PRAKHUN ACOUSTICS
Acoustic Consultants

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10 February 2006

KW Marketing Sdn. Bhd.
27-1, Medan Hujan Rahmat
Taman OUG
58200 Kuala Lumpur
Fax: 7785 8245

Attention: Norman Lim

Dear Sirs,

Review Of Type TSP Slotted And Perforated Timber Panelling Acoustic Finish - MATERIAL ASSESSMENT AND PERFORMANCE REPORT

We have been employed by KW Marketing Sdn. Bhd. to provide an acoustic assessment on the KW Bren Acoustic Wall Panelling Finish product.

We have reviewed the sample provided and have further tested the performance of the same said material at an actual site installation. The testing and commissioning measurement was conducted at The Multipurpose Hall located at No. 12, Changkat Desa, 58100 Kuala Lumpur, on 20 January 2006 at between 10.48 a.m. to 12.45p.m.

1.0 SYSTEM DESCRIPTION

The submitted individual samples are of 15mmT x 115mmL x 285mmW and 15mmT x 270mmL x 285mmW in dimension. The sample consists of a piece of MDF (Medium Density Fibre) board with the following perforated design:

- Slotted Groove and with a Decorative Timber Laminate Front Finish. Groove width is 3mm and the depth is 5mm. The slot ctrs are 15mm.

- Perforated back timber panelling with an open area of 27%. Perforation diameter is 9mm, perforation pitch is 45^0 and perforation ctrs are 16.25mm in vertical and 17.5mm in the horizontal perforations.

Refer to Appendix A for the photos of the submitted samples material. A soft copy of these photos has been attached for further perusal.

The above timber panelling has been completely installed as a front, rear and side wall finishes for the above-mentioned Multi purpose Hall. Acoustic treatment of 50mm thick 100kg/m³ Rockwool were laid behind the timber wall panelling finishes.

Refer to Appendix B for the photos of the finish timber material completely installed at an actual site, The Multipurpose Hall located at Changkat Desa, Kuala Lumpur.

2.0 MATERIAL PERFORMANCE ASSESSMENT

The material acoustical performance assessment was conducted via the following independent approaches;

1) Acoustical Performance Assessment Using Proprietary Reverberation Time (RT_{60}) Calculation Software

The said material performance assessment was conducted with the application of our proprietary internal acoustical software. Detailed parameters and calculations such as the volume of the hall, all hall dimensions, all surface areas, the individual types and surface areas of all material installed within the hall, of which the various acoustic material finishes within the hall is categorized as being, i.e. absorptive or reflective. The sound absorption values, at each 1/1 octave band, 6 values in total per material finish would be considered within the acoustic analysis.

The acoustical timber panelling is initially considered to be acoustically transparent with no interaction with the hall finishes to first establish a direct prediction of the RT_{60} resultant within the hall resultant from the acoustic insulation and treatment.

The material was initially assumed to be an 'acoustically transparent' panel to provide full efficiency of the absorption of the acoustic insulation material laid behind the finishes, functioning as an absorptive panel, consisting of 50mm thick 100kg/m^3 Rockwool.

Please refer to Appendix C for the detailed calculations on the RT_{60} value for the hall which is derived from our internal acoustic software.

Subsequently, the effect of the timber covering's 'Interaction' is taken into consideration and a performance graph is plotted to show the actual effect of this acoustical interaction. This is elaborated in Section 2 and 3 below.

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2) Reverberation Time Test Measurement

The verification on our findings for the material performance assessment was established by way of conducting an on site Reverberation Time (**RT_{60}**) measurement test for the said material which has been installed at site.

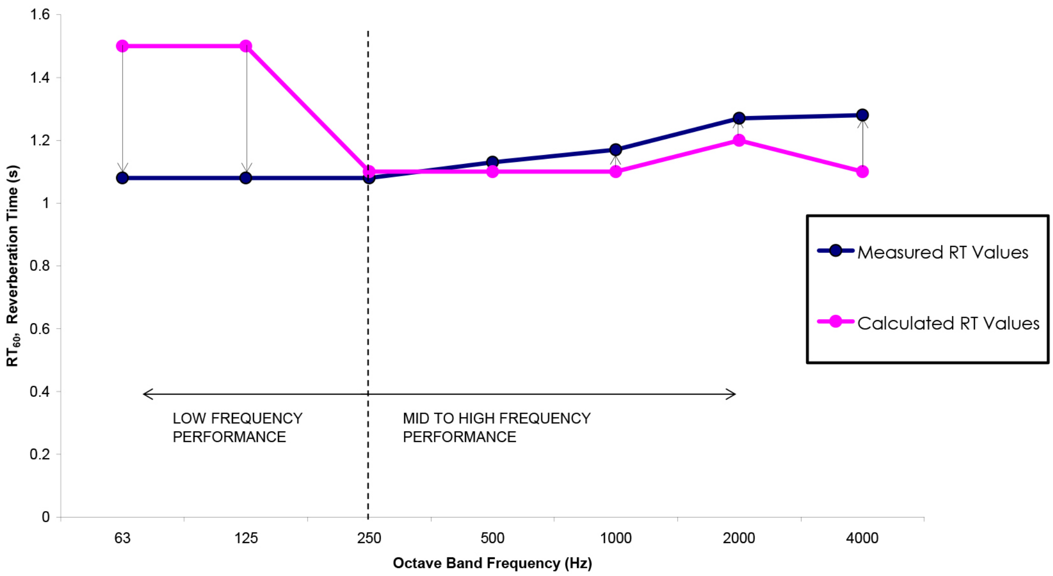
3) Comparison Of The Predicted RT_{60} Values And The Measured RT_{60} Values

To confirm the effects of the interaction of the timber panelling as a finish, a comparison is made between the predicted RT_{60} which was concluded from the internal acoustic software and the actual measured RT_{60} resultant at site for the following condition.

a) Table for RT_{60} Comparison

Description	Frequency Spectrum in Hz						
	63	125	250	500	1k	2k	4k
Calculated RT_{60} values	1.5	1.5	1.1	1.1	1.1	1.2	1.1
Measured RT_{60} values	1.08	1.08	1.08	1.13	1.17	1.27	1.28
Difference in RT_{60}	**-0.42**	**-0.42**	**-0.02**	**+0.03**	**+0.07**	**+0.07**	**+0.18**

Refer to Appendix D for a further graphical illustration.



The above data shows that the contribution of the material as a finish to the RT_{60} values. The RT_{60} values generated within a hall are dependant on the volume, surface area and the hall finishes (absorption coefficient and surface area).

As the volume and the surface areas are considered as a non-variable in this analysis, the material as a finish may then be evaluated as a factor affecting the overall absorption coefficient (as it was initially assumed to be acoustically transparent) of the backing acoustic insulation material, which consists of 50mm thick 100kg/m^3 Rockwool.

From the graph above, the timber panes finishing's '**interaction**' is concluded as follows;

1) **Low Frequency Performance**

   The timber panelling as a finish increases the low frequency absorption, thus reducing the RT_{60} value within the hall.

   From the deduction, this timber finish material may be considered as a very good low frequency panel absorber. It brings the RT_{60} values @ 63Hz and @125 Hz down by 28% from the initial RT_{60} values resultant from the Rockwool insulation performance alone.

2) **Mid - high Frequency Performance**

   The timber finish material results in the RT_{60} values going
   - down by 1.8% @250Hz
   - up by 2.7% @500Hz
   - up by 6.4% @1000Hz
   - up by 5.8% @2000Hz
   - up by 16.4% @4000Hz

   from the initial RT_{60} values resultant from the Rockwool insulation.

   The timber finish material results in a very minimal change to the RT_{60} values @ 250Hz and @500 Hz, respectively. This minimal deviation may be considered as a negligible change in the RT_{60} values.

   For frequencies higher than 500 Hz, the covering material has an effect by lowering the backing Rockwool insulation's performance.

   The analysis on these effects shall be further illustrated within the following section which would determine the actual corresponding sound absorption coefficient (**α**) performance of the material as a finishing product.

