

## Use of Different Textile Structures as Acoustic Materials

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### **Abstract**

*The knowledge of acoustic is very required because it is related to sound and is highly essential to maintain the peaceful surrounding of our environmental conditions. One of the branches of science and engineering is the architectural acoustic and it is needed for the maintaining the good sound level in the buildings. Noise level has its effect on the human health. Researchers are trying their level best to minimize sound pollution level to a minimal to reduce noise pollution for the benefit of mankind. There are various means and measures to control sound quality at any space for the required environment. Many new materials as well as methods are available to improve upon the sound level to maintain peaceful environment. For the noise control in the rooms, sound absorbing materials are used. Fibrous medium and porous foam materials are used to control noise for different places. Designers are now-a-days using various beautiful textile materials which are acoustically transparent to allow sound waves to pass through the functional core. To improve upon the sound quality at windows and partition walls, acoustic fabrics are proven highly effective.*

**Keywords:** *Acoustic fabric, Acoustic panel, Hearing loss, Noise reduction, Fibre glass, Sound absorber, Carpet pad, Fibrous mat, Reverberation time*

### **INTRODUCTION**

Natural resonances are created by the standing sound waves by their reflection ability and these are heard as pleasant and annoyance behaviour. In the concert hall and music recital area, reflective surfaces can be arrange angularly as well as coordinated way to provide coverage of sound for better approach to the listeners. Ideal materials are generally by nature are acoustic panels and are placed without a face or finish in types. Different materials with various finishes are applied in the interior parts of the buildings to improve the acoustic levels. Acoustic absorption can be improved by covering panels [1]. The modern scientific application of acoustical knowledge is related to FoggMuseum Lecture Hall, and it was applied by Wallace Sabine. The new approach was applied in the Symphony Hall in Boston. The best places to apply acoustical science are the theatre,

restaurant and railway station due to its ability to achieve good speech intelligibility. Similarly, it can enhance the quality of music in a concert hall or recording studio or suppressing noise level at offices and homes more productive and pleasant atmosphere to work and live in.

Wrong finishes cannot solve the problems related to performance of sound of any space which is a matter of concern when it is not wanted to hobble sound absorbing panels, walls and ceilings portions. Sometimes it becomes an expensive mistake. Fabric partitions can be used in different contexts, such as situations where acoustic performance is critical and the fabric's job is not to absorb sound but to allow sound absorbing products behind the fabric to do the their jobs smoothly. The purpose of the fabric is not to impede or reflecting sound before it can travel to the absorbing products [2].

In the article of Acoustic textiles, the authors [3] discussed about the textile materials employed for noise or sound absorption applications. In this discussion, various types of materials needed for the purpose of manufacturing of acoustic materials, like natural and synthetic fibres, along with finishing materials have been cited. Different types of porous and absorbing materials in panels for sound proofing materials have been stated [3]. The materials like coated, sprayed, embed and filter types for sound absorbing have also been discussed. For low and medium frequencies sound waves application of nano-materials are described in the article. The article also covered some of the recent developments in hybrid absorbers where acoustic property was effectively controlled with the help of active absorbers. Apart from these new types of absorbers are also discussed.

For a harmonious balance of acoustic and aesthetic performance, Creation and Bauman have produced the largest selection of acoustic fabrics [4]. These are ideally suitable for the controlling of background acoustic sound effects. They reduce the reverberation time depending on the weight, porosity and weaving methods of the products. When tests are carried out in the reverberation chamber, it allows comparison between the textile acoustic properties. The test specifications must satisfy the standards of ISO/EN 354, ISO 11654 and DIN EN 29053 standards and impress with the standards of the unheard quality of the sound range.

According to the manufacturers [5], designers must need beautiful textiles which will acoustically transparent to allow sound to pass through to the functional core of the sound proofing materials. In order to obtain such qualities of fabrics we have to assured that these are qualified through flame tests codes, are stable and have are certified by the third party protocol of acoustical function.

Undesirable and potentially hazardous noises are not wanted in many of the engineering and other areas. It has become matter of concern from the impact of sound noise in many areas like application of new technologies, faster moving machineries and environmental effects. Therefore considerable efforts are being made to meet the challenges for sound noise abatement. There are several solutions for combating the sound generating from the closed spaces. Low product costs and low specific gravity are the two advantages of textiles for using as noise reducing materials [6].

