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SOME NOTES ON THE NOISE DISTURBANCE CAUSED BY MOTORCYCLES

by

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ABSTRACT

Motorcycle noise is a potentially disturbing element of traffic noise but at present the numbers of these vehicles are too low to affect overall traffic noise levels as determined by indices such as L_{10} (18-hour) dB(A). The greatest awareness of motorcycle noise occurs in situations where overall noise levels are low and where people are otherwise generally reasonably content with the traffic noise they are subjected to. Further research is required to determine the noise emission from motorcycles during routine testing and under normal operating conditions in traffic.

1. INTRODUCTION

In recent years a substantial amount of research relating to vehicle and road traffic noise has been conducted by various organisations. This research has concentrated on the description of noise from individual vehicles in traffic, the prediction of noise from traffic streams and the establishment of criteria to be met at the hearer position. In order to predict traffic noise for various vehicle flows and compositions it has been found necessary to classify vehicles according to their acoustic output and mode of operation. Several studies of the acoustic classification of vehicles have been carried out and a review of this work was published in 1977[1]. It was shown that accurate traffic noise predictions could be made if the traffic population was divided into at least three vehicle categories with separate noise emission characteristics. These categories are:

1. *Light vehicles* less than 3000 kg unladen weight,
2. *Medium heavy commercial vehicles* with 2 axles but including buses and coaches, and
3. *Heavy vehicles* which include all commercial vehicles with 3 or more axles.

The above classification does not include motorcycles as a separate category or even as part of a category and they are generally excluded from any noise modelling approximations or prediction procedures.

One notable exception is the work carried out by Galloway et al[2] who, in the late sixties carried out the research and development of the NCHRP computer model of traffic noise. As part of the development of the model they carried out a study of vehicle noise sources and included motorcycles in their analysis. They reported that "these vehicles are, as a class, noisier than passenger cars and in some circumstances noisier than trucks. However, no strong correlation can be found between the size or power of the vehicle and the noise it produces, indicating that the noise level differences come from large variations in muffling practice".

The final model produced by Galloway included a simple two tier acoustic classification of the vehicle population (cars and trucks). Motorcycles were not included partly because the acoustic diversity of the class would have led to a greater degree of complexity in the model than was envisaged and partly because of the low numbers of these vehicles in the traffic stream at that time.

Since the development of these traffic noise prediction techniques there has been an increase in motorcycle ownership with a concomitant increase in motorcycle travel over and above the growth in travel from other vehicle groups. There has also been an increase in the numbers of complaints received by Local Authorities and the Department of Transport which specifically refer to the noise produced by motorcycles. It is possible, therefore, that current practice underestimates the impact of motorcycle noise and it is, therefore, timely to review the available data on the usage of motorcycles in this country and the noise disturbance that they cause. This report is intended to provide some background information.

2. TRENDS IN THE USE OF MOTORCYCLES

Data on the ownership and usage of different vehicle groups or classes reported in this section have been obtained from Transport Statistics Great Britain 1967–1977[3].

Figure 1 shows the changes in the numbers of licensed motorcycles for three different classes (by engine capacity) over the period 1967 to 1978. It can be seen that the smallest capacity motorcycles form the largest group with the largest motorcycles second and the intermediate group third. The numbers of vehicles licensed in each of the three groups shows a similar trend over the sample period, with numbers falling overall in each group between 1967 and 1972 and then gradually increasing over the period 1972 to 1978. Overall there has been a 40 per cent increase in the numbers of motorcycles registered between 1972 and 1978 whereas over the same period, the numbers of cars have increased by only 4 per cent and lorries have decreased by about 3 per cent.

Figure 2 shows the changes in motorcycle travel between 1967 and 1977 for the total motorcycle population. It can be seen that the number of vehicle-kilometres travelled has increased dramatically from 1972 following a slow decline in travel between 1967 and 1971. The increase in motorcycle travel over the period 1972 to 1977 amounts to approximately 150 per cent whereas the corresponding increase for cars and lorries over the same period is considerably less at approximately 13 per cent and 5 per cent respectively.

Further evidence of the differential growth in vehicle travel can be seen from the data given in Table 1. The table gives a comparison of the changes in travel for three vehicle classes (motorcycles, cars and lorries) over the period 1973 to 1977 and for two road classes, defined as 'built up areas' where the speed limit is less than 40 mile/h and 'non-built up areas' where the speed limit is greater than 40 mile/h*. It can be seen that motorcycle travel has increased considerably on both classes of roads while the corresponding changes in travel by both cars and lorries are small over the sample period.

