Case study

Analysis of Acoustic Behaviour of Louvers using Actran

With Actran, students were able to study sound attenuation in a louvered window configuration

B.M.S Institute of Technology and Management is a autonomous engineering college in Bangalore, India, affiliated with the Visvesvaraya Technological University.

The college offers various engineering courses with specializations which include Mechanical Engineering, Computer Science, Electronics & Communication, and AI & ML.

For an academic project as part of their curriculum, a team of students from the institution studied the impact of louvers on noise patterns transmitted across a surface containing louvers. A louver or louvre is a type of window blind with angled horizontal slats. It is designed to admit light and air but keep out rain and direct sunshine. Louver windows find applications in a wide variety of buildings, particularly in schools, factories, and commercial buildings. By adjusting the angle of louver panels, one can control the direction of airflow as well as distribution of daylight in the building.

The team was keen to investigate the sound attenuation for various window louver configurations as a function of parameters such as the number of louvers, its angular orientation as well as the coating materials used.

Analysing material properties & sound attenuation using Actran

The team decided to use a numerical method for the investigation of attenuation in sound pressure levels over louver configurations. The simulations were carried out using Actran, a finite element-based computer-aided engineering software used in modelling acoustic behaviour of mechanical systems and parts. The use of finite elements allows for the simulation of complex noise sources and a combination of multiple materials in the same model while enabling the handling of multi-million degrees-of-freedom.

The first step was to configure the model for the simulations. The model setup consisted of a louvre on one side of a room with a microphone inside and a source of sound placed outside the room. As the picture shows, the points S (Source) and M (Microphone position) were fixed and made independent of other variables i.e., the position of microphone was at the same height as that of the centre of the box (Y/2). The louvers were rotated about their mid-point. Values of A and B were 0.5 m and 1m respectively for all cases. The team measured sound pressure levels for frequencies ranging from 100 Hz to 6000 Hz in intervals of 50 Hz for configurations of 6 and 12 louvers. The angles of louvers were varied from 0° to 90° in steps of 15°. Their corresponding attenuations were noted, and the insertion losses were calculated using several in-built options of Actran. The recorded insertion losses were 0.23%, 5.25%, and 14.97% when the louvers were arranged at angles of 30°, 60° and 90° respectively.

The second part of the project involved the identification of the best sound absorbing coating material over the louver surface. The team used coatings of different materials that were all porous in nature and made of natural fibres such as coconut fibre, banana fibre, corn cobs, jute, and corn stover, each with different properties and varying sound attenuation capabilities.

The 6-louver configuration analysis was performed to understand the effect of louver material in noise mitigation. Jute was found to have the best noise attenuation property in comparison with other materials tested.

The 6-louver setup without any sound absorbing coating was considered as the base case for comparison. In general, the sound pressure levels were found to have a maximum value for 0° angular orientation given that there was a considerable gap between consecutive louver panels. For the 90° angular orientation, the sound pressure levels recorded were the lowest since the gap between consecutive louvers was at its least, thereby reducing the intensity of sound passing through them.

