INVESTIGATION ON NON-POINT SOURCES APPROXIMATION IN OUTDOOR NOISE PREDICTIONS

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1 Présentation (Français)

La norme ISO 9613 spécifie une méthode de calcul de l'atténuation de la propagation des bruits de l'extérieur, qui a été reconnu et accepté par les différentes autorités réglementaires. Comme cette méthode a été mise en œuvre dans la plupart des logiciels de pointe, tels que Cadna/A et SoundPLAN, cela rend possible la prédiction et la résolution de problèmes de bruit dans un environnement complexe ou l'évaluation du bruit d'un grand établissement. Cependant, une importante décision est à prendre sur la façon de modéliser chaque source de bruit, en particulier, en décidant quelle situation de la répartition des sources de bruit d'éléments individuels associés à une installation complexe aura une incidence sur le motif du champ de bruit qui en émane. La norme ISO 9613 indique que les sources linéiques et surfaciques (« line sources » et « area sources ») peuvent être divisées en sections, chacune représentée par une source ponctuelle en son centre. Toutefois, cela ne peut garantir la précision de calcul pour certaines distances de l'unique point source équivalent. Par conséquent, une grande segmentation des sources est nécessaire pour calculer avec précision le niveau de bruit sur le terrain à proximité de sources linéique et surfacique, ce qui peut augmenter la charge de calcul et peut être nécessaire seulement en champ proche. Ce document met l'accent sur la comparaison des résultats entre les niveaux de bruit prévus et mesurés, en général et dans bandes d'octaves qui prouvent la validité de la méthode de calcul proposée. Ensuite, le modèle validé sera utilisé pour étudier l'applicabilité et la précision dans la prédiction de bruit dans l'environnement. Les critères de distance pour la méthode de source ponctuelle peuvent être appliqués efficacement pour prédire et résoudre les problèmes de bruit dans un environnement complexe pour la prédiction de bruit extérieur et aussi pour les mesures sur le terrain.

2 Presentation (English)

ISO 9613 specifies a method for calculating the attenuation of outdoor sound propagation, which has been recognized and accepted by various regulatory authorities. As this method has been implemented in most advanced software packages, such as Cadna/A and SoundPLAN, this makes it feasible for predicting and resolving noise problems in a complex environment or the noise assessment of a large facility. However, an important decision to be taken is on how to model each noise source, in particular, deciding which situation the distribution of the individual component noise sources associated with a complex facility will affect the pattern of the noise field that emanates from it. ISO 9613 guides that line and area sources may be divided into sections, each represented by a point source at its center. However, this may only ensure the calculation accuracy at some distance from the single equivalent point source. Hence, a large segmentation of the sources is required to precisely calculate the noise level at the near field from line and area sources, which may increase calculation burden and may be only required in the near field. This paper will focus on comparing results between predicted and measured noise levels, overall and in octave-bands, which prove the validity of the proposed calculation method. Then, the validated model will be used to investigate the applicability and accuracy in the environmental noise prediction. The distance criteria for the point source method can be effectively applied for predicting and resolving noise problems in a complex environment for outdoor noise prediction and also for field measurement.

3 Introduction

A major challenge in acoustics is to accurately predict what the sound level will be at some location, far or near. The sound level at some location is the combination of all the noise sources.

In order to predict or model noise from equipment we need to understand, or better, define the sound fields and the predicted sound level associated with those fields. ISO 9613-2, *Acoustics – Attenuation of sound during propagation outdoors*, is the standard used for modeling outdoor sound propagation and predicting far field sound levels. The propagation of sound is generally described using the following expression,

$$L_p = L_w + 10\log\left(\frac{Q}{4\pi r^2}\right) - \sum A_i$$

In this method, the sound pressure level at some location is modeled by a set of geometric terms ($Q/4\pi r2$) and losses (ΣAi). Q defines the reflective surfaces (boundary conditions) that are around the source of noise having a sound power, L_W. ΣAi is the term used to account for all the elements that can affect the sound level (directivity, atmospheric loss, barriers, ground effects, trees, etc.).

The far field starts where the sound field becomes more stable and propagation is fairly uniform. The location is frequency (wavelength) dependent and is usually two to four major source dimensions (width and height of the source) away from the noise source.

In modeling, all sources can be modeled as a point source if the concerned receiver location is far enough based on the frequency consideration. This simplification will get the modeling of complex plant more efficient with reasonable accuracy.

