Circular Construction in Regenerative Cities: A H2020 project

This project received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement No 821201.

COST EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

COST is supported by the EU Framework Programme Horizon 2020

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About the project

The poster presents an overview of the H2020 project 'Circular Construction in Regenerative Cities' (CIRCuIT), started in June 2019, with a particular focus on the planned activities of Tampere University. The project cities are:

- Copenhagen, Denmark (coordinator)
- London, UK
- Hamburg, Germany
- Vantaa, Finland

Tampere University is the research partner for the Finnish city cluster of Vantaa. The other partners of the city cluster are:

- Helsinki Region Environmental Services Authority HSY (city cluster coordinator)
- City of Vantaa
- Umacon (demolition company)
- Helsinki Metropolitan Area Reuse Centre

The project has four areas of focus:

(1) mapping the flows and stocks of materials in the built environment,

(2) urban mining and recycling and reuse of building materials,

(3) life cycle extension of buildings through their transformation, and

(4) design for deconstruction (DfD), flexibility and adaptability.

1. Mapping the flows and stocks of materials in the built environment

A material flow analysis is planned for parts of the building stock in Vantaa. The work has started with mapping the available and applicable data and methods. This work is underlain by a previous project, where TAU reviewed the methods and materials available for built environment MFA in Finland (Pesu et al., 2020). As a result, the MFA will most likely be conducted bottom-up, based on analysing the following:

(1) Buildings demolished in Vantaa (cf. Figure 1),

(2) Their typical characteristics, and

(3) Their typical material contents.

Figure 1. Dataset of the demolished Vantaa buildings illustrated in GIS. Data © City of Vantaa.

2. Urban mining and recycling and reuse of building materials

Purpose

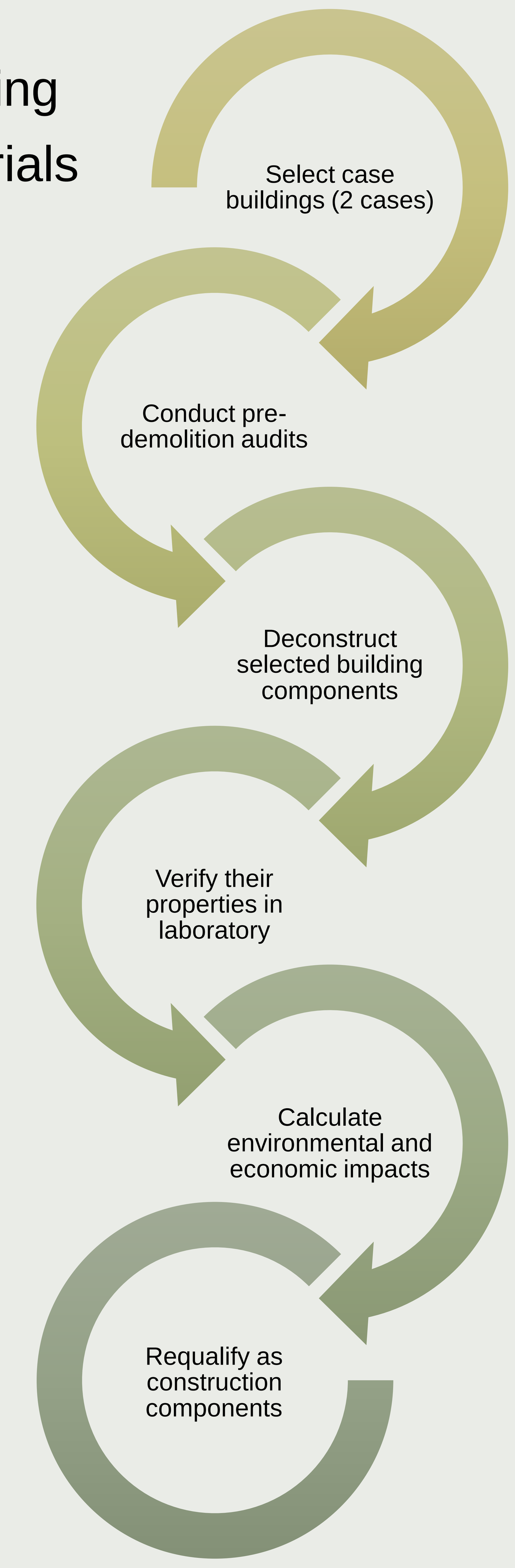
- Determine technical and economic feasibility of selective deconstruction techniques to preserve building components
- Determine environmental benefits of reuse, demonstrate reuse in a real-life pilot

Method and material

- BIM based pre-deconstruction audit
- Deconstruction conducted by Umacon, an industry partner for the Finnish city cluster
- Necessary laboratory tests in Tampere University's construction lab, where the performance of the reclaimed items is compared to virgin components
- BIM based calculation of environmental and economic impacts
- Consideration of the requalification process, proposal for standardizes testing procedures for secondary components

Status:

- Planning phase



3. Life cycle extension of buildings through their transformation

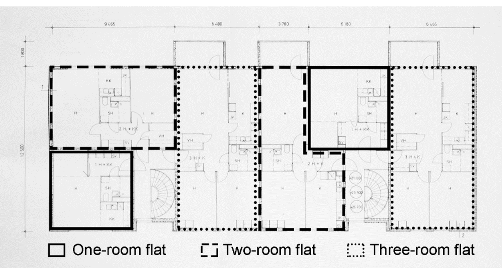


Figure 2. Mapping of recurring flat types from a building plan. Source: Kaasalainen & Huuhka, 2016.

