A STATISTICAL ANALYSIS OF TRAFFIC FLOW CHARACTERISTIC OF MULTILANE HIGHWAYS IN BAGHDAD CITY

PART B: TRAFFIC NOISE LEVELS[1]

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ABSTRACT

Road traffic noise is a function of basic traffic element (flow, speed, density) and percentage of heavy vehicles. The recognition of traffic noise as a one of the main sources of environmental pollution has led to the development of statistical models that enable the prediction of traffic noise level from fundamental variables of basic traffic element. The main objective of this research is finding out the effects of these elements on traffic noise levels for multilane highways in Baghdad city.

Data has been collected throughout an extensive field survey on twenty selected sections in the study area. Noise levels were measured by using sound level meter in five stations in each selected road and the noise level reading was taken at each ten seconds, the reading of sound level meter was recorded directly, then the noise levels were determined (L_{10}, L_{50}, L_{90}, L_{eq}).

Statistical technique is applied to analyze the collected data by the aids of computer program packages in order to present the best models to describe the influence of flow, speed , density and percentage of trucks on traffic noise levels.

The results of this study indicate that the second and third order equations are the best models that represent the effect of each traffic element on each traffic noise level in general, and especially on L_{10} noise level.

KEYWORDS
Traffic noise, noise levels, traffic flow, speed, and density

INTRODUCTION

In the recent years, highway traffic noise becomes the toll of progress, which is defined as " the unpleasant or unwanted sound" generated on our nations, streets and highways which are highly concerned with both public and local officials[2]. The source of traffic noise consists of large number of different type of vehicles , while sound or noise transfer affected by elevation of highway distance between highway and receiver, difference in topography and wind direction and speed . In general road traffic noise at a given locations is the combination of the individual noise from each vehicle that comprises the traffic stream[3,4].

Study Problem and Objective

Baghdad city, the capital of the republic of Iraq, has had a considerable leading position in the middle of Iraq as historical, business, civilization, commercial, administrative, and educational center. It is drawing significant quantities of traffic from wide spreads area, for many different purposes; so that traffic characteristics which include the traffic elements and traffic noise levels are the majority problems present a number of the constituent factors of a complex of urban problems.

The main objective of this study is to present throughout extensive field and statistical analysis , the characteristics of the traffic elements and traffic noise levels of multilane highway in Baghdad city network.

Causes of Traffic Noise

The major factors which influence the generation of road traffic noise are[5,6]: (a) traffic flow, (b) traffic speed, (c) proportion of heavy vehicles, (d) gradient of the road, and (e) nature of the road surface .

Highway traffic noise is never constant. The noise level always changing with the number, type and speed of vehicles which produce the noise. Generally, the loudness of traffic noise is increased by beaver traffic volumes, higher speed, and greater number of trucks. Vehicles noise is a combination of the noises produced by the engine, exhaust, and tires[7,8].

The Noise Levels

Statistical descriptors are almost always used to describe varying traffic noise levels[5,9]. A decibel (dB) is a unit of measurement which indicates the relative intensity of sound. It is ratio between a measured quantity of sound and an agreed reference level .The dB scale is logari-thmic and uses the hearing threshold of 20μpa as the reference level[10,11].

The L_x , a statistical descriptor, signifies the noise level that is exceeded x% of the time. This descriptor was formerly used in highway noise. The most common value of x was 10, denoting the level that was exceeded 10% of the time. The L_{eq} descriptor is a special sort of average noise level. The L_{eq} is also called an energy-mean noise level. L_{eq} for typical traffic conditions is usually about 3dBA less than the L_{10} for the same conditions [12, 13, 14].

Study Area

The study area consists of 20 sections selected from four multilane highways in Baghdad city network as described in Part A of this study. These multilane highways classified as 6-lane and 4- lane highways.

Data Collection

Commonly the data was collected on weekday through the week (from Sunday to Wednesday) , bad weather and special event conditions have adverse effects on the roadway , therefore; all measurements were carried out from March to June 2004.

Traffic noise levels, which were measured from a specific source is normally carried out at positions near to the source, where are the sound pressure level of the noise from the source was significantly greater than the sound pressure level from all other noise. Traffic source was considered to be moveable then the sound power output should be taken as maximum output from all applicable directions. In this study noise measurement was done by using a sound level meter, produced by Bruel & Kjaer(type 2235 B-K) as shown in Figure(1). After calibration procedure was finished according to the specification of Bruel and Kjaer before and after measure- ment period, traffic noise levels for each selected section was obtained. The following factors were fixed during traffic noise measurement [7,15]:

1.The grade is level.

2. Wind speed is quite not exceed 2m/sec.

3. Pavement surface is normal for all chosen segments.

4. Tires condition is good (normal).

5. Temperature rang between (15-40) ˚C .

6. The effect of sudden vibration, shocks, strange voices like horn,

talking, and noisy cloths was avoided from any measurement.

Data Analysis

After collection of the field observation data , the collected data were combined and ranged together and feed to the computer programs in order to analyze these data .

The calculation of the noise levels L_{10}, L_{50} and L_{90} (dBA) for each selected section of the study area can be obtained from recorded distribution histograms of the noise measurement that recorded from sound level meter directly. This distribution translates as decreasing cumulative" S" curve of reading as shown in Figure (2), while L_{eq}dB(A) was calculated by using the following equation[6,9,14]:

$$L_{eq} = L_{50} + (L_{10} - L_{90})^2/56 \qquad \text{..........................(1)}$$

Series of computer runs using (SPSS and Statistica) programs were carried out in order to declare the effect of traffic elements on traffic noise levels such as (L_{10}, L_{50}, L_{90}, L_{eq})dB(A).

Models Calibration and Validation

According to Federal Highway Administration[2], the models of 4-lane and 6-lane multilane highways had been calibrated entirely on the same existing data can be used in developing these data. Random samples of 150 observations were selected in order to calibrate the models.

The models were re-estimated using new data set consisting of 250 observations that were selected randomly from different sections in the study area in order to validate the models. Statistical tests were done for this purpose by using chi-square method, which is based on the error between the observed and assumed sets of distribution .

STUDY RESULTS

Base year data (i.e. 2004) was used to derive a set of models with their regression coefficients . The final derived models can be used to predict noise levels represented with any of the independent variables (traffic elements) proposed in this study.

Traffic Noise Levels and Traffic flow relationship

As shown in Table (1), the results of 6-lane multilane highways showed that the quadratic formula gives the best relationship between any level of noise and traffic flow (q) in general and especially L_{10} dB (A). The analysis indicated that the quadratic formula gives highest value of the adjusted coefficient of determination (R^2) with lowest value of standard error value, when compared with other results.

Figure (3) shows that as flow increased L_{10} dB (A) noise level increased rapidly up to 1500 veh/hr , the increased of L_{10} dB(A) noise level decreased as the traffic flow increases , due to speed reduction as a results of traffic congestion. For 4-lane multilane highway the same results in the previous paragraph were present as shown in Table (2) , and Figure(4). Figure (5) shows the effect of the distance between traffic source and receiver location on L_{10} dB(A) noise level for 6-lane multilane highway . It was found that L_{10} sound level decreased about 3dB (A) for each doubling of distance from the source.

Traffic Noise Levels and Speed Relationship

The space mean speed (v_s)has an important effect on traffic noise level. At certain speeds the noise produced by vehicles is dominated by the sound of the tires rolling on the road surface. At lower speeds below 40-50 Km/hr, the engine noise becomes important too [8]. The increase in speed has a great effect on passenger car rather than heavy vehicles , then at highest speed the noise levels of tires and engine are of great important.

