CoMSIRU

Concrete Materials and Structural Integrity Research Unit

ANNUAL REPORT 2016

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Contents

Message from the director

2016 marked an important milestone for The Concrete Materials and Structural Integrity Research Unit (CoMSIRU). We were subjected to our first accreditation review by the University Research Committee, through a panel of local and international experts. The review focused on a range of research elements including coherence and focus of our research agenda, quality of research, local engagement and relevance, international and local networks, management and sustainability. Following this rigorous process, CoMSIRU has been accredited for another five years.

The accreditation process presented a perfect opportunity for reflection and stocktaking of our activities. CoMSIRU has enjoyed sustained growth in the last 5 years. The unit graduated 3 PhD and 51 Masters Students in the period 2010-2015, an average of 1 PhD every 2 years and 10 Masters Students per year, between three academics. The unit published one book, 40 peer reviewed journal papers, 60 peer reviewed conference papers and several reports during the period 2010-2015. The unit's finances also grew by approximately 40% in the period 2010-2015 despite economic challenges facing the construction industry.

While the unit recorded strong growth in the period 2010-2015, further growth in research productivity will be limited unless additional research staff are appointed at Post-Doctoral researcher level and above. The unit is currently actively pursuing funding for two Post-Doctoral Fellowships.

Our research strength is derived from a holistic approach combining material behaviour and structural behaviour to address industry needs. The work in this programme is long-term in nature, in view of the need to understand the behaviour of construction materials in real environments over extended periods. Projects are therefore aimed at understanding basic material and structural behaviour in laboratory studies, and then careful study of these materials and structures in service, so as better to inform practice. We will continue to actively strengthen this integrated approach so as to better inform this cycle of our accreditation. In

COMSIRU advisory board and students

particular, we will seek to take advantage of developments in data analysis and technological developments in sensing and computational methods to bridge the gap between material performance and structural performance, which are often considered independently.

We are fully aware that our success as a research unit is possible because of the generous support of our industry partners, who contribute more than two thirds of our funding, as well as government funding urgencies. Our Advisory Board continues to give critical feedback on our activities and helps us to sharpen our research questions. Your contribution is valued and appreciated, thank you.

We look forward to a productive 2017!

Prof Pilate Moyo

Introduction

CoMSIRU is an active research unit in the Department of Civil Engineering at the University of Cape Town. The unit's research is focused on durability of concrete structures, structural health monitoring, structural integrity assessment, and repair and rehabilitation strategies for concrete structures.

The guiding principle for CoMSIRU is developing high-level manpower for industry, research and academia, while engaging in innovative and impactful research. This is reflected in the strong integration between the unit's research, education and technology transfer activities. The unit maintains healthy and active links with industry through an advisory board, involvement in professional bodies and continuing professional development courses, as well as postgraduate training. CoMSIRU's well-established international links provide opportunities for collaborative research and benchmarking, which enables the research unit to continuously evolve and strengthen its niche research focus.

CoMSIRU's research enjoys high impact as measured by scholarly productivity, inclusion in local standards, local and international awards and the demand for its graduates in industry.

Objectives of the research unit

- Expand and improve the pool of high-level skills in concrete materials and structural engineering, in South Africa
- Influence the culture and practice of engineering design of concrete structures
- Improve management of the infrastructure
- Embed durability and sustainability in all aspects of concrete structural/civil engineering
- Promote structural health monitoring as a key tool for structural performance assessment

Staffing

Director	Co-director	Senior Research Scholar
Prof Pilate Moyo	Prof Hans Beushausen	Emer. Prof Mark Alexander

Honorary research associates

Prof Manu Santhanam
In 2010, Prof Santhanam joined COMSIRU where he has been providing expertise to the unit from the viewpoint of microanalytical characterization of cementitious materials, and participated in the adaptation of the EN concrete standards in South Africa. Prof Santhanam's research interest lies in cement chemistry, materials characterization and non-destructive evaluation.

Dr Sifiso Nhleko
A former student of UCT's civil engineering department, where he obtained both his BSc and MSc degrees, Dr Nhleko completed his PhD at the University of Oxford. In 2013 Dr Nhleko joined CoMSIRU, and has been presenting lectures to postgraduates on a yearly basis, along with various other activities within the research unit and department. With his main research interest in structural dynamics, he is involved in a wide variety of civil and structural engineering due to his current capacity in the nuclear industry.