TABLE 1

Indices of travel (vehicle km) by vehicle class and class of road

Class of road	Class of vehicle	Indices of travel for	
		1973	1977
Built up areas ie speed limit $\leqslant$ 40 mile/h	Motorcycles	100	159
	Cars	100	107
	Lorries	100	101
Non-built up areas ie speed limit $>$ 40 mile/h	Motorcycles	100	189
	Cars	100	102
	Lorries	100	95

* Excluding motorways.

3. THE DISTURBANCE CAUSED BY MOTORCYCLES

In 1972 a national sample survey of the residential population of England was carried out to determine the attitudes of members of the public towards road traffic and of its effect on their daily lives[4]. The survey covered the whole range of environmental effects but special emphasis was given to noise in the questionnaire and to the measurement of noise undertaken by the Laboratory[5].

Figure 3 gives some results on noise disturbance obtained from the survey. The figure compares three different pieces of information for eight different noise sources which originate outside dwellings. Each block in the histogram represents a different noise source. The height of the block shows the percentage hearing the noise; the height to the top of the shaded section shows the percentage bothered; and the height to the top of the bottom section shows the percentage for whom this is the biggest noise nuisance.

From the histogram, it can be seen that road traffic is the biggest noise nuisance, and by a substantial margin. Twenty-three per cent are bothered by it compared with 16 per cent by animals, 14 per cent by children and 13 per cent by aircraft.

Figure 4 shows the results obtained from questions dealing in turn with each of seven types of noise associated with traffic. The top histogram shows the incidence of each type of noise, the lower one the disturbance it causes. The two distributions have somewhat different shapes, and the ratio between them is expressed by the percentages at the foot of the page. The histograms have several interesting features but with regard to the question of motorcycle noise disturbance it can be seen that while motorcycle noise is not the most frequently heard noise it is more likely to cause disturbance when heard than any of the other sources listed. Thirty-nine per cent of those hearing motorcycle noise are bothered by it compared with 33 per cent bothered by lorries and 25 per cent bothered by general traffic noise. It would seem, therefore, that motorcycles cause more disturbance than any other traffic noise sources.

The importance of different vehicle noise sources can be examined further by looking at the responses to the question "What sort of vehicles make the worst noise?" which was also included in the national survey questionnaire. The principal replies were: lorries 39 per cent, motorcycles 19 per cent, buses and coaches 5 per cent, cars 4 per cent. The responses to this question show that lorries are regarded as the worst noise producers with motorcycles in second place. Clearly the relative positions of lorries and motorcycles are reversed from the positions resulting from the data given in Figure 4.

An explanation of these differences in the results was given by the consultants who carried out the survey. They reported that "in the home, the sudden, isolated and comparatively penetrating sound of a motorcycle, particularly if it is late at night, can have a sharply disturbing quality heightened by a feeling that this is an unnecessary disturbance. It may, for example, be believed that young people deliberately make their motorcycles noisy because they like it and do not care about the disturbance they cause. The motorcycle also lacks the social utility that justifies the commercial or public service vehicle and may in consequence cause additional irritation. The noise of lorries, at close quarters is very loud and there are considerable numbers of them. It is now the overall amount of noise that is relevant rather than the capacity to penetrate and to disturb particular activities. Hence, the public's overall experience is that lorries are the worst source of noise".

Clearly, the consultants felt that the impact of motorcycle noise is concentrated on the home situation and particularly where the overall levels of noise outside the home are relatively low. In these situations motorcycle noise is easily distinguished from other sources of external noise.

Further evidence of the situations where motorcycle noise is important can be found by examining the data given in Figure 5. This figure shows the percentage of the population who are either 'quite a lot' or 'very much' bothered by different traffic noise sources for a range of noise levels measured outside the facades of their buildings. The data for this figure were also taken from the national survey experiment. It can be seen that for low external noise levels, say less than 60 dB(A) on the L_{10} 18-hour scale, there are more people disturbed by motorcycle noise than by lorry noise or by overall traffic noise but at the higher levels of external noise, that is L_{10}s greater than 70 dB(A), we find the noise from lorries to be the most disturbing source. This result would appear, therefore, to support the view that motorcycle noise is most important at locations where traffic flows are low and the noise levels are low and becomes less important where there are high vehicle flows with high noise levels. It follows from this that the large numbers of people who say they are bothered by noise from motorcycles arise because a large proportion of the population live alongside roads where the daily vehicle flow is low, eg 60 per cent live alongside roads where the flow is less than 500 vehicles per day, and only relatively few people live alongside noisy roads where the flow is high, eg 12 per cent live alongside roads where the flow exceeds 5,000 vehicles per day.

