



# ਗੁਰੂ ਨਾਨਕ ਦੇਵ ਇੰਜੀਨੀਅਰਿੰਗ ਕਾਲਜ Guru Nanak Dev Engineering College

An Autonomous College U/S 2(f) and 12(B) of UGC Act 1956

Institute Accredited by NAAC (A Grade) under UGC & TCS

AICTE Approved, Punjab Govt. Aided Status, Affiliated to IKG Punjab Tech. University, Jalandhar

ISO : 9001:2008 Certified • UG Programmes accredited by IEI

Ref. No. HS/E/1971

Dated 6.9.19

## NOC-CUM-EXPERIENCE-CUM-SALARY CERTIFICATE

This is to certify that Dr. Harpal Singh S/o S. Ajaib Singh is working as Professor in Civil Engineering Department of this college since 17.11.1998. He is a regular employee of this College.

During the above said period, he was on extra ordinary leave w.e.f. 11.05.2005 to 31.03.2010.

At present, he is drawing basic pay of Rs. 81984/- (Basic Pay Rs. 78080/- + IR Rs. 3904) in the pay scale of Rs. 37400-67000+10000 AGP and break up of his salary for the month of August, 2019 is as under :-

Gross Salary	Rs. 221217.00
Deductions	Rs. 61847.00
Net Salary	Rs. 159370.00

He has also performed the following duties :-

Name of duty	Duration
Officiating Principal	01.10.2017 to 13.11.2017
Head - Civil Engg. Deptt.	31.07.2003 to 10.05.2005
Dean (Academics)	05.12.2001 to 10.01.2003

This College has no objection, for applying by him, for the post of Professor (Civil Engineering) at NIT, Jalandhar. In case of his selection, for the post applied for, he will be relieved as per College rules.

This certificate is being issued on the specific request of the employee, without accepting any financial liability / responsibility on behalf of this certificate or part of this certificate.

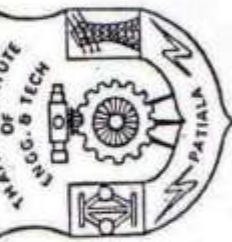
S. S.  
Principal

Utkal Institute of Engineering and Technology, Patiala  
(Deemed University)

- Doctor of Philosophy

Certified that Harpal Singh, s/o Shri Ajai Singh  
has obtained the Degree of Doctor of Philosophy on his/her having  
successfully completed the prescribed requirements for the said degree  
in June 1996.

Given this day under the seal of the Institute at Patiala  
The Eighty Fifth day of October, One Thousand Nine Hundred  
and Ninety Six.



A. Tewari,  
Registrar

*[Signature]*  
Director

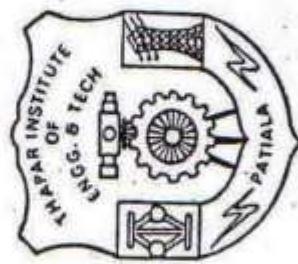
Thapar Institute of Engineering and Technology, Patiala

(Deemed University)

Master of Engineering

Certified that Harpal Singh  
has obtained the Degree of Master of Engineering in Civil Engineering  
(Structures) on his/her having  
successfully completed the prescribed requirements for the said degree  
during the Session 1986-87

He/She is placed in the First Division  
Given this day under the seal of the Institute at Patiala  
The 29<sup>th</sup> day of March, One Thousand Nine Hundred  
and Eighty Eight.



Harpal Singh  
Director

Q.S.W.  
Registrar

Regd. No. 75. 96. 195.

Roll No. 3738.

# ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ

## Bachelor of Engineering

Certified that Harpal Singh, son of Shri Ajai Singh, and of the Conna Namak Engg. College, Ludhiana, has obtained the degree in Bachelor of Engineering (Civil) of this University having passed the examination for the said degree held in May, 1984, in the First Division, with Honours.

Given under the seal of the University

Lakhwarpal

Vice-Chancellor

Due  
\_\_\_\_\_  
Registrar

Chandigarh, August 27, 1984.



ਲੜੀ ਨੰਬਰ № 496089  
Serial



ਲੜੀ ਨੰਬਰ 258827  
Roll No.

# ਪੰਜਾਬ ਸਕੂਲ ਮਿਥਿਆ ਬੈਰਡ

## ਮੇਟ੍ਰਿਕ ਪ੍ਰੀਖਿਆ

ਪ੍ਰਮਾਣਿਤ ਕੀਤਾ ਜਾਂਦਾ ਹੈ ਕਿ ਹਉਮਾਨ ਪ੍ਰੀ਷ਟ  
ਪੁੱਤਰ/ਪੁੱਤਰੀ ਸ਼੍ਰੀ \_\_\_\_\_ ਨਾਮ ਪ੍ਰੀ਷ਟ  
ਪ੍ਰਿਵੇਟ ਸਕੂਲ ਗਾ. ਕੌ: ਲੋਕਨਾਲ, ਲੁਧਿਆਣਾ  
ਇਸ ਬੈਰਡ ਦੀ ਮੇਟ੍ਰਿਕ ਦੀ ਨਾਮਤਾ 1978 ਵਿਚ ਹੋਈ ਪ੍ਰੀਖਿਆ ਅਤੇ ਮਾਮੂਲ  
ਵਿਚ 890 ਨੰਬਰ ਪ੍ਰਾਪਤ ਕਰ ਕੇ ਅਧਿਕ ਦਰਜੇ ਵਿਚ ਪਾਸ ਕੀਤੀ।  
ਜਨਮ ਮਿਤੀ 25 ਦਸੰਬਰ, ਇਕ ਹਜ਼ਾਰ ਨੌ ਸੌ  
(25-12-1962)

## Punjab School Education Board

### Matriculation Examination

Certified that Harpal Singh \_\_\_\_\_,

son/daughter of Shri Ajaib Singh \_\_\_\_\_, and of

Vishva-Karma Hr. Sec. School, Ludhiana \_\_\_\_\_, passed

the Matriculation Examination of this Board held in March 1978,  
in Eight subjects obtaining 890 marks in the First Division.

Date of Birth Twenty-fifth December One Thousand

Nine Hundred and Sixty-two (25.12.1962)

Jarni Singh Hundal

SECRETARY

CHANDIGARH  
September 1, 1978

Sr. No. 057789

Roll No. 255827

## PUNJAB SCHOOL EDUCATION BOARD

Result cum-Detailed Marks Card

(for Pass Candidates)

MATRICULATION EXAMINATION MARCH/AUGUST, 1978.

(Under Integrated Regulations)

Name Harpal SinghFather's Name Shri Ajai Singh  
has passed the Examination. Marks obtained in each subject are given below :—

Subjects offered	Marks Obtained	Maximum Marks
1. Panjabi	145	200
2. Hindi	102	150
3. English	131	150
4. Mathematics OR Arith. D. Arith. S. H.H. A/C	141	150
5. Social Studies (Hist. & Geog.)	74	150
6. Science (Phy. & Chem.) W. 99 P. 27	126	150
7. Health & Physical Education W. 37 P. 31	68	100
8. Mys. 126 W. 73 P. 30	103	150
Total	890	1200

Line below marks indicates failure in the subjects and marks not included in the grand Total.

*S. Singh Hundal*18 AUG 1978  
CHANDIGARH

SECRETARY

Sr. No. 4

Roll No... 103.

## Punjabi University



## FACULTY OF ENGINEERING AND TECHNOLOGY

## RESULT-cum-DETAILED MARKS CERTIFICATE

## Master of Civil Engineering (STRUCTURES)

Examination... May. 1985

Name.... Harpal Singh .....

Father's Name Shri.... Ajai Singh .....

## SUBJECTS QUALIFIED AND MARKS OBTAINED

*Sr No. of Subject	Marks obtained	Minimum Pass Marks	Maximum Marks
6	81	40	100
	42	25	50
11	51	40	100
	26	25	50
12	72	40	103
	38	25	50
14	57	40	100
	38	25	50
17	50	40	100
	42	25	50
	—	40	100
	—	25	50
	—	40	100
	—	25	50
Seminar/Design Project)	Sessional	50	100
TOTAL	497	—	750

(... Four ... Hundred and Ninety Seven.  
numeral)

Patiala

Dated... 20-11-1985

Accredited by  
Panjab University

Marks of FAILED paper is not included in the total.

\*Note : Please see nomenclature &amp; list of subjects on reverse.

Sr. No. 12

Roll No. 101

## Punjabi University



### FACULTY OF ENGINEERING AND TECHNOLOGY

### RESULT-cum-DETAILED MARKS CERTIFICATE

Master of Civil Engineering (STRUCTURES)

Examination... Dec 1985

Name.... Haipal Singh .....

Father's Name Shri.... Ajai Singh .....

### SUBJECTS QUALIFIED AND MARKS OBTAINED

*Sr No. of Subject	Marks obtained	Minimum Pass Marks	Maximum Marks
3	Theory 65	40	100
	Sessional 40	25	50
7	Theory 86	40	100
	Sessional 46	25	50
13	Theory 75	40	103
	Sessional 36	25	50
18	Theory 56	40	100
	Sessional 45	25	50
20	Theory 66	40	100
	Sessional 38	25	50
—	Theory	40	100
	Sessional	25	50
—	Theory	40	100
	Sessional	25	50
Seminar/Design Project)	Sessional 77	50	100
TOTAL	630	—	850

(... Sixty ... Hundred and... Thirty ... )

Patiala 11 MAR 1986  
Dated... 11 MAR 1986

Dy. Registrar (Exams.)  
for Registrar A

Marks of FAILED paper is not included in the total.

\*Note : Please see nomenclature & list of subjects on reverse.

Sr. No.....112.....

Roll No. ....3738.....

**Panjab University**

## RESULT-cum-DETAILED MARKS CARD

B.Sc. Engineering (Civil) Eighth Semester Examination, April/November, 1984.

Name : ..... Harpal Singh .....

Father's Name : Shri.... Ajit Singh.....

**DETAIL OF MARKS**

<i>Theory Papers</i>	<i>Marks obtained</i>	<i>Minimum pass marks</i>	<i>Maximum marks</i>	<i>Practicals &amp; Viva-Voce</i>	<i>Marks obtained</i>	<i>Minimum pass marks</i>	<i>Maximum marks</i>
I Foundation Engg.	{ Theory Sessional } 48 45.	30 25	75 50	{ Civil Engg. Projects Structural Design & Foundation Engg. }	{ Sessional Practical & Viva-Voce } 80 23	50 10	100 25
II Works Management and Construction Engg.	{ Theory Sessional } 63 43.	30 25	75 50	{ Environmental Engg. }	{ Sessional Practical & Viva-Voce } 79 19.	50 10	100 25
III Transport Engg.-II*	{ Theory Sessional } 62 44.	30 25	75 50	{ Vocational Training }	{ Sessional } 21	13	25
ELECTIVE <del>Advantage of Structural Design</del>	{ Theory Sessional } 59. 42.	30 25	75 50	{ General Fitness }	{ Sessional Practical & Viva-Voce } 54 22.	38 10	75 25
Total (if passed)	406	—	500	Total (if passed)	298	—	375
Total Theory, Practical & Viva-Voce					704	—	875
Marks obtained in 1st to 7th Semesters Examinations					5464	—	7125
Grand Total (if passed)					6108	—	8000

**RESULT :**

✓ 1. PASS : Total Marks obtained (if passed)..... Six thousand.....  
one hundred and eight .....

2. To Re-appear in paper(s).....  
..........

e-mail :principalgzscet@yahoo.co.in  
Website:www.gzscetbti.org

OFF 0164-2280985  
0164-2282491  
FAX: 0164-2280164



**GIANI ZAIL SINGH COLLEGE OF ENGG. & TECH.  
DABWALI ROAD, BATHINDA-151001**

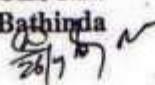
No. 489

Dated 27-04-11

**TO WHOM IT MAY CONCERN**

It is certified that Dr. Harpal Singh S/o Sh. Ajaib Singh had worked as Principal in this college w.e.f. 11.05.2005 to 31.03.2010. in the Pay Scale of Rs: 37400-67000/- During this period his work and conduct was found satisfactory.

  
Principal  
GZSCET  
Bathinda

  
26/7/11

**AHUJA BUILDERS**  
Engineers and Contractors

X-8, HAUZ KHAS, NEW DELHI-110016  
Telephones : 669685, 662550

Ref. No. 1001/85

Date: 27th Jan, 1985

TO WHOM IT MAY CONCERN.

This is to certify that Sh. Harpal Singh S/o Sh.  
Ajaib Singh has worked with us as a Project Civil Engineer  
from 20th July, 1984 to 27th January, 1985 on the construction  
of auditorium and R & D Centre at Thapar Corporate and Research  
Centre at Patiala.

His work has been very satisfactory and he left the  
job of his own for higher studies. It is a great loss to  
us to relieve him but we do not want to come in his way of  
persuading higher studies.

He bears a good moral character and we wish him every  
success in his future life.

  
Project Manager

AHUJA BUILDERS

# THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY

Post Box No. 32  
PATIALA-147 004 (INDIA)



Phone : Off. :  
Resl. :  
Grams : THAPARINST  
Fax : 0175 [ 364498, 393005  
393020 ]

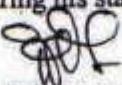
NO.TIET/ADMN/PSL/ 2379  
Dated 18-6-2003

## EXPERIENCE CERTIFICATE

This is to certify that Dr. Harpal Singh, S/o S. Ajab Singh worked in the Department of Civil Engineering of this Institute as under:-

Lecturer (on adhoc basis)	03.01.1986 to 11.08.1986
Lecturer (Regular)	12.08.1986 to 08.08.1994
Assistant Professor (Regular)	09.08.1994 to 17.01.2002

During his stay in the Institute his work and conduct was found satisfactory.

  
REGISTRAR

3454



## COLLEGE OF ENGG. & TECHNOLOGY

Dabwali Road, BATHINDA-151001

Ref. No. 95748.....

Dated....19/2/94.....

### TO WHOM IT MAY CONCERN

Sh.Harpal Singh was working in this Institution as Assistant Professor w.e.f. 1/1/93 to 8/8/94 in the scale of Rs.3700-5700/-.

It is added here that Sh.Harpal Singh was working in this Institution under the period of two years probation. His work and conduct was satisfactory.

*[Signature]*  
Principal, Principal  
College of Engineering & Technology  
BATHINDA,

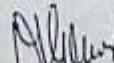
AUDITED UTILIZATION CERTIFICATE

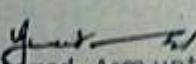
Record No./File No. 8018/RDII/POR/R&D(175)/99-2000  
As mentioned in sanctioned  
letter

Year of Sanction 1999-2000  
Name of PI/C.G: Dr. Harpal Singh  
Address Guru Nanak Dev Engg. College,  
Ludhiana (Civil Engg. Deptt).  
Project title: Tackling Vulnerability in Bridges

Certified that out of Rs. 8.00 (Rs.Eight lacs only)  
of Grants-in-aid sanctioned during the financial  
year 1999-2000 Letter No. 8018/RDII/POR/R&D(175)/99-2000  
Rs. 8,00,000.00 has been utilized for the purpose of purchase  
Equipment/recurring for which it was sanctioned and the  
balance of Rs. -- remaining unutilized at the end of  
the year has been surrendered to the All India Council for  
Technical Education (Vide No. --  
dated --)/will be adjusted towards the Grants-in-aid  
payable during the next year -- as per detail attached.

Certified that the grant has been utilized as per laid down  
terms and conditions for the purpose for which it was sanctioned.

  
Registrar/Principal/Director  
(Signature & Seal) Principal,  
G.N. Dev Engg. College,  
Dated \_\_\_\_\_ LUDHIANA-141008

  
Chartered Accountant  
(Signature & Seal)

Dated 3-9-2003 

# THAPAR CORPORATE RESEARCH & DEVELOPMENT CENTRE

Post Box No. 68  
PATIALA - 147 001

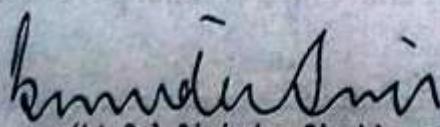
Phone :  
Grams : CENTRETHAP  
Telex : 394-207 TRDC IN

Dated: February 26, 1993

## SERVICE CERTIFICATE

Name	:	Shri Harpal Singh
Designation	:	Project Consultant
Dept./Divn./Unit	:	Mechanics & Computers Division
Salary Drawn	:	Rs.500/- per month (consolidated)
Date of joining	:	January 22, 1992
Date of leaving	:	December 31, 1992
Conduct	:	Good

Shri Harpal Singh has worked on the project entitled "PC Based Finite Element Analysis of Structures". His work was satisfactory.

  
(Lt Col Birinder Singh)

HEAD, PERSONNEL & ADMINISTRATION

(Lt Col Birinder Singh)

Head Personnel & Admin.,

Thapar Corporate Research & Development Centre,

PATIALA - 147 001.



## TESTING & CONSULTANCY CELL

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Gill Park, Gill Road, Ludhiana - 141006 Lat 30° 51' 29" N Lon 75° 51' 39"E

Ph.: 0161-2491193, 5064509 Website : <http://tcc.gndec.ac.in> E-mail : [tcc@gndec.ac.in](mailto:tcc@gndec.ac.in)

No. GNDEC/TCC/957

Dated : 15.10.2018

### TO WHOM IT MAY CONCERN

It is certified that Dr. Harpal Singh, Professor, Civil Engineering, Guru Nanak Dev Engineering College, Ludhiana was involved in the Consultancy Projects as consultant for Structural Engineering projects.

As per records of Testing and Consultancy Cell, Dr. Harpal Singh had been associated with projects worth of Rs.2.60 Crores for the last nine years (2010-2011 to April 2018-15, Oct.2018). Details are as given below:

Sr. No.	Period	Revenue generated (Lakhs)
1.	2010-2011	27.10
2.	2011-2012	34.03
3.	2012-2013	27.12
4.	2013-2014	27.88
5.	2014-2015	30.82
6.	2015-2016	39.96
7.	2016-2017	29.10
8.	2017-2018	19.76
9.	April 2018 to 15, Oct.2018	23.70
		259.47

(Dr. H.S. Rai)  
Dean Testing & Consultancy

Oral Acceptance Letter - CIVIL-COMP & CIVIL-COMP-OPTI 2019

From: Content-TRAI2019 (Content-TRAI2019@elsevier.com)

To: hps\_bhoday@yahoo.com

Date: Monday, June 3, 2019, 01:14 PM GMT+5:30



ABSTRACT REFERENCE NUMBER: TRAI2019\_601 [Please quote in all correspondence]

03 June 2019

Dear Harpal Singh,

Thank you for submitting an abstract to present at The Sixteenth International Conference on Civil, Structural & Environmental Engineering Computing & Fifth International Conference on Soft Computing & Optimisation in Civil, Structural and Environmental Engineering. On behalf of the Organising Committee, I am delighted to inform you that your abstract entitled 'Post-Earthquake Damage / Failure Studies of Reinforced Concrete RBI Building', has been accepted for oral presentation. Abstracts of an extremely high standard were submitted for the conference and we believe we have selected an excellent mix of abstracts to address the conference themes. We very much look forward to your presentation.

Your abstract details are as follows:

Title:	Post-Earthquake Damage / Failure Studies of Reinforced Concrete RBI Building
Authors:	Harpal Singh

Please check the above details of your presentation carefully as all conference material will be printed with this information. If there are any corrections, please inform us as soon as possible by email to: [Content-TRAI2019@elsevier.com](mailto:Content-TRAI2019@elsevier.com).

Subject:Oral Acceptance Letter: The Thirteenth International Conference on Computational Structures Technology

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From: content-CSTX2018@elsevier.com  
To: hps\_bhoday@yahoo.com  
Cc: office@civil-comp.com  
Date: Monday, March 05, 2018 04:43:13 PM

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The Thirteenth International Conference on Computational Structures Technology 4-6 September 2018,Sitges,Spain

**ABSTRACT REFERENCE NUMBER: CSTX2018\_0007 (Please quote in all correspondence)**

05 March 2018

Dear H. Singh,

Thank you for submitting an abstract(s) to present at the **The Thirteenth International Conference on Computational Structures Technology**. On behalf of the Organising Committee, I am delighted to inform you that your abstract(s) entitled **Inelastic Response of 3D Reinforced Concrete Infilled Frames Subjected to Earthquake**, has been accepted for an oral presentation. Abstracts of an extremely high standard were submitted for the conference and we believe we have selected an excellent mix of abstracts to address the conference themes. We very much look forward to your presentation.

Your abstract details are as follows:

Title:	<b>Inelastic Response of 3D Reinforced Concrete Infilled Frames Subjected to Earthquake</b>
Authors:	<b>H. Singh, D.K. Paul</b>
Presenting Author:	<b>H. Singh</b>

Subject: Poster acceptance letter for Eighth International Conference on Engineering Failure Analysis 2018

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From: Content-ICEFA2018@elsevier.com  
To: hps\_bhoday@yahoo.com  
Date: Tuesday, March 13, 2018 06:02:39 PM

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### Poster Acceptance Letter

REF NO: ICEFA2018\_0009

14<sup>th</sup> February 2018

Dear H. Singh,

Eighth International Conference on Engineering Failure Analysis

8-11 July 2018, Budapest, Hungary

Thank you for submitting an abstract to present at the **Eighth International Conference on Engineering Failure Analysis 2018**. On behalf of the Organising Committee I am delighted to inform you that your abstract entitled "Post Earthquake Damage / Failure Studies of Reinforced Concrete Infilled Frames" has been accepted for **Poster presentation** at the conference.

Abstracts of an extremely high standard were submitted for the conference and we believe we have selected an excellent mix of abstracts to address the conference themes. We very much look forward to your presentation.

<b>Title:</b>	Post Earthquake Damage / Failure Studies of Reinforced Concrete Infilled Frames
<b>Authors:</b>	H. Singh, D.K. Paul
<b>Presenting Author:</b>	H. Singh



[O1.35]  
Inelastic response of 3D reinforced concrete infilled frames subjected to earthquake  
H. Singh\*, D.K. Paul

<sup>1</sup>Guru Nanak Dev Engineering College, India, <sup>2</sup>IIT Roorkee, India

**Introduction:** Adel Z. et al. (2016) modelled infill with equivalent struts and found that the failure of the infilled frames with regularly distributed infill is smaller than that of the bare frames. Kai Q. and Bing Li, (2017) experimentally and analytically indicated that ignoring the effects of masonry infill walls in progressive collapse design may result in substantial inaccuracy in predicting the stiffness, strength, and failure modes of infilled frames to resist progressive collapse. Teguh M. (2017) carried out the experimental study on 2D masonry infilled reinforced concrete frames subjected to cyclic loading.

**Methods:** In the present study, 3D reinforced concrete infilled frames have been analysed using the finite element method. The skeleton frame, the panel and the interface between the frame and the panel have been modelled by 3-noded frame element, 8-noded isoparametric element and 6-noded interface element, respectively. Reinforced Frame element: Inelastic behaviour of reinforced concrete frame element is governed by the interaction of the axial force, two flexural moments and a torsional moment. The yield surface:

$$f = [(M_x/M_{x,y})^2 + (M_y/M_{x,y})^2 + (M_z/M_{x,y})^2]^{1/2} + |F_x/F_u|^2 \quad (1)$$

proposed by Powell and Chen(1986) has been used.

**Brick Masonry Infill:** To predict the cracking and crushing type of failure, Von Mises failure criterion with a tension cut off has been used.

**Interface Element:** The displacement vector is

$$\bar{u} = [u \ v]^T$$

The strains are the relative displacements at the top and the bottom of the element

$$\bar{\epsilon} = [\bar{u}_s - \bar{u}_b]^T$$

where

$$\bar{u}_s = u_{top} - u_{bot} = N_i(u_{top})i - N_i(u_{bot})i$$

$$\bar{u}_b = v_{top} - v_{bot} = N_i(v_{top})i - N_i(v_{bot})i$$

where  $N_i$  are the shape functions,

The relevant stress vector is

$$\bar{s} = [\bar{\sigma}_s \ \bar{\sigma}_b]^T$$

The material modulus matrix is defined as

$$D^i = \begin{bmatrix} k_s & 0 \\ 0 & k_b \end{bmatrix}$$

where  $k_s$  and  $k_b$  are the shear and the normal stiffness coefficients, respectively. The strain matrix is defined as

$$B = [-N_1 \ -N_2 \ -N_3 \ N_1 \ N_2 \ N_3]$$

where I is identity matrix of order 2x2. The stiffness matrix is calculated as

## Performance of Different Shear Wall Positions in Building using Pushover Analysis

Anna Yani<sup>1</sup> and Dr. Harpal Singh<sup>2</sup>

<sup>1</sup>PG Student M. Tech Structural Engineering, Guru Nanak Dev Engineering College, Ludhiana, India, 9756155980

<sup>2</sup>Professor, Department of Civil Engineering, Guru Nanak Dev Engineering College, Ludhiana, India

E-mail: <sup>1</sup>anayani1995@gmail.com

**Abstract—**Earlier the buildings used were designed mainly as resist gravity loads and check the structure for safety in withstanding the lateral loads. Many existing buildings located in various seismic zones are not able to resist earthquake. The reasons for this deficiency in seismic performance are poor detailing of reinforcement, material degradation and poor lateral resistance. There are various lateral load resisting systems and the use of shear walls is the most common amongst all the available systems. Shear walls are used to resist lateral loads as well as gravity loads due to their high strength and stiffness.

The main objective of this research is to determine the best suitable location of shear wall in multi-story building. To achieve this five models of eleven storied building are considered. The five models taken for comparison are as follows first building without shear wall, second with shear wall at outer corners, third shear wall at exterior of the building, fourth shear wall at the interior of the building and fifth with shear wall at the core of the building. The building is located in seismic zone b. All the loads considered are as per Indian standard. The software used for modelling and analysing is SAP 2000 v. 20.2.0.

Nonlinear static (pushover) analysis is done for all the five models with different positions of shear walls and the pushover curve is obtained. By the help of the pushover curve the comparison between the displacement and base shear is made. And subsequently the best location of shear wall is determined.

**Keywords:** pushover analysis, shear wall, non-linear large properties, SAP 2000.

### 1. INTRODUCTION

Shear wall is a vertical member which resists lateral loads and also supports gravity loads. They resist different types of lateral loads like earthquake load and wind load. Shear walls are provided because they help in increasing the strength and stiffness of the building. Shear walls provide earthquake resistance to multi-story building. Shear walls are provided to reduce the earthquake effects in the buildings. In multi-story buildings the size of beams and columns increases resulting increase in self weight and large displacement. By providing shear walls the size of the beams and columns can be reduced and also the displacement is reduced. The prime criteria these

days in designing of reinforced concrete structures in earthquake prone zones is to regulate lateral displacement occurring due to lateral forces. The nonlinear static analysis of a building has become important to study behaviour of concrete including the crack pattern and also load deflection pattern. It helps in providing more realistic results.

#### 1.1. Shear Wall

Shear walls are provided in high rise buildings subjected to wind forces and earthquake forces. In high-rise buildings, shear walls are used as vertical component to resist lateral load which may occur due to the effect of earthquake and winds which thereby may cause structure failure. The resistance provided by the shear wall is due to the cantilever action. Shear walls vary according to their shapes. The different types of shear walls are rectangular, channel, T shape, L shape, box shape, etc. When shear walls are provided in the core of the building, then it can be used for elevator.

### 2. PUSHOVER ANALYSIS

Pushover analysis is a non linear static analysis method in which the lateral loads are applied incrementally increasing along the height of the building. It is an approximate method of analysis. Pushover analysis can find out the maximum roof displacement and the corresponding base shear. The analysis is done until the frame reaches the target displacement or mechanism is formed. It gives the graph between the displacement of roof and base shear.

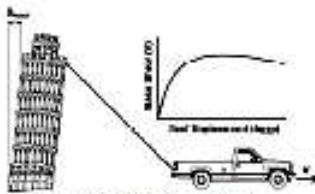


Figure 1: Pushover Curve

# Parametric Study of Multi-storey R/C Building with Plan Irregularity

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**Abstract:** The response of the structure during an earthquake depends essentially on its size, shape and geometry. Regular and symmetric buildings with simple geometry in plan and properly designed have performed well during past earthquakes than asymmetric buildings whereas the response of asymmetric buildings are unpredictable and to take in artistic and functional requirements, designers have to compromise with structural regularity. As a result, asymmetric buildings with U, V, K, L etc. shaped in plan have sustained widespread damage repeatedly in past major earthquakes. Therefore, the parametric study in the proposed thesis attempts to evaluate irregular plan structures like L-shape, H-shape and U-shape. Lateral length ratio is varied for each shape plan configuration and the assessment of each plan is done on the basis lateral length ratio. Buildings are analyzed for Dead loads, Live loads and Wind loads are set as described in IS 875 part 1, 2 and 3 respectively. Modelling and analysis of the structure is done using "ETABS" software. Based on the results and the graphs plotted for design eccentricity, internal forces, Storey shear, Storey displacement, Overturning moment and storey drift versus lateral length ratios for different shapes, conclusion for the most stable structure is drawn.

**Keywords:** lateral length ratio, ETABS, design eccentricity, storey shear.

## 1. Introduction

In 21<sup>st</sup> century, most of the countries are developing economies across the globe, there is a faster rate of growth in the cities. Due to huge population, the number of areas in units are insufficient to meet the demand and are decreasing day by day. To overcome this insufficiency of land, people tend to grow in vertical system which includes tall building structures and these building structures are affected by lateral loads in more than one way. Heavy moments and forces are caused at the base of the buildings due to the direct action of the lateral loads such as seismic and wind loads. Seismic loads (Earthquakes) are one of the greatest natural threats to life as the devastation caused by the seismic activities. Therefore, to avoid the collapse and no loss of life in the most severe possible earthquake, the structure should be designed with an optimum engineering approach. The structures show torsional and translational motions to the earthquake ground motion input if their centre of resistance and their centre of floor mass do not coincide. Torsional motions may occur in nominally symmetrical buildings due to accidental eccentricity. The difference between the assumed and actual distribution of mass and stiffness, differences in coupling of the footing with supportive soil, non-linear forms of force-deformation relationships, and asymmetric yielding strength are the sources giving rise to accidental eccentricity. The design of the symmetric and regular buildings is far more straightforward to predict and these buildings have much higher capacity to endure a strong seismic activity than an asymmetric buildings. However, the response of irregular buildings is more random and unpredictable, engineers still have to compromise structural

symmetry to accommodate serviceable and aesthetic needs. And thus serious and widespread destruction associated with structural asymmetry has been witnessed repeatedly in earlier major earthquakes.

## 2. Torsional Effects in Buildings

The most critical factor leading to torsional motions in buildings is structural asymmetry caused by mass, stiffness or strength distribution. Buildings exhibit coupled torsional and translational response to lateral ground motion if their centres of mass CM do not coincide with their centres of rigidity CR calculated at floor levels. The building's centres of rigidity are defined as the set of points at floor levels through which the set of applied lateral forces does not produce rotation of the floor slabs. The earthquake ground motion  $\ddot{u}_g(t)$  excites the structural model in the lateral direction, acting through CM and loads the structure with an inertial force of magnitude  $m \ddot{u}_g(t)$ , where  $m$  is the mass of the floor diaphragm. This lateral inertial force is resisted by the structural elements, which induce an equal, but opposite, resisting force acting through CR, which is equivalent to the centre of stiffness CS and the shear centre SC for single-storey systems.

The structure is assumed to possess a uniform mass distribution when CM is located at the geometric centre GC whereas an asymmetric stiffness distribution exists when CR is located away from GC. In this case, the earthquake induced inertia force and the structural resisting force are separated by the stiffness eccentricity or static eccentricity. Thus, such a configuration induces a torsional moment that in turn invokes torsional rotation of the floor diaphragm. This onset of an earthquake-induced torque may also eventuate

## Effect of Super Plasticizer on the Mechanical and Durable Properties of High Volume Cementitious Concrete

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### Abstract

Water reducing admixtures often called super plasticizers are used in the concrete to enhance the performance of the concrete. Design Mix of M40 grade having High volume cementitious concrete (HVCC) was prepared having cementitious content equal to that of self-compacting concrete. Mechanical, Durable properties and shear strength of concrete was calculated. Then Polycarboxylic ether (PCE) based super plasticizer (Glenium sky 8777) was added to HVCC to convert it into high volume self-compacting concrete (HVSCC). Again tests were done for mechanical, durable strength of HVSCC. Water cement ratio was kept constant for the entire study. The results showed that there is increase in the mechanical and durable properties of HVSCC when compared to HVCC.

**Keywords:** Self Compacting Concrete, Cementitious Concrete, Mechanical Strength, Durability, Super Plasticizer

### I. INTRODUCTION

Super plasticizers also referred as high range water-reducing agents, which belong to Type F and G categories of water reducers. Chemically, super plasticizers vary from other water reducers and can reduce water requirement by up to 35%. Polycarboxylates ether (PCE) composed by a methoxy - polyethylene glycol copolymer grafted with methacrylic acid copolymer. They're very strong water reducers (powerful at low dosage), with the ability to minimize water by way of 20%-35%, with much less retardation and excessive workability retention. Glenium SKY 8777 is the superplasticiser based on polycarboxylic ether polymers. The product has been primarily developed for applications in high performance ready-mix concrete. Glenium SKY 8777 is free of chloride & low alkali. It is compatible with all types of cements.

#### A. Materials used and Mix Proportions

An Ordinary Portland Cement (OPC) 43 grade confirmed to Indian Standards (IS: 8112-1989) was used in the experimental program. Class F fly ash brought from ACC Power Plant, Gurdaspur, Ludhiana, India confirmed to Indian Standards (IS:3812-2003) was used as a mineral powder. The fly ash was used due to its additional strength contributing pozzolanic activity. The chemical properties of fly ash are presented in Table 1. Locally available coarse aggregates of size 10 and 12.5 mm of specific gravity 2.68 and fineness modulus of 7.6 was used in this study. Locally available river sand of specific gravity 2.4 and fineness modulus of 2.3 was used as fine aggregate. Polycarboxylate ether based superplasticizer complying with ASTM C 494 type F, with density 1.1 kg/l and pH 7.01 was used in the present investigation.

Table - 1

Mix proportions used in the trials

Cement (kg/m <sup>3</sup> )	Fly Ash (kg/m <sup>3</sup> )	Coarse Aggregate (kg/m <sup>3</sup> )	Fine Aggregate (kg/m <sup>3</sup> )	W/C	SP (l/m <sup>3</sup> )
420	180	836	771	0.32	0
420	180	836	771	0.32	6

### II. PREPARATION OF MIXES

For the mix proportion shown in Table 2, required quantities of materials were weighed. Fine and coarse aggregate combinations were mixed for 90 sec in mixer. Cement and filler combinations were added into the aggregate mixes and remixed for 60 sec all together in dry state. The water was mixed in a flask and poured slowly into the mixer while mixing. The total mixing time was

# Physical & Analytical Investigation of Concrete with Replacement of Cement with Egg Shell Powder & Coal Powder Ash

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## Abstract

The mixture of Coal Powder Ash and Egg Shell Powder were used as partial replacement of cement in concrete structures. In this study, egg shell powder from 0% to 10% in multiples of 2.5% and coal powder ash from 0% to 5% in multiples of 1.25%. The results showed that there was increase in the Compressive strength, flexural and tensile strength of the specimens containing 11.25% egg shell powder and coal powder ash when compared to the control mix. Workability of concrete mix decreases with increase in the egg shell and coal powder ash content. The analytical result from ANSYS was obtained by the outcomes obtained from the experimental work and results were verified.

**Keywords:** Replacement, Concrete, Coal Powder Ash, Egg Shell Powder, Cement

## I. INTRODUCTION

The price of building materials now a days is very high in different parts of the nation; particularly developing areas like Punjab, Mangalore, Delhi, etc. that only the government, companies, business areas and few individual can afford it. This high and uncontrolled rising cost can be reduced to minimize by use of different building materials that are cheap, locally available and bring about a reduction in the overall self-weight of the building. Some industrial and other products that would otherwise dump the environment as waste or at best be put into only limited use could gainfully be employed as building material. Engineering in rising nations like our country India, has dependably been is still restricted by three predominant factors; the accessibility of appropriate power, the quality of the materials with which it is economically practical to work and the expense of getting or transporting the materials. The prevalent factors keeping down further improvement is still in all cases the limitation imposed by the mechanical and physical properties of as of now accessible materials.

It would likewise appear that the advancement of more refined high quality materials is inseparably connected with expanding cost to a point when the commercial utilization of such material is seriously confined. This paper analyses two of these materials in namely; Egg Shell Powder & Coal powder ash which can be utilized as alternative materials to substitute cement in the building industries, in order to evaluate and affirm the suitability of replacing cement with egg shell powder & coal powder ash in conc. Structures.

## II. MATERIALS & METHODS

### A. Concrete Materials

Cement: Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material. Cements used in construction can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water.

- Aggregates: Aggregates are hard inert filler materials mixed with a binding material like cement lime or mud in the preparation of mortar or concrete. Aggregates occupy 70 – 75% of the total volume of a mass of concrete and therefore, the properties of concrete are to a large extent dependent on the properties of the aggregates in them.
- Egg Shell Powder: Egg shell powder prepared from the raw egg shell. Raw Egg Shell collected from the dump of wastes and then dries on sunlight for 48 hr. After drying process egg shell crush in small grinder & then sieved.

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## ANALYSIS OF UNDERGROUND WATER TANK

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**ABSTRACT.** Most of work of analysis of water tank has been carried out by taking economy as the objective with the reinforced concrete Vs prestressed concrete tanks. However, mostly this analysis are carried out by approximate or IS code method. This research presents the analysis of underground water tank taking moment coefficients from IS 3370 Part (IV) code and compare results with staad pro analysis as objective. The shapes of water tank used in this research are rectangular and circular. The variables in L/B ratio for rectangular tank and thickness (t) for circular tank are also considered for comparison of analysis. STAAD PRO software is used for the analysis of water tank and comparison with conventional techniques has been made. The analysis by staad pro gives 7 to 10 % reduction in design stresses.

