

UNDERTAKING FROM THE CANDIDATE

I, **Kanakabandi Shalini**, research scholar under the supervision of **Dr. Brind Kumar**, Department of Civil Engineering, IIT (BHU, Varanasi, India give undertaking that the thesis entitled “**Study of Traffic Jam Noise at Different Floor Levels Near Intersections of Varanasi City**” submitted by me for the degree of Doctor of Philosophy is a record of first hand research work done by me during the period of study.

I avail myself to responsibility such as an act will be taken on behalf of me, mistakes, errors of facts and misinterpretations, if any of course entirely of my own.

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DECLARATION BY THE CANDIDATE

I, **Kanakabandi Shalini**, certify that the work embodied in this Ph. D. thesis is my own bona fide work carried out by me under the supervision of **Dr. Brind Kumar** for a period of 6 years 8 months from September 2011 to May 2018 at Department of Civil Engineering, Indian Institute of Technology (BHU), Varanasi, India. The matter embodied in this Ph. D. thesis has not been submitted for the award of any other degree/diploma.

I declare that I have faithfully acknowledged, given credit to and referred to the research workers wherever their works have been cited in the text and the body of the thesis. I further certify that I have not willfully lifted up some other's work, paragraph, text, data, results, etc. reported in the journals, books, magazines, reports, dissertations, theses, etc., or available at web-sites and included them in this Ph. D. thesis and cited as my own work.

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CERTIFICATE FROM THE SUPERVISOR

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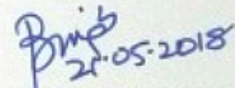
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LIST OF CONTENTS

Title	Page No.
List of Figures	i
List of Tables	iv
List of Plates	xi
List of Photographs	xii
List of Symbols	xiii
List of Abbreviations	xxiv
Preface	xxv
CHAPTER 1 INTRODUCTION	01
1.1 General	01
1.2 Traffic condition	01
1.3 Traffic Jam	03
1.4 Noise Parameters	04
1.4.1 Percentile Noise Level	04
1.4.2 Equivalent Noise Level	05
1.4.3 Noise Level Indices	05
1.4.3.1 Traffic Noise Index (<i>TNI</i>)	05
1.4.3.2 Noise Pollution Level (<i>NPL</i>)	06
1.5 Objectives	06
1.6 Scope and Limitations	07
1.7 Organisation of the Thesis	08
CHAPTER 2 LITERATURE REVIEW	09
2.1 General	09

2.2	Statutory Regulations	11
2.3	Mixed Traffic on Indian Roads	12
2.4	Congestion Characteristics of Interrupted Flow for Urban Roads	13
2.4.1	Interrupted traffic flow	14
2.4.2	Level of Service (LOS) based on congestion	15
2.4.3	Quantification of congestion	16
2.5	Effect of Traffic Composition on Road Noise	17
2.6	Traffic Noise Prediction Models	19
2.6.1	Early models	23
2.6.2	Models in recent use	26
2.6.3	Brief summary of models	52
2.7	Traffic Noise Model for Interrupted and Complex Flow	54
2.8	Urban Noise Assessment and Modeling	66
2.9	Noise Studies of City Enviroscape at Different Floor Levels	69
2.10	Research Gap	75
CHAPTER 3	STUDY AREA	77
3.1	General	77
3.2	Study Location	78
3.2	Site Details of Study Location	101
CHAPTER 4	METHODOLOGY	108
4.1	Arrangements at Data Collection Sites	108
4.2	Sound Level Meter	110

