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Report on measurement of the acoustic properites of four prototypes of Compost Board materials

Compost Board

ATA Mute B.V.

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Title:
Measuring the Acoustic Properties of Compost board Materials

Abstract:
Urbanization and environmental challenges have emphasized the importance of using sustainable, recycled materials to reduce greenhouse gas emissions. Compostboard, a Dutch company, specializes in producing eco-friendly interior materials from agricultural fibers such as flax, hemp, and paprika plant residues. Their products are designed for applications like wall cladding and furniture components, focusing on environmental sustainability and acoustic performance.
To evaluate the acoustic properties of Compostboard materials, ATA Mute tested four prototypes using an impedance tube. The tests aimed to measure the absorption coefficient (alpha) across different frequencies and identify improvements in sound absorption capabilities.

Methodology:
The acoustic properties of four prototypes were measured using an impedance tube in three configurations:

1. **Closed End (standard measurement)**
2. **Open End**
3. **Anechoic End**

The **Closed End** configuration served as the standard measurement, while the other two configurations simulated specific applications, such as using the material as a separator or in open-ended systems like pipes.

Prototype Specifications:

- Thickness: 2 cm
- Diameter: 5 cm (matching the inner diameter of the impedance tube)
- Placement: Prototypes were securely mounted in a disk to prevent leakage and ensure reliability.

Impedance Tube Details:

- Equipped with 9 microphones for measuring reflection coefficients across a frequency range of 20 Hz to 4000 Hz.
- Additional 4 microphones recorded transmission coefficients to derive absorption coefficients for open-ended or anechoic configurations.
- Measurements were recorded in 50 Hz increments, focusing on 100 Hz to 3000 Hz.

Figure 1 shows the four prototypes prepared for testing.

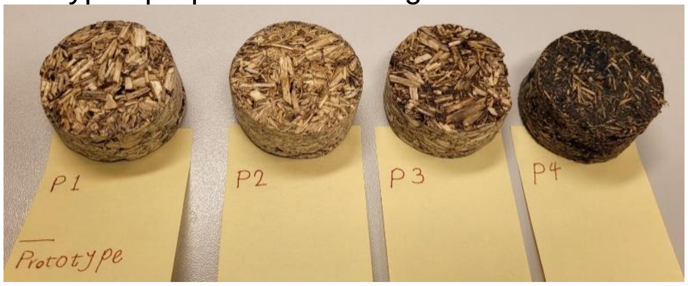

Fig.1 Prototype of material for test in Impedance tube

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Results:

The absorption coefficients of the four prototypes (P-1 to P-4) were measured and compared. The results are presented in the figures below, with frequency (Hz) on the horizontal axis and the absorption coefficient (ranging from 0 to 1) on the vertical axis:

