

# APPLICATION OF ENHANCED EGG CARTON, GYPSUM BOARD & SOUND DIFFUSER FOR THE PURPOSE OF ACOUSTICAL TREATMENT: AN OVERVIEW

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**Abstract** - Noise will merely be delineated as unwanted Sound. Noise can affect in a good sleep and cause the disturbance in listening, and cause discomfort and other non-auditory effects. There are many ways to scale back this unwanted Sound. Now a day Egg cartons are very popular for the purpose of sound absorbers because they are very cheap, simple to put in and add to that they are simply available on the market. However, there's some experiment conducted to demonstrate the negative effects of Egg cartons as a sound absorption material. To beat it flaws Enhance Egg Cartons are used that accommodates textile waste and chopped rice straw paper. Apart from Egg Carton, Gypsum Board is a decent Sound riveting material that has comparatively positive impact for each Low and High Frequency. Aside from these two materials Sound diffuser is also becoming popular for Sound absorption and sound scattering. The aim of this paper is to point out that Enhanced Egg cartons and Gypsum Board can be used for acoustical treatment purpose in an enclosed space and Sound diffuser is extremely helpful to scale back echo and reverberation because it scattered sound waves. Previous Researches are being the overview in this paper to support the reason for using this material as good Noise reducing material and thus, this material will act as a useful and economical material in soundproof construction technique.

**Key Words:** Egg carton, low cost, textile material, rice straw, Gypsum Board, Wooden plywood, sound absorption, sound diffuser, Frequency, Reverberation.

## 1.INTRODUCTION

With the enhancement in Technology, our day to day life becomes quite easier, but this also led to some side-effects, such as pollution. Pollution can be understood as the sum of the components that impart a negative effect on our environment, and noise is considered as one of those components. Noise or more specifically noise pollution has become a major problem, as it can affect the activities of a large number of people. Medical studies show that Noise pollution can cause very harmful effects on human body it might increase the stress level and can also cause hypertension. A Medical study shows that if some is in high noise frequency range for longer period of time they may

temporally or permanently loss hearing. Apart from that noise can cause sleeping disturbance, tinnitus and other harmful effect on body.

To resolve this Noise pollution problem certain technique is being developed which are called as Noise controlling technique. Now, what is Noise Controlling? It is a set of technique to minimize noise by stopping or reducing noise form it source of origin, either by hindering sound to propagate using noise barriers or similar strategies, or by the use of ear protection from noise by using earmuffs or earplugs. For the purpose Noise Barriers, tons of materials are available, and egg cartons are considered to one cheapest of them. Egg cartons have long been considered by the general public to provide good sound insulation and absorption. They have three main positive points, which make them popular as acoustic material; they are inexpensive, easy to install and easily available. However, acoustics experts have shown that egg cartons are poor sound insulators and absorbers, backed up by laboratory tests, such as those done by Quintero Antonio. Thus, egg cartons should not be used if good acoustic quality rooms as expected.

The acoustic performance of egg cartons has long been questioned. In most studies, it is found that Egg cartons are neither good sound insulators nor good sound absorbers. The sound insulation property of egg cartons is very low, so it should not be considered a sound insulator at all. Apart from Egg Cartons Rock wool, glass wool and mineral wool are widely used to provide desired sound and thermal insulation inside the building. However, these materials can cause various health related issues such as lung diseases and skin irritations and usage of these materials are banned in many countries. This growing awareness of the environment and health led researchers and the industrialists to develop a new and alternative cost effective solution.

This environment and health conscious aspect draw researcher attention to the use of the Recycled material. The sound absorption property of waste and industrial byproducts had been studied by many researchers and some effective byproduct like tea residue, cassava residue, coir, rice straw and textile waste are coming up which give good

sound insulation. Again those individual is not a quite solution as they can't be used separately they need some other material combined with.

When these additional recycled materials are combined with Egg carton by Prasasto Satwiko, Verza Dillano Gharata, Herybert Setyabudi and Fefen Suhedi results are quite satisfied they. It can absorb more than 50% of sound energy from 315 to 2500 Hz or in the lower mid-range to upper mid-range frequencies. Thus, this enhanced egg carton has a potential to be used in sound insulation. This enhanced Egg carton is more economical than acoustical foams panels.

