聲學測試服務有限公司
Acoustic Testing Services Limited
Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
Tel: (852) 2690 9126 Fax: (852) 2690 9125 E-mail: info@ATSL.com.hk http://www.ATSL.com.hk

Acoustic Assessment for Sound Insulation Performance of 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System

REPORT TO: Fujian Jumbo New Material Corporation Limited

ADDRESS: Industrial Zone,
Chang Shan Overseas Chinese Economic Development Zone,
Zhang Zhou, Fujian, China

ATTENTION: Mr. Tommy Liu

REPORT NO.: ATS18-019-RP002

ISSUE DATE: 30th August 2018

Prepared by:

Ir Dr. Fan CHONG
CEng, RPE, MHKIE, FIMechE, FIOA
FHKIOA, MCIBSE, MASHRAE, MHKIQEP

Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
Tel: (852) 2690 9126 Fax: (852) 2690 9125 E-mail: info@ATSL.com.hk http://www.ATSL.com.hk

1 Objective

This report presents an appraisal of sound insulation performance of a 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System for **Fujian Jumbo New Material Corporation Limited** based on the sound insulation test report of 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with 5mm JUMBO Plastering (JUMBO MP300) on both sides.

The laboratory sound insulation test for the tested 150mm thick JUMBO Gypsum High Density (HD) (1,100kg/m^3) Block Wall System with 5mm JUMBO Plastering (JUMBO MP300) on both sides was carried out according to ASTM E90-09 and ASTM E413-10 by Acoustic Testing Services Limited in October 2016. This laboratory sound insulation test report of 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with 5mm JUMBO Plastering (JUMBO MP300) on both sides is given in Appendix A for reference.

2 Background Information of Estimation

2.1 Sound Transmission Loss

The sound transmission loss of a building component (such as partition wall) is a measure of the airborne sound insulation it provides. It is a measure of the ratio of the sound energy W_1 striking the building component (such as partition wall) relative to the energy W_2 which is transmitted through the drywall system.

This quantity is denoted by *TL* and is expressed in decibels as follows,

$$TL = 10\lg\frac{W_1}{W_2} \qquad (1)$$

The expression "sound transmission loss (*TL*)" is in use in English-speaking countries. It is equivalent to "sound reduction index, R"

The sound transmission loss of a partition varies with frequency, usually increasing as the frequency increases.

Although sound insulation varies with frequency and is very different for different types of partitions, it is convenient to compare the effectiveness of two partitions using a method of rating sound insulation that can be represented by a single number. In North America, the most commonly used single-number rating of sound insulation is called the "sound transmission class (*STC*)". In many countries other than North America, the single-number rating system used to express the overall sound insulation value of a partition is called the weighted sound reduction index R_w. The higher the R_w or *STC* rating, the better the sound insulation provided by a partition.

The laboratory measurement methods according to ASTM E90-09 "Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements" and BS EN ISO 10140-2 (previous BS EN ISO 140-3 & BS 2750-3) can be regarded as similar for the acoustic principle and general measurement procedures. However, there is difference in evaluation of the single-number ratings of airborne sound insulation, R_w and *STC*, such as the frequency range for evaluation is 100 Hz to 3150 Hz as per BS EN ISO 717-1 for R_w, while it is 125 Hz to 4000 Hz as per ASTM E413 "Classification for rating sound insulation" for *STC*.

In this estimation report, the sound transmission loss *TL* and the sound transmission class *STC;* and sound reduction index R and weighted sound reduction index R_w will be used to present the sound insulation performance of partitions. Values of the sound transmission class *STC* and sound reduction index R_w are determined from the measured sound transmission loss *TL*.

Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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2.2 Required Variation and modification

This assessment is conducted for one gypsum block wall system with the following variation and modification to the tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with 5mm JUMBO Plastering (JUMBO MP300) on both sides,

(a) Change of the thickness of the JUMBO High Density (HD) Gypsum Block Wall from 150mm to *100mm;*

(b) Change of density of gypsum block from 1,100kg/m^3 to *1,200kg/m^3*;

(c) No plastering will be applied on both sides of modified wall system;

(d) Others, such as block fixing and block jointing compound, remain unchanged as the tested wall system.