Figure 3. Creating a theoretical flat type from a material of ca. 150 flat plans. Source: Kaasalainen & Huuhka, 2016.

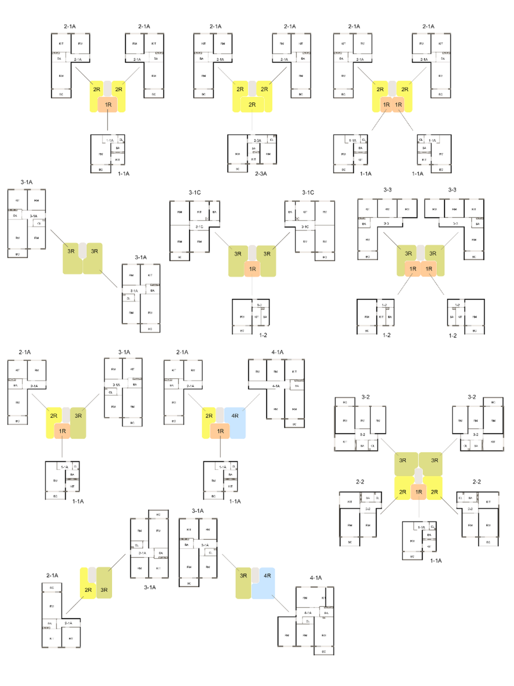


Figure 4. Most recurring plans of mass housing mapped. Source: Huuhka and Saarimaa, 2018.

Identify obsolescence and transformation potential in the building stock

Background

- There generally is quite little knowledge about the dynamic behaviour of the building stocks in cities, i.e. what the patterns of new construction, renovation and demolition are like an how they influence one another.
- In addition to viewing obsolete buildings as urban mines, they could be seen as reserves of space, and demolition could be avoided.

Purpose

- Identify patterns in demolition behaviour (Figure 1) to discuss the possibility to redirect some of the activities towards life cycle extension
- Identify buildings with low/high transformation potential.
- Select building types for further analysis in the next stage

Method and material

- Statistical and GIS analysis on demolished buildings (Vantaa only)
- Statistical and GIS analysis on transformed buildings (whole Finland)

Status

- Analyses ongoing
- Expected time of publication for first results: autumn 2020

Analyze impacts of different transformation scenarios

Background

- Building research tends to focus case studies, without sufficient focus on the representativeness of the case of generalizability of the results.

Purpose

- Create alternative development scenarios for the typical obsolete-but-transformable buildings.
- Analyse the impacts of the scenarios in terms of environmental impacts (carbon emissions), life cycle economics and social/cultural impacts.

Planned approach

- Draw from techniques developed for analyzing the typicality, i.e. representativeness of buildings (Figures 2, 3 and 4).
- Use a large mass of building plans to create a 'theoretical' case to act as the platform for the analyses. Create a BIM model for the theoretical building.
- Develop the scenarios in BIM based on reference cases. Compare impacts against the baseline (demolition and new build). The cases may include:
    - Conservation
    - Renovation
    - Extension
    - Adaptive reuse
- Calculate the environmental and economic impacts with BIM integrated software (OneClick LCA).

4. Design for deconstruction (DfD), flexibility and adaptability

The WP has twofold focus. Firstly, the barriers to implementing more flexible housing is reviewed in an interview study of experts. Secondly, possibilities to design buildings for deconstruction is reviewed.

Design for flexibility and adaptability

Background

- Design for flexibility and adaptability has a long history in the architectural discipline
- Many architectural solutions for better flexibility or adaptability are known (Figure 5 below)
- Yet, such projects are implemented on a very limited number.

Purpose

- To identify barriers and enablers for the implementation of flexible/adaptable housing.

Method and material

- A semi-structured (thematic) interview with 7-8 Finnish architects and 4-7 Danish architects
- Interviews are transcribed and a qualitative content analysis is performed

Status

- Interviews in Finland completed
- Interviews in Denmark ongoing
- Expected time of publication: autumn 2020

