EXPERIMENTAL INVESTIGATION OF SOUND ABSORPTION PROPERTIES OF 3D PRINTED PETG ABSORBERS

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Abstract:

3D printing has a large potential to produce large variety of complex shapes. It gives freedom of design in complexity of geometry. 3D printing has an advantage of no tooling design for desired shape. Sound absorbers are becoming an extraordinary solution to reduce impact of outdoor and indoor noise pollution. 3D printed sound absorbers are having a great demand in recent years. Typical production methods are limiting shape possibility and variety of absorber plates fabricated. So 3D printers are used in acoustical industries to fabricate absorbing plates in wide variety at low cost with precision. We have fabricated an absorptive plate with 60% porosity and porous holes in it. We have characterize absorption system using standard impedance tube method (ASTM C384-04) to study its absorption and transmission loss properties. They show very good absorptive properties for high frequency application and good transmission loss value.

Keywords: 3Dprinting, Absorber, Impedance tube, PETG

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1. Introduction

Noise pollution has an adverse effect on activities of human and animal life. Hence sound insulation and sound proofed environments have greater demand in recent years. Most of working spaces are made sound proofed to have a good working environments for human resource. Hospitals and health care centres have shown a great concern for sound proofed spaces. Hence use of acoustic panels sound absorbers have shown a greater demand in recent years. This field of research is booming with work of many enriched scholars and industrialists.

Many researchers have experimented on wide variety of sound absorptive panel and shared their insight on its performance. Ewa Witczak[27] Investigated Structural parameters of acoustic panels textile fronts on their sound absorption properties. She used Different font fabrics patterns with mineral wool as base plate. The sound absorption properties of material can be improved by type of yarn and font of fabric. Tomas Astrauskas [22] worked on bio degradable panel of paper sludge and clay. Sound absorption properties varied with function of grain size of paper sludge and frequency of incident wave. Stanciu [213] prepared a composite panel made up of wood, wood flakes, woven inserts. Sound attenuation property of panel far better than traditional sound proofing materials. She also worked on panel made up of Acrylonitrile butadiene styrene chips. ABS chips have good sound absorption but sound insulation properties get affected by distance between source and absorber and angle with vertical. Mohammad abid proposed a natural composite panel of kapok fibre and saw dust. Kapok fibre can be a good alternative for existing sound proof materials in market. J. Carbajo[28] Modelled grooved acoustic panels using Johnson-Champoux-Allard (JCA) model and the Transfer Matrix Method (TMM) observed absorption performance is largely influenced by these geometrical characteristics, particularly the pore size of panel. Lamyaa A Jawad [25] proposed composite panel made up of Latex, oil palm fibres absorption coefficient has increased by increasing the thickness and bulk density for a certain range. Louise Wintzell [29] made a panel of Polyester knitted fabric in combination with a polyester nonwoven batting of a total depth of 50 mm which showed that it is possible to lower the reverberation time to 0.3 s in a normally furnished bedroom with 7 wall panels. Damar Rastri Adhika [26] developed a panel using Pineapple leaf fibre and epoxy resin which showed good absorption for high frequency sound wave. isak worre foged developed a clay Acoustic Tiles which showed a good acoustical absorption coefficient.

All above proposed panels require timely maintenance and replacement which is very difficult for commercial spaces and public spots. Most of panels stated above are hardly recyclable so we propped to use recyclable PET plastic material for design of absorbers. In this paper we have proposed an absorption system with permanent fitting which don’t require timely maintenance and durable for long time. Influence of 3D printed absorbers is still un explored in field of acoustics. Hence we have proposed to use 3d printed panels to observe its effectiveness in sound absorption.

2. Material and methods

2.1 Material

In this paper we used a proper acoustic treatment for preparation of samples.

It consists of three functional constituents as below

1) Acoustic membrane
2) Absorber
3) Backing

Acoustic membrane is made from a speaker mesh cloth which is acoustically transparent and it protects the openings of absorbers holes from dust clogging. Absorber plates are made from PETG plastic with an appropriate porosity and respective process parameters. Backing material is made up of vinyl acetate sheet which is having good sound blocking properties. The process parameters for 3D printed PETG absorbers are listed in below table

Table1- process parameters for absorber plates

Process parameters	value
Nozzle diameter (mm)	0.4
Filament size (mm)	1.75
Nozzle temperature (°C)	230
Bed temperature (°C)	65
Layer thickness (mm)	0.2
Infill density (%)	60
Infill geometry	hexagonal

2.2 Modelling and Characterization Method

A typical modelling sequence of sound absorption system is illustrated in below figure

Fig1-Modelling sequence of working constituents of absorber.

