Construction noise study—M67 Hyde Bypass

R. W. SARSBY

Mr D. Foster, West Yorkshire Metropolitan County Council

Since January 1976, when Part III of the Control of Pollution Act came into force, the West Yorkshire Metropolitan County Council has undertaken some 65 contracts on civil engineering and building works, in which clauses based on BS 5228 have been included. In each case the anticipated noise levels from construction operations were predicted using the methods outlined in BS 5228, and subsequently a CEL 162 noise analyser and a B&K 4426 noise level analyser were used to measure both period and cumulative L_{eq} values. Our results have confirmed Mr Sarsby's conclusion that there is good correlation between predicted and recorded values and that in general the prediction method is likely to give levels slightly in excess of those measured. I would support the approach taken by Mr Sarsby in calculating noise levels at the initial stages by the block method as being the most practical method; it is the method we have used, and our analysis has shown that that approach gives a reasonably good indication of possible future problems.

49. The Control of Pollution Act is not primarily concerned with noise levels but with disturbance which may result from these levels. The findings of Mr Sarsby's study therefore should be used to predict construction noise levels with confidence and then to assess the results in terms of disturbance.

50. Mr Sarsby comments that at properties adjacent to a motorway construction site the L_{eq} levels were below 75 dB(A) and were therefore generally not excessive. While it may be true that noise levels up to 75 dB(A) in a particular situation may be acceptable, they cannot be taken as being acceptable in the general situation.

51. Disturbance by construction noise cannot be determined solely by the particular noise level, but must also be related to the ambient level of the area. In considering industrial noise, BS 4142 states that complaints may be expected if industrial noise exceeds background noise by 10 dB(A) or more. In a rural situation background levels may well be below 50 dB(A) and thus a 12 h L_{eq} of 75 dB(A) would represent an extremely severe increase in noise. Conversely, where other noise sources exist (e.g., by roads), the ambient level may already be fairly high and thus an L_{eq} level of 75 dB(A) may not be excessive. It should also be noted that in the urban and semi-urban situation, construction works are often close to properties and L_{eq} levels in excess of 75 dB(A) are experienced at property facades. It is in these situations where the more serious construction noise problems usually occur.

52. In order to overcome disturbance, the approach that has been operated for the past three years by the West Yorkshire County Council is that the limiting levels are agreed for each contract by the county council in conjunction with the environmental health officers of the district councils. These control levels are related to the facade

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of the most affected noise-sensitive property alongside the construction site and also to the ambient noise level of that particular area. These control levels are included within the contract documents. For instance, where ambient levels of 50 dB(A) exist, working day levels of L_{eq} have been set at 70 dB(A), evening levels at 60 dB(A) and night-time levels generally at 5 dB(A) above ambient.

53. Where it has not been possible to meet these desired levels by normal construction methods then, within the specification for the particular work, various other measures have been employed, such as restrictions on duration of operations, or timing of operations, to keep them outside unsocial hours. Noise screens have been used. There has been specification of particular equipment, such as quiet piling or sound-reduced compressors. There has been restriction on overnight operations, and properties have been insulated prior to construction.

54. Where it has not been possible to meet the desired levels by any means and the work has had to be done a more realistic level has been set. In some cases it has been necessary to specify the 'best practical means of working'. This approach has been possible as a result of the close co-operation between the county council and the environmental health officers within the district councils. A clause, agreed with the district council, is incorporated in the specification for the works with a requirement that the successful contractor applies to the district council for a 'prior consent' notice before commencing works. This application is based on the specification clause. By this means it is felt that the interests of occupants adjacent to the works are served and, as the contractor has detailed knowledge of the requirements under the Control of Pollution Act, a fair means of competitive tendering is maintained.

55. It is our experience that construction noise can be predicted with sufficient accuracy to enable possible problems to be identified at the design stage. Every endeavour should then be made to overcome or anticipate such problems by incorporating design measures or control clauses within the scheme contract. Experience in West Yorkshire in operating under the Act over the past three years has shown that significant reductions in construction noise can be achieved without incurring operating or financial penalties on contracts.

Mr G. S. Elfer, Metal Box Diversified Products Ltd

The M25 motorway is taking an area out of the middle of a 30 acre estate owned by an order of nuns. It goes between the convent house and the school which they run. In 1969 I was briefed to go to an inquiry particularly with regard to the noise and the disruption this was likely to cause both during the construction and also during the operation of the motorway.

