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NOISE CONTROL CONFIGURATIONS USING SOUND-ABSORBING MATERIALS

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ABSTRACT

The objective of noise control is not to reduce noise for its own sake, but for the sake of the receiver, usually human ear. Acoustics is a new, fast growing but a challenging field in modern technology. In India, people are quite unaware of this field. Even the acousticians are using crude method to reduce the noise. The main objectives of this work are to Study the various materials available in market. Categorization of materials based on Noise Reduction Co-efficient, Sound Transmission Class and the Weighted Reduction Index. Develop a program, which will be helpful for the acousticians. The preliminary aim of this work is to ***"Design and develop various configurations and to combine the available acoustical materials and to suggest the best suited configuration for the system with the help of a program which can be used by an acoustical consultant".*** *Program has been developed using Visual Studio and Microsoft Access as front and back end tools respectively. The calculation of area and the estimation of cost for the acoustical materials are made simpler by using this program. One can get a clear idea of noise reduction that can be achieved using the chosen material in this program.*

Keywords: Noise, Noise Absorbing Materials, Noise Reduction Co-efficient, Sound Transmission Class, Weighted Reduction Index

I. INTRODUCTION

Simple definition of sound means a disturbance of energy that comes through matter as a wave, which human beings perceive, by the sense of hearing. Sound pressure is the effect and sound power (energy) is the cause. Sound has two faces one being the one used for recognition of any action or a collection of produced octaves used in entertainment. Sound of a horn, tweaks of doors, etc are a source of recognition where as the sweet music as a part of entertainment or recreation are sound produced referred to as symphonic sounds. However, the other face of sound is the one, which is not a desired sound, which is produced, propagated in a medium, but this unwanted sound needs attention to either attenuate, control, or eliminate so that the harmful effect of the same is minimized. This unwanted sound is referred as Noise.

Practically sound and noise are same except that noise is an unwanted sound. When any such source(s) produce a quantity whose magnitude is not good for the system where biological systems including human beings live, then the real effect caused by the same is termed as Pollution. Pollution is one of the major problems of the globe and there are pollutions of various forms. Each type of pollution is produced from various processes and interestingly their effect on our systems is of different kind.

Exposure to continuous noise of 85–90 dBA, particularly over a lifetime in industrial settings, can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity [1]. There is good evidence, largely from laboratory studies, that noise exposure impairs performance [2]. Many occupational studies have suggested that individuals chronically exposed to continuous noise at levels of at least 85 dB have higher blood pressure than those not exposed to noise [3]. Therefore, the effects of noise should be controlled. The absorbing materials are a passive medium use extensively in the industry to reduce noise [4].

Table 1: Permitted Noise Levels

Ambient Noise Levels dB Zone	Day-time	Night-time
Silent Zone	50	40
Residential Zone	55	45
Commercial Zone	65	55
Industrial Zone	70	70

1.1 Principles Behind Methods of Noise Control

There are four basic principles of noise control:

- Sound insulation: Prevent the transmission of noise by the introduction of a mass barrier. Common materials have high-density properties such as brick, concrete, metal etc.
- Sound absorption: A porous material, which acts as a ‘noise sponge’ by converting the sound energy into heat within the material. Common sound absorption materials include open cell foams and fiberglass
- Vibration damping: applicable for large vibrating surfaces. The damping mechanism works by extracting the vibration energy from the thin sheet and dissipating it as heat. A common material is sound deadened steel.
- Vibration isolation: prevents transmission of vibration energy from a source to a receiver by introducing a flexible element or a physical break. Common vibration isolators are springs, rubber mounts, cork etc.

1.2 Noise Reduction Coefficient

The noise reduction coefficient (commonly abbreviated NRC) is a scalar representation of the amount of sound energy absorbed upon striking a particular surface.

- An NRC of 0 indicates perfect reflection.
- An NRC of 1 indicates perfect absorption.

NRC generally applies to a single material such as on the surface of a wall, which determines the reverb, or liveliness of a room. NRC is an arithmetic value average of sound absorption coefficients at frequencies of 250, 500, 1000 and 2000 Hz indicating a material’s ability to absorb sound. NRC generally applies to a single material such as on the surface of a wall, which determines the reverb, or liveliness of a room

1.3 Sound Transmission Class

The sound transmission class (commonly abbreviated STC) is an integer rating of how well a building partition attenuates airborne sound. In the USA, it is widely used to rate interior partitions, ceilings/floors, doors, windows and exterior wall configurations. Building materials, especially interior finishes, through standard testing earn ratings of STC and NRC based on their sound characteristics.