4.3	Methodology for Data Collection	110
4.3.1	Identification of Traffic Jam Sites and Its Timings	111
4.3.2	Finalization of Field Data Collection Programme & Duration	112
4.3.3	Training of Data Collection Party	112
4.3.4	Sound Level	113
4.3.5	Traffic Volume	115
4.3.6	Traffic Speed	115
4.3.7	Format for Data Collection	115
4.3.8	Format for Data Listing	117
CHAPTER 5	FIELD DATA AND ANALYSIS	120
5.1	Data on Building Story and Location of Observer from Source	120
5.2	Data on Traffic Jam, Traffic Noise, Traffic Volume, Projected Area of Vehicles and %Area-Occupancy	123
5.2.1	PCU & PCNE Factors	123
5.2.2	Traffic Volume, Roadway Capacity and Level of Service	128
5.2.3	Traffic Density, Occupancy and Concentration	129
5.2.4	%Area-Occupancy Concept for Heterogeneous Traffic	132
5.2.5	Vehicular Area	136
5.2.6	Field Data on Traffic Jam, Traffic Noise, Traffic Volume, Projected Area of Vehicles and %Area- Occupancy	136

5.2.7	Discussion of Results	138
5.2.7.1	General	138
5.2.7.2	Equivalent noise level (L_{eq})	230
5.2.7.3	TNI and NPL	239
5.2.7.4	Summary	239
CHAPTER 6	MATHEMATICAL MODELING	240
6.1	Parameters and General Equation	240
6.2	Model Types	241
6.3	Analysis Tool	242
6.4	Procedure Adopted	242
6.5	Floor-Wise Leg Model	244
6.6	Floor-Wise Intersection Model	248
6.7	Floor-Wise City Model	251
6.8	Consolidated City Model	253
CHAPTER 7	CONCLUSIONS, RECOMMENDATIONS AND SCOPE	303
	FOR FURTHER WORK	
7.1	Conclusions	303
7.2	Recommendations	308
7.3	Scope for Further Work	309
	References	310
	List of Publications	325

LIST OF FIGURES

Figure No.	Title	Page No.
Fig. 2.1	Quantification of congestion (a) unsaturated and saturated flow (b) unsaturated flow (c) unsaturated, saturated and oversaturated flows	18
Fig. 2.2	Comparison between different Traffic Noise Models with fixed parameters	53
Fig. 2.3	Equilibrium flow-density relationship	55
Fig. 2.4	Traffic noise measurement during a acceleration condition and b deceleration condition	62
Fig. 2.5	Illustration of the shortest slant distance d' and the shortest horizontal distance d for a reception at a relative height h from the source line	71
Fig. 2.6	Section view showing the measurement and prediction of road traffic noise at different levels of a public residential building	71
Fig. 2.7	Comparison between measured and predicted L_{A10} against height of the assessment point above the source	74
Fig. 2.8	Predicted L_{A10} by the CRTN model against measured L_{A10s}	74
Fig. 3.1	Varanasi city map showing selected intersections for study	78
Fig. 3.2	Key plan of selected intersections for study (not to scale)	79
Fig. 3.3	Location of data collection sites [●] at BHU gate intersection	82
Fig. 3.4	Location of data collection sites [●] at Ravidas gate intersection	83
Fig. 3.5	Location of data collection sites [●] at Lanka-Sankatmochan intersection	84
Fig. 3.6	Location of data collection sites [●] at Durgakund temple intersection	85
Fig. 3.7	Location of data collection sites [●] at Bhelupur intersection	86

Fig. 3.8	Location of data collection sites [●] at Rathyatra intersection	
Fig. 3.9	Location of data collection sites [●] at Sigra intersection	87
Fig. 3.10	Location of data collection sites [●] at Englishia Line intersection	88
Fig. 3.11	Location of data collection sites [●] at Andharapul intersection	89
Fig. 3.12	Location of data collection sites [●] at Chaukaghat intersection	90
Fig. 3.13	Location of data collection sites [●] at Godowlia intersection	91
Fig. 3.14	Location of data collection sites [●] at Girjaghar intersection	92
Fig. 3.15	Location of data collection sites [●] at Bhikharipur intersection	93
Fig. 3.16	Location of data collection sites [●] at Manduadih intersection	94
Fig. 3.17	Location of data collection sites [●] at Lahartara-Manduadih intersection	95
Fig. 3.18	Location of data collection sites [●] at Radisson-Varuna Bridge intersection	96
Fig. 3.19	Location of data collection sites [●] at Bhojubir intersection	97
Fig. 3.20	Location of data collection sites [●] at Pandeypur intersection	98
Fig. 3.21	Location of data collection sites [●] at Police Line intersection	99
Fig. 4.1	General arrangement showing source of traffic noise, median, façade line and point of observation on the deceleration lane	100
Fig. 4.2	Bruel&Kjaer integrating-averaging sound level meter 2240	109
Fig. 4.3	Metrex digital sound level meter	110
Fig. 4.4	Flowchart of major activities of the research	111
Fig. 5.1	Speed, volume curve showing level of service	129
Fig. 5.2	Flow-Density curve	130
Fig. 5.3	Speed-Density curve	131
Fig. 5.4	Speed-Flow curve	131

