 53 and 58 dB. On the dividing line between orange and red, the noise level is 58 dB. The noise map can be used to predict noise conditions in those areas which have a particular interest, f x near one's own home. On this map it can be seen how noise spreads in the open country north **and south of the town, whereas the noise to some extent is screened by the buildings in the town.**

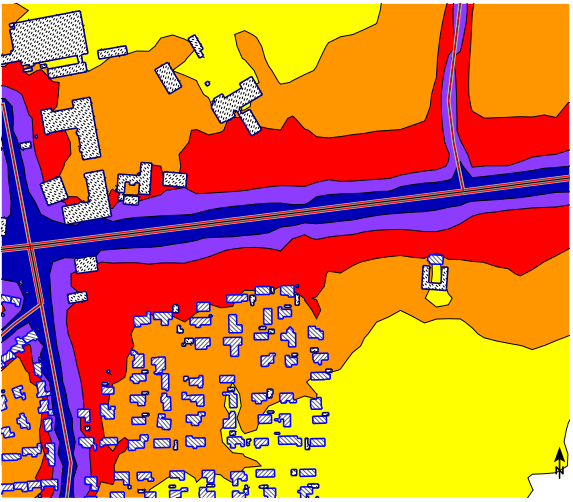


Figure 2 and 3: Two noise maps without and with a noise barrier. The two maps show the noise in the same area along a road. The only difference is that on the map on the right-hand side, a noise barrier has been added on the southern side of the road. By comparing the two maps, one can get an overview of the effect of a noise barrier at this place.

NOISE MEASUREMENTS ARE SPOT CHECKS

Noise from a road can be measured with noise measuring equipment. Measurements tell how much noise here is precisely at the point of time when the measurements are taken. In other words, noise measurements are spot checks.
If measurements are taken during a longer period, it is possible to get a better impression of the conditions, but still only at the point where the equipment has been placed. The measurement does not say anything about the amount of noise at another point in time or another place nearby. Noise measurements are therefore not well suited if information is required for a bigger area. The measurement can also not predict what will happen, if the traffic changes, the road is reconstructed or other changes are made.

Figure 4: A microphone along the road for pass-by measurements. The microphone is placed close to the road and measures noise from passing passenger vehicles and lorries.

Noise near a road is best described by a noise map, which is obtained by a calculation of noise. The calculation is based on knowledge on how much noise comes from Danish passenger cars and lorries. This knowledge is obtained from the measurements of many vehicles passing by on Danish roads.

On the other hand, measurements are used to obtain knowledge on the emission of noise from different types of vehicles, at different speeds and on different road surfaces. The Danish Road Directorate has carried out noise measurements from many thousands of vehicles, when they passed noise measuring equipment on different road surfaces. Extensive measuring programmes have also provided knowledge on how noise spreads in the neighbourhood. All results are included in a calculation model, which makes it possible to calculate noise from roads.

NOISE IS NOT CONSTANT

If one lives near a road with a lot of traffic one knows that noise is not constant. There is often more traffic and more noise during rush hour, lorries create more noise than passenger cars and if one is at some distance from the road, the wind direction can have big influence on how strong the noise is.

If one lives at some distance from the motorway, noise has a tendency to “flow together” to constant noise where it is impossible to hear each individual vehicle. If you live close to a main road or a street in a town, each individual vehicle can be heard more clearly.

When the noise varies continuously, it can be difficult to state how much noise there is. It would not be correct to give the highest or lowest value, since the total effect of the noise is not described correctly in extreme cases. Therefore, an average is used, when noise should be determined.

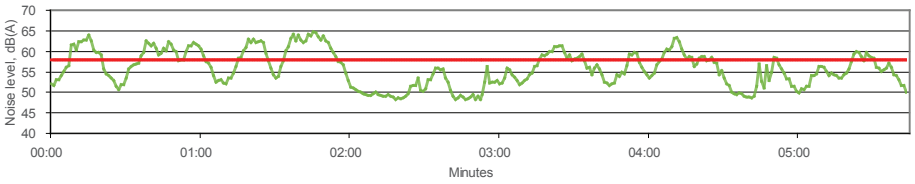


Figure 5: When noise is measured alongside a road it is not always constant. But it is not described correctly with the highest and lowest noise values, which can appear by chance. Noise from roads is therefore always described as an average value.

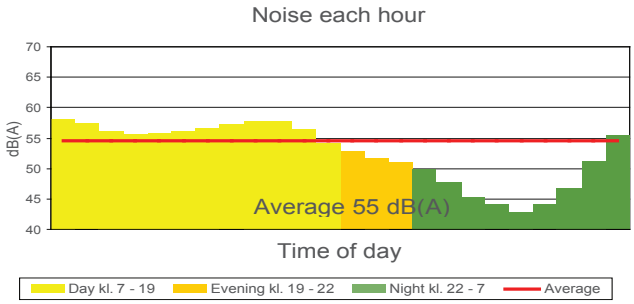


Figure 6: The traffic, and therefore noise varies during the day. During the rush hour in the morning and afternoon there is the highest noise level, whereas the noise is considerably lower at night. The figure shows a typical sequence throughout a period of 24 hours, where the noise is shown as an average by the hour. The average for the whole day in this example is 55 dB.

