

Investigation on Characteristics of Noise Induced by Construction Traffic

B. Thirukumaran^{1*}, G.H.M.J.S. De Silva¹ and G.S.Y De Silve¹

¹Faculty of Engineering, University of Ruhuna, Galle, Sri Lanka

*E-Mail: bniros@yahoo.com

Abstract: Construction traffic noise continues to grow and it is accompanied by an increasing number of complaints from people exposed to the noise. The historical dimension of noise pollution in urbanized society identified 'noise' as being unwanted or undesirable sound created by construction vehicles that are considered harmful to human health and quality of life. The most important issue is sleep disturbance. However, the assessment of construction traffic noise is highly complex. Objective of this research is to determine the characteristics of noise induced by construction traffic and normal traffic. Sound levels were measured by using Sound level meter (SVAN971) and four channel seismograph at different locations near roads where heavy construction vehicles such as ABC truck, empty truck, roller and motor grader passing through. In order to compare with ambient condition, noise induced by normal vehicles (i.e., car, three-wheeler, van, bus.) was also measured. Most of the construction vehicles induced noise, which are higher than the noise induced by the normal vehicles. Among the normal traffic, three-wheelers produce noise greater than other normal vehicles. It was found that construction traffic induced noise as high as 109 dB ($L(A)_{max}$), 79.2 dB ($L(A)_{eq}$). Construction traffic produces noise at relatively low frequencies with high amplitude. Low frequency noise can be easily transmitted through structures and it can cause windows and other elements to rattle. The noise with tonal or impulsive characteristics is likely to be more annoying than noise without such characteristics.

Keywords: Construction traffic noise, Environmental impacts, Noise pollution, Sleep disturbance, Noise annoyance

1. Introduction

Environmental noise induced by construction traffic can have significant environmental impacts. The level of construction traffic noise depends on traffic volumes, traffic speeds and percent of heavy trucks on the road. Vehicle noise is a combination of the noises produced by the engine, exhaust, and tires. The loudness of construction traffic noise can also be increased by defective mufflers or other faulty equipment on vehicles. Any condition (such as a steep incline) that causes heavy labouring of motor vehicle engines will also increase traffic noise levels. In addition, there are other more complicated factors that affect the loudness of traffic noise. For example, traffic noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles. Construction vehicles can have a very wide footprint and can cause widespread disturbances [1].

In the case of noise, there is a more gradual increase in annoyance with increasing level. Always "average noise level" is the subject of attention because it has been directly linked to noise annoyances caused to residents.

Major effect of environmental noise is sleep disturbance. It may cause primary effects during sleep (e.g. awakening), and secondary effects that can be assessed the day after night time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning. For a good night's sleep, the equivalent sound level should not exceed 30 dB (A) for continuous background noise [2]. Sleep disturbances can be reduced by reducing maximum levels of noise in residential areas. Rapid increases in noise would be particular annoying to sleep disturbance to residents living close to the road especially at night time.

It has long been recognized that exposure to levels of noise exceeding safe limits can be detrimental to hearing. However, the World Health Organization (WHO) has recently published new findings linking exposure to excess noise to high blood pressure, strokes, heart attack, feeling irritated and angry, not being able to concentrate, interrupted sleep and hearing related conditions such as tinnitus etc [3].

Noise pollution continues to grow and it is accompanied by an increasing number of complaints from people exposed to the noise. The

growth in noise pollution is not sustainable because it involves direct, as well as cumulative, adverse health effects and also adversely affects future generations, and has socio-cultural, aesthetic and economic effects.

2. Objective

Objective of the current study is to determine characteristics of noise induced by construction traffic and normal traffic.

3. Methodology

Noise induced by construction traffic and normal traffics were measured using sound level meter (SVAN 971) and four channel seismograph. Noise levels during the passage of construction traffic were measured at two selected sites: stone crushing and a road construction site. As construction traffic, empty trucks, roller, motor grader and ABC trucks were selected.