Adjunct Professor Vernon Collis
Mr Collis has been co-supervising some of our post-grad students with Professor Alexander since 2007 and officially joined the CoMSIRU team four years ago, with research interests in sustainability.

Postdoctoral research fellows:

Dr Fulvio Busatta

Joining the CoMSIRU family in 2014 from Italy, Dr Busatta received an MSc (Eng) from University of Padova and a PhD in Structural, Earthquake and Geotechnical Engineering from Politecnico di Milano. Since his arrival Dr Busatta has been working closely with Professor Moyo and his research interests cover operational modal analysis, structural health monitoring and railway bridge dynamics.

Dr Ines Tchetgnia Ngassam

Joining the CoMSIRU family in 2015 from Cameroon, Dr Ngassam completed her PhD at University of Paris East in France on the durability of the reparation made with polymer-modified mortars. Since her arrival Dr Ngassam has been working closely with Professor Beushausen with her focus now on alternative formulations of repair mortars.

Teaching activities and postgraduate training

CoMSIRU is integrally involved in two postgraduate programmes within the Department of Civil Engineering namely, the Structural Engineering and Materials (SEM) Programme and the Civil Infrastructure Management and Maintenance (CIMM) Programme. CIMM was developed by the research unit to offer a broad range of knowledge and skills including asset management, maintenance, repair and rehabilitation of civil infrastructure in line with South African Government's Immovable Asset Management Act of 2007. Courses offered in these programmes are also open to industry for continuing professional development (CPD).

Postgraduate courses

Structural concrete properties and practice

The aims of the course are to provide structural engineers with fundamental and practical knowledge in concrete materials technology, to establish an understanding on modelling and designing concrete properties relevant to structural design, and to create awareness of chemical and physical material characteristics of cementitious construction materials.

Structural dynamics with applications

This course aims to introduce the concepts of structural dynamics and its applications in structural engineering. Specifically applications considered include applications to seismic design of structures, blast and impact effects on structures and wind engineering.

Bridge management and maintenance

This course aims to introduce the principles of bridge management and maintenance, with a focus on both highway and railway bridges. The course expands on the basic philosophies behind bridge management systems, the structure of a bridge management system and the implementation of bridge management systems. Key to this course is practical bridge inspections and case studies.

Durability and condition assessment of concrete structures

This advanced course aims to develop an understanding of durability aspects, service life design and non-destructive testing of concrete structures.

Structural performance assessment and monitoring

This aims to introduce concepts of structural health monitoring of civil infrastructure through static and dynamic field measurements as well as finite element modelling.

Repair and rehabilitation of concrete structures

This course deals with the repair and rehabilitation of concrete structures. Strengthening systems, using fibre-reinforced composites are also covered.

Advanced infrastructure management

This course provides the principles and the practice of infrastructure management.

Continuing professional development courses

Bridge design, analysis and construction

This course covers various practical aspects of bridge design, analysis and construction, including bridge loads, conceptual design, and structural design and construction technologies. Emphasis is on highway and railway bridges in reinforced and restressed concrete.

Bridge management and maintenance

The course provides guidance on the development and implementation of bridge management systems to facilitate effective maintenance and rehabilitation of bridge structures.

Condition assessment and repair/ strengthening of reinforced concrete structures

The purpose of the workshop is to provide participants with a fundamental and practical understanding of condition assessment of concrete structures, and concrete repair and strengthening methods.

Structural concrete properties and practice

The underlying aims of the workshop are to highlight the importance of materials in the design and performance of concrete structures and to facilitate a good understanding of modern concrete technology in order to promote economic and sustainable design of reinforced concrete structures.

CURRENT STUDENTS

In 2016, CoMSIRU had 49 registered postgraduate students: two postdoctoral fellows, four PhD, sixteen MSc (Eng) and twenty eight MEng students. Graduation statistics show one PhD and three MSc (Eng) in 2016. Details are given in the tables below.

