



Costing the Benefit of Low Noise Surfacing

Matthew Muirhead¹

AECOM

Midpoint

Alençon Link

Basingstoke

RG21 7PP

UK

ABSTRACT

Low noise pavements are an important mitigation measure in the drive to minimise the impact of traffic noise on all our lives. The benefit provided by such surfaces is an important element of any associated life cycle cost analysis. There are existing methodologies for monetising the relative noise reductions from quieter pavements in terms of the societal cost of the associated health benefits. However, this approach requires input data on the potential reduction in exposure to traffic noise. For a particular road scheme such data are often derived from a detailed noise model, but this is not possible when considering potential benefits at a regional or national level. This paper examines potential approaches in estimating the comparative reduction in traffic noise exposure between different surface types at this strategic level. This includes methods for considering population density, noise exposure and the extent to which a low noise surface will impact the surrounding sound environment.

1. INTRODUCTION

Road traffic noise pollution is acknowledged as widespread environmental health hazard with over four times as many people in Europe estimated to be affected by high levels of road traffic noise than by rail, aircraft and industrial noise put together [1]. Therefore, it is important for road authorities to consider appropriate traffic noise mitigation as part of their strategic planning. A low noise road surface is an excellent form of mitigation with respect to road traffic noise since it is effective at reducing the sound at source, often by several decibels, and does not impinge upon visual amenity in the way that a noise barrier might. However, the resurfacing of roads can be costly and can require temporary traffic diversions. Additionally, the long-term maintenance of the surface must be considered as a factor influencing the practicability and sustainability of the resurfacing exercise.

It is therefore common practice to consider the potential for the implementation of low noise road surfacing through the means of a lifetime cost-benefit analysis. Costs can be estimated from knowledge of the associated labour and materials, required road closures or traffic management, and expected maintenance and lifetime of the surface. Corresponding benefits may relate to a number factors including changes in particulate matter from different levels of tyre wear to changes in carbon emissions during construction and changes in fuel consumption relating to rolling resistance. Benefits

¹ matthew.muirhead@aecom.com



relating to noise are typically estimated from the health impacts of expected changes in noise exposure to the general population [2].

The monetisation of changes in traffic noise is based upon studies into the effect of noise on sleep disturbance, amenity, acute myocardial infarction, stroke and dementia risk. However, before these effects can be quantified it is necessary to understand the potential extent of the change in noise exposure brought about by the strategic use of low noise surfacing. This paper considers three key parameters that feed into the calculation of the expected change in noise exposure and the different ways in which they may be estimated given the constraints of the study. This presents an interesting challenge since a detailed traffic noise model, which may be available at a scheme design level, is unlikely to be available at a strategic planning stage and therefore cannot be used directly to calculate changes in noise exposure from changes in road surfacing. On the other hand, set against all the other factors under consideration at a strategic planning stage the level of accuracy provided by a detailed noise model may not be required.

2. KEY PARAMETERS FOR A BENEFIT ANALYSIS

Costing the benefit of an intervention with the potential to change noise exposure levels, such as introducing low noise surfacing, requires the understanding of certain key factors that frame the impact on people's health. These are described in the following sections.

2.1. Impacted Population

The societal cost or benefit of changes in traffic noise is, first and foremost, directly related to the number of people exposed to such a change. Typically, such as in the UK's Transport Analysis Guidance (TAG) [3], this is analysed in terms of the number of residential households considered to be impacted. In order to estimate the number of residential households potentially impacted by a resurfacing exercise it is necessary to create a study area around the extent of the road network under consideration and examine the population density inside the study area. Methods for estimating the study area and associated population density are discussed in Section 3.

2.2. Absolute Traffic Noise Levels

The epidemiological studies upon which the monetisation of changes in noise exposure are based carefully consider the absolute levels of noise to which people are exposed, with greater health risks apparent at higher noise levels. As such changes in noise have a greater monetised impact at higher absolute noise levels. Therefore, any estimate of the potential benefit provided by low noise surfacing needs to consider the absolute noise levels to which the impacted population are already exposed. These noise levels will depend upon the local environment, such as ground type and elevation, intervening buildings, and other noise sources. Methods for estimating these levels at a strategic scale are discussed in Section 3.

2.3. The Relative Performance of the Road Surfaces

The final key parameter to consider is the relative noise reduction offered by the low noise surface when compared to the surface being replaced. Crucially this needs to be considered at the façade of the residential properties in the study and not just in terms of the change in the tyre noise at the source of the sound.

