ACOUSTICS AND LIGHTING DEPARTMENT

Acoustics Test Laboratory

TEST REPORT N° AC10-26024605/1 CONCERNING THE NUDURA® INSULATED CONCRETE FORM SYSTEM

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It comprises forty-seven pages.

REQUESTED BY: **NUDURA® CORPORATION**
27 Hooper Road – Unit 10
Barrie, Ontario
L4N 9S3
CANADA

N/Ref.:   BR-70021405
          26024605
          TB/GA

CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT

SIÈGE SOCIAL > 84 AVENUE JEAN JAURÈS | CHAMPS–SUR–MARNE | 77447 MARNE–LA–VALLÉE CEDEX 2
TÉL. (33) 01 64 68 84 87 | FAX. (33) 01 64 68 83 14 | **www.cstb.fr**
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TEST SCOPE

Determination of the airborne sound reduction index R of the NUDURA® Insulated Concrete Form System.

REFERENCE TEXTS

The measurements were carried out according to Standards NF EN ISO 140-1 (1997), NF EN 20140-2 (1993) and NF EN ISO 140-3 (1995) supplemented by the Standard NF EN ISO 717/1 (1997) for the expression of the overall weighted index $R_W(C;C_{tr})$.

The measurements of the elasticity modulus were carried out according to Standard ISO/PAS 16940 adapted to gypsum board issue/purpose (specified in our LABE/MRF test method). The results are presented in APPENDIX 4.

TEST SPECIMEN

Date of reception in the laboratory : April 26th, and August 9th and 11th, 2010
Origin and installation   : Requester (insulated concrete forms system, facings wall)
                                          CSTB (concrete)

SUMMARY LIST OF TESTS

Test #   **Object submitted for testing**

1   NUDURA® insulated concrete wall with concrete core of 152 mm (6'').

2   NUDURA® insulated concrete wall with concrete core of 152 mm (6'') and one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides.

3   NUDURA® insulated concrete wall with concrete core of 152 mm (6''), one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and plasterboard BA13 Placo® Phonique on external side.

4   NUDURA® insulated concrete wall with concrete core of 152 mm (6''), one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and one asphalt layer of SOPREMA covered with plasterboard BA13 Placo® Phonique on external side.

5   NUDURA® insulated concrete wall with concrete core of 152 mm (6''), one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side.

6   NUDURA® insulated concrete wall with concrete core of 203 mm (8″).

7   NUDURA® insulated concrete wall with concrete core of 203 mm (8″) and one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides.

8   NUDURA® insulated concrete wall with concrete core of 203 mm (8″), one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side.

9   NUDURA® insulated concrete wall with concrete core of 203 mm (8″), one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and inner partition on external side.

10   Concrete wall of 203 mm (8″) (without EPS panels both sides).

Prepared at Marne-la-Vallée, June 28, 2011

Responsible for the tests   Head of division

Thibaut BLINET   Jean-Baptiste CHÉNÉ
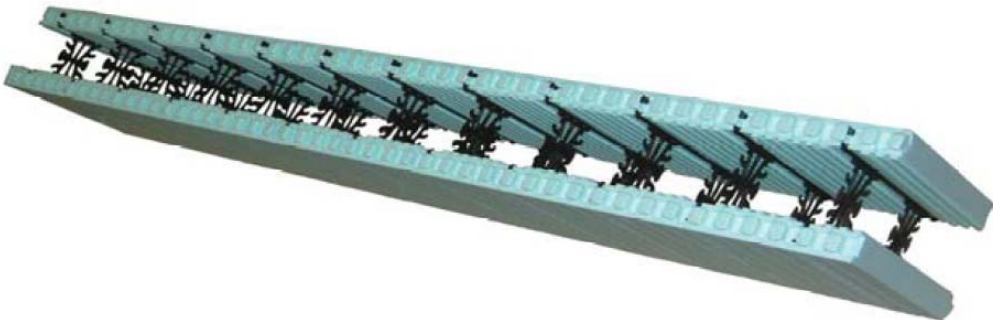
	Test	1
	Date	17/08/10
	Station	EPSILON

DESCRIPTION
OF AN INSULATED CONCRETE FORM SYSTEM

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'')**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 286
Mass per unit area in kg/m : ~ 773

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Composed of several form units consisting of two expanded polystyrene (EPS) foam plastic panels connected together with hinged HD polypropylene web, creating a formwork. Mass per unit area measured: ~ 6.33 kg/m - EPS panels: Length 2438, Height 457, Thickness 67 and density of 21.6 kg/m^3. Two panels are spaced 152 to cast concrete (=> concrete core of 152). Internal face is grooved to allow good adhesion with concrete. The upper and lower parts are equipped with slots to the vertical interlocking. - HD polypropylene hinged fastening strips: Length 152 are embedded in panels at 203 intervals, allowing the screwing of finishes, and are articulated thanks to steel hinge pins.

DESCRIPTION AND INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM

Test	1
Date	17/08/10
Station	EPSILON

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
                    CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 152 mm (6'')**

FITNESS FOR PURPOSE   **DTA 16/09-581**
                          ATE 07/0034

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	- Connection and sealing: Horizontal joint clips, length 219, are pre-bent steel wires that enable the locking between horizontal form units only where required for form specific support. NUDURA® Low Expansion Spray Foam in boxes of 750 ml. - Concrete core: Cement type: CEM 3 50/50 Exposition class: XC1 Minimum strength class: C25/30 Consistency class: S3 Nominal maximum aggregate size (Dmax): 10 Class chlorides: Cl 0.4

INSTALLATION (dimensions are given in mm)

Insulated concrete forms system:

Form units are placed on concrete footings with primers HA6 at 600 on centre intervals.

Successive form units of the first row are connected horizontally with each other using vertical joint clips used at each junction, the high and low ends of polypropylene webs.

The installation of additional rows is made by fitting the upper row on the bottom row, with an offset of 400 between the vertical joints.

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INSTALLATION	**Test**	**1**
OF AN INSULATED CONCRETE FORM SYSTEM	**Date**	**17/08/10**
	Station	**EPSILON**

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 152 mm (6'')**

FITNESS FOR PURPOSE   **DTA 16/09-581**
ATE 07/0034

INSTALLATION (dimensions are given in mm)

Once the stack is completed, expanding foam is applied to seal or obstruct the form units between them and the footing concrete. The concrete is casted between the EPS panels.

NOTE

The test was performed 98 days after concrete placement.
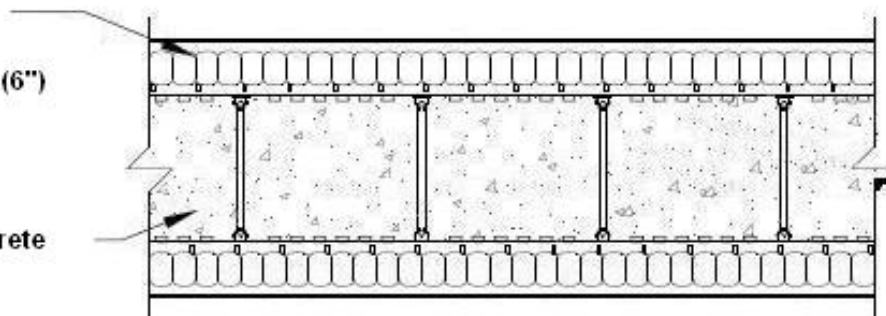

Emission and reception rooms

DRAWINGS
OF AN INSULATED CONCRETE FORM SYSTEM

Test 1
Date 17/08/10
Station EPSILON

REQUESTER NUDURA® CORPORATION

MANUFACTURERS NUDURA® CORPORATION (insulated concrete forms system)
CSTB (concrete)

NAME NUDURA® Insulated Concrete Forms (ICF)

CONFIGURATION Concrete core of 152 mm (6'')
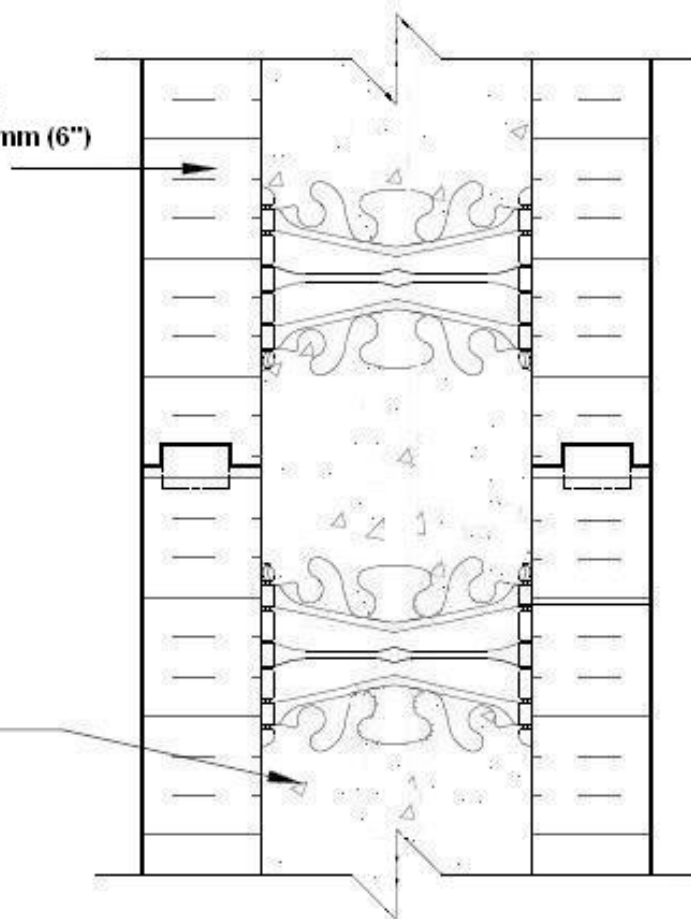
FITNESS FOR PURPOSE DTA 16/09-581
ATE 07/0034

TEST REPORT N° AC10-26024605/1

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM

AD13

Test	1
Date	17/08/10
Station	EPSILON

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 152 mm (6'')**

FITNESS FOR PURPOSE   **DTA 16/09-581**
ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 286
Mass per unit area in kg/m : ~ 773

MEASUREMENT CONDITIONS

Source room:
Temperature: 22.5 °C
Relative humidity: 42 %

Receiving room:
Temperature: 23 °C
Relative humidity: 43 %

RESULTS

■ R en / in dB   —— Courbe de référence / Reference curve
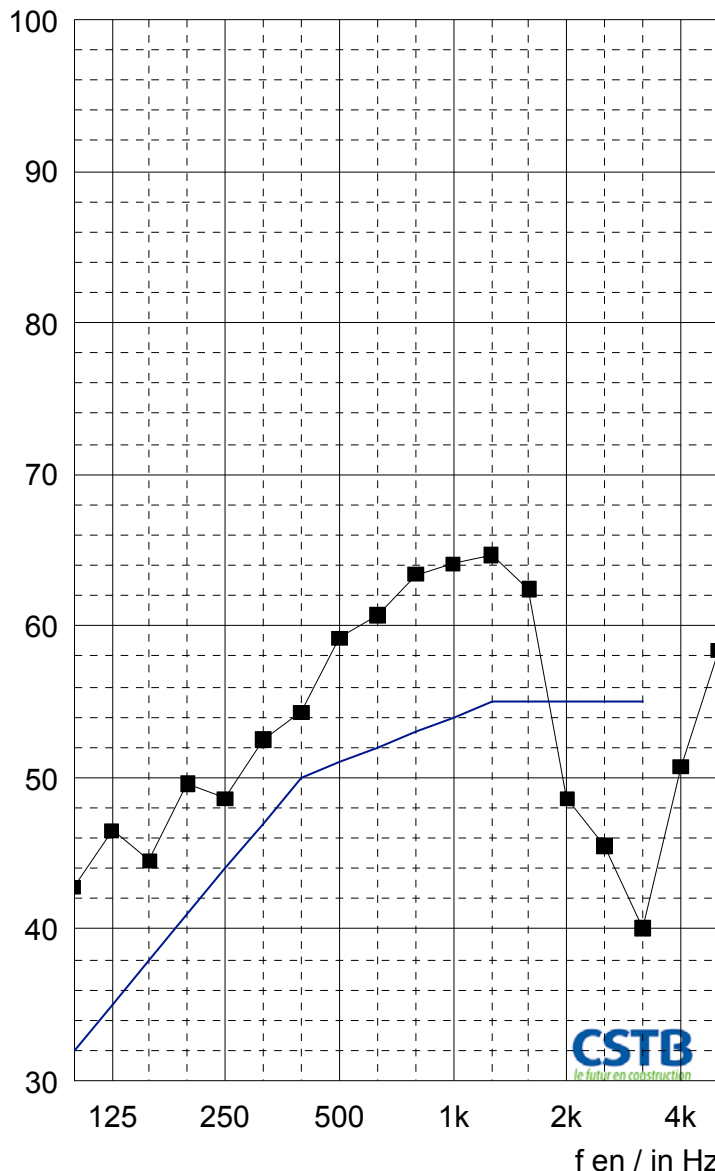
f	R
100	42,8
125	46,5
160	44,5
200	49,6
250	48,6
315	52,5
400	54,3
500	59,2
630	60,7
800	63,4
1000	64,1
1250	64,7
1600	62,4
2000	48,6
2500	45,5
3150	40,1
4000	50,7
5000	58,4
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$R_w (C;C_{tr}) = 51(-4;0)$ dB

Pour information / For information:
$R_A = R_w + C = 47$ dB
$R_{A,tr} = R_w + C_{tr} = 51$ dB

f en / in Hz

DESCRIPTION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	2
Date	18/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (facings)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 311
Mass per unit area in kg/m : ~ 788

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the Test #1 Page 4 and 5.
Facings	Composed of one layer of gypsum board ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and mass per unit area measured 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	2
Date	18/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

INSTALLATION (dimensions are given in mm)

Supporting wall:

Identical installation to the Test #1 Page 5 and 6.

Facings:

Gypsum boards are placed horizontally, in single layer, on both sides, and screwed on EPS panels fastening strips at 400 on centre intervals.