	Total	Female	Male	Black/ Indian	White	Foreign	South African
Post Doc	2	1	1	1	1	2	0
PhD	6	1	5	6	0	6	0
MSc (Eng)	13	4	9	8	5	5	8
MEng	28	3	25	25	3	11	17
Grand Total	**49**	**9**	**40**	**40**	**9**	**24**	**25**

Postdoctoral fellows

NAME	SUPERVISOR	TITLE
F Busatta	P Moyo	Dynamic assessment and structural health monitoring of civil engineering structures
I Ngassam	H Beushausen	Development of new formulations of repair mortars by using polymers and quicklime.

2016 PhD students

NAME	SUPERVISOR	TITLE
R Gopinath	MG Alexander H Beushausen	A service life prediction model based on carbonation-induced corrosion for South African conditions
M Kabani	P Moyo MG Alexander	Time-dependent bridge network reliability assessment with health monitoring
P Bukenya	P Moyo H Beushausen	Dynamic characterisation of concrete dams using operational modal analysis
P Arito	H Beushausen MG Alexander	The optimisation of mixed design parameters and constituents to minimise cracking in patch repair mortars
R Heiyantuduwa	MG Alexander	Chloride prediction model for concrete durability
B Oyegbile	H Beushausen M Otieno	Performance of reinforcement corrosion repair using sacrificial anodes and patch repair mortars

2016 MSc (Eng) students

NAME	SUPERVISOR	TITLE
A Moore	H Beushausen	Critique of environmental exposure classification for tidal zone
H Sohawon	H Beushausen	Service life extension of reinforced concrete structures using silane impregnation.
N Omar	H Beushausen	Carbonation Predictions for Modern South African Concretes
M Holmes	MG Alexander	The optimisation of the packing of powder materials for the reduction of clinker content in concrete
S Ross	MG Alexander V Collis	Bamboo construction as a sustainable building technology from a structural and materials engineering perspective
S Balendra	H Beushausen	Performance approaches for concrete durability – developing a new framework for application
J Ndawula	H Beushausen	Multiphase modelling of deterioration of reinforced concrete structures
A Titus	MG Alexander	Properties of Western Cape concrete with metakaolin

NAME	SUPERVISOR	TITLE
C Ludwig	P Moyo	The influence of the structure-ballast rail interaction on the dynamic properties of railway bridges
B Nyoni	P Moyo	Numerical modelling of concrete hydropower dams exposed to ASR: long-term environmental effects of climate change
A Goodhead	P Moyo	Fatigue life of prestressed concrete sleepers on an open decked bridge
W Smith	H Beushausen	Reinforced Concrete Durability: The effective use of cover level with the application of surface treatments on reinforced concrete
P Jassa	H Beushausen	Alternative patch repair materials for rebar corrosion damage

2016 MEng students

NAME	SUPERVISOR	TITLE
G Abed	MG Alexander	Rebar corrosion of RC structures in the Cape Peninsula
A Allison	P Moyo	Determining the dynamic responses of the non-overspill bridge decks of the Van Der Kloof dam
K Chiremboa	H Beushausen	Thesis to be decided
C Dankers	P Moyo	The evaluation of the structural safety of concrete gravity dams
W Delport	P Moyo	Metholodgy to model dam foundations
B Fredricks	H Beushausen	Cracking and width prediction for concrete
B Gombele	P Moyo	Implementation of the DER system within power generated plant environment
I Hartley	MG Alexander	Integration of IDMS & SIPDM at local municipalities
G Hove	H Beushausen	Concrete crack repair
B Isaacs	P Moyo	A review of the TNPA 7 TFR infrastructure & asset maintenance manuals
L Jappie	H Beushausen	Protective coatings for concrete structures
C Koen	P Moyo	Statistical modelling of water pipeline failure

