

# Proceedings of the 6<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering



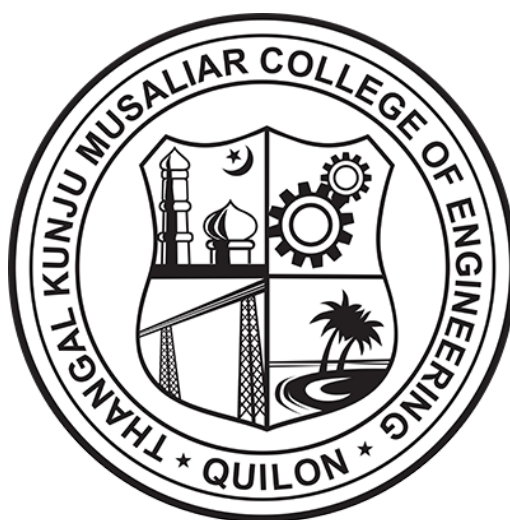
*Editors:*

Seema K. Nayar

Ramaswamy K. P.

Munavar Fairouz C.

*Organized by*



Department of Civil Engineering  
TKM College of Engineering, Kollam, Kerala, India

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Seema K. Nayar  
Ramaswamy K. P.  
Munavar Fairouz C.  
(Editors)

# *Proceedings of the 6<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering*

*ICMSC 2022 (1-3 December 2022)*

*Organized by*  
Department of Civil Engineering, TKM College of Engineering,  
Kollam, Kerala, India

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Proceedings of the 6<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering  
ICMSC 2022 (1-3 December 2022)

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# ICMSC



**INTERNATIONAL CONFERENCE ON MODELING &  
SIMULATION IN CIVIL ENGINEERING**

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# ICMSC



INTERNATIONAL CONFERENCE ON MODELING &  
SIMULATION IN CIVIL ENGINEERING

## Foreword



Civil Engineering has the power to change the way the world looks. Engineers test their creativity and ingenuity through models, prototypes and iterations before applying them in engineering marvels. Be it physical or mathematical models, live or virtual simulations, discourses on the recent developments contribute in refining and improving the weft and warp of technology in its applications. The Department of Civil Engineering, TKM College of Engineering has been organizing International Conferences on Modeling and Simulation in Civil Engineering (ICMSC) biennially with a view to bringing together on a common platform researchers, technocrats and academicians to explain their research findings and state of the art technology in the domain.

The first International Conference was held in 2011. Since then, conferences in this theme were held until 2019. In 2021, during the pandemic, the situation demanded that sustainability in construction should be brought into focus. Consequently, the Department thought it appropriate to organize an International Web Conference in Civil Engineering for a Sustainable Planet (ICCESP-2021) which was held on the 5th and 6th of March, 2021.

The current edition of ICMSC, which is the sixth in the series, was held from the 1st to the 3rd of December 2022. The conference succeeded in bringing together leading academicians, researchers, technocrats, practitioners, and students to exchange and share their experiences and research outputs on all branches of Civil Engineering. It also provided a premier interdisciplinary platform to present and discuss the most recent innovations, trends, concerns and practical challenges encountered, as well as solutions adopted in the field of Civil Engineering. It is our sincere wish that the conference proceedings shall act as the convergence of thoughts and of cutting-edge research outcomes in building a sustainable planet across geographic boundaries.

**Dr. Seema K. Nayar**  
**Dr. Ramaswamy K. P.**  
**Dr. Munavar Fairouz C.**  
**(Editors)**

## About the Conference

The main aim of this conference is to bring together leading academicians, researchers, technocrats, practitioners and students to exchange and share their experiences and research outputs on all aspects of Civil Engineering, especially related to the modeling and simulation in Civil Engineering. It will also provide a premier interdisciplinary platform to present and discuss the most recent innovations, trends, concerns as well as practical challenges encountered, and solutions adopted in the field of Civil Engineering.

### Vision

To integrate the different facets of Civil Engineering by connecting leading academicians, researchers, technocrats, practitioners, and students to share their knowledge and expertise. This conference fosters technological innovation and excellence in the field of Civil Engineering and its sustainable practices for the benefit of humanity.

### Mission

- Understand worldwide advancements in the field of Civil Engineering through broad collaboration and sharing of knowledge.
- Enhance public understanding of sustainable engineering practices and pursue standards for their functional application.
- Foster possibilities for career and professional development.
- Motivate global audience by creating communities that develop technical interests, advise public policies, and spread awareness for the benefit of humanity.

## About the Editors



***Dr. Seema K. Nayar*** is currently Professor in the Department of Civil Engineering, TKM College of Engineering, Kollam, Kerala. She took her B.Tech. and Ph.D. from the University of Kerala and M.Tech. from Indian Institute of Technology, Madras. She has specialized in Building Technology and Construction Management and her areas of interest include sustainable engineering and construction management. She has more than three decades of teaching experience.



