Proceedings of

CIVIL ENGINEERING

Research Symposium 2023

CERS 2023

BOOK OF ABSTRACTS

Department of Civil Engineering

University of Moratuwa

September 2023

CIVIL ENGINEERING RESEARCH SYMPOSIUM

2023

27th September 2023

Department of Civil Engineering

University of Moratuwa

Sri Lanka

Dedicated to

Professor Malik Ranasinghe

Professor Athula Kulathilaka

Professor Anura Nanayakkara

Professor Ruwan Weerasekera

formally retiring from University of Moratuwa on 30th September 2023.

Proceedings of the Civil Engineering Research Symposium - 2023

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Civil Engineering Research Symposium 2023

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Message from the Head of the Department

As the Head of the Department, I am delighted to present the proceedings of the Civil Engineering Research Symposium (CERS) 2023. The proceedings consist of the research outputs of undergraduate students of 2018 Intake, a selected group of researchers from National Building Research Organisation (NBRO) and a selected group of postgraduate students.

This event stands as a testament to the incredible dedication, innovation, and passion that our department embodies. The field of civil engineering plays an indispensable role in shaping the world around us. It is not merely about constructing buildings but about creating a sustainable and resilient future for generations to come. This symposium serves as a platform for us to celebrate the relentless pursuit of knowledge and sharing of groundbreaking research that will drive our profession forward. This forum is an opportunity to exchange ideas, foster collaboration, and inspire each other to push the boundaries of what civil engineering can achieve. Since our department is at the forefront of research in multi-faceted areas, I am confident that the presentations and discussions at the Symposium will provide valuable insights and solutions.

Another unique feature of CERS 2023 is that the Symposium is dedicated for four of our own eminent professors who retire from the service on 30 September 2023, Prof. Malik Ranasinghe, Prof. Anura Nanayakkara, Prof. Athula Kulathilaka and Prof. Ruwan Weerasekera. All four retiring professors have been the pillars of knowledge, wisdom, and inspiration in our academic journey. Your tireless dedication to teaching, research, and mentorship has left an indelible mark on all of us. Your contributions to the field of Civil Engineering have not only advanced the science and technology of our discipline but have also paved the way for countless students to embark on their own paths to success.

Finally, I would like to express my deepest gratitude to all the researchers, students and industry professionals who have dedicated their time and expertise to contribute to make this event a success. Your passion for advancing the field of civil engineering is truly inspiring. I also want to thank our sponsors and partners for their unwavering support. Your contributions enable us to organise a symposium of this calibre and facilitate knowledge sharing that has the potential to shape the future of civil engineering. In closing, I am excited about the wealth of knowledge that will be shared during this symposium and the positive impact it will have on our field.

Prof. (Mrs.) Chintha Jayasinghe

Senior Professor in Civil Engineering
Head of the Department of Civil Engineering
University of Moratuwa

- Dedicated to -

Professor Malik Ranasinghe

Professor Athula Kulathilaka

Professor Anura Nanayakkara

Professor Ruwan Weerasekera

Professor Malik Ranasinghe

Professor Ranasinghe was appointed to the Department of Civil Engineering at the University of Moratuwa as a Probationary Assistant Lecturer in June 1984. In 1985 he won an Open Canadian Commonwealth Scholarship for his postgraduate studies. In 1986 he obtained his MASc degree and in 1990 his PhD degree in Civil Engineering Economics from the University of British Columbia, Vancouver, Canada. After completing his doctoral degree, Professor Ranasinghe returned to the University of Moratuwa in October 1990, and he was appointed as a Senior Lecturer Grade II.

In June 1996, Professor Ranasinghe was promoted on merit to Associate Professor in Civil Engineering. In August 2000, he was promoted on merit as Professor in Civil Engineering and in August 2008, he was promoted to Senior Professor. His research focus was to combine civil engineering economics, risk analysis and environmental economics with project management. He has 140 research publications, of which over 75 are international refereed publications. He is a Sri Lanka Tier 4* researcher and his Hirsch Index (h-Index) for research publications is 19.