NAME	SUPERVISOR	TITLE
Z Mahomed	MG Alexander	Alkali aggregate reaction - current Western Cape mixes
A Marais	H Beushausen	Repair and strengthening of masonry structures
D Mashanda	H Beushausen	Concrete deterioration – trends and problems
K Mmekwa	P Moyo	The impact of aging infrastructure on South Africa's economy
M Mothetho	P Moyo	Assessing local water distribution infrastructure management and maintenance challenges
M Mulaudzi	H Beushausen	Quality assurance for the construction of concrete slabs placed on the ground
T Namalima	P Moyo	System analysis of railway bridges with concrete sleepers
D Ngwenya	P Moyo	Collapse of Tongaat Mall
E Nyambalo	H Beushausen	Thesis to be decided
M Poyo	H Beushausen	Abrassion resistance of Immersion-vibrated roller compacted concrete of the spillway steps
Z Prins	P Moyo	Investigating the operational behaviour of a double curvature arch dam
A Ragoleka	P Moyo	Vibration serviceability of footbridges in SA: An investigation of the crowd capacity of The Boomslang Footbridge.
B Rockstroh	H Beushausen	Deflection of suspended RC slabs
M Salie	P Moyo	BRT lane service life design and maintenance requirement
H Stehle	P Moyo	A comparative study on the structural behaviour of concrete arch dams subjected to swelling due to chemical reaction
L Thako	P Moyo	Railway tunnels management system in South Africa
H Van Wijk	H Beushausen	Thesis to be decided

2016 Graduated PhD students

NAME	SUPERVISOR	TITLE
M Kiliswa	MG Alexander H Beushausen	The influence of sewer environment parameters on the deterioration of concrete sewer pipes

Graduated master's degree students (2016)

NAME	SUPERVISOR	TITLE
Y Amesu	P Moyo	Fatigue reliability of pre-stressed reinforced concrete box-girder railway bridges
C Chibulu	H Beushausen MG Alexander	Influence of cement extenders on early-age stress development and cracking potential of concrete overlays
E Arito	H Beushausen	Performance requirements for patch repair mortar
S Kay	H Beushausen	The influence of concrete surface preparation on bond strength of protective coatings

Research activities

CoMSIRU's research work is focused on developing a deep understanding of both the short-term and long-term behaviour of concrete and developing methodologies for producing durable and structurally sound concrete that minimises maintenance costs.

Thus, there is a strong emphasis on understanding the deterioration mechanisms of concrete structures, development of technologies for assessment of concrete structures as well as development of life extension of deteriorated concrete structures. This is achieved through two broad research thrusts; concrete materials and construction and structural integrity and monitoring.

CoMSIRU's research work is supported by state-of-the-art laboratories for concrete technology and structural concrete. The research unit integrates laboratory work, field measurements and computational modelling of materials and structures, which places the research unit in a good position to develop realistic and practical engineering solutions.

An important consideration in deterioration science and renewal engineering is sustainability of materials and construction. To this end, the research unit has embarked

on developing knowledge and technologies that may be used by structural engineers to ensure their designs are sustainable.

Current research projects

i. Service life prediction models for reinforced concrete in the SA context

Service life prediction models exist at an international level, but it is essential that locality-specific models also be developed and calibrated, in view of the specificity of local environmental exposure conditions. Two such models are under development: one for chloride ingress into a wide variety of different concrete types, and the second a carbonation-corrosion model that couples CO_2 ingress with a tendency for subsequent corrosion.

ii. Low-clinker cements

It is imperative that modern concretes be formulated with as low a clinker factor as possible in the binder component, to minimise the carbon footprint of such concretes. This project considers practical ways of reducing the clinker factor of concrete using a combination of improved packing and reactivity of the fine filler materials, based largely on finely ground limestone and potentially reactive fly ash.

iii. Durability and deterioration studies

This research has been a consistent theme in CoMSIRU for many years. Currently, these studies relate to deterioration of concrete sewer pipes, for which PhD work is being done in order to better understand the deterioration processes in such sewers, and characterisation of the inter-tidal zone for chloride ingress into concrete. Work on deterioration of continuously reinforced concrete pavements has also been undertaken.

iv. Sustainability and resource minimisation studies

A PhD study was recently concluded that laid out a novel framework to assist structural concrete engineers to design for more sustainable concrete structures. Work is also ongoing on understanding how to minimise resource usage of concrete materials, and a study on local bamboo in construction is being completed.

v. Fatigue reliability and long-term monitoring of railway bridges

Developments in structural health monitoring of bridge structures are enabling the capture of information on as-built structural behaviour of these structures. Such information is useful for the assessment of the condition and reliability of bridges. This project is focused on the fatigue behaviour of concrete railway bridges. In particular, box-type sections will be considered. A monitoring system has been developed for the Olifants River Bridge, located in Vredendal.

