Proceedings of 20th International Congress on Acoustics, ICA 2010

23-27 August 2010, Sydney, Australia

CONTOURED FOAM ABSORBERS

M D Latimer (1), J R Pearse (1) and J P Parkinson (2)

(1) Department of Mechanical Engineering, University of Canterbury, Christchurch, New Zealand
(2 Pyrotek Noise Control, P O Box 12 032, Christchurch, New Zealand

PACS: 43.55.EV

ABSTRACT

The noise absorbing properties of two and three-dimensional contoured foam absorbers were investigated. The sound absorption of five differently shaped foams was measured in a reverberation room and comparisons made to a plain foam of equivalent volume. The effect of painting the foam surface and fabric coverings on acoustic performance were also investigated. The amount of absorption can be related to the volume and surface area of each foam. It was found that painting the absorbers had very little effect on their acoustic performance. Two and three-dimensional finite element models are being developed to further investigate the effect of surface shape on absorption.

1. INTRODUCTION

Contoured or shaped foam absorbers have been used extensively in architectural acoustics. Shapes such as pyramids or corrugations are typically used for aesthetic reasons as well as to improve the acoustic absorption. It is commonly thought that shaped absorbers have a greater surface area available to incident sound waves and hence greater absorption than equivalent plane absorbers of the same volume. This was investigated along with the effect of painting the absorber surface.

2. MATERIALS

Shapes

The foam was an open cell flexible polyurethane of the polyether type, figure 1. It typically has 35–40 cells per 25 mm, a density of 34 kg/m^3 and a flow resistivity of 13800 mks rayls/m.

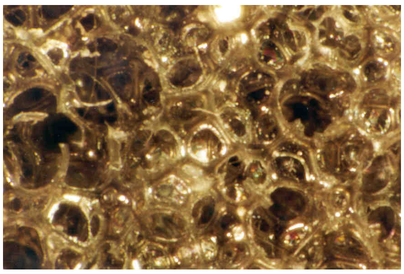

Figure 1 Micrograph view of cellular foam

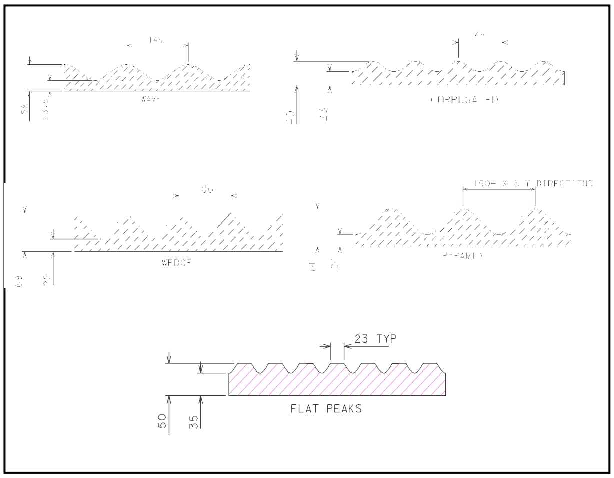

Figure 2 Absorber shapes

3. PROCEDURES

The absorption properties of five differently shaped foams (three 2-dimensional and two 3-dimensional shapes) were investigated, figure 2. The absorption of plane foams corresponding to the same total volume of the pyramid and corrugated shapes was also measured. The surface of each shaped foam was then painted and the absorption determined. Absorption coefficients were measured according to ISO 354:1988 [1]. A sufficiently diffuse sound field was established in the reverberation room by the inclusion of five stationery diffusers.

	Reverberation Room
Floor area (m^2)	60.1 +/- 0.1
Total surface area (m^2)	270.5 +/- 0.6
Room volume (m^3)	216.8 +/- 0.7

Table 1 reverberation room dimensions

The sound source was a loud speaker placed at four consecutive positions in the room. The test signals were random pink noise generated by a Bruel and Kjaer 2260 Investigator. The sound field was measured using a Bruel and Kjaer 2260 Investigator loaded with a Bruel and Kjaer BZ7204 Building Acoustics software package. The reverberation times were determined from decays of the sound field both for the empty room and for the room containing the specimen being tested. Two reverberation decays were measured at each of four microphone positions within the room. The samples were positioned centrally in the reverberation room. Each sample was enclosed within medium density fibreboard frames. The area of each specimen was 11.52 m^2, consisting of eight 1.2m square panels placed together.The weight of each absorber type was measured and the foam volume determined from the previously determined density.

4. RESULTS

The volume and average height of each contoured absorber is shown in table 2. The average height in table 2 was calculated by dividing each volume by the total absorber area (11.52 m^2).

Shape	**Shape variation**	**Volume (m^3)**	**Average Height (mm)**
Flat Peak	3D	0.569	49
Wedge	2D	0.531	46
Pyramid	3D	0.487	42
Wave	2D	0.427	37
Corru-gated	2D	0.371	32

Table 2

The average one-third octave band absorption of each of the contoured foams is shown in descending order in table 3. The results for individual frequency bands are shown in figure 3. It is clear from table 3 that the average absorption corresponds to the average height (or volume) of foam of the subject absorber shape.