***Dr. Ramaswamy K. P.*** is currently working as Associate Professor in Department of Civil Engineering in TKM College of Engineering, Kollam. He has more than 14 years teaching experience. He completed his Ph.D. in Concrete Technology from IIT Madras, M.Tech in Construction Technology and Management from IIT Madras, B.Tech in Civil Engineering from NSS College of Engineering, Palakkad (University of Calicut). His area of specialisation is Building Technology and Construction Management. He is a registered research guide under APJ Abdul Kalam Technological University. His primary research interests include cement chemistry, concrete durability, supplementary cementing

materials in concrete, special concretes, chemical attack in concrete, characterization of construction materials, alkali activated binders etc. He is the co-ordinator of the consultancy and testing activities of the Department of Civil Engineering, has undertaken more than 300 structural and NDT consultancy works and completed 6 sponsored research projects thus far. He is a member of several renowned international professional bodies. He has published more than 100 international and national publications of high reputation and also extends his services as a reviewer of many prestigious international journals.



***Dr. Munavar Fairooz C*** is presently working as Assistant Professor in the Department of Civil Engineering at TKM College of Engineering. He earned his Doctoral degree from the prestigious Indian Institute of Technology (IIT) Kharagpur, where he specialised in the field of Transportation Engineering. Prior to his Ph.D., he also obtained an M.Tech degree in Transportation Engineering from the same institution. Dr. Munavar was awarded with the German Academic Exchange Service (DAAD) Fellowship. This prestigious award allowed him to pursue his master's thesis in Germany for seven months, where he gained invaluable international exposure and expanded his

research horizons. Throughout his academic journey, Dr. Munavar has published his work in various esteemed International Journals and International conferences.

## Previous Editions of ICMSC

### ICMSC 2011



The Inaugural Function of ICMSC 2011

The Department of Civil Engineering, TKM College of Engineering, Kollam organized the First International Conference on Modeling and Simulation in Civil Engineering, ICMSC 2011, from 08-10 December 2011. The coordinator of the Conference was Dr. Lalu Mangal. Around fifty selected papers in various streams of civil engineering were presented during the Conference. Dr. K. M. Abraham, the Additional Chief Secretary in Higher Education inaugurated the Conference. Keynote lectures were delivered by Prof. Peter Stemberk, Czech Technical University Dr. Erland Rasmussen, Danish Hydraulic Institute, Dr. V. G. Idichandy IIT Madras, Dr. Ajith Haridas, Regional Research Laboratory Trivandrum.

### ICMSC 2013



The Inaugural Function of ICMSC 2013

The Second International Conference on Modeling and Simulation in Civil Engineering, ICMSC 2013 was organized by the Department of Civil Engineering from December 12 – 14, 2013. Dr. I. Bushra and Dr. Soosan J. Panicker coordinated the event. The Conference was inaugurated by Sri. E. Sreedharan, Consultant and ex- Managing Director of Delhi Metro Rail Corporation. More than forty selected papers in various streams of civil engineering were presented during the Conference. Dr. Muhd Fadhil Nuruddin, Universiti Teknologi Petronas, Malaysia, Dr. Vinu Unnithan, University of Alabama, Dr. Premkumar, Worley Parsons Canada, Dr. R. G. Robinson, IIT Madras, Dr. Lakshman Nandagiri, NIT Surathkal and Dr. Ajith Haridas, Regional Research Laboratory Trivandrum delivered the keynote lectures.

## ICMSC 2015



The Inaugural Function of ICMSC 2015

The third edition of the International Conference on Modeling and Simulation in Civil Engineering, ICMSC 2015, was held from December 9 – 11, 2015. Dr. Bindu S. and Dr. Anu V. Thomas coordinated the conference. The Conference was inaugurated by Dr. Gangan Prathap, Honorary Professor, APJ Abdul Kalam Technological University and former Vice Chancellor, Cochin University of Science and Technology.

Keynote lectures by eminent personalities in the field of civil engineering were organized during the Conference. The main speakers included Dr. P. K. Aravindan, former Professor, IIT Madras, Prof. Devdas Menon, Professor, IIT Madras, Prof. K. C. Iyer, Professor, IIT Delhi, Prof. Tom V. Mathew, Professor, IIT Bombay, Prof. P. Basak, Professor, NIT Jamshedpur and Prof. Zulkifli Yusop, Professor, Universiti Teknologi Malaysia. A panel discussion on ‘Sustainable Transportation Systems’ with Prof. Tom V. Mathew, Professor, IIT Bombay, Prof. Samson Mathew, Professor, NIT Trichy, Dr. Sreedevi, Director NATPAC and Dr. Reebu Zachariah Koshy, Professor, TKM College of Engineering, Kollam as panelists, was yet another attraction of the Conference. More than forty selected papers in various streams of civil engineering were presented during the Conference.

