

## Analysis of Noise impact on various parameters by Response Surface methodology for optimum Safe Working Area

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### ABSTRACT

Enormous growth of population and industries leads waste disposal problems and occupational health hazards like noise, illumination, pollution. They become very difficult to control and manage. Huge amount of money and time are spent year by year to minimize the effects and to find an easy and safe way to manage them. Lot of research works are going on to find an optimum level to minimize the health hazards for workers and society. Various factors are to be considered and it may vary from place to place and time to time. Noise analysis is essential with various related parameters like noise producing sources, its intensity, number of sources and distance. It is necessary to find an optimum safe working area or location for occupational health improvement of workers. This paper deals an investigation carried out in a workshop with various machineries for getting real life value. The data were analyzed and optimized by response surface methodology using minitab software. These results can be used for future reference. The scope for further proceedings is vast and it may be extended to domestic, roadside and industry noise analysis purposes also. This research gives a clear cut picture to find out a safe location for working, selection of safety equipment, precautions, provisions and implementations for developing a healthy environment.

**KEYWORDS:** noise analysis, related parameters, optimum safe working area, healthy environment, Response surface methodology.

### INTRODUCTION

For the past two decades, there has been a growing awareness on the problem such as waste disposal, noise etc. associated with population and industrial growth and technological development. Periodical noise survey of a plant is essentially needed to find out noise specifications and to collect the data to fulfill the requirements of the regulatory agencies to maintain an optimum Occupational health. In this connection the effects of noise on human beings are to be evaluated and the permissible and acceptable levels are to be determined and implemented in the working area. In developed cities is polluted control especially air pollution due to emissions from various industries, vehicles etc. But people are normally willing to live in harmless and healthy environment. Noise hazards produced by various domestic activities like piling, construction and vehicle movements, are expected. In Hongkong city the Noise control Authority takes steps to protect its people from the above pollutions with the help of Police force by severe punishments, heavy fine amounts and imprisonments [1]. Optimization of aerodynamic structure design is mostly required to build up a modern aircraft. Reliable optimization techniques like response surface methodology (RSM) are mostly used for design

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and analysis of various factors and parameters to optimize the minimum noise level. Generally noise is a bad element even it is continuous or intermittent. It will affect all human beings irrespective of age and gender factor. It might be severe when the exposing time is large. Noise exposure may be continuous, frequent and intermittent. Occupational safety and health administration (OSHA) insists to maintain the noise level at below 85 decibels (dB) for 8 hours per day is the safest limit. If it exceeds definitely people's health will be affected. It may be acute or chronic in nature [2],[15]. From an inter circulated construction safety course material it is found that the noise level is higher and more irritable on festival and function days than the ordinary days.

Now a day, it is very difficult to live nearby highways due to heavy traffic which creates noise pollution and emissions. So, the people are not willing to select the highway areas and they prefer remote areas for their comfortability [3]. Also it is found that the land value is badly affected nearby highways due to vehicle pollution [10]. Vibration of equipments is also gear up the noise production factor and it has a close relationship with equipments which are used in the field of Mechanical, Aerodynamic, Electrical and Electronics field. Lakshmikanth *et al* [4] developed a noise and vibration reduction model in permanent magnet synchronous motors. Noise effects never consider the age limit. As far as the National Institute of Public Health concerned an enormous change in life style even children are adversely affected by noise. Many researchers have analyzed and developed a model to minimize the hearing loss due to noise and gave their suggestions to control factors which Department of Mechanical Engineering create noise. More researches are going on to minimize the hearing loss effect and the factors involved in this hazard are analyzed by software which is developed by their own, according to the situation and environment. Noise Exposure Acquisition Tool (NEAT) is one of the software which gives easy solutions to overcome the hazard within a short period and expenditure. Usually males have a greater exposure than female with noise hazards since mostly they are involved in the industrial activities.

Noise Induced Hearing Loss (NIHL) will be reduced by adopting engineering controls effectively. It will improve the occupational health among the workers who are exposed to noisy atmosphere. Usage of proper personal protective equipments PPE play a vital role in reduction of noise related burdens [9]. Around 60 noise related case studies under various situations with remedies are given in the Industrial Noise Control Manual [11]. Noise effects are sometime acute and sometime chronic depending upon the working environment in which one can works. Some of the working environment like mines is very worst and it will be badly affect the health chronically [5].

