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ASSESSMENT AND MEASUREMENT OF NOISE LEVEL GENERATED BY TRAFFIC FLOW

CASE STUDY: EL KORNESH ROADWAY- ALEXANDRIA - EGYPT

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ABSTRACT:

Alexandria is the second largest city in Egypt. It is characterized by high volume of traffic inducing noise which is perceived as a serious environmental problem. In addition, rapid growth of annual traffic flow and the shortage of construction new axis in Alexandria city generate more noise pollution.

El-Kornesh Roadway is considered as the main and most important avenue in Alexandria, as it connects the city from the east to the west.

The objective of this research is to measure the noise level and traffic volume along El-Kornesh Roadway at several stations, to compare the results with the criteria mentioned in the Egyptian Environmental Law No 4/1994, and then to investigate correlation between noise level and traffic volume.

In this study, 11 stations were selected along El-Kornesh Roadway at quasi-equal distances (about 1.5 km). The noise level and traffic volume were measured from February to June 2006, and 8-hour measurement were done at each station.

The study concluded that noise level in all stations along El-Kornesh Roadway exceeds the maximum allowable level stated in Egyptian Environment Law No 4/1994.

The research recommended creating other alternatives to alleviate traffic volume in El-Kornesh Roadway.

INTRODUCTION:

Unlike other pollution, sound is not an element, compound or substance which can accumulate and harm future generations. It is a special kind of wave action, usually transmitted by air in the form of pressure waves and received by the hearing apparatus.

Independent of loudness, noise is any sound that can produce an undesired physiologica1 or psychological effect on an individual, and that may interfere with the social ends of an individual or group. These social ends include all of human activities such as communication, work, rest, recreation, and sleep[3].

Noise, with sufficient intensity and duration, can cause temporary or permanent hearing loss, ranging from slight impairment to nearly total deafness. While short-term effects, include interference with speech communication and the perception of other auditory signals,

disturbance of sleep and relaxation, annoyance, interference with an individual's ability to perform complicated tasks, and general diminution of the quality of life[2].

Human body could also be affected by noise in a number of ways: blood vessels get constricted, breathing rate is affected, muscle tension changes and glandular reactions get affected. At higher impulsive noise pollution, the pulse rate and blood pressure changes, and stored glucose from the liver increased production of adrenalin[8].

Noise generated by traffic flow is considered as main source of noise pollution. Vehicle noise could be generated from seven main parts: exhaust, engine, tires, transmission, cooling fan, intake, and aerodynamic around the vehicle.

For most automobiles, exhaust noise constitutes the predominant source for normal operation below 55 km/h. Although tire noise is much less in automobiles than in truck, it is the dominant noise source at speeds above 80 km/h. While not as noisy as trucks, the total contribution of automobiles to the noise environment is significant because of their very large number[4].

TRAFFIC NOISE PREDICTION:

The type of noise (continuous, intermittent, or impulsive) and the time of day that it occurred (day, night or evening) are significant factors in annoyance. The response to sound is also dependent on the frequency of the sound. Thus, the ideal system for noise prediction must take frequency into account. It should be differentiated between day-time and night-time noise. And, finally, it must be capable of describing the cumulative noise exposure. A statistical system can satisfy these requirements.

The parameter L_N is a statistical measure to indicate how frequently a particular sound level is exceeded. For example, if L_{40} = 72 dBA, this means that 72 dBA was exceeded for 40 percent of the measuring time. A plot of L_N against N, where N = 1 percent, 2 percent, 3 percent, and so forth, would look like the cumulative distribution curve shown in Figure (1)[5].

Allied to the cumulative distribution curve, is the probability distribution curve. A plot of this will show how often the noise levels fall into certain class intervals. For example, as shown in Figure (2), 22 percent of the time, the measured noise levels ranged from 70 to 72 dBA; for 17 percent of the time they ranged from 72 to 74 dBA; and so on.