The joints treatment between panels and board edges (5 thick in the upper part and laterally) is carried out by a fast drying coat and joint tape system.
In the lower part, the 10 thick joint is filled by soft filler.

NOTE

The test was performed 24 hours after installation of facings.

Emission and reception rooms

DRAWINGS
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

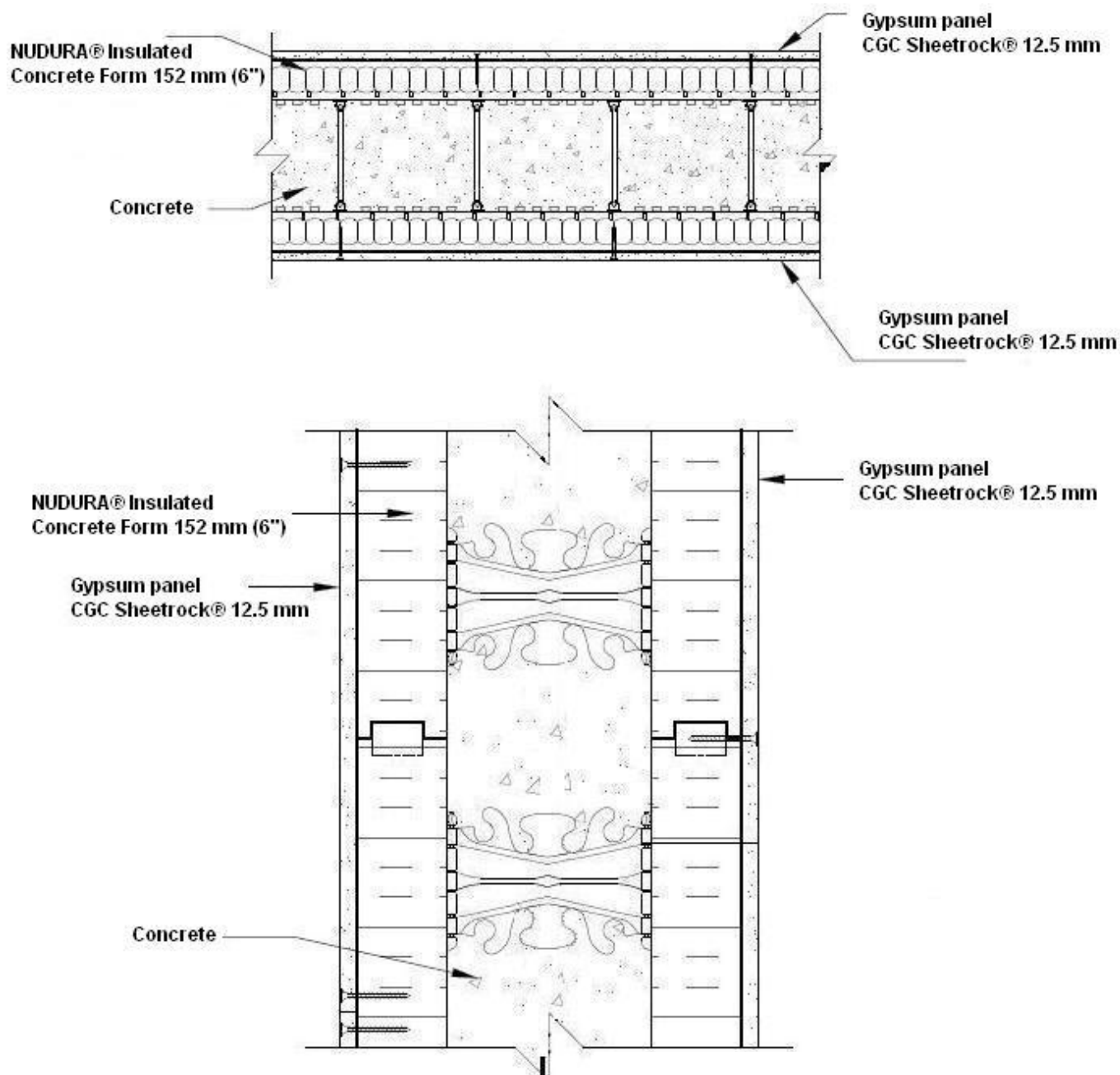|	
Test	2
Date	18/08/10
Station	EPSILON

REQUESTER   NUDURA® CORPORATION

MANUFACTURERS   NUDURA® CORPORATION (insulated concrete forms system)
CGC (facings)
CSTB (concrete)

NAME   NUDURA® Insulated Concrete Forms (ICF)

CONFIGURATION   Concrete core of 152 mm (6'') with one layer of gypsum board
CGC Sheetrock® 12.5 mm on both sides

FITNESS FOR PURPOSE DTA 16/09-581
ATE 07/0034

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

Test	**2**
Date	**18/08/10**
Station	**EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (facings)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board** **CGC Sheetrock® 12.5 mm on both sides**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 311
Mass per unit area in kg/m : ~ 788

MEASUREMENT CONDITIONS

Source room:
Temperature: 22 °C
Relative humidity: 72 %

Receiving room:
Temperature: 23.5 °C
Relative humidity: 67 %

RESULTS

■ R en / in dB   ── Courbe de référence / Reference curve
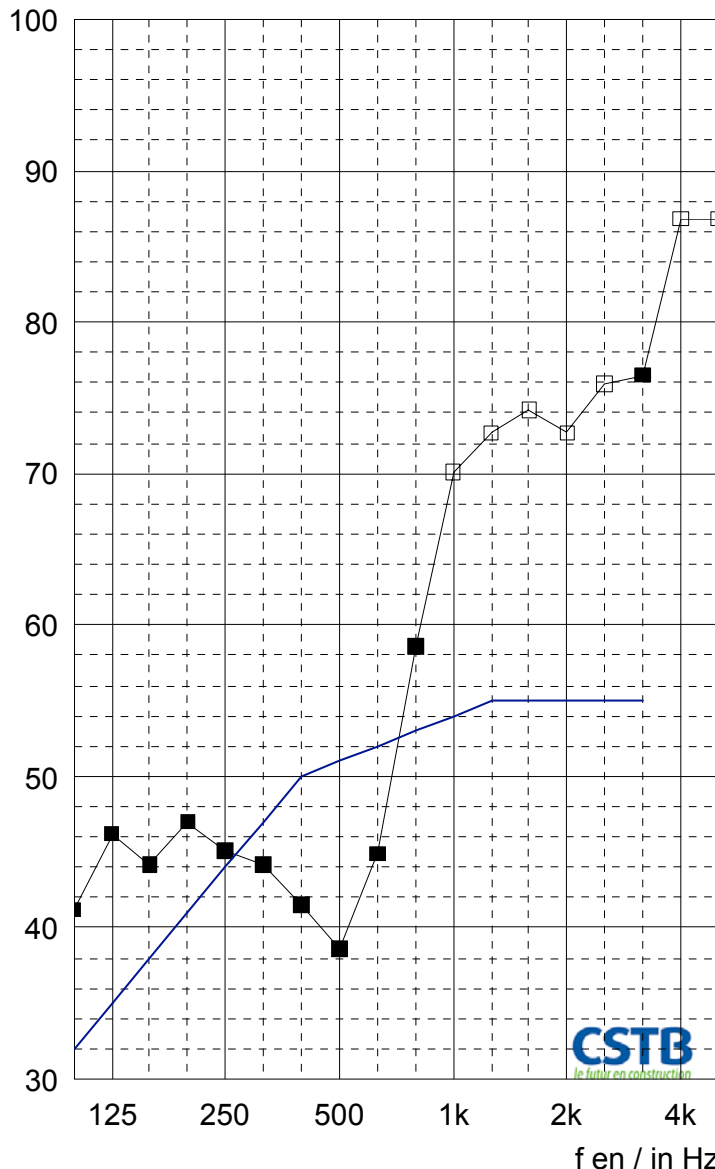
f	R
100	41,2
125	46,2
160	44,2
200	47,0
250	45,1
315	44,2
400	41,5
500	38,6
630	44,9
800	58,6
1000	70,1*
1250	72,7*
1600	74,2*
2000	72,7*
2500	75,9*
3150	76,5
4000	86,8*+ (97,9)
5000	86,8*+ (97,9)
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$R_w (C;C_{tr}) = 51(-2;-4)$ dB

Pour information / For information:
$R_A = R_w + C = 49$ dB
$R_{A,tr} = R_w + C_{tr} = 47$ dB

f en / in Hz

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DESCRIPTION	Test	3
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS	Date	19/08/10
	Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (first facing)** **PLACOPLATRE® (second facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 323.5
Mass per unit area in kg/m : ~ 800

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the Test #1 Page 4 and 5.
Facings	- First facing composed of one layer (both sides) of gypsum board ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Second facing composed of one layer (external side) of plasterboard ref. BA13 Placo® Phonique (PLACOPLATRE®) of dimensions 2600 x 1200 x 12.5 and measured mass per unit area 11.44 kg/m . Young's modulus of plasterboard (average of first three modes): E = 3.175 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	**3**
Date	**19/08/10**
Station	**EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (first facing)** **PLACOPLATRE® (second facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

INSTALLATION (dimensions are given in mm)

Supporting wall:

Identical installation to the Test #1 Page 5 and 6.

Facings:

First facing installation is identical to the Test #2 Page 10.

A second layer of plasterboard is placed vertically and is screwed, external side, on gypsum board at ~ 400 on centre intervals.

The joints treatment between panels and board edges (5 thick in the upper part and laterally) is carried out by a fast drying coat and joint tape system.
In the lower part, the 10 thick joint is filled by soft filler.

NOTE

The test was performed 24 hours after installation of facings.

Emission and reception rooms

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DRAWINGS	Test	3
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS	Date	19/08/10
	Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)**
	CGC (first facing)
	PLACOPLATRE® (second facing)
	CSTB (concrete)
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581**
	ATE 07/0034

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

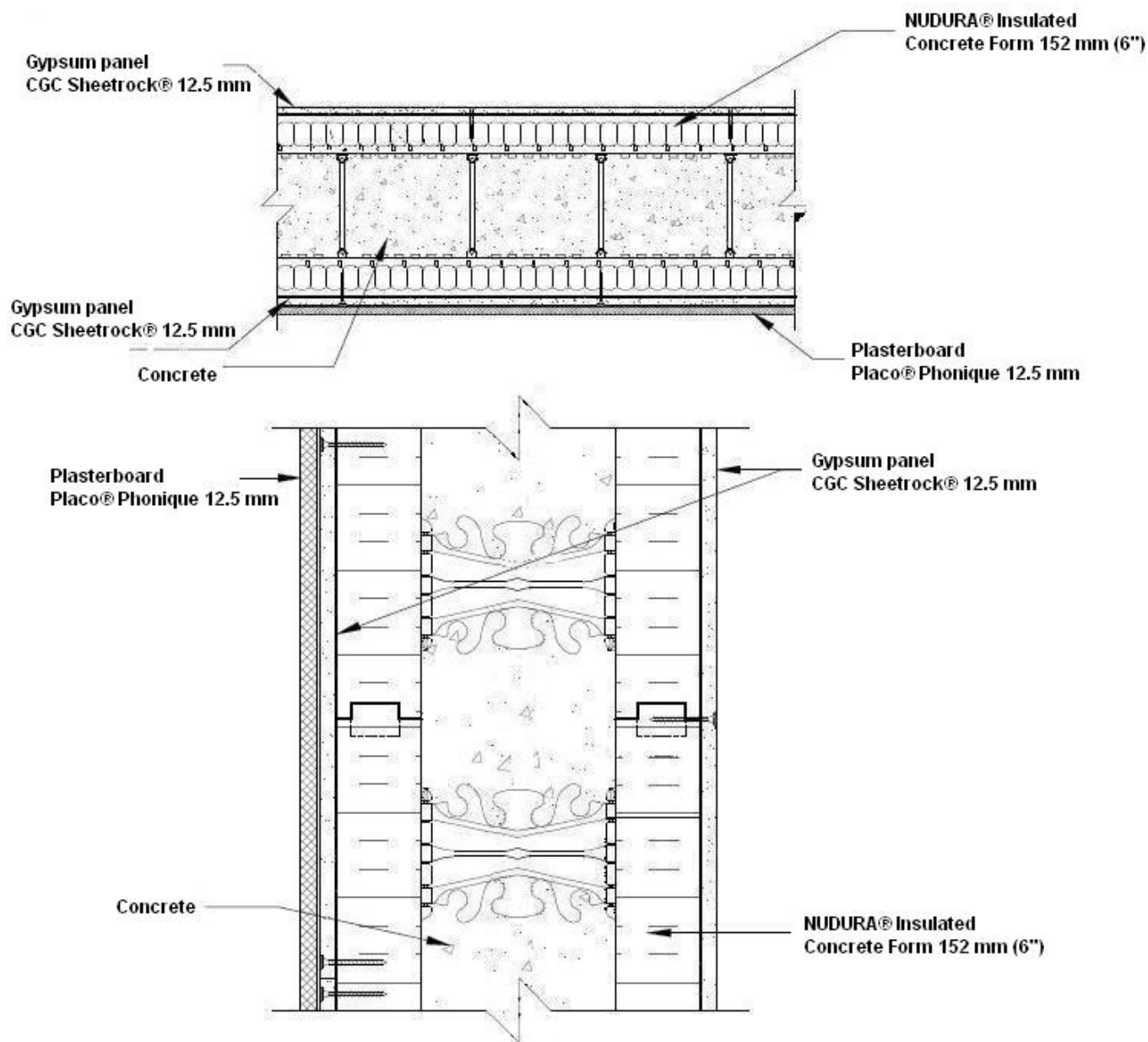| Test	3
Date	19/08/10
Station	EPSILON

REQUESTER NUDURA® CORPORATION

MANUFACTURERS NUDURA® CORPORATION (insulated concrete forms system)
CGC (first facing); PLACOPLATRE® (second facing)
CSTB (concrete)

NAME NUDURA® Insulated Concrete Forms (ICF)

CONFIGURATION Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and plasterboard BA13 Placo® Phonique on external side