Gypsum Board is also an Environment-friendly acoustical solution as it can be recycled. Apart from that, they are faster to build and the sound insulation is achieved with lower surface weights. However, lightweight constructions have a major problem. They are very unsuitable for low frequencies (under 100Hz), due to mass-air-mass resonance, and some weakness for frequencies above 2500Hz. These low-frequency limitations could cause problems with common neighbor noises, like music or talk. But a research by Acc Warnock and Jd Quirt show that by adding one or more layers of gypsum board and by increase the depth of the cavity between wall face and gypsum board face its limitation for low frequency can be overcome.

The objective of this work is to summary the acoustic performance of Gypsum Board, Improved egg carton and sound diffuser as this diffuser are designed to scatter sound waves equally in all told direction, therefore reducing reverberation and echoes to boost sound clarity.

## 2. LITERATURE REVIEW

Various literatures are being studied throughout years to get an overview for the purpose of developing an economical and eco-friendly solution for Soundproofing construction technique. Material like egg cartons are considered among the cheapest and most eco-friendly solution but this material has been highly contradicting by many researchers and hence been proven by a researcher name QUINTERO RINCON ANTONIO [1]. On the other hand, there are few researchers like one shown by PRASASTO ATWIKO, VERZA DILLANO GHARATA, HERYBERT SETYABUDI and FEFEN SUHEDI that by little enhancing the egg cartons with recycling material they might be used as an acoustical solution [2].

QUINTERO RINCON ANTONIO along with his analysis paper titled by "Measurement of the sound-absorption coefficient on egg cartons using the Tone Burst Method" confirms that egg cartons perform terribly poor as a result of sound absorption is incredibly low and it's unwise to used it for the acoustic purpose in an inside area. On top of 2 KHz it performs well. Except for lower frequencies, it has poor absorption coefficient. It is necessary to indicate that the check has no significance below 1 KHz, however the

absorption measured at that frequency is unhealthy enough to disregard this material. Along with that, egg carton has negligible reflection properties; thereby it can't be use for acoustic treatment.

PRASASTO SATWIKO, VERZA DILLANO GHARATA, HERYBERT SETYABUDI and FEFEN SUHEDI with their research paper titled by "Enhancing egg cartons' sound absorption coefficient with recycled materials" conclude that the use of free or inexpensive recycled materials (shredded rice straw paper and textile waste) and adopting low technology, common Indonesian egg cartons can be enhanced to become sound absorbers with an NRC of 0.6 and SAA of 0.59. The EEC-D absorbs more than 50% of sound energy from 315 to 2500 Hz or in the lower mid-range to upper mid-range frequencies. Although the study result is not as good as was expected at the beginning of the research (i.e. finding an acoustic material which was better than manufactured sound absorbers), the resulting **EEC-D** (made by filling the egg carton with shredded rice straw paper (light brown color) and textile waste (various colors) in small net bags. The proportion of shredded rice straw paper and textile waste was 1:1.) Is a promising sound absorber to be used in situations where resources are limited and critical acoustic requirements are not mandated? EEC-D needs further development to compete with manufactured acoustic materials produced by sophisticated technology. The better performance of EEC-D in absorbing the sound energy of lower mid-range to upper mid-range frequencies than that of the other two manufactured acoustic materials means that it can be regarded as a replacement for those two materials, particularly where sound frequencies at those ranges need to be absorbed, such as in buildings where human voices are the main noise sources. Further research is needed to improve the EEC-D's sound absorption coefficients for frequencies below 500 Hz and above 1500 Hz. For EEC-D, that future research can be more focused on finding the proportion of shredded rice straw paper, textile waste, coconut fiber (coir) and rice straw-polyurethane composite. However, to make it practical, further research into the fire safety, endurance and aesthetics issues of EEC-D is needed. EEC-D is also particularly promising from a sustainable points of view, so further research involving life cycle analysis can be conducted to investigate various alternate materials.

Now Apart from this Egg Carton, there is a bunch of material used for Soundproofing construction technique like Gypsum Board, Fiberglass, Soundboard, and Acoustic Foam in which Gypsum Board is considered as the most eco-friendly material because it is made up of recycled material and can also be recycled after its use. There is various literature studied to get an overview of the acoustical property of Gypsum Board like one shown by J. S. BRADLEY[3] he focuses on the Sound Absorption property of Gypsum Board Cavity Walls and there is another research paper by A.C.C. WARNOCK and J.D. QUIRT[4] which demonstrated the key

factor responsible for Sound transmission through Gypsum Board wall and how to control it.

