UNIVERSITY OF ALBERTA

LABORATORY MEASUREMENT OF SOUND ABSORPTION AND AIRBORNE SOUND TRANSMISSION LOSS OF EXPOCRETE 12-inch SKA BLOCK

Prepared for:

EXPOCRETE CONCRETE PRODUCTS Ltd.
#38 53016 Hwy 60
Acheson, AB, Canada
T7X 5A7

Prepared by:
THE UNIVERSITY OF ALBERTA
MECHANICAL ENGINEERING ACOUSTICS AND NOISE UNIT
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JOB NUMBER: **07-09**
2 May 2008

EXECUTIVE SUMMARY

Two types of acoustical measurements were conducted at the request of Expocrete Concrete Products Ltd. of Edmonton, AB, on their 12-inch SKA Block. Measurements were conducted using the reverberation chamber suite at the Mechanical Engineering Acoustics and Noise Unit (the "MEANU") of the University of Alberta in Edmonton, Alberta, Canada. These measurements were conducted in accordance with ASTM C423 "Standard Test Method for Sound Absorption And Sound Absorption Coefficients By The Reverberation Room Method" and ASTM, E90, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions".

For the sound absorption study (per ASTM C423) the specimen was laid out as a "patch" of blocks on the (small) reverberation chamber floor (conforming to the "A-mounting" per ASTM E795) with exposed-face dimensions of 2.65 meters (8.7 feet) by 2.39 meters (8 feet). The blocks were mortared together per standard construction practice (mortar was applied only at the upper exposed face of the blocks). The vertical perimeter of the specimen was shielded with wood so that only the upper exposed face provided the sound absorption. The outer lower edge of the wood boarding was sealed to the Chamber's concrete floor with strippable silicone caulking. Similarly, the joint between the inner edge of the wood boarding and the outer edge of the blocks (exposed face) was also sealed with caulking.

The **Noise Reduction Coefficient** determined for the 12-inch SKA Block was **0.50**.

For the sound transmission loss study (per ASTM E90) the same type of blocks were used to construct a wall specimen (fully mortared per standard construction practice) in the MEANU's wood-framed test opening (nominally 9-feet wide (2749 mm) by 8-feet high (2440mm)). Small gaps along the outer perimeter edges of the specimen were plugged with closed-cell foam backer rod (vertical edges) and multiple layers of plywood (at header) and fully sealed with strippable silicone caulking; this was applied to both faces of the specimen.

The **STC-rating** for the 12-inch SKA Block was determined to be **STC-15**.

(A more detailed description of the blocks and the respective test configurations is given in the body of this Report.)

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1.0 INTRODUCTION

The acoustical conditions within a room are determined in large part by both the sound absorbing and sound barrier capabilities of the walls enclosing the room. This report summarizes the equipment and procedures used and test results obtained in quantifying the sound absorption (per ASTM C-423) and sound transmission loss (per ASTM E90) of **12-inch SKA block** manufacture by **Expocrete Concrete Products. Ltd.**

The Mechanical Engineering Acoustics and Noise Unit of the University of Alberta in Edmonton was retained by Expocrete Concrete Products Ltd. of Acheson, AB, to conduct the tests summarized in this Report. Authorization for this study was received 16-Jul-2007, by means of Expocrete **PO #'s 173544 & 173545**. Testing was conducted at the MEANU on 1-Aug-2007 & 4-Mar-2008 by Corjan Buma, M.Sc., P.Eng.

2.0 DESCRIPTION OF TEST FACILITIES

The Mechanical Engineering Acoustics and Noise Unit (the "MEANU") is owned and operated by the University of Alberta as an integral component of the Department of Mechanical Engineering. This allows for educational and research uses as well as for standardized commercial testing. The MEANU is equipped to conduct laboratory measurements according to various standards including some American National Standards ("ANSI"), some American Society for Testing and Materials ("ASTM") standard test procedures and some International Organization for Standardization (ISO) procedures. Projects such as standard acoustical tests, research contracts and fundamental research can be developed and completed.

A partial layout of the facility is shown in Figure 1 (page 11). The two inter-connecting reverberation chambers in which most acoustical tests are conducted are arranged as essentially separate buildings on independent foundations; a cross-section through the test Chamber walls is shown in Figure 2 (page 11). A test opening, nominally 2.4 meters high by 2.7 meters wide, is provided for the installation of wall test specimens. The test opening spans the two chamber walls, the walls being physically connected through lead sheet flashing only. Normally, when testing specimens for their sound-absorbing capabilities, as in this study, only one chamber is used and a specially-constructed plug wall is installed in the test opening to acoustically decouple the two chambers.

In order to satisfy the requirements for adequate sound diffusion, for each chamber its shape, volume and the arrangement of its sound diffusing panels contained within were designed to meet or exceed all applicable testing standards and guidelines. The diffusers can be set into motion (in a slow undulating pattern), however for the tests in this study the diffusers were kept stationary.

