Architectural Acoustics
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Lecture – 20
Acoustical Criteria and Space Design (Contd.)

So, here we are with a lecture 20 which is the last lecture of this particular module which is mostly on Acoustical Criteria and Space Design. As I have already told while closing the last lecture that this time we will be focusing mainly on the recording studio.

And this is neither under the small under the kind of discussions we had earlier like starting from small rooms, classroom to lecture halls of up to capacity of up to 350 people. We this is a little different, there we were taking help of the reflections. But here the entire principle is something different and hence this has been put in to this particular lecture.

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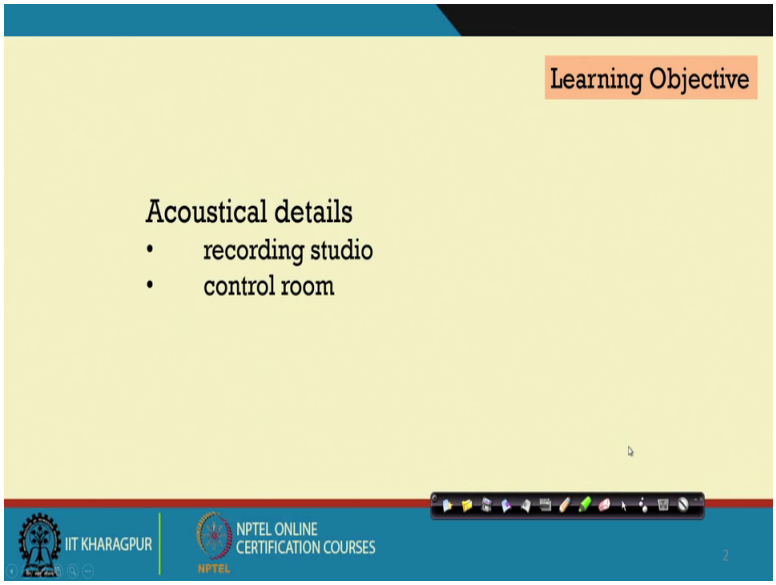

So, we will be dealing with the acoustical details of a recording studio and the control room which is very much associated to it some. Coming to the recording studio everyone knows that TV studio, broadcasting areas always are associated with such terms were recording of the personnel of the of the artist, or the musicians or the people who are in discussion are recorded and they are processed.

And then again sent back to the audience who will be listening opening their TV's or their radios at home or may be in some stage it will be placed for the audience. So, hence this kind of design is of particular interest to architects. So, we will also try to look in to how to plan for that and how to deal with the acoustics of such area.

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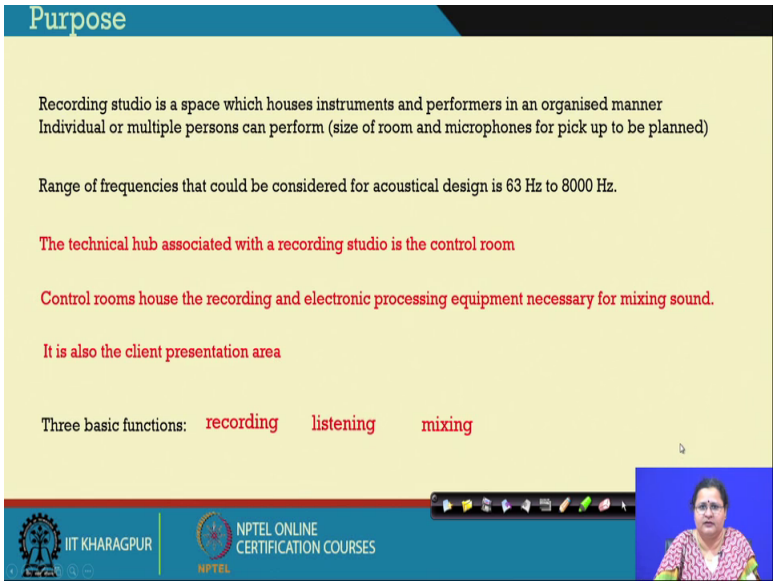

So, the purpose is to house instruments and performers in an organized fashion, it may be individual or multiple persons who can perform. And the microphones are there to pick up the sound in a very planned fashion and range of frequencies if it is not speech which is only mostly towards a 250 to 1000 mostly focusing towards 500 hertz, here we have to consider music of all format.

So, starting from 63 hertz to 8000 hertz is our range of frequency that has to be dealt with. So, the technical hub associated with the recording studio is called the control room where actually the electronic processing equipment necessary for mixing the sound is placed. So, we have to be knowing the association between these two because control room though it is totally electronically processing, but we have electronic processing, but we have to keep in mind the connection between the two it is also the clients presentation area.

So, someone who wants to intends to take the recording, buy the recording or whoever is planning to. So, this is this also houses the client presentation area. So, in the control room we have to be careful that we have to present the sound to those to the client also.

So, there are 3 basic functions that these places are performing in together one is recording, next is listening, and with listening it is the mixing of the sound which is finally, getting delivered towards the audience. Now, why this is to be specially dealt with?

