A STUDY OF NOISE IMPACT CREATED BY THE TAKEAWAY SHOPS WITHIN URBEN AREAS
بحث تأثير الضوضاء الناجمة من محلات الوجبات السريعة في المناطق السكانية

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ABSTRACT
The noise impact due to fast food outlets (takeaway shops) on residential areas has been investigated. Measurements of the hourly equivalent continuous noise level L_{Aeq} at the vicinity of various takeaway shops on different days were carried out. Comparatively, the predicted hourly equivalent continuous noise level L_{Aeq} due to car slams and car engine starts at the same sites were calculated using a predicted model. This model is dependent on the hourly numbers of car door slams and car engine starts, which were counted manually at the sites in equation.

From this investigation it has been concluded that : at sites located at open ended roads, the prediction model underestimates L_{Aeq} by variable factors in the range (5-10) dB(A), while at sites located at closed ended roads, the model predicts, relatively, a slight difference, i.e. less than 2 dB(A).

الخلاصة
تناول هذا البحث دراسة تأثير الضوضاء المتسببة من وجود محلات بيع الوجبات السريعة في المناطق السكنية. وقد أجريت الدراسة بأخذ قياسات عملية لمعامل الضوضاء (L_{Aeq}) بالقرب من محلات مختلفة للوجبات السريعة ولعدة أيام. وقد قورن المعامل مع القيم النظرية وحسب معادلات لحساب (L_{Aeq}) الناتج من صوت أغلاق باب السيارة عند النزول والصعود وكذلك من تشغيل ماكنة السيارة.

وقد أعتمدت هذه النتائج على حساب عدد مرات غلق باب السيارة وعدد مرات تشغيل مكائن السيارات عمليا بالقرب من المحلات المقصودة.

وقد أستنتج من هذة الدراسة أن النتائج المتوقعة من الحساب النظري أقل من القيم التي تم قياسها للطرق المفتوحة نهايتها بينما يكون الأختلاف طفيف نسبيا عنه في الطرق المغلقة من طرف واحد.

INTRODUCTION
The four physical characteristics of environmental noise upon which depends its numerical rating are: level, duration, intermittency and quality. Quality is determined primarily by frequency spectrum, but also by impulsive nature and tonal character when present (1).

Noise can have a significant effect on the environment; the quality of life enjoyed by individuals and communities and can create a health impact. Health impact of noise is commonly predicted from a close-effect relationship based on source, exposure, and effect measurements (1). Excessive noise exposure may produce adverse effects in human beings. Heart rate changes, altered blood flow and pressure, and startle reactions. However, most complaints are directed towards activity interference (sleep, communication, productivity) and different kinds of annoyance (2,3). Annoyance may be defined as a feeling of displeasure associated with any object or condition believed to affect adversely an individual or a group. The impact of noise can be a material consideration in the determination of planning applications. The planning system has the task of guiding development to the most appropriate locations. The planning system should ensure that, wherever practicable, noise causing developments are separated from major residential areas. It is equally important that new development involving noise activities should, if possible, be sited away from noise-sensitive land uses e.g. hospitals, housing...etc. Development plans provide the policy framework within which these issues can be weighed but careful assessment of all these factors will also be required when individual applications for development are considered (4 - 6).

Environmental Health Officers may be asked to comment on the impact of new development within their boroughs and give a prediction assessment of noise impact would be produced. Some of these developments often in the vicinity of the existing residential areas, e.g. a new hot **food takeaway** or **off licence** shop (7). These developments often have their peak activities in the evening and late at night. So, it is important for the environmental Health Officers to have, in addition to the subjective opinions, an approximate predicted noise level or quantitative information about this sort of developments and their impact on the acoustic environment of these areas. It is this main objective behind this study. The noise impact due to fast food outlets is that on which the authors are interested, particularly, what is produced by the car's user customers due to car door slams and car engine starts and by how many decibels such activities increase the average background noise level. Also, to evaluate, experimentally the prediction model of the continuous noise level developed (8) in 1995. Its details are mentioned later on. Such investigation cannot be found in the literature.