1.4 Weighted Reduction Index

The ability of a material to absorb sound is assessed in the laboratory by taking measurements over a recognized range of frequencies. The average of these measurements is expressed as Rm or the Mean Sound Reduction Index. When adjusted for the ear's response to loudness it is termed Rw or Weighted Reduction Index and is expressed in dB or decibels. Decibel is a unit of measurement of the loudness or strength of a signal.

II. METHODOLOGY

The method adopted to carry out this work is to initially, identify the sound absorbing materials and their characteristics and classification, followed by designing suitable configuration for noise control with the objective of keeping the cost of execution of the proposed work. In the process of execution of work, efforts were also made to develop a computer-based program to help ion the process of calculation and execution of work. Few of the steps followed to execute the work have been provided below:

1. Generation of information pertaining to NOISE AND NOISE CONTROL
2. Comprehensive listing of materials for noise control
3. Grouping the materials based on Sound Transmission Class(STC), Noise Reduction Co-efficient(NRC) and Weighted Reduction Index(Rw)
4. Developing a program for the various combinations obtained

III. DEVELOPMENT OF A PROGRAM

The programming is done using Visual Basics as a frontend tool and Microsoft Access as a backend tool. The data stored in backend tool comprises of materials, which can be used in the following configurations:

1. Curtains
2. Doors
3. Windows
4. Walls/ Ceilings/ Room

3.1 Classification of Materials

The materials are classified based on the Sound Transmission Loss (STC), Noise Reduction Co-efficient (NRC) and Weighted Rate Index (Rw) as per the availability and requirement of the material.

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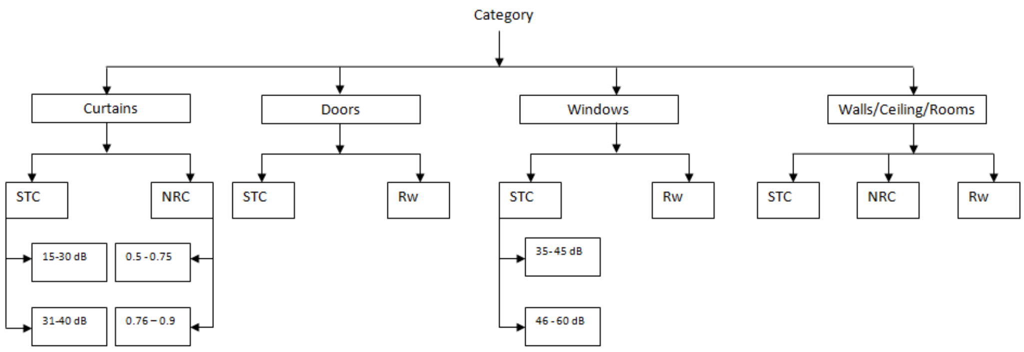
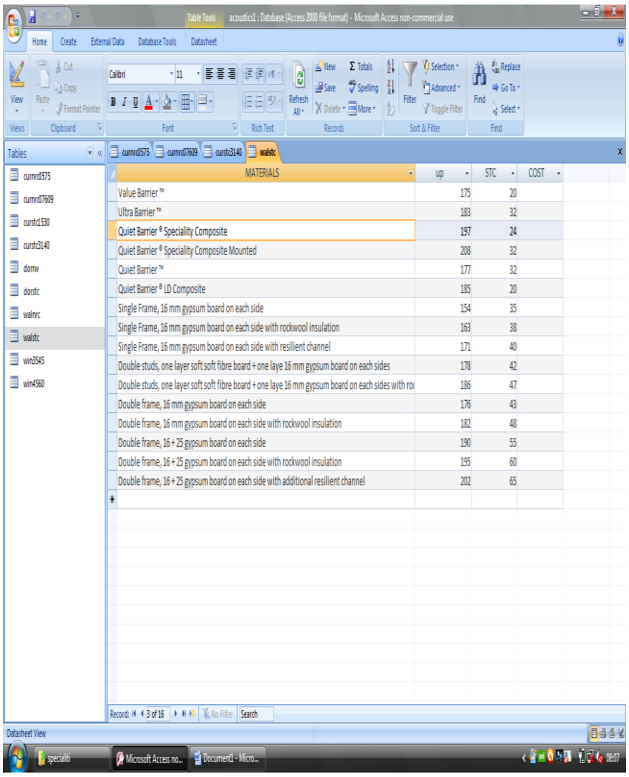