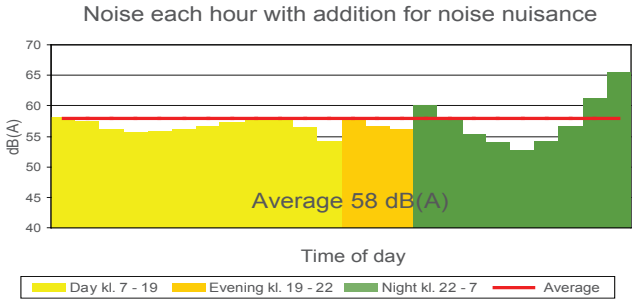


Figure 7: When calculating noise from roads it is considered whether noise in the evening and night is more irritating than noise during the day. In decibel this means that noise in the evening has an addition of 5 dB and at night 10 dB. In Figure 6 the average noise level for the whole day is 55 dB. By calculating Lden with additions of 5 dB and 10 dB, the average is 58 dB for the same amount of traffic.

NOISE ON AVERAGE

A large number of tests has shown that there is a clear connection between the average value of noise and the irritation which is experienced by the neighbours of the road.
When road noise is calculated, the results are therefore always stated as an average value. The average will normally be for an entire year.

NOISE AT NIGHT IS MORE IRRITATING

It is known that noise is more irritating and harmful to health in the evening and at night than during daytime. Thus 5 dB are added to noise levels in the evening and 10 dB are added to noise levels at night, when the average for a day is calculated. This means that vehicles in the evening count three times more than vehicles during the day and vehicles at night count ten times more than during the day.

CRITERION FOR NOISE

The average noise level from a road is stated in terms of the European criterion for noise Lden. This means that it has been taken into account that noise is more irritating in the evening and night, as described above. Lden.is an English name, which stands for Level day-evening-night. A noise map will always show the road noise as Lden in dB, normally 1.5 m above the road level,

If the addition of 5 dB and 10 dB during the evening and night are not used, the noise level is shown as LAeq,.24. This description was used until 2007. For a typical road, Lden will be 3 dB higher than LAeq,.24 . The technical description for the mean of noise is the “equivalent noise level”.

Noise maps
Every fifth year, the State and the local administrations must investigate how much noise there is in the largest cities and along major roads.

The Environmental Protection Agency has a noise map for the entire country, which shows road noise near the major roads in Denmark and in the largest cities. This noise map also shows noise from larger railways, airports and some industrial companies. The map can be found on the homepage of the Environmental Protection Agency.

WHAT ABOUT THOSE IRRITATING EVENTS?

A noisy, illegal motorcycle, a car which accelerates loudly, or noise from a loose manhole cover on the road, can for some people be very irritating events. Such events are not included in noise calculations because they occur at random and are not a part of normal road noise. The same applies to noise from emergency vehicles and the special noise from wet or snow-covered roads. However, noise calculations can take slopes on roads into account.

NOISE MAPPING

If a home is in an area where noise has been mapped, a noise map can be used to see how much noise there is in the area. In the remainder of this publication one can read more about what road noise means and how it is experienced.

The Danish Road Directorate uses noise mapping to make a priority list of those places, where it is of greatest importance to reduce noise. The Environmental Protection Agency uses the country-wide noise map as an overview of noise conditions in Denmark and follows its development continuously.
The same applies in all other countries within the EU.

The local authorities also use noise mapping to prioritise their efforts to reduce noise. Noise maps are also an important tool, when new housing areas or other new roads with noisy traffic are planned.

When larger road constructions are being planned, noise maps will always be produced, which show the consequences of the project on road noise.
The examination will be a part of the project's environmental examinations or Environmental Impact Assessments.

HOW MUCH NOISE IS ACCEPTABLE?

Traffic on roads creates noise which can be a nuisance for neighbours and the surroundings along the road. The nuisance can be prevented best by good planning of new roads and new constructions. In the legislation it is stated how planning should be carried out, but there are only recommended noise guidelines.

RECOMMENDED LIMIT VALUE

Road noise is primarily considered to be an inconvenience. There is a great difference, how people experience noise.

When the Environmental Protection Agency determines recommended limit values for noise, it is a balance between the effect noise has on human beings and economic considerations. About 10-15 per cent of the population are strongly annoyed by a noise level of 58 dB.

