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COMPUTERISED CALCULATIONS FOR THE NOISE INSULATION REGULATIONS

J. R. Hyde

Scientific Services Branch, Greater London Council

INTRODUCTION

MWAY is a software package for the prediction of traffic noise levels according to the method defined by the Department of the Environment publication, 'Calculation of Road Traffic Noise' (1). The Land Compensation Act 1973 gave occupiers of dwellings the statutory right to insulation against traffic noise from a newly constructed or improved road, provided certain criteria were met relating to the increase in noise level due to the scheme. The Noise Insulation Regulations made in conjuction with the Act described the means of implementation and method of assessment. The first Regulations published in 1973 (2), required a combination of measurement of L10 from 0600 to 1800 hrs, and calculations according to the document 'Design Bulletin 26' (3).

There were many situations in which this method could not predict noise levels and some situations where properties at 300 metres from the road scheme were eligible for insulation due to increases in local noise. This was clearly an unsatisfactory state of affairs and therefore in 1975 revised Regulations (4) were introduced to overcome these problems. A new procedure 'Calculation of Road Traffic Noise' was released placing much greater emphasis on the prediction of noise levels for both existing and future situations, moving away from the time consuming and costly measurement method. This paper describes why a software solution to implement the new method was sought, how it operates, its advantages and limitations.

CACLULATION METHODS

Charts and Calculators

When first introduced, calculations were carried out using the charts and graphs described in 'Calculation of Road Traffic Noise', but lack of detail soon led to the preparation of more refined documents using the mathematical algorithms described with the method. These same equations were subsequently used when transfering the calculations to a programmable calculator in an effort to increase the speed of the method. This prooved satisfactory for small schemes where only a few dwellings needed to be considered but larger schemes still required a substantial amount of work.

One of the main problems of using both charts and calculators was the measurement of barrier correction. The path difference calculation was complex and very sensitive to measurement accuracy, resulting in a wide dispersion of predicted results. Alterations to the scheme layout invloved the repetition of most of the calculations and designing barriers to achieve a specific attenuation was even more difficult. The combination of an increasing workload and the repetitious non-inspiring nature of this work highlighted the need for a different approach.

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Computers

The main requirement was a more rapid means of computing the numerous measurements of distances, heights and angles required by the method. In order to accomplish this aim various systems were considered. These involved the input of the coordinates of buildings and roads using data values and the specification of all buildings that acted as barriers to every calculation point. This would have been just as tedious as the manual method.

MWAY was a software package available from Applied Research of Cambridge Ltd which used various empirical techniques for the evaluation of environmental impact of road schemes. This program seemed to overcome the problems of the other systems by using digitisation, although the calculation algorithms were inappropriate. The time required for input and digitising was considered alongside computing costs. Subsequently, a new specification was agreed and a revised version of MWAY was purchased that conformed to the requirements of the Calculation of Road Traffic Noise.

MWAY

Data Preparation

The package consists of a set of programs written in Fortran which operate in three main stages, input, noise calculation and plotting. Firstly, however, it is necessary to prepare and label the scheme drawings. The roads are divided into segments which act as individual noise sources. These are then numbered for both existing and future situations. Buildings are marked by front facade and numbered and spot heights are numbered in sufficient quantity to provide a guide to the changes in ground level across the area of the map. Any noise barriers are treated as thin buildings. Four points are marked near to the corners of the map to act as a reference window for digitisation.

An input file is then prepared giving detailed information on each segment, building and spot height marked on the map. Segment information includes parameters on traffic flow, speed and percentage heavy vehicles and ground configuration on both sides of the segment. Each building is allocated a number of units (used for terraced houses), number of floors and an overall height. The spot height information is used to calculate the ground levels (i.e. the height above ordinance datum) of each road segment and building block, giving an effective 'z' coordinate.

Noise Calculations

On completion of data preparation the input program is then run. The digitisation of the four corners of each segment and building is requested by the program and a database file is created. During this digitisation stage a backup file is regularly updated, such that in the event of accidental errors it is not necessary to redigitise the entire scheme only to restart from the last update. The database can be edited at any time to change the location of blocks or segments or to change parameters such as traffic flow or barrier heights. This then forms the input file to the noise calculation stage.