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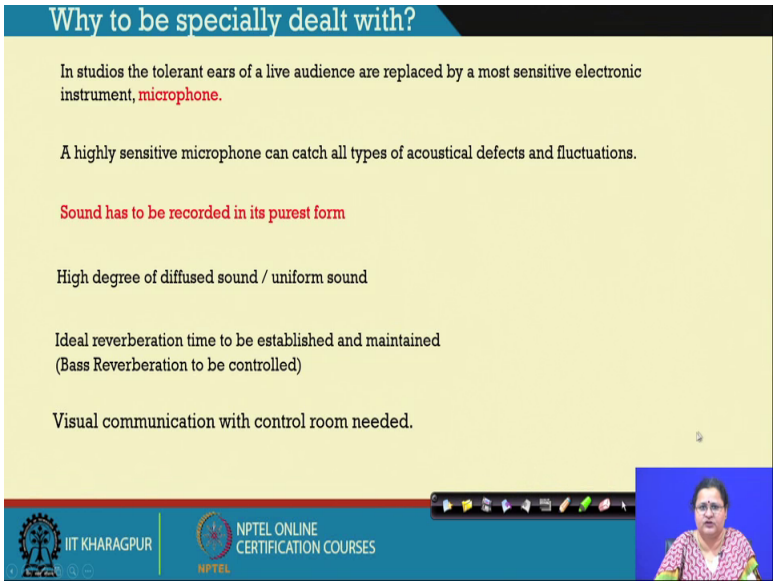

Because when we are speaking in audience our tolerant ears can accept or can understand the defects and they can take care of it. But here in studio these tolerant ears are replaced by the most sensitive electronic instrument which is the microphone which can actually record or catch all types of acoustical defects and fluctuations.

So, if the space is having different problems whatever problem be it because of reflection, be it because of have more of diffusion, be it because of reverberation. All kind of fluctuations can be can be noted down or can be captured by the microphone, it cannot be ignored like what the tolerant ears could ears could do or they would bare for one time and then they could relieve. But in recording this will be played multiple numbers of times, so that will keep on affecting the entire quality.

So, sound has to be recorded in its purest form high degree of diffused sound, or uniform sound is required in this particular spaces. Though with lot of instruments now with lot of modernization things are becoming much easier, but ideal reverberation time also has to be established and maintained. Particularly as we take care of as we are planning for 63 hertz to 80000 hertz the bass reverberations are to be controlled because these spaces

are not small not big spaces these are small spaces where the problem of bass or the low frequency is prevailing.

So, low frequency absorption by application of Helmholtz resonator is one of the one of the acoustical considerations. So, we will come to those and visual communication between the control room and the recording area is a it is desirable and it is mostly desirable. So, that one the person who is on the control room can understand what is actually happening in the floor.

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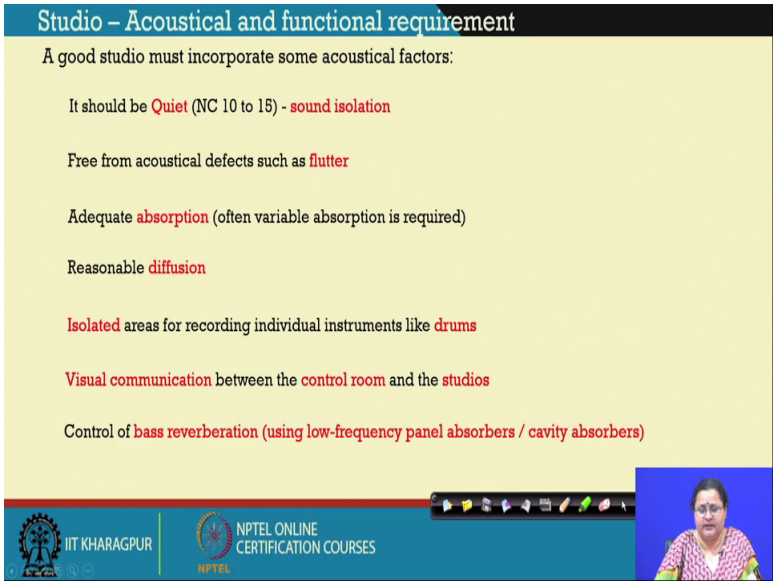

So, basic requirement towards function and towards acoustics are to have a quiet isolated area. So, I have already mentioned in one time during classroom the NC curve 10 to 15 is to be followed NC curve will be dealt with Professor Bhattacharya. Free from acoustical defects that is having parallel walls causing of flutters, and such kind of defects are to be avoided, adequate absorption by using different absorbing materials can be adapted.

If we want different absorption at different times or for different performances we had already dealt with the variable absorptions, variable absorbers we can actually plan for reasonable diffusion is also required. So, for diffusion in place of parallel walls you can have broken walls or irregular surfaces as much as possible to allow diffusion of sound isolation isolated areas for particular instruments like drums which are loud can be accommodated in an isolated or a separate recording separate studio along with other hands.

So, such isolated areas are also to be planned within studios, and always I already am repeating it. So, visual communication between the control room and the studio is also important. So, control of bass or the low frequency by appropriate panel absorbers or cavity absorbers are to be planned.