**Keywords:** Underground Water tank, IS code, Staad pro

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## STUDY OF BEHAVIOUR OF A BUILDING L-SHAPED IN PLAN

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**ABSTRACT.** In the present study the response of unsymmetrical building has been studied. An asymmetrical L-shaped building is studied for the static and dynamic analyses. The analysis is carried out by means of STAAD PRO: 2001. The dynamic analysis has been carried out using SRSS approach with IS: 1893: 2002 response spectrum loadings. The analysis has been carried out with unsymmetrical building as a whole and unsymmetrical building divided into two symmetrical building blocks. The comparative study of the two cases has been made.

**Keywords:** L-shaped, unsymmetrical building, static, dynamic analyses.

**Dr Harpal Singh** is a Professor of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana, India. His research interests are finite element based dynamic analysis of buildings.

## COMPARATIVE STUDY OF CONVENTIONAL METHOD AND FINITE ELEMENT ANALYSIS FOR OVERHEAD WATER TANK

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**ABSTRACT.** Most of the work of analyses and design of water tanks is carried out by approximate or IS code method and working stress method. This research presents the comparison of analysis of overhead water tank taking moment coefficients from manual design and using finite element method. Design of overhead water tank is carried out with limit state method. The shapes of water tank used in this research are intz and circular. These elements are designed according to the requirements of the IS 3370-2009 Part I to IV and IS 456:2000 code satisfying the serviceability and strength requirements as per codal provisions. STAAD PRO software is used for the analysis of water tank and comparison with conventional techniques has been made.

**Keyword:** Overhead water tank, moment coefficients, Staad pro

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## Elasto-Plastic Analysis of 3D Frames with Generalized Yield Function

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### ABSTRACT

Three dimensional three node elasto-plastic finite element has been presented. Hinges have been assumed to form at the points of integration (Gauss points) which are distributed over the length of the element. One integration point at the center and the other two near the ends. The inelastic interaction between biaxial bending moment, torque and axial force has been considered by means of generalized yield interaction surface and a flow rule with strain hardening has been associated. The element is more effective where the location of hinges is not known in advance. The concept has been applied successfully on three dimensional steel and reinforced concrete frames.

### Indexing terms/Keywords

Elasto-plastic, frames, yield function

### Academic Discipline And Sub-Disciplines

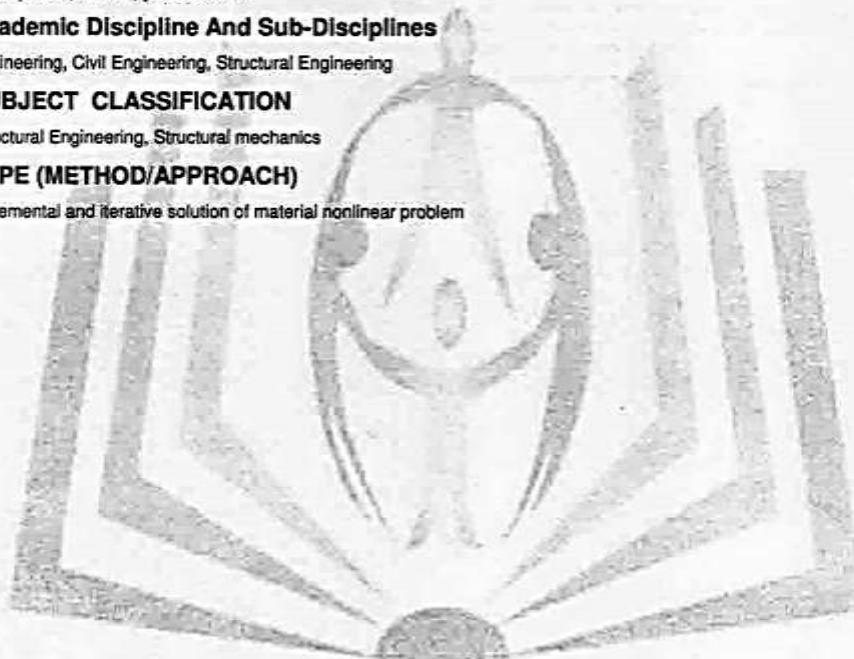
Engineering, Civil Engineering, Structural Engineering

### SUBJECT CLASSIFICATION

Structural Engineering, Structural mechanics

### TYPE (METHOD/APPROACH)

Incremental and iterative solution of material nonlinear problem



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## Relative Study of Solvers for Finite Element Analysis

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### ABSTRACT

A relative study of various linear simultaneous equation solvers has been made. The profile solver and the block solver which have been considered to be most effective solution techniques have been implemented. Medium to large sized structural analysis problems have been analyzed. The comparison of solution time, total execution time and the core memory requirement has been made. The suitability of solvers for various sized problems has also been discussed.

### INTRODUCTION

It has been seen that for larger problems common in practice, 20 to 50 percent of the computer execution time may be devoted to solution of set of linear simultaneous equations. This figure may rise further to about 80 percent in dynamic, non-linear, or structural optimization problems. Therefore, if inappropriate techniques are used for the solution of equilibrium equations, the total cost of analysis may be many times up to 100 times larger than otherwise necessary. ANSYS [1] uses a wave front (or frontal) solution procedure for system of simultaneous linear equations developed from the assembled finite elements. The amount of core storage places a limitation size of front. WILSON et al. [14] proposed an out of core band solver, in which matrix is reduced by column instead of rows, so that most of the operations involving zero multipliers can be avoided. BATHE et al. [4] developed SAP-IV, a 'Structural Analysis Program' for static and dynamic response of Linear system, which uses SESOL, a band solver for system of simultaneous linear equations. The concept of blocking is also used in this subroutine to increase the capacity of the solver. BATHE [2] used profile solver in the program ADINA. BATHE [3] presented 'COLSOL', a subroutine (or active column) (or skyline solver) with full description, based on LDLT decomposition of stiffness matrix stored in a column. IRONS [7] developed 'A Frontal Solution Program' in which the complete stiffness matrix is never found but assembly is done element by element and elimination is also done side by side. HOOD [6] developed 'A Frontal Solution Program for Unsymmetrical Equations'. MEYER [10] discussed the concept of blocking in detail to increase the capacity of band solvers. NATHAN and WILLIAMS [11] developed a solution procedure for solution of linear equations for small computer systems, which is similar to frontal solution but here the equations are assembled node-by-node instead of element by element. SLOAN [12] developed a program for reducing the profile and wave front of a sparse matrix with a symmetric structure and it can be employed to derive efficient ordering for both profile and frontal solution schemes. ZIENKIEWICZ [15] presented package called ACTSOL and UACTCL, profile equation solving subroutines for symmetric and unsymmetrical equations respectively. The LU decomposition of stiffness matrix is performed in these two subroutines. McGUIRE and GALLACHER [13] discussed banded solver, concept of blocking and frontal solvers in detail with examples. MEEK and LEE [9] presented subroutine to solve Banded symmetric matrix by Cholesky (LL<sup>T</sup>) decomposition.

### SOLUTION TECHNIQUES

The profile solver and the frontal solver have been considered to be the most effective solution techniques. These solvers have been implemented and described below.

**Skyline (or Profile) Solver:** This is based on Gauss-Elimination process. Here LDL<sup>T</sup> decomposition of matrix is carried out. The only difference is in the method of storage of the matrix. For this decomposition can be modified accordingly. An effective storage scheme for the structure-stiffness matrix is to store only the portion of each matrix column between the skyline (or profile) and the diagonal as shown in Fig. (1), in a one dimensional array. The matrix of Fig. (1) can be written in single subscript as shown in Fig. (2). Further, the different node numbering schemes can have different profile as shown in Fig. (3) and we should choose that profile which has minimum number of zero within profile because these zero can again create 'fills'. The skyline solver is column-oriented and exploits the differing heights above the diagonal exhibited by various columns, as in many finite element analyses. The advantage of skyline storage scheme is that the storage requirements are not severely affected by a few very long columns, as shown in Fig. (1). That is why, the solution technique based on this storage scheme is also known as active column solver. One thing should be kept in mind, that node numbering which give least bandwidth will result in most compacted matrix A. Solution algorithm which uses such

## CONCLUSIONS

The following are the important conclusions that can be drawn from this study.

1. The colour change has been observed from pink, whitish grey to buff colour from 400°C to 800°C.
2. The cracks were visible at 600°C temperature and got pronounced at 800°C.
3. It is noticed that at 800°C temperature, all levels of OPC replacement with GCRS have exhibited better temperature endurance properties in terms of residual compressive and split tensile strengths being much higher than that for the case of ambient temperature.
4. Residual split tensile strength prediction equations are derived in terms of residual compressive strength for normal strength concretes subjected to elevated temperatures.

## REFERENCES

1. IS: 10262-1982. Recommended guidelines for concrete mix design. Bureau of Indian Standards, New Delhi.
2. IS:516-1959. Methods of Test for Strength of Concrete. Bureau of Indian Standards, New Delhi.
3. SAAD, M., ABO-EL-ENEIN, S.A., HANNA G B AND KOTKATA M.F. Effect of silica fume on the phase composition and microstructure of thermally treated concrete, Cement and Concrete Research, Vol. 26 (5), 1996, pp. 669-675.
4. POON, C. S., AZHAR, S., ANSON M AND WONG Y L. Strength and durability recovery of fire-damaged concrete after post-fire-curing. Cement and Concrete Research, Vol. 31 (9), 2001, pp. 1307-1318.
5. XU, Y., WONG, Y L., POON, C S AND ANSON A. Impact of High temperature on PFA concrete. Cement and Concrete Research, Vol. 31 (7), 2001, pp. 1065-1073.
6. XIAO J H., XIE, M AND ZHANG CH. Residual compressive behaviour of pre-heated high-performance concrete with blast-furnace-slag. Fire Safety Journal, Vol. 41 (2), 2006, pp. 91-98.
7. HOSSAIN, K M A. High strength blended cement concretes incorporating volcanic ash. Performance at high temperatures, Cement & Concrete Composites, Vol. 28 (6), 2006, pp. 535-545.
8. TANYILDIZI H., COSKUN, A. AND SOMUNKIRAN I. An experimental investigation of bond and compressive strength of concrete with mineral admixtures at high temperature. The Arabian Journal of Science and Engineering, Vol. 33 (2B), 2008, pp. 443-449.
9. AL-AKHRAF, N A., AL-AKHRAS, K M AND ATTOM, M F. The performance of olive waste ash concrete exposed to elevated temperature, Fire safety Journal, Vol. 44 (3), 2009, pp. 370-375.
10. BALENDRAN, R V., NADEEM, A., MAQSOOD, T AND LEUNG, H Y. Flexural and Split Cylinder Strengths of HSC at Elevated Temperatures. Fire Technology, Vol. 39 (1), 2003, pp. 47-61.

## INFLUENCE OF CONCRETE INGREDIENTS ON SPECIFIC HEAT: AN EXPERIMENTAL STUDY

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**ABSTRACT:** In this experimental study, the effect of rice-husk ash (RHA), calcium-carbide residue (CCR), rubber waste from used tyres (RW), and vitrified tiles waste (VTW) on the thermal conductivity, specific heat and compressive strength of concrete were investigated. RHA and CCR being porzolamic materials have been used to replace cement in the concrete. RW in the fine crushed form have been used to replace the fine aggregates whereas VTW has been used to replace the coarse aggregates of the concrete due to their good crushing strength. It has been observed that replacement of concrete ingredients by different local waste materials significantly reduces the compressive strength of the concrete depending upon the replacement level. However, it increases the specific heat of the concrete and maximum specific heat has been obtained at 20% replacement level, when RW was used to replace the fine aggregates in the concrete. Maximum possible value of the specific heat along with a minimum reduction in the compressive strength has been obtained at replacement level of 5%, when VTW was used to replace the coarse aggregates in the concrete.

**Keywords:** Concrete, Specific heat, Thermal conductance, Local waste material, Strength.

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## SEISMIC MODELING IN SOIL STRUCTURE INTERACTION CONTINUUM

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**Abstract:** A large number of research papers and several books have been written on structure foundation soil analysis and site response due to earthquake loading. However, the majority of these publications have been restricted to the linear behavior of soil-structure systems. It is possible, with the use of the numerical methods presented here, to conduct accurate earthquake analysis of real soil-structure systems in the time domain, including many realistic nonlinear properties. Also, it can be demonstrated that the solution obtained is converged to the correct structure interactive solution.

### INTRODUCTION

Most of the civil engineering structures involve some type of structural element with direct contact with ground. When the external forces, such as earthquakes, act on these systems, neither the structural displacements nor the ground displacements are independent of each other. The process in which the response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil is termed as soil-structure interaction (SSI) [Tudhar (2006)].

Conventional structural design methods neglect the SSI effects. Neglecting SSI is reasonable for light structures in relatively stiff soil such as low rise buildings and simple rigid retaining walls. The effect of SSI, however, becomes prominent for heavy structures resting on soft soil soils for example nuclear power plants, high-rise buildings and elevated highways on soft soil walls. The effect of SSI [Wolf(1985)].

Damage sustained in recent earthquakes, such as the 1995 Kobe Earthquake, have also highlighted that the seismic behavior of a structure is highly influenced not only by the response of the superstructure, but also by the response of the foundation and the ground as well [Myloakis (2000)]. Hence, the modern seismic design codes, such as Standard Specifications for Concrete Structures: Seismic Performance Verification JSCE 2005 stipulate that the response analysis should be conducted by taking into consideration a whole structural system, including superstructure, foundation and ground.

### EFFECT OF SOIL STRUCTURE INTERACTION ON STRUCTURAL RESPONSE

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period, and thereafter decreases monotonically with period. Considering soil-structure interaction makes a structure more flexible and thus, increasing the natural period of the structure compared to the corresponding rigidly supported structure. Moreover, considering the SSI effect increases the effective damping ratio of the system. The smooth idealization of design spectrum suggests smaller seismic response with the increased natural periods and effective damping ratio due to SSI. With this assumption, it was traditionally been considered that SSI can conveniently be neglected for conservative design. In addition, neglecting SSI tremendously reduces the complication in the analysis of the structures which has tempted designers to neglect the effect of SSI in the analysis.

This conservative simplification is valid for certain class of structures and soil conditions, such as light structures in relatively stiff soil. Unfortunately, the assumption does not always hold true. In fact, the SSI can have a detrimental effect on the structural response, and neglecting SSI in the analysis may lead to unsafe design for both the superstructure and the foundation [Myloakis et al (2000)].

#### • Determinant effects of SSI

Using rigorous numerical analyses, Myloakis et al (2000) have shown that increase in natural period of structure due to SSI is not always beneficial as suggested by the simplified design spectrum. Soft soil sediments can significantly elongate the period of seismic waves and the increase in natural period of structure may lead to the resonance with the long period ground vibration. Additionally, the study showed that ductility demand can significantly increase with the failure of soil may further aggravate the seismic response of the structure.

When a structure is subjected to an earthquake excitation, it interacts with the foundation and the soil, and thus changes the motion of the ground. Soil-structure interaction broadly can be divided into two phenomena: a) kinematic interaction and b) inertial interaction. Earthquake ground motion causes soil displacement known as free-field motion. However, the foundation embedded into the soil will not follow the free field motion. This inability of the foundation to match the free field motion causes the kinematic interaction. On the other hand, the mass of the superstructure transmits the inertial force to the soil causing further deformation in the soil, which is termed as inertial interaction [Wolf(1985)].

At low level of ground shaking, kinematic effect is more dominant causing the lengthening of period and increase in radiation damping. However, with the onset of stronger shaking, near-field modulus degradation and soil-pile gapping limit radiation damping, and inertial interaction becomes predominant causing excessive displacements and bending strains concentrated near the ground surface resulting in pile damage near the ground level [Myloakis et al (2000)].

Observations from recent earthquakes have shown that the response of the foundation and superstructure, foundation and the ground can greatly influence the overall structural response. There are several cases of severe damages in structures due to SSI in the past earthquakes. Yashinsky [1998] cites damage in case of pile-supported bridge structures due to SSI effect in Loma Prieta Earthquake in San Francisco in 1989. Extensive numerical analysis carried out by Myloakis et al (2000) have cited SSI as one of the reasons behind the dramatic collapse of Hanshin Expressway in 1995 Earthquake.

### KINEMATIC OR SOIL STRUCTURE INTERACTION

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- The following are the important conclusions that can be drawn from this study.
1. The colour change has been observed from pink, whitish grey to buff colour from 400°C to 800°C.
  2. The cracks were visible at 600°C temperature and got pronounced at 800°C.
  3. It is noticed that at 800°C temperature, all levels of OPC replacement with GGBS have exhibited better temperature endurance properties in terms of residual compressive and split tensile strengths being much higher than that for the case of ambient temperature.
  4. Residual split tensile strength prediction equations are derived in terms of residual compressive strength for normal strength concretes subjected to elevated temperatures.

#### REFERENCES

1. IS: 10262-1982. Recommended guidelines for concrete mix design. Bureau of Indian Standards, New Delhi.
2. IS:316-1959. Methods of Test for Strength of Concrete. Bureau of Indian Standards, New Delhi.
3. SAAD, M. ABO-EL-ENENI, S.A. HANNA, G.B AND KOTKATA, M.F. Effect of silica fume on the phase composition and microstructure of thermally treated concrete. Cement and Concrete Research, Vol. 26 (5) 1996, pp. 669-675.
4. POON, C. S., AZHAR, S., ANSON, M. AND WONG, Y. L. Strength and durability recovery of firedamaged concrete after post-fire-curing. Cement and Concrete Research, Vol. 31 (9), 2001, pp. 1307-1318.
5. XU, Y., WONG, Y. L., POON, C. S AND ANSON, A. Impact of High temperature on PFA concrete. Cement and Concrete Research, Vol. 31 (7), 2001, pp. 1065-1073.
6. XIAO J H, XIE, M AND ZHANG CH. Residual compressive behaviour of preheated high-performance concrete with blast-furnace-slag. Fire Safety Journal, Vol. 41 (2), 2006, pp. 91-98.
7. HOSSAIN, K. M. A. High strength blended cement concrete incorporating volcanic ash: Performance at high temperatures. Cement & Concrete Composites, Vol. 28 (6), 2006, pp. 535-545.
8. TANYILDIZL, H. COSKUN, A. AND SOMUNKIRAN, L. An experimental investigation of bond and compressive strength of concrete with mineral admixtures at high temperature. The Arabian Journal of Science and Engineering, Vol. 33 (2B), 2008, pp. 443-449.
9. AL-AKHRAF, N. A., AL-AKHRAF, K. M. AND ATTOM, M. F. The performance of olive waste ash concrete exposed to elevated temperature. Fire safety journal, Vol. 44 (3), 2009, pp. 370-375.
10. BALENDRAN, R. V., NADEEM, A., MAQSOUD, T. AND LEUNG, H. Y. Flexural and Split Cylinder Strengths of HSC at Elevated Temperatures. Fire Technology, Vol. 39 (1), 2003, pp. 47-61.

#### INFLUENCE OF CONCRETE INGREDIENTS ON SPECIFIC HEAT: AN EXPERIMENTAL STUDY

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**ABSTRACT:** In this experimental study, the effect of rice-husk ash (RHA), calcium-carbide residue (CCR), rubber waste from used tyres (RW), and vitrified tiles waste (VTW) on the thermal conductivity, specific heat and compressive strength of concrete were investigated. RHA and CCR being porozolanic materials have been used to replace cement in the concrete. RW in the fine crushed form have been used to replace the fine aggregates whereas VTW has been used to replace the coarse aggregates of the concrete due to their good enabling strength. It has been observed that replacement of concrete ingredients by different local waste materials significantly reduces the compressive strength of the concrete depending upon the replacement level. However, it increases the specific heat of the concrete and maximum specific heat has been obtained at 20% replacement level, when RW was used to replace the fine aggregates in the concrete. Maximum possible value of the specific heat along with a minimum reduction in the compressive strength has been obtained at replacement level of 5%, when VTW was used to replace the coarse aggregates in the concrete.

**Keywords:** Concrete, Specific heat, Thermal conductance, Local waste material, Strength.

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- [6] Abaqus Inc. Abaqus Users Manual. Providence:ABAQUS inc. 2005
- [7] British Standards Institute. BSEN 10025-1:2004. *Hot rolled Products of Structural Steel*. London: BSI Publications. 2004.
- [8] British Standards Institute. ISO898-1 *Mechanical Properties of Fasteners Manufactured from Carbon Steel and Alloy Steel*. London:BSI Publications. 1999.
- [9] Obeng, E., Jones, F.D., Horton, H.L., & Ryffel, H.H. *Machinery's Handbook*. 25th edn. New York: Industrial Press Inc. 1996.
- [10] Bickford, J.H. *An Introduction to the Design and Behaviour of Bolted Joints*. New York: Marcel Dekker Inc. 1974.
- [11] Shigley, J.E. & Mischke, C.R. *Mechanical Engineering Design*. 5th edn. London:McGraw-Hill. 1989.
- [12] Minguez, J.M. & Vogwell, J. Effect of Torque Tightening on the Fatigue Strength of Bolted Joints. *Engineering Failure Analysis*. 13 (8), pp. 1410-1421. 2006.
- [13] Astanah-Asl, A. & Liu, J. & McMullin, K.M. Behaviour and Design of Single Plate Shear Connections. *Journal of Constructional Steel Research*. 58 (5-6), pp. 1121-1141. 2002.
- [14] Ray, M.H. Engstrand, & K. Plaxico, C.A. *Performance of W-Beam Splices*. Massachusetts:Worcester Polytechnic Institute. 2001.
- [15] Rogers, C.A. & Hancock, G.J. Bolted Connection Design for Sheet Steels Less Than 1.0mm Thick. *Journal of Constructional Steel Research*. 51 (2), pp. 123-146. 1999.
- [16] British Standards Institute. BSEN 10002-1:2001 *Metallic Materials Testing - Part I Method of Test at Ambient Temperature*. London:BSI Publications. 2001.

## Inelastic dynamic response of 3D reinforced concrete infilled frames

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### Abstract

An inelastic finite element model to simulate the behaviour of 3D reinforced concrete frames infilled with masonry panels subjected to static load and earthquake excitation has been presented. Under the loads the mortar may crack, causing sliding and separation at the interface between the frame and the infill. Furthermore, the infill may become cracked and/or crushed which then changes its structural behaviour. It may render the infill ineffective leaving the bare frame to take the entire load, which may lead to the failure of the framing system itself. In the present study, 3D reinforced concrete infilled frames have been analysed using the finite element method.

**Keywords:** *Infilled frames, inelastic, dynamic response, 3D reinforced concrete.*

### 1 Introduction

Holmes [4] and Smith [12] proposed the concept of infill as an equivalent diagonal compression strut. Liauw and Kwan [6] examined the nonlinear behaviour of non-integral infilled frames using the finite element method. The nonlinearities of material, structural interface, effects of initial lack of fit and friction at the interface were taken into account. Papia [8] used the boundary element method to model the behaviour at the frame and the infill interface. Haddad [3] analysed cracked frames with masonry infill using the finite element method and fracture mechanics.

May and Naji [7] carried out nonlinear analysis of 2D infilled frames under monotonic and cyclic loadings using the finite element method. Choubey and

## **HIGH STRENGTH SILICA FUME CONCRETE**

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### **ABSTRACT**

In the present study it is intended to design and produce high strength concrete mixes using silica fume as a mineral admixture. High strength concrete mixes of the order of M-60 to M-90 have been designed by making an extended use of Indian Standard code method and tested in the laboratory. Superplasticizer has been used to attain the desired workability.

### **INTRODUCTION**

Many researchers have worked on the use of silica fume for producing high strength or high performance concrete. ACI committee 226(1) (1987) reported that water demand of mortars and concrete incorporating SF increases with increasing amount of SF. For example at 30% replacement by mass of cement, for concrete with water cement ratio of 0.64, the water demand has been found to increase by almost 30% for some constant workability.

Wang C.K. and Salman C.G. (1985) reported that the use of superplasticizers alone can cause bleeding and segregation. The use of silica fume with superplasticizer avoids both the bleeding and segregation. Due to the filler effect and excellent pozzolanic properties of SF it can contribute significantly to the compressive strength development.

Chakraborty and Dutta (1998) provided guidelines for addition of silica fume as per Indian Standards. The study also indicates that the Indian cements are compatible with the cement conforming to ASTM standards.

Khedr and Abour Zeid (1994) have shown that both the flexural and the compressive strength at 28 days are increased with the use of silica fume. The highest increase in these strengths has been found to be at 15 % to 20 % replacement of cement with silica fume. The modulus of elasticity was found to increase 15 % with 20 % silica fume content. The bond strength was also found to be improved with the use of silica fume. He also established that the modulus of elasticity and ultimate strain of concrete increases with the increase of SF.

Singh (2002) carried out a study to design and produce high strength silica fume concrete mixes of the order of M-60 to M-90 with desired workability using superplasticizer.

### **MIX DESIGN**

In the present study high strength concrete mixes using silica fume has been designed using Indian Standards [SP: 23(1982)] Indian Standard code method is successfully used



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## Inelastic dynamic response of reinforced concrete infilled frames

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### Abstract

An inelastic finite element model to simulate the behaviour of reinforced concrete frames infilled with masonry panels subjected to static load and earthquake excitation has been presented. Under the loads, the mortar may crack causing sliding and separation at the interface between the frame and the infill. Further, the infill may get cracked and/or crushed which changes its structural behaviour and may render the infill ineffective, leaving the bare frame to take all the load which may lead to the failure of the framing system itself. In this study, a mathematical model to incorporate this behaviour has been presented. © 1998 Elsevier Science Ltd. All rights reserved.

### 1. Introduction

Considerable effort has been made on the analysis of the infilled frame systems. Holmes [1] and Smith [2] proposed the concept of infill as an equivalent diagonal compression strut. Mallick and Severn [3], Liauw and Kwan [4] and May and Ma [5] used the finite element model for the analysis of 2D infilled frames. Papia [6] used boundary elements to model the behaviour at the frame and the infill interface. Haddad [7] analysed cracked frames with masonry infill using the finite element and fracture mechanics.

May and Naji [8] carried out nonlinear analysis of infilled frames under monotonic and cyclic loadings using the finite element method. The skeletal frame was modelled with a 3-noded frame element and the panel was modelled with an 8-noded isoparametric element. A six-noded interface element was used to model the interface between the frame and the infill. Choubey and Sinha [9] carried out the experimental investigation into the behaviour of reinforced concrete frames infilled with brick masonry under lateral cyclic loading. Singh [10] investigated the inelastic response

of three dimensional reinforced concrete frames subjected to earthquake excitation using the finite element method.

### 2. Finite Element Idealization

In the present study, reinforced concrete infilled frames have been analysed using the finite element method. The skeleton frame, the panel and the interface between the frame and the panel have been modelled by a 3-noded frame element, 8-noded isoparametric element and 6-noded interface element, respectively, as shown in Fig. 1.

#### 2.1. Reinforced Concrete Frame Element

A 3-noded beam-column element as shown in Fig. 1 has been used to model the skeletal frame [11]. Inelastic behaviour of the element is governed by the interaction of the axial force, two flexural moments and a torsional moment. The yield surface:

$$f = [(M_x/M_{xu})^2 + (M_y/M_{yu})^2 + (M_z/M_{zu})^2]^{\frac{1}{2}} + [F_x/F_{xu}]^2 \quad (1)$$

\* Corresponding author.

### 3. CONCLUSIONS

The main conclusions may be summarized as follows :

- 1 - For the 5 and 10 stories buildings, the maximum horizontal displacement for all types, irrespective of the number of bays, of the studied frames is nearly the same and the maximum percentage of shear to total weight on the outer columns decreases as the number of bays increases.
- 2 - For the 15 and 20 stories buildings, the maximum horizontal displacement and the maximum percentage of shear to total weight on outer columns decreases as the number of bays increases.
- 3 - For one bay frames, the relative inertia with a ratio of  $I_g : I_c = 2 : 1$ , is the most suitable ratio to be used in the design of earthquake resistant structures and for two or more bay frames, the relative inertia with a ratio of  $I_g : I_c = 1.5 : 1.3$ , is the most suitable ratio to be used in the design of earthquake resistant structures.
- 4 - For one or two bay frame, the increase of the number of stories reduces its resistance to earthquake loads because of the resulting higher displacements.
- 5 - For more than two bay's frame, the decrease of the number of stories and the increase of the number of bays reduce the earthquake effects.
- 6 - Increasing the damping factor of the building makes it more resistant to earthquake loading.

### Response of 3-D Framed Structures under Floor Excitations

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#### ABSTRACT.

In industrial structures, vibrations produced due to different types of machines resting on various floors are of major concern to a structural engineer. In this paper behaviour of 3-D framed structures subjected to various types of such excitations has been analyzed. A computer program to study the forced dynamic response by mode superposition method has been presented.

#### INTRODUCTION

In industrial buildings, different types of machines are mounted on the floors and produce different types of excitations with different magnitudes depending upon the types of machine and the structure on which they are mounted. The problem of designing machine, so as to have a minimum unbalanced mass is in the province of the mechanical engineer. Structural engineer has to design the supporting structure so that it is safe, economical and serviceable.

The machines can be classified based upon the dynamic forces exerted by it on the supporting structure. (a) Shock or impulsive type of loads which occur at regular intervals (e.g. hammers and presses). (b) Steady-state loads which vary with time according to sine and cosine law (e.g. reciprocating and rotating machinery). The machine manufacturers generally furnish data concerning the unbalanced forces. In the present study, the response of 3D framed structures to such type of forcing functions has been presented.

The floor excitations have become a major serviceability consideration in modern building construction with the increase of use of high strength, light weight structural materials<sup>1</sup>. Mitra et al.<sup>2</sup> proposed the frequency window method to analyse harmonic forced vibration of several main structures connected by sub-structure. Singh and Sharma<sup>3</sup> presented the generation of seismic floor response spectra for structures which cannot be modelled as classically damped. The proposed approach can still employ prescribed ground response spectra directly as input for the generation of floor spectra. Tan and Lung<sup>4</sup> presented an analytical method to evaluate the maximum response of a piece of equipment installed in a structure subjected to seismic loading without the necessity of performing time history analysis. Kumar<sup>5</sup> studied the response of 3-D framed structures under different types of floor excitations using mode superposition method. It has been concluded that the dynamic response of such systems is more than equivalent static response. So dynamic analysis must be performed.

#### ANALYSIS

The equation of motion for a MDOF system is<sup>6</sup>:

$$\mathbf{M}\ddot{\mathbf{U}} + \mathbf{C}\dot{\mathbf{U}} + \mathbf{K}\mathbf{U} = \mathbf{P}(t)$$

Where  $\mathbf{M}$ ,  $\mathbf{C}$  and  $\mathbf{K}$  are mass, damping and stiffness matrices respectively. The solution of this equation is

$$\mathbf{U} = \mathbf{U}_0 \sin(\omega_n t) + \mathbf{U}_1 \cos(\omega_n t) + \mathbf{U}_2 \sin(\omega_d t) + \mathbf{U}_3 \cos(\omega_d t) \quad (1)$$

Here  $\omega_d$  is damping ratio,  $\omega_n$  is eigen value and  $\mathbf{U}_0$  is eigen value corresponding to stiff. mode.

## TECHNICAL NOTE

### NON-LINEAR ANALYSIS OF FRAMES

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(Received 19 June 1991)

**Abstract**—A simple and easily programmable technique is proposed for the second-order analysis of frames. This technique involves the iterative process with modification of the stiffness matrix as well as the load vector in each iteration. Both curvature and sway effects are included. A numerical example is included to illustrate the results.

#### INTRODUCTION

In the case of multistorey buildings subjected to heavy gravity loads and bending moments, large curvatures are developed in the structural members if they are slender. If there is also a heavy shear acting, due to lateral loads, it will cause sway in the structural members. These two effects interact with themselves. The analysis incorporating these effects is known as second-order or  $P-\Delta$  analysis.

The most common approach involves multiplying the first-order values by suitable amplification factors [1]. Alternatively, iterative procedures are employed in which standard programs are used to reanalyse the frame for the additional sway forces due to horizontal load analysis of structures [2]. Another technique was proposed by Rutenberg [3], in which the geometric stiffness matrix is modelled as a fictitious column with negative stiffness, and the effect of additional moments due to eccentricity of axial force about deflected shape was considered. Another method was proposed by Wood *et al.* [4] in which the effect of the eccentric gravity loading on the structure is transformed by stages into a fully equivalent lateral loading. By adding this equivalent lateral loading to the actual lateral loading on the structure, a lateral load analysis of the building will give the results which include the  $P-\Delta$  effects.

In this paper, an easily programmable method involving the modification of the stiffness matrix and load vectors, depending upon the nature of axial force, is presented. The above stated modifications take into consideration the curvature and sway effects.

#### ASSUMPTIONS

The material is assumed to remain linearly elastic. All members are prismatic and straight, having two axes of symmetry, so that the centroid and the shear centre of the member cross-section coincide and the twisting and bending of a member occur independently of each other. Shear deformations and strain hardening are not considered.

#### METHOD OF ANALYSIS

On the basis of first-order analysis of the frame, the frame is reanalysed using the modified matrices for the stiffness as well as for the load vectors, depending upon the nature of axial force in each member. This procedure is repeated until the forces in each member converge.

The modified member stiffness matrix is presented which takes into account the effect of axial-flexural interaction

$$[K] = \begin{bmatrix} K_3 & 0 & 0 & -K_3 & 0 & 0 \\ 0 & K_1 S_1 & K_2 S_2 & 0 & -K_1 S_1 & K_2 S_2 \\ 0 & K_2 S_2 & K_1 S_1 & 0 & -K_2 S_2 & K_1 S_1 \\ -K_3 & 0 & 0 & K_3 & 0 & 0 \\ 0 & -K_1 S_1 & -K_2 S_2 & 0 & K_1 S_1 & -K_2 S_2 \\ 0 & K_2 S_2 & K_1 S_1 & 0 & -K_2 S_2 & K_1 S_1 \end{bmatrix}$$

Table I. Nature of axial force

Compressive	Zero	Tensile
$(\cos KL - \cos Ka + \cos Kb + Kb \sin KL - 1)/\phi,$	$-b^2(3a + b)/L^3$	$(\cosh KL - \cos Ka + \cosh Kb - Kb \sinh KL - 1)/\phi,$
$(\sin KL - \sin Ka - \sin Kb - Kb \cos KL - KL \cos Kb - Ka)/K\phi,$	$-a \cdot b^2/L^2$	$(\sinh KL - \sin Ka - \sinh kb - Kb \cosh KL + KL \cosh Kb - Ka)/K\phi,$
$(\cos KL - \cos Kb + \cos Ka + Ka \sin KL - 1)/\phi,$	$-a^2(a + 3b)/L^3$	$(\cosh KL - \cosh Kb + \cosh Ka + Kb \sinh KL - 1)/\phi,$
$(-\sin KL + \sin Kb + \sin Ka + Ka \cos KL - KL \cos Ka + Kb)/K\phi,$	$a^2 \cdot b/L^2$	$(-\sinh KL + \sinh Kb + \sinh Ka + Ka \cosh KL - KL \cosh Ka + Kb)/K\phi,$

Note:  $L$  = length of member;  $a$  = distance of concentrated load from right-hand side support; and  $b = L - a$ .

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21 January, 1991

Professor R B Lall Bedi  
Thapar Institute of Engineering  
& Technology  
Patiala-147 001  
India

Dear Prof. Bedi,

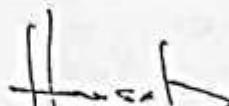
I refer to your letter of 10 January 1991 and on behalf of the committee, I welcome your paper for the forthcoming Conference on Masonry.

I have to return the text as it has to be typewritten in the conference format (guidelines and 8 blank sheets are enclosed for your use).

As part of the requirements of submission and acceptance is the attendance of the author to personally present the paper, kindly let us have your confirmation and fees.

Regards

Yours sincerely,

  
John S Y Tan  
Conference Director

enc.

S. Hanif Singh  
You may keep this document for reference until the  
final decision in your matter.

  
D.I.

## 5. CONCLUSIONS

There is a necessity to evaluate realistic response reduction factors derived from experiments, considering the construction practices and the available materials in the country. To mitigate damage under seismic forces, masonry building construction practices need to be improved and strengthened. As an alternative, reinforced hollow concrete block masonry construction be adopted with advantage.

## 6. ACKNOWLEDGEMENTS

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## 7. REFERENCES

- Bhagavan, N. G., Sreenath, H. G., Sivarama Sarma, B., Vimalandam, V. (1997), State-of-the art-report on reinforced hollow concrete block masonry for disaster resistant low-rise building construction, project report SSP003141, SERC, Madras.
- IS:1893-1984, "Criteria for earthquake resistant design of structures (fourth revision)", Bureau of Indian Standards, New Delhi and 5<sup>th</sup> revision in circulation.
- IS:4328-1993, "Earthquake resistant design and construction of buildings - Code of practice", (second revision), Bureau of Indian Standards, New Delhi.
- IS:13928-1993, "Improving earth quake resistance of low strength masonry buildings - Guidelines", Bureau of Indian Standards, New Delhi.
- Sreenath, H. G., Bhagavan, N. G., Sivarama Sarma, B., Vimalandam, V. (1997), Comparison of cost economics of proposed reinforced hollow concrete block masonry and conventional construction schemes, project report SSP003141, SERC, Madras.
- Sivarama Sarma, B., Bhagavan, N. G., Vimalandam, V., Sreenath, H. G., (1998), Experimental evaluation and recommendations for seismic resistant masonry, project report SSP003141, SERC, Madras.
- Sivarama Sarma, B. (1997), Investigations on laced reinforced concrete construction of low-rise buildings using Reinforced hollow concrete block masonry, Ph.D Thesis, Indian Institute of Technology, Madras.
- Sivarama Sarma, B. (1997), Investigations on laced reinforced concrete beams with normal and fibre reinforced concrete under monotonic and cyclic loading, Ph.D Thesis, Indian Institute of Technology, Madras.