Fig. 5.5	Relationship between %Area-Occupancy and speed of heterogeneous traffic, Governing equation $y = 0.2571x^2 - 7.0128x + 65.129$	134
Fig. 5.6	Relationship between %Area-Occupancy and flow of heterogeneous traffic Governing equation, $y = -28.081x^2 + 686.89x + 600.91$	135
Fig. 5.7	Relationship between %Area-Occupancy and V/C ratio	135

LIST OF TABLES

Table No.	Title	Page No.
Table 2.1	Ambient air quality standards in respect of noise	11
Table 2.2	Correction due to mean flux velocity	40
Table 2.3	Correction for road pavement type	40
Table 2.4	Reference equivalent noise emission levels for vehicle classes	62
Table 2.5	Measurement data for 20 floor building	73
Table 2.6	Difference between measure and predicted L_{A10} at 20 different floor levels	73
Table 3.1	Details of selected intersections and respective legs for data collection	80
Table 3.2	Site details of study location on deceleration lane	103
Table 5.1	Data on building story and location of observer from source	121
Table 5.2	Data of carriageway details, road classification and traffic flow type	124
Table 5.3	Passenger Car Unit (Source: IRC:106-1990, Table-1, Page-10)	127
Table 5.4	PCNE factors suggested by Srivastava et al.	127
Table 5.5	Vehicle categories and their sizes	136
Table 5.6	Dimension of vehicles	137
Table 5.7	Field data on traffic jam, traffic noise, traffic volume, projected area of vehicles and %Area-Occupancy (BHU Gate Towards Naria, GF)	139
Table 5.8	Field data on traffic jam, traffic noise, traffic volume, projected area of vehicles and %Area-Occupancy (BHU Gate Towards	143

	Naria, FF)	
Table 5.9	Summary of BHU Gate intersection, Leg: Towards Naria	147
Table 5.10	Summary of BHU Gate intersection, Leg: Towards Ravidas Gate	148
Table 5.11	Summary of BHU Gate intersection, Leg: Towards Trauma Centre	149
Table 5.12	Summary of Ravidas Gate intersection, Leg: Towards Assi	150
Table 5.13	Summary of Ravidas Gate intersection, Leg: Towards BHU	151
Table 5.14	Summary of Ravidas Gate intersection, Leg: Towards Durgakund	152
Table 5.15(a)	Summary of Ravidas Gate intersection, Leg: Towards Lanka	153
	Thana	
Table 5.15(b)	Summary of Ravidas Gate intersection, Leg: Towards Lanka	154
	Thana	
Table 5.16(a)	Summary of Lanka-Sankatmochan intersection, Leg: Towards	155
	Durgakund	
Table 5.16(b)	Summary of Lanka-Sankatmochan intersection, Leg: Towards	156
	Durgakund	
Table 5.17	Summary of Lanka-Sankatmochan intersection, Leg: Towards	157
	Ravidas Gate	
Table 5.18(a)	Summary of Lanka-Sankatmochan intersection, Leg: Towards	158
	Sankat Mochan Temple	
Table 5.18(b)	Summary of Lanka-Sankatmochan intersection, Leg: Towards	159
	Sankat Mochan Temple	
Table 5.19	Summary of Durgakund Temple intersection, Leg: Towards	160
	Bhelupur	
Table 5.20	Summary Durgakund Temple intersection, Leg: Towards Ravidas	161
	Gate	