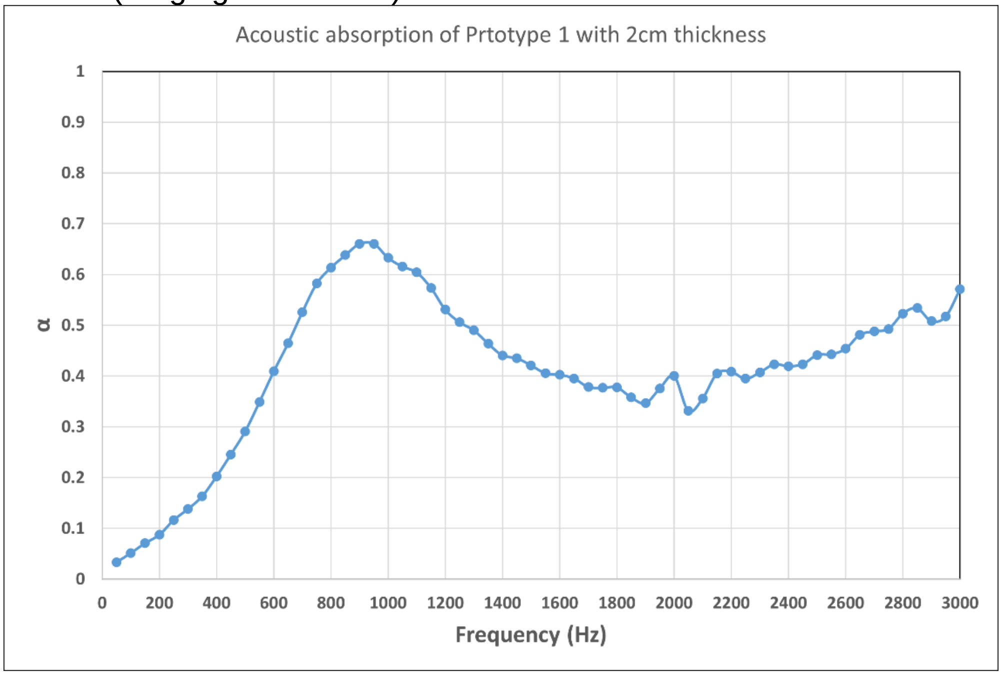

Fig. 2: Absorption Coefficient for P-1 (Closed End).

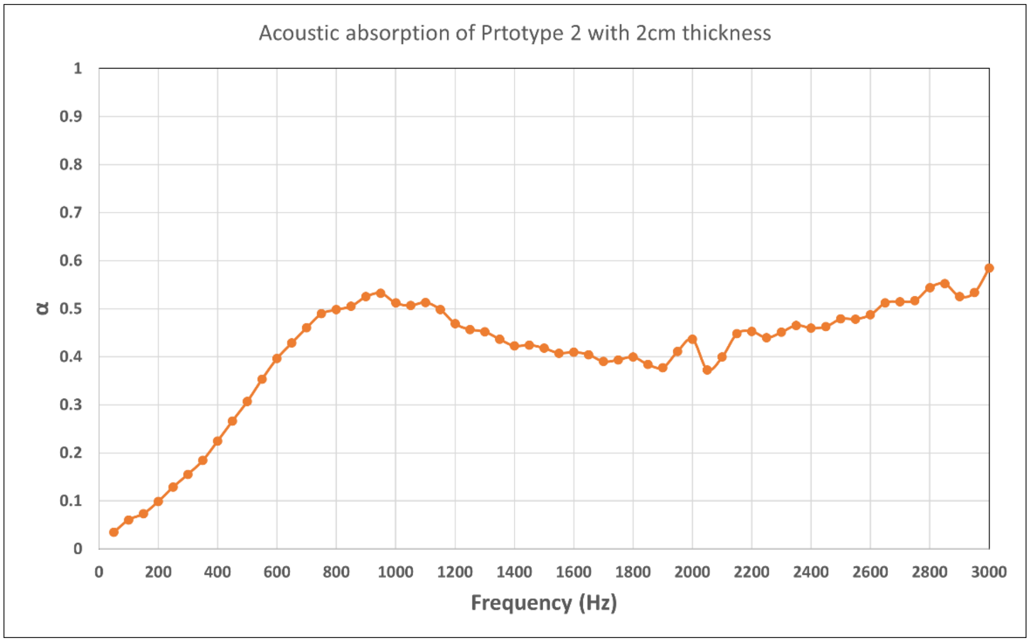

Fig. 3: Absorption Coefficient for P-2 (Closed End).

