CONCRETE MATERIALS AND STRUCTURAL INTEGRITY RESEARCH UNIT

ANNUAL REPORT 2012

Annual Report 2012

Concrete Materials & Structural Integrity Research Unit
Department of Civil Engineering
University of Cape Town

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1 INTRODUCTION AND OVERVIEW

The Concrete Materials and Structural Integrity Research Unit (CoMSIRU) has been a long-standing entity in various forms in the Department of Civil Engineering at the University of Cape Town. It attracts annual industry support and funding, strongly interacts with industry to set and monitor research priorities, and produces a steady stream of scientific, technological and human resource outputs.

The Research is strongly informed by the needs of owners and managers of large stocks of reinforced concrete infrastructure such as Eskom, the South African National Roads Agency, Department of Water Affairs and Environment, etc. Technology transfer activities (in the form of scientific papers, easy-read monographs, short courses and seminars) aimed at such entities, as well as the general cement and concrete industry and associated sectors of the economy, are also an important component.

The Research Programme is closely integrated with the postgraduate teaching programmes in *Civil Infrastructure Management and Maintenance* and *Structural Engineering and Materials* in the Department of Civil Engineering. Research students generally undertake a suite of postgraduate courses to improve their knowledge and to prepare them for their research work. Most students undertake an MSc (Eng) degree by way of 60 credits (min) of advanced coursework and a 120 credit research dissertation. Recently, there has been an encouraging increase in the number of doctoral research students.

2 HIGH-LEVEL OBJECTIVES

CoMSIRU takes as a foundational philosophy the importance of developing high-level human resources for industry, academia and research. Research is a vehicle towards this goal, and not merely an end in itself. This means that our research and activities will always be student-centred. We will endeavour to foster a collaborative attitude, critical thinking, and independent thought among students and encourage them to work in teams wherever possible. We will also regularly bring them into contact with industry and its needs so that they can better understand how their own research influences engineering practice.

In view of this, the high-level objectives of CoMSIRU are:

2.1 Materially expand and improve the pool of high-level skills in concrete materials and structural engineering, in South Africa

Our first responsibility is to educate and train students in the knowledge and application of concrete and concrete structures. This is done mainly via the pool of high-level research students (Masters and Doctoral) in our teaching and research programmes.

2.2 Influence the culture and practice of design

This needs to be done by creating a fundamental understanding in students and practitioners of the critical importance of materials in structural/civil design of infrastructure.
To do this we will undertake research aimed at the following aspects:

- Performance design.
- Life-cycle design.
- Materials and durability-based design.

These are considered points of departure from conventional design philosophies.
In addition, our post graduate courses and technology transfer activities will have a strong component of materials engineering and performance.

2.3 Improve management of the infrastructure

This will involve:

- Creating awareness of this topic among students and engineers.
- Developing improved understanding of deterioration mechanisms and maintenance/repair strategies.
- Mounting a 'Civil Infrastructure Management and Maintenance' programme from 2013 to more directly address this important issue.

2.4 Embed durability and sustainability in all aspects of concrete structural/civil engineering

This will require us to:

- Develop a more inclusive and integrated approach to design and management of infrastructure, in which a long-term, life-cycle approach is promoted.
- Consider resource efficiency for civil infrastructure in terms of design and construction practice.
- Consider ways of practical implementation of sustainability in structural/civil design, through re-thinking the design process.

2.5 Promote structural health monitoring as a key tool for structural performance assessment

This will include:

- Developing and implementing strategies for monitoring and evaluating structural performance based on appropriate sensing and data analysis procedures.
- Developing and implementing structural rehabilitation and retrofitting based on as built behaviour of structures.
- Developing strategies for transfer of structural health monitoring technology.

2.6 Influence Codes of Practice

We will need to:

- Actively participate in writing and editing codes of practice and specifications, and drafting new test methods.
- Assist engineers with interpretation and application of codes using alternative philosophies and approaches.

3 RESEARCH AND STUDENT TRAINING

As indicated under 'OBJECTIVES', CoMSIRU takes as a foundational philosophy the importance of developing high-level human resources for industry. Research is a vehicle towards this goal, and not just an end in itself. Therefore, student education and training are our top priorities, and all our activities are focused on these priorities.

4 AREAS OF RESEARCH

CoMSIRU has two broad areas of research. These intersect in key loci to permit interdisciplinary development.

4.1 Concrete materials and concrete construction

- Performance of cementitious materials.
- Deterioration studies on concrete structures.

- Durability studies on concrete structures.
- Development of durability-based design philosophies and practice.
- Development and verification of service life models.
- Repair and rehabilitation materials and methods.
- Sustainability of concrete construction.

4.2 Structural Integrity and health monitoring, and loading on bridges and structures

- Full-scale structural performance monitoring and assessment of concrete structures.
- Dynamic-based structural integrity assessment.
- Repair and strengthening of RC structures.
- Vibration serviceability of civil infrastructure.
- Bridge live loading.

4.3 Research topic areas

The research areas being pursued in 2012 are:

- Studies on modern concretes and materials.
- Concrete mix design improvement through efficient use of supplementary cementitious materials.
- Service life models and prediction of service life.
- Performance-based specifications for concrete structures.
- Durability performance of concrete structures.
- Development of the Durability Index Approach to improve quality of concrete construction.
- Studies on durability index testing and correlations with other international approaches.
- Structural monitoring and performance assessment of concrete structures.
- Dynamic based condition assessment of RC structures.
- Railway bridge reliability assessment based on monitoring.
- Vibration serviceability of concrete floors and footbridges.
- Ambient vibration testing of concrete dams.
- Bridge loading.
- Strengthening of RC structures using fibre reinforced polymers.
- Repair and rehabilitation studies in concrete materials and structures.
- Cracking behaviour of concrete overlays and patch repairs.
- Studies on concrete sustainability issues.

