LCC and LCA of dynamic construction in the context of social housing

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Short Summary

Continuously changing household needs and evolving building standards require a frequent upgrade and renovation of our existing residential building stock. A lack of adaptability of buildings, however, often leads to destructive interventions, resulting in financial and environmental impacts. The goal of this paper is to contribute to the search for new design concepts enabling easier and more cost-effective upgrade and renovation of buildings. It should moreover contribute in achieving a lower life cycle environmental impact. A more dynamic design is evaluated in the specific context of a social housing project in Mechelen (Belgium). In this context, building elements with reversible detailing techniques facilitating disassembly and component reuse are compared to more traditional static elements. The benefits and drawbacks are assessed at the building level using a life cycle approach of economic and environmental aspects, i.e. a Life Cycle Costing (LCC) and Life Cycle Assessment (LCA). Different renovation scenarios are simulated focussing on the internal restructuring of the housing units. Two alternatives were investigated: dynamic assemblies of all internal walls versus dynamic assemblies of only those internal walls which are expected to change more frequently. The analysis revealed that the building concept and layout are important for making more dynamic design beneficial or not. Building layouts which provide opportunities for change generally require limited constructive adaptations during the building life span. Application of dynamic assemblies to only those walls which are assumed to be changed in future is then preferred over an application to all internal walls. This could be called a ‘selective’ approach. Such a ‘selective’ approach can result in life cycle environmental benefits while the additional financial costs remain limited.

Keywords:adaptability; building level, life cycle assessment; life cycle costing; renovation.

1. Extended abstract

Continuously changing household needs and evolving building standards require a frequent upgrade and renovation of our existing residential building stock. A lack of adaptability of buildings, however, often leads to destructive interventions, resulting in financial and environmental impacts. To avoid these, a more dynamic design approach can be proposed, using concepts like disassembly, adaptability, transformability and multi-functionality. The basic principle is the integration of time as design parameter in order to enable buildings to deal with changing needs over their building life cycle [1].

The goal of this paper is to apply and evaluate a dynamic design approach in the specific context of the upgrade of the social housing neighbourhood “Mahatma Gandhi” in Mechelen (Belgium). The focus is set on the evaluation of a number of representative renovation scenarios at the building level, considering dynamic alternatives for internal wall systems (i.e. assemblies using reversible detailing techniques, in order to facilitate disassembly and component reuse) [1]. The benefits and drawbacks of these dynamic alternatives are assessed using an integrated life cycle approach combining economic and environmental aspects, i.e. a Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) [3],[4].

The case study focuses on one specific building block and consists of a qualitative and quantitative assessment. In the qualitative assessment the adaptability of the design proposal is evaluated in terms of construction method, characteristics of the building layer and plan layout of the housing units. This analysis revealed that different aspects related to adaptability are integrated in the case study (e.g. flexible plan-layout, space and technical clustering, adaptability for wheel chair users, external circulation). In the quantitative assessment different renovation scenarios are simulated focussing on the internal restructuring of the housing units (i.e. transformation of a two-bedroom apartment to a one-bedroom apartment). For each renovation scenario two alternatives for the traditional (static) wall systems are compared with (a) dynamic assemblies of all internal walls and (b) dynamic assemblies of only those internal walls which are expected to change more frequently. The analytical results revealed that the benefits of the dynamic design of the internal walls compared to static wall systems depend on the renovation scenario (required layout adaptations) and on the considered indicator (for example lower life cycle environmental impact but higher life cycle financial cost).

It can be concluded that the building concept and layout are important to make dynamic design beneficial or not. Due to the flexible plan-layout of the case study, renovation scenarios required only limited interventions and hence a generalized use of dynamic assemblies were found not beneficial, neither from an environmental nor financial perspective. Instead, a more selective application of dynamic assemblies, i.e. to only those walls which are assumed to be changed in future should be preferred. This selective approach can result in life cycle environmental benefits while the additional financial costs remain limited.

2. References

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