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Using RecyclingGraphs to decide the applicability of module D data in the LCA of functional wall structures

The objective of the RecyclingGraph method is to analyse and optimise structures' ability to be decomposed and their components to be recycled in order to decide if the module D can be accounted in a life-cycle assessment (LCA).

How and to which degree materials in building structures can be recycled largely depends on which degree and quality they can be reclaimed during building demolition. Even if the individual material can be recycled well, the same material can be wasted for recycling if mixed with other material, contaminated by harmful substances or just difficult to retrieve. Therefore, the decision if module D data (re-use, recovery, recycling potential) can be accounted for in the LCA depends on the design for recycling and the handling of materials during deconstruction.

RecyclingGraphs (Figure 1) and ConnectionMatrixes have been developed to analyse and optimise structures' ability to be decomposed and their components to be recycled. So far, the RecyclingGraphs and ConnectionMatrixes have been applied to static comparisons of different constructions. In the BMBF-funded project "ReBuMat", this will now be applied in a dynamic process. For this purpose, conventional wall constructions will be analysed and further developed on material level and connection level (quality of material recycling, accessibility of materials separation by type or joint recycling of material combination). This poster presents the latest developments of the method.

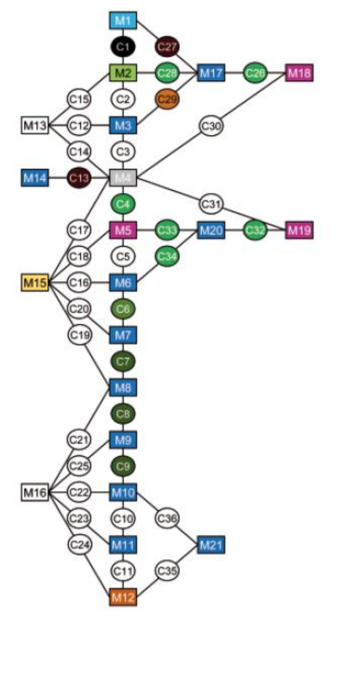

Figure 1: Example of RecylingGraph

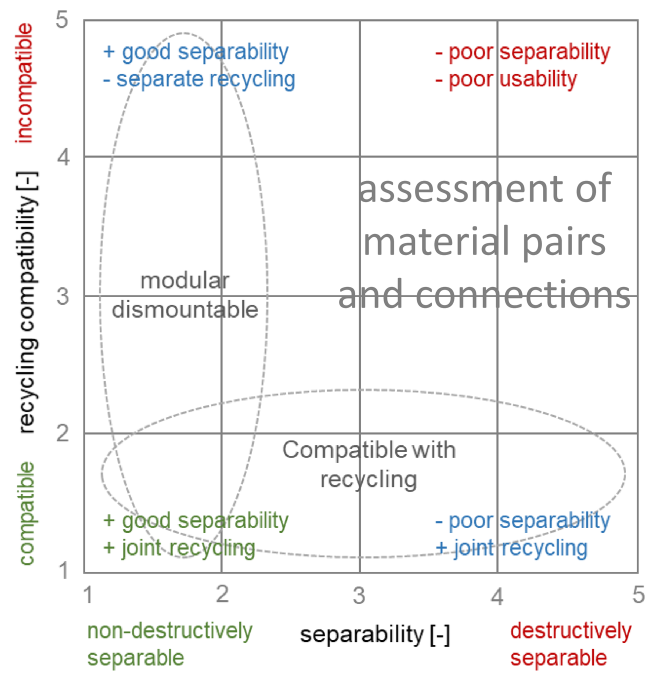

Figure 2: Dependence of connected material pairs with regard to subsequent recycling. [1]

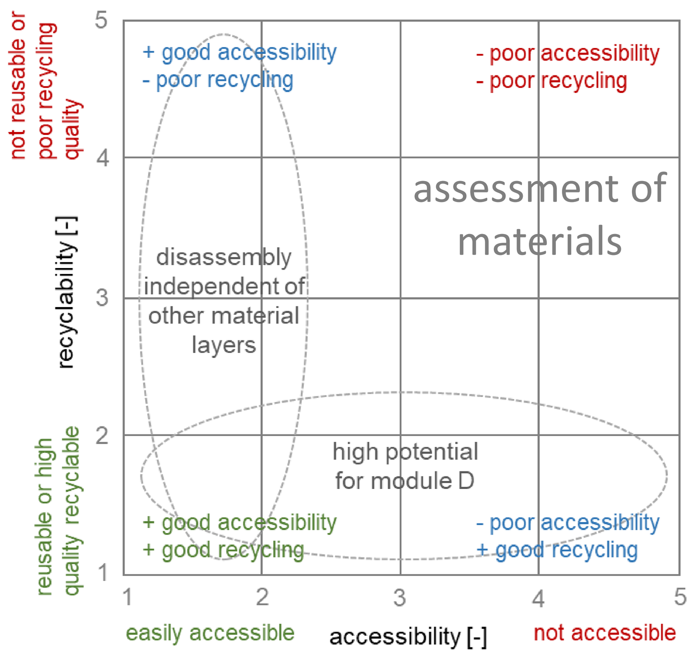

Figure 3: Dependence of material on position in construction and the recycling potential.