The relative acoustic performance of the road surfaces at source may be derived from standardised methodologies for measuring the influence of road surfaces on traffic noise, such as the Statistical Pass-By (SPB) and Close ProXimity (CPX) procedures [4, 5]. Understanding how much of the reduction in traffic noise afforded by the low noise surface is realised at residential properties in



the study area is more challenging since this will depend upon the detailed nature of the local environment, in particular traffic noise from vehicles on other roads, which will dilute the impact of the noise reduction afforded by the resurfacing. It is not possible to determine these local conditions precisely without a detailed traffic noise model and Section 3 discusses approaches that may be taken at a strategic level in the absence of this information.

3. ESTIMATING THE KEY PARAMETERS AT A STRATEGIC LEVEL

This section considers how the parameters presented in Section 2 may be estimated for the purposes of a strategic study into the potential reductions in noise exposure resulting from using quieter road surfaces. It discusses potential avenues for improvement in these methods as well as ongoing work into strategic noise modelling systems that could eventually facilitate a much greater degree of accuracy in estimating a wide range of local and regional interventions to reduce traffic noise.

3.1. A Top-Level Appraisal

The distance from a given road at which changes in road traffic noise may be perceived will vary greatly with local meteorological and ambient sound conditions. Nevertheless, knowledge of the region or country in the vicinity of the road network to which the strategic planning pertains will go a long way to understanding the likely geographical spread of changes in noise exposure. Experience with noise mapping and noise modelling, consideration of the validated ranges of road traffic noise calculation methodologies, and an understanding of the likely magnitude of the noise reduction resulting from the resurfacing exercise can also assist in estimating the study area.

For a top-level appraisal it may suffice to pick a fixed distance from the road beyond which reductions in traffic noise from that road would not be expected to change the local ambient sound environment. For rural areas this could be several hundred meters and for urban areas this could be much less.

Given such a study area, typical associated population densities may be derived from national data sets such as those gleaned from census information. For example, in the UK, population density figures for local authority areas are available from the Office for National Statistics [6]. It may be necessary to filter these data based upon the location of the road network under consideration in the strategic planning exercise. Since exposure to the noise level change is critical to costing the benefit to society and population densities can vary greatly between urban and rural regions it can be instructive to consider a sensitivity analysis based around chosen centiles within the population density figures.

Absolute traffic noise levels throughout the study area may be approximated from simple calculations based upon the likely volume and speed of traffic on the road network and distance from the road. The inaccuracies in this approach will be more pronounced at greater distances where intervening buildings reduce the noise from the road and local noise sources will provide a greater contribution to the sound environment. Nevertheless, these two factors push the expected absolute noise level in opposing directions and such an approximation may be suitable for strategic planning purposes.

Reductions in noise exposure throughout the study area, resulting from given reductions in the roadside traffic noise level, will depend upon the local environment. However, it is clear that houses close to the road are more likely to experience the full benefit than those further from the road where other noise sources, which have not been reduced, dilute the overall noise reduction. Therefore, a starting point for estimating the noise reductions at properties in the study area is to assume that properties close to the road receive the full noise reduction and properties outside the study area receive no benefit. This range in noise reduction can be interpolated over the number of properties in



the study area as a first approximation to the experienced benefits. This approach implicitly assumes that properties are evenly distributed throughout the study area in terms of their distance from the road. The following subsections highlight potential methods for cutting down on some of these assumptions through more detailed analyses.

Finally, if a lifetime cost-benefit analysis is being considered, it may also be necessary to calculate noise exposure changes in years further into the future. For example, the UK TAG requires noise exposure changes to be estimated both at the time of the intervention and 15 years later. In terms of the size of the population exposed to these changes in the future year, unless significant regional development is planned, it may not be necessary to adjust this value. Similarly, unless there are planned strategic road building projects likely to introduce new road traffic noise sources, the absolute noise exposure of the population is likely to remain at a similar level since traffic noise does not increase by noticeable amounts from small percentage increases which may result from year-on-year growth in traffic numbers. In addition, large increases in traffic volume can lead to congestion and a reduction in mean traffic speed which could result in minimal change (or even a reduction) in traffic noise.

Arguably the largest impact in change to noise exposure in future years will come from the relative acoustic degradation of the road surfaces under consideration. The acoustic performance of low noise surfacing materials can degrade over time, and it is therefore important that the durability of the surfacing products is considered within the analysis of the benefits as well as the costs. Fortunately, numerous studies have been carried out to analyse measured data on low noise road surfaces of differing ages so this effect can be quantified [7].

3.2. Potential Enhancements to a Strategic Appraisal

Depending upon the nature and location of the strategic study there may be various opportunities for improvements to the estimations surrounding population exposure, absolute noise levels and the change in noise experienced.

