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Report on

Determination of Sound Transmission Class (STC) of Door Assembly (54mm FIREBAN Core with Solid Wooden Frame)

Report No: 527413 SN1/1 C_{2-2}	Lab Project No: P-3615

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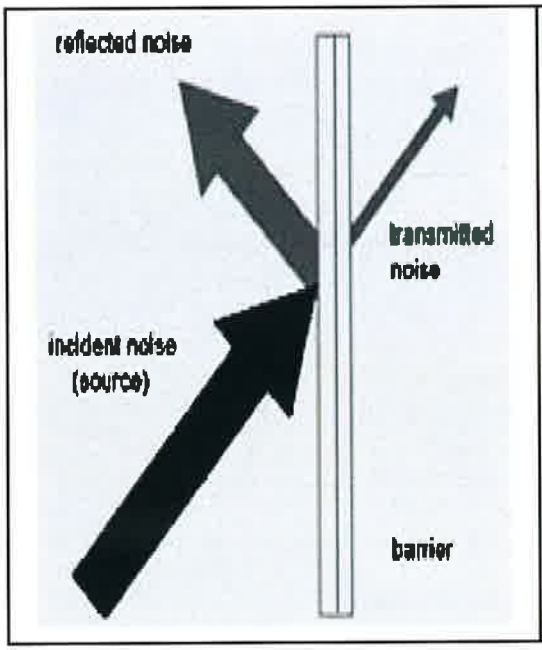

Report Contents:

Certificate Number: SNR 30362926/4/Q

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1) INTRODUCTION

This report gives the results of Sound Transmission Loss tests and determination of Sound Transmission Class / acoustic performance on the following door assembly, produced by **Gulf Trade Link (FZCO)**:

1) 60 Minutes Fire Rated Wooden Door Assembly with 54mm thick FIREBAN Core, Solid Hard Wood Frame of dimensions (2320 x 1118 x 150) mm, 2 Nos. of Acoustic fire seal (LP1504DS), Acoustic Batwing Seal (LAS1212) & Acoustic Bottom Seal (LAS8001si)

2) TESTING METHOD

The specimen were tested in accordance with the American Society for Testing and Materials designation ASTM E 90 - 2004, "*Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions*", ASTM E - 1408, "*Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems*", and classified in accordance with the American Society for Testing and Materials designation ASTM E 413 - 2004, "*Classification for Rating Sound Insulation*" and ASTM Standard E 1332 - 90 (Re-Approved 2003) entitled, "*Standard Classification for Determination of Outdoor-Indoor Transmission Class*".

3) SOUND TRANSMISSION CLASS

3.1: General:

Sound Transmission Class, or STC for short, is a measure in dB of the extent or ability for a building material to absorb sound. This is the most common rating used to determine airborne sound transmission loss between frequency ranges of 100Hz to 5000Hz. This range covers majority of noises and annoyances easily audible to humans, which include musical instruments, television, speech and many more. The STC can be used to measure sound absorption for both, external or internal building walls in a single or multi layered structure.

3.2: Principle of STC testing:

The STC is measured by placing a site representative sample in the middle of an acoustical chamber dividing the chamber into two rooms. One chamber acts as the source room where sound of a specific level is generated. In the opposite chamber sound receiving equipment measures the level of sound transmitted through the specimen allowing for the calculation of the level of noise reduced by the specimen placed in between.

For example, if a sound level of 100dB was generated in the source room and the level of sound measured in receiving room was 60dB, then the specimen placed in between has reduced noise level transmitted to the receiving room by 40dB and thus has a STC rating of 40dB.

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4) TERMS & DEFINITIONS

4.1: Sound: sound is a vibration that travels as mechanical wave having pressure and displacement. Sound is indicated in two ways, frequency and intensity.

4.2: Frequency: frequency is the high or low pitch of a sound and is expressed as the number of vibrations per second. The S.I unit of frequency is Hertz, donated by Hz, and 1 Hz is defined as one vibration per second.

4.3: Decibels: as per the definition of sound in 4.1, sound is a vibration that creates air pressure which is detected by the human ear. Greater the air pressure of the vibration, greater is the intensity or loudness of the sound. Intensity or loudness of sound is measured in decibels, donated by dB.

4.4: STC: is an integer that donates how well a building wall, roof or ceiling attenuates airborne sound. It is widely used in the USA to rate and compare interior or exterior wall configurations, ceilings and roof configurations, doors and windows.

4.5: Octave Band: is a frequency band where the highest frequency is twice the lowest frequency. The numerical value of the frequency interval in octaves is given by $lb\ (f_2 / f_1)$, $(f_2 \geq f_1)$

4.6: Sound Absorption: is the process in which a construction material takes in or absorbs sound energy decreasing the intensity or loudness of sound. This phenomenon only absorbs sound energy and does not reflect sound waves.

4.7: Transmission Loss: TL in room acoustics indicates the amount of reduction, in decibels, of sound intensity by a partitioned interior or exterior wall, roof, ceiling, window or door. It is described by ten times the logarithm of the ratio of power of an incoming wave towards the partition to the power of the same wave that has passed through the partition.

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5) SOFTWARE AND EQUIPMENT USED

5.1: Signal Spectrum:

The sound signals used for this test were random noise having a continuous spectrum within each octave band level. These signals were generated by using a loud speakers, amplifier, purpose built software, computer and specific hardware (from "National Instruments" USA) to connect the loud speaker with computer.

5.2: Sound Source:

Random sound was generated with the help of powerful loud speakers. The speakers were attached with an amplifier and a computer to generate the noise at different specified frequencies. One loud speaker was placed in the receiving room for measurement of decay rate which is used for calculation of sound absorption of the receiving room while the other speaker was placed in the source room to produce the pink noise.

5.3: Noise Measurement:

Noise was measured with the help of electronic microphones. Five calibrated "*type 1*" micro phones complying with accuracy requirements of ASTM E 90-02 Section 9.0 were placed in source room and five were placed in receiving room. All microphones were calibrated over the whole range of test frequency. Sensitivity checks of all microphones were made in accordance with ASTM E 90 section 9.3.1. Microphones were approximately 1.5 m away from each other in source and receiving room. All microphones were connected directly with the computer using a specific hardware and software. Sound generation to the specific levels and frequencies, measurement of noise level, calculation of sound reduction and recording process was fully automatic.

5.4: Test Chamber:

The test specimen wall as mentioned in the introduction was used as partition between two purposes built neighbouring rooms. The size of each room was 4.2 x 4.2 x 3.0 meters (53 m^3 each). Size of opening to fix the test specimen was 3.4 x 2.6 meter (8.84 m^2).

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6) TEST SPECIMEN DETAILS

6.1: Description:

Test was conducted on the following sample:

1) Specimen – 60 Minutes Fire Rated Wooden Door Assembly with 54mm thick FIREBAN Core, Solid Hard Wood Frame of dimensions (2320 x 1118 x 150) mm, 2 Nos. of Acoustic fire seal (LP1504DS), Acoustic Batwing Seal (LAS1212) & Acoustic Bottom Seal (LAS8001si) in 'Operable Condition'. (Average of three determinations)

Test was carried out in the one-third octave band of frequencies ranging from 100 Hz - 5000 Hz. For each test three set of readings were taken from lowest to highest frequency.

