Reuse of building components

Presentation of RFCS project

2017-2020

PROGRESS

PROVISIONS FOR GREATER REUSE OF STEEL STRUCTURES

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* Loikkanen, T. et al. Roles, effectiveness, and impact of VTT. Towards broad-based impact monitoring of a research and technology organisation. 2013. VTT, Espoo. VTT Technology 113. 106 p. + app. 5 p.

VTT Research Area: Lifecycle solutions

Manufacturing

- Raw material processing
- Powder manufacturing
- Additive manufacturing
- Full-scale testing of components and structures

Operation & maintenance

- Monitoring
- Ageing management
- Performance evaluation
- O&M services
- Asset management
- Resilience, Safety & Security
- Risk management

Ageing & lifetime extension

- Durability of materials
- Recovery, redesign & remanufacturing
- Utilization of secondary raw materials & side streams
- Circular business concepts

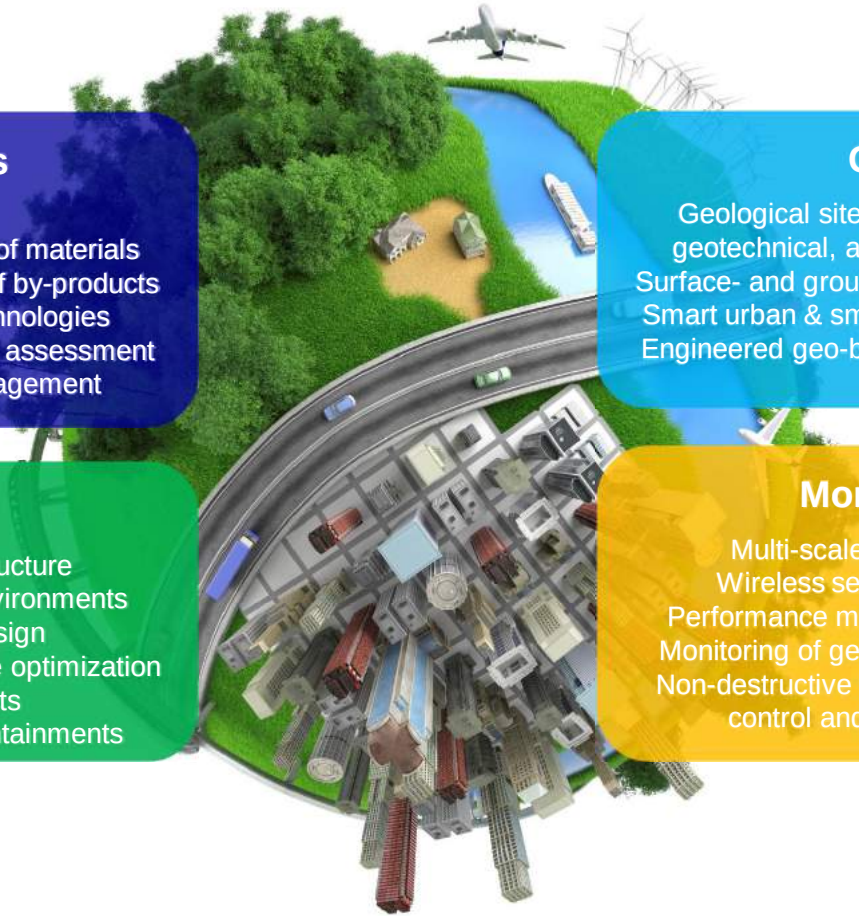
Retrofit, remanufacture re-use & recycle

Materials & design

- Multiscale modeling
- Materials design
- Components and structures
- Optimization
- Service life design
- RAMS design

Every step matters

Infrastructure Health Team



Building materials

Material development
Sustainable, resource-efficient use of materials
Eco-efficient alternatives, utilization of by-products
Material re-use and recycling technologies
Design, performance verification and assessment
Materials for nuclear waste management

Geotechnics

Geological site characterization; geophysical, geotechnical, and hydrogeochemical analyses
Surface- and groundwater modelling and monitoring
Smart urban & smart water infrastructure Design of Engineered geo-barriers for nuclear waste disposal

Structures

Safety assessment of infra-structure
Exceptional loads and extreme environments
Infrastructure service life design
Durability modelling and maintenance optimization
Novel construction products
Safety of nuclear power plants containments

Monitoring & NDE

Multi-scale monitoring and modelling
Wireless sensors and network systems
Performance monitoring in harsh environments
Monitoring of geological waste disposal systems
Non-destructive testing and evaluation for quality control and performance assessment

Vision for the future reusable buildings

High end-of-life value
Building owners will be actively engaged in offering reusable components for sale before the deconstruction.