5 IMPACT OF RESEARCH – HIGH LEVEL

The impact of research carried out in CoMSIRU, and more broadly in the postgraduate teaching and research programme in Concrete Materials and Structural Integrity at UCT, involves the following:

- A growing change of mindset to durability of concrete infrastructure in South Africa. The discourse around this issue has changed markedly over the last 10 to 20 years, as indicated by incorporation of some of our research outcomes into specifications and codes of practice nationally, and a much greater concern with durability.
- A sounder approach to condition assessment and strengthening of concrete structures. This aspect of the Research Unit's work has grown substantially in the last 10 years.
- Input into national codes and standards, where research findings are being reflected.
- Publications, specifically the series of Monographs that is produced and regularly supplemented by new Monographs. As far as scientific papers are concerned, the output of the Unit is substantial, and the vast majority appear in internationally respected journals and conferences.
- Local and international involvement and exposure of researchers in seminars, symposia, conferences, etc. In addition, researchers serve on or lead local and international organisations or technical committees of relevance to their areas of research.
- Existence of a laboratory and resources of national importance in concrete and concrete structures. This is particularly to be seen in the light of the reduction and loss in national agency resources, and to a significant degree, industry resources in these areas.
- Our Masters and Doctoral graduates are in high demand.

6 STUDENTS REGISTERED AND PROGRESS

In 2012, CoMSIRU had 7 doctoral, 20 masters fulltime students registered, as well as 2 MEng students. There were also 23 undergraduate dissertation students who worked in our areas of research for their final year projects.

6.1 Post Graduate students

POST GRADUATE STUDENTS 2012
MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo; VC – Vernon Collis

Name	Super-visor	Co-super-visor	Degree registered	Year first registered	Title of Research project	Progress on project
R Heiyantuduwa	MGA	_	PhD	2004	Prediction model for concrete durability.	Anticipated completion 2013
R Muigai	MGA	PM	PhD	2009	A Framework for the Design of more Sustainable Concrete Structures.	Anticipated completion 2013

POST GRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo; VC – Vernon Collis						
Name	**Super-visor**	**Co-super-visor**	**Degree registered**	**Year first registered**	**Title of Research project**	**Progress on project**
M Otieno	HB	MGA	PhD	2009	Development of a chloride-induced corrosion rate prediction model for marine tidal/splash exposure conditions.	Anticipated completion 2013
R Gopinath	MGA	HB	PhD	2011	A Service Life prediction model based on Carbonation induced Corrosion for South African Conditions.	Anticipated completion 2014
M Kabani	PM	HB	PhD	2011	Time dependent bridge network reliability assessment with health monitoring.	Anticipated completion 2014
P Bukenya	PM	HB	PhD	2011	Dynamic characterization of concrete dams using operational modal analysis.	Anticipated completion 2014
G Nganga	MGA	HB	PhD	2012	The Use of Low Clinker Cementitious Materials in Concrete.	Registered 2012
N Burmeister	HB	MGA	MSc (Eng)	2009	Remedial measures for concrete structures that do not meet DI specifications.	Graduated end-2012
M Gillmer	HB	MGA	MSc (Eng)	2009	Using Superabsorbent Polymers as a method of Internal Curing to improve concrete overlay performance.	Graduated end-2012
P Arito	HB	MGA	MSc (Eng)	2010	Sacrificial External Anodes and their use in service Life extension of reinforced Concrete Structures.	Graduated 2012 Registering for PhD
M Martin	HB	MGA	MSc (Eng)	2010	Concrete mix design and manufacturing techniques using durability enhancers.	Graduating mid-2013
S Gregan	PM	HB	MSc (Eng)	2010	Long term performance of corrosion damaged RC beams, patch repaired and externally strengthened using CFRP.	Graduating Mid-2013
J Thuysbaert	MGA	VC	MSc (Eng)	2010	Rammed earth construction for the Cape Town metropolitan area.	Graduated 2012

POST GRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo; VC – Vernon Collis						
Name	**Super-visor**	**Co-super-visor**	**Degree registered**	**Year first registered**	**Title of Research project**	**Progress on project**
M Chilwesa	HB	PM	MSc (Eng)	2010	Assessing the performance of concrete repair mortars/overlays.	Graduating Mid-2013 Registering for PhD
C Mutombo	PM	MGA	MSc (Eng)	2010	The effects of partitions on the vibration serviceability of concrete floors.	Graduated 2012
R Makha	PM	HB	MSc (Eng)	2010	The behaviour of Arch Dams.	Graduated 2012
N Motsieloa	MGA	HB	MSc (Eng)	2010	Acid resistance of sewer pipe concrete.	Graduated 2012
B O'Neill-Williams	MGA	VC	MSc (Eng)	2010	The use of site derived fine material as concrete aggregate.	Graduated 2012
V Gaya	PM	MGA	MSc (Eng)	2010	Assessment of abnormal loads on bridges in South Africa.	Graduated 2012
M Angelucci	HB	MGA	MSc (Eng)	2011	Mix Design Optimisation – The Effect of Mix Design Parameters and Mixture Properties on Concrete Durability.	Graduating Mid-2013
E Leo	PM	HB	MSc (Eng)	2011	Dynamic performance of concrete-concrete composite bridges.	Graduating Mid-2013
J Kanjee	HB	MGA	MSc (Eng)	2011	The influence of cracking on Durability and Service Life.	Graduating Mid-2013
N Kizito	HB	PM	MSc (Eng)	2011	Prediction and testing of tensile relaxation of concrete	Graduating Mid-2013
S Starck	HB	PM	MSc (Eng)	2011	The Integration of Non-destructive Test Methods in the South African Durability Index Approach.	Graduating Mid-2013
B Walker	MGA	VC	MSc (Eng)	2011	Assessing the long term availability of construction aggregates of the Cape Town area from a sustainable perspective.	Anticipated completion 2013
R Olulope	MGA	HB	MSc (Eng)	2011	Investigation of the Durability Performance of some selected Portland Limestone Cement Blends in South Africa.	Anticipated completion 2013

