

Project No.:  
**0761-24P-B02-1**

Title:

# Simulation – calculations of the reverberation time in an office interior. Revision 1

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**Report date:**

17.10.2024 r.

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- ❑ **Summary**

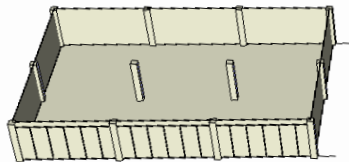
# Purpose and subject of research

## Subject of research:

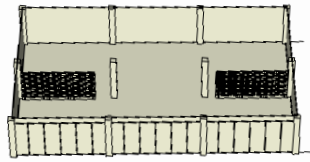
The subject of the study is an office room with walls VANK\_FLIP.

## Aim of the research:

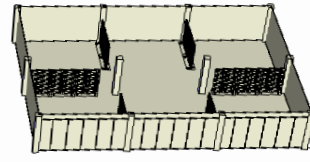
Determination of the reverberation time for 7 variants of office room adaptation.



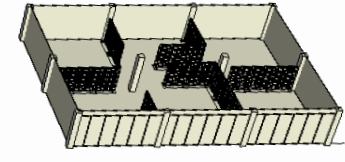
Variant 0



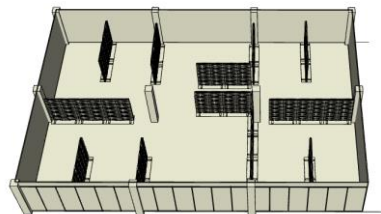
Variant 1



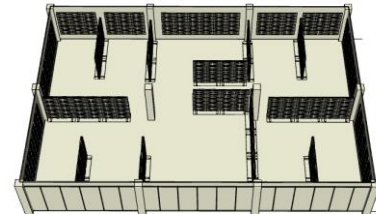
Variant 2



Variant 3



Variant 4  
Variant 6



Variant 5

# ACOUSTIC MODEL

# Acoustic model

## Introduction

For the purpose of assessing the acoustic parameters of the room, an acoustic model was prepared:

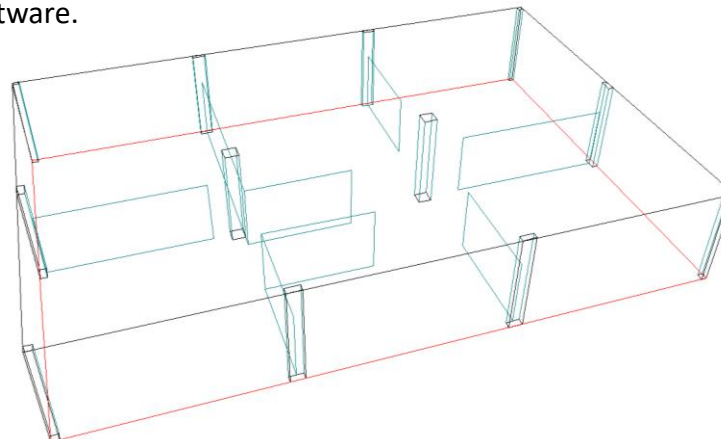
- It is based on a geometric model of an office room. The internal surfaces of the hall have been given acoustic parameters (sound absorption and dispersion coefficient) corresponding to the following types of materials:
  - Floor – concrete\*
  - Ceiling – concrete
  - Walls – plasterboard

\*In variant 6 the floor material was changed to flooring carpet

Sound absorption coefficient

	Frequency f [Hz]								$\alpha_w$
	63	125	250	500	1000	2000	4000	8000	
Plasterboard	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,05
Concrete	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,05
Flooring Carpet	0,02	0,02	0,06	0,14	0,37	0,6	0,65	0,65	0,2

The acoustic model of an example open-space office with an area of 18 x 12 m<sup>2</sup> and a height of 3 m was created using professional Odeon 18 Combined software.



# Acoustic model

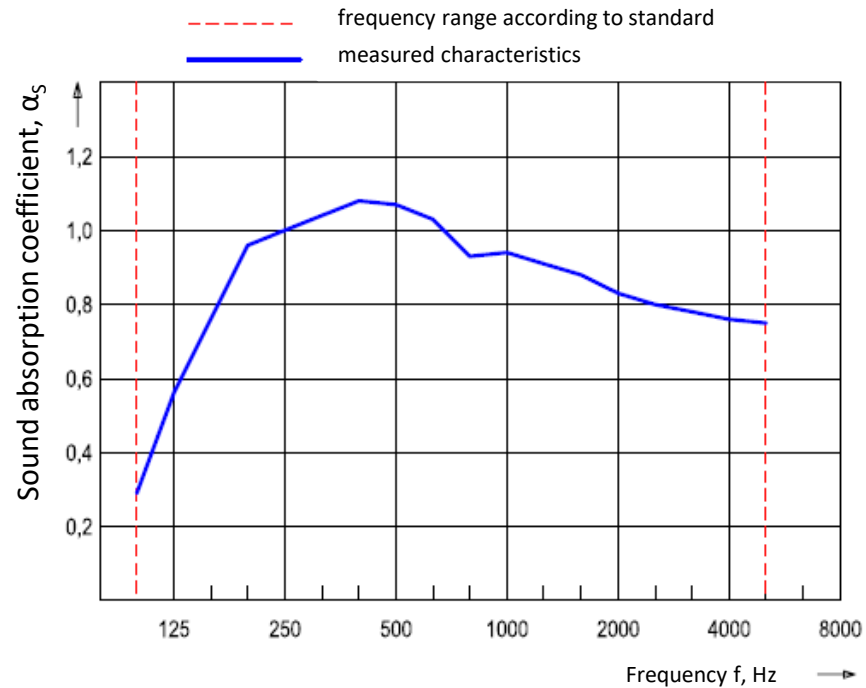
## Parameters of the tested partition VANK\_FLIP

Frequency f [Hz]	$T_1$ [s]	$T_2$ [s]	$\alpha_S$	$\alpha_p$
100	6,01	3,68	0,29	0,55
125	5,52	2,58	0,56	
160	4,81	2,05	0,76	
200	5,19	1,83	0,96	1,00
250	5,20	1,78	1,00	
315	6,01	1,81	1,04	
400	6,00	1,77	1,08	1,00
500	6,64	1,83	1,07	
630	6,67	1,88	1,03	
800	6,44	2,00	0,93	0,95
1000	6,42	1,98	0,94	
1250	6,45	2,04	0,91	
1600	6,03	2,04	0,88	0,85
2000	5,50	2,05	0,83	
2500	4,94	2,01	0,80	
3150	4,23	1,91	0,78	0,75
4000	3,56	1,78	0,76	
5000	2,70	1,54	0,75	