4) **Comparison Of The Sound Absorption Coefficient**

Subsequent to the RT_{60} analysis above, we have further extrapolated the data onto our acoustic software analysis to draw a direct comparison to the effective changes in terms of the sound absorption coefficient value when the timber finish is taken into account.

By using **α** value substitution, we are able to assess the actual absorption coefficient present at site with corresponding RT_{60} data obtained during the site measurement.

1) LOW FREQUENCY PERFORMANCE

Description	Frequency Spectrum (Hz)
	125
Absorption coefficient, 50mm thick 100kg/m³ Rockwool , on solid wall backing	α = 0.59
Absorption coefficient, 50mm thick 100kg/m³ Rockwool with timber panel finish	α = 0.95

From the above table, the timber finish material provides a very high sound absorption @ 125Hz, as high as 61% as compare to the sound absorption provided by 50mm thick 100kg/m^3 Rockwool.

The timber panel itself acts as an independent low frequency panel absorber. We make a deduction of the absorption coefficient @ 125 Hz for the panel is **α = minimum 0.85**.

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2) MID-HIGH FREQUENCY PERFORMANCE

Description	Frequency Spectrum (Hz)				
	250	500	1k	2k	4k
Absorption coefficient, 50mm thick 100kg/m³ Rockwool	α= 0.97	α=0.98	α=0.97	α=0.95	α=0.95
Absorption coefficient, α 50mm thick 100kg/m³ Rockwool with timber panel finish	α= 0.97	α=0.97	α=0.95	α=0.8	α=0.7

At 250Hz, the timber material does not change the sound absorption coefficient of the Rockwool insulation in anyway and would therefore be concluded to be an **acoustically transparent material @ 250 Hz.**

At 500Hz, the timber material change the sound absorption coefficient of the Rockwool insulation by a very marginal value of **α** = -0.01. This value is very small and may be considered, negligible. Therefore, we conclude here that the timber panelling finish is **acoustically transparent material @ 500 Hz.**

At 1000Hz, the timber finish reduces the sound absorption coefficient, **α** of the Rockwool insulation by a factor of 0.02.

At 2000Hz, the timber finish reduces the sound absorption coefficient, **α** of the Rockwool insulation by a factor of 0.16.

At 4000Hz, the timber finish reduces the sound absorption coefficient, **α** of the Rockwool insulation by a factor of 0.26.

Refer to Appendix D for graph form illustration details on the noise absorption coefficient.

3.0 SUMMARY

Subsequent to the above timber finish material performance evaluation, we summarize the acoustic material assessment as follows;

Frequency Spectrum (Hz)	Description/Conclusion of The material characteristic
125	Timber panel possess an absorption coefficient of minimum **α = 0.85**
250	Timber panel is 'acoustically transparent'
500	Timber panel is 'acoustically transparent'
1000	Timber panel provides a 2% reduction from the actual absorption coefficient of any acoustic insulation product used as backing
2000	Timber panel provides a 15.8% reduction from the actual absorption coefficient of any acoustic insulation product used as backing.
4000	Timber panel provides a 26.3% reduction from the actual absorption coefficient of any acoustic insulation product used as backing.

ADDITIONAL INFORMATION

The following literature is aimed to provide a performance comparison on the more commonly used acoustic insulation products.

The table below details the comparison of Rockwool sound absorption coefficient with and without timber panel finish;

Description	**Absorption Coefficient**	
Acoustic Insulation	**Acoustic Insulation Alone**	**Acoustic insulation with timber panel finish**
50mm thick 100 kg/m^3 Rockwool	$\alpha_{125Hz} = 0.59$ $\alpha_{250Hz} = 0.97$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.97$ $\alpha_{2kHz} = 0.95$ $\alpha_{4kHz} = 0.95$	$\alpha_{125Hz} = 0.85$ $\alpha_{250Hz} = 0.97$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.95$ $\alpha_{2kHz} = 0.80$ $\alpha_{4kHz} = 0.70$
50mm thick 80 kg/m^3 Rockwool	$\alpha_{125Hz} = 0.36$ $\alpha_{250Hz} = 0.91$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.97$ $\alpha_{2kHz} = 0.95$ $\alpha_{4kHz} = 0.95$	$\alpha_{125Hz} = 0.85$ $\alpha_{250Hz} = 0.91$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.95$ $\alpha_{2kHz} = 0.80$ $\alpha_{4kHz} = 0.70$
50mm thick 60 kg/m^3 Rockwool	$\alpha_{125Hz} = 0.29$ $\alpha_{250Hz} = 0.70$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.97$ $\alpha_{2kHz} = 0.95$ $\alpha_{4kHz} = 0.95$	$\alpha_{125Hz} = 0.85$ $\alpha_{250Hz} = 0.70$ $\alpha_{500Hz} = 0.98$ $\alpha_{1kHz} = 0.95$ $\alpha_{2kHz} = 0.80$ $\alpha_{4kHz} = 0.70$

4.0 DISCUSSION

1) This timber covering wall finish product provides superior low frequencies absorption. In addition, the performance as a low frequency absorber is non-dependant to the density of acoustic insulation used as backing.

   On a normal acoustic design, it is a common practice to increase the density of acoustic insulation to enable high values of absorption at low frequencies. The drawback of this, is that the cost for insulation is in direct proportion to the density; i.e. higher density, more expensive.

   With the use of this panel as a finish, the low frequency performance may be achievable irrespective of the insulation density (provided the density does not reduce less than 30 kg/m^3) low frequency performance may be obtained at a much lower cost due to the savings from the acoustic insulation.

   This inherent low frequency absorptive characteristic would be suitable within a hall to reduce 'boomieness' effect and thus increase the Hall's speech intelligibility and clarity. Also note that the larger the hall, the worst is the 'boomieness' within, and therefore the better the use of this product.

2) This timber covering wall finish product reduces from between 2% to 26.3% of the high frequencies absorption of the insulation product when installed as a system.

   This deficiency however is not serious or critical in the sense that mid to high frequencies absorption may be easily available and is contributed by common building elements, i.e. carpet flooring, padded seats and furniture, fabric curtains, acoustic ceiling, human occupant, etc.

With this accurate product knowledge of how the timber panel 'performs acoustically' as a finish with the acoustic insulation laid behind, proper design allowances may be allocated for to ensure the required acoustic absorption within the room is achieved satisfactorily.

The sample which underwent acoustic analysis is labelled and now kept within our office premises, to ensure full availability/accessibility of the samples by any parties having interest in the product or in the event further assessments are required.

Yours faithfully,
PRAKHUN ACOUSTICS SDN. BHD.