vi. Bridge management systems

Visual inspection is the predominant bridge assessment technique employed by most current BMS. In South Africa, substantial visual inspection data has

been collect in the last decade. However, these data have not been analysed to determine predominant deterioration mechanisms. This project seeks to gain deeper understanding of deterioration mechanisms in bridges located in the Western Cape.

vii. Long-term performance of repaired reinforced concrete structures

There is a dearth of information on the long-term performance of repaired reinforced concrete structures. Quite often, infrastructure owners have no idea about the effectiveness of repair and strengthening interventions and their long-term performance. In particular, the long-term behaviour of new cementitious grouts for structural repairs as well as fibre-reinforced polymers (FRP) for structural strengthening is not well understood.

viii. Ambient vibration monitoring of concrete dams

Finite element modelling is a powerful tool for simulating structural system behaviour. In this body of work, updated finite element models will be used to predict the future behaviour of dams. Updating of the FEM models will be based on ambient vibration testing.

ix. Numerical modelling of the swelling effect of concrete structures

The chemical reactions involving aggregates, cement paste and water may lead to the swelling of concrete. Such volume changes lead to premature deterioration and, in some cases, structural failure. . A number of numerical models have been proposed to simulate the swelling action and compute the structural response to this internal loading.

Impact of research

The unit's research in concrete durability has been ongoing for more than two decades and has led to a better understanding of the deterioration mechanisms of concrete. Test methods for the durability of concrete developed by CoMSIRU researchers have now been refined to a point where they are now within the SABS system for acceptance as national standards. In addition, the revision of SANS10100-2 will incorporate research outputs in terms of concrete durability clauses.

CoMSIRU's research has instilled a comprehensive approach to condition assessment and strengthening of concrete structures, which may be noted by the input into national codes and standards, where research findings are being reflected. The unit's publications, specifically the series of monographs that are produced and regularly supplemented by new material. As far as scientific papers are concerned, the output of CoMSIRU is substantial, and the vast majority appear in internationally respected journals and conferences. New approaches from this research continue to be applied in major national construction projects.

Publications

Books

Alexander, M.G. Several chapters for a book on concrete durability, co-authored by S Mindess and A Bentur. To be published by T&F in 2017

Alexander, M.G., "Marine concrete structures. Design, durability and performance' Cambridge: Woodhead Publishers (Imprint of Elsevier). June 2016. C. 400 pp.

Beushausen, H., Fernandez-Luco, L., 'Performance-based specifications and control of concrete durability', RILEM State-of-the-Art Report TC 230-PSC, Springer, 373 pp.

Beushausen, H. (2016): "Performance-based approaches for concrete structures", Proceedings of the 2016 fib Symposium, Cape Town, 2500 pp.

Dehn, F, Beushausen, H., Alexander, M.G., Moyo, P. (2016) (editors), 'Concrete Repair, Rehabilitation and Retrofitting IV', Proceedings for the 4th International Conference on Concrete Repair, Rehabilitation and Retrofitting ICCRRR 2015, Leipzig, September 2015, CRC Press, Taylor & Francis Group, Netherlands, 1034 pp.

Refereed/peer reviewed journals

Loseby, M., Alexander, M.G., and Beushausen, H. "The influence of aggregate grading on concrete potential durability and penetrability". Concrete Beton (147), Nov 2016, 19-27.

Otieno, M, Beushausen, H and Alexander, MG (2016) Chloride-induced corrosion of steel in cracked concrete – Part I: Experimental studies under accelerated and natural marine environments. Cement and Concrete Research, 79 (2016), Jan 2016, 373-385

Mundeli S., Mbereyaho, L., Moyo P. 2016. Finite Element Modelling of Reinforced Concrete Beams Patch Repaired and Strengthened with Fiber-Reinforced Polymers, *International Journal of Engineering and Technical Research (IJETR),* Vol (4) , Issue-3, pp 2454-4698

Otieno, MB, Beushausen, HD and Alexander, MG (2016) Chloride-induced corrosion of steel in cracked concrete – Part II: Corrosion rate prediction models. Cement and Concrete Research, 79 (2016), Jan 2016, 386-394.

