Housing & Building National Research Center

Vice-Chairman Office
for Research and Studies Affairs

المركـــز القومي لبـــحوث الإسكان والبناء

مكتب نائب رئيس مجلس الإدارة
لشئون البحوث والدراسات

مرجعنا : ٢٠١٠/٤/٨
مرجعكم :٢٠١٠/٩/١٣

الموضوع: نتائج إختبار العزل الصوتى لحائط من الطوب الرملي كثافة ٦٥٠ كجم/م^{٣} بأبعاد ٦٠×٢٠×٢٠ سم من بطبقة محارة ٢ سم في الإتجاهين.

الجهة الطالبة: شركة الدلتا للطوب الرملي

تحية طيبة... وبعد،،

ايماءاً الى خطاب سيادتكم والوارد برقم ١١٧٧ بتاريخ ٢٠١٠/٩/١٣ بخصوص الموضـــوع عاليه، مرفق طيه التقرير النهائي بالنتائج . هذا وقد سددت الجهة الطالبة للمركز الرســـوم المقـــررة بالشيك رقم ٠٠٠١٩٨٨٨ بتاريخ ٢٠١٠/٩/٢ .

المركز القومى لبحوث الإسكان
إدارة السكرتارية و المحفوظات
التاريخ ٢٠١٠/٩/١٦ المرفقات ------
رقم الصادر ٢٤٨٧ ----------

وتفضلوا بقبول فائق الاحترام،،،

مدير المعهد

أستاذ دكتور / ٢٠١٠/٩/١٥

مجدى عبد الحميد هلال

نائب رئيس مجلس الإدارة لشئون البحوث والدراسات

أستاذ دكتور/ ٢٠١٠/٩/١٦

شريف فخري محمد عبد النبي

87 El-Tahrir St., Dokki, Giza 11511
P.O.Box : 1770 Cairo, EGYPT

E_mail : hbrc@hbrc.edu.eg & www.hbrc.edu.eg
Phone: (+202) 7617102, 7617092 Fax : 3351564, 7628736

٨٧ شـــارع التحرير الدقى - جيزة
ص.ب. : ١٧٧٠ القاهرة

Building Physics Institute
(BPI)

Housing & Building National
Research Center (HBRC)

ACOUSTIC ACTIVITY

Measurement of Airborne Sound Insulation for Wall of (Autoclaved Aerated concrete) Blocks with Plaster Delivered from Delta Sand Bricks [Delta block] Company

Block dimensions 60 X 20 X 20 cm
With Plastering

Tel : (02)33356722 / 33356853
FAX : (02)33351564

P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Supplier name	Delta Block	**Testing name**	sound insulation for Wall according ISO 140-4, ISO717-1
Supplier code	BPI-A-006	**Testing date**	29/8/2010
Delivery Date	**13/9/2010**	**Sample Code**	BPI-A-TL2-013
Delivery No.	1177	**Report NO**	BPI-A-TL2-013/006
Project name	Assessment the acoustic performance for different sand block wall		

1. Test Objects

This test method is for evaluating the sound insulating properties of masonry wall that is composite of sand, cement, lime and aluminum powder (Autoclaved Aerated Concrete). Autoclaved Aerated Concrete wall of thickness 20 cm with 2cm plaster at each side installed in acoustic laboratory between two rooms and the measurements is carried out according to ISO140-4, ISO 717-1. The sound reduction between the source room and the receiving room where the sample is between the two spaces measured and the weighted level difference Rw is determined the specification of the sample as follows:

The Autoclaved Aerated Concrete blocks have dimensions: 60 X 20 X 20 cm
The density of the block: 650kg/m^3
The thickness of the wall is 24 cm includes 2cm plaster at each side

1. Test Signal

2. The sound signals used for the tests are pink noise over third octave bands with mid-band frequencies from 100 to 8000 Hz is radiated by sound source type 4224 (B&K)

3. Sound Sources

The sound source type 4292 (B&K) is used for the test and radiate sound over wide angle. Sound source is enough away from the test partition and pointing in to the test specimens. The sound source radiates enough sound above the back ground noise (more than 10 dB).

