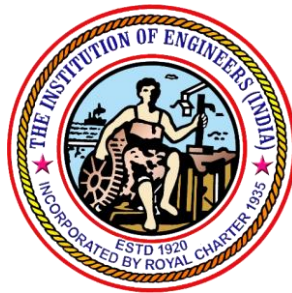


Report on  
**One day National Seminar on  
Piezoelectric and Magnetorheological Materials in Civil Engineering  
Applications**

September 14, 2016 (wed)



**Sponsored by  
INSTITUTION OF ENGINEERS (INDIA)**



**Under the aegis of  
DEPARTMENT OF CIVIL ENGINEERING  
SRI VENKATESWARA COLLEGE OF ENGINEERING  
Pennalur – Sriperumbudur – 602 117**

([www.svce.ac.in](http://www.svce.ac.in))

A one day National Seminar on

**Piezoelectric and Magnetorheological  
materials in Civil Engineering Applications  
14<sup>th</sup> September, 2016**

**Registration Form**

1. Name:
2. Designation:
3. Participant Category:  
(Student / Faculty / Industry)
4. Name of the Institution/Organisation:
5. Address for the Communication:
  
6. Telephone No:
7. E-mail ID:
8. Academic Qualifications:
9. Professional Experience (in years) (Teaching / Research / Industry):
10. Registration fee:
11. Demand draft No. Date:

**Declaration:**  
I agree to abide by the rules and regulations of the Programme.

**Signature**

**Bonafide certificate**

Dr./Mr./Ms.----- is a bonafide staff/student of-----  
He/she is permitted to attend the IE(I) sponsored National seminar on “Piezoelectric and Magnetorheological materials for Civil Engineering applications” on 14<sup>th</sup> September 2016 at Sri Venkateswara College of Engineering, Pennalur, Sriperumbudur, Tamil Nadu - 602 117.

Date: **Signature**  
: (Designation & Seal)

**REGISTRATION FEE**

Students: Rs. 500; Faculty: Rs.650  
Industries: Rs.1000  
IE(I) members / Early bird registration before 30<sup>th</sup> August 2016 can pay Rs.150 less.

Participants are requested to register with DD in favour of “The Principal, SVCE” payable at Indian bank, Sriperumbudur. Individuals are requested to register by **10<sup>th</sup> September 2016**. The participants for the seminar are limited to 40 and hence advance registration is highly recommended.

**Mailing Address:**

Dr.P.Venkateswara Rao, PhD (IITM)  
Associate Professor,  
Dept. of Civil Engineering,  
Sri Venkateswara College of Engineering,  
Pennalur, Sriperumbudur – 602 117  
Ph: 044- 27152000 Ext:475  
Mob: 9445229344

**Email id: pvenkat@svce.ac.in**

**ORGANISING COMMITTEE**

- Convenor:**  
Dr.E.Ravindranath,
- Coordinator:**  
Dr.P.Venkateswra Rao
- Committee members:**  
Mrs. Ruby Freya  
Mr. Mathiyazhagan  
Mr. G. Arun  
IE(I) & CEA student representatives

**A One Day National Seminar  
on  
Piezoelectric and  
Magnetorheological materials  
in Civil engineering  
Applications**

**14<sup>th</sup> September, 2016**

*Organised by*  
**Institution of Engineers (India)**



*under the aegis of*  
**Department of Civil Engineering**



**Sri Venkateswara College of  
Engineering,  
Pennalur, Sriperumbudur (TK),  
Tamil Nadu, 602 117,  
Phone No:044-27152000,Extn-476**

## ABOUT THE INSTITUTION

Sri Venkateswara College of Engineering (SVCE), a premier technical autonomous institution in Tamilnadu, was established in the year 1985 and is managed by Sri Venkateswara Educational and Health Trust. The college offers 10 UG Programmes, 10 PG Programmes in Engineering. The college is accredited by National Assessment and Accreditation Council (NAAC). Many of the eligible courses accredited by National Board of Accreditation and SVCE is an ISO 9001:2008 certified institution. The college is situated in a quiet environment about 37 Kms from Chennai and situated on the Chennai – Bangalore National Highway (NH4) at Pennalur, Sriperumbudur, in Kanchipuram district.

## ABOUT THE DEPARTMENT

The Department of Civil Engineering has well qualified faculty and is running undergraduate course successfully for the past 8 years. The Department is providing a very good platform for students to do projects on any aspect in civil engineering with the help of Professors from different specialization.

