The Dutch Road Noise Mitigation Program

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Summary

In July 2012 a new law on noise pollution along major roads entered into force in the Netherlands. This law contains three important elements of new noise legislation:

- the introduction of noise production limits;
- the stimulation of source related noise measures;
- the reduction of situations with high noise exposure.

The first two elements deal with the prevention of new high noise levels occurring after introduction of the law. The third element concerns the reduction of noise for existing situations that already experience high levels of road noise from major roads in the Netherlands. To deal with the third element the Dutch National Road Authority developed the Dutch "Road Noise Mitigation Program". This program consists of 3 projects in which noise mitigation measures (noise reducing pavements, noise barriers, noise insulation of houses) are designed and will be taken along all major roads in The Netherlands. This paper deals with the first pilot project MJPG 1 of the program and discusses the first's results. In this project the Dutch cost benefit analysis method is used as a decision tool for designing noise measures

PACS no. 43.50.+Y

1. Introduction

In July 2012 a new law on road traffic noise was introduced in the Netherlands. This law "Wet Milieubeheer" [1] replaces parts of the existing law on noise "Wet geluidhinder" [2]. The new law contains three key elements. The first element is the introduction of noise production limits along major roads and railways. The second element is the promotion of the use of source related noise measures like reduction of vehicle and tyre noise and noise reducing pavements. The third element is the reduction of existing high noise levels.

In this paper the first two elements are described in a global way in chapter two. This is necessary to understand the working of the system and methods that are also applied in the working process of the third element. The third element is the main subject of this paper and is described in detail in chapter 3. Whereas the first two elements are related to the prevention of traffic noise exceeding limit values, the third element is related to the reduction of traffic noise at locations where the noise from major roads and railways is already exceeding limit values.

To deal with the excessive noise on these last locations, a national program of noise mitigation was introduced by the Dutch Government. This program is called "MeerJaren Programma Geluidsanering (MJPG)" [3], and is best translated in English as "Long Term Noise Mitigation Program".

The first pilot project (MJPG 1) in the program covers regions in the north and south of the Netherlands and started in July 2012 and will finish in 2016. The other 2 projects covering other parts of the Netherlands started in the beginning of 2014 and will finish in 2018. The goal of the total program is to realise the noise mitigation measures by 2022.

2. Prevention of Road Traffic Noise

2.1 Noise Production Limits

The aim of introducing the noise production limits (NPL) is to restrict the increase of traffic noise caused by the yearly growth of traffic volume. Under the "old" Law on Noise the traffic volume and along with it the traffic noise could grow unlimited if no physical changes were made to the road itself. This "gap" in the existing Law on Noise in the Netherland was recognised by politicians in the early years of the 21st century. In July 2012 this gap was repaired and the NPL were introduced. The NPL are monitoring points along all major roads in the Netherlands at 50m distance on both sides from the road every 100m. At each point the traffic noise is monitored each year and if the noise level exceeds the NPL noise measures the Road Administration is legally obliged to take preventive noise reduction measures.

2.2 Stimulating the use of source related noise measures

The introduction of the new law facilitates the promotion of the use of source related noise measures in three different ways.

- The law requires the use of a "minimal acoustic quality" of road surface (being single layer porous asphalt) in the case of newly built roads and reconstruction of existing roads.
- Generic lowering of all NPL based on lower emission values for tyres and vehicles that are the results of EU regulations.
- The system of NPL is in itself an incentive for the use of source related noise measures because of simplified procedures.

2.3 Noise Mitigation Program

Whereas new situations of excessive noise are restricted by the NPL, the existing situations with high noise levels were not solved. At the moment of introduction of the law a great number of houses already experienced high noise levels from traffic noise above the Noise limit values of 60 and 65 dB(A). For these houses noise measures should be investigated. This investigation of the possible noise measures for existing roads culminated in the Dutch Road Traffic Noise Mitigation Program.

3. Road Noise Mitigation Program

3.1 Total Program

In 2011 a general survey [4] was held to estimate the scope of the program. The survey concluded that the scope of the total program consists of 2,5 km^2 double layer porous asphalt, 24,3 km of noise barriers and 1390 houses that needed noise insulation. Because of the size of the scope the total program was divided into 3 separate projects. The first (pilot) project MJPG 1 containing Northern en Southern regions in the Netherlands started in July 2012 and will finish in 2016. The second and third project containing the other regions in the Netherlands started in 2014 and will finish in 2018.