6.2: Items used for Door Assembly:

Name	Manufacturer/Supplier	Physical Properties	Additional Details (provided by client)
60 Minutes Fire Rated Door Leaf	FireBAN (Core Manufacturer) Khansaheb Joinery (Leaf Manufacturer)	Overall Thickness: 55 mm	54mm FireBAN Core having stated minimum density of 600 kg/m³ with 0.6mm veneer on both sides and 6mm thick solid hard wood lipping on all sides having stated minimum density of 650 kg/m³ and moisture content of 10±2 %
Door Frame for 60 Minutes Fire Rated Door	Khansaheb Joinery (Manufacturer)	Jamb Thickness: 150 mm	45mm thick solid hard wood door frame having stated minimum density of 650 kg/m³ and moisture content of 10±2 %
Door Architraves for 60 Minutes Fire Rated Door	Khansaheb Joinery (Manufacturer)	Overall Thickness: 15 mm	15mm thick solid hard wood door architraves having stated minimum density of 650 kg/m³ and moisture content of 10±2 %
Double Bearing Door Butt Hinges for 60 Minutes Fire Rated Doors	SIMPLEX (Supplier)	Overall Dimension: (102 x 76 x 3) mm	Model No.: HSSBS-SIM-FR, 304 Grade stainless steel, double ball bearing door hinges
Mortise Sash Lock Body for 60 Minutes Fire Rated Door	SIMPLEX (Supplier)	Overall Dimension: (235 x 85 x 24) mm	Model No.: 885572-SSS, mortise lock with 1mm intumescent protection sheet around the lock body
Euro Profile Double Cylinder Lock with Escutcheon for 60 Minutes Fire Rated Door	SIMPLEX (Supplier)	Dimension: 80 mm length	Model No.: 1910-40/40-AB, Complying with German Standard DIN 18252/EN 1303, double cylinder 80mm in length fixed with M5 screws
Lever Handle for 60 Minutes Fire Rated Door	SIMPLEX (Supplier)	-	Model No.: MS0101
Two Nos. of Acoustic Fire Strip for 60 Minutes Doors	LORIENT (Supplier)	Dimension: 2 Nos. of (15x4) mm only on door frame	Model No.: LP1504DS
Acoustic Automatic Door Bottom Seal for 60 Minutes Fire Rated Door	LORIENT (Supplier)	Overall Dimension: (35 x 14) mm	Model No.: LAS8001 si, medium duty bottom door seal with silver anodized aluminum with silver end plates, grey silicone rubber gasket
Acoustic Batwing Seal for 60 Minutes Fire Rated Door	LORIENT (Supplier)	Overall Dimension: (12 x 12) mm	Model No.: LAS1212, medium duty co-extruded rigid back with flexible fin single batwing seal

Table 2.1: Items used for design of 60 min Fire Rated Door

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6.3: Details of Door Leaf, Frame Ironmongery & Seals Used:

60 min Fire Rated Door Frame	
Overall Dimension of Frame	Height x Width: (2320 x 1118) mm
Overall Thickness of Jamb	150 mm
Frame Type	45 mm solid hard wood frame
Frame Constituents	45 mm solid hard wood frame having stated minimum density of 650 kg/m³ and moisture content of 10±2 %
	2 Nos. of (15 x 4) mm acoustic fire seal on three sides of frame rebate and fixed 8mm inwards from frame edge at receiving room end and 10mm apart
	(50 x 15) mm solid hard wood architraves having stated minimum density of 650 kg/m³ and moisture content of 10±2 %
	1 Nos. of (12 x 12) mm acoustic batwing seal on three sides of frame and fixed in gap between door stop and door leaf
	2mm thick mortar applied on 10mm polyurethane foam in between frame, architraves and supporting construction gaps
Frame Details and Dimensions	Rebate Face: 32 mm
	Frame Stop: 13 mm
	Rebate: 56 mm
	Soffit: 94 mm

Table 2.2: 60 min Door Frame Details

60 min Fire Rated Door Leaf	
Overall Dimension of Leaf	Height x Width: (2283 x 1050) mm
Overall Thickness of Leaf	55 mm
Core	FireBAN FD60
Leaf Constituents	54mm thick FireBAN Core having stated minimum density of 600 kg/m³
	0.6mm veneer on both front and back sides
	1 Nos. of (35 x 14) mm acoustic automatic bottom seal on bottom of leaf and fixed centrally on bottom
	6mm thick solid hard wood Lipping on all sides having stated minimum density of 650 kg/m³ and moisture content of 10±2 % fixed using Fevicol 1K PUR

Table 2.3: 60 min Door Leaf Details

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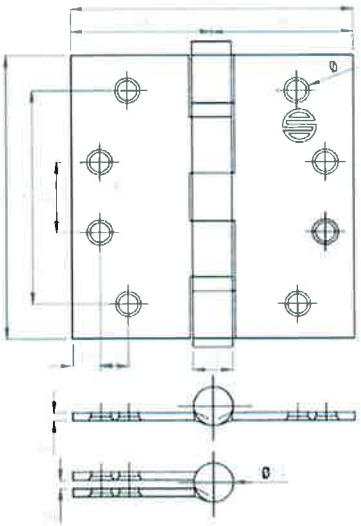
Double Bearing Butt Hinges for 60 min Fire Rated Door	
Manufacturer (Model No.)	SIMPLEX (HSSBS-SIM-FR)
Material	Grade 304 Stainless Steel
Overall Dimension	Height x Width: (102 x 76) mm
Overall Thickness	3.0 mm
No. of Hinges used in Door	FD60 = 3
Additional Detail	2mm thick interden placed under each hinge blade
Hinge Location for FD60 Door	1) 150 mm from top leaf edge to top of 1st hinge 2) 841 mm from bottom of 1st hinge and top of 2nd hinge 3) 841 mm from bottom of 2nd hinge and top of 3rd hinge 4) 145 mm from bottom leaf edge to bottom of 3rd hinge
Hinge Figure	
Hinge Dimension	

Table 2.4: Door Hinge Details

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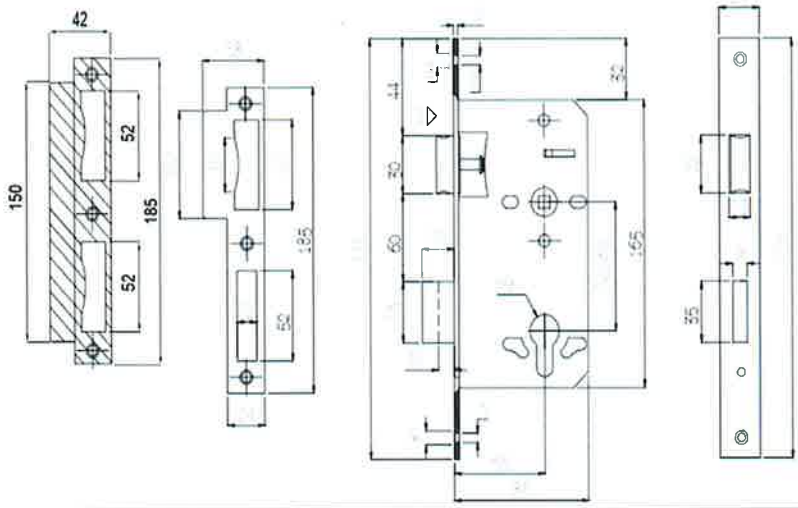
Mortise Lock for 60 min Fire Rated Door	
Supplier (Model No.)	SIMPLEX (885572-SSS)
Material	Stainless Steel dead bolt, latch bolt, forend and strike plate
Overall Dimension	Height x Width: (235 x 85) mm
Overall Thickness	24 mm
Additional Detail	1mm thick intumescent protection around lock body
Mortise Lock Body Figure	
Mortise Lock Body Dimension	

Table 2.5: Mortise Lock Details

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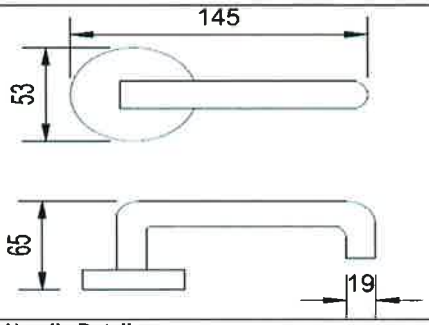
Lever Handle for 60 min Fire Rated Door	
Supplier (Model No.)	SIMPLEX (MS0101)
Door Handle Figure	
Door Handle Dimension	