## ICMSC 2017



The Inaugural Function of ICMSC 2017

The 4<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering, ICMSC 2017 was organized by the Department of Civil Engineering, T.K.M. College of Engineering, Kollam during 13-15



December 2017. The conference was co-ordinated by Dr. Nazeer M. And Dr. Muhammed Siddik A. The conference was inaugurated by Dr. Mangesh G. Korgaonker, Director General, National Institute of Construction Management and Research, Pune. Over 50 technical papers in various fields of Civil Engineering were presented by academicians/scientists from various national and international universities during the conference. Dr. Mangesh G. Korgaonker, Director General, National Institute of Construction Management and Research, Pune, Dr. Asokendu Samanta, Head of the Department, Structures Group, Indian Register of Shipping, Dr. Deepak T. J., Dean, Linton University College, Malaysia, Dr. George K. Varghese, Assistant Professor, Department of Civil Engineering, NIT Calicut and Mr. Abdul Rahim, Technical Advisor, Vizhinjam International Seaport Limited delivered keynote addresses. The selected papers were published in the International Journal of Engineering and Advanced Technology (IJEAT) with ISSN No. 2249-8958.

## ICMSC 2019



The Inaugural Function of ICMSC 2019

The fifth edition of the International Conference on Modeling and Simulation in Civil Engineering (ICMSC 2019) was organized as part of the Diamond Jubilee Celebrations of the college and was held during 11-13 December, 2019. Dr. Sajeeb R. and Dr. Adarsh S. coordinated the conference. The conference was inaugurated by Prof. Slobodan P. Simonovic, Professor Emeritus, Department of Civil and Environmental Engineering, University of Western Ontario, London, Canada. Keynote lectures were delivered by Prof. Slobodan P. Simonovic, Prof. Vahid Nourani (University of Tabriz, Iran), Prof. Narayanan Neithalath (Arizona State University, USA), Prof. C. S. Manohar (Indian Institute of Science, Bangalore), Prof. R. G. Robinson (Indian Institute of Technology, Madras) and Prof. Bhargab Maitra (Indian Institute of Technology, Kharagpur). Over 125 papers were selected for presenting during the conference. Selected papers were published in IOP Conference Series: Earth and Environmental Science.



## About the Institute

TKM College of Engineering, the first Government-aided engineering college in Kerala, is situated in the cashew hub of Kerala, City of Kollam. The campus is spanning over an area of more than 25 Acres, it is ideally located, in Karikode, on the Kollam- Shenkotta road, about 5 kilometers from the heart of the city. The campus, a distinctive landmark that cuts above the rest is built in the aesthetic Indo Saracenic architectural style with Mughal influence.

The college is the first and foremost institution for technical education, run by the TKM Educational Trust, headed by Janab A. Shahal Hassan Musaliar. The foundation stone of the college was laid in the year 1956 by Dr. Rajendra Prasad, the first President of Independent India. The college was formally inaugurated by Prof. Humayun Kabir, the then Minister for Scientific and Cultural Affairs, Govt. of India, on 3<sup>rd</sup> July, 1958.

At its start, the college began its stride with the three basic branches of engineering – Civil, Mechanical and Electrical Engineering. Today it is a renowned technical institution in India, offering courses in seven branches of engineering:

- Civil
- Mechanical
- Electrical and Electronics
- Electrical & Computer Engineering
- Electronics and Communication
- Computer Science & Engineering
- Chemical Engineering
- Architecture

Architecture is offered at under graduation level. Ten M. Tech programs, M-Planning and MCA programmes are also being offered.

The institute is a QIP centre for research in Mechanical and Civil Engineering streams. It is also an approved research centre for Mechanical and Civil Engineering. It is supported by about 375 eminent staff members; teaching and non-teaching, and about 1000 students are admitted every year in various disciplines. The college is affiliated to APJ Abdul Kalam Technological University and is approved by the All India Council for Technical Education (AICTE), New Delhi and granted Autonomy by UGC this year.

The College runs on a well- structured platform, that offers various infrastructure facilities such as the Central library, Department libraries, Central and Departmental Computer facilities, separate hostels for boys and girls of various semesters, Career Guidance and Placement Cell, Cooperative Society Store, Medical Cell and Sports facilities like Football court, Basket Ball courts, Tennis Court, Volley Ball court, Shuttle-Badminton Court, Multi-Gymnasium, Hockey Practice Court, Table Tennis Hall and a Cricket pitch. The College has a common auditorium and separate seminar halls for various departments, equipped with modern audio-visual presentation devices. The students participate regularly in events conducted by the NSS, NASA, IEEE, ISTE, SSA, IICE, UNAI and the college union.

An active Career- Guidance and Placement Cell functions here that periodically conducts personality workshops, mock tests for competitive examinations and ensures a considerable number of placements for students from this institution.