Noise emitted from premises can be a statutory nuisance. Section 79 of the 1990 Act states that any noise (or vibration) emitted from a premises (or land) and which is prejudicial to health or nuisance is statutory nuisance. An abatement notice or fine may be needed (9).

The level that reaches the recipient of the noise can be influenced by the distance. The noise level is attenuated with distance in all directions. Theoretically, for a point source, the attenuation in the absence of atmospheric effects and ground absorption would be 6 dB(A) for each doubling of distance. The presence of natural or artificial screens will act as a barrier and a degree of attenuation will be in effect (this will be negligible if the screen consists solely of vegetation). There will also be some absorption of noise, if the ground between the road and the point is soft, for example, grass land, rather than hard concrete (10). The hard surfaces of buildings will cause a reflection effect along the road; this can increase the noise in certain areas, while shadowing other areas and so decrease the noise. Another parameter is the prevailing weather conditions. Rain can significantly increase the noise emitted by a moving vehicle, increasing as high as 10 in dB(A). Such increase does not occur in case of a stationary vehicle (in a static state) and car door slams and engine starts noise should not change due to the rain (11).

PREDICTION MODEL

The impact of fast food outlets on residential areas has not been found in the literature. There is a work has been published by (8). This was regarding developing a model validate the noise impact of commercial car parking. The principles on which the model was based are:

(i) After a car was parked, its door would be slammed; hence a noise impact was created. It is assumed with noise level equivalent to SEL_1. At the car departure, its door was slammed again, hence, another noise impact was created. It is assumed with the same noise level i.e. equivalent to SEL_1. The car engine was started; a third noise impact was created. It is assumed with noise level equivalent to SEL_2.

(ii) Therefore two car door slams and one car engine start were created by one car user. If the car was used by two or three persons, the number of car door slams would be double or triple respectively.

(iii) By adding up logarithmetically the noise impact levels of one car used by one person will get the equivalent continuous noise level $\mathbf{L}_{Aeq}$ which is expressed as:

$$\mathbf{L}_{Aeq,T} = 10\log\{(10^{SEL1/10} \text{ x } 2 + 10^{SEL2/10} \text{ x } 1)/T\}$$

If the car was used by two persons who created four car door slams, $\mathbf{L}_{Aeq}$ becomes:

$$\mathbf{L}_{Aeq,T} = 10\log\{(10^{SEL1/10} \text{ x } 4 + 10^{SEL2/10} \text{ x } 1)/T\}$$

If twenty cars (in average with two persons) were parked, then left the park within one hour (3600s), the one hour $\mathbf{L}_{Aeq}$:

$$\mathbf{L}_{Aeq,1h} = 10\log\{(10^{SEL1/10} \text{ x } 4 \text{ x } 20 + 10^{SEL2/10} \text{ x } 1 \text{ x } 20)/3600\}$$

So the predicted model is expressed as:

$\mathbf{L}_{Aeq,T} = 10\log\{(10^{L1/10} \times t_1 + 10^{L2/10} \times t_2)/T\}$

Where:

L_1: is the average SEL for a car door slam = (69.0 dB(A))

t_1: is the time taken for total car door slams (one second per car door slam, hence, given by the number of car door slams)

L_2: is the average SEL for a car engine start = (70.0 dB(A))

t_2 : is the time taken for total car engine starts (one second per car engine starts)

T : is the total time period (1 hour or 3600s).