Figure 2 shows the classification of the material pairs according to their recyclability compatibility and solubility, and Figure 3 shows the recyclability and accessibility of the materials. A description follows in the section "Description of the result graphs and example calculation".

Iterative Workflow

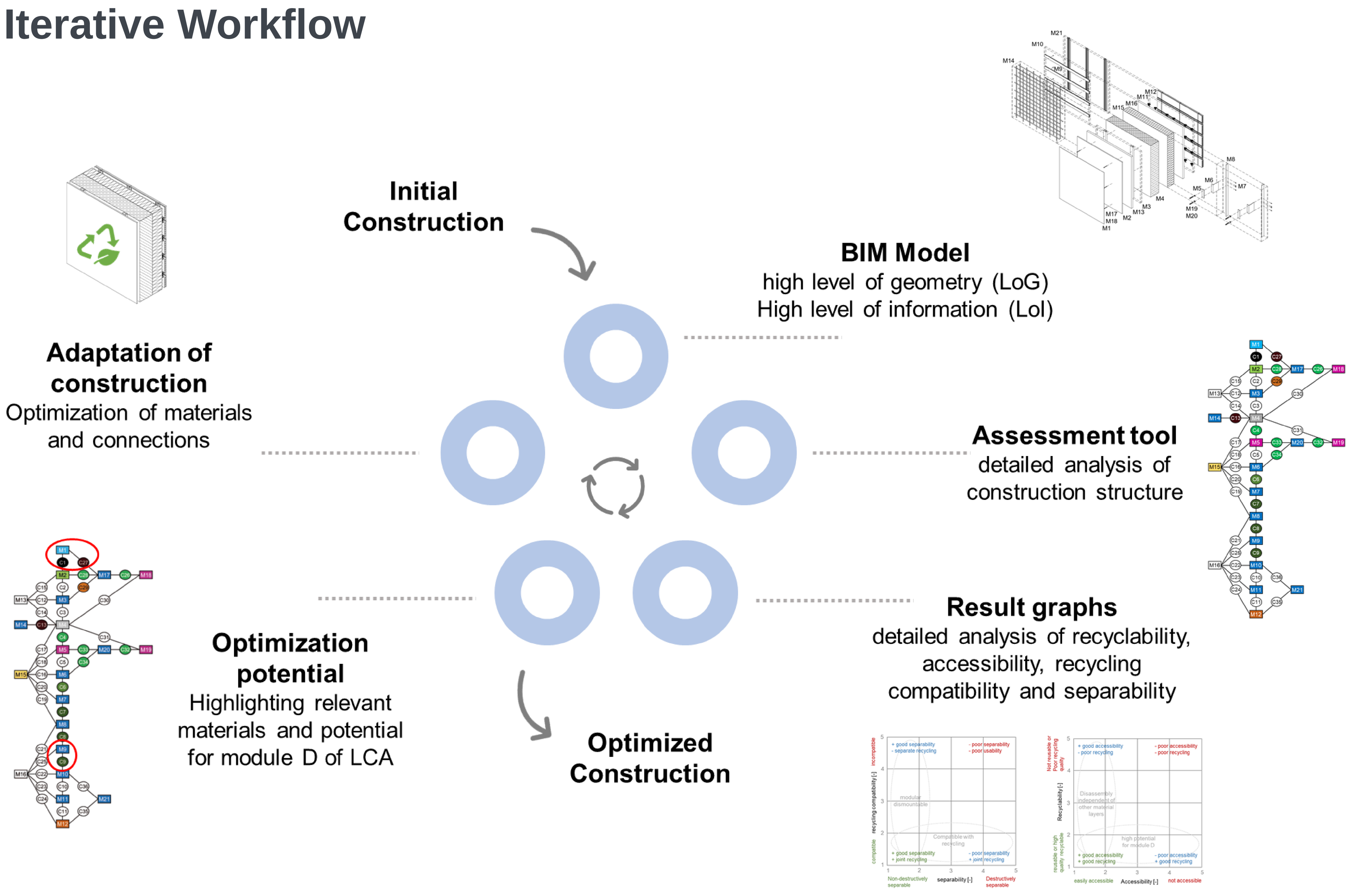

Figure 4: Process steps of iterative construction assessment.

The process flow for evaluating a structure is iterative as depicted in Figure 4. The material and connection element data of the first construction design serve as input data for the BIM model. The BIM model is augmented with material and connection element data to enable the detailed evaluation. The information is exported and classified according to the sustainability criteria introduced. The materials are classified on a qualitative scale in terms of various characteristics, namely their recyclability, and their accessibility within the construction. The connections are evaluated regarding their ability to be disassembled and the compatibility of the materials connected. Based on these characterisations, the material pairs and the entire compositions can be evaluated, and it can be determined if module D data is applicable in the specific case of a structure. This results in a potential for optimization that highlights critical materials. Based on the optimization recommendation, an adjustment is made to the structure and the materials, to improve the structure represented in the BIM model. The evaluation process ends when the structure is optimized for recycling.

