Professor Stephen Foster

Emeritus Professor Ian Gilbert

#concrete
#steel-fibre
#tensile_strength
#post_cracking

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A **vibrant** construction sector is fundamental to Australia's economic growth. **Ground-breaking research** at UNSW in the field of **concrete structures** has kept, and will continue to keep, the Australian construction sector at the forefront internationally.

Having laid its foundations in concrete engineering over 60 years ago, the School of Civil and Environmental Engineering is well known for pushing the boundaries of both construction materials and structural design.

The concrete structures team at UNSW, currently led by Professor Stephen Foster (Head of School) and Emeritus Professor Ian Gilbert of the Centre for Infrastructure Engineering and Safety (CIES), has a strong history of engagement in the development of national and international design standards that give engineers the confidence to adopt innovative new materials and techniques.

"We are leaders in bridging the gap between materials sciences and the use of modern construction materials within the community," says Stephen Foster. "We want to maintain and grow that lead".

The vibrancy of Australia's construction future rests with the development and application of materials that not only promote good economic outcomes but also are sustainable, high-performance, and safe under stress.

The team at UNSW have been responsible for the material modeling provisions for normal and high-strength concrete in the Australian Standard for Concrete Structures AS3600-2009. UNSW also leads the way in research on the use of steel fibre reinforced concrete (SFRC) to increase the longevity of concrete structures in urban environments. While the use of fibres to strengthen building materials isn't new -- horse hair and straw were used in the past to strengthen mortar and mud bricks -- engineers need to understand how steel fibres respond to residual stresses before SFRC can be safety integrated into a wider range of design applications. Residual stresses are those that begin and linger once cracks form in the concrete.

structures

Steel fibre reinforcement provides tensile strength after cracking, limits crack width and improves durability, but these effects are still to be quantified reliably. The team of researchers led by Professor Foster, is testing different steel fibre-concrete mixes and creating models that help engineers understand how much stress steel fibre reinforced concrete structures can take and how steel fibres control crack development.

The team is also making active contributions to a revision of the Australian Bridge Design Code, with the new chapter in the code on fibre reinforced concrete having been prepared directly from UNSW research by a sub-committee led by Professors Foster and Gilbert.

Separate research is underway on the use of geopolymers – waste products from other industrial processes – that can be used to replace cement in concrete.

Cement is a major contributor to greenhouse gas emissions: it is thought about 800 kilograms of carbon dioxide is released for every tonne of cement produced. By substituting the cement in concrete with a more sustainable material, the environmental footprint of buildings and other infrastructure can be significantly reduced. Potential geopolymers include fly ash, which is a by-product of burning coal, and granulated blast furnace slag, which is a by-product of steel production. UNSW researchers have been working through the CRC for Low Carbon Living to determine the gaps in research on geopolymer concrete and what has to be done in order to develop standards for its widespread use in the Australian construction sector.

Over the past five years, the team at the School has been strengthened by a new generation of researchers, including Associate Professor Arnaud Castel, Senior Lecturers Ehab Hamed and Hamid Vali Pour Goudarzi and others.

Associate Professor Castel is an expert on concrete durability and is currently extending his work to include both geopolymer concrete and the effects of steel corrosion on the serviceability and sustainability of concrete structures.

Dr Hamed's work covers ultra-high-performance concrete and functionally graded materials; the latter is about minimising the weight of structures and therefore the amount of material needed to build them, without sacrificing performance.

Dr Vali Pour Goudarzi is researching the behaviour of structures that are subjected to extreme loading scenarios, such as fire, blast or earthquake.

"They are the future," Professor Foster says. "Their work will keep us at the forefront over the next 20 years."

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