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e-STRUCT

e-Newsletter of CSIR-Structural Engineering Research Centre

CSIR–SERC
ENGINEERING SUSTAINABLE STRUCTURES

In this issue

From the Director's Desk

I am very happy to present Vol. 4, No. 1, 2020 issue of e-STRUCT. This edition of newsletter highlights our R&D pursuits, achievements, new facilities, skill development initiatives and other significant endeavors during January-March 2020.

Although the Government of India has set an ambitious target of deploying 20,000 MW of grid connected solar power by 2022, at present there are no codal provisions available for the evaluation of wind loading on the solar PV arrays which is important to ensure their safe and economic design. I am happy to share that CSIR-SERC has formulated guidelines for estimating wind force coefficients for the ground mounted solar PV array support systems, based on a comprehensive study conducted in our Wind Tunnel facility. A new facility - BOTDA system - a sophisticated distributed sensing system using Brillouin scattering in optical fibers to measure changes in both temperature and strain over long distances up to 20 km, was established during this period. This system will be helpful in developing novel techniques for damage/leak detection in long structures such as pipelines.

As a significant step towards reaching out to the industry and stakeholders, two large workshops on *Precast Concrete Lightweight Large EPS Panels for Mass Housing* and Robust *Structural Health Monitoring Technologies for Critical Infrastructure Management* were organized by this Centre. Both the events marked a significant success with around 450 participants from industry, government organizations and academia. During this period, two JIGYASA programmes were organized at Karwar and more than 500 students participated in it. As a part of the CSIR Integrated Skill Initiative, one certificate course and five advanced courses were conducted to disseminate the knowledge gained in specific domains. An orientation programme for the recently recruited scientists of CSIR-SERC was introduced for the first time and was organized during this period.

A license agreement was signed between CSIR-SERC and M/s Sapphire Consultants, Thane, for transfer of technology on Textile Reinforced Concrete Prototyping Technology (TRCPT), for preparation of Textile Reinforced Concrete (TRC) liner for water ponds and industrial wastewater ponds. Various technologies and expertise of CSIR-SERC were showcased at the Indian Science Congress 2020 - Pride India Exhibition at Bengaluru, during 3-7 January 2020.

This has indeed been a momentous quarter and as always we at CSIR-SERC look forward to more exciting opportunities and challenges.

Prof. Santosh Kapuria

One day workshop on SHM technologies held on 4 March 2020

Research highlights

Design Guidelines for Wind Resistant Support Systems of Ground Mounted Solar PV Arrays

Solar energy is one of the renewable energies that need to be harnessed at the current state of depletion of fossil fuel. The Government of India has set the target of deploying 20,000 MW of grid connected solar power by 2022 along with an aim of reducing the cost of solar power generation through R&D. In this line, Government of India and various State Governments implemented many policies towards this direction in mission mode. Numerous solar power projects are being constructed across the country. The design of support structure/frames of these solar panels are mainly governed by wind loads. Recently, quite a few structural failures were observed due to wind effects. Currently, there are no codal provisions available, for the evaluation of wind loads on such solar PV arrays.

However, designers are using the provisions of IS: 875 (Part-3), which are meant for isolated open roof systems, for the design of ground mounted solar PV array supporting systems under grouped conditions. In high capacity solar power plants, the solar PV arrays are installed in mass numbers. There is a need to ensure safe and economic design of solar PV array supporting systems against wind loads, by considering force coefficients corresponding to their locations in a plant layout, viz. front, corner, edge, interior, etc.

Hence, it is necessary to formulate guidelines on the wind force coefficients for solar PV array support systems for the evaluation of design wind loads by taking into account of the following parameters: solar panel inclination, wind angle of incidence and spacing ratio. This demands systematic wind tunnel investigations on models of solar PV arrays.

CSIR-SERC has carried out systematic boundary layer wind tunnel investigations on models of solar PV arrays by measuring wind pressures on the top and bottom surfaces of the models for various tilt angles of solar panels, angles of wind incidence and spacing ratios. Fig. 1 shows typical views of the instrumented models of solar PV arrays in the boundary layer wind tunnel. Further, CFD simulations have been carried out on the solar PV arrays using Realizable k-ε turbulence model to evaluate the wind force coefficients and to validate the numerical values with the experimental values. It has been observed that the evaluated numerical wind force coefficient values are well comparable with the experimental values for all rows of panels except for first row of panel.