Problem finding is not enough to solve it. A good analyzing method is important to analyze the factors involved and related in noise pollution. Few techniques were experimented and the solutions were implemented in the work floor by Robin Nicolai *et al* [6]. Noisy atmospheres develop job dissatisfaction due to its effects on health aspects. Fatigue, blood pressure variation, head ache and peptic ulcer are the common diseases found with people who are working in a noisy environment for long time [7]. Some of the environments like market, metal forming industrial areas, ordinance training areas are always noise prone areas. An effective control measures is required for both living and floating populations.

Sound level plays a major role in its harms and exposing period plays an important role in noise effects [13]. Sound Pressure Level increases with increase of frequency and vice versa. It is also taken into account for noise assessment. The surface of the building even it is hard in nature will reflect sound waves mostly. This effect is called as, "Façade Effect" and the stability of the building due to sound waves depends upon this effect also. It is high when closer to the surface and low when the observer is away from that surface. Three techniques to reduce the noise are commonly used. One is at sources, second is by maintaining adequate distance and the third is the usage of barriers [14]. Many social welfare organizations are involved in occupational health improvement activities and gives ideas and tips to workers for developing their health in hazardous work spots. Safe Work Australia is one such organization which has many useful and practicable ideas to overcome the risks related to noise and to maintain health and safety also. More exposure to noise leads increase in blood pressure and heart attack. Noise survey procedures, methods, models, analysis and protection methods are available in many websites [15]. Considerable occupational noise survey for designers, users and researchers reference purpose is also available. Basically there is a close interaction between noise and its control. Department of Environment, Food and Rural Affairs (DEFRA) an organization shows in its noise mapping analysis, the interaction between noise factor and controllable factor in graphical methods. Now a day, it is observed that noise hazards are everywhere. One should urge to change his life style to live among these hazards. A technical memorandum is issued by Noise Control Authority of Environment Protection Department for the assessment of noise from various places.

#### *Industrial Noise Hazards:*

The effect of noise on the person exposed depends upon the loudness, frequency and quality of noise. The physiological damage caused by noise is more severe than the psychological cause of annoyance and irritability. If a person is allowed to work in a noisy atmosphere, the noise will act as a stress which affects the body organisms. Medical history has proved that noise is one of the reasons for diseases like peptic ulcer and hyper

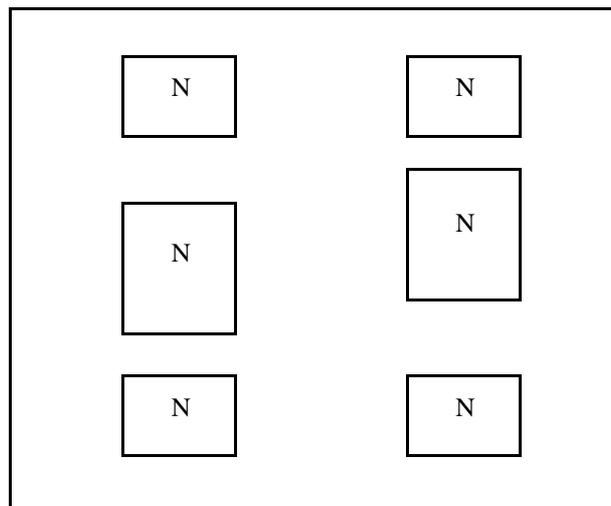
tension. During World War II noise was used as a mass killing weapon and also used to change the mentality of the human beings by irritation over a period. Noise as a stress acts on the human organism and may worsen or perpetuate diseases after it has taken hold. Noise has an adverse influence on mood, rest and relaxation. Noise can disturb sleep and rest. It interferes with performance where response to speech communication or other auditory signals is expected. According to research work conducted noise may also affect the digestive system. The noisy industrial environment is the prime cause for noise induced hearing loss among people. If a person is allowed to work in an environment where the noise is of more intensity and duration, then hearing loss will be the result. In 1976 Government of India had included Noise induced Hearing Loss as notifiable disease as per section 89 of Factories Act 1948.

