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Forms of modern architectural acoustic design: aspects of sound quality in large rooms

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Abstract

Modern acoustic design is an important aspect of the design of premises, which should be taken into account at the planning and construction stage. It allows us to create a comfortable and functional sound environment in various types of premises, including concert halls, recording studios, offices and residential premises. To achieve optimal sound quality, it is necessary to use special materials for sound absorption and dispersion, as well as consider acoustic parameters at the design stage and conduct field measurements to assess acoustic characteristics and adjust the design if necessary. Software modeling can be a useful tool for predicting acoustic response and optimizing room design. Architects should consider not only the visual design of the room, but also its acoustic characteristics. To do this, various methods can be used, such as coating concave surfaces with sound-absorbing material, splitting concave surfaces into smaller scattering surfaces, or using finely perforated metal to create an acoustic boundary of the room. Software modeling can be used to predict the acoustic response of a room and optimize its design. However, in order to achieve optimal sound quality, it is necessary to take into account acoustic parameters at the design stage and conduct field measurements to assess acoustic characteristics and adjust the design if necessary.

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Keywords

Acoustic design, architecture, large rooms, sound modeling, concave surfaces.

Introduction

Contemporary acoustic design is the process of designing and creating spaces in which the sound environment is optimized to achieve maximum comfort and functionality. This includes the use of various technical solutions such as sound-absorbing materials, sound-diffusing surfaces, acoustic ceilings and walls, and sound management systems. Modern acoustic design can be used in a variety of types of spaces, from concert halls to offices and homes. It can also take into account the individual needs of users and the characteristics of a particular room.

Main content

It is a recognized that concave surfaces can lead to echo and reverberation of sound in a room. This can create an unpleasant listening environment, especially in concert halls or recording studios where maximum purity and clarity of sound is required. To eliminate these problems, special materials can be used that absorb sound waves and reduce the level of reverberation. In addition, sound-diffusing surfaces can be used to distribute sound waves throughout the room, creating a more uniform sound field. In general, modern acoustic design strives to create more comfortable and functional listening conditions in various types of rooms.

However, to achieve optimal sound quality in such rooms, it is necessary to use special materials for absorption and dispersion of sound and consider acoustic parameters at the design stage. It is also important to conduct field measurements to evaluate acoustic performance and adjust the design if necessary. Software modeling can be a useful tool for predicting acoustic response and optimizing room design.

Contemporary architectural and acoustic design can take many forms, depending on the objectives and requirements. These include buildings that are built using environmentally friendly materials, have an effective energy saving system and use renewable energy sources. Modern design takes into account people's needs for comfort and functionality, so rooms are designed in such a way as to make maximum use of the available space. To ensure a comfortable sound environment in rooms, various technical solutions are used, such as sound-absorbing materials, sound-diffusing surfaces, etc. Natural light can be used to create a pleasant atmosphere in rooms, which also reduces energy costs for lighting. When designing buildings and spaces, the cultural and social characteristics of those who will use them are considered. For example, when designing museums or exhibition halls, the characteristics of the exhibits and visitors are considered. Modern design can use new technologies such as virtual reality or interactive devices to create more interesting and functional spaces.

Achievement of good acoustic quality in large interiors formed by curved surfaces is a challenge for both acousticians and architects. Design of an appropriate acoustic field for different applications determines the requirements for auditorium volume and shape to achieve an even distribution of sound energy in the room: these conditions are immediately violated if some of the adjacent surfaces of the room are concave.

Consider acoustic phenomena dependent on concave surfaces in enclosed spaces, mainly focusing whispering, aimed at achieving uniform distribution of sound energy in a room, exploring some approaches to architectural acoustic design and architectural solutions. Starting with the development of a conceptual design, without changing the shape of the concave body and base, the aim of the study is to develop a proposal for the use of the concave shape in multi-purpose spaces.

Architects are accustomed to the need for compromise in building design and rely on architecturally acceptable ways to avoid these unpleasant effects, but often acoustic consultants suggest other room shapes that avoid concave surfaces. To control the acoustic field to produce a uniform sound distribution of energy in a room without changing the shape of the room and the layout of the area requires the study of several approaches and solutions in the field of architectural acoustic design, starting with the development of a conceptual design.

