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A NEW LOOK AT THE DESCRIPTION OF REVERBERANT SPACES

submitted by

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Summary

The traditional description of the sound field in an enclosure begins with the assumption that the walls are locally reactive. This assumption allows a formalism which is intended to adequately predict the acoustical response of an enclosure. The work described in this thesis is concerned with a reconsideration of the classical description of the interaction between the sound field and its boundaries and with the effect of this interaction on the sound wave behavior in an enclosure. An experimental investigation in a standard reverberation room shows that the walls of the room are not locally reactive, and that the coupling between the room modes and the wall structural modes affects the reverberation times in the room. These results reveal a limitation of the locally reactive boundary assumption. They indicate that to understand the behavior of reverberant spaces, it is necessary to understand the nature of the modal interaction between the sound field and the wall vibration.

This research is an experimental and theoretical study of the characteristics of a panel-cavity system. The acoustical properties of the system at low frequencies, such as the resonance frequencies, decay times and mode shapes, are predicted by a modal coupling analysis. These predictions have been verified experimentally for conditions where the classical sound absorption theory does not apply. The effects of the boundary characteristics on the sound field are discussed in some detail.

The study is extended to higher frequencies in a reverberation room, where the very large number of cavity modes makes modal coupling analysis too difficult. In this frequency range, the modal coupling between a sound field and the panels still controls the acoustical behavior of the room. Acoustical decays are described in terms of average modal coupling, damping and density parameters using a Statistical Energy Analysis format.

Another extension of the research is to study the sound field behavior in an enclosure with a complicated boundary. A two dimensional Finite Element Method is used to calculate the resonance frequencies and shapes of cavity modes which have been altered by the presence of a semicircular diffuser. These results suggest that large variations in the cavity modal distribution caused by changing the diffuser orientation are responsible for the dependence of the boundary sound absorption upon the diffuser orientation.

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