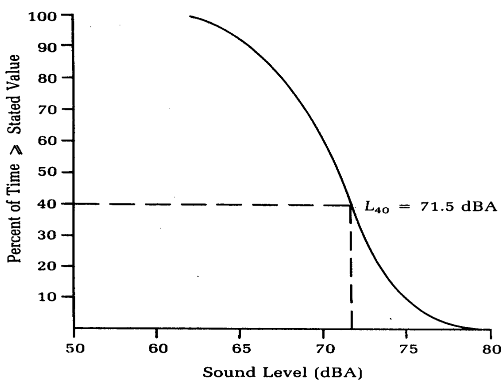

Fig. (1): Cumulative distribution curve

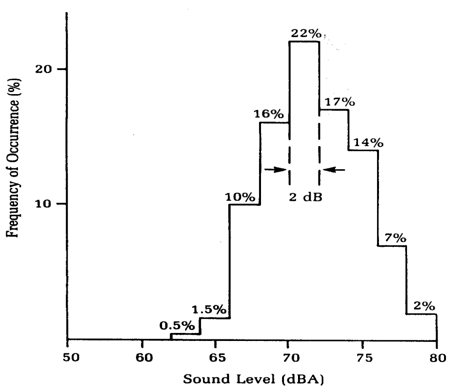

Fig. (2): Probability distribution plot

The relationship between this plot and the L_N curve is simple. By adding the percentages given in successive class intervals from right to left, corresponding L_N could be calculated, where N is the sum of the percentages and L is the lower limit of the left-most class interval added, thus, as shown in Figure (2), L_{40} = L (2+7+14+17) is corresponding to 71.5 dBA[5].

MATERIAL AND METHOD:

The objective of this research is to measure the noise level and traffic volume along El-Kornesh Roadway at several stations in different times. A comparison between the results and the criteria mentioned in the Egyptian Environmental Law No 4/1994 will be done. Also, correlation between noise level and traffic volume will be investigated.

● Site description:

Alexandria is the second largest city and the main port of Egypt; it lies at the intersection of longitude 29° 55' east and latitude 31° 13' north. The area of Alexandria is about 2818.77 km^2 with an occupied area of 1054.32 km^2 and estimated population of 4.2 million capita. Alexandria is characterized by high traffic volume, which induces noise perceived as a serious environmental nuisance. Rapid growth of traffic flow and the shortage of constructing new axis contribute to more noise pollution.

El-Kornesh roadway, which is improved recently, is considered as the main roadway in Alexandria where it connects the east and west of the city. Therefore, it has very high traffic volume level.

● Measurement Stations:

In order to evaluate the noise profile accurately as possible, eleven monitoring stations at approximately quasi-equal distances were selected along the studied roadway length as shown in Figure (3).

The distance between the first station (El-Warda Hotel) and the last one (Mohamed Abd El-Wahab Theatre) is approximately 17.4 km, with interval between stations about 1.5 km. El Kornesh roadway is two-way, and the characteristics of the road at each station are presented in Table (1).

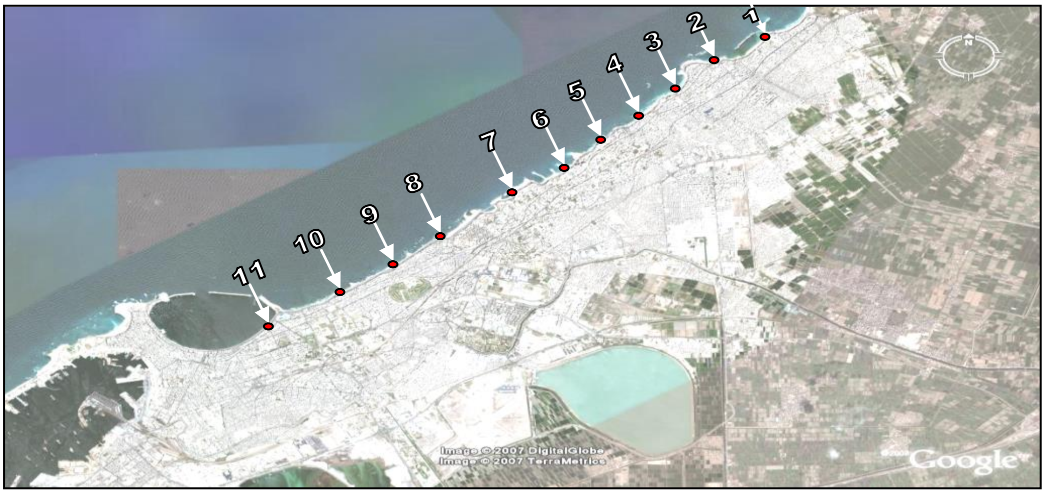

Fig. (3): Location of monitoring stations

● Measurement dates and times:

The selected days for measurement were Monday, Tuesday and Wednesday, which are the heavy working days. Holidays or week-ends or the start of the week were excluded from the measuring days. The measurement dates are represented in Table (1).

As shown in Table (2), measurement times were selected according to the classification of Egyptian Environmental Law No 4/1994 where each day time (morning–evening–night) has corresponding permissible noise level as will be demonstrated in details in next section.

● Measurement instrument:

In this research, Digital Sound Level Meter (Fig. 4) was used to measure noise level. It covers a range from 50 to 126 dB, with precision of 1 dB, and has the possibility to measure A or C-weighting. Measurement using A-weighting is selected in this study because it corresponds to frequencies from the 500 to 10,000 Hz which is the human ear's most sensitive range[7].