3.0 THEORY

3.1 Sound Absorption

The sound absorption of a surface or object is a property of the material(s) comprising the surface or object. It is ideally defined as the fraction of the randomly incident sound power absorbed by the surface. In ASTM test method C423 [1] the absorption of sound in a room is operationally defined by the Sabine equation:

$$A = 0.921\ Vd/c \qquad \text{Eqn 1}$$

where:

- A = room absorption, metric sabins or sabins,
- V = volume of room, m^3 or ft^3,
- d = rate of decay of sound pressure level in the room, dB per second,
- c = speed of sound in the medium, m/s or ft/sec.

The speed of sound is a function of temperature and can be found with:

$$c = 20.047\ \sqrt{(273.15+T)} \qquad \text{Eqn 2}$$

where:

- c = speed of sound, m/s,
- T° = room temperature, C°.

If an object positioned within a room away from any enclosing surfaces contributes to the sound absorption within the room, it is termed a "space absorber". To quantify the sound absorption contributed by the object, this is determined from the difference in room absorption "A" (Eqn. 1) within a test Chamber with the object present vs. absent. When this difference is divided by the area of the object (as is particularly appropriate for surface treatments) one obtains the "sound absorption coefficient",

$$\alpha = [(A_2 - A_1) / S] \qquad \text{Eqn 3}$$

where:

- α = absorption coefficient of specimen (dimensionless)
- A_1 = absorption of the empty reverberation room, metric sabins or sabins,
- A_2 = absorption of the room after the specimen has been brought in,
- S = area of test specimen, m^2 or ft^2.

For materials used as a surface treatment, diffraction effects usually cause the area of a specimen to be effectively greater than its geometrical area, thereby increasing the measured coefficient. This phenomenon may cause the derived values of sound absorption coefficient to exceed one (which is a theoretical impossibility). Since the effects of diffraction are less when specimen area is greater, a specimen size of at least 6.69 m^2 (72 ft^2) is recommended. Since diffraction effects are not yet completely understood, the standard recommends that no adjustments be made and the coefficients simply reported as derived. To minimize the diffraction effects for a deep specimen such as these blocks, a surround of impervious wood is applied to the entire (vertical) perimeter.

Sound absorption coefficients are normally reported in a series of 18 contiguous 1/3-octave band center frequencies ranging from 100 to 5000 Hertz (the standard audible range for good speech intelligibility for humans with average hearing capability). It is common in published data to find only the 6 required standard octave-band center frequencies of 125, 250, 500, 1000, 2000 and 4000 Hertz. Note that these 6 frequency bands are 1/3-octave band data and NOT an average of the three 1/3-octave band center frequencies that comprise a full octave band of that same frequency.

When requested, additional 1/3-octave band sound absorption coefficients may be measured and reported outside the 100-to-5000 Hz frequency range. However, these do not form part of the test procedure according to ASTM C423, and thus are not considered "valid" but only approximate. Often, they provide a useful indication of sound absorption trends outside the "valid" range.

Sound absorption coefficients normally range from a numerical value of zero to one and are defined, ideally, as the fraction of randomly-incident sound power absorbed by the specimen. Sometimes values are reported outside this coefficient range. Coefficients just below a value of zero may occur because of the uncertainty of the measurement. Coefficients exceeding a value of 1 may occur for the same reason or due to the diffraction effects discussed earlier.

The **Noise Reduction Coefficient** (**NRC**), a single number rating, is calculated by determining the arithmetic mean (to the nearest 0.05) of the absorption coefficients in the 250, 500, 1000 and 2000 Hertz 1/3-octave frequency bands.

3.2 Sound Transmission Loss

Sound transmission loss, as usually defined, refers to the ability of a partition (or one of its components such as a door or window) to function as a barrier and thereby reduce the level of sound propagating through to the other side. The standardized test procedure is based on the response of a specimen exposed to a diffuse incident sound field, that is, equal acoustic energy propagating in all directions simultaneously on the source side. This is the test condition approached when complying with ASTM test method E90 [3]. The results are therefore most directly relevant to the performance of specimens exposed to such essentially-diffuse sound fields, but they also provide a useful general measure of performance for the variety of sound fields to which a partition may typically be exposed.

This test method is not appropriate for determining the sound-isolation performance of a partition exposed to a sound field that contains only a small range of angles of incidence, nor is it applicable to sounds produced by direct mechanical contact or impact with the partition.

The sound transmission coefficient (τ) of a partition, in a specified frequency band, is defined as the fraction of airborne sound power incident on the partition that is transmitted by the partition and radiated on the other side.

The sound transmission loss (TL) of a partition, in a specified frequency band, is defined as ten times the common logarithm of the ratio of the airborne sound power incident on the partition to the sound power transmitted by the partition and radiated on the other side.

The sound transmission coefficient and the sound transmission loss are related through Equation 4:

$$TL = 10 \log_{10} (1/\tau) \qquad \text{Eqn } \mathbf{4}$$

Two adjacent reverberation rooms are arranged with an opening between them in which the test partition is installed, care being taken that the only significant sound transmission path between the rooms is by way of the test partition. An approximately diffuse sound field is produced in the smaller room, the source room, and the resulting sound pressure levels are measured in both rooms. In addition, with the test specimen in place, the sound absorption in the receiving room is determined. Then the sound transmission loss is calculated using Equation 5:

$$TL = L_1 - L_2 + 10\text{Log}_{10} (S/A) \qquad \text{Eqn } \mathbf{5}$$

where:

- TL = transmission loss, dB,
- L_1 = average sound pressure level in the source room, dB,
- L_2 = average sound pressure level in the receiving room, dB,
- S = area of test specimen common to both rooms, square meters,
- A = sound absorption of receiving room with test specimen in place, metric sabins
- $L_1 - L_2$ is defined as the noise reduction (NR), dB.