In order to subdue the level of sound passing through the insulating building components, sound insulation or sound proofing is an important method. Common people cannot differentiate between the sound insulation and sound absorption, and they are two different techniques from the view point of noise reducing problems. The sound absorbents are mostly porous materials, absorb sound and reduce sound which is reflected from the surfaces whereas, sound insulating construction reduces the sound passing through it [7].

Natural materials such as flax or recycled cellulose fibres are similar to rock wool or glass wool when compared as sound insulation material. Many natural materials like bamboo, coco fibres and kenaf fibres have good sound absorbance property and cork or recycled rubber layers are very effective insulation for impact of sound [8]. Active and passive are the two broad classifications of noise reduction techniques. Radiated noise is passively controlled by energy absorption method and the active method involves by reducing the source strength or modifying the acoustic field in the duct to reduce the noise level.

Aqueous foam, an excellent suspending medium, effectively prevents flocculation of fibres. Raw materials of long fibres to

nano-scale particles are utilized for the purpose of making very porous structures from it [9]. In automobiles acoustic materials are needed in the automotives and vehicles, and in other areas like constructions and partitioning walls, industrial equipment and machinery, appliances and consumer products, aerospace and marine, etc acoustic materials are also used.

Fabrics used for the acoustical purposes are generally thicker and heavier than other fabrics and therefore used in theatre curtains, blackout curtains, and studio blankets. Mass loaded vinyl is a dense rubber like material and is used in many areas such as car sound proofing, machinery appliances and as an under lay mat. Due to the mass of the material it acts as a sound barrier. Sound insulation bats 'are of made of mineral wool, rock wool and fibre glass and are designed to fit into the studs of walls. The bats' are snugly fit between the studs to take up air space that can transmit sound [10].

The literature survey reports that textile materials were used as acoustical purposes doe to their inherent acoustic properties [11]. As the menace of sound pollution has gone to such a high level, textiles are chosen as an alternative material for its cheaper, simpler and effectiveness character. As a result of various researches at the manufacturing techniques for the production of different products, textile materials are finding their ways into acoustic insulation.

There are a number of sound proofing materials for walls, windows and doors available in the market. One of the most common sound proofing materials is being supplied by Solution. Like standard home and office insulation Solution also provides a thermal buffer [12]. In case of sound proofing insulation, no extra arrangement is necessary for the installation of sound proofing materials.

Like standard insulation, it is usually a bat that is installed between wood or metal studs behind the dry walls. Sound proofing insulation can be used in both walls as well as floors.

Any acoustic material must have its own acoustic properties because it has to be engineered to absorb sound. In general, acoustic textiles are classified into two groups of porous sound absorber. The first one is bulky and high-loffttextiles which should behave as a rigid porous sound absorber and the second one is a light weight and compact woven textiles that must behave as a porous screen [13]. The bulk porous absorbers are fibre glass materials or mineral wools bats or blanket and needle punched resin or thermally bonded fibrous textiles. The thin and light-weight acoustic textiles like INC Engineered materials of Dec-Tex range act as flexible porous screen.

The more fibrous a material is means better the absorption and contrary to that is the denser the materials are less absorptive in nature. The sound absorber characteristics of a acoustical material vary significantly to absorb because of their long wave length. On the other hand, people are less susceptible to low frequency sound [14].

Porous materials used for noise control are generally categorized as fibrous medium or porous foam. Sound absorptive materials are mostly used in conjunction with the barriers of some types as their porous construction permits some noise to pass through relatively unaffected. When a barrier is used to back the absorber material, it reduces the energy in a sound wave by converting the mechanical motion of the air particles into low grade heat [15]. This effect prevents a build-up of the sound in enclosed spaces and reduces the strength of the reflected noise. It is known to us that almost every textile material has some potential for acoustical function. In

fact, textiles are used in many applications involving acoustics including acoustic panels for work stations, automotive insulation and upholstery in concert halls.

In the cars textiles are used for the purpose of enhancing the comfort, thermal insulation, design improvement, vehicle safety and more often for the required purpose of acoustic properties [16]. The growth of textiles worldwide in automotive industry represents a high potential market for the textile industry both for woven and nonwoven structures, composites and other textile materials. Another use of textiles in the automotives is in noise dampening. Impregnated jute or shoddy mat materials are used almost from the beginning [17]. But modern cars are much quieter and the users demand more lower level noise in the cars. Nonwovens are much more useful as dampening material than the old padding materials. One of the most interesting items is in the hood liners. New hood liners are covered with a mixture of micro denier and conventional fibres which were earlier covered with a glass mat and plastic film materials. The mixture of the above new materials are molded to shape to match the engine and compartment to which is mated, actually tuning the hood liner to cancel out the noises produced by that make and model's engine compartment. It is expected that it will be lighter in weight and much thinner.