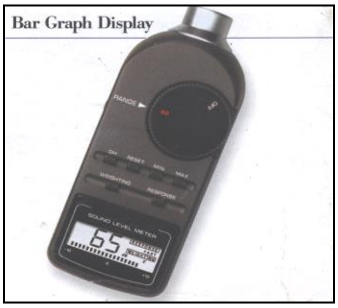

Figure (4): Sound levels meter

At each station, the sound level meter was set out in a suitable location on the walkway, at northern side of the road and nearby the residential buildings which are the main receiver of traffic noise. The decibel meter was placed at 1.60 m from ground level, and directed perpendicular to the flow direction. Each measurement hour, is monitored 240 times with 15 seconds interval.

Table (1): Characteristics of stations and measurement date[1]

No.	Station	No of lanes	Width of road (m)	Width of walk way (m)	Measurement date
1	El Warda Hotel	3	9.6	3.2	TUE 28/2/2006
2	Eskander Ibrahim Street	3	9.9	3.2	TUE 16/5/2006
3	Sidi Besher Mosque	3	8.8	3.4	MON 27/2/2006
4	El Sraya Beach	3	9.2	3.3	WED 17/5/2006
5	Abo Shakra Restaurant	3	9.7	3.5	MON 22/5/2006
6	Glym (Princess Fawzeya Palace)	4	12.7	3.4	TUE 23/5/2006
7	Engineers's Club	4	12.7	4.0	WED 24/5/2006
8	Sidi Gaber (El-Haram Hotel)	5	17.1	5.0	MON 12/6/2006
9	El Ibrahimya (Gymnasium)	5	16.2	6.6	MON 20/2/2006
10	El Shatby Casino	5	16.2	5.3	TUE 13/6/2006
11	Mohamed Abd El-Wahab Theatre	4	12.4	4.8	WED 14/6/2006

Table (2): Measurement times according to Egyptian Environmental Law No 4/1994[6]

Day time	Classification of Law 4/1994	Measurement times
Morning	From 7:00 AM to 6:00 PM	7:15, 9:30 and 11:45AM 1:30 and 3:00 PM
Evening	From 6:00 PM to 10:00 PM	8:00 PM
Night	From 10:00 PM to 7:00 AM	10:00 and 12:00 PM

●Traffic Volume Measurement:

In addition to the person assigned for monitoring noise level, another person was assigned for counting, simultaneously, the traffic volume at each station. In order to increase accuracy, each measurement hour was divided into four quarters, or fifteen minutes interval. The counting process included the total number of vehicles passing by throughout the width of the roadway as indicated in Table (1). Traffic of heavy trucks is forbidden in this road, and the classification of other vehicles type was not taken into account in this study. Monitoring process was done in suitable weather with no wind, rains or storms.

RESULTS AND DISCUSSIONS:

A typical measurement data sheet was created for each station. The noise level is monitored during separate eight hours, and each measurement hour is monitored each 15 seconds (i.e. 240 values/hour), with the corresponding traffic volume each 15 minutes. The data sheet for El-Ibrahimya station, as example, is presented in Table (3).

Using data sheets, sound level for each station at each monitoring hour (88 charts) are traced. As example, using Table (3), sound levels during one monitoring hour at El-Ibrahimya station (7.15AM–Monday–20/2/2006) is presented in Figure (5).

● Calculating L_{10} by Using Cumulative Distribution Curve:

Traffic noise variations can be plotted in Figure (5). However, it is usually inconvenient and cumbersome to represent traffic noise in this manner. A more practical method is to convert the noise data to a single representative number using statistical descriptors. The most common statistical descriptors is L_{10} which is the sound level exceeding 10 percent of the measuring time[9].

In order to calculate L_{10}, cumulative distribution curves were plotted for each hour at each station. From example, as shown in Figure (6), L_{10} for El-Ibrahimya station at 7:15 AM is equal to 77.4 dB, the noise exceeding 68 dBA occurs during 100% of the measured time, and the noise exceeding 80 dBA occurs during 0% of measured time.

L_{10} corresponding to all measurements (11 stations×8 measurement hours) are resulted using the same method. For example, Table (4) gives the values of L_{10} for the eight measurement hours at El-Ibrahimya station.

From Table(4), it is noticed that the difference between the lowest value (74.4 dBA) and the highest one (77.4 dBA) is 3 dBA. For the other stations, the differences varied between 1.5 and 3 dBA.

In order to simplify the comparison between the noise level at different points and different times, the noise level at each station will be represented by the average of L_{10} at 8 measurement hours. Accordingly, the noise level at El-Ibrahimya station, for example, is represented by the average of values presented in Table (4), which is 76.5 dBA. The average noise level for all monitoring stations is illustrated in Figure (7)[1].

