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Traffic Noise Pollution Modelling and Noise Reduction Asphalt Pavement

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Abstract: ***Noise pollution leads to the lack of concentration of people, as a result, they will be finding longer time for completing the work than that which would be done in a quiet environment and in addition they feel more tired in the noisy area. Road traffic is a complete system which wide comprises of varieties of road user, vehicle and environment interact the congestion of road intersections is due to the motorization from and increase in single occupancy vehicle. This study is carried out to understand the noise traffic pattern of Ottapalam city. So proper planning of the road should be done and proper laws should be available. A study area consisting of two locations, a busy urban street of Ottapalam city, with high population density was selected for the study to determine the impact of the noise pollution at residential zone.***

I. INTRODUCTION

Noise can be defined as the level of sound which exceeds the acceptable level and creates Annoyance. The major sources of noise are Industrial noise, Traffic noise & Community noise Out of above three parameters, the source that affects the most is traffic noise. In traffic noise, almost 70% of noise is contributing by vehicle noise. Noise pollution is one of the most significant forms of emissions observed as a result of the consequences of the development of various transport systems over the past decade. A new road traffic noise prediction model for uninterrupted four-lane Indian roads, developed using the regression analysis. This model can be effectively used as a decision-supporting tool for road traffic noise prediction when designing new highways, traffic. Noise prediction models are required in order to provide for a comfortable living environment in industrial, commercial, Residential and silence areas. Furthermore, the analysis and modelling of traffic noise facilitates proper planning of environmentally friendly roads. Appropriate prediction models can be used to develop various noise-control technique before construction. These procedures make it unnecessary to respond to complaints from people living in the vicinity of highways after their construction, and alleviate the need to minimize high-cost post- construction protection measures. Prevention is always better than the cure. In general, sound level has a lot of variations. Taking into account human ear's response to different levels of Sound, weighting filters are used to measure sound levels. The A-weighted sound level is formulated in order to characterize more accurately the response of humans to the variation of sound. This a weighted sound-level measurement in Decibels, expressed as dB (A), is a commonly accepted scale for measuring sound levels in transport sector. Noise levels generated by vehicles along highways are extremely variable over time. In order to simplify this issue, a universally used parameter Leq the energy equivalent noiselevel, has been derived to obtain a meaningful statistical average noise level that describes the same magnitude of Noise exposure during the measuring period. So, the Leq can Substitute varying noise levels with a single noise level value, which is expressed in dB (A). Hence, an attempt has been made to predict the equivalent level of noise for the four-lane uninterrupted traffic flow along the Ottapalam-Vaniyamkulam road Kerala, India. Noise measuring devices typically use a sensor to receive the noise signals emanating from a source. The Sensor, however, not only detects the noise from the source, but also any ambient background noise. Thus, measuring the Value of the detected noise is inaccurate, as it includes the ambient background noise. Many different type of Instruments are available to measure sound levels and the most widely used are sound level meters or decibel meter.

II. METHODOLOGY

Traffic noise is one of the most significant types of vehicular emissions that result in physical and psychological health effects on humans and is caused by an increase in vehicular ownership and urbanization. Traffic noise prediction models are required as aids in the design of roads and sometimes in the assessment of existing or envisaged changes in traffic noise conditions. continue to grow because of sustained growth in of vehicles. Highway noise is the sum of the total noise produced at the observer point by all the moving vehicles on the highway. Thus the fundamental component is the noise produced by the individual vehicles, which depend on the vehicle type and its mode of operation.

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The overall noise is also dependent on the characteristics of the vehicle flow and the relative proportions of the vehicle types included in the flow. Knowledge of these factors is thus necessary to define the characteristics of highway noise and to subsequently predict the associated noise level in the surrounding area. The amount of information required depends on the degree of accuracy desired in the predictions, which in turn is a function of the method selected to characterize the temporal variation of the noise. Thus the complexity of highway noise model will depend on the noise descriptor selected.

The following procedure is done in this project:

1) Site selection
2) Questionnaire survey is conducted
3) Field studies are carried out
4) Analysis of collected data using SPSS software to find the correlation between various parameters and noise level
5) Modelling of traffic noise pollution
6) Study on noise reduction rubberized asphalt pavement as a prevention measure.