Figure 1: Categorization of the Program

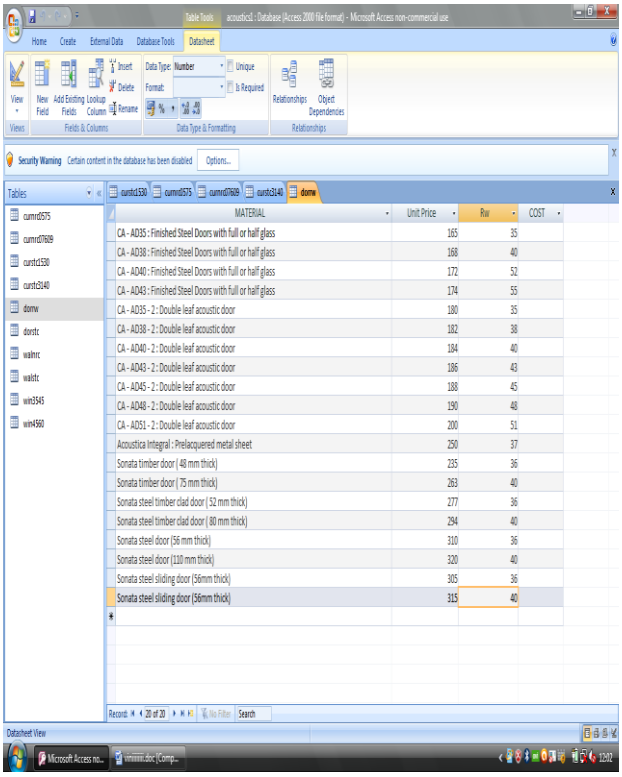
3.2 Data Storage

The database is stored in Microsoft Office Access. The samples of database are as shown in the following figures.



MATERIALS	up	STC	COST
Value Barrier ™	175	20	
Ultra Barrier ™	183	32	
Quiet Barrier ® Speciality Composite	197	24	
Quiet Barrier ® Speciality Composite Mounted	208	32	
Quiet Barrier ™	177	32	
Quiet Barrier ® LD Composite	185	20	
Single Frame, 16 mm gypsum board on each side	154	35	
Single Frame, 16 mm gypsum board on each side with rockwool insulation	163	38	
Single Frame, 16 mm gypsum board on each side with resilient channel	171	40	
Double studs, one layer soft soft fibre board + one laye 16 mm gypsum board on each sides	178	42	
Double studs, one layer soft soft fibre board + one laye 16 mm gypsum board on each sides with roc	186	47	
Double frame, 16 mm gypsum board on each side	176	43	
Double frame, 16 mm gypsum board on each side with rockwool insulation	182	48	
Double frame, 16 + 25 gypsum board on each side	190	55	
Double frame, 16 + 25 gypsum board on each side with rockwool insulation	195	60	
Double frame, 16 + 25 gypsum board on each side with additional resilient channel	202	65	

Figure 2: Snapshot of the Database of Materials which can be used for Doors



MATERIAL	Unit Price	Rw	COST
CA - AD35 : Finished Steel Doors with full or half glass	165	35	
CA - AD38 : Finished Steel Doors with full or half glass	168	40	
CA - AD40 : Finished Steel Doors with full or half glass	172	52	
CA - AD43 : Finished Steel Doors with full or half glass	174	55	
CA - AD35 - 2 : Double leaf acoustic door	180	35	
CA - AD38 - 2 : Double leaf acoustic door	182	38	
CA - AD40 - 2 : Double leaf acoustic door	184	40	
CA - AD43 - 2 : Double leaf acoustic door	186	43	
CA - AD45 - 2 : Double leaf acoustic door	188	45	
CA - AD48 - 2 : Double leaf acoustic door	190	48	
CA - AD51 - 2 : Double leaf acoustic door	200	51	
Acoustica Integral : Prelacquered metal sheet	250	37	
Sonata timber door (48 mm thick)	235	36	
Sonata timber door (75 mm thick)	263	40	
Sonata steel timber clad door (52 mm thick)	277	36	
Sonata steel timber clad door (80 mm thick)	294	40	
Sonata steel door (56 mm thick)	310	36	
Sonata steel door (110 mm thick)	320	40	
Sonata steel sliding door (56mm thick)	305	36	
Sonata steel sliding door (56mm thick)	315	40	

