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# ROAD TRAFFIC NOISE FROM AN URBAN MOTORWAY: A SPECIAL CASE

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## 1. SUMMARY

The objective nature of assessing road traffic noise was quantified by the publication in 1975 of the "Calculation of Road Traffic Noise" memorandum (CRTN). This covered most aspects of everyday traffic noise situations, but inevitably one or two shortcomings became apparent as its use became more widespread. Public Inquiries into new trunk road schemes highlighted some of these.

The revised CRTN [Ref 1] was published in 1988 and this has addressed the effect of road surface type and texture depth in empirical terms and also the noise impact due to low volumes of traffic flow. There remains, however, one case which we consider has not been adequately covered. This paper considers a particular case where the far carriageway of a motorway is visible over the top of a purpose built noise barrier from windows of some houses, but because the central reserve is narrow, less than 5m wide, the CRTN states that the total traffic should be considered to flow along a single source line 3.5m from the edge of the nearest carriageway. This source line is well hidden behind the noise barrier from those houses.

This paper evaluates a hypothetical situation which can affect a large number of nearby residents in an already sensitive area. It recommends that under certain conditions the traffic noise should be calculated using two source lines, one for each carriageway, and the noise from each should then be combined to obtain the overall noise level. Currently, this method is conditional only upon the central reservation being 5m or more in width or when the carriageways are vertically separated by more than 1m.

## 2. INTRODUCTION

Public awareness of road traffic noise has become widespread and the first statutory quantitative method of traffic noise prediction was outlined in "New housing and road traffic noise" [Ref 2], this was followed by the publication of CRTN in 1975. The method was revised in 1988 and this publication included some new corrections. However, there still remain one or two situations which we consider not adequately covered by CRTN.

In this paper, a hypothetical case is discussed which shows that traffic noise assessed under the present method is slightly under-estimated in certain circumstances. A better noise assessment is proposed whereby the traffic flow is separated for each carriageway and the noise contribution is calculated and then combined to obtain the total noise. Since this method is already given in the CRTN this paper proposes that another condition should be added in its terms of application.

## 3. THE PROBLEM

This particular example is based on a problem we experienced recently during a reassessment, as a result of the revised National Road Traffic Forecasts, of a current road widening scheme. The data used is, therefore, real and not something just invented for the sole purpose of this example.

For the prevailing situation the road was a dual two lane carriageway of 7.3m width and 4.5m central reserve. There was no significant hard-shoulder but there was a 3.5m verge. There was no noise barrier installed.

For the relevant situation the road is widened to a dual three lane carriageway of 11m width with a central reserve of 4m, 3.3m hard strip and 1.5m verge. A 3m noise barrier to mitigate the noise impact on nearby dwellings was incorporated alongside one carriageway. A typical cross-section of the new road is given in Figure 1.

The method in CRTN 1988 must be used to determine if a residential property qualifies for an offer of sound insulation under the Noise Insulation (Amendment) Regulations [Ref 3]. This method states that if the central reservation of a dual carriageway is less than 5m then "the flow of traffic in both directions shall be aggregated to obtain the total flow" [Ref 1, p5]. In effect only one source line should be used, positioned 3.5m in from the nearest carriageway and 0.5m above the road surface. If alternatively the two carriageways are separated by more than 5m then "the noise level produced by each of the two carriageways shall be evaluated separately and combined". One of the two source lines is positioned as described above and the other is 3.5m in from the edge of the far carriageway.

Trial calculations indicated that at properties where the far carriageway was visible over the top of the noise barrier, levels calculated using a single source line could be significantly lower than those calculated using separate source lines, one for each carriageway. To explore the effect further, calculations were made over a range of intervening ground slopes and receiver distances.

Data used for calculating the noise levels are given in Figure 2. Calculations were undertaken for both the old and the new roads, as described above, and for dwellings located 50m, 100m, 150m and 200m from the edge of the nearest carriageway. The intervening ground has been taken to slope at -20%,-10%, -5%, 0%, 5%, 10% and 20%. Negative gradient refers to ground sloping downwards away from the road.