As envisaged by its founder, TKM College of Engineering has become an outstanding centre of excellence in Kerala, catering to the needs of higher education to all sections of society and stands as an

example of a model learning centre. TKM College of Engineering provides value-based education to its students and to develop the overall personality of the students by enhancing their creativity, self-confidence, communication and leadership skills. The college is accredited by NAAC with an A grade, granted Autonomy by UGC and APJ AKTU.

## **Founder**



**Janab A. Thangal Kunju Musaliar (1897-1966)**

“When the mind begins to experience the sensation of physical comfort, joy or satisfied desires;  
the intelligence has to act as judge with consciousness as mediator”

## **About the Department**

The Department of Civil Engineering took its genesis in 1958 and is now one among the oldest and the most dynamic engineering departments in the State of Kerala. The Department of Civil Engineering offers Under Graduate, two Post Graduate and Doctoral programmes. It is a Centre for Quality Improvement Programme (QIP) of All India Council for Technical Education (AICTE) and also offers doctoral programmes (full-time under APJ Abdul Kalam Technological University and part-time under the University of Kerala). The research and developmental activities are mainly funded by the All India Council for Technical Education (AICTE), Technical Education Quality Improvement Programme (TEQIP), the Institution of Engineers (India), the Kerala State Council for Science, Technology and Environment (KSCSTE) and the Centre for Engineering Research and Development (CERD). Ever since its inception, the department has given importance to academic excellence, research activities and consultancy works for the general public and industries, leading to the status of accreditation for the UG (6 years) and PG programmes (2 years) by National Board of Accreditation (NBA). Today it is ranked one of the best in the state, with its alumni being forerunners in the professional diaspora in different parts of the world. Every year, the department produces the finest graduates in Kerala, who are highly sought-after by the professional community. The department is blessed with state-of-the-art facilities and highly qualified and experienced faculty members. The consultancy services offered by the department include structural design, detailing, testing, forensic investigations, field inspection and monitoring, surveying, site investigation report and expert opinion in various issues related to building construction, structural, geotechnical, transportation, environmental and water resources engineering, which in turn enrich the academic and research activities.

### **VISION**

To impart holistic and research oriented education in Civil Engineering, in conformity with global standards while adhering to environmental sustenance.

### **MISSION**

- Train and equip graduates to take up Civil Engineering profession
- Extend knowledge and expertise for the development of the community
- Motivate students for higher studies and research
- Foster continuous learning process
- Create responsible professionals, capable of initiating sustainable engineering practice

## Chairman's Message



TKM College of Engineering was established in the year 1958 as the first private engineering college in the state of Kerala by the great visionary and philanthropist Janab Thangal Kunju Musaliar. Ever since its inception, the institution has remained a defining force in shaping the higher educational landscape of Kerala. Keeping abreast of the changes envisaged in New Education Policy of Government of India, the University Grants Commission (UGC) and the APJ Abdul Kalam Technological University have granted autonomous status to the college this year, which will open up new opportunities of growth in the coming years.

The Department of Civil Engineering of the institution, with NBA accredited under graduate and post graduate programmes, is one of the most dynamic and sought after civil engineering departments in the State. The team of highly qualified and motivated faculty and staff of the department constantly strive to scale new heights in academic excellence, creating generations of socially committed engineers.

Amongst the initiatives that the Department takes to improve academic excellence, research acumen and social commitment among the faculty and students, the series of international conferences held biennially have been one of the finest. It gives me great pleasure to know that the sixth edition of the International Conference on Modelling and Simulation in Civil Engineering (ICMSC 2022) is to be held from December 1-3, 2022. I understand that the organizing committee has left no stone unturned in ensuring that the keynote lectures are delivered by experts and the high quality papers are published in proceedings. The launching of the Centre for Sustainable Practices that will be launched along with the Conference holds a lot of promises.

I congratulate all the members of faculty and staff for their commendable efforts. I wish the conference all success.

**Dr. Shahal Hassan Musaliar**

## Message from Principal



It gives me immense pleasure to know that the Department of Civil Engineering, TKM College of Engineering is organising the sixth International Conference on Modeling and Simulation in Civil Engineering (ICMSC 2022) during 1–3 December 2022. I am confident that the conference will be a forum for the exchange of knowledge and professional interaction among the researchers and academicians from various fields of Civil Engineering. I wish the conference all success. I take this opportunity to congratulate the organisers of the conference for their efforts and contributions in successfully arranging the conference, and in publishing the selected papers as proceedings.

**Dr. T. A. Shahul Hameed**

Principal, TKM College of Engineering

## Message from Convener



The Department of Civil Engineering, TKM College of Engineering is one among the oldest and most dynamic Engineering Departments in the State of Kerala. Ever since its inception, the department has been a hub of academic excellence giving great emphasis on research and consultancy, leading to the status of accreditation for the UG and PG programmes by NBA and Autonomous status by the University Grants Commission (UGC) and the APJAKTU.