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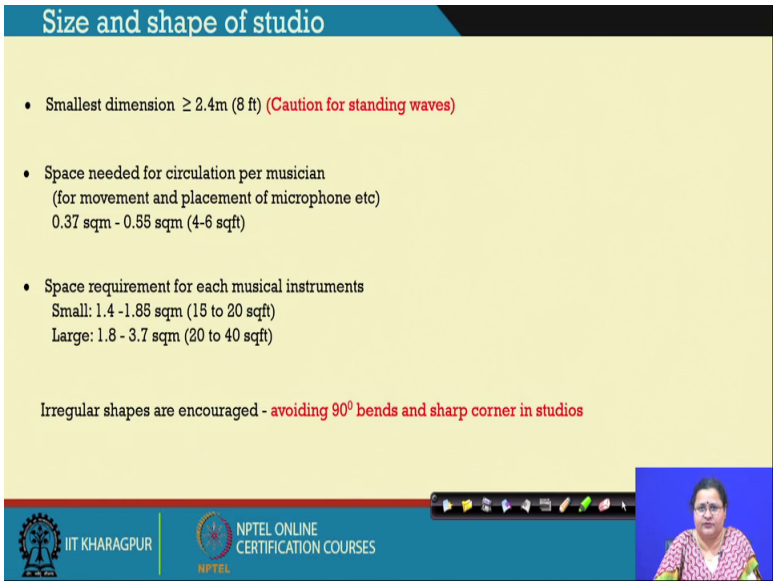

Now as architects we believe that first we have to plan for the space. So, we need to know the size and shape of the studio. So, the smallest dimension suggested is 8 feet or 2.4 meters and greater than that is acceptable and here the caution is for standing waves. Because you can understand these smallest dimensions and dimensions nearer to it are actually under the small rooms and here standing waves can be happening. Space needed for circulation per musician is kept as 4 to 6 square feet.

So, this includes places for movement and placement of the microphone and space requirement for each musical instrument if it is small it is up to 20 square feet, and if it is large up to 40 square feet. And shape of the room is to avoid flutter to avoid defects 90 degrees, or sharp corners are usually avoided irregular surfaces even in the ceilings and the walls are welcomed.

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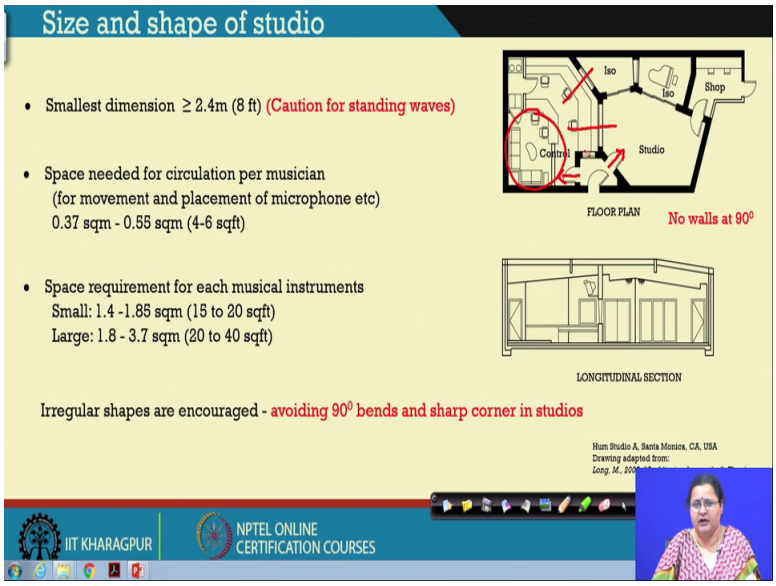

So, here we see a Hum Studio plan and which has been adapted from the book or acoustical architectural acoustics where you can see the studio major studio is located here and you see the isolation rooms are having are different and they are separated with walls, separated with glass panels.

As you can see here in the section and here you have a isolation area or a buffer space which is allowing entry to the studio as well as to the control room. So, this person in the control room is taking care of this particular studio whereas, this window is taking care of these parts. Here is a small unit for the client entertainment on client presentation area and this is how it is planned you can see none of the walls are at 90 degrees, we may not always get the opportunity to plan like this.

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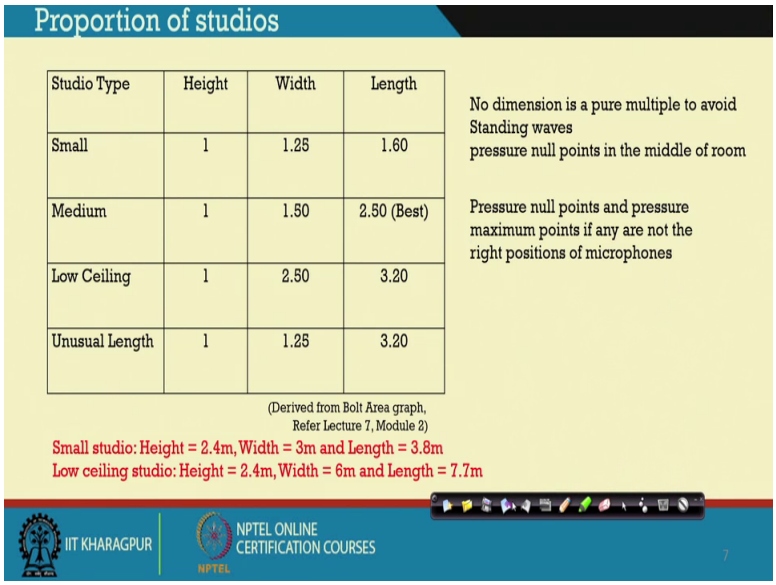

But if even if we have a rectangular space how to plan for it I will show you. So let us see the proportions of the studio if you remember in module 2, lecture 7 you can revisit that lecture. There we had talked of the bolt the scientist bolt who designed the graph to follow the proportion such that we do not have, we do not encounter standing waves or room modes.

So, no dimension should be a pure multiple of each other that was a suggestion over there and we follow the same and here we see that the proportion keeping height as 1 we see the width and length is proportion. The proportion of the width and length for different types of studio say for small medium low ceiling and unusual length as is required for different performances.