The noise guidelines are the basis for authorities to evaluate whether noise has an impact on an area. If the noise guidelines are exceeded, the area is considered to be exposed to noise. If the guidelines are exceeded, f x near existing homes, there is no general duty to reduce noise.

Type of area	Type of area
Recreational areas in open countryside, summer house , camping areas etc.	L_{den} 53 dB
Housing areas, child care institutions, schools, and teaching buildings, homes for the elderly, hospitals etc. Furthermore, allotment gardens, outdoors areas and parks	L_{den} 58 dB
Hotels, offices etc.	L_{den} 63 dB

Figure 8: Guidelines for road traffic noise

NUISANCE AND HEALTH

The economic development in society brings with it an increased need for transport and therefore also more road traffic. At the same time, society wishes good condtions of life and housing. The latest mapping of noise from roads shows approx. 30% of Denmark's housing is exceeds the noise guideline and that these homes are concentrated in cities and alongside major roads.

Noise from road traffic does not give hearing damage, but noise can be a stress factor which increases the risk of heart illnesses and increased blood pressure. Research has shown that noise can reduce people's quality of life by stress and disturbed sleep.

Figure 9: Heavy traffic at night has a big influence on the total noise level and noise during the night can influence people's health.

Noise	Number of homes impacted by noise		
	Towns	Countryside	Total
> 58 dB	728.000	58.000	786.000
> 68 dB	186.000	5.000	191.000

Figure 10: Number of homes impacted by noise in Denmark (2007) out of a total of 2.5 mill.
Source: Environmental Protection Agency

Noise can reduce children's ability to learn and there is a risk that their use of language does not develop normally.

In 2003, it was estimated that between 800 and 2,200 persons yearly in Denmark were admitted to hospital with increased blood pressure or heart disease due to noise. It was also estimated that between 200 and 500 persons annually die earlier than normal as a result of road noise.

Examination of the long-time effect of road noise seems to point to the fact that it is particularly noise during the night that causes heart disease and this effect apparently comes even though road noise is not perceived as a nuisance.

This means that noise can damage health, even though one does not wake up at night and even though noise is not regarded as a nuisance. In connection with the government's evaluation of the Road Noise Strategy from 2010, these conclusions have been confirmed.

NOISE CONSIDERATION DURING THE PLANNING STAGE

Noise considerations are handled in different ways, depending on which planning situation is under consideration.

When new housing is being planned, either along new or existing roads, the recommended limit values from the Environmental Protection Agency for construction of outdoor areas apply as well as the Building Regulations indoors.

Since 1984, it has been the duty of local authorities to take care of noise considerations in new housing areas and other new noise-sensitive functions alongside existing roads by means of local planning. There are requirements that the planning and building regulations for municipality/local authorities must follow; areas which are subjected to noise must not be used for housing or other recreational

What does L_{den} 58 dB sound like?
The guiding limit value for road noise in Denmark is L_{den} 58 dB. On a noise map one can find a place where there is 58 dB on a road of the same type as the in which one is interested. If the place is visited, it is possible to experience what experience one has. The following should be noted:

- L_{den} is an expression for the average, and not necessarily at the point of time when you are there.
- When are you there? Is the traffic typical?
- Is it the same type of road as the one you are interested in? Do the vehicles have approximately the same speed?
- Noise can be influenced by weather conditions, in particular the wind direction, unless you are very close to the road. The wind should be weak and in your direction.
- A wet road makes more noise than a dry road and snow can lower noise significantly.

It could be a good idea to visit various places at different times of the day.

areas unless the area can be ensured against noise nuisance by means of noise reducing measures.

Neither the environmental legislation nor the planning act makes provisions to intervene in noise problems at existing housing areas near existing roads. If it is necessary to construct noise protection, this must be based on voluntary actions by the local authority, own initiatives of the owner's or a noise partnership between the authorities and the landowners.

When new roads are planned, no guiding limit values have been set for noise from roads. The Environmental Protection Agency is of the opinion that the same considerations should be taken when new roads or extensions are made as those taken for new housing. New roads and considerable changes of roads are included in the rules regarding EIA. This stands for Environmental Impact Assessment.

Planning of new roads
The nuisance of road noise can be limited by good planning. There are no fixed rules how much noise there may be from a road, but the Environmental Protection Agency recommends that the same guidelines are used as for new housing, when planning new roads.

Figure 11: A meeting for citizens, where the results of an Environmental Impact Assessment for a new road is presented and debated.

When new housing areas, etc. are being planned in connection with local development plans, the noise guidelines are used as the basis for which areas are considered to be subjected to noise. According to the Planning Act, areas which are subjected to noise must only be used for noise sensitive use (f x. housing) if there are conditions in the plan regarding noise barriers, which can ensure future use against noise nuisance.

What does “noise exposed” mean?
It is common that areas or housing is called ”noise exposed ”, when the noise level for housing is above the limit value of Lden 58 dB. If the noise level is above 68 Lden, the area or housing is called heavily “noise exposed “.