Reusable BIM
BIM objects for the new building design will be equally sourced from the product manufacturers and second-hand material dealers.

Reversible and scalable design
Buildings will be designed for deconstruction and reuse. The evolution of future buildings (e.g. in thermal insulation, story height) will be anticipated in the design.

Demolition or deconstruction?

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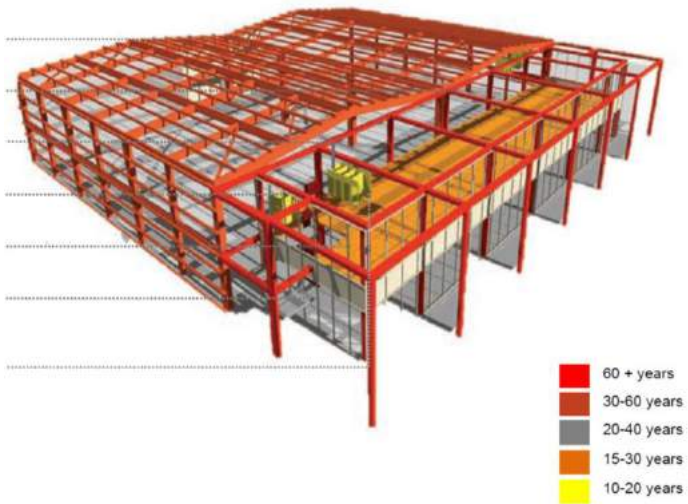
Focus on single-storey steel buildings

Broad applicability (industrial, commercial, sports, exhibition, warehouses), suitable for reuse and viable for circular-economy business models. The results will be easily extendable to other materials and building typologies.

Existing and future buildings

Reuse of existing building stock is challenging and only marginally profitable.



Documented case studies

Bus terminal at Schiphol Airport

1942 London

1958 Rotterdam

2015 Schiphol

Documented business models

Photo credits: Arnošt Balcar

Reuse of the whole primary structure (CZ)

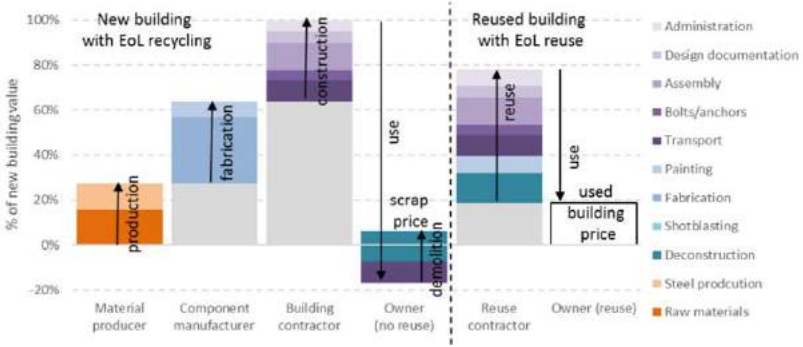
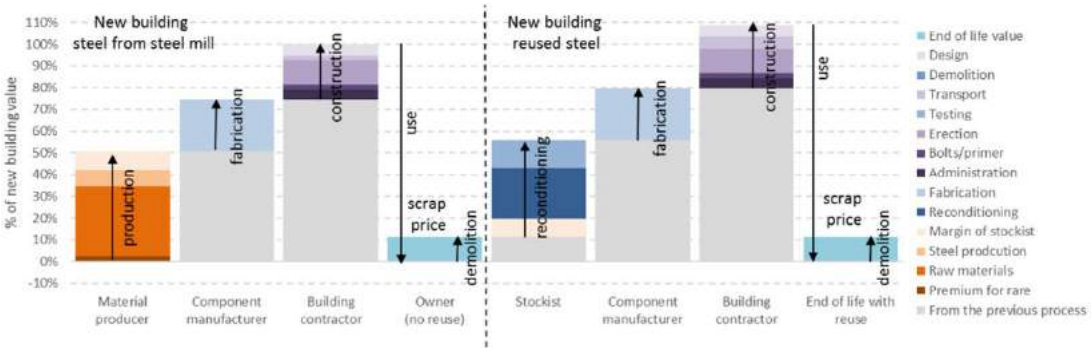