For first row of panel, the numerical values are observed to be conservative while comparing with the experimental values. Based on these investigations, design guidelines have been formulated involving positive net force coefficients (corresponding to wind load acting downward on the panels) and negative net force coefficients (corresponding to wind load acting upward on the panels) for various tilt angles, viz. 0°, 10°, 20°, 30°, 45° and 60° and for various zones, viz. front, corner, side exterior, side interior and interior zones (Fig. 2). The formulated design guidelines indicated that the current codal provisions which are being adopted in practice are unsafe for the exterior zones and over conservative for the interior zones. Hence, the formulated design guidelines ensure both safe and economic design of the wind resistant support systems of ground mounted solar PV arrays. These guidelines are being communicated to relevant BIS codal committee for their inclusion in relevant IS code after due deliberations.

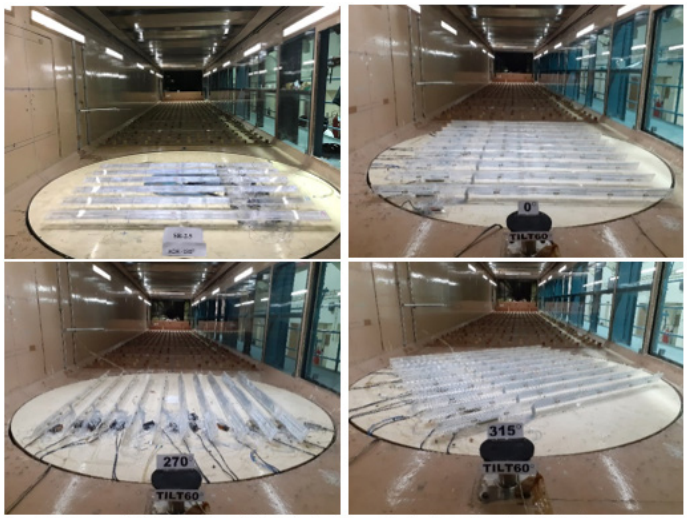

Fig. 1 Typical views of models of solar PV arrays in boundary layer wind tunnel

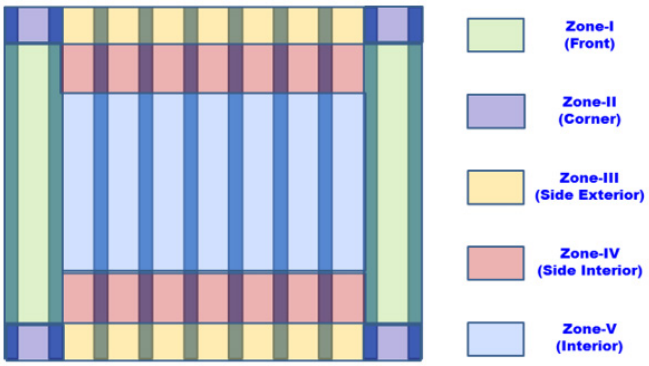

Fig. 2 Identified zones in a solar plant layout for recommended wind force coefficients

New facilities

Distributed Fibre Optic Sensor Interrogator System

The Distributed Fiber Optic Sensor Interrogator System has been added to the facilities of Structural Health Monitoring Laboratory of CSIR-SERC during January 2020. Distributed Fiber Optic Sensor Interrogator system (Fig. 1) has two in-built channel and capable of strain and temperature measurement over fiber lengths upto 100 km in BOTDA and 70 km in BOTDR mode with a spatial step of 0.08 m. Distributed fiber optic sensors measure strain and temperature variations over very long distances and it is an excellent tool for real time monitoring of large structures. Unlike conventional discrete sensors which gives the variations at pre-determined points, these distributed sensors uses the scattering phenomenon of light inside an optical fiber to obtain the strain and temperature profiles throughout the length of long distance fiber optic cables. This system offers clear cost and technical advantages in structural health monitoring applications. It can be used for monitoring oil and gas pipelines, bridges, power lines, dams, geohazard monitoring applications and border security / perimeter monitoring. Such monitoring capability is invaluable in critical structures where failure could lead to loss of lives or financial loss.