PN-EN ISO 11654:1999

$\alpha_w = 0,90(L)$

Absorption class **A**



# Acoustic model

## Description of the analyzed parameters

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In order to investigate the impact of the effectiveness of using VANK\_FLIP walls in the office space, changes in two acoustic parameters of the room were analyzed:

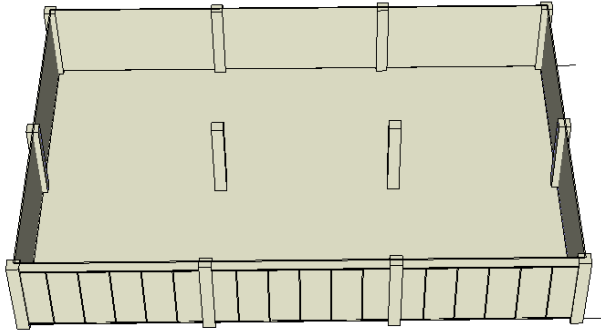
- ❑ **Reverberation time** – the time when the sound energy in a room decreases by 60 dB after the sound emission from the source has stopped. The RT60 value can range from fractions of a second to a few seconds and depends on the size of the room and the type of materials used to build it. According to the PN-B-02151-4:2015-06 standard, the recommended reverberation time in office rooms is less than 0.6 s.

# Acoustic model

## Reverberation time simulation results

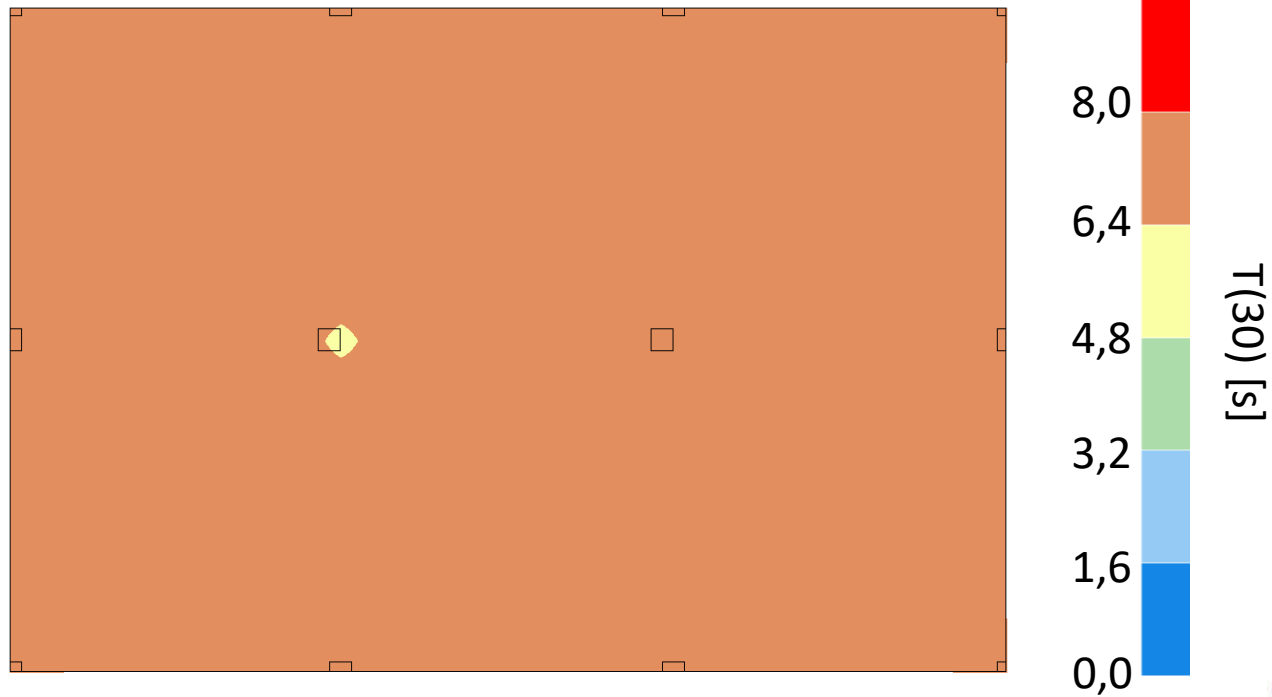
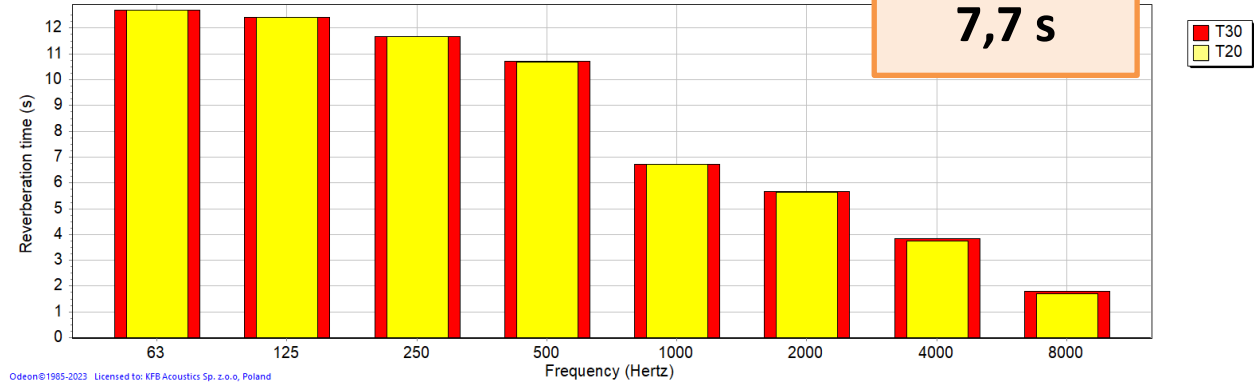
### Variant 0

A model office interior  
without walls and  
acoustic panels



Below is a map of the distribution of the T30 reverberation time (at 1kHz) for variant 0 and the values of the reverberation time in the octave bands.