In April 2000, Professor Ranasinghe was appointed as Head, Department of Civil Engineering. In March 2001, he was elected as the Dean of the Faculty of Engineering. It was a challenging period as the new Semester system was introduced to the Faculty of Engineering. He effectively managed the transition to the Semester system, the students as well as the staff members. In March 2004 he stepped down as Dean of the Faculty of Engineering after one term.

In November 2005, Professor Ranasinghe was appointed as Vice Chancellor of the University of Moratuwa. He served two terms as the VC. His End of Term report approved by the University Council concluded that during the last six years (2005-2011), the image of University of Moratuwa had improved significantly, had earned accolade from the Auditor General and the Chairman of the Committee on Public Enterprises (COPE) as one of the best managed public enterprises in Sri Lanka, and was reflected in the latest global ranking, the perception of the employers and the Society.

Professor Ranasinghe was a former member of the University Grants Commission, a Council Member of the National Research Council, a former Chairman of the Committee of Vice-Chancellors and Directors (CVCD), a former Council Member of the Association of Commonwealth Universities, and former Chairman, Centre of Excellence in Project Management at the University of Moratuwa. He was a Fellow at the National University of Singapore during his sabbatical leave.

In 1999, Professor Ranasinghe was awarded the SLASS General Research Committee Award for Outstanding Contribution to Sri Lankan Science, UGC and Hiran Tillekaratne Research Fund Award for Outstanding Postgraduate Research – 2000 in the academic discipline of Engineering for the period 1975 to 1999, Professor E O E Pereira Award for the Best Paper presented at the Annual Sessions 1998/99 of the IESL. Professor Ranasinghe was awarded the

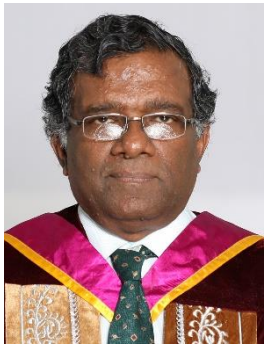
Trinity Prize for Engineering for 2004 in recognition of the outstanding contributions made to his chosen profession, the CVCD awarded its biennial Most Outstanding Senior Researcher in Technology and related Sciences including Engineering, Architecture, Quantity Surveying and Information Technology award in 2012. World Education Congress 2012, Mumbai, India honoured him with the award for Outstanding Contribution to Education. At the 4th Asia's Best B-School Awards 2013 held in Singapore, he was honoured with the prestigious Education Leadership Award. In January 2022 Professor Ranasinghe delivered the inaugural Rev. A.G Fraser Memorial Oration as the main event of the 150th Anniversary celebrations of Trinity College, Kandy.

Professor Ranasinghe is a Chartered Engineer, International Professional Engineer and Fellow of the Institution of Engineers, Sri Lanka, Fellow of the National Academy of Sciences, Sri Lanka, Fellow of the Institute of Project Managers, Sri Lanka and Graduate Member of Sri Lanka Institute of Directors. He is the Chairman of the Information and Communication Technology Agency (ICTA) of Sri Lanka.

Since 2003 Professor Ranasinghe has been an Independent non-Executive Director of Public Listed Companies (PLCs). At present he is an independent non-Executive Director of Access Engineering PLC, Resus Energy PLC, Teejay Lanka PLC and United Motors Lanka PLC. He was a former Chairman of Sampath Bank PLC and former non-executive Director of the Colombo Stock Exchange, Sampath Bank PLC, Hemas Power PLC, and Lanka IOC PLC.

Professor Ranasinghe along with the Director, CODL helped to launch the online education initiative open.uom.lk platform on 22 February 2022, a free of charge platform to prepare school leavers to be employable Trainee Full Stack Developers. Today, the open.uom.lk platform has over 220,000 students registered on it, exponentially exceeding the modest expectations UoM had at its launch. In October 2022 open.uom.lk and its developers including Professor Ranasinghe were awarded the prestigious 8th European eLearning Excellence Award for 2022.

