

Research Associate in Material and Structural Performance of Hybrid 3D Concrete Printing

REQ230993

About the School of Architecture Building and Civil Engineering

Research and teaching in the School of Architecture Building and Civil Engineering is driven by 80 academic staff, 34 technical and clerical support staff, 40 contract researchers and over 120 doctoral students. The School benefits by having academic staff from a wide variety of backgrounds, with a resulting rich diversity of perspectives. The undergraduate programmes include Architecture, Civil Engineering, Construction Engineering Management, Commercial Management and Quantity Surveying, Architectural Engineering and Design Management, Air Transport Management, and Transport and Business Management. In all courses, the academic content is directly aligned to the needs of the industry and there is a high level of sponsorship in our portfolio of programmes. Our record of graduate employment is second to none and we have been ranked 1st or 2nd in the National Student Survey for the last 6 years. Further information is available at: <http://www.lboro.ac.uk/departments/abce/>

The School of Architecture, Building and Civil Engineering delivers zero-carbon, resilient buildings, infrastructure and cities in a world under pressure from rising urban populations, ageing infrastructure, resource constraints and multiple hazards. In the 2021 Research Excellence Framework (REF), Loughborough University ranked second place for Architecture, Built Environment and Planning and the research undertaken in the School was rated 'world-leading'.

The international standing of our research is exemplified by our growing portfolio of collaborations with other leading universities and research institutes worldwide. These include: the UNSW Sydney, University of California at Berkeley, MIT, Chongqing, Hong Kong, Iowa State, Oklahoma State, RMIT, Georgia State and Penn State.

We are equally proud of our collaborations with industry such as HS2, Mace, Skanska, Aecom, Arup, Willmott Dixon, BRE, Anglia Water and many others, as well as influential organisations such as the Construction Leadership Council (CLC), Constructing Excellence, BSI and others. Built Environment research is increasingly informing government policy through, for example, the Department for Business, Energy and Industrial Strategy and The Committee on Climate Change, and working with for organisations such as the NHS, HS2, Network Rail and others. For more on our research go to: <http://www.lboro.ac.uk/departments/abce/research/>

3D (and Hybrid) Concrete Printing Group

Loughborough University is known worldwide for its pioneering work in [3D Concrete printing](#). It was the first to produce large-scale reinforced parts and double-curved panels in addition to the seminal materials research in the area.

3D concrete printing is a large-scale, additive-manufacturing process that can be deployed to deliver functional parts and elements for buildings and the built environment. There is significant interest in these automation technologies worldwide, demonstrated by the many organisations engaged with commercial R & D as well as academic research.

The 3D and (hybrid) Concrete Printing research is led out of the School of Architecture Building and Civil Engineering (ABCE) lead by Professor [Richard Buswell](#), what is a collaborative effort involving four schools in the University: Wolfson School of Manufacturing, Mechanical and Electrical Engineering (MEME), the School of Science and the School of Design and Creative Arts.

The group comprises of 10 academics, 5 Post Doctoral Researchers, Research Fellows, and technical staff, and 12 PhD students. You would be a member of this group to work on a collaborative research project between colleagues in Loughborough's [Intelligent Automation centre](#) (a multidisciplinary centre for advanced robotics and digital automation based in MEME) and the team in ABCE. On the 2.5 year EPSRC Funded "[First Time Concrete](#)".

3D concrete printing is rapidly growing as a technology worldwide, both for research and commercially, but current 3D printing processes result in geometric forms and surface finishes that are not always desirable, and part accuracy that is too low for many applications. To address this, the 3D printing process can be followed immediately by a subtractive process that mills the surface to trim off unwanted material. This improves both accuracy and surface finish. By using a two-stage process of deposition followed by milling, it is possible to create high-quality parts, with intricate features and well-controlled surface finishes. The problem is that for each new part manufactured in this way, many iterative process development trials are required to perfect the deposition and milling strategy. This is time-consuming and wasteful, and it is a barrier to the uptake of the technology.

The First Time Concrete (FT-Concrete) project will address this problem by creating new digital process and material models that can be used to help design printing and milling strategies without the need for physical trials. These goals will be undertaken by a research team experience encompassing: CAD/CAM, robotics and automation, structures and materials science, metrology and quality control.

The project team comprises of three post-doctoral researchers and a technician and in partnership with: Cundall Johnston & Partners, Fosters + Partners, Haddonstone, Sika and The Manufacturing Technology Centre.

Job Description:

Job Grade: Specialist and Supporting Academic 6

Job Purpose

The Research Associate will be responsible for the development, execution and analysis of the material and structural testing programmes based on 3D concrete printing and milling. The Research Associate will also develop time-dependent material models to predict the impact of early-age evolution of rheological and mechanical properties on the manufacturing processes and quality of the 3D printed and milled parts.

