UNIVERSITY OF CAMBRIDGE
Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

A Quantitative Study of Building Shm Data Using Reliability and Bayesian Analyses to Improve Design Efficiency

The buildings required to accommodate the growing urbanised global population are currently responsible for 39% of global carbon emissions (embodied and operational). Therefore, reducing the embodied carbon in buildings plays an essential part of the strategy for mitigation against the effects of climate change. A quantitative analysis was conducted on the data produced by the Structural Health Monitoring (SHM) system installed on 1 Soho Place, a 10 story building in London. The SHM system measured the compression of elastomeric bearings under the columns. The load was inferred using the stiffness of the bearings. These loadings were then compared with the predicted values calculated by the design consultant ARUP using linear elastic finite element analysis (FEA). This research was in part an exploratory study on whether elastomeric bearings could be used to infer building load. A method is presented for using SHM data as part of reliability and Bayesian analyses to design partial factors following Euorocde 0. The goal of this approach was to reduce partial design factors to increase material utilisation, to use less material, to reduce embodied carbon, whilst maintaining the same level of structural reliability as any design conducted under the Eurocode requirements. The total load measured was within 10% of the predicted value, and the overall correlation between the predicted and measured values was strong (Pearson's r- value 0.907). There were some significant differences caused by the system error and differences in the measured load distribution when compared with the predictions from the FEA. These differences were identified by the variability of the measured/predicted values, which was much larger than the assumptions in Eurocodes and resulted in less certainty. System Distribution Factor (SDF) is introduced to separate the load distribution effects from the assumed statistical variability specific to the applied load. This exploratory study has shown that elastomeric bearings proved to be a suitable tool for inferring structural load.

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