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PREDICTION, ASSESSMENT AND CONTROL OF CONSTRUCTION SITE NOISE

R D Jones & R H Clough

Wimpey Environmental Ltd, Beaconsfield Road, Hayes, Middlesex, UB4 0LS, UK

1. INTRODUCTION

Construction activities often temporarily bring heavy industrial activity into previously quiet areas. This can lead to potential nuisance problems. The Batho Report [1] showed that noise complaints about roadworks, construction and demolition were about 30 % of the complaints from all other industrial and commercial sources. It also showed that these complaints had more than doubled over the ten year period from 1978 to 1988.

Construction industry guidance on noise prediction and control has been available for many years. The British Standards Institution published, in 1975, the first edition of BS 5228 [2]. In 1977 the Construction Industry Research and Information Association (CIRIA) published its own guide to noise from construction sites [3] and the Building Research Establishment (BRE) commissioned a number of internal reports on the same subject at about the same time.

This paper discusses the progress on construction site noise prediction, assessment and control since these early days.

2. BS 5228 AND NOISE PREDICTIONS

To carry out noise predictions requires information on the sound power of the noise source and an estimate of the way sound attenuates as one moves away from the source. In making noise predictions, source sound power is probably the most difficult to estimate accurately. The 1975 edition of BS 5228 contained some limited information on noise levels from construction plant. The subsequent work by CIRIA and BRE included extensive on-site measurements of real plant in use in real situations. When BS 5228 was revised in 1984 [4], much of this real-life

data was incorporated into extensive tables of noise levels from a wide variety of plant being put to a variety of uses.

Since this data is largely based on measurements made before 1977, there is general agreement that it is due for revision. Apart from a general tendency to make construction plant less noisy to assist with sales, there have been powerful legislative pressures since 1977 that have tended to force down construction plant noise levels.

Most countries have introduced legislation to reduce the exposure of workers to noise and have tended to enforce it more and more vigorously. Although some worker protection has been achieved with better sealed cabs - which has no benefit for environmental noise - power units have also had better silencing to reduce worker exposure.

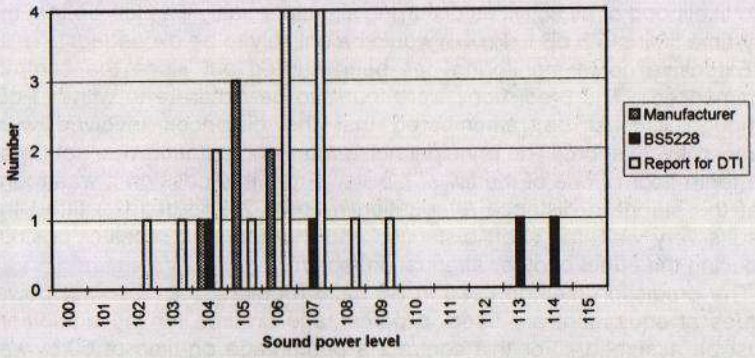
The most significant legislation for environmental noise from construction plant is however, the EC driven legislation [5] that has been introduced to ensure a level playing field in the noise standards imposed on construction plant within the European Community. This has meant that all manufacturers and importers of construction plant in the European Community have had to have the sound power of their machines measured and show that it falls below certain requirements. At the very least, this has meant that much noise measurement data on construction plant has entered the public domain.

However, the Regulation tests are carried out on machines provided by manufacturers, and therefore, these machines might be expected to be in good condition with all noise reduction equipment functioning. This also applies to a number of research projects that have been funded to provide back up data in framing the regulations. BS 5228 remains the only extensive source of noise data on typical machines in use in real situations.

This is illustrated in Figure 1, which gives the distribution of published sound power levels for wheeled loaders of less than 70 kW power taken from three sources: manufacturer's data [6], a report prepared for DTI to evaluate EC test procedures [7], and the tables in BS 5228 [4]. It can be seen that the manufacturer's values, the DTI Report values and two of the BS 5228 values appear to be from the same statistical population. However, two of the BS 5228 values are well in excess of the others. These higher levels may have been due to the use of older plant or because of some defect in the silencing system. This example does illustrate the need for, and value of, real-life data collected on typical sites, and supports the view that a survey to update the tables in BS 5228 is required.

The prediction method given in BS 5228 Part 1 [4] is designed to be as simple as is consistent with giving useful results. Techniques are given for dealing with barriers and with moving sources. Distance attenuation is assumed to be due to hemispherical spreading alone. BS 5228 Part 1 is at present being revised and there is a draft out for public comment [8].

Figure 1. *Distribution of sound power levels for wheeled loaders*



This now includes advice on including soft ground correction to distance attenuation. The same tables of noise from plant are included as in the existing standard. In view of the fact that these are now rather old, the draft standard suggests that the preferred method of obtaining sound power data is to measure similar plant operating in the same mode and at the same power over a representative period including a sufficient number of operating cycles.

3. PREDICTION CASE STUDY

Canada Water Station is being constructed as part of the Jubilee Line Extension by Wimpey Construction. There are two 20-storey residential blocks, 15 m and 35 m from the site boundary, and noise and vibration has had to be taken into account throughout the contract. The main noise producing activities were identified to be piling, rock drilling and earth moving. The procedures in BS 5228 were followed to give the following predicted levels at the nearest property.

Table 1 *Predicted noise levels*

Activity	Noise level dB $L_{Aeq(1\ hour)}$
Contiguous bored piling	72
Sheet piling	73
Rock drilling	69
Earth moving	70
Total	77

The likelihood of all activities occurring simultaneously was low so that the day-time limit of 75 dB $L_{Aeq(1\ hour)}$ would be unlikely to be exceeded.

