Lovely Professional University

Acoustic Interiors in Educational Institutions

A Dissertation

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In Partial Fulfilment

Of the Requirements for the Degree of

Masters in Interior and Furniture Design

By

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November, 2017

CERTIFICATE

This is to certify that S. SREELAKSHMI bearing Registration Number 11613749 has completed her project titled, "ACOUSTIC INTERIORS IN EDUCATIONAL INSTITUTIONS" under my guidance and supervision.

To the best of my knowledge, the present work is the result of the original investigation and study. No part of the project has ever been submitted for any other degree at any university.

This paper is fit for submission and the partial fulfilment of the conditions for the award of the degree of Masters of Interior and Furniture Design.

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This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation and referencing of published and unpublished sources). I, the student of Interior and Furniture of Design under Lovely School of Architecture and Design, Lovely Professional University, Punjab, hereby declare that all the information furnished in this paper is based on our own intensive research and is genuine.

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Contents

Abstract.....10

Chapter 1 -INTRODUCTION 11

1.1 RESEARCH QUESTIONS..... 11

1.2 AIM:..... 11

1.3 OBJECTIVE: 11

1.4 SCOPE AND PARAMETERS..... 11

1.5 LIMITATIONS: 12

1.6 METHODOLOGY 12

Chapter 2 -LITERATURE REVIEW 13

2.1 Acoustics of classroom..... 13

2.2 Background noise and reverberation 13

2.3 Poor classroom acoustics..... 14

2.4 Behavior of sound in rooms..... 15

2.5 Need of acoustic Architects 16

2.6 Four ways sound effects 17

2.6.1 Physiological..... 18

2.6.2 Psychological..... 18

2.6.3 Cognitively..... 18

2.6.4 Behaviourly 19

2.7 Sustainable acoustics..... 19

Chapter 3 -COMPARISONS 28

3.1 Comparison of Acoustic buildings with time 28

3.2 Comparison of material properties 32

3.2.1 Wood..... 32

3.2.2 Glass 32

3.2.3 Brick..... 33

3.2.4 Cork 33

3.2.5 Gypsum 33

3.2.6 Fabrics 33

3.2.7 Thermocole 33

3.2.8 Fibre board 34
3.2.9 Curtains 34
3.2.10 Cushions 34
3.4 Inferences 36
3.5 Conclusions 35
3.6 Future scope 37
3.6 Definitions 38
BIBLIOGRAPHY 39

LIST OF IMAGES

Figure no.	Title of figure	Page no.
1	Propagation wave	21
2	Reflected wave and diffracted wave	21
3	Propagation wave near sush window	22
4	Propagation wave trough opening	22
5	Propagation wave entering inside room	22
6	Propagation wave near top-up window	23
7	Reflected wave and defracted wave	23
8	Reflected wave off the façade	24
9	Reflected wave and defracted wave off façade	24
10	Reflected wave off the façade and off the window	24
11	Comparison of waves between sush window and top-up window	25
12	top-up window	26
13	General top-up window to stop sound	27
14	top-up window having extension before	27
15	Reflected pattern of sound waves from curved parabolic and plain surfaces	28

Table no.	**Title of figure**	**Page no.**
1	Differences of medieval age acoustics buildings with current building	30
2	Comparison of acoustical properties of interior materials	35

ABSTRACT

It is important to start designing for our ears. The sense to design with sound is unequivocally the part which is least taken care while designing the buildings. A branch that studies the sound and its transmission in all states of matter is acoustics. It does help us design, where we can control sound. But contemporary buildings have changed a lot since the medieval times. The meaning and use has also changed since then. The knowledge of the past can be a boon to the present building technology. This paper explores the acoustics for a classroom environment, where the communication is of utmost importance. Active learning requires clear communication. The paper discusses the importance of form and material while designing the interiors of a building.

CHAPTER 1: INTRODUCTION

Acoustics in contemporary buildings have changed a lot since the medieval times. The meaning and use has also changed since time. The knowledge of the past can be a boon to the present building technology about acoustics. This paper explores the acoustics for the classroom environment, where the communication is of utmost importance. Active learning requires clear communication. The form and material affect the sound in various ways, which is discussed in the paper.

1.1 REASEARCH QUESTION

1. Study the effects of form and material on acoustics to achieve better learning environment throughout the year.
2. Study the effects of sound in different environment for better learning environment.

1.2 AIM

Achieve maximum learning in a class room environment without any audible distractions to help students learn better and efficiently.

1.3 OBJECTIVE

1. Compare old forms in a building environment.
2. Compare old materials in a building environment.
3. Compare the need, behaviour and culture associated.

1.4 SCOPE

The research paper is about to study the effects of sound and reduction of poor acoustics in class rooms which are affecting students and teachers in different ways.

Good class room acoustics in will increase the concentration levels of children which will lead them to hear clearer and learn better without missing any words spoken by teacher. This helps the teachers to maintain medium voice levels and keep their health good too.

1.5 LIMITATIONS

The facts represented are based on the study done by others. The differences are discussed in detail for better understanding and choice of form and material while designing interiors of class room.

