DEVELOPMENT OF NOVEL CONCRETES FOR STRUCTURAL APPLICATIONS

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BEng (Architectural Engineering) Hons

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ABSTRACT

Owing to its properties and cost benefit, concrete is the most widely used construction material globally. The rapid increase in industrialization and urbanization because of the global economy and population growth has increased environmental awareness and attracted attention to new methods and innovations in concrete technology.

To respond to these needs, three novel concrete technologies are investigated in this thesis: eco-binder concrete, concrete produced with recycled concrete, and the use of external and internal reinforcements in conventional high-strength concrete (HSC). Gaps in the current literature were identified and addressed by performing new tests at the University of Adelaide. The investigations have resulted in five journal papers, which are parts of this thesis.

First, the mechanical and durability-related properties of geopolymer concrete (GPC) are reported. GPC is currently investigated as an environmentally friendly alternative to concrete based on ordinary Portland cement (OPC). Because of the lack of literature data regarding the behaviour of coal ash-based geopolymer concrete cured under ambient conditions, this study uses ambiently-cured GPCs to identify the key parameters that affect the properties of fresh and hardened concrete.

Second, the mechanical and durability-related properties of recycled aggregate concrete (RAC) was experimentally investigated in this research. In addition to this, confinement of RAC with fibre-reinforced polymer (FRP) has shown great potential as concrete for high-performance structural elements. Moreover, its use can reduce the environmental impact of natural resources depletion. This thesis also discusses the experimental results that aim to fill in the knowledge gap in the key parameters of the axial compressive behaviour of RAC-filled FRP tubes (RACFFTs) manufactured with carbon FRP (CFRP) or basalt FRP (BFRP) tubes.

Finally, owing to the inherently brittle nature of HSC, even well-confined columns often exhibit temporary postpeak axial strength-softening behaviour, which negatively affects their overall performance. In this study, steel fibres, which effectively delay and stop crack propagation, were used as internal reinforcement to address the aforementioned shortcomings of conventional FRP-confined HSC. To date, this is the first experimental investigation of the effect of key parameters on the axial compressive behaviour of steel fibre-reinforced HSC (SFRHSC)-filled FRP tubes (SFRHSCFFTs).

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Tianyu Xie Date

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