Photo credits: Arnošt Balcar

Reuse of the reconditioned steel sections (UK)



Assessment of reusability

Technical reusability (similar principle to BRE or DGNB Design for Deconstruction)

Component $r = \sum \rho_i w_i$

Performance assessment result (%)

Weighting factor for each performance category (%)

Building $R = \frac{\sum m_i r_i}{\sum m_i}$

Component mass (t)

Economic prospect (complementary score)

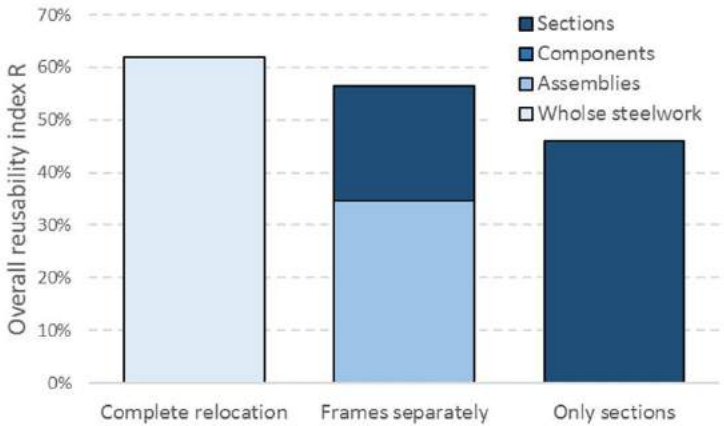
Component $e = P(c_1 \cap c_2 \cap \cdots)n$

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

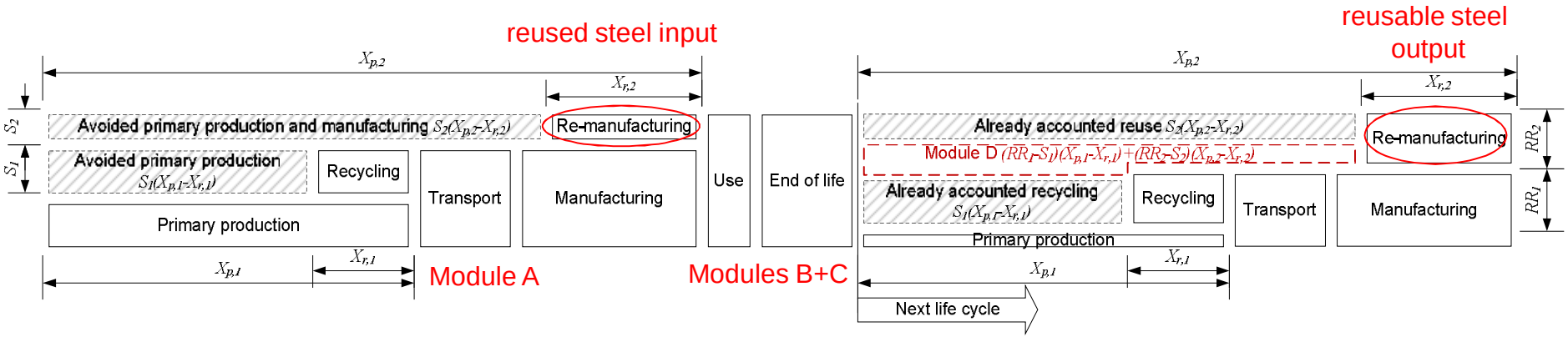
Number of new buildings in the selected area and time span