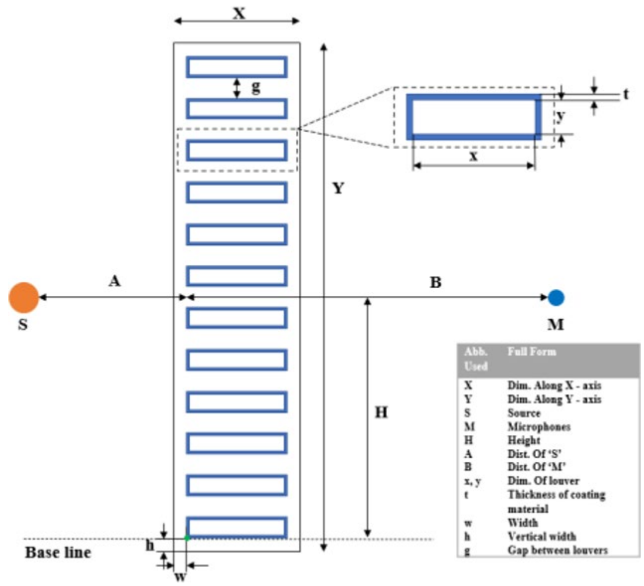

Figure 1: Schematic of louver arrangement

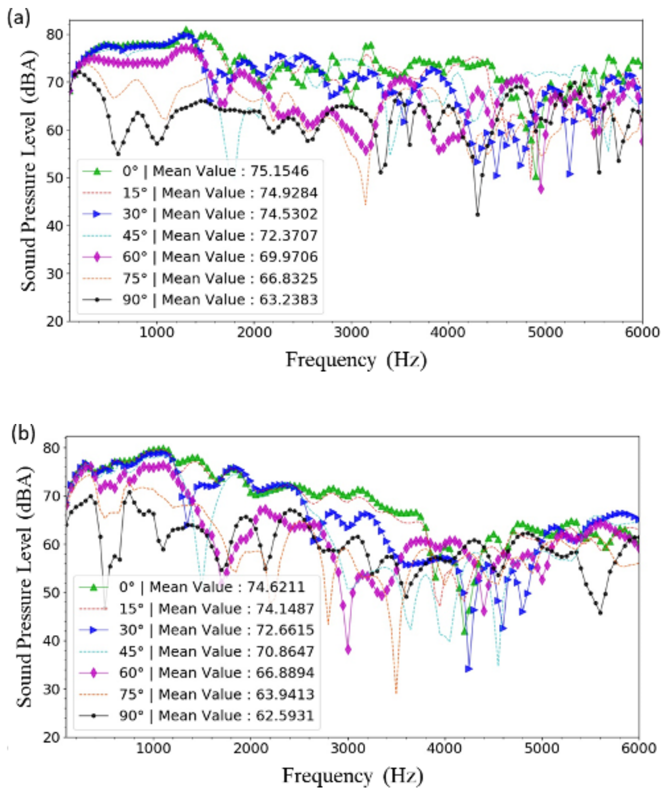

Fig 2: Variation of sound pressure level with respect to frequency for (a) Base case (b) jute as coating material

From the trend shown, the mean value of sound pressure level measured for the 0° angular orientation was the maximum having a value of 75.2 dBA. The mean value of sound pressure level for 90° angular orientation was the least with a magnitude of 63.2 dBA. This occurs due to presence of a very small gap between consecutive louvers which offers high resistance to the incident sound to be transmitted. In general, a gradual decrease in sound pressure levels is noticed as the angular orientation increases from 0° to 90°. Figure 3 represents the 6-louver setup having a coating material made of jute. The coating has a thickness of 10 mm and is covering each louver panel on all of its four sides. Due to material properties of jute, the sound attenuation ability of the louvers is increased. As shown in figure 2(b), there are multiple dips in the sound pressure levels for a frequency below 5000 Hz with least sound pressure value of 28.5 dBA for an angular orientation of 75° and at a frequency of 3450 Hz.

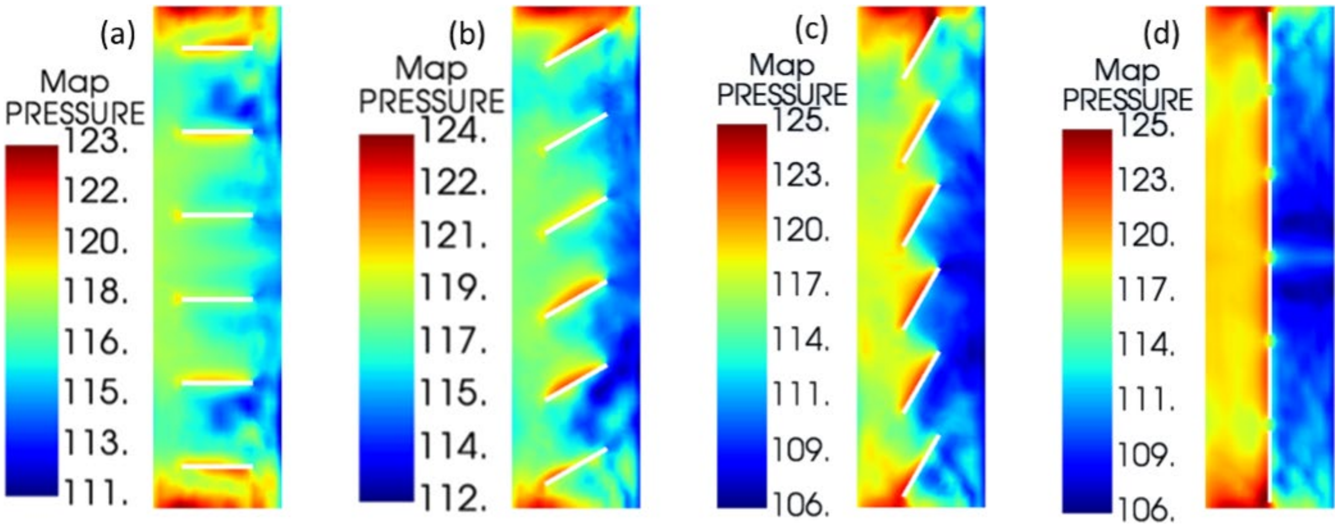

Fig 3: Averaged sound pressure level plots for jute fibre as coating material for (a) 0° (b) 30° (c) 60° (d) 90°

Modelling for Multiple Variations

With Actran, the team was able to model for several variations in a number of parameters such as number of louvers, angle of the louvers, as well as coating materials used in a short period of time. With this experience, the team now has the confidence to explore acoustic simulation in other scenarios.

“From the department of Mechanical engineering (BMSIT&M), big thanks to MSC for pioneering with software like Actran as it provides a unique experience for fresh learners by exposure to a plethora of scientific methods and yet keeping it distinctly user friendly.” said Dr Avinash Govindaraju, Assistant Professor, BMSIT.

They were also able to present the results of their study through a research paper in the International Conference on Recent Advancement of Mechanical Engineering (ICRAME) 2021, NIT Silchar (**http://icrame.nits.ac.in/**).

BMSIT Team

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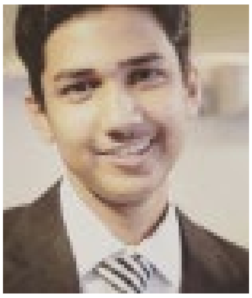

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