

Invited Paper



European Round Robin Test for sound absorption measurements

Nils-Åke Andersson

Saint-Gobain Ecophon AB
nilsake.andersson@ecophon.se

Abstract

It is well-known from earlier Round Robin tests that the uncertainty in sound absorption measurements leads to poor reproducibility between laboratories. This is an unacceptable situation as we are using the sound absorption single value, α_w , for the mandatory CE marking of products. CEN/TC 126 decided to set up a new working group with the scope to develop Test Codes for suspended, acoustic ceilings.

This working group, WG 11, has identified several details not specified in EN ISO 354 and put them into a preliminary Test Code. A Round Robin Test has been prepared including 23 European laboratories. 3 products with different sound absorption properties are included and a range of tests will take place in the beginning of 2010. Analyses will follow in the spring and summer, after which a Test Code will be proposed.

Keywords: sound absorption, measurement, laboratory, uncertainty, round robin test.

1 Introduction

Measurement of sound absorption properties of material have been performed for more than one hundred years. In the end of the 18th century Wallace Clement Sabine did physical measurements of the decay time in the Fogg lecture hall at Harvard University. Later on he set up the first laboratory chamber for measurement of sound absorption properties at Riverbank Laboratories outside Chicago. From his measurements Sabine developed what was going to be called the Sabine formula, which is still used as the basic formula for calculation of the sound absorption coefficient, even in laboratory precision measurements. Parts of this laboratory are nowadays a museum showing some of the equipments and facilities from that period.

In the second half of last century this measurement was standardized in ISO 354 [1] and ASTM C 423 [2]. Since then several Round Robin Tests (RRT) have been performed, showing a substantial spread of results between different laboratories [3, 4, 5 and 6].

In the 90-ies EU gave a mandate [7] to CEN/CENELEC to develop a harmonized product standard, EN 13 964 [8], for suspended ceilings. This standard includes, in most European countries, a mandatory requirement to label the products. This label bears a single value figure for the weighted sound absorption α_w . The weighted sound absorption is calculated according to EN ISO 11654 [9] from sound absorption measurements according to EN ISO 354 [1].

The European Commission has paid attention to the spread of results, which might be unfair for the competition between producers and between laboratories. It might also lead to deviations in the final calculations of reverberation time or sound level reduction, using the figures from the CE-marking, which finally will affect the end-users. Therefore CEN, the European standardisation body, was asked to scrutinize the circumstances and try to improve the situation. At a meeting with their building acoustic committee TC 126 in Vilnius 2007, it was therefore decided to create a working group, WG 11, to investigate what can be done.

This paper will present what has happened so far and what is going on in WG 11.

2 Scope and preparation of the work in WG 11

At the meeting referred to above, Nils-Åke Andersson from Saint-Gobain Ecophon was elected convener for the working group. Invitations were sent out to the member bodies to nominate participants and a first meeting was possible to arrange in May 2008. The group has grown since then and has now 18 participants and another 8 persons being on the document distribution list.

The first thing for WG 11 was to try to define what to do from the scope given by a resolution from CEN/TC 126 [10]. The scope says among other things:

- Identify influencing laboratory test configuration details.
- Identify relevant measurement methods.
- Identify influencing mounting details.
- Organize round robin tests to quantify the uncertainty.
- Develop a new acoustic test code including the level of uncertainty.
- The work is limited to suspended ceilings and covers sound absorption coefficient and flanking transmission.

After some discussions in the working group it was concluded that it was a comprehensive task, so a decision was taken to start with the sound absorption measurement. Work with flanking transmission will follow later on. It was also decided to concentrate on suspended ceilings. Baffles and other specialities should not be treated, at least not for the time being.

3 Preliminary Test Code

WG 11 went through a range of standards and documents to find details, which might be of importance for the measurement uncertainty for sound absorption tests. After a lot of discussions and correspondence a preliminary Test Code was put together, to be used in the requested RRT as a complement to the latest version of EN ISO 354 from 2003. The condition was to keep 354 as it is and to add clarifications and more stringent or new details

in the Test Code. Later on these details might be included in the 354 standard in a regular revision.

From the preliminary Test code the following details can be found:

3.1.1 Size of test specimen and test samples

- Size of test specimen to be as close to 10,8 m² as possible, even if the test chamber is greater than 200 m³.
- Test samples to be mounted butt together, with no seal in the joints and normally no grid covering the joints.
- The edges of the specimen and the mounting fixture shall not be parallel to any of the edges/walls of the room.

3.1.2 Mounting fixture/Frame

For this specific RRT it was decided to mount the test specimen according to the type E-200 mounting configuration in Annex B.4 in EN ISO 354, with the following additional details:

- The mounting fixture/frame shall be of solid material, without any cavities.
- Open joints within the mounting fixture/frame or between the fixture and the room surface or between the fixture and the test specimen shall be sealed, to prevent air leakage between the enclosed space and the outside. Any open cavity or joint inside the fixture shall also be sealed, to avoid sound absorption in the enclosed space.

3.1.3 Test samples support construction

The preliminary Test Code includes some drawings to explain details in the support construction:

- The samples shall under all four edges be supported by a sub structure/supporting rail with a width ≤ 30 mm and a height ≤ 50 mm. The centre distance to be approximately 0,6 m or 1,2 m.
- Each piece of the sub structure/supporting rail shall be supported from the floor by support units/rail supports at centre distance of $\geq 1,2$ m. Cross section of the support units/rail supports shall be $\leq 50 \times 50$ mm.
- The deflection of the test specimen shall be ≤ 5 mm.

