International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016
ISSN 2229-5518

Noise & Vibration Effect of Construction Projects

Dhanushka Meegaswatte

Abstract— Main purpose of this study is to understand the nature of the relationship between Noise/Vibration and Distance and to identify the social effect which arises due to these two parameters.

Index Terms— Complain, Construction, Distance, Environment, Impact, Monitoring, Noise, People, Source, Vibration

1 Introduction

This study mainly based on a Highway construction project in Sri Lanka named Outer Circular Highway (OCH) which was originally planned by Road Development Authority (RDA) with the objectives to cater for the growing need in the transport sector in Sri Lanka. This was proposed as a connecting ring road to the existing trunk roads and other proposed highways. In addition to easing the traffic congestion in Colombo by reducing through traffic, OCH was expected to promote regional development leading to a balanced urban economy.

The Phase II of the Outer Circular Highway Project (Phase II – OCHP) extending a total of 8.9 km from Kadawatha (Ch 8 + 648) to Kaduwela (Ch 17 + 500), funded by Japan International Corporation Agency (JICA) was to be completed in 36 months. Phase II – OCHP was constructed by Taisei Corporation, Japan – the contractor. The project construction was commenced on the 9th January 2012 and it was open for public on 5th August 2015. Proposed Right of Way is given in Fig1.

Environment Management Plan (EMP) was developed by Road Development Authority considering the anticipated impacts of the construction project. EMP gave a strong base for EMAP preparation. According to the contract agreement, it was essential to fulfill the requirements of EMP.

Taisei the contractor had to plan and implement admissible mechanism in order to comply with the environment regulations and requirements which were established by government agencies of Sri Lanka. Consequently, the contractor adopted a monitoring procedure with assistance of Industrial Technology Institute which is one of the recognized agencies in Sri lanka. Main purpose of nominating such third party agency to carry out the monitoring was the contractor wanted to convey the impression that they were conducting this procedure in unbiased manner.

- *Dhanushka meegaswatta graduated from University of Kelaniya, Sri lanka in Environmental Conservation and Management.*
- *He is currently working as Environmental Specialist atTaisei Corporation_OCH PII NS1 Project Sri Lanka*

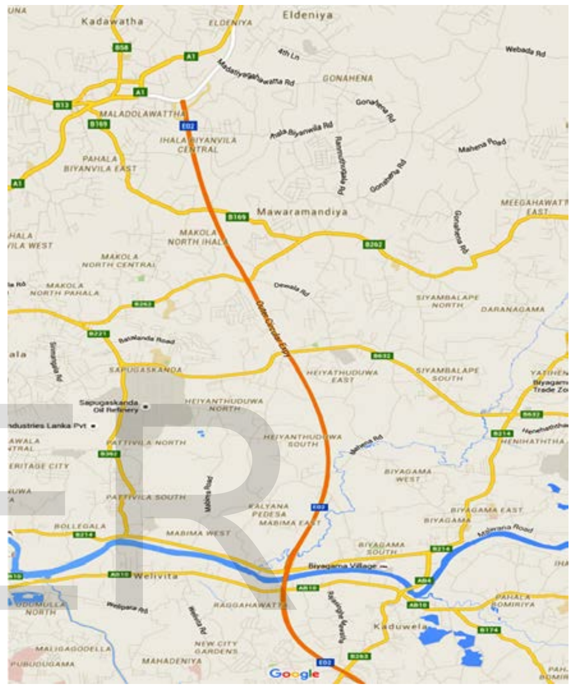

Fig1. Right of way of OCH project

2 Noise & Vibration Monitoring

2.1 Data Collection

During the construction period of OCH NS-1 Phase II, Noise and Vibration levels were measured by Industrial Technology Institute randomly and on complain basis. All the data, which were collected throughout the construction period, were utilized for this study.