## NIFAP : SOFTWARE FOR THE ANALYSIS OF 3D REINFORCED CONCRETE INFILLED FRAMES SUBJECTED TO EARTHQUAKE EXCITATION

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### ABSTRACT

A computer program to simulate the behaviour of 3D reinforced concrete frames infilled with masonry panels subjected to static load and earthquake excitation has been presented. Under the loads the mortar may crack causing sliding and separation at the interface between the frame and the infill crushed which change its structural behaviour and may render the bare frame to take all the load which may lead to the failure of the framing system itself. An inelastic finite element model to simulate this behaviour has been used. The program predicts the formation of hinges in the frame and cracks in the infills. It calculates plastic strains, displacements and acceleration history response of three dimensional reinforced concrete frames infilled with masonry panels of arbitrary configuration subjected to static load and earthquake excitation.

### INTRODUCTION

Considerable effort has been made on the analysis of the infilled frame systems. Holmes (1961) and Smith (1962) proposed the concept of infill as an equivalent diagonal compression strut. Mallick and Savren (1987) Liuw and Kwan (1984) and May and Ma (1984) used a finite element model for the analysis of 2D infilled frames. Papia (1986) used boundary element to model the behaviour at the frame and the infill interface. Haddad (1991) analysed cracked frame with masonry infill using the finite element method and fracture mechanics. May and Naji (1991) carried out nonlinear analysis of 2D infilled frames under monotonic and cyclic loadings using finite element method. Choubey and Singh (1994) carried out the experimental investigation into the behaviour of reinforced concrete frames infilled with brick masonry under lateral cyclic loading. Singh (1995) investigated the inelastic response of three dimensional reinforced concrete frames subjected to earthquake excitation using finite element method.

### FINITE ELEMENT IDEALISATION

In the present study, three dimensional reinforced concrete infilled frames have been analyzed by using the finite element method. The skeleton frame, the panel and the interface between the frame and the panel have been modelled by 3-noded frame element, 8-noded isoparametric element and 6-noded interface element, respectively as shown in Fig. 1.

### Reinforced Concrete Frame Element

A 3-noded beam-column element as shown in Fig. 1 has been used to model the skeletal frame [Hughes (1987)]. Inelastic behavior of the element is governed by the interaction of the axial force, two flexural moments and a torsional moment [Powell and Chen (1986)] has been used

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## POST EARTHQUAKE FAILURE INVESTIGATION OF A BUILDING

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### ABSTRACT

In this paper post earthquake failure analysis of reinforced concrete cycle stand cum canteen structure at Darbhanga have been carried out to investigate the causes of damage/failure. Three dimensional dynamic analysis of the building has been carried using finite element method when subjected to recorded earthquake motion. The infill panels were idealised using membrane type panel element. The comparison of results of 3D analysis with the actual behavior of structure is made. These results are also compared with the existing 3D analysis where the infill is idealised as a diagonal member.

### 1.0 INTRODUCTION

Different structures behave in different ways during an earthquake. The observation and performance of actual structures during various earthquakes and in depth analysis identifies the reasons of the observed damages and assess the reliability of various analytical procedures which provide invaluable information regarding earthquake resistance of buildings for possible improvements in the design and construction practice. Here, a post earthquake reanalysis of a building has been carried out when subjected to recorded ground spectral acceleration in order to understand the performance of the building. Kaushik (1990) and Paul et al. (1991) have already studied this damage/failure of the same building using 3D analysis. The results of their study are compared with the result of the present study.

### 2.0 THE BUILDING

A reinforced concrete cycle stand cum canteen structure (Fig. 1) was constructed at Darbhanga. The structure at Darbhanga was totally collapsed, during the Aug. 21-1988 Bihar, Nepal earthquake [Kaushik (1990), Paul et al. (1991)]. The building was basically a reinforced concrete structure with two rows of five circular columns at ground storey level with no filler walls (flexible storey). The upper storey is a reinforced concrete frame construction with brick infill. The ground floor level columns are extended to the upper storey. The unsymmetry arised due to staircase connecting ground floor to the first floor as shown in Fig. 1.

# RATING AND RETROFITTING OF BRIDGES

Harpal Singh\* and D.K. Paul\*\*

## ABSTRACT

The objective of the study is to investigate the suitability of the methods of rating and retrofitting of bridges. The existing bridge is to be checked by practical loading as per IRC code on Rating of Bridges instead of loadings used for design of bridges like Class A, Class B, or Class AA loadings for tracked and wheeled vehicles, which are imaginary. The existing bridge is to be checked for practical loadings, which may come on the bridge during its service life, whether it is safe or unsafe. If unsafe then it has to be strengthened (Retrofitted) for today's traffic demands.

## INTRODUCTION

The assessment of carrying capacity of an existing bridge is how much load the structure can support as it stands without becoming permanently deformed and the strengthening if the structure is weak has been studied by many authors. Arya, Thakkar and Bakir (1992) evaluated seismic resistance of bridge and proposed two methods to upgrade its seismic resistance. They also proposed to analyze and retrofit all old bridges, starting with the important ones before the probable earthquake attacks them.

After destructive testing of two retrofitted bridges, Aktan, Lee, Naghavi and Hebbal (1994) concluded that serviceability, damageability and failure behaviors of steel truss bridges possessing built-up members rigidly connected by rivets at the gusset plates are not adversely attacked by local deterioration. The built-up members and the connections possessed adequate deformability permitting extensive redistribution connection retrofit by welding plates was feasible and successful. Harik and Alien (1995) reviewed the seismic evaluation of bridges in Kentucky. In 1986 a study was initiated to determine the vulnerability of highway bridges. A number of bridges out of a total 111 vulnerable were retrofitted. Another study is underway to develop earthquake time histories, design spectra and maps of horizontal acceleration for use in the design of new bridges and in the seismic evaluation of existing bridges and appropriate retrofitting schemes. Nigel, Seiple et al. (1994) assessed the retrofitted bridge column susceptible to shear failure. Jacketed columns performed extremely well, with stable hysteresis loops. Performance of built and retrofitted columns

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## STRUCTURAL RESPONSE OF FRAMES SUBJECTED TO TORSION

Harpal Singh, Dr. R.B.Lal Bedi and Rajbir Singh Bhangal\*

### SYNOPSIS

Most of the available literature discusses the behaviour of individual members subjected to torsion. But the behaviour of the frames subjected to torsion seems to have been neglected so far. The available theories used in analysis are inadequate to incorporate distortion and twisting of the whole frame. An experimental investigation to study the building frames with different reinforcements subjected to torsion has been discussed in this study. Overall dimensions of the frames were kept constant. Major parameters of the study were the effect of amount and type of reinforcement to torsional resistance and cracking pattern when subjected to torsion. The development of strains in the columns of the frames is also studied.

The test results of the experimental frames are presented and discussed. Broad conclusions are drawn from the cracking pattern, progress of cracks, strains and applied torque. The results and conclusions have field applications and are a useful aspect for designers.

### NOTATIONS

$T_x = V_x E_x$	— Torsional moment due to lateral force in x-direction.
$T_y = V_y E_y$	— Torsional moment due to lateral force in y-direction.
$E_x$	— Eccentricity in x-direction.
$E_y$	— Eccentricity in y-direction.
$V_x$	— Storey shear in x-direction.
$V_y$	— Storey shear in y-direction.
$X, Y$	— Coordinates of the centroid of a particular element under consideration in plan from the centre of rigidity.
$I_p$	— Polar moment of inertia of the whole frame.
$K_{xx}, K_{yy}$	— The stiffnesses of the column under consideration in x and y directions respectively.

### INTRODUCTION

In literature, a large number of theories like Skew Bending Theory, Space Truss Analogy Theory, Dowel Force Theory and Interaction Failure Surface Approach are available to indicate the behaviour of individual members subjected to torsion as its combination with bending and shearing. But none of these theories explain the behaviour of the frames subjected to these forces. To study this behaviour the present work was undertaken.

Most building frames are unsymmetrical in plan as well as in elevation. This leads to twisting of frames when subjected to wind and earthquake forces. The magnitude of horizontal torsional moment depends upon the distance between the centre of mass (the point through which the resultant of the masses of a system acts) and the centre of rigidity (The point through which the resultant of the restoring forces acts), which is known as the eccentricity (Fig. 1). The design eccentricity is taken as 1.5 times the computed eccentricity in accordance with clause 4.2.4 of IS: 1893 - 1984. Some other codes recommend the design eccentricity to be 1.5 times the computed eccentricity or 0.05 times the maximum plan dimension of that level whichever is greater. The additional storey shear due to horizontal torsional moment may be calculated approximately by assuming the vertical elements at each storey to be fixed at their ends to parallel rigid plates. The torsional shear force acting on each element may be taken as proportional to its lateral stiffness and its distance from the centre of rigidity of the storey under consideration.

The shear in any column of a frame due to torsion 'T' in a horizontal plane in x and y directions are given by :-

$$V_x = (T_x I_p) K_{xx}$$

$$V_y = (T_y I_p) K_{yy}$$

### DESIGN OF FRAMES AND TEST PROGRAM

Shear due to torsion acting in the horizontal plane is resolved in x and y directions which cause biaxial bending in columns and columns were designed for the same as per IS : 456 - 1978, clause 38.6.

Four frames with different reinforcements were cast. Each frame was consisting of four beams of overall

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## A SIMPLIFIED MATHEMATICAL MODEL FOR SKEW BRIDGE ANALYSIS

V. V. Sastry, <sup>□</sup>FIE, Aff. M. ASCE and Harpal Singh\*

### SYNOPSIS

*A majority of bridge decks in reinforced concrete built today have some amount of skew, taper or curvature in the horizontal plan. Skew bridges are frequently necessitated on account of lack of space for providing the same in crowded urban areas and due to growing number of complex intersections provided to ease traffic congestion. Bridges with the inclination of the central line of traffic to the normal of the central line of the river or crossing has been constructed with a skew angle as high as 50°.*

*A simplified mathematical model for the analysis of single span skew reinforced concrete decks suitable for medium spans using finite difference technique is presented. The span has been varied from 25m. to 50m. with an interval of 5m. and the skew angle varied from 10° to 50° at an interval of 5°. Bending moments, twisting moments and deflections, thus obtained have been compared with the results obtained for skew slab bridges by Jensen and Allen, Gossand-Sciss Newmark and Goodman at University of Illinois and the results obtained by Ghali and Courbon.*

A simplified mathematical model for the analysis of single span skew box girder reinforced concrete decks suitable for medium spans is presented. The span has been varied from 25m to 50m with an interval of 5m and the skew angle varied from 10° to 50° at an interval of 5°. Bending moments, twisting moments and deflections thus obtained were used to compare with the results obtained from reference 2 and 21.

### NOTATIONS

$M_x, M_y$	= Longitudinal and transverse bending moments per unit length.
$M_{xy}, M_{yx}$	= Twisting moments per unit length.
$k$	= Distance between adjacent pivotal points in v-direction.
$h$	= Distance between adjacent pivotal points in u-direction.
$q(x,y)$	= Intensity of continuously distributed load.
$r$	= Ratio of width to skew span.
$\omega$	= Deflection at middle surface of plate.
$\alpha$	= Compliment of angle of skew b
$\beta$	= Skew angle
$\nu$	= Poisson's ratio.
$M_u, M_v$	= Moment per unit length about v and u axes respectively.
$M_{uv}$	= Twisting moment per unit length.
$x, y$	= Cartesian coordinates.
$u, v$	= Skew coordinates.
$D_x, D_y$	= Flexural rigidities in x and y directions.
$D_{xy}, D_{yx}$	= Torsional rigidities in x and y directions.
$D_1, D_2$	= Coupling rigidities with respect to x and y direction.
$D$	= Flexural rigidity of an isotropic plate.
$K$	= $2r^2 h^2 \sin^2 \alpha$
$\nabla^2$	= $(\delta^2 / \delta x^2) + (\delta^2 / \delta y^2)$

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# FINITE-ELEMENT ANALYSIS OF SKEW BOX GIRDERS BRIDGES

By  
HARPAL SINGH\*, DR. R.B. LAL BEDI\* & KRUNESH GARG\*\*

## 1. INTRODUCTION

Skew bridges are frequently necessitated on account of lack of space for providing right bridges in crowded urban areas and due to the growing number of complex intersections provided to ease traffic congestion. Bridges with the inclination of the central line of traffic to the normal of the central line of the river of crossing have been constructed with skew angle as high as  $50^\circ$ .

In present study the bridge deck was idealised as an equivalent plate and areas analysed by finite element technique. A parameter study for span varying from 21 m to 30 m at an interval of 3 m and skew angle from  $10^\circ$  to  $50^\circ$  at an interval of  $10^\circ$  is presented here.

## 2. IDEALISATION AND MATHEMATICAL MODEL

The skew bridge deck was converted into an equivalent plate and was discretised as shown in Fig. 1. The eight noded isoparametric parabolic element used is shown in Fig. 2. The stiffness of the element is given by (12).

$$K = \int \frac{B^T D B}{V} dV$$

The Class A loading as per IRC : 6-1966 were used in the study. The loads were converted into an equivalent distributed loads using Fourier series<sup>5</sup>. The cases for bridges with spans varying from 21 m to

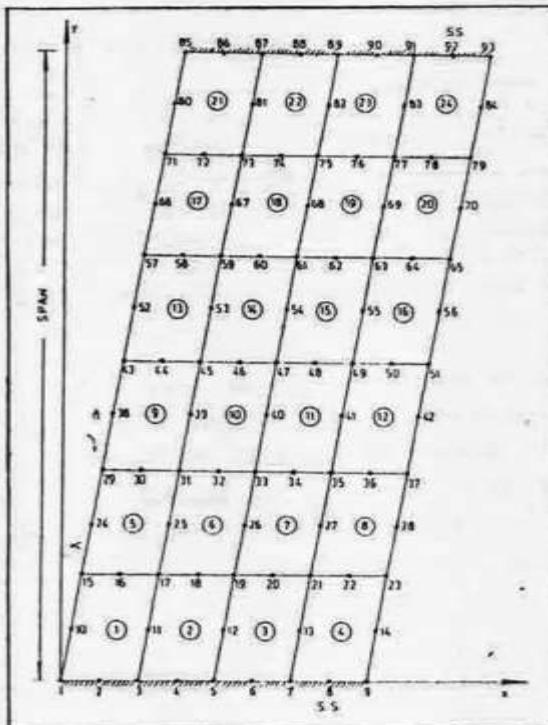


Fig. 1. Discretised plate

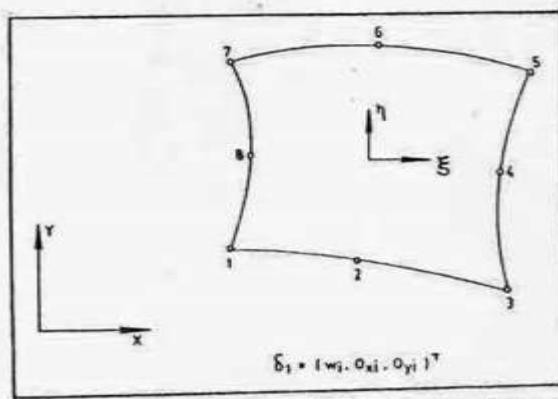


Fig. 2. Parabolic isoparametric plate bending element

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## FINITE ELEMENT ANALYSIS OF SHEAR WALL FRAME SYSTEM

HARPAL SINGH\*, DR. R.B. LAL BEDI\*, GURPREET SINGH KHAIRA\*

### SYNOPSIS

The distribution of lateral forces and their effects on the resisting elements of buildings braced with shear walls is presented. The comparison with existing methods of design which are readily adaptable in design offices is also made. The modifications in these methods are also proposed which would result in the accuracy of plane frame and plane stress finite element programmes at much lesser cost.

In this paper the shear wall and frame interaction forces and shear shared by frame and wall is presented.

#### Notations

A	Area of cross-section.
I	Moment of inertia.
E	Modulus of elasticity.
H	Total Height of Building.

$V_f/V_b$	Ratio of shear in frame to base shear.
$S_s/S_c$	Wall-column stiffness ratio at first story.
$S_c/S_b$	Column-beam stiffness at first story.
B	Element strain matrix
D	Elasticity matrix.
$V_e$	Volume of element.
$\Delta_h$	Horizontal deflections.

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## FINITE ELEMENT ANALYSIS OF SHEAR WALLS WITH LARGE OPENINGS

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Vineet Aggarwal\*\*\*

## SYNOPSIS

The construction of tall buildings is the outcome of rapid urbanization. Tall buildings require special structural system as lateral forces due to wind and earthquake start governing the design. Thus, the challenge to a structural designer in designing a multistoreyed structural system lies in providing the necessary stiffness against lateral loads in a way which will require the least premium for cost of supporting the gravity loads.

The number of systems have been developed to resist lateral loads effectively. Reinforced concrete walls, known as shear walls are introduced in multistoreyed building for the purpose. To a certain height they provide an economical system to resist the lateral loads.

In this study shear wall structural system suitable for office buildings is analysed. Various graphs are plotted to study and understand its behaviour. The deflection curves can be applied to shear walls with large openings in general. Contours for maximum principal stresses, stresses in two horizontal sections, one with opening and other without opening are plotted for a typical case which helps in understanding the behaviour of shear walls in general.

In this paper the behavior of shear walls with large openings is presented.

## NOTATIONS

A	Area of cross-section.
I	Moment of inertia.
E	Modulus of elasticity.
( $\xi, \zeta$ )	Natural coordinates.
(x, y)	Global coordinates.
v	Poisson's ratio.

$\sigma$	Stress vector.
$\epsilon$	Strain vector.
$g$	Displacement vector.
$g'$	Nodal displacement vector.
N	Set of shape functions.
B	Element strain matrix
F	Nodal force vector.
D	Elasticity matrix.
V.	Volume of the element

## INTRODUCTION

Now-a-days tall buildings with composite shear wall construction, known as Egg-Crate system, are being constructed. Major advantages of such buildings lie in speed of construction, low reinforcing steel and acoustical privacy.

This system, till now, has been used only to construct apartment buildings where permanent partitions are acceptable. A new type Egg-Crate structure suitable for tall office buildings is suggested here. A simple plan for this system is shown in figure 2.

In literature, stiff-jointed frame analogy, braced wide column analogy, braced frame analogy etc. techniques are available which are the outcome of their different simplifying assumptions. But to exactly analyse the shear wall of an Egg-Crate system—a wall with large openings, finite element technique has been employed.

S.	Surface of the element.
p	Body force per unit volume.
t	Applied surface tractions per unit surface.
$\Delta_x$	Horizontal deflections.

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## Saw Tooth Stairs - An Experimental Study

C.M. Sharma\*, Harpal Singh\*\* & C.B. Kukreja\*\*\*

### Synopsis

An important feature of some of the modern buildings is the prominence given to the position and design of the main stairs. It is not uncommon today to find saw tooth stairs displayed as an architectural and functional feature.

In the present work the behaviour and load carrying capacity of saw tooth stairs have been studied. Two stairs with odd and even number of steps were designed using plane frame analysis and were tested upto failure. The stairs were subjected to uniformly distributed loads.

Experimental results were compared with analytical values to check the reliability and suitability of analytical models available.

### Introduction

Stairs may be located away out of sight in a remote corner of a building or they may form a principal feature. In the former case they can be designed and constructed as simply and cheaply as possible, but in the latter case it is worth while spending a great deal of time and trouble on the design compared with many other structural components of a building. A rationally designed stair gives reliability, economy and grace. Saw tooth stairs are becoming popular with modern architects. Besides being asthetic, such stairs have the additional advantage of giving relatively small resistance to the lateral translations. These stairs are generally a popular choice of architects for cinema halls, stadiums, theatres and auditoriums etc.

The behaviour of saw tooth stairs is complex. There are stress concentrations at the points of re-entrants. The present methods of design are both irrational and uneconomical. So there is an urgent need to study the behaviour of such type of stairs experimentally and to check the reliability and suitability of the analytical models available. The present work is a step in this direction.

### Literature Review

Significant advances have been made in the field of analysis and design of stairs. Martin Schulz (1) in 1959 proposed a method for analysis of beams in space for stair-cases. This method was based on the principle of virtual work. Martin dealt with the case of free standing stair with curved landing i.e. horse shoe staircase but not the case with plane landing. Lienbenberg (2) Siev (3) Cusens and Kung (4) and Sauter (5) proposed various methods for the design of slab type free standing staircase. Gambhir (6) proposed a method of analysis and design of reinforced concrete Horse shoe type stair case.

Cusen's A.R. (7) in 1966 proposed a method for analysing the saw tooth stair. Because of stair profile, concentration of stresses occur in the re-entrant corners and the actual stress to be resisted will be larger than those calculated from

the moments given by this method. To resist such stresses, Cusens (7) and Charles et al (8) recommend to provide twice the reinforcement as per the calculated stresses unless suitable fillets or haunches are incorporated at these junctions.

### Analysis and Design

The analysis was done both for the odd and even stepped stairs using the formula given by Cusens (7) and Stiffness method (9). The dimensions of the stairs under study are given in Table-1.

Weight of concrete, Young's modulus of elasticity of concrete and live load on stairs are taken as  $24 \text{ kNm/m}^3$ ,  $2.5 \times 10^7 \text{ kN/mm}^2$  and  $3\text{kN/m}^2$  respectively.

### Simplified Method

Simplified method is the simplest method of calculating bending moment. Considering the stairs with waist slab, for a simply supported stair the bending moment is given by

$$M = \frac{WL^2}{8}$$

where  $W$  = weight per unit length (horizontal) and

$L$  = horizontal span of the staircase

The stairs were also designed for the bending moment obtained by using stiffness method as shown in Table 2. Five number and six number of 6mm dia rings were used for even and odd stepped stairs respectively. The reinforcement details are shown in Fig. 1.

### Test Programme

The concrete mix was designed as per Indian Standard guide lines (10) for a strength of  $15\text{N/mm}^2$ . The proportions of the mix were 1:1.86:3.68 by weight with a water cement ratio of 0.56.

The test programme consisted of casting and testing two stairs one with even steps and other with odd steps analysed using stiffness method. The shuttering for stairs was got prepared using wooden planks and I-sections. Concrete was compacted using needle vibrator. The companion specimens of  $150 \times 150 \times 150$  mm cubes were cast along with casting of stairs. The 28 days crushing strength was observed to be  $15.1 \text{ N/mm}^2$ . Curing was done for 28 days by covering stairs with wet gunny bags.

Load was applied with the help of hydraulic jack and gauge was placed under stairs to measure central deflections. Load, deflection measurement, crack initiation and their progression were recorded simultaneously.

### Results and Discussion

The summary of the test results is presented in Table 3 and 4 and typical load deflection curves are shown in Fig. 2. The curves are approximately straight lines. For even

# RESPONSE OF 3-D FRAMES WITH PANELS

DR. HARPAL SINGH \* SHAMI SINGLA\*\*

## Abstract

The behaviour of frames gets considerably modified due to the presence of shear walls or panels. The panels greatly increase the stiffness and strength of frame as a whole or locally where these are present. This largely influences the behaviour of system particularly when it is subjected to lateral loads. A finite element method of analysis of 3-D frames with panels has been used, idealising beams/columns and panels/shear walls as three noded beam element and eight noded flat shell element respectively. The response of such systems has been presented.

## Introduction

Buildings are invariably subjected to lateral loads such as wind, blast or earthquake. The structure should have sufficient strength to withstand these loads. Shear walls with large inplane stiffness exhibit greater strength against the lateral forces. By suitable arrangement of walls in a building, it is possible to eliminate rigid and heavy frames and also to keep side sway within permissible limits. The brick panel shear walls known as infills are generally used in the building frames. A finite element method of analysis of 3-D frames with infilled panels has been used in the present study considering the frame as three noded beam elements and panels as eight noded flat shell element. The frame is analysed for various position of infills. Norris [1] recommended that strength and stiffness of shear walls depend upon reinforcement and

length to height ratio of panels. Benjamin and Williams [2] reported results of static lateral load test performed on unbound shear walls and shear walls bounded by a reinforcement concrete or a steel frame. They showed that plain brick wall panels has significant strength when confined by frame. Walls in steel frame are more flexible than in concrete frames. Berg [3] showed that for a four storey undamped structure with elastic plastic system, that shear walls act as conservative elements when elastic range is exceeded. Holmes [4] gave Equivalent Theory considering wall panels to act as strut with effective width of equivalent strut as one third depth of panels. Smith [5] gave due consideration to length of contact and by checking possibility of failure by diagonal cracking in his model by finite difference method.

Smith [6] considered unbounded infill with plastic type of failure in diagonally and laterally loaded infilled rigid frames of uniform steel section width of equivalent diagonal strut. Mallick [7] used Finite Element Method for determining lateral stiffness of infilled frames considering it as rectangular element. Riddington [8] analysed infilled frames under racking loads using a four noded rectangular element. The method also stimulates cracking around interface between frame and infill. Severn and Mallick [9] analysed mortar infilled steel frames under lateral loads using analytical method taking into account the axial deformations of the members of the frame and the slip at the interface for linear elastic behaviour of a homogeneous and isotropic infill. The analysis is based on the technique of matching the displacements of the frame and the infill at

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## Analysis And Design Of Prestressed Concrete Continuous Beams

Vivek Kumar Singh\* Harpal Singh\*\* C.B.Kukreja\*

### **Abstract**

The present study deals with the computer aided analysis and design of prestressed concrete beams. The effect of prestressing has been incorporated as an equivalent load on the continuous beam. Limit state method has been used for designing the section as per the specifications of IS:1343-1980 Code using concordant cable profile. Design and computation of cable profile for multispan beams also been incorporated. Graphical representation for the cross-section and longitudinal section with cable profile are included.

### **Introduction**

Prestressed concrete is a concrete in which internal stresses of suitable magnitude and distribution are introduced so that the stresses resulting from external loads can be counteracted to a desired degree. In reinforced concrete, there is a problem of development of early cracks due to non-compatibility in the strains of steel and concrete. Perhaps this problem in reinforced concrete led to the development of prestressed concrete. Though the idea of prestressing was first put-forward in 1896 its use spread rapidly after 1935, after the development of technique for stressing the high tensile steel wires. The limit state design for prestressed concrete members was later adopted in 1966.

### **Review Of Literature**

Bennett (1) developed graphical methods for determining the prestressing and corresponding eccentricity for design for flexure by working stress method. According to Guyon, tendons in statically indeterminate structures placed to coincide with the pressure or thrust line, do not induce secondary moments. In this theory continuous prestressed beam, if tendon profile is displaced vertically at any of the intermediate supports but without altering its intrinsic shape between supports, the resultant line of thrust is unchanged. Dayarathnam (2) used the non-dimensional design variables given by Khachaturian, for design of simple beams of minimum weight by computer. A set

of tables and graphs were developed for different parameters. Arya (3) attempted to determine the concordant cable profile for the continuous beams using equivalent load method. For the parabolic cable profiles, he gave the coefficients to determine fixed end moments. Zuraski (4) gave simple algorithm for the analysis of continuous beams which is suitable for analysis with micro computers. Closed form expressions are given for end moments in continuous beams with general formulation for multiple loads for any number of spans. Cohn and Lounis (5) attempted to optimize the prestressed concrete continuous beams by formulating the constraints using ultimate limit state and serviceability limit state constraints. The results show that partial prestressing is economical as flexural steel cost decrease with higher permissible tensile stresses.

### **Analysis Of Prestressed Concrete Continuous Beams**

Prestressed continuous beams are analyzed using stiffness method. The effect of prestressing cable is incorporated by applying equivalent loads due to concordant cable profile on the beam.

### **Strength Limit State in Flexure**

Design for the limit state of collapse in flexure is based on IS:1343 -1960.

**Transfer Condition:** During transfer condition, the concrete might not have gained its full strength and prestressing force is at its maximum with very little external load acting on the structure. Therefore, the prestressing force at transfer must be treated as an external load along with dead load. The ultimate tendon force is given by:

$$P_u = r_{fp} \cdot A_p \cdot f_p \quad (1)$$

The tension produced in the tendons by the dead load moment can be approximately taken as :

$$F_d = rfd \cdot Mg / (d - 0.42Xu) \quad (2)$$

where rfd is taken in the range of 0.9 as the dead load moment is opposite to that caused by the tendons. The net compressive force to be resisted by the concrete section is

$$F_u = P_u - F_d \quad (3)$$

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## Rating and Retrofitting of Bridges

Er. Amarjit Singh Palk\* & Dr. Harpal Singh\*

### Introduction

Although a vast revenue is consumed in building bridges, 'managing' their maintenance and then actually 'executing the maintenance work' can prove even more exacting and costly if what has been built must remain operational for the intended long-term safe use. This calls for a scientific assessment of the problem for a workman-like understanding and execution. This requires:

- A thorough examination of the detailed inventories;
- Carrying out detailed condition surveys and visual and 'hands-on' inspections;
- Analyzing the data and the structure itself in order to unfold the cause of structural distresses;
- Carrying out the structural investigative computations and, where called for, the appropriate *in situ* tests on material-samples and on existing structures; and
- Ultimately writing the prescriptions for rehabilitation and repair or outright demolition and replacement, as necessary.

It can readily be realized that first the maintenance management (i.e., rationalised methodology for assessment of the condition of what exists and how to repair and rehabilitate it to retain its operational status in order to enjoy its revenue return if not financial - return), and then execution of maintenance (i.e., the physical execution of the maintenance decisions taken), form a whole new dimension of the society's rightful demand on the engineer's services if the existing bridges have to remain there for the purpose they were constructed in the first place! The effective aggregate for the aforementioned two exercises is what is referred to as the Bridge Maintenance Management System (BMMS) in the present-day technical jargon.

Bridge structures, like any other structure, deteriorate with time. Causes could lie in the inadequacy of design detailing, construction and quality of maintenance, overloading, chemical attacks, atmospheric effects, abnormal floods and erosion, abnormal earthquakes, etc. Hence they have to be looked after well.

In this context it is therefore necessary to understand what is broadly meant by the following oft-used terms:

- Maintenance
- Repair and Rehabilitation
- Strengthening

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### • Replacement

*Maintenance:* Refers to the work needed to be done to preserve the intended load carrying capacity of the bridge and safety of the public using it.

*Repair and Rehabilitation:* Refers to the maintenance work of larger 'Scope' and 'Cost' than simple routine maintenance. 'Rehabilitation' aims at restoring the bridge to the service level it originally had or was intended to have.

*Strengthening:* Refers to improving the existing load carrying capacity of the whole. 'Widening' or 'raising' the deck may also be included here.

*Replacement:* Refers to reconstruction of the whole bridge or of its major components, since the cost and / or the extent of repair or strengthening may be beyond the acceptable economic or technical limits.

The purpose of the guidelines and prescriptions given here is to assist the engineer in a simple and practical workman-like manner to:

- Inspect various concrete bridges in a highway network and 'establish their comprehensive inventory'.
- 'Rate' the condition of each structure's elements.
- Provide appropriate information in order to be able to determine as to which structures require routine maintenance and what type, which ones require major rehabilitation and what type, and which ones must be replaced in full or in part.

The tendency of some bridge engineers to feel contended at involvement only with bridge-design is wrong, to say the least. Designing a bridge is only one initial activity, whereas what is required thereafter (for the next sixty years or more) is the understanding of its service life 'tantrums' and the art and science involved in looking after these! The 'bridge' rehabilitation is an on-going process of repair and strengthening. Its importance increases with the age of the bridge and it can be suicidal to overlook the possible potential problems and not be ready with the practical solutions. Bridge maintenance and rehabilitation presupposes the knowledge of analysis and retro-design.

Bridge rehabilitation can be much more demanding than designing and constructing a new bridge. It requires a great deal of effort to tie-in all the concerned disciplines together in-order to build-back a distressed bridge, cost effectively. While in the initial designing it is mandatory to design within the prescribed limits.

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# Rating and Retrofitting of Bridges

The purpose of the guidelines and prescriptions given here is to assist the engineer in a simple and practical workman-like manner to inspect various concrete bridges in a highway network and establish their comprehensive inventory', rate the condition of each structure's elements, provide appropriate information in order to be able to determine as to which structures require routine maintenance and what type; which ones require major rehabilitation and what type; and which ones must be replaced in full or in part.

**A**lthough huge amount of money is spent in building bridges, 'managing' their maintenance and then actually executing the maintenance work can prove even more costly if what has been built must remain operational for the intended long-term safe use. This calls for a scientific assessment of the problem and requires a thorough examination of the detailed inventories, carrying out detailed condition surveys and visual and 'hands-on' inspections, analysing the data and the structure itself in order to unfold the cause of structural distresses, carrying out the structural investigative computations and, where called for, the appropriate in situ tests on material-samples and on existing structures, and ultimately writing the prescriptions for rehabilitation and repair or outright demolition and replacement, as necessary.

It can readily be realised that first the maintenance management (i.e., rationalised methodology for assessment of the condition of what exists and how to repair and rehabilitate it to retain its operational status in order to enjoy its revenue return if not financial-return), and then execution of maintenance (i.e., the physical execution of the maintenance decisions taken) form a whole new dimension of the society - rightful demands on the engineer's services. The effective aggregate for the afore-mentioned exercise is what

is referred to as the Bridge Maintenance management System (BMMS - in the present-day technical jargon).

Bridge structures, like any other structure, deteriorate with time. Causes could lie in the inadequacy of design detailing, construction and quality of maintenance, overloading, chemical attacks, atmospheric effects, floods and erosion, earthquakes, etc. In this context it is therefore necessary to understand what is broadly meant by the following oft-used terms like maintenance, repair and rehabilitation, strengthening and replacement.

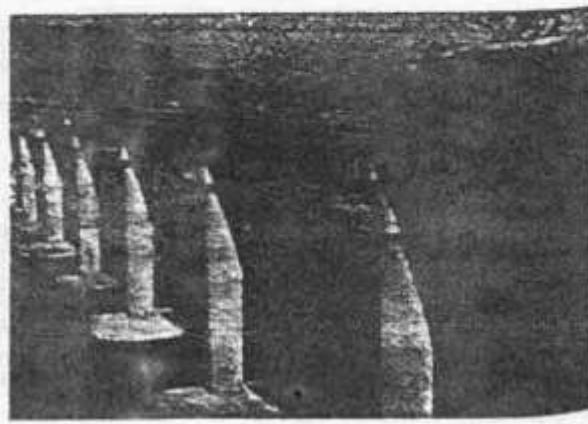
**Maintenance:** Refers to the work needed to be done to preserve the intended load carrying capacity of the bridge and safety of the public using it.

**Repair and Rehabilitation:** Refers to the maintenance work of larger 'Scope' and 'Cost' than simple routine maintenance. 'Rehabilitation' aims at restoring the bridge to the service level it originally had or was intended to have.

**Strengthening:** Refers to improving the existing load carrying capacity of the whole. Widening' or 'raising' the deck may also be included here.

**Replacement:** Refers to reconstruction of the whole bridge or of its major components, since the cost and / or the extent of repair or strengthening may be beyond the acceptable economic or technical limits.

The tendency of some bridge engineers to feel contended at involvement only with bridge-design is wrong, to say the least. Designing a bridge is only one initial activity, whereas what is required thereafter (for the next sixty years or more) is the



## Response of frames with staggered panels using finite element method

Harpal Singh

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### Abstract

The response of structural systems consisting of frames with monolithic storey-deep and bay-wide discrete panels to resist lateral loads was investigated. The finite element model with three noded frame element and eight noded panel element was used. The panels greatly increase the stiffness of the frame systems as a whole or locally where these are present. The different systematic arrangements as compared to the conventional shear wall system were critically assessed. Such systems were found to have adequate lateral stiffness to resist horizontal loads such as wind and earthquakes.

### INTRODUCTION

The restricted orientation of a panel in the form of a continuous wall is not the optimal geometrical configuration and this is reflected by large deformations and base moments even in the case of moderately tall buildings [Prasada Rao and Seetharamulu (1983)]. It is advantageous to systematically stagger bay-wide storey-deep panels in the plane of the frame and achieve a system preferable to the continuous shear wall frame [Prasada Rao, Seetharamulu and Krishnamoorthy (1984)]. To analyse such systems finite element modelling is needed. Prasada Rao and Seetharamulu (1983) analysed such systems using different types of four noded Macleod's elements [Macleod (1969)]; a panel modelled using 16 elements since these are not able to simulate the flexural response. Such a modelling for the analysis of tall buildings inefficient and very expensive.

In the present study, the different staggered shear panel systems were studied for their relative effectiveness towards the lateral loads.

### MATHEMATICAL MODEL AND THE RESPONSE

The structure was discretised into a number of isoparametric finite elements. The frame has been modelled with 3 noded frame elements. The panel was discretised with eight noded membrane elements having two degrees of freedom at each node as shown in Fig. 1. The structure was assumed to be fixed at base. The different cases of staggered panel frame systems studied are shown in Fig. 2 and are discussed below:

- |   |           |                   |
|---|-----------|-------------------|
| Case I : Extreme bays filled diagonally | Case II : | Parallel diagonal |
| Case III : Diagonal                     | Case IV:  | Shear wall        |

Proceedings of the First National Symposium on Construction  
Engineering and Management 9-10 March 1992,  
College of Engineering, Anna University, Madras.