POST GRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo; VC – Vernon Collis						
Name	**Super-visor**	**Co-super-visor**	**Degree registered**	**Year first registered**	**Title of Research project**	**Progress on project**
J Kessy	MGA	HB	MSc (Eng)	2011	Performance-based Design and Specification, including Service-Life Prediction Models and Experimental methods – an International comparison.	Graduating Mid-2013
K Wickins	MGA	VC	MSc (Eng)	2011	The use of construction and demolition waste in the Cape Peninsula.	Anticipated completion 2013
M Nzuza	PM	HB	MSc (Eng)	2011	Thermo-mechanical modelling of arch dams for performance assessment.	Graduating Mid-2013
F Mullajee	PM	-	M Eng	2011	Impact damage assessment of concrete structures repaired using FRP.	Anticipated completion 2013
R Kayonga	PM	-	M Eng	2011	Distribution of Bridge and Culvert Defects on the Saldanah-Sishen Ore Line using Bridge Management System Data.	Anticipated completion 2013
M Talotti	HB	PM	MSc (Eng)	2012	The Influence of substrate moisture preparation on overlay bond strength.	Anticipated completion 2013
T Dittmer	HB	PM	MSc (Eng)	2012	Crack resistance of concrete subjected to restrained deformation.	Anticipated completion 2013
L Mutale	HB	MGA	MSc (Eng)	2012	Performance-based tailor made concrete.	Anticipated completion 2013
Z Mukadam	MGA	HB	MSc (Eng)	2012	Critical Review of the South African Durability Index Tests, with Possible Improvements.	Anticipated completion 2013
M Loseby	MGA	HB	MSc (Eng)	2012	The effects of aggregate grading and packing on the transport properties of concrete.	Anticipated completion 2013
M Vezi	PM	MGA	MSc (Eng)	2012	Behaviour of concrete arch dams.	Anticipated completion 2013
T Dladla	PM	HB	MSc (Eng)	2012	The effect of varying patch sizes on strengthened beams with CFRP.	Anticipated completion 2013

POST GRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo; VC – Vernon Collis						
Name	**Super-visor**	**Co-super-visor**	**Degree registered**	**Year first registered**	**Title of Research project**	**Progress on project**
S Mundeli	PM	-	MSc (Eng)	2012	Strengthening of Reinforced Concrete Structures.	Anticipated completion 2013

6.2 Undergraduate students (final year dissertation students in our areas of research)

UNDERGRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo			
Name	**Super-visor**	**Degree registered**	**Title of Research project**
D Godley	MGA	BSc (Eng)	Assessment of a range of modern admixtures for concrete made with W. Cape materials.
M Makgota	MGA	BSc (Eng)	Analytical models for concrete – assessing their usefulness for local conditions.
M Ralfe	MGA	BSc (Eng)	Environmental exposure zones in the Cape Peninsula.
K Nkoana	MGA	BSc (Eng)	Influence of relative humidity on steel corrosion in R.C.
H Holmes	MGA	BSc (Eng)	Replacements for conventional fine aggregates in concrete – assessment of recent work and preparation of a guide document for industry.
R Malde	MGA	BSc (Eng)	Methodologies to enable effective resource efficient comparisons.
J Boyle	MGA	BSc (Eng)	Life-cycle carbon footprint of the New Engineering Building at UCT.
B Van Beek	HB	BSc (Eng)	The impact of the new CEMI 52.5 on concrete construction in the Western Cape – practical aspects.
S Stevens	HB	BSc (Eng)	The impact of the new CEMI 52.5 on concrete construction in the Western Cape – concrete properties.
G Golden	HB	BSc (Eng)	An investigation into the effects of hot weather conditions on the development of compressive strength in concrete.
M Bowker	HB	BSc (Eng)	High-strength concrete design with Metakaolin.
M Raubenheimer	HB	BSc (Eng)	The influence of curing conditions on concrete durability.

