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Noise from equipment used on construction sites, quarries and waste disposal sites in the UK

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ABSTRACT

The paper reports on a three stage study carried out for the United Kingdom Department for Environment, Food and Rural Affairs (Defra) on noise from equipment used on construction, demolition and landfill sites and quarries. The study was carried out to assess the relevance of noise data in use for predictions of this type of environmental noise, and to carry out survey work to provide up to date data. Much of the data published in the UK for source noise levels of equipment dated from measurements carried out in the 1970's. The data was generally 'A weighted' without octave band data. A contract was let to Hepworth Acoustics to carry out the study for Defra. Firstly a review was carried out of the existing data and whether other existing sources of data could be used. Secondly, extensive survey work was carried out on construction, demolition and landfill sites to measure a wide range of equipment. Finally, survey work was carried out on quarries to measure equipment noise levels and also to verify the methodology used for determining source noise levels of large items of equipment.

1 INTRODUCTION

Hepworth Acoustics Ltd was commissioned by the Department for Environment, Food and Rural Affairs (Defra) to update a database of noise emissions from equipment used on construction and open sites in the UK. The existing construction plant noise database is contained in Annex C, Part 1 of British Standard 5228 'Noise and vibration control on construction and open sites'[1].

It is often necessary to evaluate the potential impact of noise from proposed construction and open sites in order to assess potential environmental impact and evaluate requirements for noise mitigation. In the UK the likely noise levels must be calculated in accordance with the guidance set out in BS 5228 which is a code of practice approved by the Secretary of State under the Control of Pollution Act.

Part 1 of BS 5228 includes best practice guidelines for minimising noise impact and describes methods of calculating noise levels from construction and open sites. To assist in the calculations, the standard includes tables of noise emission data for a wide range of construction plant and activities in Annex C. However the majority of the plant noise data in Annex C of BS 5228 is based on research commissioned by the Construction Industry Research and Information Association that was published in 1977. Therefore the majority of information in the current database relates to 1970s machinery and working practices. Hence

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there was a need to obtain more recent data in respect of techniques and plant that are currently deployed on construction and open sites.

This paper provides an overview of the project and some of the findings. Reference is made to the results of the project that are published on the Defra website.

2 PROJECT METHODOLOGY

2.1 Phase 1

The first phase of the study was to assess the existing databases contained within BS5228 in order to establish if there were any omissions in the data and to identify any data that is obsolete with regards to plant and construction techniques that are used on sites today. Other sources of data were investigated to assess whether more relevant and up to date data was available.

It was concluded that there were no other suitable databases relevant to UK equipment. It was also concluded that data was required for plant in actual use on construction and open sites rather than results from standardised type testing under Schedule 6 of the Noise Emission in the Environment by Equipment for use Outdoor Regulations[2]. Site measurements would obtain real life noise levels and would include all noise sources such as horns, reversing sirens, rattling of buckets, impact noises etc. However there are no national measurement standards that apply to carrying out plant noise measurements under actual operational site conditions. Therefore a method statement for carrying out the noise measurements and data analysis was agreed with the Defra project manager prior to implementation.

2.2 Phase 2 Survey

The objective of the Phase 2 study was to:-

- Obtain measurements of noise from plant and equipment that is currently used on construction and open sites (specifically construction, demolition, landfill and opencast coal sites) in the UK and to prepare a database of the information.
- Include octave band noise levels within the database.

The surveys were carried out by Hepworth Acoustics during the summer and autumn of 2004. The plant noise measurements were undertaken at a wide range of locations within reasonable travelling distance of our offices in Warrington, Sheffield and Ashford.

Construction projects included residential sites, supermarket developments, retail parks, warehousing, hotel, civic buildings, infrastructure projects, factories and industrial installations. Road works included major trunk road widening and general re-surfacing works. Landfill and opencast coal operations covered both larger and smaller sites.

On some construction sites a number of repeat visits were made for quality assurance purposes or to measure noise from different machinery as plant deployment and activities carried out on construction sites varies as the works progress.