NAI BOONLERT SARARAKSH

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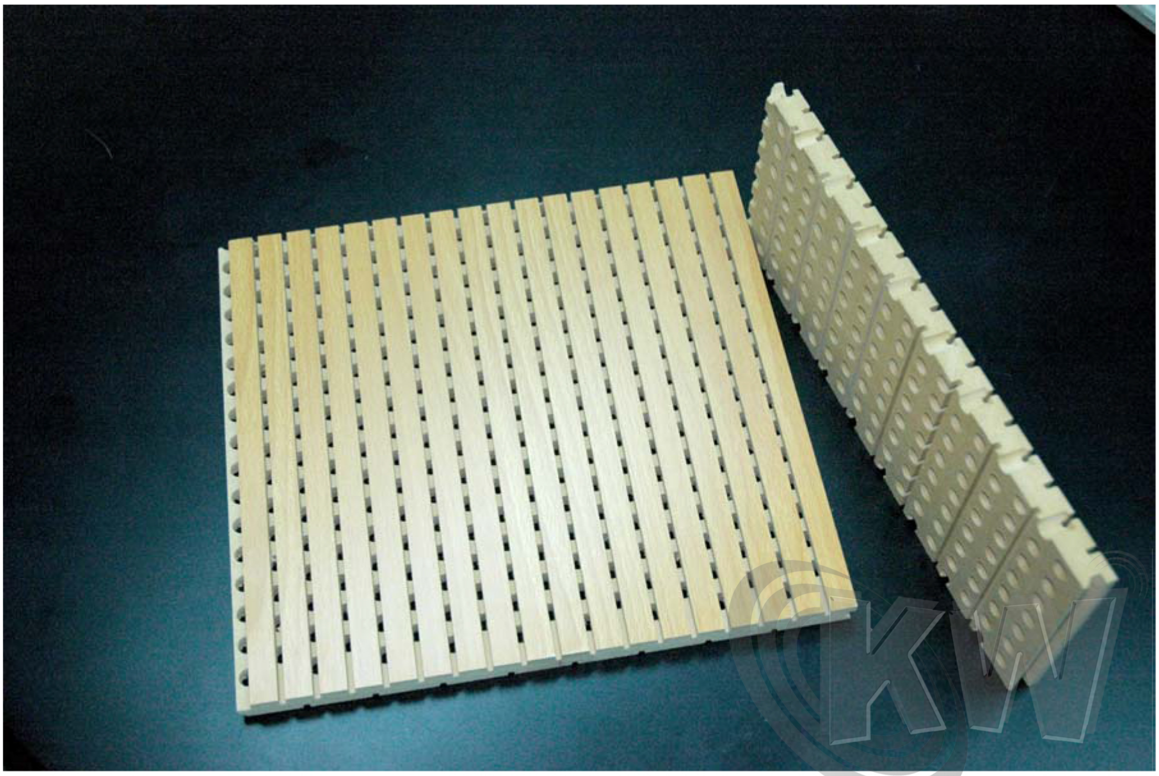
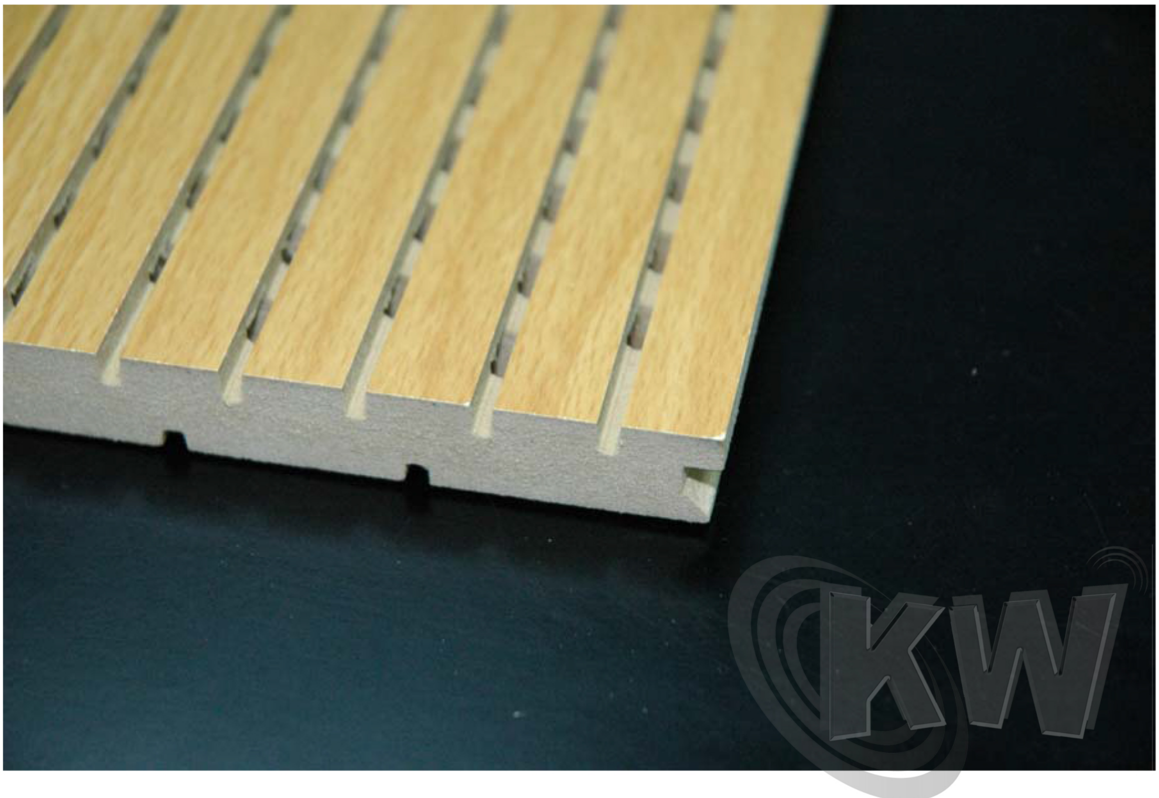
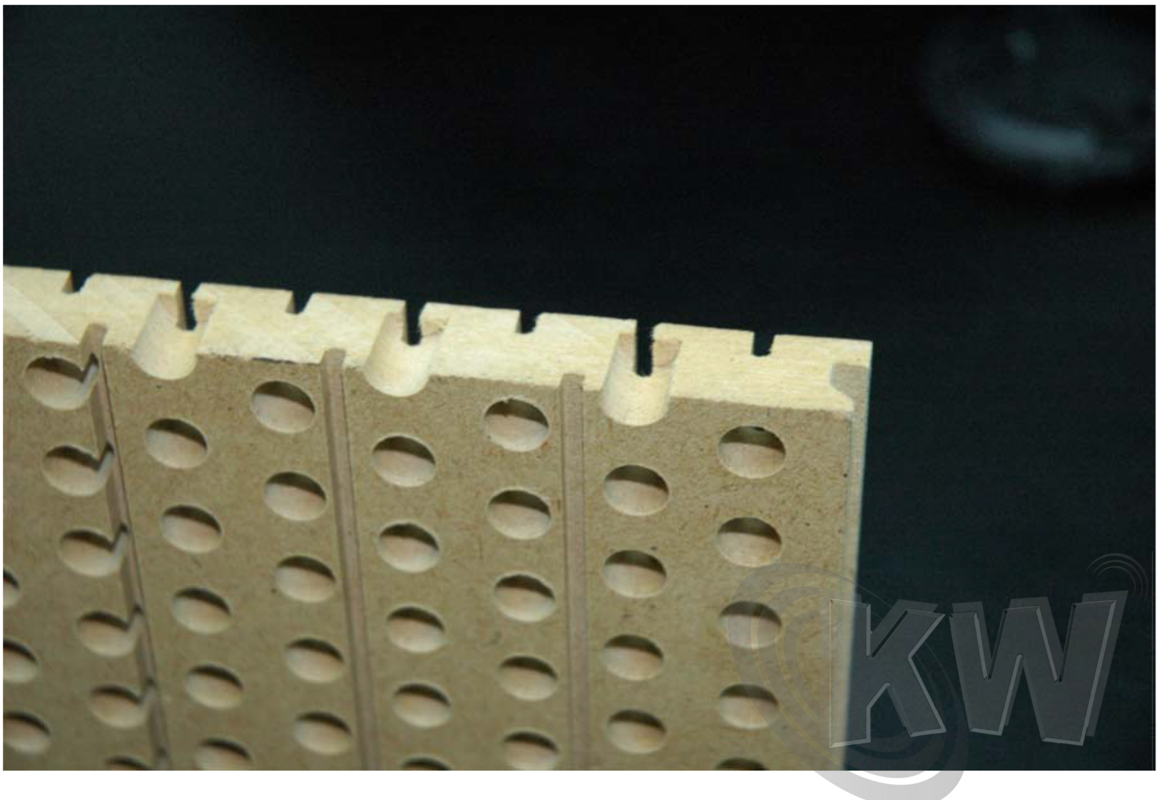
APPENDIX A