Table 5.21(a)	Summary of Bhelupur intersection, Leg: Towards Assi	162
Table 5.21(b)	Summary of Bhelupur intersection, Leg: Towards Assi	163
Table 5.22	Summary of Bhelupur intersection, Leg: Towards Durgakund	164
Table 5.23(a)	Summary of Bhelupur intersection, Leg: Towards Kamachcha	165
Table 5.23(b)	Summary of Bhelupur intersection, Leg: Towards Kamachcha	166
Table 5.24	Summary of Bhelupur intersection, Leg: Towards Ramapura	167
Table 5.25(a)	Summary of Rathyatra intersection, Leg: Towards Kamachcha	168
Table 5.25(b)	Summary of Rathyatra intersection, Leg: Towards Kamachcha	169
Table 5.26(a)	Summary of Rathyatra intersection, Leg: Towards Mahmoorganj	170
Table 5.26(b)	Summary of Rathyatra intersection, Leg: Towards Mahmoorganj	171
Table 5.27	Summary of Rathyatra intersection, Leg: Towards Sigra	172
Table 5.28	Summary of Sigra intersection, Leg: Towards Englishia Line	173
Table 5.29	Summary of Sigra intersection, Leg: Towards Rathyatra	174
Table 5.30(a)	Summary of Sigra intersection, Leg: Towards Teliyabag	175
Table 5.31(b)	Summary of Sigra intersection, Leg: Towards Teliyabag	176
Table 5.31	Summary of Englishia Line intersection, Leg: Towards Andharapul	177
Table 5.32	Summary of Englishia Line intersection, Leg: Towards Lahartara	178
Table 5.33	Summary of Englishia Line intersection, Leg: Towards Sigra	179
Table 5.34	Summary of Andharapul intersection, Leg: Towards Chaukaghat	180
Table 5.35	Summary of Andharapul intersection, Leg: Towards Englishia Line	181
Table 5.36	Summary of Andharapul intersection, Leg: Towards Nadesar	182
Table 5.37	Summary of Andharapul intersection, Leg: Towards Teliyabag	183
Table 5.38	Summary of Chaukaghat intersection, Leg: Towards Andharapul	184

Table 5.55(b)	Summary of Manduadih intersection, Leg: Towards Manduadih Police Station	206
Table 5.56	Summary of Lahartara-Manduadih intersection, Leg: Towards Cantt. Railway Station	207
Table 5.57	Summary of Lahartara-Manduadih intersection, Leg: Towards Manduadih	208
Table 5.58	Summary of Lahartara-Manduadih intersection, Leg: Towards Mohan Sarai	209
Table 5.59	Summary of Radisson-Varuna Bridge intersection, Leg: Towards PWD Office	210
Table 5.60(a)	Summary of Radisson-Varuna Bridge intersection, Leg: Towards The Mall Road	211
Table 5.60(b)	Summary of Radisson-Varuna Bridge intersection, Leg: Towards The Mall Road	212
Table 5.61	Summary of Radisson-Varuna Bridge intersection, Leg: Towards TV Tower	213
Table 5.62(a)	Summary of Bhojubir intersection, Leg: Towards Bhojubir	214
Table 5.62(b)	Summary of Bhojubir intersection, Leg: Towards Bhojubir	215
Table 5.63	Summary of Bhojubir intersection, Leg: Towards Circuit House	216
Table 5.64	Summary of Bhojubir intersection, Leg: Towards Orderly Bazar	217
Table 5.65(a)	Summary of Pandeypur intersection, Leg: Towards Hakul Ganj	218
Table 5.65(b)	Summary of Pandeypur intersection, Leg: Towards Hakul Ganj	219
Table 5.66(a)	Summary of Pandeypur intersection, Leg: Towards Khajuri	220
Table 5.66(b)	Summary of Pandeypur intersection, Leg: Towards Khajuri	221
Table 5.67	Summary of Pandeypur intersection, Leg: Towards Lalpur	222

