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An Investigation Into the Use of Neoprene (A Red Listed Material) For Soundproofing

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An Investigation Into the Use of Neoprene (A Red Listed Material) for Soundproofing

APSC 261: Impacts of Technology on Society

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ABSTRACT

Sound is an inherent part of the world today. Some forms of sounds are pleasant to the ears while some are disturbing. Most people like to enjoy a quiet and peaceful atmosphere in their offices or classrooms (without disturbances caused by the transmission of unwanted noises from other rooms). One way to accomplish this peacefulness and avoid disturbances is to soundproof the rooms. One of the materials used for soundproofing is neoprene.

Neoprene is a type of synthetic rubber that has been used for a variety of purposes. Its many properties (such as its ability to withstand weather, sun, ozone and contact with oil and several other chemicals, to name a few) make it a very useful material. Despite its usefulness though, neoprene has some negative effects, due to which it has been declared a red-listed material. One of the main problems is that over time it gives off toxic gases that are dangerous to human health and the environment. However, several alternatives exist that can be used in place of neoprene for the purpose of soundproofing. Choosing the most appropriate material for soundproofing requires that the social, economic and environmental aspects of each material be investigated. It is also important to consider the practicality of each of these materials. Ensuring that soundproofing a room will be effective in reducing noise level and thus disturbances to others is also an important step.

Neoprene is an ideal choice of material for soundproofing due to its several properties. It is also an economically viable option. However, it has quite severe negative impacts on society. Other alternatives such as MLV, Green Glue and Natural cotton fibre are potential options. However, MLV is more expensive than neoprene and is harder to recycle. Thus it is not a very good option for replacing neoprene. Natural cotton fibre and green glue are cheaper and more environmentally friendly options. Natural cotton fibre is slightly less efficient than green glue, so a possible option would be to use some combination of these materials to attain the correct balance between efficiency, costs and environmental safety.

This report aims to inform readers of the various aspects of soundproofing and of the social, economic and environmental aspects of neoprene and some of its alternatives.

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GLOSSARY

Cavity absorber: absorbers that act to absorb a narrow frequency range of sound (usually in the mid-frequency range). They include perforated materials or materials that have holes and slots in them

Membrane absorber: non-rigid, non-porous materials placed over open air spaces and allowed to vibrate flexibly in response to movements of air particles

Porous absorber: materials that have interconnected pores in them that force air movements and fluctuations into the material. The resulting friction causes the sound energy to be dissipated as heat instead

Reverberation: repetition of a loud sound as an echo

Sound intensity: Sound power (the energy of sound from a sound source per unit time) per unit area

Sound Power level: logarithmic scale used to express sound power

Sound pressure: force of sound on a surface area perpendicular to the direction of travel of the sound wave

Soundproofing: the act of making a room resistant to the passage of sound to or from the room

Thermal Degregation: Degrading over time at high temperatures or with the help of added heat.

Viscous-Elastic Compound: A solid or a liquid material that has both elastic and viscous properties when being deformed.

Volatile: An inhaled substance that can cause harm to the body or otherwise have an intoxicating effect.

1.0 INTRODUCTION

Soundproofing is a method that was devised to limit or eliminate the amount of noise (i.e. unwanted disturbances) transmitted from one room to another. An important material used for soundproofing is neoprene. Neoprene is a synthetic rubber and has several useful properties such as its ability to withstand weather, sun, exposure to ozone and other chemical substances. These properties make neoprene a particularly useful material that can be used for several different purposes. When choosing the absorber material for soundproofing, social, economic and environmental aspects need to be considered.

This report aims to present to the audience information on all three of the above-mentioned aspects (social, environmental and economic) of neoprene and some of its alternatives. Neoprene has been declared a red-listed material and so builders are trying to avoid the use of neoprene. The main reason for this is the fact that neoprene gives off toxic gases over time, which is harmful for human health. Thus alternatives for neoprene are becoming increasingly important and necessary. This report presents important factors that need to be considered before soundproofing a room and gives suggestions as to how the alternatives can be used instead of neoprene.

