Life Cycle Assessment of Timber Bridges: A case study

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Abstract

Sustainability of bridges can be evaluated by using Life Cycle Assessment (LCA) methodology, which focuses on the potential environmental impacts of a product or project during its life cycle. The impacts are quantitatively evaluated from actions during the life cycle of a bridge, including material production, transport and energy consumption. This paper shows how in principle the LCA can be applied for analysing the sustainability of timber bridges, and conducts the case study of a timber pedestrian bridge. The case study includes five major environmental impact categories, in which it displays that Freshwater Eutrophication Potential has the highest normalised value and material production stage takes the biggest share of all five impact categories in the life cycle of the bridge. In addition, renewable biomass is the largest energy source of timber material. Thus, to some extent, it confirms the sustainability of timber bridge applications.

Keywords: sustainability; Life Cycle Assessment; timber bridges; maintenance actions; environmental impact.

1 Introduction

At present, buildings and structures shall be designed durable in their whole lifespan, also taking account of the environmental aspect. This paper studies only timber bridges, since timber is commonly considered as green material compared with concrete or steel.

To evaluate environmental performance of the building in its lifespan, Life Cycle Assessment (LCA) methodology is applied. LCA is a technique to evaluate environmental impacts of a product during its life from cradle to grave. In 1997, the International Organization for Standardization (ISO) published the first ISO 14040 standard for LCA and the second one followed in 2006 [1, 2]. These standards provide principles and framework of conducting LCA for practitioners.

When conducting LCA for a bridge, four stages shall be considered: production of bridge materials and components; transportation to the bridge site and construction of the bridge; operation and maintenance during the service life of the bridge; and End-of-Life (EoL) including demolition and material recycling. Environmental impact indicators of LCA comprise two types: midpoint and endpoint. This study only considers midpoint indicators including global warming potential, acidification potential, and others.

To estimate the operation and maintenance actions closer to real bridge applications, maintenance records of existing timber bridges were collected and analysed. The records were obtained from bridge register of Finnish Transport Agency. A case study of LCA was conducted with applying the collected empirical records. In the case study, distribution of energy consumption among different construction materials and

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