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DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C.
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Letter Circular
LC-452
(Superseding #425)

SOUND ABSORPTION COEFFICIENTS OF THE MORE COMMON MATERIALS.

The following figures have been obtained at the National Bureau of Standards for the sound absorption coefficients of a number of materials now on the market as acoustic correctives. The inclusion of a material in this letter circular is not to be construed as a general approval. Each material should be judged on its merits in any particular case as there are other requirements such as fire resisting qualities; light reflection, appearance, etc. Figures are also given for the absorption of an audience seated in chairs of different kinds. All the results have been obtained by the reverberation method on samples having an area of approximately 72 square feet.

The sound absorption coefficient of a material is defined as the fractional part of the energy of a sound wave which is absorbed at each reflection. Experimental figures such as are given here must be regarded as approximate only. This branch of applied science is new and in a state of development. The methods and formulas used in obtaining these figures are those which, while not entirely satisfactory, are open to the least objection. The uncertainty involved is such that all the coefficients are probably somewhat too large.

The "noise coefficient" given in the table is the average to the nearest multiple of 0.05 of the coefficients for 256, 512, 1024 and 2048 cycles. It has been recommended by many consultants that such a coefficient be used when the problem is one of reducing the noise level, as in offices, restaurants, etc.

Fibrous materials and acoustic tiles may exhibit large variations in coefficient arising from different methods of mounting. The figures here given apply only to cases where the materials are mounted in the same manner as when tested.

Acoustic plasters require special skill in their application, as improper manipulation may reduce the coefficient. Moreover, the figures given for plasters without a base coat will be considerably reduced if a base coat is used.

It is not necessarily the case that the materials of highest coefficient are the most advantageous. When there is room enough to apply the requisite quantity, a material of low coefficient

will give better results than one of higher absorption, because of the more uniform distribution of material. Also in comparing different materials it should be borne in mind that there is some variation in manufacture, hence the sample which was measured may have more or less absorption than the material delivered on the job. Minor differences in coefficients, therefore, should be disregarded in choosing between materials.

For the foregoing reasons it is advisable in drawing up specifications for auditoriums to lay emphasis upon the reverberation time desired rather than upon coefficients of material. See Bureau of Standards Circular #396 entitled "Architectural Acoustics", which may be obtained of the Superintendent of Documents, Government Printing Office, Washington, D. C. at 5 cents per copy. Additional details regarding any of the materials mentioned in this letter circular will be furnished on application.

Additional information regarding the absorption coefficients of acoustical materials may be obtained from the Acoustical Materials Association, 919 North Michigan Avenue, Chicago, Illinois.

Sound Absorption Coefficients and Description of Test Samples

Table 1
Acoustical Tiles, Boards and Blankets

The coefficients given in the following table have been modified to some extent from those given in Letter Circular #359 and earlier letter circulars. The reason for these changes is to be found in the August, 1934 number of the Journal of Research of the National Bureau of Standards (Research Paper No. 700) entitled "Dependence of Sound Absorption upon the Area and Distribution of the Absorbent Material".

Material	Thickness	Mounting (See Footnote)	Coefficients 128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq.ft.	Surface	Date
ACOUSTICAL CORPORATION OF AMERICA													
Mutetile (2" Rockwool)	2 1/2"	4	.53	.71	.80	.78	.76	.45	.75	12"x 12"	- -	Cast plaster of paris perforated 2556 holes per sq.ft.,dia. 1/16"	1932
ACOUSTONE COMPANY, LTD.													
Trutone Tile, cast on 1/4" gypsum wall board.	7/8"	4	.16	.17	.48	.82	.65	.74	.55	12"x 24"	- -	Spray painted by manufacturer.	1932
AMERICAN ACOUSTIC CORPORATION													
Ek-O-less Tile, cast on 1" backing	3/4"	4	.22	.31	.66	.82	.74	.76	.65	11 7/8"x 22 7/8"	12.3	Unpainted	1932
Ek-O-less Tile, cast on 1/2" backing	1 7/16"	4	.18	.32	.85	.92	.77	.81	.70	11 7/8"x 22 7/8"	- -	Unpainted	1932
ARMSTRONG CORK & INSULATION COMPANY													
Ceramacoustic Tile	1 1/8"	1	.34	.48	.63	.66	.65	.58	.60	4 1/2"x 9"	3.4	Unpainted	1932
Ceramacoustic Tile	1 1/8"	1	.28	.49	.62	.62	.66	.54	.60	4 1/2"x 9"	3.4	Spray painted 4 coats at N. B. of S.	1932
Temlock	1/2"	5 (16"o.c.)	.24	.31	.27	.27	.36	.47	.30	- - - -	- -	Unpainted	1931