2.3 Supporting Data

2.3.1 Test report No. ATS16-049-RP007 for 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System JUMBO Plastering (JUMBO MP300) on both sides

The laboratory sound insulation measurement according to ASTM E90-09 for 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides was carried out by Acoustic Testing Services Limited (ATSL), Hong Kong in October 2016. In the test report, the sound transmission class *STC* was evaluated by comparing the sixteen values of sound transmission loss from 125 Hz to 4000 Hz with a defined reference contour as required in the Standard ASTM E413-10.

The tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides filled the test aperture of ATSL's testing chambers with 3500mm wide by 3000mm high. Set-up and installation of the tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO

Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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MP300) on both sides is given in the test report ATS16-049-RP007 (Appendix A). The estimated surface mass of the tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides is about 186 kg/m^2. The sound transmission class of the tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides is obtained as *STC* 50 by the laboratory test.

3 Technical Assessment

3.1 Single-leaf Partition

The improvement of sound insulation performance for a common building element can be achieved by increase the mass per area of the element.

Building element consisting of a single homogeneous panel can be modeled quite well by the mass law up to the critical frequency. The mass law predicts the sound reduction from the surface mass of the building element and the frequency. If the surface mass is in kg/m^2 and the frequency in Hz, then the sound reduction index R is given in:

$$R = 20\log(f * m) - 47 \qquad (1)$$

where, m is the surface mass of the panel.

A simple explanation of the mass law is that the motion of the panel is controlled by its inertia, the panel behaving as a limp mass, and the displacement or velocity of the panel reduces as the mass of the panel is increased or as the vibration frequency increases. The mass law is a good approximation for the great majority of materials at low and mid frequencies.

However, it is inefficient to improve the sound insulation of a heavy single-leaf partition merely by further increasing it mass per unit area.

3.2 Estimation Results

Based on the test report for the surface mass of the tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides (as given in Appendix A) and the mass law as described in Section 3.1, it can be concluded that the modified 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System *without plaster*, which has lower surface mass comparing with the tested system, will have lower sound insulation performance, summarized in the following table,

Table 3.1 JUMBO High Density (HD) Gypsum Block Wall Systems

JUMBO High Density (HD) Gypsum Block Wall Systems	Surface Mass	Sound Insulation Rating
Tested 150mm thick JUMBO High Density (HD) (1,100kg/m^3) Gypsum Block Wall System with JUMBO Plastering (JUMBO MP300) on both sides	186 kg/m^2	*STC* 50 (Test Result)
Modified 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System without plaster	120 kg/m^2	*STC* 45 / *Rw* 45dB (Assessed Results)

The assessed sound transmission class *STC* and weighted sound reduction index R_w, of modified 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System is given as *STC* 45 and *Rw* 45dB.

As no plastering is applied on the surface of the assessed wall system, it is highly suggested that, all joints between the blocks shall be sealed properly by the jointing compound to prevent sound leakage.

Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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4 Conclusions

It is our opinion that the variation and modification, as described above, modified 100mm thick JUMBO High Density (HD) (1,200kg/m^3) Gypsum Block Wall System can achieve the sound insulation rating up to *STC* 45 / *Rw* 45dB.

This assessment is based on the tested data, experience and information supplied. Any changes in the configuration of the block wall system under assessment will invalidate this assessment.

The assessed ratings are for indicative only, actual performance of the gypsum block wall system in accordance to ASTM E90-09 and BS EN ISO 10140-2 shall be verified by a laboratory test.

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References

1. "Noise Control in Building – A Practical Guide for Architects and Engineers", Cyril M. Harris, 1994

2. ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements"

3. ASTM E413-10, "Classification for Rating Sound Insulation"

4. BS EN ISO 10140-2:2010, "Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation"

5. BS EN ISO 717-1:2013, "Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: airborne sound insulation"

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Appendix A

Sound Insulation Test Report ATS16-049-RP007 for

150mm thick JUMBO High Density (HD) (1,100kg/m^3)

Gypsum Block Wall System with

5mm JUMBO Plastering (JUMBO MP300) on both sides

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HOKLAS 173 TEST

Test Report for Laboratory Measurement of Sound Transmission Loss

TEST REPORT REFERENCE NUMBER:	ATS16-049-RP007
DATE OF REPORT:	02 December 2016
TESTED FOR:	Fujian Jumbo New Material Corporation Limited Industrial Zone, Chang Shan Overseas Chinese Economic Development Zone, Zhang Zhou, Fujian, China
ATTENTION:	Mr. Tommy Liu
UNIT UNDER TEST:	JUMBO High Density (HD) 150mm thickness Gypsum Block Wall System with 5mm thick JUMBO Plastering (JUMBO MP300) on both sides
TEST STANDARD:	ASTM E90 – 09
TESTED AT:	Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong.