## PREAMBLE

The National seminar on “Piezoelectric and Magnetorheological materials for civil Engineering applications” is sponsored by “The Institution of Engineers (India).

Piezoelectric and magnetorheological materials are smart materials. Piezoelectric materials convert mechanical energy into electrical energy. Piezoelectric materials have many applications in civil engineering, such as Tuned-mass dampers, multi span beams. In multi span beams they act as actuators to create moment. Due to simplicity,

low cost and reliability, they are promising solution to the industry. To address strong demands of structural health monitoring, Piezo electric actuators and sensors are useful. In literature there are some proposals on controlling large truss vibrations induced by high winds as well as seismic excitations using piezoelectric friction as dampers. These dampers reduce inter story drift and floor accelerations. As a part of environmental protection; vibration energy also can be harvested using piezoelectric materials.

Magnetorheological (MR) fluids, elastomers and polymer gels are examples of magnetorheological materials. MR fluid is composed of micron sized magnetizable particles suspended in a non-magnetic carrier fluid. MR Fluids are currently used for exercise equipment, automotive parts and earthquake resistant structures. Smart base isolation strategies developed using MR Fluids. MR elastomers are composites, composed of magnetizable particles and elastic polymer. MR elastomers will find their use in applications where stiffness or resonance tunability is required. Among these are the adaptive tuned vibration absorbers and the variable stiffness vibration isolator. MR polymer gels are a new class of soft polymers whose properties can be controlled using magnetic field. The functional effectiveness of these gels depends on their magnetic controllability. Under the magnetic control, the stiffness of the gel can be tunable. One of the possible functional civil engineering applications of MR gels taking advantage of tunable stiffness is seismic isolation. The transmitting force of a seismic wave to the superstructure depends on the dynamic characteristics of the support. If the dynamic characteristics are tunable it will be possible to isolate large range of vibrations to the superstructure.

## SEMINAR OBJECTIVE

The programme will provide an opportunity to the participants to get introduced to the piezoelectric and magnetorheological materials behaviour, modelling techniques and their applications.

## SEMINAR CONTENTS

- Fundamentals of Piezoelectric materials
- Piezoelectric material modelling
- Fundamentals of magnetorheological materials
- Magnetorheological material modelling
- Piezoelectric material applications
- Magnetorheological material applications

## RESOURCE PERSONS

- Dr. M.S. Sivakumar, Professor of AM & Dean students, IITM, Chennai
- Dr. Arockiarajan, Associate Professor of AM, IITM, Chennai
- Dr. K. Jayabal, Assistant Professor, IITDM, Kanchipuram
- Dr. P. Venkateswararao, Associate Professor, SVCE, Sriperumbudur

## TARGET AUDIENCE

UG & PG students, research scholars, faculty members from colleges and engineers from industry.

## SCHEDULED DATES

Last date for receipt of application	10/09/2016
Date of intimation regarding selection	11/09/2016

# **Report on one day National Seminar on Piezoelectric and Magnetorheological Materials in Civil Engineering Applications**

## **Identification**

Seminar Title : National Seminar on Piezoelectric and Magnetorheological Materials in Civil Engineering Applications

Workshop Date : 14<sup>th</sup> September 2016 (Wednesday)

Workshop location : Sri Venkateswara College of Engineering, Sriperumbudur – 602 117

Name & contact information of the person completing the report: Dr.P.Venkateswara rao, Associate Professor, Dept. of Civil Engg., Sri Venkateswara College of Engineering, Sriperumbudur – 602 117.

Primary e-mail : [pvenkat@svce.ac.in](mailto:pvenkat@svce.ac.in)

Primary contact no. : +91 – 9445229344

Date of Report submission : 17<sup>th</sup> November 2016 (Thursday)

## **Sri Venkateswara College of Engineering, Pennalur, Sriperumbudur Tk**

Sri Venkateswara College of Engineering (SVCE), a premier technical autonomous institution in Tamilnadu, was established in the year 1985 and is managed by Sri Venkateswara Educational and Health Trust. The college offers 10 UG Programmes and 10 PG Programmes in Engineering. The college is accredited by National Assessment and Accreditation Council (NAAC). Many of the eligible courses accredited by National Board of Accreditation and SVCE is an ISO 9001:2008 certified institution. The college is situated in a quiet environment about 37 kms from Chennai and situated on the Chennai – Bangalore National Highway (NH4) at Pennalur, Sriperumbudur, in Kanchipuram district.