Fig.1 Distributed strain and temperature measurement system

Major projects undertaken

- Condition Assessment of RCC Structures of Desalination Plant – NTECL, Thiruvallur
- Studies on Railway Track Fastening Assembly and its Components - M/s. Vossloh Fastening Systems GmbH, Werdohl, Germany
- Experimental Investigations on a Double Lane Bridge of a Suitable Span at GRSE, Kolkata - M/s. Garden Reach Shipbuilders & Engineers Ltd., Kolkata
- Fatigue Life Evaluation of Flash-butt Welded Rail Joints - M/s. ITD Cementation India Ltd., Mumbai
- Condition Assessment of TG Deck of Unit-I Using NDT & PDT – The Chhattisgarh State Power Generation Co. Ltd., Raipur
- Testing and Destruction of 132 kV SD/ SDE -132 kV Tower SUHEP & SHEP – M/s. Skipper Ltd. Kolkata
- Testing & Destruction of 220 kV Double Circuit 'DB' Type Tower – M/s. REC Transmission Projects Company Ltd., New Delhi
- Testing & Destruction of 220 kV Double Circuit 'DC' Type Tower – M/s. REC Transmission Projects Company Ltd., New Delhi

Technology transfer / MoUs

A license agreement was signed between CSIR-SERC and M/s Sapphire Consultants, Thane, on 5 March 2020, for transfer of technology on Textile Reinforced Concrete Prototyping Technology (TRCPT), for preparation of Textile Reinforced Concrete (TRC) liner for water ponds and industrial wastewater ponds.

Capacity development

(Courses organized as a part of CSIR Integrated Skill Initiative)

- A skill development certificate course on Computer Aided Analysis and Design of Structures (CAADS 2020) was organized by CSIR-Structural Engineering Research Centre (CSIR-SERC), Chennai, during 27 January – 21 February 2020. The course aimed to provide theoretical and practical exposure to the engineering students on computer aided analysis and design of various structures. Eleven participants ranging from graduate to post-graduate students and few industrial engineers attended the course.

- An advanced course on Power Transmission and Communication Structures (PTComS-2020), was organized during 22-24 January 2020. Twenty-three engineers with Civil, Electrical and Mechanical Engineering background attended the course.

• A two day advanced course on Engineering of Precast Concrete for Mass Housing: Train the Trainers, was organized during 3-4 February 2020. The course received an overwhelming response with around 112 participants. The participants were from government sector, private sector, public sector undertakings, educational institutions, industry, etc.

• A two day advanced course on Forensic Analysis of Concrete Structures (FACS'20) was organized at CSIR-SERC during 6-7 February 2020. The course received an excellent response with around 21 participants.

• An advanced Course on Limit State Design of Steel Structures as per Indian Code (LSDSS'20), was organized during 12-14 February 2020. Ten participants from government and private sector, public sector undertakings, educational institutions and industry attended the course.

• An advanced Course on Fatigue and Fracture Behaviour of Structures and Structural Components (FFBSSC '20), was organized during 19-21 February 2020. Twenty-three engineers with mechanical engineering / civil engineering background participated in the course.

Workshops & Events

JIGYASA

• A JIGYASA programme was organized at the Naval Children School (NCS), Naval Base, Karwar, on 28 January 2020. Around 270 students participated in the event.

• A JIGYASA programme was organized at the Amrutha Vidyalaya, Karwar, on 29 January 2020. Around 265 students participated in the event.

Orientation programme for the recently recruited scientists

An orientation programme for the recently recruited scientists of CSIR-SERC was organized at the TDC Seminar Hall of CSIR-SERC, during 17 February – 6 March 2020. The Ice-breaking was held on 17 February 2020. The welcome note was given by Dr. J Rajasankar, Chief Scientist, CSIR-SERC, in which, he told that this orientation programme is the formal way of interaction for the new scientists with the project leaders and staff of CSIR-SERC.

Prof. Santosh Kapuria, Director, CSIR-SERC, in his inaugural address said that such orientation programme is being introduced for the first time in CSIR-SERC and pointed out that most R&D institutions in the country does not have any orientation programmes for new recruits. He said that the objective of this programme is to maximize the output from the new recruits and urged the new scientists to have an idea of all related areas and work towards a holistic solution.

Inaugural address by Prof. Kapuria

He briefed on the programme and said that it is comprehensively designed so that the new scientists can have a good understanding on CSIR-SERC and its work, and urged them to study the Vision and Policy Document (VPD) of CSIR-SERC carefully.

A welcome kit was given to all the participants that included CSIR-SERC golden jubilee book, latest annual report and newsletter of CSIR-SERC, the latest issue of the Journal of Structural Engineering published by CSIR-SERC, a copy of the Vision of Policy Document of CSIR-SERC, brochures of all laboratories and a copy of the programme schedule. A series of lectures and presentations were given by project leaders, heads of the laboratories/divisions and visits to all laboratories of CSIR-SERC were also done.

