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# The Transmission Of Sound Through Stud Partitions

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## Introduction

The complex nature of sound transmission through double walls and double walls with structural ties has compelled consultants to use published measured data for acoustical designs, even though theories for the prediction of sound transmission loss of such walls have been available for years. Stud partitions are one such group of walls used commonly. Predictions of sound transmission loss are only made when published data are not available. Under those circumstances the simple theories, based on the mass law and the coincidence theories are normally used.

This study looks at the ability of the simple theories in predicting sound transmission loss of stud partitions. Both common stud partitions and separate stud partitions are investigated. The study commences with the single studded partitions and proceeds according to the order of complexity with respect to sound transmission. As far as possible published rather than measured materials properties are used for the predictions since consultants are not usually equipped to measure these material properties.

## Single Studded Partitions

The well known Mass law theory and Coincidence theories are used. The sound transmission loss is predicted using the following equation,

$$R = -10 \log \left\{ \left[ 1 + \left( \frac{\omega \rho_s}{4 \rho c} \right)^2 \right]^{-1} + \left[ \left( \frac{\omega \rho_s}{2 \rho c} \right)^2 \left( \frac{f}{f_c} \cdot \frac{2}{\pi} \cdot \frac{\eta}{\sigma^2} \right) \right]^{-1} \right\}, \text{ dB} \qquad (1)$$

where $\omega$ is the angular frequency; $\rho c$ is the specific impedance of air; $\rho_s$ is the surface density of the wall; $f_c$, $\eta$, $\sigma$ are the critical frequency, total loss factor and the radiation efficiency of the wall respectively. The radiation efficiency of the wall can be predicted using Maidanik's theory (1).

These data are readily available from engineers' handbooks. Figure 1 shows a set of typical results obtainable for a studded plywood partition.

The excellent agreement between the measured and the predicted results have shown that the simple theories can give good predictions of sound transmission loss through single studded partitions.

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**Separate Stud Partitions**

A separate stud partition consists of two studded partitions without structural ties between them. The two leaves of walls are normally similar in sound transmission characteristics. The introduction of an additional leaf of wall means that the simple theories cannot be applied directly. The closeness of the two leaves of walls results in the walls behaving as a single sandwich panel and a double wall with complicated cavity effects depending on the frequency range.

Most existing theories ignore the differences in response and radiation between a wall coupled to a cavity and a wall coupled to a large reverberant room. Treating the cavity as a reverberant room, the sound transmission loss of a double leafed partition can be predicted as follows,

$$R = R_1 + R_2 + 10 \log \eta_c + 10 \log \frac{4\omega d}{c} \text{, dB} \qquad (2)$$

where $R_1$ and $R_2$ are the individual transmission loss of the two walls predicted by Eq.(1); $\eta_c$ and d are the total loss factor and the width of the cavity respectively; c is the velocity of sound in air.

Since the acoustical behaviour of a double studded partition varies with the frequency regions, careful considerations have to be made in the application of the theories. The acoustical behaviour of the wall or cavity in the various frequency ranges considered is summarised in Figure 2.

Using Eq.(1) and (2) and following the check list provided in Figure 2, a set of predicted results is given in Figure 3 together with the measured results. Figure 3 shows that good agreement between measured and predicted results is achieved in a large frequency range. This includes the frequency range 100-1000 Hz where there are only tangential modes in the cavity.

**Common Stud Partitions**

In a common stud partition building boards are fixed to both sides of a set of studs and noggings. The direct structural path between the two leaves of walls has been a problem in the prediction of sound transmission through this class of walls. Although much work has been done in this area, most theories incorporate assumptions which are not normally satisfied by building structures such as the stud partitions.

In this study, the airborne path (room-panel-cavity-panel-room) and the structural path (room-panel-studs-panel-room) are studied separately using Statistical Energy Analysis. The existing theory of Crocker et al (3) has been used for the prediction of the direct structural path. The predicted and measured results are as shown in Figure 4.

The results show that the theory of Crocker et al is not applicable for this class of structures. This is because the theory assumes the connecting ties as thin deep webs. More significantly, the results have shown that the structural path via the studs does not dominate the total sound transmission of the wall. Figure 4 shows that curves 1 and 2 agree well suggesting that, in this case, the airborne path dominates the total transmission through the wall. This is probably due to the small width of the cavity resulting in the wall behaving as a single partition for a wider frequency range. In the higher frequency range where the wall behaves as an ensemble of double walls, the lining has become an efficient radiator and hence dominates the total transmission.

## Conclusions

This study has shown that, using published material properties, the simple theories can be used to give good predictions of the sound transmission loss of stud partitions. It has also shown that, for common stud partitions, the direct structural path need not be the dominant path in the total sound transmission through the wall.

## References:

(1) Maidanik,G; Response of ribbed panels to a reverberant acoustic field. Journal of Acoustical Society of America.

(2) Cremer et al; Structure-borne sound; Springer-Verlag, Berlin; 1973.

(3) Crocker, M.J. et al; Sound and vibration transmission through panels and tie beams using statistical energy analysis; Transactions of ASME, P775-782, 1971.