This article explains various aspects of noise production, its effects, harms, and measuring, monitoring techniques, usage of measuring and protective instruments. Sometimes the noise emitted by the Tools, equipments and machineries which are used in domestic purpose will be badly affected the human beings. Especially any construction work is carried out adjacently; considerable noise hazard will be produced by the activities involved in it. The people may bear them to certain extent and over a period it will affect the aged and unhealthy people badly. They should make some protection arrangement otherwise it will cause death also <sup>[8]</sup>. Rapid population growth will lead to increase in noise level as well as its hazards. Urban people are more affected than the rural ones because of the population intensity and its requirements. World health organization (WHO) and most of the countries spent more funds in this connection for its remedies <sup>[13]</sup>. Knowing the basic things and the characteristics of noise will help to control and to eliminate.

### 3. Experimental Set Up:

Experiment was conducted on a noise producing kit consists of buzzers in industrial safety engineering laboratory. The following factors are considered for noise analysis.

- Number of noise producing sources ●Intensity of the source
- Distance between the sources ●Observer
- Height from ground level



**Fig. 1:** Experimental set up

#### *N – Noise producing units:*

20 Watts buzzers six numbers are arranged in 2 X 3 matrix as noise producing units. The distance between the sources can be varied by shifting them to the required distance. Individual on/off switches are fixed for desired operation. A varioc is used to vary the voltage as well as the current values to conduct more and random experiments. Fifty two experiments were conducted and the observed data were tabulated and analyzed by Response Surface Methodology in Minitab software. The optimum location for safe working area to develop occupational health is found.

#### *Results And Analysis:*

Response surface regression: Noise impact verses Voltage, Amps, Distance, and Height

**Table 1:** Analysis Of Variance

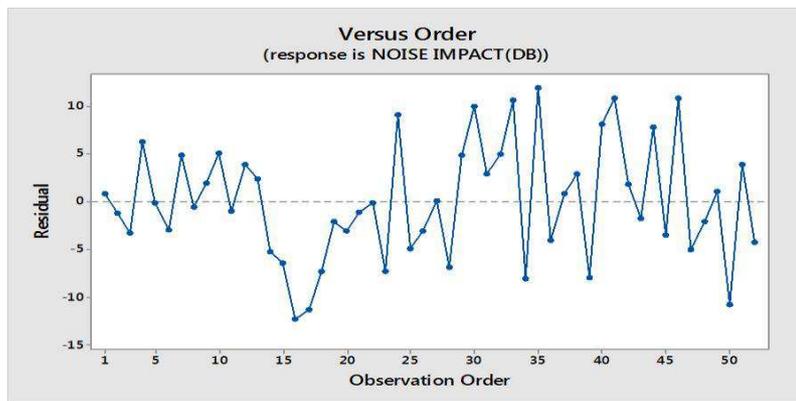
Source	DF	Adj SS	Adj MS	F - Value	P - Value
Model	5	438.71	87.743	2.12	0.080
Linear	5	438.71	87.743	2.12	0.080
Voltage	1	0.00	0.001	0.00	0.995
Amps	1	7.61	7.811	0.19	0.666
Distance	1	69.46	69.460	1.68	0.201
Height	1	137.48	137.480	3.33	0.075
No of sources	1	138.84	138.884	3.36	0.073
Error	46	1901.21	41.331	-	-
Lack-of-Fit	31	1455.49	46.951	1.58	0.175
Pure Error	15	445.72	29.714	-	-
Total	51	2339.92	-	-	-