57. In 1969 we did not have the British Standard. At that time the difference between the Surrey County Council's expert's calculations and my computations was about 20 dB(A). Nine years later our figures coincide to within about 2 dB(A) and confirm that the noise at the roadside will instantaneously be in the region of 76–80 dB(A) with a corresponding figure at the school of about 70 dB(A). This phenomenon, in the case of a school, is vitally important, since this piece of motorway may be in construction for two years.

58. If a teacher's voice cannot be heard in these classrooms a generation of children may grow up having missed vital information for two years of their schooling.

59. In the case of construction it is not the wheel tyre which creates the predominant noise because the soil is soft. It is the diesel engine with its turbo charger which is a major contributor.

60. All work done in this field stresses the fact that there is an increasing use of power. Therefore, it may seem absurd to attempt to suppress noise from such sources with nothing more than a piece of sheet metal 1.6 mm thick. The sequence of measurements described here began at noon with no more than the general level of noise experienced in the semi-rural area. The maximum instantaneous noise caused by

sundry fencing construction resulted in noise measurements of about 60 dB(A) at 80 m from the source. In the same position we also obtained the effect of aircraft noise, thanks to our neighbouring Heathrow. Later, the graders turned up and in the same position we measured 60 dB(A) to nearly 70 dB(A). Our measurements continued and in the next position, which was at the border of the motorway, with identical plant operating, we measured instantaneous noise levels of nearly 90 dB(A). This is to demonstrate that L_{eq} looks very nice indeed at about 70 dB(A) over a 12 h day but a child working under instruction on (say) a chemical experiment is disturbed by the instantaneous impact of noise and will look up when she hears this momentary distraction. The result can cause an accident.

61. In the afternoon at 2.00 p.m. the traces from our instruments showed that it was very quiet because no plant was operating. This demonstrates that in an area with a daytime ambient noise level of about or below 50 dB(A) the noise base line must be defined in that region of values.

62. Finally, measurements were made on the inside of a semi-quadrangle which is hard-paved and surrounded by school buildings. Measurements were made both inside and outside the school buildings to establish the noise levels, with the windows closed and the windows open. Our trace demonstrates that about 4 mm glazing suppresses about 10–15 dB(A) of noise level. In one corner of the quadrangle with the windows open measurements were well up in the 60 dB(A) level and once in the 70 dB(A) level.

63. This challenges comparisons with predictions calculated on the basis of *Calculation of road traffic noise* because construction and traffic noise differ. The modern trend of high impact created by power plant coupled with the echo effect that hard surfaces of buildings and/or playing fields can produce is quite interesting. The echo produced an L_{eq} level of over 54 dB(A) with two instantaneous peaks of 65 dB(A) and over 70 dB(A). There was no wind at the time. Circumstances which make further difficulties for predictions are the effects of wind and other climatic conditions. These are difficult to forecast and may assist in creating noise disturbances to people living by motorway constructions, for weeks on end.

64. Neither the constructor nor the road construction unit were prepared to discuss limiting levels of noise. Nor can either party determine noise conditions precisely. A positive contribution may be an agreement as to the level of maintenance of the mechanical equipment. This would assist and benefit the effect of the whole contract.

65. It is also important to examine the characteristics of the noise which impinges on those in the vicinity of the motorway construction site. A histogram of the octave band centre frequencies shows where the low rumbles up to about 125 Hz should cause no distraction. Whereas the incidents of noise impact in the 250–1000 Hz region can cause loss of audibility and even slight discomfort.

66. Investigations were carried out with Buel and Kjaer instruments with the assistance of PERA, whose help is acknowledged.

Mr I. P. Haigh, Sir Alexander Gibb & Partners

I was a member of the working party of CIRIA on this question of noise on construction sites. Four years ago we were much concerned with the thought that perhaps the local authorities charged with setting the sound levels might fix on 75 dB(A) and that would become the standard. I would be interested to know how widely this particular sound level has been adopted as a standard, and whether it is the right one, or even whether there is a right one.

Mr D. Twigg, Donovan H. Lee and Partners

At a meeting on construction noise held in 1973 it was shown that the German approach to construction noise control was fairly advanced for that time. Would the Author give some indication of relevant experience in Germany and other European countries?