ICMSC has gained reputation among the academic community by offering attendees a platform to learn, to share and to discuss their needs at both national and international levels in the field. The warm reception that the previous five editions of this conference received has motivated and encouraged the department to bring out a book of abstracts of the 6<sup>th</sup> ICMSC to be held during 1-3 December 2022 with over 50 technical papers from various national and international universities.

I am sure that this conference proceedings with selected high quality 32 papers will perhaps be a conceptual document of the technological advancements presented during the conference.

**Dr. Sajeeb R.**

Professor & Head, Department of Civil Engineering  
Convener, ICMSC 2022

## **Our Patrons**

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Professor & Head  
Department of Civil Engineering  
TKM College of Engineering

### Coordinator



**Dr. Seema K. Nayar**  
Professor  
Department of Civil Engineering

### Coordinator



**Dr. K. P. Ramaswamy**  
Associate Professor  
Department of Civil Engineering

### Treasurer



**Dr. Munavar Fairooz C.**  
Assistant Professor  
Department of Civil Engineering



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- Dr. Gubash Azhikodan, Department of Civil and Environmental Engineering, Tokyo Metropolitan University, Japan.
- Vice Chancellor, APJ Abdul Kalam Technological University, Kerala, India.
- Dr. Ayooob S., Pro Vice Chancellor, APJ Abdul Kalam Technological University, Kerala, India.
- Dr. Monto Mani, Professor, Centre for Sustainable Technologies (formerly ASTRA), & Centre for Product Design & Manufacturing, Indian Institute of Science, Bangalore, Karnataka, India.
- Dr. Bhargav Maitra, Professor in Civil Engineering, Indian Institute of Technology Kharagpur, India.
- Dr. K. B. Anand, Professor, Department of Civil Engineering, School of Engineering, Coimbatore, Tamil Nadu, India.
- Dr. Kasthurba A. K., Professor and Head, Department of Architecture and Planning, National Institute of Technology, Calicut, Kerala, India.
- Dr. Manoj P. Samuel, Executive Director, Centre for Water Resources Development and Management, Government of Kerala, India.
- Dr. Renjith K. R., Scientist B, Ecology and Environment Research Group, Centre for Water Resources Development and Management (CWRDM), Government of Kerala, India.
- Dr. Subha V., Professor, School of Engineering, Cochin University of Science and Technology, Kochi, Kerala, India.
- Dr. Binu Sukumar, Professor & Head, Department of Civil Engineering, R.M.K. Engineering College, Thiruvallur, Tamil Nadu, India.

## **Department Organising Committee**

### **Convenor**

Dr. Sajeeb R.

### **Coordinators**

Dr. Seema K. Nayar

Dr. Ramaswamy K. P.

Dr. Munavar Fairouz C.

### **Organizing & Venue Management**

Dr. Anu V. Thomas (Convenor)

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**Registration**

Prof. Shefeena N. (Convenor)  
Prof. Mohasin Haroon  
Smt. Waheeda Wahab  
Smt. Zajna Z.  
Smt. Shifinamol S.

**Offline Workshop/ Expo**

Dr. Muhammed Siddik A.  
Prof. Bushra M. A.  
Prof. Mamatha M.  
Prof. Asif Basheer  
Prof. Athul M. Madhu  
Prof. Alan Verghese Ittyeipe  
Prof. Anas A.  
Sri. Mohammed Riyas A.

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**Finance**

Dr. Munavar Fairouz C. (Treasurer)  
Sri. Thameem T.  
Prof. Karthika M. G.  
Prof. Nisha M. D.

## Keynote Speakers



### **Dr. Narayanan Neithalath**

Professor of Structural Engineering and Materials,  
School of Sustainable Engineering and Built  
Environment at Arizona State University, USA

Narayanan Neithalath is a Professor of Structural Engineering and Materials in the School of Sustainable Engineering and Built Environment at Arizona State University (ASU). He obtained his Ph.D. in Civil Engineering Materials from Purdue University in 2004, and was a faculty member at Clarkson University in Potsdam, New York until 2011. His research interests are in the area of materials science of novel and sustainable cementitious materials for infrastructure, energy efficient materials and design, micro- and nano-mechanics of materials, and chemistry, materials science and mechanics-based modeling of materials. He has published more than 150 papers in international journals, and more than 200 in refereed conference proceedings and publications. He has carried out research projects for various federal, state, and industrial entities, amounting to more than \$12 million. He is the recipient of the prestigious Walter L. Huber Civil Engineering Research Prize of the American Society of Civil Engineers. Prof. Neithalath is the Section Editor of the Journal of Materials in Civil Engineering published by the American Society of Civil Engineers, and the Associate Editor of the Elsevier journal Cement and Concrete Composites.



