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The climate emergency calls for urgent measures to minimize the harmful effects of the building sector. Where possible, reducing high-impact materials and building with wood and other bio-based materials help reduce harmful emissions and the use of mineral-based materials while increasing carbon sequestration. As a result, the interest in using bio-based materials, and especially wood, in construction has increased. Wood is a renewable material with high strength to weight ratio that has been utilized since ancient times, including in many global indigenous building cultures.

However, increasing the use of wood in construction is challenging because a dramatic rise in timber construction would lead to a global timber shortage. This calls for building better with timber and elevating reclaimed wood to use in construction wherever possible.

Over the last few years, the Royal Danish Academy has been experimenting with several projects that investigate the design potential for reclaimed wood, focusing specifically on loadbearing applications. *Nordic Waste Wood for Good* (Larsen O.P, Browne X., 2022) examined how different wood waste streams can be utilized for creating façade elements. Developed through a series of hands-on workshops in the Nordic countries, the project's main aim was to present the potential for the reuse of materials generally discarded as waste. Over 200 participants from Sweden, Finland, and Denmark showcased versatile designs and opportunities for further use of different wood waste streams.

The current collaborative efforts between DTU and the Royal Danish Academy focus on how to facilitate the structural use of reclaimed wood. Currently, due to premature demolition and the discarding of wood deemed unfit for

construction, there are large quantities of material coming from different timber waste streams that offer opportunities to utilize wood otherwise considered scrap. For example, in Europe, 16Mt of construction and demolition wood waste is produced annually (Vis M, et al. 2016).

Wood is an anisotropic material and building timber structures with reclaimed wood is a complex and challenging process. Using reclaimed wood requires determining its properties and ensuring structural safety. StructuralReuse researchers at DTU, as part of the Grand Solution project, investigated different non-destructive test (NDT) methods for the classification of structural wood for reuse. Preliminary results of the NDTs have shown that the variations in properties over the length of the timber can be captured by these tests, leading to a highly specified definition of strength classes. Since the lowest grade of timber determines its overall classification, segmenting the timber into smaller units based on the classification enables the use of every specimen at the highest level in structures such as gridshells.

Waste Wood Canopy (Browne X, Larsen O.P, Castriotto, C. 2021) was a full-scale demonstrator evaluating the viability of using discarded wood for loadbearing structures at an architectural scale. A full-scale prototype was developed and constructed from short elements utilizing Reciprocal Frame (RF) principles in a small timber gridshell structure. The short-offset RF timber members were joined using a timber clamp connection developed for the project that reduced the number of steel connections. The project also explored aspects of robustness through structural redundancy and optimization of structural behavior, buildability, and overall architecture.

A current PhD project investigates the potential use of reclaimed wood for construction, where the wood's defects provide design agency. The main research focus is on exploring new approaches to architecture that hold the capacity to offer undervalued timber a longer life. By building on wood's existing material culture, the project formalizes new concepts through the realization and evaluation of prototypes.

The effort included the development and construction of *Wood ReFramed*, a full-scale pavilion designed as a series of portal frames made up of trusses, which was constructed

for the UIA World Congress of Architects in 2023. The structural frames incorporated the same architectural language, yet integrated a variety of tones and geometries, with the pavilion frames' structural capacity demonstrated by a hanging amphitheatre.

Through a combination of *research by design* (qualitative) and positivistic (quantitative) methods, the study proposes new circular approaches for implementing waste wood in building design. (Browne X. , Larsen O.P., 2022)

Though challenging, through collaboration we can find ways to maximize the reuse of wood in construction. The innovation of using NDTs to classify the variability in timber properties across its length allows it to be segmented into smaller units based on their most favorable properties. The gridshell structure can then be designed and optimized to use the strongest pieces where needed. This approach enables us to fully realize the potential of the timber we have.

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