Table 5.68	Summary of Pandeypur intersection, Leg: Towards Paharia	223
Table 5.69	Summary of Pandeypur intersection, Leg: Towards Police Line	224
Table 5.70(a)	Summary of Police Line intersection, Leg: Towards Kutchhary	225
Table 5.70(b)	Summary of Police Line intersection, Leg: Towards Kutchhary	226
Table 5.71	Summary of Police Line intersection, Leg: Towards Maqbool Alam Road	227
Table 5.72	Summary of Police Line intersection, Leg: Towards Orderly Bazar	228
Table 5.73	Summary of Police Line intersection, Leg: Towards Pandeypur	229
Table 5.74	Highest and lowest L_{eq} recorded, dBA	230
Table 5.75	Floor-wise range of variation of maximum and minimum L_{eq} within 8 data sets, dBA	231
Table 5.76	Computation of the approximate range of variation of L_{eq} at GF level (within 8 data sets), dBA	233
Table 5.77	Floor-wise reduction of L_{eq} , dBA (average value of 8 data sets)	236
Table 5.78	Effect of distance doubling over reduction of L_{eq}	238
Table 6.1	Regression output for floor-wise leg model	255
Table 6.2(a)	Check for adequacy of model developed for floor-wise leg (chi- square test)	259
Table 6.2(b)	Check for adequacy of model developed for floor-wise leg (t-test)	265
Table 6.3(a)	Calibration/validation of model developed for floor-wise leg (chi- square test)	270
Table 6.3(b)	Calibration/validation of model developed for floor-wise leg (t- test)	276
Table 6.4	Regression output for the floor-wise intersection model	281

Table 6.5(a)	Check for adequacy of model developed for floor-wise intersection (chi-square test)	283
Table 6.5(b)	Check for adequacy of model developed for floor-wise intersection (t-test)	286
Table 6.6(a)	Calibration/validation of model developed for floor-wise intersection (chi-square test)	289
Table 6.6(b)	Calibration/validation of model developed for floor-wise intersection (t-test)	292
Table 6.7	Regression output for floor-wise city model	294
Table 6.8(a)	Check for adequacy of floor-wise city model (chi-square test)	296
Table 6.8(b)	Check for adequacy of floor-wise city model (t-test)	296
Table 6.9(a)	Calibration/validation of floor-wise city model (chi-square test)	297
Table 6.9(b)	Calibration/validation of floor-wise city model (t-test)	298
Table 6.10	Regression output for consolidated city model	299
Table 6.11(a)	Check for adequacy of consolidated city model (chi-square test)	300
Table 6.11(b)	Check for adequacy of consolidated city model (t-test)	301
Table 6.12(a)	Calibration/validation of consolidated city model (chi-square test)	302
Table 6.12(b)	Calibration/validation of consolidated city model (t-test)	302

LIST OF PLATES

Plate No.	Title	Page No.
Plate 1	Format for details of data collection site	116
Plate 2	Format for classified traffic volume count	116
Plate 3	Format for traffic noise level	117
Plate 4(a)	Format for listing of field data	118
Plate 4(b)	Format for listing of field data	119

LIST OF Photographs

Photograph No.	Title	Page No.
Photograph 3.1	Reduction of available carriageway for traffic movement due to encroachment for parking	102
Photograph 3.2	A traffic jam of mixed traffic composition in the mid-sized city of Varanasi	102
Photograph 4.1	Data collection at GF level (Bhelupur, towards Durgakund)	113
Photograph 4.2	Data collection at FF level (Durgakund, towards Ravidas Gate)	114
Photograph 4.3	Data collection at FF level (a) Bhelupur, towards Rathyatra(b) Sankatmochan, towards Durgakund	114

