Design, development and validation of construction elements made of composite wood waste

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Summary

With increasing focus on recycling and circular economy in Europe, wood waste represents an important source for secondary raw materials. The wide variety of different wood types, applications and sources makes the wood waste, a very heterogeneous material from a recycling perspective. According to EUROSTAT data, in 2016, the EU28 countries generated more than 48 M tonnes of wood waste, of which 1.7 M tonnes refer to hazardous waste. According to the same source, in Portugal around 333 thousand tonnes of wood waste were generated in the same year, 474 tonnes of which refer to hazardous waste. It adds a much larger amount of burnt waste, without taking advantage of its potential. It is therefore necessary to look for innovative ways to reuse / recover this waste. A significant fraction of wood waste (e.g. from railways, buildings, fence posts and bridges) is contaminated. Most of this wood has been chemically treated (e.g. with CCA or creosote) to protect it from biological degradation, containing substances toxic to health and the environment. Currently, these wood residues are burned or sent to landfill, creating additional environmental problems related to the contamination of air, soil and aquifers. Within this context, this project intends to use wood fibres recycled from wooden elements in their end-of-life and from by-products of carpentries and sawmills to develop reinforced and non-reinforced recycled wood-fibre concrete composites to design prefabricated construction elements (structural and non-structural).

Wood cement panels began to be produced in n the 60s, due to the growing public concern about the health hazards associated with the use of asbestos. Only very recently, the possibility of using alternative wood resources begin to be investigated, raising new technological challenges. Concrete and wood component mixtures, known as wood-concrete compounds, could help answer the challenge of a more sustainable concrete-based construction. By-products of the wood-use chain will be used to create a lightweight, cheap and greener construction material that has further benefits in terms of buildings 'physical properties. The composite, will be made from wood fibres recycled from wooden elements in their end-of-life and from sub-products of carpentries and sawmills. The composition of the cement composites will be defined, and the compatibility between the wood waste and cement binders will be studied. The physical, mechanical and environmental performance of the new composites will be evaluated via laboratory tests. Additionally, accelerated aging tests, will be used to assess durability. Leaching tests will be further performed to evaluate the potential release of dangerous substances. Non-structural elements include panels for internal partitions (modular internal walls), and floor coverings. Structural elements will mostly be beams and columns, which can be combined with non-structural or with other structural elements. Such combinations of elements will result in buildings/constructions for specific uses.

The prefabricated elements will be optimised by first predicting their performance using numerical models to simulate the mechanical behaviour (structural components), and physical features such as hygrothermal and acoustical performance (non-structural components). A comparative life cycle assessment (LCA) against other solutions will allow characterisation of the environmental performance of the new elements. Then the real behaviour of the elements (mechanical, acoustic, thermal) and their durability will be monitored in laboratory conditions using real scale models.

Keywords

Sustainability, sustainable construction, wood recycling, wood-cement compound, sawdust, wood shavings, wood chip concrete.