New scientists during the programme

National Science Day

National Science Day is celebrated in India every year on 28 February to mark the discovery of Raman Effect by Indian physicist Sir C.V. Raman. The Science Day was celebrated with great enthusiasm at CSIR-Structural Engineering Research Centre (CSIR-SERC) and CSIR Madras Complex (CMC).

The function was presided over by Prof. Santosh Kapuria, Director, CSIR-SERC and Coordinating Director, CMC. Prof. Samir Kumar Brahmachari, Former Director General, CSIR, was the Chief Guest of the function. In his welcome address, Prof. Kapuria, mentioned that science and technology are integral part of Indian culture, deeply interlinked and are also fundamental to the growth of the country and humanity. Talking about the theme of National Science Day 2020 – Women in Science, Prof. Kapuria highlighted on the leadership of women in CSIR and CSIR-SERC, and their excellent contributions. He also mentioned that when women are in leadership role, the entire scenario changes and they bring in new dimensions and perspectives. Speaking about the recently concluded CSIR Director's Conference, he said that CSIR-SERC's presentation was well received and CSIR-SERC project idea on Floating offshore structures and systems for renewable energy generation was well received. He also emphasized that thinking ahead is important in research and that the research should be industry oriented, socially relevant and globally competitive. Dr. K. Balaji Rao, Chief Scientist and Advisor (M), CSIR-SERC, introduced the chief guest to the audience.

Welcome address by Prof. Kapuria

The chief guest Prof. Brahmachari, delivered the National Science Day lecture on **Innovative Ideas to Market Place: What it Takes**. Endorsing Prof. Kapuria's views on thinking ahead in research, the chief guest said that CSIR has always done that and mentioned that CSIR's 12th five year plan document was the first document on Sensor based Smart Cities, which is now one of the major mission of the Govt. of India. Emphasizing that good science and making wealth can go together, he presented five case studies that proved it:

- National system for healthcare – a policy decision that facilitated sectorial growth in the pharmaceutical industry; outcome of it being attainment of self-sufficiency to a great extent and phenomenal increase in pharmaceutical exports and at the same time less imports – and CSIR's remarkable contributions towards achieving it, which proved that converting knowledge to strategy is significant
- Connecting the un-connected dots through innovation – the design and successful marketing of SOLECKSHAW – A Solar-Electric Rickshaw for eco-friendly urban transport by CSIR and the economic and social impact it created on the ground
- STI leadership needs bold vision and passion to pursue dreams – under which he mentioned various successful CSIR initiatives such as genetic map of India, India's human genome mapping project, BioSuite – a comprehensive software for the bioinformatics industry, etc.
- Open source drug discovery – a CSIR lead Team India Consortium with global participation that offers a collaborative

drug discovery platform for neglected tropical diseases – the collaborative work done and the impact it created among the research community and academia

• To lead, not to follow – in which he stressed on the importance to lead and mentioned few examples such as CSIR and Hewlett-Packard eHealth Centres across India, Integrated Child Health Record (iCHR), Sahaj Path Knowledge Foundation, etc.

Lecture by Prof. Brahmachari

At the end of the function, Director, CSIR-SERC and the chief guest felicitated CSIR-SERC scientists, Dr. Prabhat Ranjan Prem, CSIR Young Scientist Award winner for the year 2019 and Dr. J. Prawin, AcSIR Best Ph.D. Thesis Award winner for the year 2018. Dr. J. Rajasankar, Chief Scientist, CSIR-SERC, proposed vote of thanks. Earlier, as a part of the National Science Day celebration, a gallery on the Journey of Excellence of CSIR-SERC since its inception was inaugurated by Prof. Brahmachari in the lounge of CSIR-SERC main building.

One day Workshop on Precast Concrete Lightweight Large EPS Panels for Mass Housing

A one-day workshop on Precast Concrete Lightweight Large EPS Panels for Mass Housing was organized by CSIR-SERC on 2 March 2020. The workshop was coordinated by Dr. J. Prabakar, Senior Principal Scientist and Dr. K.N. Lakshmikandhan, Senior Scientist of CSIR-SERC. The workshop was inaugurated by Prof. Santosh Kapuria, Director, CSIR-SERC.