Further evidence of the relative importance of specific noise sources in a residential context can be obtained from the results of a survey reported by Galloway[6]. This work involved a survey of attitudes of urban residents living in seven major cities in the United States but living away from major noise sources such as heavily trafficked roads and airports. The results of this survey are summarised in Table 2. The table shows the percentages of people 'highly annoyed' by eleven different noise sources. The results are grouped by population density. It is shown that motorcycle noise is the most frequently cited cause of annoyance for all three population density groups and therefore underlines the importance of motorcycle noise in situations where the overall levels of traffic noise are, by virtue of the sampling conditions, relatively low.

4. NOISE EMISSION STANDARDS FOR ROAD VEHICLES

Regulations governing the emission of noise from vehicles in this country are contained in The Motor Vehicles (Construction and Use) Regulations[7] and in Directives issued more recently by the EEC[8,9]. Waters has reviewed the background to the development and implementation of this legislation[10]. A brief summary of the relevant features is given here.

The UK regulations were first introduced in 1969 and include regulations governing audible warning devices, the need for silencers and provisions against the emission of excessive noise as well as specifying sound levels and test conditions for new vehicles and for vehicles in use[7]. The UK noise limits for new vehicles including motorways are given in Table 3.

TABLE 2

Data obtained by Galloway[6]

Rank order of sources by per cent highly annoyed											
$p < 1150$ (37%)				$1150 < p < 7700$ (51%)				$p > 7700$ (12%)			
Rank	Source	% Highly annoyed	Average % standard deviation	Rank	Source	% Highly annoyed	Average % standard deviation	Rank	Source	% Highly annoyed	Average % standard deviation
1	Motorcycles	9.4	2.9	1	Motorcycles	13.2	5.5	1	Motorcycles	12.7	4.1
2	Helicopters	5.3	3.8	2	Large trucks	10.0	12.1	2	Autos	9.4	4.7
3	Autos	4.2	3.1	3	Autos	7.4	5.8	3	Large trucks	7.3	5.6
4	Construction	3.7	2.2	4	Construction	7.2	9.0	4	Construction	6.5	3.4
5	Airplanes	3.2	3.5	5	Sport cars	7.0	4.3	5	Sport cars	5.9	4.7
6	Sport cars	3.1	2.9	6	Constant traffic	5.5	6.1	6	Constant traffic	4.7	5.6
7	Large trucks	2.6	0.8	7	Small trucks	4.1	4.0	7	Buses	4.7	3.5
8	Power gardens	1.8	1.1	8	Buses	3.5	4.4	8	Small trucks	4.1	4.0
9	Small trucks	1.5	1.3	9	Airplanes	3.4	3.8	9	Helicopters	3.9	3.4
10	Constant traffic	1.5	1.5	10	Helicopters	3.1	3.9	10	Airplanes	3.6	1.4
11	Buses	1.1	1.5	11	Power gardens	2.1	1.6	11	Power gardens	1.2	1.5

p = population density in people per square kilometre

(%) = per cent of US urban population in this population density range

TABLE 3

Comparison of UK and EEC noise limits for new vehicles

UK		EEC*	
Vehicle type	Noise limits dB(A)	Vehicle type	Noise limits dB(A)
Motorcycles ⩽ 50cc	77	Motorcycles ⩽ 80cc	78
Motorcycles 50.1–125cc	82	Motorcycles ⩽ 125cc	80
Motorcycles > 125cc	86	Motorcycles ⩽ 350cc	83
		Motorcycles ⩽ 500cc	85
		Motorcycles > 500 cc	86
Cars	84	Cars	80
Light vans	85	Light vans	81
Goods and Buses	89	Buses ⩽ 200 h.p.	82
		Buses > 200 h.p.	85
		Goods ⩽ 200 h.p.	86
		Goods > 200 h.p.	88

* The EEC limits will affect most vehicles entering into service from October 1980 onwards.

On entry to the EEC, the UK initiated discussion of proposals for lower limits which were eventually agreed in 1977 for vehicles with four or more wheels[8] and the regulations governing motorcycles were added a year later in 1978[9]. These limits are compared with the UK limits in Table 3.

The table shows that while substantial reductions in vehicle noise emission standards are proposed for cars, buses and some motorcycles, other vehicle classes remain relatively unaffected. These are, principally, the largest goods vehicle class which comprise the noisiest vehicles in traffic and the smallest motorcycles. It would appear from the table that the largest capacity motorcycles are also unaffected by the new limits. However, changes in the test procedure prescribed by the new EEC Directive will tend to make large capacity motorcycles emit more noise than under the UK test method and so by holding the maximum permissible noise level constant, a reduction in noise is implied.

