ACOUSTIC PROPERTIES OF RADIO-TV STUDIOS

Ahmet ŞAHİNKAYA (Ph.D.)
Asst.Prof.of Communications
MARMARA UNIVERSITY
Faculty of Communications

The acoustic quality of all communication systems, as radio and television studios, music and video recording studios and other sound-amplifiying or reproducing systems, is influenced by the acoustic properties of studio rooms in which the sound to be transmitted,recorded and reproduced.

REQUIREMENTS FOR GOOD ACCOUSTICS

Some measurements have to be taken into consideration for good acoustics as follow :(1)

A-The sound should be sufficiently loud in the studio;

B-The studio must be free from internal or external noise;

C-The studio must be free from echoes or other interfering reflections;

D-The reflecting boundaries of the studio have to be so disposed as to provide a nearly uniform distribution of sound energy throughout the studio;

E-The studio must be free from undesirable resonance;

F-The reverberation in the studio must be sufficiently reduced to

avoid excessive overlapping or mixing with successive sounds of speech or music.

But nevertheless,the studio should be sufficiently "live" at all frequencies to give a pleasing effect to either speech or music as evaluated by the average listener.

In order to attain these necerrasy,conditions for good acoustics the architect and studio sound engineer must take the following conditions into consideration : (2)

I-The selection of the site;

II-The making of a noise survey in the proposed site;

III-The selection of a type of wall and ceiling construction which will insulate the building adequately against external noise and vibration;

IV-The selection and arrangement of studio rooms which require acoustical design;

V-The design for all speech rooms,music rooms,recording or broadcasting rooms,based upon the requirements for the proper distribution of direct and of reflected sound;

VI-The application of appropriate principles to the detailed design of shape,sound insulation and sound absorption for all studios which require acoustical design;

VII-The selection of materials which will satify the acoustical,structural,decorative,and economic requirements;

VIII-The testing of the completed building with regard to the distribution of sound,freedom from echoes,sound interfering and reflections,the optimal conditions of reverberation and sound insulation.

In general,the acoustic problem consists of the adequate reduction of noise and vibration and the designing of interiors in which the voice or instru-

mentation is heard or recorded most satisfactorily.

NOISE MEASUREMENTS FOR SOUND INSULATION

One of the prime requirements for good acoustics in every studio is absence of noise,unwanted sound.

In the design of theaters,music rooms,schools,office and industrial buildings,hotels,apartment houses and studios for the recording and broadcasting of sound for radio and TV stations,the engineer must know:

A-The amount and kind of the noise to be insulated

B-The amount of noise to be tolerated in the studio (for our case)

Most measurements of noise have been made with commercial sound-level meters which measure the overall sound level in decibels rather than the intensity level as a function of the frequency. The sound level corresponds roughly with the sensation of the sound and provides a converient numerical scale for compering the levels of different sounds.(3)

The following table gives approximate noise levels in different buildings:(4)

	Decibels
Radio,recording and television studios	25 to 30
Hospitals	35 to 40
Music rooms	30 to 35
Apartments,hotels and homes	35 to 45
Theaters,classroms and librarires	30 to 40
Private offices and conference rooms	35 to 45
Large public offices,banking rooms,stores	45 to 55

Restaurants	50 to 55
Factories	45 to 80

Special conditions for circumstances,such as experience,other near-by-noises,and costs, may alter the acceptable noise levels,but the levels given in the table are recommended.

WAVE ACOUSTICS

Wave acoustics deals with sound as waves with interference, diffraction, vibration,absorption.But applying wave acoustics to studios is a difficult subject.The methods of wave acoustics face some difficulties relating to the absorptive properties of acoustic materials as used in different studios. As applied to the accoustics of studio,it is assumed that sound travels in rays,that its frequency remains unchanged during the transient state as well as the steady state,that the rays are reflected with partial absorption and transmission.When the wave-lengths of the sound,as often,are not small compared with the dimensions of the room.For the acoustic design of radio-tv-broadcasting studios in which high-quality speech and music are required,full use of the methods of wave acoustics should be applied.

GROWTH AND DECAY OF SOUND

The sound,originating at some point in a studio, propagates rays of vibratory energy with a speed of about 332 meter per second, uniformly in all directions;that these rays are partially reflected by the boundaries of the room. Even after the source of sound is stopped these rays persist with their original frequency but become weaker after each reflection until finally they become inaudible. Although most of the absortion takes place at the boundaries at low frequencies,the absorption in the air at frequencies above 5 KHz may be greater than the absorption at the boundaries.

If the source continues to generate sound at a constant rate, a condition of equilibrium will be reached in which the rate of supply of sound enegy to the studio is just equal to the rate of absorption by the our and the boundaries. If the source is then stopped the sound in the studio will dieaway at a rate equal to the rate of absorption,which is determined principally by the size, the shape and the boundaries of the studio. The decay of the sound depends on the ab-

sorptive material is distributed throughout the boundaries of the studio and especially that it is not concentrated on one or two walls of the studio (also to the floor and ceiling).

The time required for the intensity of the sound to be reduced a specified amount will depend upon:

1- The number of reflections which occur per unit time,

2- The amount of sound energy which is absorbed at each reflection (5)

If the studio is a large one there will be only a few reflections per second,and if a little sound energy is absorbed at each reflection, it will require a relatively long time for the intensity of ordinary sound to be reduced to the threshold of audibility. On the other hand,if the studio is small and the boundaries highly absortive, the studio will be free from reverberation.Since the average intensity of speech or music in a studio is of the order of one million times the intensity which is just barely audible.The absorption of sound in the air,at high frequencies,will greatly modify the decay of sound.