4. Sound source positions

Two position of sound source is selected where 5 m from the sample and 1.5 m, from any surface and 2 m from the mic. positions

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

5. Microphone and positions

1/2 inch rotating microphone type 4189 (B&K) is used to measure average sound pressure levels in the source room and receiving room. The sound decay rates in the receiving room are measured 3 times for each position of sound source. The rotating microphone is used in 1 position that is 1.75 from the sound source in source room and 1 position in the receiving room that is 1.5 m from the sample. The sound pressure level is measured for 4 times for each position of the sound source (two positions). The number of sound pressure level measurements for each room (source room and receiving room) is 8.

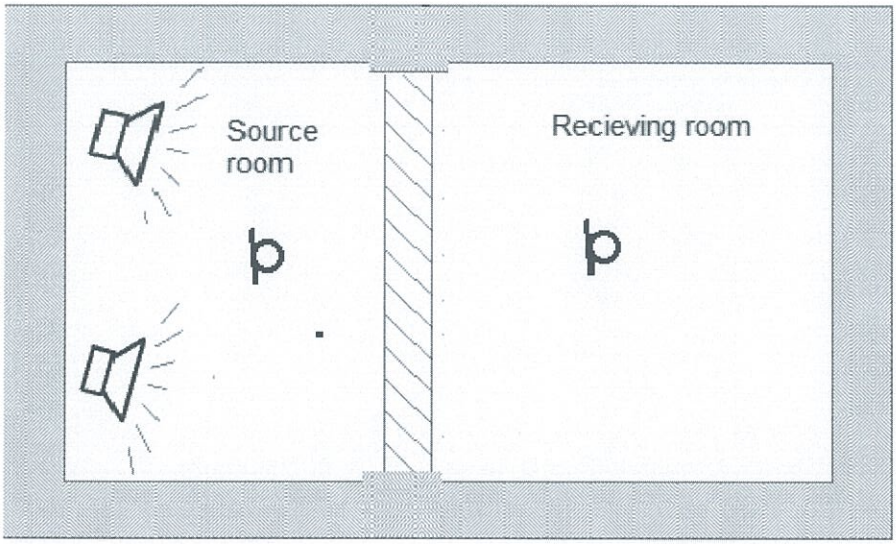


Figure (1) shows the selected positions of sound source and mic.

6. Calibration

The building acoustic analyzer connected to microphone is calibrated by using calibrator type 4231 (B&K) where the system is excited with signal at 1000 Hz. The system gave 94 dB.

7. Measurements and Instrumentation

The sound level meter type 2270 with Building Acoustics Software BZ-7228 connected with the sound source type 4292 (Brul & Kjaer) with amplifier. Pink noise generated to

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

excite the source room for two position of sound source and one position microphone for each position of sound source. The average sound pressure level in the source and receiving room is measured is determine. Sound pressure level detected by the microphone and integrated over a proper length of time (16 sec) by the sound level analyzer. In the measurement of reverberation time decay samples were taken for each position of sound source and the reverberation time was deduced from the average of the decay samples The average sound pressure level in the source and receiving room is measured by busing the rotating microphone boom type 3923 which sweeps the half inch microphone around a circular path. The sound pressure level detected by the microphone and integrated over a proper length of time by the building acoustic analyzer. In the measurement of reverberation time, 6 samples were taken for each frequency and the reverberation time was deduced from the average of the decay curve of the samples. The level difference, D is the difference in sound level between a pair of rooms, in a stated frequency band. The sound level difference D and sound reduction index R, calculated according to the international standard ISO 140 part 3 the sound reduction index, is defined by:

$$R = L_1 - L_2 + 10\log\frac{S}{A} dB$$

Where,
D= L_1-L_2
R = sound reduction index
L_1 = average sound pressure level in the source room
L_2 = average sound pressure level in the receiving room
S= the area of the test specimen in m^2

