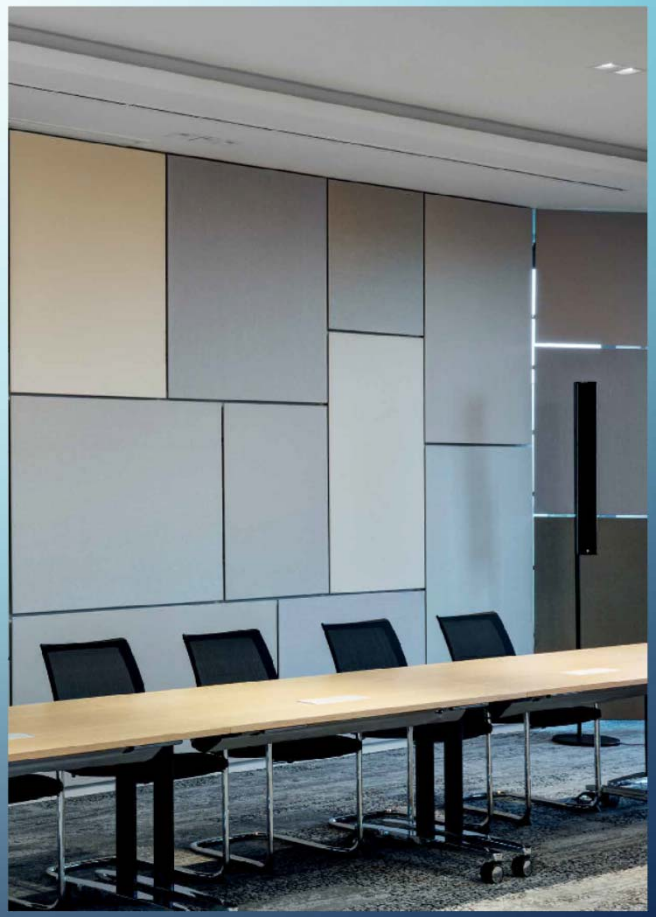
COMSOL CONFERENCE 2018 LAUSANNE

APPLICATION CREATED BY RESOLVENT FOR SIMULATING ABSORPTION CURVES ON ACOUSTIC PANELS WITH FRONT TEXTILES AND ACOUSTIC INSULATION FOLLOWING THE INTERNATIONAL STANDARD ISO 354 FOR MEASURING SOUND ABSORPTION



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ABOUT KVADRAT SOFT CELLS

Kvadrat Soft Cells offers the most compelling portfolio in acoustic textile solutions for walls and ceilings. This provides infinite design possibilities and ranges from standard post-fit panels to complex custom-made solutions.
Our product offering comprises a variety of durable, flexible designs, all of which reflect our commitment to push the aesthetic and technological boundaries of acoustic textile solutions.

KVADRAT ACOUSTIC PANELS

- ALUMINUM FRAME WITH A PATENTED TENSIONING SYSTEM
- FRONT AND BACK TEXTILES (BACK TEXTILES DEPENDING ON MODEL)
- ACOUSTIC ABSORBENT (DEPENDING ON MODEL)
- FITTINGS TO ATTACH INTO WALLS AND CEILINGS

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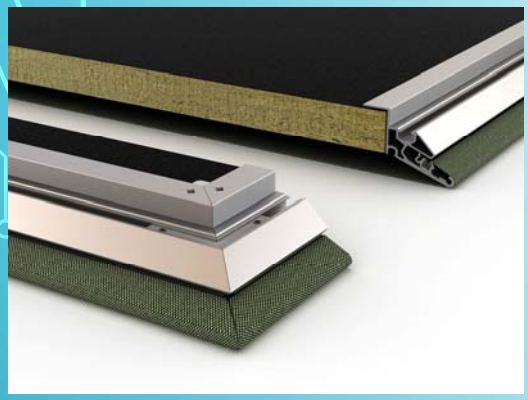
TYPES OF SOFT CELLS