For 6-lane multilane highway, as shown in Table (3), the cubic and quadratic formulas show the best relationships between the traffic noise level and space mean speed. Moreover ; this table and Figure (6) show that the L_{10} dB(A) noise level is best correlation with space mean speed according to the higher value of adjusted (R^2) with lower value of standard error. In Figure (6), L_{10}dB(A) noise level decreases rapidly as average speed increased up to 74Km/hr, which represent the optimum space mean speed. Then as an average speed increased the L_{10} dB(A) noise level increases too. These results are presented on 4-lane multilane highway in same manner as shown in Table (4). Figure (7) indicates that the optimum space mean speed is (68 Km/hr).

Traffic Noise Level and Traffic Density Relationship

The final results of statistical analysis show that the cubic equations represent the good correlation between the noise level and the harmonic mean density (k) for 6-lane and 4-lane multilane highways. Beside that, these results refer to the most significant noise levels for these relationships. Table (5) and (6) represent these equations for 6-lane and 4-lane multilane highways respectively. For 6- lane highways Figure (8) shows that the best relationship is the cubic equation . In this figure the L_{10} dB(A) noise level decreases as density increases up to (29 veh/km/ln), which represent optimum density for traffic noise level. Then the L_{10} dB(A) noise level increased as density increased up to (69 veh/km/ln), which represents the worst density for traffic noise level .Then L_{10} dB(A) noise level decreased as density increased.

In the same manner, Figure (9) gives the best cubic equation for 4-lane highways. In this figure, the densities of (20 veh/km/ln) and (66 veh/km/ln) represent the optimum and worst densities for L_{10} dB(A) noise level respectively.

Traffic Noise Level and Percentage of Heavy Vehicles Relationships

The correlation between the noise levels and the percentage of heavy vehicles was tested by using statistical analysis. All percentages of heavy vehicles were calculated when the traffic flow vary between 900 to 1100 (veh/hr) for 6-lane multilane highway and between 750 to 1000 (veh/hr) for 4-lane multilane highway.

As shown in Tables (7) and (8), the quadratic equation represent the best correlation between the percentage of heavy vehicles and the traffic noise level in general, and L_{10} dB (A) noise level especially, for 6-lane and 4-lane respectively. While Figures (10) and (11) show the best quadratic equation to represent the effect of heavy vehicles on the L_{10} dB(A) noise level for 6-lane and 4-lane respectively.

CONCLUSIONS

According to the field measurements and statistical analysis techniques used to investigate the effect of basic traffic elements on traffic noise levels along two types of multilane highways in Baghdad city. The following conclusions can be drawn out:

1- In the study area, L_{10} dB (A) is the most significant noise level among other levels that described the relationship with traffic elements. Beside that, it was found that the L_{10} dB (A) noise level very high (ranged between 79-85) dB (A) along selected section of study area. This leads to the fact that planners, designers and decision makers must not neglect traffic noise level impact which causes worst environmental effects on the road side development for highways in Iraq.

2- The second and third degree formulas give the best statistical relationships between the dependent variable L_{10} dB (A) noise level and each traffic elements as independent, according to the maximum value of adjusted (R^2) , minimum value of standard error (S.E.) , and significant by F-test , for multilane highways in Baghdad city.

i. The continuing work is needed to implement Iraqi criteria related to traffic noise on traffic network in Iraq. Considering social and environmental properties, due to importance of establishment strategy to improve acoustic environment .This criterion must be characterized by flexibility and comprehensive to be compatible with traffic conditions, which help planning government to establish strategies of vehicles noise pollution control.

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Table (1). Correlation between noise levels and traffic flow(q) for 6- lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=52.834+0.013*q	Linear	0.696	2.002	99.416 †
L_{10}=36.790+15.522*log q	Log.	0.575	5.716	72.391 †
L_{10}=93.929-14795(1/q)	Inverse	0.501	3.313	62.113 †
L_{10}=61.111+0.021*q - 0.00000043*q^2	Quadratic	0.763	1.618	119.013 †
L_{10}=12.833*$(q)^{0.241}$	power	0.646	1.991	85.191 †
L_{50}=47.454+0.011*q	Linear	0.500	2.000	11.441 †
L_{50}=33.323+14.008*log q	Log.	0.543	3.313	25.603 †
L_{50}=75.749-4510.923(1/q)	Inverse	0.531	1.810	30.001 †
L_{50}=36.041+0.028*q - 0.00000048*q^2	Quadratic	0.546	1.479	39.748 †
L_{50}=11.452*$(q)^{0.243}$	power	0.545	1.661	35.681 †
L_{90}=51.443+0.015*q	Linear	0.506	2.703	10.031 †
L_{90}=31.773+13.224*log q	Log.	0.506	1.808	11.112 †
L_{90}=71.202-4268.660(1/q)	Inverse	0.5	2.710	16.600 †
L_{90}=33.645+0.026*q - 0.00000046* q^2	Quadratic	0.571	1.399	45.615 †
L_{90}=10.688*$(q)^{0.243}$	power	0.579	1.353	33.404 †
L_{eq}=48.481+0.012*q	Linear	0.566	3.311	32.066 †
L_{eq}= 37.881+14.965*log q	Log.	0.484	4.861	18.190 †
L_{eq}=78.664-4845.396(1/q)	Inverse	0.459	5.710	17.110 †
L_{eq}=36.336+0.030*q - 0.00000051*q^2	Quadratic	0.568	1.605	37.844 †
L_{eq}=11.139*$(q)^{0.251}$	power	0.490	1.777	11.701 †

† Significant for 1% confidence level .

Table (2). Correlation between noise levels and traffic flow(q) for 4-lane highway(Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
$L_{10}=66.159+0.007*q$	Linear	0.818	3.610	32.001 †
$L_{10}=20.980+7.832*\log q$	Log	0.882	10.103	44.401 †
$L_{10}=82.139-4790.06(1/q)$	Inverse	0.683	5.616	42.622 †
$L_{10}=62.471+0.013*q-0.0000024*q^2$	Quadratic	0.927	1.011	50.166 †
$L_{10}=35.577*(q)^{0.107}$	power	0.892	2.812	42.511 †
$L_{50}=56.838+0.009*q$	Linear	0.806	4.333	4.221 ††
$L_{50}=1.863+9.556*\log q$	Log	0.779	9.309	3.515
$L_{50}=76.384-5705.74(1/q)$	Inverse	0.575	7.715	4.00 ††
$L_{50}=52.242+0.017*q-0.0000029*q^2$	Quadratic	0.836	2.301	4.926 ††
$L_{50}=24.441*(q)^{0.146}$	Power	0.796	3.337	3.919
$L_{90}=51.863+0.009*q$	Linear	0.821	7.776	7.029 ††
$L_{90}=6.815+1.076*\log q$	Log	0.876	6.512	6.616 ††
$L_{90}=72.019-6364.67(1/q)$	Inverse	0.724	9.330	3.732
$L_{90}=44.677+0.021*q-0.0000046*q^2$	Quadratic	0.911	1.406	7.229 †
$L_{90}=19.933*(q)^{0.165}$	Power	0.882	3.140	7.092 †
$L_{eq}=60.830+0.008*q$	Linear	0.778	2.001	4.022 ††
$L_{eq}=-13.058+8.336*\log q$	Log	0.737	5.503	4.221 ††
$L_{eq}=77.999-4896.32(1/q)$	Inverse	0.527	9.200	4.001 ††
$L_{eq}=57.449+0.013*\ -0.0000022*q^2$	Quadratic	0.803	1.411	4.305 ††
$L_{eq}=30.091*(q)^{0.122}$	Power	0.754	6.160	4.030 ††

† Significant for 1% confidence level .

†† Significant for 5% confidence level .