Figure 1 shows the arrangement and instrumentation and shows the selected positions of sound source and mic

8. Procedure For Evaluating the Weighted Sound Reduction Index R_W

For evaluating single number quantities of sound insulation rating of wall, Sound Reduction Index RW in the 16 test frequency bands are compared with those of the reference contour as given in ISO 717-1. If the Sound Reduction Index, R_W are plotted in a graph. The reference contour is shifted vertically relative to the test data until the sum of the deviations above the contour do not exceed 32 dB

This classification covers methods of calculating single number acoustical ratings for laboratory and field measurements of sound attenuation obtained in one-third octave bands. This value is determined as follows:

- The reference contour is defined by the array of values given in ISO717-1.
- The transmission loss data is rounded to which the contour is to be fitted to the nearest integer
- Fit the reference contour to the data by increasing simultaneously all the values in ISO in 1-dB increments until some of the data are less than the shifted reference contour.

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

- At each frequency the difference between the shifted reference value and the data is calculated. If a measured data point is less than the reference contour this is a deficiency; only
- Deficiencies are counted in the fitting procedure. increasing the reference contour values to the highest level that will satisfy the following conditions:

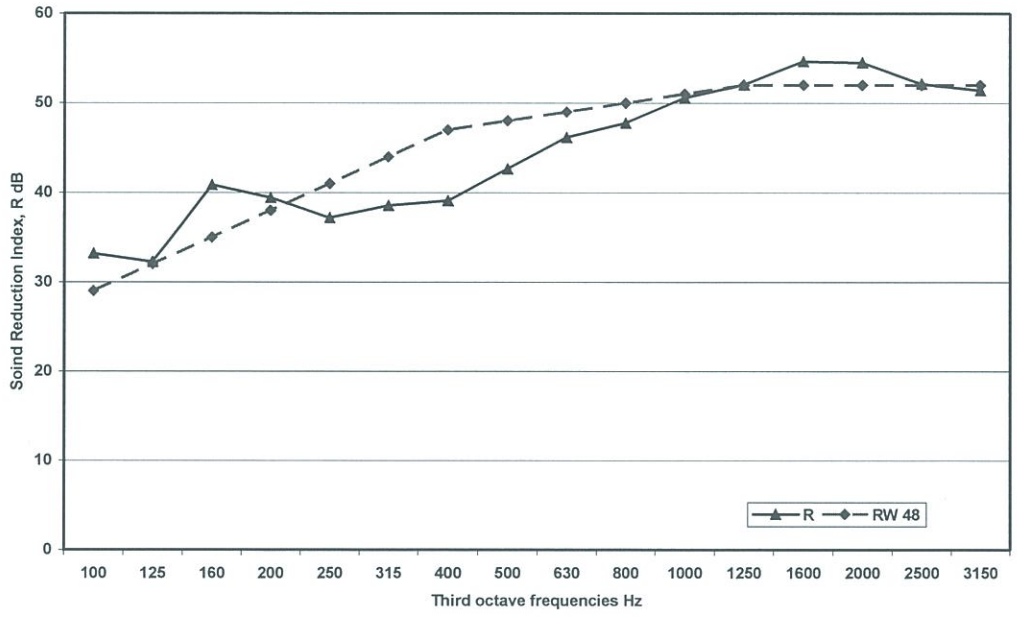
1. The sum of the deficiencies is less than or equal to 32 dB; and
2. The maximum deficiency at any one frequency does not exceed 8 dB.
3. The single-number rating is given by the value of the shifted reference contour at 500 Hz.