FITNESS FOR PURPOSE DTA 16/09-581
ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 323.5
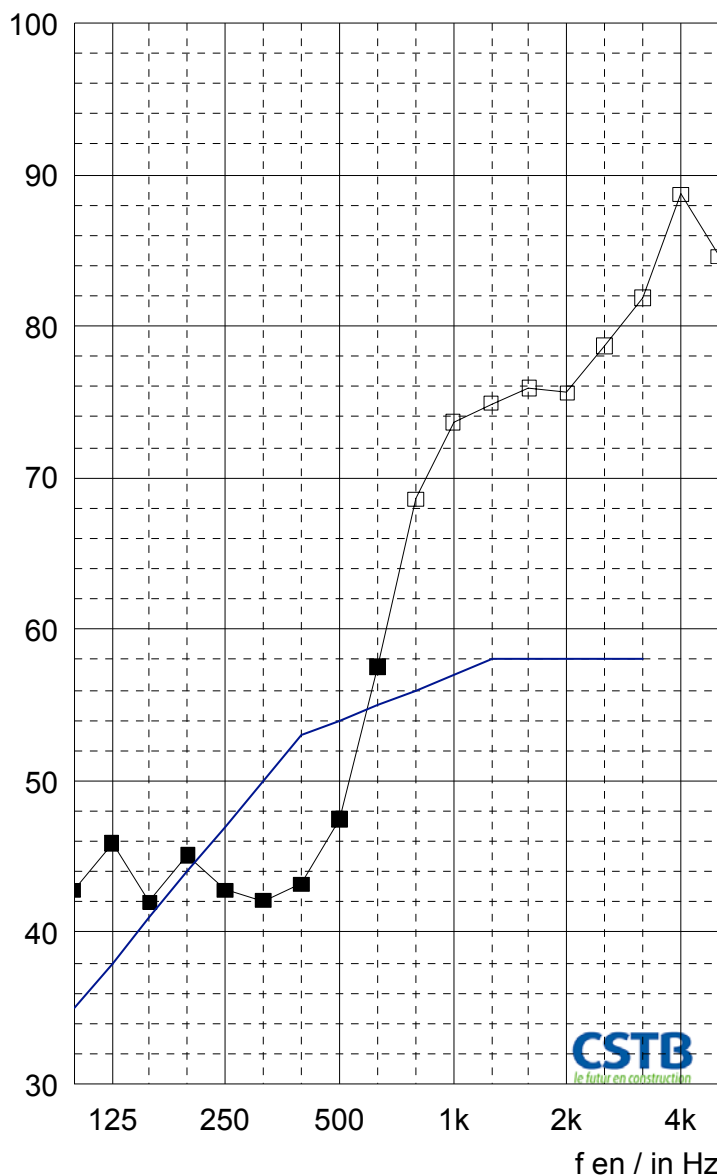Mass per unit area in kg/m : ~ 800

MEASUREMENT CONDITIONS

Source room:
Temperature: 21 °C
Relative humidity: 57 %

Receiving room:
Temperature: 23 °C
Relative humidity: 64 %

RESULTS

■ R en / in dB   —— Courbe de référence / Reference curve

f	R
100	42,8
125	45,9
160	42,0
200	45,1
250	42,8
315	42,1
400	43,2
500	47,5
630	57,5
800	68,6*
1000	73,7*
1250	74,9*
1600	75,9*
2000	75,6*
2500	78,7*
3150	81,9*+ (93,2)
4000	88,7*+ (97,9)
5000	84,6*+ (97,9)
Hz	dB

(*) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$$R_w (C; C_{tr}) = 54(-1; -4) \text{ dB}$$

Pour information / For information:
$R_A = R_w + C = 53$ dB
$R_{A,tr} = R_w + C_{tr} = 50$ dB

DESCRIPTION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	4
Date	20/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (first facing)** **SOPREMA (interposition)** **PLACOPLATRE® (external second facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and one asphalt layer of SOPREMA covered with plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 337
Mass per unit area in kg/m : ~ 805

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the Test #1 Page 4 and 5.
Facings	- First facing composed of one layer (both sides) of gypsum board ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Adhesive asphalt panels (external side) ref. STICKSON (SOPREMA) thickness 3.5 and mass per unit area 5 kg/m . - Second facing composed of one layer (external side) of plasterboard ref. BA13 Placo® Phonique (PLACOPLATRE®) of dimensions 2600 x 1200 x 12.5 and measured mass per unit area 11.44 kg/m . Young's modulus of plasterboard (average of first three modes): E = 3.175 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

TEST REPORT N° AC10-26024605/1

INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	4
Date	20/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (first facing)** **SOPREMA (interposition)** **PLACOPLATRE® (external second facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and one asphalt layer of SOPREMA covered with plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

INSTALLATION (dimensions are given in mm)

Supporting wall:

Identical installation to the Test #1 Page 5 and 6.

Facings:

First facing installation is identical to the Test #2 Page 10.

An adhesive asphalt layer is glued on external side and covered by a second layer of plasterboard screwed at ~ 400 on centre intervals.

The joints treatment between panels and board edges (5 thick in the upper part and laterally) is carried out by a fast drying coat and joint tape system.
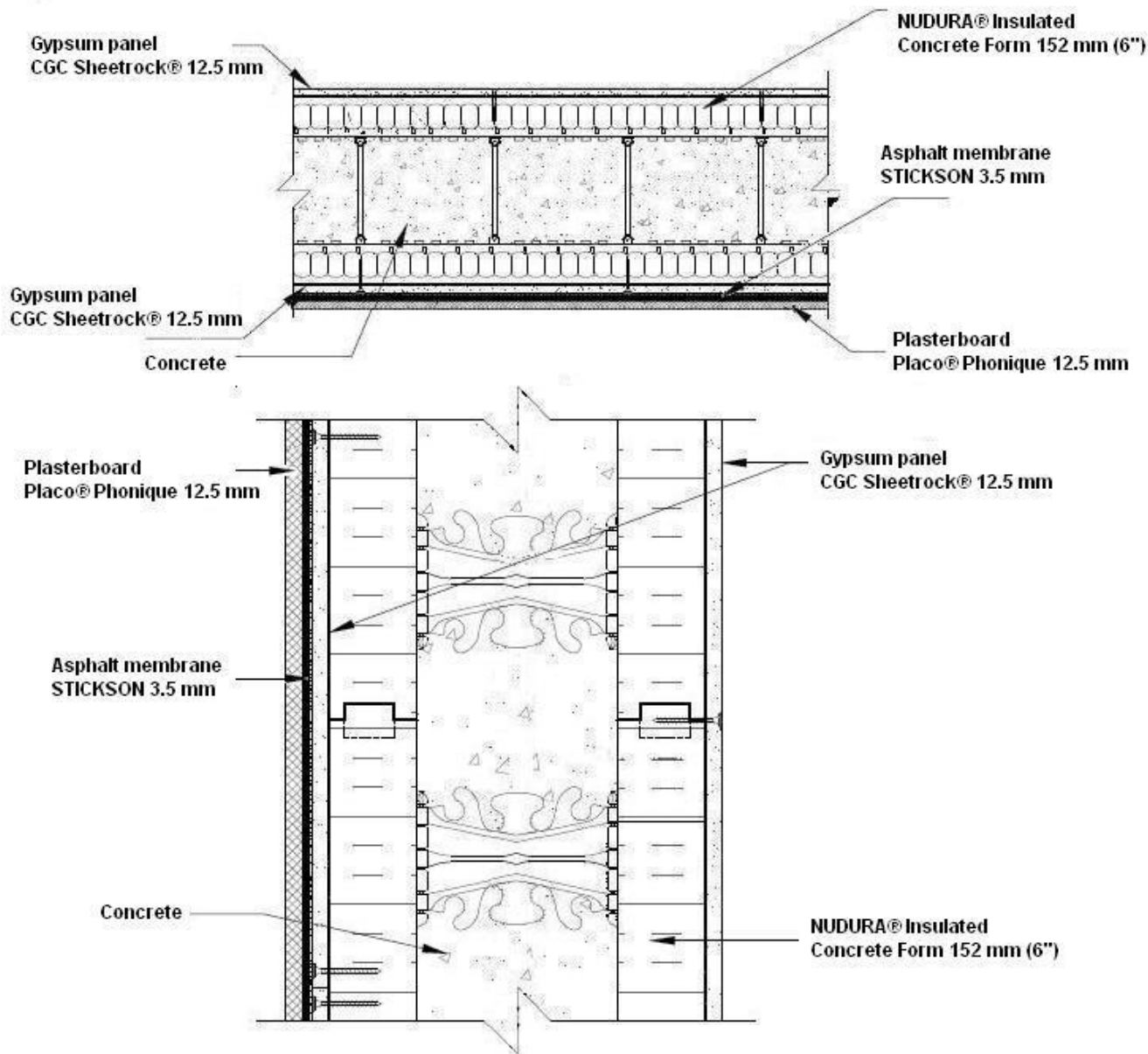In the lower part, the 10 thick joint is filled by soft filler.

NOTE

The test was performed 24 hours after installation of facings.

	Test	4
DRAWINGS	Date	20/08/10
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS	Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (first facing)** **SOPREMA (interposition)** **PLACOPLATRE® (external second facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and one asphalt layer of SOPREMA covered with plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

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TEST REPORT N° AC10-26024605/1

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

Test	4
Date	20/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)**
	CGC (first facing); SOPREMA (interposition)
	PLACOPLATRE® (external second facing); CSTB (concrete)
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides, and one asphalt layer of SOPREMA covered with plasterboard BA13 Placo® Phonique on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581**
	ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 337
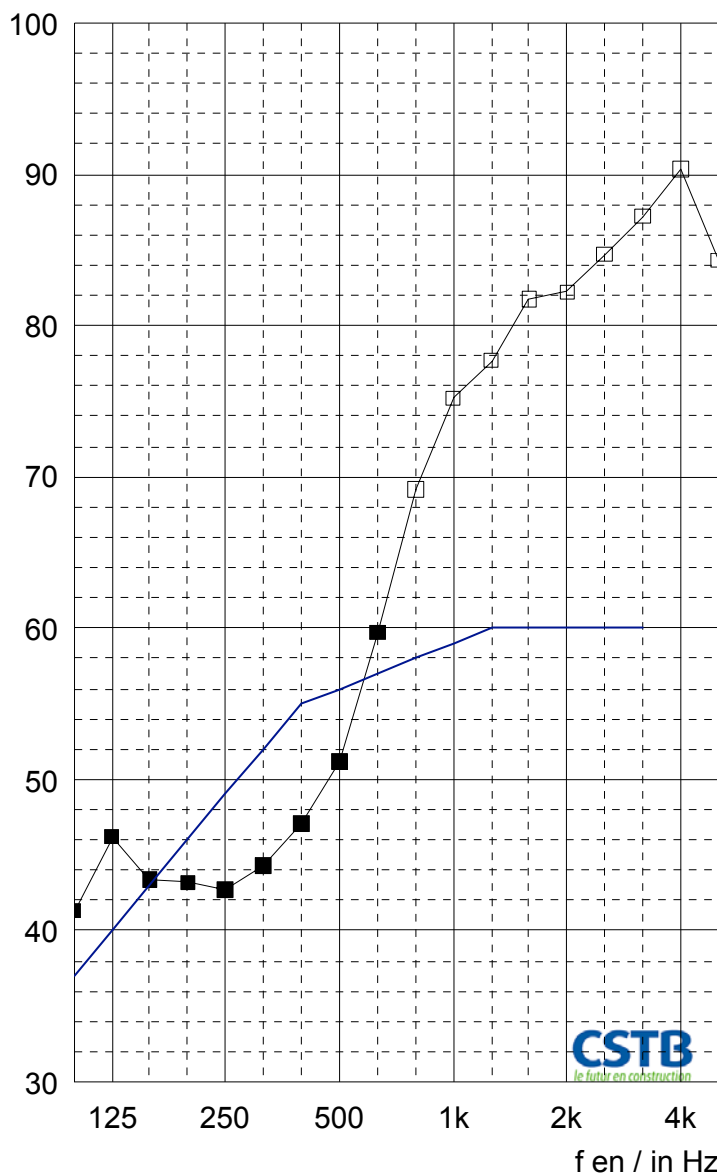Mass per unit area in kg/m : ~ 800

MEASUREMENT CONDITIONS

Source room:
Temperature: 22.5 °C
Relative humidity: 66 %

Receiving room:
Temperature: 23 °C
Relative humidity: 63 %

RESULTS

— R en / in dB —— Courbe de référence / Reference curve

f	R
100	41,3
125	46,2
160	43,4
200	43,2
250	42,7
315	44,3
400	47,1
500	51,2
630	59,7
800	69,2*
1000	75,2*
1250	77,7*
1600	81,7*+ (96,1)
2000	82,2*+ (96,8)
2500	84,7*+ (96,0)
3150	87,2*+ (93,2)
4000	90,3*+ (97,9)
5000	84,3*+ (97,9)
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$$R_w (C;C_{tr}) = 56(-1;-5) \text{ dB}$$

Pour information / For information:
$R_A = R_w + C = 55 \text{ dB}$
$R_{A,tr} = R_w + C_{tr} = 51 \text{ dB}$

TEST REPORT N° AC10-26024605/1

DESCRIPTION AND INSTALLATION OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS	**Test** **5** **Date** **23/08/10** **Station** **EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF) without external insulation**
CONFIGURATION	**Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 231.5
Mass per unit area in kg/m : ~ 774

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the Test #1 Page 4 and 5, without EPS outer panels.
Facings	Composed of one layer of gypsum board (internal side only) ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION (dimensions are given in mm)

Supporting wall:

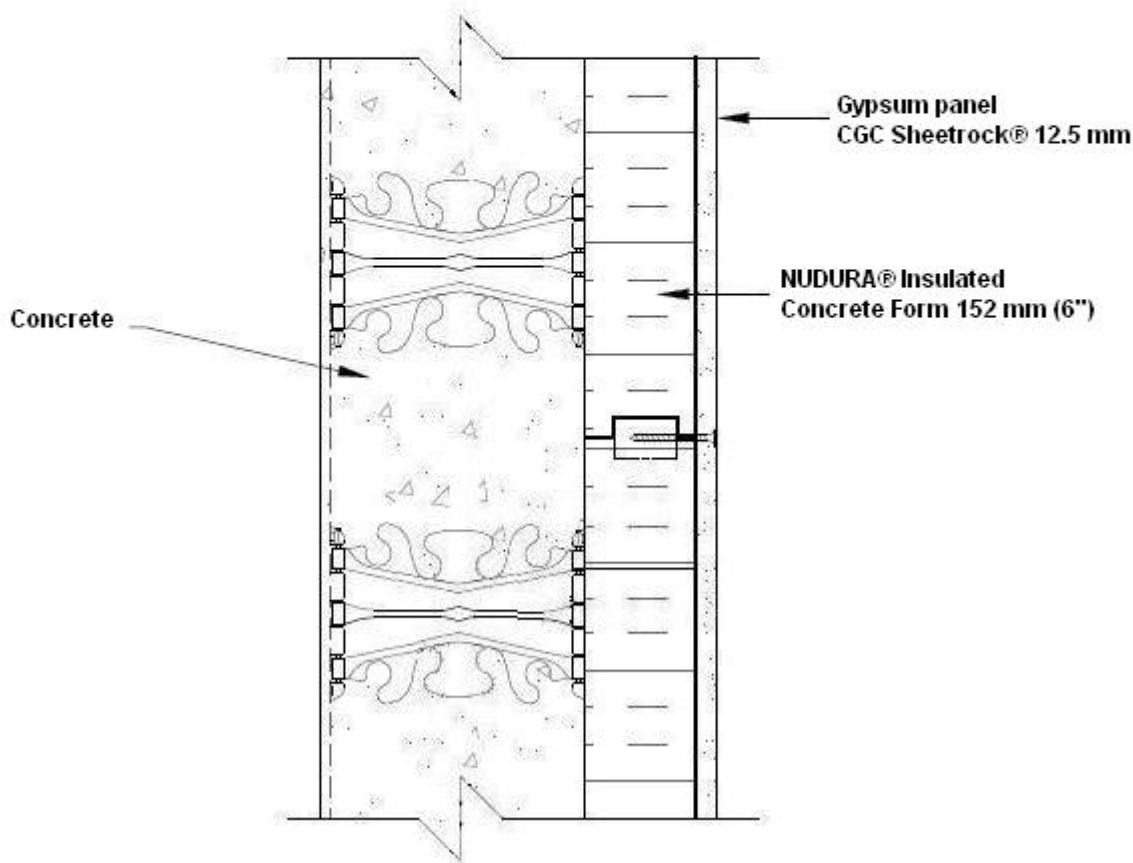Identical installation to the Test #1 Page 5 and 6.

Facings:

First facing installation, only on internal side, is identical to the Test #2 Page 10.

The other side is cleared of EPS panels. The concrete wall is bare on this side.

TEST REPORT N° AC10-26024605/1

DRAWINGS **OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS**	**Test** 5 **Date** 23/08/10 **Station** EPSILON

REQUESTER   NUDURA® CORPORATION

MANUFACTURERS   NUDURA® CORPORATION (insulated concrete forms system)
CGC (internal facing)
CSTB (concrete)

NAME   NUDURA® Insulated Concrete Forms (ICF) without external insulation

CONFIGURATION   Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side

FITNESS FOR PURPOSE   DTA 16/09-581
ATE 07/0034

SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

Test	5
Date	23/08/10
Station	EPSILON

REQUESTER NUDURA® CORPORATION

MANUFACTURERS NUDURA® CORPORATION (insulated concrete forms system)
CGC (internal facing); CSTB (concrete)

NAME NUDURA® Insulated Concrete Forms without external insulation

CONFIGURATION Concrete core of 152 mm (6'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side

FITNESS FOR PURPOSE DTA 16/09-581
ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 231.5
Mass per unit area in kg/m : ~ 774

MEASUREMENT CONDITIONS

Source room:
Temperature: 24.5 °C
Relative humidity: 70 %

Receiving room:
Temperature: 24 °C
Relative humidity: 68 %

RESULTS

- ■ R en / in dB
- —— Courbe de référence / Reference curve
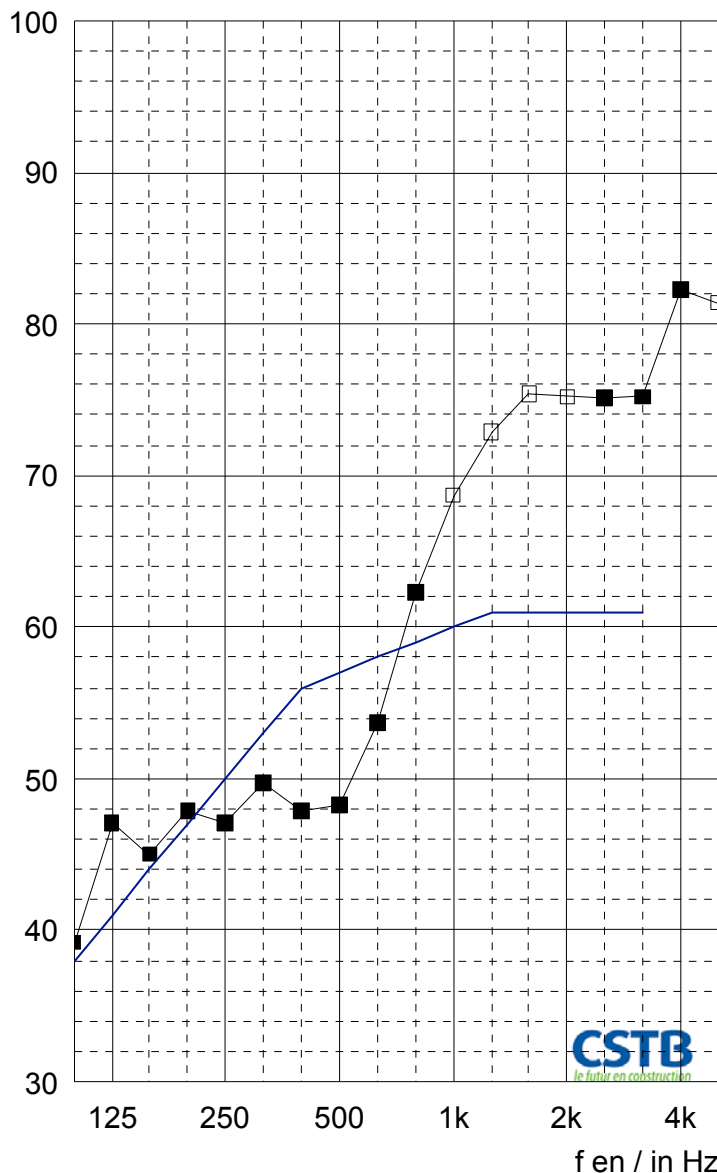
f	R
100	39,2
125	47,1
160	45,0
200	47,9
250	47,1
315	49,7
400	47,9
500	48,3
630	53,7
800	62,3
1000	68,7*
1250	72,9*
1600	75,4*
2000	75,2*
2500	75,1
3150	75,2
4000	82,3
5000	81,4*
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$R_w (C;C_{tr}) = 57(-1;-4)$ dB

Pour information / For information:
$R_A = R_w + C = 56$ dB
$R_{A,tr} = R_w + C_{tr} = 53$ dB

TEST REPORT N° AC10-26024605/1

DESCRIPTION AND INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM

Test   **6**
Date   **24/08/10**
Station   **EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'')**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 337
Mass per unit area in kg/m : ~ 968

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the Test #1 Page 4 and 5 with a concrete core of 203. Measured mass per unit area: ~ 6.64 kg/m

INSTALLATION (dimensions are given in mm)

Insulated concrete forms:

Identical installation to the Test #1 Page 5 and 6.

NOTE

The test was performed 90 days after concrete placement.

Emission and reception rooms

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DRAWINGS
OF AN INSULATED CONCRETE FORM SYSTEM

Test	6
Date	24/08/10
Station	EPSILON

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 203 mm (8'')**

FITNESS FOR PURPOSE   **DTA 16/09-581**
ATE 07/0034

NUDURA® Insulated
Concrete Form 203 mm (8")
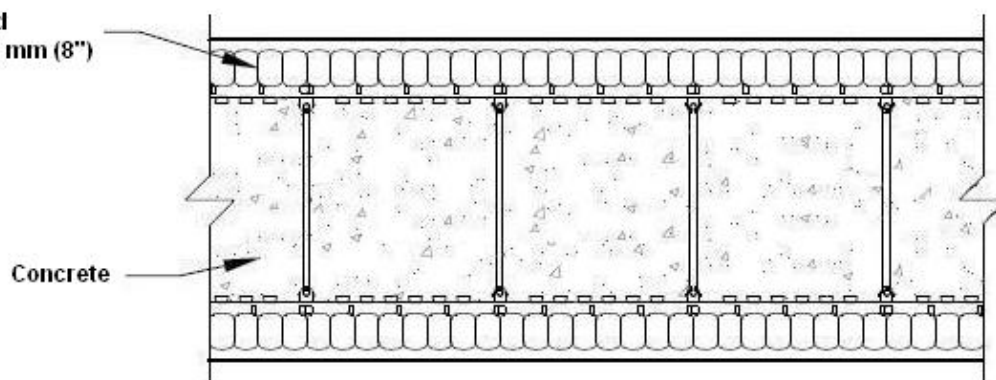
Concrete

NUDURA® Insulated
Concrete Form 203 mm (8")

Concrete

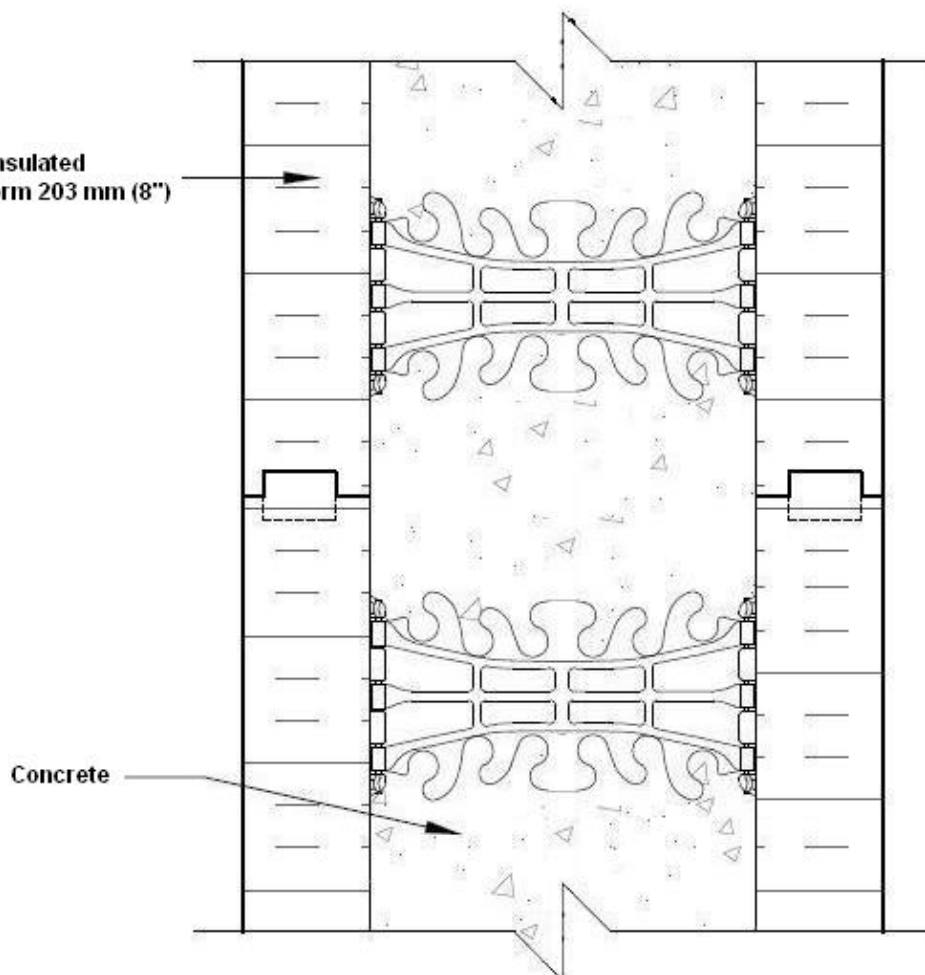**TEST REPORT N° AC10-26024605/1**

SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM

AD13

Test	6
Date	24/08/10
Station	EPSILON

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 203 mm (8'')**

FITNESS FOR PURPOSE   **DTA 16/09-581**
ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 337
Mass per unit area in kg/m : ~ 968