Table (3). Correlation between noise levels and space mean speed(v_s) for 6-lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
$L_{10}=93.795-0.161\ v_s$	Linear	0.585	2.292	33.41 †
$L_{10}=127.112-10.536\ \log v_s$	Log.	0.647	3.307	42.112 †
$L_{10}=72.944-654.614(1/v_s)$	Inverse	0.696	1.993	45.411 †
$L_{10}=113.40-0.111v_s+0.007\ v_s^2$	Quadratic	0.779	1.223	60.551 †
$L_{10}=100.8-0.445v_s-0.003\ (v_s)^2 +0.000005\ (v_s)^3$	Cubic	0.778	1.276	93.44 †
$L_{10}=137.253\ (v_s)^{-0.127}$	Power	0.654	1.515	22.219 †
$L_{50}=86.671-0.182\ v_s$	Linear	0.543	1.982	33.131 †
$L_{50}=122.112-11.036\ \log v_s$	Log.	0.543	1.772	30.092 †
$L_{50}=64.244+677.014(1/\ v_s)$	Inverse	0.531	4.335	35.52 †
$L_{50}=95.39-0.464v_s+0.002\ v_s^2$	Quadratic	0.544	2.001	51.202 †
$L_{50}=50.2+1.77v_s+0.003\ (v_s)^2 +0.0001\ (v_s)^3$	Cubic	0.564	1.558	55.66 †
$L_{50}=110.253\ (v_s)^{-0.127}$	power	0.564	3.333	32.136 †
$L_{90}=80.72-0.151\ v_s$	Linear	0.541	3.634	42.112 †
$L_{90}=111.892-9.963\ \log v_s$	Log.	0.511	7.888	39.331 †
$L_{90}=60.993+599.639(1/v_s)$	Inverse	0.505	7.902	41. 32 †
$L_{90}=91.207-0.496v_s+0.002\ v_s^2$	Quadratic	0.567	3.020	40.411 †
$L_{90}=83.113-0.81v_s-0.003\ (v_s)^2 +0.00003\ (v_s)^3$	Cubic	0.578	1.662	45.615 †
$L_{90}=126.498*(v_s)^{-0.14}$	power	0.541	5.078	22.61 †
$L_{eq}=72.347-0.178\ v_s$	Linear	0.461	2.300	10.551 †
$L_{eq}=124.926-11.332\ \log v_s$	Log.	0.487	2.711	17.37 †
$L_{eq}=66.944+687.475(1/v_s)$	Inverse	0.500	2.021	21.112 †
$L_{eq}=90.12\ -0.815v_s+0.005\ v_s^2$	Quadratic	0.518	1.976	21.221 †
$L_{eq}=44.17+2.39v_s-0.004\ (v_s)^2 +0.0002\ (v_s)^3$	Cubic	0.537	1.771	38.626 †
$L_{eq}=142.373\ (v_s)^{-0.145}$	power	0.490	3.170	12.212 †

† Significant for 1% confidence level .

Table (4).Correlation between noise levels and space mean speed (v_s) for 4-lane highway(Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=87.8452-0.115 v_s	Linear	0.722	1.808	35.769 †
L_{10}=110.682-7.294 logv_s	Log.	0.792	1.799	61.001 †
L_{10}=73.252-449.383(1/v_s)	Inverse	0.780	2.323	75.772 †
L_{10}=88.478-0.97 v_s+0.0003 v_s^2	Quadratic	0.791	1.200	81.112 †
L_{10}=95.404-0.387v_s+0.003 $(v_s)^2$ +0.00006 $(v_s)^3$	Cubic	0.797	0.975	86.163 †
L_{10}=131.238 $(v_s)^{-0.117}$	power	0.711	3.201	35.002 †
L_{50}=78.972-0.069 v_s	Linear	0.441	4.091	3.329
L_{50}=93.449-4.561 log v_s	Log.	0.456	3.331	3.228
L_{50}=69.853+293.553(1/v_s)	Inverse	0.471	6.020	3.101
L_{50}=92.784-0.501 v_s+0.003 v_s^2	Quadratic	0.465	7.717	3.500
L_{50}=83.724-0.073v_s+0.003 $(v_s)^2$ +0.0003 $(v_s)^3$	Cubic	0.495	2.380	4.414 ††
L_{50}=96.131 $(v_s)^{-0.127}$	power	0.491	2.681	3. 381
L_{90}=72.960-0.053 v_s	Linear	0.414	9.930	3.181
L_{90}=84.230-3.542 logv_s	Log.	0.460	8.163	4.111 ††
L_{90}=65.880+229.527(1/v_s)	Inverse	0.484	11.336	3. 381
L_{90}=87.761-0.516 V_s+0.003*vs^2	Quadratic	0.564	5.500	4.552 ††
L_{90}=45.360+1.486v_s-0.027 $(v_s)^2$ +0.0001 $(v_s)^3$	Cubic	0.571	4.141	5.421 ††
L_{90}=75.950 $(v_s)^{-0.051}$	power	0.498	5.552	4.911 ††
L_{eq}=71.290-0.075 v_s	Linear	0.643	3.90	3.511
L_{eq}=96.679-4.866 log v_s	Log.	0.619	3.878	4.221 ††
L_{eq}=71.563+309.192(1/v_s)	Inverse	0.578	13.131	4.002 ††
L_{eq}=88.956-0.314 v_s+0.001 v_s^2	Quadratic	0.689	3.991	4.112 ††
L_{eq}=43.617+5.948v_s+0.01 $(v_s)^2$ +0.0001 $(v_s)^3$	Cubic	0.699	3.729	4.547 ††
L_{eq}=67.392 $(v_s)^{0.037}$	power	0.619	5.391	3.911

† Significant for 1% confidence level .

†† Significant for 5% confidence level .

Table (5). Correlation between noise levels and density(k) for 6-lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=66.185+0.142 k	Linear	0.691	6.551	70.881 †
L_{10}=56.933+5.197 log k	Log.	0.638	6.501	85.661 †
L_{10}=84.244-159.915(1/k)	Inverse	0.575	11.311	100.991 †
L_{10}=76.416-0.018 k+0.0018(k^2	Quadratic	0.763	4.301	101.280 †
L_{10}=87.427-1.034 k+0.026 $(k)^2$ +0.0003 $(k)^3$	Cubic	0.777	0.896	129.096 †
L_{10}=60.685 $(k)^{0.062}$	power	0.646	3.201	60.608 †
L_{50}=69.736+0.145 k	Linear	0.512	3.221	45.800 †
L_{50}=54.642+5.727 log k	Log.	0.517	7.700	55.200 †
L_{50}=80.764-192.279(1/k)	Inverse	0.478	9.681	50.305 †
L_{50}=67.339+0.264 k-0.001$(k)^2$	Quadratic	0.525	1.998	66.760 †
L_{50}=72.871-0.167 k+0.009 $(k)^2$ +0.00007 $(k)^3$	Cubic	0.632	1.250	78.368 †
L_{50}=57.187 $(k)^{-0.127}$	power	0.518	7.250	33. 050 †
L_{90}=65.792+0.130 k	Linear	0.551	5.00	25.781 †
L_{90}=52.443+5.093 log k	Log.	0.521	5.005	30.991 †
L_{90}=75.641-169.742(1/k)	Inverse	0.512	4.552	33. 602 †
L_{90}=65.154+0.162 k-0.0003$(k)^2$	Quadratic	0.553	3.711	45.541 †
L_{90}=60.696+0.354*k-0.004 $(k)^2$ +0.00003 $(k)^3$	Cubic	0.560	3.070	54.997 †
L_{90}=50.571 $(k)^{-0.072}$	power	0.511	3.812	51.390 †
L_{eq}=72568+0.146 k	Linear	0.475	4.330	5.707 ††
L_{eq}=58.026+5.596 log k	Log.	0.447	2.801	4.001 ††
L_{eq}=83.346-180.275(1/k)	Inverse	0.380	2.951	3.707
L_{eq}=72.425+0.153k+0.0001$(k)^2$	Quadratic	0.453	3.000	31.619 †
L_{eq}=85.513-0.868k+0.0024 $(k)^2$ +0.0001 $(k)^3$	Cubic	0.512	2.751	46.922 †
L_{eq}=60.289 $(k)^{0.072}$	power	0.450	3.710	11.339 †

† Significant for 1% confidence level.
†† Significant for 5% confidence level.