Most of the information has been obtained from library and Internet sources. The use of neoprene for soundproofing is quite a vast and extensive topic. This report provides a brief overview of the triple bottom analysis of the use of neoprene for soundproofing.

2.0 SOUND AND SOUNDPROOFING

2.1 SOUND

Sound is caused as a result of vibrations in the air. These vibrations cause pressure fluctuations, through the compression and expansion of air, which in turn allows us to hear the sound. Sound waves are spread or propagated by air molecules compressing or expanding in an effort to regain their equilibrium state and in the process cause adjacent air molecules to expand or compress, respectively. There are two mechanisms for generating sounds. Any surface that moves disturbs the air around it and generates sound waves. Stopping or changing the direction of moving air, changing the way air or gases are moving or sudden expansion of gases can also generate sound. The two main physical characteristics of sound are the amplitude, which is an indication of the loudness of a sound and the frequency, which corresponds to the pitch of a sound. Two quantities associated with the amplitude of a sound are sound pressure and sound power. The ear responds to sound pressure, measure in Pascals (Pa). Sound power is a property of the source of the sound. Sound pressure, on the other hand, is dependent on the surroundings and is what is heard and measured. These two quantities are related by the fact that sound power is proportional to sound pressure squared. Sound power levels (units of decibels, dB) are defined using a logarithmic scale and a sound power of 1 watt corresponds to a sound power level of 120 dB [1].

Noise has different impacts on different people. Noise is referred to as ‘un-wanted’ sounds. There are many different types of noise, ranging from those that are slightly disturbing to those that are dangerous to health. In the modern world, several buildings are constructed either as multiple-unit housing or as buildings with a variety of rooms for various purposes (such as our new SUB), possibly including offices, lounge areas, party rooms etc [1]. Noise generated in one room may cause disturbances to people in other nearby rooms.

2.2 WHY SOUNDPROOF

Sounds behave differently in different rooms depending on various factors such as the degree of acoustic absorption of the room, whether the room is carpeted or not, the walls of the room, size of the room etc. Sound propagation from a point source follows the inverse square

law (illustrated in figure 1). The greater the distance from the sound source, the lower the sound intensity. In terms of decibels, the relationship is that for every 10m distance away from the source, the sound pressure level is 6dB less [1].

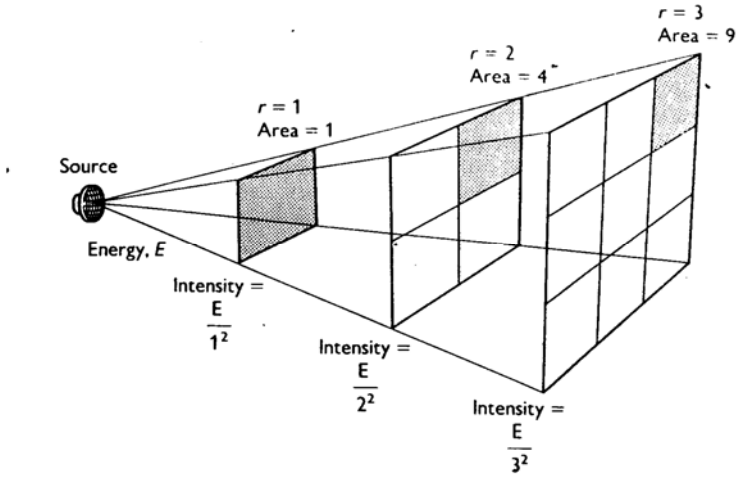

Figure 1 – Inverse Square Law [2]
Dr. A.L.S Chan, "Transmission of sound in open space". [Online], (2008 August), [2010 November 10], Available at HTTP: http://personal.cityu.edu.hk/~bsapplec/transmis1.htm

When sound strikes a boundary, some of the sound energy is transmitted to the other side of the boundary, some is absorbed by the boundary and some is reflected off the boundary, as shown in figure 2.