Figure 3: Snapshot of the Database of Materials which can be used for Walls

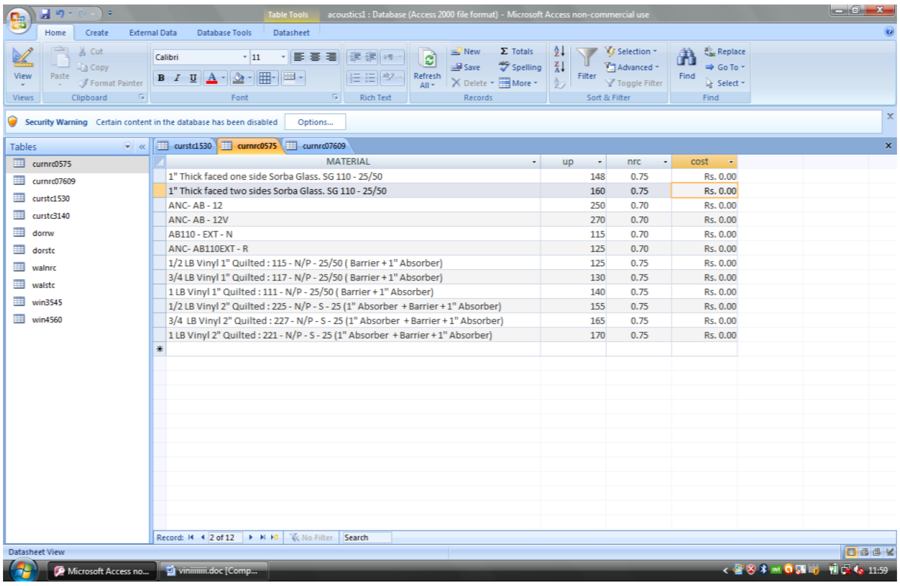


Figure 4:Snapshot of the Database of Materials which can be used for Curtains

3.3 Design of forms using Visual Studio

Visual Studio version 8.0 is used as a frontend tool, which means all the inputs, and outputs are retrieved using it. The customer can select the category, which is required by them by seeing the options available to them. The snapshots of the program are as shown below.

3.3.1 Main window

In this, the customer can choose the category of their choice like the materials, which can be used for curtain, door, and wall/ceiling or window configurations.

Figure 5: Snapshot of the Main Window of the Program

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3.3.2 About Us

Figure 6: Snapshot of the General Information about the Project

3.3.3 Curtains

Click curtains in the main window and the following screen will be displayed (Figure 7).