THE AIMS OF THE DANISH ROAD DIRECTORATE

Even though there are no limit values for noise from roads, the authorities have taken the responsibility to reduce noise nuisance. The State accepts its responsibility and the Danish Road Directorate therefore has the following aim:

- To observe the guiding limit value of 58 dB for housing areas, when planning and constructing new roads
- To use noise reducing pavements in connection with new constructions and ordinary road maintenance, where the traffic on motorways and other main roads causes noise nuisance in urban areas
- To reduce noise nuisance for as many houses as possible along road stretches with high levels of noise on existing road stretches.

Figure 12: Noise influences housing areas and pedestrians/bikers on the road

Development in society gives more noise
In Denmark it in not stated in the Environmental Protection Legislation, Planning Legislation or any other legislation that authorities must establish noise reduction on existing roads. An increased noise load from increasing traffic is part of the development of society which, as neighbour of a road, must be tolerated.

HOW DO YOU EXPERIENCE NOISE?

Figure 13: 0 decibel (dB) corresponds to the lowest level a human being can hear, 120 dB is such strong noise, that it can hurt in the ears. Frequently one can see, that it is written dB(A). "(A)" means that the noise level is adjusted to the way a human being perceives noise. Road noise in Denmark is always stated in dB(A), also if only dB is written. Illustration: DELTA

HOW DO YOU EXPERIENCE NOISE FROM A ROAD?

There are a large number of factors which influence the level of noise coming from a road and how noise is experienced by people. It depends on the traffic, the physical environment of a road and the weather.

The strength of noise is measured in decibel, which is abbreviated as dB. In Figure 13 there are some examples of different noise levels.

In the following, the influence which different factors have on road noise are described.

DISTANCE TO THE ROAD

The distance from a road to a home and the empty spaces in between have big influence on noise.

The noise from a road becomes lower, the further from the road one is. Noise decreases by at least 3 dB, each time the distance doubles. If one goes away from a road, noise decreases quickly in the beginning, but finally one needs to go quite far to note that the noise decreases noticeably, see Figure 15.

In a housing area close to a road there can therefore be a lot of difference in the noise level, whether one is in the first row of houses or in the second row. If the homes are further away, noise appears more equal. A change in traffic noise of 3 dB corresponds to a halving or doubling of traffic.

Reduction of noise	Can be achieved by:	Changes are experienced as:
1 dB	Remove 25 % of traffic, or reduce traffic speed by 10 km/h	Very small change
2 dB	Use noise reducing asphalt or reduce traffic speed by 10-20 km/h	A barely audible change
3 dB	Remove 50 % of traffic or increase distance from the road to the double amount, or reduce speed by 20 km/h	An audible, but small change
5 dB	Remove 65% of the traffic or use noise berm or noise barrier	A considerable and clear change
10 dB	Remove 90 % of the traffic or use high noise berm or noise barrier	A halving of noise
20 dB	Remove 99% of traffic or build block of flats with closed courtyard areas.	A very big change

Figure 14: Example of how and how much the noise can be lowered by various means, compared to how the changes in noise level are experienced.

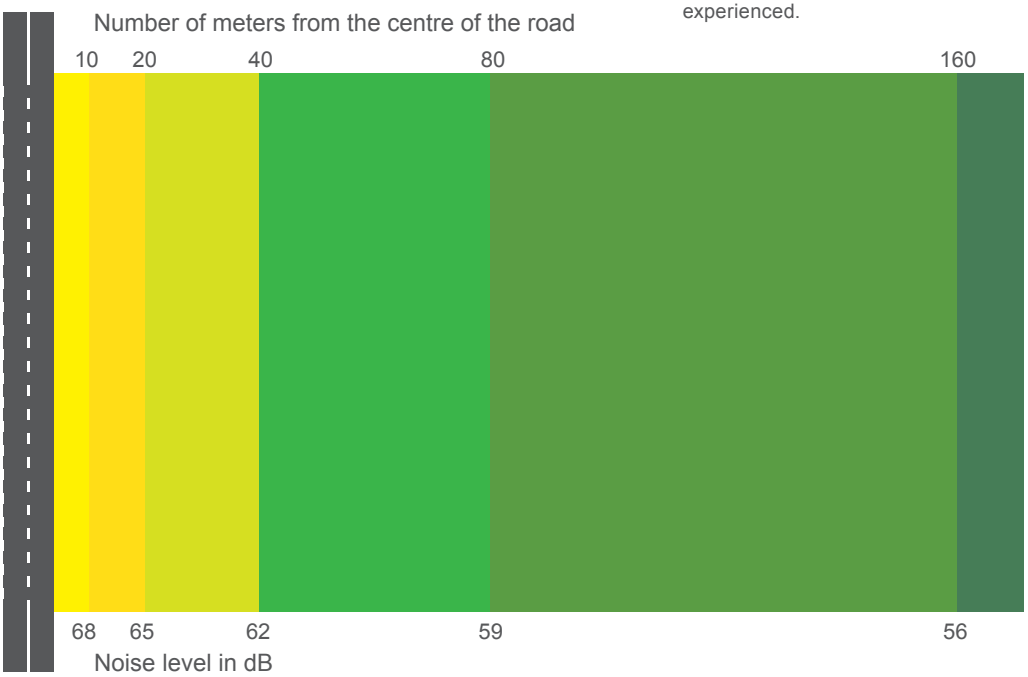


Figure 15: The noise from a road is reduced by at least 3 dB, each time the distance to the road is doubled.