MEASUREMENT CONDITIONS

Source room:
Temperature: 23 °C
Relative humidity: 58 %

Receiving room:
Temperature: 24 °C
Relative humidity: 57 %

RESULTS
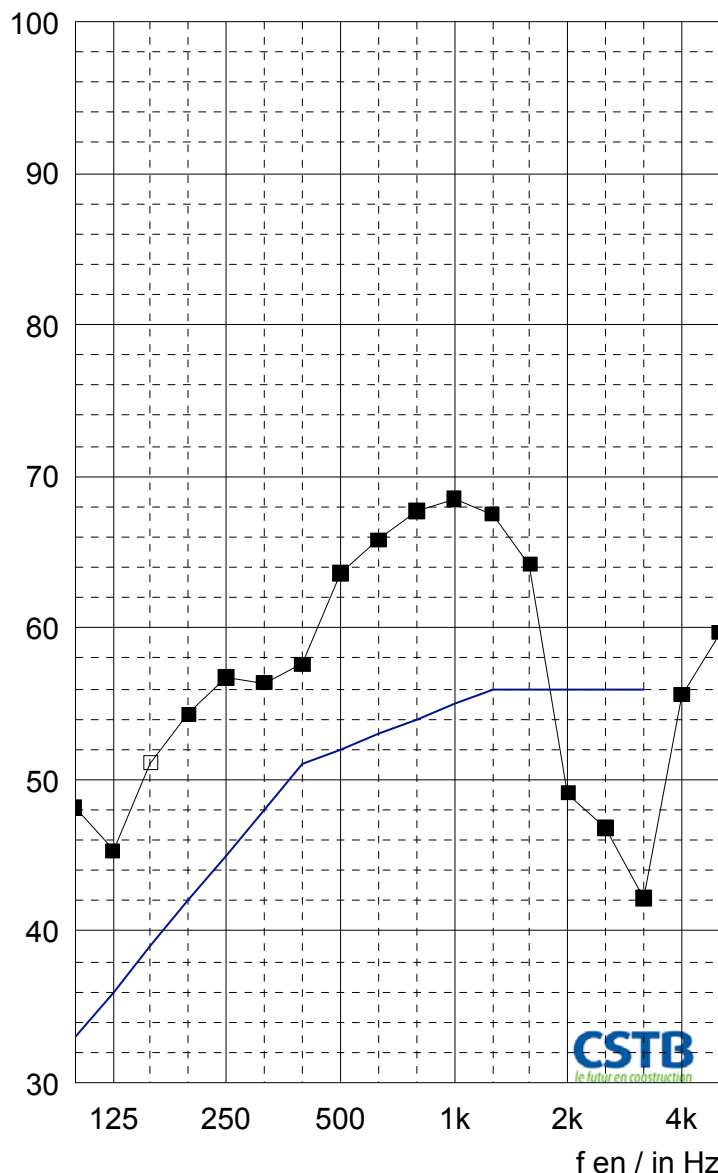
f	R
100	48,1
125	45,3
160	51,1$^+$ (64,0)
200	54,3
250	56,7
315	56,4
400	57,6
500	63,6
630	65,8
800	67,7
1000	68,5
1250	67,5
1600	64,2
2000	49,1
2500	46,8
3150	42,2
4000	55,6
5000	59,7
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$$R_w (C;C_{tr}) = 52(-3;1) \text{ dB}$$

Pour information / For information:
$R_A = R_w+C = 49$ dB
$R_{A,tr} = R_w+C_{tr} = 53$ dB

TEST REPORT N° AC10-26024605/1

DESCRIPTION AND INSTALLATION OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS	Test	**7**
	Date	**25/08/10**
	Station	**EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (finishes)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on both sides**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 362
Mass per unit area in kg/m : ~ 983

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the test #6 Page 24.
Facings	Consisting of one layer of gypsum board ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION (dimensions are given in mm)

Supporting wall and facings:
Identical installation to the Test #2 Page 10.

NOTE

The test was performed 24 hours after installation of facings.

Emission and reception rooms

**DRAWINGS
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS**

Test	7
Date	25/08/10
Station	EPSILON

REQUESTER   NUDURA® CORPORATION

MANUFACTURERS   NUDURA® CORPORATION (insulated concrete forms system)
CGC (finishes)
CSTB (concrete)

NAME   NUDURA® Insulated Concrete Forms (ICF)

CONFIGURATION   Concrete core of 203 mm (8'') with one layer of gypsum board
CGC Sheetrock® 12.5 mm on both sides

FITNESS FOR PURPOSE   DTA 16/09-581
ATE 07/0034

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

AD13

Test	7
Date	25/08/10
Station	EPSILON

REQUESTER NUDURA® CORPORATION

MANUFACTURERS NUDURA® CORPORATION (insulated concrete forms system)
CGC (finishes)
CSTB (concrete)

NAME NUDURA® Insulated Concrete Forms (ICF)

CONFIGURATION Concrete core of 203 mm (8'') with one layer of gypsum board
CGC Sheetrock® 12.5 mm on both sides

FITNESS FOR PURPOSE DTA 16/09-581
ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 362
Mass per unit area in kg/m : ~ 983

MEASUREMENT CONDITIONS

Source room:
Temperature: 22 °C
Relative humidity: 58 %

Receiving room:
Temperature: 24 °C
Relative humidity: 53 %

RESULTS

—■— R en / in dB   **—— Courbe de référence / Reference curve**
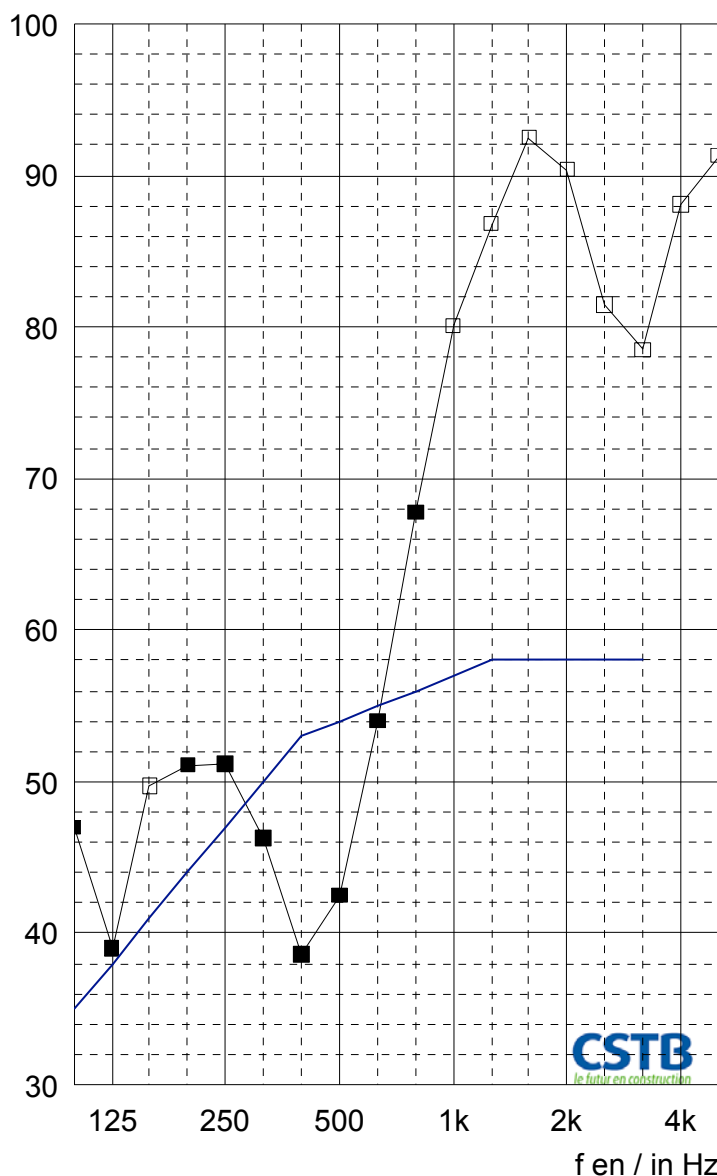
f	R
100	47,0
125	39,0
160	49,7+ (64,0)
200	51,1
250	51,2
315	46,3
400	38,6
500	42,5
630	54,0
800	67,8
1000	80,1*+ (90,2)
1250	86,8*+ (95,2)
1600	92,5*+ (96,1)
2000	90,4*+ (96,8)
2500	81,5+ (96,0)
3150	78,5+ (93,2)
4000	88,1+ (97,9)
5000	91,3*+ (97,9)
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$R_w (C;C_{tr}) = 54(-3;-5)$ dB

Pour information / For information:
$R_A = R_w + C = 51$ dB
$R_{A,tr} = R_w + C_{tr} = 49$ dB

TEST REPORT N° AC10-26024605/1

| **DESCRIPTION AND INSTALLATION**
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS | **Test** 8
Date 25/08/10
Station EPSILON |

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 282.5
Mass per unit area in kg/m : ~ 968.8

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the test #6 Page 24, without EPS outer panels.
Facings	Composed of one layer of gypsum board (internal side) ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION (dimensions are given in mm)

Supporting wall and facings:

Identical installation to the test #5 Page 21.

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DRAWINGS **OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS**	**Test** **8** **Date** **25/08/10** **Station** **EPSILON**

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
CGC (internal facing)
CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and bare concrete on external side**

FITNESS FOR PURPOSE   **DTA 16/09-581**
ATE 07/0034

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SOUND REDUCTION INDEX R
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

Test	**8**
Date	**25/08/10**
Station	**EPSILON**

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **NUDURA® CORPORATION (insulated concrete forms system)**
                        CGC (internal facing); CSTB (concrete)

NAME   **NUDURA® Insulated Concrete Forms (ICF)**

CONFIGURATION   **Concrete core of 203 mm (8'') with one layer of gypsum board**
                        CGC Sheetrock® 12.5 mm on internal side, and bare concrete on
                        external side

FITNESS FOR PURPOSE **DTA 16/09-581**
                        ATE 07/0034

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 282.5
Mass per unit area in kg/m : ~ 968.8

MEASUREMENT CONDITIONS

Source room:
Temperature: 23.5 °C
Relative humidity: 56 %

Receiving room:
Temperature: 24.5 °C
Relative humidity: 57 %

RESULTS

—■— R en / in dB   —— Courbe de référence / Reference curve
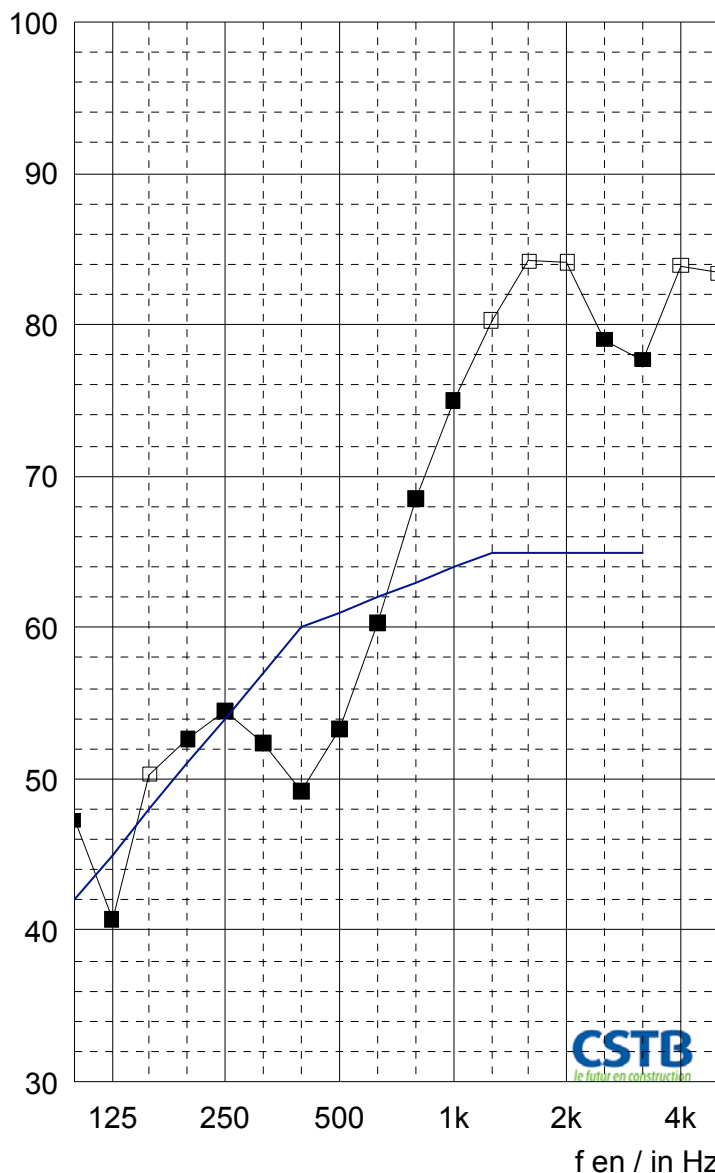
f	R
100	47,3
125	40,7
160	50,3+ (64,0)
200	52,6
250	54,5
315	52,4
400	49,2
500	53,3
630	60,3
800	68,5
1000	75,0
1250	80,3+ (95,2)
1600	84,2+ (96,1)
2000	84,1+ (96,8)
2500	79,0
3150	77,7
4000	83,9+ (97,9)
5000	83,4*+ (97,9)
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$$R_w (C; C_{tr}) = 61(-2; -5) \text{ dB}$$

Pour information / For information:
$R_A = R_w + C = 59$ dB
$R_{A,tr} = R_w + C_{tr} = 56$ dB

DESCRIPTION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	**9**
Date	**27/08/10**
Station	**EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing)** **ISOVER (insulated core)** **PLACOPLATRE® (external facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and inner partition on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 353
Mass per unit area in kg/m : ~ 979.2

DESCRIPTION (dimensions are given in mm)

Insulated concrete forms	Identical description to the test #6 Page 23.
Facings	Internal side: - Facing: Gypsum board (internal side) ref. CGC Sheetrock® (CGC) of dimensions 2440 x 1210 x 12.5 (8' x 4' x ½'') and measured mass per unit area 7.57 kg/m . Young's modulus of gypsum board (average of first three modes): E = 1.794 GN/m (see Appendix 4A). - Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE) External side: - Frame: Rails ref. R48 and studs ref. M48 (PLACOPLATRE®) - Facing: Plasterboard ref. Placoplatre® BA13 STD (PLACOPLATRE®) of dimensions 2500 x 1200 x 12.5 and measured mass per unit area 9.83 kg/m . Young's modulus of plasterboard (average of first three modes): E = 1.818 GN/m (see Appendix 4A). – Core: Glass wool ref. PAR DUO (ISOVER) of measured density 24.8 kg/m³. Presented in rolls of dimensions 15600 x 600 x 45. - Finishes: - Coating joint ref. DURABOND 90 Joint Compound (CGC) bag of 15 kg + bands - Mastic TX (ATE)

INSTALLATION
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	**9**
Date	**27/08/10**
Station	**EPSILON**

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing)** **ISOVER (insulated core)** **PLACOPLATRE® (external facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and inner partition on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

INSTALLATION (dimensions are given in mm)

Supporting wall:

Identical installation to the Test #1 Page 5 and 6.

Facings:

Gypsum boards are placed horizontally, in single layer, on internal side, and screwed on EPS panels fastening strips at 406 on centre intervals.

The joints treatment between panels and board edges (5 thick in the upper part and laterally) is carried out by a fast drying coat and joint tape system.
In the lower part, the 10 thick joint is filled by soft filler.