The noise impact is calculated through the following equation

$$NI = 70.19 + 0.2225V + 0.952A + 0.064L + 0.0450H + 0.231X \tag{1}$$

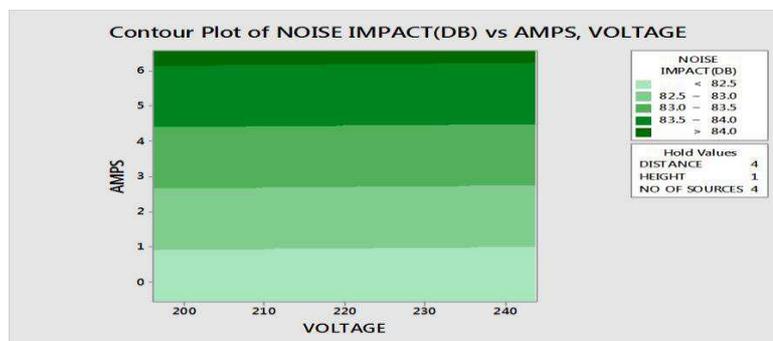
**Table 2:** Fits and Diagnostics for Unusual Observations

Obs	Impact	Fit	Residual	Standard Residual
6	48.00	59.09	-11.09	-2.90R
16	36.00	44.15	-8.15	-2.13R
29	38.00	45.84	-7.84	-2.05R



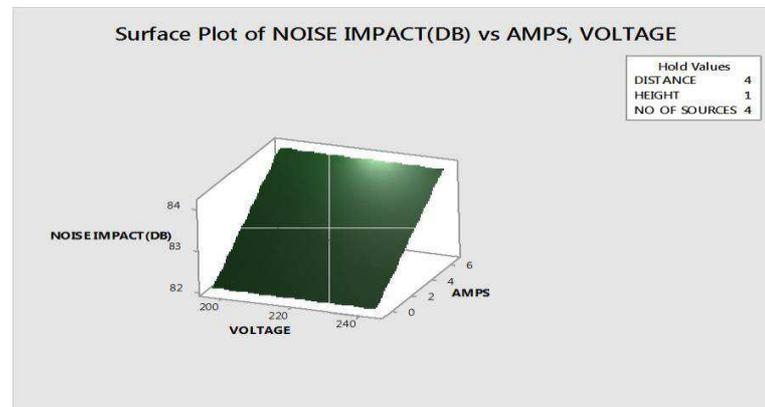
**Fig. 2:** Residual vs Observation order

Figure 2 shows the variations in residuals for entire observations i.e. fifty two experiments. Residual is nothing but the difference between the actual noise impact and the predicted ones. If the values are very near to zero then this model is considered as good. The experiments are to be repeated to get an optimum value. In this research, the residual value of experiments 16,17,30,31,37,41,46 and 50 lies beyond 10% (below 90 percent confidence level) due to the surrounding factors like wind flow, voltage and current fluctuations. Others lie within 90 percent confidence level. So this model is considered as a good model.



**Fig. 3:** Amperes vs voltage

Figure 3 Contour plot illustrates the relationship between the noise impact on voltage and current variation. It also shows the interaction effect of voltage and current values. The colour intensity shows the effects clearly. It is observed that the intensity of noise impact is directly proportional to the voltage and current values. From the above representation it is easy to understand the connection between the noise impact, voltage and current values. High and low value of voltage and current are badly affect the nearby observers. High value increases the noise intensity suddenly and hence it affects the surroundings very shortly and the low value vice versa.



**Fig. 4:** Surface plot of noise impact vs amps, voltage

Figure 4 surface plot clearly shows the relationship between the noise impact, current and voltage. The related factors have a directly proportional relationship between them. So the plot shows a flat surface, without any bend or curve in nature. The colour intensity also spread in a uniform manner due to this relationship. Duration is an important factor which justifies the noise impact on human beings, more effectively. It is not discussed here and it opens a new path on research.

#### *Conclusion:*

A statistical analysis has been performed to study the individual as well as the interaction effect of parameters on noise and found that the individual effects have more effect than interacted one. The adequacy of the models has been tested by F-test which indicates that the developed response surface equation is in good agreement with the observed data. As there is a good convergence between the experimental values and the mathematical models and the mathematical modes possess high predict to power in practical situations. The average percentage of error between the measured value and the predicted value is observed as 0.7465 percent which proves that the measured values are very close to the predicted value. By this the safe working area can be easily assessed. Hence the usage of proper personal protective equipments can be finalized for the improvement of occupational health of the workers.

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