Reusing existing envelopes

Kevin Janczyk

PROGRESS webinar 1, 07.05.2020

Reusing existing, single storey steel buildings
Introduction

Motivation for Sustainable Construction

- The building sector (worldwide) is responsible for

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Resource/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>17%</td>
<td>of fresh water consumption</td>
</tr>
<tr>
<td>25%</td>
<td>of timber use</td>
</tr>
<tr>
<td>33%</td>
<td>of CO\textsubscript{2} emissions</td>
</tr>
<tr>
<td>30-40%</td>
<td>of energy use</td>
</tr>
<tr>
<td>40-50%</td>
<td>of raw material consumption</td>
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</table>

- Sustainable planning, construction and operation of the built environment
- Saving resources during construction and operation
Introduction

Sustainable Construction

Life-Cycle

- Raw Material Extraction
- Construction
- Use
- Maintenance
- Conversion
- Renovation
- Deconstruction/Disposal
- Reuse/Recycling
Renovation market

- The renovation market overtook the market for new buildings since 2010
- Market share per building segment in European countries:

![Diagram showing market share per building segment from 2005 to 2015.]

OPENEXP (2016)
EU-RFCS Project „PROGRESS“

PROvisions for Greater REuse of Steel Structures

- Project duration 36 months (1.6.2017 - 31.5.2020)
- Focus on single-storey steel buildings
- Existing and future buildings
- Design from reused elements
- Design for improved reusability
Reuse case study buildings

• Seminar Building RWTH Aachen

Thermal Power Plant  Seminar Building
Reuse case study buildings

• Seminar Building RWTH Aachen
Reuse case study buildings

- Seminar Building RWTH Aachen
Reuse of steel cladding systems
Market Analysis Germany 1991 - 2018

PROGRESS Market Analysis Germany 1991 - 2018

Trapezoidal Profiles
Sandwich Panels

TP 700 Mio m²
SP 300 Mio m²
Energy Efficiency – Developing of requirements in Germany

- ca. 9 Mio. Residential Buildings
- ca. 2 Mio. Non-Residential Buildings
- only 15% with $U < 0.30 \text{ W/(m}^2\text{·K)}$
- $U_{\text{max}} = 0.24 \text{ W/(m}^2\text{·K)}$ for renovation

![Graph showing the development of thermal transmittance (U) over time from 1950 to 2020.

- 1950: 1.40 W/(m²·K)
- 1970: 0.80 W/(m²·K)
- 1985: 0.40 W/(m²·K)
- 2010: 0.20 W/(m²·K)
- 2020: 0.15 W/(m²·K)]
Reuse of steel cladding systems
Reuse of steel cladding systems
Reuse of liner tray profiles and over-cladding with sandwich panels

Energetic aspects

- Hybrid-Façade
  - FEM – Model
    - Existing Solution: Cassette Profile (100 mm; MW 035)
    - Hybrid Solution: Existing Cassette (100 mm; MW 035) plus Sandwich Panel (type I, 60 mm, PU 024)
Reuse of liner tray profiles and over-cladding with sandwich panels

Energetic aspects

• Hybrid-Façade
  – FEM – Result (temperature distribution)
    - Existing Solution
      $U = 0.81 \text{ W/(m}^2\text{K})$
    - Hybrid Solution
      $U = 0.29 \text{ W/(m}^2\text{K})$
Reuse of liner tray profiles and over-cladding with sandwich panels

Energetic aspects

• Comparison of solutions

![Graph showing comparison of solutions with thermal transmittance values.]

- ... + separation stripe
- ... + Ω profile, 60 mm MW 035
- ... + Z profile, 60 mm MW 035
- ... + Sandwich type I, 60 mm MW 044
- ... + Sandwich type I, 60 mm PU 024
Reuse of Sandwich Panel Constructions
Reuse of Sandwich Panel Constructions

End-Of-Life of Sandwich Panels

- Separation of materials on construction site
Reuse of Sandwich Panel Constructions

End-Of-Life of Sandwich Panels

- Scenarios

  - End-Of-Life
    - Material recovery
      - Separation of materials
        - Layers
          - Steel
            - Recycling
        - Core material
          - PU
            - Energy Recovery
          - MW
            - Landfilling
      - Relocated
      - In-Situ (Renovation)
    - Reuse
Reuse of Sandwich Panel Constructions

End-Of-Life of Sandwich Panels

• State-of-the art
  – End of Life scenarios according to Environmental Product Declarations

<table>
<thead>
<tr>
<th>End of life (C1-C4)</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collected separately waste type</td>
<td>13.3</td>
<td>kg</td>
</tr>
<tr>
<td>Recycling</td>
<td>8.3</td>
<td>kg</td>
</tr>
<tr>
<td>Energy recovery</td>
<td>4.3</td>
<td>kg</td>
</tr>
<tr>
<td>Landfilling</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Scrap content (not credited)</td>
<td>0.7</td>
<td>kg</td>
</tr>
</tbody>
</table>

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<tr>
<th>End of life (C1-C4)</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Collected separately waste type</td>
<td>20.2</td>
<td>kg</td>
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<tr>
<td>Recycling</td>
<td>8.1</td>
<td>kg</td>
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<tr>
<td>Energy recovery</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Landfilling</td>
<td>11.4</td>
<td>kg</td>
</tr>
<tr>
<td>Scrap content (not credited)</td>
<td>0.7</td>
<td>kg</td>
</tr>
</tbody>
</table>

Double skin steel faced sandwich panels with a core made of polyurethane

Double skin steel faced sandwich panels with a core made of mineral wool
Challenges for Reuse of Sandwich Panels

• Screw holes
  – “Push through mounted fastener” are usually used
  – Connection to the substructure is a direct or hidden fixation

• Insufficient thermal performance and airtightness

• Outer layer is aesthetical not sufficient
Reuse of Sandwich Panel Constructions

Thermal Performance – Requirements in Germany

- DIN 4108-2, $\geq 12 \, ^\circ\text{C}$
- EnEV Ref., 12 bis 19 °C
- EnEV Ref., $\geq 19 \, ^\circ\text{C}$
- Passivhaus
- EnEV San., 12 bis 19 °C
- EnEV San., $\geq 19 \, ^\circ\text{C}$

- SE MW 044
- SE PU 024
- SE PU 018
Reuse of Sandwich Panel Constructions

Airtightness
Reuse of Sandwich Panel Constructions

Over-cladding sandwich panel construction
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