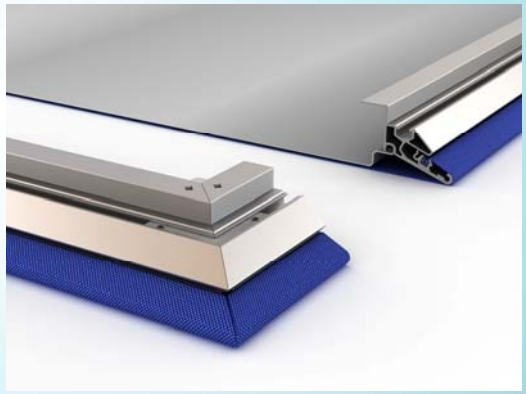


SC BROADLINE

CLASS-A SOUND ABSORPTION
SPACES WITH SEVERE REBERBERATION ISSUES
EFFECTIVE BROADBAND ABSORPTION
LOWERING OVERALL REVERBERATION

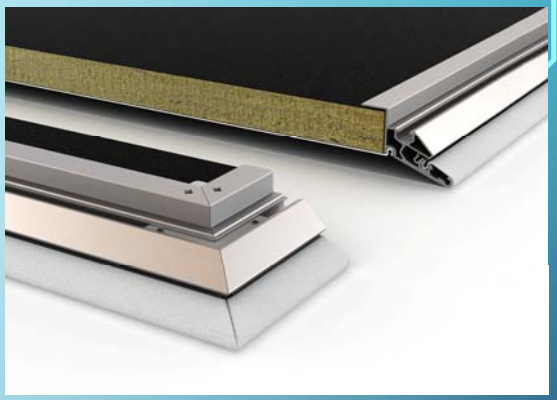
SC STANDARD

CLASS-C SOUND ABSORPTION
SPACES WITH MODERATE REVERBERATION ISSUES
HIGH FREQUENCY ABSORPTION ON WALLS
BROADBAND ABSORPTION AS SUSPENDED CEILING



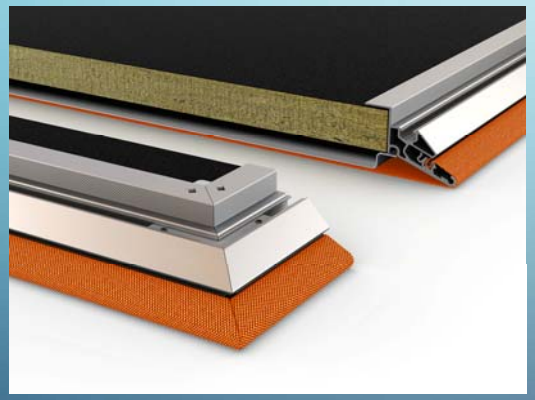
SC REFLECTIVE

CLASS-E SOUND ABSORPTION HIGH REFLECTION
ENHANCED NATURAL SPEECH TRANSFER / CLARITY THROUGH SOUND REFLECTION



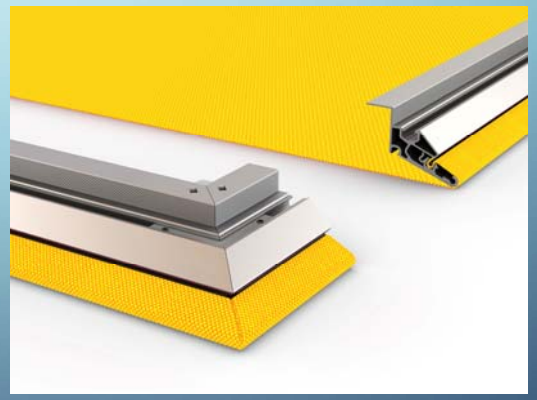
SC LOWTONE

EXCELLENT ACOUSTIC PERFORMANCE
CONCENTRATED IN LOW AND MID RANGES
SPACES WITH SPECIAL ACOUSTIC REQUIREMENTS
NOT JUST SOUND ABSORPTION



SC MAGNETIC

CLASS-A SOUND ABSORPTION
SURFACES WITH A NEED FOR PINBOARD FUNCTIONALITY COMBINED WITH MODERATE SOUND ABSORPTION



SC AESTHETIC

CLASS-C TO E SOUND ABSORPTION
SPACES WITH LOW TO MODERATE SOUND ABSORPTION ISSUES

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REVERBERATION ROOM LABORATORY

In Kvadrat Soft Cells we have our own reverberation room laboratory in our production facility in Poland where we empirically can test the acoustic behavior of our Soft Cells panels.