The determination of average sound pressure levels produced in each room accounts for variations with measurement position, microphone sensitivity, presence of diffusers and possible changes in the spectrum of the source as a function of test frequency band. The microphone is stepped through a series of locations in each room so as to adequately sample the reverberant sound field. For each sampling position, the averaging time is sufficient to yield an accurate estimate of the time-averaged sound level. The space-averaged sound levels are then determined in each room using Equation 6 :

$$L = 10 \text{ Log}_{10} [(1/n) (\Sigma 10^{(Ln/10)})] \qquad \text{Eqn } \mathbf{6}$$

where:

- L = space- and time- averaged sound pressure level, dB,
- L_n = time-averaged level taken at location n
- n = number of samples.

The sound absorption of the receiving chamber is determined by measuring the rate of decay of sound pressure level, following essentially the measurement procedures of ASTM test method C423 [1]. Note, however, that the precision requirement is less stringent in this application than in test method C423 since the quantity entering into the transmission loss calculation is only 10 log S/A. By conducting separate qualification studies it has been determined that a precision requirement of 5% uncertainty in the determination of decay rate is sufficient to achieve the overall precision required by the E90 test method.

As with test method C423, the sound absorption in the Receiving room is determined according to Equations 1 & 2 above.

4.2 Sound Transmission Loss

A different set of blocks, identical in size, shape and weight to those used for the sound absorption test, were used for sound transmission loss testing. For this test a portion of blockwall, using stack bond, was constructed in the Laboratory test opening. The wall specimen was built using standard practice mortar construction. This portion of wall completely filled the 2.7m width of the test opening, but was short of spanning the 2.4 m height of the opening by a nominal 40 mm. Remaining small gaps along the vertical (side) edges of the specimen were plugged with closed-cell foam backer rod and covered with 20-mm square wood blocking. The gap along the top of the wall was subsequently filled, on both faces, with plywood filler spanning the full width of the specimen and completely filling the vertical height of the gap. All edges of the blockwall specimen on both sides were sealed to the Laboratory's wood framed test opening with strippable silicone caulking. The surface density of the SKA blockwall specimen, including mortar, was estimated to be 200 kg/m^2 (41 lbs/ft^2).

5.0 METHODOLOGY

5.1 Equipment

A list of the equipment used in this study is given in the Appendix to this Report.

5.2 Signal Excitation and Measurement (C423 Testing)

Normally, sound absorption is frequency-dependent and therefore measurements are made in a series of frequency bands. Random noise ("pink") is used as a test signal in the range of 110 dBA and allowed to stabilize for typically 3-to-4 seconds before the noise is abruptly stopped and the decay initiated. When the excitation signal is turned off, the sound pressure level decreases and the rate of decay is determined from measurement of the average time needed for the sound pressure level in a specific frequency band to decay through a certain range. The 1/3-octave band sound pressure levels are measured without any weighting ("linear").

Reverberation time measurements were made by generating 2 channels of random, uncorrelated broadband noise simultaneously through 2 independent loudspeaker systems located in opposite corners of the test chamber. The resulting decays were measured at each of 8 microphone locations within a well-defined, allowable region within the test chamber. This procedure was done both with the specimen present and with the specimen absent. Any difference detected in the average decay rate of the sound was attributed to the presence of the specimen, accounting for any change in sound absorption by the air in the test chamber due to temperature, relative humidity and barometric pressure variations.

As reverberation data was being measured, environmental conditions were also being monitored. A mercury column barometer was used to record barometric pressure changes. A lithium chloride sensor suspended approximately in the center of the test chamber was used to verify that changes in the air absorption of sound due to temperature and relative humidity were accounted for.

Acquisition of acoustic and environmental data was accomplished with custom computer software, with individual-run data being stored temporarily on hard-disk (note that only overall averaged results of reverberation times were retained for long-term storage). Data analysis was then completed using the custom software to derive averages of the decays referred to in Equation 1 at the various microphone positions.

The precision of the average RT60 at each microphone position at each frequency was attained by collecting sufficient decays (typically, about 40) until the precision requirements of ASTM C423 were satisfied. At frequencies of 250 Hz and higher, the absorption of the test chamber, either empty or with-specimen, must be measured with an uncertainty of less than 2% with 95% confidence and at frequencies below 250 Hz, the uncertainty must be less than 4% (with 95% confidence). The precision of sound absorption values was derived from the spatial variation of the average RT60 at each microphone position for each room condition (i.e. with or without specimen) and combining their uncertainties to calculate the uncertainty for absorption coefficient at the 95% confidence level.

5.3 Signal Excitation and Measurement (E90 Testing)

Noise reduction values were determined by generating two channels of random, uncorrelated broadband noise simultaneously in the Source Chamber through two independent loudspeaker systems placed in opposite corners. The resulting sound pressure levels were measured as time-averaged spectra at each of eight stationary (fixed) microphone locations, first on the source side of the specimen and then on the receiving side. Background noise levels were also measured at each location in the Receiving Chamber.