4 Comparison on Model Scenarios

4.1 Comparison settings

The noise modeling was conducted using CadnaA by Datakustik. CadnaA is an advanced noise propagation model that considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography and geometry, vegetation and environmental conditions. The calculations performed in CadnaA were conducted in accordance with ISO 9613.

In order to investigate the point source simplification of extended noise sources such as line sources and area sources, the following scenarios were simulated using CadnaA software:

1) Single noise source (point source vs line, area and vertical area source;

2) Single gas driven compressor unit, sound power levels of the noise sources validated with field data;

3) Multiple compressor units (10x) to simulate a plant with dozens of point sources mixed with extended (line or area) noise sources.

4.2 Data analysis

In these three scenarios, the predicted overall and octave band sound pressure levels at various receiver locations using point sources were compared with the model results built from extended noise sources. The accuracy of the noise source simplification was checked at various receiver locations.

5 Results and Discussion

Figures 1-3 show the predicted overall sound pressure levels at various receiver distances in four directions for the three scenarios above. The ground absorption was modelled as 0.6 for a typical grass field. The results show that simplification of point sources could get reasonable prediction alignment compared with the extended source modelling, usually from 50m away and greater.

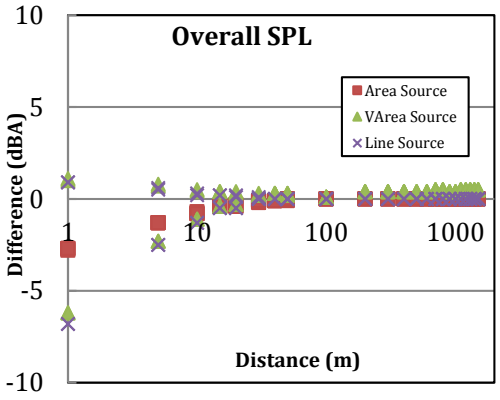

Figure 1: Predicted SPL Difference of Single Source - Point Source Compared with Extended Source (20m Length)

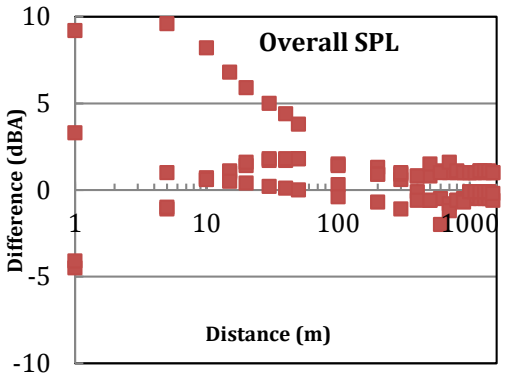

Figure 2: Predicted SPL Difference of Single Compressor Unit - Point Source Model Compared with Extended Source Model

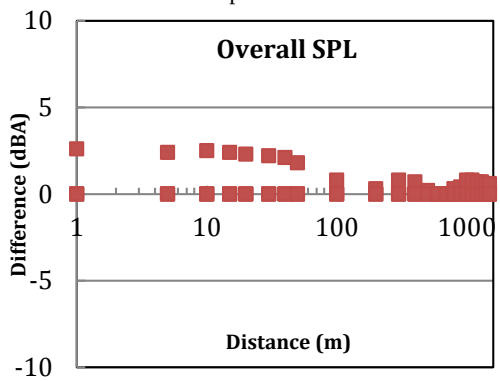

Figure 3: Predicted SPL Difference of Simulated Plant - Point Source Model Compared with Extended Source Model

Big differences in the near field is because the sound energy is fluctuating and propagation is far from uniform, especially within the wavelength of the lower frequencies. The differences are even bigger for the single compressor unit, which are also caused by the building shadow effects in the near field. In the plant scenario, less fluctuation results because the receiver locations are based on the plant boundary, which is approximated to the far field.

6 Conclusion

To create simplified point sources, the locations of the acoustical center of extended sources such as line and area sources and accurate sound power input are very important for the simplification of an accurate prediction.

Even though with the enhanced computer power of today's systems, the extended noise source can be divided automatically based on the distance and frequency consideration, which may result in a more accurate prediction in the near field. However, the simplification of point sources will make the model building more efficient and result in less calculation time. This is especially useful when the details of the noise sources are not available and near field prediction is not necessary.

References

[1] ISO 9613-2:1996, *Acoustics – Attenuation of sound during propagation outdoors.* International Organization for Standardization

[2] DataKustik GmbH. (2013). Cadna Manual