For every product configuration to be tested we need to upholster a panel surface of 3900X2800 mm and test it in the reverberation room using a lot of time, resources and materials.

As the product configuration and thus acoustics changes with different front textiles and acoustic backings, we have more than 1000 variations and constant change.

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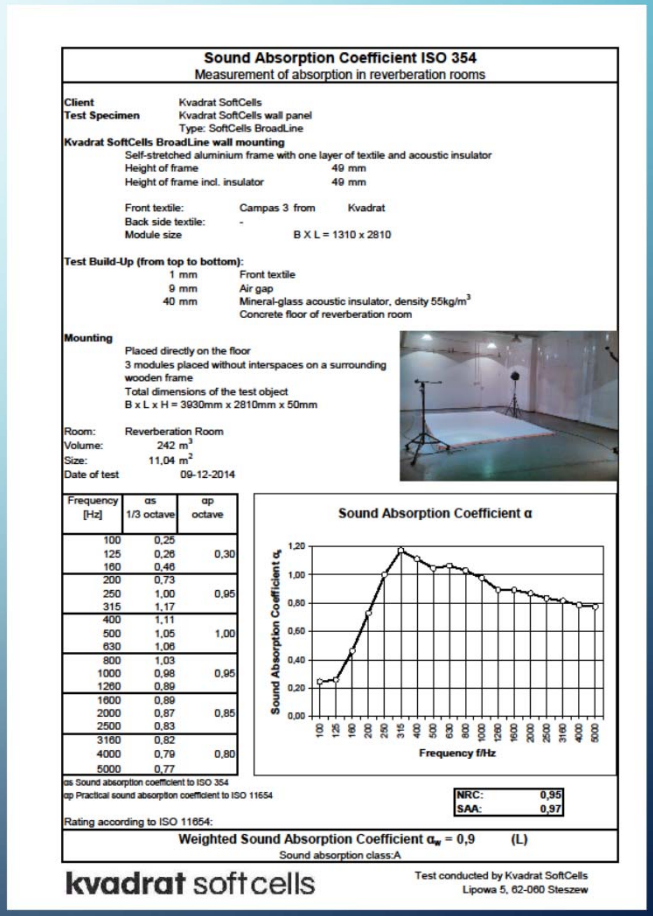
THE GOAL

The goal was to predict the panel behavior before building it and determine the band average and frequency dependent values of the Soft Cells panels with insulation and front textiles following the standard ISO 354 ACOUSTICS – MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM.

Example of physical measurement of absorption in reverberation room



Sound Absorption Coefficient ISO 354
Measurement of absorption in reverberation rooms

Client Kvadrat SoftCells
Test Specimen Kvadrat SoftCells wall panel
Type: SoftCells BroadLine
Kvadrat SoftCells BroadLine wall mounting
Self-stretched aluminium frame with one layer of textile and acoustic insulator
Height of frame 49 mm
Height of frame incl. insulator 49 mm

Front textile: Campas 3 from Kvadrat
Back side textile: -
Module size B X L = 1310 x 2810

Test Build-Up (from top to bottom):
1 mm Front textile
9 mm Air gap
40 mm Mineral-glass acoustic insulator, density 55kg/m³
Concrete floor of reverberation room

Mounting
Placed directly on the floor
3 modules placed without interspaces on a surrounding wooden frame
Total dimensions of the test object
B x L x H = 3930mm x 2810mm x 50mm