Approved by: _____

Ir Dr. Fan CHONG / Managing Director
CEng, RPE, MHKIE, FIMechE, FIOA
MHKIOA, MCIBSE, MASHRAE, MHKIQEP

HKAS has accredited Acoustic Testing Services Limited (Reg. No. HOKLAS 173) under HOKLAS for specific laboratory activities as listed in the HOKLAS directory of accredited laboratories.

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1. METHOD OF TEST

The test was conducted in accordance with ASTM E90 – 09 "Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements" in the reverberation rooms of Acoustic Testing Services Limited. The single number rating of airborne Sound Transmission Loss is given as Sound Transmission Class (STC) by evaluation in accordance with ASTM E413 – 10 "Classification for Rating Sound Insulation".

2. INSTRUMENTATION

Description:	Serial Number:
Bruel & Kjaer Type 3560-B Real Time Frequency Analyzer	2454296
Ultragraph Pro Equalizer	N0517513166
STK V-6 Amplifier	C04OM013
Bruel & Kjaer Type 4292 OmniPower Sound Source	021005
Bruel & Kjaer Type 4292-L OmniPower Sound Source	005007
Bruel & Kjaer Type 4942 Random Incident ½" Microphone (Source Room)	2497997
Bruel & Kjaer Type 4942 Random Incident ½" Microphone (Receiving Room)	2497998
Bruel & Kjaer Type 4231 Sound Level Calibrator	2478237

The measuring equipment has been calibrated by an external recognized accredited laboratory, and is in current calibration.

3. PRINCIPLE OF TEST

The Sound Transmission Loss of a partition is usually measured in a laboratory by placing the element in an opening between two adjacent reverberant rooms designed for such tests. Noise is introduced into one of the rooms, referred to as the source room, and part of the sound energy is transmitted through the test element into the second room, referred to as the receiving room. The resulting mean space-average sound pressure levels in the source room and the receiving room are L_1 and L_2, respectively.

The Sound Transmission Loss is given by

$$TL = L_1 - L_2 + 10\lg(S/A) \quad \ldots(1)$$

where,

L_1 is the average sound pressure level in the source room, in dB;
L_2 is the average sound pressure level in the receiving room, in dB;
S is the area of the test specimen, in m^2;
A is the equivalent absorption area in the receiving room, in metres sabins.

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$$A = (0.9210Vd / c) \quad \ldots(2)$$

where,

V is the receiving room volume, in m^3;
d is the rate of decay of sound pressure level in receiving room, dB/s;
c is the speed of sound in the medium, m/s.

The speed of sound changes with temperature and shall be calculated for the conditions existing at the time of test from the equation:

$$c = 20.047\sqrt{273.15 + t} \quad \ldots(3)$$

where,

t is the receiving room temperature, measured to nearest degree Celsius.

The Sound Transmission Class (STC) of test specimen is calculated by comparing the sixteen values of Sound Transmission Loss from 125 Hz to 4000 Hz with a defined reference curve which is incremented until the requirements of ASTM E413 – 10 are met.

STC contour consists of a horizontal segment from 1250 Hz to 4000 Hz, a middle segment increasing by 5 dB from 400 Hz to 1250 Hz and a low frequency segment increasing by 15 dB from 125 Hz to 400 Hz. The STC rating of an element is determined by plotting the 1/3 octave band TL of the element and comparing it with the STC contour. The STC contour is shifted vertically until the TL curve falls mainly below the contour and the following criteria are met:

1. the TL curve is never more than 8 dB below the STC contour in any 1/3 octave bands; and
2. the sum of the deficiencies below the contour over the 16 1/3 octave bands does not exceed 32 dB.

When the STC contour is shifted to meet these criteria, the STC rating is given by the value of the contour at 500 Hz.

The measured sound transmission loss values are obtained from a single direction measurement.