3.1.4 Temperature and relative humidity

- Corrections to the sound absorption coefficient shall not exceed $\pm 0,05$ due to the climatic conditions in the test chamber.
- The relative humidity in the chamber shall be at least 50 %.
- The temperature and relative humidity have to be checked for each measurement.
- The empty room reverberation time shall be measured at least once a day in the start of a test series.

3.1.5 Microphones and loudspeakers

- 4 omnidirectional loudspeaker positions in corners.
- The total amount of measurement positions, as combinations of microphone and loudspeaker positions, shall be at least 16.
- At least 5 decay measurements for each microphone-loudspeaker position, making the total number of decays at least 80.

- Measurements to be performed primary with interrupted noise.

4 Choice of laboratories

The intention was primarily to get European laboratories accredited for sound absorption measurement to join the Round Robin Test, but other laboratories making such measurements were also welcome to participate. The members of WG 11 and their contacts managed to set up a list of about 30 possible laboratories, which got an invitation together with a presentation of the project last summer. Finally 23 laboratories accepted to participate and to perform the RRT programme free of charge.

5 Choice of products for the Round Robin Test

The working group easily agreed on using 3 products in the RRT. These products should represent fundamentally different sound absorption properties, but also represent material of different origin. The following products were selected:

- A soft glass wool product in 50 mm thickness with a painted surface, giving high sound absorption.
- A wet felt product in 15 mm thickness with a painted and structured surface, giving intermediate sound absorption.
- A plaster board product in 13 mm thickness partly perforated and with an acoustic felt, giving good sound absorption in lower frequencies but low values in higher frequencies.

The principle sound absorption with an E-200 mounting can be seen in Figure 1.

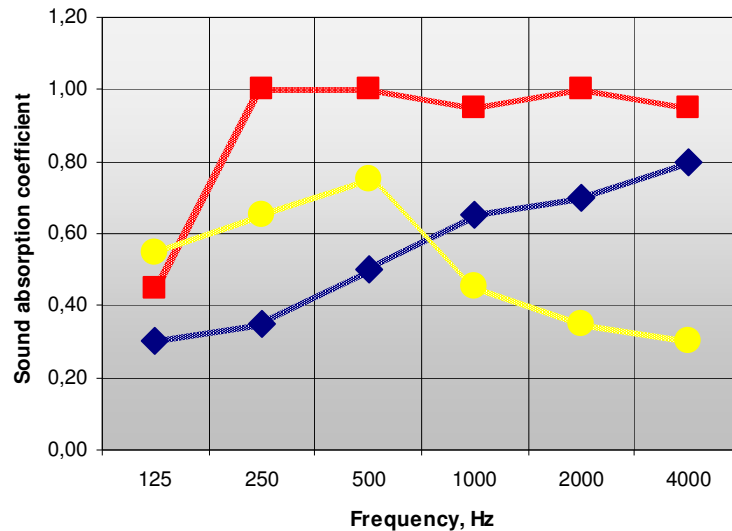


Figure 1 – Principal sound absorption for the RRT products.

Contacts were taken with 3 of the European main suppliers of suspended ceilings and they offered to deliver requested products to all 23 participating laboratories free of charge. Initially there was a discussion about the possibility to send around the same batch of products from laboratory to laboratory to be sure that the same products were measured on. But WG 11 agreed that the products were not suitable for so much handling, they run a risk to be damaged. The RRT should also become very time consuming and generate difficult logistics.

In order to secure that products sent to different laboratories were as identical as possible a discussion took place with the producers, located in Denmark, Germany and Sweden. They agreed to select all the products from one production batch only, but also to make a very special arrangement for the packaging. In principal samples in one delivery were selected from the whole batch. It was not a random selection, but means a very good distribution of the content in the batch.

The 3 product were delivered to the laboratories in November 2009.

6 Round Robin Test

As soon as the laboratories had accepted to participate in the RRT they were asked to fill an Excel template with a comprehensive amount of physical information about their facilities and measurement routines. The template did also request information about the check of diffusivity according to Annex A in EN ISO 354. The information might be used later on in the analyses in a try to explain possible differences in results.

After having delivered the finished template, laboratories were allowed to start their RRT according to a detailed programme. Mandatory for all laboratories was to run tests with the 3 products following EN ISO 354 plus the preliminary Test Code. In addition to this there were a set of voluntary measurements:

- Measuring the 3 products according to the procedure normally used.
- Measuring with an impulse response method.
- Checking repeatability by performing a second full test of the mandatory programme.
- Laboratories were welcome to perform other tests they think might be relevant.
- Laboratories were also welcome to make analyses of decay curves concerning their non-linearity and curvature.

The main part of the tests started in January-February and by the beginning of April all with the exception of 3 laboratories have run the tests, with at least 1 of them intending to run in April.

11 laboratories have so far reported the results and most of the other ones are expected later in April. For the analyses of the test results an expert has been hired and fortunately this cost will be covered by EURIMA, the European Mineral Wool Manufacturers Association.

7 Final remarks

The analyses will take place in the second and third quarters of 2010 and the intention is to be able to show some preliminary results, when this paper is presented in Lisbon. Immediately after INTERNOISE, WG 11 will hold a meeting to discuss what has been achieved and how to continue the work. The next step should be to write a Test Code proposal, which has to be treated the same way as in normal standardization. WG 11 will also start up its work with flanking transmission measurements on suspended ceilings.

When enough results are available from the analyses, the intention is to invite all the participating laboratories for a presentation of the outcome. This is supposed to take place in the early autumn.

Acknowledgments

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