Table 2.6: Door Handle Details

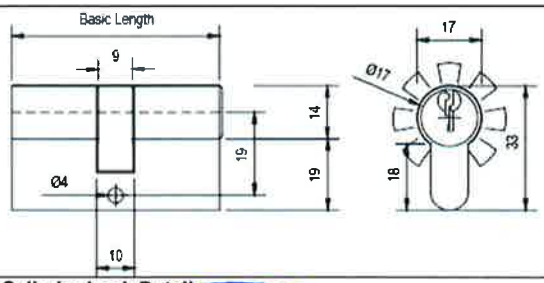
Double Cylinder Lock for 60 min Fire Rated Door	
Supplier (Model No.)	SIMPLEX (1910-40/40-AB)
Additional Details	Length: 80mm
Cylinder Lock Figure	
Cylinder Lock Dimension	

Table 2.7: Cylinder Lock Details

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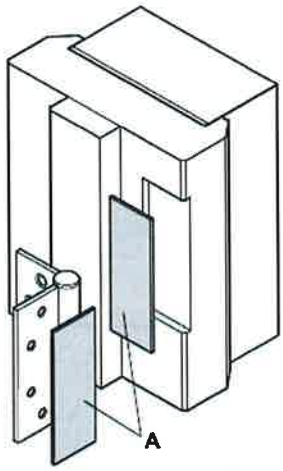
Intumescent Kit for Fire Rated Door Butt Hinge	
Manufacturer (Model No.)	LORIENT (Interdens)
Thickness	2mm
Location	Under each hinge blade screwed to door frame
Application of Protection Kit on Door Butt Hinge	 A = hinge protection kit

Table 2.8: Intumescent Kit for Door Butt Hinge Details

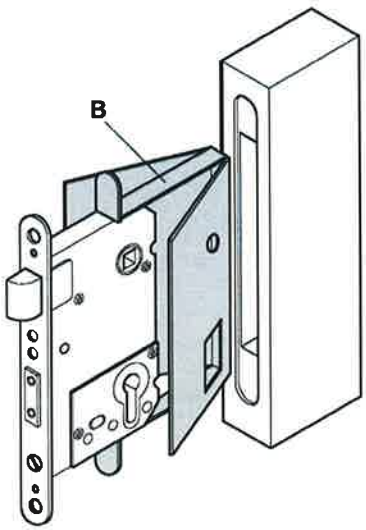
Intumescent Kit for Fire Rated Door Mortise Lock	
Manufacturer (Model No.)	LORIENT (Interdens)
Thickness	1mm
Location	Around mortise lock case
Application of Protection Kit on Mortise Lock	 B = mortise lock protection kit

Table 2.9: Intumescent Kit for Mortise Lock Case Details

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Acoustic, Fire & Smoke Seal for 60 min Fire Rated Door (Specimen – 1 & Specimen – 2)	
Manufacturer (Model No.)	LORIENT (LP1504DS)
Thickness	4mm
Material	Graphite Compound Encapsulated in PVC with Acoustic brush
Other properties	Self-Adhesive Combined Acoustic, Fire and Smoke Seal
Location on 60 min door	1. 2 Nos. of (15 x 4) mm acoustic fire on all sides of frame rebate and fixed 8mm inwards on frame edge at receiving room end and 10mm apart
Acoustic Fire Seal Figure	 15 x 4mm (LP1504DS)

Table 2.10: Acoustic Fire Seal Details

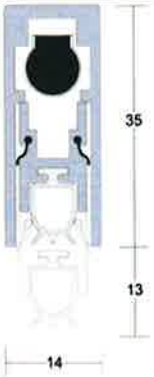
Acoustic Automatic Door Bottom Seal for 60 minutes Fire Rated Door	
Supplier (Model No.)	LORIENT (LAS8001 si)
Overall Dimensions	Height x Thickness: (35 x 14) mm
Material	Silver anodized aluminum with silver end plates, grey silicone rubber gasket
Door Bottom Acoustic Seal Dimension	

Table 2.11: Acoustic Automatic Door Bottom Seal Details

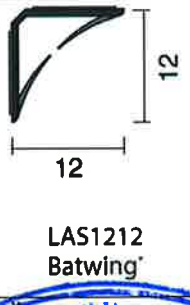
Acoustic Batwing Seal for 60 minutes Fire Rated Door	
Supplier (Model No.)	LORIENT (LAS1212 Batwing)
Overall Dimensions	Width x Thickness: (12 x 12) mm
Material	Co-extruded rigid back with flexible fin batwing seal
Acoustic Batwing Seal Dimension	

Table 2.12: Batwing Seal Details

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Installation of FD 60 Door:

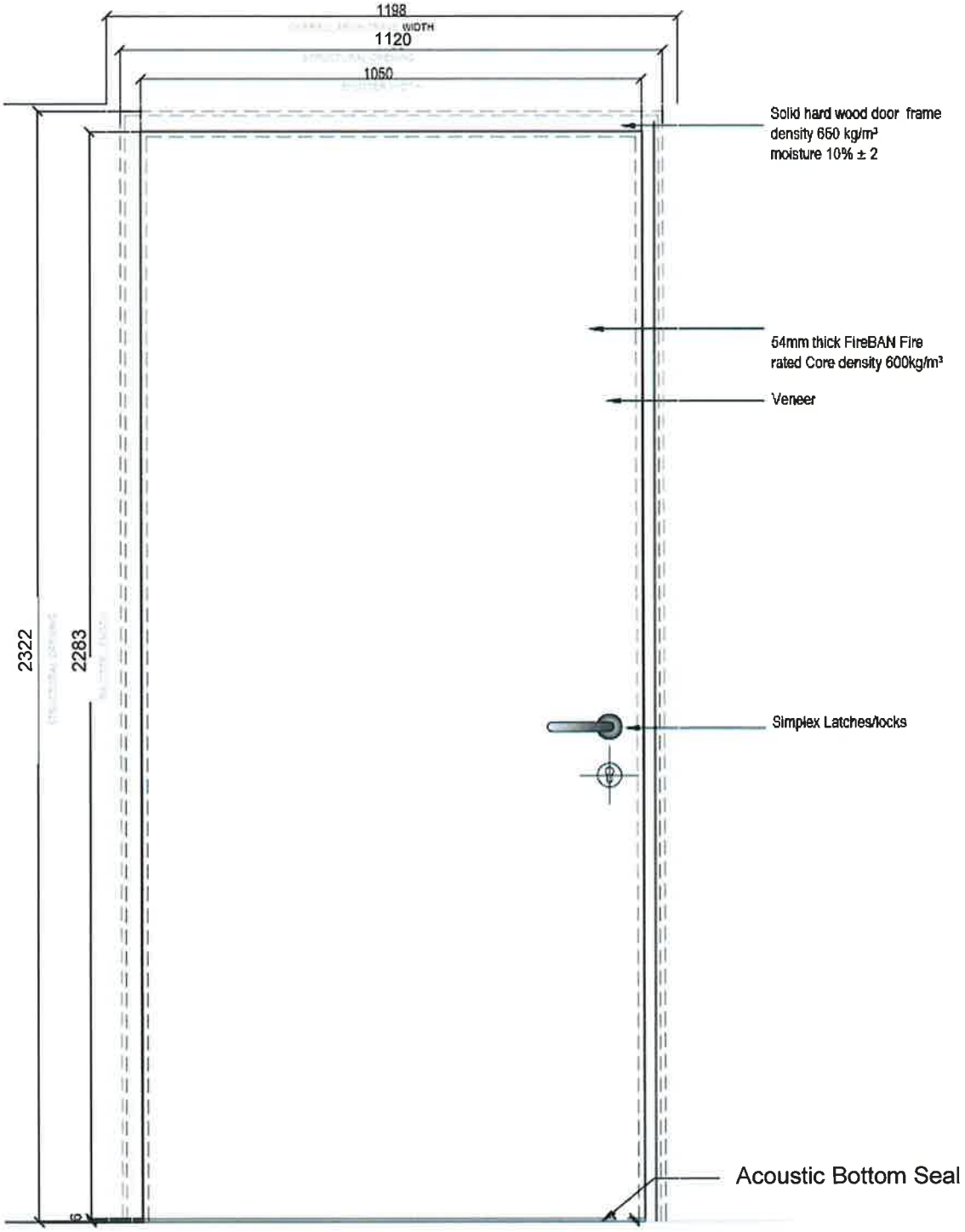

Figure 1.1: Front view of the assembled FD60 door set

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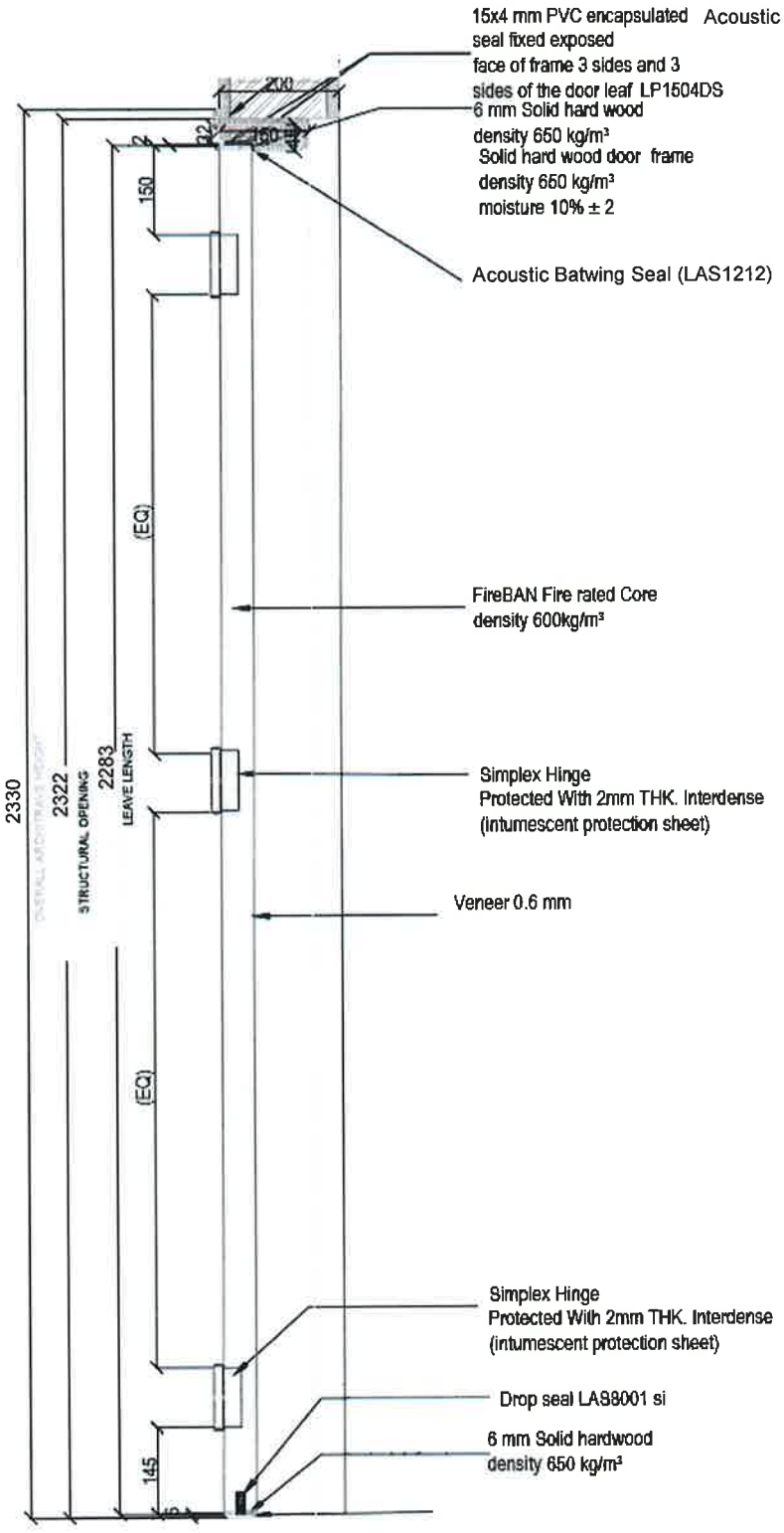
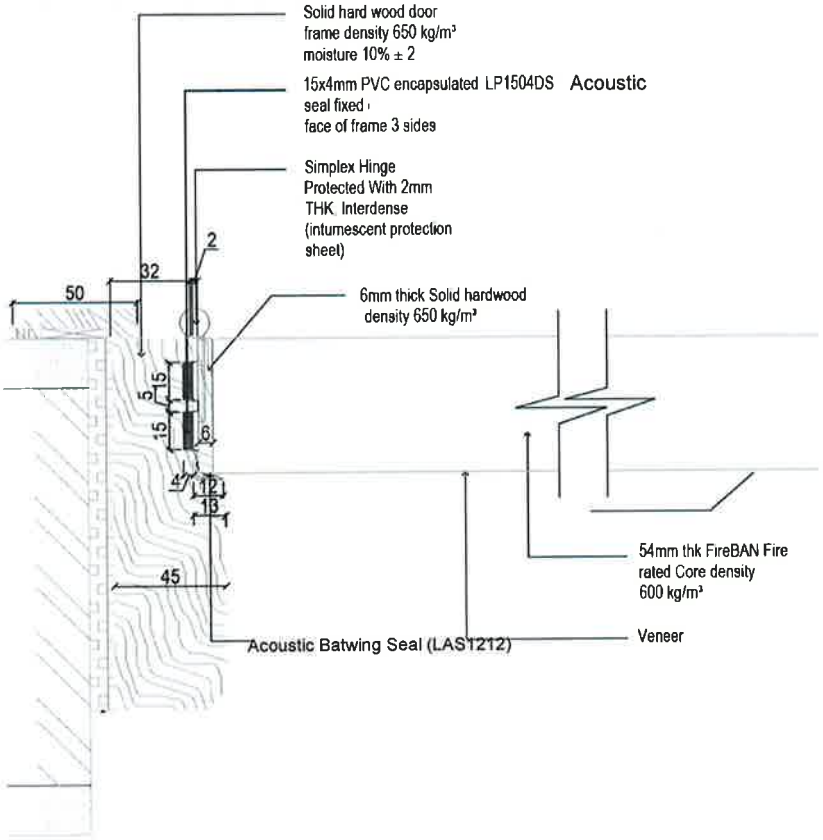


Figure 1.2: Side view of the assembled FD60 door set

(a)



(b)