Prof. Kapuria in his inaugural address mentioned that to contribute to the Housing for All scheme of Govt. of India, CSIR-SERC has been working relentlessly for the past two years and along with the participation of other CSIR labs including CSIR-CBRI, CSIR-CRRI, CSIR-NEERI, and CSIR-CSIO has come up for the first time with the comprehensive package of green solution that offers - accelerated construction in terms of speed, reduced cost without compromising on quality, durability and safety, efficient waste management, rain-water harvesting, plans and layouts for various geo-climatic conditions of the country, thermal comfort etc. He called upon the engineering community at large and the industry to critically view and implement the technology and also to provide feedback for further improvement. He also mentioned that this workshop hasreceived tremendous response with more than 300 participants — 140 from government organizations and industry and an equal number from academia and thanked the participants for attending the event.

The inaugural session was followed by technical sessions with four presentations by the scientists of CSIR-SERC:

Inaugural function

Galaxy of participants during the workshop

• Overall view of Mission Mode Project on Fast, Durable and Energy Efficient Scheme for Mass Housing by Dr. G.S. Palani

• Development of Precast Lightweight Large Wall and Roof Panels using Expanded Polystyrene (EPS) by Dr. J. Prabakar

• Development of SECROBuilt panels for Mass housing by Dr. K.N. Lakshmikandhan

• Development of Steel Foamed Concrete Wall and Roof Panels by Dr. P. Prabha.

The workshop was a great success and was well received by all the participants. During the interaction session, Prof. Kapuria, Director, CSIR-SERC and Dr. B.H. Bharathkumar and Dr.G.S.Palani, Chief Scientists, Dr. J.Prabakar, Sr. Principal Scientist, Dr. K.N.Lakshmikandhan, and Dr.P.Prabha Sr. Scientists have interacted with the participants and answered their technical queries.

One day Workshop on Robust Structural Health Monitoring Technologies for Critical Infrastructure Management

A one day workshop on Robust Structural Health Monitoring Technologies for Critical Infrastructure Management was organized at CSIR-SERC on 4 March 2020. The workshop was coordinated by Dr. B. Arun Sundaram, and Dr. Nawal Kishore Banjara, Senior Scientists of CSIR-SERC. The workshop was inaugurated by Prof. Santosh Kapuria, Director, CSIR-SERC. Prof. Kapuria, in his inaugural address mentioned that though SHM is a relatively hi-tech subject, the growing interest shown by engineering community towards it is evident from the fact that this workshop had attracted more than 150 participants from government organizations, industry and academia.

The inaugural session was followed by a technical session with presentations by scientists of CSIR-SERC:

- Brief on Mission Mode Project – SHM by Dr. S. Parivallal / Dr. Ing. Saptarshi Sasmal,
- Health Monitoring, Assessment and Life Extension of Bridges – Dr. Ing. Saptarshi Sasmal / Dr. V. Srinivas
- Techniques for Condition Monitoring and Assessment of Critical Infrastructure by Dr. S. Parivallal
- Fiber Optic Sensor Technology for Health Monitoring of Different Types of Structures by Dr. B. Arun Sundaram / Dr. K. Kesavan
- Guided Wave Propagation and Acoustic Emission Based Techniques for Localization and Characterization of Damage in Structures by Dr. Nawal Kishore Banjara / Mr. M. Kannusamy
- Damage Detection Using Advanced Signal Processing Techniques by Dr. K. Lakshmi / Dr. J. Prawin

The workshop was a great success and was well received by all the participants. Prof. Kapuria, Director, CSIR-SERC, Dr. Ing. Saptarshi Sasmal and Dr. Parivallal, Senior Principal Scientists, Dr. Arun Sundaram and Dr. Nawal Kishore Banjara, Senior Scientists, interacted with the participants and answered their technical queries.

International Women's Day

International Women's Day was celebrated at CSIR-Structural Engineering Research Centre (CSIR-SERC) and CSIR Madras Complex (CMC), Chennai, on 9 March 2020. Ms. Neenu Ittyerah, Principal Chief Operations Manager, Southern Railway, was the chief guest of the function.

The theme for International Women's Day 2020 was **I am Generation Equality: Realizing Women's Rights**. The programme had a colourful start with the Bharatanatyam dance performance by Sri Mahalakshmi Natyalaya, Chennai and vocal performance by Ms. Srelekha of CSIR-SERC. Prof. Santosh Kapuria, Director, CSIR-SERC and Coordinating Director, CMC, in his welcome address lauded the performances and briefly outlined the events that led to the founding of women's day and the role of a few powerful women, who were the pioneers of the movement. Prof. Kapuria pointed out the prevalence of prejudices in the society against women and stressed on the need to imbibe equality since childhood. He also said that there is a huge gender gap in the fields of mathematics, computer science and natural sciences and said that women need to be given freedom of thinking to fill this gap. Dr. N. Anandavalli, Senior Principal Scientist, CSIR-SERC, introduced the chief guest to the audience.