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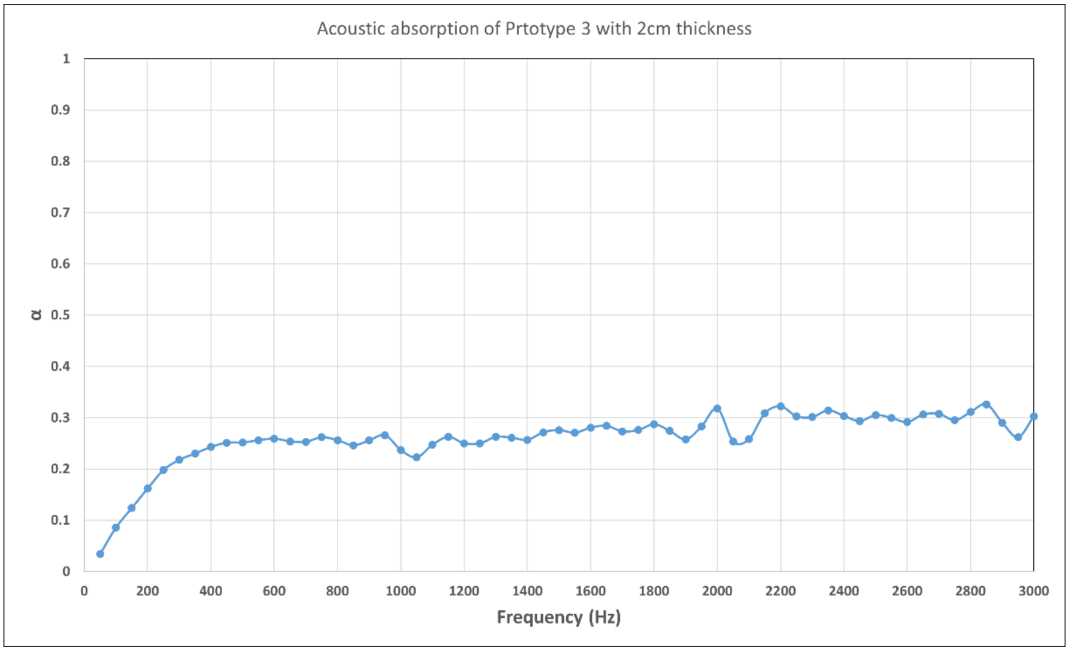

Fig. 4: Absorption Coefficient for P-3 (Closed End).

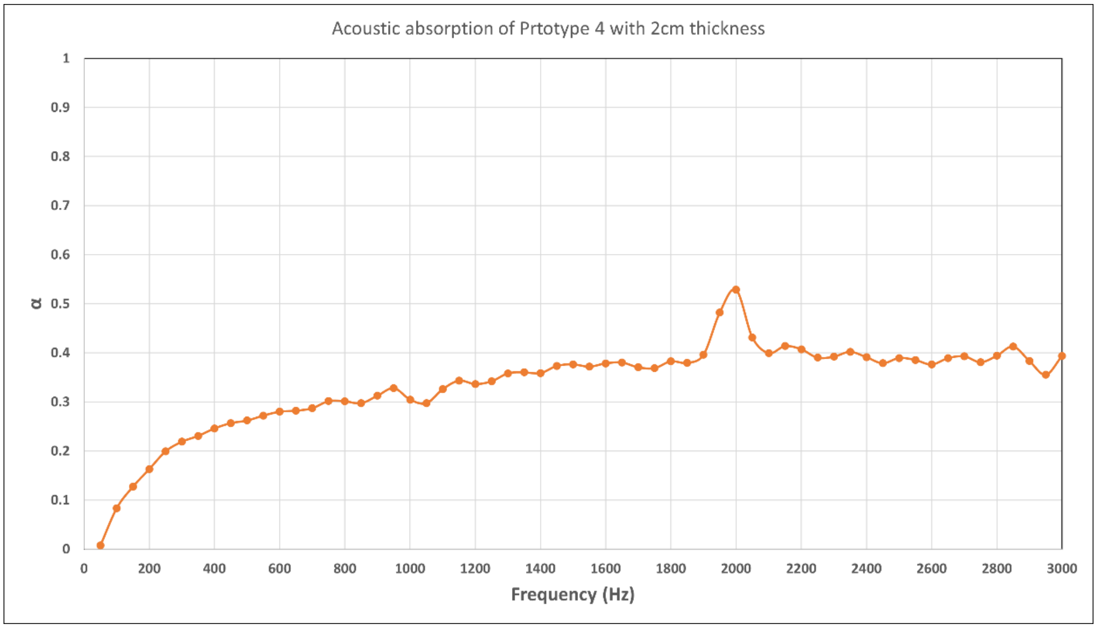

Fig. 5: Absorption Coefficient for P-4 (Closed End).

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The following observations were made:

- **Prototype 1 (P-1):** Best absorption between 600 Hz and 1200 Hz and comparable performance with P-2 and P-4 at frequencies above 1800 Hz.
- **Prototype 3 (P-3):** Showed the lowest absorption across most frequencies.
- **Low Frequencies (<400 Hz):** P-3 and P-4 performed better than other prototypes.