For the purpose of this example the noise source has, in the first instance, been considered as the total traffic flowing on the nearest carriageway, and secondly half of the total traffic is taken to flow on each of the two carriageways. For separate carriageways the noise contribution from the traffic on each is determined and added to obtain the total noise at a particular receiver. The resulting noise levels for all of these cases are tabulated in Figure 3.

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## 4. RESULTS

The calculated noise levels are tabulated in Figure 3, as follows;

- Fig 3a Dual two lane road with all traffic considered on the nearest carriageway,
- Fig 3b Dual two lane road but with traffic separated onto each carriageway,
- Fig 3c Dual three lane road with a noise barrier and all traffic assumed on the nearest carriageway,
- Fig 3d Dual three lane road with a noise barrier and traffic separated onto each carriageway.

## 5. DISCUSSION

The results shown in Figure 3 illustrate many interesting points concerning the way in which the sound propagates; details of the prediction method and the effect of the noise barrier.

1. Naturally, at a particular ground slope the noise level decreases as the distance between the road edge and the dwelling, the receiver, increases.

2. As a result of the ground absorption effect the noise level at the ground floor of a residence is lower than the noise level at the first floor height.

3. It is interesting to note that at a particular distance, as the ground slope progresses from -20% to +20% there is an increase in the noise level. This is because the ground absorption effect decreases as the sound propagation height becomes greater for positive ground slopes compared to downward slopes.

4. For the prevailing situation, that is a dual two lane road, the predicted noise level at a particular distance is slightly lower when the road is considered as two separate source lines, that is where the traffic flow has to be separated into two, one for each carriageway. This result is expected because half of the traffic has been moved further away from the receiver and so, the resultant noise level decreases especially at closer receiver distances.

5. Over a period of 15 years after this major improvement of the road, the total traffic flow increases by 78%. A 3m noise barrier was therefore proposed along one side of the road to mitigate the effects of an increase in the noise levels. The results in Figure 3c show a similar pattern to those in Figure 3a discussed above, except that noise levels are generally lower. This means that the noise barrier is indeed effective. The benefit is more pronounced for negative ground slopes and closer receiver positions because here the path difference is greatest. The reason for the increase in noise levels at steeper positive ground slopes and increasing receiver distances is two fold; a significant increase in the traffic flow and the barrier being less effective at greater distances.

Comparison of traffic noise from a road with a noise barrier considered as single and separate source lines.

6. It was concluded above that by considering a road without a noise barrier as two separate source lines noise levels were slightly lower. With a noise barrier, however, comparison of results in Figure 3c and 3d show that noise levels are greater for steeper positive ground slope and increasing receiver distance. These areas are where the path difference, even with a 3m noise barrier, are least improved.

7. Under the NI regulations, that is the results of Figures 3a and 3c, only a small area (hence few properties) would qualify for sound insulation. In fact only those properties that are on a steep uphill ground slope and lie a considerable distance from the road would qualify, as long as these are less than 300m away and their noise level is greater than the qualifying level.

8. Traffic noise calculated by means of two source lines for both the prevailing and relevant cases, albeit the latter incorporating a noise barrier is given by results in Figures 3b and 3d. These would imply that the area where the NIR conditions are met is much greater. Properties closer to the road and those lying on only a slightly positive ground slope would now qualify, in addition to those mentioned in 7. above.

9. The comments of paragraphs 6 to 8 above have not been substantiated by noise measurements. The results, nevertheless, are based on the noise calculation method given in CRTN.

## 6. CONCLUSIONS

1. Considering a road without a noise barrier as two noise source lines, one for each carriageway, noise levels were generally lower when compared with the results obtained using a single source.

2. A noise barrier is beneficial in reducing traffic noise and is most effective for properties close to the road.

3. For a road with a noise barrier, properties that lie on negative ground slope fare much better than those on positive ground slope.

