University of the Philippines

Electrical and Electronics Engineering Institute

Sound absorption testing for 16 Fabrics

Sample Test done in a classroom set-up for Fabrics

Date of activity: October 3, 2018

Generated by:

(DSP Lab personnel names were anonymized)

Sound absorption refers to the process by which a specimen subjected to sound waves absorbs the sound energy instead of reflecting it. A standard for measuring sound absorption is through the sound absorption average (SAA) which can be found in ASTM C423 or ISO 354:2003. Sound absorption average (SAA) is a single number rating, the average, rounded off to the nearest 0.01, of the sound absorption coefficients of a material for the twelve one-third octave bands from 200 through 2500 Hz. The SAA values normally range from 0.00 to 1.00, with 1.00 indicating 100% sound absorption per square foot of material. Sound absorption coefficients for the bands are computed using Sabine formula (Eq. 1):

$$A = \frac{0.9210\,V \cdot d}{20.047\sqrt{273.15 + T}} \qquad \textbf{(Eq. 1)}$$

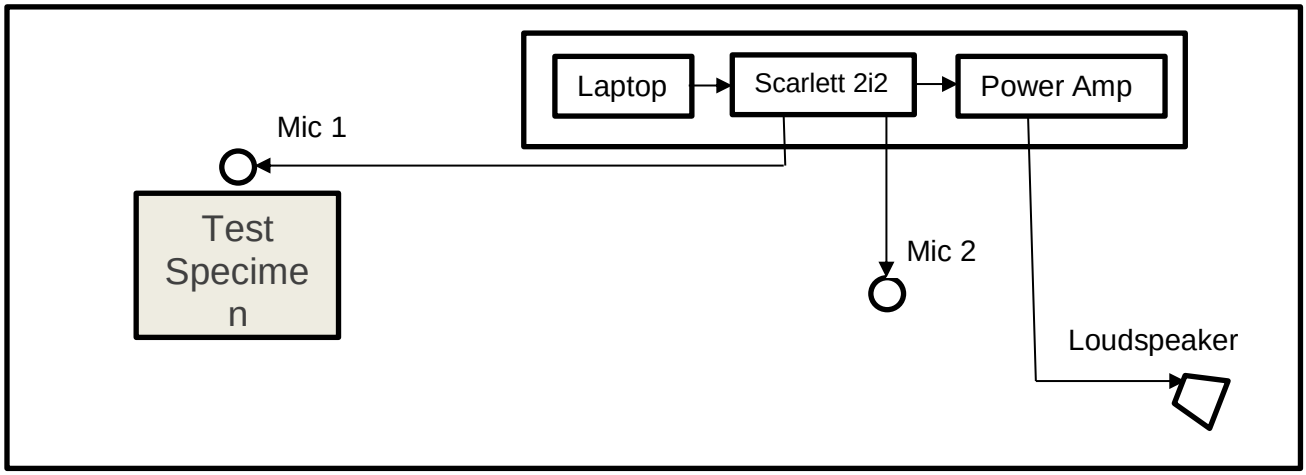
Where V is the volume of the room, T is the temperature in degrees Celsius and d is the decay rate defined as the negative of the slope of the linear, first-order regression on the average decay curve. See detailed computation of the slope described in ASTM C423.

Testing:

The following equipment were used for the testing:

- One (1) Scarlett 2i2 Digital Audio Interface
- One (1) Working Laptop with MATLAB
- One (1) Behringer Omnidirectional Condenser Mic
- One (1) AKG Omnidirectional Condenser Mic
- One (1) Kenwood 300W Power Amplifier w/ connectors
- One (1) Behringer Loudspeaker
- Two (2) XLR Cables
- Two (2) Mic Stands

Schematic Diagram:



Floor area: 174 sq. m.
Temperature during testing: 22 deg Celsius , 30% humidity

Procedure:

A test specimen was sealed in the testing room using a duct tape for a Type-A mounting described in ASTM E795. Specimen was placed accordingly at least 0.75m away from reflecting surfaces and from the microphones in height. Two fixed microphones were used, one near the specimen and another near the loudspeaker. Pink noise was generated in the laptop and loudness was adjusted so that the signal is at least 45 dB louder than the background noise. An automated script was created in MATLAB to automatically detect if the SPL of the generated Pink noise reaches 90 decibels. When it reaches 90 dB, the signal will extend for 20 seconds then stops. The sound received through the condenser microphones are then recorded and saved for analysis and computations.