Job Duties

Research

- To develop models for the early-age evolution of rheological and mechanical properties of 3D printed concrete.
- To develop new knowledge and models regarding the influence of these properties on the manufacturing processes and quality of parts subject to the milling process.
- To lead the development of materials and structural test programmes in collaboration with the project team, exploring simplified approaches to collect data on the evolution of the early-age properties critical to inform the milling process.
- To liaise and engage with the project partners and team members based in MEME.

General, technical

- To assist PI and COIs in project management and develop project delivery plan.
- To write research papers suitable for publication in high quality academic journals and for presentation at specialist scientific conferences.
- To report research progress and work with the wider project teams to ensure successful delivery of the proposed research.
- To attend and contribute to project meetings and engagement events.

Teaching

- To assist the academic staff at Loughborough with the supervision of undergraduate MSc and PhD project work and day-to-day supervision and support of other researchers.
- Where appropriate, to deliver lectures, tutorials and laboratory sessions to students.

General and administrative

- To work effectively with relevant administrative, technical and academic staff in the School and across the University.
- To engage in training programmes in the University (e.g. through Staff Development) which are consistent with your needs and aspirations and those of the project team and the host School.
- To carry out specific other duties as may be reasonably requested by the project leaders and that are commensurate with the nature and grade of the post.

Points to Note

The purpose of this job description is to indicate the general level of duties and responsibility of the post. The detailed duties may vary from time to time without changing the general character or level of responsibility entailed.

Special Conditions

All staff have a statutory responsibility to take reasonable care of themselves, others and the environment and to prevent harm by their acts or omissions. All staff are therefore required to adhere to the University's Health, Safety and Environmental Policy & Procedures.

All staff should hold a duty and commitment to observing the University's Equality & Diversity policy and procedures at all times. Duties must be carried out in accordance with relevant Equality & Diversity legislation and University policies/procedures.

Successful completion of probation will be dependent on attendance at the University's mandatory courses which include Respecting Diversity and, where appropriate, Recruitment and Selection.

Organisational Responsibility

Reports to: Professor Richard Buswell

Person Specification

Your application will be reviewed with respect to meeting the essential and desirable criteria listed below. Your application will be reviewed against the essential and desirable criteria listed below. Applicants are strongly advised to explicitly state and evidence how they meet each of the essential (and desirable) criteria in their application. Stages of assessment are as follows:

- 1 – Application
- 2 – Test/Assessment Centre/Presentation
- 3 – Interview

Essential Criteria

Area	Criteria	Stage
Experience	Background in structural engineering or materials science for the design or production of concrete components	1,3
	Developing testing protocols for material characterisation.	1,3
	Experience with modelling early-age performance of cementitious materials.	1,3
	Publication of academic articles or papers on engineering or science topics	1
Skills and abilities	Ability to undertake the duties and responsibilities of the post	1,3
	Design and modelling skills using computer-based codes	1,3
	Excellent written and oral communication	1,2
	Excellent interpersonal and organisational skills	2,3
Training	Willingness to undertake appropriate further training and to adopt new procedures as and when required	1
Qualifications	A PhD in structural engineering/concrete materials, or related field (PhD near completion, or significant other related experience will be considered)	1
Other	Commitment to observing the University's Equal Opportunities policy at all times	1,3
	Willingness to travel.	3

Desirable Criteria

Area	Criteria	Stage
Experience	Experience of using large-scale extrusion based additive manufacturing (3D concrete printing)	1,3
	Teaching and / or supervision of students in relevant areas	1,3
	Writing research proposals for funding from internal/external sources.	1,2,3
Skills and abilities	Knowledge of the rheology of pastes or other extrudable cementitious materials	1,3
	Knowledge of robotics and automation/CNC additive manufacturing/3D printing	1,3
	Ability to work with communities and stakeholders	1,3
Qualifications	PhD relates to additive manufacturing based on extruded concrete.	1

Conditions of Service

The position is full time for a fixed term period of 24 months available to start in November 2023. Salary will be within Specialist and Supporting Academic Grade 6 (£33,966 - £44,263 per annum) at a starting salary to be confirmed on offer of appointment.

The appointment will be subject to the University's Terms and Conditions of Employment for STAFF GRADES 6 AND ABOVE, details of which can be found [here](#).

The University is committed to enabling staff to maintain a healthy work-home balance and has a number of family friendly policies which can be found [here](#).

The University offers a wide range of employee benefits which can be found [here](#).

We also offer an on-campus nursery with subsidised places, subsidised places at local holiday clubs and a childcare voucher scheme (further details are available at: <http://www.lboro.ac.uk/services/hr/az/childcareinformation---page.html>)

In addition, the University is supportive, wherever possible, of flexible working arrangements. We also strive to create a culture that supports equality and celebrates diversity throughout the campus. The University holds a Bronze Athena SWAN award which recognises the importance of support for women at all stages of their academic career. For further information on Athena SWAN see <http://www.lboro.ac.uk/services/hr/athena-swan/>

Applications

The closing date for receipt of applications is 30 September 2023.