2.2 Data Assimilation

Monitoring team, gatherd raw monitoring data submitted to contractor on monthly basis. In this process all the raw data which were gatherd during entire construction period were arranged in systematic. The highest vibration measurement, which was recorded during each month and its corresponding distance from the source to monitoring location, is used to plot the graphs. Noise consists with different characteristics rather than vibration i.e. while different types of construction activities are being executed at a same time, noise level cannot be determined for each construction activity separately. It gives collective and ambient noise level. Considering these circumstances both, highest and lowest measurements are manipu-

ISSN 2229-5518

lated to establish a reliable correlation for noise since noise is a mutually inclusive variable.

3 Monitoring Data

3.1 Vibraton

Following tables demonstrate vibration monitoring data of various construction activities which had been recorded troughout the construction period of OCH project.

TABLE 1
MAXIMUM VIBRATION LEVELS OF BORED PILING

Year	Month	Highest Vibration Level (mm/Sec)	Distance (m)
2013	May	1.55	132
	Jun	1.65	19
	Jul	1.37	96
	Aug	1.62	43
	Sep	1.86	10
	Oct	1.69	19
	Nov	1.56	41
2014	Jan	1.56	54
	Mar	0.86	140

TABLE 2
MAXIMUM VIBRATION LEVELS OF GRAVEL COMPACTION PILING

Year	Month	Highest Vibration Level (mm/Sec)	Distance (m)
2013	Jan	4.69	10
	Feb	1.29	54
	Mar	1.76	72
	Apr	7.31	10
	May	2.59	19
	Jun	1.95	14
	Jul	1.62	49
	Aug	2.5	12
	Sep	1.62	15

TABLE 3
MAXIMUM VIBRATION LEVELS OF SOIL & GRAVEL COMPACTION

Year	Month	Highest Vibration Level (mm/Sec)	Distance (m)
2013	Jan	2.59	10
	Feb	1.78	15
	Mar	2.44	12
	Apr	3.2	10
	May	2.98	9
	Jun	0.21	12
	Jul	1.59	14
	Aug	3.07	18
	Sep	2.38	35
	Oct	2.11	8
	Nov	1.17	89
	Dec	2.23	22
2014	Jan	2.23	12
	Feb	2.31	12
	Mar	2.25	17
	Apr	2.5	12
	May	2.7	3
	Jun	2.23	13
	Jul	2.9	7
	Aug	2.31	8
	Sep	2.24	15
	Oct	3.14	5
	Nov	2.8	12
	Dec	2.36	12
2015	Jan	2.2	10
	Feb	2.6	20
	Mar	2.51	13

3.1 Noise

Highest and lowest noise level of each month which had been recorded during construction period is presented as follows.

TABLE 4
NOISE LEVELS RECORDED IN 2013

Month	Highest Noise Level (dB)	Distance (m)	Lowest Noise Level (dB)	Distance (m)
Jan	82	50	53	74
Feb	80	52	65	65
Mar	86	14	50	70
Apr	81	15	57	44

May	89	14	55	51
Jun	90	17	44	60
Jul	85	6	54	49
Aug	86	43	61	65
Sep	79	28	48	37
Oct	80	13	59	67
Nov	80	20	46	74
Dec	80	9	56	98

TABLE 5
NOISE LEVELS RECORDED IN 2014

Month	Highest Noise Level (dB)	Distance (m)	Lowest Noise Level (dB)	Distance (m)
Jan	78	11	56	16
Feb	88	7	57	62
Mar	85	26	58	28
Apr	79	16	59	17
May	78	12	49	33
Jun	79	16	46	74
Jul	76	20	59	18
Aug	73	10	50	49
Sep	78	17	57	34
Oct	76	17	53	15
Nov	70	14	57	16
Dec	78	14	57	21

TABLE 6
NOISE LEVELS RECORDED IN 2015

Month	Highest Noise Level (dB)	Distance (m)	Lowest Noise Level (dB)	Distance (m)
Jan	78	10	52	18
Feb	71	16	57	5
Mar	73	19	57	16

2.3 Ascertaining of Tendancy

Since this study deals with two-dimensional variables a *Trend Line* is determined in order to identify the tendency of the trend. One of the more accurate ways of finding the Trend Line is the Least Square Method. This analysis adheres to following steps In order to ascertain the Trend Line.