Characterization of system is done using impedance tube method under standards of ASTM C384-04(2022). Which require samples of 30mm and 100mm diameter each.100mm (63-1600) HZ,30mm (1600-6300) HZ Each constituent of 30mm and 100mm diameter are prepared Individually. Absorbers plates of 12mm thickness and backing material of 6mm thickness acoustic membrane of negligible thickness constituting an effective 18mm thickness. Development of samples are illustrated in below figures

Fig2,3,4- Development samples of acoustic membrane,absorber plate,backing of 100mm and 30mm diameter restively.

Samples are sequenced as in order of working constituents as illustrated in fig1. acoustic membrane,absorptive panel and backing reapectively are sandwiched to each other as in below figures.

Fig5,6,7- Sandwiching sequence of 30mm and 100mm sample.

Samples are mounted in an ipedancetube set up (ASTM C384-04) and chracterisation is done to know acoustical properties of material. Absorption(α) and transmisson loss(TL) properties of material are evaluated.

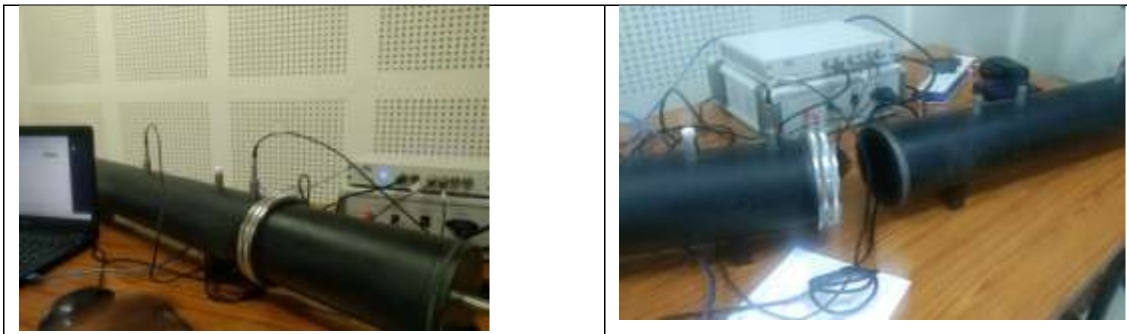


Fig8,9- Absorption test and transmisson loss test of 100mm sample

Fig10,11- Absorption and transmission loss test of 30mm sample

3. Results And Discussion

100mm specimen is tested under spectrum of (63-1600) Hz and 30mm specimen is tested over spectrum of (1000-6300) Hz. Both values are combined a cumulative graph is being ge3nerated for entire spectrum of (63-6300) Hz.