Table (3): Data sheet for El-Ibrahimya station[1]

El-Ibrahimya (Gymnasium) MON 20/2/2006

Time	VOL Veh/0.25h	VOL Veh/h	Series 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
7.15 AM	459	2592	71	74	71	77	76	74	78	80	77	72	78	76	75	76	79	73	76	74	75	76	79	74	76	76	76	78	73	76	79	73
			74	78	76	68	79	72	73	77	77	74	77	73	76	74	73	74	77	75	72	75	75	76	75	75	77	79	74	76	73	74
	711		71	76	79	73	75	78	74	74	77	74	76	75	77	74	77	75	76	72	79	75	75	75	71	73	76	74	78	74	73	73
			75	78	74	77	75	74	75	75	74	75	78	79	78	77	73	77	77	75	79	74	72	73	77	77	74	77	74	78	76	74
	709		69	72	75	71	73	74	77	73	73	75	76	73	78	73	71	78	77	77	77	75	74	75	76	74	75	78	77	74	76	74
			74	74	73	77	76	76	75	75	77	70	74	76	78	77	78	74	77	73	76	76	78	73	76	75	76	75	74	73	77	75
	713		76	78	75	77	74	78	73	75	77	72	74	76	76	76	75	76	78	74	73	77	77	73	71	78	78	74	73	78	73	77
			75	73	75	72	75	76	78	76	74	76	73	79	74	76	69	73	72	80	77	78	80	76	71	75	78	71	76	77	75	72
9.30 AM	694	2613	76	76	76	75	74	74	77	77	75	76	72	78	77	74	71	77	76	74	77	79	77	76	75	76	76	77	76	70	75	75
			74	75	77	75	75	71	77	77	73	71	77	71	74	75	74	75	76	79	74	79	75	73	78	76	73	71	75	70	75	73
	611		74	76	73	78	71	79	72	73	73	76	77	77	74	73	74	75	77	75	78	74	80	75	74	77	74	74	76	75	76	76
			73	74	75	76	69	73	72	76	73	77	77	71	76	72	76	74	73	72	76	72	74	74	75	75	76	73	76	75	75	75
	645		74	77	77	74	79	75	74	77	77	77	76	75	77	78	74	72	73	69	72	73	77	73	70	76	78	76	74	78	74	75
			72	75	75	74	74	74	69	76	71	74	75	72	72	75	74	72	72	76	71	74	73	74	76	74	73	72	73	75	72	70
	663		78	70	76	76	75	75	76	73	72	72	73	72	71	76	77	78	72	72	74	71	76	72	74	76	74	74	74	74	73	72
			75	73	71	74	75	77	74	72	76	73	74	72	73	71	79	73	71	68	76	76	72	73	76	72	74	74	75	71	73	73
11.45 AM	833	3666	75	70	71	72	74	71	76	72	75	74	72	75	78	74	76	75	72	74	75	71	74	77	73	70	74	73	75	75	75	71
			72	72	75	77	75	73	72	74	74	75	72	72	76	76	71	74	72	74	74	74	73	69	74	75	76	73	75	77	77	74
	798		76	76	73	76	75	74	76	74	75	74	74	76	77	74	70	72	75	70	75	75	77	72	75	74	76	72	77	77	75	78
			75	72	75	71	75	72	77	73	73	72	75	75	78	79	77	76	72	73	77	71	71	76	73	77	66	77	76	75	77	76
	970		77	75	74	76	71	76	73	75	71	74	78	77	77	71	75	73	77	73	72	76	76	72	77	75	75	73	73	70	76	75
			75	74	73	77	77	74	75	77	78	75	76	75	75	77	79	77	79	74	72	74	76	74	71	78	74	75	76	76	75	74
	1065		77	75	76	74	75	73	75	73	78	76	76	76	76	72	77	75	73	74	75	76	75	74	78	77	78	73	75	74	74	76
			73	77	76	77	74	75	78	79	77	77	75	76	75	78	77	73	71	74	73	76	74	76	75	71	80	72	75	73	74	74
1.30 PM	1175	5397	74	77	69	74	77	78	77	75	74	78	76	74	76	77	77	74	73	74	70	75	75	73	75	77	78	75	74	77	74	77
			75	78	77	76	78	75	77	77	75	77	77	74	75	77	77	77	76	76	78	75	74	76	79	75	77	77	77	76	74	77
	1308		74	75	78	75	78	76	77	74	75	73	75	77	75	75	73	75	77	75	74	76	75	77	76	77	72	74	78	76	74	75
			77	76	75	76	76	75	75	74	74	75	77	72	75	75	74	75	76	74	75	74	76	76	75	76	78	75	76	78	77	74
	1444		74	75	75	76	75	75	77	76	77	75	76	72	75	74	74	75	76	77	75	75	71	74	77	76	74	75	79	76	77	76
			75	76	75	73	75	74	75	75	78	74	75	75	77	75	77	76	70	74	77	77	76	73	76	75	77	72	73	76	73	74
	1470		75	76	75	77	76	75	76	73	74	75	77	72	75	73	76	75	75	77	74	77	75	76	73	75	80	73	76	77	75	75
			75	77	75	74	76	77	74	76	76	74	80	75	73	75	77	76	75	78	77	76	75	75	74	76	73	74	79	75	75	72