Figure 6 provides a comparative analysis of all prototypes.

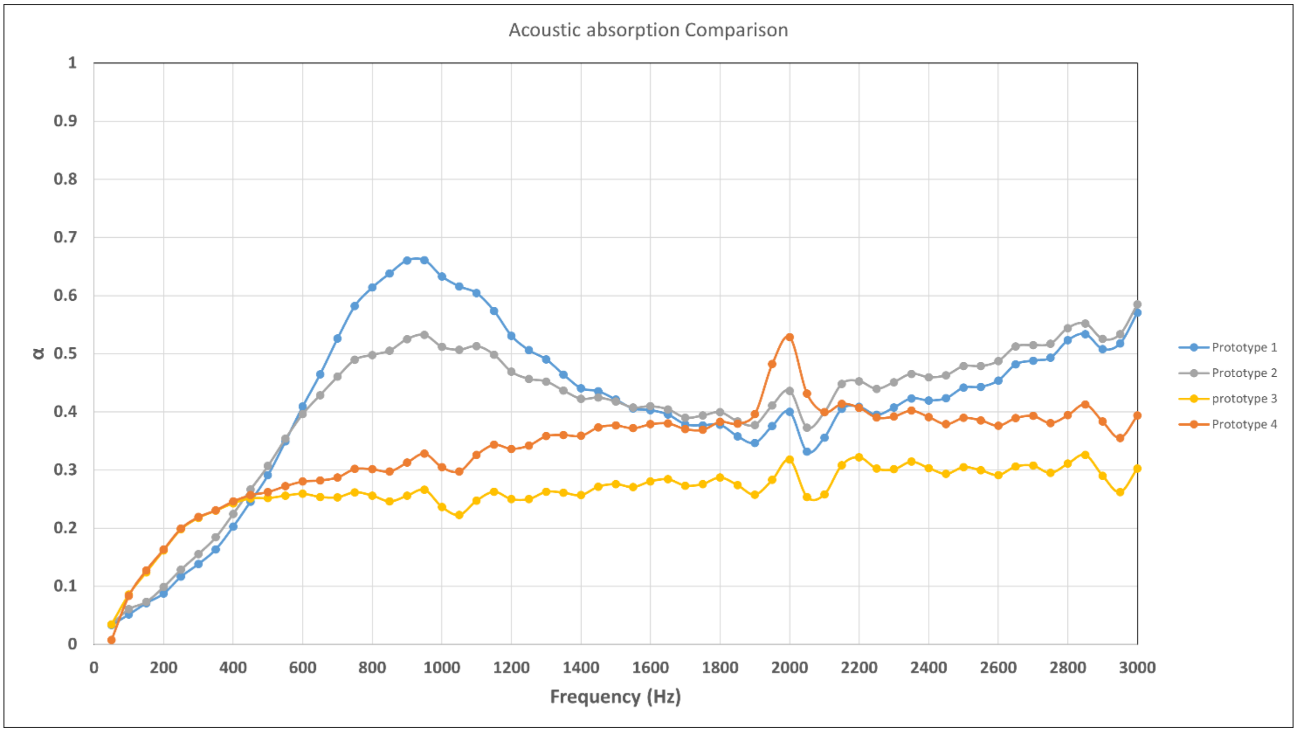

Fig. 6: Comparison of acoustic absorption of four prototypes at closed end condition.

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Additional Measurements

Open End condition

This configuration simulates applications where the material transitions to a larger space, such as when it is added inside a pipe or used in hollow walls leading to an open area. It is particularly relevant for scenarios involving sudden area expansions, such as pipes or wall hollows opening into larger spaces. The primary objective of this test is to measure the reflection coefficient of the material, where lower values indicate reduced echo and better sound management in such environments. The reflection coefficients for the four prototypes are presented in **Fig. 7**.