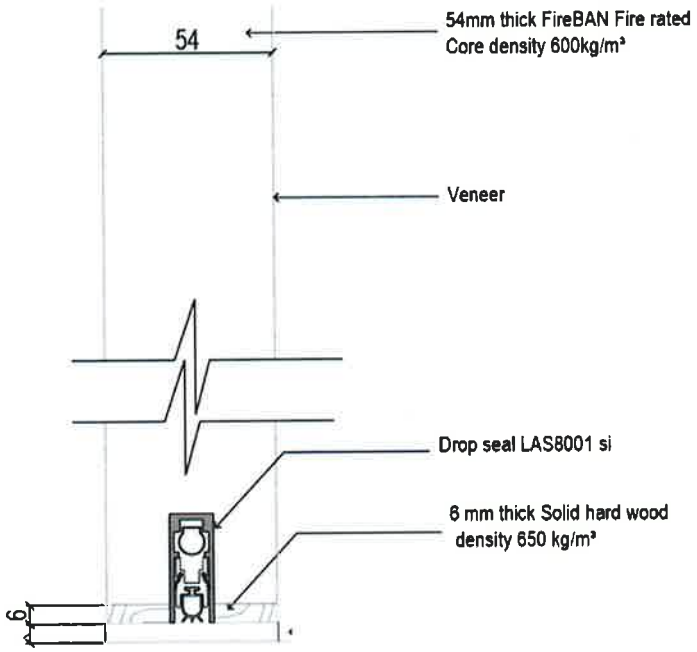


Figure 1.3: (a) Top view of hinge side fixing details of FD60 door frame and leaf (b) Side view of bottom section FD60 door leaf

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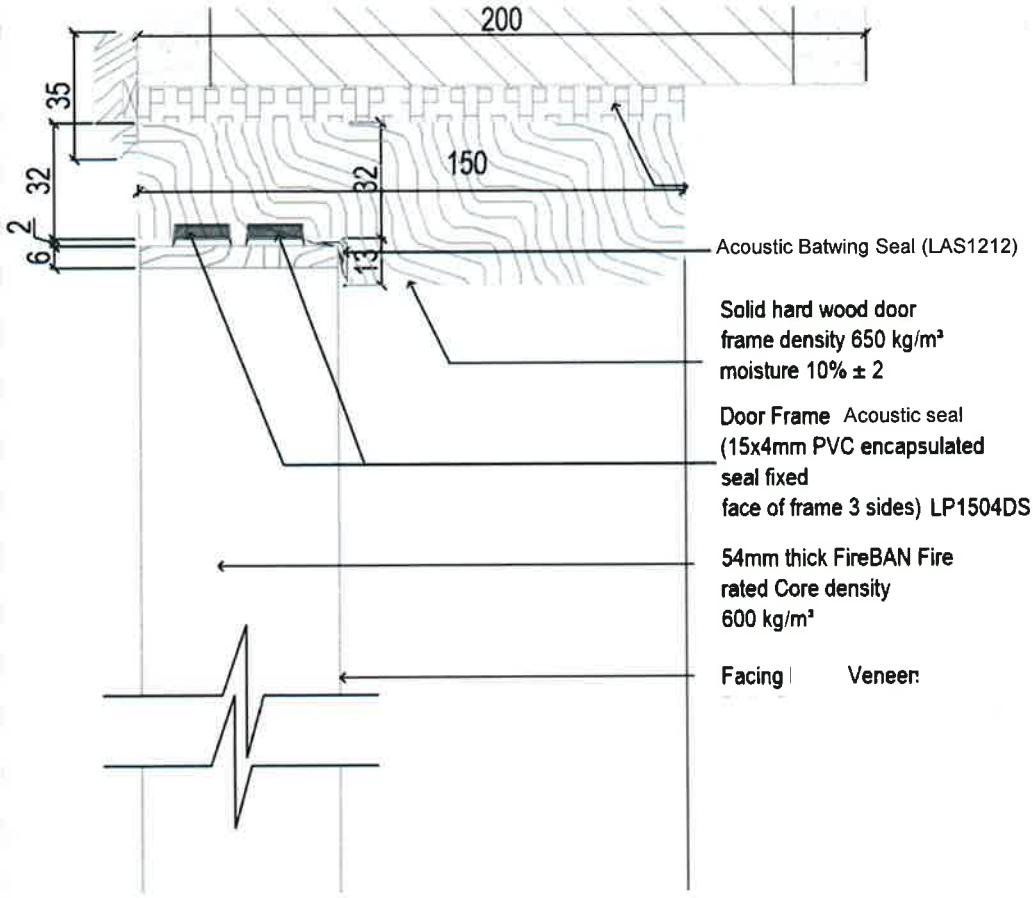

Figure 1.4: Side view of top section fixing details of FD60 door frame and leaf

Sr. No.	Component	Height
1	Door Leaf	2283
2	Frame Rebate Face	32
3	Vertical Door Gap between Frame and Leaf	2
4	Acoustic automatic drop seal extension at bottom	3
Total Height		**2320**

Table 2.15: Dimensional verification of height of FD60 dimensions

Sr. No.	Component	Width
1	Door Leaf	1050
2	Frame Rebate Face	32 * 2
3	Door Gap between Frame and Leaf	2 * 2
Total Width		**1118**

Table 2.16: Dimensional verification of width of FD60 dimensions

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6.4: Specimen Preparation & Assembly Details:

The opening for installation of the test specimen in between the source and receiving rooms of the acoustic chamber was much larger than the overall dimensions of the door. Hence supporting construction was erected and an opening having a perimeter of only (2322 x 1120) mm was left in the centre of the supporting construction for assembly of the door.

In order to ensure the STC values of supporting construction was higher than 55dB, following design was adopted:

200mm solid concrete block wall + 30mm air gap + 100mm solid concrete block wall

The above design is illustrated in figure 4 below:

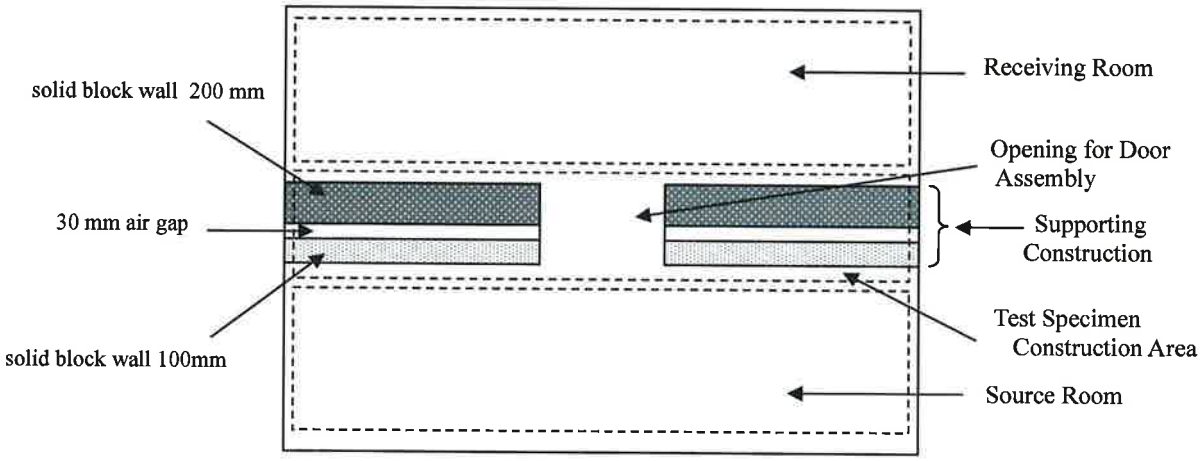

Figure 4: Top View through Acoustic Chamber

The supporting construction was erected by the laboratory's skilled workers. Upon completion of the supporting construction, the client assembled the wooden door assembly in to the opening of the supporting construction. This was done by application of 10mm polyurethane foam, with 2mm mortar overlap, in between the solid wooden frame of the door and the supporting construction.

Any gaps in between the door frame and the supporting construction were filled in with mortar. The door leaf was then fixed to the door frame and finally all acoustic and fire seals were installed around the door leaf perimeter.

6.5: Specimen Construction & Testing Dates:

All construction activities of the partition wall were carried out by representatives from Material Lab.