## **Dr. Vinu Unnikrishnan**

Assistant Professor, West Texas A&M University, USA

Dr. Vinu Unnikrishnan is presently Assistant Professor in the West Texas A&M University, USA. He received the Bachelor of Technology degree from the University of Kerala, India, Master of Science degree from the Indian Institute of Technology Madras, India and Ph.D. from Texas A&M University, College Station, all in Civil Engineering. He was a Post-Doctoral Research Associate in Mechanical Engineering also at Texas A&M University. Prior to joining WTAMU, he was an Assistant Professor in the Aerospace Engineering and Mechanics Department at The University of Alabama. He is also a Professional Affiliate Member of The Laura W. Bush Institute for Women's Health, Texas Tech University Health Sciences Center, from May 2019 onwards. His research interests include computational mechanics, experimental design- development, and computational modeling and simulation of soft materials and multifunctional nanocomposites. He has successfully developed state-of-the-art computational tools for the analysis of human pathologies, with a focus on developing market driven prototypes technologies using novel biomaterials for which he holds the two United States patents. His current focus is on developing novel computational tools for the analysis of thermal conductance of multifunctional carbon nanotube junctions and composites for aerospace and industrial applications, and anisotropic characterization of soft polymeric composite materials. He holds two U.S. patents on biofidelic soft skin simulants and customized insoles for diabetic and pressure ulcers, has authored over 42 journal papers and 90 conference publications and 4 book chapters on various topics in mechanics of nano- and biomaterials. He has also given numerous invited lectures and has been an invited speaker at numerous conferences nationally and internationally.



**Dr. Laxmi Sushama**

Professor in Civil Engineering, McGill University,  
Canada

Dr. Laxmi Sushama is Professor in Civil Engineering and holds the position of Trottier Chair in Sustainability in Engineering and Design in McGill University, Canada. She did post- doctoral fellowship , University of California, Los Angeles and University of Quebec at Montreal. She obtained her Ph.D. in Civil and Environmental Engineering from University of Melbourne, Australia. She has M.S. in Engineering Hydrology from National University of Ireland and Masters in Civil Engineering (Hydromechanics and Water Resources Engineering) from Indian Institute of Science, Bangalore. Her research group - Climate Change and Sustainable Engineering and Design (CCaSED) - brings together the fields of engineering and natural sciences, to develop and support integrated innovative approaches to sustainable engineering in the context of a changing climate. The group performs targeted super-resolution climate simulations and machine learning-based emulations to inform engineering systems and operations including renewable energy systems, cold regions engineering, water resources engineering, engineering hydrology, transportation engineering, urban planning and design. Dr. Sushama collaborates with researchers from across Canada and internationally from academia, federal and provincial organizations, private sector and non-profit organizations. Dr. Sushama's projects are/were funded through various NSERC programs (CRD, Discovery, CREATE, Engage), CRC, MITACS, CFCAS, FRQNT, and other federal/provincial organizations and NGOs. Dr. Sushama was previously Professor and Canada Research Chair in Regional Climate Modelling at Centre ESCER. She has led many major Networks including the NSERC-CCAR funded Canadian Network for Regional Climate and Weather Processes. She has publications in several international journals of high repute and has presented her work at many international conferences.



**Dr. Shubhajit Sadhukhan**

Assistant Professor, Department of Architecture and Planning, IIT Roorkee

Dr. Shubhajit Sadhukhan is presently Assistant Professor in the Department of Architecture and Planning at Indian Institute of Technology Roorkee. Earlier he served the National Institute of Technology Patna for four and half years as Assistant Professor in the Department of Architecture. Dr. Sadhukhan received his Ph.D. from Indian Institute of Technology Kharagpur in 2017. In 2010, he obtained his Master of Technology (M. Tech) Degree in Infrastructure Design and Management from Indian Institute of Technology Kharagpur and was also awarded the 'Institute Silver Medal'. He completed his Bachelor in Architecture (B. Arch) with Honours in 2008 from Jadavpur University, Kolkata. He has exposure in both the fields of Architecture and Transport Infrastructure Facility Planning. He has publications in several international journals of high repute and presented his work at many international conferences. His current research includes urban mobility planning, sustainable transportation and accessibility design, urban infrastructure planning and management.

## Peer Review Policy

All manuscripts submitted to this conference were peer-reviewed following the procedure outlined below-

**Preliminary Evaluation:** Preliminary evaluations of the manuscripts were conducted by the editors. Manuscripts with serious scientific flaws or those falling outside the scope of the conference were subjected to rejection. Additionally, all submissions undergone plagiarism checks, and manuscripts with significant plagiarism were rejected at this stage. Authors were provided with the opportunity to revise and resubmit their manuscripts if they exhibit language issues, grammatical errors, or insufficient novelty. Those manuscripts meeting the minimum criteria were subsequently forwarded to experts for further review. Authors of manuscripts rejected at the preliminary stage were promptly informed within one week of submission.

This conference proceeding employed a single-blind review process, where the reviewer remained anonymous to the authors throughout the process. Reviewers were matched to the articles according to their expertise. They were asked to evaluate the manuscripts and prepare review reports based on the following criteria:

- Originality of work.
- Suitability for publication.
- Adherence to ethical guidelines.
- Clarity and support of results in the conclusions.
- Proper referencing of relevant prior work.