1.6 METHODOLOGY

Literature review

↓

Primary data

↓

Secondary data

↓

Comparisons

↓

Inferences

↓

Conclusions

CHAPTER 2: LITRETURE REWVIEW

2.1 ACOUSTICS OF CLASSROOM:

The ability of student to hear and understand what is said in classroom is important for learning. But the ability of the students is reduced because of noisy classrooms. When the background noise or the amount of reverberation in classroom is really high that they interact with learning and teaching, this causes poor classroom acoustics. Poor classroom acoustics will affect in many ways. (Vigran, 2008)

- Speech understanding
- Reading and spelling ability
- Behaviour in the classroom
- Attention
- Concentration
- Academic achievement (Crandell, 2000)

2.2 BACKGROUND NOISE AND REVERBERATION:

Background noise which is unnecessary, these sounds interfere with the sound which we hear. The cause of background noise can be from sources such as traffic, lawnmowers, and children on the playground or in the hallway, heating or air conditioning units, audio-visual equipment, or other students. (Rhine, 2015)

Reverberation means the phenomenon of sound continuing to be present in a room because of sound reflecting off the surfaces such as desks or chairs. When sound lingers in a room there is more interference with speech. In a classroom environment it is important to have a short reverberation time. (Rhine, 2015)

2.3 POOR CLASSROOM ACOUSTICS:

All children are affected by poor classroom acoustics, but it can be a problem for children with the following problems:

- Hearing loss, including children with a hearing loss in one ear (unilateral hearing loss)
- Temporary hearing loss in one or both ears (ear infection or build-up of middle ear fluid)
- Learning disabilities
- Auditory processing disorders
- Speakers of another language
- Speech and language delay
- Attention problems (Crandell, 2000)

Poor class room acoustics is not only affecting students but also affecting teachers. The teacher has to raise their volume of speech nearly 60% more than their work day . Teacher has to speak louder to overcome poor classroom acoustics. This causes strain on the voices of the teachers. The research states teachers are 32 times more vulnerable to have voice problems compared to similar occupations. (Crandell, 2000)

The environment with good communication takes place in the best classrooms. This kind of class room or learning space should be created. When class room acoustics are poor there will be communication breakdown. This may reduce noise and reverberation in any space used for learning, such as community buildings, home-based classrooms, and classrooms in places of worship, is important. (Crandell, 2000)

2.4 BEHAVIOUR OF SOUND IN ROOMS

In general, sound or noise radiates in waves in all directions from a point source until it encounters obstacles like walls or ceilings. Two characteristics of particular importance in architectural acoustics are:

- Intensity—the loudness of the sound
- Frequency—the pitch of the sound (Vigran, 2008)

Both the intensity and the frequency of the sound wave will impact the sound/surface interaction. Some surfaces absorb sounds with high frequencies and reflect sounds with low frequencies. When sound waves strike a surface, one or several of the following can occur. (Vigran, 2008)

Transmission—sound passes through the surface into the space beyond it.

Absorption—the surface absorbs the sound.

Reflection—the sound strikes the surface and bounces off.

Reflected sound can result in

- discrete echoes, such as when the teacher's voice is continually bouncing off the back wall of a classroom,
- flutter echoes, when a sound bounces rapidly between two flat, hard surfaces, such as two walls or a floor and ceiling;

Diffusion—the sound strikes the surface and is scattered in many directions (Vigran, 2008)

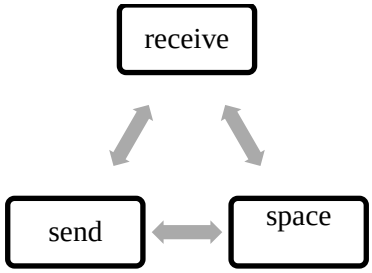
2.5 WHY ACOUSTIC ARCHITECTS ARE NEEDED

The designing to the ears should be started. The architects and designers should focus specially on noise or sound. These days design of spaces like restaurants are ended up without noise control. The sounds like loud crowd, shouting from a foot away to try and be heard by our dinner companion. Even in aeroplanes we get sounds of machines, announcements, crowd talk etc. which should avoid. The design of environment should not be designed crazy which suffers our quality of life, health, social behaviour and productivity. The sound is effecting us in two ways (Treasure, Why architects need to use their ears, 2012)

1. Ambience
2. Interference

Sound effects people physiologically, psychologically, cognitively and behaviourally every time where we are not conscious about it is ambience. The other way of affecting is interference. Communication need sending and receiving. But there is an important thing

called listening. The communication cannot happen if the space of sending is not effective. (Treasure, Why architects need to use their ears, 2012)



The spaces learn to include noise and acoustics. The hospital acoustics are the main unfair acoustics. The person sleeping in recovery room or ICU hears different beep sounds, foot stepping sounds etc... Which remind you that you are in danger? The noise levels in hospitals are increasing day by day. The quality of sleep in hospitals can be made with good acoustics around. (Treasure, Why architects need to use their ears, 2012)

The acoustics matters quality of education also. A class room with sound distractions will not help to understand clear speech. Educational institutions means is not just Morden buildings, old fashioned class rooms to suffer. Children are missing one word in two words. Children get only half what they listen .children don't have to work hard to join dots and understand the speech. The reverberation time is affected massively by how reverberant the room. In a class room the common reverberation time of 1.2 seconds which noise is with desk sounds footsteps, external voices, crowed talk which is echoing voice etc... By making reverberation time 1.2 seconds to 0.4 seconds by using acoustics treatments, sound absorbing materials the clear speech can be achieved. (Treasure, Why architects need to use their ears, 2012)

It doesn't affect only children but also teachers too. The average noise levels in classroom are 65 decibels. Teachers have to raise their voice more than 65 decibels of sound. The chart map of teacher's heart rate is against the noise levels. As the noise goes up heart rate goes up. In fact, 65 decibels is the very level at which this big survey of all the evidence on noise and health found that, that is the threshold for the danger of myocardial infarction. It causes heart attack. (Treasure, Why architects need to use their ears, 2012)