A. Site Selection

To develop mathematical model for predicting the traffic noise, the first task was site selection. The study area taken is Ottapalam. It is one of the major commercial centres in the district.

B. Study Period

Data were recorded during the morning period (8-9 am), afternoon period (1- 2 pm) and evening period (4-5 pm) for seven (7) days at two locations.

C. Field Studies

In view of the objectives, a field data collection program was designed to collect the following parameters

- Noise level
- Traffic volume
- Age of vehicle
- Road width
- Driver behavior

1) Noise Level

The noise levels were measured in decibels using a Sound Level Meter (MEX103 SL- 36). Sound levels are displayed digitally. Its measurement range varies from 30-130dB with a resolution of 0.1dB and accuracy of ±1.5dB.

Measured traffic noise levels dB

DAYS	NOISE LEVEL OBSERVED FROM 8:00AM-9:00AM	NOISE LEVEL OBSERVED FROM 1:00PM-2:00PM	NOISE LEVEL OBSERVED FROM 4:00PM- 5:00PM
MONDAY	77	72	79
TUESDAY	75	71	76
WEDNESDAY	75	70	74
THURSDAY	74	70	74
FRIDAY	72	70	73
SATURDAY	80	74	80
SUNDAY	68	67	68

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2) Traffic Volume Count

Table Measured total vehicle count

DAYS	TOTAL VEHICLE COUNT FROM 8:00AM-9:00AM	TOTAL VEHICLE COUNT FROM 1:00PM-2:00PM	TOTAL VEHICLE COUNT FROM 4:00PM-5:00PM
MONDAY	2430	1265	2285
TUESDAY	2131	1205	2100
WEDNESDAY	2205	1988	1977
THURSDAY	2019	1003	1930
FRIDAY	2420	1208	2295
SATURDAY	2672	2003	2373
SUNDAY	1097	910	909

III. RESULTS AND DISCUSSION

Using the observed data, the correlation among the variables has been studied to find out the strength of association of dependent variables with independent variables, and among independent variables. Based on the data taken at different times and the equivalent level of noise, the analysis was done using the SPSS (version 29.0.0.0) software, and a suitable model for the road traffic noise prediction was obtained.

A. Model Summary

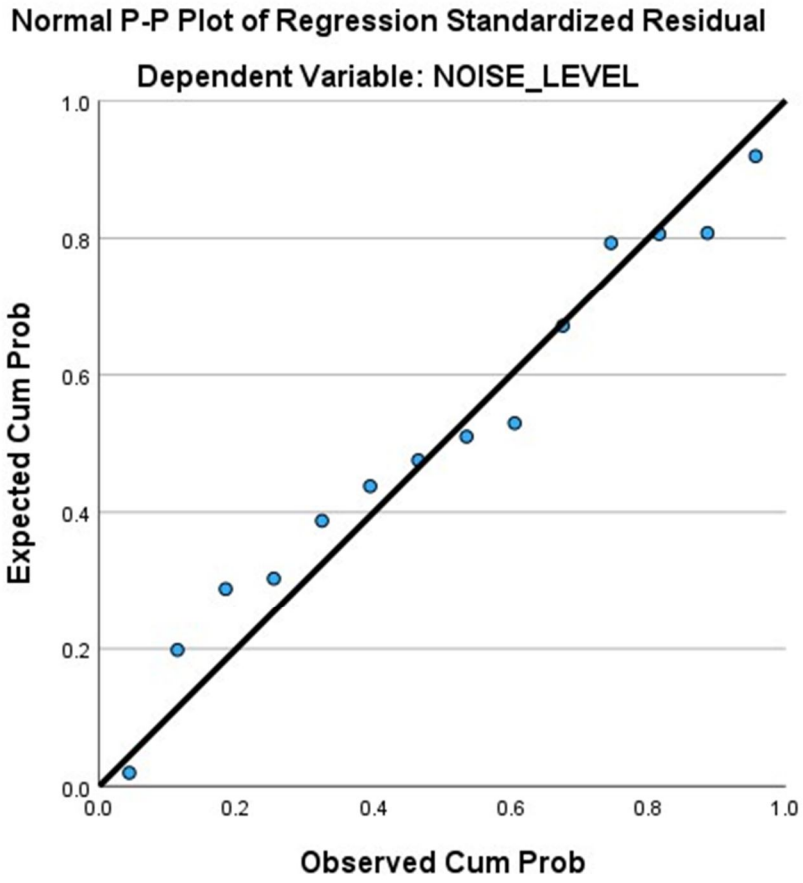
R	R Square	Adjusted R Square	R Square Change
0.935	0.874	0.836	0.874

