Handling of uncertainties for CE marking concerning Sound Transmission Loss of glazings

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A joint working group between CEN TC 126 (building acoustics) and CEN TC 129 (glass in building) has been created to handle the redaction of a test code, (give rules for CE marking) and particularly handle uncertainty problems.

A round robin has been organised, at which 23 European labs have participated, and two configuration of double glazings have been tested : one with two monolithic glass components, the other with one monolithic and one highly damped laminate component.

The paper will present the specifications and main results of this round robin, the questions that occurred concerning the possible ways to decrease uncertainty values, as well as the conclusions and decisions of the working group.

1 Introduction

This study has two reasons. The first is to compare the results of STL values of similar samples in different labs and try to find causes of dispersion and propose solutions to lower them. The second is purely economical and aims at reducing the costs by modifying the mounting conditions of the glazings by replacing Perenator putty by a foam joint.

2 Participating laboratories

In the launching of the RR project it was agreed that up to 29 laboratories could participate, but finally only 23 of them actually participated. Some laboratories could not participate at the project for financial reasons, others because they were unable to perform the tests in an acceptable time frame.

The 23 laboratories names were coded and handled anonymously in this report.

The participating laboratories are:

AIRO : Acoustical Investigation & Research Organisation Ltd Duxons Turn, Maylands Avenue, Hemel Hempstead, Herts. HP2 4SB UK

CETEF: Instituto de Acústica c/ Serrano 144 - 28006 Madrid Spain

CSI: CSI Spa- 20, viale Lombardia - 20021 Bollate (Milan) Italy

CSTB : Laboratoire d'essai acoustique CSTB 84 Av, Jean Jaurès Champs sur marne 77 447 Marne la vallée Cedex 2. France

CSTC : WTCB – CSTC Avenue Pierre Holoffe - 211342 Limelette Belgium

CTBA : CTBA allée de Boutaut B.P. 227 - 33028 Bordeaux cedex France

Delta: Teknologisk Institut (DELTA) Kongsvang Allé 29 Bygning 11 DK-8000 Aarhus C. Denmark.

Giordano: ISTITUTO GIORDANO S.p.A. Acoustic Laboratory Via Verga, 19 47030 Gatteo (FC) Italy

IAB : Institut für Akustik und Bauphysik - Kiesweg 22 - 61440 Oberursel Germany

IBP : Institut für Bauphysik - Nobelstrasse 12 – 70569 Stuttgart Germany

IFT: (two laboratories) ift Schallschutzzentrum GmbH – LSW Lackermannweg 26 D-83071 Stephanskirchen Germany

ITB: itb- Laboratoire Acoustique 21, rue Ksawerow bâtiment F 02-656 Varsovie Poland

Labein/LCCE : Laboratorio Control Calidad Edificación del Gobierno Vasco C/Aguirrelanda nº 10, 01013 Vitoria-Gasteiz (Alava) Spain

PEUTZ : Peutz bv - Postbus 66 - 6585 ZH Mook Nederlands

Pilkington: Pilkington Werk Gelsenkirchen - Haydnstrasse 19 -45884 Gelsenkirchen Germany

PTB: Fachbereich Angewandte Akustik Physikalisch-Technische Bundesanstalt Braunschweig Bundesallee 100 - 38116 Braunschweig Germany

SGG: SGG CDI Ouest 1 rue de Montluçon - 60150 Thourotte France

SINTEF: SINTEF Building and Infrastructure Materials and Structures Oslo Forskningsveien 3B, 0373 Oslo Norway

SP : SP Acoustics Brinellgatan 4, Gate 8B -50462 Borås Sweden

TNO : Eindhoven Nederlands

TU Budapest: The Budapest University of Technology and Economics Laboratory of Building Acoustics H-1111 Budapest, Műegyetem rakpart 3, Hungary

VGTU TI: VGTU Institute of Thermal Insulation, Linkmenu 28, LT-08217 Vilnius, Lithuania.

3 Test settings

It has been decided to make two types of glazings for each participating lab, 6(16)6 and 44-2A(16)10, in a way that they are as similar as possible one to the other, in order to avoid discrepancies linked to glazings. To achieve this, glazings have been fabricated by one Saint Gobain Glass factory on the same production line and at the same period of time. Specifications have been written by the WG concerning measuring conditions, to be respected by all participating labs. *Glass for Europe* has given funding to Notified Bodies.

4 Specifications

The specifications given to the laboratories include standards to be followed and precisions on the measurement procedures. Those specifications are detailed in the following paragraphs.