Material	Thickness	Mounting (See Footnote)	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq. ft.	Surface	Date
ATLANTIC GYPSUM PRODUCTS COMPANY													
Acoustex	7/8"	4	-	.19	.41	.72	-	-	-	12"x 12"	2.06	- - -	1932
Accustex Type 60	1"	4	.11	.21	.53	.77	.77	.76	.55	12"x 12"	2.5	Spray painted by mfr.	1931
Acoustex	1 1/8"	4	-	.25	.53	.79	-	-	-	12"x 12"	2.6	- - -	1932
Acoustex	1 1/8"	5 (12" o.c.)	-	.74	.88	.63	-	-	-	12"x 12"	2.6	- - -	1932
THE CALICEL COMPANY													
Calicel Acoustic Tile	1"	1	.09	.26	.74	.97	.78	.84	.70	12"x 12"	2.66	Unpainted	1935
Calicel Acoustic Tile	1"	5 (12"o.c.)	.28	.90	.86	.72	.85	.89	.85	12"x 12"	2.66	Unpainted	1935
Calicel Acoustic Tile	1 1/4"	1	.14	.43	.90	.90	.82	.80	.75	12"x 12"	3.42	Unpainted	1935
Calicel Acoustic Tile	1 1/4"	5 (12"o.c.)	.38	.95	.76	.78	.89	.87	.85	12"x 12"	3.42	Unpainted	1935
THE CELOTEX COMPANY													
Acousti-Celotex Type A	1/2"	2	.06	.65	.42	.49	.64	.64	.55	12"x 12"	0.72	Unpainted, perforated 441 holes per sq.ft. 1/4" dia., 3/8" deep.	1933
Acousti-Celotex Single B	5/8"	1	.08	.18	.48	.62	.72	.77	.50	12"x 12"	--	Unpainted, perforated 441 holes per sq. ft. 1/4" dia., 1/2" deep.	1931
Acousti-Celotex Single B	5/8"	1	.07	.20	.46	.70	.82	.81	.55	12"x 12"	--	Same as sample above, brush painted 1 coat glue size, 4 coats lead and oil at N. B. of S.	1931
Acousti-Celotex Single B	5/8"	2 (furring 1"x2")	.05	.64	.63	.85	.84	.66	.75	12"x 12"	0.76	Unpainted, perforated 441 holes per sq. ft. 1/4" dia., 1/2" deep.	1933

THE CELOTEX COMPANY (Cont'd)

Material	Thick-ness	Mounting (See Footnote)	Coefficients 128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq.ft.	Surface	Date
Acousti-Celotex Double B	13/16"	1	.15	.24	.62	.73	.70	.71	.55	12"x 12"	- -	Unpainted, perforated 441 holes per sq. ft. 1/4" dia., 5/8" deep.	1931
Acousti-Celotex Double B	13/16"	1	.13	.26	.62	.78	.86	.77	.65	12"x 12"	- -	Same as sample above, brush painted 1 coat glue size, 4 coats lead and oil at N. B. of S.	1931
Acousti-Celotex Double B	13/16"	2	.09	.56	.77	.90	.78	.62	.75	12"x 12"	.86	Unpainted, perforated 441 holes per sq. ft. 1/4" dia., 5/8" deep.	1933
Acousti-Celotex Triple B	1 1/4"	4	.12	.41	.90	.92	.66	.64	.70	12"x 12"	1.44	Unpainted, perforated 441 holes per sq. ft. 1/4" dia., 1" deep.	1932