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Measurements of airborne sound insulation for wall according ISO 140-3, ISO717-1

Project name	**Assessment the acoustic performance for different masonry wall**	**Test name**	**airborne sound insulation**
Environmental cond.	T(ave).: 28	RH(ave): 56	
Sample specification	Autoclaved Aerated Concrete wall dimensions of blocks: 60 X 20 X 20 cm. The density of the blocks is: 650kg/m^3 - thickness of wall 24cm includes 2cm plaster at each side		
Date of test	29/8/2010	**Instrumentation**	SLM 2270 (B&K) & BZ BZ-7228 & mic 4189 (B&K) &S.S 4292 (B&K))
Area of the sample	2.45 m^2		
Receiving room volume	68 m^3	**Calibration deviation**	0.25 db
Source room volume	70 m^3		

Freq.	R_W
100	33.2
125	32.3
160	40.9
200	39.4
250	37.2
315	38.5
400	39.1
500	42.6
630	46.1
800	47.8
1000	50.6
1250	52.0
1600	54.6
2000	54.5
2500	52.2
3150	51.4
Rw	**48**



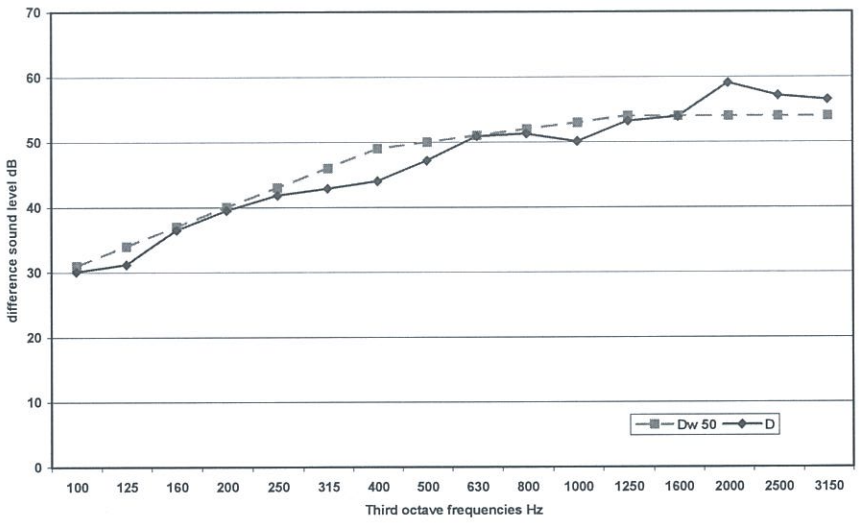
Activity Responsible	Deputy of Tech. Manage	Head of Institute
Dr. H. S. Seddeq	Prof.Dr.M.Abd-Gwad	Prof.Dr.M.Helal

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Measurements of airborne sound insulation for wall according ISO 140-3, ISO717-1

Project name	**Assessment the acoustic performance for different masonry wall**	**Test name**	**airborne sound insulation**
Environmental cond.	T(ave).: 28	RH(ave): 56	
Sample specification	Autoclaved Aerated Concrete wall dimensions of blocks: 60 X 20 X 20 cm. The density of the blocks is: 650kg/m^3 - thickness of wall 24cm includes 2cm plaster at each side.		
Date of test	29/8/2010	**Instrumentation**	SLM 2270 (B&K) & BZ BZ-7228 & mic 4189 (B&K) &S.S 4292 (B&K))
Area of the sample	2.45 m^2		
Receiving room volume	68 m^3	**Calibration deviation**	0.25 db
Source room volume	70 m^3		

Freq.	D_W
100	30.1
125	31.2
160	36.5
200	39.5
250	41.8
315	42.9
400	44.0
500	47.2
630	50.9
800	51.3
1000	50.1
1250	53.2
1600	53.9
2000	59.1
2500	57.2
3150	56.5
Dw	50



Activity Responsible	Deputy of Tech. Manager	Head of Institute
Dr. H. S. Seddeq	Prof.Dr.M.Abd-Gwad	Prof.Dr.M.Helal
		15-9-2010

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

9. Sound insulation limits

For more privacy between offices or between office and occupied space requires sound insulation for cellular office layouts the minimum acceptable sound insulation between two offices is **Dw = 48 dB** according to BS 8233

Laboratory minimum value of sound reduction index $\mathbf{R_W}$ for new internal walls within dwelling –houses, flats and rooms for residential purposes is **40** [BS 8233], [GREAT BRITAIN. Building Regulations 2000 (England and Wales, part E).