Two sets of calculations are normally carried out, one for the existing situation and one for the new road alignment. In each case appropriate segment numbers are specified to the program, including the distinction

between improved and unimproved highway. Building block numbers that act as noise barriers to any of the required calculation points are also listed. Calculation points can be specified at any facade, unit or floor level for any of the blocks. The program then sums the noise contributions from each segement, taking into account automatically any blocks that act as barriers. Output from this stage is in the form of a table, giving the block and point requested, calculated noise levels for existing and future situations and an indication of whether the block is likely to be eligible for compensation under the Noise Insulation Regulations.

Graphic presentation is provided by the plotter program which plots the requested blocks and segments as well as the calculated noise values. This can also be used to overlay the original map in order to check the accuracy of the digitised layout.

LIMITATIONS

Barriers

As with most computer models there are certain situations where it is difficult to communicate complex information to the system and the cost of modification is not justified. A problem with MWAY occurs when a scheme on hilly ground is required. Although spot height information is supplied this is solely used to compute the ground level of individual blocks and segments. If the ground itself forms a barrier this is not detected from the spot height information. It is necessary to mark an appropriate barrier block to compensate for mounds or hills that act as barriers. This problem does not occur very often, but needs to be considered at the map preparation stage.

Absorption and reflection

A second problem arises where the reflection correction needs to be applied. 'Calculation of Road Traffic Noise' does not specify boundaries for this correction, thus it has been necessary to define limits of road width, building height and angle of view of opposite facade, for this value to be adequately computed. A problem also occurs with describing ground cover. The program selects the appropriate distance attenuation chart depending on the type of ground cover specified at the segment description stage. Ideally, all open areas should be specified in terms of soft or hard ground, however, this information would be very difficult to obtain and be complicated to digitise. Therefore the results need to be inspected alongside the map information if there are large areas of mixed ground cover.

ACCURACY

Comparison

The first three schemes processed by MWAY were also calculated using the traditional manual methods. Comparison of results showed agreement within 0.5 dB(A) for simple situations without barriers, increasing to 1.5 dB(A) for calculations including barriers. This was further investigated by asking eight people to carry out the same calculations on a road junction. The individual variation caused by manual measurement of angles, distances and heights gave an average standard deviation about the mean of 1.6 dB(A) and the highest variation of results for one calculation was 7 dB(A).

The computer results were all within 0.5 dB(A) of the means of the manual calculations, thus satisfying the original program specification that results should be predicted within 1 dB(A) of the manual method. Sample checks are regularly made in order to ensure that the accuracy of the software is consistent with different map configurations.

ADVANTAGES

Speed

The main advantage of MWAY over manual techniques is undoubtedly its speed. A typical small scheme of about 1 km of roads and 100 buildings would take approximately one day to prepare and digitise, with a further half day for noise calculations and plotting. It would take about four days to do the same work manually. The time saving is even more effective if minor modifications to the scheme layout are required or if barriers need to be designed. These operations would take about one hour to reassess as opposed to one or two days by the manual method, giving an overall saving of about three man days bearing in mind that computer costs would be about £100.

Effort

On large road construction schemes the savings are considerable. A recent scheme of 7.5 km of new road with 12.5 km of connecting roads was assessed with two alternative routes for changes in noise levels and eligibility under the Noise Insulation Regulations at over 3000 dwellings. It was estimated that this would have taken about six man months using conventional methods, but in fact took six man weeks with about £1200 computer costs.

Alterations

Many minor changes or new calculations can be made at short notice making the system an ideal tool for Public Inquiry work. The graphic facilities give a good presentation for reports as any particular area of a scheme can be plotted to any scale, to include selected buildings, barriers, road segments or noise levels.

FURTHER DEVELOPMENTS

The software has been designed to allow for future expansion. A number of minor improvements have recently been made to permit the combination of separate databases and to simplify database editing, however, current proposals include suitable modification for the prediction of air pollutant levels and construction noise using the same database system.

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