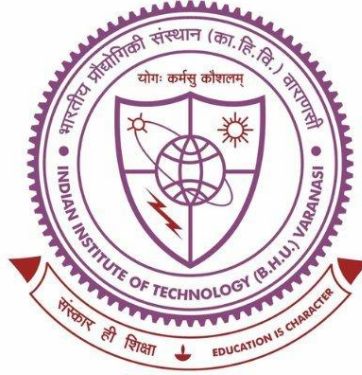


**Analysis of Nonlinear Responses in Asphalt Pavements  
Under Nonuniform Loading Using Finite Element Methods**

**फायनाइट एलिमेंट विधियों का उपयोग करके नॉन यूनिफार्म लोडिंग के तहत डामर  
सड़क के नॉन लीनियर प्रतिक्रियाओं का विश्लेषण**



*Thesis submitted in partial fulfillment  
for the Award of Degree*

**Doctor of Philosophy**

**By**

**Abhinav Kumar**

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**2024**

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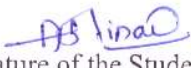
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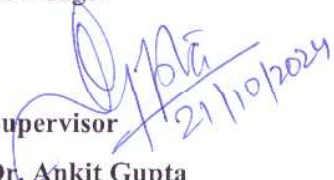
  
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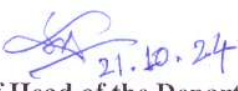
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Dedicated to  
my beloved wife Shipra

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# LIST OF ABBREVIATIONS

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AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ASTM	American Society of Testing and Material
BC	Bituminous Concrete
BCS	Black Cotton Soil
CBR	California Bearing Ratio
CH	High compressibility Clay
CI	Intermediate compressibility Clay
CL	Low compressibility Clay
CS	Cohesive Soil
DBM	Dense Bituminous Macadam
DEM	Discrete Element Method
DSR	Dynamic Shear Rheometer
DTS	Dynamic Testing System
ESAL	Equivalent Standard Axle Load
ETA	Emulsion Treated Aggregate
FAS	Fly-Ash Soil
FEM	Finite Element Method
FWD	Falling Weight Deflectometer
GDP	Gross Domestic Product
GKM	Generalized Kelvin Model
GMM	Generalized Maxwell Model
GSB	Granular Sub-base
HMA	Hot Mix Asphalt

IRC	Indian Road Congress
IS	Indian Standards
ITS	Indirect Tensile Strength
LVDT	Linear Vertical Displacement Transducer
LVE	Linear Viscoelastic
MDD	Maximum Dry Density
ME	Mechanistic Empirical
MEPDG	Mechanistic Empirical Pavement Design Guide
MI	Intermediate compressibility Silt
ML	Low compressibility Silt
MoRTH	Ministry of Road Transport and Highways
msa	Millions of Standard Axle
NCHRP	National Cooperative Highway Research Program
NH	National Highways
NMAS	Nominal Maximum Aggregate Size
OBC	Optimum Binder Content
OFC	Optimum Fluid Content
OGFC	Open Graded Friction Course
OMC	Optimum Moisture Content
PI	Plasticity Index
RS	Red Soil
SD	Stress Dependent
SMA	Stone Mastic Asphalt
SS	Slow Setting
UGL	Unbound Granular Layer
UGM	Unbound Granular Material

USA	United States of America
VG	Viscosity Grade
VFB	Voids Filled with Bitumen
VMA	Voids in Mineral Aggregate
WLF	Williams-Landel-Ferry
WMM	Wet Mix Macadam
$G_{mb}$	Bulk specific gravity of bituminous mix
$G_{mm}$	Theoretical maximum specific gravity of bituminous mix
$M_r$	Resilient Modulus
$N_f$	Fatigue Life of Asphalt layer
$N_R$	Rutting Life of Subgrade layer
$\epsilon_r$	Recoverable strain
$\theta$	Bulk stress
$\sigma_d$	Deviatoric stress
$\gamma$	Shear strain
$\epsilon$	Normal strain
$\tau_{oct}$	Octahedral shear stress
$\epsilon_z$	Compressive strain at the top of the subgrade layer
$\epsilon_t$	Tensile strain at the bottom of the asphalt layer