# A review of analytical methods for computation of partitions' sound reduction index

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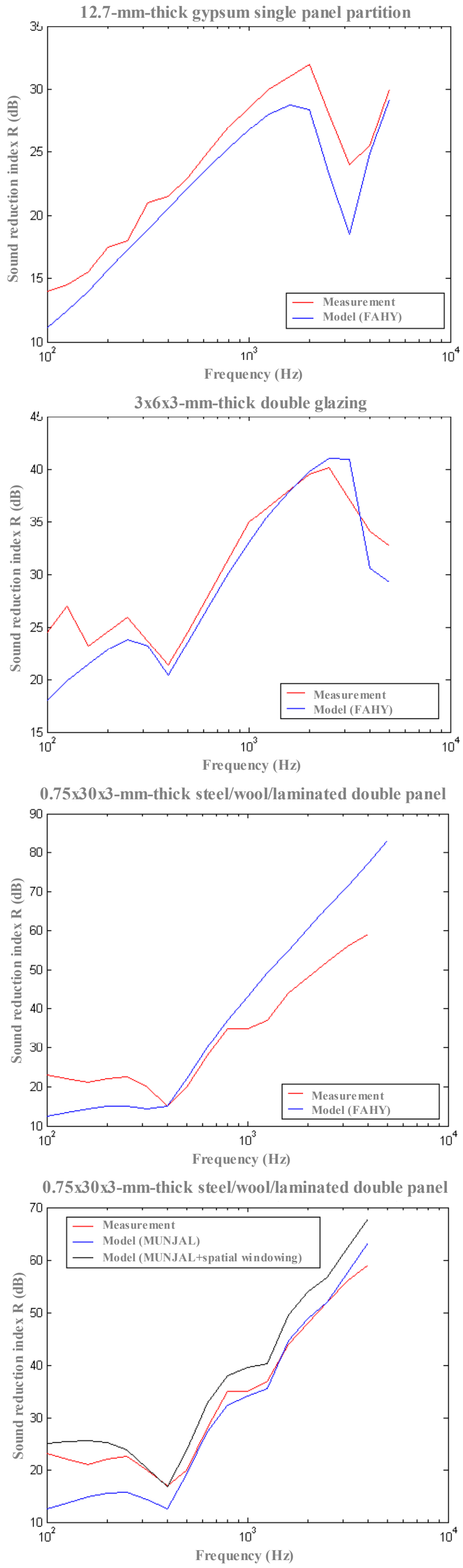
## Mode~~l~~ling

The aim of the present review is to investigate various methods of dimensioning of such partitions. Since the last half of century, sound reduction index and its calculation have become one of the researchers' main concerned and they have introduced various theories. This review however, deals with the wave theory approach. This approach has many advantages, notably it leads to rather simple calculations, highlights the dominant physical phenomena such as critical frequencies or mass law effect, and can be applied on a wide frequency range. There are however, some disadvantages. In particular, it is not adapted to the prediction of singular phenomena such as resonances and it cannot be applied only to homogeneous panels. As a result, the low frequency predictions are seldom reliable.

This review starts with cases of unbound single and double leaf partitions in pure bending (i.e. thin partitions). Our contribution is based mainly on works by F. FAHY [1], where he carries out a very clear synthesis of the past studies. His models apply from single leaf partition to double leaf partition filled with air or fibrous absorbing materials. For this last case, the absorbing material is modelled as an equivalent fluid with complex acoustic wave number, resulting in a decay of the sound wave amplitude in the cavity. Calculation of sound reduction index of a partition excited by a diffuse field requires integration over the range of the angles of incidence. Theoretically, this range lies within 0 to 90 degrees. It is well known however, that in practice, such a range would lead to an overestimation of the transmission loss. So, the upper limit is often taken as 78 degrees, an empirical value first introduced by BERANECK [2]. In a later work, H-J KANG [3] developed an angle distribution function that, although leading to slightly different results as compared to BERANECK's, has the advantage of lowering singularities around the critical frequencies for double leaf partitions. Consequently, we have introduced this function in all our models for comparisons with experiments. The acoustic partitions are often comprised of thick walls, making it necessary to take the shear wave into account. MUNJAL [4] has developed a transfer matrix technique that allows the simultaneous introduction of the normal (longitudinal) and shear (transverse) waves. Similarly, the absorbing material, filling the double leaf partitions, can be modelled by means of a transfer matrix. This technique, as shown in ref.[5], can be applied for the modelling of porous material. Transfer matrix components calculation is achieved using BIOT&ALLARD theory. All these models have also been included in the present review. As it was explained above, the wave approach does not give satisfactory results at low frequencies. This is particularly true for the singular phenomena such as resonances. Moreover, it yields to an under estimation of the sound reduction index. To correct for this last point, VILLOT and GUIGOU [6] developed a spatial windowing function analogous to that of a radiation factor. This function depends on the dimensions of the wall and allows a correction of the index at low frequencies. We have also introduced this factor into our models.

## Results

The results are presented in form of comparisons between the theoretical curves, resulting from our models, and some experimental curves found in the literature. FAHY's classical model [1] coupled with the angle distribution of the incident field technique [3] show a good agreement for typical partitions such as single gypsum panel double glazing (fig. 1&2). Applied on a complex partition, these models exhibit discrepancies due to low frequency effect and shear (fig.3). Use of matrix technique [5] allows correcting for shear effects. Using the ref. [6] spatial windowing allows correcting for low frequency effects, but increases discrepancies above the resonant frequency (fig.4).




*Figures 1 to 4*

## Conclusion

Various methods of modeling of single or double leaf partitions were applied and validated through comparisons with measurements. Comparisons with experiments yield good results. These models have proved their efficiency. It is important to underline that experimental data, found in the literature, pursued in most cases, different objectives. This argument can further validate the results of the comparisons. The principal conclusion of the present review is that the acoustic performances of a partition, in the medium-high frequency range, can be calculated through a simple and easy to understand way. This of course, depends on the type of partitions considered, which are, in the most complex case, double leaf partitions made up of panels of average thickness and filled with porous materials. Lastly, in the low frequency range, the introduction of a correction factor as a function of the panel dimensions makes possible the extension of the field of application of the models, within an acceptable error.

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