So, for a small studio if we go by the height as 2.4 meter, the width is around 3 meters, and length is around 3.8 meters, for low ceiling studios we can have a width and length of 6 meters, and 7.7 meters, keeping the height as 2.4 meters. And if at all there are locations there are formations of standing wave. If in the on the axial direction we have to keep in mind the pressure null points where they are developing.

So, the sound pressure level wherever is 0, those are the null points if you revisit the particular lecture you will see within the room there were pressure points which were 0. So, those points, those particular frequencies will be missing. So, those are not preferred for microphone location. So, for microphone location we are not supposed to put at the

pressure null points which may arise in between within the space. So, keeping this in mind the microphone location is also very important. So, first we will see how to make a plan in a particular rectangular space.

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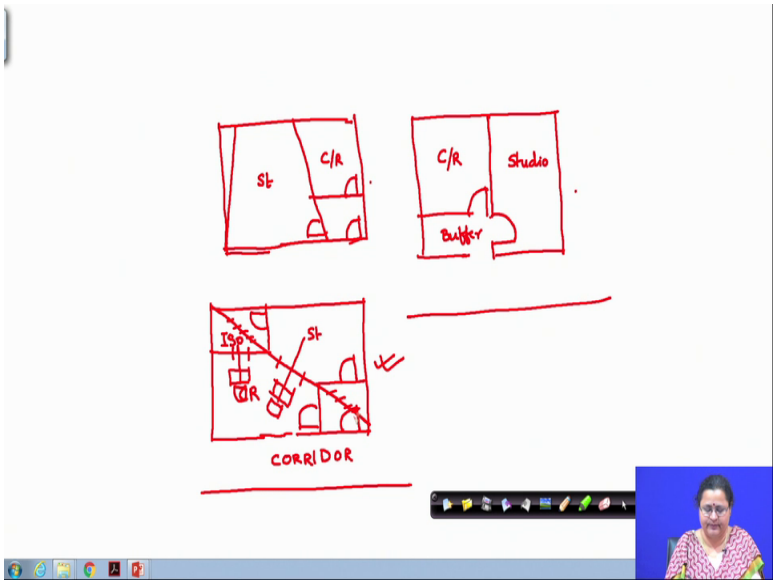

So, if we have a simple rectangle and here is a corridor and here you have to plan your recording and the studio and the recording control room and recording room. You can go for such buffer space and this is your say the control room or and this is the studio. But the problem here is the proportion is may not be achieved, it is suggested that in the same space we could have planned something like this.

Keeping this as the buffer space, this as the studio, this as the control room, and the studio could be having some chamfering to give it a better space. But the best are the efficient plan is to follow the diagonal to break the room space by its diagonal. Then what happens you can actually create, so this wall is not there. So, you can make your entry here to the studio and the control room.

So, this is the studio and this is the control room and here again you can have this as the isolation room. So, what can happen this could be the window to control this studio there could be another window to control this particular isolation room, where another instrument may be played. So, in the same space this is the corridor you can create this isolation space entering to the studio, entering to the control room with through the studio you can move to another isolation room.

And you can have your control units controlled by human beings or manned at these two opposition control all the space. So, this becomes a more efficient design this is something in between and this is not much applicable.

So, if we look into the these three plans we can understand that these two rooms are associated at this best fits the whole situation. So, if we arrive at the studio ratios find the area we can actually plan for that particular space in association with its control room.

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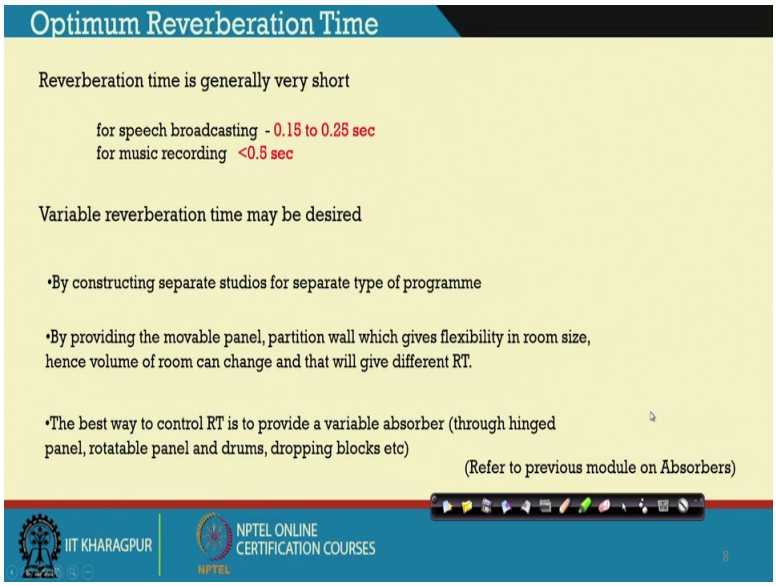

So, coming to the reverberation time what do we expect be the reverberation time in these particular studios. If it is for speech we have to keep it as low as possible. So, something around 0.5 seconds to 0.25 second, and for music recording it could be less than 0.5 seconds.

So, meanwhile you can well understand amount of absorption required in this particular spaces. So, variable reverberation time may be required if there are different kinds of performances within the same space.

So, one way is having designated rooms for speech, designated rooms for different performances which is a space taking problem which is a space taking thing. If you have abundant space you can plan for it, but it also involves cost because it is not just wall and ceiling or the structural members, but it has to be acoustically treated.