4. For situations where a noise barrier is positioned adjacent to a dual carriageway, with a central reservation less than 5m, noise levels calculated with a single source line are lower than those calculated with split source lines, particularly on rising ground where the far carriageway is visible over the top of the barrier. Differences of up to 3dB can occur in certain cases. This effect should be considered carefully when establishing eligibility for sound insulation under the NI Regulations. It is considered that levels calculated from split

source lines would be more realistic in the above situation.

## 7. RECOMMENDATIONS

The CRTN memorandum contains a basic method to predict road traffic noise taking into effect factors such as traffic flow, traffic speed, road gradient, etc. This method is supplemented by corrections to the overall noise due to others factors, for example the low volume of traffic and sound reflections within a retained cut. These corrections are only valid under certain conditions. On a similar basis, we believe that for the locality where the intervening ground slope is sufficient to allow a view, from a property, of the far carriageway over the noise barrier traffic noise should ideally be assessed using two separate source lines, regardless of the width of the central reserve. Conditions such as a certain ground slope and/or receiver distance could easily be set.

## 8. REFERENCES

1. "Calculation of Road Traffic Noise", Department of Transport, Welsh Office, HMSO, 1988.
2. "New housing and road traffic noise; a design guide for architects", Design Bulletin 26, Department of the Environment, HMSO, 1972.
3. "Noise Insulation (Amendment) Regulations", HMSO, 1988.

## 9. ACKNOWLEDGEMENTS

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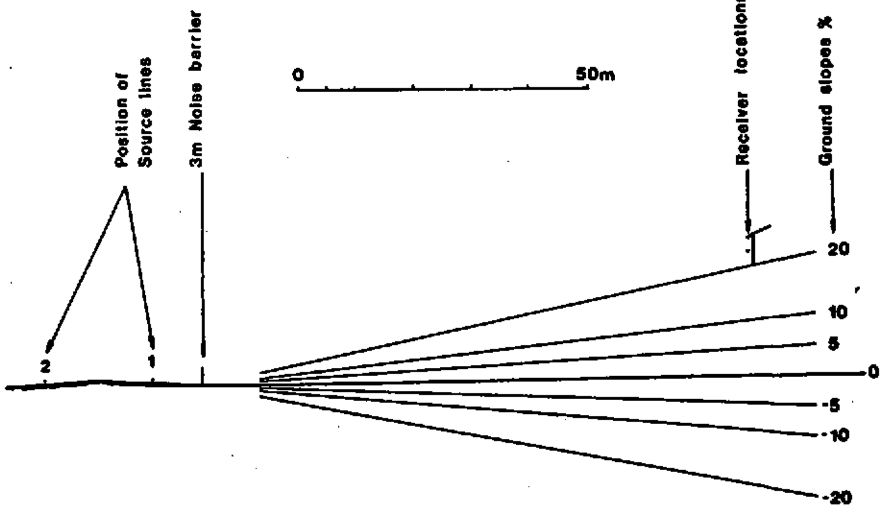


Figure 1. Cross-section of new road and intervening ground

| | Prevailing | Relevant |
|---|---|---|
| Total traffic flow | 74500 | 133000 |
| % heavies | 21 | 15 |
| Road gradient % | 1.4 | 1.4 |
| Receiver height m | 2.5 | 2.5 |
| | 5.0 | 5.0 |
| Road surface | Impervious, bituminous with texture depth of 2mm | |