## **Department of Civil Engineering**

The department of Civil Engineering has started functioning from the year 2008, offering B.E. degree programme in Civil Engineering with the sanctioned intake of 60. The department has 10 faculty members with P.G. specialization and 4 doctorates in different domains of Civil Engineering. The department is headed by *Prof.E.Ravindranath*, who is a retired scientist from Central Leather Research Institute, Adayar.

## **Programme Introduction**

Piezoelectric and Magnetorheological materials are smart materials. Piezoelectric materials convert mechanical energy into electrical energy. Piezoelectric materials have many applications in civil engineering, such as tuned-mass dampers, multi span beams. In multi span beams, they act as actuators to create moment. Due to simplicity, low cost and reliability, they are promising solution to the industry. To address strong demands of structural health monitoring, Piezoelectric actuators and sensors are useful. In literature, there are some proposals on controlling large truss vibrations induced by high winds as well as seismic excitations using piezoelectric friction as dampers. These dampers reduce inter story drift and floor accelerations. As a part of environmental protection, vibration energy also can be harvested using Piezoelectric materials.

Magnetorheological (MR) fluids, elastomers and polymer gels are examples of Magnetorheological materials. MR fluid is composed of micron sized magnetizable particles suspended in a non-magnetic carrier fluid. MR fluids are currently used for exercise equipment, automotive parts and earthquake resistant structures. Smart base isolation strategies developed using MR fluids. MR elastomers are composites, composed of magnetizable particles and elastic polymer. MR elastomers will find their use in applications where stiffness or resonance tunability is required. Among these are the adaptive tuned vibration absorbers and the variable stiffness vibration isolator. MR polymer gels are a new class of soft polymers whose properties can be controlled using magnetic field. The functional effectiveness of these gels depends on their magnetic controllability. Under the magnetic control, the stiffness of the gel can be tunable. One of the possible functional civil engineering applications of MR gels taking advantage of tunable stiffness is seismic isolation. The transmitting force of a seismic wave to the superstructure depends on the dynamic characteristics of the support. If the dynamic characteristics are tunable it will be possible to isolate large range of vibrations to the superstructure.

The one day seminar is aimed to help understand the basic concepts and role of piezoelectric and magnetorheological materials in civil engineering applications, modelling and experimental characterization of smart composites, modelling aspects of piezoelectric materials and experiments and modelling of magnetorheological gels for dynamic applications.

## Key Speakers & Brief about their Presentation

1. **Dr. M. S. Sivakumar**, Professor in Applied Mechanics & Dean Students, Indian Institute of Technology Madras, Chennai (Chief Guest)  
Title: Role of Piezoelectric and Magnetorheological materials in Civil Engineering  
“Presented on basic concepts and role of Piezoelectric and Magnetorheological materials in civil engineering applications”
2. **Dr. A. Arockiarajan**, Associate Professor, Applied Mechanics, Indian Institute of Technology Madras, Chennai  
Title: Experiments and modeling on smart composites  
“Presented on basic concepts of piezoelectricity, piezoelectric composites, experimental procedures and modeling concepts”
3. **Dr. K. Jayabal**, Assistant Professor, Indian Institute of information technology, design and manufacturing, Kanchipuram  
Title: Modeling aspects of piezoelectric materials  
“Presented on smart system, piezoceramics, piezo actuators, modeling and its implementation in FEM”
4. **Dr. P.Venkateswara Rao**, Associate Professor, Civil Engineering, Sri venkateswara College of Engineering, Sriperumbudur  
Title: Experiments and modeling on Magnetorheological Gels  
“Presented on concept of seismic isolation, early efforts of achieving seismic isolation, magnetorheological materials and their applications in civil engineering structures, concepts of MR materials, dynamic shear and static shear, stress relaxation experiments, constitutive modeling and numerical simulation.