Step 1: *The mean of the x-values and the mean of the y-values are calculated.*

$$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$\bar{Y} = \frac{\sum_{i=1}^{n} y_i}{n}$$

Step 2: *Slope of the trend line is determined by using following formula.*

$$m = \frac{\sum_{i=1}^{n}(xi \quad - \bar{X})(y_i - \bar{Y})}{\sum_{i=1}^{n}(x_i - \bar{X})^2}$$

Step 3: *y-intercept of the line is calculated by using following formula.*

$$b = \bar{Y} - m\bar{X}$$

Step 4: *The equation of the line is formed by using the slope m and the y-intercept b.*

$$y = mx + b$$

4 DISCUSSION

Fundamentally, the environment can be divided into two separate parts concerning the distance between source of the impact and affected environment as shown in Fig.2.

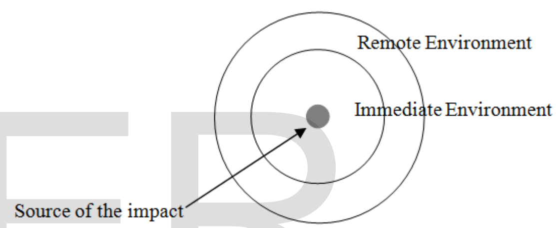

Fig2. Subcatgagorized environment

Prominent sources of impact, which were identified during this project, include dust, noise, vibration, floods. Intermittently some of those sources (especially noise and vibration) affect not only the immediate environment (with in10ft), but also the remote environment (beyond 10ft). As a result of this phenomenon, it was decided to declare the 50m corridor both side of the road as the impact area.

The vibrations of consequence are caused by waves of energy traveling away from particular construction activity such as Gravel Compaction piling, Bored piling, Winch piling, Soil/Gravel Compaction, Sheet piling and even heavy machinery mobilization. However, the particle velocity of the ground surface caused by these traveling waves of energy decreases with distance from the source, due to geometric effects.

Fig3. shows how the collective vibration effect which generated by all the construction activities of the project varies with distance away from the source.

ISSN 2229-5518

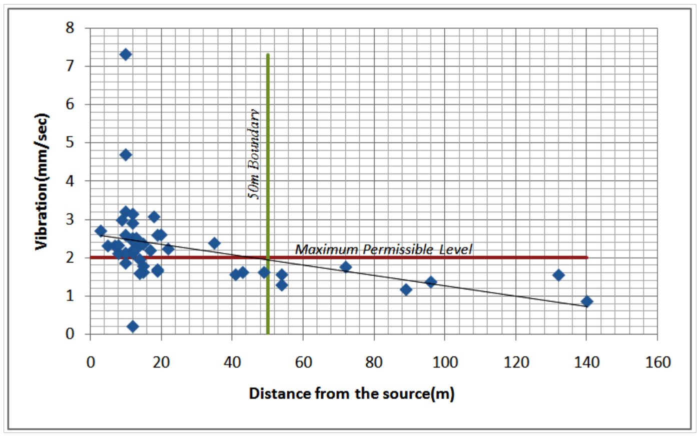

Fig3. Collective variability of vibration

According to the Fig.3 the particle velocity reaches maximum permissible level (which was proclaimed by *Central Environmental Authority* of Sri Lanka) at the 45m and continues to decline with distance from the source. Technically the repeated stressing from vibration potentially aggravates damage due to fatigue effects.

However when we consider the same correlation individually, it shows slightly deferent variations for each construction activity. Fig4. , Fig5. and Fig6. show the measured peak vibration levels during construction period from various construction activities as a function of distance away from the vibration source.