One further point of interest shown by the table is the wide range of levels for the motorcycle category. The 8 dB(A) range covering these vehicles is the same as the range for all other vehicles. This suggests that under normal operating conditions the range of levels emitted by motorcycles will be about as great as the range for all other vehicle types. This feature of motorcycle noise was reported by Galloway from measurements taken in the mix-sixties[2].

5. DISCUSSION

This report has attempted to bring together the relevant data on three aspects of the problem of motorcycle noise disturbance. Firstly, information has been presented illustrating the trends in motorcycle ownership and usage,

secondly, an analysis of exposure and response to motorcycle noise has been given, and, finally, the relevant legislation governing vehicle noise emission has been summarised.

The data show that whilst motorcycle travel is, clearly, increasing on all classes of roads and at a much faster rate than either car or commercial vehicle travel, the total number of motorcycle kilometres travelled each year is still less than 3 per cent of the total travel by all classes of vehicle. Cars account for 80 per cent of all travel and lorries account for slightly more than 17 per cent. It follows, therefore, that since traffic noise is closely related to the total volume of traffic estimations of traffic noise will not be affected, in general, if motorcycle noise is not included in the estimation procedure. This result is somewhat surprising since the data also show that people at home find motorcycle noise to be particularly irritating and currently more people are disturbed by motorcycle noise than by any other of the frequently cited components of traffic noise.

An explanation of these apparent differences in the data can be found by examining, in more detail, the way in which people respond to questions on noise disturbance.

It was shown earlier that 23 per cent of the population claimed to be disturbed by traffic noise at home in response to a question about various noise sources and yet it can be seen from the data that when the various types of noise included within the definition of traffic noise are separated out, this proportion increases to about 52 per cent. Similarly when people were asked to summarise the level of disturbance they experienced from traffic noise at home, only 9 per cent of the total sample felt that they were greatly disturbed by traffic noise which is clearly a smaller proportion than the percentage claiming to feel strongly about the noise from motorcycles alone (15 per cent) without counting the effects of other traffic sources. Consequently, it is found that, in general, noise disturbance is not tidily structured as it is not possible to add disturbances with individual sources to obtain the overall disturbance from traffic. It does not follow, therefore, that since people are disturbed at home by motorcycle noise they will also be disturbed to the same or greater degree by the overall level of noise from traffic outside their homes. In fact, the data indicate that the largest numbers of people claiming to be disturbed by motorcycle noise live alongside roads where the noise levels are low and where the average degree of disturbance with traffic noise is also low.

6. CONCLUSIONS

1. Motorcycle noise is a potentially disturbing element of traffic noise but at present the numbers of these vehicles are too low to affect the magnitudes of the currently employed indices of traffic noise and hence the overall assessments of disturbance.

2. The greatest awareness of motorcycle noise occurs at present in situations where the overall noise levels are low and where people are otherwise generally reasonably content with the traffic noise to which they are subjected.

3. There is a high correspondence between 'hearing' and 'being disturbed by' motorcycle noise.

4. It follows from 3 and the expected continuing growth in motorcycle travel, that the noise emission limits for motorcycles and test methods should be reviewed and manufacturers of motorcycles should be encouraged to improve their designs to meet lower noise emission targets. In particular, there is a case for the reduction of noise from small motorcycles, ie of 80cc or less, which are not reduced under the present EEC proposals and which currently comprise over 40 per cent of the total motorcycle population in this country.

7. SUGGESTIONS FOR FURTHER WORK

If present trends in motorcycle ownership and travel continue into the 1980s then motorcycles will begin to contribute substantially to overall traffic noise. Further work is therefore required to establish the levels of noise emitted by the whole range of motorcycles and under various operating conditions in order to prepare an acoustic classification of these vehicles for future use in noise prediction methods and also to provide insight on the development of improved legislation controlling noise emission for this class of vehicle.

8. ACKNOWLEDGEMENTS

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9. REFERENCES

1. NELSON, P M and R J PINER. Classifying road vehicles for the prediction of road traffic noise. *Department of the Environment Department of Transport, TRRL Report* LR 752. Crowthorne, 1977 (Transport and Road Research Laboratory).

2. GALLOWAY, W J, W E CLARK and J S KERRICK. Highway noise: measurement, simulation and mixed reactions. NCHRP Report, Highway Research Board. 1969. US.

3. DEPARTMENT OF TRANSPORT, SCOTTISH DEVELOPMENT DEPARTMENT, WELSH OFFICE. Transport statistics Great Britain 1967–1977. London, 1979 (H M Stationery Office).