UNDERGRADUATE STUDENTS 2012 MGA – Mark Alexander; HB – Hans Beushausen; PM – Pilate Moyo			
Name	**Super-visor**	**Degree registered**	**Title of Research project**
W de Kock	HB	BSc (Eng)	Condition assessment of structures on UCT's upper campus.
J Wale	HB	BSc (Eng)	The use of cruciform shaped precast reinforced concrete blocks for use in dry-dock blocking lines.
T Utermark	HB	BSc (Eng)	The influence of compressive stress on the permeability of concrete.
Matthew Davey	PM	BSc (Eng)	Loading verification on Lattice-type wind turbine towers.
Fiona Budlender	PM	BSc (Eng)	Structural health monitoring of arch dams.
Naasir Bassier	PM	BSc (Eng)	The effect of gypsum partitions on vibration serviceability of pre-stressed concrete floors.
Mahir Ebrahim	PM	BSc (Eng)	The damping effect of timber partitions on vibration serviceability of pre-stressed concrete floors.
Philip Keil	PM	BSc (Eng)	Evaluation of the vibration serviceability of footbridges with regards to jogging forces.
Vafa Naraghi	PM	BSc (Eng)	Operational modal analysis on the Kalbaskraal railway bridge.
Motheo Ntsolo	PM	BSc (Eng)	Strengthening of RC beams using FRP.
Catherine Reed	PM	BSc (Eng)	Condition assessment of box-girder type railway bridges.

7 PUBLICATIONS 2012

7.1 In refereed/peer reviewed journals

BISSONNETTE, B., COURARD, L., BEUSHAUSEN, H., FOWLER, D., TREVINO, M. and VAYSBURD, A. "Recommendations for the repair, the lining or the strengthening of concrete slabs or pavements with bonded cement-based material overlays". Materials and Structures Journal, published online, August 2012.

MOYO, P., SIBANDA, B. and BEUSHAUSEN, H. "Modelling and integrity assessment of shear connectors in precast - cast-in-situ concrete bridges". Structural Engineering and Mechanics, Vol. 42(1), April 2012.

BEUSHAUSEN, H., MASUKU, C. and MOYO, P. "Relaxation characteristics of cement mortar subjected to tensile strain". Materials and Structures, 2012, Vol. 45(8), pp. 1181-1188.

BEUSHAUSEN, H., ALEXANDER, M.G. and BALLIM, Y. "Early-age properties, strength development and heat of hydration of concrete containing various South African slags at different replacement ratios". Construction and Building Materials, 2012, Vol. 29, pp. 533–540.

NGANGA, G., ALEXANDER, M.G. and BEUSHAUSEN, H. "Performance-based durability design for RC structures". 3R's Journal, 2012, Vol. 2(3), pp. 284-290.

GITHACHURI, K., ALEXANDER, M.G. and MOYO, P. "Durability performance of a range of marine concretes and the applicability of the South African service life prediction model". Materials and Structures, 2012, Vol. 45, pp. 185-198.

MUIGAI, R.N., MOYO, P., and ALEXANDER, M.G. "Durability design of reinforced concrete structures- a comparison of the use of durability indexes in the deemed-to-satisfy approach and the full-probabilistic approach", Materials and Structures, 2012, Vol. 45, pp. 1233-1244. (Online DOI10.1617/s11527-012-9829-y).

MALUMBELA G., MOYO P., and ALEXANDER M. G. "Longitudinal strains and stiffness of RC beams under load as measures of corrosion levels". Engineering Structures, 2012, Vol. 35, pp. 215-227.

MALUMBELA G, MOYO P, and ALEXANDER M G. "A step towards standardising accelerated corrosion tests on laboratory Reinforced Concrete specimens". Journal of the South African Institution of Civil Engineering, October 2012, Vol. 54(2), pp. 78–85.

MUIGAI, R., MOYO, P. and ALEXANDER, M.G. "Durability design of reinforced concrete structures: a comparison of the use of durability indexes in the deemed-to-satisfy approach and the full-probabilistic approach". Materials & Structures, July 2012, Vol. 45, pp. 1233–1244.

7.2 In the proceedings of refereed international conferences

OTIENO, M., BEUSHAUSEN, H. and ALEXANDER, M. "Towards correlating natural and accelerated chloride-induced corrosion in cracked RC – preliminary results". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 415-421. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

CHILWESA, M., BEUSHAUSEN, H. (2012), "Cracking characteristics of cement mortars subjected to restrained shrinkage", Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 1082-1087. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

NGANGA, G., ALEXANDER, M., BEUSHAUSEN, H. (2012), "Control of concrete cover depth of reinforced concrete structures for durability", Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 415-421. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

KANJEE, J., BEUSHAUSEN, H., ALEXANDER, M., OTIENO, M. (2012), "Towards incorporating the influence of cracks in the durability index testing approach", Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 396-401. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

ANGELUCCI, M., BEUSHAUSEN, H., ALEXANDER, M. (2012), "Mix design optimisation - the influence of binder content on mechanical and durability properties of concrete towards incorporating the influence of cracks in the durability index testing approach". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 415-421. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

ARITO, P., BEUSHAUSEN, H., ALEXANDER, M., OTIENO, M. (2012), "The use of discrete sacrificial anodes in reducing corrosion rate in chloride contaminated reinforced concrete", Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 999-1002. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

BEUSHAUSEN, H., STARCK, S. J., ALEXANDER, M. (2012), "The integration of non-destructive test methods into the South African Durability Index Approach", 2nd International Conference of Microdurability, Amsterdam, the Netherlands, RILEM Publications, Paris, 11-13 April 2012, 10 pp.

ALEXANDER, M., OTIENO, M., BEUSHAUSEN, H. (2012), "Cracking and durability of reinforced concrete structures", Keynote paper, 2nd International Conference of Microdurability, Amsterdam, the Netherlands, RILEM Publications, Paris, 11-13 April 2012, 10 pp.