So, we had already discussed of the movable panels partitioned walls which can give flexibility to the room sizes. Hence the volume of the room can change playing with the reverberation time.

So, we as a v is involved in the RT calculation by reducing the size of the room by bringing partition walls by bringing by changing the alpha values you can actually plan for variable reverberation time. And the best way to control is control it is by hinged panels, rotatable devices, rotatable drums, dropping blocks which has been fairly covered in the module on absorbers.

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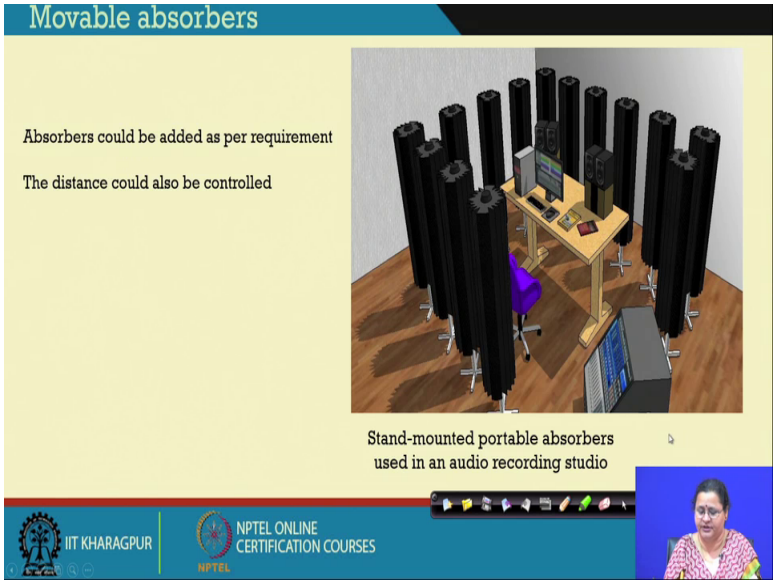

Here you have the movable absorbers, it is the same slide where absorbers could be brought in or taken out as per requirement. Their distances also could also be controlled and these are stand mounted portable kind and this could be also acquired to get a to achieve a particular reverberation time.

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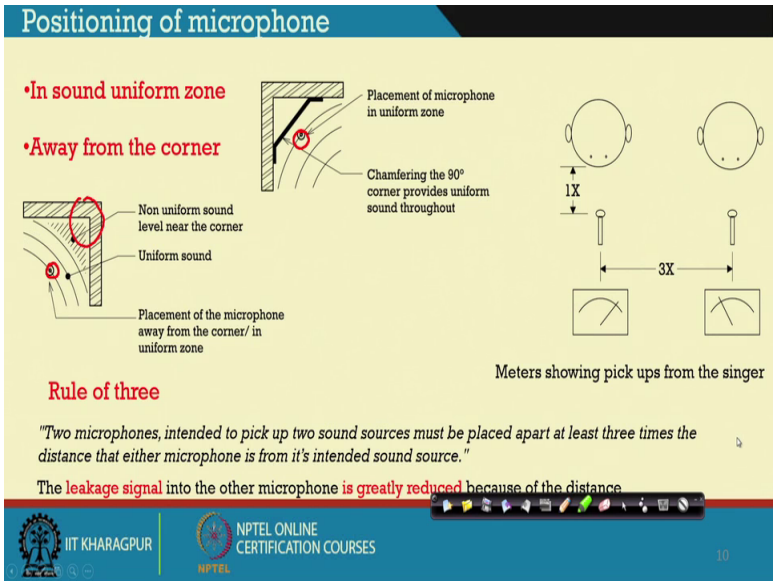

Now, coming to the positioning of the microphones which is also of very much importance; so, positioning of the microphone as I told you cannot position microphones in the null points that is where the sound pressure wall is minimal. You have to position them where the sound is expected to be uniform and in that particular zone they are preferred and it should be away from the corners.

So, if you have such situations where the angles are 90 degree, walls are there; there is non-uniform sound in this areas. So, one way is keeping the microphone away from the wall or else you can actually adapt to cut down you can actually chamfer by putting in some absorbing materials in particular angle and you can provide your microphone nearby that.

So, this will not lead to any sound concentration rather it will receive uniform sound, now coming to the rule of three if there are more than one performers the sound has to be picked up by more than one microphone and there will be; obviously, more than one performers. So, the rule of three says that when two microphones intend to pick up sound sources they must be placed apart at least 3 times the distance that distance that either microphone from its intended sound source.

So, let us try to see in this picture if the person where whom you see here is at a distance X from the microphone because there may be a system here, there may be an instrument

here which is playing. So, there it is at a distance X you see the microphone is picking up in this meter which is showing a big fluctuation or big reading.

But the other microphone which is kept here your reading is not much not at all affected if it is kept at a distance of 3 X. So, this is what the rule of three says that if you want to bring in another performer then you have to keep in mind the leakage signal in to the other microphone which is greatly reduced because which can greatly be reduced because of this distance.

So, you can actually put in the second speaker second performer if this is satisfying this particular rule of three. So, hope you could understand this.