Table (6). Correlation between noise levels and density (k) for 4-lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=65.520+0.166*k	Linear	0.702	1.002	5.990 ††
L_{10}=55.746+4.972*logk	Log.	0.717	1.500	7.002 †
L_{10}=82.507-141.371(1/k)	Inverse	0.719	1.330	35.661 †
L_{10}=71.509-0.0443*k 0.004*k^2	Quadratic	0.718	3.302	22.635. †
L_{10}=84.465-1.218*k+0.044*k^2 -0.0053*$(k)^3$	Cubic	0.727	0.594	51.842 †
L_{10}=65.373*$(k)^{0.061}$	power	0.716	2.059	18.186 †
L_{50}=71.708+0.092*k	Linear	0.538	1.882	4.325 ††
L_{50}=65.603+2.630*logk	Log.	0.502	1.800	4.445. ††
L_{50}=76.977-71.033(1/k)	Inverse	0.453	1.879	3.993
L_{50}=70.237-0.213*k+ 0.010*k^2	Quadratic	0.589	2.009	5.608 ††
L_{50}=75.057-0.039*k+0.032*k^2 -0.0003*$(k)^3$	Cubic	0.595	0.859	6.918 ††
L_{50}=66.083*$(k)^{0.038}$	power	0.502	2.000	4. 003 ††
L_{90}=65.840-0.198*k	Linear	0.600	3.330	5.524 ††
L_{90}=61.998+2.224*log k	Log.	0.601	2.100	6.260 ††
L_{90}=71.715-62.743(1/k)	Inverse	0.594	2.000	3. 133
L_{90}=66.926+0.097*k-0.0003*k^2	Quadratic	0.601	2.909	4.890 ††
L_{90}=66.926+0.097*k-0.0003*$(k)^2$ -0.117*$(k)^3$	Cubic	0.611	0.991	7.005 †
L_{90}=62.384*$(k)^{0.032}$	power	0.608	1.101	5.720 ††
L_{eq}=73.489+0.098*k	Linear	0.603	2.220	5.992 ††
L_{eq}=66.835+2.846*log k	Log.	0.619	3.702	8.811 †
L_{eq}=79.181-78.180(1/k)	Inverse	0.578	3.000	2.212
L_{eq}=60.502-0.030*k + 0.002* k^2	Quadratic	0.654	3.013	7.714 †
L_{eq}=55.502-1.233*k +0.07*$(k)^2$ -0.0008*$(k)^3$	Cubic	0.689	0.958	9.910 †
L_{eq}=67.392*$(k)^{0.037}$	power	0.619	1.900	6.113 ††

† Significant for 1% confidence level .
†† Significant for 5% confidence level .

Table (7). Correlation between noise levels and percentage of heavy vehicle (HV) for 6-lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=70.003+0.295*HV	Linear	0.551	7.003	7.917 †
L_{10}=67.104+2.727*log HV	Log.	0.392	18.330	4.414 ††
L_{10}=75.043-14.725(1/HV)	Inverse	0.207	21.210	3.001
L_{10}=73.409-0.030*HV+0.022*HV^2	Quadratic	0.661	0.547	42.596 †
L_{10}=72.621-0.027*HV-0.002*$(HV)^2$ -0.0006 *$(HV)^3$	Cubic	0.653	0.614	18.612 †
L_{10}=67.204*$(HV\%)^{-0.033}$	power	0.398	0.991	4.333 ††
L_{50}=59.736+0.145*HV%	Linear	0.512	2.080	11.127 †
L_{50}=44.642+5.727*log HV%	Log.	0.517	1.880	25.211 †
L_{50}=70.764-192.279(1/HV%)	Inverse	0.478	1.989	21.111 †
L_{50}=67.66+0.851*HV%+0.017*HV^2	Quadratic	0.535	1.762	34.201 †
L_{50}=62.66+8.127*HV+0.011*$(HV)^2$ -0.022* $(HV)^3$	Cubic	0.532	1.919	30.152 †
L_{50}=47.187*$(HV)^{0.076}$	power	0.518	2.000	28.341 †
L_{90}=57.625+0.258*HV	Linear	0.501	3.330	17.180 †
L_{90}=54.629+2.568*log HV	Log.	0.416	4.662	13.170 †
L_{90}=62.393-14.531(1/HV)	Inverse	0.424	12.24	18. 340 †
L_{90}=60.736+1.192*HV +0.027*HV^2	Quadratic	0.526	1.245	36.640 †
L_{90}=67.236+0.067*HV-0.009*$(HV)^2$ -0.001*$(HV)^3$	Cubic	0.522	1.980	31.770 †
L_{90}=54.767*$(HV)^{-0.036}$	power	0.421	3.310	29.290 †
L_{eq}=64.387+0.308*HV	Linear	0.531	2.404	21.210 †
L_{eq}=60.902+3.028*log HV	Log.	0.439	6.194	3.717
L_{eq}=70.097-17.570(1/HV)	Inverse	0.375	17.370	16.170 †
L_{eq}=65.69+0.037*HV +0.040* HV^2	Quadratic	0.561	2.330	29.055 †
L_{eq}=67.069+1.79*HV-0.090*$(HV)^2$ +0.0017* $(HV)^3$	Cubic	0.504	1.914	19.250 †
L_{eq}=61.074*$(HV)^{0.039}$	power	0.499	2.099	11.190 †

† Significant for 1% confidence level.

†† Significant for 5% confidence level.

Table (8). Correlation between noise levels and percentage of heavy vehicle (HV) for 4-lane multilane highways (Baghdad 2004).

Production Model	Relation Type	Adjusted R^2	Standard Error S.E.	Computed F-value
L_{10}=71.705+0.689*HV	Linear	0.599	2.602	21.123 †
L_{10}=70.346+4.198*log HV	Log.	0.534	3.006	18.181 †
L_{10}=74.932-13.986(1/HV)	Inverse	0.374	11.221	3.187
L_{10}=72.895+0.011*HV +0.008*HV^2	Quadratic	0.614	0.627	26.482 †
L_{10}=78.619-0.096* HV +0.002 *$(HV)^2$ -0.002*$(HV)^3$	Cubic	0.602	0.991	23.624 †
L_{10}=75.444*$(HV)^{0.027}$	power	0.547	2.911	16.385 †
L_{50}=66.242+0.195*HV	Linear	0.510	2.000	4.191 ††
L_{50}=63.989+1.917*log HV	Log.	0.530	1.898	5.595 ††
L_{50}=69.991-14.097(1/HV)	Inverse	0.483	2.330	2.612
L_{50}=67.452-0.294*HV +0.001*HV^2	Quadratic	0.562	1.302	6.722 ††
L_{50}=67.452-0.294*HV +0.054*$(HV)^2$ -0.001* $(HV)^3$	Cubic	0.558	3.300	5.761 ††
L_{50}=67.093*$(HV)^{0.025}$	power	0.536	2.939	4.556 ††
L_{90}=63.569+.447*HV	Linear	0.377	12.09	4.691 ††
L_{90}=59.41+1.751*log HV	Log.	0.200	15.033	1.669
L_{90}=64.905-12.977(1/HV)	Inverse	0.487	9.710	4.214 ††
L_{90}=60.329+1.447*HV -0.056*HV^2	Quadratic	0.511	1.012	9.926 †
L_{90}=63.319-0.724*HV+0.113*$(HV)^2$ -0.003*$(HV)^3$	Cubic	0.500	1.998	6.619 ††
L_{90}=59.51*$(HV)^{0.025}$	power	0.340	6.16	4.100 ††
L_{eq}=70.231+0.499*HV	Linear	0.217	14.229	2.999
L_{eq}=66.99+1.892*log HV	Log.	0.331	7.716	3.119
L_{eq}=71.940-14.072(1/HV)	Inverse	0.393	9.919	3.691
L_{eq}=68.785+1.211*HV -0.041*HV^2	Quadratic	0.588	3.023	6.695 ††
L_{eq}=69.044-.158*HV +0.04*$(HV)^2$ -0.0008*$(HV)^3$	Cubic	0.528	6.552	5.919 ††
L_{eq}=68.098*$(HV)^{0.0247}$	power	0.494	2.342	4.886 ††

† Significant for 1% confidence level.