A number of practical problems were encountered. Firstly the poor weather during the summer interfered with the programme, with no measurements at all being possible during the very wet August. Other problems included the administrative time spent negotiating with contractors to provide access for our staff; having to abort/repeat measurements of a particular machine due to noise from another machine passing nearby; difficulty in establishing the engine power output/weight of the equipment as identification plates were non-existent or covered up by panels or the livery of the contractor/plant hire firm; and dealing with the usual delays, stand-down time and breakdowns that occur on construction sites.

2.3 Phase 3 Survey

The original commission from Defra excluded plant employed on quarries, as research was under way for another government department on this topic. It was decided to wait until this work was published to determine whether it provided sufficient information on quarry plant noise for the database. When the work was published, it was determined that the noise data was not in a compatible format, therefore, Hepworth Acoustics was commissioned by Defra in 2005 to extend the survey work to include quarry plant. This work was completed in 2006, together with a review of the measurement methodology carried out by Salford University Acoustics Group.

3 COMMENTS AND OBSERVATIONS

Our observations and comments on the findings of the study are set out below for the various types of activities.

3.1 Demolition

The use of crane mounted wrecking balls has been replaced by the use of modern powerful hydraulic excavators either fitted with a bucket that is used to pull/push buildings down or fitted with jaws that 'chew' through the building structure. For breaking up concrete excavator-mounted peckers are used. Even though modern peckers are often 'silenced' and fitted with damped tips, breaking up concrete rubble or foundations remains the noisiest demolition operation. However use of these machines usually enables demolition works to be carried out over a relatively short period.

Large loose pieces of concrete are sometimes broken up with a jaw crusher (pulveriser) fitted to a hydraulic excavator which generates less noise. These days there is much more recycling of materials and this can often involve the use of a semi-mobile concrete crusher being used on the demolition site.

3.2 Site Preparation

Since the last database was complied the use of 'traxcavators' and mechanical grab machines has been replaced entirely with modern hydraulic excavators with 360^{o} slew turrets. Even on major earthwork operations the excavation and movement of materials is now undertaken generally by excavator and articulated dump trucks rather than the old method of bulldozers with scraper boxes or motorised tractor scrapers. Site preparation activities often overlap with demolition works and general site activities. For ease of reference all breaking out operations have been included in the data for demolition.

3.3 Piling

The existing database in Part 1 of BS 5228 includes some measurements of noise from piling and ancillary operations. However, more comprehensive information is provided in Part 4 of BS 5228.

Some measurements of piling were carried out as part of this study and the results are shown in Table 3. We have attempted to cover a range of different piling techniques and have included mini-piling and an innovative vibratory 'stone column' method.

3.4 General Site Activities

Many construction activities fall within this category. The amount of concreting operations on construction sites appears to be much less than in the 1970s due to the move towards steel framed buildings, use of pre-cast concrete building elements, and general shift towards lightweight buildings and dry-construction techniques.

Minor lifting operations were observed to be carried out by telehandlers, forklift trucks, excavators or backhoe machines. Most heavy lifting operations were found to be carried out

by mobile cranes with telescopic jibs, typically within the 35-80t range. However we were able to measure some larger tracked cranes.

As noted above, since the original database was compiled, there has been a general move away from heavy concrete framed buildings to modern lightweight structures with steel frames. Also, joinery is often delivered ready built. Consequently we found that once the preparatory ground/infrastructure works had been completed there was often little noise from the subsequent building works apart from occasional lifting operations, cutting of blocks, distribution of materials, cement mixers, etc.

3.5 Roadworks

Similar types of operations are carried out on road construction works as were included in the previous database. However there has been a move away from concrete road surfaces to bituminous surfaces. Also there is more recycling of materials on site which results in less movements of fill material offsite.

The measured noise levels range from small scale repair works to major highway widening. On road construction projects there is often a large inventory of plant and equipment. However we noted that rarely is all the equipment used simultaneously. At any one time many items of equipment may be switched off for extended periods.

3.6 Opencast Coal Sites

Opencast coal sites differ from other types of quarries in that the bulk of excavated material is 'overburden' which is stored in temporary mounds on the site or replaced in to a worked out void. The actual coal seams may only be 1 metre thick, and are usually located deep within the excavated void. Once the coal is removed the overburden and soil mounds are replaced and the land restored.