SURFACE OF THE LANDSCAPE

Noise calculations take the surface of the landscape into consideration between the road and the neighbours.
The surface is describes as hard, soft or a mixture. When road noise hits a hard surface, such as concrete, asphalt or a water surface, most of the noise is reflected and thrown back. This does not happen to the same extent with soft surfaces, such as lawns, fields, gardens and natural areas.

Distance from centre of road	Noise reduction	
	Soft surface	Hard surface
20 meters	6 dB	4 dB
50 meters	13 dB	8 dB
100 meters	16 dB	12 dB
200 meters	19 dB	17 dB
500 meters	24 dB	23 dB

Figure 16: The values in the table show how much noise is decreased in the relation to the level of noise 10 meters from the centre of the road. The noise decreases with the distance from the road.
At the same time the surface has influence whether it is soft (f x grass) or hard (f x asphalt). The rule that noise is decreased by 3 dB each time the distance is doubled is in reality on the low side. It is in fact more due to the surface and some of the noise is absorbed in the air.
The values in the table are approximate.

REFLECTIONS

When noise hits a building or another vertical and hard surface it will be reflected. If one stands in front of a road where there are large buildings right on the other side of the road, one hears the noise which comes from the road and the noise which is reflected from the buildings. Normally, reflected noise does not matter so much, it is rarely more than 0.5 – 1.0 dB.

Noise barriers can also reflect noise back to the other side of the road. Thus, noise barriers are often constructed of materials which absorb the sound, so that the sound is not reflected after all. Noise calculations always take the influence of noise into account, which can come from reflecting buildings or other surfaces.

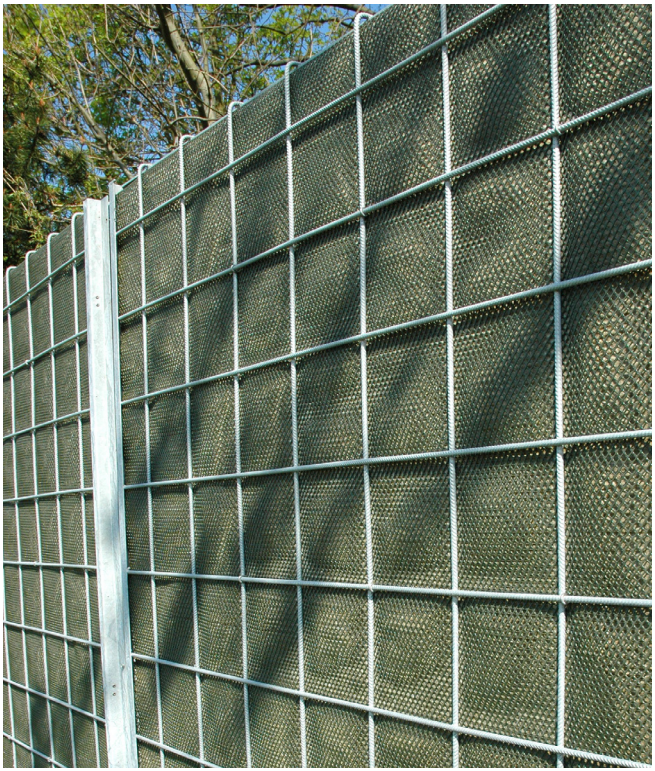


Figure 17: Noise barriers are often constructed with a surface, which is porous and therefore absorbs sound. This means that noise barriers do not reflect all the sound to the other side of the road. Often it is a porous material, usually mineral wool, on the side towards the road, covered by a perforated steel plate or planks with slits. When the cover is open in this manner, the barrier will still absorb noise.

Figure 18: At some distance from the road, the weather has great influence, how clearly noise is experienced. Close to a road, the noise is also varying and the individual vehicles can be heard clearly, when they pass. At a greater distance, there is a tendency that the noise becomes blurred and becomes an even buzz.

WEATHER

Weather conditions influence how noise is spread from the surroundings. Close to the road, the weather does not matter very much, but at a greater distance it can have a big influence. If the distance is 100 or 200 meters, one can experience that on some days the noise is barely noticed, whereas on other days it can seem that the road is much closer. Wind has the greatest influence on these variations.

