UNIVERSITY OF CAMBRIDGE
Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

Early Design Decisions for Modern Methods of Construction: How designers at concept stage can set the groundwork for flexible and efficient use of MMC

The practice of generating a preliminary concept design of a structure relies on the use of rules-of-thumb, standards, historical examples and best-practice guides that are predominantly founded on Traditional Methods of Construction, making designing for Modern Methods of Construction (MMC) a challenge. This dissertation investigates how structural and architectural consultants can enhance their current design methods at RIBA Work Stage 2: Concept Design to enable feasible and efficient design of offsite manufactured precast elements. This dissertation focuses on a select few offsite manufactured products in the context of a case study involving Laing O'Rourke delivering projects in the UK using precast elements manufactured at the Centre of Excellence for Modern Construction (CEMC). The additional constraints and design characteristics required for an efficient MMC design were considered for each of the precast elements, such as the manufacturability, transportation, constructability, quality, cost and sustainability of the systems. A simplified cost model was created for each of the elements and their in-situ counterparts and simulations were ran against independent variables to build a greater understanding of how a designer can cost-optimize each of these products. Simulating the cost of PC Columns versus RC Columns, it was clear that the factors that influenced the cost sensitivity of a PC Column, such as the varying cost of proprietary connections, were not reflected in traditional methods of optimization. Simulating the cost of Twinwall versus RC Wall, it was found that keeping a wall length under a set multiple of the maximum panel length increased the MMC:TMC cost-ratio by reducing the number of elements, joint operations and crane lifts while making relatively little difference to the in-situ rate. Assessment of the span-to-depth ratio of a slab in a live project demonstrated the need for considerate floorplate layouts, as highly utilized in-situ slabs often resulted in either unfeasible or enhanced-but-costly MMC alternatives. In completing this assessment, it was also intended that the very process by which this case study was examined can be adopted by other individuals for their systems, sectors and regions, to begin assembling a greater understanding of how MMC can be incorporated and optimized at early stages of design globally. This dissertation concludes that an 'MMC Constraints and Philosophy' guide can be used to capture the unique characteristics of a product and help designers make informed decisions at critical stages in early design. There is also a need for further investigation into the effects of early design decisions on MMC across a greater set of products, sectors and regions to make building with MMC more efficient, optimized, sustainable and fit for purpose.

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