Structural Engineering and Civil Informatics Research Topics

Supervisor(s)	Degree	Preliminary title of research project	Brief description of project	Scholarship per year
Dr Wibke De Villiers	PhD	National Annex to SANS 51996 - Design of Masonry Structures	The South African masonry industry is in the process of the adoption of Eurocode 6 (SANS 51996 - Design of masonry structures) and the accompanying materials and testing standards, thereby transitioning the regulation of masonry structural design from prescriptive-based to performance based. This project focuses on investigating elements required for the development of a National Annex to SANS 51996.	R 140 000
Dr Wibke de Villiers, Prof GPAG van Zijl	PhD	Development of BIM information path for 3D concrete printed structural elements from concept, design, manufacturing and assembly to disassembly.	BIM models serve as the starting point for 3DCP design and represent the 3 dimensional model required for 3D printing, and are purposefully sliced and digitized into the intended layers of additive manufacturing, layer by layer process of extrusion-based 3D printing. This project focuses on extracting 3DCP of structural elements following all steps from BIM to the constructed element, including deconstruction consideration.	R 180 000
Prof John Babafemi, Prof GPAG van Zijl	PhD	Mix design guidelines for durable 3D printable concrete containing recycled waste.	Develope 3D printable mixes from recycled brick and concrete as partial replacement of natural aggregate, and industrial and agricultural waste as low-carbon binder replacement of cement, while preserving the required pumpability, extrudability and buildability properties. Cooperate with a consortium partner at the University of the Western Cape in identifying and determining the compatibility and durability of these alternative materials.	R 180 000
Dr Wibke De Villiers	MEng[R] / PhD	Performance-based standardisation of alternative masonry units for low-income housing	The current regulatory framework does not accommodate alternative masonry units in a sufficiently practical manner to enable their widespread, off-the-shelf uptake. The ongoing process of the adoption of Eurocode 6 (Design of masonry structures) facilitates the transition from prescriptive to performance-based regulation of masonry design. It is proposed that material non-specific, performance-based requirements for masonry units for structural application in low-income housing can be developed using a computationally efficient macro-modelling strategy in ABAQUS.	R50k-80k typically available for MEng[R], R80k-120k for PhD, TBC
Dr Wibke de Villiers, Prof GPAG van Zijl	MEng[R] / PhD	Sustainable 3DCP houses	Work with a local mining group on the use of Kaolin in high-quality printable concrete. Develop an optimal printable mix for the use in 3D concrete printing housing. Perform a life cycle analysis, and circularity potential. This project is envisaged for upgrade to PhD.	R 140 000 to be confirmed by sponsor
Mrs Courtney Devine / Prof RS Walls	MEng[R] / PhD	Fire safety systems for bulk plastic recycling facilities	Bulk plastic recycling facilities process and store thousands of tons of combustible products. Find innovative detection, suppression and fire safety systems to make these high-risk facilities safer. Analyse how to reduce risk using such systems.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Prof C Viljoen / Prof NPJ de Koker	MEng[R] / PhD	Target reliabilities for existing structures	Because maintenance is associated with a significantly different cost profile than new structures, a separate target reliability value for maintenance must be determined to avoid overdesigned maintenance or retrofitting solutions. This target reliability value is needed to calibrate partial safety factors used in designing retrofitting and maintenance solutions. This project will aim to interpret and adapt currently available literature on target reliability for existing structures for use in maintenance planning of typical SA bridges. Establish the links that may allow available bridge condition data to inform the choice of input parameters including partial factors for assessment.	R120k
Prof NPJ de Koker	MEng[R] / PhD	Open topic in materials modeling and uncertainty quatification	Details of the project can be developed based on the intersection of interests between student and supervisor.	
