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Characterization of Noise Transmission and Abatement in Three Different Partitioning Materials

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ABSTRACT: *Noise transmission and abatement of any partitioning material is of concern in order to know the adverse effects any of the partitioning material could cause base on its noise transmission or abatement. This study assessed the noise transmission and abatement level of three different partitioning materials (i.e. cement-block, plywood and composite panel) using a transistor radio. A portable digital sound level meter HD 600 manufactured by Ex-tech Inc., USA was used to determine the noise transmission and abatement level in the prototype building erected with cement-block, plywood and composite panel. The result of the study shows that the maximum noise transmission of* 63.90 *dBA was recorded at building erected with plywood while the minimum noise transmission of 60.50 dBA was obtained from composite panel. In conclusion, noise transmitted using the different materials as partitioning is hazardous to human well being.*

Keywords: *Partitioning, Noise transmission, noise abatement, digital sound meter, prototype*

I. INTRODUCTION

Characterization between sound and noise also depends upon the habit and interest of the recipient receiving it. Presently, noise pollution is considered as one of the major challenges of urban cities that has numerous hazardous effects on the urban environment and may result in a great deal of costs on the society [1]. Institutional workplace and laboratory are noise generating media in which their sources include: student's loitering, student's discussion, fans, transistor radio etc. [2]. Human activities are the main sources of noise pollution [3]. Hence, the term Noise refers to a sound without agreeable musical quality, or as an unwanted or undesired sound. Noise is also a pollutant just like the toxic chemicals in the environment. The noise is becoming an increasingly widespread and serious source of discomfort and danger [4]. In an occupational setting, failure or inability to understand the spoken word can compromise worker safety, especially the safety of those in hazardous occupations. Hearing loss may also impair and constrain activities of daily life and personal enjoyment. Noise exposure in industry has been a considerable concern with respect to functional impairment arising from noise induced hearing loss (NIHL) and other physiological and psychological effects on exposed workers [5].

Material used in building partitioning plays a key role in noise transmission and abatement level contributes largely to the environmental pollution. While technological innovations have improved living standards of human beings they have at the same time created serious problems, especially the degradation of the environment. Efforts at containing the adverse effects of technology on human beings have been redoubled, especially in producing sustainable materials from erstwhile waste products that are biodegradable and renewable [6].

Chicken Feather Fibre (CFF) commonly regarded as a waste by-product has contributed to environmental pollution being a solid waste that presently of little demand for utilization. The two main chicken feather disposal methods that exist are burning and burying. Both methods have negative impact on the environment. Recent studies on the chicken feather waste demonstrated that the waste can be a potential composite reinforcement. The composite reinforcement application of the Chicken Feather Fibre offers effective solution to environmental challenges posed by chicken feathers than the traditional disposal methods [7][8][9][10]. Some of the advantages of the Chicken Feather Fibre as a raw material in producing composites are their being inexpensive, renewable, acceptable specific strength and bio-degradability. Because of its renewable characteristic, it has been appreciated as a new class of reinforcement for polymer-based bio-composites. Composites building materials containing Chicken Feather Material (CFM) have high level of suitability which could potentially absorb all of the chicken feathers produced yearly in the United States which eventually raised the market value [11].

According to [12], the CFF keratin bio-fibre was found to allow an even distribution within and adherence to polymers due to their hydro-phobic nature and low energy dissipation. The need to effectively contain the problems posed by the very large production of chicken feathers which are non-biodegradable has given rise to assorted uses such as for automotive parts, packaging materials, filters, insulators, household products and soil control materials [13]. Composites produced from fibres are known to possess desirable properties. These include high strength, low density, high resistance to water absorption and chemical degradation durability, electrical resistance, high thermal insulation, excellent acoustic, non-abrasive behaviour, corrosion resistance and excellent hydrophobic properties when used as composites reinforcement [7]. The properties, performances and cost effectiveness of composites from fibres make composite to be more useful in most applications [14][7][8][9][10].

A simple and practical way to incorporate poultry feathers into composite panels is to bind them with Portland cement. However, if this could be found feasible, it could offer an affordable new type of building materials with both economic and environmental advantages.

II. MATERIALS AND METHOD

The noise transmission levels were measured between 12 noon to 2 pm on 10th November – 10th December 2014. Noise measurements were done in Metrology Laboratory of Mechanical Engineering Department LAUTECH using a transistor radio as a source of noise. Sound transmission level tests were carried out on different partitioning materials which include cement block, composite panel (made of cement, sand and ground chicken feathers) and plywood to know the level at which sound is being transmitted or absorbed through the three different materials. Sound level of laboratory environment with added noise from transistor radio in a confined prototype room made of block, composite panel and plywood as shown in Plate 1-3 were determined with the sound pressure level meter in Plate 4.