J. S. BRADLEY together with his analysis paper titled by "Sound Absorption of Gypsum Board Cavity Walls" shows sound riveting properties of assorted Gypsum board construction walls. He introduces a technique to search out the precise worth sound coefficient of absorption and fits this values in an exceedingly graph which measure absorption coefficient with respect to increasing frequencies. This Graph helps to see the physical science properties of assorted stratified Gypsum board at totally different frequencies. These tests additionally recommended that tiny gap might additionally facilitate in up coefficient of absorption at medium and better frequencies.

A.C.C. WARNOCK and J.D. QUIRT with their analysis paper titled by "Control of Sound Transmission through Gypsum Board Wall" conclude that to minimize sound transfer through gypsum board further one or a lot of layer of plasterboard on either side is to be put in. Increasing the depth of the cavity may also facilitate. Furthermore, if this cavity is crammed with the sound building material it will offer nice results.

Now with the advancement in soundproof construction technique researchers are wanting up to new and precise measures to beat echoes and reverberation in soundproofing space. There is a method recognize by a reputation Sound diffuser that helps to cut back echoes and reverberation as this Sound diffuser are designed in such a fashion that they scatter sound waves equally in all told direction, therefore reducing reverberation and echoes to enhance sound clarity. Several analysis studies and experiment are conducted to induce an outline for the usage of these sound diffusers to cut back noise. One of these experiments is done by J. PICAUT, H. HOSSAM ELDIEN, and A. BILLON [5].

J. PICAUT, H. HOSSAM ELDIEN, A. BILLON with their research paper titled by "An experimental study of the use of acoustic diffusers to reduce noise in urban areas" shows that the usage of sound diffusers on building helps to minimize the amplitude. Moreover, there's a big decrease in reverberation is additionally discovered, in each high and low-frequency vary. In addition to that, the diffusers become more effective when its area is increased. Therefor it will act as a really helpful material for acoustical treatment.

### 3. ACOUSTICAL TERM AND CONCEPT OF SOUND TRANSMISSION

#### 3.1 Transmission of Sound in Air

Sound in air is described as an acoustical energy which is originated from a source and transfer through the air in a form of vibration. These vibrations produce an instantaneous sound pressure fluctuation that is detected by

a receiver. The sound is characterized by 2 things one is frequency, that determines the pitch of the sound, and another by the intensity of the pressure fluctuations, that determines however the loudness of the sound.

The frequency is outlined as number of cycles per unit time. In term of sound, the frequency is outlined as the number of cycles of instantaneous sound pressure that occur in one-second. The S.I unit frequency is hertz (Hz), which is one cycle per second. Human beings hearing capacity lies between twenty Hz to twenty kHz sound on top of twenty KHz is that the ultrasound and below twenty Hz is infrasound. But, we humans have a tendency to hear best from sounds vary between five hundred Hz and four KHz. The intensity of sound, or loudness, is measured in decibels (dB).

#### 3.2 Transmission of Sound in material

When sounds travel from a solid object like walls, floor, they undulate through the molecules of these solid elements this sound transmission is referred as Mechanically Transmitted of sound.

Sound waves travel through all quite medium like in solid, liquid, or gas medium. The vibrations produce by pressure transfer through every of those mediums by travel through its molecules. The molecules in solids are packed terribly tightly as compared to liquid and gas thereby wave travel quicker in solids matter. That why once somebody drops the ball on the higher floor it's clearly hearable on the lower floor as compared to a lesson loud music in our neighbors.