4. MORTON-WILLIAMS, J, B HEDGES and Evellyn FERNANDO. Road traffic and the environment. SCPR Report P390. London, 1978 (Social Community Planning Research).

5. HARLAND, D G and P G ABBOTT. Noise and road traffic outside homes in England. *Department of the Environment Department of Transport, TRRL Report* LR 770. Crowthorne, 1977 (Transport and Road Research Laboratory).

6. GALLOWAY, W J. An assessment of the relative importance of sources of urban noise. *Journal of Noise Control Engineering,* October 1977.

7. HOUSE OF COMMONS. Road Traffic – The Motor Vehicles (Construction and Use) Regulations 1969. Statutory Instrument No. 321.

8. EEC. Council Directive 77/212/EEC. Motor vehicle noise levels. *Journal of European Economic Community* No. L66, pp 33–34. Brussels, 1977.

9. EEC. Council Directive 78/1015/EEC. Motorcycles – noise testing. *Official Journal of European Economic Community* No. L349, pp 21–30. Brussels, 1978.

10. WATERS, P E. The control of vehicle noise by legislation. Proc. Conf. Noise and vibrations of engines and transmissions, Cranfield, 1979. (The Institution of Mechanical Engineers.)

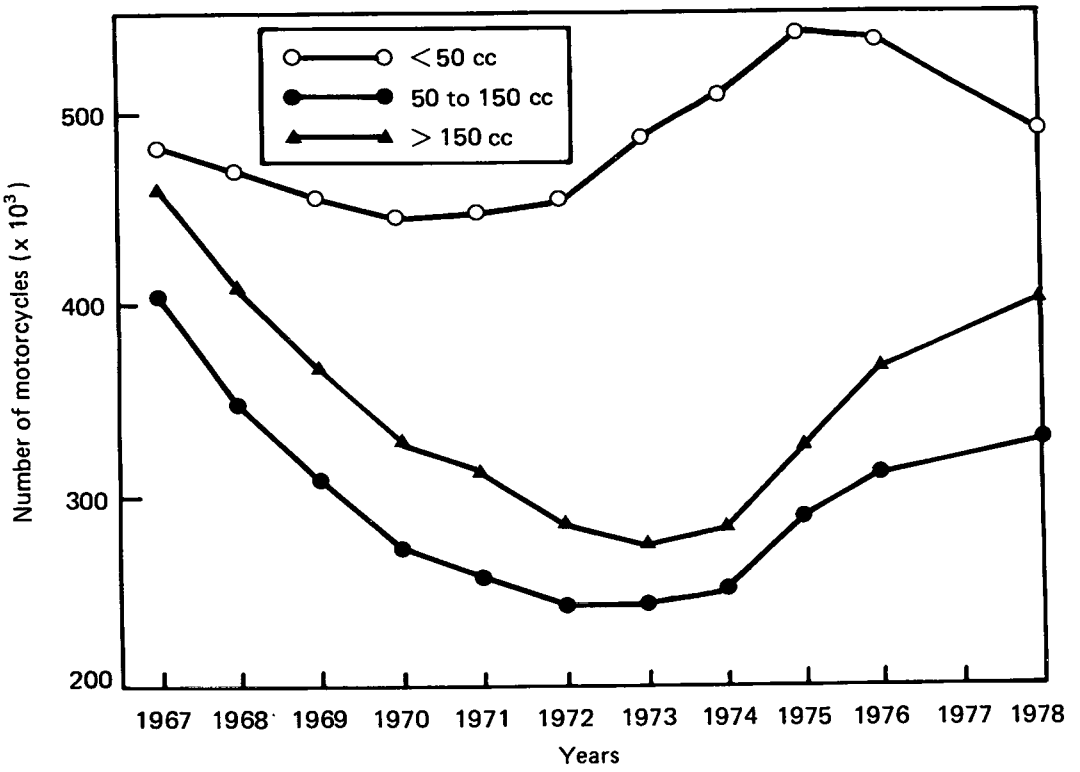


Fig.1 MOTORCYCLES CURRENTLY LICENSED : BY CAPACITY

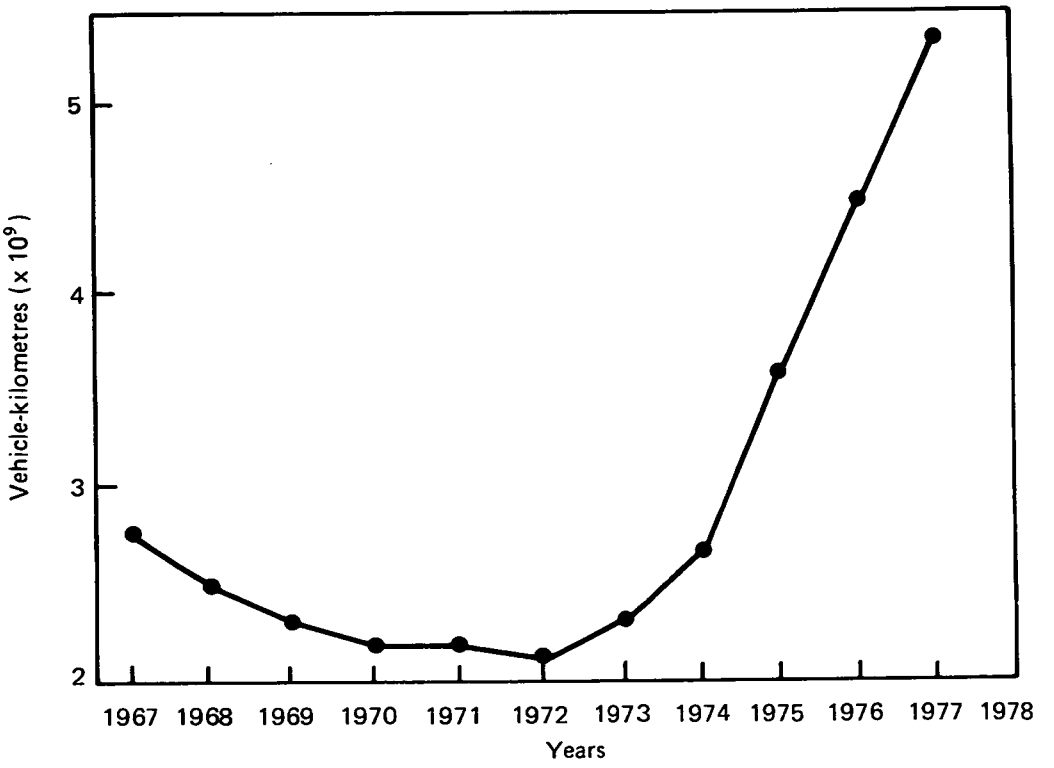
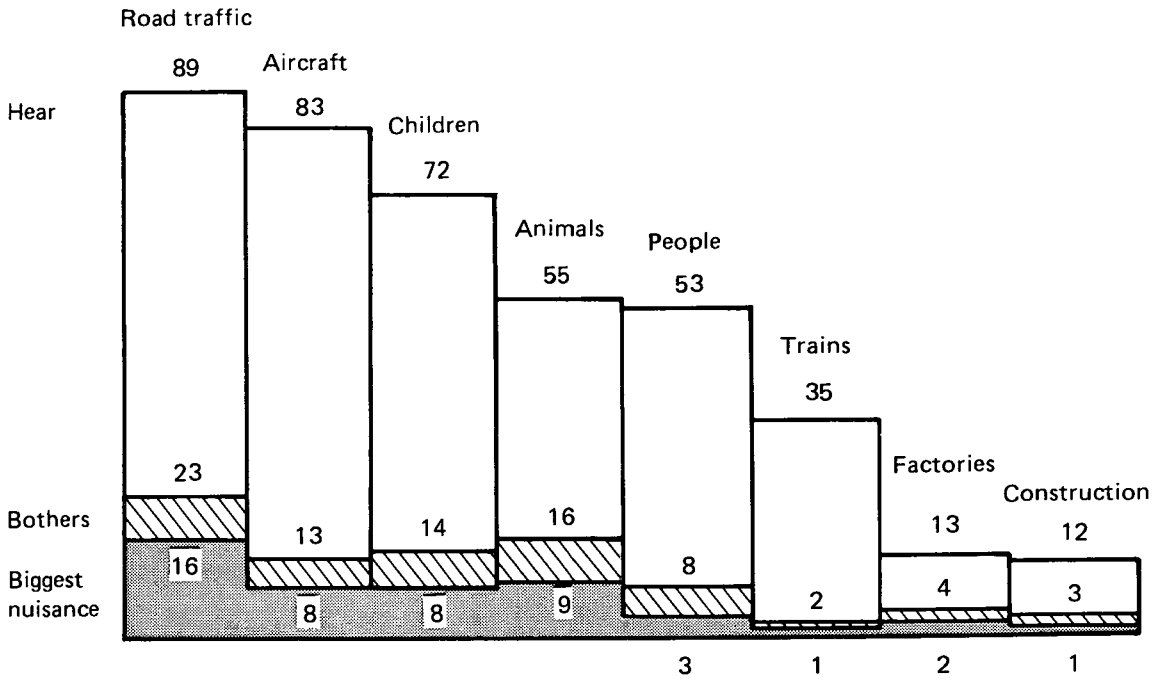
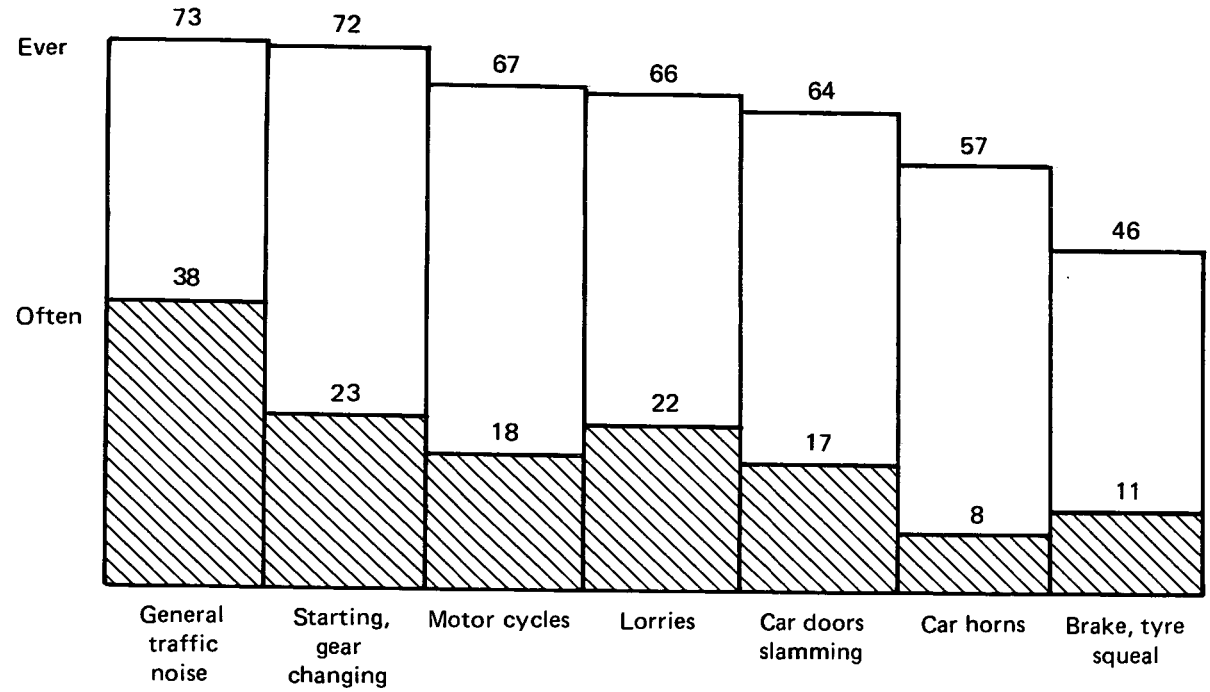