LIST OF SYMBOLS

L_{10}	Ten percentile time exceeding noise level
L_{50}	Fifty percentile time exceeding noise level
L_{90}	Ninety percentile time exceeding noise level
L_{eq}	Equivalent noise level
$p(t)$	Time varying sound pressure
p_r	Reference sound pressure
f_i	Number of occurrences of SPL_i
$(L_{10} - L_{90})$	Noise climate
$(L_{max} - L_{min})$	Noise range
L_{max}	Maximum instantaneous level
L_{min}	Minimum instantaneous level
Q_w	Weighted traffic volume
d	Observer distance from noise source
Q	Traffic volume in vehicles per hour
Q_{eq}	Equivalent vehicular flows

\bar{L}_0	Class SPL at the reference distance. The bar indicates the mean
σ	Standard deviation for the class
N_i	Number of vehicles of the i th class passing during the relevant hour
D_0	The reference distance (usually 15 m)
D	The perpendicular distance from the centre line of the traffic lane to the receiver
α	Site parameter, $0 < \alpha < 1$
S_i	Mean speed of the i^{th} class
φ_1 and φ_2	The angles from the perpendicular of the limits of the observer's view of a section of the roadway
Δ_5	The excess attenuation due to barriers, buildings, wood, etc.
A	The slope of the tyre/pavement portion of the regression curve
$B + \Delta E_b$	Height of the tyre/pavement portion
$C + \Delta E_c$	Height of the engine/exhaust portion
$D1$ to $J2$	Constants of the 6th order polynomial fit curve for the 1/3rd spectra;
L	Sub-source ratio at low frequencies
$1 - M$	Ratio at high frequencies
$N, P,$ and Q	Constants for FHWA TNM (Version 1.0)

$A_{traffic(i)}$	Adjustment for traffic flow
A_d	The adjustment for distance between the roadway and receiver and for the length of the roadway
A_s	The adjustment for all shielding and ground effects between the roadway
q	Total hourly flow
Δ_f	Traffic flow adjustment
Δ_g	Gradient adjustment
Δ_p	Pavement type adjustment
Δ_d	Distance adjustment
Δ_s	Shielding adjustment
Δ_a	Angle of view adjustment
Δ_r	Reflection adjustment
v	Hourly mean traffic speed in km/h
P	Percentage of heavy vehicles
f	Hourly flow of heavy vehicles
q	Total hourly flow

L_m	Mean A-weighted level
$L_{m,E}$	Emission level
$D_{S\perp}$	Attenuation due to distance and air absorption
D_{BM}	Attenuation due to ground and atmospheric effects
D_B	Attenuation due to the topography and building dimensions
$L_m^{(25)}$	A-weighted mean level
D_V	Correction for speed limits
D_{StrO}	Correction for road surfaces
D_{Stg}	Correction for rises and falls
D_B	Correction for the absorption characteristics of building surfaces.
M	Standardized traffic flow
v_{PKW}	Speed limit in the range of 30 to 130 km/h for light vehicles
v_{Lkw}	Speed limit in the range of 30 to 80 km/h for heavy vehicles
$D_{StrO,}$	Correction for road surface
N	Number of vehicle movements per hour, by parking spot
n	Number of parking spots

D_p	Correction for the type of car park
L_m	A-weighted mean level
R_{SL}	Correction for speed limit
R_{RS}	Correction for road surfaces
R_{RF}	Correction for rises and falls along the streets
R_E	Correction for the absorption characteristics of building surfaces
R_{DA}	Attenuation's coefficient that takes into account the distance from receiver and air absorption
R_{GA}	Attenuation's coefficient due to ground and atmospheric conditions
R_{TB}	Attenuation coefficient due to topography and building dimensions
$L_{AI,F}$ and $L_{AI,H}$	Global levels evaluated respectively for favorable and homogeneous conditions
$L_{A,w}$	Sound power level of S
S	Source
A_{div}	Geometrical spreading
A_{atm}	Atmospheric absorption
A_{bnd}	Boundary attenuations