†† Significant for 5% confidence level

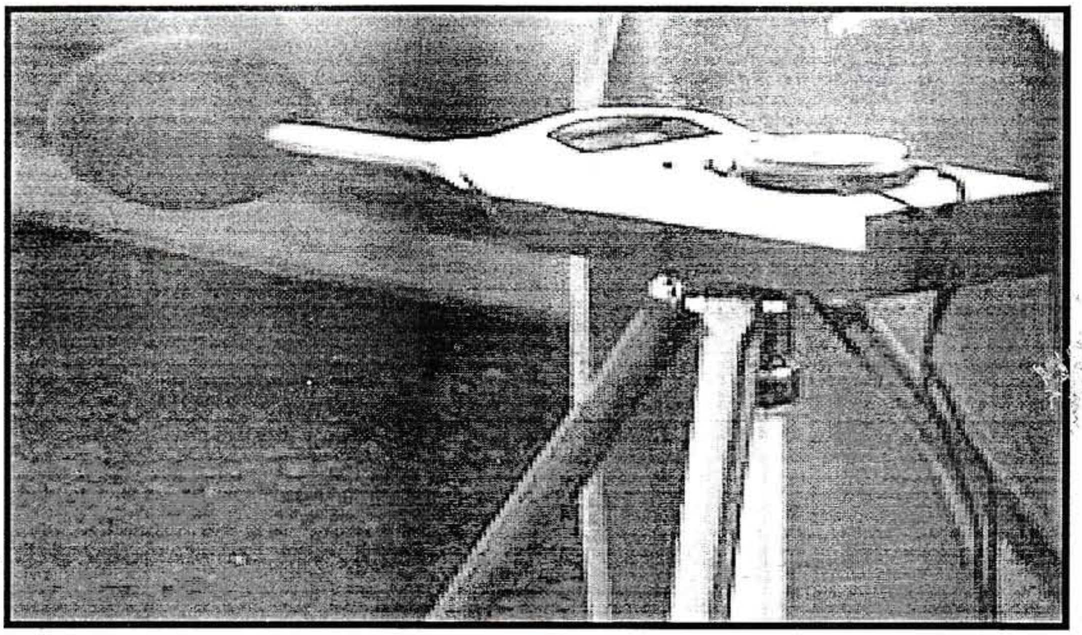
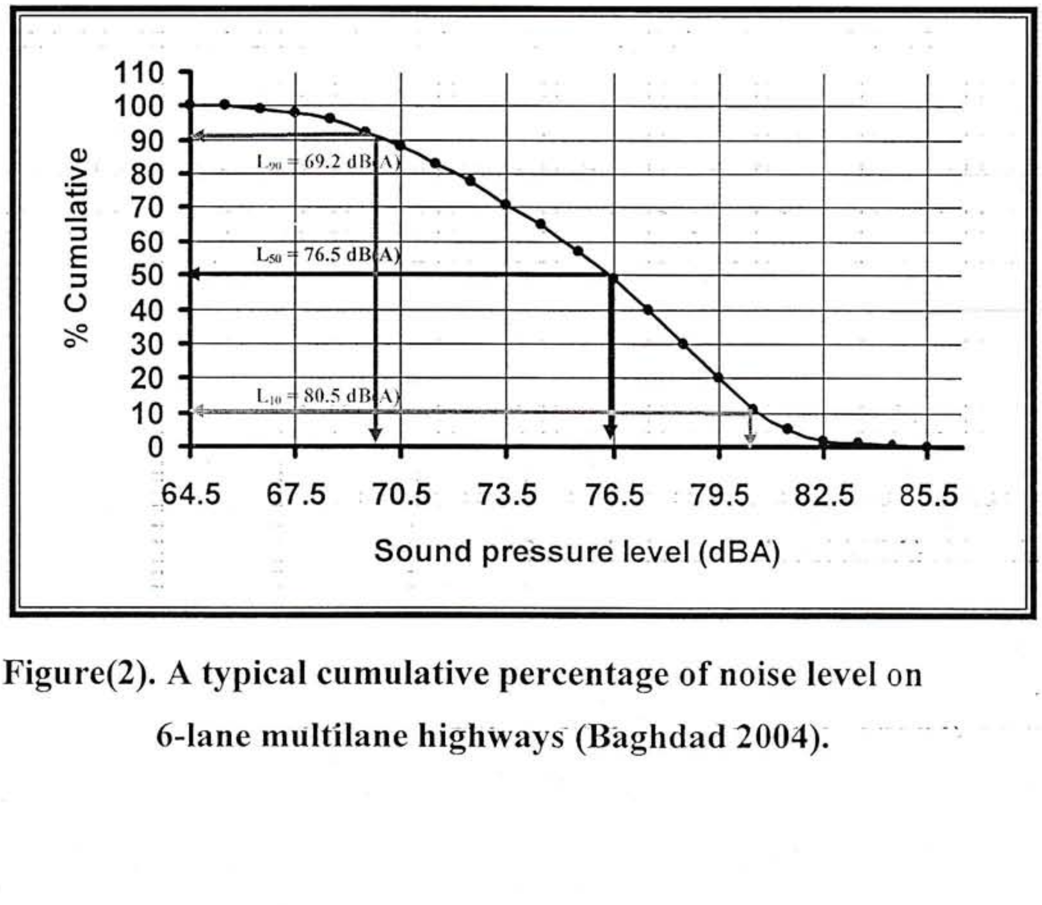


Figure (1) . Sound level meter type 2235.



Figure(2). A typical cumulative percentage of noise level on 6-lane multilane highways (Baghdad 2004).

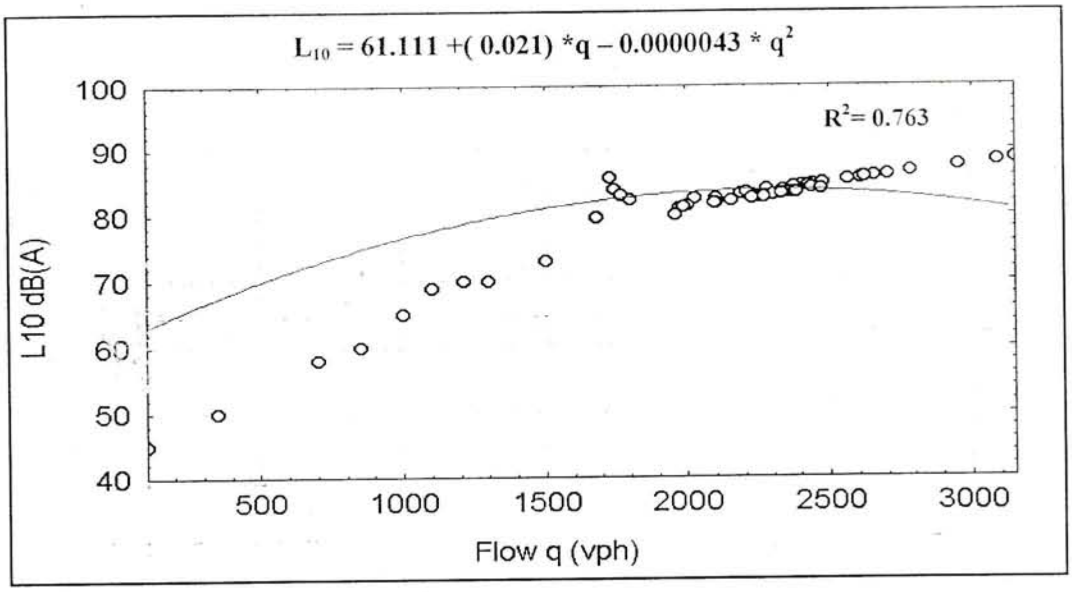


Figure (3). Relationship between traffic flow and L_{10} dB(A) noise level for 6-lane multilane highways (Baghdad 2004).

