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.

Date: 21-05-2018
Varanasi

K.Shalini
(Kanakabandi Shalini)

Ph.D. oral examination of Ms. Kanakalandi Shalini, Research Scholar was held on 22/11/2018 from 9:30 AM onwards in the Civil Engineering Department, IIT (BHU). The research Scholar has presented her work and replied to questions raised by the examiners satisfactorily. She is recommended for award of the degree of Doctor of Philosophy.

22/11/2018

22.11.18

22.11.18

Ravindra Kumar
22/11/2018

22.11.18

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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

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

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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 ith 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_S	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_{grd}	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 1/3rd-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