The sound absorption of the Receiving Chamber was determined by performing reverberation time measurements according to ASTM test method C423 except that the precision requirement was relaxed to 5% for all frequency bands. Three of the same positions used for sound pressure level measurements in the receiving chamber were used for the sound absorption measurements.

As the preceding measurements were conducted the environmental conditions were monitored with a sensor suspended approximately in the centre of each chamber in order to verify that changes in air absorption due to temperature, barometric pressure and relative humidity were negligible.

With the data obtained the sound transmission loss was calculated for a series of eighteen contiguous one-third octave frequency bands from 100 to 5000 Hertz (Hz). The STC rating was determined by comparing the measured sound transmission loss values to a reference contour which is defined in ASTM E413, "Classification for Rating Sound Insulation" [4]. This contour extends through the frequency range from 125 to 4000 Hz. (When requested, additional one-third octave sound transmission loss values may be reported above or below the standard 100 to 5000 Hz frequency range. While the data in these additional bands are not part of the required data for test method E90, they may be useful as an indication of trending outside the valid range.)

Data acquisition of time-averaged sound level spectra and reverberation decay data was accomplished with custom computer software designed to configure the real-time analyzer for specific acoustic measurements. The data, including information on microphone position, type of measurement and prevailing environmental conditions, was stored electronically for later reference.

Data analysis was performed with custom software that formed averages of the various transmission loss quantities referred to in Equation 5. The sound transmission loss values, with error analysis, were calculated for each valid frequency band. The data-sheets obtained as part of the test procedure are given in Figure 5 (page 14). An explanation of each data column is as follows:

FREQ: one-third octave band frequency, Hertz;

SOURCE: space and time-averaged sound pressure level in the Source room, dB;

RCVR: space and time-averaged sound pressure level in the Receiver room, dB;

BACKG: space and time-averaged sound pressure level of the background sound in the Receiver room (i.e. Source room loudspeakers turned OFF), dB;

RT60: the RT60 reverberation time in the Receiver room, seconds;

NR: Noise Reduction: the difference between the Source and Receiver sound levels, dB;

TL: Transmission Loss (to the nearest integer), dB; and

TL UNCERTAINTY: estimate of error (precision) of **TL**, ±dB.

The precision of a sound transmission loss determination was derived from the precision of the individual quantities in Equation 5 by calculating their individual uncertainties at the 95% confidence level and combining them to calculate the uncertainty for TL at the 95% confidence level.

The E90 test method requires that the uncertainty of the reported transmission loss be no greater than 3 dB for the 1/3 octave bands centred on 125 and 160 Hz, 2 dB for bands centred on 200 and 250 Hz, and 1 dB for the bands in the range 315 to 4000 Hz.

6.0 RESULTS

6.1 C423 Testing (Sound Absorption)

The results of the sound absorption test for the specimen tested as described above is given in Figure 4 (page 13). The Noise Reduction Coefficient ("NRC") derived for this specimen was:

Test 07-09A, 12-inch SKA Block (in A-mounting with 4 sides blocked) : **NRC = 0.50**

6.2 E90 Testing (Sound Transmission Loss)

The Sound Transmission Class (STC) rating obtained for the SKA block was :

Test 07-09B, 12-inch SKA Block : **STC = 15**

The data-sheet corresponding to this result is given in Figure 5 (page 14).

7.0 DECLARATION OF COMPLIANCE

Every effort has been made to conduct and report the measurements and derived results in accordance with the requirements of ASTM Standard Test Method C423, "Standard Test Method for Sound Absorption And Sound Absorption Coefficients By The Reverberation Room Method", along with ASTM Standard Mounting Practices E795, "Standard Practices for Mounting Test Specimens During Sound Absorption Tests", except where noted. While test procedure C423 requires only one microphone position and the measurement of only a limited number of reverberation decays, the procedure as applied for this study meets or exceeds the minimum requirements.

Similarly, for the sound transmission loss measurements, the test procedure and the precision requirements were conducted in accordance with the requirements of ASTM test method E90, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". A detailed outline of the test procedure is available upon request. The determination of the STC (Sound Transmission Class) Rating was derived using ASTM E413, "Classification for Rating Sound Insulation".

8.0 DISCLAIMER

The MECHANICAL ENGINEERING ACOUSTICS AND NOISE UNIT (MEANU) has absolutely no financial or managerial interests vested in the Client named in this report nor does the Client so-mentioned have any vested interests in the MEANU.

Although every effort has been made to comply with all aspects of the standards referred to in this report, as of this writing the MEANU has no recognized certification.

9.0 REFERENCES

[1] ASTM C423 – 99a: "Standard Test Method for SOUND ABSORPTION AND SOUND ABSORPTION COEFFICIENTS BY THE REVERBERATION ROOM METHOD"; American Society for Testing and Materials, Volume 04.06, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

[2] ASTM E795 – 93: "Standard Practices for Mounting Test Specimens During Sound Absorption Tests"; American Society for Testing and Materials, Volume 04.06, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

[3] ASTM, E90–97, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions", American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA, USA 19428.

