Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

Exploitation of Automation for Large-Scale Rebar Prefabrication: An Investigation of Design and Equipment Factors at Hinkley Point C

Automation and robotics have delivered a range of benefits to other industrial sectors over the past decades, including increased productivity, quality and safety. The construction industry needs these benefits to meet global infrastructure demands and achieve sustainability goals yet has been much slower to adopt these technologies. Reinforced concrete (RC) is one of the world's most widely used man-made materials and the United Kingdom (UK) uses around 1.2 million tonnes of steel reinforcement (rebar) each year. This study investigated how automation could be further exploited for prefabrication of large-scale rebar assemblies. Traditionally a complicated, labour-intensive task beset by inefficiencies, rebar assembly has seen the introduction of automation for some limited, standard and typically smaller-scale applications. However, the capability of currently available equipment is insufficient for industry's requirements since design and construction constraints are not effectively accommodated. In addition, existing rebar design and detailing practices do not adequately consider buildability issues associated with automated assembly.

The study adopted a Mixed Methods approach, with 11 semi-structured interviews with experienced design, construction and manufacturing practitioners involved in recent efforts to automate rebar assembly, and quantitative data analysis of existing rebar design. The UK's new £22.5 billion nuclear project Hinkley Point C (HPC) was used as an exemplar of large-scale RC design and construction; with over 200,000 tonnes of rebar modelled in 3D and investment in a multi-million-pound automated production facility for rebar assembly.

The study provides important insights into the interrelationships between rebar design and assembly equipment. Changes to both were found to be necessary and examples are provided of how closer integration of the design and assembly processes could deliver benefits. Key obstacles to further automation and problematic features of rebar design for automated assembly were identified. Recommendations for feasible changes are provided, including further adoption of 'design for assembly' principles through incremental adaptations within existing design codes. The study also identified limitations in existing equipment capabilities. Finally, the baseline volume of HPC rebar suitable for automated assembly using currently available equipment (20%) was quantified and the magnitude of time and cost benefits from developing new assembly processes (which could feasibly increase the proportion to 46%) were estimated. The study's important real-world insights could be utilised by organisations seeking to further exploit automated assembly in construction applications.

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