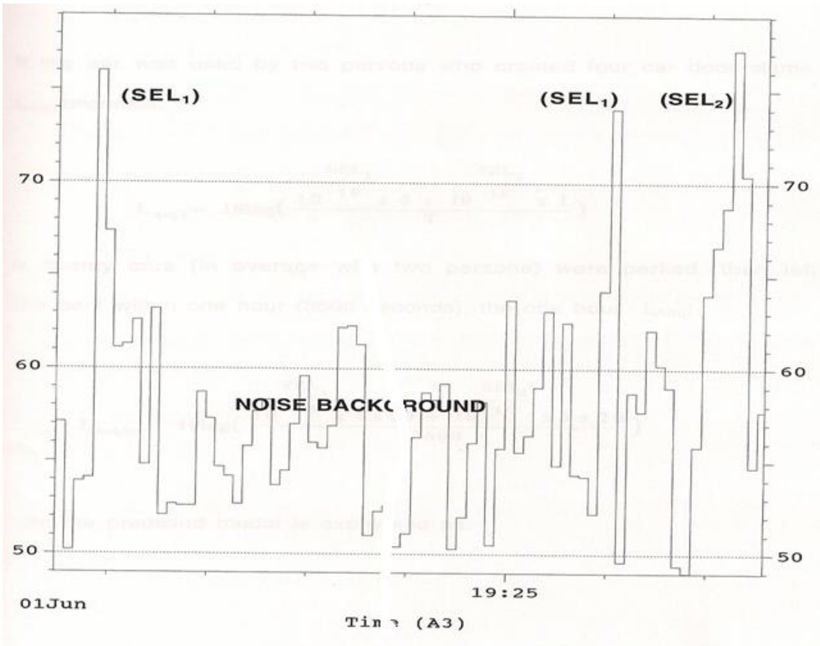

Figure 1 : Presentation of Noise Impacts created by two car door slams (SEL_1) and one car engine start (SEL_2).

EXPERIMENTAL MEASURENTS AND COMPUTATION

The main instruments used for this project were Larson-Davis Laboratories Sound Level Meter model 820 (12), free field Microphone model 2542, Pre-amplifier model 827 and wind screen in addition to a PC computer connected to a printer and loaded with IMsoft 820 v1.20 microsoft (13). The measurements were taken in positions 5 - 15 m from where the most cars are parking.

The measurements were taken on different weekdays including the weekends at times between 18:00 and 20:00 and sometimes late night i.e. 22:30 – 24:00. These are the busiest evening hours according to the opinions of the most shop keepers.

Measurements conditions were dry road surface, average wind speed at a height of 1.2 m and midway between the road and the reception point is not more than 2m/s in the direction from the reception point. In all cases it is recommended that a wind screen should be used on the microphone and that measurements should only be carried out when the peaks of wind noise at the microphone are 10 dB(A) or below the measured value of L_{A10}.

The measurement points were chosen so that the view of the area in question is substantially unobstructed. There was no sound reflecting surfaces near the microphone position. Measurements were focused on the hourly L_{Aeq} and SEL (6).

The recordings from the SLM were analysed using a computer software package, used in conjunction with the Larson-Davis 820; called IMsoft 820 v1.20. This software is designed for use with Microsoft 'Windows' version 3.1 on MS-DOS compatible machines. The minimum hardware requirements are:

CPU intel6/8 MHz 80286 based PC

Graphics EGA
MEMORY 640 K
Hard Disk 40 MB 40 ms
Mouse
Difficulties were associated with the noise measurements, the authors faced, were limiting the sites where the noise measurements should be carried out. E.g. searching for suitable places, in residential areas, in which the background noise level is relatively low comparing with the noise produced by car door slams and car engine starts. These places should be in the vicinity of a fast food shop and/or an off licence shop. Children were playing noisily, and motorcyclist and motorists revving the engines gratuitously in the vicinity of the sound noise level meter for a portion of the measurement time.

RESULTS AND DISCUSSION

To evaluate the predicted model experimentally, many runs on different days and places were carried out. In addition to the data recorded by the sound level meter (LDL-820), other data were recorded manually, e.g. timing of each door slam and engine start from the start time, vehicle make and its approximate age and its distance from the sound level meter.
Single Exposure Levels (SELs) for the carried out noise measurements have been shown in Tables 1-4, these were examples of the data collected. For **each one hour** run collected data there is one SEL based on the HOURLY measured L_{Aeq} and there are sixty SELs based on one minute interval L_{Aeq} . The former has been obtained as follow:

$$SEL = 10\log(10^{L_{Aeq}/10} \times 3600)$$
$$SEL = 10\log(10^{L_{Aeq}/10}) + 10\log 3600$$
$$= L_{Aeq} + 35.6$$

While the latter have been obtained as follow:

$$SEL = 10\log(10^{L_{Aeq}/10} \times 60)$$
$$SEL = 10\log(10^{L_{Aeq}/10}) + 10\log 60$$
$$= L_{Aeq} + 17.8$$

Table 1: Experimental data collected in the first run at open-ended road.
Day of the week: Thursday, Name of the road Humbleton Drive. Starting Time 18:50:00.
Noise background : 53.8 dB(A).