Building $E = \frac{\sum m_i e_i}{\sum m_i}$

Comparison of different scenarios



Environmental benefits of reuse



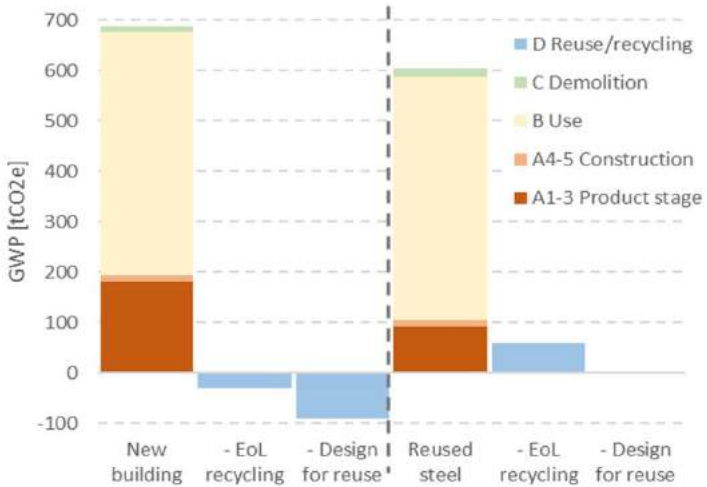
Recovery rate

Recoverd material on input (e.g. scrap for recycling)

$$\text{Module D} = \sum (RR_i - S_i)(X_{r,i} - X_{p,i})\, Y_i$$

Unit impact of the recovery

Unit impact of the primary production



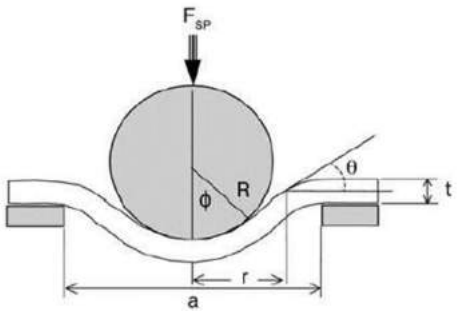
Drone photogrammetry

[3D model]

Testing protocol

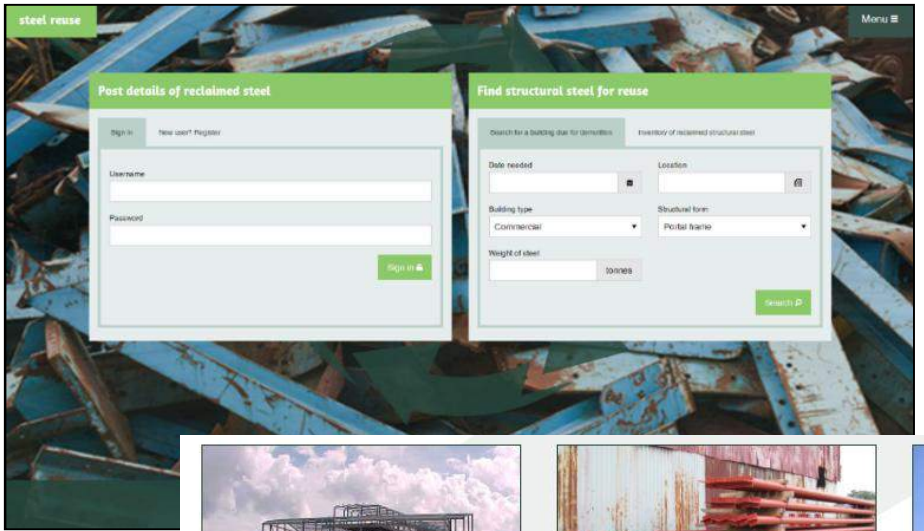
<u>Non-destructive testing</u>
- XRF spectrometer
- Hyperspectral camera
- Hardness testing

<u>Minimum-invasive testing</u>
- strength and ductility
- impact toughness
- weldability



<u>Standard coupon tests</u>

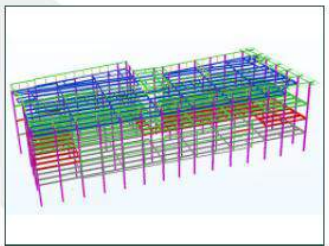
On-line trading platform



Find steel buildings scheduled for demolition

Find used steel sections

Sell structural steel



Upload as-built BIM model

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