THE EFFECT OF VARIOUS PLACEMENTS AND DENSITIES ON THE SOUND ABSORPTION OF BAFFLES

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ABSTRACT

Unit absorbers, commonly referred to as sound absorbing baffles have obtained widespread use in buildings for reverberation and noise level control. The effect on sound absorption of varying baffle densities greater than 2 m²/unit has been investigated in the past. Little or no information exists on the sound absorption of baffles suspended at densities less than this value. To further understand their sound absorbing characteristics, laboratory tests were performed on various configurations and densities less than 2 m²/unit. Of particular interest was the effect of horizontal and vertical placements and the mutual influence on absorbing efficiency due to the change in baffle density. Results indicate that spatial arrangement had minimal effect on sound absorption for the densities measured. However, sound absorbing efficiency did increase notably as the baffle density decreased.

SOMMAIRE

Des unités absorbantes, sont en usage commun afin de contrôler le bruit et la réverbération dans le batîment. L'éffet d'absorbtion de ces absorbants à un nombre supérieur à une unité par deux metres carrés (1 unité/2 m²) a déja été recherché. Cependant, peu d'information existe au sujet de densités moindre à celle-ci. Afin de mieux comprendre ces charatéristiques d'absorbtion, des test en laboratoire ont été éffectué avec différentes configurations et densités moins d'une unité/2 m². Spécifiquement l'éffet de l'orientation horizontal et vertical, et de l'éfficacité d'absorbtion due au nombre d'absorbants par metre carré a été investigué. Les résultats indiquent que l'orientation a peu d'influence mais que l'éfficacité d'absorbtion par unité augmente quand leur nombre par metre carré diminue.

INTRODUCTION

The use of baffles as an effective method to control noise in industrial work environments is common. A successful application of these units to lower reverberant noise levels requires that they be efficient sound absorbers and placed densely throughout the entire ceiling area. Typically, sound absorption applied to the wall surfaces is not feasible in these buildings.

Baffles used to control noise and reverberation in recreation facilities; particularly swimming pools, have also proven to be useful. In many cases, baffles used in conjunction with sound absorptive wall panels are the preferred methods of placing sound absorption in these buildings. An economically feasible solution results in baffles suspended at lower densities than those normally required for industrial noise control. Sound absorbing characteristics of baffles at these lower densities is useful information in the calculation of noise reduction and reverberation time.

Measurements of sound absorption using a typical baffle configuration were performed within a reverberation chamber with a diffuse environment. The measured baffle densities ranged from 2.1 m^2/unit to 14.7 m^2/unit relative to the test room floor. This report describes the methodology of measurement, test results and related observations.

BAFFLE DESCRIPTION

The acoustic material used for the baffle core was a rigid glass fibre having a physical density of 48 kg/m^3. Each baffle measured 1220 mm X 610 mm X 50 mm and was encased within an aluminum channel framework 50 mm X 25 mm X 3 mm thick. The baffles were supported on a stand that was constructed of 38 mm diameter ABS piping. To approximate the suspension of these units in a room, the support stand kept the central axis of each baffle 1000 mm ± 10 mm from the test room floor.

TEST PROCEDURES

Sound absorption tests were performed at the Mechanical Engineering Acoustics and Noise Unit (MEANU), University of Alberta located in Edmonton. Recognized as an acoustical test laboratory which meets or exceeds existing standards, the reverberation chamber used had a floor area of 58.8 m^2 with a volume of 311 m^3. All measurements were done in strict accordance to the method described in ASTM C 423-81 [1].

A random sample of the baffles was assembled to form a standard rectangular test specimen and were measured directly on the laboratory floor (Type A Mounting). This was done to assure that the rigid glass fibre conformed with absorption data of similar material tested in other laboratories. Test results were in close agreement with those from other laboratories which confirmed the sound absorbing properties of the material and accuracy of the measurement method. The various baffle placements and densities measured are described and illustrated in Figure 1. The baffles were measured both vertically (perpendicular to the floor plane) and horizontally (parallel to the floor plane).