Fig. 2 MOTORCYCLE TRAVEL : 1967 TO 1977

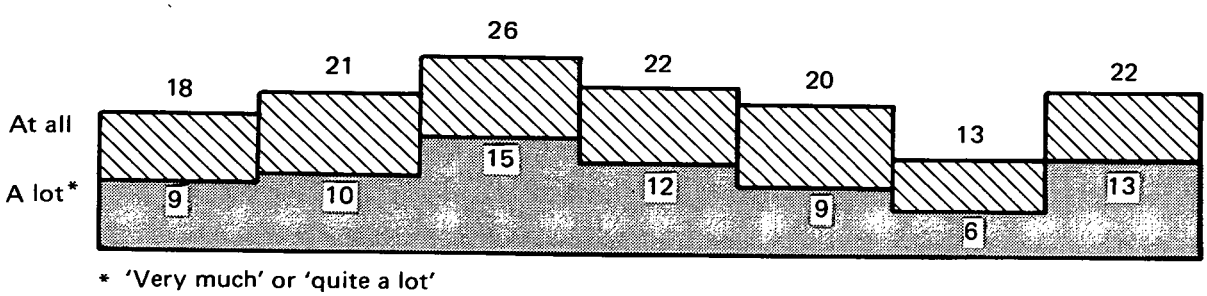


Note:- percentages are cumulative

Fig. 3 NOISES HEARD FROM OUTSIDE BY PEOPLE AT HOME



(a) TYPES OF TRAFFIC NOISE HEARD



* 'Very much' or 'quite a lot'