A_{gra}	Ground effect
A_{diff}	Diffraction
E_L and E_P	Emission levels obtained from for light and heavy vehicle
l_i	Length in meter of considered road
$R(j)$	Value of normalized noise spectra from CEN 1793-3
L_{A50}	50 percentile A-weighted sound pressure level
L_{WA}	A-weighted sound power level of a vehicle
ΔL_{surf}	Correction term for a drainage asphalt pavement
ΔL_{grad}	Correction for road gradient
ΔL_{dir}	Correction for sound radiation directivity
ΔL_{etc}	Correction for other factors
L_{WR}	Rolling noise
L_{WP}	Propulsion noise
a_R, b_R, a_P and b_P	Coefficients are given in 1/3 rd -octave bands in the frequency range 25 to 10 kHz
L_R	Sound pressure level at receiver
L_W	Sound power level within the considered frequency band

ΔL_d	Propagation effect of spherical divergence of sound energy
ΔL_a	Propagation effect of air absorption
ΔL_t	Propagation effect of the terrain (ground and barriers)
ΔL_s	Propagation effect of scattering zones
$L_{w',eq,line,i,m}$	Directional sound power per metre per frequency band of the source line
$L_{w,i,m}$	Instantaneous directional sound power in 'semi free-field' of a single vehicle
Q_m	Traffic flow data
K	Density
V	Flow speed
S_n	Mean speed of traffic on nearside of observer (both sides of road)(km/h)
S_f	Mean speed of traffic on farside of observer (both sides of road)(km/h)
V_n	Volume of traffic for far-side of observer (both sides of road)(vehicles/h)
V_f	Volume of traffic for far-side of observer (both sides of road)(vehicles/h)

D_g	Geometric mean of road section (m)
d_f	Distance from observer to centerline of far-side roadway (m)
d_n	Distance from observer to nearside roadway curb (m)
A	Location of sound level meter on acceleration side (A)
B	Location of sound level meter on deceleration side (B)
$d_f(a)$	Distance from observer (A) to centerline of roadway on farside (m)
$d_n(a)$	Distance from observer (A) to roadway curb on nearside (m)
$d_f(b)$	Distance from observer (B) to centerline of roadway on farside (m)
$d_n(b)$	Distance from observer (B) to roadway curve on nearside (m)
J	Distance from observer to the nearest junction (m)
$S_f(a)$	Mean speed of traffic on farside of observer (A) (km/h)
$S_f(b)$	Mean speed of traffic on farside of observer (B) km/h)
$S_n(a)$	Mean speed of traffic on nearside of observer (A) (km/h)
$S_n(b)$	Mean speed of traffic on nearside of observer (B) (km/h)
$V_f(a)$	Volume of traffic for farside of observer (A) (vehicles/h)
$V_f(b)$	Volume of traffic for farside of observer (B) (vehicles/h)
$V_n(a)$	Volume of traffic for nearside of observer (A) (vehicles/h)

$V_n(b)$	Volume of traffic for nearside of observer (B) (vehicles/h)
E	Acoustic equivalence
Q_E	Total hourly equivalent traffic flow in vehicles per hour
Q_{Tru}	Hourly traffic flow for trucks in vehicles per hour
Q_{Bus}	Hourly traffic flow for bus in vehicles per hour,
Q_{Tw}	Hourly traffic flow for two-wheelers in vehicles per hour,
$Q_{LCV/MB}$	Hourly traffic flow for LCV/MB in vehicles per hour
Q_{Auto}	Hourly traffic flow for autorickshaw in vehicles per hour
Q_{Car}	Hourly traffic flow for car/jeep/van in vehicles per hour
S_E	Equivalent speed of traffic flow in kilometers per hour, van in kilometers per hour
S_{Tru}	Mean speed of trucks in km per hour, /
S_{Bus}	Mean speed of bus in kilometers per hour,
$S_{LCV/MB}$	Mean speed of LCV/MB in kilometers per hour,
S_{Auto}	Mean speed of autorickshaw in kilometers per hour,
S_{Tw}	Mean speed of two-wheelers in kilometers per hour, and
S_{Car}	Mean speed of car/jeep