R. GUASTAVINO COMPANY

Material	Thick-ness	Mounting (See Footnote)	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq.ft.	Surface	Date
Akoustolith Tile Grade D	1"	4	.03	.13	.25	.54	.67	.42	.40	- - -	- -	Unpainted	1930
Akoustolith Tile Grade D	2"	4	.15	.26	.59	.74	.52	.50	.55	- - -	- -	Unpainted	1930
Akoustolith Tile Grade C	1 1/2"	4	.12	.19	.44	.61	.66	.56	.50	6"x 12"	7.5	Unpainted	1930
Akoustolith Tile Grade C	2"	4	.19	.26	.53	.64	.70	.56	.55	6"x 12"	10.1	Unpainted	1930
Akoustolith Tile Grade B-2	1"	4	.09	.17	.46	.77	.77	.58	.55	6"x 12"	4.6	Unpainted	1932
Akoustolith Tile Grade B-2	1 1/2"	4	.14	.30	.67	.87	.82	.57	.65	6"x 12"	6.1	Unpainted	1932
Akoustolith Tile Grade B-2	2"	4	.21	.50	.85	.81	.70	.70	.70	6"x 12"	8.5	Unpainted	1932

Material	Thickness	Mounting (See Footnote)	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq. ft.	Surface	Date
HAWAIIAN CANE PRODUCTS, LTD.													
Hawaiian Cane Tile	1"	1	.10	.40	.69	.78	.77	.79	.65	11 1/2"x 11 1/2"	0.75	Unpainted	1933
Hawaiian Cane Tile	1"	2	.24	.70	.40	.48	.54	.60	.55	12"x 12"	.81	Unpainted	1935
THE INSULITE COMPANY													
Insulite Acoustile Type 44	1 3/4"	4	.26	.42	.50	.57	.61	.59	.55	12"x 12"	1.47	Unpainted	1931
JOHNS-MANVILLE SALES CORPORATION													
Nashkote A	1/2"	1	.05	.13	.25	.26	.20	.18	.20	36"x 48"	- -	Painted 2 coats oil paint.	1929
Nashkote A	1/2"	1	.08	.15	.43	.62	.65	.58	.45	36"x 48"	- -	Same as above except membrane perforated with fine holes after painting.	1929
Nashkote A	3/4"	1	.09	.16	.27	.30	.23	.23	.25	36"x 48"	- -	Painted 2 coats oil paint.	1929
Nashkote A	3/4"	1	.11	.21	.51	.68	.71	.68	.55	36"x 48"	- -	Same as above except membrane perforated with fine holes after painting.	1929
Nashkote A	1"	1	.12	.20	.33	.33	.28	.28	.30	36"x 48"	- -	Painted 2 coats oil paint.	1929
Nashkote A	1"	1	.13	.26	.58	.73	.77	.71	.60	36"x 48"	- -	Same as above except membrane perforated with fine holes after painting.	1929
Nashkote B-332	1/2"	1	.09	.15	.31	.52	.74	.63	.45	36"x 48"	- -	Covered with perforated membrane.	1929
Nashkote B-332	3/4"	1	.12	.21	.40	.63	.81	.73	.50	36"x 48"	- -	Covered with perforated membrane.	1929
Nashkote B-332	1"	1	.19	.26	.51	.73	.89	.77	.60	36"x 48"	- -	Covered with perforated membrane.	1929

Material	Thickness	Mounting (See Footnote)	Coefficients 128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq.ft.	Surface	Date
JOHNS-MANVILLE SALES CORPORATION (Cont'd)													
Sanacoustic Tile (Rock Wool Filler)	1 1/4"	4	.17	.41	.82	.94	.85	.55	.75	12"x 12"	1.6 (Pad)	Baked enameled metal perforated 4608 holes per sq.ft.,dia. 1/16".	1930
Sanacoustic Tile (Rock Wool Filler)	1 1/4"	2	.19	.63	.82	.82	.76	.57	.75	12"x 24"	1.3 (Pad)	Baked enameled metal perforated 4608 holes per sq.ft., dia.1/16".	1931
Sanacoustic Tile (Rock Wool Filler)	1 1/4"	2	.17	.49	.79	.75	.81	.78	.70	12"x 24"	1.3 (Pad)	Same as above except brush painted 3 coats oil paint at N.B. of S.	1931
Sound Isolation Blanket (Rock Wool)	- -	4	.11	.58	.85	.83	.81	.83	.75	- - -	1.5	Metal lath.	1932
Transite Accoustical Tile	1 1/8"	4	.19	.39	.77	.74	.70	.55	.65	12"x 12"	3.0	Transite, perforated 576 holes per sq. ft. diameter 5/32".	1931
KALITE COMPANY, LTD.													
Kalite Tile, cast on 1/2" backing	1 1/2"	4	.15	.32	.50	.52	.40	.40	.45	12"x 12"	- -	Unpainted	1932
LUSE STEVENSON CO.													
Lusco Hair Felt	1"	4	.06	.27	.57	.77	.81	.88	.60	4'x 9'	- -	No surface covering	1934
MAIZEWOOD PRODUCTS CORPORATION													
Maizewood Tile	1 1/2"	4	.23	.41	.63	.79	.70	.62	.65	12"x 12"	2.1	12 saw cuts across tile 1" deep	1932
Maizewood Tile	1 1/2"	4	.21	.41	.64	.73	.70	.58	.60	12"x 12"	2.1	Same sample as above painted 1 coat glue size, 2 coats lead & oil at N.B. of S.	1932