Professor Athula Kulathilaka



Professor Kulathilaka obtained BSc Eng (Hons) in Civil Engineering from the University of Moratuwa with first class honours in 1981. He joined the Department of Civil Engineering as a Probationary Assistant Lecturer in July 1981 and proceeded for postgraduate studies in 1984 on receiving a Scholarship from Monash University, Australia.

Professor Kulathilaka obtained his doctoral degree from Monash University specialising in the field of Geotechnical Engineering. Upon his return, he was appointed Senior Lecturer Grade II in April 1991. He was promoted Senior Lecturer Grade I in April 1997, Professor on merit in April 2006 and Senior Professor in 2014. He is a Chartered Engineer since 2004.

Professor Kulathilaka was the Head of the Department of Civil Engineering from March 2019 to June 2021. He served the University as Chairman - Staff Development Centre, from September 2008 to September 2013 where a Centre for IT skills with 35 computers was developed with special funding from University Grants Commission.

Professor Kulathilaka pursued research in the areas of Earth Retaining Structures, Ground Improvement Techniques, Unsaturated Soil Mechanics, Rain induced Slope Failure and Stabilisation of Slopes. He has supervised many undergraduate projects in these areas and more than 30 postgraduate projects. He has published over 100 refereed research articles in conferences and refereed journals.

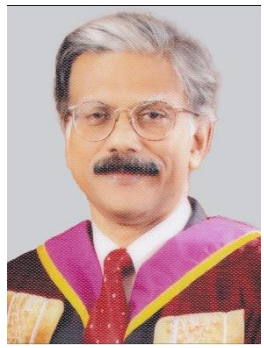
Professor Kulathilaka has provided guidance to Road Development Authority and National Building Research Organisation (NBRO) through his expertise in the field of geotechnical engineering in construction of expressways in the country in the areas of Soft Ground Improvement and Stabilisation of Cut Slopes. The experience gained through these projects led to the upgrading the teaching materials and formulating research projects, thus benefitting both undergraduate and postgraduate students. He won the Commonwealth Research Fellowship to University of Newcastle Upon Tyne in the UK in 2004.

Professor Kulathilaka has provided expert guidance to NBRO in many Landslide Rectification projects throughout the country. He has guided young Engineers in the design measures for many potential landslides and post landslide rectifications. Professor Kulathilaka has contributed immensely to the advancement of Geotechnical Engineering through numerous activities conducted by the Sri Lankan Geotechnical Society. He held the posts of Honorary Secretary from 1994-2004, Vice President from 2005-2011 and President from 2011 to 2021. During this period, the Geotechnical Society organised several activities to advance the field of Geotechnical Engineering in the country. Three International conferences were organised in 2007, 2015 and 2021 with the participation of world renowned academics and practitioners as keynote speakers and resource persons along with Sri Lankan Geotechnical Engineers. Workshops were conducted with leading international experts to transfer new knowledge. Events such as Project Day (conducted annually uninterrupted from year 2000) – a competition

among undergraduate students doing research projects in the field of Geotechnical Engineering were organised to enhance their research and presentation skills.

Professor Kulatilaka is among those who entered the portals of the University of Moratuwa, then a fledgling university as a young undergraduate. His uninterrupted service of dedication and commitment to the University, in the fields of teaching, research and consultancy, for a period of over four decades is an inspiration to his colleagues who consider him a mentor and role model.

Professor Anura Nanayakkara



Professor Nanayakkara obtained BSc Eng (Hons) in Civil Engineering from the University of Moratuwa in 1982. He was recruited to the academic staff of the university immediately thereafter as a Probationary Assistant Lecturer in the Department. He proceeded to the University of Tokyo in 1985 from where he obtained both an M.Eng degree in 1987 and a D.Eng degree in 1990. His doctoral dissertation was on the topic of "Computational model for pumpability of concrete". Professor Nanayakkara returned to the University of Moratuwa in 1990 as a Senior Lecturer Grade II and was promoted to Professor on merit in 2006 and Senior Professor eight years thereafter.

