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PII: S2352-7102(17)30342-X
DOI: http://dx.doi.org/10.1016/j.jobe.2017.06.013
Reference: JOBE289

To appear in: *Journal of Building Engineering*

Received date: 17 March 2016
Revised date: 21 April 2017
Accepted date: 22 June 2017

Cite this article as: P. Block, A. Schlueter, D. Veenendaal, J. Bakker, M. Begle, I. Hischier, J. Hofer, P. Jayathissa, I. Maxwell, T. Méndez Echenagucia, Z. Nagy, D. Pigram, B. Svetozarevic, R. Torsing, J. Verbeek, A. Willmann and G.P. Lydon, Investigating lightweight construction and adaptive energy systems the NEST HiLo building, *Journal of Building Engineering* http://dx.doi.org/10.1016/j.jobe.2017.06.013

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Abstract

This paper presents research on lightweight construction and smart, integrated and adaptive building systems. The research is focused on addressing challenges related to the building industry at large, including most prominently the improvement of energy efficiency, onsite power generation, and the reduction of the quantity of materials required to build. We introduce four innovations in context of the design of an experimental building (NEST HiLo): a lightweight, unreinforced funicular floor system; a flexibly formed, concrete shell sandwich roof; a soft actuated, adaptive solar facade and an automated, occupant-centred control system. We demonstrate novel structural engineering approaches to compression-only concrete elements and shell design using multi-criteria shape optimisation. We explore a building facade concept, which employs robotic actuators for solar shading and on-site generation. In addition, the operational phase of the building will be used as a living laboratory where occupants' locations and needs for comfort are detected and used for the control of the energy innovations. The research provides insight into design topics that will become increasingly relevant for the evolution of improved lifecycle energy buildings.