Porous concrete masonry and cinder concrete are some examples of porous rigid materials. These materials provide 10% higher insulation as compared to non-porous rigid partitions due to their sound absorptive quality. To enhance the results of insulation it is recommended that porous partitions should be plastered on at least one side of the partition and if possible it may be done on both the sides [18]. Flexible porous materials available in the market provide low insulation.

The noise created both by human as well as industry is an environmental problem. The recognition of noise as a serious health hazard is a development of modern times. Too much noise obviously impairs our physical and mental existence and therefore it is responsible to pursue technology assessment concerning noisy technologies [19, 20]. Answer of the above problems is to replace the traditional synthetic materials by the acoustical sustainable materials either natural or made from recycled materials [21]. Air borne sound insulation of natural materials such as flax or recycled cellulosic fibres is similar to one of the rock or glass wool. Many natural materials show good sound absorptive performances, like cork, or recycled rubber layers can be very effective for impact sound insulation.

The majority of the sustainable materials for noise control can be divided into three main categories: like natural materials, recycled materials and mixed and composite materials. There is a great variety of natural fibres which can be used for thermal and acoustical applications. These are commercially available in the form of coconut, kenaf, hemp, mineralized wood fibres [22].

According to the Sound Proofing Tips, there are 15 best sound proofing materials and products. They have recommended 10 materials to sound proof a room in our houses. Sound absorbing foams (Pro Studio Acoustics Tiles) are made in the USA from a high quality acoustic foam. These are installed on walls where noise reflection is a problem or as ceiling tiles to cut down echo and reverberation [23]. The sound dampening materials are the materials in which the mass and density of the materials dissipates sound and reduces the amplitude and energy of the noise. Sound dampening materials come in the form of mats, rolls, sprays and paints and help kill vibrations, rattles and overall

dissipations of the noise [24]. Rock wool Rock board is an awesome insulation board product ideally suitable for improving the acoustic insulation for homes and buildings. Rock board is a rigid fire resistant mineral wool insulation used for both acoustic as well as thermal insulation. It is best used in residential and commercial buildings [25]. Roberts Super Felt underlayment is an excellent choice for noise proofing a floor, especially with laminates, hard woods, and engineered wood. The felt is made from recycled fibres, compressed and heat treated form a rich sound absorbing material [26].

### **METHODS OF SOUNDPROOFING OR ACOUSTICAL INSULATION**

Sound travels in the form of longitudinal waves and each wave moves backward and forward passing on the vibrations to the next. In order to hear sound clearly, it is important for the sound waves to travel uninterrupted. Sound travels fastest in the solids, then in liquids and least in the air. The speed of sound in the air depends upon the moisture or dryness in air. The more the moisture the faster is the sound travelling rate. Loudness is the response of humans to impact of sound and intensity is the amount of sound distinguishes between the loudness at different frequencies. The quality of sound enables us to differentiate between two musical tones played on different instruments. Sound waves from a plain surface reflect in the same way as that of light like reflection on flat surface, reflection on convex surface and reflection on concave surface [7]. When sound waves strike a surface some of the sound is absorbed by friction. The materials that absorb are known as absorbents. Examples of common materials of absorption of sound are acoustic plaster, perforated and imperforated compressed cane or wood board, wood particle board, compressed wool, mineral or glass wool mats, mineral glass wool tiles and composite units of

perforated hard board backed with perforated fibre board.

Any good variety of acoustical material should have high absorption power and should be able to absorb a wide range of frequencies. The material should be cheaper and easily available as well as look should be attractive after fixing it in the place. It has to be fire resistant and stronger. It should be non-hygroscopic, insects and termites free. Impact insulation is a rating of how well a building floor reduces the impact of sound, like footsteps. The normally available types of insulation materials are non-porous rigid partitions, porous rigid partitions and flexible porous partitions. Walls are considered to be as vertical insulation barrier of sound. There are four types of wall constructions for the purpose of insulation which are such as, rigid homogeneous walls, partition walls of porous materials, double wall partition and cavity wall construction [18]. Floor and ceiling insulation can be made by the application of resilient surface materials on floor, concrete floor floating construction and timber floor floating construction.