Table (4): L_{10} for eight measurement hours at El-Ibrahimya station

Time	7.15 AM	9.30 AM	11.45 AM	1.30 PM	3.00 PM	8.00 PM	10.00 PM	12.00 PM
L_{10} (dBA)	77.4	76.9	76.9	77.0	77.4	76.2	75.8	74.4

From Figure (7), it is noticed that the highest noise level (78.5 dBA) was monitored at (El-Sraya) and (Glym) station, and the lowest noise level (76.5 dBA) was at (El-Ibrahimya) station. However, this difference is relatively small since the human ear's is not sensible to a variation of 2 dBA[7].

The allowable noise levels according to Egyptian Environmental Law # 4/1994 for residential areas in which can be found some workshops or commercial establishments or which are located on a main road, are as follow: 60 dBA (morning), 55 dBA (night) and 50 dBA (evening) (Egyptian Environmental Law No 4/1994). These values are compared with those in Figure (7), it is noticed that the noise level at all monitoring stations are greater than the allowable values in Egyptian Environmental Law.

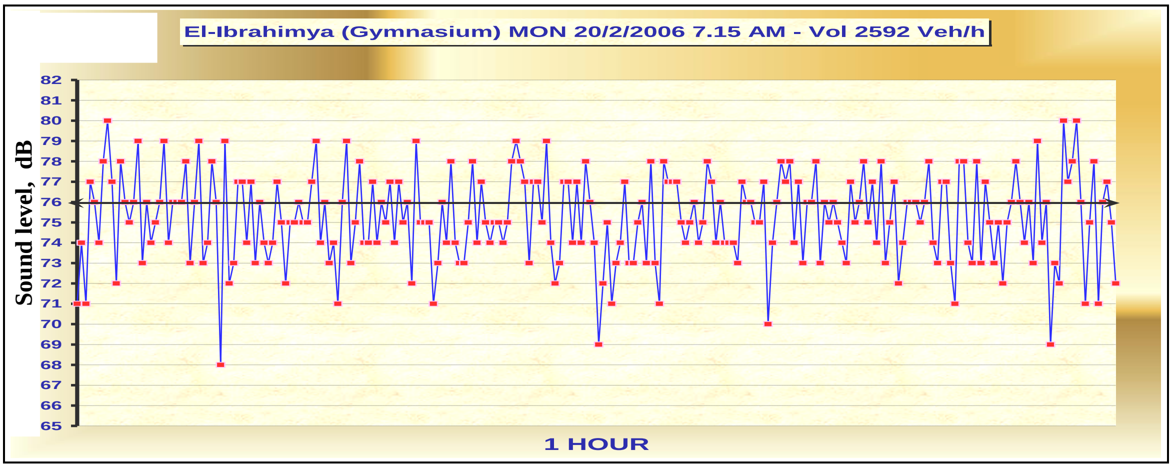

Figure (5): Sound level in El-Ibrahimya station from 7:15 to 8:15 A.M.