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Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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4. MEASUREMENT PROCEDURES

4.1 Firstly, the background noise level was measured in the receiving room before the sound pressure level measurement.

4.2 Then, sound source was generated in the source room. The sound pressure levels were measured for 15s in the source room and receiving room simultaneously for each measurement. Total 16 measurements of sound pressure level in each room were made.

4.3 After measurements of sound pressure level, the decay rates were measured at total 3 microphone positions with 5 times measurement at each microphone positions in the receiving room.

4.4 Before and after the measurement, the used measurement system was calibrated by sound level calibrator.

5. RESULTS APPLICATION

The results obtained can be used to design building elements with appropriate acoustic properties, to compare the sound insulation properties of building elements and to classify such elements according to their sound insulation capabilities.

The test was performed in laboratory facilities in which transmission of sound through flanking paths is suppressed. Results of measurements shall not be applied directly in the field without accounting for other factors affecting sound insulation, especially flanking transmission and loss factor.

The test results obtained relate only to the Unit Under Test.

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6. DETAILS OF TEST

Date of receipt of Unit Under Test:	22 October 2016
Date of commencement of construction of Unit Under Test:	30 October 2016
Date of test:	31 October 2016
Unit Under Test:	JUMBO High Density (HD) 150mm thickness Gypsum Block Wall System with 5mm thick JUMBO Plastering (JUMBO MP300) on both sides
Sample I. D.:	ATS16-049-TS004
Dimensions used for calculation:	3500 mm (width) X 3000 mm (height)
Manufacturer:	Fujian Jumbo New Material Corporation Limited
Installed by:	Fujian Jumbo New Material Corporation Limited

Additional Description:

Brand:	"JUMBO"
Model:	B 150
Density:	1100 kg/m^3 (±5%)
Size:	600mm (L) x 247mm (H)
Thickness:	150mm
Others:	Gypsum block fixed to supporting frame using JUMBO Gypsum Bonding Adhesive (JUMBO MB100). Jointing of blocks to be filled by JUMBO Gypsum Bonding Adhesive (JUMBO MB100). 5mm thick JUMBO Plastering (JUMBO MP300) was applied on surface of gypsum block wall on both sides.

The details of the Unit Under Test refer to the drawings given in Appendix 1, if applied. The information of the Unit Under Test is provided by the Client and is not verified by the laboratory.

聲學測試服務有限公司
Acoustic Testing Services Limited
Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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7. TEST RESULTS

Source Room:

Temperature:	26	°C
Humidity:	70	%
Volume:	221	m^3

Receiving Room:

Temperature:	26	°C
Humidity:	70	%
Volume:	80	m^3

Specimen Dimension used for calculation:

Width:	3500	mm
Height:	3000	mm

Sound Transmission Loss (TL):

Freq. (Hz)	1/3 Oct, TL (dB)	1/1 Oct, TL (dB)
100	35	
125	37	37
160	40	
200	37	
250	38	38
315	40	
400	43	
500	45	45
630	49	
800	50	
1000	52	52
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1600	56	
2000	59	58
2500	59	
3150	60	
4000	62	61
5000	63	