Average  
reverberation time  
**7,7 s**

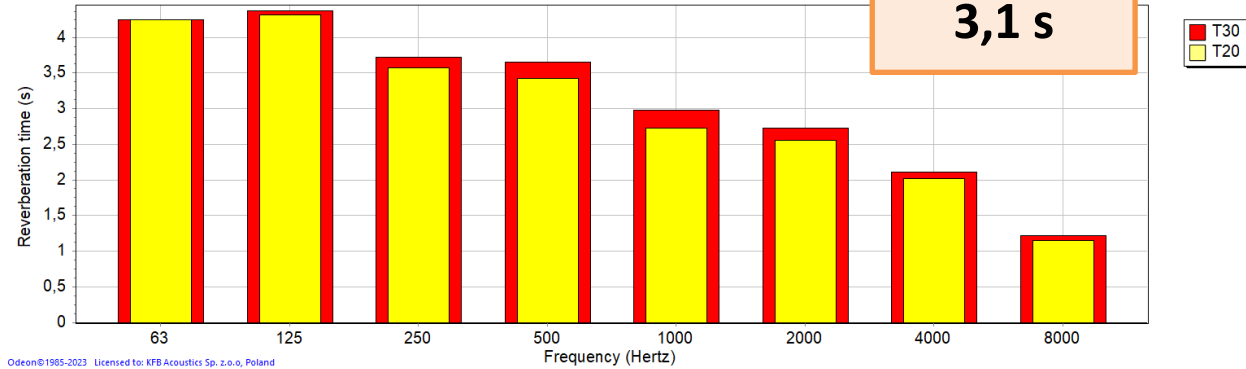
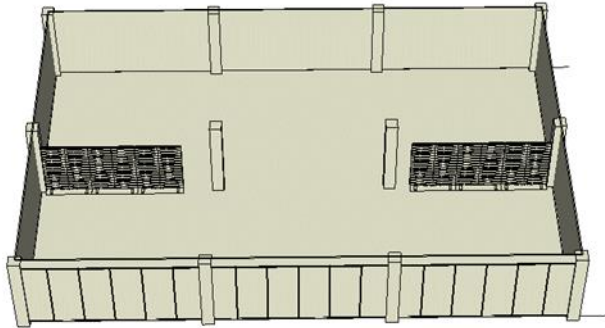




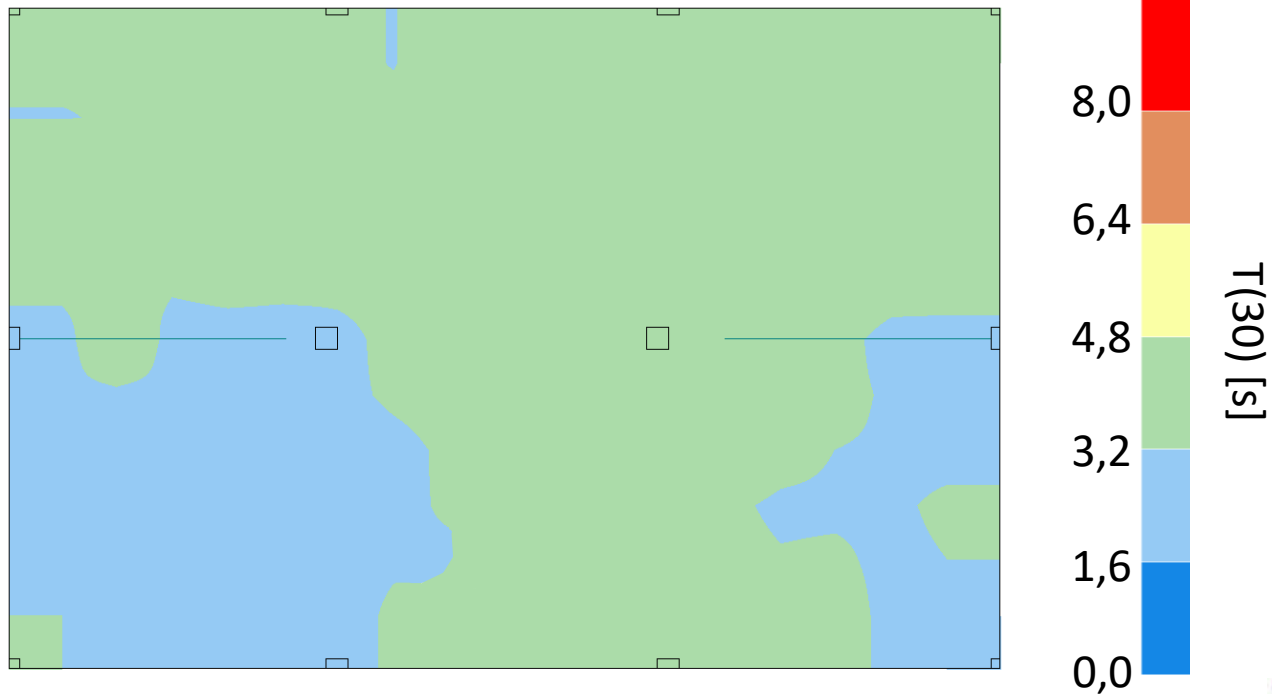
# Acoustic model Reverberation time simulation results Variant 1

Below is a **map of the distribution of the T30 reverberation time** (at 1kHz) for variant 1 and the values of the **reverberation time in the octave bands**.

Model office interior after adding 6 VANK\_FLIP acoustic walls (160x200 cm)