## FLEXURAL BEHAVIOUR OF FERRO-CEMENT BEAMS UNDER QUASI-CYCLIC LOADING

HARPAL SINGH AND SUKHDEEP SINGH  
Thapar Institute of Engineering & Technology  
PUNJAB

### **ABSTRACT**

*This study presents an experimental investigation of the behaviour and strength of ferro cement elements in flexure under repeated loading. The mix proportion cement: sand was 1:2 with water cement ratio 0.5. The variable parameters are the depth of the section, the percentage of the reinforcement and the arrangement of the reinforcement. The ultimate strength, the load deflection characteristics and the load time characteristics have been studied.*

### **INTRODUCTION**

Ferro-cement can be considered a type of thin reinforced concrete construction. Where instead of discretely placed reinforcing bars, large amount of smaller diameter wire meshes are used and instead of concrete cement mortar is used.

Little information is available on the behaviour of ferrocement members under cyclic loading. In present work the behaviour of ferrocement beam under quasi-cyclic loading was studied. Top and bottom, even and bottom mesh arrangements were used. The amount of mesh arrangement was also varied.

### **EXPERIMENTAL PROGRAM**

#### **Test Materials**

Commercially available square woven wire mesh of c/c spacing 5.0 mm, thickness 0.81 mm, Young's modulus of elasticity  $2.0 \times 10^6$  kg/cm<sup>2</sup> and tensile strength 5150 kg/cm<sup>2</sup> was used. The mix proportion was 1:2 (cement : Sand) and water cement ratio 0.5 was used.

#### **Test Specimens**

The beams of sizes 50x10x3 cm, 50x10x4 cm and 50x10x5 cm with 18 samples of each size were casted in wooden moulds. The number of mesh layers was varied as 2, 4 and 6. The three mesh arrangements were used i.e. Top and bottom arrangement, Even arrangement and Bottom arrangement.

#### **Test Setup**

The test setup used is shown in figure 1. The clear span of the beams was fixed as 42 cm, leaving 4 cm on both edges. A two point loading at L/4 from ends was applied by the mechanical jack and measured by proving ring. Dial gauge having least count of 0.00254 cm was used.

#### **Test Procedure**

The beams were tested under cyclic loading. The load and corresponding vertical deflection of the central point for various load cycles were recorded. The fracture load was applied in three four cycles. Load

## COMPUTER AIDED ANALYSIS AND DESIGN OF OVER HEAD SERVICE RESERVOIR

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GURINDER MOHAN SINGH

Department of Civil Engineering  
Thapar Institute of Engineering & Technology  
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### ABSTRACT

In the present paper a general purpose computer program for the analysis of INTZE type overhead service reservoir is presented. The computer program is applicable for the shaft or column supported (4 to 12 Nos of columns) overhead service reservoir. The analysis include wind and seismic forces considering the system as single degree of freedom system. The program gives complete design for the vessel and design forces for staging and functions.

### 1. INTRODUCTION

In major water supply schemes, overhead service reservoirs consume a major part of overall project cost. The design of overhead service reservoirs is a cumbersome and repetitive process. There are many practical constraints like available size of formwork etc. Thus there is a need for general purpose computer program which can handle such situations.

### 2. ANALYSIS AND DESIGN

#### 2.1 General

The analysis and design of intze type O.H.S.R. was performed as per various Indian Standards [5,6,7,8,9], neglecting the continuity effects in the vessel [1,2]. The design and analysis of some of the components is discussed here. For the rest of the components, design is given else where [1,2,9]. The important features of the software are discussed in this paper.

#### 2.2 Analysis and Design of tank wall

## NONLINEAR ANALYSIS OF CIRCULAR SHELL WITH OPENING USING FINITE ELEMENT METHOD

Harpal Singh

Hardeep S. Rai

### INTRODUCTION

The development of appropriate methods for the analysis of shell structures is increasingly demanded to ensure the integrity of the structural designs. Analytical solutions to shell structures are limited in scope and in general are not applicable to arbitrary shapes, load conditions, irregular stiffening and support conditions, cutouts and many other aspects of practical design.

Linear shell theories adequately predict stresses and deformations for shells exhibiting small deformations. The nonlinear theory of elasticity forms the basis for the finite deflection and stability theories of shells. Large deflection theories are often required when dealing with shallow shells, highly elastic membranes and buckling problems. The finite element method has gained much popularity in the analysis of shells because of the ease with which complexities of shape, loading, support conditions can be dealt with.

### APPROACHES TO THE FINITE ELEMENT REPRESENTATION

Although finite element procedures have been applied to shell analysis for over thirty years, the search for suitable elements which are readily applicable to general shell structures is still in progress (1,2). Three distinct approaches to the finite element representation of shell structures have been tried based on:

- I. Flat triangular or quadrilateral elements.
- II. Curved elements formulated on the basis of various shell theories and
- III. Elements derived from three dimensional elements by the use of degeneration methods.

A number of difficulties and shortcomings arise from the first approach (2), such as the presence of discontinuity, bending moments, which do not appear in the continuously curved actual structure. In the second approach a classical concept is employed whereby a shell theory is used as the starting point of the finite element formulation. Curved shell elements based on the Kirchhoff-Love theory guarantee a high solution accuracy but are complicated by convergence and compatibility requirements. In the case of a fully nonlinear analysis, additional difficulties arise in the formulation of efficient finite elements due to the in-availability of a general nonlinear shell theory.

The third approach employed in the formulation of shell elements, which has been used in the reported study, avoids the complexities of fully general shell theories by discretizing directly the three dimensional equations of continuum mechanics. Isoparametric elements with independent rotational and displacement degrees of freedom are employed, in which the three dimensional stress and strain conditions are degenerated to shell behaviour. The originally proposed method (3) was improved with the adoption of reduced integration technique (4,5).

### DEGENERATE ISOPARAMETRIC ELEMENTS

Fig. (1)a shows a solid three dimensional element based on a quadratic displacement field and Figs. 1(b) and 1(c) illustrate the corresponding quadratic degenerate shell element. Following two basic assumptions are adopted in this process:

- I. Normals to the middle surface remain practically straight after deformation, even for the thick shells.
- II. The strain energy corresponding to stresses perpendicular to the middle surface is disregarded.

### ELEMENT GEOMETRY

In the isoparametric formulation the co-ordinates of a point within the element are obtained by applying the element shape functions to the nodal co-ordinates.

### DISPLACEMENT FIELD

Taking into consideration the two shell assumption of the degeneration process, the displacement field is described by the five degrees of freedom of a normal, the three displacements of its mid point and two rotations.

### SHELL ELEMENT, 9-NODE LAGRANGIAN:

Experiments carried out by Pugh et al (7) with linear, quadratic and cubic elements of the Serendipity and Lagrangian families show that the 9-node Lagrangian element, Fig.(2), is nearly optimal as a general plate element. The performance exhibited by Lagrangian elements appeared to be superior to Serendipity elements when reduced or selective integration was adopted. However, a serious problem may arise with this element when reduced integration is employed; the stiffness matrix exhibits rank deficiency which originates the appearance of

National Seminar on Computer Application in Civil Engg. TJET Patiala April 21-22, 1994

## MAPPING CONGESTION PATTERNS ON URBAN HIGHWAY NETWORKS USING COMPUTER GRAPHICS

Gurmeet Singh      Shami Singla      Harpal Singh  
Lecturer in Civil Engg      Post Graduate Student      Lecturer in Civil Engg.  
T. I. E. T., Patiala (Pb)—147001

**ABSTRACT :** Road Accidents in Urban highways are primarily at points of traffic congestion. A major function of the traffic planner in a metropolitan area is to find ways to reduce or eliminate congestion in the urban highway networks. Techniques of mapping congestion pattern on urban highway networks using computer graphics is highlighted in this paper. It is also intended to give the transportation planner an idea of using computer graphics for interpreting traffic congestion patterns, and also planning to prevent and mitigate road accidents.

### INTRODUCTION

The 1960s have been characterised as the era of computer numbers, the 70s as the era of the computer words and the 80s as the era of computer graphics. Computer graphics has extended traditional data processing methods by providing ways of communicating information pictorially.

What makes computer graphics the most rapidly growing segment of computer technology? What does this technology hold for decision makers of all kinds? For one, computer graphics saves a most valuable and coveted resource time. Since many types of data are already available in digital form, often with geographic location identifiers, it is relatively simple to use graphic systems to convert those numbers into charts, graphs and maps. The use of such charts is more important in the interpretation and communication of complex sets of data.

A more significant reason for its growth is the role of Computer Graphics in the decision making process. Information can be both digested and understood more readily when information is rendered in graphics as opposed to numeric or tabular form. Decision makers need the ability to spot deviations in the data both for trend validation and exception reporting. Computer graphics also provides decision makers with the ability to ask "What If" questions in order to test alternative scenarios and depict the results quickly and efficiently.

### DESCRIPTION OF THE PROBLEM

A major function of the transportation planner in a metropolitan areas is to find ways to reduce or eliminate congestion in the urban highway networks. The current effort is to highlight how computer graphics can be used to map congestion in various points of the urban highway network at various time of the day. Such displays are necessary because the relief of congestion is one of the major tasks of the transportation planner.

Congestion is neither defined nor measured easily. It is necessarily a constructed variable in that it cannot be directly observed. Differing definitions for congestion have been proposed by several authors. Wingo (1959) suggests that congestion simply means traffic conditions that substantially reduce any aspects on the roadways. Rothrock (1954) suggests that congestion is the absence of the complete freedom of A second source of data is the set of monitoring systems installed and operating in many urban areas.

Examples are loop detectors, television monitors, aerial photography and other sensing and counting devices. Such voluminous data can be interpreted for evaluation of congestion indices and displays using computer graphics.

Some application of computer graphics have utilised data from these sources. In Toronto (Canada), a graphics system has been developed to display data from loop detectors that have been installed on a freeway

National Workshop on Road Safety, TIET, Patiala, April 10-11, 1992.

## DEVELOPMENTS IN STRUCTURAL STEEL WORK

By  
Sandeep Singh and Prof. Harpal Singh

T.I.E.T., Patiala

### ABSTRACT

In the present study various structural systems used for the design of Industrial Structures have been discussed. The study explores relatively new concepts and design procedures in structural steel work that may contribute towards the future development.

### INTRODUCTION

With the technological development in almost all branches of Engineering, the industry has taken a new turn. Rapid industrialisation in India demands Industrial Buildings to be efficient structural systems, which fulfill all structural and functional requirements with an appreciation for practical requirements like safety, feasibility and economy.

Steel is the most commonly used material in frame work construction and is an ideal material for such type of construction. Frames may be constructed of (i) Hot rolled sections, (ii) Cold formed sections, which are either riveted, bolted, welded together or to a suitably shaped gusset plates or joined by connectors.

### TYPES OF STRUCTURES

The classification of structures which can be used as Industrial Buildings is difficult due to great variety of possible forms, however they may be broadly divided into:

- (1) LATTICE STEEL TRUSSES
- (2) LATTICE STEEL PORTAL FRAMES
- (3) LATTICE STEEL SPACE FRAMES
- (4) STRESSED SKIN FOLDED PLATE STRUCTURES

### LATTICE STEEL TRUSSES

The system contains compressive and tensile members in triangular assemblage, which form a stable composition complete in itself, that if suitably supported receives asymmetrical loads and transfers them to the ends.

## 1. EARTHQUAKE RESISTANT DESIGN OF BRICK MASONRY STRUCTURES

HARPDAL SINGH  
Assistant Professor

College of Engg. & Tech.  
Bathinda (Punjab)

B.S.Rai  
Lecturer

1.0 INTRODUCTION: Earthquake is a ground motion random in nature. As a result ground below the building moves and produces inertia forces proportional to mass of structural system. Since the ground motion is generally tri-directional, both vertical and horizontal inertia forces will be acting on the structure, changing in time, and resulting in the three dimensional vibrations of the building. The structural systems which were carrying basically vertical forces before the earthquake will be subjected to horizontal forces also, causing additional bending and shearing effects. In this paper, simple and economical methods are discussed to take care of these forces due to earthquake.

2.0 BEHAVIOR OF BUILDINGS DURING THE EARTHQUAKE: Vibrations of building as a whole are strongly dependent as how the walls are inter-connected and anchored at the floor and roof levels e.g. free standing wall is not stable to out-of-plane forces while for in-plane forces resistance in wall acts like a shear wall. A small building enclosed with properly inter-connected walls acts like a rigid box.

3.0 TYPES OF DAMAGES: It is seen during the post-earthquake all over the world that following type of damages are most common in masonry buildings:

1. Falling of parapets, cornices, chimneys, cantilever balconies,
2. Displacement and falling of roofing elements,
3. Dislodging of roof tanks, wooden logs or joists and other beams from the walls.

# 8th PUNJAB SCIENCE CONGRESS

February 7-9, 2005

## D-11 SOIL STRUCTURE INTERACTION ON THE RESPONSE OF TURBO-GENERATOR FOUNDATION

Harpal Singh\* and Manbir Kaur\*\*

\*G.N.D.E.C., Ludhiana-141 004, India

\*\*Thapar Institute of Engg. & Tech., Patiala-147 002, India

Turbo-generator machinery assumes special importance in a power plant. It is the key component among power generating equipment. A typical solution of framed type foundation for a turbo-generator machine consists of reinforced concrete (or steel) beam and column type elements, arranged in a spatial form, the columns being supported on a thick base raft. The foundation experiences at top the dynamic loads caused by the unbalanced state of the rotor during the operation of the machinery. It should be designed to resist any abnormal loads (e.g. loads due to blade failure etc.) which may exceed the "normal operational" loads and further to ensure adequate safety against dynamic loads caused by earthquakes in severe seismic zones. For the realistic dynamic analysis of this type of structure, it is necessary to consider the mutual interactions between the machinery comprising of the rotor bearings, stator supports etc.), the superstructure of the foundation (made of concrete or steel elements) and the substructure (consisting of soil/piles etc.). Efforts are under way to develop such a generalised model for this class of structures. This includes, (a) the long rotor with multiple disks, having varying cross sectional properties aged which rests on multiple bearings possessing frequency dependent stiffness and damping properties. (By the three-dimensional form of the superstructure with complex geometry and loading on it, and (c) the substructure consisting of soil/pile system (as the case may be), all in one and the same mathematical models. Practical difficulties do exist however, in identifying the range of uncertain parameters that are involved in such a mode. This paper considers the dynamic interaction of the superstructure consisting of the machine and foundation (The former being considered as a rigid attachment to the latter) on one hand and the soil substructure on the other.

*Organised by*  
DEPARTMENT OF ZOOLOGY  
PUNJABI UNIVERSITY  
PATIALA - 147 002 (INDIA)

*Under the auspices of*  
PUNJAB ACADEMY OF SCIENCES

# **SEISMIC RISK AND ASEISMIC DESIGN IN PUNJAB**

**Harpal Singh**

Principal  
Giani Zail Singh College of Engg. & Tech.  
Bathinda.

**Manbir Kaur**

Head, EED  
Thapar Inst. of Engg & Tech.  
Patiala.

## **Abstract**

Earthquake is an unpredictable natural phenomenon. Punjab is vulnerable to seismic risk. The fault line passes through Chandigarh. The major part of Punjab lies in Zone IV and rest of Punjab in Zone III. Major earthquakes of magnitude 6 to 8.5 have occurred with their epicenter in the vicinity of Punjab. The recent earthquake in Pakistan and J&K has caused tremendous loss to life and property. Due to earthquake ground shakes and buildings resting on it vibrate and inertial forces are induced in the structures causing the heavy loss to the structures. The structures are to be designed earthquake resistant should have additional strength and ductility to withstand earthquake shocks. The build layout recommendations and the philosophy of structural design of earthquake resistant structures have been presented.

## **Introduction**

The earth is divided into solid core, the molten magma mantle and the crust floating at the top as shown in Fig. 1. The crust is broken into plates, convection currents in the magma cause the plates to move in different directions. The most earthquakes occur at the plate boundaries where plates converge; one plate is drawn slowly beneath the other. This takes place over thousands of the year. Where plates collide, rock layers are formed upwards crusting mountains. Where plates diverge, lava emerges from the mantle and cools form new sections of crust. Diverging plate boundaries are found under the water.

Other plates move very slowly along side each other. Faults are found at the edges of the plates where the crust is moving in different directions as shown in Fig. 2. In some places plates become locked together. Kinetic energy builds up in the locked plates. Where plates give the stored energy is released in the form of an earthquake. The point of earthquake's origin beneath the surface is called hypocenter.

An earthquake emits its power as the waves of energy. Primary and P-waves are felt as sudden jolt. Secondary or S-waves arrive a few seconds later and are felt as more sustained side to side shaking. Surface waves radiate outwards. From the epicenter, the point on the surface directly above the hypocenter and arrive after the main P and S-waves.

## **Seismic Vulnerability in India**

Depending upon seismic risk a region is likely to be subjected to India is divided into different zones as shown in Fig. 3. The higher zone is more vulnerable to seismic risk. The map of India and its surrounding showing the epicenter has been presented in Fig. 4. The principal tectonic features of India are presented in Fig. 5. The principal lithological (geological) groups are shown in Fig. 6. The seismic risk depends upon all these factors i.e. seismic zone epicentral distance tectonic features and lithological group. Higher seismic risk attracts higher inertial forces induced in the structure and higher loss to the structure.

## **Earthquake Damage**

Due to earthquake ground vibrates in all the six directions, inducing inertial forces in all the six directions in the structures resting on the ground. These inertial forces cause damage to the structures. The damage is also caused due to the earthquake induced liquefaction of soil, tsunami, fire and other indirect effects.

# THAPAR CORPORATE RESEARCH & DEVELOPMENT CENTRE

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Dated: February 26, 1993

## SERVICE CERTIFICATE

Name	:	Shri Harpal Singh
Designation	:	Project Consultant
Dept./Divn./Unit	:	Mechanics & Computers Division
Salary Drawn	:	Rs.500/- per month (consolidated)
Date of joining	:	January 22, 1992
Date of leaving	:	December 31, 1992
Conduct	:	Good

Shri Harpal Singh has worked on the project entitled "PC Based Finite Elements Analysis of Structures". His work was satisfactory.

  
(Lt Col Birinder Singh)

HEAD, PERSONNEL & ADMINISTRATION

(Lt Col Birinder Singh)

HEAD Personnel & Admin.,

Thapar Corporate Research & Development Centre,

PATIALA - 147 001.

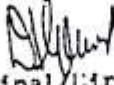
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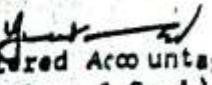
Record No./File No. 8018/RDII/PCR/R&D(175)/99-2000  
As mentioned in sanctioned  
letter

Year of Sanction 1999-2000  
Name of PI/Ce: Dr. Harpal Singh  
Address Guru Nanak Dev Engg. College,  
Ludhiana (Civil Engg. Deptt).  
Project title: Tackling Vulnerability in Bridges

Certified that out of Rs. 8.00 (Rs.Eight lacs only)  
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balance of Rs. -- remaining unutilized at the end of  
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Technical Education (Vide No. --)  
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Certified that the grant has been utilized as per laid down  
terms and conditions for the purpose for which it was sanctioned.

  
Registrar/Principal/Director  
(Signature & Seal) Principal,  
G.N. Dev Engg. College,  
Dated \_\_\_\_\_ LUDHIANA-141006

  
Chartered Accountant  
(Signature & Seal)

Dated 3-9-2003

## **MTech. Thesis Guided**

## EFFECT OF INDUSTRIAL WASTE ON SELF COMPACTING CONCRETE

### THESIS

Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of

MASTER OF TECHNOLOGY  
(Structural Engineering)

### SUBMITTED BY

SALMAN RABHANI  
University Roll No - 1508671  
JULY, 2017

GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA, PUNJAB – 141096  
PUNJAB TECHNICAL UNIVERSITY  
KAPURTHALA (PUNJAB), INDIA

Guru Nanak Dev Engineering College Ludhiana

### CANDIDATE'S DECLARATION

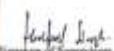
I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF INDUSTRIAL WASTE ON SELF COMPACTING CONCRETE" by Salman Rabhani in partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under Panjab Technical University, Kapurthala is an authentic record of my own work carried out during a period from January 2017 to May 2017 under the supervision of Prof. Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

  
Signature of the Student

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

  
Signature of the Supervisor

The M.Tech Viva-Voce Examination of Salman Rabhani has been held on 23-07-17 and accepted.

  
Signature of Supervisor

  
Signature of External Examiner

  
Signature of H.O.D.  
Guru Nanak Dev Engineering College Ludhiana

## EFFECT OF MARBLE POWDER AND STEEL FIBERS ON HARDENED PROPERTIES OF CONCRETE

### THESIS

Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of

MASTER OF TECHNOLOGY  
(Structural Engineering)

Submitted By

GURJIT KAUR  
(University Roll No -1508657)

June, 2017

UNDER GUIDANCE OF

Propal Kaur, Assistant Professor

Harpal Singh, Professor

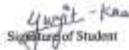
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I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
KAPURTHALA, INDIA

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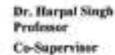
### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled, "EFFECT OF MARBLE POWDER AND STEEL FIBERS ON HARDENED PROPERTIES OF CONCRETE", by Gurjit Kaur in partial fulfillment of requirements for the award of Degree of Master of Technology in the Department of Civil Engineering (Structural Engineering) at GURU NANAK DEV ENGINEERING COLLEGE under I.K.G. PUNJAB TECHNICAL UNIVERSITY, KAPURTHALA having University Roll No. 1508657, is an authentic record of my own work carried out during a period from January, 2017 to June, 2017 under the supervision of Er. Propal Kaur and Dr. Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech degree.

  
Signature of Student

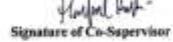
This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

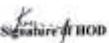
  
Er. Propal Kaur  
Assistant Professor  
Supervisor

  
Dr. Harpal Singh  
Professor  
Co-Supervisor

The M.Tech. viva-voce examination of Gurjit Kaur has been held on 18/10/17 and is accepted.

  
Signature of Supervisor

  
Signature of Co-Supervisor

  
Signature of H.O.D.

  
Signature of External Examiner

**TO STUDY THE EFFECT OF NUMBER OF CELLS IN  
2-LANE AND 4-LANE PRE-STRESSED BOX  
GIRDER BRIDGE DECK**

**THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD  
OF THE DEGREE OF

**MASTER OF TECHNOLOGY**  
(Structural Engineering)

**SUBMITTED BY**

**ROMILA**

University Roll No. 1508670

July 2017

UNDER GUIDANCE OF

Dr. HARPAL SINGH, Professor

**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA**  
(An autonomous college under UGC Act, 1956)

**I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**  
Kapurthala, INDIA

**CANDIDATE'S DECLARATION**

I hereby declare that the present work presented in this thesis entitled "To Study The Effect Of Number Of Cells In Two Lane And Four Lane Pre-stressed Box Girder Bridge Deck" by ROMILA in partial fulfillment of requirements for the award of Degree of M.Tech. in Structural Engineering submitted in the Department of Civil Engineering at the GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA (An autonomous college under UGC Act) under I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from JAN 2017 to JULY 2017 under the supervision of Dr. HARPAL SINGH, Professor, Department of Civil Engineering GNDEC, Ludhiana. I have not submitted the matter presented in this thesis to any other University / Institute for the award of Degree of M.Tech.

*Romila*  
Signature of the Student

Date: 31/07/2017

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

*Harpal Singh*  
Signature of Supervisor

The M.Tech Viva-Voce Examination of ROMILA (University roll no.-1508670) has been held on  
31/07/2017 and accepted.

*Harpal Singh*  
Signature of Supervisor

*Agarwal*  
Signature of External Examiner

**ANALYSIS OF SHEAR WALL WITH  
DIFFERENT CONFIGURATION IN  
MULTISTOREY BUILDING**

**THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY**  
(Structural Engineering)

**Submitted By**

**MANVINDER KINRA**  
(University Roll No.-1508662)

July, 2017

UNDER GUIDANCE OF  
Dr. HARPAL SINGH, Professor

**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA**  
(An autonomous college under UGC Act, 1956)

**I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**  
Kapurthala, INDIA

**CANDIDATE'S DECLARATION**

I hereby declare that the present work presented in this thesis entitled "Analysis of Shear Wall with different configuration in Multistorey Building" by MANVINDER KINRA in partial fulfillment of requirements for the award of Degree of M.Tech. in Structural Engineering submitted in the Department of Civil Engineering at the GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA (An autonomous college under UGC Act) under I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from JAN 2017 to JULY 2017 under the supervision of Dr. HARPAL SINGH, Professor, Department of Civil Engineering GNDEC, Ludhiana. I have not submitted the matter presented in this thesis to any other University / Institute for the award of M.Tech. Degree.

*Manvinder Kinra*  
Signature of the Student

Date: 31/07/2017

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

*Harpal Singh*  
Signature of Supervisor

The M.Tech Viva-Voce Examination of MANVINDER KINRA (University roll no.-1508662) has been held on  
31/07/2017 and accepted.

*Harpal Singh*  
Signature of Supervisor

*Agarwal*  
Signature of External Examiner

## Effect Of Shear Wall On The Seismic Performance Of Irregular RC Buildings

### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
(Structural Engineering)

SUBMITTED BY

SAMEEKSHA  
Reg. No./Roll No. 1168207



IKG PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF SHEAR WALL ON THE SEISMIC PERFORMANCE OF IRREGULAR RC BUILDINGS" is partial fulfillment of requirement for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA, Under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from 2011-2012 to 2015-2016 under the supervision of Dr. Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

(NAME/KAISHA)  
Signature of the Student

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

(Dr. Harpal Singh)  
Signature of the SUPERVISOR

The M.Tech Viva-Voce Examination of SAMEEKSHA has been held on 27-05-2016 and accepted

Signature of HOD

Signature of External Examiner  
V.S. Puri, IIT R

## TO STUDY RESPONSE AND DESIGN CHART OF L AND T SHAPED COMBINED FOOTING

### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)

Submitted by  
AMIT DUGGAL  
(University Roll No. 1707303)  
JUNE 2019



IKG PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### CANDIDATE DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "TO STUDY RESPONSE AND DESIGN CHART OF L AND T SHAPED COMBINED FOOTING" in partial fulfillment of requirement for the award of degree of M.Tech (Structural engineering) submitted in the department of civil engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from JAN 2019 to JUNE 2019 under the supervision of Dr. HARPAL SINGH and Co. guide Er. BHUPINDER SINGH. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M. Tech Degree.

Signature of Student  
1107303

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

Guided by  
Dr. Harpal Singh

Professor  
Dept. of Civil engineering

Assistant Professor  
Dept. of Civil engineering

The M.Tech viva voce examination of Amit Duggal has been held on 27-07-2019 and accepted

Signature of HOD

Signature of External

## PERFORMANCE OF DIFFERENT SHEAR WALL POSITIONS IN BUILDING USING PUSHOVER ANALYSIS

### THESIS REPORT

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
(Structural Engineering)



SUBMITTED BY:-  
ASNA YANI  
UNIV. ROLL. 1707305

Department of Civil Engineering  
Guru Nanak Dev Engineering College, Ludhiana  
(An Autonomous College Under UGC Act)

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "PERFORMANCE OF DIFFERENT SHEAR WALL POSITIONS IN BUILDING USING PUSHOVER ANALYSIS" in partial fulfillment of requirements for the award of degree of M. Tech (Structural Engineering) submitted to the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K. GURU PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from January 2019 to June 2019 under the supervision of Dr. HARPAL SINGH and PROF. PRABHJOT SINGH. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M. Tech Degree.

Signature of Student  
(1707305)

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

Signature of Guide

Signature of Co-Guide

The M. Tech viva voce Examination of ASNA YANI has been held on 16-06-2019 and is accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

## LABORATORY STUDY ON EFFECTS OF CRUSHED GLASS AND META-KAOLIN ON MECHANICAL PROPERTIES OF CONCRETE

### THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTERS OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)

SUBMITTED BY:-  
ANISH SHARMA  
UNIVERSITY ROLL NO - 1707304  
CLASS ROLL NO - 174503  
JUNE 2019



DEPARTMENT OF CIVIL ENGINEERING  
GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "LABORATORY STUDY ON EFFECTS OF CRUSHED GLASS AND META-KAOLIN ON MECHANICAL PROPERTIES OF CONCRETE" is partial fulfillment of requirements for the award of degree of M. Tech. (Structural Engineering) submitted to the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I. K. GURU PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from JAN 2019 to JUNE 2019 under the supervision of Dr. HARPAL SINGH. The matter presented in this thesis has not been submitted by me in any other University/ Institute for the award of M. Tech Degree.

Signature of Student  
1707304

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

Guided by:

Dr. Harpal Singh  
Professor

Dept. of Civil Engineering

The M. Tech viva voce examination of ANISH SHARMA has been held on 15-06-2019 and is accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

## **STUDY OF RC WRAPPED BEAM USING POLYMERS (GFRP/CFRP) AND METAL MATRIX COMPOSITES**

### **THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)**

Submitted by  
AMANDEEP KAUR  
(University Roll No. 1707582)

GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA-141006  
JUNE 2019

IKG PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

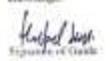
GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### **CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "STUDY OF RC WRAPPED BEAM USING POLYMERS (GFRP/CFRP) AND METAL MATRIX COMPOSITES" is partial fulfillment of requirements for the award of degree of M. Tech (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under IKG PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from January 2019 to June 2019 under the supervision of Dr. HARPAL SINGH and PROF. MANDEEP KAUR. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M. Tech Degree.

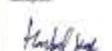
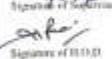
Amanandeep Kaur  
Signature of Student  
(1707582)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge:

  
Signature of Supervisor

  
Signature of Co-Guide

The M. Tech Viva-Voce Examination of AMANDEEP KAUR has been held on 16/07/19 and is accepted.

  
Signature of Supervisor  
  
Signature of I.D.O.D.

  
Signature of External Examiner

### **CANDIDATE'S DECLARATION**

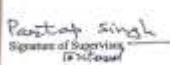
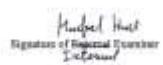
This is to certify that the work presented in Thesis entitled "Flexural Properties In High Strength Concrete By Using Silica Fume With Superplasticizer" submitted by Mr. Bhupinder Singh in partial fulfillment of the requirements for the award of degree of Master of Engineering in Civil (Structures) at Guru Nanak Dev Engineering Ludhiana, is an authentic record of student's own work carried out under our supervision and guidance. The matter embodied in this thesis has not been submitted anywhere for award of any other degree.

  
Signature of the Student

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

  
Signature of the Supervisor

The M. Tech Viva-Voce Examination of Bhupinder Singh has been held on 22-09-14 and is accepted.

  
Signature of Supervisor  
  
Signature of External Examiner  
  
Signature of I.D.O.D.

## **FLEXURAL PROPERTIES IN HIGH STRENGTH CONCRETE BY USING SILICA FUME WITH SUPERPLASTICISER**

### **THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF

THE DEGREE OF

**MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING  
(Structural Engineering)**

SUBMITTED BY  
Er. BHUPINDER SINGH  
Roll No. 100376480111  
JUNE 2014

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR (PUNJAB), INDIA

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "NUMERICAL ANALYSIS OF SLABS WITH DIFFERENT TYPES OF OPENINGS" by "PRITPAL KAUR" is partial fulfillment of requirements for the award of degree of M.Tech. (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, CHA PARK, LUDHIANA under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from Jun. 2012 to July 2014 under the supervision of Dr. Harpal Singh & Assoc Prof Harvinder Singh. The work presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Pritpal Kaur

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

  
Dr. Harvinder Singh  
Associate Professor  
GNDEC, Ludhiana

The M.Tech Viva -Voce Examination of PRITPAL KAUR has been held on 21st July 2014 and accepted.

  
Signature of Supervisor

  
Dr. Harpal Singh  
Professor  
GNDEC, Ludhiana

  
Signature of External Examiner

Signature of H.O.D.

**NUMERICAL ANALYSIS OF SLABS WITH DIFFERENT TYPES OF OPENINGS****THESIS****SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS****FOR THE AWARD OF THE DEGREE OF****MASTER OF TECHNOLOGY**

(Civil Engineering)  
(Structural Engineering)

**SUBMITTED BY**

PRITPAL KAUR

Univ. Roll No.: 100576480115

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

June 2014

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "CORROSION BEHAVIOR OF DIFFERENT TYPES OF STEEL BARS EMBEDDED IN CEMENT MORTAR" by "ADITI SAHNI" is partial fulfillment of requirements for the award of degree of M.Tech. (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from 24.09.2012 to 24.09.2013 under the supervision of DR. HARPAL SINGH & PROF. K.S. BEDIL. The work presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Signature of the Student

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

  
Signature of the SUPERVISOR (S)

The M.Tech Viva -Voce Examination of (ADITI SAHNI) has been held on 24.09.2013 and accepted.

  
Signature of Supervisor(s)

  
Signature of External Examiner

  
Signature of H.O.D.

**CORROSION BEHAVIOR OF DIFFERENT TYPES OF STEEL BARS EMBEDDED IN CEMENT MORTAR****THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY**

(Structural Engineering)

**SUBMITTED BY**

ADITI SAHNI

Univ. Roll No. 13111843

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA,

(JULY 2015)

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "STUDY OF COMPRESSIVE AND FLEXURAL STRENGTH OF STEEL FIBRE REINFORCED - HIGH STRENGTH CONCRETE AT ELEVATED TEMPERATURES" by "MANDEEP KAUR" in partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from JANUARY, 2013 to JUNE, 2013 under the supervision of DR. HARPAL SINGH & DR. HARVINDER SINGH. The matter presented in this project has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

*Maneep Kaur*  
(MANDEEP KAUR)

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

*Harpal Singh*  
(DR. HARPAL SINGH)  
Professor  
GNDEC, Ludhiana

*Harvinder Singh*  
(DR. HARVINDER SINGH)  
Associate Professor  
GNDEC, Ludhiana

The M.Tech viva-voce Examination of MANDEEP KAUR has been held on 25/06/15 and is accepted.

Signature of Supervisor (S)

Signature of External Examiner

Signature of H.O.D

STUDY OF COMPRESSIVE AND FLEXURAL  
STRENGTH OF STEEL FIBRE REINFORCED  
HIGH STRENGTH CONCRETE  
AT ELEVATED TEMPERATURES

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR  
THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
(Structural Engineering)

SUBMITTED BY

MANDEEP KAUR  
(University Roll No. - 1311856)  
June 2015

GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA - 141006

June 2015

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EXPERIMENTAL STUDY OF SHEAR STRENGTH CHARACTERISTICS OF HIGH STRENGTH CONCRETE BEAMS" by "BALWINDER KAUR" in partial fulfillment of requirements for the award of degree of M. Tech. (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, GILL PARK, LUDHIANA under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from Jan 2012 to April 2014 under the supervision of Dr. Harpal Singh (Professor, Civil Engineering, Department). The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M. Tech Degree.

*Balwinder Kaur*  
Signature of the Student

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

*Harpal Singh*  
Signature of the Supervisor (S)

The M. Tech Viva - Voice Examination of BALWINDER KAUR has been held on 09/04/14 and accepted

*Kamal Wala*  
Signature of Supervisor (S)

Signature of the H.O.D

EXPERIMENTAL STUDY OF SHEAR  
STRENGTH CHARACTERISTICS OF HIGH  
STRENGTH CONCRETE BEAMS

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE  
AWARD OF THE DEGREE OF  
MASTER OF TECHNOLOGY  
IN CIVIL ENGINEERING  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
Er. BALWINDER KAUR  
University Roll No. : 100376400110  
APRIL 2014

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

### CANDIDATES DECLARATION

I, Ravinder Maurya, hereby certify that the work which is being presented in this thesis entitled "ANALYSIS AND DESIGN OF UNDERGROUND WATER TANK" is partial fulfillment of requirements for the award of degree of M.Tech in Department of CIVIL ENGINEERING of Guru Nanak Dev Engineering College, Ludhiana, is an authentic record of my own work carried out during a period from January 2014 to June 2014 under the supervision of Dr. Harpal Singh and Dr. Hardeep Singh Bal. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech. Degree.

Ravinder Maurya  
(Ravinder Maurya)

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

Guided by Co-guided by

  
(Dr. Harpal Singh)  
Professor  
Department of Civil Engineering

  
(Dr. Hardeep Singh Bal)  
Professor  
Department of Civil Engineering

The M.Tech Viva-Voce Examination of RAVINDER MAURYA has been held on \_\_\_\_\_ and accepted.

Signature of Supervisor \_\_\_\_\_

Signature of External Examiner \_\_\_\_\_

Signature of H.O.D. \_\_\_\_\_

## **ANALYSIS AND DESIGN OF UNDERGROUND WATER TANK**

### **THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD  
OF THE DEGREE  
OF

**MASTERS OF TECHNOLOGY  
IN  
STRUCTURAL ENGINEERING**

Submitted by

Ravinder Maurya  
University Roll No. - 1268625  
(June 2014)



PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

### CANDIDATES DECLARATION

I, Amninder Singh, hereby certify that the work which is being presented in this thesis entitled "ANALYSIS AND DESIGN OF OVERHEAD WATER TANK" is partial fulfillment of requirements for the award of degree of M.Tech in Department of CIVIL ENGINEERING of Guru Nanak Dev Engineering College, Ludhiana, is an authentic record of my own work carried out during a period from January 2014 to June 2014 under the supervision of Dr. Harpal Singh and Dr. Hardeep Singh Bal. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech. Degree.

Amninder Singh  
(Amninder Singh)  
Date : 13 August 2014

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

Guided by Co-guided by

  
(Dr. Harpal Singh) 2000  
Professor  
Department of Civil Engineering

  
(Dr. Hardeep Singh Bal)  
Professor  
Department of Civil Engineering

The M.Tech Viva-Voce Examination of AMNINDER SINGH has been held on 17.12.14 and accepted.