3.2 Project MJPG 1

Project MJPG 1 is carried out by a consortium of three major engineering companies in the Netherlands which is led by "AnteaGroup". Project MJPG 1 is an integrated project containing the following activities:

- building the acoustical calculation models for the different sections of major roads;
- calculating and analysing the noise levels on individual houses along the sections;
- developing noise mitigation measures and performing cost benefit analysis on the noise measures using the Dutch CBA tool;
- communication with stakeholders (municipalities, individual people) about the proposed noise measures;
- design and cost calculation of the noise measures;
- legal advice;
- project management (risk- and quality management, planning, budget control)

The first step in the project is to establish in detail the number of houses that are part of the program. The houses involved are divided into 3 categories:

- Category 1 "BSV": the houses built before 1986 and a noise level of 60 dB(A) and higher;
- Category 2 "NoMo": the houses indicated in the policy document "Nota Mobiliteit" [5] with a noise level of 65 dB(A) and higher;
- Category 3 "GGG": the houses with a noise level of 55 dB(A) and more, which experienced an increase in noise level of at least 5 dB(A) in the period 1986 - 2012.

The second step is to develop noise mitigation measures (noise barriers, noise reducing pavements and façade insulation) for the houses involved in the program. To investigate the cost effectiveness of these measures the Dutch cost benefit analyses method is used.

3.3 Dutch cost benefit analysis method

The Dutch cost benefit analysis method is part of the new law on noise and therefore mandatory for the major roads.

The method is described in detail in the Dutch publication "Kader Doelmatigheidscriterium Geluidsmaatregelen" [6] and is based on a system of so called "reduction points" and "noise measure points". The number of houses and their noise levels determine the number of reduction points that are available for noise measures. From the total budget of reduction points for a group of houses, noise measures can be "bought", up to the maximum level of the budget. The "costs" of the noise measures is determined by a standardised system of "noise

measure points" that are related to the size of the noise measures.
The (combination of) noise measures to reduce the noise at a group of houses costs "noise measure points" and if the budget of "reduction points" is exceeded the measure will no longer be cost effective. The system deliberately uses "points" instead of "Euro's" to avoid discussion over actual costs which might fluctuate under influence of economic market conditions.
The budget of available "reduction points" per house increases if the noise level is higher. For example: a combination of 2 houses with noise level of 65 dB(A) resp. 66 dB(A) will lead to resp. 5.000+7.800= 12.800 points.
In the same way noise abatement measures will cost points. For example: a noise barrier with a height of 3 meters will cost 133 points per meter length. Thus a simple noise barrier with a length of 100 meters and a height of 3 meter will cost 13.300 points. In this example the total budget of 12.800 point, is not enough to "buy" a noise barrier with a length of 100 meter and a height of 3 meter. So, according to the method, this barrier is not an effective noise measure.
The most important rule in the method is rule number 1, which regulates that the noise measure that will be applied is designed in such a way that the noise level on the houses is decreased (as far as possible) to the preferred noise limit value of 60 dB(A) and no further. If the preferred noise limit value is reached within the budget the measure is considered effective and a survey into higher noise barriers is not needed even if there is budget left.
For noise barriers, or noise barriers in combination with noise reducing pavement, an additional rule was introduced ordering that the noise reduction, from (the combination) of measures, for at least 1 house in the group should be no less than 5 dB(A).
Rule 3 of the method is a rule to prevent that irrational noise measures should be applied in case the available budget of reduction points is relatively high. One can imagine that in a large residential area with many houses with high noise levels the budget of reduction points may be quite large (some millions!). Rule 3 regulates that the addition of an extra noise measure (for example 1 meter extra height of a noise barrier) should still give a relevant contribution to the noise reduction of the houses involved. If an alternative noise measure leads to 95% of the noise reduction of the alternative that uses the total budget of reduction points, the 95% alternative will be considered as the most effective one.

When more than one (combination of) measures is possible within the budget and require more or less the same number of points, the most effective measure will be the one with the highest noise reduction index. The noise reduction index (1) is determined by adding up the number of houses with the same noise in a cluster reduction multiplied with their noise reduction.

$$NRI = \sum_{i=1}^{n} (Hi * NRi) \qquad (1)$$

NRI = Noise Reduction Index
H = Number of houses with the same noise reduction in a cluster
NR= Noise Reduction in dB(A)

3.4 Designing optimized noise measures using the Dutch cost benefit analysis method

The working of the method is demonstrated in the next example.