NATIONAL GYPSUM COMPANY

Material	Thick-ness	Mounting (See Footnote)	Coefficients 128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq.ft.	Surface	Date
Acoustolic (Maftex)	1/2"	5	.44	.24	.31	.44	.48	.37	.35	- - -	- -	Unpainted	1930
Acoustolic	1/2"	5	-	.29	.28	.41	-	-	-	- - -	- -	Tinted with water soluble aniline color at N. B. of S.	1930
Acoustolic	1/2"	5	.40	.33	.31	.38	.37	.35	.35	- - -	- -	Painted with water color paint at N.B. of S.	1930

THE SPHINX ACOUSTICAL COMPANY

Material	Thick-ness	Mounting	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt.	Surface	Date
Sphinxstone	2"	4	.10	.35	.78	.87	.71	.70	.65	18"x 24"	- -	Unpainted	1932

THERMAX CORPORATION

Material	Thick-ness	Mounting	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt.	Surface	Date
Absorbex Type A	1"	1	-	.22	.45	.87	.91	-	.60	9"x 9"	2.5	Spray painted by mfr.	1932
Absorbex Type A	1"	2 (9"o.c.)	-	.27	.65	.92	.77	-	.65	9"x 9"	2.5	Spray painted by mfr.	1932
Absorbex Type A on 1" Absorbex Type C (10 gauge)	2"	4	-	.39	.80	.96	.92	-	.75	9"x 9" tile on 20"x 64" sheets.	-	Spray painted by mfr.	1932
Absorbex Type C (14 gauge)	1"	4	.14	.19	.34	.73	.62	.62	.45	20"x 64"	-	Unpainted	1932
Absorbex Type C (14 gauge)	1"	2 (20"o.c.)	.14	.21	.67	.69	.59	.62	.55	20"x 64"	-	Unpainted	1932
Absorbex Type C (10 gauge)	1"	2 (16"o.c.)	.06	.17	.47	.66	.53	-	.45	20"x 64"	-	Spray painted by mfr.	1934
Absorbex Type C (8 gauge)	2"	7	.13	.47	.98	.70	.78	.70	.75	20"x 64"	4.7	Spray painted 4 coats paint at N. B. of S.	1934

UNITED STATES GYPSUM COMPANY

Material	Thickness	Mounting (see Footnote)	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq. ft.	Surface	Date
Acoustone Type D	1"	1	.14	.46	.78	.78	.77	.83	.70	12"x 12"	1.89	Unpainted	1935
Quietile Type SC	1"	4	.06	.47	.76	.74	.72	.76	.65	12"x 12"	0.81	Unpainted, brush finish	1932
Red Top Acoustic Tile	1/2"	1	.14	.22	.40	.48	.52	.51	.40	12"x 12"	0.55	Unpainted	1933
Thermofil	3"	4	.43	.39	.66	.78	.81	.93	.65	- - -	-	No surface covering	1932
U.S.Gypsum Metal Tile, Rock Wool pad.	1 1/2"	4	.12	.56	.91	.87	.78	.70	.80	12"x 12"	1.03 (pad)	Painted by mfr. perforated 2401 holes per sq. ft.	1933

WOOD CONVERSION COMPANY

Material	Thickness	Mounting (see Footnote)	128	256	512	1024	2048	4096	Noise Coef.	Size of Unit Tested	Wt. (lbs) sq. ft.	Surface	Date
Balsam Wool	1"	4	.18	.36	.55	.65	.67	-	.55	- - -	.29	Scrim facing	1928
Krextone Tile (Balsam Wool)	1"	6	.12	.24	.62	.73	.73	.78	.60	12"x 12"	0.83	Screen wire	1931
Nuwood Bevel Lap Tile	1/2"	6	.12	.19	.30	.40	.40	.51	.30	12"x 12"	0.69	Unpainted	1931
Nuwood Bevel Lap Tile	1"	6	.14	.19	.37	.37	.41	.56	.35	12"x 12"	1.4	Unpainted	1931