KABANI, M., MOYO, P. and ALEXANDER, M.G. "Structural reliability targets for assessment of ageing infrastructure". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 777-782. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

MUIGAI, R., ALEXANDER, M.G. and MOYO, P. "The role of the structural engineer in the design of low embodied energy concrete-frame buildings". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 1476-1481. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

NGANGA, G., ALEXANDER, M.G. and BEUSHAUSEN, H. "Control of concrete cover depth of reinforced concrete structures for durability". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 428-432. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

OTIENO, M., BEUSHAUSEN, H. and ALEXANDER, M.G. "Towards correlating natural and accelerated chloride-induced corrosion in cracked RC – preliminary results". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 534-539. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

MAKHA, R., MOYO, P. "Observations from the calibration of an arch dam model using ambient modal properties". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 534-539. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

BUKENYA, P., MOYO, P. OOSTHUIZEN, C. "Modal parameter estimation from ambient vibration measurements of a dam using stochastic subspace identification methods", Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 534-539. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

GAYA, V., MOYO, P. "Impact of mobile cranes on medium span bridges". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 534-539. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.
NEWMARK, A.A>, MOYO, P., KRUGER, E.J. "Repair and dynamic-based condition assessment of impact damage to a freeway overpass bridge near Mossel Bay, South Africa". Proceedings ICCRRR 2012, Cape Town, September 2012, pp. 534-539. Taylor and Francis CRC Press, ISBN 978-0-415-89952-9.

7.3 In the proceedings of other conferences and symposia

HEATH, K., ALEXANDER, M.G. "Rapid chloride penetration testing: is it appropriate for concrete durability specifications?" 12th International Conference on Recent Advances in Concrete Technology and Sustainability Issues, October 2012, Prague, Czech Republic.

Oral Presentations:

ALEXANDER, M.	CSSA CONCRAX, October 2012
ALEXANDER, M.	IBRACON Conference, October 2012
ALEXANDER, M.	ASPASA Seminar, September 2012
ALEXANDER, M.	NIST, Washington, March 2012
ALEXANDER, M.	RILEM NUCPERF, Paris, November 2012

7.4 In non-peer reviewed journals, symposia, and un-refereed articles

None in 2012.

7.5 In books

ALEXANDER, M.G., BERTRON, A. and DE BELIE, N. "RILEM TC 211-PAE State of the Art Report: Performance of Cement-based Materials in Aggressive Aqueous Environments". Springer, 2012.

ALEXANDER, M.G., BEUSHAUSEN, H.D., DEHN, F., MOYO, P. (Editors). "Proceedings Concrete Repair, Rehabilitation and Retrofitting III – 3 to 5 September, 2012". Taylor & Francis, 2012.

7.6 Papers accepted or submitted for publication or presentation:

7.6.1 Accepted for publication in peer-reviewed Journals

7.6.2 Submitted for publication in peer-reviewed Journals

NGANGA, G., ALEXANDER, M.G., BEUSHAUSEN, H. "Practical Implementation of the Durability Index performance-based design approach". Submitted to Construction and Building Materials, Nov 2012.

MUIGAI, R., ALEXANDER, M.G., MOYO, P. "Thermodynamic Methods for Evaluating Resource Consumption of Concrete Elements and Structures". Submitted to International Journal of Life-Cycle Assessment. 2011. **Under review**

OTIENO, M.B., BEUSHAUSEN, H.D., ALEXANDE"R, M.G. "Towards incorporating the influence of cover cracking on steel corrosion in RC design codes", Submitted to Materials and Structures Journal, Oct 2011 – **Under review**

NGANGA, G.W., GOUWS, S.M., ALEXANDER, M.G. "The oxygen permeability index test: Its application and addressing the variability issues". Submitted to Concrete Beton.

GITHACHURI, K., ALEXANDER, M.G. "Durability performance potential and strength of blended Portland limestone cement concrete". Cement & Concrete Composites, March 2012

8 AWARDS, PRIZES, AND APPOINTMENTS DURING 2012

Prof Alexander was elected President of RILEM (International Union of Laboratories and Experts in Construction Materials, Systems and Structures, France) in September 2012.

Prof Alexander, Assoc Prof Beushausen and Mr Mike Otieno were awarded the American Concrete Institute (ACI) Wason Medal for Materials Research for the best paper in the ACI Materials journal.

Ms Gladwell Nganga and Lombe Mutale received the Department of Science and Technology SA Women in Science Awards.

Ms Rachel Muigai received the Federal Ministry of Education and Research (BMBF), Germany Green Talents Award.

Assoc Prof Beushausen received the UCT College of Fellow's Award for Young Researchers.

Dr Beushausen was promoted to Associate Professor.

Associate Professor Moyo was promoted to full Professor.

9 RESEARCH IMPACTS AND RESEARCH HIGHLIGHTS FOR YEAR UNDER REVIEW

10.1 Durability test methods

Durability test methods that have been under research development for more than a decade are now with the SABS for drafting as national standards.

10.2 Number of student graduates and publications

There has been an excellent number of student graduates and publication outputs over the past year, as can be seen under the relevant headings.

10.3 New approaches

New approaches from the research continue to be used in major national construction projects. For example: the structural health monitoring work is now being used in a growing number of large concrete dams; evaluation and strengthening of major railway bridge infrastructure is being brought into the research effort; deterioration and durability studies are increasingly being carried out on affected infrastructure.

10 COLLABORATIONS AND LINKAGES

CoMSIRU has strong links with the University of the Witwatersrand. A portion of the research programme is jointly administered with Wits University and certain joint funding arrangements exist.

CoMSIRU also has strong links with the University of Stellenbosch through students undertaking courses at UCT and Stellenbosch (movement both ways), and via research links.