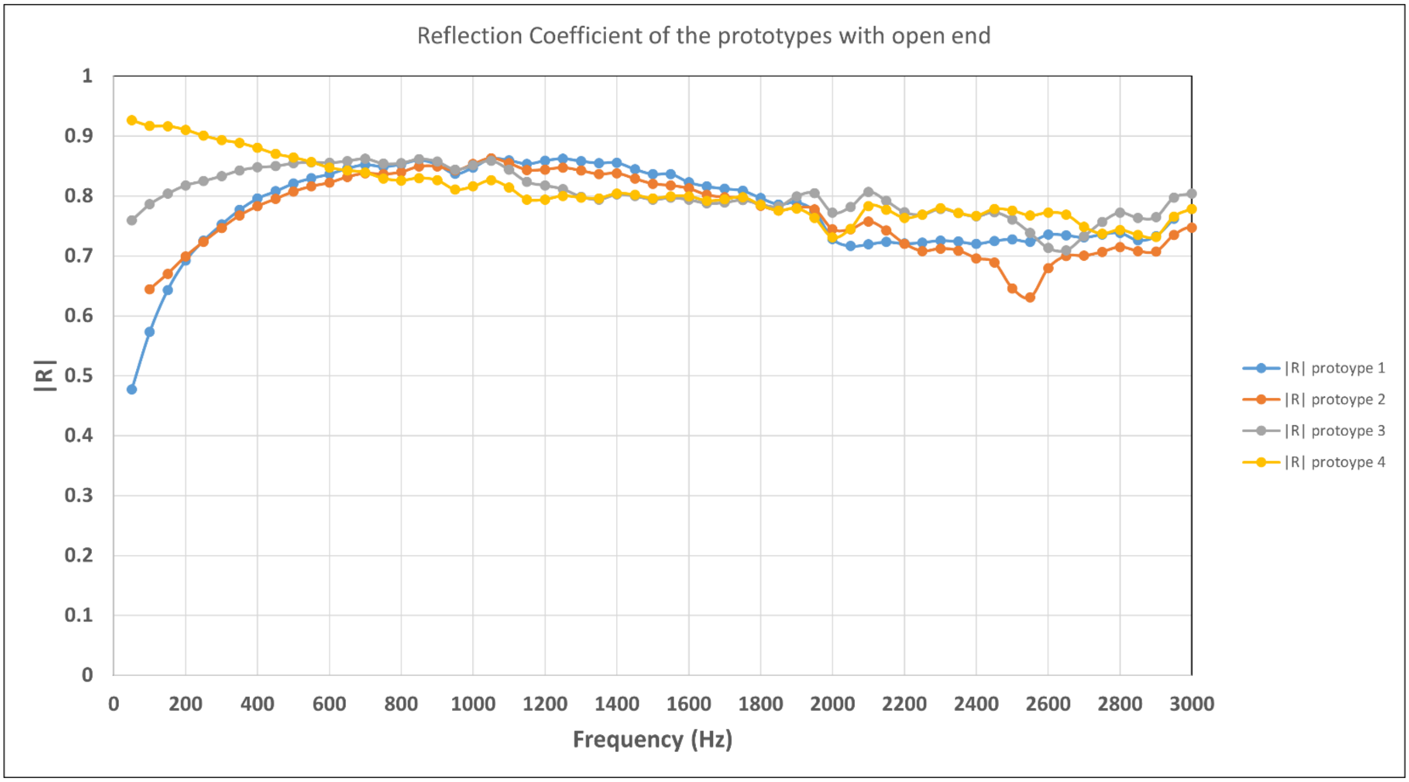

Fig. 7: Comparison of reflection coefficient of four prototypes at open end condition.

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Anechoic end condition:

This test simulates scenarios where the Compostboard material acts as a wall separator between two large rooms. It measures key acoustic properties, including reflection, transmission, and absorption coefficients, as well as transmission loss expressed in decibels (dB).

The results for absorption and transmission loss for the four prototypes are presented in **Fig. 8 and Fig. 9**. These results help evaluate the material's effectiveness in managing sound transfer between separated spaces.