Most of the sound energy is absorbed by the sound absorbing materials with the striking them and reflecting a very little. For the purpose of room noise control, sound absorbing materials are found to be very useful. The effect of noise has become a health hazard in the modern days [8]. Too much of noise makes us physically and mentally impaired and therefore it is quite reasonable to per sue technology assessment concerning noisy technologies [19]. Noise has become an important factor among the environmental effects on which industry sets down a big part of its noisy efforts and concerns. For an example air ports create a huge noise environment [20]. Two types of noise reduction techniques are known to us, namely passive type and active type. Many

natural materials are available which have their own impact property of sound insulation as well as thermal insulation property [21]. The effectiveness of sound absorption is directly related to the thickness of the material and it is observed that sound absorbers are most effective when their thickness is between  $\frac{1}{4}$  to  $\frac{1}{2}$  the wave length of the sound [22]. There are a great variety of sustainable materials for noise control in natural fibres, which are used for thermal and acoustical applications.

### **SOUNDPROOFING MATERIALS**

Presently, many good quality soundproofing materials are available in the market. Soundproofing Tips have furnished a list of best soundproofing materials. After comparing all the products, one may possibly come to conclude which one or more can be selected for their rooms to make them soundproofing [10]. They have categorized their products into various groups, like sound absorbing, sound insulation, sound dampening, and sound decoupling. Studio Foam is also known as Acoustic Foam which is highly effective as sound absorbing when attached to walls as panels. Bats made of mineral wool, rock wool or fibre glass are used as sound insulating materials placed between the studs. Acoustic boards are also sound insulations materials, which made of foam with appealing colours, and can be used both in homes as well as in the office decoration. Curtains, black out curtains, and studio curtains made of fabrics are also acoustic fabrics. MLV (Mass Loaded Vinyl) dense rubber like material is suitable as soundproofing materials in the cars, machinery, appliances, etc. For the floor underlayment, materials like cork, felt and polymers, etc are employed as the decoupling purposes. The architectural soundproofing materials are those materials which are used in the buildings for soundproofing.

Pro Studio Acoustics Tiles or Sound Absorbing Foam is used by the people in their homes or in the offices for the purpose of sound absorption. These are used in the theatre rooms, gaming rooms, voice booths or in studios for the purpose of absorbing sound and killing echoes [23]. Sound dampening materials are available in the form of mats, rolls, sprays, or paints. They help kill vibrations, rattles and overall dissipation of sound [24]. Mineral wool (Rock wool or Rock board) is used as sound insulation material. Most easy and cost effective technology to improve noise level in rooms these material are employed. Rock wool Safe N Sound is a great alternative for Rock board and is a high-performance soundproofing insulation material for walls and ceiling [25]. Noise proofing a floor can be done by Roberts Super Felt Underlayment. These are available with laminates, hard woods, or engineered wood. These are made of recycled fibres, compressed and heat treated to form a rich sound absorbing material [26]. Sound Dampening Spray (DEI Boom Mat), Sound Deadening Paint (Acoustical Paint), Sound Decoupling Products like Noise proofing Compound (Green Glue), Resilient Channel, Sound Proof Dry Wall and Sound Proof Windows are all belong to soundproofing materials.

### **ACOUSTICAL MATERIALS FOR ARCHITECTURAL WORKS**

According to the available literatures it is learnt that the modern scientific method of architectural acoustic application done by Wallace Sabine in the Fogy Museum lecture room and later on he applied the same technology to design to decorate the Symphony Hall, Boston. The fundamental approach behind the installation of acoustical technique is to achieve good speech intelligibility in a theatre, restaurant, or railway station as well as in a concert hall or recording studio or sometimes to reduce the sound level in offices and homes to maintain a pleasant environment in the work culture.

According to the author [1], in any covered place the noise paths are through roofs, gabs, walls, windows, doors, and other penetrations. The solution of the soundproofing depends on the source of noise generation and the movement path of acoustic transmission. For residential buildings, appropriate part walls are used to minimize the noise by the residents in adjacent apartments. In any concert or recital hall in order to have good coverage of sound it is suitable to install reflective surfaces in angular and coordinated manner. Sometimes to provide good noise absorption by walls, pre-fabricate panels are laid on a wall. The methods proposed by ABCD are also applied to improve work place acoustic problems to improve the situation. There are four standard methods in ABCD technique, which are namely Absorb, Block, Cover-up and Diffuse sound by any of the above techniques.

