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Changes in Material Stocks and Flows of a Century-old Rail Network Caused by Refurbishment

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Background and Scope

In terms of mass, construction and demolition activities are among the biggest sources of waste in Europe (construction and demolition waste (CDW)). In order to tackle this challenge, the recycling of construction and demolition waste is encouraged by an EU-wide mandatory target of 70%. The extent to which this is already fulfilled within the case study is demonstrated. Thereto, material and waste flows, and stock changes of subway infrastructure associated with its refurbishment are investigated. Specific attention is given to the relation between recycling, reuse and virgin material flows.

Method

The method used to answer the research questions is a bottom-up material flow analysis (MFA). All material flows are presented in the mass unit "metric ton (t)"; and the reference period selected is one year (2016). Three material categories are considered: minerals, organics and metals.

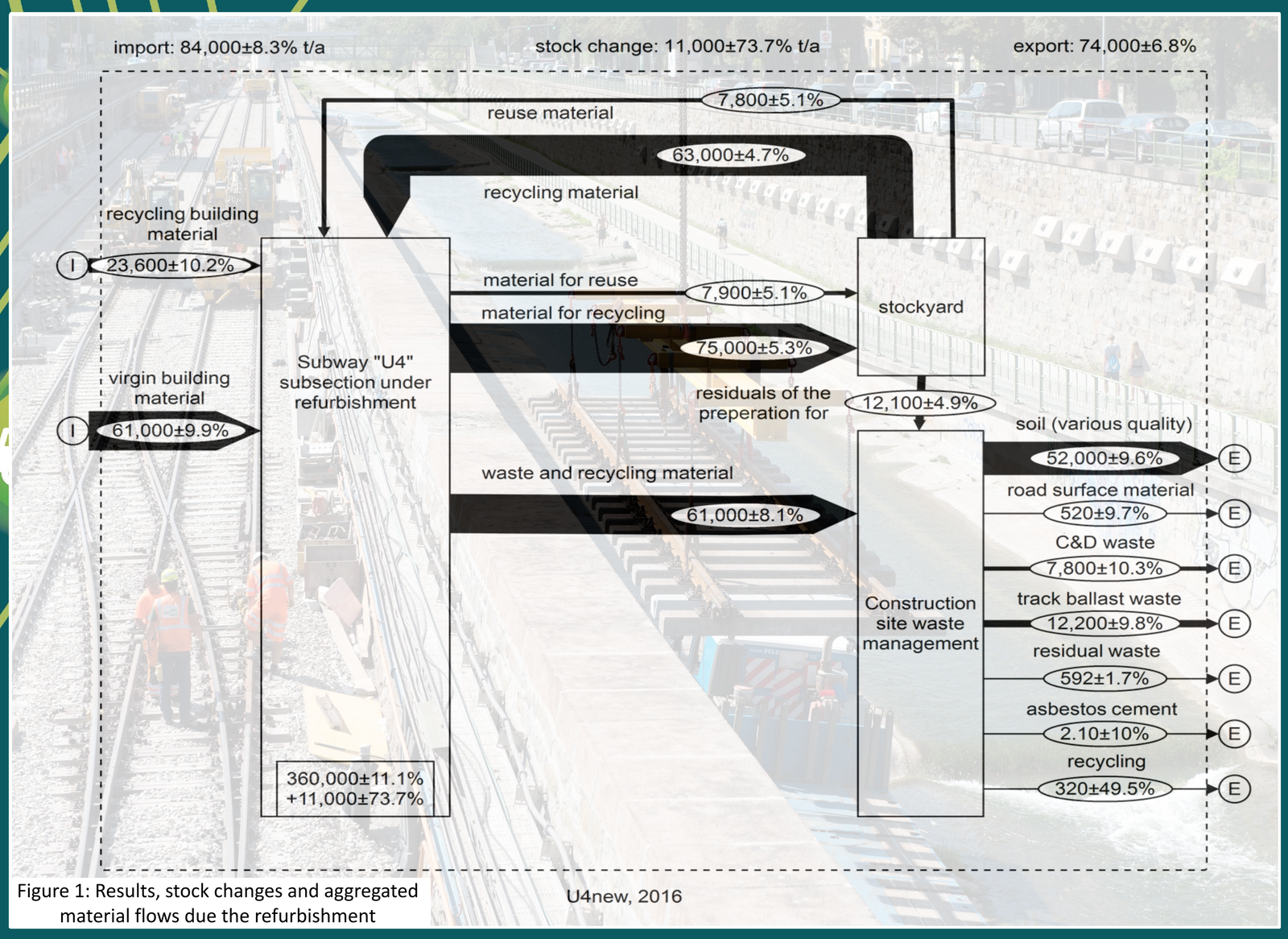


Figure 1: Results, stock changes and aggregated material flows due the refurbishment

Case Study

- Subsection (3.5 km) of Vienna's subway network
- Built in the 19th Century
- Refurbishment in 2016
- Building measures: replacement of substructure and superstructure; refurbishment of the viaduct and buildings; technological modernization

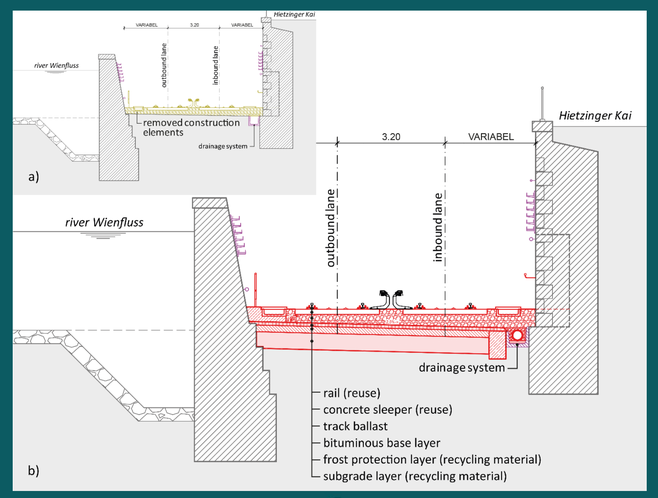
Results

- Material stock increase of 3% up to 360,000 t
- Material categories: ~97% mineral building materials, ~3% metals, and <1% organics
- Main materials brought into the system: gravel (57%), concrete (30%), and asphalt (11%)
- 400 t of metals: 73% iron and steel, 16% copper, 10% aluminium, and <1% others
- Overall 155,000 t was built into the subsection of which 55% was recycling building material
- 7,800 t of building material was reused
- 94,000 t of primary material was avoided because building material was recycled and reused
- 47% of the resulting CDW of the refurbishment are used as recycling building material on site.

Conclusions

- Tender documents are a suitable data source to investigate materials flows of a specific refurbishment.
- Reuse and recycling are state of the art by refurbishment. Within the case study 15% recycling material, 41% on-site recycling material and 5% reused construction elements were used.
- The EU-wide mandatory target of 70% recycling of CDW by 2020 has not yet been achieved directly at the case study (47% recycling) but with recycling of waste flows outside of the construction site this goal is achievable. However, off-site recycling was not investigated in the study.
- With the refurbishment process increased not only the overall material stock but also its complexity mainly due to a more complex substructure. (see Figure 2)
- >75% of the material stock maintained their function after refurbishment, in terms of mass the majority of this stock have been in use for 120 years and will continue to be part of the network in future. Lifetimes commonly used in environmental assessment studies (50 – 100 years) are to be questioned.

Figure 2: Open track standard cross section before (a) and after (b) refurbishment



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