CAR		TIME OF			Distance (m)
Serial No.	Make (Reg.)	DOOR SLAM AT		Engine Start	
		Arrival	Departure		
1	Escort (Y)	8:32	9:21	9:25	18
2	Fiesta (Y)	9:10	10:30	10:35	12
3	Fiat E)	-----	8:45	8:48	10
4	Carlton (B)	-----	10:19	10:32	10
5	Fiat (E)	14:15	16:17	16:30	11
6	Metro (F)	19:02	41:42	42:05	10
7	Sierra (N)	19:38	35:16	35:18	15
8	Fiat (E)	21:53	40:29	40:34	10
9	Vauxhall (M)	22:55	24:00	24:05	4
10	Mercedes Van (M)	23:25	25:00	Kept Running	18
11	Sierra (K)	24:20	25:05	Kept Running	25
12	Volvo (A)	-----	35:57	36:08	15
13	VW Golf (C)	38:28	40:09	40:19	13
14	Citroen (C)	40:51	47:14	47:19	5
15	Renault (D)	-----	43:30	43:45	17
16	Volvo (Y)	47:00	48:17	48:25	9
17	Talbot (N)	48:16	49:18	49:30	7
18	Sunny (B)	47:30	49:59	50:45	16
19	Fiat (E)	53:34	57:45	57:51	14
20	Citroen (C)	53:35	58:54	59:11	15
21	Vauxhall (C)	58:13	59:10	59:10	10

L_{eq} = 61.2 dB(A)   Lmax = 89.1 dB(A) at 18:50:16
L_5 = 67.1 dB(A) L_{10} = 64.3 dB(A) L_{90} = 50.4 dB(A)
L_{95} = 49.6 dB(A)   SEL = 96.9 dB(A)

Table 2: Experimental data collected in the second run at open-ended road.
Day of the week: Monday, Name of the road Humbleton Drive. Starting Time 18:15:00.
Noise background : 54.3 dB(A).

CAR		TIME OF			Distance (m)
Serial No.	Make (Reg.)	DOOR SLAM AT		Engine Start	
		Arrival	Departure		
1	Vauxhall (A)	2:24	3:08	-----	10
2	Vauxhall (L)	3:45	4:25	4:27	10
3	Vauxhall (G)	4:07	4:23	4:28	12
4	Honda (G)	4:03, 4:07	-----	-----	8
5	Volvo (A)	5:10	11:48	13:14	25
6	Peugeot Diesel (M)	8:18	24:10	24:15	9
7	Escort Van (Y)	9:12	11:29	11:31	30
8	Vauxhall (A)	9:47, 9:50	41:35	41:40	5
9	Escort (M)	14:15, 14:17	24:25	24:25	40
10	Fiat (E)	21:33, 32:08	32:20	32:21	4
11	Sierra (E)	23:27	24:31	24:35	30
12	Escort Van (D)	24:30	25:44	25:45	27
13	Vauxhall (E)	25:06	36:41	36:43	35
14	Talbot (A)	-----	25:15	26:25, 27:10	25
15	Escort (F)	29:05	31:09	31:23	11
16	Vauxhall (C)	38:52	41:16	41:26	11
17	Escort (D)	-----	41:51	41:52	9
18	Toyota (M)	-----	44:40	44:46	3
19	Montego (D)	-----	47:00	46:56	30
20	Rover (L)	48:30	49:43	49:48	11
21	Fiat (E)	50:41	-----	-----	4
22	Metro (F)	52:25	56:25	56:36	10
23	Sierra (G)	-----	53:52	53:55	8
24	Sunny (B)	-----	55:25	55:27	20
25	Escort (C)	58:55	59:55	-----	12

L_{eq} = 61.6 dB(A) Lmax = 87.0 dB(A)
L_5 = 64.6 dB(A) L_{10} = 61.4 dB(A) L_{90} = 48.6 dB(A)
L_{95} = 48.0 dB(A) SEL = 97.0 dB(A)

Two types of the results have been found out, the first from open-ended roads Tables 1-3 and the second from closed- ended roads Table 4.