Figure 2. Input Data for Noise Calculations

| | Receiver Distance (m) | Intervening ground slopes -20% | -10% | -5% | 0 % | +5% | +10% | +20% |
|---|---|---|---|---|---|---|---|---|
| Fig 3a | 50 | 74.2 | 75.1 | 75.5 | 75.7 | 76.0 | 76.2 | 76.5 |
| | | 75.3 | 76.9 | 77.1 | 77.2 | 77.3 | 77.4 | 77.6 |
| Dual 2 lane road, | 100 | 70.2 | 70.7 | 71.0 | 71.3 | 71.6 | 71.8 | 72.2 |
| single source line | | 71.1 | 72.5 | 72.6 | 72.8 | 72.9 | 73.0 | 73.2 |
| | 150 | 67.8 | 68.0 | 68.4 | 68.7 | 68.9 | 69.2 | 69.5 |
| | | 68.6 | 69.8 | 70.0 | 70.1 | 70.3 | 70.4 | 70.6 |
| | 200 | 65.9 | 66.1 | 66.4 | 66.7 | 67.0 | 67.2 | 67.6 |
| | | 67.0 | 67.9 | 68.0 | 68.2 | 68.3 | 68.4 | 68.6 |
| Fig 3b | 50 | 72.5 | 74.5 | 75.1 | 75.5 | 75.8 | 76.1 | 76.5 |
| | | 73.8 | 76.2 | 76.6 | 76.8 | 76.9 | 77.1 | 77.3 |
| Dual 2 lane road, | 100 | 68.5 | 70.3 | 71.1 | 71.6 | 71.9 | 72.2 | 72.6 |
| two source lines | | 69.4 | 71.9 | 72.6 | 72.9 | 73.0 | 73.2 | 73.4 |
| | 150 | 66.2 | 67.4 | 67.7 | 68.2 | 68.7 | 69.0 | 69.6 |
| | | 67.0 | 69.3 | 69.4 | 69.7 | 79.9 | 70.1 | 70.5 |
| | 200 | 64.5 | 65.6 | 65.8 | 66.4 | 66.8 | 67.2 | 67.7 |
| | | 65.4 | 67.4 | 67.6 | 67.9 | 68.1 | 68.3 | 68.6 |
| Fig 3c | 50 | 68.0 | 69.5 | 70.3 | 71.2 | 72.1 | 73.1 | 75.3 |
| | | 68.8 | 70.4 | 71.3 | 72.2 | 73.2 | 74.3 | 77.5 |
| Dual 3 lane road with | 100 | 64.9 | 66.4 | 67.2 | 68.1 | 69.1 | 70.1 | 72.5 |
| a 3m noise barrier, | | 65.2 | 66.8 | 67.7 | 68.6 | 69.6 | 70.7 | 73.3 |
| single source line | 150 | 63.0 | 64.5 | 65.4 | 66.3 | 67.3 | 68.3 | 70.7 |
| | | 63.3 | 64.8 | 65.7 | 66.6 | 67.6 | 68.7 | 71.2 |
| | 200 | 61.7 | 63.2 | 64.0 | 65.0 | 65.9 | 67.0 | 69.4 |
| | | 61.8 | 63.4 | 64.3 | 65.2 | 66.2 | 67.3 | 69.8 |
| Fig 3d | 50 | 67.3 | 69.2 | 70.4 | 71.7 | 73.3 | 75.2 | 77.4 |
| | | 68.4 | 70.5 | 71.8 | 73.5 | 75.2 | 77.2 | 78.5 |
| Dual 3 lane road with | 100 | 64.2 | 66.3 | 67.5 | 69.0 | 70.8 | 72.7 | 74.4 |
| a 3m noise barrier, | | 64.8 | 66.9 | 68.2 | 69.9 | 72.3 | 74.0 | 75.0 |
| two source lines | 150 | 62.4 | 64.5 | 65.8 | 67.3 | 69.1 | 71.1 | 72.5 |
| | | 62.8 | 64.9 | 66.2 | 67.9 | 70.2 | 72.0 | 73.0 |
| | 200 | 61.1 | 63.2 | 64.5 | 66.1 | 68.0 | 69.9 | 71.0 |
| | | 61.4 | 63.5 | 64.8 | 66.5 | 68.6 | 70.5 | 71.4 |

Figure 3. Calculation of Road Traffic Noise by Single and Two Source Lines