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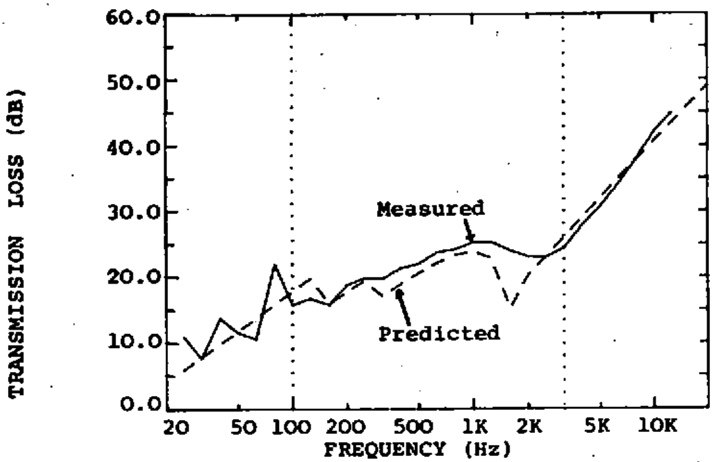


FIGURE 1. Transmission loss of a single studded plywood partition (12mm plywood with 50x50mm studs at 500mm centres). (material properties are obtained from Cremer et al (2)).

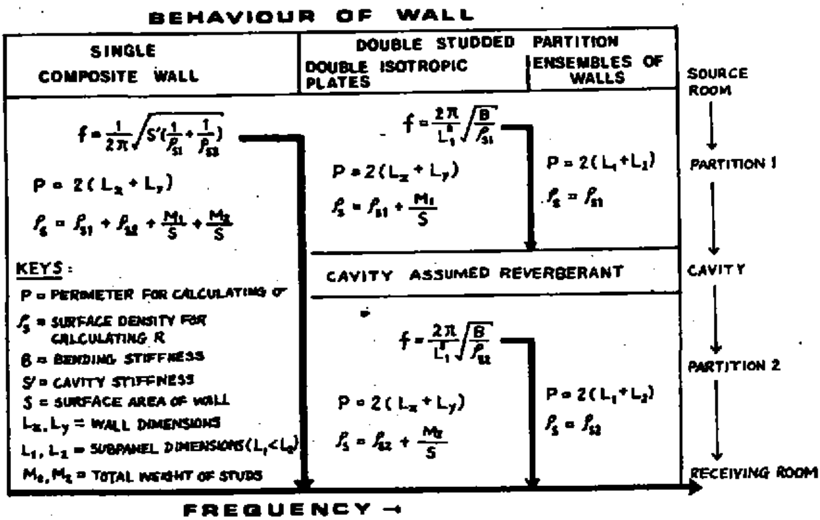


FIGURE 2. The behaviour of a double studded partition in the various frequency regions.

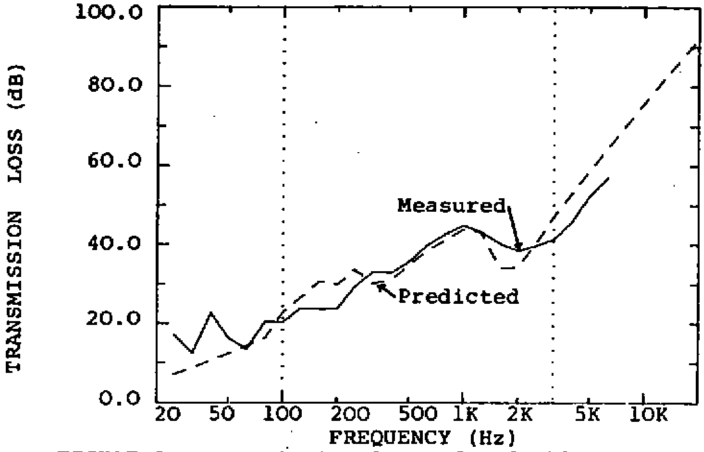


FIGURE 3. Transmission loss of a double studded plywood partition. (12mm studd plywood with 50x50mm studs at 500mm centres).

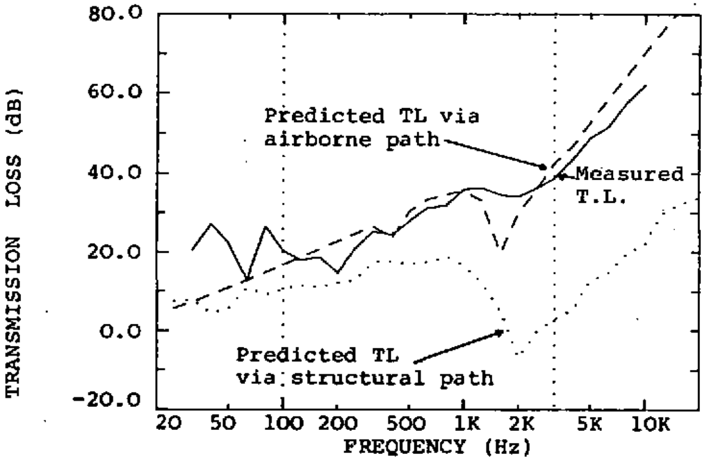


FIGURE 4. Transmission loss of a common studs partition. (12mm plywoods on both sides of 50x50mm studs at 500mm centres)