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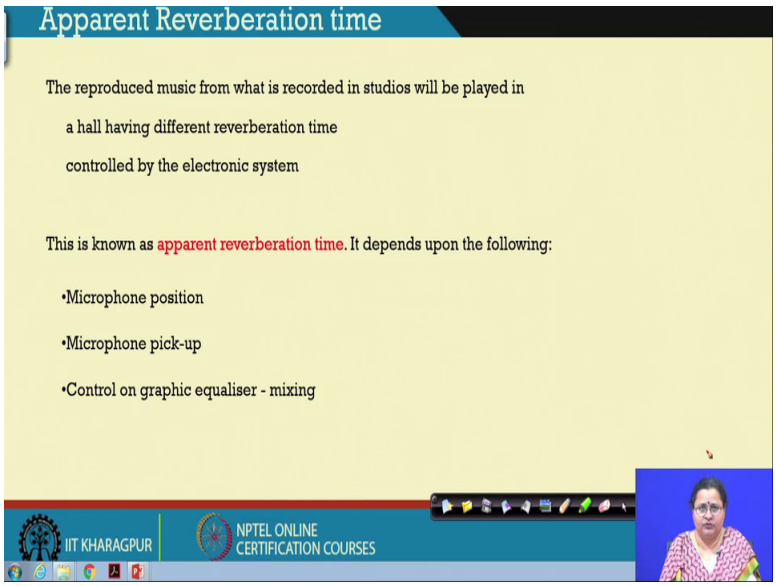

Now, with this we also would suggest like to keep in mind the apparent reverberation time. Because whatever is recorded here under whatever environment under whatever reverberation time this will be reproduced in another place in another environment. So, a hall have a hall will have; obviously, a different reverberation time and hence the microphone position is very important.

This particular reverberation time in which environment this entire thing is going to be played is called the apparent reverberation time. So, if the apparent reverberation time has to be is known then the microphone positioning can be also planned. So, microphone

pickup control on the graphic equalizer, or the mixing part these are very important though these are not particularly in our domain.

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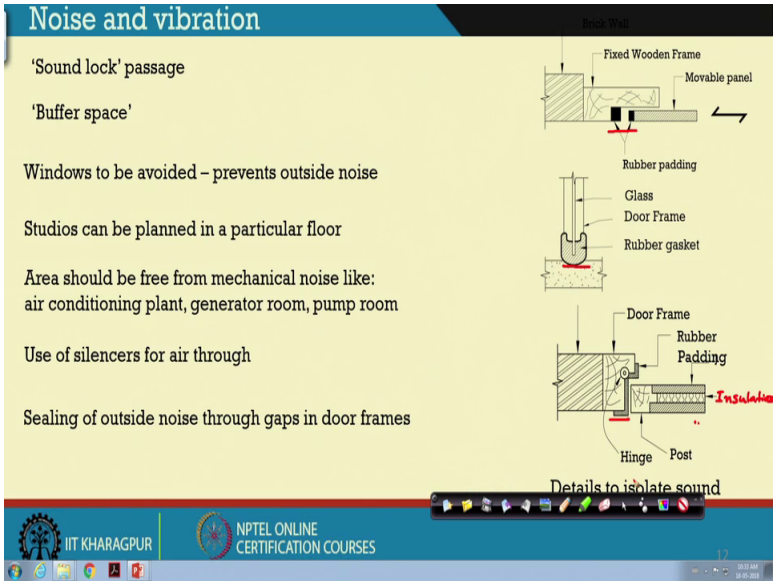

Now, coming to the noise and vibration isolation as I told you need a sound lock area, which I had showed a buffer area or a buffer space. So, you actually lock the outside sound windows are to be avoided to prevent the outside noise because if you are providing window it will be glass, and glass is reflecting the sound studios can be particular planned in a particular floor which can be devoid of sound or devoid of noise.

So, areas should be free from mechanical noise that is the particular floor or the particular area should be free from the mechanical noise like air conditioning plants, generator rooms, pump rooms, using of silencers for air through all these are to be planned. We have to be particularly aware of the leakage sound or the leakage noise entering below the gaps on the door fronts between the movable panels at the edges and corners and you can see a number of details to isolate sound.

So, here you see the application of rubber gasket at the bottom of the door. Here you see the rubber gaskets or the padding between the panel and frame here you see the rubber padding at the edge you also see the door is filled in with insulator insulation and so on. So, these as an architect we have to specify these particularly when the detail drawings are being produced.

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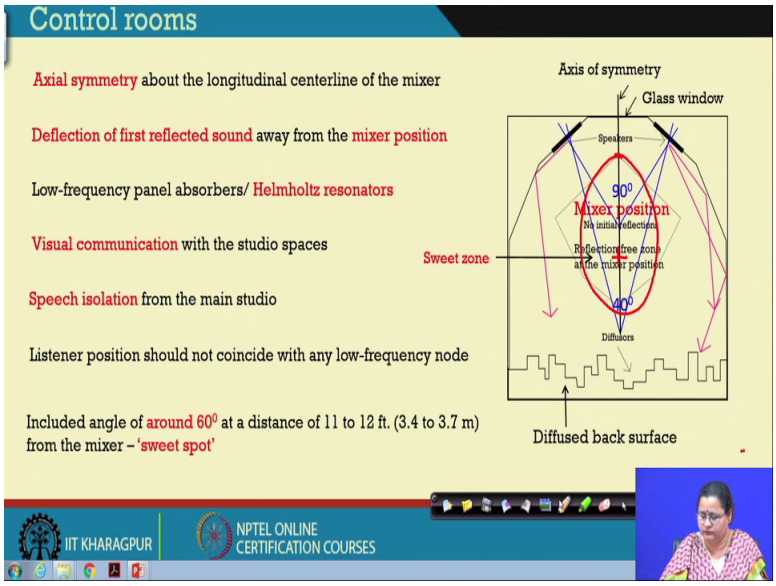

Coming to the control room this area is totally controlled by electronic devices which we are not expert in we are only to keep the plan for the space. So, what we see here is the axis of symmetry is to be kept to locate the speakers, and this axis of symmetry is for the mixing area.