10.1 International Collaborations

Prof Santhanam from IIT Madras is an Honorary Research Associate of CoMSIRU. Visits by researchers between IIT Madras and UCT are regularly undertaken. Co-supervision arrangements are also in place. Student exchanges are beginning to occur. IIT Madras has significant strengths in analytical areas that UCT finds valuable.

Prof A Bentur, Technion, Haifa, Israel. A new Student and Staff Exchange Agreement is now in place between CoMSIRU and Technion in Israel, having been negotiated in 2011-12. The first two UCT students are due to take up these arrangements in late 2012/2013. Prof Bentur also teaches on our PG courses occasionally.

Prof Steffen Marx, University of Hanover Germany. A new link has been established between CoMSIRU and University of Hanover.

Prof Oded Rabinovitch, Technion, Haifa, Israel. A new link has been established between CoMSIRU and Technion in Israel, specific to Structural Integrity research.
Other active international collaborations are:

Prof	Karen Scrivener	EPFL Lausanne	Lausanne
Prof	Sidney Mindess	UBC	Vancouver
Prof	Douglas Hooton	University of Toronto	Toronto
Prof	Frank Dehn	MFPA	University of Leipzig
Dr	Peter Taylor	Iowa State University	Iowa
Prof	James Brownjohn	University of Sheffield	UK
Dr	Giovanna Concu	University of Cagliari	Italy
Prof	Oded Rabinovitch	Technion	Israel
Prof	Barbara De Nicolo	University of Cagliari	Italy
Prof	Alvaro Cuhna	University of Porto	Portugal

10.2 Visiting Scholars and Researchers

Professor Arnon Bentur, Technion Haifa, Israel. Feb-March 2012

Mr Jens Pieller, University of Hanover, Germany. Sept-Oct 2012

Professor Oded Rabinovitch, Technion Haifa, Israel. Sept-Oct 2012

Professor Frank Dehn, University of Leipzig, Germany.

Dr Alexander Taffe, Federal Materials Research and Testing Institute, Berlin, Germany

10.3 Industrial Linkages

	Industrial linkages	Personal contact	Nature of Linkage
1.	Cement Industry, via C&CI	Mr B. Perrie, other C&CI staff, Ms M. De Jager (Library), and Information Centre	Regular contact is had with C&CI and each of the major cement companies, via personal contact. Unfortunately, the Advisory Board did not meet in 2010. The C&CI library is regularly used by researchers and students.
2.	Concrete Manufacturers Association	Mr H Laing	Personal contact is maintained. The need for a SMME in the THRIP programme resulted in the CMA coming on board.
3.	ESKOM	Mr T Courtney	Personal contact is maintained. Contact is had with other ESKOM staff when particular problems arise.
4.	Dept of Water Affairs	Dr C Oosthuizen	Research on dam safety.
5.	Cement Companies: Afrisam, Lafarge, NPC	Various	Regular contact is had directly with the Cement Companies, in order to review their needs and help set priorities.
6.	PPC	Mr S Crosswell	PPC have sponsored a project on properties of concrete with Saldanha slag, at UCT. PPC and WITS often share test facilities for characterising cements used in research projects.
7.	Water Research Commission	Mr W Nomquphu	Research on dam safety.
8.	Sika	Mr W Smithers, Mr P Adams	Sika is sponsoring projects on the performance of protective coatings for concrete structures in UCT.

Industrial linkages	Personal contact	Nature of Linkage
9. Transnet	Mr Josiah Mpofu	Research on railway bridges and structures.
10. NNR	Dr. Sifiso Nhleko	Research on nuclear structures.
11. Misc. Consultancies, Contractors, Public Auth.	Various	Queries, specialist lab work, limited consultancies carried out.

11 CONFERENCES

CONFERENCES/WORKSHOPS/TRAINING SEMINARS ORGANISED/ATTENDED OVER THE LAST YEAR.			
Year	**Organiser (O)/ Attendee (A)**	**Title of Conference/ workshop/seminar & Venue**	**No of Attendees**
2012	MGA/HB/SS (A)	2nd International Conference on Micro Durability: "Microstructure related durability of cementitious composites", Amsterdam, 11-13 April, 2012.	150
2102	MGA/MO (A)	American Concrete Institute Spring Convention, Dallas, Texas, 18-21 March, 2012.	1500
2012	HB (O)	Technical Workshop on "Concrete Structures in Fire", Cape Town, Durban, Johannesburg, March 2012.	100
2012	HB ()O)	International Concrete Conference and Exhibition, Florianopolis, Brazil, March 2012.	400
2012	MGA/HB/PM (O)	3rd International Conference on Concrete Rehabilitation, Retrofitting and Repair, 2-5 September 2012, University of Cape Town.	400
2012	MGA/HB/PM (O)	International RILEM Week, 3-7 September 2012, University of Cape Town.	100
2012	HB/PM (O)	Technical Workshop on "Non-destructive Testing of Concrete Structures", September 2012, University of Cape Town.	80

Year	Organiser (O)/ Attendee (A)	Title of Conference/ workshop/seminar & Venue	No of Attendees
2012	MGA/MO (Speaker)	CSSA Workshop, "CONCRAX", Johannesburg, Cape Town, Durban, 1-4 October, 2012.	400
2012	MGA (Speaker)	IBRACON (Brazil Concrete Institute) Annual Conference, Maceio, Brazil, 8-11 October, 2012.	1000
2012	MGA (Speaker)	RILEM TC-226 Conference "Nucperf", Performance of Concrete Structures in Nuclear Containments, Cadarache, France, 12-13 November, 2012.	120

12 ACTIVITIES OF AND COLLABORATION WITH HRAs

CoMSIRU has two Honorary Research Associates:

Prof Manu Santhanam, Department of Civil Engineering, IIT Madras, Chennai, India

Prof Santhanam spent a sabbatical period of 6 months at UCT in 2010. During this period, he worked with us on aspects specifically related to durability performance-based specifications, and provided valuable input for the current revision of SANS 10100. He also interacted extensively with the postgraduate students. Currently, he is a co-supervisor for an MSc project on particle packing and its influence on concrete durability.