2.6 FOUR WAYS SOUND EFFECTS US

There is relationship with sound how it transforms. In general the sound around us we absorb is accidental, and which is unpleasant. The sound we hear in street corners, noise like traffic, shouting over noises, horn's which we pretend doesn't exist. The sound has meant that sound has become largely unconscious with our relationship. There are 4 major ways sound effects. (Treasure, The 4 ways sound affects us, 2009)

1. Physiological
2. Psychological
3. Cognitively
4. Behaviourally (Treasure, The 4 ways sound affects us, 2009)

2.6.1 PHYSIOLOGICAL:

The sounds that affect us physically consider as physiological effects. Due to different sound intensities it affects fight-flight hormone. Sound affects hormone secretions every time; it also effects breathing, heart rate, and brain waves. (Treasure, The 4 ways sound affects us, 2009)

2.6.2 PSYCHOLOGICAL:

The second way it affects in psychological. The powerful form if sound that effects emotional state is music. The different types of music affects different emotional moods like sad, happy, romantic, angry, peaceful, etc. music is only kind of sound which affects emotions (Treasure, The 4 ways sound affects us, 2009)

2.6.3 COGNITIVELY:

The third way it affects cognitively. Generally we cannot understand two people talking voice over voices .we have to choose one voice to listen. The voice over voices around in spaces likes offices, it extremely damages productivity. (Treasure, The 4 ways sound affects us, 2009)

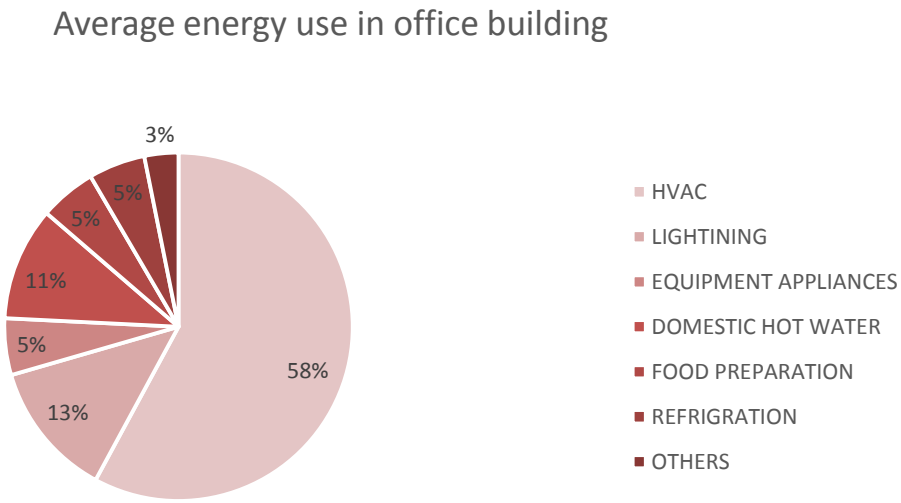
2.6.4 BEHAVIOURALLY

The fourth way it affects behaviourally. The different sounds around affect people behaviour. It was record that 30 percent of business is lose with people leaving shops faster or turning around the door because of dreadful sounds around. There are four rules for people who run business for commercial sound. Initially it should be made congruent, pointing in same direction like our visual communication. The increase impact by over 1100 percent. If the sound is in opposite direction, incongruent it reduced the impact to 68 present. Second rule is to make appropriate situation. Third rule to make it worth able and fourth is to test and test more times. Sound is complex. Soundscape is important and good for your health and productivity. (Treasure, The 4 ways sound affects us, 2009)

2.7 SUSTAINABLE ACOUSTICS:

There actually very less connection between sustainability and acoustics. There are simple demonstrations to improve the acoustics performance of windows which as very big impact on energy usage in the building. Basically people want to live the sustainable life which it an impact on the amount of carbon on country. If one individual have an impact upon countries carbon footprint. For this we need to be energy consultant, energy management, and more to have a chance of influencing the amount of energy that we use. (Nunes, 2016)

The very simple principle, if we don't have ears that is what it means the amount of energies are building news. If they do not have ears there is no need of thick walls between houses, it may have paper thin walls. We could have reduced thickness of slabs between schools, buildings we could have lighten up the structure of building significantly. This would have a major impact upon the embodied energy in building. (Nunes, 2016)



The significant means the amount of energy we use for the ventilation system, more than 50 percent of energy usage in building should be with in ventilation system. The ventilation building means buildings efficiently have two main methods. The first method is heat recovery, where we cover up the building, close the windows and recirculate the air around in that building. It maintains the heat inside the building that is the very efficient way in the building in the wintertime. We have to allow the correct amount of the air in and then push the air around the building. There is problem in this is that we have lots of ducts, these ducks consume energy and it becomes hard. For this we have to open holes like atrium holes on the slab so that it forth drive the air around thee large holes which is more energy efficient. The problem with that it is it transfers noise from one space to another space. In general we provide windows to room to maintain the internal atmosphere, but problem with windows is they don't stop sound and if we absorb the acoustics performance of the windows (Nunes, 2016)

We have to manage and understand the acoustic performance of the windows. The simple concept is visualizing the sound going through window and also should understand why window performs the way it performs. (Nunes, 2016)

For the understanding let us consider slinky tool. In slinky they put impulse in it. The waves travel along the way. This demonstrates how sound goes through windows. They have put an obstacle in the middle of slinky the impulse hits the object and it travels back. This is how sound performs. To demonstrate it and to create much more realistic model, how sound propagates. As to the figure no 1 the wave propagating away from the sound source .it is round as we expect. When it touches the obstacle the wave get reflections. The sound bends around the object and travels can be seen in fig no 2 (Nunes, 2016)