4.1 Recommendations for the laboratory

- EN ISO 140-1 and -3: in principle all specifications included within EN ISO 140 parts 1 & 3 will be fulfilled, even if not mandatory. Any divergence will be stated :

$1s \leq Tr \leq 2(V/50)^{2/3} s$ (§3.1 EN 140-1)

averaging : logarithmic averaging as far as position of loudspeaker does not change, otherwise arithmetic averaging (see §3.1 and 6.2.1 of EN 140-3)

Thickness of the wall : ≤ 50cm (§3.2.3 EN 140-1)

check R'T following Annex B

…

- rooms : use the largest room as emission room
- niche : use 1/3 on the emission side and 2/3 on the reception side
- position of the sample in the separating wall : avoid symmetries

4.2 recommendations for all the measurements

- Check in Excel files all the data (L_{pe}, L_{pr}, RT, L_{bg}) for each position
- Precise the surface S of the sample used in the calculation of R
- Follow carefully EN ISO 140-3 and particularly :

▪ Position of microphones :

Rotating arm: two rotations of at least 30s each or five fixed positions of at least 10s (the solution used is given in the report)

At least two fixed positions of loudspeaker, but more if the procedure in the annex requires it.

Use preferably rotating arm.

▪ Reverberation time measurement

- If the laboratory has other procedure, it can also make one measurement for each glazing according to this one.

4.3 Tests

4.3.1 Sealing:

Test the two compositions with Perenator

Test the two compositions with foam

Make all the other tests of the round robin with foam.

4.3.2 Diffusivity of the sound field

Use 5 random fixed positions of microphones at emission and reception at least at 1 m from the walls and sample for the 2 usual loudspeaker positions:

For the two compositions of glazing, one measurement :

L_{pe}, L_{pr}, L_{bg} and RT for the five positions

Note:

No need to use EN ISO 140-3 Annex C in this case but provide drawing with used positions;

In addition, to check the sound pressure level in the test opening in front of the glazing, which is also an important parameter, the SPL will be measured by two microphone positions in the test opening at the emission side of the test wall on the diagonal of the test opening at ¼ of each end of the diagonal.

4.3.3 Repeatability

For the two compositions of glazing : 6 measurements with usual lab method

provide all the data : L_{pe}, L_{pr}, L_{bg}, RT without dismounting the panes

4.4 Report of each laboratory

Excel file with all the data of the different measurements (L_{pe}, L_{pr}, RT, L_{bg} for each position).

Photos of the mounting, plan of the laboratory and all data requested by EN ISO 140 part 3 § 9.

Exact description of the divergences with the standards.

An excel template has been prepared and provided to all laboratories.

Panes will be kept.

4.4.1 Mounting with foam

Final setting of the joint after crushing shall be as indicated in the drawing Fig.1. Crushing can be done by putting pressure on the pane or on the beading. One beading may be left in place during changing of pane.

N.B: The joint is self adhesive and stuck to the beading. When the pane is taken out and not compressed any more, the joint will take back its original thickness after ½ h. No tape is needed. Mounting conditions are stated in Fig 1

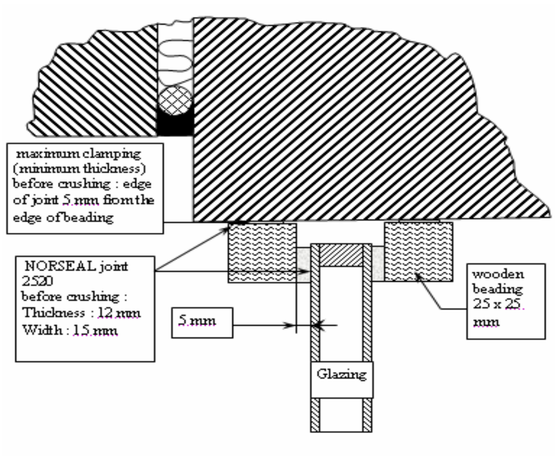

Fig 1 Mounting conditions with foam

5 Results

5.1 presentation of the results

We will show here the results of the tests for all laboratories. For confidentiality reasons, labs are indicated by a code name. Results for each glazing and each mounting will be presented for all the 23 labs in the same figure. 1/3rd octave values of standard deviation are also presented.