In order to compare environmental noise induced by construction traffic with normal traffic, noise induced by normal vehicle was also measured. As normal traffic cars, three-wheelers, vans, and buses were selected.

The sound levels were recorded at 5 m distance from the edge of the roads where heavy construction vehicles passing through. The microphone was kept at 1.5-meter height above ground level. SVAN 971 which has a wide range of measures from 25dB to 140dB, was used to record the continuous sound levels (LAeq). Four channel seismograph was used to record the peak noise levels (LAmx).

4. Results and Discussion

4.1 Evaluation of equivalent noise induced by construction traffic and normal traffic

It was found that A weighted equivalent noise level(LAeq) is 79.2 dB at the road near stone crushing plant. According the guidelines recommended by Central Environmental Authority (CEA) in Sri Lanka (Table 1), equivalent noise level (LAeq) should not exceed 55 dB for low noise areas (within Pradeshiya sabhas) at day time. It was found that the equivalent noise level of 79.2 dB exceeding the CEA guide lines of 55 dB. In addition to the effect of construction traffic, LAeq might be included of a noise component induced

by crushing operation. When there is an increase of background noise, there should be an increase in equivalent noise level (LAeq). Normally in the urban areas, these background noises are high due to industrial activities, business activities and public conversations.

Table 1: Maximum permissible noise levels given in CEA guidelines

Area		Day Time	Night Time
Low Noise areas (within Pradeshiya sabha)	(within 55 dB(A)	55 dB(A)	45 dB(A)
Medium Noise areas (within Municipal Councils or Urban Councils)	(within 63 dB(A)	63 dB(A)	50 dB(A)
High Noise areas (within Export Processing Zones or Industrial Estates)	(within 70 dB(A)	70 dB(A)	60 dB(A)
Silent zones (100 meters from the boundary of a courthouse, hospital, public library, school, zoo, sacred area and areas set apart for recreation or environment)	(within 50 dB(A)	50 dB(A)	45 dB(A)

For example, it can be seen that noise levels of vehicles rapidly increase compared with its background noise (Figure1). Such rapid increases in noise would be particular annoying and sleep disturbance to residents living close to the road ,especially, at night time.

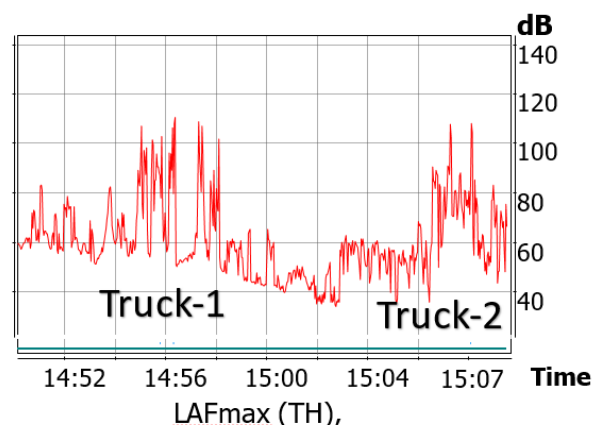


Figure 1: Variation of sound levels when passing a truck

Frequency distribution for a spot time of same kind of trucks are shown in Figures 2 and 3. Truck-1 was loaded by rubble and Truck 2 was unloaded. It can be found that low frequency noises are

occurred by both Trucks 1 and 2. However, Truck-2 produces noise in lower frequencies than Truck 1, implying that lighter vehicles produce noise at very low frequencies.