(b) TYPES OF TRAFFIC NOISE THAT BOTHER

25	29	39	33	31	23	48

(c) PERCENTAGE OF THOSE HEARING EACH TYPE OF NOISE WHO ARE BOTHERED BY IT

Fig. 4 TRAFFIC NOISE HEARD FROM OUTSIDE BY PEOPLE AT HOME

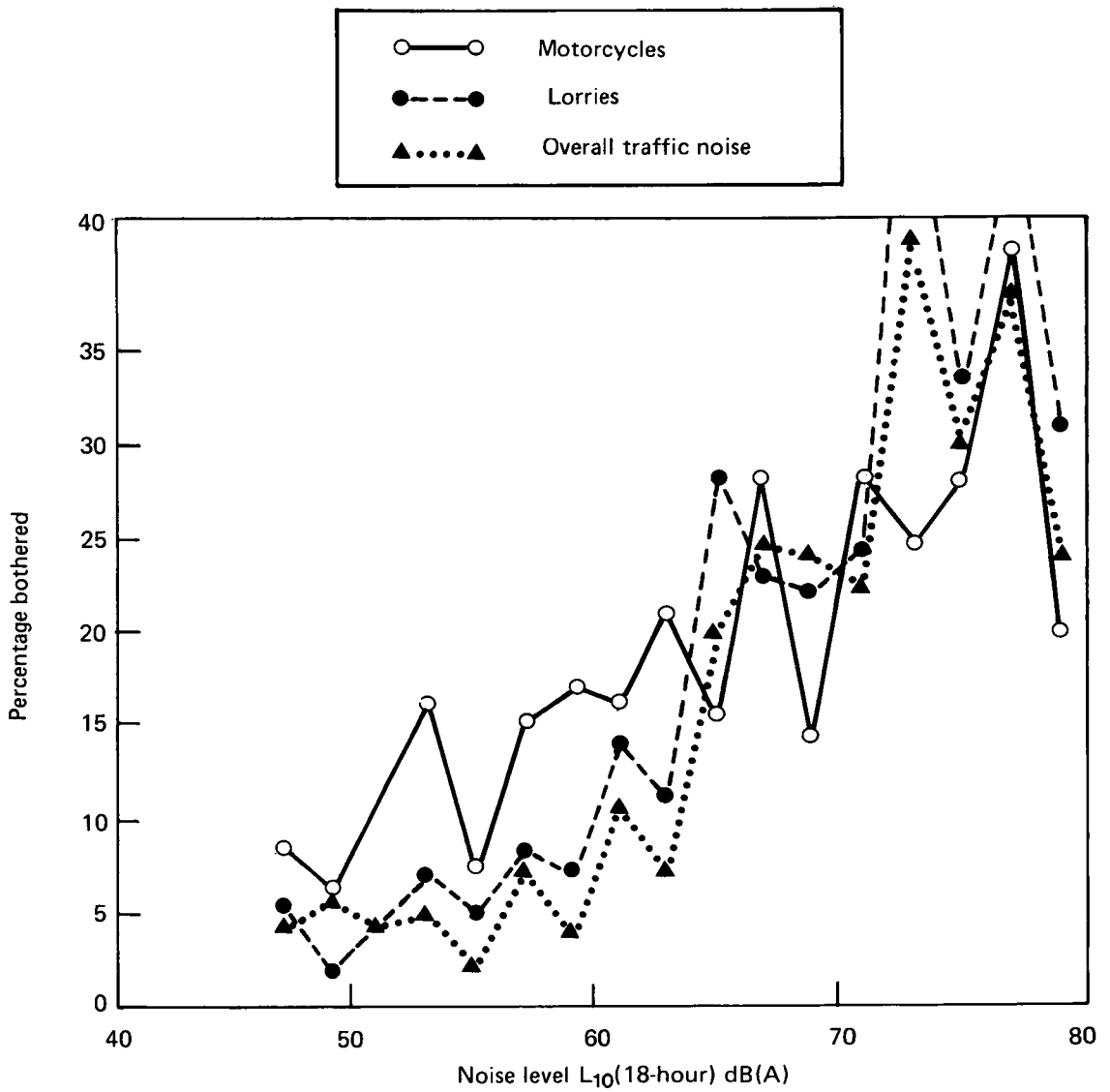


Fig. 5 PERCENTAGE BOTHERED ('Quite a lot' or 'Very much') BY DIFFERENT TRAFFIC NOISE SOURCES FOR A RANGE OF OUTSIDE NOISE LEVELS

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