The influence of the ground in source strength models of explosions

A method has been developed to model the source strength of explosion in vicinity of complex ground surfaces. The model will be used to plan noise reduction measures at military shooting ranges and is currently being included in the advanced EMPA-calculation model.

The laboratory of acoustics of EMPA has been dealing with shooting noise from military training areas for many years. A frequent reason for complaints are explosions and detonations of hand grenades. A common method to reduce the noise is to shield the sources either by putting them in cavities or by placing barriers nearby. To be able to predict the effect of those noise reduction measures, a calculation method has been developed. This method combines a theoretical approach to calculate the source strength of explosions, the Weber model with an empirical model, the height of burst gain, which is described in common standards. Based on measurement results from a series of explosions of 200 g TNT set off at 9 different source positions and firing site geometries, the following conclusions can be taken:

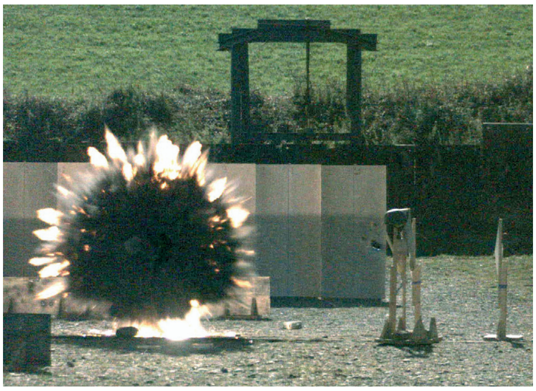

Fig. 1: *Example of an explosion close to the ground with barriers in the back (picture by GR).*

For situations with source positions above surface level the two models can successfully be combined by applying a constant correction term. However, to reproduce experiments from cavities, the definition of the source location has to be adapted. Additionally, the fraction of energy that is transferred into the ground has to be considered and a spectral shift towards lower frequencies has to be taken into account. With these corrections, calculations and measurements agree very well. This good agreement is surprising when considering how little information the model needs to yield reliable predictions. Furthermore, the ability of the so called Weber model is very convincing (Fig. 2), not only to predict the acoustical source strength in terms of overall sound energy levels but also to yield accurate spectral information.

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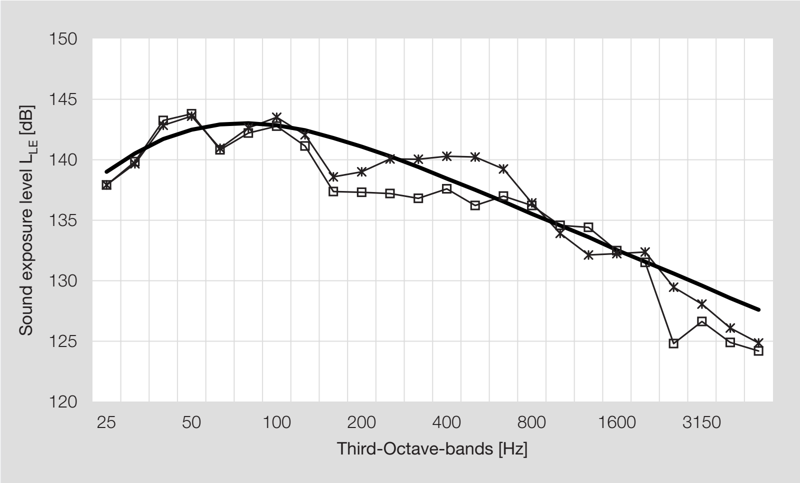

Fig. 2: *Comparison of measured sound exposure spectra calculated back to a reference distance of 1 m with predicted source spectra for explosion directly from grassy ground. (Bold line: calculation; line with stars: source values based on measurements at 4 m height; line with squares: source values based on measurements at 1.5 m height).*

The measurements can also be used to draw conclusions on how to model propagation of explosions. When using classical linear sound propagation models, it is proposed not to employ shielding effects within the region of non-linear conditions and to assume strong turbulence for the calculation of the ground effect.

The results of this study are included in the advanced EMPA-calculation model that is currently developed in the laboratory of acoustics of EMPA by order of the Defence Procurement Agency of Switzerland (GR).

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References:
J.M. Wunderli, Acta Acustica, accepted (2003)