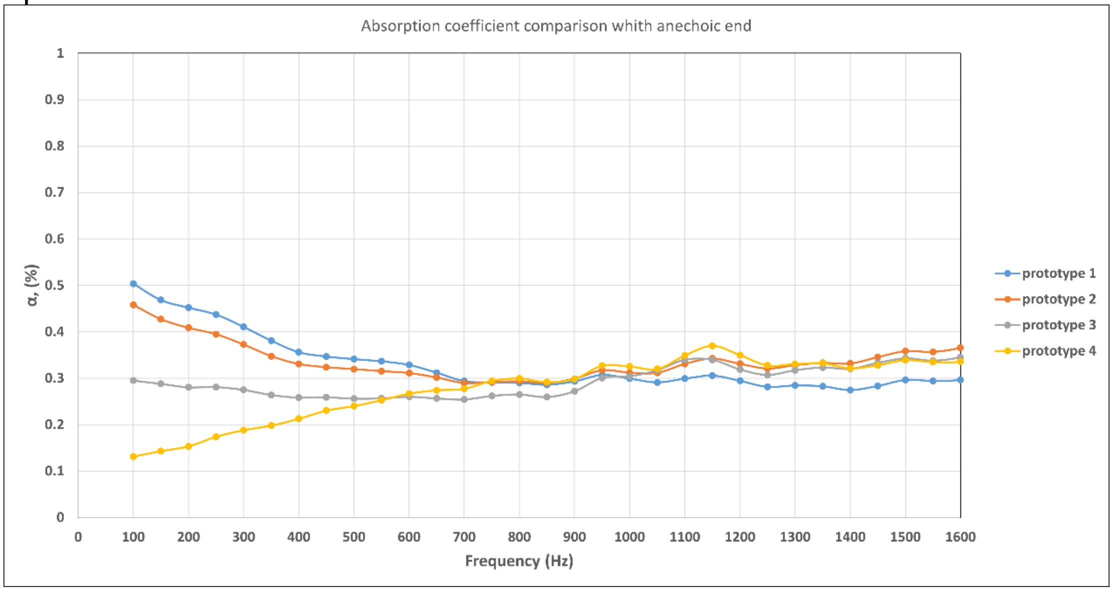

Fig. 8: Comparison of absorption of four prototypes at anechoic end condition.

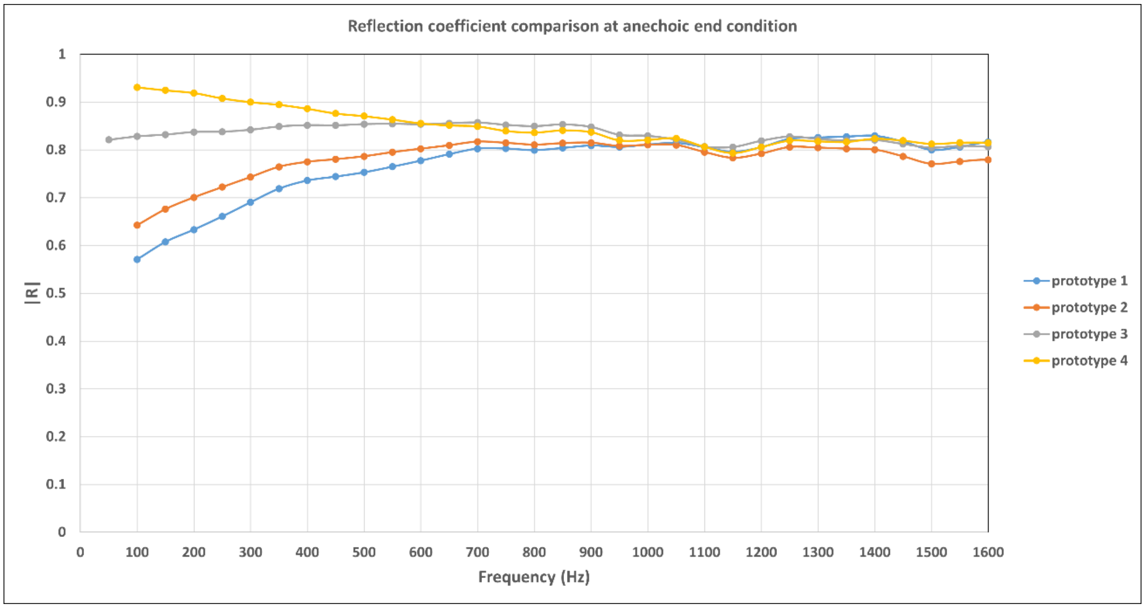

Fig. 8: Comparison of reflection of four prototypes at anechoic end condition.