Prof NPJ de Koker / Prof C Viljoen	MEng[R] / PhD	Time-dependent reliability of reinforced concrete structures due to material deterioration	Modern structural design codes are calibrated to target reliability values (safety levels). With the course of time as a structure is exposed to various environmental and loading factors, the concrete and reinforcing steel will decay and corrode, resulting in a systematic reduction in structural capacity. The structural reliability will decay along with the capacity, and once a critical minimum safety level is reached, maintenance work should be performed to return the structure to a more acceptable reliability value. Determining the service life from the perspective of reliability requires a description of the systematic decay in reliability in response to material deterioration. This project will aim to interpret and adapt currently available literature on material decay to obtain a practical description of time-dependent reliability of structures in a South African context.	R120k

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Prof RS Walls	MEng[R] / PhD	Agricultural building fire safety	Agricultural builings are getting bigger and storing large quantities of combustible products. Investigate how to improve the structural fire resistance of such warehouse, cold rooms (with polystyrene walls) and processing plants.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Prof RS Walls / Dr Natalia Flores-Quiroz	MEng[R] / PhD	Fire safety for developing world hospitals	During COVID 19 many hospitals around the world burnt down, but especially in developing countries. This project will focus on understanding and enhancing fire safety for hospitals by identifying operational and practical issues that compromise fire safety and how they can be best addressed.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Prof RS Walls / Dr Natalia Flores-Quiroz	MEng[R] / PhD	Fire spread modelling for informal settlements	Develop models for analysing the spread of fire in informal settlements during disasters. Existing models have been developed at SU and these can be enhanced, validated and implemented.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Prof RS Walls / Dr Natalia Flores-Quiroz	MEng[R] / PhD	GIS modelling of wildland urban interface fires in South Africa	The destruction of many buildings at UCT was an example of how wildland fires are affecting towns and cities in SA more frequently. Using GIS and available software engines develop fire spread models for SA wildland fires.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Prof RS Walls / Prof John Babafemi	MEng[R] / PhD	Fire resistance of 3D printed concrete incorporating waste plastic	SU has developed both normal 3D printed concrete and 3D printed concrete incorporating waste plastic. Test at elevated temperature such mixes to determine how their material properties change in fire. Also, identify whether the plastic can burn.	Company linked competitive bursary (R70-R110k per year) to be sought. TBC.
Dr AS van Rooyen	MEng[R]	Development of foamed alkali activated strain hardening material for 4IR application	The CDSI is an internationally leading team in material science, structural engineering and technology for 3DCP. Using rheology principles with foam stability in mind, develop foamed alkali activated strain hardening material	
Dr AS van Rooyen	MEng[R]	Influence of secondary reinforcement on the bond behaviour of foamed concrete	Extend the current design bond model for reinforced structural foamed concrete by quantifying the effect of secondary reinforcement.	
Dr AS van Rooyen	MEng[R]	Durability of 3D printable FAAM	Investigate of the long-term (carbonation / creep / shrinkage) deterioration processes of 3D printable Foamed alkali activated material	
Dr AS van Rooyen, Dr Humaira Fataar	MEng[R]	Durability of foamed alkali activated material	Characterise the long-term behaviour of foamed alkali activated material under sustained loading	
Dr AS van Rooyen, Prof GPAG van Zijl	MEng[R]	Improved resistance to deterioration processes in 3DCP	The CDSI is an internationally leading team in material science, structural engineering and technology for 3DCP. This study will focus on improving the resistance to deterioration processes in 3DCP. A recent study published by the team on durability showed deeper penetration of carrbonation and chlorides between successive layers. Collaborate with current team members working on improving interlayer bond (chemically and / or physically) to improve the materials durability performance.	R100, 000 TBC
Dr Jacques Kruger	MEng[R]	3DCP interfacial improvement towards water tighness	This project kicks off with a sponsored visit to COBOD in Norway, in the December-January period, to be trained in 3D concrete printing. Return to Stellenbosch to develop, test and confirm strategies for improved, watertight 3DCP interfaces. Dr Stephan Zeranka and Dr Gerius Moelich (COBOD) will participate in the project through co-supervision.	R 100 000 to be confirmed by sponsor

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Dr. WI de Villiers, Prof GPAG van Zijl	MEng[R]	3DCP Housing, a regulatory framework from Structural Engineering perspective	The CDSI is an internationally leading team in material science, structural engineering and technology for 3DCP. Laboratory proof of concept for a 3DCP residence is close. Certified housing construction projects demand an appropriate regulatory framework, including national building regulations and standards. Work with the technical CDSI-3DCP team to develop a regulatory Structural Engineering framework. Consult role players like owners (Province City of Cape Town), Construction and Consulting engineers, and regulatory bodies.	R 140 000 to be confirmed by sponsor