Signature of Supervisor Amninder Singh  
Signature of External Examiner Hardeep Singh Bal  
Signature of H.O.D. H.S. Bal

## **Analysis and Design of Overhead Water Tank**

### **THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF  
THE  
DEGREE OF

**MASTER OF TECHNOLOGY  
IN  
(STRUCTURAL ENGINEERING)**

SUBMITTED BY  
Ex. AMNINDER SINGH  
University Roll No. 1268625  
(Aug 2014)

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

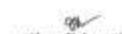
GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA  
CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF USING PAPER INDUSTRY WASTE AS A REPLACEMENT OF CEMENT IN CONCRETE" by "Ankur Kumar Chauhan" is partial fulfillment of requirement for the award of degree of Master of Technology in Structural Engineering, submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under Panjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from January 2014 to August 2014 under the supervision of Professor "Dr. Harpal Singh" and my co-guide professor "Bikramjeet Kaur". The matter presented in this thesis has not been submitted by me to any other University/Institute for the award of M.Tech Degree.

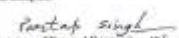
  
Ankur Kumar Chauhan

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

  
Guide: Dr. Harpal Singh  
Professor, Civil Engineering Department,  
GNDEC, Ludhiana.

  
Co-guide: Prof. Bikramjeet Kaur  
Professor, Civil Engineering  
Department, GNDU, Ludhiana

The M.Tech Viva – Voice Examination of (Ankur Kumar Chauhan) has been held on 10/08/2014 and accepted.

  
Signature of External Examiner 10/08/2014

  
Signature of Head, C.E.D. (Civil Engineering Department)

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF SUPER PLASTICIZER ON THE MECHANICAL AND DURABLE PROPERTIES OF HIGH VOLUME CEMENTITIOUS CONCRETE" by "Preeti Sandhu" is partial fulfillment of requirement for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under I.K.G. Panjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from Jan 2010 to June 2014 under the supervision of Professor Harpal Singh and Professor K.S. Rishi. The matter presented in this thesis has not been submitted by me to any other University / Institute for the award of M.Tech Degree.

  
Signature of the Student

This is to verify that the above statement made by the candidate is correct to the best of my knowledge.

  
Signature of Supervisor

The M.Tech Viva – Voice Examination of Preeti Sandhu has been held on 05/05/2014 and accepted.

  
Signature of External Examiner

  
Signature of Head, C.E.D.

  
Signature of I.K.G.P.T.U.

EFFECT OF USING PAPER INDUSTRY  
WASTE AS A REPLACEMENT OF CEMENT  
IN CONCRETE: EXP INVESTIGATION

THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF  
THE

DEGREE OF

MASTER OF TECHNOLOGY  
IN  
(STRUCTURAL ENGINEERING)

SUBMITTED BY

ANKUR KUMAR CHAUHAN  
University Roll No. 1268984  
(Aug 2014)

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

PUNJAB TECHNICAL UNIVERSITY

JALANDHAR, INDIA

Effect of Super Plasticizer on the  
Mechanical and Durable Properties of  
High Volume Cementitious Concrete

THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
PREEM GARGII

University Roll No.: 142288  
June 2014

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

#### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF SUPERPLASTICIZER ON THE MECHANICAL AND DURABLE PROPERTIES OF HIGH VOLUME CEMENTITIOUS CONCRETE" by "Prem Gaddi" is partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under L.K.G. Gurjal Technical University. I declare that an academic record of my own work carried out during a period from Jan 2016 to June 2016 under the supervision of Professor Dr. Harpal Singh and Professor K.S. Dhill. The work presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Signature of the Student

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

  
Signature of Supervisor

The M.Tech Visa - Visa Examination of Prem Gaddi has been held on 25-06-2016 and accepted.

  
Signature of Supervisor

  
Signature of External Examiner

  
Signature of H.O.D.

#### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "NUMERICAL MODELLING OF CONCRETE CONTAINING WASTE TYRE RUBBER AS PARTIAL REPLACEMENT OF FINE AGGREGATE" by Ravinder Singh is partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, GILL PARK, LUDHIANA UNDER L.K.G. GURJAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an academic record of my own work carried out during a period from Jan 2016 to April 2016 under the supervision of Professor Dr. Jagbir Singh and co-guide Professor Dr. Harpal Singh. The content presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Signature of the Student

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

  
Signature of Supervisor

  
Signature of Co-Supervisor

The M.Tech Visa - Visa Examination of Ravinder Singh has been held on 16-01-2016 and accepted.

  
Signature of External Examiner

  
Signature of Supervisor

  
Signature of H.O.D.

  
Signature of Co-Supervisor

#### PHYSICAL AND ANALYTICAL INVESTIGATION OF CONCRETE WITH REPLACEMENT OF CEMENT WITH EGG SHELL AND COAL ASH POWDER

##### THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING

SUBMITTED BY  
VARINDER SINGH

University Roll No.: 145202

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

December 2016

L.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

#### NUMERICAL MODELLING OF CONCRETE CONTAINING WASTE TYRE RUBBER AS PARTIAL REPLACEMENT OF FINE AGGREGATE

##### THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
KANWARDEEP SINGH

University Roll No.: 1452010

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

December 2016

L.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
KAMPOTHALA, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

#### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "THE EFFECTS OF 30% REPLACEMENT OF CEMENT AND SAND IN CONCRETE BY MARBLE POWDER" by Himanshu Sharma is partial fulfillment of requirements for the award of degree of Master of Technology in Structural Engineering, submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under I.K.G. Panjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from January 2014 to May 2015 under the supervision of Dr. Harpal Singh as guide and Dr. Jagjeet Singh as co-guide. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

  
Himanshu Sharma

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

  
Dr. Harpal Singh  
Professor  
Civil Engineering Department  
GNDEC, Ludhiana

  
Dr. Jagjeet Singh  
Professor  
Civil Engineering Department  
GNDEC, Ludhiana

The M.Tech Visa-A-Vote Examination of (Himanshu Sharma) has been held on 22-05-2015 and accepted.

  
Signature of Supervisor

  
Signature of External Examiner

  
Signature of H.O.D. (Civil Engineering Department)

#### THE EFFECTS OF REPLACEMENT OF CEMENT AND SAND IN CONCRETE BY MARBLE POWDER

#### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
STRUCTURAL ENGINEERING

SUBMITTED BY  
HIMANSHU SHARMA  
University Roll No. - 1268613  
August, 2016

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

I.K.G PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

90

ii

#### Effect of Super Plasticizer on the Mechanical and Durable Properties of High Volume Cementitious Concrete

#### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
PREM GANDHI

University Roll No. : 1453818  
June 2016

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

#### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF SUPER PLASTICIZER ON THE MECHANICAL AND DURABLE PROPERTIES OF HIGH VOLUME CEMENTITIOUS CONCRETE" by "Prem Gandhi" is partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering in Guru Nanak Dev Engineering College, Ludhiana under I.K.G. Panjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from Jan 2010 to June 2010 under the supervision of Professor Deepal Singh and Professor K.S. Sandhu. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Signature of El. Student

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

  
Signature of Supervisor

The M.Tech Visa-A-Vote Examination of Prem Gandhi has been held on 25-06-2016 and accepted.

  
Signature of Supervisor

  
Signature of External Examiner

  
Signature of H.O.D.

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "PHYSICAL AND ANALYTICAL INVESTIGATION OF CONCRETE WITH REPLACEMENT OF CEMENT WITH EGG SHELL POWDER AND COAL ASH POWDER" by "Varinder Singh" in partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted to the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under I.K. Gujral Punjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from Jan 2010 to June 2010 under the supervision of Prof. Dr. Harpal Singh and Prof. S.S. Rai. The thesis presented in this thesis has not been submitted by me to any other University / Institute for the award of M.Tech Degree.

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

The M.Tech Viva-Voce Examination of Varinder Singh has been held on 11-11-2016 and accepted.

  
External Examiner**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "COMPARATIVE STUDY OF MULTI-STORY BUILDING AS PER IS 1893:2016 (PART 1) AND IS 1893:2002 (PART 2)" by "ABHISHEK NANDA" (1607615) in partial fulfillment of requirements for the award of the degree of M.Tech (Structural Engineering) submitted to the department of (Civil Engineering) at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K. Gujral Punjab Technical University, Jalandhar, India is an authentic record of my own work carried out during a period from January 2018 to June 2018 under the supervision of Dr. HARPAL SINGH and Dr. H.S. RAI. The earlier process to this thesis work has not been submitted by me to any other University/Institutes for the award of M.Tech Degree.

Date: 22/06/2018**CERTIFICATE**

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

Dr. HARPAL SINGH  
(Guide)

Professor

Department of Civil Engineering  
GNDEC, Ludhiana

Dr. H.S. RAI  
(Co-Guide)

Professor

Department of Civil Engineering  
GNDEC, Ludhiana

The M.Tech Viva-Voce Examination of Abhishek Nanda has been held on 22/06/2018 and accepted.

  
Signature of Co-Guide**PHYSICAL AND ANALYTICAL INVESTIGATION OF CONCRETE WITH REPLACEMENT OF CEMENT WITH EGG SHELL AND COAL ASH POWDER****THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING**

SUBMITTED BY  
VARINDER SINGH

University Roll No.: 145282

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

November 2016

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

**COMPARATIVE STUDY OF MULTI-STOREY BUILDING AS PER IS 1893:2016 (PART 1) AND IS 1893:2002 (PART 1)****THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY  
(Structural Engineering)**

SUBMITTED BY:

ABHISHEK NANDA  
(University Roll No: 1607615)

GURU NANAK DEV ENGINEERING COLLEGE

LUDHIANA

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
KAPURTHALA, INDIA  
JUNE, 2018

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in this Thesis entitled "STRESS - STRAIN BEHAVIOUR OF FIBER REINFORCED HIGH PERFORMANCE CONCRETE AT ELEVATED TEMPERATURE" At Panjab University Roll No. 1607617 is partial fulfillment of requirement for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering of Guru Nanak Dev Engineering College, Ludhiana under Panjab Technical University, Jalandhar. It is an authentic record of my own work carried out during a period from January 2010 to June 2012 under the supervision of Dr. Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

Signature of the Student

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

(Dr. Harpal Singh)

(Prof. Tarsem Singh)

Professor

Department of Civil Engineering

GNDEC, Ludhiana

Department of Civil Engineering

GNDEC, Ludhiana

The M.Tech Viva-Voce Examination of Panjab University has been held on 19/5/14 and accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

## STUDY OF FLEXURAL RESPONSE OF FIBER REINFORCED HIGH PERFORMANCE CONCRETE AT ELEVATED TEMPERATURE

**THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD  
OF THE DEGREE OF

**MASTER OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)**

**SUBMITTED BY**

FAHMEED SHAFI

Univ. Roll No- 1607617

JUNE 2018

**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA  
PUNJAB, INDIA – 141006**

**L.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY  
KAPURTHALA, PUNJAB, INDIA**

## STRESS - STRAIN BEHAVIOUR OF FLYASH CONCRETE WITH STEEL FIBRE

**THESIS**

Submitted to Guru Nanak Dev Engineering College, Ludhiana  
In partial fulfillment for the award of degree of

**MASTERS OF TECHNOLOGY  
STRUCTURAL ENGINEERING**

**Submitted by**

Er. Nirmal Singh

University Roll No – 1208620

**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA  
(July 2014)**

**PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA**

**CANDIDATE'S DECLARATION**

I, Nirmal Singh, hereby certify that the work which is being presented in this thesis entitled "STRESS - STRAIN BEHAVIOUR OF FLYASH CONCRETE WITH STEEL FIBRE" is partial fulfillment of requirements for the award of degree of Master of Technology in Structural Engineering, submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under Panjab Technical University, Jalandhar. It is an authentic record of my own work carried out during a period from January 2010 to July 2014 under the supervision of Professor Dr. Harpal Singh and Dr. Hardeep Singhpal. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

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

(Dr. Harpal Singh)

Professor

Department of Civil Engineering

(Dr. Hardeep Singhpal)

Professor

Department of Civil Engineering

The M.Tech Viva -Voce Examination of Nirmal Singh has been held on \_\_\_\_\_ and accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

**CANDIDATE'S DECLARATION**

I hereby certify that the work, which is being presented in the Thesis entitled, "IMPACT OF IS 1893:2014 (PART-II) REVISION ON DESIGN OF INTZ WATER TANK SUPPORTED ON RC SHAFT" by "AMANDEEP SINGH", University Roll No. 1607616 in partial fulfillment of requirements for the award of degree of Master of Technology in Civil Engineering with specialization in Structural Engineering, submitted to the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K.GUJRAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from June 2016 to July 2018 under the guidance of Dr. Harpal Singh and Mr. Bhupinder Singh. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech or any other degree.

*Amandeep Singh*  
Signature of the Student

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

*Harpal Singh*  
Signature of the Supervisor

*Bhupinder Singh (John)*  
Signature of Co-Supervisor

The M.Tech Visa-Voce Examination of Amandeep Singh has been held on 26-07-18 and accepted.

*Harpal Singh*  
Signature of the Supervisor

*[Signature]*  
Signature of External Examiner

*[Signature]*  
Signature of I.O.D.

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "Experimental Investigation of Partial Replacement of Coarse Aggregate with Waste Tiles in Concrete" by "Sandeep Kaur (Uni. Roll No.1452819)" in partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under I.K.Gujral Punjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from 06-06-16 to 17-02-18 under the supervision of Dr Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

*Sandeep Kaur*  
Signature of the Student

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

*Harpal Singh*  
Signature of Supervisor

The M.Tech Visa-Voce Examination of (Sandeep Kaur) has been held on 22-01-2018 and accepted.

*Harpal Singh*  
Signature of Supervisor

*[Signature]*  
Signature of External Examiner

*[Signature]*  
Signature of I.O.D.

**IMPACT OF IS 1893:2014 (Part II)  
REVISION ON DESIGN OF INTZ WATER  
TANK SUPPORTED ON RC SHAFT****THESIS**

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**Masters of Technology**  
(Structural Engineering)

Submitted By

**AMANDEEP SINGH**  
College Roll No. - 164582  
University Roll No. - 1607616

June 2018



**Department of Civil Engineering**  
**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA**  
(An autonomous college under UGC Act)

**Experimental Investigation of Partial  
Replacement of Coarse Aggregates with  
Waste Tiles in Concrete****THESIS**

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY**  
(Civil Engineering)

SUBMITTED BY

**SANDEEP KAUR**  
(University Roll No -1452819)

June, 2018

UNDER GUIDANCE OF  
Dr. Harpal Singh

**GURU NANAK DEV ENGINEERING COLLEGE**  
LUDHIANA, PUNJAB - 141006

**I.K.GUJRAL PUNJAB TECHNICAL UNIVERSITY**  
JALANDHAR (PUNJAB), INDIA

## EFFECT OF SKEW ANGLE ON THE BEHAVIOUR OF RC T-BEAM BRIDGE

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "EFFECT OF SKEW ANGLE ON THE BEHAVIOUR OF RC T-BEAM BRIDGE" by "SANTOKH SINGH" is partial fulfillment of requirements for the award of degree of M.Tech (Structures Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K.G.PUNJAB TECHNICAL UNIVERSITY, KAPURTHALA as an authentic record of my own work carried out during a period from 2010-11 to 2013-14 under the supervision of Dr. RAMPAL SINGH and Dr. HARVINDER SINGH. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

Signature of the Student

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

Signature of the SUPERVISOR (S)

The M.Tech Viva - Voice Examination of SANTOKH SINGH has been held on 6/6/14 and accepted.

Signature of Supervisor(s)

Signature of External Examiner

Signature of H.O.D.

### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD

OF THE DEGREE OF

MASTER OF TECHNOLOGY

(Structure Engineering)

SUBMITTED BY

SANTOKH SINGH

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

April 2016

## PUNJAB TECHNICAL UNIVERSITY

JALANDHAR, INDIA

### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "THE EFFECTS OF REINFORCEMENT OF CEMENT AND SAND IN CONCRETE BY MARBLE POWDER" by Hemanshu Sharma is partial fulfillment of requirements for the award of degree of Master of Technology in Structural Engineering, submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under I.K.G.PUNJAB TECHNICAL UNIVERSITY, KAPURTHALA as an authentic record of my own work carried out during a period from January 2011 to May 2013, under the supervision of Dr. Harpal Singh as guide and Dr. Jagbir Singh as co-guide. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

Hemanshu Sharma

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

Dr. Harpal Singh  
Professor,  
Civil Engineering Department,  
GNDEC, Ludhiana

Dr. Jagbir Singh  
Professor,  
Civil Engineering Department  
GNDEC, Ludhiana

The M.Tech Viva - Voice Examination of Hemanshu Sharma has been held on 22-8-2014 and accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D. Civil Engineering Department

## THE EFFECTS OF REPLACEMENT OF CEMENT AND SAND IN CONCRETE BY MARBLE POWDER

### THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
STRUCTURAL ENGINEERING

SUBMITTED BY

HEMANSHU SHARMA

University Roll No. - 1288633

August, 2016

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

I.K.G PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

#### CANDIDATE'S DECLARATION

I hereby certify that the work thus is being presented to the thesis entitled "STUDY OF SHEAR CHARACTERISTICS OF RECYCLED AGGREGATE CONCRETE BEAMS" by "RAVIINDER SINGH DHALIWAL" is partial fulfillment of requirements for the award of degree of Master of Technology in Structural Engineering, submitted in the Department of Civil Engineering at Guru Nanak Dev Engineering College, Ludhiana under Panjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from January 2013 to June 2013 under the supervision of Dr. Harpal Singh and Aksharajit Singh Bedi. The matter presented in this thesis has not been submitted by me to any other University/Institute for the award of M.Tech Degree.

  
Ravi Inder Singh Dhaliwal

This is to certify that the above statement made by the candidate is correct to the best of my knowledge:

  
Asstt. Prof. Dr. Harpal Singh  
Associate Professor,  
Civil Engineering Department,  
GNDEC, Ludhiana

  
Dr. Harpal Singh  
Professor,  
Civil Engineering Department,  
GNDEC, Ludhiana

The M.Tech Viva-Voce Examination of Ravi Inder Singh Dhaliwal has been held on 18/3/2015, and accepted.

  
Signature of the External Examiner  
  
  
Signature of Head, C.E. (Civil Engineering Department)

#### STUDY OF SHEAR CHARACTERISTICS OF RECYCLED AGGREGATE CONCRETE BEAMS

#### THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
RAVIINDER SINGH DHALIWAL  
University Roll No. 3168266  
(September, 2015)

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA  
(An Autonomous College under UGC Act - 1956 [2(f) and 12(B)])

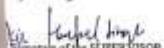
PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

#### CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "DURABILITY STUDY OF THE RECYCLED AGGREGATE AND SILICA FUME CONCRETE" by AKSHAT MAHAJAN is partial fulfillment of requirements for the award of degree of M.Tech. (Structural Engineering) submitted in the Department of Civil Engineering at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from January, 2013 to June, 2013 under the supervision of Dr. HARSH PAL SINGH. This matter presented in this thesis has not been submitted by me to any other university / Institute for the award of M.Tech degree.

  
Signature of the student

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

  
Signature of the SUPERVISOR

The M.Tech Viva-Voce Examination of Akshat Mahajan has been held on 14/7/2015, and accepted.

  
Signature of the SUPERVISOR

  
Signature of the External Examiner

  
Signature of Head, C.E.

#### DURABILITY STUDY OF RECYCLED AGGREGATE AND SILICA FUME CONCRETE

#### THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF

MASTER OF TECHNOLOGY  
(STRUCTURAL ENGINEERING)

SUBMITTED BY  
AKSHAT MAHAJAN  
Univ. R. No. 1311846

GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA, INDIA

JUNE, 2015

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the thesis entitled "Durability properties of self-compacting concrete with recycled aggregate and silica fume" by Mohd Ishaq" in partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the Department of Civil Engineering of Guru Nanak Dev Engineering College, Ludhiana under H. Gajral Punjab Technical University, Jalandhar is an authentic record of my own work carried out during a period from January 2010 to June 2010 under the supervision of Prof. Harpal Singh and Prof. K.S. Bedi. The matter presented in this thesis has not been submitted by me in any other University/Institute for the award of M.Tech Degree.

Signature of the Student

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

Signature of the Supervisor

The M.Tech Viva-Voce Examination of Mohd Ishaq has been held on 02-15-2016 and accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

**Durability Properties of Self Compacting Concrete with Recycled Aggregate and Silica Fume****THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY**

(Structural Engineering)

**SUBMITTED BY**

Mohd ISHFAQ

(University Roll No -1452816)

June, 2016

**UNDER GUIDANCE OF**

Dr. Harpal Singh

Prof. K.S. Bedi

**GURU NANAK DEV ENGINEERING COLLEGE**  
LUDHIANA, PUNJAB - 141006**IK GUJRAL PUNJAB TECHNICAL UNIVERSITY**  
JALANDHAR (PUNJAB), INDIA**CANDIDATE'S DECLARATION**

I Akash Aneja, hereby certify that the work which has been presented in the thesis entitled "PARAMETRIC STUDY OF MULTISTOREY R/C BUILDING WITH PLAN IRREGULARITY" in partial fulfillment of requirement for the award of Degree of M. Tech (Structural Engineering) in Department of CIVIL ENGINEERING of Guru Nanak Dev Engineering College, Ludhiana, is an genuine record of my own work carried out during the period from January 2015 to June 2015 under the supervision of Dr. Harpal Singh. The matter that I have presented in this thesis has not been submitted by me in any other university/ institute for the award of M. Tech Degree.

(Akash Aneja)

Dated: 03-08-2015

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

(Dr. Harpal Singh)

Professor

Department of Civil Engineering

The M. Tech Viva-Voce examination of Akash Aneja has been held on 29-06-2015 and is accepted.

Signature of Supervisor

Signature of External Examiner

Signature of H.O.D.

**PARAMETRIC STUDY OF MULTISTOREY R/C BUILDING WITH PLAN IRREGULARITY****THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

**MASTERS OF TECHNOLOGY**

IN

STRUCTURAL ENGINEERING

**SUBMITTED BY**

AKASH ANEJA

University Roll No. - 1311845

(May 2015)

**PUNJAB TECHNICAL UNIVERSITY**  
JALANDHAR, INDIA**GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA**  
(An Autonomous College under UGC Act – 1956 [2(f) and 12(B)])

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "A COMPARATIVE STUDY OF SHEAR WALL LOCATION / CONFIGURATION IN A FRAMED SYSTEM OF MULTI-STORY BUILDING" is partial fulfillment of requirements for the award of degree of M.Tech (Structural Engineering) submitted in the department of (Civil Engineering) at GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from January 2012 to June 2014 under the supervision of Dr Hardeep Singh Rai & Dr. Harpal Singh. The matter presented in this thesis has not been submitted by me in any other University / Institute for the award of M.Tech Degree.

  
Avnish  
Kumar

This is to certify that the above statement made by the candidate is correct to the best of my / our knowledge:  
  
(Dr. Hardeep Singh Rai)  
Supervisor

  
(Dr. Harpal Singh)  
Co-supervisor

The M.Tech viva-voce Examination of AVNISH KUMAR has been held on 15/12/2014 and is accepted.

  
Signature of Supervisor

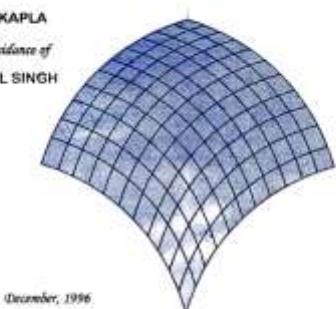
  
Signature of External Examiner 15/12/14

  
Signature of M.O.D.

NFEMRCS - AN INTERACTIVE SOFTWARE FOR  
NONLINEAR FINITE ELEMENT MODELLING OF  
REINFORCED CONCRETE SHELLS

A thesis  
submitted in partial fulfillment of  
requirements for the award of degree of  
MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING

By  
PRADEEP KAPLA  
Under the guidance of  
Dr. HARPAL SINGH



December, 1996

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY  
(Approved University)  
PATIALA - 147001

A COMPARATIVE STUDY OF SHEAR WALL  
LOCATION / CONFIGURATION IN A  
FRAMED SYSTEM OF MULTI-STORY  
BUILDING

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY

STRUCTURAL ENGINEERING

SUBMITTED BY  
AVNISH KUMAR  
University Roll No. 1268605

Guru Nanak Dev Engineering College, Ludhiana

June 2014

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR, INDIA

CERTIFICATE

This is to certify that Thesis titled "NFEMRCS - An Interactive Software for Nonlinear Finite Element Modelling of Reinforced Concrete Shells" being submitted by Mr. Pradeep Kapla in partial fulfillment of requirement for the award of degree of Master of Engineering in Structural Engineering of Thapar Institute of Engineering and Technology (Approved University), Patiala, is a record of student's own work carried out under my guidance. No other individual is of direct concerned for the award of above mentioned degree.

  
Dr. HARPAL SINGH  
Assistant Professor,  
Department of Civil Engineering,  
Thapar Institute of Engineering and Technology,  
Patiala-147001

  
Dr. M.L. GAVISH  
Chairman, Board of Studies,  
Department of Civil Engineering,  
Thapar Institute of Engineering and Technology,  
Patiala-147001

  
Dr. P.A. KHURANA  
Dean of Academic Affairs,  
Thapar Institute of Engineering and Technology,  
Patiala-147001

## BOND PROPERTIES OF STEEL FIBRE REINFORCED CONCRETE

(1)

### CERTIFICATE

This is to certify that the thesis entitled  
**'BOND PROPERTIES OF STEEL FIBRE REINFORCED CONCRETE'** which  
is being submitted by Mr. DILRAJ SINGH in partial fulfillment  
for the award of the Degree of Master of Civil Engineering  
(Structures) of Thapar Institute of Engineering and Technology,  
Patiala (Deemed University) is a record of student's own work  
carried out by him under our supervision and guidance. The  
matter embodied in this thesis has not been submitted for  
the award of any other degree.

This is further to certify that the candidate  
has worked for a period of about six months for the preparation  
of this thesis.

Mr. DILRAJ SINGH  
LECTURER  
Department of Civil Engineering  
Thapar Institute of Engineering  
& Technology, Patiala.

PROFESSOR AND HEAD  
Department of Civil Engineering  
Thapar Institute of Engineering  
& Technology, Patiala.

DEAN OF ACADEMIC AFFAIRS  
Thapar Institute of Engineering  
& Technology, Patiala.

A Thesis  
Submitted in partial fulfillment of the requirements  
for the Degree of

MASTER OF CIVIL ENGINEERING (Structures)

of

THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY, PATIALA  
(Deemed University)

By  
Mr. DILRAJ SINGH



Department of Civil Engineering  
Thapar Institute of Engineering & Technology, Patiala  
(Deemed University)  
March, 1991

## BEHAVIOUR OF FERROCEMENT-CONFINED CONCRETE IN COMPRESSION

### A Dissertation

Submitted to the Panjab Technical University, Jalandhar  
in partial fulfillment of the requirements  
for the award of degree of

MASTER OF TECHNOLOGY  
in  
CIVIL ENGINEERING  
(Structural Engineering)

By  
Pooja  
Utsle, Roll No.-1407

Mr. Harvinder Singh  
Lecturer

Prof. Harpal Singh  
Professor

Under the guidance of  
Department of Civil Engineering  
GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA  
November, 2002

### CERTIFICATE

This is to certify that the thesis entitled '*Behaviour of Ferrocement Confined Concrete in Compression*' submitted by Pooja (Utsle, Roll No. 1407) in partial fulfillment of the requirement for the award of degree of Master of Technology in Civil Engineering with specialization in Structural Engineering to Panjab Technical University, Jalandhar is a beneficial work carried out by her under our guidance and supervision. To the best of our knowledge, the matter embodied in this thesis has not been submitted for the award of any degree.

Mr. Harvinder Singh  
Lecturer  
Dept. of Civil Engg.  
Guru Nanak Dev Engg. College,  
Ludhiana.

Prof. Harpal Singh  
Professor  
Dept. of Civil Engg.  
Guru Nanak Dev Engg. College,  
Ludhiana.

## FLEXURAL BEHAVIOUR OF FERRO-CEMENT BEAMS UNDER CYCLIC LOADING

A Thesis submitted to  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATTIALA  
(Deemed University)  
in partial fulfillment of the requirements  
for the award of the degree of  
MASTER OF CIVIL ENGINEERING, (Structures)

By :  
SUKHDEEP SINGH

POST GRADUATE SECTION,  
DEPARTMENT OF CIVIL ENGINEERING,  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATTIALA  
(Deemed University)  
JANUARY, 1991

### CERTIFICATE

It is hereby certified that the thesis entitled  
"Flexural Behaviour of Ferrocement Beams under Cyclic  
loading" which is being submitted herewith by  
Mr. Sukhdeep Singh in partial fulfillment for the award  
of degree of Master of Civil Engineering (Structural)  
of Thapar Institute of Engineering and Technology,  
Pattiala is his own work carried out by him under my  
supervision and guidance and that no part of this has  
been submitted for any other degree.

*Harpal Singh*  
Harpal Singh  
Lecturer in Civil Engineering,  
Thapar Institute of Engineering  
and Technology, Pattiala-147004.

*C. P. S. Balakrishna*  
C. P. S. Balakrishna  
Chairman Board of Studies in  
Civil Engineering,  
Thapar Institute of  
Engineering & Technology,  
Pattiala-147004.

Dean of Academic Affairs

Thapar Institute of Engineering

and Technology, Pattiala-147004.

## THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS

A Thesis Submitted to  
THAPAR INSTITUTE OF ENGG. & TECH., PATTIALA  
(Deemed University)  
in partial fulfillment of the requirements  
for the award of degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
PREM PAL

Under the Supervision of:  
**PROF. HARPAL SINGH**



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATTIALA - 147 001.  
February, 1995

### CERTIFICATE

Certified that the study entitled, "Three-Dimensional  
Analysis of Building Systems", which is being submitted by  
Mr. Prem Pal, is partial fulfillment for the award of Master  
of Engineering degree in Civil (Structural Engineering) of  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY DEEMED  
UNIVERSITY PATTIALA is a record of student's own work carried  
out by him under my supervision and guidance. The matter  
encompassed in this thesis has not been submitted to any other  
University or Institute for the award of any degree. The  
thesis has reached the standards fulfilling the requirements  
of the regulation for the award of said degree.

*Harpal Singh*  
Harpal Singh  
Assistant Professor  
Dept. of Civil Engineering  
Thapar Institute of Engineering  
and Technology (Deemed University)  
Pattiala - 147004

*C. P. S. Balakrishna*  
C. P. S. Balakrishna  
Chairman, Board of Studies in  
Civil Engineering Department  
Thapar Institute of Engineering  
and Technology (Deemed Univ.)  
Pattiala-147004

T.D. I

**RESPONSE OF FRAMES WITH INFILLED PANELS USING FINITE ELEMENT METHOD**

A Thesis Submitted To  
Thapar Institute of Engineering & Tech.  
In partial fulfillment of the requirement  
for the award of degree of

**Master of Civil Engineering  
(STRUCTURES)**

By  
**Shami Singla**

Under the Guidance of  
**S. Harpal Singh**

Department of Civil Engineering  
Thapar Institute of Engineering and Tech.  
(DEEMED UNIVERSITY)  
PATIALA-147001

**CERTIFICATE**

This is to certify that the thesis entitled  
**"RESPONSE OF FRAMES WITH INFILLED PANELS USING FINITE ELEMENT  
METHOD"** which is being submitted by Mr. Shami Singla in partial  
fulfillment of the requirement for the award of the degree of  
Master of Civil Engineering (STRUCTURES) of Thapar Institute of  
Engineering and Technology (Deemed University), Patiala, is a  
record of student's own work carried out by him under my  
supervision and guidance. The matter embodied in the thesis has  
not been submitted for the award of any other degree.

This is to further certify that he has  
worked for a period of about ten months from March 1991 to January  
1992 for the preparation of this thesis at the institute in the  
present form.

*Shami Singla*  
Harpal Singh  
Lecturer,  
Dept. of Civil Engg.,  
Thapar Institute of Engg.  
and Technology, PATIALA.

*Chairman*  
Chairman, 2001  
Board of Studies in Civil Engg.  
Thapar Institute of Engg.  
and Technology, PATIALA.

*C. Singh*  
Dawn  
Research & Development  
Thapar Institute of Engg.  
and Technology, PATIALA.

**COMPARATIVE STUDY OF FIRST AND SECOND  
ORDER ANALYSES OF FRAMES**

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH.  
in partial fulfillment of the requirements  
for the award of degree of  
**MASTER OF CIVIL ENGINEERING  
(STRUCTURES)**

By  
**GURINDER MOHAN SINGH**

Under the guidance of  
**S. HARPAL SINGH**



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA-147001.  
Feb. 1992

**CERTIFICATE**

This is to certify that the thesis entitled  
**"Comparative Study of First and Second Order Analyses of  
Frames"** which is being submitted by Mr. Gurinder Mohan Singh  
in partial fulfillment of the requirement for the award of  
the degree of Master of Civil Engineering (STRUCTURES) of  
Thapar Institute of Engineering & Technology (Deemed  
University), Patiala, is a record of student's own work  
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.

This is further to certify that he has worked  
for a period of about seven months from July, 1990 to  
Jan, 1991 for the preparation of this thesis at the  
institute in the present form.

*Gurinder Mohan Singh*  
Harpal Singh  
Lecturer,  
Thapar Institute of Engg.  
& Technology, PATIALA.

*Chairman*  
Chairman, 2001  
Board of Studies in Civil Engg.  
Thapar Institute of Engg.  
and Technology, PATIALA.

*C. Singh*  
Dawn  
Academic Affairs,  
Thapar Institute of Engg.  
& Technology, PATIALA.

**RESPONSE OF 3-D FRAMED  
STRUCTURES  
UNDER FLOOR EXCITATIONS**

A Thesis  
Submitted in Partial Fulfillment  
of Requirement for the Award of Degree of

MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING

By  
**RAJINDER KUMAR**

Under the guidance of  
**Prof. HARPAL SINGH**



APRIL, 1996

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING AND  
TECHNOLOGY  
(Deemed University)  
PATIALA-147001

**SOIL STRUCTURE INTERACTION ANALYSIS  
USING FINITE ELEMENT METHOD**

Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH. PATIALA.  
In partial fulfillment of the requirements for the  
award of Degree of  
MASTER OF CIVIL ENGINEERING  
GEOTECHNICAL ENGINEERING

BY  
**SHAMI SINGLA**

Under the guidance of :

**Dr. V. K. SOOD**  
Professor & Dean of Student Affairs

**Dr. HARPAL SINGH**  
Assistant Professor



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY  
(DEEMED UNIVERSITY)  
PATIALA - 147 001  
1998

**CERTIFICATE**

Certified that the study entitled, "Response of 3-D Framed Structures under floor excitations", which is being submitted by Mr. Rajinder Kumar, in partial fulfillment for the award of Master of Engineering in Civil / Structures / Engineering to Thapar Institute of Engineering & Technology (Deemed University), Patiala, is a record of student's own work carried out by him under my supervision & guidance. The work embodied in this thesis has not been submitted to any other University or Institute for the award of any degree. The thesis has reached the standards fulfilling the requirements of the regulation for the award of said degree.

*Harpal Singh*  
**I. HARPAL SINGH**  
Assistant Professor  
Dept. of Civil Engineering  
Thapar Institute of Engg.  
& Tech. (Deemed University)  
Patiala - 147001

*Dr. H. L. Gambhir*  
**Dr. H. L. GAMBHIR**  
Chairman, Board of Studies  
in Civil Engg.  
Thapar Institute of Engg.  
& Tech. (Deemed University)  
Patiala - 147001

*Dr. P. S. Bhatia*  
**Dr. P. S. BHATIA**  
Dean of Academic Affairs  
Thapar Institute of Engg.  
& Tech. (Deemed University)  
Patiala - 147001

(1)

**CERTIFICATE**

This is to certify that the thesis entitled "Soil-Structure Interaction Analysis Using Finite Element Method" being submitted by Mr. Shami Singla in partial fulfillment of requirements for the award of degree of Master of Civil Engineering in Geotechnical Engineering of Thapar Institute of Engineering and Technology (Deemed University), Patiala, is a record of student's own work carried out under my guidance. The work embodied is of desired standard for the award of above mentioned degree.

*V.K.Sood*  
**(Dr. V.K.SOOD)**  
Professor and Dean of Student Affairs  
Thapar Institute of Engineering & Tech.  
PATIALA - 147 001 (Punjab)

*Harpal Singh*  
**(Dr. HARPAL SINGH)**  
Assistant Professor  
Department of Civil Engineering  
Thapar Institute of Engineering and Tech.  
PATIALA - 147 001 (Punjab)

*V.K.Sood*  
**(Dr. V.K.SOOD)**  
Chairman, Board of Studies  
Department of Civil Engineering  
Thapar Institute of Engineering & Tech.  
PATIALA - 147 001 (Punjab)

*S.C.Parth*  
**(Dr. S.C.PARTH)**  
Dean of Academic Affairs  
Thapar Institute of Engineering and Tech.  
PATIALA - 147 001 (Punjab)

(2)

**THE STUDY OF TENSILE BEHAVIOUR OF  
FEROCEMENT WITH FLY ASH AS AN  
ADMIXTURE**

**A Dissertation**

Submitted to the Panjab Technical University, Jalandhar  
in partial fulfillment of the requirements  
for the award of degree  
of

**MASTER OF TECHNOLOGY  
in  
CIVIL ENGINEERING  
(Structural Engineering)**

By  
**Harpreeet Kaur**  
Univ. Roll No. 1404

Under the guidance of  
**Mr. Harvinder Singh**      **Prof. Harpal Singh**

Department of Civil Engineering  
**GURU NANAK DEV ENGINEERING COLLEGE**  
LUDHIANA  
November, 2002

**CERTIFICATE**

This is to certify that thesis entitled "The Study of Tensile Behavior of Ferocement with Fly Ash as an Admixture" submitted by "Harpreeet Kaur" in partial fulfillment for the award of degree of MASTER OF TECHNOLOGY IN STRUCTURAL ENGINEERING (CIVIL ENGINEERING) to Panjab Technical University, Jalandhar is a record of student's work carried out by her under my supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other degree or diploma.