On the other side, the EPS panels are removed.

Rails are fixed at the top and bottom at 500 on centre intervals.

Studs are placed in the rails at 600. They are doubled (two elements back to back set at 500 on centre intervals) in the current part.

Glass wool, maintained by simple compression, is inserted between the studs.

Plasterboards, constituting the external facing, are screwed onto the frame in step 300.

The joints treatment between panels and board edges (5 thick in the upper part and laterally) is carried out by a fast drying coat and joint tape system.
In the lower part, the 10 thick joint is filled by soft filler.

NOTE

The test was performed 24 hours after installation of facings.

DRAWINGS
OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS

Test	9
Date	27/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing)** **ISOVER (Insulated core)** **PLACOPLATRE® (external facing)** **CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and inner partition on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

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OF AN INSULATED CONCRETE FORM SYSTEM AND FACINGS
AD13

Test	9
Date	27/08/10
Station	EPSILON

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURERS	**NUDURA® CORPORATION (insulated concrete forms system)** **CGC (internal facing); ISOVER (Insulated core)** **PLACOPLATRE® (external facing); CSTB (concrete)**
NAME	**NUDURA® Insulated Concrete Forms (ICF)**
CONFIGURATION	**Concrete core of 203 mm (8'') with one layer of gypsum board CGC Sheetrock® 12.5 mm on internal side, and inner partition on external side**
FITNESS FOR PURPOSE	**DTA 16/09-581** **ATE 07/0034**

MAIN CHARACTERISTICS

Dimensions in mm : 4180 x 2470
Thickness in mm : 353
Mass per unit area in kg/m : ~ 979.2

MEASUREMENT CONDITIONS

Source room:
Temperature: 24 °C
Relative humidity: 75 %

Receiving room:
Temperature: 24 °C
Relative humidity: 66 %

RESULTS

—■— R en / in dB   —— Courbe de référence / Reference curve
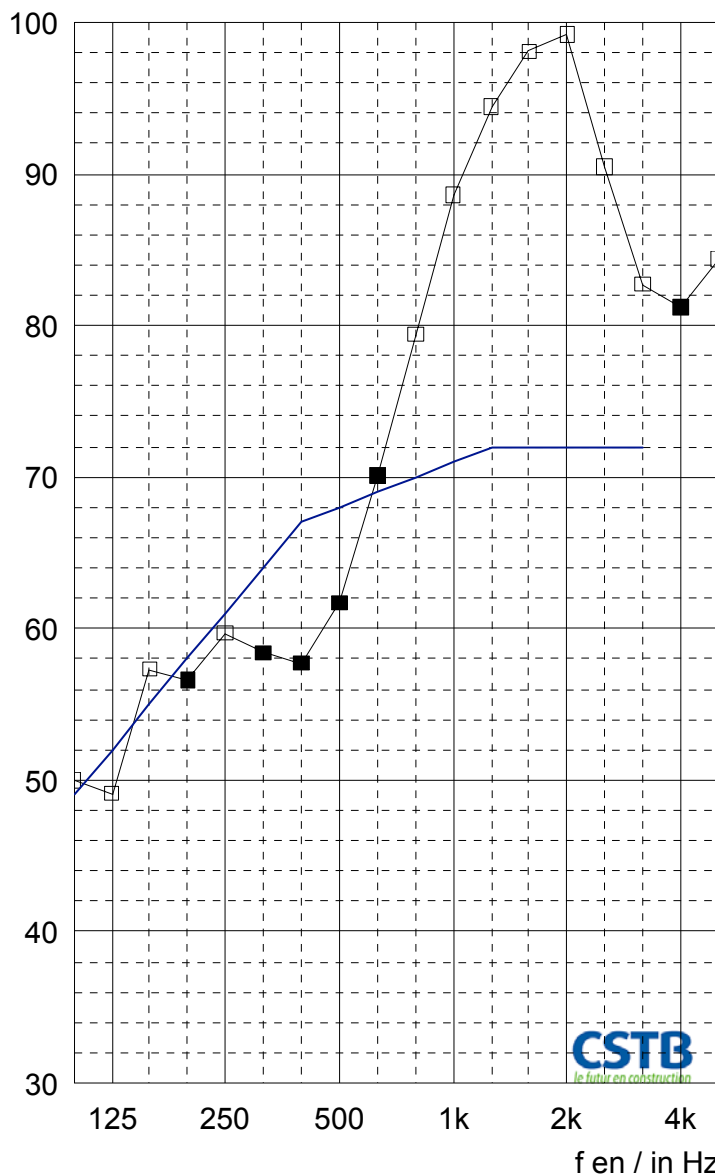
f	R	
100	$50{,}0^+$	(64,5)
125	$49{,}1^+$	(64,0)
160	$57{,}3^+$	(64,0)
200	56,6	
250	$59{,}7^+$	(74,1)
315	58,4	
400	57,7	
500	61,7	
630	70,1	
800	$79{,}4^+$	(87,0)
1000	$88{,}6^+$	(90,2)
1250	$94{,}4^+$	(95,2)
1600	$98{,}1^+$	(96,1)
2000	$99{,}2^+$	(96,8)
2500	$90{,}5^+$	(96,0)
3150	$82{,}7^+$	(93,2)
4000	81,2	
5000	$84{,}4^+$	(97,9)
Hz	dB	

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$$R_w \ (C; C_{tr}) \geq 68(-1; -5) \ dB$$

Pour information / For information:
$R_A = R_w + C \geq 67$ dB
$R_{A,tr} = R_w + C_{tr} \geq 63$ dB

f en / in Hz

TEST REPORT N° AC10-26024605/1

DESCRIPTION AND INSTALLATION OF A CONCRETE WALL	**Test** **10** **Date** **30/08/10** **Station** **EPSILON**

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **CSTB (concrete)**

DESIGNATION   **Bare concrete wall of 203 mm (8'')**

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 203
Mass per unit area in kg/m : ~ 954.7

DESCRIPTION (dimensions are given in mm)

Concrete wall thickness 203 and mass per unit area ~ 954.7 kg/m :

- Type of cement: CEM 3 50/50
- Exposition class: XC1
- Minimum strength class: C25/30
- Consistency class: S3
- Nominal maximum aggregate size (Dmax): 10
- Class chlorides: Cl 0.4

INSTALLATION (dimensions are given in mm)

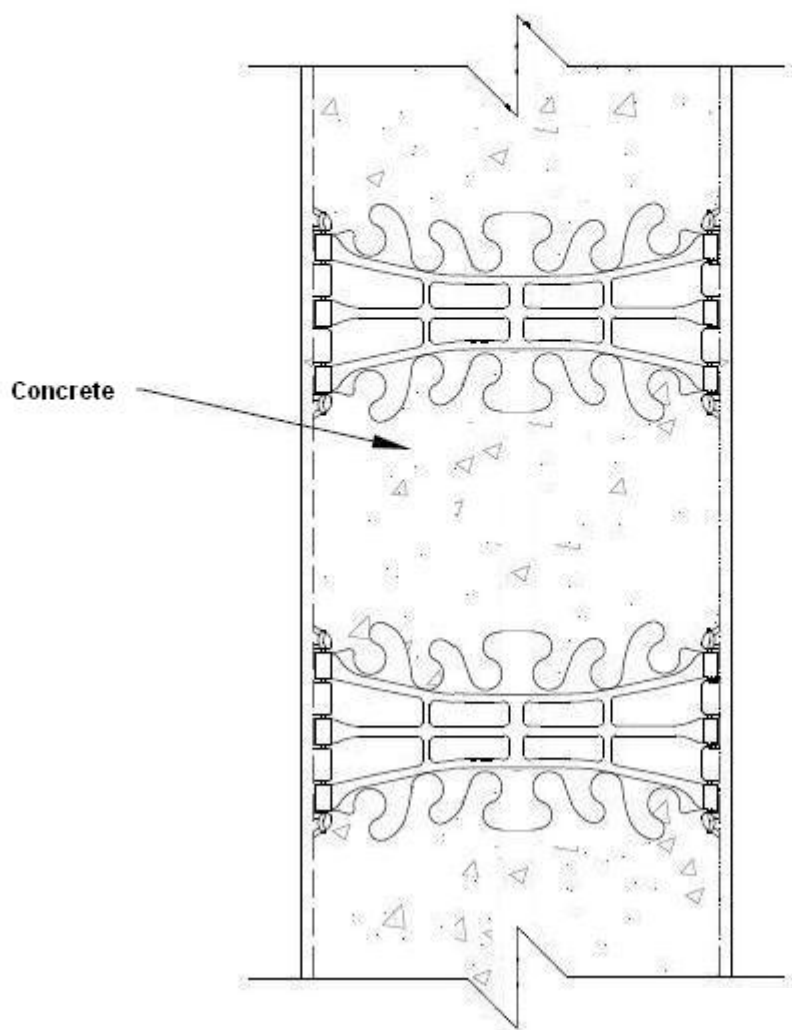*Supporting wall:*

Identical installation to the Test #1 Page 5 and 6 without EPS panels.

DRAWINGS
OF A CONCRETE WALL

Test	**10**
Date	**30/08/10**
Station	**EPSILON**

REQUESTER   **NUDURA® CORPORATION**

MANUFACTURERS   **CSTB (concrete)**

DESIGNATION   **Bare concrete wall of 203 mm (8'')**

Concrete

Concrete

TEST REPORT N° AC10-26024605/1
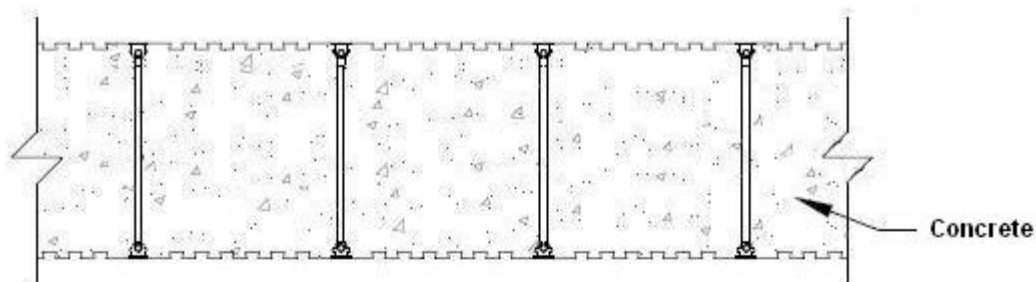
SOUND REDUCTION INDEX R
OF A CONCRETE WALL

AD13

Test	10
Date	30/08/10
Station	EPSILON

REQUESTER   NUDURA® CORPORATION

MANUFACTURERS   CSTB (concrete)

DESIGNATION   Bare concrete wall of 203 mm (8'')

MAIN CHARACTERISTICS

Dimensions in mm   : 4180 x 2470
Thickness in mm   : 203
Mass per unit area in kg/m : ~ 954.7

MEASUREMENT CONDITIONS

Source room:
Temperature: 20.5 °C
Relative humidity: 52 %

Receiving room:
Temperature: 23 °C
Relative humidity: 51 %

RESULTS
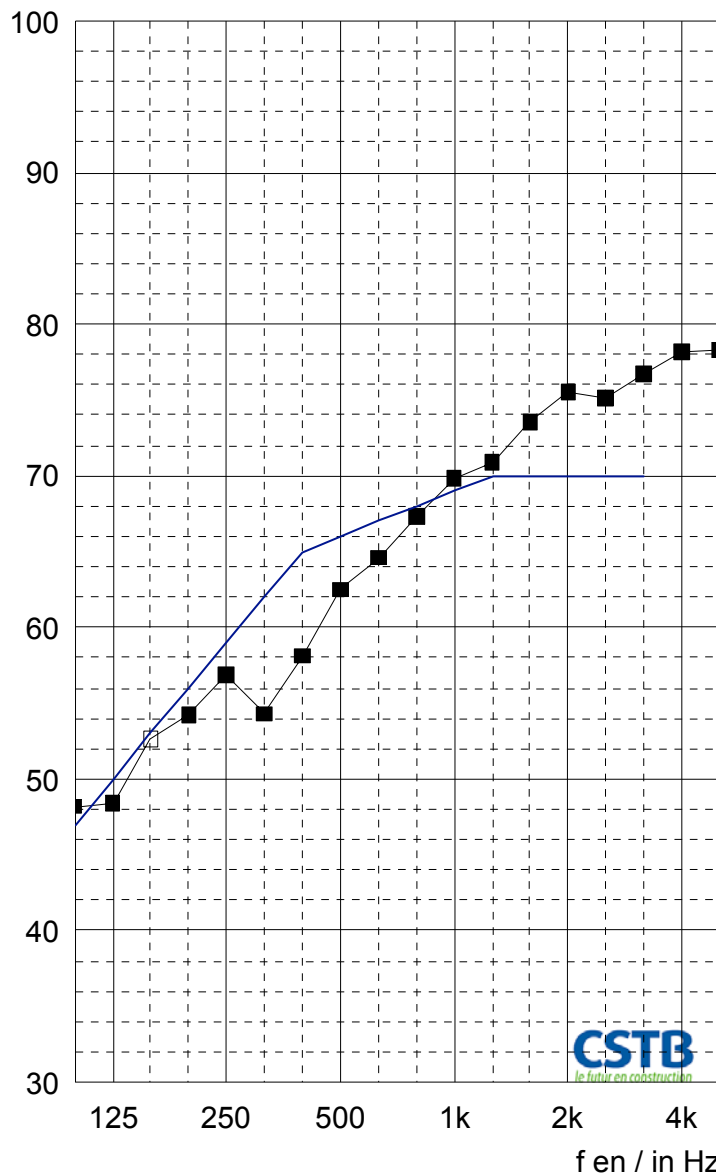
f	R
100	48,2
125	48,4
160	52,6$^+$ (64,0)
200	54,2
250	56,9
315	54,3
400	58,1
500	62,5
630	64,6
800	67,3
1000	69,8
1250	70,9
1600	73,5
2000	75,5
2500	75,1
3150	76,7
4000	78,2
5000	78,3
Hz	dB

(∗) : valeur corrigée/corrected value. (+) : limite de poste/station limit.