Mr A. I. Robertson, Sir William Halcrow & Partners

When we drafted the specifications for the Hyde Bypass and referred to noise levels, I think we had in mind the particular operation of piling in the urban area of Hyde. I would like to ask Mr Sarsby, on the basis of the work that he did on construction noise levels at Hyde, whether he feels that we can provide a specification which is related not to individual sources but to a number of sources. As he has said, this is often the situation which creates nuisance in an urban area. I think this might be very difficult to specify and exceptionally difficult to enforce in a contract. I can certainly foresee considerable arguments with contractors about the basis of measurement and the recording of the observations.

70. Regarding the appropriateness of the 12 h L_{eq} , I think that it is really the individual high level noise which may happen quite infrequently during the day that causes the disturbance and annoyance. I think the situation is similar to that which applies to the measurement of aircraft noise, where for a long time in the UK the accepted basis was the noise and number indication (NNI). This was a subjective combination of noise level from individual aircraft—a mix of aircraft in most cases—and the number of occurrences. I think that that basis for measurement has become somewhat discredited recently and one comes back to the situation that it is the once or twice a day when Concorde goes over that creates annoyance and is the main factor in the opposition to aircraft in urban areas. I believe that this is analogous to the opposition to disturbance from heavy construction in urban areas.

Mr Foster

West Yorkshire Metropolitan County Council, in addition to setting maximum L_{eq} values for the working period, also include a maximum peak level within the specification.

Dr A. J. Wills, Cementation Research Ltd

With reference to the 75 dB(A) limit figures, it is increasingly our experience at Cementation that local authorities are recognizing the desirability of setting upper limits in relation to existing ambient levels.

73. We are also finding that local authorities are beginning to introduce limits on maxima as well as L_{eq} values. Recently, at the Wistow Shafts site, Selby New Mine, the stipulated L_{eq} values were being well complied with, with room to spare, during day-time, evening and night-time working. But impulsive noise arising from blasting and mucking out gave rise to momentary, very high peak values which disturbed the neighbourhood. A substantial programme of additional sound-proofing and screening was carried out to ameliorate the matter. We are finding that new shaft sites are having both L_{eq} and peak limiting values imposed, both at Selby and elsewhere (e.g., Scottish region). In other areas similar limitations appear for piling operations, particularly in sensitive surroundings such as teaching establishments.

74. As a result of our own measurements, we have considerable knowledge of the noise levels associated with our machines. We are using this in conjunction with BS 5228, CIRIA report 64 etc. to predict likely neighbourhood noise levels to meet tender document specifications. Typical values for machinery noise, such as those given in Table 5 of BS 5228, will often yield neighbourhood levels above the specified levels and we then have to consider ways of achieving lower levels.

75. In our piling and ground engineering operations we would frequently be acting as a subcontractor and we would, therefore, stipulate that the compliance of our operations with a given noise level specification is exclusive of any other operations which the main contractor may wish to implement. In other words, if we, as a piling subcontractor, are operating within the specification we cannot be held responsible for excessive noise which may be generated simultaneously by, for instance, a demolition contractor. However, where we are a main contractor such as in shaft sinking we

would be obliged to organize the programme to comply with the specification, always having regard to 'best practicable means'.

Mr Foster

Regarding the acceptability of the use of 75 dB(A) as a control level, at West Yorkshire Metropolitan County Council we are under great pressure from the environmental health departments of the district councils to specify much lower levels than the standards we are setting at the moment, and in many cases these are already below 75 dB(A).

77. Having said that, I would like to stress the previous comment about co-operative working. If they can see that all possible steps have been taken to mitigate noise then they for their part are prepared to accept that the job must go on and therefore disturbance has to be accepted for a particular time.

Mr J. D. Blood, Midland Road Construction Unit, Warwickshire CC Sub-Unit

An important point, which I support, is that although they are variable throughout the working day, noise levels from construction plant operations can be predicted.

79. In order to prepare for negotiations with the district council on likely construction noise climate from major roadworks schemes, we examined available literature (TRRL, BRE), contacted other authorities for site noise data, and collected some ourselves. Graphs were prepared showing results from typical combined plant operations, superimposed on predictions using BS 5228 noise levels. There was an interesting correlation, but a noticeable trend was that site measurements were generally less than those derived from BS 5228 sound power levels. Also tables were prepared indicating mean levels of L_{eq} with distance from source for various plant combinations in typical working conditions, and relationships of L_{eq} levels with percentage 'on time'. These results, figures etc. have been used for 'in house' training on the subject.