A portable digital sound level metre HD 600 manufactured by Extech Inc. USA, set to the A-weighing scale was used to measure noise levels. The equipment meets Type 2 requirements of ANSI S1.4 and IEC 61672-1, has dimensions 278 x 76 x 50 mm which was powered by one 9V battery or by an AC power adaptor, and measures and displays Sound Pressure Level (SPL) from 30 dB (A) to130 dB (A) with $\pm$ 1.4 dB (A) accuracy in 3 measurement ranges and 0 to 40 ^{o}C and 10% to 90% relative humidity operating conditions.

The equipment was placed at least 0.8 m and 1.0 m above the ground and from the source of noise respectively. The metre was directed toward the nearby noisy source and was calibrated before the study started. At the end of experiments, data were downloaded to a personal computer with the help of utility software packed with the equipment; equivalent SPL and noise spectrum at each reading were obtained.

Measurements taken were:
Maximum sound pressure level (peak noise) – the noise with the maximum intensity (L_{max})
Minimum sound pressure level (baseline noise) – the noise with the minimum intensity (L_{min})
A – weighted equivalent continuous level ($L_{A\ eq}$) as expressed by [3] is given as:

$$L_{eq} = 10 \log \sum_{i=t}^{i=n} \left(10^{\frac{L_i}{10}}\right) (t_i) \qquad (1)$$

where,

n = the total number of samples taken
L_i = the noise level in dB (A) of the ith sample
t_i = fraction of total sample time

iv Average Noise Level ($L_{average}$)

Plate 1: Sound level measurement of cement-block building

Plate 2: Sound level measurement of composite panel building

Plate 3: Sound level measurement of plywood building

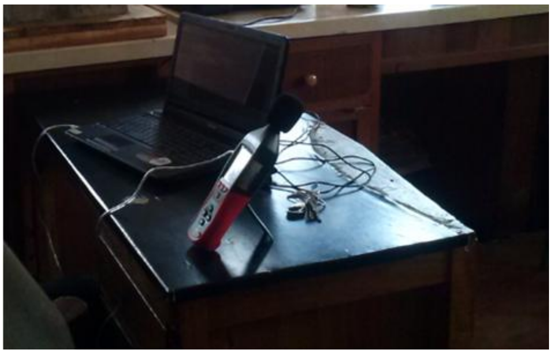

Plate 4: Pictorial view of a sound pressure level meter

III. Results and Discussion

Noise transmission levels were measured from different prototypes building erected with different types of materials. Average, equivalent, minimum and maximum noise levels in different building are shown in Table 1. The maximum noise transmission level was measured at prototype building erected with plywood which was 63.90 dB (A). This value is below the maximum permitted noise transmission level of 85 dB (A) described by the National Environmental Standards and Regulations Enforcement agency [15]. The minimum noise transmission level (i.e. maximum noise abatement) was 16.10 dB (A), measured in the prototype building erected with cement block. In addition, the results further demonstrated that working in any of the building partitioned with any of these materials as employee will be less exposed to noise where the average noise values in these buildings were below 80 dB(A). The graphs of noise transmission level within the buildings are presented in Figure 1-3. Building erected with plywood absorbed less and transmit more noise to the environment.

Table 1: Results of noise transmission level in building erected, using different materials

Partitioning Materials	Radio out (R_{out})			Radio in (R_{in})			Rate of Noise Absorbed ($R_{out} - R_{in}$)		
	L_{max}	L_{min}	L_{avg}	L_{max}	L_{min}	L_{avg}	L_{max}	L_{min}	L_{avg}
Cement-Block (20 mm)	77.50	63.20	73.30	61.40	52.80	58.24	16.10	10.40	15.00
Plywood (18 mm)	76.50	58.50	67.10	63.90	53.30	57.90	12.60	5.20	9.20
Composite Panel (20 mm)	76.50	58.50	67.1	60.50	52.90	55.20	16.00	5.60	11.90