The weather conditions are included when noise from roads is calculated. Statistics for typical weather in Denmark throughout an entire year are included. The large differences, which can arise from day to day, are therefore levelled out to an average.

In Denmark, the wind mainly comes from the west and this means that the noise near a road which goes north-south will be somewhat higher on the easterly side of the road than on the westerly side of the road. The difference can be of the order of 2 dB measured some hundred meters from the road. Close to the road there is no difference in the noise level on the easterly or western side.

SCREENING OF NOISE

Buildings, noise barriers, earth berms, hills in the landscape and dense forest can screen for noise. Closely constructed blocks of apartments can reduce the noise by 20 dB or more in the courtyard areas of constructions, whereas noise is only reduced a little in widespread constructions. Noise barriers and earth berms can reduce noise up to 10 dB, in some rare cases up to 15 dB.

The noise reduction is always greatest just behind the screening object and is reduced at a greater distance. In general, noise will travel straight through plantations, but a dense forest (f x with coniferous trees) can reduce noise.

Hills in the countryside must be high to reduce noise appreciably, because the sound waves are distributed in bent paths and therefore have a tendency to travel over a hill, which is at some distance from the road. For the same reason, noise barriers must preferably be placed as close to road as possible or close to the area, where the noise should be lowered. When the noise is screened, it becomes lower, but also sounds somewhat differently.

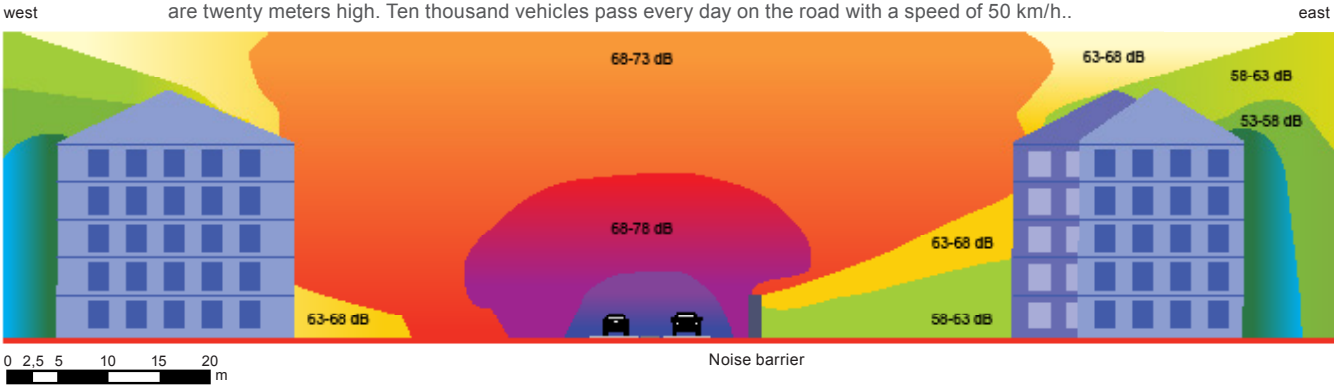
Passages of lorries will become more pronounced in the general noise picture even though the total noise level is lower. Noise calculations will always take buildings, noise barriers, earth berms, etc. into account, which reduce noise.

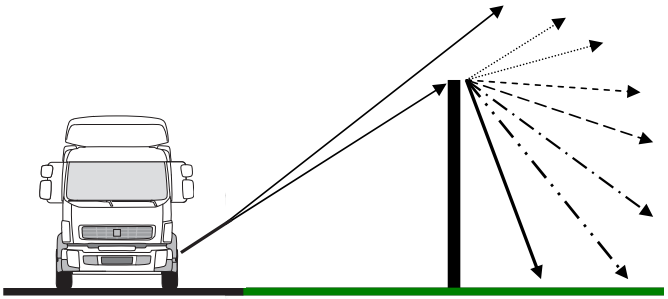
Figure 19: How much a noise barrier reduces the noise depends on local conditions, but it can never remove noise, only lower it. Barriers and berms work best for housing, which is nearby. The bigger the distance, the less the effect.

The illustration in Figure 20 shows an example of the effect of a noise barrier. On the right side of the road a three meter high noise barrier has been constructed. On the left side of the road there is no noise barrier. The important issue for the effect of the barrier is that the barrier stops the direct propagation of the sound from various noise sources to the receiver. If noise levels are compared on the left and right side of the road, one can clearly see the effect of the barrier on the block of flats.

Noise barriers are most effective for homes on the lowest floors and it is in general difficult to reduce noise noticeably for homes above the first floor. In such cases it may be necessary instead to carry out noise insulation of the facades.

Figure 20: The figure shows the propagation of noise with a three meter high barrier and buildings which are twenty meters high. Ten thousand vehicles pass every day on the road with a speed of 50 km/h..