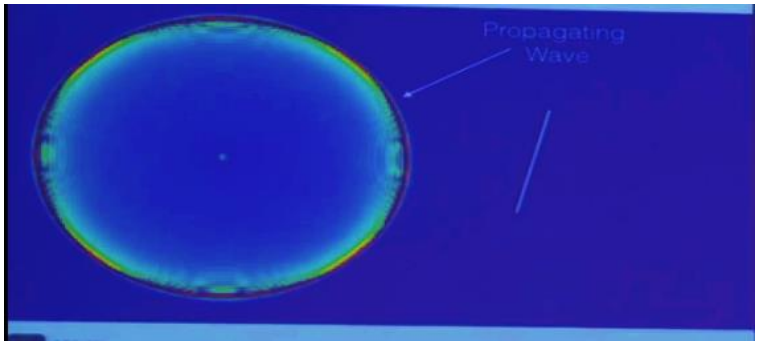


Figure no 1: propagation wave (Nunes, 2016)

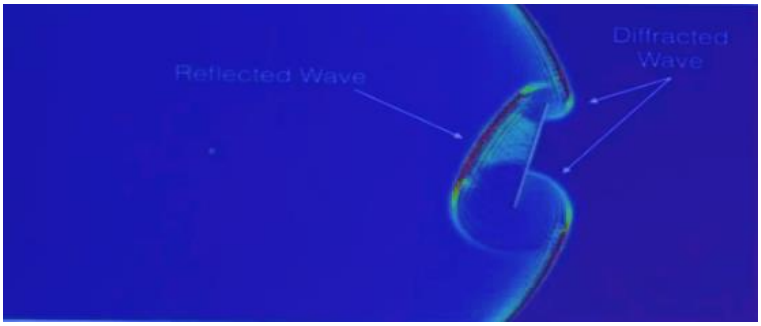


Figure no 2: reflected wave and diffracted wave (Nunes, 2016)

This technology is taken and studies the difference between sash window and other type windows. The propagating wave coming towards the window. It hits the window, get curve to the wave radiates into the room as shown in fig 3, 4, 5. (Nunes, 2016)

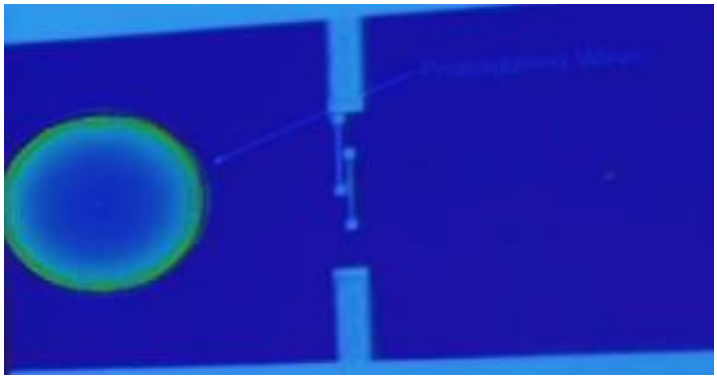


Figure no 3: propogation wave near sush window (Nunes, 2016)

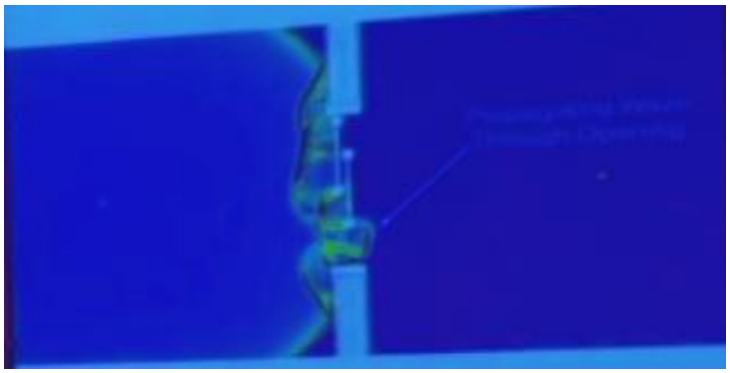


Figure no 4: propagation wave through opening (Nunes, 2016)

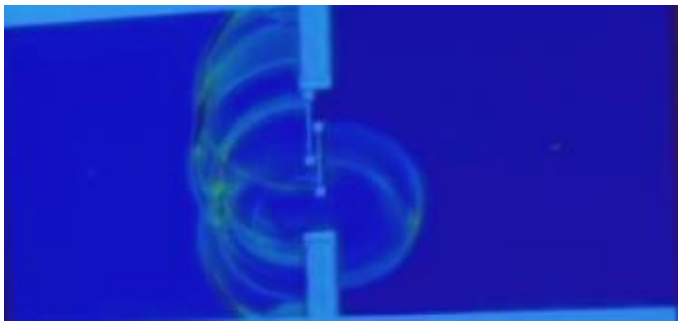


Figure no 5: prorpagation wave entering inside room (Nunes, 2016)

If it is in the case of top hung window there will be differnace on radiating. In this case the sound is distracting around the window an it comes in as shown in fig 7,8. It is reflecting the faceade of the bottom and it strats travelling back and it hits the window and retavels. So we get more than one wave coming coming into the building and the second wave coming down as shown in the fig 9. (Nunes, 2016)