  
**Mr. Harvinder Singh**  
Lecturer,  
Civil Engineering Dept.,  
Guru Nanak Dev Engg. College,  
Ludhiana

  
**Prof. Harpal Singh**  
Professor,  
Civil Engineering Dept.,  
Guru Nanak Dev Engg. College,  
Ludhiana

**BEHAVIOUR OF FRAMES WITH  
INFILLED PANELS**

A Thesis Submitted To  
**Thapar Institute of Engineering & Tech.**  
in partial fulfillment of the requirement  
for the award of degree of

**Master of Civil Engineering  
(STRUCTURES)**

by  
**Ishminder Kaur**

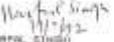
Under the Guidance of  
**S. Harpal Singh**

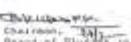
Department of Civil Engineering  
**Thapar Institute of Engineering and Tech.**  
(DEEMED UNIVERSITY)  
PATIALA-147001.

**CERTIFICATE**

This is to certify that the Thesis entitled "**BEHAVIOUR OF FRAMES WITH INFILLED PANELS**", which is being submitted by Ms. Ishminder Kaur in partial fulfillment of the requirement for the award of the degree of Master of Civil Engineering (Structures) of Thapar Institute of Engineering and Technology (Deemed University), Patiala, is a record of student's own work carried out by her under my supervision and guidance. The matter embodied in the thesis has not been submitted for the award of any other degree.

This is to further certify that she has worked for a period of about eight months from April, 1991 to December, 1991 for the preparation of this thesis at the institute in the present form.

  
**S. Harpal Singh**  
Lecturer  
Dept. of Civil Engg.  
Thapar Institute of Engg.  
and Technology, PATIALA.

  
**Chairman, Board of Studies in Civil Engg.**  
Thapar Institute of Engg.  
and Technology, PATIALA.

  
**Dean, Research & Development**  
Thapar Institute of Engg.  
and Technology, PATIALA.

# INTERACTIVE GRAPHICAL PRE AND POSTPROCESSOR FOR 3D BUILDING FRAMES

A Thesis Report  
Submitted in Partial Fulfilment  
of Requirements for the Award of Degree of

MASTER OF ENGINEERING IN CIVIL ENGINEERING  
(STRUCTURES)

By  
P. S. S. KUMAR

Under the Guidance of  
Dr. HARPAL SINGH



JULY 1996

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY  
(Deemed University)  
PATIALA - 147001

## CERTIFICATE

Certified that the study entitled, "Interactive Graphical Pre and Postprocessor for 3D Building Frames," which is being submitted by Mr. P. S. S. Kumar, in partial fulfillment for the award degree of Master of Engineering in Civil (Structures) Engineering of Thapar Institute of Engineering and Technology (Deemed University), Patiala, is a record of student's own work 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. The thesis has reached the standards fulfilling the requirements of the regulation for the award of said degree.

Harpal Singh  
25/7/96  
Dr. Harpal Singh  
Asst. Professor  
Dept. of Civil Engineering,  
Thapar Institute of Engineering  
and Technology (Deemed University),  
Patiala - 147001

M.L. Gaur  
30/7/96  
Mr. M.L. Gaur  
Chairman, Board of Studies,  
Department of Civil Engineering,  
Thapar Institute of Engineering  
and Technology (Deemed University),  
Patiala - 147001

(1)

# BEHAVIOUR OF A SHEAR WALL SYSTEM

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH.  
(Deemed University)  
in partial fulfillment of the requirements  
for the degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
VINEET AGGARWAL

Under the Guidance of  
DR. R. S. L. BEDI  
PROF. HARPAL SINGH



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA - 147001  
July, 1996

## CERTIFICATE

This is to certify that the thesis "BEHAVIOR OF A SHEAR WALL SYSTEM" submitted by Mr. Vineet Aggarwal, for the degree of Master of Civil Engineering (Structures), is a record of work carried out by him under my supervision and guidance, and that no part of this thesis has been submitted for the award of any other degree.

Harpal Singh  
Instructor  
Department of Civil Engg.,  
T.I.E.T., Patiala.

Rajinder Singh  
Chairman,  
Board of Studies in Civil Engg.,  
T.I.E.T., Patiala.

U. Singh  
30/7/96  
Mr. U. Singh  
Head of Academic Affairs  
T.I.E.T., Patiala.

C. K. Balraj Singh  
30/7/96  
Mr. C. K. Balraj Singh  
Chairman,  
Board of Studies in Civil Engg.,  
T.I.E.T., Patiala.

(1)

**NONLINEAR ANALYSIS OF CIRCULAR SHELLS  
WITH OPENING USING F.E.M.**

A THESIS  
SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE  
OF  
Bachelor of Engineering  
IN  
Civil Engg. (Structural)  
DEEPMALA UNIVERSITY

SUBMITTED BY  
**AMANJIT HANS**  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY  
PATIALA

**CERTIFICATE**

This is to certify that the thesis entitled **NONLINEAR ANALYSIS OF CIRCULAR SHELLS WITH OPENING USING F.E.M.** submitted by **AMANJIT HANS** in partial fulfillment for the award of the degree of master of **CIVIL SHELL (STRUCTURE)**, of Thapar Institute of Engineering and Technology (Deemed Univ.), Patiala, is a honest work carried out by him under my supervision and guidance and at no part of this thesis has been submitted for the award of another degree.

*Haranpal Singh*  
24/3/97  
I, Harpal Singh, I  
declare Civil Engineering,  
Thapar Institute of Engineering  
& Technology, Patiala-147001.  
  
*M. L. Grewal*  
Chairman  
Board of Studies (1993)  
Civil Engineering,  
Thapar Institute of  
Engineering & Technology,  
Patiala-147001.

*Ms. Ritu Sood*  
Chairman  
Board of Academic Affairs (1993)  
Thapar Institute of Engineering  
& Technology, Patiala-147001.

**FEAPS - AN INTERACTIVE PROGRAM  
FOR LINEAR STATIC ANALYSIS OF  
3D FRAMED STRUCTURES**

A Thesis Report  
Submitted in Partial Fulfillment of  
Requirements for the Award of Degree of  
MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING

By  
**MEENU SHARMA**

Under the guidance of  
**Dr. HARPAL SINGH**  
**Ms. RITU SOOD**



March 1998

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA-147001.

**CERTIFICATE**

Certified that the study entitled, "FEAPS - AN INTERACTIVE PROGRAM FOR LINEAR STATIC ANALYSIS OF 3D FRAMED STRUCTURES" which is being submitted by Ms. Meenu Sharma, in partial fulfillment for the award of degree of Master of Engineering in Structural Engineering of Thapar Institute of Engineering and Technology (Deemed University), Patiala is a record of student's own work carried out by her under our supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other degree. The thesis has reached the standards fulfilling the requirements of the regulation for the award of said degree.

*Harpal Singh*  
13/3/98  
(Dr. Harpal Singh)  
Asst. Professor  
Dept. of Civil Engineering,  
Thapar Institute of Engg. & Tech.,  
(Deemed University),  
Patiala - 147001.

*Ritu Sood*  
13/3/98  
(Ms. Ritu Sood)  
Lecturer  
Chairman  
Board of Computer Science & Engg.  
Thapar Institute of Engg. & Tech.,  
(Deemed University),  
Patiala - 147001.

*M. L. Grewal*  
13/3/98  
(Dr. M. L. Grewal)  
Chairman, Board of Studies,  
Dept. of Civil Engineering,  
Thapar Institute of Engg. & Tech.,  
(Deemed University),  
Patiala - 147001.

*S. C. Park*  
13/3/98  
(Dr. S. C. Park)  
Dean of Academic Affairs,  
Thapar Institute of Engg. & Tech.,  
(Deemed University),  
Patiala - 147001.

**STUDIES ON FLYASH  
STEEL FIBRE CONCRETE  
(COMPRESSIVE STRENGTH & WORKABILITY)**

A thesis report submitted  
in partial fulfillment of the award of  
degree of  
**MASTER OF TECHNOLOGY**  
IN  
**CIVIL ENGINEERING**  
**(STRUCTURAL ENGINEERING)**  
TO  
PUNJAB TECHNICAL UNIVERSITY, JALANDHAR

Submitted By:  
**GURDEEP SINGH**

Under the guidance of  
**PROF. HARPAL SINGH**  
**PROF. BHUPINDER SINGH**  
Department of Civil Engineering

GURU NANAK DEV ENGINEERING COLLEGE  
GILL PARK, LUDHIANA - 141 006  
May 2003

**CERTIFICATE**

This is to certify that the thesis entitled "Studies on Flyash steel  
fiber concrete (Compressive Strength and Workability)" submitted by  
Gurdeep Singh in partial fulfillment of the requirement for the award of  
degree of Master of Technology in Civil Engineering with specialization in  
structural engineering of Panjab Technical University, Jalandhar is a record  
of student own work carried out by him under our supervision and  
guidance. The matter embodied in this thesis has not been submitted for  
the award of any degree or diploma.

All the experimental work has been conducted in the laboratories of  
Guru Nanak Dev Engg. College, Ludhiana.

*Harpal Singh*  
2001/02  
Prof. Harpal Singh  
Dept. of Civil Engineering  
G.N.D.E.C., Ludhiana

*Bhupinder Singh*  
2001/02  
Prof. Bhupinder Singh  
Dept. of Civil Engineering  
G.N.D.E.C., Ludhiana

**STUDY OF SHEAR STRENGTH OF FIBRE  
REINFORCED CONCRETE WITH FLY ASH  
AS A ADMIXTURE**

**THESIS**

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
AWARD OF THE DEGREE OF

**MASTER OF TECHNOLOGY**  
IN  
**CIVIL ENGINEERING**  
**(STRUCTURAL ENGINEERING)**

SUBMITTED BY  
**BALVIR SINGH**  
GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA (Punjab), INDIA  
SEPTEMBER 2004

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR (Punjab), INDIA

GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA, INDIA

**DECLARATION**

I hereby certify that the work, which is being presented in this thesis titled STUDY OF  
SHEAR STRENGTH OF FIBRE REINFORCED CONCRETE WITH FLY ASH AS A  
ADMIXTURE by BALVIR SINGH is a partial fulfillment of requirement for the award of  
degree of M.Tech (Structural Engg.) submitted to the department of Civil Engineering  
GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA under PUNJAB  
TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work  
carried out during period from AUGUST 2002 to JUNE 2004 under the supervision of  
Dr. HARPAL SINGH and Mr. HARVINDER SINGH. The matter presented in this thesis  
has not been submitted in any other University/ Institute for the award of M.Tech.  
Degree:

*Balvir Singh*  
(BALVIR SINGH)  
The above statement made by the student is correct to the best of  
my knowledge.

*Havinder Singh*  
(HARVINDER SINGH)  
Lecturer  
Department of Civil Engg.  
Signature of the Supervisor (Dr. HARPAL SINGH)  
Head of Deptt.  
Department of Civil Engg.

The M.Tech. Viva-Voce Examination of BALVIR SINGH has been held on  
23-09-04 and accepted  
Signature of the Examiner (Dr. HARPAL SINGH)  
Signature of the H.O.D. (Dr. HARVINDER SINGH)  
Signature of the External Examiner (Dr. HARVINDER SINGH)

**DYNAMIC RESPONSE OF T-SHAPED  
BUILDING**

**THESIS**

SUBMITTED IN THE PARTIAL FULFILMENT OF THE REQUIREMENT  
FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY  
IN  
CIVIL ENGINEERING  
[STRUCTURAL ENGINEERING]

SUBMITTED BY  
MANPREET NAGI  
GURU NANAK DEV ENGINEERING COLLEGE  
LUDHIANA (PUNJAB)  
May 2005

PUNJAB TECHNICAL UNIVERSITY  
JALANDHAR (Punjab), INDIA

GURU NANAK DEV ENGINEERING COLLEGE

LUDHIANA-141006

**DECLARATION**

I hereby certify that the work, which is being presented in this thesis, entitled "DYNAMIC RESPONSE OF T-SHAPED BUILDING" by MANPREET NAGI in partial fulfillment of requirement for the award of degree of M-tech (Structural Engineering) submitted to Department of Civil Engineering, GURU NANAK DEV ENGINEERING COLLEGE under PUNJAB TECHNICAL UNIVERSITY, JALANDHAR is an authentic record of my own work carried out during a period from 16-01-2003 to 06-05-2005 under the supervision of Dr. HARPAL SINGH. The matter presented in this thesis has not been submitted to any other university/institution for the award of M-tech Degree.

*[Signature]*

Signature of the student.

This is to certify that the above statement made by the candidate is correct to the best of my knowledge:

*[Signature]*  
Dr. Harpal Singh  
Head of department

Department Of Civil Engineering.  
The M-Tech Viva - Voce Examination of MANPREET NAGI has been held  
*[Signature]* and accepted.

Signature of supervisor: *[Signature]*  
Signature of external examinee: *[Signature]*

**BEHAVIOUR AND ANALYSIS OF  
SHEAR WALL FRAME SYSTEM**

**CERTIFICATE**

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH.  
(Deemed University)  
in partial fulfillment of the requirement  
for the degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
Gurpreet Singh Khaira

Under the Guidance of  
DR. R. B. L. BEDI  
S. HARPAL SINGH



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA-147001  
Jan, 1990

This is to certify that the thesis  
THE BEHAVIOR AND ANALYSIS OF SHEAR WALL FRAME SYSTEM  
submitted by Mr. GURPREET SINGH KHAIRA, for the degree of  
Master of Civil Engineering (Structures), is authentic work  
carried out by him under our supervision and guidance, and that  
no part of this thesis has been submitted for the award of any  
degree.

*[Signature]*  
(Dr. R. B. L. BEDI)  
Lecturer  
Department of Civil Engineering  
T.I.E.T., Patiala.

*[Signature]*  
(Dr. S. B. L. BEDI)  
Chairman  
Board of Studies in Civil  
Engineering  
T.I.E.T., Patiala.

*[Signature]*  
(Dr. S. Singh)  
Dean of Academic Affairs  
T.I.E.T., Patiala.

*[Signature]*  
(Dr. C. S. Koknani M.Sc., Ph.D.)  
Chairman  
Board of Studies in Civil  
Engineering  
T.I.E.T., Patiala.

## SKEW BOX DECK ANALYSIS

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH.  
(Deemed University)  
in partial fulfillment of the requirements  
for the degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
**KRISHNA GARG**

Under the Guidance of  
**DR. R. S. L. BEDI**  
**PROF. HARPAL SINGH**



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA - 147001  
July-1988

### CERTIFICATE

This is to certify that the thesis entitled "SKEW BOX DECK ANALYSIS" submitted by Mr. Krishan Garg for the degree of Master of Civil Engineering (Structures), is a bona fide work carried out by him under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree.

Prof. Harpal Singh  
Lecturer  
Department of Civil Engg.  
Thapar Instit.of Engg.& Tech.,  
Deemed University,  
Patiala - 147 001.

Dr. R.S.L. Bedi  
Vice-Chairman  
Department of Civil Engg. &  
Dean of Students Affairs,  
Thapar Instit.of Engg.& Tech.,  
Deemed University,  
Patiala - 147 001.

Prof. Vivek Kumar Singh  
Dean of Academic Affairs,  
Thapar Instit.of Engg.& Tech.,  
Deemed University,  
Patiala - 147 001.

Dr. C.B. Kukreja  
Chairman,  
Board of Studies in Civil Engg.,  
Thapar Instit.of Engg. & Tech.,  
Deemed University,  
Patiala - 147 001.

(1)

(1)

### CERTIFICATE

This is to certify that the thesis entitled "ANALYSIS AND DESIGN OF PRE-STRESSED CONCRETE CONTINUOUS BEAMS" being submitted by Mr. Vivek Kumar Singh in partial fulfillment for the award of degree of MASTER OF ENGINEERING in CIVIL (STRUCTURES) ENGINEERING of Thapar Institute of Engineering and Technology, (Deemed University) Patiala, is a record of study conducted by him under my supervision and guidance and that no part of this thesis has been submitted for any other degree.

Prof. Harpal Singh  
Asstt. Prof. Civil Engg. Deptt.  
Thapar Instit.of Engg.  
and Technology  
PATIALA - 147 001.

Dr. C.B. Kukreja  
Professor, Civil Engg. Deptt.  
(Head, Research & Dev.)  
Thapar Instit.of Engg.  
and Technology  
PATIALA - 147 001.

Dr. H.L. Gahlot  
Chairman, Board of Studies  
Civil Engineering Department  
Thapar Instit.of Engg.  
and Technology  
PATIALA - 147 001.

Prof. P.S. Rambhera  
Dean of Academic Affairs  
Thapar Instit.of Engg.  
and Technology  
PATIALA - 147 001.

## ANALYSIS AND DESIGN OF PRE-STRESSED CONCRETE CONTINUOUS BEAMS

A Thesis Submitted to  
THAPAR INSTITUTE OF ENGG. & TECH., PATIALA  
(Deemed University)  
in partial fulfillment of the requirements  
for the award of the degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
**VIVEK KUMAR SINGH**

Under the Guidance of:  
**Prof. (Dr.) C. B. KUKREJA**  
**Shri HARPAL SINGH**



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA - 147 001.

## STUDY OF BEHAVIOUR OF A BUILDING L-SHAPED IN PLAN

A Thesis  
Submitted to

Punjab Technical University, Jalandhar in partial fulfillment of the requirement for the award of Degree of

Master of Technology

In

Civil Engineering (Structural Engg.)

Submitted By

Arinder Pal Singh

Univ. Roll No. 001401

Under the Guidance of

Dr. Harpal Singh

Dept. Of Civil Engg.

Guru Nanak Dev Engineering College, Ludhiana



DEPARTMENT OF CIVIL ENGINEERING

GURU NANAK DEV ENGINEERING COLLEGE  
GILL PARK, LUDHIANA-6

### CERTIFICATE

I, the author of work which is being presented in this thesis entitled "STUDY OF BEHAVIOR OF A BUILDING L-SHAPED IN PLAN" in partial fulfillment of the requirement for the award of degree of Master of Technology in Civil Engineering submitted to Panjab Technical University, Jalandhar, is an authentic record of my own work carried out during the period July 2000 to June 2003, under the able guidance of Dr. Harpal Singh, Professor department of Civil Engineering, Guru Nanak Dev Engg. College, Ludhiana.

The matter embodied in this thesis work has not been submitted by me for the award of any other Degree or Diploma.

Date \_\_\_\_\_

Arinder Pal Singh

This is to certify that the above statement made by candidate is correct to the best of my knowledge:

Date: 20/6/03

Dr. Harpal Singh  
Professor  
Department of Civil Engg.  
Guru Nanak Dev Engg. College  
Ludhiana.

## ELASTIC - PLASTIC ANALYSIS OF SPACE FRAMES

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH., PATTIALA  
in partial fulfillment of the requirements  
for the award of degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
SANDEEP SHRIDHAR

SUPERVISOR :  
SHRI HARPAL SINGH

Dr. M.L. GAMBHIR  
Professor  
Dept. of Civil Engg. and  
Construction Technology

May, 1993



DEPARTMENT OF CIVIL ENGINEERING & CONSTRUCTION TECHNOLOGY,  
THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY,  
(DEEMED UNIVERSITY),  
PATTIALA-147001.

### CERTIFICATE

It is certified that the thesis entitled "Elastic-Plastic Analysis of Space Frames" submitted by Mr. Sandeep Shridhar, Roll No. 50111-5/91 in partial fulfillment requirement for the award of Master of Engineering (Structures) of THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY (DEEMED UNIVERSITY) PATTIALA is a record of the student's own work, carried out by him under our supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other degree.

Dr. M.L. GAMBHIR  
Professor  
Dept. of Civil Engg. and  
Construction Technology,  
Thapar Institute of Engg.  
and Technology  
PATTIALA

Dr. C.K. Ahluwalia  
Chairman  
Board of Studies in Civil Engineering  
Thapar Institute of Engineering  
and Technology, PATTIALA.

Date:  
Research and Development,  
Thapar Institute of Engineering  
and Technology, PATTIALA.

## BEHAVIOUR OF SAW TOOTH STAIRS

A THESIS  
Submitted in partial fulfilment of the requirements  
for the degree of  
MASTER OF CIVIL ENGINEERING (STRUCTURES)  
To  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA - 147 001.

By  
SHARMA CHANDER MOHAN

Under the guidance of  
SHRI HARPAL SINGH  
DR. C. B. KUREKJA



POST GRADUATE SECTION  
DEPARTMENT OF CIVIL ENGINEERING & CONSTRUCTION TECHNOLOGY  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA - 147 001.  
August 1992

### CERTIFICATE

This is to certify that the Thesis entitled "BEHAVIOUR OF SAW TOOTH STAIRS" which is being submitted by MR. CHANDER MOHAN SHARMA, is partial fulfillment for the award of the degree of MASTER OF CIVIL ENGINEERING (STRUCTURES) of the Thapar Institute of Engineering and Technology (Deemed University) Patiala is approved. It is further certified that this is a bonafide work carried out by him under our supervision and that no part of this thesis has been submitted elsewhere for the award of any other degree.

He has spent about one year in preparing this thesis report.

Manjeet Singh  
(Ex-HARPAL SINGH)  
Lecturer  
Dept. of Civil Engg. and  
Construction Technology,  
Thapar Institute of Engg. and  
Technology,  
(Deemed University)  
Patiala - 147 001

T. B. KUREKJA  
(PROF. DR. C. B. KUREKJA) 19/8/92  
Professor and Head,  
Dept. of Civ. Engg. and  
Construction Technology,  
Thapar Institute of Engg. and  
Technology,  
(Deemed University)  
Patiala - 147 001

T. B. KUREKJA  
Chairman, 19/8/92  
Board of Studies in Civil Engg.  
and Construction Technology,  
Thapar Institute of Engg. & Tech.,  
(Deemed University),  
Patiala 147 001  
(Dean, Research & Development)

## Behaviour of Infilled Frames (A Software Approach)

By  
Ms. ROMA GARG

Under the Guidance of  
S. HARPAL SINGH

### THESIS

Submitted in partial fulfilment of the requirements  
for the award of the degree of

## Master of Civil Engineering (Structures)

Department of Civil Engineering  
Thapar Institute of Engineering and Technology  
(Deemed University)  
PATIALA - 147 001

### CERTIFICATE

This is to certify that the thesis entitled "behaviour of infilled frames-A software approach submitted for the degree of Master of Civil Engineering (structures) of Thapar Institute of Engineering and Technology (Deemed University) by Ms. Roma Garg is a bonafide work carried out by her under my supervision and guidance and that no part of this thesis has been submitted for any other degree.

Dr. G. KUREKJA 19/7/93  
Chairman  
Board of Studies in Civil Engg.  
Thapar Institute of Engg. & Tech.  
(Deemed University)  
PATIALA

Manjeet Singh  
Ex-HARPAL SINGH  
Lecturer  
Thapar Institute of  
Engg. & Tech.  
(Deemed University)  
PATIALA

Dr. G. SINGH 19/7/93  
Dean  
Research & Development  
Thapar Institute of Engg. & Tech.  
(Deemed University)  
PATIALA

**SOFTWARE DEVELOPMENT FOR DESIGN OF  
OVERHEAD SERVICE RESERVOIRS  
USING C++  
THESIS**

SUBMITTED TO PUNJAB TECHNICAL UNIVERSITY, JALANDHAR IN  
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
**MASTER OF TECHNOLOGY**

(STRUCTURE ENGINEERING)

SUBMITTED UNDER THE GUIDANCE OF  
**PROF. DR. HARPAL SINGH**  
PROFESSOR IN CIVIL ENGINEERING

BY  
**AMANPREET KAUR**  
(MESTM/072K)

DEPARTMENT OF CIVIL ENGINEERING  
GURU NANAK DEV ENGINEERING COLLEGE  
GILL PARK LUDHIANA- 140006

**CERTIFICATE**

Certified that the thesis titled " SOFTWARE DEVELOPMENT FOR THE DESIGN OF OVERHEAD SERVICE RESERVOIRS USING C++ " which is being submitted by AMANPREET KAUR in partial fulfillment of the requirements for the award of degree of

MASTER OF TECHNOLOGY (Structure Engineering)

is a record of student's own work carried out under my supervision and guidance. The matter embodied in this thesis has not been submitted to any university.

The thesis has reached the standard fulfilling the requirements of the regulation for the award of the said degree.

Date:

*Harpal Singh*  
(Harpal Singh)

Thesis Supervisor,

Professor,

Department of Civil Engineering,  
Guru Nanak Dev Engineering College,  
Ludhiana 141005

**ANALYSIS AND EXPERIMENTAL BEHAVIOUR OF R.C.C.  
RECTANGULAR SLAB HAVING CIRCULAR OPENING BY YILED  
LINE THEORY**

A Dissertation

Submitted to:

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR  
In partial fulfillment of the requirements for the award of the degree of  
**MASTER OF TECHNOLOGY**

(Civil)

In

Structural Engineering



**Under The Guidance of**

Dr. Harpal Singh  
(H.O.D. Civil Engg. Dept.)  
Ex. Harvinder Singh  
(Lecturer, Civil Engg. Dept.)

By  
Sukhjwan Singh

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA  
December-2003

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the dissertation entitled "ANALYSIS AND EXPERIMENTAL BEHAVIOR OF R.C.C. RECTANGULAR SLAB HAVING CIRCULAR OPENING BY YIELD LINE THEORY" is in partial fulfillment of the requirements for the award of degree of Master of Technology in Civil Engineering with Specialization in Structure, submitted to Panjab Technical University, Jalandhar is an authentic record of my own work carried out under the guidance of Dr. Harpal Singh, Head of Civil Engineering Department, Guru Nanak Dev Engineering College and Ex. Harvinder Singh, Lecturer Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana.

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

Date:

*20/01/04*  
(Dr. Harpal Singh)

Place:

**CERTIFICATE**

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

*Harvinder Singh*  
(Ex. Harvinder Singh)  
Lecturer, Civil Engg. Dept.,  
Guru Nanak Dev Engg. College,  
Ludhiana.

*Harpal Singh*  
(Dr. Harpal Singh)  
H.O.D. Civil Engg. Dept.,  
Guru Nanak Dev Engg. College,  
Ludhiana.

## POST FAILURE STUDY OF A BUILDING AFTER EARTHQUAKE

A Thesis Submitted to  
THAPAR INSTITUTE OF ENGINEERING & TECH.  
in partial fulfillment of the requirement  
for the award of degree of  
Master of Civil Engineering  
(STRUCTURES)

By  
BALBIR SINGH DHILLON

Under the guidance of  
S. HARPAL SINGH

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(DEEMED UNIVERSITY)  
PATIALA-147 001

## IADIS-A SOFTWARE FOR ITERATIVE ANALYSIS AND DESIGN OF INDUSTRIAL STRUCTURES

A THESIS  
Submitted in partial fulfillment of the requirements  
for the award of degree of  
MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING

By  
SANDEEP SINGH

Under the guidance of  
DR. HARPAL SINGH

DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(DEEMED UNIVERSITY)  
PATIALA - 147 001  
May, 1997

### CERTIFICATE

This is to certify that the thesis entitled, POST FAILURE STUDY OF A BUILDING AFTER EARTHQUAKE, which is being submitted by Mr. Balbir Singh Dhillon in partial fulfillment of the requirement for the award of the degree of Master of Civil Engineering (Structures) of Thapar Institute of Engineering and Technology (Deemed University), Patiala is a record of student's own work carried out by him under my supervision and guidance. The matter embodied in the thesis has not been submitted for the award of any other degree.

This is to further certify that he has worked for a period of about ten months from Oct. 1992 to July 1993 for the preparation of this thesis in the present form.

*Harpal Singh*  
(Dr. Harpal Singh)  
Lecturer  
Dept. of Civil Engineering  
and Construction Technology,  
Thapar Institute of Engg.  
and Technology, PATIALA.

*M.L.Ganesh*  
Chairman 1/19/93  
Board Of Studies In Civil Engg.  
and Construction Technology,  
Thapar Institute of Engg.  
and Technology, PATIALA.

*C.S. Bimbhra*  
Dean 1/19/93  
Research & Development  
Thapar Institute of Engg.  
and Technology, PATIALA.

### CERTIFICATE

It is certified that the thesis entitled "IADIS-A SOFTWARE FOR ITERATIVE ANALYSIS & DESIGN OF INDUSTRIAL STRUCTURES" later selected in Mr. SANDEEP SINGH in the partial fulfillment of requirement for the award of MASTER OF ENGINEERING IN CIVIL (STRUCTURES) ENGINEERING of THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY (DEEMED UNIVERSITY), PATIALA, is a record of student's own work carried out by him under my supervision and guidance. The work embodied is of distinct methods for the award of above mentioned degree.

*Harpal Singh*  
(Dr. HARPAL SINGH)  
Assistant Professor,  
Department Of Civil Engineering,  
Thapar Institute of Engg. & Tech.,  
Patiala-147001.

*M.L.Ganesh*  
(Dr. M.L.GANESH)  
Chairman Board of Studies,  
Thapar Institute of Engg. & Tech.,  
Patiala-147001.

*C.S. Bimbhra*  
(Dr. C.S. BIMBRA)  
Dean Of Academic Affairs,  
Thapar Institute of Engg. & Tech.,  
Patiala-147001.

SEMINAR REPORT ON  
**EFFICIENT SOLVERS**  
FOR  
**FINITE ELEMENT EQUILIBRIUM EQUATIONS**

Submitted in Partial Fulfilment Requirement of  
**MASTER OF ENGINEERING (STRUCTURES)**  
Degree of  
Thapar Institute of Engineering and Technology

By  
**VIJAY KUMAR GARG**

SUPERVISOR:

**Dr. M. K. DAS**  
Research Engineer  
Thapar Corporate Research & Development Centre  
PATIALA-147001

**Prof. HAREPAL SINGH**  
Assistant Professor  
Dept. of Civil Engineering  
Thapar Institute of Engg.  
and Technology  
(Deemed University)  
PATIALA-147001

February, 1998



CERTIFICATE

Certified that the study titled "Efficient Solvers for Finite Element Equilibrium Equations" which is being submitted by Mr. Vijay Kumar Garg, in partial fulfillment for the award of Master of Engineering in Civil (Structures) Engineering of Thapar Institute of Engineering and Technology (Deemed University) Patiala, is a record of student's own work carried out by him under our supervision and guidance.

*Harepal Singh*  
(Dr. M. K. Das)  
Research Engineer  
Thapar Corporate Research & Development Centre  
PATIALA-147001

*Harepal Singh*  
(Prof. HAREPAL SINGH)  
Assistant Professor  
Dept. of Civil Engineering  
Thapar Institute of Engg.  
and Technology  
(Deemed University)  
PATIALA-147001

**BEHAVIOUR OF FRAMES SUBJECTED  
TO TORSION**

A THESIS SUBMITTED  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
**MASTER OF CIVIL ENGINEERING (STRUCTURES)**  
OF  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY,  
(Deemed University)  
PATIALA-147001.

By  
**RAJBIR SINGH BHANGAL**

Under the Guidance of:  
**DR. R. B. LAL BEGI**  
Prof. & Head  
Civil Engg. Deptt.

POST GRADUATE SECTION  
DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATIALA  
(Deemed University)  
Jan., 1999

CERTIFICATE

Certified that the thesis entitled "BEHAVIOUR OF FRAMES SUBJECTED TO TORSION" which is being submitted by Rajbir Singh Bhangal, in partial fulfillment for the award of the degree of Master of Civil Engineering (Structures) of the Thapar Institute of Engineering and Technology, (Deemed University), Patiala is hereby approved. It is further certified that the work has been carried out under my supervision and has not been submitted elsewhere for a degree.

*Rajbir Singh Bhangal*  
(Dr. Rajbir Singh)  
Lecturer, Civil Engg. Deptt.,  
Thapar Institute of Engg. & Tech.,  
(Deemed University)  
Patiala- 147001

*R. B. Lal*  
(Prof. R. B. Lal)  
Professor & Head  
Civil Engg. Deptt.  
Thapar Institute Engg. & Tech.  
(Deemed University)  
Patiala-147001

*G. Singh*  
(Dr. G. Singh)  
Chairman  
Board of Studies in Civil Engg.  
Thapar Inst. of Engg. & Tech.,  
(Deemed University)  
Patiala-147001

*G. Singh*  
(Dr. G. Singh)  
Dean  
Faculty of Engg. & Tech.,  
Thapar Inst. of Engg. & Tech.,  
(Deemed University)  
Patiala-147001

## COMPARATIVE STUDY OF FIRST AND SECOND ORDER ANALYSES OF FRAMES

A Thesis submitted to  
THAPAR INSTITUTE OF ENGG. & TECH.  
in partial fulfillment of the requirements  
for the award of degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
**GURINDER MOHAN SINGH**

Under the guidance of  
**S. HARPAL SINGH**



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(Deemed University)  
PATIALA-147001.  
Feb. 1991

### CERTIFICATE

This is to certify that the thesis entitled "Comparative Study of First and Second Order Analyses of Frames" which is being submitted by Mr. Gurinder Mohan Singh in partial fulfillment of the requirement for the award of the degree of Master of Civil Engineering (STRUCTURES) of Thapar Institute of Engineering & Technology (Deemed University), Patiala, is a record of student's own work 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.

This is further to certify that he has worked for a period of about seven months from July, 1990 to Jan. 1991 for the preparation of this thesis at the institute in the present form.

*Harnob Singh*  
Harnob Singh  
Lecturer,  
Thapar Institute of Engg.  
& Technology, PATIALA.

*Chairman*  
Chairman \_\_\_\_\_ d[3]91  
Board of Studies in Civil Engg.  
Thapar Institute of Engg.  
& Technology, PATIALA.

*Chaudhary*  
Chaudhary \_\_\_\_\_ d[3]91  
Dean  
Academic Affairs,  
Thapar Institute of Engg.  
& Technology, PATIALA.

## RELATIVE STUDY OF SOLVERS FOR FINITE ELEMENT ANALYSIS

Thesis Submitted to  
THAPAR INSTITUTE OF ENGG. & TECH., PATIALA  
(DEEMED UNIVERSITY)  
in partial fulfillment of the requirements  
for the award of degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By:  
**VUJAY KUMAR GARG**

Under the Supervision of:  
**PROF. HARPAL SINGH**  
June, 1995



DEPARTMENT OF CIVIL ENGINEERING  
THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY  
(DEEMED UNIVERSITY)  
PATIALA-147001.

### CERTIFICATE

This is to certify that the thesis entitled "RELATIVE STUDY OF SOLVERS FOR FINITE ELEMENT ANALYSIS" being submitted by Mr. VUJAY KUMAR GARG in partial fulfillment of the requirements for the award of degree of MASTER OF ENGINEERING in CIVIL (STRUCTURES) ENGINEERING of Thapar Institute of Engineering and Technology, (Deemed University) Patiala, is a record of study conducted by him under our supervision and guidance and that no part of this thesis has been submitted for any other degree. This thesis has reached the standards fulfilling the requirements of the regulation for the award of said degree.

*Vujay Kumar Garg*  
Vujay Kumar Garg  
Asstt. Professor,  
Department of Civil Engg.  
Thapar Institute of Engg.  
& Technology  
PATIALA - 147 001

*M. L. Gambhir*  
Dr. M. L. Gambhir  
Chairman, Board of Studies  
Civil Engineering Department  
Thapar Institute of Engg.  
& Technology  
PATIALA - 147001

*P. S. Bimbhra*  
Dr. P. S. Bimbhra  
Dean of Academic Affairs  
Thapar Institute of Engg.  
& Technology  
PATIALA - 147001

# **SHEAR STRENGTH CHARACTERISTICS OF HIGH STRENGTH CONCRETE**

Thesis Submitted to  
Punjab Technical University in  
Partial fulfillment of the requirement for the Award of Degree of  
Master of Technology  
( Civil )  
In  
Structural Engineering

Under the Guidance of

Dr. Harpal Singh  
(H.O.D. Civil Engg Deptt.)  
Submitted By  
Kanwar Jot Singh



**Guru Nanak Dev Engineering College  
Ludhiana**

(Dec. 2003)

**CANDIDATE'S DECLARATION**

I hereby certify that the work which is being presented in the dissertation entitled "SHEAR STRENGTH CHARACTERISTICS OF HIGH STRENGTH CONCRETE" in partial fulfillment of the requirements for the award of degree of Master of Technology in Civil Engineering with Specialization in Structures, submitted to Panjab Technical University, Jalandhar is an authentic record of my own work carried out under the guidance of Dr. Harpal Singh, Head of Civil Engineering Department, Guru Nanak Dev Engineering College and Dr. Ravinder Singh, Lecturer Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana.

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

Date: 3/12/03

Place: Ludhiana

Kanwar Jot Singh B.E.  
Kanwar Jot Singh B.E.

**CERTIFICATE**

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

*Harpal Singh*  
S.I.E.T.  
(Dr. Harpal Singh)

HOD, Civil Engg. Dept.,  
Guru Nanak Dev Engg. College,  
Ludhiana.