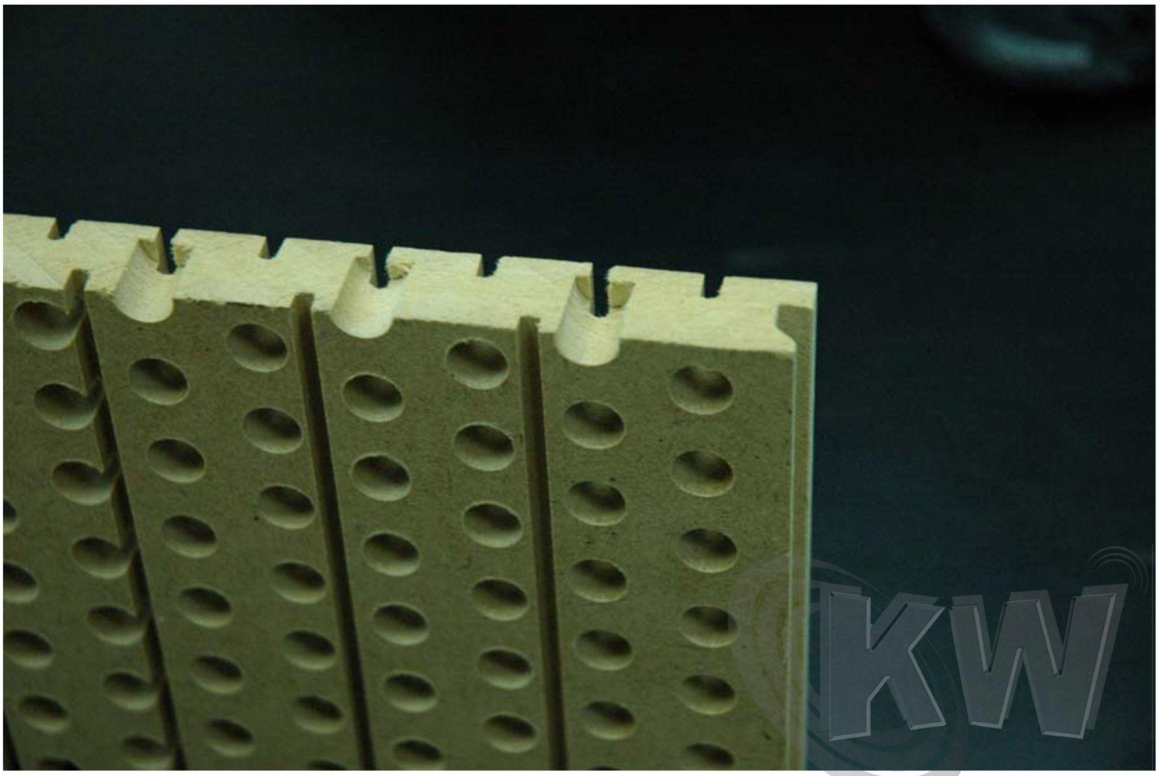
PHOTOS OF

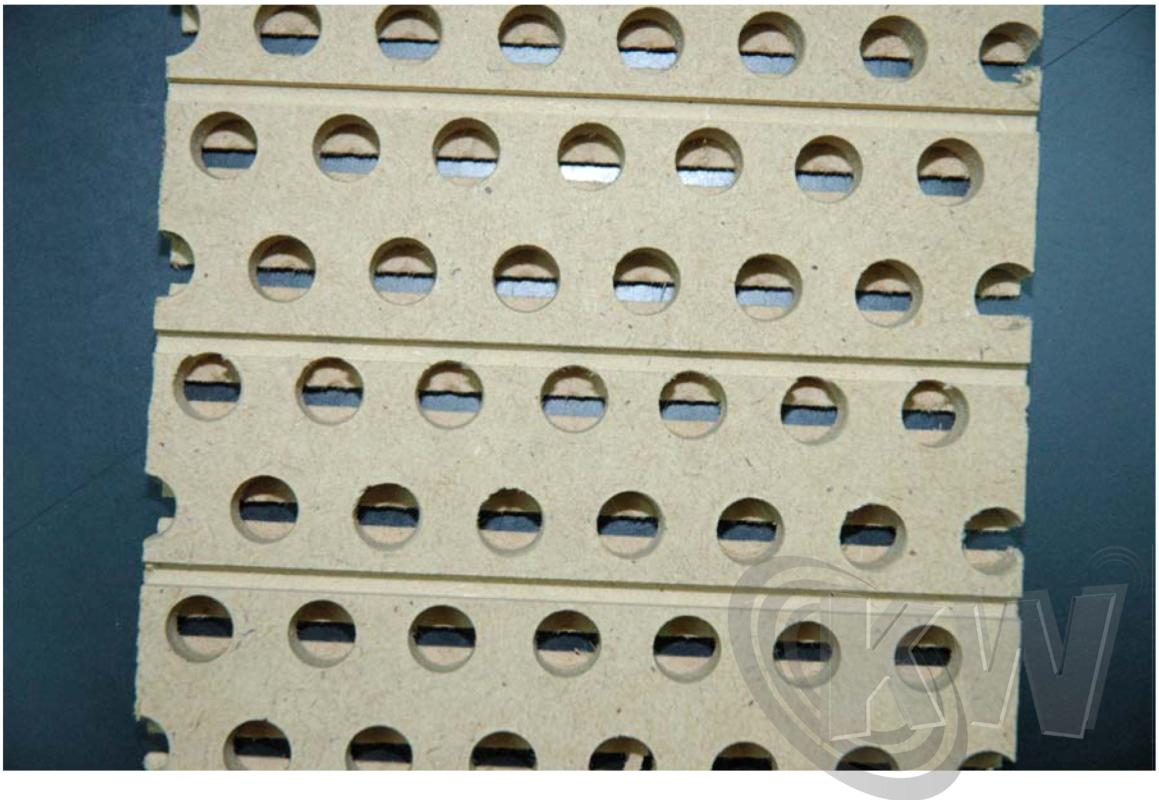
INDIVIDUAL SUBMITTED SAMPLE

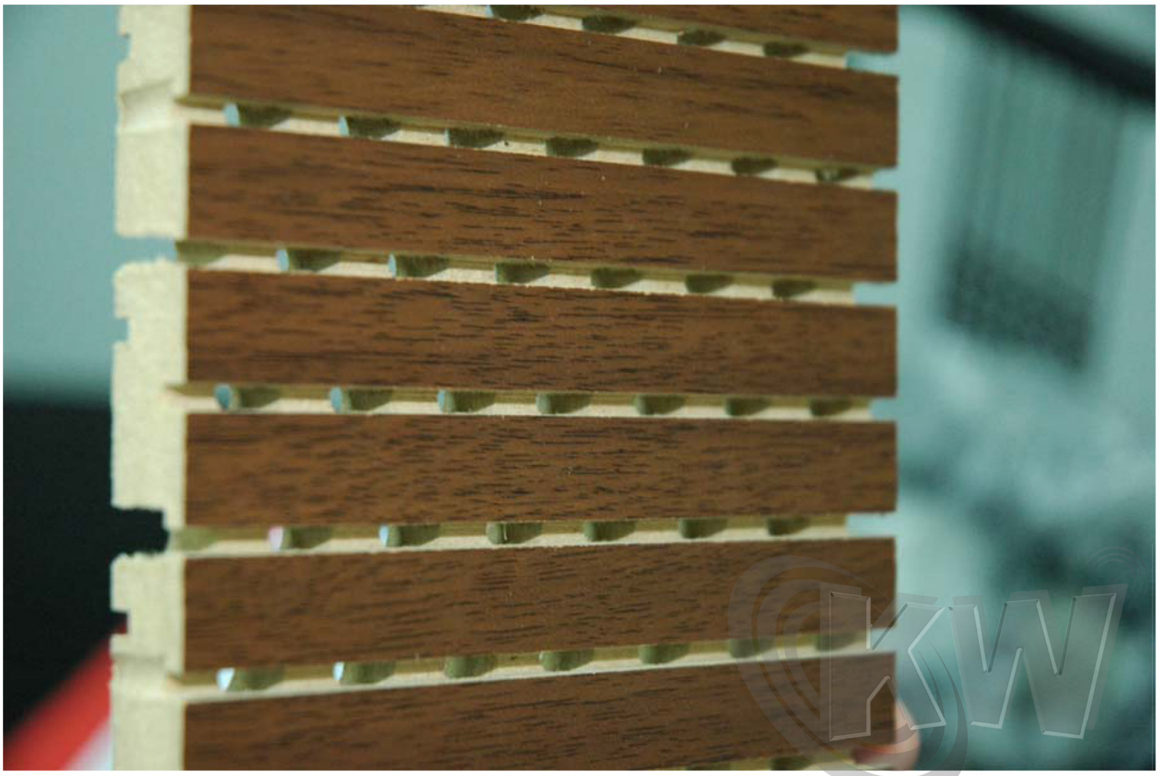