Room: Reverberation Room
Volume: 242 m³
Size: 11,04 m²
Date of test 09-12-2014

Frequency [Hz]	αs 1/3 octave	αp octave
100	0,25	
125	0,26	0,30
160	0,46	
200	0,73	
250	1,00	0,95
315	1,17	
400	1,11	
500	1,05	1,00
630	1,06	
800	1,03	
1000	0,98	0,95
1260	0,89	
1600	0,89	
2000	0,87	0,85
2500	0,83	
3160	0,82	
4000	0,79	0,80
5000	0,77	

αs Sound absorption coefficient to ISO 354
αp Practical sound absorption coefficient to ISO 11654

Sound Absorption Coefficient α

NRC: 0,95
SAA: 0,97

Rating according to ISO 11654:

Weighted Sound Absorption Coefficient α_w = 0,9 (L)
Sound absorption class:A

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Test conducted by Kvadrat SoftCells
Lipowa 5, 62-060 Steszew

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COMSOL MULTIPHYSICS

RESOLVENT CERTIFIED CONSULTANTS

Transforming our complex acoustics model into a simple user interface (an app)

Customizing the app to our needs by selecting inputs and outputs for the app users

COMSOL ACOUSTIC MODULE

BIOT-ALLARD MODEL

SIMULATING POROELASTIC WAVES WITH THERMAL AND VISCOUS LOSSES

COMSOL SERVER

Using the COMSOL Server product to make them accessible to other team members

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TEXTILE PARAMETERS

Ideally simulations would be based on standard textile data for the specific designs

- Yarn properties
- Textile construction
- Poro-Acoustic parameters (5-parameter equivalent to fluid model)

Often the poro-acoustic parameters are not readily available and specific yarn properties and textile construction data might be proprietary supplier information. Therefore, initially, the dependencies and effect of the various parameters related to the sound absorption curve were analyzed.

Result was that within a standard range, the airflow resistance value could be isolated as far the most determining parameter.

AIRFLOW RESISTANCE VALUE

For the insulation material, airflow value of mineral wool would normally be available from manufacturer and is a constant value/component.

For the textiles, we already had an in in-house setup to measure Airflow.
We use a textile piece of 300x300 mm to get the airflow resistance value.

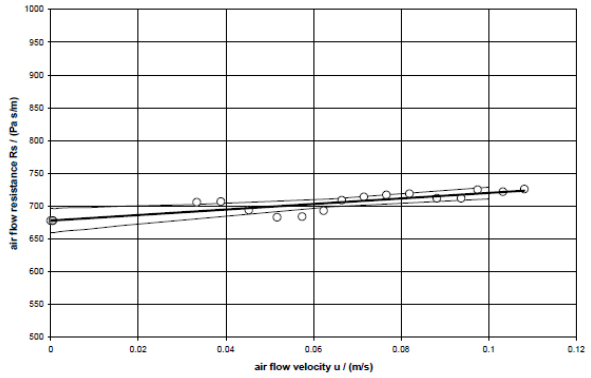
Airflow values as well as material thicknesses are now introduced into the simulation tool.

Example of Airflow resistance values

Determination of airflow resistance acc. to EN 29053

Project : Kvadrat
Test report No. : M60836/6
tested by : nm
Date of measurement : 06/06/2005

Details about test specimen
Number : 3954
Construction : felt fabric, single layer
Designation : Divina 2 973 Kvadrat A/S
Material : 100 % new wool
Purpose : upholstery
Thickness : 1.45 mm
Diameter : 100 mm
Mounting details: both sides equal
Mass : 21.70 g
Size : 0.040 m²
barom. air pressure : 95.6 kPa
abs. air pressure : 101,3 kPa
area spec. mass: 542.5 g/m²



Air flow velocity u / (m/s)	Specific air flow resistance R_S / (Pa s/m)	Specific air flow resistance rel. length r / (Pa s/m²)
0.0005	678	4.68E+05

Extrapolated acc. to EN 29 053:

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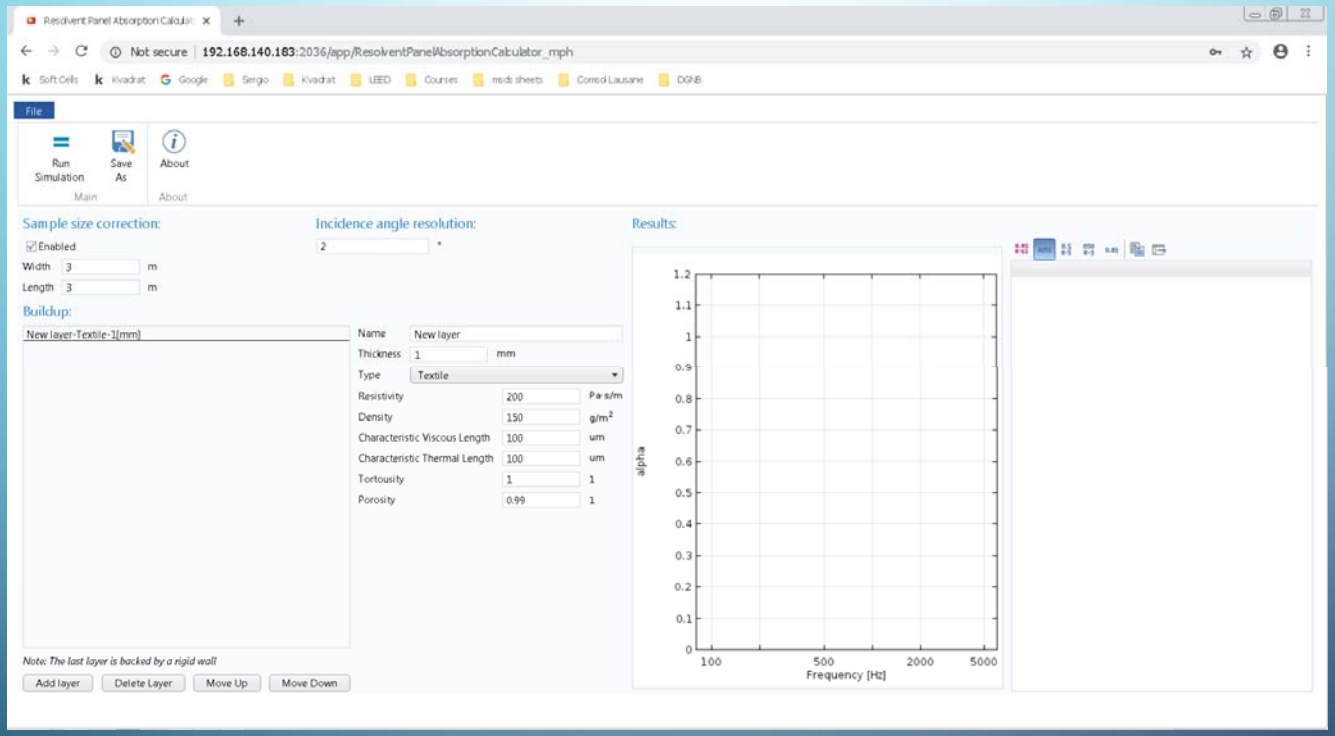
RESOLVENT PANEL ABSORPTION CALCULATOR

Specially designed by Resolvent (Comsol's certified consultants)



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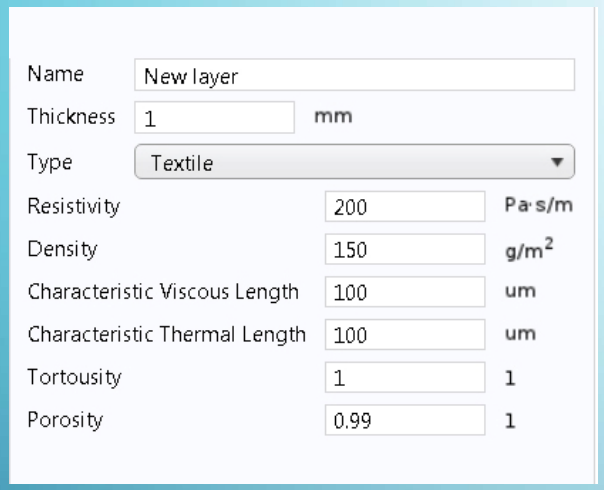
RESOLVENT PANEL ABSORPTION CALCULATOR PARAMETERS