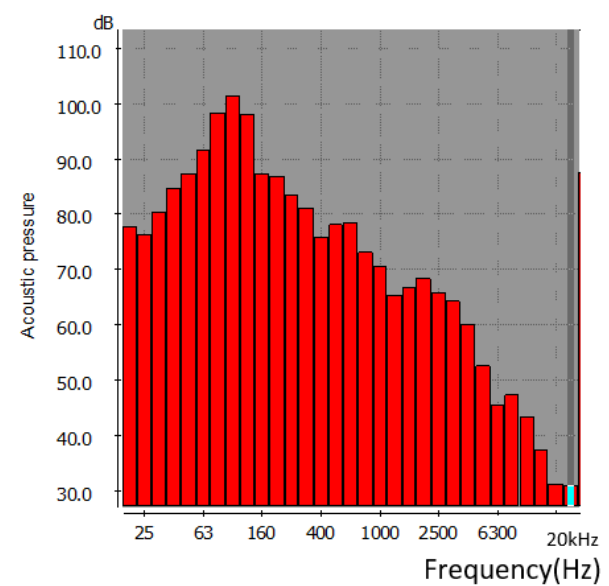


Figure 2 Frequency content of noise induced by Truck-1

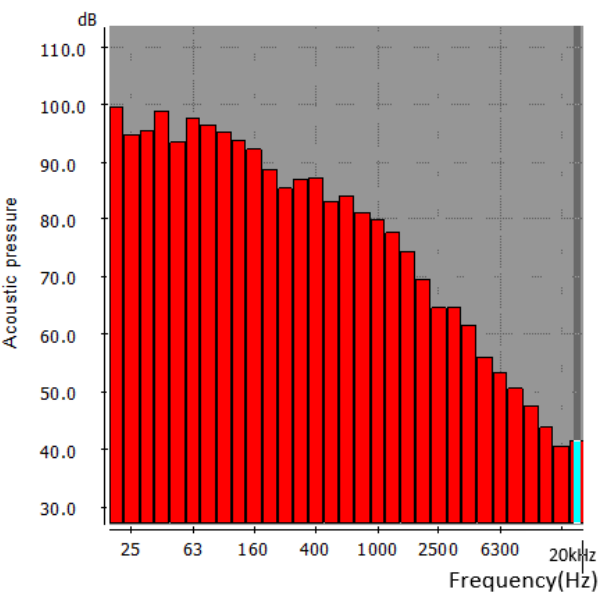


Figure 3 Frequency content of noise induced by Truck-2

4.2 Evaluation of peak noises induced by construction traffic and normal traffic

Figure 4 shows the peak noise levels induced by construction vehicles and normal vehicles. It can be seen that most of the construction vehicles

produce greater noise than that induced from the normal vehicles (Figure 4). Loaded trucks produce greater noise of 105dB than noise of 94dB, which induced from unloaded trucks. Roller and motor grader produce noise of 109dB and 107dB, respectively.

Among the normal traffic, three-wheelers produce much noise than the other normal vehicles. And the normal vehicles are producing the noise less than 100dB. According to the WHO guide lines, these LA_{max} values should not exceed 110dB for industrial, commercial, shopping and traffic areas [2].