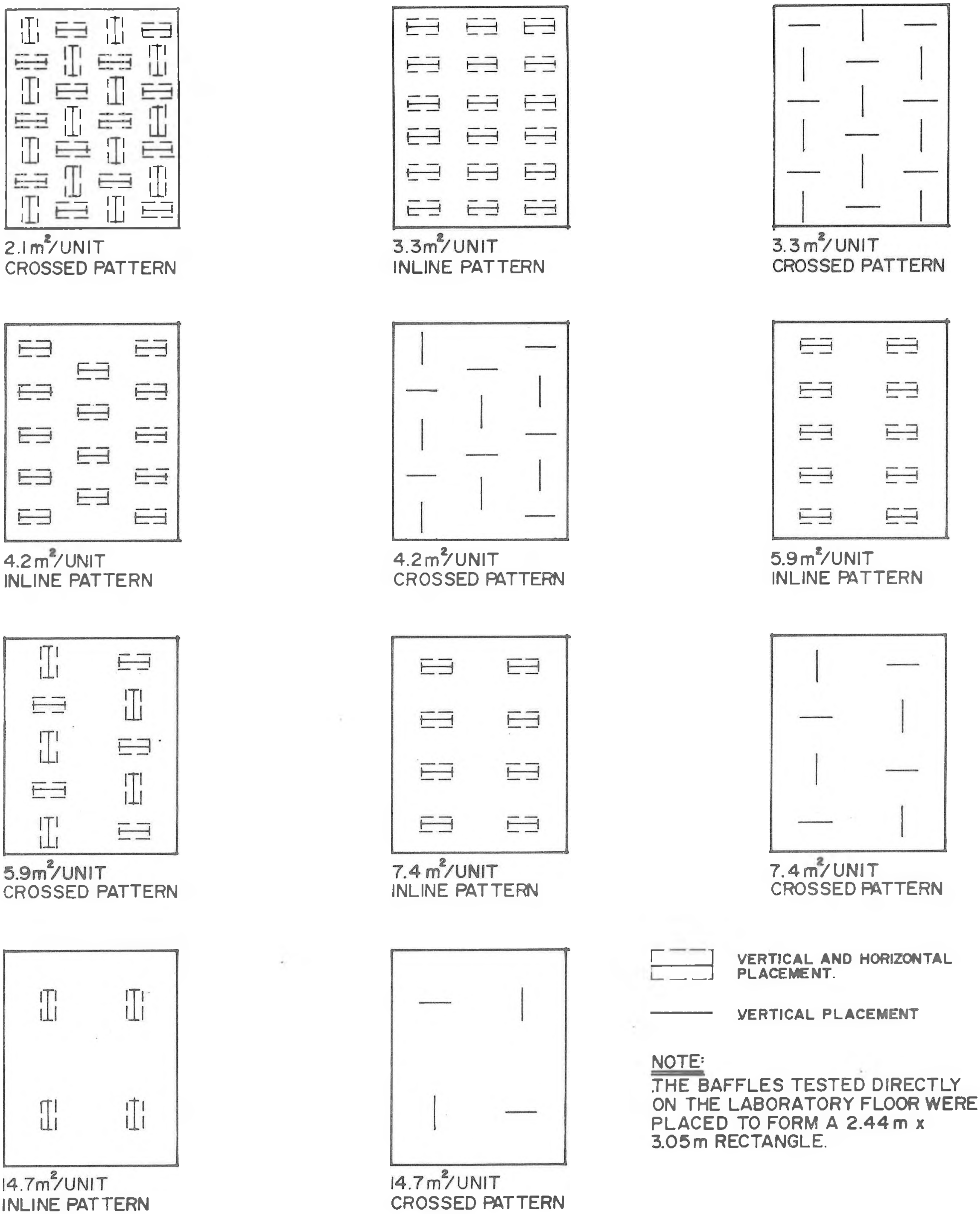

Figure 1. Plan View of Baffle Test Layouts

Sound absorption in metric sabins per baffle was calculated for each one-third octave band from 100 Hz to 5000 Hz. Results for the individual tests were compared at the standard ISO octave band centre frequencies from 125 Hz to 4000 Hz.

TEST RESULTS

Table 1 lists the sound absorption measured for the various baffle densities and layouts:

TABLE I

Sound Absorption Of Standard Baffle For
Various Placements and Densities In Metric
Sabins Per Unit

DENSITY (m^2/UNIT)	PLACEMENT	FREQUENCY (Hz) 125	250	500	1000	2000	4000
2.1	Vertical, Crossed	0.36	0.48	0.96	1.32	1.17	1.13
2.1	Horizontal, Crossed	0.28	0.62	0.93	1.18	1.05	1.09
3.3	Vertical, Inline	0.26	0.58	1.09	1.38	1.23	1.16
3.3	Horizontal, Inline	0.37	0.64	1.12	1.40	1.28	1.12
3.3	Vertical, Crossed	0.40	0.58	1.09	1.37	1.30	1.30
4.2	Vertical, Inline	0.26	0.51	1.14	1.47	1.25	1.13
4.2	Horizontal, Inline	0.28	0.63	1.18	1.45	1.32	1.21
4.2	Vertical, Crossed	0.35	0.64	1.16	1.49	1.31	1.25
5.9	Vertical, Inline	0.35	0.58	1.16	1.46	1.21	1.11
5.9	Horizontal, Inline	0.32	0.64	1.19	1.48	1.31	1.17
5.9	Vertical, Crossed	0.40	0.58	1.15	1.51	1.35	1.20
5.9	Horizontal, Crossed	0.18	0.64	1.18	1.49	1.30	1.16
7.4	Vertical, Inline	0.34	0.65	1.15	1.54	1.32	1.17
7.4	Horizontal, Inline	0.24	0.64	1.25	1.53	1.34	1.29
7.4	Vertical, Crossed	0.35	0.67	1.16	1.57	1.38	1.33
14.7	Vertical, Inline	0.31	0.68	1.21	1.59	1.33	1.23
14.7	Horizontal, Inline	0.31	0.73	1.31	1.59	1.37	1.18
14.7	Vertical, Crossed	0.36	0.70	1.28	1.57	1.34	1.21
10 Baffles directly on Laboratory Floor *		0.19	0.57	0.83	0.82	0.74	0.68