Professor Nanayakkara served as Head of the Department of Civil Engineering from 2013 to 2016. During this period, he was also required to act as dean of the Faculty of Engineering on four occasions. It was during his tenure as Head of Department, that the Department of Civil Engineering obtained full accreditation from the Institution of Engineers Sri Lanka for its undergraduate degree which granted recognition among the Washington Accord signatories.

Professor Nanayakkara's research is in the area of Concrete Technology focusing on the use of alternative ingredients used in making of concrete, mitigation of early age thermal cracking, and durability of concrete. The research carried out by Professor Nanayakkara and his collaborators has impacted the Sri Lankan construction industry beneficially. The use of offshore sand as an alternative to river sand, the use of fly ash in concrete (both to utilise a waste material and to improve concrete durability), and the mitigation of plastic shrinkage cracking in ready-mixed concrete pours have all been driven by their research. His research collaboration with National Building Research Organisation led to the patent on a highly permeable and energy absorbing paving block made from polyester spandex fabric waste where he is one of the three inventors.

Professor Nanayakkara's research has led to many publications and at present he counts 70 publications in refereed journals and conference proceedings. He won the Anton Award for the best technical paper on "Water related infrastructure" at Annual Sessions of IESL in 2006. He was the co-author of the paper that was adjudged as the best paper at the Annual Sessions of the Society of Structural Engineering Sri Lanka in 2018 which was awarded the Gold Medal. Professor Nanayakkara won the Commonwealth Academic Fellowship to Imperial College of Science Technology and Medicine, University of London in the UK in 2004 while in 1999 he secured the AIEJ (Association of International Education, Japan) Research Fellowship. He is the recipient of many awards for his outstanding contribution to industry and the Profession of Structural Engineering which includes the President's Award for his Scientific Research contribution in 2010 and 2017.

Professor Nanayakkara has contributed immensely to the development of national standards relating to building materials over the past 25 years having served and chaired working groups and sectoral committees of the Sri Lanka Standards Institution. Professor Nanayakkara was a committee member and Chairman of the committee set up to develop the Model Code for

Concrete in Asia from its formative stages. His expertise was sought by the NBRO where his shared knowledge, skills, and experience have enabled their research teams to achieve tangible outcomes. Professor Nanayakkara has made a significant contribution to the research and development programme at NBRO over the last ten years. Preparation of Handbooks for the selection of materials and products for the construction industry, development of alternative fibres for roofing sheets, and investigation of the suitability of Fly Ash Blended Cement for construction of concrete water storage tanks are some of his significant contributions.

Professor Nanayakkara's skills as an organiser and as chairperson have contributed to the success of many a conference both in Sri Lanka and overseas. He also serves as a reviewer of prestigious journals such as the Journal of the American Society of Civil Engineers Journal of Materials in Civil Engineering and the Construction and Building Materials Journal.

Professor Nanayakkara is a chartered engineer, of the Institution of Engineers, Sri Lanka, and an Honorary Fellow of the Society of Structural Engineers, Sri Lanka. He has been involved in many structural assessment projects for industry. He was a Senior Structural Engineering Consultant for the Project Consultancy Unit, University of Moratuwa on the design review and approval of the Colombo Lotus Tower Project. Assessment of properties of PFA blended cement in concrete in 2000, assessment of suitability of offshore sand, manufactured sand and quarry dust for concrete plastering work in 2002, development of an inorganic polymer concrete material for walling units in 2004, investigation of pile cap cracking of Southern Transport Development Project in 2009 and review of structural design of rapid sand filter house of Chilaw water treatment plant in 2012, are some of his other notable contributions.

An alumnus of the University of Moratuwa, Professor Nanayakkara counts over forty years of uninterrupted service to the University, in the fields of teaching, research and consultancy. His commitment and excellence in research in Concrete Technology is unparalleled.