## Committee Members

- Dr.E.Ravindranath - Convener
- Dr.P.Venkateswara Rao - Coordinator
- Mrs.Ruby Freya - Assistant Professor
- Mr.R.Mathiyazahagan - Assistant Professor
- Mr.G.Arun - Assistant Professor
- Student representatives of Institution of Engineers (India) & Civil Engineering Association

## About the coordinator

Dr. P. Venkateswara Rao holds a B.E. (Civil) from SRKR Engg. College, Bhimavaram, Affiliated to Andhra University; M.E. (Hydrology and water resources Engg.) from College of Engineering, Guindy, Anna university, Chennai and PhD in Applied Mechanics from IIT Madras. During his PhD programme he conducted dynamic shear, static shear and stress relaxation experiments on magnetorheological gels at IITM. As a part of PhD programme he went to Lund University, Sweden and TU Dortmund University, Germany; and carried out magneto-viscoelastic modelling of Magneto-rheological gels.

At present he is an Associate Professor of the Department of Civil Engineering, Sri Venkateswara college of Engineering (SVCE), Sriperumbudur. He has 20 years of experience in teaching and about 8 years in research. His areas of interest include solid mechanics, Constitutive modelling, smart materials and Seismic isolation.

On 21<sup>st</sup> June 2014, he has delivered a lecture on '2D stress' for Anna University sponsored FDP programme conducted by Dept. of Civil Engg., Agni college of Engg., Chennai. On 8<sup>th</sup> June 2015, he has delivered a lecture on "2D stress and Analysis of plane truss" for the FDP organized on Mechanics of solids by the dept. of Civil Engineering, Loyola Institute of Technology, Chennai. On 7<sup>th</sup> September 2015, he has delivered a guest lecture on "shear and bending in beams" at St.Joseph College of Engineering, Sriperumbudur. During 6<sup>th</sup> to 14<sup>th</sup> June 2016, he organized a Anna university approved Faculty development Training Programme (FDTP) on Mechanics of solids at SVCE, sriperumbudur. He had publications in national and international journals and conferences.

## Event Result

Major outcome of the seminar are:

- The technologies using smart materials are useful for both new and existing constructions. Civil engineering structures with the smart systems will improve the safety against natural hazards and vibrations.
- One of the videos of presentation shows that innovation comes from emotional quotient of a person. This inspired the young participants and may ignite their minds to do research in the area of their interest.
- Piezoelectric materials generate electrical displacement when mechanical loading is applied or generate mechanical displacement when subjected to electric field.

- Procedures for experimental setup for piezocomposites under electrical loading, mechanical loading and electro-mechanical coupling and their modelling concepts .
- Concepts of piezoceramics, piezo actuators and smart systems. Material modelling of Ferroelectric ceramics and implementation in FEM. Construction of polygons in FEM. Numerical examples and polarization rotation experiments.
- Achievement of seismic isolation or vibration isolation with stiffness changing property of Magnetorheological gel under the influence of magnetic field. Application of MR fluid devices for towers and bridges to dissipate the energy caused by wind forces.
- Dynamic shear experiments on MR gels to understand the tunability of its shear modulus under magnetic field.
- Magneto-visco elastic modelling of MR gel. Static shear and stress relaxation tests for numerical simulation.
- Finally the seminar is motivated the research potential of these smart materials in the area of civil engineering applications.

<b>Event Participants</b>
---------------------------

Sl. No.	Name	Designation	Organisation
1	Karthiga. C.R	Assistant Professor	Satyabama University, Chennai
2	Sarayu Ravikumar	Assistant Professor	Satyabama University, Chennai
3	Sinduja. N	Assistant Professor	Satyabama University, Chennai
4	Nivedhitha.M	Assistant Professor	Velammal Engg. college, Chennai
5	Saleema Begum.R	Assistant Professor	Sri Sastha Institute of Engineering & Technology, Chennai
6	Neamitha.M	Assistant Professor	Velammal Engg. college, Chennai
7	Surekha.S.K	P G student	Easwari Engineering college, Chennai
8	Evangeline.K	Design Engineer	i Design Technologies, Chennai
9	Gnanapoongothai.V	Assistant Professor	Velammal Engg. college, Chennai
10	Abarna.P	Assistant Professor	St.Joseph College of Engg, Chennai
11	Alagu Sankareswari. K	Assistant Professor	SKR Engineering College, Chennai
12	Acchuthan.G	U G student	SVCE, Sriperumbudur
13	Adithya.M.V	U G student	SVCE, Sriperumbudur
14	Adithya Anil Kumar	U G student	SVCE, Sriperumbudur
15	Ajith Kumar.R.B	U G student	SVCE, Sriperumbudur
16	Divya Priya. V	U G student	SVCE, Sriperumbudur
17	Hariharan.M	U G student	SVCE, Sriperumbudur
18	Keerthana.K	U G student	SVCE, Sriperumbudur