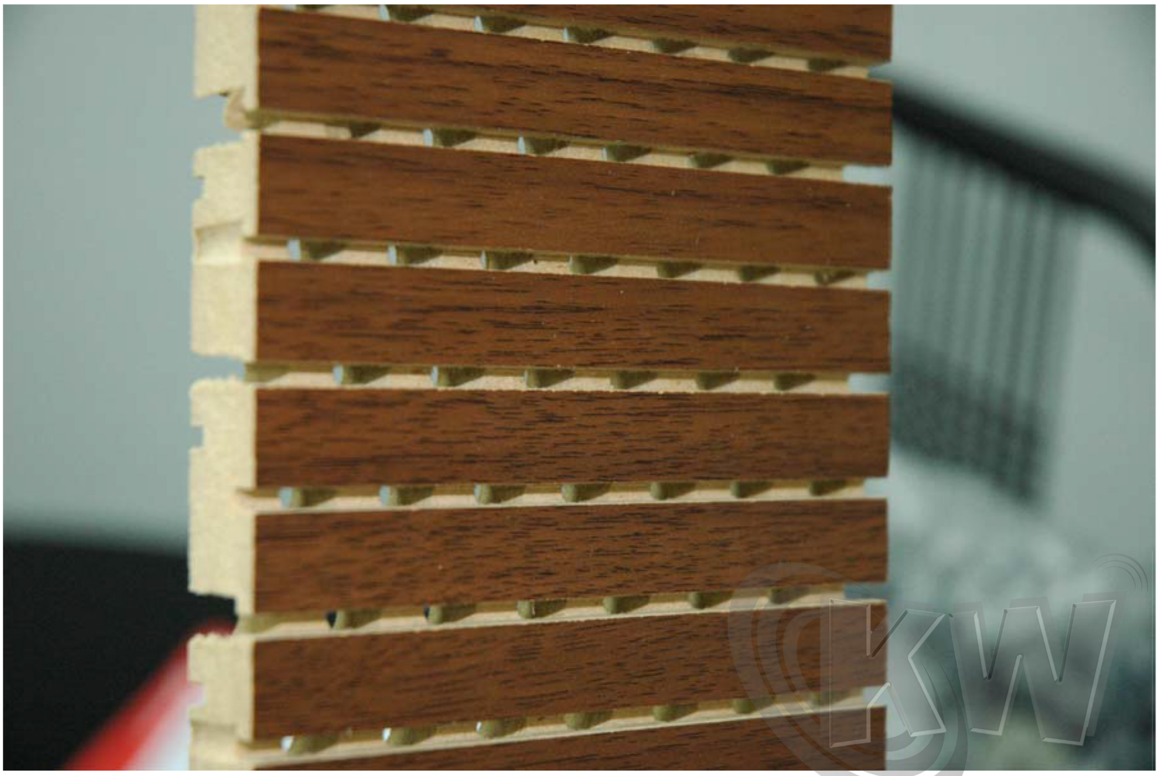












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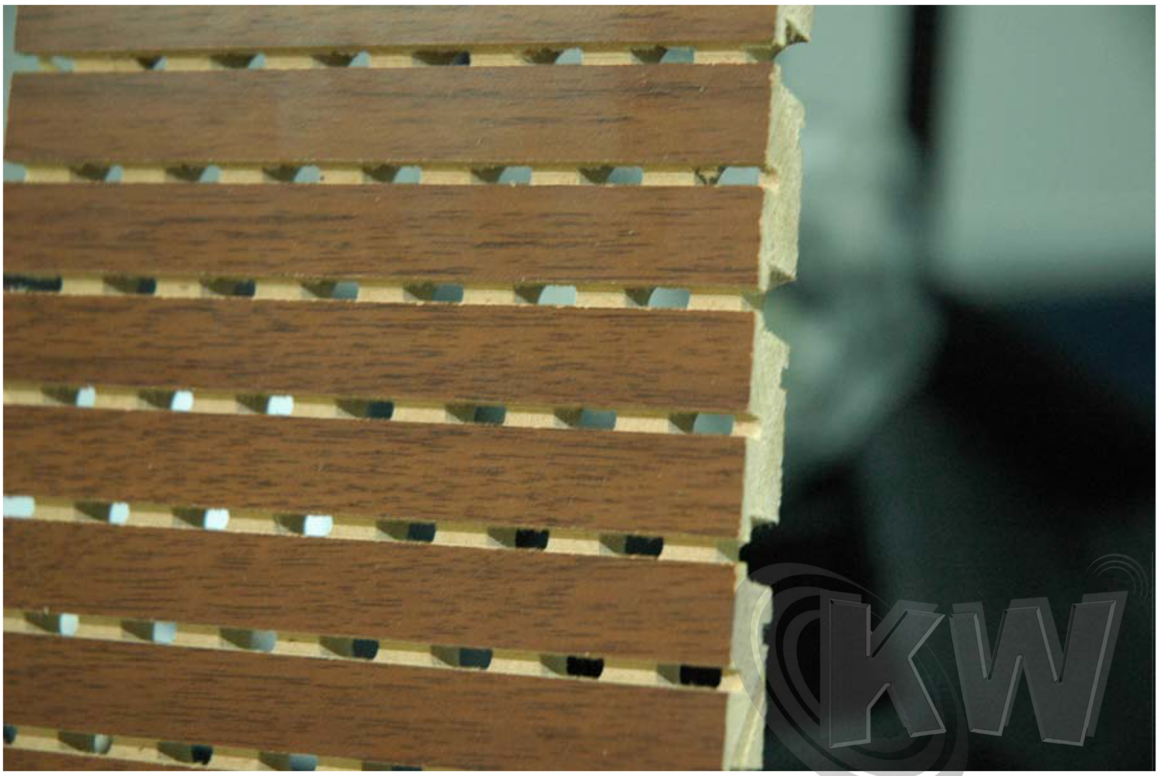