Mr Vernon Collis, Independent Consultant, Cape Town

Mr Collis provides much of the intellectual background to the projects on sustainability currently being undertaken in CoMSIRU. He co-supervises several MSc students, as well as providing oversight and supervision to several final year thesis students. Through his practical work, he also feeds in opportunities for students and staff to be involved in unusual external work.

13 LAB AND OTHER EXTERNAL WORK UNDERTAKEN

Major external work carried out by Prof Alexander in 2012:

- Completion of several years of ongoing work into the design and construction of a major Marina Complex in Abu Dhabi, for Murray and Roberts Marine.
- Work on the failure of concrete joints in a very large warehouse facility in Germiston, for Markram Inc.

Prof Moyo regularly consults industry on vibration problems, integrity assessment finite element modelling and calibration.

A/Prof Beushausen is very active in a wide range of external work – much of it related to durability assessments, structural evaluations, and development of repair and maintenance strategies for reinforced concrete structures. Much of this work is also channelled through the laboratory with PG students being involved.

14 CIVIL INFRASTRUCTURE MANAGEMENT AND MAINTENANCE PROGRAMME

The Department of Civil Engineering, via CoMSIRU, launched a new postgraduate specialisation programme in ***Civil Infrastructure Management and Maintenance*** in February 2013. The programme offers a broad suite of skills including asset management, project management, maintenance, repair and rehabilitation of civil infrastructure. This programme accords with the South African Government's Immoveable Asset Management Act of 2007, the South African Government National Development Plan, vision 2013 and National Infrastructure Maintenance Strategies proposed by the Department of Works, 2006, the Department of Water Affairs, 2008, and the Department of Transport, 2008.

The program seeks to train high level human recourses [MSc, MEng and PhD] to address human capital shortages in this area. This should stimulate research and development in Infrastructure Management and maintenance, leading to innovative solutions to address challenges associated with infrastructure management and maintenance. Thus there is potential to create jobs in this sector as the number of professionals and innovative solutions grow.

The following courses will be offered in 2013.

Course title	Course dates 2013	# Students
CIV5116Z: Durability & Condition Assessment of Concrete Structures	11 – 15 Feb	9
CIV5067Z: Advanced Infrastructure Management	15 – 19 Apr	15
CIV5115Z: Bridge Management & Maintenance	24 – 28 June	10
CIV5120Z: Repair & Rehabilitation of Concrete Structures	02 – 06 Sep	19
CON5016Z Project Planning and Implementation	25 – 28 March	10

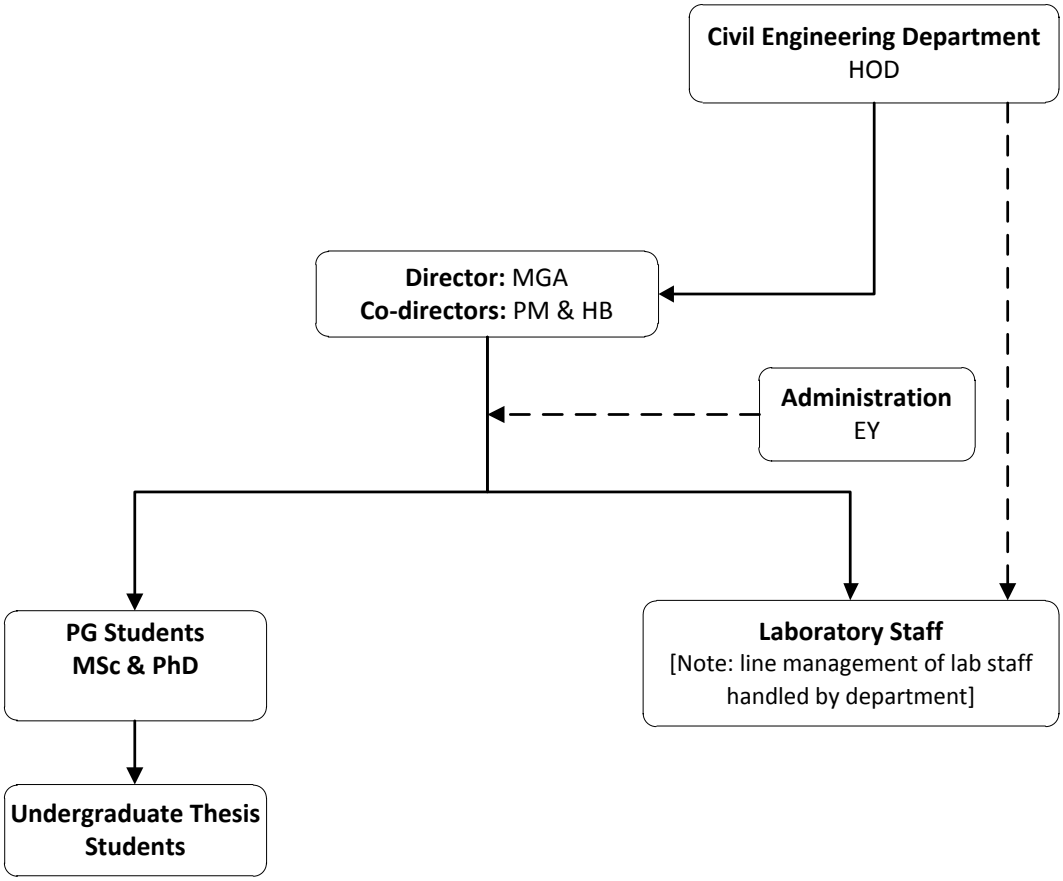
Judging by the number of registered students in this program, it is clear that there is demand for this programme, especially considering that advertising was not very extensive.