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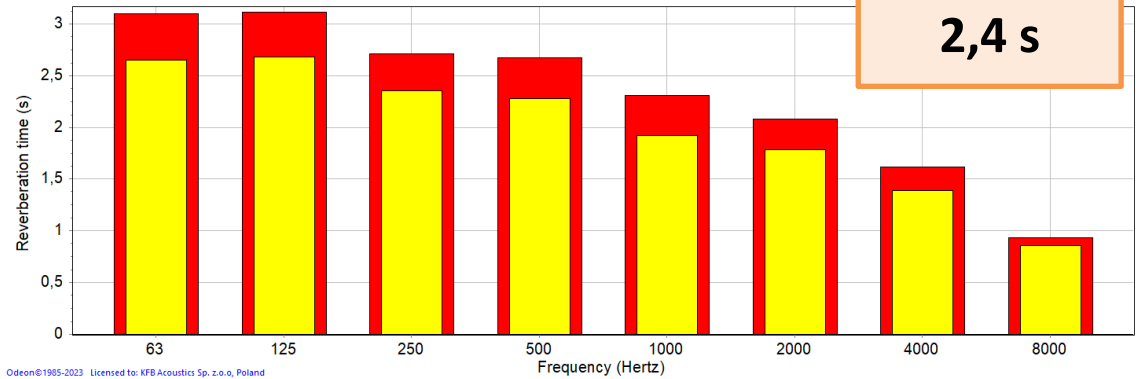
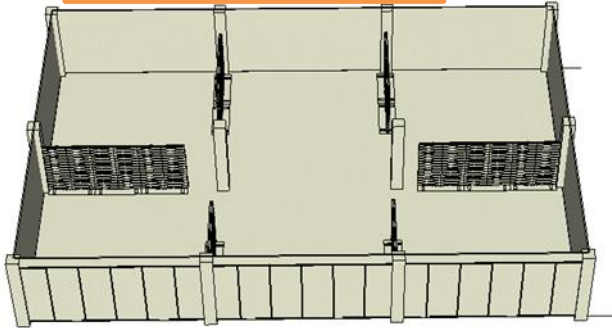


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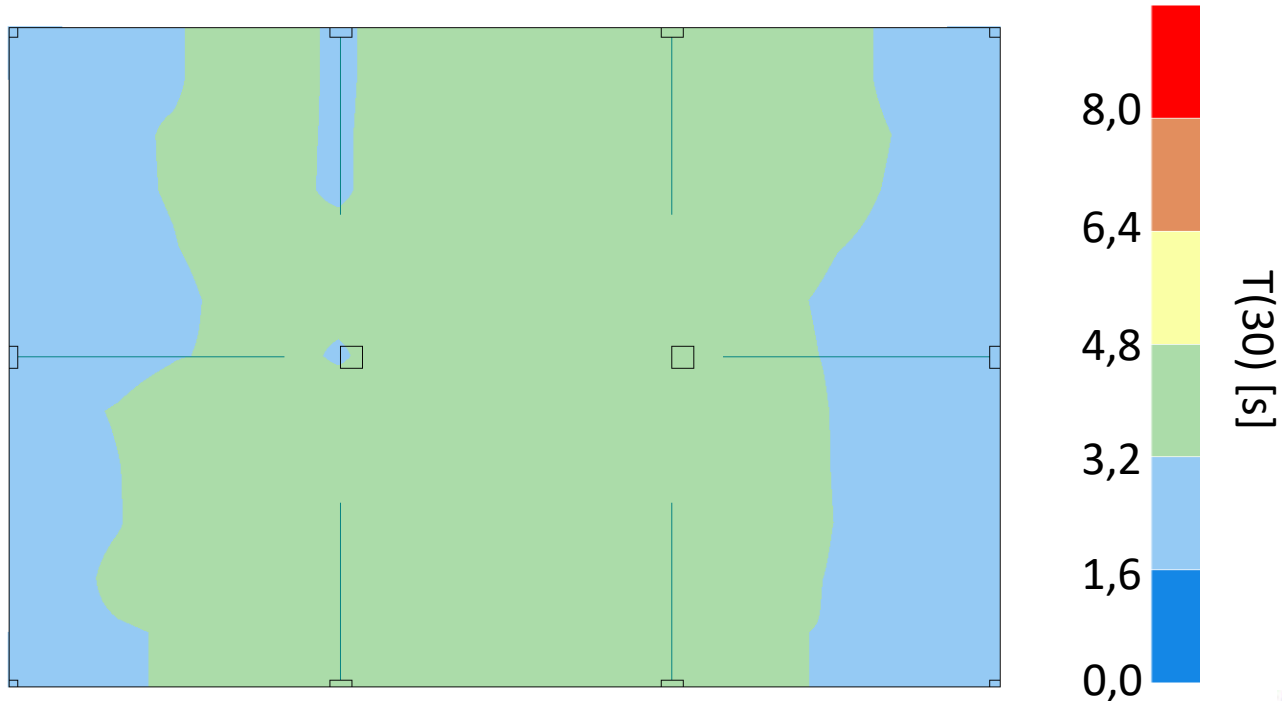
# Acoustic model Reverberation time simulation results Variant 2

Below is a map of the distribution of the **T30 reverberation time** (at 1kHz) for variant 2 and the values of the reverberation time in the octave bands.

Model office interior after adding 14 VANK\_FLIP acoustic walls (160x200 cm)

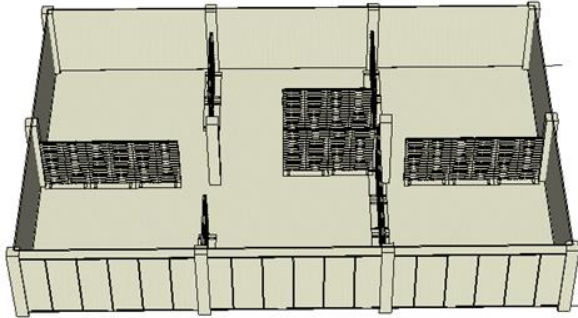


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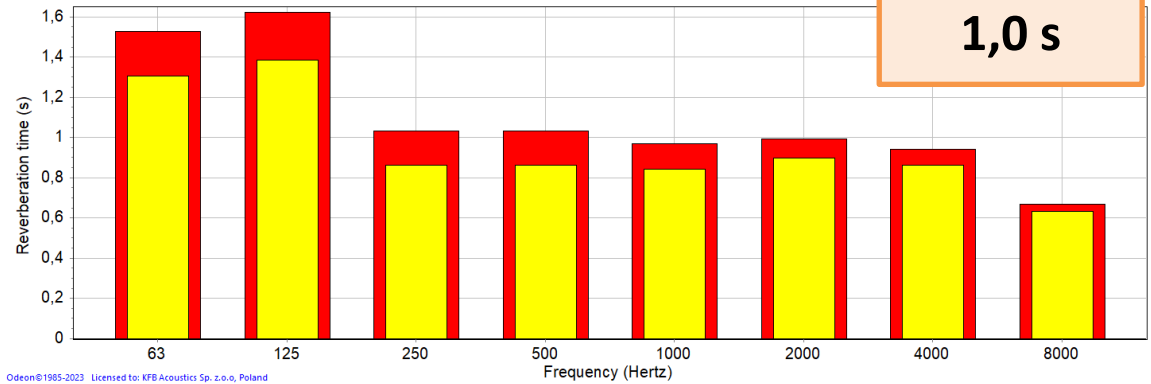