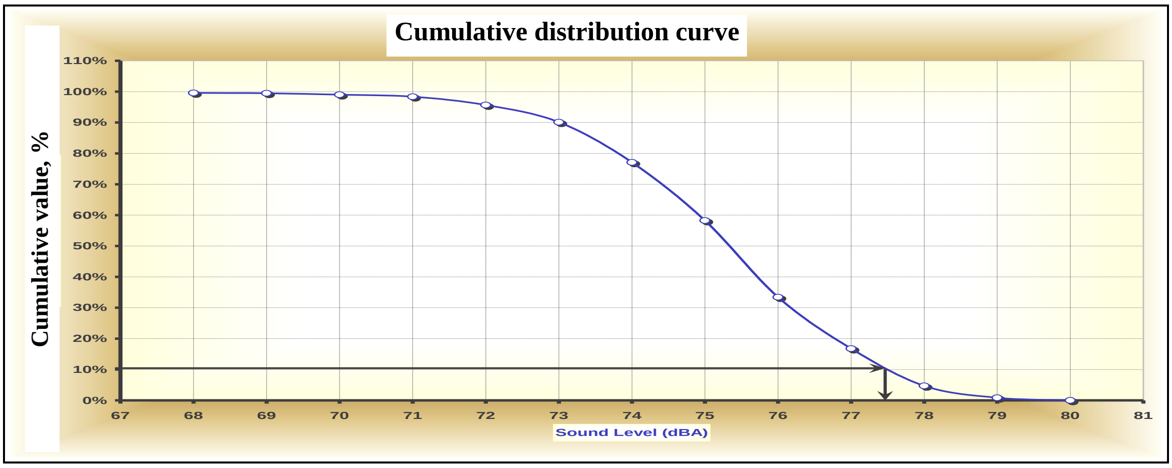

Figure (6): Cumulative distribution curve at El-Ibrahimya station at 7:15 A.M.

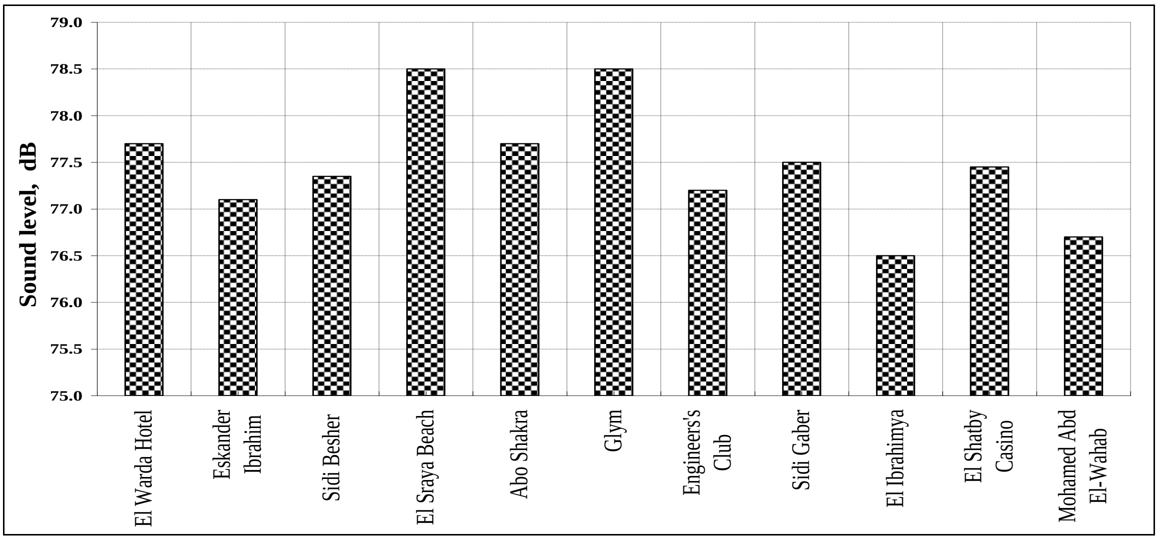

Figure (7): Average noise level along El- Kornesh Roadway

● Traffic Volume Monitoring:

In order to find out the relation between noise level and traffic volume, the number of vehicles passing at different stations was counted with intervals of 15 minutes during each monitored hour (i.e., each hour is presented by 4 values).

Figure (8) represents the traffic volume at El-Ibrahimya station at Monday 20/2/2006 at different monitoring hours[1].

It is noticed that the peak hour occurs at 3:00 PM where the number of vehicle is about 1400 vehicle per 15 minutes (or 5600 veh./hr). The traffic volume decreases gradually up to 12:00 PM where the number of vehicle is 550 vehicle per 15 minutes (or 2200 veh./hr).

●Correlation between L_{10} and Traffic Volume:

In order to find out a correlation between average noise level and traffic volume, the two parameters are plotted for all stations. Figure (9) represents the corresponding curve at El-Ibrahimya station.

From Figure (9), it is noticed that values are scattered. The same noise level (for example 77.5 dBA), could be produced by 2600 or 5700 vehicle/hour. Also, a small variation of traffic volume (2200 to 2600 veh/hr) corresponds to variation of 3 dBA.

This statement means that the traffic volume is not the only parameter affecting the noise level. The vehicle speed and other parameters such as horn sound could influence considerably the noise level. However, a trial to find out a correlation between noise level and traffic volume was carried out by applying Pearson's linear correlation to obtain the form of the following equation:

$$\text{Noise level} = a\,(\text{Traffic volume}) + b$$

or

$$L_{10} = a\,(V) + b$$

For example, the curve illustrated in figure (9) led to the following equation:

$L_{10} = 0.0003\ V + 75.2$ with Pearson's correlation coefficient (R) = 0.425.

