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Sustainable design concepts for short span, timber-only structures

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Abstract

The construction sector is one of the major contributors to greenhouse gas emission. Therefore, sustainability and more environmentally friendly structural concepts and structures structures are becoming increasingly relevant. Timber, as a natural grown building material, can play a key role in this process, in particular due to its large potential of reducing CO2 emissions. Currently, salvaged material from the fabrication process of engineered wood products or from construction processes is incinerated for energy recovery. Thus, the full environmental potential of timber has not yet been achieved.

In this study, a novel, low-tech design concept for short span structures is introduced. The structural system is entirely based on wooden products, including salvaged material. Individual timber boards with uniform or variable dimensions are connected with hardwood nails to load bearing members. At present, the used hardwood nails contain a minimum amount of adhesive, which is attributed to the production process, but in the long run, the project is aiming for timber-only structures.

This paper presents a range of design proposals for different batches of salvaged materials having different dimensions. Our approach is driven by the following three guiding aspects: firstly by the limitation of the possible timber board patterns, which result from the used material; secondly by the assembly process, which aims for the ease of use and its robustness against assembly-errors; thirdly by the arrangement of the nails, which allow for the highest possible grade of flexibility in design and material use and which respect the aforementioned aspects.

Experimental investigations of the connection between adjacent timber boards using hardwood nails have been performed. Due to the variable dimensions of salvaged material a wide range of hardwood nails and different nails patterns have been investigated. Based on the results of the experimental investigations, the main findings, which are relevant for the above mentioned guiding aspects, are summarized and discussed. The application of the design concept is exemplified in a natural trail path containing short span bridges in the Kouvola region in southern Finland.