Date Sample Received: 06/01/2017

Date Wall Completed: 06/01/2017

Date of test Started: 16/01/2017

Date of test completed: 16/01/2017

Date of Report Issue: 17/01/2017

*Note: the supporting construction was cured for ten days prior date of testing as instructed by the client.

Certificate Number: SNR 30362926/4/Q

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6.6: Picture of Test Specimen Components:

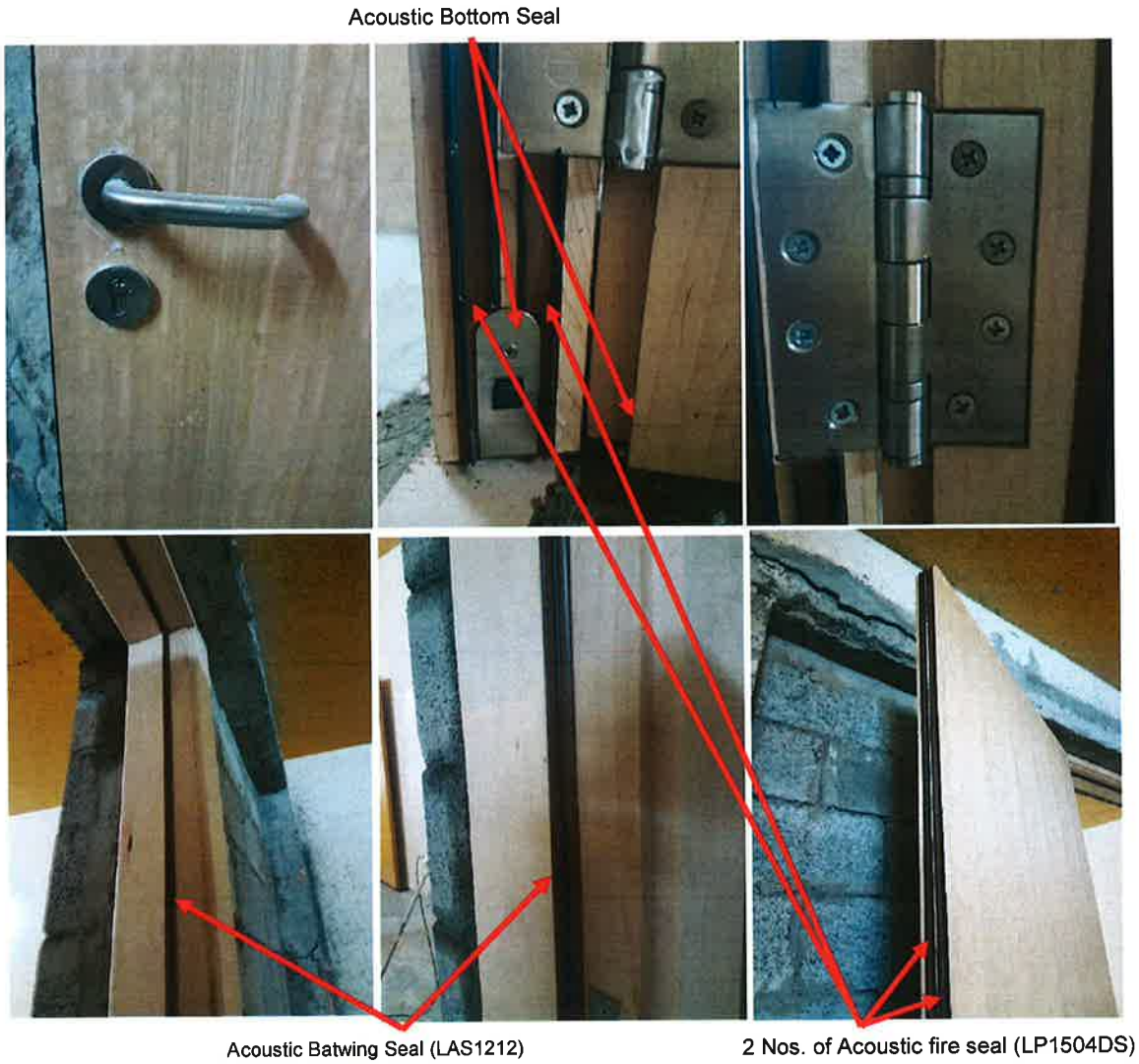

Figure 5: Test Specimen components pictures

6.7: Critical Dimensions & Clearance Measurements:

Total Area of Specimen Door used to determine STC value (Door Frame + Architraves: 2330mm X 1198mm) was 2.79134 m².

Prior testing gap measurements were taken. Gap at sill level between the floor and the bottom of the door leaf on the back side was approximately 3mm. Acoustic bottom seal, LAS8001 si was applied here to seal floor level gap. Vertical and Horizontal gaps between the door leaf and the door frame on receiving room side of the door were less than 2mm. LAS1212 Acoustic Batwing seal was applied on the door stop to conceal this gap. Similarly vertical and horizontal gaps between the door leaf and door frame on the source room side of the door were less than 2mm. Two Nos. of Acoustic, Fire & Smoke seal, LP1504DS, was applied on the door rebate to conceal gaps between the door frame and leaf.

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7) SUMMARY OF TEST RESULTS

Sample No.	Description of Sample	Avg. STC
17-527413/1-1	60 Minutes Fire Rated Wooden Door Assembly with 54mm thick FIREBAN Core, Solid Hard Wood Frame of dimensions (2320 x 1118 x 150) mm, 2 Nos. of Acoustic fire seal (LP1504DS), Acoustic Batwing Seal (LAS1212) & Acoustic Bottom Seal (LAS8001si)	**36**

Table 3: STC rating obtained for Test Specimen

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Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

Certificate Number: SNR 30362926/4/Q

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8) TEST DATA & DETAILED RESULTS

8.1: Determination of Average Decay Rate in Receiving Room for All Test Trials:

Octave Band Center Frequency (Hz)	Decay Rate dB/sec				
	Mic-6	Mic-7	Mic-8	Mic-9	Mic-10
100	1,58	1,57	1,47	1,73	2,01
125	2,09	2,27	2,20	2,35	2,30
160	3,94	3,88	3,87	3,82	4,06
200	2,88	2,96	3,14	2,84	2,88
250	2,46	2,36	2,14	2,50	2,16
315	2,17	1,98	2,00	2,25	2,21
400	2,19	2,14	2,24	2,18	2,26
500	2,03	2,01	2,04	2,01	2,02
630	1,86	2,04	1,98	1,88	1,90
800	1,82	1,81	1,76	1,77	1,79
1000	1,87	1,79	1,84	1,84	1,90
1250	1,83	1,83	1,87	1,80	1,83
1600	1,91	1,95	2,00	1,93	1,98
2000	1,78	1,74	1,84	1,82	1,79
2500	1,64	1,57	1,67	1,62	1,66
3150	1,52	1,52	1,54	1,53	1,49
4000	1,38	1,38	1,39	1,37	1,35
5000	1,27	1,25	1,26	1,20	1,28

Table 4: Average Decay rate obtained after all test trials

Certificate Number: SNR 30362926/4/Q

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8.2: Determination of Average Sound Absorption in Receiving Room for All Test Trials:

Octave Band Center Frequency (Hz)	Sound Absorption dB.m²				
	Mic-6	Mic-7	Mic-8	Mic-9	Mic-10
100	0,22	0,22	0,21	0,24	0,28
125	0,29	0,32	0,31	0,33	0,32
160	0,56	0,55	0,55	0,54	0,57
200	0,41	0,42	0,44	0,40	0,41
250	0,35	0,33	0,30	0,35	0,30
315	0,31	0,28	0,28	0,32	0,31
400	0,31	0,30	0,32	0,31	0,32
500	0,29	0,28	0,29	0,28	0,28
630	0,26	0,29	0,28	0,27	0,27
800	0,26	0,26	0,25	0,25	0,25
1000	0,26	0,25	0,26	0,26	0,27
1250	0,26	0,26	0,26	0,25	0,26
1600	0,27	0,28	0,28	0,27	0,28
2000	0,25	0,25	0,26	0,26	0,25
2500	0,23	0,22	0,24	0,23	0,23
3150	0,21	0,21	0,22	0,22	0,21
4000	0,19	0,19	0,20	0,19	0,19
5000	0,18	0,18	0,18	0,17	0,18