Table 3: Experimental data collected in the third run at open-ended road.
Day of the week: Monday, Name of the road Humbleton Drive. Starting Time 19:49:04.
Noise background : 51.7 dB(A).

CAR		TIME OF			Distance (m)
		DOOR SLAM AT			
Serial No.	Make (Reg.)	Arrival	Departure	Engine Start	
1	Citroen (J)	-----	6:14	6:20	5
2	Escort (G)	5:32	6:31	6:33	20
3	Vauxhall (J)	7:49	13:17	13:25	10
4	Fiat (E)	16:32	17:02	17:20	4
5	Vauxhall (F)	-----	16:40	17:00	14
6	Vauxhall (D)	20:14	22:01	21:48	9
7	Escort Van (Y)	29:10	30:24	30:34	22
8	Mazda (D)	35:28	36:18	36:25	20
9	Sierra (Y)	40:40, 42:15	42:38, 44:37	44:31	9
10	Fiat (E)	41:42	42:53	42:53	4
11	Volvo (B)	45:30	48:40	48:50	18
12	Peugeot (J)	52:32	-----	-----	10
13	Fiat (E)	53:08	59:37, 59:36	-----	4
14	Vauxhall (G)	-----	56:36	56:38	22

L_{eq} = 58.8 dB(A)   Lmax = 88.5 dB(A) at 20:27:00
L_5 = 64.3 dB(A) L_{10} = 60.4 dB(A) L_{90} = 48.5 dB(A)
L_{95} = 47.9 dB(A)   SEL = 94.3 dB(A)

Table 4: Experimental data collected in the fourth run at closed-ended road.
Day of the week: Wednesday Name of the road: Park Farm Starting Time 18:26:29.
Noise background : 54.2 dB(A).

CAR		TIME OF			Distance (m)
Serial No.	Make (Reg.)	DOOR SLAM AT Arrival	DOOR SLAM AT Departure	Engine Start	
1	Astra (G)	-----	0:48	0:50	13
2	Fiesta (D)	3:18	7:00, 7:10	7:11	13
3	Fiesta (D)	-----	4:15	4:28	13
4	Sunny (M)	4:57	10:06	10:16	10
5	VW Golf (L)	4:56	7:11	7:28	13
6	Fiesta (L)	6:28	13:40	13:46	13
7	Mondeo(M)	8:23	12:56	13:01	15
8	Mazda (N)	-----	9:17	9:23	6
9	VW Polo (Y)	12:19	17:30	17:43, 17:49 17:53	13
10	Metro (M)	-----	17:30, 17:59	18:00	3
11	Austin (D)	18:31	43:15	45:36	8
12	Mini (A)	17:46	23:21	-----	25
13	Citroen (N)	21:50	24:05	24:12	13
14	Lorry (M)	22:59	32:49	32:51	18
15	Motorcycle	-----	-----	24:32	8
16	VW Golf (C)	25:11	32:30	32:54	13
17	Orion (N)	-----	25:44	25:46	16
18	Volvo (E)	29:16	30:53, 31:04 37:10, 37:40	----	15
19	BMW (G)	30:17	34:04, 34:09	34:13	5
20	Van (H) Diesel	41:10	-----	Kept Running ~10min	19
21	Renault (L)	44:57	55:53	55:58	13
22	Motorcycle	-----	-----	45:10	10
23	Fiesta (J)	48:07, 48:09	-----	-----	8
24	Escort (E)	52:09	53:31	53:34	16
25	Fiesta (N)	57:05	59:06	59:11	13

L_{eq} = 58.4 dB(A) Lmax = 80.6 dB(A) at 18:44:01
L_5 = 62.8 dB(A) L_{10} = 62.0 dB(A) L_{90} = 51.1 dB(A)
L_{95} = 50.8 dB(A) SEL = 93.9 dB(A)