APPENDIX B

PHOTOS OF

ACTUAL SITE INSTALLATION

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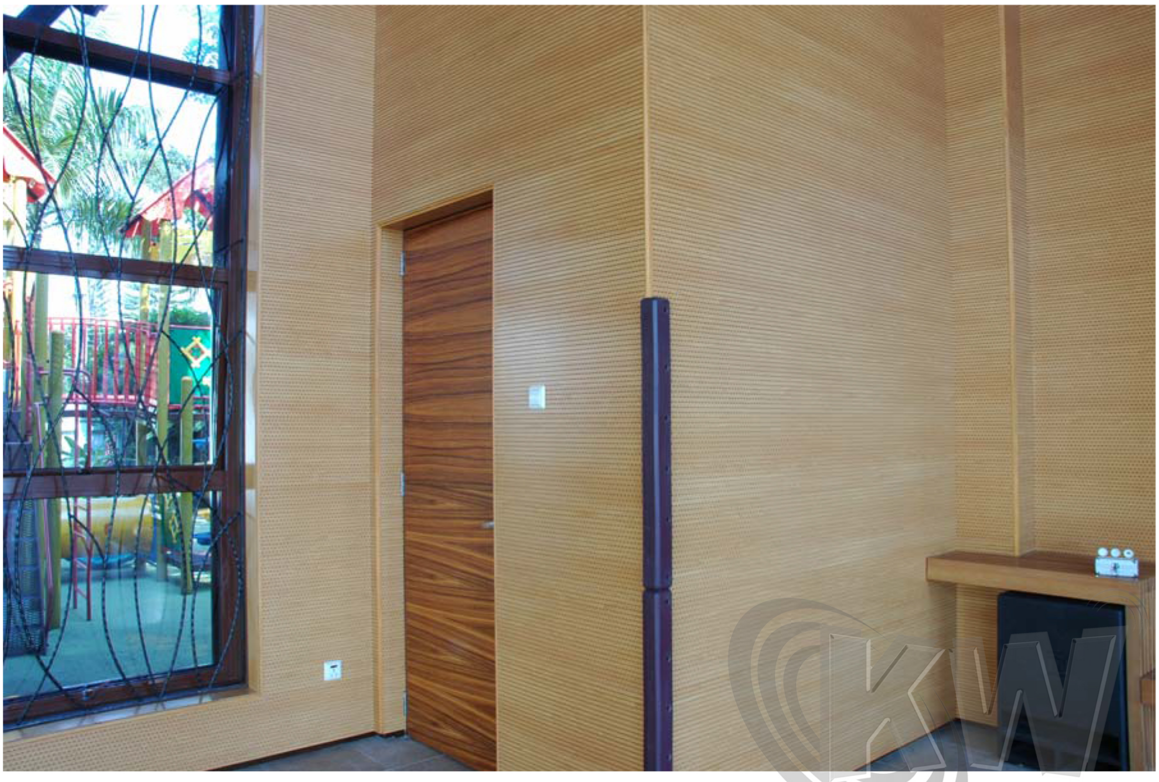

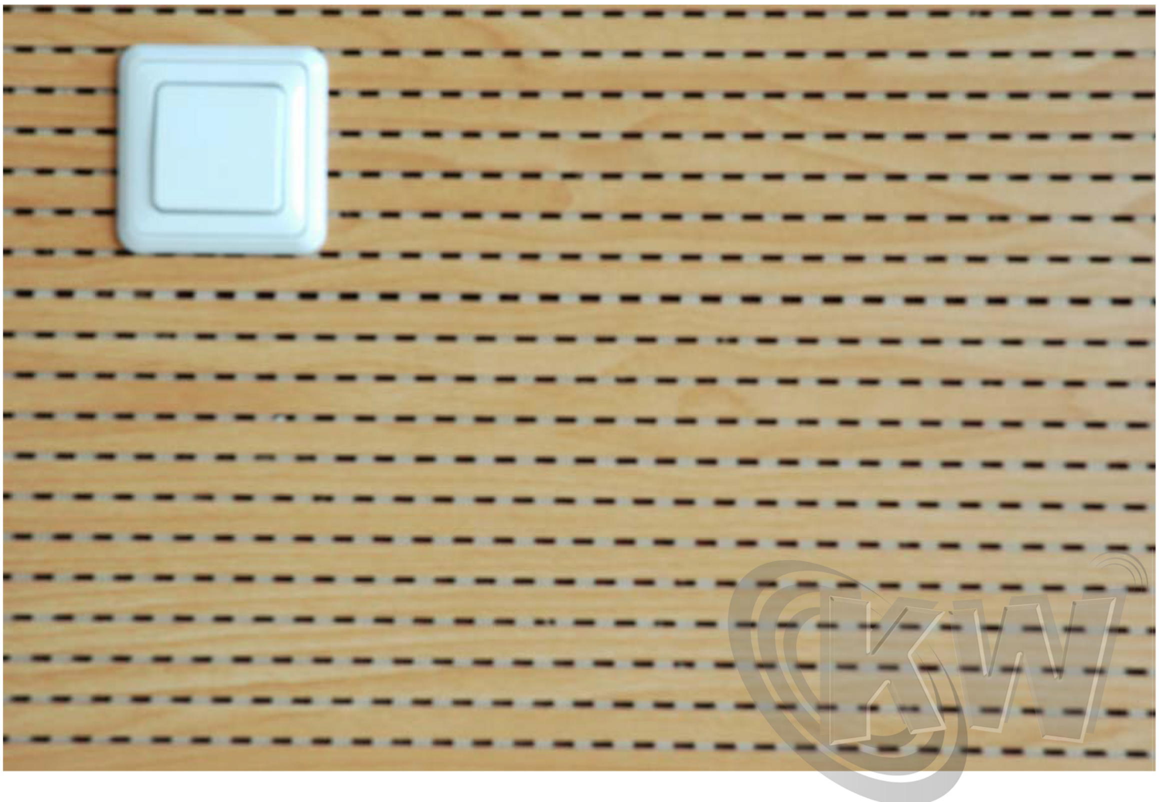

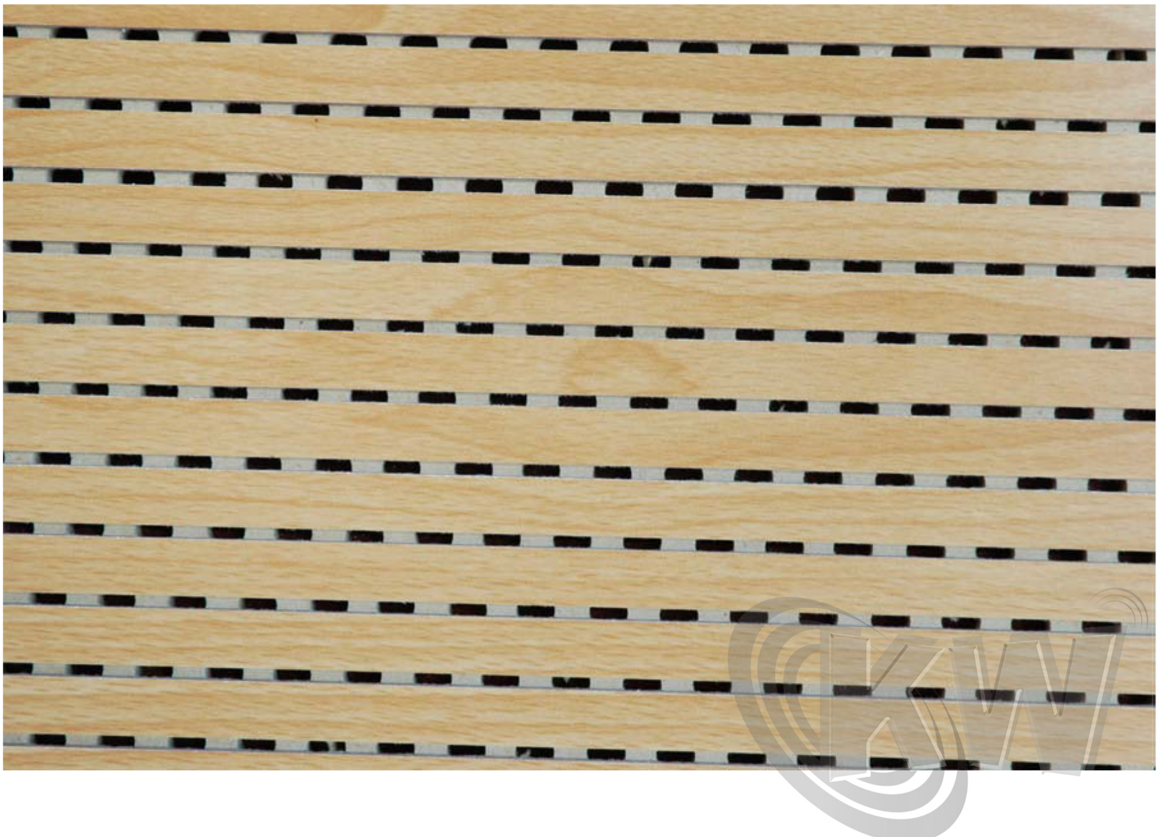

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APPENDIX C

DETAILED RT_{60} CALCULATION

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Job Name:	Dt Liew Hse		
Room:	MultiP Hall		
Job Number:	J04-14		
Initials:	ana		
Date:	09-Feb-2006	02:49 PM	
Room Volume (cu m):		3058	
Room Surface Area (sq m):		1406	