**Peer Review Process:** Reviewers were requested to advise the editors on whether to accept or reject the submitted manuscript and to provide suggestions or modifications to enhance the quality of manuscript. Upon receiving the Review Reports, the editors made the final decisions on the acceptance or rejection of the manuscripts. These decisions were communicated to the authors, along with any recommendations made by the reviewers. Following the peer review process, 32 manuscripts were accepted for publication. The entire process of submission, review, and communication with authors was facilitated through the utilization of the Microsoft Conference Management Toolkit (CMT). The committee and technical chairs would like to express their gratitude to all the reviewers for their diligence and for dedicating their time, effort, and technical expertise to the review process.



## **List of Technical Reviewers**

Dr. Albert Thomas, Indian Institute of Technology, Bombay, India  
Dr. Alexandra Bertron, INSA Toulouse, Cedex 4, France  
Dr. K.B. Anand, Professor, Amrita School of Engineering, Coimbatore, Tamil Nadu, India  
Dr. Binu M Issac, Amal Jyothi College of Engineering, Kanjirapally, Kottayam, Kerala, India  
Dr. Binu Sukumar, R.M.K. Engineering College, Thiruvallur, Tamil Nadu, India  
Dr. Dhanya B.S., RIT, Kottayam  
Dr. Kasthurba A.K., National Institute of Technology, Calicut  
Dr. Laxmi Sushama, McGill University, Canada  
Dr. Mini Koshy, RIT Kottayam  
Dr. Monto Mani, Indian Institute of Science, Bangalore  
Dr. Prahsant Prasad, BITS Mesra  
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Dr. B. Saraswathy, TKM Institute of Technology  
Dr. Swathy Manohar, IIT Bombay  
Dr. Vinu Unnikrishnan, West Texas A&M University, USA  
Dr. Vishnu Radhakrishnan, NIT Suratkal  
Dr. Sajeeb R, TKM College of Engineering, Kollam, Kerala, India  
Dr. Seema K. Nayar, TKM College of Engineering  
Dr. Adarsh S., TKM College of Engineering  
Dr. Ramaswamy K. P., TKM College of Engineering  
Dr. Anu V. Thomas, TKM College of Engineering  
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Dr. Munavar Fairouz C., TKM College of Engineering  
Dr. Kavitha Madhu, TKM College of Engineering  
Dr. Chinsu Mereena Joy, TKM College of Engineering  
Dr. Jithin Raj P. V., TKM College of Engineering

# Program Schedule

## 1<sup>st</sup> December 2022, Thursday

10:00 a.m.	<b>Inauguration of ICMSC 2022</b> : Dr. Narayanan Neithalath
10:30 a.m.	<b>Inauguration of the Centre for Sustainable Practices:</b> Dr. B. V. Venkatarama Reddy
11:15 a.m.	<b>Keynote 1:</b> Dr. Narayanan Neithalath
12:15 p.m.	<b>Keynote 2:</b> Dr. B. V. Venkatarama Reddy
01:30 p.m.	<b>Keynote 3:</b> Dr. Shubhajit Sadhukhan
02:30 p.m.	<b>Technical Sessions (Parallel)</b> Session 1A: Transportation Engineering Session 1B: Transportation Engineering

## 2<sup>nd</sup> December 2022, Friday

09:00 a.m.	<b>Keynote 4:</b> Dr. Laxmi Sushama
10:00 a.m.	<b>Technical Sessions (Parallel)</b> Session 2A: Building Technology & Construction Management Session 2B: Water Resources & Environmental Engineering
02:00 p.m.	<b>Keynote 5:</b> Dr. Vinu Unnikrishnan
03:00 p.m.	<b>Technical Sessions (Parallel)</b> Session 3A: Structural Engineering Session 3B: Structural Engineering

## 3<sup>rd</sup> December 2022, Saturday

09.30 a.m.	Valedictory Session
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# Inaugural Session