Sl. No.	Name	Designation	Organisation
19	Narendiran.K	U G student	SVCE, Sriperumbudur
20	Pawan Kumar.S	U G student	SVCE, Sriperumbudur
21	Sathish Aravind. S	U G student	SVCE, Sriperumbudur
22	Shravan Kumar. S	U G student	SVCE, Sriperumbudur
23	Srishinduja.K.K	U G student	SVCE, Sriperumbudur
24	Suhas.C.S	U G student	SVCE, Sriperumbudur
25	Yashwanth.K.P	U G student	SVCE, Sriperumbudur
26	Aarlius Rebonny.A	U G student	SVCE, Sriperumbudur
27	Abinaya.S	U G student	SVCE, Sriperumbudur
28	Anuwar Husain.S	U G student	SVCE, Sriperumbudur
29	Mosikeeran.N	U G student	SVCE, Sriperumbudur
30	Muthunellaippan.S	U G student	SVCE, Sriperumbudur
31	Roselin Kiruba. C	U G student	SVCE, Sriperumbudur
32	Praveen Raj. A.S	U G student	SVCE, Sriperumbudur
33	Sai Sharath. B	U G student	SVCE, Sriperumbudur
34	Swathy. A	U G student	SVCE, Sriperumbudur
35	Manikandan.G	U G student	SVCE, Sriperumbudur
36	Nirmal	U G student	SVCE, Sriperumbudur
37	Shalom Jennifer	U G student	SVCE, Sriperumbudur
38	Guru Praveen Kumar.A.S.	U G student	SVCE, Sriperumbudur
39	Athisivan. A	U G student	SVCE, Sriperumbudur
40	Dinesh Kumar. T.M.	U G student	SVCE, Sriperumbudur
41	Sethipathy.M.S.	U G student	SVCE, Sriperumbudur
42	Hariharan. B	U G student	SVCE, Sriperumbudur
43	Aravindan. V.P.	U G student	SVCE, Sriperumbudur
44	Harish Kumar. S	U G student	SVCE, Sriperumbudur
45	DR. Tamizhselvi. V	Associate Professor	SVCE, Sriperumbudur
46	DR. Selvakumar. M	Associate Professor	SVCE, Sriperumbudur
47	Gopalakrishnan. R	Assistant Professor	SVCE, Sriperumbudur
48	Ruby Freya	Assistant Professor	SVCE, Sriperumbudur
49	Arun. G	Assistant Professor	SVCE, Sriperumbudur
50	Mathiyazhagan. R	Assistant Professor	SVCE, Sriperumbudur
51	Kumar. G	Assistant Professor	SVCE, Sriperumbudur
52	Arun. K	Assistant Professor	SVCE, Sriperumbudur
53	Sandhiya. C	Assistant Professor	SVCE, Sriperumbudur
54	Sathya Priya. K	Assistant Professor	SVCE, Sriperumbudur
55	Diraviya Balan. S	Assistant Professor	SVCE, Sriperumbudur
56	Praveen Kumar. K	U G student	SVCE, Sriperumbudur

## Event Photos



Prayer song during Inauguration of the Seminar



Welcome address by Dr.E.Ravindranath, Professor and Head, Dept. of Civil Engineering, SVCE



Presidential address by Dr.K,R. Santha, Vice Principal, SVCE



Introduction of Chief Guest Dr.M.S. Sivakumar, Professor, Dean students, IIT Madras by Dr.P.Venkateswara Rao, seminar Coordinator



Inaugural address and Technical talk on “Role of Piezoelectric and Magnetorheological materials in Civil Engineering applications” by the Chief Guest Dr.M.S. Sivakumar, Professor & Dean students, IITM



Interaction of participants with the Chief guest Dr.M.S.Sivakumar



Dr. A.Arockiarajan, Associate Professor, AM, IITM delivering a lecture on “Experiments and modelling on smart composites”



Dr. A. Arockiarajan receiving memento from Dr.E.Ravindranath



Dr.K.Jayabal, Assistant Professor, IITDM, Kanchipuram delivering a lecture on “Modelling aspects of Piezoelectric materials”



Dr.P.Venkateswara Rao, Associate Professor, SVCE delivering a lecture on “Experiments and Modeling on Magnetorheological gels”