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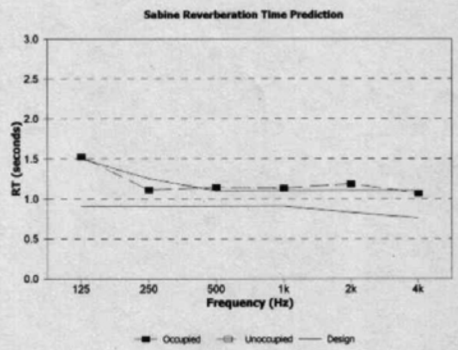
SABINE REVERBERATION TIME PREDICTI
Version 7.1 (October 1997)

Code	Area	Description	Surface Material	125Hz a	125Hz Sa	250Hz a	250Hz Sa	500Hz a	500Hz Sa	1 kHz a	1 kHz Sa	2 kHz a	2 kHz Sa	4 kHz a	4 kHz Sa
Walls:															
P03	0	all	smooth finish on tile/brick	0.01	0	0.01	0	0.02	0	0.03	0	0.04	0	0.05	0
X45	134	side wall	Bradford Fibretex 650 50mm thick 1	0.59	79	0.97	130	0.98	131	0.97	130	0.95	127	0.95	127
G02	101	side window	6mm heavy plate (lg panes)	0.04	4	0.04	4	0.03	3	0.03	3	0.02	2	0.02	2
G02	44	left side roller shu	6mm heavy plate (lg panes)	0.04	2	0.04	2	0.03	1	0.03	1	0.02	1	0.02	1
T06	4	side door	6mm ply/hardboard on 50mm airspa	0.50	2	0.20	1	0.08	0	0.05	0	0.05	0	0.04	0
X45	69	front wall	Bradford Fibretex 650 50mm thick 1	0.59	41	0.97	67	0.98	68	0.97	67	0.95	66	0.95	66
T06	8	front door	6mm ply/hardboard on 50mm airspa	0.50	4	0.20	2	0.08	1	0.05	0	0.05	0	0.04	0
G02	22	front window	6mm heavy plate (lg panes)	0.04	1	0.04	1	0.03	1	0.03	1	0.02	0	0.02	0
X45	76	rear wall	Bradford Fibretex 650 50mm thick 1	0.59	45	0.97	74	0.98	75	0.97	74	0.95	73	0.95	73
G02	23	rear window	6mm heavy plate (lg panes)	0.04	1	0.04	1	0.03	1	0.03	1	0.02	0	0.02	0
G03	43	right roller shutter	"Open Window"	1.00	43	1.00	43	1.00	43	1.00	43	1.00	43	1.00	43
Ceilings:															
P04	193		Gypsum Board 1 - 2 layers, 100-150	0.14	27	0.07	14	0.05	10	0.05	10	0.05	10	0.05	10
T05	117		6mm ply/hardboard on 100mm airsp	0.30	35	0.08	9	0.05	6	0.05	6	0.05	6	0.05	6
	235	diffusor		0.10	24	0.34	80	0.28	66	0.29	68	0.19	45	0.16	38
G02	47		6mm heavy plate (lg panes)	0.04	2	0.04	2	0.03	1	0.03	1	0.02	1	0.02	1
Floors:															
F03	336		Wood parquet and asphalt on concr	0.04	13	0.04	13	0.07	24	0.06	20	0.06	20	0.07	24
Unoccupied Seating:															
B05			Wood padded seat - Unoccupied (p	0.08		0.14		0.20		0.26		0.25		0.20	
Occupied Seating:															
B04			Wood padded seat + Audience (pp)	0.17		0.36		0.43		0.43		0.47		0.43	
Air:															
A01	3058		50% R.H. per cubic m							0.00	9	0.01	21	0.02	70
Average coef & Total Absorption (occupied)			Sabines	0.23	323	0.31	442	0.31	430	0.31	435	0.30	416	0.33	461
Absorption reqd to achieve Design RT (occupied)			Sabines		29		-14		62		57		119		118



Design RT 1.0 sec
Allow Base Rise: 2 (1=no, 2=yes)

	125	250	500	1k	2k	4k
Occupied Design RT	1.4	1.2	1.0	1.0	0.9	0.9
RT occupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**
RT half occupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**
RT unoccupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**