Disclaimer: This is a non-standardized test as the setup: 1) does not follow standard room dimensions prescribed in ASTM C423, 2) does not use standard RTA equipment for recording, 3) is not conducted by an ASTM/ISO certified acoustician.

Test specimen: (specimen names were modified to anonymize the materials)

Code	Description	Dimensions
poly100	100% Polyester (1 layer)	29 x 29 in
poly100_2	100% Polyester (2 layers)	29 x 29 in
Polyab1	Mixed polyester and material 1 specimen 1	29 x 29 in
polyab2	Mixed polyester and material 1 specimen 2	29 x 29 in
Polyab3	Mixed polyester and material 1 specimen 3	29 x 29 in
Polyab4	Mixed polyester and material 1 specimen 4	29 x 29 in
Polybb1	Mixed polyester and material 2 specimen 1	29 x 29 in
Polybb2	Mixed polyester and material 2 specimen 1	29 x 29 in
Polybb3	Mixed polyester and material 2 specimen 2	29 x 29 in
Polybb4	Mixed polyester and material 2 specimen 3	29 x 29 in
Polywh1	Mixed polyester and material 3 specimen 1	29 x 29 in
Polywh2	Mixed polyester and material 3 specimen 2	29 x 29 in
Polywh3	Mixed polyester and material 3 specimen 3	29 x 29 in
Polywh4	Mixed polyester and material 3 specimen 4	29 x 29 in
Polywh5	Mixed polyester and material 3 specimen 5	29 x 29 in
rockwool	100% Rockwool (1 layer)	29 x 29 in

Test Results:

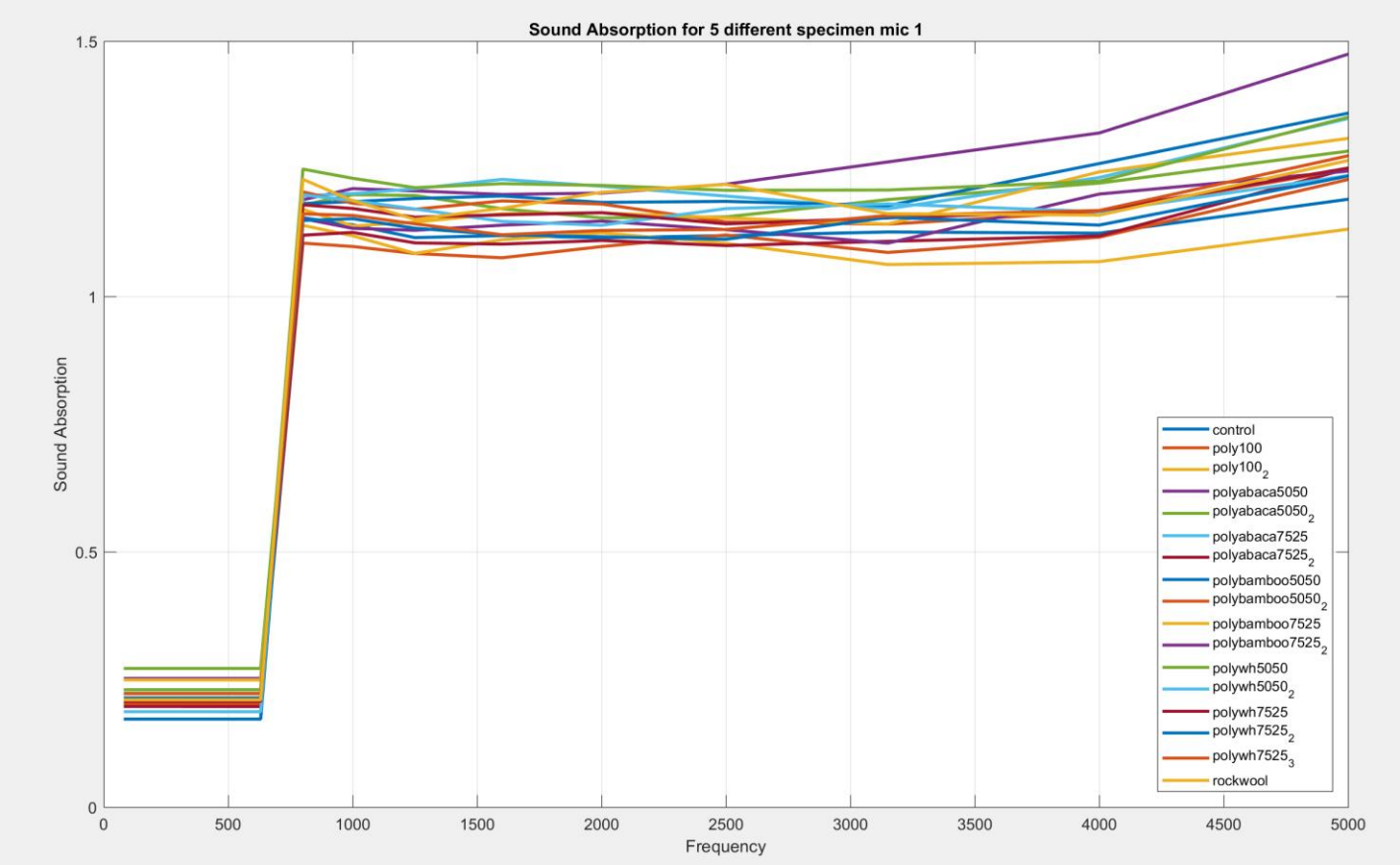


Figure 1. Sound Absorption obtained in microphone 1 for different specimen

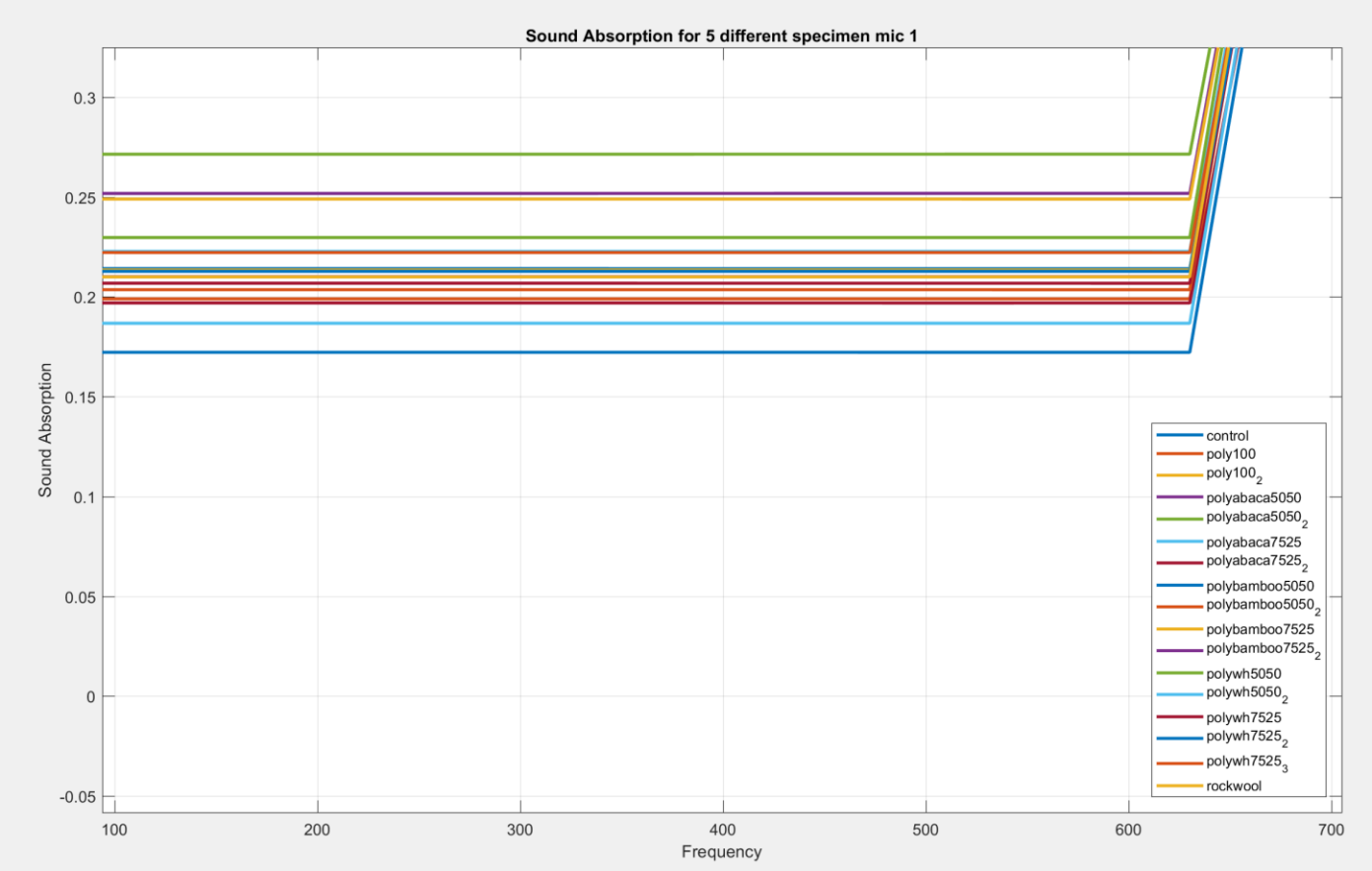


Figure 2. Sound Absorption obtained in microphone 1 for different specimen zoomed at low frequencies

Table 1. Sound Absorption Coefficients for the different specimen

Material	**polyabaca 5050**	**poly wh5050**	**polyabaca 7525**	**polyba-mboo 7525**	**rockwool**	**polywh 7525**	**polybam-boo5050**	**poly100**
rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SAA	0.106	0.103	0.083	0.058	0.058	0.026	0.017	-0.042
80	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
100	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
125	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
160	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
200	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
250	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
315	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
400	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
500	0.069	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
630	0.070	0.029	0.016	0.064	-0.008	-0.013	-0.077	-0.028
800	0.065	0.175	0.080	0.031	0.139	0.047	0.051	-0.092
1000	0.131	0.168	0.113	-0.004	0.087	0.059	0.084	-0.078
1250	0.169	0.180	0.176	0.056	0.066	0.074	0.141	-0.057
1600	0.149	0.187	0.203	0.079	0.099	0.075	0.143	-0.080