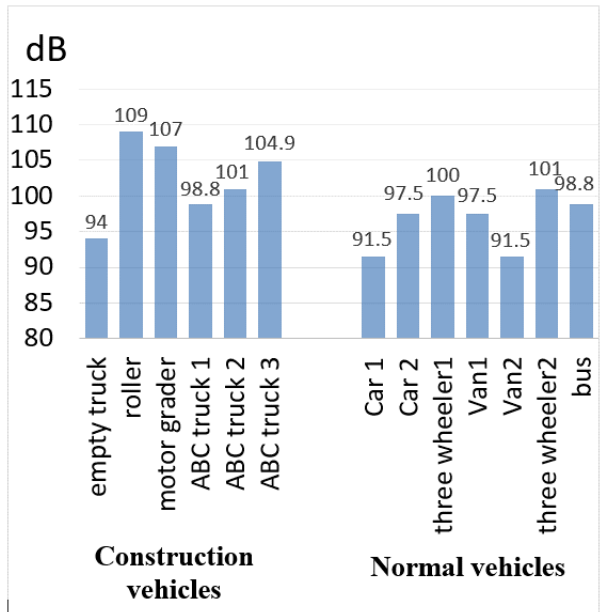


Figure 4: Peak noise levels of construction vehicles and normal vehicles

Sound levels of construction vehicles and normal vehicles are listed in Tables 2 and 3, respectively. Most of the construction vehicles induced noise, which are higher than the noise induced by the normal vehicles. Lighter vehicle induces noise with less amplitude and the heavy vehicle induces noise with high amplitude. It can be observed that the peak noises of vehicles are occurred in the frequency of less than 100Hz. And the lighter vehicles induce the peak noise with very less frequency (car-2Hz and three-wheeler-3.5Hz). Low frequency noise can be easily transmitted through structures and it can cause windows and other elements to rattle [4]. Low Frequency Noise (LFN) is not clearly defined but it is generally taken to mean noise below a frequency of about 100 to 150Hz [4].

Table 2: Sound levels of construction vehicles

Construction vehicle type	Peak noise dB(A)max	Frequency (Hz)
Empty truck	94	47.5
Roller	109	34.5
Motor grader	107	71
ABC truck -1	98.8	23
ABC truck- 2	101	52.5
ABC truck- 3	105	92

Table 3: Sound levels of normal vehicles

Normal vehicle type	Peak noise dB(A)max	Frequency (Hz)
Car-1	91.5	2
Car-2	97.5	2
Van-1	97.5	43.5
Van-2	91.5	51.5
Bus	98.8	93.5
Three wheeler-1	100	3.5
Three wheeler-2	101	2

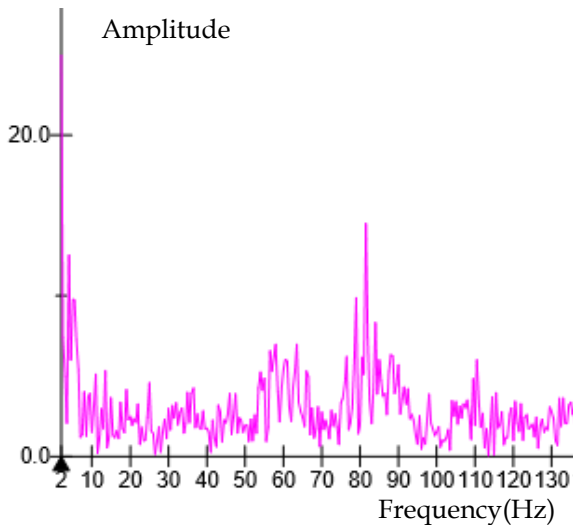


Figure 5: Frequency distribution of peak noise induced by a car

Noise with tonal or impulsive characteristics is likely to be more annoying. Some noise sources are inherently likely to give rise to tonal noise (i.e., vehicle's horn). This tonal noise is more noticeable than normal noise, resulting more annoying. A tonal noise source can normally be identified as shown in Figure 6. If there is a rapid frequency drop or increase greater than or equal to the following values in both adjacent

one-third-octave bands: 15dB in low-frequency one-third-octave bands (25Hz to 125Hz), 8dB in middle-frequency bands (160Hz to 400Hz) and 5dB in high-frequency bands (500Hz to 10,000Hz), there should be a tonal noise [4].

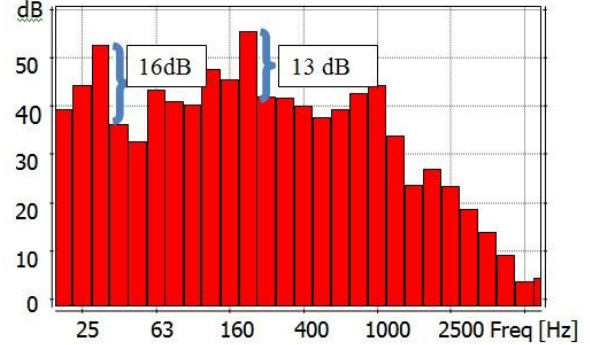


Figure 6: Identification of tonal noise

Some noise has the potential to generate impulsive noise. Normally an impulsive characteristic is determined subjectively as it is clearly audible. For examples, stone crusher that consistently produces an impact noise as when feed the stone to crusher the noise from the dropping of material that causes a short burst of loud sound as the material hits the ground or the noise of heavy hammering.