# Acoustic model Reverberation time simulation results Variant 3

Model office interior after adding 20 VANK\_FLIP acoustic walls (160x200 cm)



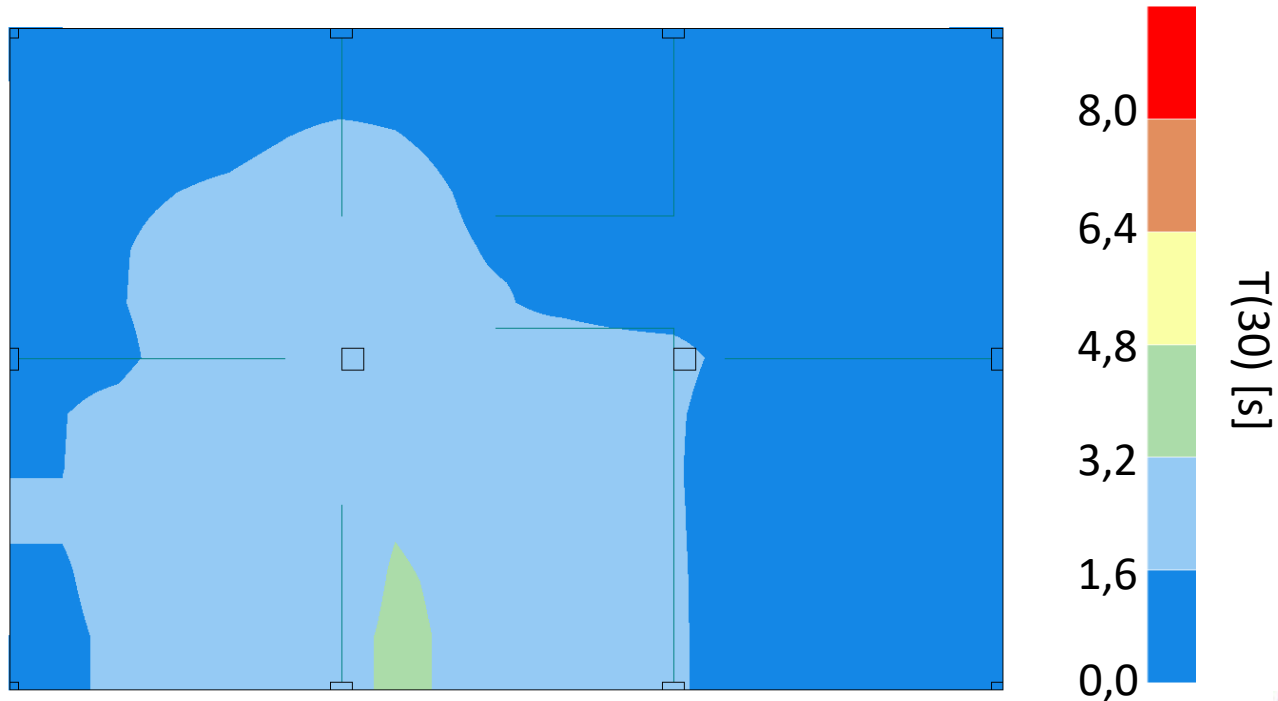
Below is a map of the distribution of the T30 reverberation time (at 1kHz) for variant 3 and the values of the reverberation time in the octave bands.



Average reverberation time  
**1,0 s**

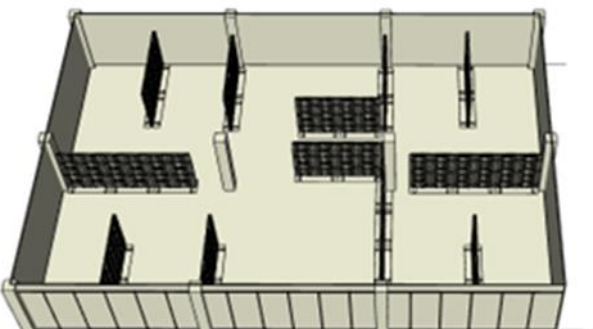
T30  
T20

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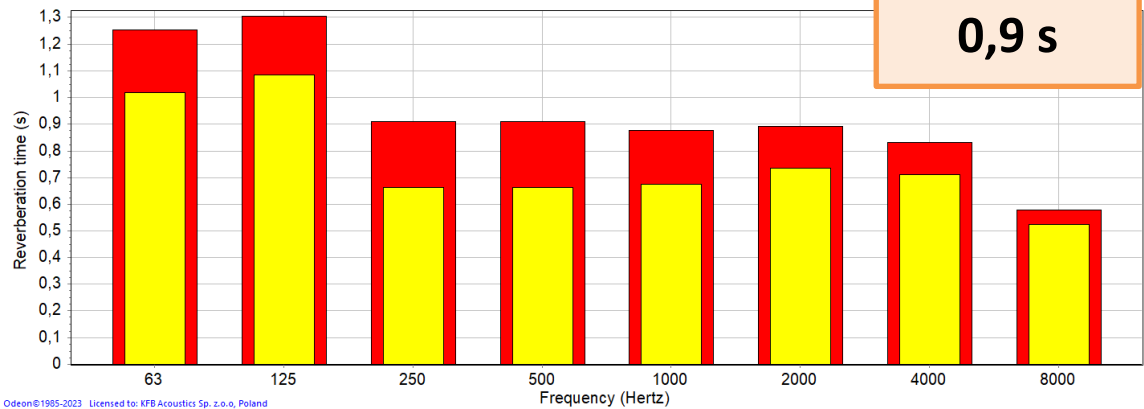
# Acoustic model Reverberation time simulation results Variant 4

Model office interior after adding 30 VANK\_FLIP acoustic walls (160x200 cm)

