Reusability assessment

PROGRESS webinar 3
Life cycle assessment and reusability assessment of single-storey steel buildings
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Design for deconstruction or reusability?

Example recommendations (Seppälä 2018)
- regular distance between columns,
- increasing natural loads,
- braces as buckling support, braces for stiffening,
- regular cross sections, regular load-bearing sheets,
- regular material grade,
- friction clamp connection for sandwich element detailing,
- assembling columns from standard pieces,
- base – and end plate connected with bolts to columns,
- same cross section for diagonal bars,
- "expendable" parts,
- regular distance between inside columns,
- and using screws as fasteners for load-bearing sheets.
Selected Existing methods

BRE Design for Deconstruction

![Diagram of deconstruction process]

- Frame
- Foundation
- External walls
- Ground floor, upper floor and ceiling
- Cladding
- Floor finishes
- Windows and doors
- Sanitary ware
- Services
- Fixtures and fittings

- Environmental footprint
- Project documentation
- Connections
- Accessibility
- Reuse and recycling potential
- Optimisation of deconstruction process

- Weighting factors
- Performance criteria
- Scoring per criteria and element group
- Overall score per element group

- Elements inventory
- Elements groups

Value 0, 0.5 or 1

DGMB Deconstruction and Disassembly


Pre-defined indicators, weighted scores

- Ease of disassembly, scope of disassembly, recycling and disposal plan
- Component categories
- Scoring per indicator and category
- Overall score per category

Building services,
- Non-structural building components
- Non-load-bearing components of the shell
- Load-bearing components of the shell
- Several effort levels up to 100 points in total

Contribution to the sustainability goals

Picture credits: Paul Kamrath

Reusability indicator

Picture credits: Paul Kamrath

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Adapting common approach for DfD assessment

Structure and envelope divided further according to the reuse scenario

One overall score for each reuse scenario

Technical reusability index

Reusability indicator of the component

\[ r = \sum \rho_i w_i \]

Performance assessment result (%)  
Weighting factor for each performance category (%)  

Reusability indicator of the building

\[ R = \frac{\sum m_i r_i}{\sum m_i} \]

Performance categories

Deconstruction, handling, separation and cleaning, reuse of design, repurposing, alteration, quality control, geometry check

Performance assessment

very easy  \( \rho_i = 100\% \)

easy  \( \rho_i = 80\% \)

moderate  \( \rho_i = 60\% \)

difficult  \( \rho_i = 40\% \)

very difficult  \( \rho_i = 20\% \)

impossible  \( \rho_i = 0\% \)

### Performance checklist

<table>
<thead>
<tr>
<th>Structure</th>
<th>Performance criteria</th>
<th>very difficult</th>
<th>difficult</th>
<th>moderate</th>
<th>easy</th>
<th>very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deconstruction</td>
<td>Welded connections, high risk of damage during decomposition</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Mostly welded connections between components with difficult access</td>
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<tr>
<td></td>
<td>Easily accessible bolted connections between components</td>
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<tr>
<td></td>
<td>Adhesive connections, high risk of damage during deconstruction</td>
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<tr>
<td></td>
<td>Mostly adhesive connections between components</td>
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<tr>
<td></td>
<td>Easily accessible adhesive connections between components</td>
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<tr>
<td>Separation</td>
<td>Cleaning</td>
<td>Insufficient cleaning tools needed to separate other materials</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Cleaning</td>
<td>Standard transport, prone to damage, requires special protection</td>
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<tr>
<td></td>
<td>Manipulation</td>
<td>Manipulation by crane, not damage sensitive</td>
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<tr>
<td></td>
<td>Quality control</td>
<td>Laboratory tests are needed to check material properties</td>
<td></td>
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<tr>
<td></td>
<td>Geometry checking</td>
<td>Component would not pass geometry requirements without modification</td>
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</tr>
<tr>
<td>Redesigning</td>
<td>No documentation, testing, environmental conditions, loading history is difficult to estimate, laboratory tests are needed</td>
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</tr>
</tbody>
</table>

### Economic prospect

Reusability indicator of the component

\[ e = P(c_1 \cap c_2 \cap \ldots) n \]

Criteria (e.g. span, height, floor area)

Number of new buildings in the selected area and time span

Reusability indicator of the building

\[ E = \frac{\sum m_i e_i}{\sum m_i} \]

Component mass (t)

Case study

3 pre-designed structures from PRECASTEEL project and 3 scenarios

- Hot-rolled frame
- Welded-tapered frame
- Truss on columns

Future development:
Automated evaluation of BIM model
Summary

• Reusability assessment method can be used for new and existing buildings to compare different designs or different end-of-life scenarios

• The method can support pre-deconstruction audits, material testing plan or lifecycle assessment

• It is possible to analyse BIM models with the reusability assessment methods

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beyond
the obvious

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