

EXPERIMENTAL EVALUATION OF SIMPLIFIED MODELS FOR PREDICTING NOISE LEVELS IN INDUSTRIAL WORKROOMS

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Introduction

Simplified models for predicting industrial noise levels have the advantage of simplicity and negligible calculation time over more generally-applicable and comprehensive methods such as ray tracing. Simplified models predict octave-band and/or A-weighted steady-state sound-pressure level as a function of distance from a single omnidirectional sound source of known output power level. The industrial workroom is typically described by model parameters describing the room geometry, surface absorption and contents (fittings - the numerous machines, stockpile, benches etc. in the workroom).

In recent work [1], existing simplified models for predicting noise levels in industrial workrooms were reviewed and critiqued. Models developed by Embleton & Russell (E&R - this is a Canadian Standard), Friberg, Kuttruff, Sacerdote, Sergeev, Thompson *et al*, Wilson and Zetterling were considered. Full references to the papers presenting these models, full details of the models themselves and a conceptual critique of the models are given in [1]. Most models were found to be conceptually inadequate; for example, some ignored a key parameter - the fittings. Preliminary attempts were subsequently made to develop an improved model (the Hodgson model)[2].

In the present work, these nine simplified models were evaluated by comparing predicted sound-propagation curves - $SP(r)$, the variation with distance r of the sound pressure level L_p minus the source sound power level L_w - with those measured in empty and fitted industrial workrooms with and without absorptive surface treatments.

Workrooms

The study involved thirty industrial workrooms. All were of typical modern construction, with a steel-deck roof, concrete floor, masonry/glazing/metal-cladding walls, and horizontally-uniform fitting distribution. The workrooms were in four categories: empty (10), empty with absorbent surface treatment (5); fitted (10); fitted with absorbent surface treatment (5). The absorbent treatments consisted of various sound-absorbing materials applied to or suspended from the ceiling and/or all or part of the walls.

Test and Prediction Procedures

In each workroom sound-propagation curves were measured in octave bands from 125-4000 Hz. A calibrated omnidirectional

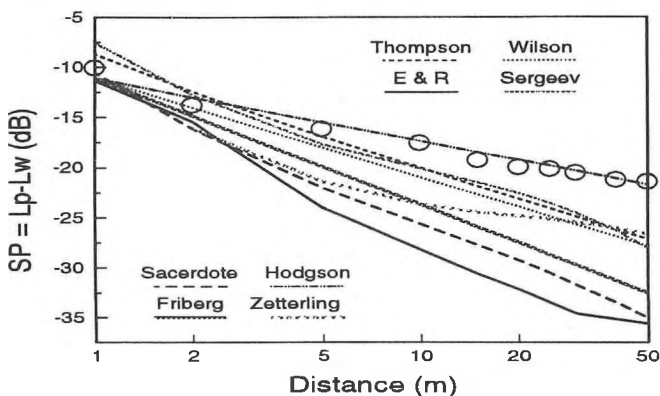


Fig. 1. A-weighted or 1000-Hz sound-propagation curves in an untreated empty workroom as (O) measured and as predicted by eight simplified models.

loudspeaker array was placed near one end wall at half width. Steady-state sound-pressure levels were measured at convenient distances along the workroom at half width. Reverberation times were also measured. All models were programmed using spreadsheets. Parameters originally presented in the form of curves were predicted using equations determined by regression techniques.

Input data was estimated for each workroom. Surface absorption coefficients were estimated from measured reverberation times using diffuse-field theory. Fitting parameters were estimated from a knowledge of the fittings involved and from experience.

Each of the 9 models was used to predict SP curves for each of the 30 workrooms. 125-4000 Hz octave-band and/or A-weighted total levels were predicted as applicable. Predicted and measured results were compared using plots and statistics.

Results

Figs. 1 and 2 show the A-weighted or 1000-Hz octave-band results for untreated typical empty and fitted workrooms, respectively. The main conclusions can be generalized as follows:

In empty workrooms, the Embleton & Russell, Friberg, Sacerdote and Wilson models significantly underestimate levels in most cases. The Hodgson, Sergeev, Thompson *et al* and Zetterling models perform quite well.

In fitted workrooms the Embleton & Russell, Kuttruff, Sacerdote, Sergeev, Thompson *et al* and Wilson models significantly underestimate levels in most cases; the Thompson *et al* model overestimates levels. The Friberg, Hodgson and Zetterling models perform quite well.

Only the Hodgson model performed very well in most cases; this is not surprising since it was developed from the same workroom $SP(r)$ data used in this evaluation work.

[1] M. R. Hodgson, "Review and critique of existing simplified models for predicting factory noise levels", *Canadian Acoustics* 19(1) 15-23 (1991).

[2] M. R. Hodgson, "Preliminary simplified models for predicting sound-propagation curves in factories", *Canadian Acoustics* 20(3) 37-38 (1992) and Erratum, 20(4) 19 (1991).

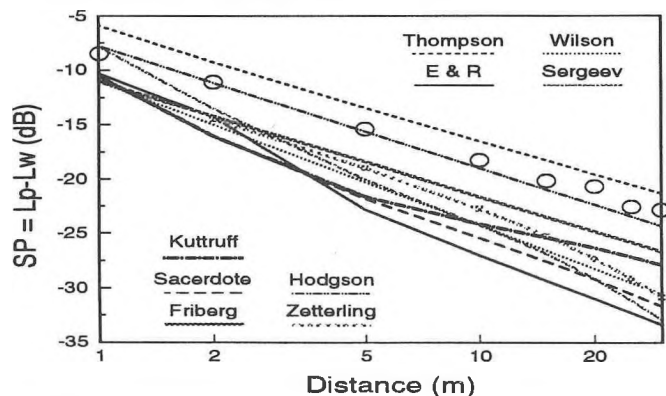


Fig. 2. A-weighted or 1000-Hz sound-propagation curves in an untreated fitted workroom as (O) measured and as predicted by eight simplified models.