The first method is to cover a concave, curved wall or ceiling with sound-absorbing material. Absorption is effective at high frequencies; at lower frequencies, treatment is required, which includes several thick absorbing layers that eliminate many reflections from walls and ceilings. This approach allows the architect to maintain the appearance of a curved surface, but it eliminates many reflections from the walls and ceiling, even if they are not inherently irregular. The complete lack of reflections from walls and ceilings is a disadvantage, at least for all types of musical performances. Therefore, it is necessary to replace useful reflections that are lost in heavy sound-absorbing materials.

The second way to avoid focusing is to break the concave surface into smaller scattering surfaces and thus change the geometrically focused reflection into a diffuse reflection. The dimensions of these scattering elements must be comparable to the wavelengths of the sound field. Finding a technical solution to integrate such acoustic elements into an aesthetic design scheme is not an easy architectural task.

A third approach to avoid focusing allows one surface to be the acoustic boundary of the room, while the other surface (visual boundary) is made of finely perforated metal that forms a suitable shield for light waves but allows sound waves to pass through. All three approaches can be used when designing a new space and for renovating an existing building. In this latter case, field measurements are recommended to evaluate the acoustic performance.

To avoid the disturbing effects of focus and whisper and to control the acoustic field to achieve uniform distribution of sound energy in a space with curved surfaces without changing the shape of envelope and physical plan, the design process is determined in stages.

These steps indicate the methodology that must be applied before selecting the optimal acoustic range for various acoustic parameters according to the possible use of the room. In detail this is to:

– test prediction methods for acoustic field analysis at the design stage (simulation or scale models)

– find technical acoustic solutions to control the acoustic field, which must be integrated into the aesthetic design scheme, evaluating the possibility of testing acoustic properties in a reverberation chamber.

To evaluate the ability to predict the acoustic response using software, instead of constructing a scale model for measurements, a smaller segment to which the laws of concave surfaces apply was selected using software.

The software allows one to import a virtual model realized using 3D cad. The value of this software is demonstrated by its use in similar studies.

Software modeling begins with the development of a space model. Based on previous studies, the simulation is performed by fixing the parameters. Setting the scattering coefficients considers the sensitivity of the software based on the degree of geometric discretization of the volume model. Shapes in which some surfaces of room boundaries are concave can be incorporated into modern architectural and acoustic design.

Conclusion

To achieve optimal sound quality in such rooms, it is necessary to use special materials for absorption and dispersion of sound and take into account acoustic parameters at the design stage. It is also important to conduct field measurements to evaluate acoustic performance and adjust the design if necessary. Software modeling can be a useful tool for predicting acoustic response and optimizing room design.

Architects should consider not only the visual design of a space, but also its acoustic characteristics. This can be done through a variety of methods, such as covering concave surfaces with sound-absorbing material, breaking concave surfaces into smaller dispersive surfaces, or using finely perforated metal to create an acoustic boundary for the room.

Software modeling can be used to predict the acoustic response of a room and optimize its design. However, to achieve optimal sound quality, it is necessary to consider acoustic parameters during the design phase and carry out field measurements to evaluate acoustic performance and adjust the design if necessary.

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Формы современного архитектурного акустического дизайна: аспекты качества звука в больших помещениях

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Аннотация

Современный акустический дизайн является важным аспектом проектирования помещений, который должен учитываться на этапе планирования и строительства. Он позволяет создавать комфортное и функциональное звуковое окружение в различных типах помещений, включая концертные залы, студии звукозаписи, офисы и жилые помещения. Для достижения оптимального звукового качества необходимо использовать специальные

материалы для поглощения и рассеивания звука, а также учитывать акустические параметры на этапе проектирования и проводить полевые измерения для оценки акустических характеристик и корректировки дизайна при необходимости. Программное моделирование может быть полезным инструментом для предсказания акустического ответа и оптимизации дизайна помещения. Архитекторы должны учитывать не только визуальный дизайн помещения, но и его акустические характеристики. Для этого могут использоваться различные методы, такие как покрытие вогнутых поверхностей звукопоглощающим материалом, разбиение вогнутых поверхностей на более мелкие рассеивающие поверхности или использование тонко перфорированного металла для создания акустической границы помещения. Программное моделирование может быть использовано для предсказания акустического ответа помещения и оптимизации его дизайна. Однако для достижения оптимального звукового качества необходимо учитывать акустические параметры на этапе проектирования и проводить полевые измерения для оценки акустических характеристик и корректировки дизайна при необходимости.

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Ключевые слова

Акустический дизайн, архитектура, большие помещения, моделирование звука, вогнутые поверхности.

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