For example, it may be possible to run several test calculations for typical urban and rural road and building layouts to help inform the size of the study area. Rather than work from population density figures, residential properties within the study area could be mapped using Geographic Information System (GIS) software, leading to a definitive number of households likely to be impacted by the chosen intervention.

Absolute traffic noise levels could be informed by such test calculations and, for countries within the European Union (EU), cross referenced against road traffic noise maps produced under the Environmental Noise Directive (END) [8]. Test calculations could also inform refined assumptions on the relative benefit of the resurfacing as experience by residents. Differing amounts may be defined based upon varying population densities throughout the study area and not just upon the distance of properties from the road network.

3.3. A Road Map to a Full and Detailed Appraisal

The END and subsequent directives on its implementation, see [9, 10, 11], have provided a framework for the strategic mapping of road traffic (and rail and industrial) noise. This is an excellent starting point for not just meeting the requirements of the END (for those countries it applies to) but for also performing strategic based analyses on the potential impacts on noise exposure of major interventions such as the use of low noise surfacing as discussed in this paper.

In the UK, Defra (Department for Environment, Food and Rural Affairs) has responsibility for meeting the requirements of the END and as part of the latest round of mapping has recognised the potential for the wider benefits of such strategic noise models. Work is currently ongoing on a modelling system, with the aim to:



“...supplement core minimum requirements with improved and/or additional datasets, either at a national strategic level, and also at a more focussed, regional or local level.”

It is hoped that this will provide an important and useful resource for all strategic interventions with an impact on noise exposure in the future. It may not be proportionate to use such a modelling system for all interventions as data collection and calculation times may be considered prohibitive, especially if noise exposure changes are expected to be minimal. Nevertheless, it will showcase the importance of detailed three-dimensional environmental noise modelling and how the nature of our local environment impacts the sound around us all.

4. CONCLUSIONS

From this examination of some of the key parameters impacting the benefit of low noise surfacing in terms of noise reductions within the environment, the complexity of a cost-benefit analysis regarding strategic infrastructure interventions may be inferred. Even without considering any factors beyond noise or the ongoing research into how noise exposure impacts health (and how this may be costed) there are other parameters that could influence the benefit of noise mitigation measures such as low noise surfacing. These include:

- the consideration of the benefits to noise sensitive, non-residential buildings and places such as hospitals, schools, parks and tranquil spaces. These benefits are more challenging to capture accurately as people do not typically spend as much time in these locations as at home but not evaluating them is certainly underplaying the benefit of measures such as low noise surfacing.
- the relative noise levels and impacts during both the daytime and night-time. The assumption of a typical diurnal profile to the traffic flow, often used at a strategic level, may not be applicable in certain scenarios, such as for a road that leads to distribution hub and facilitates overnight delivery vehicles.

Finally, it is important to keep a sense of perspective in any such analysis where it forms a small part of a larger picture. It may not always be necessary to understand the noise exposure impact in detail if the costed benefits resulting from this are orders of magnitude lower than other effects. However, as noise modelling systems, computer processing power and the understanding of the impact noise exposure can have on health all continue to improve we are better placed than ever to highlight the importance of noise mitigation to society.

5. REFERENCES

1. European Environment Agency, *Environmental Noise in Europe 2020*, EEA Report No 22/2019, 2020.
2. Defra, *An Economic Valuation of Noise Pollution – developing a tool for policy appraisal*, First report of the interdepartmental Group on Costs and Benefits, Noise Subject Group, 2008.
3. Department for Transport, *TAG Unit A3 Environmental Impact Appraisal*, Transport Analysis Guidance, 2019.
4. International Standards Organisation, *Acoustics – Measurement of the influence of road surfaces on traffic noise – Part 1 Statistical Pass-By method*, BS EN ISO 11819-1:2001.
5. International Standards Organisation, *Acoustics – Measurement of the influence of road surfaces on traffic noise – Part 2 Close Proximity method*, BS EN ISO 11819-2:2017
6. <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2020>, Accessed April 2022.



7. Tollenaar C., van Blokland G., van Loon R., QUESTIM - *Report on Acoustic Aging of Road Surfaces*. The Netherlands: CEDR (2014).
8. The European Parliament and Council of the European Union, *Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise – Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise* (2002).
9. The European Parliament and Council of the European Union, *Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*, OJEU L 168 of July 2015
10. The European Parliament and Council of the European Union, *Corrigendum to Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council* (Official Journal of the European Union L 168 of 1 July 2015), OJEU L 5, 2018.
11. The European Parliament and Council of the European Union, *Commission Delegated Directive (EU) 2021/1226 amending, for the purposes of adapting to scientific and technical progress, Annex II to Directive 2002/49/EC of the European Parliament and of the Council as regards common noise assessment methods*, C/2020/9101, 2020