FOOTNOTES:

1. Cemented to gypsum wall board. This is considered equivalent to cementing to plaster or masonry.
2. Placed on 13/16" x 2" furring 12" c.c. unless otherwise indicated.
3. Metal supports attached to 13/16" x 2" wood furring.
4. Laid directly on laboratory floor. As a rule the results obtained this way are the same as when the tile is cemented to gypsum wall board.
5. Placed on 2 x 4's 24" o.c. unless otherwise indicated.
6. Cemented to the floor of the reverberation chamber.
7. Back of sample covered with concrete.

Table 2

Acoustical Plasters

Unless otherwise stated each sample of acoustical plaster was mixed according to the specifications furnished by the manufacturers and applied by a skilled plasterer on a false ceiling at the N. B. of S. The panels were laid on the floor of the Reverberation Chamber for test.

Material	Thickness	128	256	512	1024	2048	4096	Noise Coef.	No. of Coats	Base Coat	Application	Surface Treatment	Date
THE AMERICAN GYPSUM COMPANY													
Reverbolite Plaster	5/8"	.10	.32	.35	.40	.51	.35	.40	1st coat 1/4" 2nd coat 1/4" 3rd coat 1/8"	Gypsum plaster	2nd coat applied 24 hrs. after 1st coat. 3rd coat applied immediately after 2nd coat.	Floated with wood float.	1934
ATLANTIC GYPSUM PRODUCTS COMPANY													
Rockwall Acoustic Plaster	1/2"	.18	.19	.34	.73	.80	.77	.50	1st coat 1/4" 2nd coat 1/4"	Gypsum plaster	1st coat applied to dry base coat. 2nd coat applied 2 hrs. after 1st coat.	Finished with steel trowel.	1935
CALIFORNIA STUCCO PRODUCTS OF NEW ENGLAND, INC.													
Stuccostic Plaster Type A. D.	3/4"	.18	.36	.65	.65	.62	.62	.55	1st coat 7/16" 2nd coat 5/16"	Gypsum plaster	1st coat applied to half green base coat. 2nd coat applied 3 hrs. after 1st coat.	Troweled with steel trowel.	1935

Columns 128–4096 are Coefficients.

Material	Thickness	128	256	512	1024	2048	4096	Noise Coef.	No. of Coats	Base Coat	Application	Surface Treatment	Date
CERTAIN-TEED PRODUCTS CORPORATION													
Kalite H Coarse Aggregate	1/2"	.36	.33	.46	.70	.66	.68	.55	1st coat 3/8" 2nd coat 1/8"	Gypsum plaster on metal lath attached to 1" channels.	1st coat applied to dry base coat. 2nd coat applied 1 hr. after 1st coat.	Finished with steel trowel	1935
Kalite H Coarse Aggregate	3/4"	.43	.38	.63	.78	.65	.70	.60	1st coat 5/8" 2nd coat 1/8"	Gypsum plaster on metal lath attached to 1" channels.	1st coat applied to dry base coat. 2nd coat applied 1 hr. after 1st coat.	Finished with steel trowel.	1935
CLEVELAND GYPSUM SUPPLY COMPANY													
Hushkote Acoustic Plaster	1/2"	.13	.24	.45	.71	.56	.49	.50	1st coat 1/4" 2nd coat 1/4"	Gypsum plaster	1st coat applied to dry base coat. 2nd coat applied 24 hrs. after 1st coat.	Finished with steel.	1935
R. GUASTAVINO COMPANY													
Akoustolith Plaster	1/4"	.13	.21	.19	.23	.33	.45	.25	1 coat	Gypsum plaster	Applied on binder coat. See mfg. directions.	Floated	1931
Akoustolith Plaster	3/4"	.20	.26	.35	.56	.59	.50	.45	1 coat	Gypsum plaster	Applied on binder coat. See mfg. directions.	Floated	1932

Coefficients: 128–4096 cycles.