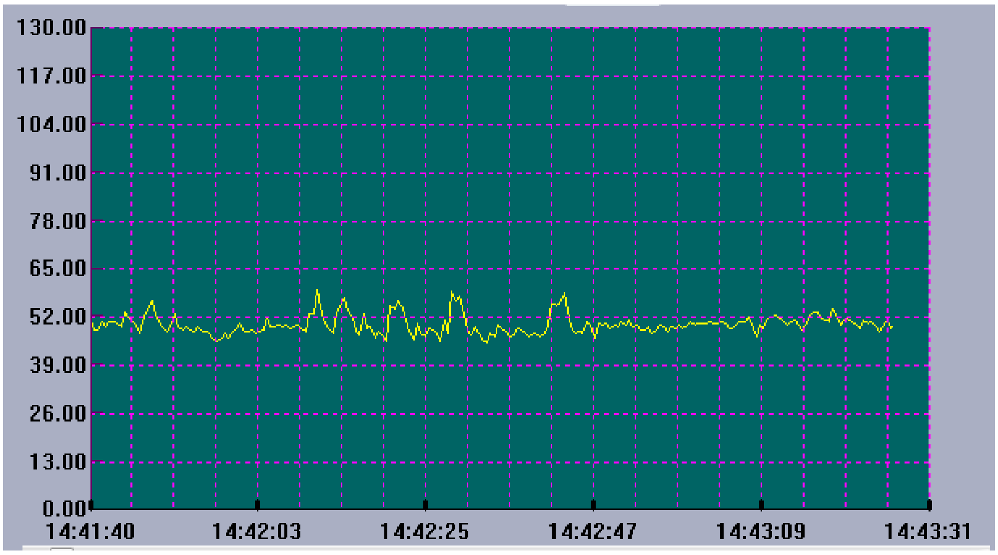

Figure 1: Graph of noise transmission level in building erected using cement-block

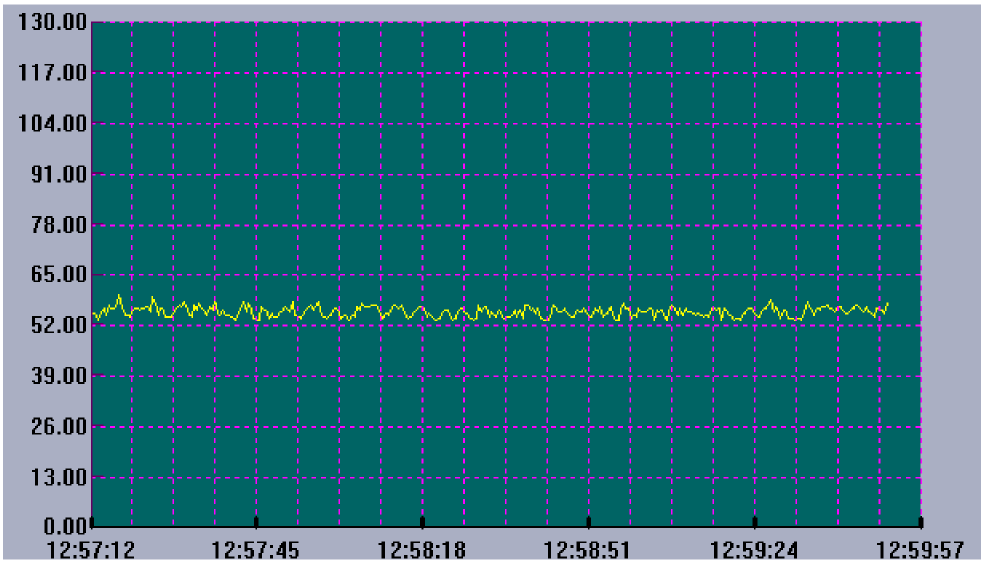

Figure 2: Graph of noise transmission level in building erected using plywood

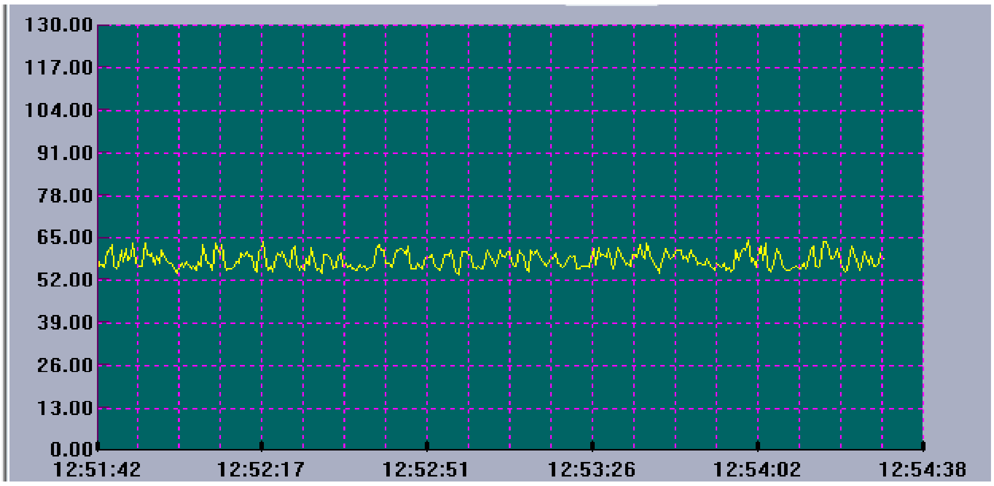

Figure 3: Graph of noise transmission level in building erected using composite panel

IV. CONCLUSION

This study showed that the noise transmission levels in different building are well below the standard limit of exposure of 85 dB. Employees exposed to noise below 85 dB will not develop hearing loss and are aware of this hazard. Noise should be seen as a nuisance that constitutes health hazard to the recipients and on this basis, some control measures that include the following should be adopted. The wall acoustic of the building made with different partitioning materials should be upgraded to absorb sound emanating from the building. Noise abatement materials should be introduced.

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