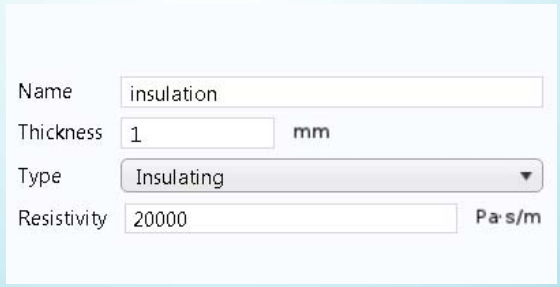
TEXTILES



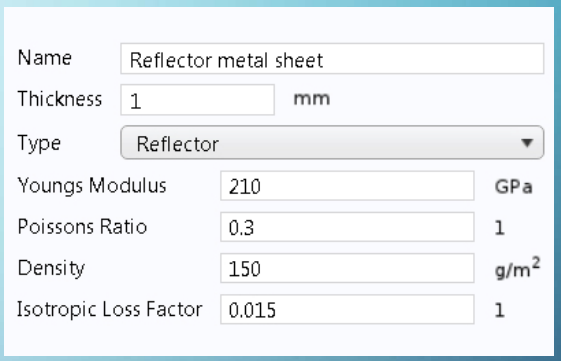
Resistivity, thickness and density are the key parameters

The others usually stays by default

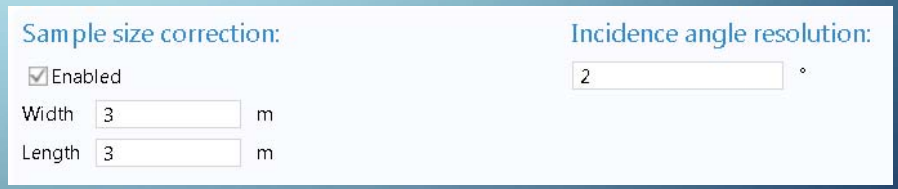
INSULATION



REFLECTOR METAL SHEET



SAMPLE SIZE CORRECTION AND INCIDENCE ANGLE RESOLUTION



Just change the low frequency behavior (edge and size effect)

To tweak the reverberation chamber results

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RESOLVENT PANEL ABSORPTION CALCULATOR

We have thus – for most cases – replaced the physical sound absorption measurements in reverberation room

WE CAN NOT SIMULATE/REPLACE

- Perforated metal sheets
- Baffles
- Acoustic island (no enclosure test, free hanging panels)
- Big air cavity tests (like 600mm)
- Wave curtains measurements
- Extreme Airflow values

