ABSTRACT

There is always a demand for acoustical comfort in domains like automobiles, home appliances, living areas, working places, *etc.* Prolonged exposure to noise can create various health related issues and results in a reduction of overall working efficiency of humans. The reverberation sound field inside rooms or automobile passenger cavity is controlled by using sound absorbing materials placed in a single or multilayer configuration. There are different kinds of sound absorbing materials available ranging from the synthetic materials like polymeric foams, glass wool, rock wool, *etc*. to some natural fibrous materials like sheep wool, coconut, hemp, sisal, kenaf, and jute. Synthetic materials have several disadvantages such as not being biodegradable, high cost, and also create health related problems. Therefore presently there is a trend developing to use natural materials in the field of noise control engineering.

The present study focuses on the acoustical characterization of natural jute material. Sound absorption coefficient and sound transmission loss of jute material is experimentally measured by using an impedance tube setup. However, for predicting the acoustical performance of jute material, the knowledge of its non-acoustical parameters like porosity, tortuosity, air flow resistivity, viscous characteristic length, and the thermal characteristic length is essential. If these non-acoustical parameters are known, then acoustical properties of jute material can be predicted using the established theoretical models. Furthermore, these non-acoustical parameters could be input to finite or boundary element method software, using which the acoustical performance of the system under study can be predicted in the early design stage. These non-acoustical parameters could be measured, but it needs dedicated measurement facilities. These facilities are very costly and not available everywhere.

This research work estimates the non-acoustical parameters of three types of jute felts using the inverse acoustical characterization method. The inverse acoustical characterization is performed using the particle swarm optimization method (PSO). This method minimizes the error between the experimental and predicted sound absorption data. The Johnson-Allard equivalent fluid model with rigid and limp frame model and the Garai and Pompoli model are used in inverse characterization method for sound absorption prediction. The eight coefficients in the Dunn and Davern model are also inversely estimated for the three types of jute felt by the PSO method. The sound absorption coefficient predicted by using this method matches perfectly with experimental data.

Sound absorption of a multilayer sound absorber constructed from the micro-perforated panel (MPP), jute felt, and air gap are predicted using the transfer matrix method and validated experimentally using an impedance tube. Sound absorption in multilayer configuration is more effective in the low-frequency region and absorbs sound over wideband frequencies. The effect of the position of MPP on the sound absorption of multilayer sound absorbers is also studied. Furthermore, the interior acoustics of an enclosure is evaluated for the reduction in sound pressure level due to different liner treatments of jute material on the inside of the wall of the enclosure.