## **ELASTOPLASTIC ANALYSIS OF 3D FRAMES WITH GENERALIZED YIELD FUNCTION**

A Thesis Submitted to  
THAPAR INSTITUTE OF ENGG. & TECHNOLOGY  
in partial fulfillment of the requirements  
for the award of the degree of  
MASTER OF CIVIL ENGINEERING  
(STRUCTURES)

By  
RAJNEESH KUMAR SHARMA

Under the guidance of  
PROF. HARPAL SINGH

**CERTIFICATE**

This is to certify that the thesis entitled "ELASTOPLASTIC ANALYSIS OF 3D FRAMES WITH GENERALIZED YIELD FUNCTION" being submitted by RAJNEESH KUMAR SHARMA in partial fulfillment for the award of the degree of Master of Civil Engg. (Structures), at Thapar Institute of Engg. and Technology (Deemed University) Patiala, is a bonafide work 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 and he has worked for nearly six months on the topic.

*Harpal Singh*  
Harpal Singh (3/3/92)  
Lecturer in Civil Engg.  
Thapar Institute of Engg.  
& Tech., Patiala

*Chairman*  
Chairman  
Board of Studies in  
Civil Engineering  
Thapar Institute of  
Engineering & Technology  
Patiala

*Dean, Research & Development*  
Dean, Research & Development  
Thapar Institute of Engg. &  
Technology, Patiala

Department of Civil Engineering  
Thapar Institute of Engineering & Technology  
(Deemed University)  
Patiala-147001

# **HIGH STRENGTH SILICA FUME CONCRETE**

*A Dissertation*

Submitted in partial fulfillment of the requirement of the award of  
the degree of

**MASTER OF TECHNOLOGY**

In

**Civil Engineering**

With specialization in

**Structures**

By

**TARANDEEP SINGH**

Univ. Reg. No. 1408

*Guided by*

**DR. HARPAL SINGH**

*Professor*

**Department of Civil Engineering**

**Guru Nanak Dev Engineering College**  
**Ludhiana**

## CERTIFICATE

This is to certify that the thesis entitled '**HIGH STRENGTH SILICA FUME CONCRETE**' submitted by '**Tarandeep Singh**' in the partial fulfillment of the award of degree of *Master of Technology* in *Civil Engineering* with specialization in *Structures* to *Punjab Technical University, Jalandhar*, is a bonafide work carried out by him under my supervision and guidance. It is further certified that the dissertation as a part or whole has not been submitted to any other university or college for the award of any degree or diploma.

*Harpal Singh*  
Dr. Harpal Singh

Professor,  
Dept. of Civil Engineering,  
G.N.D.E.C.  
Ludhiana.



# INDIAN GEOTECHNICAL SOCIETY: LUDHIANA CHAPTER

**Chairman**

Dr. J N Jha

Dated 16<sup>th</sup> February, 2013

**Co-chairman**

Prof. K S Gill

Dr. B S Wallia

To whom it may concern

**Secretary**

Dr. Jagbir Singh

**Joint Secretary**

Prof. Gurdeepak Singh

**Treasurer**

Dr. Harvinder Singh

**E. C. Members**

Er. G S Bath

Er. Anil Singla

Dr. A Agnihotri

Prof. Sanjeev Naval

Dr. Sanjiv Aggarwal

Prof. Puneetpal Singh Cheema

Er. Daljit Singh

Er. Pavittar Singh

Er. H K Khullar

Prof. Amanpreet Kaur

Prof. Rajesh Pathak

Dr. Jaspal Singh

It is certified that **Professor Harpal Singh** from Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana has presented a key note address on *Urban Sustainability and Infrastructure Development* during the two day (15-16 February, 2013) National Conference '*Geotechnical and Geoenvironmental Aspects of Wastes and Their Utilization in Infrastructure Projects*' organised by Civil Engineering Department of Guru Nanak Dev Engineering College, Ludhiana in association with Indian Geotechnical Society: Ludhiana Chapter and Testing & Consultancy Cell of the college.

14/2/13  
Organising Secretary

Jagbir Singh  
Chairman

**DEPARTMENT OF CIVIL ENGINEERING**

GURU NANAK DEV ENGINEERING COLLEGE CAMPUS  
Gill Road, Ludhiana - 141006, Punjab, India,  
E-mail : igs.ldh@gmail.com



## DEPARTMENT OF PRODUCTION ENGINEERING

Guru Nanak Dev Engineering College, Ludhiana

An Autonomous College u/s 2(f) and 12 (B) of UGC Act 1956

Punjab Government Aided Status

Institute Accreditation: "A" Grade NAAC, Tata Consultancy Services

AICTE Approved, Affiliated to IKG Punjab Technical University, ISO : 9001:2008 Certified

Production Engineering Programme Accreditation: UG under NBA Tier-I (Washington Accord), Institution of Engineers (India), PG under NBA Tier-I

Ref. No. RS/HS/12-2017

Dated 13/12/2017

### LETTER OF APPRECIATION

We are thankful to Dr. Harpal Singh, Prof. Civil Engineering Dept, GNDEC Ludhiana, for two expert talks during 2-Week Faculty development programme (sponsored by AICTE, New Delhi) on Waste Management by Additive Manufacturing (11-23 Dec. 2017).

Session-I Basics of FEM (9.30-11.00 AM on 13-12-2017)

Session-II FEM applications in Engineering (11.15-12.45 PM on 13-12-2017)



  
(Dr. Rupinder Singh)  
Co-ordinator (FDP) & Prof. (Prod. Engg.)

Professor (Prod. Engg.)  
Guru Nanak Dev. Engg. College  
Ludhiana-141006

---

Gill Park, Gill Road, Ludhiana-141006 (INDIA)

Ph: 0161-5064585 (O), Fax: 2502240, Mobile: 9872257575

Email: singhrupinder@gndec.ac.in, rupindersingh78@yahoo.com, Website: www.gndec.ac.in/pe



# ਗੁਰੂ ਨਾਨਕ ਦੇਵ ਇੰਜੀਨੀਅਰਿੰਗ ਕਾਲਜ Guru Nanak Dev Engineering College

An Autonomous College U/S 2(f) and 12(B) of UGC Act 1956

Institute Accredited by NAAC (A Grade) under UGC & TCS

AICTE Approved, Punjab Govt. Aided Status, Affiliated to IKG Punjab Tech. University, Jalandhar.

ISO : 9001:2008 Certified • UG Programmes accredited by IEI

Ref. No. GNE /Mech /014

Dated 29/12/2017

## TO WHOM IT MAY CONCERN

This is to certify that Dr. Harpal Singh, Department of Civil Engineering, Guru Nanak Dev Engineering College, Ludhiana has delivered an Expert Talk on 8<sup>th</sup> December, 2017 during QIP Short Term Course on "Finite Element Method for Engineering Applications". This course was organized by Department of Mechanical Engineering, Guru Nanak Dev Engineering College, Ludhiana from 4<sup>th</sup> December, 2017 to 8<sup>th</sup> December, 2017.

*Gurinder Singh Brar*  
*29/12/17*  
(Dr. Gurinder Singh Brar)

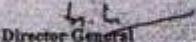
Course Co-ordinator



**Er. H.R. Singla**  
Chief Engineer, PSEB (Retd.)  
Director General

To Whom it may concern

It is certified that Dr. Harpal Singh, Professor in Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana has presented a key note address on **BRIDGES - WORLD'S MOST FAMOUS WORLD'S LONGEST**, at Lovely Professional University, Phagwara, Punjab on 29 March, 2013.

  
**Director General**  
**Lovely Professional University**



## GURU NANAK DEV ENGINEERING COLLEGE

Gill Road, Ludhiana-141 006. (Pb.) India.

E-mail : principal@gndec.ac.in Website : www.gndec.ac.in

Tele (O) : 0161-2490339 Fax : 0161-2502240

Ref. No. 12.2.2.....

To Whom it may concern

Dated. 9-10-13.....

It is certified that Dr. Harpal Singh, Professor in Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana has delivered the lectures on

1. Finite Element Method-concepts
2. Finite Element Modeling Briefs

during a FDP, **Finite Element Method to Solve Engineering Problems**, at GNDEC, Ludhiana held on, 22-26, July, 2013

  
Coordinator

**Finite Element Method to Solve Engineering Problems**

  
Head

**Department of Civil Engineering  
Guru Nanak Dev Engg. College,  
Ludhiana.**



## ਗੁਰੂ ਨਾਨਕ ਦੇਵ ਇੰਜੀਨੀਅਰਿੰਗ ਕਾਲਜ Guru Nanak Dev Engineering College

(Punjab Govt. Aided Status)

NBA Accredited, ISO - 9001 : 2000 Certified

### TO WHOM IT MAY CONCERN

This is to certify that Dr. Harpal Singh attended one day UKIERI international seminar on "**Concrete for Sustainable High Performance Infrastructure : Challenges and Opportunities**" organized by Civil Engineering Department at Guru Nanak Dev Engineering College, Ludhiana on 17/02/2010.

*[Signature]*  
Professor & Head,  
Dept. of Civil Engineering  
Prof. & Head of Civil Engg. Dep't  
G. N. D. E. College,  
LUDHIANA.



## GURU NANAK DEV ENGINEERING COLLEGE

Gill Road, Ludhiana-141 006. (Pb.) India.

E-mail : principal@gndec.ac.in Website : www.gndec.ac.in

Tele (O) : 0161-2490339 Fax : 0161-2502240

Ref. No. 1232.....

To Whom it may concern

Dated 9-10-13

It is certified that Dr. Harpal Singh, Professor in Civil Engineering Department, Guru Nanak Dev Engineering College, Ludhiana has delivered the lectures on

1. Finite Element Method-concepts
2. Finite Element Modeling Briefs

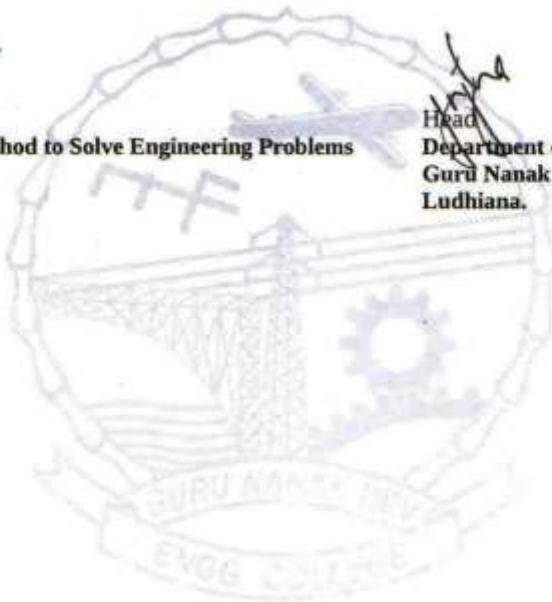
during a FDP, **Finite Element Method to Solve Engineering Problems**, at GNDEC, Ludhiana held on, 22-26, July, 2013

  
Coordinator

**Finite Element Method to Solve Engineering Problems**

  
Head

Department of Civil Engineering  
Guru Nanak Dev Engg. College,  
Ludhiana.





Ref. No. GIMET/8802

## Global Institute of Management and Emerging Technologies

(Approved by AICTE, New Delhi/Punjab Govt. & Affiliated to PTU, Kapurthala)

Dated: 6/10/2016

**Dr. Harpal Singh**

**Professor, Department of Civil Engineering  
Guru Nanak Dev Engineering College, Ludhiana**

**Subject: Invitation for Guest Lecture on 14<sup>th</sup> Oct 2016**

Dear Sir—

It gives me immense pleasure to inform you that Global Institute of Management and Emerging Technologies, Amritsar has been taking new strides in providing quality education to nurture the future technocrats and managers for bright career in global perspective since its inception in July, 2008. We are setting new benchmarks in Engineering and Management education and are the flag bearers of excellence in higher education through Total Quality Management Techniques. We are running B-Tech, M-Tech., MBA, MCA, Diploma (CSE, ECE, ME, CIVIL, EE), B.Com(Prof), BCA, B.Sc (ATHM and B. Sc(HMCT) courses. Sincere inputs of our highly experienced faculty have proven tremendously fruitful as our students have bagged 7 Gold Medals, 40 University toppers and 250 plus merit positions in the Punjab Technical University examinations.

I will be highly obliged if you accept our invitation for delivering the expert lecture for our B. Tech Civil Engineering students on 14<sup>th</sup> Oct, 2016. I am sure our students will be benefited immensely from interaction with a learned Professor like you. You will be paid honorarium and TA/DA as per the institute norms.

*With warm regards,*

*Balwinder Kaur*

*Assistant Professor & Head-CE*

*Global Institute of Management and Emerging Technologies*

*Amritsar*

*Contact 9646361325*

*E-mail hodcivil@globalinstitutes.com*

*Director*



## SANT BABA BHAG SINGH UNIVERSITY

Prof Ved Raj Sharma  
Vice - Chancellor

D.O. No.VC/SBBSU/2015/98

Dated : 8<sup>th</sup> July, 2015

Sub: Nomination to the Academic Council of Sant Baba Bhag Singh University

Dear Dr. Harpal Singh,

The Sant Baba Bhag Singh University has been established vide Punjab Government's Ordinance No.8, 2014 dated 18<sup>th</sup> December, 2014 and Act No.6, 2015 dated 12<sup>th</sup> February, 2015.

As per clause 14.2 of the above said Act, the Hon'ble Chancellor of University, Sant Baba Malkit Singh Ji is pleased to nominate your goodself as a member of the Academic Council of Sant Baba Bhag Singh University to have the benefit of your vast experience.

Hope, you will kindly spare sometime from your busy schedule and oblige us by accepting the offer, which will benefit the University

Honorarium and traveling expenses will be paid as per University rules for attending the meeting

With regards,

Yours sincerely

*Dr. Ved Raj Sharma*  
(Ved Raj Sharma)

Dr. Harpal Singh



# CHANDIGARH UNIVERSITY

Discover. Learn. Empower.

Established under Punjab Govt. Act No. 7  
of 2012 and recognized under section 2(f)  
of UGC Act of 1956

Ref. No. CU/CE 2015-16/1254

Date: 26/06/2015

**Dr. Harpal singh**

**Professor,**

**GNDEC, Ludhiana**

**Sub: Invitation For an Expert Lecture on faculty development program**

Respected Sir,

Greetings for the day!!

We take immense pleasure to inform you that Department of Civil Engineering, Chandigarh University, Gharuan, Mohali is going to organize a Faculty Development Programme from 8th to 14th July, 2015. Since you have already established your work with several years of research experience, your contribution for this faculty development programme will enlighten to the participants.

We take this opportunity to invite you for delivering Expert lecture on date, 8 July 2015 on the topic mentioned below.

Topic 1- Finite element methods of structural design (10AM- 11:15 AM)

Topic 2- Finite element model for double composite beam (11:45 AM- 1:00 PM)

(The topics can be modified according to your convenience)

TA and Honorarium will be given as per CU guidelines

Regards

**Er. Sandeep Sahoo**  
Head, Department of Civil Engineering

Chandigarh University

GHARUAN, MOHALI- 140413 (Punjab). Tel : 0160-2710300, 3014444, Fax: 0160-3014402

PE7001305

The Institution of Engineers (India)



*By virtue of expertise in the profession of engineering*

*Dr Harpal Singh*

*is hereby authorised to use the style and title of*

*Professional Engineer (India)*

*This certificate is valid upto*

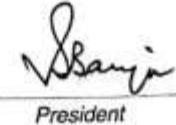
*31<sup>st</sup> July 2023*

*IN WITNESS WHEREOF the said Institution has  
caused its Common Seal to be affixed this  
29<sup>th</sup> Day of July 2018*



8 Gokhale Road  
Kolkata - 700 020, India

  
Secretary & Director General

  
President

**The Institution of Engineers (India)**

F110886-3



**This Diploma is granted to**

**HARPAL SINGH**  
**who was elected as**  
**Fellow**

on the **thirty-first** day of **October** **2005**

**In witness whereof the said Institution has caused its Common Seal to be**

**affixed this**

**ninth** day of **December** **2005**

**President**

**Secretary and Director General**

## CERTIFICATE OF LIFE MEMBERSHIP

*Presented to*

**Dr. HARPAL SINGH**  
Membership No. 1984-C-7

*On behalf of Genco Alumni Council, We would like to congratulate you on your becoming a Life Member of Genco Alumni Association, Guru Nanak Dev Engineering College, Ludhiana. Your role as a Genconian is highly appreciated and commendable.  
Wish you best of luck for continued success.*

  
*Bhagwant Singh*  
**Er. Bhagwant Singh Warer**  
President

*B.S.Brar*  
**Er. B.S. Brar**  
Secretary

*Kanwaljit Singh*  
**Er. Kanwaljit Singh**  
Secretary



LM 16819

FOUNDED 1967

# THE INDIAN SOCIETY FOR TECHNICAL EDUCATION

*By approval of the Executive Council, has elected*

HARPAL SINGH

LIFE MEMBER

*of the Society, an organisation for promoting  
the quality and standards  
in technical education.*

1994



EXECUTIVE SECRETARY



## *Indian Society of Earthquake Technology*

*(Established in 1962; Registration No. 845/64-65)*

Department of Earthquake Engineering Building  
Indian Institute of Technology Roorkee, Roorkee-247 667, India  
(Affiliated to International Association for Earthquake Engineering)

*This is to certify that*

**HARPAL SINGH**

*is a*

**LIFE FELLOW**

**(LF 42)**

*of this Society*

*with effect from*

**September 08, 2007**

*B.K. Maheshwari*  
(B.K. Maheshwari,  
Secretary)

*D.K. Paul*  
(D.K. Paul)  
President

# The American Biographical Institute Research Association

5126 Bur Oak Circle, P.O. Box 31226, Raleigh, North Carolina 27622 U.S.A.

## World Headquarters

Fax Number 919-781-8712

J. M. Evans  
Chairman



L. M. Kellander  
Vice Chairman

January 30, 2004

Dr. Harpal Singh  
Department of Civil Engineering  
Guru Nanak Dev. Engineering College  
Ludhiana INDIA

Dear Dr. Singh:

It is my distinct pleasure to enclose your personal nomination for membership on the ABI Research Association's Board of Governors. This invitation, sent only to select individuals, is issued on a limited basis each year. Seats on this international board are lifetime.

Board membership carries with it the distinguished title of DEPUTY GOVERNOR. I urge you to read the important information in the brochure regarding this seat of high ranking, Dr. Singh.

The ABI Research Association is a prominent organization with worldwide membership. I hope you will wish to be among the elite in our Association. You may recommend your colleagues for consideration in an upcoming ABI reference volume by completing the form overleaf.

Sincerely,

J. M. Evans  
Chairman

# The Institution of Engineers (India) 022188

F-110886-3



By virtue of Professional training, experience and Corporate Membership of this Institution

HARPAL SINGH

OF

CIVIL ENGINEERING DIVISION

is hereby authorised to use the style and title of

**Chartered Engineer [India]**

Dated this

Sixteenth day of November

2011

Dated 16 NOV 2011

Secretary and Director General

PE7001305

# The Institution of Engineers (India)



*By virtue of expertise in the profession of engineering*

**Dr Harpal Singh**

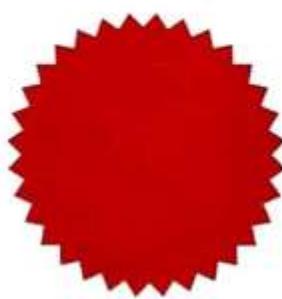
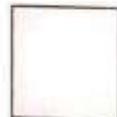
*is hereby authorised to use the style and title of*

**Professional Engineer (India)**

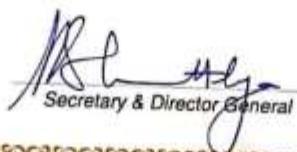
*This certificate is valid upto*

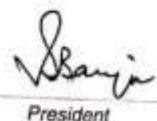
**31<sup>st</sup> July 2023**

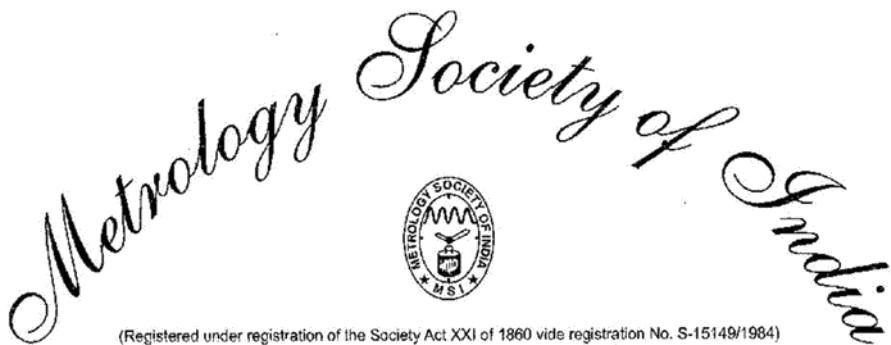
**IN WITNESS WHEREOF** the said Institution has  
caused its Common Seal to be affixed this  
29<sup>th</sup> Day of July 2018



8 Gokhale Road  
Kolkata - 700 020, India

  
Secretary & Director General

  
President



(Registered under registration of the Society Act XXI of 1860 vide registration No. S-15149/1984)

**National Physical Laboratory**  
**Dr. K.S. Krishnan Marg, New Delhi - 110 012, India**

## *Certificate of Membership*

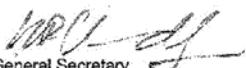
By approval of the Executive Council

**Harpal Singh**

has been enrolled as Life Member of Metrology Society of India.

Date of Admission : August 2013

L M No. : 928

  
General Secretary

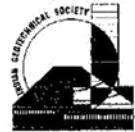


  
President



LM 3716

# Indian Geotechnical Society



## Certificate of Membership

HARPAL SINGH

has been Elected as a Life Member  
in the year 2014



Dr. -



National Institute of  
Technical Teachers Training and Research  
Chandigarh

GOVERNMENT OF INDIA  
MINISTRY OF HUMAN RESOURCE DEVELOPMENT

Certificate

*This is to certify that*

**Mr. HARPAL SINGH**

**GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA, PUNJAB**

*Participated in the Short Term Course  
on*

**STRENGTHENING RESEARCH METHODOLOGY**

*Conducted by ENTREPRENEURSHIP DEVELOPMENT &  
INDUSTRIAL COORDINATION Department*

*from*

**14.05.2012 to 18.05.2012**

*at*

**GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA, PUNJAB**



B D Shams

Coordinator

D D Shams

Head of Department

Director



Serial No. EC- 646/11

National Institute of  
Technical Teachers Training and Research  
Chandigarh

GOVERNMENT OF INDIA  
MINISTRY OF HUMAN RESOURCE DEVELOPMENT

Certificate

*This is to certify that*

**HARPAL SINGH**

*GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA*

*Participated in the Short Term Course*

*on*

**STUDENT EVALUATION**

*Conducted by Education and Educational  
Management Department*

*from*

*25.07.2011 to 29.07.2011*

*at*

**GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA**



*Rakesh Singh*  
Coordinator

*GP Bedi*  
Head of Department

*Kiran Singh*  
Director

# Certificate of Participation

## National Programme on Technology Enhanced Learning

(Supported by MHRD)

This is to certify that Mr. Harpal Singh, Principal of  
Giani Zail Singh College of Engineering & Technology, Punjab  
had participated in the one - day National Workshop on the  
"Use & Deployment of WEB & Video Courses"  
held on 30th March, 2007 at  
Indian Institute of Technology, Delhi.

  
NPTEL Coordinator, IIT Delhi

**Indian Institutes of Technology and IISc Bangalore**





Thapar University  
Punjab

Metrology Society of India

New Delhi

AdMet - 2014

# 3<sup>rd</sup> National Conference on Advances in Metrology

Sensors for Metrological, Environment, Health and Safety Applications

AdMet - 2014

February 19 - 21, 2014

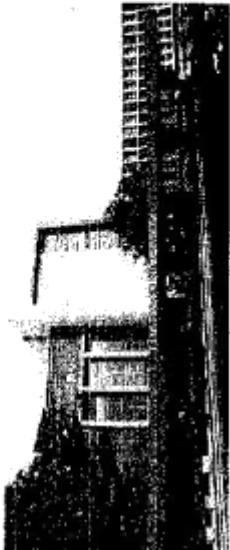
organised by  
Thapar University, Patiala

in collaboration with  
Metrological Society of India (Northern Region)

## CERTIFICATE OF ATTENDANCE

This is to certify that Dr. Harpal Singh ..... has attended 3<sup>rd</sup> National Conference on Advances in Metrology: Sensors for Metrological, Environment, Health and Safety Applications (AdMet- 2014) held on February 19 - 21, 2014 at Thapar University, Patiala.

He / She has also Chaired / Co-Chaired Technical Session / Delivered Invited Talk / Presented a Technical Paper during AdMet - 2014.



S. Ghosh

Dr. Smarajit Ghosh  
Chairman, AdMet-2014

Agarwal

Dr. Ravinder Agarwal  
Convenor, AdMet-2014



**Guru Nanak Dev Engineering College, Ludhiana**  
(Punjab Govt. Aided Status, NBA Accredited)

**Two Day Workshop**  
ON

**Learning Content Management System**

**(22<sup>nd</sup> and 23<sup>rd</sup> May, 2012)**

It is certified that Dr. Harpal Singh of Department of Civil Engineering of Guru Nanak Dev Engineering College, Ludhiana attended two day workshop on "Learning Content Management System" organised by Department of Civil Engineering and Department of Computer Science & Engineering.

**Dr. H.S. Rai**  
*(Chairman)*

**Er. Gurdeepak Singh**  
*(Coordinator)*

**Er. Parminder Singh**  
*(Coordinator)*

# Guru Nanak Dev Engineering College

LUDHIANA, PUNJAB

## DEPARTMENT OF CIVIL ENGINEERING



It is certified that Mr/Ms./Dr. Harpal Singh  
of Institute GNDEC Ludhiana had participated in  
the One-day International Workshop on Reinforced Soil and Geosynthetic Engineering

organised by the Department of Civil Engineering, Testing & Consultancy Cell and Indian  
Geotechnical Society: Ludhiana Chapter in association with the Edith Cowan University,  
Australia on 16th December, 2012.

**Dr. M S Salhi**  
Director

**Dr. Nitisha**  
Professor & Head  
Civil Engineering Department



UKIERI Collaborative  
Concrete Research  
Partners



UKIERI Concrete Congress  
Concrete: The Global Builder  
5 - 8 March 2019  
Dr B R Ambedkar National Institute of Technology  
Jalandhar, Punjab, India

## Certificate of Participation

This is to certify that

**HARPAL SINGH**

has participated and presented the paper entitled

***Parametric Study of Multi Storey RC Building with Plan  
Irregularity [UCC 401]***

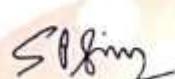
in the UKIERI Concrete Congress  
Concrete: The Global Builder

held on

5-8 March 2019

at

Dr B R Ambedkar National Institute of Technology  
Jalandhar INDIA

  
Professor S P Singh

Congress Secretary

  
Professor Ravindra K Dhir OBE

Congress Chairman

Host Organisations: Dr B R Ambedkar National Institute of Technology, Jalandhar and Guru Nanak Dev Engineering College, Ludhiana (Punjab)

3158/19



National Institute of  
Technical Teachers Training and Research  
Chandigarh

MINISTRY OF HUMAN RESOURCE DEVELOPMENT, GOVERNMENT OF INDIA

Certificate

*This is to certify that*

**Harpal Singh**

*Guru Nanak Dev Engineering College, Ludhiana*

*Participated in AICTE recognized Short Term Course  
On*

**GREEN BUILDING AND TECHNIQUES**

*Conducted by Civil Engineering Department  
from*

*17.12.2018 to 21.12.2018*

*One Week*

*at*

**Guru Nanak Dev Engineering, Ludhiana**



*[Signature]*  
Coordinator

*[Signature]*  
Head of Department

*[Signature]*  
Director

ES



Guru Nanak Dev Engineering College  
Ludhiana, Punjab

Department of Civil Engineering



It is certified that Ms./Dr. Harpal Singh  
of institute CNDEC, Ludhiana

had participated in the two-week Staff-Development Program (SDP) sponsored by All India Council for Technical Education (AICTE) on **Ground Improvement and Ground Control including Waste Containment With Geosynthetics** organised by the Department of Civil Engineering of the college from 22nd December, 2011 to 05th January, 2012.

  
Dr. Harpal Singh  
Course Coordinator and  
Professor & Head

  
Dr M S Saini  
Director

**QUALITY IMPROVEMENT PROGRAMME CENTRE  
IIT ROORKEE, ROORKEE**



**SHORT TERM COURSE**

*This is to certify that*

Sri HARPAL SINGH

attended the Course on COMPUTER AIDED DRAFTING IN

MINI AND MICRO COMPUTERS

held from 18 JUNE to 1 JULY 1989

in the Department of CIVIL ENGINEERING

The Course has been devoted to the imparting of specialised and advanced instruction in the subject.

*D. Verma*

Prakash Verma  
Course Coordinator (s)

*D. Verma*  
Professor & Coordinator  
Quality Improvement Programme Centre

**THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY**  
(DEEMED UNIVERSITY)  
**PATIALA-147 001**

**CERTIFICATE OF PARTICIPATION**

Presented to

SHRI HARPAL SINGH

for Participation

at the

SEMINAR/SYMPHOIUM/WORKSHOP/REFRESHER-COURSE

On

WATER POLLUTION CONTROL : PROBLEMS AND

PROSPECTS - MARCH 8, 1991.

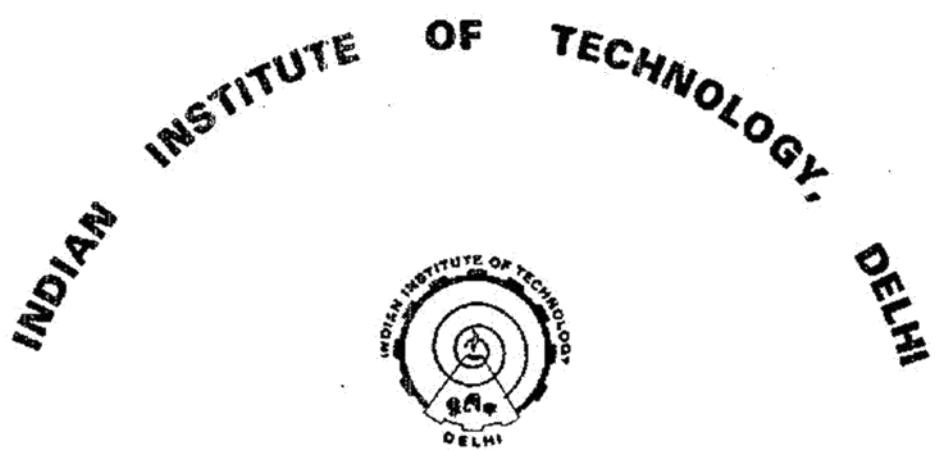
Organised by

Department of Civil Engineering

*DR. C. S. SINGH*

*CBEC/CE/91*

*C. S. Singh*



This is to Certify that  
**Karpal Singh**  
 has participated in the Short Term Course on  
**DYNAMIC LOADINGS ON STRUCTURES AND THEIR TREATMENT**

Conducted by the  
 Structures Section

Department of Civil Engineering  
 during December 8-21, 1988

Under the Quality Improvement Programme  
 Government of India

and Continuing Education Programme, IIT Delhi

M. Datta  
 W. Fomii  
 Co-ordinators

Head, Civil Engineering

A. J. S. Ali  
 Co-ordinator  
 QIP : CEP



# Guru Nanak Dev Engineering College

(An Autonomous College under UGC Act)

LUDHIANA, PUNJAB

LUDHIANA CHAPTER

## DEPARTMENT OF CIVIL ENGINEERING

It is certified that Mr./Ms./Dr. Harpal Singh

of Guru Nanak Dev Engineering College Ludhiana had participated/presented paper in the Two-day National Conference on 'Geotechnical and Geoenvironmental Aspects of Wastes and their utilization in Infrastructure Projects' organised on 15-16 February, 2013 in association with Testing & Consultancy Cell of the college and Indian Geotechnical Society : Ludhiana Chapter.

Organising Secretary

*[Signature]*  
Head of Department and  
Chairman (G.G.U.I.P-2013)

**QUALITY IMPROVEMENT PROGRAMME CENTRE  
UNIVERSITY OF ROORKEE, ROORKEE**



**SHORT TERM COURSE**

*This is to certify that*

**HARPAL SINGH**

*attended the Course on* **UNDERSTANDING EARTHQUAKE DISASTERS**

*held from June 19, 1997 to July 3, 1997*

*in the Department of Earthquake Engineering*

*The Course has been devoted to the imparting of specialised and advanced instruction in the subject.*

*Mari Kartiwa Sinha*

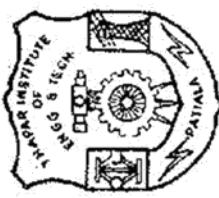
*Vipul Prakash*

*Course Coordinator(s)*

*Professor & Coordinator  
Quality Improvement Programme Centre*

# Thapar Institute of Engineering & Technology, Patiala

(An Institution Deemed to be a University)



This is to certify that Shri HARPAL SINGH  
attended the NATIONAL WORKSHOP ON ROAD SAFETY  
sponsored by \_\_\_\_\_  
to 11-4-1992 in the Department of Civil Engineering.

held from 10-4-1992

C. Singh  
Prof. & Head  
Civil Engg. Deptt.  
Patiala  
Dated: \_\_\_\_\_

Prof. & Head  
Civil Engg. Deptt.  
Patiala  
Dated: \_\_\_\_\_

Prof. & Head  
Civil Engg. Deptt.  
Patiala  
Dated: \_\_\_\_\_



**SHORT TERM COURSE**

*This is to certify that*

**HARPAL SINGH**

attended the Course on FINITE ELEMENT APPLICATION TO

DYNAMIC CONTINUUM PROBLEMS

held from 19.6.88 to 2.7.88

in the Department of EARTHQUAKE ENGINEERING

The Course has been devoted to the imparting of specialised and advanced instruction in the subject.

*Dr. Harpal Singh*  
Professor & Coordinator  
Quality Improvement Programme Centre

*S. K. Bhawar*  
Course Coordinator(s)

**QUALITY IMPROVEMENT PROGRAMME CENTRE  
UNIVERSITY OF RORKEE, RORKEE**



**SHORT TERM COURSE**

*This is to certify that*

**HARPAL SINGH**

attended the Course on SEISMIC ANALYSIS AND DESIGN OF

TALL BUILDINGS

held from 22.6.87 to 5.7.87

in the Department of EARTHQUAKE ENGINEERING

The Course has been devoted to the imparting of specialised and advanced instruction in the subject.

Paranjay S. Thawar  
*To Hand*



## **SHORT TERM COURSE**

*This is to certify that*

**HARPAL SINGH**

attended the Course on **APPLICATION OF FINITE ELEMENT METHOD IN  
SOLUTION OF NONLINEAR PROBLEMS**

held from **June 21** to **July 5, 1994**

**Earthquake Engineering**

in the Department of  
The Course has been devoted to the imparting of specialized and advanced  
instruction in the subject.

*[Signature]*

*[Signature]*  
Course Coordinator (s)

Professor & Coordinator  
Quality Improvement Programme Centre

**12SEE-2002**  
**TWELFTH SYMPOSIUM ON EARTHQUAKE ENGINEERING**  
DECEMBER 16-18, 2002

Dr. D.K. Paul, *Chairman*  
Tel +91 1332 85278  
Dr. Ashok Kumar, *Organising Secretary*  
Tel +91 1332 85527  
Dr. M.L. Sharma, *Co Organising Secretary*  
Tel +91 1332 85536



Department of Earthquake Engineering  
Indian Institute of Technology, Roorkee  
*(Formerly University of Roorkee)*  
Roorkee - 247 667, India  
Fax No.: +91 1332 7651  
E-mail: 12see@iit-roorkee.ernet.in

No. DEQ/12SEE/Delegate/  
Dated: Dec. 18, 2002

**TO WHOM IT MAY CONCERN**

This is to certify that Mr. Harpal Singh, Guru Nanak Dev Engineering College, Ludhiana has attended the 12<sup>th</sup> Symposium on Earthquake Engineering from December 16 to 18, 2002 at Indian Institute of Technology Roorkee.

(D.K. Paul)  
Chairman, 12SEE

**12SEE-2002**  
**TWELFTH SYMPOSIUM ON EARTHQUAKE ENGINEERING**  
DECEMBER 16-18, 2002

Dr. D.K. Paul, *Chairman*  
Tel +91 1332 85278  
Dr. Ashok Kumar, *Organising Secretary*  
Tel +91 1332 85527  
Dr. M.L. Sharma, *Co Organising Secretary*  
Tel +91 1332 85536



Department of Earthquake Engineering  
Indian Institute of Technology, Roorkee  
*(Formerly University of Roorkee)*  
Roorkee - 247 667, India  
Fax No.: +91 1332 7605  
E-mail: 12see@iit-roorkee.ernet.in

No. DEQ/12SEE/Delegate/  
Dated: Dec. 18, 2002

**TO WHOM IT MAY CONCERN**

This is to certify that Mr. Harpal Singh, Guru Nanak Dev Engineering College, Ludhiana has attended the 12<sup>th</sup> Symposium on Earthquake Engineering from December 16 to 18, 2002 at Indian Institute of Technology Roorkee.

(D.K. Paul)  
Chairman, 12SEE

**CONTINUING EDUCATION CENTRE  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**



*Certificate of Participation*

This is to certify that

**HARPAL SINGH**

has attended a six-week training course on

*Earthquake Risk Management*

sponsored by the **Ministry of Home Affairs, Government of India**, under National Programme for Capacity Building of Engineers in Earthquake Risk Management (NPCBERRM), and organized by the Department of Earthquake Engineering, Indian Institute of Technology Roorkee from January 03 to February 11, 2005.