[4] ASTM E413–87 (Reapproved 1994), "Classification for Rating Sound Insulation", American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA, USA 19428.

FIGURES

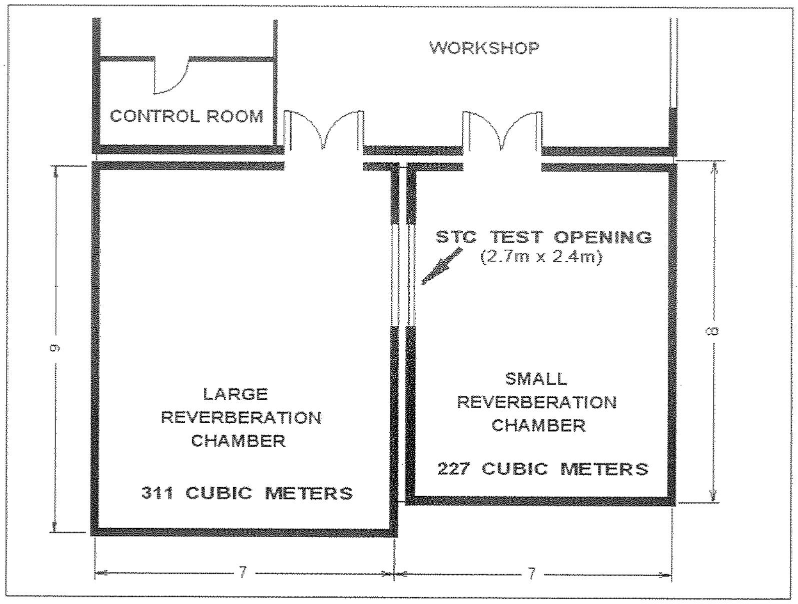

Figure 1 – MEANU Floor Plan (partial)