Figure no 6 : propogation wave near topup window (Nunes, 2016)

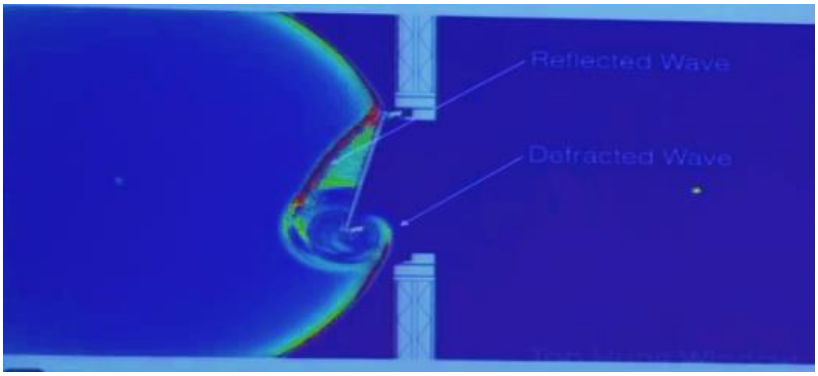


figure no 7:reflected wave and defracted wave near topup window (Nunes, 2016)

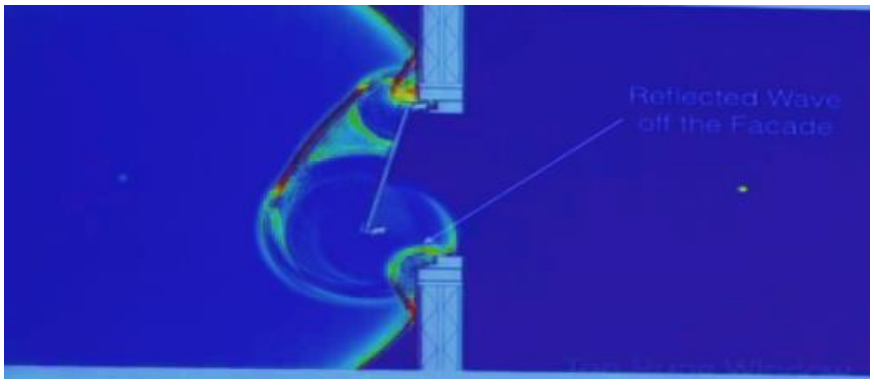


Figure no 8: reflected wave off the facade (Nunes, 2016)

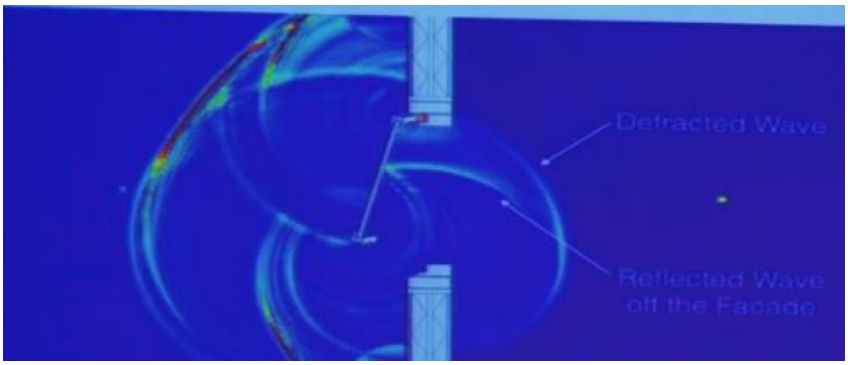


figure no 9: defracted wave and reflected wave off the facade (Nunes, 2016)

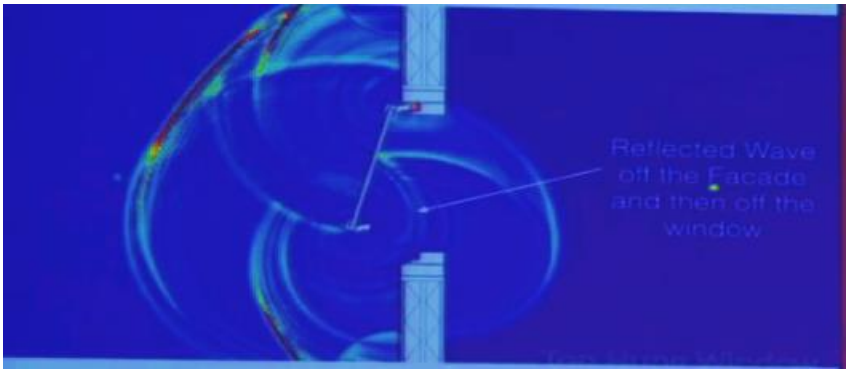


Figure no 10: reflected wave off the façade and then off the window (Nunes, 2016)

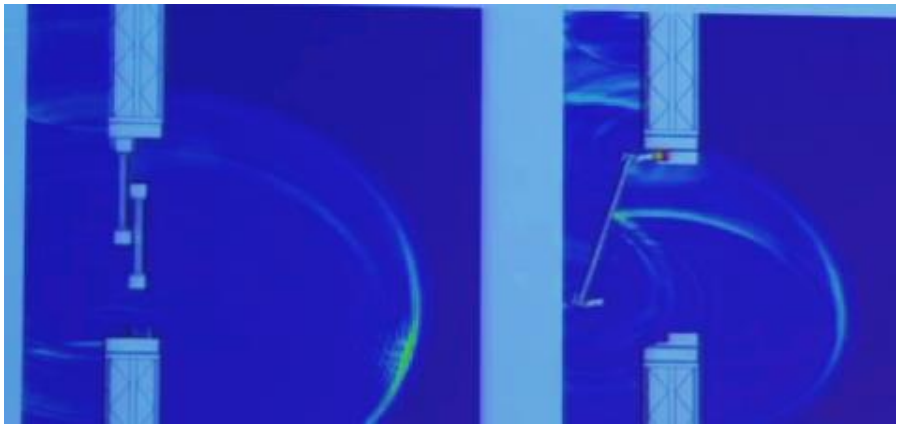


Figure no 11: comparison of waves between sush window and topup window (Nunes, 2016)