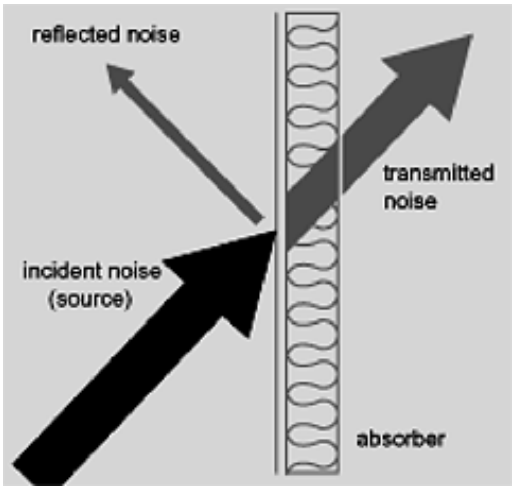

Figure 2 – Sound Absorption, Reflection and Transmission [3]
"Understanding Noise Control Product Types". [Online], (2010), [2010 November 2], Available at HTTP: http://www.industrialnoisecontrol.com/noise-control-products.htm

It is important to ensure that loud noises from one room not be able to get through to other rooms, as this could cause great disturbances for people. One way of dealing with this is to control the noise in a room and make rooms soundproof so that sounds from the room are not able to escape into other rooms. An important consideration for the soundproofing of rooms is to find good sound absorbers. The main function of an absorber is to reduce the amount of sound that is reflected, as shown in figure 3.

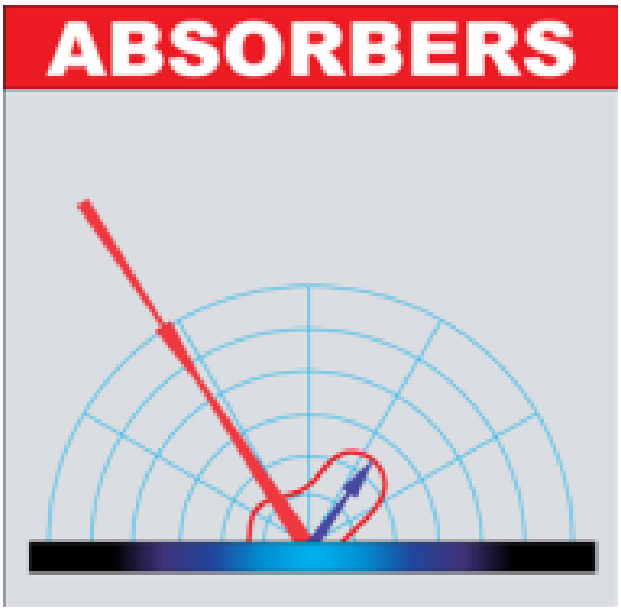

Figure 3 – Function of Absorbers [4]

"Acoustics First® Product Overview", [Online], (2010), [2010 November 4], Available at HTTP: http://www.acousticsfirst.com/acoustics-first-products-overview.htm

Absorbers are mainly of three distinct types, namely the porous or dissipative absorbers, the membrane absorbers (panel absorbers) and the cavity absorber (resonators) [5]. Each of these uses different methods to absorb the sound energy by converting it to heat. Neoprene is an example of the porous absorber.

3.0 NEOPRENE

Neoprene, also known as polychloroprene, is a type of synthetic rubber (shown in figure 4), which has been used for various purposes for several years now. The original function of neoprene was to serve as an oil-resistant substitute for natural rubber [6].