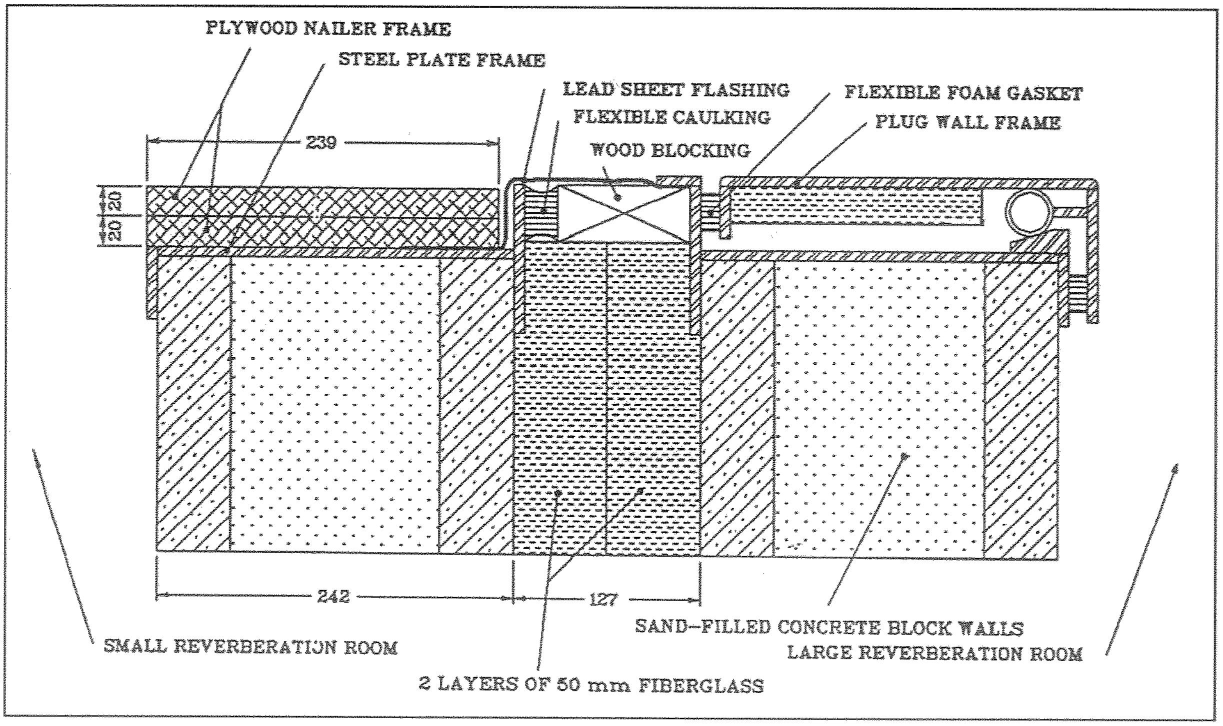

Figure 2 – Cross-Section through MEANU Chamber Walls

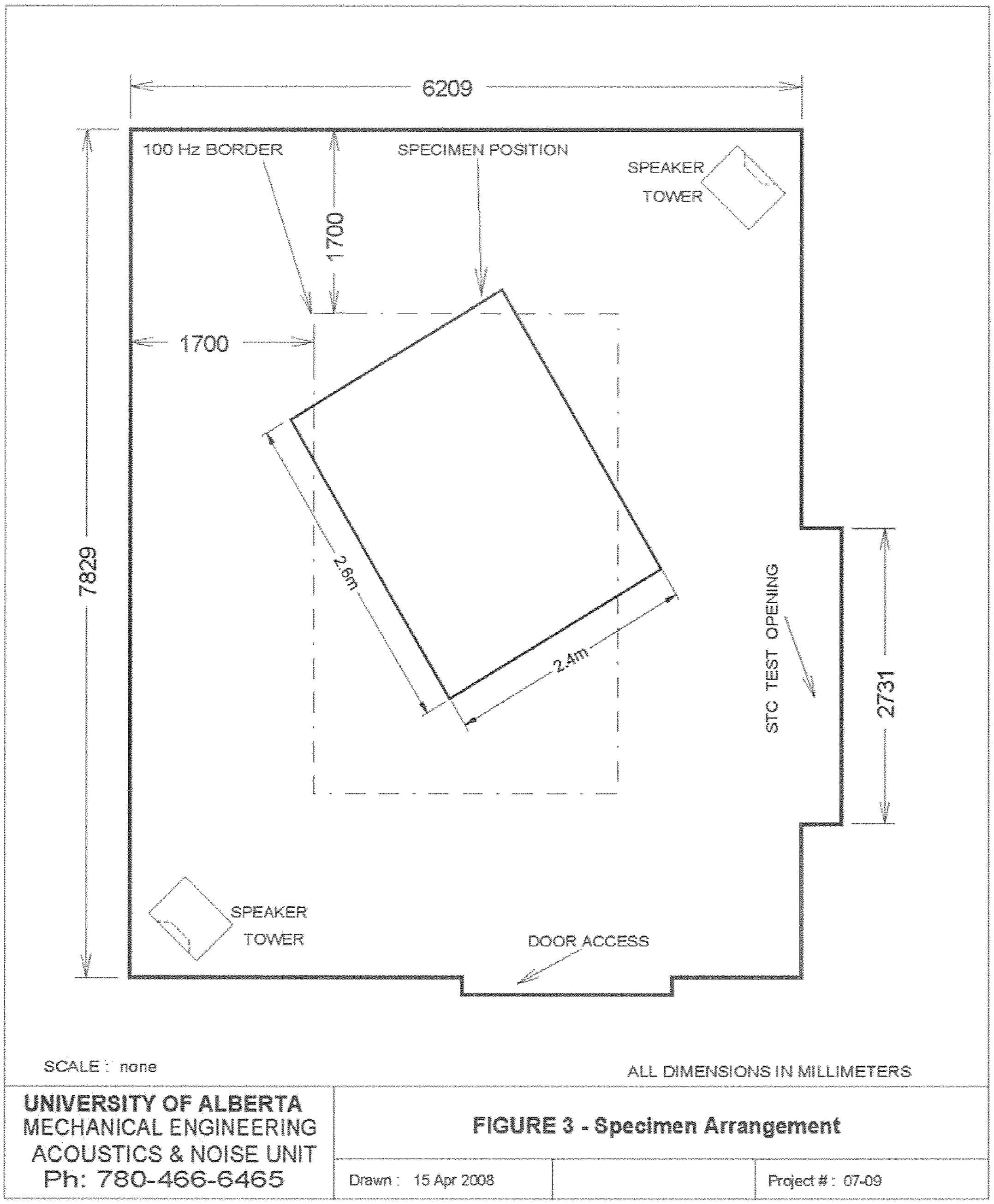

Figure 3 – Test Configuration of Specimen Within Small Reverberation Chamber

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EDMONTON, ALBERTA, CANADA

DETERMINATION OF NOISE REDUCTION COEFFICIENT (NRC)
ACCORDING TO ASTM STANDARD: C423

DATE: 2008 MARCH 04 (Tues)
CLIENT: Expocrete Concrete Products Ltd.

TEST NO: 1
TEST PERFORMED BY:
CJ Buma, M.Sc., P.Eng.

REVERB ROOM VOLUME: 228.3621 Cubic Meters
MICROPHONE PLACED AT 8 FIXED POSITIONS

ENVIRONMENT:	TIME	DATE	TEMP(C)	RH(%)	ATMOSPHERIC PRESSURE (KPa)
# 1 EMPTY ROOM:	02:17	03-04-08	17.97	20.05	93.72 (705.0 mm Hg @ 22.2 C)
# 8 EMPTY ROOM:	03:16	03-04-08	13.16	29.15	93.72 (705.0 mm Hg @ 22.2 C)
# 1 SAMPLE ROOM:	04:53	02-27-08	18.11	26.95	92.54 (696.0 mm Hg @ 21.0 C)
# 8 SAMPLE ROOM:	06:10	02-27-08	16.32	31.80	92.54 (696.0 mm Hg @ 21.0 C)

TEST SAMPLE SURFACE AREA : 6.118 Sq m [2.39 m wide by 2.56 m high]
MOUNTING CONFIGURATION : 'A'

TEST SAMPLE DESCRIPTION :
Specimen on Chamber Floor in A-mounting; all vertical perimeter edges blocked with wood; perim gaps sealed with clear silicone caulking at bottom edge of perim wood at floor and along top perim of boarding with blocks; block specimen mortared as per normal installation.