Shape	**Average Height (mm)**	**Average Absorption of One-third Octave Band Centre Frequencies**
Flat Peak	49	0.74
Wedge	46	0.68
Pyramid	42	0.64
Plane 1	42	0.63
Wave	37	0.63
Corrugated	32	0.55
Plane 2	32	0.54

Table 3

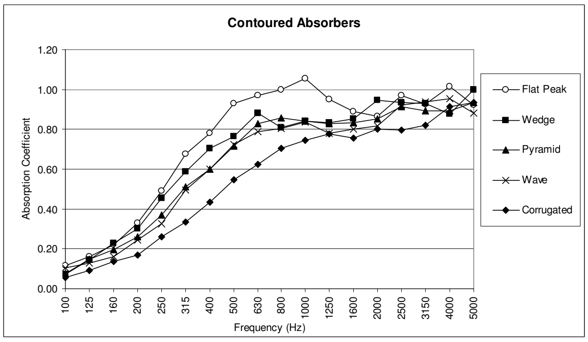

Figure 3 Contoured absorbers

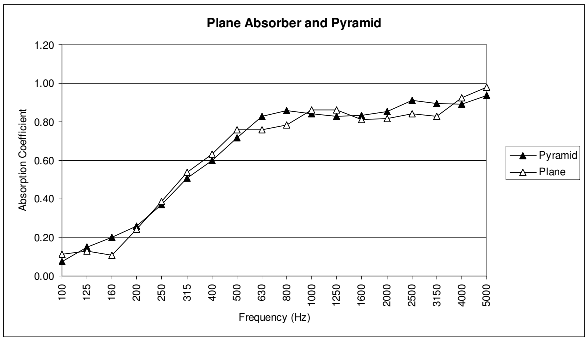

Figure 4 Comparison of plane absorber and pyramid (same volume of foam)

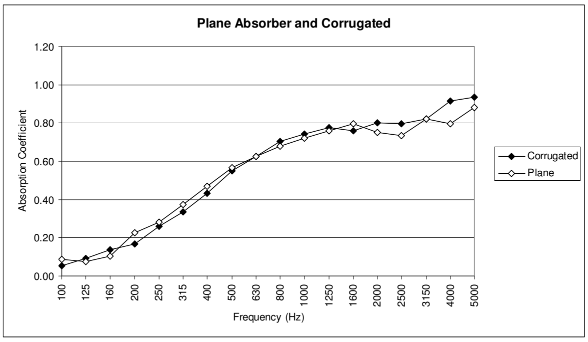

Figure 5 Comparison of plane absorber and corrugated (same volume of foam)

The effect of painting the absorbers' surface can be seen in figure 6. The painted absorbers show very similar absorption trends to the original foams in figure 3; this is illustrated for the pyramid shaped absorber in figure 7.

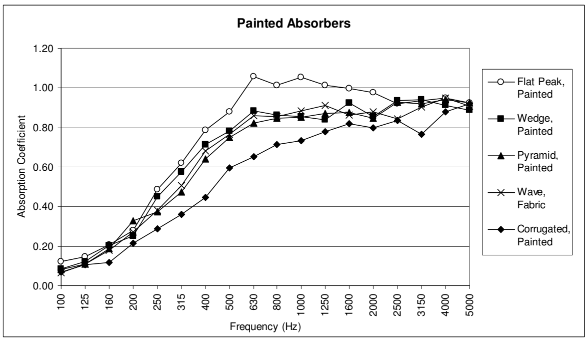

Figure 6 Effect of absorber coverings

It is clear that the pyramid foam's absorption changed only slightly across the whole frequency range, figure 7. Similar trends were observed in the results of the other painted absorbers.

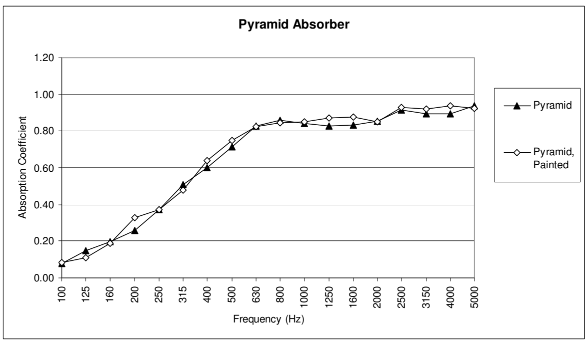

Figure 7 Effect of painting the surface of the pyramid absorber

The fabric covered wave absorber had greater absorption in the mid-frequency range than the original wave foam, figure 8.

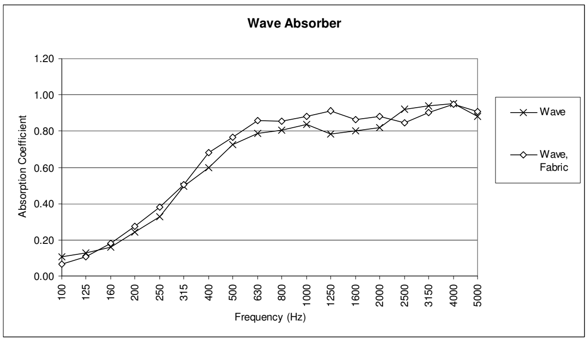

Figure 8 Effect of fabric covering

5. CONCLUSIONS

The sound absorption of contoured foam absorbers has been investigated. The sound absorption was strongly dependant on the volume of foam and relatively independent of the shape of the foam. Painting the surface of the absorbers only slightly changed the absorption. Fabric coverings can be used to increase the absorption.

REFERENCES

[1]International Standard ISO 354:1988, Acoustics - Measurement of sound absorption in a reverberation room, International Organisation for Standardisation, Switzerland, 1988.