Scott, A. and Alexander, M.G. "Effect of supplementary cementitious materials (binder type) on the pore solution chemistry and the corrosion of steel in alkaline environments". Cement and Concrete Research, 89 (2016), pp. 45–55

Beushausen, H. (2016), 'Modelling the age at cracking of bonded concrete overlays subjected to restrained shrinkage', Materials & Structures, 49 (2016), 1905 - 1916.

Otieno, M., Beushausen, H. and Alexander, M.G. "Resistivity-based chloride-induced corrosion rate prediction models and hypothetical framework for interpretation of resistivity measurements in cracked RC structures". Materials & Structures, 49 (2016), pp 2349–2366.

Beushausen, H., Bester, N., 'The Influence of Curing on Restrained Shrinkage Cracking of Bonded Concrete Overlays' Cement & Concrete Research, Volume 87, September 2016, pp. 87–96.

Mukadam, Z, Alexander, M.G., and Beushausen, H. "The effect of drying preconditioning on the South African durability index tests". Cement & Concrete Composites, 69 (2016), 8 pp.

Muigai, R., Alexander, M.G., and Moyo, P. "A novel framework towards the design of more sustainable concrete infrastructure". Materials & Structures, 49 (2016), 1127-1141.

Proceedings of refereed international conferences

Alexander, M.G. (2016) 'Performance-based concrete durability design and specification in South Africa – background, implementation, and quo nunc?' fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Oyegbile, B. (2016), 'Investigation on seismic behaviour for structural integrity of a collapsed RC building', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Busatta, F., Moyo, et al. (2016), 'Performance monitoring of a prestressed concrete railway viaduct', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Nganga, G.W., Alexander, M.G., Moyana, P., and Beushausen, H. (2016), 'Practical implementation of the durability index performance-based specifications: current experience.' fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Beushausen, H., Hoehlig, B., Martin, M. (2016), 'The influence of curing methods on durability indicators & micro- and macro porosity of concrete', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Moore, A., Beushausen, H., Golden, G., Alexander, M. (2016), 'Critique of the environmental exposure classification for marine concrete structures in the tidal zone', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Otieno, M., Mutale, L., Beushausen, H. (2016), 'Using Wenner probe resistivity to estimate chloride diffusion coefficients in concrete', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Sohawon, H., Beushausen, et al. (2016), 'Evaluating the performance of ECC as a patch repair mortar', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Arito, P., Beushausen, H and Alexander, M.G. (2016), 'Barriers to the realisation of effectiveness in the cracking performance of concrete patch repair mortars in service.' fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Ngassam, I., Beushausen, H. (2016), 'Effect of an expansive admixture on the failure mechanisms due to cracking of polymer modified mortars', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Baum, O., Beushausen, H. (2016), 'The influence of varying binder contents on carbonation of concrete', fib Symposium on Performance-based Approaches for Concrete Structures, Cape Town, South Africa, November.

Arito, P., Beushausen, H., Alexander, M. (2016), 'An experimental investigation into the effects of water and binder-related parameters on restrained shrinkage cracking in concrete patch repair mortars', Concrete Solutions, 6th International Conference on Concrete Repair, Athens, Greece, June.

Okwori, E.J, Moyo, P., Kabani, M. (2016), 'An investigative study into the application of non-destructive testing techniques for integrity assessment of RC piles', ICCRRR - 4th International Conference on Concrete Repair Rehabilitation and Retrofitting, Leipzig, Germany, October.

Kiliswa, M.W., Alexander, M.G., Beushausen, H. (2016), 'Durability design of concrete mixtures for sewer pipe applications: A review of the Life Factor Method', ICCRRR - 4th

International Conference on Concrete Repair Rehabilitation and Retrofitting, Leipzig, Germany, October.

Mbanjwa, T.D., Moyo, P. (2016), 'Relationships between defects and inventory data of RC bridges and culverts in the Western Cape South Africa', ICCRRR - 4th International Conference on Concrete Repair Rehabilitation and Retrofitting, Leipzig, Germany, October.

Arito, P., Beushausen, H. (2016) 'The effectiveness of corrosion inhibitors in reducing corrosion in chloride contaminated RC structures', ICCRRR - 4th International Conference on Concrete Repair Rehabilitation and Retrofitting, Leipzig, Germany, October.