Model	Unstandardized coefficients	Value of T	Value of P	Variance of inflation factor
Constant	87.913	4.883	<0.001	
Total vehicle count	0.004	2.903	0.016	1.853
Driver behavior	-1.834	-4.293	0.002	1.490

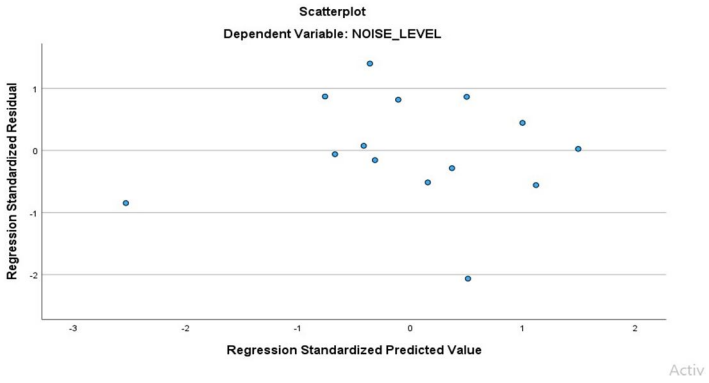
The b-coefficients dictate our regression model:
L_{eq} = 87.91 + 0.004(TVC) - 1.834(DB)
TVC – Total vehicle count
DB – Driver behavior

The value given under the heading R square tells you how much of the variance in the dependent variable is explained by the model (independent variables or predictors). The Beta values indicate which variable makes the strongest unique contribution to explaining the dependent variable, when the variance explained by all other variables in the model is controlled for. For each variable, check the Sig value to assess whether the variable is making a statistically significant unique contribution to the model. Excluded variable in this context are those predictor variables that were either not added to and/or not retained in the final model. That doesn't mean that they are not important, and certainly not that they are not part of a causal system driving the behavior of the outcome variable.

1) Normal P-P plot of Regression standardized residual



2) Scatterplot



IV. PREVENTION MEASURE

As an alternative solution to sound walls for mitigating highway noise, The upper surface layer of the pavement has been made of rubberized bituminous mixture, produced by the wet process. Results of the measurements on conventional and modified pavement sections are compared, certifying that rubberized asphalt layers can be not only environmentally friendly—since a category of solid wastes (worn automobile tires) is utilized—but also, addition of tire rubber particles in bituminous binder provides up to 3dB noise reducing bituminous mixtures and pavements, noise reduction that remains even after 8 months of road section's operation.

A. Marshall Stability Test

Marshall stability test is done to find the percentage of air voids. Marshall stability test is conducted to compare the bituminous specimen before and after adding crumb rubber to the mixture. The percentage of air voids will be more after adding the crumb rubber so it will absorb noise.

Table 5.1 Observed Marshall stability values with crumb rubber

Sl no	Percentage of crumb rubber added	Specific gravity of specimen (G_m)	Theoretical specific gravity without considering air void(G_t)	Air void (%)
1.	6%	2.19	2.27	3.5
2.	8%	2.12	2.22	4.5
3.	10%	2.052	2.17	5.44

V. CONCLUSION

Modelling of traffic noise has several uses, including estimating current noise exposure along roadways. Traffic noise level measured using decibel meter helps to identify noise pollution in that area. To develop road traffic noise model a relationship is found between two or more variables and these relationships are expressed in mathematical form. Collected data on noise generating parameters was applied to calculate the predicted noise level with the help of regression analysis. The comparison tests were made in order to examine the goodness of fit, between the predicted and measured noise level from the collected field data and to suggest a suitable model for Indian conditions Rubberized pavement helps to reduce noise pollution. There is an increase in noise pollution due to increase in total vehicle count . There is also a decrease in noise pollution due to drier behavior.