FREQ (Hz)	EMPTY RT60 (sec)	SAMPLE RT60 (sec)	TOTAL METRIC SABINE	ABSORB COEFF	COEFF UNCERTAINTY (+/-)
100	3.73	2.55	4.55	0.74	0.14
125	3.81	2.36	5.98	0.98	0.19
160	4.34	2.63	5.57	0.91	0.16
200	5.12	2.95	5.31	0.87	0.11
250	5.09	3.27	4.00	0.65	0.05
315	5.06	3.50	3.20	0.52	0.04
400	5.03	3.70	2.60	0.42	0.03
500	4.88	3.83	2.03	0.33	0.04
630	4.63	3.82	1.68	0.27	0.02
800	4.34	3.38	2.47	0.40	0.04
1000	3.83	3.05	2.64	0.43	0.05
1250	3.36	2.76	2.68	0.44	0.04
1600	3.02	2.45	3.42	0.56	0.04
2000	2.66	2.16	4.10	0.67	0.06
2500	2.29	1.90	4.79	0.78	0.07
3150	1.84	1.67	4.24	0.69	0.09
4000	1.46	1.41	4.07	0.67	0.13
5000	1.13	1.12	4.80	0.78	0.15

NRC = 0.50

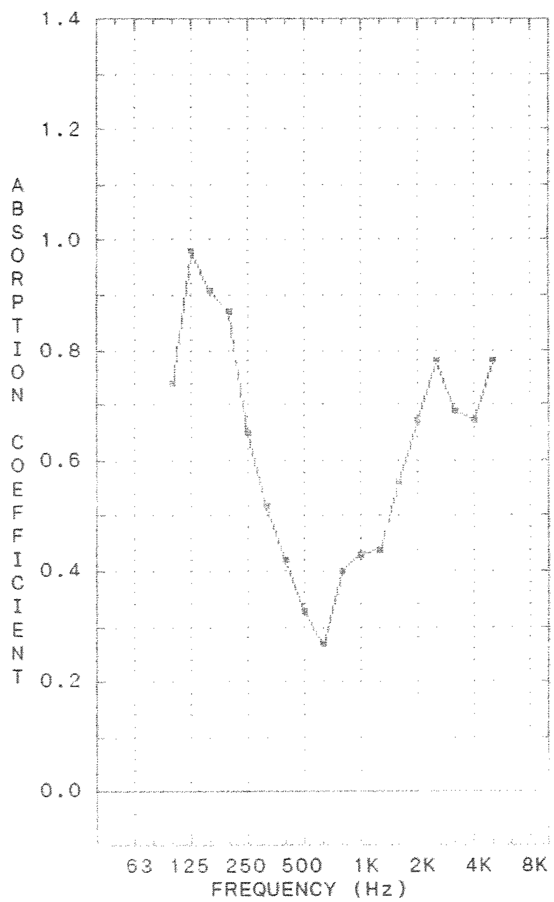

Figure 4 – Sound Absorption of 12-inch SKA Block in A-Mounting

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EDMONTON, ALBERTA, CANADA

DETERMINATION OF SOUND TRANSMISSION CLASS (STC)
ACCORDING TO ASTM STANDARD: E90

DATE: 2007 AUGUST 01 (Wdn) TEST NO: 1
CLIENT: Expocrete Concrete Products Ltd. TEST PERFORMED BY:
CJ Buma, M.Sc., P.Eng.

RECEIVER CHAMBER VOLUME: 316.2016 Cubic Meters
MICROPHONE(S) PLACED AT 8 FIXED POSITIONS

ENVIRONMENT:	TIME	DATE	TEMP(C)	RH(%)	ATMOSPHERIC PRESSURE (KPa)
# 1 RCV ROOM SPL	15:23	08-01-07	21.00	59.10	93.96 (707.1 mm Hg @ 25.0 C)
# 8 RCV ROOM SPL	15:45	08-01-07	21.20	58.65	93.96 (707.1 mm Hg @ 25.0 C)
# 1 RCV ROOM RT	15:47	08-01-07	21.20	58.64	93.96 (707.1 mm Hg @ 25.1 C)
# 3 RCV ROOM RT	16:02	08-01-07	21.20	58.58	93.96 (707.1 mm Hg @ 25.1 C)

TEST SAMPLE SURFACE AREA : 6.491 Sq m [2.701 m wide by 2.403 m high]

TEST SAMPLE DESCRIPTION

Specimen = SKA block built into Lab test opening; 6-&-2/3 columns by 12 rows in stack bond; gaps at vertical edges at extreme sides and header-jamb plugged with closed-cell foam rod on Source side; vert. edges on Receive side blocked with 20-mm square wood trim; Rcv-side all perimeter edges (except bottom) fully sealed with clear strippable silicone caulking; top gap blocked with 2 layers 20-mm plywood both faces; mortar joints nominal 13-mm width/height (= standard construction).

