Investigations into the Prediction of Construction Noise

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Introduction

In contrast to industrial plants, traffic routes, or leisure facilities, no calculation method has been specified for the determination of noise emissions from building sites. The only test and assessment code available - the General Administrative Regulation for the Protection Against Construction Noise; Noise Immissions [1] – dates back to 1970. As the noise emission from inner-city building sites presents a particular source of noise impact to residents, several attempts have been made to standardize ambient-noise prediction [2] [3].

A large part of the equipment used on building sites is subject to noise-emission limits [4]. So far, construction-equipment manufacturers have refused to accept a construction-noise calculation code, as they suspect even stricter noise-emission limits to ensue from such a guideline.

Due to the conflict of interests between the builder-owner/building contractor, on the one hand, and the residents, on the other hand, there is always a need for determining the noise emissions from building sites. This is the only basis on which to grant special permits, develop technical or organisational noise-control measures, or negotiate agreements with the residents concerned.

Prediction of construction noise

Based on the General Administrative Regulation for the Protection Against Construction Noise; Noise Immissions [1] and the Technical Instruction Noise [5], the ambient noise from the individual sound sources of a building site is calculated for each reception point. The contributions made by the sound sources to the noise impact at any one reception point are added energetically, all equipment/processes belonging to one building work being combined. Simultaneous building works may be superimposed. The sound pressure level determined at the reception point is a rating level. It can be verified by applying the measurement method described in [1], and assessed by comparison to the indicated ambient-noise standard values.

As per [1], separate rating levels are determined for daytime and night-time (07.00 hrs to 20.00 hrs, 20.00 hrs to 07.00 hrs). The penalties to be added to the time-averaged sound pressure level for impulse or tonal components (in [1]: annoyance penalty) are taken into account for each sound source (effective sound power, see also [6]).

Times of machine use

The time of use of a construction machine, which has an effect on ambient noise during the rating period, can considerably influence the sound power to be assumed. Observing [1] strictly, specified bonuses are to be included (see Table 1). The energy-equivalent level can be calculated as described in DIN 45645-1 [7]. Both methods are compared in Figure 1.

In practical approval cases, some of the Länder exclusively require the method as per [1] to be followed for construction-noise predictions. Below, the method of energy-equivalent averaging (as per DIN 45645) is discussed.

The time of use of all construction machines involved in performing one particular building work is not only determined by the point in time at which they are started. Reducing the engine speed during the working process will also result in a reduction of the time-averaged sound pressure level. The sound power may vary by up to 10 dB(A) between running under load and idling.

Simplified method for complex building processes

In Germany, building-construction and civil-engineering projects are, to a great extent, executed as reinforced-concrete constructions. This construction method is characterised by the main processes formwork, reinforcement, concrete work. In [8], the times of use of the machinery and equipment used in reinforced-concrete construction were determined by measuring the times and levels for the individual processes. The time ratios of the individual processes were used as weighting factors for the times of use, allowing to determine the time-ratio contributions of the construction equipment to the overall building work „reinforced-concrete construction“ (see Table 2). Based on these time ratios, the effective sound power level for each item of construction equipment was determined in accordance with DIN 45645 [7] (sound-power rating level).

Where the distance between the building site and the reception point is large when compared to the site dimensions, the effective sound power levels of the items of construction equipment can be regarded as radiating from one sound source. Alternatively, a surface sound source can be assumed, as a preliminary-construction team works on a surface area of approx. 400 m².

For the model project (Central Berlin) investigated in [8], typical sound power levels were determined. On account of the construction technology used, the relation between the size of the construction site and the utilisation of machinery/personnel may be assumed to be approximately linear.

Assessment, conclusion

Applying the simplified method for construction-noise prediction offers advantages in the

- determination at an early planning stage (e. g. during development planning) of the ambient-noise levels to be expected,
- acoustical assessment of various construction technologies,
- determination of the ambient-noise levels to be expected, without knowing which construction equipment will actually be used (prior to contracting the building work).

The method described does not allow to identify high-noise equipment or processes, including the development of noise-control measures (this would require predictions for the individual machines.); nor does the simplified statistical approach allow to determine individual low-noise construction works that might be performed during resting hours.

Table 1: Time-correction for calculation of rating level as described in AVV Baulärm [1]

Averaged daily time of use during		
07.00 to 20.00 hrs	20.00 to 07.00 hrs	Time-correction
up to 2 ½ h	up to 2 h	10 dB(A)
more than 2 ½ h to 8 h	more than 2 h to 6 h	5 dB(A)
more than 8 h	more than 6 h	0 dB(A)

that are characterised by typical work sequences and a typical use of machinery. Whereas the use of machinery for a complex building work can be determined on the basis of the working schedule for the construction site, the times of use having an effect on ambient noise will have to be determined separately for the individual items of equipment.

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Table 2: Calculation of time ratios for use of construction machines in reinforced-concrete constructions [8]

Work area		Main item		Technology		Machines, equipment	Measured time ratio related to technology in %	Time ratio related to work area in %
Concrete & reinforced concrete work	100%	Formwork	47%	System formwork	46%	Crane	37	8
						Hammer	14	3
						Circular saw	10	2
						Hand-circular saw	2	0
				Carpenter's formwork	54%	Crane	5	1
						Hammer	12	3
						Circular saw	26	7
						Hand-circular saw	2	1
		Reinforcement	19%	Laying/ mounting	100%	Crane	5	1
						Angular grinder	3	1
		Concrete work	10%	Bucket-concreting	40%	Crane	60	2
						Internal vibrator	69	2
						Mixer truck	100	4
				Pump-concreting	60%	Concrete pump	100	5
						Mixer truck	100	5
						Internal vibrator	86	5
		Formwork (removal)	24%	Formwork (removal and recycling)	100%	Crane	24	6
						Hammer	9	2
Sum	100%	Sum	100%					

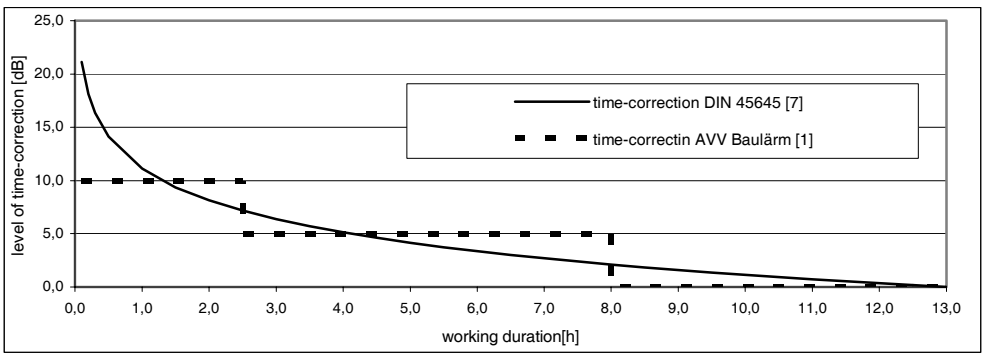

Figure 1: Time-correction of sound pressure levels for daytime as described in AVV Baulärm [1] and DIN 45645 Part 1 [7]