Figur 21: A noise barrier has great effect on the high tones of noise than on low tones. Lorries give off more noise with low tones than passenger cars. Therefore, lorries are more clear in the noise picture even though the noise level is lower, when a noise barrier has been constructed.

ROAD PAVEMENTS

The road pavement has influence on how much noise there is emitted from the road. Noise reducing pavements can reduce the noise by 2-3 dB in relation to a traditional asphalt pavement. This does not remove the noise, but can reduce the nuisance, since it is in particular the high buzzing noise from the contact of the tyres onto the road surface which is reduced. When a worn road pavement is replaced by a new pavement, one will clearly hear the difference from before. The noise will then rise as the pavement becomes worn again. This also happens with noise reducing pavements, but the noise level remains somewhat lower all the time compared to a regular pavement.

The most commonly used noise reducing pavements are called thin layer pavements. Here small aggregate is used than normally. This gives the pavement a more even surface and a more open structure, which means that the tyre/road surface noise is reduced. Noise reducing pavements are expected to have a slightly shorter lifetime than normal pavements which have a lifetime of approximately fifteen years.

Figure 22: Special road surfaces can reduce the noise, but not as much as a noise barrier. On the other hand, the decrease is good for all the surroundings of the roads, not only for the people living behind the noise barrier.

SPEED AND ACCELERATION

There is an obvious connection between the speed of vehicles and the level of noise: the higher the speed, the higher the noise. It can be seen from Figure 23 how much the noise changes, if the speed on a road increases or decreases.
If the speed is decreased by 10 km/h, the noise is reduced by 1-1.5 dB. This is not a big decrease, but it is of benefit for everyone who lives or walks near the road. If the speed is reduced on a motorway, the noise effect is less than on other roads, because the speed of lorries will often be unchanged.

Uneven driving creates even more noise. Acceleration and braking create more noise than even driving.

Modern cars normally only produce a little more noise when accelerating, f x from an intersection, than during normal driving at even speed. However, strong acceleration and illegal exhaust systems can produce a lot more noise than normal driving and produce a great deal of nuisance for the neighbours of the road and those moving along the road.

Change in speed	Change in noise level
From 130 to 120 km/h	0.9 dB
From 120 to 110 km/h	0.9 dB
From 110 to 100 km/h	0.9 dB
From 100 to 90 km/h	0.9 dB
From 90 to 80 km/h	1.3 dB
From 80 to 70 km/h	1.4 dB
From 70 to 60 km/h	1.4 dB
From 60 to 50 km/h	1.5 dB
From 50 to 40 km/h	1.2 dB*
From 40 to 30 km/h	0.7 dB*

** At a decrease in speed to less than 50 km/h, a further reduction of 0.5 to 1 dB can be achieved if there are no or very few heavy vehicles, which frequently is the case on minor roads.*

Figure 23: The effect of a change in speed. It is assumed that there are 10 % heavy vehicles and a typical spread of traffic during the entire day. The noise-decreasing effect can be added, so that a reduction of speed from f x 80 km/h to 50 km/h reduces the noise by 4.3 dB.

AMOUNT OF TRAFFIC

Changes in the number of vehicles also have influence. But not as much, as one might believe.
F x, ten per cent more traffic only gives an increase of 0.5 dB, whereas a doubling of traffic will give an increase of 3 dB more noise. Further examples can be seen in Figure 14.

NUMBER OF HEAVY VEHICLES

Lorries and busses are known under the name of heavy traffic. Heavy traffic produces more noise than passenger cars and on major roads they are 10-15 % of the total traffic. Heavy traffic is therefore a major source of noise and is, in relation to passenger cars, responsible for approximately half of the noise from most major roads.

Heavy vehicles stand clearly out from other noise and are often experienced as especially irritating. In particular in towns, heavy traffic can be an important reason for noise nuisance. It can therefore be of great advantage for inhabitants, if heavy traffic is limited. In Figure 24 examples are shown how much the total noise can be reduced, if heavy traffic is limited.

Change in the part of heavy traffic	In towns with a speed limit of 50 km/h	On country roads with a speed limit of 80 km/h
From 5 % to 0 %	1.5 dB	1.0 dB
From 10 % to 0 %	2.5 dB	1.5 dB
From 15 % to 0 %	3.5 dB	2.5 dB

Figure 24: If heavy traffic is totally removed from a road stretch, the total noise will be lower. It is normally experienced as absence of lorries, which can be very clear in relation to the other noise. There are only few places where it is possible to limit or remove heavy traffic and normally not on major roads.

Distribution throughout the day

The traffic changes during the day. There is most traffic in the morning and afternoon hours and least traffic in the middle of the night. Also the speed of traffic and the composition changes typically during the course of a day. For example, on a motorway, there can be relatively more lorries at night. Also traffic noise is more of a nuisance in the evening and at night than during the day. Noise calculations take this fact into consideration.

