CERTIFICATE

This is to certify that the statement made by Mr. Narinder, in the declaration of his major project thesis entitled **"AN APPROACH OF FINDING DAMPING USING FRICTION DAMPER"** is correct to the best of my knowledge and belief.

(ALOK VERMA)
Asstt. Professor
Department of Civil Engineering
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CANDIDATE DECLARATION

I hereby certified that the major project entitled **"AN APPROACH OF FINDING DAMPING USING FRICTION DAMPER"** which is being submitted by Mr. Narinder Thukral in Partial fulfillment for the award of the Degree Of Master of engineering in Structural Engineering of University of Delhi is carried out by him under my supervision and guidance.

The matter embodied in this thesis has not been submitted for the award of any other degree or diploma.

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ACKNOWLEGMENT

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ABSTRACT

Large-magnitude long-distance earthquakes generated from Himalaya region have significant potential engineering implications in Delhi region.

If part of input energy due to earthquake could be dissipated through special devices which can be easily be replaced, as necessary, after an earthquake, the structural damage could be reduced. These devices can be classified into three categories: viscous and viscoelastic dampers, metallic dampers, and friction dampers. The purpose of this study is to evaluate the seismic behavior of tall building structures by friction damper. The finite element modeling technique (ETAB Software) is used in this study to learn the behavior of structure equipped by friction dampers. Three different methods of analyzing (Free vibration, Response spectrum, and Time History analysis) have been done to achieve this purpose. In general, this study indicates that the response of structure such as story drifts, axial load of columns and beams, shear load and bending moment of beams, and base shear can be dramatically reduced by using friction damper devices. This happens as the presence of Friction Damper modifies the damping of overall building frame.

CONTENTS

LIST OF ABBREVIATIONS

IBC	-	International Building Code
NEHRP	-	National Earthquake Hazards Reduction Program
ADAS	-	Added Damping And Stiffness
SMRF	-	Special Moment Resisting Frame
FEMA	-	Federal Emergency Management Agency
RC	-	Reinforced Concrete
SBC	-	Slotted Bolted Connection
PED	-	Passive Energy Dissipation
VE	-	Viscoelastic
SDOF	-	Single Degree of Freedom
U.S.	-	United State of America
DBE	-	Design Basis Earthquake
MCE	-	Maximum Considered Earthquake
FDD	-	Friction Damper Device
EC	-	Euro code 8
FE	-	Finite Element
2D	-	2 Dimensional
3D	-	3 Dimensional
RSA	-	Response Spectrum Analysis
THA	-	Time History Analysis
SEER	-	Engineering Seismology and Earthquake Engineering Research

LIST OF SYMBOLS

m	-	Meter
cm	-	Centimeter
mm	-	Millimeter
kN	-	Kilo Newton
kN /mm^2	-	Kilo Newton per millimeter square
N/mm^2	-	Newton per millimeter square
kg/cm^2	-	Kilogram per centimeter square
kg/cm^3	-	Kilogram per centimeter cube
g	-	Gravitational ground acceleration
U1	-	Global X-direction
%	-	Percentage
$\ddot{x}$	-	Ground acceleration
$\dot{x}$	-	Ground velocity
x	-	Ground displacement
t	-	Time/period
Hz	-	Hertz
k	-	Linear elastic stiffness
m	-	Mass
c	-	Damping coefficient
$\ddot{u}$	-	Structural acceleration
$\dot{u}$	-	Structural velocity
u	-	Displacement
±	-	Approximation

δ	-	Inter story drift
b	-	Brace
d	-	Damper
f	-	Shear force/friction coefficient
N	-	Applied normal force
ΔT	-	Time step
fy	-	Strength of reinforcement
f'_c	-	Strength of concrete
E	-	Modulus of elasticity
G	-	Shear modulus
v	-	Poisson ratio
Y_e	-	Yield strength
U_e	-	Ultimate strength
p	-	Axial force
M	-	Bending moment
V	-	Shear force
i.e.	-	Initialism; “In other words”
syn	-	Signum Function