80. Local authorities require indications of noise climate prior to work starting and the Engineer needs to include appropriate clauses in the contract specification. Levels that are included in these clauses must be realistic for the operations envisaged and local authorities should not insist on unobtainable low levels, as this could have serious programming and cost implications for the employer. We suggest using a table of noise levels, indicating allowable L_{eq} (12 h) and maximum noise level for specified periods (i.e., normal day-time work, 0700 to 1900; evenings/night, 1900 to 0700; and for Sundays etc.). The Author's views on specification for noise control would be welcomed.

81. Site monitoring should be carried out by RE staff. Direct-reading L_{eq} equipment is available, but expensive. Other simpler equipment would suffice in most cases, measuring maximum noise level. This may be related to L_{eq} ; an approximate relationship for typical earthmoving operations is

$$L_{eq} = L_{10} - 3$$

Used sensibly it will give 'on the spot' readings, and a check on noise emission.

82. Another important aspect is the standard of plant maintenance. Observations show the effect of a silencer can be great—5–10 dB(A). Overall, good plant maintenance and silencers will have a much greater effect on reducing noise levels than other means such as reducing the number and size of machines in operation, limiting vehicle speeds etc.

Mr A. R. McAvoy, CIRIA, and Mr R. D. Jones, Wimpey Laboratories Ltd

Mr Sarsby's paper is an interesting case study and the results tie in fairly well with BS 5228. We should like to make the following two comments. First, an indication of the size of plant in relation to the type would have been useful. Secondly, no reference was made to CIRIA report 64,¹³ which contains a vast amount of noise data collected from various sites, together with worked examples. This information would have helped the Author with his predicted L_{eq} levels, by reducing the errors.

Mr Sarsby

I agree with **Mr Foster** that an L_{eq} value of 75 dB(A) at a site boundary does not necessarily mean that the emanated noise level will be acceptable to residents in the locality. However, I do feel that if, for urban construction, an initial pre-contract appraisal of the noise levels indicates that an L_{eq} (12 h) value of 75 dB(A) will not be exceeded, then the incidence of complaints during the period of the works will be low.

85. **Mr Elfer**'s comments emphasize the point that any noise level specification must take account of ambient noise levels and the use to which the properties adjacent to the site are put. In addition his remarks demonstrate the difficulty of taking into account every factor which may influence the value of the received noise level at a facade.

86. With regard to **Mr Haigh**'s question as to whether a limiting L_{eq} value of 75 dB(A) will become the standard, I think that it is clear from the comments of other contributors that this is very unlikely.

87. In reply to **Mr Twigg**'s question, I must admit that my knowledge of noise control in Germany is limited to directives concerning road traffic. In this area I consider that the methods employed in the UK are as sophisticated as those used in Germany, although Germany has a greater wealth of published data pertaining to noise prediction and control.

88. **Mr Robertson** says that it may be difficult to specify and enforce a noise requirement where a number of sound sources are involved. I believe that it is possible to provide and enforce a specification for such a situation because of the way in which individual noise components are summed. It is generally the engineering operations which have inherently high sound power levels, and which are readily identified, that determine the noise level received at facades adjacent to the site. At the pre-contract stage an experienced engineer will be able to predict, with a reasonable degree of accuracy, those parts of the site in which operations with high sound power levels will be carried out. It is then a reasonably easy task to assess whether compliance with the noise specification is feasible.

89. It is pointed out by **Mr McAvoy** and **Mr Jones** that I omitted to give an indication of the size of plant for which noise measurements were reported. This was a deliberate omission on my part because I wished to emphasize that at the pre-contract stage a designer will not have a detailed knowledge of the plant to be employed by the contractor and therefore he has to employ typical sound power levels for his analyses. I undertook the construction noise study in the summer of 1976; CIRIA report 64 was not then available and all analyses were made using the data which were available at the time of the study.

90. It is gratifying to find that so much work is currently being undertaken on the problem of noise from construction operations and I hope that the data presented in the Paper will help in the assessment of the nuisance caused by construction noise. I think that two major points are evinced by the contributions to the discussion.

- (a) It is possible to predict construction noise levels accurately using data which have been published to date.
- (b) When setting permissible construction noise levels, reference must be made to the ambient noise level at the location under consideration and the use to which adjacent properties are put. It is not possible, or correct, to specify limiting values of L_{eq} (12 h) for urban and rural situations which are applicable throughout the whole of the UK.

Reference

13. BEAMAN A. L. and JONES R. D. *Noise from construction and demolition sites—measured levels and their prediction*. Construction Industry Research and Information Association, London, 1977, report 64.