Demountable and reusable Envelope Systems

Kevin Janczyk

PROGRESS webinar 2, 14.05.2020

Design of new single-storey steel buildings for reuse

Motivation

Sandwich Panels as reusable Envelope System

• High degree of pre-fabrication
• Self-supporting insulating elements
• Quick installation on construction site
• Meet requirement for a modular design
State of the Art

Fixation on substructure

Push-through mounted fastener

- Penetration of steel layer and core material
- Direct fixation
- Hidden fixation

State of the Art

Design possibilities for substructure

- One- or multi-span systems
- Span length can vary
- High flexibility
- Each building has an individual substructure
State of the Art

Determination of design values

- Design values are determined by testing
- Several tests according to EN 14509
  - Compressive Test
  - Tensile Test
  - Shear Test
  - Bending Test
  - ...

Example: Setup for shear test (EPAQ testing rules)

Requirements for reusable Envelope Systems

Fixation of panels
- Push trough mounted fastener
- Clamping Solution

Span design
- Multi-span system
- Horizontally installed single-span system

Design Values
- Initial values determined by testing
- Knowledge about design values after first Life-Cycle
Smart Flashing Connector

Requirements for Prototype Development

1. General applicability
2. Adjustment of dimensional tolerances
3. Statically sufficient
4. Sufficient building physics properties
5. Economically viable

Smart Flashing Connector

Small scale specimen tensile-test
Evaluation of load-bearing-behaviour of the clamping system
Smart Flashing Connector

Full scale tensile-test

- Evaluation of load-bearing-behaviour of the wall system
- Testing of a horizontally installed panel

Smart Flashing Connector

Building Physics Properties

FEM Analysis

General Joint

Smart Flashing Connector
Assessment of Sandwich Panels – Long Time Performance

CUBE-DemoHouse: Deconstruction
Dismantling of the red and yellow wall

Tests according to DIN EN 14509 after a lifetime of 14 Years
- Cross panel tensile strength
- Tensile E-modulus of the core
- Compressive strength
- Compressive modulus
- Shear strength
- Shear modulus
- Wrinkling stress
Assessment of Sandwich Panels – Long Time Performance

Position of Panels used for testing
Westside

Assessment of Sandwich Panels – Long Time Performance

Position of Panels used for testing
Southside
Assessment of Sandwich Panels – Long Time Performance

Compressive test

- Determination of
  - Compressive strength $f_{cc}$
  - Compressive modulus $E_{cc}$
- Number of tests
  - 5 specimen per wall
- Specimen dimensions $w \times l \times h$
  - 150 mm x 150 mm x $d$

Cross panel tensile test

- Determination of
  - Tensile test $f_{ct}$
  - Tensile modulus $E_{ct}$
- Number of tests
  - 7 specimen per wall
- Specimen dimensions $w \times l \times h$
  - 150 mm x 150 mm x $d$
Assessment of Sandwich Panels – Long Time Performance

Shear test on core material

- Determination of
  - Shear strength $f_{cv}$
  - Shear modulus $G_C$

- Number of tests
  - 7 specimen per wall

- Specimen dimensions $w \times l \times h$
  - 100 mm $\times$ 1100 mm $\times$ $d$

- Span length $L_s$
  - 1000 mm

Assessment of Sandwich Panels – Long Time Performance

Bending test

- Determination of
  - Wrinkling strength $\sigma_k$

- Number of tests
  - 2 specimen per wall

- Span length
  - 6200 mm
Assessment of Sandwich Panels – Long Time Performance

Interim Results

- Panel performance sufficient
- Test results on a satisfactory level for reuse
- Statistical analysis follows

Conclusion

Reusable Envelope Systems

- Sandwich panels meet the requirements for reusable envelope systems
- Clamping as a solution for fixation on the substructure
- *Smart Flashing Connector* successful as prototype
- Long time performance of sandwich panels sufficient for reuse
Demountable and reusable Envelope Systems

Kevin Janczyk

PROGRESS webinar 2, 14.05.2020

Design of new single-storey steel buildings for reuse