IT IS POSSIBLE BY FINETUNING THE APP BY RESOLVENT

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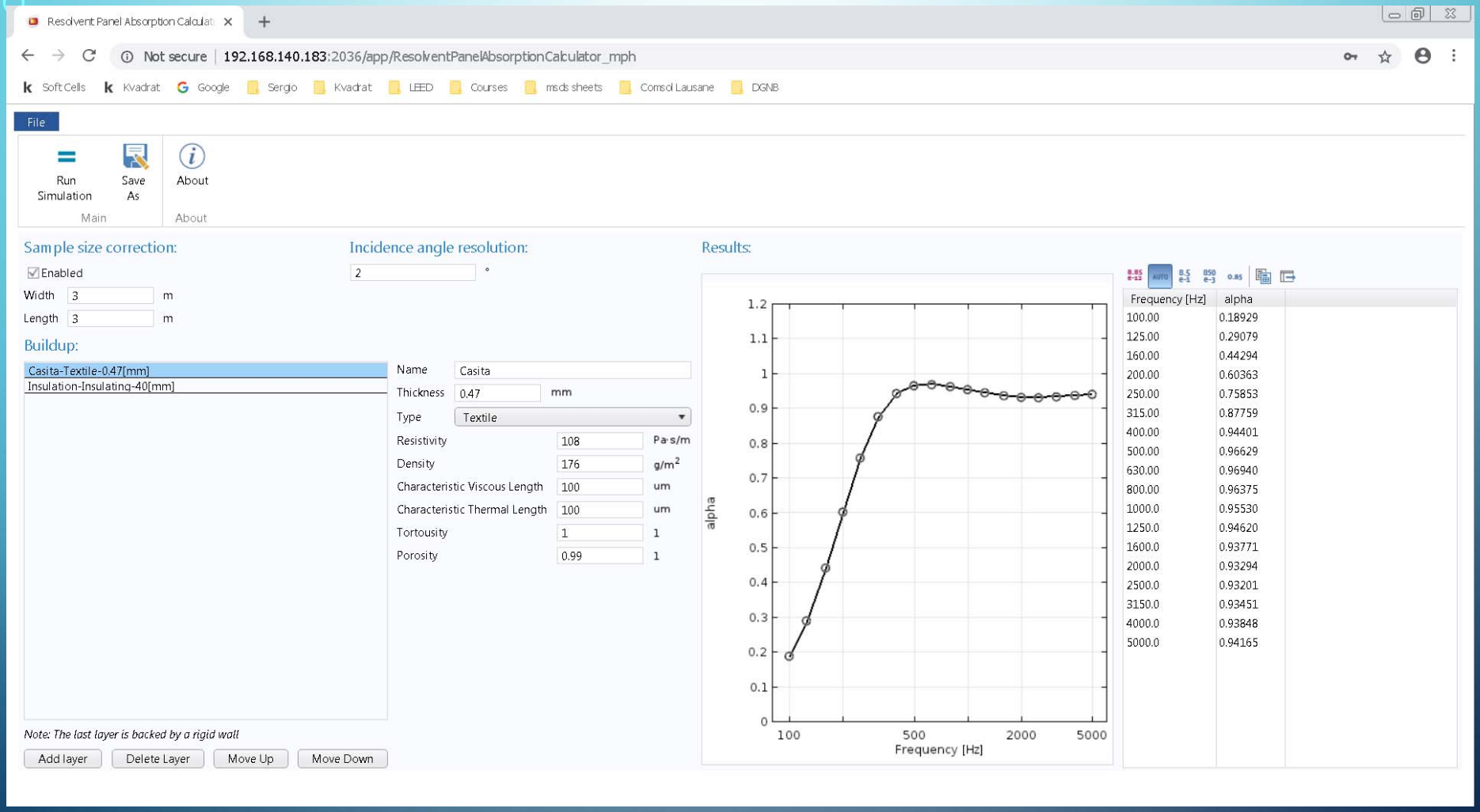
RESOLVENT PANEL ABSORPTION CALCULATOR EXAMPLE



To run the app and obtain the sound absorption curves is a matter of 2 minutes once the required parameters have been introduced

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CONCLUSIONS

The designed app works as intended for the Soft Cells panels with front textiles within a certain range of (non extreme) airflow resistance values and thus covers most configurations while obtaining the needed absorption curve values on the different Soft Cells models.

The app is designed as a browser based solution allowing easy access worldwide to the tool and the results, thus saving time, resources and materials.

SUMMARY

- KVADRAT SOFT CELLS ACOUSTIC PANELS AND TYPES
- REVERBERATION ROOM LABORATORY
- THE GOAL
- COMSOL MULTIPHYSICS
- TEXTILE PARAMETERS
- AIRFLOW RESISTANCE VALUE
- RESOLVENT PANEL ABSORPTION CALCULATOR
- RESOLVENT PANEL ABSORPTION CALCULATOR PARAMETERS
- RESOLVENT PANEL ABSORPTION CALCULATOR EXAMPLE
- CONCLUSIONS

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