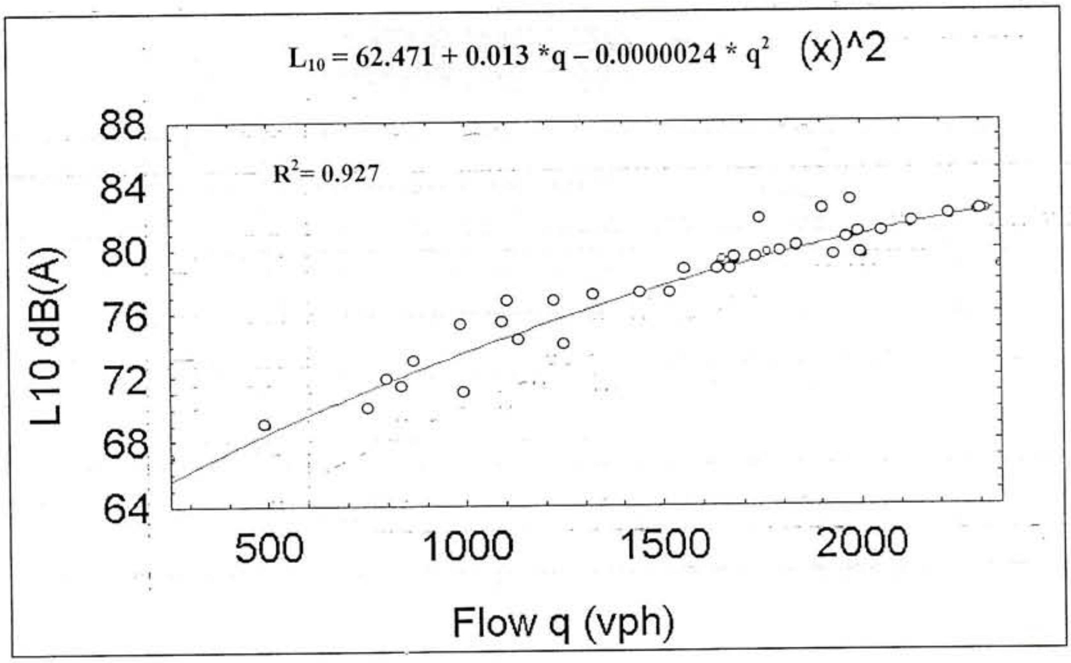


Figure (4). Relationship between traffic flow and L_{10} dB(A) noise level for 4-lane multilane highways (Baghdad 2004).

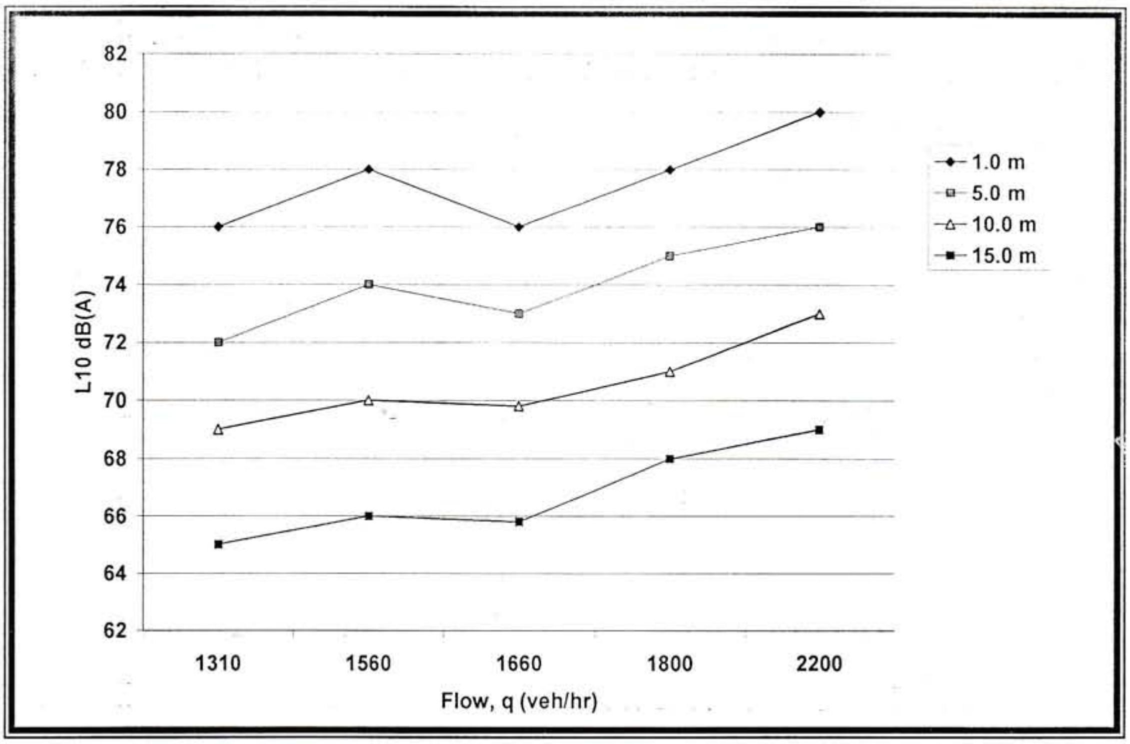


Figure (5) . The effect of the distance between traffic source and receiver location on L_{10} dB(A) noise level for 6-lane multilane highways (Baghdad 2004).