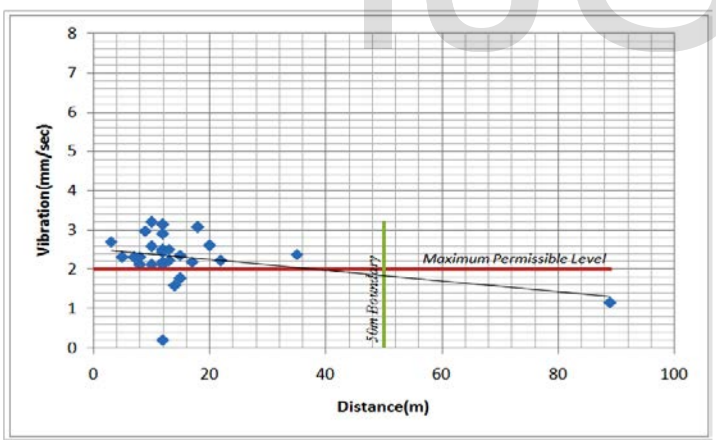

Fig4. Vibration effect of Gravel Compaction Piling

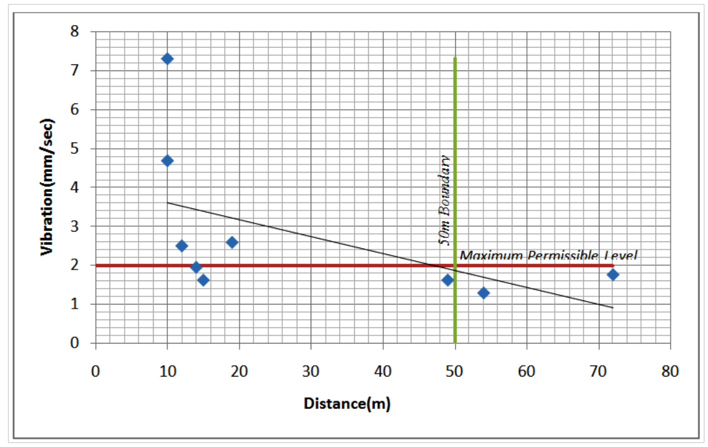

Fig5.Vibration effect of Soil & Gravel Compaction

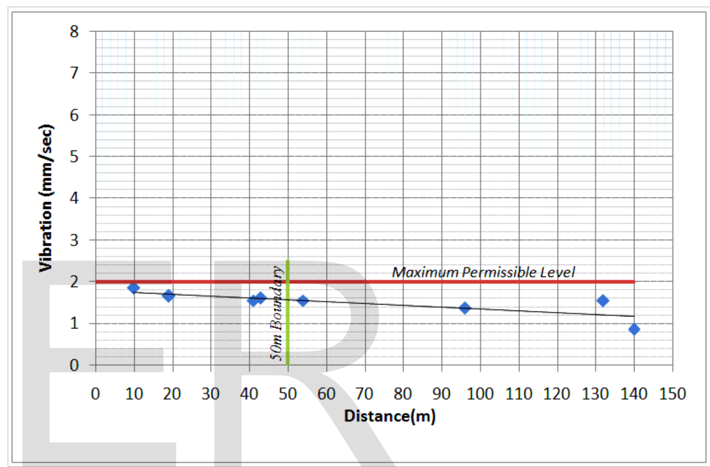

Fig6.Vibration effect of Bored Piling

The available data and experience show that unless Bored piling is occurring few feet away from a structure, it does not cause damage to the structure from vibrations. Nevertheless, there may be other consequential effects such as vibration can accelerate ground settlement.

People can generally feel vibrations above 0.2 mm/sec, which means people can feel and become concerned about vibrations that are only 1/10th of those that might begin to cause damage to structures. As per the experience, once vibration levels reach and exceed 1.0-1.2 mm/sec people complained regarding inconvenient caused by vibration. People complain about vibration effects because they are much more sensitive to vibrations than are buildings. They tend to assume their personal sensitivity to vibrations to a concern about the safety of their building.