Figure 4 – Rolls of Neoprene [7]
"Dongguan Tongtianxia Rubber Co., Ltd - SBR (Neoprene) Roll (SBR-02)". [Online], (2010), [2010 November 5], Available at HTTP: http://ttxrubber.en.made-in-china.com/product/EqexjiMVnRcC/China-SBR-Neoprene-Roll-SBR-02-.html

3.1 PROPERTIES OF NEOPRENE

Since then, Neoprene has become quite a versatile material, as a result of the unique properties it has [6]. Some of the useful properties of neoprene include:

- Resistance to degradation from the sun, ozone and weather
- Ability to perform well in contact with oil and several other chemicals
- Ability to remain useful over a wide temperature range
- Excellent physical toughness
- Resists burning more than solely hydrocarbon rubbers
- Resistance to damage caused by twisting and flexing

One of the main uses of neoprene is in wetsuits. Others include the use of neoprene in laptop sleeves and water bottle sleeves etc. The use of neoprene that this report considers is the use of neoprene for soundproofing. Neoprene is a porous material and thus, as mentioned above, can act as a porous absorber of sound.

3.2 NEOPRENE FOR SOUNDPROOFING

Porous absorbers allow air movement into the fabric of the material. The sound energy is dissipated as heat, as a result of the friction between the air particles and the narrow airways of the material. For this to work, the pores of the material have to be interconnected. If the porous material is contained in a non-porous material, the absorptive effect is reduced, but not eliminated. Increasing the thickness of the outer cover decreases the capacity of the porous material within it to absorb sounds. These materials are most efficient at absorbing sounds at high frequencies, but are poorer absorbers at lower frequencies. The frequency at which absorption begins depends on the thickness of the absorber and also on the wavelength of the sound wave compared to the thickness of the absorber. Very thick porous materials can absorb low frequencies; however this is not always a practical option. Design targets for soundproofing focus on three main things – permissible background noise levels, optimum reverberation times and permissible levels of structural vibrations. This provides guidelines for the design of a room and the selection of furnishings for it etc.

One of the main problems with neoprene is that it gives off toxic gases including formaldehyde, lead, chlorine, hydrochloric acid and toluene. People who are sensitive to these chemicals have some kind of skin or allergic reaction to neoprene. This off gassing makes neoprene a dangerous material to use. Hence the use of neoprene for soundproofing has several social and economic implications [8] and so it has been declared a red-listed material.

4.0 TRIPLE BOTTOM LINE ANALYSIS

The triple bottom line is the economic, environmental and social aspects of the sustainability of neoprene. We look at how good it is for the use of the material, how cost effective it is, how well it is recyclable or reused as well as the harmful effects that neoprene can have.

4.1 ECONOMIC

The economic impacts of the various decisions we make have become increasingly important in the world today. One of the main things to consider is the cost of soundproofing a particular room. This would depend on the size and shape of the room and the kind of soundproofing material being used. The aim, as in most construction tasks, is to accomplish the final task, but to minimize the costs as much as possible. When soundproofing a room, one would have to attach the absorber to the walls of the room, the floors and perhaps even the ceilings. One way to minimize the overall costs is to choose the most economic and effective option of *material* for soundproofing. In other words, the material chosen should demonstrate effectiveness in blocking the sound but also be economically feasible for the project. Neoprene can be obtained at US$ 1.71 per foot, at a thickness of 1/16 inches. The cost increases with increasing thickness [9].

Another option is to choose the most efficient and cost effective *method* of soundproofing the room. Some additional steps can be taken, other than adding the absorber to the walls of the room, to help reduce the level of sound generated within the room, or entering the room. The two main application methods used for soundproofing are laying large sheets across a surface (i.e. complete flooring) or underlayment, which covers less surface area. For the first method, thinner sheets of neoprene would be sufficient, but larger areas would be needed to cover an entire surface. For the second method though, the neoprene sheets would be covering less area and so the sheets would need to be thicker to account for the smaller amount of area that they cover. The thickness of material needed would also depend on the level of sound that is to be blocked or absorbed [9].