The traffic noise depends on the number of vehicles, the speeds of the vehicles, and the types of vehicles using the roadway. Generally, the loudness of traffic noise is increased by heavier traffic volume, higher speeds, and greater numbers of medium and heavy trucks. A 10-fold increase in vehicle volume equates to a noise level increase of approximately 10 dBA, or a perceptible doubling in volume [5]. Similarly, an increase in speed from 30 to 65 mph would also equate to a noise level increase of approximately 10 dBA, or a perceptible doubling in noise level (or volume) [5]. One heavy truck at 55 mph contains about the same acoustic energy as approximately 28 cars at that same speed [5]. Given this comparison it is clear that composition of traffic (i.e., the percentages of heavy truck volumes) can have as much (or more) of an effect on final noise levels than volume or speed of traffic.

Noise can be controlled by altering its propagation path through the use of various

techniques. Planting of trees along roads and residential areas help in noise reduction. In addition, traffic management can often be the cornerstone to good noise control. Accordingly, some traffic management measures are outlined below.

- Minimize the number of heavy construction vehicles (e.g. roller, excavator) [5]
- Limit the vehicle's speed [5]
- Limit the vehicle volume [5]
- Maintain vehicles in good order, employ the principles of preventive maintenance and undertake reference vehicle noise measurements at defined intervals
- Ensure that noisy vehicles are parked as far as possible from noise sensitive areas
- Switch off idling engines where possible and prevent excessive revving
- Maintain road surfaces in good order
- Ensure that drivers are aware of the potential for noise to cause annoyance/disturbance to local residents (e.g. no unnecessary horn blowing [4].

Construction traffic is identified as one of the main sources of noise, which induced noise great than the normal traffic. Findings of this study may help construction and transportation authorities to regulate construction traffic in several domains: the routes of daily and night lines, the highest acceptable number of vehicles at daytime and at night, and the optimal type of construction vehicles.

5. Conclusions

The construction traffic is a significant predictor for high noise annoyance in an urban area. Most of the construction vehicles induced noise, which are higher than the noise induced by the normal vehicles. A-weighted maximum noise level (LAFmax) values are found to be 109 dB for roller, 107 dB for motor grader and 104.9 dB for ABC truck. Construction traffic produces noise at relatively low frequencies with high amplitude. Low frequency noise can be easily transmitted through structures and it can cause windows and other elements to rattle. The noise with tonal or impulsive characteristics is likely

to be more annoying than noise without such characteristics. Reducing construction traffic noise to the lowest level in residential areas may be a simple measure to reduce noise annoyance, and to improve general health and quality of life.

References

- [1] Watts, G. R. and Stait, R. E., "Characteristics of Vehicles Producing Excessive Noise and Ground Borne Vibration", 2006, phase 1, Viewed 29th June 2015, from <http://www.transportresearchfoundation.co.uk/Publications/>.
- [2] World Health Organization, "Guidelines for Community Noise", Stockholm University and Karolinska Institute, 1995.
- [3] World Health Organisation, 2011. Burden of Disease from Environmental Noise. Copenhagen .
- [4] Environmental Protection Agency, "Guidance Note for Noise: License Applications, Surveys and Assessments in relation to Scheduled Activities (NG4)", 2012.
- [5] http://www.strongsville.org/content/documents/ODOT_Ch_3_Fundamentals_of_Highway_Traffic_Noise.pdf [Online], [Accessed 28 November 2015]