Description of the result graphs and example calculation

The classification of material pairs according to their separability and recyclability (Figure 1) was already introduced in [1]. Figure 2 shows the classification of materials according to their accessibility and recyclability. The horizontal axis shows the accessibility and the vertical axis the recyclability rating. The data points represent the material layers of the construction, and the size of the data points indicate the sum of the masses of the materials. Materials that fall in the lower left corner of the diagram are in the "good accessibility/good recyclability" category. Materials in the upper right corner are characterized by poor accessibility and poor recyclability. Materials with good accessibility and poor recyclability fall in the upper left corner and materials with poor accessibility and good recyclability belong in the lower right corner. After that, the concrete wall with thermal insulation system is more likely to be classified as "non-demountable" and " not recycling compatible" (Figure 5), consisting by materials with a good recyclability, which are mainly "poor accessibility". The evaluation of both diagrams together shows that the materials/material pairs circled in red (M1, M10) form the outer construction layers and have a poor recycling potential.

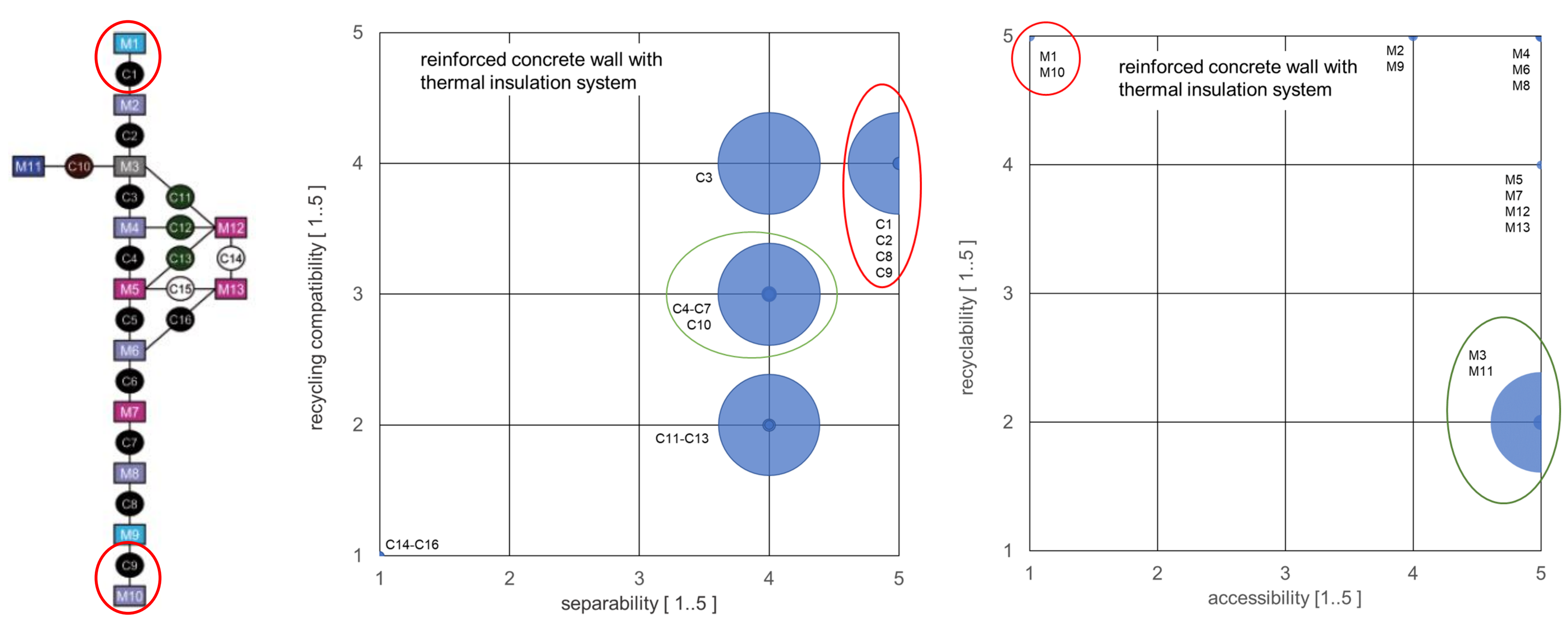

Figure 5: Classification of materials and material pairs of a concrete wall with thermal insulation system.

The material pairs (C1, C9) cannot be separated and are poorly recyclable with each other. This inhibits the recycling and potential for module D of other materials, such as M3 and M11 (material pair C10), which have a higher recycling potential, see green circles. As optimization potential of the first iteration, this would result in an adjustment of the materials M1 and M11.

[1]: **Schwede, D**, Störl, E (2017). „Methode zur Analyse der Rezyklierbarkeit von Baukonstruktionen", Bautechnik Heft 1/2017, DOI: 10.1002/bate.201600025.

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The RecyclingGraph method has been extended with the concepts "recyclability" and "accessibility" of material components. Potential for LCA optimisation in combination with the assessment of the ability to be recycled have been shown, so that decisions can be informed if module D can be accounted in the LCA.

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