Table 5: Average Sound absorption obtained after all test trials

Certificate Number: SNR 30362926/4/Q

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8.3: STC Rating for Wooden Door Assembly, 54 mm thick FIREBAN Core & Solid Hard Wood Frame:
(17-527413/1-1)

1/3 Octave Band Center Frequency (Hz)	Sound Transmission Loss Data		
	Test 1	Test 2	Test 3
100	35	36	36
125	36	38	37
160	39	38	38
200	40	39	38
250	40	38	39
315	38	39	39
400	39	40	40
500	39	41	41
630	40	40	40
800	38	38	38
1000	37	37	37
1250	37	37	37
1600	36	37	36
2000	36	36	36
2500	35	36	35
3150	35	37	35
4000	36	38	38
5000	39	39	39
Sound Transmission Loss	**36**	**37**	**36**

Table 6: STC obtained for each individual test

Certificate Number: SNR 30362926/4/Q

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8.4: Sound Transmission Class Graph for Test #1:

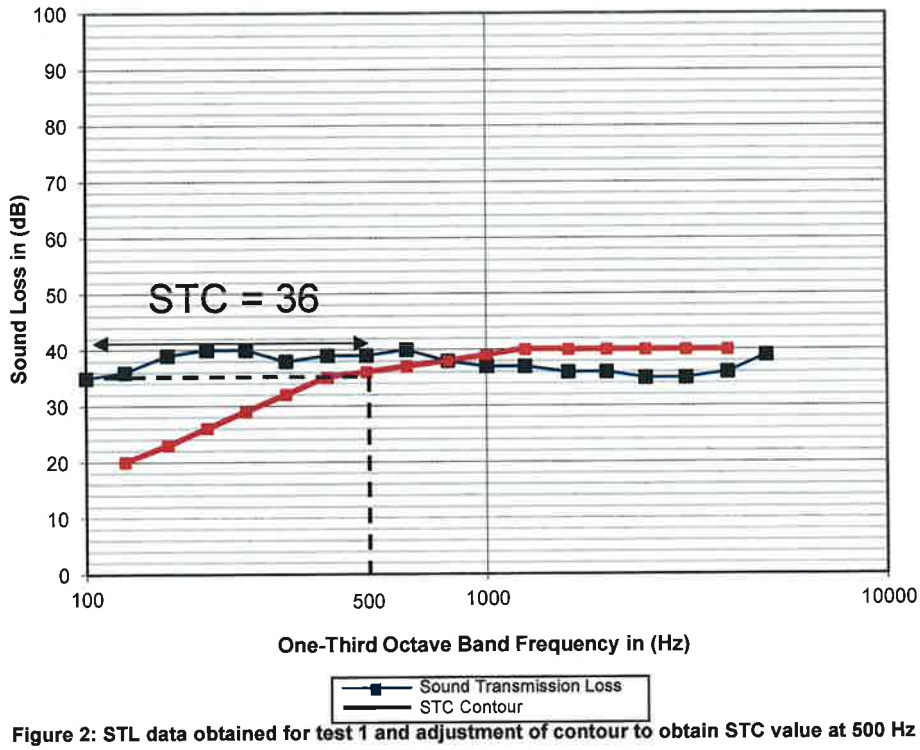

Figure 2: STL data obtained for test 1 and adjustment of contour to obtain STC value at 500 Hz

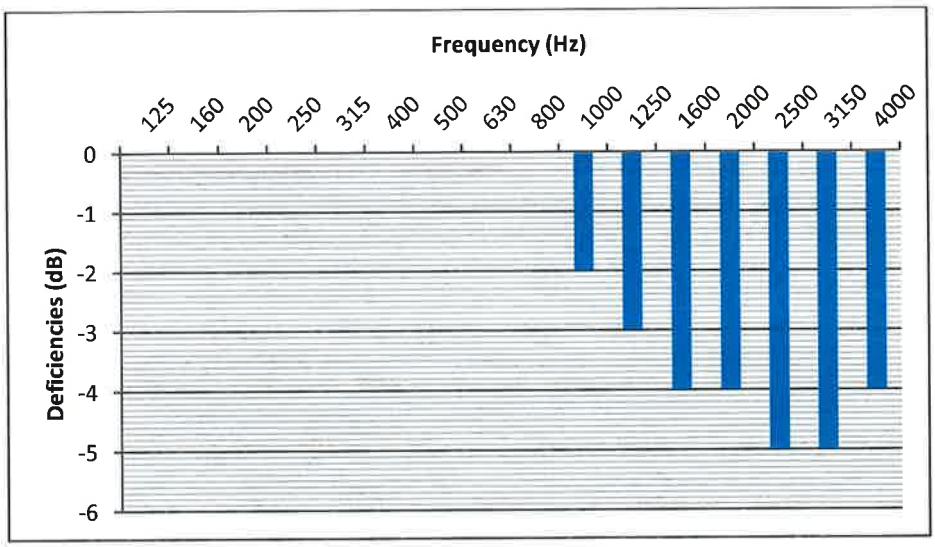

Figure 3: Negative deficiency for test 1 between contour and STL raw data for each frequency. The sum of all deficiencies does not exceed 32 dB and the value of an individual deficiency does not exceed 8 dB.

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8.5: Sound Transmission Class Graph for Test #2:

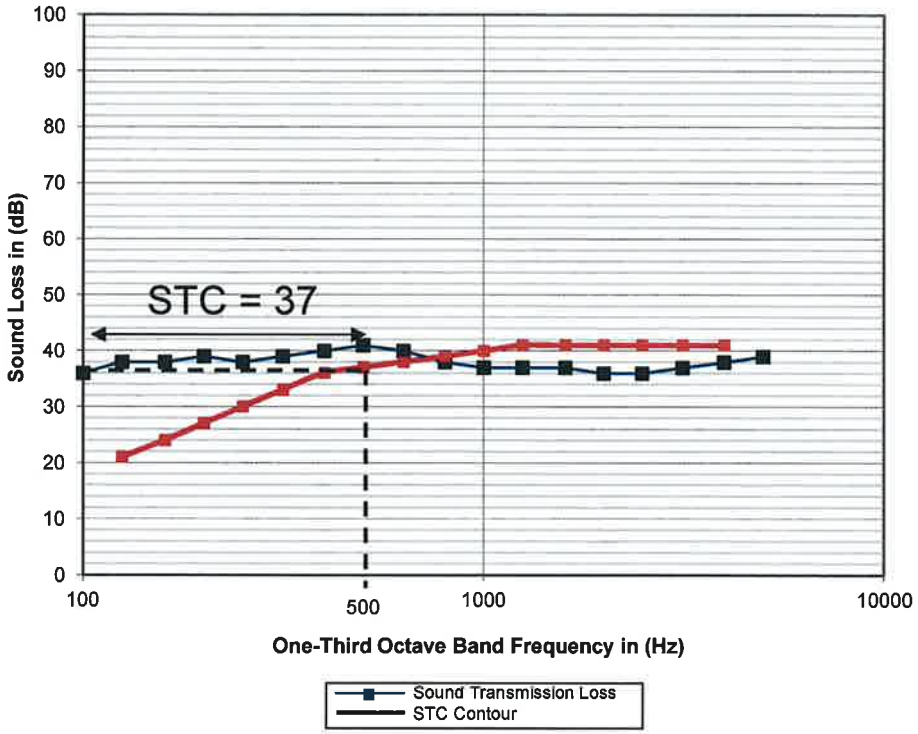

Figure 4: STL data obtained for test 2 and adjustment of contour to obtain STC value at 500 Hz