Special conditions

Lorries and cars which are in poor condition can produce more noise than other vehicles. A legal motor bike produces four times as much noise as a normal passenger car and if it has an illegal exhaust, it produces even more noise.

Uneven tyres on the road and unevenness of the road pavement can also cause more noise than usual. Road bumps can be shaped, so that they do not produce additional noise, but the opposite can also occur. Such special conditions or individual occurrences are normally not taken into account when making noise calculations. Illegal vehicles are the responsibility of the police, whereas poor roads should be repaired by the local authority or the Danish Road Directorate.

WHAT ARE WE DOING ABOUT IT?

The Danish Road Directorate is continuously working to prevent and limit nuisance from noise on the main road network. Furthermore, we also work continuously with development of new and better methods to combat road noise and to disseminate knowledge to the Danish road sector.

Along the existing road network, work is being done to reduce noise problems where they are biggest and where as much noise reduction as possible can be obtained within the economic means. When new roads are constructed or existing roads are being improved, noise reduction is a part of the construction project.

NOISE CONTROL ON EXISTING ROADS

The Danish Road Directorate administers the financial resources, which the politicians set aside for noise control on the existing state road network.

From 1992 to 2008, the Danish Road Directorate has used over 300 mill. DKK (40 mill. €) to construct noise barriers and to a lesser extent finance façade insulation on the existing road network. More than 5,000 houses exposed to noise across the country have obtained less noise as a result of these efforts.

In the Government's agreement "A Green Transportation Policy" from January 2009, a total amount of 400 mill DKK

(53 mill. €) has been set aside up to 2014 to reduce noise problems along the Danish railways and roads by constructing noise barriers and noise insulation of houses, etc.

On the roads, the money will be primarily used on road stretches, where as many houses as possible, highly exposed to noise (more than 68 dB) can get an improved situation for the money invested.

It is not always possible to reduce noise by constructing noise barriers. This is the case in apartment blocks, where a barrier typically only protects the lowest floors. In those cases it is most appropriate to insulate the façade against noise to obtain acceptable noise levels indoors.

In connection with ordinary road maintenance and new constructions, the Danish Road Directorate uses noise reducing asphalt pavements where the traffic on motorways and other main roads has an impact in urban areas with a noise level over 58 dB.

NOISE CONSIDERATIONS WHEN CONSTRUCTING NEW ROADS

Noise considerations to the surroundings are an integral part of planning, when an existing road is extended or a new road is constructed.

In this way the noise efforts are prioritised on the main road network

- On existing roads housing areas with high noise levels are given high priority, where road noise exceeds 68 dB and where a maximum noise reduction can be obtained for the money spent.
- In road maintenance, noise reducing asphalt is used on road stretches which pass housing areas, which have a noise level above 58 dB.
- When constructing new roads or extending existing roads, an attempt is made to reduce noise for all-year housing and recreational housing, where the road noise exceeds 58 dB.

An attempt is made to reduce noise nuisance from roads as much as possible by constructing noise barriers and using noise reducing asphalt pavements. Nuisance from noise can – if possible – be prevented by placing the road as far away as possible from areas which are exposed to noise or by constructing the road below surface level.

When making new road constructions, the Danish Road Directorate tries to reduce noise in housing areas, child care

institutions, educational facilities, old age homes etc. where road noise exceeds the guideline values set by the Environmental Protection Agency of 58 dB. Also an attempt is being made to improve areas with summer cottages.

Home owners, who live with noise levels over 63 dB are normally offered noise insulation. This is the case if it is their permanent home where it either not appropriate to establish noise barriers or where a noise barrier would not have a sufficient effect. When carrying out sound insulation, it is attempted to reduce the noise level indoors to at least 33 dB, corresponding to the requirements made in the Building Regulations for new homes.

When the Danish Road Directorate constructs new roads, it is normally not the practice to make special noise protection of recreational areas or nature areas, but in special situations one diverges from this practice.

When carrying out new road projects, the noise reducing measures are a part of the construction budget,

RESEARCH AND DEVELOPMENT

In particular, noise reducing pavements are an important part of the research and development efforts in the Danish Road Directorate. Work is carried out with acoustics and structural durability, including optimisation of the noise reduction and development of completely new solutions, which also make it possible for local administrations to choose solutions with a documented noise effect for local roads. One important issue in this is development and practical use of a system to label asphalt pavements in relation to noise.

The Danish Road Directorate has for many years developed and tested noise reducing pavements in research projects in co-operation with the asphalt industry and local authorities, as also within EU projects and in collaboration with the Dutch road authorities. Today there is good documentation to show the durability and noise reducing effect of noise reducing pavements.

Figur 25 Road Directorate noise measuring trailer called DeciBellA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Road Directorate

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