Acoustic designs related to architectural patterns are basically concerned with three elements such as absorption, reflection and diffusion. A good number of solutions are available in the market related to the sound proofing of buildings, apartment complex and homes. The available materials with different specifications are related to installation of floating doors, sketches of acoustic windows, location and sizes of speakers, room finish options, size and location of ducts, position of heating and cooling vents as suggested [12].

It is important to consider the actual problem (s) related to sound beforehand any solution is asked for the same. In this respect the acoustical problem for sound to carry clearly and without distortion must have to be understood. The first problem is the sound dampening quality of furniture and the second one is related to too much noise reflection. In the study areas like class rooms, libraries, and other study environments, to control internal and external noise in the form of transferring

from one place to another is very important. In this respect one solution is to install sound dampening extender panels can be placed to avoid the problems. In the office buildings, doctors' chambers and hospitals, to prevent the disturbances over the confidential discussions it is recommended to use insulation methods where some of the rooms or all the rooms can be made sound proof. Floor underlayment can be used for the purpose of soundproofing of a floor or floor joining isolators can also be installed. Walls, doors and windows can be made soundproofing using soundproofing insulation materials. Fabric-wrapped panels with a customized image can also be used as interior decoration material for renovations and redesigning of sound-dampening purposes.

VTT products are manufactures mostly from textile materials. Fibrous glass wool is applicable to indoor acoustic ceiling panel and industrial halls [9]. Fibrous structure polyester nonwoven materials are used for office acoustical decoration. For the purpose of solving automotive acoustic problems fibrous textile shoddy materials are used. For the purpose of appliances and machinery applications, cellular open cells polyurethane foam is mostly recommended. Glass wool is installed with the support of laminating materials. Perforated boards or fabrics are used in between polyester nonwoven materials. Laminating materials are used to support for both from textile shoddy nonwoven and polyurethane foam.

### **ACOUSTICAL TEXTILES**

When people get disturbed by the sound problems from their available space, usually they select some finishes to avoid the problems. According to the experts views it is a wrong approach for the correct solution. In the cases of critical situations related to acoustic problems, sometimes using textile products may not provide the relief. It is to be considered that using any textile material the purpose

is not to absorb the sound only, but the fabric when is backed by sound absorbing materials gives the right approach for acoustic problems to be sorted out. As per the available report NRC (Noise Reduction Coefficient), method is widely used for industrial problems for acoustic performance [2]. When NRC number is greater, the sound absorbing is better in acoustic sensitive system.

Acoustic fabrics produced by BAUMANN having 90 fabrics in 2000 colours, which are qualitatively versatile fabrics. They are balanced fabrics both acoustically as well as aesthetically. These are standard fabrics and maintain the quality standards of ISO/FN 354, ISO 11654 and DIN EN 29053. The fabrics are in various types like Alpha acoustic, Beta acoustic, Delta acoustic, Gamma acoustic and Zeta acoustic and many more [4]. They produce opaque acoustic fabrics and printed fabrics also. The absorption values of acoustic fabrics are measurable also. Opaque acoustic fabrics are very effective to use at windows as well as in partitioning screens. According to the recommendations of the experts, sound absorption depends on the size, shape and use of a room when fabric acoustics are used.

Acoustic panels are a good solution for providing technical solution but are not aesthetically so. It is recommended that designers need beautiful textile products which are acoustically transparent to allow sound to pass through to the functional core. These products are FR proved, stable and are approved by third party assessors [5]. The panels are composed of yarns which are stable and hydrophobic in nature. In acoustical panels, the panels themselves do the job but not the fabrics. Fabrics for the acoustic panels are supposed to have NRC of 1. The purpose of the textile fabric in the panels is to look great and allow sound to pass through to the acoustical substrates. The textile materials should be acoustically

transparent and the finished panel should achieve an NRC rating in the range of 0.90 and 1.05.

The acoustical properties of different materials like coated, sprayed or embedded with and fillers have been studied by the authors [3]. Nano-materials were having been tried for acoustical applications for low and medium frequency levels. Research was also carried out on the recent trends in hybrid acoustic absorbers, where property of the acoustic behaviours was used in controlled manner.