#### 3.3 Sound Reflection

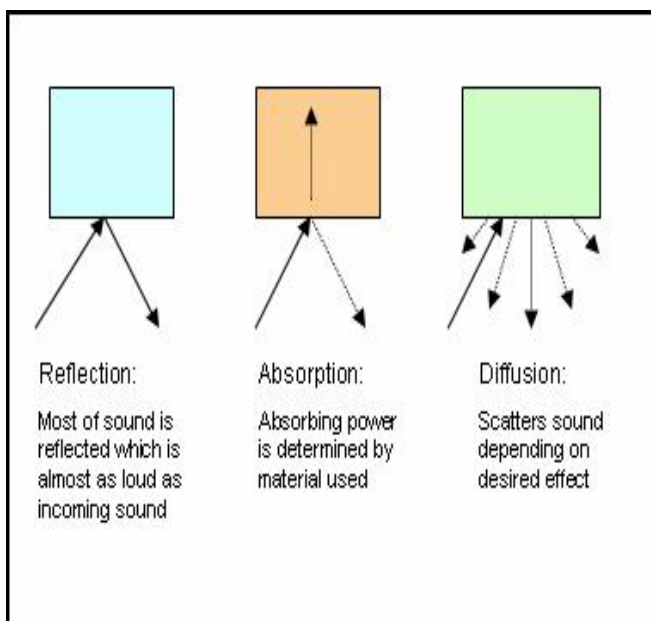
In sound reflectivity rather than the absorption of wave they're mirrored back once they touch the reflective surface. Materials like concrete, block, wood and metals, etc. These Reflective materials simply bounce them in exceedingly completely different directions.

#### 3.4 Sound Absorption

Sound Absorption may be a technique within which a number of the sound energy is reborn into heat in bit within the fascinating material, despite being transmission or reflection of sound. There are lots of ways within which sound may be absorbed by a material. The choice of sound fascinating material is determined on the behalf of its acoustical absorption profile in different frequency. Some of regularly used sound absorbing materials are rock wool, cellular melamine foam, fiberglass, open cell polyfoams, thick cloth wall coverings and heavy curtain blankets.

### 3.5 Sound diffuser

Sound diffuser works in an exceedingly principle within which sound wave are scatter equally all told direction in an exceedingly given atmosphere rather than being mirrored back. Diffusors (or diffusers) are used for the treatment unwanted sound issues in an exceedingly rooms like reverberation and echoes. They are considered as a good alternative or complement material to sound absorption because this sound diffuser do not reflect or remove sound energy, however they're designed to scatter or disperse sound waves rather than eliminating it, therefore they reducing echoes and reverberation to boost sound clarity.



### 3.6 Reverberation

Reverberation is defined as the prolongation of sound after a sound is produced. It is caused by the reflection of sound waves from exhausting surfaces and subsequently this mirrored sound waves starts decay that's the sound have gotten absorbed by the surfaces of objects within the house. Reverberation occurs naturally when someone tries to plays an instrument, or tries to sing or talk in a hall or performance space which has sound-reflective surfaces. Reverberation time is describe as the time needed by a sound signal to urge born up to sixty decibel. RT (60) is that the time needed for reflections of a direct sound to decay sixty decibel. This Reverberation time is calculated by a formula given by Harvard physics academician named Wallace Clement Sabineis.

$$RT(60) = \frac{0.05V}{(\Sigma S\alpha)}$$

Where:

“RT (60) = reverberation time (sec)

V = Room volume (ft<sup>3</sup>)

S = Surface area (ft<sup>2</sup>)

a = absorption coefficient of material(s) at given frequency

S indicates the summation of S times”

### 3.7 Sound Transmission Class

The Sound Transmission Class (STC) is a mechanism design to determine the efficiency of a material or construction assembly to hold back sound transmission. It is described as the minimization of sound in ceiling and wall. STC helps to tell a listener regarding what proportion loud transmitted sound is being listened on the opposite facet of a wall or ceiling. Material with higher STC values is more effective at reducing sound transmission. This technique is being employed by several architects, contractors, designers, distributors of acoustic building merchandise and makers of acoustic merchandise.

### 3. CONCLUSIONS

Environment-friendly materials created either naturally or by recycled materials have gotten common to scale back the carbon footprint. Egg carton and Gypsum board square are few of these eco-friendly materials that are mentioned here. The review during this paper covers different aspects of the acoustic performance of Gypsum board, improved egg carton, and sound diffuser. The hassle has been created to search out the key factors to blame for making noise in an indoor area and what's the answer to beat it. This paper provided a comprehensive survey of recent developments in economical and eco-friendly answer for Soundproofing construction technique. And support the explanations to use Enhance Egg carton and gypsum board as a brand new developing answer. Since not abundant work has been done concerning this material, therefore, it's powerfully suggested the need to develop a brand new and mix strategies victimization this material for soundproof construction technique.

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