Now we knew if we treat the windows we can start to control the amount of sound that is radiating into the building. If we compare the two windows sash window and toppling window. There is more energy zone in the sash window than toppling window. To reduse the noise levels it is better to use top hung window.it transfers less sound . if we can angle window away from sources of sound it in redusing sound levels upto 20 decibels. We can further use our brains, block the line of sight through window as shown in fig 10. The extension to the conventional window so sound cant radiate more into the building. This is significant benefit upon the performance. (Nunes, 2016)

Figure no 12: topup window (Nunes, 2016)

When the extension is fixes to the mirror part as shown in the fig 11 the sound travel from outide is compartively less ones the extenion is removed noise levels gets increses. The next simple principle which is just to put the short panel infront of the window that which flex the sound away from the window and significantly increases the performances of the window. Now we can increase the performance of the windows to live in more comfortable buildings that are in inner cities and we can open our windows without cooling and we can take schools and offices and many other buildings and reduse the amount of mechanical ventialation we need simply by adapting the adjesting the windows . this will have major impact on the energy usage of our buildings . (Nunes, 2016)

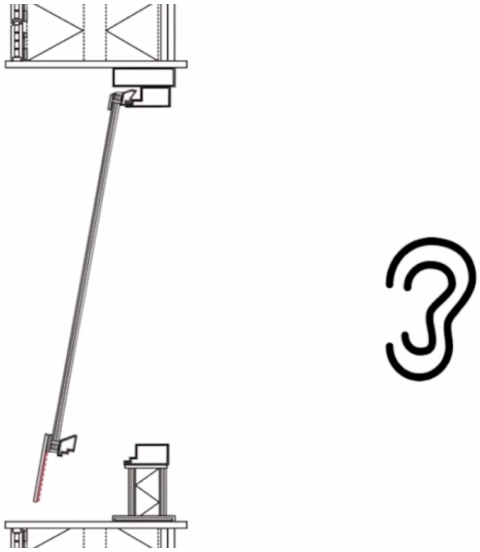


Figure no 13 general topup window to stop sound (Nunes, 2016)

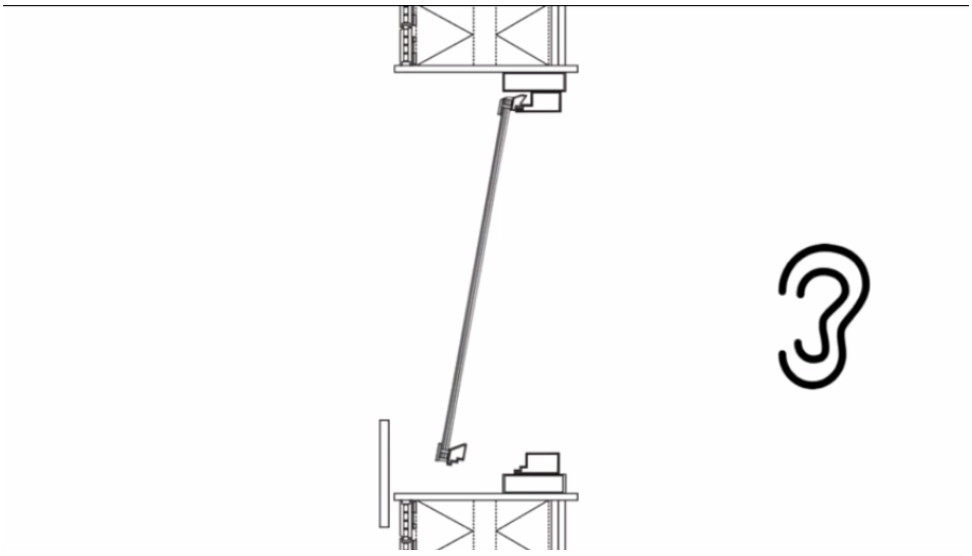


Fig no 14: the topup window having with extention before window (Nunes, 2016)

CHAPTER 3: COMPARISIONS

3.1 COMPARISON OF MEDIVAL AGE ACOUSTIC BUILDINGS WITH CURRENT ACOUSTIC NEEDS/SITUATION:

From medieval times to the present there are large number of changes in the environment, education system, forms of buildings, and human psychology. All the changes in the time gap affect the speech quality in different ways. There are huge changes in the construction techniques of the buildings and in the shape and forms of the buildings. In the medieval time the walls of the building used to be very thick and able to stop the noise entering inside the building. But now-a-days the walls are becoming thinner and thinner. The structure of the old buildings relates the art forms. The build form used to control the weather and human nature. The ceilings mostly used are dome and parabolic structure. They used to maintain speech clarity. Because of parabolic structure the noise reflections do not intersect each other and do not produces the noise disturbances as shown in the figure.