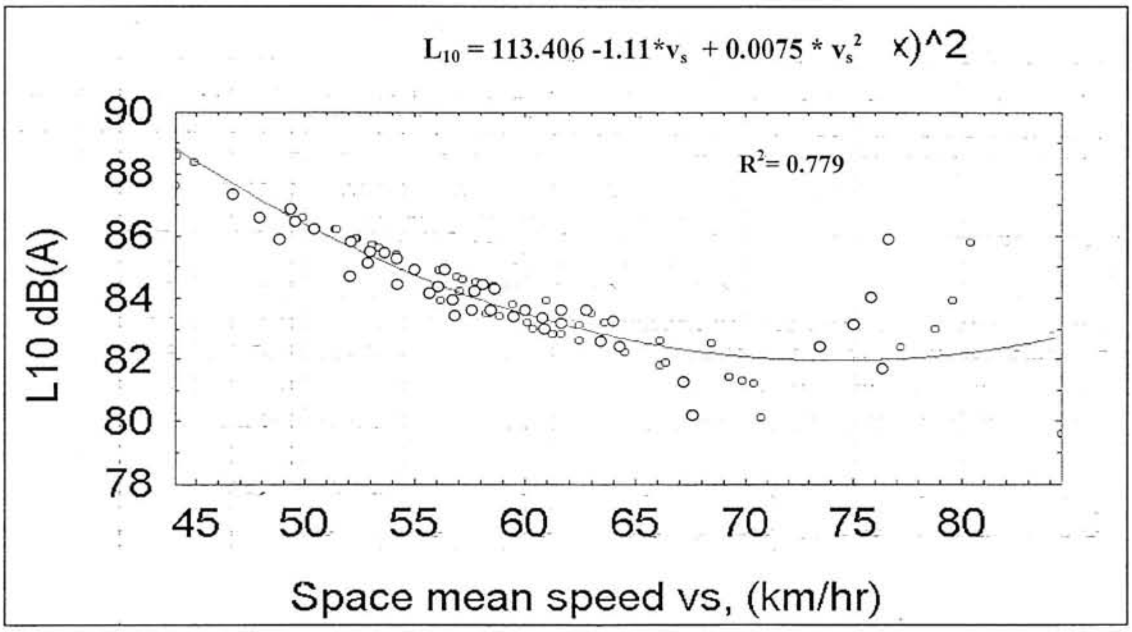


Figure (6). Relationship between space mean speed and L_{10} dB(A) noise level for 6-lane multilane highways (Baghdad 2004).

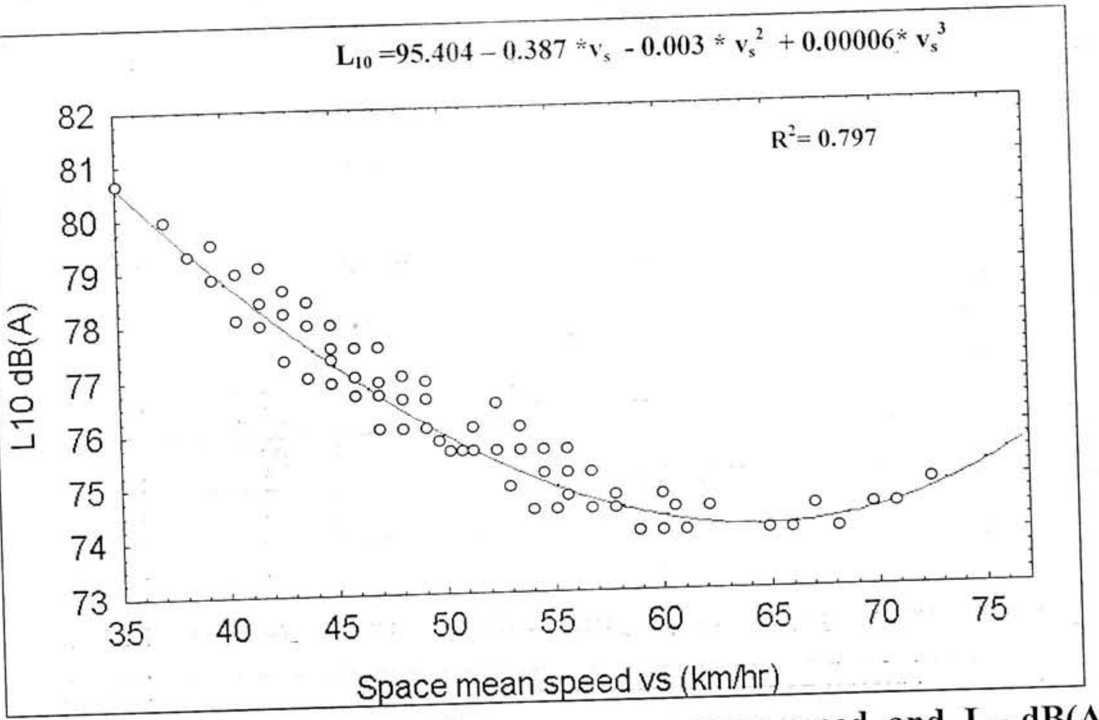


Figure (7). Relationship between space mean speed and L_{10} dB(A) noise level for 4-lane multilane highways (Baghdad 2004).

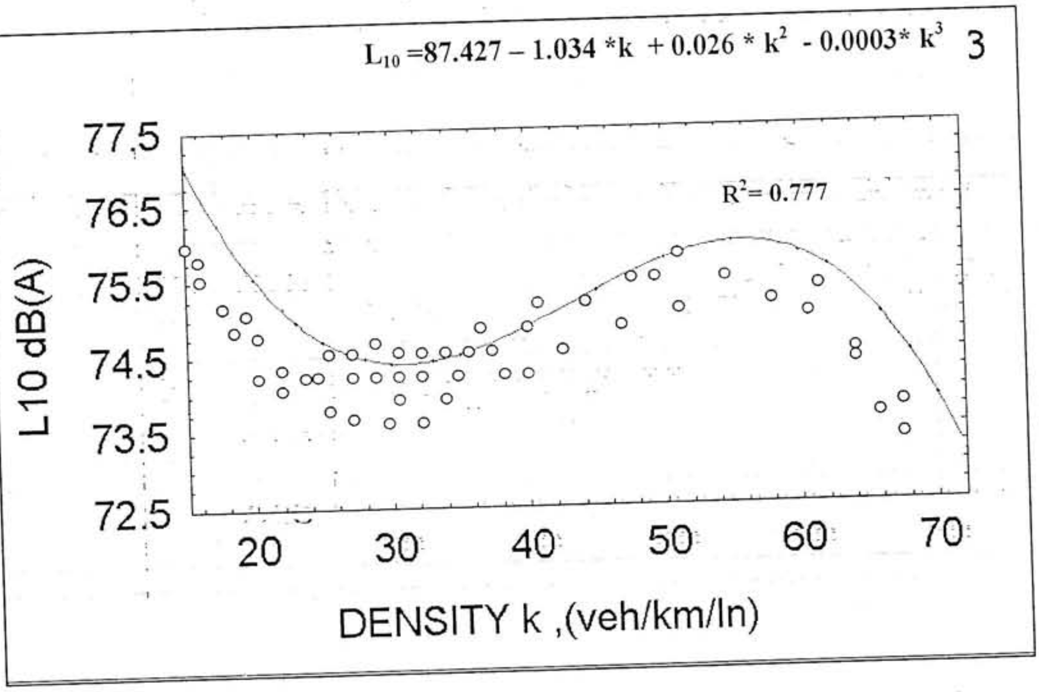


Figure (8). Relationship between traffic density and L_{10} dB(A)noise level for 6-lane multilane highways (Baghdad 2004).