Requirements of airborne sound insulation, $\mathbf{R_W}$\ according to DIN 4109 for walls between operating or treatments rooms and wall between corridors and operating or treatments room is **42** in hospitals and sanatoria {DIN 4109}.

Requirements of airborne sound insulation, $\mathbf{R_W}$\ according to DIN 4109 for walls between wards, wards and corridors, corridors and examination room is **47** in hospitals and sanatoria {DIN 4109}.

10. Conclusion

The results shows that the weighted sound level $\mathbf{D_W}$ for the tested wall of Autoclaved Aerated Concrete is **50** that comply with the requirements for sound insulation for important privacy between offices or between office and occupied space that requires good sound insulation and moderate background noise to mask intruding speech in cellular office layouts.
Also the results shows that the weighted sound reduction index $\mathbf{R_W}$ for the tested sample is **48** that comply with the required sound insulation for new internal walls within dwelling –houses, flats and rooms for residential purposes [BS 8233], [GREAT BRITAIN. Building Regulations 2000 (England and Wales, part E)

And the sound insulation required for walls between wards, wards and corridors, corridors and examination room in hospitals and sanatoria according to DIN 4109

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

ACOUSTIC ACTIVITY

Measurement of Laboratory Sound Transmission for Wall of (Autoclaved Aerated Concrete) Blocks Delivered from Delta Sand Bricks [Delta block] Company

Block dimensions 60 X 20 X 20 cm
With Plastering

Tel : (02)33356722 / 33356853
FAX : (02)33351564

P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Supplier name	Delta Block	**Testing name**	Laboratory sound transmission loss According to ASTM E-90
Supplier code	BPI-A-006	**Testing date**	29/8/2010
Delivery Date	13/9/2010	**Sample Code**	BPI-A-TL2-013
Delivery No.	1177	**Report NO**	BPI-A-TL2-013/006
Project name	Assessment the acoustic performance for different sand block wall		

1. Test Objects

This test method is for evaluating the sound insulating properties of masonry wall that is composite of sand, cement, lime and aluminum powder (Autoclaved Aerated Concrete). Autoclaved Aerated Concrete wall is installed in acoustic laboratory between two rooms and the measurements are carried out according to ASTM E-90. The sound Transmission Loss between the source room and the receiving room where the sample is between the two spaces measured and the sound transmission class is determined. The specification of the sample as follows:

The Autoclaved Aerated Concrete blocks have dimensions: 60 X 20 X 20 cm
The density of the block: 650kg/m^3
The thickness of the wall is 24 cm includes 2cm plaster at each side

2. Test Signal

5. The sound signals used for the tests are pink noise over third octave bands with mid-band frequencies from 100 to 8000 Hz is radiated by sound source type 4224 (B&K)

3. Sound Sources

6. The sound source type 4292 (B&K) is used for the test and radiate sound over wide angle. Sound source is enough away from the test partition and pointing in to the test specimens. The sound source radiates enough sound above the back ground noise (more than 10 dB).

4. Sound source positions

Two position of sound source is selected where 5 m from the sample and 1.5 m, from any surface and 2 m from the mic. positions

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

5. Microphone and positions

1/2 inch rotating microphone type 4189 (B&K) is used to measure average sound pressure levels in the source room and receiving room. The sound decay rates in the receiving room is measured 3 time for each position of sound source. The rotating microphone is used in 1 position that is 1.75 from the sound source in source room and 1 position in the receiving room that is 1.5 m from the sample. The sound pressure level is measured for 4 times for each position of the sound source (two position). The number of sound pressure level measurements for each room (source room and receiving room) is 8 .