Another important consideration is maintenance costs. This looks at how often the sound absorbing material would have to be changed or replaced. One of the easiest ways of reducing this cost is to use materials that would incur low maintenance costs (i.e. materials that either do not have to be changed or replaced very often or materials that can be changed or replaced easily at low costs). Thus, neoprene is a very good option for soundproofing because it has good resistance and is resistant to both oil and ozone as well as to weather and the sun. This resistance to damage along with many of its other properties makes neoprene a good option as a soundproofing material. Some of the alternatives available are discussed further on in this report.

One other thing to be considered when soundproofing a building is the practicality of soundproofing for each room. In addition to this, it would be useful to consider and evaluate whether each room in a particular building needs to be soundproofed. If loud sounds/noises are expected from a particular room (based on the purposes of the room and what it may be used for), it would be useful to soundproof those rooms. However soundproofing rooms, which do not generate loud sounds, would be a waste. Some additional steps can be taken, other than adding the absorber to the walls of the room, to help reduce the level of sound generated within the room, or entering the room. Some furniture items absorb some of the sounds produced within a room. Using items such as couches, heavy drapes and upholstered furniture is also an effective way of reducing the level of noise generated in the room of interest. Spacing between various furniture items can also play a role in lowering sound pressure levels. Carpeting the floors of a room can also be quite effective in soundproofing. All of these reduce the final level of sound that needs to be blocked or absorbed. This in turn reduces the amount/thickness of the sound absorber material that needs to be used, further decreasing the costs of soundproofing.

4.2 ENVIRONMENTAL

The environmental impacts of Neoprene are that it produces volatile products over its lifetime from thermal degradation including hydrogen chloride which is a colorless gas and when comes in contact with water will form hydrochloric acid which is quite corrosive. Neoprene isn’t hazardous by itself but over time will degrade and can produce hazardous products. Neoprene can be recycled into a variety of products and is less wasteful and saves money [10]. Its properties of being water resistant, breathable and durable make it a useful product for wetsuits, boots and gloves but can sometimes be irritating to the skin.

4.3 SOCIAL

There are both advantages and disadvantages of using neoprene for soundproofing purposes. Since neoprene is a good absorber of sounds, it is quite efficient for soundproofing. Thus, it helps to prevent sounds from being transmitted from one room to another. Hence, the main benefits are identical to the advantages of soundproofing.

One of the main advantages of soundproofing is the peace and quiet it provides within the soundproofed room. This peacefulness is something most people like to enjoy at home or in offices. Soundproofing also allows a greater level of sounds to be produced within a soundproofed room without disturbing neighbors. These features are useful, especially in a building like the new Student Union Building (SUB), which will have rooms and areas that are used for a variety of different purposes. Soundproofing ensures privacy within a room and also ensures that the sounds generated within a room do not cause any kind of disturbance for others outside the room [11]

One of the biggest problems with using neoprene is that it gives off a very toxic gas, including formaldehyde, lead, chlorine, hydrochloric acid and toluene, which can be harmful to human health. People who are sensitive to these chemicals have some kind of skin or allergic reaction to neoprene. This off gassing makes neoprene a dangerous material to use. Hence the use of neoprene for soundproofing has several social implications [8]. So, before using neoprene, builders would have to investigate the harmful nature of neoprene and either find ways of eliminating this risk or find alternatives that can be used in place of the neoprene.

5.0 ALTERNATIVES TO NEOPRENE

There are many alternatives to using Neoprene for soundproofing which include Mass Loaded Vinyl (MLV), Green Glue or Natural Cotton Fiber. These materials include varieties in expense, availability, and recyclability.

5.1 MASS LOADED VINYL

MLV is a flexible heavy noise barrier used in flooring or walls to reduce airborne and impact noise (Figure 5). It is a very good soundproofing material but is heavy and more expensive than the alternatives at $1.13 per square foot [12]. MLV is available locally and can be found at Burnaby Insulation. MLV is not easily recyclable unlike Neoprene. It is tough and wear resistant and can be used along with other sound proofing materials.