Arito, P.A., Beushausen, H., Alexander, M.G. (2016), 'Towards improved cracking resistance in concrete patch repair mortars', ICCRRR - 4th International Conference on Concrete Repair Rehabilitation and Retrofitting, Leipzig, Germany, October.

Saisi, A., Busatta, F., Gentile, C. and Ruccolo, A. (2016) 'Monitoring cultural heritage buildings: The Santa Maria del Carrobiolo bell-tower in Monza, Italy, SEMC - Semantic Interoperability Conference, Rome, Italy, May.

Busatta, F. and Moyo, P. (2016), 'Lessons learned from the dynamic assessment of railway bridges for heavy haul transport in South Africa', SEMC - Semantic Interoperability Conference, Rome, Italy, May.

Prins, Z.J, Mahlabela, C.N. and Moyo, P. (2016), 'Identifying behavioural trends and the development of calibrated finite element models for a double curvature arch dam', ICOLD - International Committee on Large Dams, Johannesburg, South Africa, May.

Bukenya, P., Moyo, P. and Oosthuizen C. (2016), 'Long term integrity monitoring of a concrete arch dam using continuous dynamic measurements and a multiple linear regression model', ICOLD - International Committee on Large Dams, Johannesburg, South Africa, May.

Otieno, M., Alexander, M.G. and Du Plessis, J. (2016) 'Ingula Pumped Storage Scheme: Assessment of Deterioration of Concrete Tunnel Linings', Hydro 2016 Conference, Montreux, Switzerland, October.

Ngassam, I., Arito, P., Beushausen, H. (2016), 'Rethinking the formulation of patch repair mortars', 2nd Advances in Cement and Concrete Technology in Africa, Dar Es Salaam, Tanzania, January.

Proceedings of other conferences and symposia

Grengg, C., Kiliswa, M., Mittermayr, F., and Alexander, M "Microbially-induced Concrete Corrosion- A worldwide problem". RILEM TC-MCI Workshop Delft, June 2016.

Alexander. M.G. and Otieno, M.B. "Corrosion in Reinforced Concrete: Cracking, Durability, and Service Life". Keynote Lecture, ACF, Vietnam, Oct 2016. 8 pp. (Editor of conference proceedings)

Papers in non-peer reviewed journals; un-refereed articles

Beushausen, H., Bester, N. (2016), 'Appropriate curing methods to reduce shrinkage cracking of bonded concrete overlays', Concrete Plant International, Vol. 6, 2016, pp.

Kessy, J., Alexander, M., Beushausen, H. (2016), 'Concrete durability design in North America, Australia and Europe', Concrete Plant International, Vol. , 2016, pp.

Nganga, G., Alexander, M., Beushausen, H. (2016), 'The effects of a reduction in clinker content on concrete properties', Concrete Plant International, Vol. 6, 2016, pp.

Beushausen, H., Holmes, M. (2016), 'Recycled concrete aggregate for structural precast concrete manufacture', Concrete Plant International, Vol. 2, 2016, pp.

Awards, prizes and appointments

- Hans Beushausen became a a full Professor from Jan 2017
- Mark Alexander was made a RILEM Honorary Member at the RILEM Annual Week, Copenhagen, Sep 2016
- Philemon Arito received a Carnegie scholarship
- Mark Alexander was appointed Associate Editor of the international journal Cement & Concrete Research, 2016 – 2018
- Mark Alexander became a member of International Expert Panel for a French National Research Project, 'Perfdub' ("Performance-based approach for concrete structures

durability") aimed at defining suitable methodology for justifying concrete durability through performance tests and corresponding criteria (for the different exposure classes of European Standard EN 206).

- Dr Moses Kiliswa receiving The Joseph Arenow Prize for the best PhD thesis in the EBE faculty in 2016

Organisational arrangements

Governance

CoMSIRU is overseen by its two directors, Prof Pilate Moyo and Prof Hans Beushausen. Prof Mark Alexander now plays the role of senior advisor to CoMSIRU. Regular meetings are held by these three directors to discuss teaching, research, administration and budget issues. CoMSIRU is serviced administratively and financially by a research administrative finance officer, Mr Werner van der Ross.