Professor Ruwan Weerasekera

Professor Weerasekera obtained BSc Eng (Hons) in Civil Engineering from the University of Moratuwa in 1982 and joined the Department of Civil Engineering as a Probationary Assistant Lecturer in July 1983. He proceeded for postgraduate studies in 1985 upon receiving a Scholarship from the University of Calgary, Alberta, Canada.

Professor Weerasekera obtained his doctoral degree from University of Calgary specialising in the field of Structural Engineering in 1991 and returned to the University of Moratuwa as a Senior Lecturer Grade II. He was promoted Professor on merit in 2009 and Senior Professor in 2017. He obtained charter status from the Institution of Engineers Sri Lanka in 2006.

Professor Weerasekera led the Building and Structural Engineering Group of the Department for over seven years and contributed to the improvement of structural analysis and design modules of the undergraduate programme. He played a pioneering role in the commencement of the postgraduate course in Structural Engineering Design and served as its first coordinator. He taught a number of modules on the course and even those on the Highway Engineering postgraduate programme.

Professor Weerasekera also served as the first Director, Quality Assurance of Faculty of Engineering for 3 years. He introduced a process of documentation that enhanced the quality of teaching and assessment within the faculty.

Professor Weerasekera's research interests are in Structural Engineering and encompasses Analysis, Design and Materials Technology. His research has won awards. He is also the co-author of over 60 research papers.

Professor Weerasekera was also a resource person and the organiser of several short courses organised by the Department of Civil Engineering under the auspices of Uni-Consultancy Services of the Faculty of Engineering. The topics covered were Bridge Structures, Water-retaining Structures, Transmission line Structures and Finite Element Analysis. Some of these courses were repeated due to the heavy demand in the Industry and Academia with the support of ACECOMS, AIT of which Society of Structural Engineers acted as a Satellite Centre.

Having held several posts in the Society of Structural Engineers for well nigh twenty five year including that of Honorary Secretary for seven years, Professor Weerasekera was elected to the coveted position of President for four consecutive years (2012-2015). In the year 2015, he had the privilege of being Chair, of the Silver Jubilee International Conference in Structural Engineering in Colombo, on the theme "Towards Excellence in Structural Engineering". A conference well attended by world reputed professionals in Structural Engineering. In recognition of his overall career achievements and his dedicated service to the Structural Engineering community, he was conferred an Honorary Fellowship in 2017 by Society of

Structural Engineers, Sri Lanka. He has also been a practising Structural and Civil Engineer for several projects in Sri Lanka.

An alumnus of the University of Moratuwa, Professor Weerasekara's service spans forty years. His pioneering activities within the university and with the structural engineering fraternity is exemplary.

Symposium Agenda

08:30 – 08:35	Lighting the Oil Lamp
08:35 – 08:40	Opening remarks by the Head of the Department
08:40 – 08:55	Address by the Chief Guest, Mr.Daniel Bood, Chargé d'Affaires (acting), Canadian High Commission
08:55 – 09:30	Keynote Address by Eng. (Dr) Asiri Karunawardena, Director General, National Building Research Organisation
09:30 – 10:00	Morning Tea Break
10:00 – 10:40	Research Presentations: Technical Session 1[1]
10:40 – 11:00	Panel Discussion for Technical Session 1
11:00 – 11:40	Research Presentations: Technical Session 2[2]
11:40 – 12:00	Panel Discussion for Technical Session 2
12:00 – 12:40	Research Presentations: Technical Session 3[3] - NBRO
12:40 – 13:00	Panel Discussion for Technical Session 3
13:00 – 14:00	Lunch Break
14:00 – 14:25	3-MT Challenge Video Presentation and Award Ceremony
14:25 – 16:30	Farewell Lectures by Four Retiring Professors Prof. Malik Ranasinghe Prof. Anura Nanayakkara Prof. Athula Kulathilaka Prof. Ruwan Weerasekera
16:30	Concluding Remarks and Vote of Thanks by Conference Secretary