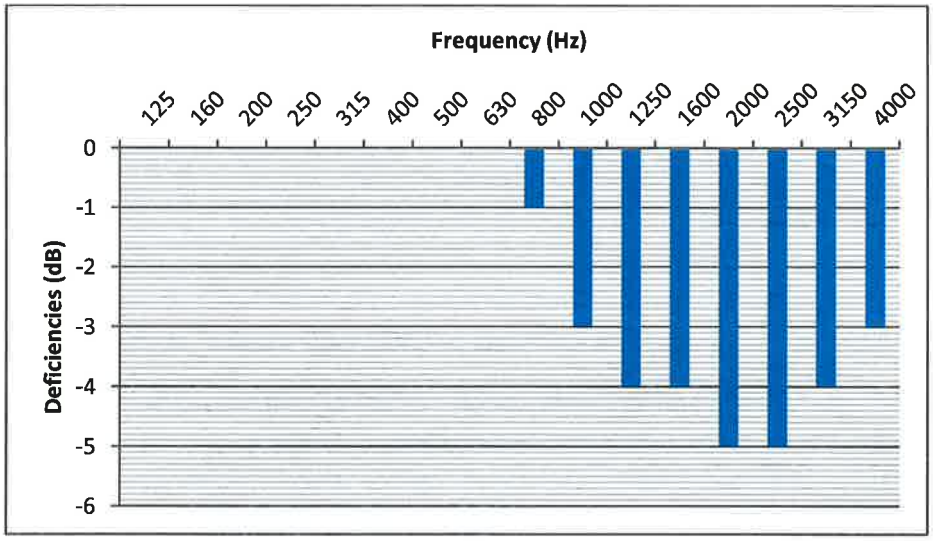

Figure 5: Negative deficiency for test 2 between contour and STL raw data for each frequency. The sum of all deficiencies does not exceed 32 dB and the value of an individual deficiency does not exceed 8 dB.

Certificate Number: SNR 30362926/4/Q

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8.6: Sound Transmission Class Graph for Test #3:

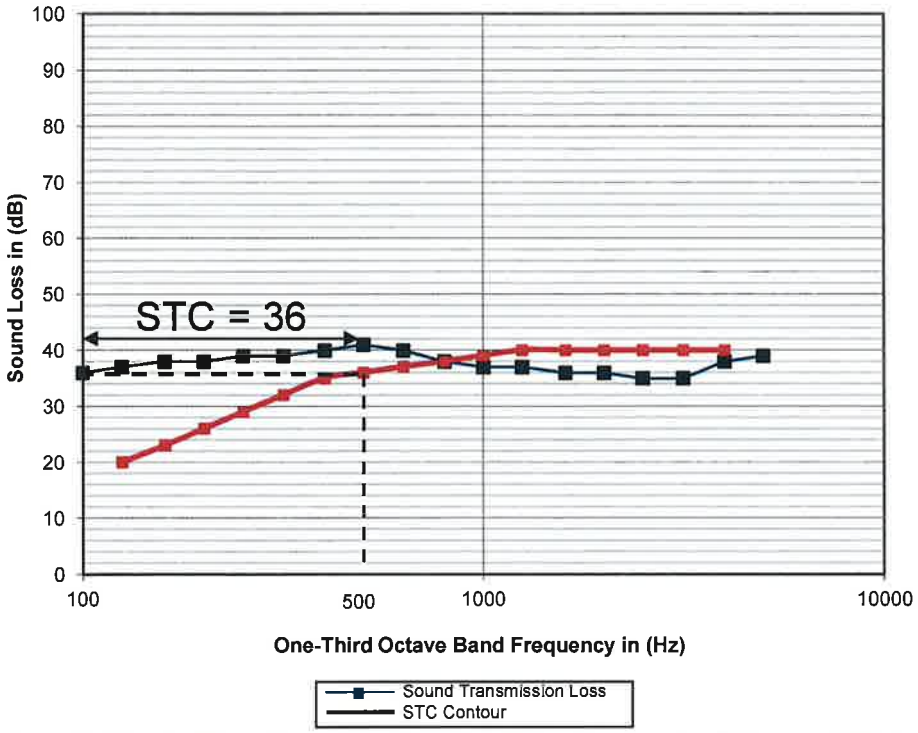

Figure 6: STL data obtained for test 3 and adjustment of contour to obtain STC value at 500 Hz

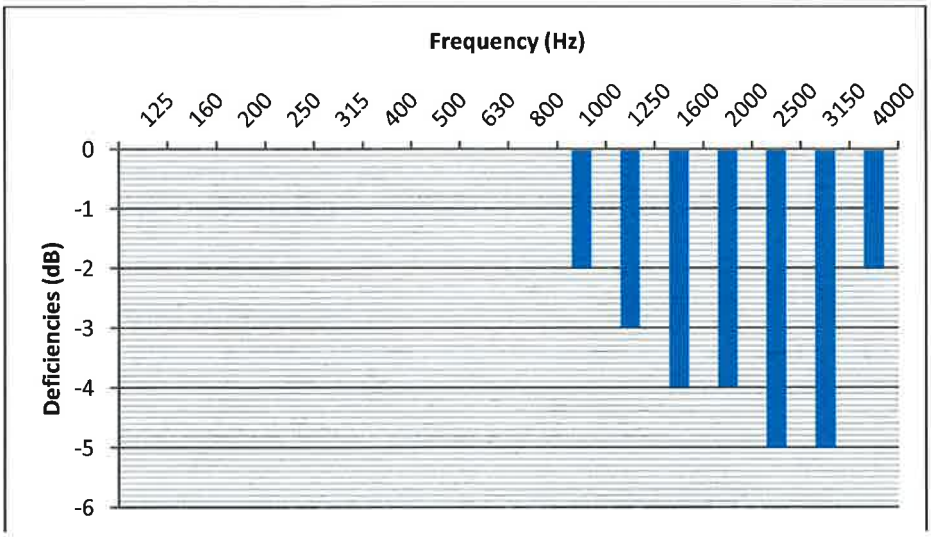

Figure 7: Negative deficiency for test 3 between contour and STL raw data for each frequency. The sum of all deficiencies does not exceed 32 dB and the value of an individual deficiency does not exceed 8 dB.

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9) REMARKS

1. Room temperature during testing was 24°C ± 2°C
2. Relative Humidity: 50%
3. The test specimen supporting construction was cured for ten days before testing.

10) CONCLUSION & LIMITATIONS

The test method employed for this test has no pass-fail criteria; therefore, the evaluation of the test results is left to the discretion of the client / consultant as per their specific contract specification requirement.

- Supporting construction was cured for ten days only in accordance with instructions from the client.
- The door assembly was tested in operable condition.
- Mortar was used as sealant for gaps.
- The torque value of the door closer was not determined.
- This report is related to the door assembly tested only.
- This report relates only to the items (ironmongery and seals) used in assembly of the tested door.
- Test results given in this report are valid only for the conditions under which the test was performed.
- This test report represents the results of the door in operable condition only.
- This report cannot be reproduced except in full and without written approval of the laboratory.
- Upon the request of the test sponsor two separate reports have been issued, one for Khansaheb Joinery with Lab Ref. No. 527413 SN1/1 C1-2 and 527413 SN1/1 C1-2 for Gulf Trade Link. Management ensures that there is no changes in test data and the only changes are in the names of the test sponsor.

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