1<sup>st</sup> December, 2022

APJ Hall, TKM College of Engineering, Kollam, Kerala, India

09:30 a.m.	<b>Welcome Address</b> Dr. Sajeeb R., Head of the Department of Civil Engineering
09:40 a.m.	<b>Overview of the Conference</b> Dr. Seema K. Nayar, Coordinator, ICMSC 2022
09:50 a.m.	<b>Presidential Address</b> Jb. T.K. Shahal Hassan Musaliar, President, TKM Trust
10:00 a.m.	<b>Inauguration of ICMSC 2022</b> Dr. Narayanan Neithalath, Professor, School of Sustainable Engineering and the Built Environment, Arizona State University
10:10 a.m.	<b>Release of the Book of Abstracts</b> Jb. T.K. Jalaluddin Musaliar, Treasurer, TKM College Trust
10:20 a.m.	<b>Centre for Sustainable Practices: The Dream Come True</b> Dr. K.P. Ramaswamy, Coordinator, ICMSC 2022
10:30 a.m.	<b>Inauguration of the Centre for Sustainable Practices</b> Dr. B. V. Venkatarama Reddy, Professor (Rtd.), Department of Civil Engineering, Indian Institute of Science, Bangalore
10:40 a.m.	<b>Felicitations</b> Dr. T. A. Shahul Hameed, Principal, TKM College of Engineering
10:50 a.m.	<b>Vote of Thanks</b> Dr. Munavar Fairouz C., Treasurer, ICMSC 2022
11:00 a.m.	<b>Tea Break</b>
11:15 a.m.	<b>Keynote Lecture</b> Dr. Narayanan Neithalath: Journey towards Carbon Neutrality: Construction's Realistic Path
12:15 p.m.	<b>Keynote Lecture</b> Dr. B. V. Venkatarama Reddy: Whither Sustainable Development?

# Valedictory Function

3<sup>rd</sup> December, 2022

APJ Hall, TKM College of Engineering, Kollam, Kerala, India

Welcome Address	:	Dr. Seema K. Nayar Coordinator, ICMSC 2022
Conference Summary	:	Dr. Ramaswamy K. P. Coordinator, ICMSC 2022
Presidential Address	:	Dr. T. A. Shahul Hameed Principal, TKM College of Engineering
Certificate distribution	:	Dr. Sajeeb R. Professor & Head, Department of Civil Engineering
Vote of Thanks	:	Dr. Munavar Fairouz C. Treasurer, ICMSC 2022

## Acknowledgement

The editors of the 6<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering (ICMSC 2022) express their sincere thanks to Dr. Shahal Hassan Musaliar (President, TKM College Trust), Sri.T. K. Jalaluddin Musaliar (Treasurer, TKM College Trust), other TKM Trust members, Dr. T. A. Shahul Hameed (Principal of TKM College of Engineering) for their guidance and support in conducting ICMSC 2022.

We extend our heartfelt gratitude and sincere thanks to the Chief Guest of the day, Dr. Narayanan Neithalath, Professor, School of Sustainable Engineering and the Built Environment, Arizona State University, who inaugurated the conference and delivered a keynote talk on the topic “Journey towards Carbon Neutrality: Construction’s Realistic Path”. We also extend our sincere thanks to Dr. B. V. V. Reddy, Former Professor of Indian Institute of Science, Bengaluru who inaugurated the Centre for Sustainable Practices (CSP) and delivered the keynote talk on the topic “Whither sustainable Development?”.

We also extend our sincere gratitude to the keynote speakers for sharing their knowledge and experience in their domain of expertise. We wish to thank the delegates, researchers and industry experts, for contributing papers and participating in the discussions, physically and virtually, thus enriching the Conference. We also wish to thank to the reviewers and the Chairpersons of the technical sessions for the time and efforts they invested in the assigned jobs thereby improving the quality of the discourses and the publications.

The organizers wish to place on record our sincere thanks to the sponsors: TEQIP II, RAMCO Cements, Kerala Minerals and Metals Ltd. (KMML), Smithline Reinforced Composites, Habilete Learning Solutions Pvt. Ltd. and GeoERA.

We wish to thank the Organizers of the Conference, the Head, faculty and staff of the Department of Civil Engineering, TKM College of Engineering, for their wholehearted support in conducting the Conference and for bringing out the Proceedings.

**Dr. Seema K. Nayar**  
**Dr. Ramaswamy K. P.**  
**Dr. Munavar Fairouz C.**  
(Editors)

# Proceedings of the 6<sup>th</sup> International Conference on Modeling and Simulation in Civil Engineering



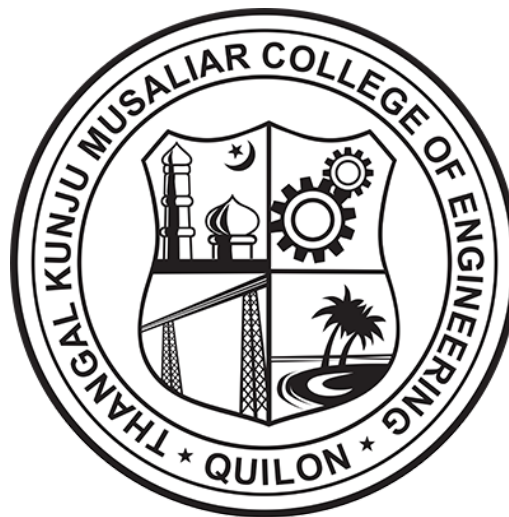
*Editors:*

Seema K. Nayar

Ramaswamy K. P.

Munavar Fairouz C.

*Organized by*



Department of Civil Engineering  
TKM College of Engineering, Kollam, Kerala, India

1-3 December 2022