N.C. Singh  
**(N.C. Singh)**  
Course Co-ordinator

D.K. Paul  
**(D.K. Paul)**  
Prof. & Head, DEQ



*M. Kumar*  
**(M. Kumar)**  
Prof. & Head

# INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Centre for Development of Technical Education

Continuing Education Programme

## CERTIFICATE

This is to certify that Harpal Singh  
attended the Short Course on RANDOM RESPONSE OF  
STRUCTURES TO WINDS AND EARTHQUAKES held at  
Indian Institute of Technology, Kanpur from June 5 to  
June 9, 1995.

# KONGU ENGINEERING COLLEGE



Perundurai, Erode - 638 052, Tamil Nadu

ISTE - XXX Annual Convention & National Seminar on  
Management of Technical Education in the 21st Century.  
December 10-12, 1999

## CERTIFICATE

This is to certify that Prof / Dr / Ms. Mカル Singh  
of Guru Nanak Dev Engg. College, Ludhiana  
participated in ISTE - XXX Annual Convention of Indian Society for Technical Education  
& National Seminar on "Management of Technical Education in the 21st Century" held  
during December 10-12, 1999 at Kongu Engineering College, Perundurai, Erode.

Dr. Vishwanathan

**R.K. Vishwanathan**

Chairman, Organising Committee &  
Secretary, Kongu Engineering College.

Dr. A. M. Natarajan

**Dr. A. M. Natarajan,**  
Organising Secretary &  
Principal, Kongu Engineering College.

**QUALITY IMPROVEMENT PROGRAMME CENTRE  
UNIVERSITY OF RORKEE, RORKEE-247 667, U.P.**



**SHORT TERM COURSE**

*This is to certify that*

**HARPAL SINGH**

attended the Course one on **EARTHQUAKE RESISTANT DESIGN**

**OF BUILDINGS**

held from **22.6.1993** to **6.7.1993**

in the Department of **EARTHQUAKE ENGINEERING**

The Course has been devoted to the imparting of specialized and advanced instruction in the subject.

University of Roorkee  
Department of Continuing Education



This is to certify that

HARPAL SINGH

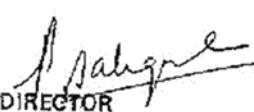
attended a Special course on EARTHQUAKE HAZARDS EVALUATION

FOR DESIGN OF STRUCTURES AND FOUNDATION

held from 23. 6. 1992 to 2. 7. 1992

in this department. The course has been devoted to the imparting of specialised and advanced knowledge in the subject.

   
COURSE CO-ORDINATOR(S)

  
DIRECTOR

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# The Institution of Engineers (India)

DELHI STATE CENTRE



## CERTIFICATE

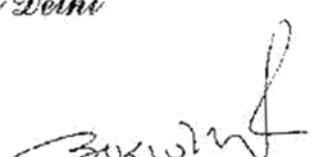
This is to certify that

Dr. / Mr. / Mrs. Harpal Singh, Giani Zail Singh College  
of Engg. & Tech.  
Participated in the

All India Seminar on  
"Sustaining Quality in Technical Education in India  
& Environmental Issues in Engineering  
Curricula - Challenges Ahead"

during April 27-28, 2007 at New Delhi

  
(Dr. G. S. Yadava)  
Chairman, IEI-DSC

  
(R.N. Rajpoot)  
Honorary Secretary, IEI-DSC

\*\*\*\*\*  
\*  
\*  
**The Institution of Engineers (India)**

(ESTABLISHED 1920, INCORPORATED BY ROYAL CHARTER 1935)



**CERTIFICATE**

*This is to certify that*

*DR. HARPAL SINGH GUANI ZAKIR SHAIKH, C.M. O.E. ENGG.*

*Participated in the  
All India Seminar on*

*"Automation Trends in Manufacturing Industries:*

*Cutting Edge Technologies & their Impact"*

*organised by the Mechanical Engineering Division Board of  
Delhi State Centre, The Institution of Engineers (India)*

*during May 23-24, 2008 at New Delhi*

(Dr. G. S. Yadava)  
Chairman, IEI-DSC

(R.N. Rajpoot)  
Honorary Secretary, IEI-DSC

\*\*\*\*\*

# The Institution of Engineers (India)

(ESTABLISHED 1920, INCORPORATED BY ROYAL CHARTER 1935)



## CERTIFICATE

*This is to certify that*

*DR. HARPAL SINGH, G.Z.SINGH Coll. Of ENGG. &  
TECH.*

*Participated in the*

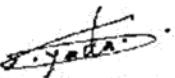
*All India Seminar on*

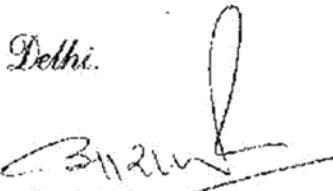
*"Sustaining Quality in Technical Education in India - Challenges Ahead"*

*organised by the*

*Delhi State Centre of The Institution of Engineers (India)*

*during July 11-12, 2008 at New Delhi.*

  
(Dr. G. S. Yadava)  
Chairman, IEI-DSC

  
(R.N. Rajpoot)  
Honorary Secretary, IEI-DSC

University of Roorkee  
Department of Continuing Education



This is to certify that

Harpal Singh

attended a Special course on Finite Element Application  
to Structural Dynamic Problems

held from 17. 7. 1991 to 30. 7. 1991

in this department. The course has been devoted to the imparting of  
specialised and advanced knowledge in the subject.

D. Paul  
COURSE CO-ORDINATOR(S)

J. Malhotra  
DIRECTOR



# WESSEX INSTITUTE



*Wessex Institute of Technology*

*It is certified that Dr H Singh has participated in the conference*

## BEM/MRM 29

29th World Conference on Boundary Elements and other Mesh Reduction Methods

*held from 4 - 6 June 2007 in the New Forest, UK*

Prof C A Brebbia  
Director

June 2007





# Guru Nanak Dev Engineering College

( AN AUTONOMOUS COLLEGE UNDER UGC ACT )  
LUDHIANA, PUNJAB

## DEPARTMENT OF CIVIL ENGINEERING

It is certified that Mr./Ms./Dr. **Harpal Singh**

of **GNDCE, Ludhiana**

had participated/presented  
paper in the Two-day National Conference on 'Geotechnical Engineering Practice and  
**Sustainable Infrastructure Development**' organised on 11-12 October, 2014  
in association with Testing & Consultancy Cell of the college and  
Indian Geotechnical Society : Ludhiana Chapter.

*[Signature]*  
Organising Secretary

*[Signature]*  
Head of Department and  
Chairman GTP-SID-2014)



# Guru Nanak Dev Engineering College

(AN AUTONOMOUS COLLEGE UNDER UGC ACT)

LUDHIANA, PUNJAB



LUDHIANA CHAPTER

## DEPARTMENT OF CIVIL ENGINEERING

It is certified that Mr./Ms./Dr. Harpal Singh

of GNDEC, Ludhiana

participated in Indian  
Geotechnical Society TC-8 workshop on **Numerical and Physical Modelling** conducted by

Department of Civil Engineering on 3<sup>rd</sup> October, 2015 in association with Testing & Consultancy

Cell of the college and Indian Geotechnical Society : Ludhiana Chapter.

  
Organising Secretary

  
Head of Department and  
Chairman (IGS-Ludhiana Chapter)



UKIERI Concrete Congress  
Concrete Research Driving Profit and Sustainability  
2 - 5 November 2015  
Dr B R Ambedkar National Institute of Technology  
Jalandhar, Punjab, India

UKIERI Collaborative  
Concrete Research  
Partners



## Certificate of Participation

This is to certify that

**HARPAL SINGH**

has participated and presented the paper entitled

*Study of behaviour of a building I-shaped in plan*  
[UCC-15-413]

in the UKIERI Concrete Congress  
Concrete Research Driving Profit and Sustainability

held on

2-5 November 2015

at

Dr B R Ambedkar National Institute of Technology  
Jalandhar INDIA

Professor S P Singh  
Congress Secretary

Professor Ravindra K Dhir OBE  
Congress Chairman

Host Organisations: Dr B R Ambedkar National Institute of Technology, Jalandhar and Guru Nanak Dev Engineering College, Ludhiana (Punjab)



# Guru Nanak Dev Engineering College

(AN AUTONOMOUS COLLEGE UNDER UGC ACT)

LUDHIANA, PUNJAB



## DEPARTMENT OF CIVIL ENGINEERING

It is certified that Mr./Ms./Dr. Harpal Singh  
of GINDEC, Ludhiana participated in Indian  
Geotechnical Society 2-Day Training Program on **Geotechnical Investigations and Ground  
Improvement with Geosynthetics for Structural and Construction Engineers** conducted by  
Department of Civil Engineering on 9-10 December, 2015 in association with Testing &  
Consultancy Cell of the college and Indian Geotechnical Society: Ludhiana Chapter and  
sponsored by TEQIP-II and TATA Structura.

Organising Secretary

  
Head of Department and  
Chairman (IGS-Ludhiana Chapter)

**Guru Nanak Dev Engineering College, Ludhiana**  
(An Autonomous College under UGC Act)

## **Certificate of Participation**

This certificate is awarded to

**HARPAL SINGH (GNDEC, LDH)**

who had presented a research paper / participated in two-day International Conference on

### **Sustainable Waste Management through Design**

organised by the Department of Civil Engineering in association with the

Indian Geotechnical Society: Ludhiana Chapter and Institution of Engineers (I): Local Chapter

on 2 - 3 November, 2018.

*[Signature]*  
Organising Secretary

*[Signature]*  
Professor & Head  
Civil Engineering Department

## **CERTIFICATE OF PARTICIPATION**

### **SPOC FELICITATION WORKSHOP**

PRESENTED TO

**Dr. HARPAL SINGH**

Conducted by Indian Institute of Technology Kanpur

at  
**GNDEC, Ludhiana**

on

**19<sup>th</sup> November, 2018**



*[Signature]*  
Prof. Satyaki Roy  
NPTEL Coordinator, IIT Kanpur

CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA

	HPS				
	Monday	Tuesday	Wednesday	Thursday	Friday
<b>8 AM (1ST)</b>	---	---	D4 CE A DSS-II L F-103	M.TECH STR 1 FEM L S-202	D4 CE A DSS-II L F-103
<b>9 AM (2ND)</b>	M.TECH STR 1 FEM L S-202	---	---	---	---
<b>10 AM (3RD)</b>	D4 CE A DSS-II L F-103	---	---	D4 CE A2 DSS-II T G-1	---
<b>11 AM (4TH)</b>	---	---	---	---	---
<b>12 PM (5TH)</b>	---	---	---	---	---
<b>1 PM (6TH)</b>	---	D4 CE A1 DSS-II T G-1	<b>HPS</b> , IPK M.TECH STR 2 PROJECT (STR) P S-202	---	---
<b>2 PM (7TH)</b>	D4 CE A1 MC L F-107	M.TECH STR 1 FEM L S-202		AMAN, MVK, <b>HPS</b> , AJS, BPS, BHS D4 CE B MAJ PROJECT P TEACH OFFICE	---
<b>3 PM (8TH)</b>	---	-X-		---	---
<b>4 PM (9TH)</b>	-X-	-X-	-X-	-X-	-X-
Timetable generated with FET 5.37.5 on 8/12/19 1:34 PM					

**CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA**

		HPS						
		Monday	Tuesday	Wednesday	Thursday	Friday		
<b>08:00</b>	---	---	---	---	D4 CE A DSS-II L F-104	---	<b>08:00</b>	
<b>09:00</b>	---	---	---	---	---	---	<b>09:00</b>	
<b>10:00</b>	M.TECH STR 1 BR ENGG L S-210	D4 CE A2 DSS-II T S-201	---	---	D3 CE B1 MC T S-210	D4 CE A DSS-II L F-104	<b>10:00</b>	
<b>11:00</b>	---	---	---	---	---	---	<b>11:00</b>	
<b>12:00</b>	---	---	---	---	---	---	<b>12:00</b>	
<b>13:00</b>	M.TECH STR 2 THESIS P	HPS, JGS, GPS, BSW, SKP D4 CE A1, D4 CE A2 MAJ PROJ P	---	---	HPS, SKS, PJS, SKP, SWS, PPSC <b>D3 CE C3</b> MIN PROJ P	D4 CE A1 DSS-II T S-202	<b>13:00</b>	
<b>14:00</b>	D4 CE A DSS-II L F-104	HPS, SKS, PJS, SWS, SAHIB, PPSC D3 CE A1 MIN PROJ P	M.TECH STR 1 BR ENGG L S-210	---	---	M.TECH STR 1 BR ENGG L S-210	<b>14:00</b>	
<b>15:00</b>	---	M.TECH STR 1 BR ENGG L S-210	---	---	---	---	<b>15:00</b>	
<b>16:00</b>	-x-	-x-	-x-	-x-	-x-	-x-	<b>16:00</b>	
<b>17:00</b>	-x-	-x-	-x-	-x-	-x-	-x-	<b>17:00</b>	
<b>18:00</b>	-x-	-x-	-x-	-x-	-x-	-x-	<b>18:00</b>	
Timetable generated with FET 5.35.5 on 4/15/19 8:25 AM								

**CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA**

		HPS				
		Monday	Tuesday	Wednesday	Thursday	Friday
08:00	---	---	---	---	---	---
09:00	D4CEB DSS-II L F-104	---		M.Tech STR 1 APSG L S-210	---	D4CEB1 DSS-II T S-202
10:00	---	D4CEB DSS-II L F-104		D3CEB1 MC T S-210	---	M.Tech STR 1 APSG L S-210
11:00	---	---	---		D4CEB DSS-II L F-104	---
12:00	---	---	---	---	---	---
13:00	HPS, IPK, KSG, AJS, SDK D4CEA MAJOR PROJECT P SEMINAR HALL TCC			D4CEB2 DSS-II T F-107	M.Tech STR 1 APSG L S-210	---
14:00	M.Tech STR 1 APSG L S-210			---	---	---
15:00	---			---	---	---
16:00	-x-	-x-	-x-	-x-	-x-	-x-
17:00	-x-	-x-	-x-	-x-	-x-	-x-
18:00	-x-	-x-	-x-	-x-	-x-	-x-
	Timetable generated with FET 5.35.5 on 10/16/18 11:24 AM					

**CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA**

		HPS					
		Monday	Tuesday	Wednesday	Thursday	Friday	
<b>08:00</b>	---	---		D4 CE A DSS-II L F-104	---	D2 CE B1 MC T N.ROOM	<b>08:00</b>
<b>09:00</b>	---	---		---	---	D4 CE A DSS-II L F-104	<b>09:00</b>
<b>10:00</b>	---	M.TECH STR 1 BR ENGG L N.ROOM		D4 CE A2 DSS-II T CONC LAB	---	---	<b>10:00</b>
<b>11:00</b>	M.TECH STR 1 BR ENGG L N.ROOM	---		---	---	---	<b>11:00</b>
<b>12:00</b>	---	---		---	---	---	<b>12:00</b>
<b>13:00</b>	D4 CE A1 DSS-II T SURVEY LAB	---		---	---	---	<b>13:00</b>
<b>14:00</b>	D4 CE A DSS-II L F-104	HPS, GPS, KLS, APK, PPAL, SIMRAN D4 CE A MAJ PROJ P F-104		M.TECH STR 2 THESIS P	HPS, SDK, IPK, <b>PIK</b> , SKS, AJS, KSG D3 CE A1 MIN PROJ P G-2	M.TECH STR 1 BR ENGG L N.ROOM	<b>14:00</b>
<b>15:00</b>	---	---		HPS, SDK, IPK, <b>PIK</b> , AJS, PRINCE, HEENA D3 CE C3 MIN PROJ P G-2	M.TECH STR 1 BR ENGG L N.ROOM	---	<b>15:00</b>
<b>16:00</b>	-x-	-x-		-x-	-x-	-x-	<b>16:00</b>
<b>17:00</b>	-x-	-x-		-x-	-x-	-x-	<b>17:00</b>
<b>18:00</b>	-x-	-x-		-x-	-x-	-x-	<b>18:00</b>
	Timetable generated with FET 5.34.3 on 3/22/18 11:32 AM						

CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA

	HPS				
	Monday	Tuesday	Wednesday	Thursday	Friday
<b>08:00</b>	---	---	---	D2CEB1 MC T S-202	---
<b>09:00</b>	---	---	---	---	---
<b>10:00</b>	---	M.Tech STR 1 <b>APSG L</b> N. Room	---	---	---
<b>11:00</b>	HPS, AJS, ISN, APK M.Tech STR 2	---	---	M.Tech STR 1 <b>APSG L</b> N. Room	M.Tech STR 1 <b>APSG L</b> N. Room
<b>12:00</b>	SEMINAR (STR) P DEP LIB	---	M.Tech STR 1 <b>APSG L</b> N. Room	---	---
<b>13:00</b>	---	---	---	---	---
<b>14:00</b>	---	---	---	---	---
<b>15:00</b>	---	---	---	---	---
<b>16:00</b>	-x-	-x-	-x-	-x-	-x-
<b>17:00</b>	-x-	-x-	-x-	-x-	-x-
<b>18:00</b>	-x-	-x-	-x-	-x-	-x-
	Timetable generated with FET 5.33.1 on 10/26/17 3:16 PM				

CIVIL ENGINEERING DEPARTMENT, GURU NANAK DEV ENGINEERING COLLEGE,  
LUDHIANA

	HPS				
	Monday	Tuesday	Wednesday	Thursday	Friday
08:00 ---	---	---	---	---	D4 CE B DSS-II L F-104
09:00 ---	D4 CE B DSS-II L F-104	M.TECH (STR 1) BR ENGG L S-210	---	---	---
10:00 M.TECH (STR 1) BR ENGG L S-210	---	M.TECH (STR 2) Dissertation P	---	M.TECH (STR 1) BR ENGG L S-210	
11:00 ---	---	---	---	D4 CE B DSS-II L F-104	---
12:00 ---	M.TECH (STR 1) BR ENGG L S-210	---	---	---	---
13:00 D4 CE B DSS-II L F-104	---	HSR , HJS, HPS, PPSC	---	---	---
14:00 HPS, GGN, GPS D3 CE A1 MIN PROJECT P S-211	---	D4 CE A MAJ PROJECT P TCC SEMINAR HALL	---	---	---
15:00 ---	---	---	---	---	---
16:00 -x-	-x-	-x-	-x-	-x-	-x-
17:00 -x-	-x-	-x-	-x-	-x-	-x-
18:00 -x-	-x-	-x-	-x-	-x-	-x-
Timetable generated with FET 5.30.8 on 2/5/17 7:02 PM					



**INDIAN SOCIETY OF EARTHQUAKE TECHNOLOGY**  
(ESTABLISHED IN 1962; REGISTRATION NO. 845/64-65)

Department of Earthquake Engineering Building  
Indian Institute of Technology Roorkee, Roorkee-247 667, India  
(AFFILIATED TO INTERNATIONAL ASSOCIATION FOR EARTHQUAKE ENGINEERING)



## CERTIFICATE of PARTICIPATION

THIS ACKNOWLEDGES THAT

**Harpal Singh**

HAS PARTICIPATED IN THE WEBINAR ON

### EARTHQUAKE ENGINEERING & TECHNOLOGY

DELIVERED BY **PROF. VASANT MATSAGAR**, EDITOR, ISET JOURNAL &  
PROFESSOR IN CIVIL ENGG. DEPT., IIT DELHI ON 9<sup>TH</sup> MAY 9, 2020

(RAVI S. JAKKA)  
Secretary, ISET

(T.G. SITHARAM)  
President, ISET



**INDIAN SOCIETY OF EARTHQUAKE TECHNOLOGY**  
(ESTABLISHED IN 1962; REGISTRATION NO. B45/64-65)

Department of Earthquake Engineering Building  
Indian Institute of Technology Roorkee, Roorkee-247 667, India  
(AFFILIATED TO INTERNATIONAL ASSOCIATION FOR EARTHQUAKE ENGINEERING)



## CERTIFICATE of PARTICIPATION

THIS ACKNOWLEDGES THAT

**Harpal Singh**

HAS PARTICIPATED IN THE WEBINAR ON

### **Seismic Hazard Assessment**

DELIVERED BY **PROF. M.L. SHARMA**, DEPARTMENT OF EARTHQUAKE  
ENGINEERING, INDIAN INSTITUTE OF TECHNOLOGY ROORKEE  
ON 27<sup>TH</sup> MAY, 2020

(RAVI S. JAKKA)  
Secretary, ISET

(T.G. SITHARAM)  
President, ISET



**INDIAN CONCRETE INSTITUTE**  
WESTERN UP CENTRE GHAZIABAD



SUPPORTED BY

**ANULAB**

**EXPERT**  
AE SOLUTIONS

### Certificate of Participation

This is to certify that Mr/Ms/Dr. Harpal Singh has participated in **International Webinar on Durability, Design and Construction Aspects of Bridges**, organised by Indian Concrete Institute, Western UP Centre (ICI-WUPC) Ghaziabad, India in association with CSIR - Central Road Research Institute (CRRI), New Delhi, India during May 29-31, 2020.

21/05/2020

**Dr. Rajeev Goel**  
Head (BES), CRRI, New-Delhi

**Er. Arun Kumar**  
Organising Secretary

**Er. G.K. Sahu**  
Chairman, ICI-WUPC, Ghaziabad



**INDIAN SOCIETY OF EARTHQUAKE TECHNOLOGY**  
(ESTABLISHED IN 1962; REGISTRATION NO. 845/64-65)

Department of Earthquake Engineering Building  
Indian Institute of Technology Roorkee, Roorkee-247 667, India  
(AFFILIATED TO INTERNATIONAL ASSOCIATION FOR EARTHQUAKE ENGINEERING)



## CERTIFICATE of PARTICIPATION

THIS ACKNOWLEDGES THAT

**Harpal Singh**

HAS PARTICIPATED IN THE WEBINAR ON

### **Relevance of Site Effect In Earthquake Resistant Construction**

DELIVERED BY **DR. S.K. PRASAD**, PROFESSOR OF CIVIL  
ENGINEERING (RETIRED), SRI JAYACHAMARAJENDRA COLLEGE OF  
ENGINEERING, MYSORE ON 23<sup>RD</sup> MAY, 2020

**(RAVI S. JAKKA)**  
Secretary, ISET

**(T.G. SITHARAM)**  
President, ISET



**INDIAN SOCIETY OF EARTHQUAKE TECHNOLOGY**  
(ESTABLISHED IN 1962; REGISTRATION NO. 845/64-65)

Department of Earthquake Engineering Building  
Indian Institute of Technology Roorkee, Roorkee-247 667, India  
(AFFILIATED TO INTERNATIONAL ASSOCIATION FOR EARTHQUAKE ENGINEERING)



## CERTIFICATE of PARTICIPATION

THIS ACKNOWLEDGES THAT

**Harpal Singh**

HAS PARTICIPATED IN THE WEBINAR ON

**Performance-Based Seismic Design of Structures**

DELIVERED BY **PROF. YOGENDRA SINGH**, DEPARTMENT OF  
EARTHQUAKE ENGINEERING, I.I.T. ROORKEE ON 16<sup>TH</sup> MAY, 2020

(RAVI S. JAKKA)  
Secretary, ISET

(T.G. SITHARAM)  
President, ISET



## SWAYAM ARPIT ONLINE COURSE CERTIFICATION

*This Certificate is awarded to*

**HARPAL SINGH**

*for successfully completing the ARPIT Course for*

*Career Advancement Scheme(CAS) promotion*

**Sustainable Construction Materials & Techniques**

*with a "D" Grade in the proctored examination held on 16.02.2020*

*NITTTR Chennai*

Authorized Signatory of Institution (Course Coordinator)  
NITTTR Chennai

Authorized Signatory of AICTE

Date of Issue : 30/06/2020

[www.swayam.gov.in](http://www.swayam.gov.in)

# *Certificate of Achievement*

MIDAS SOFTWARE TRAINING PROGRAM

This is to certify that the recipient has attended a course organized by  
MIDAS Research & Development Centre, India

## Awarded to

Recipient :

**Harpal Singh**

Organization:

**GNDEC, Ludhiana**

## Course Details

Product	midas Civil						
Course Title	<b>Short Course: midas Civil Advanced Features</b>						
Number of Days	5 Sessions						
Instructor	Midas Technical Team						
Date	May 18, 2020 to May 22, 2020						
Contents	<table><tr><td>(1) Transverse Analysis of PSC Box Girder Bridge</td><td>(4) Rail Structure Interaction Analysis – Theory</td></tr><tr><td>(2) Vibration Analysis of Steel Foot Over Bridge</td><td>(5) Rail Structure Interaction Analysis – Simulation, Results Interpretation &amp; Report Generation</td></tr><tr><td>(3) Analysis and Design of Multi Span Segmental Bridge Constructed using FEM technique</td><td></td></tr></table>	(1) Transverse Analysis of PSC Box Girder Bridge	(4) Rail Structure Interaction Analysis – Theory	(2) Vibration Analysis of Steel Foot Over Bridge	(5) Rail Structure Interaction Analysis – Simulation, Results Interpretation & Report Generation	(3) Analysis and Design of Multi Span Segmental Bridge Constructed using FEM technique	
(1) Transverse Analysis of PSC Box Girder Bridge	(4) Rail Structure Interaction Analysis – Theory						
(2) Vibration Analysis of Steel Foot Over Bridge	(5) Rail Structure Interaction Analysis – Simulation, Results Interpretation & Report Generation						
(3) Analysis and Design of Multi Span Segmental Bridge Constructed using FEM technique							

Date May 22, 2020 Signed by Mr. Ravi Anne

Director of training and education

MIDAS Research & Development Centre, India  
(Group of MIDAS Information Technology Co. Ltd.)

# *Certificate of Achievement*

MIDAS SOFTWARE TRAINING PROGRAM

This is to certify that the recipient has attended a course organized by  
MIDAS Research & Development Centre, India

## Awarded to

Recipient :

**Harpal Singh**

Organization:

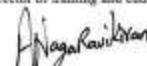
**GNDEC, Ludhiana**

## Course Details

Product	midas Civil						
Course Title	<b>Short Course: Basic Conventional Bridges</b>						
Number of Days	<b>6 Sessions</b>						
Instructor	<b>Midas Technical Team</b>						
Date	<b>May 11, 2020 to May 16, 2020</b>						
Contents	<table><tr><td>(1) Frame and Box Culvert Analysis and Design as per IRC 112</td><td>(4) Steel Composite I Girder Bridge Analysis and Design as per IRC 22</td></tr><tr><td>(2) Four Lane PSC I Girder Bridge Analysis and Design as per IRC 112</td><td>(5) Steel Truss Bridge Analysis and Design as per IRC 24</td></tr><tr><td>(3) Design and Analysis of Multi-Span PSC Box Girder Bridge as per IRS Bridge Rules</td><td>(6) Integral Bridge Analysis and Design as per IRC 112</td></tr></table>	(1) Frame and Box Culvert Analysis and Design as per IRC 112	(4) Steel Composite I Girder Bridge Analysis and Design as per IRC 22	(2) Four Lane PSC I Girder Bridge Analysis and Design as per IRC 112	(5) Steel Truss Bridge Analysis and Design as per IRC 24	(3) Design and Analysis of Multi-Span PSC Box Girder Bridge as per IRS Bridge Rules	(6) Integral Bridge Analysis and Design as per IRC 112
(1) Frame and Box Culvert Analysis and Design as per IRC 112	(4) Steel Composite I Girder Bridge Analysis and Design as per IRC 22						
(2) Four Lane PSC I Girder Bridge Analysis and Design as per IRC 112	(5) Steel Truss Bridge Analysis and Design as per IRC 24						
(3) Design and Analysis of Multi-Span PSC Box Girder Bridge as per IRS Bridge Rules	(6) Integral Bridge Analysis and Design as per IRC 112						

Date May 16, 2020 Signed by Mr. Ravi Anne

Director of training and education



*MIDAS Research & Development Centre, India*  
*(Group of MIDAS Information Technology Co. Ltd.)*

# *Certificate of Achievement*

MIDAS SOFTWARE TRAINING PROGRAM

This is to certify that the recipient has attended a course organized by  
MIDAS Research & Development Centre, India

## Awarded to

Recipient :

**Harpal Singh**

Organization:

**GNDEC, Ludhiana**

## Course Details

Product	midas GTS NX
Course Title	Short Course Numerical Solutions to Geotechnical Challenges
Number of Days	9 Sessions
Instructor	Tadavarthi Sree Harsha & Chinmoy Pattanaik
Date	May 28, 2020 to June 12, 2020
Contents	<p>[1] Slope Stability Analysis of Reinforced Slopes (2D) with Soilworks</p> <p>[2] Landslide Analysis of Hilly Terrain with Bedding Plane (3D) with GTS NX</p> <p>[3] Seepage Induced slope stability analysis of a Tailings Dam(3D)</p> <p>[4] Fully Coupled Analysis of a Slope</p> <p>[5] High speed moving load analysis and embankment stability</p> <p>[6] Direct Method for Soil Structure Interaction - Compatibility with Midas Structure Software</p> <p>[7] Seismic Soil Structure Interaction</p> <p>[8] Open Pit mining/ Global/Local Slope Stability using SRM Method</p> <p>[9] Underground Mining and Tunneling</p>

Date June 12, 2020 Signed by Mr. Ravi Anne

Director of training and education

*MIDAS Research & Development Centre, India*  
*(Group of MIDAS Information Technology Co. Ltd.)*



## Certificate of Accomplishment

Hilti India Pvt. Ltd.  
presents this certificate to

# Harpal Singh

In recognition of professional achievement  
by successfully completing the webinar

**Why you should design MEP  
support fixings for Seismic  
Conditions?**

*Neeraj Nayyar*

Instructor



**Certificate of Accomplishment**

Hilti India Pvt. Ltd.  
presents this certificate to

**Harpal Singh**

In recognition of professional achievement  
by successfully completing the webinar

**Productivity and Efficiency in  
Designing Steel-to-Concrete  
Connections**

*Karan Khanna*

Instructor

02-04-2020

Hilti India Private Limited  
Building 8, Tower C, 6th Floor, DLF Cyber City  
DLF Phase II Gurgaon - 122002  
Haryana, INDIA

[teamaskhilti.in@hilti.com](mailto:teamaskhilti.in@hilti.com)



## Certificate of Accomplishment

Hilti India Pvt. Ltd.  
presents this certificate to

# Harpal Singh

In recognition of professional achievement  
by successfully completing the webinar

## Productivity and Efficiency in Designing Steel-to-Concrete Connections

*Karan Khanna*

Instructor

02-04-2020

Hilti India Private Limited  
Building 8, Tower C, 6th Floor, DLF Cyber City  
DLF Phase II Gurgaon - 122002  
Haryana, INDIA

[teamaskhilti.in@hilti.com](mailto:teamaskhilti.in@hilti.com)



## राष्ट्रीय तकनीकी शिक्षक प्रशिक्षण एवं अनुसंधान संस्थान

National Institute of Technical Teachers Training & Research

मानव संसाधन विकास मंत्रालय, भारत सरकार का एक स्वायत संस्थान

An Autonomous Institute of Ministry of Human Resource Development, Govt of India

Prof (Dr) Rupinder Singh  
Dept. of Mechanical Engineering

सेक्टर 26, चंडीगढ़ 160019 (भारत)  
SECTOR 26, CHANDIGARH 160 019 (India)

दिनांक:  
Ref: NITTTR/RS/Covid-19/33      Dated : 11 July 2020

### Letter of Appreciation

Dr. Harpal Singh  
Professor (Civil Engg.)  
Guru Nanak Dev Engg. College, Ludhiana

Dear Sir,  
One week Short Term Course (STC) on "Waste Management" organized by Mechanical Engineering Department, National Institute of Technical Teachers Training and Research, Chandigarh during 08 June - 12 June, 2020 was a great success.

For this STC 926 participants were registered from all over the country.

We express our gratitude for accepting our invitation to deliver an expert talk on **FEA for waste minimization** and to address the participants on 08-06-2020. All participants expressed happiness for having learnt this powerful industry practice for leadership in quality.

We value your support and appreciate your contribution in making the event meaningful. Kindly accept our sincere thanks for your valuable time for supporting our activities on the quality path and the bit of knowledge and device to the participants.

We look forward to your similar cooperation and continued support in future.

Thank you.

Sincerely yours,

(Dr. Rupinder Singh)  
Co-ordinator (ICTO-62)

Department of Mechanical Engineering, NITTTR, Sector 26, Chandigarh  
दूरध्वाप / Phone: (O)0172-2759780, 9872257575 (Mobile)  
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SECTOR 26, CHANDIGARH 160 019 (India)

दिनांक:

Ref: NITTTR/RS/Covid-19/41

Dated : 11 July 2020

### Letter of Appreciation

Dr. Harpal Singh  
Professor, Civil Engg.  
GNDEC, Ludhiana

Dear Sir,

One week Short Term Course (STC) on “Waste Management” organized by Mechanical Engineering Department, National Institute of Technical Teachers Training and Research, Chandigarh during 11 May - 15 May, 2020 was a great success.

For this STC 599 participants were registered from all over the country.

We express our gratitude for accepting our invitation to deliver an expert talk on **FEA for waste minimization** and to address the participants on 11-05-2020. All participants expressed happiness for having learnt this powerful industry practice for leadership in quality.

We value your support and appreciate your contribution in making the event meaningful. Kindly accept our sincere thanks for your valuable time for supporting our activities on the quality path and the bit of knowledge and device to the participants.

We look forward to your similar cooperation and continued support in future.

Thank you.

Sincerely yours,

(Dr. Rupinder Singh)  
Co-ordinator (ICTO-29)

Department of Mechanical Engineering, NITTTR, Sector 26, Chandigarh

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Prof (Dr) Rupinder Singh  
Dept. of Mechanical Engineering

सेक्टर 26, चंडीगढ़ 160019 (भारत)  
SECTOR 26, CHANDIGARH 160 019 (India)

दिनांक:  
Ref: NITTTR/RS/Covid-19/46

Dated : 13 July 2020

### Letter of Appreciation

Dr. Harpal Singh  
Professor, Civil Engg.  
GNDEC, Ludhiana

Dear Sir,

One week Short Term Course (STC) on “Mechanical Manufacturing and Process Optimization” organized by Mechanical Engineering Department, National Institute of Technical Teachers Training and Research, Chandigarh during June 25 - 29, 2020 was a great success.

For this STC 207 participants were registered from all over the country.

We express our gratitude for accepting our invitation to deliver an expert talk on **Application of FEA in Mechanical manufacturing** and to address the participants on 28-06-2020. All participants expressed happiness for having learnt this powerful industry practice for leadership in quality.

We value your support and appreciate your contribution in making the event meaningful. Kindly accept our sincere thanks for your valuable time for supporting our activities on the quality path and the bit of knowledge and device to the participants.

We look forward to your similar cooperation and continued support in future.

Thank you.

Sincerely yours,

(Dr. Rupinder Singh)  
Co-ordinator (ICTO-95)

Department of Mechanical Engineering, NITTTR, Sector 26, Chandigarh

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## राष्ट्रीय तकनीकी शिक्षक प्रशिक्षण एवं अनुसंधान संस्थान

National Institute of Technical Teachers Training & Research

गानधर्म संसाधन विकास नंगलवाह, भारत सरकार का एक स्वायत्त संस्थान

An Autonomous Institute of Ministry of Human Resource Development, Govt of India

Prof. (Dr.) Rupinder Singh (C Eng)  
(UGC Research Awardee)  
Dept. of Mechanical Engineering

सेक्टर 26, चंडीगढ़ 160019 (भारत)  
SECTOR 26, CHANDIGARH 160019 (India)

दिनांक:

Ref: NITTTR/RS/ICTO-122/2

Dated : 21 August 2020

### Letter of Appreciation

Dr. Harpal Singh  
Professor, Mech. Engg.  
GNDEC, Ludhiana

Dear Sir,

The two week Short Term Course (STC) on “Refresher Course in Mechanical Engineering” organized by Mechanical Engineering Department, National Institute of Technical Teachers Training and Research, Chandigarh during Aug 10 - 21, 2020 was a great success.

For this STC 332 participants were registered from all over the country.

We express our gratitude for accepting our invitation to deliver an expert talk on Basics of FEM and to address the participants on 11-08-2020. All participants expressed happiness for having learnt this powerful industry practice for leadership in quality.

We value your support and appreciate your contribution in making the event meaningful. Kindly accept our sincere thanks for your valuable time for supporting our activities on the quality path and the bit of knowledge and device to the participants.

We look forward to your similar cooperation and continued support in future.

Thank you.

Sincerely yours,

(Dr. Rupinder Singh)  
Co-Coordinator (ICTO-122)

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# CERTIFICATE

PROUDLY PRESENTED TO

*Harpal Singh*

JSW Series-07: BIS National Workshop on: "LATEST  
DEVELOPMENTS IN THE INDIAN STANDARDS IN  
CIVIL ENGINEERING AND NBC 2016"

Aug 21, 2020

Date of Completion

*Indian Concrete  
Institute-Bangalore centre*

Organizer



Ref: - SDEI/17/027



Guru Nanak Dev Engineering College  
Ludhiana, Punjab

TEQIP-3  
Technical Education Quality Improvement Programme

### *Certificate of Participation*

It is certified that Mr./Ms./Dr. Harpal Singh from Guru Nanak Dev Engineering College, Ludhiana has **Chaired** a session at TEQIP-III sponsored International Congress on **Sustainable Development through Engineering Innovations** held on September 17-19, 2020, organized by the college in association with Indian Geotechnical Society: Ludhiana Chapter and Institution of Engineers (I): Ludhiana Center.

Dr Harmeet Singh  
Coordinator (*Conduct*)

Dr Harvinder Singh  
Coordinator (*Finance & Printing*)

Dr Sehjpal Singh  
Principal