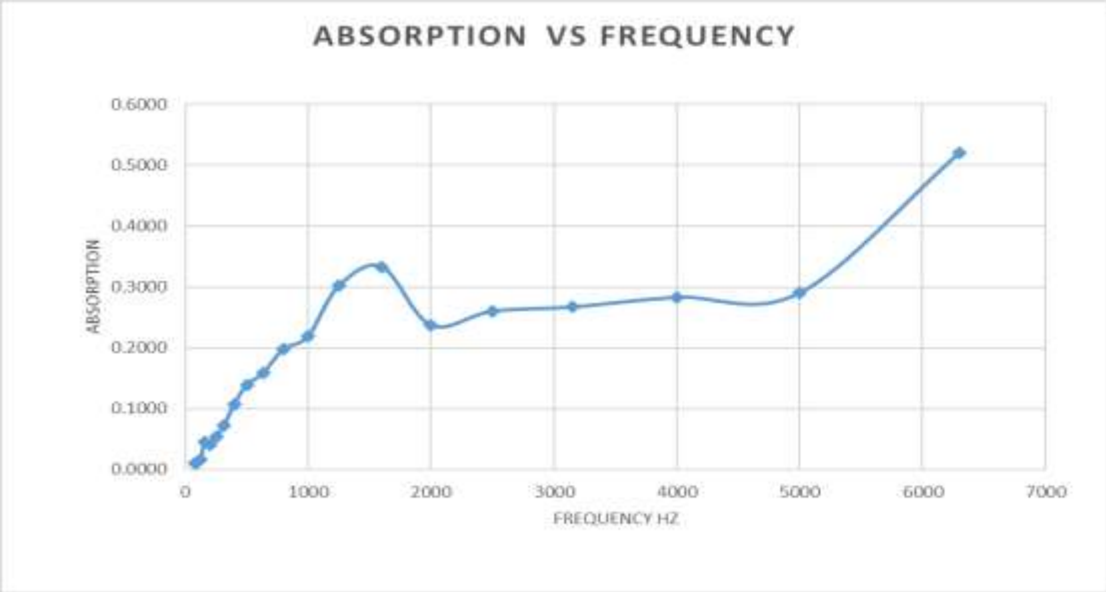
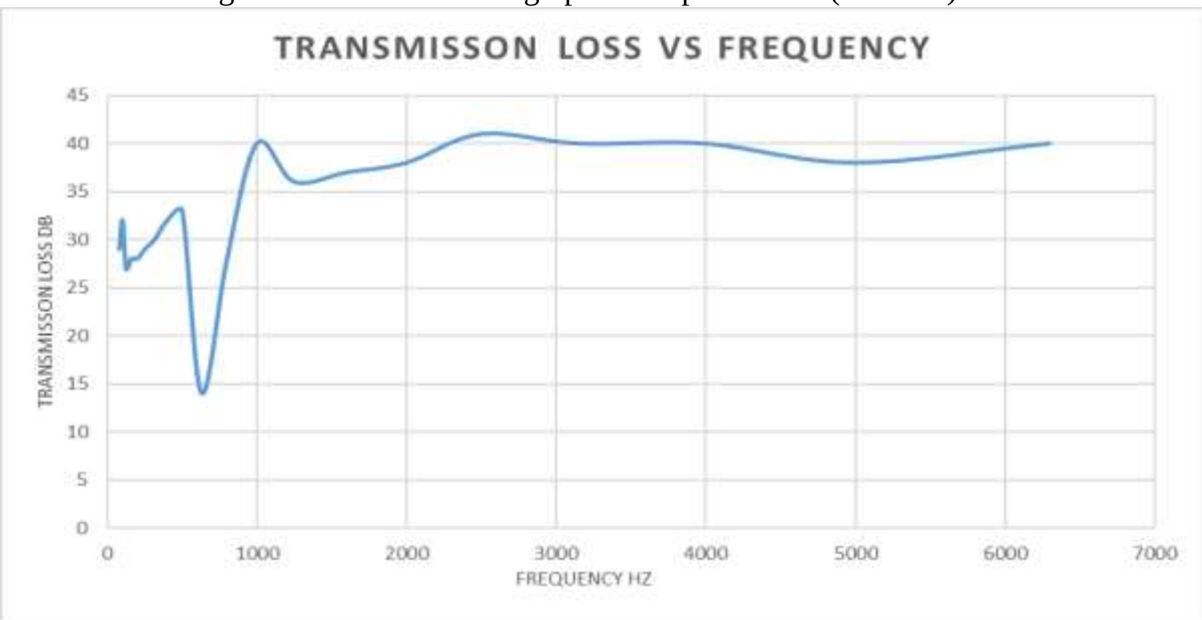


Fig12- Absorption graph over spectrum of (63-6300) Hz.

Similary trnsmisson loss test is conducted for both 30mm and 100mm sample and their cumulative graph is plotted for entire spectrum.

Fig13- Transmission loss graph over spectrum of (63-6300) Hz.



As we could see that continuous increase of absorption value with excitation frequency indicates no resonance in sample with in tested spectrum. Absorption value shows steady absorption from a frequency of 2KHz and reaches to a maximum of 0.52 at 6300 Hz. Transmission loss of sample shows steady value from 1600Hz with highest value of 41 dB in frequency band of (2000-2500) Hz.

4. Conclusion

The absorption system sample shows a steady absorption value from a frequency of 2000Hz. The transmission loss value is remarkable for frequency band of (2-3) KHz. This particular system would be effective for application of higher frequencies between 2 to 3 KHz. Hence I would like to conclude above absorption system can be utilized for higher frequency application of around 3KHz.

5. References

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