* Values are given in metric sabins per baffle. To convert to absorption coefficients, multiply by 1.34.

To obtain a single number rating for sound absorption, values for each placement in Table 1 were averaged from 250 Hz to 2000 Hz. These have been plotted in Figure 1.

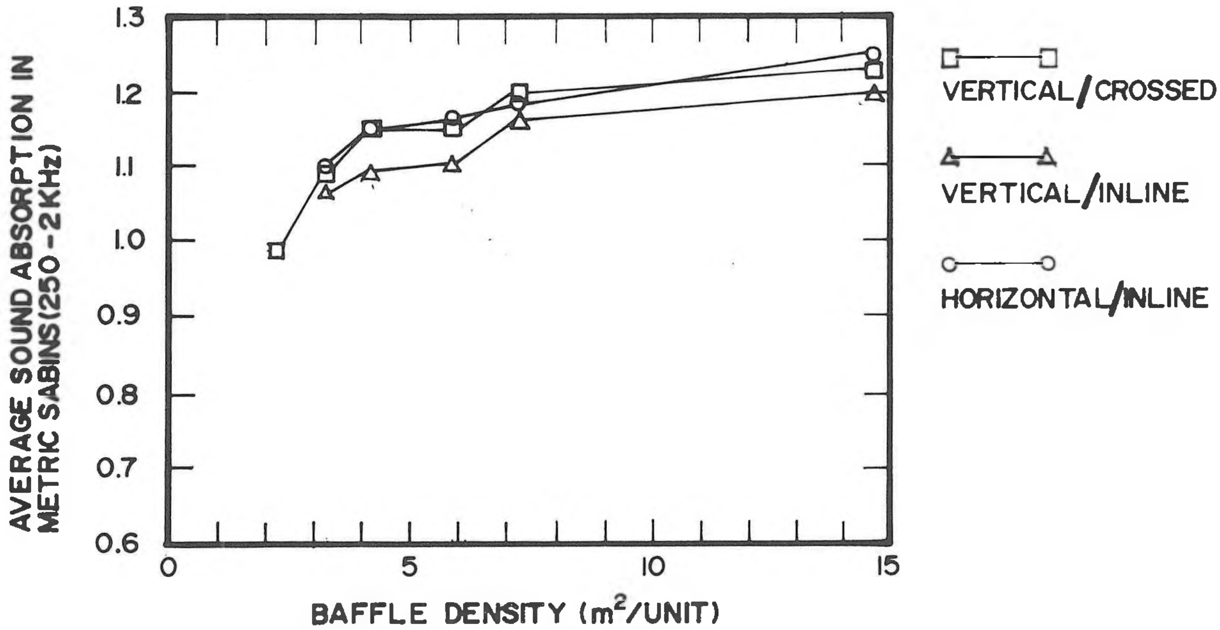

Figure 1. Average sound absorption of baffles for various placements and densities.

Both the VERTICAL/CROSSED and the HORIZONTAL/INLINE placements were similar in sound absorbing efficiency for all the densities measured. Although the differences were small, the VERTICAL/INLINE placement was the least efficient for sound absorption. For all baffle placements, the general trend was an increase in sound absorbing efficiency with a decrease in density. Similar results have been reported by others for baffle densities greater than 2 m^2/unit [5].

CONCLUSIONS

The sound absorbing efficiency of the tested baffles did not change significantly due to a change in placement. A notable increase of sound absorption (10 - 20%) was perceived as the baffle density decreased. It should be noted that these results apply to the baffle configuration tested and other shapes and/or sizes might produce different conclusions. Also, the results relate to acoustical conditions typical for a laboratory environment (diffuse). Tests under actual field conditions, such as those found in a large recreation facility, may provide further useful information.

REFERENCES

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