Welcome address by Prof. Kapuria

The chief guest, in her special lecture titled **Gender**, said that there is a tendency to find differences instinctively in the society and there are generalized presumptions about the capabilities of women in workplaces. She pointed out that these presumptions deny women to show their actual capabilities and their families who may be willing to change their roles; and when women are given opportunities, these perceptions change positively. She also called upon the women not to assign any predefined narratives on themselves and not to give up only because they are women. She also said that the horrible crimes against women and abuses they face at home and workplace are not reported/discussed enough and stressed on the need to make workplaces safe for women.

Lecture by the Chief Guest

The programme concluded with the distribution of prizes to the winners of the competitions held in connection with the women's day celebration (one minute game, treasure hunt and musical chair), token of appreciation to the dance performers and felicitation to the chief guest of the function. Smt. S. Sobhana, Controller of Administration, CMC, proposed vote of thanks.

Visits & Technology showcase

- Prof. Baidurya Bhattacharya, Indian Institute of Technology Kharagpur, visited CSIR-SERC on 5 March 2020 and delivered a special lecture during the Orientation programme for the recently recruited scientists, organized between 17 February – 6 March 2020
- Prof. S. Gopalakrishnan, Indian Institute of Science, Bengaluru, visited CSIR-SERC on 5 March 2020 and delivered a special lecture during the Orientation programme for the recently recruited scientists, organized between 17 February – 6 March 2020
- Prof. Ashok Saxena, Adjunct Regents' Professor, School of Materials Science and Engineering, Georgia Institute of Technology, USA, visited CSIR-SERC on 11 February 2020
- CSIR-SERC participated in the Indian Science Congress 2020 – Pride India Exhibition at Bengaluru, during 3-7 January 2020. Mass Housing Technologies, Cyclone Shelter model and Chart of Jigyasa events were showcased during the exhibition

Invited lectures

• Dr. S. Vishnuvardhan, Principal Scientist, delivered a lecture on Integrity Assessment Studies on Large Components/Structures, at the two day theme meeting on Non-destructive Evaluation for Robust Indian Nuclear Programme (NDERNP-2020), organized by the Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, during 28-29 January 2020

• Prof. Santosh Kapuria, Director, delivered a talk on Civil, Infrastructure and Engineering Theme: Activities, Achievements and Action Plan, at the Director's Conference held at CSIR-National Institute of Oceanography, Goa, during 23-26 February 2020

• Dr. S. Maheswaran, Senior Principal Scientist, delivered a keynote lecture on Nano-Bio Materials in Civil Engineering, at the Seminar organized by Mannar Durai Singam Government Arts College, Sivagangai, on 10 March 2020

Honours, awards & recognitions

• Prof. Santosh Kapuria, Director, was nominated as member of Board of Governors of Engineering Council of India (ECI) since November 2019

• Dr. Smitha Gopinath was selected as Member, RILEM Technical Committee on MCC: Mechanical Characterization and Structural design of Textile Reinforced Concrete, during February 2020

• Dr. Smitha Gopinath was selected as the External DC Committee member of Mr. Shaise K John, Research Scholar, APJ Abdul Kalam Technological University, College of Engineering, Trivandrum, during February 2020

• Ms. C. Bharathi Priya, Senior Scientist, was awarded Doctor of Philosophy for the thesis entitled Seismic vibration control of structures using magnetorheological (MR) damper coupled mass driver, by the Academy of Scientific and Innovative Research (AcSIR), Chennai

• Dr. K. Sathish Kumar, Chief Scientist, was elected as the Fellow of Institution of Engineers India (IEI) in the Civil Engineering Division from 19 February 2020

• Dr. G. V. Rama Rao, Senior Scientist, received the best paper award for the paper titled Studies on seismic safety of hospital buildings, presented at the National Conference on Emerging Technologies in Civil Engineering (ETCE-2020), organized at the Bapatla Engineering College, during 6-7 March 2020

Paper publications

- **SCI Journals - 16**
- **Reputed Indian Journals - 5**

CSIR–SERC
ENGINEERING SUSTAINABLE STRUCTURES

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