2000	0.162	0.189	0.186	0.090	0.164	0.091	0.128	-0.032

2500	0.186	0.164	0.143	0.064	0.185	0.043	0.124	0.002
3150	0.253	0.151	0.083	0.029	0.066	0.050	0.095	-0.074
4000	0.362	0.188	0.201	0.221	0.065	0.081	0.251	-0.014
5000	0.524	0.296	0.292	0.220	0.140	0.113	0.311	0.071

Table 2. Sound Absorption Averages for the 16 fabrics

Material	**SAA**	**Material**	**SAA**
polyabaca5050	0.106	polywh7525_3	0.020
polywh5050	0.103	polybamboo5050	0.017
polyabaca5050_2	0.098	polywh5050_2	0.014
polyabaca7525	0.083	polybamboo7525_2	0.007
polybamboo7525	0.058	polywh7525_2	0.002
rockwool	0.058	poly100_2	-0.013
polybamboo5050_2	0.038	polyabaca7525_2	-0.031
polywh7525	0.026	poly100	-0.042

In table 1, the Polyester-Abaca-5050 performed the best, followed by Polyester-Water-Hyacinth-50-50, then Polyester-Abaca-75-25, then Polyester-Bamboo-75-25 then the commercially available Rockwool. Comparing the results for Rockwool (typ. SAA of 0.7-1.05) and 100% Polyester (typ. SAA of 0.25-0.4), the relative ranking in Table 1 is still consistent. Typically, a 2-layer will have higher SAA than a 1-layer fabric. However, results in Table 2, show otherwise for some specimen. There are a few observations among the tested fabrics: 1) inconsistencies among the specimen, 2) small differences in sizes, 3) dryness of the fabrics. Thus, further investigation on the consistency of the specimen is suggested.