You see the mixer position where the sound mixing will happen is at the central position which has its axis of symmetry and sound which is coming here is to be deflected and in the mixer position no direct sound is going to hit. So, it will be uniform sound which is reaching this mixture position.

So, the deflection of the first reflected sound is desired in this mixing position, and hence based on that the shape of the control room is to be designed. Here you see at the back there are diffusers which also will help in uniform sound reaching to the mixer position. Helmholtz resonators or low frequency absorbers are to be planned in the walls visual communication.

So, you have this glass window at this particular location, so that you can have visual communication it is expected that studio is on this side speech isolation should be there between the with the main studio because no sound from this particular space should be reaching back to the studio. So, that isolation has also to be checked particularly for this visual communication pane the glass window is made of double glass we will show some pictures on that listeners position should not coincide with any low frequency node.

So, even if there is any low frequency inside created in this particular room because of this speaker because of the sound from the speakers the mixer position should be or the listener who is in the mixture position should be avoided.

And if you see that the sound which is coming to this particular location is between 90 degree forming 90 degree, and 40 degree that is the ideal location of the mixer particularly at the central point which is at 60 degree, almost at 60 degree where actually the mixer position is to be planned that is called the sweet spot rather this particular entire area is called the sweet zone.

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Let us see some pictures this is a community radio station, at Pondicherry, it is Pudiya Udayan one side it is a very small thing for community radio station in a rural area where you see on this side is the this side is the control room. And the sorry this side is the control room and here on this the on the other side is the this side is the control room and on the other side is the recording area studio.

So, here you can see the equalizer or the mixer located here and through the glass you can see recording area.

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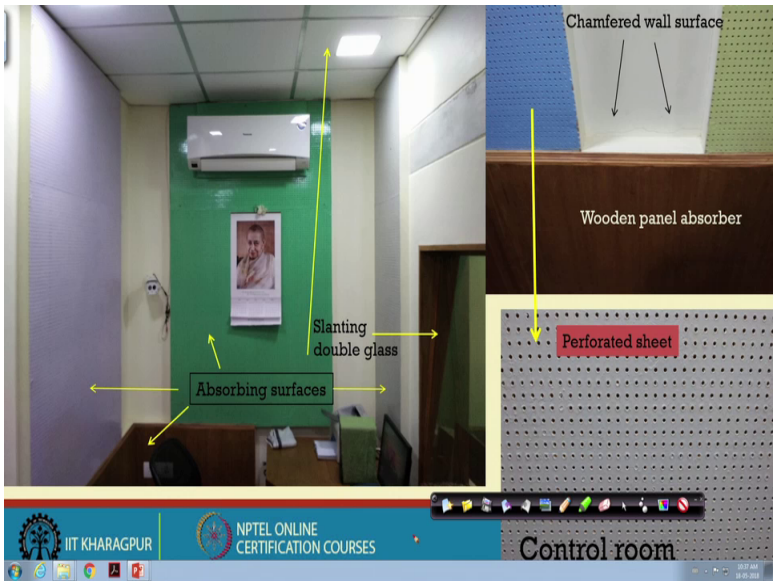

So, this is another view from the on the recording area. So, what you see on the walls? Let us see what is there in the walls you see there are absorbing surface all around starting from the ceiling and all the walls. So, these are primarily required for these particular kind of spaces here you see the slanting double glass, here this has been located in this fashion.

So, that the light is not forming any glare and it is also believed that sound is not rebounding to the mixing area. So, this is told to keep the things in a slanting position. So, that the light which is falling will go to the which will not directly hit the eyes neither sound which is falling will hit directly the mixing area or the source.

So, the sound which is falling on this glass surface will go down that will be directed to the ceiling or towards the walls, so that is why this kind of slanting location is adapted.

You see here are wooden panel absorbers below what I suggested like to chamfer the walls you can see from the chirography clearly that these insets are chamfered wall surfaces. Here you see perforated sheet or perforated panel absorbers and this is how this small spaces are designed.

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You see the two control room, the pictures of the control rooms sound control room at IIT Kharagpur, where the NPTEL lectures are being recorded. So, here there is not much of visual communication required, here the sound is being captured and the lady sitting over here is actually took taking care of the entire equalization process of the mix sound mixing process.

Here in the second picture you can see the entire wall surfaces are treated acoustically with absorbers and also the barriers what you see here the barriers what you see here are all absorbing. So, that the sound produced in this particular chamber is not disturbing the other two persons at the two ends.