REVERBERATION

The time of reverberation in a studio is proportional directly to the volume of the room and inversely to the total amount of absorption supplied by the boundaries of the room. The modification of the reverberation is dependent upon the shape of the studio and the location of the source. The absorption of sound in the air of the studio,which is of considerable importance at the higher audible frequencies and especially in large studios. In large rooms, such as concert halls, school auditoriums, theaters, tv studios,the lowest modes of vibration are usvally in the subaudible range of frequencies, all frequencies above about 100 Hz, and the effects of room resonance usually can be neglected

The time of reverberation refers to a pure tone of 512 Hz.Excessive reverberation would cause the studio be too reflected for the bass notes of music, and even the low-frequency components of speech will be reverberant and overemphasized. On the other hand, the higher tones and harmonics in music will be suppressed at the high-frequencies.Such rooms are not suitable for recording and broadcasting purposes. (6)

The success and failure in the acoustical design of rooms will depend upon the selection of absorptive materials which will give the proper reverberatory characteristics throughout the entire range of frequencies used in speech and music.

The reverberation time of a studio, or the total absorption of the studio can be determined by measuring either the rate of decay of sound or the time for decay between known intensity limits. For determining the sound-absorptive coefficients of materials it is customary to make measurement of the rate of decay of the sound in a reverberant studio first when the studio contains a certain area of the acoustical material to be tested and again when the material is removed from the studio.

The rate of decay is measured by some type of reverberation meter which in general consists of

I- A suitable source of steady tone, usually on oscillator, an electrical low-pass filter, a power amplifier and an electrodynamic loudspeaker;

II- A high-quality microphone and amplifier;

III- An electrical attenuator for varying the gain of the amplifier;

IV- A recorder which register continuously, a graphic record of the decay. (7)

Reverberation measurements are useful not only for determining the coefficients of sound absorption of acoustical materials in a reverberation chamber but equally for determining the reverberation chamber but equally for determining the reverberatory properties of all studios. In general, a reverberaiton at all frequencies between about 128 and 4096 Hz. and should reveal the detailed nature of the decay of the sound, especially during the first 30 to 40 db of the decay. In music studios, recording and broadcasting studios, it is desirable to make measurements at frequencies as high as 8000 Hz.

MUSIC STUDIOS

The reverberatory properties of a studio are of even greater significance for music than they are for speach. The acoustical properties of a music studio are no less important than those of the musical instrument to be played in

the studio. The studio and instrument together comprise a coupled system, and it is this combiend system that the ear or microphone hears. The resonant frequencies of a room depend on the dimensions of the studio; their intensities and their rates of growth and decay are largely influenced by the distribution of the absorptive and reflective materials over the boundaries of the studio. (8)

A music studio should be so dimensioned, shaped with absorptive and reflective materials as to support and enhance the rich quality of the individual tones and harmonies of music, and join togather these separate tones and harmonies for continuous flowing melody. The best music studios are free from prominent resonance and which have a relatively uniform steady-state response throughout the entire frequency range.

The design of music studios should always be guided by the principles of wave acoustics. The optimal reverberation time for music studios depends not only on the size of the studio but also on the type of music to be performed in the studio. The ideal arrangement should provide for adjustable reverberation so that the optimal reverberatory properties can be readily obtained for all musical performances for which the studio is designed.

AUDITORIUM TYPE STUDIOS

The radio or TV studios which include places for listeners or watchers are called auditorium type studios. Four principal factors affect the hearing of speech in auditirium type studios :

- The shape of the room,

- The loudness of the speech which reaches the listeners,

- The reverberation characteristics of the room,

- The amount of noise in the room.

If average speech is loud and distinct, and entirely free from the interfering effects of noise and reverberation,the average listener would hear monosylabic speech sounds correctly. In calculating the acoustics parameters of the studio, it will be necessary to have the distortion factors of the shape of the studio, inadequate loudness, excessive rverberation and external noise. In the ideal studio each of these factors will be equal to unity. (9)

There are three important forms which should never be tolerated in shaping the studios :

- Facusing of sound which will produce excessive concentration of sound in some places and low level sound in other places,

- Excessive delays between the sound which reaches the listeners by a direct path from the source and that which reaches the listeners by reflection from the ceiling or walls,

- Sound reaching the listeners travels a relatively long distance, over a highly absorptive surfaces.

The sound which comes by the reflected paths always has to travel a greater distance than that comes by the direct path. If the difference in these path lenghts is as great as 20 meter the reflected sound will be deloyed to the extent that it is heard as a seperate sound. And this delayed sound is called echo.

In many auditorium type studios,and even in some sound-recording , broadcasting studios, it may be difficult or even impossible to avoid large and troublesome differences of path between the direct and reflected sound. In such cases, the surfaces causing these delayed reflections have to be covered by irregular materials as coffers, plasters. Some of the studios with good acoustics, have been designed with walls and ceiling covered with polycylindrical sound diffusers. Both speech and music studios should be designed so that the listeners receive a relatively large amount of sound which travels directly from the source or from the reflectors located sufficiently near the source so that this reflected sound is nearly in phase with the direct sound. (10)

As a result, the procedure for obtaining good acoustics in studios begins with the selection of the site and ends with the furnishing, testing and maintaining the studio. Modern theories of studio acoustics mostly, depend on the best acoustical shape of a studio, the most favorable distribution of absorptive and reflective marerials throughout the studio.

NOTES

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