15 ORGANISATIONAL ARRANGEMENTS

15.1 Governance

CoMSIRU is overseen by its three directors, Professor M Alexander, Assoc Professor P Moyo and Dr H Beushausen. 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, Ms E Yelverton.

15.2 Organogram



15.3 Staff active in the research unit for 2012

Prof M G Alexander (Team Leader); Prof P Moyo; A/Prof H-D Beushausen; Mr V Collis (Pr. Eng, Hon. Res Assoc.); Prof M Santhanam (Indian Institute of Technology); Dr S Nhleko (National Nuclear Regulator) Mr C May, Mr L Adams and Mr D Ferus (Laboratory Assistants); Ms E Yelverton (Administrative and Finance Officer).

16 FINANCIAL STATEMENT

INCOME AND EXPENDITURE 2012

Balance as at 1 January 2012 **R 1,730,410**

INCOME

Source	Bursaries	Running Expenses	Total
Investment Fund (Interest)	R 0	R 21,240	R 21,240
C&CI	R 222,800	R 774,920	R 997,720
TESP	R 0	R 210,000	R 210,000
SIKA	R 30,000	R 40,000	R 70,000
CMA	R 0	R 35,190	R 35,190
PPC	R 0	R 59,000	R 59,000
THRIP*	R 0	R 541,880	R 541,880
WRC	R 0	R 427,000	R 427,000
NRF	R 288,000	R 135,320	R 423,320
URC	R 80,000	R 110,000	R 190,000
Non-CoMSIRU Units contrib. to admin	R 0	R 117,930	R 117,930
Industry (Lab work)	R 142,330	R 736,790	R 879,120
Courses/Workshops	R 50,000	R 295,660	R 345,660
TOTAL	**R 813,130**	**R 3,504,930**	**R 4,318,060**

***THRIP cannot be used for bursaries, so shortfall in bursaries is paid by means of contribution to industry (lab) work, but has to be recorded as salaries and paid via HR**

EXPENDITURE

Description	Total
Bursaries	R 1,085,630
Transfer from Investment/Other Funds for bursaries	R 450,000
Salaries (student bursary top-upvia HR)	R 192,420
Salaries (academics payments via HR)	R 273,610
Admin Finance Officer	R 248,550
Computers/Computer consumables	R 97,730
Equipment & Repairs	R 316,460
Chemicals/Workshop Sundries	R 175,360
Stationery/Telephone/Postage/Printing	R 68,620
Local Airfare	R 72,500
Local Subsistence and Travel	R 66,730
Foreign Airfare	R 215,610
Foreign Subsistence and Travel	R 131,930
Bakkie/Vehicle hire	R 87,940
Refreshments/Entertainment	R 42,150
Cost Recovery	R 215,920
Other (Books, Memberships, Conference Venue Hire, Miscellaneous)	R 232,170
TOTAL	**R 3,973,330**
SURPLUS/DEFICIT	**R 344,730**
Add funds carried forward from 2011	**R 1,730,410**

Balance as at 31 December 2012 **R 2,075,140**

17 BUDGET FOR 2013

This is given in the accompanying document covering the Business Plan.

18 APPENDICES

Thirteen post graduate students graduated during 2012. A condensed version of their research as represented by Abstracts from their theses is available on the CoMSIRU website www.comsiru.uct.ac.za/. The dissertation titles are:

NAME	TITLE
Philemon Arito	Discrete sacrificial anodes and their use in service life extension of chloride contaminated reinforced concrete structures.
Nicholas Burmeister	Evaluation of surface treatments for RC structures failing to meet South African durability index requirements.
Masuzyo Chilwesa	Assessing the age at cracking of concrete repair mortars/overlays subjected to restrained drying shrinkage
Vishal Gaya	Impact of mobile cranes on short and medium span bridges
Steven Gregan	The fatigue performance assessment of corrosion damaged RC beams, patch repaired and externally strengthened using CFRP.
Marc Gillmer	Investigating repair mortars containing superabsorbent polymers as a method of internal curing to improve concrete patch repair performance.
Ramonate Makha	Finite element analysis calibration of arch dams models using ambient vibration properties.
Michael Martin	The influence of curing techniques and chemical admixtures on the properties of concrete.
Ntseuoa Motsieloa	Acid resistance of sewer pipe concrete.
Christian Mutombo	The effects of partitions on the vibration serviceability of concrete floors.
Gladwell Nganga	Practical implementation of the durability index-based performance approach.
Barrie O'Neill-Williams	The use of natural site derived materials as concrete aggregate.
John Thuysbaert	The suitability of rammed earth for construction in the Cape Town Metropolitan area.