Material	Thickness	Coefficients 128	256	512	1024	2048	4096	Noise Coef.	No. of Coats	Base Coat	Application	Surface Treatment	Date
HACHMEISTER - LIND COMPANY													
Hachmeister-Lind Acoustic Plaster	1/2"	.16	.19	.25	.36	.44	.49	.30	1st coat 1/4" 2nd coat 1/4"	Gypsum plaster	2nd coat applied immediately after 1st coat.	Stippled with large pins, holes 1/2" deep.	1930
NATIONAL GYPSUM COMPANY													
Standard Macoustic	1/2"	.16	.21	.28	.44	.57	.57	.40	1	7/8" Gypsum plaster on metal lath.	Applied in one coat.	Stippled with rice root brush containing nails.	1935
UNITED STATES GYPSUM COMPANY													
Sabinite Plaster Hydraulic	1/2"	.14	.24	.27	.38	.49	.64	.35	1st coat 1/4" 2nd coat 1/4"	Gypsum plaster.	1st coat applied on dry base coat. 2nd coat applied after 1st coat had set and partly dried.	Floated with cork float.	1931
Sabinite Plaster A	1/2"	.16	.24	.38	.78	.75	.77	.55	1st coat 1/4" 2nd coat 1/4"	Gypsum plaster.	1st coat applied on dry base coat. 2nd coat applied 24 hrs. after 1st coat.	Floated with cork float.	1935
Sabinite Plaster	3/4"	.15	.27	.59	.81	.74	.85	.60	1st coat 1/4" 2nd coat 1/4" 3rd coat 1/4"	3/4" Gypsum plaster on metal lath.	1st coat applied on dry base coat. 2nd coat applied 48 hrs. after 1st coat. 3rd coat applied 72 hrs. after 2nd coat.	Floated with cork float.	1935

Table 3

Audience seated in chairs of various types

A = cane seat chairs, open back
B = theatre chairs, box spring seat, heavily padded back
C = same as B, but single layer of padding on back
D = church pews, seating five.

Absorption per person *

		128	256	512	1024	2048	Date
Women without coats,	A	0.7	1.3	2.3	3.6	4.6	1930
Women with coats,	A	1.3	2.4	4.0	5.8	6.7	1930
Men without overcoats,	A	1.3	2.1	4.1	5.5	7.4	1930
Men with overcoats,	A	2.3	3.2	4.8	6.2	7.6	1930
Mixed audience ,	B			3.9	4.7		1929
Empty seat,	B		3.4	3.0	3.3	3.6	1929
Mixed audience,	C		3.5	4.1	4.9	4.2	1930
Empty seat,	C		3.0	2.5	2.9	3.1	1929
Mixed audience,	D		2.7	3.3	3.8	3.6	1930
Plywood chair,			0.2	0.3	0.5	0.5	1930

* These figures are numerically equal to the number of square feet of a material having unit absorption, which would absorb the same amount of sound energy.

Suggestions Concerning the Proper Use of Acoustical Material

As there has been considerable misconception as to the proper use of acoustical material it is considered desirable to call attention to two of the fundamental principles underlying the formulas which are used in acoustical design. It is assumed in all of the formulas that (1) the absorption is proportional to the area of the absorbing material and that(2) there is a uniform distribution of sound energy. As a rule neither one of these assumptions is true.

It has been found from experiment when very small areas are used, such as the panels in a coffered ceiling having areas from 1 to 4 square feet and separated from each other by a foot or more, that the effective absorption of the material in these panels is greater than when the material is installed in one large area. In fact, for materials having large coefficients, this effective absorption may be as much as 50 percent more than one would expect from the coefficient.

It has also been found when all of the acoustical material is applied on one surface of a relatively small room, say 50,000 cubic feet or under, that this creates a non-uniform distribution of sound energy in the following manner. Let us assume that the ceiling of a room is covered with a highly absorbent material. Under these conditions the sound energy which is traveling between the floor and ceiling is absorbed quite rapidly, while that traveling between the untreated wall surfaces,having very little to absorb it, may continue for some considerable time. This persistence of sound energy between the untreated surfaces may cause the measured reverberation time to be considerably longer than would be computed using the ordinary reverberation formula and the coefficient usually given. For this reason, it is essential in small rooms that the acoustical material be distributed on the side walls as well as on the ceiling, if the effective absorption of the material is to be anywhere near that which one would expect from the coefficient of the material.

We also wish to call attention to the fact that a proper distribution of the acoustical material should be worked out in the initial plans of a building, as it is frequently impossible to obtain a satisfactory distribution after the interior design has been completed without taking into account the acoustical treatment.