Extensive noise monitoring has been carried out since the contract commenced. The predictions were found to be accurate to within 1 dB, although it must be remembered that the distances involved were comparatively short. The principal noise monitoring station was set up on the tenth floor of one of the tower blocks. From this position it was found that the standard distance attenuation ratio of $20\text{Log}(d_1/d_2)$ fitted the results very well, the short distances and the elevated receiver position reducing the effect of other attenuation factors.

The prediction method used in BS 5228 requires that, if sound power values of equipment are used, a percentage on-time for the equipment must be assumed. For this contract a percentage on-time of 50 % was assumed for the predictions, and this turned out to accord very well with actual conditions on site.

Further details of this contract and the noise and vibration measurements have been reported by Stubbs *et al* [9].

During the presentation of the paper, the opportunity will be taken to give other examples, based on work carried out for the construction of the Channel Tunnel Terminal at Folkestone.

4. ASSESSMENT

There are no national criteria for assessing construction noise. It is normally left to local authorities to determine criteria appropriate to their area of jurisdiction. The Wilson Report to Parliament [10] gives advice on day-time construction noise but not night-time. The suggestion in the Wilson Report is that day-time noise levels outside the nearest building should not exceed:

- 70 dBA in rural, suburban and urban areas away from main road traffic and industrial noise, and
- 75 dBA in urban areas near main roads and heavy industrial areas.

The above limits were arrived at by a subcommittee of the Wilson Committee meeting in a room subject to construction noise. With a level of 70 dBA outside a window that reduced the noise by about 15 dBA they found they could conduct business, and telephone conversations, without undue difficulty.

The more recent Batho report [1] to the Secretary of State for the Environment discusses construction noise but does not give any specific levels.

BS 5228 [4] gives no specific limits for day-time noise. For night-time noise it states that site noise expressed as L_{Aeq} over 1 hour at the façade of noise sensitive premises may need to be as low as 40 dB to 45 dB to

avoid sleep disturbance. The draft revision is similar except the 45 dB value has been removed.

5. NOISE CONTROL CASE STUDY

BS 5228 [4] includes advice on how to control noise from construction sites. the following case study illustrates some of these principles.

The site involved was a city centre office development next to which was an office building, separated by a side street that was used for site access. A noise abatement notice under Section 60 of the Control of Pollution Act [11] had been served prior to commencement of works, requiring that work only be carried out between certain hours and also that the best practicable means be employed to minimise noise nuisance. The Notice was invoked following a complaint from a nearby office occupant that the general noise level from the site was making his work

Table 2 *Case study noise control measures*

Main source of noise nuisance	Solution employed
Concrete lorries discharging ready mixed concrete onto site directly below complainant' office window.	Relocate discharge point at furthest practicable position away from window. (Approximately 20 m away).
Dumper truck causing noise nuisance.	Dumper trucks barred from street by offices except for access.
Noise from pneumatic drill breaking out concrete etc.	To be screened wherever possible by simple timber screen and use to be limited as far as possible to times of highest ambient noise (morning and evening rush hours).
Noise from circular disc cutters.	Discontinue use and employ burning or pipe cutting gear.
Noise from circular saws.	Surround with timber enclosure wherever possible
Tipping waste from skips into lorries.	Discontinue this practice. Remove skips directly.
Noise from compressed air cleaning guns.	Screen wherever possible and restrict use to times of highest ambient noise as far as possible.
Compressor mounted at 1st floor level on scaffold walkway.	Relocate at ground level, screen by site hoarding

difficult, if not impossible. He found it difficult to identify a single specific item for complaint but stated that several sources of noise on the site were causing annoyance. Table 2 lists the problem areas which were

identified and the general solutions employed. Noise measurements made by the local authority showed that these noise reduction measures had reduced the noise at nearby affected buildings by very approximately 10 dB L_A, from between 65 dB and 80 dB L_A to between 55 dB and 70 dB L_A. The main contractor also wrote to all sub-contractors currently or expected to be on site, stressing the need to avoid unnecessary noise, and supplied the original complainant and also a representative of the local residents with a timetable of future potentially noisy operations with forecast completion dates. Because of the specific noise reduction measures instituted by the contractor and also the undertaking given by the site management that the need to minimise noise nuisance would be constantly borne in mind and given a high priority, the local authority was satisfied that the best practicable means were being used to reduce noise and therefore the noise abatement notice was withdrawn.

6. REFERENCES

[1] W.J.S. Batho, Report of the noise review working party (HMSO, London, 1990).
[2] BS 5228:1975 Code of Practice for Noise control on construction and demolition sites.
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[4] BS 5228:1984 Noise control on construction and open sites. Part 1. Code of practice for basic information and procedures for noise control.
[5] Construction plant and equipment (Harmonisation of noise emission standards) Regulations 1988 (SI1988/361 as amended by SI 1992/3043 and SI 1995/2357).
[6] Information supplied by Caterpillar to a public inquiry into landfilling at Darcy Lever, Bolton, 1994.
[7] 'Noise emission tests on various earth moving machines', SRL Report C/7924/405/2, 1990.
[8] Draft BS 5228:1984 Noise and vibration control on construction and open sites. Part 1. Code of practice for basic information and procedures for noise and vibration control. BSI Document 96/101064 DC.
[9] W. Stubbs *et al*, The assessment of noise and vibration for the construction of Canada Water Station on the Jubilee Line Extension project with reference to BS 5228, Proc. I.O.A. **17**, 5, (1995).
[10] 'Noise Final Report', Cmnd. 2056, (HMSO, London, 1963).
[11] Control of Pollution Act 1994.