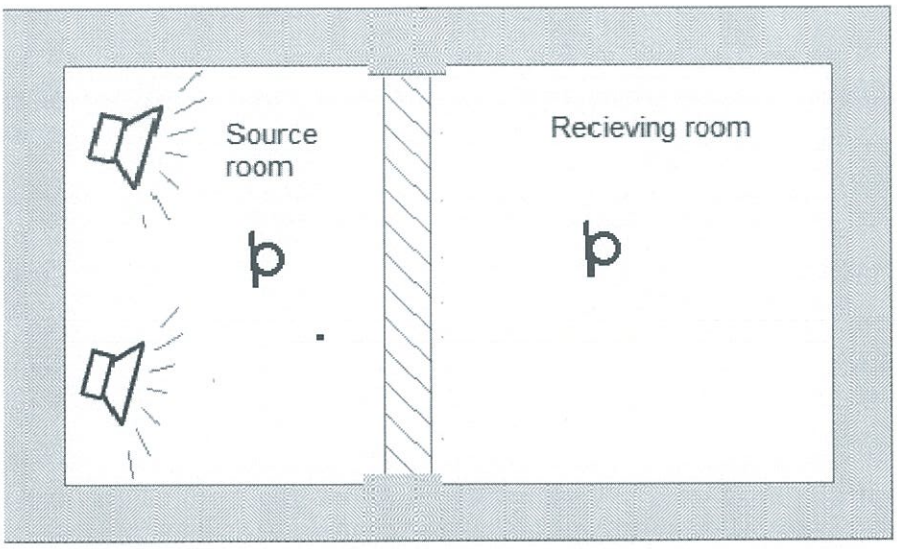


Figure (1) shows the selected positions of sound source and mic.

6. Calibration

The building acoustic analyzer connected to microphone is calibrated by using calibrator type 4231 (B&K) where the system is excited with signal at 1000 Hz. The system gave 94 dB.

7. Sound transmission loss measurements

The measurements also are carried out according to **ASTM E90 and ASTM E2235 to** determine the Sound Transmission and the Sound Transmission Class STC. According to **ASTM 413**

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Building National Research Center
BPI
Building Physics & Environment Institute

٢٠/٩/١٠

- **Measurements procedure**

The sound level meter type 2270 with Building Acoustics Software BZ-7228 connected with the sound source type 4292 (Brul & Kjaer) with amplifier. Pink noise generated to excite the source room for two position of sound source and one position microphone for each position of sound source. The average sound pressure level in the source and receiving room is measured is determine. Sound pressure level detected by the microphone and integrated over a proper length of time (16 sec) by the sound level analyzer. In the measurement of reverberation time, 3 decay samples were taken for each position of sound source and the reverberation time was deduced from the average of the decay samples.

- **Determination of Receiving Room Absorption A**

The source room absorption and receiving room absorption, A_2 is determined by measuring the reverberation time in the receiving room in the same one-third octave bandwidths according to **ASTME2235**. The sound absorption of the receiving room, *A2* is determined, by

$$A2= 0.921\, Vd/c$$

where:
A2= sound absorption of the room, m^2
c = speed of sound in air, m/s,
V = volume of room, m3, and
d = rate of decay of sound pressure level in the room, dB/s.
where:
$d = 60/T$,
T is reverberation time in seconds

Then the sound transmission loss is calculated according to the international standard ASTM E90 04 , the sound transmission loss is found from