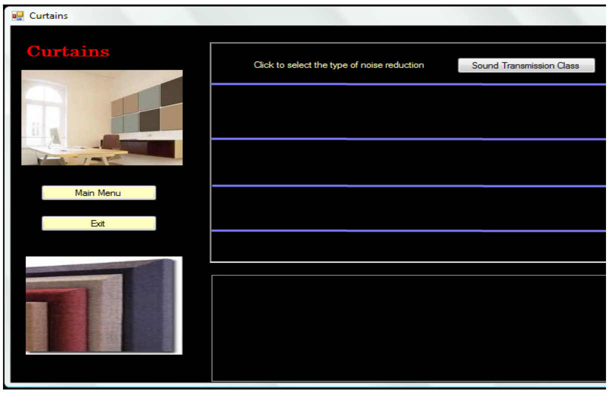


Figure 7: Snapshot of Curtain Design

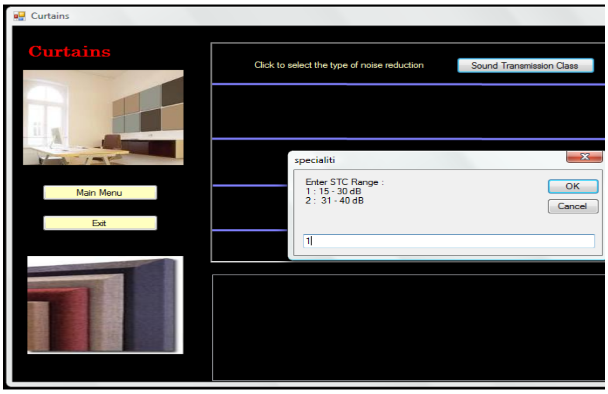


Figure 8: Snapshot of the Selection of type of Noise Reduction in the Program

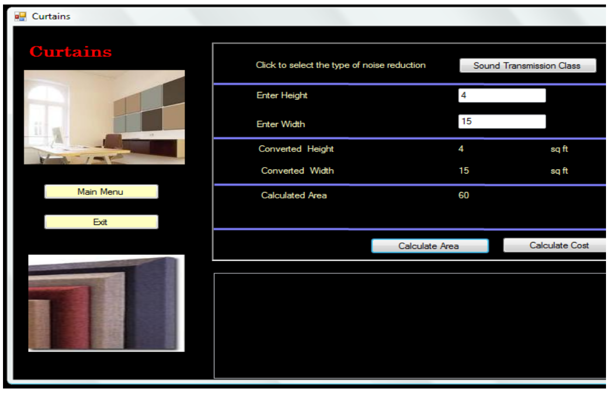


Figure 9: Snapshot of Calculation of Area in the Program

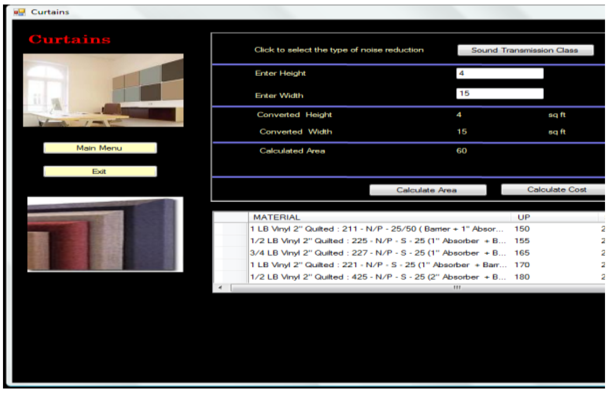


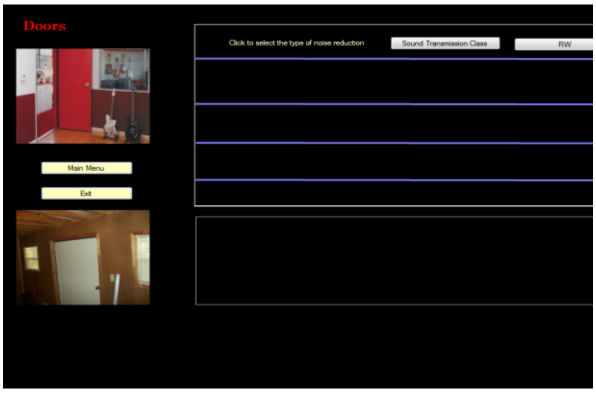
Figure 10: Snapshot of Calculation of cost and the Display of the Materials List

Select the type of noise reduction to be achieved: Sound Transmission Class / Noise Reduction Co-efficient. If you choose Sound Transmission Class, a screen will be displayed as shown in Figure 8. Enter the range as per the requirement. As soon as the range is entered, next screen (Figure 9) appears, wherein one has to enter the area in terms of height and width of the configuration. For the convenience of the user a provision to enter the area in terms of meters, inches and feet are provided. Whichever choice maybe, but the area is converted into square feet for the calculation of the cost of the material.

The table with materials and the cost of the materials for the entered area will be displayed as shown in Figure 10. One can choose the material available to them with the cost of the configuration.

3.3.4 Doors

Click Doors from main menu. The following screens will appear as shown in figure 11 and figure 12. The categorization of the doors is based on STC and Rw.



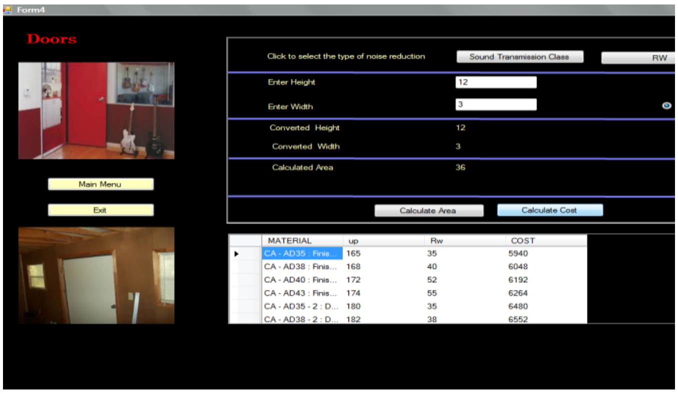


Figure 11: Snapshot of Door Design

Figure 12: Snapshot of Cost Calculation for the Door Materials respectively

4 Walls/ Ceilings:

Click Walls/Ceilings from main menu. The following screen appears. The categorization of the doors is based on STC, NRC and Rw.

