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SOUND ABSORBING ELEMENTS IN OFFICE WORKPLACE

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ABSTRACT

There are many acoustic solutions available on the market that support the acoustic comfort in office spaces by ensuring the proper level of privacy and low acoustic background. One of such solutions is the use of desktop screens, which divide employees' space. Such screens isolate office users from each other, but if they are made of hard materials like transparent plexiglass, they enhance sound reflections negatively affecting the interior acoustics. To minimise unfavourable sound reflections, the authors propose the use of PET absorptive materials both on desktop screens and on other selected desk surfaces. The analyses of the effectiveness of such a solution were performed using 1:8 scale model measurements and computer models created in CATT-Acoustic. The obtained results allowed the determination of the most preferable locations which combine high sound absorption properties of office furniture pieces with little material usage.

1. INTRODUCTION

In recent years, providing comfortable working conditions in open office spaces has become a growing challenge. The ever-increasing demand for office work implies the emergence of more and more new open office spaces, which generates the need for a proper interior design. The basic equipment of office spaces are desks which are usually equipped with desktop screens. These screens divide employees' space and hence support the acoustic comfort in office spaces by ensuring the appropriate level of privacy. Interior architects willingly use transparent acoustic screens as they do not constitute a barrier to sight and light, which makes them blend in perfectly with the surroundings. Unfortunately, such desk screens, but also other desk surfaces, are made of hard materials. As a consequence, due to strong sound reflections from all these surfaces, the acoustic parameters of the interior are getting worse. To minimize the unfavourable sound reflections in open office spaces, the authors propose the use of PET absorptive materials both on transparent desktop screens and on other selected desk surfaces. The research presented in this article is aimed at the determination of the most preferable locations of sound absorbing materials ensuring high sound absorption properties of office furniture pieces as well as significant improvement of the acoustic parameters of the interior.

2. METHODOLOGY

The first stage of research involved model measurements. For the tests, a special measuring stand has been constructed, i.e. a 1:7.73 scale model of the full-scale reverberation chamber placed at the AGH University of Science and Technology. However, the measurement samples and the range of measurement frequencies were scaled according to the 1:8 scale to meet the minimum chamber volume requirements, i.e. 200 m³. The measuring system consisted of a high-frequency sound source which was made of piezoelectric elements, a Bruel & Kjaer loudspeaker amplifier, 46BE 1/4" measuring microphone with preamplifier, G.R.A.S. 12AL microphone amplifier, the UMC204HD BEHRINGER U-PHORIA sound card and a computer. In order to record meteorological conditions (temperature, humidity and pressure) [1], a special measuring system with software was created.

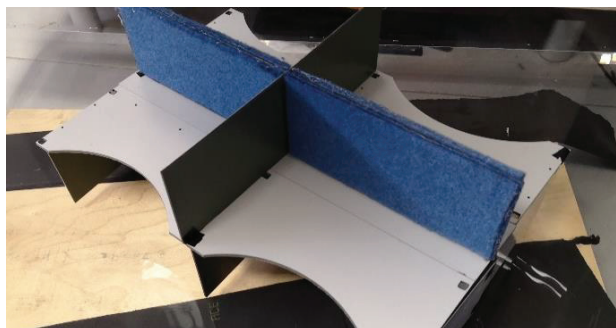


Figure 1. 1:8 scale model of an office desk with a reference absorptive material on the desktop screens

Measurement samples, i.e. 1:8 scale models of office desks equipped with desktop screens (Fig. 1), were made of a rigid high pressure laminate (HPL) characterised by low acoustic absorption. Their scaled dimensions were as follows: tabletop height - 9 cm, height of desktop screens - 9 cm, width of a single desk - 18 cm, depth of a single desk - 13 cm. The samples were tested to determine the increase of the equivalent sound absorption surface area after mounting on them a highly sound absorbing reference material in different locations:

- **Variant A:** no absorptive material;
- **Variant B:** absorptive material on the desktop;
- **Variant C:** absorptive material under the desktop;
- **Variant D:** absorptive material on the side inner surfaces of the desk;

- **Variant E:** absorptive material on the rear inner surfaces of the desk;
 - **Variant F:** absorptive material on the desktop screens.
- In each variant, the amount of the sound absorbing material used was the same – 648 cm². Acoustic absorption measurements were performed according to ISO 354 [2] and ISO 20189 [3] standard procedures.

The second stage of the research involved computer simulations of acoustic parameters of the reference interior equipped with the full-sized tested office desks. Simulations were performed using CATT-Acoustic software. Firstly, the results of scaled measurements of office desk models in all 6 variants of the absorptive material location were validated with the results of computer simulations that included a full size reverberation chamber. Then, 4 such desks were placed in the modelled reference room (Fig. 2). The room had dimensions of 8.6 m x 9.0 m and a height of 2.7-3.1 m. The total volume of the room was 223 m³. The finish of the walls and the ceiling were set up as a painted plaster; the floor was covered with PVC. Due to the lack of essential sound absorbing elements (only a few cabinets and boards on the walls), the interior was highly reverberant. The results of the computer simulations were used to determine the acoustic parameters of the interior depending on the location of the absorptive material on the office desks (variants A-F).