5.1.1 6(16)6 glazing

standard mounting conditions :

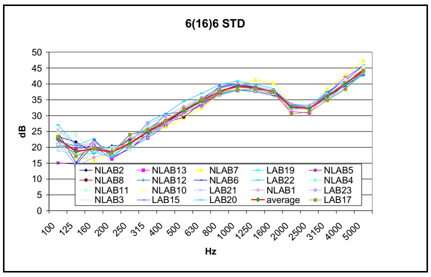

Fig.2 STL of glazings

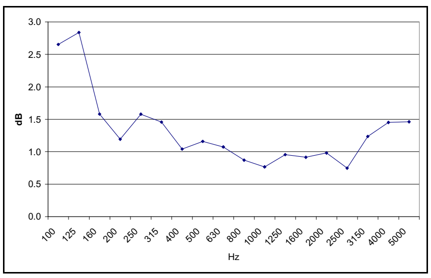

Fig.3 standard deviation

mounting with foam :

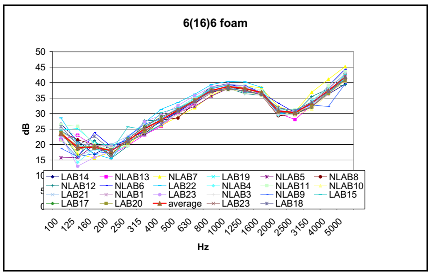

Fig.4 STL of glazings

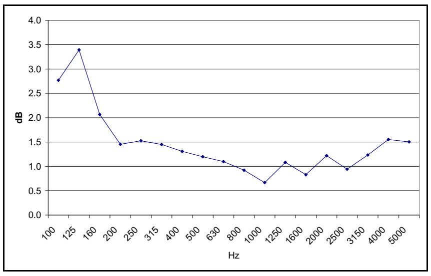

Fig.5 standard deviation

5.1.2 44-2(16)10 glazing

standard mounting conditions

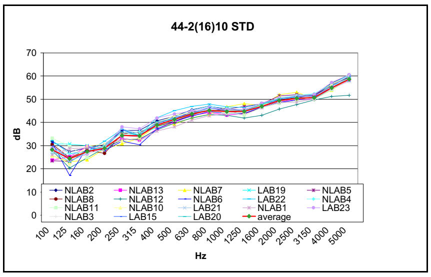

Fig.6 STL of glazings

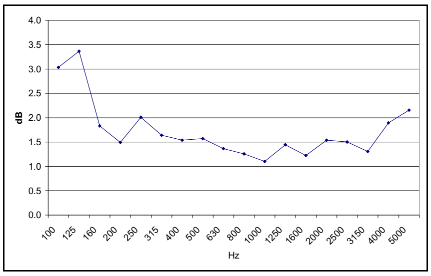

Fig.7 Standard deviation

mounting with foam

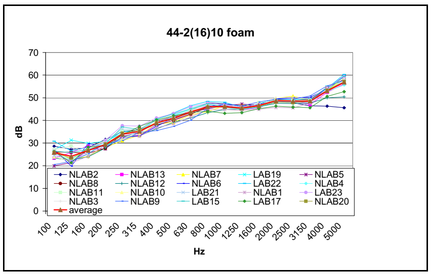

Fig.8 STL of glazings

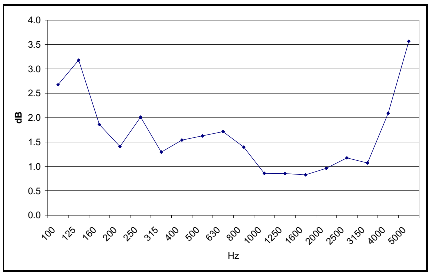

Fig.9 standard deviation

6 Analysis of the results

6.1 Verification of specifications

The first step was to verify that all tests had been done following specifications, but all labs did not answer all questions.

There were several non conformities concerning reverberation time range (labs 9,10,17), use of largest room as emission room (labs 5,7,11,17,21), thickness of the wall (lab 11), niche (lab 7), volume over 100 m^3 (labs 1,3,4,5,18,20,21).

Volumes of both rooms were checked : emission room from 55.5 to 124.4 m^3 and receiving room from 49.2 to 122.3 m^3.

Presence or not of diffusers was also checked.

6.2 repeatability

Second step was to check repeatability of each lab, which has to be below the values stated by ISO 140-2 standard.

Each lab had to send its repeatability and diffusivity results, and all data allowing to calculate the Sound Transmission Loss.

Repeatability tests were done following ISO140-2. The result were compared to the reference **r** tabulated in that standard.

Repeatability data were not always below reference.

6.3 Verification of physical quantities

6.3.1 Verification of reverberation time

In the specifications, reverberation time must fulfill following conditions :

$1s \leq Tr \leq 2(Vr/50)^{2/3}s$ Vr being the volume of the receiving room. This has been verified by checking curves.