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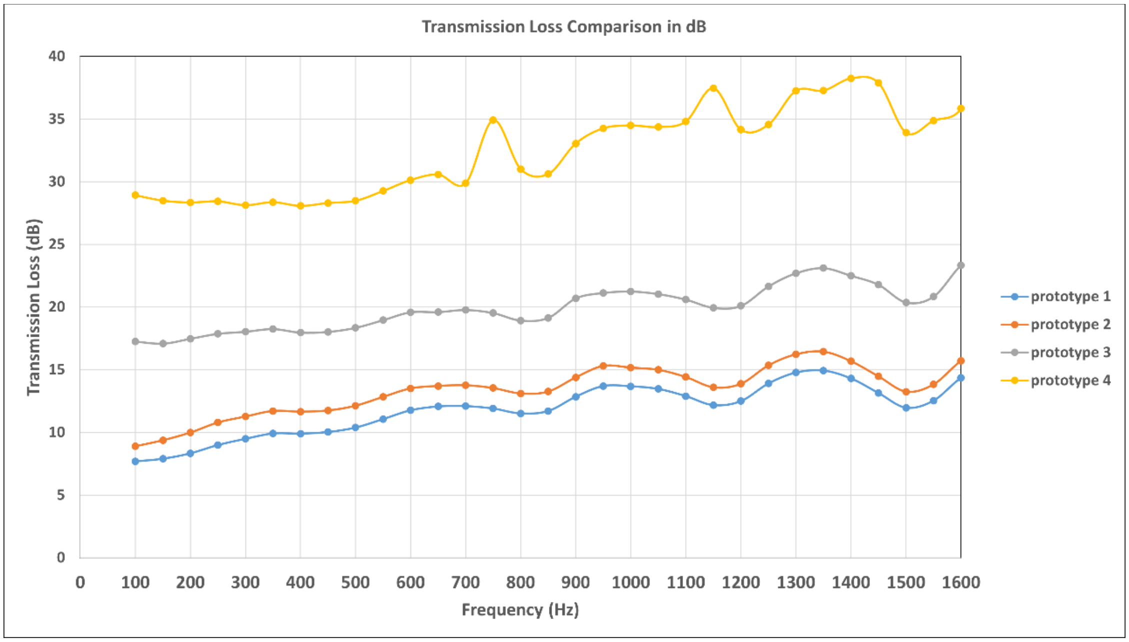

Fig. 9: Comparison of Transmission Loss of four prototypes at anechoic end condition.

Conclusion:

Key Observations from Figures 8, 9, and 10:

1. **Absorption decreases** from Prototype 1 to Prototype 4, reflecting reduced acoustic wave penetration.
2. **Transmission loss increases**, indicating the material becomes more rigid and reflective as it transitions from Prototype 1 to Prototype 4.

The tests revealed that **Prototype 1** demonstrated the best overall acoustic absorption performance, particularly in mid to high frequencies. This makes it suitable for applications where high absorption is a priority, especially in scenarios where the back side of the material is closed, such as against a wall.

Prototype 4, on the other hand, exhibited higher transmission loss despite its relatively lower absorption. This indicates that it is more rigid and less permeable to acoustic waves, making it an effective soundproof material when used as a separator wall between two rooms. Its higher reflectivity could be an issue due to echoing the sound.

Future Development:

At **ATA Mute**, we propose enhancing **Prototypes 1 and 4** by designing optimized perforation patterns on the same material. This approach could significantly improve the absorption performance, with potential increases of 50-100%, especially in low-frequency ranges. These improvements would enable Compostboard materials to serve a broader range of applications, offering an optimal combination of soundproofing and absorption capabilities.

This strategy provides a pathway for Compostboard to advance its materials, catering to diverse acoustic and noise reduction requirements.

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