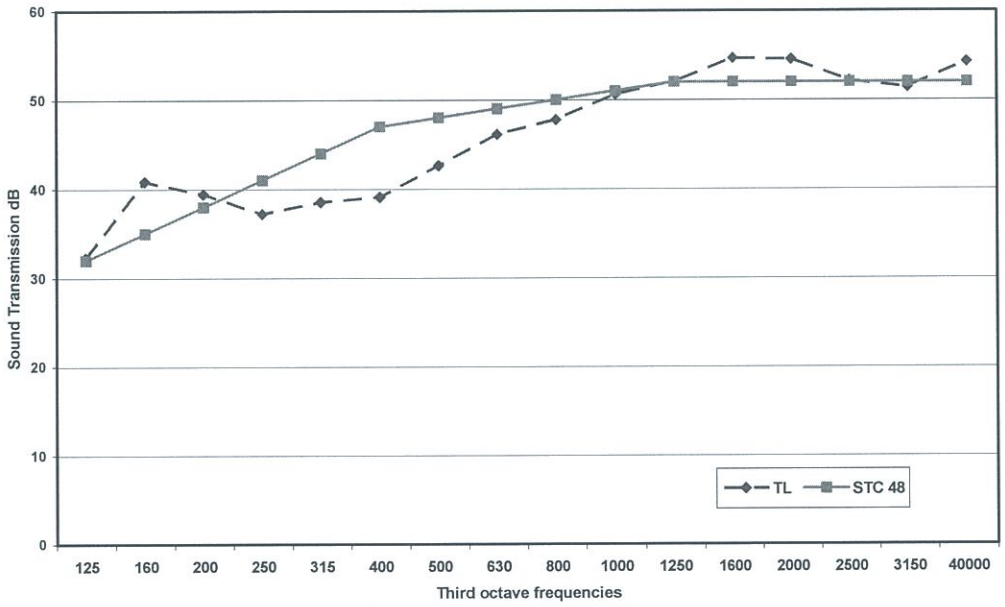
$$\mathbf{TL = L1 - L2 + 10\log(S/A2)}$$

Where
L1 = average sound pressure level in the source room
L2 = average sound pressure level in the receiving room
S = area of the test specimen
A2 = equivalent absorption area in the receiving room,

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

Measurements of laboratory sound transmission loss according to ASTM E90-04 & ASTME 2235- 04 & ASTM E413			
Project name	**Assessment the acoustic performance for different masonry wall**	**Test name**	**Laboratory sound insulation**
Environmental cond.	Tave.:	RHave:	
Sample specification	Autoclaved Aerated Concrete wall dimensions of blocks: 60 X 20 X 20 cm. The density of the blocks is: 650kg/m^3 - thickness of wall 24cm includes 2cm plaster at each side		
Date of test	**29/8/2010**	**Instrumentation**	SLM 2270 (B&K) & BZ BZ-7228 & mic 4189 (B&K) &S.S 4292 (B&K)
Area of the sample	**2.45 m^2**		
Receiving room volume	**68 m^3**	**Calibration deviation**	**0.25 db**
Source room volume	**70 m^3**		

Freq.	TL
125	32.3
160	40.9
200	39.4
250	37.2
315	38.5
400	39.1
500	42.6
630	46.1
800	47.8
1000	50.6
1250	52.0
1600	54.6
2000	54.5
2500	52.2
3150	51.4
4000	54.3
STC	48



Activity Responsible	Deputy of Tech. Manager	Head of Institute
Dr. H. S. Seddeq	Prof.Dr.M.Abd-Gwad	Prof.Dr.M.Helal

15.9.2010

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt

8. Conclusion

The results shows that the sound transmission class for the tested Autoclaved Aerated Concrete wall **STC** is **45** that comply with the required minimum STC ratings for single or composite wall, floor-ceiling, and roof-ceiling assemblies that separate an enclosed core learning space from an adjacent space in schools [Corridor, a staircase, office or conference room] [ANSI S12.60-2002]

Tel : (02)33356722 / 33356853
FAX : (02)33351564
P.O. BOX 1770
87 El-Tahrir St., Dokki, Cairo, Egypt