More Than the Sum of Their Parts - How UK Timber Houses Can Be Deconstructed and Reused

Marlene Cramer
Edinburgh Napier University,
Unit 1, Seven Hills Business Park,
Bankhead Crossway S,
Edinburgh EH11 4EP, United Kingdom
+44 07526141672
m.cramer@napier.ac.uk

Ylva Sandin

Background

Buildings in the UK are often being demolished because they are in the wrong place at the wrong time, and intact materials become waste in the process (Cramer and Ridley-Ellis, 2020a). About one quarter of the UK's wood waste results from building demolition and is mostly chipped and incinerated for energy production (Cramer and Ridley-Ellis, 2020b). Deconstruction instead of demolition would allow the reuse of timber and wooden building elements, so that they could replace virgin materials and avoid becoming waste, while also having a smaller environmental impact than new materials (Bertino *et al.*, 2021; Niu *et al.*, 2021). The InFutUReWood project (infuturewood.info) focuses on the reuse of structural timber and is working on improving the design of buildings to facilitate deconstruction and reuse, amongst other things. For this purpose, we conducted six case studies in four of the partner countries, which analyse the design of contemporary houses and seek to improve them to facilitate deconstruction and reuse. The case study presented here focuses on a Scottish light timber frame house, which is partly manufactured offsite and is a typical example of UK timber-frame construction, as described by Lancashire and Taylor, 2012.

Keywords: Circular economy, offsite construction, timber frame, demolition.

Case Study Method

The case study was conducted in collaboration with Robertson Timber Engineering and Offsite Solutions Scotland. The companies selected a typical Scottish light timber frame house with offsite manufactured elements. Nobody in the companies had ever attempted to deconstruct one of their buildings, so

we discussed how a possible deconstruction could be attempted and which complications could occur. To narrow the scope of the discussion, we focused on a scenario in which the house has to be moved after 50 years of service life but is rebuilt in a short distance under the same wind- and snow loads. In this scenario the building elements can stay assembled to a high degree and do not need retrofit. We analysed the deconstruction steps, tools needed, complications that might occur and damage to the parts we could foresee and focused on the load-bearing timber structure only. Mike Turner, Managing Director of Robertson Timber Engineering and Nicola Jackson, Technical Manager of Robertson Timber Engineering, provided valuable insights in the building's construction and possible deconstruction and reuse.

The results of the discussion revealed which factors in the building design facilitate deconstruction and which factors complicate deconstruction and therefore compromise the reuse potential of timber elements. We addressed some of these factors with design changes that facilitate deconstruction and reuse.

Results and Discussion

Robertson's "Everett Grand", a 5-bedroom detached house, represents typical Scottish construction methods and materials. The timber frame structure is partly manufactured offsite and includes a trussed rafter roof, 2D-wall panels with solid wood studs and OSB sheathing, and floor cassettes with I-joists and OSB cover.

The case study building presents with several advantages for deconstruction, and generally Robertson's team was very optimistic regarding the reuse potential of building elements. It is estimated that 95% of the structure could be recovered and reused. Advantages include:

- Industrially produced, large elements can be deconstructed in a reversed construction process, resulting in even more finished/ larger elements. Fast and rational deconstruction is possible.
- Knowledge and logistics are already in place for the prefabricated system with its efficient transport and assembly methods. Deconstruction and reuse, as well as quality control and possible repair works, can be worked into the business model if there are incentives to do so.
- Lifting of wall and floor elements is planned. They have existing positions for lifting devices and can be lifted in the same way as during the original construction.
- Few, common tools are needed, such as drill, saw and electric screwdriver. As the elements are large, a crane will be needed for lifting, which is already part of the construction process.
- Services and membranes are accessible after the (relatively easy) removal of the plasterboard. Services and membranes as well as insulation can then be replaced, repaired or altered.

We also identified factors that complicate deconstruction and reuse, and in the following table propose solutions for the most important ones:

Table 1 Factors that complicate deconstruction and reuse and proposed solutions

Factors that complicate deconstruction	Proposed solutions
Nailed connections are irreversible and it could be difficult to remove nails without damaging the wood. The process could be labour intensive.	Nails could be replaced with screws in all on-site works.
75 different types of wall panel are present. Highly specific wall panels have limited reuse potential, should they not be reused in exactly the same building. In addition, room layouts are often not adaptable for different use scenarios.	Wall panels could be standardised to come in fewer different configurations, e.g. the panel height could be made the same on all floors and walls could have lengths that are multiples of 600 mm. Room layouts should be adaptable for different uses.
Not prescribed connectors might be used by the assembly team, which would complicate deconstruction and pose a health and safety risk.	A deconstruction plan should specify the position of all fasteners. During construction, a protocol should enforce workers to record additional fasteners.
Verification of assembled elements according to building regulations would be needed before mass-reuse is possible. The reuse of elements needs to be negotiated with insurance providers.	Initially recovered elements should be tested. From these results a protocol should be developed for visual and factory assessment of recovered parts.

Conclusions

Deconstruction and reuse of building elements from modern UK timber frame houses might already be feasible with conventional designs. Up to 95% of the timber structure can be recovered and reused, and small adaptations of the design would facilitate recovery and open more reuse possibilities. If companies had the intention to reuse houses when they are planning and building them, most obstacles that complicate deconstruction and reuse would fall into place effortlessly.

References

Bertino, G. et al. (2021). Fundamentals of Building Deconstruction as a Circular Economy Strategy for the Reuse of Construction Materials. Applied Sciences 11(3), p. 939. doi:10.3390/app11030939.

Cramer, M. and Ridley-Ellis, D. (2020a). A case study of timber demolition recycling in the UK. WSE 2020, Helsinki.

Cramer, M. and Ridley-Ellis, D. (2020b). A shed resource: A look at timber recycling in the UK. Timber 2020. Available at: https://www.infuturewood.info/wp-content/uploads/2020/11/Cramer-Timber2020-Wood-Recycling.pdf.

Lancashire, R. and Taylor, L. (2012). Timber frame construction: designing for high performance. High Wycomb. Timber research and development Association.

Niu, Y. et al. (2021). Prolonging life cycles of construction materials and combating climate change by cascading: The case of reusing timber in Finland. Resources, Conservation and Recycling 170, p. 105555. doi: 10.1016/j.resconrec.2021.105555.