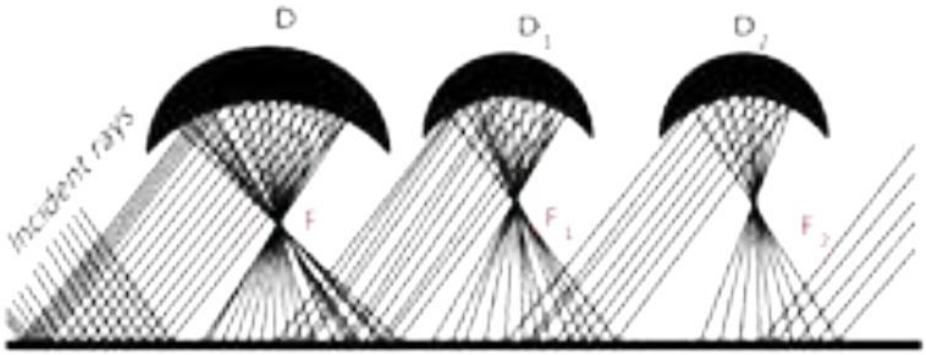


Figure no 15: reflected pattern of sound waves from curved parabolic and plane surfaces (Rhine, 2015)

Now-a-days the structure has mostly flat ceilings, pop ceilings which cause the noise disturbances. The windows are made big now-a-days for the ventilation which are alternatively causing the way to noise to enter into the building or room.

There are various changes in the use of materials. In the medieval time usage of stone, granite, marble, lime motor, slate, and clay. In modern era the usages of materials are different. The major materials used are concrete, steel, p.o.p., plastic, bricks, textiles tiles etc. The materials used it impacts more for indoor sound quality.

There is lot of difference in the class room environment, behaviours of people, teaching techniques and surroundings. There is enormous over generations. In the medieval times the education is treated as holy. They used to have classes in open surroundings under trees. The seasonal climatic conditions used to mild and comfortable. Equipment's requirements used to be very less. There used to be no benches, fans, ac, speakers, projectors, etc. around the class rooms. The peaceful environment is used to maintain, whereas there was no traffic and pollution around the place. The speech clarity is used to be clearer because of no distracting materials around. The silent environment used to maintain in the class areas. Due to these circumstances the children used to have high concentration levels.

The present generation education is entirely different. We have closed class rooms because of saviour climatic conditions. The HVAC is not maintaining properly for the closed class rooms which affect the speech clarity. There are many things which affect

speech clarity. In now we place so many things benches, blackboards, projectors, speakers, fans, ac, experimental equipment's, lights etc. according to the requirements of subject. All the materials affect the indoor speech clarity. The surroundings are now noisy because of traffic, transportation, noise of city. Speech clarity is due to many distractions. The way of education is also changed. The class became noisy and class are based on activity. Class became interactive and explorative. The children concentration levels are decreased a lot. This is time to maintain the indoor speech quality better to increase quality of education and increase the concentration levels of children.

TABLE 1: DIFFERENCES OF MEDIVAL AGE ACOUSTIC BUILDINGS WITH CURRENT BUILDING

SERIAL NO	**CLASSIFICATIONS**	**MEDIVAL PERIOD**	**PRESENT**
1	FORMS	▪ Thick walls ▪ Small windows ▪ Rounded arches ▪ Parabolic forms ▪ Domes ▪ Wooden	▪ Thin walls ▪ Flat, pop ceilings ▪ Big windows ▪ Square or rectangle structures

		ceilings ▪ Limited heights	
2	MATERIALS	▪ Marble ▪ Granite ▪ Stone ▪ Lime mortar ▪ Clay ▪ Brick ▪ Logs, wood ▪ Glass ▪ Soil ▪ Iron ▪ Copper ▪ Lead	▪ Concrete ▪ Wood ▪ Steel ▪ Plastic ▪ Stone ▪ Textiles ▪ Glass ▪ Brick ▪ Tiles
3	CLASS ROOM ENVIRONMENT CHANGES	▪ Open class rooms, under trees ▪ Seasons are mild ▪ Less equipment’s ▪ No luxury like	▪ Closed class rooms ▪ Seasons are high ▪ Equipment’s ▪ Basic requirements like fan, ac ▪ Benches,

		fans, ac, benches, speakers etc. ▪ Peaceful surroundings ▪ Speech clarity is more	speakers ▪ Noisy surroundings ▪ Speech clarity is less
4	BEHAVIORS	▪ Silent ▪ Education is holy ▪ High concentration levels	▪ Noisy ▪ Activity class ▪ Interactive ▪ Explorative ▪ Less concentration levels

3.2 COMPARISION OF ACOUSTICAL PROPERTIES OF INTERIOR MATERIALS:

3.2.1 WOOD:

Wood is used as many ways in interiors, mostly in class room's wood is used as benches and desks. Wood is light material. The sound insulation is different to different types of wood. The thick wood reflects sounds and it can be used as sound reflectors. The wooden flooring can be done with natural timber. Timber is a good thermal insulator and partially

good as sound insulator. Wood can diffuses the sound, and very bad at having barrier property. Wood is very good at reflecting sounds

3.2.2 GLASS:

Glass is used in windows to stop sound, light, wind; smell etc. glass has variant properties. There are different types of glasses in use in market according to the purpose. The glass are very good sound barriers. Glass wool or fibre glass is good sound insulators. The thickness of the glass performs different sound properties. The class can act as both sound reflectors and sound barriers.

3.2.3 BRICK:

Bricks are the basic material in construction. Bricks are good sound diffusers. The thickness of the wall increases the property of sound absorption is also increases.