To calculate the predicted L_{Aeq} for each hourly run, the prediction model has been applied as follow:

$$\mathbf{L}_{Aeq} = 10 \log\{(10^{69/10} \text{ x } t_1 + 10^{70/10} \text{ x } t_2)/3600\}$$

Where:
69 and 70 are the average SELs of car door slams and car engine starts respectively.
t_1 and t_2 are the hourly total numbers of car door slams and car engine starts respectively.
Therefore, for example, from the hourly data collected (starting time 18:15:00):

t_1= 46 car slams and t_2= 22 car engine starts

Hence,

$$\mathbf{L}_{Aeq} = 10 \log\{(10^{6.9} \text{ x } 46 + 10^{70} \text{ x } 22)/3600\}$$

L_{Aeq} = 52.1 dB(A), and so on for the other runs. The summarised results obtained for the noise measurements carried out on sites at open-ended roads are shown in Table 5 .

Table 5: Summary of the obtained results at open-ended roads.

Day and Date	Loca-tion	Starting Time hh:mm:ss	L_{Aeq} in dB(A)				No. of	
			Back-ground	Measu-red	Correc-ted	Pred-icted	Door Slams	Engine Starts
Thurs. 16th May	Humbl-eton Dr.	18:50:00	53.8	61.2	60.3	51.4	39	19
Mon. 20 May	Humbl-eton Dr.	18:15:00	54.3	61.6	60.7	52.1	46	22
Mon. 20 May	Humbl-eton Dr.	19:49:04	51.7	58.8	57.8	49.7	27	12
Tues. 21 May	Drayton Av.	18:12:00	56.9	56.8	53.8	48.3	22	7
Tues. 21 May	Drayton Av.	19:40:00	54.6	51.7	54.6	47.6	20	5
Wed. 22 May	P. Charles Av.	22:54:27	49.5	54.3	52.6	44.5	9	3
Sat. 25 May	Broad-way LS5	19:03:55	56.2	61.1	59.4	48.3	22	7
Sat. 1 June	Humbl-eton Dr.	18:59:10	52.2	58.2	56.9	52.7	57	22

And the summarised results obtained for the noise measurements carried out on sites at closed-ended roads are shown in Table 6.

Table 6: Summary of the obtained results at closed-ended roads.

Day and Date	Loca-tion	Starting Time hh:mm:ss	L_{Aeq} in dB(A)				No. of	
			Back-ground	Measu-red	Correc-ted	Pred-icted	Door Slams	Engine Starts
Wed. 19 June	Park Farm	18:26:29	54.2	58.4	56.3	52.3	49	22
Thurs. 20 June	Park Farm	18:08:46	52.7	55.4	52.1	53.8	70	30
Wed. 3 July	Park Farm	18:58:29	51.2	56.0	54.3	52.5	52	22
Thurs. 11 July	Park Farm	18:58:01	51.1	56.2	54.6	52.8	56	25
Mon. 29 July	Park Farm	19:18:38	50.1	56.8	55.7	53.1	57	28

CONCLUSIONS

The main objective of this study is to test, experimentally for fast food and /or off licence shops, the predicted model of the acoustics impact for commercial car parking developed by (8). This is suggesting a method for assessing the acoustic impact from such impulsive noises which could be used in the determination of planning applications.

From this experimental investigation and after various noise measurements were carried out results summary is shown in Tables 5 and 6, the main conclusions are:

- the model in question has a variable under estimated factor in the range (5-10) dB(A) of the hourly measured equivalent continuous noise level L_{Aeq} for the shops sited at open–ended roads as shown in Figure 2. These roads are used regularly for passing vehicles and minibuses to serve local people. The reason for such under estimation is because the noise produced by the road users has a dominant influence on the measured L_{Aeq} noise level as well as on the measured L_{Aeq} for the background. While applying the model to predict the noise level on sites at closed-ended roads gives relatively slight differences from the measured L_{Aeq} as shown in Figure 3. The background measurement, for the sites located at open-ended roads needs to be obtained for the whole measuring time period (here one hour) and cover all the noisy events except those generated due to the presence of the shops in question. In other words two sound level meters (preferably, accompanied with two persons) ought to be adjusted to monitor the noise measurement. The first within 10 meters from the center of the parking area and the second within a distance far from the first e.g. 100 - 150 meters. The second is expected to record all the noise events (recorded by the first) but these from car door slam and car engine starts (produced from vehicles parked at the vicinity of the shops in question) would have an insignificant effect on the measurements levels.