STC = 50

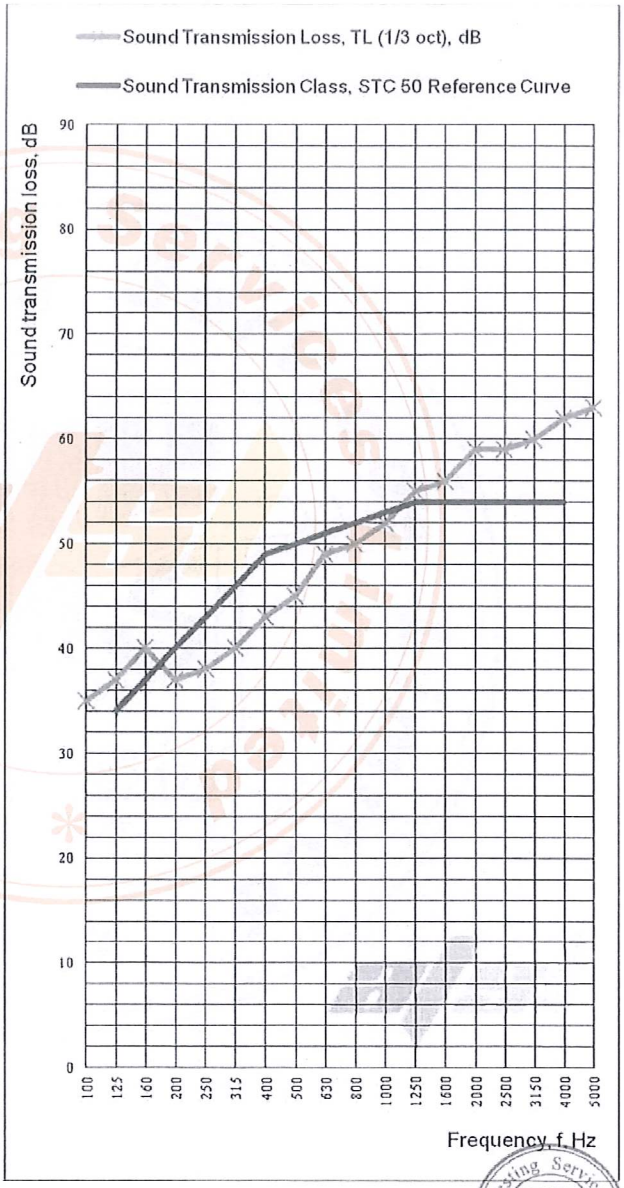

Figure 1. Sound Transmission Loss against Frequency

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Acoustic Testing Services Limited
Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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APPENDIX LIST

APPENDIX 1 Details of Unit Under Test

APPENDIX 2 Photographic Records

聲學測試服務有限公司
Acoustic Testing Services Limited
Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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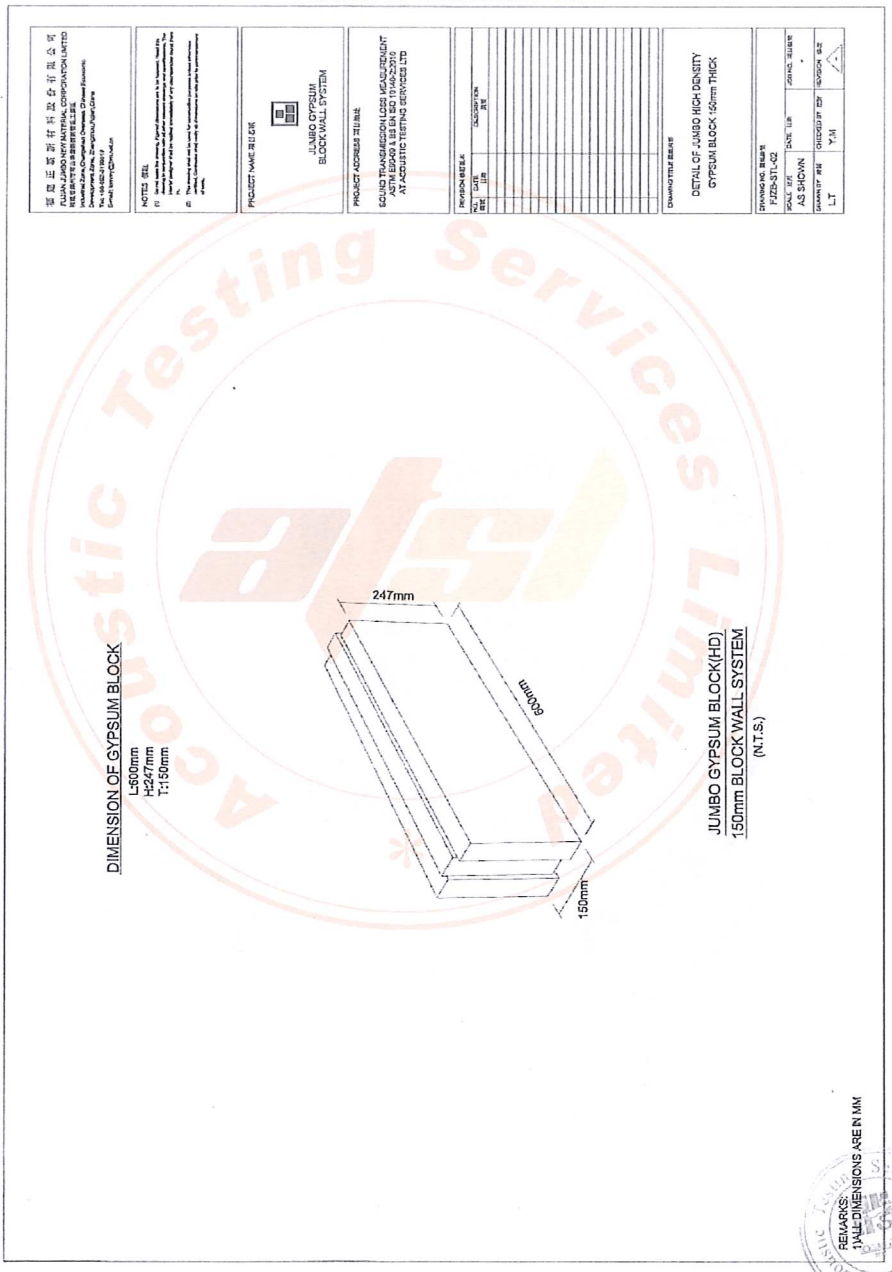
APPENDIX 1