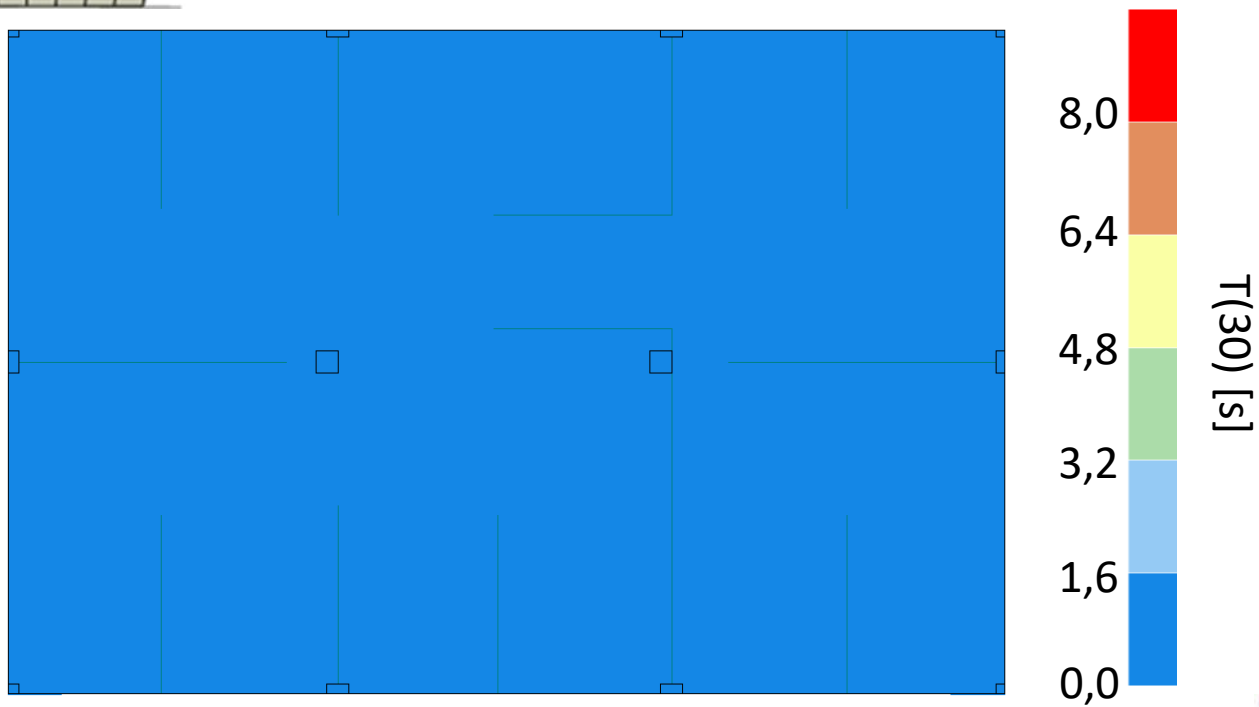


Below is a map of the distribution of the T30 reverberation time (at 1kHz) for variant 4 and the values of the reverberation time in the octave bands.

Average reverberation time  
**0,9 s**



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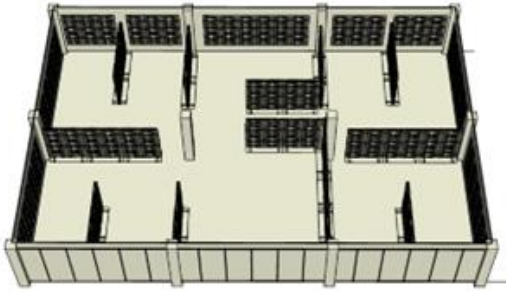


0761-24P-E24-1 Simulation – calculations of the reverberation time in an office interior