A statistical analysis for all cases is conducted, and Table (5) represents the concluded linear equations for all monitoring stations and the corresponding Pearson's correlation coefficients.

It is important to notice that at stations which have positive correlation coefficient (shaded rows in the Table 5), the traffic was very fluent. This statement means that, in general, noise level could be directly proportional to traffic volume in case of fluent traffic. While, at stations which have negative correlation coefficient, the traffic was not fluent enough. At these stations, the presence of obstacles (such as road crossing or important curvatures) reduced the vehicles speed which become an important factor influencing the noise level.

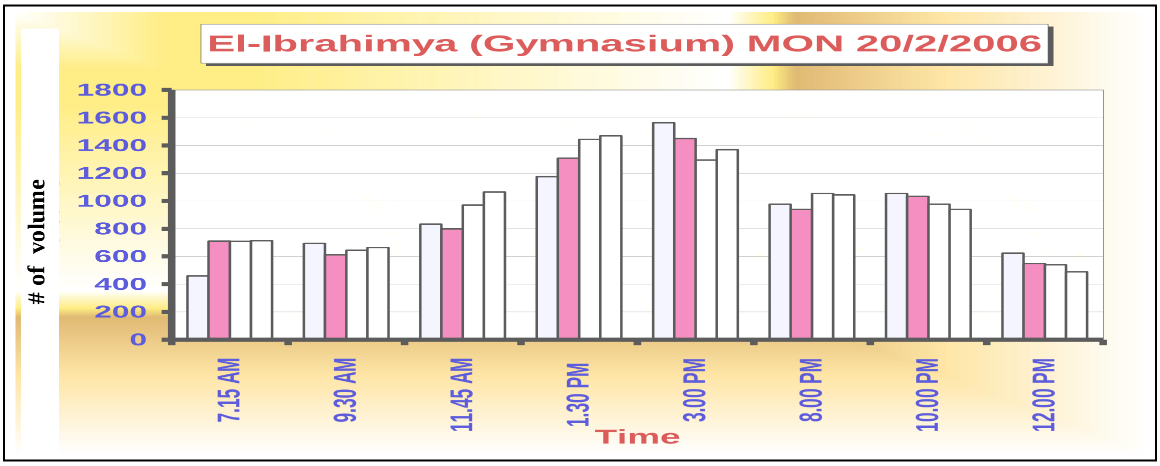

Figure (8): Traffic volume every 15 minutes at El-Ibrahimya station

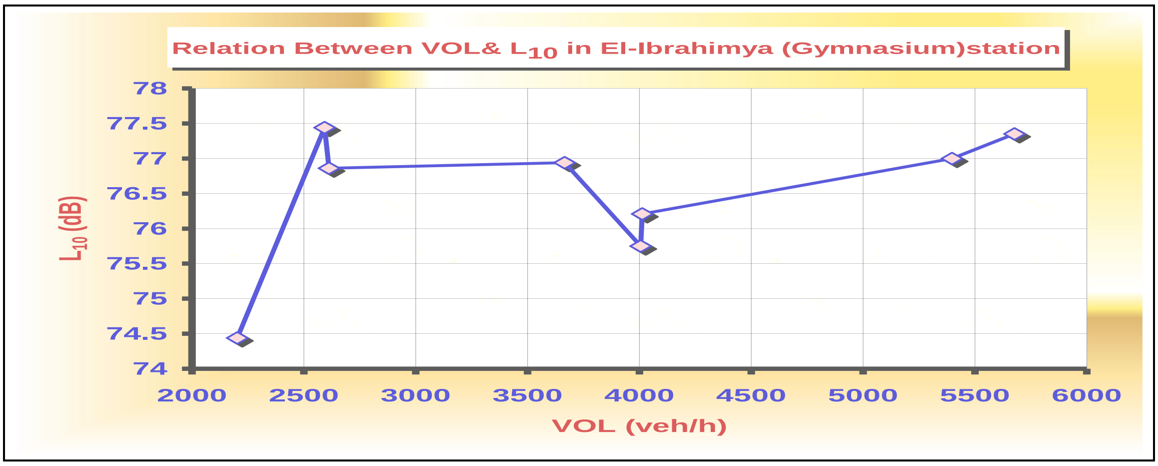

Figure (9): Relation between traffic volume and average L_{10} at El-Ibrahimya station

Table (5): Linear equations for all stations and corresponding correlation coefficients[1]