Details of Unit Under Test



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Unit E, 2/F., Century Industrial Centre, 33-35 Au Pui Wan Street, Fo Tan, Shatin, New Territories, Hong Kong
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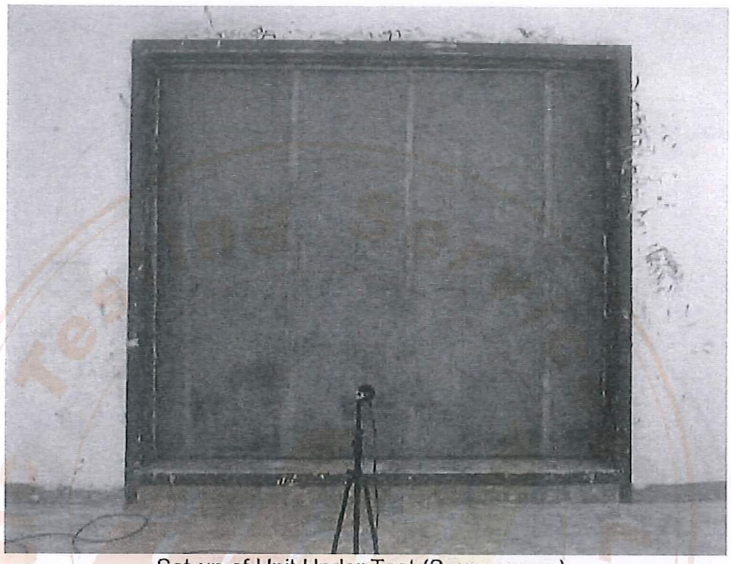
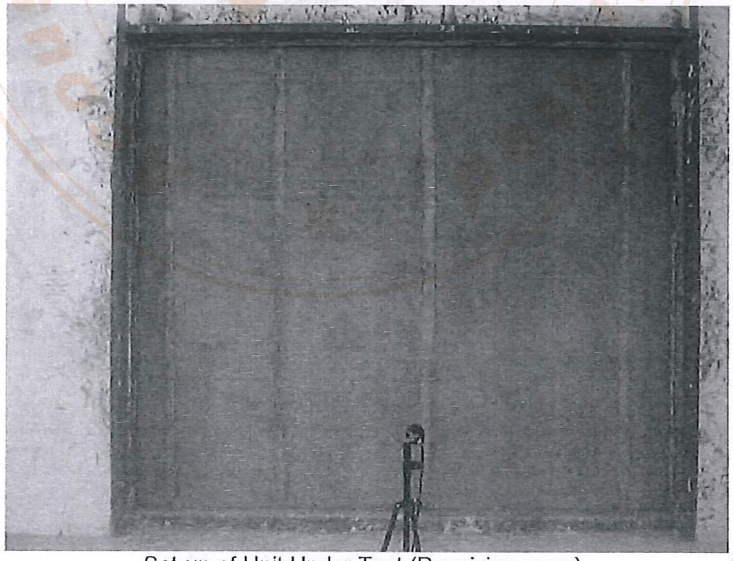
APPENDIX 2

Photographic Records



Set-up of Unit Under Test (Source room)



Set-up of Unit Under Test (Receiving room)

End of Report