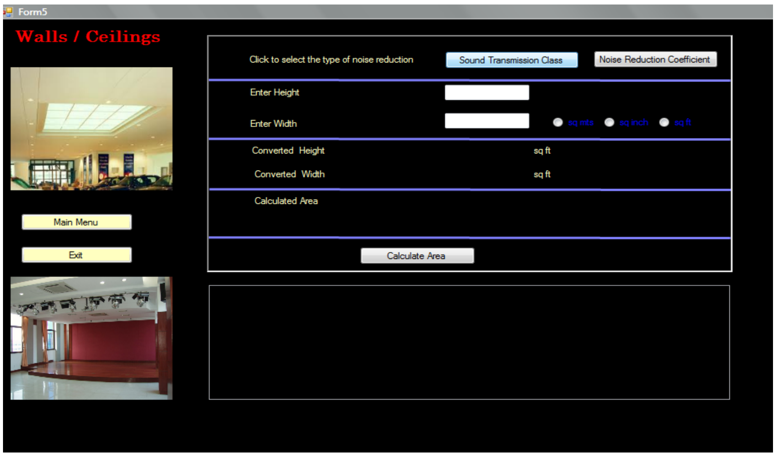


Figure 13: Snapshot of Walls / Ceiling Design

3.3.5 Windows:

Click Windows from main menu. The following screens appear. The categorization of the windows is based on STC alone

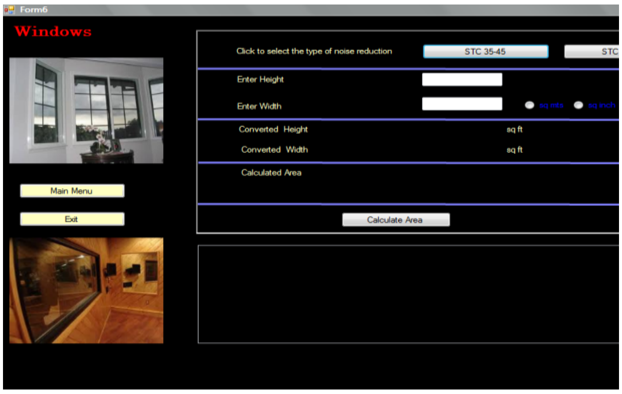


Figure 14: Snapshot of Window Design

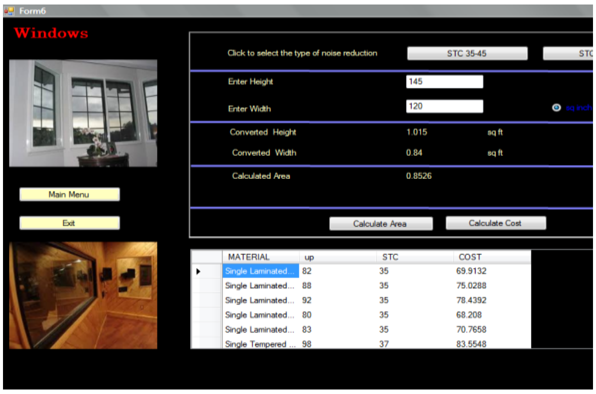


Figure 15: Snapshot of Display of Cost Estimate for Windows

IV. CALCULATION

The program contains only two simple calculations. The first is to convert the entered height and width into square meters. Customers are given an option to enter height and width in either inches or meters or feet. Irrespective of the entered value, area is converted into square feet in order to estimate the cost. The second calculation is nothing but the estimation of the cost to the area calculated. Both calculations include simple multiplication operation.

V. CONCLUSION

Present work has been executed with the objective of using as many sound absorbing materials as possible to arrive at the options of developing a comprehensive solution for noise problems. However, there are many more applications, which can also be considered for implementation. These are some of the opportunities for improving the work, which is already completed. They are listed below.

1. Computer Program can be appended with some more enhancements including description, configurations, design, products, cost, applications, etc.
2. Program can also be customized so that the materials to be used can be viewed by the customer.
3. Program can also be linked to other application software to get 2D models and 3D models including the drafting and assembly.
4. A knowledge base can be developed based on the experience of the professionals and few of the artificial intelligence models can be tried out for better implementation.
5. Annexure can be prepared with cost details and the configurations
6. More materials has to be studied and systematic categorization has to done using program
7. A separate program may also be generated to evaluate selection of materials and subsequent cost of designs with the intentions of using most appropriate materials for better acoustic properties and better Noise control

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