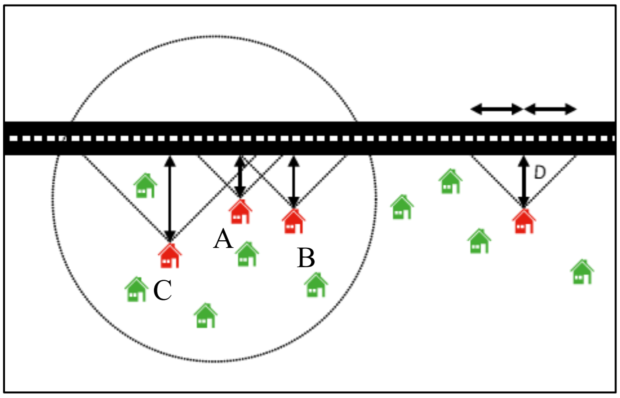

Figure 1. Clustering the houses

In the situation shown in figure 1, first of all according to rule 1, the number of houses that don't comply with their noise limit value is determined. In the figure these houses are marked red. The houses marked green don't need noise abatement measures because they comply with the noise limit value (rule 1).
To get a coherent set of noise measures, the houses (red) with a noise level that exceeds the noise limit value, are clustered using the 1D view angle method. All buildings with overlapping view angles (A, B and C in figure 4) are combined into one cluster. In the situation above the buildings will be divided into 2 clusters. The clustering is performed to prevent that irrational noise measures are developed. The buildings in the 2 separate clusters are too far apart to form a logical group for one integrated noise measure. In this example the

buildings in cluster 1 (A, B and C) are each supposed to consist of 2 connected houses, so the total budget is calculated for the total number of houses. Building D in cluster 2 is just a single house. In table 1 the actual noise levels, the preferred noise limit values and the reduction points for the red houses in cluster 1 (encircled) and cluster 2 (single house) are given.

Table 1 – Noise levels & reduction points

Houses (#)	Actual noise level	Noise limit value	Reduction points
Cluster 1			
Houses A (2)	66	60	15.600
Houses B (2)	65	60	5.000
Houses C (2)	63	60	4.400
total			34.400
Cluster 2			
House D (1)	65	60	5000
total			5000

The road consists of 2x2 traffic lanes and the standard width for applying porous asphalt for this type of road is given in the method as 15 meter.

The possible alternatives for noise measures to consider for cluster 1 are:

1. Two layer porous asphalt (the method requires a minimum length of 500 meter related to maintenance requirements);
2. A noise barrier (the method requires a minimum height of 2 meters, below this height noise barriers are considered not effective).
3. A combination of two layer porous asphalt and a noise barrier.

The next step in the process is to design and optimize the measures for the alternatives above within the available budget. Ideally noise measures like porous asphalt and noise barriers are considered most effective if they cover the 2D view angle of the houses which they are designed for. The total length to cover based on this view angle would be 400 meter. As the minimum length of two layer porous asphalt (TLPA) is 500m, the first alternative consist of applying TLPA over the full length and width of the both lanes (500m x 15m). In table 2 the noise reduction in dB(A) and the costs in noise measure points are shown. The noise reduction is 3 dB(A) for each building and the measure costs 16.500 points. This is well within the budget but only for building C the preferred noise limit value is reached and there is still budget left. Although we comply with rule 2 (costs within the budget) we don't comply with rule 1, trying to reach the preferred noise limit values if there is still budget available.

Table 2 – Noise measure alternative and effectiveness

Alt.	Measure(s)	Costs (pts.)	Noise reduction (dB(A))			Noise Reduction Index
			A	B	C	
1	TLPA 500m	16.500	3	3	3	18
2	NB l=250m h=3m	33.250	5	4	3	24
3	TLPA 500m &	16.500	3	3	3	28
	NB l=190m h=2m	17.670	3	2	1	
	Total	34.170	6	5	4	

In alternative 2 we are looking for a noise barrier instead of using the TLPA from alternative 1. The ideal length would be 400m (full 2D view angle covered). But with a minimum height required of 2m this alternative costs 37.200 points which exceeds the budget. Also with 2m height none of the buildings will have a noise reduction of 5 dB(A) (and this is required for at least one house). It is therefore not necessary to calculate this alternative in detail, but is it possible to optimize this alternative? Following the method from the other end we just look at a design for a logical solution that fits into the budget and the rules. If we limit the length of the noise barrier and increase the height (to deal with the 5 dB(A) requirement) a possible solution is a noise barrier of 250m and 3m height. This will cost 33.250 points and gives more noise reduction than alternative 1, but still the preferred noise limit values for A en B are not reached (see table 2). Increasing the height or length to reach the preferred noise limits values for A en B will cost more points and these are not available because the budget is spent.