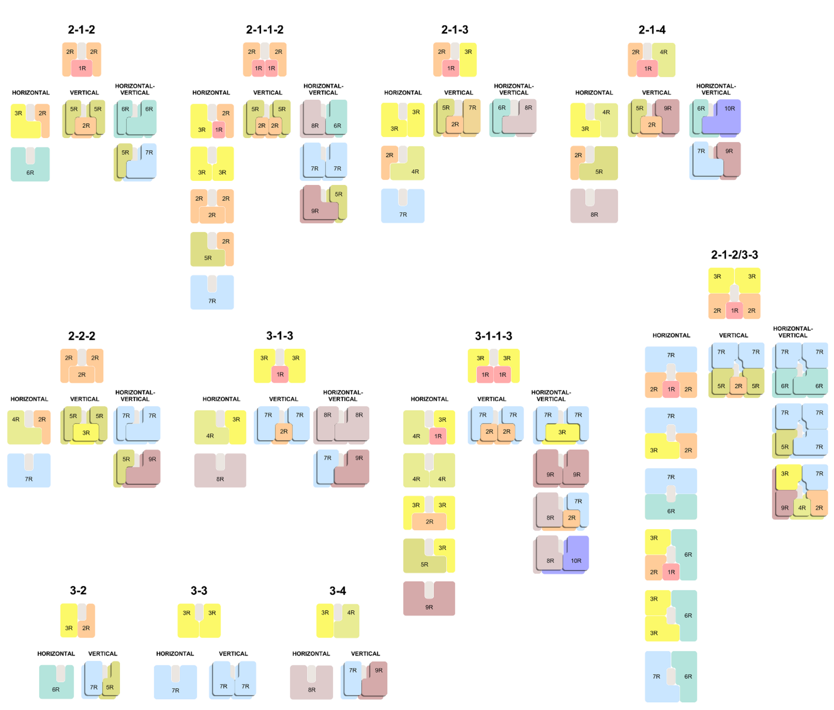


Figure 5. Adaptability by combining flats. Source: Huuhka & Saarimaa, 2018.

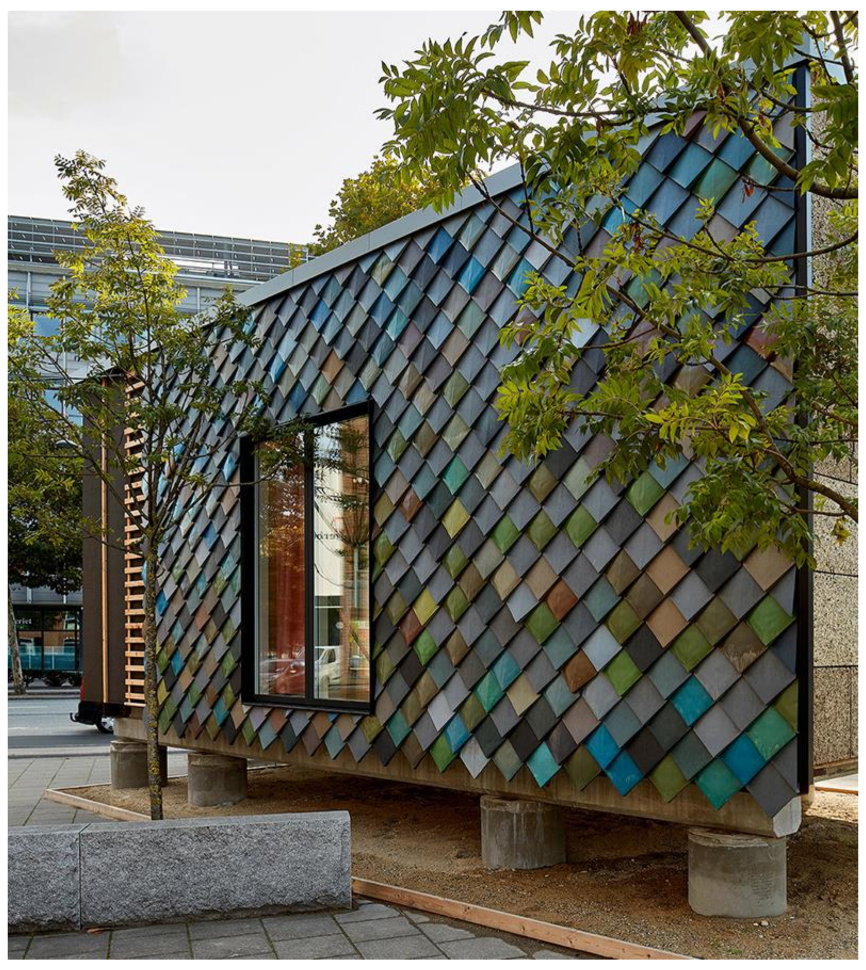


Figure 6. The Circle House. Source: Tom Jersø, https://gxn.3xn.com/project/circle-house-demonstrator

Design for deconstruction

Background

- Buildings are been made out of carbon intensive materials, usually reinforced concrete.
- The average age of a demolished buildings is only 50 years in Finland.
- Non-residential buildings are even younger at the time of demolition (30…40 years).
- The technical life span has not been drained by the time of demolition, the demolition is driven by other factors (functional, land value, urban development).

Purpose

- Develop a deconstructable building systems for non-residential buildings

Planned approach

- Build on the previous work of GXN and Lendager group (Danish project partners) in the Circle House project (Figure 6 above).

Acknowledgements & Funding:

In addition to the authors, the research team of Tampere University includes Jyrki Tarpio, Inge Vestergaard, Jukka Lahdensivu, and Arto Köliö.
The project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 821201.

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