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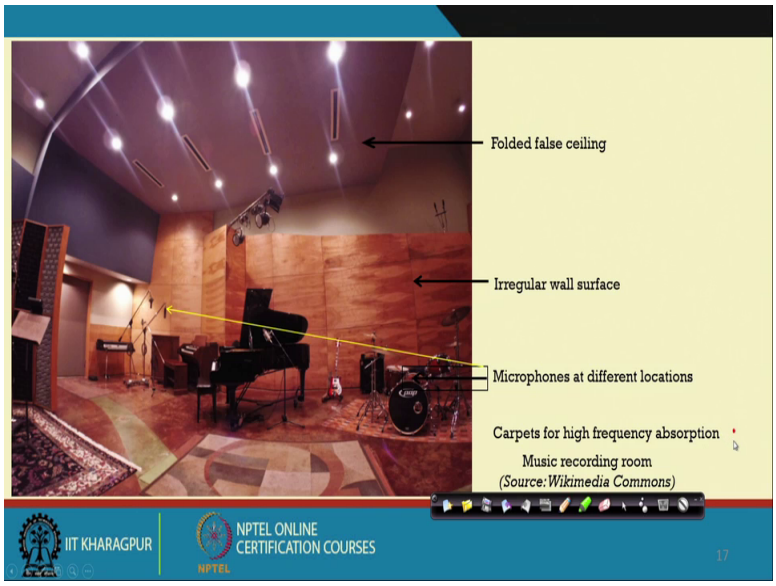

Here is another picture taken from the Wikimedia Commons. Here you see the irregular walls surface, irregular folded ceiling, and carpets on the floor different instruments located and the number of microphones which are all following the rule of three.

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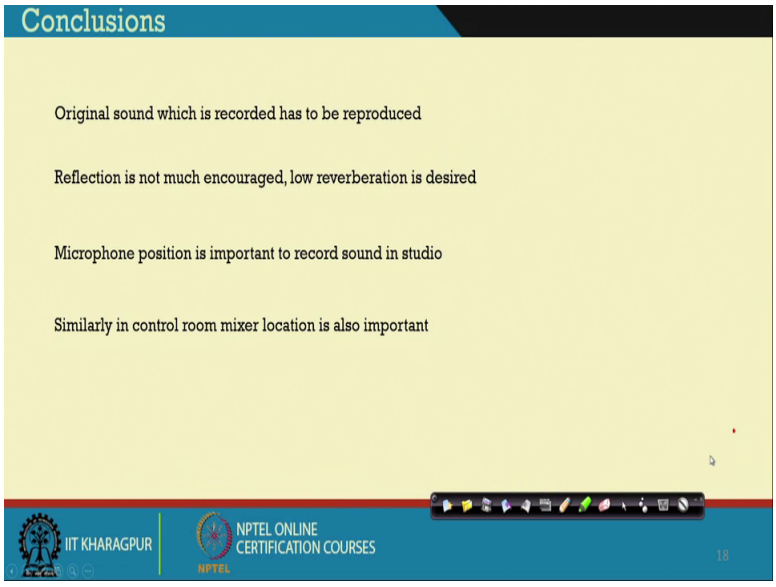

So, what we can conclude original sound which is recorded has to be reproduced and that is the primary objective of recording studio. And there plays a vital role of the control room also sound control room. Also reflection is not at all encouraged low reverberation time is desired microphone positions are very important in case of sound recording.

Whereas control room in control room the mixer location is of very much importance. So, if this microphone location and the mixer location is appropriately done then it is expected that the sound will be recorded in its best at its best or the purest form.

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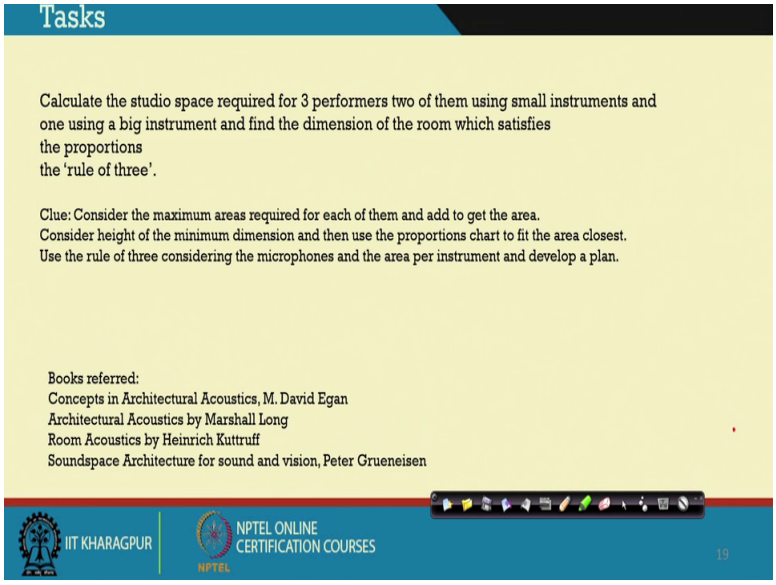

So, I leave you with this task to calculate the studio space required for 3 performers, two of them using small instruments and one using a big instrument and find the dimension of the room which satisfies the proportion and also the rule of three for the microphone location.

So, I have given you some clue considering the maximum consider the maximum area from the chart given consider the height as 2.4 to start with 2.4 meters or 8 feet to start with and find out the proportions which can fit in to this chart to the area which is closest to it. Then if you plan that you will see how to satisfy or how to locate your instruments so that the rule of three is compiled.

If you try it out you will actually learn how to plan for it. We as architects we need to translate whatever we have learnt in to the plans. So, first is going by the basic dimensions and by this time you are equipped with what kind of absorbers to be put in here.

And through this module you understood how you have to plan for how you have to keep in mind how to plan for class starting from classroom to open office spaces to restaurants to lecture halls and particularly recording studio and its associated control room.

So, in the next module we will move to auditorium design and auditorium acoustics so, that we can move into another particular space which is coming under the big space.

So, thank you for now.