Alternative 3 is a combination of TLPA and a noise barrier. We learned from alternative 1 that with

TLPA, building C has reached its preferred noise limit value, so no noise barrier is needed for this building. For the remaining two buildings a total cover over 2D view angle requires a length of 220 m, with a minimum height of 2m, the budget needed is 20.460 points. This exceeds the remaining budget of 17.900 (budget after applying TLPA). As in alternative 2 it is possible to optimize the length of the noise barrier. With a height of 2m a length of 190m is possible within the budget. In this alternative the preferred noise limit value on all buildings is reached (see table 2), also on at least one house the required minimum of 5 dB(A) noise reduction is reached for a noise barrier in combination with noise reducing pavement.
Although the number of points required is slightly higher in alternative 3, compared to alternative 2, the combination of measures in alternative 3 is the most cost effective one, as it remains within the budget, all houses reach their noise limit value and the total of noise reduced houses (Noise Reduction Index) is the highest (index of 28[1] compared to 24 for alternative 2 and 18 for alternative 1).

Cluster 2 is much simpler because the budget of available reduction points is only 5000. This budget is not sufficient to "finance" any measure at all. TLPA requires minimum length of 500m and will cost 17.600 points which is well above the budget. With a minimum height of 2m the maximum length possible for a noise barrier is 50m. As the house is 50m away from the road this will not lead to the required noise reduction of 5 dB(A). No further survey is needed.
This example shows how the method works and leads to cost effective noise measures. Non logical, insufficient and ineffective noise measures will be directly removed from the possible alternatives. In this way the actual costs of the noise measures will be less than without using the cost benefit method.

3.5 Results from the Zeeland region

The examples in 3.4 are fictitious situations, so the question rises; does the method also work in practice? This is highlighted using the actual results from the region Zeeland of MJPG 1. The Zeeland region is the pilot region within the project because it is one of the smallest regions and in the planning this region was the first to be surveyed. In the beginning of 2014 the first results for Zeeland were available. The first results contained the objects with actual noise levels above their noise limit value and an initial clustering. In Zeeland only two major roads needed to be surveyed; the major road A58 from Bergen op Zoom to Vlissingen and the N59 from Bruinisse to Burgh-Haamstede.
In this paper 1 (out of 9) locations along the A58 is presented, it concerns a location near the city of Middelburg (Arnemuiden). The location consists of one large cluster containing 60 houses with a noise level above the noise limit value. For this cluster the budget of available reduction points was established and the process of designing optimized noise measures as described in 3.4 was followed.
The total budget of reduction points available is 315.900. With a 2D view angle of 900m a maximum solution for this cluster could be 900m of TLPA combined with a noise barrier of 900m with a height of 7m. The CBA showed that this solution is an overkill for this location, because with a combination of TLPA and a noise barrier of 5m high all houses already meet their preferred noise limit value (rule 1).
At this stage of the process a further step in the optimization was taken by introducing integrated design. For this location all the requirements from the different stakeholders including the municipality were introduced in the designing process. Meetings were held to discuss the possible alternatives within the margins of the CBA method and taking into account other aspects like technical engineering problems, aesthetics, design, traffic regulations etc. In these meetings experts from the Road Administration departments of road maintenance, communications, technical engineering & design and acoustics were present.
Two specific requirement were important. The rest area (parking) must stay accessible for cars, in earlier stages is was thought that the rest area could be abandoned. Secondly from an aesthetic point of view the noise barrier should be of transparent material and of reclining type because of possible noise reflections. These and other minor requirements determined the final location, shape and heights of the noise barrier. This final solution consists of the application of 660m TLPA and 2 noise barriers of 2 to 5 m high and a length of 175 m at the parking place and 350m along the main road.
The total actual costs based on standardised cost figures are estimated as follows:

[1] Noise reduction under the preferred noise limit value are not calculated in the NRI

- Alternative 1: 900m TLPA and 900m noise barrier 7m high € 3.580.000
- Alternative 2: 900m TLPA and 900m noise barrier 5m high € 2.645.000
- Alternative 3: 660m TLPA and 570m noise barrier (varying heights) € 1.381.000

If these alternatives are compared on estimated actual costs it becomes clear that not only the "best fit" and integrated solution but also the alternative with the lowest estimated costs has the preference.

4. Conclusions

The project MJPG 1 is the first pilot project within the "Dutch Road Noise Mitigation Program" and is well on its way. The use of CBA method in an integrated design process leads in all regions to optimised and cost effective noise abatement measures and the following conclusions:

- Less survey is needed as incoherent, non-logical alternatives are not investigated in detail;
- Less costs are spent on detailed survey and investigating "oversized" noise measures because the method leads to the "best fit" solution of noise measures;
- The "best fit" solutions of noise measures lead to less costs compared with traditional methods of designing noise measures;
- The CBA method is embedded in the legal system of the new law on noise which gives it a strong position against objections made in legal procedures;
- The method contributes to the general use of source related noise measures, like noise reducing pavements, because these are always considered as first option in the process.
- The design process leads to an integrated design of noise measures, which take other aspects and requirements from stakeholders into account.

References

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