Presently, in acoustic insulation are made from various forms of textile materials like fibrous mats, needle punched nonwoven and polymer composites made of nonwoven. The work done by the authors [11], focus on the manufacturing techniques used to produce different acoustic insulation from textile materials. Textile materials are normally found in the form of dense as well as porous structures and they reflect sound waves rather than absorbing. Similarly many porous structures tend to absorb sound waves by dissipating energy passing through their tortuous paths.

Various parameters of nonwoven materials have been studied to observe their influence on sound absorption properties due to the fibrous structures of the materials. These parameters are related to fibre size, fibre surface area, air flow resistance, porosity, tortuosity, thickness, density, compression, surface treatment, placement of the absorbing materials. The application of nonwoven as acoustic textiles in automobiles have been discussed in details [6]. Acoustic properties are in-built characteristics of acoustical textiles and the materials are to be scientifically engineered to make them sound absorbing materials. They are by nature categories into two classes, like rigid sound absorber and compact porous



screen. Fibre glass or mineral wool balls or blankets and needle punched, resins or thermally bonded fibrous textiles are all belong to rigid porous absorber class. Thin light weight acoustic textiles, such as INC Engineered materials Deci-Tex range are regarded as flexible porous screens [13].

Porous materials have the inherent character to allow sound through it, where as acoustic porous materials can have porosity more than 90%. Absorption of sound by any material is a process of energy conversion, because when the kinetic energy of sound strikes the cells of fibres it is converted into heat energy. As a result of which, the sound disappears after striking the material due to conversion into heat [14]. When any change in the flow direction takes place of sound waves, together with the expansion and contraction of flow through irregular pores, a loss of momentum occurs. Again, due to excitement of the sound molecules air in the pores undergo periodic compression and relaxation, it causes change in the temperature. Due the phenomenal changes at low and high frequencies, the isothermal and adiabatic processes the heat exchange results in loss of sound energy. In fibrous materials, the loss is high and due to this reason textile materials are used as sound absorbers. For presence of more fibrous materials the absorption is better and for denser materials the absorption is lesser.

For any noise control, fibrous materials or porous foam medium are used. Glass, Rockwool or Polyester fibres are used as high acoustic absorption materials, as they are fibrous media. Barrier materials and absorptive materials are used in conjunction with one another as the porous nature of the absorptive materials permit some noise to pass through remaining unaffected. This is because when any backed barrier is employed it reduces the energy in a sound wave by converting mechanical motion of air particles into low-grade heat [15].

The growth of automotive materials in the world shows that it is due to the textile materials like nonwovens as well as for woven materials. As per the report of the Association of the Nonwoven Fabrics Industry, spun bonded needle punched and hydro-entangled/resin treated structures are widely used. The various areas in the cars where textiles are used for the purpose of enhancing comfort, thermal insulation, design, vehicle safety and many more often for acoustic covering [16].

The earliest use of nonwovens in the cars is the sound dampening purpose. But the modern cars are much quieter by their in-built nature. It is known to us that there are various types of nonwovens which are more sophisticated than old padding and are presently used as sound dampening. Textile composites are used in the cars, because they have certain advantageous. Acoustic protection is presently recognised as a major contributor to vehicle comfort, which comes in the form of fittings in the interior decoration systems [17].

## CONCLUSIONS

Sound travels mechanically through a medium and requires disturbing sound to be discarded and pleasant sounds to be accepted. Apart from the modified and developed textiles materials, textiles agglomerates can be used as sound proofing materials to reduce impact of sound in public housings. After a careful study and observations, the perfect soundproofing materials can be selected from the lists of materials available in the markets. ABCD's rule may be applied to improve work place acoustics for sound problems. Control of sound at different work places is to be done by adopting scientific techniques and selecting the required sound proof material. Apart from the textile products, acoustic foams may be used as sound proof materials. Correct method for rating the sound absorbing products are to be done accurately by the available techniques. Acoustic fabrics of

different types and with various color combinations are available in the market, which are based on their functional and aesthetic properties. Designers must select from the major products available, keeping in mind the acoustically transparent character of the materials. Hybrid acoustic absorbing materials are also in process of development. Considering the effect of sound on ill health, researchers are looking for the development of non-conventional approaches and materials to reduce noise pollution. Use of nonwovens as insulation in automobiles has wide spread applications in various forms in different areas of the cars.

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