3.2.4 CORK:

Cork it made with bark of cork –oak tree. This material is also light material. The cork sheets are used for panelling. Cork is porous and it cannot be affected by the moisture. It is good sound insulator and it transfers sounds with acoustic effects.

3.2.5 GYPSUM:

Gypsum means hydrated calcium sulphate. When gypsum heated it loses the water and it forms plaster of Paris. These boards are mostly used for celling .These are good at thermal and sound insulation. Pop is good sound reflector.

3.2.6 FABRICS:

Fabrics are mostly used for interiors. These fabrics they use different material for different usage. Fabrics are basically sound absorbers different types of fabrics are used for the different use.

3.2.7 THERMOCOLE:

Thermocole is a type of plastic. It has good thermal insulation properties. These Thermocole are used as ceilings. There are available in different sizes from 50mm. The Thermocole is light in weight. It has good sound insulation properties. Thermocole absorbs sound.

3.2.8 FIBRE BOARD:

Fibre board and particle board are made of waste wood, grass, crushed sugarcane and similar substances. These boards are used as interior and exterior grade. These are also good at sound insulation. The acoustic effects increases because of half performed random hole on one side of the board. Due to these wholes the echoes and reverberations will get reduced

3.2.9 CURTAINS:

Curtains of natural cloths like cotton wool are very good sound insulators and very good sound absorbers. The artificial clothing like polyester or nylon is not good for acoustics

3.2.10 CUSHIONS:

Cushion padding are used on walls or partitions. Because of the cushioning on walls and partitions it controls sound insulation. Cushions are very good sound absorbers. Cotton, U-foam, coir foam, rubber foam are used for padding. The cotton or woollen cloths are

used for draping. The properties of cushion padding varies with use of natural cloth or leather

TABLE 2 : COMPARISION OF ACOUSTICAL PROPERTIES OF INTERIOR MATERIALS:

SERIAL NO	MATERIALS	ABSORBERS	DIFFUSERS	BARRIERS	REFLECTS
1	**WOOD**	Wood is not good absorption material	Wood can also diffuses the sound	Wood is very bad barrier of sound	Dense wood is very good reflector of sound
2	**GLASS**	Glass is not good absorber of sound	Glass is not good diffuser of sound	Yes, glass is good barriers of sound	Glass reflects sound good reflector
3	**BRICKS**	Brick walls absorbs sound very less	Bricks walls are bad diffusers	Bricks are good barriers of sound	Brick walls are bad reflectors
4	**CORK**	Good absorber	Bad diffuser	Good barriers	Bad reflector

5	**GYPSUM /POP**	Good absorber	Bad diffusers	Optimum barrier	Bad reflector
6	**FABRIC**	Good absorber	Bad diffuser	Bad barrier	Bad reflector
7	**THERMOCOLE, POLYURETHANE**	Very good absorber	Bad diffuser	Bad barrier	Bad reflector
8	**FIBRE BOARD/ PARTICLE BOARD**	Good absorber	Bad diffuser	Good barrier	Bad reflector
9	**CUSHION PADDING**	Good absorber	Bad diffuser	Bad barrier	Bad reflector
10	**CURTAINS**	Good absorber	Bad diffuser	Bad barrier	bad reflector

3.4INFERENCES:

- Cork, gypsum and padded cloth and curtains seem to be easy choice, but since in a classroom environment lot of attention is paid to the robust materials which last longer, Thermocole, polyurethane and particle/fibre boards must be used.
- As far as form is studied the best is to use a concave or convex, since it enhances the sound at the centre points in a room and help listener to pay more attention to the speaker.

- The windows has to be designed carefully because these are the main sources of external noise entering into the classrooms
- Wall thickness also lessens the noise to enter inside the room and soft material cladding may help maintain the clarity.

3.5 CONCLUSION:

It is clear from the table 1 and table 2 that correct form and right material selection plays vital role in design of acoustical interiors. It does have an impact on functionality of the room and its use. It will enhance hearing and boost academic results of the students. It will help create seriousness among students. Since the classrooms as compared to old times have grown to be more activity oriented where people share ideas rather than indulge in individual studies. And the walls in contemporary architecture have grown thin; the need has arisen to explore more forms and materials.

3.6 FUTURE SCOPE: In the light of above we need to further study the forms and material in conjunction with sustainability needs. The whole world is moving towards sustainability and the lifestyle has changed to meet the current classroom learning to adapt the changing market and world. Information is now consumed faster than ever which means a lot of changes are needed to be seen in classroom environment.

3.7 DEFINITINS:

ACOUSTICS - the properties or qualities of a room or building that determine how sound is transmitted in

REVERBERATION - prolongation of a sound; resonance

INTENSITY - the loudness of the sound,

FREQUENCY - the pitch of the sound.

TRANSMISSION - sound passes through the surface into the space beyond it.

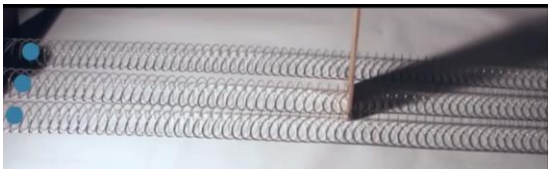
ABSORPTION - the surface absorbs the sound.

REFLECTION - the sound strikes the surface and bounces off.

DIFFUSION - the sound strikes the surface and is scattered in many directions.

AMBIENCE - the character and atmosphere of a place

INTERFERENCE- the action of interfering or the process of being interfered with

SLINKY TOOL - 

IMPULSE - a sudden strong and unreflective urge or desire to act

BARRIERS - a fence or other obstacle that prevents movement or access

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