Noise from construction activities rarely if ever produces structural damage, but it causes annoyance that may reach a long distance. Fig7. demonstrates measured peak noise levels from the construction activities, which was executed during this project as a function of distance away from the noise source.

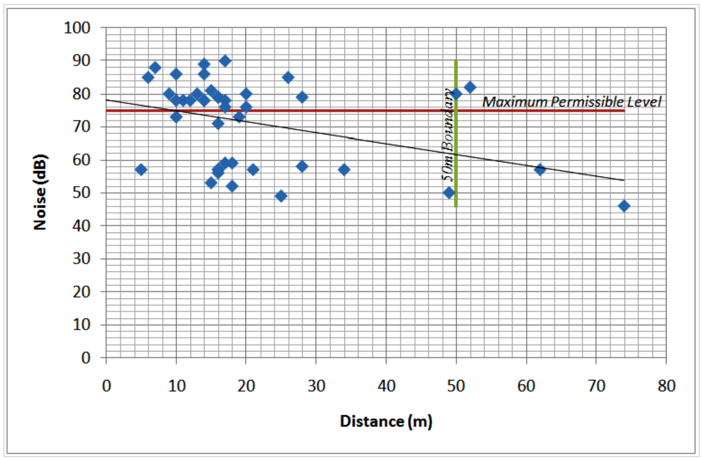

Fig7. Variability of noise levels

Sound level decreases by approximately 3 dB at every 10m. When it reaches to the boundary, of impact area (50m) noise level becomes much less than the permissible level (75dB), which had been set out in the approval granted by Central Environmental Authority. Usually bored pile driving has the potential to annoy a lot of people. When people become annoyed, they also become concerned. They start looking for evidence of damage to their property from the construction work. When people look for evidence to confirm their suspicions, they will usually find something and complain. Noise may be the most serious threat to the pile driving activity not because it is causing damage but because it creates a perceived problem to those impacted.

However an integrated remedial mechanism was successfully implemented with following approaches in order to overcome these controversial circumstances.

1. Indemnity

The entire compensation procedure, which includes pre/post condition survey and damage valuation was carried out by an independent third party who helped to build up an assurance among local public regarding the compensation mechanism. The damage valuation took place in accordance with a rational and admissible criterion while ensuring equitability.

2. Monitoring and awareness

Throughout the construction period noise and vibration was measured at complain / key locations with assistance of recognized independent third party. Monitored data were used to demonstrate that construction work was well below the levels that cause harm and feeling vibrations and hearing noise does not equate to physical harm or damage. Whenever the permissible level was being exceeded, particular work process was altered in order to correct the problem with immediate effect.

3. Abatement

Appropriate actions were taken to reduce vibration and noise levels to the extent that they are economically possible. The time of potential construction activities, which might cause excessive noise and vibration, was limited to daylight hours when people are less affected by these nuisances.

5 Conclution

Notwithstanding that noise and vibration are considered as environment pollutants, they do not act like other pollutants such as gaseous substances, chemical substances, hazardous materials etc. The prominent characteristic of previously mentioned pollutants is "persistency". Effect of Noise and vibration decreases with the distance and they do not accumulate in the environment. Unlike some other pollutant, noise and vibration do not diversify into subcategorized pollutant. Which means magnitude of the impact from noise and vibration is comparatively less than other environmental pollutants. Annoyance and property damage are the most notable impact respectively from noise and vibration.

However, during the entire period of this project all affected parties were served with reasonable solution and none of them were neglected in any way.

Acknowledgment

A special gratitude is given to the management of TAISEI Corporation, OCH P2 NS1, Sri Lanka, who supported the integration of environmental considerations into the project decision-making process in order to ensure the environmental soundness and sustainability.

References

[1] R.D. Woods, "Dynamic Effects of Pile Installations on Adjacent Structures," Synthesis of Highway Practice 253, Transportation Research Board, National Research Council, National Academy Press, Washington, D.C., pp. 18-42, 1997.