- more accurate measurements to validate the predicted model would be at closed-ended roads which are, somewhat, similar to the situation in a commercial car parking.

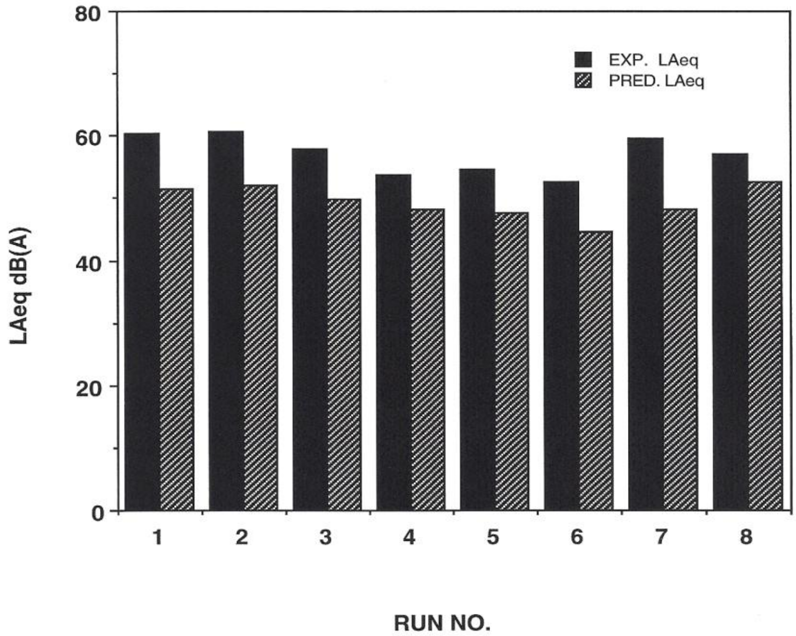

Figure 2: Comparison between the experimental and the predicted hourly equivalent continuous noise level L_{Aeq} at OPEN-ENDED roads.

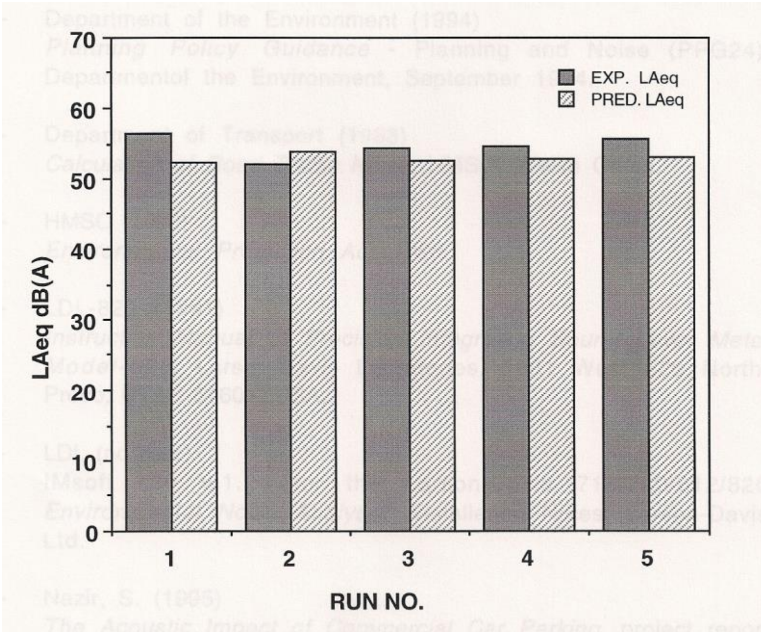

Figure 3: Comparison between the experimental and the predicted hourly equivalent continuous noise level L_{Aeq} at CLOSED-ENDED roads.

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