CoMSIRU Advisory Panel

Name	Company/Institution	E-mail
Pilate Moyo	UCT	pilate.moyo@uct.ac.za
Hans Beushausen	UCT	hans.beushausen@uct.ac.za
Mark Alexander	UCT	mark.alexander@uct.ac.za
Paul Adams	SIKA	adams.paul@za.sika.com
Eduardo Auger	PPC	eduardo.auger@ppc.co.za
Yunus Ballim	WITS	yunus.ballim@wits.ac.za
Chris Botha	Aveng Grinaker-LTA	Chris.botha@avenggroup.com
Billy Boshoff	SUN	bboshoff@sun.ac.za
Vernon Collis	Collis and Associates	vernoncollis@mweb.co.za
Mahlabela Comfort	Department of Water and Sanitation	MahlabelaC@dwa.gov.za

Name	Company/Institution	E-mail
Steve Crosswell	PPC	scrosswell@ppc.co.za
Mike McDonald	Afrisam	mike.mcdonald@za.afrisam.com
Enzo Menegaldo	Haw and Inglis	emenegaldo@haw-inglis.co.za
Josiah Mpofu	Transnet	Josiah.mpofu@transnet.net
Sifiso Nhleko	National Nuclear Regulator	SNhleko@nnr.co.za
Wandile Nomquphu	Water Research Commission	wandilen@wrc.org.za
Mike Otieno	WITS	mike.otieno@wits.ac.za
Bryan Perrie	TCI	bryanp@theconcreteinstitute.org.za
Manu Santhanam	Indian Institute of Technology, Madras	manusanthanam@gmail.com

CoMSIRU team attending the fib Symposium, Cape Town, November 2016

Highlights
fib Symposium Cape Town 2016

The *fib* Symposium in Cape Town took place in November 2016 at the University of Cape Town's Graduate School of Business in the V&A Waterfront, bringing together *fib* members from around the world and facilitating presentations, discussions and social interactions between researchers, consulting engineers, contractors, material suppliers and students. The event was attended by a total of 420 delegates from over 45 countries and strongly supported by members of the local concrete and structural engineering industries.

The conference was devoted to performance-based approaches for concrete structures and a total of 242 papers had been accepted for presentation, covering the general themes of structural analysis and design, shrinkage and creep, concrete materials technology and associated experimental methods, precast technology, bridge structures, durability and service life, and concrete condition assessment, repair, strengthening and protection. The broad coverage of topics and the generally very high quality of technical presentations was very well received and prevented delegates from giving the vast offer of tourist attractions preference over the technical part of the symposium.

Another technical highlight of the event was a Workshop on the *fib* Model Code 2020, held on Thursday, 24 November 2016. The workshop, attended by about 70 delegates, introduced ideas for linking and addressing the requirements for new and existing structures, with the concept that these matters would be addressed in a new version of the *fib* Model Code for Concrete Structures. The workshop included lively discussions on controversial opinions, especially in view of performance approaches for concrete design and specification, which formed a good foundation for future developments of the next *fib* Model Code and which offered a suitable closing for an overall very successful and well-received *fib* Symposium 2016.

Prof Mark Alexander, in his capacity as Immediate Past President of RILEM, delivered a keynote lecture at the Asian Concrete Federation Conference in Hanoi, Vietnam (Nov 2016); he also delivered a keynote at the fib Symposium in Cape Town (Nov 2016). He was a scientific moderator at the Gordon Research Conference on "Advanced Materials for Sustainable Infrastructure Development - The Science and Technology of Sustainable Concrete", in Hong Kong in August 2016, and contributed to an industry workshop at the Lafarge Research Centre in Lyons, France, in December 2016, on performance-based approaches to concrete durability.

Dr Moses Kiliswa, in his PhD project, developed a significantly improved 'Life Factor Method' model for concrete sewer design in aggressive environments, which greatly extended the range of cementitious materials that can now be more accurately modelled using this approach.

Funders

Collaborations and linkages

CoMSIRU
University of Cape Town, Department of Civil Engineering
Upper Campus, New Engineering Building, South Lane, off Ring Road
Tel: +27 21 650 1082

www.comsiru.uct.ac.za

www.rothko.co.za