The data in Table C10 of BS 5228 for opencast coal sites is, as the title suggests, of 'historic' interest only. The data relates to obsolete plant and working practices such as use of 2-stroke scrapers and large electrically powered draglines and crowd shovels.

Much of the data in Table C11 of BS 5228 relates to measurements carried out by Hepworth Acoustics in 1993. This data is more up to date and reflects the move towards the use of large diesel powered hydraulic excavators for excavation of overburden. Working practices are the same now as in 1993.

In the 2004 noise survey, plant noise levels have been measured on a number of open cast coal sites including very large and smaller operations. Only one large site was a traditional 'drill and blast' operation, on the other sites (as is increasingly common) overburden is simply dug out by hydraulic excavators.

One operator (H J Banks & Co Ltd) has reported considerable success in achieving reductions in noise emissions from standard excavators and dump trucks used on their opencast coal sites by finding innovative design solutions in conjunction with the manufacturers. Such plant has not been included in this survey.

3.7 Landfill Sites

There are three main types of equipment used on landfill sites. Firstly plant used to compact and cover waste that is deposited by the delivery vehicles at the tipping area. Often this may involve only one waste compactor and one bulldozer, although on larger sites there may be two separate tipping areas each with a compactor and dozer. Secondly, there are earthworks (often seasonal) associated with preparing and lining the next 'cell'; and thirdly ancillary items such as generators for pumps and site cabins, fuel bowser, road sweeper, etc.

Landfill operations normally take place at large distances from residential areas and often the only noise audible is from reversing bleepers of compactors/dozers. Our noise measurements include the normal operation of these bleepers.

3.8 Quarry Sites

There was no separate database of noise levels for quarry plant in BS5228, although some plant noise levels could be found from the other data within the standard. The survey data was split in to hard rock quarries, other quarries and general activities such as lorry movements and water pumps. Fixed processing plant was not included in the survey.

4 RESULTS

The results of the noise measurements taken on site are presented as un-weighted octave band activity L_{eq} levels together with overall activity L_{Aeq} values. Where relevant, pass by measurements were made for moving sources such as dump trucks, and these are presented as un-weighted octave band L_{max} values, and overall L_{Amax} values. All sound pressure levels are standardized to a distance of 10m from the plant.

The aim has been to simplify the database as far as possible by reducing the number of data entries and the number of tables. Thus, where appropriate and following approval from Defra, results for similar sized plant have been averaged logarithmically. Also we have amalgamated some activities to reduce the number of data tables.

Weights for machines, where given, relate to the usual weight references used in the construction industry i.e. weights for machines such as bulldozers, excavators, rollers, etc are the actual weights of the machines; weights for dump trucks and dumpers are the load capacity weights; and weights for cranes are the lifting capacity weights.

The databases produced as part of the study are published as two documents on the Defra website[3,4].

5 CONCLUSIONS

Hepworth Acoustics have produced an updated noise database for plant used on construction and open sites. The update has amounted to a major overhaul based upon an extensive programme of noise measurements carried out on construction and open sites in 2004 and 2006.

The scope of the database has been extended to include plant used on landfill and quarry sites. The database has also been enhanced by the provision of octave band noise data for all plant and activities. However, where possible, the presentation of the information has been simplified by reducing both the number of tables and number of data entries.

In our judgement (and as recommended in Part 1 of BS 5228) when calculating noise from proposed construction operations, the best starting point is to actually measure the noise emissions from the type of plant that is to be used. However, in many cases it may not be practical to do so and in such circumstances use of the new database for environmental noise calculations will give greater accuracy than relying on noise emission data quoted by plant manufacturers.

6 ACKNOWLEDGEMENTS

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7 REFERENCES

[1] *Noise and vibration control on construction and open sites* British Standard 5228: Part 1: 1997 (British Standards Institute, London, 1997).

[2] *The Noise Emission in the Environment by Equipment for use Outdoors Regulations 2001* Statutory Instrument 2001 No. 1701 The Stationery Office Limited, London, 2001.

[3] http://www.defra.gov.uk/environment/noise/research/construct-noise/constructnoise-database.pdf
[4] http://www.defra.gov.uk/environment/noise/research/pdf/noise-database-phase3.pdf