Prof GPAG van Zijl, Dr AS van Rooyen	MEng[R]	Concrete Durability Design, Investigation of In-situ vs Laboratory Testing	Develop, as part of the team performing a SANRAL durability research project, a simpler in-situ test than laboratory tests currently performed to assess the structural durability of infrastructure. Build a data base of Resistivity and Chloride Conductivity Index (CCI) readings on reinforced concrete structures in SA, and internationally. Perform in-situ resistivity measurements as well as laboratory CCI tests on specimens collected from SA coastal infrastructure, and study the correlation between these results to establish the accuracy of resistivity-based test methods for design against chloride-induced reinforcement corrosion.	R 100 000 to be confirmed by sponsor
Prof GPAG van Zijl, Dr AS van Rooyen	MEng[R]	Concrete Durability Design, Investigation of In-situ vs Laboratory Testing	Develop, as part of the team performing a SANRAL durability research project, a simpler in-situ test than laboratory tests currently performed to assess the structural durability of infrastructure. Build a data base of Resistivity and Chloride Conductivity Index (CCI) readings on reinforced concrete structures in SA, and internationally. Perform in-situ resistivity measurements as well as laboratory CCI tests on specimens collected from SA coastal infrastructure, and study the correlation between these results to establish the accuracy of resistivity-based test methods for design against chloride-induced reinforcement corrosion.	R 100 000 to be confirmed by sponsor
Prof GPAG van Zijl, Dr Humaira Fataar	MEng[R]	Integral bridge abutment support design	Be part of the team performing a SANRAL research project on integral RC bridges. This M-project will collaborate wth an existing M on numerical modelling. From the models and their agreement with scaled physical experiments performed at U Pretoria, derive design recommendations for abutment backfill soil type, and modelling considerations for the purpose of design with particular reference to the abutments and their interaction with the backfill. Derive practical modelling strategies for design.	R 100 000
Prof GPAG van Zijl, Prof AJ Babafemi	MEng[R]	3DCP reinforcement	This project kicks off with a sponsored visit to COBOD in Norway, in the December-January period, to be trained 3D concrete printing. Return to Stellenbosch to develop reinforcement strategies for 3DCP. Evaluate innovative internal and external methods of reinforcement, considering mechanical resistance and durability. Dr Stephan Zeranka and Dr Gerius Moelich (COBOD) will participate in the project through co-supervision.	R 100 000 to be confirmed by sponsor
Prof NPJ de Koker / Prof RS Walls	MEng[R]	Anisotropic thermal properties of timber in fire	Anisotropic thermal properies of timber are often included in models of its behavior in fire, despite being rather poorly known. This project will aim to combine experimental testing and numerical modeling to improve our understanding of this effect at the high temperatures characteristic of fires.	
Prof R Combrinck	MEng[R]	Coarse aggregate 3DCP	This project kicks off with a sponsored visit to COBOD in Norway, in the December-January period, to be trained 3D concrete printing. Return to Stellenbosch to develop a printable mix with up to 8 mm coarse aggregate. The project is envisaged for upgrade to PhD. Dr Stephan Zeranka and Dr Gerius Moelich (COBOD) will participate in the project through co-supervision.	R 100 000 to be confirmed by sponsor
Prof Riaan Combrinck	MEng [S]	Cost and performance of calcined clay concrete	Calcined clay of metakoalin is a pozzolanic extender that promises to be one of the most viable alternatives or replacements for ordinary Portland cement (OPC). This study should investigate the cost and performance of metakoalin concrete versus the traditional OPC concrete. This is a desktop study more suited towards a MEng (S) research project.	TBC
Prof John Babafemi	MEng [R]/PhD	Development and performance evaluation of geopolymer concrete with environmentally friendly activators	Currently, the alkaline activators used in producing geopolymers have a high carbon footprint; hence, they are not environmentally friendly. This study will use possible environmentally friendly activators in developing geopolymer concrete using low-grade metakaolin and other aluminosilicate materials, and the performance investigated. Furthermore, a life cycle assessment for the concrete will be conducted.	TBC

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Prof John Babafemi, Prof Riaan Combrinck	MEng [R]/PhD	Low-carbon concrete from limestone calcined clay cement and recycled construction and demolition waste	The call for low-carbon concrete continues to grow globally. This research will develop a performance-based concrete mix from limestone calcined clay cement and waste streams, such as recycled construction and demolition waste. The mixes will be optimised to produce a high-performance concrete and the mechanical and durability properties investigated. Also, a life cycle assessment of the mixes will be conducted.	TBC
Prof John Babafemi/Prof Riaan Combrinck	MEng [R]/PhD	Metakaolin concrete	This study will investigate the optimal content of metakaolin that can be used with the various types of cement available in the SA market for normal strength and high strength concrete. The compatibility of metakaolin with different chemical admixtures will also be investigated. The fresh, mechanical, and durability properties, including shrinkage tests will be performed.	TBC
Prof R Combrinck, Prof John Babafemi	MEng [R]/PhD	3D-printing of ordinary concrete	3D-printed concrete has gained a lot of popularity for the construction of precast elements and even complete buildings. It does not require any formwork and can be constructed much faster than ordinary concrete. However, the mixes used are highly specialised and contains several admixtures and additives, making it expensive. This study should continue with the work started on printing ordinary concrete using more conventional concrete mix proportions and constituents.	Scholarships of R50k-80k typically available, speak to lecturer to confirm