[1] Research Presentations: Technical Session 1 (10:00 – 10:40)

10:00 – 10:10	Analysis of curved crease origami structures by K.A.L.H. Kuruppu
10:10 – 10:20	Developing a masonry block by using glass waste as an alternative material by O.M. Hasaranga
10:20 – 10:30	Vulnerability of Colombo suburbs for Kelani river floods by P.G.T.N. Geeshan
10:30 – 10:40	Development of an economical level of service estimation model using GPS data in a mixed traffic condition by S.S. Jayawardhana

[2] Research Presentations: Technical Session 2 (11:00 – 11:40)

11:00 – 11:10	Finite element analysis of a deep excavation supported using a secant pile wall: a case study by V.S.S.D. Silva
11:10 – 11:20	Prediction and uncertainty quantification of mechanical properties of homogenised woven composites by G. N. C. Ariyasinghe
11:20 – 11:30	Assessing the readiness for digital technologies adoption for enhancing productivity in the Sri Lankan construction industry by I.H.N. Chathuranga
11:30 – 11:40	Evaluation of environmental impacts of solar PV systems with conceptual life cycle assessment and recycling of end-of-life PV panels by A.R.I. De Alwis

[3] Research Presentations: Technical Session 3 from NBRO (12:00 – 12:40)

12:00 – 12:10	Development of fibre-reinforced paving block for outdoor sports surfaces by G.K.B.M. Gannoruwa
12:10 – 12:20	Development of ISO standard sand from local silica sand deposits for cement testing by E.G.H.D.B. Ellegama
12:20 – 12:30	Roadside slope risk assessment in Sri Lanka by V.G.D. Gangani
12:30 – 12:40	Validation of rain-induced failure of unsaturated colluvium slopes: a case study by M.P. Amarasinghe

Keynote: An insight into the advances of Geotechnical Engineering in Landslides and soil improvement technology in Sri Lanka

About the Keynote Speaker

Eng. (Dr.) Asiri Karunawardena is the Director General/Chief Executive Officer of the National Building Research Organisation (NBRO) of Sri Lanka. NBRO is the main focal point for landslide disaster risk reduction in Sri Lanka and it is taking a leading role in promoting resilient and safe infrastructure construction in the country.

Dr. Karunawardena graduated as a Civil Engineer and obtained his Master's Degree in Geotechnical Engineering from the University of Moratuwa, and he obtained Doctoral degree of Engineering from Kyoto University, Japan. His major fields of work are related to Landslide risk reduction, Geotechnical Engineering applications, Resilient constructions, etc. He has engaged in many large-scale infrastructure development projects as a Geotechnical Expert and authored over 10 peer-reviewed technical papers. He is a Chartered Engineer and a member of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

As the Director General of the institute, he leads a team of multidisciplinary professionals to reduce the losses due to disasters by integrating disaster risk reduction into the planning and development process in the country to achieve the vision of safer built environment and sustainable development gains.

Synopsis

Landslides are a fatal natural cause in Sri Lanka, which needs to be determined and managed adeptly. Detailed field and laboratory investigations, instrumentation and monitoring were performed to investigate the characteristics and the possible causes of the landslide. As a proactive action to minimise the adverse impacts of landslides, structural mitigation is being carried out using several highly advanced slope stabilisation techniques by assessing the failure mechanism by applying Geotechnical Engineering principals. This includes the use of retaining walls, soil nailing, anchoring, or drainage systems, depending on the specific site conditions.

The construction of expressways in Sri Lanka involved in extensive ground improvement work as many parts of the Expressway traverses through flood plains and marshy ground consisting of very soft peat, organic soils, and clays. Soft ground improvement design had to be carried

out in order to control the settlements and to ensure the stability of the highway embankment. Depending on the ground conditions, various ground improvement methods including remove and replacement, preloading, preloading with vertical drains, dynamic compaction and vacuum consolidation were applied to improve the properties of the natural ground to support infrastructure development and mitigate the risks associated with weak or problematic soils.

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