FREQ (Hz)	SOURCE (dB)	RCVR (dB)	BACKG (dB)	RT60 (sec)	NR (dB)	TL (dB)	DEF (dB)	TL UNCERTAINTY (+/- dB)
80	99.9	89.4	23.8	3.19	10.5	7		1.63
100	100.7	90.7	24.2	4.45	9.9	7		1.72
125	100.9	93.2	28.5	4.29	7.7	5	-	1.51
160	100.5	91.9	19.8	3.84	8.6	5	-	0.97
200	102.9	93.2	23.8	4.15	9.6	7	-	0.97
250	99.1	89.7	16.8	3.85	9.4	6	2	0.83
315	99.4	88.1	16.1	4.34	11.3	9	2	0.82
400	101.3	88.2	13.2	4.31	13.1	10	4	0.62
500	99.8	84.2	13.5	4.64	15.6	13	2	0.64
630	100.9	83.4	19.8	4.58	17.5	15	1	0.40
800	101.4	85.0	13.2	4.32	16.4	14	3	0.46
1000	100.9	84.8	11.3	3.79	16.1	13	5	0.57
1250	100.7	81.8	10.0	3.71	19.0	16	3	0.49
1600	100.5	81.1	9.3	3.37	19.5	16	3	0.49
2000	99.5	79.1	9.4	3.09	20.5	16	3	0.54
2500	100.2	79.5	9.7	2.74	20.7	16	3	0.41
3150	100.6	75.9	10.1	2.47	24.1	19	-	0.52
4000	99.9	72.1	10.8	2.19	27.8	22	-	0.55
5000	100.4	71.3	11.7	1.80	29.0	23		0.73

STC = 15
Rw = 15
DEFICIENCY = 31

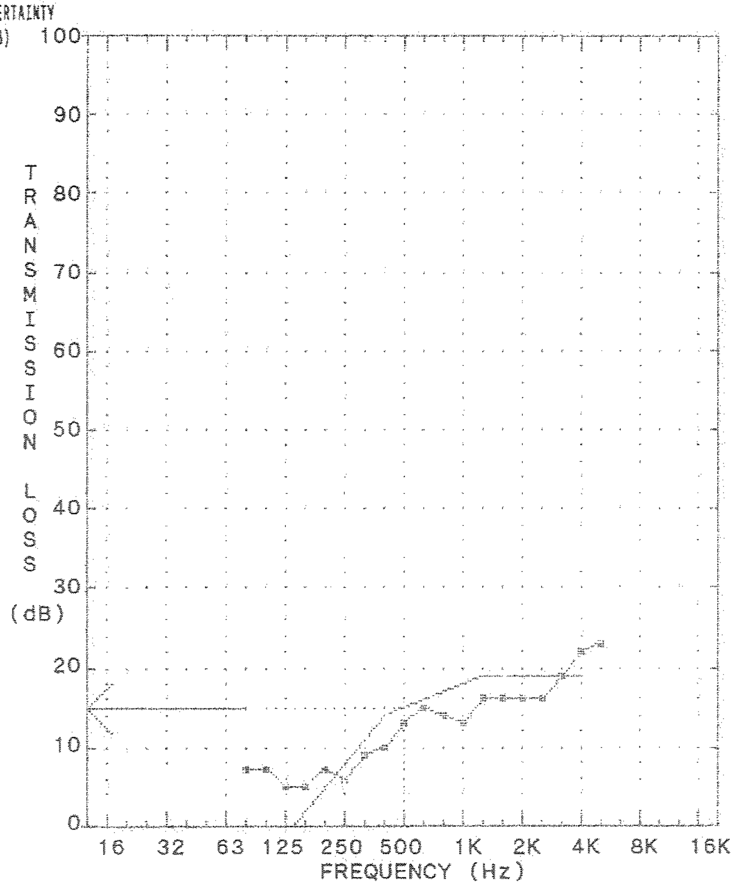

Figure 5 – Sound Transmission Loss of 12-inch SKA Block

APPENDIX

EQUIPMENT LIST

The following equipment was used to make the various acoustical measurements:

EXCITATION and CONDITIONING:

Custom-built Dual Channel Pink/White noise Generator
Crest FA-800 Stereo Power Amplifiers (2; "LOW" & "MID")
Crest 7001 Stereo Power Amplifier ("HIGH")
Furman VU-40 Power Monitors (3)
Urei 525 3-Way Stereo Crossover (18 dB/octave)
White 4650 One-Third Octave Band Equalizers (2)

3-Way Loudspeaker Systems (2 per Chamber):
SMALL REVERBERATION (C423 & E90 SOURCE) CHAMBER:

- EV SH1810L-ER 18" sub-woofer cabinets
- JBL 2220H 15" woofers in custom mid-range cabinets
- JBL 2446J 2" horns in 2385A radial flares

LARGE REVERBERATION (E90 RECEIVER) CHAMBER :

- EV SH1810L-ER 18" sub-woofer cabinets (2)
- JBL 2220H 15" woofers in custom mid-range cabinets (2)
- JBL 2426J 1" horns in Beyma TD-250 radial flares (4)

MEASUREMENT:

Pentium II/350 PC compatible computer running custom data-acquisition software
Bruel and Kjaer 4231 Sound Level Calibrator
Bruel and Kjaer 4134 Microphone
Larson-Davis 900B Microphone Preamplifier
Larson-Davis Model 3200 Precision Sound Level Analyzer
Small (227 m^3) and Large (310 m^3) Reverberation Chambers

ATMOSPHERIC:

Princo Model 453 Mercury column barometer
Hygrodynamics L15-3087 Hygrometer