$R_w (C;C_{tr}) = 66(-2;-5)$ dB

Pour information / For information:
$R_A = R_w + C = 64$ dB
$R_{A,tr} = R_w + C_{tr} = 61$ dB

APPENDIX 1
ANALYSIS PROCEDURE AND EXPRESSION OF THE RESULTS

SOUND REDUCTION INDEX R

> ➢ *Method of evaluation: NF EN ISO 140-3 (1995)*

The standard NF EN ISO 140-3 (1995) is the method of evaluation of the airborne sound insulation of the building elements like walls, floors, doors, windows, facade element, facades, …

The measurement must be run into a test laboratory without any flanking transmissions. The test facility is composed of two rooms: one fixed room where we put onto the concrete frame with the sample to be tested and a moving box, creating a couple "emission room – reception room ». Those rooms and the concrete frame are separated (neoprene seals) and are in accordance to the standard NF EN ISO 140-1 (1997). The conception of rooms (box in the box) gets a strong soundproofing towards the outside and allows to measure very weak levels of background noise.
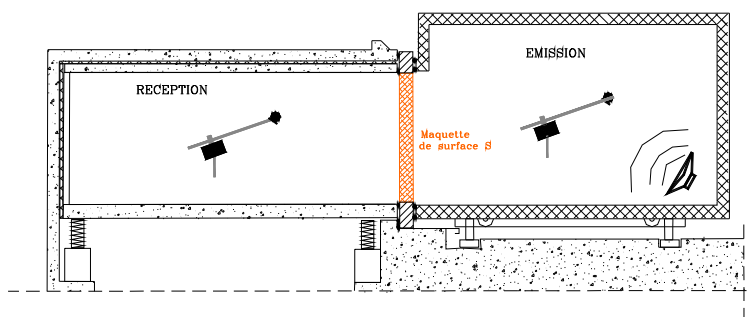
Measurement by 1/3 of octave, from 100 to 5000 Hz:

- Of the background noise level in the reception room L_{BdF}

- Of the insulation: $L_E - L_R$

- Of the reverberation time of the reception room T

Calculation of the airborne sound insulation R in dB for any 1/3 of octave:

R = $L_E - L_R$ + 10 log (S/A)

L_E: Sound level in the emission room in dB
L_R: Sound level in the reception room, corrected with the background sound in dB
S: surface of the sample to be tested in m
A: Equivalent absorption area in the reception room in m
$\quad$ A = (0.16 x V)/T $\quad$ with V the volume of the reception room in m^3
$\quad\quad\quad\quad\quad\quad\quad\quad$ and T the reverberation time of this room in s.

The more R is high, the more insulating the element is.

> ➢ *Expression of the results: Calculation of the overall weighted index $R_w(C;C_{tr})$ according to the standard NF EN ISO 717-1 (1997)*

Consideration of the values of R by third (third party) of octave between 100 and 3150 Hz with a precision in the $1/10^{th}$ of dB.

Vertical movement of a reference curve by jump of 1 dB until the sum of the unfavourable distances is the biggest while remaining lower or equal to 32.0 dB.

Rw dB is the value given then by the curve of reference to 500 Hz.
The terms of adaptation to a spectre (C and Ctr) are calculated by means of reference spectres to obtain:

RA,tr = RW + Ctr dB The terms of adaptation to a spectrum (C and C_{tr}) are calculated with reference spectrum to obtain:

- The insulation towards noises of airport or industrial neighbourhood, activities:
  $R_A = R_w + C$ en dB

- The isolation towards the noise of infrastructure of ground transport: **$R_{A/tr} = R_W + C_{tr}$ en dB**

APENDIX 2 – EQUIPMENT | EPSILON STATION

Emission room: EPSILON 3

DESIGNATION	BRAND	TYPE	# CSTB
Microphone network	Bruël & Kjær	Microphone 4166	CSTB 01 0215
	Bruël & Kjær	Pre-amplifier 2669	
Rotating arm	Bruël & Kjær	3923	CSTB 97 0162
Amplifier	LAB GRUPPEN	LAB1000	CSTB 97 0195
Speaker	CSTB-PHL AUDIO	Cube	CSTB 97 0187
Speaker	CSTB-PHL AUDIO	Cube	CSTB 97 0189

Reception room: EPSILON 1

DÉSIGNATION	MARQUE	TYPE	# CSTB
Microphone network	Bruël & Kjær	Microphone 4166	CSTB 01 0209
	Bruël & Kjær	Préamplificateur 2669	
Rotating arm	Bruël & Kjær	3923	CSTB 80 0007
Amplifier	CARVER	PM600	CSTB 91 0121
Speaker	CSTB-ELECTRO VOICE	Pyramide	CSTB 97 0200

Control room

DESIGNATION	BRAND	TYPE	# CSTB
Real time analyser	Bruël & Kjær	2144	CSTB 95 0146
Microcomputer	DELL	OPTIPLEX GX 270	
Calibrator	Bruël & Kjær	4231	CSTB 95 0144

APPENDIX 3 – DRAWINGS OF THE TEST STATION | **STATION EPSILON**

SCHEME

CONTROL STATION

EPSILON 2
V = 62,3 m³

EPSILON 1
V = 62,3 m³

EPSILON 3
V= 78,0 m³

EPSILON 3 LATERAL TRANSLATION

SECTION AA'

EPSILON 1 or 2
V = 62,3 m³

EPSILON 3
V= 78,0 m³

EPSILON 3 LONGITUDINAL TRANSLATION
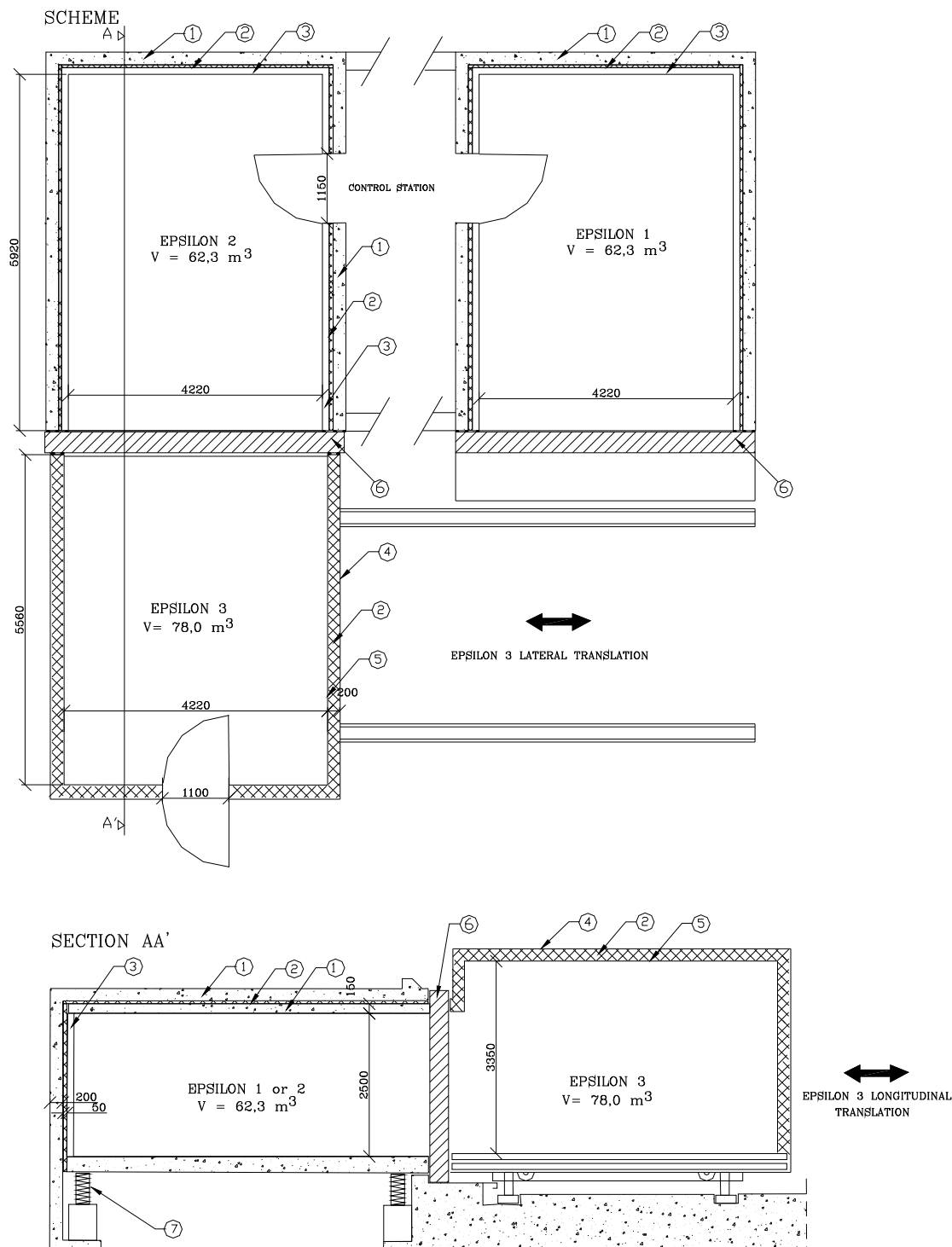
dimensions in mm

REP	DESIGNATION
7	Box on springs
6	Aperture area S=10.5 m²
5	Steel plate 6mm
4	Steel plate 2mm
3	Filled concrete e=100 mm
2	Mineral wool
1	Concrete e=200 mm

scale: 1/100

EPSILON STATION

ACOUSTICS

TEST REPORT N° AC10-26024605/1

APPENDIX 4A – YOUNG'S MODULUS OF A GYPSUM BOARD AND PLASTERBOARD

REQUESTER   NUDURA® CORPORATION

MANUFACTURER   CGC

TESTS RESULTS

EQUIVALENT BENDING STIFFNESS FOR GYPSUM BOARD

Requester: NUDURA CORPORATION
Reference: BA13 CGC Sheetrock®
File: AC10-26024605
Test date: 03/09/2010

Temperature in °C : 23,5
Relative humidity in % : 54

Sample	Length (in mm)	Width (in mm)	Thickness (in mm)	Mass (in kg)	Mass per unit area (in kg/m²)
A	600	59	13,37	0,275	7,8
B	601	60	13,49	0,27	7,5
C	602	60	13,51	0,265	7,3
D	602	60	13,66	0,275	7,6
					7,55

B: Equivalent bending stiffness
E: Young's modulus (12*B/t^3)
η: Loss factor

Sample	Resonance frequency (in Hz)	Δf at - 3 dB	B (in Nm)	E (in GN/m²)		η (in %)
A	1 st — 50	1,609	502	2,522		3,22
	2 nd mode — 304,7	3,771	475	2,385	2,403	1,24
	3 rd mode — 838,3	10,34	459	2,303		1,23
	4 th mode — 1583	27,08	426	2,138		1,71
	5 th mode — 2473	44,92	380	1,910		1,82
	6 th mode — 3420	64,14	326	1,637		1,88
	7 th mode — 4409	79,62	278	1,394		1,81
B	1 st — 37,5	0,768	274	1,340		2,05
	2 nd mode — 242,2	2,758	291	1,424	1,395	1,14
	3 rd mode — 677,3	7,851	290	1,420		1,16
	4 th mode — 1297	15,48	277	1,356		1,19
	5 th mode — 2070	29,48	259	1,264		1,42
	6 th mode — 2954	42,73	236	1,153		1,45
	7 th mode — 3890	65,87	210	1,025		1,69
C	1 st — 46,09	0,845	409	1,988		1,83
	2 nd mode — 290,6	5,791	414	2,012	1,971	1,99
	3 rd mode — 793	11,35	393	1,911		1,43
	4 th mode — 1491	21,8	362	1,760		1,46
	5 th mode — 2300	67,26	315	1,532		2,92
	6 th mode — 3225	56,4	277	1,350		1,75
	7 th mode — 4198	70,88	241	1,173		1,69
D	1 st — 39,06	0,781	304	1,434		2,00
	2 nd mode — 243	3,212	300	1,413	1,407	1,32
	3 rd mode — 671,1	9,61	292	1,374		1,43
	4 th mode — 1283	17,12	278	1,308		1,33
	5 th mode — 2042	31,78	258	1,213		1,56
	6 th mode — 2917	51,48	236	1,109		1,76
	7 th mode — 3785	80,09	203	0,957		2,12

Sample	Resonance frequency (in Hz)		B (in Nm)	E (in GN/m²)		η (in %)
Average	1 st — 43		372	1,821		2,27
	2 nd mode — 270		370	1,808	1,794	1,42
	3 rd mode — 745		358	1,752		1,31
	4 th mode — 1414		336	1,640		1,43
	5 th mode — 2221		303	1,480		1,93
	6 th mode — 3129		269	1,312		1,71
	7 th mode — 4071		233	1,137		1,83

B: Equivalent bending stiffness (average of the first seven modes) in Nm	320

E: Young's modulus (average of the first seven modes) in GN/m²	1,564

Note: in the mid-and high- frequency range, there was the hypothesis of a thin plate, it will take for the simulations so that the first three modes.

