UNIVERSITY OF CAMBRIDGE
Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

Quantifying the Opportunity to Reduce Material Use in Insitu Reinforced Concrete Frames

Half of the world's steel production is used by the construction industry with the largest area of application as rebar (reinforcing bar) for reinforced concrete (RC). The global demand for concrete's ingredients, steel and cement, is predicted to double over the next thirty-five years. This will occur over the same period in which the industry is tasked with significantly reducing the emissions associated with construction.

Recent research has highlighted steel framed office buildings have an average structural utilisation below 50% suggesting that such buildings contain twice as much steel as necessary for structural performance. There is little literature on the utilisation of RC framed buildings. This dissertation investigated the structural utilisation of RC frames to identify opportunities to use less material by design.

The utilisation ratios for sample RC projects were calculated. It was interesting to find that, for the projects investigated in this dissertation, the average utilisation ratio for RC beams was approximately 70%, significantly higher than the value derived for steel framed buildings. However, the majority of the RC material is contained within the floor slabs (whereas steel is confined to beams and columns in the steel frame analyses). The data analysed and collected for the RC slabs in this dissertation concluded they were approximately 85% utilised based on slab thickness (but lower utilisation ratios were recorded when the reinforcement design was investigated).

The results were presented in a questionnaire distributed to structural engineers which identified key factors which the engineers consider contribute to the current levels of utilisation.

Despite being a small proportion of overall project costs (typically 1-2%) the cost of the structural engineering design process was identified as an important contributing factor to the current utilisation ratios. Comparisons of different levels of optimisation of reinforced concrete elements were carried out to identify the potential savings of material costs. As there are few incentives to engineers to maximise the use of material, the reduced materials costs were then compared with varying scales of increased design fees.

It is concluded, that contrary to what the engineers stated, design time does not appear to be the issue rather it is the current methods of procurement. When commissioned to carry out a design there is no incentive to consider the material used or the level of structural utilisation. The actual driver is minimum design time to provide an overall efficient structure. The current procurement processes do not lead to an optimum design.

The lack of incentives that exist to engineers is discussed. Recommendations include the provision of appropriate procurement models, and effective utilisation measurement and recording during the design process to maximise material utilisation in the design of RC structures.

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