

Life cycle assessment of timber structures: a cradle-to-grave perspective

Summary

The increasing concern for the environment has led to a worldwide increase of initiatives that promote the reduction of the environmental impacts of products and services used by Society. In Europe, the construction sector is responsible for approximately 40% of total energy consumption and 36% of carbon dioxide emissions into the atmosphere. It is therefore important that decision-making in this sector takes into account the environmental impacts of products and services. Life Cycle Assessment (LCA) is a methodology regulated by Global and European standards that intends to quantify the environmental impacts of products and services. It has been used in scientific and industrial studies to quantify and compare the environmental impacts of various products and construction solutions. Some of these studies have identified environmental benefits from the use of woodbased products in construction, mainly due to the carbon dioxide captured during the growth phase of the trees. In this context, this study intends to apply the LCA methodology to the Portuguese reality of construction with wood-based products, through the following objectives: i) identification of the LCA procedures that must be followed to perform a LCA study of woodbased structural and durability solutions, ii) identification of the structural and durability design procedures of wood-based structures, iii) definition of the methods for comparison of products and solutions based on structural and durability equivalence units, iv) comparison of the environmental impacts of roundwood of various wood species, countries of origin and forest management, v) comparison of the environmental impacts of various structural products and solutions for a residential floor, vi) comparison of the environmental impacts of various durability solutions for a deck floor, vii) identification of the environmental hotspots during the life cycle of wood-based structural and durability solutions, and viii) analysis of the influence of variations of LCA approaches on environmental impacts of various solutions.

In this study, the quantification of environmental impacts of wood-based products through LCA methodology was performed following the procedures recommended by the Global and European standards (mainly ISO 14040, ISO 14044, EN 15804, and EN 16485). The structural and durability design of wood products followed the rules given by the standards EN 1990, EN 1991, EN 1995 and EN 350. The methods developed for the comparison of structural products were based on the methods for determining the strength classes defined by EN 14081-1 (visual and mechanical) and bending strength and modulus of elasticity. The methods for comparison of structural and durability solutions followed the European design standards. The comparison of roundwood analysed the environmental impacts of: Maritime pine (*Pinus Pinaster*), Cryptomeria (*Cryptomeria Japonica*), Eucalyptus (*Eucalyptus globulus*), Scots pine (*Pinus Sylvestris*), and Norway spruce (*Picea Abies*); from Portugal, Sweden and Germany; and with different forest management models. Cryptomeria was the wood species that showed the lowest environmental impact on the majority of the environmental categories. Eucalyptus was the wood species that presented the highest environmental impacts. German management models showed higher environmental impacts than Swedish models. As regards the Maritime pine, the forest management model that considers natural regeneration of the trees had the lowest environmental impacts. Finally, the analysis of the influence of LCA procedures on the results identified that the volumetric allocation led to a lower environmental impact of roundwood and sawnwood. The choice of different databases for inventory influences mainly the impacts related to fuel production and consumption.

Keywords

Life Cycle Assessment (LCA), timber structures, sawnwood, glued laminated timber, laminated veneer lumber, I-joists beams.



Example of forest operations of Maritime pine roundwood production.



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