E: Young's modulus (average of the first three modes) in GN/m²	1,794

E: Longitudinal Young's modulus (average of the first three modes) in GN/m²	2,187
E: Transversal Young's modulus (average of the first three modes) in GN/m²	1,401

TEST REPORT N° AC10-26024605/1

REQUESTER	**NUDURA® CORPORATION**
MANUFACTURER	**PLACOPLATRE®**

TESTS RESULTS

EQUIVALENT BENDING STIFFNESS FOR PLASTERBOARD

Requester:	**NUDURA CORPORATION**
Reference:	**BA13 Placo® Phonique**
File:	**AC10-26024605**
Test date:	**03/09/2010**

Temperature in °C : 23,5
Relative humidity in %: 54

Sample	Length (in mm)	Width (in mm)	Thickness (in mm)	Mass (in kg)	Mass per unit area (in kg/m²)
A	601	60	12,88	0,44	12,2
B	604	62	13,13	0,45	12,0
C	600	60	12,97	0,43	11,9
D	600	60	13,03	0,425	11,8
					11,99

B: Equivalent bending stiffness
E: Young's modulus $(12*B/t^3)$
η: Loss factor

Sample	Resonance frequency (in Hz)		Δf at - 3 dB	B (in Nm)	E (in GN/m²)		η (in %)
A	1 st	46,06	0,647	674	3,786		1,40
	2 nd mode	290,6	2,832	683	3,837	3,782	0,97
	3 rd mode	801,6	8,531	663	3,724		1,06
	4 th mode	1520	19,75	621	3,487		1,30
	5 th mode	2378	59,43	556	3,123		2,50
	6 th mode	3326	48,65	487	2,738		1,46
	7 th mode	4347	53,96	427	2,397		1,24
B	1 st	39,06	1,25	487	2,582		3,20
	2 nd mode	242,2	4,22	477	2,528	2,528	1,74
	3 rd mode	671,1	16,39	467	2,475		2,44
	4 th mode	1309	21,12	463	2,452		1,61
	5 th mode	2055	43,65	417	2,212		2,12
	6 th mode			0	0,000		#DIV/0!
	7 th mode			0	0,000		#DIV/0!
C	1 st	45,31	1,231	634	3,489		2,72
	2 nd mode	289,1	4,733	658	3,616	3,548	1,64
	3 rd mode	800,8	10,5	643	3,539		1,31
	4 th mode	1524	22,81	607	3,338		1,50
	5 th mode	2416	38,55	558	3,070		1,60
	6 th mode	3406	55,65	497	2,734		1,63
	7 th mode	4427	60,89	431	2,368		1,38
D	1 st	41,41	0,606	524	2,840		1,46
	2 nd mode	261,7	2,717	533	2,889	2,842	1,04
	3 rd mode	721,1	6,882	516	2,797		0,95
	4 th mode	1382	13,98	493	2,676		1,01
	5 th mode	2209	29,19	461	2,502		1,32
	6 th mode	3148	38,3	420	2,277		1,22
	7 th mode	4147	49,02	373	2,025		1,18
Average	1 st	43		580	3,174		2,20
	2 nd mode	271		587	3,217	3,175	1,35
	3 rd mode	749		572	3,134		1,44
	4 th mode	1434		546	2,988		1,36
	5 th mode	2265		498	2,727		1,89
	6 th mode	3293		351	1,937		#DIV/0!
	7 th mode	4307		308	1,698		#DIV/0!

B: Equivalent bending stiffness (average of the first seven modes) in Nm	492

E: Young's modulus (average of the first seven modes) in GN/m²	2,696

Note: in the mid - and high - frequency range, there was the hypothesis of a thin plate, it will take for the simulations so that the first three modes.

E: Young's modulus (average of the first three modes) in GN/m²	3,175

E: Longitudinal Young's modulus (average of the first three modes) in GN/m²	3,665
E: Transversal Young's modulus (average of the first three modes) in GN/m²	2,685

TEST REPORT N° AC10-26024605/1

REQUESTER NUDURA® CORPORATION

MANUFACTURER PLACOPLATRE®

TESTS RESULTS

EQUIVALENT BENDING STIFFNESS FOR PLASTERBOARD

Requester: **NUDURA CORPORATION**
Reference: **BA13 STD**
File: **AC10-26024605**
Test date: **03/09/2010**

Temperature in °C : 23,5
Relative humidity in %: 54

Sample	Length (in mm)	Width (in mm)	Thickness (in mm)	Mass (in kg)	Mass per unit area (in kg/m²)
A	598	60	12,9	0,335	9,3
B	596	58,5	13,01	0,33	9,5
C	598	59	13,08	0,335	9,5
D	600	59	13,33	0,335	9,5
					9,44

B: Equivalent bending stiffness
E: Young's modulus (12*B/t^3)
η: Loss factor

Sample	Resonance frequency (in Hz)		Δf at - 3 dB	B (in Nm)	E (in GN/m²)		η (in %)
A	1 st	35,16	0,771	295	1,647		2,19
	2 nd mode	225	5,82	307	1,717	1,692	2,59
	3 rd mode	628,9	15,89	306	1,711		2,53
	4 th mode	1223	24,71	301	1,685		2,02
	5 th mode	1995	46,1	294	1,641		2,31
	6 th mode			0	0,000		#DIV/0!
	7 th mode			0	0,000		#DIV/0!
B	1 st	38,28	0,698	349	1,903		1,82
	2 nd mode	255,5	2,325	396	2,159	2,043	0,91
	3 rd mode	700	9,61	379	2,067		1,37
	4 th mode	1355	16,78	370	2,017		1,24
	5 th mode	2130	85,21	335	1,824		4,00
	6 th mode	2813	48,92	262	1,426		1,74
	7 th mode	3116	57,39	165	0,897		1,84
C	1 st	35,94	1,098	313	1,679		3,06
	2 nd mode	230,5	4,89	328	1,758	1,714	2,12
	3 rd mode	635,9	13,97	318	1,707		2,20
	4 th mode	1227	25,63	309	1,655		2,09
	5 th mode	1941	47,75	283	1,515		2,46
	6 th mode	2771	63,06	258	1,384		2,28
	7 th mode	3579	79,03	221	1,183		2,21
D	1 st	36,72	1,109	330	1,672		3,02
	2 nd mode	239,8	5,138	358	1,816	1,824	2,14
	3 rd mode	701,6	10,05	391	1,983		1,43
	4 th mode	1294	20,66	347	1,756		1,60
	5 th mode	2105	49,42	336	1,701		2,35
	6 th mode	3002	59,66	306	1,550		1,99
	7 th mode	3805	122	252	1,277		3,21

Sample	Resonance frequency (in Hz)		Δf at - 3 dB	B (in Nm)	E (in GN/m²)		η (in %)
Average	1 st	37		322	1,725		2,52
	2 nd mode	238		347	1,862	1,818	1,94
	3 rd mode	667		349	1,867		1,88
	4 th mode	1275		332	1,778		1,74
	5 th mode	2043		312	1,670		2,78
	6 th mode	2862		206	1,090		#DIV/0!
	7 th mode	3500		159	0,839		#DIV/0!

B: Equivalent bending stiffness (average of the first seven modes) in Nm	**290**

E: Young's modulus (average of the first seven modes) in GN/m²	**1,547**

Note: in the mid - and high - frequency range, there was the hypothesis of a thin plate, it will take for the simulations so that the first three modes.

E: Young's modulus (average of the first three modes) in GN/m²	**1,818**

E: Longitudinal Young's modulus (average of the first three modes) in GN/m²	**1,703**
E: Transversal Young's modulus (average of the first three modes) in GN/m²	**1,933**

APPENDIX 4B – YOUNG'S MODULUS OF A PLASTERBOARD

MEASUREMENT METHOD:

The bending stiffness modulus and the loss factor (intrinsic to the material) are determined thanks to the measure of the input impedance of a plasterboard sample (beam type) according to the Standard ISO/PAS 16940.

The input impedance is the transfer function between the injected force at one point and velocity. The input impedance is measured with an impedance head giving both information (velocity and force) at the fixing point of the tested structure; the beam is excited by an electro-dynamic shaker. The tested samples are beams of length 60 cm and width 6 cm; it allows limit/reduce the number of resonance in a frequency bandwidth in comparison with a plate sample. The boundary conditions of the tested sample are free, corresponding to the easiest conditions to set up. We will measure the input impedance at the sample center, that is to say at half of the length for mounting reasons (see photo). We will use a force with a "white noise" between 0 and 5000 Hz.

Once the transfer function corresponding to the input impedance measured, we will take a reading of the resonance frequencies f, as well as the bandwidth Δf, for each resonance frequency in order to determine the loss factor as well as the bending stiffness modulus B. We can compute the elasticity modulus for a simple plate as $E = 12B/t^3$ (with t the thickness of the plate).

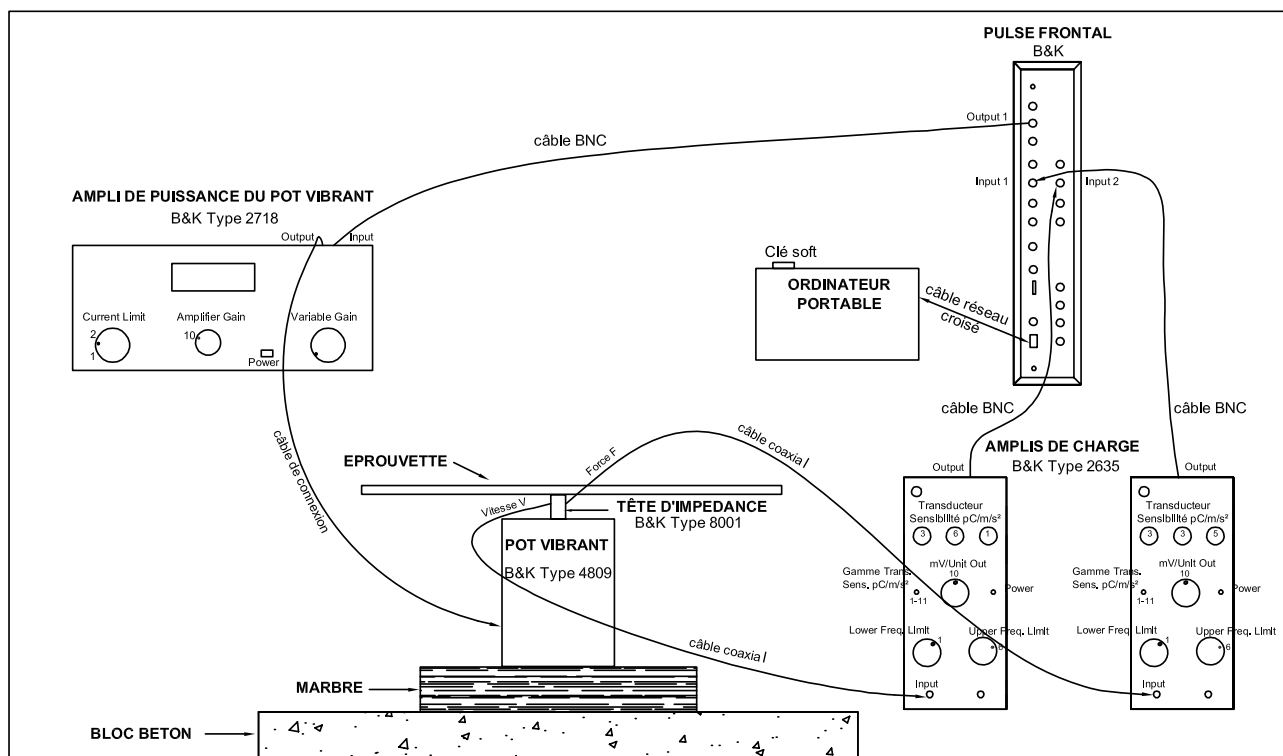The tests are carried out on four samples cut out in a plate according to the drawing below:
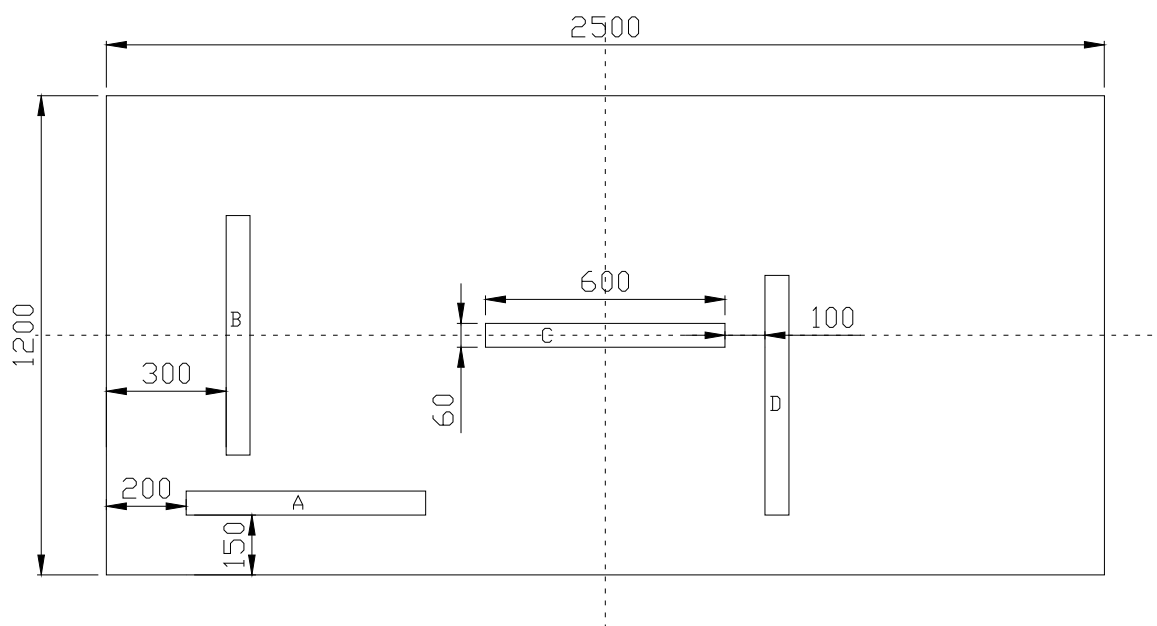
APPENDIX 4C – YOUNG'S MODULUS OF A PLASTERBOARD

EQUIPMENT:

DESIGNATION	BRAND	TYPE	# CSTB
Balance	Précia	Quartz 3	CSTB 9300131
Comparator	Digico		CSTB 06 0168
Thermo - hygrometer	Testo Therm	Thermo - hygrometer 6100	CSTB 91 0110
Analyzer	Bruël & Kjær	PULSE	CSTB 04 1501
Impedance head	Bruël & Kjær	8001	CSTB 05 0371
Load amplifier	Bruël & Kjær	2635	CSTB 04 1502
Load amplifier	Bruël & Kjær	2635	CSTB 04 1503
Electro-dynamic shaker	Bruël & Kjær	4809	CSTB 10 0069
Power amplifier	Bruël & Kjær	2718	CSTB 05 0369
Calibrator	Bruël & Kjær	4294	CSTB 89 0064

STANDARD DRAWING:

END REPORT