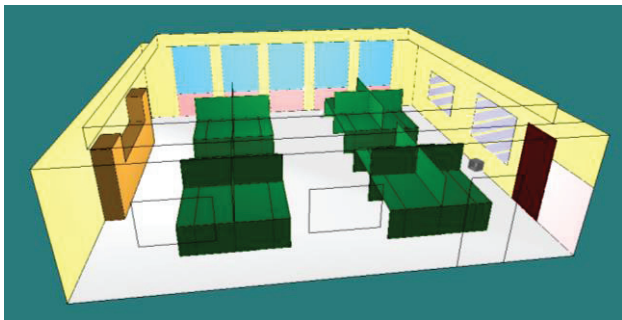


Figure 2. CATT-Acoustic model of the reference room equipped with tested office desks

3. RESULTS AND CONCLUSIONS

The performed research gave the following results:

- **Scale model measurements:** dependence of the office desk equivalent sound absorption area on the absorptive material location (Fig. 3);
 - **Computer simulations:** dependence of the reference room reverberation time T20 and speech transmission index STI on the absorptive material location (Fig. 4)
- Based on the presented results, it can be concluded that desktop screens are the best location for the sound absorptive materials. These areas demonstrate the greatest increase in the office desk total acoustic absorption and the best acoustic parameters of the interior. At the same time, it seems most practical to place any additional acoustic systems on these surfaces. Even in the case of transparent desktop screens, one may only partially cover their surface with absorptive material (e.g. PET material), preserving the basic design features (Fig. 5). On the other hand, the research results also indicated that by placing

the sound absorbing material on the desk inner surfaces, it is possible to increase the desk's total acoustic absorption significantly, hence improving the acoustic parameters of the interior. Such a location of the sound absorbing elements is very eligible if additional elements cannot influence the interior design.

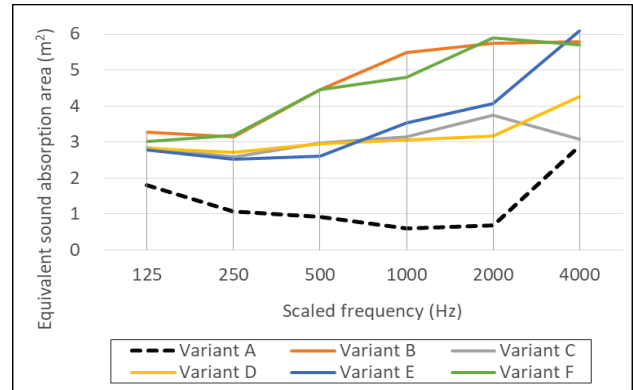


Figure 3. Office desk equivalent sound absorption area depending on the reference absorptive material location

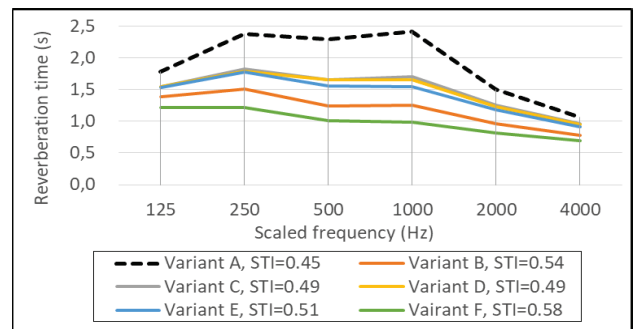


Figure 4. T20 and STI parameters of the reference room depending on the absorptive material location

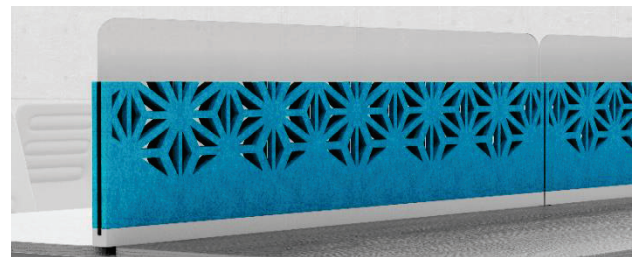


Figure 5. Transparent desktop screen partially covered by PET absorptive material

4. REFERENCES

- [1] K. Baruch, A. Majchrzak, B. Przysucha, A. Szelać, T. Kamisiński: „The effect of changes in atmospheric conditions on the measured sound absorption coefficients of materials for scale model tests”, *Appl. Acoust.*, Vol. 141, pp. 250-260, 2018.
- [2] ISO 354:2003, *Acoustics - Measurement of sound absorption in a reverberation room.*
- [3] ISO 20189:2018, *Acoustics - Screens, furniture and single objects intended for interior use - Rating of sound absorption and sound reduction of elements based on laboratory measurements.*