Prof T Haas	MEng [R] / PhD	Evaluating the effect of eccentric loading on **circular** slender Concrete Filled Double Skin Tubular columns strenghtened with carbon fibre reinforced polymers.	The strength of Concrete Filled Double Skin Tubular (CFDST) columns can be significantly enhanced rapping the outer tube with carbon fibre reinforced polymers (CFRP). Limited research is availble on the enhancement when the load is concentric, while no published work is available on eccentric loading of **circular** slender CFDST columns strengthened with CFRP. The research will be conducted using experimental and FE analysis.	TBC
Prof T Haas	MEng [R] / PhD	Evaluating the effect of eccentric loading on **recangular** slender Concrete Filled Double Skin Tubular columns strenghtened with carbon fibre reinforced polymers.	The strength of Concrete Filled Double Skin Tubular (CFDST) columns can be significantly enhanced rapping the outer tube with carbon fibre reinforced polymers (CFRP). Limited research is availble on the enhancement when the load is concentric, while no published work is available on eccentric loading of **rectangular** slender CFDST columns strengthened with CFRP. The research will be conducted using experimental and FE analysis.	TBC
Prof T Haas	MEng [R] / PhD	Quantifying the potential risk of a moderate seismic event on infrastructure in earthquake prone regions in South Africa.	A significant number of insfrastructure in South Africa were either designed prior to the 1st seismic provision (SABS 0160-1980) or designed thereafter but did not consider the effects of seismicity for various reasons. This places these infrastructure at risk when subjected to a moderate intensity earthquake. The aim is to evaluate a number of different infrastructure to evaluate whether it meants the codified requirements; i.e. SANS 10160-4:2017	TBC
Prof T Haas, Dr AS van Rooyen	MEng [R] / PhD	Determining the effect of replacing concrete with "alternative" concrete for **circular** slender double skinned tubular columns subjected to eccentric loading.	Concrete Filled Double Skin Tubular (CFDST) columns can be used to enhance the construction process and is also a viable alternative in seismic prone areas. The aim is to evaluate the effects of using "alternative" concrete [i.e. alkali actived material / geopolimers, lightweight foamed concrete] on the mechanical performance of the **circular** slender CFDST columns subjetced to eccentric loading. The research will be conducted using experimental and FE analysis.	TBC
Prof T Haas, Dr AS van Rooyen	MEng [R] / PhD	Determining the effect of replacing concrete with "alternative" concrete for **rectangular** slender double skinned tubular columns subjected to eccentric loading.	Concrete Filled Double Skin Tubular (CFDST) columns can be used to enhance the construction process and is also a viable alternative in seismic prone areas. The aim is to evaluate the effects of using "alternative" concrete [i.e. alkali actived material / geopolimers, lightweight foamed concrete] on the mechanical performance of the **rectangular** slender CFDST columns subjetced to eccentric loading. The research will be conducted using experimental and FE analysis.	TBC
Dr Humaira Fataar, Prof Gideon van Zijl	MEng [R]	Fatigue behaviour of 3DPC	Most fatigue failures are caused by loads significantly lower than the yield load due to the crack growth over time caused by cyclic loads. Cyclic loading may occur under continuous applied loading/unloading, or as a result of thermal expansion and contraction, etc. This study will focus on the cyclic behaviour of 3DPC at the interlayer bond.	Student to apply to NRF

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Prof Riaan Combrinck	MEng [R]	Nano-bubble water concrete	Stable Nano-bubble infused water can be used to replace the mixing water of any concrete. The type of gas inside the bubble can be changed as needed. This study should investigate the use of different gasses within the bubble and the effect this has on the concretes fresh and hardened properties.	Scholarships of R50k-80k typically available, speak to lecturer to confirm
Prof Riaan Combrinck	MEng [R]	Nano-materials in conventional concrete applications	Nano-materials have been used in several high performance and complex concrete mixes. However, the use of these material to improve more conventional concrete applications and mixes has not received allot of attention. This study should investigate using Nano-materials to improve more conventional concrete applications. This includes test on the fresh and hardened properties of concrete. The Nano-materials are not limited and can include a wide variety such as: bubbles, graphene, silica, calcined clay, iron etc.	Scholarships of R50k-80k typically available, speak to lecturer to confirm
Prof Riaan Combrinck	MEng [R]	Using South African tree gums/saps as admixture in concrete	The gums of trees are widely used in various industries. This study should test the influence of several gums from trees available in South Africa on the fresh and hardened properties of concrete, with the aim of using these tree gums as admixtures.	Scholarships of R50k-80k typically available, speak to lecturer to confirm
Prof Riaan Combrinck	MEng [R]	Guidelines for the use of internal and external preventative methods for plastic cracking in concrete	The cracking of plastic concrete can result in serious and premature durability issues. However, these cracks can be prevented using externally applied preventative measures such as water curing, curing agent, sheets, shades, re-vibration and sequential placement as well as internal preventative measures such as shrinkage reducing admixtures, SAP and fibres. These measures are often ineffective due to incorrect application. This study should investigate and propose guidelines for the optimum application of these measures for preventing or minimising the cracking of plastic concrete.	Scholarships of R50k-80k typically available, speak to lecturer to confirm