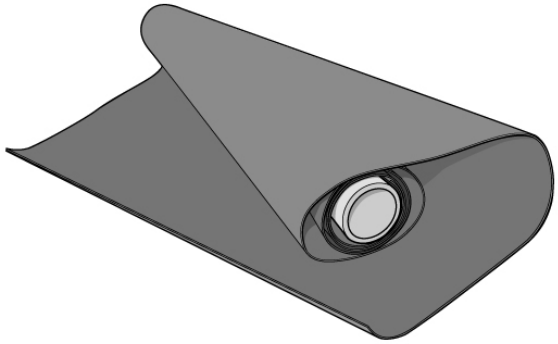

Figure 5 - MLV Floor Mat [12]
Bjnash, "Soundproofing Mass Loaded Vinyl barrier," Super soundproofing co [online], Febreary 22nd 2010, http://www.soundproofing.org/infopages/flooring.htm#.

5.2 GREEN GLUE

Green Glue is a water based viscous-elastic compound that dampens sound waves as they go through this material (Figure 6). It can be found in many different shapes and forms such as a compound, clips, sealant, and joist tape. I haven't been able to find it locally but it can be found at AcoustiGuard in Ontario for $0.50 per square foot [13]. Green Glue is water based and is more sustainable than MLV or Neoprene. Green Glue very efficiently changes the mechanical energy of the sound waves into heat and then dissipates.

Fig 6 Green Glue Compound Tube [13]
"Noiseproof Your Life", Green Glue Company [online], http://www.greengluecompany.com/ [retrieved 10 November 2010].

5.3 NATURAL COTTON FIBRE

Natural Cotton Fiber is a very green, sustainable material used in insulation and soundproofing (Figure 7). While it is not as efficient as the other alternatives, it is very environmentally friendly as it contains no chemical irritants and is made from natural fibers, 85% of which are post-industrial natural fibers. Natural Cotton Fiber can be found in California for $0.80 per square foot [10]. It is a very sustainable and recyclable material. Natural Cotton Fiber does not itch and is easy to install and work with.

Figure 7 - Natural Cotton Fiber [12]
Bjnash, "Soundproofing Mass Loaded Vinyl barrier," Super soundproofing co [online], Febreary 22nd 2010, http://www.soundproofing.org/infopages/flooring.htm#.

6.0 CONCLUSION

Neoprene is a rubbery material which acts as a barrier for sound waves that is used for soundproofing a room or a building. The material is a solid material with good properties such as being waterproof, durable and flexible. It is relatively cheap and can be recycled into other materials such as gloves, boots and wetsuits.

It is not a very safe material to have in hot temperatures. It is a material that degrades over time and produces volatile products such as hydrochloric acid which is harmful to people and the environment. To reduce the harmful effects of neoprene we suggest a few alternatives such as MLV, Green Glue, and Natural Cotton Fiber.

Any of these alternatives can be used for soundproofing or any combination of the three. Which alternative to be used is to be decided on the application of the SUB project. All three are sustainable, relatively cheap and can be used for soundproofing. We recommend using one or all three in substitute for neoprene.

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APPENDIX A: MEETING LOG

Sept 21st:

-Formed Groups and decided to do Red Listed Materials

Sept 24th:

-Colten emailed Andreanne and talked with other groups doing Red Listed Materials and we decided to do Neoprene and talk about alternatives.

Sept 28th:

-Decided who is doing each section of the body paragraphs. Neetha is doing the sound and neoprene as well as the social and economic aspects and Colten is doing the environmental aspect and alternatives to neoprene.

Oct 11th:

-Got together to plan our progress report.

Nov 2nd:

-Talked about how report is going and planned out our timeline and divided up the rest of the report between us. Neetha is doing the introduction and abstract and Colten is doing the conclusion and table of contents.

Nov 14th:

-Worked on the project presentations. We did a power point presentation each taking turns talking.

Nov 27th:

-Neetha did the title page and we got together to finish up the report.