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X45	134	side wall	Bradford Fibretex 650 50mm thick 1	0.59	79	0.97	130	0.98	131	0.97	130	0.95	127	0.95	127
G02	101	side window	6mm heavy plate (lg panes)	0.04	4	0.04	4	0.03	3	0.03	3	0.02	2	0.02	2
G02	44	left side roller shu	6mm heavy plate (lg panes)	0.04	2	0.04	2	0.03	1	0.03	1	0.02	1	0.02	1
T06	4	side door	6mm ply/hardboard on 50mm airspa	0.50	2	0.20	1	0.08	0	0.05	0	0.05	0	0.04	0
X45	69	front wall	Bradford Fibretex 650 50mm thick 1	0.59	41	0.97	67	0.98	68	0.97	67	0.95	66	0.95	66
T06	8	front door	6mm ply/hardboard on 50mm airspa	0.50	4	0.20	2	0.08	1	0.05	0	0.05	0	0.04	0
G02	22	front window	6mm heavy plate (lg panes)	0.04	1	0.04	1	0.03	1	0.03	1	0.02	0	0.02	0
X45	76	rear wall	Bradford Fibretex 650 50mm thick 1	0.59	45	0.97	74	0.98	75	0.97	74	0.95	73	0.95	73
G02	23	rear window	6mm heavy plate (lg panes)	0.04	1	0.04	1	0.03	1	0.03	1	0.02	0	0.02	0
G03	43	right roller shutter	"Open Window"	1.00	43	1.00	43	1.00	43	1.00	43	1.00	43	1.00	43
Ceilings:															
P04	193		Gypsum Board 1 - 2 layers, 100-150	0.14	27	0.07	14	0.05	10	0.05	10	0.05	10	0.05	10
T05	117		6mm ply/hardboard on 100mm airsp	0.30	35	0.08	9	0.05	6	0.05	6	0.05	6	0.05	6
	235	diffusor		0.10	24	0.34	80	0.28	66	0.29	68	0.19	45	0.16	38
G02	47		6mm heavy plate (lg panes)	0.04	2	0.04	2	0.03	1	0.03	1	0.02	1	0.02	1
Floors:															
F03	336		Wood parquet and asphalt on concr	0.04	13	0.04	13	0.07	24	0.06	20	0.06	20	0.07	24
Unoccupied Seating:															
B05			Wood padded seat - Unoccupied (p	0.08		0.14		0.20		0.26		0.25		0.20	
Occupied Seating:															
B04			Wood padded seat + Audience (pp)	0.17		0.36		0.43		0.43		0.47		0.43	
Air:															
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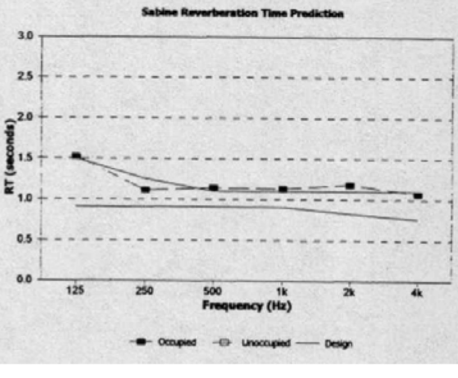
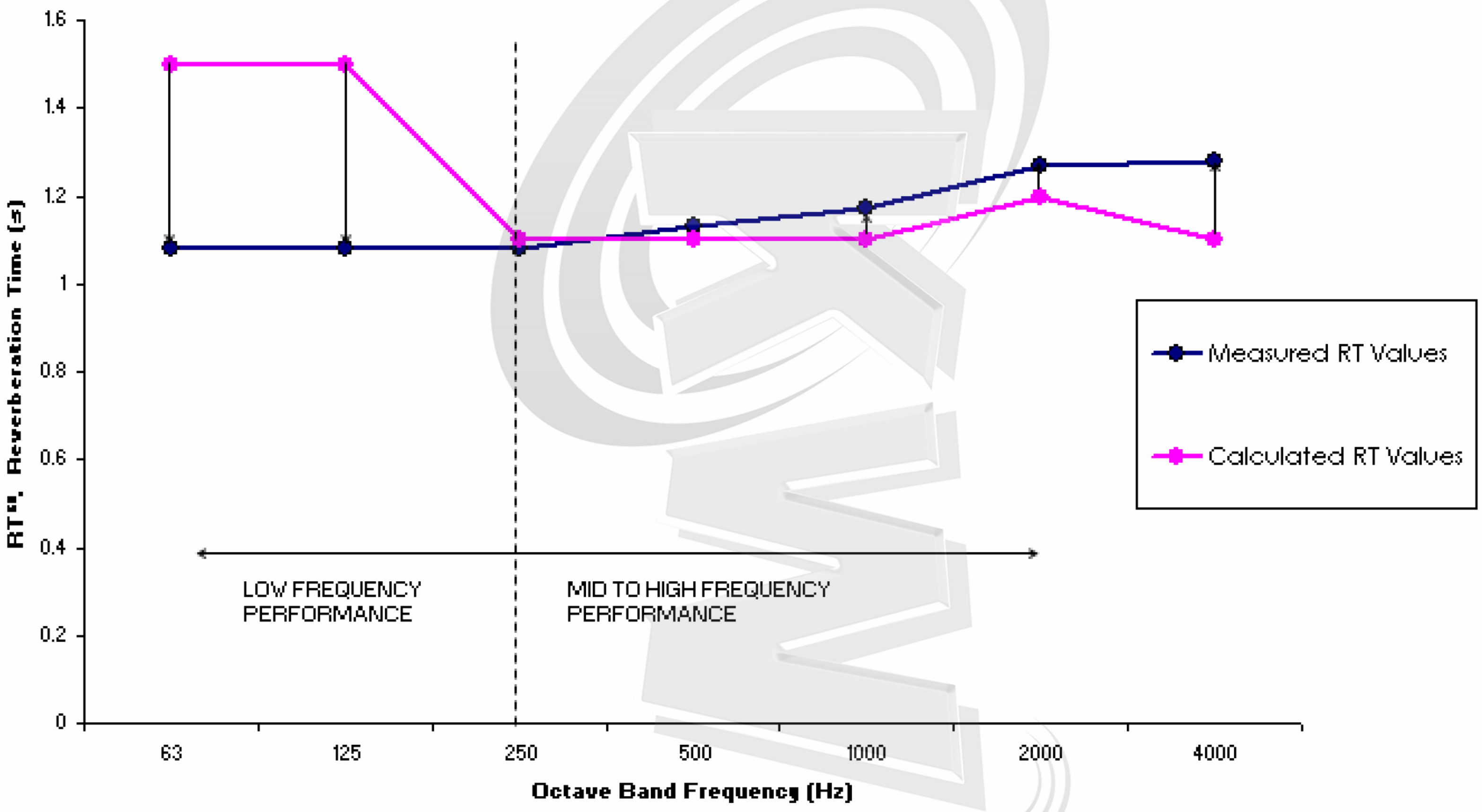


Design RT 1.0 sec
Allow Base Rise: 2 (1=no, 2=yes)

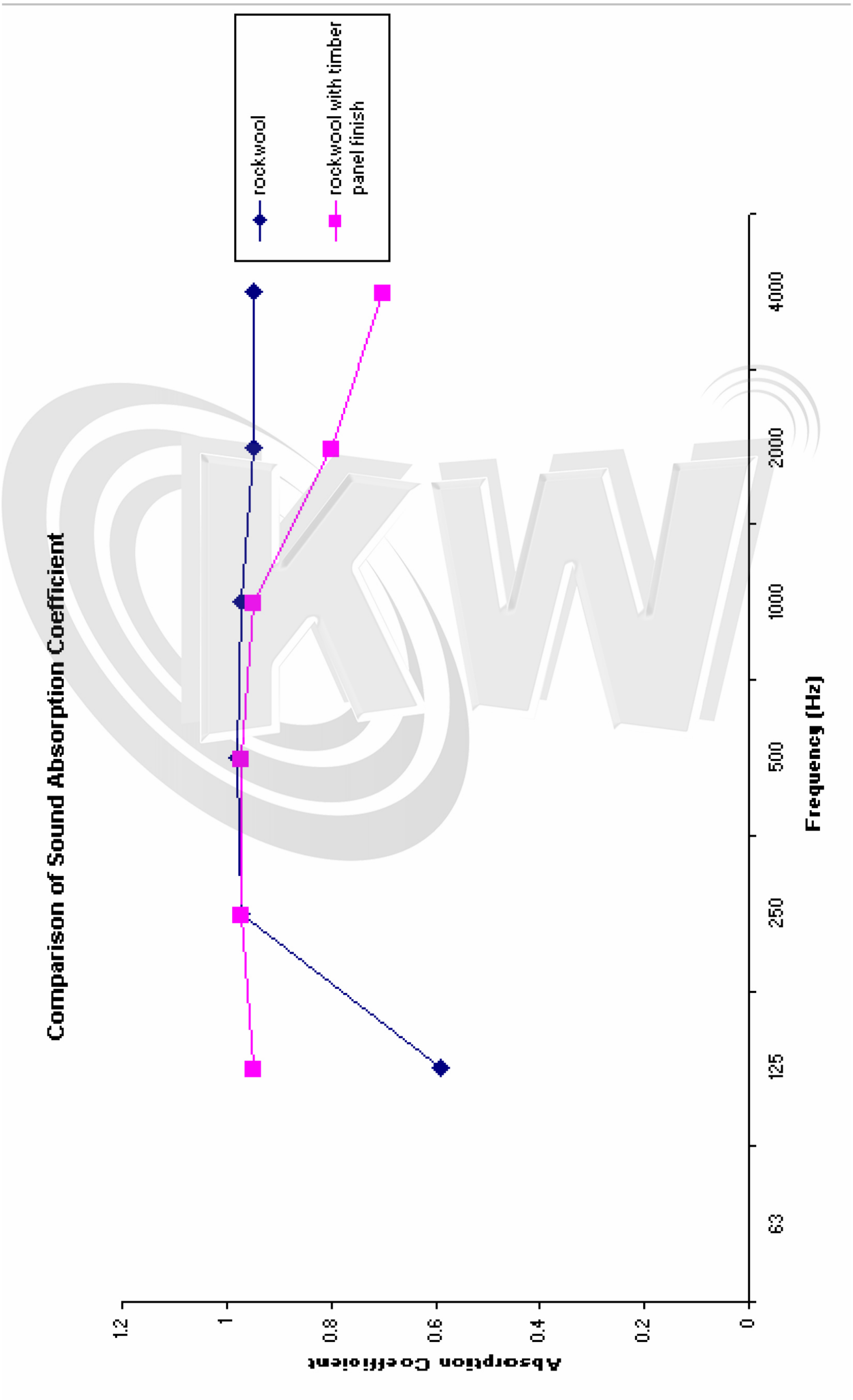
	125	250	500	1k	2k	4k
Occupied Design RT	1.4	1.2	1.0	1.0	0.9	0.9
RT occupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**
RT half occupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**
RT unoccupied	**1.5**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**

APPENDIX D

GRAPHS



PRAKHUN ACOUSTICS


Comparison of Sound Absorption Coefficient
Absorption Coefficient
1.2
1
0.8
0.6
0.4
0.2
0
63
125
250
500
1000
2000
4000
Frequency (Hz)
rockwool
rockwool with timber panel finish