Valedictory address by Dr.K.S.Badrinathan, Professor, Dean-Educational development, SVCE



Feedback by one of the participants



Certificate distribution to one of the participants



Key Speakers of the Seminar with organising committee



## Acknowledgement

I wish to express my deep gratitude to the Institution of Engineers (India) for accepted the proposal and allocated a sum of Rs.10,000 to conduct the seminar in our college SVCE. I am also very grateful to the management of SVCE for permitted to organise this event. I thank the chief guest and key speakers for lending us their valuable time and knowledge. I also thank our HOD, colleagues, supporting staff for their support. I thank Dr.K.S..Badrinathan for spent his valuable time during valedictory function. I thank our college transport in-charge Dr.S.Saravanan, Professor-Mechanical Engineering and all the staff who have helped in making a success. I sincerely thank the organising committee members Ms.Ruby Freya, Mr.Mathiyazhagan, Mr.G.Arun, IE(I) & CEA student representatives. I also extend my sincere thanks to student representative Mr. Aarlius Rebony, who worked hard and spend his time to make this event to happen. I express my sincere thanks to all the participants for their interest in attending the seminar and spent their valuable time.


## List of Enclosures

CD containing presentations : 1 No.;

Seminar brochure : 1 No.



Signature of the Coordinator  
Dr.P.Venkateswara Rao  
Associate Professor  
Department of Civil Engineering,  
Sri Venkateswara College of Engineering  
Pennalur, Sriperumbudur TK



Head of the Department  
Department of Civil Engineering  
Sri Venkateswara College of Engineering  
Sriperumbudur -602 117. INDIA.

Signature of the Head of the Department  
Dr.E.Ravindranath  
Professor & Head,  
Department of Civil Engineering,  
Sri Venkateswara College of Engineering  
Pennalur, Sriperumbudur TK

**Annexure I Proposal Acceptance Letter from IE (India)**

**Fwd: National Seminar on “Piezoelectric and Magnetroheological Materials in Civil Engineering Application”**

Dr. A.C.Muthiah

May 24

Chairman <[acm@svce.ac.in](mailto:acm@svce.ac.in)>

to me, RAVINDRANATH, Principal

----- Forwarded message -----

From: <[alok.basu@ieindia.org](mailto:alok.basu@ieindia.org)>

Date: Tue, May 24, 2016 at 10:31 AM

Subject: National Seminar on “Piezoelectric and Magnetroheological Materials in Civil Engineering Application”

To: [acm@svce.ac.in](mailto:acm@svce.ac.in)

Cc: [kalpakkamlc@ieindia.org](mailto:kalpakkamlc@ieindia.org)

E-mail: [acm@svce.ac.in](mailto:acm@svce.ac.in)

TECH/D.35/IM-000111-4 23 May 2016

Dr P Venkateswara Rao,  
Associate Professor,  
Department of Civil Engineering,  
Sri Venkateswara College of Engineering,  
Post Bag No. 3, Pennalur, Sriperumbudur,  
PIN : 602 105

Dear Sir,

This has reference to your letter no. nil dated 12.02.2016 proposing to organize a National Seminar on “Piezoelectric and Magnetroheological Materials in Civil Engineering Application” on August 20, 2016 under the aegis of your college.

We have pleasure to inform you that your proposal has been accepted by the “Empowered Committee of Directors” and allocated a sum of Rs. 10,000/- for the said activity from the financial year 2016-17. Kindly note that the aforesaid amount can only be released after the culmination of the activity and also after receiving the following documents from your end :

- i) Report of the technical activity along with a few photographs depicting the main features of the said National Seminar;
- ii) Recommendation, if any;
- iii) Proceedings / CD consisting of technical papers presented in the Seminar; and
- iv) Any other item related to the activity.

Meanwhile, we request you to kindly take appropriate action at your end in order to organize the said activity in a befitting manner so that all the stake holders who would attend the Seminar get benefit out of it and thereby serve profession in a most befitting manner.

Anticipating your success we thank you for taking interest in organizing the activity.

Thanking you,  
Yours faithfully,  
(Alok Basu)  
Deputy Director (Technical)

cc: The Honorary Secretary  
Kalpakkam Local Centre of IEI  
Email: [kalpakkamlc@ieindia.org](mailto:kalpakkamlc@ieindia.org)