Station	Equation	R
El-Warda Hotel	L_{10} = 0.0020V+74.3	0.204
Eskander Ibrahim Street	L_{10} = 0.0006V+75.7	0.482
Sidi-Besher Mosque	L_{10} = - 0.0004V+78.2	- 0.142
El-Sraya Beach	L_{10} = 0.0012V+75.8	0.573
Abo- Shakra Restaurant	L_{10} = - 0.0003V+78.7	- 0.119
Glym (Princess Fawzeya Palace)	L_{10} = - 0.0017V+84.4	- 0.810
Engineers's Club	L_{10} = - 0.0008V+80.0	- 0.571
Sidi-Gaber	L_{10} = 0.0008V+74.4	0.380
El-Ibrahimya	L_{10} = 0.0003V+75.2	0.425
El-Shatby Casino	L_{10} = 0.0008V+73.8	0.592
Mohamed Abd El-Wahab Theatre	L_{10} = - 0.0004V+78.1	- 0.082

CONCLUSION:

From February to June 2006, the assessment and measurement of traffic volume

and noise level generated by traffic flow was carried out for El-Kornesh roadway at Alexandria City in Egypt. Eleven stations, at quasi-equal distances, were selected to monitor noise level along the roadway. Digital sound level meter was used in the study to measure noise levels, and measurement times were selected according to the classification of Egyptian Environmental Law No 4/1994.

It is concluded that noise level in all stations exceeded the allowable level stated in Egyptian Environment Law No 4/1994. Within 11 monitoring stations, El-Saray and Glym recorded the highest noise level, and the lowest level was recorded at El-Ibrahimya station.

The correlation between noise level and traffic volume demonstrated that they are positively proportional in case of fluent traffic, and inversely proportional in the presence of obstacles. The speed of vehicles remains a primordial parameter affecting traffic noise level.

Therefore, it is strongly recommended to create another axis for traffic to alleviate traffic volume in El-Kornesh Roadway.

REFERENCES:

1-Abo Hamad M., Assessment and Measurement of Noise Pollution Generated by Traffic Flow-Case Study: El-Kornesh Roadway–Alexandria–Egypt, Master of Science Thesis, Arab Academy for Science, Technology and Maritime Transport, Alexandria, Egypt, 2007.

2-Ambasht R. S., Environment and Pollution, S. K. Jain for CBS Publishers & Distributors, New Delhi, 1999.

3-Botkin D. B. and Keller E. A., Environmental Science, John Wiley & Sons, California, 2005.

4-Crocker M. J., Handbook of Acoustics, Wiley-Interscience, New York, 1998.

5-Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, McGraw-Hill, New York, 1998.

6-Egyptian Environmental Law No 4 for year 1994.

7-Kinsler L. E., Frey A. R. and Coppens. A. B., Fundamentals of Acoustics, Wiley, New York, 2000.

8-Olishifski J. B. and Harford E. R., Industrial Noise and Hearing Conservation, Chicago National Safety Council, 1995.

9-Wang L. K., Pereira N. C. and Tse H., Advanced Air and Noise Pollution Control, Prentice Hall, New Jersey, 2005.

تقييم وقياس مستوى الضوضاء الناتجة عن حركة المرور
دراسة حالة : طريق الكورنيش – الاسكندرية - مصر

وائل كامل

أستاذ مساعد بالأكاديمية العربية للعلوم والتكنولوجيا والنقل البحرى

قسم هندسة التشييد والبناء – كلية الهندسة والتكنولوجيا

تعد مدينة الأسكندرية ثانى أكبر مدن جمهورية مصر العربية وتتصف شوارعها الرئيسية بكثافة مرور عالية ينتج عنها ارتفاع مستوى الضوضاء مع الزيادة السريعة فى أعداد السيارات وقلة المحاورالمرورية الجديدة، ويعتبر طريق الكورنيش من أهم محاور مدينة الأسكندرية حيث أنه يربط شرق المدينة بغربها.

الهدف من هذا البحث هو قياس شدة الضوضاء وحجم المرورعلى طول محور الكورنيش فى أماكن وتوقيتات مختلفة بهدف تقييمها ومقارنة النتائج بالحدود القصوى المسموح بها فى قانون البيئة المصرى رقم (٤) لسنة ١٩٩٤، كما يهدف البحث إلى محاولة الوصول إلى علاقة رياضية مبسطة تربط شدة الضوضاء وحجم المرور. وفى هذه الدراسة تم اختيار ١١ نقطة قياس على طول الكورنيش وعلى مسافات متساوية تقريباً (حوالى ١.٥ كم) وتم قياس شدة الضوضاء وحجم المرور عند هذه النقاط على مدار خمسة أشهر بواقع ٨ ساعات قياس لكل نقطة.

وخلص البحث إلى أن مستوى الضوضاء بجميع النقط المرصودة على طول محور الكورنيش أعلى من الحد الأقصى المسموح به فى قانون البيئة المصرى، وأوصى البحث بضرورة ايجاد بدائل لتخفيف العبء عن محور الكورنيش.