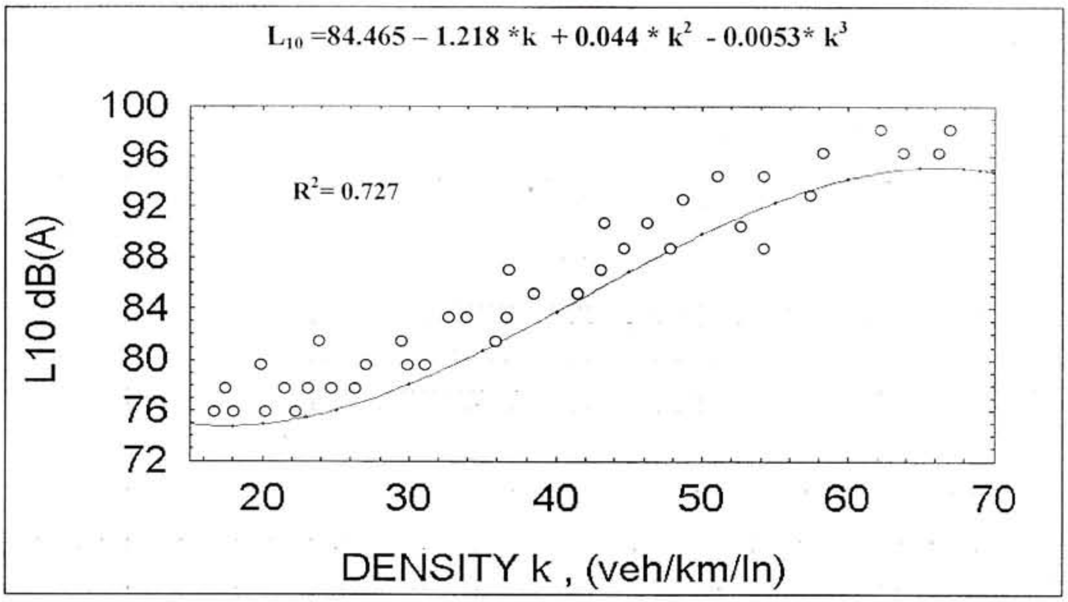
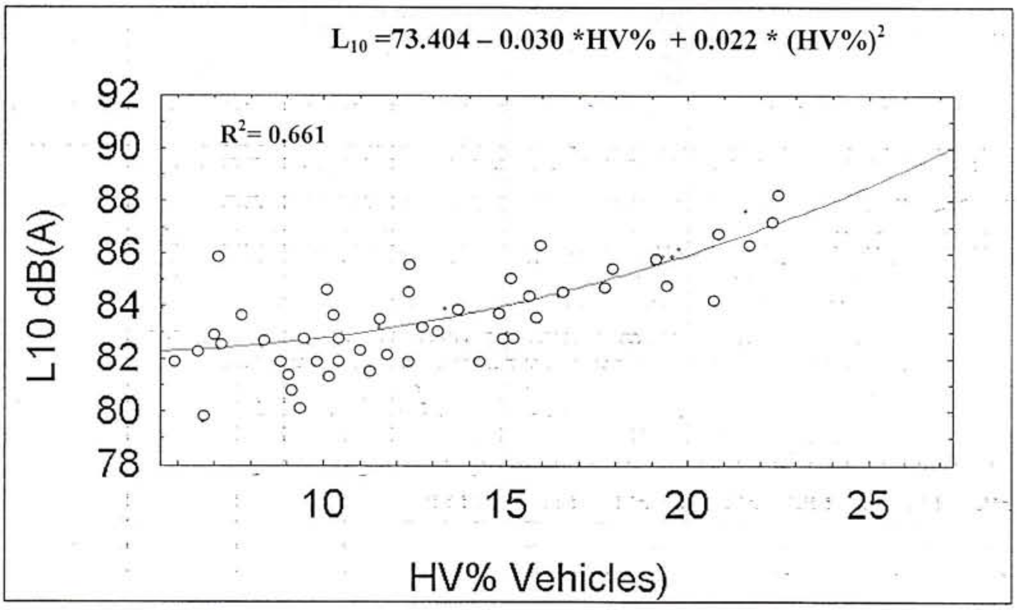


Figure (9). Relationship between traffic density and L_{10} dB(A) noise level for 4-lane multilane highways (Baghdad 2004).



Figure(10). Relationship between percentage of heavy vehicle and L_{10} dB (A) noise level for 6-lane multilane highways (Baghdad 2004).

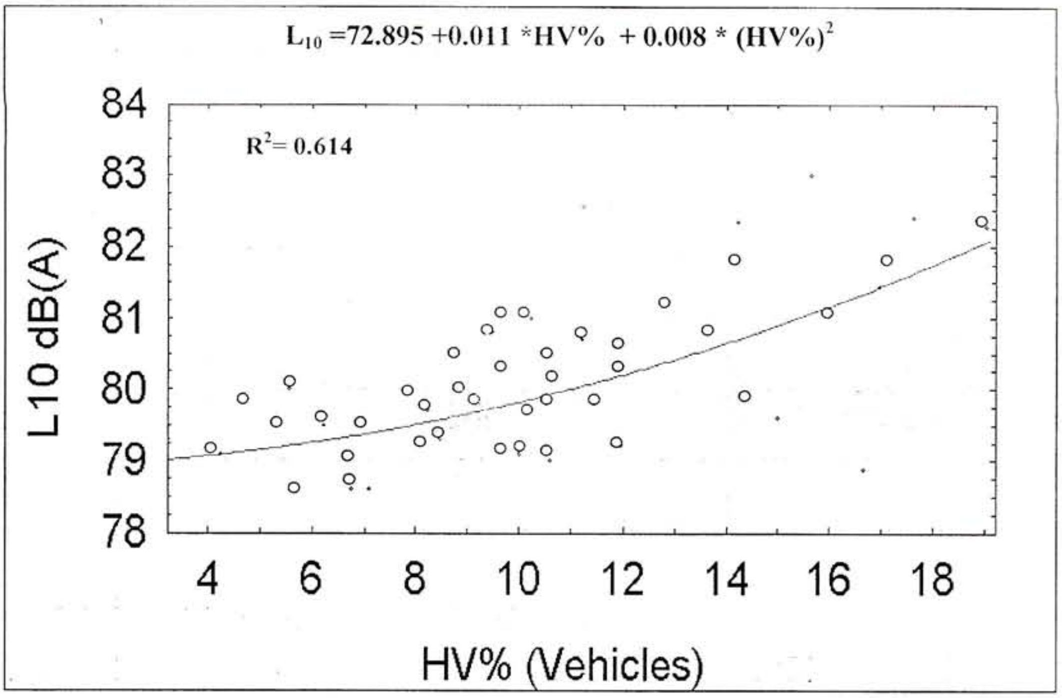


Figure (11). Relationship between percentage of heavy vehicle and L_{10} dB (A) noise level for 4-lane multilane highways (Baghdad 2004).

التحليل الإحصائي لخصائص حركة المرور على الطرق متعددة الممرات في مدينة بغداد

الجزء ب : مستويات مناسيب ضوضاء حركة المرور

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الخلاصة

ضوضاء الطرق الناتجة عن حركة المرور هي دالة العناصر الأساسـية لحركـة المـرور (الحجم المروري والسرعة والكثافة المرورية) ونسبة المركبات الثقيلة.إن تمييز ضوضاء حركـة المرور كإحدى المصادر الأساسية للتلوث البيئي يستدعي إعداد موديلا ت إحصائية قـادرة علـى التنبوء بمستوى ضوضاء حركة المرورمن قيم المتغيرات الأساسية لعناصر المـرور. و الهـدف الرئيسي من هذا البحث هو إيجاد تأثير عناصر حركة المرور الأساسية على مـستويات مناسـيب ضوضاء حركة المرورللطرق المتعددة الممرات في مدينة بغداد.

جمعت المعلومات المطلوبة من خلال مسوحات حقلية شاملة في ٢٠ موقع أختير من منطقة الدراسة.أستخدم جهاز قياس مستوى الصوت لحساب قيم مستويات ضوضاء حركة المرور فـي ٥ محطات لكل طريق من منطقة الدراسة.في كل محطة سجلت قراءات الجهاز لكل ١٠ ثواني ، ومن خلالها تم إيجاد قيم مستويات مناسيب ضوضاء حركة المرور (L10, L50, L90, Leq) .

أستخدم التحليل الإحصائي للبيانات الحقلية بمساعدة البرامج الجاهزة للحاسوب لإيجاد أفضل علاقة تصف تأثيرات عناصر المرور الأساسية على مستويات مناسيب الضوضاء المروري.

إن نتائج هذه الدراسة تشير الى ان المعادلتين الرياضيتين من الدرجة الثانية والثالثة تعطـي أفضل وصف لعلاقة عناصر المرور الأساسية ومستويات مناسيب الضوضاء المـروري بـصورة عامة وخاصة منسوب الضوضاء الذي يتجاوز ١٠% من الفترة الزمنية للقياس .