As a preventive measure rubberized asphalt pavement can be used to reduce noise. Number of air voids will be more in rubberized asphalt pavement. Comparison test were conducted before and after adding crumb rubber before adding crumb rubber the percentage of air voids present in the bituminous specimen is 2.7% after adding 6% ,8%,10%of crumb rubber to the mixture the percentage of air voids became 3.5%,4.5%,5.44% respectively that mean that it will absorb noise so it will reduce noise pollution.

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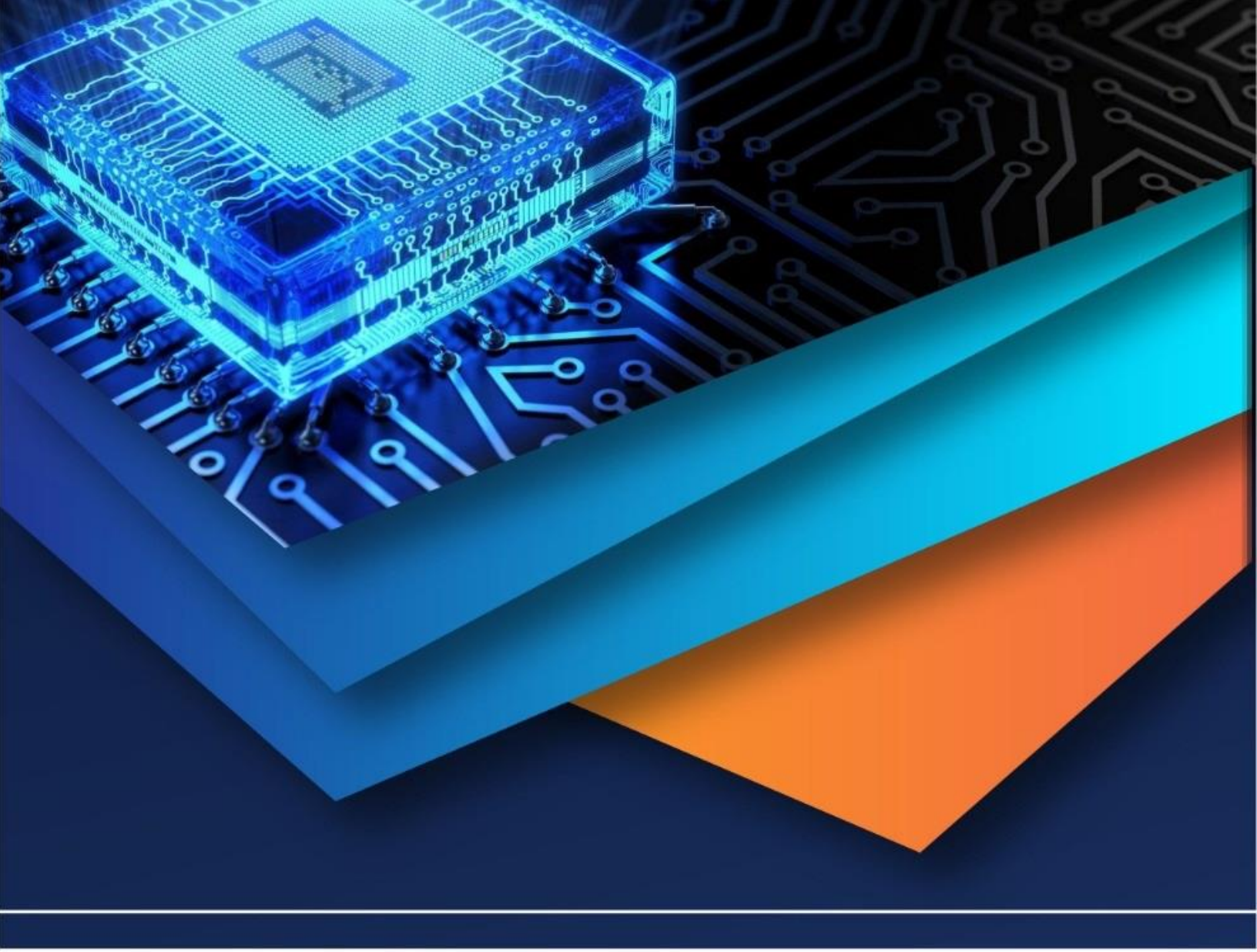

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