Several non conformities from different labs have been put into evidence.

6.3.2 Homogeneity of the sound field in the emission and receiving rooms

It is verified here that the sound pressure level measured by changing the microphone position in the room does not vary too much.

This verification is done graphically, by looking at curves like Fig.10

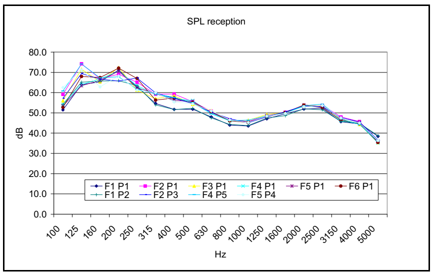

Fig.10 homogeneity of receiving room of lab. 12

Homogeneity is not verified here, specially in low frequency range.

6.4 Extra laboratory reproducibility

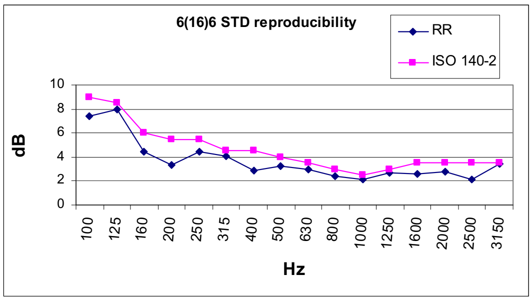

Fig.11 reproducibility of 6(16)6 pane with Perenator mounting

Reproducibility with standard (perenator) mounting is below ISO 140-2 data but still rather high and unacceptable for CE marking.

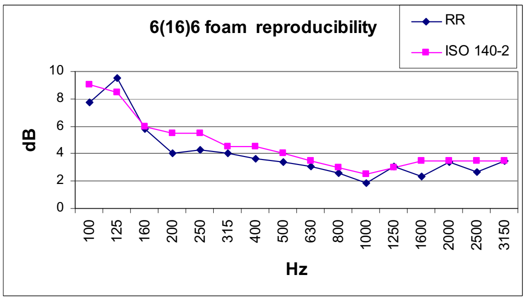

Fig.12 reproducibility of 6(16)6 pane with foam joint mounting

Reproducibility with foam joint mounting is also rather high and even overcomes ISO 140-2 data at 125 Hz.

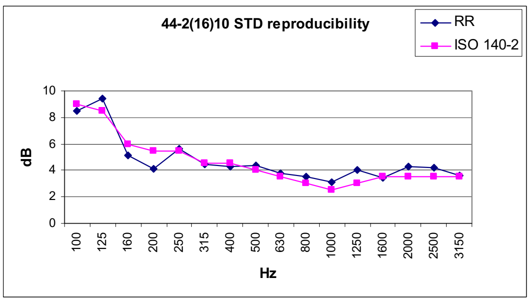

Fig.13 reproducibility of 44-2(16)10 pane with Perenator mounting

Reproducibility of tests for standard mounting is above ISO 140-2 reference for several 1/3rd octave bands.

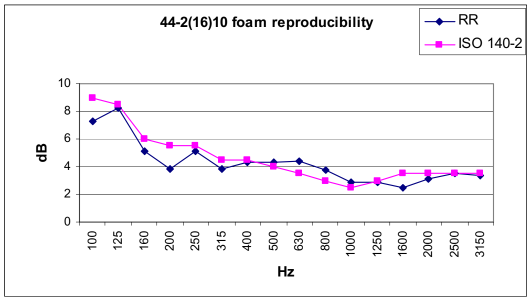

Fig.14 reproducibility of 44-2(16)10 pane with foam joint mounting

Reproducibility of tests for foam mounting is above the reference in the 500-1000 Hz range and is also rather high in the other frequency bands.

By eliminating some labs, reproducibility can be highly improved.

7 Conclusions

Calculations of repeatability and reproducibility have allowed us to know the quality of test results and check labs with likely results.

Verification of conformity of the labs with specifications have allowed to eliminate some labs.

Concerning replacement of Perenator with foam joint, it has been decided to keep standard mounting, as replacement of Perenator should have obliged to re-make several tests and then cost advantage should have disappeared. Dispersion is also higher with foam joint.

Dispersion of labs fulfilling specifications can only been explained by the fact that structure of labs varies deeply from one lab to the other.

Acknowledgements

Acknowledgements to all laboratories who participated at this study.

References

[1] ISO 140 parts 1, 2 and 3 standards *ISO Case postale 56 CH 1211 Geneva 20*