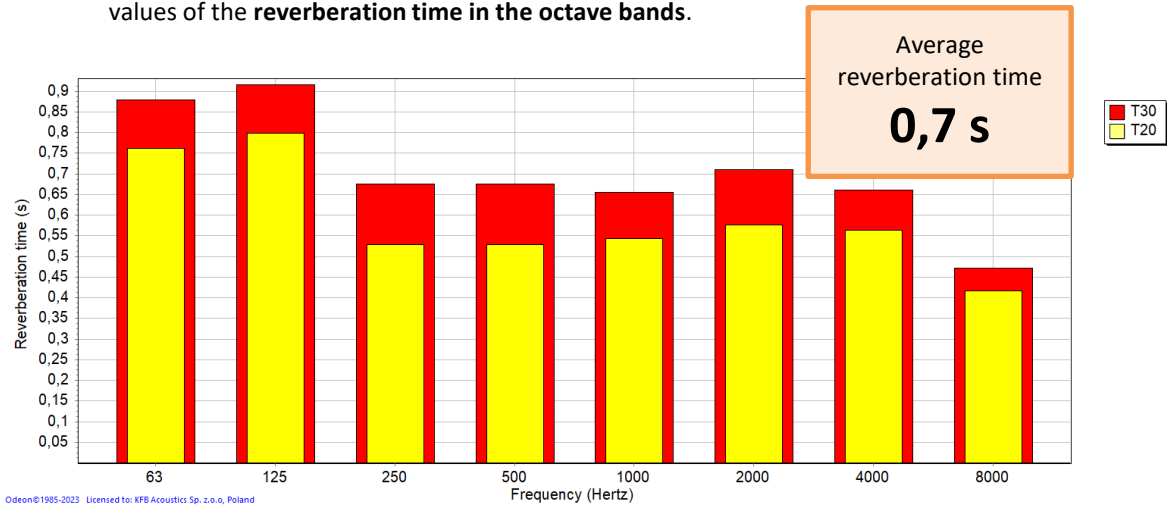


# Acoustic model Reverberation time simulation results Variant 5

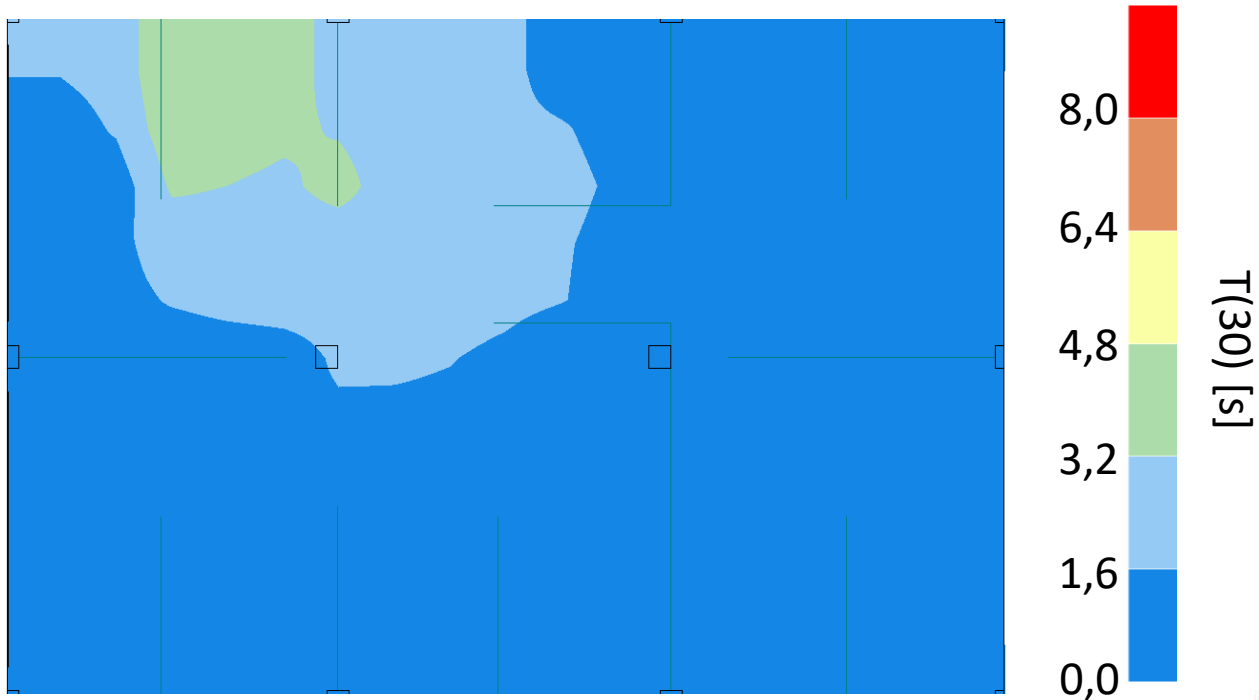
Model office interior after adding **30 VANK\_FLIP acoustic walls** (160x200 cm) and **14 pictures** made of **VANK\_FLIP acoustic panels** (4,8 m<sup>2</sup> each)



Below is a **map of the distribution of the T30 reverberation time** (at 1kHz) for variant 5 and the values of the reverberation time in the octave bands.



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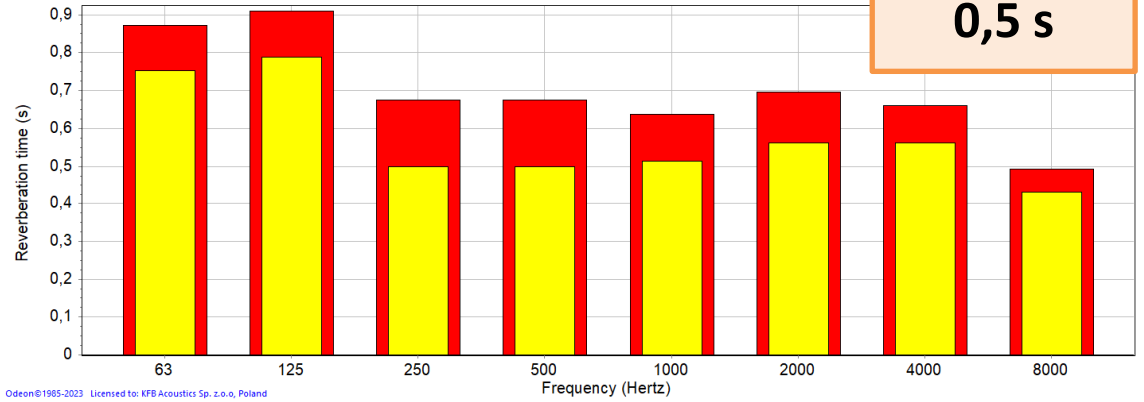
0761-24P-E24-1 Simulation – calculations of the reverberation time in an office interior

# Acoustic model Reverberation time simulation results Variant 6

Model office interior with carpet flooring after adding 20 VANK\_FLIP acoustic walls (160x200 cm) and carpet on the floor.

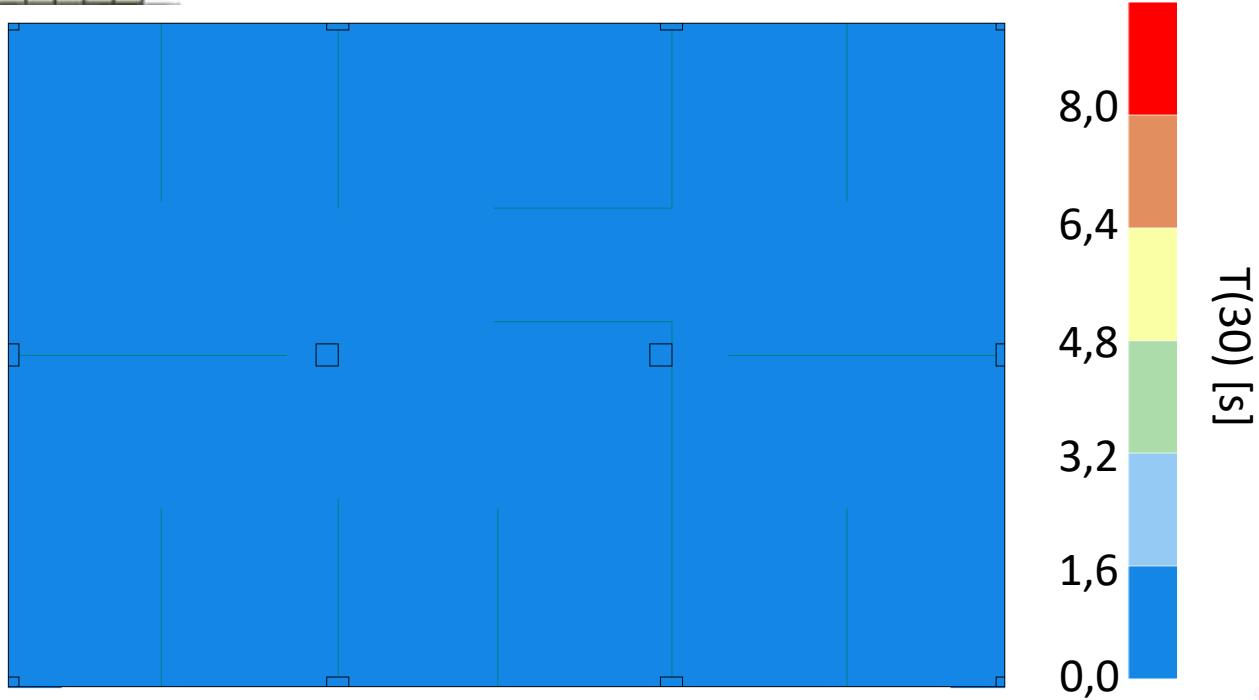
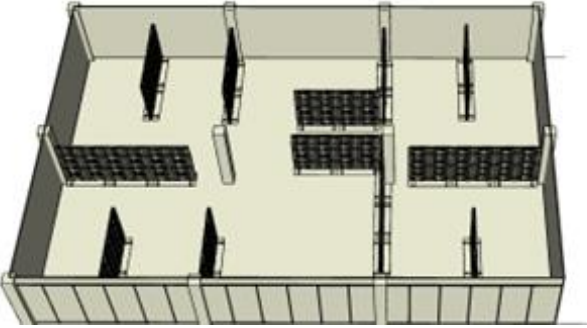
Below is a map of the distribution of the T30 reverberation time (at 1kHz) for variant 6 and the values of the reverberation time in the octave bands.

