Next Generation Residential High-Rise: Evaluating and Comparing the Global Warming Potential of Different Structural Systems and Materials

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Abstract

Initiated by SUTD's Urban Housing Lab and the Renewable Architecture Lab, the research project "Next Generation Residential High-Rise" aims at improving the environmental impact of housing developments in high-density urban environments. The main goal of the research is the development of a software tool that evaluates the impact of early and intermediate design decisions on the Global Warming Potential (GWP) of a building. Based on a modular and systemic division into a permanent support- and a flexible infill system [1], this tool will help to determine the interdepending material ratios of alternative load-bearing systems and the respectively required infill components. As an integral component, it also considers the impact of alterations within the infill system during a building's service lifetime, which are necessary due to changing user demands and demographics, and might enable an extension of service lifetime.

By using a notional building as a reference, the here presented early-stage studies evaluate and compare the GWP of different construction systems such as frame construction, shear wall construction, and Prefabricated Prefinished Volumetric Construction (PPVC). The comparison of the outcome for each variant will clarify their respective advantages and disadvantages. A specific structural system can have an impact on the flexibility and adaptability of floorplan layouts and the infill system. Due to a high degree of prefabrication, PPVC and other modular approaches have the advantage of shorter construction time. On the other hand, there is also a high degree of redundancy, as all floors, ceilings and walls are doubled. In principle, this might be justifiable due to the potential reusability and reconfigurability of the modules. Potentially, rather undetermined frame structures might allow for higher levels of flexibility but necessitate a large amount of infill components to meet spatial requirements, with a subsequent impact on material investments and consequently environmental performance. While shear-walls systems are space enclosing and would thus require less material investment to accommodate alterations, they might also offer less flexibility. Poly-valency though, as a strategy for determined layouts that cater flexible appropriations only by multiple connectivity options for spaces and their function-neutral dimension, offers alternative means.

References

[1] N. J. Habraken, *Supports: an Alternative to Mass Housing*, Urban International Press, UK, Edited by Jonathan Teicher, 1999. Edited reprint of the 1972 English edition.