Average reverberation time  
**0,5 s**



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T30  
T20



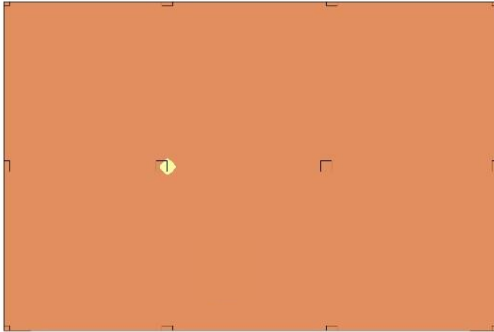
# Acoustic model

## Reverberation time simulation results

### Summary

Simulations of the reverberation time in an office room for four variants of the VANK\_FLIP wall arrangement show that the use of partitions reduces the reverberation time.

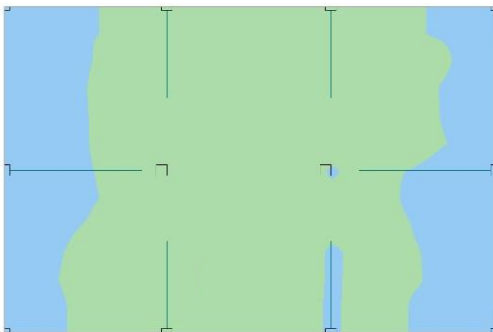
Variant 0



Variant 1



Variant 2



Variant 3



	Average reverberation time [s]
Variant 0	7,7
Variant 1	3,1
Variant 2	2,4
Variant 3	1,0
	Achieved reverberation time reduction [s]
Variant 1	-4,6
Variant 2	-5,3
Variant 3	-6,7

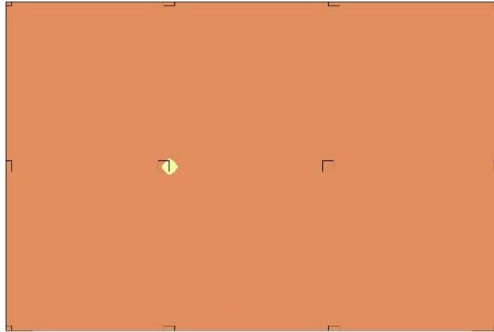
# Acoustic model

## Reverberation time simulation results

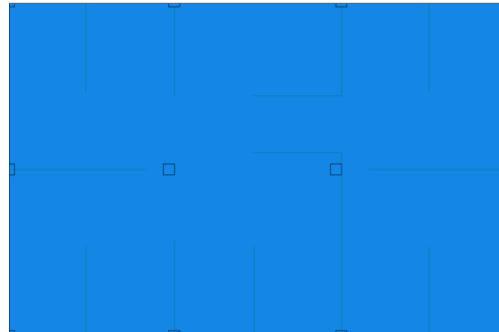
### Summary

Simulations of the reverberation time in an office room for four variants of the VANK\_FLIP wall arrangement show that the use of partitions reduces the reverberation time.

Variant 0



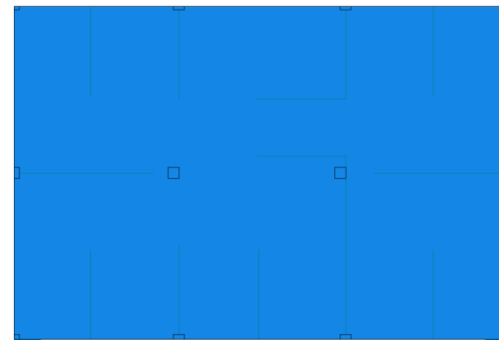
Variant 4



Variant 5



Variant 6



	Average reverberation time [s]
Variant 0	0,9
Variant 4	0,9
Variant 5	0,7
Variant 6	0,5
	Achieved reverberation time reduction [s]
Variant 4	-6,8
Variant 5	-7,0
Variant 6	-7,2



# Summary

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Based on the simulations of seven variants of the arrangement of VANK\_FLIP walls in the office room, it was found that:

- ❑ Adding partitions with a high sound absorption coefficient significantly reduces the reverberation time in the room.
- ❑ The walls VANK\_FLIP allow for a reverberation time of 0.7 seconds in the tested office room. For further reduction, it is necessary to introduce materials with a higher absorption coefficient on highly reflective surfaces (floor and ceiling) – as shown in variant 6.

Changing the above-mentioned parameters affects the:

- ❑ Increase acoustic comfort: the reverberation time decreases, the sound quality in the office space improves. Employees can communicate more easily, which reduces the need to raise their voices and eliminates the stress associated with misunderstanding speech.
- ❑ Increased work efficiency: better acoustic conditions promote concentration and effective communication between employees, which translates into higher productivity. Faster reverberation time reduces noise and interference so you can stay focused on the task at hand.
- ❑ Improved health and well-being: reducing noise levels because of improved office acoustics has a positive impact on the mental and physical health of employees. Reduces fatigue from constant noise exposure and improves overall well-being, leading to greater job satisfaction.
- ❑ Better collaboration: shorter reverberation time makes it easier to meet and have conversations, both in small and large groups. This makes communication more fluid and effective, which is conducive to building better relationships between colleagues.

# Thank you for your attention

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